Microclimate and Forests

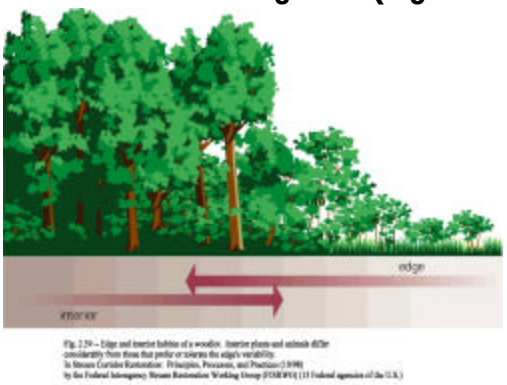
Introduction

Climate is a combination of temperature, moisture, precipitation, and winds for a given place over a period of time and is characterized by means, averages and extremes of these variables. The regional climate describes the general climatic conditions of the locality that plants and animals inhabit, but it does not describe the actual climate in which they live. Within the area they live, organisms encounter a wide range of local temperature, moisture, precipitation and wind conditions that are influenced by soil, vegetation, ground cover, slope gradient, aspect (direction the slope faces), and other factors that vary greatly from one location to another. The climate at a very local scale that influences the presence and distribution of organisms is known as the **microclimate**.

By altering wind movement, evaporation, moisture, and soil temperatures, vegetation influences the microclimate of an area, especially near the ground. Temperatures at ground level in the shade are lower than those in places exposed to sun and wind. Vegetation reduces the steepness of the temperature gradient above the ground surface and influences relative humidity and the height of the **active surface**, the surface of any object that receives or is impacted directly by solar radiation. Vegetative cover will also influence the extremes and daily maximum and minimum temperatures.

In addition to providing shelter and food for animals, vegetation creates a range of microclimates for organisms to exploit. Animals will seek environmental conditions in and beneath vegetation, in the canopy or near the ground, or beneath rocks and litter, where temperature and moisture are most favorable. That part of the general **habitat** [that place where a plant or animal lives] that is actually utilized by an organism is known as its **microhabitat**.

The place where two or more different vegetation types meet is called an **edge (figure 1)**.



The place where the edge of one patch meets the edge of another patch is called a **border**. The two edges and the border together make up the **boundary**. The environmental conditions along the edge are

different from those in the adjacent vegetation communities, especially in the case of forests.

Fragmentation (reduction of a large habitat area into small, scattered remnants) of forests is an international environmental issue that affects long term biological diversity and species conservation. For migratory species, habitat loss and fragmentation are major problems across their total range (Terbough 1992). Fragmentation begins when large tracts of forest are broken into smaller patches of openings or clearings within otherwise contiguous vegetative cover, generally as a result of human development (Harris and Silva-Lopez 1992). Fragmentation is a scale dependent process and up to a point results in no loss of species. As the process continues, however, the remaining area is reduced to a critical size below which it will not support many of the original species, and local extinction occurs (Whitcomb et al. 1976, Robbins et al. 1989). The first to disappear are those species, termed interior species, that require large areas of habitat to maintain viable populations. For these species, the probability of occurrence increases with patch size. Others are area-sensitive because they require large territories or foraging areas. As fragmentation continues, edge and area-insensitive species, ones at home in small to large units of habitat, increase in abundance. Although the number of species in a fragmented habitat may increase initially with the creation of edge environments, the number of species it contains will eventually decline as fragmentation continues.

Although species diversity is related to area, what is important is the ratio of edge or perimeter to area. At some small size all patches are edge. If the depth of the edge remains constant while the area increases, the ratio of edge to interior decreases as the habitat island increases. When the island size becomes large enough to maintain interior conditions, an interior begins to develop. However, size alone is not the only determinant of edge/interior conditions. Configuration or shape of the island is also important.

Aerial photos taken in 1954 before development of the Fairfax campus of George Mason University, show a generally forested area with scattered pastures and housing. Today, the remaining oak-hickory forest is highly fragmented (figure 2).

In this lab we will explore three variables of microclimate as influenced by forest cover in a forested patch (indicated by the red arrow in figure 2) on the George Mason University campus. We also will examine the edge effect and the development of interior forest conditions.

Objectives

- Learn how to measure and interpret temperature and relative humidity data.
- Learn how forest cover influences air and soil temperature and relative humidity.
- Determine the penetration of the edge effect into a forest patch.
- Use Microsoft Excel to manage and display data.

Materials

- 7 HOBO TEMP H8 series temperature and humidity data loggers
- 7 HOBO External Sensor Cables
- 7 HOBO Pro Temp/RH Rainshields
- 1 HOBO Shuttle
- BoxCar Pro software
- Microsoft Excel software
- Desktop computer and printer

Hypotheses

Air and soil temperature are lower within a forest than at the forest edge.

Relative humidity is lower within the forest than at the forest edge.

Air and soil temperatures and relative humidity continue to decrease with increasing distance from the forest edge until interior conditions are obtained.

Aspect affects the depth of penetration of the edge effect into the forest parcel.

Procedure

The instructor will explain each procedure.

1. Each group will collect data from the seven HOBO temperature and humidity data loggers located in a forest parcel on the GMU campus using the HOBO Shuttle. Be careful to insert the Shuttle probe in the proper slot in the data logger without removing the logger from the rain shield, as demonstrated by the instructor.
2. Using the data transfer cable, download the data from the Shuttle to your lab computer using the BoxCar software. When prompted by the software, create data files for each of the transects and save them for later use. Make a backup copy of your data.

Data Analysis

1. Using the data transfer function within the BoxCar software,

transfer your files into Microsoft Excel.

2. Display the data using the graph feature of Microsoft Excel for each of the stations.
3. For each parameter measured (air temperature, soil temperature and relative humidity), prepare a line graph for the parameter measured versus time, for each transect. You should have three graphs and each graph will contain a line for each transect. Submit these graphs with your write-up. Remember to give the graph a title and label the axes.

Forest Microclimate LAB WRITE-UP Submit Pages 5-7

Student Name: _____Lab Date: _____
Lab Instructor: _____ Lab Section: _____

Results (Data)

Figure 1. Air temperature versus time for all transects.

- *Attach graph prepared in Excel* -

Figure 2. Relative humidity versus time for all transects.

- *Attach graph prepared in Excel* -

Figure 3. Soil temperature versus time for all transects.

- *Attach graph prepared in Excel* -

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Conclusions (Questions): *For full credit, these questions should be answered thoroughly, in complete sentences, in legible handwriting.*

1. Characterize the daily change in temperature and relative humidity. Are temperatures and humidity higher or lower during the day or at night? Why? Are temperature and humidity higher or lower at the edge or within the forest? Why?

2. Characterize the daily change in soil temperature. Is the daily change in soil temperatures [actual temperatures and differences between high and low temperatures] greater or less than air temperature? How does soil temperature change from the edge along the transects into the forest. Why? Do the daily maximums and minimums occur before, after, or at the same time as the air temperature maximums and minimums? Why?

3. Is there a difference in air temperatures, relative humidity measurements, and soil temperatures at similar points along the two transects? Why or why not?

4. About where along the temperature transects does the temperature no longer change between stations? About where along the humidity transect does the relative humidity no longer change? About where along the humidity transect does soil temperature no longer change? Based on air temperature, relative humidity and soil temperature, about how far into the forest parcel would you find interior forest conditions?

For Further Reading

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Mitchell, John G. 2001. Urban sprawl: The American dream. National Geographic 200(1): 48-73.

Robbins, C. S., D. K. Dawson, and B. A. Dowell. 1989. Habitat requirements of breeding forest birds of the Middle Atlantic States. Wildlife Monographs 103. The Wildlife Society.

Sampson, Neil and Lester DeCoster. 2000. Forest fragmentation: Implications for sustainable private forests. Journal of Forestry 98(3):4-8.

Terbough, J. 1992. Diversity in Tropical Rainforest. Scientific America Library, William Freeman, New York.

Whitcomb, R. F., J. F. Lynch, P.A. Opler, and C. S. Robbins. 1976. Island biogeography and conservation: Strategy and limitations. Science 193:1030-1032.