Macroinvertebrate drift along an elevational and stream size gradient in a southern Appalachian stream.

by

Patricia Anne Turner

Thesis submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

Master of Science

in

Biology

APPROVED:

E.F. Benfield

E.F. Benfield, Chairman

J.R. Webster

Albert C. Hendricks

A.C. Hendricks

August 26, 1994

Blacksburg, Virginia

c. 2

LD
5655
V855
1994
T876
c.2

Macroinvertebrate drift along an elevational and stream size gradient in a southern Appalachian stream.

by

Patricia Anne Turner

E.F. Benfield, Chairman

Biology

(ABSTRACT)

Drift was measured monthly at four sites on a southern Appalachian stream in order to examine spatial and temporal patterns along elevational and stream size gradients. Measurements constisted of four, one-hour samples corresponding to dawn, mid-day, dusk, and mid-night monthly for 14 months. On average, only 10% of the drifting insects were terrestrial, but terrestrial inputs became numerically important during summer and fall. There were no significant differences among sites in aquatic insect drift density, although taxa richness and total drift (#/sec) increased significantly downstream. None of the sites exhibited a consistent diel pattern. But, all of the lower three sites exhibited decreased drift density during the day. *Baetis*, the dominant aquatic taxon in the drift, exhibited a typical alterans patterns at UBC, LBC, and CC. Aquatic insect drift density was highest in summer when flows were lowest, while total drift (#/s) was highest in late spring and winter. FPOM and mean daily water temperature accountd for 64% of the variation in total aquatic insect drift density and 60% of *Baetis* drift density, suggesting both passive and active components in drift. Both variables were also highly correlated with drift density. Taxonomic composition of drift differed from that of the benthos, indicating drift was not simply random, but

that taxa vary in the propensity to drift. Overall, this study found more evidence of temporal (diel and seasonal) drift patterns than spatial (along the gradient).

Acknowledgments

I would like to thank Dr. Fred Benfield for his guidance throughout my thesis and for going "above and beyond the call of duty" for a major advisor on many occasions. Thanks also go to Dr. Jack Webster for his assistance on both my project and my professional career. Dr. Reese Voshell gave me advice and logistical help throughout the project. I would also like to thank Dr. Albert Hendricks for "saving the day" and Dr. Horton Hobbs, III for inspiring me.

Completing this project would have been impossible without the help of the Virginia Tech Stream Team: Jennifer Tank, John Hutchens, Terry Ehrman, and Mary Schaeffer. I appreciate the field assistance as well as the companionship. I am also thankful for Patricia Greiner, Derek Hodges, Jimmy Blakeney, John Owens, and the many other undergraduate volunteers who helped in the field and picking bugs. Without their contribution, this work would have been impossible to complete. Also, researchers at Coweeta were always willing to provide data and field support. Thanks also go to Dr. Richard Fell, Steve Hiner, and Brett Marshall for help identifying bugs.

Finally, I am especially grateful to my friends and family. Without their love and support, this would have been impossible. Thanks for being there.

Table of Contents

List of Figures

List of Tables

Introduction

Invertebrate drift, the downstream transport of aquatic organisms in the current of a stream, was first documented by Needham (1928). Although he was primarily interested in the drift of terrestrial insects that fell into the stream as a food source for fish, his nets also collected a significant number of aquatic organisms. Müller (1954) was first to document the numerical significance of drifting aquatic organisms in comparison to benthic macroinvertebrate density. Since then, there have been numerous studies on invertebrate drift in streams.

Several categories of drift are recognized: catastrophic, behavioral, distributional, and constant (Brittain and Eikeland 1988). Catastrophic drift is usually associated with flooding, though pesticides, heated waters, and drought can also stimulate catastrophic drift (Wojtalik and Waters 1970; Cibrowski et al. 1977; Bernard et al. 1990; Poff et al. 1991). Behavioral drift has received much attention recently, mainly because of a debate over whether drift is active or passive. This debate, begun by Waters (1972), has been the basis for many studies, which have shown a clear behavioral component in drift. Active drift entry offers an energetically inexpensive means of escaping stress due to predation, oxygen deprivation, overcrowding, or lack of food (Allen 1978; Walton 1980; Doeg and Milledge 1991; Poff and Ward 1991; Waringer 1992). Distributional drift is thought to be an active method of dispersal, especially for young instars (i.e., the "colonization cycle" proposed by Müller 1954). One category of drift that is rarely contested is constant or background drift, i.e. organisms in the drift due to accidental dislodgment from the substrate.

Soon after Müller's 1954 paper, it was discovered that drift is not constant but varies with season, from day to day, and during the course of a day. Tanaka (1960), Waters (1962), and Müller (1963) independently documented distinct diel periodicity in drift in which rates and densities were higher at night. Diurnal drift was found to include subtle patterns, which varied according to the life cycle stages of various species. Ephemeroptera, Plecoptera, Simuliidae, and *Gammarus* exhibited higher drift densities at night (Tanaka 1960; Waters 1962; Müller 1963) while limnephilid caddisflies drifted more during the day (Pearson and Kramer 1972). Coleoptera mostly appear in constant drift, while some Chironomidae show peak density corresponding to peak light intensity (Brittain and Eikeland 1988). Two main diel patterns are exhibited in drift: 1) bigeminus, which includes a major peak at dusk and a minor peak at sunrise; and 2) alterans, which includes a minor peak at dusk and builds up to a major peak at dawn (Müller 1964; Waters 1972).

Current velocity, discharge, oxygen concentration, water temperature, benthic density, and food availability, while having no direct effect on periodicity, have been shown to affect the amplitude of drift in streams. In general, rapid changes in flow induce increases in drift rate or density (Anderson and Lehmkul 1968; Bishop and Hynes 1969; Elliot 1967; Müller 1954; Ulfstrand 1968; Waters 1972; Brittain and Eikeland 1988; Walton 1980). On the other hand, low discharge may also lead to high drift rates, possibly because of a decrease in available oxygen (Elliot 1967; Wiley and Kohler 1980). Responses to changes in temperature and benthic density seem to be species-specific. Most day-drifters have been shown to increase drift with increasing temperatures (Neves 1979), but some show a negative relationship (Reisen 1977). Spacing among immature aquatic insects with nets, tubes, or cases suggests that drift may be density-dependent. Individuals not able to fit into the spacing pattern at a particular site may leave the substrate and drift downstream (Walton et al. 1977; Walton 1980; Hildrew and Townsend 1980). But, studies of organisms such as mayflies (*Baetis*) or caddisflies (*Micrasema*) suggest an independent relationship between drift and benthic density; similar drift rates are found in areas of high and low density (Hildebrand 1974; Corkum 1978; Cibrowski 1983). Drift can also be influenced by food availability and quality. Several studies have shown mayflies to increase drift rates due to a reduction of standing crop of food in the microhabitat (Otto 1976; Bohle 1978; Hildebrand 1974). None of the above factors work independently and any number of them can significantly influence drift rates and densities at times.

Forty years of study has shown drift to play an important role in stream ecosystems. Drift between suitable microhabitats is important in terms of colonization, distribution, and recolonization of denuded substrates (Hynes 1970). It also appears to regulate benthic populations in accordance with space and food requirements and may even play a pivotal role in the trophic dynamics and community structure of stream ecosystems by regulating the flow of biomass through the system (Brittain and Eikeland 1988). Understanding this energy flow along the stream continuum is important in terms of the total energy budget of stream ecosystems. Although drift is well documented, studies tend to focus on species-specific mechanisms or site-specific descriptions, limiting not only the understanding of drift within specific streams, but also the broad applicability of these studies to streams in general.

The objectives of this study were: 1) to investigate the changes in composition and abundance of drifting aquatic organisms along an elevational and stream size gradient in Ball Creek-Coweeta Creek, 2) to describe the seasonal and diel periodicity of drifting macroinvertebrates along the continuum, 3) to investigate correlations between selected abiotic factors and drift, and 4) to compare the structure of assemblages of drifting organisms with those in the stream benthos.

Methods

Site description

The study stream was Ball Creek-Coweeta Creek located at Coweeta Hydrologic Laboratory, Macon County, North Carolina. Coweeta is a U.S. Forest Service research station in the Nantahala National Forest in the southern Appalachian Mountains. It is a Long-Term Ecological Research site supported by the National Science Foundation.

The climate at Coweeta is characterized by high moisture and mild temperatures. Average monthly air temperatures range from 3^{o} C to 22^{o} C. Precipitation is dominated by frequent, low-intensity rains - annual rainfall ranges from 180 to 250 cm (Swank and Crossley 1988). Vegetation is dominated by oaks (*Quercus spp*), red maple (*Acer rubrum*), yellow poplar (*Lirodendron tulipfera*), dogwood (*Cornus florida*), and a dense undergrowth of rhododendron (*Rhododendron maximum*) (Swank and Crossley 1988).

Four 100-m reaches were chosen along an elevational gradient in Ball Creek-Coweeta Creek (Fig. 1). The uppermost site, Watershed 27 (WS27), is a narrow, second-order stream at an elevation of 1070 m. The intermediate sites were Upper Ball Creek (UBC), a second-order reach, and Lower Ball Creek (LBC), a fourth-order reach. Coweeta Creek (CC), a fifth-order stream formed by the confluence of Ball Creek and Shope Fork at 675 m, was the lowest site. Gradient, width, canopy, substrate, and discharge are shown in Table 1.

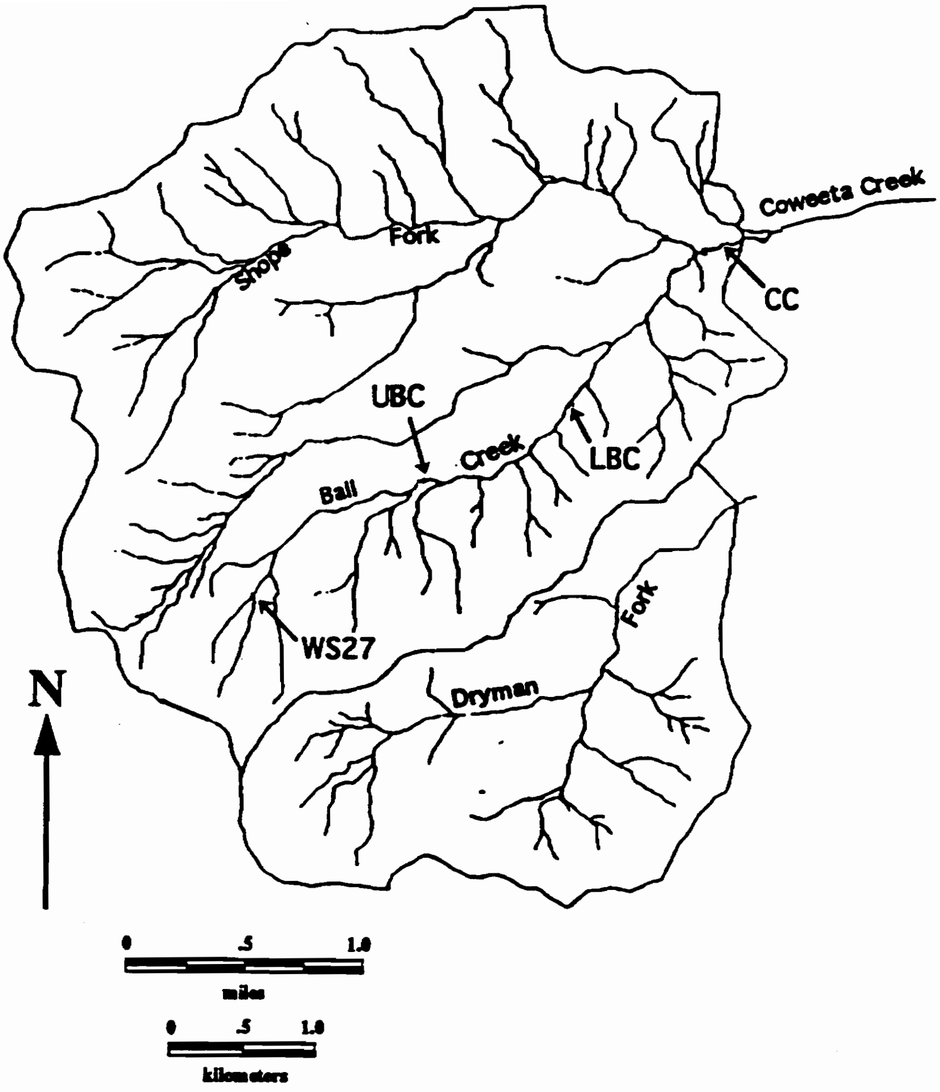

Figure 1. Map of Coweeta basin: Study sites located at Coweeta Hydrologic Laboratory, Macon Co., North Carolina. Four sites were located along Coweeta Creek-Ball Creek and are marked by arrows.

Table 1. Characteristics of study sites along Ball Creek-Coweeta Creek.

	WS27	UBC	LBC	CC
Stream order[1]	2	2	4	5
Elevation (m)[1]	1070	922	721	675
Distance from source (m)[2]	950	2600	3850	5550
Gradient (m/m)[2]	0.16	0.17	0.04	0.02
Width (m)[2]	2-5	3-5	4-5	7-8
Canopy	heavy shade	heavy shade	medium shade	partially open canopy
Substrate	cobble boulder	variable bedrock to sand	mostly large cobble	mostly large cobble
Mean annual discharge (L/s)	20.5[3]	96.8[4]	148.8[4]	590.4[5]
Drainage (ha)[1]	38.8	206.8	380.5	1561.6

1. From Coweeta Hydrologic Laboratory Forest Service Files or Coweeta 1:7200 map.

2. From Webster et al., unpublished.

3. Based on mean annual discharge in Shope Fork (1935-1991) and regression from data for WS27 (1945-1991).

4. Based on regression of data at weirs 20 and 15 (1938-1942) versus Shope Fork.

5. Calculated from regression of watershed area and regression of discharge versus drainage for sites along Ball Creek (weirs 9, 15, 20, and 27).

Because the geology of Coweeta is dominated by metasedimentary rocks (feldspar and metasandstones), groundwater nutrients are low. Stream nutrients ($O\text{-}PO_4$, NO_3-N, and NH_4-N) generally do not change along the elevational gradient. $O\text{-}PO_4$, as Phosphorus, remains at minimum detection levels throughout the year (<0.001 mg/L). NO_3-N is generally lower at WS27 than CC (usually less that 0.05 mg/L), and drops at CC in autumn with the input of leaves. NH4-N is usually less than 0.005 mg/L year round (data from CHL).

Drift sampling

Drift samples were collected from each of the four sites on 14 sampling dates between July 1992 and August 1993. Each 24-h sampling period consisted of four 1-h collections corresponding to dawn, mid-day, dusk, and mid-night. Ten 355-$\mu\mu$m Nitex mesh nets were used (3 each at CC and LBC, 2 each at UBC and WS27). Nets were 1.5 m long and had 0.3 x 0.4 m opening. Sampling was accomplished by attaching the nets to fence posts driven in to the streambed. Samples were preserved in the field in 10% formalin and returned to the lab in plastic containers.

Water velocity (measured with a Marsh-McBirney Flo-Mate 2000) and depth at the net opening were measured at the beginning and at the end of each 1 hr collecting period. An average of these two values was used to estimate total flow through the net over the sampling period. Stream width, depth every 0.5 m, and velocity every 0.5 m across the stream were used to estimate total discharge at each site for each sample date. Since samples were never collected during storm flows, this estimate of discharge was assumed to remain constant over the 24-h sample period. Discharge estimates were compared to weir readings at 2 sites along the gradient and were found to be consistent.

Sample processing

Organic material in the samples was elutriated from inorganic substrates when necessary and macroinvertebrates were picked from debris by hand and placed in 80% ethanol. Organic matter was sorted into 2 size classes using 1-mm and 300μm nested sieves. Material retained on the sieves was classified as coarse particulate organic matter (CPOM) and fine particulate organic matter (FPOM), respectively. Both categories of organic matter were oven dried for at least 48 hrs at 50^{o}C and weighed. FPOM samples were subsampled, ashed for 20 minutes at 550^{o}C, re-wetted to restore the weight of hydration, and re-weighed to determine total ash free dry mass (AFDM).

Macroinvertebrate identification

Organisms were identified and counted under a stereo microscope. Aquatic insect larvae were identified to genus and aquatic adults identified to family according to Merritt and Cummins (1984), Wiggins (1977), and Stewart and Stark (1993). Terrestrial insects were identified to family according to Borror et al. (1989) and McAlpine et al. (1981; 1987). Larval chironomids were identified to family. Non-insect taxa were identified to order or higher.

Biomass

Dry weight for each taxon was obtained from mean mass of individuals in each sample. Each taxon was oven dried for 48 hrs at 50°C and weighed.

Statistical Analysis

Macroinvertebrate drift density (#/100m^3) was statistically examined for site and time of year differences using a repeated measures analysis on the log transformed data. Diel patterns were examined using a one-way ANOVA on log transformed data for time of day at each site.

Bray-Curtis biotic similarity index was used to compare community stucture (taxa abundance and occurrence) for each site during each season (Nemec and Brinkhusrt 1988). Seasons were determined using average water temperature (see Results), and taxa accounting for 90% of the total number of drifting organisms at each site were used in the analysis. The Bray-Curtis Index determines a biotic similarity coefficient, B_2, for each unit and then uses the bootstrap method to assess statistical significance of the two clusters linked at each stage of the cluster analysis. The cluster and dendogram analysis was performed using Sigtree (Nemec 1986).

Relationships between average drift density per site per sample day (response variable) and factors (independent variables) influencing the density while accounting for the variation caused by factors that vary together (covariates) were tested using a stepwise multiple regression. The stepwise method begins by selecting the one independent variable that produces the greatest R^2 (coefficient of determination) value.

Other independent variables are then added in a stepwise manner in order of their decreasing partial correlation coefficients (R^2) until the ratio of sample variances (partial F value) calculated for the most recent variable is not significant. CPOM, FPOM, average water temperature, and discharge were used as independent variables and site and date were entered as covariates. If either covariate contributes significantly to the model, the independent variables may be significant at certain times of the year or at certain sites but not all the time.

A chi-square analysis was used to compare the percent composition of drifting organisms with that found in the benthos UBC, LBC, anc CC in a previous study. Because proportions were used rather than density, the results of the test can only be used as a comparison among sites and not an exact chi-square measure to compare with other studies. Drift was collected in cobble riffle areas and thus benthic density from cobble riffle areas was used as the observed values.

Except where otherwise noted, all statistical tests were run using SAS (SAS 1991).

Results and Discussion

Abiotic Factors

Average daily air temperature at Coweeta during the sampling dates ranged from 4°C in October 1992 to 24°C in May 1993 (Fig. 2). Average daily water temperatures at the sites ranged from 6.1°C in December 1992 to 17.3°C in July 1993 (Fig. 2). Mean daily discharge at each site ranged from 0.0004 m^3/s (WS27 in August 1993) to 1.26 m^3/s (CC in November 1992) (Fig. 3). Since samples were not collected during storms, little fluctuation in the discharge was observed while sampling.

Drift Dynamics

Overall Composition of Drift

Fourteen diel drift collections totaling 560 hourly samples were made over a 14-month period between July 1992 and August 1993. A total of 13,100 aquatic insects and 1591 terrestrial insects were collected, identified and weighed. The drift density of aquatic organisms in this study is low compared to most previously reported studies. Values seldom exceed 100/m^3 (Waters 1972), but densities vary widely from place to place even within the same species (Brittain and Eikeland 1988). A list of aquatic taxa collected in the drift samples is presented in Appendix 1. Sixty-three terrestrial insect families and orders were collected in the drift (Appendix 2).

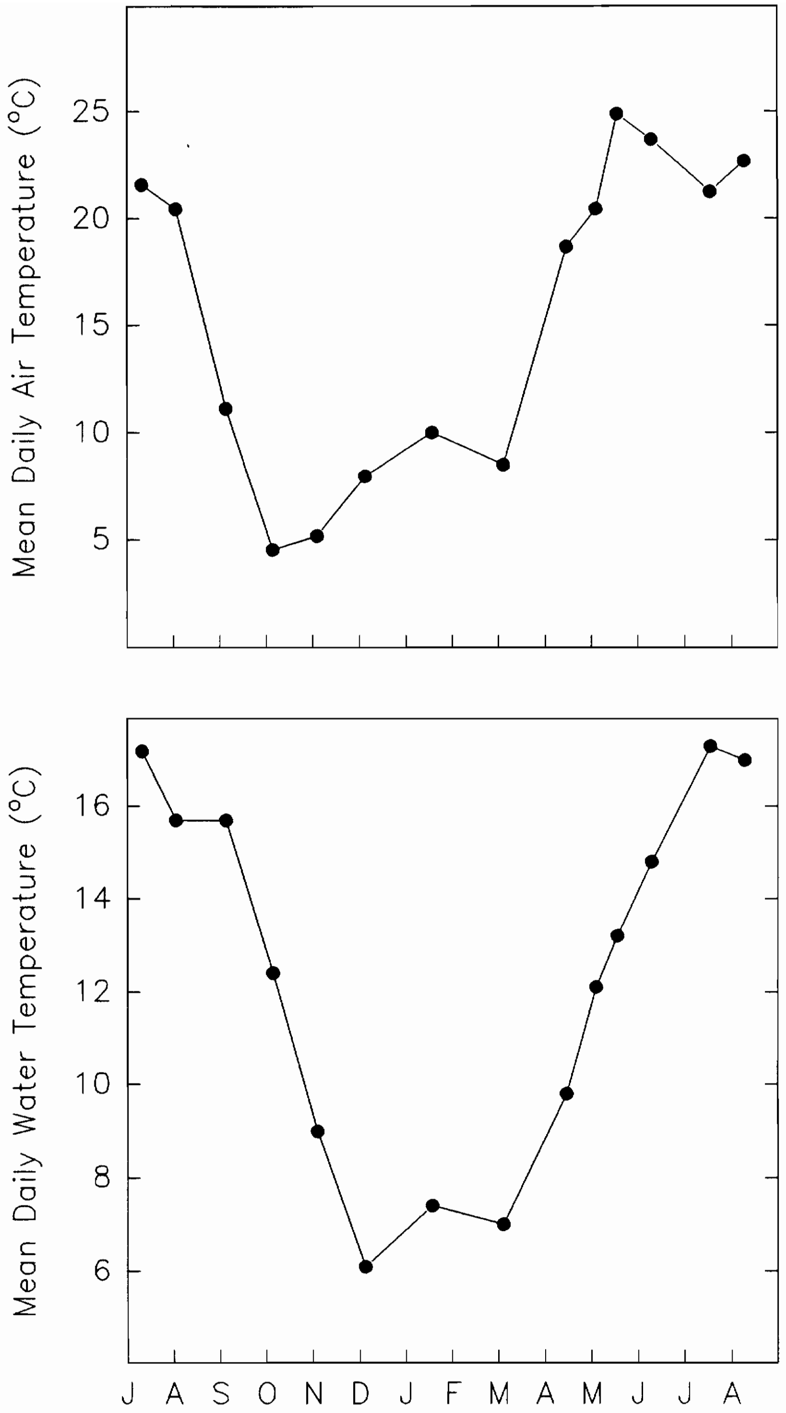

Figure 2. Mean daily air and water temperature for each sample date.

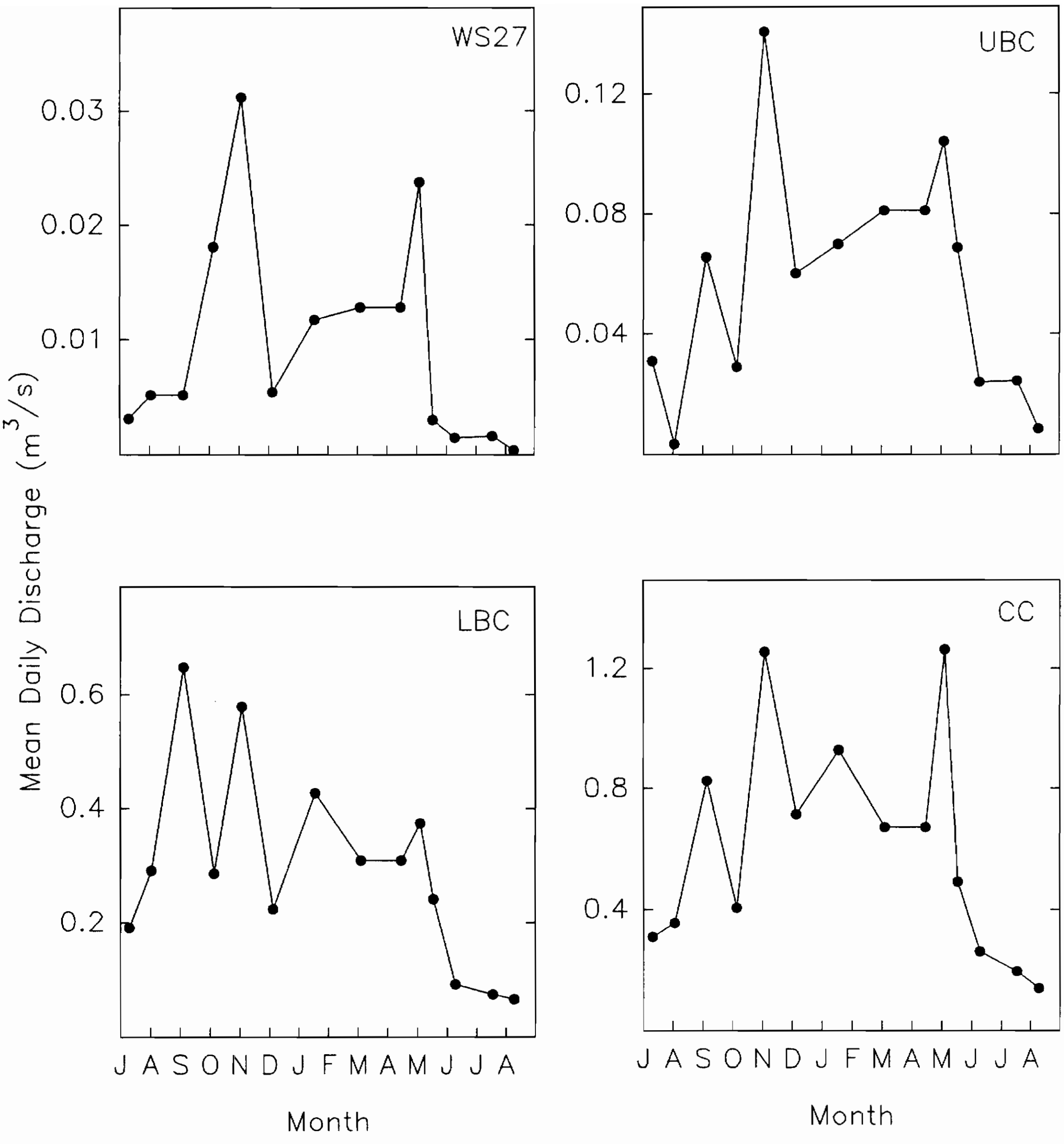

Figure 3. Mean daily discharge at each site on each sample date.

One genus, *Baetis* (Ephemeroptera), accounted for 44% of all drifting organisms in this study. In many studies, *Baetis* exhibits high drift rates and dominates the composition of drift (Clifford 1972; Zelinka 1976; Stoneburner and Smock 1978). Eleven taxa, including *Baetis* spp. accounted for over 90% of the total drifting aquatic insects (Fig 4). Five aquatic insect orders, Epehemeroptera, Plecoptera, Coleoptera, Trichoptera, and Diptera, were consistently represented in the drift (Appendix 3): Ephemeroptera, Diptera and Plecoptera accounted for 43%, 27%, and 26%, respectively. This is not surprising because these groups often dominate the benthos in many stream habitats.

Spatial Patterns

With the changes in physical attributes at each site (Table 1), one might expect to see a change in the abundance and composition of organisms associated with those sites. Instead, abundance of drifting aquatic organisms along the elevational and stream size gradient did not change significantly (ANOVA, P=0.086). WS27 did have a higher overall drift density than the other three sites, but the peak is not significantly different than the density at the other three sites, probably because of the high variability associated with this site (Fig. 5). Site did, however, have a significant interaction effect with time of year (ANOVA, P=0.0001).

Even though the drift density of aquatic insects at each site did not differ, the total number of insects passing by each site was significantly different. With increases in flow at each of the lower three sites (Table 1), the total number of insects passing by each site (transport) increase downstream from UBC to CC (ANOVA, P<0.0002)

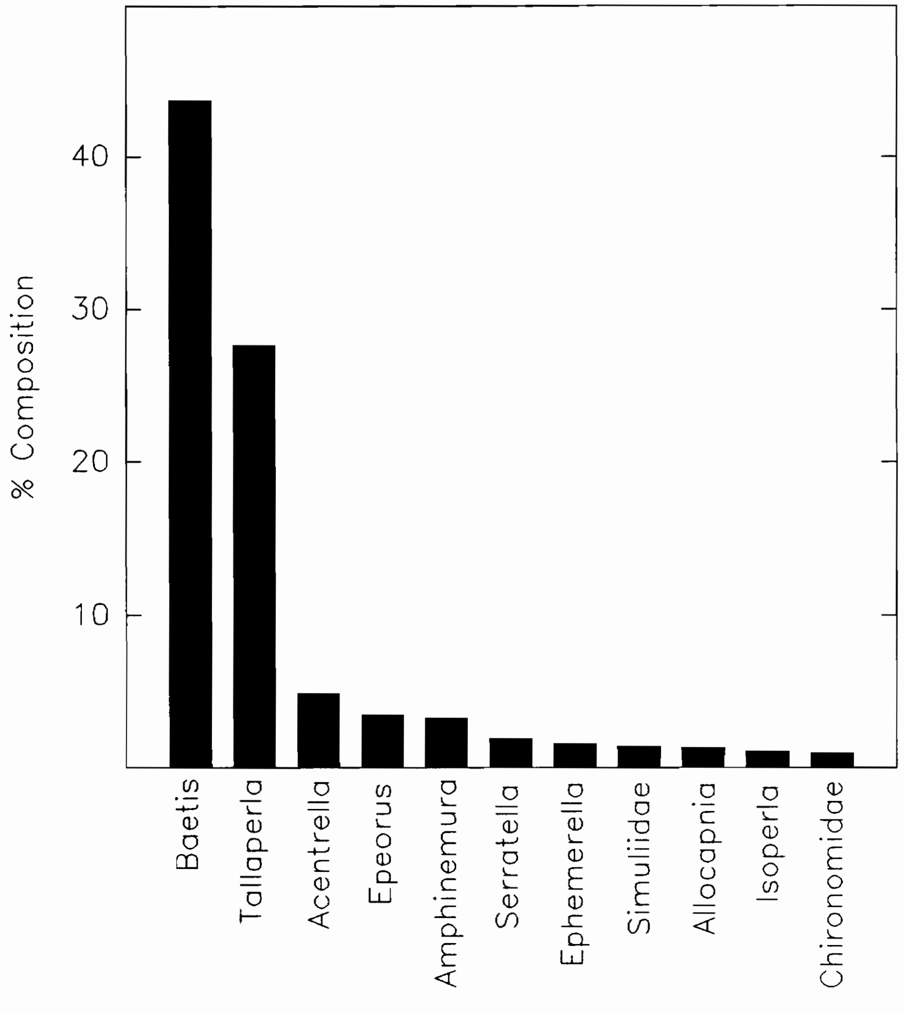

Figure 4. Taxa that accounted for 90% of the total number of aquatic organisms collected in drift at all sites combined.

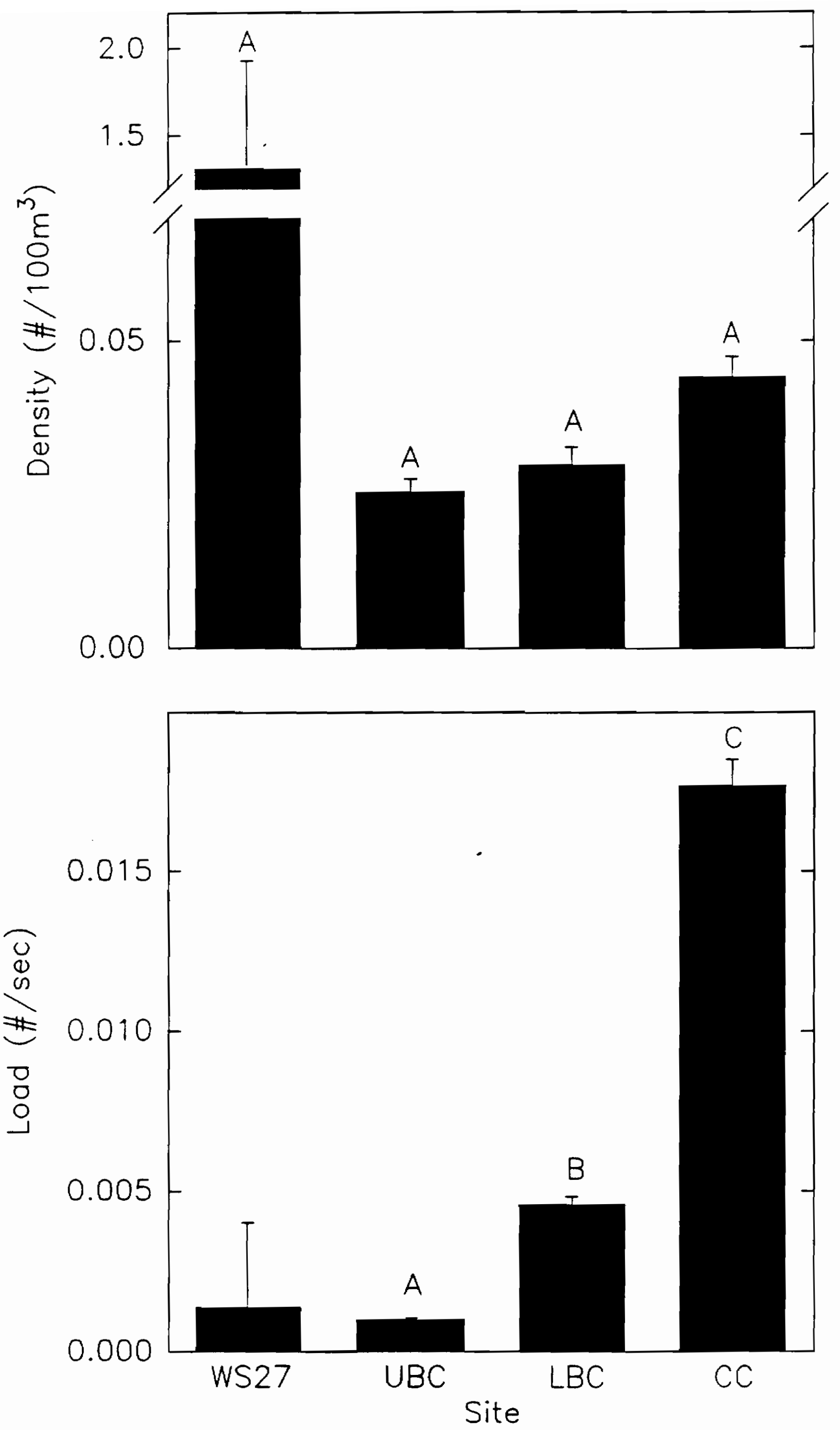

Figure 5. Density and load of aquatic insects in drift at each site throughout the study. Values with same letters are not significantly different (ANOVA $p<0.05$).

(Fig. 5). The results of this test also indicate a significant interaction between site and time of year (ANOVA, P=0.0001).

Although the density of aquatic insects did not change significantly along the gradient, the number of insect species dominating the samples increased in the downstream direction. At WS27, *Baetis* was the dominant taxon, making up 51% of the total aquatic organisms. Three additional taxa accounted for over 39% of the total drifting aquatic organisms at this site (Fig. 6). *Tallaperla* and *Baetis* made up 25% and 16%, respectively at UBC. Twenty taxa, including *Tallaperla* spp. and *Baetis* spp. accounted for 90% of the total (Fig. 6). Twenty taxa made up 90% of the total drift at LBC also, but *Acentrella* spp. and *Baetis* spp. contributed 25% and 11%, respectively (Fig. 7). At CC, *Baetis* spp. contributed 24% and *Acentrella* spp. contributed 18% to the total. Here, twenty-two taxa made up 90% of the total drifting aquatic insects (Fig. 7).

Temporal Patterns

Diel Patterns

A general pattern of diel differences in drift density at each site was not detected. However, individual samples collected from the sites suggested one or the other of the two recognized diel patterns: bigeminus (major peak at dusk and a minor peak at sunrise) and alterans (minor peak at dusk and a major peak at dawn) (Figs. 8-21). Both patterns imply a decrease in overall drift activity during the day, although certain taxa

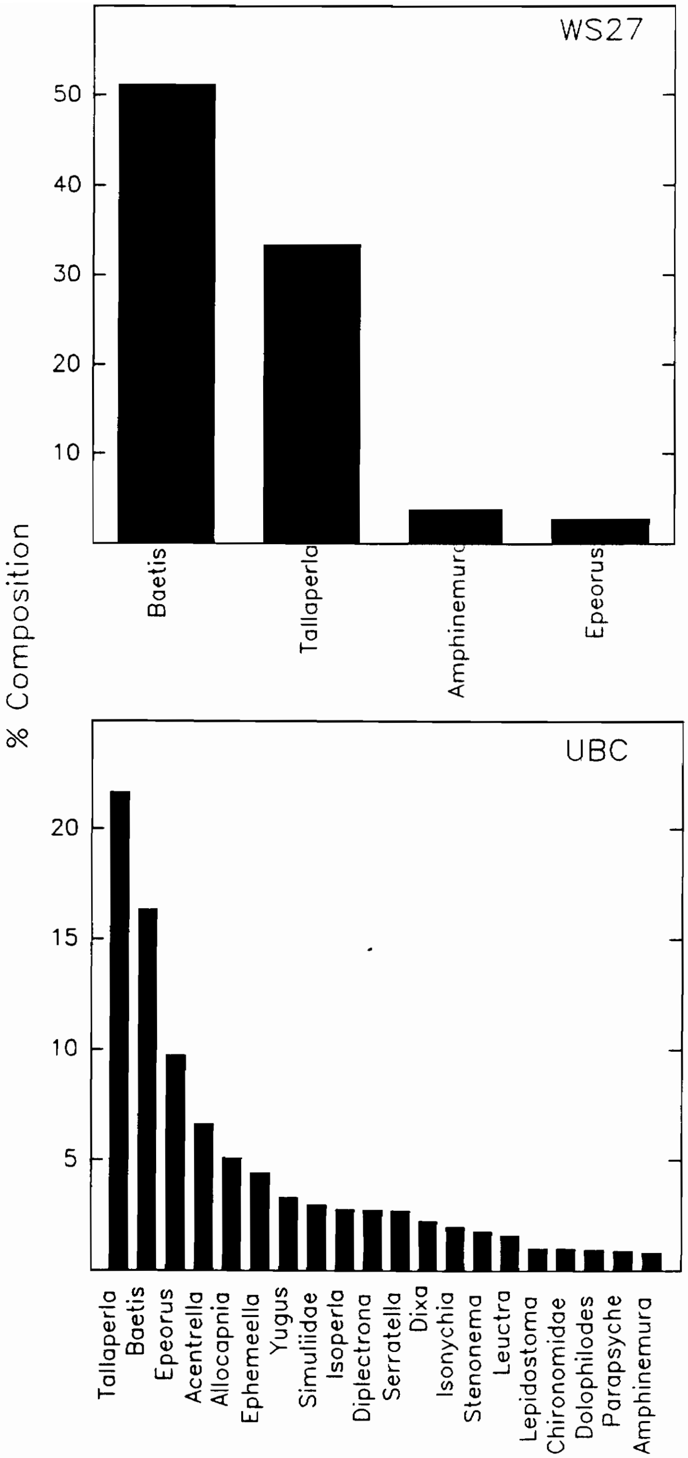

Figure 6. Taxa that accounted for 90% of the total number of aquatic insects collected in drift at WS27 and UBC.

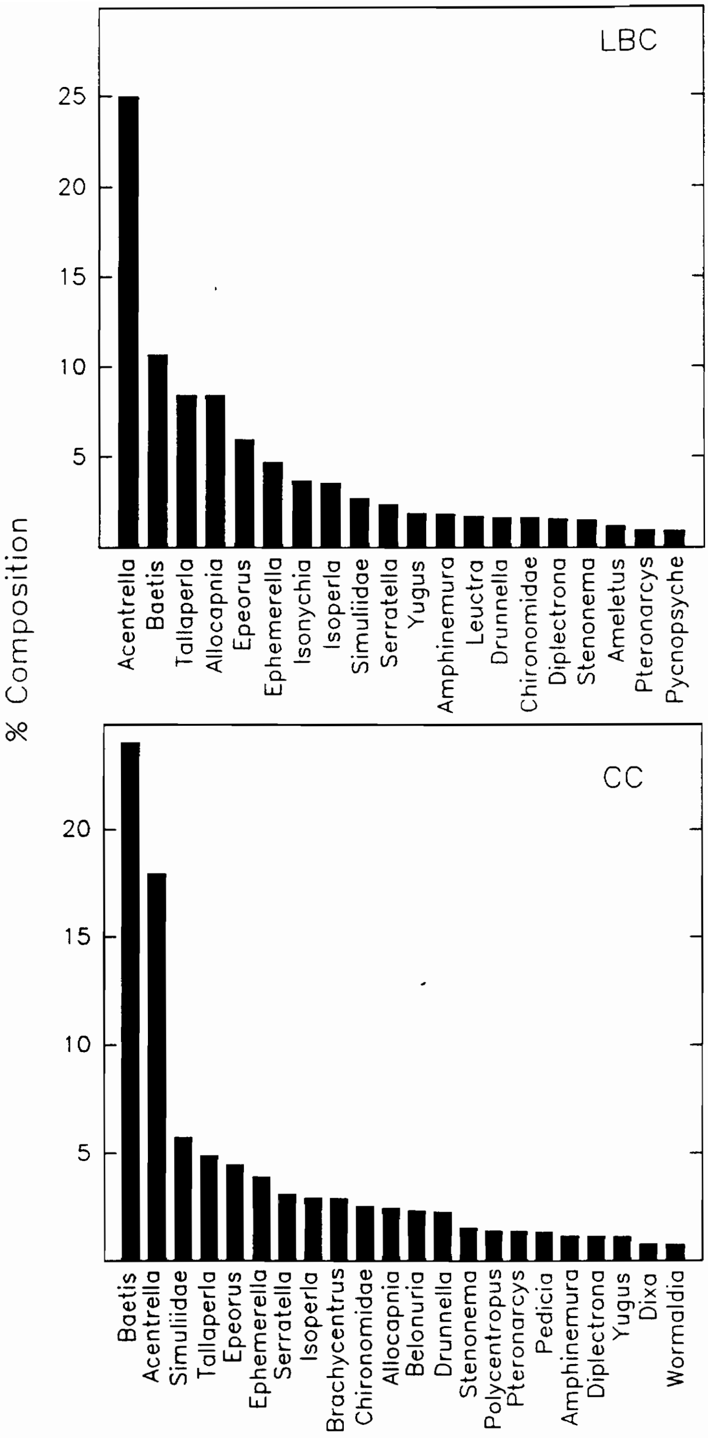

Figure 7. Taxa that accounted for 90% of the total number of aquatic insects collected in drift at LBC and CC.

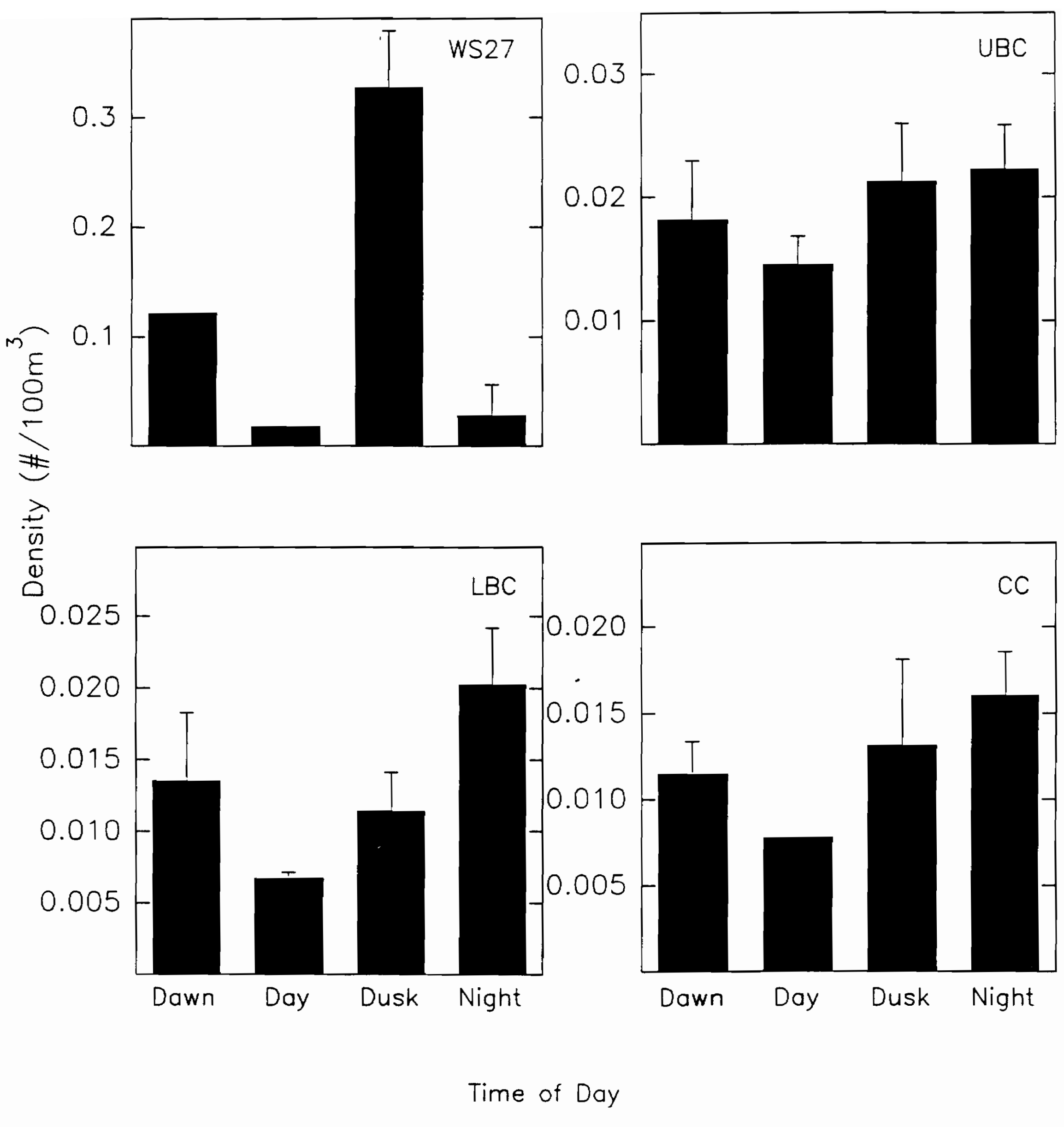

Figure 8. Mean Density of drifting aquatic insects at each time for each site on 28 July 1992.

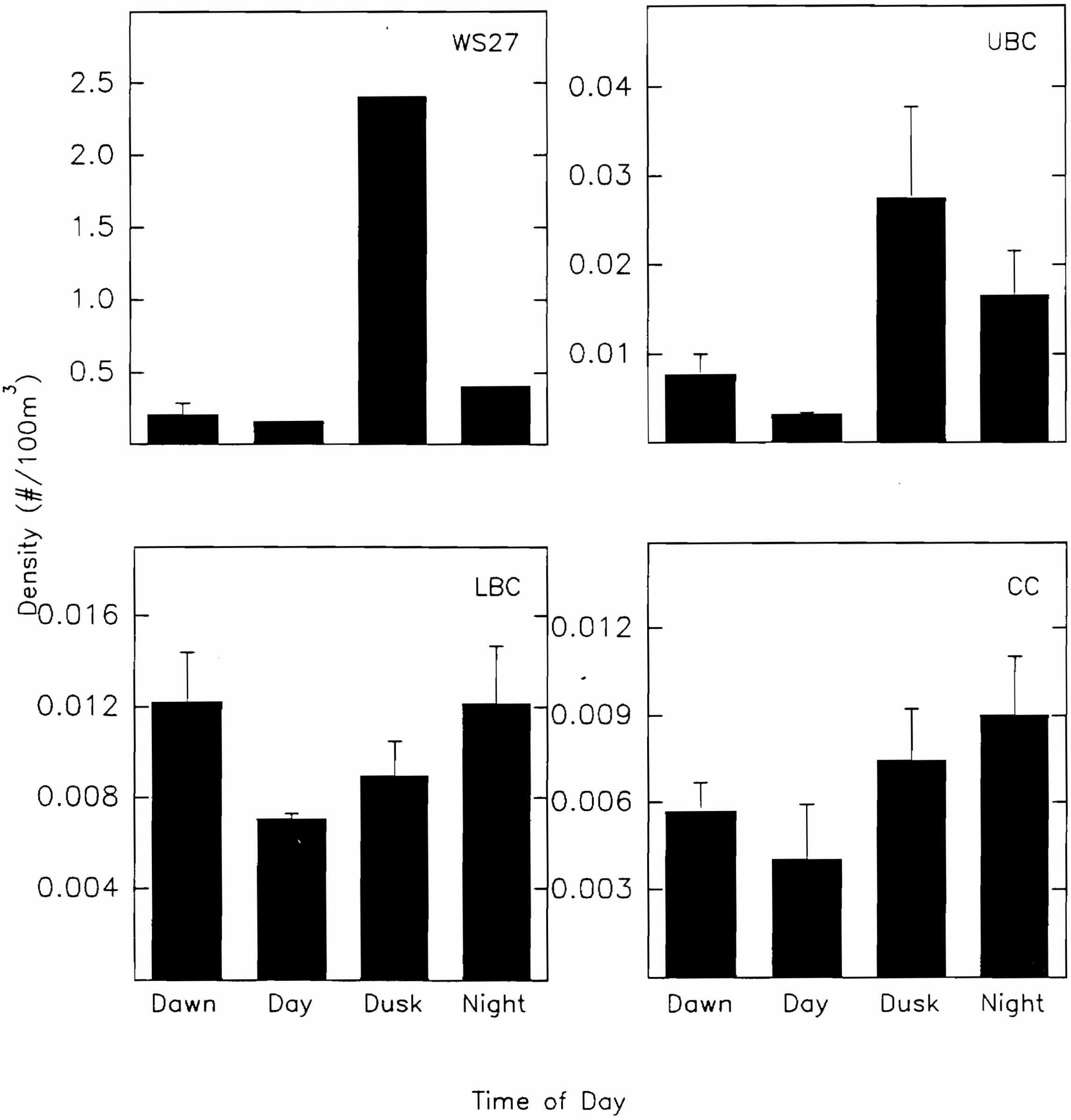

Figure 9. Mean density of drifting aquatic insects at each time for each site on 18 August 1992.

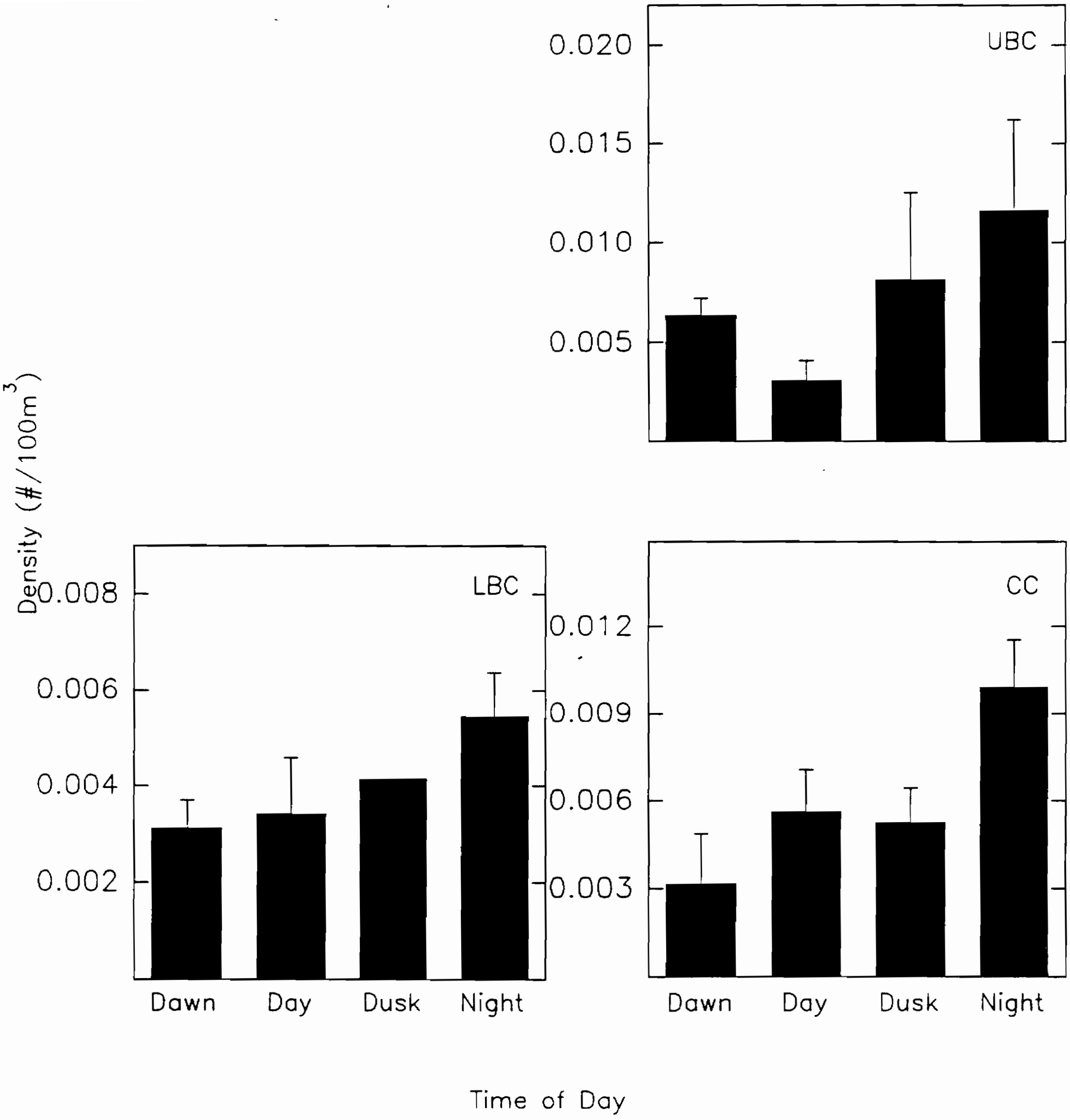

Figure 10. Mean density of drifting aquatic insects at each time for each site on 18 September 1992. No samples were collected at WS27.

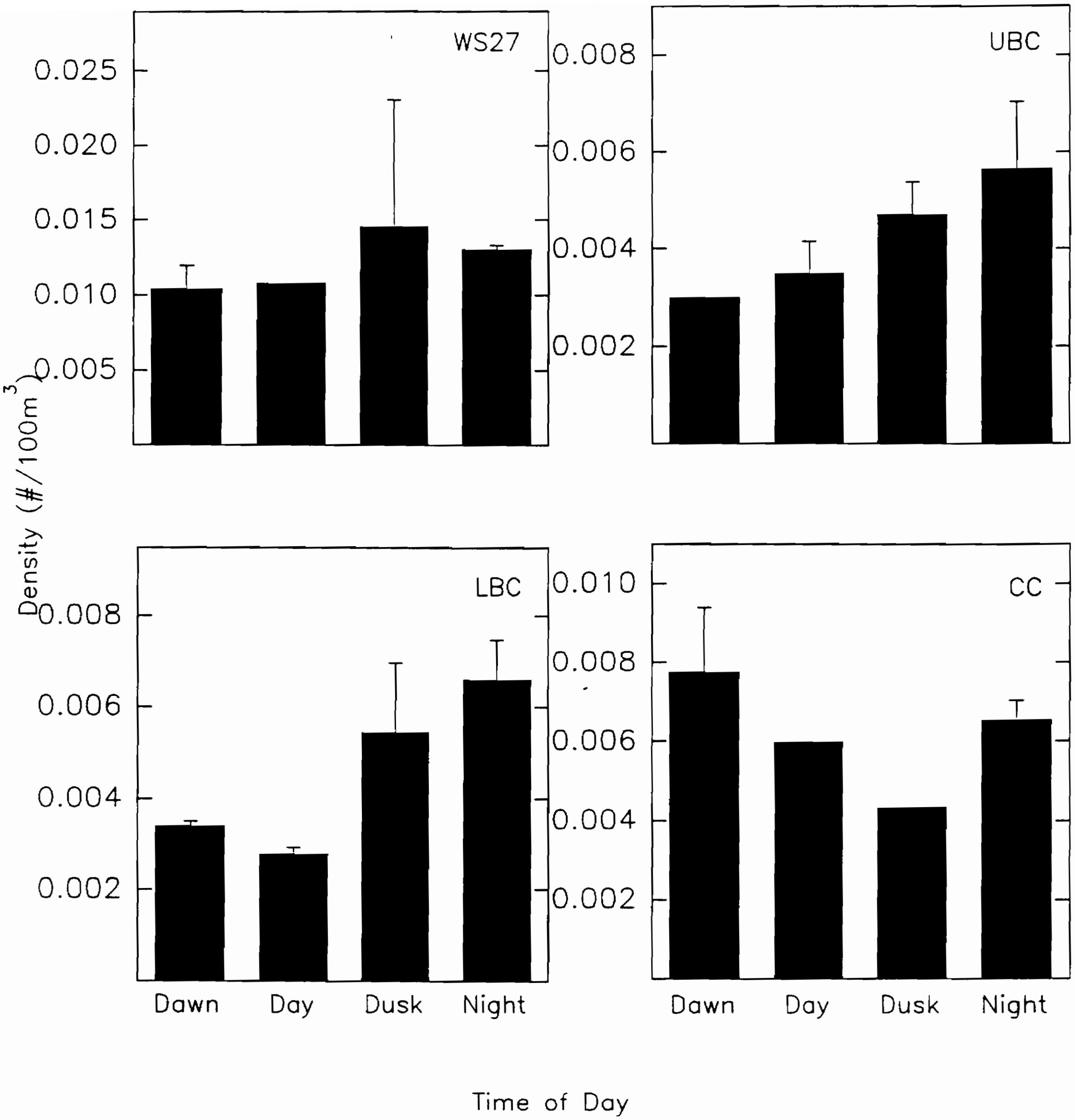

Figure 11. Mean density of drifting aquatic insects at each time for each site on 17 October 1992.

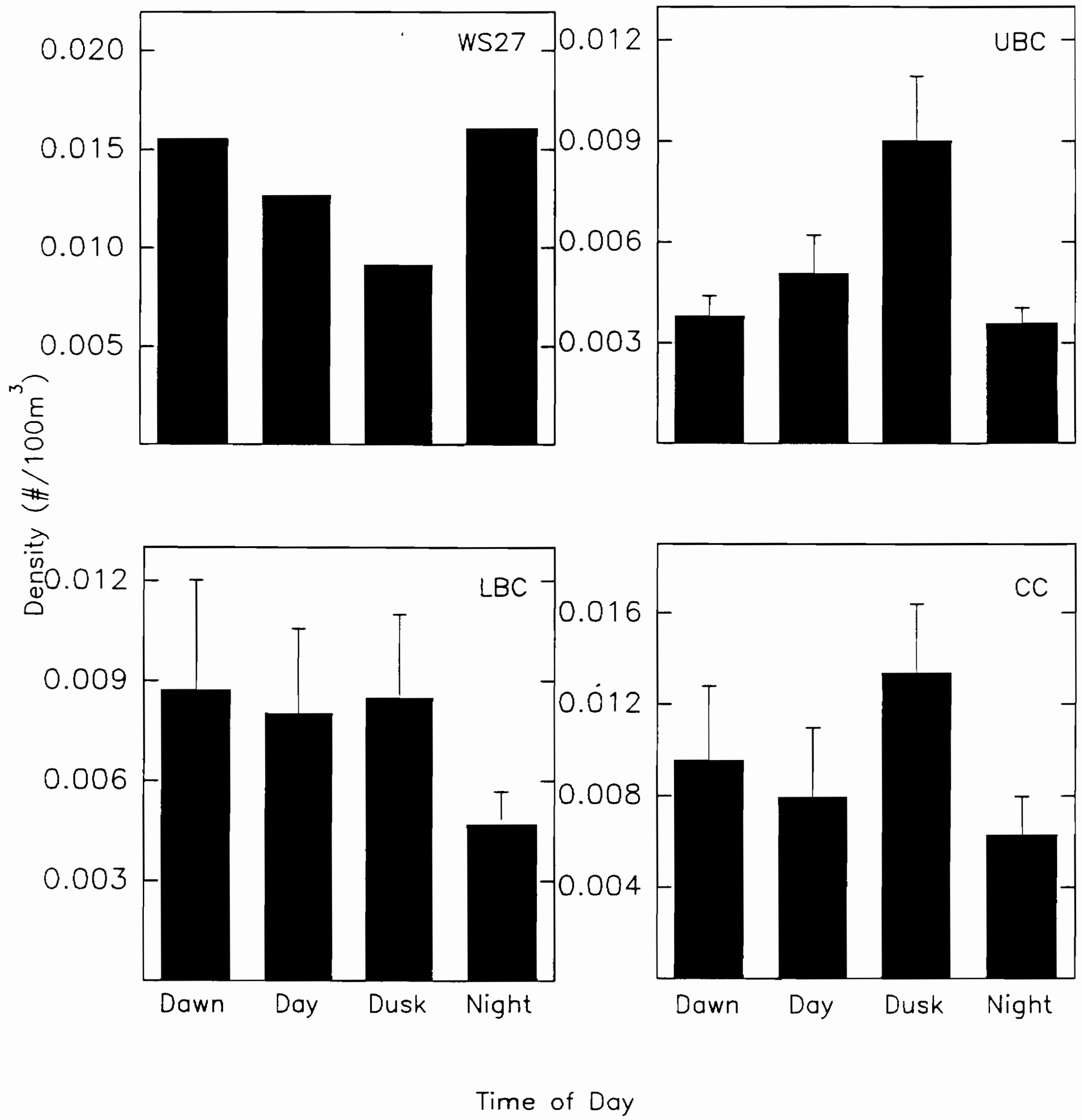

Figure 12. Mean density of drifting aquatic insects at each time for each site on 13 November 1992.

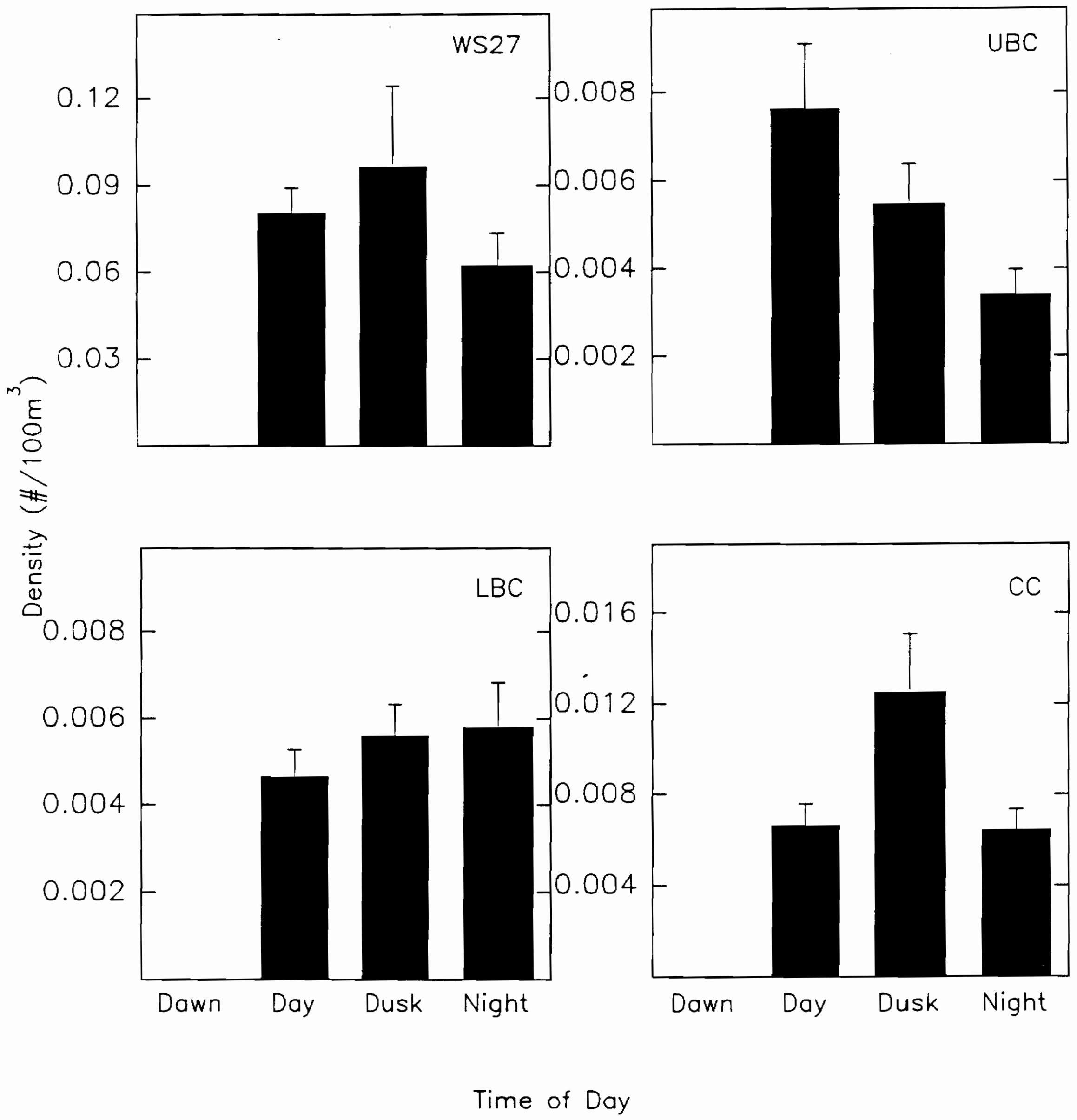

Figure 13. Mean density of drifting aquatic insects at each time for each site on 15 December 1992.

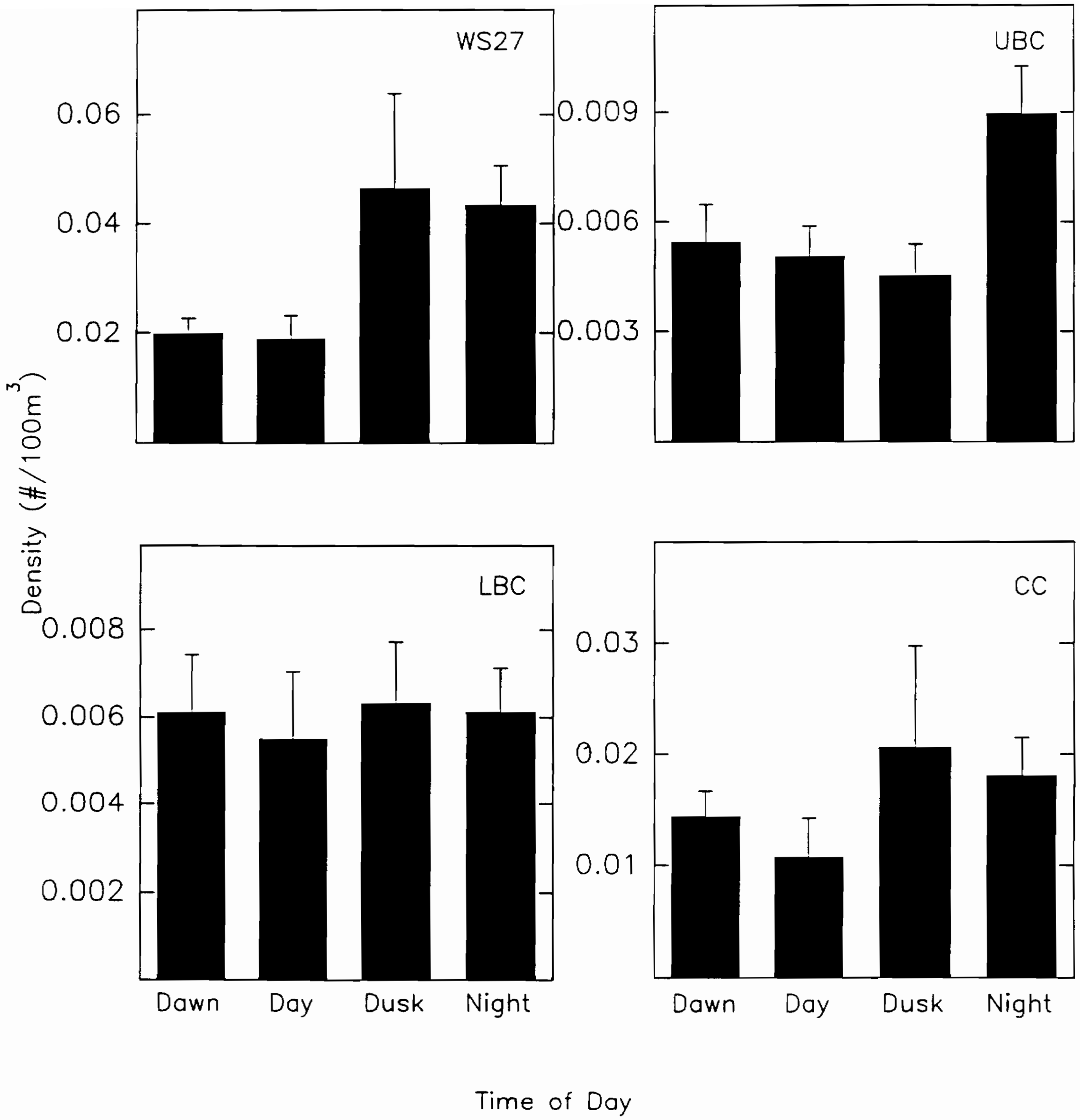

Figure 14. Mean density of drifting aquatic insects at each time for each site on 23 January 1993.

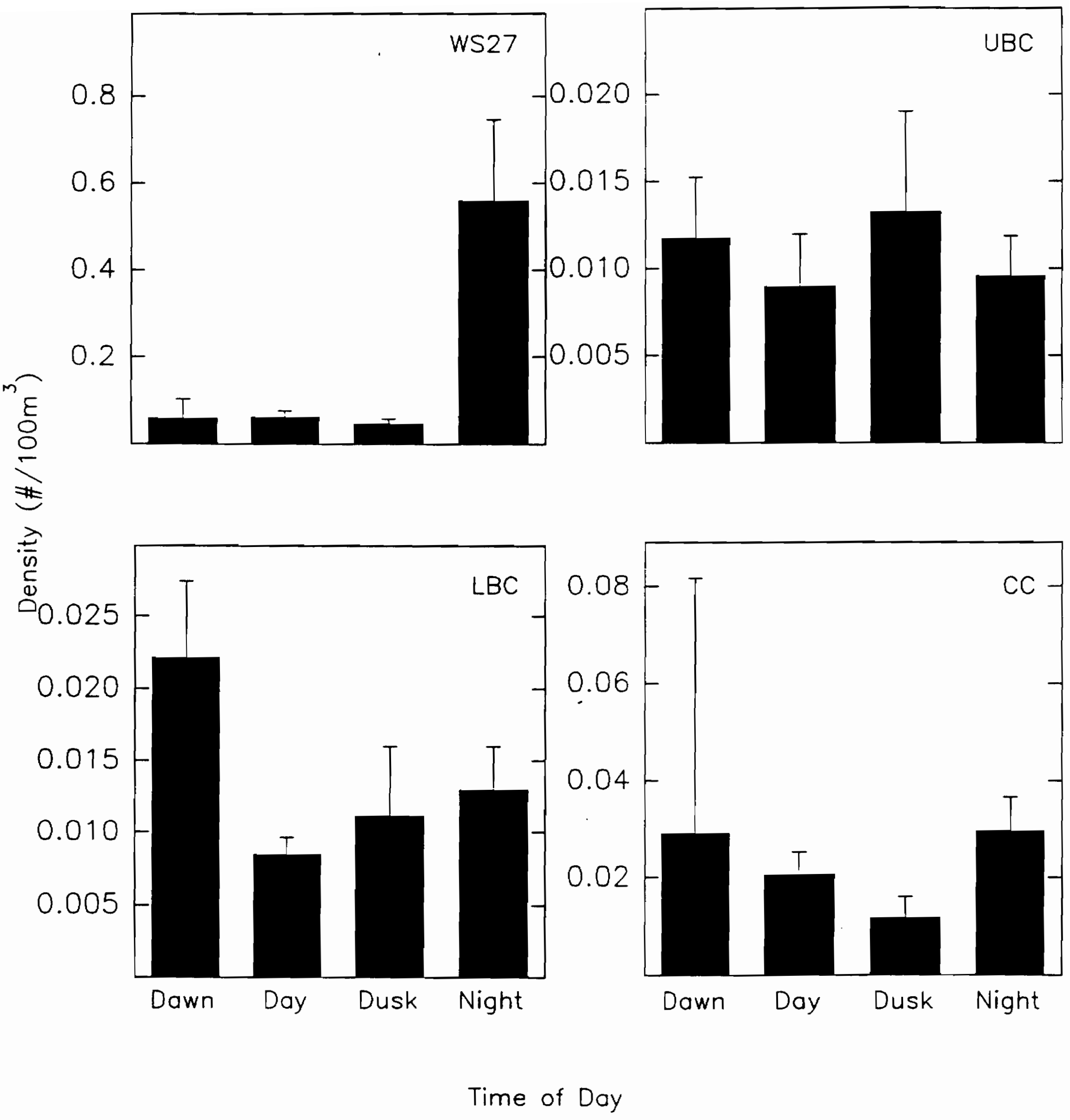

Figure 15. Mean density of drifting aquatic insects at each time for each site on 8 March 1993.

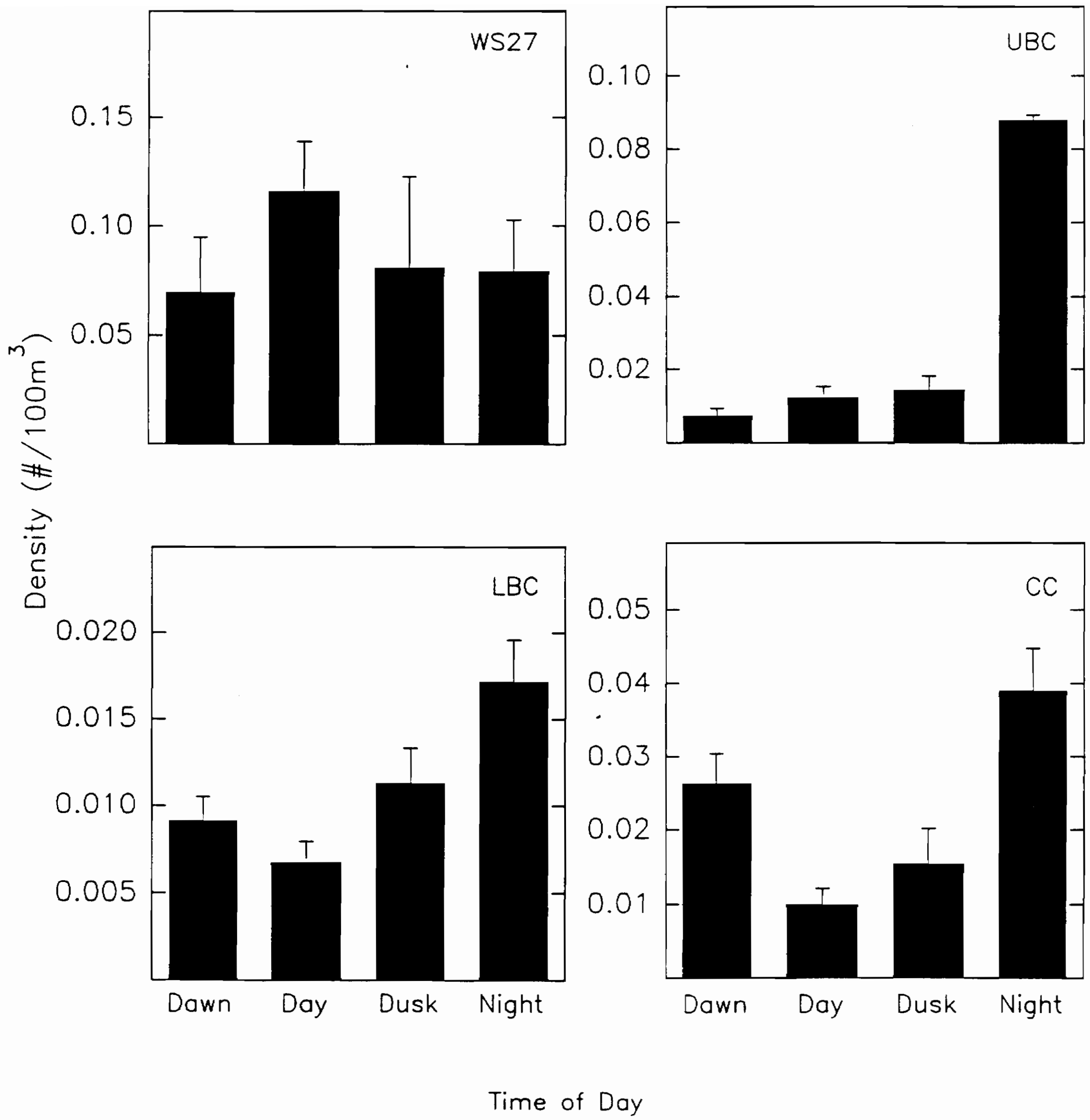

Figure 16. Mean density of drifting aquatic insects at each time for each site on 16 April 1993.

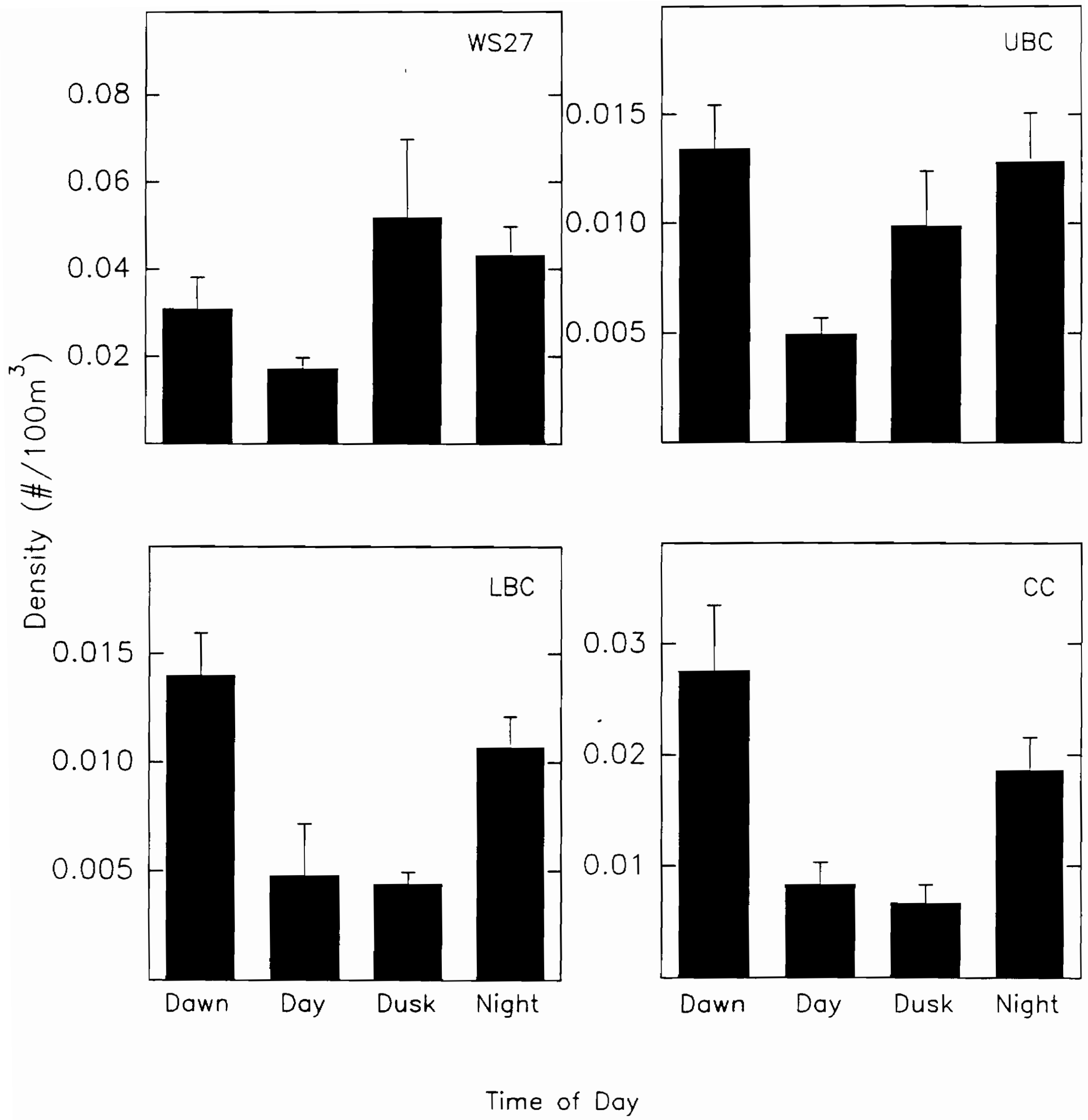

Figure 17. Mean density of drifting aquatic insects at each time for each site on 4 May 1993.

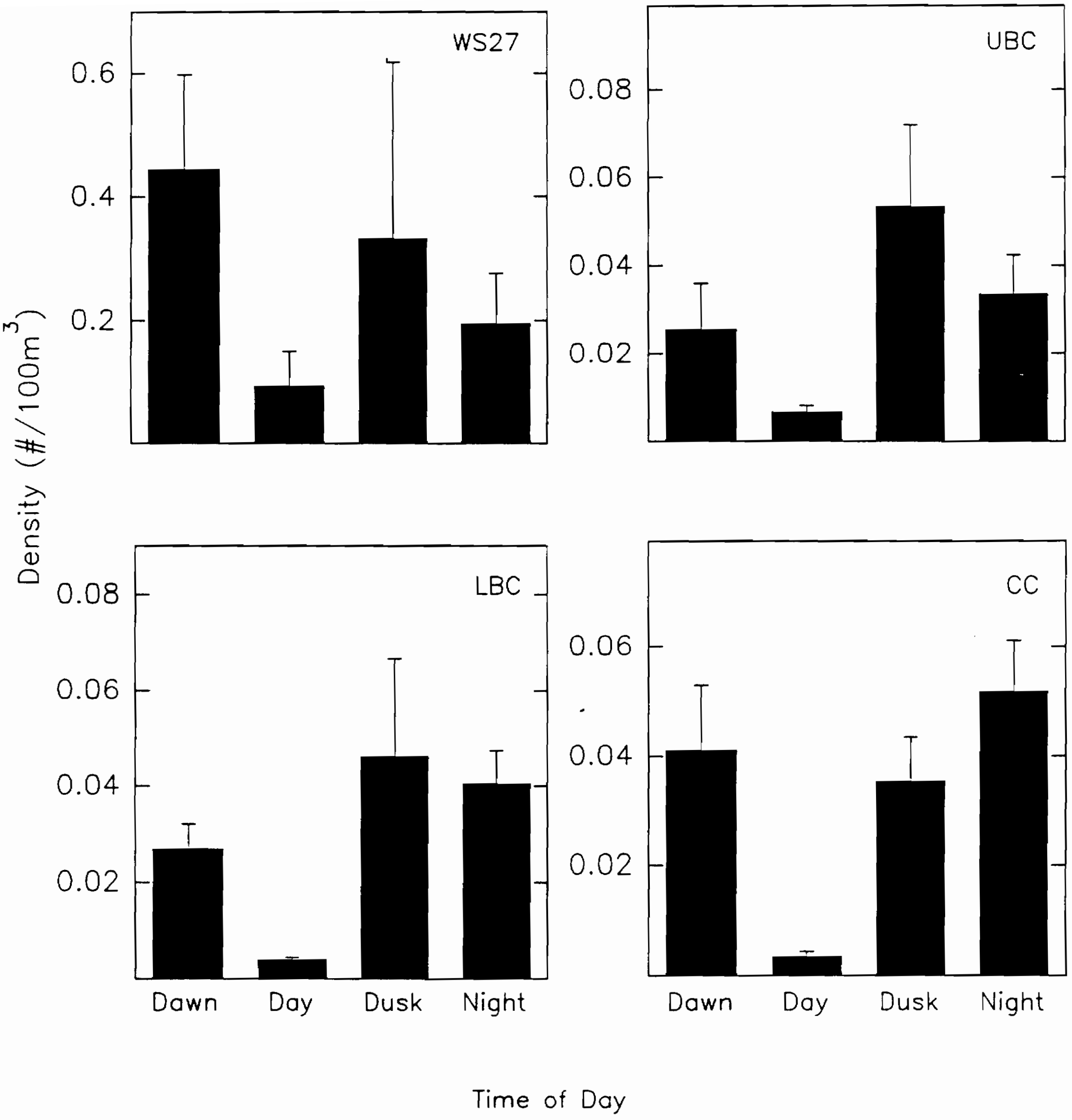

Figure 18. Mean density of drifting aquatic insects at each time for each site on 17 May 1993.

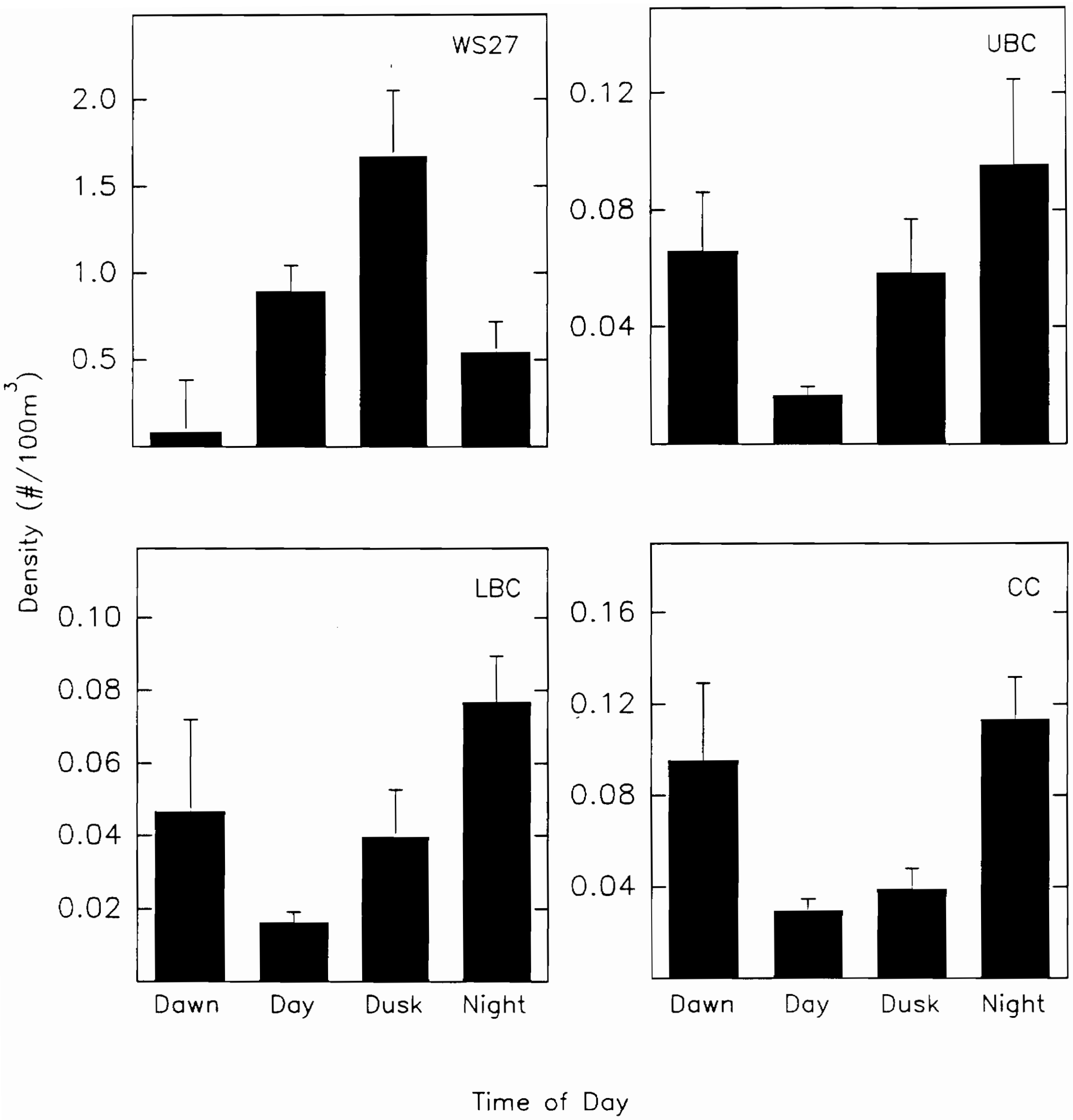

Figure 19. Mean density of drifting aquatic insects at each time for each site on 7 June 1993.

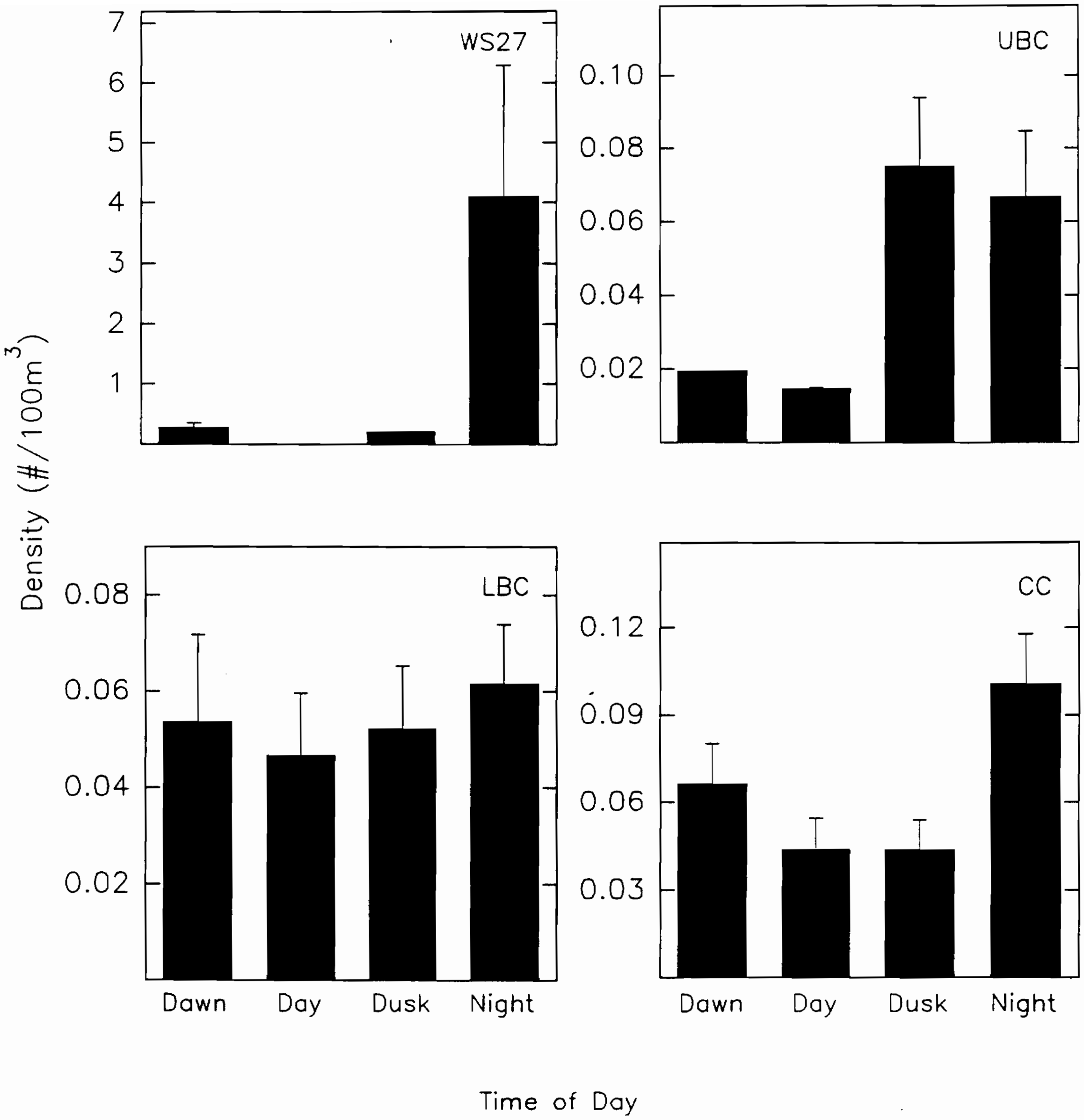

Figure 20. Mean density of drifting aquatic insects at each time for each site on 13 July 1993.

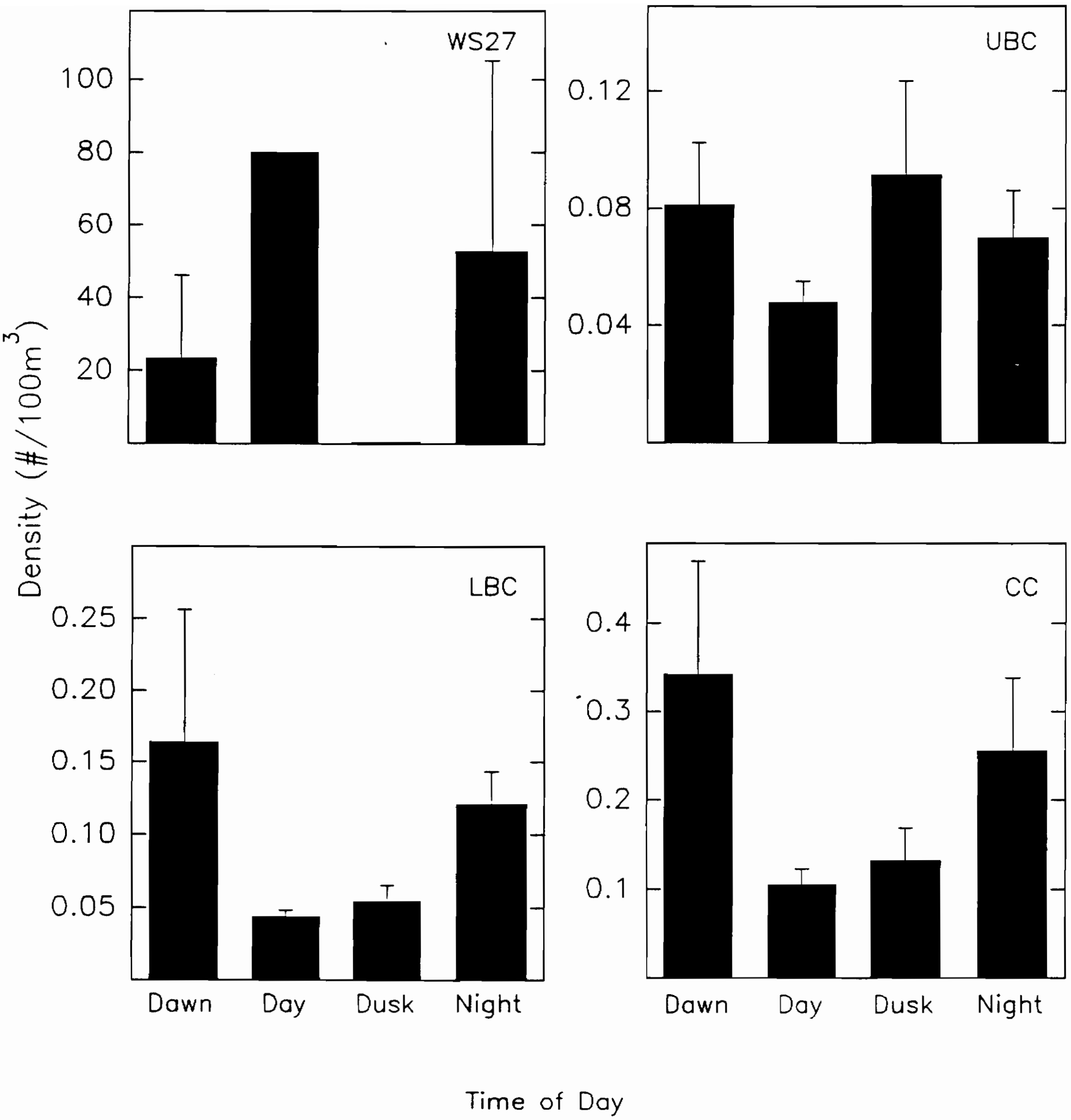

Figure 21. Mean density of drifting aquatic insects at each time for each site on 3 August 1993.

(Limnephilidae, Coleoptera, and Chironomidae) are known to drift more during the day (Brittain and Eikeland 1988). Samples from UBC in Dec 1992 (Fig. 13), WS27 in April 1993 (Fig. 16), and WS27 in August 1993 (Fig. 21) exhibited a peak during the day sample, but no particular taxon could account for the peak values.

Averaging the density of aquatic organisms for each site throughout the year shows different diel patterns. There appears to be no significant diel pattern (ANOVA P=0.923) at WS27, although there was a slight increase in drift density during the day (Fig. 22). Lack of significant differences in time of day is probably due to the high variability of the data (note the large standard errors). Low flows at WS27 tend to exaggerate the influence of the few organisms caught in the nets. UBC exhibited a diel pattern with peaks in drift density at dawn, dusk, and night that were significantly higher than those during day sampling (ANOVA, P=0.008). This pattern most closely approximates a bigeminus pattern (Fig. 22). Drift density at LBC throughout the study showed a significant major peak at night and a smaller significant peak at dawn (Fig. 22, ANOVA, P=0.0003). This pattern is similar to an alterans pattern where a minor peak at dusk increases to a major peak at dawn. CC samples show a significant peak at night (Fig. 22, ANOVA, P=0.0001). With the exception of WS27, the sites follow an expected diel trend i.e., low density of drifting aquatic insects during the day and peaks at either dawn, dusk, night, or some combination of the three.

Combining all taxa in the analysis potentially masks a considerable amount of information about individual taxa and their specific patterns since these behaviors are often species-specific. Similar tests were run on *Baetis* in order to test for any such patterns. At the upper three sites, there was not enough data to statistically test for diel patterns, but UBC and LBC did exhibit a alterans-type pattern with a minor peak at

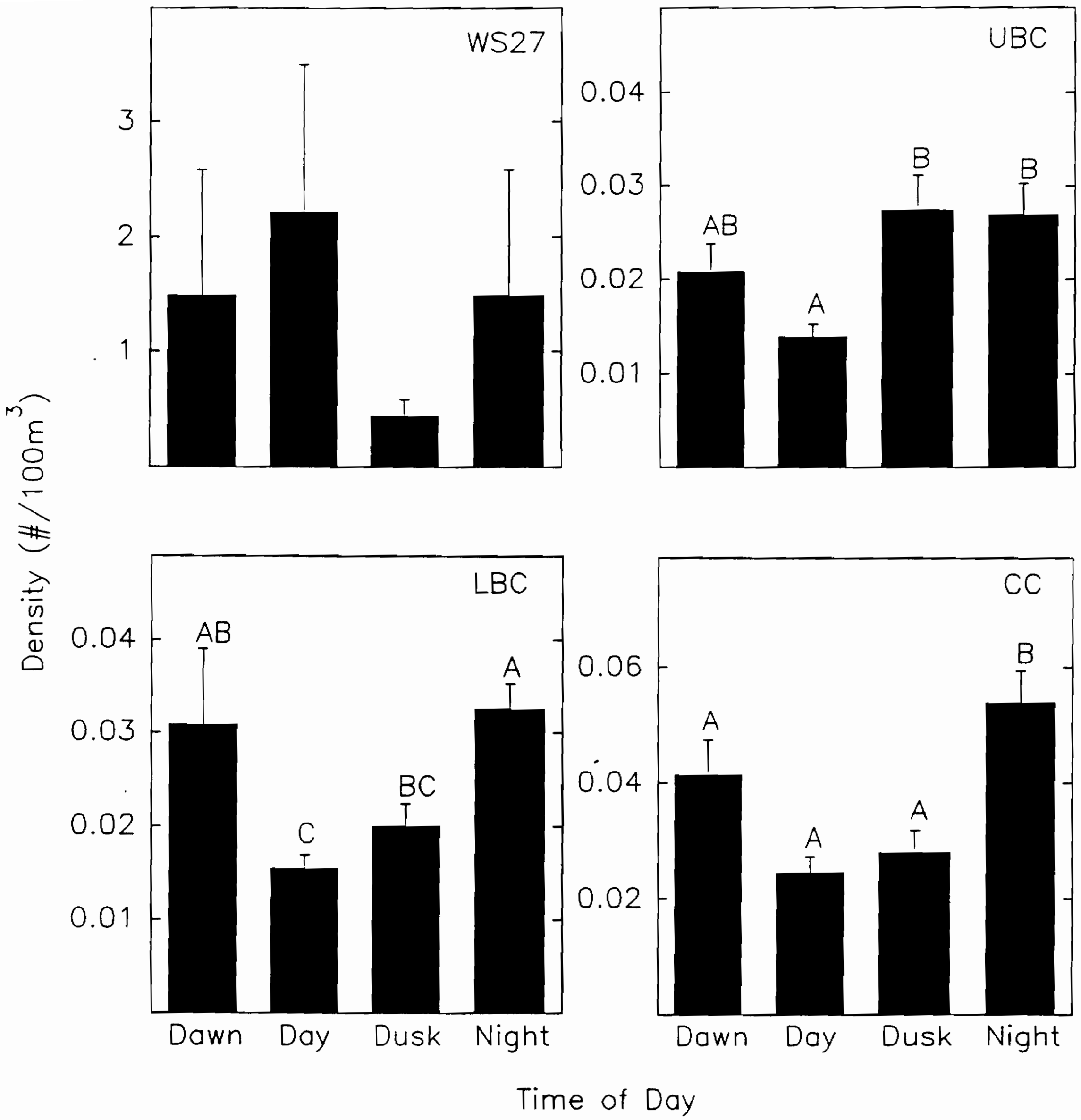

Figure 22. Total density of aquatic organisms drifting for each time at each site throughout the study. Values with the same letters are not significantly different (ANOVA, $p<0.05$).

dusk that builds up to a major peak at dawn. CC had a similar pattern with significant peaks at dawn and night (ANOVA, $P<0.05$) (Fig. 23). This alterans pattern has been observed in *Baetis* in other studies (Waters 1972; Cowell and Carew 1976).

Seasonal Patterns

Regardless of site, the overall density of drifting aquatic organisms was highest during summer (June, July, and August) and lowest in fall (October and November) (Fig. 24). Repeated measures analysis of variance indicate a significant time of year effect on the density of drifting aquatic organisms (ANOVA, $p=0.0001$). Follow-up comparisons show that drift samples collected between November 1992 and April 1993 were not significantly different from each other (ANOVA, $p=0.0001$). In temperate regions, minimum drift density is often reported during the late fall and winter (McLay 1968; Clifford 1972; Stoneburner and Smock 1978; and Koetsier and Bryan 1989) Density can range from $<50/100m^3$ in November to $1150/100m^3$ in April (Koetsier and Bryan 1989).

Higher values in summer may be due to normally lower discharge rather than actual higher numbers of aquatic insects in the drift, but the pattern changes some what when the data are put in terms of transport of aquatic organisms (#/sec). The transport of insects was relatively low from the beginning of the study in July 1992 through Dec of 1992 and then increased during late winter and early spring (Fig. 24). Another peak occurred in early summer. It is interesting to note that density and transport were higher in July and August 1993 than the same months the previous year. This difference is not attributable to differences in discharge because discharge was not

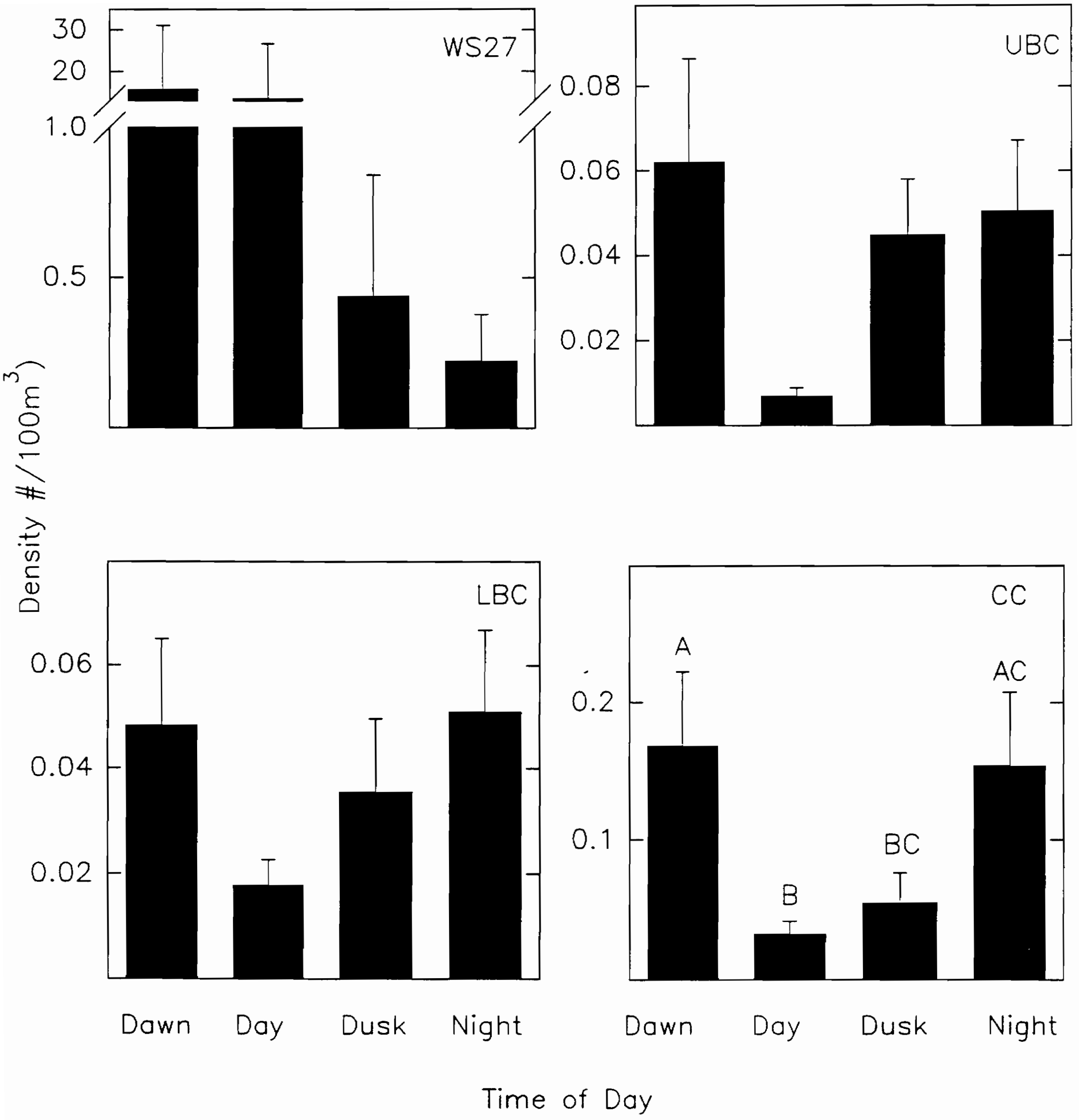

Figure 23. Density of Baeits drifting for each time of day at each site throughout the study. Values with the same letters are not significantly different (ANOVA, $p<0.05$).

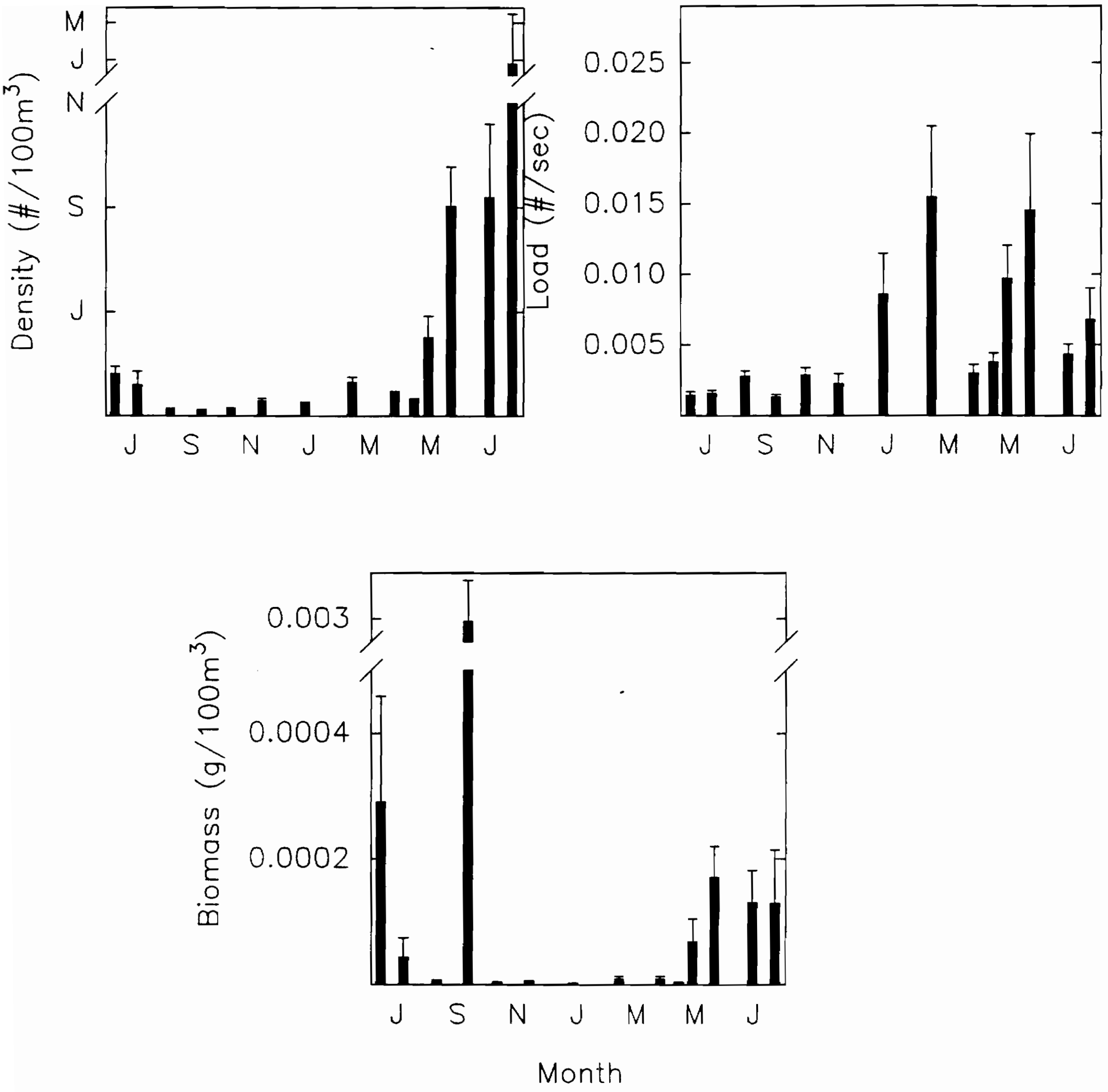

Figure 24. Density, load, and total biomass of drifting aquatic insects at all sites for each diel study.

different between years (Fig. 3).

Total biomass of aquatic insects moving downstream from late spring through summer is greater than the rest of the year, except for an October peak (Fig. 24). This trend corresponds to the life histories of most aquatic insects. Hynes (1970) found that the average biomass of aquatic insects begins to decrease in June to a low in October, indicating seasonal cycles of aquatic insects. Many are in diapause or early stages of development in fall and winter, and are therefore small or not active. In spring and summer, most aquatic insects are in late stages of development and ready to emerge.

Seasonal Drift Groups

Drift patterns were examined by season based on periods of either stable or changing water temperature to reflect the importance of temperature on insect life cycles (Fig. 2). These data were clustered using B_2 values calculated in the Bray-Curtis Biotic Similarity Index. In terms of aquatic insects, December is used as a starting point for discussing patterns of drift because water temperature approaches $0^{o}C$ and many aquatic insects are either in diapause or early stages of development (Langford and Deffern 1975; Langford 1975; and Lehmkuhl 1979). December through March was chosen to represent winter and June through August for summer because water temperatures during these times were relatively stable (Fig. 2). Rising temperatures during April and May were chosen to represent spring, and falling temperatures of September through November to represent autumn (Fig 2).

The clustering of B_2 values calculated by the Bray-Curtis Biotic Similarity Index is shown in Fig. 25. In general, samples from each season clustered together

```
                       *********************** WS27 Summer
                       *
                       *             ********* UBC Summer
                  ******           ***
                  *    *           * ********* CC Winter
                  *    *    ********
                  *    *    *      *    ****** LBC Summer
            *******    ******      ******
            *     *         *           ****** CC Summer
            *     *         *
*************     *         ****************** UBC Winter
*           *     *
*           *     **************************** WS27 Winter
*           *
*           ********************************** LBC Winter
*
*                  *************************** WS27 Fall
*                  *
*           ********      ******************** WS27 Spring
*           *      * ******
*           *      * *    ******************** LBC Fall
*************      ***
            *        *      ****************** UBC Fall
            *        ********
            *               ****************** CC Fall
            *
            *          *********************** UBC Spring
            ************
                       *            ********** LBC Spring
                       **************
                                    ********** CC Spring

0---------.2---------.4---------.6---------.8---------1
```

Figure 25. Dendogram of biotic similarity values (B_2) using Bray-Curtis Biotic Similarity Index.

regardless of site, which gives credibility to using water temperature as a means to separate seasons. Winter samples did not cluster together as tightly as other seasons. Winter samples from WS27, UBC, and LBC are next to each other, but only clustered together in the first cluster. The CC sample for winter clustered out with the summer samples. Because the Bray-Curtis Index over-emphasizes the most abundant taxa, the winter CC sample may be similar to the summer samples in terms of the dominant taxa, but the less abundant taxa may be different. This particular index may not be sensitive enough to distinguish between samples with similar numerous taxa but dissimilar infrequent ones. The spring sample for WS27 clustered out with the fall samples. Again, although the samples may be similar in terms of dominant taxa, an emphasis on the less abundant taxa may have resulted in a different cluster.

Seasonal Drift Characteristics

Winter (December-March): Mean drift density for all sites was low in the winter, never exceeding 0.05/100m3 (Fig 18). Dominant taxa during the winter included *Epeorus*, Chironomidae, Simuliidae, *Serratella*, and *Baetis* (contributing 15.5%, 15.7%, 13.6%, 6.4%, and 6.3% of the total, respectively). The winter stoneflies, *Taeniopteryx* and *Strophopteryx*, although not dominant in the drift at this time, drifted at their highest density of the year. Combined, they account for only 1.4% of the winter drift. The only other time of the year they were present was in fall when the nymphs are becoming active and resuming development after diapause. Another winter stonefly, *Allocapnia*, was present in the winter drift (accounting for

3.7% of the total), although it was more common in fall samples. Most of the winter stoneflies collected in the drift were late larval instars or adults.

Spring (April-May): Spring samples were characterized by high densities of Simuliidae, Chironomidae, and *Baetis*, which made up almost 40% of the drifting organisms. Other organisms, including *Leuctra*, Philopotamidae (adult), Empididae (larvae), *Ephemerella*, *Drunnella*, and *Acentrella*, did not contribute significantly to the total spring drift but were more abundant in spring than in any other season (Appendix 3). Emerging ephemeropteran adults were also present in the samples.

Summer (June-August): Drift density was highest in summer, with an average density of 1.5/100m^3 (Fig. 24) reaching values as high as 80/100m3 in August (Fig. 21). Both *Baetis* and *Tallaperla* were present at their greatest density during this season, accounting for 38% and 25% of the total, respectively. Species richness of the summer samples was low with only 6 taxa representing 1% or more of the total number drifting (Appendix 3).

Fall (September-November): Fall drift samples never exceeded 0.016/100m3, making this period lowest of all the seasons (Fig. 11). Drift was dominated by the winter stonefly *Allocapnia* (23% of the total) and *Pycnopsyche* (15%). Immature *Allocapnia* densities were higher in the fall than in the winter samples. *Baetis*, *Epeorus*, Chironomidae, *Stenonema*, and *Tallaperla* also occurred in these samples.

A seasonal succession in drift composition was apparent in Ball Creek/Coweeta Creek. Many of the changes in dominant taxa seemed to correlate to times when the nymphs were in late developmental stages.

Factors Influencing Drift

As indicated by the stepwise multiple regression procedure, only two variables, FPOM and average water temperature, influenced mean drift density of aquatic insects. Together, these two variables accounted for 64% of the variation in the numbers of drifting aquatic insects (Table 2). Site and date, along with the other variables, were not significant at the 0.05 level and therefore did not contribute significantly to the variation in the numbers of organisms.

FPOM accounted for 61% of the variation in aquatic insect density in this study (P=0.001). Changes in the amount of FPOM are commonly associated with changes in discharge. An increase in flow causes a scouring of the substrate and results in a short term increase in the concentration of FPOM (Doeg and Milledge 1991). So, one might expect a relationship between drift density of insects and discharge similar to the observed relationship between insect density and FPOM. But, discharge did not account for a significant amount of the variation in this model. Other studies show that while numbers and density of drifting insects increase in turbid water, only numbers, not density, increase at higher discharges (Cibrorowski et al. 1977). Doeg and Milledge (1991) found that increasing the concentration of FPOM five-fold in artificial streams resulted in a seven-fold increase in drift, especially for taxa that like cool, clean, well-oxygenated water. Specifically, *Peltoperla* was found to be related more to

Table 2. Effect of FPOM and water temperature on overall drift density.

	Stepwise Multiple Regression R^2	Correlation Coefficient r
FPOM	0.61 (p=0.0001)	0.53 (p=0.0001)
Water temperature	0.03 (p=0.04)	0.13 (p=0.0001)

detritus transport than to benthic density or discharge (O'Hop and Wallace 1983). Discharge also had no effect on drift in gravel-and-rubble bottomed streams similar to Coweeta streams (Zimmer 1976). Correlation (r=0.53, P=0.0001) (Table 2.) between density and FPOM seen in this study can be most likely attributed to the movement of bedload (sediments that move along the surface of the substrate). My nets were placed flush with the substrate, and apparently insects were swept downstream with seston moving as bedload. The movement of sediments could easily scour insects that were on the substrate.

Average water temperature, although only accounting for 3% of the variation in total numbers of drifting insects, also contributed significantly to the multiple regression model (P=0.04). The exact mechanisms involved in regulating temporal patterns of drift are not known, but development is thought to be controlled through interactions of water temperature and photoperiod (Hynes 1970, 1976). Aquatic insects tend to drift more during early instars as a means of dispersal and at mature stages just before emerging (Muller 1954; Hynes 1970). Since insect development is strongly influenced by water temperature, the relationship between drift density and water temperature indicates a possible behavioral component in drift.

Abiotic and biotic factors can affect taxa differently, so a stepwise multiple regression was also run on *Baetis* to determine if additional variables would influence the drift density. Again, FPOM and average water temperature were the only two variables that significantly influenced the mean drift density of *Baetis*. These two variable accounted for 57% of the variation (P=0.0001) in the model, with FPOM accounting for 54% (P=0.0001) and water temperature 3% (P=0.05) (Table 3).

Table 3. Effect of FPOM and water temperature on *Baetis* drift density.

	Stepwise Multiple Regression R^2	Correlation Coefficient r
FPOM	0.54 ($p=0.0001$)	0.74 ($p=0.0001$)
Water temperature	0.03 ($p=0.05$)	0.37 ($p=0.0001$)

FPOM was highly correlated with Baetis drift density (r=0.74, P=0.0001), while water temperature was significant but not highly correlated (r=0.38, P=0.0001) (Table 3). This suggests that *Baetis* is also more strongly influenced by passive processes (moving with the bedload) at Coweeta than active processes (temperature influences on the life cycle).

Comparison with the Benthos

The percent composition of dominant taxa in the drift of Coweeta Creek were compared with those found in the benthos at each of the lower three sites (UBC, LBC, and CC) from the previous year (Houston 1992) (Appendix 4). For each site, the chi-square test showed a significant difference between the two communities (UBC x^2=48.14 P=0.001; LBC x^2=66.9 P=0.0001; CC x^2=101.6 P=0.0001). Even though a few of the minor taxa had similar proportions in benthos and drift, the dominant taxa did not. This result could be interpreted as evidence supporting the idea of active drift. If drift were purely random, the proportions should be similar (chi-square not significant). Similar proportions would suggest that insects are getting caught up in the flow or being swept downstream in the bedload, not actively entering the water column. On the other hand, this result might actually reflect the specific habitat in which each taxon lives. For example, the dominant benthic animal at UBC was oligochaete worms, which tend to live below the surface and would not be likely to accidentally enter the drift with an increase in flow. Therefore, a significant chi-square value would not necessarily reflect an active process.

In this study, the drift community did not have the same proportions of insects as those found in the benthos. This suggests that drift is not a random, passive process, but that there is some factor or factors influencing the insects to drift. Other studies have also shown that the taxonomic composition of drift differs from that of the benthos because taxa vary in both the propensity to drift and overall mobility (Waters 1972; Bergey and Ward 1989).

Terrestrial Drift

Drifting terrestrial insects made up over 60% of the total drift at WS27 throughout the study (Fig. 26). "Terrestrials" were rarely >10% of the composition at the other three sites. The importance of terrestrial insects at the upper site may be attributed to the physical properties of the stream (Table 1). At this site, the stream is very narrow (1-2 m wide) and is heavily shaded. Insects living in the trees have a much greater chance of falling into the stream and getting collected in the drift nets than at the other sites where the stream widens and the canopy opens. Also, the shallow, narrow nature of WS27 allows much more contact with the bank; insects living on the banks are much more likely to either crawl in or be caught in the current at this site than at the others.

Density of drifting terrestrial insects was low through winter and spring (Fig. 27). Peak numbers were collected during July and August 1993 samples. These dates accounted for over 95% of the total terrestrial drift collected during the study. Three families dominated the terrestrial organisms during the July 1993 sample: darkling beetles, Tenebrionidae (49%), and two families of springtails, Entomobryidae (14%)

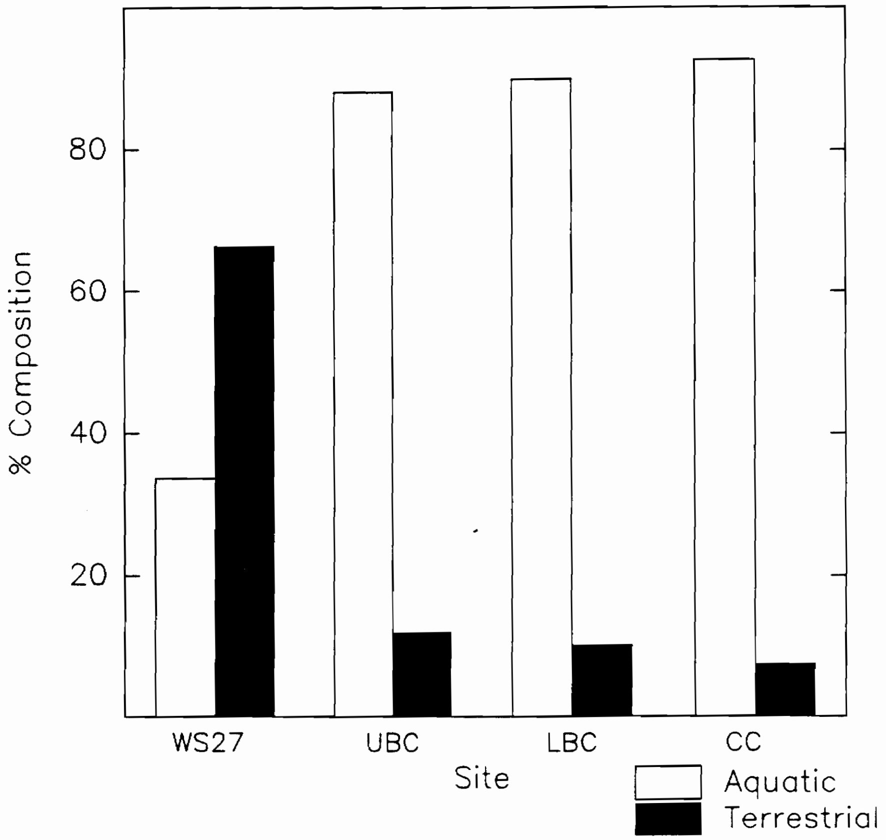

Figure 26. Mean percent aquatic and terrestrial organisms drifting at each site over the study period.

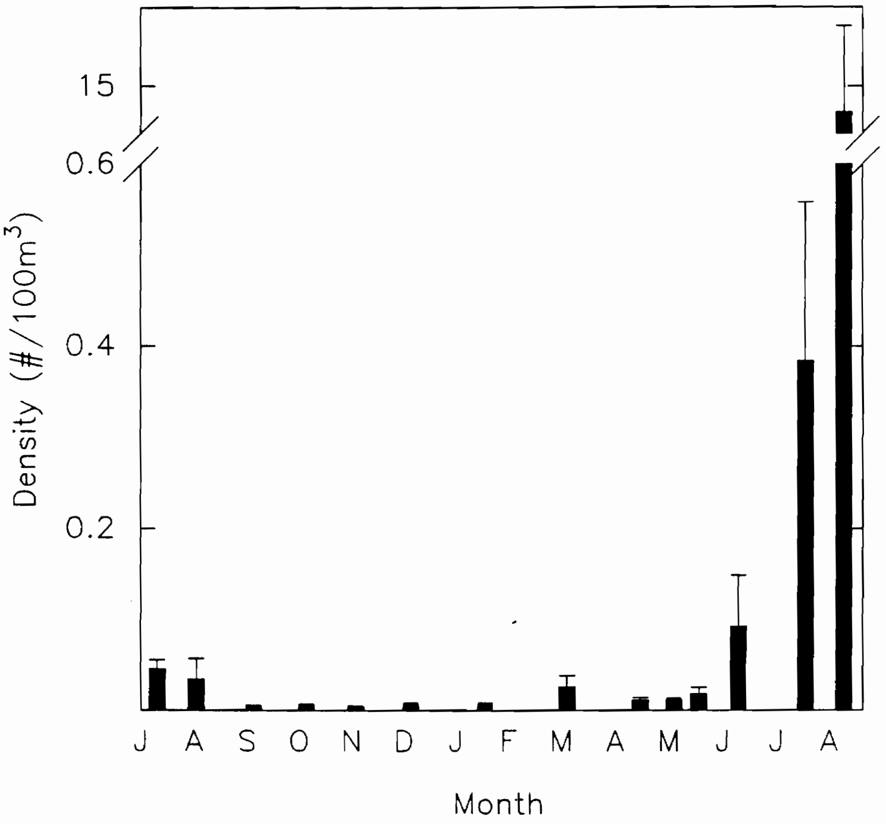

Figure 27. Total density of drifting terrestrial organisms at all sites and times for each diel study.

and Sminthuridae (28%). Spring tails (Sminthuridae and Entomobryidae), spiders (Araneae), bark lice (Psocoptera), and ants (Formicidae) made up 29%, 27%, 21%, 13%, and 6.5% of the terrestrial drift during the August 1993 sample.

Although aquatic insects made up about 90% of the total drifting organisms in most samples, the July and August 1993 samples each contained a substantial amount of terrestrial organisms (70% of the organisms in August 1993 were terrestrial in origin) (Fig. 28). There was also a slight increase in the contribution of terrestrial insects during fall (Fig. 28). "Terrestrials" dominating autumn samples included ants (Formicidae), house flies (Muscidae), fungus gnats (Mycetophilidae), snipe flies (Rhagionidae), and primitive crane flies (Tanyderidae).

Several studies have suggested that drifting terrestrial insects may be an important food source for salmonid fish and some invertebrates (Elliot 1973; Hunt 1975; Mason and MacDonald 1982). The pulses of terrestrial insects in the drift in summer and fall at Coweeta may be important as allochthonous energy inputs to the stream during times of low availability of aquatic insects as food as well as times of high demand for prey items.

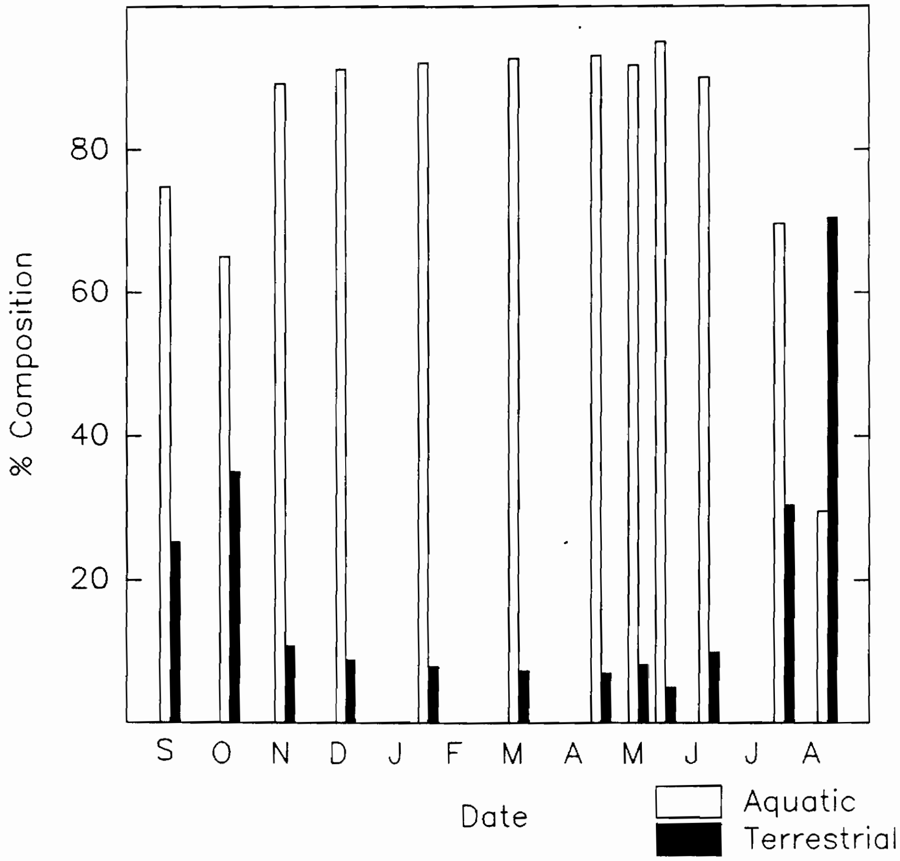

Figure 28. Mean percent aquatic and terrestrial organisms at all sites and times drifting for each diel study.

Summary and Conclusions

Drift in the study stream was dominated by immature aquatic insects for much of the year. Terrestrial insects were numerically important in late summer and fall when there is a potentially high demand for additional food sources. Overall, *Baetis* dominated the drift in terms of percent composition, and although similar insects were dominant at each site, the number of taxa accounting for 90% of the total density increased downstream. The density found in this study tends to be lower than in other streams. There were no significant differences in density among sites.

Diel fluctuations of drift density did not exhibit a consistent general pattern, although UBC, LBC, and CC did have low density during the day-- an expected trend in both the bigeminus and alterans patterns. *Baetis* exhibited an alterans pattern at the three lower sites. Seasonal growth patterns seemed to influence drift. Both density and biomass of drifting aquatic insects were higher during summer when insects are more active and in late develpomental stages.

Two abiotic factors, FPOM and average water temperature, were identified as influencing both overall drift and *Beatis* drift. Increased drift density associated with FPOM is probably a result of insects being carried downstream with the bedload, which suggests a strong passive component to drift. Since water temperature controls the life cycle of aquatic insects and certain stages tend to drift more than others, the relationship between water temperature and drift density indicates an active component in the drift. Since water temperature was not as significant in the regression, this active component is probably not as important in the overall drift of insects in this stream as the passive movement with FPOM.

Comparison of the taxonomic composition of drift differed from that of the benthos, but whether or not this indicates active or passive drift cannot be determined. Differences in dominant taxa found in the drift compared to the benthos reflect both behavioral and physiological attributes of each taxon.

Literature Cited

Allan, J.D., 1978. Trout predation and size composition of stream drift. Limnology and Oceanography 23: 1231-1237.

Anderson, N.H. and D.M. Lemkuhl, 1968. Catastrophic drift of insects on a woodland stream. Ecology 49: 198-206.

Bergey, E.A. and J.V. Ward, 1989. Upstream-downstream movements of aquatic invertebrates in a Rocky Mountain stream. Hydrobiologia 185: 71-82.

Bernard, D.P., W.E. Neill, and L.Rowe, 1990. Impact of mild experimental acidification on short term invertebrate drift in a sensitive British Columbia stream. Hydrobiologia 203: 63-72.

Bishop, J.E. and H.B.N. Hynes, 1969. Downstream drift of the invertebrate fauna in a stream ecosystem. Archives of Hydrobiologia 66: 56-90.

Borrer, D.J., C.A. Triplehorn, and N.F. Johnson. 1989. An introduction to the study of insects. 6th edition. Saunders College Publishing, Philadelphia.

Brittain, J.E. and T.J. Eikeland, 1988. Invertebrate drift- a review. Hydrobiologia 166: 77-93.

Ciborowski, J.J.H., 1983. Influence of current velocity, density, and detritus on drift of two mayfly species (Ephemeroptera). Canadian Journal of Zoology 61: 119-125.

Ciborowski, J.J.H., P.J. Pointing, and L.D. Corkum, 1977. The effect of current velocity and sediment on the drift of the mayfly *Ephemerella subvaria* McDunnough. Freshwater Biology 7: 567-572.

Clifford, H.F., 1972. A year's study of the drifting organisms in a brown-water stream of Alberta, Canada. Canadian Journal of Zoology 50: 975-983.

Corkum, L.D., 1978. The influence of density and behavioral type on the active entry of two mayfly species (Ephemeroptera) into the water column. Canadian Journal of Zoology 56: 1201-1206.

Cowell, B.B. and W.C. Carew, 1976. Seasonal and diel periodicity in the drift of aquatic insects in a subtropical Florida stream. Freshwater Biology 6: 587-594.

Doeg, T.J. and G.A. Milledge, 1991. Effect of experimentally increasing concentrations of suspended sediment on macroinvertebrate drift. Australian Journal of Marine and Freshwater Resources 42: 519-526.

Elliot, J.M., 1967. Invertebrate drift in a Dartmoor stream. Archives of Hydrobiologia 66: 202-237.

Elliot, J.M., 1973. The food of brown trout and rainbow trout (*S. trutta* and *S. gairdneri*) in relation to the abundance of drifting invertebrates in a mountain stream. Oecologia 6: 350-379.

Hildebrand, S.G., 1974. The relation of drift to benthos density and food level in an artificial stream. Limnology and Oceanography 19: 951-957.

Hildrew, A.G. and C.R. Townsend, 1980. Aggregation, interference and foraging by larvae of *Plectrocnemia conspersa* (Trichoptera: Polycentropidae). Animal Behavior 28: 553-560.

Houston, L.A., 1993. Macrofaunal community structure and production along a second to fifth order stream gradient: comparison of microhabitats and stream reaches.. Masters Thesis, University of Georgia, Athens, Georgia.

Hynes, H.B.N., 1970. The Ecology of Running Waters. Liverpool University Press, U.K., 555pp.

Hynes, J.D., 1975. Downstream drift of invertebrates in a river in southern Ghana. Freshwater Biology 5: 515-532.

Koetsier, P. and C.F. Bryan, 1989. Winter and spring macroinvertebrate drift in an outpocketing of the lower Mississippi river, Louisiana (USA). Hydrobiologia 185: 205-209

Langford, T.E., 1975. The emergence of insects from a British River, warmed by the power station cooling water. Part II. The emergence patterns of some species of Ephemeroptera, Trichoptera and Megaloptera in relation to water temperature and river flow upstream and downstream of the cooling water outfalls. Hydrobiologia 47: 91-133.

Langford, T.E. and J.R. Daffern, 1974. The emergence of insects from a British River warmed by power station cooling water. Part I. The use and performance of insect emergence traps in a large river and the effects of various factors in total catches, upstream and downstream of the cooling water outfalls. Hydrobiologia 46: 71-114.

Lehmkuhl, D.M., 1979. Environmental disturbance and life histories: principles and examples. Journal of the Fisheries Resources Board Canada 36: 329-334.

Mason, C.F. and S.M. MacDonald, 1982. The input of terrestrial invertebrates from tree canopies to a stream. Freshwater Biology 12: 305-311.

McAlpine, J.F., B.V. Peterson, G.E. Shewell, H.J. Teskey, J.R. Vockeroth, and D.M. Wood, eds. 1981. Manual of nearctic diptera. monograph 27 (vol 1). Research Branch Agriculture Center, New York.

McAlpine, J.F., B.V. Peterson, G.E. Shewell, H.J. Teskey, J.R. Vockeroth, and D.M. Wood, eds. 1987. Manual of nearctic diptera. monograph 28 (vol 2). Research Branch Agriculture Center, New York.

McLay, C.L., 1968. A study of drift in the Kakanui River, New Zealand. Australian Journal of Marine and Freshwater Reser. 19: 139-149.

Merritt, R.W. and K.W. Cummins. 1984. An introduction to the aquatic insects of North America. 2nd edition. Kendall-Hunt, Dubuque.

Muller, K., 1954. Investigations on the organic drift in north Swedish streams. Rep. Inst. Freshwat. Res. Drottninholm 35: 133-148.

Muller, K., 1963. Diurnal rhythm in "organic drift" of *Gammarus pulex*. Nature, London 198: 806-807.

Needham, P.R., 1928. A quantitative study of fish food suppl. Ann. Rep. 17: 192-206.

Nemec, A.F.L., 1986. Sigtree. Government of Canada. 11pp.

Nemec, A.F.L. and R.O. Brinkhurst, 1988. Using the bootstrap to assess statistical significance in the cluster analysis of species abundance data. Canadian Journal of Fisheries and Aquatic Sciences 45(6): 965-970.

Neves, R.J., 1979. Movements of larval and adult *Pycnopsyche guttifer* (Walker) (Trichoptera: Limnephilidae) along Factory Brook, Massachusetts. American Midland Naturalist 102: 51-58.

O'Hop, J. and J.B. Wallace, 1983. Invertebrate drift, discharge, and sediment relations in a southern Appalachian headwater stream. Hydrobiologia 98: 71-84.

Otto, C., 1976. Factors affecting the drift of *Potamophylax cingulatus* (Trichoptera) larvae. Oikos 27: 93-100.

Pearson, W.D. and R.H. Kramer, 1972. Drift and production of two aquatic insects in a mountain stream. Ecological Monographs 42: 365-385.

Poff, N.L. and J.V. Ward, 1991. Drift responses of benthic invertebrates to experimental streamflow variation in a hydrologically stable stream. Canadian Journal of Fisheries and Aquatic Sciences 48: 1926-1936.

Reisen, W.K., 1977. The ecology of Honey Creek, Oklahoma: population dynamics and drifting behavior of three species of *Simulium* (Diptera: Simuliidae). Canadian Journal of Zoology 55: 325-337.

SAS Institute, Inc., 1991 SAS user's guide: statistics, version 6. 4th edition. SAS Institute, Inc., Cory, North Carolina.

Schram, M.D., A.V. Brown, and D.C. Jackson, 1990. Diel and seasonal drift of zooplankton in a headwater stream. American Midland Naturalist 123: 135-143.

Stoneburner, D.L. and L.A. Smock, 1979. Seasonal fluctuations of macroinvertebrate drift in a South Carolina Piedmont stream. Hydrobiologia 63: 49-56.

Stewart, K.W. and B.P. Stark. 1993. Nymphs of North American stonefly genera (Plecoptera). University of North Texas Press, Denton.

Swank, W.T. and D.A. Crossley, Jr. (editors) 1988. Forest hydrology and ecology at Coweeta. Springer Verlag, New York.

Tanaka, H., 1960. On the daily change of the drifting of benthic animals in streams, especially on the types of daily changes observed in taxonomic groups of insects. Bull. Freshwat. Fish. Res. Lab., Tokyo 9: 13-24.

Ulfstrand, S., 1968. Benthic animal communities in Lapland streams. Oikos suppl. 10: 1-120.

Walton, O.E. Jr., 1980. Invertebrate drift from predator-prey associations. Ecology 61: 1486-1497.

Walton, O.E. Jr., S.R. Reice, and R.W. Andrews, 1977. The effects of density, sediment particle size and velocity on drift of *Acroneuria abnormis* (Plecoptera). Oikos 28: 291-298.

Waringer, J.A., 1992. The drifting of invertebrates and particulate organic matter in an Austrian mountain brook. Freshwater Biology 27: 367-378.

Waters, T.F., 1962. Diurnal periodicity in the drift of stream invertebrates. Ecology 43: 316-320.

Waters, T.F., 1972. The drift of stream insects. Annual Review of Entomology 17: 253-272.

Wiggins, G.B. 1977. Larvae of the North American caddisfly genera (Trichoptera). University of Toranto Press, Ontario.

Wiley, M.J. and S.L. Kohler, 1980. Positioning changes of mayfly nymphs due to behavioral regulation of oxygen consumption. Canadian Journal of Zoology 58: 618-622.

Wojtalik, T.A. and T.F. Waters, 1970. Some effects of heated water on the drift of two species of stream invertebrates. Transactions of the American Fisheries Society 99(4): 782-788.

Zelinka, M., 1976. Mayflies (Ephemeroptera) in the drift of trout streams in the Beskydy Mountains (Czechslovakia). Acta Ent. Boheoslov. 73: 94-101.

Zimmer, D.W., 1976. Observations of invertebrate drift in the Skunk River, Iowa. Proc. Iowa Academy of Sciences 82(3-4): 175-178.

Appedix 1. List of drifting aquatic insect taxa collected in Ball Creek-Coweeta Creek, Macon Co., North Carolina, July 1992-August 1993.

- PHYLUM: Annelida
  - CLASS: Oligochaeta

- PHYLUM: Arthropoda
  - CLASS: Arachnida
    - ORDER: Acari
  - CLASS: Crustacea
    - ORDER: Decopoda
      - Cambaridae
        - Cambarus
  - CLASS: Insecta
    - ORDER: Ephemeroptera
      - Siphlonuridae
        - Ameletus
      - Baetidae
        - Acentrella
        - Baetis
      - Oligonuridae
        - Isonychia
      - Heptageniidae

        Epeorus
        Stenacron
        Stenonema
    Ephemerellidae
        Drunnella
        Ephemerella
        Eurylophella
        Serratella
    Leptophlebiidae
        Habrophlebia
        Paraleptophlebia
ORDER: Odonata
 SUBORDER: Anisoptera
        Cordulegastridae
            Cordulegaster
        Gomphidae
            Lanthus
ORDER: Plecoptera
        Pteronarcyidae
            Pteronarcys
        Peltoperlidae
            Tallaperla
        Taeniopterygidae
            Taeniopteryx

- Strophopteryx

- Nemouridae
    - Amphinemura
    - Soyedina
- Leuctridae
    - Leuctra
- Capniidae
    - Allocapnia
- Perlidae
    - Neoperla
    - Aconeuria
    - Beloneuria
- Perlodidae
    - Hydroperla
    - Isogenoides
    - Malirekus
    - Yugus
    - Isoperla
- Chloroperidae
    - Utaperla
    - Alloperla
    - Swelsta

ORDER: Hemiptera

- Gerridae

- Notonectidae
- Veliidae

ORDER: Megaloptera

- Corydalidae
  - Chauliodes

ORDER: Trichoptera

- Philopotamidae
  - Dolophilodes
  - Wormaldia
- Psychomyiidae
  - Lype
- Polycentropodidae
  - Polycentropus
- Hydropsychidae
  - Arctopsyche
  - Parapsyche
  - Diplectrona
  - Hydropsyche
- Rhyacophiloidea
  - Rhyacophila
- Glossosomatidae
  - Glossosoma
- Phyrganeidae
- Brachycentridae

- Brachycentrus
- Micrasema

Lepidostomatidae
- Lepidostoma

Limnephilidae
- Neophylax
- Pychnopsyche

Sericostomatidae
- Fattigia

Odontoceridae
- Psilotreta

Leptoceridae

ORDER: Lepidoptera

Pyralidae

Noctuidae

ORDER: Coleoptera

Haliplidae

Dytiscidae

Hydrophilidae
- Helophorus

Psepheidae
- Psephenus
- Ectopria

Dryopidae

- Elmidae
    - Opistoservus
    - Promoresia
    - Stenelmis

ORDER: Diptera

- Blephariceridae
    - Blephariceras
- Tipulidae
    - Holorusia
    - Tipula
    - Antocha
    - Hexatoma
    - Ormosia
    - Pedicia
    - Pilaria
- Ceratopoginidae
- Simuliidae
- Chironomidae
- Dixidae
    - Dixa
- Athericidae
    - Atherix
- Empididae
- Syrphidae

Appendix 2. List of drifting terrestrial insect taxa collected in Ball Creek-Coweeta Creek, Macon Co., North Carolina, July 1992- August 1993.

PHYLUM: Mollusca
    CLASS: Gastropoda

PHYLUM: Arthropoda
    CLASS: Arachnida
        ORDER: Araneae
        ORDER: Acari
    CLASS: Malacostraca
        Order: Isopoda
    CLASS: Diplopdoa
    CLASS: Chilopoda
    CLASS: Insecta
        ORDER: Collemola
            Isotomidae
            Entomobryiidae
            Sminthuridae
        ORDER: Orthoptera
            Gryllacrididae
            Gryllidae

ORDER: Psochoptera

ORDER: Hemiptera

- Saldidae
- Tingidae
- Miridae
- Nabidae
- Reduviidae
- Lygaeidae
- Coreidae
- Pentatomidae

ORDER: Homoptera

- Membracidae
- Aetalionidae
- Cercopidae
- Cicadellidae
- Delphacidae
- Cixiidae
- Aphididae
- Erisomatidae
- Coccidae

ORDER: Thysanoptera

ORDER: Coleoptera

- Carabidae
- Staphylinidae

- Scarabaeidae
- Heteroceridae
- Elateridae
- Lampyridae
- Cantharidae
- Phalacridae
- Tenebrionidae
- Alleculidae
- Cerambycidae
- Chrysomelidae
- Curculionidae

ORDER: Lepidoptera

- Pyralidae
- Noctuidae
- Cossidae

ORDER: Diptera

- Tanyderidae
- Tipulidae
- Bibionidae
- Mycetophilidae
- Cecidomyiidae
- Anisopodidae
- Rhagionidae
- Stratiomyidae

Dolichopodidae

Phoridae

Sciomyzidae

Sepsidae

Drosophilidae

Muscidae

Tachinidae

ORDER: Hymenoptera

Braconidae

Ichneumonidae

Formicidae

Appendix 3. Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dawn sample at WS27 for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella							
Allocapnia				0.01			
Alloperla							
Ameletus							
Amphinemura							
Baetis							
Beloneuria							
Brachycentrus							
Ceratopogonidae							
Chironomidae				0.02			
Diplectrona							
Dixa							
Dolophilodes							
Drunnella							
Epeorus				0.01	0.02		0.02
Ephemerella							0.02
Isonychia							
Isoperla					0.02		0.03

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							
Leuctra	0.12	0.12					0.03
Lype		0.28					
Malirekus							
Optioservus							
Paraleptophlebia							0.02
Parapsyche							
Pedicia							
Polycentropus							0.02
Pteronarcys							
Pychnopsyche							
Rhyacophila							
Serratella							
Simuliidae							
Stenonema							
Taenipteryx							
Tallaperla	0.12	0.12		0.01			0.02
Wormaldia					0.02		
Yugus				0.01			

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dawn sample at WS27 for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella				0.28		0.43	
Allocapnia			0.02				
Alloperla							
Ameletus							
Amphinemura					0.08		
Baetis			0.04	0.03	0.93	0.43	0.92
Beloneuria							
Brachycentrus							
Ceratopogonidae							
Chironomidae	0.01		0.02		1.22	0.11	
Diplectrona						0.11	
Dixa					1.79		0.19
Dolophilodes							
Drunnella							
Epeorus	0.01	0.11	0.03		0.08	0.22	
Ephemerella			0.02		1.79	0.11	
Isonychia							
Isoperla			0.02	0.52	0.08		

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma			0.02				
Leuctra							
Lype							
Malirekus							
Optioservus							
Paraleptophlebia							
Parapsyche				0.52			
Pedicia							
Polycentropus							0.19
Pteronarcys							
Pychnopsyche							
Rhyacophila							
Serratella	0.19	0.07	0.06	1.04			
Simuliidae	0.01				1.01	0.22	0.58
Stenonema			0.04				
Taenipteryx							
Tallaperla	0.01	0.03	0.01			0.65	0.19
Wormaldia							
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each day sample at WS27 for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella							
Allocapnia	0.08						
Alloperla							
Ameletus						0.09	0.01
Amphinemura							
Baetis							
Beloneuria						0.05	
Brachycentrus							
Ceratopogonidae							
Chironomidae				0.01			0.02
Diplectrona							
Dixa							
Dolophilodes							
Drunnella							
Epeorus		0.16					
Ephemerella							0.03
Isonychia							
Isoperla							0.01

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							
Leuctra						0.09	
Lype							
Malirekus							
Optioservus							
Paraleptophlebia							
Parapsyche							
Pedicia							
Polycentropus					0.01		
Pteronarcys							
Pychnopsyche				0.01			
Rhyacophila							
Serratella						0.09	
Simuliidae		0.16		0.01			
Stenonema							
Taenipteryx							
Tallaperla							0.01
Wormaldia							
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each day sample at WS27 for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella							
Allocapnia	0.06	0.14					
Alloperla							
Ameletus	0.06		0.01				
Amphinemura				0.06			
Baetis		0.07	0.03	0.03	0.75		0.08
Beloneuria							
Brachycentrus			0.01				
Ceratopogonidae							
Chironomidae	0.05	0.05	0.01				0.04
Diplectrona							
Dixa							
Dolophilodes							
Drunnella							
Epeorus	0.02	0.07	0.02	0.03	1.49		
Ephemerella					0.75		
Isonychia							
Isoperla			0.01		0.75		

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma			0.01				
Leuctra		0.10		0.03	0.75		
Lype							
Malirekus							
Optioservus							
Paraleptophlebia							
Parapsyche		0.20	0.03	0.03			
Pedicia							
Polycentropus							
Pteronarcys							
Pychnopsyche	0.09	0.05	0.01				
Rhyacophila							
Serratella		0.21	0.03	0.26			
Simuliidae				4.47	9.69		
Stenonema							
Taenipteryx							
Tallaperla	0.09	0.05	0.01				
Wormaldia							
Yugus							

Appendix 3. Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dusk sample at WS27 for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella							
Allocapnia	0.47						
Alloperla							
Ameletus					0.01		
Amphinemura	0.47						
Baetis							
Beloneuria							
Brachycentrus							
Ceratopogonidae							
Chironomidae							0.03
Diplectrona	0.23					0.10	
Dixa							
Dolophilodes							
Drunnella							
Epeorus						0.13	0.06
Ephemerella							
Isonychia							
Isoperla					0.01		

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							
Leuctra	0.23						
Lype							
Malirekus							
Optioservus							
Paraleptophlebia							
Parapsyche							
Pedicia	0.23						
Polycentropus							
Pteronarcys							
Pychnopsyche							
Rhyacophila							
Serratella							
Simuliidae							
Stenonema				0.02		0.10	0.05
Taenipteryx							
Tallaperla	0.47	2.42		0.01			
Wormaldia	0.23					0.03	
Yugus							

Appendix 3. Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dusk sample at WS27 for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella					2.05		
Allocapnia	0.10						
Alloperla							
Ameletus							
Amphinemura	0.01		0.02				
Baetis	0.03	0.05	0.03		0.02		
Beloneuria							
Brachycentrus							
Ceratopogonidae							
Chironomidae	0.10	0.07	0.04		0.63		0.37
Diplectrona							
Dixa							
Dolophilodes							
Drunnella							
Epeorus	0.06	0.17	0.21				
Ephemerella		0.04					
Isonychia							
Isoperla			0.01	0.03			

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma			0.06				
Leuctra	0.05	0.02					0.19
Lype							
Malirekus							
Optioservus							
Paraleptophlebia	0.10						
Parapsyche			0.02				
Pedicia							
Polycentropus		0.03			0.03		
Pteronarcys							
Pychnopsyche							
Rhyacophila							
Serratella			0.03		1.10		
Simuliidae					0.17		0.56
Stenonema	0.01						
Taenipteryx							
Tallaperla	0.01	0.02	0.05	0.19		0.22	
Wormaldia							
Yugus			0.02				

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each night sample at WS27 for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella							
Allocapnia	0.18					0.05	0.03
Alloperla							
Ameletus							
Amphinemura				0.01			
Baetis	0.18						0.05
Beloneuria							
Brachycentrus							
Ceratopogonidae							
Chironomidae							0.09
Diplectrona						0.05	
Dixa							
Dolophilodes							
Drunnella							
Epeorus						0.12	0.05
Ephemerella							
Isonychia							
Isoperla					0.02	0.05	

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							
Leuctra							0.02
Lype							
Malirekus							
Optioservus							
Paraleptophlebia							0.02
Parapsyche						0.05	0.05
Pedicia							
Polycentropus	0.18						
Pteronarcys							
Pychnopsyche							
Rhyacophila							
Serratella							
Simuliidae							
Stenonema	0.06						
Taenipteryx		0.40		0.01	0.02	0.05	0.07
Tallaperla							
Wormaldia							0.02
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each night sample at WS27 for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella					0.07		
Allocapnia							
Alloperla							
Ameletus							
Amphinemura			0.02			0.63	
Baetis		0.03	0.02		0.83		
Beloneuria							
Brachycentrus							
Ceratopogonidae							
Chironomidae		0.03	0.02	0.28	0.49	2.26	
Diplectrona			0.03				
Dixa							
Dolophilodes			0.02				
Drunnella							
Epeorus		0.10	0.06	0.28	0.83	4.1	
Ephemerella			0.05				
Isonychia							
Isoperla		0.10	0.02				

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma			0.07				
Leuctra							
Lype						0.41	
Malirekus							
Optioservus							
Paraleptophlebia	0.37						
Parapsyche			0.05				
Pedicia			0.02				
Polycentropus							
Pteronarcys							
Pychnopsyche							
Rhyacophila							
Serratella	0.37	0.10	0.05	0.15			
Simuliidae	1.12		0.02				
Stenonema			0.02				
Taenipteryx							
Tallaperla		0.03	0.11		0.49	3.29	105
Wormaldia							
Yugus	0.37		0.02				

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dawn sample at UBC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella	0.06						
Allocapnia		0.02	0.004		0.01		
Alloperla							
Ameletus					0.002		0.01
Amphinemura					0.004		
Baetis	0.03		0.01				0.003
Beloneuria							
Brachycentrus	0.005						
Ceratopogonidae							
Chironomidae	0.01		0.01	0.003			0.005
Diplectrona		0.01					
Dixa	0.005						
Dolophilodes					0.004		
Drunnella	0.01						
Epeorus	0.01				0.004		0.003
Ephemerella							
Isonychia							
Isoperla					0.003		

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							0.003
Leuctra	0.02	0.005					
Lype					0.002		
Malirekus							
Optioservus							
Paraleptophlebia							
Parapsyche	0.01		0.004				0.003
Pedicia							
Polycentropus			0.004		0.003		
Pteronarcys							
Pychnopsyche					0.01		0.004
Rhyacophila							0.01
Serratella							0.01
Simuliidae			0.004				
Stenonema					0.002		
Taenipteryx							
Tallaperla	0.05	0.01	0.01	0.003	0.003		0.003
Wormaldia							
Yugus		0.005					

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dawn sample at UBC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella					0.118		0.077
Allocapnia			0.023				0.039
Alloperla							
Ameletus		0.002	0.005				
Amphinemura	0.005	0.002	0.005	0.009			
Baetis	0.008	0.029	0.044	0.051	0.184	0.019	0.249
Beloneuria							
Brachycentrus							
Ceratopogonidae			0.008				
Chironomidae	0.005	0.003	0.005				
Diplectrona		0.004	0.011				0.043
Dixa							0.048
Dolophilodes							0.039
Drunnella							
Epeorus	0.026	0.012	0.017			0.019	0.039
Ephemerella			0.019	0.051	0.118		
Isonychia							
Isoperla		0.002	0.011	0.009	0.026		

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma		0.009	0.019				
Leuctra				0.009			
Lype		0.003	0.006				
Malirekus	0.005						
Optioservus			0.005			0.014	0.048
Paraleptophlebia		0.003					
Parapsyche			0.005			0.019	0.048
Pedicia			0.006				
Polycentropus			0.011				
Pteronarcys			0.011				
Pychnopsyche		0.003					
Rhyacophila							
Serratella		0.009	0.034			0.019	
Simuliidae					0.026		
Stenonema		0.003				0.019	0.039
Taenipteryx							
Tallaperla	0.008	0.003	0.014		0.066		0.134
Wormaldia							
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each day sample at UBC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella							
Allocapnia	0.02				0.002	0.01	0.003
Alloperla							
Ameletus							
Amphinemura							
Baetis	0.02	0.002			0.002		0.003
Beloneuria							
Brachycentrus							
Ceratopogonidae							
Chironomidae	0.006		0.005	0.003	0.02		0.03
Diplectrona	0.01		0.002				0.003
Dixa							
Dolophilodes							
Drunnella	0.02	0.004					
Epeorus		0.004		0.003	0.012	0.01	0.01
Ephemerella							0.003
Isonychia							
Isoperla						0.01	0.004

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							
Leuctra						0.02	
Lype							
Malirekus							
Optioservus							
Paraleptophlebia							
Parapsyche							0.003
Pedicia					0.006		
Polycentropus							
Pteronarcys							
Pychnopsyche					0.01	0.004	0.004
Rhyacophila		0.004					
Serratella					0.002	0.005	0.01
Simuliidae		0.002					0.003
Stenonema		0.002			0.006		0.006
Taenipteryx					0.006		
Tallaperla	0.01	0.002	0.004	0.004	0.002		
Wormaldia							
Yugus		0.004					0.01

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each day sample at UBC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella					0.013		0.04
Allocapnia		0.007	0.002		0.013		0.122
Alloperla							
Ameletus							
Amphinemura			0.002				
Baetis	0.006		0.005		0.013		
Beloneuria							
Brachycentrus							
Ceratopogonidae			0.002				
Chironomidae	0.006	0.038	0.005				0.081
Diplectrona						0.014	
Dixa				0.004			0.04
Dolophilodes				0.003			0.041
Drunnella							
Epeorus	0.023		0.006	0.004		0.014	
Ephemerella			0.009	0.017	0.04	0.016	
Isonychia					0.013		
Isoperla		0.015		0.004			

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma	0.006	0.008	0.004		0.013		
Leuctra		0.015				0.016	
Lype			0.002				
Malirekus			0.002				
Optioservus				0.003			0.041
Paraleptophlebia						0.016	
Parapsyche							0.04
Pedicia							
Polycentropus			0.003	0.003			
Pteronarcys				0.004			
Pychnopsyche							
Rhyacophila							
Serratella			0.011	0.008	0.013	0.016	
Simuliidae					0.04	0.066	0.081
Stenonema							0.04
Taenipteryx							
Tallaperla						0.014	0.04
Wormaldia							
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dusk sample at UBC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella	0.006						
Allocapnia	0.02				0.02	0.005	
Alloperla							
Ameletus			0.005				
Amphinemura							
Baetis	0.02	0.006	0.02		0.004	0.005	0.007
Beloneuria							
Brachycentrus							
Ceratopogonidae							
Chironomidae					0.008	0.01	0.004
Diplectrona			0.005		0.008		0.004
Dixa	0.006						
Dolophilodes							0.003
Drunnella							
Epeorus	0.04	0.03	0.005	0.006	0.004	0.009	0.007
Ephemerella							
Isonychia	0.013	0.06					
Isoperla					0.004	0.005	0.004

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							
Leuctra	0.024	0.011	0.005		0.004	0.018	0.003
Lype							
Malirekus							
Optioservus							
Paraleptophlebia					0.004		
Parapsyche			0.003				
Pedicia							
Polycentropus							
Pteronarcys							
Pychnopsyche					0.025	0.005	
Rhyacophila							
Serratella	0.011						
Simuliidae		0.006					
Stenonema	0.006	0.006		0.007	0.012		0.003
Taenipteryx						0.005	
Tallaperla	0.04	0.073	0.003	0.005	0.017		
Wormaldia							
Yugus	0.014						0.003

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dusk sample at UBC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella		0.007			0.172	0.152	0.05
Allocapnia	0.002				0.029	0.061	
Alloperla							
Ameletus							
Amphinemura			0.004				
Baetis	0.009	0.024	0.031	0.082	0.172	0.05	0.1
Beloneuria							
Brachycentrus							
Ceratopogonidae							
Chironomidae	0.006			0.011	0.014		0.04
Diplectrona			0.004				0.175
Dixa							
Dolophilodes							
Drunnella							
Epeorus	0.035	0.022	0.026	0.164	0.043	0.025	0.05
Ephemerella		0.007	0.004	0.025	0.014	0.03	
Isonychia							
Isoperla	0.006	0.014		0.036	0.012		0.025

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma			0.004				
Leuctra			0.004	0.011			0.038
Lype							
Malirekus			0.003				
Optioservus							
Paraleptophlebia			0.004				
Parapsyche							
Pedicia							
Polycentropus							
Pteronarcys			0.004				
Pychnopsyche							
Rhyacophila				0.011			0.044
Serratella		0.01	0.02	0.032	0.043		
Simuliidae	0.002		0.004		0.1	0.04	0.052
Stenonema		0.003		0.011			
Taenipteryx							
Tallaperla			0.006		0.029	0.126	0.296
Wormaldia						0.03	
Yugus				0.018			0.044

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each night sample at UBC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella							
Allocapnia	0.026		0.004		0.007	0.004	0.005
Alloperla			0.004				
Ameletus							0.01
Amphinemura				0.003	0.003		
Baetis	0.006		0.018	0.008	0.001	0.003	0.022
Beloneuria	0.011						
Brachycentrus						0.003	
Ceratopogonidae							
Chironomidae	0.017		0.008	0.005	0.003		
Diplectrona			0.004	0.003	0.003		0.005
Dixa							
Dolophilodes	0.019	0.005		0.006	0.004		
Drunnella							
Epeorus	0.011	0.014	0.015	0.004	0.004	0.005	0.017
Ephemerella							
Isonychia	0.037	0.021					
Isoperla					0.006		0.008

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							0.01
Leuctra	0.028			0.003		0.005	
Lype					0.001		
Malirekus							
Optioservus							
Paraleptophlebia							
Parapsyche							
Pedicia							
Polycentropus	0.006				0.003		
Pteronarcys							
Pychnopsyche				0.003	0.005		
Rhyacophila			0.004	0.003		0.003	0.004
Serratella							
Simuliidae				0.004			0.005
Stenonema	0.04				0.001	0.005	
Taenipteryx							
Tallaperla	0.044	0.033	0.035	0.02	0.004	0.002	0.006
Wormaldia			0.004		0.004		0.004
Yugus	0.022	0.009	0.004	0.004			0.017

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each night sample at UBC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella					0.179	0.017	0.052
Allocapnia		0.009	0.005		0.047	0.127	0.052
Alloperla							
Ameletus		0.004		0.011			
Amphinemura		0.008	0.005	0.017	0.023	0.017	
Baetis	0.014	0.03	0.016	0.057	0.304	0.135	0.078
Beloneuria						0.034	
Brachycentrus							
Ceratopogonidae							
Chironomidae	0.01	0.006	0.007	0.012		0.022	
Diplectrona		0.007	0.015	0.015		0.022	
Dixa						0.015	0.083
Dolophilodes			0.007	0.008			
Drunnella					0.023		
Epeorus	0.011	0.021	0.027	0.163	0.023	0.024	
Ephemerella	0.005	0.008	0.01	0.063	0.187		
Isonychia				0.017		0.042	0.026
Isoperla			0.021	0.049	0.062		0.044

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma		0.003	0.014	0.008	0.015		
Leuctra			0.005				
Lype		0.011					
Malirekus		0.004					
Optioservus		0.005		0.015	0.015		
Paraleptophlebia		0.006		0.011		0.013	
Parapsyche		0.003	0.005	0.008			
Pedicia							
Polycentropus						0.017	
Pteronarcys			0.021				
Pychnopsyche		0.003					
Rhyacophila			0.01		0.019		
Serratella		0.006	0.018	0.015	0.047		
Simuliidae	0.005	0.003	0.005	0.006	0.152	0.027	
Stenonema	0.012	0.006		0.008		0.017	0.044
Taenipteryx							
Tallaperla		0.013	0.029	0.019	0.288	0.329	0.161
Wormaldia					0.023		
Yugus	0.005	0.009	0.021	0.083	0.038	0.048	

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dawn sample at LBC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella	0.006	0.024					
Allocapnia	0.045	0.013	0.005	0.003	0.01		0.003
Alloperla							
Ameletus							
Amphinemura							
Baetis			0.004				0.008
Beloneuria							
Brachycentrus	0.006						
Ceratopogonidae							
Chironomidae							0.023
Diplectrona	0.004						
Dixa							
Dolophilodes		0.007					0.003
Drunnella		0.012					
Epeorus							0.014
Ephemerella					0.002		0.002
Isonychia							
Isoperla							

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							
Leuctra	0.028	0.007	0.002	0.003	0.002		0.002
Lype							0.002
Malirekus							
Optioservus							
Paraleptophlebia							0.002
Parapsyche				0.004			0.002
Pedicia		0.009					
Polycentropus					0.002		
Pteronarcys	0.005						
Pychnopsyche					0.021		0.003
Rhyacophila	0.004						0.002
Serratella							0.002
Simuliidae				0.003			0.002
Stenonema							0.005
Taenipteryx					0.002		
Tallaperla	0.013	0.013	0.002				
Wormaldia					0.002		
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dawn sample at LBC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella	0.052	0.021	0.026	0.054	0.23	0.155	0.891
Allocapnia	0.004					0.029	0.097
Alloperla							
Ameletus		0.002					0.085
Amphinemura	0.007	0.007	0.013	0.015			
Baetis	0.027	0.02	0.021	0.085	0.041	0.028	0.16
Beloneuria							
Brachycentrus							0.032
Ceratopogonidae			0.007				
Chironomidae	0.007	0.007	0.007	0.007	0.012	0.028	0.032
Diplectrona	0.004	0.003	0.006	0.007	0.018		0.074
Dixa							
Dolophilodes			0.016	0.006			
Drunnella		0.002	0.004	0.014	0.018		
Epeorus	0.085	0.025	0.005	0.01	0.008	0.057	0.083
Ephemerella	0.016	0.021	0.044	0.061	0.045		
Isonychia						0.02	
Isoperla	0.007		0.005	0.016	0.018	0.057	0.023

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma		0.005	0.01		0.008		
Leuctra		0.003			0.019		
Lype		0.004	0.005	0.007		0.018	
Malirekus	0.004	0.004				0.04	
Optioservus			0.005				
Paraleptophlebia	0.004						
Parapsyche		0.007				0.02	
Pedicia							0.064
Polycentropus		0.002					
Pteronarcys		0.005	0.013	0.011			
Pychnopsyche							
Rhyacophila		0.003		0.008			0.053
Serratella	0.007	0.013	0.018	0.023			0.032
Simuliidae	0.009	0.009	0.021	0.018	0.018	0.018	0.023
Stenonema		0.002	0.004				
Taenipteryx							
Tallaperla	0.004			0.008		0.024	0.044
Wormaldia							0.029
Yugus					0.008		0.074

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each day sample at LBC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella	0.006	0.008					
Allocapnia			0.002		0.01	0.008	0.007
Alloperla							
Ameletus							
Amphinemura							
Baetis				0.003			0.003
Beloneuria							
Brachycentrus	0.007						
Ceratopogonidae							
Chironomidae							
Diplectrona			0.005	0.006	0.013	0.006	0.017
Dixa		0.007					
Dolophilodes	0.006						0.004
Drunnella							
Epeorus					0.003	0.003	0.005
Ephemerella						0.003	
Isonychia							
Isoperla						0.005	

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							0.002
Leuctra	0.006		0.005	0.003	0.003	0.004	0.005
Lype							0.002
Malirekus							
Optioservus							
Paraleptophlebia			0.005				
Parapsyche							
Pedicia							
Polycentropus					0.003		
Pteronarcys							
Pychnopsyche				0.003	0.016	0.002	0.003
Rhyacophila							0.002
Serratella					0.003		0.002
Simuliidae				0.003	0.008		0.004
Stenonema						0.003	
Taenipteryx						0.006	
Tallaperla	0.009						
Wormaldia						0.003	
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each day sample at LBC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella	0.012	0.02			0.034	0.08	0.031
Allocapnia						0.106	0.031
Alloperla							
Ameletus							
Amphinemura							
Baetis	0.008	0.004	0.002		0.02	0.032	0.046
Beloneuria							
Brachycentrus							
Ceratopogonidae							
Chironomidae	0.064	0.033		0.003	0.025	0.064	0.105
Diplectrona					0.009		0.031
Dixa							
Dolophilodes				0.003			
Drunnella							
Epeorus	0.011	0.012	0.002	0.003			0.062
Ephemerella		0.004	0.012	0.006			
Isonychia							
Isoperla				0.003			0.06

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma	0.004	0.008			0.015		
Leuctra	0.009	0.013					0.06
Lype							
Malirekus				0.003			
Optioservus							
Paraleptophlebia	0.013				0.011	0.022	
Parapsyche	0.004						
Pedicia							
Polycentropus		0.004					
Pteronarcys				0.006			
Pychnopsyche							
Rhyacophila		0.004					
Serratella	0.007	0.004		0.003			
Simuliidae	0.044	0.016	0.003	0.004	0.021		0.091
Stenonema		0.004					
Taenipteryx							
Tallaperla					0.011		
Wormaldia							
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dusk sample at LBC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella	0.011	0.003					
Allocapnia	0.024	0.017			0.037	0.006	0.009
Alloperla							
Ameletus				0.009	0.002		
Amphinemura					0.004		0.003
Baetis		0.007	0.004				0.007
Beloneuria							
Brachycentrus	0.005	0.007					
Ceratopogonidae							
Chironomidae				0.004	0.003	0.011	0.018
Diplectrona		0.005			0.008		
Dixa	0.005				0.002		
Dolophilodes					0.002	0.004	
Drunnella							
Epeorus	0.005	0.007			0.009	0.009	0.018
Ephemerella						0.004	
Isonychia	0.008	0.013					
Isoperla		0.003			0.002		

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							
Leuctra	0.022	0.007			0.002	0.012	0.003
Lype							
Malirekus							
Optioservus							
Paraleptophlebia					0.002		
Parapsyche							
Pedicia	0.007						
Polycentropus							
Pteronarcys							
Pychnopsyche					0.025	0.004	0.002
Rhyacophila							0.003
Serratella							0.004
Simuliidae							0.003
Stenonema		0.007			0.002		0.003
Taenipteryx					0.005		
Tallaperla	0.016	0.017		0.004	0.005	0.005	
Wormaldia		0.007					
Yugus	0.004						

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dusk sample at LBC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella	0.005	0.011	0.005	0.143	0.164	0.127	0.122
Allocapnia			0.002		0.009	0.047	0.065
Alloperla							
Ameletus				0.013			
Amphinemura		0.006	0.003	0.008		0.023	
Baetis	0.004	0.014	0.013	0.172	0.05	0.047	0.065
Beloneuria							
Brachycentrus					0.011		0.022
Ceratopogonidae							
Chironomidae	0.074	0.005	0.004	0.009	0.023	0.023	0.095
Diplectrona		0.003	0.008	0.008			0.022
Dixa			0.003	0.008			
Dolophilodes		0.003			0.011		
Drunnella		0.003	0.003	0.008	0.011		0.038
Epeorus	0.037	0.023	0.003	0.013			
Ephemerella	0.005	0.008	0.005	0.023			
Isonychia							
Isoperla			0.003	0.008			

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma		0.007	0.005	0.013	0.016		
Leuctra	0.004			0.013	0.016		
Lype							
Malirekus							
Optioservus		0.003					
Paraleptophlebia					0.031		
Parapsyche		0.003		0.013	0.011		
Pedicia			0.002			0.024	
Polycentropus		0.003	0.003	0.008			
Pteronarcys		0.004					
Pychnopsyche							
Rhyacophila							
Serratella		0.009	0.005		0.016		
Simuliidae	0.007	0.036	0.004	0.019	0.046		0.043
Stenonema		0.013		0.013			
Taenipteryx							
Tallaperla					0.031	0.058	0.043
Wormaldia	0.004					0.023	
Yugus			0.006				

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each night sample at LBC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella	0.023						
Allocapnia	0.034		0.003	0.004	0.016	0.005	0.002
Alloperla							
Ameletus		0.007	0.003	0.004			0.003
Amphinemura				0.004	0.002		0.002
Baetis	0.023	0.007	0.007	0.011	0.001	0.006	0.007
Beloneuria							
Brachycentrus	0.008	0.004					
Ceratopogonidae							
Chironomidae	0.008			0.012	0.002	0.002	0.008
Diplectrona	0.008	0.006	0.008	0.004	0.003		0.005
Dixa							
Dolophilodes	0.008	0.008		0.006	0.003	0.002	0.003
Drunnella							
Epeorus	0.006	0.004	0.004	0.008	.003	0.007	0.023
Ephemerella					0.002		
Isonychia	0.029	0.026					
Isoperla		0.014				0.006	0.01

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma					0.002		0.007
Leuctra	0.021	0.007	0.005	0.004		0.009	
Lype					0.001		
Malirekus							0.003
Optioservus							
Paraleptophlebia		0.004			0.001	0.002	0.009
Parapsyche					0.004		
Pedicia	0.015						
Polycentropus					0.001		
Pteronarcys			0.002				
Pychnopsyche		0.004		0.004	0.017	0.003	0.007
Rhyacophila						0.004	0.002
Serratella	0.008	0.011					0.006
Simuliidae			0.008	0.006			0.003
Stenonema	0.021	0.004		0.01	0.003	0.003	0.003
Taenipteryx					0.003	0.015	0.002
Tallaperla	0.03	0.03	0.012	0.009	0.002	0.005	0.005
Wormaldia		0.007					
Yugus			0.004	0.004	0.001	0.002	0.005

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each night sample at LBC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella	0.021	0.058	0.018	0.108	0.447	0.031	0.463
Allocapnia		0.005			0.125	0.205	0.252
Alloperla				0.007			
Ameletus					0.019		0.157
Amphinemura	0.008	0.024	0.019	0.015	0.037	0.025	0.06
Baetis	0.017	0.022	0.014	0.11	0.195	0.025	0.09
Beloneuria				0.007	0.02	0.016	
Brachycentrus							
Ceratopogonidae			0.006				
Chironomidae	0.038	0.008	0.004	0.009	0.022	0.017	0.06
Diplectrona	0.004	0.017	0.007	0.01	0.016		0.041
Dixa		0.002	0.004	0.013		0.025	0.03
Dolophilodes			0.006		0.02		
Drunnella				0.022	0.089	0.014	0.039
Epeorus	0.04	0.046	0.007	0.02	0.042	0.015	0.15
Ephemerella	0.008	0.019	0.037	0.132	0.122	0.012	
Isonychia					0.017	0.239	0.112
Isoperla		0.016	0.012	0.114	0.108	0.021	0.035

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma		0.003	0.007	0.016	0.021	0.019	
Leuctra	0.004		0.003	0.012	0.09		
Lype		0.003	0.003	0.015			
Malirekus							
Optioservus				0.01	0.013	0.076	0.071
Paraleptophlebia		0.009			0.04		
Parapsyche		0.002				0.019	0.06
Pedicia		0.005	0.003		0.032		
Polycentropus		0.004	0.004	0.008	0.02	0.019	0.007
Pteronarcys		0.011	0.003	0.015	0.036	0.026	
Pychnopsyche							
Rhyacophila	0.004	0.004	0.003	0.015	0.021		0.052
Serratella	0.014	0.033	0.025	0.077	0.075	0.016	
Simuliidae	0.008	0.021	0.008	0.009	0.047	0.038	0.06
Stenonema	0.004	0.012	0.003		0.017	0.037	0.054
Taenipteryx							
Tallaperla	0.004	0.008	0.01	0.027	0.201	0.270	0.152
Wormaldia				0.008	0.021		
Yugus		0.002	0.01	0.054	0.067	0.045	

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dawn sample at CC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella	0.015	0.006					
Allocapnia	0.021	0.004	0.015	0.005	0.034		0.004
Alloperla							
Ameletus				0.005			
Amphinemura							0.012
Baetis	0.019		0.006	0.008	0.004		0.025
Beloneuria							0.004
Brachycentrus	0.006	0.007	0.003				
Ceratopogonidae							
Chironomidae							0.041
Diplectrona	0.008	0.004			0.003		0.013
Dixa							
Dolophilodes							
Drunnella							
Epeorus	0.009			0.005	0.002		0.022
Ephemerella							0.013
Isonychia							
Isoperla					0.005		0.009

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							0.019
Leuctra	0.004	0.007	0.007	0.021	0.002		0.004
Lype							0.004
Malirekus							
Optioservus							
Paraleptophlebia			0.005		0.003		0.017
Parapsyche							
Pedicia							
Polycentropus			0.004				0.008
Pteronarcys							0.004
Pychnopsyche				0.005	0.012		
Rhyacophila			0.003	0.005			0.004
Serratella							0.014
Simuliidae			0.005	0.005			0.024
Stenonema			0.003	0.005			0.006
Taenipteryx					0.008		
Tallaperla	0.006		0.005	0.01	0.003		0.014
Wormaldia	0.004				0.003		0.015
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dawn sample at CC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella	0.087	0.062	0.052	0.096	0.373	0.11	0.805
Allocapnia	0.005	0.012	0.006		0.044	0.041	
Alloperla							
Ameletus					0.041		
Amphinemura	0.006	0.023	0.018	0.024	0.041		
Baetis	0.056	0.105	0.184	0.276	0.682	0.136	0.636
Beloneuria							
Brachycentrus		0.006		0.005	0.044		0.277
Ceratopogonidae							
Chironomidae	0.01	0.014	0.012	0.01	0.04	0.027	0.074
Diplectrona	0.004	0.012	0.004		0.026		0.023
Dixa			0.006	0.005	0.021		0.277
Dolophilodes		0.006					
Drunnella			0.012	0.03	0.027		
Epeorus	0.093	0.023	0.021	0.026	0.041	0.069	0.277
Ephemerella	0.016	0.063	0.072	0.021	0.021		
Isonychia							
Isoperla	0.014	0.007	0.017	0.007			

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma		0.01	0.018	0.007			
Leuctra		0.007	0.005		0.024	0.069	
Lype		0.007	0.012				
Malirekus	0.004				0.021	0.034	
Optioservus	0.004		0.004				
Paraleptophlebia	0.007				0.021		
Parapsyche	0.004	0.013					
Pedicia		0.004	0.006			0.02	0.277
Polycentropus		0.012	0.016	0.023		0.027	
Pteronarcys	0.005	0.006	0.011	0.007	0.021		
Pychnopsyche		0.003					
Rhyacophila	0.01		0.006	0.005			
Serratella	0.042	0.04	0.021	0.021	0.022		
Simuliidae	0.098	0.062	0.01	0.019	0.079	0.034	0.049
Stenonema	0.012	0.008	0.004		0.037		
Taenipteryx							
Tallaperla			0.015	0.011	0.062	0.04	
Wormaldia	0.004	0.006	0.008				
Yugus			0.013	0.023	0.011		

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each day sample at CC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella							
Allocapnia		0.002			0.014	0.006	0.006
Alloperla							
Ameletus							
Amphinemura							0.003
Baetis			0.006	0.006		0.004	0.011
Beloneuria							
Brachycentrus		0.01				0.005	
Ceratopogonidae							
Chironomidae						0.008	0.054
Diplectrona						0.004	
Dixa							
Dolophilodes							
Drunnella	0.008	0.002					
Epeorus						0.012	0.006
Ephemerella							0.004
Isonychia							
Isoperla						0.015	

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							0.004
Leuctra			0.005		0.003	0.004	
Lype							0.004
Malirekus							
Optioservus		0.003					0.004
Paraleptophlebia							
Parapsyche							
Pedicia							
Polycentropus							0.003
Pteronarcys							
Pychnopsyche					0.01	0.006	0.004
Rhyacophila							0.004
Serratella							0.003
Simuliidae						0.004	0.01
Stenonema							
Taenipteryx					0.004	0.004	
Tallaperla			0.005		0.004	0.005	
Wormaldia							
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each day sample at CC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella	0.047	0.022	0.004		0.054	0.041	0.206
Allocapnia				0.002		0.051	
Alloperla							
Ameletus					0.013		0.042
Amphinemura	0.022						
Baetis	0.062	0.023	0.026	0.003	0.028	0.026	0.147
Beloneuria							
Brachycentrus						0.013	
Ceratopogonidae							
Chironomidae	0.19	0.008	0.01	0.002	0.032	0.062	0.118
Diplectrona	0.006		0.005				0.085
Dixa							
Dolophilodes							
Drunnella		0.007		0.005	0.037	0.013	
Epeorus	0.015	0.005					
Ephemerella	0.018	0.007	0.006	0.002			
Isonychia						0.026	
Isoperla							

TAXA	**8MAR**	**16APR**	**4MAY**	**17MAY**	**7JUN**	**13JUL**	**3AUG**
Lepidostoma		0.003	0.005		0.013	0.026	
Leuctra	0.006					0.026	
Lype			0.004				
Malirekus							
Optioservus							0.042
Paraleptophlebia	0.006						
Parapsyche							0.062
Pedicia							
Polycentropus	0.006	0.004					
Pteronarcys		0.003	0.004				
Pychnopsyche	0.006						
Rhyacophila	0.006		0.004	0.003			0.034
Serratella	0.015	0.009	0.009				
Simuliidae	0.034	0.018	0.007	0.006	0.025	0.086	0.12
Stenonema	0.014	0.003					0.011
Taenipteryx							
Tallaperla			0.005		0.013	0.141	0.032
Wormaldia							
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dusk sample at CC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella							
Allocapnia	0.007				0.068	0.027	
Alloperla			0.003				
Ameletus		0.005			0.003		
Amphinemura							
Baetis		0.007	0.01		0.01	0.011	0.022
Beloneuria							
Brachycentrus	0.049	0.027	0.003	0.004	0.002		
Ceratopogonidae							
Chironomidae	0.005	0.013	0.008	0.004		0.013	0.094
Diplectrona			0.007		0.003		
Dixa					0.002		
Dolophilodes					0.005		
Drunnella	0.009	0.003					
Epeorus		0.004			0.011	0.005	0.009
Ephemerella			0.004				0.004
Isonychia			0.003				
Isoperla					0.015		

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							
Leuctra	0.004	0.004		0.004			
Lype							
Malirekus							
Optioservus						0.005	
Paraleptophlebia	0.004				0.007		
Parapsyche					0.006		
Pedicia							
Polycentropus							
Pteronarcys	0.004						
Pychnopsyche			0.003		0.02		
Rhyacophila					0.003	0.005	
Serratella							0.013
Simuliidae	0.004	0.005		0.006	0.003	0.014	0.013
Stenonema	0.004				0.011		0.009
Taenipteryx					0.014	0.009	
Tallaperla		0.004			0.01	0.014	
Wormaldia					0.003		
Yugus							

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each dusk sample at CC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella		0.011	0.015	0.072	0.058	0.028	0.308
Allocapnia							
Alloperla							
Ameletus						0.02	0.022
Amphinemura					0.014		
Baetis	0.013	0.022	0.023	0.075	0.122		0.336
Beloneuria		0.002					
Brachycentrus					0.021		
Ceratopogonidae							
Chironomidae	0.008	0.004	0.003	0.009	0.019	0.04	0.301
Diplectrona		0.002				0.032	
Dixa							0.065
Dolophilodes							
Drunnella			0.003	0.009	0.011		0.022
Epeorus	0.002	0.009	0.002	0.021			
Ephemerella		0.015	0.003		0.013		
Isonychia					0.014		
Isoperla							

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma		0.006	0.003	0.009	0.14		
Leuctra		0.008				0.018	
Lype							
Malirekus							
Optioservus		0.004					
Paraleptophlebia							0.065
Parapsyche		0.002				0.016	
Pedicia							
Polycentropus		0.004	0.002				
Pteronarcys		0.004		0.011			
Pychnopsyche							
Rhyacophila					0.014		0.121
Serratella		0.005	0.003	0.021	0.14		0.121
Simuliidae	0.019	0.058	0.003	0.026	0.067	0.067	0.068
Stenonema	0.004	0.004					0.242
Taenipteryx	0.004						
Tallaperla		0.002				0.094	0.022
Wormaldia							
Yugus		0.004					0.121

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each night sample at CC for July 1992- January 1993.

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Acentrella	0.033					0.005	
Allocapnia	0.008	0.011	0.016		0.025	0.017	0.012
Alloperla							
Ameletus			0.014				
Amphinemura					0.002		0.004
Baetis	0.041	0.008	0.029	0.005	0.005	0.011	0.028
Beloneuria	0.015	0.005	0.003				
Brachycentrus	0.024	0.017	0.009	0.006	0.002		
Ceratopogonidae							
Chironomidae			0.008		0.005	0.004	0.055
Diplectrona	0.008				0.004		
Dixa					0.002		
Dolophilodes			0.005	0.008	0.002		
Drunnella							
Epeorus	0.021	0.014	0.006	0.01	0.004	0.008	0.072
Ephemerella					0.002	0.006	0.005
Isonychia	0.012						
Isoperla					0.002	0.003	0.007

TAXA	28JUL	18AUG	18SEP	17OCT	13NOV	15DEC	23JAN
Lepidostoma							
Leuctra	0.015	0.005	0.008	0.006	0.003		0.004
Lype							
Malirekus		0.003	0.006				
Optioservus		0.009	0.004				
Paraleptophlebia			0.005	0.005	0.004		0.008
Parapsyche							
Pedicia							
Polycentropus	0.008		0.007	0.006	0.002		
Pteronarcys	0.007	0.005	0.007				
Pychnopsyche					0.008	0.002	0.012
Rhyacophila							0.004
Serratella					0.001		0.006
Simuliidae	0.025		0.003	0.008		0.005	0.031
Stenonema	0.012	0.003	0.003	0.008	0.007	0.01	0.012
Taenipteryx					0.005	0.005	
Tallaperla	0.033	0.015	0.023		0.005	0.006	0.007
Wormaldia		0.009			0.002	0.005	0.004
Yugus			0.007	0.005	0.003		

Appendix 3. (con't) Density (#/100m^3) of aquatic taxa that accounted for at least 1% of each night sample at CC for March 1993- August 1993.

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Acentrella	0.099	0.105	0.018	0.136	0.598	0.094	0.63
Allocapnia					0.068	0.068	0.028
Alloperla				0.009	0.014		
Ameletus			0.007				
Amphinemura	0.006	0.036	0.039	0.02	0.02	0.012	
Baetis	0.041	0.09	0.067	0.278	0.447	0.097	0.952
Beloneuria					0.186	0.292	
Brachycentrus		0.013			0.047	0.177	0.088
Ceratopogonidae							
Chironomidae	0.018	0.011	0.018	0.014	0.336	0.063	0.147
Diplectrona	0.007	0.009	0.005		0.063		0.147
Dixa			0.004	0.009	0.014		
Dolophilodes	0.006	0.009	0.007		0.033		0.084
Drunnella	0.007	0.007	0.009	0.054	0.1	0.135	
Epeorus	0.03	0.048	0.016	0.067	0.067	0.058	0.088
Ephemerella		0.115	0.085	0.094	0.173		
Isonychia			0.005		0.041	0.054	0.147
Isoperla	0.006	0.164	0.011	0.045	0.188	0.072	0.147

TAXA	8MAR	16APR	4MAY	17MAY	7JUN	13JUL	3AUG
Lepidostoma	0.007	0.017	0.011	0.01	0.033		
Leuctra	0.007		0.005		0.027		
Lype		0.009	0.006	0.009			
Malirekus		0.013			0.027		
Optioservus					0.066	0.083	0.147
Paraleptophlebia		0.004		0.009	0.044		
Parapsyche	0.007						
Pedicia					0.023	0.229	0.147
Polycentropus	0.011	0.011	0.003	0.04	0.441		
Pteronarcys		0.009	0.013	0.036	0.12	0.046	
Pychnopsyche			0.007		0.014		
Rhyacophila		0.004		0.011	0.014		
Serratella	0.034	0.042	0.031	0.045	0.147	0.041	
Simuliidae	0.084	0.099	0.017	0.019	0.293	0.058	0.028
Stenonema		0.01		0.016	0.04	0.046	
Taenipteryx							
Tallaperla	0.007	0.009	0.021	0.048	0.134	0.2	0.308
Wormaldia							0.175
Yugus		0.02	0.014	0.047	0.129		

Appendix 4. List of taxa used in chi-squared analysis. Percent composition of each taxa at each site in the drift and in the benthos (in parentheses).

Taxa	Order	% UBC	% LBC	% CC
Oligochaetae		<0.01 (12.36)	<0.01 (11.15)	<0.01 (8.45)
Hydracarina	H	0.00 (6.29)	0.00 (7.27)	0.00 (7.50)
Ameletus	E	0.34 (0.05)	1.20 (0.01)	0.32 (0.08)
Baetis	E	22.93 (5.28)	35.64 (6.31)	41.98 (14.01)
Isonychia	E	2.00 (0.47)	3.69 (0.23)	0.74 (0.05)
Cinygmula	E	0.00 (0.10)	0.00 (0.71)	0.000 (1.03)
Epeorus	E	9.74 (5.10)	5.93 (4.44)	4.43 (3.18)
Stenonema	E	1.79 (1.33)	1.51 (1.17)	1.55 (1.98)
Dannella	E	0.00 (0.54)	0.00 (0.94)	0.00 (2.11)
Drunnella	E	0.34 (0.09)	1.65 (0.57)	2.27 (0.81)
Ephemerella	E	4.39 (1.00)	4.71 (0.48)	3.87 (0.67)
Serratella	E	2.71 (1.69)	2.36 (3.35)	3.12 (2.72)
Paraleptophlebia	E	0.40 (0.41)	0.74 (0.94)	0.59 (1.70)
Pteronarcys	P	0.23 (0.14)	0.92 (0.76)	1.39 (0.60)

Tallaperla	P	21.66 (4.52)	8.41 (1.71)	4.91 (0.81)
Taeniopteryx	P	0.06 (0.01)	0.23 (0.73)	0.22 (0.22)
Amphinemura	P	0.81 (0.75)	1.83 (0.98)	1.15 (0.40)
Leuctra	P	1.62 (5.94)	1.70 (4.31)	0.66 (2.46)
Allocapnia	P	5.10 (0.28)	8.39 (0.21)	2.48 (0.19)
Beloneuria	P	0.27 (0.01)	0.18 (0.00)	2.33 (0.00)
Malirekus	P	0.09 (0.10)	0.16 (0.24)	0.20 (0.26)
Isoperla	P	2.77 (1.92)	3.53 (2.02)	2.92 (2.01)
Alloperla	P	0.02 (0.10)	0.02 (1.18)	0.12 (0.10)
Dolophilodes	T	0.93 (0.40)	0.37 (1.27)	0.40 (0.27)
Wormaldia	T	0.41 (0.08)	0.30 (0.23)	0.75 (0.54)
Lype	T	0.16 (0.31)	0.29 (0.26)	0.15 (1.07)
Polycentropus	T	0.36 (1.24)	0.38 (1.02)	1.39 (0.50)
Parapsyche	T	0.90 (1.30)	0.46 (0.38)	0.20 (0.00)
Diplectrona	T	2.76 (2.12)	1.56 (3.34)	1.14 (0.58)
Rhyacophila	T	0.78 (1.33)	0.64 (1.08)	0.49 (0.75)

Brachycentrus	T	0.04 (0.00)	0.36 (0.29)	2.90 (0.22)
Lepidostoma	T	1.00 (0.00)	0.74 (0.01)	0.63 (0.14)
Pychnopsyche	T	0.57 (0.00)	0.90 (0.01)	0.37 (0.00)
Optioservus	C	0.72 (1.44)	0.02 (0.60)	0.04 (0.77)
Pedicia	D	0.07 (0.01)	0.62 (<0.01)	1.33 (<0.01)
Ceratopogonidae	D	0.11 (0.75)	0.04 (0.91)	0.01 (0.42)
Simuliidae	D	2.99 (2.25)	2.73 (5.21)	5.72 (4.11)
Chironomidae	D	1.00 (27.32)	1.63 (25.80)	2.54 (29.85)
Dixa	D	2.26 (0.18)	0.59 (0.00)	0.77 (0.01)

Vita

CURRICULUM VITAE
of
Patricia Anne Turner
August 12, 1994
Patricia A Turner

Address: Department of Biology
Virginia Polytechnic Institute & State
University
Blacksburg, VA 24061
(703) 231-8948

Personal Data: Date of Birth: 17 May 1969
Place of Birth: Louisville, KY

Education:

1987-1991 Wittenberg University, B.A. in Biology

1991-1994 Virginia Polytechnic Institute and State University, M.S. in Biology. Thesis title: Patterns of macroinvertebrate drift along an elevational and stream size gradient in a southern Appalachian stream. Major advisor: Dr. E.F. Benfield.

Professional Experience:

1991-1994 Graduate Teaching Assistant, General Biology Laboratory, Principles of Biology Laboratory Freshwater Ecology, Field & Lab Ecology, Department of Biology, VPI&SU

1992-1994 Graduate Research Assistant, Department of Biology, VPI&SU

Memberships in Professional Associations:

American Institute of Biological Sciences
Ecological Society of America
North American Benthological Society
Virginia Academy of Sciences

Abstracts and Presentations at Professional Meetings:

Turner, P.A. and K.L. Harpster. The effects of drying techniques in artificial leaf pack construction on leaf processing and macroinvertebrate colonization. Bulletin of the Ohio Academy of Sciences 91(2):72. Presented at the Centennial Annual Meeting of the Ohio Academy of Sciences. April 1991.

Webster, J.R., E.F. Benfield, T.P. Ehrman, J.J. Hutchens, J.L. Meyer, M.A. Schaeffer, J.L. Tank, P.A. Turner, and J.B. Wallace. Organic matter processing along a 1st- to 4th- order stream gradient in the southern Appalachian Mountains. Bulletin of the North American Benthological Society 10:106. Presented at the annual North American Benthological Society meeting, Calgary, Alberta, May 1993.

Turner, P.A., E.F. Benfield, and J.R. Webster. Patterns of macroinvertebrate drift along an elevational and stream size gradient in a southern Appalachian stream. Presented at the Long-Term Ecological Research All Scientists Meeting, Estes Park, Colorado, September 1993.

Turner, P.A., E.F. Benfield, and J.R. Webster. Patterns of macroinvertebrate drift along an elevational and stream size gradient in a southern Appalachian stream. Bulletin of the North American Benthological Society 11:158. Presented at the annual North American Benthological Society Meeting, Orlando Florida, May, 1994.

Professional Activites:

Biology Graduate Student Association (BGSA), member 1991-1994

Elected Graduate Student Assembly (GSA) Delegate, 1992-1994

Elected to Coordinating Council for Women's Concerns (CCWC), 1992-1994

Elected CCWC representative for the Organization of Women Faculty, 1993-1994

GSA Repersentative for the Faculty, Staff, and Graduate Student Women's Network, 1992-1994

Elected Information Officer for Women's Network, 1993-1994

Women's Week Planning Committee, 1994

Participated in Stream Organic Matter Budget Workshop at annual NABS meeting, May 1993, Calgary, Alberta.

BGSA Election Comittee, 1992

Graduate Student Committee Meeting Workshop, 1992

Graduate Advisory Committee, 1992-1994

Travel Fund Board Committee member, 1992

Elected Graduate Student Assembly and Student Government Association Liason, 1992

References:

Dr. E F Benfield, Department of Biology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061. (703) 231-5802.

Dr. J R Webster, Department of Biology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061. (703) 321- 8941.

Dr. J R Voshell, Department of Entomology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061. (703) 231-5707.