Changing of the Green

Students investigate differences in the abundance of woody and herbaceous plants growing in areas with different mowing regimes to explore the tendency for forests to succeed field habitats that are left undisturbed.

Background

When Captain John Smith first reached Virginia in the early 1600s he noted, "Virginia dothe afford many excellent vegetables and living creatures, yet grass there is little or none, but what groweth in low marshes; for all the country is overgrown with trees." Such would still be the case today were it not for the steady influence of saws, plows, mowers and livestock, since there is a natural tendency for land in this state to revert to forest after being disturbed.

Signs of this succession can be easily found on almost any patch of open ground left undisturbed for a few years. The evidence is young, woody plants—vines, shrubs, and trees—sprouting among the grasses and other herbaceous species that preceded them. Among the most obvious and abundant pioneer trees in the Piedmont region of Virginia are pines and red cedar. However, several other woody plants might be among the first to grow in a given area, including Japanese honeysuckle, poison ivy, staghorn or winged sumac, blackberries, green briar, wild rose, sassafras, tulip polar or red maple.

Most woody species cannot tolerate being cropped off by mowers or grazing animals and are thus absent or scarce on lawns and pastures. But if left undisturbed, woody plants rapidly appear. At first they are scattered and somewhat hidden among the grasses, goldenrod Queen Anne's lace and other annuals and perennials. With each successive year, more woody plants appear. Many sprout from seeds, and others—particularly the vines and brambles—grow as vegetative shoots from the original pioneer plants. Woody plants will appear in small patches of ground, such as the corner of a lawn, along the edge of a fence or in an untended flowerbed, or will take over entire fields if left to grow.

During the early stages of succession, the combined woody and herbaceous plant growth can be very dense and lush, providing valuable cover and food for many animal species such as bobwhite, cottontail rabbits, box turtles, snakes, grasshoppers, praying mantises and garden spiders. Some state parks keep sections of old fields in the early stages of succession using grazing or by mowing them on a two to four-year cycle. This maintains habitat diversity which is valuable to wildlife. Also, the purposeful use of controlled fire can be used to manage succession habitats. This controlled burning or prescribed fire must be used with caution and by experienced resource managers. Prescribed fire delays succession and keeps lands in a permanent grass state. It also releases nutrients and keeps grasses lush and productive. Furthermore, it adds diversity to the landscape by allowing multiple species to occupy a site.

Succession also plays an important role in riparian or streamside areas. Healthy forests near streams provide water quality protection. Allowing riparian areas to grow naturally with many herbaceous species, including trees, protects stream banks and stream bottoms from grazing animals. This lush vegetation also sucks up extra nutrients protecting the stream from fertilizer or other pollutants. Many times farmers will also use fencing to further protect streams from grazing

Grade Levels: 6-12

Objectives

Students will *investigate* change in plant composition of quadrats of earlier and later succession stages by:

- *predicting* relative abundance of plants;
- *distinguishing* between herbaceous and woody plants;
- *quantifying* plants within a given space; and,
- *comparing* actual ratios of plants.

Materials

- insect repellent (ticks and chiggers can be a nuisance in tall grass)

Per team:

- quadrat markers (1 hula-hoop or other circle OR four meter sticks, bolts and wing nuts)
- bean bags or other tools for random point selection
- clipboard, paper and pencil

When

Late spring through fall is best, but can be done in winter.

Where

All parks.

Time Required

At the Site: Allow 45 minutes per study location.

Extensions

1. Ask students to search for successional changes by finding old photographs of familiar places and comparing them with the locations today.
2. Fence off a one square meter plot on the school grounds and keep a monthly record of the species growing there for a period of several years.

animals. State park managers may use fences to protect critical stream areas from human intrusion through recreational activities. Mature forests in riparian areas are the best land use due to their ability to stabilize stream banks, take up nutrients and provide habitat diversity.

Procedure

Before the Trip:

1. Visit the site to locate at least two study locations. One should be an area that is grazed or mowed at least twice a year. The other should be a place that has not been mowed or grazed for at least two years. If possible, locate several areas at various stages of succession (e.g., 0 years, 2-3 years, 5-6 years, greater than 10 years). Park staff should be able to help identify these locations and give some indication of the last mowing date.
2. Review with the class the concept of species abundance in which abundance (A) is calculated by dividing the number of individuals of one species (or group of species) (N) by the total number of individuals of all species found in an area (T). Thus: A = N/T. For example, there may be 400 pine seedlings growing on a plot with 1,600 other plants. Thus: A = 400/ (1,600 + 400) = 400/2,000 = 0.20
3. Divide the class into teams of three.
4. Have each team list two or three ways to estimate the abundance of plants in a large area without counting each plant. Write their ideas on the board and discuss the pros and cons of each. Lead the class to the concept of using quadrats (samples of small sections of the area) to make population estimates about the whole area.
5. Have each team make a quadrat marker by one of the following methods:

- Square marker: Join the ends of four meter sticks with wing nuts and bolts to make a square. (Any other meter long pieces of thin, sturdy material will do.) The wing nuts can be loosened or removed to fold down the marker for storage or transport.
- Hoop-style marker: Hula-hoops work well, but be prepared to cut them in one place to fit them around large plants. Otherwise, a circle of sturdy rubber tubing the same diameter as a hula-hoop can be used.

6. Ask the class to think of ways that sampling with quadrats could be biased (e.g., the sampler is allergic to poison ivy so doesn't take any samples near poison ivy plants). Lead them to the concept of taking random samples and have each team think of two or three ways to choose random quadrat samples. Write their ideas on the board and settle on a simple method that can be used during the field trip. (A bean bag tossed randomly into the study site is sufficient for this activity.)
7. On the school grounds, practice selecting random samples, using the quadrat markers, and calculating the abundance of some type of plant, such as grasses or broad-leaved plants.
8. Explain to the class that they will be investigating the abundance of woody plants in various locations at the site. Provide the recent history of each location: Has it been mowed, plowed, burned? If so, when? Have each team rank the sites on paper and predict which ones will have the greatest abundance of woody plants.
9. Review ways to distinguish woody from herbaceous plants:

- Woody plants usually have solid, tough, flexible stems. The main stems on herbaceous plants are often hollow and usually easy to break.
- Woody plants stay alive through the winter. Even though they may lose their leaves, the stems remain flexible and the bark, when scraped a little, has a greenish tint and is moist and supple. Many

Variations

1. Do a quadrat study with areas along a different gradient such as the transition from lighter to darker areas at the edge of a forest, or various levels of moisture in a ravine or on a ridgetop.
2. Consider doing this activity along different power line easements. Power companies generally keep records of mowing regimes for easements. Be sure to get permission from the power company and property owner.

Younger students:

1. Encourage the students to categorize the woody stems in their own different ways. Map the site area and label each study location prior to the trip. Students draw or color types of vegetation, shading drawings to represent the predicted abundance of woody plants.
2. Estimate species abundance in the quadrats together as a group.

Resources

www.dcr.virginia.gov/natural-heritage/natural-communities/document/ncoverviewphys-veg.pdf

Flora of Virginia, 2012, By Alan S. Weakley, J. Christopher Ludwig, and John F. Townsend.

Andrews, W.A. 1974. *Terrestrial Ecology*. Prentice-Hall, NJ.

Credits

Illustration of poison ivy used with permission from *The Manual of the Vasular Flora of the Carolinas.* 1960©. C. Richie Bell, et. al. University of North Carolina Press.

herbaceous plants stay green through the winter, but these are usually low to the ground and lack a live, central stem.

10. Make sure everyone can recognize poison ivy, which can cause an irritating rash. It may appear as a woody vine or look more like a low shrub. The leaves are usually smooth and shiny above and divided into three distinct leaflets. The main stem of mature vines is often covered with brown "hair."

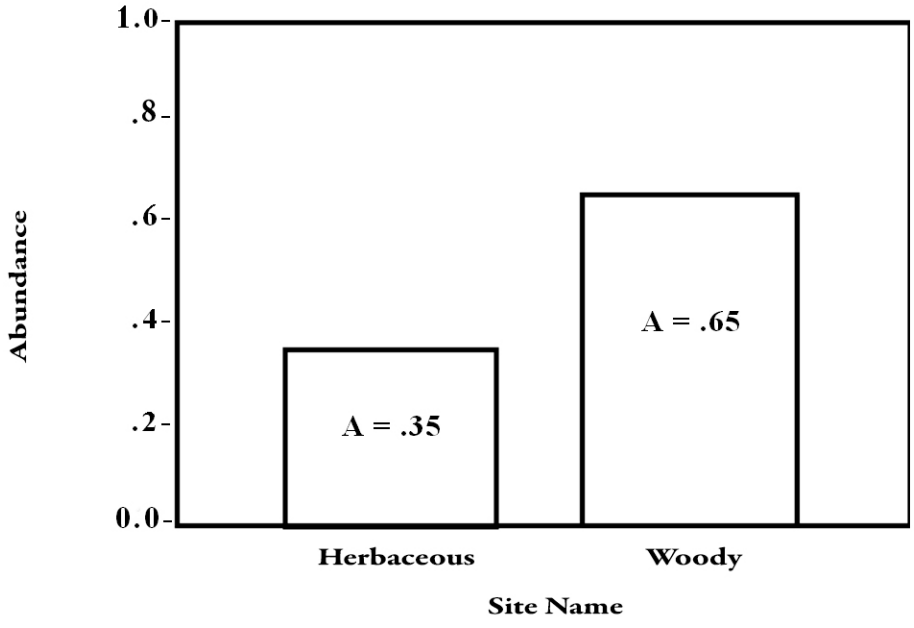
At the Site:

At each study location, set the boundaries for the area being investigated and have each team do the following:

1. Randomly select three points within the study area.
2. At each point, lay the quadrat marker on the ground with the point at its center. (Disconnect at one corner, if necessary, to get around trees too large to reach over.)
3. In each quadrat, count all the woody plants and all herbaceous plants and record the numbers. Plants that are partially within the quadrat should be counted. Consider as one plant anything that grows in a clump, such as some grasses, or plants that are joined above the ground by runners, such as strawberries.
4. Repeat the above steps two more times and use the total counts to calculate the abundance of the woody plants for the location.

Follow-up:

1. Each team compares its predicted rankings for the locations with the results of their field study. Take a show of hands to determine which teams ranked the locations accurately. Discuss their results:
   - *How did the mowing regime seem to affect the abundance of woody plants growing in a location?*
   - *Why might woody plants be less able to survive in frequently mowed areas than herbaceous plants?*
   - *What factors, other than mowing, might affect the abundance of woody plants?* (e.g., A swampy area might never be mowed but might not have woody plants in lower areas due to the influence of frequent flooding. The floor of densely shaded forests may have few or no woody plants, if the mature trees are not counted.) Consider also the effects of natural and human-made fires.
2. Take the class totals for the woody and herbaceous plants counted at each study location and calculate abundance using these numbers. Make a bar chart on the board showing the results for each team.
3. Discuss the results shown on the graph with questions such as:
   - *Which is likely to give more accurate results—large samples or small samples? Many samples or fewer samples?*
   - *If each team had taken 20 samples at each site, and the class results were again graphed, would the difference between individual team results be greater, smaller or about the same?* (Team results should approach the class average with increased sample size.)



SOL's: Science 6.1, 6.2, 6.7 Life Science: LS.1, LS.6, LS.9, LS.10, LS.11, LS.12
Biology: BI0.1, BI0.7, BI0.8 Math: 6.2, 6.18, 7.1, 7.3, 7.12