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Know your place: Utilizing natural areas around campus to increase connection among students, their campus, and nature

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How can we help our students bolster their mental health and perhaps even increase retention while addressing common learning objectives of Introductory Biology courses? Getting students outside and committed to monitoring and improving small natural areas on campus may hold some answers. Two different types of plant community diversity assessment that can be used in almost any natural space are presented here. The first activity focuses on assessing species richness and helping students recognize features of plants that may be useful for identification such as leaf arrangement. The second activity allows students to use the user-friendly plant identification app Seek! by inaturalist to identify plants and measure Simpson's Diversity Index of a transect. These lab activities are part of a month-long "Nature-based" module used in a Non-majors Introductory Biology II lab but could easily be modified to fit different courses or time constraints. No special equipment is needed, and students do not need any background in plant identification. Topics addressed by the lab activities in this workshop include community diversity, general plant anatomy, species accumulation curves, and scientific process.

Keywords: community ecology, biodiversity, plant identification, ecological sampling

Link to Supplemental Materials: https://doi.org/10.37590/able.v43.sup30

Introduction

Spending time in campus green spaces helps students feel less stressed and happier and can contribute to overall well-being (McFarland et. al. 2008, Holt et. al. 2019). However, many undergraduate students, especially those on commuter campuses, do not engage with natural spaces on campus as part of their daily lives. To address this, I implemented a month-long outdoor lab module in my Introductory Biology II lab course and replaced labs that are traditionally performed indoors with outdoor labs exercises. The two lab exercises I present here are part of that module. These exercises both allow students to spend more time outside, help students connect with their local ecosystems, and address learning objectives common to introductory biology courses. In both exercises, students carry out the scientific process, generate an original data set, and practice graphing skills. Data collected from these activities may be used to contribute to a long-term campus dataset and/or campus resources such as campus species guides so that students' work has an impact that extends beyond the classroom.

Student Outline

Objectives

Activity 1 Objectives

Explain what species richness is and know how to assess species richness of a plant community
Evaluate whether sampling efforts yield accurate representation of species richness
Discern plant species from one another using reliable identification traits

Activity 2 Objectives

Explain what a diversity index is and how it differs from species richness
Use transect sampling and the Seek! app to assess diversity of a plant community
Calculate Simpson's Diversity index for a data set
Recognize and name the most common plant species in the campus greenspace

Introduction

Ecological communities are not just found in pristine environments, parks, or preserves, they are found anywhere multiple species are interacting with one another. You may not have noticed, but we have ecological communities right here on campus! *What species are in our campus ecological communities? How many species can we find there? Are the communities relatively healthy and stable?* Over the next two weeks, you will help answer some of these questions by measuring the diversity of a plant community on campus. In doing so, you will also become familiar with some of the most common plant species that grow in our area and learn some basics of ecological sampling methods. Regular assessments of biodiversity can also help us track how the community changes over time, so the data you collect will also contribute to a long-term dataset of our campus plant communities.

This week, you will begin by assessing **species richness.** Species richness is simply the number of different species within a given area. It is an important baseline measure for all ecological communities. You will also learn how to graph and use a **species accumulation curve** to determine whether our assessment of species richness is accurate.

Next week, you will conduct a more comprehensive assessment of species diversity by identifying plants within a sampling area and calculating a measure called **Simpson's Diversity Index**, which takes the relative abundance of each species into account as well as the number of different species. This will allow us to determine whether plant species are distributed relatively evenly throughout the community (that is, all species are present in similar numbers), or whether our community is dominated by one or two species. As with all our outdoor labs, your instructor will encourage you to take some time for quiet outdoor observation, deep breathing, or reflection before the activities begin.

Methods and Data Collection

Note: As you work on this lab, you should complete the questions and data table on the provided worksheet.

Week 1: Assessing Species Richness and Constructing a Species Accumulation Curve

Sampling: You will be assigned a designated sampling area by your instructor. Using a pair of garden pruners, clip a sample of each different species you can find in the area. Try to collect one of every type of plant you observe (excluding ferns, mosses, and gymnosperms) over a period of about ten minutes (your instructor will tell you when time is up). Your instructor will specify whether they want you to collect all angiosperms, or dicots only. Be sure to collect a stem that includes at least three leaves, so you are able to see leaf arrangement along the stem. Put each sample in your bag.

Organizing your samples: When you return to your classroom or outdoor space with tables, remove your samples from the bag and separate each so that you have a "pile" for each species. Most "piles" will only have one sample in them. However, look closely and make sure you did not collect any duplicates! If you have multiple samples that are from the same species, put them in a single pile. After you are confident in your piles, fill out the first row

in the table on your worksheet. ***Samples*** are the number of clippings you took, while ***Species*** is the number of different piles you made. For example, if you collected twelve clippings, but three were from the same species, you would have 12 samples and 10 species.

Combining samples: When you are ready, combine your piles with those of the person nearest you! It is likely that you have some "duplicate" species and some species that are unique to each of you. Look closely at each sample – combine piles with your partner when you see a species you both have in common.
Continue to keep each species in a separate pile, but make sure there are not multiple piles that contain the same species. Ask your instructor for help if you need it! When you are satisfied with your piles, record the number of samples (this should be your samples + the number of samples your partner collected) and the number of species (total number of piles) in row 2 of the table.
Now, combine samples with the pair of people nearest you, and repeat the same process! Complete row 3 of your table. Continue this process until the entire class has combined their samples!

Graphing a species accumulation curve: Use the data in your table to draw a species accumulation curve. Your instructor may have you do this by hand or in Excel or Google Sheets. Look at the completed graph. Does it seem to "level off" or begin to reach an asymptote? If so, we probably did a thorough job sampling! If the graph looks like it has not started to level off and is continuing to increase, we probably did not spend enough time sampling and may want to continue our efforts.

Complete the questions on your worksheet and turn it in to your instructor.

Week 2: Measuring and Comparing Simpson's Diversity Index

Laying transects: Working in your lab groups, use a meter tape to lay out a transect of the length specified by your instructor starting at the designated point. Be sure your transect is parallel (do your best) to the other student groups.

Identifying species: Your instructor will give a brief demonstration on how to use the Seek! app. Do your best to identify each plant that is in contact with the meter tape along the transect to at least the ***Genus*** level. You may use a blank sheet as a "background" to a plant while you are scanning it with your phone to help the app separate and focus on the plant you are attempting to identify. For each 0.5 m section of tape, write down all species that you find along that section. Complete Table 1 in your worksheet accordingly.

Calculating Simpson's Diversity Index: Use the information from Table 1 to complete Table 2 in your worksheet and calculate Simpson's Diversity Index. In the worksheet N is the total number of individual plants you identified, while n is the number of each species. For example, if you found 40 plants along your transect and 12 of them were Green Briar, then N= 40 and n for Green Briar = 12. When you have completed the table, you have all the information you need to calculate Simpson's Diversity Index.

Comparing Transects: After returning to the classroom, you will transfer your results from Table 2 into a designated tab in Google Sheets. Each lab group will have its own tab/worksheet. Make sure you are working in the one that is labeled with your group number. Now, you can use the data to compare diversity among transects, and test to see whether there is a correlation between species richness and Simpson's Diversity Index.

Complete the worksheet and turn it in to your instructor.

Materials

For activity 1: You will need garden pruners or clippers (one for each student or one per pair of students if they are working in pairs). Each student will also need a plastic bag or something to collect samples in.

For activity 2: You will need measure tapes to establish transects (one for each transect). Students will need a phone with the Seek! by inaturalist app (https://www.inaturalist.org/pages/seek_app) already installed. One phone per group will work. You will also need access to a computer and Google Sheets.

Notes for the Instructor

It is highly recommended that you spend time in your campus greenspace to do some "pre-planning", choose a suitable area, and ensure that the lab exercises will work as written for your particular area. I recommend using an area on campus that is not landscaped, has enough species present for students to sample, and is easy for students to access/walk around in. Avoid areas with excessive undergrowth. Note that this activity was designed for a relatively small campus with only two sections of this lab course. For campuses with many lab sections, you may choose several different areas to work in to avoid damaging any one particular area.

Activity 1 (assessing species diversity): Depending on your campus' natural area and plant community, you may choose to limit your students to specific types of plants (for example, dicots only, as grasses can be difficult to sample and distinguish from one another). You may also need to review with your students what a leaf is and make sure they understand the difference between compound leaves and simple leaves before sampling, so they are able to collect samples that accurately represent leaf arrangement. As students sort and combine their samples, I recommend walking around from group to group and helping students. This is a good time to help students determine which aspects of plants are useful for identification (leaf arrangement, leaf margins, etc.) and which are not (color, size). If your course learning objectives include twig anatomy, leaf arrangement, or other aspects of plant anatomy, you may choose to use students' samples to illustrate/review these concepts after the species richness activity has concluded.

Activity 2: Revisit the sampling area to determine the best sampling methods for your plant community. You may choose to use quadrats instead of transects. For transect sampling, determine a length that will work well in terms of any time constraints you may have. I use 5 to 10 meters, depending on the density of plants in an area. Ensure students have the Seek! app downloaded before coming to class. Spend some time showing them how the app works. Note that the app does a good job with common species, but like any AI technology, is not perfect. You may choose to discuss with students and encourage them to work slowly and carefully rather than "blindly" trusting the first suggestion that appears on the app. Discuss ways to "check" the app using their own common sense (if it identified one plant as species x, is it also identifying other plants that look the same as this species?). You can also show students how to access more information about the species using the app to determine whether it is native or invasive. As a follow-up activity or discussion, you may choose to focus on invasive vs. native species prevalence.

The instructions and worksheets provided here are easily adapted and modified based on the needs and goals of your course. The activities presented here should work for any level of student on any campus that has even a small natural area. You may choose to focus on different questions or hypotheses to test such as comparing different sampling areas, comparing the same area among years, or comparing plant diversity data with insect or other animal diversity data that you collect in other lab activities.

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