STOMACH ANALYSIS OF RELIC POPULATIONS OF THE CUTTHROAT TROUT NATIVE TO SNAKE VALLEY UTAH-NEVADA

Submitted to
Zoology 445

by
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I. INTRODUCTION

Recent discoveries by U.S. Bureau of Land Management biologist (1973) and myself, while working for the Utah Division of Wildlife Resources (1975) have found the Snake Valley cutthroat inhabiting headwater reaches of Trout and Birch Creek of the Deep Creek Mountain Range, Tooele and Juab counties, Utah. The status of this species has since been listed as rare and endangered by professional and conservation orgationations. The Snake Valley Cutthroat is the original inhabitor of waters in the Deep Creek Mountain Range, but until 1973, it was assumed that the only fish that remained in these waters was the introduced rainbow trout, *Salmo gairdneri*.

From May, 1976 to August, 1976, I surveyed , collected and analyzed fish specimens, aquatic invertebrates, and aquatic habitat from all waters of Deep Creek Mountain Range to determine the status of native Snake Valley cutthroat.

I found the Snake Valley cutthroat inhabiting only a total of 1 3/4 miles in two streams. The remaining waters were occupied by rainbow trout and sculpins, *Cottus bairdi*.

The results of my findings are very significant in that the state of Utah may have only three other known small streams which contain the pure form of the native cutthroat trout.

No detailed knowledge exists on the life history and ecology of the Snake Valley cutthroat - its food, reproduction or limiting factors. General remarks indicate that all weatern trouts are highly adaptable; they can live in a variety of environments, ranging from small brooks to large rivers and lakes, and they feed on a broad spectrom of organisms. This wide range of adaptability makes it highly misleading to base the ecological characteristics of an entire taxon on data taken from a population in a specific habitat (Behnke 1976).

II. OBJECTIVES

The objective of this study is to analyze the stomach contents of the Snake Valley cutthroat in an attempt to better understand the food habits of this species.

Ricker (1930) indicated that the study of stomach contents may serve three purposes: (1) If the food requirement of trout and the food availability in any particular body of water be known, the first step toward determining its suitability for supporting a trout fisheries has been taken; (2) If the food requirements of trout and the food available in various trout habitats be known, sportsmen may have an explanation for the great disparity in the maximum size attained by trout in different waters; (3) If the differences in the food organisms taken by trout of various sizes and the distribution of these organisms along the course of a stream be known, fishery biologist will have an accurate method of establishing restoration programs for rare and endangered species.

In accordance with study I collected aquatic organisms with the use of a 1/4 meter squared macroinvertebrate basket, in the same areas that the cutthroat trout were taken. Currently the U.S. Forest Service is analyzing the organisims and together with this study species diversity, biomass and forage ratios will be determined.

The following combinations of methods for the enumeration of stomach contents will be used: Frequency of occurence, numerical and volumetrics methods. All of these will be expressed as a percent of the total number of stomachs analyzed. These combined indices give a better picture of the importance of different food organisms than either of their componets singly.

III. DESCRIPTION OF THE STUDY AREA

Trout and Birch Creek flow from the southeastern part of the Deep Creek Mountains in extreme western Utah into the Snake Valley portion of the Bonneville Basin desert. The highest elevation on the drainages of these two streams is 11,588 feet at Red Chief Cain on the northern edge of Trout Creek's drainage. This portion of the Deep Creek Mountains are composed mainly of pre-cambrian metasedimentary rocks, chiefly agrillite and quartzite, resulting in stream water which is relatively pure chemically.

The following characteristics are found in these two creeks above 7,900 feet where the cutthroat trout are located:

	January	July
Avg. depth	150cm	200cm
Avg. width	170cm	185cm
Avg. discharge	2csf	5csf
Avg. Temp.	-3 C	11 C
Avg. pH	8.1	8.1

Plant communities found along these streams and on their watersheds are: a mixed conifer - montane zone in which douglas fir, white fir, englemen spruce, aspen, gamble oak, curl-leaf mountain mahogany, big sage brush , black sage brush, snowberry, coniflower, Indian paintbrush, waterleaf and bluebunch wheatgrass are representative species.

Along the stream courses, aspen, birch, wild rose, willow and red ozier dogwood are common. (Duff 1975).

IV. METHODS

Since we are dealing with a rare species only 30 stomachs were obtained, 15 at 8,000 feet and 15 at 9,200 feet. The fish were taken by hook and line from June 1, 1976 to July 30, 1976, between 0700 hours and 1800 hours.

Immediately after capture each fish was weighed and measured, injected with 30% formaline and wrapped in cheese cloth. Each fish was carefully labeled, recording size, date and time of capture. An insignificant amount of regurgitation was observed. The fish were transported to individual jars of 50% isopropyl alcohol two weeks after capture.

In September,at Colorado State University, each stomach was removed from the cutthroat trout and all adhering organs removed. The intestine was cut off directly behind the stomach, no effort was made to examine the intestinal content because undue emphasis would then be placed on hard-shelled insects such as beetles or stone protected caddisfly larvae, while the soft-bodied animals would be in a fragmentary or disintegrated state, very difficult to identify. Analysis and comparisons were thus based on the content of the stomach proper.

The stomach was cut open with scissors and the contents emptied into a petri dish. The items were sorted and identified with the aide of a binocular dissecting scope. The various food items were then classified by frequency of occurence, numerical and volumetric methods. If only parts of an organisims were present it was considered as a whole in the count.

The following outline of methods is based mainly on the reviews by Hynes(1950) and Bortusky et. al. (1961).

Frequency of Occurence: The number of stomachs in which each item occurs is recorded and expressed as a percentage of the total number of stomachs examined.

Numerical method: The number of organisms of each food type in each stomach is counted. These are summed to give totals for each kind of food item in the whole sample, and then a grand total of all items. The quotient of these gives the percentage representation, by number, of each type of food item.

Volumetric Method: The quantity of each food type in a stomach is measured by water displacement, using a graduated cylinder. Food items are then totaled and expressed as a percent of the total volume of food in the stomach.

The reason that I used a combination of the above three methods is; Frequency of occurence demonstrates what organisms are being fed upon, but it gives no information on quantities or numbers and does not take into account the accumulation of food organisms resistant to digestion. The numerical method could become a problem in that one must consider that the food most injested may not be the most important to the fish nutritionaly. Volumetric studies alone tend to mask the importance of the smaller food items. Data may be much distorted by the occasional occurence of an exceptionaly bulky food item.

All of the methods were represented graphically. A comparison between 8,000 feet and 9,300 feet elevation was made to show the difference in food items injested at these two locations. Since there was a high incidence of terrestrial organisms in the diet a comparison between aquatic and terrestrial organisms was also made.

The taxa were only identified to order because futher classification would not have been consistant.

The results of both Trout and Birch Creek were combined because there was no significant difference between the two.

The average size for the 30 cutthroat trout was 20 cm in length and 200 grams in weight. The ranges were from 15 - 25 cm for length and 125 - 250 for weight.

A list was also made to summarize the importance of each insect order in the diet of the cutthroat trout examined.

V. RESULTS

Needham (1968), indicated that over eighty-five percent of trout stomachs contain organisms belonging to five main orders of insects: Trichoptera, Ephemeroptera, Plecoptera, Diptera and Megaloptera. He did not include the terrestrial components in this generalization. Since alot of his work was done in the east, we could substitute coleoptera for megaloptera and these were the five most abundant aquatic orders in the cutthroat trout diet.

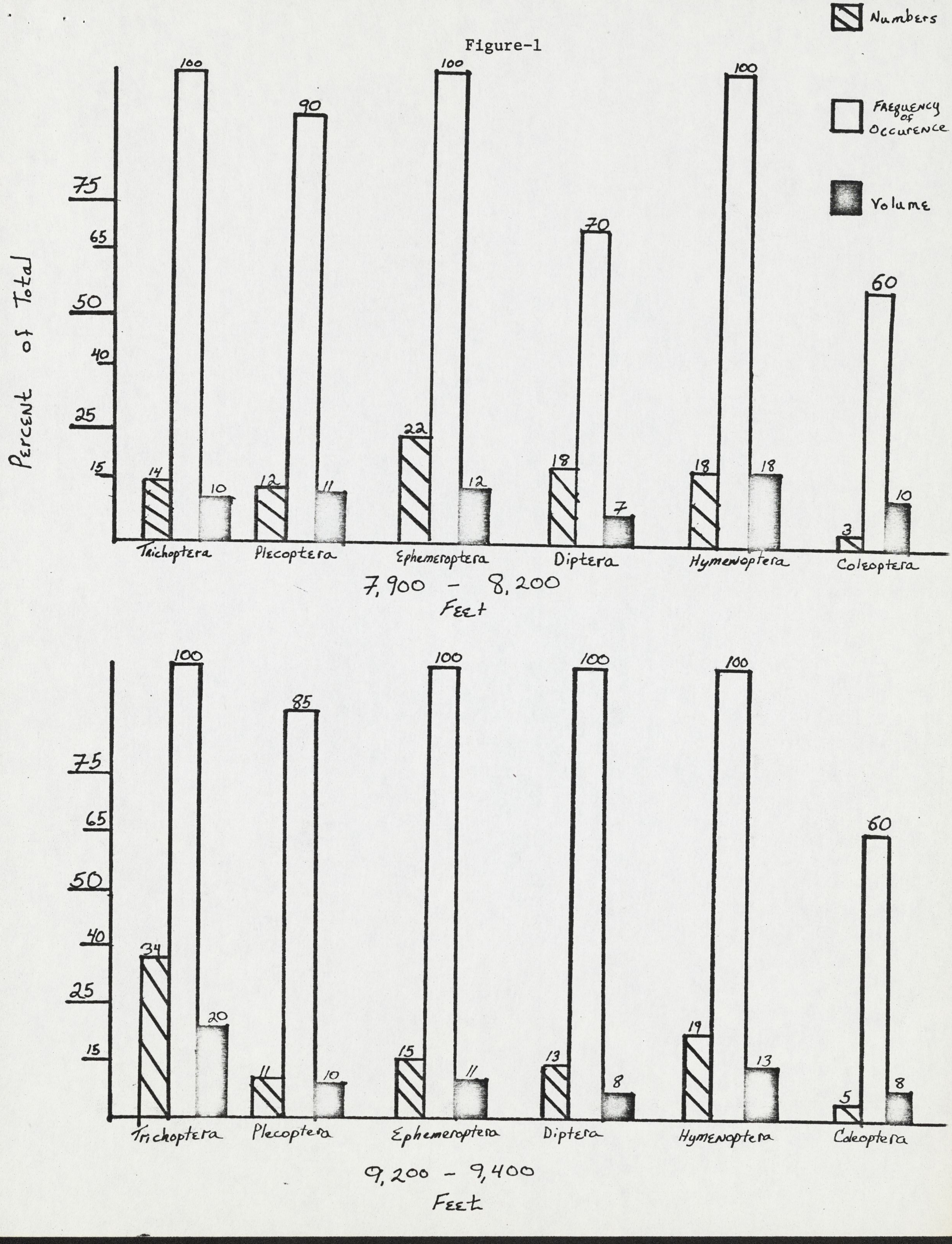
Figure 1 shows the results of the stomach analysis. The most significant difference in the comparison of stomach contents of fish from 8,000 feet with those of 9,300 feet is the abundance of ephemeroptera at 8,000 feet and trichoptera at 9,300. The other orders remained essentially the same.

A significant result is shown in the Frequency of occurence, both at 8,000 feet and 9,300 feet, about four out of the six insect orders occured in every stomach.

The most impressive result is the abundance of terrestrial organisms in the diet of the trout. The volume of the terrestrial insects and aquatic insects were nearly equal. Approximately 90% of the Hymenoptera were ants, while the other 10% were wasps.

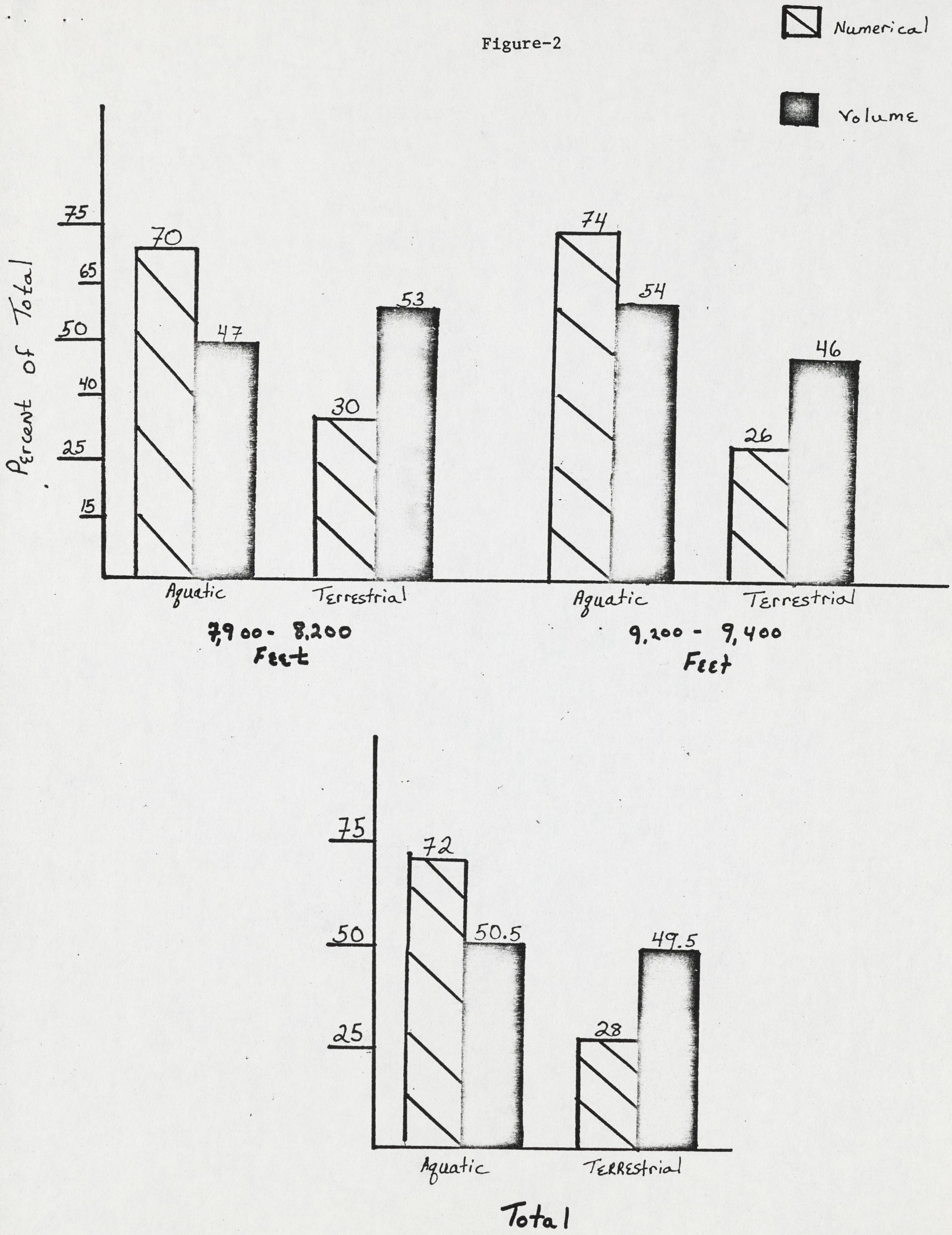
Results from the U.S. Forest Service (Mangum 1976) of the aquatic insects I collected from the areas where the trout were collected show a biomass of 10.2 gm/m^2 and a mean diversity index of 14.9. The biomass reading indicates good productivity, this would be significant information for proper maintenance of the streams fishery, the mean diversity index reading indicates good water quality in these areas.

Figure-1



Numbers
Frequency of Occurence
Volume
Percent of Total
75
65
50
40
25
15
100
90
100
70
100
60
14
10
12
11
22
12
18
7
18
18
3
10
Trichoptera
Plecoptera
Ephemeroptera
Diptera
Hymenoptera
Coleoptera
7,900 - 8,200
Feet
100
85
100
100
100
60
34
20
11
10
15
11
13
8
19
13
5
8
Trichoptera
Plecoptera
Ephemeroptera
Diptera
Hymenoptera
Coleoptera
9,200 - 9,400
Feet

Figure-2



Numerical
Volume
Percent of Total
75
65
50
40
25
15
70
47
30
53
74
54
26
46
Aquatic
Terrestrial
Aquatic
Terrestrial
7,900 - 8,200 Feet
9,200 - 9,400 Feet
75
50
25
72
50.5
28
49.5
Aquatic
Terrestrial
Total

The remaining groups of arthropods were each represented by less than 5% of the total number and volume; Hemiptera, Arane and Lepidoptera larva. The following list summarizes the importance of the insect orders in the diet of the cutthroat trout:

	% VOLUME	%NUMBER
8,000 Feet		
	1. Hymenoptera - most important -	1. Ephemeroptera
	2. Ephemeroptera	2. Hymenoptera
	3. Plecoptera	3. Diptera
	4. Trichoptera	4. Trichoptera
	5. Coleoptera	5. Plecoptera
	6. Diptera	6. Hemiptera
	7. Hemiptera - least important-	7. Coleoptera
9,300 Feet		
	1. Trichoptera	1. Trichoptera
	2. Hymenoptera	2. Hymenoptera
	3. Ephemeroptera	3. Ephemeroptera
	4. Plecoptera	4. Diptera
	5. Diptera	5. Plecoptera
	6. Coleoptera	6. Coleoptera
	7. Hemiptera	7. Hemiptera
	8. Arane	8. Arane
	9. Lepidoptera	9. Lepidoptera

There were no other orders represented in the stomachs. Many rocks were found in the stomachs (mainly from Trichoptera cases), plant material and other digested materials which were not included in the percent volume or numbers. It is significant to note that there were no vertebrates found in the stomachs.

VI. DISCUSSION

Previous reports of stomachs analysis of cutthroat trout are numerous, but since the treatment of data by authors varies it is difficult to express the combined results in figures. Also many studies in this country consider several species of trout together without differentiating between them. This limits the use of such data since the species have been shown by Needham(1968) and others,to differ in some respects as to the feeding habits. There is little information concerning the winter food of cutthroat trout. The majority of reports are based on summer surveys or on trout taken by anglers during the open season. It is obvious that the season of the year during which the trout are collected and the type of food available in the particular area has a very important bearing on the final analysis.

The literature generally indicates that all trouts are opportunistic and eclectic in their diet, which essentially reflects the availability of food organisms in their particular environment (Behnke 1976). Needham (1968) indicated that generally the insects most abundant in the stream are eaten the most. The major factor which makes my analysis difficult to generalize in this manner is the added variable of the terrestrial componet. It is very difficult to obtain quatitative data on terrestrial impact on the diet of trout.

Various opinions have been expressed by biologists concerning the importance of terrestrial organisms in the diet of trout. Needham(1968) said that terrestrial foods supply a portion of the food available during the warmer months of the year, but it is the aquatic animals that afford the bulk of their sustanance.

Much of the literature indicates that terrestrial insects may comprise 50% of the trout diet in the summer but only about 10% in the winter. Griffith(1974) indicated that the amount of terrestrial insects in the diet of cutthroat trout in Idaho streams was insignificant.

Lord(1933) made the most extensive year-around stomach analysis that has every been done on trout in streams. He found that the average amount of terrestrial insects in the trout diet during the winter months was about 11% and that for the summer months was about 52%. The total for the two years the study was conducted was 66% for the aquatic and 34% for the terrestrial organisms.

If you take into account the elevation, depth and width of the streams, winter temperature and low metabolic rates it is possible that the Snake Valley cutthroat trout is not feeding very much during this period of the year. If this is the case than the importance of terrestrial insects in the diet over the entire year would be enhanced. Lord's studies found many aquatic animals that were not found in the Snake Valley cutthroat; eggs, snails, fish and leeches. Without these items the terrestrial foods become magnified in relationship to their importance.

Ricker(1930) emphasied the importance of terrestrial insects, suggesting that in some streams terrestrial insects might be substituted for aquatic foods when evaluating resources of streams in relation to trout production.

In the current trend of ecological analysis in terms of trophic relations between feeding levels and in energy flow between levels, it is important to consider the additional energy derived by the aquatic ecosystem from the surrounding terrestrial system.

Utilization of large amounts of terrestrial insects by the cutthroat trout may confer a degree of stability to the community which otherwise might be lacking. The use of outside sources of food by the fish reduces their dependence on lower trophic levels in the stream and provide alternate pathways along which energy may flow.

The amount or number of organisms that fall into the stream depends upon a number of conditions. The first, and most important, is the type of environment along the banks of the stream.

In the Deep Creek Mountains the streams flow through forested areas where the stream banks are bordered by a growth of tall trees, and low-brush-covered banks. Such an environment shelters large numbers of terrestrial insects.

It is obvious that futher studies on the winter food habits of the Snake Valley cutthroat are needed. During the winter of 1977, collections of fish and aquatic organisms will be made in an attempt to better correlate the food habits of this trout species.

Previous studies indicated that Trichoptera were the most abundant item in the diet of trout inhabiting streams (Ide 1942, Ricker 1930, Evans 1952, Reed and Bear 1966, Griffith 1974). While this seemed to hold true in the 9,300 foot area it was not the case at 8,000 feet, where Ephemeroptera was more abundant.

This again, may be a result of local environmental conditions, which supports the idea that each situation may not be the same and therefore would merit special management regulations.

VII. SUMARY

Stomach analysis were made on 30 species of a rare cutthroat trout recently discovered in the Deep Creek Mountain Range, Snake Valley Utah-Nevada. The fish were collected from May 1976, to August 1976. The stomachs were analyzed at Colorado State Univ. 15 of the trout were collected around 8,000 feet(lower limits of the pure form) and 15 were collected at 9,300 feet.

Graphic representation of % frequency of occurence, numerical and volumetric methods were made comparing the collection from 8,000 feet with that of 9,300. The only significant result was that the most abundant order of insect in the diet of the trout at 9,300 feet was Trichoptera, while at 8,000 Ephemeroptera were the most abundant item. Other orders found,in order of importance were: Hymenoptera,Diptera, Plecoptera, Coleoptera,Hemiptera,Arane and Lepidoptera.(The last two orders were only found at 9,300 feet).

The most significant result was that terrestrial insects comprised about 50% of the volume of food found in the stomachs. The most dominant terrestrial organisms was ants.

Futher studies need to be done to asses the yearly importance of terrestrial organisms in the diet of Snake Valley Cutthroat.

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