SEASONAL FLUCTUATION IN FOOD AVAILABILITY AND FEEDING OF JUVENILE STEELHEAD TROUT (*Salmo gairdneri*) IN A SMALL COASTAL STREAM

by

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ABSTRACT

Seasonal fluctuations in benthic and drift invertebrate abundance and feeding of juvenile steelhead trout (Salmo gairdneri) were examined in three different habitat types from November 1978 to October 1979 on Jacoby Creek, a small coastal stream in northern California. Benthic invertebrate abundance was greatest from August to October and lowest in February and March. Drift abundance, in terms of total number of organisms, was greatest in winter and spring and lowest in summer and fall. Flow appeared to have the greatest affect on drift; as discharge declined over the summer so did aquatic drift abundance. Terrestrial drift was only abundant in the fall. Observed differences in absolute and relative abundance and distribution between sites of some benthic invertebrate groups and taxa, and terrestrial drift, was reflective of differences in canopy and substrate composition.

Juvenile steelhead utilized Trichopteran nymphs throughout the year, but most extensively in winter and spring. Organisms which were in the drift were consumed in greater frequency than benthic organisms, with the exception of Trichoptera. Size and visibility of prey items, and the type of habitat in which fish resided appeared to be more important than invertebrate abundance in determining food selection by juvenile steelhead. Diversity was examined for drift, benthos and stomach composition. Differences in diversity were observed between sites for benthic invertebrates, but not for drift of stomach composition.

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INTRODUCTION

Production and growth of fish is largely dependent on the amount of food consumed which in turn depends on the available food supply. Generally, rates of food consumption and growth of salmonids are highest in spring and summer when water temperature regimes are favorable for efficient food metabolism and food supply is abundant (Allen 1969).

Harper (1980) examined growth of juvenile steelhead (Salmo gairdneri) in Jacoby Creek and observed rapid growth from June through August, little growth begining in September and continuing through the winter and resumption of growth in March. He postulated that warm water temperatures coupled with reduced food supply in September might be responsible for slowed growth at this time of year. A similar growth pattern was noted for juvenile steelhead in California coastal streams (Cross 1975; Reeves 1980) and for cutthroat trout (Salmo clarki) in Oregon coastal streams (Lowry 1966).

Jacoby Creek is typical of Northwest coastal streams; highly variable flows in winter, declining flows through the summer and low flows in the fall. Reduced flows may result in reduction of available territory for fish and a reduction in food supply in the form of drift (Mundie 1969). Chapman (1966a) concluded that relatively stable, low flows during the fall in Oregon coastal streams were not conducive to dislodging benthic fauna, making aquatic foods less available as drift at this time of the year. Regularly declining summer flows in this region could have this effect, resulting in increased dependence of salmonids on terrestrial drift and benthic organisms.

The direct significance of invertebrate drift to fish is an apparent increase in accessibility of prey items (Waters 1969). Trout are visual feeders and prey exposure and activity tend to be the most significant attributes of prey taken by rainbow trout (Ware 1973). There is also general agreement that the diet of stream salmonids is more closely related to physical and biological properties of food items than to food biomass or density (Allen 1941; Egglishaw 1967; Ware 1972). Terrestrial organisms have been shown to constitute a major fraction of salmonid diets in summer and early fall (Kennedy 1967; Elliot 1967a; Hunt 1975), apparently related to easy accessibility as prey items and abundance at this time of year. Drift feeding presumably requires less energy for capture of prey than does benthic foraging, leaving more energy available for growth. Reliance on epibenthic feeding by rainbow trout in the McCloud River, California was thought to be partly responsible for slow growth rates observed for fish in this stream (Tippets and Moyle 1978).

A strong correlation between stream discharge and quantity of drift has been shown (Chapman 1966a; Elliot 1967a; Waters 1972; Everest and Chapman 1972). However, drift has also been found to be greatest in summer decreasing in the fall to a low in winter and increasing during the spring to peak abundance in summer, a pattern probably related more to life cycles, temperature and emergence patterns than to stream flow (Waters 1969; Chapman and Bjornn 1969). Drift abundance has been found to decline as summer progressed (Griffith 1974). Drift density on the other hand has been observed to increase with declining flows (Minshall and Winger 1968; Pearson and Franklin 1968; Canton et al. 1984). However, Minshall and Winger based their conclusions on extreme artificial flow reductions over a short period of time and Pearson and Franklin examined two species with a prospensity for behavioral drift.

Direct comparison to other published studies on prey consumed vs. prey availability for salmonids is often difficult. A number of studies have concluded that trout feed largely on drifting benthic and terrestrial invertebrates (Elliot 1967b, 1973; Chaston 1969; Jenkins et al. 1970). Others have found correlations only between terrestrial drift (Chaston 1968) or benthic invertebrate drift (Elliot 1970). There also are cases where bottom organisms appear to be the primary food (Warren et al. 1964; Tippets and Moyle 1978). These diverse findings are not suprising since feeding habits have been shown to differ with age (Elliot 1967b, 1970; Tippets and Moyle 1978), species (Egglishaw 1967; Allan 1978; Johnson and Johnson 1981) and habitat (Egglishaw 1967; Johnson and Ringler 1980; Wilzbach and Hall 1985). Other factors including season, differences in prey species present and geographical location contribute to differing conclusions. Interpretation is further complicated by various methodologies used to gather and analyze data.

Clearly, comparisons between various prey injested vs. prey availability studies must be based on generalizations. These studies demonstrate that differing charateristics for individual streams affect prey availability and feeding. To fully understand interactions between the two, a seasonal program of drift, benthic, and feeding evaluations is necessary.

The purpose of this study was to compare seasonal abundance of aquatic invertebrates to utilization by juvenile steelhead trout. A secondary objective was to determine if food abundance in late fall could be a limiting factor in growth rates of juvenile steelhead in

Jacoby Creek during this period. Three diverse habitats were chosen for examination because the physical characteristics of a stream (i.e. depth velocity, substrate, bank vegetation, etc.) often influence invertebrate abundance and composition. Specific objectives were to:

1) Determine relative seasonal abundance and compositon of drift and benthic organisms.

2) Examine feeding habits of juvenile steelhead trout in relation to food present in the environment.

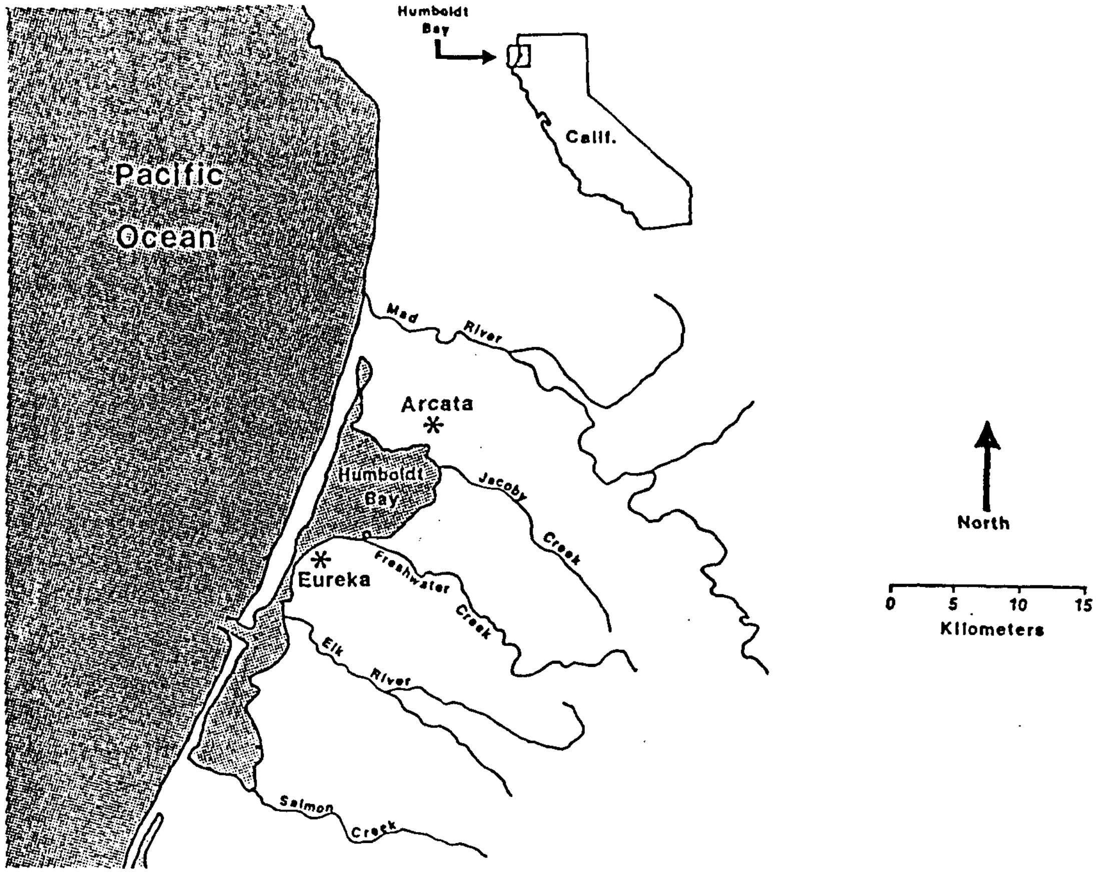
STUDY AREA

Jacoby Creek, located in northern California, empties into Humboldt Bay 10 kilometers north of the city of Eureka (Figure 1). The stream is 17 kilometers long and drains an area of 42 square kilometers. The study area was restricted to the anadromous zone of the creek which extends 8.3 kilometers from the mouth.

The geology of the watershed is primarily Franciscan formation, characterized by shear zones which collect water. Climate is characterized by cool, wet winters and mild, dry summers. Much of the drainage is cooled by coastal fog during spring and summer. Approximately 90 percent of mean annual precipitation (60.65 inches) occurs from October to April (Elford and McDonough 1974). Flow is maintained during the dry summers by release of ground and bank storage.

The creek is subject to highly variable flows in the winter and stable low flows during the summer. No recent discharge data are available. Discharge measured in the upper 15.7 km^2 (6.07 square miles) of watershed from 1954 to 1960 ranged from a minimum of 0.02 m^3/sec (0.6 $ft.^3$/sec) in September to a maximum of 47 m^3/sec (1,670 ft^3/sec) in December (USGS 1964).

Three sites which were disimilar in habitat characteristics were sampled (Figure 1). The lower sample site (station I) was located 1.4 kilometers from the mouth in an alluvial flood plain. This section of stream is channelized, with steep banks and a narrow streambed width of 3-4 meters. The streambed is characterized by numerous shallow silt-filled pools and riffles composed of primarily small gravels 0.5-3.5 cm



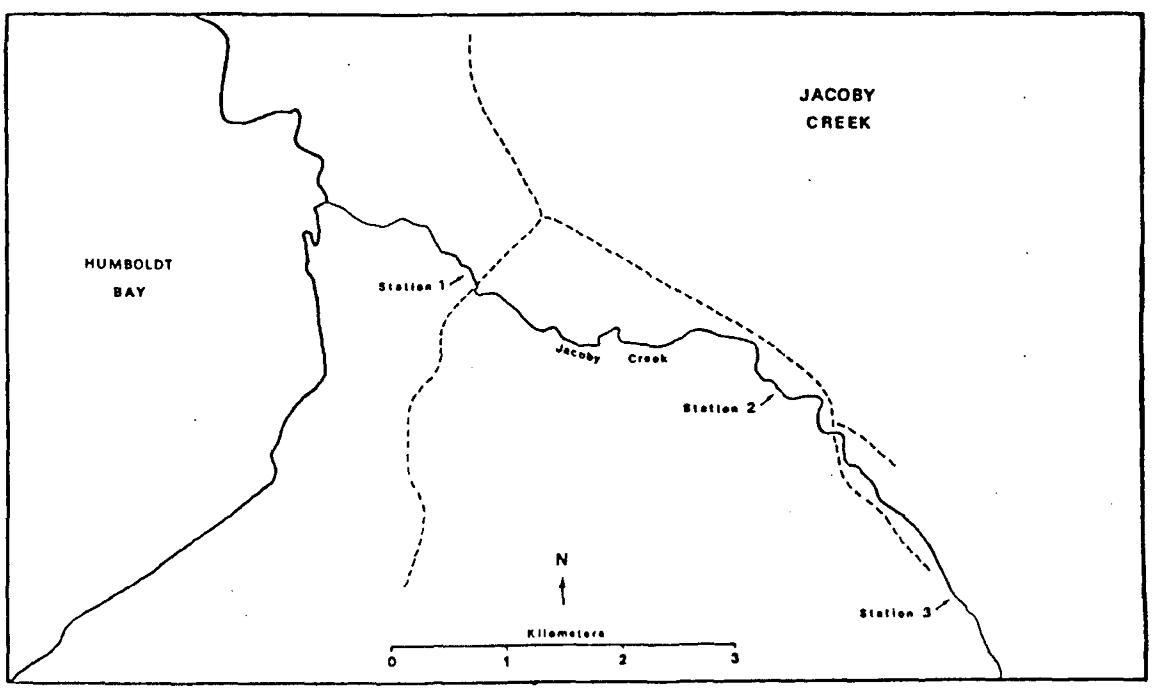


Figure 1. Location map of Jacoby Creek (upper) and sampling sites (lower).

in diameter (Appendix A). The banks are heavily vegetated with grasses and shrubs, including salmonberry (*Rubus spectabilis*) and evergreen huckleberry (*Vaccinium ovatum*). Willow (*Salix* spp.) and red alder (*Alnus rubra*) dominate a dense canopy along with scattered cottonwood (*Populus trichocarpa*).

The middle site (station II) was located 4.5 kilometers from the mouth, running through a lightly developed residential area. The streambed in this section is characterized by long stretches of riffles and runs and a few large deep pools. Substrate consists primarily of gravels 0.9-6.2 cm in diameter. The average streambed width is 6.0 meters. Streambank vegetation is lacking except for grasses, though a dense overstory of big-leaf maple (*Acer macrophylum*), willow, and red alder, exists. The average gradient in this section of stream is 1.5 percent.

The upper site (station III) was located 6.5 kilometers from the mouth and runs through an area of relatively steep side slopes of second growth conifers. The streambed is open except for small willows along the banks; very little overstory exists near the stream channel. This section of stream has a gradient of 3-5 percent and is characterized by cascades and pocket water with numerous large rocks and boulders. Streambed width was 4-7 meters. The study riffle was composed of mostly large gravel and cobble, 8.0-15.0 cm in diameter.

MATERIALS AND METHODS

Data Collection

Benthos. Benthic samples were taken in riffles using a kick method modified from Frost et al. (1971). Modifications included disturbing the substrate three times per sample to a depth of approximately 10 cm and the use of a quadrat (30 cm by 1 m) laid on the stream bottom to delineate the area to be sampled. The kick net consisted of a 25 cm long, 12 strand per cm net attached to a 30.5 cm triangular frame with a 1.3 meter handle.

Four samples were taken each month at each site except in low flow periods when reduced riffle area necessitated a reduction to three samples. Sampling locations in riffles were selected by eye. The study riffles were generally too small in area during low flow months for assigning sampling location by random or systematic methods. Depth of samples ranged from 7.5 to 18.0 cm and current velocity ranged from 0.2 to 0.9 m/sec, though a few exceptions occurred on the March sampling date. Substrate compostion within each sample riffle was fairly uniform, minimizing variation when selecting sample location. All contents were removed from the net and placed in 80 percent ethanol for later sorting and identification.

The kick method was chosen due to the highly variable substrate at station III, which prohibited the use of other standard samplers. Limitations of this method have been discussed by Frost et al. (1971); the main disadvantage is the possibility of underestimating firmly attached organisms. However, a number of studies have shown this technique to be less variable than many standard samplers (Morgan and Egglishaw 1965; Grossman and Cairns 1974; Kinney et al. 1977). This method has also been shown to provide the best statistical reproducibility of standard methods (Kinney et al. 1977).

Drift. Two drift nets (30.5 cm square frame with 90 cm long, 12 strand per cm net) were placed across the stream at the downstream end of the riffle at each station. During low flow periods only one net was used. Nets were emptied every four hours over a 24 hour period except when flows exceeded 0.3 cubic meters per second (10 cfs). Due to large amounts of debris that accumulated in nets under higher flow conditions, sampling was limited to one hour during each four hour period, decreasing the possibility of backwash and loss of samples. Depth and velocity were recorded at each net during the sampling period for use in estimating the volume of water sampled and subsequent calculations of drift densities. Samples were removed from the nets and placed in 80 percent ethanol for later sorting.

Stomachs. Fish were collected by electrofishing approximately one to two hours after sunrise. Fish were measured, weighed, and placed in a five percent formalin solution. Within eight hours stomachs were removed, tagged with identification, and placed in 80 percent ethanol for later analysis.

Physical Data. Substrate size analysis of the three study riffles was accomplished using a gravel sampler similar to the one described by NcNeil and Ahnell (1964). Four replicate samples were collected at each site. Seive sizes are shown in Appendix A. Flow was measured using a Gurley pygmy meter.

Data Analysis

Laboratory. Benthic, drift and stomach samples were sorted from debris and placed into large taxanomic groups for later identification. Sorting and identification were done using a 10X magnification binocular dissecting microscope. All aquatic invertebrates were identified to the lowest practical taxanomic level using keys and classification systems from Usinger (1956), Edmunds et al. (1976), Wiggins (1977), and Merrit and Cummins (1978). Terrestrial organisms were identified to order or family levels.

Contents of the cardiac and pyloric regions of the stomach were used in diet determination. Identification of organisms from stomachs was not always possible due to breakdown, particularly of soft bodied species. Most hard body parts such as head capsules and legs were placed into family or generic levels by comparison to drift and benthic sample specimens.

Volume was estimated for stomach samples by displacement in a series of graduated cylinders. Contents of each stomach were removed, dried on filter paper for three minutes, then measured to the nearest 0.01 cc. Food items were separated from non-food items (i.e. gravel, caddisfly cases etc.) prior to volume measurements. Percentage volume was obtained by combining all stomachs from each sample site for each date, due to the difficulty of obtaining accurate volume measurements of small items for separate stomach samples.

Statistical. Analyses were performed to determine if significant differences between sites were present for major groups and taxa from benthic, drift and stomach samples. The null hypothesis (Ho) was that no significant difference in numbers would be present across sampling sites. A rejection of this hypothesis was assumed to be due to differences in observed and measured habitat characteristics between sites. Benthic and stomach data were transformed by $\log_{10}(x + 1)$ for analysis. Confidence intervals for mean benthic densities were calculated for transformed means but applied to arithmetic means as described by Elliot (1977, p91).

Initial two-way ANOVA's (station verus date) performed on benthic densities and stomach contents were consistent for almost all group and taxa comparisons in that station x date interactions were significant. These results reflected the inherent variability in macroinvertebrate samples, whether from the benthos or stomachs, due to the cyclic nature of macroinvertebrate populations. Because sample sizes were too small to conduct statistical tests by individual months, a decision was made to analyze data within seasons by two-way ANOVA. It was also thought that testing for differences within seasons would be biologically more meaningfull since macroinvertebrate life cycles fluctuate with changes in seasons. A posteriori comparisons, to determine which stations differed, were made using Tukey's test (Sokal and Rohlf 1969, p238). Seasons used in analyses were winter (February and March), spring (April to June), summer (July to September), and fall (October to December).

Drift samples were treated differently than benthic and stomach samples, since no estimate of variability could be made due to lack of replication. Differences between sites were tested by Friedman's non-parametric ANOVA (Sokal and Rohlf 1969, p398) in which dates were treated as blocks, and density at the three sites was ranked for each date. Statements in the text concerning maximum and minimum drift densities are made, even though there was no statistical support due to lack of variance estimates. However, drift samples are generally less variable than benthic samples (Chutter 1975; Allen 1982).

A predetermined level of significance for all tests involving multiple comparisons (i.e. large number of taxa) was set at $\alpha = 0.10$ and divided by the number of comparisons (taxa and groups) made for a specific analysis. This correction, based on Bonferroni's inequality (Feller 1950), was used to eliminate erroneous significant differences which can occur when multiple, dependent tests are conducted. Analysis was performed using the Statistical Package for the Social Sciences, SPSS (Nie et al. 1981).

Diversity was calculated for benthic, drift, and stomach samples using the Shannon-Weaver (H) index (Pielou 1975):

$$H = -\sum_{i=1}^{s} p_i \ln p_i$$

where s = number of taxa in sample

$\ln$ = natural log

p_i = relative abundance of individuals of the ith taxa as a proportion of the total number of individuals of all taxa

Diversity was calculated using the lowest taxanomic groups identified as shown in Appendix C.

A linear index of food selection (Strauss 1979) was used to compare the relative abundance of prey items in the gut to the relative abundance of prey items in the feeding environment:

$$L = r_i - p_i$$

where L = electivity index

r_i = relative abundance of food item in stomachs

p_i = relative abundance of food item in environment

Several problems are apparent when applying a selection index to evaluate the relationship between feeding habits and availability of potential prey items: (1) all prey items are not equally susceptable to predation in the same proportions in which they are sampled from the environment; (2) in a stream it is not always possible to determine, except in the case of terrestrial organisms, whether a food item has been taken from the substrate or while drifting; (3) the relationship between abundance of food items in the drift and benthos varies with changes in flow and invertebrate life cycles.

It is difficult to compensate for the influence of the first problem on a selection index. The vulnerability of a prey item can be substantially different with respect to predation and sampling. Benthic organisms may occupy a microhabitat, under rocks or beneath the substrate, which makes them relatively inaccessible to predation but not to sampling. Because of this, an index can only be used as a tool in interpretation of food selection and not as an absolute measure.

The next two problems can be dealt with by assuming that a feeding fish would have at its disposal all food items present on the substrate and those drifting in the water column above the substrate within its feeding area. Following this assumption the relative abundance of prey items was estimated by combining the number of drifting invertebrates which passed over a unit area of stream during a four hour period (number/4 hrs/m^3) prior to stomach sampling and the number of benthic invertebrates in the same unit area (number/m^2).

A four hour period was selected because drift samples were collected in four hour intervals. Based on gastric evacuation data from Windell et al. (1976), and temperature ranges encountered in this study, most food items injested during this time period would still be in the gut and identifiable.

Months referred to in the text and tables are approximately the first day of that month, since all sampling dates were within one to two days of the first of each month. January sampling was not completed due to high flows. The following convention is used throughout the text: aquatic refers to those organisms which are totally aquatic or in an aquatic stage of life, terrestrial refers to those organisms which are totally terrestrial or aquatic forms in a terrestrial life stage.

RESULTS

Benthos

Fauna Composition

Of the 77 taxa collected from benthic samples 55 were common to all stations, eight occurred at only two stations and 14 were exclusive to one station (Appendix C). Twelve of the 14 taxa found at only one station were represented by less than 10 individuals over the sampling season. Station III contained 10 taxa not found at the other stations, two of which, *Hydroptila* sp. and *Neophylax* sp., were common at this site. Seventeen taxa, represented by less than 10 individuals from all samples collected during the year were considered rare and of little importance to overall benthic abundance.

Though possessing similar fauna, differences in proportions of some major component taxa between stations were apparent (Table 1). The total of monthly mean benthic densisties showed a trend toward a longitudinal relationship between stations for some taxa. This was particularly evident in the Trichoptera and Ephemeroptera. *Glossosoma* sp., abundant at station III exhibited progressively decreasing numerical importance moving downstream to station I. The opposite was true of *Lepidostoma* sp., the most abundant Trichopteran at station I. Among the Ephemeroptera, *Cinygmula* sp., *Paraleptophlebia* sp., *Heptegenia* sp., *Ephemerella coloradensis*, and *Tricorythodes minutus* also exhibited a longitudinal relationship in total numbers between stations.

By station, the major orders were dominated numerically by the same taxa with the exception of the Trichoptera. Over 70 percent of the

Table 1. Total of monthly mean benthic densities (number per m²), November 1978 to October 1979, of major aquatic invertebrate taxa from benthic samples taken at three sites on Jacoby Creek, California.

Taxa	Station I	Station II	Station III
EPHEMEROPTERA			
Ameletus sp.	40	41	128
Baetis sp.	921	609	1,021
Cinygmula sp.	2,271	1,292	683
Ephemerella coloradensis	50	119	435
Ephemerella hecuba	18	19	18
Ephemerella levis	4	18	71
Ephemerella teresa	9	30	38
Ephemerella tibialis	27	8	45
Heptegenia sp.	352	140	77
Iron sp.	131	246	115
Paraleptophlebia sp.	228	68	6
Paraleptophlebia helena	83	26	24
Rithrogena sp.	801	2,278	1,326
Tricorythodes minutus	9	20	68
Other Ephemeroptera	24	12	57
PLECOPTERA			
Calineuria californica	220	217	400
Hesperoperla pacifica	34	17	16
Alloperla sp.	95	42	122
Capnia sp.	39	7	3
Isogenus sp.	44	19	18
Isoperla spp.	27	71	93
Nemoura sp	240	142	147
Other Plecoptera	2	1	--
TRICHOPTERA			
Dicosmoecus sp.	28	7	12
Gumaga nigricula	13	5	80
Glossosoma sp.	68	433	1,087
Hydropsyche sp.	19	65	379
Hydroptila sp.	--	--	99
Lepidostoma sp.	645	153	187
Limniphilidae sp.	3	26	61
Neophylax sp.	--	--	221
Neophylax rickeri	15	24	34
Onocosmoecus sp.	22	5	2
Rhyacophila sp.	289	257	440
Other Trichoptera	13	42	71
DIPTERA			
Chironomidae[1]	390	1,189	1,106
Simulium sp.[1]	19	178	28
Tipulidae[1]	255	188	216
Other Diptera	5	30	29
COLEOPTERA			
Dytiscidae[2]	159	9	104
Elmidae[2]	2,757	1,104	2,389
Eubrianax edwardsi	21	88	107
Other Coleoptera	26	11	10
OLIGOCHEATA	69	11	10
MISCELLANEOUS	13	12	33

[1] larvae and pupae

[2] larvae and adult

Ephemeroptera at all stations consisted of Baetis sp., Cinygmula sp. and Rithrogena sp. The dominate Trichopterans were Lepidostoma sp. and Rhyacophila sp. at station I, Glossosoma sp., Lepidostoma sp. and Rhyacophila sp. at station II and Glossosoma sp., Rhyacophila sp. and Hydropsyche sp. at station III. Diptera and Coleoptera were dominated by Chironomidae and Elmidae, respectively, at all stations. Nemoura sp. and Calineuria californica accounted for approximately 70 percent of the total mean densities of Plecoptera at each station.

Seasonal Fluctuations

Total benthic densities were lowest between December and March and highest between August and October (Figure 2). Confidence intervals (95%) for major groups and taxa and are included in Appendix D. For clarity, these were omitted from Figures 2, 3 and 4. Minimum total benthic densities of 56 and 126 individuals per m^2 occurred in March at stations I and II respectively, and in December at station III (161 individuals per m^2). Benthic densities were highest in September at station III (2,300 individuals per m^2) and October a stations I and II (1,974 and 2,166 individuals per m^2). The major orders with the exception of the Ephemeroptera followed similar seasonal patterns with low densities during winter and spring months (December to May) and peaks occurring in late summer and early fall (August to October) (Figure 3).

The Ephemeroptera was the only order to exhibit no definitive seasonal peak (Figure 3). Minimum densities occurred in December at station III (112 individuals per m^2) and March at stations I and II (48 and 96 individuals per m^2), but accounted for over 70 percent of the total benthic population during these months. From April to November mayfly densities were relatively constant except for two large peaks,

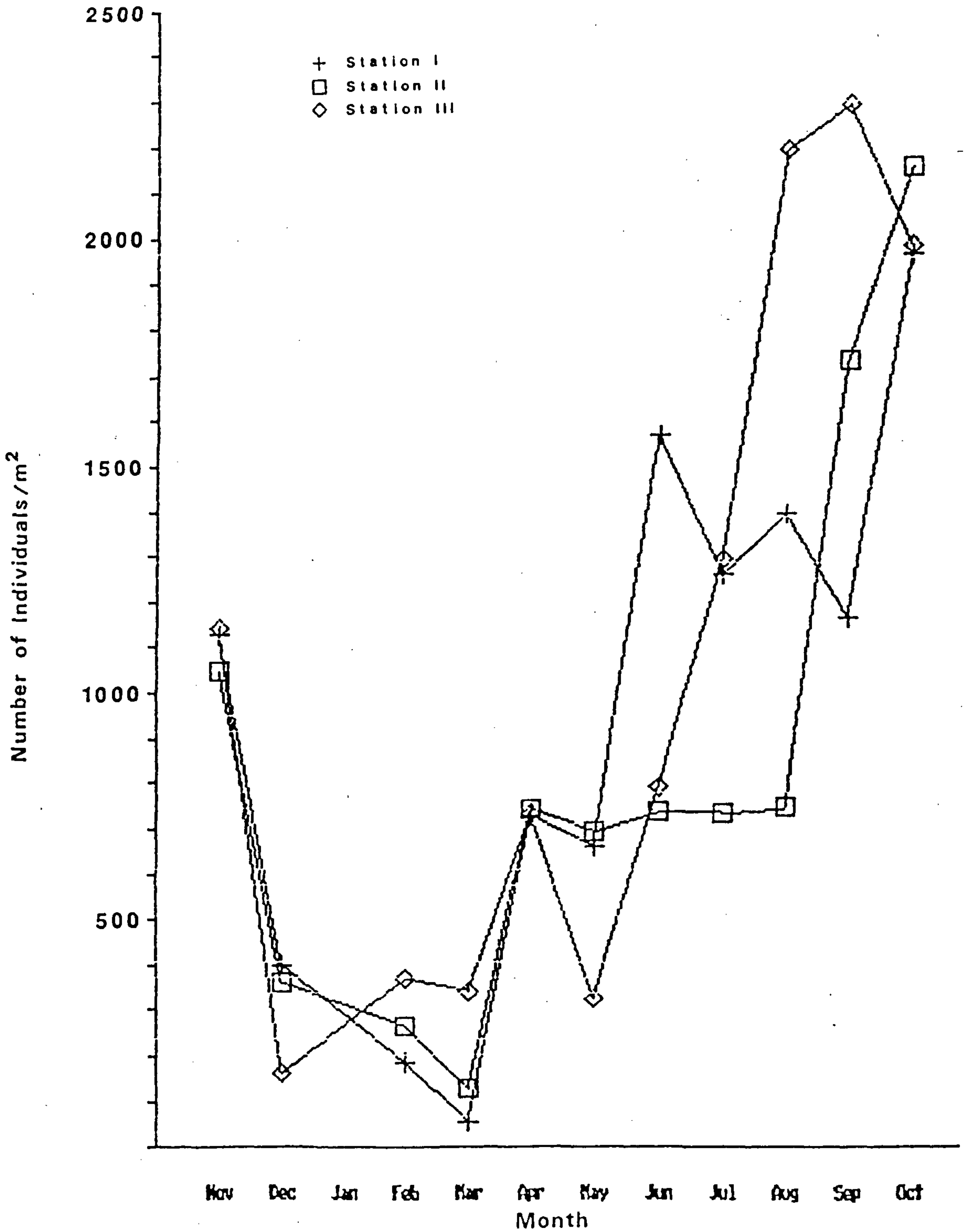


Figure 2. Seasonal fluctuations in total benthic densities (number/m^2) at three sites on Jacoby Creek from November 1978 to October 1979.

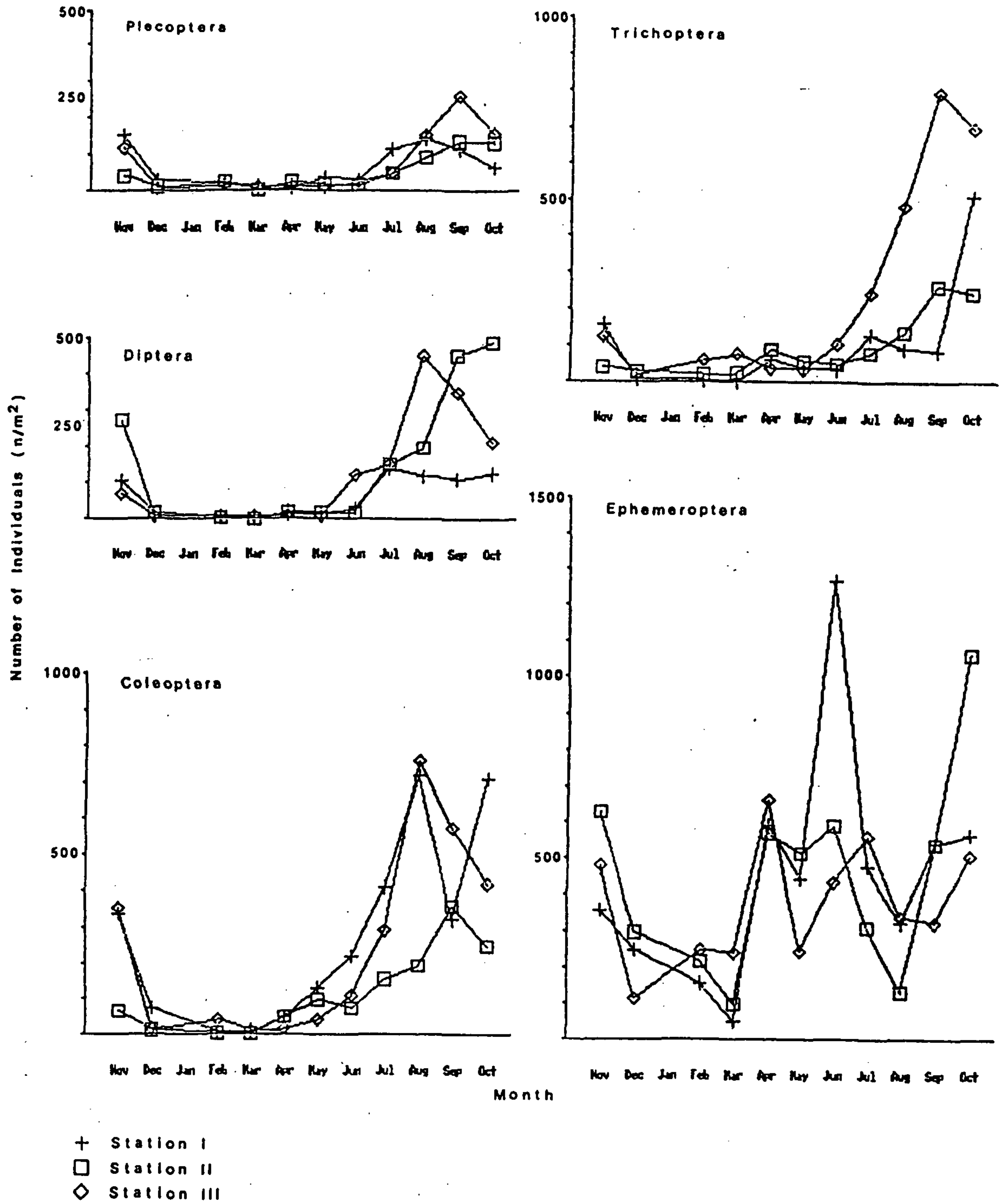


Figure 3. Seasonal fluctuations in benthic densities (number/m^2) of major orders at three sites on Jacoby Creek from November 1978 to October 1979.

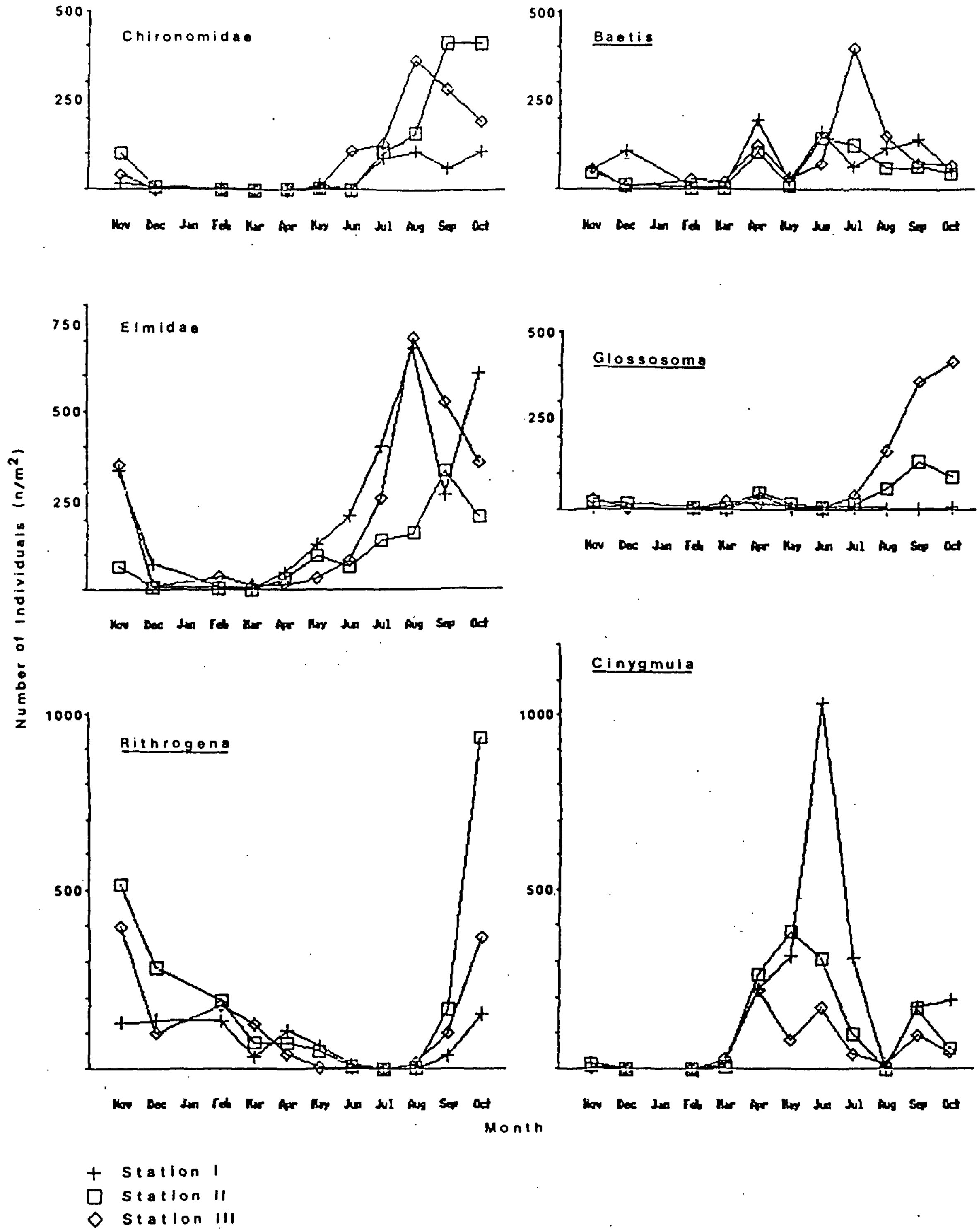


Figure 4. Seasonal fluctuations in benthic densities (number/m^2) of major taxa at three sites on Jacoby Creek from November 1978 to October 1979.

June at staion I, due mainly to Cinygmula sp. (1,034 individuals per m^2) and October at station II, due mainly to Rithrogena sp. (932 individuals per m^2) (Figure 4).

Seasonal fluctuations of mayflies were primarily the result of variations in Baetis sp., Cinygmula sp. and Rithrogena sp. populations (Figure 4). Cinygmula sp. and Rithrogena sp. displayed divergent seasonal cycles. Rithrogena sp. were most abundant from September to April with peaks in October and November while Cinygmula sp. obtained maximum densities between April and July with essentially no individuals present from November to March.

Caddisfly densities were lowest between December and June with Glossosoma sp., Hydropsyche sp., Rhyacophila sp. and Limniphilidae being the most abundant at the three stations during this time period. Maximum densities were obtained in October at stations I and II (513 and 242 individuals per m^2, respectively) and in September at station III, 798 individuals per m^2 (Figure 3).

At station I, Lepidostoma sp. accounted for 95 percent of all caddisfly larvae in October and 85 percent in November, the two months of highest Trichopteran density at this station. The increase in Trichoptera populations at stations II and III beginning in July and continuing through October was mainly due to Glossosoma sp. (Figure 4), which represented 45 percent of the total numbers during this period at both stations. Hydroptila sp. and Neophylax sp., two taxa exclusive to station III, only occurred in benthic samples between July and October.

The principal taxa responsible for seasonal changes in the Diptera and Coleoptera were Chironomidae and Elmidae. The similarity in seasonal fluctuations between these two groups and associated taxa can be seen in Figures 3 and 4. Stoneflies exhibited the lowest overall densities of any of the major orders. Maximum densities were observed between July and November and attributed to two genera, Nemoura sp. and Calineuria californica (Figure 3).

Significant differences between stations for major groups and taxa were found primarily in winter and summer (Table 2). In most cases, station versus date interactions within seasons were not significant by two-way ANOVA. In cases where a significant interaction was found, a posteriori tests were not conducted. Most significant interactions occurred in spring and summer, when benthic populations were increasing, apparently an influence of differing peaks and declines in life cycles of some taxa between sites.

Significant differences observed in winter were not considered as important as those observed in summer, due to the level of discrimination and the magnitude at which a difference could be detected. For example, means differed by approximately a factor of three for Trichoptera when a significant difference was detected between stations in both winter and summer. Since means were much lower in winter than summer, the actual difference between densities was substantially greater in summer. It was also considered more indicative of major differences in mean densities between stations when a taxon or group was at the peak of its life cycle, and not at a low point where few individuals occurred. Following this reasoning, differences between stations for Ephemerella spp. (fall, winter, and spring), Hydropsyche sp. (fall, winter, and summer), and Trichoptera (summer) including associated taxa, Gumaga nigricula, Glossosoma sp., and Limniphilidae were considered strong indicators of differences between sites as these were the periods in

Table 2. Results of two-way ANOVAs for differences in benthic densities of major groups and taxa within seasons between stations I, II, and III, Jacoby Creek, November 1978 to October 1979. Inequality signs indicate results of Tukey's a posteriori test when significant difference ($p<0.005$; see methods for calculation of significance level) was detected.

Groups and Taxa	Season			
	Fall	Winter	Spring	Summer
Ephemeroptera	ns	ns	ns	ns
Plecoptera	ns	ns	ns	ns
Trichoptera	ns	I<II<III	ns	I=II<III
Diptera	ns	ns	ns	ns
Coleoptera	ns	ns	ns	I=III>II
Baetis sp.	ns	I=II<III	ns	ns
Cinygmula sp.	ns	ns	I=II>III	ns
Ephemerella spp.	I=II<III	I=II<III	I=II<III	ns
Rithrogena sp.	ns	ns	I=II>III	ns
Nemouridae	ns	ns	ns	ns
Glossosoma sp.	ns	ns	ns	I<II=III
Gumaga nigricula	ns	--*	ns	I=II<III
Hydropsyche sp.	I=II<III	I=II<III	ns	I=II<III
Lepidostoma sp.	ns	ns	ns	ns
Limniphilidae	ns	ns	ns	I=II<III
Chironomidae[1]	ns	ns	ns	ns
Elmidae[2]	ns	ns	ns	I=III>II
Total Fauna	ns	I<III	ns	ns

[1] larvae and pupae
[2] larvae and adult
* no individuals collected

which these taxa were at peak densities. In all the above cases station I and II showed lower densities than station III with the exception of Glossosoma sp. in summer.

Percentage Composition

Total mean number per m^2 and percentage occurrence of major orders are given in Table 3. Ephemeroptera dominated all sites from December to June and averaged 76, 78 and 71 percent of the total fauna at stations I, II and III, respectively, during this time period. A more even distribution between major groups was observed from July to November at all stations with no single order dominating. The only major exception occurred at station I in November when mayflies accounted for 60 percent of the total.

During the period from July to November Ephemeroptera and Coleoptera combined, accounted for 62 to 74 percent of the benthic population at station I. There was only one sampling date during this time period in which an order, other the above, accounted for over 20 percent of the bottom fauna at this station. From July to October at station II all orders except the Plecoptera accounted for a substantial portion of the total benthic population, although the highest overall percentage was due to Ephemeroptera.

The percentage of Trichoptera were higher at station III between July and October than either stations I or II. In September and October this order accounted for the largest proportion at station III, the only dates in which Trichoptera dominated the benthic fauna at any of the three stations. Percentages of other major groups varied considerably from July to October at this station.

Table 3. Percentage composition of major groups and total mean number per m^2 of aquatic invertebrates from benthic samples taken at three sites on Jacoby Creek, November 1978 to October 1979.

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
Station I											
Ephemeroptera	31.7	61.2	81.0	85.8	81.3	66.6	80.4	37.7	22.9	46.3	28.5
Trichoptera	13.9	1.7	1.9	--	8.4	5.4	2.0	10.2	6.6	7.0	25.9
Plecoptera	13.3	7.4	10.9	4.7	0.1	5.2	1.7	8.8	10.2	9.6	3.1
Coleoptera	30.0	17.7	3.3	9.5	6.5	19.4	13.9	32.3	51.1	27.5	35.7
Diptera	9.3	3.8	1.0	--	2.4	2.3	1.7	11.0	8.2	9.1	6.4
Miscellaneous	1.8	8.2	1.9	--	1.3	1.1	0.3	--	1.0	0.5	0.4
Mean No./m^2	1,124	398	188	56	727	663	1,572	1,263	1,400	1,165	1,974
Station II											
Ephemeroptera	60.1	82.4	81.3	76.4	76.8	73.8	79.7	42.1	17.3	30.8	48.7
Trichoptera	3.8	7.1	7.4	20.0	11.7	7.7	6.5	10.3	18.1	15.1	11.2
Plecoptera	3.6	2.9	9.1	2.2	3.0	1.8	1.8	6.2	12.4	7.5	6.2
Coleoptera	6.2	2.4	0.3	0.7	6.3	14.0	9.5	21.1	25.4	20.5	11.4
Diptera	26.0	3.9	1.3	--	1.8	2.2	2.1	20.0	25.9	25.8	22.5
Miscellaneous	0.3	1.3	0.6	0.7	0.4	0.5	0.4	0.3	0.9	0.3	--
Mean No./m^2	1,047	361	265	126	742	695	740	735	748	1,741	2,166
Station III											
Ephemeroptera	42.0	70.4	68.0	69.5	90.2	73.7	54.8	43.4	15.3	14.0	25.5
Trichoptera	10.9	11.1	16.0	22.5	5.1	9.5	12.8	18.7	22.1	34.8	34.5
Plecoptera	10.2	4.4	4.4	3.2	1.3	3.7	2.5	3.5	6.7	11.2	7.7
Coleoptera	30.9	8.9	10.2	3.5	2.2	11.7	13.8	22.5	34.4	24.8	21.1
Diptera	5.8	2.8	1.4	1.3	1.1	1.4	15.5	11.6	20.3	15.0	10.7
Miscellaneous	0.2	2.4	--	--	0.1	--	0.6	0.3	1.2	0.2	0.5
Mean No./m^2	1,141	161	368	341	735	327	792	1,296	2,197	2,300	1,994

Five taxa accounted for 65 to 93 percent of the total benthic population at each station through the year (Table 4). For all sampling dates two or three taxa combined to make up over 50 percent of the total benthic fauna. The highest percentage contribution of any single taxon was in December at stations II and III (78 and 62 percent) and February at station I (71 percent), due to *Rithrogena* sp. The three stations were dominated by the same taxa on six of the eleven sampling dates. Individuals of *Cinygmula* sp. and *Rithrogena* sp. were the most important taxa at all stations from November to June except for station I in November. Elmidae and Chironomidae made up significant proportions of the total fauna for the remaining months at all sites.

Drift

Fauna Composition

The aquatic drift fauna was similar between the three sites for major taxa. A total of 78 aquatic taxa were identified of which 52 were common to all stations, eight were represented at two stations and 17 were found exclusively at one station (Appendix C). Twenty two of the 78 taxa were considered rare (i.e. less than 10 individuals collected over the season from all stations), 16 occurred at only one station, of which nine were found specifically at station III. All major terrestrial groups were present in the drift at all stations.

Total monthly densities of major aquatic drift taxa varied little between sites (Table 5). Three taxa, *Baetis* sp., Chironomidae and Elmidae were the primary representative taxa occurring at all stations, though total Chironomidae density was lower overall at station III. Limniphilidae sp. was a major drift component at stations II and III,

Table 4. Five most common taxa by percentage of total number of invertebrates from benthic samples taken at three sites on Jacoby Creek, November 1978 to October 1979.

Date	Station I	%	Station II	%	Station III	%
	Elmidae	30	*Rithrogena* sp.	49	*Rithrogena* sp.	35
	Paraleptophlebia sp.	14	*Simulium* sp.	12	Elmidae	31
Nov.	*Lepidostoma* sp.	12	Chironomidae	10	*Isoperla* B sp.	7
	Nemoura sp.	11	Elmidae	6	*Baetis* sp.	5
	Rithrogena sp.	11	*Paraleptophlebia* sp.	5	*Hydropsyche* sp.	4
		78		82		82
	Rithrogena sp.	34	*Rithrogena* sp.	78	*Rithrogena* sp.	62
	Baetis sp.	27	*Glossosoma* sp.	4	Elmidae	7
Dec.	Elmidae	18	*Baetis* sp.	3	*Rhyacophila* sp.	5
	Oligocheata	7	*Rhyacophila* sp.	2	*Hydropsyche* sp.	4
	Capnia sp.	3	Elmidae	2	*Baetis* sp.	4
		89		89		82
	Rithrogena sp.	71	*Rithrogena* sp.	71	*Rithrogena* sp.	49
	Nemoura sp.	7	*Iron* sp.	7	*Hydropsyche* sp.	10
Feb.	*Iron* sp.	7	*Isoperla* B sp.	7	Elmidae	9
	Baetis sp.	3	*Glossosoma* sp.	3	*Baetis* sp.	7
	Elmidae	3	*Rhyacophila* sp.	2	*Ephemerella levis*	6
		91		90		81
	Rithrogena sp.	52	*Rithrogena* sp.	56	*Rithrogena* sp.	36
	Cinygmula sp.	25	Limniphilidae sp.	12	*Iron* sp.	10
Mar.	Elmidae	8	*Iron* sp.	7	Limniphilidae sp.	10
	Baetis sp.	3	*Glossosoma* sp.	6	*Cinygmula* sp.	8
	Capnia sp.	3	*Cinygmula* sp.	6	*Ephemerella coloradensis*	7
		91		87		71
	Cinygmula sp.	31	*Cinygmula* sp.	36	*Cinygmula* sp.	30
	Baetis sp.	26	*Baetis* sp.	14	*Ephemerella coloradensis*	25
Apr.	*Rithrogena* sp.	15	*Rithrogena* sp.	10	*Baetis* sp.	17
	Iron sp.	6	*Iron* sp.	10	*Ameletus* sp.	8
	Elmidae	6	*Glossosoma* sp.	7	*Rithrogena* sp.	5
		84		77		85
	Cinygmula sp.	47	*Cinygmula* sp	55	*Ephemerella coloradensis*	27
	Elmidae	20	Elmidae	14	*Cinygmula* sp.	25
May	*Rithrogena* sp.	10	*Rithrogena* sp.	7	*Baetis* sp.	10
	Baetis sp.	3	*Iron* sp.	6	Elmidae	10
	Isogenus sp.	3	*Ephemerella coloradensis*	4	*Ameletus* sp.	8
		83		86		80
	Cinygmula sp.	66	*Cinygmula* sp.	41	*Cinygmula* sp.	21
	Elmidae	13	*Baetis* sp.	20	Chironomidae	14
Jun.	*Baetis* sp.	10	*Iron* sp.	10	*Ephemerella coloradensis*	12
	Limoniinae	2	Elmidae	9	Elmidae	11
	Iron sp.	2	*Ephemerella coloradensis*	4	*Baetis* sp.	9
		93		84		67
	Elmidae	32	Elmidae	20	*Baetis* sp.	31
	Cinygmula sp.	24	*Baetis* sp.	17	Elmidae	20
Jul.	*Rhyacophila* sp.	8	Chironomidae	14	Chironomidae	10
	Chironomidae	7	*Cinygmula* sp.	13	*Rhyacophila* sp.	7
	Calineuria californica	7	*Rhyacophila* sp.	5	*Neophylax* sp.	6
		78		69		74
	Elmidae	48	Elmidae	22	Elmidae	32
	Heptegenia sp.	12	Chironomidae	21	Chironomidae	16
Aug.	*Baetis* sp.	8	*Calineuria californica*	8	*Glossosoma* sp.	7
	Chironomidae	8	*Baetis* sp.	8	*Baetis* sp.	7
	Calineuria californica	6	*Glossosoma* sp.	8	*Rhyacophila* sp.	5
		82		67		67
	Elmidae	23	Chironomidae	23	Elmidae	23
	Heptegenia sp.	15	Elmidae	19	*Glossosoma* sp.	17
Sep.	*Cinygmula* sp.	14	*Cinygmula* sp.	10	Chironomidae	12
	Baetis sp.	12	*Rithrogena* sp.	9	*Calineuria californica*	7
	Rhyacophila sp.	5	*Glossosoma* sp.	8	*Hydropsyche* sp.	6
		69		69		65
	Elmidae	31	*Rithrogena* sp.	43	*Glossosoma* sp.	21
	Lepidostoma sp.	25	Chironomidae	19	*Rithrogena* sp.	18
Oct.	*Cinygmula* sp.	10	Elmidae	9	Elmidae	18
	Rithrogena sp.	8	*Glossosoma* sp.	5	Chironomidae	10
	Chironomidae	6	*Lepidostoma* sp.	4	*Calineuria californica*	5
		80		80		72

Table 5. Total of monthly drift densities (number per 100 m^3), November 1978 to October 1979, of major aquatic invertebrates from drift samples taken at three sites on Jacoby Creek, California.

Taxa	Station I	Station II	Station III
AQUATIC			
EPHEMEROPTERA			
Ameletus sp.	35	56	15
Baetis sp.	352	563	503
Cinygmula sp.	52	67	39
Ephemerella spp.	17	17	27
Iron sp.	19	15	19
Paraleptophlebia sp.	37	49	22
Paraleptophlebia helena	10	39	35
Rithrogena sp.	15	15	28
Tricorythodes minutus	2	26	13
Other Ephemeroptera	10	26	19
PLECOPTERA			
Capnia sp.	67	28	12
Nemoura sp.	25	18	30
Isoperla spp.	4	19	9
Other Plecoptera	10	6	4
TRICHOPTERA			
Amiocentrus aspilus	3	5	24
Gumaga nigricula	7	10	12
Glossosoma sp.	10	14	21
Hydatophylax hesperus	15	27	28
Limniphilidae sp.	23	105	190
Other Limniphilidae	14	8	15
Lepidostoma sp.	62	27	70
Other Trichoptera	6	3	22
DIPTERA			
Chironomidae[1]	182	201	81
Simulium sp.[1]	52	39	41
Other Diptera	9	15	10
COLEOPTERA			
Dytiscidae[2]	37	22	23
Elmidae[2]	148	108	136
Other Coleoptera	18	11	10
MISCELLANEOUS AQUATIC	50	19	30
TERRESTRIAL			
Ephemeroptera	24	6	25
Diptera (w/o Chironomidae)	296	42	76
Chironomidae	164	22	98
Coleoptera	76	7	23
Hemiptera	24	18	19
Homoptera	107	42	56
Hymenoptera	64	9	14
Psocoptera	215	21	17
Araneida	21	13	12
Other Terrestrials	4	3	11

[1] larvae and pupae

[2] larvae and adult

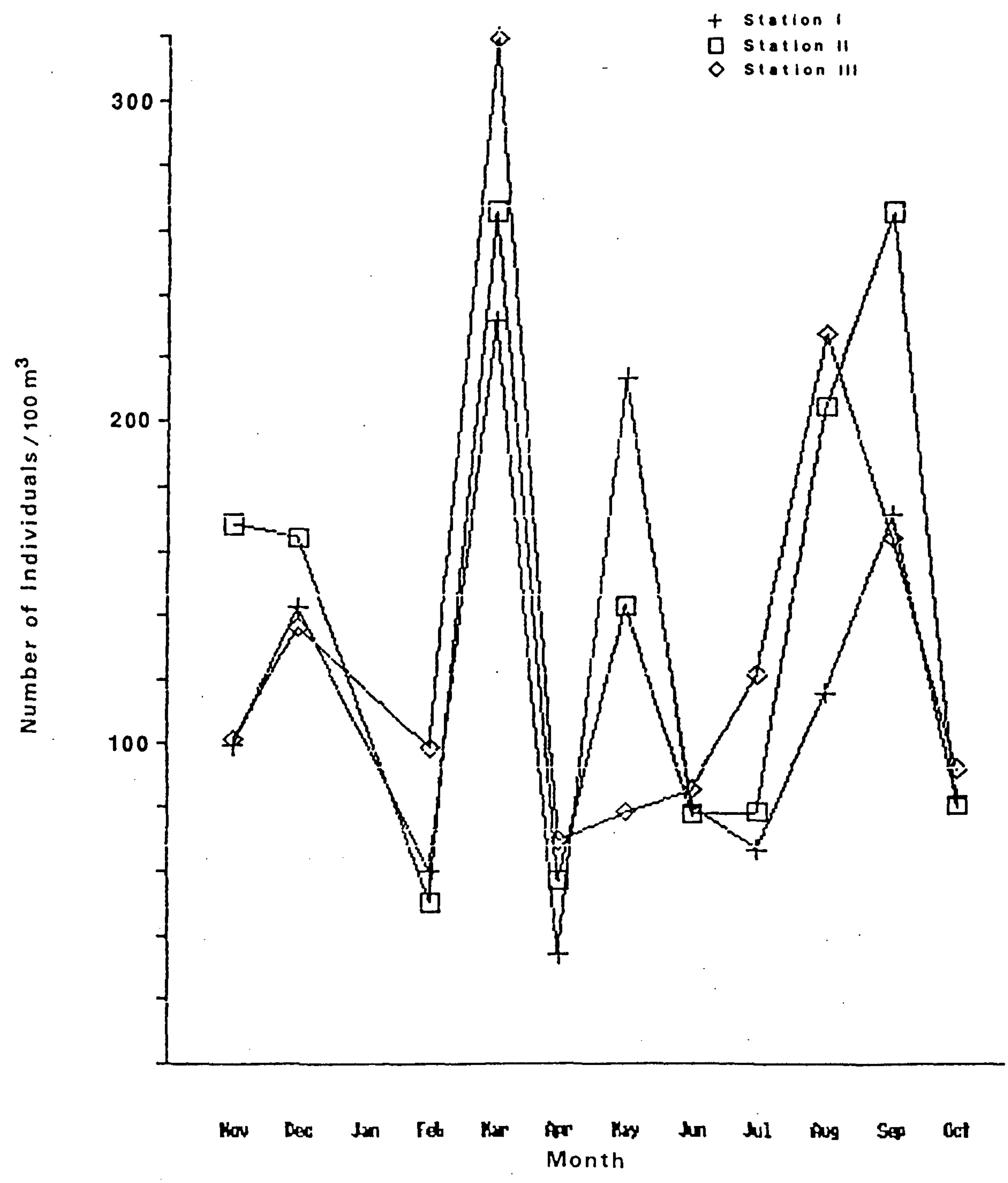


Figure 5. Seasonal fluctuations in total aquatic drift densities (number/100 m^3) at three sites on Jacoby Creek from November 1978 to October 1979.

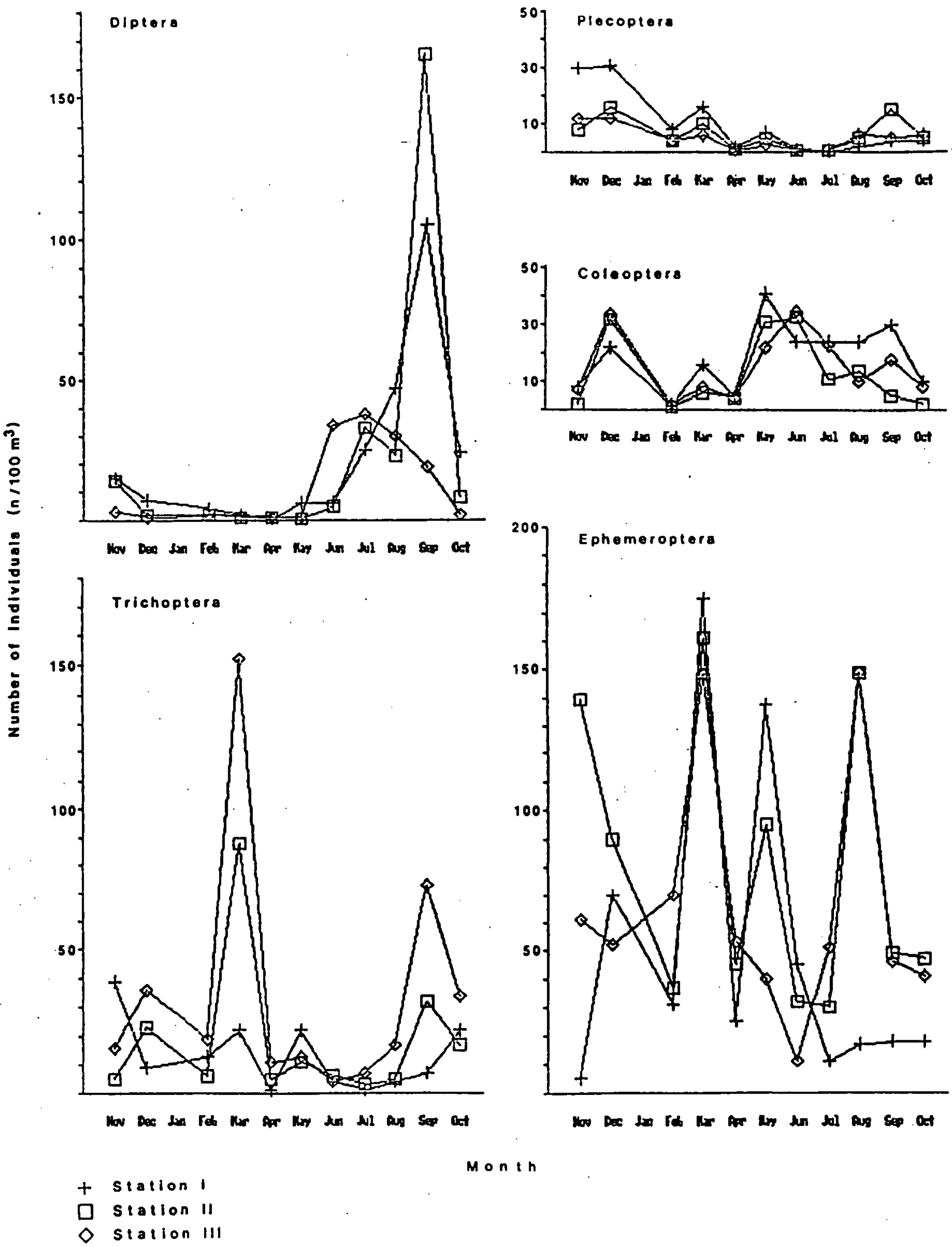


Figure 6. Seasonal fluctuations in drift densities (number/100 m^3) of major aquatic orders at three sites on Jacoby Creek from November 1978 to October 1979.

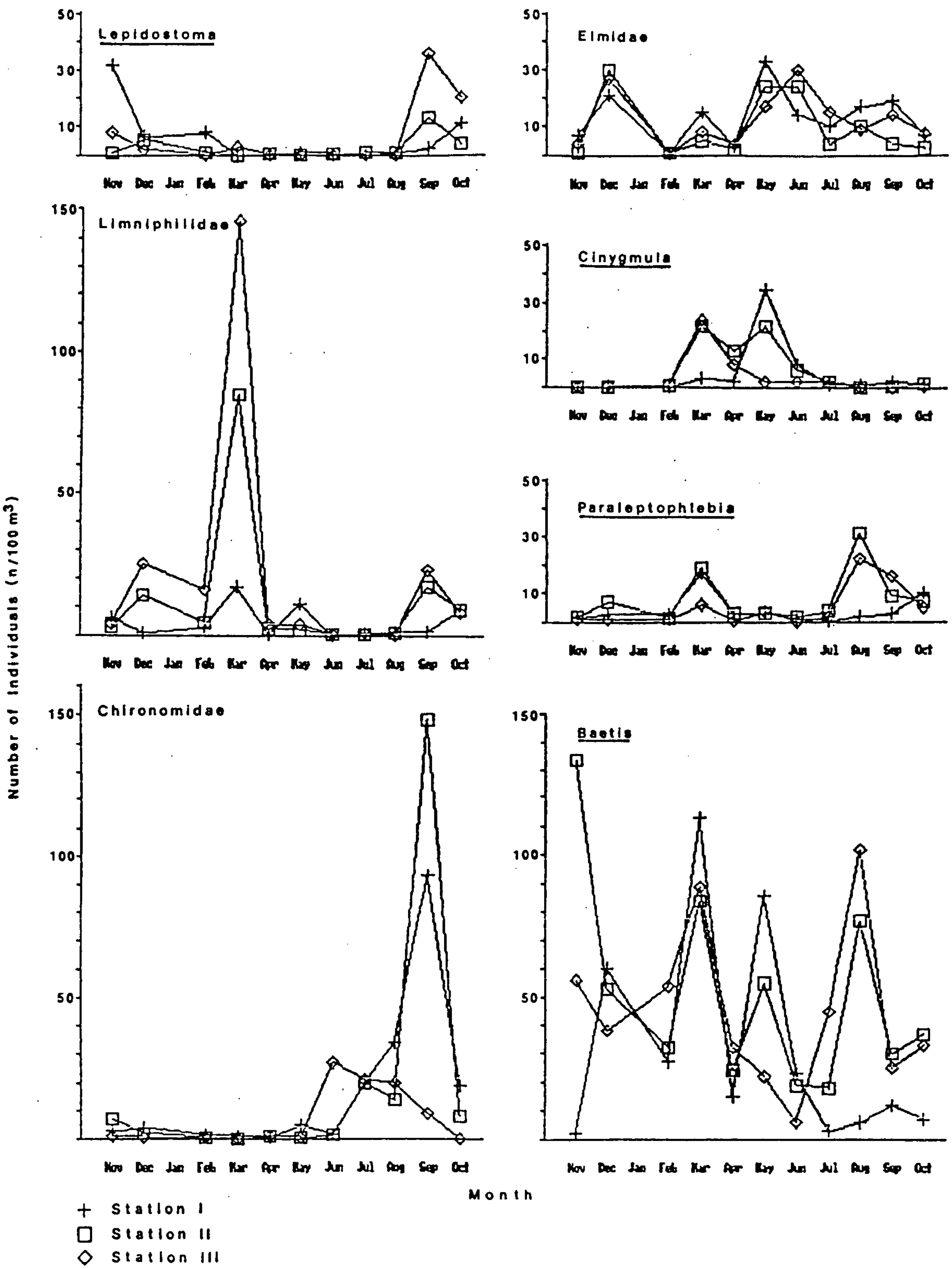


Figure 7. Seasonal fluctuations in drift densities (number/100 m^3) of major aquatic taxa at three sites on Jacoby Creek from November 1978 to October 1979.

Caddisflies generally drifted in low numbers for most of the year. Major peaks at station I was noticeably absent, even in March when densities at stations II and III exhibited the strongest peaks of the year (Figure 6). This peak at the latter stations was almost exclusively the result of an influx of Limniphilidae (Figure 7). The lack of Limniphilidae in the drift at station I reflected the low numbers in benthic samples from this site. Taxa responsible for major seasonal changes in drift density of the Trichoptera were Limniphilidae sp. and Lepidostoma sp. (Figure 7). Limniphilidae sp. (small individuals approximately 3 mm in length, which were most likely early instars of Hydatophylax hesperus or Onocosmoecus sp.) were primarily responsible for the peaks at stations II and III in March. Smaller peaks observed between September and December at stations I and III were due to increased densities of Lepidostoma sp.

Elmidae were primarily responsible for seasonal fluctutions in the drift of Coleoptera (Figures 6 and 7). Major drift activity occurred from May to September. Most Plecoptera drift activity was attributed to Nemoura sp. and Capnia sp. Maximum Plecoptera densities were observed in November and December at all stations (Figure 6).

The only order that did not to exhibit a pulse in drift density during March was the Diptera (Figure 6), primarily due to the very low numbers occurring in the benthos during this period. Chironomidae were responsible for the largest portion of total Dipteran drift during the year (Figure 7). Maximum densities occurred at station III in June and August and stations I and II in September.

A majority of terrestrial drift activity took place from June to October (Figure 8). Peak drift densities observed at station I, from

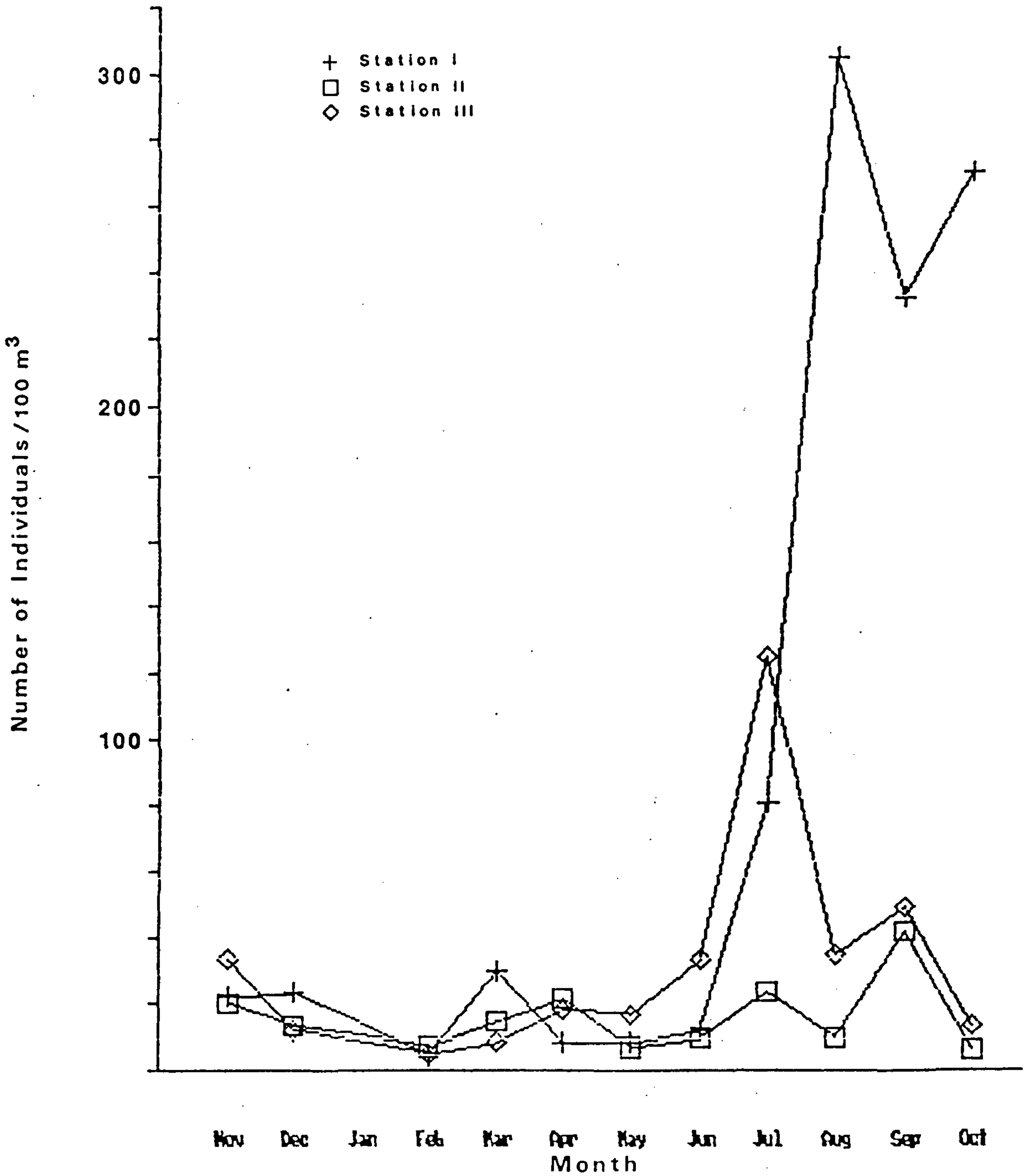


Figure 8. Seasonal fluctuations in total terrestrial drift densities (number/100 m^3) at three sites on Jacoby Creek from November 1978 to October 1979.

August to October, were considerably greater than other stations for all major groups and total drift.

No significant differences between stations for major aquatic and terrestrial drift groups or taxa were found by Friedman's two-way ANOVA, in which dates were treated as blocks, sampling locations as fixed-effect factors, and density at each station was ranked for each date. Since samples were not replicated, tests within seasons, as were done with benthic and stomach samples, were prohibitive due to small sample sizes. However, one notable difference between sites can be inferred on the basis of previous graphical representations. Terrestrial drift from August to October was substantially higher at station I than stations II and III and *Baetis* sp. drift was relatively low at station I during this same time period. The biological significance of this observed difference is discussed in the stomach analysis section.

Drift density, in terms of individuals per unit volume of water, provides a means of comparing drift between sites and is often used in invertebrate studies. However, another measure, drift rate (number of individuals drifting past a given point per unit time) is dependent on total discharge. Table 6 shows shows the total number of organisms passing through a cross section of stream in a 24 hour period compared to drift density (number per 100 m^3). The lowest aquatic drift rates occurred between July and November when stream discharge was low. In contrast, this was also when some of the highest aquatic drift densities were observed. This is important when considering drift availability to fish, since the total number of items over a period of time is more important than density.

Table 6. Drift rate (number of organisms passing through a cross section of stream in 24 hours) and density (number per 100 m^3) of aquatic and terrestrial organisms, November 1978 to October 1979, in Jacoby Creek, California.

	Station					
	I		II		III	
Date	Aquatic	Terres-trial	Aquatic	Terres-trial	Aquatic	Terres-trial
			Drift Rate			
Nov.	4,619	1,062	9,144	1,111	4,886	1,617
Dec.	41,714	6,898	45,343	3,677	32,901	2,885
Feb.	13,219	1,001	8,208	1,114	11,854	582
Mar.	276,618	35,335	305,666	17,000	308,690	8,034
Apr.	6,845	1,635	11,327	4,280	13,305	3,454
May	65,638	2,672	48,185	2,431	23,207	5,017
Jun.	12,442	1,844	11,456	1,461	11,888	4,661
Jul.	4,457	9,786	5,256	1,577	7,945	8,141
Aug.	4,109	10,812	7,262	347	7,092	1,080
Sep.	5,466	7,480	8,997	1,410	4,534	1,365
Oct.	2,223	7,284	1,889	146	1,987	287
			Drift Density			
Nov.	99	23	168	20	101	33
Dec.	142	23	164	13	136	12
Feb.	59	5	50	7	98	5
Mar.	232	30	266	15	319	8
Apr.	34	8	57	21	70	18
May	214	9	143	7	79	17
Jun.	80	12	78	10	86	34
Jul.	67	81	79	24	121	124
Aug.	116	305	205	10	228	35
Sep.	171	234	267	42	164	49
Oct.	83	271	81	6	92	13

Percentage Composition

With the exception of the Trichoptera, all major aquatic drift groups displayed highest relative proportions during the same time of year at each station (Table 7). Ephemeroptera dominated aquatic drift from October to May and August at stations II and III and December through June at station I. The major difference between stations was the comparatively low proportion of mayflies at station I from July to November.

Caddisfly contribution to drift was more pronounced at station III than other stations. On seven of eleven sampling dates this order made up the largest or second largest percentage of aquatic drift at this station. The highest percentages were observed in September (44.2%) and March (47.7%). The largest percentage of Trichoptera at station I occurred in November (39.7%), the only date on which caddisflies made up a majority of the total aquatic drift at this station. Trichoptera did not account for a major portion of total aquatic drift on any sampling date at station II. The percentage of Coleoptera in the drift was highest between May and July at stations II and III and from April to September at station I. In June this order made up the largest percentage of any group at station II (43.0%) and station III (40.2%). Maximum Diptera proportions occurred between July and October at stations I and II. A majority of the total drift was due to this order at station I (61.1%) and station II (61.7%) in September. The percentage contribution of Plecoptera to total aquatic drift was the lowest of the five major orders.

Similar to the benthic fauna a large percentage of the aquatic drift was due to a small number of taxa on each sampling date (Table 8).

Table 7. Pecentage composition of major aquatic groups and total number per 100 m^3 of aquatic invertebrates from drift samples taken at three sites on Jacoby Creek, November 1978 to October 1979.

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
Station I											
Ephemeroptera	4.8	49.5	52.4	75.4	73.4	64.1	55.6	16.0	14.5	10.4	21.3
Trichoptera	39.7	6.4	21.8	9.3	3.5	10.4	4.8	1.7	3.0	4.2	26.5
Plecoptera	30.5	21.5	13.3	7.0	6.5	3.2	1.5	--	1.2	2.3	5.1
Coleoptera	7.8	15.7	1.3	7.0	13.7	18.9	29.7	34.9	19.9	17.5	11.5
Diptera	14.8	5.0	7.3	0.8	1.5	2.8	7.9	37.5	40.3	61.1	29.1
Miscellaneous	2.1	1.6	3.5	0.5	1.0	0.3	0.3	9.4	19.9	3.7	5.1
No./100 m^3	99	142	59	232	34	214	80	67	116	171	83
Station II											
Ephemeroptera	82.3	54.6	74.6	60.6	78.6	66.1	41.3	38.3	72.5	18.1	58.0
Trichoptera	2.7	13.8	11.2	33.1	8.4	7.4	7.5	3.7	2.5	12.1	20.9
Plecoptera	4.8	9.9	7.4	3.6	2.0	3.7	0.5	0.8	2.2	5.5	6.1
Coleoptera	1.1	19.4	2.2	2.1	7.8	21.5	43.0	13.3	6.5	2.1	4.6
Diptera	8.5	1.3	3.8	0.4	1.3	0.4	6.7	41.3	11.3	61.7	10.0
Miscellaneous	0.3	0.6	0.4	0.4	1.5	--	0.5	2.2	4.7	--	--
No./100 m^3	168	164	50	266	57	143	78	79	205	267	81
Station III											
Ephemeroptera	60.7	38.4	71.5	46.3	75.3	50.2	13.3	41.5	65.2	28.1	44.5
Trichoptera	16.3	26.5	19.4	47.7	14.9	16.8	4.7	5.6	7.6	44.2	36.9
Plecoptera	12.1	8.8	4.1	1.9	6.3	3.0	0.7	0.8	2.5	2.8	6.7
Coleoptera	7.3	25.3	1.3	2.6	6.0	27.4	40.2	19.0	4.1	10.7	8.9
Diptera	3.0	0.6	2.2	0.5	1.4	1.0	39.4	31.3	13.2	11.3	2.0
Miscellaneous	0.2	0.2	1.1	1.0	1.4	1.2	1.3	1.2	7.0	2.4	0.7
No./100 m^3	101	136	98	319	70	79	86	121	228	164	92

Table 8. Five most common aquatic taxa by percentage of total number of aquatic invertebrates form drift samples taken at three sites on Jacoby Creek, November 1978 to October 1979.

Date	Station I	%	Station II	%	Station III	%
	Lepidostoma sp.	32	*Baetis* sp.	80	*Baetis* sp.	56
	Capnia sp.	22	Chironomidae	4	*Lepidostoma* sp.	8
Nov.	*Simulium* sp.	11	*Capnia* sp.	4	*Capnia* sp.	6
	Nemoura sp.	9	*Simulium* sp.	3	Elmidae	4
	Elmidae	7	Limniphilidae sp.	2	*Rithrogena* sp.	4
		81		93		73
	Baetis sp.	42	*Baetis* sp.	33	*Baetis* sp.	28
	Capnia sp.	17	Elmidae	19	Elmidae	20
Dec.	Elmidae	15	*Ameletus* sp.	15	Limniphilidae sp.	13
	Ameletus sp.	5	Limniphilidae sp.	7	*Nemoura* sp.	7
	Lepidostoma sp.	4	*Capnia* sp.	7	*Gumaga nigricula*	5
		83		81		73
	Baetis sp.	45	*Baetis* sp.	65	*Baetis* sp.	55
	Lepidostoma sp.	14	Limniphilidae sp.	6	Limniphilidae sp.	15
Feb.	*Capnia* sp.	8	*Rithrogena* sp.	4	*Rithrogena* sp.	7
	Simulium sp.	5	*Simulium* sp.	3	*Ephemerella levis*	4
	Nemoura sp.	5	*Paraleptophlebia* sp.	2	*Iron* sp.	2
		77		80		83
	Baetis sp.	49	*Baetis* sp.	32	Limniphilidae sp.	45
	Paraleptophlebia sp.	8	Limniphilidae sp.	31	*Baetis* sp.	28
Mar.	*Capnia* sp.	7	*Cinygmula* sp.	8	*Cinygmula* sp.	8
	Elmidae	6	*Paraleptophlebia* sp.	7	*Rithrogena* sp.	3
	Limniphilidae sp.	6	*Ameletus* sp.	5	Elmidae	3
		76		83		87
	Baetis sp.	45	*Baetis* sp.	42	*Baetis* sp.	46
	Elmidae	10	*Cinygmula* sp.	23	*Cinygmula* sp.	11
Apr.	*Paraleptophlebia* sp.	9	*Paraleptophlebia* sp.	5	*Iron* sp.	7
	Ameletus sp.	8	*Ameletus* sp.	4	*Ephemerella coloradensis*	5
	Cinygmula sp.	6	Elmidae	4	Limniphilidae sp.	5
		78		78		74
	Baetis sp.	40	*Baetis* sp.	39	*Baetis* sp.	28
	Cinygmula sp.	16	Elmidae	17	Elmidae	21
May	Elmidae	15	*Cinygmula* sp.	15	*Amiocentrus aspilus*	9
	Dicosmoecus sp.	4	*Ameletus* sp.	4	*Iron* sp.	8
	Ephemerella sp.	3	*Iron* sp.	4	*Paraleptophlebia* sp.	4
		78		79		70
	Baetis sp.	28	Elmidae	31	Elmidae	34
	Elmidae	18	*Baetis* sp.	24	Chironomidae	32
Jun.	*Ameletus* sp.	11	*Cinygmula* sp.	8	*Simulium* sp.	8
	Cinygmula sp.	10	*Oreodytes* sp.	8	*Baetis* sp.	7
	Oreodytes sp.	6	*Simulium* sp.	5	*Oreodytes* sp.	3
		73		76		84
	Chironomidae	30	Chironomidae	25	*Baetis* sp.	37
	Elmidae	15	*Baetis* sp.	23	Chironomidae	17
Jul.	*Oreodytes* sp.	8	*Simulium* sp.	14	Elmidae	13
	Simulium sp.	5	Elmidae	10	*Simulium* sp.	11
	Baetis sp.	4	*Paraleptophlebia* sp.	5	*Amiocentrus aspilus*	4
		62		77		82
	Chironomidae	29	*Baetis* sp.	37	*Baetis* sp.	45
	Collembola	15	*Paraleptophlebia helena*	15	*Paraleptophlebia helena*	10
Aug.	Elmidae	14	*Tricorythodes minutus*	10	Chironomidae	9
	Simulium sp.	8	Chironomidae	6	*Tricorythodes minutus*	4
	Baetis sp.	5	*Heptegenia* sp.	6	Elmidae	4
		71		74		72
	Chironomidae	54	Chironomidae	56	*Lepidostoma* sp.	22
	Elmidae	11	*Baetis* sp.	11	*Baetis* sp.	15
Sep.	*Baetis* sp.	7	*Hydatophylax hesperus*	6	*Hydatophylax hesperus*	14
	Simulium sp.	6	*Lepidostoma* sp.	5	Elmidae	8
	Dytiscidae	3	*Dixa* sp.	3	*Paraleptophlebia helena*	7
		81		81		66
	Chironomidae	23	*Baetis* sp.	46	*Baetis* sp.	36
	Lepidostoma sp.	13	Chironomidae	9	*Lepidostoma* sp.	22
Oct.	*Paraleptophlebia helena*	10	*Ameletus* sp.	8	Elmidae	8
	Cinygmula sp.	9	*Hydatophylax hesperus*	8	*Glossosoma* sp.	6
	Hydatophylax sp.	9	*Lepidostoma* sp.	5	Limniphilidae sp.	4
		64		76		76

Baetis sp. were the most common taxon collected during the year, accounting for the largest percentage at all stations from December to May. Major taxa composition differed considerably between stations from June through November; station I was dominated by Chironomidae and Elmidae, station II by Baetis sp. and Chironomidae, and station III by Baetis sp. A notable difference between stations from September to November was the large percentage of Lepidostoma sp. at stations I and III and the relative lack of this taxon in the drift at station II.

Dipterans were the most important terrestrial invertebrates collected during the year at all sites (Table 9). The Homoptera was a major element of terrestrial drift between November and February at all stations and the only group other than Diptera to account for over 50 percent of terrestrial drift on any date.

The percentage of total drift of terrestrial and aquatic origin is shown on a monthly basis in Figure 9. Terrestrial drift accounted for minor proporitons at all sites from December to March. From July to October terrestrial drift exceeded aquatic drift at station I, making up between 54.5 and 76.6 percent of the total. Station II had the lowest overall percentage contribution of terrestrial drift over the year with the highest relative percentage (27.4%) observed in April. This station did not show the increase in percent of terrestrial drift in late summer as did the other sites. Terrestrial drift at station III reached maximum relative percentages in June (28.2%) and July (50.6%).

Stomach Contents

A total of 270 stomachs were examined from the three stations. Sample sizes and age compostion are presented in Appendix E. An attempt

Table 9. Percentage composition of major terrestrial groups and total number per 100 m^3 of terrestrial invertebrates from drift samples taken at three sites on Jacoby Creek, November 1978 to October 1979.

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
Station I											
Diptera	56.6	38.6	46.4	60.8	84.8	56.1	36.4	48.4	51.0	15.4	56.1
Coleoptera	4.2	1.4	--	11.6	--	7.9	6.0	4.9	4.9	11.9	7.5
Homoptera	15.5	37.2	21.1	11.6	--	18.4	13.9	21.3	11.3	8.0	4.3
Hymenoptera	4.2	3.6	--	7.8	6.2	--	7.7	4.2	4.2	12.2	5.1
Psocoptera	10.1	11.2	18.3	3.9	--	2.5	6.0	15.6	12.4	39.8	21.5
Ephemeroptera	--	--	3.5	--	2.1	5.1	6.0	0.7	--	5.6	3.3
Hemiptera	4.2	--	5.5	--	2.1	--	17.0	0.7	3.7	3.1	0.3
Araneida	1.6	6.5	7.2	1.9	--	--	6.0	3.5	1.2	3.5	1.3
Miscellaneous	3.6	1.5	--	2.4	4.8	10.0	--	3.9	11.3	0.5	0.6
No./100 m^3	23	23	5	30	8	9	12	81	305	234	271
Station II											
Diptera	25.8	34.5	5.8	41.7	46.3	35.5	50.4	49.7	68.2	19.9	50.0
Coleoptera	0.9	2.8	--	14.8	2.7	12.5	10.6	2.5	--	3.0	--
Homoptera	60.9	35.8	88.4	22.9	31.7	23.0	15.0	12.5	--	6.1	--
Hymenoptera	2.3	5.3	--	3.7	8.0	--	2.1	--	7.7	8.8	--
Psocoptera	4.6	17.3	--	3.7	1.3	--	4.2	17.3	7.7	26.5	--
Ephemeroptera	0.5	1.3	--	--	3.4	14.2	2.1	4.7	--	4.0	10.0
Hemiptera	--	--	--	--	0.6	2.1	10.6	--	7.7	19.9	--
Araneida	2.3	1.3	5.6	7.6	4.0	8.3	4.2	9.9	7.7	10.3	29.2
Miscellaneous	2.7	1.7	0.2	5.6	2.0	4.4	0.8	3.4	1.0	1.5	10.8
No./100 m^3	20	13	7	15	21	7	10	24	10	42	6
Station III											
Diptera	38.2	33.5	67.4	35.7	50.4	23.0	52.5	60.4	61.2	32.8	52.5
Coleoptera	0.3	1.4	--	44.7	4.8	19.6	10.3	5.9	--	5.6	4.7
Homoptera	50.6	44.6	17.0	9.2	15.9	11.2	15.6	15.4	7.5	--	--
Hymenoptera	2.4	--	2.7	--	8.2	15.1	6.0	0.8	5.6	4.7	9.5
Psocoptera	4.4	9.6	2.7	--	3.0	2.2	1.1	2.7	1.8	16.8	4.7
Ephemeroptera	3.3	4.1	8.6	--	2.4	16.3	4.9	7.9	1.8	12.9	4.7
Hemiptera	--	1.4	--	--	--	--	5.3	0.8	20.4	19.0	--
Araneida	--	5.6	--	--	2.4	4.5	2.2	1.9	1.8	6.5	19.1
Miscellaneous	0.8	--	1.6	10.4	12.9	8.1	2.1	4.2	--	1.7	4.8
No./100 m^3	33	12	5	8	18	17	34	124	35	49	13

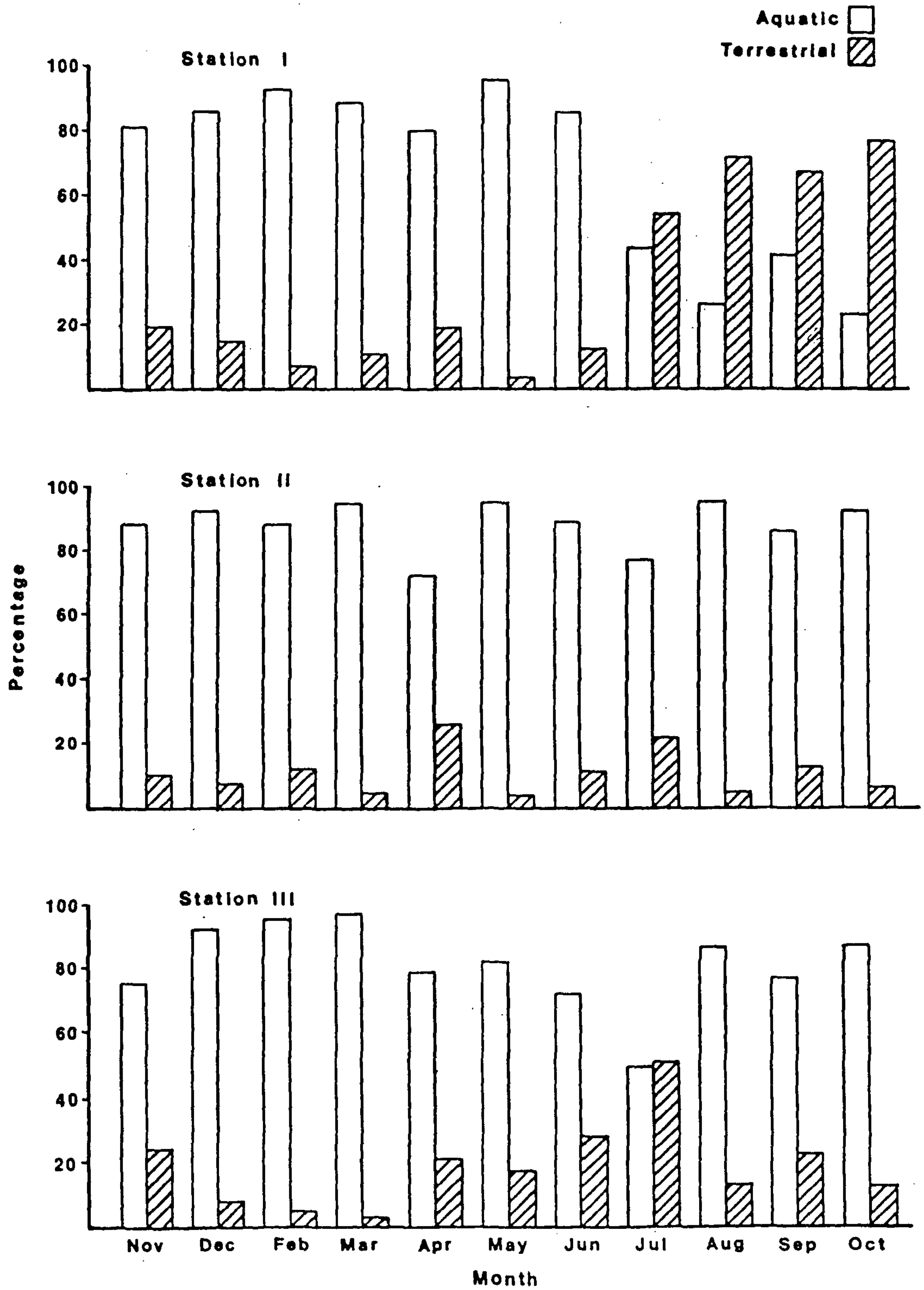


Figure 9. Percentage contribution of aquatic and terrestrial drift by month at three sites on Jacoby Creek from November 1978 to October 1979.

was made to collect 8 to 10 fish at each station on each sampling date with a proportion of approximately 3:1 for 0+ to 1+ fish. This was to give a reasonable sample size without adversely affecting the population. However, this sampling scheme proved to be difficult in winter months, especially at station I where only five fish were collected on three separate dates in November, December and February. Fish collected in April, May and June at all three sites were almost entirely of one age class. Two of the 270 stomachs examined were empty.

Tests were conducted to determine if any significant difference was present between 0+ and 1+ fish for numbers of organisms of major groups and taxa from stomach samples at each station. Samples from April, May, and June were not included since most fish were of one age class. Seventeen aquatic taxa, 11 aquatic and terrestrial groups and total number of organisms present were tested. Significant differences (Mann-Whitney U-test; $p<0.05$) were found for Trichoptera at station I, although no taxa within this order were found to differ significantly, *Paraleptophlebia* sp. at station II and *Hydropsyche* sp. at station III. These results indicate that there was essentially no difference between age classes with respect to numbers of various food items in the diet. Based on this, a decision was made to combine all fish for subsequent analysis.

Mean numbers per stomach varied through the year, generally lower between September and February when fish were feeding on larger organisms such as caddisflies, and higher between April and September when smaller organisms, mayflies and Chironomids, were consumed (Appendix F). On three dates, December at station I and March and June at station III, respective total mean numbers per stomach of 50.8, 49.5

and 75.9 were considerably higher than for other dates. These high averages were due to fish feeding on large numbers of small Plecoptera (Nemouridae) and Ephemeroptera (Baetis sp.) at station I, Ephemeroptera (Baetis sp.) at station III in March and Diptera (Chironomidae) at station III in June. Excluding these dates, total mean numbers ranged from 9.2 to 23.8 at station I, 8.8 to 19.7 at station II and 5.0 to 28.0 at station III. Mean numbers per stomach for terrestrial organisms ranged from 0 to 10.4 (station I), 0 to 5.0 (station II) and 0.2 to 4.7 (station III).

Ranges in number of food items per stomach was highly variable. The greatest range, 17-270 individual organisms, occurred at station III in June. The widest ranges observed were often attributed to the consumption of a large number of a single taxon or group by one or two individual fish. Out of a total of 577 Diptera from nine stomachs at station III in June, 377 were from just two stomachs. At station I in April, 67 of a total of 76 Ephemeroptera were found in one stomach. On the same date at this station, 34 of a total of 48 terrestrial organisms were also from one stomach. A total of 102 Trichoptera were found in eight stomachs at station II in June, of which 85 (all Gumaga nigricula) were from one stomach.

Tests (Kruskall-Wallis one-way ANOVA) were conducted to determine if differences were present between seasons for number of aquatic and terrestrial food items and total volume from stomachs at each station. Volumes were standardized by dividing the volume for each stomach by the fish's weight to compensate for differences in size of fish collected at different times of the year. Results for volume indicated that there was no significant difference ($p>0.05$) between seasons. As expected, numbers of terrestrial organisms consumed differed between seasons at all stations (Kruskall-Wallis one-way ANOVA, $p<0.05$), stemming from the seasonal nature of this food source. Numbers of aquatic food items were found to differ significantly ($p<0.05$) between seasons only at station III. This result was due mainly to the large number of Baetis sp. consumed in winter at this station.

Significant differences between stations for major groups and taxa from steelhead stomachs were found mainly in spring and summer (Table 10). Lepidostoma sp. was the only taxon to show a significant difference in fall and winter, higher numbers in stomachs from station I than stations II and III. Fish from station I also contained a larger number of terrestrials than station III in the fall. A major difference between stations in the spring, greater numbers of Baetis sp. in stomachs at station III than stations I and II, was also reflected in differences found in the Ephemeroptera and total number of organisms. In the summer, fish from station I had significantly lower numbers of Baetis sp. than station III. However, fish from station I showed a significantly greater number of terrestrials than station III. Differences in stomach contents between these two stations in the summer was apparently due to differences in availability of these food items in the drift.

In cases where a significant time versus station interaction was found, a posteriori tests were not conducted. Significant time versus station interactions were found in 10 of 19 comparisons in the fall and only 10 of 57 comparisons for other seasons. The anomoly of the fall comparisons apparently stems from a greater disparity in stomach contents of individual fish, within and between, sites and dates.

Table 10. Results of two-way ANOVAs for differences in mean stomach contents of major groups and taxa within seasons between stations I, II, and III, Jacoby Creek, November 1978 to October 1979. Inequality signs indicate results of Tukey's *a posteriori* test when significant difference ($p<0.005$; see methods for calculation of significance level) was detected.

	Season			
Groups and Taxa	Fall	Winter	Spring	Summer
Ephemeroptera	ns	ns	I=II<III	I=II<III
Plecoptera	ns	ns	ns	ns
Trichoptera	ns	ns	ns	ns
Diptera	ns	ns	ns	ns
Coleoptera	ns	ns	ns	ns
Baetis sp.	ns	ns	I=II<III	I<II=III
Cinygmula sp.	ns	ns	ns	ns
Ephemerella spp.	--*	ns	I<III	ns
Rithrogena sp.	ns	ns	ns	ns
Nemouridae	ns	ns	ns	ns
Glossosoma sp.	ns	ns	ns	I<II=III
Gumaga nigricula	ns	ns	ns	I>II=III
Hydropsyche sp.	ns	ns	I=II<III	ns
Lepidostoma sp.	I>II=III	I>II=III	ns	ns
Limniphilidae	ns	ns	ns	ns
Chironomidae[1]	ns	ns	ns	I=II<III
Elmidae[2]	ns	ns	ns	ns
Total Aquatic	ns	ns	I=II<III	I=II<III
Total Terrestrial	I>III	ns	ns	I>II=III

[1] larvae and pupae
[2] larvae and adult
* no individuals collected

Percentage Composition

Number. Major groups occurring in stomachs over the year were Trichoptera (28.8%), terrestrial (24.3%) and Ephemeroptera (20.0%) at station I, Trichoptera (32.2%) and Ephemeroptera (31.1%) at station II and Ephemeroptera (37.6%) and Diptera (35.7%) at station III (Figure 10).

Steelhead diets at all stations were dominated by Ephemeroptera and Trichoptera from December to May (Table 11). These two groups combined, accounted for an average of 69 percent (station I), 67 percent (station II) and 78 percent (station III) of all food items during this period. Trichoptera made up the largest percentage in December, March and May and Ephemeroptera in February and April at stations I and II. In contrast, Ephemeroptera contributed the largest percentage to the diet on all sampling dates at station III during this time period.

From June through October major differences between sites were apparent with respect to the most utilized food groups. Terrestrials dominated the diet at station I between August and October, accounting for 43.8 to 48.5 percent of all food items during this period. This compares to a maximum of 17.9 percent at station II and 14.5 percent at station III for terrestrial food items during the same time period. Diptera accounted for 85 percent of total stomach contents in June and 50 percent in August at station III. The percentage of Diptera increased between July and September at station II, but Trichoptera and Ephemeroptera remained the major food items at this station.

The November sampling date was unusual compared to adjacent dates at station II. Terrestrial organisms accounted for 49 percent of total stomach contents. However, it was observed that 63 percent of all terrestrial items occurred in one stomach. Without this one outlier

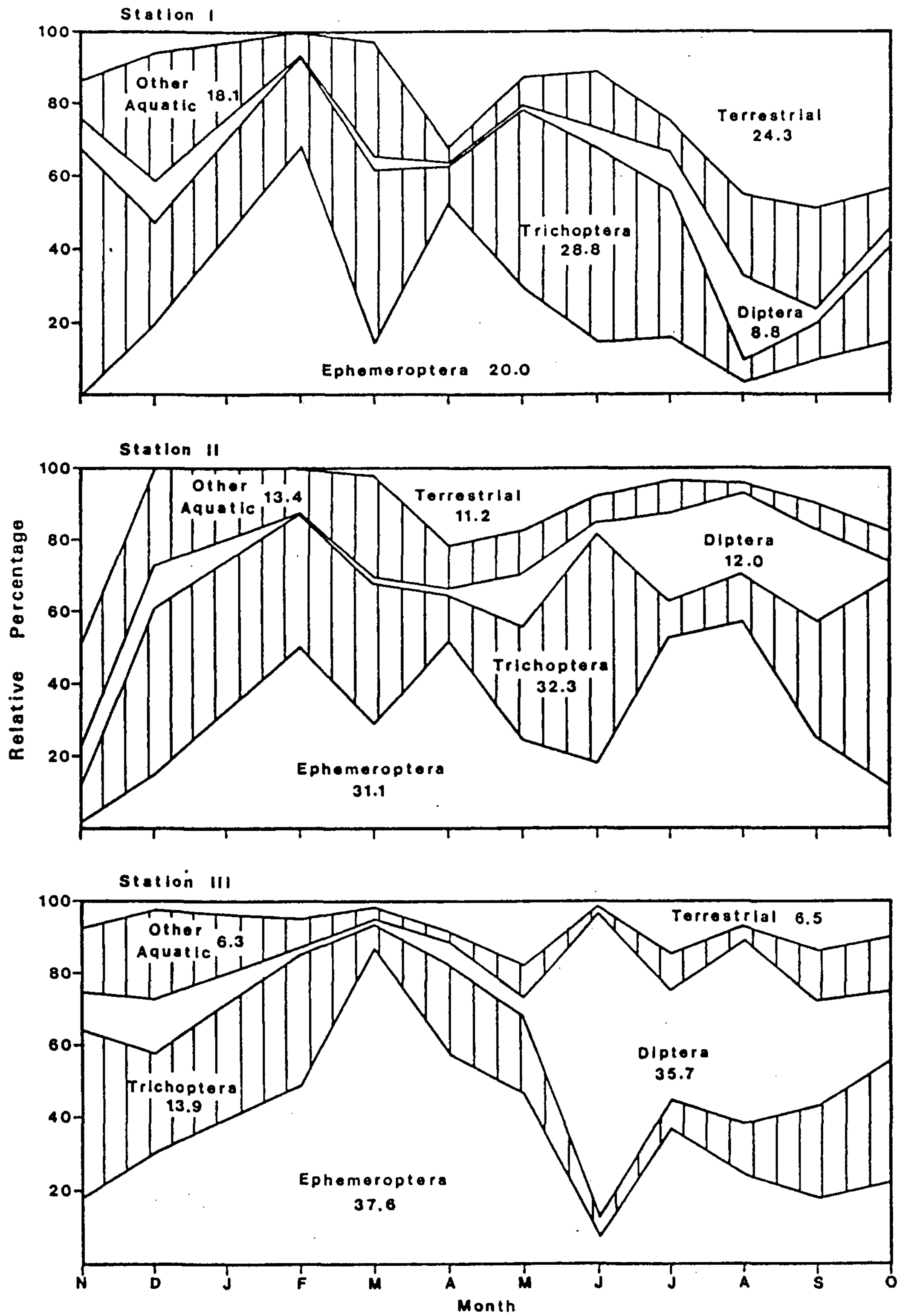


Figure 10. Relative percentage of major groups of organisms from juvenile steelhead stomachs, Jacoby Creek, November 1978 to October 1979.

Table 11. Percentage composition by number of major groups of aquatic and terrestrial organisms from juvenile steelhead stomachs taken at three sites on Jacoby Creek, November 1978 to October 1979.

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Season Total
					Station I							
Sample Size	5	5	5	7	6	5	7	9	9	8	9	
Aquatic												
Ephemeroptera	--	20.2	67.8	14.3	52.4	30.4	14.8	15.9	3.9	9.9	15.2	20.0
Trichoptera	67.8	27.4	25.0	47.6	10.5	47.8	53.1	39.9	6.4	9.9	25.7	28.8
Diptera	8.0	11.1	--	3.2	0.7	1.4	4.9	11.2	22.7	4.0	4.7	8.8
Plecoptera	5.7	23.8	5.3	12.7	0.7	4.3	2.4	--	1.5	4.0	2.8	6.8
Coleoptera	3.4	4.4	--	3.2	1.4	2.9	11.1	6.9	18.3	17.0	0.9	6.5
Miscellaneous	1.3	7.5	1.8	15.8	0.7	--	2.4	1.5	1.0	6.7	6.9	4.0
Terrestrial												
Diptera	3.4	1.6	--	--	30.7	4.3	1.2	2.6	6.4	9.9	1.9	6.3
Homoptera	--	--	--	--	--	--	--	6.4	4.4	3.0	17.1	2.1
Hymenoptera	--	0.8	--	1.6	0.7	1.4	6.2	9.5	17.8	14.8	3.8	7.2
Coleoptera	5.7	--	--	--	0.7	5.8	1.2	4.2	9.4	1.0	12.4	3.9
Psocoptera	4.6	1.6	--	--	--	--	--	1.6	4.4	10.9	1.9	2.4
Miscellaneous	--	1.6	--	1.6	1.5	1.4	2.4	--	3.6	8.9	6.7	2.1
Total Aquatic	86.3	94.4	100.0	96.8	66.4	87.0	88.7	75.4	53.8	51.5	56.2	75.7
Total Terrestrial	13.7	5.6	--	3.2	33.6	13.0	11.3	24.6	46.2	48.5	43.8	24.3

Table 11. Percentage composition by number of major groups of aquatic and terrestrial organisms from juvenile steelhead stomachs taken at three sites on Jacoby Creek, November 1978 to October 1979. (continued)

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Season Total
Station II												
Sample Size	10	7	7	9	8	6	8	10	10	10	9	
Aquatic												
Ephemeroptera	2.0	15.5	50.0	28.6	51.9	24.3	17.7	52.7	57.0	25.7	11.4	31.1
Trichoptera	9.9	45.1	37.8	39.4	12.6	31.1	64.5	10.7	14.1	31.2	58.2	32.3
Diptera	10.9	12.7	--	1.4	1.3	14.8	3.2	24.4	22.5	26.4	3.8	12.0
Plecoptera	4.0	5.6	6.1	3.4	6.3	5.4	--	0.9	--	1.4	6.3	2.8
Coleoptera	1.0	1.4	3.0	1.4	1.3	4.0	3.2	6.9	0.7	2.8	--	2.4
Isopoda	5.0	18.3	--	19.0	--	1.4	1.3	--	--	--	1.2	4.2
Miscellaneous	17.8	1.4	3.1	5.4	5.1	1.4	1.9	0.7	1.4	2.8	1.2	4.0
Terrestrial												
Diptera	27.7	--	--	--	20.2	--	1.9	1.5	2.1	4.2	7.6	5.4
Homoptera	20.8	--	--	--	--	--	--	--	1.4	--	3.8	2.2
Hymenoptera	1.0	--	--	--	--	2.7	0.6	--	--	2.1	2.5	0.7
Coleoptera	--	--	--	--	--	2.7	1.9	--	--	1.4	1.2	0.7
Ephemeroptera	--	--	--	--	--	4.0	3.2	1.5	--	--	--	0.8
Miscellaneous	--	--	--	1.4	1.3	8.2	0.7	0.7	1.0	2.0	2.5	1.2
Total Aquatic	50.6	100.0	100.0	98.6	78.5	82.4	91.8	96.3	95.7	90.3	82.1	88.8
Total Terrestrial	49.4	--	--	1.4	21.5	17.6	8.2	3.7	4.3	9.7	17.9	11.2

Table 11. Percentage composition by number of major groups of aquatic and terrestrial organisms from juvenile steelhead stomachs taken at three sites on Jacoby Creek, November 1978 to October 1979. (continued)

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Season Total
Station III												
Sample Size	9	8	7	10	8	9	9	10	10	10	9	
Aquatic												
Ephemeroptera	17.7	30.7	48.6	87.0	57.4	47.3	7.9	37.1	24.9	18.5	23.3	37.6
Trichoptera	46.6	27.3	37.1	7.0	26.0	21.2	4.5	7.5	13.8	25.2	32.7	13.9
Diptera	11.1	14.8	1.4	1.2	5.9	5.3	84.8	31.1	50.5	29.1	19.6	35.7
Plecoptera	6.6	3.4	7.1	2.0	0.6	2.4	--	0.3	0.3	3.9	4.6	1.5
Coleoptera	--	4.5	--	1.0	0.6	3.4	0.3	2.8	0.7	7.9	6.5	1.9
Isopoda	11.1	12.5	--	1.4	0.6	0.5	0.7	2.1	0.7	--	0.9	1.5
Miscellaneous	--	4.6	0.4	0.2	0.6	1.9	--	4.6	2.1	1.3	2.8	1.4
Terrestrial												
Diptera	--	--	1.4	0.4	3.5	1.9	0.1	1.1	1.1	4.6	1.8	1.1
Homoptera	--	--	1.4	0.2	0.6	0.5	0.1	--	--	0.6	--	0.2
Hymenoptera	--	2.3	--	0.4	0.6	8.2	0.5	3.2	--	2.6	2.8	1.6
Coleoptera	--	--	--	0.2	1.7	1.9	0.5	0.7	--	0.6	0.9	0.6
Ephemeroptera	6.6	--	--	--	0.6	3.8	--	8.2	4.9	3.3	--	2.1
Miscellaneous	--	--	1.4	0.4	1.3	1.5	0.5	1.1	0.3	2.2	3.9	0.5
Total Aqautic	93.1	97.8	94.6	98.2	91.7	82.0	98.2	85.5	93.0	85.9	90.4	93.5
Total Terrestrial	6.9	2.2	5.4	1.8	8.3	18.0	1.8	14.5	7.0	14.1	9.6	6.5

percent contribution of terrestrials would have been comparable to other dates at this site.

The percentage occurrence of the five most common aquatic taxa found in stomachs at the three stations for each sampling date are shown in Table 12. Of the eleven sampling dates, the five most common taxa made up over 70 percent of the total stomach contents on nine dates at stations I and II and on six dates at station III.

From December to May the dominate Ephemeropteran taxon at all stations was Baetis sp., although Cinygmula sp. and Rithrogena sp. were also responsible for a significant percentage on some dates. On two sampling dates, April (station I) and March (station III), Baetis sp. accounted for 70 percent of all aquatic items consumed. The most common caddisfly taxa at stations II and III over this same time period were Glossosoma sp., Neophylax rickeri and Hydropsyche sp., none of which made up more than five percent of the diet at station I. Lepidostoma sp. was the primary Trichopteran present in stomachs at station I, and in March accounted for 43 percent of all aquatic food items.

Major aquatic taxa occurring in stomachs from June to November were Gumaga nigricula, Lepidostoma sp., Baetis sp. and Chironomidae. Gumaga nigricula was a dominate component of the diet at station I in June (47%) and July (49%). While a large portion (63%) of the diet at station II in June was due to Gumaga nigricula, this taxa did not contribute significantly to the diet at this site or station III on any other dates.

Chironomidae and Lepidostoma sp. accounted for a large percentage of stomach contents at stations I and III from September to November and station II in September and October. Lepidostoma sp. accounted for 75

Table 12. Five most common aquatic taxa by percentage of total number of aquatic organisms from juvenile steelhead stomachs taken at three sites on Jacoby Creek, November 1978 to October 1979.

Date	Station I	%	Station II	%	Station III	%
	Lepidostoma sp.	75	Oligocheata	35	Lepidostoma sp.	31
	Capnia sp.	7	Chironomidae	14	Asellus sp.	12
Nov.	Chironomidae	7	Asellus sp.	10	Baetis sp.	10
	Gumaga nigricula	4	Limniphilidae sp.	8	Rithrogena sp.	9
	Elmidae	1	Capnia sp.	6	Neophylax rickeri	7
		94		73		69
	Baetis sp.	17	Asellus sp.	18	Baetis sp.	19
	Capnia sp.	16	Gumaga nigricula	18	Asellus sp.	13
Dec.	Lepidostoma sp.	15	Lepidostoma sp.	14	Rithrogena sp.	13
	Chironomidae	10	Baetis sp.	11	Glossosoma sp.	10
	Gumaga sp.	8	Onocosmoecus sp.	6	Antocha saxicola	9
		66		67		64
	Baetis sp.	23	Baetis sp.	33	Baetis sp.	22
	Lepidostoma sp.	18	Glossosoma sp.	21	Glossosoma sp.	20
Feb.	Rithrogena sp.	18	Rithrogena sp.	12	Rithrogena sp.	19
	Paraleptophlebia sp.	12	Limniphilidae sp.	9	Neophylax rickeri	15
	Ameletus sp.	12	Lepidostoma sp.	5	Paraleptophlebia sp.	6
		83		80		82
	Lepidostoma sp.	43	Neophylax rickeri	30	Baetis sp.	70
	Oligocheata	12	Baetis sp.	23	Cinygmula sp.	8
Mar.	Capnia sp.	10	Asellus sp.	19	Rithrogena sp.	5
	Baetis sp.	7	Glossosoma sp.	4	Neophylax rickeri	4
	Paraleptophlebia sp.	5	Oligocheata	3	Glossosoma sp.	2
		77		79		89
	Baetis sp.	70	Baetis sp.	31	Baetis sp.	35
	Lepidostoma sp.	12	Cinygmula sp.	16	Iron sp.	12
Apr.	Ameletus sp.	4	Rithrogena sp.	13	Glossosoma sp.	10
	Rithrogena sp.	3	Neophylax rickeri	6	Rithrogena sp.	8
	Cinygmula sp.	3	Calineuria californica	6	Hydropsyche sp.	8
		92		72		73
	Gumaga nigricula	33	Cinygmula sp.	16	Ephemerella coloradensis	20
	Cinygmula sp.	18	Glossosoma sp.	13	Baetis sp.	13
May	Lepidostoma sp.	12	Hydropsyche sp.	10	Cinygmula sp.	11
	Baetis sp.	7	Limoniinae	10	Hydropsyche sp.	11
	Iron sp.	7	Ephemerella coloradensis	8	Glossosoma sp.	8
		77		57		63
	Gumaga nigricula	47	Gumaga nigricula	63	Chironomidae	84
	Elmidae	11	Baetis sp.	6	Baetis sp.	6
Jun.	Cinygmula sp.	8	Iron sp.	5	Gumaga nigricula	3
	Dicosmoecus sp.	8	Cinygmula sp.	3	Simulium sp.	1
	Baetis sp.	7	Ephemerella coloradensis	3	Ephemerella coloradensis	1
		81		80		95
	Gumaga nigricula	49	Baetis sp.	50	Baetis sp.	38
	Chironomidae	13	Chironomidae	22	Chironomidae	31
Jul.	Baetis sp.	11	Glossosoma sp.	8	Elmidae	3
	Elmidae	6	Dytiscidae	4	Rhyacophila sp.	3
	Ephemerella maculata	3	Elmidae	3	Asellus sp.	2
		82		87		77
	Chironomidae	39	Baetis sp.	55	Chironomidae	47
	Elmidae	30	Chironomidae	20	Baetis sp.	23
Aug.	Gumaga nigricula	8	Glossosoma sp.	9	Glossosoma sp.	8
	Baetis sp.	5	Simulium sp.	3	Simulium sp.	6
	Simulium sp.	3	Iron sp.	2	Amiocentrus aspilus	3
		85		89		87
	Corixidae	19	Chironomidae	22	Chironomidae	27
	Elmidae	13	Lepidostoma sp.	18	Baetis sp.	14
Sep.	Chironomidae	10	Baetis sp.	14	Lepidostoma sp.	11
	Gumaga nigricula	10	Glossosoma sp.	12	Elmidae	8
	Lepidostoma sp.	10	Heptegenia sp.	7	Glossosoma sp.	6
		62		73		66
	Lepidostoma sp.	31	Lepidostoma sp.	45	Chironomidae	21
	Paraleptophlebia helena	25	Gumaga nigricula	14	Lepidostoma sp.	16
Oct.	Chironomidae	8	Paraleptophlebia helena	11	Baetis sp.	16
	Limniphilidae sp.	7	Calineuria californica	5	Glossosoma sp.	7
	Collembola	5	Glossosoma sp.	5	Gumaga nigricula	5
		76		80		65

percent of stomach items at station I in November. A primary difference between stations form June to September was the percent contribution of Baetis sp. This taxon accounted for a large portion of stomach contents in July and August at stations II and III, 23 to 55 percent, while making up only 5-11 percent of stomach items at station I.

Volume. The largest percentage by volume at station I on all sampling dates except April and September was due to Trichoptera (Table 13). The only month in which Ephemeroptera accounted for a significant percentage was in February (37%). In April, terrestrial Diptera contributed 78.5 percent of the total volume, most of which was due to a large fly, Bibionidae. The majority of the volume in September was due to one individual steelhead (54.3%) and one terrestrial slug (30.2%). One slug also accounted for 40 percent of the volume in October.

Trichoptera made up a major percentage by volume on six of the 11 sampling dates at station II (Table 14). In November Oligocheates made up 64.2 percent of the total volume, most of which was from the stomach of one fish. A single silver salmon accounted for 89.4 percent of the total volume in February. Similar to station I, Bibionidae accounted for a large percentage of the volume at station II in April. Although terrestrial volume appeared substantial on some dates at station II, the majority was attributed to a few large items.

Although Trichoptera made up the largest average percentage (36.7%) by volume over the year at station III, the average percentage of Ephemeroptera (26.9%) was substantial and much higher than the other stations (Table 15). The largest proportion from November to February at this station was due to Trichoptera, ranging from 43.6 to 72.7 percent. Ephemeroptera accounted for 60.9 percent of the volume in

Table 13. Percentage composition by volume (cc) of major groups of aquatic and terrestrial organisms from juvenile steelhead stomachs taken at station I on Jacoby Creek, November 1978 to October 1979.

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Season % Average
Sample Size	5	5	5	7	6	5	7	9	9	8	9	
Aquatic												
Ephemeroptera	--	5.7	37.0	3.2	9.9	13.9	2.7	14.5	2.6	0.3	5.1	8.6
Trichoptera	91.0	50.0	55.7	35.2	2.9	77.8	83.1	63.9	33.9	1.0	40.6	48.6
Diptera	0.5	1.7	--	6.3	--	2.1	1.7	1.2	2.6	--	0.1	1.5
Plecoptera	0.6	11.2	2.3	17.8	0.1	2.1	0.8	--	2.7	1.2	2.7	3.8
Coleoptera	6.5	0.5	--	0.5	0.6	3.5	1.5	5.2	7.4	0.1	0.8	2.4
Isopoda	--	4.2	5.0	--	1.1	--	0.8	1.1	--	0.2	--	1.1
Oligocheata	--	--	--	28.1	--	--	4.1	5.4	3.1	--	--	3.7
Megaloptera	--	13.8	8.0	--	--	--	--	--	--	--	--	2.0
Pisces	--	--	--	--	--	--	--	--	--	54.3[a]	--	4.9
Misc.	--	4.2	--	--	--	--	--	--	--	3.2	4.7	1.1
Terrestrial												
Diptera	0.2	--	--	--	78.5	0.3	--	0.7	3.7	0.6	--	7.6
Hymenoptera	--	3.1	--	0.7	--	--	1.0	5.2	17.6	0.4	3.0	2.9
Coleoptera	0.7	--	--	--	0.3	--	--	1.8	7.2	--	1.5	1.0
Dermaptera	--	--	--	--	1.1	--	4.1	--	15.3	--	--	1.8
Diplopoda	--	5.2	--	--	5.4	--	--	--	--	--	--	1.0
Mollusca (slugs)	--	--	--	--	--	--	--	--	--	30.2[b]	40.1[b]	6.4
Misc.	0.5	0.4	--	0.3	--	0.3	--	1.0	3.8	8.5	1.4	1.5
Total Aquatic	98.6	91.3	100.0	99.1	14.6	99.4	94.9	91.3	52.3	60.3	54.0	77.7
Total Terrestrial	1.4	8.7	--	0.9	85.4	0.6	5.1	8.7	47.7	39.7	46.0	22.3
Mean Volume (cc) Per Stomach	0.106	0.394	0.076	0.169	0.263	0.096	0.127	0.086	0.096	0.647	0.192	

[a]one young of the year steelhead

[b]one terrestrial slug

Table 14. Percentage composition by volume (cc) of major groups of aquatic and terrestrial organisms from juvenile steelhead stomachs taken at station II on Jacoby Creek, November 1978 to October 1979.

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Season % Average
Sample Size	10	7	7	9	8	6	8	10	10	10	9	
Aquatic												
Ephemeroptera	1.2	3.7	3.8	6.7	9.3	16.2	17.4	54.2	31.9	17.2	12.6	15.8
Trichoptera	7.3	56.3	5.5	30.2	15.6	27.6	64.1	6.7	59.6	41.7	49.3	33.1
Diptera	2.7	5.6	--	0.7	--	16.4	0.7	5.2	5.0	6.4	1.6	4.0
Plecoptera	0.6	1.0	1.0	12.1	32.6[a]	2.4	--	3.7	--	4.0	20.0	7.0
Coleoptera	0.3	0.3	0.2	0.8	--	1.1	1.0	4.0	0.2	0.9	--	0.8
Isopoda	19.1	33.0	--	20.7	--	2.6	2.3	--	--	--	6.4	7.6
Oligocheata	64.2	--	--	2.0	6.5	--	11.4	--	--	--	--	7.6
Megaloptera	--	--	--	2.0	1.3	--	--	--	--	--	--	0.3
Pisces	--	--	89.4[b]	--	--	--	--	--	--	--	--	8.1
Misc.	--	--	--	5.0	--	--	--	--	1.1	3.5	3.3	1.2
Terrestrial												
Diptera	2.3	--	--	--	34.5	--	0.3	--	0.5	0.7	4.2	3.8
Hymenoptera	--	--	--	--	--	1.6	0.3	--	--	1.4	1.6	0.6
Coleoptera	--	--	--	--	--	1.6	1.3	--	--	0.2	0.3	0.3
Dermaptera	--	--	--	--	--	--	--	--	--	11.8	--	1.0
Diplopoda	--	--	--	19.8	--	--	--	--	--	12.0	--	2.9
Mollusca (slugs)	--	--	--	--	--	--	--	25.0[c]	--	--	--	2.3
Plecoptera	--	--	--	--	--	26.5[d]	--	--	--	--	--	2.4
Misc.	2.2	--	--	--	--	4.0	1.2	1.0	1.6	0.2	0.7	1.0
Total Aquatic	95.5	100.0	100.0	80.2	65.5	66.3	96.9	74.0	97.9	73.7	93.2	85.8
Total Terrestrial	4.5	--	--	19.8	34.5	33.7	3.1	26.0	2.1	26.3	6.8	14.2
Mean Volume (cc) Per Stomach	0.088	0.137	0.317	0.106	0.162	0.067	0.081	0.043	0.041	0.046	0.031	

[a]four *Calineuria californica*; [b]one silver salmon; [c]one terrestrial slug
[d]one *Calineuria californica* adult

Table 15. Percentage composition by volume (cc) of major groups of aquatic and terrestrial organisms from juvenile steelhead stomachs taken at station III on Jacoby Creek, November 1978 to October 1979.

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Season % Average
Sample Size	9	8	7	10	8	9	9	10	10	10	9	
Aquatic												
Ephemeroptera	7.2	11.1	26.3	60.9	33.4	21.8	13.3	39.5	39.5	28.1	15.5	26.9
Trichoptera	72.7	43.6	61.6	25.8	20.0	31.6	47.7	10.4	30.2	33.8	26.1	36.7
Diptera	0.2	5.6	0.5	4.3	2.4	4.6	32.7	6.5	16.2	11.0	2.2	7.8
Plecoptera	0.6	0.7	6.9	1.9	14.5	29.7	--	1.4	2.8	12.8	20.8	8.4
Coleoptera	--	0.5	--	1.2	0.4	0.5	0.1	1.0	0.5	1.1	2.5	0.7
Isopoda	18.6	25.6	--	2.9	1.7	0.6	3.7	8.4	2.4	--	4.2	6.2
Oligocheata	--	1.2	--	1.0	0.8	--	--	--	--	--	--	0.3
Megaloptera	--	--	--	--	--	--	--	4.1	--	--	5.5	0.9
Pisces	--	--	--	--	--	--	--	18.8	--	--	--	1.7
Misc.	--	4.2	3.3	--	--	0.3	--	2.4	0.5	3.6	--	1.4
Terrestrial												
Diptera	--	--	0.3	0.1	19.1	0.2	0.4	--	2.4	1.7	--	2.1
Hymenoptera	--	7.3	--	1.0	0.3	1.5	0.7	2.5	--	4.3	2.5	1.8
Coleoptera	--	--	--	0.4	0.6	0.8	0.8	0.2	--	--	11.1	1.3
Dermaptera	--	--	--	--	5.8	--	--	--	--	8.3	8.3	1.3
Diplopoda	--	--	--	--	6.5	--	--	--	--	--	--	0.6
Mollusca (slugs)	--	--	--	--	--	--	--	--	--	--	--	--
Misc.	0.7	--	1.1	0.3	0.9	1.8	0.5	4.6	5.5	3.6	1.2	1.8
Total Aquatic	99.3	92.7	98.6	98.2	73.3	89.2	97.6	92.7	92.1	90.4	76.9	91.1
Total Terrestrial	0.7	7.3	1.4	1.8	26.7	10.8	2.4	7.3	7.9	9.6	23.1	8.9
Mean Volume (cc) Per Stomach	0.040	0.127	0.109	0.069	0.161	0.174	0.166	0.110	0.037	0.040	0.037	

March and 39.5 percent in July and August. A relatively large percentage in June (32.9%) was due to Diptera, mainly Chironomidae. Unlike the other sites there were no instances in which one or two large organisms accounted for a significant percentage of the volume at station III. Three young of the year steelhead were found in stomachs at this station in July.

Availability vs. Consumption

Values for food selection (Linear Index, Strauss 1979) are presented in Table 16 for major aquatic and terrestrial groups and taxa. A t-test was used to evaluate significant differences of index values from zero (ie. no selection). For ease of discussion all references to positive or negative index value pertains only to those that were found to be significant.

Of major aquatic groups, only the Trichoptera (stations I and II) and Diptera (station III) were consistently utilized at levels exceeding those present in the environment for most months. Positive values for Trichoptera were observed on six sampling dates at station I and seven dates at station II. Negative values were not present on any dates at these two sites. Values for Trichoptera at station III varied, positive values occurring on three dates between December and April and negative values from June to September. Selection for Diptera at station III was observed on eight of the 11 sampling dates. Non-significant values for Plecoptera at all stations and Diptera, on most dates at stations I and II, indicates that these groups were utilized in the same frequency as occurred in the environment for most of the year. Negative selection values were found for Coleoptera for most dates. Positve values were observed for Ephemeroptera on just two dates at stations II and III.

Table 16. Food selection values (linear index) for major aquatic and terrestrial invertebrate groups and taxa important in the diet of juvenile steelhead trout at three sites on Jacoby Creek, November 1978 to October 1979. Index values indicated are significant (P<0.05, t-test; Strauss 1979). + or - sign indicates not significant. Blank indicates organisms not present in stomachs or environment. (T)=Terrestrial.

Month	Ephemeroptera			Trichoptera			Diptera			Plecoptera			Coleoptera		
Station	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Nov.	-0.29	-0.56	-0.22	+0.50	+	+0.36	-	-0.15	+	-0.07	-	-	-0.24	-	-0.29
Dec.	-0.26	-0.51	-0.19	+0.18	+0.35	+	+0.06	+0.11	+0.14	+0.10	-	-	-0.11	-0.07	-0.11
Feb.	+	-0.24	-0.22	+	+0.28	+0.19	-0.03	-	0	-	-	+	-0.02	+	-0.05
Mar.	-0.64	-0.31	+0.41	+0.41	+0.12	-0.39	+	+	+	+	0	+	-	+	-
Apr.	-0.21	-0.19	-0.17	+	+	+0.10	-	-	+0.04	-	+	-	-0.05	-0.04	-
May	-0.28	-0.36	-0.09	+0.35	+0.22	+	-	+0.13	+0.04	-	+	-	-0.10	-0.12	-0.07
Jun.	-0.61	-0.50	-0.32	+0.51	+0.58	-0.04	+	-	+0.61	+	-	-	-	-0.11	-0.12
Jul.	-0.18	+0.13	+	+0.31	+	-0.08	-	+	+0.19	-0.07	-0.05	-	-0.23	-0.13	-0.16
Aug.	-0.14	+0.32	+0.06	+	-	-0.06	+0.11	-	+0.30	-0.06	-0.10	-0.06	-0.23	-0.21	-0.30
Sep.	-0.20	-0.04	+	+	+0.16	-0.08	-	+	+0.14	-	-0.06	-0.09	-0.14	-0.16	-0.15
Oct.	-0.11	-0.37	-	+	+0.46	-	-	-0.18	+0.09	-	+	-	-0.20	-0.11	-0.14

Month	Diptera (T)			Coleoptera (T)			Homoptera (T)			Hymenoptera (T)			Psocoptera (T)		
Station	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Nov.	+	+0.27	-	+0.06			-	+0.20	-	-	+	-	+	-	-
Dec.	+		-	-	-		-	-	-	+		+	+	-	
Feb.	-		+					-0.05	+				-		
Mar.	-	-	-	-	-	-		-	-	+	-	+			
Apr.	+0.22	+0.16	+	+		+	-	-	-	-		0			
May	+	-0.04	0	-	+	+	-	-	-	+	+	+0.07			
Jun.	+	-	-0.08	+	+	-	-	-	-	+0.06	+	-	-	-	
Jul.	-	-	-0.08	+0.04		+	+			+0.09		+0.03	0	-	-
Aug.	+	+	-	+0.08			+	+		+0.17			+		+
Sep.	+	+0.04	+0.04	-0.03	+	+	+	-	+	+0.13	+	+	-	-	-
Oct.	-	+0.07	+	+0.11	+	+	+	+0.04		+0.16	+	+	-	+	

Table 16. Food selection values (linear index) for major aquatic and terrestrial invertebrate groups and taxa important in the diet of juvenile steelhead trout at three sites on Jacoby Creek, November 1978 to October 1979. Index values indicated are significant (P<0.05, t-test; Strauss 1979). + or - sign indicates not significant. Blank indicates organisms not present in stomachs or environment. (T)=Terrestrial. (Continued)

Month	*Baetis* sp.			*Cinygmula* sp.			*Rithrogena* sp.			*Iron* sp.			*Paraleptophlebia* spp.		
Station	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Nov.	-0.05	-0.08	+	-	-	-	-0.11	-0.44	-0.23				-0.13	-	-
Dec.	-0.14	-0.18	-0.15				-0.09	-0.21	+				-	-0.04	-
Feb.	-	+	-0.18		-	+	-0.12	-0.31	-	-0.04	-	-	+	-	+0.06
Mar.	-0.42	-0.12	+0.46	-	-0.06	+	-0.05	-0.05	-	-0.06	-	-	-	-	+0.04
Apr.	+0.15	+	+0.15	-0.21	-0.17	-0.15	-0.09	+	+	-0.05	-	+0.07	-	-	-
May	-0.11	+0.04	-0.06	-0.12	-0.27	-0.06	-0.05	-	0	+	+	+0.04	-	-	
Jun.	-0.17	-0.16	-	-0.36	-0.27	-0.14	-	0	-	-	-	-	-	-	
Jul.	+	+0.32	+0.07	-0.19	-0.10	-				-	-0.03	-	+		+
Aug.	-0.04	+0.45	+0.12	+		0		-	-	+	+	-		-0.03	-
Sep.	-0.06	+0.08	+0.09	-0.09	-0.08	-0.03	0	-0.08	-0.04				+	+	+
Oct.	-	-	+0.10	-0.08	-	-	-0.06	-0.41	-0.16				+	-0.07	+

Month	*Ephemerella* spp.			*Calineuria californica*			*Capnia* sp.			*Nemoura* sp.			*Asellus* sp.		
Station	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Nov.	-	-	-		-	-	+	-	+	-0.10	-	-0.03		+0.05	+0.11
Dec.		-	-		-	-	+0.05	-0.07	-	+0.05	+	-	+	+0.18	+0.12
Feb.		-	-0.04	-	-	-	-	-	+	-	+	-	+		-
Mar.	-	-	-	+	+	-	+	-	0		-	-		+0.19	+
Apr.	-	-	-0.14	-	+	0	+					-	+		+
May	-	+	+		-	+			-	-	-	+		+	+
Jun.	-	-	-0.10			-	+				-	-	+	+	+
Jul.	-	-0.04	-0.04	-0.05	-0.04	-						-	+		+
Aug.	-	-	-	-0.05	-0.06	-0.03				0	-	-			+
Sep.	-	-	+	+	-	-0.04			-	-	-0.03	0	+		
Oct.				+	+	0			-	-	-0.03	-0.03	-	+	+

Table 16. Food selection values (linear index) for major aquatic and terrestrial invertebrate groups and taxa important in the diet of juvenile steelhead trout at three sites on Jacoby Creek, November 1978 to October 1979. Index values indicated are significant (P<0.05, t-test; Strauss 1979). + or - sign indicates not significant. Blank indicates organisms not present in stomachs or environment. (T)=Terrestrial. (Continued)

	Station														
Month	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
	Gumaga nigricula			*Glossosoma* sp.			*Lepidostoma* sp.			Limniphilidae			*Rhyacophila* sp.		
Nov.	+	+	-	-	+	-	+0.49	+	+0.28	-	+	+0.15	-	-	-
Dec.	+0.08	+0.18	+	+0.04	+	+0.09	+0.07	+0.13	-	-	+	-	-	+	-
Feb.	+	+		0	+0.19	+0.17	+	+	+	-	+	+	-	-	-
Mar.		+	+	+	+0.04	+	+0.41	+	-	-	+	-0.39		-	-
Apr.		-		-0.03	-0.04	+0.06	+0.08		+	+	+	-	-	-	-
May	+0.30	+	+	+	+0.09	+0.06	+0.10	+		-	+0.06	-	-	-	-
Jun.	+0.41	+0.58	+		-	-			-	+0.09	+	-	+	-	-
Jul.	+0.37	+	-	-	+0.06	-				+	-	-0.03	-0.06	-0.04	-
Aug.	+0.04	+	-	+	+	+	-	+	-	-	+	-0.03	-0.03	-0.05	-0.03
Sep.	+0.05	+	+	-	+	+0.10	+	+0.12	+0.06	-	+	+	-0.03	-	-
Oct.	+	+0.11	+	+	-	-0.14	-	+0.32	+0.11	+	+	-	+	-	-
	Elmidae			Chironomidae			Chironomidae (T)			Total Aquatic			Total Terrestrial		
Nov.	-0.26	-0.05	-0.28	+	-	+		+0.17	-	-0.12	-0.48	-	+0.12	+0.48	+
Dec.	-0.11	-0.08	-0.08	+0.06	+	+				-	+0.02	-	+	-0.02	+
Feb.	-	+	-0.04	-						+0.03	+0.05	-	-0.03	-0.05	+
Mar.	-	-	-		+				+	+	+0.05	+	-	-0.05	-
Apr.	-0.06	-0.04	-	+	+	+			+	-0.23	-0.14	-	+0.23	+0.14	+
May	-0.11	-0.11	-0.06	-	+	+	+	-		-	-0.10	-0.06	+	+0.10	+0.06
Jun.	-	-0.08	-0.09	+	+	+0.63		+	-0.07	-0.08	-	+0.10	+0.08	+	-0.10
Jul.	-0.23	-0.14	-0.14	+	+	+0.16	-	-	-0.06	-0.16	+	+	+0.16	-	-
Aug.	-0.24	-0.18	-0.28	+0.11	-	+0.28	0	-	-	-0.33	-	-0.05	+0.33	+	+0.05
Sep.	-0.10	-0.14	-0.15	-	-	+0.12	-0.02	-	-	-0.20	-	-0.09	+0.20	+	+0.09
Oct.	-0.25	-0.09	-0.12	0	-0.16	+0.09	-0.03		-	-0.32	-0.17	-0.08	+0.32	+0.17	+0.08

Negative values were found for Ephemeroptera at station I on all but one date. Most terrestrial groups were utilized in the same proportions as were available for most dates at all stations.

Fish from all stations showed positive selection for Trichoptera between September and March. During this time period Lepidostoma sp. was selected for at all stations. Positive selection for Glossosoma sp. was observed at stations II and III for a few dates during this same time period.

Considerable variation was observed between stations for taxa selection from April to October. Gumaga nigricula and terrestrials were consistently selected for at station I. At station III, Baetis sp. and Chironomidae were the two major food items to show positive selection. Fish from station II were found to consistently select only Baetis sp. during this same time period. Differences between stations for Baetis sp. and terrestrials was apparently related to differences observed in proportions found in the drift. While Baetis sp. was a major component of the drift at stations II and III, this taxon made up a small percentage of the drift at station I from July to November. During the same time period, terrestrial drift was significantly greater at station I than the other stations.

Seasonal percentage occurrence by number of major aquatic groups and taxa from juvenile steelhead stomachs, and comparable benthic and drift (4 hours prior to stomach collection) percentages are shown in Table 17. Stomachs from all stations during winter and spring exhibited a high percentage of predominately drift organisms, Baetis sp. (stations I, II and III) and Chironomidae (station III), and a comparatively low percentage of major benthic organisms, Rithrogena sp. and Cinygmula sp.

Table 17. Major aquatic taxa, expressed in percent of total number of aquatic organisms, consumed by juvenile steelhead trout from Jacoby Creek and corresponding benthic and aquatic drift percentages (> 5%) by season (Winter = February and March, Spring = April to June, Summer = July to September, Fall = October to December). S = stomachs, B = benthic, D = drift 4 hrs prior to stomach samples. (< sign indicates less than 1%).

Taxa	Winter			Spring			Summer			Fall		
	S	B	D	S	B	D	S	B	D	S	B	D
Station I												
Baetis sp.	14		50	33	13	43	7	8		11		27
Lepidostoma sp.	31			8			2			29	18	16
Gumaga nigricula	2			18			27			7		
Chironomidae	0			0			23	7	31	11		5
Elmidae	4			5	13	11	17	35	21	3	29	12
Nemouridae	8	8	9	1			<			17	6	14
Cinygmula sp.	0	6		8	53	14	1	13		0	6	
Rithrogena sp.	9	74	5	1	6		1			2	12	
Paraleptophlebia spp.	8		9	<			2			4	8	6
Glossosoma sp.	3			9			3			3		
Station II												
Baetis sp.	27		42	10	12	29	40	8	13	5		31
Gumaga nigricula	1			35			2			12		
Lepidostoma sp.	2			<			7		5	22		
Chironomidae	<			1			21	21	18	6	14	
Glossosoma sp.	10			3			10	7		4		
Neophylax rickeri	21			3			0			0		
Asellus sp.	13			3			0			10		
Elmidae	<			3	9	15	2	18	6	0	8	9
Cinygmula sp.	1		7	9	44	18	<	8		0		
Rithrogena sp.	4	66		4	5		0	5		1	48	
Paraleptophlebia spp.	1		5	<		5	2		8	5		6
Station III												
Baetis sp.	64	7	34	11	12	20	27	11	23	15		38
Chironomidae	0			57	6	16	37	13	19	9	7	
Lepidostoma sp.	<			1			2			13		
Glossosoma sp.	4			3			5	10		7	13	
Cinygmula sp.	8		7	3	25		<			1		
Rithrogena sp.	6	43		1			0			7	26	
Gumaga nigricula	<			2			<			4		
Elmidae	1	6		1	7	6	3	26	10	4	22	13
Paraleptophlebia spp.	1			0			1			2		
Ephemerella spp.	1	8		5	22		2			0		
Limniphilidae sp.	5	5	41	2		11	3			7		13

(stations I, II and III), and Ephemerella spp. (station III). An exception to this trend was a low percentage of Limniphilidae sp., a major drift organism, in stomachs from station III in the winter. Other major food items, mainly Trichopterans, Lepidostoma sp. (station I), Gumaga nigricula (stations I and II) and Neophylax rickeri, Glossosoma sp., and Asellus sp. (station II) made up no more than five percent of the drift or benthos during these two seasons.

Of the major food items at station I in the summer, Gumaga nigricula sp. accounted for relatively low percentages of drift and benthic samples, Chironomidae accounted for a large portion of the drift but not the benthos, and Elmidae made up large portions of both drift and benthic samples. Stations II and III were similar in summer, Baetis sp. and Chironomidae accounting for the largest percentage of stomach contents. Though these two taxa made up the largest percentage of drift they also accounted for a high percentage of benthic organisms.

The greatest variation between sites with respect to the use of high drift or benthic organisms occurred in the fall. At station I, high percentage aquatic drift taxa, Lepidostoma sp., Baetis sp., and Nemouridae, were also major food items. However, Lepidostoma sp. also accounted for a large percentage of benthic items at this station. Other major benthic organisms, Elmidae and Rithrogena sp. were not heavily utilized. Major food items at station II in the fall, Lepidostoma sp., Gumaga nigricula and Asellus sp. accounted for less than five percent of benthic and drift samples. The high percentage drift (Baetis sp.) and benthic (Rithrogena sp.) organisms made up a very small percentage of stomach items at this station. Of the two items making up the largest percentage of stomach items at station III in the fall, Baetis sp. occurred mainly in the drift and Gumaga nigricula was not a major component of either drift or benthic samples. The two major benthic taxa at this station, Rithrogena sp. and Elmidae made up a small percentage of stomach contents.

In summary, winter and spring samples at all stations showed a tendency toward consumption of predominately drift organisms or those which were relatively rare in both drift and benthic samples. Determination of feeding on drift or benthic items was not well defined for summer and fall months since some high percentage drift organisms were also represented by a similar percentage in the benthos. Lepidostoma sp., one of the most utilized food items at all stations in the fall, was a major drift and benthic item at station I, but did not make up over five percent of either food source at stations II and III.

Diversity

Shannon-Weaver diversity values and number of taxa for benthic samples, and aquatic portions of drift and stomach samples are given in Table 18. Freidman's two-way ANOVA was used to test for significant differences between stations for diversity and number of taxa. Dates were treated as blocks, sampling sites as fixed-effects, and diversity and number of taxa for each station was ranked for each date. Diversity and number of taxa were found to differ significantly ($p<0.05$) only for benthic samples. A posteriori comparisons of ranked sums indicated that station III had higher diversity and a larger number of taxa than stations I and II. Benthic diversity and number of taxa increased steadily from winter months to summer, August and September. No trend was apparent for drift or stomach diversity values or number of taxa.

Table 18. Diversity indicies (Shannon-Weaver H) and number of taxa collected for benthic samples and aquatic portions of drift and stomach samples, by month, from three sites on Jacoby Creek, November 1978 to October 1979.

Date	Station I H	Station I Number of Taxa	Station II H	Station II Number of Taxa	Station III H	Station III Number of Taxa
			Benthic			
Nov.	2.14	19	1.94	27	1.96	27
Dec.	1.77	17	1.08	18	1.62	17
Feb.	1.23	15	1.23	14	1.93	20
Mar.	1.32	8	1.63	15	2.27	22
Apr.	1.93	21	2.22	26	1.98	22
May	1.88	27	1.71	25	2.23	24
Jun.	1.26	17	1.95	25	2.58	31
Jul.	2.13	22	2.52	29	2.39	35
Aug.	1.92	26	2.59	37	2.56	43
Sep.	2.45	29	2.44	34	2.65	40
Oct.	2.16	27	2.03	32	2.43	35
Mean (H)	1.83		1.94		2.23	
			Drift			
Nov.	2.13	25	0.99	23	1.91	32
Dec.	1.94	31	2.13	25	2.36	30
Feb.	2.07	22	1.62	23	1.77	29
Mar.	1.83	20	1.98	19	1.99	22
Apr.	2.17	26	2.06	30	2.09	27
May	2.08	36	2.12	31	2.44	31
Jun.	2.29	22	2.23	27	1.93	26
Jul.	2.51	22	2.29	22	2.07	25
Aug.	2.41	26	2.23	25	2.13	24
Sep.	1.82	21	1.77	21	2.47	26
Oct.	2.55	22	2.03	17	2.16	20
Mean (H)	2.16		1.95		2.12	
			Stomachs			
Nov.	1.05	10	2.19	15	2.20	12
Dec.	2.49	20	2.39	16	2.61	21
Feb.	2.00	10	2.05	14	2.07	13
Mar.	2.00	16	2.19	26	1.46	26
Apr.	1.23	12	2.33	19	2.30	21
May	2.19	17	2.87	21	2.60	25
Jun.	1.98	17	1.64	19	0.75	15
Jul.	1.93	22	1.63	16	2.05	29
Aug.	1.85	20	1.54	16	1.82	26
Sep.	2.48	16	2.31	22	2.68	27
Oct.	2.17	17	1.97	15	2.50	21
Mean (H)	1.94		2.10		2.09	

DISCUSSION

Benthos

Distribution and abundance of stream invertebrates is largely a function of the particular environment that exists in a section of stream. Factors which greatly influence invertebrate distribution in streams include depth, velocity, food and substrate (Hynes 1970, Rabeni and Minshall 1977). Depth and velocity were similar for the three sites on Jacoby Creek, however, there was considerable difference in canopy and substrate composition. Food availability, particularly the quality of food present, is largely dependent upon canopy type present (Fahy 1975; Hawkins et al. 1982). Detritus in the form of leaves and woody debris is generally more abundant in shaded areas of stream while periphyton production is higher in unshaded areas (Minshall 1978). Substrate has been found to be especially important in determining distribution of many stream invertebrates (Kennedy 1967; Ulfstrand 1967). Observed differences in absolute and relative abundances, and distribution of some major benthic groups and taxa between sites in Jacoby Creek was reflective of differences in canopy type and substrate composition. Classification of feeding types (ie. shredder, scraper etc.) used in the following discussion is based on functional feeding relationships presented by Merrit and Cummins (1978).

Station I, characterized by a heavy canopy of trees and shrubs, had relatively large numbers of shredders which are generally associated with detritus. This included Lepidostoma sp. and Nemouridae. This site also contained a higher number, although not significantly greater, of a collector, Paraleptophlebia. Collectors have been found to occur in large numbers when associated with shredders (Cummins et al. 1973). Taxa which were more abundant at station III, an unshaded section of stream, were scrapers which are associated with periphyton. These included Glossosoma sp., Neophylax sp., Eubrianax edwardsi and Ephemerella. These findings agree with Hawkins and Sedell (1981) who found higher abundances of shredders in shaded areas and scrapers in open areas in Oregon streams. One species, Hydroptila sp., was found only at station III. This species feeds primarily on filamentous algae (Wiggins 1977) which was noted to be very abundant at this site. Station II contained intermediate numbers of many of these taxa which is consistent with the qualitative characteristic of this site of an intermediate canopy type.

The kinds of food present is a major factor in determining stream invertebrate abundance and distribution. However, as Ulfstrand (1967) pointed out, a combination of factors often influence benthic invertebrate distribution more than isolated ones. This appeared to be the case for two of the most common taxa, Cinygmula sp. and Rithrogena sp. These species, which feed primarily on periphyton, were more abundant at stations I and II which theoretically would be lower in periphyton production due to shading. These taxa may have been influenced more by substrate preference than food quality or availability.

Significantly higher numbers of Trichoptera and greater species diversity observed at station III was apparently a function of the large substrate at this site. Similar observations of higher caddisfly densities and greater species diversity in larger substrate were made by Nuttal (1972), Barber and Hevern (1973), Kimble and Wesche (1977), and

Williams and Mundie (1978). Williams and Mundie (1978) hypothesized that larger substrate may allow for more attachment sites for filter feeders such as Hydropsyche, which coincidentally were found in significantly larger numbers at station III.

Peak benthic invertebrate abundance in Jacoby Creek occurred between August and October while the lowest densities were observed from December through May. Similar seasonal patterns were observed for other Pacific Northwest coastal streams by Malick (1977) and Gislason (1985).

Seasonal fluctuations in benthic invertebrate densities and life cycles observed on Jacoby Creek are probably related to seasonal changes in food availability. It was noted that larger amounts of detritus and algae were collected in benthic samples in late summer and fall, the time of maximum invertebrate abundance, than at other times of the year. An association between detritus levels and invertebrate abundance has been demonstrated by Egglishaw (1968), Cummins (1973), Fahy (1975), and Hawkins and Sedell (1981). Highest periphyton standing crop was found in autumn in Oregon Cascade streams (Hawkins and Sedell 1981). A trend toward higher scraper biomass associated with high periphyton standing crop was observed by Hawkins et al. (1982).

A decline in benthic invertebrate abundance in Jacoby Creek occurred between November and December and continued until April. This is generally the time of year when rain and high flows occur in this region. High flows can cause a significant reduction in detritus by transporting it downstream (Malmqvist et al. 1978). Reduced algae production has been observed during periods of high flow by Moore (1978). Minimum standing crops of periphyton were observed in winter and associated with high winter flows in streams in the Pacific

Northwest (Gregory 1980). This apparent lack of food during winter and abundance of food in summer and fall may explain the seasonal changes in abundance of benthic invertebrates noted in Jacoby Creek.

In comparison to Jacoby Creek, Kennedy (1967) noted highest benthic standing crop during winter in a Sierra Nevada stream. He also noted that maximum amounts of detritus were present at this time of year. Minimum benthic densities occurred in the spring. In this stream it also appeared that invertebrate life cycles were tied to maximum food availability as high spring runoff from snow melt would significantly reduce food availability.

Drift

The dominate drift organism in Jacoby Creek, Baetis sp., has been shown to be a major component of drift in streams studied by Waters (1964), Hinkley and Kennedy (1972), Clifford (1972), and Stoneburner and Smock (1979) from different georaphical areas throughout North America. Waters (1972) noted that Baetis sp. universally exhibit high drift rates. Stream insects that are most important quantitatively in drift are Ephemeroptera, Diptera, Trichoptera, and Plecoptera, in that order (Waters 1972). This was true in Jacoby Creek with the exception that Coleoptera, mainly Elmidae, also exhibited high drift rates at certain times of the year.

Causitive factors of drift have been classified as behavioral, catastrophic, and constant (Waters 1965). A major feature of behavioral drift is that of diel perodicity. Often it is not possible to distinguish among these types of drift as they overlap and interact. This was apparent on the March sampling date on Jacoby Creek. Stream discharge was significantly greater in March than on other sampling dates and coincidentally the highest drift densities occurred on this date. Even more significant was the fact that drift rates were substantially greater in March than for other dates. Considering that benthic densities were very low on this date, the ratio of invertebrates in the drift compared to the benthos was considerably higher than for any other sampling period (Appendix G), an indication that drift was catastrophic in nature due to high streamflow and associated scouring of the stream bottom. However, it was also noted that the two taxa which made up the largest percentage of the drift, Baetis sp. and Limniphilidae sp., exhibited distinct diel periodicity that was behaviorally characteristic (Appendix H). Baetis sp. generally show marked nocturnal drift tendicies (Waters 1972) while many Limniphilidae are reported to be primarily day-active (Anderson 1967). A similar pattern was noted by Anderson and Lehmkhul (1968) in an Oregon stream during a period of high water in which drift increased but most taxa retained their behavioral day-night periodicity.

Seasonal fluctuation in total invertebrate drift densities in Jacoby Creek were affected by both discharge and life history patterns. The majority of drift studies conducted in northernly areas of the temperate zone indicate maximum drift occurs during summer months (Waters 1969). This occurs at a time when maximum growth of most stream invertebrates takes place (Elliot 1967c). Drift densities on Jacoby Creek were relatively high in August and September. Much of this was due to an increase in drift of Chironomids at stations I and II and Baetis sp. at stations II and III. Both these taxa showed behavioral drift tendencies as flows were very low at this time of year, making accidental dislodgement from the substrate improbable. Dominant behavioral drift invertebrates collected during summer in an Oregon coastal stream were Baetis and Chironomidae (Wilzbach and Hall 1985). Seasonal peaks were found to be primarily due to Ephemeroptera and Diptera in a South Carolina stream with little flow fluctuation (Stoneburner and Smock 1979).

High discharge has been shown to increase drift (Elliot 1967a; Waters 1972). The fluctuations in drift density between February and June paralleled changes in stream discharge with the exception of station III in May. Low drift density in May at this site may have been related to the comparatively low benthic density at this station on this sampling date, although as pointed out by Waters (1972), a relationship between drift and bottom population densities has not been clearly demonstrated. It was quite apparent that high flows in winter and spring increased drift, both in total numbers and density.

Drift density increased between June and September before declining substantially in November. However, drift rates were much lower between July and November than for other dates. This pattern was similar to that observed in other drift studies. Clifford (1972) and Canton et al. (1984) observed increasing drift density through the summer as discharge decreased. This agrees with a similar relationship found by Minshall and Winger (1968) of increasing drift density with decreasing flow. Griffith (1974) observed a decline in abundance of drift, total number of organisms captured, as summer progressed.

Terrestrial drift density was highest in summer and lowest in winter in Jacoby Creek. The same pattern was observed by Kennedy (1967), Elliot (1967b), and Hunt (1975). The amount of shoreline vegetation present is a major factor in the input of terrestrial invertebrate to streams (Hunt 1975; Mason and McDonald 1982). The higher terrestrial drift found at station I in the summer was probably the result of the extensive riparian vegetation compared to the other sites. It was also found that little diel variation existed for drifting terrestrials (Appendix H). Data from Hinckley and Kennedy (1972) and Johnson and Ringler (1980) also indicated little diel fluctuation in terrestrial drift.

Stomach Contents

Juvenile steelhead in Jacoby Creek were found to feed year round with no appreciable difference between seasons for average number or volume of food items found in stomachs. It was also noted that stomach content diversity was similar throughout the year, an indication that food supply was diverse, and sufficient numbers were present. The generally lower average number of items per stomach observed between September to November were due to fish feeding on mainly larger organisms such as caddisflies, Oligocheates, and Isopods. Reimers (1957) and Chapman and Bjornn (1969) found the amount of food in rainbow trout and steelhead stomachs were not much different in winter than the rest of the year. They suggested that even though food supply was low in winter, particularly in the form of drift, slow digestion rates in cold water still allowed fish to obtain an adequate food supply. This is probably partly true in Jacoby Creek, though winter stream temperatures were not as severe as in the above studies, and food supply, in the form of drift, was relatively abundant in Jacoby Creek during the winter.

There is general agreement in many salmonid feeding studies that fish feed heavily on the most abundant prey (Elliot 1970, 1973; Jenkins et al. 1970; Allan 1978) and over a year benthic organisms are important food sources in winter and drifting organisms in summer (Egglishaw 1967; Elliot 1967b; Kennedy 1967). In Jacoby Creek the most abundant drift items were major food items throughout the year. A significant tendency for common drift taxa to be common in the diet of trout was also observed by Allan (1981). However, it was noted that the most abundant benthic taxa in Jacoby Creek were usually not dominate food items at any time of the year. When major benthic taxa were consumed in relatively large numbers, they coincidentally accounted for a large portion of the drift. This was especially true for Chironomidae and Nemouridae. In such cases a distinction between drift and benthic feeding cannot be made (Chaston 1968; Allan 1978).

Major food items in winter and spring in Jacoby Creek were high drift density Baetis sp. and low benthic density Trichopterans. Caddisflies were also observed to make up a large percentage of winter food for steelhead in another California coastal stream (Shapovalov and Taft 1954). The two taxa which accounted for the largest proportion of benthic densities during the winter, Cinygmula sp. and Rithrogena sp., were not heavily utilized. The same pattern observed in winter and spring was generally true in summer and fall as high drift rate taxa, Baetis sp., Chironomidae and terrestrials were utilized along with Trichopterans. The more heavily used food items throughout the year also showed positive selection index values. These findings agree with Allan (1978), who found that prey consumed in excess of their frequency in the environment were in the drift or large (e.g. Trichopterans).

Based on the feeding patterns observed for steelhead in Jacoby Creek, it is apparent that drift abundance and composition were important in determining foods eaten but the same was not true for benthic invertebrates. That feeding by salmonids in streams is often not proportional to the abundance of food present has been demonstrated by Ware (1971, 1972) and Ringler (1979). Size, visibility, and movement of prey have been implicated in these studies as being major elements in determining the diet of stream salmonids. Obviously, prey items which are in the drift fit these characteristics, the direct significance of drift to fish being an increase in accessibility and visibility (Waters 1969).

Prey size and visibility appeared to play an important role in food selection by steelhead in Jacoby Creek at all times of the year. Other related factors, prey behavior and distribution, have also been found to be important factors in determining salmonid feeding patterns (Allen 1941; Egglishaw 1967). _Baetis_ sp. and Chironomidae, prey items that display behavioral drift fall into this category. The two most utilized Trichopterans, _Lepidostoma_ sp. and _Gumaga nigricula_, besides being large and visible, exhibit behavioral qualities which would allow easy detection by predators. _Lepidostoma_ are often associated with detritus and have been observed to congregate around such food sources (Wiggins 1977). Prior to pupation, _Gumaga nigricula_ form extensive aggregations along stream margins (Resh et al. 1981). This probably accounts for these taxa showing up in large numbers in some fish and absent in others. It may also be why they appeared to be selected for, since benthic samples would have underestimated densities for these taxa if they occurred near the margins of the stream or in large aggregations. High benthic density taxa such as *Cinygmula* sp. and *Rithrogena* sp. generally did not drift in large numbers and their habit of foraging for food on the underside of rocks makes them a relatively inaccessible prey. One item which occurred in large proportions in the drift and benthos in summer and fall, Elmidae, was not a major food item. These individuals are apparently not a preferred as food as other investigators have found a similar relationship (Kennedy 1967; Griffith 1974).

The differences found between sites for abundance of some major benthic organisms compared to the differences between sites for stomach contents indicates that habitat may have influenced feeding. Substrate composition was one of the most prominant features differentiating sites. Ware (1972) found that intensity of predation and total food consumption was inversely related to the complexity of the substrate, because a number of prey were able to find cover and escape detection. Wilzbach and Hall (1985) concluded that lack of cover structures may promote more efficient foraging behavior or at least different than that in a more complex habitat. Such may have been the case in Jacoby Creek, since station III, containing large substrate and pocket water, was visibly more complex than stations I or II.

Another major difference between sites was the amount of riparian vegetation, which as discussed earlier largely influences the quantity of terrestrial organisms entering a stream. The site with the highest terrestrial abundance, station I, had significantly greater numbers of terrestrial organisms in stomachs. Terrestrial drift was relativley low at the other two sites as were terrestrials in the diet. Griffith (1974) observed that when terrestrial drift is poorly developed terrestrials in the diet also tends to be low. Another reason terrestrial drift was more prominent as a food item at station I could be related to the the type of habitat fish occupied during summer when terrestrial drift was most abundant. Fish at this station were forced to remain in pools during the summer as riffle area decreased and cover was limited because of the lack of instream structures and small substrate present. Egglishaw (1967) found greater terrestrial consumption by trout residing in pools than in runs and suggested that lower numbers of benthic organisms in pools coupled with the high visibility of terrestrials on the surface were conducive to feeding on these organisms. Johnson and Ringler (1980) concluded that differences observed in the diet between coho and steelhead for terrestrials were partly due to differences in habitat occupied by the two species, coho residing in pools and steelhead in riffles.

The interruption of growth of juvenile steelhead in Jacoby Creek in September (e.g. Harper 1980) cannot be explained by lack of available food, considering benthic densities were at a peak during this period and did not decline until December. Low drift rates however, could have been a factor. Waters (1972) hypothesized that drift feeding may be more efficient than epibenthic feeding. Fish that forage from the benthos, rather than the drift, may expend more energy to obtain food (Chapman 1966b). Allen (1969) speculated that since growth is influenced by the amount of energy expended to obtatin food, and more foraging may be required to obtain adequate food at reduced flows, there is a potential for reduced growth in slower currents. Also, available fish habitat is limited at reduced flows, further contributing to energy expenditure through competition for space and food.

CONCLUSION

The low flow period in Jacoby Creek, and in other coastal streams in northern California with similar characteristics, appears to be a limiting factor in juvenile steelhead production. Carrying capacity in these streams is probably controlled by summer and fall discharge. Although there appeared to be adequate food year round in Jacoby Creek, especially in summer and fall, low flows apparently limit fish habitat. An abundant benthic population cannot be regarded as a sole source for determining whether a stream can support a large number of fish. The low abundance of drift as a food source in late summer (September to November) may reduce the capability of fish to acquire prey without a large energy expenditure. If habitat is limited in low flow periods, fish may be forced into pools or pockets away from major sources of food (i.e. riffles). This may explain reduced growth during this time of year. The type of organisms present, their behavior, and drift patterns all appear to be major elements in determining feeding patterns of juvenile steelhead in Jacoby Creek. This is probably also true for other coastal streams with similar characteristics.

Any type of water development in Jacoby Creek could have adverse impact on the capabilities of the stream to support fish production. Logging, which continues to take place in the watershed, can further reduce summer flows by decreasing the capacity for water retention in the watershed, which provides most of the summer flow.

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Appendix A. Substrate particle size composition from three benthic invertebrate sampling sites on Jacoby Creek, California. Samples taken in April, 1979.

Seive Size in.	Seive Size mm	Geometric Mean Particle Diameter (mm)	Percent Volume Retained (Mean) Station I	II	III
3.0	76.20	107.15*	0.0	0.0	52.6
2.0	50.80	61.66	0.0	15.2	11.3
1.0	25.40	35.48	13.9	28.4	10.8
0.5	12.70	17.78	29.9	16.3	6.7
0.25	6.35	8.91	21.0	10.4	3.1
0.131	3.33	4.57	11.5	6.6	1.5
0.065	1.65	2.34	7.2	5.9	1.2
0.033	0.84	1.18	7.9	9.3	7.3
<0.033	<0.84	Fines	8.6	7.9	5.6

* with six inch upper size limit (size of sampler)

Appendix B. Flow and water temperature from three study sites on Jacoby Creek, California, November 1978 to October 1979.

	Station I				Station II				Station III			
	Flow		Water Temperature		Flow		Water Temperature		Flow		Water Temperature	
Date	cms	(cfs)	°C	(°F)	cms	(cfs)	°C	(°F)	cms	(cfs)	°C	(°F)
Nov.	0.054	(1.9)	10.0	(50)	0.063	(2.2)	9.4	(49)	0.056	(1.9)	11.1	(52)
Dec.	0.34	(12.0)	7.7	(46)	0.32	(11.3)	7.2	(45)	0.28	(9.9)	6.6	(44)
Feb.	0.25	(9.0)	5.5	(42)	0.19	(6.7)	5.0	(41)	0.14	(4.9)	5.0	(41)
Mar.	1.38	(48.7)	10.5	(51)	1.33	(46.9)	10.5	(51)	1.12	(39.5)	11.1	(52)
Apr.	0.233	(8.2)	11.1	(52)	0.23	(8.1)	10.0	(50)	0.22	(7.7)	10.0	(50)
May	0.35	(12.5)	13.9	(57)	0.39	(13.8)	13.3	(56)	0.34	(12.0)	12.7	(55)
Jun.	0.18	(6.3)	11.7	(53)	0.17	(6.0)	11.7	(53)	0.16	(5.6)	11.1	(52)
Jul.	0.077	(2.7)	13.9	(57)	0.077	(2.7)	13.9	(57)	0.076	(2.7)	14.4	(58)
Aug.	0.041	(1.4)	17.2	(63)	0.041	(1.4)	16.6	(62)	0.036	(1.3)	16.6	(62)
Sep.	0.037	(1.3)	17.2	(63)	0.039	(1.4)	16.6	(62)	0.032	(1.1)	15.5	(60)
Oct.	0.031	(1.1)	17.7	(64)	0.027	(0.9)	17.2	(63)	0.025	(0.9)	16.6	(62)

APPENDIX C. Aquatic invertebrates collected in benthic and drift samples at three sites on Jacoby Creek, California, November 1978 to October 1979. Numbers indicate sites where collected.

	Benthic	Drift
ORDER EPHEMEROPTERA		
Family Baetidae		
Baetis sp.	1,2,3	1,2,3
Centroptilium sp.	1,2,3	1,2,3
Family Ephemerellidae		
Ephemerella sp.	1,2,3	1,2,3
Ephemerella coloradensis	1,2,3	1,2,3
Ephemerella hecuba	1,2,3	1,2,3
Ephemerella levis	1,2,3	1,2,3
Ephemerella maculata	1,2,3	
Ephemerella teresa	1,2,3	1,2,3
Ephemerella tibialis	1,2,3	
Family Heptegeniidae		
Cinygmula sp.	1,2,3	1,2,3
Iron sp.	1,2,3	1,2,3
Ironodes sp.	1,2,3	1,3
Ironopsis grandis	3	
Heptegenia sp.	1,2,3	1,2,3
Rithrogena sp.	1,2,3	1,2,3
Family Leptophlebia		
Paraleptophlebia sp.	1,2,3	1,2,3
Paraleptophlebia helena	1,2,3	1,2,3
Family Siphlonuridae		
Ameletus sp.	1,2,3	1,2,3
Siphlonurus sp.		2
Family Trichorythodes		
Trichorythodes minutus	1,2,3	1,2,3
ORDER PLECOPTERA		
Family Chloroperlidae		
Alloperla sp.	1,2,3	1,2,3
Kathroperla perdita		3
Paraperla frontalis	1,2	
Family Nemouridae		
Capnia sp.	1,2,3	1,2,3
Nemoura (*Melenka*) sp.	1,2,3	1,2,3
Nemoura (*Zapada*) sp.		3
Family Peltoperlidae		
Peltoperla sp.		2
Family Perlidae		
Calineuria californica	1,2,3	1,2
Hesperoperla pacifica	1,2,3	
Family Perlodidae		
Isogenus sp.	1,2,3	1,2,3
Isoperla sp. A	1,2,3	1,2,3
Isoperla sp. B	1,2,3	1,2,3

APPENDIX C. Aquatic invertebrates collected in benthic and drift samples at three sites on Jacoby Creek, California, November 1978 to October 1979. Numbers indicate sites where collected. (continued)

	Benthic	Drift
ORDER COLEOPTERA		
Family Dryopidae		
Helichus suturalis	1,2,3	1,2,3
Family Dytiscidae		
Agabus regularis		1
Bedessus subtilis		1
Deronectes sp.	1,2,3	1,2,3
Hydroporus sp.		3
Oreodytes sp.	1,2,3	1,2,3
Family Elmidae		
Elmidae sp.	1,2,3	1,2,3
Optioservus seriatus	1,2,3	1,2,3
Zaitzevia sp.	1,2,3	1,2,3
Family Gyrinidae		
Gyrinus picipes		1,2,3
Family Haliplidae		
Brychius pacificus	1,2,3	1,2,3
Peltodytes callosus		1,2,3
Family Hydrophilidae		
Ametor latus	3	1,3
Family Psphenidae		
Eubrianax edwardsi	1,2,3	1,2,3
ORDER DIPTERA		
Family Blephariceridae		
Bibiocephala comstocki	2,3	3
Family Chironomidae		
Chironomidae spp.	1,2,3	1,2,3
Symbiocladius sp.	1,2	
Family Dixidae		
Dixa californica	2	1,2,3
Family Heleidae		
Palpomyia sp.	1,2,3	
Family Simuliidae		
Simulium sp.	1,2,3	1,2,3
Family Stratiomyiidae		
Stratiomyiidae sp.	3	3
Family Tabanidae		
Tabanidae sp.	3	
Family Tipulidae		
Antocha saxicola	1,2,3	2,3
Dicranota sp.	1,2,3	3
Hexatoma sp.	1,2,3	
Limoniinae sp.	1,2,3	1,2,3
Pedecia sp.	1,2,3	

APPENDIX C. Aquatic invertebrates collected in benthic and drift samples at three sites on Jacoby Creek, California, November 1978 to October 1979. Numbers indicate sites where collected. (continued)

	Benthic	Drift
ORDER AMPHIPODA		
Family Gammaridae		
Gammarus sp.		1,2
ORDER TRICHOPTERA		
Family Brachycentridae		
Amiocentrus aspilus	3	1,2,3
Micrasema sp.	3	
Family Glossosomatidae		
Agapetus sp.	2,3	3
Glossosoma sp.	1,2,3	1,2,3
Family Hydropsychidae		
Hydropsyche sp.	1,2,3	1,2,3
Family Hydroptilidae		
Hydroptila sp.	3	1,3
Neotrichia sp.	3	
Family Lepidstomatidae		
Lepidostoma sp. A	1,2,3	1,2,3
Lepidostoma sp. B		1,2,3
Family Limniphilidae		
Cryptochia sp.		3
Dicosmoecus sp.	1,2,3	1,2,3
Ecclisomyia conspersa	2,3	2,3
Hydatophylax hesperus	1,2,3	1,2,3
Limniphilidae sp.	1,2,3	1,2,3
Neophylax sp.	3	3
Neophylax rickeri	1,2,3	1,2,3
Onocosmoecus sp.	1,2,3	1,2,3
Family Odontoceridae		
Parthina linea	2,3	3
Family Polycentropidae		
Polycentropus sp.	2,3	2,3
Family Rhyacophilidae		
Rhyacophila sp. A	1,2,3	1,2,3
Rhyacophila sp. B	3	
Family Sericostomatidae		
Gumaga nigricula	1,2,3	1,2,3
ORDER MEGALOPTERA		
Family Corydalidae		
Corydalis sp.		1
Family Sialidae		
Sialis sp.	2	1,2,3

APPENDIX C. Aquatic invertebrates collected in benthic and drift samples at three sites on Jacoby Creek, California, November 1978 to October 1979. Numbers indicate sites where collected. (continued)

	Benthic	Drift
ORDER ISOPODA		
Family Asellidae		
Asellus sp.	1	1,3
ORDER HEMIPTERA		
Family Corixidae		
Corixa sp.		1,2,3
Family Gerridae		
Gerris remigis		1,2,3
ORDER LEPIDOPTERA		
Family Pyralidae		
Synclita occindentalis	2,3	
ORDER COLLEMBOLA		1,2,3
ORDER HYDRACARINA (Water Mites)	2	1,2,3
ORDER ASPIDOBRANCHIA (Snails)	1,2,3	1
CLASS OLIGOCHEATA	1,2,3	
CLASS NEMATODA	1,2,3	1

Appendix D. Mean number per sample and 95% confidence intervals (parentheses) of major groups and total number of invertebrates from benthic samples collected at three sites on Jacoby Creek, November 1978 to October 1979. Confidence intervals estimated from log (x + 1) transformations. Estimates of confidence intervals for number per m^2 can be calculated by dividing by 0.28. Station I - July to December, N=3; February to June, N=4. Station II and III - November to July, N=4; August to October, N=3.

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
					Station I						
Ephemeroptera	100 (57-175)	69 (9-336)	43 (32-56)	13 (10-18)	165 (117-228)	123 (49-251)	354 (247-506)	133 (72-243)	90 (17-459)	151 (81-284)	158 (60-275)
Plecoptera	42 (37-48)	8 (0-247)	6 (0-20)	1 (0-3)	2 (0-7)	10 (6-15)	7 (2-19)	31 (7-121)	40 (9-168)	31 (10-116)	17 (9-32)
Trichoptera	44 (0-519)	2 (2-2)	1 (0-4)	0 - -	17 (3-52)	10 (4-19)	9 (5-16)	36 (18-83)	23 (13-46)	23 (7-85)	143 (13-799)
Coleoptera	94 (83-108)	20 (1-146)	2 (0-6)	1 (0-5)	15 (5-36)	35 (21-55)	71 (34-138)	115 (101-131)	200 (83-480)	90 (78-104)	197 (131-300)
Diptera	29 (11-100)	4 (2-9)	1 (0-2)	0 - -	5 (0-23)	4 (2-8)	7 (2-29)	39 (13-140)	32 (29-37)	30 (9-114)	35 (18-68)
Total	315 (252-393)	113 (26-383)	53 (42-65)	16 (12-21)	206 (141-289)	184 (92-327)	451 (382-532)	355 (272-465)	389 (220-775)	327 (128-829)	553 (295-1034)

Appendix D. Mean number per sample and 95% confidence intervals (parentheses) of major groups and total number of invertebrates from benthic samples collected at three sites on Jacoby Creek, November 1978 to October 1979. Confidence intervals estimated from log (x + 1) transformations. Estimates of confidence intervals for number per m^2 can be calculated by dividing by 0.28. Station I - July to December, N=3; February to June, N=4. Station II and III - November to July, N=4; August to October, N=3. (Continued)

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
Station II											
Ephemeroptera	176 (71-354)	83 (70-96)	60 (36-94)	27 (20-36)	159 (69-316)	143 (91-215)	165 (106-245)	87 (68-112)	36 (21-62)	151 (87-253)	296 (109-734)
Plecoptera	11 (7-16)	3 (1-7)	7 (2-17)	1 (0-3)	6 (0-31)	4 (1-8)	4 (1-8)	13 (4-28)	26 (6-91)	37 (13-91)	37 (7-151)
Trichoptera	11 (3-31)	7 (5-11)	5 (2-12)	7 (4-11)	24 (7-61)	15 (9-22)	13 (4-32)	22 (10-41)	40 (14-105)	74 (41-127)	68 (19-214)
Coleoptera	18 (5-45)	2 (2-4)	1 (0-2)	1 (0-1)	13 (0-89)	28 (13-52)	20 (9-36)	43 (27-66)	53 (25-108)	100 (50-190)	69 (37-125)
Diptera	76 (6-311)	4 (1-12)	1 (0-4)	0 - -	4 (0-15)	4 (0-17)	4 (0-19)	41 (18-80)	54 (4-359)	126 (80-195)	137 (15-846)
Total	293 (110-634)	101 (87-115)	74 (46-111)	35 (26-45)	207 (76-461)	195 (138-258)	207 (138-299)	206 (155-272)	212 (66-593)	488 (343-686)	607 (193-1701)

Appendix D. Mean number per sample and 95% confidence intervals (parentheses) of major groups and total number of invertebrates from benthic samples collected at three sites on Jacoby Creek, November 1978 to October 1979. Confidence intervals estimated from log (x + 1) transformations. Estimates of confidence intervals for number per m^2 can be calculated by dividing by 0.28. Station I - July to December, N=3; February to June, N=4. Station II and III - November to July, N=4; August to October, N=3. (Continued)

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
Station III											
Ephemeroptera	134 (62-250)	32 (23-44)	70 (38-118)	66 (16-193)	186 (106-300)	67 (30-129)	121 (65-206)	158 (72-302)	95 (45-187)	90 (43-179)	141 (5-1815)
Plecoptera	32 (15-62)	2 (1-5)	4 (1-13)	3 (0-12)	3 (2-5)	3 (0-10)	5 (1-16)	13 (8-20)	42 (13-117)	73 (42-121)	43 (0-1317)
Trichoptera	35 (18-61)	5 (4-7)	16 (3-49)	21 (9-42)	10 (4-23)	9 (5-14)	28 (6-81)	68 (51-89)	136 (61-286)	227 (64-694)	192 (29-939)
Coleoptera	99 (39-209)	4 (1-12)	10 (0-57)	3 (0-13)	4 (2-8)	11 (1-36)	30 (15-55)	82 (57-114)	213 (59-655)	160 (92-267)	117 (51-253)
Diptera	18 (6-51)	1 (0-4)	1 (0-5)	1 (0-5)	2 (0-10)	1 (0-4)	34 (9-85)	42 (11-107)	126 (86-180)	97 (15-439)	59 (45-78)
Total	320 (237-422)	45 (32-62)	103 (44-204)	95 (26-252)	206 (122-323)	91 (40-176)	221 (169-285)	364 (248-1278)	617 (281-1278)	647 (310-1281)	554 (177-1541)

Appendix E. Age class, mean length (mm) and number of fish (n) collected for stomach analysis on 11 sampling dates at three sites on Jacoby Creek, California, November 1978 to October 1979.

		Station I		Station II		Station III	
Date	Age	Mean Length(mm)	n	Mean Length(mm)	n	Mean Length(mm)	n
Nov.	0+	75.3	3	82.6	7	83.4	7
	1+	157.5	2	128.7	3	138.5	2
Dec.	0+	96.5	4	93.6	5	85.8	6
	1+	146.0	1	143.5	2	143.0	2
Feb.	0+	84.5	4	88.4	5	101.2	5
	1+	129.0	1	128.0	2	160.0	2
Mar.	0+	93.2	6	89.3	7	80.2	8
	1+	122.0	1	162.0	2	127.0	2
Apr.	0+	94.8	6	87.0	7	87.6	8
	1+	---	0	127.0	1	---	0
May	0+	105.0	1	89.2	6	92.2	9
	1+	128.0	4	---	0	---	0
Jun.	0+	96.1	7	103.7	8	98.1	8
	1+	---	0	---	0	127.0	1
Jul.	0+	55.4	5	50.1	7	57.6	7
	1+	110.5	4	105.7	3	119.3	3
Aug.	0+	64.3	6	55.0	7	60.4	7
	1+	104.3	3	101.7	3	114.3	3
Sep.	0+	68.8	5	62.4	8	71.5	7
	1+	138.3	3	100.0	2	118.0	3
Oct.	0+	75.8	6	73.9	6	68.5	6
	1+	139.7	3	110.7	3	119.3	3

Appendix F. Mean number per stomach and range (in parentheses) of major groups and total food items from juvenile steelhead stomachs collected at three sites on Jacoby Creek, November 1978 to October 1979.

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
Station I											
Ephemeroptera	--	10.8 (3-31)	7.6 (4-15)	1.3 (0-3)	12.7 (0-67)	4.6 (1-12)	1.7 (0-8)	2.7 (0-11)	0.9 (0-3)	1.2 (0-7)	1.8 (0-6)
Plecoptera	1.0 (0-4)	12.0 (0-31)	0.6 (0-3)	1.1 (0-3)	0.2 (0-1)	0.6 (0-2)	0.4 (0-2)	0.2 (0-2)	0.3 (0-1)	0.5 (0-2)	0.3 (0-2)
Trichoptera	11.8 (0-26)	14.2 (4-36)	2.8 (0-8)	4.4 (1-13)	2.3 (0-8)	5.4 (0-18)	6.1 (1-14)	9.1 (0-32)	1.4 (0-8)	1.2 (0-6)	3.0 (0-9)
Coleoptera	0.8 (0-2)	2.2 (0-5)	--	0.1 (0-1)	0.3 (0-2)	1.0 (0-5)	1.3 (0-4)	1.4 (0-4)	4.2 (0-14)	0.9 (0-3)	0.1 (0-1)
Diptera	1.4 (0-5)	5.6 (2-9)	--	0.3 (0-1)	0.2 (0-1)	0.2 (0-1)	0.6 (0-3)	2.3 (0-6)	5.2 (0-11)	0.5 (0-2)	0.6 (0-3)
Total Aquatic	15.0 (2-29)	47.6 (16-92)	11.2 (5-17)	8.9 (3-16)	15.8 (1-68)	11.8 (3-26)	10.4 (4-16)	16.1 (4-43)	12.3 (5-28)	6.4 (1-13)	6.2 (1-10)
Total Terrestrial	2.6 (0-8)	3.2 (0-8)	--	0.3 (0-1)	8.0 (1-34)	1.8 (0-6)	1.3 (0-4)	5.3 (0-16)	10.4 (2-26)	6.2 (1-15)	5.4 (0-16)
Total	17.6 (7-29)	50.8 (16-95)	11.2 (5-17)	9.2 (3-16)	23.8 (5-73)	13.6 (6-27)	11.7 (4-20)	21.4 (6-45)	22.7 (10-43)	12.6 (2-28)	11.6 (6-19)

Appendix F. Mean number per stomach and range (in parentheses) of major groups and total food items from juvenile steelhead stomachs collected at three sites on Jacoby Creek, November 1978 to October 1979. (continued)

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
					Station II						
Ephemeroptera	0.2 (0-1)	1.6 (0-6)	4.7 (0-13)	4.7 (0-33)	5.1 (0-29)	3.8 (1-12)	3.5 (0-10)	6.9 (0-39)	8.1 (0-39)	3.7 (0-10)	1.0 (0-2)
Plecoptera	0.4 (0-1)	0.6 (0-1)	0.6 (0-2)	0.6 (0-2)	0.6 (0-3)	0.7 (0-8)	--	0.1 (0-1)	--	0.2 (0-1)	0.6 (0-1)
Trichoptera	1.0 (0-4)	4.6 (2-9)	3.4 (0-12)	6.4 (0-19)	1.2 (0-5)	3.8 (0-8)	12.7 (1-85)	1.4 (0-9)	2.0 (0-4)	4.5 (0-12)	5.2 (2-12)
Coleoptera	0.1 (0-1)	0.1 (0-1)	0.3 (0-1)	0.2 (0-2)	0.1 (0-1)	0.7 (0-3)	0.6 (0-2)	0.9 (0-4)	0.1 (0-1)	0.4 (0-1)	--
Diptera	1.1 (0-3)	1.3 (0-3)	--	0.2 (0-1)	0.1 (0-1)	1.8 (0-4)	0.6 (0-3)	3.2 (1-11)	3.2 (0-7)	3.8 (0-8)	0.3 (0-1)
Total Aquatic	5.1 (1-19)	10.1 (6-16)	9.1 (2-19)	16.0 (5-37)	7.7 (3-34)	10.8 (5-25)	18.0 (3-90)	12.6 (4-61)	13.6 (2-46)	12.7 (2-21)	7.3 (4-13)
Total Terrestrial	5.0 (0-31)	--	--	0.3 (0-1)	2.1 (1-4)	2.5 (0-5)	1.7 (0-6)	0.7 (0-3)	0.6 (0-2)	1.5 (0-8)	1.5 (0-7)
Total	10.1 (2-38)	10.1 (6-16)	9.1 (2-19)	16.3 (5-37)	9.8 (4-35)	13.3 (8-25)	19.7 (4-96)	13.3 (4-61)	14.2 (2-46)	14.2 (8-23)	8.8 (4-16)

Appendix F. Mean number per stomach and range (in parentheses) of major groups and total food items from juvenile steelhead stomachs collected at three sites on Jacoby Creek, November 1978 to October 1979. (continued)

Group	Nov.	Dec.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
Station III											
Ephemeroptera	0.9 (0-5)	3.4 (0-13)	4.9 (1-18)	42.3 (3-116)	12.1 (0-29)	10.9 (1-28)	6.2 (0-22)	10.4 (2-37)	7.0 (2-19)	2.8 (0-7)	2.8 (1-6)
Plecoptera	0.3 (0-1)	0.4 (0-1)	0.7 (0-2)	1.0 (0-3)	0.1 (0-1)	0.6 (0-1)	--	0.1 (0-1)	0.1 (0-1)	0.6 (0-2)	0.6 (0-2)
Trichoptera	2.3 (0-8)	3.0 (0-7)	3.9 (0-12)	3.4 (0-9)	5.5 (0-9)	4.9 (2-12)	3.4 (0-15)	2.1 (0-6)	3.9 (0-9)	4.0 (0-11)	3.9 (1-9)
Coleoptera	--	0.5 (0-2)	--	0.5 (0-2)	0.1 (0-1)	0.8 (0-2)	0.2 (0-2)	0.8 (0-6)	0.2 (0-1)	1.2 (0-5)	0.8 (0-3)
Diptera	0.6 (0-2)	1.6 (0-5)	0.1 (0-1)	0.6 (0-2)	0.9 (0-3)	1.2 (0-3)	64.2 (7-246)	8.7 (3-18)	14.3 (1-56)	4.4 (0-11)	2.2 (0-12)
Total Aquatic	4.7 (2-8)	11.1 (3-34)	9.7 (3-27)	48.6 (12-120)	19.4 (5-40)	18.8 (4-47)	74.8 (17-270)	23.5 (6-60)	26.2 (5-65)	13.2 (4-34)	10.7 (4-19)
Total Terrestrial	0.3 (0-2)	0.2 (0-1)	0.4 (0-1)	0.9 (0-3)	1.7 (0-4)	4.5 (0-23)	1.1 (0-3)	4.7 (0-31)	1.8 (0-6)	2.1 (0-7)	1.0 (0-3)
Total	5.0 (2-8)	11.3 (3-35)	10.1 (4-28)	49.4 (13-120)	21.1 (5-42)	23.3 (4-53)	75.9 (17-270)	28.2 (9-91)	28.0 (11-65)	15.3 (5-34)	11.7 (4-19)

Appendix G. Aquatic drift (number/4 hrs/m^3) and benthic (number/m^2) densities used to calculate relative percentages of available organisms used in Linear Index (L). Drift does not include terrestrials for comparative purposes.

Date	Station I		Station II		Station III	
	Benthic	Drift	Benthic	Drift	Benthic	Drift
Nov.	1,124	95	1,047	119	1,141	58
Dec.	398	729	361	824	161	1,015
Feb	188	242	265	156	368	582
Mar.	56	1,651	126	1,818	341	2,350
Apr.	727	214	742	226	755	454
May	663	679	695	303	327	202
Jun.	1,572	1,061	740	321	792	353
Jul.	1,263	131	735	62	1,296	107
Aug.	1,400	179	748	188	2,197	233
Sep.	1,165	167	1,741	136	2,300	143
Oct.	1,974	113	2,166	77	1,994	62

Appendix H. Diel periodicity (percent by number) of major groups and taxa from drift collected at three sites on Jacoby Creek, California.

Groups and Taxa	Station I Day	Station I Night	Station II Day	Station II Night	Station III Day	Station III Night
Aquatic						
Baetis sp.	4	96	4	96	5	95
Cinygmula sp.	6	94	5	95	24	76
Ephemerella spp.	9	91	8	92	22	78
Iron sp.	6	94	4	96	7	93
Paraleptophlebia spp.	2	98	1	99	1	99
Rithrogena sp.	7	93	12	88	11	89
All Ephemeroptera	4	96	4	96	6	94
Capnia sp.	6	94	9	91	8	92
Nemoura sp.	12	88	16	84	4	96
All Plecoptera	9	91	13	87	7	93
Gumaga nigricula	30	70	13	87	33	67
Glossosoma sp.	31	69	15	85	17	83
Hydropsyche sp.	0	100	0	100	22	78
Lepidostoma sp.	48	52	33	67	51	49
Limniphilidae	62	38	73	27	76	24
Rhyacophila sp.	11	89	34	66	19	81
All Trichoptera	47	53	57	43	57	43
Simulium sp.	14	86	17	83	6	94
Chironomidae	22	78	55	45	40	60
All Diptera	20	80	46	54	25	75
Elmidae	21	79	8	92	11	89
All Coleoptera	19	81	8	92	10	90
Total Aquatic	16	84	17	83	20	80
Terrestrial						
Diptera (w/o Chironomidae)	86	14	60	40	58	42
Chironomidae	17	83	14	86	14	86
Coleoptera	60	40	85	15	61	39
Homoptera	60	40	58	42	77	23
Hymenoptera	56	44	37	63	59	41
Psocoptera	48	52	24	76	30	70
Total Terrestrial	56	44	43	57	40	60