Peer Evaluation
Observation Report

Professor Observed: Dr. Tracy Feldman **Course:** Biology 100 **Date:** 11-12-2009

Type of Activity Observed: Biology 100 Lecture on Evolution & Natural Selection

Dr. Feldman's lecture to his non-majors biology class on this day centered around the topics of natural selection and speciation. Throughout his lecture, I felt that Dr. Feldman exhibited excellent interaction with his students. He displayed skill in getting students to participate in classroom discussions. It was obvious that he has created a stimulating atmosphere in the classroom, an atmosphere in which students feel comfortable asking questions and offering their ideas. For the most part, students were attentive and actively taking notes during the lecture. The pace of his presentation was fine, and he gave students adequate time to complete note-taking related to a given topic or example before moving on to the next. Terms were explained very clearly. Examples illustrating forms of natural selection and speciation were presented clearly and logically.

Periodically, the class broke out into groups to discuss a topic or question pertaining to natural selection or speciation. Students in the groups around me were actively discussing the assigned topic for most of the allotted time; they only began to drift to non-related issues near the end of that time. However, Tracy was cued into this situation and quickly ended group discussions at an appropriate point. He then got students back on task by asking them to share with the entire class the ideas that came out of their group discussions.

I was very favorably impressed with the organization and presentation of Tray's lecture, and I was pleasantly surprised by the effectiveness of the break-out group discussions. I think that this approach worked well for the classroom session that I observed today. I was also impressed with the enthusiasm that Tracy brings to the classroom. It is obvious that he enjoys teaching and interacting with his students. It is equally apparent that he invests considerable time in planning out his lecture, both in terms of topics and materials that are presented and in terms of topics and questions for discussion groups.

The last several minutes of the lecture session today was reserved for handing back recent exam papers. Students were given the opportunity to improve their scores by submitting written responses as to why questions that they answered incorrectly were, in fact, incorrect and by providing corrected responses. This policy indicates to me that Tracy possesses an understanding of the student clientele in Biology 100. Many of these students have little or no science background. Allowing these students to revisit topics, issues and questions that they did not understand initially creates the kind of encouraging atmosphere that is needed for success in this course. I think this approach also encourages students to think more about the role of science and science-related issues in their daily lives.

Ed Gasque, Peer Observer

Tracy Feldman, Faculty Member Observed

Comments from Faculty Member Observed:

Peer Evaluation
Observation Report

Professor Observed: Tracy Feldman

Course: Bio. 305 (Ecological Methods)

Dates: May 3, 2011 & May 11, 2011

Type of activity observed:
Lab - Instructor consultations & student presentations

Observations:

I observed Dr. Feldman in his class on two separate occasions this semester. The first opportunity occurred on May 3, 2011. At the beginning of this class Dr. Feldman reminded students to turn in lab reports and he offered students an opportunity to revise lab reports and resubmit these for a revised grade. Dr. Feldman then spent the remainder of the class session working with students to finalize details regarding their research projects, meeting with each group of students and discussing the status of their respective projects. He offered advice on topics ranging from final project design issues, data collection and data analysis. He instructed students to carefully and explicitly articulate the hypotheses they were choosing to test. Dr. Feldman also provided advice to the students regarding presentation tips and the format for presentations to be given in the following week. Dr. Feldman made reference to the relevant pages in the lab manual regarding presentation details. He also spent approximately 15 minutes querying students on "what makes a good presentation?" The discussion was very interactive and students seemed to enjoy the discussion and anecdotes of speaker failures and what factors can also contribute to a poor or ineffective presentation. Dr. Feldman spent time explaining what elements should go into the methods, results, and discussion portions and urged the students to articulate the following four items in their methods sections: a null hypothesis, the name of the statistical test employed, the reasons for using this test, and the α level chosen for the test. Finally, Dr. Feldman reminded students to use the discussion section to explore the limitations and implications of their research results. Dr. Feldman used the remaining 20 minutes to meet with each group to discuss their project abstract, report, and presentation preparation. I watched Dr. Feldman's interaction with a group of students and observed as he queried them about what constitutes the actual replicate in their design and what test is most appropriate given the likely non-normal distribution of their collected data.

The second opportunity I had to observe Dr. Feldman's class was on May 11, 2011. The primary objective of this class meeting was to provide students the opportunity to present the results of their projects. Dr. Feldman also administered the course evaluations at the beginning of this meeting as well. Four different groups presented their project results during this class period. A copy of the project title, abstract, and list of participants is attached to this peer observation report. Each presentation lasted about 15 minutes and presentations were followed by extensive questions by fellow students, Dr. Feldman, and Dr. Holsman (a student-invited guest).

(over ⇒)

Positive Attributes:

Typical peer observations usually consist of the following: the observer is invited to a class meeting where the observed gives a lecture or leads a lab exercise. The observation consists of a single lesson or exercise wedged somewhere within a semester of lectures and exercises. For the observer, sometimes the context and learning outcomes of the lesson are clear, other times less so. I mention this because of the significant nature of my two observations in Dr. Feldman's class: the class sessions focused specifically on demonstrating student learning outcomes as facilitated by the instructor. Bio. 306 has a readily identifiable primary learning outcome: the provision of tools and methods to conduct and understand ecological research. By having students work in groups to design projects, formulate hypotheses, collect data, employ statistical tests, and present the results, the course learning outcomes are clearly assessable by observing the final sessions of the class.

I was impressed by how clearly and carefully students were able to summarize their studies. Several students (not currently presenting) queried about hypotheses and appropriate statistical tests at the end of each presentation. Given what I observed on May 3, I know that students received careful prodding and guidance from Dr. Feldman on all facets of their projects.

Concisely, I was impressed by the efforts of Dr. Feldman and the learning outcomes so prominently achieved and displayed during my observations. As a casual aside, during the presentation session, Dr. Holsman leaned over to me and commented "I think all the smart students are Biology majors." I noted that while that might be true, I reminded him of the importance of clear and careful teaching in developing those students, as evidenced in Bio. 306 by Dr. Feldman.

Suggestions for improvement:

I observed that the students enjoyed the banter and discussion regarding the elements of a good and poor presentation. You might consider as part of this discussion making a four or five slide PowerPoint that displays (and purposely exaggerates) each of the common mistakes on a given slide (e.g., too small of font, too many words, shocking color schemes, etc.…). The students really liked this topic and sometimes nothing teaches as well as a bad example (that no one in the class has to serve as in this case.)

Signature of observer: _____ (TODD C. HUSPENI)

Signature of observed person: _____

This is to verify that this report has been seen and discussed; it does not imply that the observed person agrees with the findings.

Comments of person observed:

PEER EVALUATION/OBSERVATION REPORT

Professor Observed: Dr. Tracy Feldman
Course: Biology 355/555, Plant Ecology
Day, date, time, and site of observation: Monday, 13 September 2010, 1300-1600 hrs, CNR/TNR 461 and in the field near Plainfield, Wisconsin.
Type of activity: Lab on Plant Succession.

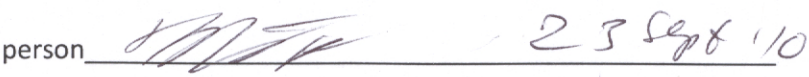
Observations: Dr. Feldman began his lab with overview of the construct of the lab, equipment, field location, etc., and he indicated that some material covered in "today's" lab would dovetail with material in an upcoming lab later in the semester. He then specifically asked the students for a definition of plant succession. The answer came via some of his remarks and through him expanding on some pitches rendered by students. Dr. Feldman also used a Power Point image to complement his introduction to key concepts and lab procedures; the image was part of a several page e-version given to students (and this observer) prior to the lab's meeting. He also briefly covered some details of the history of the ecological theme of plant succession.

He then indicated that the goal of the lab was to conduct field work at a lake near Plainfield such that sampling and subsequent analyses of data from said site would perhaps demonstrate plant succession. He divided the class into five groups, had them take requisite equipment and then drove to Plainfield. There Dr. Feldman said a few words about the site and where and how students were to sample plants. Students then walked onto the study site and set up transects and began sampling; Dr. Feldman walked among the groups and offered advice on how to count and record species...he too assisted with identification of plants (I add that the aforementioned e-handout contained numerous excellent photos of the various plant species students would likely encounter). I left the study site while students were still sampling.

Students seemed to this observer to understand what and how they needed to sample. Dr. Feldman spoke clearly, was organized, and joked a bit with them (e.g., told them that their sampling in effect meant going considerably back in time and that he hoped they brought enough food to allow for an extended stay). He was very helpful with students while in the field. I indicated to him that the field site was an excellent outdoor setting for this lab and that I looked forward to and was hoping to be present in his lab when students analyzed their data; Dr. Feldman welcomed me to do so. I add that Tracy explicitly welcomed me to comment on an upcoming field-experiment in another plant ecology lab concerning fruit removal rates by birds.

Suggestion(s) for possible improvement: The sampling occurred in a relatively small area of the lake and was wondering if the sampling design was random (or would it matter given your objective[s]?).

Signature of observer  23 Sept '10

Signature of observed person  23 Sept '10

This is to verify that this report has been sent and that an offer to discuss its contents was made by the reviewer to the person observed.

This observer has a copy of the report and the original notes upon which it was based.

END-OF-SEMESTER EVALUATION

It would be great to receive constructive feedback from you about the course (more specific and less general comments will be more helpful). After you fill these out, one of you will bring it to Jackie Engum in the Biology department office (167 TNR). Then, **I will pick them up after your grades are all posted**. None of the things you write will affect your grades.

1. What are some aspects of the course that are working well so far, or that you have enjoyed?

   I enjoyed the lectures and your enthusiasm for the class. I was never upset about having to go to this class. I actually enjoyed it.

2. What were some aspects of this course that could be improved? Specific, constructive comments and suggestions will be more helpful than general ones.

   Perhaps taking more time to allow for questions in lecture.

3. What was effective about the lectures/classes (were they clear, easy to follow, informative, etc.)? Are there things I can do to make them more effective for future classes?

   Yes they were clear. I was glad the notes were put on D2L. Continuing that would be great.

4. Were the labs been effective? (Were they informative? Did you like their format?) Please offer any suggestions you might have for ways I can make labs more effective in future classes.

   Yes, I enjoyed the labs, the book was extremely helpful

5. Was I responsive to your concerns and questions, and was I available in class and outside of class to answer your questions? What can I do to make myself more available?

Yes, I appreciated you answering emails directly and in class.

6. Do you feel that I have evaluated your work fairly? Please explain, with specific examples, if there are ways I could be fairer.

Yes. I never felt unjustly graded

7. Please feel free to raise any other comments or concerns you may have. Again, specific constructive comments and suggestions will be more helpful than general ones.

I enjoyed this class! and did learn a lot.

CLASS/INSTRUCTOR EVALUATION

Please answer the following questions about the course or about the professor. The following information be kept anonymous, and will **not** be read by the professor until well after grades have been handed in, so this will **not** affect your grades. If you need more space, feel free to use the back of this sheet.

1. What were some things you thought worked well in this course overall?

   I really liked how the lab reports only consisted of two sections because writing a full lab report for each lab would have been stressful. Also writing only two sections allowed us to focus on the quality which helped when writing the full report for the group project.

2. What were some things that could be improved about this course, overall?

   Personally, I would have rather written lab reports for all the labs and not done a rewrite on one of the labs.

3. Were the lectures effective (clear, easy to follow, informative, etc.)? Please list any suggestions you might have for ways the instructor can make lectures more effective.

   The lectures were very clear and helpful especially the lectures on the statistical tests.

4. Were the labs effective (Did they complement the lecture material? Were they informative? Did you like their format?)? Please list any suggestions you might have for ways the instructor can make labs more effective.

   I really liked the labs we did and I feel that I learned a lot from them.

5. Was the instructor responsive to your concerns and questions, and available (was it a problem if they were not often able to come to campus)?

I felt very comfortable with going and asking for help.

6. Do you feel that your work was evaluated fairly? Please explain.

Yes, I feel that the effort I put into the labs and the report was fairly evaluated.

7. Please feel free to raise any other comments or concerns here.

END-OF-SEMESTER EVALUATION

It would be great to receive constructive feedback from you about the course (more specific and less general comments will be more helpful). After you fill these out, one of you will bring it to Jackie Engum in the Biology department office (167 TNR). Then, **I will pick them up after your grades are all posted**. None of the things you write will affect your grades.

1. What are some aspects of the course that worked well, or that you have enjoyed?
   Field trips! I really like collecting data to work with. It makes it more interesting to know you actually collected the data. Also, the partial lab reports were way better and more time efficient than writing full ones for every experiment
2. What were some aspects of this course that could be improved? Specific, constructive comments and suggestions will be more helpful than general ones.
   The Weather!!! Ha ha. The Foraging lab was a bit Comprehensive for the time we spent talking about it in class. I realized this when I went to write the report, I didn't fully understand how to look at the data. BUT. There is the one lab you don't have to do. AND if I choose to do that one I know you would be more than happy to help

So, maybe a bit more time could have been spent on discussing this lab, →

3. What was effective about the background information given through the manual and in-class information (was it clear, easy to follow, informative, etc.)? Are there things I can do to make this part more effective for future classes?
   I thought that information was very good. I used the manual whenever I was curious or needed to know a little more background info to better understand the project or lab. Your info in class was also good enough for an understanding, yet not too much to bore us.

4. Were the labs been effective? (Do they teach skills relevant to ecology and science in general? What did you like or dislike about their format, and why?) Please offer any suggestions you might have for ways I can make labs more effective in future classes.
   I thought they were effective. They laid down the general aspects of ecology, as far as I know, very nicely. It was a good intro to ecology. I liked all the hands on labs

5. Was I responsive to your concerns and questions, and was I available in class and outside of class to answer your questions? What can I do to make myself more available? Yes! you are very prompt with email, and helpful And I also sought out help in class and when you were in your office, I never had a problem reaching you and getting beneficial help! I can tell you want to give students the best understanding and you care about that!

6. Do you feel that I have evaluated your work fairly? Please explain, with specific examples, if there are ways I could be fairer.
In my opinion you have. There was always an explaination when you took points off for something Usually I agreed, otherwise I asked for clarification, then I agreed No. Unfairness was seen by me.

7. Please feel free to raise any other comments or concerns you may have. Again, specific constructive comments and suggestions will be more helpful than general ones.
I really like how you mainly let us come up with the hypothesis, or act that we wanted to test. A few times things got a bit confusing for me but I just went to you for help and I was good after that. As long as students come to you with questions if they don't understand something, and you give no reason not to/or to be afraid ect, they will do well in your classes. I enjoyed this class!

Lab 3 (Part II): Species Interactions and Experimental Design: Prelab

Pre-lab: Read through the lab, and answer these questions on a separate sheet of paper **before coming to lab**! You will turn in this in at the start of lab.

1. Think of an insect you have seen: describe and/or draw the various stages in the insect's life cycle (e.g. is metamorphosis involved?). You may use the web to research the insect. Give the web address for your reference.

2. What are **two** different ways that different types of insects use plants for food (different ways that insects can eat plants)? In other words, what are **two** examples of different ways these plant-eating (herbivorous) insects use the plants they eat? Use this lab, your textbook, or any other sources on **herbivorous** (plant-eating) insects to help you.

3. What type of ecological relationship (e.g., parasitism, commensalism, mutualism) does the insect example you gave in #1 have with plants? Why do you think so?

4. What system and question do you think you'd like to address?

Lab 3 (Part II): Species Interactions and Experimental Design:

Objectives

- to understand that many insects have different ways of eating plants
- to understand that insects and fungi can affect plants in different ways
- to understand how biologists measure some of the effects of insects and fungi on plants
- to understand that clear hypotheses help biologists to design better experiments

Introduction

Many organisms (including insects and fungi) use plants in different ways. We will again be conducting lab in the Schmeeckle Reserve. Your job is to study one **biological system** (one type of insect or fungus and the plants it uses) by designing an experiment (something you can measure) to test one question you have that can help us better understand potential effects of one species on another. You should avoid damaging plants or insects you study during this lab—you will want to plan an experiment that does not require you to harm either plants or other organisms.

Here are a few biological systems worth exploring (just pick one):

1. **Gall insects:** Canada goldenrod (*Solidago canadensis* L.) stems are often inhabited by the goldenrod gall fly (*Eurosta solidaginis* (Diptera: Tephritidae)). Gall flies are one of many species that lay their eggs in the stems of the plant. When the eggs hatch, the larva (a maggot) begins to grow inside the plant. The maggot gives off chemicals that signal the plant to produce excess tissues that eventually forms a mass surrounding the young fly, called a **gall**. A number of bird species will peck open the gall to feed on the maggot inside, leaving a destroyed gall in its place.

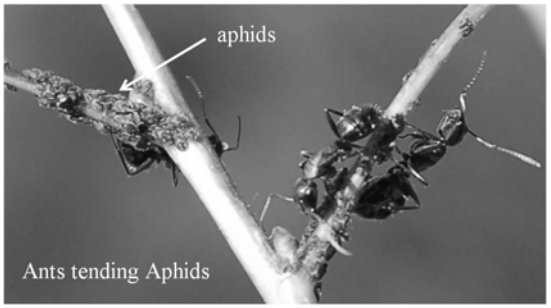
   Biologists are often interested in whether interactions among species are harmful or beneficial to the individuals involved. Certainly, the gall fly benefits from this relationship; it gets protection and nourishment from the plant. On the other hand, is the goldenrod affected in any way by this relationship? If the gall fly reduces the chances that the plant will produce seeds, biologists would call this **parasitism**. On the other hand, the gall fly may have no effect on the plant's reproduction (**commensalism**) or may even benefit the plant (**mutualism**). Likewise, the birds that eat the fly larva can also benefit, but does their activity benefit or hurt the goldenrod?

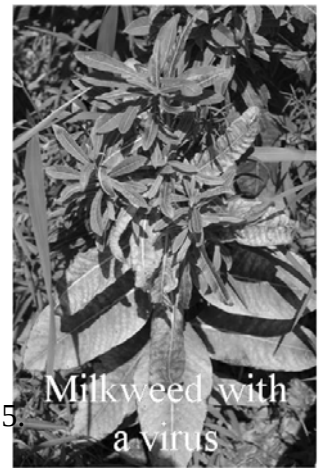
2. **Gall insects** may also occur on Poplar leaf stems, willow trees, or oak leaves. You could ask similar questions using galls on those plants as you could with galls on goldenrods.

3. **Rust fungi** (*Puccinia* spp.) commonly infect the leaves of goldenrod plants, and sometimes other plants in the area—they form patches that are rusty in color. Each rust fungus species uses a different 1-2 plant species as its host. As the rust fungus infects a

plant, often it produces sugars that attract insects. Rusts may harm plants directly by filling leaf tissue with the body of the fungus. Also, if they attract insects, they could harm plants indirectly if those insects eat the plant too.

4. **Aphids** are small insects that may occur on Poplar leaves or leaves and stems of other plants (goldenrods, asters, milkweeds, etc.). As the aphids suck out plant juices, they take in more water than they can handle all at once. So aphids excrete some of the plant juices, which contain sugars that attract ants. Ants may protect or eat the aphids. In turn, aphids may harm the plants on which they feed. Aphids also commonly transmit plant diseases like **plant viruses**, which make the leaves of infected plants appear smaller, mottled (green with yellow spots or stripes) or curly (like lumpy potato chips).





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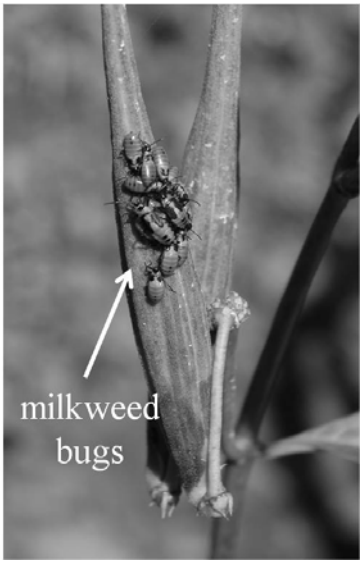
6. **Seed-feeding bugs** (like milkweed bugs, which are black and red) eat seeds of plants. Milkweed bugs occur on the outsides of milkweed pods, sometimes in large numbers.



7. Insects in **rolled leaves**: Sometimes herbivores feed from leaves they roll up around themselves (what might be an advantage of this?). Spiders also sometimes hunt from leaves they have rolled up with silk.

8. Other insects (unknowns): You can use **holes in leaves** as evidence that an herbivore was there. Different types of plants, or different locations of a population or an individual, may be attacked more often.

Lab Procedure & Report

We will go to a meadow at the Schmeeckle reserve to make measurements. You should use the plants in the designate plots as your subjects. Setup an ecological study with your team, and define research question and hypothesis to test during lab today.

The following are some examples of possible questions you could address, to give you idea about possible approaches (**you can pick one, or come up with your own**):

1. Are plants taller or shorter or no different in height when they have herbivores or no herbivores?

2. Do flowers grow bigger when no herbivory is present?

3. What is the natural variation in gall length and width? Do bigger plants (or leaves) have bigger galls? To answer this, you could use a caliper to measure the width and length of galls. Graph the length and width of the galls to visualize the variation in the data. You may also calculate the variation as described below.

4. Does infestation by gall-forming or other herbivorous insects reduce plant growth? Not all plants have herbivores on them. Within each established plots, measure the height and/or stem width of all individuals with herbivores and without herbivores. You may compare the means (averages) mathematically as described below.

5. Do birds choose to eat larger galls? To answer this, measure the length and width of all galls within a plot. Separate the data into galls that have not been disturbed and those that have been eaten by birds (how can you tell?). Make a graph of the length x width of galls in the two categories and calculate the means and variances of the two groups.

6. Are more or fewer herbivores found on leaves or plants with rust fungi than without rust fungi?

7. Are more or fewer aphids found when ants are present? This could mean that ants are gathering where more (or fewer) aphids are (for more food), or that aphids do better (or worse) in the presence of ants.

8. Do herbivores reduce the plant's ability to produce offspring? To answer this, count the number of flowers, the length of the **inflorescences** (groups of flowers), or the weight of the inflorescences (do not pick flowers unless directed to by the instructor) of plants within your plots that do or do not have herbivores.

9. Are more seed bugs found on bigger seeds/pods, or bigger plants?

10. Do herbivores attack a plant species more or less often when it occurs in big clumps than when plants are isolated? To address this question, you could measure the number of herbivores (or number of galls or leaves with rust or chewed holes, and also measure the distance from each individual plant to the nearest neighboring plant(s) of the same species.

Methods:

1. In your group of 3-4 people, write out the scientific question you have selected to investigate:

2. Now from the question, write the hypothesis you will test today below. In your hypothesis, you should specify the pattern you think you will see **and explain why**, as well as what you will measure.

3. Form a scientific plan for getting the data (testing your hypothesis). [The following supplies are available to conduct your experiment: meter sticks, and tape measures.] Provide a description of your plan in the space provided below. Your plan must include your list of required materials, the procedure you will follow in taking your measurements, plot(s) dimensions, subjects, etc. Remember aspects of good experimental design we discussed.

4. Collect your experimental data and record the results in the Table 1.

Table 1. Experimental Data

Subject	**Variable Measured:**	**Variable Measured:**
1		
2		
3		
4		
5		
6		
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19		
20		

Lab 3 (Part II): Lab Assignment (Due at the start of lab next week):

1. Carefully explain the hypothesis you tested, and the observations or ideas that led you to forming it. **(4 points)**

2. On graph paper provided, plot a graph of your experimental results (do EITHER a OR b). **(8 points)**
    a. If you have two "treatments" take the mean measurement and make a bar graph, plotting the mean for each treatment as a bar. Also, graph your actual data next to the bar for each treatment, so you know how much your data vary around your means.

    b. If you have two variables that change together (e.g. plant size varies with number of leaves with holes), plot one characteristic on the vertical (Y) axis and the other on the horizontal (X) axis. Usually, the first characteristic mentioned in your hypothesis will be on the X (horizontal axis), as this is the factor you think is causing the pattern. The Y axis will be the second characteristic, the variable affected by X. For each of your test subjects, put a dot on the graph for their measurements. After you have plotted each of your subjects, connect the dots (or judge the best line) to make a line graph.

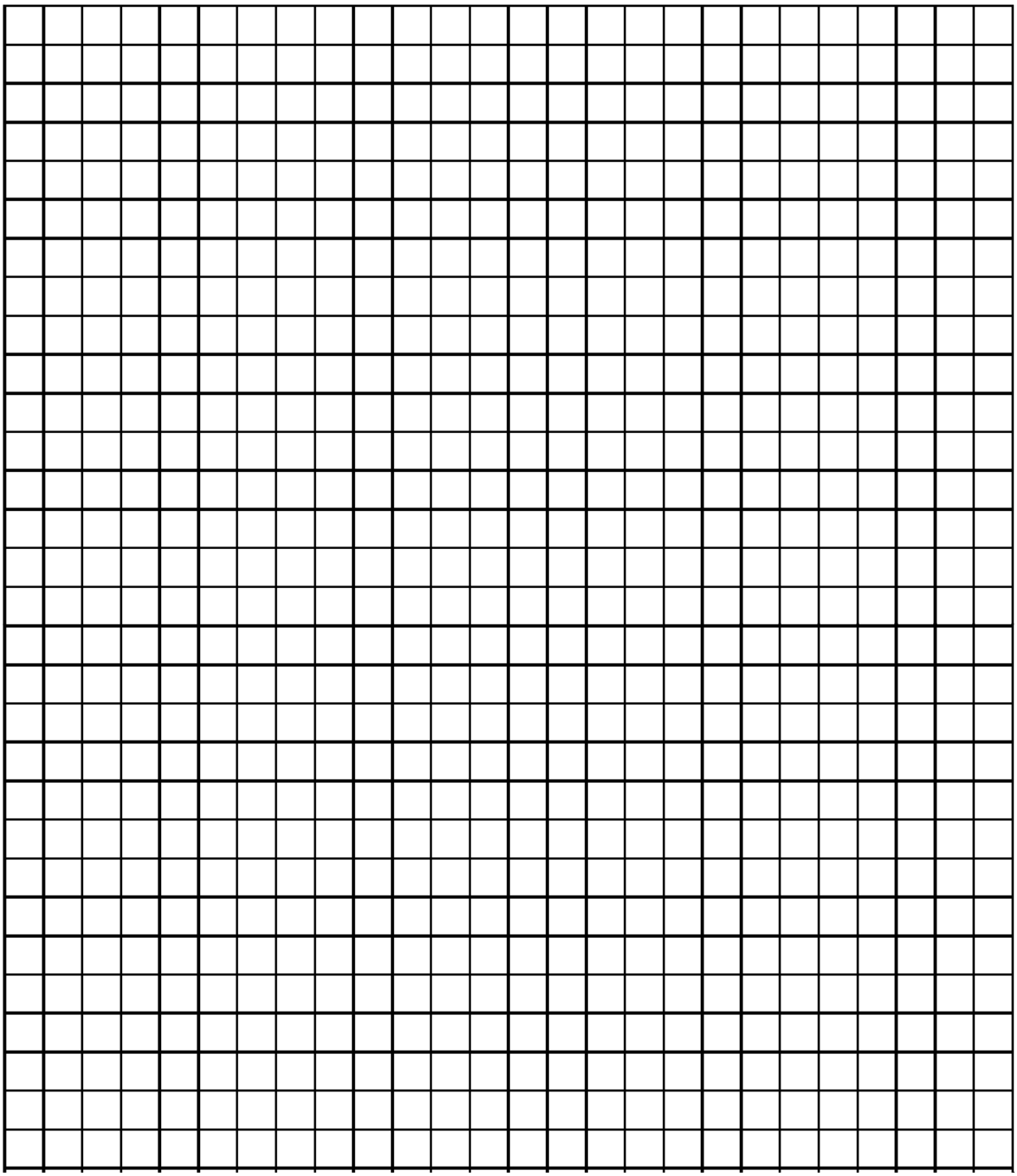
3. Write a conclusion based on your hypothesis and collected data. **Support your conclusion** with data you collected during your ecological study. In other words, what patterns did you find? Do the patterns you found support your hypothesis? **(6 points)**

4. How confident are you in this conclusion? **Explain your answer.** What would need to be done to make you even more confident in your conclusion? **(4 points)**

5. What was the most interesting thing you discovered today? How does it relate to what we've been doing in class? **(4 points)**

6. What questions do you still have about this biological system? Come up with a new hypothesis based upon this new question. **(4 points)**

You can draw your graph here or on a separate sheet. Either way, you will turn this in (if I collect this lab):



Community Ecology and Species Diversity
using Fungal Endophytes

Introduction:

Fungal endophytes are fungi that live "inside plants". These fungi are found in every plant known (when people have looked), and affect plants in various ways. Some may be **pathogens**, and may harm the plants under the right conditions. Some may be **saprotrophs** (decomposers that feed on dead material) waiting for the plant to die so they can be the first to decompose the plant tissue. However, many endophytes have positive effects on plants, including enhanced drought tolerance, disease and herbivore resistance, as well as increased biomass. In fact, some endophytes of grasses have even been patented and used in agricultural crops because of these positive effects.

During the first week of this lab, I will introduce the topic of fungal endophytes, and some questions ecologists have addressed regarding these organisms. As a class, you will come up with a question about fungal endophyte diversity in the needles of winter evergreens, and articulate hypotheses, and a sampling scheme to test your hypotheses.

Questions and hypotheses:

You may wish to ask questions comparing the diversity or abundance of endophytes from different locations on one tree, or from different trees of the same species, or between different species of trees. In each case, you should figure out your reasoning for your hypotheses and your predictions. It may not make sense to come up with a hypothesis about the number of species you predict to find, because there is no basis for making that prediction.

If you ask questions relating to species diversity, one way to address species diversity is by simply counting the number of species you have (this is called **species richness**). Another method involves calculating some index of diversity that takes into account both the number of species in your sample and how abundant each species is in the sample. One commonly used "diversity index" is the **Shannon diversity Index**, or **H'**. This index weights common species more than rare ones, so a community in which all species are equally abundant would get a higher score than a community in which there is one common species and many rare ones. It is also informative to construct a **species-sampling curve**—how does the **cumulative number of new species** you find change with increasing numbers of samples? You know that the number of species will increase with the number of samples, but we can learn a lot about the diversity of a community by the shape of this increasing curve. A curve that increases rapidly indicates that the area may be more diverse. However, if the curve levels off quickly (no new species with additional samples), this means that the community diversity may be low. Either way, you will have to make decisions about how to determine the different "species" you have.

Sampling scheme (some questions to consider):

1. What can you measure that would help you effectively test your hypotheses?
2. How can we obtain enough replicates?
3. How can we sample randomly? We may have to choose trees arbitrarily, but we can sample randomly from within a tree.
4. How many treatments will we have?
5. Will we have any controls? What sorts of controls might be useful?

The more organized you are, the more smoothly you will be able to collect samples during next week's lab. Sterilization and plating takes some time, so the more quickly we can collect samples, the better. However, we want to collect and surface-sterilize samples within the same day, if possible, to minimize the chances of contaminating our samples with airborne fungi that could grow while samples are in storage during the week. Thus, we cannot collect samples during one week and plate samples the next. It might be wise to scout out the "field site" this week, to plan our course of action.

Collecting samples:

To isolate fungal endophytes, we will first collect leaf samples (as determined by your experimental design). Each person in your group should collect one or more branches, **enough to obtain a total of 15 spruce or pine needles per person.** So far, spruce needles are yielding more endophytes, so it might be better to use spruce for this experiment. Make notes of any important measurements you might wish to make associated with your sample, possibly including:

- collection date
- temperature
- cloud cover
- location of the tree
- identity of the tree (if we can figure it out)
- size of the tree
- where the branches you collected were from on the tree
    - which side of the tree
    - how high up
    - closer to the outside or the trunk
- any other information you think might affect the diversity of endophytes

You will have to clearly define your "experimental unit". In other words, what is a sample is in your experiment? Each leaf? Each plate? Each branch? Remember to avoid pseudoreplication—the size of your "experimental units" will depend upon the question you are asking.

To surface-sterilize the leaf/branch segments:

Back in the lab, prepare the samples for surface-sterilization. Label your test tube with labeling tape and a sharpie marker, so you can identify you sample (your initials would be fine).

If you sampled **spruce needles**, you can just break needles off of the branches and put them into the sterilization tubes (test tubes).

If you collected **pine needles**, cut or break the leaves (needles) into pieces 1 cm long (use enough leaves to get around 10 pieces per person), and place into a sterilization tube.

If you collected **small tree branches**, cut the branches into 1 cm (**less than 0.5"**) long pieces with pruning shears.

Procedure:

1. Your personal transfer pipette can be stored in bleach solution in between steps (**label it as yours with a sharpie**)—rinse it out with bleach solution in between steps, but **make sure it is empty of bleach** when using your pipette in the other steps below!

2. Carefully pour a **small amount** (5-7 ml) of 70% Ethanol in your vial, **without touching the bottle to the vial**. Swirl the vial vigorously for 2 minutes, enough to cover the leaf segments and "agitate" them. Use **your personal transfer pipette** to remove the Ethanol. Do not leave them in the Ethanol for longer than 2 minutes!

3. Once the Ethanol is gone, carefully pour a **small amount** (5-7 ml) of 2% NaOCl (Sodium Hypochlorite—bleach is about 6% Sodium Hypochlorite) in the vial (**do not touch the neck of the bottle to the vial**), and swirl vigorously for 5 minutes. Use **your personal transfer pipette** to remove the bleach (in the hood)—do it carefully but as quickly as you can. If you need to do so, begin removing the bleach early to make sure your samples are not soaking for longer than 5 minutes.

4. Rinse with sterile water **twice**—pour the water carefully from the bottle (not too much, and do not touch the rim!), and after swirling, use **your personal transfer pipette** to remove the water from the vial.

5. Carefully pour a **small amount** (5-7 ml) of 70% Ethanol in your vial. Rinse for 1 minute. Remove it with **your transfer pipette**. Take the tubes of leaves to the tissue culture hood in 452.

Plating fungi:

We will use forceps to place these leaves into Petri dishes of our fungal growth medium. We have used 0.1 X Potato Dextrose Agar because it contains nutrients that are conducive to the growth of many endophytes. However, it contains a low concentration of these nutrients, to "coax" out the endophytes and get them to grow more prolifically as they search for more

resources. Some researchers even use water agar to isolate these fungi. Often, fungal endophytes are slow growers. The medium also contains a little bit of antibiotic to discourage bacterial contamination of the plates. There are some bacterial endophytes as well, but we will not likely find those.

Procedure:

1. Careful with the Petri Dishes—**you shouldnot open them** until you are ready to put your leaf samples in them!

2. Use the sharpie pen to label your two Petri dishes. **Label theside of thetop piece of the dish** and **around the outer rim of the bottompiece** (in case they get separated or switched somehow—**but keep the Petri plate closed!!**) with the following information:
    a. date
    b. group name/number
    c. treatment (where did you get these leaves?)—something that will help you remember your sampling scheme, and how to distinguish the leaves in your dish from leaves in other dishes.

3. Set your Petri Dishes aside in the laminar flow hood.

4. Dip the tips of the forceps in 95% Ethanol.

5. Carefully pass the forceps through the flame, and **let the flame disappear completely before proceeding further**!!

6. Use the sterilized forceps to grab hold of your surface-sterilized leaf bits, and embed them into the agar. Space the leaf pieces out on the dish so you do not crowd one area on the dish. Place no more than six leaf pieces on each dish.

7. Take a piece of parafilm ® (about 1" X 4") and stretch it around the edges of the Petri dish to seal the top to the bottom of the dish—this will keep the dish closed and prevent some types of contamination from getting in.

8. When you are done with one sample, hand the forceps to those in the next group.

After plating:

Check the Petri dishes every day or two, and make notes on the fungi as they emerge:

- Which leaf pieces in each dish have fungi?
- What do they look like?
- How quickly are they growing?
- How many different types do you have?
- How many tissue segments contained endophytes?

It may take a while before you see any fungi growing. To analyze the data for this experiment, we will use data from the entire class. Bring your plates to lab so that everyone can see the endophytes from the entire section!

Species diversity measures:

1. **Species richness:** How many species are there among all samples in a treatment?

2. **Species diversity indices:** These indices take into account both species **richness** (numbers of species) and **evenness**, which is a measure of how abundant each species is in the community. The most common way to do this is using the **Shannon diversity index**, also called **H'**. The value for this index is larger when there are more species, but it is also larger when all species in the community are roughly equally abundant. The index values will be lower for less species-rich communities and communities that are **dominated** by only a few species. The equation to calculate this index can be written as:

$$\mathbf{H' = -\sum p*ln(p)}$$

   To calculate **H'**, use the following instructions:

   To calculate **H'**, use the following instructions:

   a. Calculate the total number of individuals of each species over all samples in each treatment.
   b. Calculate the total number of individuals (**of all species**) in each treatment.
   c. Calculate the **proportion** of the total number of individuals that belong to each species. This is called "**p**".
   d. Take the natural logarithm of that proportion. This is **ln(p)**.
   e. Multiply **ln(p)** by p. In other words, calculate **p*ln(p)** for each species in the total sample that includes all samples in a treatment.
   f. Add up all of the **p*ln(p)** values for each species, andmultiply that by -1.
   g. To calculate **evenness**, take H´ and **divideby ln(richness)**. This number should be between 0 and 1 (1 means all species are equally abundant).

3. **Species-sampling curve:** this is a graph of the cumulative number of species as a function of the number of samples. If the first sample has 3 species, and the second sample has 2 species that were not in the first sample, then the value for the first sample is 3 species and the value for the second sample would be 3+2 = 5 species. **You will have to clearly understand what a sample is in your experiment! Each leaf? Each plate? Each branch? Remember to avoid pseudoreplication—the size of your "experimental units" will depend upon the question you are asking.**

Predicting the Establishment of Invasive Species Using Models

Dr. Quixotic had a brilliant stroke of luck, which was also bad luck for the Pacific islands where she worked. While conducting fieldwork on coastal forest, she discovered tiny, newly established populations of an invasive exotic plant, *Comandra wreckii* (or wreck plant for short), one population on each of ten islands. She would have the opportunity to document an invasive plant in process, to understand how its populations grow and spread. Unfortunately, poor funding and hurricanes nearby prevented her from revisiting the islands for four years after her first visit.

Knowing she would return one day, she came up with a mathematical model to help her predict the population growth of the plants, which can produce about 600 seeds in their first year, on average, per plant, before adults die (an annual plant). She was able to determine through greenhouse and field studies on already invaded (and more accessible) islands that about 33% of their seeds germinate, and 5% of germinated seeds survive to produce more seeds the next year.

Dr. Quixotic has chosen to use an exponential growth model.

1. Do you think she could be justified in using an exponential model? Why or why not?

2. What additional information would you like to know to justify this choice? Why would this information help you know whether the exponential model would work?

3. Help her create the model in the space below—use the information above, and feel free to use life cycle diagrams to help you.

4. Make a prediction, based upon this model, about the size of **one population after four years** if she counted 20 individuals in each of the ten populations she found (**round to the nearest individual**).

5. Upon her return to the ten islands in question, she found that **six** of the populations had gone extinct, and **one additional population** had **fewer** individuals than her model had predicted. What is going on? Come up with **two** alternative hypotheses for what could explain this result:

    1.

    2.

General questions:

6. If you were to measure **three** separate populations that start with the same number of organisms at time zero, graph what you expect to see over time.

7. Would the graph of population size over time look the same for each of the three populations? **Why or why not?**

8. If conditions in which these populations grow are exactly the same, would the three population growth curves be the same as each other? **Why or why not? To answer this, think about the following:** Do all organisms reproduce the same amount every year? Do all organisms survive to exactly the same age? Could this affect the population growth curves?

After reading more of the scientific literature, Dr. Quixotic wondered if variation in birth and death rates could explain her result. For instance, she realized that no plants she measured produced exactly 600 seeds. In fact, they produce 600 ± 300 seeds **on average**, (± standard error—lots of variation!). Further, she realized that although 33% of seeds germinated, this reflects **a one in three chance of germinating**. Likewise, 5% (or one in 20) seeds survive, **on average**! She had not incorporated into her model the idea of **randomness**, or **stochasticity**—that not every individual in a population does the exact same thing each year. Randomness in birth, death, and growth rates of populations is called **demographic stochasticity**.

9. Based upon the information above, and knowledge between members of your group, come up with a good definition of **stochasticity**. Use the information above, and your own words, rather than the internet or your textbook.

10. How do you predict that **demographic stochasticity** could affect population size over time among populations?

Dr. Quixotic tested her ideas and incorporated stochasticity into her model by using **probabilities** (which are random) rather than fractions (which are not random) in her model, and running this more complex model several times. Each time the model ran, it used different random values that reflected the variation she observed in her experiments.

11. If she runs her simulation 20 times, how many times will the simulated population be above the average value after four years? How many times will it be below average? **Why do you think so?**

After running her model twenty times, using random numbers in place of fractions, she got the following output, representing the predicted population sizes for twenty "simulated" populations after four years of population growth:

Simulation run	**Population size after 3 years**		**Simulation run**	**Population size after 3 years**
1	0		11	529,185
2	0		12	666,329
3	0		13	355,915
4	141,530		14	0
5	463,330		15	0
6	0		16	0
7	0		17	0
8	982,674		18	30,096
9	0		19	0
10	0		20	0

12. Given these predicted values above, do you think her hypothesis (described at the top of page 3) could explain the data she collected from the island populations? **Why or why not?**

13. Do the results above match what you expected in your answer to question 11? If not, how are they different? What does this tell you about the effect of demographic stochasticity on population growth? Cite evidence from the simulation above in your answer.

14. The results of her model are actually not just specific to her model—this represents a general result. Why might demographic stochasticity affect populations in this way?

15. When are populations most often affected by demographic stochasticity? Why do you think so? Would the results have been the same starting with a population of 4,000? **Why or why not?**

16. Randomness plays an important role in experimental design as well. If Dr. Quixotic wanted to collect a **random** sample of individuals within one of her populations, what should she do?

17. What if she sampled individuals **haphazardly** (as she encountered them)? Is that the same as random sampling? Why or why not?

18. Why might it be important to incorporate randomness into experimental design?