

Ecology in a Three Module Format

M. Carmen Hall¹ and Sheryl Shanholtzer²

¹ Georgia Perimeter College, Science Department, 3251 Panthersville Rd., Decatur GA 30034 USA

² Georgia Perimeter College, Department of Life and Earth Sciences, 2101 Womack Rd., Dunwoody GA 30338 USA

(myra.hall@gpc.edu; sheryl.shanholtzer@gpc.edu)

The choice between depth and breadth is a common dilemma in most courses. We found that to be particularly true when developing our environmental science labs. The students in our environmental science classes are primarily non-science majors who may not have taken another science course before enrolling in this class. We developed the labs to work as stand alone modules that take place over the course of three weeks. In this workshop we introduce you to the ecology module. We begin our exercise by mapping a study area using Google Earth and using digital resources to explore the study area. From our information we identify two different habitats within our study area. Our exercise is continued by conducting a plant and animal survey in the two habitats. We conclude our exercise by comparing the importance values (plants) and diversity (animals) in the two habitats.

Keywords: ecology, vegetation, survey, animal surveys, diversity index, importance values

Introduction

This module is designed to introduce students to ecological studies. It requires three lab periods beginning with Exercise 1, which uses digital data and remote sensing to assess a study area. Two different habitats in close proximity are chosen for comparison. In the second exercise, vegetation and animal surveys are conducted at the study sites. In the final phase the students work with their data, calculating the importance values of plants and diversity index of animals. The goals include: comparing initial remote assessment to on ground measurements; analyzing and interpreting data, testing hypotheses concerning the differences in the two ecosystems.

Student Outline

Introduction

Ecology is the study of the interactions of living organisms with one another and their environment. By environment we can include any living or non-living component that affects an organism: temperature, precipitation, topography, elevation, and other living organisms. In short we can include all biotic and abiotic components that an organism may come in contact with in their habitat. When we consider such an interacting system we call it an ecosystem.

While we many not think about ecosystems often, they are a part of our everyday life. This is because ecosystems perform a number of functions for us and if these services stopped, life could become very unpleasant. Many of these services would be quite expensive for us to maintain without the help of ecosystems. While it is difficult, if not impossible, to place a true monetary value on the services provided by ecosystems, many scientists have tried to quantify the value of ecosystems. Costanza et al. (1997) determined that the value of ecosystems to us came to about \$33,000,000,000,000 annually.

Given the value of ecosystems, it becomes important for us to assess the quality and conditions of our ecosystems. Typically we have specific goals in mind when we conduct an ecosystem assessment. We might want to determine if the land is suitable as a conservation area. We may want to see if some change is having an effect on the ecosystem, or if you want to determine the best way to manage the land.

By conducting an ecosystem assessment we increase our understanding of the land's past, present, and future conditions. When ecology was a young science, most of the work revolved around describing, naming and classifying organisms and the parts of the environment that determined when and where we found these organisms. Over time, however, ecology has gone from being a descriptive science to being a predictive science. Ecologists look for explanations of interactions between organisms and their environment and propose hypotheses and develop models that help explain these interactions.

In order to examine, evaluate, and analyze an ecosystem, the ecologists may use a number of tools and techniques. The tools may be equipment that precisely measures components of the abiotic ecosystem (temperature, pH, salinity, percent nitrogen), that help process information (computers), or it may be techniques that allow measurements of populations (abundance, survivorship, distribution).

In the next three labs you will be introduced to some of the techniques used by ecologists to define geographic areas of interest, vegetation distribution, and animal distribution. You will then use these to characterize ecosystems and make judgments as to their condition and value.

Exercise 1: Preliminary Survey and Background Research

When conducting an ecological assessment you must first identify the need and objectives of the survey. What is the purpose of the survey? Once you know your objective you should choose the survey area and then obtain all the available information on the area.

In this study we will compare two habitats that are near one another. Differences in climate, slope, elevation, and soils might be expected to make a difference in the vegetation. In addition, the history of the area and the successional stage may determine the plants present. In terrestrial systems, the vegetation supplies the food and structure of the ecosystem which affects the animal life. Variety in the physical area and the vegetation will also affect the diversity of organisms.

Based on this knowledge and the following survey of available information, we should be able to predict whether the two habitats will vary and if this will cause the communities to differ.

Ecologists employ a number of different tools when conducting ecosystem assessments including maps, soil surveys, published papers, and data bases.

Activity 1 - Prepare Base Map

Open Google Earth (<http://www.google.com/earth/>) and type in the coordinates (or address) of your study site.

Identify the specific location of your study site on the satellite image. Choose two areas of about the same size, but with what appears to be different vegetation to study. Then click on the polygon tool on the toolbar.

Start in any corner of each of your study sites and drag the polygon until the entire site is covered. If you make a mistake, just start over. When you are satisfied, give your polygon a name and save it.

Activity 2 - Determine Size of the Project Area

Measure the area boundaries and calculate the size of the area in:

$$m^2 = \underline{\hspace{2cm}} \text{ hectares} = \underline{\hspace{2cm}} \text{ acres} = \underline{\hspace{2cm}}$$

To determine the square meters, click the measuring tool and draw the length of your polygon. Record the distance. Repeat with the width of your polygon. Multiply $l * w$ to get m^2 .

A hectare is a common unit of land measurement; 10,000 square meters = 1 hectare. Most of you are more familiar with the measurement of acre. An acre is 4,050 square meters (about 40% of a hectare).

Compare your data with another group. Did you all come up with the same value for your study area? Explain any discrepancies.

This is a group project. Everyone needs to agree on the study area. Discuss the location and size of the study area until a consensus is reached.

Activity 3 - Summarize Available Information

Use the internet resources in Table 1 in addition to any other resources provided by your instructor and gather as much information about your study site as possible. You will need to find information about vegetation, topography, soils, water, and animals that may be present at your site.

Vegetation

- What appears to be the major features of your study area? (For example, dense pine woods with a stream, several trails, one road, and sparse deciduous trees)
- Describe the topography. (Flat, steep hills, small hills, valley)
- What physiographic region is your study in?
- What plants are typical for your study area?
- What invasive species might be found in your study area?
- What hypothesis do you suggest regarding the diversity of your study area?
- What was the historical use of your study area? (farming, industrial site, pasture, logging,)

Soils

- What types of soils are present at your study area?
- What are the characteristics of these soils?

Hydrology

- Is there a significant, well-defined drainage through the area?
- Is the area within a major floodplain?
- Do any past images show the area to be flooded?
- Is there any stream gage data for a nearby water body that apparently influences the area? If so then answer the following:
 - What is the daily mean gauge height (ft)?
 - What is the daily mean stream-flow (ft³/s)?

Fauna

- Describe/list the typical animals you expect to find in your site.
- Choose three animals you listed above and identify their trophic level. Do not forget to include invertebrates.

Table 1. Internet Resources

Internet Resources	
Invasive Species	http://www.gacaps.org/publications.html
Animals	http://naturalhistory.uga.edu/~GMNH/gawildlife/index.php
Soils	http://websoilsurvey.nrcs.usda.gov/app/

Analysis

Prepare a report that addresses your project. Include:

- Location and size of study area
- Expected ecosystems/habitats (a description of what you expect to find)
- Expected soil types
- Expected hydrology
- Expected fauna
- Bibliography of sources

Review Questions

You studied two ecosystems on campus. What abiotic factors if any differed between the two? Explain the basis of your statement.

1. The size of the study areas were measured in _____.
2. Define physiographic region. In which one is your study site located?
3. Why are soils of interest when studying an ecosystem?
4. Topography describes the _____.
5. The biological part of an ecosystem includes the vegetation, called the _____, and the animals called the _____.
6. When speaking of the set of conditions in an ecosystem necessary to provide for the needs of a particular organism we call this their _____.

Exercise 2: Ecological Survey

Now that two study areas have been identified and information collected from available sources, you should have some idea as to whether or not the habitats in the two areas will have different communities. Methods to measure ecosystem characteristics are presented in this exercise.

What predictions can you make about the two areas that can be tested?

Vegetative Analysis

In the most basic form of vegetative analysis, we are interested in which species are present within the habitat. Even when a study area is small it is difficult to identify and count every single plant present. Instead we identify and count a subset of plants and from that data extrapolate to the entire population. There are several different methods that can be used. The method chosen will depend on the location and the primary question being asked about the habitat.

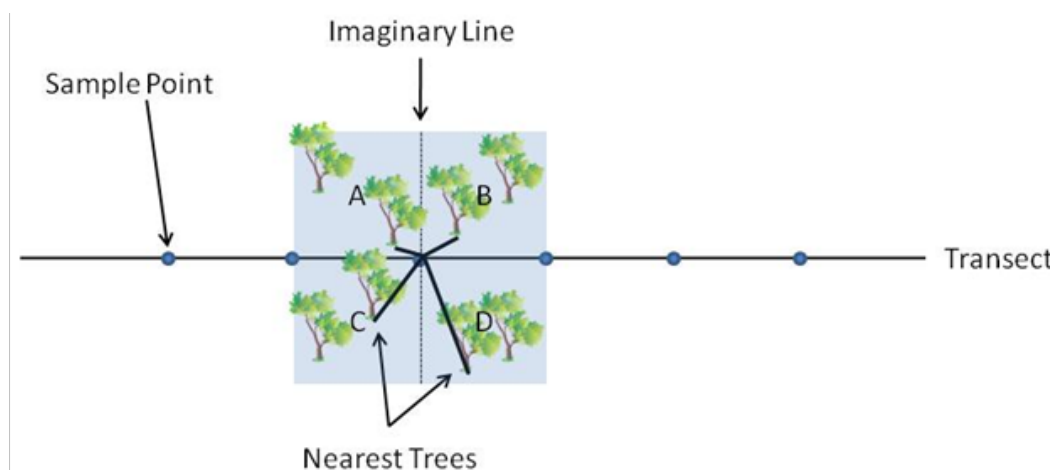


Figure 1. Diagram of point-quarter sampling. At a sample point along the transect an imaginary line is drawn perpendicular to the transect. Using that line we imagine four quadrants (A, B, C, and D). Within those four quadrants we sample the nearest tree.

Point or Plotless Sampling

Plotless surveys are good to use for stationary organisms because it requires measuring the distance between organisms. One of the easiest point sampling techniques is the point-quarter (Fig. 1). To perform a point-quarter survey you must first choose transects (lines) that run through your study area. The start, stop, direction and length of your transect should be chosen before you get to the study location. Then you must choose sample points along your transect. These may be uniform (every 2 meters) or they may be random. At each sample point draw an imaginary line perpendicular to and running across your transect. This will result in four quadrants (squares) at your sample point. You then measure the distance to the nearest tree (or plant) in each quadrant and its circumference at about 4 ½ feet from the ground, or its diameter (known as diameter at breast height - DBH).

Animal Surveys

In addition to conducting a vegetation analysis, it is also important to know what other organisms are living within an ecosystem. You will find that there are many organisms that live in your study site. Because there is not enough time to study them all, only one type of organism will be surveyed.

Macroinvertebrates are small organisms that are typically found everywhere. Some macroinvertebrates will be primarily terrestrial (live on land) while others will be primarily aquatic (live in water). You may choose to hunt for macroinvertebrates in soil, leaf litter, decaying logs, or on target plant species. If your study site is mainly water, you may want to survey the macroinvertebrates found in the water. These macroinvertebrates are also good indicators of the quality of the water.

If there is a lot of cover (bushes and trees) you may have an area with a lot of birds. Open areas will have birds as well but perhaps not as many as covered areas. If your area is very small you are unlikely to have large vertebrates (animals with a backbone) but you may have smaller ones. If your area is prime habitat for an endangered or threatened species, you may want to focus on just looking for a single species.

Activity 1 - Sampling Preparation

1. Choose two different habitats within your study site for comparison.
2. Which habitat would you hypothesize is most diverse? Why?
3. Which habitat would you hypothesize has the largest trees? Why?
4. At which stage of succession would you place these habitats?
5. Is the edge of the habitat the same as the center?
6. How would food, cover, and seasonal variation differ and which animals would it likely support?
7. Can you differentiate these differences from an aerial map?

Activity 2 - Vegetation Sampling

The point-quarter sampling technique is typically used where there are a lot of trees. Write up a sampling protocol so everyone will take samples the same way.

Point-Quarter Sampling

- Go to the starting point of your first transect. Lay out a 100 meter line to mark your transect. Follow your sampling protocol to find the first sampling point along your transect.
- At your sampling point place a two meter stick perpendicular to your transect to help you visualize your four quadrants, or stand with one foot on either side of the transect line and spread your arms.
- Select the closest tree in each of the four quadrants and record the species of each tree in Table 2.
- Measure and record the diameter of each tree at breast height (about 4 ½ feet up from the ground).
- Repeat for each sampling point along your transect.

Table 2. Data table for point-quarter samples (you will need a copy for each transect)

Sampling Point	Quarter No.	Species	Distance (m)	Diameter (cm)
1	1			
	2			
	3			
	4			
2	1			
	2			
	3			
	4			
3	1			
	2			
	3			
	4			
4	1			
	2			
	3			
	4			
5	1			
	2			
	3			
	4			
6	1			
	2			
	3			
	4			
7	1			
	2			
	3			
	4			
8	1			
	2			
	3			
	4			
9	1			
	2			
	3			
	4			
10	1			
	2			
	3			
	4			

Activity 3: Animal Surveys

Many different types of animals may live in your study location. There are different ways to sample different types of animals. Choose one type of animal and conduct a survey in the two habitats.

Terrestrial Macroinvertebrate Sampling

1. Macroinvertebrates can be sampled from almost any location. Sample areas should be no larger than 25 cm². You may determine the area using premade quadrats or you can measure on location. When collecting leaf litter collect all of the debris within the 25 cm² quadrat and return it to the lab. When collecting soil, remove the debris from the ground before digging. Remove soil to predetermined depth and return it to the lab.
2. In the lab sift through the soil or leaf litter and remove any invertebrates you see. Place them in 70% ethanol and label your vial. Place the remainder of the soil or leaf litter in Berlese Funnel (for soil samples line the bottom of the funnel with cheese cloth). The Berlese Funnel is placed through a ring on a support stand. Beneath the funnel is a jar with 70% ethanol. Above the funnel is a light. The heat of the light dries out the litter which drives the inhabitants toward the bottom of the funnel. Eventually the invertebrates drop out of the funnel into the waiting jar of alcohol.
3. Collect the alcohol jars and pour the contents into glass dishes and observe using a dissecting microscope. Most animals can be identified to Order and many to Family using reference guides and keys.

Table 3. Terrestrial Macroinvertebrate Data Table

Observer Name	Date		Quadrat Size		
Type	Quadrat 1 Number	Quadrat 2 Number	Quadrat 3 Number	Quadrat 4 Number	Quadrat 5 Number

Recommended Field Guides and Keys

- Borror, D. J. and R. E. White. 1998. *A Field Guide to Insects: America North of Mexico*. Houghton Mifflin Harcourt, 2nd edition. ISBN-10: 0395911702; ISBN-13: 978-0395911709
- Evans, A. V. and C. Rufts. 2007. *National Wildlife Federation Field Guide to Insects and Spiders & Related Species of North America*. Sterling. ISBN-10: 1402741537; ISBN-13: 978-1402741531.
- National Audubon Society. 1980. *National Audubon Society Field Guide to North American Insects and Spiders* (National Audubon Society Field Guides). Knopf. ISBN-10: 9780394507637; ISBN-13: 978-0394507637.
- Johnson, N. F. and C. A. Triplehorn. 2004. *Borror and DeLong's Introduction to the Study of Insects*. Brooks and Cole. ISBN-10: 0030968358; ISBN-13: 978-0030968358.

Bird Survey

There are a number of ways to determine the distribution and abundance of birds. Because birds are very mobile and often secretive, most methods tend to underestimate the number of birds present in a given location. Also the identification skills of the observer will also influence the accuracy of the bird count. Birds are often more easily heard than seen. If possible listen to recordings of expected birds before going in the field. One of the easiest methods of counting birds is the **Double Observer Point Count**.

In order to conduct a bird survey you will need binoculars, watch, pens, notebook, clipboard, and field guides. The best times to make your observations are early mornings (from sunrise until about 10:00 am). You will need to make multiple visits and should visit the sampling stations in different orders. Work in pairs and use the same sampling points used in the vegetation survey so you can correlate vegetation with birds observed.

Move quietly to each sampling station so you do not disturb the birds. At the first station Observer 1 identifies and counts all birds seen and/or heard within 50 yards of this location for five minutes and records the data. At the same time, Observer 2 identifies and counts any birds missed by Observer 1. At the end of five minutes quietly move to the next sampling station. At the next sampling station the observers switch roles. The observers continue through all sampling stations, switching roles each time.

Table 4. Bird Survey Data Table

Observer Name				Date	
	Station 1	Station 2	Station 3	Station 4	Station 5
Species	Number	Number	Number	Number	Number

Mammal Survey

The most reliable method of mammal surveys consists of mark-and-recapture techniques that are beyond the scope of this class. Instead we will use some indirect techniques to survey the mammals in our study area. There are a variety of indirect methods used to conduct mammal surveys. The easiest is the **Double Observer Point Count** (see above in the bird section) Another method consists of setting up **scent stations** at predetermined sampling points. A scent station consists of sand rubbed smooth and a luring scent. The scent may be decaying meat, fish oil, and rotting eggs. A number of artificial scents can be used such as deer or coyote urine or bird scents. Plant extracts, such as anise, valerian, and peanut butter can also be used as scents.

1. To set up a scent station you first need to clear an area approximately 1 meter square (or diameter) by removing all of the debris. You want bare ground for your station. Then cover the area with sand to approximately 1/2 inch in depth. The sand should be smoothed and the edge of your station well defined. In the center of your station place a vial with your scents.
2. Check each station daily for prints. Identify the prints of all mammals that entered your scent station. In some cases the prints may be defined well enough to make Plaster of Paris casts.

Table 5. Mammal Survey Data Table

Observer Name				Date	
	Station 1	Station 2	Station 3	Station 4	Station 5
Species	Number	Number	Number	Number	Number

Review Questions

1. Why did you sample the trees and not count all of them in the study area?
2. Could you differentiate the two sampled areas from aerial photographs?
3. What differences on the photograph do you see and what could produce these visual differences?
4. What are the two variables you are measuring for each tree?
5. Why is it important to know the type of trees found in the study area?
6. You sampled only one type of animal. Why are different methods for the different groups of animals?
7. How did the method you used apply to the organisms you chose to look at?

Exercise 3: Survey Analysis

Once your survey is complete you will need to analyze and interpret your data. Often it is enough to just have a list of species present. However the data can be used to calculate other important measures.

In a vegetation survey the number of species present, circumference and distance measures can be used to determine other parameters such as abundance, frequency, density, coverage, or importance value:

Absolute abundance is the number of individuals of a given plant species within the total sampled area. Relative abundance is the abundance of one species as a percentage of total plant abundance. Absolute abundance is affected by the size of your sample area and in some cases is not very helpful.

Density is determined by the number of plants within an area of defined size (ex. per meter square or hectare.) *Relative density* is the density of one species as a percent of total plant density

Cover is the percentage of sample area beneath the canopy of a given species. This value means different things depending on the perspective. It can give insight into the economic value or ecological value because it looks at size of the trees.

The *importance* of a species takes into account the comparative number of plants present or *frequency*, the *density* of the plants and the size of the plants (*coverage* or dominance). The importance of a plant species that is spread throughout the area is different than if the same numbers of individuals are clumped together. Larger plants have a different value than smaller plants.

In the animal surveys the data can be used to estimate the diversity of a population and make a comparison between habitats. Just like plants, we can calculate abundance, density, and frequency. However, most often we are interested in abundance and diversity.

Activity 1 - Vegetation Analysis for a Point-Quarter Sample

The purpose of the following calculations is to determine the importance of each of the tree species in the study area. Importance has several components. The first, relative density, tells us the proportion that each species is of the total trees sampled. The second, relative frequency looks at the likelihood of finding a type of tree at any sample point (how spread out they are). The third, relative dominance looks at size. The larger the trees of one species, the greater will be their importance. Work through the calculations below to determine relative density, relative frequency, relative dominance and the importance values for your tree species.

Relative Density

Density information can allow inferences about the condition of the forest or help with decisions pertaining to harvesting. Too many trees in an area mean competition for resources. When there is competition, trees will not grow as well. In order to keep the forest healthy some trees may need to be removed. In this case knowing the relative density can help with deciding which trees should be removed.

You need to know two numbers to calculate relative density. You need to know the number of individuals of each species counted and you need to know how many trees you counted total.

$$\text{Relative Density} = \frac{\text{Number of individuals of a species}}{\text{Total number of all individuals}} \times 100$$

Table 6. Relative Density Calculation

Species	Total Individuals	Relative Density
Total		100

Relative Frequency

Relative frequency is a useful measure. The primary purpose is to compare the frequency of the different tree species to one another. If you know the relative frequencies then you can quickly assess whether invasive species are prevalent, whether beneficial food trees are sparse, or you could determine if there is a high or low number of harvestable trees in the area. First you must calculate the frequency for each species of tree by dividing the number of points with a species by the total number of points. Figure out these values for all of your tree species before you continue to relative frequency.

$$\text{Frequency} = \frac{\text{Number of points having a particular species}}{\text{Total number of points}} \times 100$$

Table 7. Frequency Calculation

Species	Point 1	Point 2	Point 3	Point 4	Point 5	Total Number	Frequency

Then calculate relative frequency for each species by dividing the frequency of the tree species by the total frequency of all of your trees. When you finish the relative frequencies of your trees should add up to 1.

$$\text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Total frequency of all species}} \times 100$$

Table 8. Relative Frequency Calculation

Species	Frequency (from Table 7)	Relative Frequency
Total		100

Relative Dominance

While density and frequency are useful measures, they often do not tell the entire story. For example there may be a large number of saplings in an area but they are very small and contribute little to the overall community while large mature trees may be few but have a large impact on the community. Relative dominance allows you to get a clearer picture of the community structure by taking into account the size of the trees in addition to their density.

Calculation of relative dominance (cover) is a multi-step process. The first step requires that you convert the diameter or circumference you measured for each into basal area. Then calculate the total basal area for each species of tree.

$$\text{Basal Area} = \pi \left(\frac{D}{2} \right)^2 \quad \text{where } D = \text{diameter}$$

and

$$D = \frac{C}{\pi} \quad \text{where } C = \text{circumference}$$

Table 9. Basal Area of Each Tree and Total

Species	A	B	C	D	E	F
Individuals	BA	BA	BA	BA	BA	BA
Total BA						

The next step calculates the relative dominance for each species.

$$\text{Relative Dominance (Cover)} = \frac{\text{Total BA of a species}}{\text{Total BA of all species}} \times 100$$

Table 10. Relative Dominance of Each Species

Species	Relative Dominance
Total	100

Importance Value

The importance value is a measure that combines relative density, relative frequency and relative dominance of a species. By combining these measures we can get a good idea on how important a particular tree is within the community. A tree with higher importance value is the one that probably has a strong place within the community. It may mean that it is a species best available for harvesting or it may mean it is an integral part of the community structure serving as food, shelter, or other functions for the forest stand.

The calculation for the importance value is straight forward. You simply need to add the relative density, relative frequency and relative dominance for each species.

Table 11. Importance Value of Tree Species

Species	Relative Density (Table 6)	Relative Frequency (Table 8)	Relative Dominance (Table 10)	Importance Value

Questions

1. Which tree has the highest importance value? Why?
2. Are all trees equal in ecological value? Economic value? Explain.
3. Do the importance values you calculated match your perceptions about which species are most important in this community? Explain?
4. Is it possible to identify and measure all the trees in an area? Why or why not?
5. What can the tree composition tell you about the ecology of an area?
6. Which habitat was most diverse?
7. Which habitat had the largest trees?
8. Was the edge of the habitat the same as the center?

Activity 2 - Animal Analysis

When we look at animal communities we can calculate density and frequency of the animal species and use it to make inferences on communities and populations. However, since we have calculated those measures already in or vegetation analysis, we will focus here instead on the diversity of the animal community and the similarities between communities. Diversity and similarity can also be conducted for plant communities.

Diversity is calculated the same regardless of sampling technique or taxa being studied. Diversity allows us to look at a community and determine if there are many different types of species present or if there are only a few present. Sometimes it is easy to tell. If there is only one species present then we can be fairly safe at saying there is low diversity. However, most communities have many species present, so we want to quantitatively assess the diversity. By doing this we can then compare diversity of one community to the diversity of another community.

To determine diversity we will use the Simpson's Diversity Index (S).

$$S = 1 - \frac{\sum n_i(n_i-1)}{N(N-1)}$$

Where n=the number of individuals in species I, and N=the total number of individuals

1. Make a list of all the species you found and put them in Table 12. If you could not identify your animals to species then list to the lowest common classification you were able to identify.
2. Count how many individuals you found for each species (group). Record this value in Table 12 under Number (n).
3. Subtract one from the number of individuals you found for each species.
4. Multiply (n) times (n-1) and fill in Table 12.

5. Total column two Number (n) and column four n(n-1) in Table 12.

Table 12. List and Number of Animal Species Identified and Calculations for Simpson's Diversity Index.

Species	Number (n)	(n-1)	n(n-1)
Total			

6. Fill in Table 13 and calculate N-1 and N(N-1).

Table 13. Sample Size and Calculations for Simpson's Diversity Index

Total Number (n) = N	N -1	N(N-1)	Total n(n-1)

7. The final step of the calculation is to divide Total n(n-1) by N(N-1). Then subtract from 1.

8. What is your Simpson's Diversity Index? _____

You should now have a value between 0 and 1. If you have a 0 then your community is not diverse at all. If you have a 1 then your community is extremely diverse.

Similarity indices calculate the species in common between two communities, but ignores the number of individuals. While we can look at the diversity index of two communities and say one is more diverse than the other, it does not tell us if the communities are similar or no in terms of the type of inhabitants. To do this we can calculate similarity indexes. We will use the Similarity Index.

$$\text{Sørensen's Similarity Index Density} = \frac{2w}{(A+B)}$$

Where A= the number of species in habitat A; B= the number of species in habitat B; w= number of species in common

1. To calculate Sørensen's Similarity Index count how many species you found in Habitat A and record the number in Table 14. If you were unable to identify your animals to species use the lowest common classification.
2. Count the number of species you found in Habitat B and record the number in Table 14.
3. Add A and B and record in Table 14.
4. Count the number of species found in both and record.

Table 14. Similarity of species in two communities

Number of Species in Habitat A	Number of Species in Habitat B	A + B	Number of Species Common to Both A and B (w)

5. Complete the calculation to get the Sørensen's Similarity Index. You should get a value between 0 and 1. With 0 interpreted as no similarity between communities and 1 interpreted as identical communities.
6. What is your Sørensen's Similarity Index? _____

Questions

1. Which species was most abundant?
2. Which habitat had the greatest amount of diversity?
3. How similar were the habitats in species composition?
4. Can you link all of the organisms (from a single habitat) together in a food web?
5. Which organisms did not have links in the food web? Why?
6. Into which trophic level do most of your organisms fall?
7. Can you draw any correlation between the vegetation analysis and your organisms? i.e. does the diversity of your organisms appear to be dependent on the density, abundance, diversity, importance of your plant species?

Hypothesis support or rejection

Now you have considerable information about your two sites. After collecting information available in the literature and from maps in Exercise 1, you predicted whether or not the communities of the two would be similar or different.

State the original hypothesis. _____

Do your data support your hypothesis? _____

It is possible that it is supported by some criteria and not others. Can you suggest causes for their similarities and differences measured?

What additional data would be helpful in testing your hypothesis?

Review Questions

1. The point quarter method of sampling allows for the calculation of what parameters of the forest?
2. What is meant by relative frequency of a tree species?
3. How is this different from relative density?
4. If a species occurred at most stations, but never more than once at each station, would it have a high relative frequency or density?
5. What values are combined to determine importance value?
6. Use the values calculated to compare the two areas you sampled.
7. Which index did you use to determine the similarity of species composition between the two areas that you sampled?
8. Does this index consider the number of individual animals you counted?
9. What do the diversity indexes tell you about the animal communities in the two different areas of study?
10. What connections can you make between the animals and plants in your study areas.

Materials

Exercise 1: Preliminary Survey and Background Research

Computers with internet access and Google Earth (1 per four students minimum)

Exercise 2: Ecological Survey - Vegetation Surveys

Point Quarter

- 100 m measuring tape
- 5 m measuring tape
- Tree identification guide
- Flagging

Exercise 2: Ecological Survey – Animal Surveys

Terrestrial macroinvertebrate

- 1 gallon zipbags
- Rake or shovel
- Berlese funnels
- 70% ethanol
- Macroinvertebrate identification guides

Birds

- Stopwatch
- Binoculars
- Bird identification guides

Mammals

- Shovel or rake
- 5 gallons of sand for each scent station
- Scents
- Small stake
- Mammal prints identification guide

Exercise 3: Survey Analysis

- Calculators
- Scratch paper

Notes for the Instructor

Exercise 1: Preliminary Survey and Background Research

The instructor should be familiar with the study area prior to lab including physical location, map location, and GPS coordinates. The introductory lecture should be used to introduce the students to the overall lab that will take place over the next three weeks. The purpose of this lab is to get the students thinking about what they should see once they get to the study site.

Activity 1. Prepare Base Map

The students will use Google Earth to locate the study area. Instructors need to be familiar with using the polygon tool and know how to quickly direct students to the correct location. Having the GPS coordinates that can be entered into Google Earth using the pin tool is helpful.

Activity 2. Determine Size of Area

Instructor should have predetermined polygon of study site measured. This will be the final measurement used. Walk students through using the measuring tool on Google Earth to determine the size of their polygon. No two groups will have the same size. Have the students discuss why they have different sizes and how they could ensure they all get the same size. Then show them the Google Earth image with polygon and the measured size that was prepared earlier. Have the students use this as their map.

Activity 3. Summarize Available Information

Students will spend a lot of time on this section. It is recommended that you set a time limit, assign as homework, or assign sections. Web links are provided in the exercise but other websites could be used.

Vegetation: Have the students use Google Earth to determine the overall vegetation type of the site. Changing the time frame will often help. Then have the students use the computers to determine additional information about vegetation found in their area.

Soils: Using the soil website: Go to the soil website and click the green button at the top of the page that says ‘Start WSS’. Click ‘Address’ under the Quick Navigation bar on the left hand side of the page. Type in the address. Use the pan tool (looks like a hand) to center the study area on the map. Use the zoom features to zoom in to the location.

At the top of the map there are two buttons labeled ‘AOI’ (Area of Interest). The first will draw a rectangle; the second will draw a polygon. The polygon is easier to use. Click once to place a point. Move the cursor to the next point location you want to place. Repeat until all points are in place then double click.

If you make a mistake look for the option to ‘Clear AOI’ on the left. Clear the AOI and start over. Once the AOI is selected click the ‘Soil Map’ tab at the top of the page. The map will show different soil types. On the left will be the names of the soil types. The names link to longer descriptions. Students can then click the ‘Soils Data Explorer’ tab and find out additional information about the soils in their area.

Hydrology: If there is a stream in or near the study area, students can get stream-flow data. Otherwise they should be able to extrapolate hydrologic data based on the soil types.

Fauna: Students should research the types of animals they expect to find at the study site given the location, vegetation, soils, and water.

Activity 4

The students should be able to summarize what they expect to find at the study site.

Exercise 2: Ecological Survey

This lab consists of a vegetation and animal survey and will consist of a point-quarter and animal survey. I sometimes let the students choose which type of animal they wish to survey. You may want to choose the one you are most comfortable with.

Introduce students to the type of surveys they will be conducting. Give safety brief for the field. Students should wear long pants tucked into socks. Students should wear long sleeve shirts and shirts should be tucked into pants. Gloves, hats, sunscreen, and bug spray may be desirable. Make sure they recognize poison ivy.

Activity 1. Sample Preparation

Have students work through the sample preparation questions as a class.

Activity 2. Vegetation Sampling.

Point-quarter samples consist of a transect (long line) with sampling points along the length. Every 20 meters is a good way to set up the sampling points. At each sampling point the students need to measure in each quarter. To set up quarters lay a stick across the transect line or have a student stand on the line and hold their arms out to form the perpendicular line.

Activity 3. Animal Survey

Only one animal survey will be conducted. The terrestrial macroinvertebrate samples can be taken at the same time as the vegetation sampling. Just have the students collect the leaf litter or soil after they take their vegetation measurements as each sample point.

Bird surveys can be conducted at the same sample points as the vegetation survey but will need to be done at a separate time. Measuring vegetation will be noisy and the birds will not be visible or vocal.

The mammal survey can also be conducted at the same sample points and can be set up at the same time as the vegetation survey but will need to be checked at least 24 hours after they have been set up to give the animals time to respond to the scents.

Exercise 3 – Survey

Introduce students to the meaning of the measures they will be calculating: density, frequency, dominance, importance value, diversity, and similarity. Note that you only conducted one type of vegetation survey and one type of animal survey so only complete the calculations for the completed surveys.

Activity 1. Vegetation Analysis for a Point-Quarter Sample

Have students fill out the tables and work through the calculations for each measurement. It may be better to work through the calculations as a class. Once the calculations are complete have the students answer the questions or use the questions as discussion points.

Activity 3. Animal Analysis

Dominance and importance values are measures primarily seen in discussion of plant communities. Frequency and density are used for both plant and animal communities, but because the students have already worked through frequency and density with the vegetative community we do not repeat here. Instead they will calculate diversity and similarity. There are several different ways to calculate diversity and similarity. Only one calculation for each has been included in the exercise. Once the calculations are complete have the students answer the questions or use the questions as discussion points.

Discussion

Discuss the findings based on the surveys and calculations. Discuss how closely “the real thing” met the expectation based on the preliminary research on the study site.

About the Authors

Carmen Hall is an Assistant Professor Biology at Georgia Perimeter College. She holds a BS in Wildlife Biology and an MS in Biology from Texas State University and a PhD in Ecology from the University of Georgia.

Sheryl Shanholtzer is a Professor of Biology at Georgia Perimeter College. She holds a BA in Biology from Columbia College, an MS in Biology from Florida State University, and a PhD in Zoology from the University of Georgia.

Mission, Review Process & Disclaimer

The Association for Biology Laboratory Education (ABLE) was founded in 1979 to promote information exchange among university and college educators actively concerned with teaching biology in a laboratory setting. The focus of ABLE is to improve the undergraduate biology laboratory experience by promoting the development and dissemination of interesting, innovative, and reliable laboratory exercises. For more information about ABLE, please visit <http://www.ableweb.org/>.

Papers published in *Tested Studies for Laboratory Teaching: Peer-Reviewed Proceedings of the Conference of the Association for Biology Laboratory Education* are evaluated and selected by a committee prior to presentation at the conference, peer-reviewed by participants at the conference, and edited by members of the ABLE Editorial Board.

Citing This Article

Hall, M. C. and S. Shanholtzer. 2014. Ecology in a Three Module Format. Pages 103-119 in *Tested Studies for Laboratory Teaching*, Volume 35 (K. McMahon, Editor). Proceedings of the 35th Conference of the Association for Biology Laboratory Education (ABLE), 477 pages. <http://www.ableweb.org/volumes/vol-35/?art=7>

Compilation © 2014 by the Association for Biology Laboratory Education, ISBN 1-890444-17-0. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the copyright owner.

ABLE strongly encourages individuals to use the exercises in this proceedings volume in their teaching program. If this exercise is used solely at one's own institution with no intent for profit, it is excluded from the preceding copyright restriction, unless otherwise noted on the copyright notice of the individual chapter in this volume. Proper credit to this publication must be included in your laboratory outline for each use; a sample citation is given above.