

# FOREST ECOLOGY

## I. Objectives:

1. Gain experience in the design of field population and community studies.
2. Gain experience in the application of quadrat, point-quarter, belt transect, and/or line transect sampling techniques for sedentary organisms.
3. Observe the importance of disturbances, such as fire, in structuring communities.

## II. Introduction:

Fire disturbance is an important factor affecting the composition of forests and grasslands in many parts of the world, including coastal regions of the southeastern United States. Coastal forests from North Carolina to northern Florida are often dominated by one of several species of pines. However, these pine forests are often maintained as a persistent, disclimax forest type only through periodic fires. The pine trees dominating these forests, such as the long-leaf pine of southeastern North Carolina are often resistant to mortality from fires. Mature long-leaf pines have a thick bark that insulates them from quick, relatively cool ground fires that burn litter accumulated on the forest floor. The seedlings of long-leaf pines have a tuft-like stage that protects the growing tip during the first few years, and then exhibit a quick growth spurt that carries the growing tip several meters above the forest floor in only a few years (above the level of ground fire effects). The accumulation of needles in long-leaf pine forests, combined with characteristically dry summers and lightning storms, actually creates a situation that promotes periodic low-intensity fires.

In the absence of fires, hardwoods, including oaks, gums and maples, will begin growing under the mature pines. These hardwoods do not have the bark or growth characteristics of pines to make them resistant to fire mortality. However, many hardwood species are more tolerant of shading than pines. As they continue growing, the hardwoods will eventually form a canopy above the forest floor. This canopy greatly increases the amount of shading and eventually kills any pine seedlings that may germinate in the area. The mature pines eventually die and the former pine forest becomes dominated almost exclusively by hardwoods. Since hardwood seedlings can tolerate considerable shade, such a hardwood forest would be relatively persistent until disturbed. The overall succession from pine forest to hardwood forest can take several decades, with a variety of intermediate stages occurring in the interim.

Aside from fire, a variety of other factors also affect which trees dominate the coastal forests of the southeast. Important among these are local habitat characteristics such as drainage patterns, nutrient availability, soil moisture content and soil composition. A very different forest may form in a valley that is poorly drained with high soil moisture content compared to dry sandy ridges. Such habitat differences may produce observable differences in the composition of a forest community on a relatively small spatial scale.

## II. Methodology

### A. *Defining the question:*

Using one or a combination of techniques, your laboratory class will design a field sampling project to answer the following questions:

How does fire affect southeastern North Carolina forest communities?

Can you distinguish a forest that has been burned more recently than another?

What criteria might you expect to observe to best show these differences?

These questions are actually much broader than they seem and your lab will not be able to address all variables associated with them in just the two sampling periods allotted. Below are some examples of ways in which this question can be narrowed to a more manageable topic:

1. Do pine trees dominate in forests that have been recently burned compared to forests that have not been burned for an extended period? (Remember, to answer this question one may want to look at mature trees and seedlings separately because seedlings may be affected long before the composition of the adult trees changes significantly).
2. Are pine trees more abundant in forests that have been recently burned compared to forests that have not been burned for an extended period? (Once again, the pattern may be different for seedlings versus mature trees, depending on time since burning).
3. Does fire affect total tree density (density of seedlings and density of mature trees)?
4. Do more frequent fires affect the type and amount of herbaceous plant cover and litter cover in the forest floor community?

These are a few examples of how you can narrow the broad question into a more manageable, smaller topic. You will do so by dividing into groups of up to four people within your lab. You will then visit the forests on campus, **devise at least three null hypotheses** that address the above or other questions, and develop a research design for testing those hypotheses. Ultimately, and with advice from your TA, your group will narrow your research design towards testing two null hypotheses. Then, you will collect and analyze the data to complete these tests. Each person in the group will complete a report, using standard scientific manuscript format and terminology, on the two null hypotheses and how the data either supported or rejected them (see Section C below).

### B. *Designing the Sampling Program*

Your sampling will be conducted in 2 forests. One forest, the long-leaf pine conservation area across from Watson Hall, is burned on a regular basis as part of a long-term management strategy to preserve a small long-leaf pine forest. However, this forest was last burned over ten years ago. The second forest is an area in the back part of campus that has not been burned since the early 1980s. As can be seen when you visit this area, the community is currently in a state of transition from pine forest to hardwood community.

In a previous lab you have been introduced to 4 of the basic sampling techniques used to determine abundances of sedentary organisms: quadrat, belt transect, point-quarter, and line transect. After you have defined your specific question, you need to use one or a combination of these techniques to collect the appropriate data.

In designing the sampling program, you will make use of information from your previous labs, class discussion, and suggestions from the laboratory instructor. However, following are some general points to keep in mind:

1. Some sampling techniques, such as line transects, can be used to measure relative numbers, but they do not provide any information on actual abundances (density).
2. Some sampling techniques are best used to answer specific questions such as changes across environmental gradients (certain kinds of transect sampling).
3. You need sufficient replication to do statistical analyses. The more replication, the more likely you are to pick up significant patterns. A bare minimum to detect moderately strong patterns in a community as variable as a forest community would be 10-15 replicates per forest.
4. If you decide to use quadrats, you need to decide on the correct size. Larger quadrats may provide better density estimates, but they take longer to do and thus reduce the number of replicates that can be completed in a limited lab period.
5. Sampling points (location of quadrats, start of transects, point-quarter center points) need to be selected in an unbiased manner. Throwing a frisbee and walking 5 spaces in a direction indicated by a marker on the frisbee is one method we have used before. Laying out a measuring tape and sampling at set intervals (e.g. placing quadrats at every 10m) is another method. Overlaying a grid on a photograph of the area and selecting random sampling areas is another.
6. Do you need to collect any physical data (temperature, light penetration, canopy cover, etc.)? For some questions, this is not necessary. For others, additional physical data may be very useful.

Your completed sampling design should include:

1. Where the work will be done? (we have already decided this for you).
2. What type of sampling method(s) will you use (e.g. quadrat, point-quarter, belt transect, and/or line transect)? If you are doing quadrats, how big will they be? Will you use different-sized quadrats for seedlings versus mature trees? If you do transects, how long will they be?
3. What is your replication (how many quadrats, center points and/or transects will be taken per site). How will their location be selected?
4. What type of data will you collect? For example, will you identify and count all tree species or only numbers of pines and hardwoods? Will pine or hardwood seedlings be sampled separately from adults? Do you want relative numbers or actual densities? Do you want to take counts or percent cover (particularly important if you want to look at ground cover)? How will you distinguish seedlings, saplings, and mature trees? (In the past we have said

everything that was at least 2 m high and you could NOT close your thumb and forefinger around its trunk was a mature tree.)

5. How will you statistically analyze your data (e.g. what tests do your plan to use to compare data within or between sites)? We will talk about this more in a later lab.
6. Details of any physical measurements to be taken.

### ***C. Format of Lab Report***

After completing your data collection and analysis to test your null hypotheses regarding the two forests on campus, each person is required to complete a written report (typed) in the form of a standard manuscript to be submitted for publication. This manuscript should be *double spaced* with all *pages numbered* and include the following:

1. Title Page (Title, author names and affiliations)

2. Abstract (~300 word summary of your paper including the purpose, hypotheses, and major findings)

3. Introduction & Objective/Hypotheses

The introduction tells the reader why the study was conducted. You should state both null hypotheses you tested and state the overall objective in testing these hypotheses. You should also consider why it was important to address the questions/hypotheses you did.

4. Materials and Methods

This section describes what you did so that you or someone else could repeat the study. Your initial sampling plan serves as a first draft of this section. In this section:

- Describe the methods so that anyone could read them and *repeat* your experiment.
- Use metric measurements for your data.
- State how the data will be analyzed, e.g., which statistical tests will be used and at what probability (P) value will you use to determine significance.
- Employ at least two different statistical tests in your analyses, as well as a test for normality for those data assumed to be normally distributed (parametric).

5. Results

Here, give clear and concise statements of the results of your work. This will include a data table(s), figure(s), and statements regarding your statistical tests.

Statistical statements must include the name of the test, the statistical value calculated (e.g., t value or chi square value given as  $\chi^2$ ), degrees of freedom (df), sample size (N), and probability value (P). For example,

“The number of mature pines in Forest A was significantly greater than the number in Forest B ( $\chi^2 = 4.23$ , df = 1, P = 0.032).”

Look at publications in the journal Ecology for more examples of how statistical results are reported. It is pretty standard.

In addition, you should present a table of your data with descriptive statistics including mean, standard deviation, and range (if appropriate). The point here is providing enough of your data so that someone could *repeat* your analyses. Also, include at least one graph of your data. It could be a bar plot or regression, depending on your data. Make sure to follow the formatting guidelines and examples shown on the Rubric.

Do not give any interpretations of the results in this section.

## 6. Discussion

In science reports we separate our description of the results from our interpretation of what they mean. The discussion section is where you provide your interpretation of the data. In essence, this is a persuasive essay – you are trying to convince the reader that your interpretation of the data is correct.

This section does not need to be too long. In many cases a paragraph or two will be sufficient.

Do not repeat what is already stated in the results.

## 7. Acknowledgements

This is a short statement of who helped you with the work and report. For example you should acknowledge your laboratory team who helped you design the study and collect the data. You should also acknowledge anyone who read early drafts of your report and provided helpful feedback.

## 8. Literature Cited

This section includes full citations for the literature cited in your report. For this assignment, you must cite at least five sources from the primary literature (peer reviewed journals). Please follow the citation and reference format shown on the Rubric.

A rough draft of your report is due in Lab on the week of Oct. 13-17. Your instructors will review these drafts and provide constructive critiques. Your final report is due in Lab on the week of Nov. 17-21. Your report will be assessed using a modified version of Dr. Alan Christian's Laboratory Rubric available from our course website.

### **III. Assessment of Today's Laboratory**

At the end of lab today submit a written summary of your proposed research question(s), specific hypotheses, and sampling design.

### **IV. Acknowledgements**

This laboratory appears in the UNCW Ecology Laboratory Guide compiled by the faculty, and was modified most recently by S.R. Borrett