ESM 221 Applied Environmental Studies
Homework Assignment 3

This assignment must be typed and the document must be organized so that answers are easy to find and read (provide numbers please).

For this assignment, you will use the module_2_data_set_pt_1. This dataset consists of abundance for diatom species found on the rocks of 2 streams in New Zealand. These data were taken from a study of 12 New Zealand streams that used diatom abundance, richness, and diversity to measure the difference between streams in forested watersheds and streams in watersheds with moderate livestock grazing on grasslands. Two of the 12 streams were chosen for this homework assignment: Rough and Kyeburn, which have reported water chemistry (Table 1).

For streams, phosphorus is often measured as SRP (Soluble reactive phosphorus), so SRP on the table means phosphorus concentration. Also, conductivity is a measure of salts and ions and chlorophyll a is a measure of the total algae in the system (diatoms are just one type of algae). For this assignment, you will need to download the dataset and use Table 1.

**Table 1. Water chemistry parameters for two streams in New Zealand**

| | Stream 1: Rough | Stream 2: Kyeburn |
|---|---|---|
| Temperature ( $^{0}C$) | 6.8 | 7.6 |
| Nitrate ($mg/m^3$) | 19.2 | 4.0 |
| SRP ($mg/m^3$) | 1.6 | 1.8 |
| Conductivity (µSiemens/cm) | 45 | 53 |
| Chlorophyll a ($mg/m^2$) | 3.1 | 9.6 |

1. Just by looking at the data table above, which stream do you think is in a forested watershed and which one is in a watershed with livestock grazing. Explain your answer by discussing each variable from the table and why you think it indicates a specific watershed type.

It's not clear which is which. Your statement should point out some inconsistencies.

In a watershed with grazing, you would expect the streams to be more affected by nutrients and runoff. Depending upon the extent of the grazing, the geology of the watershed, and the characteristics of the stream, the extent of the effects can vary. The general theory is that all of the parameters listed in the table are expected to increase in a watershed with moderate to extensive increases in grazing. All of the parameters except nitrate are lower in Rough, so it is logical to conclude that Rough is forested. However, Rough has such elevated nitrate levels that it could be that grazing is low to moderate with trees along the riparian corridor and so nitrate is the only parameter that shows an effect. Based upon these data, you could answer either way, but you would need to support your answer with one of the above arguments. In fact the Rough is in a podocarp/beech forest, I'm guessing the catchment has high nitrogen soils, possibly from volcanic input. Also, the level of grazing is fairly low around the Kyeburn so its levels are not particularly high, especially for nitrate. I wanted you to think before finding out more because that's what you should always do when you have data – what are your expectations? Now find out the answer and don't let you're a priori expectations color how you interpret the data. Also, I think this is a good lesson. We know nitrate is typically higher when there's farming or grazing; however, many

factors affect these variables and so we can find forested watersheds with higher nitrates than grazed ones.

2. Using the diatom data from the data set, calculate species richness for each stream.

This is a simple count of the number of species. The richness of diatom species for each stream is 15, which therefore doesn't indicate much about either stream.

3. Just by looking at the species abundance, explain similarities and difference you see between the diatom species of these two streams.

Your answers to this question will vary widely but should include qualitative differences and similarities based upon abundance (no calculations). E.g.,
The streams generally overlap in species composition, with 14 of 16 species in common, each just having one species the other lacks. However, in general the species abundances vary greatly across the streams. Only about three species have similar relative abundances across the streams, and these all have low abundance (*E. minutum, G. subclavatum, and N. palea*). Species are generally more abundant in the Kyeburn and its most abundant species (*E. sorex, E. zebra, G. minuta,* and *S. ulna*) are rare to absent in the Rough; in contrast the Rough's most abundant species (*G. clevei, G. tenellum, R. linearis, D. hiemale*, and *E. minutissimum*) have moderate abundances in the Kyeburn, except for *E. minutissimum*, which is uncommon there.

4. Without doing any calculations for diversity, which stream would you expect to have the higher Shannon diversity index score? Explain why you think that.

As long as you have carefully looked at the data then made a prediction (one over the other) and a reason why you think it will be different, then you answer should be okay. My answer:
Neither stream has just one or two strongly dominant species with all the others rare and they both have a good number of species (15) so, they should both have fairy high diversity. I expect that the Kyeburn will have slightly higher diversity though because the Rough has one species with over $1/5^{th}$ of the overall abundance and it has four species with just one representative and another with just 2 whereas the Kyeburn doesn't have any species quite as rare or common.

5. Using the spreadsheet, calculate the Shannon diversity index (just as you did in lab) for each of these two streams. Show your calculated values, and describe what each value indicates about each stream. Also, describe if your prediction of which stream would have a higher/lower value was correct (from number 4).

   Diatom papers typically use Shannon's index because the rare species may be important to the overall signal and community, and numbers of diatoms are typically high. Below I just report Shannon's using log, but check out my spreadsheet if you'd like to see this calculated other ways: On my spreadsheet (also posted) I also show the calculation using ln instead of log and the calculation for the alternative formula $-\Sigma p_i * \log(p_i)$ (you may encounter that formula as well and on my spreadsheet you can see that it gives the same exact value; if you use ln instead of log, you'll get different values but if you convert it to S', # of equally abundant species that would yield this Shannon index, you'll see the S' values are identical no matter how you get there).

   Both streams are fairly diverse but Kyeburn has a higher diversity number, most likely due to the fact that most species that are present are highly abundant. In Rough, several species are present with a value of 1 or 2 (rare species), and about 2/3 the species have a value under 10. In Kyeburn,

no species present has a value below 5, and only 3 species have a value below 10. These are important comparisons to make.

Log base e answers are 2.17 and 2.53

| **CountRough** | **CountKyeburn** | ni*log(ni)Rough | ni*log(ni)Kye |
|---|---|---|---|
| 28.0 | 5.0 | 40.520 | 3.495 |
| ***1.0*** | 14.0 | 0.000 | 16.046 |
| 5.0 | 18.0 | 3.495 | 22.595 |
| 28.0 | 19.0 | 40.520 | 24.296 |
| 7.0 | 14.0 | 5.916 | 16.046 |
| ***1.0*** | 32.0 | 0.000 | 48.165 |
| **0.0** | 34.0 | | 52.070 |
| 3.0 | 62.0 | 1.431 | 111.128 |
| 46.0 | 23.0 | 76.487 | 31.320 |
| ***1.0*** | **0.0** | 0.000 | |
| 19.0 | 25.0 | 24.296 | 34.949 |
| 39.0 | 22.0 | 62.052 | 29.533 |
| ***1.0*** | 8.0 | 0.000 | 7.225 |
| 2.0 | 5.0 | 0.602 | 3.495 |
| 29.0 | 20.0 | 42.410 | 26.021 |
| 9.0 | 33.0 | 8.588 | 50.111 |
| Total # individuals | | sum(ni*logni)R | sum(ni*logni)K |
| **219.0** | **334.0** | **306.317** | **476.494** |
| N(log(N)):R | N(log(N)):K | | |
| **512.5572611** | **842.9313199** | | |
| | | H'Rough | H'Kyeburn |
| | | **0.942** | **1.097** |
| | | S' Rough | S' Kyeburn |
| | | **8.745** | **12.506** |

6. List the five most abundant diatom Genus and species (with abundance number) for Rough.

| Genus | Species | Abundance |
|---|---|---|
| Gomphonema | clevei | 46 |
| Gompnonema | tenellum | 39 |
| Rossithidium | linearis | 29 |
| Diatoma | hiemale | 28 |
| Achnanthidium | minutissimum | 28 |

7. List the five most abundant diatom Genus and species (with abundance number) for Kyeburn.

| Genus | Species | Abundance |
|---|---|---|
| *Gomphoneis* | *minuta* | 62 |
| *Epithemia* | *zebra* | 34 |
| *Synedra* | *ulna* | 33 |
| *Epithemia* | *sorex* | 32 |
| *Gomphonema* | *subclavatum* | 25 |

8. Describe the similarities and differences between the two lists in questions 6 and 7.

Similarities:

- About same average abundance

for each stream abundances of the five most common species are all above 25 and that total abundance for each stream's top five is relatively close (170 for Rough and 186 for Kyeburn). If you took an average abundance for the top 5 species, it would be 34 for Rough and 37.5 for Kyeburn – this is pretty similar.

Differences:

- None of the top 5 species are the same in both streams and only one shared genus
- Rough has a more even distribution and Kyeburn has one species that's almost 2x as common as the next level
-

There are no similar species between these two streams, largely reflecting the different abiotic conditions of the streams. Second, even though the averages are similar, the values in Rough are closer to the mean and spread more evenly. The values in Kyeburn are all below the average except for the most abundant species (*G. minuta*). This is an important difference because it indicates that there is more consistency in the species of Rough and that one highly abundant species (almost 1/3 higher than the most abundant species on Rough) is dominating the Diatom assemblage of the Kyeburn. So, Kyeburn's top 5 has the most abundant species and the least abundant species of these 10 species.

9. Based upon you answers to question 8, do you think these streams are similar based on diatom composition? Describe your reasoning.

While the streams vary in which species are most abundant, the species abundant in one stream are typically found in the other stream, just in lower abundance. So, one would expect an intermediate amount of community similarity between the streams.