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RELATIONSHIPS BETWEEN DIET AND GROWTH IN RAINBOW TROUT *(Salmo gairdneri)*, BROOK TROUT *(Salvelinus fontinalis)*, AND BROWN TROUT *(Salmo trutta)*.

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RELATIONSHIPS BETWEEN DIET AND GROWTH IN RAINBOW TROUT (SALMO GAIRDNERI), BROOK TROUT (SALVELINUS FONTINALIS), AND BROWN TROUT (SALMO TRUTTA)[1]

By Gaylord R. Alexander and Howard Gowing

ABSTRACT

Samples of trout were collected periodically from several lakes, ponds, and streams during their major growing season in the northern Lower Peninsula of Michigan. Stomach contents were examined to determine the kind, number, and volume of organisms present. Data were stratified by the age of the trout.

The mean quantity of food per stomach had a significant direct relationship with annual trout growth irrespective of species of trout, habitat (lake or stream), genetics (wild or hatchery), and age class. The regression accounted for 80.6% of the total variation. Since trout show extreme variability in their diet in most habitats, quantity, not quality, is the most important factor determining growth. The great difference between mean volume of food in stomachs and the potential capacity of their stomach indicate feeding in most environments is at a low level.

Empirical diet, in contrast to the real diet, tends to underestimate annelids, fish, and amphibians, and overestimate crustaceans and most insects. In adjusting for caloric content, fish become more important while crustaceans and insects diminish in importance.

Quantity of food in the stomachs of trout from streams is more variable than in trout from lakes. In lake habitats, forage fish comprise the single largest category in the diet, followed by crustaceans, and combined insects. In streams the trout diet was comprised of 50% annelids, 20% insects, 15% forage fish, and the balance molluscs, crustacea, terrestrial organisms, and unidentifiable material. Worms and terrestrial organisms make a greater contribution to the diet of trout in small streams than in large streams. Trout in large streams are more dependent on food produced within the stream whereas in small streams a greater amount of food originates outside the stream.

Experimentally, the stomach evacuation rate for trout varies with the kind of food organism and with temperature. The ratio of instantaneous stomach volume to daily ration is about 1:3. The observed (empirical) diet of trout was adjusted for taxa, temperature, and caloric content. Gastric evacuation rates can significantly alter the observed diet. Temperature corrections are minor in our environments but could be significant in marginal waters.

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[1] Contribution from Dingell-Johnson Project F-35-R, Michigan.

Introduction

Over the geographic range of trout, growth varies widely and, in fact, considerable differences in growth can be found within relatively small geographical areas. Biologists have attributed these growth differences to variables such as water temperature, food supply, and genetic differences in trout stocks. Little doubt exists that trout growth is directly related to the amount of food consumed. Under laboratory conditions, Baldwin (1956) demonstrated that brook trout growth was directly correlated to the amount of food eaten and that the amount of food eaten was related to water temperatures.

Our study seeks to answer three principal questions: (1) are the observed growth differences for trout in the natural environments of northern Lower Michigan mainly due to the quality or to the kinds of food consumed; (2) what is the relationship between volume of food per trout stomach which we observed and the trout's real daily ration; and (3) what is the composition of the trout diet in various habitats and its significance.

Methods

Trout diet and growth in 15 ponds, lakes, and streams in Michigan's northern Lower Peninsula were analyzed. Diet analysis was done for three species of trout collected over the major part of their growing season, from the last Saturday in April to mid-September which coincided with Michigan's regular trout fishing season. For most environments we divided the fishing season into ten consecutive, biweekly sampling periods but in others we sampled on a monthly basis (May-September). Most fish were sampled by angling, except some of the fish from East Fish Lake and Fuller Pond were captured by gill nets during the latter years of the study. Also, the Hunt Creek samples of trout were taken by electrofishing during the years 1971-1974.

The stomach was removed from the trout by cutting out the gills, stomach, and intestines as one unit. This viscera was then preserved in a 10% formalin solution with a waterproof identification tag inserted in the esophagus. After a period of preservation to harden the viscera, the stomach was cut open and the contents and tag transferred to a vial containing 70% alcohol. Subsequent analyses consisted of sorting, counting, and measuring the volumes of various taxonomic groups of food by liquid displacement. For the purposes of this investigation, 1 ml is equivalent to 1 g net weight (Ball 1948).

The mean volume of food present per trout stomach was calculated for each of the sampling periods. The mean stomach-volume index for the entire growing season was then determined by averaging these means. Thus, samples throughout the growing season received equal weight in the index. This parameter was compared with the annual growth increments for trout in the various waters studied.

Annual growth of wild trout in streams was determined from population estimates of the trout as described by Shetter (1957). In general, the procedure was to calculate the trout population size by inch classes, and the proportion of fish belonging to various age classes was determined from scale readings. In this manner the number and average size of trout in a particular age class were determined. Growth during a particular year of life was the difference in average weight of two consecutive age classes.

Growth of wild trout in ponds was determined from back-calculations derived from scale readings. Hatchery trout stocked in ponds were of known age because all had been fin clipped. Therefore, growth increments were determined simply by comparing the annual change in average weight.

Laboratory feeding tests were conducted to determine the relative gastric evacuation rates of various kinds of food from trout stomachs and the effects of water temperature on these evacuation rates (Alexander 1975a). The procedure was to force-feed equal amounts, by weight, of fish flesh (minnows) and invertebrates (such as insects). Trout were held in aquaria for either 12 or 24 hours, then sacrificed and dissected to determine the amounts of undigested food. In other tests, fish flesh was force-fed to trout held at various water temperatures. After periods of 24, 48, and 72 hours trout were sacrificed and dissected to determine amounts undigested.

Results

Mean stomach content and growth

Annual gains in growth of trout varied from a low of 17 g to a high of 795 g for the array of 15 habitats studied (Table 1). The average volume of food per trout stomach also varied widely, from 0.2 ml to 8.0 ml. For some environments, certain years were pooled in Table 1 because they either shared a uniform stocking density, angling regulation, or habitat alteration.

Separate regressions of mean stomach volume on annual growth increments were calculated for the following strata: species of trout, lake or stream fish, stocks of wild or hatchery trout, and age class. No significant differences in the regressions were found. Therefore, all strata were pooled and a single regression was calculated:

$$\text{Mean stomach volume} = 0.34076 + 0.00935\ (\text{annual weight gain in grams})$$

Ninety-five percent confidence limits were:

$$\pm 2\left(0.72521 \sqrt{0.02041 + \frac{(\text{annual gain} - 155.27)^2}{1,180,892}}\right)$$

The average quantity of food per stomach was linearly related to annual trout growth (Fig. 1). The correlation coefficient (r) was 0.898; the coefficient of determination (r^2) was 80.7%.

The taxonomic composition of foods found in trout stomachs is shown in Table 2. Under Annelida are two principal classes: Oligochaeta (aquatic earthworms) and Hirudinea (leeches). The former were found mostly in the diet of trout in streams and the latter in the diet of trout in lakes. It is evident that much variability exists in the diet of trout in the various habitats. From this it may be concluded that quantity, not quality, of food is the overriding factor determining growth in these natural environments. On the other hand, we know that certain trout foods have properties that make them better than others. For example, Alexander (1975a) has shown that the gastric digestion rates are different for various kinds of trout food (Table 3). Other investigators (Hess and Rainwater

1939; Seaburg and Moyle 1964; Schneider 1973) have reported similar differences. Further, Cummins and Wuycheck (1971), Warren and Davis (1967), and Kelso (1973) have shown that the caloric content of various fish foods is variable (Table 4). One might ask why the importance of food quality is not evident in these data. We believe these trout, and probably trout in most natural environments (not only in Michigan but elsewhere), are feeding at such a low level compared to their real potential that quality is not manifested. For example, in our study the mean stomach volume of food of stream trout was only 1.2 ml; 2.2 ml for lake fish. For comparison, we have compiled Table 5 which we believe to be the maximum stomach capacity of various sizes of trout. These estimates are extrapolated from consumption rates of experimental rainbow trout fed all they wanted to eat during a 2-month period. Obviously, the food volumes present in trout stomachs in these natural environments are substantially below their potential capacity.

Monthly mean stomach volumes of food were tabulated in Table 6. Note that the quantity of food per stomach is more variable in stream trout than in trout from lakes. Generally, stomachs contain the most food in June and the least amount in August. This seasonal periodicity in food volumes corresponds closely with seasonal periodicity in growth of stream trout (Cooper 1953; Horton 1961), and also fishing success.

Daily ration vs. mean volume of food in the stomach

It is important to know the relationship between the instantaneous food content of a trout's stomach and its daily ration. This information would be of great value in reconstructing the total annual consumption for an individual trout or a population of trout. The following procedures were used to estimate this relationship. At the outset we assumed that the growing season for trout is about 6 months long (May-October) or 180 days (Alexander and Shetter 1969). From Figure 1 we used the average instantaneous volume of food of 8.00 ml which results in an annual growth increment of 800 g. If we use an average conversion ratio of food to trout flesh of about 5:1 (Richardson 1921; Schneider 1973) then the food consumed by a trout for the entire growing season is 4,000 g per growing season (800 × 5). This amounts to a daily ration of 22.2 g. Thus the relationship between instantaneous stomach volume and daily ration in this example is 8 to 22.2 or 36%, an average ratio of about 1:3 for the season. As the intercept for the regression is not zero, the ratio of observed volume of food to estimated daily ration is reduced slightly below 1:3 if smaller volumes of food are used. For example, a ratio of 1:25 (40%) would be obtained if the 2.2 ml mean volume observed in all lakes is used. Also, this relationship may change seasonally with water temperature.

Composition of diet

The trout in these habitats show considerable variation in diet (Table 2). Apparently they exercise little selectivity but consume whatever organism is vulnerable.

As indicated above, the observed contents of the trout stomach may not accurately reflect the real diet because we know that the gastric evacuation rate of food from the stomach varies with the types of food (taxa) and with water temperature (Hathaway 1927; Molnar and Tolg 1962; Brett 1970; and Noble 1972). Therefore, to determine the trout's real diet we need to adjust the observed diet.

In Table 3 we arbitrarily designated the evacuation rate for fish flesh (minnows) as unity and compared the gastric evacuation rates of all other food to this. For example, oligochaetes evacuate much faster than fish, insects only half as fast, on the average, and adult crayfish much slower.

Furthermore, we know that gastric evacuation is fastest in trout at about 55-58 F. Therefore we considered the evacuation rate in this temperature range to be 1.00 and compared it with rates at other temperatures. We determined, for example, that evacuation is only 0.88 as fast at 65 F, 0.77 as fast at 45 F, and 0.41 as fast at 35 F as at 57 F (Alexander, unpublished). The data in Table 7 are presented to show how a portion of the empirical diet of brook trout from the North

Branch of the Au Sable River was adjusted to arrive at the real value of the dietary components. After the real diet composition is derived by using the correction for differential evacuation rates (interpolated from curve of observed values), this diet also should be adjusted for relative energy content of the various foods (Table 4) to assess its true dietary value.

From the example, it is evident that the correction for gastric evacuation rate is very important and changes the interpretation of the observed diet significantly. The correction for temperature has only a minor effect in our data because we dealt with good trout habitats having water temperatures near the optimal level. In environments where trout would be forced to live in waters of marginal temperatures, then the temperature correction factor could be significant. In making temperature corrections in our data for trout in lakes, we assumed that trout digest their food at water temperatures near the optimum. We know that trout in lakes forage in the littoral and surface waters which may be warm, but these forays are probably of short duration and trout actually spend most of their time in the deeper zone of the lake where water temperatures are optimal or preferred. We have observed on sonar instruments that most trout (and salmon) will be "marked" in zones having water temperatures near 55 F and this includes the Great Lakes. Also, it has been observed that trout tend to congregate in cold seepage areas of marginal streams as water temperatures increase during July and August (Shetter 1937).

The estimated percentage composition of the real diets of trout in several habitats is shown in Tables 8a, 8b, and 8c and the caloric value, percentage wise, of this food consumed by trout is shown in Tables 9a, 9b, and 9c. Figures 2 and 3 graphically illustrate the average diet relationships. The main differences between the empirical and estimated real diet are that the former underestimates the importance of Annelida, fish and amphibia, but overestimates Crustacea, Odonata, Hemiptera, Coleoptera, Trichoptera, and terrestrial organisms. The principal differences between the empirical and caloric diets are that the former also underestimates the value of Annelida, fish, and Amphibia whereas it overestimates values for Mollusca, Crustacea, Odonata, Hemiptera, Coleoptera, Diptera, and terrestrials.

The real diet composition varies considerably between trout living in lakes and trout in streams. In lake habitats forage fish comprise the highest single category in the diet (26%) followed by Crustacea (24%). All insects, when combined, comprised 32%. The most important insect order is Diptera, followed by Ephemeroptera. The remaining 18% of the diet is composed of annelids, molluscans, amphibians, terrestrial organisms, and unidentifiable material. By contrast, annelids constitute 50% of the diet of trout in streams. Insects contribute about 20%, forage fish 15%, and molluscans, crustaceans, terrestrial organisms, and unidentifiable material make up the balance.

Trout diet also varies considerably within the habitat type. For example, in Hunt Creek during one study covering several years, annelids made up over 80% of the brook trout diet, whereas brook trout in the North Branch of the Au Sable River had only a 6% diet of annelids. In streams annelids usually comprise about 50% of the real diet, on the average. We believe that, in general, worms and terrestrial organisms make a greater contribution to the diet of trout in small streams than in large streams because of the "edge effect." Trout in large streams are more dependent on foods produced within the stream; about 10% of the food originates outside the system compared to 54% for small streams.

Generally, anglers have a distorted picture of a trout's real diet. For example, many anglers believe stoneflies contribute significantly to the diet of trout when in fact in streams their contribution is less than 1% and in lakes it is almost naught. Many fly fishermen tend to underestimate the importance of worms and forage fish.

The trout diet also varies considerably between one lake and another. The crustacean component is most variable. In the deeper and generally larger lakes, planktonic crustaceans (mostly cladocerans) are commonly the predominant crustacean in the diet, whereas in shallow and generally smaller lakes and ponds the crayfish is dominant. The forage fish component of the trout's diet in lakes is also quite variable, but part of this comes about because of periodic chemical treatment of lakes to rid them of competing fish populations. This of course reduces forage fish abundance. However, the removal of all competing fish from lakes, including forage fish, generally enhances trout production by reducing competition for foods of the lower trophic level (Alexander 1975b and 1975c).

Discussion

Management considerations and observations

Trout growth in most environments is dependent primarily upon the quantity of food ingested. The quality of the food item, i.e., foods with high gastric evacuation rates, become important only at high feeding levels. If an environment produces large quantities of quality foods then trout growth may be increased significantly through manipulation of stocking rates. By limiting trout numbers, fewer but larger fish can be grown. These are the waters which produce trophy trout. On the other hand, if the environment produces mostly poor quality foods then individual trout growth will be relatively slow and greatest trout production can be achieved only at comparatively high trout densities. Manipulation of trout food supplies by replacing poor food types with higher quality foods could result in greater trout production. Likewise, the replacement of food types with low availability and utilization with food types of high availability and utilization could also result in production gains. Another aspect to consider is the shorter the food chain, the more efficient is food production. In view of the relatively low daily rations of trout in most natural environments, the greatest overall gains could be made simply by increasing the production of all good types.

Trout growth is directly related to food ingested irrespective of species or habitat type. Rainbow trout generally grow better than brook trout and some strains of brook trout grow better than others. This is so because they eat more food per day and/or are more efficient converters of food to fish flesh. It could be simply a genetic factor influencing the appetite level, or that the faster growing species and strains are more efficient foragers. Behavioral characteristics also could limit food intake because some fish have a very limited forage territory.

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Table 1.--Mean volume (ml) of food in stomachs and annual growth (g) of trout in their second and third growing season

(Species and origin: Rainbow, R; brook S; brown, B; hatchery, H; and wild, W)

Location, species and year	Number of trout	Mean volume of food in stomachs	Weight (age I or II)	Weight (age II or III)	Annual gain
		Second growing season, age I to II			
Fuller Pond					
RH 1966-1967	132	1.7	27	204	177
Sage Lake					
RH 1964-1965	95	1.9	59	304	245
W. Lost Lake					
SH 1966	54	0.3	29	65	36
Ford Lake					
SH 1966	50	0.2	29	46	17
Lost Lake					
SH 1966	47	0.4	29	70	41
S. Twin Lake					
SH 1966	38	0.3	29	141	112
Hemlock Lake					
SH 1966	26	0.3	29	135	106
N. Twin Lake					
SH 1966	23	1.1	29	202	173
Hunt Creek (ZA)					
SW 1971-1974	393	0.6	6	35	29
Hunt Creek (BC)					
SW 1971-1974	388	0.5	6	32	26
		Third growing season, age II to III			
E. Fish Lake					
RH 1959-1963	677	8.0	104	794	690
1964-1965	248	6.4	104	899	795
1966	102	4.9	104	490	386
1967	97	2.6	104	327	223
1968	94	1.1	104	245	141
1969	103	1.4	104	200	96
1973	39	5.5	104	463	359

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Table 1.--continued

Location, species and year		Number of trout	Mean volume of food in stomachs	Weight (age I or II)	Weight (age II or III)	Annual gain
		Third growing season, cont.				
E. Fish Lake						
SH	1959-1963	162	2.7	114	481	367
	1964-1965	64	4.3	114	409	295
	1966	64	2.2	114	277	163
	1967	43	2.4	114	222	108
	1968	35	1.9	114	182	68
	1969	36	1.5	114	186	72
	1973	91	2.8	114	245	131
SW	1956-1965	68	2.0	132	300	168
Fuller Pond						
RH	1970	148	2.4	195	463	268
	1971	150	1.2	218	418	200
	1972	146	1.1	136	295	159
	1973	101	2.5	173	345	172
	1960-1965	363	3.0	104	395	291
SW	1958-1965	223	1.0	82	145	63
SH	1958-1967	229	2.0	232	386	154
BH	1965-1966	119	2.6	127	354	227
D Pond						
SW	1957-1960	98	1.0	54	163	109
W. Fish Lake						
RH	1965	50	0.7	114	154	40
BH	1965	34	1.1	114	209	95
Sutton Pond						
SW	1957-1965	52	0.7	36	68	32
Ford Lake						
SH	1966	17	0.3	167	177	10
Lost Lake						
SH	1966	22	0.8	71	84	14
S. Twin Lake						
SH	1966	18	0.3	117	215	98
Hemlock Lake						
SH	1966	26	0.5	99	206	107

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Table 1.--concluded

Location, species and year		Number of trout	Mean volume of food in stomachs	Weight (age I or II)	Weight (age II or III)	Annual gain
			Third growing season, cont.			
N. Twin Lake						
SH	1966	13	1.0	146	313	167
N. Br. Au Sable R.						
SW	1957-1965	88	1.0	50	127	77
BW	1957-1965	64	2.4	82	213	131
Hunt Creek (ZA)						
SW	1957-1960	626	0.9	35	72	37
SW	1971-1974	197	1.5	35	72	37
Hunt Creek (BC)						
SW	1957-1960	579	0.8	32	66	34
SW	1971-1974	202	1.0	32	66	34
Fuller Creek						
SW	1957-1960	268	0.9	36	64	28

Table 2.--The empirical diet (percentage by volume) of trout during their second and third growing season

(Species and origin: Rainbow, R; brook, S; brown, B; hatchery, H; and wild, W)

Location, species, and year		Annelida	Mollusca	Crustacea	Aquatic insects	Terrestrial insects	Fish	Amphibia	Other	Unidentified
				Second growing season						
Fuller Pond										
RH	1966-1967	0.0	1.1	29.5	18.2	3.8	43.1	0.4	1.4	2.5
Sage Lake										
RH	1964-1965	0.1	2.5	44.4	36.7	0.3	7.3	3.7	3.2	1.8
W. Lost Lake										
SH	1966	20.9	0.0	45.7	24.0	4.7	0.0	0.0	0.0	4.7
Ford Lake										
SH	1966	0.0	1.1	14.8	49.1	14.9	20.1	0.0	0.0	0.0
Lost Lake										
SH	1966	0.0	0.0	31.5	30.2	34.8	0.0	0.0	0.0	3.5
S. Twin Lake										
SH	1966	0.0	0.0	11.7	74.7	0.4	0.0	0.0	0.0	13.2
Hemlock Lake										
SH	1966	0.0	0.0	17.1	70.3	0.0	12.0	0.0	0.0	0.6
N. Twin Lake										
SH	1966	0.0	0.0	2.6	86.4	0.1	0.0	0.9	0.0	10.0
Hunt Creek (ZA)										
SW	1971-1974	60.3	2.1	0.2	26.2	3.5	2.3	0.5	0.3	4.6
Hunt Creek (BC)										
SW	1971-1974	46.1	1.6	0.4	31.3	10.7	2.5	0.2	0.6	6.6
				Third growing season						
E. Fish Lake										
RH	1959-1963	0.2	tr	48.9	48.1	0.1	1.9	tr	0.2	0.6
	1964-1965	tr	0.0	37.3	49.5	0.1	10.6	0.0	0.4	2.1
	1966	0.0	0.1	65.5	25.1	0.2	8.4	0.0	0.0	0.7
	1967	0.0	0.0	77.8	13.9	0.9	6.2	0.0	0.0	1.2
	1968	0.3	0.2	73.7	16.2	1.9	2.8	0.0	0.0	4.9
	1969	0.0	0.4	32.8	52.7	5.5	3.6	0.0	0.0	5.0
	1973	0.0	0.3	15.6	20.6	2.7	60.0	0.0	0.0	0.8

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Table 2.--continued

Location, species, and year	Annelida	Mollusca	Crustacea	Aquatic insects 1/	Terrestrial insects	Fish	Amphibia	Other	Unidentified
				Third growing season, cont.					
E. Fish Lake									
SH 1959-1963	0.0	tr	38.3	39.7	0.1	17.2	1.6	1.0	2.1
1964-1965	0.0	tr	15.3	45.3	0.1	37.4	0.0	0.4	1.5
1966	0.0	0.0	29.4	22.1	0.1	47.4	0.0	0.0	1.0
1967	0.0	0.0	28.4	42.6	9.5	8.9	0.0	tr	10.6
1968	0.0	0.2	17.2	32.5	19.4	26.7	0.0	0.0	4.0
1969	0.0	0.5	20.4	18.1	6.7	51.8	0.0	0.0	2.5
1973	0.0	tr	7.8	13.1	2.9	74.9	tr	0.0	1.3
SW 1956-1965	0.0	0.0	33.2	52.2	0.5	9.9	0.0	2.3	1.9
Fuller Pond									
RH 1970	0.9	53.3	0.5	30.9	0.5	0.6	1.8	0.2	11.3
1971	2.6	10.1	0.3	49.7	0.4	19.0	6.8	0.1	11.0
1972	0.7	4.1	9.0	41.4	2.5	26.1	1.5	0.1	14.6
1973	0.2	6.1	65.3	14.1	1.0	7.8	1.4	0.0	4.1
SW 1958-1965	0.0	7.0	11.4	40.0	1.7	25.2	2.0	6.0	6.7
SH 1958-1967	0.1	12.7	25.6	23.7	0.8	13.9	1.0	19.4	2.8
BH 1965-1966	0.0	11.0	35.5	10.7	0.2	40.0	0.6	1.8	0.2
D Pond									
SW 1957-1960	1.2	3.1	2.1	32.9	9.0	42.7	1.4	6.4	1.2
W. Fish Lake									
RH 1965	0.5	0.0	8.1	19.0	41.6	0.7	3.2	13.8	13.1
BH 1965	0.0	0.0	22.0	55.5	0.4	3.7	10.8	2.8	4.8
Sutton Pond									
SW 1957-1965	3.0	4.8	8.9	62.4	11.8	1.2	6.8	0.0	1.1
Ford Lake									
SH 1966	0.0	1.2	0.0	39.7	10.5	14.9	0.0	33.1	0.6
Lost Lake									
SH 1966	6.2	0.0	29.1	30.3	18.2	0.0	2.6	0.0	13.6
S. Twin Lake									
SH 1966	0.0	0.0	52.1	45.4	0.5	0.0	0.0	0.0	2.0
Hemlock Lake									
SH 1966	0.0	0.0	10.2	68.6	0.0	20.1	0.0	0.0	1.1

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Table 2.--concluded

Location, species, and year		Annelida	Mollusca	Crustacea	Aquatic insects [1]	Terrestrial insects	Fish	Amphibia	Other	Unidentified
					Third growing season, cont.					
N. Twin Lake										
SH	1966	0.0	0.0	70.5	28.2	1.3	0.0	0.0	0.0	0.0
N. Br. Au Sable R.										
SW	1957-1965	5.4	4.9	9.7	57.6	4.4	8.0	0.3	1.6	8.1
BW	1957-1965	2.3	1.5	12.9	35.7	3.2	33.3	0.0	1.4	9.7
Hunt Creek (ZA)										
SW	1957-1960	15.5	0.4	0.7	38.2	15.5	10.3	0.0	2.3	17.1
SW	1971-1974	54.8	1.3	10.7	17.6	5.7	4.5	1.4	0.0	4.0
Hunt Creek (BC)										
SW	1957-1960	17.1	1.4	4.7	27.1	11.5	15.5	1.2	4.4	17.1
SW	1971-1974	40.1	0.2	2.3	21.7	10.4	17.2	1.6	tr	6.5
Fuller Creek										
SW	1957-1960	16.3	0.4	15.2	24.5	14.4	8.5	0.9	4.6	15.2

[1] Aquatic insects include: Ephemeroptera, Plecoptera, Odonata, Hemiptera, Coleoptera, Trichoptera, and Diptera.

Table 3.--Relative gastric evacuation rates of various kinds of food in trout stomachs at 55 F, compared to minnows [1]

Kind of food	Rate
Minnows	1.00
Amphipoda	0.58
Isopoda	0.63
Cladocera	1.32
Decapoda: young of year	0.49
Decapoda: yearlings	0.17
Oligochaeta aquatic	1.68
Hirudinea	0.54
Gastropoda	0.66
Diptera: Tipulidae	0.86
Ephemeroptera	0.60
Trichoptera: with case	0.33
Odonata	0.21
Hemiptera	0.25
Coleoptera	0.17
Orthoptera: terrestrial	0.14
Salmon eggs	1.21
Percidae: darters	0.80

[1] Arbitrarily expressed as 1.00

Table 4.--Mean caloric values for some categories of trout foods (Data derived from Cummins and Wuycheck, 1971)

	Calories per gram dry weight	Calories per gram ash free dry weight	Calories per gram wet weight	Percent water
Annelida				
Oligochaeta	5,574	6,689	760	91
Hirudinea	5,443	6,532	760	81
Mollusca	2,024	5,675	430	82
Crustacea and Cladocera	5,133	5,504	392	81
Copepoda and Amphipoda	3,877	4,845	834	73
Isopoda and Decapoda	3,541	4,773	1,077	82
Insecta				
Ephemeroptera	5,469	6,553	1,124	85
Plecoptera	5,360	6,207	1,000	80
Odonata	5,117	5,898	1,023	80
Hemiptera	5,159	5,963	1,008	80
Coleoptera	5,371	5,908	1,074	80
Trichoptera	4,999	5,789	1,000	81
Diptera	4,269	5,527	612	80
Megaloptera	5,210	5,375	1,042	80
Terrestrial	5,274	5,673	2,008	68
Fish	5,191	5,296	1,493	89
Amphibia	5,813	5,933	1,493	89
Other	4,955	5,835	1,003	81
Unidentified	4,955	5,835	1,003	81

Table 5.--Maximum volumes of food observed in some trout stomachs and estimates of potential capacity based on daily voluntary feeding at excess levels (grams wet weight or milliliters preserved material, 80% alcohol)

Total trout length	Observed rainbow trout	Observed brook trout	Experimental rainbow trout[1]	Estimated potential
3.5	....	2.4	....	2.5
4.5	....	3.1	....	11.5
5.5	....	9.6	....	21.0
6.5	....	9.9	....	31.0
7.5	....	24.4	....	41.5
8.5	....	11.6	....	51.0
9.5	....	24.5	....	61.0
10.5	32.3	17.2	55.3	71.0
11.5	36.8	21.4	63.6	80.5
12.5	38.9	23.0	64.4	90.5
13.5	45.8	37.1	....	100.5
14.5	57.4	11.6	....	110.5
15.5	44.9	24.9	100.3	120.5
16.5	61.5	....	....	130.5
17.5	63.6	....	....	140.5
18.5	97.7	....	76.9	150.5
19.5	14.5	....	109.0	160.5
20.5	101.2	....	171.1	171.0
21.5	42.3	....	....	180.5
22.5	20.0	....	....	190.5
23.5	71.1	....	....	200.5
24.5	93.6	....	....	210.5
25.5	53.3	....	....	221.0

[1] Conditioned to feeding daily at maximum voluntary rates for 2 months and then sacrificed to determine volume of stomach contents.

Table 6.--Monthly mean volumes of food per trout stomach for fish in their second and third growing season

(Species and origin: Rainbow, R; brook, S; brown, B; hatchery, H; and wild, W)

Location, species and year	Mean stomach volume of food May	June	July	Aug	Sep	May - September
		Second growing season				
Fuller Pond						
RH 1966-1967	1.0	2.2	1.6	1.4	2.1	1.7
Sage Lake						
RH 1964-1965	2.8	3.6	1.0	0.7	1.4	1.9
W. Lost Lake						
SH 1966	0.1	0.4	0.1	0.4	0.6	0.3
Ford Lake						
SH 1966	0.2	0.2	0.1	0.2	0.2	0.2
Lost Lake						
SH 1966	0.1	0.3	0.1	0.3	1.4	0.4
S. Twin Lake						
SH 1966	0.3	0.1	0.4	0.2	0.3	0.3
Hemlock Lake						
SH 1966	0.1	0.6	0.3	0.3	0.3	0.3
N. Twin Lake						
SH 1966	0.5	0.4	0.8	0.2	3.8	1.1
Means (lakes and pond)	0.6	1.0	0.6	0.5	1.3	0.8
Hunt Creek (ZA)						
SW 1971-1974	0.5	1.0	0.7	0.5	0.3	0.6
Hunt Creek (BC)						
SW 1971-1974	0.6	0.8	0.5	0.4	0.3	0.5
Means (streams)	0.6	0.9	0.6	0.4	0.3	0.6
		Third growing season				
E. Fish Lake						
RH 1959-1963	8.0	10.8	6.4	5.5	9.3	8.0
1964-1965	6.1	10.6	5.8	3.3	6.2	6.4
1966	8.2	3.8	4.1	4.2	4.0	4.9
1967	2.6	1.4	2.0	3.2	3.8	2.6
1968	1.1	1.8	1.0	0.6	1.0	1.1
1969	1.0	2.8	1.2	1.0	1.0	1.4
1973	2.8	4.8	2.6	7.4	9.9	5.5

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Table 6.--continued

Location, species and year		Mean stomach volume of food May	June	July	Aug	Sep	May - September
		Third growing season, cont.					
E. Fish Lake							
SH	1959-1963	2.8	3.9	2.1	2.7	2.2	2.7
	1964-1965	3.7	5.7	5.3	3.9	3.1	4.3
	1966	2.1	2.2	1.8	1.2	3.7	2.2
	1967	1.3	1.7	4.9	1.2	2.9	2.4
	1968	1.8	2.8	2.5	0.6	...	1.9
	1969	3.9	1.3	0.8	1.2	0.2	1.5
	1973	1.7	2.9	1.6	4.9	...	2.8
SW	1956-1965	2.2	2.8	2.2	1.8	1.2	2.0
Fuller Pond							
RH	1970	2.2	1.8	2.2	2.5	3.5	2.4
	1971	0.8	1.0	1.5	1.8	0.8	1.2
	1972	0.5	1.0	1.0	1.2	1.7	1.1
	1973	1.2	1.2	5.1	1.7	3.2	2.5
	1960-1965	2.8	2.4	3.0	3.4	3.4	3.0
SW	1958-1965	1.8	1.0	0.8	0.6	0.8	1.0
SH	1958-1967	2.4	2.0	2.4	2.2	1.0	2.0
BH	1965-1966	2.4	3.2	2.0	2.7	2.6	2.6
D Pond							
SW	1957-1960	1.4	1.0	0.8	0.8	1.2	1.0
W. Fish Lake							
RH	1965	0.2	0.5	0.9	0.6	1.5	0.7
BH	1965	0.9	0.7	0.9	0.8	2.4	1.1
Sutton Pond							
SW	1957-1965	0.8	1.0	0.7	0.3	0.6	0.7
Ford Lake							
SH	1966	0.4	0.1	0.6	tr	0.5	0.3
Lost Lake							
SH	1966	0.7	1.0	0.7	0.2	1.2	0.8
S. Twin Lake							
SH	1966	tr	0.1	0.8	tr	0.6	0.3
Hemlock Lake							
SH	1966	0.8	0.3	0.6	0.4	0.3	0.5
N. Twin Lake							
SH	1966	...	2.7	0.2	0.2	...	1.0
Means (lakes and ponds)		2.2	2.5	2.1	2.0	2.4	2.2

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Table 6.--concluded

Location, species and year	Mean stomach volume of food May	June	July	Aug	Sep	May - September
	Third growing season, cont.					
N. Br. Au Sable R.						
SW 1957-1965	1.4	1.2	0.8	0.9	1.0	1.1
BW 1957-1965	3.2	3.2	2.4	1.0	2.4	2.4
Hunt Creek (ZA)						
SW 1957-1960	1.0	1.1	0.8	0.7	0.8	0.9
SW 1971-1974	1.1	2.2	2.0	1.4	0.7	1.5
Hunt Creek (BC)						
SW 1957-1960	1.2	1.2	0.8	0.4	0.6	0.8
SW 1971-1974	1.0	1.6	1.5	0.6	0.4	1.0
Fuller Creek						
SW 1957-1960	1.2	1.2	0.8	0.6	0.7	0.9
Means (streams)	1.4	1.7	1.3	0.8	0.9	1.2

Table 7.--Example of the procedure to determine the average real diet (grams) per trout from the observed diet of brook trout from the North Branch Au Sable River.[1] (Monthly mean water temperatures (F) are in parentheses)

	Annelida[2]	Mollusca	Crustacea	Ephemer-optera	Odonata	Hemiptera	Coleop-tera	Trichop-tera	Diptera	Terres-trials	Fish	Totals
May (55 F) Temperature factor 1.00												
Observed food	.039	.039	.114	.457	.237	.000	.001	.244	.034	.009	.184	1.510
Adjusted food	.039	.039	.114	.457	.237	.000	.001	.244	.034	.009	.184	1.510
June (63 F) Temperature factor .93												
Observed food	.000	.150	.128	.394	.006	.022	.011	.344	.067	.028	.039	1.294
Adjusted food	.000	.140	.119	.366	.006	.020	.010	.320	.062	.026	.036	1.203
July (65 F) Temperature factor .88												
Observed food	.026	.024	.031	.226	.105	.005	.019	.112	.038	.031	.090	0.826
Adjusted food	.023	.021	.027	.199	.092	.004	.017	.099	.034	.027	.079	0.727
Aug (62 F) Tempature factor .96												
Observed food	.073	.008	.108	.142	.062	.008	.031	.142	.019	.080	.000	0.742
Adjusted food	.070	.008	.104	.136	.060	.007	.030	.136	.018	.077	.000	0.712
Sep (57 F) Temperature factor 1.00												
Observed food	.140	.030	.120	.150	.000	.025	.000	.005	.020	.075	.095	0.760
Adjusted food	.140	.030	.120	.150	.000	.025	.000	.005	.020	.075	.095	0.760
Adjusted mean (May-Sep)	.054	.048	.097	.262	.079	.011	.012	.161	.033	.043	.079	0.982
Taxa factor	1.68	0.66	0.17	0.60	0.21	0.25	0.17	0.33	0.86	0.14	1.00	.....
Real diet	.091	.032	.016	.157	.017	.003	.002	.053	.028	.006	.079	0.547
Percent of all items	16.6	5.8	2.9	28.7	3.1	0.6	0.4	9.7	5.1	1.1	14.4	100.0
Empirical mean diet	.056	.050	.100	.274	.082	.012	.012	.169	.036	.045	.082	1.026
Empirical diet comp. (%)	5.4	4.9	9.7	26.7	8.0	1.2	1.2	16.5	3.5	4.4	8.0	100.0

[1] Data for Plecoptera, Amphibia, and the categories other and unidentified are omitted from this summary, therefore sums of rows in the body of the table do not equal the total columns.

[2] Mostly Oligochaeta.

Table 8a.--The real diet, by percent, of trout during their second growing season

(Species and origin: Rainbow, R; brook, S; brown, B; hatchery, H; and wild, W)

Location, species and year	Annelida [1]	Mollusca	Crustacea	Fish	Amphipoda	Other	Unidentified
Fuller Pond							
RH 1966-1967	...	1.2	8.5	72.9	0.7	1.4	2.5
Sage Lake							
RH 1964-1965	0.1	2.2	43.5	9.7	4.9	2.5	1.4
W. Lost Lake							
SH 1966	45.5	...	22.4	...	...	...	5.5
Ford Lake							
SH 1966	...	1.5	22.2	40.8	...	...	...
Lost Lake							
SH 1966	...	...	51.7	...	...	...	6.3
S. Twin Lake							
SH 1966	...	...	16.7	...	...	...	12.0
Hemlock Lake							
SH 1966	...	...	15.0	14.3	...	...	0.4
N. Twin Lake							
SH 1966	...	...	1.7	...	1.2	...	8.3
Hunt Creek (ZA)							
SW 1971-1974	83.3	1.1	0.1	1.9	0.4	0.2	2.3
Hunt Creek (BC)							
SW 1971-1974	76.0	1.0	0.1	2.5	0.2	0.4	3.9

[1] Taxa adjustment based on mean evacuation rate for Oligochaeta and Hirudinea.

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Table 8a.--continued

Location, species and year	Ephemeroptera	Plecoptera	Odonata	Hemiptera	Coleoptera	Trichoptera	Diptera	Terrestrial
Fuller Pond								
RH 1966-1967	6.3	...	1.4	2.0	0.7	0.1	1.4	0.9
Sage Lake								
RH 1964-1965	1.3	...	1.1	0.3	tr	0.9	32.1	tr
W. Lost Lake								
SH 1966	1.8	...	...	1.7	2.6	...	19.2	1.3
Ford Lake								
SH 1966	2.1	...	13.7	2.0	1.3	0.7	11.5	4.2
Lost Lake								
SH 1966	...	...	8.5	8.1	1.1	...	9.8	14.5
S. Twin Lake								
SH 1966	2.8	...	...	8.2	1.3	...	58.9	0.1
Hemlock Lake								
SH 1966	0.4	...	0.3	0.2	...	...	69.4	...
N. Twin Lake								
SH 1966	0.8	...	1.7	4.5	0.9	...	80.9	tr
Hunt Creek (ZA)								
SW 1971-1974	2.7	tr	0.1	tr	0.1	4.0	3.4	0.4
Hunt Creek (BC)								
SW 1971-1974	2.5	0.1	0.1	0.2	0.2	5.7	5.6	1.5

Table 8b.--The real diet, by percent, of trout during their third growing season in lakes and ponds

(Species and origin: Rainbow, R; brook, S; brown, B; hatchery, H; and wild, W)

Location, species[1] and year		Annelida	Mollusca	Crustacea	Fish	Amphibia	Other	Unidentified
East Fish Lake								
RH	1959-1963	0.3	tr	47.4	2.5	tr	0.3	0.5
	1964-1965	tr	...	34.7	13.3	...	0.3	1.6
	1966	...	0.1	63.6	11.0	...	...	0.5
	1967	...	...	77.2	8.3	...	...	0.6
	1968	0.4	0.2	75.7	3.9	...	...	4.1
	1969	...	0.4	37.2	5.5	...	...	4.6
	1973	...	0.2	13.6	70.7	...	...	0.6
SH	1959-1963	...	tr	37.0	22.4	2.1	0.8	1.6
	1964-1965	...	tr	13.1	43.2	...	0.3	1.0
	1966	...	...	25.5	55.5	...	...	0.7
	1967	...	...	33.7	14.3	...	tr	10.2
	1968	...	0.2	21.7	45.6	...	...	4.1
	1969	...	0.4	18.8	64.5	...	...	1.9
	1973	...	...	6.4	83.5	tr	...	0.9
SW	1956-1965	...	...	31.7	12.8	...	1.8	1.5
Fuller Pond								
RH	1970	1.8	63.5	0.2	1.1	3.2	0.2	12.2
	1971	5.3	12.2	0.1	34.9	12.5	0.1	12.1
	1972	1.4	5.1	2.9	48.4	2.8	1.1	16.3
	1973	0.6	11.6	31.8	22.4	4.0	...	7.1
	1960-1965	...	8.8	6.2	43.7	15.9	5.1	8.9
SW	1958-1965	...	8.7	3.7	47.5	3.8	6.8	7.6
SH	1958-1967	0.2	17.6	9.1	29.2	2.1	24.4	3.5
BH	1965-1966	...	12.4	10.3	68.5	1.0	1.9	0.3
D Pond								
SW	1957-1960	2.0	3.0	0.5	63.7	2.1	5.7	1.1
W. Fish Lake								
RH	1965	1.5	...	3.7	1.9	8.7	22.4	21.3
BH	1965	...	...	7.2	7.2	21.0	3.3	5.6
Sutton Pond								
SW	1957-1965	7.4	7.0	3.3	2.7	15.1	...	1.5

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Table 8b.--continued

Location, species and year	Annelida [1]	Mollusca	Crustacea	Fish	Amphibia	Other	Unidentified
Ford Lake							
SH 1966	...	1.6	...	29.9	...	39.8	0.7
Lost Lake							
SH 1966	15.6	...	36.4	...	5.9	...	18.6
S. Twin Lake							
SH 1966	...	...	67.4	...	...	...	1.6
Hemlock Lake							
SH 1966	...	...	9.5	25.2	...	...	0.8
N. Twin Lake							
SH 1966	...	...	57.4	...	...	...	...

[1] Taxa adjustment based on mean evacuation rate for Oligochaeta and Hirudinea.

Location, species and year		Ephemeroptera	Plecoptera	Odonata	Hemiptera	Coleoptera	Trichoptera	Diptera	Terrestrial
East Fish Lake									
RH	1959-1963	10.9	...	tr	0.1	tr	tr	38.0	tr
	1964-1965	6.9	...	tr	0.1	tr	...	43.1	tr
	1966	8.0	...	...	tr	tr	...	16.8	tr
	1967	4.8	...	...	0.1	tr	tr	8.8	0.2
	1968	5.5	...	tr	0.1	0.3	0.1	9.3	0.4
	1969	38.8	...	0.1	0.1	0.2	...	11.9	1.2
	1973	14.1	...	0.1	tr	tr	...	0.2	0.5
SH	1959-1963	15.3	...	0.5	tr	tr	0.2	20.1	tr
	1964-1965	3.0	...	0.2	0.1	...	0.1	39.0	tr
	1966	6.2	...	tr	tr	tr	0.5	11.6	tr

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Table 8b.--concluded

Location, species and year		Ephemeroptera	Plecoptera	Odonata	Hemiptera	Coleoptera	Trichoptera	Diptera	Terrestrial
East Fish Lake									
SH	1967	37.8	...	0.6	0.1	tr	0.5	0.7	2.1
	1968	10.3	...	4.1	0.3	0.6	2.3	6.2	4.6
	1969	8.8	...	0.3	0.1	0.2	0.3	3.5	1.2
	1973	7.5	...	tr	tr	0.1	tr	1.1	0.5
Fuller Pond									
RH	1970	0.3	...	3.0	2.6	0.4	8.0	3.4	0.1
	1971	0.1	...	7.2	12.1	0.3	1.6	1.4	0.1
	1972	2.4	...	4.4	10.4	0.3	2.2	1.6	0.7
	1973	14.8	...	0.4	1.9	0.1	tr	4.9	0.4
	1960-1965	0.3	...	4.3	1.2	1.0	0.5	3.3	0.8
SW	1958-1965	0.1	...	4.9	2.7	2.7	7.7	4.0	0.4
SH	1958-1967	0.3	...	2.4	1.5	1.7	6.7	1.1	0.2
BH	1965-1966	1.3	...	0.8	2.1	tr	1.1	0.2	0.1
D Pond									
SW	1957-1960	0.7	...	2.5	1.4	0.6	5.2	9.6	1.9
W. Fish Lake									
RH	1965	...	...	3.2	0.5	2.0	...	19.1	15.7
BH	1965	...	...	0.6	1.8	0.6	17.5	35.1	0.1
Sutton Pond									
SW	1957-1965	5.4	...	6.9	9.3	2.4	2.5	32.8	3.7
Ford Lake									
SH	1966	...	...	10.4	3.1	0.8	...	10.7	3.0
Lost Lake									
SH	1966	...	...	1.2	6.3	5.5	...	4.7	5.8
S. Twin Lake									
SH	1966	...	...	2.6	4.8	0.8	...	22.7	0.1
Hemlock Lake									
SH	1966	...	...	2.3	0.6	0.2	...	61.4	...
N. Twin Lake									
SH	1966	...	...	...	0.3	...	...	42.0	0.3

Table 8c.--The real diet, by percent, of trout during their third growing season in streams

(Species and origin: Rainbow, R; brook, S; brown, B; hatchery, H; and wild, W)

Location, species and year		Annelida [1]	Mollusca	Crustacea	Fish	Amphibia	Other	Unidentified
N. Br. Au Sable R.								
SW	1957-1965	16.6	5.8	2.9	14.4	0.6	1.8	8.6
BW	1957-1965	5.8	1.5	3.3	50.4	...	1.3	8.8
Hunt Creek (ZA)								
SW	1957-1960	37.2	0.4	0.3	14.7	...	2.0	14.7
SW	1971-1974	80.6	0.8	3.1	3.9	1.2	...	2.1
Hunt Creek (BC)								
SW	1957-1960	39.1	1.3	2.1	21.1	1.6	3.6	14.0
SW	1971-1974	66.2	0.1	0.8	16.9	1.6	tr	3.8
Fuller Creek								
SW	1957-1960	41.0	0.4	7.5	12.8	1.4	4.1	13.6

Location, species and year		Ephemeroptera	Plecoptera	Odonata	Hemiptera	Coleoptera	Trichoptera	Diptera	Terrestrial
N. Br. Au Sable R.									
SW	1957-1965	28.7	0.6	3.1	0.6	0.4	9.7	5.1	1.1
BW	1957-1965	21.4	0.4	0.6	tr	0.3	3.6	1.9	0.7
Hunt Creek (ZA)									
SW	1957-1960	10.8	0.3	0.5	0.3	0.1	7.4	8.2	3.1
SW	1971-1974	1.5	0.1	0.1	tr	0.1	2.6	3.2	0.7
Hunt Creek (BC)									
SW	1957-1960	3.8	0.6	1.5	0.3	0.3	5.0	3.5	2.2
SW	1971-1974	1.6	0.1	0.2	0.6	0.1	3.8	2.8	1.4
Fuller Creek									
SW	1957-1960	2.6	0.7	1.5	0.5	0.3	4.3	6.3	3.0

[1] Taxa adjustment based on mean evacuation rate for Oligochaeta and Hirudinea.

Table 9a.--The caloric value, by percent, of the trout diet during their second growing season in lakes and ponds

(Species and origin: Rainbow, R; brook, S; brown, B; hatchery, H; and wild, W)

Location, species and year	Annelida	Mollusca	Crustacea	Fish	Amphibia	Other	Unidentified
Fuller Pond							
RH 1966-1967	...	0.4	6.7	79.2	0.7	1.0	1.9
Sage Lake							
RH 1964-1965	0.1	1.2	38.9	17.6	8.9	3.1	1.8
W. Lost Lake							
SH 1966	41.2	...	27.4	...	...	...	6.6
Ford Lake							
SH 1966	...	0.6	14.4	53.5	...	...	...
Lost Lake							
SH 1966	...	...	42.5	...	...	...	6.1
S. Twin Lake							
SH 1966	...	...	14.5	...	...	...	16.9
Hemlock Lake							
SH 1966	...	...	14.5	27.9	...	...	0.7
N. Twin Lake							
SH 1966	...	...	2.2	...	2.7	...	12.1
Hunt Creek (ZA)							
SW 1971-1974	79.3	0.6	0.1	3.5	0.8	0.2	2.8
Hunt Creek (BC)							
SW 1971-1974	70.3	0.6	0.1	4.5	0.4	0.4	4.7

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Table 9a.--concluded

Location, species and year	Ephemeroptera	Plecoptera	Odonata	Hemiptera	Coleoptera	Trichoptera	Diptera	Terrestrial insects
Fuller Pond								
RH 1966-1967	5.2	...	1.0	1.4	0.5	0.1	0.6	1.3
Sage Lake								
RH 1964-1965	1.7	...	1.4	0.3	tr	1.1	23.8	0.1
W. Lost Lake								
SH 1966	2.4	...	...	2.0	3.3	...	14.0	3.1
Ford Lake								
SH 1966	2.0	...	12.2	1.8	1.2	0.6	6.2	7.5
Lost Lake								
SH 1966	...	...	8.4	7.8	1.1	...	5.8	28.3
S. Twin Lake								
SH 1966	4.4	...	...	11.5	1.9	...	50.5	0.3
Hemlock Lake								
SH 1966	0.6	...	0.4	0.2	...	...	55.7	...
N. Twin Lake								
SH 1966	1.2	...	2.5	6.5	1.4	...	71.4	tr
Hunt Creek (ZA)								
SW 1971-1974	3.8	tr	0.1	tr	0.1	5.1	2.6	1.0
Hunt Creek (BC)								
SW 1971-1974	3.5	0.1	0.1	0.2	0.3	7.0	4.2	3.6

Table 9b.--The caloric value, by percent, of the trout diet during their third growing season in lakes and ponds

(Species and origin: Rainbow, R; brook, S; brown, B; hatchery, H; and wild, W)

Location, species and year		Annelida	Mollusca	Crustacea	Fish	Amphibia	Other	Unidentified
East Fish Lake								
RH	1959-1963	0.3	tr	46.3	4.9	tr	0.4	0.6
	1964-1965	tr	...	31.3	24.4	...	0.4	1.9
	1966	...	0.1	56.3	19.8	...	...	0.5
	1967	...	...	70.1	15.3	...	...	0.7
	1968	0.5	0.1	70.3	7.3	...	...	5.2
	1969	...	0.2	29.0	8.8	...	...	4.9
	1973	...	0.1	7.5	79.2	...	...	0.4
SH	1959-1963	...	tr	28.2	34.8	3.2	0.8	1.7
	1964-1965	...	tr	9.3	62.5	...	0.3	1.0
	1966	...	...	16.0	70.9	...	...	0.5
	1967	...	...	23.6	20.4	...	tr	9.8
	1968	...	0.1	13.3	56.5	...	...	3.4
	1969	...	0.2	10.8	75.5	...	...	1.5
	1973	...	...	3.4	88.8	tr	...	0.6
SW	1956-1965	...	...	27.7	22.7	...	2.1	1.8
Fuller Pond								
RH	1970	2.1	42.2	0.3	2.5	7.5	0.4	19.0
	1971	3.5	4.6	0.1	45.2	16.2	0.1	10.5
	1972	0.9	1.8	2.5	58.9	3.4	0.9	13.2
	1973	0.4	4.6	31.4	30.6	5.5	...	6.5
	1960-1965	...	0.3	5.3	52.4	19.1	4.1	7.2
SW	1958-1965	...	3.1	3.3	59.2	4.7	5.7	6.3
SH	1958-1967	0.2	7.1	9.3	41.0	3.0	23.1	3.3
BH	1965-1966	...	4.2	8.6	79.8	1.2	1.4	0.2
D Pond								
SW	1957-1960	1.2	1.0	0.5	73.9	2.4	4.5	0.8
W. Fish Lake								
RH	1965	1.0	...	3.5	2.5	11.3	19.7	18.7
BH	1965	...	...	7.7	10.6	31.0	3.2	5.6
Sutton Pond								
SW	1957-1965	5.9	3.2	3.8	4.2	23.7	...	1.5

(continued, next page)

Table 9b.--continued

Location, species and year		Annelida	Mollusca	Crustacea	Fish	Amphibia	Other	Unidentified
Ford Lake								
SH	1966	...	0.6	...	39.4	...	35.3	0.6
Lost Lake								
SH	1966	12.1	...	31.4	...	9.0	...	18.9
S. Twin Lake								
SH	1966	...	...	68.1	...	...	...	2.0
Hemlock Lake								
SH	1966	...	...	8.0	43.6	...	...	1.0
N. Twin Lake								
SH	1966	...	...	66.2	...	...	...	...

Location, species and year		Ephemeroptera	Plecoptera	Odonata	Hemiptera	Coleoptera	Trichoptera	Diptera	Terrestrial insects
East Fish Lake									
RH	1959-1963	16.3	...	tr	0.1	tr	tr	31.0	0.1
	1964-1965	9.6	...	tr	tr	tr	...	32.4	tr
	1966	10.8	...	...	tr	tr	...	12.4	0.1
	1967	6.7	...	...	0.1	0.1	tr	6.6	0.4
	1968	7.8	...	0.1	0.1	0.4	0.1	7.2	0.9
	1969	46.4	...	0.1	0.1	0.3	...	7.7	2.5
	1973	12.0	...	tr	tr	tr	...	0.1	0.7
SH	1959-1963	17.8	...	0.5	tr	tr	0.2	12.8	tr
	1964-1965	3.2	...	0.3	0.1	...	0.1	23.2	tr
	1966	6.0	...	tr	tr	tr	0.5	6.1	tr
	1967	40.6	...	0.5	0.1	tr	0.5	0.4	4.1
	1968	9.7	...	3.5	0.2	0.5	1.9	3.1	7.8
	1969	7.8	...	0.3	0.1	0.1	0.2	1.7	1.8
	1973	6.0	...	tr	tr	0.1	tr	0.5	0.6
SW	1956-1965	16.3	...	tr	0.2	tr	0.1	28.9	0.2

(continued, next page)

Table 9b.--concluded

Location, species and year		Ephemeroptera	Plecoptera	Odonata	Hemiptera	Coleoptera	Trichoptera	Diptera	Terrestrial insects
Fuller Pond									
RH	1970	0.6	...	4.8	4.0	0.7	12.3	3.2	0.4
	1971	0.1	...	6.4	10.6	0.3	1.4	0.8	0.2
	1972	2.1	...	3.7	8.6	0.3	1.8	0.8	1.1
	1973	15.3	...	0.3	1.7	0.2	tr	2.8	0.7
	1960-1965	0.3	...	3.5	1.0	0.9	0.4	1.6	1.2
SW	1958-1965	0.1	...	4.2	1.7	2.4	6.4	2.1	0.8
SH	1958-1967	0.3	...	2.3	1.4	1.8	6.2	0.6	0.4
BH	1965-1966	1.2	...	0.6	1.7	tr	0.9	0.1	0.1
D Pond									
SW	1957-1960	0.6	...	2.0	1.1	0.5	4.0	4.6	2.9
W. Fish Lake									
RH	1965	...	...	2.9	0.4	1.9	...	10.3	27.8
BH	1965	...	...	0.7	1.8	0.7	17.3	21.2	0.2
Sutton Pond									
SW	1957-1965	6.4	...	7.4	9.8	2.7	2.6	21.1	7.7
Ford Lake									
SH	1966	...	...	9.5	2.8	0.8	...	5.8	5.2
Lost Lake									
SH	1966	...	...	1.2	6.5	6.1	...	2.9	11.9
S. Twin Lake									
SH	1966	...	...	4.3	7.9	1.0	...	16.5	0.2
Hemlock Lake									
SH	1966	...	...	2.8	0.8	0.2	...	43.6	...
N. Twin Lake									
SH	1966	...	...	...	0.4	...	...	32.7	0.8

Table 9c.--The caloric value, by percent, of the trout diet during their third growing season in streams

(Species and origin: Rainbow, R; brook, S; brown, B; hatchery, H; and wild, W)

Location, species and year		Annelida	Mollusca	Crustacea	Fish	Amphibia	Other	Unidentified
N. Br. Au Sable R.								
SW	1957-1965	12.2	2.4	3.2	20.9	0.8	1.8	8.5
BW	1957-1965	3.5	0.5	2.9	59.9	...	1.0	7.0
Hunt Creek (ZA)								
SW	1957-1960	28.4	0.2	0.3	22.1	...	2.0	14.8
SW	1971-1974	74.4	0.4	3.6	7.2	2.2	...	2.6
Hunt Creek (BC)								
SW	1957-1960	29.0	0.5	2.0	30.7	2.4	3.5	13.7
SW	1971-1974	53.7	0.1	0.8	26.9	2.5	tr	4.1
Fuller Creek								
SW	1957-1960	31.9	0.2	7.4	19.6	2.1	4.2	14.0

Location, species and year		Ephemeroptera	Plecoptera	Odonata	Hemiptera	Coleoptera	Trichoptera	Diptera	Terrestrial insects
N. Br. Au Sable R.									
SW	1957-1965	31.2	0.5	3.2	0.5	0.3	9.5	2.9	2.1
BW	1957-1965	19.2	0.3	0.5	tr	0.2	2.9	1.0	1.1
Hunt Creek (ZA)									
SW	1957-1960	12.2	0.3	0.5	0.3	0.1	7.4	5.1	6.3
SW	1971-1974	2.0	0.1	0.1	tr	0.1	3.2	2.4	1.7
Hunt Creek (BC)									
SW	1957-1960	4.2	0.6	1.5	0.3	0.3	4.9	2.1	4.3
SW	1971-1974	2.0	0.1	0.2	0.6	0.1	4.0	1.8	3.1
Fuller Creek									
SW	1957-1960	3.0	0.7	1.5	0.5	0.3	4.4	4.0	6.2

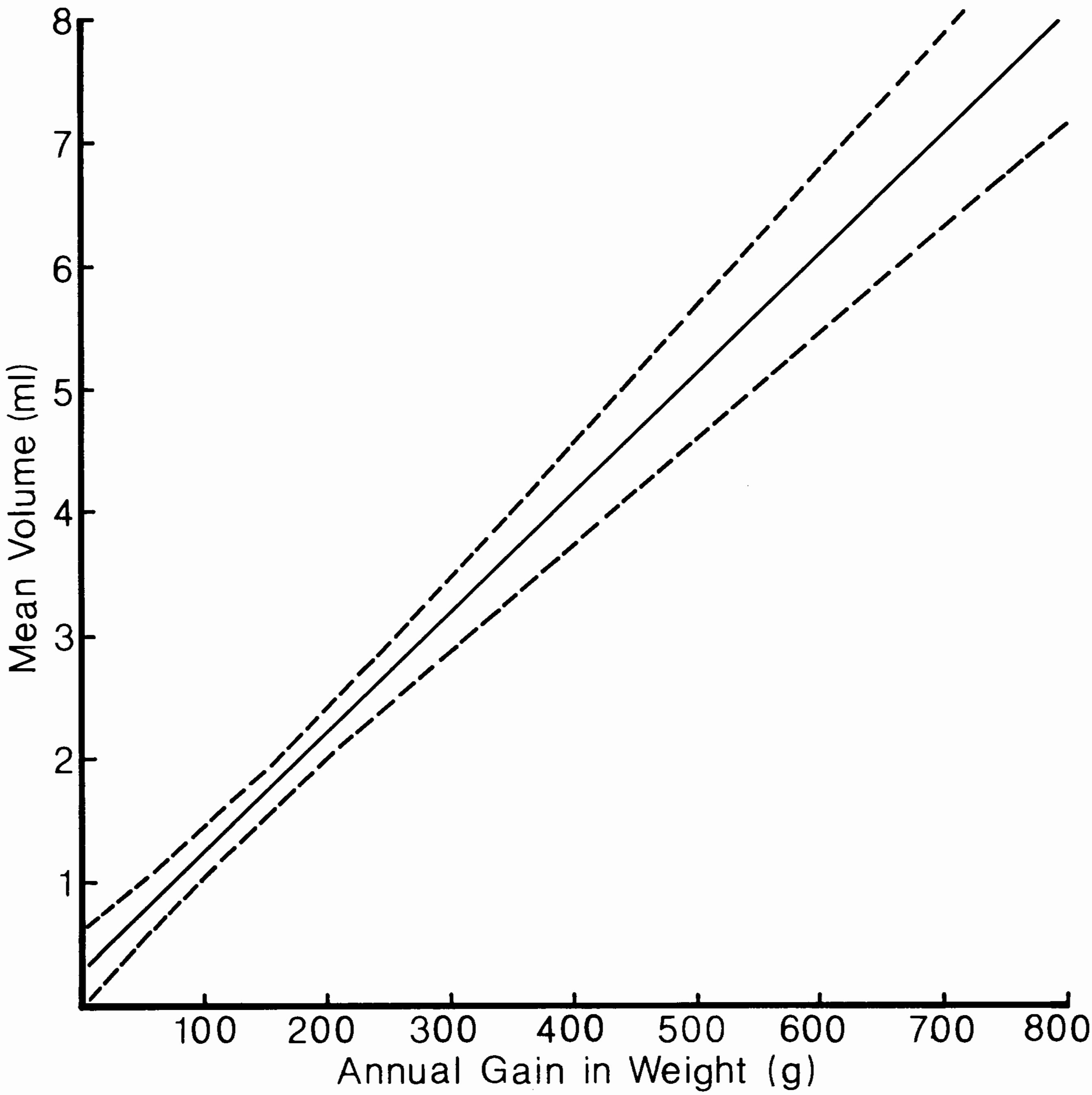

Figure 1.--Mean volumes of stomach contents for all species and age classes of trout regressed on annual gains in weight with confidence limits of 95%.

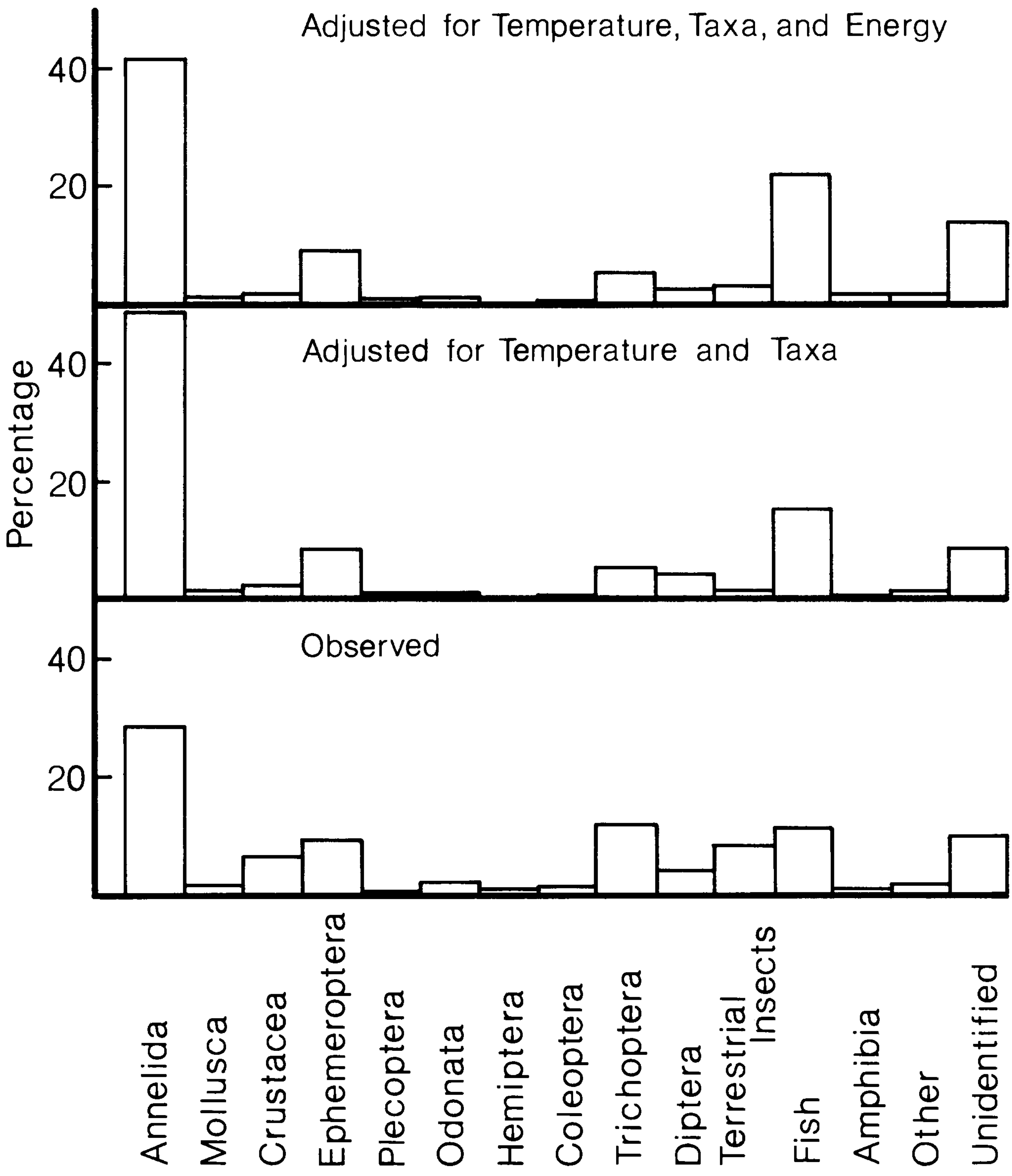

Figure 2.--Observed diet, by percent, of trout in streams and the adjustments for temperature, taxa, and energy (calories).

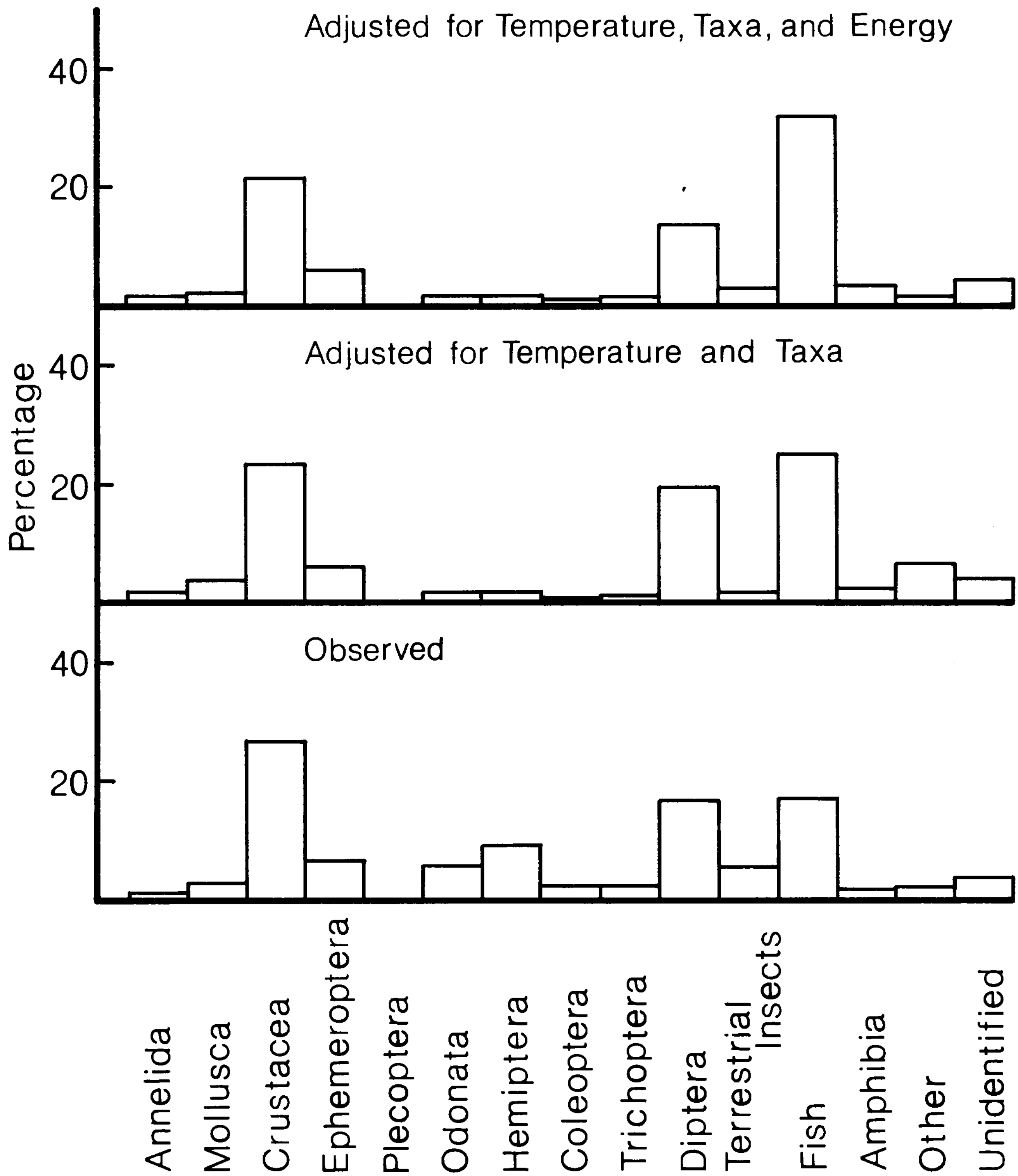

Figure 3.--Observed diet of trout, by percent, in lakes and ponds and the adjustments for temperature, taxa, and energy (calories).

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