[1]MODULE 5: SPATIAL VARIATIONS IN MACROINVERTEBRATE ASSEMBLAGES AMONG DIFFERENT CHANNEL UNITS

Introduction

This module is the continuation of Module 4. Here we will determine the numbers of organisms in each taxonomic unit, the % of individuals of the total number of individuals in each taxonomic unit and the number of "morphospecies" (groups of individual organisms that are morphologically similar) in each taxonomic unit. We will also determine the % of each functional feeding group. We will combine data from the whole class for analyses for your report.

Exercise 1: Relative abundance of different taxonomic groups and number of "species"

In this exercise we will study how the relative abundance of different taxonomic groups and the number of morphospecies in each taxonomic group vary among the channel units. For this exercise we will further identify the organisms using the keys provided in Module 4.

I suggest the following process:

1. For each sample, count and identify the organisms in each sample vial into the categories indicated in bold on Table 1. Record the numbers of each bold taxonomic category on Data Table 1. Calculate the total number of organisms in each sample (this should be somewhere around 200 individuals) and the relative proportion of each taxonomic grouping (based on number of individuals) and record this information on Data Table 1. In this case only the lowest taxonomic grouping in major group needs to be totaled.

2. As you are counting, divide the specimens into "morphospecies" in each taxonomic grouping. For this exercise, a morphospecies will be individuals that look alike. Record the number of morphospecies for each taxonomic grouping on Data Table 1. **Keep the morphospecies in separate vials as these morphospecies will be used in Exercise 4.**

3. Each student should collect the data from the rest of the class and record on Master Data Tables 1 and 2. In Master Data Table 1 be sure to indicate the total number of organisms in each sample in the last row of the table. By the end of the process you should have the

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compiled data for all the samples in the class (12).

Exercise 2: Differences in functional-feeding group composition among the different channel units

In lecture we have begun to talk about the division of macroinvertebrates assemblages into guilds, or functional-feeding groups, which are based on the food consumed, morphological adaptations for feeding and the habitat where feeding occurs. These guilds are used because most macroinvertbrates in streams are omnivores, so the classical trophic designation does not provide much information to classify macroinvertebrate assemblages by feeding characteristics. In macroinvertebrates the major functional-feeding group classifications are shredders, filtering collectors, gathering collectors, scrapers and predators (Table 1). Previous research has shown that relative abundances of organisms in the functional-feeding group classifications also vary among channel units (why?). Thus, in this part of the lab we will determine the relative proportion of each functional-feeding group of the total number of individuals in each sample. Please note that functional-feeding group designations do not necessarily follow the taxonomic designations.

Use Cummins and Wilzbach (1985, provided in class) to classify each "morphospecies" into one of the five functional feeding groups. Record the number of individuals of each morphospecies in the appropriate column and total number of individuals in each functional feeding group in Data Table 2. After you have classified all of the species into a functional-feeding group, total the number of individuals in each functional feeding group and determine its proportion of the entire sample. If you have trouble with this classification please ask me about it. As a check remember that the total number of individuals in the sample should be the same in Data Tables 1 and 2. Collect the data from the rest of the class and record in Master Data Table 3. This exercise has been modified from Merritt and Cummins (1996).

Assignment: Your Report

For your report, you will need to gather all the data from the samples taken in your class from the different channel units. Before you write the report, you should have complete macroinvertebrate data (Master Data Tables 1, 2 and 3) and physicochemical data from Rocky Creek riffle and pool and the planebed channel unit of Bear Creek (which you have already summarized for a previous module). Use graphical techniques to explore the data and investigate potentially interesting comparisons. Use the information in Module 3: Data Analysis to determine means for the relative abundance of individuals in different taxonomic units and in functional feeding groups, number of species, total number of individuals in each channel unit etc. You will want to calculate means and standard errors and do some statistical tests on these data. Below is the information needed to construct the report.

Writing assignment for Stream Ecology

The writing assignment, or report, for stream ecology will synthesize the data we collected on the physical features and biotic assemblages of the three stream channel units. This exercise should be approached as if you we preparing the data for publication, thus, the format will be one that is required to submit a paper. Grading will be done on that basis (see attached rating sheet). You should use the papers that we have read in class to give you some idea of the style. Our goal is to unite the laboratory modules. Your hypothesis (-ses) should be related to the influence of physicochemical features on the biota and the objectives are 1) to describe the physicochemical conditions in the channel units, 2) to describe the biological assemblages in the channel units and 3) to use the physicochemical conditions to explain why the biological assemblages vary in the manner detected. You should restate the hypothesis and objectives to make them more specific and may modify them for your paper (e.g., change the focus somewhat). Each student should write his or her own paper, although you will share data.

The paper should be typed, doubled spaced and be less than 10 pages long (exclusive of figures and tables). The format of the report should be as follows:

Abstract: A one paragraph description of your paper. The abstract should include a sentence or two giving the reason that the research was conducted, a brief description of how the research was done, a brief description of important results and a sentence or two listing major conclusions.

Introduction: The introduction should state the problem (i.e., the hypotheses or research questions) and the specific objectives of the study. The hypotheses should be related to broader concepts in stream ecology and the objectives are the specific questions addressed in your study. Both must be clearly written. If you modify the objectives state the newer version. The objectives can be stated in the form of questions. This portion of the paper should indicate why the research is important (i.e., what is the major research question) and lead the reader to the specific objectives of the study. Thus, it will be supported by literature citations that suggest the reason for the study. You can use your text book and some of the papers we have read in class as citations and as an introduction to other primary literature. However, you must find at least 5 other references from the primary, peer-reviewed literature that deal directly with your topic.

Methods: In this section you describe your methods in enough detail that others, if they wish, could repeat your study. You must be concise, but you must not omit essential detail. Write out trade names of materials. Include descriptions of the study sites. This can be done in words, a Figure or a combination. Include only those details that are relevant to your study.

Results: Present your results in this section. This includes data that answer the objectives, not a discussion of why the results occur (this goes in the discussion section). The results section has text which refer to the data. Data can be presented in the text itself if they are small bits, but larger amounts of data are usually presented in Tables or Figures which are referred to in the text. Table and Figures should be numbered separately and appear in numbered order at the end of the document. **Data should be summarized somehow (e.g., means and standard errors) and should not appear as "raw" data tables.** Data should also only appear once in the paper. For example, if you have a Table with the physical features summarized, do not present these data in a Figure. Choose one or the other way to present your data. Journals typically ask that Tables and Figures be clear without reference to the text (i.e., they stand alone and can be understood without reference to the text). Using standard scientific units (meters not feet, liters not gallons).

Discussion: The discussion should contain a logical argument about what your results "mean" and how they relate to the larger hypotheses posed in the introduction. **It should not be a repetition of the results**. It should enlarge on the significance of your results and explain how they add to the existing knowledge. Did you answer your questions or meet your stated objectives? Why or why not? Answering these questions will facilitate discussion. Do not dwell on the negative. The discussion should not include as its **major focus** the reasons why things did not work. If flaws in the work exist (which they do in almost all studies) these can be mentioned, but not as the major focus.

References or Literature Cited: The references listed at the end of the paper should be only those that are cited in the text. Follow the reference conventions of one of the papers that we read in class. Different journals have different formats for references and the main thing in your paper is to be consistent. You should have 5 to 10 references to the primary literature.

The following are some general hints to make the paper writing go easier. Do not write this paper the night before it is due. Real scientific papers are never written this way. They require thought, writing, editing and re-editing. Ask a friend to read your paper and tell you where it makes sense and where it does not. If you do not want to have a friend read it, read it aloud to yourself, you can often "hear" errors in language this way. Write in active voice. Do not use passive voice. Active voice is much easier to read than passive voice. For example, "We collected macroinvertebrate samples from three channel unit types....." is much easier to read than "Macroinvertebrate samples were collected from three channel unit types..." Science writing for ecology and related fields is typically active voice. Keep sentences simple. Define all terms that your readers might not understand. You can assume that the people reading your paper are stream ecologists familiar with many common terms. Follow rules of grammar. Spell check your paper. I have a little book called "Communicating in Science" by Vernon Booth, which you may borrow if you have any questions.

Please turn in your worksheets from the laboratories with your report. [These are not included with the report.]

The following is the grading sheet that I will use for the report. Please look at it carefully.

Grading cover sheet for paper

	A	B	C	D/F
1.	The paper fits format specifications.	The paper fits almost all format specifications, deviations are minor.	The paper fits most of the specifications.	The paper ignores the specifications.
2.	The abstract conveys the essence of the paper.	The abstract conveys most important material.	The abstract is confusing, focuses on unimportant details.	The abstract is missing; or lacks connections with the paper.
3.	The hypotheses and objectives are clearly stated in the introduction.	The hypotheses and objectives are included but one is not clearly stated.	Both hypotheses and objectives are included But neither are clearly stated.	No hypotheses and objectives.
4.	The methods are clearly described. clearly test hypotheses and meet objectives.	The methods are described, but a few confusing areas; seem to test hypotheses and meet objectives.	The methods are described, but confusing. Not clear whether hypotheses are tested and objectives met.	The description of the methods is inadequate. Hypotheses not tested, objectives not met.
5.	Data are well presented and clearly related to objectives. Figures and tables well done. Data analyses adequate.	Data are generally well presented, some flaws occur, but appear to meet objectives	Data are presented, but some missing pieces. Data presentation messy, but seems to relate to objectives.	Data not presented well; much missing data; do not relate to objectives.
6.	Ideas are logically organized throughout the paper.	There are some small defects in the logical order of ideas, but these defects do not interfere with understanding the paper.	Some parts of the paper lack logical order.	Ideas are not logically and are confusingly presented or presented in insufficient detail to be evaluated.
7.	Terms are clearly defined and the paper is easy to read.	The writing is fairly clear.	The writing is sometimes confusing, but it is generally possible to understand what you intend to communicate. Writing is wordy.	Terms and ideas are not explained; the writing is unclear. It is not possible to understand what you intend to communicate.
8.	No technical errors.	One to three technical errors.	Four to five technical errors.	More than five technical errors; very sloppy.
9.	The literature cited section follows an appropriate format; the citations in the text correspond perfectly with the citations in the literature cited section; correct number of citations and number of peer reviewed citations.	Only a few errors in format of the literature cited section; the citations in the text correspond very well with the citations in the literature cited section; correct number of citations; however, < 5 peer reviewed, citations (not including those read in class).	Only a few errors in format of the literature citations and in correspondence between the text and the literature cited section; fewer citations than requested and < 5 peer peer reviewed, citations (not including those read in class)	Literature citations do not follow an appropriate format; little correspondence between the citations in the text and and the literature cited section; too few and inappropriate citations.

Literature Cited

Cummins, R.W. and M.A. Wilzbach. 1985. Field procedures for analysis of functional feeding groups of stream macroinvertebrates. Pymatuning Laboratory of Ecology, University of Pittsburgh.

Merritt, R.W. and K.W. Cummins 1996. Trophic relations of macroinvertebrates. Pp. 453 - 474, in "Methods in Stream Ecology" , Hauer, F.R. and Lamberti, G.A. (Eds), Academic Press, N.Y.

Table 1. Functional Feeding Groups

1. **Shredders**--eat CPOM (Coarse particulate organic material) usually after it is dead, typically chewing mouthparts

2. **Filtering collectors**--filter FPOM (Fine particulate organic material) from water column, typically have morphology modified for filtering (e.g., simulids [blackflies]) or construct filtering devices (e.g., hydropyschid caddisflies)

3. **Gathering collectors**--remove FPOM from surface of sediment, mouthparts often have brushes etc. to aid in collection of fine particles

4. **Scrapers** (also called grazers or grazer-scrapers)--eat periphyton and associated materials, often have mouthparts that can scrape, or loosen tightly attached algae

5. **Predators**--eat other animals, many have adaptations to help catch prey (e.g., mouthparts of dragonflies extend to capture); usually reserved for those organisms that are predominantly predatory as many invertebrates will eat other animals when they are easy to catch etc.

6. Other (parasites, unknown)

Data Table 1

SITE: YOUR NAME:
DATE:
CHANNEL UNIT: SAMPLE NUMBER:

TAXON	Number of Organisms	% of Individuals of Total	Number of "Morphospecies'
Phylum Porifera			
Phylum Cnidaria			
Phylum Platyhelminthes			
Phylum Nematoda			
Phylum Mollusca			
Class Gastropoda			
Class Bivalvia			
Phylum Annelida			
Class Oligochaeta			
Class Hirudinea			
Phylum Arthropoda			
Subphylum Chelicerata			
Subphylum Crustacea			
Subphylum Uniramia			
Class Insecta			
Order Collembola			
Order Ephemeroptera			
Order Plecoptera			
Order Trichoptera			
Order Odonata			
Order Hemiptera			
Order Coleoptera			
Order Lepidoptera			

Order Megaloptera			
Order Diptera			
Other (Unknown)			
Total Number of Organisms or Morphospecies		**100%**	

Data Table 2

Site: Your Name:

Date:

Channel Unit: Sample Number:

	Tally numbers of individuals of all species categorized in each functional-feeding group	**Total Number of individuals in each functional-feeding category**	**% of each functional-feeding category of the total number of individuals**
Shredders			
Filtering collectors			
Gathering collectors			
Scrapers			
Predators			
Other (unknown)			
Total (total of 2nd data column should be the same as that of Data Table 1)			100%

Master Data Table 1:Taxonomic Composition

Site/Channel Units	Rocky Creek Riffle				Rocky Creek Pool				Bear Creek			
Sample Number												
Percent Composition	%	%	%	%	%	%	%	%	%	%	%	%
Phylum Porifera												
Phylum Cnidaria												
Phylum Platyhelminthes												
Phylum Nematoda												
Phylum Mollusca												
Class Gastropoda												
Class Bivalvia												
Phylum Annelida												
Class Oligochaeta												
Class Hirudinea												
Phylum Arthropoda												
Subphylum Chelicerata												
Subphylum Crustacea												
Subphylum Uniramia												
Class Insecta												
Order Collembola												

Order Ephemeroptera												
Order Plecoptera												
Order Trichoptera												
Order Odonata												
Order Hemiptera												
Order Coleoptera												
Order Lepidoptera												
Order Megaloptera												
Order Diptera												
Other (Unknown)												
Total %	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Total Number of Organisms												

Master Data Table 2:Number of Morphospecies

Site/Channel Units	Rocky Creek Riffle				Rocky Creek Pool				Bear Creek			
Sample Number												
Number of Morphospecies	#	#	#	#	#	#	#	#	#	#	#	#
Phylum Porifera												
Phylum Cnidaria												
Phylum Platyhelminthes												
Phylum Nematoda												
Phylum Mollusca												
Class Gastropoda												
Class Bivalvia												
Phylum Annelida												
Class Oligochaeta												
Class Hirudinea												
Phylum Arthropoda												
Subphylum Chelicerata												
Subphylum Crustacea												
Subphylum Uniramia												
Class Insecta												
Order Collembola												

Order Ephemeroptera												
Order Plecoptera												
Order Trichoptera												
Order Odonata												
Order Hemiptera												
Order Coleoptera												
Order Lepidoptera												
Order Megaloptera												
Order Diptera												
Other (Unknown)												
Total Number of Morphospecies												

Master Data Table 3: Percent Composition by Functional Feeding Group

Site/Channel Unit	Rocky Creek Riffle				Rocky Creek Pool				Bear Creek			
Sample Number												
Percent Composition by Functional Feeding Group	%	%	%	%	%	%	%	%	%	%	%	%
Shredders												
Filtering collectors												
Gathering collectors												
Scrapers												
Predators												
Other (unknown)												
Total Percent	100	100	100	100	100	100	100	100	100	100	100	100