**Environmental Components of Species Distribution**

**Guide to Instructors**

**Introduction:** This lab is one that can be adapted to almost any habitat with even small amounts of water, and it gives groups of students a sense of what it is like to be an environmental professional or a biologist. They are challenged to look at an ecosystem, collect data using valid scientific practices and describe its current state and the potential for human impacts on that ecosystem using that data. The key to success, from an instructors’ perspective, is to be open to the environment and the possibility that you might not know the answer to a question or how to solve a problem. Focusing on teamwork, having students work to answer their own questions, and help problem-solve in the field will go a long way in helping an instructor gain confidence with this type of lab. It is important to encourage students to think about experimental issues such as consistency of sampling, the need for replication, and good descriptive techniques/note taking. In addition, this exercise also provides an opportunity to collect long term data, potentially each semester over years in the same area, which would allow students to see their environment in a cohesive and long term fashion, and encourages them to support the idea of environmental stewardship. Also, for lessons that combine math and biology or environmental science, this type of longer term data set works well for use with statistical analysis at a very basic level, and if changes are detected over time, then also allows for students to get involved in potential environmental mitigation projects at the school or district level. Further, this type of project can be easily adapted for potential granting agencies such as the Splash! Grants offered through the Southwest Florida Water Management District.

In terms of the pre-planning and preparatory teaching that this lab would require, it can be used during the final chapters of Campbell investigating ecology and environmental science in a traditional biology class as well as courses in Environmental Science. I have also used it with small modifications in Marine Biology courses, and in those latter two contexts, use this early in the courses to help students understand the relationships between abiotic and biotic factors that can affect and structure ecosystems. I pair this outdoor lab with an indoor lab the previous week investigating environmental factors and how to measure them. We learn how to use the tools in lab, and then students are ready to complete the lab the following week. The day before I run the lab I work with students to discuss potential hypotheses to investigate when we go out into the field and what types of patterns we might see.

**Standards covered using the lab**: Below is an outline of the purposes of the lab and a partial list of standards completed with the lab. The list may change depending on which aspects of the lab you choose to focus on.

1. Scientific Practices in the Field
	1. Model Lesson that:
		1. Incorporates multiple standards into a lesson or activity
		2. Can be adapted and applied inexpensively in most Florida high schools by taking advantage of our natural wetlands, manmade retention ponds or seasonal creeks.
		3. Teaches students simple yet essential field sampling practices
		4. Stimulates student interest and connection to their local environment
		5. demonstrates the importance of animal and plant diversity and the impact human activities may have on this diversity
		6. demonstrates the connection between physical and biological factors in aquatic systems
		7. Provides hands-on experience with data collection, interpretation and analysis using simple tools
		8. Facilitates student construction of visual summaries of their data (graphs)
	2. Specific objectives of the model lesson:
		1. To provide an example of an engaging, motivating lesson
		2. To demonstrate the use of an inexpensive, field-based activity to activate student learning
		3. To demonstrate a way to expose students in their local environment and stimulate inquiry about their natural world, and investment in their local environment
		4. To demonstrate a way for students to generate their own data sets to interpret and analyze as an example of how science is conducted
		5. To demonstrate a lesson that connects students to animal and plant diversity which may serve as a mechanism for discussing the organization and hierarchy of living organisms
		6. To observe the interconnection between physical and biological components of an ecosystem
		7. To demonstrate the importance of scientific practices (as outlined in the new NGSS)
			1. i.e., Asking questions, using models, carrying out investigations
		8. To provide an example of an alternate mode of assessment
	3. Standards that may be addressed using this model lesson:
		1. SC.912.L.15.6 Discuss distinguishing characteristics of the domains and kingdoms of living organisms.
		2. SC.912.L.17.2 Explain the general distribution of life in aquatic systems as a function of chemistry, geography, light, depth, salinity, and temperature.
		3. SC.912.L.17.4 Describe changes in ecosystems resulting from seasonal variations, climate change and succession.
		4. SC.912.L.17.8 Recognize the consequences of the losses of biodiversity due to catastrophic events, climate changes, human activity, and the introduction of invasive, non-native species.
		5. SC.912.L.17.13 Discuss the need for adequate monitoring of environmental parameters when making policy decisions.
		6. SC.912.L.17.20 Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability.
		7. SC.912.N.1.1 Define a problem based on a specific  body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following:
			1. pose questions about the natural world,
			2. conduct systematic observations,
			3. examine books and other sources of information to see what is already known,
			4. review what is known in light of empirical evidence,
			5. plan investigations,
			6. use tools to gather, analyze, and interpret data (this includes the use of measurement in metric and other systems, and also the generation and interpretation of graphical representations of data, including data tables and graphs),
			7. pose answers, explanations, or descriptions of events,
			8. generate explanations that explicate or describe natural phenomena (inferences),
			9. use appropriate evidence and reasoning to justify these explanations to others,
			10. communicate results of scientific investigations, and
			11. evaluate the merits of the explanations produced by others.
		8. MA.912.S.1.2 Determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment
		9. MA.912.S.3.2 Collect, organize, and analyze data sets, determine the best format for the data and present visual summaries from the following: bar graphs, line graphs, histograms, scatter plots (etc.)

**Materials needed**: The list below is a complete set of what I use in my lab research, but for most of the items there are simple and inexpensive alternatives.

1. Students should be told to bring a hat, water, sunscreen and possibly bug spray (depending on what time of year you are working), but teachers should have extra sunscreen and water on hand as well
2. Thermometers
3. Salinity meter (hydrometers can be purchased at any pet store for a few dollars)
4. Turbidity meter (a Secchi disk\* works as well, or you can use a long white PVC tube marked at 15 cm intervals)
5. PVC square/quadrat – ½ meter and 1 meter squares both work
6. Phosphate dip tests or drop tests (can be purchased at a pet store)
7. Nitrate/Nitrite dip tests or drop tests (can be purchased at a pet store)
8. Hand nets – regular medium sized aquarium nets work fine
9. Field guides to fish, invertebrates, local plants, pond life algae and protists, etc. (optional, but often fun for students to look up what they find, and also a way to decrease the stress on the teacher in terms of the “need to know everything”)

\*A Secchi disk is a round weighted disk with the top colored 50% with White and 50% with Black. You can purchase one, or create your own using an old vinyl record or a plastic disposable plate weighted with fishing weights on the underside.

**Procedure**:

Pre- field work – Prior to the field experience, the instructor should identify a safe but varied location to take students to for the purpose of running the experiment. Discussions leading up to the event could focus on environmental science or biological concepts, but working with students to ask questions and come up with them on their own is an important part of getting them invested in the process. Sites selected can be a retention pond where one end is near a parking lot or street with runoff and the other end towards a green-space. Shaded or sunny waterways can also be compared. If there are a few bodies of water close to campus, then if they vary with their location relative to agriculture (sources of fertilizers rich in nitrogen or phosphorus), natural areas, housing developments, etc. they can be used as separate sites for investigation and comparison. Students should be broken into teams, with each team responsible for their own “research” gear. Instructor should discuss with students issues of replication and why it is important, and discuss some of the issues students will face when they get out to the site (identifying plants, trying to catch fish with a net, the difficulty of estimating the number of live organisms moving in water, etc.) and have them discuss ways they might solve these problems in the classroom before they get out to the site. Instructor should stress that any time in the field can be unpredictable, and students may be called to think on their feet to solve problems.

Field day – Students should have some kind of supervision when they reach their sites, but be allowed to work through the requirements listed on the lab assignment. As they work, instructors (also can be older students, etc.) should ask them questions about what they are doing and what they are seeing to keep them on task. The handout attached for the lab is fairly self explanatory, but for some things, students will need some instruction. For temperature, they need to take repeated water temperatures and air temperatures in their sites, and they need to wait a minute or two for each temperature reading to stabilize. For salinity, they just need to fill the chamber and record the value, but they should do that a repeated number of times (5 for each site). Measuring water “cloudiness” can be done many ways, with a simple homemade Secchi disk as described in the materials or a long PVC tube with markings for depth. For plant and animal diversity, identifying the specific organisms can be fun but very time consuming, and so the biggest issue is to just identify how many different kinds there are. Also, students may see other organisms at their site, but they have to be reminded that if the organism didn’t occur in their sampling area specifically (inside the quad or a pre specified area) then they can include the critter as a note but can’t include it in their count.