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Wetlands Ecology and Human Impacts Lab: Connecting Students with Their Local Environment

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How do you get biology non-major students interested in ecosystems and apply biology concepts to their own local environment? The Wetlands Ecology and Human Impacts lab was designed to meet the needs of general biology instructors who wanted to take students out of the classroom and help them learn more about their own local ecosystem. This lab is broken up into multiple parts, during which students will visit several nearby locations to learn about ongoing ecological research, the function of local ecosystems, and how human impacts can disrupt those functions. Students start by visiting sites that are a part of a current research project. Students will explore the sites, make observations, formulate hypotheses, and make predictions about the research. They will then examine animal specimens of local wildlife, consider the ecophysiology of these specimens, and discuss how human behavior can impact local wildlife. Students will be introduced to at least one invasive species and contemplate the ways this organism is disruptive and the challenges we face in attempting to remove it. Finally, students will explore a local water system and consider how humans have altered that system and why. In this workshop, we will focus on local wetland ecosystems and have a strong emphasis on invasive species, although this lab is designed to be easily modified to fit the needs of instructors in other parts of the world. Although this lab can be taught at any point, it is an effective way to culminate an ecology unit and help students make connections between different ecological concepts.

Keywords: Wetland ecology, ecosystems, ecophysiology, invasive species, community interactions

Introduction

Several years ago, a group of instructors were having a conversation about what got us all excited about biology. One common theme was that, for all of us, it involved us getting outside, making observations, and interacting with our local environments. We realized that nearly all of the labs we offer for our introductory courses for non-majors involve being inside and often didn't focus on ecosystems in the Midwest. We decided to write this lab as a way to get non-major students outside and understand how they fit into the natural world around them. We wanted them to see that the decisions they make do have an impact, and that even in an urban landscape there are many ways to explore and appreciate nature. Additionally, we wanted students to see actual scientific experiments put into action, and so we used this lab as a way to tie all this in and to wrap up the semester.

Learning Outcomes

a. Students will identify the role of wetlands in ecosystems, and evaluate the efficacy of ecological restoration projects.

b. Students will demonstrate their ability to observe and generate predictions regarding the relationship between an organism's physiology and its ecological niche.

c. Students will assess the positive and negative impacts of invasive species in restored habitats and decide how invasives should be dealt with in ecosystems.

d. Students will compare habitats and make predictions regarding the organisms existing within those habitats.

Leading the Lab

This lab involves students walking to an area that has experimental wetlands and visible invasive species, primarily honeysuckle, *Lonicera spp.* Typically, students will walk to the wetlands (approximately a mile) with their TA and they will meet the instructor there. The lab is primarily led by an instructor or an experienced TA. In the past, we had multiple sections of the course do the lab at the same time. Instructors for the different sections would trade off days, so only one instructor was running the labs on a given day.

This lab involves a great deal of walking, and so it is important to consider accessibility beforehand. Students walk to the wetlands, and then we make a large loop around the wetlands to complete the different sections of the lab. The first stop is in the experimental kidneys. Here, we discuss the role of wetlands and students are able to see how ecological research is being conducted right on their own campus. Students are given a little bit of instruction, but then must determine the hypotheses and predictions of the experiment. They are then able to walk around the kidneys and make observations. From those observations, they draw tentative conclusions. We then have a discussion on what scientists have actually concluded. In this case, these kidneys were set up to look at invasion. One experimental kidney was planted with native plants when it was developed; the other was not. Students will often note that they look very similar. Both have large amounts of cattail and common reeds, both of which are invasive.

We then have a discussion on the local fish species that can be found in different types of water bodies in Ohio. We show them three specimens who have visible morphological differences that indicate their habitat. Students observe the specimens and assess the relationship between the ecophysiology of the fish and its niche. This can be done with all native fish or with an example of an invasive fish. From there, we move on to further discuss invasives by taking a step back from a stand of trees and making observations. In late April, honeysuckle may be blooming while native plants are still buds. Students can see very clearly where there is “a line of green” (the honeysuckle). They are asked to think about how this makes honeysuckle successful in its environment and how local organisms may be impacted by this.

Once students have thought about how the relationship between an organism’s ecophysiology and niche and why wetlands are important and how they have been impacted by invasive organisms, we then finish by walking along the Olentangy River. Students will begin their walk near a weir, and finish their walk near a second weir. This happens to be right where we started the lab, so students will be able to leave from here. During their walk along the river, they will see how the flow of the river is affected by these weirs. They are also likely to see some fun examples of local wildlife, like snakes, box turtles, wood ducks, etc. They will then analyze how that may impact the community assemblage around those weirs. In doing this, they are summarizing several concepts covered in the lab up until this point, so it’s a good way to finish the day.

The best way for this lab to be successful is to have an instructor that is highly engaged and enthusiastic. This is meant to be more of a “hands-on” lab and they may miss the point if they aren’t given enough direction. When we designed this lab, we did it with the intention of wrapping up the semester on a fun note, so this lab is a good way for the students to interact with the instructor outside of the course and for the instructor to tie in some “real-world” examples to concepts covered in lecture.

Student Outline

NAMES:______________________________________ SECTION/TA:_________________________

Meet your TA on the bike path under Lane Avenue at your normally scheduled meeting time (see map uploaded on the course website). Do not be late, as you will be left behind, and will not receive credit for the lab. In the event of inclement weather, assume lab will occur unless you've received an e-mail >1 hr. before the scheduled lab time. Dress accordingly, as we will still have lab outdoors if it is raining. Bring a clipboard, notebook, or hardcover book to use as a writing surface when completing this lab sheet.

Pre-lab

1. Define mitigated wetland.

2. What are some of the ecosystem services provided by wetlands?

Introducing the Olentangy Wetlands

The Olentangy River Wetland Park were established in 1993 and 1994, and have been utilized for research and educational purposes since. Section 404 of the clean water act requires existing wetlands to be rehabilitated, enhanced, or (if destroyed) replaced elsewhere if development impacts them. The park has a section called the "Oxbow" that serves this purpose since wetlands were destroyed for the construction of I-670.

One proximate benefit of sewer overflows-mitigation wetlands (such as those in ORWP) is to reduce stormwater flow into the sewer systems, so less overflow of sewage being washed straight into the river during heavy rainfalls.

To learn more about the Wilma H. Schiermeier Olentangy Wetland Research Park and to see a map of the different parts we will explore in this exercise, please visit http://flux.org.ohio-state.edu/site-description-orv/.

Objectives

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I. Kidneys

Notice the two kidney-shaped, experimental wetlands on either side of you. When the "kidneys" were developed in 1994, one was planted and the other was left to colonize naturally.

1. What do you think the hypothesis and predictions of this experiment were? (1 pt)

Now take some time to walk around with your lab groups and make observations about the two wetlands. Consider both the biotic and abiotic components of each wetland. Write your observations below. (3 pts)

2. How do the two experimental wetlands compare? Which do you think was planted and which was left to colonize? (2 pts)

3. Do your observations support or refute your hypotheses from Question #1? (1 pt)

II. Physiology and Ecology

In many taxa, we can examine the physiological characteristics of organisms and make predictions about their *niche*. An organism's niche is defined as "how it utilizes the resources of its environment, including the space it requires, the food it consumes, and timing of reproduction" (Phelan, 2014). For example, if we were to examine the feet of gecko lizards, we could make predictions about their preferred habitat. Look at the gecko feet (figure 1) and make predictions about where you would find them living. Which would be terrestrial? Which would be arboreal? Which would dig burrows?

We can make similar predictions based on the head shape of fish. Look at the fish on the following page and answer the questions that follow.

Figure 1. The feet of different species of gecko lizards vary in structure. Photo © Kellar Autumn

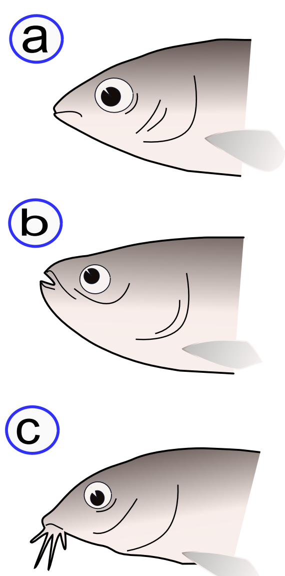

Figure 2. Three distinct head morphs found in fish. The mouth may be terminal (a), superior (b), or inferior sub-terminal (c).

4. Compare the head shape of the various fish species pictured to the left. What predictions would you make about their niche based on your observations? (1 pt)

5. Look at the fish your instructor has brought and compare the head and body shape of the riparian (river) and stillwater (wetland) fish. What differences do you think were selected for/against in particular habitats? Why? (2 pts)

III. Exotic Species

Japanese Honeysuckle (*Lonicera spp.)* is a shrub native to East Asia. It was introduced to the United States in the 1800s and as you can see, it has been very successful. Honeysuckle tends to leaf early, and so it can outcompete native understory plants. The first nesters of the season will often take advantage of this and nest in honeysuckle. Honeysuckle berries are very sweet but have few nutrients. They're sort of like fast food for animals that eat them. They also alter the pH of the soil around them.

6. In what ways is honeysuckle detrimental? What potential benefits might honeysuckle provide to local organisms? (1 pt)

When the levee in the wetlands was originally built, honeysuckle shrubs were able to successfully move into the area. After the levee was removed, honeysuckle struggled and natives had an easier time reestablishing the area.

7. Thinking about the information above, what are some reasons exotic species are able to move into a novel environment and potentially outcompete a native species? (2 pts)

8. A. Exotic species can be incredibly challenging to remove. It's not uncommon to organize groups of people to pull out as much honeysuckle as possible, but these attempts are often not successful. Why might this be? (1 pt)

B. How should our community respond to invasive species like honeysuckle? Support your answer. (1 pt)

IV. Getting Weir-ed

Weirs are barriers intended to alter the flow of a river or stream. While similar to dams, weirs are generally smaller and allow water to flow over the top of them. There are two weirs on the Olentangy River near the wetlands (marked as black lines across the river in the map on pg. 1). Observe both the upstream weir and the downstream weir (each is near the bike path bridge at either end of the wetland) and answer the follow questions about the impact of weirs.

8. How are weirs changing the flow of the river? (1 pt)

9. Think back to the fish you saw earlier, how would the presence of weirs influence the *community assemblage* (what species are there)? (1 pt)

V. Wrap-up

10. Excluding the concepts or organisms explicitly addressed in this lab, briefly connect something else you saw today to a concept we discussed in lecture. (1 pt)

References

Mitsch WJ, Zhang L, Stefanik KC, Nahlik AM, Anderson CJ, Bernal B, Hernandez M, Song K. 2012. Creating wetlands: primary succession, water quality changes, and self-design over 15 years. Bioscience. 62: 237-250.

Phelan J. 2015. What is life? A guide to biology. 3rd ed. New York (NY). W.H. Freeman and Company. 628 p.

Materials

Instructors Need:

- Lab handouts for students
- Wildlife specimens for students to view and make hypotheses about an organism's habitat based on the ecophysiology of that organism. These work best if students can pass the specimens around.
    - We use three fish specimens for this lab: A still-water, stream, and river or generalist fish.
    - We use a green sunfish (*Lepomis cyanellus)*, a brook silverside *Labidesthes sicculus* , and a mottled sculpin (*Cottus bairdii)*.
- First-aid kit
- Keys to research plots, if necessary
- Some instructors will find it helpful or necessary to have a van to transport the students or have a bus map if students will be using campus transportation

Students Need:

- A pencil
- A clipboard or notebook
- Appropriate attire for an outdoor lab
    - Closed-toe shoes
    - Rain gear

Notes for the Instructor

A major goal of this lab is to help students make connections to the ecosystems around them. It is a good idea to have someone who is familiar with local ecology leading the labs, or to at least have some talking points. It is also important that instructors engage with the students as much as possible. There are several parts of this lab where students explore on their own, but bringing students back to have full group discussions will provide a better experience for the students and any TAs.

Preparation for this lab primarily involves ensuring accessibility to the sites you will visit. If using experimental plots, you will need to ensure that you are allowed to bring groups of students to them and that you can access them. For example, the wetlands at Ohio State have areas that are fenced off, but we will get a key ahead of time. This lab entails students walking to the locations we visit, but if those locations are out of walking distance you will need to have a van to transport student or make sure there is campus transportation that will reasonably work. It is also a good idea to walk through the lab with TAs ahead of time to ensure that you are comfortable with what students will likely see during this lab and so that TAs are comfortable getting students to and from the sites you will be visiting.

Students will walk to and from the wetlands with a TA. We do have students meet at a different location than the lab room they are typically in, and it is critical to be clear about this. While students are meeting at a well-known location on campus, we find that some of them will still get confused. We provide students with a map of the location and have TAs wait about 5 minutes before walking the group up to the wetlands. Once the lab is over, we typically encourage students to walk back to campus in groups and/or with a TA.

Cited References

Mitsch WJ, Zhang L, Stefanik KC, Nahlik AM, Anderson CJ, Bernal B, Hernandez M, Song K. 2012. Creating wetlands: primary succession, water quality changes, and self-design over 15 years. Bioscience. 62: 237-250.

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