

4-H Virtual Forest User's Guide

Sprawl

Concept

This module will illustrate the influence of human activity on a forested ecosystem. Students will observe how a typical development pattern impacts forest cover, temperature, animal species, and erosion as a road, subdivision, shopping center, school complex, and park are constructed in a forested area known as "Shady Grove."

This module supports the following Science SOLs:

Scientific Investigation, Reasoning, and Logic

- 3.1 a) asking questions and defining problems
- 3.1 d) constructing and critiquing conclusions and explanations
- 4.1 a) develop hypotheses as cause-and-effect relations

Living Systems

- 4.3 The student will investigate and understand that organisms, including humans, interact with one another and with the nonliving components in the ecosystem. Key ideas include:
 - a) interrelationships exist in populations, communities, and ecosystems;
 - b) food webs show the flow of energy within an ecosystem;
 - c) changes in an organism's niche and habitat may occur at various stages in its life cycle

Earth Resources

- 3.8 a) human activity affects the quality of air, water, and habitats
- 4.8 d) forests, soil, and land
- 6.9 The student will investigate and understand that humans impact the environment and individuals can influence public policy decisions related to energy and the environment. Key ideas include:
 - a) natural resources are important to protect and maintain;
 - b) renewable and nonrenewable resources can be managed;
 - c) major health and safety issues are associated with air and water

- quality;
- d) major health and safety issues are related to different forms of energy;
- e) preventive measures can protect land-use and reduce environmental hazards; and
- f) there are cost/benefit tradeoffs in conservation policies.

LS.9 The student will investigate and understand that relationships exist between ecosystem dynamics and human activity. Key ideas include

- a) changes in habitat can disturb populations;
- b) disruptions in ecosystems can change species competition; and
- c) variations in biotic and abiotic factors can change ecosystems.

Module Description

Begin. The module begins with an overhead frame of Shady Grove forest bisected by a stream. We hear the sound of birds singing and water trickling. Text reads:

“Welcome to Shady Grove – a healthy forest ecosystem covered by trees that shade the environment, protect water quality, provide wildlife habitat, and prevent erosion.”

“Striking the right balance between growth and conservation is a pressing challenge for most cities and towns. Watch what happens to Shady Grove as a nearby suburb spreads outward.”

Students will be prompted to track the effects of each development activity on tree cover, temperature, box turtles, water quality, erosion, and feral cats. (A feral cat is a domesticated cat that has turned wild). Shady Grove begins with:

100% tree cover, 320 box turtles, a temperature of 70 degrees, zero feral cats, excellent water quality, and no erosion.

Students will use an arrow in the lower right corner to navigate through the module, adding different development features each time they advance.

Add a Road. Screen shows that 10% of the tree cover has been removed to make room for a new road. The narrator says:

“A new road cuts through the heart of Shady Grove, paving the way for future growth. Click the arrows to guess the impacts on Shady Grove.”

The student can now indicate what trend they expect to see for each item listed. An incorrect answer results in the message "Not quite, try again". Correct answers result in brief summary text. The answers are:

Tree Cover (down). "Correct! The decline in tree cover by at least 10% is a typical consequence of constructing the new bridge."

Box Turtles (down). "Correct! There was a drop in the box turtle population to 283 due to habitat fragmentation and loss."

Temperature (up). "Correct! The slight increase in temperature to 70.5 degrees is due to a slight decrease in tree cover in favor of the new road and bridge."

Feral Cats (up). "Correct! The appearance of unwanted cats by the roadside has led to increased feral populations which can disrupt local wildlife and ecosystems."

Water Quality (down). "Correct! The decrease in water quality is due to runoff from construction sites, increased pollutants, and disturbed soil making its way into water bodies. This affects aquatic life and the overall health of the ecosystem."

Erosion (up). "Correct! The increase in erosion, particularly around stream banks, is a direct result of land disturbance."

Houses and a Shopping Center. A subdivision and shopping plaza have been constructed in Shady Grove to meet the demands of the growing population. What impact did this have on the Shady Grove ecosystem?

Tree Cover (down). "Correct! The decline in tree cover by at least 40% is a typical consequence of constructing new roads and buildings."

Box Turtles (down). "Correct! The current box turtle population is 150. Turtles and other wildlife often struggle to adapt to the changes in their environment caused by urban expansion, leading to a decline in their numbers."

Temperature (up). "Correct! The increase in temperature to 73 degrees can be attributed to the heat island effect. Areas with asphalt and concrete absorb and re-radiate heat more than natural landscapes, leading to higher temperatures."

Feral Cats (up). "Correct! The appearance of kittens and additional adult cats leads to even more feral cats."

Water Quality (down). "Correct! More construction, pollutants, and more disturbed soil is decreasing the water quality even more."

Erosion (up). “Correct! Construction and the removal of vegetation destabilize the soil, making it more susceptible to erosion, while faster-flowing stream waters also break down their banks after rain events.”

In addition to these trends, students will notice an increase in traffic on Shady Grove Road and signs of erosion along the stream banks.

A School and a Park. To serve the needs of the residents, the Shady Grove School complex, home of the Fighting Cardinals, is constructed. Forest is removed to make way for parking lots, school buildings, and playing fields. The same trends exhibited during the previous frames continue here. Forest gives way to development.

The last remaining tract of forestland comes up for sale, and the newly formed Shady Grove Parks Committee successfully lobbies the county government to purchase the area and turn it into a park.

Summary. This screen summarizes the trends illustrated in the Shady Grove scenario.

“As suburban development increases, forest cover is removed to make way for buildings and roads. Wildlife that are sensitive to habitat loss are reduced in their numbers, while animals that thrive in the presence of humans, like feral cats, multiply.”

“The once cool and shaded Grove feels the heat, meanwhile waterways are overwhelmed by increased runoff and erosion. While development has its benefits, it also has costs. Let’s see how we can help create a sustainable urban forest.”

Although not stated in the module, it may be helpful to point out that, since public funds are used to support road, water, and sewer construction and maintenance projects, the amount of tax dollars needed to support a sprawling community increases as well.

Let's Shape the Future! An interactive learning activity that encourages students to “shape the future” and help make Shady Grove a sustainable urban forest environment. Students can click and drag three features to the appropriate location.

Leaving trees along streams—called riparian buffers--helps cool the water, stop runoff from reaching the stream, and provides wildlife habitat. Drag the riparian buffer symbol and drop it beside the stream.

Large parking lots built with asphalt and concrete cause water to run off quickly when it rains. There are materials that we can use for parking lot construction, called ‘permeable pavement’, that allow water to soak into the ground rather than run off into a stream. Drag the permeable pavement symbol and drop it on the shopping center parking lot.

Instead of building homes throughout an entire forest, we can group houses together in one area on smaller lots. This way, the rest of the land in the subdivision remains forested. This is called cluster development. Drag the cluster development symbol and drop it on Shady Acres.

We can make other improvements that are not presented in this activity. For example, school buildings, parking lots, and playing fields need lots of space.

Planting trees on the school grounds can help provide shade, habitat for birds, and improve how the school complex looks. People might go to a park to relax, walk, or watch birds. Putting the parking lot by the main road will reduce vehicle traffic and noise inside the park.

P.S. A small act, like having our pets spayed or neutered, can help protect wildlife for generations.

Shady Grove finishes with:

Declined tree cover, 49 box turtles, a temperature of 74 degrees, thriving communities of feral cats, low and still decreasing water quality, and increasing erosion.

We tried to use realistic numbers throughout the Sprawl module. Here is how we arrived at the numbers we used.

Tree Cover. We reduced tree cover by visual estimation in proportion to the land area occupied by the various additions to “Shady Acres.”

Temperature. A study by Akbari et al. (1992) showed a two degree temperature increase from rural to suburban land use, a two degree increase from suburban to commercial suburban land use, and a three degree increase from commercial to urban core land use (seven degrees total). Since this study looked at Phoenix, we went the conservative route and reduced the temperature increase by half for Virginia, with the exception of the change from suburban to commercial suburban land use.

Box Turtles. Data from the 1930’s showed that approximately 9 to 17 terrestrial turtles per hectare occupied the habitat offered by pristine forests in Maryland. To arrive at the numbers for the module, we assumed that our forest represented an 80 acre area. We then assumed a conservative 10 turtles per hectare, or 4 turtles per acre. We reduced the total number of turtles in proportion to the habitat loss, and added in a factor for road mortality. For example, we begin with $80 \times 4 = 320$ turtles. Road construction reduces the forest canopy by 10%, so we reduced the number of turtles by 10% as well, and then subtracted an additional five turtles knowing that some individuals will become road kill. The number of turtles becomes 283. The subdivision and shopping center reduce habitat by an additional 40%. As a result, we multiply our original number (320) by 50%, the remaining habitat, and further reduced the number by 10 to reflect

increased road kill resulting from the increased traffic. We continued this pattern throughout the module, until our final turtle count stands at 49.

Feral Cats. We began with the two cats dropped off at Frame 2. Although we did not use actual numbers thereafter, literature shows that feral cat populations increase exponentially. So, we can estimate the number of cats as well. Assume one cat dropped off by the roadside is a female that then has a litter of six kittens. The total number of feral cats then becomes eight. Next, assume that four of these cats are females, each of which has a litter containing six kittens. The population becomes 32: 24 kittens, plus eight adults. Sixteen females could possibly produce 96 kittens, and so on.

References

Akbari, H., S.D. Davis, J. Huang, and S. Winnett, eds. 1992. *Cooling our Communities*. LBL Report 31587, Berkeley, CA.

Booth, D. 2000. *Field Evaluation of Permeable Pavements for Stormwater Management*. United States Environmental Protection Agency. EPA-841-B-00-005B. 2 p.

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 2000. *Turtles of the United States and Canada*. Smithsonian Institution Press. 571 pp.