BES 316 2010

**VEGETATION DATA ANALYSIS**

Goals for Today

1. To learn about and practice data analysis approaches for the vegetation data collected last week
2. To learn appropriate design of visual materials for representing data in an oral presentation

***SCHEDULE for APRIL 13, 2010***

|  |  |
| --- | --- |
| **Time Period** | **Activity** |
| 11:00 – 11:30 | Ecological concepts exercise presentations (if needed) |
| 11:30 – 1:05 | Lecture: Community ecology & data analysis  |

**DOMINANCE & DIVERSITY IN PLANT COMMUNITIES**

Species diversity is an important characteristic of biological communities. There is evidence that ecosystem stability and resilience in the face of disturbance are related to community diversity. In ecological science, diversity is considered to have two important components: (1) richness and (2) evenness. Richness is simply defined as the number of species in a community. For our measurements, eveness is the degree to which % cover is distributed equally among all of the species present in a plant community. If there are 5 species, each with exactly 12% cover, that community is **highly even**. Alternatively, if four species had 12% cover and the fifth species had 45% cover, the community would be considered **less even** than the first example. A community that is less even is considered to have **high dominance** (dominance is the inverse of evenness). There are a variety of indices used to express the degree of dominance (or eveness) in a community. We will be using Simpson’s index of dominance (C), a common one in plant ecology. There are also a variety of indices used to express diversity. These indices all combine data on richness and dominance (eveness). We will use the Shannon-Wiener diversity index (H’) to express diversity within our communities. This index is probably the most widely used calculation to express diversity in ecological communities, though there are many alternative formulations used to calculate diversity. There are also different spatial levels of diversity that can be examined. The diversity of species within a community (what we are examining) is called α-diversity. Ecologists also consider the diversity of communities on a larger landscape, called γ-diversity. Finally, the rate of change of communities over a landscape in space is another factor often examined and this is termed β-diversity. See the electronic reserve readings and the texts they were taken from for more detail on many of these topics.

**VEGETATION ANALYSIS CALCULATIONS**

We will examine how to summarize the wetland community vegetation data that the class collected last week in a number of ways: to examine important patterns, and calculating dominance and diversity. You should do the analysis as a group for your group’s data and either as a group or independently for the entire data set (including the other group’s data). If you choose to do a group written report you may do all of the analyses as a group (collaboratively). If you choose to do an independent written report, you must do the data analysis for the other group’s data by yourself.

**I. Transect Data**

**1. Plant Species Cover**

Organize the % cover for all species found into a table like the example below. Calculate the total % cover for each transect. Any species listed in the table must have been found in at least one of the transects. This table will allow you to compare particular species in the two wetland communities sampled as it was detected by transect sampling. What are the dominant species? Are there indicator species present that might give you clues as to the nature of differences in the environments? It is always a good idea to first start with this level of basic analysis BEFORE proceeding onto calculating derived variables such as diversity.

|  |  |  |
| --- | --- | --- |
| **Species** | **Transect 1** | **Transect 2** |
| *Alnus rubra* | 14.0 | 0.0 |
| *Acer macrophyllum* | 12.0 | 12.6 |
| *Cornus canadensis* | 3.2 | 14.3 |
| *Lonicera involucrata* | 6.3 | 0.0 |
| **Total Cover** | **50.5** | **36.9** |

*Note in this example table not all species are listed, so numbers do not add up to total cover*

**2. Growth Form Cover**

You should calculate the cover in the transects by growth form (trees, shrubs, herbs, grasses & sedges). This can be done manually, or more expediently with the “sort” function in Excel.

|  |  |  |
| --- | --- | --- |
| **Growth Form** | **Transect 1** | **Transect 2** |
| Trees | 14.0 | 0.0 |
| Shrubs | 12.0 | 12.6 |
| Herbs | 3.2 | 14.3 |
| Grasses & Sedges | 15.0 | 10.0 |
| **Total Cover** | **50.5** | **36.9** |

*The total cover in each transect should add up to the same as those calculated in the table above*

**3. Species Richness**

Calculate the plant species richness of your data from each transect separately (# species per transect). Be careful not to simply count the number of species listed in a table, as some species may only appear in one of the two transects.

**4. Dominance**

Calculate **Simpson's index of dominance** **(C)** for each transect separately using the cover data. The easiest way to do this is indicated in the spreadsheet example below (see part V). It is just a matter of entering a few formulae and copying those formulae to other cells. This will allow rapid calculations of both Simpson’s index of dominance and the Shannon-Wiener diversity index (in part 5 below).

1. Use the table of % cover by species described in part 1 above
2. In a new column, calculate the fractional representation for each species (pi):

 pi = (% cover of that species) / (total % cover of all species in the transect)

The sum of this column should be 1.00 – otherwise you’ve done something wrong!

1. In the next column, calculate the square value of the proportional representation for each species: (pi)2
2. Calculate the sum of the (pi)2 values at the bottom of the column. This sum value is Simpson’s index of dominance. In other words, Simpson's index (C) for that community is the sum of the square of all pi values for all species in the community:

 C = Σ (pi)2 (Note that Σ indicates the SUM of all values)

The Simpson’s index can theoretically range from zero to one. A higher value indicates a less even community. In practice values below 0.5 indicate a relatively even community, while high values are indicative of communities dominated by one or a few species. Most data collected by BES 316 students from 2001-2004 in our campus wetlands indicated a value of C between 0.15 and 0.5.

**5. Species Diversity**

Calculate the **Shannon-Wiener diversity index (H’)** for each transect using the cover data. There is a spreadsheet example (MS Excel) below (part V).

1. For each species, calculate pi as described above
2. For each species calculate ln (pi). This is the natural logarithm of pi
3. For each species multiply the first two calculations together (pi x ln (pi))
4. The negative sum of all these final values (for each species) gives the Shannon-Weiner diversity index. Note that one of the most common mistakes is to not use the negative sum.

 H’ = - Σ [(pi)(ln pi)] **(Note that this is the NEGATIVE of the sum)**

The Shannon-Wiener index can theoretically range from zero (a community with only one species, which is technically just a “population”) to infinity. In practice though, a value of 7 indicates an extremely rich community while values under 1 suggest a community with low diversity. Often values above 1.7 are taken to indicate a relatively diverse community. Most data collected by BES 316 students from 2001-2004 in our campus wetlands indicated a value of H’ between 1 and 2.

**II. Quadrat Data**

**1. Plant Cover**

For each nested quadrat set:

Combine all of the species (herbaceous and woody) into one data set for the two nested quadrats (the 1 x 1 meter herb quadrat plus the 4 x 4 meter woody plant quadrat).

*This is now considered one quadrat (even though herbs were only sampled from a restricted central area)*

**Quadrat 1**

For the entire class you will have 4 quadrat data sets: two quadrats that you sampled along your transect and the two that your classmates sampled.

Organize the % cover data in a similar general fashion as you did for the transect data. However – and this is a big “however” – you have replicate samples of the vegetation in each community using the quadrat approach. With the transects, you could not use any statistical comparisons between the communities sampled because you only sampled once in each community. With the quadrat data you will have two samples in each community. Thus, you should first begin with a separate analysis table of cover for each community that lists the cover data for each quadrat and calculates the mean and standard deviation (SD) for each species:

***Community # 1***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Species** | **Quadrat 1** | **Quadrat 2** | **Mean** | **SD** |
| *Alnus rubra* | 14.0 | 0.0 | 7.0 |  |
| *Acer macrophyllum* | 12.0 | 12.6 | 12.3 |  |
| *Cornus canadensis* | 3.2 | 14.3 | 8.8 |  |
| *Lonicera involucrata* | 6.3 | 0.0 | 3.2 |  |
| **Total Cover** | **35.5** | **26.9** | **31.2** |  |

After completing the two separate tables (one for each community), combine the mean and SD data into a single table for both communities so you can compare them as you did using the transect data. Note that the list of species will be longer in this table than the two tables above, which only had species from one community. The example below presents the means and SDs in a format similar to a publication. For purposes of the analysis you could palce the means and SDs into separate columns if you prefer. Also beware that the values of total cover mean and standard deviation should be calculated from the two values of total cover produced by the quadrats (do not simply add up the average cover of all of the species and add each individual standard deviation).

|  |  |  |
| --- | --- | --- |
| **Species** | **Community 1** | **Community 2** |
| *Alnus rubra* | 11.3 ± 2.2 | 0.0 ± 0.0 |
| *Acer macrophyllum* | 10.0 ± 2.0 | 18.6 ± 4.2 |
| *Cornus canadensis* | 2.2 ± 0.1 | 0.0 ± 0.0 |
| *Lonicera involucrata* | 6.3 ± 0.7 | 14.0 ± 3.0 |
| **Total Cover** |  |  |

**2. Growth Form Cover**

For each quadrat:

Calculate the total growth form cover for the quadrat as you did for a transect. As you did with the cover data by species, you should create separate tables for each community and then a combined table for both communities with the mean and SD values. Even though a sample size of 2 provides minimal statistical power, you should examine the statistical validity of comparisons that you might wish to highlight. I recommend using a simple t-test for these purposes.

**3. Species Richness**

Calculate the total plant species richness for each quadrat as you did for a transect. Even though a sample size of 2 provides minimal statistical power, you should examine the statistical validity of comparisons that you might wish to highlight. I recommend using a simple t-test for these purposes.

**4. Dominance**

Calculate Simpson’s index of dominance (C) for each quadrat as outlined for the transects. See the example Excel spreadsheet on next page for calculations. Even though a sample size of 2 provides minimal statistical power, you should examine the statistical validity of comparisons that you might wish to highlight. I recommend using a simple t-test for these purposes.

**5. Species Diversity**

Calculate Shannon-Weiner diversity index (H’)for each quadrat as outlined for the transects. See the example Excel spreadsheet on next page for calculations. Even though a sample size of 2 provides minimal statistical power, you should examine the statistical validity of comparisons that you might wish to highlight. I recommend using a simple t-test for these purposes.

**III. Comparing Transect and Quadrat Data**

The two sections above concentrated on analyzing the vegetation data based upon transect sampling separately from those data based upon quadrat sampling. Thus, you should be able to draw some conclusions about the two communities based separately upon each sampling approach. Once you have completed that, you should compare the results and conclusions of the quadrat and sampling approaches. As the transect approach did not have statistical replication, your comparisons can not be supported by statistical inferences, but you should be able to comment (in a less certain way) on patterns you may (or may not) see.

**IV. Data Examination Summary**

Here is a brief list of some of the basic things to be sure and examine in your data (and think about in preparing your oral and written reports):

* Based upon the transect data, how do the communities compare in terms of species richness, diversity, dominance, major species, etc.? Are differences in diversity explained by differences in richness or dominance or both? Given what you can find out about the biology of major species (or indicator species) present in each community, can you draw an inferences about differences in the environment of those two communities?
* Based upon the quadrat data, how do the communities compare in terms of species richness, diversity, dominance, major species, etc.? Are differences in diversity explained by differences in richness or dominance or both? Given what you can find out about the biology of major species (or indicator species) present in each community, can you draw an inferences about differences in the environment of those two communities?
* How do your conclusions (above) compare when examing the two different approaches (quadrat versus transect)?

**V. Dominance & Diversity Indices: Calculation Examples**

**MS Excel Spreadsheet Design for Dominance (C) & Diversity (H') Calculations**

*(Calculations for one transect or one quadrat)*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **A** | **B** | **C** | **D** | **E** | **F** |
| **1** | **Your Data** | **Calculations** |
| **2** |  |  | ***Col 1*** | ***Col 2*** | ***Col 3*** | ***Col 4*** |
| **3** | **Species** | **% Cover** | **pi** | **pi2** | **ln pi** | **pi \* ln pi** |
| **4** | ***R. discolor*** | 20 | 0.25 | 0.064 | -1.37 | -0.348 |
| **5** | ***R. parviflorus*** | 13 | 0.16 | 0.027 | -1.80 | -0.297 |
| **6** | ***S. douglasii*** | 35 | 0.44 | 0.196 | -0.81 | -0.361 |
| **7** | ***A. macrophyllum*** | 8 | 0.10 | 0.010 | -2.29 | -0.232 |
| **8** | ***G. elata*** | 3 | 0.04 | 0.001 | -3.27 | -0.124 |
| **9** | **Totals** | **79** | **1.00** | **0.299** |  | **1.362** |
|  |  |  |  | **C** |  | **H'** |
|  |  |  |  |  |  |  |
|  | **Formulae Used in Excel Spreadsheet** |
| ***(formulae are shown within the square brackets - you do not need to type in the brackets)*** |
| **These formulae are entered for calculating values in row 4** |
| **and then copied down the column for all other species** |
| **Formula for Totals is shown for Col 1 (copied to all other columns)** |
|  |  | ***Col 1*** | [= b4/b$9] *see note below* |  |  |
|  |  | ***Col 2*** | [=C4^2] |  |  |  |
|  |  | ***Col 3*** | [=ln(c4)] |  |  |  |
|  |  | ***Col 4*** | [=c4\*e4] |  |  |  |
|  |  | *Col 1 Total* | [=sum(c4:c8)] |  |  |
|  |  | *Col 2 Total* | [=sum(d4:d8)] |  |  |
|  |  | *Col 4 Total* | [=-sum(f4:f8)] | **NOTE NEGATIVE SIGN IN FRONT OF “SUM”!!!** |
|  | Note: the $ symbol ensures that b9 will always be the denominator when the formula is copied down the column |

**VI. Products**

1. Oral Presentation / Discussion

On April 20 each student group will be expected to give a (approx.) 20-minute presentation / discussion on the results and preliminary conclusions from that group’s data (based just upon the patterns you find in the data). It is up to you to decide how to divide up the responsibilities for that time, but all individuals should be involved in the presentation and leading the discussion. You should use a PowerPoint presentation for the illustrations of your data and calculations. I will expect a well-organized presentation that examines all aspects of the calculations described in this handout. Grading will be on a group basis.

2. Written Report

You should submit a written report at the start of class on April 27th. The report can be submitted as a group (one copy is sufficient) or as an individual. This is your choice. If you choose to submit an individual report, all of the data analysis and illustrations of the other group’s data and all of the writing must be your own (no collaborations). This report will include:

* A brief written summary of the results and your interpretation (this should be very brief and direct, like one would find in a combined “Results and Discussion” section of a scientific paper). Please make this double spaced. There are no page restrictions, but I would not expect much more than 2 - 4 pages of text. Cite references where appropriate (though I do not expect a literature search – use the class readings and other easily available materials, such as background materials from your previous course in basic ecology).
* I expect you to go beyond the preliminary conclusions presented in your oral report. For the written report I will expect you to incorporate some ecological information on the species measured (see below) to help explain things about your communities in a more robust fashion.
* The tables used for analysis (described previously in this handout)
* Any other graphics you might generate to present ideas
* Literature cited list

The emphasis in grading will be on your analysis, but presentation will also be a significant factor. You should treat all written products for this class as you would a professional paper with a target audience of well educated peers not taking this same class. It should be well written, with close attention paid to clarity of writing and brevity (but not at the expense of completeness).

**Some information sources on Pacific Northwest wetland plants:**

Wetland and general plant field guides used in class

Leigh, M. 1999. Grow your own native landscape. Available on loan from the instructor.

## USDA NRCS PLANTS database <http://plants.usda.gov/index.html>

Native Plant Workbook: <http://depts.washington.edu/propplnt/plantindex.htm>

WSU Extension native plants database: <http://cahedb.wsu.edu/nativePlant/scripts/webMain.asp>

DNR wetland guide: <http://www.dnr.wa.gov/Publications/lm_ess_recognizing_wetlands.pdf>

King county native plant guide: <http://green.kingcounty.gov/GoNative/Plant.aspx?Act=find>

Technical report on King County wetland vegetation: <http://your.kingcounty.gov/dnrp/library/archive-documents/wlr/wetlands-urbanization-report/Chap3.pdf>