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A QUALITATIVE AND QUANTITATIVE METHODOLOGY IN INTERPRETING  
THE RESULTS OF FIELD TOXICITY SURVEY

A Dissertation Presented

by

MING-JUNG COLER

Submitted to the Graduate School of the  
University of Massachusetts Amherst in partial fulfillment  
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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Plant and Soil Sciences

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A QUALITATIVE AND QUANTITATIVE METHODOLOGY IN INTERPRETING  
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MING-JUNG COLER


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To my  
Husband  
Parents and Parents-in-law  
and Children

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## ABSTRACT

### A QUALITATIVE AND QUANTITATIVE METHODOLOGY IN INTERPRETING THE RESULTS OF FIELD TOXICITY SURVEY

FEBRUARY 1995

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Though ample evidence supports the detrimental effects of residual chlorine to many aquatic biota, the on-site response of macroinvertebrates has hitherto been little documented. Accordingly, year-long in-stream collections were undertaken to assess and characterize the response of the macroinvertebrate community inhabiting Lampson Brook, Belchertown, Massachusetts. Artificial substrates (limestone chips) were used in the data gathering and a new methodology, Wrona's, was applied to the data analysis. One control station and four downstream stations extending for 3000 meters along the stream were established. All the macroinvertebrates captured at these stations were counted and identified to their lowest taxonomic group.

These data were employed to evaluate several diversity indices as well as qualitative and quantitative community comparison indices. The implications of the respective mathematical formulae applied to biological collections were examined and revisions of certain of the formulae are proposed.



The combination of density estimates, species richness, EPT value (a value derived from total identified species of Ephemeroptera, Plecoptera and Tricoptera), and a number of selected indices was chosen to describe the impact of chlorinated/non-chlorinated sewage. A list of macroinvertebrate species has been designated as chlorine sensitive/tolerant with the respective total residual chlorine (TRC) concentration.

The results indicate that community comparison indices are more sensitive than diversity indices in measuring pollution effects. Community comparison indices, however, showed considerable variations in assessing the severity of the impact.

The macroinvertebrate community structures of all the downstream stations were altered due to changes in environmental conditions with regard to all aspects of community parameters.

The suspected causes of such disruption in aquatic macroinvertebrate community may be attributed to either the immediate impact of TRC in the water column at station 2 or the chronic effects of stable chlorinated by-products associated with the sediments at stations 3, 4, and 5.

The level of impact with regard to each station is a matter of subjective definition as to which are the most important parameters in describing community structure. Different aspects of change in relation to water quality need to be further tested before imposing any judgement on the extent of impact at each station.

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## CHAPTER I

### INTRODUCTION

#### A. Use of Artificial Substrates for Collection of Benthic Macroinvertebrates

In a previous study conducted from September 15 to October 30, 1987, limestone fragments were employed to collect biological samples to assess the impact of chlorinated secondary municipal effluent on benthic macroinvertebrates at Lampson Brook, Belchertown, Massachusetts (Coler, 1990). A total of five stations (one control station upstream and four treatment stations downstream from the sewage outfall) were selected. During the period in which the substrates were deployed, water samples were collected weekly at each station and the sewage outfall for analysis of the following chemical, physical, and biological parameters: chlorine (free and combined), temperature, pH, dissolved oxygen, biological oxygen demand, fecal coliforms, acidity, alkalinity, ammonia, nitrate, phosphorus, calcium, hardness, chloride, total solids, and suspended solids.

The level of impact on benthic macroinvertebrates was measured by the loss of sensitive species, dominance of tolerant species, reduction in diversity, and shifts in community structure. Toxicity was tentatively attributed to TRC (total residual chlorine) from the water column and cumulated TOX (total organic halides) from the sediment.

Stream-bed rocks were used to compare with, and standardize against, limestones as colonization substrates. The data showed that stream-bed rocks supported more organisms and greater diversity. Limestone, though more selective, allowed an accurate and rapid estimate of the surface area (Coler, et. al., 1989). Limestone-generated data also showed mitigation of chlorine toxicity. Both substrates produced basically the same trends regarding toxicity effects. To expedite experimental procedures, the limestone fragments were therefore chosen to implement an extensive, replicated year long study to more clearly define the impact of chlorinated domestic sewage on the aquatic biota.

The data generated from the deployment and retrieval of artificial substrates were supported by an extensive chemical database. Quality control and quality assurance (QC/QA) were incorporated into the study by having the biological identifications confirmed by an EPA/DEP (Environmental Protection Agency/Department of Environmental Protection) taxonomist. Chemical procedures were reviewed by an analyst of the Environmental Engineering Department, University of Massachusetts, Amherst. The stream was impacted by no other sources - point or diffuse.

### B. Use of Indices to Analyze Field Data

There are a number of approaches which are currently available to facilitate the analysis of multispecies toxicity field data:  $LC_{50}$ 's can be applied to assess the toxicity level, density for individual stones can be calculated to derive 95% confidence interval

(Wrona, et. al., 1986), diversity indices and community comparison indices can be employed to measure changes in community structure and composition (Pratt and Coler, 1976; Pratt, 1977; Godfrey, 1978; Pratt et al., 1981; Perkins, 1983; Pontash and Brusven, 1988; Pontasch et al., 1989). Further, biotic index and EPT (total species of Ephemeroptera, Plecoptera, and Trichoptera), based on the indicator organisms, may be applied to the data to measure the effects of the pollution (Chutter, 1972; Penrose and Overton, 1987). Multivariate techniques, such as factor analysis, cluster analysis or canonical discriminant analysis can be used to evaluate community level of impact (Cairns and Kaesler, 1969; Roback et al., 1969; Kaesler et al., 1971; Osborne and Davies, 1987; Pontasch et al., 1989).

Environmental variables can also be incorporated to predict community changes using stepwise regression analysis or multiple discriminant analysis (Green and Vascotto, 1978; Osborne and Davies, 1987; James and McCulloch, 1990). Ideally, mathematical models should be tested in a defined environment to determine their efficacy. In a field situation where the environmental (physical, chemical, and geological) variables are inherently different, the use of indices may indicate a difference between communities. The cause, however, is not unequivocally clear. Nevertheless, the diversity and community comparison indices have been widely used to assess the impact of pollution both in laboratory and field toxicity situations because they are useful in condensing large volumes of data generated during the study to a simpler number. For example, the diversity indices were used for the biological assessment of pollution by Wilhm (1967, 1970), Cairns et al. (1968), and Haedrich (1975). Community comparison indices were used to assess

macroinvertebrate response to pollutants by Pontasch and Brusven (1988) and Pontasch et al. (1989). As Pontasch et al. (1989) pointed out, no single index is equally effective or adequate in measuring all of the responses of aquatic communities to a particular environmental stress. Most of the indices were developed for the assessment of a particular pollutant family, such as the Trent biotic index and the Chandler biotic score in assessing the degree of organic pollution. Therefore the investigators must consider the limitations of the indices together with their ecological judgement to choose the appropriate indices to interpret their results.

Since communities rely increasingly on surface or aquifer supplies for water needs as well as recreational pursuits, and further, the WPCA 1972, MPRSA 1973, TSCA 1976, and FIFRA 1978 legislation all mandate the application of toxicity testing instead of chemical analyses to determine limits of effluent concentrations (Foster, 1984), it seems inevitable that we will have to, for the foreseeable future, continue to work with the biotic community as a measure of pollution. Unfortunately, most of our pollution control legislation is based on laboratory derived  $LC_{50}$  toxicity testing with little ecological significance. On the other hand, the implementation of field-measured toxicity testing is hindered by the inherent difficulty in establishing sufficient replicates and controls to support statistically significant data with quantitative ecological inferences. Additionally, the study of aquatic biota in relation to water quality often involves extensive and exhaustive investment of time and resources. These weaknesses, notwithstanding, we must evolve ecologically meaningful measures of stress for water pollution remains fundamentally an ecological problem.

### C. Objectives

In this light I propose using the data generated in the Lampson Brook survey to evolve a consistent quantitative biological measure of water quality. The data are not confounded by other sources of pollution and are supported by QC/QA over the entire year. Accordingly, it is my intent to:

1. Evaluate currently used indices for measuring community structure and community structure changes with field macroinvertebrate data generated at Lampson Brook.
2. Compare and evaluate the qualitative and quantitative methodology for assessment of field data.
3. Describe and interpret the impact of chlorinated sewage on benthic macroinvertebrate community inhabiting Lampson Brook.

## CHAPTER II

### LITERATURE REVIEW

#### A. Introduction

It is common in pollution studies to collect a certain group of organisms at polluted and non-polluted sites or in a time frame before and after the onset of pollution to identify their respective taxonomic composition, and to compare the corresponding changes in the assemblages of organisms in these collections. Such changes often result from environmental perturbation, either from a natural catastrophe or of anthropogenic origin. The collected samples are analyzed to measure the extent of the change, and subsequently used to compare or refer to the changes in communities. However, a "community" can be defined in many different contexts. For the purpose of my research, I chose Roughgarden and Diamond's (1986) definition of a community as "all the organisms in a prescribed area" to facilitate the comparisons. Accordingly, in order to describe the structure of the members in the community, representative samples must be drawn from the community by an appropriate sampling method.

Assuming that we have a representative sample obtained from a community and we want to know from the sample data, whether a pollutant is affecting the community, we can do this by making temporal or spatial comparisons - is the community at this site similar before and after pollutant exposure? or is the

community at the polluted site similar to a control site sheltered from pollution?

Obviously, to answer these questions, we need to quantify the scope of the temporal and spatial difference in community characteristics to achieve a meaningful interpretation of the data derived.

The ecological data acquired from such collections are often composed of a matrix of rows and columns representing the sampling unit (in this instance a limestone fragment of known area) and a list of species or vice versa (in this instance a limestone-filled basket). Each element of the matrix may be represented by individuals, density, or biomass, etc. The interpretation of these data is not without difficulty because of the large volumes of numbers generated during the collection process. Equally important, biologists must convey their findings to administrators and the public, who are not specifically trained to interpret complex sets of ecological data. Thus, a single number characterizing the biological impact of water quality is generally favored by water managers (Thomas, 1976). Ecologists as well as other biologists have long been searching for means to condense the data into a comprehensible number which measures community changes. To meet this need, three categories of indices have evolved - the biotic index, diversity index and community comparison index.

Whether the indices are used to characterize a community or to measure changes, we need to consider if the indices reflect the scope of temporal and spatial differences. If one has of a set of possible events or probabilities,  $p_1, p_2, p_3, \dots, p_n$ , the individuals in the community could be treated as messages on a piece of paper and a measure calculated as to how much choice was involved in the selection of the event

or how "uncertain one is of the outcome" (Shannon and Weaver, 1949); alternatively their relationship could be considered as the probability of interspecific encounters (Hurlbert, 1971); or as the distance value of a sample from an area of bare ground with no individuals (McIntosh, 1967). In the interest of measurement techniques, the comparisons may be made by arbitrary addition, multiplication, subtraction, or division. The appropriate choice becomes complicated since many of the theories on which indices have been postulated have not yet been tested in real field situations. Clearly, there can be no satisfactory index until we have a universal understanding of how we must characterize a community and measure the structure of its members. One is left to hope that models will emerge that will provide insights similar to the dose-response relationship used to measure the toxicity of a chemical and the Michaelis-Menten model which assesses enzyme kinetics, because we understand the behavior of a chemical or an enzyme in a defined system.

The following review examines the indices (biotic, diversity, and community comparison) that have been developed for both theoretical and practical applications in ecology.

### B. Biotic Indices

Biotic indices have been developed to measure the changes brought about by allochthonous input of organic matter in a flowing water system. They are based on the assumption that there are defined faunal communities in clean streams and rivers, that the change in community composition is predictable upon the addition of organic



matter, and that the biggest change occurs, accordingly, with the largest addition of organic matter (Chutter, 1972). The biotic index assigns a value to each organism or groups of organisms on the basis of its or their relative tolerance/sensitivity to low dissolved oxygen in running water (Sladeczek, 1973). The sum of these values provides an index to assess perturbation at particular sites. Either qualitative (presence-absence) or quantitative (abundance or density) measures may be used.

The first biotic index (Saprobien system) was devised primarily to classify rivers according to the presence or absence of indicator species of animals and plants in zones characterized by four different oxidation state of organic matter, from less to most oxidized - polysaprobic,  $\alpha$ -mesosaprobic,  $\beta$ -mesosaprobic and oligosaprobic respectively (Kolkwitz and Marsson, 1908, 1909; Kolkwitz, 1950). Each zone contained characteristic animal and plant species reflecting the grossly polluted environment, with little or no dissolved oxygen, to the recovery zone with normal oxygen content allowing complete mineralization. The Saprobien system was modified by Liebmann in 1951 by carefully selecting and describing indicator organisms, then later developed by Pantle and Buck (1955) to incorporate the relative abundance of organisms. In this country, a similar system was developed by Wilber (1969) who divided a stream receiving an organic pollutant into zones of degradation, active decomposition, recovery, and finally a clean stream which had been returned to its original unpolluted condition. Each zone had its characteristic organisms. The application of the Saprobien index is very common in Europe, but is less popular in Britain and North America because its usefulness is limited by its rigidity and the similar associations of organisms which appear both in severely polluted waters and

natural waters. Additionally, Hynes (1963) noted that the Saprobien system was "applicable only to the particular conditions produced by heavy sewage pollution in a slow and evenly flowing river". He viewed it as a "clumsy tool" due to its inflexibility in the assessment of water pollution. As he put it, "Nature is not as simple as this, and every example is different". Further, it is not likely that a given species would express equal sensitivity or tolerance against all environmental stressors. A given organism may be very sensitive to low dissolved oxygen but more tolerant to high metal concentrations. Moreover, most biological studies take place in assessing water quality in toxic, intermittent, or mild organic polluted conditions, where changes of chemical parameters are not readily detected by chemical analyses. Equally important, the Saprobic index becomes unsatisfactory because it results in findings which cannot be clearly stated in a comprehensible fashion. Hynes (1963) concluded that tables of comparative numerical data provided the most appropriate way of showing the biological response to pollution. Hawkes (1962), on the other hand, who argued the advantages of a biological index, advanced a line of reasoning which led to the development of a number of new biotic indices after 1962.

The two indices which are most widely used in Britain are the Trent biotic index (TBI) (Woodiwiss, 1964) and the Chandler biotic score (CBS) (Chandler, 1970). The Trent biotic index developed by Woodiwiss in 1964 requires only the presence or absence of species and species richness. TBI assigns a score according to the total number of groups present in given key organisms. TBI divides the total number of groups into five categories (0-1, 2-5, 6-10, 11-15, 16+) in six key organisms: Plecoptera, Ephemeroptera, Trichoptera, Gammarus, Asellus, and Tubificid worms

and/or Red Chironomids based on the order of the tendency to disappear as the degree of pollution increases. The score ranges from 0 to 10 indicating the grossly polluted waters where no macroinvertebrates are present to unpolluted water where the macroinvertebrates species are rich. The disadvantage of disregarding abundance data may have a disproportionate effect on the index if a species present is not resident at a given site but adrift from upstream. Also its applicability is greatly reduced in an area for which the system is not originally designed.

In 1970, Chandler produced an index (CBS) by taking into account the abundance and richness of each indicator species. The CBS index divides a sample into five abundance classes, present (1-2), few (3-10), common (11-50), abundant (51-100), and very abundant (100+) and 26 groupings (1 being the most sensitive to organic pollution, 25 the most tolerant, and 26 indicating no animal life). Each species is assigned a score according to its relative abundance. For example, if 100 organisms are found to belong to a species of group 1, a score of 100 is given, whereas if 100 organisms are found to belong to a *Nais sp.*, a score of 2 is specified. The minimum score is zero indicating no animal life is present, and there is no upper limit.

There are a number of drawbacks to using CBS in the monitoring of water quality: (1) the assignment of a value is based on individual judgement, subject to the investigator's opinion and experience; (2) the index requires counting as well as identification of individual taxa, therefore it is time consuming; (3) the score may vary depending on sampling strategy. Therefore, a number of modifications of CBS have been proposed for different purposes. The score can be transformed to give an

average ranges from 0 to 100 by dividing the total score by the number species (Cook, 1976). Bryce et al. (1978) reduced the number of abundance classes, reorganized taxonomic grouping and revised some of the scores. Hargreaves et al. (1979) also decreased the number of abundance classes and grouping to simplify the score for the use of field study. To minimize the effects of variations in sample size, percent composition was used instead of relative abundance.

The most recent biotic index derived empirically which represents a compromise between ecological validity and practical constraints was adopted by Britain as the BMWP score (Biological Monitoring Working Party) (National Water Council, 1981). The BMWP score combines a number of families of macroinvertebrates and assigns a score. A total of ten categories with a score of 1 to 10 are created. The specimen collected in a sample is identified to the family level and assigned a score according to the scheme. The sum of the individual scores of the specimens yields the BMWP score for that sample. The advantage of this system is its taxonomic simplicity and applicability to a wide range of waters and geographical areas. However it does not consider the abundance or the fact that a family may be represented by a number of different species.

Other biotic indices that have been used in temporal sequence as cited in Washington (1984) include: Wright and Tidd's "oligochaete indicator" (1933), Patrick's histograms (1950), Beck's index (1955), Beak et al.'s "lake" index (1959), Goodnight and Whitley's "oligochaetes" (1960), King and Balls' index (1964), Graham's index (1965), Beak's "river" index (1966), Brinkhurst's index (1966), Sander's Rarefaction method (1968), Palmer's index (1969), Chutter's index (1972),

Heister's modification to Beck's index (1972), The average Chandler biotic score (CBS) (Balloch, 1976), Hilsenhoff's index (1977), and Raffaelli and Mason's index (1981). Washington (1984) provides a detailed review regarding their advantages and disadvantage of their application.

In summation, it is clear that there are inherent limitations to this type of index: (1) Aquatic systems suffer not only organic pollution but also other forms of disturbances such as urban runoff, industrial discharge, and agricultural discharge; (2) Factors other than pollutants may contribute to stream community variation. The sampling method, the area sampled, the season the sample is taken and the taxonomic level of identification all affect community structure without the influence of pollution (Hughes, 1978); (3) Knowledge of the ecological characteristics and requirements of individual species and its identification is often the major obstacle when poor taxonomic tools and little information on life history are available.

### C. Diversity Indices

Biotic indices emphasizing principally the impact of organic pollution may not be suitable in assessing other types of pollution. Accordingly, another type of index, the diversity index, is considered to measure the stress in the environment. Diversity is a measurement of heterogeneity and is composed of two components - the number of species (species richness) and the distribution of individuals among those species (equitability). It is based on the concept that in a clean environment the stream is characterized by the presence of a large number of species, each well represented.

When an environment becomes polluted, the richness and abundance of the community is restricted to those forms capable of tolerating the changed conditions.

Whittaker (1965) classifies most diversity indices into two types: qualitative species diversity indices, or quantitative dominance diversity indices. Species diversity indices emphasize only the number of taxa present in the environment. Dominance diversity indices consider both the number of the taxa and the numbers or biomass distributed among them.

Washington (1984) divides 18 diversity indices into 8 categories according to the approaches that are used to formulate the respective diversity index (Table 2.1). He suggests that among all the diversity indices, only Simpson's *D*, Hurlbert's *PIE*, Cairns *SCI*, Keefe's *TU* and possibly McIntosh's *M* are found to be applicable to biological system. Shannon and Brillouin diversity, based on information theory, are unsatisfactory due to the lack of exploration of their biological relevance.

The simplest method for the estimation of biological diversity is the Sequential comparison index (*SCI*) of Cairns (Cairns et al., 1968; Cairns and Dickson, 1971):

$$SCI = \overline{DI}_1 \times no. taxa; \overline{DI}_1 = \frac{\sum \frac{no. run}{no. specimens}}{N_{SCI}};$$

$$r_n = \sum \frac{no. run}{no. specimens}$$

It does not require taxonomic expertise. The only requirement is the capability of the investigator to distinguish differences between consecutive individuals in the sample based on the shape, color, and size. The concept is based on the "sign test" and the "theory of runs". Only two symbols are necessary in a worksheet to represent a change of a current organism analyzed in relation to the previous one. If it is the

same, it forms part of the same run and the symbol does not change. If different, the current organism forms the beginning of a new run and the symbol of the other is utilized. The *SCI* is equal to the number of runs divided by the number of individuals, times the number of taxa.

The number of taxa is determined after establishing the number of runs. The greater the number of runs per number of individuals being examined, the greater the biological diversity, and so presumably the healthier the environment. Cairns suggests that approximately 250 individuals are necessary to estimate a reliable index for a healthy stations. The resulting *SCI* value in determining the number of taxa is influenced by the investigator's taxonomic training. Additionally, closely related species with different sensitivity to a given pollutant will not be detected.

Simpson's *D* and Hurlbert's *PIE*, though they were grouped into different categories by Washington (1984), are in fact based on the same principle (the probability of choosing two individuals at random and independently from the population whether or not they belong to the same group):

$$\text{Simpson's } D = \sum_{i=1}^s \frac{n_i (n_i - 1)}{N (N - 1)}$$

$$\text{Hurlbert's } PIE = \left( \frac{N}{N-1} \right) \left( 1 - \sum_{i=1}^s p_i^2 \right)$$

Keefe's *TU* though based on "theory of runs", resembles Simpson's *D* and Hurlbert's *PIE* because the formation of a run is related to the probability of picking pairs of individuals from a population which do or do not find themselves in the same group:

$$\text{Keefe's } TU = 1 - \left( \frac{n}{n-1} \right) \left( \sum_{i=1}^k p_i^2 - \frac{1}{n} \right)$$

As a result, Simpson's  $D$  is equal to 1 minus  $PIE$  and  $PIE$  is equal to  $TU$  (APPENDIX B). If we recall the index proposed by Cairns et al. (1968),  $r_n$  is designated as the number of observed runs among  $n$  organisms. If the population mean number of runs per specimen is denoted by  $\mu_r$ , then  $r_n/n$  can be considered an estimate of  $\mu_r$ . Keefe and Bergersen (1977) use the formula proposed by Mood (1940) based on theory of runs and show that, approximately

$$\mu_r = 1 - \sum_{i=1}^k \pi_i^2$$

Keefe and Bergersen (1977) state that clearly an estimate of  $\mu_r$ , say  $T$ , can be obtained by simply using the *sample* taxa proportions in the above formula:

$$T = 1 - \sum_{i=1}^k p_i^2$$

where  $p_i = n_i/n$ ,  $i = 1, 2, \dots, k$ , and  $T$  is erroneously claimed as the maximum likelihood estimate of  $\mu_r$  ( $T$  is actually the minimum estimate of  $\mu_r$ ).

If the runs are calculated as described by Cairns et al. (1968), neither Keefe's  $T$  or  $TU$  is a correct or an unbiased estimator of  $\mu_r$ . Mood's formula serves in fact to calculate the probability of summing all the distinct neighbors over all possible permutations. If we designate the sum of all the distinct neighbors of all possible permutations as  $D_d$ , then an unbiased estimate of the population mean number of runs per specimen, denoted by  $\mu_r$ , can be obtained by the following formula:



$$\mu_r = \frac{D_d + \text{permutations of } N}{\text{permutations of } N \times N}$$

where  $N = \sum n_i$ , and  $i = 1, 2, 3, \dots, s$ .

It is unfortunate that neither Simpson's  $D$  nor Hurlbert's  $PIE$  nor Keefe's  $TU$  has been extensively used by aquatic ecologists, because they are built based on a solid biological foundation.

McIntosh's  $M$  (1967) treats a community as a point in space and the point is calculated by measuring the distance from the origin of a system with as many axes as there are species. This point is equal to:

$$\sqrt{\sum_{i=1}^s n_i^2}$$

McIntosh claims that the above index is dependent upon the number of individuals in the sample and their distribution among the species. Therefore it is a measure of diversity. However, for any number of species in a given total number of individuals, this index gives a theoretical maximum when one species having the most individuals and the rest having a minimum of one individual each and a theoretical minimum when there are as many species as the number of individuals. Thus, McIntosh claims that the above index is actually the complement of diversity and an index directly related to diversity is obtained by subtracting the index from 1:

$$1 - \sqrt{\sum_{i=1}^s n_i^2}$$

He tabulates the maximum and minimum diversity values for a sample of 100 individuals with a given number of species according to the above formula. If one would calculate the values from the index for the above example and obtain that complement by subtracting the values from 1, one would realize that the values listed in McIntosh's table (Table 3) are incorrect. In fact the values are obtained by subtracting the index from  $N$ . It implies that the "universe" for his system is  $N$ , though McIntosh never defines it, and the "complement" of his index is:

$$N - \sqrt{\sum_{i=1}^s n_i^2}$$

To overcome the deficiency of comparing samples of different size, he gives the following formula:

$$M = \frac{N - \sqrt{\sum_{i=1}^s n_i^2}}{N - \sqrt{N}}$$

McIntosh claims that this index has the advantage of expressing the observed diversity as a proportion of the absolute maximum diversity at a given  $N$  and ranges from 0 if there is only one species to 1 if diversity is maximum. This treatment is similar to the index proposed by Pielou (1966b) and Macarthur (1966) which represents a measure of evenness.

McIntosh's formula can also be expressed as the ratio of observed diversity to maximum possible diversity of a given  $N$  and  $s$ :

$$\frac{N - \sqrt{\sum_{i=1}^s n_i}}{N - \frac{N}{\sqrt{s}}}$$

or the ratio of observed diversity to minimum possible diversity at any  $N$  and  $s$ :

$$\frac{N - \sqrt{\sum_{i=1}^s n_i}}{N - \sqrt{N - (s-1)^2 + (s-1)}}$$

where, at any given  $s$  and  $N$ , the maximum diversity is given by:

$$N - \frac{N}{\sqrt{s}}$$

and the minimum diversity is given by:

$$N - \sqrt{N - (s-1)^2 + (s-1)}$$

McIntosh states that the above three indices served as base points for comparison distributions of individuals among species, and may not be found in most natural communities.

Washington (1984) notes "with pity" that McIntosh's index has not received enough attention in the field of ecology. He states that Hurlbert (1971) does not discuss this index and Liljelund (1977) merely notes the existence of McIntosh's  $M$ .

The quantitative indices evolved by Shannon (1948) and Brillouin (1956), based on information theory, are preferentially used by stream biologists over the qualitative TBI and semi-quantitative CBS. The Shannon index ( $H'$ ) is calculated as: and the Brillouin index ( $H$ ) as:

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

$$H = \ln \frac{N!}{N_1! N_2! N_3! \dots N_s!}$$

In a biological collection, the diversity is associated with the degree of uncertainty that exists regarding the specific individual species selected at random from a population.

The greater the number of species, the more evenly they are distributed, the greater the uncertainty and hence according to Pielou (1966c) the greater the diversity .

Pielou (1966a, 1967) suggests that the Brillouin index should be applied to situations where the entire community can be identified and counted, and the Shannon index should be used when the diversity is to be estimated from a community where the true population is too large to be counted. Pielou (1966b, 1967) also modifies Shannon's formula to derive her evenness index:

$$E' = \frac{H'}{H'_{\max}}$$

and Brillouin's formula to consider the diversity per individual for samples of different size:

$$H = \frac{1}{N} \ln \frac{N!}{N_1! N_2! N_3! \dots N_s!}$$

Accordingly, Brillouin's evenness can be expressed as:

$$E = \frac{H}{H_{\max}}$$

Pielou (1967, 1975) further shows that diversity indices can be partitioned to consider hierarchical nature of biological classification so that they reflect the contribution made by different taxonomic levels of that sample. She (1975) suggests that a sample is more diverse if the species are distributed among several genera as opposed to are congeneric and more diverse still if the genera belong to several families rather than are confamilial.

Hamilton (1975) notes that usually ecologists calculate redundancy as well as diversity. Redundancy associated with Shannon index is given by Hamilton as:

$$R = \frac{(D_{\max} - D)}{(D_{\max} - D_{\min})}$$

$$D_{\min} = - \left( \frac{t - 1}{N} \right) \log_2 \frac{1}{N} - \left( \frac{N - t + 1}{N} \right) \log_2 \left( \frac{N - t + 1}{N} \right)$$

$$D_{\max} = - (t - r) \left( \frac{k}{N} \right) \log_2 \frac{k}{N} - r \left( \frac{k + 1}{N} \right) \log_2 \left( \frac{k + 1}{N} \right)$$

where  $k$  is the greatest integer less than  $N/t$ , and  $r = N - kt$ . Redundancy associated with Brillouin index can be expressed as:

$$R^* = \frac{(D_{\max}^* - D^*)}{(D_{\max}^* - D_{\min}^*)}$$

$$D_{\min}^* = \frac{1}{N} (\log_2 N! - \log_2 (N - t + 1)!) )$$

$$D_{\max}^* = \frac{1}{N} (\log_2 N! - t \log_2 k! - r \log_2 (k + 1)) )$$

Redundancy measures the evenness of the distribution of individuals among the taxa and the values fall between 0 (maximum observed diversity) and 1 (minimum observed diversity). Redundancy and evenness were employed as measurement of relative diversity by many researchers (Wilhm and Dorris, 1966; Barrett, 1968; Peet, 1974). However, Hamilton (1975) feels that neither  $D$  and  $R$  nor  $D^*$  and  $R^*$  adequately conveys whatever ecologists meant by the concept of diversity. But he states that most ecologists, whom he has worked with, seem satisfied with using four summarized statistics -diversity, redundancy, number of taxa, and total number of individuals.

Shannon's formula has become increasingly popular so that many researchers (Wilhm, 1967, 1968, 1969, 1970, 1972; Wilhm and Dorris, 1966, 1968; Mathis and Dorris, 1968; Dambach and Olive, 1969; Benson-Evans et al., 1975; Devaux, 1975) have incorporated the Shannon index into their water quality studies. Wilhm and Dorris (1968) calculated diversity for biological communities using Shannon's formula to assess water quality in a range of polluted and unpolluted streams, and suggested that "pollution results in depression in diversity in the biotic community". He concluded that values of more than 3 were for clean water, values between 1 and 3

were zones of moderately pollution, and values less than 1 were characteristic of heavily polluted conditions.

A summary of the main properties of several diversity indices is shown in Table 2.2. Most of the diversity values fall between the minimum and maximum of 0 and 1 except for Shannon and Brillouin diversities where the maxima approach infinity.

Other indices based on approaches with little biological relevance are relatives of species number, guesses by data fitting and curve fitting approach (See Table 2.1). These indices were reviewed extensively by Washington (1984) but will not be used here for the data analysis.

The abundance and the kinds of organisms are obviously important in assessing the impact of the pollution, but they can also result in the misinterpretation of water quality conditions. Mason (1977) studied macroinvertebrates collected from hypereutrophic and eutrophic lakes. He showed that while in most instances the diversity was lower at the hypereutrophic lake, it was lower at the eutrophic lake in the month of June of both years, due to the rapidly developed population of chironomid larvae *Tanytarsus holochlorus*. In this situation, Mason concluded that the number of species alone rather than its respective abundance gave a more consistent indication of the eutrophic status of the two lakes. Similar conclusions were arrived at by Winner et al. (1975) in a study of the macroinvertebrate response to a stream polluted with copper. Murphy (1978) demonstrated that the seasonal variations in some of the diversity indices at a given site were greater than the differences between sites along a river. Murphy (1978), therefore, questioned the difficulty of these

indices in differentiating temporal variability from consistent spatial discrimination between sites, subsequently, the usefulness of these indices in reflecting changes in water quality.

Obviously, the diversity index may give misleading results if samples are taken in different seasons. Moreover, the diversity index does not designate the sensitivity or tolerance of each species to a given pollutant. Therefore, a stressed environment consisting of many tolerant species with an ample number of animals may generate an identical diversity value as a clean environment consisting of many sensitive individuals. It is highly undesirable in a pollution survey to derive the same value when two sites share absolutely no common species.

#### D. Community Comparison Indices

Another type of index, the community comparison index (Table 2.3), which allows the simultaneous comparison of impacted and nonimpacted sites has recently become popular in assessing the impact of pollution. Some community comparison indices utilize only presence-absence data for qualitative studies to assess the differences between communities. These indices include Jaccard's coefficient of community (Jaccard, 1902, 1908, 1912), coefficient of similarity (Kulczynski, 1927), quotient of similarity (Sørensen, 1948), Ochiai's index (1957), Sokal and Michener's simple matching coefficient (Sokal and Michener, 1958), index of similarity (Mountford, 1962), and Fager and McGowan index (1963). In the above coefficients,



low similarities may be negative or zero, while high similarities assume values from near to unity to infinity.

Others incorporate abundance or biomass into the formula for quantitative investigation. The quantitative measures can be grouped into two categories: similarity and dissimilarity measures. Similarity indices include percent similarity (Renkonen, 1938), percentage similarity (Whittaker, 1952), Morisita similarity index (Morisita, 1959), simplified Morisita index (Horn, 1966), cosine or SIMI index (Stander, 1970), and Pinkham-Pearson index  $B$  and  $B_2$  (Pinkham and Pearson, 1976). Dissimilarity indices include Bray-Curtis index (Bray and Curtis, 1957), squared Euclidean distance (Sokal, 1961), Canberra metric (Lance and Williams, 1967), distance measure (Clifford and Stephenson, 1975), collection and percent dissimilarity (Pratt et al., 1981), and the average chi-square (Parrish and Wagner, 1983).

The simplest and oldest similarity index is that of Jaccard's (Jaccard1, 1902 and 1912; Jaccard2, 1908):

$$JCC1 = \frac{c}{a + b - c}$$

$$JCC2 = \frac{c}{a + b}$$

Similarity indices with different comparison schemes were proposed by Sørensen (1948) and Sokal and Michener (1958). Sørensen's quotient of similarity is defined as:

$$I = \frac{2c}{(a + b)}$$

Sokal and Michener's simple matching coefficient is defined as:

$$SMC = \frac{c + d}{d + a + b}$$

The index proposed by Sørensen in 1948 builds upon the same approach as the index proposed by Jaccard in 1908 (Jaccard2). Values obtained by Sørensen's quotient of similarity are always two times higher than the Jaccard2 index. Similarly, Sokal and Michener's simple matching coefficient (1958) obtain values that are identical to the index proposed by Jaccard in 1902 and 1912 (Jaccard1) if the number of mismatches (the absence of species at both sites) is not included. Jaccard's coefficient of community and Sokal and Michener's simple matching coefficient have been applied extensively to the surveys of protozoa, insects, non-insect macroinvertebrates, fish, and limnological data by many researchers (Cairns and Kaesler, 1969; Roback, et al., 1969; Kaesler, et al., 1971; Cairns and Kaesler, 1971; Kaesler and Cairns, 1972). More recently according to Washington (1984), Jaccard's index is still in use for terrestrial systems by plant ecologists but is seldom used in freshwater, pollution related work.

Indices proposed by Kulczynski (1927), Ochiai (1957), Mountford (1962) and Fager and McGowan (1963) take on a different approach. Kulczynski's index (1927) utilizes a multiplicative rather than an additive (Jaccard's index, Sørensen's index) way of averaging:

$$I = \frac{c}{2} \left( \frac{1}{a} + \frac{1}{b} \right)$$

It is clear that the additive calculation behave nicely when the denominators are very small, while the multiplicative one behaves well for large denominators. However, the relation between additive or multiplicative averaging is not always monotone increasing.

Mountford (1962) feels that any similarity index should possess two basic properties: it should be independent of sample size; it should increase with increasing common species and decrease with increasing species at both sites. He states that the underlying theoretical distribution of the species frequencies is necessary to derive an index that possesses these two properties. According to Fisher, Corbet and Williams (1943) the species frequency distribution in a random sample of an animal population follows a logarithmic-series distribution:

$$\alpha x, \frac{\alpha x^2}{2}, \frac{\alpha x^3}{3}, \dots$$

where  $\alpha x^2/n$  is the number of species with  $n$  individuals.  $\alpha$  is a constant for all samples of whatever size from the same population. With the assumption of above species frequency distribution Mountford (1962) derives a similarity index which he claims is less dependent on sample size:

$$I = \frac{2c}{2ab - (a + b) c}$$

Clifford and Stephenson (1975) explain that the denominator of Ochiai's index:

$$I = \frac{c}{\sqrt{(c+b)(c+a)}}$$

involves a geometric mean which in some circumstances is likely to be a more effective "standardization" than a sum. Furthermore, an index derived from it, the Fager and McGowan index (1963):

$$I = \frac{c}{\sqrt{(c+b)(c+a)}} - \frac{1}{2\sqrt{c+b}}$$

has been associated with a particular form of non-hierarchical inverse "clumping". The association of Fager and McGowan index with the recognition of "recurrent species groups" has been widely used in marine ecology (Fager and McGowan, 1963; Sheard, 1965; Fager and Longhurst, 1968; Fager, 1968; Jones, 1969; Longhurst, 1969; Lie and Kelley, 1970; Bayer et al., 1970; Martin et al., 1970; Boesch, 1971; and Bowman, 1971).

Pinkham and Pearson (1976) comment that the above indices calculate only species numbers not the abundances, therefore, they may not detect changes related to the relative abundances in the communities.

Percent similarity proposed by Renkonen (1938) is the first index to include species occurrences and relative abundances simultaneously in the formula. This index measures the differences by summing up the minimum of relative abundances of each species of the compared pairs and can be expressed as:

$$PS_C = \sum_{I=1}^k \min(r_{ia}, r_{ib})$$

where  $k$  is the number of different taxa at stations  $a$  and  $b$ , and  $r_{ia}$  and  $r_{ib}$  are the relative abundances of the  $i^{\text{th}}$  taxa in stations  $a$  and  $b$ , respectively.

Pinkham and Pearson (1976) criticize the failure of this index in detecting the differences in absolute abundances. In order to overcome such shortcoming Pinkham and Pearson (1976) continue with the above theoretical approach by comparing the species compositions with the average  $X_{ia} \cap X_{ib}$  as opposed to the minimum  $X_{ia} \cap X_{ib}$ , where  $X_{ia}$  and  $X_{ib}$  are the numbers of individuals in the  $i^{\text{th}}$  taxon for station  $a$  and  $b$ , respectively. The comparison of two stations is made by dividing the smaller of  $X_{ia}$ ,  $X_{ib}$  by the larger  $X_{ia}$ ,  $X_{ib}$ ; summing over  $k$  (the number of comparisons or different taxa in the two stations) and averaging by  $k$ . Expressing the above conditions in a formula Pinkham and Pearson gives:

$$B = \frac{1}{k} \sum_{I=1}^k \frac{\min(X_{ia}, X_{ib})}{\max(X_{ia}, X_{ib})}$$

Pinkham and Pearson note that this index can be employed with other indicators of "importance" in pollution surveys such as biomass or relative abundance and is not limited to the number of individuals. However, they feel that when the sample consists of organisms from the same trophic level, the desirability of assigning the same weight to each taxon may be lessened and the dominant taxa may be considered to play a more significant role in that trophic level. They conclude that the relative abundance of each taxon is a good weighing factor that reflects this

dominance and is intuitively the most acceptable. The formula proposed to include the weighing factor is given as:

$$B_2 = \frac{1}{k} \sum_{i=1}^k \frac{\min(X_{ia}, X_{ib})}{\max(X_{ia}, X_{ib})} \left( \frac{\frac{X_{ia}}{N_a} \frac{X_{ib}}{N_b}}{2} \right)$$

in which  $N_a$  and  $N_b$  are the total numbers of individuals at stations  $a$  and  $b$ , respectively.

Bray-Curtis index (1957) has been quoted in a number of different contexts. Clifford and Stephenson (1975), Weinstein (1976) and Clifford and Williams (1976) quote Bray-Curtis dissimilarity as:

$$D = \frac{\sum_{j=1}^s |x_{1j} - x_{2j}|}{\sum_{j=1}^s (x_{1j} + x_{2j})}$$

where  $x_{1j}$  = numbers in species  $j$  in quadrant 1 and  $x_{2j}$  = numbers in species  $j$  in quadrant 2. Clifford and Stephenson (1975) note that the above index is sensitive to occasional large numbers because the denominator of this coefficient involves the sum of all individuals of all species at the two sites. If one of the species is exceedingly abundant at one site and not the other, Bray-Curtis index is primarily dominated by that particular species. For example, if site A consists of five species with abundance status of 5, 3, 1, 0, and 2000 and site B with abundance status of 0, 3, 5, 1, 1 for species 1, 2, 3, 4, and 5, respectively, Bray-Curtis index in this case gives a value of 0.99. The influence of a species with 2000 individuals at site A, but not at site B, is

obvious with the above example. Bray-Curtis index has been applied to a number of marine studies (Field, 1969, 1971; Stephenson and Williams, 1971).

Poole (1974) quotes Bray-Curtis dissimilarity as:

$$D_{1j} = \frac{1}{2} \sum_{j=1}^s |p_{1j} - p_{2j}|$$

This formula was later cited by Dyer (1978), and is actually the "complement" of percentage similarity index discussed by Whittaker in 1952 and used by Whittaker and Fairbanks (1958) to compare copepod communities of small lakes and ponds.

Whittaker's percentage similarity index can be rewritten as percent similarity proposed by Renkonen (1938):

$$\begin{aligned} PS_{1k} &= 1 - \frac{1}{2} \sum_{j=1}^s |p_{1j} - p_{kj}| \\ &= \sum_{j=1}^s \min(p_{1j}, p_{kj}) \end{aligned}$$

Bray-Curtis dissimilarity assumes the maximum and minimum values of 1 (when two communities share no common species) and 0 (when two communities share all common species). Both the Bray-Curtis dissimilarity index and its complement have been used to analyze species dissimilarity (Dyer, 1978) and to measure niche overlap (Hurlbert, 1978; Hanski, 1978).

Canberra metric (Lance and Williams, 1967),  $CM$ , can be expressed as:

$$CM = \frac{1}{k} \sum_{i=1}^s \frac{|n_{1i} - n_{2i}|}{(n_{1i} + n_{2i})}$$

where  $k$  is the number of comparisons or different taxa in the two sampling units.

This coefficient assumes the maximum value of 1. It implies that the "universe" of both Bray-Curtis index and Canberra metric is equal to 1. Therefore, their complements can be expressed as  $1-D$  and  $1-CM$ , respectively. Clifford and Stephenson (1975) note that Canberra metric differs from the Bray-Curtis index in that it is not influenced by outstanding abundant species or an outstanding difference because the coefficient involves the sum of a series of fractions. However, the term:

$$\frac{|n_{1i} - n_{2i}|}{(n_{1i} + n_{2i})}$$

becomes unity when one element of any comparison is zero. Thus, it is suggested that one of the compared elements is replaced by an arbitrary small positive number (Clifford and Stephenson, 1975). When both elements of any comparison are zero, the resulting value is decreased by the divisor ( $k$ ), particularly when two compared stations share very few species in common. In this instance, the divisor  $k$  can be substituted by  $k-r$ , where  $r$  is the number of comparisons involving double zero comparisons (Clifford and Stephenson, 1975).

Morisita (1959) proposes a similarity measure to overcome the influence of sample size that many indices experience:



$$C_\lambda = \frac{2n_{1i}n_{2i}}{(\lambda_1 + \lambda_2)N_1N_2}; \lambda_1 = \frac{n_{1i}(n_{1i} - 1)}{N_1(N_1 - 1)}; \lambda_2 = \frac{n_{2i}(n_{2i} - 1)}{N_2(N_2 - 1)}$$

He feels that a difference between two samples may be nothing but a reflection of the difference between densities, not of the true relation if a index is sample size sensitive. He states that this index is almost uninfluenced by the size of  $N_1$  and  $N_2$  unless either or both of  $N_1$  and  $N_2$  are small. He also notes that the minimum values of  $C_\lambda$  is 0 when two communities share no common species, and the maximum, 1, when these two communities share all common species.

Horn's simplified Morisita index (Horn, 1966) is a simplified form of Morisita similarity index by using an estimate of  $\lambda$  appropriate for a model of sampling with replacement and can be expressed as:

$$C_\lambda = \frac{2 \sum n_{1i}n_{2i}}{(\lambda_1 + \lambda_2) N_1N_2}; \lambda_j = \frac{\sum n_{ji}^2}{N_j^2}$$

It is suggested that this index be used as an empirical measure as opposed to an estimate of statistical parameter of the population from which the sample is drawn, or as "test" for heterogeneity (Horn, 1966). The minimum and maximum of Horn's simplified Morisita index are also between 0 (share no common species between two communities) and 1 (share all the common species).

Horn (1966) notes that Morisita similarity index, based on Simpson's diversity index, is a measure of the availability of items within certain categories and successive choices are combined multiplicatively. His index, derived from Shannon

index, is designed as a measure of the choices which can be made among items in certain categories and successive choices are combined additively.

Stander (1970) states that comparative studies of ecological systems require an objective measure of the similarity between different populations. Similarity is given in his study by the *SI* and *SIMI* measures given below.  $SI_{12}$  represents the similarity between collections 1 and 2. It is given by:

$$SI_{12} = \sum_{i=1}^s p_{1i} p_{2i}$$

where  $p_{1i}$  = proportion of  $i^{th}$  species in first collection,  $p_{2i}$  = proportion of  $i^{th}$  species in second collection, and  $s$  = number of species over both collections.

*SIMI* also represents similarity, but it is scaled by the factor  $(Sd_1) (Sd_2)$  so that the value of *SIMI* ranges from 0 to 1 with maximum similarity occurring at  $SIMI = 1$ , and minimum similarity at  $SIMI = 0$ . The formula is defined by Stander (1970) as:

$$SIMI_{12} = \frac{SI_{12}}{(Sd_1) (Sd_2)} ,$$

where the  $Sd$  values are the square root of the  $Sd^2$  values and  $Sd^2$  is defined as:

$$Sd^2 = \sum_{i=1}^s P_i^2$$

*SIMI* values represent the probability that two individuals drawn randomly from each population will belong to the same species, relative to the square root of the probability of randomly drawing them from each population alone.

The concept of Squared Euclidean distance ( $D^2$ ) derives from representations of taxonomic relationships (Sokal, 1961). The equation can be expressed as follow:

$$\delta_{i,2}^2 = \sum_{i=1}^n (X_{i1} - X_{i2})^2$$

where  $X_{i1}$  is the state code of species  $i$  for character  $i$ . In comparing biological collections,  $X_{i1}$  can be treated as the number of individuals or the proportion of species  $i$  in a sample in collection 1. Alternatively, Euclidean distance can be obtained by taking the square root of Squared Euclidean distance and be expressed as:

$$\delta_{i,2} = \left[ \sum_{i=1}^n (X_{i1} - X_{i2})^2 \right]^{\frac{1}{2}}$$

Sokal (1961) feels that among various types of coefficients in numerical taxonomy, the coefficient of distance is more appealing to taxonomists and somewhat simpler to visualize. Clifford and Stephenson (1975) state that the Euclidean distance between entities may vary from zero (completely similarity) to an indefinitely large value depending on the number and magnitudes of the differences involved. The larger the distance the smaller the degree of similarity between taxa, therefore, Euclidean distance is often used as a dissimilarity measure. Also because the maximum can approach infinity there is no direct similarity counterpart to this measure (Clifford and Stephenson 1975). The complement of Squared Euclidean distance and Euclidean distance have been used in computer simulation to test a number of community parameters associated with species richness and equitability (Wolda, 1981; Boyle et al., 1990). The employment of the complement of Squared Euclidean distance ( $1-D_{1,2}^2$ ) by Wolda is dubious because the "universe" of Squared Euclidean distance approaches infinity.

Pratt et al. (1981) propose a new measure (collection dissimilarity) in their study to assess the effects of urban stormwater runoff on benthic macroinvertebrates. They suggest that the most common species occurring in appropriately matched collections be added to the list until approximately 60% of each collection is accounted for. They feel that a species that does not make the list is relatively uncommon and more prone to sampling error, and as such would have little effect on the overall characterization of either collection. They first adjust the actual abundances for the species from the urban collections ( $N_{ui}$ ) when their sum ( $\sum N_{ui}$ ) is not equal to the sum of the reference species ( $\sum N_{ri}$ ). The adjusted abundances ( $N'_{ui}$ ) are obtained by multiplying each  $N_{ui}$  by  $\sum N_{ri}/\sum N_{ui}$ . They explain that in order to take into account whether a particular species is in both collections or only in one, as well as the magnitudes of  $N_{ri}$  and  $N'_{ui}$  relative to each other and to  $\sum N_{ri}$ , the absolute differences between  $N_{ri}$  and  $N'_{ui}$  are adjusted. Their collection dissimilarity ( $CD$ ) in short can be expressed as:

$$CD = \frac{1}{S} \sum_{i=1}^S \left[ \frac{|N_{ri} - N'_{ui}|}{(N_{ri} + N'_{ui})} + \frac{|N_{ri} - N'_{ui}|}{\sum_{i=1}^S N_{ri}} \right], \quad N'_{ui} = N_{ui} \times \frac{\sum_{i=1}^S N_{ri}}{\sum_{i=1}^S N_{ui}}$$

where  $N_{ri}$  = the observed reference abundance of the  $i^{th}$  species,  $N'_{ui}$  = the adjusted urban abundance of the  $i^{th}$  species.  $CD$  value ranges from zero (indicating the two collections had the same species predominating in equivalent relative amounts) to maximum of  $1+(2/s)$  (indicating the failure of two collections to shared any of their most common species). Pratt et al. (1981) state that collection dissimilarity can be expressed as a percentage of the maximum dissimilarity:

$$PD = \frac{CD}{1 + (2/s)}$$

Dividing  $CD$  by  $1 + (2/s)$  yields the dissimilarity value that ranges from zero to maximum of 1 as opposed to  $1+(2/s)$ . This implies that the "universe" of  $PD$  is 1, therefore, it's possible to find the similarity counterpart ( $1-PD$ ).

The average chi-square (Parrish and Wagner, 1983) is the most recent dissimilarity index claimed to be sensitive to water pollution. The average chi-square is determined according to the following formula:

$$\bar{\chi}^2 = \frac{2}{N} \sum_{i=1}^n \frac{(O_i - E_i)^2}{E_i}$$

where  $E_i$  is the mean of the individuals in a taxon in the two communities being compared,  $O_i$  is the number of individuals in one community, and  $N$  is the total number of individuals in both communities. Parrish and Wagner (1983) explain that their method differs from others in that the expected ( $E$ ) is the mean of the total number of individuals in a taxon in both samples - the assumptions being that both communities are unstressed and identical, with the individuals equally distributed between the samples and frequency differences due to sampling. The resulting values range from 0 (identical samples) to 1 (totally different samples). They claim that the coefficient results in a dimensionless "distance" that is linear and independent of sample size.

A summary of the qualitative and quantitative similarity or dissimilarity indices with their respective formulae is listed in Table 2.3. An attempt is made to unify the notations to avoid confusion. The main properties of these qualitative and quantitative

community comparison indices are shown in Tables 2.4 and 2.5. Most indices have the minimum and maximum values of 0 and 1. The maximum values of Mountford's index of similarity, Morisita similarity index, and Squared Euclidean distance approach infinity. Jaccard's coefficient of community (1908), Ochiai's index and Pinkham-Pearson index  $B_2$  have maximum similarity values of 0.5.

Similarity indices are more widely employed by terrestrial ecologists, and relatively few have been used by aquatic biologists. The mathematical manipulation of estimating the differences and adding the differences over the two communities being compared often results in discrepancies among the various index values. Most community comparison indices have inherited some kind of bias. Some indices are sensitive for or against rare taxa. Some are biased for dominant species. The results of all possible comparisons yield a matrix that can be shaded differentially according to a different level of similarity. Such pattern can be visually inspected in some cases. When large numbers of comparison are made, multivariate technique such as cluster analysis (Williams, 1971; Pielou, 1984) can be implemented to construct a dendrogram which displays visually the varying degrees of similarity among the samples.

Very often, the investigators tend to make the assumption that the index employed is capable of truthfully and accurately reflecting the similarity or dissimilarity between the two communities in a pollution assessment. Huhta (1979) evaluates various similarity indices using the data generated from the study of arthropod communities succession and finds that the resulting values depend largely on the indices applied. Boyle et al. (1990) analyze nine diversity and seven similarity indices of three communities with different initial structure following three types of

perturbations, using computer simulation techniques, to determine whether the response of these diversity and similarity indices are dependent on the initial structure or on the manner in which the community is changed. He concludes that the similarity indices are dependent on both initial structure and perturbation. In particular, similarity indices should be used in conjunction with other indices. He states that "further statistically based research and field validation" is necessary to develop an understanding of the assumptions that each of the indices makes about measuring community structure.

Therefore, it is important to understand the limitations of the indices when they are applied to data analysis. Indices should be used in conjunction with sound ecological judgement in pollution impact assessments. Sophisticated data treatment should not be a substitute for one's ecological reasoning. One should only draw definite conclusions after using several indices and comparing the results. For example, Johansson and Minns (1987) suggest that the percentage similarity index is the best index for distinguishing community differences. Pinkham and Pearson (1976), however, point out that this index can result in similarity between two communities if eutrophication is the only factor influencing the community structure and composition. Pontasch and Brusven (1988) show that in quantifying differences in macroinvertebrate composition between gas-impacted and a reference area, the Bray-Curtis and average chi-square community comparison indices are the most effective. In quantifying macroinvertebrate response to a complex effluent in laboratory microcosms, the Bray-Curtis index is superior to all other community comparison indices in yielding the most meaningful condensation of data (Pontasch, et al., 1989).

## E. Chlorine Toxicity

It is estimated that 18,700 tons of chlorine were applied to sewage treatment in the U.S. in 1973. The quantity is a testament to its pervasiveness in the public health domain (Chlorine Institute, 1974). Like most states in U.S., Massachusetts requires the disinfection of wastewater during the months of April to October. However, the discharge of a broad spectrum biocide, such as chlorine, is counter to the goal of "...The protection and propagation of fish, shellfish, and wildlife..." promulgated by the 1972 and 1977 Amendments (the Clean Water Act (CWA)) to the Federal Water Pollution Control Act (FWPCA) of 1948 (Foster, 1984). The irony here is that by mandating the application of chlorine to sewage, the Commonwealth may well be a major offender of these statutes.

When chlorine is added to pure water, two forms of free chlorine are formed: the hypochlorous acid (HOCl) and the hypochlorite ion (OCl<sup>-</sup>). Both HOCl and OCl<sup>-</sup> provide effective bacterial kills with HOCl being the more toxic. The concentrations of HOCl and OCl<sup>-</sup> in the water is pH dependent. At pH 7.5, the concentrations of HOCl and OCl<sup>-</sup> are equal. At pH above or below 7.5, OCl<sup>-</sup> and HOCl predominate respectively.

In the presence of ammonia, chlorine will react to produce a combination of monochloramines (NH<sub>2</sub>Cl), dichloramines (NHCl<sub>2</sub>) and trichloramines (NCl<sub>3</sub>). Chloramine speciation is pH and temperature dependent. Although free chlorine is the most reactive and toxic form (Brungs, 1973), all three chloramine compounds are known to be toxic to many macroinvertebrates (Larson et al., 1978; Seegert and



Brooks, 1979). The total amount of measurable free and combined chlorine in the water is referred to as total residual chlorine (TRC). Both free and combined chlorine demonstrate approximately the same order of magnitude of toxicity (Merkens, 1958). Therefore, the measure of total residual chlorine (TRC) is sufficient for the estimation of chlorine toxicity (Doudoroff and Katz, 1950).

In the presence of organic compounds (particularly municipal wastewater where the organic content is high), a number of chlorinated organic byproducts (TOX) are created (Jolly, 1975; Murphy, 1975; Oliver and Visser, 1980; Miller and Uden, 1983; Kinstley et al., 1983; Boyce and Horning, 1983; Trehy et al., 1986). TOX were also found in bleached pulp and papermill effluent (Paasivirta, 1988). One compound, trichloroacetic acid, has been shown to increase oxygen consumption and ammonia excretion in the dragonfly nymph *Somatochlora cingulata* at levels of environmental relevance (i.e. 10-100 µg/l) (Correa et al., 1985). These chlorinated organic byproducts, particularly those that are non-polar in nature, have been shown to persist in the sediment (Larsson, 1985 and 1986).

Chlorine toxicity has been demonstrated to affect all trophic levels of aquatic biota. Such damage to non-target organisms has provided an increase in research to describe the extent of chlorine toxicity. Fish were the first organisms investigated with regard to the toxicity of chlorinated municipal sewage effluent because of their commercial and political importance (Coventry et al., 1935; Merkens, 1958; Tasi, 1969; Arthur and Eaton, 1971; Tsai, 1971; Heath, 1978; Larson and Schlesinger, 1978; Thomas et al., 1980; Trabalka et al., 1980; Ward and DeGraeve, 1978a; Ward and DeGraeve, 1980; Osborne et al., 1981; Brooks and Bartos, 1984). Much of the

research was performed in the laboratory with continuous or intermittent chlorination and focused on determining the tolerance limits of various species to free or/and combined chlorine. Brooks and Seegert (1978) categorized fish, based on the toxicity of intermittent doses of monochloramines, as either sensitive (72-hr LC<sub>50</sub> of 0.35 to 0.71 mg/l) or resistant (72-hr LC<sub>50</sub> of 1.15 to 1.50 mg/l). Among the ten species of freshwater fish tested the salmonids (trout and salmon) were found to be the most sensitive. Rainbow trout, *Salmo gairdneri*, had a 96-hr LC<sub>50</sub> of 0.037 mg/l and this concentration only reflected 19% of that in the original effluent (Ward and Degraeve, 1980).

Physiological parameters have also been selected as endpoints to evaluate the effects of chlorine toxicity on the fathead minnow, *Pimephales promelas*. Working with trout, Dandy (1972) found disequilibrium to be the point at which removal of the toxicant no longer resulted in recovery. Exposure to chlorine initially caused increase in activity, ventilation, and the "coughing" reflex. The intense activity remained high for several hours followed by slow and spasmodic movement. Eventually the fish tended to lose equilibrium. Grothe and Eaton (1975) found a one hour exposure to 1.5 mg/l monochloramine resulted in a loss of equilibrium. They speculated that the oxidation of hemoglobin to methemoglobin resulted in hypoxia and eventually death. However, Bass and Heath (1977) reported that the physiological response to exposure of residual chlorine caused reduced blood pH, increased lactate levels, lowered arterial pO<sub>2</sub>, slightly elevated methemoglobin levels. The authors concluded that the increase in methemoglobin probably was not physiologically significant, but rather death was caused by internal hypoxia induced by damage to the gills.

Much of the data collected to date regarding chlorine toxicity with macroinvertebrates has been laboratory oriented (Arthur and Eaton, 1971; Arthur et al., 1975; Gregg, 1974). These laboratory-based toxicity tests have provided median lethal concentrations (LC<sub>50</sub>) for many zooplankton species. The 48-hr LC<sub>50</sub> values of TRC for zooplankton range from 0.017 mg/l for *Daphnia magna* to 3.2 mg/l for *Aeolosoma headleyi* (Clarke et al., 1977; Ward and DeGraeve, 1978b; Cairns et al., 1978).

Laboratory studies also provided LC<sub>50</sub> for many macroinvertebrate species. Arthur et al. (1975) found that, in general, the macroinvertebrates had 7-d TL<sub>50</sub> values from 0.21 to >0.81 mg/l TRC in wastewater. Amphipods, for example, had a mean long-term no adverse effect level of 12 ug/l. However, 7-d LC<sub>50</sub> values as low as 0.01 mg/l have been observed for some invertebrates (Gregg, 1974). The amphipod *Hyalella azteca* and the crayfish *Orconectes australis* had 96-hr LC<sub>50</sub> values of 0.65 to 0.83 mg/l TRC and 1.08 mg/l TRC, respectively (Clarke et al., 1977). Overall, *Daphnia magna*, with acute LC<sub>50</sub>'s of 2 to 45 ug/l, were the most sensitive invertebrates (Arthur et al, 1975; Ward and DeGraeve, 1980; EPA, 1985). In general, however, fish and invertebrates demonstrated comparable ranges of sensitivities (EPA, 1985).

Although laboratory studies are reproducible and scientifically rigorous (Odum, 1977; Cairns, 1986), they lack a degree of ecological relevance (Livingston, 1979; Carriker et al., 1982; Bascom, 1982). In particular, it is difficult to draw any conclusion about the ecological impact of a pollutant at the community level (Connell and Sousa, 1983; Likens, 1985; Cairns, 1986; Perry and Troelstrup, 1988). Unfortunately, very limited field research into the effects of chlorinated municipal

wastewater on the macroinvertebrate community of the receiving stream have been investigated. Simpson (1980) observed the abnormalities in the tracheal gills of the net spinning Tricoptera recovered from the streams that received chlorinated and crude oil wastes. Moore et al. (1980) recorded the mutagenic activity of Sheep River, Alberta that received a chlorinated sewage effluent. Research by Pagel and Langdon (1981) compared the macroinvertebrate communities upstream and downstream of chlorinated sewage discharge for a number of rivers but was limited to a preliminary study "...designed to identify possible areas in which problems were occurring". Osborne (1985) and Osborne and Davies (1987) made intersite comparisons of macroinvertebrate communities. However, the community response was confounded by a thermal discharge just below the sewage outfall. Temperature was shown to exert a profound effect on chlorine toxicity (Capuzzo, 1977; Heath, 1978; Capuzzo, 1979). Research by Lewis (1986) on the impact of a municipal wastewater effluent on macroinvertebrates in the Little Miami River was limited by the scarcity of macroinvertebrates found in their circular Hester-dendy plates. Most recently, chlorine was found to reduce the colonization of amphipod shredders, and consequently reduced litter processing rates (Newman et al. 1987).

Brungs (1973) reviewed chlorine toxicity and recommended continuous TRC concentrations of 0.002 mg/l to protect most aquatic organisms. To protect salmonids, Brungs suggested TRC should not exceed 0.01 mg/l for 30 minutes. Mattice and Zittel (1976) recommended the chronic toxicity threshold for freshwater be 0.0015 mg/l TRC. The 1984 ambient water quality criteria for chlorine (EPA, 1985) stipulated a TRC concentration of 0.002 mg/ml to protect salmonid fish and 0.01 mg/l

to protect general aquatic life. They also recommended that a four-day average TRC concentration of 0.011 mg/l not be exceeded more than once every three years.

Table 2.1 Diversity indices which are proposed in ecosystem studies, arranged in eight categories according to their theoretical approach. After Washington (1984).

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(1) SIMPSON'S INDEX

(A) Simpson's  $D$  (1949), where

$$D = \sum_{i=1}^s \frac{n_i (n_i - 1)}{n (n - 1)}$$

(2) RELATIVE OF SPECIES NUMBER

(B) Kothe's species deficit (1962)

$$\frac{A_s - A_x}{A_s} * 100$$

(C) Odum's species per thousand individuals (1960)

(3) GUESSES BY DATA FITTING

(D) Gleason's index (1922)

$$D = \frac{s}{\ln N}$$

(E) Margalef's index (1958)

$$D = \frac{s-1}{\ln N}$$

(F) Menhinick's index (1964)

$$D = \frac{s}{\sqrt{N}}$$


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Continued, next page.

Table 2.1 (Continued).

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(4) CURVE FITTING APPROACH

(G) Motomura's geometric series (Motomura, 1932; Whittaker, 1965)

$$y = AC^{(x-1)}$$

(H) Fisher's

$$s_1 = \alpha \ln \left( 1 + \frac{N}{\alpha} \right)$$

(I) The modified Yules "characteristic" (Yules, 1944; Williams, 1964)

$$\frac{M_1^2}{M_2 - M_1} = \frac{n^2}{\sum n(n-1)}$$

(J) Preston's log-normal "a" (1948), where

$$y = y_0 \exp(-aR)^2$$

(5) INFORMATION THEORY

(K) Brillouins  $H$  (1951)

$$H = \frac{1}{N} \ln \frac{N!}{N_1! N_2! N_3! \dots N_s!}$$

(L) Shannon's  $H'$  (Shannon and Weaver, 1949)

$$H' = - \sum_{i=1}^s \frac{n_i}{n} \ln \frac{n_i}{n}$$

(M) Evenness  $E'$  (Pielou, 1966b; Macarthur, 1966)

$$E' = \frac{H'}{H'_{\max}}$$

(N) Redundancy  $R'$  (Patten, 1962; Hamilton, 1975)

$$R' = \frac{H'_{\max} - H'}{H'_{\max} - H'_{\min}}$$


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Continued, next page.

Table 2.1 (Continued).

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(6) HURLBERT'S "ENCOUNTER " INDEX (1971)

(O) Hurlbert's *PIE*, where

$$PIE = \left( \frac{N}{N-1} \right) \left( 1 - \sum_{i=1}^s p_i^2 \right)$$

(7) MCINTOSH'S 'ECOLOGICAL DISTANCE" RELATIVE (1967)

(P) McIntosh's *M*

$$M = \frac{n - \sqrt{\sum_{i=1}^s n_i^2}}{n - \sqrt{n}}$$

(8) THEORY OF RUNS

(Q) Cairns *SCI* (Cairns et al., 1968; Cairns and Dickson, 1971)

$$SCI = \overline{DI}_1 \times \text{no. taxa}; \quad \overline{DI}_1 = \frac{\sum \frac{\text{no. run}}{\text{no. specimens}}}{N_{SCI}}$$

(R) Keefe's *TU* (Keefe and Bergersen, 1976; 1977)

$$TU = 1 - \left( \frac{n}{n-1} \right) \left( \sum_{i=1}^k p_i^2 - \frac{1}{n} \right)$$


---

List of terms

*s* = the number of species in either a "sample" or a "population"

*k* = number of taxa in either "sample" or a "population"

*N* = the number of individuals in a population or community

*N<sub>i</sub>* = the number of individuals in species *i* of a population or community

*n* = the number of individuals in a sample from a population

*n<sub>i</sub>* = the number of individuals in a species *i* of a sample from a population

*p<sub>i</sub>* = the fraction of a sample of individuals belonging to species *i*

*π<sub>i</sub>* = the fraction of a population of individuals belonging to species *i*



Table 2.2 Summary of the main properties of several diversity indices.

| Diversity Indices                       | Range of Values |          | Corresponding Diversity |              |
|---|-----------------|----------|-------------------------|--------------|
|   | Min.            | Max      | Min.                    | Max          |
| Simpson's D (1949)                      | 0               | 1        | more diverse            | less diverse |
| Information Theory Indices (1949, 1951) | 0               | $\infty$ | less diverse            | more diverse |
| Hurlbert's PIE (1971)                   | 0               | 1        | less diverse            | more diverse |
| McIntosh's M (1967)                     | 0               | 1        | less diverse            | more diverse |
| Keefe's TU (1976)                       | 0               | 1        | less diverse            | more diverse |
| Theory of Run (1994)                    | 0               | 1        | less diverse            | more diverse |
| Shannon's Redundancy (Patten, 1962)     | 0               | 1        | more diverse            | less diverse |
| Brillouin's Redundancy (Hamilton, 1975) | 0               | 1        | more diverse            | less diverse |
| Shannon's Evenness (Macarthur, 1966)    | 0               | 1        | less diverse            | more diverse |
| Brillouin's Evenness (Hamilton, 1975)   | 0               | 1        | less diverse            | more diverse |

Table 2.3 Various qualitative and quantitative similarity/dissimilarity indices proposed in ecosystem studies.

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QUALITATIVE COMMUNITY COMPARISON INDICES

- (1) Jaccard's Coefficient of community (1902, 1912)

$$JCC1 = \frac{c}{a + b - c}$$

- (2) Jaccard's Coefficient of community (1908)

$$JCC2 = \frac{c}{a + b}$$

- (3) Coefficient of Similarity (Kulczynski, 1927)

$$I = \frac{c}{2} \left( \frac{1}{a} + \frac{1}{b} \right)$$

- (4) Quotient of Similarity (Sørensen, 1948)

$$I = \frac{2c}{(a + b)}$$

- (5) Ochiai's Index (1957)

$$I = \frac{c}{\sqrt{(c+b)(c+a)}}$$

- (6) Sokal and Michener's Simple Matching Coefficient (1958)

$$SMC = \frac{c + d}{d + a + b}$$

- (7) Index of Similarity (Mountford, 1962)

$$I = \frac{2c}{2ab - (a + b)c}$$

- (8) Fager and McGowan Index (1963)

$$I = \frac{c}{\sqrt{(c+b)(c+a)}} - \frac{1}{2\sqrt{c+b}}$$

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Continued, next page.

Table 2.3 (Continued).

(9) Revised Fager and McGowan Index (1994)

$$I = \frac{2 \times c}{\sqrt{(c+b)(c+a)}} - \left( \frac{1}{2\sqrt{c+b}} + \frac{1}{2\sqrt{c+a}} \right)$$

QUANTITATIVE COMMUNITY COMPARISON INDICES

SIMILARITY INDICES

(10) Percent Similarity (Renkonen, 1938)

$$PS = \sum_{i=1}^s \min(P_{1i}, P_{2i})$$

(11) Morisita Similarity Index (1959)

$$MSI = \frac{2 \sum_{i=1}^s n_{1i}n_{2i}}{(\lambda_1 + \lambda_2) N_1 N_2}; \lambda_1 = \frac{\sum_{i=1}^s n_{1i} (n_{1i} - 1)}{N_1 (N_1 - 1)}; \lambda_2 = \frac{\sum_{i=1}^s n_{2i} (n_{2i} - 1)}{N_2 (N_2 - 1)}$$

(12) Simplified Morisita Index (Horn, 1966)

$$C_{\lambda} = \frac{2 \sum_{i=1}^s n_{1i}n_{2i}}{(\lambda_1 + \lambda_2) N_1 N_2}; \lambda_j = \frac{\sum_{i=1}^s n_{ji}^2}{N_j^2}$$

(13) Stander's SIMI (1970)

$$SIMI = \frac{\sum_{i=1}^s P_{1i}P_{2i}}{\sqrt{\sum_{i=1}^s P_{1i} \sum_{i=1}^s P_{2i}}}$$

(14) Pinkham-Pearson Index B (1976)

$$B = \frac{1}{s} \sum_{i=1}^s \frac{\min(n_{1i}, n_{2i})}{\max(n_{1i}, n_{2i})}$$

Continued, next page.

Table 2.3 (Continued).

(15) Pinkham-Pearson Index  $B_2$  (1976)

$$B_2 = \frac{1}{s} \sum_{i=1}^s \frac{\min(n_{1i}, n_{2i})}{\max(n_{1i}, n_{2i})} \left[ \frac{\frac{n_{1i}}{N_1} \frac{n_{2i}}{N_2}}{2} \right]$$

DISSIMILARITY INDICES

(16) Bray-Curtis Index (1957)

$$BC = \frac{\sum_{i=1}^s |n_{1i} - n_{2i}|}{\sum_{i=1}^s (n_{1i} + n_{2i})}$$

(17) Bray-Curtis Index (Poole, 1974)

$$D = \frac{1}{2} \sum_{i=1}^s |p_{1i} - p_{2i}|$$

(18) Squared Euclidean Distance and Euclidean Distance (Sokal, 1961)

$$\delta_{1,2}^2 = \sum_{i=1}^s (n_{1i} - n_{2i})^2;$$

$$\delta_{1,2} = \left[ \sum_{i=1}^s (n_{1i} - n_{2i})^2 \right]^{\frac{1}{2}}$$

(19) Distance Measure (Clifford and Stephenson, 1975)

$$d_{1,2} = \left[ \sum_{i=1}^s (p_{1i} - p_{2i})^2 \right]^{\frac{1}{2}};$$

$$d_{1,2}^2 = \sum_{i=1}^s (p_{1i} - p_{2i})^2$$

(20) Canberra Metric (Lance and Williams, 1967)

$$CM = \frac{1}{s} \sum_{i=1}^s \frac{|n_{1i} - n_{2i}|}{(n_{1i} + n_{2i})}$$

Continued, next page.

Table 2.3 (Continued).

(21) Collection Dissimilarity (Pratt et al., 1981)

$$\%D = \frac{CD}{1 + \frac{2}{s'}} * 100$$

$$CD = SD_1 + SD_2 + SD_3 + \dots + SD_s$$

$$SD_1 = \frac{AD_1}{n_{11} + n'_{21}} + \frac{AD_1}{\sum_{i=1}^{s'} n_{1i}}$$

$$AD_1 = |n_{11} - n'_{21}|$$

$$n'_{21} = n_{21} \times \frac{\sum_{i=1}^{s'} n_{1i}}{\sum_{i=1}^{s'} n_{2i}}$$

(22) The Average Chi-Square (Parrish and Wagner, 1983)

$$\bar{\chi}^2 = \frac{2}{N} \sum_{i=1}^s \frac{(O_i - E_i)^2}{E_i}$$

List of terms

$a$  = the number of species in community 1

$b$  = the number of species in community 2

$c$  = the number of matches in which a give species is present in both communities

$d$  = the number of matches in which a give species is absent from both communities

$P_{1i}$  = the proportion of species  $i$  in community 1

$P_{2i}$  = the proportion of species  $i$  in community 2

$n_{1i}$  = the number of individuals in species  $i$  in community 1

$n_{2i}$  = the number of individuals in species  $i$  in community 2

$N_1$  = the total number of individuals in community 1

$N_2$  = the total number of individuals in community 2

$s$  = the number of species present in communities 1 and 2

$s'$  = the adjusted number of species present in communities 1 and 2

$O_i$  = the number of individuals in species  $i$  in one community

$E_i$  = the sum of the individuals in species  $i$  in both communities divided by 2

$N$  = the total number of individuals in both communities indices usually require intensive calculations.

$N_{ri}$  = the observed reference abundance of the  $i^{\text{th}}$  species

$N_{ui}$  = the observed urban abundance of the  $i^{\text{th}}$  species

Table 2.4 Summary of the main properties of several qualitative community comparison indices.

| Qualitative Community Comparison Indices                | Range of Values |          | Corresponding Similarity |              |
|---|-----------------|----------|--------------------------|--------------|
|   | Min.            | Max.     | Min.                     | Max.         |
| Jaccard's Coefficient of Community (1902, 1912)         | 0               | 1        | less similar             | more similar |
| Jaccard's Coefficient of Community (1908)               | 0               | 0.5      | less similar             | more similar |
| Coefficient of Similarity (Kulczynski, 1927)            | 0               | 1        | less similar             | more similar |
| Quotient of Similarity (Sørensen, 1948)                 | 0               | 1        | less similar             | more similar |
| Ochiai's Index (1957)                                   | 0               | 0.5      | less similar             | more similar |
| Sokal and Michener's Simple Matching Coefficient (1958) | 0               | 1        | less similar             | more similar |
| Index of Similarity (Mountford, 1962)                   | 0               | $\infty$ | less similar             | more similar |
| Fager and McGowan Index (1963)                          | < 0             | < 0.5    | less similar             | more similar |

Table 2.5 Summary of the main properties of several quantitative community comparison indices.

| Quantitative Community Comparison Indices        | Range of Values |          | Corresponding Similarity |              |
|--|-----------------|----------|--------------------------|--------------|
|  | Min.            | Max.     | Min.                     | Max.         |
| Percent Similarity (Renkonen, 1938)              | 0               | 1        | less similar             | more similar |
| Morisita Similarity Index (1959)                 | 0               | $\infty$ | less similar             | more similar |
| Simplified Morisita Index (Horn, 1966)           | 0               | 1        | less similar             | more similar |
| Stander"s SIMI (1970)                            | 0               | 1        | less similar             | more similar |
| Pinkham-Pearson Index B (1976)                   | 0               | 1        | less similar             | more similar |
| Pinkham-Pearson Index B <sub>2</sub> (1976)      | 0               | 0.5      | less similar             | more similar |
| Bray-Curtis Index (1957)                         | 0               | 1        | more similar             | less similar |
| Euclidean Distance (Sokal, 1961)                 | 0               | $\infty$ | more similar             | less similar |
| Canberra Metric (Lance and Williams, 1967)       | 0               | 1        | more similar             | less similar |
| Distance Measure (Clifford and Stephenson, 1975) | 0               | $\infty$ | more similar             | less similar |
| Percent Dissimilarity (Pratt et al., 1981)       | 0               | 1        | more similar             | less similar |
| Average Chi-Square (Parrish and Wagner, 1983)    | 0               | 1        | more similar             | less similar |

## CHAPTER III

### MATERIALS AND METHODS

#### A. Study Site

##### 1. Lampson Brook and Belchertown, Massachusetts

The study was conducted at Lampson Brook, a second order stream, located in the west-central portion of Belchertown in the State Reservation (Coler, 1990). The headwaters of Lampson Brook originate in the swamp north of the intersection of State Street and Turkey Hill Road. The stream flows past Belchertown State School and meets with a small tributary, which originates in the small swamp south-west of the intersection of routes 9 (Sargen Street) and 202 (Main Street), passes wastewater treatment plant, then flows under George Hannum Street. The brook enters a swamp about 120 meters below the sewage treatment plant, crosses back under George Hannum Street 900 meters below the outfall, and is joined by Western Brook 900 meters below Hannum Street. It extends 1320 meters to a small pond adherent to Mill Road. Along Mill Road, it passes two private swimming pools, crosses Boardman Street and Rural Street, finally ends, 3680 meters from the outfall, in Forge Pond, Granby (United States Department of the Interior Geological Survey Topo Map, Belchertown, Massachusetts quadrangle).

Belchertown is located in west-central Massachusetts, Hampshire County. It has a population of 7,863 with a land area of 55.4 square miles (Massachusetts



Municipal Profiles, 1987). The general climate is characterized by warm, humid summers and moderately cold winters. The median temperature ranged from 19° F to 70° F and the total rainfall ranged from 0.95 to 6.80 inches during the study period (Monthly Report of Wastewater Treatment Plant, September, 1987 to October, 1988). The annual average evaporation is 28 inches, and average runoff is 20 inches (Smith, 1975). Stream water recharge occurs between October and April and reaches the lowest levels in the summer due to evaporation.

Above the sewage outfall, the watershed is composed of a combination of agricultural land, areas of dense mixed hardwood and softwood trees (21-40 feet high), as well as Wastewater Treatment Plant-utilized filter bed. The watershed of downstream area consists of a shallow marsh, areas of dense mixed hardwood and softwood trees (21-60 feet high), clustered residential land, unimproved land, and a light density residential area (MacConnell, 1975).

## 2. Belchertown Wastewater Treatment Plant

The treatment facility is located on State Street, Belchertown. The sewage lines service only the village of Belchertown. It is a secondary sewage treatment facility with a designed flow of 0.5 million gallon per day (MGD). The average daily flow, as of 1987, was 0.336 MGD with the maximum and minimum of 1.083 and 0.215 respectively. In 1988 the maximum and minimum flows were 0.632 and 0.189, and the average was 0.302 MGD (Monthly report of Wastewater Treatment Plant, 1987; 1988). Chlorine is applied to disinfect sewage discharge between the months of April and October. The minimum-maximum required chlorine residuals recommended by EPA are 0.5-1.5 mg/l after 15 minutes contact at peak hourly flow. Effluent

discharge limitations and monitoring requirements are listed in Table 3.1 (Chang, 1989).

### 3. Stream Quality

Water quality above the sewage outfall is generally good. Below the outfall water quality of Lampson Brook reflects the influence of the discharge from the Wastewater Treatment Plant (WWTP). Between the months of April and October the stream also receives varied concentrations of chlorinated sewage discharge. It reflects a typical organic pollution with elevated BOD and high nutrient levels. Other than chlorine, the most biologically significant effluent constituents are phosphorus and ammonia. The levels of ammonia on the average ranged between 0.07 and 0.55 mg/l at station 1, between 0.97 and 2.47 mg/l at the outfall, between 0.30 and 0.91 mg/l at station 2, between 0.13 and 0.50 mg/l at station 3, between 0.10 and 0.47 mg/l at station 4, and between 0.09 and 0.40 mg/l at station 5 respectively for the six sampling period (Tables 4.1 through 4.6). The levels of phosphorus on the average ranged between 0.05 and 0.16 mg/l at station 1, between 1.38 and 2.12 mg/l at the outfall, between 0.43 and 1.57 mg/l at station 2, between 0.31 and 1.14 mg/l at station 3, between 0.19 and 1.31 mg/l at station 4, and between 0.14 and 0.31 mg/l at station 5 (Tables 4.1 through 4.6). Clearly, the levels of ammonia and phosphorus exceed the recommended levels of 0.02 mg/l for ammonia and 0.05 mg/l for phosphorus, respectively (Table 3.2). All other chemical, physical, and biological parameters exhibit little impact on stream water quality. The criteria of water quality for freshwater aquatic life and public health recommended by EPA are listed in Table 3.2 (EPA, 1986).

#### 4. Selection of Study Site

A control station and four treatment stations along Lampson Brook were chosen to assess the impact of chlorinated sewage on stream benthic macroinvertebrates. The exact locations were selected in an attempt to minimize the differences in current, depth, and insolation among stations. The locations were as follows:

- Control (station 1) - 60 meters upstream from sewage outfall
- Station 2 - 60 meters downstream (1 reversing meander) from the sewage outfall
- Station 3 - 830 meters below sewage outfall at Hannum Street overpass
- Station 4 - 150 meters downstream from Station 3
- Station 5 - 2000 meters downstream from Station 4 at Rural Road overpass

#### B. Experimental Design

##### 1. Chemical-Physical Sampling

###### a. Field Methods

Water samples were collected weekly from each station and the sewage outfall during the colonization periods and then analyzed for the following chemical, physical, and biological parameters: chlorine (free and combined), temperature, pH, D.O., BOD, fecal coliform, acidity, alkalinity, ammonia, nitrate, phosphorus, calcium, hardness,

chloride, total solids, and suspended solids during the period that substrates were in place. Heavy metals were not measured routinely because two sets of initial analyses revealed no concentrations above background levels. Water samples were transported to the laboratory in a cooler with ice.

#### b. Laboratory Methods

All the water samples were placed in the refrigerator at 4° C pending analysis. Residual chlorine and D.O. were determined immediately upon return to the laboratory. BOD analysis was initiated within 2 hours and fecal coliform counts within 6 hours. All other tests were completed within 4 days except for temperature and pH which were taken on site. Analytical procedures (Table 3.3) were performed in accordance with those stipulated in Standard Methods of Water and Wastewater Analysis (APHA, 1985).

## 2. Biological Sampling

#### a. Field Methods

Wire barbecue baskets, containing 30 limestones of 2" to 3" in diameters (except for 10/30/87 stream-bed rocks), were deployed at one station upstream (control) and four stations downstream from the Belchertown Wastewater Treatment Plant outfall. A number of one-meter long steel rods, one centimeter in diameter, were first inserted one foot into the river substrate. Each basket was secured to the steel rod with a two-meters segment of heavy duty rope and placed about five centimeters above the river bed. The baskets were removed from the stream after 5.5 - 6 weeks of colonizations and each individual stone was placed immediately into an

18 oz. whirl-pak containing 70% ethyl alcohol. The substrates were then transported to the laboratory.

#### b. Laboratory Methods

Upon return to the laboratory, animals were first captured with insect screen by brushing the stone under running water and then separated from the debris by sugar flotation (Fast, 1970; Lackey and May, 1971; Pratt, 1977) and sorted under a 1.7 x magnifier. The samples collected on August 22, and October, 1988 were sorted directly under dissecting microscope at various magnification without sugar flotation. The specimens colonizing each stone substrate were preserved in a separate 7-ml vial containing 70% ethyl alcohol. Chironomid larvae and pupae as well as oligochaetes were mounted on the slides using CMC-10 mounting media. The mounting technique used was in accordance with the protocol suggested by the Department of Environmental Quality Engineering (DEQE), Division of Water Pollution Control, Massachusetts (DEQE, 1989) and a technical series published by the Department of Environmental Regulation, the State of Florida (Beck, 1976). Identifications were made to the lowest taxonomic level possible by using appropriate keys and confirmed by the DEP staff. Each vial of specimen(s) and each slide of mounted material were labeled with the species ID, the station code, date of collection, name of the stream, and location.

#### c. Sampling Schedules

In all, five experiments were implemented, including the experiment conducted from September 15 to October 30, 1987. The experiments included five deployments and six retrievals. The experiments were carried out as follows:

Experiment 1 consisted of a set of 10 baskets. Two baskets, one containing stream-bed rocks and the other containing limestones of comparable size, were deployed at each station on September 15, 1987 and retrieved on October 30, 1987, while the effluent was still being chlorinated.

Experiment 2 also consisted of 10 baskets. Two baskets, each containing 30 limestones, were deployed at each station on November 10, 1987 and retrieved on December 22, 1987 after the cessation of chlorination.

Experiment 3 consisted of 15 baskets. Three baskets each containing 30 limestones of comparable surface area were deployed on February 18 at each station. Of these, one basket contained individual stones each separated from each other by an embossed plastic floor mat (12" by 6") and one with 30 pieces of limestone, were retrieved on March 29 before the chlorination resumed. The remaining baskets were netted and retrieved on April 14, 1988 after two weeks of chlorination.

Experiment 4 consisted of 5 baskets. One basket, containing 30 limestones, was deployed at each station on July 10, 1988 and retrieved on August 22, 1988.

Experiment 5 consisted of a set of 5 baskets, each filled with 30 limestones. These baskets were placed at the control station (station 1) to allow colonization of the macroinvertebrates on August 22, 1988. All the baskets were then netted on October 1, 1988, and four of them were distributed among the four downstream stations. After 17 days of exposure to chlorinated sewage the baskets were retrieved from each station on October 17, 1988.

#### d. Raw Data

After all the organisms were identified and counted, the data which resulted consisted of: (1) the number of species on each stone ( $s$ ); (2) the number of individuals among each species on each stone ( $n_i$ ), where  $i = 1, 2, 3, \dots, s$ ; (3) the total number of organisms on a stone ( $N$ ); (4) the number of species in each basket ( $sb$ ); (5) the number of individuals among each species in a basket ( $nb_i$ ), where  $i = 1, 2, 3, \dots, sb$ ; (6) total number of organisms in a basket ( $NB$ ); (7) surface area of each stone ( $SA$ ) (8) total surface area of 30 stones ( $SA_{total}$ ); (9) the name of each species.

The identified macroinvertebrate taxa with their respective abundance during chlorination and non-chlorination regimes are listed in APPENDIX A.1. The sorted macroinvertebrates were recorded in two fashions. The first data set was recorded for individual basket which composed of a matrix of rows and columns representing the sampling unit (in this case, the individual stone) and a list of species. The second data set combined all the organisms in a basket and was recorded as a matrix of rows and columns representing a list of species and the basket (APPENDICES A.2 and A.3). The macroinvertebrate data were retabulated to yield two midge data sets and two family level census data sets according to the above two recording schemes. In all, six distinct data sets were generated. The six data sets were used for the subsequent evaluation of diversity and community comparison indices. The baskets designation is reflected in Table 3.4.

## C. Selection of Diversity and Community Comparison Indices

### 1. Evaluation of Various Diversity Indices

Hurlbert's *PIE* was computed according to the formula listed in Table 2.1, 6, O. As Hurlbert (1971) points out, his formula when used with sample collections, is a consistent unbiased estimator as long as  $n \geq 2$  and does not require knowledge of the number of species in the community. When using the individual stone as a sampling unit, the exclusion of  $n < 2$  in many instances will affect the values of the indices, particularly in those collections where the abundances were low and the number of species was high and evenly distributed.

McIntosh's "ecological distance" relative was calculated according to the formula listed in Table 2.1, 7, P. McIntosh's formula, like Hurlbert's, also requires that collections have a sample size greater than two individuals.

Since I have demonstrated Keefe's *TU* is equal to Hurlbert's *PIE*, the "run" cannot conform to Keefe's *TU*. If we assume a community has the species distribution  $n_1, n_2, n_3, \dots, n_s$ , where  $n_i$  is the number of individuals in species  $i$  and  $i = 1, 2, 3, \dots, s$ . For a given set of distributions, there will be only one possible run if all possible permutations have been considered. The run can be calculated for each permutation and the average obtained by dividing the sum of the runs by the permutations. The formula for calculating the run is shown in APPENDIX C. Unlike Hurlbert's and McIntosh's formulae the "run" formula applies to any collection that contains at least one individual.



Shannon index ( $H'$ ) and Brillouin index ( $H$ ) were calculated according to the formulae listed in Table 2.1, 5, K and L. Their associated indices (evenness,  $E'$  and  $E$  as well as redundancy,  $R'$  and  $R$ ) were calculated according to the formulae proposed by Pielou (1966b) and Hamilton (1975) except that the values were obtained by using the natural log instead of  $\log_2$ .

The above five diversity values were calculated for each sampling unit (i.e. each individual stone). The same formulae were used to calculate diversity for the basket, where  $N$  is replaced by  $NB$  and  $n_i$  by  $nb_i$ . In most instances, the number of organisms was not sufficient to calculate evenness and redundancy for the individual stone, therefore, only the values obtained from the basket were used for the analysis.

The pooled diversity was applied when the diversity was calculated from the individual stone as a sampling unit. Pooled diversity was calculated by generating random variables with normal distribution for each stone, and sorted in ascending order according to the random variables. The census of the collections was added cumulatively through the 30 stones. The pooled diversity was obtained by calculating the cumulative diversity. Three pooled diversity values were generated for each basket. The asymptotic diversity was estimated by calculating the differences of the consecutive cumulative diversity. The number of stones was determined when the differences were consistently within 10% of the total diversity of that basket. The maximum number of stones among those three asymptotic diversities was chosen as the minimum requirement of stones to reach asymptotic diversity. This procedure was applied to all the basket collections.

A sample SAS program was coded to calculate the diversity and pooled diversity values for the collected benthic macroinvertebrates (APPENDIX D). A total of 45 programs were generated for the 45 basket collections. The same programs were used to calculate midge and family level diversities.

The Sign test was applied to compare the means of diversity values calculated from the basket and the stones, respectively. The test was performed for Hurlbert's *PIE*, McIntosh's "ecological distance" relative, the "run" formula, Shannon diversity, and Brillouin diversity across the 45 basket collections.

Spearman rank correlation was applied to measure the degree of association between all possible pairs of the diversity values (i.e. Hurlbert's *PIE*, McIntosh's "ecological distance" relative, the "run" formula, Shannon diversity, Brillouin diversity for the basket and the stones; Shannon and Brillouin's evenness and Shannon and Brillouin's redundancy for the basket).

The Sign test and Spearman rank correlation were used to test the differences in mean diversity values and the degree of association among macroinvertebrates, midges, and family level census. This procedure was intended to examine whether a subset of the population or the family level of identification is sufficient to be employed in a pollution study.

## 2. Evaluation of Various Community Comparison Indices

### a. Qualitative Community Comparison Indices

Jaccard's coefficient of community (Jaccard, 1902, 1908), Kulczynski's coefficient of similarity (1927), Sørensen's quotient of similarity (1948), Ochiai's index (1957), Mountford's index of similarity (1962), Fager and McGowan index

(1963), and revised Fager and McGowan index were analyzed according to the formulae listed in Table 2.3. A SAS computer program (APPENDIX E) was used to calculate the values of the above indices for all possible comparisons across 45 basket collections (990 pairs).

An analysis of the relative strength and weakness of each of the formulae was undertaken. Spearman rank correlation was applied to measure the degree of association among all possible pairs of indices using the values calculated from the above SAS program (APPENDIX E).

#### b. Quantitative Community Comparison Indices

Renkonen's percent similarity (1938), Morisita similarity index (1959), Horn's simplified Morisita index (1966), Stander's SIMI (1970), Pinkham-Pearson index B (1976), Pinkham-Pearson index B<sub>2</sub> (1976), Bray-Curtis index (1957), Sokal's Euclidean distance ( $\delta_{1,2}$ ) (1961), Clifford and Stephenson's distance measure ( $d_{1,2}^2$ ) (1975), Lance and Williams' Canberra metric (1967), Pratt et al.'s collection and percent dissimilarity (1981), and Parrish and Wagner's average chi-square (1983) were calculated according to the formulae listed in Table 2.3. Hypothetical communities (Table 3.5) were created to examine the differences of these quantitative community comparison indices. SAS computer programs were coded to calculate the values of the above indices for all possible comparisons of the hypothetical communities. The computer programs are similar to those coded in APPENDIX F except for the specification of the magnitude of the variables. Before application of Spearman rank correlation, the repeated comparisons were deleted. The resulting data set consisted of 146 observations instead of 378. Spearman rank correlation was again applied to measure

the degree of association for all possible pairs of the indices using the data set that contained 146 observations for the hypothetical communities.

SAS computer programs (APPENDIX F) were coded to calculate the quantitative community comparison indices for all possible comparisons across 45 basket collections (990 pairs). All the organisms were included in the calculation, even with Pratt et al.'s collection and percent dissimilarity (1981) where they only included those organisms whose ranked abundance made up the 60% of the collections.

Spearman rank correlation was again applied to measure the degree of association for all possible pairs of the indices using the values calculated from the above SAS program (APPENDIX F) for the 45 basket collections.

#### D. Interpretation of the Field Data

##### 1. Density of Stone-Dwelling Organisms

Density is defined in terms of individuals per unit area (number of individuals/m<sup>2</sup>). The population densities of stone-dwelling organisms are estimated on the basis of the individual stones themselves as the primary sampling units (Wrona, 1986). This procedure is predicated on the accurate and rapid assessment of surface area. The determination of surface area of the limestone was described by Coler et al. (1989).

The population density colonizing artificial substrates was calculated using the formula:

$$d = (1/\bar{a}) \bar{x}$$

where

$$\bar{a} = \frac{(\sum_{r=1}^{30} a_r)}{30}$$

$$\bar{x} = \frac{(\sum_{i=1}^{30} x_i)}{30}$$

$\bar{a}$  = the mean surface area of the stone in a basket,  $\bar{x}$  = the mean number of organisms per stone,  $a_r$  = the surface area of the  $r^{\text{th}}$  replicate stone from a basket. The density estimates were calculated for each basket collection. The approximate 95% confidence intervals were calculated by multiplying the standard error of the mean density with the appropriate student t distribution value (2.045).

## 2. Abundance and Species Richness

The abundance and species richness were calculated for total macroinvertebrates, midges, and family level census data sets by counting the number of organisms and species for each basket collection.

## 3. Diversity

Since the Spearman rank correlation indicated that Hurlbert's *PIE* was highly correlated to McIntosh's "ecological distance" relative and the "run" formula, and further Shannon diversity was highly correlated to Brillouin diversity, therefore, only Hurlbert's *PIE* and Brillouin diversity were selected for the interpretation of the field data.

### a. Brillouin Diversity

The overall diversity of a collection was calculated according to the formula:

$$H = \frac{1}{N} \ln \frac{N!}{N_1! N_2! N_3! \dots N_s!}$$

The midge diversity of a collection was calculated according to the formula:

$$H_m = \frac{1}{N} \ln \frac{N!}{N_1! N_2! N_3! \dots N_m!}$$

The family level diversity was determined by the following equation:

$$H_f = \frac{1}{N} \ln \frac{N!}{N_1! N_2! N_3! \dots N_f!} ;$$

$$i = 1, 2, 3, \dots, f; \sum_{i=1}^f N_i = N$$

The specific diversity within in the  $i^{\text{th}}$  family was calculated as:

$$H_{f,i} = \frac{1}{N_i} \ln \frac{N!}{N_{i1}! N_{i2}! N_{i3}! \dots N_{if_i}!} ;$$

$$j = 1, 2, 3, \dots, f_i; \sum_{j=1}^{f_i} N_{ij} = N$$

According to Pielou (1967), the overall species diversity of a collection is equal to the sum of the major-taxa diversity of the collection and the within-taxa species diversity for the entire collection:

$$H = H_f + \sum_{i=1}^f \frac{N_i}{N} H_{f,i}$$

Thus, the percent contribution of family level diversity was obtained by dividing the family level diversity by the overall diversity and the percent contribution of the

species diversity (midge diversity) within the  $i^{\text{th}}$  taxon was obtained by multiplying the weighted diversity and divided by the overall diversity.

#### b. Hurlbert's *PIE*

Values obtained from Hurlbert's *PIE* for total macroinvertebrates, midges and family level census were also employed to interpret the field results. However, since Hurlbert's *PIE* does not possess additive property, only the diversity values (not the percent contribution) were presented.

### 4. Community Comparison

#### a. Qualitative Community Comparison

According to the Spearman rank correlation, most of the indices were highly correlated among each other, Jaccard's coefficient of community was absolutely correlated to Sørensen's quotient of similarity, therefore, only two indices, Sørensen's quotient of similarity and revised Fager and McGowan index, were selected to compare upstream vs. downstream communities. These two indices represent two types of averaging - the sum or the geometric mean.

#### b. Quantitative Community Comparison

Unfortunately, almost every quantitative community comparison index is unique in measuring the "difference" between two communities and not all of them have been analyzed to reflect the response of these indices upon the changes of community parameters, therefore, it is difficult to establish the criteria for selection. Four quantitative (Morisita similarity, Sokal's Euclidean distance, Pinkham-Pearson index B, and Parrish and Wagner's average chi-square) indices were arbitrary chosen to describe the similarity/dissimilarity of upstream vs. downstream communities. The

Morisita similarity index was shown not only to be independent of sample size but also independent of diversity (Wolda, 1981). Sokal's Euclidean distance was shown to be able to distinguish true dissimilarity. Pinkham-Pearson index B gave sensitive, stable and consistent response towards community structure changes (Boyle et al., 1990). Parrish and Wagner's average chi-square is the most recent dissimilarity index derived for water pollution study. Average chi-square was found to be effective in quantifying differences in macroinvertebrate composition between gas-impacted and a reference area (Pontasch and Brusven, 1988). The Morisita similarity index was selected to describe temporal variations for each station and compare baskets collected at the same sampling date.

#### 5. EPT

EPT was calculated by counting the species of Ephemeroptera, Plecoptera and Tricoptera for each basket collection. The abundance of these species was not included in the calculation.

#### 6. Indicator Species

A number of macroinvertebrates were selected as potential indicator species with respect to the TRC concentrations detected at station 2. The species was considered as tolerant if its abundance was greater than 9 at the time of collection. A species was designated sensitive if its abundance at control station was between 3 and 9, and absence at station 2. A few rare organisms (with their respective abundance less than 3) found at the control but absence at station 2 were also designated as sensitive with some marginal uncertainty.



Table 3.1 Effluent discharge limitations and monitoring requirements of Belchertown Wastewater Treatment Plant.

| Effluent Characteristic                     | Discharge limitations   |                |               |
|---|---|----------------|---------------|
|   | Average monthly   | Average weekly | Maximum daily |
| Flow - m <sup>3</sup> /day (MGD)            |   |                | (0.50)        |
| BOD   | 30 mg/l   | 45 mg/l        | 50 mg/l       |
| TSS   | 30 mg/l   | 45 mg/l        | 50 mg/l       |
| Settleable solids                           |   | 0.1 ml/l       | 0.3 ml/l      |
| pH  | 6.5 - 8.0 at any time   |                |               |
| Fecal coliform <sup>2</sup><br>(per 100 ml) | 200   | 400            | 400           |
| Chlorine residual                           | Minimum total chlorine residual 0.5 mg/l,<br>maximum 1.5 mg/l after 15 minutes contact<br>at peak hourly flow |                |               |

| Effluent Characteristic                     | Monitoring Requirement |                   |
|---|------------------------|-------------------|
|   | Measurement frequency  | Sample type       |
| Flow - m <sup>3</sup> /day (MGD)            | Continuous             | see footnote 1    |
| BOD   | Weekly                 | Composite - 8 hrs |
| TSS   | Weekly                 | Composite - 8 hrs |
| Settleable solids                           | 1/Day                  | Grab              |
| pH  | 1/Day                  | Grab              |
| Fecal coliform <sup>2</sup><br>(per 100 ml) | Weekly                 | Grab              |
| Chlorine residual <sup>2</sup>              | 1/Day                  | Grab              |

1 Report maximum and minimum daily rates and total flow for each operating day.

2 Applicable from April 1 to October 31.

Table 3.2 The criteria of water quality for freshwater aquatic life and public health (EPA, 1986).

| Water quality parameter | Criterion   |
|-------------------------|---|
| Chlorine                | TRC 2.0 $\mu\text{g/l}$ for salmonid fish; 10.0 $\mu\text{g/l}$ for other freshwater organisms.   |
| Fecal coliform          | not to exceed a log mean of 200 per 100 ml, nor more than 10% of the total samples taken during any 30 day period exceed 400 per 100 ml for bathing waters.   |
| Ammonia                 | 0.02 mg/l for freshwater aquatic life.  |
| Alkalinity              | 20 mg/l or more as $\text{CaCO}_3$ for freshwater aquatic life except where natural concentrations are less.  |
| Nitrates; Nitrites      | 10 mg/l nitrate nitrogen (N) for domestic water supply (health). Total phosphate..... not to exceed an average of 0.05 mg/l as P during any monthly sampling period for fish and wildlife (Class C in Massachusetts). |
| Total Phosphate         | not to exceed an average of 0.05 mg/l as P during any monthly sampling period for fish and wildlife (Class C in Massachusetts).   |
| Temperature             | A maximum of 90° F with maximum permissible rise above the naturally existing temperatures of 5° F in stream and 3° F in lakes.   |
| pH                      | 6.5-9.0 for freshwater aquatic life; and 5.0-9.0 for domestic water supplies (welfare).   |
| Dissolved oxygen        | 5.0 mg/l for freshwater biota.  |
| Hardness                | concentration 0-75 mg/l $\text{CaCO}_3$ is rated as soft water; 75-150 as moderately hard; 150-300 as hard; and 300 up as very hard.  |

Table 3.3 Analytical procedures for chemical, physical, and biological parameters.

| Parameter        | Analytical methods  |
|------------------|---|
| Temperature      | Thermometer (FISHERbrand 15-043A)   |
| Chlorine         | DPD colorimetric method   |
| pH               | pH meter ALTEX Expand-Mate  |
| D.O.             | Azide modification  |
| BOD              | 5-day BOD test  |
| Fecal coliform   | MILLIPORE application manual AM302  |
| Ammonia          | Preliminary distillation step and Nesslerization method                   |
| Acidity          | Potentiometric titration (to pH 8.3)                                      |
| Alkalinity       | Potentiometric titration (to pH 4.5)                                      |
| Nitrate          | Low range nitrate test model NI-14 of HACH Inc. with Spectrophotometer 21 |
| Phosphorus       | Persulfate digestion and ascorbic acid method                             |
| Chloride         | Mercuric nitrate method   |
| Calcium          | EDTA titrimetric method   |
| Hardness         | EDTA titrimetric method   |
| Total solids     | Total solids dried at 103-105° C  |
| Suspended solids | Total suspended solids dried at 103-105° C                                |

Table 3.4 Baskets designation.

| Treatment/Basket designation | Stations |    |    |    |    |
|------------------------------|----------|----|----|----|----|
|                              | 1        | 2  | 3  | 4  | 5  |
| 10-30-87 (Stream bed rock)   | 1        | 3  | 5  | 7  | 9  |
| 10-30-87 (Limestone)         | 2        | 4  | 6  | 8  | 10 |
| 12-22-87 (Replicate 1)       | 11       | 13 | 15 | 17 | 19 |
| 12-22-87 (Replicate 2)       | 12       | 14 | 16 | 18 | 20 |
| 3-29-88 (Individual stones)  | 21       | 23 | 25 | 27 | 29 |
| 3-29-88 (Regular treatment)  | 22       | 24 | 26 | 28 | 30 |
| 4-14-88 (after chlorination) | 31       | 32 | 33 | 34 | 35 |
| 8-22-88 (summer collection)  | 36       | 37 | 38 | 39 | 40 |
| 10-17-88 (fall collection)   | 41       | 42 | 43 | 44 | 45 |

Table 3.5 Hypothetical communities used to test the differences among various quantitative community comparison indices.

| Community | Species |   |   |   |   |
|-----------|---------|---|---|---|---|
|           | A       | B | C | D | E |
| 1         | 1       | 0 | 0 | 0 | 0 |
| 2         | 1       | 0 | 0 | 0 | 0 |
| 3         | 1       | 1 | 0 | 0 | 0 |
| 4         | 1       | 1 | 0 | 0 | 0 |
| 5         | 1       | 1 | 1 | 0 | 0 |
| 6         | 1       | 1 | 1 | 0 | 0 |
| 7         | 2       | 2 | 0 | 0 | 0 |
| 8         | 2       | 2 | 0 | 0 | 0 |
| 9         | 2       | 2 | 2 | 0 | 0 |
| 10        | 2       | 2 | 2 | 0 | 0 |
| 11        | 2       | 2 | 2 | 2 | 0 |
| 12        | 2       | 2 | 2 | 2 | 0 |
| 13        | 3       | 3 | 0 | 0 | 0 |
| 14        | 3       | 3 | 0 | 0 | 0 |
| 15        | 3       | 3 | 3 | 0 | 0 |
| 16        | 3       | 3 | 3 | 0 | 0 |
| 17        | 3       | 3 | 3 | 3 | 0 |
| 18        | 3       | 3 | 3 | 3 | 0 |
| 19        | 4       | 4 | 0 | 0 | 0 |
| 20        | 4       | 4 | 0 | 0 | 0 |
| 21        | 4       | 4 | 4 | 0 | 0 |
| 22        | 4       | 4 | 4 | 0 | 0 |
| 23        | 0       | 0 | 2 | 2 | 0 |
| 24        | 0       | 0 | 4 | 4 | 0 |
| 25        | 3       | 2 | 1 | 0 | 0 |
| 26        | 1       | 2 | 3 | 0 | 0 |
| 27        | 1       | 2 | 3 | 4 | 5 |
| 28        | 5       | 4 | 3 | 2 | 1 |

## CHAPTER VI

### RESULTS

#### A. Chemical Data

Chemical, physical, and biological data were generated weekly during the entire study. Average values, and their standard deviations from different study periods are shown in Table 4.1 through Table 4.6. At the control station, all the parameters were in compliance with the standards for freshwater aquatic life and public health recommended by EPA (EPA, 1986), except for slightly elevated ammonia and phosphorus levels.

At stations 2 through 5, the stream received a continuous point source of a pollutant (domestic sewage) all year round and a chemical pollutant (chlorine) between the months of April and October. Average combined chlorine and total residual chlorine for the chlorination regime for the four study periods are presented in Figures 4.1, 4.2, 4.3, and 4.4. In general, there was no detectable free chlorine. The concentration of combined chlorines was highest at the effluent and diluted to one half to one third of that level at station 2 (about 60 meters below the outfall) by the stream. No significant free or combined chlorines were found beyond station 3. Among the combined chlorines, the concentration of monochloramines ( $\text{NH}_2\text{Cl}$ ) was highest followed by dichloramines ( $\text{NHCl}_2$ ). No trichloramines ( $\text{NCl}_3$ ) were detected in any collected water samples. Total residual chlorines were highest at the effluent,

reduced by one half or one third at station 2, and then dropped below 0.05 mg/l or occasionally below measurable levels at stations 3, 4, and 5 (Figures 4.1, 4.2, 4.3, 4.4). Average concentration of total phosphorus, ammonia and acidity at control, wastewater effluent, and four downstream stations analyzed from six sampling periods are presented in Figure 4.5 through Figure 4.7. Phosphorus and ammonia levels all exceeded EPA criteria, regardless of the stations or the sampling periods. The limiting nutrient (phosphorus) in freshwater environments discharged from the WWTP at station 2, ranged in concentrations from 0.43 to 1.57 mg/l during different sampling periods and remained at least 55% above the control at 3040 meters downstream (station 5). Ammonia levels ranged from 0.30 to 0.91 mg/l at station 2, and dropped to 0.09 to 0.40 mg/l at station 5. Acidity, on the other hand, reached the highest levels at either stations 3 ( $1.42 \pm 0.47$ ) or 4 ( $1.13 \pm 0.50$ ). The other important phenomenon was the low levels of oxygen detected at stations 3 and 4 between July 20th and August 20th sampling period in 1988 (Table 4.5).

## B. Biological Data

### 1. Evaluation of Indices

#### a. Diversity Indices

. . . . . The results of the Sign test for the 45 baskets in comparing the differences in mean diversity values calculated either from the basket or the stones for the total macroinvertebrates, midges, and family level census are shown in Table 4.7. There were significant differences in the mean diversity values in all three census data with

all the diversity indices. Hurlbert's *PIE* showed a slightly higher values (0.0446, 0.0641, and 0.0412 for total macroinvertebrates, midges, and family level census, respectively) for the basket while McIntosh's (-0.0702, -0.0562, and -0.0536) and "run" (-0.0401, -0.0928, and -0.2289) values were lower. Shannon (1.5390, 1.3433, and 0.5486) and Brillouin's (1.5273, 1.2501, and 0.5455) values for the basket were considerably higher than the values calculated from the stones. Though there were significant differences in the mean, these two means were clearly correlated for Hurlbert's (0.745, 0.591, and 0.935 for total macroinvertebrates, midges, and family level census, respectively), McIntosh's (0.768, 0.575, and 0.932), and the "run" (0.846, 0.716, and 0.679) diversity (Tables 4.8, 4.9 and 4.10). For Shannon and Brillouin diversities, the two means were poorly correlated to each other (0.243 and 0.290 for total macroinvertebrates and midges respectively for Shannon; and 0.483 and 0.481 respectively for Brillouin) except for the family level census data. Surprisingly, Shannon and Brillouin's diversity values calculated from the stones were highly correlated to each other with all three census data sets (0.993, 0.837, and 0.941 for total macroinvertebrates, midges, and family level census). In general, however, these were poorly correlated to all of the other indices with respect to total macroinvertebrates and midges (Tables 4.8 and 4.9).

Furthermore, the diversity values calculated for the basket indicated that Hurlbert's *PIE*, McIntosh's "ecological distance" relative, and the "run" formula were significantly correlated among each other (0.981 for Hurlbert's *PIE* and McIntosh's "ecological distance" relative; 1.000 for Hurlbert's *PIE* and the "run" formula; and 0.981 for McIntosh's "ecological distance" relative and the "run" formula respectively



for total macroinvertebrates; 0.981, 0.963, and 0.957 for midges; and 0.998, 0.999, and 0.999 for family level census), and were less correlated with Shannon and Brillouin diversities with total macroinvertebrates and midges (H1 vs. S1, 0.902; H1 vs. B1, 0.703; M1 vs. S1, 0.839; M1 vs. B1, 0.600; R1 vs. S1, 0.901 and R1 vs. B1, 0.701 for total macroinvertebrates, respectively ; H1 vs. S1, 0.877; H1 vs. B1, 0.657; M1 vs. S1, 0.812; M1 vs. B1, 0.560; R1 vs. S1, 0.826 and R1 vs. B1, 0.594 for midges, respectively). However, Shannon and Brillouin diversities were highly correlated to each other (0.913, 0.906, and 0.993 for macroinvertebrates, midges, and family level census, respectively) (Tables 4.8, 4.9 and 4.10).

One interesting phenomenon observed in the results of Spearman rank correlation was that, though derived from Shannon and Brillouin's index, Shannon and Brillouin's redundancy as well as evenness were more correlated to Hurlbert's, McIntosh's, and the "run" index (SR vs. H1, -0.827; BR vs. H1, -0.853; SE vs. H1, 0.896; BE vs. H1, 0.899; SR vs. M1, -0.790; BR vs. M1, -0.818; SE vs. M1, 0.952; BE vs. M1, 0.954; SR vs. R1, -0.827; BR vs. R1, -0.853; SE vs. R1, 0.897; BE vs. R1, 0.900 for total macroinvertebrates; SR vs. H1, -0.840; BR vs. H1, -0.886; SE vs. H1, 0.914; BE vs. H1, 0.916; SR vs. M1, -0.803; BR vs. M1, -0.832; SE vs. M1, 0.965, BE vs. M1, 0.966; SR vs. R1, -0.783; BR vs. R1, -0.811; SE vs. R1, 0.899; BE vs. R1, 0.899 for midges; SR vs. H1, -0.891; BR vs. H1, -0.889; SE vs. H1, 0.935; BE vs. H1, 0.937; SR vs. M1, -0.887; BR vs. H1, -0.889; SE vs. H1, 0.935; BE vs. H1, 0.937; SR vs. M1, -0.887; BR vs. M1, -0.883; SE vs. M1, 0.940; BE vs. M1, 0.943; SR vs. R1, -0.891; BR vs. R1, -0.889; SE vs. R1, 0.937; BE vs. R1, 0.940 for family level census, respectively) than Shannon and Brillouin's index (SR vs. S1, -0.731; BR

vs. S1, -0.749; SE vs. S1, 0.684; BE vs. S1, 0.688; SR vs. B1, -0.604; BR vs. B1, -0.608; SE vs. B1, 0.406; BE vs. B1, 0.412 for total macroinvertebrates; SR vs. S1, -0.751; BR vs. S1, -0.767; SE vs. S1, 0.679; BE vs. S1, 0.681; SR vs. B1, -0.688; BR vs. B1, -0.690; SE vs. B1, 0.399, BE vs. B1, 0.402 for midges; SR vs. S1, -0.808; BR vs. S1, -0.808; SE vs. S1, 0.870; BE vs. S1, 0.867; SR vs. B1, -0.835; BR vs. B1, -0.835; SE vs. B1, 0.863; BE vs. B1, 0.863 for family level census) for all three census data sets.

To examine whether a particular groups of organisms or the family level of identification would be sufficient to use as an indication in pollution study, the Sign test and Spearman rank correlation were used to compare the differences in mean diversity values and the degree of association. The comparisons were made among macroinvertebrates, midges, and family level census. The results are shown in Tables 4.11 and 4.12. It is clear that there were differences in mean diversity values when using different groups of organisms or different level of identification as tools for analysis (0.4388, 0.4172, 0.4327, 1.4792, 1.2708, -0.3112, -0.3280, 0.3194, 0.3307 for Hurlbert's *PIE*, McIntosh's "ecological distance" relative, the "run" formula, Shannon diversity, Brillouin diversity, Shannon's redundancy, Brillouin's redundancy, Shannon's evenness, and Brillouin's evenness, respectively, for total macroinvertebrates vs. family level census; 0.0685, 0.0644, 0.0579, 0.4068, 0.3822, -0.028, -0.0318, 0.0185, and 0.0205 for total macroinvertebrates vs midges; 0.3703, 0.3527, 0.3748, 1.0724, 0.8886, -0.2933, -0.3071, 0.3073, and 0.3169 for midges vs. family level census). The biggest difference was observed between total macroinvertebrates and family level census and much less so for total

macroinvertebrates and midges. The Spearman rank correlation values were the highest between total macroinvertebrates and midges census (0.853, 0.837, 0.829, 0.838, 0.806, 0.757, 0.787, 0.852, and 0.846 for Hurlbert's *PIE*, McIntosh's "ecological distance" relative, the "run" formula, Shannon diversity, Brillouin diversity, Shannon's redundancy, Brillouin's redundancy, Shannon's evenness, and Brillouin's evenness, respectively) and the lowest between midges and family level census (0.107, 0.138, 0.160, -0.029, -0.177, -0.016, 0.005, 0.303, and 0.287 for Hurlbert's *PIE*, McIntosh's "ecological distance" relative, the "run" formula, Shannon diversity, Brillouin diversity, Shannon's redundancy, Shannon's evenness and Brillouin's evenness, respectively).

b. Community Comparison Indices

i. Qualitative Community Comparison Indices To examine the degree of discrepancy among the qualitative community comparison indices, the Spearman rank correlation was applied to all possible pairs of indices with the values calculated for the combinations of all possible pairs of baskets (i.e. 990 pairs comparisons) and the results shown in Table 4.13. Jaccard1, Jaccard2, and Sørensen were absolutely correlated among each other with Spearman rank correlation values equal to one. The rest of the indices were also highly correlated with correlation values ranging from 0.959 to 0.996, except for Mountford's index. Mountford's index was much less correlated to the rest of the indices (values ranged from 0.777 to 0.889). The results of the Spearman rank correlation for midges and family level census are shown in Tables 4.14 and 4.15. The same trends were observed. In both instances, Jaccard1, Jaccard2, and Sørensen's quotient of similarity had Spearman rank correlation values

equal to 1. With midges, Mountford's values were the least correlated to the rest of the indices (ranged from 0.758 to 0.899). The same phenomenon was observed with family level census with Mountford's values ranged from 0.686 to 0.906 .

ii. Quantitative Community Comparison Indices The differences of various quantitative community comparison indices in detecting pairs beyond upper and lower limits of similarity and dissimilarity are shown in Tables 4.16 and 4.17. It is evident that among the similarity indices, Renkonen's percent similarity, Bray-Curtis index, Horn's simplified Morisita index , Pinkham-Pearson index  $B_1$ , and Stander's SIMI failed to distinguish both upper and lower limits. The same is true with dissimilarity measures of Pratt's percent dissimilarity, Lance and Williams' Canberra metric, and Parrish and Wagner's average chi-square. The rest of the indices allowed the distinguishing of either similar or dissimilar pairs with different abundances. Among those, Sokal's Euclidean distance was shown to be the most sensitive, followed by the Morisita similarity index, and the Pinkham-Pearson index  $B_2$ . Pratt et al.'s collection dissimilarity and Clifford and Stephenson's distance measure shared the same level of sensitivity. Additionally, the Morisita similarity index and the Pinkham-Pearson index  $B_2$  were able to further differentiate similar pairs with different numbers of taxa. Morisita similarity values increased with the increase in the number of similar pairs of taxa, but decreased with an increase in the magnitude of abundance. Pinkham-Pearson index  $B_2$  values, however, decreased with an increasing number of similar taxa regardless of the magnitude of abundance. These properties of the Morisita similarity index and the Pinkham-Pearson index  $B_2$  may not be justified in a biological collection. All the similarity and dissimilarity indices were able to reflect the

differences between two communities, but only one index (Sokal's Euclidean distance) was able to measure the true dissimilarity.

The results of the Spearman rank correlation for all possible combinations of various quantitative community comparison indices for the hypothetical communities are shown in Table 4.18. Most of the indices were highly correlated among each other except for the Morisita similarity index (correlation values ranged from 0.430 to 0.795) and Sokal's Euclidean distance (correlation values ranged from -0.596 to -0.817). The next least correlated indices was the Pinkham-Pearson index B (values ranged from 0.430 to -0.981). The discrepancies were more profound than the qualitative ones. Aside from the Morisita similarity index and the Sokal's Euclidean distance, the remaining indices appeared to be correlated among each other with the lowest correlation greater than 0.7 except for one instance (Pinkham-Pearson index B and Stander's SIMI had Spearman rank correlation value equals to 0.695).

The results of the Spearman rank correlation for the field data with total macroinvertebrates, midges, and family level census are shown in Tables 4.19 through 4.21. It is evident that much lower correlation was observed with field data. It seemed that Sokal's Euclidean distance was index of its own and had very little correlation with the rest of the indices. The low correlations of the Morisita similarity index for the hypothetical communities were not observed in the field data. Correlation dropped considerably across the indices with family level census with the exception of a few correlated indices. The Morisita similarity index, Horn's simplified Morisita index, Renkonen's percent similarity, and Stander's SIMI showed notably high correlation among each other throughout the three data sets. The Bray-Curtis

index and Parrish and Wagner's average chi-square were also highly correlated throughout the three data sets. The same was true with the Pinkham-Pearson index B and Lance and Williams' Canberra metric. These two indices were highly correlated to each other throughout the three census data sets.

Based on the results of the Sign test and Spearman rank correlation and the justification mentioned in the Chapter of Materials and Methods, two diversity indices (Hurlbert's *PIE* and Brillouin's diversity index), two qualitative community comparison indices (Sørensen's quotient of similarity, revised Fager and McGowan index), and four quantitative community comparison indices (Morisita similarity index, Sokal's Euclidean distance, Pinkham-Pearson index B, and Parrish and Wagner's average chi-square) were chosen to interpret the impact of chlorinated sewage on macroinvertebrate community structure. Additionally, the general census data, abundance, species richness, and EPT were also included in the interpretation.

## 2. Interpretation of the Field Data

### a. General Census Data and Trends

A total of 45 baskets, 8037 benthic macroinvertebrates, 188 taxa, and 40 EPT (a value derived from total identified species of Ephemeroptera, Plecoptera and Tricoptera) were collected from stone-filled basket artificial substrates recovered from the Lampson Brook from October 30, 1987 to October 17, 1988. The general census data for collections of benthic macroinvertebrates from the control and four downstream stations are listed in Table 4.22.

The distribution (number of organisms and number of species belonging to these taxa) of major benthic macroinvertebrates for the entire study is presented in

Tables 4.23 and 4.24. The most prevalent organisms and species were the immature insects with relatively few other invertebrates. They comprised 72.6% to 98.2% of the total abundance and 79.4% to 93.2% of the total species richness, respectively, for a sampling station. Among those, Diptera occupied 64.6% to 92.0% of the total abundance and 56.8% to 63.4% of the total species richness, respectively. Among the Diptera, the chironomids were found to occupy 60.6% to 90.7 % of the total abundance and 50.5% to 56.2% of the total species richness. The next most important taxa were, in descending order, Ephemeroptera, Plecoptera, Tricoptera, Coleoptera, Odonata, and Megaloptera. Other than immature insects, Amphipoda and Oligochaeta were also found to be abundant at stations 3 and 4.

#### b. Density, Abundance and Species Richness

i. Non-chlorination Regime: December 22, 1987 and March 29, 1988 The average substrate densities, at each station, indicated that at station 5, population densities ( $736 \pm 153$  and  $342 \pm 122$ ) had returned to control (station 1) levels ( $347 \pm 125$  and  $388 \pm 157$ ). Both sets of replicates yielded populations of very similar magnitude. There was also agreement between replicates within each set. Analysis of early winter (December 22) substrates showed that the highest density was observed at station 2 ( $1607 \pm 259$  and  $1999 \pm 433$ ). In early spring (March 29), however, the density did not peak until station 3 ( $1686 \pm 349$ ) for stones not in mutual contact and ( $1726 \pm 319$ ) for standard exposure (Table 4.25). The abundance followed basically the same trends, with comparable organisms isolated from stations 1 and 5, and showed that the highest abundance was observed at station 2 during the winter months and at station 3 in early

spring. Species richness on average, though, was highest at station 2, followed by stations 3, 1, 4, and 5 (Table 4.26).

The abundance and species data for chironomids and their respective percent contribution are presented in Tables 4.27 and 4.28. The chironomids were most abundant at station 2 in December and at station 3 in March. Many fewer chironomids were found at stations 1 and 5. Species richness was also higher at stations 2 and 3, and lower at stations 1 and 5. It is clear that chironomids occupied a large portion of the population at stations 2 (68.9% to 93.7%), 3 (69.6% to 91.5%), and 4 (77.3% to 97.7%). At station 1, only half of the population were chironomids (34.4% to 72.0%). At station 5 the chironomids comprised 58.9% to 80.6% of the population. There was, however, no clear relationship between the abundance and species richness for the chironomid communities for each basket collection. The percent contribution of the species richness relative to its abundance varied from 50.0%:34.4% (3/29/88 standard exposure) to 52.9%:86.5% (12/22/87 replicate basket 2), respectively.

ii. Chlorination Regime: October 30, 1987 and April 14, August 22, 1988

The macroinvertebrate density values at stations 1, 4, and 5 during chlorination (except August 22) were of the same order of magnitude as during the non-chlorination treatment. During periods of chlorination, the peak values at stations 2 and 3 were depressed to less than half of the densities to their non-chlorinated counterparts (Table 4.25). Species richness was also depressed to one third at stations 2 and 3 (Table 4.26). Though macroinvertebrate abundance remained the same during chlorination



and non-chlorination period at stations 1, 4, and 5, the species richness, however, were only greatly reduced at station 4.

When comparing chlorination and non-chlorination collections made during the biologically and hydrologically stable low temperature periods (October 30, 1987 and December 22, 1987), the density peaks shifted from station 3 to station 2 and doubled in magnitude following the cessation of chlorination. Interestingly enough, the densities at station 4 and 5 also increased proportionately when chlorination ceased (Table 4.25). Species richness, though, only increased at station 2 and remained approximately the same for the rest of the stations (Table 4.26).

Chironomid populations in general were lower at stations 1 and 5. The population peak values were greatly reduced at station 2 during the chlorination period and less so for station 3. Species richness, however, was lower at station 3 than at station 2 (Table 4.27). The percent contributions of chironomid abundance and species richness during chlorination and non-chlorination regimes stayed about the same degree of magnitude at stations 1, 2, 3, and 5 with baskets retrieved before March 29, 1988. Samples collected in April, showed that midges comprised more than 81.0% of the population at all stations except for station 4. In summer collections, however, midges occupied 94.6% at station 2, approximately one third at stations 1 and 5, and only less than 20% at stations 3 and 4 (Table 4.28).

The results from the summer samples were different from the samples collected at other times of the year. Densities (Table 4.25) were an order of magnitude greater than fall, winter, and spring samples. The pattern, however, remained essentially unchanged, except that population density decreased only by half of peak values,

whereas the spring and fall values dropped to one fifth of peak values. Species richness was greatest during the summer months. More than 40 species were recovered from all the stations except for station 4 where only 13 species were found. Among these macroinvertebrates species, chironomid species comprised from 7.7% at station 4 to 71.7% at station 2.

iii. Placement Experiment: October 17, 1988 To more clearly identify the impact of the chlorinated sewage in Lampson Brook, ten substrates that were initially placed at station 1 on August 22 to allow macroinvertebrates to colonize, were netted on October 1, and subsequently removed and redeployed for 17 days at each of the four downstream stations. The observed densities followed the same sequence observed in a treatment one year earlier (October 30, 1987). Though the respective densities were consistently higher at each station, they remained lower than the non-chlorinated counterparts (Table 4.25). The species richness, however, remained high relative to the control station (Table 4.26). Chironomids clearly were reduced by much greater proportion relative to the control with respect to both abundance and species richness (Tables 4.27 and 4.28).

### c. Species Diversity

i. Non-chlorination Regime: December 22, 1987 and March 29, 1988 When applying diversity as a measure of the biological response, a somewhat different picture emerged. Brillouin's diversity did not increase with distance from the outfall (Table 4.29). Diversity peaked at either station 3 (2.0030 and 2.3216) on December 22 or at station 2 (2.8289 and 2.4099) on March 29, but never in that station supporting the highest densities. During the early winter (December 22), diversity

peaked at station 3 (2.0030 and 2.3216) and dropped gradually to below control levels at station 5 (1.3334 and 1.5702 ). The early spring data revealed the same general trend, a drop in diversity below station 3 (2.0768 and 2.2022 for station 4 and 1.7995 and 2.3473 for station 5, respectively ).

Hurlbert's diversity showed a slightly different picture (Table 4.30). Diversity remained highest at the control station both in winter (0.8987 and 0.8918) and early spring. (0.9733 and 0.9617). In winter the diversity dropped to the lowest level at station 2 (0.6380 and 0.7005), increased to near station 1 at stations 3 (0.8518 and 0.8939) and 4 (0.8033 and 0.8585) and dropped again at station 5 (0.6563 and 0.7987). In early spring, the diversity decreased gradually from station 1 (0.9733 and 0.9617) to station 4 (0.8739 and 0.8829) and rose to station 3 level at station 5 (0.8839 and 0.9364).

According to Brillouin's diversity values for midges, the percent contributions of this level of diversity were the highest at station 4 (76.0% to 95.0%), intermediate at station 3 (67.2% to 82.2%), lower at station 2 (57.5% to 78.7%), and the lowest at stations 1 (23.8% to 63.7%) and 5 (29.2% to 65.2%) (Table 4.31). Hurlbert's diversity values for the midges gave an entirely different picture (Table 4.32). In winter, the highest diversity occurred at station 3 (0.8238 and 0.8577), the next highest values were observed at stations 1 (0.7159 and 0.8360) and 4 (0.7745 and 0.8196), and the lowest at stations 2 (0.5882 and 0.6020) and 5 (0.3210 and 0.6742). In spring, however, the highest diversity occurred at station 1 (0.9739 and 0.9818) and diversity decreased from the outfall to the lowest level at station 5 (0.8233 and 0.8864).

Brillouin diversity for family level census, on the contrary, in the reverse order, stations 1 (34.2% to 68.0%) and 5 (34.8% to 70.8%) shared approximately the same level of percent contributions with their respective total macroinvertebrate populations. Percent contributions of family level diversity decreased from the outfall at stations 2 (21.1% to 40.9%) to intermediate level at station 3 (17.8% to 29.8%), and to the lowest level at station 4 (5.0% to 23.3%) (Table 4.33). Hurlbert's diversity values basically showed the same trends at family level (Table 4.33), highest values at station 1 (0.4700 to 0.8085), decreased in values, in descending order, at stations 5 (0.3527 to 0.6318), 2 (0.1217 to 0.5164), 3 (0.1629 to 0.4401), and 4 (0.0462 to 0.2198) (Table 4.34).

ii. Chlorination Regime: October 30, 1987 and April 14, August 22, 1988

As during the non-chlorination period the greatest Brillouin's diversity values for total macroinvertebrates (except during the summer, August 22) occurred at stations 2 (2.2503 and 2.2207 for October collection and 2.0944 for April collection) (Table 4.29). Surprisingly, diversity values were generally lower during this period. In October collection Hurlbert's diversity, however, was the highest at station 1 (0.9436 and 0.9300) and decreased from the outfall to the lowest level at station 5 (0.5820 and 0.6129). In spring, the highest diversity occurred at station 5 (0.9364) and the lowest at station 4 (0.5091) (Table 4.30).

The percent contributions of midge diversity in October collection showed that, in general, stations 2, 3, and 4 had higher values than stations 1 and 5. In April and the summer, the lowest values occurred at station 4 (42.8% and 0.0%, respectively) (Table 4.31). Hurlbert's diversity values for midges showed exactly

same trends as total macroinvertebrates for October collection. In April, midges were the most diverse at station 5 (0.9265), and the least at station 3 (0.6764). In summer, no midge diversity was observed at all at station 4 (0.0000), and the highest diversity occurred at station 1 (0.8925) (Table 4.32).

The percent contributions of family level diversity were approximately the same as during the non-chlorination regime except for April and summer collections where the highest values were observed at either stations 2 (75.5%) or 3 (57.2% and 73.9%) (Table 4.33). Hurlbert's diversity values at the family level indicated that October collections at station 1 (0.7603 and 0.6600) were approximately one third to one half higher than the rest of the stations both in winter and early spring. In summer, the peak occurred at stations 3 (0.7985) and 4 (0.7407) (Table 4.34).

iii. Placement Experiment: October 17, 1988 The results indicated that chlorinated sewage exerted very little impact on total macroinvertebrate with regard to Brillouin diversity (Table 4.29). The biggest drop in diversity (from 2.4490 at control to 2.2882 at station 2) was less than 10% (6.56%), in fact diversity increased at two downstream stations, stations 3 (2.4560) and 5 (2.6052). With Hurlbert's diversity, the biggest drop occurred at station 3 (from 0.9147 at control to 0.8797) and was less than 5% (3.83%) compared to the control station (0.9147). Only station 5 showed an increase in Hurlbert's diversity (Table 4.30).

The percent contributions of midge diversity, though, according to Brillouin diversity, were all depressed at downstream stations compared to the control (Table 4.31). Hurlbert's Diversity for midges only showed depression at stations 2, 3, and 4 (Table 4.32).

The percent contributions of Brillouin's diversity at the family level showed that all downstream stations increased more than one half of that of control (Table 4.33). Hurlbert's diversity also showed increase in diversity values at downstream stations (Table 4.34).

#### d. Community Comparison

i. Non-chlorination Regime: December 22, 1987 and March 29, 1988 With regard to qualitative community comparison indices (Sørensen's quotient of similarity and revised Fager and McGowan index), both indices gave a similar assessment between upstream and downstream populations of total macroinvertebrates (Tables 4.35 and 4.36). In winter, station 2 was the most similar to station 1, and station 3 was the least similar. In spring, however, station 4 was the most similar to station 1, and station 5 was the least similar. Both indices also gave consistent assessment of midge populations upstream and downstream (Tables 4.37 and 4.38). In winter, station 2 had the most similar midge populations to station 1, and station 5, the least similar. In spring, though, stations 3 or 4 had the most similar midge populations to station 1, and station 5 had the least similar midge populations. Family level similarities, in winter, also showed the highest values at station 2, and the lowest at station 3. In spring, however, the highest values occurred at station 5, just the opposite to the similarity values for total macroinvertebrates and midges, and the lowest at station 4 (Tables 4.39 and 4.40).

Examination of quantitative community comparison indices (Morisita similarity index, Sokal's Euclidean distance, Pinkham-Pearson index B, and Parrish and Wagner's average chi-square) indicated that there were considerable variations in

assessing the upstream and downstream populations of total macroinvertebrates (Tables 4.41 through 4.44), midges (Tables 4.45 through 4.48), and macroinvertebrate families (Tables 4.49 through 4.52). This is not all surprising because of the poor Spearman rank correlation observed with the field data among these indices.

With regard to Morisita similarity values as an index of evaluation during non-chlorination regime, two different trends were observed during non-chlorination regime. The winter macroinvertebrate populations became increasingly dissimilar from control station with distance from the outfall. It then became more similar at station 5. The spring populations, however, became less similar with distance from the outfall, with the greatest dissimilarity occurring at station 5 (Table 4.41).

In winter, with regard to Sokal's Euclidean distance values, station 2 was the most dissimilar, and stations 3 and 4 were the least dissimilar. In spring, however, the most dissimilar macroinvertebrate populations occurred at station 3, and stations 2 and 5 were the least dissimilar (Table 4.42).

The Pinkham-Pearson index B values indicated that in winter macroinvertebrate populations were the most similar at station 2 and the least similar at station 3. In spring, station 4 was the most similar to station 1 and either stations 3 or 5, the least similar (Table 4.43).

The Average chi-square index values showed that, in winter, either stations 2 or 3 were the most dissimilar to station 1 and station 5, the least dissimilar. In spring, station 3 was the most dissimilar to station 1 and station 2 the least dissimilar (Table 4.44).

In winter, midge populations at station 2, according to the Morisita similarity index values, were the most similar to station 1 and the least similar at station 4. In spring, midge populations at station 3 were the most similar to station 1 and at station 5, the least similar (Table 4.45).

Sokal's Euclidean distance values indicated that, in winter, midge populations at station 2 were the most dissimilar to station 1. In spring station 3 was the most dissimilar to station 1 (Table 4.46)

The Pinkham-Pearson index B values for midge populations showed the highest similarity at either stations 2 or 3 in winter, and the highest similarity at station 4 in spring (Table 4.47).

The average chi-square index values indicated that midge populations at station 2 were the most dissimilar to station 1 in winter, and at station 3, the most dissimilar in spring (Table 4.48).

The Morisita similarity index values calculated for the macroinvertebrate families were the highest at station 5 in winter. Stations 2, 3, and 4 had the same level of similarity values. In spring, stations 2 and 5 had the highest similarity values and lower at stations 3 and 4 (Table 4.49). The differences between these similarity values were much smaller than the values obtained from total macroinvertebrates and midges data.

The dissimilarity values obtained from Sokal's Euclidean distance for macroinvertebrate families had the similar assessment with those values obtained for total macroinvertebrates and midges, with the highest similarity values at station 2 in winter and at station 3 in spring (Table 4.50).



ii. Chlorination Regime: October 30, 1987 and April 14, August 22, 1988

Sørensen's quotient of similarity and revised Fager and McGowan index also gave consistent assessment total macroinvertebrate populations upstream and downstream (Tables 4.35 and 4.36). In fall, all the downstream stations had very close similarity values compared to the control. On April 14, 14 days after the chlorination resumed, station 2 were the most similar to station 1. After 4 months of chlorination, in summer, the similarities remained the highest at stations 2. Same phenomenon was observed for the midge populations and family level census (Tables 4.37 through 4.40).

The same statement can be made with regard to the inconsistency of similarity/dissimilarity assessment of upstream and downstream populations of total macroinvertebrate, midge, and macroinvertebrate family with quantitative community comparison indices during the chlorination regime (Tables 4.41 through 4.52). Overall, the inconsistent trends of similarity/dissimilarity values were observed throughout the indices across all three data sets.

According to Morisita similarity index values, the total macroinvertebrate populations at either stations 2 or 3 were the most similar to station 1 in spring. On April 14, 14 days after chlorination resumed, station 2 still had the most similar macroinvertebrate community. In summer, after 4 months of chlorination, at least half of the populations found at station 1 were replaced by other macroinvertebrates (Table 4.41).

Sokal's Euclidean distance values indicated that macroinvertebrate populations at station 3 were the most dissimilar to station 1 in fall. On April 14, station 2 was

the least dissimilar to station 1 and became the most dissimilar in summer after 4 months of chlorination (Table 4.42).

The Pinkham-Pearson index B values obtained for total macroinvertebrates did not show big differences in similarity among all the stations on October, 30 1987 collections. On April 14, 1988, 14 days after chlorination resumed, station 2 was the most similar to station 1. On August, 22, 4 months after chlorination, station 5 became the most similar to station 1 (Table 4.43).

The average chi-Square index values for total macroinvertebrates also did not show big differences in dissimilarity among all the stations on October, 10, 1987 collections. On April, 14, 1988, macroinvertebrate populations were the most dissimilar at station 5 and the least dissimilar at station 2. On August, 22, however, macroinvertebrate populations were the most dissimilar at station 4 and the least dissimilar at station 5 (Table 4.44)

The Morisita similarity index values for midge populations indicated that, in fall, either stations 2 or 3 were the most similar to station 1. On April 14, midges populations were the most similar at station 2 and the least similar at station 5. On August 22, midge populations became the most similar at station 5 and the least similar at station 4 (Table 4.45).

Sokal's Euclidean distance index values showed that, in October, midge populations at station 3 were the most dissimilar to station 1, and station 2 were the least dissimilar. In April, midge populations remained the most dissimilar at station 3, and the least dissimilar at station 2. In August, however, midge populations became the most dissimilar at station 2 and the least dissimilar at station 3 (Table 4.46).

The Pinkham-Pearson index B values for midge populations showed that, in October, either stations 2 or 5 were the most similar to station 1. In the following April, station 2 was the most similar to station 1. In August, station 3 was the most similar to station 1 (Table 4.47).

In October, the average chi-square index values, though, showed the highest dissimilarity with midge populations at station 5. In the following April, the highest dissimilarity occurred at station 5 and the lowest at station 2. In August, the highest dissimilarity occurred at station 4 and the lowest at station at station 3 (Table 4.48).

The Morisita similarity index values for macroinvertebrate families constantly showed the highest values at station 5 both in October, April, and August. The least similar station, though, varied at different sampling dates (Table 4.49).

Sokal's Euclidean distance values indicated that, in October and April, station 3 had the most dissimilar macroinvertebrate families and either stations 5 or 2 the least dissimilar in October or April, respectively. In August, station 2 was the most dissimilar and station 4 the least dissimilar (Table 4.50).

The Pinkham-Pearson index B values showed that macroinvertebrate families at station 5 were the most similar to station 1 in October, station 2 in April, and station 5 in August, respectively; stations 3 or 4 were the least similar to station 1 in October, station 3 in April, and station 4 in August (Table 4.51).

The average chi-square index values showed that macroinvertebrate families at station 3 were the most dissimilar to station 1 in October, station 4 in April and in August, respectively. Macroinvertebrate families at station 2 were the least dissimilar to station 1 in October, station 2 in April, and station 5 in August (Table 4.52).

indices (Sørensen's quotient of similarity, the Fager and McGowan index, the Morisita similarity index, Sokal's Euclidean distance, the Pinkham-Pearson index B, and the average chi-square) showed basically the similar assessment for the populations of macroinvertebrate or midge, they were the most similar either at station 2 or at station 5 (Tables 4.35 through 4.38 and Tables 4.41 through 4.48). The similarity/dissimilarity values obtained for populations of macroinvertebrate families varied between qualitative and quantitative indices. Sørensen's quotient of similarity and the revised Fager and McGowan index showed that macroinvertebrate families at stations 3 and 5 were more similar to station 1 whereas macroinvertebrate families at stations 2 and 4 were less similar to station 1 (Tables 4.39 through 4.40).

Quantitative community comparison indices also showed consistent assessment among themselves except for Sokal's Euclidean distance. The Morisita similarity index, the Pinkham-Pearson index B and the average chi-square showed that macroinvertebrate families at station 5 were the most similar to station 1 whereas Sokal's Euclidean distance indicated that macroinvertebrate families at station 4 were the most similar to station 1 (Tables 4.49 through 4.52).

e. EPT

It is clear that during the non-chlorination regime, stations 1 and 2 shared approximately the same EPT values (average EPT equal 6 at station 1 and 7.2 at station 2). However, when chlorination resumed, the average EPT value at station 2 was depressed to approximately 10 fold of that of control (Table 4.53). Stations 3, 4, and 5 appeared to have similar average EPT values during chlorination and

non-chlorination periods. There was partial recovery, about two thirds of the control level, of the EPT at station 5.

Table 4.1 Analysis of water quality of selected stations along Lampson Brook from September 25, 1987 to October 29, 1987. All the data are presented as average  $\pm$  S.D. in mg/l unless otherwise indicated.

| Measure/Site               | Station 1       | WWTP              | Station 2         | Station 3         | Station 4         | Station 5         |
|----------------------------|-----------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Distance (meters)          | 0               | 60                | 120               | 950               | 1100              | 3100              |
| Temperature (°C)           | 12.4 $\pm$ 2.8  | 14.6 $\pm$ 2.4    | 12.8 $\pm$ 2.3    | 11.8 $\pm$ 2.3    | 12.3 $\pm$ 2.6    | 11.6 $\pm$ 2.6    |
| D.O. (mg/l)                | 9.10 $\pm$ 0.14 | 8.26 $\pm$ 1.00   | 8.49 $\pm$ 0.95   | 6.36 $\pm$ 0.85   | 6.40 $\pm$ 0.76   | 9.18 $\pm$ 0.66   |
| D.O. (% saturation)        | 86 $\pm$ 4      | 81 $\pm$ 9        | 80 $\pm$ 7        | 59 $\pm$ 5        | 59 $\pm$ 4        | 84 $\pm$ 4        |
| pH                         | 6.84 $\pm$ 0.32 | 6.76 $\pm$ 0.05   | 7.00 $\pm$ 0.23   | 6.69 $\pm$ 0.32   | 6.70 $\pm$ 0.40   | 6.92 $\pm$ 0.26   |
| Free chlorine (mg/l)       | 0               | 0.052 $\pm$ 0.016 | 0.024 $\pm$ 0.020 | 0                 | 0                 | 0                 |
| Monochloramine (mg/l)      | 0               | 2.585 $\pm$ 0.224 | 0.515 $\pm$ 0.301 | 0.005 $\pm$ 0.006 | 0.011 $\pm$ 0.020 | 0.006 $\pm$ 0.012 |
| Dichloramine (mg/l)        | 0               | 0.320 $\pm$ 0.093 | 0.076 $\pm$ 0.041 | 0.005 $\pm$ 0.006 | 0.006 $\pm$ 0.007 | 0.003 $\pm$ 0.004 |
| Trichloramine (mg/l)       | 0               | 0                 | 0                 | 0                 | 0                 | 0                 |
| TRC (mg/l)                 | 0               | 2.957 $\pm$ 0.238 | 0.791 $\pm$ 0.062 | 0.010 $\pm$ 0.011 | 0.017 $\pm$ 0.018 | 0.009 $\pm$ 0.014 |
| Fecal coliform (no./10 ml) | 21 $\pm$ 10     | 0                 | 6 $\pm$ 1         | 12 $\pm$ 7        | 13 $\pm$ 9        | 15 $\pm$ 13       |
| B.O.D. (mg/l)              | 2.93 $\pm$ 1.17 | 5.27 $\pm$ 2.57   | 4.04 $\pm$ 2.63   | 2.35 $\pm$ 1.62   | 2.28 $\pm$ 1.29   | 2.53 $\pm$ 1.31   |

Continued, next page.

Table 4.1 (Continued).

| Measure/Site                                   | Station 1  | WWTP        | Station 2  | Station 3  | Station 4  | Station 5  |
|--|------------|-------------|------------|------------|------------|------------|
| Distance (meters)                              | 0          | 60          | 120        | 950        | 1100       | 3100       |
| Acidity (mg CaCO <sub>3</sub> /l)<br>pH=8.3    | 3.32+1.46  | 7.40+2.65   | 4.37+1.85  | 8.09+2.21  | 8.67+2.61  | 4.42+1.74  |
| Alkalinity (mg CaCO <sub>3</sub> /l)<br>pH=4.5 | 40.5+6.6   | 41.6+0.8    | 43.3+2.1   | 37.1+2.4   | 37.3+1.6   | 31.2+2.4   |
| Ammonia (mg/l)                                 | 0.07+0.03  | 1.05+0.43   | 0.46+0.24  | 0.16+0.14  | 0.15+0.10  | 0.14+0.12  |
| Nitrate (mg/l)                                 | 0.03+0.01  | 0.80+0.20   | 0.33+0.12  | 0.20+0.08  | 0.20+0.10  | 0.05+0.03  |
| Phosphorus Total (mg/l)                        | 0.07+0.02  | 2.01+0.13   | 0.95+0.10  | 0.52+0.10  | 0.51+0.09  | 0.29+0.10  |
| Calcium (mg Ca/l)                              | 24.22+4.58 | 25.30+15.96 | 23.85+7.80 | 22.13+6.48 | 22.37+6.11 | 17.65+5.16 |
| Hardness (mg CaCO <sub>3</sub> /l)             | 81.44+3.51 | 71.92+2.72  | 79.36+3.99 | 74.80+4.34 | 71.92+3.81 | 61.99+5.32 |
| Chloride (mg/l)                                | 40.00+6.67 | 56.92+1.25  | 43.36+4.19 | 39.24+4.45 | 36.29+4.24 | 28.13+2.29 |
| Total solids (mg/l)                            | 170+19     | 271+35      | 211+18     | 175+22     | 180+19     | 130+36     |
| Suspended solids (mg/l)                        | 1.2+0.5    | 4.9+3.8     | 2.8+2.6    | 1.2+0.3    | 1.4+0.5    | 2.2+1.7    |

Table 4.2 Analysis of water quality of selected stations along Lampson Brook from November 19, 1987 to December 17, 1987. All the data are presented as average  $\pm$  S.D. in mg/l unless otherwise indicated.

| Measure/Site               | Station 1        | WWTP            | Station 2        | Station 3       | Station 4       | Station 5        |
|----------------------------|------------------|-----------------|------------------|-----------------|-----------------|------------------|
| Distance (meters)          | 0                | 60              | 120              | 950             | 1100            | 3100             |
| Temperature (°C)           | 5.1 $\pm$ 1.8    | 7.1 $\pm$ 2.1   | 4.9 $\pm$ 1.3    | 4.8 $\pm$ 2.3   | 4.5 $\pm$ 2.4   | 4.8 $\pm$ 2.3    |
| D.O. (mg/l)                | 11.17 $\pm$ 0.59 | 9.36 $\pm$ 0.53 | 10.75 $\pm$ 0.42 | 8.62 $\pm$ 0.45 | 8.70 $\pm$ 0.47 | 10.96 $\pm$ 0.41 |
| D.O. (% saturation)        | 88 $\pm$ 4       | 79 $\pm$ 8      | 86 $\pm$ 4       | 67 $\pm$ 3      | 67 $\pm$ 3      | 85 $\pm$ 5       |
| pH                         | 6.94 $\pm$ 0.12  | 6.81 $\pm$ 0.10 | 7.00 $\pm$ 0.15  | 6.71 $\pm$ 0.12 | 6.62 $\pm$ 0.20 | 6.84 $\pm$ 0.16  |
| Free chlorine (mg/l)       | ----             | ----            | ----             | ----            | ----            | ----             |
| Monochloramine (mg/l)      | ----             | ----            | ----             | ----            | ----            | ----             |
| Dichloramine (mg/l)        | ----             | ----            | ----             | ----            | ----            | ----             |
| Trichloramine (mg/l)       | ----             | ----            | ----             | ----            | ----            | ----             |
| TRC (mg/l)                 | ----             | ----            | ----             | ----            | ----            | ----             |
| Fecal coliform (no./10 ml) | 10 $\pm$ 3       | 236 $\pm$ 187   | 98 $\pm$ 79      | 98 $\pm$ 19     | 19 $\pm$ 14     | 9 $\pm$ 2        |
| B.O.D. (mg/l)              | 2.42 $\pm$ 0.46  | 5.33 $\pm$ 0.10 | 3.43 $\pm$ 0.60  | 2.13 $\pm$ 0.40 | 2.06 $\pm$ 0.53 | 3.35 $\pm$ 0.27  |

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Table 4.2 (Continued).

| Measure/Site                                   | Station 1  | WWTP       | Station 2  | Station 3  | Station 4   | Station 5  |
|--|------------|------------|------------|------------|-------------|------------|
| Distance (meters)                              | 0          | 60         | 120        | 950        | 1100        | 3100       |
| Acidity (mg CaCO <sub>3</sub> /l)<br>pH=8.3    | 5.46±0.47  | 11.10±1.71 | 6.34±0.90  | 10.29±2.39 | 10.74±2.54  | 5.91±1.69  |
| Alkalinity (mg CaCO <sub>3</sub> /l)<br>pH=4.5 | 36.34±2.52 | 52.30±7.91 | 38.33±3.20 | 29.99±2.27 | 29.33±5.28  | 24.58±1.80 |
| Ammonia (mg/l)                                 | 0.10±0.07  | 0.97±0.48  | 0.30±0.16  | 0.13±0.09  | 0.10±0.08   | 0.09±0.05  |
| Nitrate (mg/l)                                 | 0.04±0.00  | 0.78±0.14  | 0.23±0.05  | 0.14±0.02  | 0.13±0.01   | 0.08±0.02  |
| Phosphorus Total (mg/l)                        | 0.08±0.02  | 2.01±0.15  | 0.70±0.07  | 0.37±0.04  | 0.35±0.07   | 0.21±0.05  |
| Calcium (mg Ca/l)                              | 16.72±0.66 | 16.25±0.71 | 16.88±0.82 | 14.80±0.91 | 14.78±0.84  | 11.38±0.64 |
| Hardness (mg CaCO <sub>3</sub> /l)             | 67.76±2.21 | 72.00±2.50 | 72.56±7.08 | 60.64±3.09 | 71.92±13.54 | 49.36±3.13 |
| Chloride (mg/l)                                | 28.87±0.63 | 51.64±2.36 | 35.07±0.77 | 28.85±1.65 | 28.54±1.21  | 22.02±1.31 |
| Total solids (mg/l)                            | 159±45     | 264±43     | 187±34     | 164±38     | 169±36      | 152±34     |
| Suspended solids (mg/l)                        | 1.4±0.4    | 2.9±0.8    | 1.5±0.5    | 1.5±1.0    | 0.9±0.2     | 1.0±0.5    |

Table 4.3 Analysis of water quality of selected stations along Lampson Brook from February 25, 1988 to March 29, 1988. All the data are presented as average  $\pm$  S.D. in mg/l unless otherwise indicated.

| Measure/Site               | Station 1        | WWTP            | Station 2        | Station 3        | Station 4        | Station 5        |
|----------------------------|------------------|-----------------|------------------|------------------|------------------|------------------|
| Distance (meters)          | 0                | 60              | 120              | 950              | 1100             | 3100             |
| Temperature (°C)           | 4.0 $\pm$ 0.8    | 6.5 $\pm$ 1.1   | 5.9 $\pm$ 2.2    | 5.1 $\pm$ 2.7    | 5.4 $\pm$ 2.8    | 4.1 $\pm$ 2.1    |
| D.O. (mg/l)                | 11.42 $\pm$ 0.58 | 9.78 $\pm$ 0.63 | 11.02 $\pm$ 0.50 | 10.94 $\pm$ 0.37 | 10.80 $\pm$ 0.92 | 11.58 $\pm$ 0.41 |
| D.O. (% saturation)        | 90 $\pm$ 2       | 81 $\pm$ 1      | 87 $\pm$ 2       | 86 $\pm$ 8       | 83 $\pm$ 6       | 89 $\pm$ 2       |
| pH                         | 7.28 $\pm$ 0.11  | 7.13 $\pm$ 0.05 | 7.29 $\pm$ 0.05  | 6.94 $\pm$ 0.06  | 6.92 $\pm$ 0.08  | 7.06 $\pm$ 0.10  |
| Free chlorine (mg/l)       | ----             | ----            | ----             | ----             | ----             | ----             |
| Monochloramine (mg/l)      | ----             | ----            | ----             | ----             | ----             | ----             |
| Dichloramine (mg/l)        | ----             | ----            | ----             | ----             | ----             | ----             |
| Trichloramine (mg/l)       | ----             | ----            | ----             | ----             | ----             | ----             |
| TRC (mg/l)                 | ----             | ----            | ----             | ----             | ----             | ----             |
| Fecal coliform (no./10 ml) | 3 $\pm$ 6        | 40 $\pm$ 29     | 17 $\pm$ 15      | 7 $\pm$ 9        | 8 $\pm$ 6        | 2 $\pm$ 2        |
| B.O.D. (mg/l)              | 1.63 $\pm$ 0.76  | 5.04 $\pm$ 0.62 | 2.90 $\pm$ 0.73  | 1.89 $\pm$ 0.47  | 2.24 $\pm$ 0.70  | 1.60 $\pm$ 0.73  |

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Table 4.3 (Continued).

| Measure/Site                                   | Station 1  | WWTP       | Station 2  | Station 3  | Station 4  | Station 5  |
|--|------------|------------|------------|------------|------------|------------|
| Distance (meters)                              | 0          | 60         | 120        | 950        | 1100       | 3100       |
| Acidity (mg CaCO <sub>3</sub> /l)<br>pH=8.3    | 3.52±0.35  | 10.84±3.23 | 4.91±0.35  | 8.55±2.06  | 8.82±2.41  | 4.73±1.22  |
| Alkalinity (mg CaCO <sub>3</sub> /l)<br>pH=4.5 | 30.82±3.24 | 58.34±3.65 | 33.89±2.14 | 27.89±2.88 | 28.80±2.29 | 22.13±1.75 |
| Ammonia (mg/l)                                 | 0.20±0.10  | 2.47±0.95  | 0.40±0.32  | 0.29±0.20  | 0.28±0.14  | 0.29±0.18  |
| Nitrate (mg/l)                                 | 0.36±0.06  | 1.07±0.55  | 0.56±0.10  | 0.46±0.07  | 0.46±0.06  | 0.40±0.04  |
| Phosphorus Total (mg/l)                        | 0.09±0.06  | 1.79±0.19  | 0.43±0.08  | 0.31±0.10  | 0.28±0.03  | 0.14±0.03  |
| Calcium (mg Ca/l)                              | 13.71±0.95 | 17.06±0.72 | 14.58±1.00 | 12.95±0.94 | 13.53±1.99 | 9.06±2.04  |
| Hardness (mg CaCO <sub>3</sub> /l)             | 62.40±6.40 | 74.24±1.80 | 61.52±4.60 | 54.48±3.80 | 55.60±4.90 | 46.60±2.70 |
| Chloride (mg/l)                                | 29.37±5.40 | 59.75±2.52 | 35.36±5.28 | 29.17±4.61 | 30.11±5.09 | 25.73±7.02 |
| Total solids (mg/l)                            | 167±78     | 227±31     | 155±42     | 127±45     | 131±42     | 108±44     |
| Suspended solids (mg/l)                        | 10.2±9.5   | 6.6±4.9    | 9.8±6.7    | 2.8±1.5    | 2.5±1.4    | 5.3±4.3    |

Table 4.4 Analysis of water quality of selected stations along Lampson Brook from April 1, 1988 to April 14, 1988. All the data are presented as average  $\pm$  S.D. in mg/l unless otherwise indicated.

| Measure/Site               | Station 1         | WWTP              | Station 2         | Station 3         | Station 4         | Station 5        |
|----------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------------------|
| Distance (meters)          | 0                 | 60                | 120               | 950               | 1100              | 3100             |
| Temperature (°C)           | 11.2 $\pm$ 1.7    | 14.7 $\pm$ 0.9    | 12.4 $\pm$ 0.9    | 13.8 $\pm$ 0.3    | 13.5 $\pm$ 0.4    | 11.9 $\pm$ 0.2   |
| D.O. (mg/l)                | 9.50 $\pm$ 0.10   | 9.75 $\pm$ 1.45   | 9.70 $\pm$ 0.30   | 9.10 $\pm$ 0.40   | 9.48 $\pm$ 0.37   | 10.43 $\pm$ 0.92 |
| D.O. (% saturation)        | 86 $\pm$ 2        | 96 $\pm$ 16       | 90 $\pm$ 2        | 88 $\pm$ 4        | 91 $\pm$ 3        | 96 $\pm$ 8       |
| pH                         | 7.43 $\pm$ 0.05   | 7.37 $\pm$ 0.19   | 7.47 $\pm$ 0.03   | 7.15 $\pm$ 0.03   | 7.12 $\pm$ 0.02   | 7.39 $\pm$ 0.10  |
| Free chlorine (mg/l)       | 0                 | 0                 | 0                 | 0                 | 0                 | 0                |
| Monochloramine (mg/l)      | 0                 | 0.983 $\pm$ 0.176 | 0.277 $\pm$ 0.058 | 0.010 $\pm$ 0.022 | 0                 | 0                |
| Dichloramine (mg/l)        | 0.06 $\pm$ 0.085  | 0.187 $\pm$ 0.033 | 0.048 $\pm$ 0.011 | 0.015 $\pm$ 0.007 | 0.015 $\pm$ 0.007 | 0                |
| Trichloramine (mg/l)       | 0                 | 0                 | 0                 | 0                 | 0                 | 0                |
| TRC (mg/l)                 | 0.060 $\pm$ 0.085 | 1.168 $\pm$ 0.183 | 0.325 $\pm$ 0.062 | 0.025 $\pm$ 0.025 | 0.015 $\pm$ 0.007 | 0                |
| Fecal coliform (no./10 ml) | 1 $\pm$ 1         | 0                 | 1 $\pm$ 1         | 0                 | 0                 | 1 $\pm$ 0        |
| B.O.D. (mg/l)              | 1.45 $\pm$ 0.35   | 4.78 $\pm$ 0.07   | 2.55 $\pm$ 0.45   | 1.98 $\pm$ 0.57   | 1.55 $\pm$ 0.05   | 1.48 $\pm$ 0.27  |

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Table 4.4 (Continued).

| Measure/Site                                   | Station 1              | WWTP                   | Station 2              | Station 3              | Station 4              | Station 5              |
|--|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Distance (meters)                              | 0                      | 60                     | 120                    | 950                    | 1100                   | 3100                   |
| Acidity (mg CaCO <sub>3</sub> /l)<br>pH=8.3    | 2.95 <sub>+0.47</sub>  | 8.08 <sub>+3.32</sub>  | 3.90 <sub>+1.42</sub>  | 6.59 <sub>+0.64</sub>  | 7.03 <sub>+0.19</sub>  | 2.52 <sub>+0.81</sub>  |
| Alkalinity (mg CaCO <sub>3</sub> /l)<br>pH=4.5 | 37.10 <sub>+5.54</sub> | 59.33 <sub>+2.20</sub> | 37.80 <sub>+1.05</sub> | 33.08 <sub>+4.72</sub> | 32.97 <sub>+4.20</sub> | 24.68 <sub>+2.20</sub> |
| Ammonia (mg/l)                                 | 0.40 <sub>+0.13</sub>  | 1.39 <sub>+0.32</sub>  | 0.50 <sub>+0.18</sub>  | 0.23 <sub>+0.00</sub>  | 0.27 <sub>+0.15</sub>  | 0.13 <sub>+0.13</sub>  |
| Nitrate (mg/l)                                 | 0.16 <sub>+0.01</sub>  | 0.55 <sub>+0.03</sub>  | 0.30 <sub>+0.00</sub>  | 0.30 <sub>+0.10</sub>  | 0.37 <sub>+0.15</sub>  | 0.22 <sub>+0.05</sub>  |
| Phosphorus Total (mg/l)                        | 0.05 <sub>+0.03</sub>  | 2.12 <sub>+0.36</sub>  | 0.67 <sub>+0.02</sub>  | 0.40 <sub>+0.04</sub>  | 0.19 <sub>+0.15</sub>  | 0.19 <sub>+0.01</sub>  |
| Calcium (mg Ca/l)                              | 16.84 <sub>+1.68</sub> | 19.24 <sub>+2.56</sub> | 15.39 <sub>+0.16</sub> | 15.79 <sub>+3.53</sub> | 14.23 <sub>+1.00</sub> | 10.90 <sub>+0.64</sub> |
| Hardness (mg CaCO <sub>3</sub> /l)             | 61.00 <sub>+1.40</sub> | 77.80 <sub>+1.80</sub> | 63.60 <sub>+2.00</sub> | 57.20 <sub>+9.20</sub> | 59.20 <sub>+4.00</sub> | 48.60 <sub>+3.00</sub> |
| Chloride (mg/l)                                | 32.14 <sub>+4.50</sub> | 64.08 <sub>+0.80</sub> | 40.89 <sub>+3.70</sub> | 32.07 <sub>+5.58</sub> | 31.77 <sub>+4.97</sub> | 23.17 <sub>+3.97</sub> |
| Total solids (mg/l)                            | 182 <sub>+51</sub>     | 283 <sub>+31</sub>     | 194 <sub>+27</sub>     | 169 <sub>+37</sub>     | 159 <sub>+20</sub>     | 161 <sub>+52</sub>     |
| Suspended solids (mg/l)                        | 7.0 <sub>+1.8</sub>    | 4.7 <sub>+1.0</sub>    | 13.0 <sub>+8.0</sub>   | 1.5 <sub>+0.3</sub>    | 2.6 <sub>+0.3</sub>    | 4.9 <sub>+2.7</sub>    |

Table 4.5 Analysis of water quality of selected stations along Lampson Brook from July, 20, 1988 to August, 20, 1988. All the data are presented as average  $\pm$  S.D. in mg/l unless otherwise indicated.

| Measure/Site               | Station 1       | WWTP              | Station 2         | Station 3         | Station 4         | Station 5         |
|----------------------------|-----------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Distance (meters)          | 0               | 60                | 120               | 950               | 1100              | 3100              |
| Temperature (°C)           | 21.4 $\pm$ 2.6  | 25.1 $\pm$ 2.4    | 24.0 $\pm$ 2.4    | 24.3 $\pm$ 2.8    | 23.9 $\pm$ 3.2    | 25.4 $\pm$ 3.3    |
| D.O. (mg/l)                | 7.23 $\pm$ 0.87 | 4.78 $\pm$ 0.68   | 5.27 $\pm$ 1.03   | 1.42 $\pm$ 0.47   | 1.13 $\pm$ 0.50   | 6.19 $\pm$ 0.33   |
| D.O. (% saturation)        | 80 $\pm$ 6      | 57 $\pm$ 8        | 62 $\pm$ 12       | 17 $\pm$ 5        | 13 $\pm$ 6        | 75 $\pm$ 4        |
| pH                         | 7.36 $\pm$ 0.15 | 6.91 $\pm$ 0.10   | 7.13 $\pm$ 0.08   | 6.83 $\pm$ 0.12   | 6.72 $\pm$ 0.13   | 7.32 $\pm$ 0.15   |
| Free chlorine (mg/l)       | 0               | 0                 | 0                 | 0                 | 0                 | 0                 |
| Monochloramine (mg/l)      | 0               | 0.502 $\pm$ 0.235 | 0.208 $\pm$ 0.115 | 0.018 $\pm$ 0.013 | 0.004 $\pm$ 0.007 | 0.020 $\pm$ 0.015 |
| Dichloramine (mg/l)        | 0               | 0.128 $\pm$ 0.071 | 0.046 $\pm$ 0.026 | 0.014 $\pm$ 0.011 | 0.016 $\pm$ 0.012 | 0.016 $\pm$ 0.014 |
| Trichloramine (mg/l)       | 0               | 0                 | 0                 | 0                 | 0                 | 0                 |
| TRC (mg/l)                 | 0               | 0.630 $\pm$ 0.297 | 0.254 $\pm$ 0.140 | 0.032 $\pm$ 0.024 | 0.020 $\pm$ 0.017 | 0.036 $\pm$ 0.029 |
| Fecal coliform (no./10 ml) | 27 $\pm$ 11     | 60 $\pm$ 119      | 58 $\pm$ 90       | 8 $\pm$ 3         | 6 $\pm$ 2         | 19 $\pm$ 5        |
| B.O.D. (mg/l)              | 2.12 $\pm$ 0.41 | 5.98 $\pm$ 0.47   | 3.86 $\pm$ 0.49   | 2.74 $\pm$ 0.11   | 2.68 $\pm$ 0.32   | 2.48 $\pm$ 0.40   |

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Table 4.5 (Continued).

| Measure/Site                                   | Station 1   | WWTP       | Station 2  | Station 3   | Station 4  | Station 5  |
|--|-------------|------------|------------|-------------|------------|------------|
| Distance (meters)                              | 0           | 60         | 120        | 950         | 1100       | 3100       |
| Acidity (mg CaCO <sub>3</sub> /l)<br>pH=8.3    | 4.23±0.64   | 17.54±4.48 | 9.69±2.58  | 13.91±2.21  | 15.41±1.86 | 4.15±0.55  |
| Alkalinity (mg CaCO <sub>3</sub> /l)<br>pH=4.5 | 43.97±2.90  | 66.42±1.58 | 53.06±3.97 | 45.89±6.66  | 46.13±6.19 | 39.30±3.46 |
| Ammonia (mg/l)                                 | 0.35±0.12   | 1.62±0.32  | 0.79±0.17  | 0.50±0.06   | 0.38±0.21  | 0.11±0.21  |
| Nitrate (mg/l)                                 | 0.14±0.03   | 1.08±0.27  | 0.61±0.17  | 0.33±0.05   | 0.39±0.10  | 0.12±0.04  |
| Phosphorus Total (mg/l)                        | 0.11±0.02   | 2.39±0.20  | 1.57±0.39  | 1.03±0.25   | 1.06±0.34  | 0.25±0.03  |
| Calcium (mg Ca/l)                              | 19.06±3.63  | 19.32±1.74 | 18.40±2.14 | 16.45±5.14  | 16.47±2.81 | 13.69±2.54 |
| Hardness (mg CaCO <sub>3</sub> /l)             | 75.68±12.51 | 76.00±1.13 | 73.88±7.07 | 66.32±15.71 | 69.20±9.58 | 57.76±7.25 |
| Chloride (mg/l)                                | 39.24±3.49  | 59.93±4.92 | 46.39±3.99 | 31.99±4.99  | 33.79±5.92 | 24.29±3.23 |
| Total solids (mg/l)                            | 225±28      | 257±25     | 232±25     | 202±36      | 204±32     | 161±31     |
| Suspended solids (mg/l)                        | 1.5±1.0     | 5.0±0.6    | 6.4±3.0    | 1.8±0.6     | 3.0±2.5    | 5.1±3.2    |

Table 4.6 Analysis of water quality of selected stations along Lampson Brook from October 8, 1988 to October 15, 1988. All the data are presented as average  $\pm$  S.D. in mg/l unless otherwise indicated.

| Measure/Site               | Station 1        | WWTP              | Station 2         | Station 3       | Station 4       | Station 5        |
|----------------------------|------------------|-------------------|-------------------|-----------------|-----------------|------------------|
| Distance (meters)          | 0                | 60                | 120               | 950             | 1100            | 3100             |
| Temperature (°C)           | 7.8 $\pm$ 0.8    | 9.8 $\pm$ 0.3     | 10.8 $\pm$ 1.8    | 8.3 $\pm$ 0.8   | 8.0 $\pm$ 1.0   | 7.8 $\pm$ 0.8    |
| D.O. (mg/l)                | 10.63 $\pm$ 0.67 | 7.63 $\pm$ 0.78   | 9.45 $\pm$ 0.65   | 6.05 $\pm$ 0.55 | 5.20 $\pm$ 0.00 | 11.05 $\pm$ 0.45 |
| D.O. (% saturation)        | 89 $\pm$ 7       | 67 $\pm$ 6        | 85 $\pm$ 9        | 52 $\pm$ 6      | 44 $\pm$ 1      | 93 $\pm$ 6       |
| pH                         | 7.38 $\pm$ 0.09  | 7.13 $\pm$ 0.24   | 7.28 $\pm$ 0.14   | 7.09 $\pm$ 0.17 | 7.00 $\pm$ 0.14 | 7.35 $\pm$ 0.17  |
| Free chlorine (mg/l)       | 0                | 0                 | 0                 | 0               | 0               | 0                |
| Monochloramine (mg/l)      | 0                | 0.905 $\pm$ 0.025 | 0.240 $\pm$ 0.060 | 0               | 0               | 0                |
| Dichloramine (mg/l)        | 0                | 0.470 $\pm$ 0.040 | 0.145 $\pm$ 0.025 | 0               | 0               | 0                |
| Trichloramine (mg/l)       | 0                | 0                 | 0                 | 0               | 0               | 0                |
| TRC (mg/l)                 | 0                | 1.370 $\pm$ 0.060 | 0.385 $\pm$ 0.085 | 0               | 0               | 0                |
| Fecal coliform (no./10 ml) | 105 $\pm$ 85     | 5 $\pm$ 5         | 52 $\pm$ 51       | 19 $\pm$ 16     | 9 $\pm$ 7       | 23 $\pm$ 8       |
| B.O.D. (mg/l)              | 3.08 $\pm$ 1.78  | 6.23 $\pm$ 0.22   | 6.18 $\pm$ 0.52   | 1.73 $\pm$ 0.02 | 3.33 $\pm$ 0.52 | 1.75 $\pm$ 0.10  |

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Table 4.6 (Continued).

| Measure/Site                                   | Station 1               | WWTP                    | Station 2               | Station 3               | Station 4               | Station 5               |
|--|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Distance (meters)                              | 0                       | 60                      | 120                     | 950                     | 1100                    | 3100                    |
| Acidity (mg CaCO <sub>3</sub> /l)<br>pH=8.3    | 4.38 <sub>±</sub> 0.30  | 13.04 <sub>±</sub> 4.54 | 6.63 <sub>±</sub> 0.85  | 11.44 <sub>±</sub> 4.46 | 9.52 <sub>±</sub> 1.70  | 3.80 <sub>±</sub> 1.25  |
| Alkalinity (mg CaCO <sub>3</sub> /l)<br>pH=4.5 | 42.60 <sub>±</sub> 3.90 | 60.15 <sub>±</sub> 1.50 | 45.23 <sub>±</sub> 7.13 | 46.28 <sub>±</sub> 0.07 | 45.45 <sub>±</sub> 0.45 | 36.60 <sub>±</sub> 0.45 |
| Ammonia (mg/l)                                 | 0.55 <sub>±</sub> 0.06  | 2.17 <sub>±</sub> 0.10  | 0.91 <sub>±</sub> 0.07  | 0.46 <sub>±</sub> 0.02  | 0.47 <sub>±</sub> 0.03  | 0.40 <sub>±</sub> 0.06  |
| Nitrate (mg/l)                                 | 0.19 <sub>±</sub> 0.06  | 0.30 <sub>±</sub> 0.00  | 0.36 <sub>±</sub> 0.07  | 0.79 <sub>±</sub> 0.04  | 0.82 <sub>±</sub> 0.09  | 0.12 <sub>±</sub> 0.03  |
| Phosphorus Total (mg/l)                        | 0.16 <sub>±</sub> 0.06  | 2.26 <sub>±</sub> 0.01  | 1.38 <sub>±</sub> 0.34  | 1.14 <sub>±</sub> 0.15  | 1.31 <sub>±</sub> 0.03  | 0.31 <sub>±</sub> 0.10  |
| Calcium (mg Ca/l)                              | 23.03 <sub>±</sub> 1.23 | 18.71 <sub>±</sub> 1.05 | 21.29 <sub>±</sub> 1.19 | 18.91 <sub>±</sub> 0.85 | 18.77 <sub>±</sub> 1.26 | 16.22 <sub>±</sub> 0.68 |
| Hardness (mg CaCO <sub>3</sub> /l)             | 86.53 <sub>±</sub> 0.17 | 62.56 <sub>±</sub> 1.36 | 82.79 <sub>±</sub> 5.61 | 76.50 <sub>±</sub> 3.40 | 74.80 <sub>±</sub> 0.00 | 65.62 <sub>±</sub> 4.08 |
| Chloride (mg/l)                                | 46.73 <sub>±</sub> 0.75 | 64.98 <sub>±</sub> 8.50 | 62.36 <sub>±</sub> 8.37 | 59.23 <sub>±</sub> 9.25 | 59.54 <sub>±</sub> 8.56 | 42.36 <sub>±</sub> 9.37 |
| Total solids (mg/l)                            | 235 <sub>±</sub> 51     | 303 <sub>±</sub> 47     | 270 <sub>±</sub> 40     | 279 <sub>±</sub> 62     | 276 <sub>±</sub> 50     | 212 <sub>±</sub> 54     |
| Suspended solids (mg/l)                        | 1.7 <sub>±</sub> 0.8    | 1.7 <sub>±</sub> 0.3    | 2.3 <sub>±</sub> 1.1    | 2.0 <sub>±</sub> 0.9    | 5.9 <sub>±</sub> 1.8    | 1.4 <sub>±</sub> 0.3    |

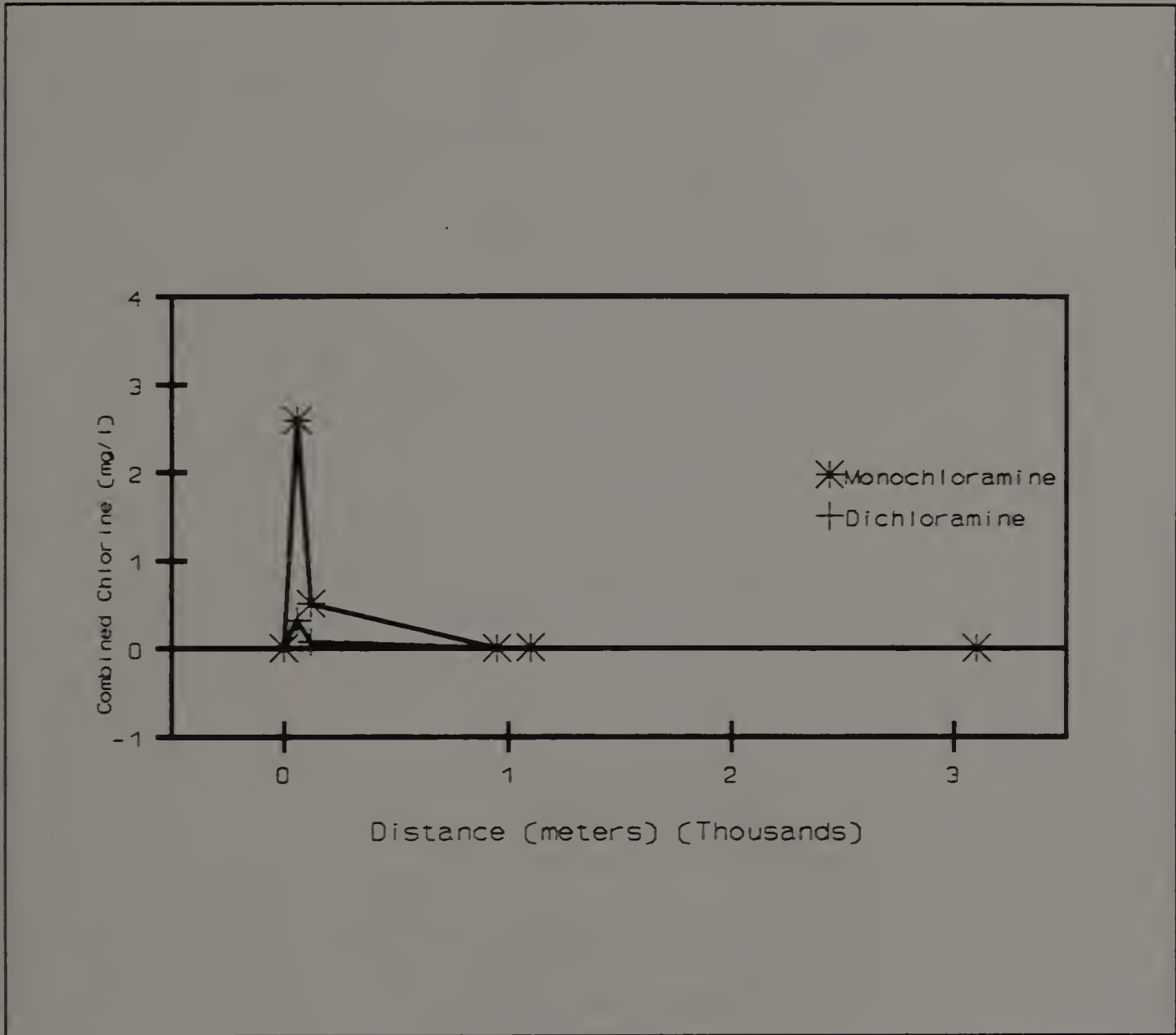


Figure 4.1 Average combined chlorine of the five sampling stations and the outfall from September 25 to October 29, 1987.

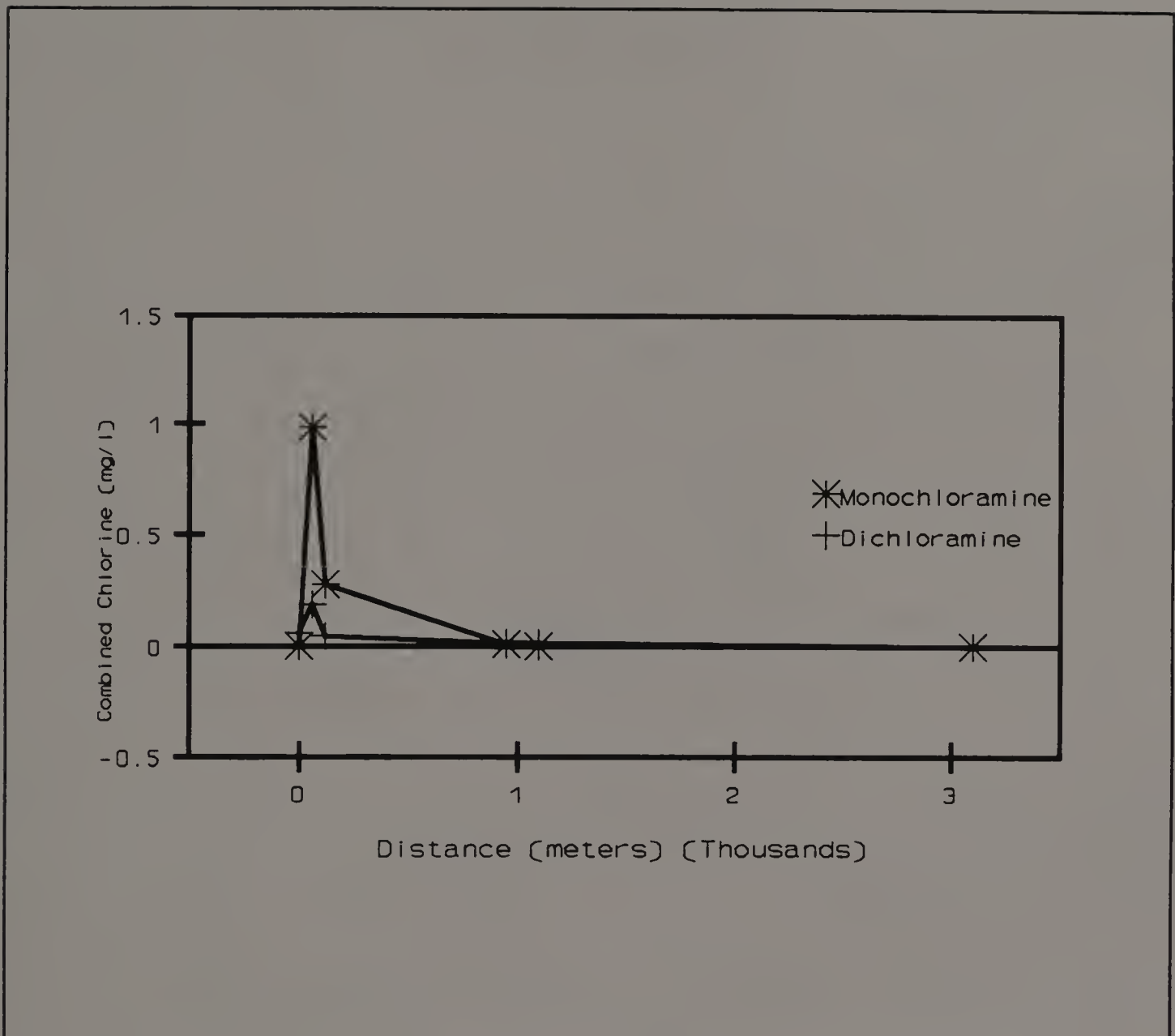


Figure 4.2 Average combined chlorine of the five sampling stations and the outfall from April 1 to April 14, 1988.

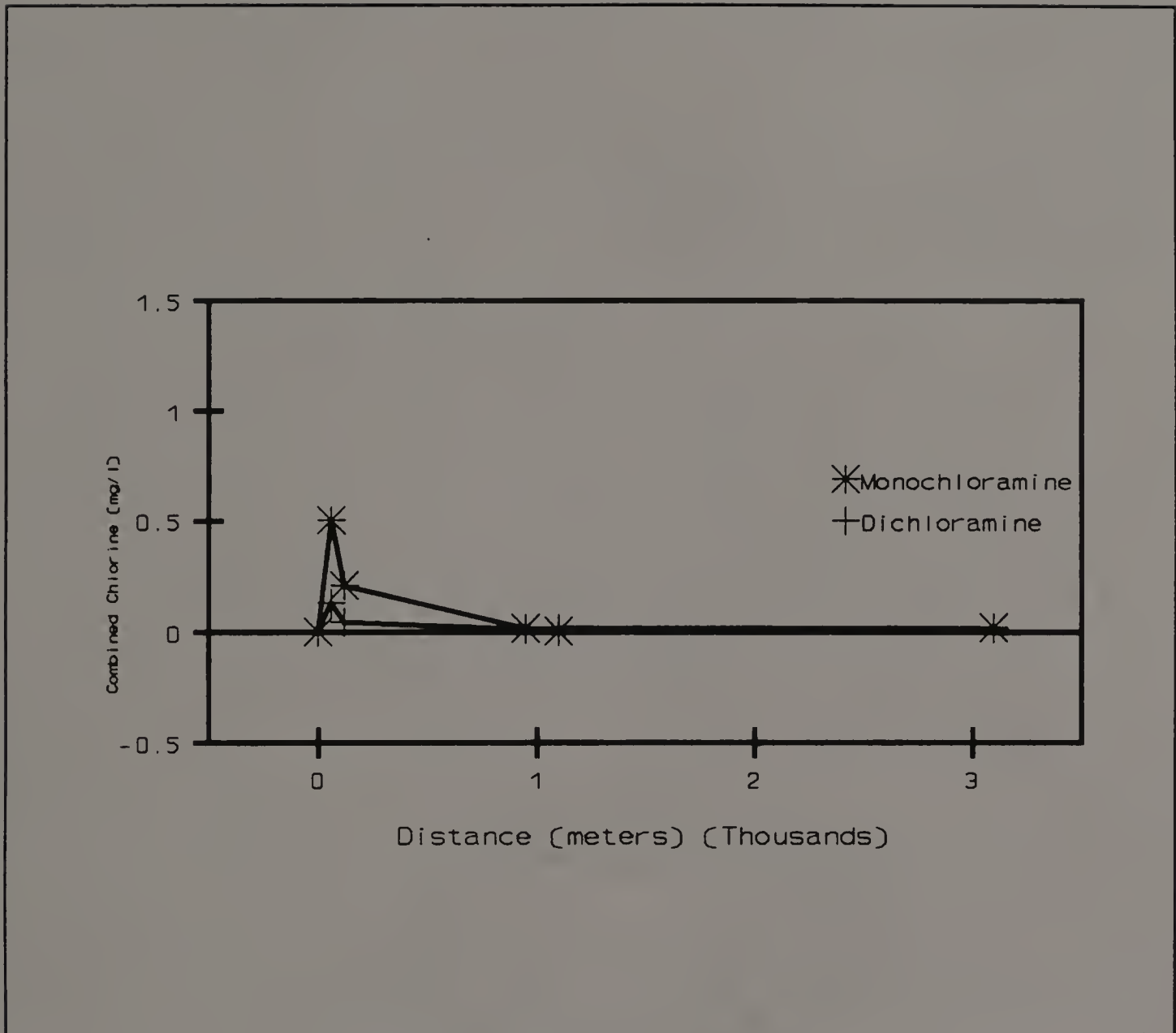


Figure 4.3 Average combined chlorine of the five sampling stations and the outfall from July 20 to August 20, 1988.

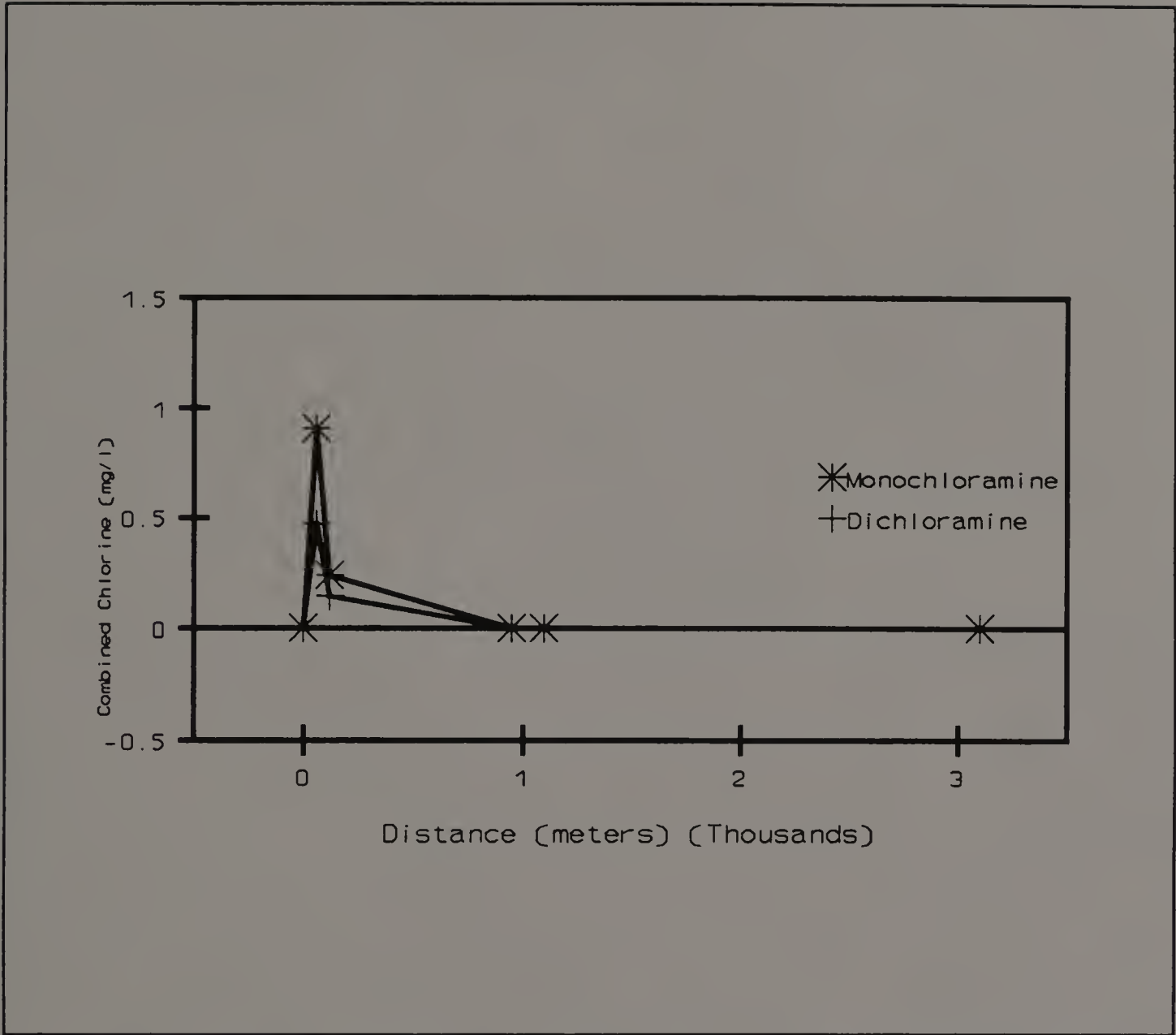


Figure 4.4 Average combined chlorine of the five sampling stations and the outfall from October 8 to October 15, 1988.

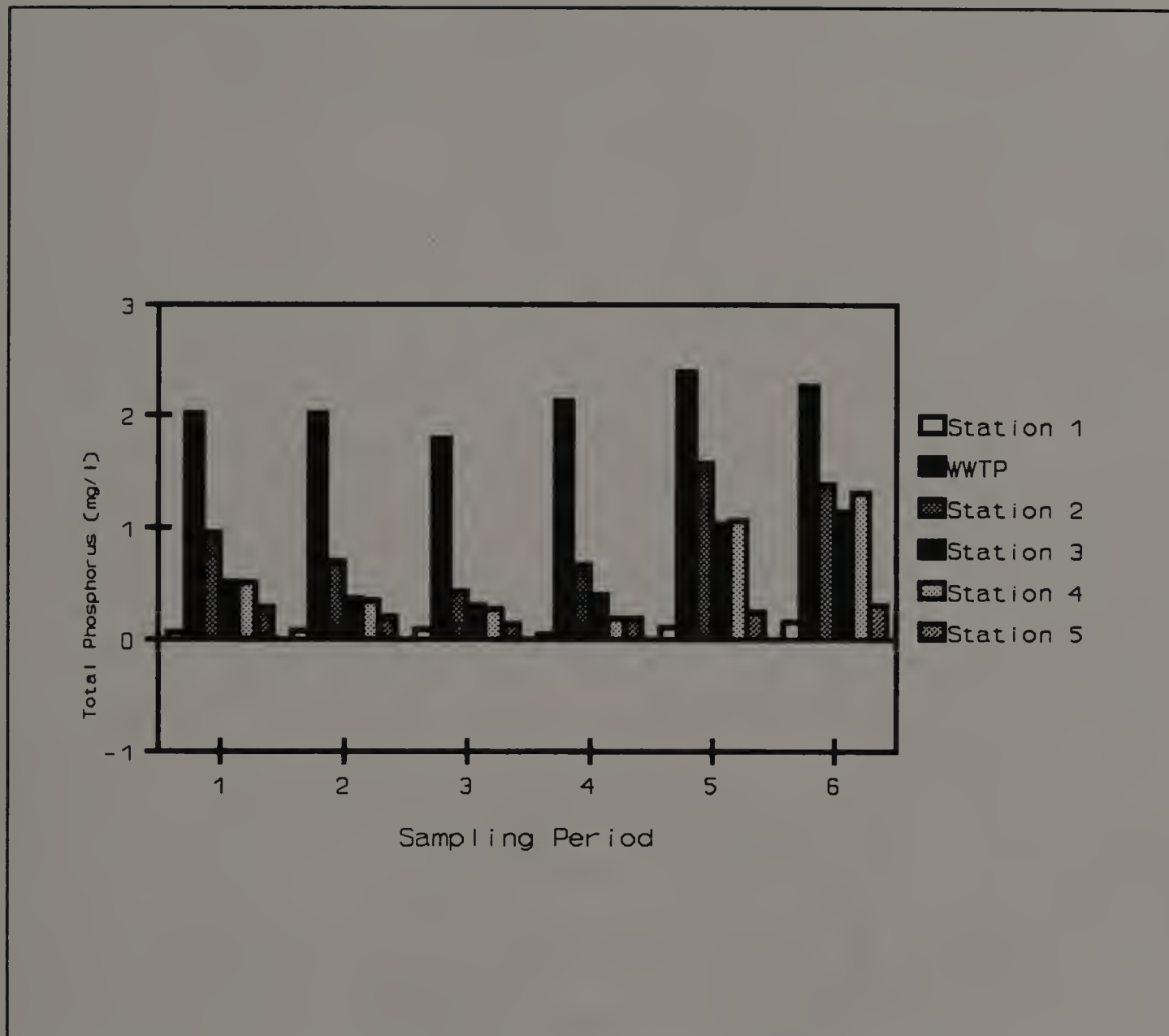


Figure 4.5 Average concentration of phosphorus at different stations for the six sampling periods (1 = 9/25/87-10/29/87, 2 = 11/19/87-12/17/87, 3 = 2/25/88-3/28/88, 4 = 4/1/88-4/14/88, 5 = 7/20/88-8/20/88, 6 = 10/8/88-10/15/88).

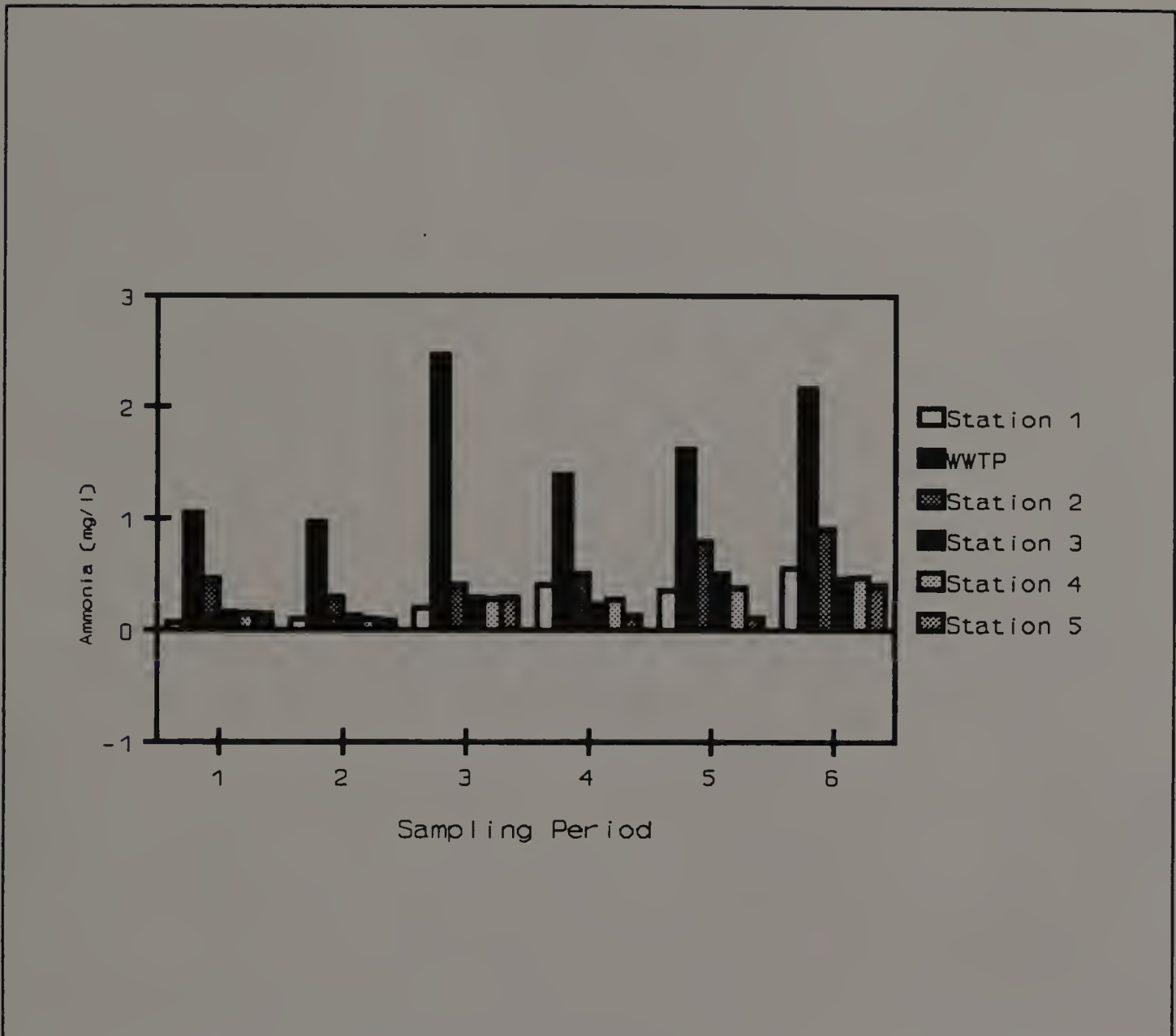


Figure 4.6 Average concentration of ammonia at different stations for the six sampling periods (1 = 9/25/87-10/29/87, 2 = 11/19/87-12/17/87, 3 = 2/25/88-3/28/88, 4 = 4/1/88-4/14/88, 5 = 7/20/88-8/20/88, 6 = 10/8/88-10/15/88).

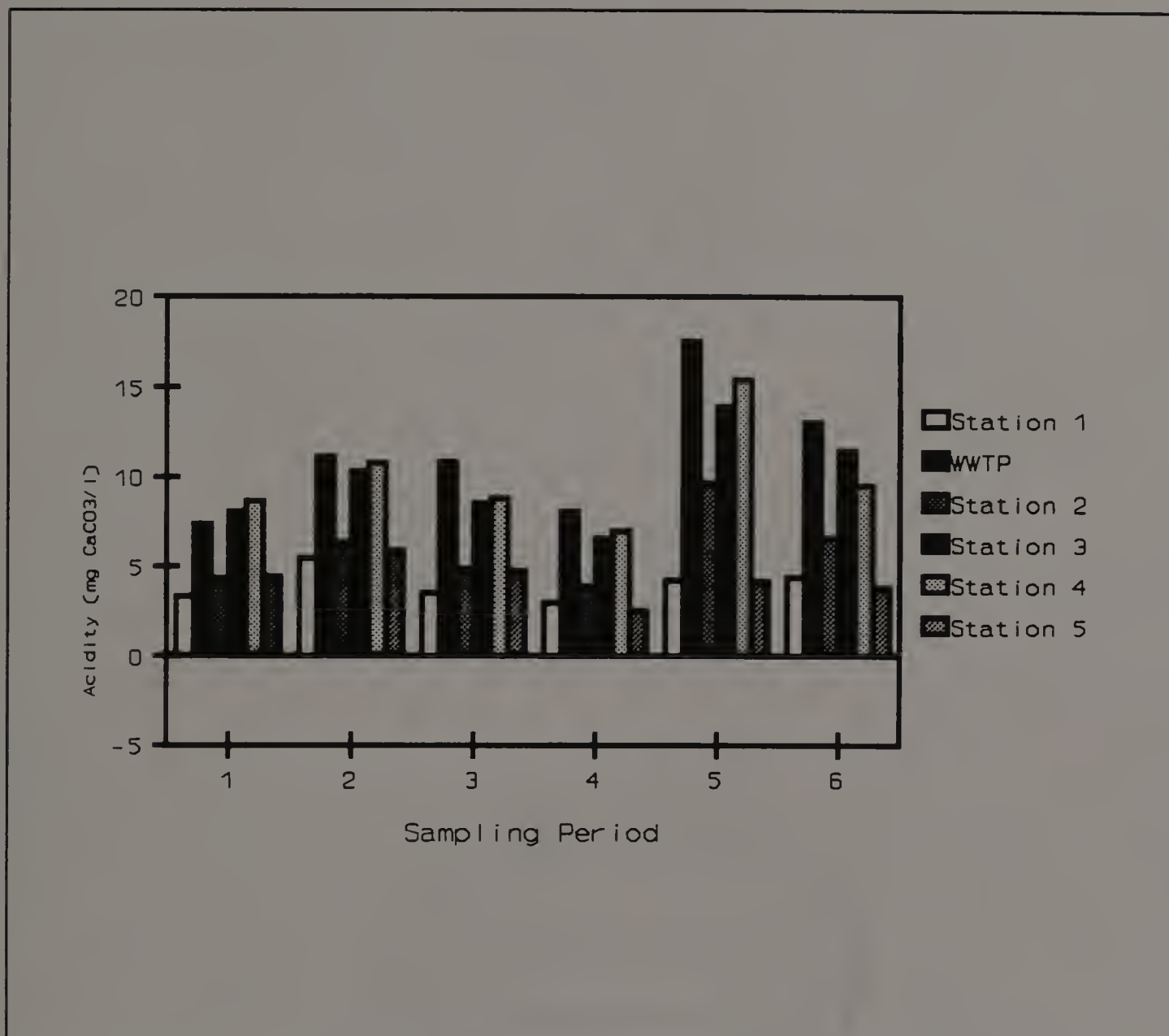


Figure 4.7 Average concentration of acidity at different stations for the six sampling periods (1 = 9/25/87-10/29/87, 2 = 11/19/87-12/17/87, 3 = 2/25/88-3/28/88, 4 = 4/1/88-4/14/88, 5 = 7/20/88-8/20/88, 6 = 10/8/88-10/15/88).



Table 4.7 The results of the Sign test in comparing the differences in mean diversity values calculated either from the basket or the stones for macroinvertebrates, midges, and family level census.

| MACROINVERTEBRATES  |                     |                            |
|---------------------|---------------------|----------------------------|
| Index               | Difference in Means | Pr $\geq$ IMI <sup>1</sup> |
| Hurlbert            | 0.0446              | 0.0025                     |
| McIntosh            | -0.0702             | 0.0001                     |
| Run                 | -0.0401             | 0.0001                     |
| Shannon             | 1.5390              | 0.0001                     |
| Brillouin           | 1.5273              | 0.0001                     |
| MIDGES              |                     |                            |
| Index               | Difference in Means | Pr $\geq$ IMI <sup>1</sup> |
| Hurlbert            | 0.0641              | 0.0360                     |
| McIntosh            | -0.0562             | 0.0001                     |
| Run                 | -0.0928             | 0.0001                     |
| Shannon             | 1.3433              | 0.0001                     |
| Brillouin           | 1.2501              | 0.0001                     |
| FAMILY-LEVEL CENSUS |                     |                            |
| Index               | Difference in Means | Pr $\geq$ IMI <sup>1</sup> |
| Hurlbert            | 0.0412              | 0.0357                     |
| McIntosh            | -0.0536             | 0.0001                     |
| Run                 | -0.2289             | 0.0001                     |
| Shannon             | 0.5488              | 0.0001                     |
| Brillouin           | 0.5455              | 0.0001                     |

1 Significant values of the Sign test

Table 4.8 The results of Spearman rank correlation in measuring the degree of association for all possible combination of diversity values for total macroinvertebrates.

| Index | H1     | H2     | M1     | M2     | R1     | R2     | S1     | S2     | B1     | B2     | SR     | BR     | SE     | BE     |
|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| H1    | 1.000  | 0.745  | 0.981  | 0.781  | 1.000  | 0.843  | 0.902  | -0.046 | 0.703  | -0.113 | 0.827  | -0.853 | 0.896  | 0.899  |
| H2    | 0.745  | 1.000  | 0.700  | 0.960  | 0.744  | 0.798  | 0.712  | 0.195  | 0.650  | 0.123  | -0.597 | -0.618 | 0.592  | 0.599  |
| M1    | 0.981  | 0.700  | 1.000  | 0.768  | 0.981  | 0.881  | 0.839  | -0.179 | 0.600  | -0.244 | -0.790 | -0.818 | 0.952  | 0.954  |
| M2    | 0.781  | 0.960  | 0.768  | 1.000  | 0.782  | 0.889  | 0.689  | 0.005  | 0.564  | -0.070 | -0.639 | -0.663 | 0.716  | 0.721  |
| R1    | 1.000  | 0.744  | 0.981  | 0.782  | 1.000  | 0.846  | 0.901  | -0.052 | 0.701  | -0.119 | -0.827 | -0.853 | 0.897  | 0.900  |
| R2    | 0.843  | 0.798  | 0.881  | 0.889  | 0.846  | 1.000  | 0.660  | -0.321 | 0.419  | -0.387 | -0.634 | -0.670 | 0.885  | 0.887  |
| S1    | 0.902  | 0.712  | 0.839  | 0.689  | 0.901  | 0.660  | 1.000  | 0.243  | 0.913  | 0.170  | -0.731 | -0.749 | 0.684  | 0.688  |
| S2    | -0.046 | 0.195  | -0.179 | 0.005  | -0.052 | -0.321 | 0.243  | 1.000  | 0.549  | 0.993  | 0.001  | 0.031  | -0.396 | -0.381 |
| B1    | 0.703  | 0.650  | 0.600  | 0.564  | 0.701  | 0.419  | 0.913  | 0.549  | 1.000  | 0.483  | -0.604 | -0.608 | 0.406  | 0.412  |
| B2    | -0.113 | 0.123  | -0.244 | -0.070 | -0.119 | -0.387 | 0.170  | 0.993  | 0.483  | 1.000  | 0.057  | 0.089  | -0.457 | -0.442 |
| SR    | -0.827 | -0.597 | -0.790 | -0.639 | -0.827 | -0.634 | -0.731 | 0.001  | -0.604 | 0.057  | 1.000  | 0.996  | -0.779 | -0.787 |
| BR    | -0.853 | -0.618 | -0.818 | -0.663 | -0.853 | -0.670 | -0.749 | 0.031  | -0.608 | 0.089  | 0.996  | 1.000  | -0.806 | -0.813 |
| SE    | 0.896  | 0.592  | 0.952  | 0.716  | 0.897  | 0.885  | 0.684  | -0.396 | 0.406  | -0.457 | -0.779 | -0.806 | 1.000  | 0.999  |
| BE    | 0.899  | 0.599  | 0.954  | 0.721  | 0.900  | 0.887  | 0.688  | -0.381 | 0.412  | -0.442 | -0.787 | -0.813 | 0.999  | 1.000  |

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Table 4.8 (Continued).

List of terms

- H1 = Hurlbert's *PIE* calculated for the basket
- H2 = Hurlbert's *PIE* calculated for the individual stone
- M1 = McIntosh's "ecological distance" relative calculated for the basket
- M2 = McIntosh's "ecological distance" relative calculated for the individual stone
- R1 = "run" formula calculated for the basket
- R2 = "run" formula calculated for the individual stone
- S1 = Shannon diversity calculated for the basket
- S2 = Shannon diversity calculated for the individual stone
- B1 = Brillouin diversity calculated for the basket
- B2 = Brillouin diversity calculated for the individual stone
- SR = Shannon's redundancy calculated for the basket
- BR = Brillouin's redundancy calculated for the basket
- SE = Shannon's evenness calculated for the basket
- BE = Brillouin's evenness calculated for the basket

Table 4.9 The results of Spearman rank correlation in measuring the degree of association for all possible combination of diversity values for midges.

| Index | H1     | H2     | M1     | M2     | R1     | R2     | S1     | S2     | B1     | B2     | SR     | BR     | SE     | BE     |
|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| H1    | 1.000  | 0.591  | 0.981  | 0.617  | 0.963  | 0.678  | 0.877  | -0.026 | 0.657  | 0.082  | -0.840 | -0.886 | 0.914  | 0.916  |
| H2    | 0.591  | 1.000  | 0.535  | 0.986  | 0.600  | 0.636  | 0.683  | 0.252  | 0.625  | 0.227  | -0.500 | -0.522 | 0.441  | 0.443  |
| M1    | 0.981  | 0.535  | 1.000  | 0.575  | 0.957  | 0.728  | 0.812  | -0.156 | 0.560  | -0.009 | -0.803 | -0.832 | 0.965  | 0.966  |
| M2    | 0.617  | 0.986  | 0.575  | 1.000  | 0.625  | 0.684  | 0.680  | 0.162  | 0.588  | 0.149  | -0.514 | -0.537 | 0.498  | 0.500  |
| R1    | 0.963  | 0.600  | 0.957  | 0.625  | 1.000  | 0.716  | 0.826  | -0.084 | 0.594  | 0.058  | -0.783 | -0.811 | 0.899  | 0.899  |
| R2    | 0.678  | 0.636  | 0.728  | 0.684  | 0.716  | 1.000  | 0.481  | -0.439 | 0.203  | -0.312 | -0.542 | -0.575 | 0.832  | 0.831  |
| S1    | 0.877  | 0.683  | 0.812  | 0.680  | 0.826  | 0.481  | 1.000  | 0.290  | 0.906  | 0.275  | -0.751 | -0.767 | 0.679  | 0.681  |
| S2    | -0.026 | 0.252  | -0.156 | 0.162  | -0.084 | -0.439 | 0.290  | 1.000  | 0.586  | 0.837  | -0.119 | -0.101 | -0.361 | -0.354 |
| B1    | 0.657  | 0.625  | 0.560  | 0.588  | 0.594  | 0.203  | 0.906  | 0.586  | 1.000  | 0.481  | -0.688 | -0.690 | 0.399  | 0.402  |
| B2    | 0.082  | 0.227  | -0.009 | 0.149  | 0.058  | -0.312 | 0.275  | 0.837  | 0.481  | 1.000  | -0.189 | -0.183 | -0.212 | -0.204 |
| SR    | -0.840 | -0.500 | -0.803 | -0.514 | -0.783 | -0.542 | -0.751 | -0.119 | -0.688 | -0.189 | 1.000  | 0.997  | -0.781 | -0.781 |
| BR    | -0.886 | -0.522 | -0.832 | -0.537 | -0.811 | -0.757 | -0.767 | -0.101 | -0.690 | -0.183 | 0.997  | 1.000  | -0.806 | -0.806 |
| SE    | 0.914  | 0.441  | 0.965  | 0.498  | 0.899  | 0.832  | 0.679  | -0.61  | 0.399  | -0.212 | -0.781 | -0.806 | 1.000  | 1.000  |
| BE    | 0.916  | 0.443  | 0.966  | 0.500  | 0.899  | 0.831  | 0.681  | -0.354 | 0.402  | -0.204 | -0.781 | -0.806 | 1.000  | 1.000  |

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Table 4.9 (Continued).

List of term

- H1 = Hurlbert's *PIE* calculated for the basket
- H2 = Hurlbert's *PIE* calculated for the individual stone
- M1 = McIntosh's "ecological distance" relative calculated for the basket
- M2 = McIntosh's "ecological distance" relative calculated for the individual stone
- R1 = "run" formula calculated for the basket
- R2 = "run" formula calculated for the individual stone
- S1 = Shannon diversity calculated for the basket
- S2 = Shannon diversity calculated for the individual stone
- B1 = Brillouin diversity calculated for the basket
- B2 = Brillouin diversity calculated for the individual stone
- SR = Shannon's redundancy calculated for the basket
- BR = Brillouin's redundancy calculated for the basket
- SE = Shannon's evenness calculated for the basket
- BE = Brillouin's evenness calculated for the basket

Table 4.10 The results of Spearman rank correlation in measuring the degree of association for all possible combination of diversity values for family level census.

| Index | H1     | H2     | M1     | M2     | R1     | R2     | S1     | S2     | B1     | B2     | SR     | BR     | SE     | BE     |
|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| H1    | 1.000  | 0.935  | 0.998  | 0.931  | 0.999  | 0.669  | 0.973  | 0.685  | 0.973  | 0.561  | -0.891 | -0.889 | 0.935  | 0.937  |
| H2    | 0.935  | 1.000  | 0.932  | 0.988  | 0.934  | 0.705  | 0.932  | 0.703  | 0.930  | 0.576  | -0.793 | -0.795 | 0.861  | 0.865  |
| M1    | 0.998  | 0.932  | 1.000  | 0.932  | 0.999  | 0.692  | 0.971  | 0.660  | 0.969  | 0.531  | -0.887 | -0.883 | 0.940  | 0.943  |
| M2    | 0.931  | 0.988  | 0.932  | 1.000  | 0.932  | 0.775  | 0.927  | 0.629  | 0.914  | 0.491  | -0.790 | -0.791 | 0.886  | 0.886  |
| R1    | 0.999  | 0.934  | 0.999  | 0.932  | 1.000  | 0.679  | 0.971  | 0.675  | 0.971  | 0.549  | -0.891 | -0.889 | 0.937  | 0.940  |
| R2    | 0.669  | 0.705  | 0.692  | 0.775  | 0.679  | 1.000  | 0.649  | 0.060  | 0.598  | -0.091 | -0.553 | -0.530 | 0.786  | 0.769  |
| S1    | 0.973  | 0.932  | 0.971  | 0.927  | 0.971  | 0.649  | 1.000  | 0.714  | 0.993  | 0.576  | -0.808 | -0.808 | 0.870  | 0.867  |
| S2    | 0.685  | 0.703  | 0.660  | 0.629  | 0.675  | 0.060  | 0.714  | 1.000  | 0.760  | 0.941  | -0.646 | -0.649 | 0.483  | 0.505  |
| B1    | 0.973  | 0.930  | 0.969  | 0.914  | 0.971  | 0.598  | 0.993  | 0.760  | 1.000  | 0.628  | -0.835 | -0.835 | 0.863  | 0.863  |
| B2    | 0.561  | 0.576  | 0.531  | 0.491  | 0.549  | -0.091 | 0.576  | 0.941  | 0.628  | 1.000  | -0.560 | -0.560 | 0.352  | 0.372  |
| SR    | -0.891 | -0.793 | -0.887 | -0.790 | -0.891 | -0.553 | -0.808 | -0.646 | -0.835 | -0.560 | 1.000  | 0.997  | -0.918 | -0.931 |
| BR    | -0.889 | -0.795 | -0.883 | -0.791 | -0.889 | -0.530 | -0.808 | -0.649 | -0.835 | -0.560 | 0.997  | 1.000  | -0.915 | -0.928 |
| SE    | 0.935  | 0.861  | 0.940  | 0.886  | 0.937  | 0.786  | 0.870  | 0.483  | 0.863  | 0.352  | -0.918 | -0.915 | 1.000  | 0.998  |
| BE    | 0.937  | 0.865  | 0.943  | 0.886  | 0.940  | 0.769  | 0.867  | 0.502  | 0.863  | 0.372  | -0.931 | -0.928 | 0.998  | 1.000  |

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Table 4.10 (Continued).

List of terms

- H1 = Hurlbert's *PIE* calculated for the basket
- H2 = Hurlbert's *PIE* calculated for the individual stone
- M1 = McIntosh's "ecological distance " relative calculated for the basket
- M2 = McIntosh's "ecological distance " relative calculated for the basket
- R1 = "run" formula calculated for the basket
- R2 = "run" formula calculated for the individual stone
- S1 = Shannon's diversity calculated for the basket
- S2 = Shannon's diversity calculated for the individual stone
- B1 = Brillouin's diversity calculated for the basket
- B2 = Brillouin's diversity calculated for the individual stone
- SR = Shannon's redundancy
- BR = Brillouin's redundancy
- SE = Shannon's evenness
- BE = Brillouin's evenness

Table 4.11 The results of the Sign test in comparing the differences in mean diversity values for total macroinvertebrates, midges, and family level census.

| TOTAL MACROINVERTEBRATES VS. FAMILY LEVEL CENSUS |                     |                        |
|--|---------------------|------------------------|
| Index  | Difference in Means | Pr >= IMI <sup>1</sup> |
| Hurlbert   | 0.4388              | 0.0001                 |
| McIntosh   | 0.4172              | 0.0001                 |
| Run  | 0.4327              | 0.0001                 |
| Shannon  | 1.4792              | 0.0001                 |
| Brillouin  | 1.2708              | 0.0001                 |
| Shannon's R                                      | -0.3112             | 0.0001                 |
| Brillouin's R                                    | -0.3280             | 0.0001                 |
| Shannon's E                                      | 0.3194              | 0.0001                 |
| Brillouin's E                                    | 0.3307              | 0.0001                 |
| TOTAL MACROINVERTEBRATES VS. MIDGES              |                     |                        |
| Index  | Difference in Means | Pr >= IMI <sup>1</sup> |
| Hurlbert   | 0.0685              | 0.0001                 |
| McIntosh   | 0.0644              | 0.0001                 |
| Run  | 0.0579              | 0.0001                 |
| Shannon  | 0.4068              | 0.0001                 |
| Brillouin  | 0.3822              | 0.0001                 |
| Shannon's R                                      | -0.028              | 0.0660                 |
| Brillouin's R                                    | -0.0318             | 0.0436                 |
| Shannon's E                                      | 0.0185              | 0.0037                 |
| Brillouin's E                                    | 0.0205              | 0.0013                 |
| MIDGES VS. FAMILY LEVEL CENSUS                   |                     |                        |
| Index  | Difference in Means | Pr >= IMI <sup>1</sup> |
| Hurlbert   | 0.3703              | 0.0001                 |
| McIntosh   | 0.3527              | 0.0001                 |
| Run  | 0.3748              | 0.0001                 |
| Shannon  | 1.0724              | 0.0001                 |
| Brillouin  | 0.8886              | 0.0001                 |
| Shannon's R                                      | -0.2933             | 0.0001                 |
| Brillouin's R                                    | -0.3071             | 0.0001                 |
| Shannon's E                                      | 0.3073              | 0.0001                 |
| Brillouin's E                                    | 0.3169              | 0.0001                 |

1 Significant values of the Sign test



Table 4.12 The results of Spearman rank correlation in measuring the degree of association among total macroinvertebrates, midges and family level census for a number of diversity values.

| Index         | macroinvertebrates vs.<br>family-levels census | macroinvertebrates vs.<br>midges | midges vs.<br>family level census |
|---------------|--|----------------------------------|-----------------------------------|
| Hurlbert      | 0.356  | 0.853                            | 0.107                             |
| McIntosh      | 0.330  | 0.837                            | 0.138                             |
| Run           | 0.380  | 0.829                            | 0.160                             |
| Shannon       | 0.441  | 0.838                            | -0.029                            |
| Brillouin     | 0.382  | 0.806                            | -0.177                            |
| Shannon's R   | 0.204  | 0.757                            | -0.016                            |
| Brillouin's R | 0.227  | 0.787                            | 0.005                             |
| Shannon's E   | 0.316  | 0.852                            | 0.303                             |
| Brilliance E  | 0.298  | 0.846                            | 0.287                             |

Table 4.13 The results of Spearman rank correlation in measuring the degree of association for all possible combination of qualitative similarity values for total macroinvertebrates.

| Index      | Jaccard1 | Jaccard2 | Kulczynski | Sørensen | Mountford | Ochiai | Fager1 | Fager2 |
|------------|----------|----------|------------|----------|-----------|--------|--------|--------|
| Jaccard1   | 1.000    | 1.000    | 0.970      | 1.000    | 0.889     | 0.996  | 0.959  | 0.980  |
| Jaccard2   | 1.000    | 1.000    | 0.970      | 1.000    | 0.889     | 0.996  | 0.959  | 0.980  |
| Kulczynski | 0.970    | 0.970    | 1.000      | 0.970    | 0.889     | 0.987  | 0.964  | 0.972  |
| Sørensen   | 1.000    | 1.000    | 0.970      | 1.000    | 0.889     | 0.996  | 0.959  | 0.980  |
| Mountford  | 0.889    | 0.889    | 0.889      | 0.889    | 1.000     | 0.894  | 0.777  | 0.807  |
| Ochiai     | 0.996    | 0.996    | 0.987      | 0.996    | 0.894     | 1.000  | 0.967  | 0.984  |
| Fager1     | 0.959    | 0.959    | 0.964      | 0.959    | 0.777     | 0.967  | 1.000  | 0.991  |
| Fager2     | 0.980    | 0.980    | 0.972      | 0.980    | 0.807     | 0.984  | 0.991  | 1.000  |

Table 4.14 The results of Spearman rank correlation in measuring the degree of association for all possible combination of qualitative similarity values for midges.

| Index      | Jaccard1 | Jaccard2 | Kulczynski | Sørensen | Mountford | Ochiai | Fager1 | Fager2 |
|------------|----------|----------|------------|----------|-----------|--------|--------|--------|
| Jaccard1   | 1.000    | 1.000    | 0.948      | 1.000    | 0.859     | 0.997  | 0.964  | 0.979  |
| Jaccard2   | 1.000    | 1.000    | 0.948      | 1.000    | 0.859     | 0.997  | 0.964  | 0.979  |
| Kulczynski | 0.948    | 0.948    | 1.000      | 0.948    | 0.899     | 0.966  | 0.937  | 0.942  |
| Sørensen   | 1.000    | 1.000    | 0.948      | 1.000    | 0.859     | 0.997  | 0.964  | 0.979  |
| Mountford  | 0.859    | 0.859    | 0.899      | 0.859    | 1.000     | 0.872  | 0.758  | 0.772  |
| Ochiai     | 0.997    | 0.997    | 0.966      | 0.997    | 0.872     | 1.000  | 0.968  | 0.981  |
| Fager1     | 0.964    | 0.964    | 0.937      | 0.964    | 0.758     | 0.968  | 1.000  | 0.991  |
| Fager2     | 0.979    | 0.979    | 0.942      | 0.979    | 0.772     | 0.981  | 0.991  | 1.000  |

Table 4.15 The results of Spearman rank correlation in measuring the degree of association for all possible combination of qualitative similarity values for family level census.

| Index      | Jaccard1 | Jaccard2 | Kulczynski | Sørensen | Mountford | Ochiai | Fager1 | Fager2 |
|------------|----------|----------|------------|----------|-----------|--------|--------|--------|
| Jaccard1   | 1.000    | 1.000    | 0.956      | 1.000    | 0.886     | 0.994  | 0.895  | 0.966  |
| Jaccard2   | 1.000    | 1.000    | 0.956      | 1.000    | 0.886     | 0.994  | 0.895  | 0.966  |
| Kulczynski | 0.956    | 0.956    | 1.000      | 0.956    | 0.906     | 0.981  | 0.900  | 0.942  |
| Sørensen   | 1.000    | 1.000    | 0.956      | 1.000    | 0.886     | 0.994  | 0.895  | 0.966  |
| Mountford  | 0.886    | 0.886    | 0.906      | 0.886    | 1.000     | 0.902  | 0.686  | 0.773  |
| Ochiai     | 0.994    | 0.994    | 0.981      | 0.994    | 0.902     | 1.000  | 0.906  | 0.967  |
| Fager1     | 0.895    | 0.895    | 0.900      | 0.895    | 0.686     | 0.906  | 1.000  | 0.953  |
| Fager2     | 0.966    | 0.966    | 0.942      | 0.966    | 0.773     | 0.967  | 0.953  | 1.000  |

Table 4.16 The differences of various quantitative community comparison in detecting the upper and lower limits of similar/dissimilar pairs.

| *Community 1 | 13   | 11    | 1      | 21     | 9     | 17   | 7    | 3    | 5      | 19     |
|--------------|------|-------|--------|--------|-------|------|------|------|--------|--------|
| *Community 2 | 14   | 12    | 2      | 22     | 10    | 18   | 8    | 4    | 6      | 20     |
| BRAY         | 0    | 0     | 0      | 0      | 0     | 0    | 0    | 0    | 0      | 0      |
| CANBERRA     | 0    | 0     | 0      | 0      | 0     | 0    | 0    | 0    | 0      | 0      |
| CD           | 0    | 0     | 0      | 0      | 0     | 0    | 0    | 0    | 0      | 0      |
| PD           | 0    | 0     | 0      | 0      | 0     | 0    | 0    | 0    | 0      | 0      |
| MORISI       | 1.25 | 1.75  | 1.2222 | 1.6667 | 1.375 | 1.5  | 1.5  | 3.15 | 1.1667 | 1.1667 |
| HORN         | 1    | 1     | 1      | 1      | 1     | 1    | 1    | 1    | 1      | 1      |
| PARRISH      | 0    | 0     | 0      | 0      | 0     | 0    | 0    | 0    | 0      | 0      |
| PINKHAM1     | 1    | 1     | 1      | 1      | 1     | 1    | 1    | 1    | 1      | 1      |
| PINKHAM2     | 0.25 | 0.125 | 0.5    | 0.1667 | 0.125 | 0.25 | 0.25 | 0.25 | 0.1667 | 0.25   |
| MCINTO       | 0    | 0     | 0      | 0      | 0     | 0    | 0    | 0    | 0      | 0      |
| RENKON       | 1    | 1     | 1      | 1      | 1     | 1    | 1    | 1    | 1      | 1      |
| SIMI         | 1    | 1     | 1      | 1      | 1     | 1    | 1    | 1    | 1      | 1      |
| CLIFFO       | 0    | 0     | 0      | 0      | 0     | 0    | 0    | 0    | 0      | 0      |

List of terms

BRAY = Bray-Curtis index; CANBERRA = Canberra metric; CD = collection dissimilarity;  
 PD = percent dissimilarity; MORISI = Morisita similarity index; HORN = simplified  
 Morisita index; PARRISH = Parrish and Wagner's average chi-square; PINKHAM1 = Pinkham-Pearson  
 index B; PINKHAM2 = Pinkham-Pearson index B<sub>2</sub>; MCINTO = Euclidean distance (Sokal, 1961);  
 RENKON = percent similarity; SIMI = Stander's SIMI index; CLIFFO = distance measure  
 (Clifford and Stephenson, 1975)

\* See Table 3.5 for community structure

Table 4.17 The differences of various quantitative community comparison in detecting the upper and lower limits of similar/dissimilar pairs.

|              | 1   | 7      | 7      | 13    | 13     | 1      | 19     | 3     | 19     |
|--------------|-----|--------|--------|-------|--------|--------|--------|-------|--------|
| *Community 1 | 1   | 23     | 24     | 24    | 24     | 23     | 24     | 24    | 24     |
| *Community 2 | 7   | 23     | 24     | 24    | 24     | 23     | 24     | 24    | 24     |
| BRAY         | 1   | 1      | 1      | 1     | 1      | 1      | 1      | 1     | 1      |
| CANBERRA     | 1   | 1      | 1      | 1     | 1      | 1      | 1      | 1     | 1      |
| CD           | 1.5 | 1.5    | 1.5    | 1.5   | 1.6667 | 1.6667 | 1.5    | 1.5   | 1.5    |
| PD           | 1   | 1      | 1      | 1     | 1      | 1      | 1      | 1     | 1      |
| MORISI       | 0   | 0      | 0      | 0     | .      | .      | 0      | 0     | 0      |
| HORN         | 0   | 0      | 0      | 0     | 0      | 0      | 0      | 0     | 0      |
| PARRISH      | 1   | 1      | 1      | 1     | 1      | 1      | 1      | 1     | 1      |
| PINKHAM1     | 0   | 0      | 0      | 0     | 0      | 0      | 0      | 0     | 0      |
| PINKHAM2     | 0   | 0      | 0      | 0     | 0      | 0      | 0      | 0     | 0      |
| MCINTO       | 4   | 6.3246 | 7.0711 | 5.099 | 3      | 6.3246 | 5.7446 | 5.831 | 3.1623 |
| RENKON       | 0   | 0      | 0      | 0     | 0      | 0      | 0      | 0     | 0      |
| SIMI         | 0   | 0      | 0      | 0     | 0      | 0      | 0      | 0     | 0      |
| CLIFFO       | 1   | 1      | 1      | 1     | 1.5    | 1.5    | 1      | 1     | 1      |

List of terms

BRAY - Bray-Curtis index; CANBERRA - Canberra metric; CD - collection dissimilarity;  
 PD - percent dissimilarity; MORISI - Morisita similarity index; HORN - simplified  
 Morisita index; PARRISH - Parrish and Wagner's average chi-square; PINKHAM1 - Pinkham-Pearson  
 index B; PINKHAM2 - Pinkham-Pearson index B<sub>2</sub>; MCINTO - Euclidean distance (Sokal, 1961);  
 RENKON - percent similarity; SIMI - Stander's SIMI index; CLIFFO - distance measure  
 (Clifford and Stephenson, 1975)

\* See Table 3.5 for community structure

Table 4.18 The results of Spearman rank correlation in measuring the degree of association for all possible combination of quantitative similarity/dissimilarity values for hypothetical communities.

| Index  | Bray   | Canbe. | CD     | PD     | Moris. | Horn   | Parri. | Pinkh1 | Pinkh2 | McIn.  | Renk.  | SIMI   | Cliff. |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Bray   | 1.000  | 0.948  | 0.815  | 0.818  | -0.439 | -0.790 | 0.965  | -0.959 | -0.938 | 0.744  | -0.810 | -0.776 | 0.808  |
| Canbe. | 0.948  | 1.000  | 0.870  | 0.873  | -0.528 | -0.795 | 0.949  | -0.981 | -0.944 | 0.710  | -0.837 | -0.744 | 0.821  |
| CD     | 0.815  | 0.870  | 1.000  | 0.979  | -0.771 | -0.952 | 0.913  | -0.789 | -0.842 | 0.628  | -0.976 | -0.935 | 0.978  |
| PD     | 0.818  | 0.873  | 0.979  | 1.000  | -0.772 | -0.957 | 0.919  | -0.788 | -0.883 | 0.694  | -0.985 | -0.942 | 0.959  |
| Moris. | -0.439 | -0.528 | -0.771 | -0.772 | 1.000  | 0.795  | -0.582 | 0.430  | 0.586  | -0.596 | 0.794  | 0.794  | -0.781 |
| Horn   | -0.790 | -0.795 | -0.952 | -0.957 | 0.795  | 1.000  | -0.893 | 0.716  | 0.849  | -0.685 | 0.989  | 0.997  | -0.976 |
| Parri. | 0.965  | 0.949  | 0.913  | 0.919  | -0.582 | -0.893 | 1.000  | -0.915 | -0.944 | 0.761  | -0.914 | -0.879 | 0.905  |
| Pinkh1 | -0.959 | -0.981 | -0.789 | -0.778 | 0.430  | 0.716  | -0.915 | 1.000  | 0.921  | -0.689 | 0.753  | 0.695  | -0.746 |
| Pinkh2 | -0.938 | -0.944 | -0.842 | -0.883 | 0.586  | 0.849  | -0.944 | 0.921  | 1.000  | -0.817 | 0.870  | 0.841  | -0.823 |
| McIn.  | 0.744  | 0.710  | 0.628  | 0.694  | -0.596 | -0.685 | 0.761  | -0.689 | -0.817 | 1.000  | -0.696 | -0.688 | 0.623  |
| Renk.  | -0.810 | -0.837 | -0.976 | -0.985 | 0.794  | 0.989  | -0.914 | 0.753  | 0.870  | -0.696 | 1.000  | 0.980  | -0.980 |
| SIMI   | -0.776 | -0.744 | -0.935 | -0.942 | 0.794  | 0.997  | -0.879 | 0.695  | 0.841  | -0.688 | 0.980  | 1.000  | -0.965 |
| Cliff. | 0.808  | 0.821  | 0.978  | 0.959  | -0.781 | -0.976 | 0.905  | -0.746 | -0.823 | 0.623  | -0.980 | -0.965 | 1.000  |

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Table 4.18 (Continued).

|   |
|---|
| List of term                                  |
| Bray = Bray-Curtis index                      |
| Canbe. = Canberra metric                      |
| CD = collection dissimilarity                 |
| PD = percent dissimilarity                    |
| Moris. = Morisita similarity index            |
| Horn = simplified Morisita similarity index   |
| Parri. = the average chi-square               |
| Pinkh1 = Pinkham-Pearson index B              |
| Pinkh2 = Pinkham-Pearson index B <sub>2</sub> |
| McIn. = Sokal's Euclidean distance            |
| Renk. = percent similarity                    |
| SIMI = Stander's SIMI index                   |
| Cliff. = distance measure                     |



Table 4.19 The results of Spearman rank correlation in measuring the degree of association for all possible combination of quantitative similarity/dissimilarity values for total macroinvertebrates.

| Index  | Bray   | Canbe. | CD     | PD     | Moris. | Horn   | Parri. | Pinkh1 | Pinkh2 | McIn.  | Renk.  | SIMI   | Cliff. |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Bray   | 1.000  | 0.765  | 0.792  | 0.827  | -0.853 | -0.860 | 0.986  | -0.739 | -0.894 | 0.417  | -0.886 | -0.860 | 0.615  |
| Canbe. | 0.765  | 1.000  | 0.868  | 0.895  | -0.627 | -0.623 | 0.752  | -0.992 | -0.822 | 0.279  | -0.714 | -0.626 | 0.483  |
| CD     | 0.792  | 0.868  | 1.000  | 0.960  | -0.729 | -0.729 | 0.808  | -0.832 | -0.817 | 0.203  | -0.853 | -0.731 | 0.595  |
| PD     | 0.827  | 0.895  | 0.960  | 1.000  | -0.738 | -0.733 | 0.842  | -0.859 | -0.847 | 0.342  | -0.853 | -0.737 | 0.550  |
| Moris. | -0.853 | -0.627 | -0.729 | -0.738 | 1.000  | 0.994  | -0.878 | 0.599  | 0.888  | -0.345 | 0.937  | 0.989  | -0.790 |
| Horn   | -0.860 | -0.623 | -0.729 | -0.733 | 0.994  | 1.000  | -0.888 | 0.593  | 0.905  | -0.287 | 0.943  | 0.997  | -0.754 |
| Parri. | 0.986  | 0.752  | 0.808  | 0.842  | -0.878 | -0.888 | 1.000  | -0.717 | -0.908 | 0.402  | -0.912 | -0.889 | 0.622  |
| Pinkh1 | -0.739 | -0.992 | -0.832 | -0.859 | 0.599  | 0.593  | -0.717 | 1.000  | 0.800  | -0.281 | 0.678  | 0.596  | -0.468 |
| Pinkh2 | -0.894 | -0.822 | -0.817 | -0.847 | 0.888  | 0.905  | -0.908 | 0.800  | 1.000  | -0.228 | 0.920  | 0.915  | -0.552 |
| McIn.  | 0.417  | 0.279  | 0.203  | 0.342  | -0.345 | -0.287 | 0.402  | -0.281 | -0.228 | 1.000  | -0.242 | -0.279 | 0.444  |
| Renk.  | -0.886 | -0.714 | -0.853 | -0.853 | 0.937  | 0.943  | -0.912 | 0.678  | 0.920  | -0.242 | 1.000  | 0.945  | -0.681 |
| SIMI   | -0.860 | -0.626 | -0.731 | -0.737 | 0.989  | 0.997  | -0.889 | 0.596  | 0.915  | -0.279 | 0.945  | 1.000  | -0.726 |
| Cliff. | 0.615  | 0.483  | 0.595  | 0.550  | -0.790 | -0.754 | 0.622  | -0.468 | -0.552 | 0.444  | -0.681 | -0.726 | 1.000  |

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Table 4.19 (Continued).

|   |
|---|
| List of term                                |
| Bray = Bray-Curtis index                    |
| Canbe. = Canberra metric                    |
| CD = collection dissimilarity               |
| PD = percent dissimilarity                  |
| Moris. = Morisita similarity index          |
| Horn = simplified Morisita similarity index |
| Parri. = the average chi-square             |
| Pinkh1 = Pinkham-Pearson index B            |
| Pinkh2 = Pinkham-Pearson index $B_2$        |
| McIn. = Sokal's Euclidean distance          |
| Renk. = percent similarity                  |
| SIMI = Stander's SIMI index                 |
| Cliff. = distance measure                   |

Table 4.20 The results of Spearman rank correlation in measuring the degree of association for all possible combination of quantitative similarity/dissimilarity values for midges.

| Index  | Bray   | Canbe. | CD     | PD     | Moris. | Horn   | Parri. | Pinkh1 | Pinkh2 | McIn.  | Renk.  | SIMI   | Cliff. |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Bray   | 1.000  | 0.751  | 0.777  | 0.801  | -0.794 | -0.821 | 0.984  | -0.726 | -0.871 | 0.389  | -0.843 | -0.817 | 0.727  |
| Canbe. | 0.751  | 1.000  | 0.827  | 0.862  | -0.588 | -0.591 | 0.734  | -0.992 | -0.808 | 0.252  | -0.673 | -0.587 | 0.578  |
| CD     | 0.777  | 0.827  | 1.000  | 0.960  | -0.754 | -0.761 | 0.800  | -0.787 | -0.821 | 0.169  | -0.865 | -0.754 | 0.749  |
| PD     | 0.801  | 0.862  | 0.960  | 1.000  | -0.768 | -0.767 | 0.824  | -0.823 | -0.855 | 0.284  | -0.869 | -0.761 | 0.720  |
| Moris. | -0.794 | -0.588 | -0.754 | -0.768 | 1.000  | 0.986  | -0.828 | 0.559  | 0.867  | -0.330 | 0.949  | 0.981  | -0.904 |
| Horn   | -0.821 | -0.591 | -0.761 | -0.767 | 0.986  | 1.000  | -0.859 | 0.560  | 0.895  | -0.266 | 0.961  | 0.997  | -0.880 |
| Parri. | 0.984  | 0.734  | 0.800  | 0.824  | -0.828 | -0.859 | 1.000  | -0.699 | -0.888 | 0.373  | -0.878 | -0.856 | 0.749  |
| Pinkh1 | -0.726 | -0.992 | -0.787 | -0.823 | 0.559  | 0.560  | -0.699 | 1.000  | 0.789  | -0.255 | 0.636  | 0.556  | -0.553 |
| Pinkh2 | -0.871 | -0.808 | -0.821 | -0.855 | 0.867  | 0.895  | -0.888 | 0.789  | 1.000  | -0.220 | 0.905  | 0.902  | -0.709 |
| McIn.  | 0.389  | 0.252  | 0.169  | 0.284  | -0.330 | -0.266 | 0.373  | -0.220 | -0.220 | 1.000  | -0.240 | -0.254 | 0.380  |
| Renk.  | -0.843 | -0.673 | -0.865 | -0.869 | 0.949  | 0.961  | -0.878 | 0.636  | 0.905  | -0.240 | 1.000  | 0.956  | -0.859 |
| SIMI   | -0.817 | -0.587 | -0.754 | -0.761 | 0.981  | 0.997  | -0.856 | 0.556  | 0.902  | -0.254 | 0.956  | 1.000  | -0.859 |
| Cliff. | 0.727  | 0.578  | 0.749  | 0.720  | -0.904 | -0.880 | 0.749  | -0.553 | -0.709 | 0.380  | -0.859 | -0.859 | 1.000  |

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Table 4.20 (Continued).

List of term

- Bray = Bray-Curtis index
- Canbe. = Canberra metric
- CD = collection dissimilarity
- PD = percent dissimilarity
- Moris. = Morisita similarity index
- Horn = simplified Morisita similarity index
- Parri. = the average chi-square
- Pinkh1 = Pinkham-Pearson index B
- Pinkh2 = Pinkham-Pearson index B<sub>2</sub>
- Meln. = Sokal's Euclidean distance
- Renk. = percent similarity
- SIMI = Stander's SIMI index
- Cliff. = distance measure

Table 4.21 The results of Spearman rank correlation in measuring the degree of association for all possible combination of quantitative similarity/dissimilarity values for family level census.

| Index  | Bray   | Canbe. | CD     | PD     | Moris. | Horn   | Parri. | Pinkh1 | Pinkh2 | McIn.  | Renk.  | SIMI   | Cliff. |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Bray   | 1.000  | 0.585  | 0.547  | 0.594  | -0.491 | -0.501 | 0.978  | -0.610 | -0.711 | 0.754  | -0.513 | -0.515 | 0.482  |
| Canbe. | 0.585  | 1.000  | 0.768  | 0.751  | -0.316 | -0.305 | 0.594  | -0.990 | -0.901 | 0.414  | -0.359 | -0.314 | 0.320  |
| CD     | 0.547  | 0.768  | 1.000  | 0.896  | -0.682 | -0.675 | 0.609  | -0.741 | -0.826 | 0.265  | -0.725 | -0.657 | 0.698  |
| PD     | 0.594  | 0.751  | 0.896  | 1.000  | -0.689 | -0.680 | 0.664  | -0.712 | -0.830 | 0.342  | -0.853 | -0.737 | 0.550  |
| Moris. | -0.491 | -0.316 | -0.682 | -0.689 | 1.000  | 0.990  | -0.572 | 0.314  | 0.557  | -0.239 | 0.965  | 0.941  | -0.985 |
| Horn   | -0.501 | -0.305 | -0.675 | -0.680 | 0.990  | 1.000  | -0.583 | 0.306  | 0.585  | -0.197 | 0.982  | 0.959  | -0.981 |
| Parri. | 0.978  | 0.594  | 0.609  | 0.664  | -0.572 | -0.583 | 1.000  | -0.606 | -0.741 | 0.717  | -0.599 | -0.598 | 0.560  |
| Pinkh1 | -0.610 | -0.990 | -0.741 | -0.712 | 0.314  | 0.306  | -0.606 | 1.000  | 0.911  | -0.431 | 0.354  | 0.318  | -0.321 |
| Pinkh2 | -0.711 | -0.901 | -0.826 | -0.830 | 0.557  | 0.585  | -0.741 | 0.911  | 1.000  | -0.441 | 0.631  | 0.606  | -0.564 |
| McIn.  | 0.754  | 0.414  | 0.265  | 0.342  | -0.239 | -0.197 | 0.717  | -0.431 | -0.441 | 1.000  | -0.171 | -0.211 | 0.216  |
| Renk.  | -0.513 | -0.359 | -0.725 | -0.853 | 0.965  | 0.982  | -0.599 | 0.354  | 0.631  | -0.242 | 1.000  | 0.943  | -0.953 |
| SIMI   | -0.515 | -0.314 | -0.657 | -0.737 | 0.941  | 0.959  | -0.598 | 0.318  | 0.606  | -0.279 | 0.943  | 1.000  | -0.919 |
| Cliff. | 0.482  | 0.320  | 0.698  | 0.550  | -0.985 | -0.981 | 0.560  | -0.321 | -0.564 | 0.216  | -0.953 | -0.919 | 1.000  |

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Table 4.21 (continued)

List of terms

- Bray = Bray-Curtis index
- Canbe. = Canberra metric
- CD = collection dissimilarity
- PD = percent dissimilarity
- Moris. = Morisita similarity index
- Horn = simplified Morisita index
- parri. = the average chi-square
- Pinkh1 = Pinkham-Pearson index B
- Pinkh2 = Pinkham-Pearson index  $B_2$
- McIn. = Sokal's Euclidean distance
- Renk. = percent similarity
- SIMI = Stander's SIMI index
- Cliff. = distance measure

Table 4.22 General census data for collections of benthic macroinvertebrates isolated from stone-filled basket substrates retrieved from upstream station 1 (control) and downstream 4 stations receiving chlorinated sewage of Lampson Brook.

| Station   | 1 (Control)                 | 2                              | 3                            | 4                          | 5                            | Total |
|---|-----------------------------|--------------------------------|------------------------------|----------------------------|------------------------------|-------|
| Baskets processed                                   | 9                           | 9                              | 9                            | 9                          | 9                            | 45    |
| Organisms identified                                | 712                         | 3215                           | 1967                         | 820                        | 1323                         | 8037  |
| Average per basket $\pm$ S.D.<br>(minimum, maximum) | 79 $\pm$ 88<br>(25,66)      | 357 $\pm$ 621<br>(53,2095)     | 219 $\pm$ 133<br>(94,550)    | 91 $\pm$ 24<br>(52,128)    | 147 $\pm$ 246<br>(21,837)    |       |
| Species found                                       | 88                          | 112                            | 97                           | 63                         | 96                           | 188   |
| Average per basket $\pm$ S.D.<br>(minimum, maximum) | 23 $\pm$ 24<br>(14,45)      | 29 $\pm$ 30<br>(18,45)         | 27 $\pm$ 27<br>(17,43)       | 17 $\pm$ 17<br>(8,25)      | 21 $\pm$ 21<br>(10,53)       |       |
| Total density                                       | 4129                        | 18413                          | 11604                        | 4717                       | 7866                         | 46729 |
| Average per basket $\pm$ S.D.<br>(minimum, maximum) | 459 $\pm$ 453<br>(158,1788) | 2046 $\pm$ 3461<br>(250,11700) | 1289 $\pm$ 844<br>(524,3342) | 524 $\pm$ 132<br>(316,724) | 874 $\pm$ 1459<br>(135,5074) |       |
| EPT   | 24                          | 19                             | 13                           | 8                          | 18                           | 40    |
| Average per basket $\pm$ S.D.                       | 6.6 $\pm$ 2.3               | 3.6 $\pm$ 3.7                  | 1.9 $\pm$ 1.7                | 1.4 $\pm$ 1.3              | 3.9 $\pm$ 2.0                |       |

Table 4.23 Distribution of major benthic macroinvertebrate taxa inhabiting basket substrates recovered from the five stations along the Lampson Brook. Expressed as total organisms (species found).

| TAXA/STATION    | 1 (Control) | 2          | 3         | 4        | 5         |
|-----------------|-------------|------------|-----------|----------|-----------|
| INSECTA         |             |            |           |          |           |
| Diptera         |             |            |           |          |           |
| Chironomidae    | 699:(82)    | 3050:(100) | 1432:(77) | 595:(50) | 1296:(84) |
| Simuliidae      | 460:(50)    | 2958:(71)  | 1366:(56) | 571:(38) | 883:(59)  |
| Ceratopogonidae | 452:(48)    | 2915:(63)  | 1193:(49) | 564:(35) | 865:(54)  |
| Tipulidae       | 0           | 2:(2)      | 169:(5)   | 2:(1)    | 8:(2)     |
| Other diptera   | 0           | 4:(1)      | 0         | 1:(1)    | 1:(1)     |
|                 | 8:(2)       | 5:(3)      | 1:(1)     | 0        | 2:(1)     |
| Ephemeroptera   | 119:(10)    | 32:(2)     | 3:(1)     | 4:(1)    | 7:(1)     |
| Plecoptera      | 63:(7)      | 35:(9)     | 29:(4)    | 8:(4)    | 245:(7)   |
| Tricoptera      | 25:(7)      | 22:(5)     | 2:(2)     | 4:(1)    | 80:(7)    |
| Odonata         | 3:(3)       | 12:(6)     | 17:(7)    | 7:(4)    | 63:(5)    |
| Coleoptera      | 19:(4)      | 7:(1)      | 10:(3)    | 2:(1)    | 14:(2)    |
| Megaloptera     | 10:(1)      | 12:(7)     | 6:(3)     | 3:(2)    | 7:(3)     |
| MOLLUSCA        |             | 4:(1)      | 2:(2)     | 0        | 4:(1)     |
| Gastropoda      | 0           | 4:(2)      | 14:(3)    | 1:(1)    | 9:(4)     |
| CRUSTACEA       |             |            |           |          |           |
| Amphipoda       | 1:(1)       | 5:(1)      | 242:(1)   | 89:(1)   | 1:(1)     |
| Isopoda         | 0           | 4:(1)      | 0         | 0        | 0         |
| ANNELIDA        |             |            |           |          |           |
| Hirudinea       | 0           | 0          | 27:(3)    | 24:(1)   | 1:(1)     |
| Oligochaeta     | 12:(5)      | 150:(7)    | 244:(11)  | 94:(9)   | 11:(5)    |
| NEMATODA        | 0           | 0          | 1:(1)     | 0        | 0         |
| COPEPODA        | 0           | 0          | 7:(1)     | 17:(1)   | 0         |
| PUPA            | 0           | 2:(1)      | 0         | 0        | 5:(1)     |
| TOTAL           | 712:(88)    | 3215:(112) | 1967:(97) | 820:(63) | 1323:(96) |



Table 4.24 Percentage distribution of major benthic macroinvertebrate taxa inhabiting basket substrates recovered from the five stations along the Lampson Brook. Expressed as total organisms (species found) with the percent composition greater than one percent.

| TAXA/STATION    | 1 (Control)  | 2           | 3           | 4           | 5           |
|-----------------|--------------|-------------|-------------|-------------|-------------|
| INSECTA         |              |             |             |             |             |
| Diptera         | 98.2:(93.2)  | 94.9:(89.3) | 72.8:(79.4) | 72.6:(79.4) | 98.0:(87.5) |
| Chironomidae    | 64.6:(56.8)  | 92.0:(63.4) | 69.4:(57.7) | 69.6:(60.3) | 66.7:(61.4) |
| Simuliidae      | 63.5:(54.5)  | 90.7:(56.2) | 60.6:(50.5) | 68.8:(55.6) | 65.3:(56.2) |
| Ceratopogonidae |              |             | 8.59:(5.15) |             |             |
| Tipulidae       |              |             |             |             |             |
| Other diptera   | 1.12:(2.27)  |             |             |             |             |
| Ephemeroptera   | 16.7:(11.36) | 1.09:(8.04) | 1.47:(4.12) | 18.5:(7.29) |             |
| Plecoptera      | 8.85:(7.95)  |             |             |             | 6.05:(7.29) |
| Tricoptera      | 3.51:(7.95)  |             |             |             | 4.76:(5.21) |
| Odonata         |              |             |             |             | 1.06:(2.08) |
| Coleoptera      | 2.67:(4.54)  |             |             |             |             |
| Megaloptera     | 1.40:(1.14)  |             |             |             |             |
| MOLLUSCA        |              |             |             |             |             |
| Gastropoda      |              |             |             |             |             |
| CRUSTACEA       |              |             |             |             |             |
| Amphipoda       |              |             |             |             |             |
| Isopoda         |              |             | 12.3:(1.03) | 10.8:(1.59) |             |
| ANNELIDA        |              |             |             |             |             |
| Hirudinea       |              |             | 1.37:(3.09) | 2.93:(1.59) |             |
| Oligochaeta     |              |             | 244:(11)    | 11.5:(14.3) |             |
| NEMATODA        | 1.68:(5.68)  | 4.67:(6.25) |             |             |             |
| COPEPODA        |              |             |             |             |             |
| PUPA            |              |             |             | 2.07:(1.59) |             |

Table 4.25 The density data for collections of benthic macroinvertebrates colonizing limestones-filled basket substrates.

| COLLECTION/STATION               | 1 (Control)           | 2                       | 3                     | 4                    | 5                     | Chlorination |
|----------------------------------|-----------------------|-------------------------|-----------------------|----------------------|-----------------------|--------------|
| 10/30/87<br>Stream Bed Rocks     | 166 <sub>-</sub> 51   | 250 <sub>+</sub> 111    | 532 <sub>+</sub> 124  | 478 <sub>+</sub> 118 | 367 <sub>+</sub> 141  | yes          |
| 10/30/87<br>Limestones           | 158 <sub>-</sub> 63   | 458 <sub>+</sub> 154    | 987 <sub>+</sub> 256  | 329 <sub>+</sub> 116 | 178 <sub>+</sub> 102  | yes          |
| 12/22/87<br>Replicate Basket 1   | 347 <sub>+</sub> 125  | 1607 <sub>+</sub> 259   | 524 <sub>+</sub> 99   | 532 <sub>+</sub> 144 | 736 <sub>+</sub> 153  | no           |
| 12/22/87<br>Replicate Basket 2   | 388 <sub>+</sub> 157  | 1999 <sub>+</sub> 433   | 606 <sub>+</sub> 165  | 482 <sub>+</sub> 122 | 342 <sub>+</sub> 122  | no           |
| 3/29/88<br>Stone not in Contact  | 161 <sub>+</sub> 82   | 369 <sub>+</sub> 143    | 1686 <sub>+</sub> 349 | 574 <sub>+</sub> 163 | 236 <sub>+</sub> 114  | no           |
| 3/29/88<br>Standard Exposure     | 171 <sub>+</sub> 81   | 688 <sub>+</sub> 205    | 1726 <sub>+</sub> 319 | 724 <sub>+</sub> 186 | 300 <sub>+</sub> 118  | no           |
| 4/14/88<br>Chlorination Resumed  | 309 <sub>+</sub> 91   | 324 <sub>+</sub> 108    | 923 <sub>+</sub> 263  | 316 <sub>+</sub> 98  | 135 <sub>+</sub> 62   | yes          |
| 8/22/88<br>Summer Collection     | 1788 <sub>+</sub> 389 | 11700 <sub>+</sub> 1965 | 3342 <sub>+</sub> 591 | 663 <sub>+</sub> 216 | 5074 <sub>+</sub> 886 | yes          |
| 10/17/88<br>Placement Experiment | 641 <sub>+</sub> 184  | 1018 <sub>+</sub> 230   | 1278 <sub>+</sub> 296 | 619 <sub>+</sub> 219 | 498 <sub>+</sub> 156  | yes          |

Table 4.26 The abundance and species data for collections of benthic macroinvertebrates colonizing limestones-filled basket substrates.

| COLLECTION/STATION               | 1 (Control) | 2         | 3        | 4        | 5        | Chlorination |
|----------------------------------|-------------|-----------|----------|----------|----------|--------------|
| 10/30/87<br>Stream Bed Rocks     | 40:(19)     | 63:(18)   | 130:(23) | 115:(16) | 94:(18)  | yes          |
| 10/30/87<br>Limestones           | 25:(14)     | 78:(23)   | 173:(19) | 52:(16)  | 32:(11)  | yes          |
| 12/22/87<br>Replicate Basket 1   | 54:(20)     | 270:(25)  | 94:(17)  | 88:(14)  | 121:(13) | no           |
| 12/22/87<br>Replicate Basket 2   | 66:(22)     | 327:(34)  | 100:(27) | 77:(19)  | 55:(10)  | no           |
| 3/29/88<br>Stone not in Contact  | 25:(18)     | 53:(25)   | 237:(27) | 86:(18)  | 31:(14)  | no           |
| 3/29/88<br>Standard Exposure     | 32:(20)     | 106:(41)  | 293:(30) | 128:(20) | 56:(24)  | no           |
| 4/14/88<br>Chlorination Resumed  | 50:(21)     | 56:(21)   | 162:(19) | 59:(8)   | 21:(13)  | yes          |
| 8/22/88<br>Summer Collection     | 319:(45)    | 2095:(46) | 550:(43) | 108:(13) | 837:(53) | yes          |
| 10/17/88<br>Placement Experiment | 101:(28)    | 167:(28)  | 228:(37) | 107:(26) | 76:(32)  | yes          |

Table 4.27 The abundance and species data for collections of chironomids colonizing limestones-filled basket substrates.

| COLLECTION/STATION               | 1 (Control) | 2         | 3        | 4        | 5        | Chlorination |
|----------------------------------|-------------|-----------|----------|----------|----------|--------------|
| 10/30/87<br>Stream Bed Rocks     | 18:(11)     | 56:(15)   | 111:(20) | 84:(13)  | 76:(12)  | yes          |
| 10/30/87<br>Limestones           | 14:(8)      | 72:(19)   | 152:(13) | 45:(13)  | 25:(6)   | yes          |
| 12/22/87<br>Replicate Basket 1   | 28:(10)     | 253:(16)  | 86:(12)  | 82:(11)  | 81:(6)   | no           |
| 12/22/87<br>Replicate Basket 2   | 33:(9)      | 283:(18)  | 85:(19)  | 68:(13)  | 37:(7)   | no           |
| 3/29/88<br>Stone not in Contact  | 18:(14)     | 46:(19)   | 188:(22) | 84:(16)  | 25:(9)   | no           |
| 3/29/88<br>Standard Exposure     | 11:(10)     | 73:(25)   | 204:(22) | 119:(16) | 33:(14)  | no           |
| 4/14/88<br>Chlorination Resumed  | 41:(16)     | 53:(18)   | 135:(12) | 18:(7)   | 17:(11)  | yes          |
| 8/22/88<br>Summer Collection     | 210:(26)    | 1980:(33) | 106:(19) | 2:(1)    | 528:(35) | yes          |
| 10/17/88<br>Placement Experiment | 79:(17)     | 99:(18)   | 126:(18) | 62:(14)  | 43:(15)  | yes          |

Table 4.28 The percentage of chironomids abundance and species colonizing limestones-filled basket substrates.

| COLLECTION/STATION               | 1 (Control) | 2           | 3            | 4           | 5           | Chlorination |
|----------------------------------|-------------|-------------|--------------|-------------|-------------|--------------|
| 10/30/87<br>Stream Bed Rocks     | 45.0:(57.9) | 88.9:(83.3) | 85.4:(87.0)  | 73.0:(81.2) | 80.9:(66.7) | yes          |
| 10/30/87<br>Limestones           | 56.0:(57.1) | 92.3:(82.6) | 87.9:(68.42) | 86.5:(81.2) | 78.1:(54.5) | yes          |
| 12/22/87<br>Replicate Basket 1   | 51.9:(50.0) | 93.7:(64.0) | 91.5:(70.6)  | 93.2:(78.6) | 66.9:(46.2) | no           |
| 12/22/87<br>Replicate Basket 2   | 50.0:(40.9) | 86.5:(52.9) | 85.0:(70.4)  | 77.3:(68.4) | 67.3:(70.0) | no           |
| 3/29/88<br>Stone not in Contact  | 72.0:(77.8) | 83.0:(76.0) | 79.3:(81.5)  | 97.7:(88.9) | 80.6:(64.3) | no           |
| 3/29/88<br>Standard Exposure     | 34.4:(50.0) | 68.9:(61.0) | 69.6:(73.3)  | 93.0:(80.0) | 58.9:(58.3) | no           |
| 4/14/88<br>Chlorination Resumed  | 82.0:(76.2) | 94.6:(85.7) | 83.3:(63.2)  | 30.5:(87.5) | 81.0:(84.6) | yes          |
| 8/22/88<br>Summer Collection     | 65.8:(57.8) | 94.5:(71.7) | 19.3:(44.2)  | 1.9:(7.7)   | 63.1:(66.0) | yes          |
| 10/17/88<br>Placement Experiment | 78.2:(60.7) | 59.3:(64.3) | 55.3:(48.6)  | 57.9:(53.8) | 56.6:(46.9) | yes          |

Table 4.29 Brillouin's diversity of total benthic macroinvertebrates colonizing limestones-filled basket substrates.

| COLLECTION/STATION               | 1 (Control) | 2      | 3      | 4      | 5      | Chlorination |
|----------------------------------|-------------|--------|--------|--------|--------|--------------|
| 10/30/87<br>Stream Bed Rocks     | 2.2068      | 2.2503 | 2.1793 | 1.8506 | 1.3349 | yes          |
| 10/30/87<br>Limestones           | 1.8744      | 2.2207 | 1.9487 | 1.9417 | 1.1824 | yes          |
| 12/22/87<br>Replicate Basket 1   | 2.1061      | 1.5036 | 2.0030 | 1.7633 | 1.3334 | no           |
| 12/22/87<br>Replicate Basket 2   | 2.1549      | 1.8332 | 2.3216 | 1.9776 | 1.5702 | no           |
| 3/29/88<br>Stone not in Contact  | 2.1098      | 2.4099 | 2.4284 | 2.0768 | 1.7995 | no           |
| 3/29/88<br>Standard Exposure     | 2.2074      | 2.8289 | 2.4047 | 2.2022 | 2.3473 | no           |
| 4/14/88<br>Chlorination Resumed  | 2.0224      | 2.0944 | 1.8128 | 1.0109 | 1.8060 | yes          |
| 8/22/88<br>Summer Collection     | 2.7868      | 1.7430 | 2.3233 | 1.8697 | 2.4693 | yes          |
| 10/17/88<br>Placement Experiment | 2.4490      | 2.2882 | 2.4560 | 2.3775 | 2.6052 | yes          |

Table 4.30 Hurlbert's diversity of total benthic macroinvertebrates colonizing limestones-filled basket substrates.

| COLLECTION/STATION               | 1 (Control) | 2      | 3      | 4      | 5      | Chlorination |
|----------------------------------|-------------|--------|--------|--------|--------|--------------|
| 10/30/87<br>Stream Bed Rocks     | 0.9436      | 0.9242 | 0.8729 | 0.8217 | 0.5820 | yes          |
| 10/30/87<br>Limestones           | 0.9300      | 0.8954 | 0.8388 | 0.8771 | 0.6129 | yes          |
| 12/22/87<br>Replicate Basket 1   | 0.8987      | 0.6380 | 0.8518 | 0.8033 | 0.6563 | no           |
| 12/22/87<br>Replicate Basket 2   | 0.8918      | 0.7005 | 0.8939 | 0.8585 | 0.7987 | no           |
| 3/29/88<br>Stone not in Contact  | 0.9733      | 0.9449 | 0.9035 | 0.8739 | 0.8839 | no           |
| 3/29/88<br>Standard Exposure     | 0.9617      | 0.9551 | 0.8829 | 0.8829 | 0.9364 | no           |
| 4/14/88<br>Chlorination Resumed  | 0.8669      | 0.8909 | 0.7684 | 0.5091 | 0.9381 | yes          |
| 8/22/88<br>Summer Collection     | 0.9205      | 0.6188 | 0.8534 | 0.8429 | 0.8705 | yes          |
| 10/17/88<br>Placement Experiment | 0.9147      | 0.8821 | 0.8797 | 0.9138 | 0.9488 | yes          |

Table 4.31 Brillouin's diversity of midges colonizing limestones-filled basket substrates. Percent contribution of the midge diversity indicated in parenthesis.

| COLLECTION/STATION               | 1 (Control)       | 2                 | 3                 | 4                 | 5                 | Chlorination |
|----------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------|
| 10/30/87<br>Stream Bed Rocks     | 1.6848<br>(34.4%) | 2.0890<br>(82.5%) | 2.0142<br>(78.9%) | 1.6520<br>(65.2%) | 0.8384<br>(50.8%) | yes          |
| 10/30/87<br>Limestones           | 1.3949<br>(41.7%) | 2.0700<br>(86.0%) | 1.7161<br>(77.4%) | 1.7245<br>(76.9%) | 0.6267<br>(41.4%) | yes          |
| 12/22/87<br>Replicate Basket 1   | 1.5367<br>(37.8%) | 1.2635<br>(78.7%) | 1.7992<br>(82.2%) | 1.5971<br>(84.4%) | 0.5807<br>(29.2%) | no           |
| 12/22/87<br>Replicate Basket 2   | 1.2846<br>(29.8%) | 1.3517<br>(63.8%) | 2.0253<br>(74.2%) | 1.7021<br>(76.0%) | 1.1459<br>(49.1%) | no           |
| 3/29/88<br>Stone not in Contact  | 1.8679<br>(63.7%) | 2.1636<br>(74.5%) | 2.3079<br>(75.4%) | 2.0203<br>(95.0%) | 1.4556<br>(65.2%) | no           |
| 3/29/88<br>Standard Exposure     | 1.5281<br>(23.8%) | 2.3631<br>(57.5%) | 2.3193<br>(67.2%) | 2.0595<br>(86.9%) | 1.8308<br>(46.0%) | no           |
| 4/14/88<br>Chlorination Resumed  | 1.7431<br>(70.7%) | 1.9861<br>(89.7%) | 1.4126<br>(64.9%) | 1.4189<br>(42.8%) | 1.6378<br>(73.4%) | yes          |
| 8/22/88<br>Summer Collection     | 2.3900<br>(56.5%) | 1.5572<br>(84.4%) | 1.6504<br>(13.7%) | 0.0000<br>(0.0%)  | 2.2095<br>(51.8%) | yes          |
| 10/17/88<br>Placement Experiment | 2.0297<br>(64.8%) | 1.8392<br>(47.6%) | 1.9429<br>(43.7%) | 1.7224<br>(42.0%) | 1.9136<br>(41.6%) | yes          |



Table 4.32 Hurlbert's diversity of midges colonizing limestones-filled basket substrates.

| COLLECTION/STATION               | 1 (Control) | 2      | 3      | 4      | 5      | Chlorination |
|----------------------------------|-------------|--------|--------|--------|--------|--------------|
| 10/30/87<br>Stream Bed Rocks     | 0.9231      | 0.9084 | 0.8452 | 0.7734 | 0.3768 | yes          |
| 10/30/87<br>Limestones           | 0.8901      | 0.8783 | 0.8015 | 0.8424 | 0.3667 | yes          |
| 12/22/87<br>Replicate Basket 1   | 0.8360      | 0.5882 | 0.8238 | 0.7745 | 0.3210 | no           |
| 12/22/87<br>Replicate Basket 2   | 0.7159      | 0.6020 | 0.8577 | 0.8196 | 0.6742 | no           |
| 3/29/88<br>Stone not in Contact  | 0.9739      | 0.9239 | 0.8957 | 0.8678 | 0.8233 | no           |
| 3/29/88<br>Standard Exposure     | 0.9818      | 0.9235 | 0.8927 | 0.8665 | 0.8864 | no           |
| 4/14/88<br>Chlorination Resumed  | 0.8134      | 0.8781 | 0.6764 | 0.8693 | 0.9265 | yes          |
| 8/22/88<br>Summer Collection     | 0.8925      | 0.5748 | 0.7520 | 0.0000 | 0.7763 | yes          |
| 10/17/88<br>Placement Experiment | 0.8679      | 0.8058 | 0.8290 | 0.8244 | 0.8848 | yes          |

Table 4.33 Brillouin's diversity of macroinvertebrate families colonizing limestone-filled basket substrates. Percent contribution of the family level diversity indicated in parentheses.

| COLLECTION/STATION               | 1 (Control)       | 2                 | 3                 | 4                 | 5                 | Chlorination |
|----------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------|
| 10/30/87<br>Stream Bed Rocks     | 1.4486<br>(65.6%) | 0.3934<br>(17.5%) | 0.4595<br>(21.1%) | 0.6344<br>(34.3%) | 0.6570<br>(49.2%) | yes          |
| 10/30/87<br>Limestones           | 1.0933<br>(58.3%) | 0.3096<br>(13.9%) | 0.4409<br>(22.6%) | 0.4493<br>(23.1%) | 0.6028<br>(58.6%) | yes          |
| 12/22/87<br>Replicate Basket 1   | 1.2686<br>(60.2%) | 0.3170<br>(21.1%) | 0.3570<br>(17.8%) | 0.2751<br>(15.6%) | 0.9447<br>(70.8%) | no           |
| 12/22/87<br>Replicate Basket 2   | 1.4645<br>(68.0%) | 0.6297<br>(34.3%) | 0.5737<br>(24.7%) | 0.4601<br>(23.3%) | 0.7993<br>(50.9%) | no           |
| 3/29/88<br>Stone not in Contact  | 0.7210<br>(34.2%) | 0.6138<br>(25.5%) | 0.5308<br>(21.9%) | 0.1035<br>(5.0%)  | 0.6257<br>(34.8%) | no           |
| 3/29/88<br>Standard Exposure     | 1.4774<br>(66.9%) | 1.1563<br>(40.9%) | 0.7168<br>(29.8%) | 0.2875<br>(13.1%) | 1.2560<br>(53.5%) | no           |
| 4/14/88<br>Chlorination Resumed  | 0.5573<br>(27.6%) | 0.2147<br>(10.3%) | 0.5528<br>(30.5%) | 0.5780<br>(57.2%) | 0.4802<br>(26.6%) | yes          |
| 8/22/88<br>Summer Collection     | 1.1458<br>(41.1%) | 0.2651<br>(15.2%) | 1.7544<br>(75.5%) | 1.3821<br>(73.9%) | 1.1835<br>(47.9%) | yes          |
| 10/17/88<br>Placement Experiment | 0.8318<br>(34.0%) | 1.1776<br>(51.5%) | 1.3009<br>(53.0%) | 1.2846<br>(54.0%) | 1.4331<br>(55.0%) | yes          |

Table 4.34 Hurlbert's diversity of macroinvertebrate families colonizing limestones-filled basket substrates.

| COLLECTION/STATION               | 1 (Control) | 2      | 3      | 4      | 5      | Chlorination |
|----------------------------------|-------------|--------|--------|--------|--------|--------------|
| 10/30/87<br>Stream Bed Rocks     | 0.7603      | 0.2079 | 0.2575 | 0.4101 | 0.3363 | yes          |
| 10/30/87<br>Limestones           | 0.6600      | 0.1479 | 0.2206 | 0.2481 | 0.3911 | yes          |
| 12/22/87<br>Replicate Basket 1   | 0.6751      | 0.1217 | 0.1629 | 0.1314 | 0.5131 | no           |
| 12/22/87<br>Replicate Basket 2   | 0.7124      | 0.2489 | 0.2739 | 0.2198 | 0.4963 | no           |
| 3/29/88<br>Stone not in Contact  | 0.4700      | 0.3106 | 0.3328 | 0.0462 | 0.3527 | no           |
| 3/29/88<br>Standard Exposure     | 0.8085      | 0.5164 | 0.4401 | 0.1344 | 0.6318 | no           |
| 4/14/88<br>Chlorination Resumed  | 0.3184      | 0.1052 | 0.2914 | 0.4313 | 0.3381 | yes          |
| 8/22/88<br>Summer Collection     | 0.5325      | 0.1053 | 0.7985 | 0.7407 | 0.5617 | yes          |
| 10/17/88<br>Placement Experiment | 0.3838      | 0.5980 | 0.6241 | 0.6313 | 0.6621 | yes          |

Table 4.35 The Sørensen's quotient of similarity of corresponding control and downstream basket populations of total benthic macroinvertebrates colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2        | Station 3        | Station 4        | Station 5        | Chlorination |
|---------------------------------|------------------|------------------|------------------|------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | 0.3243<br>0.2857 | 0.4286<br>0.2632 | 0.3429<br>0.2857 | 0.3243<br>0.2000 | yes          |
| 10/30/87<br>Limestones          | 0.1250<br>0.3243 | 0.2703<br>0.1212 | 0.2667<br>0.2000 | 0.3125<br>0.2400 | yes          |
| 12/22/87<br>Replicate Basket 1  | 0.5778           | 0.2703           | 0.2941           | 0.4242           | no           |
| Replicate Basket 2              | 0.5556           | 0.2128           | 0.3077           | 0.4000           |              |
| 12/22/87<br>Replicate Basket 1  | 0.5957           | 0.2564           | 0.3333           | 0.3429           | no           |
| Replicate Basket 2              | 0.6429           | 0.2041           | 0.3415           | 0.2500           |              |
| 3/29/88<br>Stone not in Contact | 0.4091           | 0.5778           | 0.6111           | 0.3125           | no           |
| Standard Exposure               | 0.3509           | 0.4583           | 0.5263           | 0.3333           |              |
| 3/29/88<br>Standard Exposure    | 0.3044           | 0.4255           | 0.4210           | 0.1176           | no           |
| Standard Exposure               | 0.3390           | 0.3600           | 0.4000           | 0.2273           |              |
| 4/14/88                         | 0.52389          | 0.2500           | 0.2069           | 0.2353           | yes          |
| 8/22/88                         | 0.4444           | 0.3636           | 0.1034           | 0.4694           | yes          |
| 10/17/88                        | 0.5714           | 0.4615           | 0.4151           | 0.5667           | yes          |

Table 4.36 The revised Fager and McGowan index of corresponding control and downstream basket populations of total benthic macroinvertebrates colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2   | Station 3        | Station 4        | Station 5         | Chlorination |
|---------------------------------|---|------------------|------------------|-------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | Stream Bed Rocks<br>0.2878<br>Limestones 0.2528               | 0.4185<br>0.2343 | 0.3051<br>0.1016 | 0.2878            | yes          |
| 10/30/87<br>Limestones          | Stream Bed Rocks<br>-0.0132<br>Limestones 0.2936              | 0.2244<br>0.0979 | 0.1920<br>0.1340 | 0.2594            | yes          |
| 12/22/87<br>Replicate Basket 1  | Replicate Basket 1<br>0.5561<br>Replicate Basket 2<br>0.5685  | 0.2198<br>0.1652 | 0.2441<br>0.2726 | 0.3944<br>0.3653  | no           |
| 12/22/87<br>Replicate Basket 2  | Replicate Basket 1<br>0.5839<br>Replicate Basket 2<br>0.6410  | 0.2075<br>0.1556 | 0.3008<br>0.3189 | 0.3111<br>0.1876  | no           |
| 3/29/88<br>Stone not in Contact | Stone not in Contact<br>0.4048<br>Standard Exposure<br>0.3740 | 0.5695<br>0.4671 | 0.5729<br>0.5043 | 0.2594<br>0.3131  | no           |
| 3/29/88<br>Standard Exposure    | Stone not in Contact<br>0.2858<br>Standard Exposure<br>0.3589 | 0.4268<br>0.3623 | 0.4004<br>0.3824 | -0.0184<br>0.1785 | no           |
| 4/14/88                         | Chlorination Resumed<br>0.5107                                | 0.2002           | 0.1165           | 0.1668            | yes          |
| 8/22/88                         | Summer Collection<br>0.2457                                   | 0.2016           | -0.0168          | 0.2626            | yes          |
| 10/17/88                        | Placement Experiment<br>0.5765                                | 0.4888           | 0.4237           | 0.5781            | yes          |

Table 4.37 The Sørensen's quotient of similarity of corresponding control and downstream basket populations of midges colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2        | Station 3        | Station 4        | Station 5        | Chlorination |
|---------------------------------|------------------|------------------|------------------|------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | 0.4615<br>0.3333 | 0.5161<br>0.4167 | 0.4167<br>0.1176 | 0.4348           | yes          |
| 10/30/87<br>Limestones          | 0.1739<br>0.1905 | 0.3571<br>0.2857 | 0.3810<br>0.2896 | 0.4000           | yes          |
| 12/22/87<br>Replicate Basket 1  | 0.5385           | 0.4546           | 0.3810           | 0.3750           | no           |
| Replicate Basket 2              | 0.5714           | 0.3448           | 0.4348           | 0.3529           |              |
| 12/22/87<br>Replicate Basket 2  | 0.5600<br>0.6667 | 0.4762<br>0.3571 | 0.4000<br>0.4545 | 0.4000<br>0.2500 | no           |
| 3/29/88<br>Stone not in Contact | 0.5294<br>0.4737 | 0.6667<br>0.6111 | 0.7333<br>0.6667 | 0.4348<br>0.4286 | no           |
| 3/29/88<br>Standard Exposure    | 0.4000<br>0.3529 | 0.5625<br>0.5625 | 0.6154<br>0.5385 | 0.2105<br>0.3333 | no           |
| 4/14/88                         | 0.5882           | 0.3571           | 0.2609           | 0.2963           | yes          |
| 8/22/88                         | 0.5085           | 0.4889           | 0.0741           | 0.5000           | yes          |
| 10/17/88                        | 0.6285           | 0.4571           | 0.4667           | 0.6250           | yes          |

Table 4.38 The revised Fager and McGowan index of corresponding control and downstream basket populations of nidges colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2        | Station 3        | Station 4        | Station 5         | Chlorination |
|---------------------------------|------------------|------------------|------------------|-------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | 0.4047<br>0.3608 | 0.4845<br>0.2506 | 0.3464<br>0.3464 | 0.3601<br>-0.1151 | yes          |
| 10/30/87<br>Limestones          | 0.0274<br>0.3254 | 0.3160<br>0.0394 | 0.2945<br>0.1765 | 0.3080<br>0.1123  | yes          |
| 12/22/87<br>Replicate Basket 1  | 0.4825           | 0.3759           | 0.2893           | 0.2494            | no           |
| Replicate Basket 2              | 0.5237           | 0.2959           | 0.3616           | 0.2294            |              |
| 12/22/87<br>Replicate Basket 1  | 0.5005           | 0.3933           | 0.3051           | 0.2664            | no           |
| Replicate Basket 2              | 0.6024           | 0.3098           | 0.3785           | 0.0846            |              |
| 3/29/88<br>Stone not in Contact | 0.4999           | 0.6234           | 0.6506           | 0.3648            | no           |
| Standard Exposure               | 0.4621           | 0.5789           | 0.6005           | 0.3764            |              |
| 3/29/88<br>Standard Exposure    | 0.3653<br>0.3314 | 0.5372<br>0.5372 | 0.5499<br>0.4825 | 0.0531<br>0.2525  | no           |
| 4/14/88                         | 0.5487           | 0.2989           | 0.1625           | 0.2210            | yes          |
| 8/22/88                         | 0.5260           | 0.4868           | -0.1776          | 0.5198            | yes          |
| 10/17/88                        | 0.5847           | 0.4295           | 0.4251           | 0.5736            | yes          |

Table 4.39 The Sørensen's quotient of similarity of corresponding control and downstream basket populations of macroinvertebrate families colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2        | Station 3        | Station 4        | Station 5        | Chlorination |
|---------------------------------|------------------|------------------|------------------|------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | 0.3077<br>0.1429 | 0.3077<br>0.4000 | 0.3333<br>0.1538 | 0.5000<br>0.4000 | yes          |
| 10/30/87<br>Limestones          | 0.1818<br>0.3333 | 0.1818<br>0.1538 | 0.2000<br>0.1818 | 0.2857<br>0.3077 | yes          |
| 12/22/87<br>Replicate Basket 1  | 0.7778<br>0.6956 | 0.1333<br>0.2500 | 0.4615<br>0.4000 | 0.5882<br>0.6154 | no           |
| 12/22/87<br>Replicate Basket 2  | 0.7619<br>0.6923 | 0.1111<br>0.3158 | 0.3750<br>0.2222 | 0.4000<br>0.3750 | no           |
| 3/29/88<br>Stone not in Contact | 0.3636<br>0.2500 | 0.5000<br>0.1818 | 0.2857<br>0.2222 | 0.4000<br>0.4286 | no           |
| 3/29/88<br>Standard Exposure    | 0.3750<br>0.3810 | 0.3077<br>0.1250 | 0.1667<br>0.2857 | 0.1333<br>0.3158 | no           |
| 4/14/88                         | 0.4444           | 0.1818           | 0.2857           | 0.2500           | yes          |
| 8/22/88                         | 0.4348           | 0.2857           | 0.2105           | 0.6207           | yes          |
| 10/17/88                        | 0.6000           | 0.7200           | 0.6316           | 0.6956           | yes          |



Table 4.40 The revised Fager and McGowan index of corresponding control and downstream basket populations of macroinvertebrate families colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2          | Station 3          | Station 4          | Station 5         | Chlorination |
|---------------------------------|--------------------|--------------------|--------------------|-------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | 0.1375<br>0.2664   | 0.1375<br>-0.0989  | 0.1650<br>0.2664   | 0.3796            | yes          |
| 10/30/87<br>Limestones          | -0.0842<br>-0.0985 | -0.0842<br>-0.0842 | -0.0732<br>0.1280  | 0.1111            | yes          |
| 12/22/87<br>Replicate Basket 1  | 0.6250             | -0.1080            | 0.3213             | 0.4689            | no           |
| Replicate Basket 2              | 0.5995             | 0.0846             | 0.2664             | 0.4690            |              |
| 12/22/87<br>Replicate Basket 2  | 0.6346<br>0.6057   | -0.1180<br>0.2027  | 0.2675<br>0.0676   | 0.3080<br>0.2675  | no           |
| 3/29/88<br>Stone not in Contact | 0.1735<br>0.0987   | 0.2584<br>-0.0842  | -0.0264<br>-0.0626 | 0.1964<br>0.3013  | no           |
| 3/29/88<br>Standard Exposure    | 0.2453<br>0.2910   | 0.1375<br>-0.1113  | -0.0919<br>0.1161  | -0.1080<br>0.1974 | no           |
| 4/14/88                         | 0.2241             | -0.0845            | -0.0214            | -0.0459           | yes          |
| 8/22/88                         | 0.3601             | 0.2104             | 0.0560             | 0.5632            | yes          |
| 10/17/88                        | 0.5000             | 0.6262             | 0.5205             | 0.5960            | yes          |

Table 4.41 The Morisita similarity index values of corresponding control and downstream basket populations of total benthic macroinvertebrates colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2                                 | Station 3        | Station 4        | Station 5        | Chlorination |
|---------------------------------|---|------------------|------------------|------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | Stream Bed Rocks<br>Limestones 0.3106     | 0.3982<br>0.2681 | 0.2926<br>0.1304 | 0.1592           | yes          |
| 10/30/87<br>Limestones          | Stream Bed Rocks<br>Limestones 0.5053     | 0.4807<br>0.0797 | 0.1625<br>0.0656 | 0.1116           | yes          |
| 12/22/87<br>Replicate Basket 1  | Replicate Basket 1<br>Replicate Basket 2  | 0.4373<br>0.5893 | 0.3601<br>0.3982 | 0.6287<br>0.8098 | no           |
| 12/22/87<br>Replicate Basket 2  | Replicate Basket 1<br>Replicate Basket 2  | 0.2514<br>0.4060 | 0.2383<br>0.2491 | 0.4440<br>0.5839 | no           |
| 3/29/88<br>Stone not in Contact | Stone not in Contact<br>Standard Exposure | 0.6274<br>0.4956 | 0.5236<br>0.5520 | 0.3434<br>0.3480 | no           |
| 3/29/88<br>Standard Exposure    | Stone not in Contact<br>Standard Exposure | 0.2875<br>0.2320 | 0.2210<br>0.2136 | 0.2219<br>0.1861 | no           |
| 4/14/88                         | Chlorination Resumed                      | 0.8652           | 0.1076           | 0.1172           | yes          |
| 8/22/88                         | Summer Collection                         | 0.1376           | 0.0159           | 0.4152           | yes          |
| 10/17/88                        | Placement Experiment                      | 0.4329           | 0.5091           | 0.7345           | yes          |

Table 4.42 Sokal's Euclidean distance index values of corresponding control and downstream basket populations of total benthic macroinvertebrates colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2      | Station 3      | Station 4      | Station 5 | Chlorination |
|---------------------------------|----------------|----------------|----------------|-----------|--------------|
| 10/30/87<br>Stream Bed Rocks    | 19.10<br>67.24 | 44.83<br>20.15 | 47.59<br>21.68 | 59.93     | yes          |
| 10/30/87<br>Limestones          | 17.83<br>69.87 | 44.96<br>20.62 | 49.03<br>21.42 | 60.72     | yes          |
| 12/22/87<br>Replicate Basket 1  | 153.64         | 34.35          | 37.79          | 60.22     | no           |
| Replicate Basket 2              | 169.58         | 28.88          | 29.10          | 16.40     |              |
| 12/22/87<br>Replicate Basket 1  | 155.25         | 38.99          | 41.26          | 63.55     | no           |
| Replicate Basket 2              | 170.74         | 33.26          | 33.45          | 22.96     |              |
| 3/29/88<br>Stone not in Contact | 13.11          | 72.25          | 29.61          | 11.92     | no           |
| Standard Exposure               | 22.65          | 99.17          | 42.65          | 15.78     |              |
| 3/29/88<br>Standard Exposure    | 14.11          | 73.57          | 31.27          | 13.23     | no           |
| Standard Exposure               | 23.87          | 100.23         | 44.34          | 16.97     |              |
| 4/14/88                         | 12.33          | 63.44          | 43.78          | 19.97     | yes          |
| Chlorination Resumed            |                |                |                |           |              |
| 8/22/88                         | 1244.23        | 218.52         | 100.90         | 276.89    | yes          |
| Summer Collection               |                |                |                |           |              |
| 10/17/88                        | 41.59          | 73.26          | 33.23          | 23.69     | yes          |
| Placement Experiment            |                |                |                |           |              |

Table 4.43 The Pinkham-Pearson index B values of corresponding control and downstream basket populations of total benthic macroinvertebrates colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2            | Station 3        | Station 4        | Station 5        | Chlorination |     |
|---------------------------------|----------------------|------------------|------------------|------------------|--------------|-----|
| 10/30/87<br>Stream Bed Rocks    | 0.1091<br>0.0463     | 0.1332<br>0.1194 | 0.0662<br>0.0248 | 0.1038           | yes          |     |
| 10/30/87<br>Limestones          | 0.0167<br>0.0112     | 0.0619<br>0.0370 | 0.0686<br>0.1091 | 0.1049           | yes          |     |
| 12/22/87<br>Replicate Basket 1  | 0.2230               | 0.0912           | 0.0705           | 0.1376           | no           |     |
| Replicate Basket 2              | 0.2090               | 0.0712           | 0.1177           | 0.1146           |              |     |
| 12/22/87<br>Replicate Basket 1  | 0.2550               | 0.0383           | 0.0771           | 0.1329           | no           |     |
| Replicate Basket 2              | 0.2680               | 0.0268           | 0.1075           | 0.0860           |              |     |
| 3/29/88<br>Stone not in Contact | 0.1362               | 0.1256           | 0.2494           | 0.1025           | no           |     |
| Standard Exposure               | 0.0989               | 0.0619           | 0.1416           | 0.1404           |              |     |
| 3/29/88<br>Standard Exposure    | 0.0778<br>0.1060     | 0.0836<br>0.0255 | 0.1122<br>0.0916 | 0.0391<br>0.0705 | no           |     |
| 4/14/88                         | Chlorination Resumed | 0.1854           | 0.0599           | 0.0622           | yes          |     |
| 8/22/88                         | Summer Collection    | 0.0917           | 0.0895           | 0.1049           | yes          |     |
| 10/17/88                        | Placement Experiment | 0.2258           | 0.1447           | 0.1795           | 0.2223       | yes |

Table 4.44 The average chi-square index values of corresponding control and downstream basket populations of total benthic macroinvertebrates colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2            | Station 3        | Station 4        | Station 5        | Chlorination |
|---------------------------------|----------------------|------------------|------------------|------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | 0.7337<br>0.7929     | 0.7643<br>0.7544 | 0.7751<br>0.8190 | 0.7547           | yes          |
| 10/30/87<br>Limestones          | 0.8247<br>0.9164     | 0.8336<br>0.8822 | 0.8533<br>0.8296 | 0.7787           | yes          |
| 12/22/87<br>Replicate Basket 1  | 0.6833<br>0.6840     | 0.6587<br>0.6240 | 0.6117<br>0.6318 | 0.5227<br>0.4013 | no           |
| 12/22/87<br>Replicate Basket 2  | 0.7066<br>0.6643     | 0.7474<br>0.6996 | 0.6847<br>0.7046 | 0.6171<br>0.5434 | no           |
| 3/29/88<br>Stone not in Contact | 0.6286<br>0.7326     | 0.7871<br>0.8371 | 0.6426<br>0.7335 | 0.7550<br>0.7371 | no           |
| 3/29/88<br>Standard Exposure    | 0.7274<br>0.7658     | 0.8668<br>0.8897 | 0.8014<br>0.8344 | 0.8667<br>0.8197 | no           |
| 4/14/88                         | Chlorination Resumed | 0.6420           | 0.7726           | 0.8404           | yes          |
| 8/22/88                         | Summer Collection    | 0.7557           | 0.9623           | 0.6329           | yes          |
| 10/17/88                        | Placement Experiment | 0.5440           | 0.5522           | 0.3801           | yes          |

Table 4.45 The Morisita similarity index values of corresponding control and downstream basket populations of midges colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2                                 | Station 3        | Station 4        | Station 5        | Chlorination |
|---------------------------------|---|------------------|------------------|------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | Stream Bed Rocks<br>Limestones 0.6436     | 0.8457<br>0.5538 | 0.6795<br>0.1272 | 0.1529           | yes          |
| 10/30/87<br>Limestones          | Stream Bed Rocks<br>Limestones 0.7197     | 0.7488<br>0.1187 | 0.2931<br>0.0154 | 0.0359           | yes          |
| 12/22/87<br>Replicate Basket 1  | Replicate Basket 1<br>Replicate Basket 2  | 0.6762<br>0.9053 | 0.4830<br>0.6099 | 0.6349<br>0.7330 | no           |
| 12/22/87<br>Replicate Basket 2  | Replicate Basket 1<br>Replicate Basket 2  | 0.3062<br>0.4799 | 0.2480<br>0.2916 | 0.4118<br>0.4512 | no           |
| 3/29/88<br>Stone not in Contact | Stone not in Contact<br>Standard Exposure | 1.0241<br>1.0652 | 0.7182<br>0.7430 | 0.4164<br>0.4818 | no           |
| 3/29/88<br>Standard Exposure    | Stone not in Contact<br>Standard Exposure | 1.1451<br>1.2002 | 0.7195<br>0.6650 | 0.6345<br>0.5434 | no           |
| 4/14/88                         | Chlorination Resumed                      | 0.9051           | 0.8455           | 0.1324           | yes          |
| 8/22/88                         | Summer Collection                         | 0.3950           | 0.0344           | 0.8599           | yes          |
| 10/17/88                        | Placement Experiment                      | 0.6389           | 0.5919           | 0.7905           | yes          |

Table 4.46 Sokal's Euclidean distance index values of corresponding control and downstream basket populations of midges colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2      | Station 3      | Station 4      | Station 5      | Chlorination |
|---------------------------------|----------------|----------------|----------------|----------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | 15.94<br>65.56 | 40.83<br>17.18 | 37.44<br>20.07 | 59.35          | yes          |
| 10/30/87<br>Limestones          | 16.25<br>67.73 | 41.56<br>19.26 | 39.77<br>20.86 | 60.28          | yes          |
| 12/22/87<br>Replicate Basket 1  | 153.22         | 31.18          | 36.06          | 58.47          | no           |
| Replicate Basket 2              | 168.96         | 24.35          | 25.34          | 15.84          |              |
| 12/22/87<br>Replicate Basket 1  | 154.78         | 36.15          | 39.64          | 61.27          | no           |
| Replicate Basket 2              | 170.24         | 29.33          | 30.32          | 21.63          |              |
| 3/29/88<br>Stone not in Contact | 12.17          | 58.55          | 29.33          | 10.91          | no           |
| Standard Exposure               | 19.26          | 64.44          | 42.01          | 11.79          |              |
| 3/29/88<br>Standard Exposure    | 11.87<br>20.30 | 59.81<br>65.75 | 30.32<br>43.29 | 10.49<br>11.83 | no           |
| 4/14/88                         | 11.40          | 61.48          | 14.39          | 18.97          | yes          |
| 8/22/88                         | 1240.59        | 68.32          | 70.11          | 244.29         | yes          |
| 10/17/88                        | 23.02          | 42.25          | 26.96          | 21.91          | yes          |

Table 4.47 The Pinkham-Pearson index B values of corresponding control and downstream basket populations of midges colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2                                 | Station 3        | Station 4        | Station 5        | Chlorination |
|---------------------------------|---|------------------|------------------|------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | Stream Bed Rocks<br>Limestones 0.1179     | 0.1803<br>0.1886 | 0.0747<br>0.0031 | 0.1398           | yes          |
| 10/30/87<br>Limestones          | Stream Bed Rocks<br>Limestones 0.1504     | 0.0861<br>0.0556 | 0.1049<br>0.1667 | 0.1458           | yes          |
| 12/22/87<br>Replicate Basket 1  | Replicate Basket 1<br>Replicate Basket 2  | 0.1716<br>0.1246 | 0.1066<br>0.1602 | 0.0559<br>0.0537 | no           |
| 12/22/87<br>Replicate Basket 2  | Replicate Basket 1<br>Replicate Basket 2  | 0.0814<br>0.0513 | 0.0664<br>0.1267 | 0.1768<br>0.0345 | no           |
| 3/29/88<br>Stone not in Contact | Stone not in Contact<br>Standard Exposure | 0.1535<br>0.0916 | 0.3282<br>0.1982 | 0.1538<br>0.2008 | no           |
| 3/29/88<br>Standard Exposure    | Stone not in Contact<br>Standard Exposure | 0.1128<br>0.0455 | 0.1869<br>0.1279 | 0.0735<br>0.1250 | no           |
| 4/14/88                         | Chlorination Resumed                      | 0.0912           | 0.0747           | 0.0812           | yes          |
| 8/22/88                         | Summer Collection                         | 0.1532           | 0.0192           | 0.0960           | yes          |
| 10/17/88                        | Placement Experiment                      | 0.1249           | 0.1626           | 0.2339           | yes          |



Table 4.48 The average chi-square index values of corresponding control and downstream basket populations of midges colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2                                 | Station 3        | Station 4        | Station 5        | Chlorination |
|---------------------------------|---|------------------|------------------|------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | Stream Bed Rocks<br>Limestones 0.6785     | 0.7142<br>0.6413 | 0.7106<br>0.9114 | 0.8255           | yes          |
| 10/30/87<br>Limestones          | Stream Bed Rocks<br>Limestones 0.7345     | 0.7937<br>0.8463 | 0.7905<br>0.8974 | 0.8556           | yes          |
| 12/22/87<br>Replicate Basket 1  | Replicate Basket 1<br>Replicate Basket 2  | 0.5569<br>0.4876 | 0.5874<br>0.5184 | 0.6512<br>0.5160 | no           |
| 12/22/87<br>Replicate Basket 2  | Replicate Basket 1<br>Replicate Basket 2  | 0.6604<br>0.5774 | 0.6960<br>0.6479 | 0.7146<br>0.6245 | no           |
| 3/29/88<br>Stone not in Contact | Stone not in Contact<br>Standard Exposure | 0.7438<br>0.7666 | 0.6111<br>0.7204 | 0.6809<br>0.6347 | no           |
| 3/29/88<br>Standard Exposure    | Stone not in Contact<br>Standard Exposure | 0.8333<br>0.8333 | 0.7533<br>0.8167 | 0.7667<br>0.7121 | no           |
| 4/14/88                         | Chlorination Resumed                      | 0.5688           | 0.5799           | 0.8046           | yes          |
| 8/22/88                         | Summer Collection                         | 0.5857           | 0.9478           | 0.7222           | yes          |
| 10/17/88                        | Placement Experiment                      | 0.4293           | 0.4592           | 0.3421           | yes          |

Table 4.49 The Morisita similarity index values of corresponding control and downstream basket populations of macroinvertebrate families colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2                             | Station 3        | Station 4        | Station 5 | Chlorination |
|---------------------------------|---------------------------------------|------------------|------------------|-----------|--------------|
| 10/30/87<br>Stream Bed Rocks    | Stream Bed Rocks<br>Limestones 0.7608 | 0.7839<br>0.7854 | 0.7986<br>0.8599 | 0.8490    | yes          |
| 10/30/87<br>Limestones          | Stream Bed Rocks<br>Limestones 0.8794 | 0.8790<br>0.8797 | 0.8877<br>0.9446 | 0.9485    | yes          |
| 12/22/87<br>Replicate Basket 1  | Replicate Basket 1                    | 0.8165           | 0.8241           | 0.9716    | no           |
| Replicate Basket 2              | Replicate Basket 2                    | 0.8408           | 0.8308           | 0.9866    |              |
| 12/22/87<br>Replicate Basket 1  | Replicate Basket 1                    | 0.8134           | 0.8190           | 0.9509    | no           |
| Replicate Basket 2              | Replicate Basket 2                    | 0.8394           | 0.8314           | 0.9615    |              |
| 3/29/88<br>Stone not in Contact | Stone not in Contact                  | 0.9550           | 0.9479           | 0.9909    | no           |
| Standard Exposure               | Standard Exposure                     | 0.9199           | 0.9592           | 0.9623    |              |
| 3/29/88<br>Standard Exposure    | Stone not in Contact                  | 0.6357           | 0.5863           | 0.6610    | no           |
|                                 | Standard Exposure                     | 0.6370           | 0.6055           | 0.7418    |              |
| 4/14/88                         | Chlorination Resumed                  | 0.9830           | 0.4002           | 0.9882    | yes          |
| 8/22/88                         | Summer Collection                     | 0.4182           | 0.0631           | 0.9821    | yes          |
| 10/17/88                        | Placement Experiment                  | 0.8790           | 0.9302           | 0.9509    | yes          |

Table 4.50 Sokal's Euclidean distance index values of corresponding control and downstream basket populations of macroinvertebrate families colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2  | Station 3        | Station 4       | Station 5      | Chlorination |
|---------------------------------|--|------------------|-----------------|----------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | Stream Bed Rocks<br>Limestones 54.94<br>39.41<br>134.83      | 94.83<br>28.98   | 72.21<br>10.77  | 58.53          | yes          |
| 10/30/87<br>Limestones          | Stream Bed Rocks<br>Limestones 58.35<br>42.64<br>139.07      | 98.50<br>31.86   | 75.67<br>12.04  | 62.43          | yes          |
| 12/22/87<br>Replicate Basket 1  | Replicate Basket 1<br>Replicate Basket 2<br>225.30<br>225.49 | 59.83<br>59.16   | 55.21<br>42.53  | 54.96<br>10.34 | no           |
| 12/22/87<br>Replicate Basket 2  | Replicate Basket 1<br>Replicate Basket 2<br>220.34<br>250.42 | 55.10<br>54.52   | 50.38<br>37.83  | 51.02<br>9.43  | no           |
| 3/29/88<br>Stone not in Contact | Stone not in Contact<br>Standard Exposure<br>28.39<br>56.44  | 176.42<br>202.96 | 66.16<br>101.49 | 8.49<br>17.97  | no           |
| 3/29/88<br>Standard Exposure    | Stone not in Contact<br>Standard Exposure<br>36.26<br>63.56  | 183.40<br>209.59 | 73.70<br>108.63 | 17.46<br>25.85 | no           |
| 4/14/88                         | Chlorination Resumed<br>13.19                                | 96.41            | 47.42           | 25.00          | yes          |
| 8/22/88                         | Summer Collection<br>1772.51                                 | 243.44           | 221.97          | 343.12         | yes          |
| 10/17/88                        | Placement Experiment<br>40.77                                | 76.97            | 26.68           | 36.92          | yes          |

Table 4.51 The Pinkham-Pearson index B values of corresponding control and downstream basket populations of macroinvertebrate families colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2                                 | Station 3        | Station 4        | Station 5        | Chlorination |
|---------------------------------|---|------------------|------------------|------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | Stream Bed Rocks<br>Limestones 0.0192     | 0.0375<br>0.0333 | 0.0964<br>0.1116 | 0.1892           | yes          |
| 10/30/87<br>Limestones          | Stream Bed Rocks<br>Limestones 0.0694     | 0.0126<br>0.0311 | 0.0185<br>0.0873 | 0.0570           | yes          |
| 12/22/87<br>Replicate Basket 1  | Replicate Basket 1<br>Replicate Basket 2  | 0.0233<br>0.0712 | 0.1072<br>0.1038 | 0.2108<br>0.3063 | no           |
| 12/22/87<br>Replicate Basket 2  | Replicate Basket 1<br>Replicate Basket 2  | 0.0226<br>0.1180 | 0.0886<br>0.0772 | 0.1338<br>0.2165 | no           |
| 3/29/88<br>Stone not in Contact | Stone not in Contact<br>Standard Exposure | 0.0715<br>0.0088 | 0.0357<br>0.0189 | 0.1525<br>0.0912 | no           |
| 3/29/88<br>Standard Exposure    | Stone not in Contact<br>Standard Exposure | 0.0508<br>0.0036 | 0.0119<br>0.0494 | 0.0314<br>0.0490 | no           |
| 4/14/88                         | Chlorination Resumed                      | 0.0304           | 0.0732           | 0.0592           | yes          |
| 8/22/88                         | Summer Collection                         | 0.0389           | 0.0165           | 0.1483           | yes          |
| 10/17/88                        | Placement Experiment                      | 0.3276           | 0.3278           | 0.3472           | yes          |

Table 4.52 The average chi-square index values of corresponding control and downstream basket populations of macroinvertebrate families colonizing limestones-filled basket substrates.

| Station 1 (Control) vs.         | Station 2        | Station 3        | Station 4        | Station 5        | Chlorination |
|---------------------------------|------------------|------------------|------------------|------------------|--------------|
| 10/30/87<br>Stream Bed Rocks    | 0.4516<br>0.6283 | 0.6167<br>0.4410 | 0.5732<br>0.2905 | 0.4053           | yes          |
| 10/30/87<br>Limestones          | 0.4909<br>0.7410 | 0.6792<br>0.4453 | 0.6571<br>0.2700 | 0.4906           | yes          |
| 12/22/87<br>Replicate Basket 1  | 0.6062           | 0.4291           | 0.3246           | 0.2586           | no           |
| Replicate Basket 2              | 0.6252           | 0.4218           | 0.3512           | 0.1050           |              |
| 12/22/87<br>Replicate Basket 2  | 0.5664<br>0.5754 | 0.4039<br>0.3991 | 0.2918<br>0.3306 | 0.2896<br>0.1840 | no           |
| 3/29/88<br>Stone not in Contact | 0.2981           | 0.7378           | 0.4658           | 0.2049           | no           |
| Standard Exposure               | 0.4950           | 0.7919           | 0.5912           | 0.3439           |              |
| 3/29/88<br>Standard Exposure    | 0.5090<br>0.5981 | 0.8356<br>0.8715 | 0.6703<br>0.7316 | 0.5150<br>0.5508 | no           |
| 4/14/88                         | 0.0953           | 0.4066           | 0.5410           | 0.3230           | yes          |
| 8/22/88                         | 0.6661           | 0.5715           | 0.9077           | 0.2790           | yes          |
| 10/17/88                        | 0.2248           | 0.2851           | 0.2065           | 0.1485           | yes          |

Table 4.53 The EPT data for the basket collections.

| COLLECTION/STATION              | 1   | 2   | 3   | 4   | 5   | Chlorination |
|---------------------------------|-----|-----|-----|-----|-----|--------------|
| 10/30/87<br>Stream Bed Rocks    | 6   | 0   | 1   | 2   | 4   | yes          |
| 10/30/87<br>Limestones          | 4   | 1   | 2   | 0   | 3   | yes          |
| 12/22/87<br>Replicate Basket 1  | 9   | 7   | 1   | 3   | 4   | no           |
| 12/22/87<br>Replicate Basket 2  | 10  | 11  | 3   | 3   | 2   | no           |
| 3/29/88<br>Stone not in Contact | 4   | 5   | 1   | 0   | 4   | no           |
| 3/29/88<br>Standard Exposure    | 8   | 6   | 0   | 2   | 6   | no           |
| 4/14/88<br>Chlorination Resumed | 5   | 2   | 0   | 0   | 0   | yes          |
| 8/22/88<br>Summer Collection    | 9   | 0   | 4   | 0   | 5   | yes          |
| 10/17/88                        | 5   | 0   | 5   | 2   | 7   | yes          |
| Average (non-chlorination)      | 6   | 7.2 | 1.2 | 2   | 4   |              |
| Average (chlorination)          | 5.8 | 0.6 | 2.4 | 0.8 | 3.8 |              |

## CHAPTER V

### DISCUSSION

#### A. Evaluation of the Qualitative and Quantitative Methodology

##### 1. Individual Stones as Discrete Sampling Units

Wrona's formula in estimating density of stone-dwelling organisms was originally designed for stream-bed rock substrates. Though limestone substrates are less heterogeneous in providing natural habitats for many organisms, the idea of using them as discrete sampling units has provided an opportunity to examine and validate such methodology. There are many advantages of applying Wrona's method to artificial substrates: (1) substrates can be manipulated into the same size class to simplify calculation; (2) the procedures generate data with the same unit for comparison; (3) the methods allow simultaneous quantitative measures of densities and spatial dispersion of a population; (4) the treatment of single stones as sampling units provides flexibility in selecting replicates, thus expediting the experimental process.

In order to better understand the significance of using individual stones as sampling units, the density estimate with its respective 95% confidence interval (Table 4.25) was expressed as the percent precision and summarized in Table 5.1. Spearman rank correlation was applied to examine the relationship between the density estimates and the 95% confidence intervals. The results are shown in Tables 5.2 and 5.3. Though 30 replicate stones provided 29 degree of freedom for estimating the

population density, the percent 95% confidence interval relative to its mean for each basket indicated that considerable variations were found for the macroinvertebrates collections from Lampson Brook (Table 5.1). The values ranged from 16.1% (12/22/87 replicate basket 1) to 57.3% (10/30/87 limestones). Resh (1979) points out that the number of sampling units is dependent on the size of the mean, the degree of aggregation exhibited by the population, and the desired precision of the mean estimate. The determination of sample size can be obtained with the following formula (Elliott, 1977):

$$n_{est} = \frac{t^2 S^2}{D^2 \bar{X}^2}$$

where

$$\bar{X} = \frac{\sum X}{n}$$

$$S^2 = \frac{\sum (X - \bar{X})^2}{n - 1}$$

$$SE = \sqrt{\frac{S^2}{n}}$$

$$D = \frac{SE}{\bar{X}}$$

Thus, if the 95% confidence limits (i.e. the desired precision) and the size of the mean are determined, the more aggregated the population, the greater the number of samples will be required. And if the 95% confidence limits and the degree of aggregation (i.e. the variance) are ascertained, then the larger the size of the mean the smaller number



of samples will be required. Elliott (1977) states that the aggregation, a common phenomenon of insect behavior, may be a function of the size of the sampling unit and the number of samples collected. In this field study, since the sampling units and the sample size were manipulated to yield similar treatment for all the collections, the variations of 95% confidence limits were the results of the degree of aggregation and the size of the mean. The high degree of negative Spearman rank correlation (-0.852) for the 45 basket collections between the size of the mean and its relative 95% confidence limit suggests that the contribution to the variations is from the size of the mean (Table 5.2). When the Spearman rank correlation was analyzed based on the spatial arrangement, a high negative correlation was found at stations 2 and 5, and to a lesser extent, at station 1. No significant correlation was found at stations 3 and 4 (Table 5.3). These correlations seem to correspond to the range of the size of the mean for that station. At stations 2 and 5, the ratios of the maximum and minimum of the mean individuals were 46.8 and 37.6 folds, whereas at stations 1, 3, and 4 were 11.3, 6.4 and 2.3 folds, respectively. Apart from this, there was no apparent treatment, season or site specific regularity that contributed to these variations.

Wrona's method, when applied to the limestone substrates, can provide a good estimate of macroinvertebrate density with reasonable D values. Approximately 1018 organisms/m<sup>2</sup> (i.e. 167 organisms/stone) are required to yield  $D \approx 0.20$  (Table 5.1). Since the stone was manipulated into the same size category (2" to 3" in diameter), the number of the organisms per stone is highly correlated to the number of the organisms per square meter (i.e. density) (Table 5.4). This suggests that the standardization of the limestone surface area to give a comparable unit (in this case, per square meter) is

not necessary. The abundance can simply be expressed as "number of organisms per stone". Wrona's method, however, will be very valuable in estimating the density of a stream-bed rock-dwelling benthic population provided that an accurate estimation of surface area can be obtained. As shown in the regression analysis of surface area against volume and weight, the standardization of stream-bed rock surface area is complicated by the lower  $r^2$  values (Coler et al., 1989). Furthermore, the size of the rock, which is associated with the population density, cannot be manipulated when it is sampled from the stream.

It is also true that the diversity value calculated from each limestone substrate is mostly invalid because the limestone does not provide enough surface area to collect adequate distribution of organisms, as my research indicates. Pratt (1977) showed that diversity and species count are a function of sample size. He demonstrated the asymptotic diversity values for pooled sampling units that are greater than 9 and continuing gradually upward slope for cumulative species count. McIntosh (1967) regards the relationship between the species count and the diversity % maximum as "redundancy increase"- the uncertainty of the information is reduced by the redundancy or repetition of individuals of the same species. Therefore, more and more individuals are required in order to find new species. When these two parameters reach an equilibrium, the increase in diversity ceases.

The poor correlation of Shannon's and Brillouin's diversity values between the individual stones and the basket largely results from the insufficient collection of organisms on the individual stones. Abundance and species composition may change a great deal by chance when there are not enough representative organisms on the

stone. The minimum number of rocks required to attain asymptotic diversity values vary among the indices and ranges on the average from 1 to 26 rocks, depending on the basket collections (Table 5.5). The number of rocks required is not entirely dependent on either the abundance, or the precision, or the diversity as indicated with Spearman rank correlation (Table 5.6). It would appear that the distribution of the organisms on the rocks has much more impact on the pooled diversity than merely abundance or diversity. Therefore, in any type of collection, the diversity values are only valid if asymptotic diversity can be attained. Once asymptotic values are obtained, any excess random rocks provide an adequate representation of the population (Pielou, 1967). As indicated in Table 5.5, thirty rocks were sufficient to collect representative samples to obtain asymptotic diversity. Thus, the interpretation of the field data with respect to the diversity would preferably be based on basket samples.

## 2. Diversity Indices

Species diversity has been used for many years as a tool to describe community structure. Several researchers have suggested that diversity indices be used to assess the impact of contaminants on water quality and subsequently on aquatic community structure (Whilm and Dorris, 1968; Zand, 1976). The underlying hypothesis of applying diversity as an indication of environmental stress is that the contaminants reduce abundance and the number of species in such a way that lower diversity results. The advantage of diversity indices is that a large volume of data are condensed to a single number that can be utilized to compare diversity values with other stations. Unfortunately, many diversity indices have been found to have no

biological relevance (Washington, 1984); others were criticized as being dependent on sample size (Washington, 1984) and influenced by the initial structure of the community, as well as the manner in which the community was disturbed (Boyle, 1990). However, in many ecological studies, the size of a sample is in direct relation to the abundance status of a community. Therefore, it is reasonable to include sample size as part of the community characteristics and be considered in the assessment of water quality. Thus, diversity indices that are sample size dependent may not be able to truly reflect the interspecific association of species because such value may merely be a reflection of abundance.

As mentioned in the literature review and demonstrated in APPENDIX B, Simpson's  $D$  Hurlbert's  $PIE$  and Keefe's  $TU$  provide an essentially identical measure of diversity. Therefore, only Hurlbert's  $PIE$  is considered in the discussion.

Diversities can be grouped into two major types according to their degree of association - one that is associated with interspecific encounters and the other associated with information theory. When a community is either at the most diverse or the least diverse situations, these two formulae essentially share identical concept. However, within these two limits, these two formulae are not always in agreement as to which is more diverse than the other. Thus, in any examination of a representative sample, when species representation in a sample reaches an intermediate level, the respective indices may be differentiated among those that give one set of diversity indices and a second which give a separate set of diversity indices with limited correlation between sets. It would therefore suggest that a diversity index for populations falling between intermediate levels may simply reflect the internal

structure from which the index derives rather than the actual representation of species at a given sampling point.

With Hurlbert's, McIntosh's or the "run" indices, though a collection need not be large in order to derive values from them, the numbers can be very misleading. For example, if a community comprises only two organisms, there are only two possibilities of species distribution - two species each with one individual or one species having two individuals. In the first instance, Hurlbert's *PIE* is equal to 1 and the second instance to 0. However, if we have a community with a total of 4 individuals, there are five possibilities of species distribution - (1) four species each with one individual; (2) one species having two individuals, two species having one individual each; (3) two species each with two individuals; (4) one species having three individuals, one with one individual; (5) one species having 4 individuals. The first instance also gives value of 1 with Hurlbert's *PIE*, the fifth, value of 0, and with some intermediate values in between. As we can see, there are definite structural differences between communities with two individuals or four individuals. If we would use only these diversity values to describe community characteristics, at least at two extreme instances, they would be classified into the same category.

The emphasis of interspecific encounter of the members in a community is the probability associated with the "universe" in which it is contained. This "universe" of Hurlbert and related indices is not discriminated and it is always equal to 1. Therefore, abundance becomes an unimportant issue in Hurlbert's index and perturbation in the proportion reduction of abundance, which is very common in the presence of low level toxic substances, will not affect the index values as expected.

Shannon and Brillouin diversities differ from Hurlbert's diversity in that at the most diverse situation where all the individuals are evenly distributed among the species, the diversity values are a monotonic increasing function of  $N$ . This is evident as shown in the resulting diversity values obtained with individual stones and baskets. They also differ in the representation of the species abundance and richness reflected in the formulae.

These differences not only contribute to the discrepancy of the derived values but also affect the way the communities are perturbed. As demonstrated with computer simulation, in the perturbation involved in the disproportional loss of abundance of common species or the eliminating the least common species, Hurlbert's index is sensitive to both parameters in certain ranges, whereas the perturbation of community structure is more severely impacted by species loss and less impacted by the abundance with Shannon and Brillouin diversity (Boyle, et al., 1990).

Another drawback of diversity indices is that species are not differentiated. The abundance of *Nais communis* is as important as the abundance of *Eurylophella funeralis*, but as is commonly known, their environmental requirements are remarkably different.

Many studies have shown that diversity indices are significant only with major perturbation, subtle changes cannot be identified. In fact, Barrett (1968) described an increase in some arthropod species diversity after exposure to an insecticide. Odum (1975) demonstrated the natural fluctuations in diversity through time and space unrelated to environmental stress. Such fluctuations in species diversity may represent the internal relations of a community dependent on productivity, competition, and

predation (Abugov, 1982). Perkin (1983) evaluated a number of diversity indices with bioassay system to determine the impact of copper on the macroinvertebrate community and found that the decrease in number of species and individuals did not always result in decrease in the diversity. Perkin (1983) concluded that "... Shannon's index is very likely to increase in spite of harmful perturbation".

Hellawell (1977, 1978) summarized the possible changes in community structure upon exposure to pollution - the reduction of biomass with no change in community structure; the change in abundance distribution among species with no change in species richness; the changes in abundance distribution and species richness. Accordingly, the extent of the responses will depend upon the nature and severity of the pollution. Murphy (1978) pointed out that the difficulty in many indices in differentiating the spatial differences was due to the extreme temporal variability exhibited by some of the indices. Hughes (1978) listed a number of factors that influence the diversity values unrelated to pollution. Variability in diversity values apart from pollution is obviously undesirable, unless it clearly reflects water quality changes.

It is suggested that taxonomic hierarchical diversity be used to compensate for some of the anonymity inherent in species richness and abundance (Pratt, 1977). In this study, examination of the data, reveals that order level diversity would probably yield a similar pattern to family level diversity because most families belong to different orders. The same statement can be made about genus level and species level diversity because very few species belong to the same genus (Table 5.7). Therefore, only two hierarchical diversities were calculated - family level and species level.

The results indicate that species level diversity give an entirely different pattern from family level diversity. Hughes (1978) calculated Shannon's diversity values at six taxonomic levels with the same data set and concluded that identification to species is unnecessary for detecting intersite differences for River Cynon, South Wales due to the similar pattern observed between order level and species level diversity. Kaesler et al. (1978) reported generic level identification was sufficient to interpret community structure due to the significant correlations between the generic and specific components of the Hierarchical Diversity Index (HDI). Osborne (1977) felt that family level identification would have been adequate to detect intersite diversity differences due to a significant difference in family level diversity between sites. However, seasonal variability was found in the different components of HDI (Osborne, 1980). Therefore, it would suggest that the taxonomic level that will detect intersite differences rests upon a specific collection which is predicated upon many factors. The different HDI pattern in detecting the intersite difference and the variability in contribution of each component of HDI have not yet provided any indisputable empirical regularities thus far. Osborne, et al. (1980) though questioning the ecological meaning of HDI, proposed the use of HDI in future studies because more information was gained through the assessment of the contribution that different taxonomic units make to the total diversity. Pratt (1977) also found the supplement of hierarchical diversity an effective technique for investigating macroinvertebrate populations for inferring environmental quality. Boyle et al. (1984) used the hierarchical approach to measure the changes in community structure induced by environmental stress and found that it provided a more interpretable comprehensive



analysis. Resh and Unzicker (1975), however, strongly argued the importance of species identification in water pollution studies.

Godfrey (1978) pointed out the problems of diversity indices in equating a *tubifex*-Tendipedidae-*Asellus* community with a Plecoptera-Ephemeroptera-Trichoptera community. Peet (1974) gave an example of the influence of sample size on Brillouin's formula in inferring equitability, hence an index of heterogeneity. Shannon's formula, though more appropriate in representing equitability, is only valid for an infinite sample (Pielou, 1966a, 1966b, 1966c, and 1967). McIntosh (1967) comments that "...some way of specifying the range of community differentiation included, ....., is necessary to make the concept of diversity of maximum use in ecological studies. The entity and its scope must be made clear before the measure of diversity takes on useful meaning." Contemplating the limitations, it is clear that it would be a gross simplification to take only diversity indices in the evaluation of water quality on community structure. One must consider: firstly, are there other factors that significantly influence the internal temporal and spatial structure of the community; secondly, should abundance be a constituent of a diversity concept; thirdly, should an "*a priori*" condition of species diversity be established for a defined community? One must be aware that diversity is only one of the properties of community characteristics and best be used with other attributes of the community to describe the spectrum of the structure changes.

The macroinvertebrate data collected from Lampson Brook indicate that the variations in abundance (21 - 2095 organisms per rock) have complicated the meaning of Brillouin's diversity values. At station 1, where the habitat was not subjected to

sewage discharge, the Brillouin diversity ranged from 1.8744 to 2.0224 from October, 30, 1987 to April, 14, 1988, and Hurlbert's diversity from 0.8669 to 0.9733, respectively. An increase in Brillouin's diversity was observed on August, 22 and October, 17 collections, however, such increase were not observed with Hurlbert's diversity. It is evident that Brillouin's diversity increases with the increase in the number of individuals when the species representation is similar. It is, therefore, questionable whether the abundance should be a constituent of the diversity concept, or in using Brillouin's diversity, one must consider the diversity values with collections of comparable sample size. To more clearly visualize the relationship of the diversity values of upstream and downstream stations at a given sampling point, Tables 4.29 through 4.34 were summarized in Tables 5.8 and 5.9 to show the ranking. The results indicate that if we would rank the Brillouin's and Hurlbert's diversity values, Hurlbert's diversity values are more consistent in ranking station 1 as an unstressed environment across all three census, whereas Brillouin's diversity values are not.

Questions which therefore remain and deserve further analysis are the redundancy and evenness indices. Though derived from Shannon and Brillouin's diversity indices, they are more correlated to Hurlbert's index. However, they behave very differently from either Hurlbert's index or Shannon and Brillouin's diversity indices upon perturbation as demonstrated by Boyle et al. (1990). The effects of abundance and species loss do not give a reliable indication of community structure changes. One must assume that in these too the internal structure of the respective formula limits broader consistency.

### 3. Community Comparison Indices

#### a. Qualitative Community Comparison Indices

Likewise, for most of the similarity indices the expected maxima provided by the respective formulae also depend more or less strongly on sample size and diversity (Wolda, 1981). A number of indices are also insensitive in measuring community changes (Boyle et al., 1990).

Many contributions to the literature have criticized the fact that qualitative community comparison indices do not take into account the abundances of the various taxa. Thus, a great deal of information about a particular community is ignored. Additionally, as tested in this study, there are a number of limitations to these types of indices. Most of the indices tested are unable to distinguish lower and upper limits of similarity. There are further fundamental flaws in certain indices in that they fail to reflect biological characteristics of the system while satisfying a geometric principle.

Besides the lack of consideration of abundance in this type of index, there are discrepancies in the resulting similarity values with a particular set of  $a$ ,  $b$ , and  $c$ , where  $a$  and  $b$  are the number of species in community A and B, respectively; and  $c$  is the common species in both communities.

If there are no common shared species between the two compared communities (communities A and B), the indices give zero values regardless of the arrangement of species richness in A or B. The Fager and McGowan index shows distinction in events corresponding to the number of species in the B site. This is obvious simply by looking at the formula. The added factor

$$- \frac{1}{2 \sqrt{c+b}}$$

certainly contributes to this distinction. It is unfortunate that this index does not take into account the number of species in A site as a factor. Both communities should be given the same degree of weighing factor. The same kind of treatment is suggested by Pinkham and Pearson (1976) in their quantitative index. Both communities are given same degree of weight. To overcome this weakness, the same factor is accounted for  $a$  and the first part of equation is multiply by 2 to compensate for the subtraction.

Thus, the revised index can be expressed as:

$$I = \frac{2 \times c}{\sqrt{(c+b)} (c+a)} - \left( \frac{1}{2 \sqrt{c+b}} + \frac{1}{2 \sqrt{c+a}} \right)$$

It basically contains two parts - the first part

$$I = \frac{2 \times c}{\sqrt{(c+b)} (c+a)}$$

and the second

$$\frac{1}{2 \sqrt{c+b}} + \frac{1}{2 \sqrt{c+a}}$$

The first part of the formula resembles Ochiai's index except that the maximum value is 0.5 with Ochiai's index whereas the maximum value of this formula is 1. The second part is where the complete similarity and dissimilarity are distinguished where no other qualitative community comparison indices are capable of these distinctions. This formula has a number of distinct properties. In differentiating the upper limit of similarity, this formula is consistent with the geometric principle implicit in the

biological collections in that when two communities are complete similar (i.e. when  $a=b=c$ ), the larger the  $c$ , the more similar the two communities. Furthermore, when the two communities are not completely similar, for a given  $c$ , the closer the  $a$  and  $b$ , the more similar the two communities. However, in detecting the lower limit of dissimilarity this formula may not possess the property that is desired for biological collections because when there is no common shared species (i.e. when  $c=0$ ), the second part of the formula indicates that the larger the  $a$  and  $b$ , the more similar the two communities. Thus, it appears that it is highly unlikely that a single formula can be derived that will satisfy all the aspects of describing similarity/dissimilarity of two communities at the same time satisfy the mathematical principle, as is also shown with the quantitative community comparison indices.

The same is true with the upper limit. If communities A and B shared all the common species, then the indices in most cases (except for Fager and McGowan index) give values of 1 regardless of how many species pairs are in A and B.

With Jaccard's and Sørensen's indices, if the ratio of shared common species (numerator) and the sum of the number of species in A and B (denominator) are the multiple of other compared pairs, they would give identical values. However, with Kulczynski's, Mountford's, Ochiai's, and Fager and McGowan's indices, these instances are classified into different similarity values.

Not so obvious, however, are the indices of Kulczynski and Mountford. Upon examining all the qualitative comparison indices, we would notice that there are essentially two major parts in these equations - the numerator and the denominator. Two communities become more similar with increasing numerator values and

decreasing denominator values. If what we intend to derive are the indices corresponding to the values of  $a$ ,  $b$ , and  $c$ . According to Kulczynski's formula, the numerator and denominator involves the sum of  $a$  and  $b$  and the product of  $a$  and  $b$ , respectively. If we relate  $a$ ,  $b$  and  $c$  to a biological collection, mathematically these two indices fail to reflect what they originally intended. It is clear that a biological collection with a constant of common species  $c$ , the closer the  $a$  and  $b$  the more similar the two communities. If we refer to  $a$  and  $b$  as the sides of a rectangle, then given a fixed area, the closer the number of  $a$  and  $b$ , the smaller the circumference (i.e. the smaller the sum of  $a$  and  $b$ ), the smaller the numerator, and the less similar. In this regard, Kulczynski's formula fails to show that the increase in the numerator leads to an increase in similarity. The same is true with Mountford's index. The difference is that Mountford's formula places the sum of  $a$  and  $b$  and the product of  $a$  and  $b$  in the denominator. According to Mountford's formula, the closer the number of  $a$  and  $b$ , the larger the denominator, the less similar the two communities.

Particularly troublesome are the values that fall between the lower and upper limits of these indices. It is evident that the indices do not show monotonic increase with regard to increasing common species and decreasing numbers of species in either A or B as demonstrated with Spearman rank correlation. Apart from these unsatisfactory qualities in some of the indices, overall, the remaining indices share considerably high correlation among each other. To demonstrate Sørensen and Fager and McGowan's similarity indices in describing the level of impact on downstream stations, Tables 4.35 through 4.40 were summarized in Table 5.10 to show the chlorination, non-chlorination, and year-long average with respective ranking. The

result reveals that both indices basically give similar assessment. The slight inconsistency due to the way of averaging or the behavior of the mathematical function will be the main determinants of which types of indices may be more ecologically or biologically relevant.

#### b. Quantitative Community Comparison Indices

Quantitative community comparison indices proposed to date to assess the structural differences between two communities reflect a number of strategies. Many techniques of mathematical manipulation are used to measure the differences - the minimum, the absolute difference, the product, and the distance. The results of such treatments give extreme variability in values and impose a great risk of employing these indices.

When applying the indices to communities that are as simple as the artificially created ones, it seems that these indices generally predict the similarity or dissimilarity between two communities. However, when these indices are applied to field data, one will notice that the inconsistency is greatly magnified. It seems that each index becomes "*sui generis*" in measuring the differences, particularly Sokal's Euclidean distance, with no definite relation to the other indices in measuring increase or decrease of the differences. To demonstrate the difficulty of these similarity/dissimilarity indices in describing the level of impact on downstream stations, Tables 4.41 through 4.52 were summarized in Table 5.11 to show the chlorination, non-chlorination, and year-long average with respective ranking. These results suggest that in using these indices, with the same data set, one index may tell you that the downstream stations are impacted, while the other index tells you just the

opposite. In fact, none of the four selected similarity/dissimilarity indices (Morisita similarity index, the average chi-square, Pinkham-Pearson index B, and Sokal's Euclidean distance) give the same similarity/dissimilarity assessments between upstream and downstream communities as shown in Table 5.10. Brock (1977) compared Renkonen's percent similarity and Pinkham-Pearson index B and concluded that Pinkham-Pearson index B was too sensitive to rare species and not sensitive enough to variation in dominant forms and therefore might be more prone to sampling error. Renkonen's percent similarity, on the other hand, showed a greater response to variation in dominant forms and relationships between dominant and semidominant species, and hence it might better point out structural-functional differences between communities. Brock (1977) also pointed out the problems with these two indices in differentiating the degree of "transitivity". Thus, two communities which are 70 percent similar to a third one does not imply that the two communities are just as similar to each other. In fact, all the community comparison indices are unable to distinguish the degree of "transitivity". Boyle et al. (1990), however, acknowledged the overall response of Pinkham-Pearson index B towards community structure changes. In this study, the artificial manipulation of the field data to produce some structure changes in community was not executed to test a number of important community structure characteristics. It is clear, however, Sokal's Euclidean distance responds strongly to the abundance. A further analysis of the data will allow us to clarify some strengths and weaknesses of each index.

If we consider the species and the number of individuals in each species as the underlying assemblages of a community, then a data set should yield identical



information in relation to external disturbances however we want to summarize them. But this "identical information" is not reflected in the indices. This dilemma is stated by Patil (1984) "..... 4. So we summarize the information through a set of indices (statistics) so that it would be comprehensible. 5. But now, we do not comprehend quite what the indices exactly mean. 6. And, therefore, we do not (quite) comprehend the situation. 7. Thus, without (all) information, or with (partial) information, or with summarized information, we do not quite comprehend a situation!".

Haedrich (1975) suggested the use of diversity and similarity indices as a useful and quantifiable means in measuring environmental quality. Boyle et al. (1984) provided a method that was capable of detecting hierarchical differences in community changes induced by environmental stress. Boyle et al. (1990) tested seven similarity indices (Jaccard's index, Renkonen's percent similarity, Bray-Curtis D, Pinkham-Pearson index B, Pinkham-Pearson index  $B_2$ , Euclidean distance D, and SIMI) and found that only Pinkham and Pearson's B, to a lesser extent,  $B_2$  and Euclidean distance gave a more consistent behavior with the four basic qualitative parameters (reference condition, sensitivity, stability and consistency) of community change. Though the information is valuable, it does not address the fundamental problem in the assessment of community differences.

Thus, a central issue in assessing the significance of any index must be a prior consensus on what constitutes a community. The appearance of specimen at random similar or dissimilar from one another at any given sampling point may be only a reflection of what prevails with a given index rather than a meaningful statement of

the spectrum of the species truly reflecting the temporal or spatial elements of that community.

Many key questions need to be answered before we can reach a consensus on measuring the similarity/dissimilarity of the communities. We must ask ourselves: does abundance matter; do we want to distinguish the extent of upper and lower limits of similarity/dissimilarity; which type of standardization" (geometric mean or sum) is more effective in assessing fluctuation; is the sample size important; how the "differences" between two communities should be measured; are the indices able to reflect the external environmental stress; how do they respond to abundance and species increase or loss. Therefore, in order to make reasonable comparisons and meaningful interpretation, not only should the indices be examined but also the ecological concepts need to be understood. The statement by Pontasch et al. (1989) "no single diversity or community comparison index has been proven effective in quantifying all of the responses of aquatic communities to stressors" largely results from our lack of knowledge about the range of temporal and spatial variation in community characteristics.

Due to the specificity of biotic indices and the insensitivity of diversity indices in detecting various forms of pollution, it is apparent that community comparison at the quantitative level of the community structure represents the most valid assessment of differentiating the environmental impact as long as comparable control stations can be established. The core question, therefore, remains: on what basis may the most appropriate index be selected and validated. At this time, it appears that there is no defining principle which will validate one community comparison index as more

preferential to another. Similar conclusions were drawn by Perkins (1983) with regard to community comparison indices. In assessing the impact of copper on macroinvertebrate community, Perkins (1983) stated that "...this study has not shown that one or even a combination of indices can accurately address the issue of magnitude of impact on the community". If we would have a universal consensus about how a "community" should be defined; how the interaction among its members should be demonstrated; and how the "differences" between two communities should be measured, then there may be a universal model to assess the changes in the assemblages of a community. Perhaps, community structure may be better described as the number of links in the food web, or the energy flow at different trophic level, or the functional assessment of a given ecosystem as opposed to simply the number and the species count. Exploitation of such a potentiality merits further analysis.

Contemplating the weakness of the indices, the following interpretation is offered based on all aspects of community parameters (density estimate, species richness, EPT, Hurlbert's diversity, and Morisita's similarity) for making inferences concerning the impact of chlorinated and non-chlorinated sewage on the water quality of Lampson Brook. In this interpretation, I have assumed that the communities are defined as all the organisms collected in a defined area (Roughgarden and Diamond, 1986) and the changes in community structure are, in part, an indication of some environmental changes (in this case, the discharge of chlorinated or non-chlorinated sewage) to that community.

## B. Interpretation of the Field Data

Three major components that contribute to the existing community structure of benthic macroinvertebrates in Lampson Brook are temporal and spatial variations as well as long term effects of chlorinated and non-chlorinated sewage. To identify spatial variation apart from the sewage effect is difficult in this study because there is no reference (before the sewage plant was built) to compare to. To infer the treatment effect (sewage ) is also difficult because of the pseudoreplicated nature of the experiment (Hurlbert, 1984). To interpret treatment effect based on temporal interaction is only valid if the differences between upstream and downstream locations will remain constant overtime (Hurlbert, 1984). This "difference" is further complicated by arbitrary decisions about how we want to measure it (Hurlbert, 1984). A solution to overcome this complication was proposed by Stewart-Oaten and Murdoch (1986) called "Before the discharge begins and After it has begun, at both the Control and Impact sites (BACI)". Even with BACI design, the samples should be taken over a period of years to assess the temporal fluctuations. Thus, the discussions presented here are descriptive of the macroinvertebrate response in part due to long-term exposure of chlorinated and non-chlorinated sewage. A multi-year investigations with BACI experimental design will be necessary to distinguish sewage from chlorinated sewage effects.

The following discussions focus on the characterization of community parameters at each station, starting with the description of stream biota with their respective abundance and percent composition. It is their presence that subsequently

affects the numerical number of density, abundance, percent composition, species richness, diversity, and similarity.

### 1. Station 1 (Control station)

The control station (station 1) was selected as an unstressed reference station that receives no sewage discharge. The variability in species composition and abundance from one season to the next that station 1 experienced suggests a strong temporal effect on stream benthic macroinvertebrate community. Though considerable seasonal changes in density and distribution of benthos populations were apparent at station 1 (Table 5.12), most of the abundant species (such as chironomid *Diplocladius* sp., *Parakiefferiella* sp. *Parametriocnemus lundbecki*, stonefly *Isoperla marlynia*, *Paracapnia opis*, and mayfly *Ephemerella excrucians*, *Paraleptophlebia* sp.) were pollution intolerant, with the Hilsenhoff Biotic Index (HBI) (Hilsenhoff, 1982) ranging from 1.0 to 2.0. No species comprised more than 25% of the individuals (except for 4/14/88 collections where chironomid *Conchapelopia* sp. comprised 34% of the total population).

The density of organisms at station 1 ranged from  $158_{\pm 63}$  to  $388_{\pm 157}$  from October, 30, 1987 to April, 14, 1988, and abundance and species richness ranged from 25 to 66 and 14 to 22, respectively. The increase in the density, abundance, and species richness on August 22 ( $1788_{\pm 389}$ , 319, and 45, respectively) and October 17 ( $641_{\pm 184}$ , 101, 28) was in part due to the sorting procedure. Many smaller size mayflies and chironomids were recovered with microscopic sorting but were lost with sugar flotation and the 1.7x magnifier sorting process. Apart from these two collections, the density and abundance were slightly higher in winter mainly due to the

increase in number of *Conchapelopia* sp., *Diplocladius* sp., *Parametriocnemus lundbecki*, and *Paracapnia opis*. Species richness remains approximately at 20, except for the October, 30 limestone collection. It is suspected that stream-bed rocks provide more heterogeneous surface complexity for macroinvertebrates than the limestones (Coler, 1990). In Erman and Erman's (1984) study on the response of stream macroinvertebrates to substrate heterogeneity, it was demonstrated that the surface heterogeneity only supported more individuals, not the number of taxa. Their findings neither support nor oppose the surface complexity of the limestones because in essence their rocks were all collected from the stream banks and bars, and the surface heterogeneity was classified into three categories (quartzite, sandstone, and granite) based on the chemical composition of the rocks. The lower species richness for the limestone collections did not account for the species present on the stream-bed rock collections, rather, there were significant differential preference of the substrates (Coler, 1990). More species were associated with stream-bed rocks than the limestones. Differential preference of macroinvertebrates in substrate types, color, and roughness is well documented (Clements et al., 1989; Clifford et al., 1989).

Six out of nine collections have the highest Hurlbert diversity values ranking. The fluctuations in abundance and species richness do not seem to affect the diversity of macroinvertebrate community at station 1 (Table 5.8). The highest ranking in Hurlbert's diversity is maintained partly by species replacement associated with seasonal changes in environmental conditions which favors different assemblages of species. Similar ranking is also observed for midge diversity, and for the most part, family level diversity (Table 5.9). The netting of the control baskets on April, 14,

August 22, and October, 17 seems to reduce family level diversity at this station relative to the downstream stations. The lower ranking is due to the presence of other families of downstream macroinvertebrates that do not present at station 1, mainly families of class Mollusca, Crustacea, and Annelida.

The EPT values at this station is also reasonably maintained throughout the entire study period (minimum of 4 to maximum of 10). Many species of Ephemeroptera, Plecoptera, and Tricoptera are found to be either intolerant or facultative. Their absence may indicate deterioration of minor or moderate levels of organic contaminants (Weber, 1973). Accordingly, the assessment of water quality can be obtained by a quick survey of species of these three orders (Penrose and Overton, 1987).

## 2. Station 2

The dominant benthos collected from station 2 (Table 5.13) were highly variable with regard to HBI. All three categories (intolerant, facultative, and tolerant) were represented to a substantial extent (12.3% - 60.7%) depending on the sampling dates. The intolerant chironomid species (*Diplocladius sp.* and *Parakiefferiella sp.*) were found mostly during the non-chlorination regime. Sewage alone does not affect their abundance. *Micropsectra sp.* is thought to be an intolerant chironomid species, but in this study, their abundance was not affected by either chlorinated or non-chlorinated sewage. The tolerant species, such as *Conchapelopia sp.*, was the most dominant in 10/17/87, 3/29/88, and 4/14/88 collections and was second only to *Polypedilum scalaenum* in 8/22/88 collections which comprised 60.7% of the population. Aside from seasonal changes a few mayfly species (*Eurylophella bicolor*,

*Eurylophella funeralis*, *Leptophlebia sp.*, *Paraleptophlebia sp.*, and *Stenonema modestum*), a stonefly species (*Paracapnia opis*), and a caddisfly species (*Cheumatopsyche sp.*) which existed during the non-chlorination regime either completely disappeared or were substantially reduced during the chlorination regime. *Serratella deficiens* was not observed at all at this station either during chlorination or non-chlorination period. *Isoperla marlynia* also seemed to be sensitive to chlorinated and non-chlorinated sewage. The dominant species (*Diplocladius sp.* and *Polypedilum scalaenum*) could occupy more than 50% of the total population on December and summer collections.

The increase in density on December 22, 1987 is mostly attributed to the increase in number of *Diplocladius sp.* and *Micropsectra sp.*. Such an increase may be a combination of the available nutrients and the stoppage of the chlorination. Since neither of these two variables is held constant to test the other, it is difficult to separate the cause. It is evident, however, the density of these two species is not distressed by non-chlorinated sewage. Similarly, during summer chlorination, the density increased to 11700±1965 in part due to season-related emergence of *Polypedilum scalaenum*.

The rankings of Hurlbert's diversity for total macroinvertebrates and midges stand mostly at 2. The low diversity values obtained on December 22, 1987 are the result of abundant *Diplocladius sp.* and *Micropsectra sp.* The increase in the number of *Polypedilum scalaenum* also results in lower total macroinvertebrates (5) and midges (4) diversity ranking on August 22, 1988. Family level diversities, however, rank mostly at 5, and fewer at 4, throughout the year due to the abundant chironomids.



Receiving the chlorinated or non-chlorinated sewage discharge, 60 meters downstream from the outfall, the effluent seems to support those chlorine-resistant organisms with rich organic material with a more abundant community than the control station. The effluent from the Belchertown WWTP seems to furnish the stream ecosystem with more available nutrients, which increases the primary production, and subsequently secondary production. After chlorination was applied, however, the chlorinated sewage suppressed the presence of Ephemeroptera, Plecoptera and Trichoptera as indicated by the average of EPT values at this station.

Arthur (1975) demonstrated that the total residual chlorine was the main element that contributed to consistent damaging effects to all the test species. Paller et al. (1988) indicated that removal of the chlorine compounds was more beneficial than the removal of the ammonia. Osborne (1985) demonstrated partial TRC effects on the depressed macroinvertebrate species richness, diversity and evenness, but elevated macroinvertebrates abundance. Later the contribution of TRC toxicity on the depression of macroinvertebrate community structure were separated from temperature effects using multiple discriminant analysis (Osborne and Davies, 1987). In this field survey, however, no depression in the macroinvertebrate species richness and total macroinvertebrate diversity at this station was observed, instead the change in water quality was reflected in the increase in population density, changes in species composition, dominance of chlorine-resistant species, drop in family level diversity throughout the year, and loss of EPT during the chlorination period.

The structural changes in macroinvertebrates community by the replacement of dominant chlorine-resistant species and loss of non-tolerant species was also observed in other studies (Osborne and Davies, 1987; Sheridan and Badger, 1981).

### 3. Station 3

A completely different dominant biota were found at station 3 compared to station 2 on the same sampling dates. Collection of benthos from station 3 (Table 5.14) comprised mostly tolerant species *Conchapelopia sp.* and the amphipod, *Hyaella azteca*. In the fall, mainly four species of chironomids (*Conchapelopia sp.*, *Diplocladius sp.*, *Paratanytarsus sp. 2*, and *Rheotanytarsus exiguus* group) and one amphipod species (*Hyaella azteca*) accounted for more than 50% of the population. In the winter, *Conchapelopia sp.*, and *Diplocladius sp.* maintained their abundance, *Paratanytarsus sp. 2*, and *Rheotanytarsus exiguus* group population were reduced but still substantial in their percent composition. In the spring, the stream was dominated by *Paratanytarsus sp. 2* (another chironomid) and a simuliid fly, *Stegopterna mutata* complex which are also pollution tolerant. In the summer, the stream was mainly dominated by Oligochaetes and *Hyaella azteca*. A similar phenomenon was observed at this station with regard to the sensitive mayfly and stonefly species. They either vanished or were depressed during the chlorination period.

Density and abundance were generally higher than those of the control. The contributions of each species to the total macroinvertebrate populations, however, varied from season to season, even with those organisms (*Conchapelopia sp.*, *Micropsectra sp.*, and *Paratanytarsus sp. 2*) that occurred throughout the year.

Hurlbert's diversity ranking for total macroinvertebrates and midges, on the average, approximately stands at 3. However, family level diversity ranking stands at 4, corresponding to the abundance of chironomids. The EPT values are lower than those of the control, and are of the same level of magnitude during chlorination or non-chlorination regime. The consistently low EPT values at station 3 are mostly likely due to the combination of inherent physical habitat and long term effect of chlorinated and non-chlorinated sewage exposure.

The different macroinvertebrate communities exhibited at this station, evidently are not a consequence of the influence of the TRC because no significant amount of TRC in the water column were detected during the study period. It is suspected, though, that the chlorinated organic by-products, detected between station 2 and station 3 by the Department of Environmental Engineering at UMASS, might have contributed to the changes of macroinvertebrate community structure. Chlorination of water high in organic matter produces many chlorinated organic by-products (TOX) (Jolley, 1975; Murphy, 1975; Kinstley et al., 1983; Trehy et al., 1986). The toxicity of some of these compounds on aquatic animals varies and their ecological effects are not entirely clear. In general, they are less toxic than TRC. Gehrs and Southworth (1976) tested 17 compound mixtures, that identified by Jolley (1973) from chlorinated sewage effluent, and found no significant effect on *Daphnia magna* at concentrations of < 10 mg/l. Trabalka and Burch (1979) indicated a relatively low or moderate toxicity ( $LC_{50} > 10-100$  mg/l) for 5-chlorouracil and 4-chlororesorcinol, which were commonly found in chlorinated effluents. Correa et al. (1985) reported an increase in

oxygen consumption and ammonia excretion in the dragonfly nymph *Somatochlora cingulata* at levels of environmental relevance (10-100  $\mu\text{g/l}$ ).

It is known that most of the chlorinated organic products are quite stable under natural conditions (Kringstad et al., 1983), some are lipophilic in nature (Kringstad et al., 1984), and 50% are associated with particles less than 0.45  $\mu\text{m}$  (McCahill et al., 1980). Furthermore, many non-polar chlorinated organic compounds were found to persist in the sediments for a long period of time (Larsson, 1985 and 1986). These findings suggest that it is possible, after long-term chlorination of the sewage, that these chlorinated organics may have concentrated in the sediment. Sludge beds can be carried further downstream with the first high water after an extended low water period (Tarzwell and Gaufin, 1953). The seasonal recharge of water in Lampson Brook may have initiated such phenomenon. Study of the impact of urban runoff on benthic macroinvertebrates also indicated the disruption was centered in the river bed and thin boundary layer rather than in the overlaying water column (Pratt, 1977). Furthermore, recent investigations at the University of Massachusetts have suggested that the toxicity of chlorinated sewage on aquatic macroinvertebrates may be attributed to the chronic effects of stable chlorinated by-products associated with the sediments (Coler, 1990; Jones, 1991). The ecological significance of chronic effects of these chlorinated organics merits further investigations.

#### 4. Station 4

At station 4 (Table 5.15), different benthic communities were observed. They were represented by tolerant species such as *Hyaella azteca* (an amphipod), the *Rheotanytarsus exiguus* group (a chironomid), *Dero obtusa* (an oligochaete), and

*Helobdella stagnalis* (a leech). One dominant chironomid species, *Orthocladius oliveri*, which is designated as pollution intolerant, was found abundant only during the non-chlorination regime at stations 3 and 4.

Density and abundance fluctuated the least during the entire study period, and were comparable to those in the control. However, many fewer species were collected (a total of 63 species for the year), and fewer species of Ephemeroptera, Plecoptera, and Tricoptera were found. Hurlbert's diversity rank for total macroinvertebrates, on the average, stands at 4 whereas it stands at 3 for midges. Hurlbert's diversity rank for macroinvertebrate families varies at different sampling dates. In general, macroinvertebrate families were more similar to the control during chlorination period and less similar during non-chlorination period (Table 5.9).

With only 150 meters from station 3, station 4 seems to suffer even greater impact with respect to the suppression of the abundance, species richness, and EPT, and is consequently reflected in Hurlbert's diversity. This fauna response clearly is not the immediate effect of TRC, and chlorinated organics may have assumed the role in such depression as postulated at station 3.

## 5. Station 5

The dominant chironomid species found at station 5 (Table 5.16) were either intolerant chironomids (*Diplocladius sp.* and *Parakiefferiella sp.*) and stoneflies (*Paracapnia opis*) or facultative chironomids (*Tanytarsus sp.* and the *Cricotopus tremulus* group). In October and December, *Diplocladius sp.* comprised more than 50% of the total population, however, they hardly existed in March and August. *Paracapnia opis* was also abundant in October and December and declined in March

and August. August population were primarily dominated by *Paratanytarsus sp. 2* and *Tanytarsus sp.*

A partial recovery was observed from station 5 with regard to the density, abundance, and EPT. Hurlbert's diversity ranking for total macroinvertebrates and midges, however, constantly depressed from October, 30 to December, 22, 1987. Slight improvement was observed on March, 29, 1988 and ameliorated substantially after that. Hurlbert's ranking for macroinvertebrate families consistently showed a higher diversity. Though many species of Ephemeroptera, Plecoptera, and Tricoptera that were absent at station 2 during chlorination period, reappeared at this station, the macroinvertebrate fauna was still different in their composition and distribution.

#### 6. Placement Experiment

Data derived from October 17, 1988 indicate that there was a shift to tolerant species (*Conchapelopia sp.*, *Hemerodromia sp.*, *Hyalella azteca*, and *Nais communis*) at stations 2 and 3 (Table 5.17). There was also an increase in oligochaetes at station 4. Species composition was least impacted at station 5. Density and abundance increased at stations 2, 3, and 4 due to those tolerant species. Hurlbert's diversity values indicate that station 5 had the most diverse populations of total macroinvertebrates, midges, and macroinvertebrates families. Mayflies species (*Paraleptophlebia sp.*, *Eurylophella bicolor*, and *Eurylophella funeralis*) and one stonefly species (*Perlinella ephyre/fumipennis*) disappeared at stations 2 and 4. Two small mayflies belonged to family (Ephemerellidae) were found at station 4, whereas a total of 11 and 9 mayflies were captured at stations 3 and 5, respectively. The

decimation of mayfly and stonefly species at station 2 is consistently observed during chlorination regime.

## 7. Temporal Variations of Species Occurrence and Succession

If we choose Morisita similarity index as an example to describe the temporal variations, we observe that the replicate baskets (December 22, 1987) were very similar for all the collection sites (0.9563, 0.9958, 0.9546, 1.0010, 0.9104 for stations 1, 2, 3, 4, and 5, respectively). Baskets collected in the same season (October, 30, 1987 and March 29, 1988), though not truly replicated, also showed much higher similarity values compared to those not collected at the same time period (0.8385, 0.9659, 0.7171, 0.8348, and 1.0167 on October 30; and 0.8083, 0.5414, 0.9804, 0.8261, 0.6473 on March 29, 1988 for station 1, 2, 3, 4, and 5, respectively (Tables 5.18 through 5. 22).

If we look at the comparable basket collections from one season to the next (i.e. October 30, 1987 limestone collections; December 22, 1987 replicate baskets 1 and 2, and March 29, 1988 standard exposure), changes in species composition of populations of five sampling stations indicate that the biggest species variations (the successive replacement of some species to others) occurred between spring and summer collections (Tables 5.18 through 5.22).

In December, immediately after the cessation of chlorination, stations 1, 3, and 5 appear to have very similar stream biota. However, more than 50% of the stream biota were replaced at stations 2 and 4. From December to March, stream macroinvertebrates were least replaced at stations 3 and 4, and a large proportion were displaced at stations 1, 2, and 5. This suggests that the temporal variation was the

most gradual at station 3 and the least at stations 1 and 5. The most fluctuation in the stability of species composition also occurred at stations 1 and 5 and the least at station 3, as shown by the percent standard deviations over their respective means (Table 5.23).

### 8. Indicator Species

The structure of macroinvertebrate community of a stream is the result of the combined physical, chemical, biological, and geological factors of the area in which the stream occurs. Therefore, the presence of a species, particularly when it is abundant, indicates that such environmental conditions are met. Its absence, though, not completely the result of the absence of such environmental conditions, does suggest a probable cause. Many species, therefore, are selected as "indicator species" as an indication of environmental quality. For example, The presence of *Pontoporeia hoyi* (a benthic amphipod) reflects the oligotrophic status of a lake (Ryder and Edwards, 1985), whereas the presence of *Hexagenia limbata* (a benthic mayfly) is associated with mesotrophic habitats (Edwards and Ryder, 1990). The idea of applying an "indicator species" approach provides a quick check of the condition of water quality. Given the complexity of the environmental conditions and the differential sensitivity of individual species to different type of stress, it is best to select a group of organisms that may be integrated in detecting different aspects of environmental stress as "indicator species" to address a more defined environmental condition.

Table 5.24 lists a number of potential indicator species, with its designated TRC tolerance/sensitivity, specifically associated with Lampson Brook. The tolerant



species mostly belonged to species of Family Chironomidae and species of Class Oligochaeta. Apparently, they sustained their abundance corresponding to the combination of nutrient availability and their tolerance to chlorine. Many studies also indicate that Oligochaeta are TRC-tolerant (Oliver, 1984; Osborne, 1985; and Sheridan and Badger, 1981). Chironomids as a whole were found to be sensitive to TRC in Osborne's study, however, they were also discovered to be tolerant in an other study (Heckman, 1983). The sensitive species were mostly distributed among the Ephemeroptera, Plecoptera, Tricoptera, and one species of chironomids (*Parakiefferiella* sp.). A number of chironomid species (*Tanytarsus* sp. *Zavreliomyia* sp. 2) were also considered as sensitive to TRC due to the significant reduction of their abundance at station 2 compared to the control at that sampling date. Similar observation regarding the sensitivity of mayflies, stoneflies, and caddisflies was also reported by Osborne (1985).

Using the "indicator species" approach in this study, reveals the control station with common species of mayflies (*Paraleptophlebia* sp., *Serratella deficiens*, *Eurylophella bicolor*, *Eurylophella funeralis*, and *Stenonema modestum*), stonefly (*Paracapnia opis*), caddisflies (*Cheumatopsyche* sp. and *Pycnopsyche* sp.), and alderfly (*Nigronia serricornis*), as an indication of a relatively unstressed environment. The presence of chironomid species such as *Chironomus* sp., *Conchapelopia* sp., *Micropsectra* sp., *Parametriocnemus lundbecki*, *Paratendipes* sp., *Paratanytarsus* sp. 2, *Paratanytarsus* sp. 3, *Polypedilum fallax*, *Polypedilum laetum*, *Polypedilum illinoense*, *Polypedilum scalaenum*, *Psectrotanypus dyari*, *Psectrotanypus* nr. *dyari*, and *Tribelos* poss. *jucundum*, and a Oligochaete *Nais communis* is specifically

associated with chlorinated sewage. The specific fauna associated with stations 3, 4, and 5 may be attributed to the chronic effects of chlorinated and non-chlorinated sewage discharge, the exact cause is, however, not entirely clear. It will be necessary to conduct a more detail investigation with regard to these organisms in response to these stressors in order to compile a population list corresponding to these environmental conditions.

## 9. Conclusion

Assessment of the macroinvertebrate community in a series of stations exposed to chlorinated and non-chlorinated sewage reveals that the distinct ecosystem at each station supported a different assemblage of macroinvertebrates. In effect, the environmental conditions of all the downstream stations were altered due to long-term discharge of chlorinated and non-chlorinated sewage. These differences were evident with regard to all aspects of community parameters such as species assemblage, species composition, density, abundance, diversity, EPT, similarity to control station, species secession, and seasonal fluctuation.

Table 5.1 The variability in the precision of density estimate.

| COLLECTION/STATION              | 1     | 2     | 3     | 4     | 5     | Chlorination |
|---------------------------------|-------|-------|-------|-------|-------|--------------|
| 10/30/87<br>Stream Bed Rocks    | 30.7% | 44.4% | 23.3% | 24.7% | 38.4% | yes          |
| 10/30/87<br>Limestones          | 39.9% | 33.6% | 25.9% | 35.2% | 57.3% | yes          |
| 12/22/87<br>Replicate Basket 1  | 36.0% | 16.1% | 18.3% | 27.1% | 20.8% | no           |
| 12/22/87<br>Replicate Basket 2  | 40.5% | 21.7% | 27.2% | 25.3% | 35.7% | no           |
| 3/29/88<br>Stone not in Contact | 50.9% | 38.8% | 20.7% | 28.4% | 48.3% | no           |
| 3/29/88<br>Standard Exposure    | 47.4% | 29.8% | 18.5% | 25.7% | 39.3% | no           |
| 4/14/88<br>Chlorination Resumed | 29.4% | 33.3% | 28.5% | 31.0% | 45.9% | yes          |
| 8/22/88<br>Summer Collection    | 21.8% | 16.8% | 17.7% | 32.6% | 17.5% | yes          |
| 10/17/88                        | 28.7% | 22.6% | 23.2% | 35.4% | 31.3% | yes          |

Table 5.2 The Spearman rank correlation between the size of the mean and its relative 95% confidence limit.

|                               | size of the mean | relative 95% confidence limit |
|-------------------------------|------------------|-------------------------------|
| size of the mean              | 1.000            | -0.852                        |
| relative 95% confidence limit | -0.852           | 1.000                         |

Table 5.3 The Spearman rank correlation between the size of the mean and its relative 95% confidence limit analyzed based on the spatial arrangement.

| Site      | Spearman rank correlation |
|-----------|---------------------------|
| station 1 | -0.633                    |
| station 2 | -0.900                    |
| station 3 | -0.417                    |
| station 4 | 0.067                     |
| station 5 | -0.933                    |

Table 5.4 The Spearman rank correlation between the mean density and the abundance.

|              | mean density | abundance |
|--------------|--------------|-----------|
| mean density | 0.1000       | 0.965     |
| abundance    | 0.965        | 0.1000    |

Table 5.5 Number of rocks required to attain asymptotic diversity.

| Basket<br>Collection | Estimated Sources |          |     |         |           |                            |
|----------------------|-------------------|----------|-----|---------|-----------|----------------------------|
|                      | Hurlbert          | McIntosh | Run | Shannon | Brillouin | Average+Standard Deviation |
| 1                    | 4                 | 5        | 4   | 20      | 20        | 11+8                       |
| 2                    | 14                | 14       | 14  | 12      | 12        | 13+1                       |
| 3                    | 7                 | 7        | 7   | 7       | 7         | 7+0                        |
| 4                    | 3                 | 5        | 1   | 4       | 4         | 3+1                        |
| 5                    | 3                 | 3        | 3   | 4       | 9         | 4+2                        |
| 6                    | 1                 | 3        | 1   | 4       | 4         | 3+1                        |
| 7                    | 4                 | 6        | 4   | 8       | 13        | 7+3                        |
| 8                    | 8                 | 12       | 8   | 11      | 11        | 10+2                       |
| 9                    | 13                | 16       | 13  | 13      | 12        | 13+1                       |
| 10                   | 25                | >29      | 25  | 25      | 25        | 26+2                       |
| 11                   | 4                 | 11       | 4   | 8       | 4         | 6+3                        |
| 12                   | 3                 | 11       | 3   | 10      | 10        | 7+4                        |
| 13                   | 5                 | 6        | 5   | 4       | 4         | 5+1                        |
| 14                   | 6                 | 6        | 6   | 6       | 6         | 6+0                        |
| 15                   | 5                 | 5        | 5   | 3       | 3         | 4+1                        |
| 16                   | 4                 | 5        | 4   | 8       | 8         | 6+2                        |
| 17                   | 6                 | 6        | 6   | 7       | 7         | 6+0                        |
| 18                   | 3                 | 5        | 2   | 7       | 5         | 4+2                        |
| 19                   | 7                 | 7        | 7   | 7       | 7         | 7+0                        |
| 20                   | 10                | 10       | 4   | 15      | 15        | 11+4                       |
| 21                   | 9                 | 9        | 5   | 5       | 4         | 6+2                        |
| 22                   | 6                 | 11       | 1   | 13      | 13        | 9+5                        |
| 23                   | 2                 | 3        | 2   | 4       | 4         | 3+1                        |
| 24                   | 1                 | 1        | 1   | 2       | 2         | 1+0                        |
| 25                   | 1                 | 3        | 1   | 2       | 3         | 2+1                        |
| 26                   | 2                 | 6        | 1   | 6       | 4         | 4+2                        |
| 27                   | 2                 | 2        | 2   | 2       | 2         | 2+0                        |
| 28                   | 5                 | 5        | 5   | 7       | 7         | 6+1                        |
| 29                   | 6                 | 11       | 6   | 28      | 11        | 12+8                       |
| 30                   | 3                 | 19       | 3   | 5       | 7         | 7+6                        |
| 31                   | 7                 | 7        | 7   | 12      | 12        | 9+2                        |
| 32                   | 5                 | 10       | 4   | 7       | 7         | 7+2                        |
| 33                   | 3                 | 10       | 3   | 10      | 10        | 7+3                        |
| 34                   | 11                | 11       | 11  | 11      | 8         | 10+1                       |
| 35                   | 9                 | 9        | 5   | 12      | 12        | 9+3                        |
| 36                   | 2                 | 3        | 2   | 3       | 3         | 3+0                        |
| 37                   | 3                 | 6        | 3   | 3       | 3         | 4+1                        |
| 38                   | 2                 | 2        | 2   | 7       | 7         | 4+2                        |
| 39                   | 6                 | 6        | 6   | 6       | 7         | 6+0                        |
| 40                   | 3                 | 3        | 3   | 2       | 4         | 3+1                        |
| 41                   | 1                 | 5        | 1   | 6       | 6         | 4+2                        |
| 42                   | 2                 | 3        | 2   | 4       | 4         | 3+1                        |
| 43                   | 3                 | 3        | 2   | 4       | 4         | 3+1                        |
| 44                   | 2                 | 2        | 2   | 5       | 6         | 3+2                        |
| 45                   | 5                 | 5        | 5   | 9       | 9         | 7+2                        |

Table 5.6 The Spearman rank correlation between the number of rocks required to attain asymptotic diversity and a number of suspected causes (abundance, diversity, or the precision).

| Estimated Sources vs. Suspected Causes | Spearman rank correlation |
|--|---------------------------|
| Hurlbert vs. abundance                 | -0.567                    |
| Hurlbert vs. precision                 | 0.461                     |
| McIntosh vs. abundance                 | -0.582                    |
| McIntosh vs. precision                 | 0.583                     |
| run vs abundance                       | -0.397                    |
| run vs. precision                      | 0.292                     |
| Shannon vs. abundance                  | -0.632                    |
| Shannon vs. precision                  | 0.577                     |
| Brillouin vs. abundance                | -0.534                    |
| Brillouin vs. precision                | 0.509                     |
| Average vs. abundance                  | -0.634                    |
| Average vs. precision                  | 0.563                     |
| Hurlbert vs.Hurlbert's diversity       | -0.240                    |
| Average vs. Hurlbert's diversity       | -0.137                    |
| Brillouin vs. Brillouin's diversity    | -0.428                    |
| Average vs. Brillouin's diversity      | -0.588                    |



Table 5.7 Total number of individuals, species, genera, families, and orders of macroinvertebrates as well as total number of individuals and species of midges for each basket collection.

| Basket Collection | No. Individuals | No. species | No. genera | No. families | No. orders | No. midges | No. midge sp. |
|-------------------|-----------------|-------------|------------|--------------|------------|------------|---------------|
| 1                 | 40              | 19          | 18         | 9            | 6          | 18         | 11            |
| 2                 | 25              | 14          | 14         | 7            | 5          | 14         | 8             |
| 3                 | 63              | 18          | 16         | 4            | 3          | 56         | 15            |
| 4                 | 78              | 23          | 22         | 5            | 4          | 72         | 19            |
| 5                 | 130             | 23          | 18         | 4            | 4          | 111        | 20            |
| 6                 | 173             | 19          | 17         | 7            | 4          | 152        | 13            |
| 7                 | 115             | 16          | 15         | 3            | 3          | 84         | 13            |
| 8                 | 52              | 16          | 14         | 4            | 4          | 45         | 13            |
| 9                 | 94              | 18          | 16         | 7            | 5          | 76         | 12            |
| 10                | 32              | 11          | 11         | 6            | 5          | 25         | 6             |
| 11                | 54              | 20          | 20         | 9            | 5          | 28         | 10            |
| 12                | 66              | 22          | 21         | 12           | 7          | 33         | 9             |
| 13                | 270             | 25          | 23         | 9            | 5          | 253        | 16            |
| 14                | 327             | 34          | 30         | 14           | 7          | 283        | 18            |
| 15                | 94              | 17          | 17         | 6            | 4          | 86         | 12            |
| 16                | 100             | 27          | 23         | 7            | 5          | 85         | 19            |
| 17                | 88              | 14          | 14         | 4            | 4          | 82         | 11            |
| 18                | 77              | 19          | 18         | 6            | 5          | 68         | 13            |
| 19                | 121             | 13          | 13         | 8            | 5          | 81         | 6             |
| 20                | 55              | 10          | 10         | 4            | 3          | 37         | 7             |
| 21                | 25              | 18          | 15         | 4            | 4          | 18         | 14            |
| 22                | 32              | 20          | 18         | 9            | 5          | 11         | 10            |
| 23                | 53              | 25          | 22         | 7            | 5          | 46         | 19            |
| 24                | 106             | 39          | 35         | 13           | 7          | 73         | 25            |
| 25                | 237             | 27          | 19         | 4            | 3          | 188        | 22            |
| 26                | 293             | 30          | 24         | 7            | 6          | 204        | 22            |
| 27                | 86              | 18          | 14         | 3            | 2          | 84         | 16            |
| 28                | 128             | 20          | 13         | 5            | 5          | 119        | 16            |
| 29                | 31              | 14          | 13         | 6            | 5          | 25         | 9             |
| 30                | 56              | 24          | 24         | 10           | 6          | 33         | 14            |
| 31                | 50              | 21          | 19         | 5            | 4          | 41         | 16            |
| 32                | 56              | 21          | 17         | 4            | 2          | 53         | 18            |
| 33                | 162             | 19          | 17         | 6            | 5          | 135        | 12            |
| 34                | 59              | 8           | 8          | 2            | 2          | 18         | 7             |
| 35                | 21              | 13          | 12         | 3            | 2          | 17         | 11            |
| 36                | 319             | 45          | 39         | 13           | 8          | 210        | 26            |
| 37                | 2095            | 45          | 35         | 11           | 6          | 1980       | 33            |
| 38                | 550             | 43          | 38         | 14           | 11         | 106        | 19            |
| 39                | 108             | 13          | 13         | 7            | 5          | 2          | 1             |
| 40                | 837             | 53          | 42         | 17           | 10         | 528        | 35            |
| 41                | 101             | 28          | 23         | 10           | 7          | 79         | 17            |
| 42                | 167             | 28          | 25         | 10           | 6          | 99         | 18            |
| 43                | 228             | 37          | 36         | 15           | 12         | 126        | 18            |
| 44                | 107             | 25          | 24         | 9            | 8          | 62         | 14            |
| 45                | 76              | 32          | 30         | 13           | 9          | 43         | 15            |

Table 5.8 Ranking of Brillouin and Hurlbert's diversity values for total macroinvertebrates.

| COLLECTION/STATION                | 1 | 2 | 3 | 4 | 5 | Chlorination |
|-----------------------------------|---|---|---|---|---|--------------|
| <b>BRILLOUIN'S DIVERSITY RANK</b> |   |   |   |   |   |              |
| 10/30/87 (Stream-bed Rocks)       | 2 | 1 | 3 | 4 | 5 | yes          |
| 10/30/87 (Limestones)             | 4 | 1 | 2 | 3 | 5 | yes          |
| 12/22/87 (Replicate Basket 1)     | 1 | 4 | 2 | 3 | 5 | no           |
| 12/22/87 (Replicate Basket 2)     | 2 | 4 | 1 | 3 | 5 | no           |
| 3/29/88 (Stone not in Contact)    | 3 | 2 | 1 | 4 | 5 | no           |
| 3/29/88 (Standard Exposure)       | 4 | 2 | 1 | 5 | 3 | no           |
| 4/14/88 (Chlorination Resumed)    | 2 | 1 | 3 | 5 | 4 | yes          |
| 8/22/88 (Summer Collection)       | 1 | 5 | 3 | 4 | 2 | yes          |
| 10/17/88 (Placement Experiment)   | 3 | 5 | 2 | 4 | 1 | yes          |
| <b>HURLBERT'S DIVERSITY RANK</b>  |   |   |   |   |   |              |
| 10/30/87 (Stream-bed Rocks)       | 1 | 2 | 3 | 4 | 5 | yes          |
| 10/30/87 (Limestones)             | 1 | 2 | 4 | 3 | 5 | yes          |
| 12/22/87 (Replicate Basket 1)     | 1 | 5 | 2 | 3 | 4 | no           |
| 12/22/87 (Replicate Basket 2)     | 2 | 5 | 1 | 3 | 4 | no           |
| 3/29/88 (Stone not in Contact)    | 1 | 2 | 3 | 5 | 4 | no           |
| 3/29/88 (Standard Exposure)       | 1 | 2 | 4 | 4 | 3 | no           |
| 4/14/88 (Chlorination Resumed)    | 3 | 2 | 4 | 5 | 1 | yes          |
| 8/22/88 (Summer Collection)       | 1 | 5 | 3 | 4 | 2 | yes          |
| 10/17/88 (Placement Experiment)   | 2 | 4 | 5 | 3 | 1 | yes          |

Table 5.9 Ranking of Hurlbert's diversity values for midges and family level census.

| COLLECTION/STATION              | 1 | 2 | 3 | 4 | 5 | Chlorination |
|---------------------------------|---|---|---|---|---|--------------|
| <b>MIDGES</b>                   |   |   |   |   |   |              |
| 10/30/87 (Stream-bed Rocks)     | 1 | 2 | 3 | 4 | 5 | yes          |
| 10/30/87 (Limestones)           | 1 | 2 | 4 | 3 | 5 | yes          |
| 12/22/87 (Replicate Basket 1)   | 1 | 4 | 2 | 3 | 5 | no           |
| 12/22/87 (Replicate Basket 2)   | 3 | 5 | 1 | 2 | 4 | no           |
| 3/29/88 (Stone not in Contact)  | 1 | 2 | 3 | 4 | 5 | no           |
| 3/29/88 (Standard Exposure)     | 1 | 2 | 3 | 5 | 4 | no           |
| 4/14/88 (Chlorination Resumed)  | 4 | 2 | 5 | 3 | 1 | yes          |
| 8/22/88 (Summer Collection)     | 1 | 4 | 3 | 5 | 2 | yes          |
| 10/17/88 (Placement Experiment) | 2 | 5 | 3 | 4 | 1 | yes          |
| <b>FAMILY LEVEL CENSUS</b>      |   |   |   |   |   |              |
| 10/30/87 (Stream-bed Rocks)     | 1 | 5 | 4 | 2 | 3 | yes          |
| 10/30/87 (Limestones)           | 1 | 5 | 4 | 3 | 2 | yes          |
| 12/22/87 (Replicate Basket 1)   | 1 | 5 | 3 | 4 | 2 | no           |
| 12/22/87 (Replicate Basket 2)   | 1 | 4 | 3 | 5 | 2 | no           |
| 3/29/88 (Stone not in Contact)  | 1 | 4 | 3 | 5 | 2 | no           |
| 3/29/88 (Standard Exposure)     | 1 | 3 | 4 | 5 | 2 | no           |
| 4/14/88 (Chlorination Resumed)  | 3 | 5 | 4 | 1 | 2 | yes          |
| 8/22/88 (Summer Collection)     | 4 | 5 | 1 | 2 | 3 | yes          |
| 10/17/88 (Placement Experiment) | 5 | 4 | 3 | 2 | 1 | yes          |

Table 5.10 Average qualitative similarity values calculated for chlorination, non-chlorination, and year-long periods with their respective ranking at each station for total macroinvertebrates, midges, and family level census.

|                                 |                  | STATION |       |        |       |   | ranking <sup>1</sup> |   |   |  |
|---------------------------------|------------------|---------|-------|--------|-------|---|----------------------|---|---|--|
| 1 vs.                           |                  | 2       | 3     | 4      | 5     | 2 | 3                    | 4 | 5 |  |
| <b>TOTAL MACROINVERTEBRATES</b> |                  |         |       |        |       |   |                      |   |   |  |
| Sørensen Index                  | chlorination     | .3379   | .2828 | .2343  | .2969 | 1 | 3                    | 4 | 2 |  |
|                                 | non-chlorination | .4719   | .3457 | .4044  | .3010 | 1 | 3                    | 2 | 4 |  |
|                                 | year             | .4145   | .3187 | .3315  | .2992 | 1 | 3                    | 2 | 4 |  |
| revised Fager's Index           | chlorination     | .2629   | .2069 | .1548  | .2020 | 1 | 3                    | 4 | 2 |  |
|                                 | non-chlorination | .4716   | .3217 | .3746  | .2489 | 1 | 3                    | 2 | 4 |  |
|                                 | year             | .3822   | .2725 | .2804  | .2288 | 1 | 3                    | 2 | 4 |  |
| <b>MIDGES</b>                   |                  |         |       |        |       |   |                      |   |   |  |
| Sørensen Index                  | chlorination     | .4171   | .3738 | .3059  | .3397 | 1 | 2                    | 4 | 3 |  |
|                                 | non-chlorination | .5116   | .5044 | .5280  | .3418 | 2 | 3                    | 1 | 4 |  |
|                                 | year             | .4711   | .4485 | .4328  | .3445 | 1 | 2                    | 3 | 4 |  |
| revised Fager's Index           | chlorination     | .3655   | .3127 | .1914  | .2344 | 1 | 2                    | 4 | 3 |  |
|                                 | non-chlorination | .4710   | .4565 | .4523  | .2346 | 1 | 2                    | 3 | 4 |  |
|                                 | year             | .4285   | .3948 | .3405  | .2345 | 1 | 2                    | 3 | 4 |  |
| <b>FAMILY LEVEL CENSUS</b>      |                  |         |       |        |       |   |                      |   |   |  |
| Sørensen Index                  | chlorination     | .3075   | .2518 | .2275  | .3940 | 2 | 3                    | 4 | 1 |  |
|                                 | non-chlorination | .5327   | .2406 | .3024  | .4070 | 1 | 4                    | 3 | 2 |  |
|                                 | year             | .4387   | .2454 | .2703  | .4015 | 1 | 4                    | 3 | 2 |  |
| revised Fager's Index           | chlorination     | .1136   | .0579 | -.0094 | .2337 | 2 | 3                    | 4 | 1 |  |
|                                 | non-chlorination | .4092   | .0327 | .1073  | .2626 | 1 | 4                    | 3 | 2 |  |
|                                 | year             | .2825   | .0435 | .0572  | .2502 | 1 | 4                    | 3 | 2 |  |

1 similarity ranking between 1 and 4; 1 being the most similar to one another and 4 being the least.

Table 5.11 Average quantitative similarity/dissimilarity values calculated for chlorination, non-chlorination, and year-long periods with their respective ranking at each station for total macroinvertebrates, midges, and family level census.

|                                 |                  | STATION |        |       |       |   | ranking <sup>1</sup> |   |   |  |
|---------------------------------|------------------|---------|--------|-------|-------|---|----------------------|---|---|--|
| 1 vs.                           |                  | 2       | 3      | 4     | 5     | 2 | 3                    | 4 | 5 |  |
| <b>TOTAL MACROINVERTEBRATES</b> |                  |         |        |       |       |   |                      |   |   |  |
| Squared Euclidean Distance      | chlorination     | 224.01  | 84.81  | 47.01 | 76.77 | 4 | 3                    | 1 | 2 |  |
|                                 | non-chlorination | 90.37   | 60.09  | 36.18 | 27.63 | 4 | 3                    | 2 | 1 |  |
|                                 | year             | 147.64  | 70.68  | 40.82 | 48.69 | 4 | 3                    | 1 | 2 |  |
| Average Chi-Square              | chlorination     | .7072   | .7824  | .8333 | .7759 | 1 | 3                    | 4 | 2 |  |
|                                 | non-chlorination | .6991   | .7638  | .7056 | .6579 | 2 | 4                    | 3 | 1 |  |
|                                 | year             | .7025   | .7725  | .7603 | .7085 | 1 | 4                    | 3 | 2 |  |
| Morisita Similarity Index       | chlorination     | .4997   | .4030  | .1544 | .1665 | 1 | 2                    | 4 | 3 |  |
|                                 | non-chlorination | .5001   | .4158  | .3445 | .4457 | 1 | 3                    | 4 | 2 |  |
|                                 | year             | .4999   | .4103  | .2630 | .3261 | 1 | 2                    | 4 | 3 |  |
| Pinkham-Pearson B Index         | chlorination     | .1007   | .0670  | .0605 | .0850 | 1 | 3                    | 4 | 2 |  |
|                                 | non-chlorination | .1717   | .0655  | .1210 | .1030 | 1 | 4                    | 2 | 3 |  |
|                                 | year             | .1413   | .0662  | .0950 | .0952 | 1 | 4                    | 3 | 2 |  |
| <b>MIDGES</b>                   |                  |         |        |       |       |   |                      |   |   |  |
| Squared Euclidean Distance      | chlorination     | 221.97  | 57.58  | 33.03 | 70.64 | 4 | 2                    | 1 | 3 |  |
|                                 | non-chlorination | 88.85   | 46.20  | 34.54 | 25.28 | 4 | 3                    | 2 | 1 |  |
|                                 | year             | 145.90  | 51.07  | 33.89 | 44.72 | 4 | 3                    | 1 | 2 |  |
| Average Chi-Square              | chlorination     | .6578   | .7298  | .7572 | .8361 | 1 | 2                    | 3 | 4 |  |
|                                 | non-chlorination | .6949   | .6824  | .6689 | .6626 | 4 | 3                    | 2 | 1 |  |
|                                 | year             | .6790   | .7027  | .7068 | .7370 | 1 | 2                    | 3 | 4 |  |
| Morisita Similarity Index       | chlorination     | .7211   | .6250  | .4208 | .2206 | 1 | 2                    | 3 | 4 |  |
|                                 | non-chlorination | .8617   | .8053  | .5598 | .5384 | 1 | 2                    | 3 | 4 |  |
|                                 | year             | .8015   | .7537  | .5002 | .4022 | 1 | 2                    | 3 | 4 |  |
| Pinkham-Pearson B Index         | chlorination     | .1315   | .0541  | .0525 | .0543 | 1 | 3                    | 4 | 2 |  |
|                                 | non-chlorination | .1630   | .1040  | .1626 | .1093 | 1 | 4                    | 2 | 3 |  |
|                                 | year             | .1495   | .1018  | .1299 | .1076 | 1 | 4                    | 2 | 3 |  |
| <b>FAMILY LEVEL CENSUS</b>      |                  |         |        |       |       |   |                      |   |   |  |
| Squared Euclidean Distance      | chlorination     | 330.17  | 134.51 | 79.69 | 85.32 | 4 | 3                    | 1 | 2 |  |
|                                 | non-chlorination | 142.03  | 125.12 | 66.99 | 24.44 | 4 | 3                    | 2 | 1 |  |
|                                 | year             | 222.66  | 129.15 | 72.43 | 50.53 | 4 | 3                    | 2 | 1 |  |
| Average Chi-Square              | chlorination     | .4558   | .6072  | .5942 | .3431 | 2 | 4                    | 3 | 1 |  |
|                                 | non-chlorination | .5342   | .6113  | .4696 | .3065 | 3 | 4                    | 2 | 1 |  |
|                                 | year             | .5006   | .6096  | .5230 | .3222 | 2 | 4                    | 3 | 1 |  |
| Morisita Similarity Index       | chlorination     | .8646   | .7903  | .6358 | .9287 | 2 | 3                    | 4 | 1 |  |
|                                 | non-chlorination | .8339   | .7903  | .6358 | .9287 | 2 | 3                    | 4 | 1 |  |
|                                 | year             | .8470   | .8000  | .7299 | .9142 | 2 | 3                    | 4 | 1 |  |
| Pinkham-Pearson B Index         | chlorination     | .0755   | .0402  | .0448 | .1088 | 2 | 4                    | 3 | 1 |  |
|                                 | non-chlorination | .1913   | .0462  | .0616 | .1489 | 1 | 4                    | 3 | 2 |  |
|                                 | year             | .1417   | .0436  | .0544 | .1317 | 1 | 4                    | 3 | 2 |  |

<sup>1</sup> similarity ranking between 1 and 4; 1 being the most similar to one another and 4 being the least.

Table 5.12 Change in abundance and percent distribution (in parenthesis) of benthic macroinvertebrate species collected from station 1 baskets during the period of substrate deployment from October 30, 1987 to August 22, 1988. Only those with substantial abundance and percent composition were listed.

| TAXA/COLLECTION                     | 10/30/87N  | 10/30/87L  | 12/22/87B1 | 12/22/87B2 | 3/29/88I   | 3/29/88R   | 4/14/88    | 8/22/88     |
|-------------------------------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <i>Conchelopodia sp.</i>            | 3:(7.5%)   | 4:(16.0%)  | 5:(9.3%)   | 8:(12.0%)  | 2:(8.0%)   | 1:(3.2%)   | 17:(34.0%) | 22:(6.9%)   |
| <i>Diplocladius sp.</i>             | 1:(2.5%)   | 0:(0%)     | 9:(16.7%)  | 8:(12.1%)  | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)      |
| <i>Micropsectra sp.</i>             | 0:(0%)     | 1:(4.0%)   | 2:(3.7%)   | 1:(1.5%)   | 2:(8.0%)   | 1:(3.1%)   | 0:(0%)     | 5:(1.6%)    |
| <i>Microtendipes caelum</i>         | 0:(0%)     | 2:(8.0%)   | 1:(1.8%)   | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 11:(3.4%)   |
| <i>Nanocladius sp. 2</i>            | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 3:(6.0%)   | 1:(0.3%)    |
| <i>Parakiefferiella sp.</i>         | 0:(0%)     | 3:(12.0%)  | 0:(0%)     | 0:(0%)     | 1:(4.0%)   | 2:(6.2%)   | 0:(0%)     | 3:(0.9%)    |
| <i>Parametriocnemus lundbecki</i>   | 3:(7.5%)   | 0:(0%)     | 6:(11.1%)  | 16:(24.2%) | 1:(4.0%)   | 1:(3.1%)   | 5:(10.0%)  | 2:(0.63%)   |
| <i>Polypedilum scalaenum</i>        | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 3:(6.0%)   | 51:(16.0%)  |
| <i>Rheotanytarsus exiguus group</i> | 3:(7.5%)   | 0:(0%)     | 1:(1.8%)   | 1:(1.5%)   | 2:(8.0%)   | 1:(3.1%)   | 2:(4.0%)   | 0:(0%)      |
| <i>Tanytarsus sp.</i>               | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 20:(6.3%)   |
| <i>Thienemanniella sp. 1</i>        | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 2:(8.0%)   | 1:(3.1%)   | 0:(0%)     | 0:(0%)      |
| <i>Zavrelimyia sp. 2</i>            | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 26:(8.2%)   |
| Ephemeroptera                       | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 2:(8.0%)   | 0:(0%)     | 0:(0%)     | 14:(4.4%)   |
| <i>Serratella deficiens</i>         | 3:(7.5%)   | 0:(0%)     | 2:(3.7%)   | 3:(4.5%)   | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)      |
| <i>Ephemerella excrucians</i>       | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 3:(9.4%)   | 0:(0%)     | 0:(0%)      |
| <i>Paraleptophlebia sp.</i>         | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 5:(10.0%)  | 56:(17.6%)  |
| <i>Isoperla marlynia</i>            | 0:(0%)     | 0:(0%)     | 0:(0%)     | 5:(7.6%)   | 3:(12.0%)  | 2:(6.2%)   | 1:(2.0%)   | 2:(0.63%)   |
| <i>Paracapnia opis</i>              | 7:(17.5%)  | 5:(20.0%)  | 13:(24.1%) | 12:(18.2%) | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)      |
| <i>Ceratonina sp.</i>               | 4:(10.0%)  | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)      |
| <i>Cheumatopsyche sp.</i>           | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 4:(12.5%)  | 0:(0%)     | 0:(0%)      |
| <i>Hydatophylax sp.</i>             | 0:(0%)     | 2:(8.0%)   | 2:(3.7%)   | 1:(1.5%)   | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)      |
| <i>Hydropsyche sp. 1</i>            | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 4:(12.5%)  | 0:(0%)     | 0:(0%)      |
| <i>Nigronia serricornis</i>         | 3:(7.5%)   | 0:(0%)     | 0:(0%)     | 1:(1.5%)   | 0:(0%)     | 0:(0%)     | 0:(0%)     | 5:(1.6%)    |
|                                     | 27:(67.5%) | 17:(68.0%) | 41:(75.9%) | 56:(84.8%) | 15:(60.0%) | 20:(62.5%) | 36:(72.0%) | 218:(68.3%) |

Table 5.13 Change in abundance and percent distribution (in parenthesis) of benthic macroinvertebrate species collected from station 2 baskets during the period of substrate deployment from October 30, 1987 to August 22, 1988. Only those with substantial abundance and percent composition were listed.

| TAXA/COLLECTION                        | 10/30/87N  | 10/30/87L  | 12/22/87B1  | 12/22/87B2  | 3/29/88I   | 3/29/88R   | 4/14/88    | 8/22/88      |
|--|------------|------------|-------------|-------------|------------|------------|------------|--------------|
| <i>Chironomus sp.</i>                  | 3:(4.8%)   | 4:(5.1%)   | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 44:(2.1%)    |
| <i>Conchapelopia sp.</i>               | 12:(19.0%) | 16:(20.5%) | 10:(3.7%)   | 18:(5.6%)   | 4:(7.5%)   | 11:(10.4%) | 13:(23.2%) | 43:(2.1%)    |
| <i>Corynoneura taris</i>               | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 3:(5.8%)   | 3:(1.8%)   | 0:(0%)     | 0:(0%)       |
| <i>Diplocladius sp.</i>                | 5:(7.9%)   | 7:(9.0%)   | 152:(56.3%) | 170:(52.0%) | 2:(3.8%)   | 3:(2.8%)   | 0:(0%)     | 0:(0%)       |
| <i>Endochironomus nigricans</i>        | 6:(9.5%)   | 3:(3.8%)   | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 1:(1.8%)   | 0:(0%)       |
| <i>Heterotrissocladius marcidus</i> g. | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 5:(9.4%)   | 2:(1.9%)   | 1:(1.8%)   | 0:(0%)       |
| <i>Micropsectra sp.</i>                | 6:(9.5%)   | 17:(21.8%) | 56:(20.7%)  | 50:(15.3%)  | 2:(3.8%)   | 9:(8.5%)   | 2:(3.6%)   | 59:(2.8%)    |
| <i>Nanocladius sp. 2</i>               | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 3:(5.8%)   | 2:(1.9%)   | 1:(1.8%)   | 1:(0.0%)     |
| <i>Parakiefferiella sp.</i>            | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 10:(18.9%) | 1:(0.9%)   | 0:(0%)     | 0:(0%)       |
| <i>Parametriocnemus lundbecki</i>      | 5:(7.9%)   | 6:(7.7%)   | 9:(3.3%)    | 15:(4.6%)   | 2:(3.8%)   | 13:(12.3%) | 12:(21.4%) | 0:(0%)       |
| <i>Paratendipes sp.</i>                | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 24:(1.1%)    |
| <i>Paratanytarsus sp. 2</i>            | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 109:(5.2%)   |
| <i>Psectrotanytarsus dyari</i>         | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 38:(1.8%)    |
| <i>Psectrotanytarsus nr. dyari</i>     | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 30:(1.4%)    |
| <i>Polypedilum aviceps</i>             | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 5:(8.9%)   | 1:(0.0%)     |
| <i>Polypedilum laetum</i>              | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 4:(7.1%)   | 17:(0.8%)    |
| <i>Polypedilum fallax</i>              | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 146:(7.0%)   |
| <i>Polypedilum illinoense</i>          | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 85:(4.1%)    |
| <i>Polypedilum scalaenum</i>           | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 1271:(60.7%) |
| <i>Tanytarsus sp.</i>                  | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 4:(3.8%)   | 4:(7.1%)   | 5:(0.2%)     |
| <i>Tribelos poss. jucundum</i>         | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 34:(1.6%)    |
| <i>Trissopelopia ogemawi</i>           | 6:(9.5%)   | 1:(1.3%)   | 2:(0.7%)    | 6:(1.8%)    | 0:(0%)     | 5:(4.7%)   | 1:(1.8%)   | 0:(0%)       |
| <i>Baetis brunneicolor</i>             | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 3:(5.8%)   | 0:(0%)     | 0:(0%)     | 0:(0%)       |
| <i>Leptophlebia sp.</i>                | 0:(0%)     | 0:(0%)     | 0:(0%)      | 10:(3.1%)   | 1:(1.9%)   | 0:(0%)     | 0:(0%)     | 0:(0%)       |
| <i>Hyaella azteca</i>                  | 4:(6.3%)   | 1:(1.3%)   | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)       |
| IWCC                                   | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     | 9:(8.5%)   | 0:(0%)     | 4:(0.2%)     |
|  | 47:(74.6%) | 55:(70.5%) | 229:(84.8%) | 269:(82.3%) | 35:(66.0%) | 62:(58.5%) | 44:(78.6%) | 1911:(91.2%) |

Table 5.14 Change in abundance and percent distribution (in parenthesis) of benthic macroinvertebrate species collected from station 3 baskets during the period of substrate deployment from October 30, 1987 to August 22, 1988. Only those with substantial abundance and percent composition were listed.

| TAXA/COLLECTION                     | 10/30/87N   | 10/30/87L   | 12/22/87B1 | 12/22/87B2 | 3/29/88I    | 3/29/88R    | 4/14/88     | 8/22/88     |
|-------------------------------------|-------------|-------------|------------|------------|-------------|-------------|-------------|-------------|
| <i>Conchapelopia</i> sp.            | 35:(26.9%)  | 17:(9.8%)   | 30:(31.9%) | 22:(22.0%) | 28:(11.8%)  | 37:(12.6%)  | 71:(43.8%)  | 42:(7.6%)   |
| <i>Diplocladius</i> sp.             | 13:(10.0%)  | 29:(16.8%)  | 12:(12.8%) | 21:(21.0%) | 4:(1.7%)    | 2:(0.7%)    | 0:(0%)      | 0:(0%)      |
| <i>Hydorbauenus pilipes</i>         | 5:(3.8%)    | 0:(0%)      | 0:(0%)     | 1:(1.0%)   | 0:(0%)      | 0:(0%)      | 0:(0%)      | 0:(0%)      |
| <i>Meropelopia flavifrons</i>       | 5:(3.8%)    | 2:(1.2%)    | 3:(3.2%)   | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)      | 1:(0.2%)    |
| <i>Micropsectra</i> sp. 1           | 6:(4.6%)    | 9:(5.2%)    | 3:(3.2%)   | 3:(3.0%)   | 25:(10.5%)  | 30:(10.2%)  | 8:(4.9%)    | 3:(0.5%)    |
| <i>Nanocladius</i> sp. 1            | 5:(3.8%)    | 1:(0.6%)    | 0:(0%)     | 1:(1.0%)   | 3:(1.3%)    | 3:(1.0%)    | 1:(0.6%)    | 0:(0%)      |
| <i>Nanocladius</i> sp. 2            | 1:(0.8%)    | 0:(0%)      | 0:(0%)     | 2:(2.0%)   | 15:(6.3%)   | 15:(5.1%)   | 19:(11.7%)  | 0:(0%)      |
| <i>Orthocladius oliveri</i>         | 0:(0%)      | 0:(0%)      | 8:(8.5%)   | 3:(3.0%)   | 11:(4.6%)   | 16:(5.5%)   | 0:(0%)      | 0:(0%)      |
| <i>Parakiefferiella</i> sp.         | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 9:(3.8%)    | 11:(3.8%)   | 0:(0%)      | 0:(0%)      |
| <i>Paratanytarsus</i> sp. 2         | 9:(6.9%)    | 38:(22.0%)  | 12:(12.8%) | 7:(7.0%)   | 36:(15.2%)  | 37:(12.6%)  | 22:(13.6%)  | 31:(5.6%)   |
| <i>Polypedilum scalaenum</i>        | 1:(0.8%)    | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)      | 10:(1.8%)   |
| <i>Rheotanytarsus exiguus</i> group | 20:(15.4%)  | 45:(26.0%)  | 9:(9.6%)   | 8:(8.0%)   | 13:(5.5%)   | 10:(3.4%)   | 4:(2.5%)    | 0:(0%)      |
| <i>Thienemanniella</i> prob. xena   | 0:(0%)      | 2:(1.2%)    | 0:(0%)     | 1:(1.0%)   | 21:(8.9%)   | 12:(4.1%)   | 3:(1.8%)    | 0:(0%)      |
| <i>Thienemanniella</i> sp. 1        | 0:(0%)      | 0:(0%)      | 4:(4.2%)   | 2:(2.0%)   | 8:(3.4%)    | 9:(3.1%)    | 0:(0%)      | 0:(0%)      |
| <i>Stegopterna mutata</i> complex   | 0:(0%)      | 0:(0%)      | 3:(3.2%)   | 6:(6.0%)   | 42:(17.7%)  | 75:(25.6%)  | 9:(5.6%)    | 0:(0%)      |
| <i>Simulium vittatum</i> complex    | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 1:(0.4%)    | 5:(1.7%)    | 11:(6.8%)   | 0:(0%)      |
| <i>Helobdella stagnalis</i>         | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)      | 2:(0.7%)    | 1:(0.6%)    | 22:(4.0%)   |
| <i>Dero obtusa</i>                  | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 3:(1.8%)    | 90:(16.4%)  |
| <i>Paraleptophlebia</i> sp.         | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)      | 16:(2.9%)   |
| <i>Cheumatopsyche</i> sp.           | 1:(0.8%)    | 16:(9.2%)   | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)      | 2:(0.4%)    |
| <i>Hyaella azteca</i>               | 16:(12.3%)  | 1:(0.6%)    | 2:(2.1%)   | 2:(2.0%)   | 1:(0.4%)    | 3:(1.0%)    | 1:(0.6%)    | 157:(28.5%) |
| <i>Oligochaeta</i>                  | 0:(0%)      | 0:(0%)      | 1:(1.1%)   | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)      | 89:(16.2%)  |
| <i>Nais communis</i>                | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 1:(0.6%)    | 14:(2.5%)   |
| <i>Pristinella osborni</i>          | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)      | 13:(2.4%)   |
|                                     | 117:(90.0%) | 160:(92.5%) | 87:(92.6%) | 79:(79.0%) | 217:(91.6%) | 267:(91.1%) | 154:(95.1%) | 490:(89.1%) |



Table 5.15 Change in abundance and percent distribution (in parenthesis) of benthic macroinvertebrate species collected from station 4 baskets during the period of substrate deployment from October 30, 1987 to August 22, 1988. Only those with substantial abundance and percent composition were listed.

| TAXA/COLLECTION                     | 10/30/87N   | 10/30/87L  | 12/22/87B1 | 12/22/87B2 | 3/29/88I   | 3/29/88R    | 4/14/88     | 8/22/88    |
|-------------------------------------|-------------|------------|------------|------------|------------|-------------|-------------|------------|
| <i>Conchapelopia</i> sp.            | 12:(10.4%)  | 1:(1.9%)   | 12:(13.6%) | 14:(18.2%) | 2:(2.3%)   | 22:(17.2%)  | 5:(8.5%)    | 0:(0%)     |
| <i>Diplocladius</i> sp.             | 4:(3.5%)    | 1:(1.9%)   | 16:(18.2%) | 13:(16.9%) | 1:(1.2%)   | 0:(0%)      | 0:(0%)      | 0:(0%)     |
| <i>Hydrobaenus pillipes</i>         | 4:(3.5%)    | 0:(0%)     | 5:(5.7%)   | 1:(1.3%)   | 0:(0%)     | 0:(0%)      | 0:(0%)      | 0:(0%)     |
| <i>Micropeetra</i> sp. 1            | 5:(4.3%)    | 4:(7.7%)   | 3:(3.4%)   | 3:(3.9%)   | 14:(16.3%) | 5:(3.9%)    | 3:(5.1%)    | 0:(0%)     |
| <i>Nanocladius</i> sp. 1            | 0:(0%)      | 6:(11.5%)  | 1:(1.1%)   | 1:(1.3%)   | 5:(5.8%)   | 4:(3.1%)    | 0:(0%)      | 0:(0%)     |
| <i>Nanocladius</i> sp. 2            | 0:(0%)      | 1:(1.9%)   | 0:(0%)     | 0:(0%)     | 4:(4.6%)   | 7:(5.5%)    | 3:(5.1%)    | 0:(0%)     |
| <i>Orthocladus oliveri</i>          | 0:(0%)      | 1:(1.9%)   | 33:(37.5)  | 21:(27.3)  | 10:(11.6%) | 26:(20.3%)  | 2:(3.4%)    | 0:(0%)     |
| <i>Parametriocnemus lundbecki</i>   | 1:(0.9%)    | 3:(5.8%)   | 1:(1.1%)   | 1:(1.3%)   | 1:(1.2%)   | 0:(0%)      | 1:(1.7%)    | 0:(0%)     |
| <i>Paratanytarsus</i> sp 2          | 15:(13.0%)  | 12:(23.1%) | 7:(8.0%)   | 8:(10.4%)  | 23:(26.7%) | 24:(18.8%)  | 3:(5.1%)    | 0:(0%)     |
| <i>Rheotanytarsus exiguus</i> group | 35:(30.4%)  | 12:(23.1%) | 0:(0%)     | 1:(1.3%)   | 2:(2.3%)   | 2:(1.6%)    | 0:(0%)      | 0:(0%)     |
| <i>Thienemanniella prob. xena</i>   | 2:(1.7%)    | 0:(0%)     | 0:(0%)     | 0:(0%)     | 10:(11.6%) | 10:(7.8%)   | 1:(1.7%)    | 0:(0%)     |
| <i>Hyalella azteca</i>              | 28:(24.3%)  | 4:(7.7%)   | 0:(0%)     | 2:(2.6%)   | 1:(1.2%)   | 6:(4.7%)    | 41:(69.5%)  | 0:(0%)     |
| <i>Helobdella stagnalis</i>         | 0:(0%)      | 2:(3.8%)   | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 22:(20.4%) |
| <i>Dero obtusa</i>                  | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 26:(24.1%) |
| <i>Oligochaeta</i>                  | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 9:(8.3%)   |
| IWCC                                | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 23:(21.3%) |
| ICC                                 | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)      | 10:(9.3%)  |
|                                     | 106:(92.2%) | 47:(90.4%) | 78:(88.6%) | 65:(84.4%) | 73:(94.8%) | 106:(82.8%) | 59:(100.0%) | 90:(83.3%) |

Table 5.16 Change in abundance and percent distribution (in parenthesis) of benthic macroinvertebrate species collected from station 5 baskets during the period of substrate deployment from October 30, 1987 to August 22, 1988. Only those with substantial abundance and percent composition were listed.

| TAXA/COLLECTION                       | 10/30/87N  | 10/30/87L  | 12/22/87B1  | 12/22/87B2 | 3/29/88I   | 3/29/88R   | 4/14/88    | 8/22/88     |
|---------------------------------------|------------|------------|-------------|------------|------------|------------|------------|-------------|
| <i>Conchapelopia</i> sp.              | 2:(2.1%)   | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 2:(3.6%)   | 0:(0%)     | 17:(2.0%)   |
| <i>Cricotopus tremulus</i> group      | 0:(0%)     | 0:(0%)     | 11:(9.1%)   | 9:(16.4%)  | 0:(0%)     | 9:(16.1%)  | 1:(4.8%)   | 8:(1.0%)    |
| <i>Diplocladius</i> sp.               | 60:(63.8%) | 20:(62.5%) | 66:(54.5%)  | 19:(34.5%) | 0:(0%)     | 1:(1.8%)   | 0:(0%)     | 0:(0%)      |
| <i>Hydrobaenus pilipes</i>            | 3:(3.2%)   | 0:(0%)     | 1:(0.8%)    | 5:(9.1%)   | 0:(0%)     | 1:(1.8%)   | 0:(0%)     | 0:(0%)      |
| <i>Labrundinia pilosella</i>          | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 9:(1.1%)    |
| <i>Micropectra</i> sp.                | 1:(1.1%)   | 1:(3.1%)   | 1:(0.8%)    | 0:(0%)     | 0:(0%)     | 2:(3.6%)   | 4:(19.0%)  | 1:(0.1%)    |
| <i>Microtendipes caelum</i>           | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 1:(4.8%)   | 15:(1.8%)   |
| <i>Microtendipes rydalensis</i> group | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 1:(1.8%)   | 2:(9.5%)   | 34:(4.1%)   |
| <i>Nanocladius</i> sp. 1              | 1:(1.1%)   | 0:(0%)     | 0:(0%)      | 0:(0%)     | 1:(3.2%)   | 0:(0%)     | 0:(0%)     | 7:(0.8%)    |
| <i>Nanocladius</i> sp. 2              | 1:(1.1%)   | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 1:(4.8%)   | 6:(0.7%)    |
| <i>Orthocladius carlatus</i> group    | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)     | 7:(22.6%)  | 6:(10.7%)  | 1:(4.8%)   | 0:(0%)      |
| <i>Parakiefferiella</i> sp.           | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)     | 8:(25.8%)  | 4:(7.1%)   | 0:(0%)     | 0:(0%)      |
| <i>Paratanytarsus</i> sp. 2           | 0:(0%)     | 0:(0%)     | 0:(0%)      | 1:(1.8%)   | 1:(3.2%)   | 1:(1.8%)   | 0:(0%)     | 189:(22.6%) |
| <i>Paratanytarsus</i> sp. 3           | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 9:(1.1%)    |
| <i>Tanytarsus</i> sp.                 | 2:(2.1%)   | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 3:(14.3%)  | 157:(18.8%) |
| <i>Thienemanniella</i> sp. 2          | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 12:(1.4%)   |
| Tanytarsini                           | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 8:(1.0%)    |
| <i>Stegopterna mutata</i> complex     | 0:(0%)     | 0:(0%)     | 1:(0.8%)    | 0:(0%)     | 0:(0%)     | 3:(5.4%)   | 3:(14.3%)  | 0:(0%)      |
| <i>Paraleptophlebia</i> sp.           | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 102:(12.2%) |
| <i>Paracapnia opis</i>                | 10:(10.6%) | 2:(6.3%)   | 20:(16.5%)  | 13:(23.6%) | 1:(3.2%)   | 2:(3.6%)   | 0:(0%)     | 0:(0%)      |
| <i>Taeniopteryx maura</i>             | 0:(0%)     | 0:(0%)     | 15:(12.4%)  | 2:(3.6%)   | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)      |
| <i>Neophylax</i> sp.                  | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)     | 2:(6.5%)   | 8:(14.3%)  | 0:(0%)     | 0:(0%)      |
| Ephemeroptera (early instar)          | 0:(0%)     | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 1:(1.8%)   | 0:(0%)     | 126:(15.1%) |
| Tricoptera (early instar)             | 1:(1.1%)   | 0:(0%)     | 0:(0%)      | 0:(0%)     | 0:(0%)     | 0:(0%)     | 0:(0%)     | 48:(5.7%)   |
|                                       | 81:(86.2%) | 23:(71.9%) | 115:(95.0%) | 49:(89.1%) | 23:(74.2%) | 42:(75.0%) | 16:(76.2%) | 748:(89.4%) |

Table 5.17 Change in abundance and percent distribution (in parenthesis) of benthic macroinvertebrate species collected on October 17, 1988. Only those with substantial abundance and percent composition were listed.

| TAXA/STATION                        | 1          | 2           | 3           | 4          | 5          |
|-------------------------------------|------------|-------------|-------------|------------|------------|
| <i>Chironomus sp.</i>               | 4:(4.0%)   | 4:(2.4%)    | 0:(0%)      | 0:(0%)     | 2:(2.6%)   |
| <i>Conchapelopia sp.</i>            | 18:(17.8%) | 36:(21.6%)  | 12:(5.3%)   | 3:(2.8%)   | 4:(5.3%)   |
| <i>Micropsectra sp.</i>             | 0:(0%)     | 1:(0.6%)    | 22:(9.6%)   | 17:(15.9%) | 1:(1.3%)   |
| <i>Microtendipes caelum</i>         | 11:(10.9%) | 21:(12.6%)  | 43:(18.9%)  | 17:(15.9%) | 5:(6.6%)   |
| <i>Nanocladius sp. 1</i>            | 5:(5.0%)   | 0:(0%)      | 0:(0%)      | 0:(0%)     | 1:(1.3%)   |
| <i>Polypedilum scalaenum</i>        | 19:(18.8%) | 13:(7.8%)   | 12:(5.3%)   | 10:(9.3%)  | 8:(10.5%)  |
| <i>Tanytarsus sp.</i>               | 2:(2.0%)   | 4:(2.4%)    | 9:(3.9%)    | 5:(4.7%)   | 11:(14.5%) |
| <i>Hemerodromia sp.</i>             | 5:(5.0%)   | 24:(14.4%)  | 2:(0.9%)    | 4:(3.7%)   | 7:(9.2%)   |
| <i>Paraleptophlebia sp.</i>         | 5:(5.0%)   | 0:(0%)      | 7:(3.1%)    | 0:(0%)     | 1:(1.3%)   |
| <i>Dero obtusa</i>                  | 0:(0%)     | 0:(0%)      | 5:(2.2%)    | 9:(8.4%)   | 0:(0%)     |
| <i>Nais communis</i>                | 1:(1.0%)   | 29:(17.4%)  | 4:(1.8%)    | 1:(0.9%)   | 0:(0%)     |
| <i>Hyalella azteca</i>              | 0:(0%)     | 0:(0%)      | 59:(25.9%)  | 7:(6.5%)   | 0:(0%)     |
| Tanypodinae (early instar)          | 2:(2.0%)   | 2:(1.2%)    | 7:(3.1%)    | 1:(0.9%)   | 0:(0%)     |
| Ephemereididae                      | 0:(0%)     | 0:(0%)      | 2:(0.9%)    | 2:(1.9%)   | 6:(7.9%)   |
| <i>Ablabesmyia annulata</i>         | 0:(0%)     | 0:(0%)      | 7:(3.1%)    | 0:(0%)     | 0:(0%)     |
| <i>Corynoneura taris</i>            | 3:(3.0%)   | 0:(0%)      | 0:(0%)      | 0:(0%)     | 3:(3.9%)   |
| <i>Paratanytarsus sp. 2</i>         | 3:(3.0%)   | 2:(1.2%)    | 2:(0.9%)    | 0:(0%)     | 2:(2.6%)   |
| <i>Eurylophella bicolor</i>         | 1:(1.0%)   | 0:(0%)      | 2:(0.9%)    | 0:(0%)     | 2:(2.6%)   |
| <i>Eurylophella funeralis</i>       | 1:(1.0%)   | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     |
| <i>Perlinella ephyre/fumipennis</i> | 1:(1.0%)   | 0:(0%)      | 0:(0%)      | 0:(0%)     | 0:(0%)     |
| <i>Optioservus sp.</i>              | 2:(2.0%)   | 0:(0%)      | 3:(1.3%)    | 2:(1.9%)   | 3:(3.9%)   |
| <i>Promoresia sp.</i>               | 3:(3.0%)   | 2:(1.2%)    | 0:(0%)      | 0:(0%)     | 1:(1.3%)   |
|                                     | 86:(85.1%) | 138:(82.6%) | 200:(87.7%) | 80:(74.8%) | 63:(82.9%) |

Table 5.18 The Morisita similarity index values for collections of total benthic macroinvertebrates colonizing limestones-filled basket substrates at station 1.

| COLLECTION                       | 10/30/87N | 10/30/87L | 12/22/87B1 | 12/22/87B2 | 3/29/88I | 3/29/88R | 4/14/88 |
|----------------------------------|-----------|-----------|------------|------------|----------|----------|---------|
| 10/30/87N<br>Stream-bed Rocks    |           |           |            |            |          |          |         |
| 10/30/87L<br>Limestones          | 0.8385    |           |            |            |          |          |         |
| 12/22/87B1<br>Replicate Basket 1 | 0.8277    | 0.7955    |            |            |          |          |         |
| 12/22/87B2<br>Replicate Basket 2 | 0.7642    | 0.5035    | 0.9563     |            |          |          |         |
| 3/29/88I<br>Stone not in Contact | 0.4093    | 0.4634    | 0.2662     | 0.3506     |          |          |         |
| 3/29/88R<br>Standard Exposure    | 0.4949    | 0.2770    | 0.1362     | 0.2143     | 0.8083   |          |         |
| 4/14/88<br>Chlorination Resumed  | 0.4328    | 0.5831    | 0.3887     | 0.3342     | 0.4908   | 0.2115   |         |
| 8/22/88<br>Summer Collection     | 0.3032    | 0.3639    | 0.1303     | 0.1027     | 0.2550   | 0.0698   | 0.5043  |

Table 5.19 The Morisita similarity index values for collections of total benthic macroinvertebrates colonizing limestones-filled basket substrates at station 2.

| COLLECTION                      | 10/30/87N | 10/30/87L | 12/22/87B1 | 12/22/87B2 | 3/29/88I | 3/29/88R | 4/14/88 |
|---------------------------------|-----------|-----------|------------|------------|----------|----------|---------|
| 10/30/87<br>Stream-bed Rocks    |           |           |            |            |          |          |         |
| 10/30/87<br>Limestones          | 0.9659    |           |            |            |          |          |         |
| 12/22/87<br>Replicate Basket 1  | 0.3468    | 0.4566    |            |            |          |          |         |
| 12/22/87<br>Replicate Basket 2  | 0.3855    | 0.4733    | 0.9958     |            |          |          |         |
| 3/29/88<br>Stone not in Contact | 0.3886    | 0.4127    | 0.1637     | 0.1853     |          |          |         |
| 3/29/88<br>Standard Exposure    | 0.7617    | 0.7347    | 0.2104     | 0.2382     | 0.5414   |          |         |
| 4/14/88<br>Chlorination Resumed | 0.7697    | 0.7094    | 0.1081     | 0.1460     | 0.4388   | 0.8094   |         |
| 8/22/88<br>Summer Collection    | 0.8144    | 0.1201    | 0.0180     | 0.0161     | 0.01632  | 0.1067   | 0.0742  |

Table 5.20 The Morisita similarity index values for collections of total benthic macroinvertebrates colonizing limestones-filled basket substrates at station 3.

| COLLECTION                      | 10/30/87N | 10/30/87L | 12/22/87B1 | 12/22/87B2 | 3/29/88I | 3/29/88R | 4/14/88 |
|---------------------------------|-----------|-----------|------------|------------|----------|----------|---------|
| 10/30/87<br>Stream-bed Rocks    |           |           |            |            |          |          |         |
| 10/30/87<br>Limestones          | 0.7171    |           |            |            |          |          |         |
| 12/22/87<br>Replicate Basket 1  | 0.9283    | 0.7003    |            |            |          |          |         |
| 12/22/87<br>Replicate Basket 2  | 0.8847    | 0.7186    | 0.9546     |            |          |          |         |
| 3/29/88<br>Stone not in Contact | 0.5270    | 0.5351    | 0.6466     | 0.6235     |          |          |         |
| 3/29/88<br>Standard Exposure    | 0.4570    | 0.4069    | 0.5929     | 0.5786     | 0.9804   |          |         |
| 4/14/88<br>Chlorination Resumed | 0.7565    | 0.4200    | 0.8594     | 0.6887     | 0.5996   | 0.5795   |         |
| 8/22/88<br>Summer Collection    | 0.4397    | 0.0980    | 0.2022     | 0.1841     | 0.1826   | 0.1725   | 0.1785  |

Table 5.21 The Morisita similarity index values for collections of total benthic macroinvertebrates colonizing limestones-filled basket substrates at station 4.

| COLLECTION                      | 10/30/87N | 10/30/87L | 12/22/87B1 | 12/22/87B2 | 3/29/88I | 3/29/88R | 4/14/88 |
|---------------------------------|-----------|-----------|------------|------------|----------|----------|---------|
| 10/30/87<br>Stream-bed Rocks    |           |           |            |            |          |          |         |
| 10/30/87<br>Limestones          | 0.8348    |           |            |            |          |          |         |
| 12/22/87<br>Replicate Basket 1  | 0.1850    | 0.2284    |            |            |          |          |         |
| 12/22/87<br>Replicate Basket 2  | 0.3220    | 0.3533    | 1.0010     |            |          |          |         |
| 3/29/88<br>Stone not in Contact | 0.3759    | 0.7416    | 0.4756     | 0.5575     |          |          |         |
| 3/29/88<br>Standard Exposure    | 0.4189    | 0.5545    | 0.7440     | 0.8498     | 0.8261   |          |         |
| 4/14/88<br>Chlorination Resumed | 0.5598    | 0.2389    | 0.0880     | 0.1587     | 0.1310   | 0.2291   |         |
| 8/22/88<br>Summer Collection    | 0.2009    | 0.2114    | 0.0826     | 0.1311     | 0.2600   | 0.1386   | 0.1949  |

Table 5.22 The Morisita similarity index values for collections of total benthic macroinvertebrates colonizing limestones-filled basket substrates at station 5.

| COLLECTION                      | 10/30/87N | 10/30/87L | 12/22/87B1 | 12/22/87B2 | 3/29/88I | 3/29/88R | 4/14/88 |
|---------------------------------|-----------|-----------|------------|------------|----------|----------|---------|
| 10/30/87<br>Stream-bed Rocks    |           |           |            |            |          |          |         |
| 10/30/87<br>Limestones          | 1.0166    |           |            |            |          |          |         |
| 12/22/87<br>Replicate Basket 1  | 0.9618    | 0.9620    |            |            |          |          |         |
| 12/22/87<br>Replicate Basket 2  | 0.8045    | 0.7840    | 0.9104     |            |          |          |         |
| 3/29/88<br>Stone not in Contact | 0.0218    | 0.0080    | 0.0232     | 0.0554     |          |          |         |
| 3/29/88<br>Standard Exposure    | 0.0718    | 0.0669    | 0.1529     | 0.3259     | 0.6473   |          |         |
| 4/14/88<br>Chlorination Resumed | 0.0232    | 0.0331    | 0.0349     | 0.07254    | 0.3279   | 0.5283   |         |
| 8/22/88<br>Summer Collection    | 0.0170    | 0.0004    | 0.0040     | 0.0370     | 0.2124   | 0.1374   | 0.3460  |



Table 5.23 Morisita similarity index values of macroinvertebrate populations collected with comparable substrates in different seasons

|   |         |         |         |         |         |
|---|---------|---------|---------|---------|---------|
| 10/30/87 Limestone vs. 12/22/87 Replicate Basket 1        | 0.7995  | 0.4566  | 0.7003  | 0.2284  | 0.962   |
| 10/30/87 Limestone vs. 12/22/87 Replicate Basket 2        | 0.5035  | 0.4733  | 0.7168  | 0.3533  | 0.784   |
| 12/22/87 Replicate Basket 1 vs. 3/29/88 Standard Exposure | 0.1362  | 0.2104  | 0.5929  | 0.744   | 0.1529  |
| 12/22/87 Replicate Basket 2 vs. 3/29/88 Standard Exposure | 0.2143  | 0.2382  | 0.5786  | 0.8498  | 0.3259  |
| 3/29/88 Standard Exposure vs. Summer Collection           | 0.0698  | 0.1067  | 0.1725  | 0.1386  | 0.1374  |
| Average   | 0.3447  | 0.2970  | 0.5522  | 0.4628  | 0.4724  |
| Standard Deviation  | 0.2713  | 0.1440  | 0.1978  | 0.2832  | 0.3384  |
| S.D./Average (%)  | 78.7247 | 48.4888 | 35.8125 | 61.1802 | 71.6280 |

Table 5.24 Potential macroinvertebrate indicator species found at station 2, 60 meters downstream from the sewage outfall, in Lampson Brook. Estimates of sensitivity/tolerance with respective TRC concentrations and their seasonal abundance.

| TRC (mg/l)                         | 2.957 $\pm$ 0.238<br>(Fall)      | 0.630 $\pm$ 0.297<br>(Summer) | Seasonal Occurrence |        |        |        |
|------------------------------------|----------------------------------|-------------------------------|---------------------|--------|--------|--------|
| Indicator Species                  | Estimated Tolerance <sup>1</sup> |                               | Fall                | Winter | Spring | Summer |
| <b>INSECTA</b>                     |                                  |                               |                     |        |        |        |
| <b>Diptera</b>                     |                                  |                               |                     |        |        |        |
| <i>Chironomus sp.</i>              |                                  | +                             | *                   |        |        | *      |
| <i>Conchapelopia sp.</i>           | +                                | +                             | *                   | *      | *      | *      |
| <i>Micropsectra sp.</i>            | +                                | +                             | *                   | *      | *      | *      |
| <i>Parakiefferiella sp.</i>        | -                                | -                             | *                   |        | *      | *      |
| <i>Parametrioctnemus lundbecki</i> | +                                |                               | *                   | *      | *      | *      |
| <i>Paratendipes sp.</i>            |                                  | +                             |                     |        |        | *      |
| <i>Paratanytarsus sp. 2</i>        |                                  | +                             | *                   | *      | *      | *      |
| <i>Paratanytarsus sp. 3</i>        |                                  | +                             | *                   | *      | *      | *      |
| <i>Polypedilum fallax</i>          |                                  | +                             |                     |        |        | *      |
| <i>Polypedilum laetum</i>          |                                  | +                             |                     | *      | *      | *      |
| <i>Polypedilum illinoense</i>      |                                  | +                             | *                   | *      | *      | *      |
| <i>Polypedilum scalaenum</i>       |                                  | +                             | *                   | *      | *      | *      |
| <i>Psectrotanypus dyari</i>        |                                  | +                             |                     |        |        | *      |
| <i>Psectrotanypus nr. dyari</i>    |                                  | +                             |                     |        | *      | *      |
| <i>Tribelos poss. jucundum</i>     |                                  | +                             |                     |        | *      | *      |
| <i>Tanytarsus sp.</i>              | - (?)                            | - (?)                         | *                   | *      | *      | *      |
| <i>Zavrelimyia sp. 2</i>           |                                  | - (?)                         |                     |        |        | *      |
| <b>Ephemeroptera</b>               |                                  |                               |                     |        |        |        |
| <i>Paraleptophlebia sp.</i>        | -                                | -                             | *                   | *      | *      | *      |
| <i>Serratella deficiens</i>        | -                                |                               | *                   | *      |        |        |
| <i>Paracapnia opis</i>             | -                                |                               | *                   | *      | *      |        |
| <i>Eurylophella bicolor</i>        |                                  | - (?)                         |                     | *      |        | *      |
| <i>Eurylophella funeralis</i>      |                                  | - (?)                         |                     | *      | *      | *      |
| <i>Stenonema modestum</i>          | -                                | -                             | *                   | *      | *      | *      |
| <i>Cheumatopsyche sp.</i>          | -                                |                               | *                   | *      | *      | *      |
| <i>Pycnopsyche sp.</i>             |                                  | -                             |                     | *      | *      | *      |
| <i>Nigronia serricornis</i>        | -                                | -                             | *                   | *      | *      | *      |
| <b>ANNELIDA</b>                    |                                  |                               |                     |        |        |        |
| <b>Oligochaeta</b>                 |                                  |                               |                     |        |        |        |
| <b>Tubificida</b>                  |                                  |                               |                     |        |        |        |
| <i>Nais communis</i>               |                                  | +                             |                     |        | *      | *      |

1 + = Tolerant and - = Sensitive

## CHAPTER VI

### CONCLUSIONS AND RECOMMENDATIONS

#### A. Summary of Conclusions

##### 1. Evaluation of Qualitative and Quantitative Methodology

1. The practice of censusing individual stones permits generation of confidence intervals and statistically significant observations with regard to density that provide close agreement when replicated.
2. Approximately 1018 organisms per m<sup>2</sup> (or 167 organisms per stone) are required to obtain a sample with the precision of  $\approx 0.20$ . The field collections indicate that only 9-10 out of 45 baskets reach that threshold.
3. Direct microscopic sorting with various magnifications yields much greater recovery than combination of sugar floating and the 1.7x magnifier sorting.
4. When using individual stones as a sampling unit to calculate diversity values, an "asymptotic diversity" has to be attained in order to give a reliable diversity value for a given basket collection.
5. Shannon diversity and Brillouin diversity are sample size dependent (the number of organisms in a sample), with similar distribution, the larger the sample, the larger the values derived from them.
6. Brillouin's hierarchical diversity exhibits additive property, whereas Hurlbert's does not. Though not always in agreement, both provide additional information regarding a particular community.

7. Based on the Spearman rank correlation of field data, diversity can be classified into two major groups, one that is associated with interspecific encounter and the other based on information theory. At the two extreme limits, these two diversity values show a close agreement, however, when species representation is in the intermediate level, they show very limited correlation.
8. Shannon's redundancy and evenness as well as Brillouin's redundancy and evenness though derived from Shannon and Brillouin's diversity, are more correlated to Hurlbert-type Diversity with regard to the field data collected in this study.
9. Diversity indices have very limited implication in pollution studies in that they cannot demonstrate species replacement or succession. They are indications of species rarity and are best used as a supplement to other community parameters.
10. Spearman rank correlation indicates that most of the qualitative indices are highly correlated among each other for macroinvertebrates, midges, and family level census except for Mountford's Index. Jaccard1, Jaccard2, and Sørensen's index, if applied to nonparametric analysis, will always give an identical assessment. The actual values may be exaggerated or understated depending upon the scaling factor on the denominator or nominator. Kulczynski and Mountford's indices present some fundamental flaws in that their formulae, when implemented in biological collections, do not conform the basic principle of geometry.

11. Spearman rank correlation for quantitative indices shows a considerably larger variation than the qualitative ones. In some cases, particularly Sokal's euclidean distance, there is no correlation at all. This imposes the possibilities of serious misinterpretation when using these indices to define any laboratory or field results.
12. When the collections consist of samples with great differences in sample size, the dissimilarity measured by the Squared Euclidean Distance clearly corresponds to the size of the sample.
13. Apparently, it is unlikely to derive a formula to satisfy both upper and lower limits of similarity/dissimilarity. If similarity indices are able to distinguish upper limits, then they will not be able to reasonably detect lower limits. The same is true with dissimilarity indices.
14. EPT survey proved to be very effective method in assessing the effect of chlorinated sewage.

## 2. Interpretation of Field Results

- 1 Using total organisms collected, species identified, and EPT values to provide an assessment of impact indicates that the magnitude of negative impact is, in descending order, station 4, station 3, station 2, and station 5.
2. Assessment of the response to non-chlorinated sewage indicates no negative impacts with regard to density. The most dramatic impact is a 5 - 8 fold fertilization effect at stations 2 or 3 that decreases to a two fold magnification at station 5.
3. Exposure to a chlorinated effluent elicits the same general response except that the magnification effect is about half that produced by non-chlorinated sewage

and this magnification does not persist to station 5. It would seem that chlorination exerts a subtle negative impact to 3 km. downstream from the outfall though TRC was not measured below station 3.

4. Hurlbert's diversity for macroinvertebrate and midge at downstream stations shows a different level of depression during chlorinated and non-chlorinated periods. Hurlbert's diversity for macroinvertebrate families indicates that station 2 is the most impacted.
5. The level of impact with regard to each station is a matter of subjective definition as to which are the most important parameters in describing community structure and community structure changes. Different aspects of change in relation to water quality need to be further tested before imposing any judgement on the extent of impact at each station.
6. The suspected causes of such disruption in aquatic macroinvertebrate community may be attributed to either the immediate impact of TRC in the water column at station 2 or the chronic effects of stable chlorinated by-products associated with the sediments at stations 3, 4, and 5.
7. The high correlation between the diversities calculated for macroinvertebrates and midges suggests that chironomids alone may have provided adequate representation for the interpretation of this pollution study. Family level diversity values were poorly correlated to either macroinvertebrates or midges, and therefore, would not be accurate predictors of the entire macroinvertebrate communities.
8. The Morisita similarity index values indicate that temporal variations are much greater than replicated or not truly replicated variations and the greatest species

variations occurred between spring and summer collections. The values also show that temporal variations and the fluctuation in species composition were the most gradual at station 3 and the least at stations 1 and 5.

9. Seasonal species occurrence and succession are evident throughout all the selected stations, including the control. Temporal and spatial variations and the presence of sewage, and chlorinated sewage all contributed to some degree of community structure changes.
10. The aquatic insect trophic relations were very similar for the entire study sites with predominant collectors, predators, scrapers, and filter feeders. The majority of benthos found at station 1 were collectors, predators, filter feeders, and detritivores. Increasing number of collectors and scrapers were found downstream four stations below the outfall, indicating the increase availability of fine particulate organic matter and attached algae and associated material.
11. Maximum degradation of stream quality occurred during the summer with regard to D.O. and acidity. Dissolved Oxygen values reached as low as  $1.42 \pm 0.47$  and  $1.13 \pm 0.50$  and acidity reached the maximum high of  $6.96 \pm 2.58$  and  $13.91 \pm 2.21$  at station 3 and 4, respectively. However, the water quality did not suppress the secondary production of the stream biota.
12. Generally, mayflies, stoneflies, and caddisflies seem more sensitive to chlorinated sewage than non-chlorinated sewage.
13. Oligochaetes are resistant to chlorinated sewage.
14. Midges exhibit a wide spectrum of tolerance to both chlorinated and non-chlorinated sewage. Their HBI does not always agree with the extent of the pollution.

15. Tabulation of community members with regard to their abundance is a more effective means of describing the whole spectrum of the community structure than simply the citation of numbers derived from a statistical summary.

### B. Recommendations

1. When using stones as a sampling unit (whether artificial or natural samples), the organisms can be brushed off the stone surface and sorted directly under the microscope at various magnifications. This sorting process provides good recovery of the macroinvertebrates present.
2. A year prior to the initiation of the experiment, a general census of abundance of stream biota is crucial in determining the number of baskets necessary to achieve the desired precision for the survey purpose.
3. Preferably, two reference stations with comparable environmental conditions should be selected to measure the normal structure variation of the macroinvertebrate community in an unstressed environment.
4. Depending on the objectives of the survey, at least three sites should be included - one immediately after the discharge, a second at the end, and a third in the middle.
5. All the sites should be physically similar with regard to depth, insolation, current, and stream substratum.
6. Baskets should be suspended at least two inches above river bed to avoid shifting sediment.



7. Substrates should be left in the stream for a period of 5.5 to 6 weeks to ensure that a large number of macroinvertebrates are colonized.
8. Two collections in each season are recommended to more clearly identify temporal variations.
9. A two-year survey at a minimum should be implemented to distinguish the effect of chlorinated sewage from non-chlorinated sewage on the macroinvertebrate community structure.
11. Microscopic sorting is recommended whenever possible as opposed to sugar flotation and 1.7x magnifier sort.
12. The use of individual stones as sampling units provides density estimates with statistical significance. More stones (1-26) are required to obtain reliable diversity values. To construct confidence intervals for the diversity, the stones can be pooled or a "bootstrap sample" can be generated.
13. If funding, labor, and expertise are available, the assessment of the whole macroinvertebrate community is the most accurate means of describing a given ecosystem. When such an opportunity is not available, a quick survey of EPT and macroinvertebrate families provides indication of some structural changes in the macroinvertebrate community.
14. Brillouin's diversity is not appropriate in collections with considerable variations in sample size, Hurlbert's diversity is recommended in such instance.
15. Hurlbert's diversity should be used in conjunction with other community parameters such as species richness, density, EPT, and hierarchical diversity to describe a more defined community structure.

16. Sokal's Euclidean distance is also strongly affected by the sample size. This index should be used only if one considers sample size as a very important community characteristic.

## APPENDICES

APPENDIX A  
BENTHIC MACROINVERTEBRATES DATA

1. Benthic macroinvertebrate species associated with chlorinated or non-chlorinated sewage, collected by basket-type artificial substrates from Lampson Brook.

Benthic macroinvertebrate species associated with chlorinated or non-chlorinated sewage, collected by basket-type artificial substrates from Lampson Brook. Indicated as +++ , abundant (>9); ++, common (3-9); +, rare (<3); or -, absent. October 17, 1988 collections not included.

| STATION<br>TAXA                                      | NON-CHLORINATED SEWAGE |     |     |     |   | CHLORINATED SEWAGE |     |     |     |     |
|--|------------------------|-----|-----|-----|---|--------------------|-----|-----|-----|-----|
|  | 1                      | 2   | 3   | 4   | 5 | 1                  | 2   | 3   | 4   | 5   |
| PHYLUM ARTHROPODA                                    |                        |     |     |     |   |                    |     |     |     |     |
| Class Insecta  |                        |     |     |     |   |                    |     |     |     |     |
| Order Diptera  |                        |     |     |     |   |                    |     |     |     |     |
| Family Chironomidae                                  |                        |     |     |     |   |                    |     |     |     |     |
| subfamily Tanypodinae                                |                        |     |     |     |   |                    |     |     |     |     |
| Genus <i>Ablabesmyia</i> Johannsen, 1905             |                        |     |     |     |   |                    |     |     |     |     |
| <i>Ablabesmyia</i> sp.                               | -                      | -   | -   | -   | - | -                  | -   | -   | -   | ++  |
| <i>Ablabesmyia annulata</i> Say, 1823                | -                      | -   | -   | -   | - | +                  | -   | +   | -   | -   |
| <i>Ablabesmyia mallochi</i> Walley, 1925             | -                      | -   | -   | -   | - | -                  | -   | -   | -   | ++  |
| <i>Ablabesmyia tarella</i> Roback, 1971              | -                      | -   | -   | -   | - | -                  | -   | -   | -   | +   |
| <i>Ablabesmyia parajanta</i> Roback, 1971            | -                      | -   | -   | -   | - | -                  | -   | -   | -   | +   |
| <i>Ablabesmyia philosphagnos</i> Beck and Beck, 1926 | -                      | -   | -   | -   | - | -                  | -   | -   | -   | +   |
| Genus <i>Conchapelopia</i> Fittkau, 1913             |                        |     |     |     |   |                    |     |     |     |     |
| <i>Conchapelopia</i> sp.                             | +++                    | +++ | +++ | +++ | + | +++                | +++ | +++ | +++ | +++ |
| Genus <i>Hudsonimyia</i> Roback, 1979                |                        |     |     |     |   |                    |     |     |     |     |
| <i>Hudsonimyia</i> sp.                               | +                      | ++  | +   | -   | + | -                  | +   | -   | -   | +   |
| Genus <i>Labrundinia</i> Fittkau, 1962               |                        |     |     |     |   |                    |     |     |     |     |
| <i>Labrundinia neopilosella</i> var. 3               | -                      | -   | -   | -   | - | -                  | -   | -   | -   | +   |
| <i>Labrundinia pilosella</i> Loew, 1866              | -                      | -   | -   | -   | - | +                  | -   | -   | -   | ++  |
| <i>Labrundinia becki</i>                             | -                      | -   | -   | -   | - | +                  | -   | -   | -   | -   |
| Genus <i>Larsia</i> Fittkau, 1962                    |                        |     |     |     |   |                    |     |     |     |     |
| <i>Larsia</i> sp.                                    | -                      | -   | +   | -   | - | -                  | ++  | -   | -   | -   |
| Genus <i>Meropelopia</i> Roback, 1970                |                        |     |     |     |   |                    |     |     |     |     |
| <i>Meropelopia flavifrons</i> Johannsen, 1905        | -                      | ++  | ++  | -   | - | +                  | ++  | ++  | +   | -   |

| STATION<br>TAXA                                       | NON-CHLORINATED SEWAGE |     |     |     |    | CHLORINATED SEWAGE |     |    |    |     |
|---|------------------------|-----|-----|-----|----|--------------------|-----|----|----|-----|
|   | 1                      | 2   | 3   | 4   | 5  | 1                  | 2   | 3  | 4  | 5   |
| Genus <i>Natarsia</i> Fittkau, 1962                   | -                      | -   | -   | -   | -  | -                  | +   | -  | -  | -   |
| <i>Natarsia</i> sp.                                   | -                      | -   | -   | -   | -  | -                  | +   | -  | -  | -   |
| Genus <i>Paramerina</i> Fittkau, 1962                 | -                      | -   | ++  | +   | -  | ++                 | -   | +  | -  | -   |
| <i>Paramerina</i> sp.                                 | -                      | -   | ++  | +   | -  | ++                 | -   | +  | -  | -   |
| Genus <i>Procladius</i> Skuse, 1889                   | -                      | -   | -   | -   | -  | -                  | +   | -  | -  | -   |
| <i>Procladius</i> sp.                                 | -                      | -   | -   | -   | -  | -                  | +   | -  | -  | -   |
| Genus <i>Psectrotanypus</i> Kieffer, 1909             | -                      | -   | -   | -   | -  | -                  | +++ | -  | -  | -   |
| <i>Psectrotanypus dyari</i> Coquillett, 1902          | -                      | -   | -   | -   | -  | -                  | +++ | -  | -  | -   |
| <i>Psectrotanypus</i> nr. <i>dyari</i>                | -                      | -   | -   | -   | -  | +                  | +++ | -  | -  | -   |
| Genus <i>Rheopelopia</i> Fittkau, 1962                | +                      | +   | -   | -   | -  | +                  | -   | -  | -  | -   |
| <i>Rheopelopia acra/perda</i> Roback, 1971            | +                      | +   | -   | -   | -  | +                  | -   | -  | -  | -   |
| Genus <i>Thienemanniella</i> Fittkau, 1957            | -                      | -   | +++ | +++ | ++ | -                  | -   | ++ | ++ | ++  |
| <i>Thienemanniella</i> prob. <i>xena</i> Roback, 1957 | -                      | -   | +++ | +++ | ++ | -                  | -   | ++ | ++ | ++  |
| <i>Thienemanniella</i> sp.1                           | ++                     | -   | +++ | +++ | +  | -                  | -   | -  | +  | -   |
| <i>Thienemanniella</i> sp.2                           | -                      | -   | -   | -   | -  | -                  | -   | -  | -  | +++ |
| Genus <i>Trissopelopia</i> Kieffer, 1923              | +                      | +++ | -   | -   | -  | +                  | ++  | +  | -  | -   |
| <i>Trissopelopia ogemawi</i> Roback, 1971             | +                      | +++ | -   | -   | -  | +                  | ++  | +  | -  | -   |
| Genus <i>Zavrelimyia</i> Fittkau, 1962                | -                      | +   | -   | -   | -  | +++                | ++  | +  | -  | +   |
| <i>Zavrelimyia</i> sp.1                               | -                      | +   | -   | -   | -  | +++                | ++  | +  | -  | +   |
| <i>Zavrelimyia</i> sp.2                               | -                      | -   | -   | -   | -  | +++                | ++  | +  | -  | ++  |
| <i>Zavrelimyia</i> sp.3                               | -                      | -   | -   | -   | -  | +++                | ++  | +  | -  | ++  |
| subfamily Orthoclaadiinae                             |                        |     |     |     |    |                    |     |    |    |     |
| Genus <i>Brillia</i> Kieffer, 1913                    |                        |     |     |     |    |                    |     |    |    |     |
| <i>Brillia flavifrons</i> Johannsen, 1905             | +                      | -   | -   | -   | +  | +                  | +   | -  | -  | -   |
| <i>Brillia parva</i> Johannsen, 1934                  |                        |     |     |     |    |                    |     |    |    |     |
| Genus <i>Corynoneura</i> Winnertz, 1846               |                        |     |     |     |    |                    |     |    |    |     |
| <i>Corynoneura taris</i> Roback, 1957                 | +                      | ++  | -   | +   | ++ | +++                | +   | +  | +  | ++  |

STATION TAXA

|   | NON-CHLORINATED SEWAGE |     |     |     |     | CHLORINATED SEWAGE |     |     |    |     |
|---|------------------------|-----|-----|-----|-----|--------------------|-----|-----|----|-----|
|   | 1                      | 2   | 3   | 4   | 5   | 1                  | 2   | 3   | 4  | 5   |
| Genus <i>Cricotopus</i> Wulp, 1814                              |                        |     |     |     |     |                    |     |     |    |     |
| <i>Cricotopus bicinctus</i> group                               | -                      | -   | -   | +   | -   | -                  | -   | +   | +  | ++  |
| <i>Cricotopus sylvestris</i> group                              | -                      | ++  | -   | -   | -   | -                  | ++  | -   | -  | -   |
| <i>Cricotopus tremulus</i> group                                | +                      | ++  | -   | ++  | +++ | +                  | -   | -   | -  | ++  |
| Genus <i>Diplocladius</i> Kieffer, 1908                         |                        |     |     |     |     |                    |     |     |    |     |
| <i>Diplocladius</i> sp.   | +++                    | +++ | +++ | +++ | +++ | +                  | +++ | +++ | ++ | +++ |
| Genus <i>Eukiefferiella</i> Thienemann, 1926                    |                        |     |     |     |     |                    |     |     |    |     |
| <i>Eukiefferiella bavarica</i> group                            | -                      | +   | -   | -   | -   | -                  | -   | -   | -  | -   |
| <i>Eukiefferiella brevicolar</i> group                          | -                      | -   | -   | -   | +   | -                  | -   | -   | -  | -   |
| <i>Eukiefferiella claripennis</i> group                         | -                      | -   | -   | -   | +   | -                  | -   | -   | -  | -   |
| <i>Eukiefferiella pseudomotana</i> group                        | -                      | -   | -   | -   | +   | -                  | -   | -   | -  | -   |
| Genus <i>Heterotrissocladius</i> Spärek, 1923                   |                        |     |     |     |     |                    |     |     |    |     |
| <i>Heterotrissocladius marcidus</i> group poss. <i>marcidus</i> | -                      | ++  | -   | -   | -   | +                  | +   | +   | -  | -   |
| Genus <i>Hydrobaenus</i> Sæther, 1977                           |                        |     |     |     |     |                    |     |     |    |     |
| <i>Hydrobaenus pilipes</i> Malloch, 1915                        | -                      | +   | +   | ++  | ++  | +                  | +   | ++  | ++ | ++  |
| Genus <i>Nanocladius</i> Kieffer, 1913                          |                        |     |     |     |     |                    |     |     |    |     |
| <i>Nanocladius</i> sp.1   | +                      | +   | ++  | +++ | +   | ++                 | +   | ++  | ++ | ++  |
| <i>Nanocladius</i> sp.2   | +                      | ++  | +++ | +++ | -   | ++                 | +   | +++ | ++ | ++  |
| <i>Nanocladius spiniplenus</i> saether, 1977                    | +                      | ++  | +   | -   | -   | -                  | +   | -   | -  | -   |
| Genus <i>Orthocladius</i> Wulp, 1874                            |                        |     |     |     |     |                    |     |     |    |     |
| <i>Orthocladius</i> sp.   | -                      | -   | ++  | ++  | -   | -                  | -   | -   | -  | -   |
| <i>Orthocladius carlatus</i> group                              | +                      | +   | ++  | ++  | +++ | +                  | +   | -   | +  | +   |
| <i>Orthocladius obumbratus</i> group                            | -                      | +   | -   | +   | -   | -                  | -   | -   | -  | -   |
| <i>Orthocladius oliveri</i> Soptonis, 1977                      | +                      | -   | +++ | +++ | -   | -                  | -   | -   | ++ | -   |
| Genus <i>Parakiefferiella</i> Thienemann, 1936                  |                        |     |     |     |     |                    |     |     |    |     |
| <i>Parakiefferiella</i> sp.                                     | ++                     | +++ | +++ | ++  | +++ | ++                 | -   | -   | -  | -   |
| Genus <i>Parametriocnemus</i> Goetghebuer, 1932                 |                        |     |     |     |     |                    |     |     |    |     |
| <i>Parametriocnemus lundbecki</i> Johannsen, 1905               | +++                    | +++ | +++ | ++  | +   | +++                | +++ | ++  | ++ | +   |



| STATION<br>TAXA   | NON-CHLORINATED SEWAGE |    |   |   |   | CHLORINATED SEWAGE |     |   |   |     |
|---|------------------------|----|---|---|---|--------------------|-----|---|---|-----|
|   | 1                      | 2  | 3 | 4 | 5 | 1                  | 2   | 3 | 4 | 5   |
| Genus <i>Paraphaenocladus</i> Thienemann, 1924            |                        |    |   |   |   |                    |     |   |   |     |
| <i>Paraphaenocladus</i> sp.1                              | +                      | ++ | - | - | - | -                  | -   | - | - | -   |
| <i>Paraphaenocladus</i> sp.2                              | -                      | -  | + | + | - | -                  | +   | - | - | +   |
| Genus <i>Pseudoorthocladus</i> Goetghebuer, 1932          |                        |    |   |   |   |                    |     |   |   |     |
| <i>Pseudoorthocladus</i> sp.                              | -                      | +  | - | - | - | -                  | -   | - | - | -   |
| Genus <i>Psilonetrioctenus</i> Sæther, 1969               |                        |    |   |   |   |                    |     |   |   |     |
| <i>Psilonetrioctenus</i> sp.                              | -                      | -  | - | - | - | +                  | -   | - | - | -   |
| Genus <i>Rheocricotopus</i> Thienemann and Harnisch, 1932 |                        |    |   |   |   |                    |     |   |   |     |
| <i>Rheocricotopus fuscipes</i> group                      | -                      | +  | + | - | - | -                  | -   | + | - | +   |
| Genus <i>Tvetenia</i> Kieffer, 1922                       |                        |    |   |   |   |                    |     |   |   |     |
| <i>Tvetenia bavarica</i> group                            | -                      | -  | + | - | - | -                  | -   | - | - | -   |
| subfamily Chironominae                                    |                        |    |   |   |   |                    |     |   |   |     |
| Tribe Chironomini   |                        |    |   |   |   |                    |     |   |   |     |
| Genus <i>Chironomus</i> Meigen, 1803                      |                        |    |   |   |   |                    |     |   |   |     |
| <i>Chironomus</i> sp.                                     | -                      | -  | - | - | - | ++                 | +++ | - | + | -   |
| Genus <i>Cryptochironomus</i> Kieffer, 1918               |                        |    |   |   |   |                    |     |   |   |     |
| <i>Cryptochironomus fulvus</i> Johannsen, 1905            | -                      | -  | - | - | - | -                  | ++  | + | - | -   |
| Genus <i>Dicrotendipes</i> Kieffer, 1913                  |                        |    |   |   |   |                    |     |   |   |     |
| <i>Dicrotendipes neomodestus</i> Malloch, 1915            | -                      | +  | - | - | + | -                  | ++  | - | - | ++  |
| Genus <i>Endochironomus</i> Kieffer, 1918                 |                        |    |   |   |   |                    |     |   |   |     |
| <i>Endochironomus nigricans</i> Johannsen, 1905           | -                      | -  | - | - | - | -                  | +++ | - | - | -   |
| Genus <i>Glyptotendipes</i> Kieffer, 1913                 |                        |    |   |   |   |                    |     |   |   |     |
| <i>Glyptotendipes lobiferus</i> Say, 1823                 | -                      | -  | - | - | - | -                  | ++  | - | - | -   |
| Genus <i>Kiefferulus</i> Goetghebuer, 1922                |                        |    |   |   |   |                    |     |   |   |     |
| <i>Kiefferulus</i> sp.                                    | -                      | -  | - | - | - | -                  | ++  | - | - | -   |
| Genus <i>Microtendipes</i> Kieffer, 1915                  |                        |    |   |   |   |                    |     |   |   |     |
| <i>Microtendipes caelum</i> Townes, 1945                  | +                      | +  | + | - | - | +++                | ++  | + | + | +++ |
| <i>Microtendipes rydalsensis</i> group                    | -                      | -  | - | - | - | -                  | -   | + | - | +++ |

| STATION<br>TAXA                                    | NON-CHLORINATED SEWAGE |     |     |     |     | CHLORINATED SEWAGE |     |     |     |     |
|--|------------------------|-----|-----|-----|-----|--------------------|-----|-----|-----|-----|
|  | 1                      | 2   | 3   | 4   | 5   | 1                  | 2   | 3   | 4   | 5   |
| Genus <i>Parachironomus</i> Lenz, 1921             | -                      | ++  | -   | -   | -   | -                  | -   | -   | -   | ++  |
| <i>Parachironomus arcuatus</i> group               | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | -   |
| Genus <i>Paratendipes</i> Kieffer, 1911            | -                      | -   | -   | -   | -   | +                  | +++ | -   | -   | -   |
| <i>Paratendipes</i> sp.                            | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | -   |
| Genus <i>Phaenopsectra</i> Kieffer, 1921           | -                      | -   | -   | -   | -   | -                  | +   | -   | -   | +   |
| <i>Phaenopsectra</i> sp.                           | +                      | -   | +   | -   | -   | -                  | ++  | -   | -   | -   |
| <i>Phaenopsectra flavipes</i> Meigen, 1818         | -                      | ++  | -   | -   | -   | -                  | ++  | -   | -   | +   |
| Genus <i>Polypedium</i> Kieffer, 1913              | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | -   |
| <i>Polypedium aviceps</i> Townes, 1945             | -                      | -   | -   | -   | -   | -                  | +   | -   | -   | -   |
| <i>Polypedium convictum</i> Walker, 1856           | -                      | -   | -   | -   | -   | -                  | -   | +++ | -   | -   |
| <i>Polypedium fallax</i> group                     | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | -   |
| <i>Polypedium laetum</i> Meigen, 1818              | -                      | +   | -   | -   | -   | +                  | +++ | -   | -   | -   |
| <i>Polypedium illinoense</i> Malloch, 1915         | -                      | +   | ++  | +   | -   | +                  | +++ | ++  | +   | -   |
| <i>Polypedium scalaenum</i> Schrank, 1803          | -                      | ++  | -   | -   | -   | +++                | +++ | +++ | -   | +   |
| Genus <i>Robackia</i> Saether, 1977                | -                      | +   | -   | -   | -   | -                  | -   | -   | -   | -   |
| <i>Robackia</i> sp.                                | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | -   |
| Genus <i>Saetheria</i> Jackson, 1977               | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | +   |
| <i>Saetheria</i> sp.                               | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | -   |
| Genus <i>Tribelos</i> Townes, 1945                 | -                      | -   | -   | -   | -   | ++                 | +++ | +   | -   | +   |
| <i>Tribelos</i> poss. <i>jucundum</i> Walker, 1848 | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | -   |
| <i>Tribelos</i> sp.1                               | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | -   |
| Tribe tanytarsini                                  | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | -   |
| Genus <i>Cladotanytarsus</i> Kieffer, 1922         | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | -   |
| <i>Cladotanytarsus</i> sp.                         | -                      | -   | -   | -   | -   | -                  | -   | -   | -   | -   |
| Genus <i>Micropsectra</i> Kieffer, 1909            | +++                    | +++ | +++ | +++ | +++ | +++                | +++ | +++ | +++ | +++ |
| <i>Micropsectra</i> sp.                            | +++                    | +++ | +++ | +++ | +++ | +++                | +++ | +++ | +++ | +++ |

| STATION<br>TAXA                                   | NON-CHLORINATED SEWAGE |     |     |     |    | CHLORINATED SEWAGE |     |     |     |     |
|---|------------------------|-----|-----|-----|----|--------------------|-----|-----|-----|-----|
|   | 1                      | 2   | 3   | 4   | 5  | 1                  | 2   | 3   | 4   | 5   |
| Genus <i>Paratanytarsus</i> Bause, 1913           |                        |     |     |     |    |                    |     |     |     |     |
| <i>Paratanytarsus sp.1</i>                        | -                      | -   | +   | +   | -  | -                  | +   | +   | -   | +   |
| <i>Paratanytarsus sp.2</i>                        | +                      | -   | +++ | +++ | ++ | -                  | +++ | +++ | +++ | +++ |
| <i>Paratanytarsus sp.3</i>                        | -                      | -   | ++  | ++  | -  | -                  | +++ | ++  | +   | ++  |
| Genus <i>Rheotanytarsus</i> Bause, 1913           |                        |     |     |     |    |                    |     |     |     |     |
| <i>Rheotanytarsus distinctissimus</i> group       | +                      | +   | ++  | -   | -  | -                  | -   | +   | -   | ++  |
| <i>Rheotanytarsus exiguus</i> group               | ++                     | ++  | +++ | ++  | +  | ++                 | ++  | +++ | +++ | +   |
| Genus <i>Tanytarsus</i> Wulp, 1874                |                        |     |     |     |    |                    |     |     |     |     |
| <i>Tanytarsus sp.</i>                             | -                      | +++ | ++  | -   | ++ | +++                | +++ | ++  | -   | +++ |
| Genus <i>Diamesa</i> Waltl, 1837                  |                        |     |     |     |    |                    |     |     |     |     |
| <i>Diamesa sp.</i>                                |                        |     |     |     |    |                    |     |     |     |     |
| Genus <i>Sympothastia</i> Pagast, 1947            |                        |     |     |     |    |                    |     |     |     |     |
| <i>Sympothastia sp.</i>                           | -                      | -   | -   | +   | -  | -                  | -   | -   | -   | -   |
| Family Simuliidae                                 |                        |     |     |     |    |                    |     |     |     |     |
| Genus <i>Prosimulium</i> Roubaud, 1906            |                        |     |     |     |    |                    |     |     |     |     |
| <i>Prosimulium sp.</i>                            | -                      | -   | ++  | -   | -  | -                  | +   | +   | -   | +   |
| Genus <i>Stegopterna</i> Malloch, 1914            |                        |     |     |     |    |                    |     |     |     |     |
| <i>Stegopterna mutata complex</i>                 | -                      | +   | +++ | -   | ++ | -                  | -   | ++  | -   | ++  |
| Merritt, Ross, and Peterson, 1978                 |                        |     |     |     |    |                    |     |     |     |     |
| Genus <i>Simulium</i> Latreille, 1802             |                        |     |     |     |    |                    |     |     |     |     |
| <i>Simulium tuberosum complex</i> Lundstrom, 1911 | -                      | -   | -   | -   | -  | -                  | -   | +   | -   | -   |
| <i>Simulium vittatum complex</i> Say, 1823        | -                      | -   | ++  | +   | -  | -                  | -   | +++ | -   | -   |
| Family Tipulidae                                  |                        |     |     |     |    |                    |     |     |     |     |
| Genus <i>Hexatoma</i> Latreille, 1809             |                        |     |     |     |    |                    |     |     |     |     |
| <i>Hexatoma sp.</i>                               | -                      | +   | -   | -   | -  | -                  | +   | -   | -   | -   |
| Genus <i>Tipula</i> Linnaeus, 1758                |                        |     |     |     |    |                    |     |     |     |     |
| <i>Tipula sp.</i>                                 | -                      | +   | -   | -   | -  | -                  | -   | -   | -   | -   |

| STATION<br>TAXA                                 | NON-CHLORINATED SEWAGE |    |   |   |   | CHLORINATED SEWAGE |    |   |   |     |
|---|------------------------|----|---|---|---|--------------------|----|---|---|-----|
|   | 1                      | 2  | 3 | 4 | 5 | 1                  | 2  | 3 | 4 | 5   |
| Family Ceratopogonidae                          | -                      | ++ | - | - | - | -                  | +  | - | + | +   |
| Family Chaoboridae                              |                        |    |   |   |   |                    |    |   |   |     |
| Genus <i>Chaoborus</i> Lichtenstein, 1800       |                        |    |   |   |   |                    |    |   |   |     |
| <i>Chaoborus</i> sp.                            | +                      | -  | - | - | - | -                  | -  | - | - | -   |
| Family Empididae                                |                        |    |   |   |   |                    |    |   |   |     |
| Genus <i>Hemerodromia</i> Meigen, 1803          |                        |    |   |   |   |                    |    |   |   |     |
| <i>Hemerodromia</i> sp.                         | -                      | -  | + | - | - | +                  | ++ | - | - | -   |
| Family Psychodidae                              |                        |    |   |   |   |                    |    |   |   |     |
| Genus <i>Telmatoscopus</i> Eaton, 1904          |                        |    |   |   |   |                    |    |   |   |     |
| <i>Telmatoscopus</i> sp.                        | -                      | -  | - | - | - | +                  | -  | - | - | -   |
| Order Ephemeroptera                             |                        |    |   |   |   |                    |    |   |   |     |
| Family Baetidae                                 |                        |    |   |   |   |                    |    |   |   |     |
| Genus <i>Baetis</i> Leach, 1815                 |                        |    |   |   |   |                    |    |   |   |     |
| <i>Baetis brunneicolor</i> McDunnough, 1925     | +                      | ++ | - | - | - | -                  | -  | - | - | -   |
| Family Ephemerellidae                           |                        |    |   |   |   |                    |    |   |   |     |
| Genus <i>Ephemerella</i> Walsh, 1862            | +                      | -  | - | - | + | +++                | -  | + | - | +++ |
| <i>Ephemerella excrucians</i> Walsh, 1862       | ++                     | +  | - | - | - | -                  | -  | - | - | -   |
| <i>Ephemerella invaria</i> Walker, 1853         | ++                     | +  | - | - | - | -                  | -  | - | - | -   |
| Genus <i>Eurylophella</i> Tiensuu, 1935         |                        |    |   |   |   |                    |    |   |   |     |
| <i>Eurylophella</i> sp.                         | -                      | -  | - | - | - | -                  | -  | - | - | +   |
| <i>Eurylophella bicolor</i> Clemens, 1913       | +                      | +  | - | - | - | +                  | -  | - | - | -   |
| <i>Eurylophella funeralis</i> McDunnough, 1925  | +                      | ++ | - | - | - | +                  | -  | - | - | -   |
| <i>Eurylophella temporalis</i> McDunnough, 1924 | -                      | -  | - | - | - | -                  | +  | - | - | -   |
| Genus <i>Serratella</i> Edmunds, 1959           |                        |    |   |   |   |                    |    |   |   |     |
| <i>Serratella deficiens</i> Morgan, 1911        | ++                     | -  | - | - | - | ++                 | -  | - | - | -   |
| Family Oligoneuridae                            |                        |    |   |   |   |                    |    |   |   |     |
| Genus <i>Isonychia</i> Eaton, 1871              |                        |    |   |   |   |                    |    |   |   |     |
| <i>Isonychia</i> sp.                            | -                      | -  | - | - | + | -                  | -  | - | - | -   |

| STATION<br>TAXA   | NON-CHLORINATED SEWAGE |     |   |    |     | CHLORINATED SEWAGE |   |     |   |     |
|---|------------------------|-----|---|----|-----|--------------------|---|-----|---|-----|
|   | 1                      | 2   | 3 | 4  | 5   | 1                  | 2 | 3   | 4 | 5   |
| Family Leptophlebiidae  |                        |     |   |    |     |                    |   |     |   |     |
| Genus <i>Leptophlebia</i> Westwood, 1840                          |                        |     |   |    |     |                    |   |     |   |     |
| <i>Leptophlebia</i> sp.   | +                      | +++ | - | ++ | -   | +                  | - | -   | - | -   |
| Genus <i>Paraleptophlebia</i> Lestage, 1917                       |                        |     |   |    |     |                    |   |     |   |     |
| <i>Paraleptophlebia</i> sp.                                       | ++                     | ++  | - | +  | -   | +++                | + | +++ | - | +++ |
| Family Heptageniidae  |                        |     |   |    |     |                    |   |     |   |     |
| Genus <i>Stenonema</i> Traver, 1933                               |                        |     |   |    |     |                    |   |     |   |     |
| <i>Stenonema modestum</i> Banks, 1910                             | ++                     | ++  | - | +  | -   | ++                 | - | -   | - | +   |
| Order Plecoptera  |                        |     |   |    |     |                    |   |     |   |     |
| <i>Agneta capitata</i>  | +                      | -   | - | -  | ++  | +                  | - | -   | - | -   |
| Family Perlidae   |                        |     |   |    |     |                    |   |     |   |     |
| Genus <i>Eccoptura</i> Kalpálek, 1921                             |                        |     |   |    |     |                    |   |     |   |     |
| <i>Eccoptura xanathenes</i> Newman, 1828                          |                        |     |   |    |     |                    |   |     |   |     |
| Genus <i>Perlinella</i> Banks, 1900                               |                        |     |   |    |     |                    |   |     |   |     |
| <i>Perlinella ephyre/fumipennis</i><br>(Newman, 1839/Walsh, 1862) | -                      | -   | - | -  | -   | +                  | - | -   | - | -   |
| Family Perlodidae   |                        |     |   |    |     |                    |   |     |   |     |
| Genus <i>Isoperla</i> Banks, 1906                                 |                        |     |   |    |     |                    |   |     |   |     |
| <i>Isoperla lata</i> Banks, 1906                                  | -                      | +   | - | -  | -   | -                  | - | -   | - | -   |
| <i>Isoperla marlynia</i> Needham and Claassen, 1925               | +++                    | +   | + | -  | -   | +                  | - | -   | - | -   |
| Family Nemouridae   |                        |     |   |    |     |                    |   |     |   |     |
| Genus <i>Ostrocer</i> Ricker, 1952                                |                        |     |   |    |     |                    |   |     |   |     |
| <i>Ostrocer</i> sp.   | -                      | -   | - | -  | +   | -                  | - | -   | - | -   |
| Genus <i>Podmosta</i> Ricker, 1952                                |                        |     |   |    |     |                    |   |     |   |     |
| <i>Podmosta</i> sp.   | -                      | -   | - | -  | +   | -                  | - | -   | - | -   |
| Family Capniidae  |                        |     |   |    |     |                    |   |     |   |     |
| Genus <i>Paracapnia</i> Hanson, 1946                              |                        |     |   |    |     |                    |   |     |   |     |
| <i>Paracapnia opis</i> Newport, 1839                              | +++                    | ++  | - | ++ | +++ | +++                | - | -   | - | +++ |

| STATION<br>TAXA                                 | NON-CHLORINATED SEWAGE |    |   |   |     | CHLORINATED SEWAGE |   |     |   |     |
|---|------------------------|----|---|---|-----|--------------------|---|-----|---|-----|
|   | 1                      | 2  | 3 | 4 | 5   | 1                  | 2 | 3   | 4 | 5   |
| Family Taeniopterygidae                         |                        |    |   |   |     |                    |   |     |   |     |
| Genus <i>Taeniopteryx</i> Pictet, 1841          |                        |    |   |   |     |                    |   |     |   |     |
| <i>Taeniopteryx</i> sp.                         | -                      | -  | - | - | -   | -                  | - | -   | - | ++  |
| <i>Taeniopteryx maura</i> Pictet, 1841          | ++                     | ++ | - | - | +++ | -                  | - | -   | - | -   |
| <i>Taeniopteryx parvula</i> Banks, 1918         | -                      | ++ | - | - | -   | -                  | - | -   | - | -   |
| Family Peltoperlidae                            |                        |    |   |   |     |                    |   |     |   |     |
| Genus <i>Tallaperla</i> Stark and Stewart, 1981 |                        |    |   |   |     |                    |   |     |   |     |
| <i>Tallaperla maria</i> Needham and Smith, 1916 | +                      | -  | - | - | -   | -                  | - | -   | - | +   |
| Order Tricoptera                                |                        |    |   |   |     |                    |   |     |   |     |
| Family Limnephilidae                            |                        |    |   |   |     |                    |   |     |   |     |
| Genus <i>Anobolia</i> Stephens, 1837            | -                      | -  | - | - | -   | ++                 | - | -   | - | +++ |
| <i>Anobolia</i> sp.                             |                        |    |   |   |     |                    |   |     |   |     |
| Genus <i>Hydatophylax</i> Wallengren, 1891      | +                      | -  | - | - | -   | -                  | - | -   | - | -   |
| <i>Hydatophylax</i> sp.                         | +                      | +  | - | - | +   | ++                 | + | -   | - | +   |
| Genus <i>Neophylax</i> MacLachlan, 1871         |                        |    |   |   |     |                    |   |     |   |     |
| <i>Neophylax</i> sp.                            | ++                     | -  | - | - | +++ | -                  | - | -   | - | -   |
| Genus <i>Platycentropus</i> Ulmer, 1905         |                        |    |   |   |     |                    |   |     |   |     |
| <i>Platycentropus</i> sp.                       | -                      | -  | + | - | -   | -                  | - | -   | - | -   |
| Genus <i>Pycnopsyche</i> Banks, 1905            |                        |    |   |   |     |                    |   |     |   |     |
| <i>Pycnopsyche</i> sp.                          | -                      | +  | + | - | -   | ++                 | - | -   | - | -   |
| Family Polycentropodidae                        |                        |    |   |   |     |                    |   |     |   |     |
| Genus <i>Cernotina</i> Ross, 1938               | -                      | -  | - | - | -   | -                  | - | +   | - | -   |
| <i>Cernotina</i> sp.                            |                        |    |   |   |     |                    |   |     |   |     |
| Family Hydorpsychidae                           |                        |    |   |   |     |                    |   |     |   |     |
| Genus <i>Cheumatopsyche</i> Wallengren, 1891    |                        |    |   |   |     |                    |   |     |   |     |
| <i>Cheumatopsyche</i> sp.                       | ++                     | ++ | - | + | +   | ++                 | - | +++ | + | -   |

| STATION<br>TAXA                           | NON-CHLORINATED SEWAGE |    |   |   |    | CHLORINATED SEWAGE |   |    |   |    |
|---|------------------------|----|---|---|----|--------------------|---|----|---|----|
|   | 1                      | 2  | 3 | 4 | 5  | 1                  | 2 | 3  | 4 | 5  |
| Genus <i>Hydropsyche</i> Pictet, 1834     |                        |    |   |   |    |                    |   |    |   |    |
| <i>Hydropsyche</i> sp.1                   | ++                     | +  | + | - | -  | -                  | - | -  | + | -  |
| <i>Hydropsyche</i> sp.2                   |                        |    |   |   |    |                    |   |    |   |    |
| Family Philopotamidae                     |                        |    |   |   |    |                    |   |    |   |    |
| Genus <i>Chimarra</i> Stephens, 1829      |                        |    |   |   |    |                    |   |    |   |    |
| <i>Chimarra</i> sp.                       | -                      | -  | - | - | -  | -                  | - | -  | - | +  |
| Family Glossosomatidae                    |                        |    |   |   |    |                    |   |    |   |    |
| Genus <i>Glossosoma</i> Curtis, 1829      |                        |    |   |   |    |                    |   |    |   |    |
| <i>Glossosoma</i> sp.                     | -                      | +  | - | - | -  | -                  | - | -  | - | -  |
| Family Lepidostomatidae                   |                        |    |   |   |    |                    |   |    |   |    |
| Genus <i>Lepidostoma</i> Rambur, 1842     |                        |    |   |   |    |                    |   |    |   |    |
| <i>Lepidostoma</i> sp.                    | -                      | +  | - | - | -  | -                  | - | -  | - | -  |
| Family Hydroptilidae                      |                        |    |   |   |    |                    |   |    |   |    |
| Genus <i>Ptilostomis</i> Kolenati, 1859   |                        |    |   |   |    |                    |   |    |   |    |
| <i>Ptilostomis</i> sp.                    | -                      | -  | + | + | -  | -                  | - | -  | - | -  |
| Order Odonata                             |                        |    |   |   |    |                    |   |    |   |    |
| Family Aeshnidae                          |                        |    |   |   |    |                    |   |    |   |    |
| Genus <i>Aeshna</i> Fabricius, 1775       |                        |    |   |   |    |                    |   |    |   |    |
| <i>Aeshna</i> sp.                         | -                      | -  | + | - | -  | -                  | - | -  | - | -  |
| Genus <i>Boyeria</i> McLachlan, 1896      |                        |    |   |   |    |                    |   |    |   |    |
| <i>Boyeria</i> <i>vinosa</i> . Say, 1839  | +                      | -  | - | - | -  | +                  | - | -  | - | -  |
| Family Calopterygidae                     |                        |    |   |   |    |                    |   |    |   |    |
| Genus <i>Calopteryx</i> Leach, 1815       |                        |    |   |   |    |                    |   |    |   |    |
| <i>Calopteryx maculata</i> Beauvois, 1805 | +                      | ++ | - | - | ++ | -                  | + | -  | - | ++ |
| Family Coenagrionidae                     |                        |    |   |   |    |                    |   |    |   |    |
| Genus <i>Coenagrion</i> Kirby, 1890       |                        |    |   |   |    |                    |   |    |   |    |
| <i>Coenagrion</i> sp.                     | -                      | -  | - | + | -  | -                  | - | ++ | - | -  |

| STATION<br>TAXA                                 | NON-CHLORINATED SEWAGE |   |   |   |   | CHLORINATED SEWAGE |    |   |   |   |
|---|------------------------|---|---|---|---|--------------------|----|---|---|---|
|   | 1                      | 2 | 3 | 4 | 5 | 1                  | 2  | 3 | 4 | 5 |
| Genus <i>Hataerina</i> Hagen, 1854              |                        |   |   |   |   |                    |    |   |   |   |
| <i>Hataerina</i> sp.                            | -                      | - | - | - | - | +                  | -  | - | - | - |
| Order Coleoptera                                | -                      | - | + | - | - | -                  | -  | - | - | - |
| Family Ptilodactylidae                          |                        |   |   |   |   |                    |    |   |   |   |
| Genus <i>Anchytarsus</i> Guérin-Méneville, 1843 |                        |   |   |   |   |                    |    |   |   |   |
| <i>Anchytarsus bicolor</i> Melsheimer, 1846     | -                      | - | - | - | - | -                  | +  | - | - | - |
| Family Dytiscidae                               |                        |   |   |   |   |                    |    |   |   |   |
| Genus <i>Dytiscus</i> Linnaeus, 1758            |                        |   |   |   |   |                    |    |   |   |   |
| <i>Dytiscus</i> sp.                             | -                      | - | - | - | - | -                  | ++ | - | - | - |
| Genus <i>Hydroporus</i> Clairville, 1806        |                        |   |   |   |   |                    |    |   |   |   |
| <i>Hydroporus</i> sp.                           | -                      | - | - | - | - | -                  | +  | + | - | - |
| Genus <i>Oreodytes</i> Seidlitz, 1887           |                        |   |   |   |   |                    |    |   |   |   |
| <i>Oreodytes</i> sp.                            | -                      | - | - | - | - | -                  | -  | - | - | - |
| Family Psephenidae                              |                        |   |   |   |   |                    |    |   |   |   |
| Genus <i>Ectopria</i> LeConte, 1853             |                        |   |   |   |   |                    |    |   |   |   |
| <i>Ectopria</i> sp.                             | +                      | - | - | - | - | +                  | -  | - | - | - |
| <i>Ectopria nervosa</i> Melsheimer, 1844        |                        |   |   |   |   |                    |    |   |   |   |
| Genus <i>Psephenus</i> Haldeman, 1853           |                        |   |   |   |   |                    |    |   |   |   |
| <i>Psephenus</i> sp.                            | -                      | - | - | - | - | -                  | -  | - | - | + |
| Family Elmidae                                  |                        |   |   |   |   |                    |    |   |   |   |
| Genus <i>Optioservus</i> Sanderson, 1954        |                        |   |   |   |   |                    |    |   |   |   |
| <i>Optioservus</i> sp.                          | -                      | - | - | - | - | ++                 | +  | - | - | + |
| Genus <i>Promoresia</i> Sanderson, 1954         |                        |   |   |   |   |                    |    |   |   |   |
| <i>Promoresia</i> sp.                           | -                      | - | - | - | - | ++                 | -  | - | - | - |
| Genus <i>Stenelmis</i> Dufour, 1835             |                        |   |   |   |   |                    |    |   |   |   |
| <i>Stenelmis</i> sp.                            | +                      | + | - | - | - | +                  | -  | - | - | - |
| Family Stayphilinidae                           |                        |   |   |   |   |                    |    |   |   |   |



| STATION<br>TAXA                                  | NON-CHLORINATED SEWAGE |    |    |    |   | CHLORINATED SEWAGE |   |     |     |    |
|--|------------------------|----|----|----|---|--------------------|---|-----|-----|----|
|  | 1                      | 2  | 3  | 4  | 5 | 1                  | 2 | 3   | 4   | 5  |
| Genus <i>Stenus</i>                              | -                      | -  | -  | -  | - | -                  | - | +   | -   | -  |
| <i>stenus</i> sp.                                |                        |    |    |    |   |                    |   |     |     |    |
| Order Megaloptera                                |                        |    |    |    |   |                    |   |     |     |    |
| Family Corydalidae                               |                        |    |    |    |   |                    |   |     |     |    |
| Genus <i>Chauliodes</i> Latreille, 1796          |                        |    |    |    |   |                    |   |     |     |    |
| <i>Chauliodes pectinicornis</i> Linnaeus, 1763   | -                      | -  | +  | -  | - | -                  | - | -   | -   | -  |
| Genus <i>Nigronia</i> Banks, 1908                |                        |    |    |    |   |                    |   |     |     |    |
| <i>Nigronia serricornis</i> Say, 1824            | +                      | +  | -  | -  | - | ++                 | + | -   | -   | ++ |
| Class Crustacea                                  |                        |    |    |    |   |                    |   |     |     |    |
| Order Amphipoda                                  |                        |    |    |    |   |                    |   |     |     |    |
| Family Hyalellidae                               |                        |    |    |    |   |                    |   |     |     |    |
| Genus <i>Hyaella</i> Smith, 1873                 |                        |    |    |    |   |                    |   |     |     |    |
| <i>Hyaella azteca</i> Saussure, 1857             | -                      | -  | ++ | ++ | + | -                  | + | +++ | +++ | -  |
| Genus <i>Asellus</i> Geoffroy st. Hillaire, 1764 |                        |    |    |    |   |                    |   |     |     |    |
| <i>Asellus communis</i> Say, 1818                | +                      | ++ | -  | -  | - | -                  | - | -   | -   | -  |
| PHYLUM MOLLUSCA                                  |                        |    |    |    |   |                    |   |     |     |    |
| Class Gastropoda                                 |                        |    |    |    |   |                    |   |     |     |    |
| Order Basommatophora                             |                        |    |    |    |   |                    |   |     |     |    |
| Family Ancyliidae                                |                        |    |    |    |   |                    |   |     |     |    |
| Genus <i>Ferrissia</i> Westerlund, 1885          |                        |    |    |    |   |                    |   |     |     |    |
| <i>Ferrissia</i> sp.                             | -                      | -  | -  | -  | - | -                  | - | ++  | +   | ++ |
| Family Lymnaeidae                                |                        |    |    |    |   |                    |   |     |     |    |
| Genus <i>Fossaria</i> Westerlund, 1885           |                        |    |    |    |   |                    |   |     |     |    |
| <i>Fossaria</i> sp.                              | -                      | -  | -  | -  | + |                    |   |     |     |    |
| Family Planorbidae                               |                        |    |    |    |   |                    |   |     |     |    |
| Genus <i>Gyraulus</i> 'Agassiz'Charpentier, 1837 |                        |    |    |    |   |                    |   |     |     |    |
| <i>Gyraulus</i> sp.                              | -                      | -  | +  | -  | - | -                  | - | -   | -   | -  |

| STATION<br>TAXA  | NON-CHLORINATED SEWAGE |    |   |   |   | CHLORINATED SEWAGE |    |     |     |   |
|--|------------------------|----|---|---|---|--------------------|----|-----|-----|---|
|  | 1                      | 2  | 3 | 4 | 5 | 1                  | 2  | 3   | 4   | 5 |
| Family Physidae  |                        |    |   |   |   |                    |    |     |     |   |
| Genus <i>Physa</i> Draparnaud, 1801                      |                        |    |   |   |   |                    |    |     |     |   |
| <i>Physa</i> sp.   | -                      | ++ | - | - | + | -                  | -  | -   | -   | - |
| Class Bivalvia   |                        |    |   |   |   |                    |    |     |     |   |
| Order Veneroidea   |                        |    |   |   |   |                    |    |     |     |   |
| Family Sphaeriidae                                       |                        |    |   |   |   |                    |    |     |     |   |
| Genus <i>Musculium</i> Link, 1807                        |                        |    |   |   |   |                    |    |     |     |   |
| <i>Musculium</i> sp.                                     | -                      | -  | - | - | - | -                  | -  | +   | -   | - |
| Genus <i>Pisidium</i> Pfeiffer, 1821                     |                        |    |   |   |   |                    |    |     |     |   |
| <i>Pisidium</i> sp.                                      | -                      | -  | - | - | + | -                  | -  | -   | -   | - |
| PHYLUM ANNELIDA  |                        |    |   |   |   |                    |    |     |     |   |
| Class Hirudinea  |                        |    |   |   |   |                    |    |     |     |   |
| Order Pharyngobdellida                                   |                        |    |   |   |   |                    |    |     |     |   |
| Family Erpobdellidae                                     |                        |    |   |   |   |                    |    |     |     |   |
| Genus <i>Dina</i> R. Blanchard, 1892                     |                        |    |   |   |   |                    |    |     |     |   |
| <i>Dina</i> sp.  | -                      | -  | - | - | - | -                  | -  | +   | -   | - |
| Genus <i>Mooreobdella</i> Pawlowski, 1955                |                        |    |   |   |   |                    |    |     |     |   |
| <i>Mooreobdella melanostoma</i> Sawyer and Shelley, 1976 | -                      | -  | - | - | - | -                  | -  | +   | -   | - |
| Order Phynchobdellida                                    |                        |    |   |   |   |                    |    |     |     |   |
| Family Glossiphoniidae                                   |                        |    |   |   |   |                    |    |     |     |   |
| Genus <i>Helobdella</i> R. Blanchard, 1896               |                        |    |   |   |   |                    |    |     |     |   |
| <i>Helobdella stagnalis</i> Linnaeus, 1758               | -                      | -  | + | - | - | -                  | -  | +++ | +++ | - |
| Class Oligochaeta  |                        |    |   |   |   |                    |    |     |     |   |
| Order Tubificida   |                        |    |   |   |   |                    |    |     |     |   |
| IWCC   | -                      | -  | - | - | - | -                  | ++ | +   | +++ | + |
| ICC  | -                      | +  | + | - | - | -                  | -  | +   | +++ | - |

| STATION<br>TAXA                                     | NON-CHLORINATED SEWAGE |   |   |   |   | CHLORINATED SEWAGE |     |     |     |   |
|---|------------------------|---|---|---|---|--------------------|-----|-----|-----|---|
|   | 1                      | 2 | 3 | 4 | 5 | 1                  | 2   | 3   | 4   | 5 |
| Family Tubificidae                                  |                        |   |   |   |   |                    |     |     |     |   |
| Genus <i>Aulodrilus</i> Bretscher, 1899             |                        |   |   |   |   |                    |     |     |     |   |
| <i>Aulodrilus limnosius</i>                         |                        |   |   |   |   |                    |     |     | +   |   |
| Family Naididae                                     |                        |   |   |   |   |                    |     |     |     |   |
| Genus <i>Dero</i> Oken, 1815                        |                        |   |   |   |   |                    |     |     |     |   |
| <i>Dero obtusa</i> d'Udekem, 1855                   |                        |   |   |   |   | +                  | ++  | +++ | +++ |   |
| Genus <i>Homochaeta</i> Bretscher, 1896             |                        |   |   |   |   |                    |     |     |     |   |
| <i>Homochaeta</i> sp.                               |                        |   |   |   |   |                    |     | +   | ++  |   |
| Genus <i>Nais</i> Müller, 1773                      |                        |   |   |   |   |                    |     |     |     |   |
| <i>Nais communis</i> Piguet, 1906                   |                        | + |   |   |   | ++                 | +++ | +++ | +   | + |
| Genus <i>Pristina</i> Ehrenberg, 1928               |                        |   |   |   |   |                    |     |     |     |   |
| <i>Pristina longiseta longiseta</i> Ehrenberg, 1928 |                        |   |   |   |   | +                  |     | ++  |     |   |
| <i>Pristina longisoma</i> Harman, 1977              |                        |   |   |   |   |                    |     | +   |     |   |
| <i>Pristina sima</i> Marcus, 1944                   |                        |   |   |   |   |                    |     |     |     |   |
| Genus <i>Pristinella</i> Brinkhurst, 1984           |                        |   |   |   |   |                    |     |     |     |   |
| <i>Pristinella jenkiniae</i> Stephenson, 1931       |                        |   |   |   |   | +                  |     |     |     |   |
| <i>Pristinella osborni</i> Walton, 1906             |                        |   |   |   |   |                    |     | +++ | ++  |   |
| Genus <i>Slavina</i> Vejdovsky, 1883                |                        |   |   |   |   |                    |     |     |     |   |
| <i>Slavina appendiculata</i> d'Udekem, 1855         |                        |   |   |   |   |                    |     | +   | +   | + |
| Order Limbriculida                                  |                        |   |   |   |   |                    |     |     |     |   |
| Family Lumbricidae                                  |                        |   |   |   |   |                    |     |     |     |   |
| PHYLUM NEMATODA                                     |                        |   |   |   |   |                    |     |     |     |   |
| Copepod   |                        |   |   |   |   |                    |     |     |     |   |
| Pupa of unidentified insects                        |                        |   |   |   |   |                    |     |     |     |   |

2. Data recorded with Individual Stone as a Sampling Unit

| <i>Conchapelopia</i> sp. | <i>Corynoneura</i> taris | <i>Diplocladius</i> sp. | <i>Microtendipes</i> rydalenis group | <i>Paramerina</i> sp. | <i>Parametriocnemus</i> lundbecki | <i>Polypedilum</i> aviceps | <i>Polypedilum</i> scalaenum | <i>Rheopelopia</i> acra/perda | <i>Rheotanytarsus</i> exiguus group | <i>Tanytarsus</i> sp. | <i>Paraleptophlebia</i> sp. | <i>Serratella</i> deficiens | <i>Stenonema</i> modestum | <i>Paracapnia</i> opis | <i>Tallaperla</i> maria | <i>Cernotina</i> sp. | <i>Hataerina</i> sp. | <i>Nigronia</i> serricornis | Total Organisms | Surface Area |
|--------------------------|--------------------------|-------------------------|--------------------------------------|-----------------------|-----------------------------------|----------------------------|------------------------------|-------------------------------|-------------------------------------|-----------------------|-----------------------------|-----------------------------|---------------------------|------------------------|-------------------------|----------------------|----------------------|-----------------------------|-----------------|--------------|
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 1                      | 0                       | 0                    | 0                    | 0                           | 1               | 7494         |
| 2                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 1                           | 0                         | 0                      | 0                       | 0                    | 0                    | 1                           | 4               | 7772         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 1                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 1               | 6976         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 0               | 6408         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 1                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 1                           | 0                         | 0                      | 0                       | 0                    | 1                    | 0                           | 3               | 7872         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 1                      | 0                       | 2                    | 0                    | 0                           | 3               | 9353         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 0               | 7789         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 1                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 1               | 7735         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 1                      | 0                       | 0                    | 0                    | 0                           | 1               | 8390         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 0               | 6242         |
| 1                        | 1                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 2               | 7239         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 1                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 1               | 7028         |
| 0                        | 0                        | 0                       | 1                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 1               | 8686         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 1                         | 0                      | 0                       | 0                    | 0                    | 0                           | 1               | 9252         |
| 0                        | 0                        | 1                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 2                      | 0                       | 0                    | 0                    | 0                           | 3               | 8278         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 0               | 6717         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 1                         | 0                      | 0                       | 0                    | 0                    | 0                           | 1               | 7434         |
| 0                        | 0                        | 0                       | 0                                    | 1                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 1               | 9291         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 0               | 6398         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 1                                 | 0                          | 0                            | 0                             | 1                                   | 0                     | 0                           | 0                           | 0                         | 1                      | 0                       | 0                    | 0                    | 0                           | 3               | 8854         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 0               | 6079         |
| 0                        | 1                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 1                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 2               | 7992         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 1                                 | 0                          | 0                            | 1                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 2               | 8852         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 2                    | 0                    | 0                           | 2               | 6968         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 1                      | 0                       | 0                    | 0                    | 0                           | 1               | 7053         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 1                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 1                           | 2               | 8064         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 0               | 8070         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 1                       | 0                    | 0                    | 1                           | 2               | 7270         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 0                                   | 1                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 1               | 9656         |
| 0                        | 0                        | 0                       | 0                                    | 0                     | 0                                 | 0                          | 0                            | 0                             | 1                                   | 0                     | 0                           | 0                           | 0                         | 0                      | 0                       | 0                    | 0                    | 0                           | 1               | 8893         |
| 3                        | 2                        | 1                       | 1                                    | 1                     | 3                                 | 1                          | 1                            | 1                             | 3                                   | 1                     | 1                           | 3                           | 2                         | 7                      | 1                       | 4                    | 1                    | 3                           | 40              | 234105       |
|                          |                          |                         |                                      |                       |                                   |                            |                              |                               |                                     |                       |                             |                             |                           |                        |                         |                      |                      |                             |                 | Total        |

| <i>Brillia flavifrons</i> | <i>Conchapelopia sp.</i> | <i>Corynoneura taris</i> | <i>Hydrobaenus pilipes</i> | <i>Micropsectra sp.</i> | <i>Microtendipes caelum</i> | <i>Parakiefferiella sp.</i> | <i>Tanytarsus sp.</i> | <i>Telmatoscopas sp.</i> | <i>Paraleptophlebia sp.</i> | <i>Agnetina capitata</i> | <i>Paracapnia opis</i> | <i>Hydatophylax sp.</i> | <i>Ectopria sp.</i> | Total Organisms | Surface Area |
|---------------------------|--------------------------|--------------------------|----------------------------|-------------------------|-----------------------------|-----------------------------|-----------------------|--------------------------|-----------------------------|--------------------------|------------------------|-------------------------|---------------------|-----------------|--------------|
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 1                        | 0                      | 0                       | 0                   | 1               | 4642         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 1                   | 1               | 5016         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 1                       | 0                   | 1               | 5737         |
| 1                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 1               | 4800         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 1                        | 1                           | 0                        | 0                      | 0                       | 0                   | 2               | 4690         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 6978         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 1                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 1               | 5326         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 5057         |
| 0                         | 2                        | 0                        | 0                          | 0                       | 1                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 3               | 7009         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 1                      | 0                       | 0                   | 1               | 6439         |
| 0                         | 0                        | 0                        | 1                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 1               | 7177         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 6133         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 1                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 1               | 5231         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 4560         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 1                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 1               | 5366         |
| 0                         | 1                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 1               | 6734         |
| 0                         | 0                        | 1                        | 0                          | 1                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 2               | 4848         |
| 0                         | 1                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 1               | 4883         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 4692         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 1                      | 1                       | 0                   | 2               | 4674         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 1                           | 0                     | 0                        | 0                           | 0                        | 2                      | 0                       | 0                   | 3               | 4719         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 5476         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 5215         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 5830         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 5192         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 1                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 1               | 6000         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 5179         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 5096         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 0                        | 0                      | 0                       | 0                   | 0               | 4410         |
| 0                         | 0                        | 0                        | 0                          | 0                       | 0                           | 0                           | 0                     | 0                        | 0                           | 1                        | 0                      | 0                       | 0                   | 1               | 4423         |
| 1                         | 4                        | 1                        | 1                          | 1                       | 2                           | 3                           | 1                     | 1                        | 1                           | 1                        | 5                      | 2                       | 1                   | 25              | 161532 Total |

| <i>Chironomus sp.</i> | <i>Conchapelopia sp.</i> | <i>Cricotopus sylvestris</i> group | <i>Diplocladius sp.</i> | <i>Endochironomus nigricans</i> | <i>Larsia sp.</i> | <i>Meropelopia flavifrons</i> | <i>Micropsectra sp.</i> | <i>Orthocladiinae</i> | <i>Parametrioctenemus lundbecki</i> | <i>Polypedilum aviceps</i> | <i>Polypedilum illinoense</i> | <i>Polypedilum scalaenum</i> | <i>Rheotanytarsus exiguus</i> group | <i>Trissopelopia ogemawi</i> | <i>Hemerodromia sp.</i> | <i>Calopteryx maculata</i> | <i>Hyaella azteca</i> | Total Organisms | Surface Area |
|-----------------------|--------------------------|------------------------------------|-------------------------|---------------------------------|-------------------|-------------------------------|-------------------------|-----------------------|-------------------------------------|----------------------------|-------------------------------|------------------------------|-------------------------------------|------------------------------|-------------------------|----------------------------|-----------------------|-----------------|--------------|
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 2                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 2               | 8723         |
| 0                     | 0                        | 1                                  | 0                       | 0                               | 0                 | 0                             | 1                       | 0                     | 1                                   | 0                          | 0                             | 0                            | 1                                   | 0                            | 0                       | 0                          | 0                     | 4               | 8738         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 1                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 1               | 8933         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 0               | 9795         |
| 0                     | 0                        | 0                                  | 1                       | 1                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 1                            | 0                       | 0                          | 0                     | 3               | 8526         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 1                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 1               | 7498         |
| 0                     | 1                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 1                       | 0                     | 1                                   | 0                          | 1                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 1                     | 5               | 7747         |
| 1                     | 0                        | 0                                  | 0                       | 1                               | 1                 | 1                             | 0                       | 0                     | 0                                   | 0                          | 1                             | 1                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 6               | 8325         |
| 0                     | 1                        | 0                                  | 0                       | 1                               | 0                 | 0                             | 1                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 3               | 9865         |
| 0                     | 1                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 1               | 8170         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 1                          | 0                     | 1               | 6259         |
| 0                     | 0                        | 0                                  | 1                       | 1                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 2                            | 0                       | 0                          | 0                     | 4               | 9534         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 0               | 7598         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 1                     | 1               | 8754         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 0               | 7295         |
| 0                     | 2                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 1                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 1                       | 0                          | 0                     | 4               | 8562         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 0               | 9136         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 0               | 9349         |
| 0                     | 2                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 2               | 6800         |
| 0                     | 1                        | 1                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 1                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 3               | 7434         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 0               | 7971         |
| 0                     | 2                        | 1                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 3               | 7807         |
| 2                     | 1                        | 0                                  | 2                       | 0                               | 0                 | 2                             | 0                       | 1                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 2                            | 1                       | 0                          | 1                     | 12              | 8553         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 0               | 8754         |
| 0                     | 1                        | 0                                  | 0                       | 1                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 1                            | 0                       | 0                          | 0                     | 3               | 9310         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 0               | 8535         |
| 0                     | 0                        | 0                                  | 0                       | 1                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 1                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 2               | 9304         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 1                     | 1               | 8406         |
| 0                     | 0                        | 0                                  | 1                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 1               | 8365         |
| 0                     | 0                        | 0                                  | 0                       | 0                               | 0                 | 0                             | 0                       | 0                     | 0                                   | 0                          | 0                             | 0                            | 0                                   | 0                            | 0                       | 0                          | 0                     | 0               | 8636         |
| 3                     | 12                       | 3                                  | 5                       | 6                               | 1                 | 3                             | 6                       | 1                     | 5                                   | 1                          | 2                             | 1                            | 1                                   | 6                            | 2                       | 1                          | 4                     | 63              | 252682       |
|                       |                          |                                    |                         |                                 |                   |                               |                         |                       |                                     |                            |                               |                              |                                     |                              |                         |                            |                       |                 | Total        |

| <i>Chironomus</i> sp. | <i>Conchapelopia</i> sp. | <i>Corynoneura</i> taris | <i>Cricotopus sylvestris</i> group | <i>Dicrotendipes neomodestus</i> | <i>Diplocladius</i> sp. | <i>Endochironomus nigricans</i> | <i>Glyptotendipes lobiferus</i> | <i>Hudsonimyia</i> sp. | <i>Hydrobaenus pilipes</i> | <i>Larsia</i> sp. | <i>Meropelopia flavifrons</i> | <i>Micropsectra</i> sp. | <i>Parametriocnemus lundbecki</i> | <i>Paraphaenocladus</i> sp. 2 | <i>Polypedium illinoense</i> | <i>Polypedium scalaenum</i> | <i>Tanytarsus</i> sp. | <i>Trissopelopia ogemawi</i> | <i>Hemerodromia</i> sp. | <i>Hydatophylax</i> sp. | <i>Anchytarsus bicolor</i> | <i>Hyaella azteca</i> | Total Organisms | Surface Area |       |
|-----------------------|--------------------------|--------------------------|------------------------------------|----------------------------------|-------------------------|---------------------------------|---------------------------------|------------------------|----------------------------|-------------------|-------------------------------|-------------------------|-----------------------------------|-------------------------------|------------------------------|-----------------------------|-----------------------|------------------------------|-------------------------|-------------------------|----------------------------|-----------------------|-----------------|--------------|-------|
| 1                     | 3                        | 1                        | 0                                  | 1                                | 0                       | 0                               | 0                               | 0                      | 0                          | 1                 | 0                             | 0                       | 1                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 8               | 4810         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 1                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 1                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 2               | 6404         |       |
| 0                     | 2                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 2               | 4543         |       |
| 0                     | 2                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 1                       | 2                                 | 0                             | 0                            | 1                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 6               | 5876         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 1                       | 0                                 | 0                             | 0                            | 0                           | 1                     | 0                            | 1                       | 0                       | 0                          | 0                     | 3               | 6526         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 0               | 5598         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 1                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 1               | 5909         |       |
| 0                     | 1                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 1                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 2               | 6311         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 3                       | 0                                 | 1                             | 1                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 5               | 4904         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 1                      | 0                          | 0                 | 0                             | 1                       | 0                                 | 0                             | 1                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 3               | 5602         |       |
| 0                     | 1                        | 0                        | 0                                  | 0                                | 1                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 2               | 6601         |       |
| 0                     | 3                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 2                       | 1                                 | 0                             | 1                            | 0                           | 0                     | 0                            | 0                       | 1                       | 0                          | 0                     | 8               | 5370         |       |
| 1                     | 0                        | 0                        | 0                                  | 0                                | 1                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 2               | 6006         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 0               | 5743         |       |
| 0                     | 0                        | 0                        | 1                                  | 0                                | 1                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 1                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 1                            | 0                       | 0                       | 0                          | 0                     | 4               | 4914         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 1                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 1               | 5503         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 1                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 1               | 5018         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 0               | 6039         |       |
| 0                     | 0                        | 0                        | 1                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 1               | 6263         |       |
| 1                     | 0                        | 0                        | 1                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 1                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 1                          | 0                     | 4               | 6377         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 2                               | 0                               | 0                      | 0                          | 0                 | 0                             | 2                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 4               | 5111         |       |
| 0                     | 1                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 1                          | 0                 | 0                             | 2                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 4               | 9169         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 1                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 1               | 5399         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 0               | 6178         |       |
| 1                     | 0                        | 0                        | 0                                  | 0                                | 1                       | 1                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 1                            | 0                       | 0                       | 0                          | 0                     | 4               | 7797         |       |
| 0                     | 1                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 1                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 2               | 5067         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 1                       | 0                               | 1                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 1                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 3               | 6330         |       |
| 0                     | 2                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 1                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 0                          | 0                     | 3               | 5183         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 1                            | 0                       | 0                       | 0                          | 0                     | 1               | 6711         |       |
| 0                     | 0                        | 0                        | 0                                  | 0                                | 0                       | 0                               | 0                               | 0                      | 0                          | 0                 | 0                             | 0                       | 0                                 | 0                             | 0                            | 0                           | 0                     | 0                            | 0                       | 0                       | 1                          | 1                     | 5094            |              |       |
| 4                     | 16                       | 1                        | 3                                  | 1                                | 7                       | 3                               | 1                               | 1                      | 1                          | 1                 | 1                             | 17                      | 6                                 | 1                             | 4                            | 2                           | 1                     | 1                            | 3                       | 1                       | 1                          | 1                     | 78              | 176356       | Total |



| <i>Conchapelopia</i> sp. | <i>Corynoneura</i> taris | <i>Cricotopus</i> binctus group | <i>Diplocladius</i> sp. | <i>Heterotrissocladius</i> marcidus group | <i>Hydrobaenus</i> pilipes | <i>Meropelopia</i> flavifrons | <i>Micropsectra</i> sp. | <i>Microtendipes</i> caelum | <i>Microtendipes</i> rydalensis group | <i>Nanocladius</i> sp. 1 | <i>Nanocladius</i> sp. 2 | <i>Paramerina</i> sp. | <i>Parametriocnemus</i> lundbecki | <i>Paratanytarsus</i> sp. 2 | <i>Paratanytarsus</i> sp. 3 | <i>Polypedilum</i> illinoense | <i>Polypedilum</i> scalaenum | <i>Rheotanytarsus</i> exiguus group | Tanypodinae (early instar) | <i>Cheumatopsyche</i> sp. | <i>Hydroporus</i> sp. | <i>Hyalella</i> azteca | Total Organisms | Surface Area |       |
|--------------------------|--------------------------|---------------------------------|-------------------------|---|----------------------------|-------------------------------|-------------------------|-----------------------------|---------------------------------------|--------------------------|--------------------------|-----------------------|-----------------------------------|-----------------------------|-----------------------------|-------------------------------|------------------------------|-------------------------------------|----------------------------|---------------------------|-----------------------|------------------------|-----------------|--------------|-------|
| 4                        | 0                        | 0                               | 2                       | 0   | 1                          | 0                             | 1                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 1                                   | 0                          | 0                         | 0                     | 9                      | 10064           |              |       |
| 1                        | 0                        | 0                               | 0                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                            | 1                                   | 0                          | 0                         | 0                     | 3                      | 7063            |              |       |
| 2                        | 0                        | 0                               | 0                       | 0   | 0                          | 0                             | 1                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 1                          | 0                         | 0                     | 2                      | 6               | 7461         |       |
| 1                        | 1                        | 0                               | 0                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 0                     | 3                      | 9067            |              |       |
| 1                        | 0                        | 0                               | 1                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 2                                   | 0                          | 0                         | 0                     | 4                      | 7459            |              |       |
| 0                        | 0                        | 0                               | 0                       | 0   | 0                          | 2                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 1                                   | 0                          | 0                         | 0                     | 3                      | 6611            |              |       |
| 0                        | 0                        | 0                               | 0                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 1                         | 0                     | 2                      | 7998            |              |       |
| 2                        | 0                        | 0                               | 0                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 2                     | 4                      | 7691            |              |       |
| 2                        | 0                        | 0                               | 0                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 1                                   | 0                          | 0                         | 0                     | 3                      | 8698            |              |       |
| 0                        | 0                        | 0                               | 1                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 0                     | 1                      | 10593           |              |       |
| 0                        | 0                        | 0                               | 0                       | 0   | 1                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 0                     | 1                      | 10388           |              |       |
| 0                        | 0                        | 0                               | 0                       | 0   | 0                          | 1                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 1                                   | 0                          | 0                         | 0                     | 2                      | 8286            |              |       |
| 4                        | 0                        | 0                               | 0                       | 1   | 0                          | 0                             | 0                       | 0                           | 1                                     | 1                        | 0                        | 0                     | 1                                 | 2                           | 0                           | 0                             | 0                            | 1                                   | 0                          | 0                         | 0                     | 12                     | 9534            |              |       |
| 0                        | 0                        | 0                               | 0                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 0                     | 1                      | 8491            |              |       |
| 1                        | 0                        | 0                               | 1                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 1                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 1                             | 1                            | 0                                   | 0                          | 0                         | 0                     | 3                      | 8145            |              |       |
| 2                        | 0                        | 1                               | 0                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 1                     | 4                      | 7430            |              |       |
| 2                        | 0                        | 0                               | 1                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 1                         | 1                     | 5                      | 9302            |              |       |
| 1                        | 0                        | 0                               | 0                       | 0   | 0                          | 1                             | 1                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 1                                   | 0                          | 0                         | 0                     | 3                      | 7               | 9598         |       |
| 1                        | 0                        | 0                               | 0                       | 0   | 1                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 0                     | 2                      | 8558            |              |       |
| 2                        | 0                        | 0                               | 0                       | 0   | 1                          | 1                             | 0                       | 0                           | 0                                     | 1                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 1                         | 0                     | 6                      | 7594            |              |       |
| 1                        | 0                        | 0                               | 0                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 0                     | 1                      | 6960            |              |       |
| 1                        | 0                        | 0                               | 0                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 0                     | 2                      | 7768            |              |       |
| 0                        | 0                        | 0                               | 0                       | 0   | 0                          | 0                             | 1                       | 0                           | 0                                     | 2                        | 0                        | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                            | 3                                   | 0                          | 0                         | 0                     | 2                      | 9               | 7751         |       |
| 1                        | 0                        | 0                               | 2                       | 0   | 0                          | 0                             | 2                       | 1                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                            | 2                                   | 0                          | 0                         | 0                     | 9                      | 7830            |              |       |
| 1                        | 0                        | 0                               | 1                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 1                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 1                                   | 0                          | 0                         | 0                     | 4                      | 6960            |              |       |
| 2                        | 0                        | 0                               | 1                       | 0   | 1                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 1                     | 5                      | 7627            |              |       |
| 1                        | 0                        | 0                               | 1                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 0                     | 2                      | 5579            |              |       |
| 0                        | 0                        | 0                               | 0                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 1                     | 0                                 | 0                           | 0                           | 0                             | 0                            | 0                                   | 0                          | 0                         | 0                     | 1                      | 7098            |              |       |
| 2                        | 0                        | 0                               | 0                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 2                           | 0                           | 0                             | 1                            | 0                                   | 0                          | 0                         | 0                     | 5                      | 9175            |              |       |
| 0                        | 0                        | 0                               | 2                       | 0   | 0                          | 0                             | 0                       | 0                           | 0                                     | 0                        | 0                        | 0                     | 0                                 | 0                           | 0                           | 0                             | 4                            | 0                                   | 0                          | 0                         | 0                     | 6                      | 7600            |              |       |
| 35                       | 1                        | 1                               | 13                      | 1   | 5                          | 5                             | 6                       | 1                           | 1                                     | 5                        | 1                        | 1                     | 1                                 | 9                           | 2                           | 1                             | 1                            | 20                                  | 1                          | 1                         | 2                     | 16                     | 130             | 244379       | Total |

| <i>Conchapelopia</i> sp. | <i>Diplocladius</i> sp. | <i>Meropelopia flavifrons</i> | <i>Micropectra</i> sp. | <i>Nanocladius</i> sp. 1 | <i>Parametrioctonus lundbecki</i> | <i>Paratanytarsus</i> sp. 1 | <i>Paratanytarsus</i> sp. 2 | <i>Paratanytarsus</i> sp. 3 | <i>Polypedilum illinoense</i> | <i>Rheotanytarsus exiguus</i> group | Tanypodinae (early instar) | <i>Thienemanniella</i> prob. <i>xena</i> | <i>Prosimulium</i> sp. | <i>Simulium tuberosum</i> complex | <i>Cerrotina</i> sp. | <i>Cheumatopsyche</i> sp. | <i>Coenagrion</i> sp. | <i>Hyaella azteca</i> | Total Organisms | Surface Area |       |
|--------------------------|-------------------------|-------------------------------|------------------------|--------------------------|-----------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|-------------------------------------|----------------------------|--|------------------------|-----------------------------------|----------------------|---------------------------|-----------------------|-----------------------|-----------------|--------------|-------|
| 0                        | 4                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 3                           | 0                           | 0                             | 3                                   | 0                          | 1  | 0                      | 0                                 | 0                    | 0                         | 0                     | 0                     | 11              | 8083         |       |
| 0                        | 1                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 2                           | 0                           | 0                             | 1                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 0                     | 4               | 4141         |       |
| 2                        | 1                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 0                           | 0                           | 0                             | 2                                   | 1                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 0                     | 6               | 6425         |       |
| 0                        | 0                       | 0                             | 0                      | 0                        | 1                                 | 0                           | 1                           | 0                           | 0                             | 2                                   | 0                          | 0  | 0                      | 0                                 | 2                    | 0                         | 1                     | 7                     | 8075            |              |       |
| 0                        | 0                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 0                           | 0                           | 0                             | 1                                   | 0                          | 0  | 0                      | 0                                 | 1                    | 0                         | 0                     | 2                     | 5523            |              |       |
| 0                        | 1                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 0                           | 0                           | 0                             | 1                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 2                     | 5749            |              |       |
| 0                        | 0                       | 1                             | 0                      | 0                        | 0                                 | 0                           | 0                           | 0                           | 0                             | 0                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 1                     | 7888            |              |       |
| 0                        | 2                       | 0                             | 1                      | 0                        | 0                                 | 0                           | 0                           | 0                           | 1                             | 0                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 4                     | 4999            |              |       |
| 0                        | 1                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 1                           | 0                           | 0                             | 0                                   | 0                          | 0  | 1                      | 0                                 | 0                    | 1                         | 0                     | 4                     | 5098            |              |       |
| 1                        | 0                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 2                           | 0                           | 0                             | 4                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 7                     | 6201            |              |       |
| 3                        | 0                       | 0                             | 1                      | 0                        | 0                                 | 1                           | 4                           | 0                           | 0                             | 0                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 1                         | 0                     | 10                    | 6684            |              |       |
| 0                        | 1                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 0                           | 0                           | 0                             | 0                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 1                     | 5892            |              |       |
| 0                        | 0                       | 0                             | 1                      | 1                        | 0                                 | 0                           | 3                           | 0                           | 0                             | 3                                   | 0                          | 1  | 0                      | 0                                 | 0                    | 3                         | 0                     | 12                    | 5532            |              |       |
| 1                        | 1                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 3                           | 0                           | 0                             | 0                                   | 0                          | 0  | 0                      | 1                                 | 0                    | 1                         | 0                     | 7                     | 5132            |              |       |
| 2                        | 1                       | 0                             | 1                      | 0                        | 1                                 | 0                           | 1                           | 0                           | 0                             | 4                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 1                     | 11                    | 5612            |              |       |
| 1                        | 1                       | 1                             | 0                      | 0                        | 0                                 | 0                           | 1                           | 0                           | 0                             | 0                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 4                     | 5612            |              |       |
| 1                        | 0                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 3                           | 0                           | 0                             | 0                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 4                     | 4819            |              |       |
| 0                        | 1                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 0                           | 0                           | 0                             | 4                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 5                     | 5946            |              |       |
| 1                        | 0                       | 0                             | 1                      | 0                        | 0                                 | 0                           | 2                           | 0                           | 0                             | 4                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 8                     | 6991            |              |       |
| 0                        | 3                       | 0                             | 2                      | 0                        | 0                                 | 0                           | 5                           | 0                           | 0                             | 1                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 4                         | 0                     | 15                    | 5501            |              |       |
| 0                        | 0                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 0                           | 0                           | 1                             | 0                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 1                     | 5403            |              |       |
| 2                        | 0                       | 0                             | 1                      | 0                        | 0                                 | 0                           | 0                           | 1                           | 0                             | 0                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 4                     | 7440            |              |       |
| 0                        | 0                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 0                           | 0                           | 0                             | 0                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 0                     | 6477            |              |       |
| 0                        | 1                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 0                           | 0                           | 0                             | 3                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 4                     | 8444            |              |       |
| 1                        | 0                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 1                           | 0                           | 0                             | 0                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 2                     | 6230            |              |       |
| 1                        | 5                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 3                           | 0                           | 0                             | 4                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 13                    | 5575            |              |       |
| 0                        | 1                       | 0                             | 1                      | 0                        | 1                                 | 0                           | 1                           | 0                           | 0                             | 3                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 1                         | 0                     | 8                     | 4827            |              |       |
| 0                        | 1                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 0                           | 1                           | 0                             | 3                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 5                     | 5219            |              |       |
| 0                        | 3                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 1                           | 0                           | 0                             | 1                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 3                         | 0                     | 8                     | 5326            |              |       |
| 1                        | 0                       | 0                             | 0                      | 0                        | 0                                 | 0                           | 1                           | 0                           | 0                             | 1                                   | 0                          | 0  | 0                      | 0                                 | 0                    | 0                         | 0                     | 3                     | 5567            |              |       |
| 17                       | 29                      | 2                             | 9                      | 1                        | 3                                 | 1                           | 38                          | 2                           | 2                             | 45                                  | 1                          | 2  | 1                      | 1                                 | 1                    | 16                        | 1                     | 1                     | 173             | 180411       | Total |

| <i>Conchapelopia</i> sp. | <i>Corynoneura</i> taris | <i>Cricotopus</i> bicinctus group | <i>Diplocladius</i> sp. | <i>Hydrobaenus</i> pilipes | <i>Meropelopia</i> flavifrons | <i>Micropsectra</i> sp. | <i>Orthocladius</i> carlatus group | <i>Parametriocnemus</i> lundbecki | <i>Paratanytarsus</i> sp. 2 | <i>Rheotanytarsus</i> exiguus group | <i>Thienemanniella</i> prob. xena | <i>Thienemanniella</i> sp. 1 | <i>Cheumatopsyche</i> sp. | <i>Hydropsyche</i> sp. 1 | <i>Hyalella</i> azteca | Total Organisms | Surface Area |
|--------------------------|--------------------------|-----------------------------------|-------------------------|----------------------------|-------------------------------|-------------------------|------------------------------------|-----------------------------------|-----------------------------|-------------------------------------|-----------------------------------|------------------------------|---------------------------|--------------------------|------------------------|-----------------|--------------|
| 1                        | 0                        | 0                                 | 0                       | 0                          | 1                             | 1                       | 0                                  | 0                                 | 1                           | 0                                   | 0                                 | 0                            | 0                         | 0                        | 3                      | 7               | 8655         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 2                           | 0                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 2               | 6263         |
| 1                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 1                       | 0                                  | 0                                 | 1                           | 1                                   | 1                                 | 0                            | 0                         | 0                        | 1                      | 6               | 10017        |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 2                                   | 0                                 | 0                            | 0                         | 0                        | 1                      | 3               | 9556         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 0                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 0               | 7022         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 1                       | 0                                  | 0                                 | 0                           | 0                                   | 0                                 | 0                            | 0                         | 0                        | 1                      | 2               | 7047         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 0                                   | 0                                 | 0                            | 0                         | 0                        | 3                      | 3               | 7246         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 3                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 3               | 6504         |
| 1                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 1                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 2               | 6518         |
| 1                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 2                                   | 0                                 | 0                            | 0                         | 0                        | 1                      | 4               | 7747         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 1                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 1               | 9111         |
| 1                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 0                                   | 0                                 | 0                            | 0                         | 0                        | 2                      | 3               | 9474         |
| 0                        | 0                        | 0                                 | 1                       | 0                          | 0                             | 2                       | 0                                  | 0                                 | 0                           | 0                                   | 0                                 | 0                            | 0                         | 0                        | 2                      | 5               | 9045         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 0                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 0               | 8288         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 1                                  | 0                                 | 1                           | 1                                   | 0                                 | 0                            | 2                         | 0                        | 5                      | 10              | 8541         |
| 0                        | 1                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 1                           | 0                                   | 0                                 | 0                            | 0                         | 0                        | 2                      | 4               | 7575         |
| 2                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 1                           | 2                                   | 0                                 | 0                            | 0                         | 0                        | 1                      | 6               | 7036         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 2                           | 3                                   | 0                                 | 0                            | 0                         | 0                        | 3                      | 8               | 7838         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 0                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 0               | 8531         |
| 1                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 1                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 2               | 7337         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 0                                   | 0                                 | 1                            | 0                         | 1                        | 3                      | 5               | 7061         |
| 0                        | 0                        | 1                                 | 2                       | 1                          | 0                             | 0                       | 0                                  | 0                                 | 4                           | 2                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 10              | 8806         |
| 1                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 1                                 | 1                           | 2                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 5               | 7009         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 1                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 1               | 10711        |
| 1                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 2                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 3               | 8280         |
| 0                        | 0                        | 0                                 | 1                       | 2                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 4                                   | 1                                 | 0                            | 0                         | 0                        | 0                      | 8               | 9739         |
| 2                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 2                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 4               | 9654         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 1                             | 0                       | 0                                  | 0                                 | 0                           | 1                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 2               | 6763         |
| 0                        | 0                        | 0                                 | 0                       | 1                          | 0                             | 0                       | 0                                  | 0                                 | 0                           | 2                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 3               | 6796         |
| 0                        | 0                        | 0                                 | 0                       | 0                          | 0                             | 0                       | 0                                  | 0                                 | 1                           | 2                                   | 0                                 | 0                            | 0                         | 0                        | 0                      | 3               | 5894         |
| 12                       | 1                        | 1                                 | 4                       | 4                          | 2                             | 5                       | 1                                  | 1                                 | 15                          | 35                                  | 2                                 | 1                            | 2                         | 1                        | 28                     | 115             | 240064       |
| Total                    |                          |                                   |                         |                            |                               |                         |                                    |                                   |                             |                                     |                                   |                              |                           |                          |                        |                 |              |

| <i>Conchapelopia</i> sp. | <i>Diplocladius</i> sp. | <i>Micropsectra</i> sp. | <i>Microtendipes caelum</i> | <i>Nanocladius</i> sp. 1 | <i>Nanocladius</i> sp. 2 | <i>Orthocladius oliveri</i> | <i>Parametrioctonus lundbecki</i> | <i>Paratanytarsus</i> sp. 2 | <i>Paratanytarsus</i> sp. 3 | <i>Polypedilum illinoense</i> | <i>Rheotanytarsus exiguus</i> group | <i>Thienemanniella</i> sp. 1 | <i>Ferrissia</i> sp. | <i>Hyaella azteca</i> | <i>Helobdella stagnalis</i> | Total Organisms | Surface Area |
|--------------------------|-------------------------|-------------------------|-----------------------------|--------------------------|--------------------------|-----------------------------|-----------------------------------|-----------------------------|-----------------------------|-------------------------------|-------------------------------------|------------------------------|----------------------|-----------------------|-----------------------------|-----------------|--------------|
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 1                                   | 0                            | 0                    | 1                     | 0                           | 2               | 4261         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 1                        | 1                           | 0                                 | 0                           | 0                           | 0                             | 1                                   | 0                            | 0                    | 0                     | 0                           | 3               | 4564         |
| 0                        | 0                       | 1                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 1                           | 1                           | 0                             | 2                                   | 0                            | 1                    | 0                     | 0                           | 6               | 5797         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 1                                 | 1                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 1                     | 0                           | 3               | 5152         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 3                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 3               | 4330         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 1                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 1               | 5797         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 2                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 1                     | 0                           | 3               | 4841         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 1                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 1               | 5592         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 0               | 6425         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 0               | 5154         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 1                                   | 0                            | 0                    | 0                     | 0                           | 1               | 4829         |
| 0                        | 0                       | 1                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 1               | 6587         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 0               | 4634         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 1                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 1               | 5830         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 1                                 | 0                           | 0                           | 0                             | 1                                   | 0                            | 0                    | 0                     | 0                           | 2               | 5760         |
| 0                        | 0                       | 0                       | 0                           | 1                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 1               | 7090         |
| 0                        | 0                       | 0                       | 0                           | 1                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 1               | 5256         |
| 0                        | 0                       | 1                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 1               | 4452         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 0               | 5125         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 0               | 4779         |
| 1                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 1                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 2               | 5134         |
| 0                        | 0                       | 0                       | 1                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 2                                   | 0                            | 0                    | 0                     | 0                           | 3               | 4873         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 0               | 5032         |
| 0                        | 0                       | 0                       | 0                           | 1                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 2                                   | 0                            | 0                    | 0                     | 0                           | 3               | 5221         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 0               | 6269         |
| 0                        | 0                       | 1                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 1                             | 2                                   | 1                            | 0                    | 1                     | 0                           | 6               | 6288         |
| 0                        | 0                       | 0                       | 0                           | 1                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 1               | 4642         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 1                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 2                           | 3               | 7747         |
| 0                        | 0                       | 0                       | 0                           | 0                        | 0                        | 0                           | 0                                 | 0                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 0               | 6754         |
| 0                        | 1                       | 0                       | 0                           | 2                        | 0                        | 0                           | 0                                 | 1                           | 0                           | 0                             | 0                                   | 0                            | 0                    | 0                     | 0                           | 4               | 4495         |
| 1                        | 1                       | 4                       | 1                           | 6                        | 1                        | 1                           | 3                                 | 12                          | 1                           | 1                             | 12                                  | 1                            | 1                    | 4                     | 2                           | 52              | 162710       |
| Total                    |                         |                         |                             |                          |                          |                             |                                   |                             |                             |                               |                                     |                              |                      |                       |                             |                 |              |

| <i>Conchapelopia</i> sp. | <i>Diplocladius</i> sp. | <i>Hydrobaenus pilipes</i> | <i>Micropsectra</i> sp. | <i>Nanocladius</i> sp. 1 | <i>Nanocladius</i> sp. 2 | <i>Paraphaenocladius</i> sp. 2 | <i>Polypedium aviceps</i> | <i>Rheotanytarsus distinctissimus</i> group | <i>Rheotanytarsus exiguus</i> group | <i>Saetheria</i> sp. | <i>Tanytarsus</i> sp. | <i>Prosimulium</i> sp. | <i>Eurylophella</i> sp. | <i>Paracapnia opis</i> | <i>Taeniopteryx</i> sp. | Tricoptera | <i>Calopteryx maculata</i> | Total Organisms | Surface Area |       |
|--------------------------|-------------------------|----------------------------|-------------------------|--------------------------|--------------------------|--------------------------------|---------------------------|---|-------------------------------------|----------------------|-----------------------|------------------------|-------------------------|------------------------|-------------------------|------------|----------------------------|-----------------|--------------|-------|
| 0                        | 1                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 1                          | 7598            |              |       |
| 1                        | 0                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 1                       | 0                      | 0                       | 0          | 2                          | 8902            |              |       |
| 0                        | 0                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 0                          | 7718            |              |       |
| 1                        | 0                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 1                          | 7840            |              |       |
| 0                        | 1                       | 0                          | 0                       | 0                        | 0                        | 1                              | 0                         | 1   | 0                                   | 0                    | 0                     | 0                      | 1                       | 2                      | 0                       | 0          | 6                          | 8110            |              |       |
| 0                        | 1                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 2                       | 0                      | 0                       | 0          | 3                          | 8589            |              |       |
| 0                        | 1                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 2                       | 0                      | 0                       | 0          | 3                          | 8574            |              |       |
| 0                        | 2                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 1                       | 0          | 3                          | 7743            |              |       |
| 0                        | 0                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 1          | 1                          | 8249            |              |       |
| 0                        | 0                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 0                          | 8734            |              |       |
| 0                        | 1                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 1                          | 8151            |              |       |
| 0                        | 10                      | 0                          | 0                       | 0                        | 0                        | 0                              | 1                         | 0   | 0                                   | 0                    | 0                     | 0                      | 1                       | 0                      | 0                       | 0          | 12                         | 8160            |              |       |
| 0                        | 11                      | 0                          | 1                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 2                      | 0                       | 0          | 14                         | 9092            |              |       |
| 0                        | 2                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 2                          | 8238            |              |       |
| 0                        | 1                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 1                          | 7358            |              |       |
| 0                        | 4                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 1                      | 0                       | 0                      | 0                       | 0          | 5                          | 10222           |              |       |
| 0                        | 3                       | 0                          | 0                       | 0                        | 1                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 4                          | 8294            |              |       |
| 0                        | 4                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 1                       | 0                      | 0                       | 0          | 5                          | 9042            |              |       |
| 0                        | 0                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 0                          | 7702            |              |       |
| 0                        | 2                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 2                          | 9144            |              |       |
| 0                        | 1                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 1                                   | 0                    | 0                     | 0                      | 1                       | 0                      | 0                       | 0          | 3                          | 9299            |              |       |
| 0                        | 6                       | 0                          | 0                       | 0                        | 0                        | 1                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 7                          | 7559            |              |       |
| 0                        | 0                       | 0                          | 1                       | 1                        | 0                        | 0                              | 0                         | 0   | 0                                   | 1                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 3                          | 7461            |              |       |
| 0                        | 0                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 1                       | 0                      | 0                       | 0          | 1                          | 9090            |              |       |
| 0                        | 4                       | 1                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 5                          | 9416            |              |       |
| 0                        | 2                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 1                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 3                          | 9090            |              |       |
| 0                        | 0                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 0                          | 8769            |              |       |
| 0                        | 1                       | 1                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 1                     | 0                      | 0                       | 0                      | 0                       | 0          | 3                          | 9517            |              |       |
| 0                        | 0                       | 1                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 1                          | 7119            |              |       |
| 0                        | 2                       | 0                          | 0                       | 0                        | 0                        | 0                              | 0                         | 0   | 0                                   | 0                    | 0                     | 0                      | 0                       | 0                      | 0                       | 0          | 2                          | 8251            |              |       |
| 2                        | 60                      | 3                          | 1                       | 1                        | 1                        | 1                              | 1                         | 2   | 1                                   | 1                    | 2                     | 1                      | 1                       | 10                     | 4                       | 1          | 1                          | 94              | 253031       | Total |

| <i>Brillia flavifrons</i> | <i>Diplocladius</i> sp. | <i>Endochironomus nigricans</i> | <i>Hudsonimyia</i> sp. | <i>Microsectra</i> sp. | <i>Rheotanytarsus distinctissimus</i> group | <i>Paracapnia opis</i> | <i>Taeniopteryx</i> sp. | <i>Chimarra</i> sp. | <i>Optioservus</i> sp. | <i>Nigronia serricornis</i> | Total Organisms | Surface Area |       |
|---------------------------|-------------------------|---------------------------------|------------------------|------------------------|---|------------------------|-------------------------|---------------------|------------------------|-----------------------------|-----------------|--------------|-------|
| 0                         | 0                       | 0                               | 0                      | 1                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 1               | 6665         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 1                      | 0                       | 0                   | 0                      | 0                           | 1               | 5451         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 5552         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 1                   | 0                      | 0                           | 1               | 5612         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 5291         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 5119         |       |
| 0                         | 2                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 2               | 6887         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 4674         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 7210         |       |
| 0                         | 1                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 1               | 5724         |       |
| 0                         | 1                       | 0                               | 1                      | 0                      | 0   | 0                      | 1                       | 0                   | 0                      | 0                           | 3               | 8182         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 1                       | 0                   | 0                      | 0                           | 1               | 9285         |       |
| 0                         | 1                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 1               | 4841         |       |
| 0                         | 1                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 1               | 6172         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 7706         |       |
| 0                         | 1                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 1                      | 0                           | 2               | 4771         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 5880         |       |
| 0                         | 1                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 1               | 5731         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 5948         |       |
| 0                         | 7                       | 1                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 8               | 5909         |       |
| 0                         | 1                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 1               | 6873         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 1                      | 0                       | 0                   | 0                      | 1                           | 2               | 5608         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 6081         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 4978         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 6029         |       |
| 0                         | 3                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 3               | 4827         |       |
| 1                         | 1                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 2               | 7816         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 6242         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 1   | 0                      | 0                       | 0                   | 0                      | 0                           | 1               | 4941         |       |
| 0                         | 0                       | 0                               | 0                      | 0                      | 0   | 0                      | 0                       | 0                   | 0                      | 0                           | 0               | 5664         |       |
| 1                         | 20                      | 1                               | 1                      | 1                      | 1   | 2                      | 2                       | 1                   | 1                      | 1                           | 32              | 181669       | Total |

| <i>Conchapelopia</i> sp. | <i>Cricotopus tremulus</i> group | <i>Diamesa</i> sp. | <i>Diplocladius</i> sp. | <i>Hudsonimyia</i> sp. | <i>Micropsectra</i> sp. | <i>Microtendipes caelum</i> | <i>Parametriocnemus lundbecki</i> | <i>Rheotanytarsus distinctissimus</i> group | <i>Trissopelopia ogemawi</i> | <i>Baetis brunneicolor</i> | <i>Eurylophella bicolor</i> | <i>Paraleptophlebia</i> sp. | <i>Serratella deficiens</i> | <i>Isoperla marlynia</i> | <i>Paracapnia opis</i> | <i>Taeniopteryx maura</i> | <i>Hydatophylax</i> sp. | <i>Neophylax</i> sp. | <i>Calopteryx maculata</i> | Total Organisms | Surface Area |
|--------------------------|----------------------------------|--------------------|-------------------------|------------------------|-------------------------|-----------------------------|-----------------------------------|---|------------------------------|----------------------------|-----------------------------|-----------------------------|-----------------------------|--------------------------|------------------------|---------------------------|-------------------------|----------------------|----------------------------|-----------------|--------------|
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 0               | 6288         |
| 1                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 1                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 1                      | 0                         | 0                       | 0                    | 0                          | 3               | 4779         |
| 0                        | 0                                | 0                  | 1                       | 0                      | 0                       | 1                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 2               | 4829         |
| 0                        | 0                                | 1                  | 0                       | 0                      | 0                       | 0                           | 1                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 1                      | 0                         | 0                       | 0                    | 0                          | 3               | 5592         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 0               | 6425         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 2                           | 1                        | 2                      | 0                         | 0                       | 0                    | 0                          | 5               | 4800         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 0               | 5032         |
| 1                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 1               | 4564         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 1                      | 0                         | 0                       | 0                    | 1                          | 2               | 4423         |
| 0                        | 0                                | 0                  | 1                       | 0                      | 0                       | 0                           | 0                                 | 1   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 2               | 5016         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 1                      | 1                         | 0                       | 1                    | 0                          | 3               | 7747         |
| 0                        | 1                                | 0                  | 0                       | 0                      | 0                       | 0                           | 1                                 | 0   | 0                            | 0                          | 1                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 3               | 5797         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 0               | 4841         |
| 1                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 1                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 2               | 5152         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 0               | 5154         |
| 0                        | 0                                | 0                  | 1                       | 0                      | 1                       | 0                           | 0                                 | 0   | 0                            | 1                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 3               | 4528         |
| 0                        | 0                                | 0                  | 1                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 1                         | 0                       | 0                    | 0                          | 2               | 4495         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 0               | 6754         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 0               | 4261         |
| 0                        | 0                                | 0                  | 2                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 2               | 6269         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 0               | 5256         |
| 0                        | 0                                | 0                  | 1                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 5                      | 0                         | 0                       | 0                    | 0                          | 6               | 5797         |
| 0                        | 0                                | 0                  | 1                       | 1                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 1                      | 0                         | 1                       | 0                    | 0                          | 4               | 6587         |
| 0                        | 0                                | 0                  | 1                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 1               | 5830         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 0               | 5134         |
| 1                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 1               | 4873         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 0               | 5125         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 1                       | 0                           | 2                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 1                         | 1                       | 0                    | 0                          | 5               | 4642         |
| 0                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 0                                 | 0   | 1                            | 0                          | 0                           | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                    | 0                          | 1               | 4634         |
| 1                        | 0                                | 0                  | 0                       | 0                      | 0                       | 0                           | 1                                 | 0   | 0                            | 0                          | 0                           | 0                           | 0                           | 0                        | 1                      | 0                         | 0                       | 0                    | 0                          | 3               | 4330         |
| 5                        | 1                                | 1                  | 9                       | 1                      | 2                       | 1                           | 6                                 | 1   | 1                            | 1                          | 1                           | 1                           | 2                           | 1                        | 13                     | 3                         | 2                       | 1                    | 1                          | 54              | 158954       |

Total

| <i>Brillia flavifrons</i> | <i>Brillia parva</i> | <i>Conchapelopia sp.</i> | <i>Diplocladius sp.</i> | <i>Micropsectra sp.</i> | <i>Parametrioctonus lundbecki</i> | <i>Paraphaenocladus sp. 1</i> | <i>Rheopelopia acra/perda</i> | <i>Rheotanytarsus exiguus group</i> | <i>Baetis brunneicolor</i> | <i>Stenonema modestum</i> | <i>Eurylophella funeralis</i> | <i>Leptophlebia sp.</i> | <i>Paraleptophlebia sp.</i> | <i>Serratella deficiens</i> | <i>Isoperla marlynia</i> | <i>Paracapnia opis</i> | <i>Taeniopteryx maura</i> | <i>Hydatophylax sp.</i> | <i>Boyeria vinosa</i> | <i>Nigronia serricornis</i> | <i>Asellus communis</i> | Total Organisms | Surface Area |
|---------------------------|----------------------|--------------------------|-------------------------|-------------------------|-----------------------------------|-------------------------------|-------------------------------|-------------------------------------|----------------------------|---------------------------|-------------------------------|-------------------------|-----------------------------|-----------------------------|--------------------------|------------------------|---------------------------|-------------------------|-----------------------|-----------------------------|-------------------------|-----------------|--------------|
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 1                       | 1               | 4674         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 0               | 4690         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 0               | 4883         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 1                      | 1                         | 0                       | 0                     | 0                           | 0                       | 2               | 5096         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 1                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 1               | 4719         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 0               | 5737         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 1                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 1               | 4642         |
| 1                         | 0                    | 1                        | 0                       | 0                       | 2                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 1                       | 2                           | 1                           | 0                        | 0                      | 0                         | 0                       | 1                     | 0                           | 0                       | 9               | 6734         |
| 0                         | 1                    | 0                        | 0                       | 0                       | 0                                 | 1                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 2               | 5366         |
| 0                         | 0                    | 0                        | 1                       | 0                       | 1                                 | 0                             | 1                             | 1                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 1                      | 0                         | 0                       | 0                     | 0                           | 0                       | 5               | 5192         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 1                         | 1                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 2               | 4692         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 2                        | 1                      | 0                         | 0                       | 0                     | 0                           | 0                       | 3               | 7177         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 1                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 1               | 5215         |
| 0                         | 0                    | 1                        | 1                       | 0                       | 1                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 1                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 4               | 5231         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 1                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 1               | 5830         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 2                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 2               | 6000         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 0               | 5476         |
| 0                         | 0                    | 0                        | 1                       | 0                       | 4                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 1                           | 1                           | 2                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 9               | 5326         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 0               | 5344         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 1                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 1                       | 0                           | 0                           | 1                        | 0                      | 1                         | 0                       | 0                     | 0                           | 0                       | 4               | 6978         |
| 0                         | 0                    | 0                        | 1                       | 0                       | 1                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 2               | 4560         |
| 0                         | 0                    | 0                        | 1                       | 1                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 2               | 6133         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 1                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 1                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 2               | 8314         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 0               | 7141         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 1                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 1               | 5466         |
| 0                         | 0                    | 0                        | 2                       | 0                       | 1                                 | 0                             | 0                             | 0                                   | 1                          | 0                         | 0                             | 0                       | 0                           | 0                           | 1                        | 0                      | 0                         | 1                       | 0                     | 0                           | 0                       | 6               | 5057         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 1                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 1               | 5221         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 0               | 5179         |
| 0                         | 0                    | 0                        | 1                       | 0                       | 0                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 1                             | 0                       | 0                           | 0                           | 0                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 2               | 7090         |
| 0                         | 0                    | 0                        | 0                       | 0                       | 1                                 | 0                             | 0                             | 0                                   | 0                          | 0                         | 0                             | 0                       | 0                           | 1                           | 1                        | 0                      | 0                         | 0                       | 0                     | 0                           | 0                       | 3               | 5760         |
| 1                         | 1                    | 2                        | 8                       | 1                       | 16                                | 2                             | 1                             | 1                                   | 1                          | 1                         | 1                             | 2                       | 2                           | 3                           | 5                        | 12                     | 2                         | 1                       | 1                     | 1                           | 1                       | 66              | 168923       |
|                           |                      |                          |                         |                         |                                   |                               |                               |                                     |                            |                           |                               |                         |                             |                             |                          |                        |                           |                         |                       |                             |                         | Total           |              |



| <i>Brillia flavifrons</i> | <i>Chaoborus sp.</i> | <i>Conchapelopia sp.</i> | <i>Cricotopus sylvestris</i> group | <i>Cricotopus tremulus</i> group | <i>Diplocladius sp.</i> | <i>Meropelopia flavifrons</i> | <i>Micropsectra sp.</i> | <i>Parametrioctenemus lundbecki</i> | <i>Paraphaenocladus sp. 1</i> | <i>Polypedilum aviceps</i> | <i>Polypedilum laetum</i> | <i>Rheopelopia acra/perda</i> | <i>Rheotanytarsus distinctissimus</i> group | <i>Tanytarsus sp.</i> | <i>Trissopelopia ogemawi</i> | <i>Baetis brunneicolor</i> | <i>Eurylophella sp.</i> | <i>Leptophlebia sp.</i> | <i>Paraleptophlebia sp.</i> | <i>Stenonema modestum</i> | <i>Paracapnia opis</i> | <i>Taeniopteryx maura</i> | <i>Calopteryx maculata</i> | <i>Asellus communis</i> | Total Organisms | Surface Area |       |
|---------------------------|----------------------|--------------------------|------------------------------------|----------------------------------|-------------------------|-------------------------------|-------------------------|-------------------------------------|-------------------------------|----------------------------|---------------------------|-------------------------------|---|-----------------------|------------------------------|----------------------------|-------------------------|-------------------------|-----------------------------|---------------------------|------------------------|---------------------------|----------------------------|-------------------------|-----------------|--------------|-------|
| 0                         | 0                    | 0                        | 0                                  | 0                                | 5                       | 0                             | 1                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 2                     | 0                            | 0                          | 0                       | 1                       | 0                           | 0                         | 0                      | 0                         | 0                          | 9                       | 5652            |              |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 3                       | 0                             | 2                       | 2                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 7               | 5583         |       |
| 0                         | 1                    | 0                        | 0                                  | 0                                | 3                       | 0                             | 2                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 1                         | 0                          | 0                       | 7               | 5572         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 2                       | 0                             | 5                       | 1                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 1                       | 9               | 5177         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 1                       | 0                             | 3                       | 0                                   | 1                             | 0                          | 0                         | 0                             | 1   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 6               | 5752         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 7                       | 0                             | 2                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 9               | 5104         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 3                       | 0                             | 2                       | 0                                   | 0                             | 0                          | 1                         | 0                             | 0   | 0                     | 1                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 1                          | 0                       | 8               | 6300         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 3                       | 0                             | 0                       | 1                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 4               | 5132         |       |
| 0                         | 0                    | 1                        | 0                                  | 0                                | 8                       | 0                             | 3                       | 1                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 1                          | 0                       | 14              | 6894         |       |
| 0                         | 0                    | 1                        | 0                                  | 1                                | 9                       | 0                             | 0                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 11              | 6966         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 1                       | 0                             | 2                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 3               | 5758         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 2                       | 0                             | 2                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 1                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 5               | 5345         |       |
| 0                         | 0                    | 1                        | 0                                  | 0                                | 1                       | 0                             | 1                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 1                          | 0                       | 4               | 4650         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 0                       | 0                             | 0                       | 0                                   | 1                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 1                      | 0                         | 2                          | 0                       | 4               | 5497         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 5                       | 0                             | 1                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 1                         | 0                          | 0                       | 7               | 4854         |       |
| 0                         | 0                    | 1                        | 0                                  | 0                                | 8                       | 0                             | 5                       | 2                                   | 0                             | 0                          | 0                         | 0                             | 0   | 1                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 17              | 5258         |       |
| 0                         | 0                    | 1                        | 1                                  | 0                                | 5                       | 0                             | 1                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 8               | 5798         |       |
| 0                         | 0                    | 1                        | 0                                  | 0                                | 2                       | 1                             | 0                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 4               | 5186         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 4                       | 0                             | 1                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 5               | 6275         |       |
| 1                         | 0                    | 0                        | 0                                  | 0                                | 5                       | 0                             | 2                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 8               | 4759         |       |
| 0                         | 0                    | 2                        | 0                                  | 0                                | 3                       | 0                             | 4                       | 1                                   | 0                             | 0                          | 0                         | 1                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 11              | 4760         |       |
| 0                         | 0                    | 1                        | 0                                  | 1                                | 7                       | 0                             | 1                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 1                         | 0                      | 0                         | 0                          | 0                       | 11              | 5488         |       |
| 0                         | 0                    | 0                        | 0                                  | 1                                | 8                       | 0                             | 2                       | 0                                   | 1                             | 0                          | 0                         | 0                             | 0   | 1                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 13              | 5085         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 7                       | 1                             | 2                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 1                           | 0                         | 0                      | 0                         | 0                          | 0                       | 11              | 5975         |       |
| 0                         | 0                    | 0                        | 0                                  | 2                                | 7                       | 0                             | 3                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 1                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 13              | 8328         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 10                      | 0                             | 3                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 1                         | 0                      | 0                         | 0                          | 0                       | 14              | 4700         |       |
| 0                         | 0                    | 0                        | 0                                  | 0                                | 12                      | 1                             | 4                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 1                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 18              | 6745         |       |
| 0                         | 0                    | 1                        | 0                                  | 0                                | 7                       | 0                             | 0                       | 0                                   | 0                             | 1                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 1                          | 0                       | 10              | 4831         |       |
| 0                         | 0                    | 0                        | 0                                  | 1                                | 10                      | 0                             | 2                       | 0                                   | 0                             | 0                          | 0                         | 0                             | 0   | 0                     | 0                            | 0                          | 0                       | 0                       | 0                           | 0                         | 0                      | 0                         | 0                          | 0                       | 13              | 5821         |       |
| 1                         | 1                    | 10                       | 1                                  | 6                                | 152                     | 3                             | 56                      | 9                                   | 3                             | 1                          | 1                         | 1                             | 1   | 5                     | 2                            | 1                          | 1                       | 1                       | 1                           | 1                         | 3                      | 3                         | 5                          | 1                       | 270             | 168546       | Total |

|   |   |   |    |   |   |     |   |   |   |    |    |   |   |   |   |   |   |   |   |   |       |
|---|---|---|----|---|---|-----|---|---|---|----|----|---|---|---|---|---|---|---|---|---|-------|
| <i>Brillia flavifrons</i>                   | 0 | 0 | 0  | 0 | 0 | 12  | 0 | 0 | 0 | 2  | 0  | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0     |
| <i>Brillia parva</i>                        | 0 | 0 | 2  | 0 | 0 | 1   | 0 | 0 | 0 | 0  | 2  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Conchapelopia sp.</i>                    | 0 | 0 | 1  | 0 | 0 | 3   | 0 | 0 | 0 | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Cricotopus sylvestris</i> group          | 0 | 0 | 3  | 0 | 0 | 4   | 0 | 0 | 0 | 0  | 1  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Cricotopus tremulus</i> group            | 0 | 0 | 1  | 0 | 1 | 9   | 1 | 0 | 0 | 2  | 3  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0     |
| <i>Diplocladius sp.</i>                     | 0 | 1 | 0  | 0 | 0 | 4   | 0 | 0 | 0 | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Eukiefferiella bavarica</i> group        | 0 | 0 | 0  | 0 | 0 | 7   | 0 | 0 | 0 | 3  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Hudsonimyia sp.</i>                      | 0 | 0 | 1  | 0 | 0 | 10  | 0 | 1 | 0 | 2  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Meropelopia flavifrons</i>               | 0 | 0 | 1  | 0 | 0 | 1   | 0 | 0 | 0 | 1  | 1  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Micropsectra sp.</i>                     | 0 | 0 | 1  | 0 | 0 | 9   | 0 | 0 | 1 | 2  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Parametrioctenemus lundbecki</i>         | 0 | 0 | 1  | 0 | 0 | 14  | 0 | 0 | 0 | 2  | 1  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Paraphaenocladus sp. 1</i>               | 0 | 0 | 0  | 0 | 0 | 1   | 0 | 0 | 0 | 1  | 0  | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0     |
| <i>Polypedilum aviceps</i>                  | 0 | 0 | 0  | 0 | 0 | 5   | 0 | 0 | 0 | 3  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Rheopelopia acra/perda</i>               | 0 | 0 | 1  | 0 | 0 | 3   | 0 | 1 | 0 | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Rheotanytarsus distinctissimus</i> group | 0 | 0 | 0  | 0 | 0 | 2   | 0 | 0 | 0 | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Rheotanytarsus exiguus</i> group         | 0 | 0 | 2  | 0 | 0 | 3   | 0 | 0 | 0 | 1  | 1  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0     |
| <i>Tanytarsus sp.</i>                       | 0 | 0 | 0  | 0 | 0 | 5   | 0 | 0 | 0 | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Trissopelopia ogemawi</i>                | 0 | 0 | 0  | 0 | 0 | 7   | 0 | 0 | 0 | 2  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| <i>Stegopterna mutata</i> complex           | 0 | 0 | 0  | 0 | 0 | 4   | 0 | 0 | 0 | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
| Other Diptera                               | 0 | 0 | 0  | 1 | 0 | 6   | 0 | 1 | 0 | 2  | 1  | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1     |
|   | 0 | 0 | 0  | 0 | 0 | 4   | 0 | 0 | 0 | 2  | 1  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
|   | 0 | 0 | 0  | 1 | 0 | 14  | 0 | 0 | 0 | 10 | 1  | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0     |
|   | 1 | 0 | 0  | 0 | 0 | 11  | 0 | 0 | 0 | 3  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
|   | 0 | 0 | 0  | 0 | 0 | 4   | 0 | 0 | 0 | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0     |
|   | 1 | 1 | 18 | 2 | 3 | 170 | 1 | 3 | 1 | 50 | 15 | 3 | 1 | 1 | 1 | 2 | 4 | 6 | 1 | 1 |       |
|   |   |   |    |   |   |     |   |   |   |    |    |   |   |   |   |   |   |   |   |   | Total |

| <i>Baetis brunneicolor</i> | <i>Leptophlebia sp.</i> | <i>Paraleptophlebia sp.</i> | <i>Stenonema modestum</i> | <i>Isoperla marlynia</i> | <i>Paracapnia opis</i> | <i>Taeniopteryx maura</i> | <i>Taeniopteryx parvula</i> | <i>Cheumatopsyche sp.</i> | <i>Hydatophylax sp.</i> | <i>Pycnopsyche sp.</i> | <i>Calopteryx maculata</i> | <i>Physa sp.</i> | <i>Asellus communis</i> | Total Organisms | Surface Area |
|----------------------------|-------------------------|-----------------------------|---------------------------|--------------------------|------------------------|---------------------------|-----------------------------|---------------------------|-------------------------|------------------------|----------------------------|------------------|-------------------------|-----------------|--------------|
| 0                          | 0                       | 2                           | 0                         | 1                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 1                | 0                       | 19              | 5327         |
| 0                          | 0                       | 0                           | 1                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 3                       | 9               | 3776         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 1                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 5               | 4622         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 8               | 5712         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 1                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 19              | 5416         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 1                         | 0                       | 0                      | 0                          | 0                | 0                       | 6               | 5766         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 1                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 11              | 6179         |
| 0                          | 0                       | 0                           | 1                         | 0                        | 1                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 16              | 5530         |
| 1                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 5               | 6875         |
| 0                          | 1                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 1                      | 0                          | 0                | 0                       | 15              | 5005         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 1                      | 0                         | 0                           | 0                         | 0                       | 1                      | 0                          | 0                | 0                       | 20              | 5084         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 3               | 7104         |
| 0                          | 1                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 9               | 5142         |
| 0                          | 1                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 6               | 4601         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 1                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 3               | 5084         |
| 0                          | 3                       | 0                           | 0                         | 0                        | 1                      | 1                         | 1                           | 1                         | 1                       | 0                      | 0                          | 0                | 0                       | 16              | 5308         |
| 0                          | 1                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 8               | 5030         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 1                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 10              | 4644         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 1                          | 0                | 0                       | 5               | 6586         |
| 0                          | 0                       | 1                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 15              | 4958         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 1                         | 0                       | 0                      | 0                          | 0                | 0                       | 8               | 6022         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 7               | 6813         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 11              | 6444         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 1                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 9               | 6597         |
| 0                          | 2                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 11              | 5683         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 8               | 7877         |
| 0                          | 1                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 14              | 4528         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 3                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 32              | 6288         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 15              | 5353         |
| 0                          | 0                       | 0                           | 0                         | 0                        | 0                      | 0                         | 0                           | 0                         | 0                       | 0                      | 0                          | 0                | 0                       | 4               | 5840         |
| 1                          | 10                      | 3                           | 2                         | 1                        | 6                      | 4                         | 4                           | 3                         | 1                       | 2                      | 1                          | 1                | 3                       | 327             | 169194       |
|                            |                         |                             |                           |                          |                        |                           |                             |                           |                         |                        |                            |                  |                         |                 | Total        |

| <i>Conchapelopia</i> sp. | <i>Diplocladius</i> sp. | <i>Hudsonimyia</i> sp. | <i>Meropelopia flavifrons</i> | <i>Micropsectra</i> sp. | <i>Orthocladius oliveri</i> | <i>Parametriocnemus lundbecki</i> | <i>Paratanytarsus</i> sp. 2 | <i>Polypedilum illinoense</i> | <i>Rheotanytarsus exiguus</i> group | <i>Tanytarsus</i> sp. | <i>Thienemanniella</i> sp. 1 | <i>Stegopterna mutata</i> complex | <i>Hemerodromia</i> sp. | <i>Hydropsyche</i> sp. 1 | <i>Hyaella azteca</i> | Oligochaeta | Total Organisms | Surface Area |       |
|--------------------------|-------------------------|------------------------|-------------------------------|-------------------------|-----------------------------|-----------------------------------|-----------------------------|-------------------------------|-------------------------------------|-----------------------|------------------------------|-----------------------------------|-------------------------|--------------------------|-----------------------|-------------|-----------------|--------------|-------|
| 0                        | 1                       | 0                      | 0                             | 0                       | 1                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 2               | 4827         |       |
| 3                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 3               | 5098         |       |
| 4                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 4               | 5749         |       |
| 0                        | 0                       | 0                      | 0                             | 0                       | 2                           | 0                                 | 1                           | 0                             | 0                                   | 0                     | 1                            | 0                                 | 0                       | 0                        | 1                     | 0           | 5               | 6230         |       |
| 1                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 1                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 2               | 5219         |       |
| 0                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 3                           | 0                             | 0                                   | 0                     | 0                            | 1                                 | 1                       | 0                        | 0                     | 1           | 6               | 7440         |       |
| 1                        | 1                       | 0                      | 1                             | 0                       | 0                           | 0                                 | 1                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 4               | 5523         |       |
| 0                        | 1                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 1                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 2               | 5362         |       |
| 1                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 1                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 2               | 6425         |       |
| 1                        | 1                       | 0                      | 1                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 3               | 6201         |       |
| 0                        | 0                       | 0                      | 0                             | 0                       | 0                           | 1                                 | 0                           | 0                             | 2                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 3               | 4141         |       |
| 0                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 1                           | 0                             | 0                                   | 0                     | 1                            | 0                                 | 0                       | 0                        | 0                     | 0           | 2               | 4819         |       |
| 0                        | 0                       | 0                      | 0                             | 1                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 1               | 6477         |       |
| 1                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 1                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 2               | 5501         |       |
| 0                        | 1                       | 0                      | 0                             | 0                       | 1                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 1                                 | 0                       | 0                        | 0                     | 0           | 3               | 5567         |       |
| 3                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 3               | 5892         |       |
| 0                        | 0                       | 0                      | 0                             | 0                       | 1                           | 0                                 | 0                           | 0                             | 1                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 2               | 7888         |       |
| 0                        | 1                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 1               | 5612         |       |
| 0                        | 1                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 2                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 3               | 4999         |       |
| 0                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 0               | 5403         |       |
| 1                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 1                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 2               | 5946         |       |
| 2                        | 2                       | 0                      | 0                             | 1                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 1                        | 0                     | 0           | 6               | 5132         |       |
| 1                        | 2                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 1                                 | 0                       | 0                        | 0                     | 0           | 4               | 6991         |       |
| 4                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 4               | 5575         |       |
| 2                        | 1                       | 0                      | 0                             | 0                       | 1                           | 0                                 | 0                           | 0                             | 1                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 5               | 5532         |       |
| 3                        | 0                       | 0                      | 1                             | 0                       | 0                           | 0                                 | 0                           | 1                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 1                     | 0           | 6               | 8444         |       |
| 0                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 1                            | 0                                 | 0                       | 0                        | 0                     | 0           | 1               | 8075         |       |
| 0                        | 0                       | 0                      | 0                             | 1                       | 2                           | 0                                 | 1                           | 0                             | 1                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 5               | 8083         |       |
| 1                        | 0                       | 0                      | 0                             | 0                       | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                     | 1                            | 0                                 | 0                       | 0                        | 0                     | 0           | 2               | 5612         |       |
| 1                        | 0                       | 1                      | 0                             | 0                       | 0                           | 1                                 | 3                           | 0                             | 0                                   | 0                     | 0                            | 0                                 | 0                       | 0                        | 0                     | 0           | 6               | 6684         |       |
| 30                       | 12                      | 1                      | 3                             | 3                       | 8                           | 2                                 | 12                          | 1                             | 9                                   | 1                     | 4                            | 3                                 | 1                       | 1                        | 2                     | 1           | 94              | 180447       | Total |

| <i>Conchapelopia</i> sp. | <i>Diplocladius</i> sp. | <i>Hydrobaenus pilipes</i> | <i>Micropectra</i> sp. | <i>Nanocladius</i> sp. 1 | <i>Nanocladius</i> sp. 2 | <i>Orthocladius oliveri</i> | <i>Paramerina</i> sp. | <i>Parametrioctenus lundbecki</i> | <i>Paraphaenocladius</i> sp. 2 | <i>Paratanytarsus</i> sp. 2 | <i>Paratanytarsus</i> sp. 3 | <i>Phaenopsectra flavipes</i> | <i>Polypedilum illinoense</i> | <i>Rheotanytarsus distinctissimus</i> group | <i>Rheotanytarsus exiguus</i> group | <i>Tanytarsus</i> sp. | <i>Thienemanniella</i> prob. <i>xena</i> | <i>Thienemanniella</i> sp. 1 | Simuliidae | <i>Stegopterna mutata</i> complex | <i>Platycentropus</i> sp. | <i>Ptilostomis</i> sp. | <i>Pycnopsysche</i> sp. | <i>Chauliodes pectinicornis</i> | <i>Gyraulus</i> sp. | <i>Hyaella azteca</i> | Total Organisms | Surface Area |       |
|--------------------------|-------------------------|----------------------------|------------------------|--------------------------|--------------------------|-----------------------------|-----------------------|-----------------------------------|--------------------------------|-----------------------------|-----------------------------|-------------------------------|-------------------------------|---|-------------------------------------|-----------------------|--|------------------------------|------------|-----------------------------------|---------------------------|------------------------|-------------------------|---------------------------------|---------------------|-----------------------|-----------------|--------------|-------|
| 2                        | 2                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 1                             | 1   | 0                                   | 0                     | 0  | 0                            | 1          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 7                     | 6421            |              |       |
| 0                        | 2                       | 0                          | 0                      | 0                        | 0                        | 1                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 3                     | 4647            |              |       |
| 0                        | 2                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 1  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 3                     | 4694            |              |       |
| 0                        | 1                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 1                     | 6056            |              |       |
| 0                        | 1                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 1                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 2                     | 4543            |              |       |
| 1                        | 2                       | 0                          | 0                      | 1                        | 0                        | 0                           | 1                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 1                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 6                     | 5838            |              |       |
| 2                        | 1                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 1                              | 0                           | 0                           | 0                             | 0                             | 1   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 5                     | 4995            |              |       |
| 0                        | 0                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 2                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 1          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 3                     | 4906            |              |       |
| 0                        | 1                       | 0                          | 0                      | 0                        | 0                        | 0                           | 1                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 1                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 3                     | 4910            |              |       |
| 3                        | 1                       | 0                          | 0                      | 0                        | 0                        | 0                           | 1                     | 0                                 | 0                              | 0                           | 1                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 1          | 0                                 | 1                         | 0                      | 0                       | 0                               | 0                   | 8                     | 7105            |              |       |
| 2                        | 2                       | 0                          | 0                      | 0                        | 0                        | 0                           | 1                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 1                      | 1                       | 0                               | 0                   | 7                     | 4653            |              |       |
| 1                        | 0                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 1                     | 5733            |              |       |
| 0                        | 0                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 0                     | 4147            |              |       |
| 0                        | 0                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 0                     | 5637            |              |       |
| 0                        | 0                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 1                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 1                     | 5629            |              |       |
| 0                        | 0                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 1                         | 0                      | 0                       | 0                               | 0                   | 1                     | 5787            |              |       |
| 1                        | 0                       | 1                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 1                   | 3                     | 3834            |              |       |
| 0                        | 0                       | 0                          | 0                      | 0                        | 0                        | 1                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 1                     | 4375            |              |       |
| 2                        | 2                       | 0                          | 0                      | 0                        | 2                        | 0                           | 1                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 2   | 1                                   | 0                     | 0  | 0                            | 1          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 11                    | 5948            |              |       |
| 1                        | 0                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 1                     | 5774            |              |       |
| 3                        | 0                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 3                     | 6808            |              |       |
| 0                        | 0                       | 0                          | 1                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 1                              | 0                           | 0                           | 0                             | 0                             | 1   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 3                     | 4423            |              |       |
| 0                        | 0                       | 0                          | 0                      | 0                        | 1                        | 0                           | 0                     | 0                                 | 1                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 2                     | 6052            |              |       |
| 2                        | 1                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 1                              | 0                           | 0                           | 0                             | 0                             | 1   | 0                                   | 0                     | 0  | 0                            | 1          | 0                                 | 0                         | 0                      | 0                       | 0                               | 1                   | 7                     | 7144            |              |       |
| 1                        | 0                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 1                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 2                     | 3938            |              |       |
| 0                        | 0                       | 0                          | 0                      | 0                        | 1                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 1                               | 0                   | 2                     | 7249            |              |       |
| 0                        | 2                       | 0                          | 1                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 0                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 3                     | 4336            |              |       |
| 1                        | 0                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 0   | 0                                   | 1                     | 0  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 2                     | 4688            |              |       |
| 0                        | 1                       | 0                          | 0                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 0                              | 0                           | 0                           | 0                             | 0                             | 1   | 0                                   | 0                     | 1  | 0                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 3                     | 7032            |              |       |
| 0                        | 0                       | 0                          | 1                      | 0                        | 0                        | 0                           | 0                     | 0                                 | 1                              | 1                           | 0                           | 0                             | 0                             | 2   | 0                                   | 0                     | 0  | 1                            | 0          | 0                                 | 0                         | 0                      | 0                       | 0                               | 0                   | 6                     | 5996            |              |       |
| 22                       | 21                      | 1                          | 3                      | 1                        | 2                        | 3                           | 2                     | 4                                 | 1                              | 7                           | 3                           | 1                             | 1                             | 1   | 8                                   | 1                     | 1  | 2                            | 1          | 6                                 | 1                         | 2                      | 1                       | 1                               | 1                   | 2                     | 100             | 163298       | Total |

| <i>Conchapelopia</i> sp. | <i>Corynoneura</i> taris | <i>Diplocladius</i> sp. | <i>Hydrobaenus</i> pilipes | <i>Micropsectra</i> sp. | <i>Nanocladius</i> sp. 1 | <i>Orthocladius</i> oliveri | <i>Paramerina</i> sp. | <i>Parametrioctenus</i> lundbecki | <i>Paratanytarsus</i> sp. 2 | <i>Thienemanniella</i> sp. 1 | <i>Leptophlebia</i> sp. | <i>Paracapnia</i> opis | <i>Ptilostomis</i> sp. | Total Organisms | Surface Area |
|--------------------------|--------------------------|-------------------------|----------------------------|-------------------------|--------------------------|-----------------------------|-----------------------|-----------------------------------|-----------------------------|------------------------------|-------------------------|------------------------|------------------------|-----------------|--------------|
| 2                        | 0                        | 0                       | 0                          | 0                       | 0                        | 2                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 4               | 4877         |
| 1                        | 0                        | 0                       | 0                          | 0                       | 0                        | 1                           | 0                     | 0                                 | 0                           | 0                            | 1                       | 1                      | 0                      | 4               | 5202         |
| 1                        | 0                        | 0                       | 0                          | 0                       | 0                        | 0                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 1               | 4945         |
| 0                        | 0                        | 0                       | 0                          | 0                       | 0                        | 0                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 0               | 5262         |
| 0                        | 0                        | 1                       | 0                          | 0                       | 0                        | 3                           | 0                     | 0                                 | 2                           | 0                            | 0                       | 0                      | 0                      | 6               | 7463         |
| 0                        | 0                        | 0                       | 0                          | 0                       | 0                        | 2                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 2               | 5629         |
| 0                        | 0                        | 2                       | 0                          | 0                       | 1                        | 1                           | 0                     | 1                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 5               | 5598         |
| 0                        | 0                        | 0                       | 1                          | 0                       | 0                        | 1                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 2               | 5026         |
| 0                        | 0                        | 0                       | 0                          | 0                       | 0                        | 0                           | 0                     | 0                                 | 1                           | 0                            | 0                       | 0                      | 0                      | 1               | 4945         |
| 0                        | 0                        | 0                       | 0                          | 0                       | 0                        | 0                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 0               | 5941         |
| 0                        | 0                        | 0                       | 0                          | 0                       | 0                        | 0                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 0               | 5650         |
| 0                        | 0                        | 0                       | 0                          | 1                       | 0                        | 0                           | 0                     | 0                                 | 1                           | 0                            | 0                       | 0                      | 0                      | 2               | 6412         |
| 1                        | 0                        | 2                       | 0                          | 0                       | 0                        | 3                           | 1                     | 0                                 | 0                           | 0                            | 0                       | 1                      | 0                      | 8               | 6060         |
| 2                        | 0                        | 3                       | 0                          | 0                       | 0                        | 0                           | 1                     | 0                                 | 0                           | 0                            | 0                       | 1                      | 0                      | 7               | 5583         |
| 0                        | 0                        | 0                       | 1                          | 0                       | 0                        | 6                           | 0                     | 0                                 | 0                           | 0                            | 1                       | 0                      | 0                      | 8               | 5998         |
| 0                        | 1                        | 0                       | 0                          | 0                       | 0                        | 0                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 1               | 5579         |
| 0                        | 0                        | 0                       | 0                          | 0                       | 0                        | 3                           | 0                     | 0                                 | 1                           | 1                            | 0                       | 0                      | 0                      | 5               | 5753         |
| 0                        | 0                        | 1                       | 0                          | 0                       | 0                        | 0                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 1               | 5687         |
| 1                        | 0                        | 0                       | 0                          | 0                       | 0                        | 3                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 4               | 4415         |
| 0                        | 0                        | 0                       | 1                          | 0                       | 0                        | 3                           | 0                     | 0                                 | 1                           | 0                            | 0                       | 0                      | 0                      | 5               | 5312         |
| 0                        | 0                        | 0                       | 0                          | 0                       | 0                        | 1                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 1               | 4910         |
| 0                        | 0                        | 2                       | 0                          | 1                       | 0                        | 0                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 3               | 5069         |
| 0                        | 0                        | 1                       | 0                          | 0                       | 0                        | 0                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 1               | 3811         |
| 1                        | 0                        | 1                       | 1                          | 1                       | 0                        | 0                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 4               | 7565         |
| 1                        | 0                        | 0                       | 0                          | 0                       | 0                        | 0                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 1                      | 2               | 4261         |
| 0                        | 0                        | 1                       | 0                          | 0                       | 0                        | 1                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 2               | 4526         |
| 1                        | 0                        | 1                       | 0                          | 0                       | 0                        | 1                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 3               | 4560         |
| 1                        | 0                        | 1                       | 0                          | 0                       | 0                        | 0                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 2               | 4265         |
| 0                        | 0                        | 0                       | 1                          | 0                       | 0                        | 2                           | 0                     | 0                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 3               | 8036         |
| 0                        | 0                        | 0                       | 0                          | 0                       | 0                        | 0                           | 0                     | 1                                 | 0                           | 0                            | 0                       | 0                      | 0                      | 1               | 4207         |
| 12                       | 1                        | 16                      | 5                          | 3                       | 1                        | 33                          | 2                     | 1                                 | 7                           | 1                            | 2                       | 3                      | 1                      | 88              | 162547 Total |

| <i>Conchapelopia</i> sp. | <i>Cricotopus bicinctus</i> group | <i>Cricotopus tremulus</i> group | <i>Diplocladius</i> sp. | <i>Hydrobaenus pilipes</i> | <i>Micropsectra</i> sp. | <i>Nanocladius</i> sp. 1 | <i>Orthocladius oliveri</i> | <i>Parametrioctonus lundbecki</i> | <i>Paraphaenocladus</i> sp. 2 | <i>Paratanytarsus</i> sp. 2 | <i>Rheotanytarsus exiguus</i> group | <i>Thienemanniella</i> sp. 1 | <i>Simulium vittatum</i> complex | <i>Leptophlebia</i> sp. | <i>Paraleptophlebia</i> sp. | <i>Cheumatopsyche</i> sp. | <i>Coenagrion</i> sp. | <i>Hyaella azteca</i> | Total Organisms | Surface Area |       |
|--------------------------|-----------------------------------|----------------------------------|-------------------------|----------------------------|-------------------------|--------------------------|-----------------------------|-----------------------------------|-------------------------------|-----------------------------|-------------------------------------|------------------------------|----------------------------------|-------------------------|-----------------------------|---------------------------|-----------------------|-----------------------|-----------------|--------------|-------|
| 0                        | 0                                 | 1                                | 0                       | 0                          | 0                       | 0                        | 6                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 7               | 5252         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 0                           | 1                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 1               | 4479         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 1                           | 0                                 | 1                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 2               | 5575         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 1                        | 2                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 3               | 4893         |       |
| 1                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 1                           | 0                         | 0                     | 0                     | 2               | 5181         |       |
| 0                        | 0                                 | 0                                | 1                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 1                                | 0                       | 0                           | 0                         | 0                     | 0                     | 2               | 5544         |       |
| 0                        | 0                                 | 0                                | 1                       | 0                          | 1                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 1                     | 3               | 4966         |       |
| 1                        | 0                                 | 0                                | 1                       | 0                          | 0                       | 0                        | 1                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 3               | 6058         |       |
| 1                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 1                           | 1                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 3               | 5511         |       |
| 3                        | 0                                 | 0                                | 2                       | 0                          | 0                       | 0                        | 1                           | 0                                 | 0                             | 2                           | 0                                   | 1                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 9               | 7364         |       |
| 0                        | 0                                 | 0                                | 0                       | 1                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 1                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 2               | 5973         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 1                           | 0                                   | 0                            | 0                                | 1                       | 0                           | 0                         | 0                     | 0                     | 2               | 5559         |       |
| 0                        | 0                                 | 0                                | 1                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 1                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 2               | 5005         |       |
| 1                        | 0                                 | 0                                | 2                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 1                         | 0                     | 0                     | 4               | 5418         |       |
| 2                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 1                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 3               | 5567         |       |
| 3                        | 1                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 1                     | 5               | 4203         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 1                     | 0                     | 1               | 4068         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 2                           | 0                                 | 0                             | 1                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 3               | 5857         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 0               | 4688         |       |
| 0                        | 0                                 | 0                                | 1                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 1                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 2               | 5656         |       |
| 1                        | 0                                 | 0                                | 1                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 2               | 5074         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 1                       | 0                        | 1                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 2               | 4821         |       |
| 0                        | 0                                 | 0                                | 1                       | 0                          | 0                       | 0                        | 2                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 1                       | 0                           | 0                         | 0                     | 0                     | 4               | 5188         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 0               | 4195         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 3                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 3               | 3867         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 0               | 4400         |       |
| 1                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 1                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 2               | 5130         |       |
| 0                        | 0                                 | 0                                | 1                       | 0                          | 0                       | 0                        | 1                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 2               | 6342         |       |
| 0                        | 0                                 | 0                                | 0                       | 0                          | 0                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 1                     | 0                     | 1               | 6039         |       |
| 0                        | 0                                 | 0                                | 1                       | 0                          | 1                       | 0                        | 0                           | 0                                 | 0                             | 0                           | 0                                   | 0                            | 0                                | 0                       | 0                           | 0                         | 0                     | 0                     | 2               | 4653         |       |
| 14                       | 1                                 | 1                                | 13                      | 1                          | 3                       | 1                        | 21                          | 1                                 | 1                             | 8                           | 1                                   | 2                            | 1                                | 2                       | 1                           | 1                         | 2                     | 2                     | 77              | 156526       | Total |

| <i>Cricotopus tremulus</i> group | <i>Diplocladius</i> sp. | <i>Hydrobaenus pilipes</i> | <i>Micropsectra</i> sp. | <i>Rheotanytarsus exiguus</i> group | <i>Thienemanniella</i> sp. 1 | <i>Stegopterna mutata</i> complex | <i>Paracapnia opis</i> | <i>Taeniopteryx maura</i> | <i>Cheumatopsyche</i> sp. | <i>Hydatophylax</i> sp. | <i>Calopteryx maculata</i> | <i>Hyaella azteca</i> | Total Organisms | Surface Area |       |
|----------------------------------|-------------------------|----------------------------|-------------------------|-------------------------------------|------------------------------|-----------------------------------|------------------------|---------------------------|---------------------------|-------------------------|----------------------------|-----------------------|-----------------|--------------|-------|
| 0                                | 2                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 1                         | 0                         | 0                       | 0                          | 0                     | 4               | 3990         |       |
| 2                                | 2                       | 0                          | 0                       | 0                                   | 1                            | 0                                 | 2                      | 0                         | 0                         | 0                       | 0                          | 0                     | 7               | 5084         |       |
| 0                                | 1                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 0                         | 0                         | 0                       | 0                          | 0                     | 1               | 4025         |       |
| 0                                | 4                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 0                         | 0                         | 0                       | 0                          | 0                     | 5               | 5654         |       |
| 0                                | 3                       | 0                          | 1                       | 0                                   | 0                            | 0                                 | 0                      | 0                         | 0                         | 0                       | 1                          | 0                     | 5               | 6000         |       |
| 1                                | 0                       | 0                          | 0                       | 0                                   | 0                            | 1                                 | 0                      | 0                         | 0                         | 0                       | 0                          | 0                     | 2               | 6124         |       |
| 0                                | 3                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 0                         | 0                         | 0                       | 0                          | 0                     | 4               | 5921         |       |
| 0                                | 2                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 0                         | 0                         | 0                       | 0                          | 0                     | 2               | 4437         |       |
| 0                                | 4                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 0                         | 0                         | 0                       | 0                          | 0                     | 4               | 7061         |       |
| 1                                | 2                       | 0                          | 0                       | 1                                   | 0                            | 0                                 | 2                      | 2                         | 0                         | 0                       | 0                          | 0                     | 8               | 5832         |       |
| 0                                | 2                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 0                         | 0                         | 0                       | 0                          | 0                     | 2               | 6230         |       |
| 0                                | 5                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 2                      | 0                         | 0                         | 0                       | 0                          | 1                     | 8               | 6674         |       |
| 1                                | 2                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 2                         | 0                         | 0                       | 0                          | 0                     | 6               | 5554         |       |
| 0                                | 3                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 1                         | 0                         | 0                       | 0                          | 0                     | 5               | 5892         |       |
| 1                                | 3                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 1                         | 0                         | 0                       | 0                          | 0                     | 5               | 5998         |       |
| 0                                | 2                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 1                         | 0                         | 0                       | 0                          | 0                     | 3               | 5803         |       |
| 0                                | 3                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 1                         | 1                         | 0                       | 0                          | 0                     | 6               | 4841         |       |
| 0                                | 2                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 1                         | 0                         | 0                       | 0                          | 0                     | 3               | 4174         |       |
| 0                                | 2                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 2                      | 0                         | 0                         | 0                       | 0                          | 0                     | 4               | 5403         |       |
| 1                                | 0                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 0                         | 0                         | 0                       | 0                          | 0                     | 1               | 4307         |       |
| 2                                | 2                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 1                         | 0                         | 1                       | 0                          | 0                     | 7               | 5109         |       |
| 0                                | 5                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 2                         | 0                         | 0                       | 0                          | 0                     | 8               | 5194         |       |
| 0                                | 0                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 0                         | 0                         | 0                       | 0                          | 0                     | 1               | 6296         |       |
| 0                                | 2                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 0                         | 0                         | 0                       | 0                          | 0                     | 2               | 5208         |       |
| 0                                | 3                       | 1                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 1                         | 0                         | 0                       | 0                          | 0                     | 5               | 4452         |       |
| 1                                | 2                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 0                         | 0                         | 0                       | 0                          | 0                     | 4               | 6537         |       |
| 0                                | 0                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 1                         | 0                         | 0                       | 0                          | 0                     | 2               | 5722         |       |
| 0                                | 3                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 1                      | 0                         | 0                         | 0                       | 0                          | 0                     | 4               | 6506         |       |
| 0                                | 2                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 0                         | 0                         | 0                       | 0                          | 0                     | 2               | 6066         |       |
| 1                                | 0                       | 0                          | 0                       | 0                                   | 0                            | 0                                 | 0                      | 0                         | 0                         | 0                       | 0                          | 0                     | 1               | 6831         |       |
| 11                               | 66                      | 1                          | 1                       | 1                                   | 1                            | 1                                 | 20                     | 15                        | 1                         | 1                       | 1                          | 1                     | 121             | 166925       | Total |



| <i>Cricotopus tremulus</i> group | <i>Dicrotendipes neomodesius</i> | <i>Diplocladius</i> sp. | <i>Hydrobaenus pilipes</i> | <i>Parametriocnemus lundbecki</i> | <i>Paratanytarsus</i> sp. 2 | <i>Thienemanniella</i> prob. <i>xena</i> | <i>Paracapnia opis</i> | <i>Taeniopteryx maura</i> | <i>Calopteryx maculata</i> | Total Organisms | Surface Area |       |
|----------------------------------|----------------------------------|-------------------------|----------------------------|-----------------------------------|-----------------------------|--|------------------------|---------------------------|----------------------------|-----------------|--------------|-------|
| 0                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 0               | 6301         |       |
| 0                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 0               | 4460         |       |
| 0                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 1                      | 0                         | 2                          | 3               | 4651         |       |
| 0                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 1                      | 0                         | 0                          | 1               | 6429         |       |
| 0                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 0               | 5712         |       |
| 0                                | 0                                | 1                       | 0                          | 0                                 | 0                           | 0  | 1                      | 0                         | 0                          | 2               | 5001         |       |
| 0                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 1                      | 0                         | 0                          | 1               | 4628         |       |
| 0                                | 0                                | 1                       | 0                          | 0                                 | 0                           | 0  | 1                      | 0                         | 0                          | 2               | 4462         |       |
| 0                                | 0                                | 1                       | 1                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 2               | 5335         |       |
| 1                                | 0                                | 0                       | 1                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 2               | 7849         |       |
| 0                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 1                      | 0                         | 0                          | 1               | 5202         |       |
| 0                                | 0                                | 1                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 1                          | 2               | 4719         |       |
| 1                                | 0                                | 1                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 2               | 6877         |       |
| 2                                | 0                                | 3                       | 1                          | 1                                 | 0                           | 0  | 0                      | 0                         | 0                          | 7               | 5215         |       |
| 0                                | 0                                | 1                       | 0                          | 0                                 | 0                           | 0  | 0                      | 1                         | 0                          | 2               | 5409         |       |
| 1                                | 0                                | 0                       | 1                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 2               | 4750         |       |
| 0                                | 0                                | 1                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 1               | 4831         |       |
| 0                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 1                      | 0                         | 0                          | 1               | 3992         |       |
| 0                                | 0                                | 0                       | 0                          | 0                                 | 1                           | 0  | 1                      | 0                         | 0                          | 2               | 4348         |       |
| 0                                | 0                                | 0                       | 1                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 1               | 4433         |       |
| 0                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 0               | 5130         |       |
| 3                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 1                      | 0                         | 0                          | 4               | 4941         |       |
| 1                                | 0                                | 1                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 2               | 4412         |       |
| 0                                | 1                                | 1                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 2               | 6829         |       |
| 0                                | 0                                | 1                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 1               | 5275         |       |
| 0                                | 0                                | 1                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 1               | 5942         |       |
| 0                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 0               | 5200         |       |
| 0                                | 0                                | 0                       | 0                          | 0                                 | 0                           | 0  | 0                      | 0                         | 0                          | 0               | 7072         |       |
| 0                                | 0                                | 4                       | 0                          | 0                                 | 0                           | 1  | 0                      | 1                         | 0                          | 6               | 4796         |       |
| 0                                | 0                                | 1                       | 0                          | 0                                 | 0                           | 0  | 4                      | 0                         | 0                          | 5               | 11911        |       |
| 9                                | 1                                | 19                      | 5                          | 1                                 | 1                           | 1  | 13                     | 2                         | 3                          | 55              | 166112       | Total |

| <i>Conchapelopia</i> sp. | <i>Corynoneura taris</i> | <i>Micropsectra</i> sp. | <i>Nanocladius</i> sp. 1 | <i>Nanocladius</i> sp. 2 | <i>Nanocladius spinipennis</i> | <i>Orthocladius carlatus</i> group | <i>Orthocladius oliveri</i> | <i>Parakiefferiella</i> sp. | <i>Parametriocnemus lundbecki</i> | <i>Paratanytarsus</i> sp. 2 | <i>Phaenopsectra flavipes</i> | <i>Rheotanytarsus exiguus</i> group | <i>Thienemanniella</i> sp. 1 | Ephemerellidae | <i>Ephemerella invaria</i> | <i>Isoperla marlynia</i> | <i>Anobolia</i> sp. | Total Organisms | Surface Area |
|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|--------------------------------|------------------------------------|-----------------------------|-----------------------------|-----------------------------------|-----------------------------|-------------------------------|-------------------------------------|------------------------------|----------------|----------------------------|--------------------------|---------------------|-----------------|--------------|
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 5027         |
| 0                        | 0                        | 1                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 1               | 4854         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 5486         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 1                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 1               | 6869         |
| 0                        | 1                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 1              | 0                          | 0                        | 0                   | 2               | 3919         |
| 1                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 1               | 4428         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 1                            | 0              | 0                          | 0                        | 0                   | 1               | 4346         |
| 1                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 1                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 1                          | 1                        | 4                   | 5217            |              |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 5941         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 1                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 1               | 5818         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 1                          | 0                        | 0                   | 1               | 4457         |
| 0                        | 0                        | 1                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 1               | 4863         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 1                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 1                            | 0              | 0                          | 0                        | 0                   | 2               | 4307         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 5061         |
| 0                        | 0                        | 0                       | 1                        | 1                        | 0                              | 0                                  | 0                           | 0                           | 1                                 | 0                           | 0                             | 1                                   | 0                            | 0              | 0                          | 2                        | 0                   | 6               | 7476         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 1                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 1               | 5420         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 4414         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 1                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 1               | 4286         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 4134         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 1                                   | 0                            | 0              | 0                          | 0                        | 0                   | 1               | 3845         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 4142         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 4080         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 4628         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 5199         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 3923         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 3984         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 3682         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 1              | 0                          | 0                        | 0                   | 1               | 5110         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 4181         |
| 0                        | 0                        | 0                       | 0                        | 0                        | 0                              | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                            | 0              | 0                          | 0                        | 0                   | 0               | 4426         |
| 2                        | 1                        | 2                       | 1                        | 1                        | 1                              | 1                                  | 1                           | 1                           | 1                                 | 1                           | 1                             | 2                                   | 2                            | 2              | 1                          | 3                        | 1                   | 25              | 143523       |
|                          |                          |                         |                          |                          |                                |                                    |                             |                             |                                   |                             |                               |                                     |                              |                |                            |                          |                     |                 | Total        |

| <i>Conchapelopia</i> sp. | <i>Micropsectra</i> sp. | <i>Nanocladius</i> sp. 2 | <i>Paratanytarsus</i> sp. 2 | <i>Parakiefferiella</i> sp. | <i>Parametriocnemus lundbecki</i> | <i>Rheopelopia acra/perda</i> | <i>Rheotanytarsus distinctissimus</i> group | <i>Rheotanytarsus exiguus</i> group | <i>Thienemanniella</i> sp. 1 | <i>Ephemera</i> sp. | <i>Ephemera</i> sp. | <i>Stenonema modestum</i> | Plecoptera | <i>Isoperla marlynia</i> | <i>Tallaperla maria</i> | <i>Cheumatopsyche</i> sp. | <i>Hydropsyche</i> sp. | <i>Ectopria nervosa</i> | <i>Stenelmis</i> sp. | Total Organisms | Surface Area |
|--------------------------|-------------------------|--------------------------|-----------------------------|-----------------------------|-----------------------------------|-------------------------------|---|-------------------------------------|------------------------------|---------------------|---------------------|---------------------------|------------|--------------------------|-------------------------|---------------------------|------------------------|-------------------------|----------------------|-----------------|--------------|
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 1                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 1                    | 6451            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 1                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 1                    | 6228            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 5463            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 1                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 1                    | 8154            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 4480            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 1                       | 0                         | 0                      | 0                       | 1                    | 5353            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 5504            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 6166            |              |
| 0                        | 0                       | 0                        | 1                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 1                            | 0                   | 1                   | 1                         | 0          | 0                        | 1                       | 0                         | 0                      | 0                       | 5                    | 6587            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 4987            |              |
| 0                        | 0                       | 1                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 1                       | 1                         | 0                      | 0                       | 3                    | 4988            |              |
| 1                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 2                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 1                      | 0                       | 4                    | 7396            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 6062            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 2                         | 0                      | 0                       | 2                    | 6787            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 6724            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 1                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 1          | 0                        | 1                       | 1                         | 0                      | 0                       | 4                    | 6681            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 1                       | 1                    | 6401            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 5717            |              |
| 0                        | 1                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 1                    | 5844            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 1   | 0                                   | 0                            | 1                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 2                    | 5302            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 6954            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 1                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 1                       | 0                         | 0                      | 0                       | 2                    | 8422            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 6841            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 6848            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 5020            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 7678            |              |
| 0                        | 0                       | 0                        | 0                           | 2                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 2                    | 5085            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 0                    | 5911            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 0                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 1          | 0                        | 0                       | 0                         | 0                      | 0                       | 1                    | 5410            |              |
| 0                        | 0                       | 0                        | 0                           | 0                           | 0                                 | 1                             | 0   | 0                                   | 0                            | 0                   | 0                   | 0                         | 0          | 0                        | 0                       | 0                         | 0                      | 0                       | 1                    | 5135            |              |
| 1                        | 1                       | 1                        | 1                           | 2                           | 1                                 | 1                             | 1   | 1                                   | 3                            | 2                   | 2                   | 1                         | 2          | 1                        | 4                       | 4                         | 1                      | 1                       | 32                   | 184579          |              |
|                          |                         |                          |                             |                             |                                   |                               |   |                                     |                              |                     |                     |                           |            |                          |                         |                           |                        |                         |                      | Total           |              |

| <i>Conchapelopia</i> sp. | <i>Corynoneura</i> taris | <i>Dicrotendipes</i> neomodestus | <i>Diplocladius</i> sp. | <i>Heterotrissocladius</i> marcidus group | <i>Hydrobaenus</i> pilipes | <i>Micropsectra</i> sp. | <i>Nanocladius</i> sp. 1 | <i>Nanocladius</i> sp. 2 | <i>Nanocladius</i> spiniplenus | <i>Orthocladius</i> obumbratus group | <i>Parachironomus</i> arcuatus group | <i>Parakiefferiella</i> sp. | <i>Parametriocnemus</i> lundbecki | <i>Polypedilum</i> aviceps | <i>Polypedilum</i> illinoense | <i>Rheotanytarsus</i> exiguus group | <i>Robackia</i> sp. | <i>Rheocricotopus</i> fuscipes group | <i>Baetis</i> brunneicolor | <i>Leptophlebia</i> sp. | <i>Isoperla</i> lata | <i>Glossosoma</i> sp. | <i>Cheumatopsyche</i> sp. | Lumbricuridae | Total Organisms | Surface Area |       |
|--------------------------|--------------------------|----------------------------------|-------------------------|---|----------------------------|-------------------------|--------------------------|--------------------------|--------------------------------|--------------------------------------|--------------------------------------|-----------------------------|-----------------------------------|----------------------------|-------------------------------|-------------------------------------|---------------------|--------------------------------------|----------------------------|-------------------------|----------------------|-----------------------|---------------------------|---------------|-----------------|--------------|-------|
| 0                        | 0                        | 0                                | 0                       | 1   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 1                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 2               | 4883         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 2                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 2               | 3986         |       |
| 1                        | 0                        | 0                                | 0                       | 0   | 0                          | 1                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 2               | 4216         |       |
| 1                        | 0                        | 0                                | 0                       | 2   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 1                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 2             | 6               | 5896         |       |
| 0                        | 0                        | 0                                | 1                       | 0   | 0                          | 0                       | 0                        | 1                        | 0                              | 0                                    | 0                                    | 2                           | 0                                 | 1                          | 0                             | 0                                   | 0                   | 0                                    | 1                          | 1                       | 0                    | 0                     | 0                         | 0             | 7               | 4571         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 1                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 1                    | 0                     | 0                         | 0             | 2               | 4546         |       |
| 0                        | 1                        | 1                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 1                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 1                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 4               | 3772         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 1                           | 0                                 | 0                          | 0                             | 1                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 1                     | 0                         | 0             | 3               | 5818         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 0               | 5943         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 0               | 5217         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 0               | 4304         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 2                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 2               | 5696         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 0               | 4231         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 1                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 1               | 6074         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 0               | 5474         |       |
| 0                        | 1                        | 0                                | 1                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 1                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 3               | 4893         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 1                                    | 1                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 2               | 4236         |       |
| 0                        | 0                        | 0                                | 0                       | 1   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 1                                    | 1                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 1                                    | 1                          | 0                       | 0                    | 0                     | 0                         | 0             | 5               | 5643         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 0               | 4044         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 1                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 1               | 5973         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 0               | 4953         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 1                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 1                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 2               | 4128         |       |
| 1                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 1                     | 0                         | 0             | 2               | 4813         |       |
| 1                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 1               | 4455         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 0               | 5031         |       |
| 0                        | 1                        | 0                                | 0                       | 0   | 0                          | 0                       | 1                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 2               | 5019         |       |
| 0                        | 0                        | 0                                | 0                       | 1   | 0                          | 0                       | 0                        | 2                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 3               | 4208         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 0               | 5043         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 0                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 0               | 4207         |       |
| 0                        | 0                        | 0                                | 0                       | 0   | 0                          | 1                       | 0                        | 0                        | 0                              | 0                                    | 0                                    | 0                           | 0                                 | 0                          | 0                             | 0                                   | 0                   | 0                                    | 0                          | 0                       | 0                    | 0                     | 0                         | 0             | 1               | 4181         |       |
| 4                        | 3                        | 1                                | 2                       | 5   | 1                          | 2                       | 1                        | 3                        | 2                              | 1                                    | 2                                    | 10                          | 2                                 | 1                          | 1                             | 1                                   | 1                   | 1                                    | 3                          | 1                       | 1                    | 1                     | 1                         | 2             | 53              | 145454       | Total |



| <i>Zavrelimyia</i> sp. | Ceratopogonidae | <i>Ephemerella excrucians</i> | <i>Ephemerella invaria</i> | <i>Eurylophella funeralis</i> | <i>Paraleptophlebia</i> sp. | <i>Hydropsyche</i> sp. 1 | <i>Lepidostoma</i> sp. | <i>Stenelmis</i> sp. | <i>Nigronia serricornis</i> | <i>Physa</i> sp. | IWCC | ICC | <i>Nais communis</i> | Tipulidae | <i>Hexatoma</i> sp. | <i>Tipula</i> sp. | Total Organisms | Surface Area |
|------------------------|-----------------|-------------------------------|----------------------------|-------------------------------|-----------------------------|--------------------------|------------------------|----------------------|-----------------------------|------------------|------|-----|----------------------|-----------|---------------------|-------------------|-----------------|--------------|
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 1                   | 0                 | 6               | 5252         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 2               | 5142         |
| 1                      | 0               | 0                             | 0                          | 1                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 4    | 0   | 0                    | 0         | 0                   | 0                 | 14              | 5803         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 1               | 6808         |
| 0                      | 0               | 1                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 3               | 4821         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 2               | 5409         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 1   | 0                    | 0         | 0                   | 0                 | 2               | 5005         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 1                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 6               | 4622         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 1                    | 0                           | 0                | 1    | 0   | 0                    | 0         | 0                   | 0                 | 6               | 4375         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 0               | 5418         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 1                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 4               | 5579         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 2               | 5687         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 1    | 0   | 0                    | 0         | 0                   | 1                 | 5               | 5018         |
| 0                      | 0               | 1                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 1                    | 0         | 0                   | 0                 | 7               | 6829         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 1               | 5069         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 1               | 5733         |
| 0                      | 1               | 0                             | 0                          | 0                             | 1                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 3               | 6877         |
| 0                      | 0               | 0                             | 0                          | 0                             | 1                           | 0                        | 0                      | 0                    | 0                           | 1                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 5               | 3776         |
| 0                      | 0               | 0                             | 0                          | 1                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 5               | 5973         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 2               | 5567         |
| 0                      | 0               | 0                             | 1                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 1               | 3811         |
| 0                      | 1               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 1                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 2               | 3867         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 0               | 4460         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 1               | 5712         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 1                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 2               | 5208         |
| 0                      | 0               | 0                             | 0                          | 1                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 4               | 6444         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 1    | 0   | 0                    | 0         | 0                   | 0                 | 5               | 4203         |
| 0                      | 1               | 0                             | 0                          | 0                             | 1                           | 0                        | 0                      | 0                    | 0                           | 0                | 2    | 0   | 0                    | 0         | 0                   | 0                 | 6               | 4719         |
| 0                      | 0               | 0                             | 1                          | 0                             | 0                           | 0                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 2               | 7072         |
| 0                      | 0               | 0                             | 0                          | 0                             | 0                           | 1                        | 0                      | 0                    | 0                           | 0                | 0    | 0   | 0                    | 0         | 0                   | 0                 | 6               | 4437         |
| 1                      | 3               | 2                             | 2                          | 3                             | 3                           | 1                        | 2                      | 1                    | 1                           | 2                | 9    | 1   | 1                    | 0         | 1                   | 1                 | 106             | 158696       |
|                        |                 |                               |                            |                               |                             |                          |                        |                      |                             |                  |      |     |                      |           |                     |                   |                 | Total        |

| <i>Conchapelopia</i> sp. | <i>Diplocladius</i> sp. | <i>Larsia</i> sp. | <i>Micropsectra</i> sp. | <i>Microtendipes caelum</i> | <i>Nanocladius</i> sp. 1 | <i>Nanocladius</i> sp. 2 | <i>Nanocladius spiniplenus</i> | Orthoclaadiinae | <i>Orthoclaadius</i> sp. | <i>Orthoclaadius carlatus</i> group | <i>Orthoclaadius oliveri</i> | <i>Parakiefferiella</i> sp. | <i>Parametrioctenemus lundbecki</i> | <i>Paratanytarsus</i> sp. 1 | <i>Paratanytarsus</i> sp. 2 | <i>Paratanytarsus</i> sp. 3 | <i>Rheotanytarsus distinctissimus</i> group | <i>Rheotanytarsus exiguus</i> group | <i>Tanytarsus</i> sp. | <i>Thienemanniella</i> prob. xena | <i>Thienemanniella</i> sp. 1 | <i>Prosimulium</i> sp. | <i>Stegopterna mutata</i> complex | <i>Simulium vittatum</i> complex | <i>Isoperla marlynia</i> | <i>Hyaella azteca</i> | Total Organisms | Surface Area |       |
|--------------------------|-------------------------|-------------------|-------------------------|-----------------------------|--------------------------|--------------------------|--------------------------------|-----------------|--------------------------|-------------------------------------|------------------------------|-----------------------------|-------------------------------------|-----------------------------|-----------------------------|-----------------------------|---|-------------------------------------|-----------------------|-----------------------------------|------------------------------|------------------------|-----------------------------------|----------------------------------|--------------------------|-----------------------|-----------------|--------------|-------|
| 1                        | 0                       | 0                 | 0                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 0                           | 0                           | 0                           | 0   | 0                                   | 0                     | 0                                 | 0                            | 5                      | 0                                 | 0                                | 0                        | 6                     | 4815            |              |       |
| 0                        | 0                       | 0                 | 0                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 0                           | 1                           | 0                           | 0   | 1                                   | 0                     | 0                                 | 0                            | 1                      | 0                                 | 0                                | 0                        | 3                     | 4633            |              |       |
| 0                        | 0                       | 0                 | 2                       | 0                           | 0                        | 0                        | 0                              | 0               | 1                        | 1                                   | 0                            | 0                           | 0                                   | 2                           | 0                           | 1                           | 0   | 0                                   | 5                     | 0                                 | 0                            | 1                      | 0                                 | 0                                | 0                        | 13                    | 3855            |              |       |
| 0                        | 0                       | 0                 | 0                       | 0                           | 1                        | 0                        | 0                              | 0               | 0                        | 1                                   | 0                            | 0                           | 0                                   | 0                           | 0                           | 0                           | 0   | 0                                   | 0                     | 0                                 | 1                            | 0                      | 3                                 | 0                                | 0                        | 0                     | 6               | 5459         |       |
| 1                        | 0                       | 0                 | 1                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 1                            | 0                           | 0                                   | 0                           | 0                           | 0                           | 0   | 0                                   | 0                     | 0                                 | 0                            | 3                      | 0                                 | 0                                | 0                        | 6                     | 5238            |              |       |
| 1                        | 0                       | 0                 | 0                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 0                           | 0                           | 0                           | 1   | 0                                   | 0                     | 1                                 | 1                            | 0                      | 0                                 | 0                                | 0                        | 4                     | 3975            |              |       |
| 2                        | 1                       | 0                 | 1                       | 0                           | 1                        | 0                        | 0                              | 0               | 0                        | 0                                   | 1                            | 0                           | 0                                   | 0                           | 0                           | 0                           | 1   | 0                                   | 0                     | 0                                 | 0                            | 0                      | 0                                 | 1                                | 0                        | 0                     | 8               | 4278         |       |
| 2                        | 0                       | 0                 | 2                       | 0                           | 2                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 1                           | 0                           | 0                           | 0   | 0                                   | 0                     | 0                                 | 0                            | 0                      | 0                                 | 0                                | 1                        | 0                     | 8               | 3965         |       |
| 0                        | 1                       | 0                 | 2                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 1                                   | 1                            | 0                           | 0                                   | 2                           | 0                           | 0                           | 1   | 0                                   | 1                     | 0                                 | 1                            | 0                      | 0                                 | 0                                | 0                        | 10                    | 6284            |              |       |
| 3                        | 0                       | 0                 | 2                       | 0                           | 1                        | 1                        | 0                              | 0               | 0                        | 2                                   | 0                            | 0                           | 0                                   | 6                           | 0                           | 0                           | 0   | 0                                   | 3                     | 0                                 | 0                            | 0                      | 0                                 | 0                                | 0                        | 18                    | 5426            |              |       |
| 5                        | 1                       | 0                 | 2                       | 0                           | 0                        | 2                        | 0                              | 0               | 0                        | 1                                   | 2                            | 0                           | 1                                   | 1                           | 0                           | 0                           | 0   | 0                                   | 0                     | 0                                 | 0                            | 4                      | 0                                 | 0                                | 0                        | 19                    | 4052            |              |       |
| 1                        | 0                       | 0                 | 0                       | 0                           | 0                        | 1                        | 1                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 0                           | 0                           | 0                           | 1   | 0                                   | 0                     | 0                                 | 0                            | 2                      | 0                                 | 0                                | 0                        | 6                     | 4724            |              |       |
| 1                        | 0                       | 0                 | 0                       | 0                           | 1                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 3                           | 0                           | 0                           | 0   | 0                                   | 0                     | 0                                 | 0                            | 0                      | 0                                 | 0                                | 0                        | 5                     | 4117            |              |       |
| 1                        | 0                       | 0                 | 0                       | 0                           | 0                        | 0                        | 0                              | 0               | 1                        | 1                                   | 3                            | 0                           | 0                                   | 1                           | 0                           | 0                           | 1   | 0                                   | 1                     | 0                                 | 0                            | 2                      | 0                                 | 0                                | 1                        | 12                    | 4973            |              |       |
| 1                        | 0                       | 0                 | 0                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 1                           | 0                                   | 1                           | 0                           | 0                           | 0   | 0                                   | 1                     | 0                                 | 0                            | 0                      | 0                                 | 0                                | 0                        | 4                     | 4952            |              |       |
| 0                        | 0                       | 0                 | 0                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 1                           | 0                           | 0                           | 1   | 0                                   | 1                     | 0                                 | 1                            | 1                      | 0                                 | 0                                | 0                        | 5                     | 4454            |              |       |
| 0                        | 0                       | 0                 | 1                       | 0                           | 0                        | 2                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 1                           | 0                           | 0                           | 3   | 0                                   | 1                     | 1                                 | 0                            | 3                      | 0                                 | 0                                | 0                        | 12                    | 7125            |              |       |
| 1                        | 0                       | 0                 | 0                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 2                           | 0                           | 0                           | 1   | 0                                   | 1                     | 0                                 | 1                            | 2                      | 0                                 | 0                                | 0                        | 8                     | 5160            |              |       |
| 0                        | 0                       | 0                 | 0                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 1                            | 0                           | 0                                   | 1                           | 0                           | 0                           | 1   | 0                                   | 0                     | 0                                 | 0                            | 0                      | 0                                 | 0                                | 0                        | 3                     | 4272            |              |       |
| 1                        | 0                       | 0                 | 1                       | 0                           | 0                        | 2                        | 0                              | 0               | 1                        | 0                                   | 0                            | 0                           | 0                                   | 3                           | 0                           | 0                           | 0   | 0                                   | 0                     | 0                                 | 0                            | 1                      | 0                                 | 0                                | 0                        | 9                     | 4079            |              |       |
| 2                        | 0                       | 0                 | 2                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 0                           | 0                           | 0                           | 1   | 0                                   | 0                     | 0                                 | 0                            | 1                      | 0                                 | 0                                | 0                        | 6                     | 4534            |              |       |
| 1                        | 0                       | 0                 | 0                       | 0                           | 0                        | 2                        | 0                              | 0               | 0                        | 1                                   | 0                            | 0                           | 0                                   | 1                           | 0                           | 0                           | 1   | 0                                   | 1                     | 1                                 | 0                            | 0                      | 0                                 | 0                                | 0                        | 8                     | 5247            |              |       |
| 2                        | 0                       | 0                 | 0                       | 0                           | 0                        | 1                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 2                           | 0                           | 0                           | 0   | 0                                   | 0                     | 0                                 | 0                            | 1                      | 0                                 | 0                                | 0                        | 6                     | 4317            |              |       |
| 0                        | 0                       | 0                 | 2                       | 0                           | 0                        | 1                        | 0                              | 0               | 0                        | 1                                   | 0                            | 0                           | 0                                   | 1                           | 0                           | 0                           | 0   | 0                                   | 2                     | 0                                 | 0                            | 2                      | 0                                 | 0                                | 0                        | 9                     | 4363            |              |       |
| 1                        | 0                       | 0                 | 2                       | 0                           | 0                        | 1                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 1                           | 0                           | 0                           | 0   | 0                                   | 0                     | 0                                 | 0                            | 2                      | 0                                 | 0                                | 0                        | 7                     | 4192            |              |       |
| 0                        | 0                       | 0                 | 2                       | 1                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 2                           | 0                           | 0                           | 0   | 0                                   | 1                     | 2                                 | 0                            | 4                      | 0                                 | 0                                | 0                        | 12                    | 3994            |              |       |
| 0                        | 0                       | 0                 | 1                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 0                                   | 0                           | 0                           | 0                           | 0   | 0                                   | 1                     | 0                                 | 0                            | 0                      | 0                                 | 0                                | 0                        | 2                     | 4218            |              |       |
| 0                        | 0                       | 1                 | 0                       | 0                           | 0                        | 0                        | 0                              | 0               | 0                        | 0                                   | 0                            | 0                           | 1                                   | 1                           | 0                           | 0                           | 0   | 0                                   | 0                     | 0                                 | 0                            | 0                      | 0                                 | 0                                | 0                        | 3                     | 5669            |              |       |
| 0                        | 1                       | 0                 | 1                       | 0                           | 0                        | 0                        | 0                              | 1               | 0                        | 0                                   | 1                            | 0                           | 0                                   | 0                           | 0                           | 0                           | 0   | 0                                   | 1                     | 1                                 | 0                            | 3                      | 0                                 | 0                                | 0                        | 9                     | 5476            |              |       |
| 1                        | 0                       | 0                 | 1                       | 0                           | 0                        | 0                        | 1                              | 0               | 0                        | 1                                   | 0                            | 0                           | 0                                   | 3                           | 0                           | 0                           | 0   | 0                                   | 1                     | 1                                 | 0                            | 1                      | 0                                 | 0                                | 0                        | 10                    | 5012            |              |       |
| 28                       | 4                       | 1                 | 25                      | 1                           | 3                        | 15                       | 1                              | 2               | 2                        | 2                                   | 11                           | 9                           | 1                                   | 2                           | 36                          | 1                           | 1   | 13                                  | 1                     | 21                                | 8                            | 4                      | 42                                | 1                                | 1                        | 1                     | 237             | 142858       | Total |

| <i>Conchapelopia</i> sp. | <i>Diplocladius</i> sp. | <i>Micropsectra</i> sp. | <i>Nanocladius</i> sp. 1 | <i>Nanocladius</i> sp. 2 | Orthoclaadiinae | <i>Orthoclaadius</i> sp. | <i>Orthoclaadius carlatus</i> group | <i>Orthoclaadius oliveri</i> | <i>Parakiefferiella</i> sp. | <i>Paramerina</i> sp. | <i>Parametriocnemus lundbecki</i> | <i>Paratanytarsus</i> sp. 2 | <i>Paratanytarsus</i> sp. 3 | <i>Polypedilum illinoense</i> | <i>Rheocricotopus fuscipes</i> group | <i>Rheotanytarsus distinctissimus</i> group | <i>Rheotanytarsus exiguus</i> group | <i>Tanytarsus</i> sp. | <i>Thienemanniella</i> prob. <i>xena</i> | <i>Thienemanniella</i> sp. 1 | <i>Tvetenia bavarica</i> group | <i>Prosimulium</i> sp. | <i>Stegopterna mutata</i> complex | <i>Simulium vittatum</i> complex | <i>Aeshna</i> sp. | Coleoptera | <i>Hyaella azteca</i> | <i>Helobdella stagnalis</i> | ICC  | Total Organisms | Surface Area |
|--------------------------|-------------------------|-------------------------|--------------------------|--------------------------|-----------------|--------------------------|-------------------------------------|------------------------------|-----------------------------|-----------------------|-----------------------------------|-----------------------------|-----------------------------|-------------------------------|--------------------------------------|---|-------------------------------------|-----------------------|--|------------------------------|--------------------------------|------------------------|-----------------------------------|----------------------------------|-------------------|------------|-----------------------|-----------------------------|------|-----------------|--------------|
| 2                        | 0                       | 0                       | 0                        | 0                        | 0               | 0                        | 1                                   | 0                            | 0                           | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 3                                 | 0                                | 0                 | 0          | 0                     | 0                           | 0    | 6               | 5162         |
| 1                        | 0                       | 0                       | 0                        | 1                        | 0               | 1                        | 0                                   | 1                            | 0                           | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                                    | 0   | 1                                   | 0                     | 1  | 0                            | 0                              | 0                      | 0                                 | 0                                | 0                 | 0          | 0                     | 0                           | 0    | 7               | 5368         |
| 5                        | 0                       | 0                       | 0                        | 1                        | 0               | 0                        | 0                                   | 0                            | 0                           | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                                    | 0   | 1                                   | 0                     | 0  | 0                            | 0                              | 0                      | 0                                 | 0                                | 0                 | 0          | 1                     | 0                           | 9    | 6956            |              |
| 1                        | 0                       | 1                       | 0                        | 0                        | 1               | 0                        | 0                                   | 1                            | 0                           | 0                     | 0                                 | 0                           | 0                           | 0                             | 1                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 1                                 | 0                                | 0                 | 0          | 0                     | 0                           | 6    | 5359            |              |
| 2                        | 0                       | 1                       | 0                        | 1                        | 0               | 0                        | 0                                   | 0                            | 0                           | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                                    | 0   | 1                                   | 0                     | 0  | 0                            | 0                              | 0                      | 3                                 | 0                                | 0                 | 0          | 1                     | 0                           | 10   | 4498            |              |
| 2                        | 0                       | 2                       | 1                        | 1                        | 0               | 0                        | 0                                   | 0                            | 0                           | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 0                                 | 0                                | 1                 | 0          | 0                     | 7                           | 4848 |                 |              |
| 2                        | 0                       | 4                       | 0                        | 0                        | 0               | 0                        | 0                                   | 0                            | 0                           | 0                     | 0                                 | 3                           | 0                           | 0                             | 0                                    | 0   | 1                                   | 0                     | 2  | 0                            | 0                              | 0                      | 6                                 | 1                                | 0                 | 0          | 0                     | 19                          | 5282 |                 |              |
| 0                        | 0                       | 1                       | 0                        | 0                        | 0               | 0                        | 1                                   | 0                            | 0                           | 0                     | 1                                 | 0                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 1                     | 1  | 1                            | 0                              | 0                      | 0                                 | 0                                | 0                 | 0          | 0                     | 6                           | 5239 |                 |              |
| 2                        | 0                       | 1                       | 0                        | 0                        | 1               | 0                        | 0                                   | 1                            | 0                           | 0                     | 1                                 | 1                           | 0                           | 0                             | 0                                    | 1   | 0                                   | 0                     | 2  | 1                            | 0                              | 0                      | 2                                 | 0                                | 0                 | 0          | 0                     | 13                          | 5815 |                 |              |
| 1                        | 0                       | 0                       | 0                        | 1                        | 0               | 0                        | 0                                   | 0                            | 1                           | 1                     | 0                                 | 1                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 2                                 | 0                                | 0                 | 0          | 0                     | 7                           | 5128 |                 |              |
| 0                        | 0                       | 1                       | 1                        | 1                        | 0               | 0                        | 0                                   | 2                            | 0                           | 0                     | 0                                 | 2                           | 0                           | 0                             | 0                                    | 1   | 0                                   | 0                     | 3  | 1                            | 0                              | 0                      | 3                                 | 0                                | 0                 | 0          | 0                     | 15                          | 6770 |                 |              |
| 0                        | 0                       | 0                       | 0                        | 0                        | 0               | 0                        | 0                                   | 1                            | 0                           | 0                     | 1                                 | 0                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 1  | 0                            | 0                              | 0                      | 2                                 | 0                                | 0                 | 1          | 0                     | 6                           | 7198 |                 |              |
| 1                        | 0                       | 0                       | 0                        | 0                        | 0               | 1                        | 0                                   | 0                            | 1                           | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                                    | 1   | 1                                   | 0                     | 0  | 0                            | 0                              | 0                      | 1                                 | 0                                | 0                 | 1          | 0                     | 7                           | 6476 |                 |              |
| 2                        | 0                       | 3                       | 1                        | 1                        | 0               | 0                        | 0                                   | 0                            | 1                           | 0                     | 1                                 | 1                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 0                                 | 0                                | 0                 | 0          | 0                     | 11                          | 6182 |                 |              |
| 3                        | 0                       | 2                       | 0                        | 0                        | 0               | 0                        | 0                                   | 1                            | 0                           | 0                     | 0                                 | 0                           | 0                           | 1                             | 0                                    | 0   | 0                                   | 0                     | 1  | 0                            | 0                              | 0                      | 0                                 | 0                                | 0                 | 0          | 0                     | 8                           | 4607 |                 |              |
| 1                        | 1                       | 3                       | 0                        | 1                        | 0               | 0                        | 0                                   | 2                            | 1                           | 0                     | 1                                 | 1                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 2                                 | 0                                | 0                 | 0          | 0                     | 13                          | 5552 |                 |              |
| 0                        | 0                       | 1                       | 0                        | 0                        | 0               | 0                        | 0                                   | 0                            | 1                           | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 1                                 | 0                                | 0                 | 0          | 0                     | 3                           | 6088 |                 |              |
| 0                        | 0                       | 1                       | 0                        | 0                        | 0               | 0                        | 0                                   | 1                            | 0                           | 0                     | 0                                 | 2                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 2  | 0                            | 0                              | 0                      | 4                                 | 1                                | 0                 | 0          | 0                     | 11                          | 5034 |                 |              |
| 2                        | 0                       | 1                       | 0                        | 1                        | 0               | 1                        | 0                                   | 0                            | 1                           | 0                     | 0                                 | 4                           | 1                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 1  | 0                            | 0                              | 0                      | 10                                | 1                                | 0                 | 0          | 0                     | 23                          | 6464 |                 |              |
| 0                        | 0                       | 0                       | 0                        | 0                        | 0               | 0                        | 0                                   | 0                            | 0                           | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 1                                 | 1                                | 0                 | 0          | 0                     | 2                           | 5860 |                 |              |
| 1                        | 0                       | 0                       | 0                        | 0                        | 0               | 0                        | 0                                   | 0                            | 0                           | 0                     | 0                                 | 2                           | 0                           | 0                             | 0                                    | 0   | 1                                   | 0                     | 0  | 0                            | 0                              | 0                      | 8                                 | 0                                | 0                 | 0          | 0                     | 12                          | 5267 |                 |              |
| 0                        | 0                       | 1                       | 0                        | 0                        | 0               | 0                        | 0                                   | 1                            | 0                           | 0                     | 0                                 | 0                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 1  | 1                            | 0                              | 1                      | 7                                 | 0                                | 0                 | 0          | 0                     | 12                          | 6221 |                 |              |
| 1                        | 0                       | 0                       | 0                        | 2                        | 0               | 0                        | 0                                   | 0                            | 1                           | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 1                                 | 0                                | 0                 | 0          | 0                     | 6                           | 4935 |                 |              |
| 3                        | 0                       | 0                       | 0                        | 0                        | 0               | 0                        | 0                                   | 0                            | 0                           | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                                    | 0   | 2                                   | 0                     | 0  | 1                            | 0                              | 0                      | 15                                | 1                                | 0                 | 0          | 0                     | 23                          | 5790 |                 |              |
| 1                        | 0                       | 1                       | 0                        | 0                        | 0               | 0                        | 0                                   | 1                            | 1                           | 0                     | 0                                 | 1                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 0                                 | 0                                | 0                 | 0          | 0                     | 5                           | 6673 |                 |              |
| 0                        | 0                       | 1                       | 0                        | 0                        | 0               | 0                        | 0                                   | 2                            | 0                           | 0                     | 0                                 | 5                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 0                                 | 0                                | 0                 | 0          | 0                     | 8                           | 4931 |                 |              |
| 0                        | 1                       | 2                       | 0                        | 1                        | 0               | 0                        | 0                                   | 0                            | 1                           | 0                     | 2                                 | 0                           | 1                           | 0                             | 0                                    | 0   | 1                                   | 0                     | 0  | 1                            | 0                              | 0                      | 0                                 | 0                                | 0                 | 0          | 0                     | 10                          | 6789 |                 |              |
| 0                        | 0                       | 2                       | 0                        | 2                        | 0               | 0                        | 0                                   | 0                            | 0                           | 0                     | 0                                 | 3                           | 0                           | 0                             | 0                                    | 0   | 1                                   | 0                     | 0  | 0                            | 0                              | 0                      | 0                                 | 0                                | 0                 | 0          | 0                     | 8                           | 4916 |                 |              |
| 1                        | 0                       | 0                       | 0                        | 1                        | 0               | 0                        | 0                                   | 0                            | 1                           | 0                     | 0                                 | 2                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 0                     | 0  | 0                            | 0                              | 0                      | 3                                 | 0                                | 0                 | 0          | 0                     | 8                           | 5054 |                 |              |
| 3                        | 0                       | 1                       | 0                        | 0                        | 0               | 0                        | 0                                   | 2                            | 0                           | 0                     | 1                                 | 2                           | 0                           | 0                             | 0                                    | 0   | 0                                   | 1                     | 0  | 0                            | 0                              | 0                      | 0                                 | 0                                | 1                 | 0          | 1                     | 12                          | 6405 |                 |              |
| 37                       | 2                       | 30                      | 3                        | 15                       | 2               | 3                        | 1                                   | 16                           | 11                          | 1                     | 6                                 | 37                          | 2                           | 1                             | 1                                    | 3   | 10                                  | 1                     | 12                                       | 9                            | 1                              | 1                      | 75                                | 5                                | 1                 | 1          | 3                     | 2                           | 1    | 293             | 170867 T.    |



| <i>Conchapelopia</i> sp. | <i>Cricotopus tremulus</i> group | <i>Diplocladius</i> sp. | <i>Micropsectra</i> sp. | <i>Nanocladius</i> sp. 1 | <i>Nanocladius</i> sp. 2 | <i>Orthocladius</i> sp. | <i>Orthocladius carlatus</i> group | <i>Orthocladius oliveri</i> | <i>Parakiefferiella</i> sp. | <i>Parametrioctenus lundbecki</i> | <i>Paratanytarsus</i> sp. 2 | <i>Polypedilum illinoense</i> | <i>Rheotanytarsus exiguus</i> group | <i>Thienemanniella</i> prob. xena | <i>Thienemanniella</i> sp. 1 | <i>Simulium vittatum</i> complex | <i>Hyaella azteca</i> | Total Organisms | Surface Area |
|--------------------------|----------------------------------|-------------------------|-------------------------|--------------------------|--------------------------|-------------------------|------------------------------------|-----------------------------|-----------------------------|-----------------------------------|-----------------------------|-------------------------------|-------------------------------------|-----------------------------------|------------------------------|----------------------------------|-----------------------|-----------------|--------------|
| 0                        | 0                                | 0                       | 2                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 2               | 4551         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 0               | 4210         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 0               | 4695         |
| 0                        | 2                                | 0                       | 0                       | 0                        | 0                        | 2                       | 0                                  | 1                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 1                                 | 0                            | 0                                | 0                     | 6               | 4674         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 1                           | 0                           | 0                                 | 1                           | 0                             | 1                                   | 0                                 | 0                            | 0                                | 0                     | 3               | 4169         |
| 0                        | 0                                | 1                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 2                           | 0                             | 0                                   | 0                                 | 1                            | 0                                | 0                     | 4               | 4538         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 1                           | 0                             | 0                                   | 1                                 | 0                            | 0                                | 0                     | 2               | 4872         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 1                                 | 0                            | 0                                | 0                     | 1               | 4483         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 0               | 4190         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 0               | 4929         |
| 0                        | 0                                | 0                       | 1                       | 0                        | 0                        | 0                       | 0                                  | 1                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 2               | 3835         |
| 0                        | 0                                | 0                       | 1                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 2                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 3               | 4999         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 1                           | 0                             | 0                                   | 0                                 | 1                            | 0                                | 0                     | 2               | 5376         |
| 0                        | 0                                | 0                       | 1                       | 1                        | 1                        | 1                       | 2                                  | 1                           | 0                           | 0                                 | 1                           | 0                             | 0                                   | 2                                 | 0                            | 0                                | 0                     | 10              | 6494         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 1                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 1               | 4347         |
| 0                        | 0                                | 0                       | 1                       | 0                        | 1                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 1                                 | 0                            | 0                                | 0                     | 3               | 5145         |
| 0                        | 0                                | 0                       | 1                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 1                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 1                     | 3               | 4615         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 2                                  | 1                           | 0                           | 1                                 | 1                           | 0                             | 0                                   | 1                                 | 0                            | 0                                | 0                     | 5               | 4277         |
| 0                        | 0                                | 0                       | 0                       | 1                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 3                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 4               | 4039         |
| 0                        | 0                                | 0                       | 1                       | 1                        | 0                        | 1                       | 0                                  | 1                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 4               | 5132         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 1                                 | 1                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 2               | 5663         |
| 0                        | 0                                | 0                       | 3                       | 1                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 1                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 5               | 4895         |
| 0                        | 0                                | 0                       | 1                       | 0                        | 1                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 1                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 3               | 5359         |
| 0                        | 0                                | 0                       | 0                       | 1                        | 1                        | 0                       | 0                                  | 1                           | 0                           | 0                                 | 1                           | 0                             | 0                                   | 2                                 | 0                            | 0                                | 0                     | 6               | 5895         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 1                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 1               | 4995         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 1                                 | 0                            | 0                                | 0                     | 1               | 4916         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 0                           | 1                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 1               | 3985         |
| 1                        | 0                                | 0                       | 1                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 1                           | 0                             | 1                                   | 0                                 | 0                            | 1                                | 0                     | 5               | 5262         |
| 1                        | 0                                | 0                       | 1                       | 0                        | 0                        | 0                       | 0                                  | 1                           | 0                           | 0                                 | 4                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 7               | 5583         |
| 0                        | 0                                | 0                       | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                           | 0                           | 0                                 | 0                           | 0                             | 0                                   | 0                                 | 0                            | 0                                | 0                     | 0               | 4052         |
| 2                        | 2                                | 1                       | 14                      | 5                        | 4                        | 4                       | 2                                  | 10                          | 1                           | 1                                 | 23                          | 1                             | 2                                   | 10                                | 2                            | 1                                | 1                     | 86              | 144175       |
|                          |                                  |                         |                         |                          |                          |                         |                                    |                             |                             |                                   |                             |                               |                                     |                                   |                              |                                  |                       |                 | Total        |

| <i>Conchapelopia</i> sp. | <i>Micropsectra</i> sp. | <i>Nanocladius</i> sp. 1 | <i>Nanocladius</i> sp. 2 | <i>Orthocladius</i> sp. | <i>Orthocladius carlatus</i> group | <i>Orthocladius obumbratus</i> group | <i>Orthocladius oliveri</i> | <i>Parakiefferiella</i> sp. | <i>Paratanytarsus</i> sp. 1 | <i>Paratanytarsus</i> sp. 2 | <i>Paratanytarsus</i> sp. 3 | <i>Rheotanytarsus exiguus</i> group | <i>Symptothastia</i> sp. | <i>Thienemanniella</i> prob. <i>xena</i> | <i>Thienemanniella</i> sp. 1 | <i>Stenonema modestum</i> | <i>Paracapnia opis</i> | <i>Ptilostomis</i> sp. | <i>Hyaella azteca</i> | Total Organisms | Surface Area |       |
|--------------------------|-------------------------|--------------------------|--------------------------|-------------------------|------------------------------------|--------------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------------|--------------------------|--|------------------------------|---------------------------|------------------------|------------------------|-----------------------|-----------------|--------------|-------|
| 3                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 0                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 1                      | 0                      | 0                     | 4               | 5362         |       |
| 1                        | 1                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 0                           | 1                           | 0                           | 0                           | 0                           | 0                                   | 0                        | 1  | 0                            | 0                         | 0                      | 0                      | 0                     | 4               | 5098         |       |
| 1                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 1                           | 0                           | 0                           | 0                           | 1                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 3               | 5612         |       |
| 1                        | 1                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 0                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 2               | 5567         |       |
| 2                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 1                                    | 0                           | 0                           | 0                           | 0                           | 0                           | 0                                   | 1                        | 0  | 0                            | 0                         | 0                      | 0                      | 1                     | 5               | 6991         |       |
| 0                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 0                           | 0                           | 1                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 1               | 5575         |       |
| 1                        | 0                       | 0                        | 1                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 0                           | 0                           | 0                                   | 0                        | 0  | 0                            | 1                         | 0                      | 0                      | 1                     | 4               | 5749         |       |
| 1                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 1                           | 0                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 2               | 6425         |       |
| 1                        | 0                       | 0                        | 0                        | 0                       | 1                                  | 0                                    | 1                           | 0                           | 0                           | 0                           | 1                           | 0                                   | 0                        | 1  | 0                            | 0                         | 0                      | 0                      | 0                     | 5               | 6201         |       |
| 1                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 1                           | 0                           | 0                           | 3                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 5               | 5501         |       |
| 0                        | 0                       | 0                        | 2                        | 0                       | 1                                  | 0                                    | 2                           | 0                           | 0                           | 3                           | 1                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 9               | 4999         |       |
| 1                        | 1                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 1                           | 0                           | 0                           | 0                           | 0                           | 0                                   | 0                        | 3  | 1                            | 0                         | 0                      | 0                      | 0                     | 7               | 5612         |       |
| 0                        | 0                       | 1                        | 0                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 0                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 1                      | 0                     | 2               | 5132         |       |
| 0                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 1                           | 0                           | 0                           | 2                           | 2                           | 0                                   | 0                        | 1  | 0                            | 0                         | 0                      | 0                      | 0                     | 6               | 4819         |       |
| 2                        | 0                       | 1                        | 1                        | 0                       | 0                                  | 0                                    | 4                           | 0                           | 0                           | 1                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 2                     | 11              | 7888         |       |
| 0                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 1                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 1               | 5219         |       |
| 0                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 2                           | 0                           | 0                           | 3                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 5               | 5403         |       |
| 0                        | 0                       | 1                        | 0                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 1                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 2               | 6684         |       |
| 0                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 1                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 1               | 6230         |       |
| 0                        | 0                       | 0                        | 0                        | 2                       | 0                                  | 0                                    | 5                           | 0                           | 0                           | 0                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 7               | 6477         |       |
| 0                        | 0                       | 0                        | 1                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 0                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 1               | 5946         |       |
| 2                        | 1                       | 0                        | 0                        | 1                       | 0                                  | 1                                    | 2                           | 1                           | 0                           | 1                           | 0                           | 1                                   | 0                        | 2  | 0                            | 0                         | 0                      | 0                      | 0                     | 12              | 5523         |       |
| 1                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 0                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 1               | 5892         |       |
| 1                        | 0                       | 1                        | 0                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 0                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 2               | 7440         |       |
| 0                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 2                           | 0                           | 0                           | 1                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 3               | 4141         |       |
| 0                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 1                           | 0                           | 0                           | 2                           | 0                           | 0                                   | 0                        | 2  | 0                            | 0                         | 0                      | 0                      | 0                     | 5               | 4827         |       |
| 1                        | 0                       | 0                        | 1                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 1                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 3               | 8075         |       |
| 2                        | 0                       | 0                        | 1                        | 0                       | 0                                  | 0                                    | 0                           | 0                           | 0                           | 1                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 4               | 5532         |       |
| 0                        | 0                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 2                           | 0                           | 0                           | 1                           | 0                           | 0                                   | 0                        | 0  | 0                            | 0                         | 0                      | 0                      | 0                     | 3               | 8083         |       |
| 0                        | 1                       | 0                        | 0                        | 0                       | 0                                  | 0                                    | 1                           | 0                           | 0                           | 2                           | 1                           | 0                                   | 0                        | 0  | 1                            | 0                         | 0                      | 0                      | 2                     | 8               | 8444         |       |
| 22                       | 5                       | 4                        | 7                        | 3                       | 2                                  | 2                                    | 26                          | 2                           | 1                           | 24                          | 6                           | 2                                   | 1                        | 10                                       | 2                            | 1                         | 1                      | 1                      | 6                     | 128             | 180447       | Total |

| <i>Corynoneura taris</i> | <i>Eukiefferiella claripennis</i> group | <i>Eukiefferiella pseudomotana</i> group | <i>Nanocladius</i> sp. 1 | <i>Orthocladus carlatus</i> group | <i>Parakiefferiella</i> sp. | <i>Paratanytarsus</i> sp. 2 | <i>Tanytarsus</i> sp. | <i>Thienemanniella</i> prob. <i>xena</i> | <i>Isonychia</i> sp. | <i>Ostrocera</i> sp. | <i>Paracapnia opis</i> | <i>Neophylax</i> sp. | <i>Fossaria</i> sp. | Total Organisms | Surface Area |
|--------------------------|---|--|--------------------------|-----------------------------------|-----------------------------|-----------------------------|-----------------------|--|----------------------|----------------------|------------------------|----------------------|---------------------|-----------------|--------------|
| 0                        | 1                                       | 0  | 1                        | 0                                 | 0                           | 1                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 3               | 4319         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 4304         |
| 1                        | 0                                       | 1  | 0                        | 1                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 3               | 4066         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 4776         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 3749         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 5239         |
| 0                        | 0                                       | 0  | 0                        | 2                                 | 1                           | 0                           | 0                     | 0  | 0                    | 1                    | 1                      | 0                    | 0                   | 5               | 4551         |
| 0                        | 0                                       | 0  | 0                        | 2                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 2               | 4102         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 4384         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 1  | 0                    | 0                    | 0                      | 0                    | 0                   | 1               | 4329         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 4254         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 1                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 1               | 4499         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 4398         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 4119         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 1                   | 1               | 4556         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 3886         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 1                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 1               | 4645         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 1                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 1               | 4374         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 1                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 1               | 4412         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 4501         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 1                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 1               | 4450         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 4398         |
| 1                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 1               | 4141         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 4406         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 1                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 1               | 4525         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 1                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 1               | 4179         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 2                     | 0  | 1                    | 0                    | 0                      | 0                    | 0                   | 3               | 4795         |
| 0                        | 0                                       | 0  | 0                        | 2                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 2                    | 0                   | 4               | 4084         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 1                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 1               | 5082         |
| 0                        | 0                                       | 0  | 0                        | 0                                 | 0                           | 0                           | 0                     | 0  | 0                    | 0                    | 0                      | 0                    | 0                   | 0               | 4202         |
| 2                        | 1                                       | 1  | 1                        | 7                                 | 8                           | 1                           | 3                     | 1  | 1                    | 1                    | 1                      | 2                    | 1                   | 31              | 131725       |
|                          |   |  |                          |                                   |                             |                             |                       |  |                      |                      |                        |                      |                     |                 | Total        |



| <i>Conchapelopia</i> sp. | <i>Cricotopus tremulus</i> group | <i>Heterotrissocladius marcidus</i> group | <i>Meropelopia flavifrons</i> | <i>Nanocladius</i> sp. 2 | Orthoclaadiinae | <i>Parametriocnemus lundbecki</i> | <i>Polypedilum aviceps</i> | <i>Polypedilum laetum</i> | <i>Polypedilum scalaenum</i> | <i>Psectrotanypus</i> nr. <i>dyari</i> | <i>Psilonetriocnemus</i> sp. | <i>Rheotanytarsus exiguus</i> group | <i>Tanytarsus</i> sp. | <i>Trissopelopia ogemawi</i> | <i>Zavrelimyia</i> sp. | <i>Leptophlebia</i> sp. | <i>Paraleptophlebia</i> sp. | <i>Isoperla marlynia</i> | <i>Perlinella ephyrefumipennis</i> | <i>Pycnopsyche</i> sp. | Total Organisms | Surface Area |       |
|--------------------------|----------------------------------|---|-------------------------------|--------------------------|-----------------|-----------------------------------|----------------------------|---------------------------|------------------------------|--|------------------------------|-------------------------------------|-----------------------|------------------------------|------------------------|-------------------------|-----------------------------|--------------------------|------------------------------------|------------------------|-----------------|--------------|-------|
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 0               | 6506         |       |
| 0                        | 0                                | 0   | 0                             | 1                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 1               | 5941         |       |
| 3                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 3               | 5629         |       |
| 1                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 1               | 6124         |       |
| 1                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 1                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 1                        | 0                                  | 0                      | 3               | 5948         |       |
| 1                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 1               | 4910         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 1                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 1               | 5109         |       |
| 1                        | 0                                | 0   | 0                             | 1                        | 0               | 2                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 4               | 5262         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 0               | 3938         |       |
| 0                        | 1                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 1                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 2               | 5656         |       |
| 1                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 1                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 2               | 4068         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 1                                 | 0                          | 0                         | 1                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 1                       | 0                           | 0                        | 0                                  | 0                      | 3               | 4415         |       |
| 1                        | 0                                | 0   | 0                             | 0                        | 1               | 0                                 | 0                          | 1                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 3               | 5194         |       |
| 0                        | 0                                | 0   | 0                             | 1                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 1               | 4265         |       |
| 2                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 2               | 6674         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 3                           | 0                        | 0                                  | 0                      | 3               | 4653         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 0               | 5840         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 0               | 5530         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 1                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 1               | 6066         |       |
| 2                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 1                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 1                      | 4               | 5766         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 0               | 5202         |       |
| 1                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 1               | 7565         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 1                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 1               | 5654         |       |
| 1                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 1               | 4147         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 0               | 4462         |       |
| 0                        | 0                                | 1   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 2                           | 0                        | 1                                  | 0                      | 4               | 5787         |       |
| 0                        | 0                                | 0   | 1                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 1               | 7849         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 1                            | 0                                      | 0                            | 1                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 2               | 5712         |       |
| 2                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 0                          | 0                         | 0                            | 0                                      | 0                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 2               | 5030         |       |
| 0                        | 0                                | 0   | 0                             | 0                        | 0               | 0                                 | 1                          | 0                         | 1                            | 0                                      | 1                            | 0                                   | 0                     | 0                            | 0                      | 0                       | 0                           | 0                        | 0                                  | 0                      | 3               | 6052         |       |
| 17                       | 1                                | 1   | 1                             | 3                        | 1               | 5                                 | 1                          | 1                         | 3                            | 1                                      | 1                            | 2                                   | 1                     | 1                            | 1                      | 1                       | 5                           | 1                        | 1                                  | 1                      | 50              | 164954       | Total |

| <i>Brillia parva</i> | <i>Conchapelopia sp.</i> | <i>Dicrotendipes neomodestus</i> | <i>Endochironomus nigricans</i> | <i>Heterotrissocladius marcidus</i> group | <i>Meropelopia flavifrons</i> | <i>Micropectra sp.</i> | <i>Nanocladius sp. 2</i> | <i>Nanocladius spiniplenus</i> | <i>Orthocladus carlatus</i> group | <i>Parametriocnemus lundbecki</i> | <i>Phaenopsectra flavipes</i> | <i>Polypedilum aviceps</i> | <i>Polypedilum laetum</i> | <i>Polypedilum illinoense</i> | <i>Polypedilum scalaenum</i> | <i>Tanytarsus sp.</i> | <i>Trissopelopia ogemawi</i> | Ceratopogonidae | <i>Eurylophella temporalis</i> | <i>Paraleptophlebia sp.</i> | Total Organisms | Surface Area |       |
|----------------------|--------------------------|----------------------------------|---------------------------------|---|-------------------------------|------------------------|--------------------------|--------------------------------|-----------------------------------|-----------------------------------|-------------------------------|----------------------------|---------------------------|-------------------------------|------------------------------|-----------------------|------------------------------|-----------------|--------------------------------|-----------------------------|-----------------|--------------|-------|
| 0                    | 1                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 1               | 6377         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 1                            | 0               | 0                              | 0                           | 1               | 6224         |       |
| 0                    | 0                        | 0                                | 1                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 1               | 5550         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 1                     | 0                            | 0               | 0                              | 0                           | 1               | 6596         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 1                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 1               | 6701         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 0               | 0            | 6273  |
| 0                    | 0                        | 1                                | 0                               | 1   | 0                             | 0                      | 0                        | 0                              | 0                                 | 1                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 3               | 7797         |       |
| 0                    | 1                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 1                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 2               | 5299         |       |
| 0                    | 1                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 2                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 3               | 5231         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 0               | 5677         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 1                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 1               | 5879         |       |
| 0                    | 0                        | 1                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 1               | 5813         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 0               | 5323         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 1                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 1               | 6357         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 1                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 1                     | 0                            | 0               | 1                              | 0                           | 3               | 3973         |       |
| 0                    | 2                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 1                                 | 0                             | 0                          | 0                         | 1                             | 0                            | 0                     | 0                            | 1               | 0                              | 0                           | 5               | 8957         |       |
| 0                    | 1                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 1                            | 0                     | 0                            | 0               | 0                              | 0                           | 2               | 5657         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 1                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 1               | 6504         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 1                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 1                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 1                           | 3               | 6019         |       |
| 0                    | 1                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 1                            | 0                     | 0                            | 0               | 0                              | 0                           | 2               | 5791         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 1                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 1               | 6037         |       |
| 0                    | 1                        | 0                                | 0                               | 0   | 0                             | 1                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 2               | 6527         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 1                                 | 0                             | 2                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 3               | 7238         |       |
| 0                    | 1                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 1                                 | 0                             | 1                          | 3                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 6               | 5516         |       |
| 0                    | 1                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 1                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 2               | 4215         |       |
| 0                    | 1                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 1               | 5789         |       |
| 0                    | 1                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 1                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 2               | 4247         |       |
| 0                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 0               | 6554         |       |
| 1                    | 0                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 0                                 | 0                             | 0                          | 0                         | 0                             | 0                            | 0                     | 0                            | 0               | 0                              | 0                           | 1               | 5871         |       |
| 0                    | 1                        | 0                                | 0                               | 0   | 0                             | 0                      | 0                        | 0                              | 0                                 | 4                                 | 0                             | 0                          | 0                         | 0                             | 1                            | 0                     | 0                            | 0               | 0                              | 0                           | 6               | 5177         |       |
| 1                    | 13                       | 2                                | 1                               | 1   | 1                             | 2                      | 1                        | 1                              | 1                                 | 12                                | 1                             | 5                          | 4                         | 1                             | 1                            | 4                     | 1                            | 1               | 1                              | 1                           | 56              | 179169       | Total |

| <i>Conchapelopia</i> sp. | <i>Micropsectra</i> sp. | <i>Nanocladius</i> sp. 1 | <i>Nanocladius</i> sp. 2 | <i>Parametrioctenus lundbecki</i> | <i>Paratanytarsus</i> sp. 2 | <i>Paratanytarsus</i> sp. 3 | <i>Rheocricotopus fuscipes</i> group | <i>Rheotanytarsus exiguus</i> group | <i>Tanytarsus</i> sp. | <i>Thienemanniella</i> prob. <i>xena</i> | <i>Tribelos</i> poss. <i>jucundum</i> | <i>Stegopterna mutata</i> complex | <i>Hyalella azteca</i> | <i>Helobdella stagnalis</i> | <i>Dero obtusa</i> | <i>Nais communis</i> | <i>Stenus</i> sp. | <i>Simulium vittatum</i> complex | Total Organisms | Surface Area |       |
|--------------------------|-------------------------|--------------------------|--------------------------|-----------------------------------|-----------------------------|-----------------------------|--------------------------------------|-------------------------------------|-----------------------|--|---------------------------------------|-----------------------------------|------------------------|-----------------------------|--------------------|----------------------|-------------------|----------------------------------|-----------------|--------------|-------|
| 3                        | 0                       | 0                        | 1                        | 0                                 | 1                           | 0                           | 0                                    | 0                                   | 0                     | 1  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 6               | 8072         |       |
| 3                        | 1                       | 0                        | 2                        | 0                                 | 0                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 6               | 5261         |       |
| 4                        | 1                       | 0                        | 0                        | 0                                 | 1                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 5                                 | 1                      | 0                           | 1                  | 0                    | 0                 | 5                                | 18              | 4989         |       |
| 0                        | 1                       | 0                        | 0                        | 0                                 | 1                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 1                  | 0                    | 0                 | 0                                | 3               | 5097         |       |
| 6                        | 0                       | 0                        | 1                        | 1                                 | 0                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 8               | 6374         |       |
| 0                        | 0                       | 1                        | 1                        | 0                                 | 0                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 1                 | 0                                | 3               | 5899         |       |
| 1                        | 0                       | 0                        | 1                        | 0                                 | 0                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 1                  | 0                    | 0                 | 0                                | 3               | 6124         |       |
| 1                        | 1                       | 0                        | 1                        | 0                                 | 0                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 1                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 4               | 8155         |       |
| 0                        | 0                       | 0                        | 1                        | 0                                 | 1                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 2               | 5036         |       |
| 2                        | 0                       | 0                        | 0                        | 0                                 | 1                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 1                                | 4               | 4981         |       |
| 2                        | 0                       | 0                        | 0                        | 0                                 | 2                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 4               | 6056         |       |
| 3                        | 0                       | 0                        | 0                        | 0                                 | 1                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 4               | 5451         |       |
| 1                        | 2                       | 0                        | 2                        | 0                                 | 0                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 5               | 4950         |       |
| 2                        | 1                       | 0                        | 0                        | 0                                 | 0                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 3               | 6401         |       |
| 5                        | 0                       | 0                        | 2                        | 0                                 | 0                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 2                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 9               | 7664         |       |
| 0                        | 0                       | 0                        | 0                        | 0                                 | 2                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 2               | 5718         |       |
| 2                        | 0                       | 0                        | 0                        | 0                                 | 0                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 2               | 5186         |       |
| 8                        | 0                       | 0                        | 2                        | 0                                 | 1                           | 0                           | 0                                    | 0                                   | 0                     | 1  | 0                                     | 0                                 | 1                      | 0                           | 0                  | 0                    | 0                 | 0                                | 13              | 6074         |       |
| 1                        | 0                       | 0                        | 0                        | 0                                 | 1                           | 0                           | 0                                    | 0                                   | 0                     | 1  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 3               | 7171         |       |
| 0                        | 0                       | 0                        | 0                        | 0                                 | 1                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 1               | 5725         |       |
| 0                        | 0                       | 0                        | 2                        | 0                                 | 1                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 3               | 5206         |       |
| 1                        | 0                       | 0                        | 0                        | 0                                 | 1                           | 0                           | 0                                    | 2                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 4               | 5772         |       |
| 0                        | 0                       | 0                        | 0                        | 0                                 | 0                           | 1                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 2                                | 3               | 5319         |       |
| 2                        | 0                       | 0                        | 0                        | 0                                 | 0                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 2               | 5363         |       |
| 3                        | 0                       | 0                        | 0                        | 0                                 | 0                           | 1                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 4               | 6344         |       |
| 5                        | 1                       | 0                        | 1                        | 0                                 | 2                           | 1                           | 0                                    | 1                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 11              | 9576         |       |
| 4                        | 0                       | 0                        | 1                        | 0                                 | 1                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 1                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 1                                | 8               | 5171         |       |
| 4                        | 0                       | 0                        | 1                        | 0                                 | 0                           | 0                           | 0                                    | 0                                   | 1                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 0                                | 6               | 6198         |       |
| 5                        | 0                       | 0                        | 0                        | 0                                 | 2                           | 0                           | 0                                    | 0                                   | 0                     | 0  | 0                                     | 0                                 | 0                      | 0                           | 0                  | 0                    | 0                 | 2                                | 9               | 4965         |       |
| 3                        | 0                       | 0                        | 0                        | 0                                 | 2                           | 0                           | 1                                    | 1                                   | 0                     | 1  | 0                                     | 0                                 | 0                      | 0                           | 1                  | 0                    | 0                 | 0                                | 9               | 4880         |       |
| 71                       | 8                       | 1                        | 19                       | 1                                 | 22                          | 3                           | 1                                    | 4                                   | 1                     | 3  | 1                                     | 9                                 | 1                      | 1                           | 3                  | 1                    | 1                 | 11                               | 162             | 179178       | Total |

| <i>Conchapelopia</i> sp. | <i>Micropsectra</i> sp. | <i>Nanocladius</i> sp. 2 | <i>Orthocladius</i> oliveri | <i>Parametriocnemus</i> lundbecki | <i>Paratanytarsus</i> sp. 2 | <i>Thienemanniella</i> prob. xena | <i>Hyalella</i> azteca | Total Organisms | Surface Area |       |
|--------------------------|-------------------------|--------------------------|-----------------------------|-----------------------------------|-----------------------------|-----------------------------------|------------------------|-----------------|--------------|-------|
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 1                      | 1               | 4841         |       |
| 0                        | 0                       | 1                        | 0                           | 0                                 | 0                           | 0                                 | 6                      | 7               | 7439         |       |
| 0                        | 1                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 5                      | 6               | 7797         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 1                      | 1               | 4810         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 0                      | 0               | 5876         |       |
| 1                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 2                      | 3               | 5451         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 2                      | 2               | 7210         |       |
| 0                        | 0                       | 0                        | 1                           | 0                                 | 0                           | 0                                 | 1                      | 2               | 5909         |       |
| 0                        | 1                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 4                      | 5               | 6330         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 1                      | 1               | 6887         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 1                      | 1               | 5924         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 4                      | 4               | 6029         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 1                      | 1               | 6282         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 0                      | 0               | 6006         |       |
| 1                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 0                      | 1               | 5612         |       |
| 0                        | 0                       | 0                        | 1                           | 0                                 | 0                           | 0                                 | 4                      | 5               | 7706         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 1                           | 0                                 | 0                      | 1               | 4674         |       |
| 0                        | 0                       | 1                        | 0                           | 0                                 | 0                           | 0                                 | 0                      | 1               | 4978         |       |
| 1                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 0                      | 1               | 5165         |       |
| 0                        | 0                       | 1                        | 0                           | 0                                 | 0                           | 0                                 | 0                      | 1               | 5664         |       |
| 0                        | 0                       | 0                        | 0                           | 1                                 | 0                           | 0                                 | 0                      | 1               | 5948         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 1                      | 1               | 5094         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 1                                 | 0                      | 1               | 5183         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 4                      | 4               | 5503         |       |
| 1                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 3                      | 4               | 6711         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 0                      | 0               | 5608         |       |
| 0                        | 1                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 0                      | 1               | 5399         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 2                           | 0                                 | 0                      | 2               | 5370         |       |
| 0                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 0                      | 0               | 6383         |       |
| 1                        | 0                       | 0                        | 0                           | 0                                 | 0                           | 0                                 | 0                      | 1               | 4771         |       |
| 5                        | 3                       | 3                        | 2                           | 1                                 | 3                           | 1                                 | 41                     | 59              | 176560       | Total |



| <i>Corynoneura taris</i> | <i>Cricotopus tremulus</i> group | <i>Micropsectra</i> sp. | <i>Microtendipes caelum</i> | <i>Microtendipes rydalensis</i> group | <i>Nanocladius</i> sp. 2 | <i>Orthocladius carlatus</i> group | <i>Parametriocnemus lundbecki</i> | <i>Rheocricotopus fuscipes</i> group | <i>Tanytarsus</i> sp. | <i>Thienemanniella</i> prob. <i>xena</i> | <i>Stegopterna mutata</i> complex | <i>Nigronia serricornis</i> | Total Organisms | Surface Area |
|--------------------------|----------------------------------|-------------------------|-----------------------------|---------------------------------------|--------------------------|------------------------------------|-----------------------------------|--------------------------------------|-----------------------|--|-----------------------------------|-----------------------------|-----------------|--------------|
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 5084         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 6693         |
| 0                        | 1                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 1               | 4891         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 5511         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 4479         |
| 0                        | 0                                | 0                       | 0                           | 1                                     | 0                        | 0                                  | 0                                 | 0                                    | 1                     | 0  | 0                                 | 0                           | 2               | 4601         |
| 0                        | 0                                | 0                       | 1                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 1               | 4624         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 1                     | 0  | 0                                 | 0                           | 1               | 4261         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 5998         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 4653         |
| 1                        | 0                                | 0                       | 0                           | 1                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 2               | 4433         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 1                     | 0  | 1                                 | 0                           | 2               | 5629         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 1                                 | 0                           | 1               | 5074         |
| 0                        | 0                                | 1                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 1               | 5722         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 5200         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 4651         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 5308         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 7364         |
| 0                        | 0                                | 1                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 1               | 4412         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 4688         |
| 0                        | 0                                | 1                       | 0                           | 0                                     | 0                        | 0                                  | 1                                 | 0                                    | 0                     | 0  | 1                                 | 0                           | 3               | 5832         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 6845         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 1                                    | 0                     | 1  | 0                                 | 0                           | 2               | 7463         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 4650         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 6429         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 1                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 1               | 4628         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 1                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 1                           | 2               | 5312         |
| 0                        | 0                                | 1                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 1               | 5258         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 6000         |
| 0                        | 0                                | 0                       | 0                           | 0                                     | 0                        | 0                                  | 0                                 | 0                                    | 0                     | 0  | 0                                 | 0                           | 0               | 4534         |
| 1                        | 1                                | 4                       | 1                           | 2                                     | 1                        | 1                                  | 1                                 | 1                                    | 3                     | 1  | 3                                 | 1                           | 21              | 160227 Total |



| <i>Zavrelimyia</i> sp. 3 | <i>Hemerodromia</i> sp. | Ephemereleidae | <i>Eurylophella bicolor</i> | <i>Eurylophella funeralis</i> | <i>Paraleptophlebia</i> sp. | <i>Stenonema modestum</i> | Plecoptera | <i>Isoperla marlynia</i> | <i>Taeniopteryx maura</i> | <i>Pycnopsyche</i> sp. | <i>Boyeria vinosa</i> | <i>Optioservus</i> sp. | <i>Promoresia</i> sp. | <i>Stenelmis</i> sp. | <i>Nigronia serricornis</i> | <i>Dero obtusa</i> | <i>Nais communis</i> | <i>Pristinella jenkiniae</i> | <i>Pristina longiseta longiseta</i> | Total Organisms | Surface Area |
|--------------------------|-------------------------|----------------|-----------------------------|-------------------------------|-----------------------------|---------------------------|------------|--------------------------|---------------------------|------------------------|-----------------------|------------------------|-----------------------|----------------------|-----------------------------|--------------------|----------------------|------------------------------|-------------------------------------|-----------------|--------------|
| 0                        | 0                       | 0              | 0                           | 0                             | 1                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 1                     | 0                    | 1                           | 0                  | 1                    | 1                            | 0                                   | 18              | 5177         |
| 0                        | 0                       | 1              | 0                           | 0                             | 1                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 8               | 5516         |
| 0                        | 0                       | 0              | 0                           | 0                             | 3                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 10              | 7137         |
| 0                        | 0                       | 0              | 0                           | 0                             | 0                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 1                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 3               | 5359         |
| 0                        | 0                       | 0              | 0                           | 0                             | 2                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 9               | 7797         |
| 0                        | 0                       | 0              | 0                           | 0                             | 0                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 1                    | 0                            | 0                                   | 12              | 6019         |
| 0                        | 0                       | 0              | 0                           | 0                             | 1                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 5               | 5813         |
| 0                        | 0                       | 0              | 0                           | 0                             | 0                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 5               | 5871         |
| 0                        | 0                       | 0              | 0                           | 0                             | 1                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 4               | 6486         |
| 0                        | 0                       | 1              | 0                           | 0                             | 2                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 1                    | 0                            | 0                                   | 4               | 6273         |
| 0                        | 0                       | 1              | 0                           | 0                             | 8                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 1                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 13              | 7238         |
| 0                        | 1                       | 1              | 0                           | 0                             | 2                           | 0                         | 0          | 0                        | 0                         | 1                      | 0                     | 1                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 10              | 6454         |
| 0                        | 0                       | 0              | 0                           | 0                             | 0                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 11              | 5677         |
| 0                        | 0                       | 0              | 0                           | 0                             | 0                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 1                    | 1                           | 0                  | 0                    | 0                            | 0                                   | 5               | 5258         |
| 0                        | 0                       | 2              | 0                           | 0                             | 4                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 1                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 14              | 5516         |
| 0                        | 0                       | 0              | 0                           | 0                             | 0                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 9               | 5550         |
| 0                        | 0                       | 2              | 0                           | 0                             | 10                          | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 24              | 6504         |
| 0                        | 0                       | 0              | 0                           | 0                             | 2                           | 0                         | 1          | 0                        | 0                         | 0                      | 0                     | 1                      | 0                     | 0                    | 1                           | 0                  | 0                    | 0                            | 0                                   | 24              | 6037         |
| 0                        | 0                       | 0              | 0                           | 0                             | 1                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 3               | 5617         |
| 0                        | 0                       | 0              | 1                           | 0                             | 2                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 1                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 7               | 5306         |
| 0                        | 0                       | 1              | 0                           | 0                             | 0                           | 0                         | 0          | 0                        | 0                         | 0                      | 1                     | 0                      | 0                     | 0                    | 1                           | 0                  | 0                    | 0                            | 0                                   | 10              | 6527         |
| 0                        | 0                       | 0              | 0                           | 0                             | 0                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 2                  | 0                    | 0                            | 0                                   | 10              | 5299         |
| 0                        | 0                       | 0              | 0                           | 0                             | 1                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 1                           | 0                  | 0                    | 0                            | 0                                   | 5               | 7272         |
| 0                        | 0                       | 1              | 0                           | 0                             | 3                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 17              | 5231         |
| 0                        | 1                       | 0              | 0                           | 1                             | 1                           | 1                         | 0          | 0                        | 1                         | 1                      | 0                     | 0                      | 1                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 21              | 5791         |
| 1                        | 0                       | 0              | 0                           | 0                             | 1                           | 0                         | 0          | 2                        | 0                         | 0                      | 0                     | 0                      | 1                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 11              | 6596         |
| 0                        | 0                       | 1              | 0                           | 0                             | 5                           | 1                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 13              | 6383         |
| 0                        | 0                       | 2              | 0                           | 0                             | 0                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 2                    | 0                            | 2                                   | 15              | 5084         |
| 1                        | 0                       | 1              | 0                           | 0                             | 2                           | 0                         | 0          | 0                        | 0                         | 1                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 16              | 6224         |
| 0                        | 0                       | 0              | 0                           | 0                             | 3                           | 0                         | 0          | 0                        | 0                         | 0                      | 0                     | 0                      | 0                     | 0                    | 0                           | 0                  | 0                    | 0                            | 0                                   | 3               | 5820         |
| 2                        | 2                       | 14             | 1                           | 1                             | 56                          | 2                         | 1          | 2                        | 1                         | 3                      | 1                     | 4                      | 5                     | 1                    | 5                           | 2                  | 5                    | 1                            | 2                                   | 319             | 180832       |
|                          |                         |                |                             |                               |                             |                           |            |                          |                           |                        |                       |                        |                       |                      |                             |                    |                      |                              |                                     | Total           |              |

| <i>Chironomini</i> | <i>Chironomus sp.</i> | <i>Conchapelopia sp.</i> | <i>Cryptochironomus fulvus</i> | <i>Glyptotendipes lobiferus</i> | <i>Kiefferulus sp.</i> | <i>Larsia sp.</i> | <i>Micropsectra sp.</i> | <i>Microtendipes caelum</i> | <i>Nanocladius sp. 1</i> | <i>Nanocladius sp. 2</i> | <i>Natarsia sp.</i> | <i>Paratendipes sp.</i> | <i>Paratanytarsus sp. 1</i> | <i>Paratanytarsus sp. 2</i> | <i>Paratanytarsus sp. 3</i> | <i>Phaenopsectra sp.</i> | <i>Phaenopsectra flavipes</i> | <i>Polypedilum aviceps</i> | <i>Polypedilum convictum</i> | <i>Polypedilum fallax</i> | <i>Polypedilum laetum</i> | <i>Polypedilum illinoense</i> | <i>Polypedilum scalaenum</i> | <i>Procladius sp.</i> | <i>Psectrotanypus dyari</i> | <i>Psectrotanypus nr. dyari</i> | Total |
|--------------------|-----------------------|--------------------------|--------------------------------|---------------------------------|------------------------|-------------------|-------------------------|-----------------------------|--------------------------|--------------------------|---------------------|-------------------------|-----------------------------|-----------------------------|-----------------------------|--------------------------|-------------------------------|----------------------------|------------------------------|---------------------------|---------------------------|-------------------------------|------------------------------|-----------------------|-----------------------------|---------------------------------|-------|
| 0                  | 2                     | 3                        | 0                              | 0                               | 0                      | 1                 | 3                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 3                           | 0                           | 0                        | 1                             | 0                          | 0                            | 5                         | 0                         | 14                            | 34                           | 0                     | 0                           | 2                               |       |
| 0                  | 1                     | 1                        | 0                              | 0                               | 0                      | 1                 | 3                       | 1                           | 0                        | 0                        | 0                   | 0                       | 0                           | 4                           | 0                           | 0                        | 0                             | 0                          | 11                           | 3                         | 3                         | 72                            | 0                            | 0                     | 0                           |                                 |       |
| 0                  | 1                     | 3                        | 0                              | 0                               | 1                      | 0                 | 3                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 1                           | 1                           | 0                        | 0                             | 0                          | 4                            | 1                         | 6                         | 32                            | 0                            | 0                     | 1                           |                                 |       |
| 0                  | 2                     | 3                        | 0                              | 1                               | 0                      | 0                 | 1                       | 0                           | 0                        | 0                        | 0                   | 2                       | 1                           | 5                           | 0                           | 0                        | 0                             | 0                          | 5                            | 0                         | 7                         | 30                            | 0                            | 2                     | 1                           |                                 |       |
| 0                  | 0                     | 0                        | 0                              | 1                               | 1                      | 1                 | 0                       | 0                           | 0                        | 0                        | 0                   | 0                       | 1                           | 0                           | 0                           | 0                        | 0                             | 0                          | 1                            | 1                         | 1                         | 15                            | 0                            | 0                     | 0                           |                                 |       |
| 0                  | 0                     | 0                        | 1                              | 0                               | 0                      | 0                 | 0                       | 0                           | 0                        | 0                        | 0                   | 1                       | 0                           | 3                           | 0                           | 0                        | 0                             | 0                          | 7                            | 1                         | 0                         | 24                            | 0                            | 2                     | 2                           |                                 |       |
| 0                  | 0                     | 0                        | 0                              | 0                               | 0                      | 0                 | 1                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 1                           | 0                           | 0                        | 0                             | 0                          | 5                            | 0                         | 1                         | 21                            | 0                            | 2                     | 0                           |                                 |       |
| 0                  | 1                     | 0                        | 0                              | 0                               | 0                      | 0                 | 0                       | 1                           | 0                        | 0                        | 0                   | 0                       | 0                           | 0                           | 0                           | 0                        | 0                             | 0                          | 3                            | 0                         | 0                         | 29                            | 0                            | 1                     | 0                           |                                 |       |
| 0                  | 5                     | 6                        | 0                              | 0                               | 0                      | 0                 | 1                       | 1                           | 0                        | 0                        | 0                   | 1                       | 0                           | 17                          | 2                           | 0                        | 2                             | 0                          | 7                            | 0                         | 7                         | 48                            | 0                            | 3                     | 3                           |                                 |       |
| 1                  | 1                     | 2                        | 0                              | 0                               | 0                      | 0                 | 0                       | 0                           | 1                        | 0                        | 0                   | 0                       | 0                           | 1                           | 0                           | 0                        | 0                             | 0                          | 0                            | 0                         | 0                         | 10                            | 0                            | 1                     | 1                           |                                 |       |
| 1                  | 1                     | 1                        | 0                              | 0                               | 0                      | 1                 | 2                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 3                           | 0                           | 0                        | 0                             | 0                          | 5                            | 1                         | 3                         | 36                            | 1                            | 0                     | 0                           |                                 |       |
| 0                  | 2                     | 0                        | 0                              | 0                               | 0                      | 0                 | 5                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 2                           | 1                           | 0                        | 0                             | 0                          | 5                            | 0                         | 10                        | 33                            | 0                            | 0                     | 1                           |                                 |       |
| 0                  | 2                     | 0                        | 0                              | 0                               | 0                      | 0                 | 2                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 2                           | 0                           | 0                        | 0                             | 0                          | 5                            | 2                         | 0                         | 33                            | 0                            | 1                     | 1                           |                                 |       |
| 0                  | 1                     | 1                        | 0                              | 0                               | 0                      | 0                 | 1                       | 0                           | 0                        | 0                        | 0                   | 1                       | 0                           | 1                           | 0                           | 0                        | 0                             | 0                          | 5                            | 0                         | 0                         | 23                            | 0                            | 1                     | 0                           |                                 |       |
| 0                  | 1                     | 0                        | 0                              | 0                               | 1                      | 0                 | 1                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 1                           | 0                           | 0                        | 0                             | 0                          | 3                            | 0                         | 1                         | 39                            | 0                            | 2                     | 1                           |                                 |       |
| 0                  | 1                     | 0                        | 0                              | 0                               | 0                      | 0                 | 1                       | 0                           | 0                        | 0                        | 0                   | 1                       | 0                           | 3                           | 3                           | 0                        | 1                             | 0                          | 7                            | 1                         | 5                         | 35                            | 0                            | 1                     | 3                           |                                 |       |
| 1                  | 2                     | 0                        | 0                              | 0                               | 0                      | 0                 | 0                       | 0                           | 0                        | 0                        | 0                   | 2                       | 0                           | 1                           | 2                           | 0                        | 0                             | 0                          | 4                            | 0                         | 2                         | 18                            | 0                            | 3                     | 2                           |                                 |       |
| 0                  | 0                     | 0                        | 0                              | 0                               | 2                      | 0                 | 2                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 2                           | 0                           | 0                        | 0                             | 0                          | 6                            | 1                         | 1                         | 32                            | 1                            | 0                     | 2                           |                                 |       |
| 0                  | 1                     | 3                        | 0                              | 0                               | 0                      | 0                 | 0                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 3                           | 1                           | 0                        | 0                             | 0                          | 7                            | 2                         | 1                         | 18                            | 0                            | 2                     | 1                           |                                 |       |
| 0                  | 0                     | 2                        | 0                              | 0                               | 0                      | 0                 | 0                       | 0                           | 0                        | 0                        | 0                   | 1                       | 0                           | 0                           | 0                           | 0                        | 0                             | 0                          | 2                            | 0                         | 4                         | 19                            | 0                            | 2                     | 0                           |                                 |       |
| 0                  | 2                     | 2                        | 1                              | 0                               | 1                      | 0                 | 4                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 3                           | 1                           | 0                        | 1                             | 0                          | 6                            | 0                         | 1                         | 80                            | 0                            | 2                     | 1                           |                                 |       |
| 0                  | 4                     | 1                        | 1                              | 0                               | 0                      | 0                 | 4                       | 0                           | 0                        | 0                        | 0                   | 1                       | 0                           | 1                           | 0                           | 0                        | 0                             | 0                          | 6                            | 0                         | 0                         | 83                            | 0                            | 2                     | 0                           |                                 |       |
| 0                  | 2                     | 1                        | 0                              | 0                               | 1                      | 0                 | 2                       | 0                           | 0                        | 0                        | 1                   | 4                       | 0                           | 7                           | 1                           | 0                        | 0                             | 0                          | 5                            | 1                         | 1                         | 33                            | 0                            | 2                     | 0                           |                                 |       |
| 0                  | 5                     | 0                        | 0                              | 0                               | 0                      | 0                 | 5                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 1                           | 1                           | 0                        | 0                             | 0                          | 6                            | 0                         | 2                         | 101                           | 0                            | 0                     | 3                           |                                 |       |
| 0                  | 2                     | 0                        | 1                              | 0                               | 0                      | 0                 | 1                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 1                           | 0                           | 0                        | 0                             | 0                          | 1                            | 0                         | 0                         | 54                            | 0                            | 0                     | 1                           |                                 |       |
| 0                  | 1                     | 2                        | 0                              | 0                               | 0                      | 0                 | 3                       | 0                           | 0                        | 0                        | 0                   | 3                       | 0                           | 3                           | 0                           | 0                        | 0                             | 0                          | 6                            | 0                         | 4                         | 85                            | 0                            | 4                     | 2                           |                                 |       |
| 0                  | 3                     | 2                        | 0                              | 0                               | 0                      | 0                 | 1                       | 1                           | 0                        | 0                        | 0                   | 4                       | 0                           | 17                          | 0                           | 0                        | 1                             | 0                          | 2                            | 0                         | 2                         | 65                            | 0                            | 2                     | 0                           |                                 |       |
| 0                  | 0                     | 3                        | 0                              | 0                               | 0                      | 0                 | 4                       | 0                           | 0                        | 1                        | 0                   | 2                       | 0                           | 9                           | 0                           | 1                        | 0                             | 0                          | 10                           | 2                         | 5                         | 46                            | 0                            | 2                     | 0                           |                                 |       |
| 0                  | 1                     | 3                        | 0                              | 0                               | 0                      | 0                 | 3                       | 0                           | 0                        | 0                        | 0                   | 1                       | 0                           | 2                           | 0                           | 0                        | 0                             | 1                          | 4                            | 1                         | 1                         | 67                            | 0                            | 1                     | 2                           |                                 |       |
| 0                  | 0                     | 4                        | 0                              | 0                               | 0                      | 0                 | 6                       | 0                           | 0                        | 0                        | 0                   | 0                       | 0                           | 12                          | 0                           | 0                        | 0                             | 2                          | 3                            | 0                         | 3                         | 56                            | 0                            | 0                     | 0                           |                                 |       |
| 3                  | 44                    | 43                       | 4                              | 2                               | 7                      | 4                 | 59                      | 4                           | 1                        | 1                        | 1                   | 24                      | 2                           | 109                         | 13                          | 1                        | 6                             | 1                          | 2                            | 146                       | 17                        | 85                            | 1271                         | 2                     | 38                          | 30                              |       |

| <i>Rheotanytarsus exiguus</i> group | Tanypodinae (early instar) | <i>Tanytarsus</i> sp. | <i>Tribelos</i> poss. <i>jucundum</i> | <i>Zavrelimyia</i> sp. 1 | <i>Zavrelimyia</i> sp. 2 | <i>Prosimulium</i> sp. | <i>Hemerodromia</i> sp. | <i>Dytiscus</i> sp. | <i>Hydroporus</i> sp. | <i>Optioservus</i> sp. | <i>Nigronia serricornis</i> | <i>Oligochaeta</i> | <i>Dero obtusa</i> | IWCC | ICC | <i>Nais communis</i> | <i>Hexatoma</i> sp. | Pupa | Total Organisms | Surface Area |       |
|-------------------------------------|----------------------------|-----------------------|---------------------------------------|--------------------------|--------------------------|------------------------|-------------------------|---------------------|-----------------------|------------------------|-----------------------------|--------------------|--------------------|------|-----|----------------------|---------------------|------|-----------------|--------------|-------|
| 0                                   | 0                          | 0                     | 0                                     | 0                        | 2                        | 0                      | 1                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 4                    | 0                   | 0    | 75              | 5558         |       |
| 0                                   | 0                          | 0                     | 2                                     | 1                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 5                  | 0                  | 0    | 0   | 1                    | 0                   | 0    | 109             | 8036         |       |
| 0                                   | 0                          | 0                     | 1                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 1                  | 0    | 0   | 2                    | 0                   | 0    | 58              | 5466         |       |
| 0                                   | 0                          | 1                     | 1                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 2                    | 0                   | 0    | 64              | 4854         |       |
| 0                                   | 0                          | 0                     | 1                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 2                    | 0                   | 0    | 25              | 5289         |       |
| 0                                   | 0                          | 0                     | 0                                     | 0                        | 1                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 1                  | 0                  | 0    | 0   | 2                    | 0                   | 0    | 45              | 4760         |       |
| 0                                   | 0                          | 0                     | 1                                     | 0                        | 0                        | 0                      | 0                       | 2                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 1                    | 0                   | 0    | 35              | 6597         |       |
| 0                                   | 0                          | 1                     | 3                                     | 2                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 2    | 0   | 3                    | 0                   | 0    | 46              | 5845         |       |
| 0                                   | 0                          | 1                     | 1                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 3                    | 0                   | 0    | 108             | 8328         |       |
| 0                                   | 0                          | 0                     | 1                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 1                    | 0                   | 1    | 21              | 5103         |       |
| 0                                   | 0                          | 0                     | 0                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 2                    | 0                   | 0    | 57              | 5552         |       |
| 1                                   | 0                          | 0                     | 0                                     | 0                        | 2                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 1                  | 0                  | 0    | 0   | 2                    | 0                   | 0    | 65              | 5620         |       |
| 0                                   | 0                          | 0                     | 2                                     | 0                        | 1                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 1                    | 0                   | 0    | 52              | 6275         |       |
| 0                                   | 0                          | 0                     | 2                                     | 0                        | 0                        | 0                      | 0                       | 1                   | 0                     | 0                      | 0                           | 0                  | 0                  | 1    | 0   | 0                    | 0                   | 0    | 38              | 6497         |       |
| 0                                   | 0                          | 0                     | 0                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 7                    | 0                   | 0    | 57              | 4700         |       |
| 0                                   | 0                          | 0                     | 1                                     | 1                        | 1                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 1                    | 0                   | 0    | 66              | 5879         |       |
| 0                                   | 0                          | 0                     | 1                                     | 0                        | 1                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 1                  | 1                  | 1    | 0   | 4                    | 0                   | 0    | 46              | 6845         |       |
| 0                                   | 0                          | 0                     | 1                                     | 0                        | 0                        | 1                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 3                    | 0                   | 0    | 54              | 6812         |       |
| 1                                   | 0                          | 0                     | 1                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 3                    | 0                   | 0    | 44              | 5752         |       |
| 0                                   | 0                          | 0                     | 0                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 1                    | 0                   | 0    | 31              | 5280         |       |
| 0                                   | 0                          | 0                     | 2                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 1                  | 0                  | 0    | 0   | 0                    | 0                   | 0    | 108             | 6509         |       |
| 0                                   | 0                          | 0                     | 1                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 3                  | 0                  | 0    | 0   | 3                    | 0                   | 1    | 111             | 6179         |       |
| 0                                   | 1                          | 0                     | 0                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 11                   | 0                   | 0    | 73              | 8923         |       |
| 0                                   | 0                          | 1                     | 3                                     | 0                        | 1                        | 0                      | 1                       | 0                   | 0                     | 1                      | 0                           | 0                  | 1                  | 0    | 0   | 1                    | 0                   | 0    | 133             | 5323         |       |
| 0                                   | 0                          | 0                     | 1                                     | 0                        | 0                        | 0                      | 0                       | 1                   | 1                     | 0                      | 0                           | 1                  | 0                  | 0    | 0   | 1                    | 0                   | 0    | 66              | 5301         |       |
| 0                                   | 0                          | 0                     | 4                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 3                    | 0                   | 0    | 120             | 5327         |       |
| 2                                   | 0                          | 0                     | 2                                     | 1                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 2                           | 0                  | 0                  | 0    | 0   | 6                    | 0                   | 0    | 113             | 5543         |       |
| 0                                   | 0                          | 0                     | 1                                     | 0                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 3                    | 1                   | 0    | 90              | 5259         |       |
| 0                                   | 0                          | 0                     | 1                                     | 1                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 0                           | 0                  | 0                  | 0    | 0   | 2                    | 0                   | 0    | 91              | 6875         |       |
| 0                                   | 0                          | 1                     | 0                                     | 1                        | 0                        | 0                      | 0                       | 0                   | 0                     | 0                      | 1                           | 2                  | 0                  | 0    | 0   | 3                    | 0                   | 0    | 94              | 6357         |       |
| 4                                   | 1                          | 5                     | 34                                    | 7                        | 9                        | 1                      | 2                       | 4                   | 1                     | 1                      | 1                           | 17                 | 3                  | 4    | 0   | 78                   | 1                   | 2    | 2095            | 180644       | Total |



| <i>Ferrissia</i> sp. | <i>Musculium</i> sp. | <i>Hyalella</i> azteca | <i>Dina</i> sp. | <i>Helobdella</i> stagnalis | <i>Mooreobdella</i> melanostoma | Oligochaeta | <i>Dero</i> obtusa | <i>Homochaeta</i> sp. | IWCC | ICC | Lumbricidae | <i>Nais</i> communis | <i>Pristina longiseta</i> longiseta | <i>Pristina</i> longisoma | <i>Pristinella</i> osborni | <i>Slavina</i> appendiculata | Copepod | Total Organisms | Surface Area |       |
|----------------------|----------------------|------------------------|-----------------|-----------------------------|---------------------------------|-------------|--------------------|-----------------------|------|-----|-------------|----------------------|-------------------------------------|---------------------------|----------------------------|------------------------------|---------|-----------------|--------------|-------|
| 0                    | 0                    | 1                      | 0               | 1                           | 0                               | 0           | 0                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 3               | 4910         |       |
| 0                    | 0                    | 4                      | 0               | 0                           | 0                               | 0           | 2                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 9               | 5892         |       |
| 1                    | 0                    | 7                      | 0               | 1                           | 0                               | 11          | 11                 | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 3                          | 0                            | 1       | 38              | 7249         |       |
| 0                    | 0                    | 4                      | 0               | 3                           | 0                               | 4           | 5                  | 0                     | 0    | 0   | 0           | 0                    | 1                                   | 0                         | 0                          | 0                            | 1       | 21              | 4622         |       |
| 2                    | 0                    | 24                     | 0               | 1                           | 0                               | 5           | 8                  | 0                     | 0    | 0   | 0           | 4                    | 0                                   | 0                         | 3                          | 0                            | 0       | 49              | 6058         |       |
| 1                    | 0                    | 6                      | 0               | 0                           | 0                               | 2           | 7                  | 0                     | 0    | 0   | 0           | 1                    | 1                                   | 0                         | 2                          | 0                            | 0       | 22              | 6066         |       |
| 1                    | 0                    | 10                     | 0               | 0                           | 0                               | 10          | 10                 | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 1                          | 0                            | 0       | 33              | 6444         |       |
| 1                    | 0                    | 1                      | 0               | 0                           | 0                               | 10          | 0                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 1       | 16              | 4877         |       |
| 0                    | 0                    | 1                      | 0               | 0                           | 0                               | 0           | 0                  | 0                     | 0    | 0   | 0           | 0                    | 1                                   | 0                         | 0                          | 0                            | 0       | 4               | 4261         |       |
| 0                    | 0                    | 0                      | 0               | 0                           | 0                               | 8           | 1                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 27              | 5998         |       |
| 0                    | 0                    | 5                      | 0               | 0                           | 0                               | 2           | 1                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 11              | 4068         |       |
| 0                    | 0                    | 3                      | 0               | 0                           | 0                               | 1           | 3                  | 0                     | 0    | 0   | 0           | 0                    | 1                                   | 1                         | 0                          | 0                            | 0       | 11              | 4375         |       |
| 0                    | 0                    | 8                      | 0               | 0                           | 0                               | 2           | 2                  | 0                     | 0    | 0   | 1           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 13              | 6230         |       |
| 0                    | 1                    | 13                     | 0               | 4                           | 1                               | 2           | 0                  | 0                     | 0    | 1   | 0           | 1                    | 0                                   | 0                         | 1                          | 0                            | 1       | 27              | 5650         |       |
| 0                    | 0                    | 2                      | 1               | 0                           | 0                               | 0           | 0                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 19              | 4526         |       |
| 0                    | 0                    | 2                      | 0               | 1                           | 0                               | 3           | 3                  | 0                     | 0    | 0   | 0           | 2                    | 0                                   | 0                         | 0                          | 0                            | 0       | 18              | 5838         |       |
| 0                    | 1                    | 6                      | 0               | 0                           | 0                               | 0           | 2                  | 0                     | 0    | 0   | 0           | 2                    | 0                                   | 0                         | 0                          | 0                            | 0       | 19              | 5084         |       |
| 1                    | 0                    | 5                      | 0               | 0                           | 0                               | 5           | 2                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 19              | 5656         |       |
| 0                    | 0                    | 6                      | 0               | 1                           | 0                               | 1           | 8                  | 0                     | 0    | 0   | 0           | 1                    | 0                                   | 0                         | 0                          | 0                            | 0       | 19              | 5030         |       |
| 0                    | 0                    | 4                      | 0               | 0                           | 0                               | 3           | 2                  | 1                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 10              | 5208         |       |
| 0                    | 0                    | 5                      | 0               | 1                           | 0                               | 1           | 0                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 14              | 7463         |       |
| 0                    | 0                    | 4                      | 0               | 1                           | 0                               | 7           | 5                  | 0                     | 0    | 0   | 0           | 1                    | 0                                   | 0                         | 0                          | 0                            | 0       | 18              | 6808         |       |
| 0                    | 0                    | 5                      | 0               | 0                           | 0                               | 2           | 1                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 14              | 5109         |       |
| 0                    | 0                    | 7                      | 0               | 6                           | 0                               | 1           | 2                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 1       | 25              | 6429         |       |
| 1                    | 0                    | 3                      | 0               | 0                           | 0                               | 3           | 2                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 1                          | 0                            | 0       | 12              | 4653         |       |
| 0                    | 0                    | 5                      | 0               | 0                           | 0                               | 2           | 2                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 14              | 3938         |       |
| 0                    | 0                    | 3                      | 0               | 0                           | 0                               | 2           | 5                  | 0                     | 0    | 0   | 0           | 2                    | 0                                   | 0                         | 2                          | 0                            | 1       | 17              | 5598         |       |
| 0                    | 0                    | 7                      | 0               | 1                           | 0                               | 1           | 2                  | 1                     | 2    | 0   | 1           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 18              | 5202         |       |
| 0                    | 0                    | 2                      | 0               | 0                           | 0                               | 1           | 4                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 1                            | 0       | 25              | 4265         |       |
| 0                    | 0                    | 4                      | 0               | 1                           | 0                               | 0           | 0                  | 0                     | 0    | 0   | 0           | 0                    | 0                                   | 0                         | 0                          | 0                            | 0       | 5               | 5130         |       |
| 8                    | 2                    | 157                    | 1               | 22                          | 1                               | 89          | 90                 | 2                     | 2    | 1   | 2           | 14                   | 4                                   | 1                         | 13                         | 1                            | 6       | 550             | 162637       | Total |

| <i>Chironomus sp.</i> | Ceratopogonidae | <i>Helobdella stagnalis</i> | Oligochaeta | <i>Aulodrilus limnosius</i> | <i>Dero obtusa</i> | <i>Homochaeta sp.</i> | IWCC | ICC | <i>Nais communis</i> | <i>Pristinella osborni</i> | <i>Slavina appendiculata</i> | Copepod | Total Organisms | Surface Area |
|-----------------------|-----------------|-----------------------------|-------------|-----------------------------|--------------------|-----------------------|------|-----|----------------------|----------------------------|------------------------------|---------|-----------------|--------------|
| 0                     | 0               | 0                           | 1           | 0                           | 2                  | 0                     | 1    | 0   | 0                    | 0                          | 0                            | 0       | 4               | 4415         |
| 0                     | 0               | 0                           | 0           | 0                           | 1                  | 1                     | 0    | 0   | 0                    | 1                          | 1                            | 0       | 4               | 3867         |
| 0                     | 0               | 0                           | 1           | 0                           | 0                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 1               | 6199         |
| 1                     | 0               | 0                           | 4           | 0                           | 3                  | 0                     | 0    | 0   | 0                    | 1                          | 0                            | 0       | 9               | 6342         |
| 0                     | 0               | 0                           | 0           | 0                           | 2                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 2               | 7565         |
| 0                     | 0               | 0                           | 0           | 0                           | 0                  | 0                     | 1    | 0   | 0                    | 0                          | 0                            | 0       | 1               | 6537         |
| 0                     | 0               | 0                           | 0           | 1                           | 0                  | 0                     | 0    | 1   | 0                    | 0                          | 0                            | 0       | 1               | 6674         |
| 0                     | 0               | 0                           | 0           | 0                           | 1                  | 1                     | 3    | 0   | 0                    | 0                          | 0                            | 0       | 5               | 5941         |
| 0                     | 0               | 0                           | 0           | 0                           | 0                  | 0                     | 1    | 2   | 0                    | 0                          | 0                            | 0       | 3               | 4831         |
| 1                     | 0               | 0                           | 1           | 0                           | 5                  | 1                     | 1    | 0   | 0                    | 1                          | 1                            | 0       | 11              | 5629         |
| 0                     | 0               | 1                           | 0           | 0                           | 4                  | 0                     | 0    | 1   | 0                    | 0                          | 0                            | 0       | 1               | 5069         |
| 0                     | 0               | 2                           | 0           | 0                           | 0                  | 2                     | 3    | 3   | 1                    | 0                          | 0                            | 0       | 11              | 4452         |
| 0                     | 0               | 0                           | 0           | 0                           | 0                  | 0                     | 1    | 0   | 0                    | 0                          | 0                            | 0       | 1               | 4886         |
| 0                     | 0               | 0                           | 0           | 0                           | 2                  | 0                     | 1    | 0   | 0                    | 0                          | 0                            | 0       | 1               | 4796         |
| 0                     | 0               | 1                           | 0           | 0                           | 0                  | 0                     | 2    | 0   | 0                    | 0                          | 0                            | 0       | 3               | 5005         |
| 0                     | 0               | 0                           | 0           | 0                           | 1                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 1               | 5712         |
| 0                     | 0               | 0                           | 1           | 0                           | 2                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 3               | 4203         |
| 0                     | 0               | 0                           | 0           | 0                           | 2                  | 0                     | 7    | 0   | 0                    | 0                          | 0                            | 0       | 9               | 6808         |
| 0                     | 0               | 0                           | 0           | 0                           | 0                  | 0                     | 1    | 1   | 0                    | 0                          | 0                            | 0       | 2               | 5637         |
| 0                     | 0               | 0                           | 0           | 0                           | 0                  | 0                     | 0    | 1   | 0                    | 0                          | 0                            | 0       | 1               | 5308         |
| 0                     | 1               | 0                           | 0           | 0                           | 0                  | 0                     | 0    | 1   | 0                    | 0                          | 0                            | 0       | 2               | 4958         |
| 0                     | 0               | 0                           | 1           | 0                           | 1                  | 0                     | 1    | 0   | 0                    | 0                          | 0                            | 0       | 3               | 4841         |
| 0                     | 0               | 3                           | 0           | 0                           | 0                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 3               | 6052         |
| 0                     | 0               | 2                           | 0           | 0                           | 0                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 2               | 5948         |
| 0                     | 0               | 1                           | 0           | 0                           | 0                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 1               | 5996         |
| 0                     | 0               | 1                           | 0           | 0                           | 0                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 1               | 5941         |
| 0                     | 0               | 1                           | 0           | 0                           | 0                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 1               | 6674         |
| 0                     | 0               | 6                           | 0           | 0                           | 0                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 6               | 6537         |
| 0                     | 0               | 4                           | 0           | 0                           | 0                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 4               | 6808         |
| 0                     | 0               | 0                           | 0           | 0                           | 0                  | 0                     | 0    | 0   | 0                    | 0                          | 0                            | 0       | 0               | 4174         |
| 2                     | 1               | 22                          | 9           | 1                           | 26                 | 5                     | 23   | 10  | 1                    | 3                          | 2                            | 3       | 108             | 167805       |
|                       |                 |                             |             |                             |                    |                       |      |     |                      |                            |                              |         |                 | Total        |





| <i>Tanytarsus</i> sp. | <i>Thienemanniella</i> prob. xena | <i>Thienemanniella</i> sp. 2 | <i>Tribelos</i> poss. <i>jucundum</i> | <i>Zavrelimyia</i> sp. 1 | <i>Zavrelimyia</i> sp. 2 | Ceratopogonidae | Ephemerellidae | <i>Paraleptophlebia</i> sp. | <i>Stenonema modestum</i> | Tricoptera | <i>Hydatophylax</i> sp. | <i>Calopteryx maculata</i> | Coenagrionidae | <i>Optioservus</i> sp. | <i>Psephenus</i> sp. | <i>Nigronia serricornis</i> | <i>Ferrissia</i> sp. | Oligochaeta | IWCC | <i>Nais communis</i> | <i>Slavina appendiculata</i> | Tipulidae | Pupa | Total Organisms | Surface Area |       |
|-----------------------|-----------------------------------|------------------------------|---------------------------------------|--------------------------|--------------------------|-----------------|----------------|-----------------------------|---------------------------|------------|-------------------------|----------------------------|----------------|------------------------|----------------------|-----------------------------|----------------------|-------------|------|----------------------|------------------------------|-----------|------|-----------------|--------------|-------|
| 0                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 2              | 1                           | 0                         | 1          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 2                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 11              | 5409         |       |
| 4                     | 0                                 | 2                            | 0                                     | 0                        | 0                        | 0               | 0              | 3                           | 0                         | 2          | 0                       | 0                          | 1              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 19              | 4941         |       |
| 9                     | 0                                 | 0                            | 0                                     | 0                        | 1                        | 0               | 2              | 3                           | 0                         | 0          | 0                       | 0                          | 1              | 1                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 1    | 25              | 5821         |       |
| 6                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 4              | 2                           | 0                         | 2          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 33              | 5344         |       |
| 11                    | 0                                 | 0                            | 0                                     | 0                        | 0                        | 1               | 1              | 5                           | 0                         | 2          | 0                       | 0                          | 0              | 0                      | 1                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 35              | 7104         |       |
| 5                     | 1                                 | 2                            | 0                                     | 0                        | 0                        | 0               | 9              | 2                           | 0                         | 2          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 37              | 4437         |       |
| 6                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 2              | 3                           | 0                         | 2          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 26              | 5497         |       |
| 3                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 2              | 4                           | 0                         | 2          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 1    | 17              | 4821         |       |
| 6                     | 0                                 | 2                            | 0                                     | 0                        | 0                        | 0               | 11             | 5                           | 0                         | 0          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 1           | 0    | 0                    | 0                            | 1         | 0    | 40              | 6301         |       |
| 14                    | 0                                 | 1                            | 0                                     | 0                        | 0                        | 0               | 10             | 3                           | 0                         | 0          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 33              | 6877         |       |
| 4                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 2              | 3                           | 0                         | 5          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 28              | 5511         |       |
| 5                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 5              | 1                           | 0                         | 0          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 1           | 0    | 0                    | 0                            | 0         | 0    | 37              | 4423         |       |
| 4                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 3              | 7                           | 0                         | 10         | 0                       | 1                          | 0              | 0                      | 0                    | 0                           | 0                    | 1           | 0    | 0                    | 0                            | 0         | 1    | 34              | 4084         |       |
| 3                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 3              | 4                           | 1                         | 0          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 19              | 6421         |       |
| 4                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 7              | 2                           | 0                         | 1          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 1                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 24              | 4966         |       |
| 8                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 3              | 3                           | 1                         | 0          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 22              | 5186         |       |
| 0                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 2              | 3                           | 0                         | 2          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 12              | 4941         |       |
| 4                     | 0                                 | 0                            | 1                                     | 1                        | 0                        | 0               | 4              | 6                           | 0                         | 0          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 1                    | 0                            | 0         | 0    | 22              | 6179         |       |
| 4                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 4              | 3                           | 0                         | 0          | 0                       | 0                          | 0              | 0                      | 0                    | 1                           | 0                    | 0           | 1    | 0                    | 0                            | 0         | 0    | 23              | 5177         |       |
| 3                     | 0                                 | 0                            | 0                                     | 1                        | 0                        | 0               | 2              | 4                           | 0                         | 2          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 20              | 7141         |       |
| 6                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 1              | 0                           | 0                         | 4          | 0                       | 2                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 24              | 5583         |       |
| 4                     | 0                                 | 2                            | 0                                     | 0                        | 0                        | 0               | 4              | 3                           | 0                         | 4          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 1           | 0    | 0                    | 0                            | 0         | 0    | 41              | 5327         |       |
| 11                    | 0                                 | 1                            | 0                                     | 0                        | 0                        | 0               | 6              | 2                           | 0                         | 0          | 1                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 1                    | 0                            | 0         | 1    | 42              | 7072         |       |
| 4                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 3              | 3                           | 0                         | 0          | 0                       | 0                          | 1              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 1                            | 0         | 0    | 16              | 5652         |       |
| 3                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 6              | 3                           | 0                         | 0          | 0                       | 1                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 24              | 6745         |       |
| 1                     | 0                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 3              | 6                           | 0                         | 0          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 19              | 5552         |       |
| 2                     | 1                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 6              | 0                           | 0                         | 1          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 13              | 5733         |       |
| 4                     | 1                                 | 0                            | 0                                     | 0                        | 0                        | 0               | 0              | 6                           | 0                         | 6          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 1           | 0    | 0                    | 0                            | 0         | 0    | 23              | 5085         |       |
| 8                     | 3                                 | 2                            | 0                                     | 0                        | 1                        | 0               | 9              | 2                           | 0                         | 0          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 2    | 59              | 5005         |       |
| 11                    | 0                                 | 0                            | 0                                     | 0                        | 1                        | 0               | 10             | 10                          | 0                         | 0          | 0                       | 0                          | 0              | 0                      | 0                    | 0                           | 0                    | 0           | 0    | 0                    | 0                            | 0         | 0    | 59              | 6000         |       |
| 157                   | 6                                 | 12                           | 1                                     | 2                        | 3                        | 1               | 125            | 102                         | 2                         | 48         | 1                       | 4                          | 3              | 1                      | 1                    | 1                           | 3                    | 5           | 1    | 2                    | 1                            | 2         | 5    | 837             | 168335       | Total |

| Chironomini | <i>Chironomus</i> sp. | <i>Conchapelopia</i> sp. | <i>Corynoneura taris</i> | <i>Hudsonimyia</i> sp. | <i>Microtendipes caelum</i> | <i>Nanocladius</i> sp. 1 | <i>Parametriocnemus lundbecki</i> | <i>Paratanytarsus</i> sp. 2 | <i>Polypedilum fallax</i> | <i>Polypedilum laetum</i> | <i>Polypedilum illinoense</i> | <i>Polypedilum scalaenum</i> | Tanytopodinae (early instar) | <i>Tanytarsus</i> sp. | <i>Zavrelimyia</i> sp. 2 | <i>Zavrelimyia</i> sp. 3 | <i>Hemerodromia</i> sp. | <i>Eurylophella bicolor</i> | <i>Eurylophella funeralis</i> | <i>Paraleptophlebia</i> sp. | <i>Paracapnia opis</i> | <i>Perlrella ephyre/fumipennis</i> | <i>Optioservus</i> sp. | <i>Promoresia</i> sp. | <i>Nigronia serricornis</i> | Oligochaeta | <i>Nais communis</i> | Total Organisms | Surface Area |       |
|-------------|-----------------------|--------------------------|--------------------------|------------------------|-----------------------------|--------------------------|-----------------------------------|-----------------------------|---------------------------|---------------------------|-------------------------------|------------------------------|------------------------------|-----------------------|--------------------------|--------------------------|-------------------------|-----------------------------|-------------------------------|-----------------------------|------------------------|------------------------------------|------------------------|-----------------------|-----------------------------|-------------|----------------------|-----------------|--------------|-------|
| 0           | 0                     | 0                        | 1                        | 0                      | 1                           | 0                        | 0                                 | 1                           | 0                         | 0                         | 0                             | 2                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 5                    | 5840            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 1                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 1                    | 6039            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 1                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 1                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 1                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 3                    | 4719            |              |       |
| 0           | 0                     | 2                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 1                           | 1                         | 0                         | 1                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 1           | 6                    | 4479            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 1                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 1                            | 0                            | 0                     | 0                        | 1                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 3                    | 6124            |              |       |
| 0           | 3                     | 0                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 1                         | 0                             | 2                            | 0                            | 1                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 7                    | 4893            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 1                         | 0                         | 0                             | 2                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 3                    | 4025            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 2                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 1                             | 0                            | 0                            | 0                     | 1                        | 0                        | 0                       | 0                           | 1                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 5                    | 5567            |              |       |
| 0           | 0                     | 1                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 1                            | 1                            | 0                     | 0                        | 0                        | 0                       | 1                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 4                    | 5202            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 1                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 1                    | 5208            |              |       |
| 0           | 0                     | 2                        | 0                        | 0                      | 0                           | 1                        | 1                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 1                        | 0                        | 1                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 6                    | 5275            |              |       |
| 0           | 1                     | 3                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 4                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 1                           | 0                      | 0                                  | 0                      | 0                     | 1                           | 10          | 5973                 |                 |              |       |
| 0           | 0                     | 4                        | 1                        | 0                      | 0                           | 2                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 1                            | 0                            | 1                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 1                           | 0           | 10                   | 5803            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 1                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 1                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 2                    | 5262            |              |       |
| 0           | 0                     | 2                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 2                            | 0                            | 0                     | 0                        | 1                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 5                    | 5252            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 0                           | 1                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 1                    | 5579            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 1                        | 0                       | 0                           | 0                             | 0                           | 0                      | 1                                  | 1                      | 0                     | 0                           | 0           | 3                    | 6829            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 0                           | 1                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 1                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 1                             | 1                           | 0                      | 0                                  | 1                      | 0                     | 0                           | 0           | 5                    | 4207            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 0                           | 0                        | 1                                 | 0                           | 0                         | 0                         | 0                             | 1                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 2                    | 5575            |              |       |
| 0           | 0                     | 0                        | 0                        | 1                      | 1                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 1                           | 0                             | 0                           | 1                      | 0                                  | 0                      | 0                     | 0                           | 0           | 4                    | 5921            |              |       |
| 0           | 0                     | 1                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 2                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 3                    | 7061            |              |       |
| 1           | 0                     | 1                        | 0                        | 0                      | 1                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 1                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 4                    | 5553            |              |       |
| 0           | 0                     | 1                        | 1                        | 0                      | 1                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 3                    | 5312            |              |       |
| 1           | 0                     | 1                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 1                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 3                    | 3811            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 1                      | 0                     | 0                           | 0           | 1                    | 4460            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 1                                  | 0                      | 0                     | 0                           | 0           | 1                    | 3776            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 0                    | 3992            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 0                    | 4147            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 0                    | 5188            |              |       |
| 0           | 0                     | 0                        | 0                        | 0                      | 0                           | 0                        | 0                                 | 0                           | 0                         | 0                         | 0                             | 0                            | 0                            | 0                     | 0                        | 0                        | 0                       | 0                           | 0                             | 0                           | 0                      | 0                                  | 0                      | 0                     | 0                           | 0           | 0                    | 5722            |              |       |
| 2           | 4                     | 18                       | 3                        | 1                      | 11                          | 5                        | 1                                 | 3                           | 2                         | 1                         | 2                             | 19                           | 2                            | 2                     | 2                        | 1                        | 5                       | 1                           | 1                             | 5                           | 1                      | 1                                  | 2                      | 3                     | 1                           | 1           | 1                    | 101             | 156794       | Total |

| <i>Brillia flavifrons</i> | Chironomini | <i>Chironomus sp.</i> | <i>Conchapelopia sp.</i> | <i>Meropelopia flavifrons</i> | <i>Micropsectra sp.</i> | <i>Microtendipes caelum</i> | <i>Parakiefferiella sp.</i> | <i>Paratendipes sp.</i> | <i>Paratanytarsus sp. 2</i> | <i>Polypedilum laetum</i> | <i>Polypedilum illinoense</i> | <i>Polypedilum scalaenum</i> | <i>Rheotanytarsus exiguus</i> group | Tanypodinae (early instar) | <i>Tanytarsus sp.</i> | <i>Zavrelimyia sp. 1</i> | <i>Zavrelimyia sp. 2</i> | <i>Hemerodromia sp.</i> | <i>Oreodytes sp.</i> | <i>Promoresia sp.</i> | <i>Nigronia serricornis</i> | <i>Ferrissia sp.</i> | Oligochaeta | IWCC | <i>Nais communis</i> | <i>Pristina sima</i> | Tipulidae | Total Organisms | Surface Area |       |
|---------------------------|-------------|-----------------------|--------------------------|-------------------------------|-------------------------|-----------------------------|-----------------------------|-------------------------|-----------------------------|---------------------------|-------------------------------|------------------------------|-------------------------------------|----------------------------|-----------------------|--------------------------|--------------------------|-------------------------|----------------------|-----------------------|-----------------------------|----------------------|-------------|------|----------------------|----------------------|-----------|-----------------|--------------|-------|
| 0                         | 0           | 1                     | 4                        | 1                             | 0                       | 2                           | 0                           | 0                       | 0                           | 0                         | 0                             | 1                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 1                       | 0                    | 0                     | 0                           | 0                    | 0           | 1    | 0                    | 1                    | 1         | 13              | 5399         |       |
| 0                         | 0           | 0                     | 3                        | 1                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 3                    | 0                    | 0         | 7               | 5111         |       |
| 0                         | 0           | 0                     | 0                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 3                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 0         | 3               | 6377         |       |
| 0                         | 0           | 0                     | 1                        | 0                             | 0                       | 2                           | 0                           | 0                       | 0                           | 0                         | 0                             | 1                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 0         | 4               | 6302         |       |
| 1                         | 0           | 0                     | 1                        | 0                             | 0                       | 1                           | 0                           | 0                       | 0                           | 0                         | 0                             | 1                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 0         | 4               | 5482         |       |
| 0                         | 0           | 0                     | 2                        | 0                             | 0                       | 0                           | 0                           | 0                       | 1                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 1                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 0         | 4               | 6205         |       |
| 0                         | 1           | 0                     | 2                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 1                            | 0                                   | 0                          | 0                     | 1                        | 0                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 1                    | 0         | 6               | 6311         |       |
| 0                         | 0           | 0                     | 1                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 1                        | 0                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 2                    | 0                    | 0         | 4               | 6711         |       |
| 0                         | 0           | 1                     | 2                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 1                        | 1                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 0         | 5               | 5711         |       |
| 0                         | 0           | 0                     | 2                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 1                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 1                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 0         | 4               | 6006         |       |
| 0                         | 0           | 0                     | 0                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 2                       | 0                    | 0                     | 0                           | 0                    | 0           | 5    | 0                    | 0                    | 7         | 4876            |              |       |
| 0                         | 0           | 0                     | 2                        | 0                             | 0                       | 1                           | 0                           | 0                       | 0                           | 0                         | 1                             | 0                            | 0                                   | 1                          | 0                     | 0                        | 1                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 2    | 0                    | 0                    | 8         | 7797            |              |       |
| 0                         | 0           | 0                     | 0                        | 0                             | 0                       | 1                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 3                       | 0                    | 1                     | 0                           | 0                    | 0           | 2    | 0                    | 1                    | 8         | 5018            |              |       |
| 0                         | 2           | 0                     | 0                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 1                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 1                        | 0                       | 0                    | 0                     | 0                           | 1                    | 0           | 1    | 0                    | 0                    | 6         | 5909            |              |       |
| 0                         | 0           | 1                     | 1                        | 0                             | 0                       | 2                           | 0                           | 0                       | 0                           | 0                         | 1                             | 0                            | 0                                   | 1                          | 0                     | 0                        | 0                        | 0                       | 0                    | 1                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 7         | 5743            |              |       |
| 0                         | 0           | 0                     | 0                        | 0                             | 0                       | 1                           | 1                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 1    | 0                    | 0                    | 3         | 4502            |              |       |
| 0                         | 0           | 0                     | 1                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 1         | 5094            |              |       |
| 0                         | 0           | 0                     | 1                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 2                       | 0                    | 0                     | 0                           | 0                    | 0           | 1    | 0                    | 0                    | 4         | 6039            |              |       |
| 0                         | 0           | 0                     | 2                        | 0                             | 0                       | 2                           | 0                           | 0                       | 1                           | 1                         | 0                             | 1                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 7         | 5478            |              |       |
| 0                         | 0           | 0                     | 1                        | 0                             | 0                       | 1                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 2                       | 0                    | 0                     | 0                           | 0                    | 1           | 0    | 4                    | 0                    | 9         | 5863            |              |       |
| 0                         | 1           | 0                     | 3                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 1                             | 1                            | 1                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 7         | 5076            |              |       |
| 0                         | 0           | 0                     | 1                        | 0                             | 1                       | 2                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 1                    | 0                     | 0                           | 1                    | 0           | 2    | 0                    | 0                    | 8         | 5183            |              |       |
| 0                         | 0           | 0                     | 2                        | 0                             | 0                       | 3                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 0                    | 0                     | 0                           | 1                    | 0           | 2    | 0                    | 0                    | 8         | 5024            |              |       |
| 0                         | 0           | 0                     | 3                        | 1                             | 0                       | 0                           | 0                           | 1                       | 0                           | 0                         | 0                             | 1                            | 0                                   | 1                          | 0                     | 0                        | 0                        | 4                       | 0                    | 0                     | 0                           | 0                    | 1           | 0    | 1                    | 0                    | 13        | 4897            |              |       |
| 0                         | 0           | 1                     | 1                        | 0                             | 0                       | 2                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 1    | 0                    | 0                    | 5         | 4810            |              |       |
| 0                         | 0           | 0                     | 0                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 1                     | 0                        | 0                        | 2                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 3         | 4363            |              |       |
| 0                         | 0           | 0                     | 0                        | 0                             | 0                       | 1                           | 0                           | 0                       | 0                           | 0                         | 3                             | 0                            | 0                                   | 1                          | 0                     | 0                        | 0                        | 0                       | 0                    | 1                     | 0                           | 0                    | 0           | 1    | 0                    | 0                    | 7         | 5215            |              |       |
| 0                         | 0           | 0                     | 0                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 1                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 1         | 5879            |              |       |
| 0                         | 0           | 0                     | 0                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 1                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 1         | 6330            |              |       |
| 0                         | 0           | 0                     | 0                        | 0                             | 0                       | 0                           | 0                           | 0                       | 0                           | 0                         | 0                             | 0                            | 0                                   | 0                          | 0                     | 0                        | 0                        | 0                       | 0                    | 0                     | 0                           | 0                    | 0           | 0    | 0                    | 0                    | 0         | 0               | 4543         |       |
| 1                         | 4           | 4                     | 36                       | 3                             | 1                       | 21                          | 1                           | 1                       | 2                           | 1                         | 1                             | 13                           | 1                                   | 2                          | 4                     | 2                        | 1                        | 24                      | 2                    | 2                     | 2                           | 1                    | 4           | 1    | 29                   | 1                    | 2         | 167             | 167254       | Total |

| <i>Ablabesmyia annulata</i> | <i>Ablabesmyia parajanta</i> | <i>Ablabesmyia philosphagnos</i> | Chironomini | <i>Conchapelopia</i> sp. | <i>Dicrotendipes neomodestus</i> | <i>Micropsectra</i> sp. | <i>Microtendipes caelum</i> | <i>Nanocladius spiniplenus</i> | <i>Paramerina</i> sp. | <i>Paratanytarsus</i> sp. 2 | <i>Phaenopsectra</i> sp. | <i>Polypedilum scalaenum</i> | Tanytarsinae (early instar) | Tanytarsini | <i>Tanytarsus</i> sp. | <i>Trissopelopia ogemawi</i> | <i>Zavrelimyia</i> sp. 1 | <i>Hemerodromia</i> sp. | Ephemerelellidae | <i>Eurylophella bicolor</i> | <i>Paraleptophlebia</i> sp. | <i>Stenonema modestum</i> |       |
|-----------------------------|------------------------------|----------------------------------|-------------|--------------------------|----------------------------------|-------------------------|-----------------------------|--------------------------------|-----------------------|-----------------------------|--------------------------|------------------------------|-----------------------------|-------------|-----------------------|------------------------------|--------------------------|-------------------------|------------------|-----------------------------|-----------------------------|---------------------------|-------|
| 0                           | 0                            | 0                                | 1           | 0                        | 0                                | 2                       | 0                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         |       |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 0                       | 5                           | 0                              | 0                     | 0                           | 1                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 1                           | 0                         | 0     |
| 1                           | 0                            | 0                                | 0           | 1                        | 0                                | 1                       | 1                           | 0                              | 0                     | 0                           | 0                        | 2                            | 1                           | 0           | 1                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 0                       | 1                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 1                     | 0                            | 0                        | 1                       | 0                | 0                           | 0                           | 0                         | 0     |
| 1                           | 0                            | 0                                | 0           | 0                        | 0                                | 0                       | 2                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 1                           | 0                           | 0                         | 0     |
| 1                           | 0                            | 0                                | 0           | 2                        | 0                                | 0                       | 1                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 1           | 3                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 1                           | 0                            | 0                                | 0           | 0                        | 0                                | 2                       | 2                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 1                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 0                       | 2                           | 0                              | 0                     | 0                           | 0                        | 1                            | 1                           | 0           | 1                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 1                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 1                       | 1                           | 0                              | 0                     | 0                           | 0                        | 1                            | 1                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 1                         | 0     |
| 1                           | 0                            | 0                                | 0           | 0                        | 0                                | 1                       | 2                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 1                           | 0                            | 0                                | 0           | 0                        | 0                                | 0                       | 3                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 1                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 2                        | 0                                | 2                       | 3                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 1                     | 0                            | 0                        | 0                       | 1                | 0                           | 2                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 1                                | 0                       | 0                           | 0                              | 0                     | 1                           | 0                        | 0                            | 1                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 1                                | 0           | 0                        | 0                                | 1                       | 2                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 1                        | 0                                | 2                       | 0                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 1                            | 0                                | 0           | 1                        | 0                                | 0                       | 1                           | 0                              | 0                     | 1                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 0                       | 1                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 1                       | 1                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 0                       | 1                           | 0                              | 0                     | 0                           | 0                        | 1                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 1                       | 2                           | 0                              | 1                     | 0                           | 0                        | 1                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 1                       | 1                           | 0                              | 0                     | 0                           | 0                        | 3                            | 1                           | 0           | 0                     | 1                            | 0                        | 0                       | 0                | 1                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 1                        | 0                                | 1                       | 3                           | 0                              | 1                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 1                       | 3                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 1                       | 0                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 1                       | 0                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 0                           | 0                            | 1                                | 0           | 1                        | 0                                | 1                       | 1                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 1                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 1                         | 0     |
| 0                           | 0                            | 0                                | 0           | 1                        | 0                                | 1                       | 2                           | 0                              | 0                     | 0                           | 0                        | 0                            | 1                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 1     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 0                       | 0                           | 1                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 1                           | 0                            | 0                                | 0           | 2                        | 0                                | 1                       | 2                           | 0                              | 0                     | 0                           | 0                        | 3                            | 1                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 1                         | 0     |
| 0                           | 0                            | 0                                | 0           | 0                        | 0                                | 0                       | 0                           | 0                              | 0                     | 0                           | 0                        | 0                            | 0                           | 0           | 0                     | 0                            | 0                        | 0                       | 0                | 0                           | 0                           | 0                         | 0     |
| 7                           | 1                            | 2                                | 1           | 12                       | 1                                | 22                      | 43                          | 1                              | 2                     | 2                           | 1                        | 12                           | 7                           | 1           | 9                     | 1                            | 1                        | 2                       | 2                | 2                           | 7                           | 1                         | Total |

| <i>Eccoptura xanathenes</i> | <i>Optioservus</i> sp. | <i>Nigronia serricornis</i> | <i>Ferrissia</i> sp. | <i>Hyalella azteca</i> | <i>Helobdella stagnalis</i> | Oligochaeta | <i>Dero obtusa</i> | <i>Nais communis</i> | <i>Pristina longisetia longisetia</i> | <i>Pristinella osborni</i> | <i>Slavina appendiculata</i> | Nematode | Copepod | Total Organisms | Surface Area |       |
|-----------------------------|------------------------|-----------------------------|----------------------|------------------------|-----------------------------|-------------|--------------------|----------------------|---------------------------------------|----------------------------|------------------------------|----------|---------|-----------------|--------------|-------|
| 0                           | 0                      | 0                           | 1                    | 1                      | 0                           | 1           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 6               | 4623         |       |
| 0                           | 0                      | 0                           | 0                    | 6                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 13              | 7810         |       |
| 0                           | 0                      | 0                           | 0                    | 2                      | 0                           | 0           | 1                  | 0                    | 0                                     | 0                          | 1                            | 0        | 0       | 12              | 5469         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 0                  | 2                    | 0                                     | 0                          | 0                            | 0        | 0       | 5               | 7702         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 4               | 6075         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 8               | 6007         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 1                  | 0                    | 0                                     | 0                          | 1                            | 0        | 0       | 8               | 6991         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 1       | 7               | 6330         |       |
| 1                           | 0                      | 0                           | 0                    | 8                      | 0                           | 0           | 0                  | 1                    | 0                                     | 0                          | 0                            | 0        | 0       | 15              | 5583         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 4               | 6905         |       |
| 0                           | 0                      | 0                           | 0                    | 1                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 6               | 5260         |       |
| 0                           | 1                      | 0                           | 0                    | 4                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 16              | 5267         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 3               | 5473         |       |
| 0                           | 0                      | 0                           | 0                    | 1                      | 0                           | 0           | 1                  | 1                    | 0                                     | 0                          | 0                            | 0        | 0       | 7               | 4859         |       |
| 0                           | 0                      | 0                           | 0                    | 1                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 4               | 4863         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 1                           | 1           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 6               | 4994         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 2               | 7770         |       |
| 0                           | 0                      | 0                           | 0                    | 5                      | 0                           | 0           | 1                  | 0                    | 1                                     | 0                          | 0                            | 0        | 0       | 9               | 6480         |       |
| 0                           | 0                      | 0                           | 0                    | 10                     | 0                           | 0           | 1                  | 0                    | 0                                     | 0                          | 0                            | 1        | 0       | 14              | 5186         |       |
| 0                           | 0                      | 0                           | 1                    | 0                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 6               | 7909         |       |
| 0                           | 1                      | 0                           | 0                    | 3                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 12              | 7398         |       |
| 0                           | 0                      | 0                           | 0                    | 9                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 1                            | 0        | 0       | 16              | 5702         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 0                  | 0                    | 0                                     | 1                          | 0                            | 0        | 0       | 5               | 4704         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 1               | 5087         |       |
| 0                           | 0                      | 0                           | 0                    | 1                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 3               | 6682         |       |
| 0                           | 1                      | 0                           | 0                    | 2                      | 0                           | 1           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 10              | 9488         |       |
| 0                           | 0                      | 0                           | 0                    | 3                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 9               | 7282         |       |
| 0                           | 0                      | 1                           | 1                    | 2                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 1                            | 0        | 0       | 6               | 4914         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 11              | 5261         |       |
| 0                           | 0                      | 0                           | 0                    | 0                      | 0                           | 0           | 0                  | 0                    | 0                                     | 0                          | 0                            | 0        | 0       | 0               | 7075         |       |
| 1                           | 3                      | 1                           | 3                    | 59                     | 1                           | 3           | 5                  | 4                    | 1                                     | 1                          | 4                            | 1        | 1       | 228             | 185149       | Total |

| <i>Conchapelopia</i> sp. | <i>Diplocladius</i> sp. | <i>Hydrobaenus pilipes</i> | <i>Micropsectra</i> sp. | <i>Microtendipes caelum</i> | <i>Paramerina</i> sp. | <i>Parametriocnemus lundbecki</i> | <i>Phaenopsectra</i> sp. | <i>Polypedilum laetum</i> | <i>Polypedilum scalaenum</i> | Tanypodinae (early instar) | Tanytarsini | <i>Tanytarsus</i> sp. | <i>Zavrelimyia</i> sp. 1 | <i>Hemerodromia</i> sp. | Ephemerelellidae | Tricoptera | <i>Optioservus</i> sp. | <i>Stenelmis</i> sp. | <i>Hyalella azteca</i> | Oligochaeta | <i>Dero obtusa</i> | <i>Nais communis</i> | <i>Pristinella osborni</i> | <i>Slavina appendiculata</i> | Copepod | Total Organisms | Surface Area |       |
|--------------------------|-------------------------|----------------------------|-------------------------|-----------------------------|-----------------------|-----------------------------------|--------------------------|---------------------------|------------------------------|----------------------------|-------------|-----------------------|--------------------------|-------------------------|------------------|------------|------------------------|----------------------|------------------------|-------------|--------------------|----------------------|----------------------------|------------------------------|---------|-----------------|--------------|-------|
| 0                        | 0                       | 0                          | 1                       | 2                           | 0                     | 0                                 | 0                        | 1                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 1                  | 0                    | 0                          | 0                            | 0       | 5               | 6750         |       |
| 1                        | 0                       | 0                          | 0                       | 2                           | 0                     | 1                                 | 0                        | 0                         | 0                            | 0                          | 0           | 1                     | 0                        | 0                       | 0                | 0          | 0                      | 1                    | 0                      | 0           | 2                  | 0                    | 0                          | 0                            | 0       | 8               | 5629         |       |
| 1                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 1                     | 0                        | 1                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 1       | 4               | 4528         |       |
| 0                        | 1                       | 0                          | 1                       | 1                           | 0                     | 0                                 | 1                        | 0                         | 2                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 1       | 7               | 5760         |       |
| 0                        | 0                       | 0                          | 1                       | 1                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 2               | 6587         |       |
| 0                        | 0                       | 0                          | 2                       | 1                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 1                      | 0                    | 0                      | 0           | 1                  | 1                    | 0                          | 0                            | 0       | 6               | 4966         |       |
| 1                        | 0                       | 0                          | 1                       | 1                           | 0                     | 0                                 | 0                        | 0                         | 1                            | 0                          | 0           | 1                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 5               | 7463         |       |
| 0                        | 0                       | 0                          | 0                       | 3                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 1                  | 0                    | 0                          | 0                            | 3       | 7               | 5152         |       |
| 0                        | 0                       | 0                          | 1                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 1                            | 0                          | 0           | 0                     | 0                        | 0                       | 1                | 0          | 0                      | 0                    | 1                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 4               | 6848         |       |
| 0                        | 0                       | 0                          | 1                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 1                  | 0                    | 0                          | 0                            | 1       | 3               | 6243         |       |
| 0                        | 0                       | 0                          | 4                       | 2                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 1           | 0                     | 0                        | 1                       | 0                | 0          | 1                      | 0                    | 0                      | 1           | 0                  | 0                    | 0                          | 0                            | 2       | 12              | 6337         |       |
| 0                        | 0                       | 0                          | 1                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 1                      | 0           | 2                  | 0                    | 0                          | 0                            | 1       | 5               | 5074         |       |
| 0                        | 0                       | 0                          | 0                       | 1                           | 0                     | 0                                 | 0                        | 0                         | 1                            | 0                          | 0           | 1                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 2                          | 0                            | 1       | 6               | 5312         |       |
| 0                        | 0                       | 0                          | 2                       | 1                           | 0                     | 1                                 | 1                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 1                  | 0                    | 0                          | 0                            | 1       | 7               | 7364         |       |
| 0                        | 0                       | 0                          | 1                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 1               | 4564         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 1                       | 0                | 0          | 0                      | 0                    | 1                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 2               | 5608         |       |
| 0                        | 0                       | 0                          | 1                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 3                            | 1                          | 0           | 0                     | 1                        | 0                       | 1                | 0          | 0                      | 0                    | 1                      | 0           | 0                  | 0                    | 0                          | 0                            | 1       | 9               | 4829         |       |
| 0                        | 0                       | 0                          | 0                       | 2                           | 0                     | 0                                 | 0                        | 0                         | 1                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 1                      | 0           | 0                  | 0                    | 0                          | 1                            | 2       | 7               | 5993         |       |
| 0                        | 0                       | 1                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 1                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 1          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 3               | 5849         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 1                     | 0                        | 1                       | 0                | 0          | 0                      | 0                    | 1                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 3               | 7090         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 1                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 1               | 5087         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 0               | 5328         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 0               | 7444         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 0               | 6271         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 0               | 4495         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 0               | 5221         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 0               | 5760         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 0               | 4634         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 0               | 6803         |       |
| 0                        | 0                       | 0                          | 0                       | 0                           | 0                     | 0                                 | 0                        | 0                         | 0                            | 0                          | 0           | 0                     | 0                        | 0                       | 0                | 0          | 0                      | 0                    | 0                      | 0           | 0                  | 0                    | 0                          | 0                            | 0       | 0               | 6288         |       |
| 3                        | 1                       | 1                          | 17                      | 17                          | 0                     | 2                                 | 2                        | 1                         | 10                           | 1                          | 1           | 5                     | 1                        | 4                       | 2                | 1          | 2                      | 1                    | 7                      | 1           | 9                  | 1                    | 2                          | 1                            | 14      | 107             | 175277       | Total |

| Chironomini | <i>Chironomus</i> sp. | <i>Conchapelopia</i> sp. | <i>Corynoneura</i> taris | <i>Labrundinia neopilosella</i> var. 3 | <i>Labrundinia pilosella</i> | <i>Micropsectra</i> sp. | <i>Microtendipes caelum</i> | <i>Nanocladius</i> sp. 1 | <i>Nanocladius spiniplenus</i> | <i>Orthocladius carlatus</i> group | <i>Parametriocnemus lundbecki</i> | <i>Paratanytarsus</i> sp. 2 | <i>Polypedilum scalaenum</i> | <i>Tanytarsus</i> sp. | <i>Hemerodromia</i> sp. | Ephemere | <i>Eurylophella bicolor</i> | <i>Leptophlebia</i> sp. | <i>Paraleptophlebia</i> sp. | <i>Stenonema modestum</i> | <i>Paracapnia opis</i> | <i>Taeniopteryx</i> sp. | <i>Calopteryx maculata</i> | Coenagrionidae | <i>Optioservus</i> sp. | <i>Promoresia</i> sp. | <i>Nigronia serricornis</i> | <i>Ferrissia</i> sp. | <i>Helobdella stagnalis</i> | <i>Pristinella osborni</i> | <i>Slavina appendiculata</i> | Total Organisms | Surface Area |      |      |
|-------------|-----------------------|--------------------------|--------------------------|--|------------------------------|-------------------------|-----------------------------|--------------------------|--------------------------------|------------------------------------|-----------------------------------|-----------------------------|------------------------------|-----------------------|-------------------------|----------|-----------------------------|-------------------------|-----------------------------|---------------------------|------------------------|-------------------------|----------------------------|----------------|------------------------|-----------------------|-----------------------------|----------------------|-----------------------------|----------------------------|------------------------------|-----------------|--------------|------|------|
| 0           | 0                     | 1                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 1                       | 1        | 1                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 4            | 4412 |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 1                           | 0                        | 0                              | 0                                  | 0                                 | 1                           | 0                            | 0                     | 0                       | 1        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 3            | 4462 |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 1                     | 0                       | 0        | 0                           | 0                       | 0                           | 1                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 2            | 4958 |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 1                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 1                           | 1                            | 0                     | 1                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 1                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 0            | 5    | 5026 |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 1                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 1                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 0            | 2    | 5567 |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 1                           | 0                        | 0                              | 0                                  | 0                                 | 1                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 0            | 2    | 4433 |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 1                           | 0                        | 0                              | 0                                  | 1                                 | 0                           | 0                            | 2                     | 0                       | 1        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 0            | 5    | 4750 |
| 0           | 0                     | 1                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 1                           | 3                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 1                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 6            | 5069 |      |
| 1           | 0                     | 0                        | 0                        | 0                                      | 0                            | 1                       | 1                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 3            | 4651 |      |
| 0           | 0                     | 0                        | 1                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 2                            | 0                     | 0                       | 0        | 1                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 4            | 5712 |      |
| 0           | 0                     | 0                        | 1                        | 0                                      | 0                            | 0                       | 0                           | 1                        | 0                              | 0                                  | 0                                 | 1                           | 0                            | 0                     | 1                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 4            | 4945 |      |
| 0           | 0                     | 0                        | 1                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 1            | 5787 |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 1                                  | 0                                 | 0                           | 1                            | 2                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 1                     | 0                           | 0                    | 0                           | 1                          | 0                            | 6               | 5530         |      |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 1                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 1                            | 2               | 6166         |      |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 1                              | 0                                  | 0                                 | 1                           | 1                            | 0                     | 0                       | 0        | 0                           | 1                       | 1                           | 0                         | 0                      | 0                       | 1                          | 0              | 1                      | 1                     | 1                           | 0                    | 0                           | 0                          | 8                            | 4988            |              |      |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 2                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 1                           | 0                          | 3                            | 6451            |              |      |      |
| 0           | 0                     | 0                        | 0                        | 1                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 1                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 2               | 5239         |      |      |
| 0           | 1                     | 1                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 1                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 3               | 4348         |      |      |
| 0           | 0                     | 1                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 1                           | 0                            | 0                     | 1                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 3               | 5629         |      |      |
| 0           | 1                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 1                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 1                           | 0                    | 0                           | 0                          | 3                            | 6060            |              |      |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 0            | 4906 |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 0            | 5998 |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 1                       | 1        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 1                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 3                            | 5181            |              |      |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 1                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 1                            | 4543            |              |      |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 1                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 1                            | 4400            |              |      |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 5998         |      |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 5001         |      |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 5074         |      |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 4307         |      |      |
| 0           | 0                     | 0                        | 0                        | 0                                      | 0                            | 0                       | 0                           | 0                        | 0                              | 0                                  | 0                                 | 0                           | 0                            | 0                     | 0                       | 0        | 0                           | 0                       | 0                           | 0                         | 0                      | 0                       | 0                          | 0              | 0                      | 0                     | 0                           | 0                    | 0                           | 0                          | 0                            | 0               | 6848         |      |      |
| 1           | 2                     | 4                        | 3                        | 1                                      | 1                            | 1                       | 5                           | 1                        | 1                              | 1                                  | 1                                 | 2                           | 8                            | 11                    | 7                       | 6        | 2                           | 1                       | 1                           | 2                         | 1                      | 1                       | 1                          | 1              | 3                      | 1                     | 1                           | 2                    | 1                           | 1                          | 1                            | 76              | 156439       | T.   |      |



3. Data Recorded with Basket as a Sampling Unit

| Taxa                                      | Basket Collection |   |    |    |    |    |    |   |    |    |    |    |     |     |    |    |    |    |    |    |    |    |    |
|---|-------------------|---|----|----|----|----|----|---|----|----|----|----|-----|-----|----|----|----|----|----|----|----|----|----|
|   | 1                 | 2 | 3  | 4  | 5  | 6  | 7  | 8 | 9  | 10 | 11 | 12 | 13  | 14  | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| <i>Ablabesmyia</i> sp.                    | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ablasbesmyia annulata</i>              | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ablabesmyia mallochi</i>               | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ablabesmyia ornata</i>                 | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ablabesmyia parajanta</i>              | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ablabesmyia philosphagnos</i>          | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Brillia flavifrons</i>                 | 0                 | 1 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 1  | 0  | 1  | 1   | 1   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Brillia parva</i>                      | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 1  | 0   | 1   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Chaoborus</i> sp.                      | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 1   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Chironomini                               | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Chironomus</i> sp.                     | 0                 | 0 | 3  | 4  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Cladotanytarsus</i> sp.                | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Conchapelopia</i> sp.                  | 3                 | 4 | 12 | 16 | 35 | 17 | 12 | 1 | 2  | 0  | 5  | 2  | 10  | 18  | 30 | 22 | 12 | 14 | 0  | 0  | 2  | 1  | 4  |
| <i>Corynoneura taris</i>                  | 2                 | 1 | 0  | 1  | 1  | 0  | 1  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 1  | 0  | 0  | 0  | 1  | 0  | 3  |
| <i>Cricotopus bicinctus</i> group         | 0                 | 0 | 0  | 0  | 1  | 0  | 1  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  |
| <i>Cricotopus sylvestris</i> group        | 0                 | 0 | 3  | 3  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 1   | 2   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Cricotopus tremulus</i> group          | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 1  | 0  | 6   | 3   | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 11 | 9  |
| <i>Cryptochironomus fulvus</i>            | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Dicrotendipes neomodestus</i>          | 0                 | 0 | 0  | 1  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 1  |
| <i>Diamesa</i> sp.                        | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 1  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Diplocladius</i> sp.                   | 1                 | 0 | 5  | 7  | 13 | 29 | 4  | 1 | 60 | 20 | 9  | 8  | 152 | 170 | 12 | 21 | 16 | 13 | 66 | 19 | 0  | 0  | 2  |
| <i>Endochironomus nigricans</i>           | 0                 | 0 | 6  | 3  | 0  | 0  | 0  | 0 | 0  | 1  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Eukiefferiella bavarica</i> group      | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 1   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Eukiefferiella brevicular</i> group    | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Eukiefferiella claripennis</i> group   | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Eukiefferiella pseudomotana</i> group  | 0                 | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Glyptotendipes lobiferus</i>           | 0                 | 0 | 0  | 1  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Heterotrissocladius marcidus</i> group | 0                 | 0 | 0  | 0  | 1  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 5  |
| <i>Hudsonimyia</i> sp.                    | 0                 | 0 | 0  | 1  | 0  | 0  | 0  | 0 | 0  | 1  | 1  | 0  | 0   | 3   | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

| Taxa                                   | Basket Collection |   |   |    |   |    |    |    |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|--|-------------------|---|---|----|---|----|----|----|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|  | 1                 | 2 | 3 | 4  | 5 | 6  | 7  | 8  | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| <i>Hydrobaenus pilipes</i>             | 0                 | 1 | 0 | 1  | 5 | 0  | 4  | 0  | 3 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 5  | 1  | 1  | 5  | 0  | 0  | 1  |
| <i>Kiefferulus</i> sp.                 | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Labrundinia neopilosella</i> var. 3 | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Labrundinia pilosella</i>           | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Labrundinia becki</i>               | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Larsia</i> sp.                      | 0                 | 0 | 1 | 1  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Meropelopia flavifrons</i>          | 0                 | 0 | 3 | 1  | 5 | 2  | 2  | 0  | 0 | 0  | 0  | 3  | 1  | 3  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Micropsectra</i> sp.                | 0                 | 1 | 6 | 17 | 6 | 9  | 5  | 4  | 1 | 1  | 2  | 1  | 56 | 50 | 3  | 3  | 3  | 3  | 1  | 0  | 2  | 1  | 2  |
| <i>Microtendipes caelum</i>            | 1                 | 2 | 0 | 0  | 1 | 0  | 0  | 1  | 0 | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Microtendipes rydalensis</i> group  | 0                 | 0 | 0 | 0  | 1 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Nanocladius</i> sp. 1               | 0                 | 0 | 0 | 0  | 5 | 1  | 0  | 6  | 1 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 0  | 0  | 1  | 0  | 1  |
| <i>Nanocladius</i> sp. 2               | 0                 | 0 | 0 | 0  | 1 | 0  | 0  | 1  | 1 | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 1  | 1  | 3  |
| <i>Nanocladius spiniplenus</i>         | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  |
| <i>Natarsia</i> sp.                    | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Orthoclaadiinae</i>                 | 0                 | 0 | 1 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Orthoclaadius</i> sp.               | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Orthoclaadius carlatus</i> group    | 0                 | 0 | 0 | 0  | 0 | 0  | 1  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Orthoclaadius obumbratus</i> group  | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Orthoclaadius oliveri</i>           | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 1  | 0 | 0  | 0  | 0  | 0  | 0  | 8  | 3  | 33 | 21 | 0  | 0  | 1  | 0  | 0  |
| <i>Parachironomus arcuatus</i> group   | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Parakiefferiella</i> sp.            | 0                 | 3 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Paramerina</i> sp.                  | 1                 | 0 | 0 | 0  | 1 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 2  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Parametriocnemus lundbecki</i>      | 3                 | 0 | 5 | 6  | 1 | 3  | 1  | 3  | 0 | 0  | 6  | 16 | 9  | 15 | 2  | 4  | 1  | 1  | 0  | 1  | 1  | 1  | 2  |
| <i>Paraphaenoclaadius</i> sp. 1        | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 2  | 3  | 3  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Paraphaenoclaadius</i> sp. 2        | 0                 | 0 | 0 | 1  | 0 | 0  | 0  | 0  | 1 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 1  | 0  | 0  | 0  | 0  | 0  |
| <i>Paratendipes</i> sp.                | 0                 | 0 | 0 | 0  | 0 | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Paratanytarsus</i> sp. 1            | 0                 | 0 | 0 | 0  | 0 | 0  | 1  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Paratanytarsus</i> sp. 2            | 0                 | 0 | 0 | 0  | 9 | 38 | 15 | 12 | 0 | 0  | 0  | 0  | 0  | 0  | 12 | 7  | 7  | 8  | 0  | 1  | 1  | 1  | 0  |
| <i>Paratanytarsus</i> sp. 3            | 0                 | 0 | 0 | 0  | 2 | 2  | 0  | 1  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 3  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

| Taxa  | Basket Collection |   |   |   |    |    |    |    |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |   |
|---|-------------------|---|---|---|----|----|----|----|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|---|
|   | 1                 | 2 | 3 | 4 | 5  | 6  | 7  | 8  | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |   |   |
| <i>Phaenopsectra</i> sp.                    | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |   |   |
| <i>Phaenopsectra flavipes</i>               | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 1  | 0  | 0 |   |
| <i>Polypeditilum aviceps</i>                | 1                 | 0 | 1 | 0 | 0  | 0  | 0  | 0  | 1 | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1 |   |
| <i>Polypeditilum convictum</i>              | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Polypeditilum fallax</i>                 | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Polypeditilum laetum</i>                 | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Polypeditilum illinoense</i>             | 0                 | 0 | 2 | 4 | 1  | 2  | 0  | 1  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 1 |   |
| <i>Polypeditilum scalaenum</i>              | 1                 | 0 | 1 | 2 | 1  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Procladius</i> sp.                       | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Psectrotanypus dyari</i>                 | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Psectrotanypus</i> nr. <i>dyari</i>      | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Pseudoorthocladius</i> sp.               | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Psilonetrioctenus</i> sp.                | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Rheocricotopus fuscipes</i> group        | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Rheopelopia acra/perda</i>               | 1                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 1  | 1  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1 |   |
| <i>Rheotanytarsus distinctissimus</i> group | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 2 | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 1 | 0 |
| <i>Rheotanytarsus exiguus</i> group         | 3                 | 0 | 1 | 0 | 20 | 45 | 35 | 12 | 1 | 0  | 0  | 1  | 0  | 2  | 9  | 8  | 0  | 1  | 1  | 0  | 2  | 1  | 1  | 1 |   |
| <i>Robackia</i> sp.                         | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1 |   |
| <i>Saetheria</i> sp.                        | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 1 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Symptothastia</i> sp.                    | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Tanypodinae</i> (early instar)           | 0                 | 0 | 0 | 0 | 1  | 1  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Tanytarsini</i>                          | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Tanytarsus</i> sp.                       | 1                 | 1 | 0 | 1 | 0  | 0  | 0  | 0  | 2 | 0  | 0  | 0  | 5  | 4  | 1  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2 |   |
| <i>Thienemanniella</i> prob. <i>xena</i>    | 0                 | 0 | 0 | 0 | 0  | 2  | 2  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Thienemanniella</i> sp. 1                | 0                 | 0 | 0 | 0 | 0  | 0  | 1  | 1  | 0 | 0  | 0  | 0  | 0  | 0  | 4  | 2  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Thienemanniella</i> sp. 2                | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Tribelos</i> poss. <i>jucundum</i>       | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Tribelos</i> sp. 1                       | 0                 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Trissopelopia ogemawi</i>                | 0                 | 0 | 6 | 1 | 0  | 0  | 0  | 0  | 0 | 0  | 1  | 0  | 2  | 6  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |

| Taxa                              | Basket Collection |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-----------------------------------|-------------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                                   | 1                 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| <i>Tvetenia bavarica</i> group    | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Zavrelimyia</i> sp. 1          | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Zavrelimyia</i> sp. 2          | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Zavrelimyia</i> sp. 3          | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Simuliidae                        | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Prosimulium</i> sp.            | 0                 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Stegopterna mutata</i> complex | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 1  | 3  | 6  | 0  | 0  | 1  | 0  | 0  | 0  | 0  |
| <i>Simulium tuberosum</i> complex | 0                 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Simulium vittatum</i> complex  | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Ceratopogonidae                   | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Other Diptera                     | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Hemerodromia</i> sp.           | 0                 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Telmatoscopus</i> sp.          | 0                 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Ephemeroptera                     | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Baetis brunneicolor</i>        | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 1  | 1  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  |
| EphemereIIDae                     | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ephemerella excrucians</i>     | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ephemerella invaria</i>        | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Eurylophella</i> sp.           | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Eurylophella bicolor</i>       | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 1  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Eurylophella funeralis</i>     | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Eurylophella temporalis</i>    | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Isonychia</i> sp.              | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Leptophlebia</i> sp.           | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 2  | 1  | 10 | 0  | 0  | 2  | 2  | 0  | 0  | 0  | 0  | 1  |
| <i>Paraleptophlebia</i> sp.       | 1                 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 1  | 2  | 1  | 3  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Serratella deficiens</i>       | 3                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 2  | 3  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Stenonema modestum</i>         | 2                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 1  | 1  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  |
| Plecoptera                        | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Agnetina capitata</i>          | 0                 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

## Basket Collection

| Taxa                                | 1 | 2 | 3 | 4 | 5 | 6  | 7 | 8 | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|-------------------------------------|---|---|---|---|---|----|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| <i>Eccoptura xanathenes</i>         | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Isoperla lata</i>                | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  |
| <i>Isoperla marlynia</i>            | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 1  | 5  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 3  | 2  | 0  |
| <i>Ostrocera sp.</i>                | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Paracapnia opis</i>              | 7 | 5 | 0 | 0 | 0 | 0  | 0 | 0 | 10 | 2  | 13 | 12 | 3  | 6  | 0  | 0  | 3  | 0  | 20 | 13 | 0  | 0  | 0  |
| <i>Perlinella ephyre/fumipennis</i> | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Podmosta sp.</i>                 | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Taeniopteryx sp.</i>             | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 4  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Taeniopteryx maura</i>           | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 3  | 2  | 3  | 4  | 0  | 0  | 0  | 0  | 0  | 15 | 2  | 0  | 0  |
| <i>Taeniopteryx parvula</i>         | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 4  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Tallaperla maria</i>             | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  |
| Tricoptera                          | 1 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Anobolia sp.</i>                 | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  |
| <i>Cernotina sp.</i>                | 0 | 0 | 0 | 0 | 1 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Cheumatopsyche sp.</i>           | 4 | 0 | 0 | 0 | 1 | 16 | 2 | 0 | 0  | 0  | 0  | 0  | 0  | 3  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 4  | 1  |
| <i>Chimarra sp.</i>                 | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Glossosoma sp.</i>               | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  |
| <i>Hydatophylax sp.</i>             | 0 | 2 | 0 | 1 | 0 | 0  | 0 | 0 | 0  | 0  | 1  | 1  | 0  | 1  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  |
| <i>Hydropsyche sp. 1</i>            | 0 | 0 | 0 | 0 | 0 | 0  | 1 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 4  | 0  |
| <i>Hydropsyche sp. 2</i>            | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Lepidostoma sp.</i>              | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Neophylax sp.</i>                | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Platycentropus sp.</i>           | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Polycentropodidae                   | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ptilostomis sp.</i>              | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Pycnopsyche sp.</i>              | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Odonata                             | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Aeshna sp.</i>                   | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Boyeria vinosa</i>               | 0 | 0 | 0 | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

| Taxa                            | Basket Collection |   |   |   |    |   |    |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |   |
|---------------------------------|-------------------|---|---|---|----|---|----|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|---|
|                                 | 1                 | 2 | 3 | 4 | 5  | 6 | 7  | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |   |   |
| <i>Calopteryx maculata</i>      | 0                 | 0 | 1 | 0 | 0  | 0 | 0  | 0 | 0 | 1  | 0  | 1  | 0  | 5  | 1  | 0  | 0  | 0  | 0  | 1  | 3  | 0  | 0  | 0 |   |
| Coenagrionidae                  | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Coenagrion sp.</i>           | 0                 | 0 | 0 | 0 | 1  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Hataerina sp.</i>            | 1                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| Coleoptera                      | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Anchytarsus bicolor</i>      | 0                 | 0 | 0 | 1 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Dytiscus sp.</i>             | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Ectopria sp.</i>             | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Ectopria nervosa</i>         | 0                 | 1 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |   |
| <i>Hydroporus sp.</i>           | 0                 | 0 | 0 | 0 | 2  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1 | 0 |
| <i>Optioservus sp.</i>          | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Oreodytes sp.</i>            | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Psephenus sp.</i>            | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Promoresia sp.</i>           | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Stenelmis sp.</i>            | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1 | 0 |
| Megaloptera                     | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Chauliodes pectinicornis</i> | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Nigronia serricornis</i>     | 3                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 1  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| Gastropoda                      | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Ferrissia sp.</i>            | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 1 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Fossaria sp.</i>             | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Gyraulus sp.</i>             | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Musculium sp.</i>            | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Physa sp.</i>                | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Pisidium sp.</i>             | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| Amphipoda                       | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |
| <i>Hyaella azteca</i>           | 0                 | 0 | 4 | 1 | 16 | 1 | 28 | 4 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 2  | 0  | 2  | 1  | 0  | 0  | 0  | 0 | 0 |
| <i>Asellus communis</i>         | 0                 | 0 | 0 | 0 | 0  | 0 | 0  | 0 | 0 | 0  | 0  | 1  | 1  | 3  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 |

| Taxa                                | Basket Collection |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------------------------------------|-------------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                                     | 1                 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| Annelida                            | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Dina sp.</i>                     | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Helobdella stagnalis</i>         | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Mooreobdella melanostoma</i>     | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Oligochaeta                         | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Aulodrilus limnosius</i>         | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Dero obtusa</i>                  | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Homochaeta sp.</i>               | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| IWCC                                | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| ICC                                 | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Lumbricidae                         | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  |
| <i>Nais communis</i>                | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Pristinella jenkiniae</i>        | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Pristina longiseta longiseta</i> | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Pristina longisoma</i>           | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Pristina sima</i>                | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Pristinella osborni</i>          | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Slavina appendiculata</i>        | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Nematode                            | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Tipulidae                           | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Hexatoma sp.</i>                 | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Tipula sp.</i>                   | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Staphilinidae                       | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Stenus sp.</i>                   | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Copepod                             | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Pupa                                | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |



## Basket Collection

| Taxa                                      | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |   |
|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|
| <i>Ablabesmyia</i> sp.                    | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 6  | 0  | 0  | 0  | 0  | 0 |
| <i>Ablabesmyia annulata</i>               | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 2  | 0  | 0  | 1  | 0  | 7  | 0  | 0  | 0 |
| <i>Ablabesmyia mallochi</i>               | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 4  | 0  | 0  | 0  | 0  | 0 |
| <i>Ablabesmyia tarella</i>                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0 |
| <i>Ablabesmyia Parajanta</i>              | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 1  | 0  | 0 |
| <i>Ablabesmyia philosphagnos</i>          | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 2  | 0  | 0 |
| <i>Brillia flavifrons</i>                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0 |
| <i>Brillia parva</i>                      | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Chaoborus</i> sp.                      | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| Chironomini                               | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 10 | 3  | 0  | 0  | 0  | 0  | 2  | 4  | 1  | 0  | 1  | 0 |
| <i>Chironomus</i> sp.                     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 4  | 44 | 0  | 2  | 0  | 4  | 4  | 0  | 0  | 2  | 0  | 0 |
| <i>Cladotanytarsus</i> sp.                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 0 |
| <i>Conchapelopia</i> sp.                  | 11 | 28 | 37 | 2  | 22 | 0  | 2  | 17 | 13 | 71 | 5  | 0  | 22 | 43 | 42 | 0  | 17 | 18 | 36 | 12 | 3  | 4  | 0 |
| <i>Corynoneura taris</i>                  | 3  | 0  | 0  | 0  | 2  | 1  | 0  | 0  | 0  | 0  | 1  | 15 | 0  | 0  | 0  | 0  | 2  | 3  | 0  | 0  | 0  | 3  | 0 |
| <i>Cricotopus bicinctus</i> group         | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 7  | 0  | 0  | 0  | 0  | 0 |
| <i>Cricotopus sylvestris</i> group        | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Cricotopus tremulus</i> group          | 0  | 0  | 0  | 2  | 0  | 0  | 9  | 1  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 8  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Cryptochironomus fulvus</i>            | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 4  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Dicrotendipes neomodestus</i>          | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 3  | 0  | 0  | 1  | 0  | 0  | 0 |
| <i>Diamesa</i> sp.                        | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Diplocladius</i> sp.                   | 3  | 4  | 2  | 1  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0 |
| <i>Endochironomus nigricans</i>           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Eukiefferiella bavarica</i> group      | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Eukiefferiella brevicular</i> group    | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Eukiefferiella claripennis</i> group   | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Eukiefferiella pseudomotana</i> group  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Glyptotendipes lobiferus</i>           | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Heterotrissocladius marcidus</i> group | 2  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Hudsonimyia</i> sp.                    | 2  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0 |

| Taxa                                    | Basket Collection |    |    |    |    |    |    |    |    |    |    |    |    |     |    |    |     |    |    |    |    |    |    |   |
|---|-------------------|----|----|----|----|----|----|----|----|----|----|----|----|-----|----|----|-----|----|----|----|----|----|----|---|
|   | 24                | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37  | 38 | 39 | 40  | 41 | 42 | 43 | 44 | 45 |    |   |
| <i>Hydrobaenus pilipes</i>              | 0                 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 1  | 0 |
| <i>Kiefferulus</i> sp.                  | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 7   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Labrundinia neopilosella</i> var. 3  | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0   | 2  | 0  | 0  | 0  | 0  | 0  | 1 |
| <i>Labrundinia pilosella</i>            | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0   | 0  | 0  | 0   | 0  | 9  | 0  | 0  | 0  | 0  | 1 |
| <i>Labrundinia becki</i>                | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Larsia</i> sp.                       | 0                 | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 4   | 1  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Meropelopia flavifrons</i>           | 1                 | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 0  | 0   | 1  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Micropsectra</i> sp.                 | 9                 | 25 | 30 | 14 | 5  | 0  | 2  | 0  | 2  | 8  | 3  | 4  | 5  | 59  | 3  | 0  | 1   | 0  | 1  | 0  | 1  | 22 | 17 | 1 |
| <i>Microtendipes caelum</i>             | 1                 | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 11 | 4   | 1  | 0  | 15  | 11 | 21 | 43 | 17 | 5  | 5  |   |
| <i>Microtendipes rydalenensis</i> group | 0                 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 2  | 0  | 0   | 1  | 0  | 34  | 0  | 0  | 0  | 0  | 0  | 0  |   |
| <i>Nanocladius</i> sp. 1                | 0                 | 3  | 3  | 5  | 4  | 1  | 0  | 0  | 0  | 1  | 0  | 0  | 4  | 1   | 0  | 0  | 7   | 5  | 0  | 0  | 0  | 0  | 1  |   |
| <i>Nanocladius</i> sp. 2                | 2                 | 15 | 15 | 4  | 7  | 0  | 0  | 3  | 1  | 19 | 3  | 1  | 1  | 1   | 1  | 0  | 0   | 6  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Nanocladius spiniplenus</i>          | 3                 | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 1  | 0  | 1 |
| <i>Natarsia</i> sp.                     | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Orthoclaadiinae</i>                  | 0                 | 2  | 1  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 1  | 0   | 1  | 0  | 2   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Orthoclaadius</i> sp.                | 0                 | 2  | 3  | 4  | 3  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Orthoclaadius carlatus</i> group     | 1                 | 2  | 1  | 2  | 2  | 7  | 6  | 0  | 1  | 0  | 0  | 1  | 1  | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 1 |
| <i>Orthoclaadius obumbratus</i> group   | 0                 | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Orthoclaadius oliveri</i>            | 0                 | 11 | 16 | 10 | 26 | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Parachironomus arcuatus</i> group    | 1                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 4   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Parakiefferiella</i> sp.             | 1                 | 9  | 11 | 1  | 2  | 8  | 4  | 0  | 0  | 0  | 0  | 0  | 3  | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 1  | 0  | 0 |
| <i>Paramerina</i> sp.                   | 0                 | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0   | 1  | 0  | 0   | 0  | 0  | 0  | 0  | 2  | 0  | 0 |
| <i>Parametriocnemus lundbecki</i>       | 13                | 1  | 6  | 1  | 0  | 0  | 0  | 5  | 12 | 1  | 1  | 1  | 2  | 0   | 0  | 0  | 0   | 1  | 0  | 0  | 2  | 1  | 0  | 0 |
| <i>Paraphaenoclaadius</i> sp. 1         | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Paraphaenoclaadius</i> sp. 2         | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Paratendipes</i> sp.                 | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 24  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Paratanytarsus</i> sp. 1             | 0                 | 2  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2   | 0  | 0  | 1   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Paratanytarsus</i> sp. 2             | 0                 | 36 | 37 | 23 | 24 | 1  | 1  | 0  | 0  | 22 | 3  | 0  | 0  | 109 | 31 | 0  | 189 | 3  | 2  | 2  | 0  | 2  | 0  | 2 |
| <i>Paratanytarsus</i> sp. 3             | 0                 | 1  | 3  | 0  | 6  | 0  | 0  | 0  | 0  | 0  | 3  | 0  | 0  | 13  | 2  | 0  | 9   | 0  | 0  | 0  | 0  | 0  | 0  | 0 |

## Basket Collection

| Taxa  | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37   | 38 | 39 | 40  | 41 | 42 | 43 | 44 | 45 |
|---|----|----|----|----|----|----|----|----|----|----|----|----|----|------|----|----|-----|----|----|----|----|----|
| <i>Phaenopsectra</i> sp.                    | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1    | 0  | 0  | 2   | 0  | 0  | 1  | 2  | 0  |
| <i>Phaenopsectra flavipes</i>               | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 6    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Polypedilum aviceps</i>                  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 5  | 0  | 0  | 0  | 0  | 1    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Polypedilum convictum</i>                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Polypedilum fallax</i>                   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 146  | 0  | 0  | 0   | 2  | 0  | 0  | 0  | 0  |
| <i>Polypedilum laetum</i>                   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 4  | 0  | 0  | 0  | 0  | 17   | 0  | 0  | 0   | 1  | 1  | 0  | 1  | 0  |
| <i>Polypedilum illinoense</i>               | 1  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 1  | 85   | 0  | 0  | 0   | 2  | 1  | 0  | 0  | 0  |
| <i>Polypedilum scalaenum</i>                | 3  | 0  | 0  | 0  | 0  | 0  | 0  | 3  | 1  | 0  | 0  | 0  | 51 | 1271 | 10 | 0  | 2   | 19 | 13 | 12 | 10 | 8  |
| <i>Procladius</i> sp.                       | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Psectrotanypus dyari</i>                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 38   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Psectrotanypus</i> nr. <i>dyari</i>      | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 30   | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Pseudoorthocladius</i> sp.               | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Psilonetriocnemus</i> sp.                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Rheocricotopus fuscipes</i> group        | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 1  | 0  | 0    | 0  | 0  | 0   | 1  | 0  | 0  | 0  | 0  |
| <i>Rheopelopia acra/perda</i>               | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Rheotanytarsus distinctissimus</i> group | 0  | 1  | 3  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 1  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Rheotanytarsus exiguus</i> group         | 1  | 13 | 10 | 2  | 2  | 0  | 0  | 2  | 0  | 4  | 0  | 0  | 0  | 4    | 0  | 0  | 1   | 0  | 1  | 0  | 0  | 0  |
| <i>Robackia</i> sp.                         | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Saetheria</i> sp.                        | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Symptothastia</i> sp.                    | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Tanypodinae</i> (early instar)           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 12 | 1    | 0  | 0  | 2   | 2  | 2  | 7  | 1  | 0  |
| <i>Tanytarsini</i>                          | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 2  | 0  | 8   | 0  | 0  | 1  | 1  | 0  |
| <i>Tanytarsus</i> sp.                       | 4  | 1  | 1  | 0  | 0  | 3  | 1  | 1  | 4  | 1  | 0  | 3  | 20 | 5    | 3  | 0  | 157 | 2  | 4  | 9  | 5  | 11 |
| <i>Thienemanniella</i> prob. <i>xena</i>    | 0  | 21 | 12 | 10 | 10 | 1  | 1  | 0  | 0  | 3  | 1  | 1  | 0  | 0    | 0  | 0  | 6   | 0  | 0  | 0  | 0  | 0  |
| <i>Thienemanniella</i> sp. 1                | 0  | 8  | 9  | 2  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Thienemanniella</i> sp. 2                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0   | 0  | 12 | 0  | 0  | 0  |
| <i>Tribelos</i> poss. <i>jucundum</i>       | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 3  | 34   | 0  | 0  | 1   | 0  | 0  | 0  | 0  | 0  |
| <i>Tribelos</i> sp. 1                       | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |
| <i>Trissopelopia ogemawi</i>                | 5  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 1  | 0    | 1  | 0  | 0   | 0  | 0  | 0  | 0  | 0  |

| Taxa                              | Basket Collection |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |    |    |    |    |    |   |
|-----------------------------------|-------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|----|----|----|----|----|---|
|                                   | 24                | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40  | 41 | 42 | 43 | 44 | 45 |   |
| <i>Tvetenia bavarica</i> group    | 0                 | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Zavrelimyia</i> sp. 1          | 1                 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 9  | 7  | 1  | 0  | 2   | 0  | 2  | 1  | 1  | 0  | 0 |
| <i>Zavrelimyia</i> sp. 2          | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 26 | 9  | 1  | 0  | 3   | 2  | 1  | 0  | 0  | 0  | 0 |
| <i>Zavrelimyia</i> sp. 3          | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| Simuliidae                        | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Prosimulium</i> sp.            | 0                 | 4  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Stegopterna mutata</i> complex | 0                 | 42 | 75 | 0  | 0  | 0  | 3  | 0  | 0  | 9  | 0  | 3  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Simulium tuberosum</i> complex | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Simulium vittatum</i> complex  | 0                 | 1  | 5  | 1  | 0  | 0  | 0  | 0  | 0  | 11 | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| Ceratopogonidae                   | 3                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| Other Diptera                     | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Hemerodromia</i> sp.           | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 2  | 0  | 0  | 0   | 5  | 24 | 2  | 4  | 7  | 0 |
| <i>Telmatoscopus</i> sp.          | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| Ephemeroptera                     | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Baetis brunneicolor</i>        | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| Ephemerellidae                    | 0                 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 14 | 0  | 1  | 0  | 126 | 0  | 0  | 2  | 2  | 6  | 0 |
| <i>Ephemerella excrucians</i>     | 2                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Ephemerella invaria</i>        | 2                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Eurylophella</i> sp.           | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Eurylophella bicolor</i>       | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0   | 1  | 0  | 2  | 0  | 2  | 0 |
| <i>Eurylophella funeralis</i>     | 3                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0   | 1  | 0  | 0  | 0  | 0  | 0 |
| <i>Eurylophella temporalis</i>    | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| Isonychia sp.                     | 0                 | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Leptophlebia</i> sp.           | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Paraleptophlebia</i> sp.       | 3                 | 0  | 0  | 0  | 0  | 0  | 0  | 5  | 1  | 0  | 0  | 0  | 56 | 0  | 16 | 0  | 102 | 5  | 0  | 7  | 0  | 1  | 0 |
| <i>Serratella deficiens</i>       | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Stenonema modestum</i>         | 0                 | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 2   | 0  | 0  | 1  | 0  | 2  | 0 |
| Plecoptera                        | 0                 | 0  | 0  | 0  | 0  | 0  | 4  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| <i>Agnatina capitata</i>          | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0 |

| Taxa                             | Basket Collection |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----------------------------------|-------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                                  | 24                | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
| <i>Eccoptura xanathenes</i>      | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Isoperla lata</i>             | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Isoperla marlynia</i>         | 0                 | 1  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ostrocer a</i> sp.            | 0                 | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Paracapnia opis</i>           | 0                 | 0  | 0  | 0  | 1  | 1  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 1  |
| <i>Perlina ephyre/fumipennis</i> | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  |
| <i>Podnosta</i> sp.              | 0                 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Taeniopteryx</i> sp.          | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Taeniopteryx maura</i>        | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Taeniopteryx parvula</i>      | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Tallaperla maria</i>          | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Tricoptera                       | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 48 | 0  | 0  | 0  | 0  | 1  |
| <i>Anobolia</i> sp.              | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Cernotina</i> sp.             | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Cheumatopsyche</i> sp.        | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Chimarra</i> sp.              | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Glossosoma</i> sp.            | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Hydatophylax</i> sp.          | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Hydropsyche</i> sp. 1         | 1                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  |
| <i>Hydropsyche</i> sp. 2         | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Lepidostoma</i> sp.           | 2                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Neophylax</i> sp.             | 0                 | 0  | 0  | 0  | 0  | 2  | 8  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Platycentropus</i> sp.        | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Polycentropodidae                | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ptilostomis</i> sp.           | 0                 | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Pycnopsyche</i> sp.           | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 3  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Odonata                          | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Aeshna</i> sp.                | 0                 | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Boyeria vinosa</i>            | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

| Taxa                            | Basket Collection |    |    |    |    |    |    |    |    |    |    |    |    |    |     |    |    |    |    |    |    |    |
|---------------------------------|-------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|----|----|----|----|----|----|----|
|                                 | 24                | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38  | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
| <i>Calopteryx maculata</i>      | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 4  | 0  | 0  | 0  | 0  | 1  |
| Coenagrionidae                  | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2   | 0  | 3  | 0  | 0  | 0  | 0  | 1  |
| <i>Coenagrion</i> sp.           | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 6   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Hataerina</i> sp.            | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Coleoptera                      | 0                 | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Anchytarsus bicolor</i>      | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Dytiscus</i> sp.             | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 4  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ectopria</i> sp.             | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ectopria nervosa</i>         | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Hydroporus</i> sp.           | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Optioservus</i> sp.          | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 4  | 1  | 0  | 0   | 1  | 2  | 0  | 3  | 2  | 3  | 3  |
| <i>Oreodytes</i> sp.            | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 2  | 0  | 0  | 0  | 0  |
| <i>Psephenus</i> sp.            | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 1  | 0  | 0  | 0  | 0  | 0  |
| <i>Promoresia</i> sp.           | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 5  | 0  | 0  | 0   | 0  | 3  | 2  | 0  | 0  | 1  | 1  |
| <i>Stenelmis</i> sp.            | 1                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 1  | 0  | 0  |
| Megaloptera                     | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Chauliodes pectinicornis</i> | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Nigronia serricornis</i>     | 1                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 5  | 1  | 0  | 0   | 1  | 1  | 2  | 1  | 0  | 1  | 0  |
| Gastropoda                      | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Ferrissia</i> sp.            | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 8   | 0  | 3  | 0  | 1  | 3  | 0  | 2  |
| <i>Fossaria</i> sp.             | 0                 | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Gyraulus</i> sp.             | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Musculium</i> sp.            | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Physa</i> sp.                | 2                 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Pisidium</i> sp.             | 0                 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Amphipoda                       | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Hyaella azteca</i>           | 0                 | 1  | 3  | 1  | 6  | 0  | 0  | 0  | 0  | 1  | 41 | 0  | 0  | 0  | 157 | 0  | 0  | 0  | 0  | 0  | 59 | 7  |
| <i>Asellus communis</i>         | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

| Taxa                                | Basket Collection |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------------------------------------|-------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                                     | 24                | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
| Annelida                            | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Dina sp.</i>                     | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Helobdella stagnalis</i>         | 0                 | 0  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 22 | 22 | 0  | 0  | 0  | 1  | 0  | 1  |
| <i>Mooreobdella melanostoma</i>     | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Oligochaeta                         | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 17 | 89 | 9  | 5  | 1  | 4  | 3  | 1  | 0  |
| <i>Aulodrilus limnosius</i>         | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Dero obtusa</i>                  | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 3  | 0  | 0  | 2  | 3  | 90 | 26 | 0  | 0  | 0  | 5  | 9  | 0  |
| <i>Homochaeta sp.</i>               | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 5  | 0  | 0  | 0  | 0  | 0  | 0  |
| IWCC                                | 9                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 4  | 2  | 23 | 1  | 0  | 1  | 0  | 0  | 0  |
| ICC                                 | 1                 | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 10 | 0  | 0  | 0  | 0  | 0  | 0  |
| Lumbricidae                         | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Nais communis</i>                | 1                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 5  | 78 | 14 | 1  | 2  | 1  | 29 | 4  | 1  | 0  | 0  |
| <i>Pristinella jenkiniae</i>        | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Pristina longiseta longiseta</i> | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 4  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  |
| <i>Pristina longisoma</i>           | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Pristina sima</i>                | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  |
| <i>Pristinella osborni</i>          | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Slavina appendiculata</i>        | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 13 | 3  | 0  | 0  | 0  | 1  | 2  | 1  |
| Nematode                            | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 2  | 1  | 0  | 0  | 4  | 1  | 1  |
| Tipulidae                           | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  |
| <i>Hexatoma sp.</i>                 | 1                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Tipula sp.</i>                   | 1                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Staphilinidae                       | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| <i>Stenus sp.</i>                   | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Copepod                             | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 6  | 3  | 0  | 0  | 0  | 1  | 14 | 0  |
| Pupa                                | 0                 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 0  | 0  | 5  | 0  | 0  | 0  | 0  | 0  |

APPENDIX B

SIMPSON' *D*, HURLBERT'S *PIE* AND KEEFE'S *TU*



To unify the notations let's rewrite Simpson's  $D$  as:

$$D = \sum_{i=1}^s \frac{n_i (n_i - 1)}{N (N - 1)}$$

Hurlbert's "encounter" index as:

$$PIE = \left( \frac{N}{N-1} \right) \left( 1 - \sum_{i=1}^s p_i^2 \right)$$

and Keefe's  $TU$  as:

$$TU = 1 - \left( \frac{N}{N-1} \right) \left( \sum_{i=1}^k p_i^2 - \frac{1}{N} \right)$$

where  $n_i$  is the number of individuals in species  $i$ ,  $N$  is the number of individuals in a sample, and  $p_i = n_i / N$ .

As mentioned in the literature review, Simpson's  $D$  Hurlbert's  $PIE$  and Keefe's  $TU$  are in principle measuring the exact same thing. This can be proved by solving their mathematical equations.

By solving for Simpson's  $D$ :

$$\begin{aligned} D &= \sum_{i=1}^s \frac{n_i (n_i - 1)}{N (N - 1)} \\ &= \frac{\sum_{i=1}^s n_i^2}{N (N - 1)} - \frac{\sum_{i=1}^s n_i}{N (N - 1)} \\ &= \frac{\sum_{i=1}^s n_i^2}{N (N - 1)} - \frac{N}{N (N - 1)} \end{aligned}$$

we get

$$D = \frac{\sum_{i=1}^s n_i^2}{N^2 - N} - \frac{1}{(N-1)}$$

Similarity Hurlbert's *PIE*:

$$\begin{aligned}
 PIE &= \left( \frac{N}{N-1} \right) \left( 1 - \sum_{i=1}^s p_i^2 \right) \\
 &= \left( \frac{N}{N-1} \right) \left( 1 - \sum_{i=1}^s \left( \frac{N_i}{N} \right)^2 \right) \\
 &= \left( \frac{N}{N-1} \right) \left( 1 - \frac{1}{N^2} \sum_{i=1}^s N_i^2 \right) \\
 &= \frac{N}{N-1} - \left( \frac{N}{N-1} \frac{1}{N^2} \sum_{i=1}^s N_i^2 \right) \\
 &= \frac{N}{N-1} - \frac{\sum_{i=1}^s N_i^2}{N^2 - N} \\
 &= \frac{-1}{N-1} + \frac{\sum_{i=1}^s N_i^2}{N^2 - N}
 \end{aligned}$$

thus yields

$$1 - PIE = \frac{\sum_{i=1}^s N_i^2}{N^2 - N} - \frac{1}{N-1}$$

Rearranging for Keefe's  $TU$ :

$$\begin{aligned}
 TU &= 1 - \left( \frac{N}{N-1} \right) \left( \sum_{i=1}^k p_i^2 - \frac{1}{N} \right) \\
 &= 1 - \frac{N}{N-1} \sum_{i=1}^k p_i^2 + \frac{N}{N-1} \frac{1}{N} \\
 &= 1 - \frac{N}{N-1} \sum_{i=1}^k p_i^2 + \frac{1}{N-1} \\
 &= 1 + \frac{1}{N-1} - \frac{N}{N-1} \sum_{i=1}^k p_i^2 \\
 &= \frac{N-1+1}{N-1} - \frac{N}{N-1} \sum_{i=1}^k p_i^2 \\
 &= \frac{N}{N-1} - \frac{N}{N-1} \sum_{i=1}^k p_i^2 \\
 &= \frac{N}{N-1} \left( 1 - \sum_{i=1}^k p_i^2 \right)
 \end{aligned}$$

$$\therefore TU = PIE$$

APPENDIX C  
FORMULA FOR THEORY OF RUN

$$T = 1 - \sum_{i=1}^s p_i^2$$

$$= 1 - \sum_{i=1}^s \left(\frac{n_i}{N}\right)^2$$

$$= \frac{N^2 - \sum_{i=1}^s n_i^2}{N^2}$$

$$= \frac{N^2 - \sum_{i=1}^s n_i^2}{N^2}$$

$$= \frac{D_d}{\text{Permutations of } N \times N}$$

$$\therefore D_d = \frac{(\text{Permutations of } N \times N) \times (N^2 - \sum_{i=1}^s n_i^2)}{N^2}$$

$$\therefore D_d = \frac{(\text{Permutations of } N) \times (N^2 - \sum_{i=1}^s n_i^2)}{N}$$

$$\mu_r = \frac{D_d + \text{permutations of } N}{\text{permutations of } N \times N}$$

$$\therefore \mu_r = \frac{(\text{Permutations of } N) \times (N^2 - \sum_{i=1}^s n_i^2) + (\text{Permutations of } N \times N)}{\text{Permutations of } N \times N}$$

$$= \frac{(\text{Permutations of } N) \times (N^2 - \sum_{i=1}^s n_i^2 + N)}{\text{Permutations of } N \times N}$$

$$= \frac{(N^2 - \sum_{i=1}^s n_i^2 + N)}{N^2}$$

$$= \frac{N^2}{N^2} - \sum_{i=1}^s \frac{n_i^2}{N} + \frac{N}{N^2}$$

$$\therefore = 1 - \sum_{i=1}^s p_i^2 + \frac{1}{N}$$

APPENDIX D

A SAS PROGRAM TO CALCULATE DIVERSITY INDICES OF BENTHIC  
MACROINVERTEBRATES

```

libname ming'[]';

data temp;
infile 'basket1.dos' LRECL=300;
input c1-c21;
drop c21;
array b1{20} c1-c20;
array pvar{20} p1-p20;
denprod = 0;
shannon = 0;
sumtot=sum(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,c16,c17,c18,c19);

count = 19;
k = FLOOR(sumtot/count);
r = sumtot - (k * count);

do i=1 to 20;
fin = b1{i};
pvar{i} = 0;
if fin = 0 then pvar{i} = 0;
else do j =1 to fin;
pvar{i} = pvar{i} + log(j);
end;
if (i < 20) then denprod = denprod + pvar{i};
end;

if b1{20} EQ 0 then
Shannon=.;
do i=1 to 19;
if b1{i} NE 0 then
Shannon = Shannon + (b1{i}/sumtot) * log(b1{i}/sumtot);
end;
Shannon = - Shannon;

if (b1{20} NE 0) then
Brillou = 1/c20 * (pvar{20} - denprod);

if (sumtot NE 0) and (((sumtot - count + 1)/ sumtot) GT 0) then
SMIN = - (((count - 1)/sumtot) * log(1/sumtot))
- ((sumtot - count + 1)/sumtot) *log((sumtot - count + 1) /sumtot);

if (sumtot NE 0) and ((k/sumtot) GT 0) then
SMAX = - (count - r) * (k/sumtot) * log(k/sumtot)
- r * ((k + 1)/sumtot) * log((k +1)/sumtot);

pvar1 = 0;

```



```

do j=1 to (sumtot - count + 1);
pvar1 = pvar1 + log(j);
end;

pvar2 = 0;
do j=1 to k;
if k NE 0 then
pvar2 = pvar2 + log(j);
end;

if sumtot NE 0 then
BMIN = (1/sumtot) * (pvar{20} - pvar1);
if sumtot NE 0 then
BMAX = (1/sumtot) * (pvar{20} - count * pvar2 - r * log(k + 1));

if (SMAX - SMIN) NE 0 then
ShannonR = (SMAX - Shannon) / (SMAX - SMIN);
if (BMAX - BMIN) NE 0 then
BrillouR = (BMAX - Brillou) / (BMAX - BMIN);
if SMAX NE 0 then
ShannonE = Shannon / SMAX;
if BMAX NE 0 then
BrillouE = Brillou / BMAX;

run;

proc print data=temp;
var p20 fin denprod Shannon Brillou k r SMIN SMAX BMIN BMAX
ShannonR BrillouR ShannonE BrillouE;

data temp1; set temp;
if sumtot=40 then delete;
proc means mean STD USS CSS CV STDERR T PRT;
var Shannon Brillou ShannonR BrillouR ShannonE BrillouE;
output out=meansout;
proc print data=meansout;

data temp1; set temp;
array b1{19} c1-c19;
dentotal =sum(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,c16,c17,c18,c19);
count=19;
numtot1=0; numtot2=0;

do i=1 to 19;
if b1{i} > 0 then
numtot1 = numtot1 + b1{i} * (b1{i} - 1);

```

```

numtot2 = numtot2 + b1{i} * b1{i};
end;

if denttotal > 1 then
simpson = numtot1/ (denttotal * (denttotal - 1));
hurlkeef = 1 - simpson;

if (denttotal-sqrt(denttotal)) NE 0 then
mcintosh=(denttotal-sqrt(numtot2))/(denttotal-sqrt(denttotal));

if (denttotal-(denttotal/sqrt(count))) NE 0 then
mcinmax=(denttotal-sqrt(numtot2))/(denttotal-(denttotal/sqrt(count)));

if (denttotal-sqrt((denttotal-count+1)*(denttotal-count+1)+(count-1))) NE 0 then
mcinmin=(denttotal-sqrt(numtot2))
/(denttotal-sqrt((denttotal-count+1)*(denttotal-count+1)+(count-1)));

if denttotal NE 0 then
rntheory = (denttotal * denttotal + denttotal - numtot2)/(denttotal *denttotal);

proc print data=temp1;
var count denttotal simpson hurlkeef mcintosh mcinmax mcinmin
rntheory;

data temp2; set temp1;
if denttotal = 40 then delete;
proc means mean STD USS CSS CV STDERR T PRT;
var simpson hurlkeef mcintosh mcinmax mcinmin rntheory;
output out=meansout;
proc print data=meansout;

run;

data temp2; set temp;
if c20=40 then delete;
seed=0;
rand=rannor(seed);
proc sort;
by rand;

proc transpose data=temp2 out=trans1 prefix=t;
var c1-c20;

data temp3; set trans1;
array transp{30} t1-t30;
array pool{30} po1-po30;

```

```

pool{1}=transp{1};
do i=1 to 29;
pool{i+1} = pool{i} + transp{i+1};
end;
run;

proc transpose data=temp3 out=trans2 prefix=c;
var po1-po30;
proc print data=trans2;

data temp4; set trans2;
array b1{20} c1-c20;
array pvar{20} p1-p20;
denprod = 0;
shannon = 0;
sumtot=sum(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,c16,c17,c18,c19);

count = 19;
k = FLOOR(sumtot/count);
r = sumtot - (k * count);

do i=1 to 20;
fin = b1{i};
pvar{i} = 0;
if fin = 0 then pvar{i} = 0;
else do j =1 to fin;
pvar{i} = pvar{i} + log(j);
end;
if (i < 20) then denprod = denprod + pvar{i};
end;

if b1{20} EQ 0 then
Shannon=.;
do i=1 to 19;
if b1{i} NE 0 then
Shannon = Shannon + (b1{i}/sumtot) * log(b1{i}/sumtot);
end;
Shannon = - Shannon;

if (b1{20} NE 0) then
Brillou = 1/c20 * (pvar{20} - denprod);

if (sumtot NE 0) and (((sumtot - count + 1)/ sumtot) GT 0) then
SMIN = - (((count - 1)/sumtot) * log(1/sumtot))
- ((sumtot - count + 1)/sumtot) * log((sumtot - count + 1) /sumtot);

```

```

if (sumtot NE 0) and ((k/sumtot) GT 0) then
  SMAX = - (count - r) * (k/sumtot) * log(k/sumtot)
  - r * ((k + 1)/sumtot) * log((k + 1)/sumtot);

pvar1 = 0;
do j=1 to (sumtot - count + 1);
  pvar1 = pvar1 + log(j);
end;

pvar2 = 0;
do j=1 to k;
  if k NE 0 then
    pvar2 = pvar2 + log(j);
end;

if sumtot NE 0 then
  BMIN = (1/sumtot) * (pvar{20} - pvar1);
if sumtot NE 0 then
  BMAX = (1/sumtot) * (pvar{20} - count * pvar2 - r * log(k + 1));

if (SMAX - SMIN) NE 0 then
  ShannonR = (SMAX - Shannon) / (SMAX - SMIN);
if (BMAX - BMIN) NE 0 then
  BrillouR = (BMAX - Brillou) / (BMAX - BMIN);
if SMAX NE 0 then
  ShannonE = Shannon / SMAX;
if BMAX NE 0 then
  BrillouE = Brillou / BMAX;
run;

proc print data=temp4;
var p20 fin denprod Shannon Brillou k r SMIN SMAX BMIN BMAX
ShannonR BrillouR ShannonE BrillouE;
run;

data temp; set trans2;
count=19;
dentotal =
sum(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,c16,c17,c18,c19);
array b1{19} c1-c19;

numtot1=0; numtot2=0;

do i=1 to 19;
  if b1{i} > 0 then
    numtot1 = numtot1 + b1{i} * (b1{i} - 1);

```

```

numtot2 = numtot2 + b1{i} * b1{i};
end;

if denttotal > 1 then
simpson = numtot1/ (denttotal * (denttotal - 1));
hurlkeef = 1 - simpson;

if (denttotal-sqrt(denttotal)) NE 0 then
mcintosh=(denttotal-sqrt(numtot2))/(denttotal-sqrt(denttotal));

if (denttotal-(denttotal/sqrt(count))) NE 0 then
mcinmax=(denttotal-sqrt(numtot2))/(denttotal-(denttotal/sqrt(count)));

if (denttotal-sqrt((denttotal-count+1)*(denttotal-count+1)+(count-1))) NE 0 then
mcinmin=(denttotal-sqrt(numtot2))
/(denttotal-sqrt((denttotal-count+1)*(denttotal-count+1)+(count-1)));

if denttotal NE 0 then
rntheory = (denttotal * denttotal + denttotal - numtot2)/(denttotal *denttotal);

proc print data=temp;
var count denttotal simpson hurlkeef mcintosh mcinmax mcinmin
rntheory;

data comb; merge temp4 temp;
proc tranpose data=comb out=out1 prefix=t;
var Shannon Brillou Hurlkeef mcintosh rntheory;

data calcu; set out1;
array trans{30} t1-t30;
array diff{30} d1-d30;
do i=1 to 29;
diff{i}=trans{i+1}-trans{i};
end;
proc transpose data=calcu out=differ;
var d1-d30;
proc print data=differ;

data temp6; set temp;
if c20=40 then delete;
seed=0;
rand=rannor(seed);
proc sort;
by rand;
proc transpose data=temp6 out=trans3 prefix=t;

```

```

var c1-c20;

data temp7; set trans3;
array transp{30} t1-t30;
array pool{30} po1-po30;
pool{1}=transp{1};
do i=1 to 29;
pool{i+1} = pool{i} + transp{i+1};
end;
run;

proc transpose data=temp7 out=trans4 prefix=c;
var po1-po30;
proc print data=trans4;

data temp8; set trans4;
array b1{20} c1-c20;
array pvar{20} p1-p20;
denprod = 0;
shannon = 0;
sumtot=sum(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,c16,c17,c18,c19);

count = 19;
k = FLOOR(sumtot/count);
r = sumtot - (k * count);

do i=1 to 20;
fin = b1{i};
pvar{i} = 0;
if fin = 0 then pvar{i} = 0;
else do j =1 to fin;
pvar{i} = pvar{i} + log(j);
end;
if (i < 20) then denprod = denprod + pvar{i};
end;

if b1{20} EQ 0 then
Shannon=.;
do i=1 to 19;
if b1{i} NE 0 then
Shannon = Shannon + (b1{i}/sumtot) * log(b1{i}/sumtot);
end;
Shannon = - Shannon;

if (b1{20} NE 0) then
Brillou = 1/c20 * (pvar{20} - denprod);

```

```

if (sumtot NE 0) and (((sumtot - count + 1)/ sumtot) GT 0) then
SMIN = - (((count - 1)/sumtot) * log(1/sumtot))
- ((sumtot - count + 1)/sumtot) * log((sumtot - count + 1) /sumtot);

if (sumtot NE 0) and ((k/sumtot) GT 0) then
SMAX = - (count - r) * (k/sumtot) * log(k/sumtot)
- r * ((k + 1)/sumtot) * log((k + 1)/sumtot);

pvar1 = 0;
do j=1 to (sumtot - count + 1);
pvar1 = pvar1 + log(j);
end;

pvar2 = 0;
do j=1 to k;
if k NE 0 then
pvar2 = pvar2 + log(j);
end;

if sumtot NE 0 then
BMIN = (1/sumtot) * (pvar{20} - pvar1);
if sumtot NE 0 then
BMAX = (1/sumtot) * (pvar{20} - count * pvar2 - r * log(k + 1));

if (SMAX - SMIN) NE 0 then
ShannonR = (SMAX - Shannon) / (SMAX - SMIN);
if (BMAX - BMIN) NE 0 then
BrillouR = (BMAX - Brillou) / (BMAX - BMIN);
if SMAX NE 0 then
ShannonE = Shannon / SMAX;
if BMAX NE 0 then
BrillouE = Brillou / BMAX;

run;

proc print data=temp8;
var p20 fin denprod Shannon Brillou k r SMIN SMAX BMIN BMAX
ShannonR BrillouR ShannonE BrillouE;

run;
data temp; set trans4;
count=19;
dentotal =
sum(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,c16,c17,c18,c19);
array b1{19} c1-c19;

```

```

numtot1=0; numtot2=0;

do i=1 to 19;
if b1{i} > 0 then
numtot1 = numtot1 + b1{i} * (b1{i} - 1);
numtot2 = numtot2 + b1{i} * b1{i};
end;

if denttotal > 1 then
simpson = numtot1/ (denttotal * (denttotal - 1));
hurlkeef = 1 - simpson;

if (denttotal-sqrt(denttotal)) NE 0 then
mcintosh=(denttotal-sqrt(numtot2))/(denttotal-sqrt(denttotal));

if (denttotal-(denttotal/sqrt(count))) NE 0 then
mcinmax=(denttotal-sqrt(numtot2))/(denttotal-(denttotal/sqrt(count)));

if (denttotal-sqrt((denttotal-count+1)*(denttotal-count+1)+(count-1))) NE 0 then
mcinmin=(denttotal-sqrt(numtot2))
/(denttotal-sqrt((denttotal-count+1)*(denttotal-count+1)+(count-1)));

if denttotal NE 0 then
rntheory = (denttotal * denttotal + denttotal - numtot2)/(denttotal *denttotal);

proc print data=temp;
var count denttotal simpson hurlkeef mcintosh mcinmax mcinmin
rntheory;

data comb; merge temp8 temp;
proc transpose data=comb out=out1 prefix=t;
var Shannon Brillou Hurlkeef mcintosh rntheory;

data calcu; set out1;
array trans{30} t1-t30;
array diff{30} d1-d30;
do i=1 to 29;
diff{i}=trans{i+1}-trans{i};
end;

proc transpose data=calcu out=differ;
var d1-d30;
proc print data=differ;

data temp10; set temp;
if c20=40 then delete;

```



```

seed=0;
rand=rannor(seed);
proc sort;
by rand;

proc transpose data=temp10 out=trans5 prefix=t;
var c1-c20;

data temp11; set trans5;
array transp{30} t1-t30;
array pool{30} po1-po30;
pool{1}=transp{1};
do i=1 to 29;
pool{i+1} = pool{i} + transp{i+1};
end;
run;

proc transpose data=temp11 out=trans6 prefix=c;
var po1-po30;
proc print data=trans6;

data temp12; set trans6;
array b1{20} c1-c20;
array pvar{20} p1-p20;
denprod = 0;
shannon = 0;
sumtot=sum(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,c16,c17,c18,c19);

count = 19;
k = FLOOR(sumtot/count);
r = sumtot - (k * count);

do i=1 to 20;
fin = b1{i};
pvar{i} = 0;
if fin = 0 then pvar{i} = 0;
else do j =1 to fin;
pvar{i} = pvar{i} + log(j);
end;
if (i < 20) then denprod = denprod + pvar{i};
end;

if b1{20} EQ 0 then
Shannon=.;
do i=1 to 19;
if b1{i} NE 0 then

```

```

Shannon = Shannon + (b1{i}/sumtot) * log(b1{i}/sumtot);
end;
Shannon = - Shannon;

if (b1{20} NE 0) then
Brillou = 1/c20 * (pvar{20} - denprod);

if (sumtot NE 0) and (((sumtot - count + 1)/ sumtot) GT 0) then
SMIN = - (((count - 1)/sumtot) * log(1/sumtot))
- ((sumtot - count + 1)/sumtot) * log((sumtot - count + 1) /sumtot);

if (sumtot NE 0) and ((k/sumtot) GT 0) then
SMAX = - (count - r) * (k/sumtot) * log(k/sumtot)
- r * ((k + 1)/sumtot) * log((k + 1)/sumtot);

pvar1 = 0;
do j=1 to (sumtot - count + 1);
pvar1 = pvar1 + log(j);
end;

pvar2 = 0;
do j=1 to k;
if k NE 0 then
pvar2 = pvar2 + log(j);
end;

if sumtot NE 0 then
BMIN = (1/sumtot) * (pvar{20} - pvar1);
if sumtot NE 0 then
BMAX = (1/sumtot) * (pvar{20} - count * pvar2 - r * log(k + 1));

if (SMAX - SMIN) NE 0 then
ShannonR = (SMAX - Shannon) / (SMAX - SMIN);
if (BMAX - BMIN) NE 0 then
BrillouR = (BMAX - Brillou) / (BMAX - BMIN);
if SMAX NE 0 then
ShannonE = Shannon / SMAX;
if BMAX NE 0 then
BrillouE = Brillou / BMAX;

run;

proc print data=temp12;
var p20 fin denprod Shannon Brillou k r SMIN SMAX BMIN BMAX
ShannonR BrillouR ShannonE BrillouE;
run;

```

```

data temp; set trans6;
count=19;
dentotal =
sum(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,c16,c17,c18,c19);
array b1{19} c1-c19;

numtot1=0; numtot2=0;

do i=1 to 19;
if b1{i} > 0 then
numtot1 = numtot1 + b1{i} * (b1{i} - 1);
numtot2 = numtot2 + b1{i} * b1{i};
end;

if dentotal > 1 then
simpson = numtot1/ (dentotal * (dentotal - 1));
hurlkeef = 1 - simpson;

if (dentotal-sqrt(dentotal)) NE 0 then
mcintosh=(dentotal-sqrt(numtot2))/(dentotal-sqrt(dentotal));

if (dentotal-(dentotal/sqrt(count))) NE 0 then
mcinmax=(dentotal-sqrt(numtot2))/(dentotal-(dentotal/sqrt(count)));

if (dentotal-sqrt((dentotal-count+1)*(dentotal-count+1)+(count-1))) NE 0 then
mcinmin=(dentotal-sqrt(numtot2))
/(dentotal-sqrt((dentotal-count+1)*(dentotal-count+1)+(count-1)));

if dentotal NE 0 then
rntheory = (dentotal * dentotal + dentotal - numtot2)/(dentotal *dentotal);

proc print data=temp;
var count dentotal simpson hurlkeef mcintosh mcinmax mcinmin
rntheory;

data comb; merge temp12 temp;
proc transpose data=comb out=out1 prefix=t;
var Shannon Brillou Hurlkeef mcintosh rntheory;

data calcu; set out1;
array trans{30} t1-t30;
array diff{30} d1-d30;
do i=1 to 29;
diff{i}=trans{i+1}-trans{i};

```

```
end;  
  
proc transpose data=calcu out=differ;  
var d1-d30;  
proc print data=differ;  
run;libname ming'[]';  
options pagesize=56;  
data temp1;
```

APPENDIX E

A SAS PROGRAM TO CALCULATE QUALITATIVE COMMUNITY  
COMPARISON INDICES OF BENTHIC MACROINVERTEBRATES

```

libname ming '[]';
infile 'datarev.prn';
input b1-b45;
data temp2; set temp1;
array com{45} b1-b45;
array agree{44,45} a1-a1980;
do i=1 to 44;
ind=i+1;
do j=ind to 45;
agree{i,j}=0;
if ((com{i} GT 0) and (com{j} GT 0)) then agree{i,j}=1;
end;
end;
do i=1 to 45;
if com{i} GT 1 then com{i} = 1;
end;
proc means noprint data=temp2;
var b1-b45 a1-a1980;
output out=totals sum=s1-s45 sa1-sa1980;

```

```

data temp3 (keep=Basket i j a b c jaccard1 Jaccard2 Kulczyn Sorensen
Mountfor Ochiai Fager1 Fager2 SMC);
set totals;
array com{45} s1-s45;
array agree{44,45} sa1-sa1980;
do i=1 to 44;
ind=i+1;
do j=ind to 45;
a=com{i};
b=com{j};
c=agree{i,j};
Basket=i;
if (a + b - c) GT 0 then
Jaccard1 = c/(a+b-c);
Jaccard2 = c/(a+b);
if ((a NE 0) and (b NE 0)) then
Kulczyn = c/2 * ((1/a) + (1/b));
if (a + b) NE 0 then
Sorensen = (2 * c) / (a + b);
if (((2 * a * b) - ((a + b) * c)) NE 0) then
Mountfor = (2 * c) / ((2 * a * b) - ((a + b) * c));
Ochiai = c / (SQRT((c+b) * (c+a)));
Fager1 = (c / (SQRT((c+b) * (c+a)))) - (1 / (2 * SQRT(c+b)));
Fager2 = (2*c/(SQRT((c+b) * (c+a)))) -
((1/(2 * SQRT(c+b))) + (1/(2 * SQRT(c+a))));
SMC = Jaccard1;

```

```
output;  
end;  
end;  
proc print data=temp3;  
run;
```

APPENDIX F

SAS PROGRAMS TO CALCULATE QUANTITATIVE COMMUNITY  
COMPARISON INDICES OF BENTHIC MACROINVERTEBRATES



1. Program to Calculate Percent Similarity (Renkonen, 1938), SIMI (Stander, 1970) and Distance Measure (Clifford and Stephenson, 1975).

```

options pagesize=56;
data temp1;
infile 'datarev.prn';
input b1-b45;
proc transpose data=temp1 out=trans prefix=c;
var b1-b45;

data temp2 (keep = f1-f199); set trans;
sumtot = sum(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,
c16,c17,c18,c19,c20,c21,c22,c23,c24,c25,c26,c27,c28,c29,c30,c31,
c32,c33,c34,c35,c36,c37,c38,c39,c40,c41,c42,c43,c44,c45,c46,c47,
c48,c49,c50,c51,c52,c53,c54,c55,c56,c57,c58,c59,c60,c61,c62,c63,
c64,c65,c66,c67,c68,c69,c70,c71,c72,c73,c74,c75,c76,c77,c78,c79,
c80,c81,c82,c83,c84,c85,c86,c87,c88,c89,c90,c91,c92,c93,c94,c95,
c96,c97,c98,c99,c100,c101,c102,c103,c104,c105,c106,c107,c108,
c109,c110,c111,c112,c113,c114,c115,c116,c117,c118,c119,c120,c121,
c122,c123,c124,c125,c126,c127,c128,c129,c130,c131,c132,c133,c134,
c135,c136,c137,c138,c139,c140,c141,c142,c143,c144,c145,c146,c147,
c148,c149,c150,c151,c152,c153,c154,c155,c156,c157,c158,c159,c160,
c161,c162,c163,c164,c165,c166,c167,c168,c169,c170,c171,c172,c173,
c174,c175,c176,c177,c178,c179,c180,c181,c182,c183,c184,c185,c186,
c187,c188,c189,c190,c191,c192,c193,c194,c195,c196,c197,c198,
c199);
array raw{199} c1-c199;
array fract{199} f1-f199;
do i=1 to 199;
if sumtot NE 0 then
fract{i} = raw{i} / sumtot;
end;

proc transpose data=temp2 out=fract prefix=frac;
var f1-f199;

data temp3 (keep = fmin1-fmin1980 ps1-ps1980 d1-d1980
na1-na1980 nb1-nb1980 dis1-dis1980);
set fract;
array frac{45} frac1-frac45;
array fmin{44,45} fmin1-fmin1980;
array absolu{44,45} ab1-ab1980;
array psimilar{44,45} ps1-ps1980;
array SIMIden{44,45} d1-d1980;
array SIMInuA{44,45} na1-na1980;
array SIMInuB{44,45} nb1-nb1980;
array dist{44,45} dis1-dis1980;

do i=1 to 44;

```

```

ind = i + 1;
do j=ind to 45;
if frac{i} NE 0 then
fmin{i,j} = MIN(frac{i},frac{j});
psimilar{i,j} = ABS (frac{i} - frac{j});
SIMIden{i,j} = frac{i} * frac{j};
SIMInuA{i,j} = frac{i} * frac{i};
SIMInuB{i,j} = frac{j} * frac{j};
dist{i,j} = (frac{i} - frac{j}) * (frac{i} - frac{j));
end;
end;
run;

```

```

proc means noprint data=temp3;
var fmin1-fmin1980 ps1-ps1980 d1-d1980 na1-na1980 nb1-nb1980 dis1-dis1980;
output out=minout sum=fmin1-fmin1980 ps1-ps1980 d1-d1980
na1-na1980 nb1-nb1980 dis1-dis1980;
run;

```

```

data temp4 (keep =basket i j Renkonen ComplmtR Wittaker SIMI
ComplmtS Distance); set minout;
array fmin{44,45} fmin1-fmin1980;
array psimilar{44,45} ps1-ps1980;
array SIMIden{44,45} d1-d1980;
array SIMInuA{44,45} na1-na1980;
array SIMInuB{44,45} nb1-nb1980;
array dist{44,45} dis1-dis1980;

```

```

do i=1 to 44;
ind = i + 1;
do j=ind to 45;
basket = i;
Renkonen = fmin{i,j};
ComplmtR = 1 - Renkonen;
Wittaker = 1 - 1/2 * psimilar{i,j};
SIMI = SIMIden{i,j}/ SQRT(SIMInuA{i,j} * SIMInuB{i,j});
ComplmtS = 1 - SIMI;
Distance = dist{i,j};
output;
end;
end;
proc print data= temp4;
run;

```

2. Program to Calculate Bray-Curtis Index (1957), Canberra Metric (Lance and Williams, 1967), Collection and Percent Dissimilarity (1981).

```

options pagesize=56;
data temp1;
infile 'datarev.prn';
input b1-b45;
run;
proc means noprint data=temp1;
var b1-b45;
output out=sumbout sum=bsum1-bsum45;

data temp2 (keep = b1-b45 bsum1-bsum45 bray1-bray1980 ag1-ag1980
narr1-narr1980 p1-p1980 a1-a1980 c1-c1980);
if _n_ = 1 then set sumbout; set temp1;
array NN{45} b1-b45;
array agree{44,45} ag1-ag1980;
array absolu{44,45} a1-a1980;
array combine{44,45} c1-c1980;
array bray{44,45} bray1-bray1980;
array NP{44,45} narr1-narr1980;
array Nsum{45} bsum1-bsum45;
array abso{44,45} ab1-ab1980;
array Part1{44,45} para1-para1980;
array Part2{44,45} parb1-parb1980;
array CD{44,45} p1-p1980;

do i=1 to 44;
ind = i + 1;
do j=ind to 45;
agree{i,j} = 0;
if ((NN{i} GT 0) or (NN{j} GT 0)) then
agree{i,j} = 1;
absolu{i,j} = ABS(NN{i} - NN{j});
combine{i,j} = NN{i} + NN{j};
if combine{i,j} NE 0 then
bray{i,j} = absolu{i,j} / combine{i,j};

NP{i,j} = NN{j} * Nsum{i}/Nsum{j};
abso{i,j} = ABS(NN{i} - NP{i,j});
if (NN{i} + NP{i,j}) NE 0 then
Part1{i,j} = abso{i,j} / (NN{i} + NP{i,j});
Part2{i,j} = abso{i,j}/Nsum{i};
CD{i,j} = Part1{i,j} + Part2{i,j};
end;
end;

proc means noprint data=temp2;
var bray1-bray1980 ag1-ag1980 p1-p1980 a1-a1980 c1-c1980;

```

```

output out=sumout sum=sb1-sb1980 sa1-sa1980 sp1-sp1980 sab1-sab1980 sc1-sc1980;

data temp3 (keep = basket i j agree Bray Braycurt Canberra CD PD); set
sumout;
array sumbray{44,45} sb1-sb1980;
array sumagree{44,45} sa1-sa1980;
array sumCD{44,45} sp1-sp1980;
array sumabso{44,45} sab1-sab1980;
array sumcom{44,45} sc1-sc1980;

do i=1 to 44;
ind = i + 1;
do j=ind to 45;
basket = i;
Bray = sumabso{i,j}/sumcom{i,j};
Braycurt = sumbray{i,j};
agree = sumagree{i,j};
if agree NE 0 then
Canberra = 1/agree * braycurt;
CD = 1/agree * sumCD{i,j};
PD = CD / (1 + 2/agree);
output;
end;
end;
proc print data=temp3;
run;

```

3. Program to Calculate Morisita Similarity Index (1959) and Simplified Morisita Index (Horn, 1966).

```

options pagesize=56;
data temp1;
infile 'datarev.prn';
input b1-b45;
run;

```

```

data temp2 (keep = p1-p1980 la1-la1980 lb1-lb1980 lsa1-lsa1980
lsb1-lsb1980); set temp1;
array raw{45} b1-b45;
array prod{44,45} p1-p1980;
array lamdaA{44,45} la1-la1980;
array lamdaB{44,45} lb1-lb1980;
array lamdaSA{44,45} lsa1-lsa1980;
array lamdaSB{44,45} lsb1-lsb1980;
do i=1 to 44;
ind = i + 1;
do j=ind to 45;
prod{i,j} = raw{i} * raw{j};
lamdaA{i,j} = raw{i} * (raw{i} - 1);
lamdaB{i,j} = raw{j} * (raw{j} - 1);
lamdaSA{i,j} = raw{i} * raw{i};
lamdaSB{i,j} = raw{j} * raw{j};
end;
end;
run;

```

```

proc means noprint data=temp2;
var p1-p1980 la1-la1980 lb1-lb1980 lsa1-lsa1980 lsb1-lsb1980;
output out=sumout sum = sp1-sp1980 sla1-sla1980 slb1-slb1980
slsa1-slsa1980 slsb1-slsb1980;

```

```

proc means noprint data=temp1;
var b1-b45;
output out=sumb sum=sb1-sb45;

```

```

data temp4 (keep =basket i j Morisita Horn ComplmtH);
if _n_ = 1 then set sumb; set sumout;
array slamdaA{44,45} sla1-sla1980;
array slamdaB{44,45} slb1-slb1980;
array sprod{44,45} sp1-sp1980;
array slamdaSA{44,45} slsa1-slsa1980;
array slamdaSB{44,45} slsb1-slsb1980;
array sb{45} sb1-sb45;
do i=1 to 44;
ind = i + 1;
do j=ind to 45;

```



```

basket = i;
lamdaA = slamdaA{i,j};
lamdaB = slamdaB{i,j};
prod = spro{d}{i,j};
lamdaSA = slamdaSA{i,j};
lamdaSB = slamdaSB{i,j};
if ((sb{i} * (sb{i} - 1)) NE 0) then
flamdaA = lamdaA / (sb{i} * (sb{i} - 1));
if ((sb{j} * (sb{j} - 1)) NE 0) then
flamdaB = lamdaB / (sb{j} * (sb{j} - 1));
flamdaSA = lamdaSA / (sb{i} * sb{i});
flamdaSB = lamdaSB / (sb{j} * sb{j});
if (((flamdaA + flamdaB) NE 0) and (sb{i} NE 0) and (sb{j} NE 0)) then
Morisita = 2 * prod / ((flamdaA + flamdaB) * sb{i} * sb{j});
if (((flamdaSA + flamdaSB) NE 0) and (sb{i} NE 0) and (sb{j} NE 0)) then
Horn = 2 * prod / ((flamdaSA + flamdaSB) * sb{i} * sb{j});
ComplmtH = 1 - Horn;
output;
end;
end;

proc print data=temp4;
run;

```

4. Program to Calculate Squared Euclidean Distance (Sokal, 1961), Pinkham-Pearson Index B, and Pinkham-Pearson Index  $B_2$  (1976)

```

options pagesize=56;
data temp1;
infile 'datarev.prn';
input b1-b45;
run;

proc means noprint data=temp1;
var b1-b45;
output out=sumbout sum=sb1-sb45;

data temp2 (keep = div1-div1980 a1-a1980 dis1-dis1980
fac1-fac1980);
if _n_ = 1 then set sumbout; set temp1;
array raw{45} b1-b45;
array total{45} sb1-sb45;
array div{44,45} div1-div1980;
array fmax{44,45} fmax1-fmax1980;
array fmin{44,45} fmin1-fmin1980;
array agree{44,45} a1-a1980;
array dist{44,45} dis1-dis1980;
array factor{44,45} fac1-fac1980;
do i=1 to 44;
ind = i + 1;
do j=ind to 45;
fmax{i,j} = MAX(raw{i},raw{j});
fmin{i,j} = MIN(raw{i},raw{j});
agree{i,j} =0;
if (raw{i} NE 0) or (raw{j} NE 0) then
agree{i,j} =1;
if fmax{i,j} NE 0 then
div{i,j} = fmin{i,j} / fmax{i,j};
dist{i,j} = (raw{i} - raw{j}) * (raw{i} - raw{j});
factor{i,j} = ((raw{i}/total{i}) * (raw{j}/total{j}))/2;
end;
end;

proc means noprint data=temp2;
var div1-div1980 a1-a1980 dis1-dis1980 fac1-fac1980;
output out=sumout sum=sd1-sd1980 sa1-sa1980 sdis1-sdis1980
sfac1-sfac1980;

data temp3 (keep = basket i j div agree Pinkham1 Complmt1
Pinkham2 Clifford); set
sumout;
array sumdiv{44,45} sd1-sd1980;
array sumagree{44,45} sa1-sa1980;

```

```

array sumdist{44,45} sdis1-sdis1980;
array sumfac{44,45} sfac1-sfac1980;
do i=1 to 44;
  ind = i + 1;
  do j=ind to 45;
    div = sumdiv{i,j};
    agree = sumagree{i,j};
    distance = sumdist{i,j};
    factor = sumfac{i,j};
    basket=i;
    if agree NE 0 then
      Pinkham1 = 1/agree * div;
      Complmt1 = 1 - Pinkham1;
      Pinkham2 = Pinkham1 * factor;
      Clifford = SQRT(distance);
    output;
  end;
end;

proc print data=temp3;
run;

```

5. Program to Calculate the Average Chi-Square (Parrish and Wagner, 1983).

```

options pagesize=56;
data temp1;
infile 'datarev.prn';
input b1-b45;
run;

```

```

data temp2 (keep = f1-f1980 s1-s1980); set temp1;
array raw {45} b1-b45;
array average {44,45} a1-a1980;
array final {44,45} f1-f1980;
array sumboth {44,45} s1-s1980;

```

```

do i=1 to 44;
ind = i + 1;
do j=ind to 45;
average {i,j} = MEAN(raw {i},raw {j});
if (average {i,j} NE 0) then
final {i,j} = ((raw {i} - average {i,j}) * (raw {i} - average {i,j}))/average {i,j};
sumboth {i,j} = raw {i} + raw {j};
end;
end;

```

```

proc means noprint data=temp2;
var f1-f1980 s1-s1980;
output out=sumout sum=sf1-sf1980 sb1-sb1980;

```

```

data temp3 (keep = basket i j sumfina sumboth Parrish ComplmtP); set sumout;
array sumf {44,45} sf1-sf1980;
array sboth {44,45} sb1-sb1980;
do i=1 to 44;
ind = i + 1;
do j = ind to 45;
basket = i;
sumfina = sumf {i,j};
sumboth = sboth {i,j};
if (sumboth NE 0) then
Parrish = (2 / sumboth) * sumfina;
ComplmtP = 1 - Parrish;
output;
end;
end;

```

```

proc print data=temp3;
run;

```

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