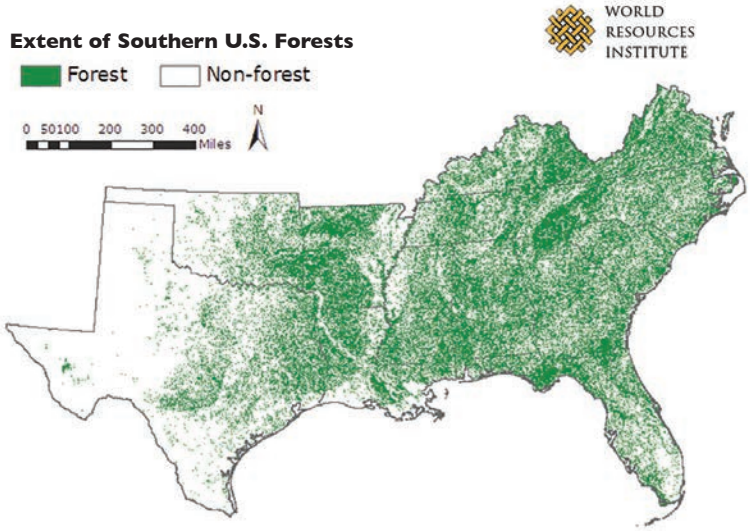
SECTION 2

Forest Management and Adaptation

Forests can be managed to thrive in a changing climate.

FORESTS COVER ABOUT 40 PERCENT OF THE LAND AREA in the southeastern United States (Miles, 2014). Several ***species*** of pine trees dominate these forests, growing in both tree ***plantations*** and ***naturally regenerated forests*** on private and public lands. Based on landowner management objectives, pine forests can be managed to provide multiple benefits, including ***timber*** products, ***nontimber forest products***, wildlife ***habitat***, water quality protection, soil stabilization, recreation, aesthetics, and land stewardship. Private land accounts for 86 percent of southeastern forests, one-third of which are owned by corporations (Butler & Wear, 2011). ***Industrial private forest landowners*** typically grow trees for timber production, creating wood products such as paper, lumber, ***biomass*** for energy, and more. As a region, the Southeast produces more wood than any single nation, accounting for 58 percent of the total U.S. industrial wood production and almost 16 percent of the world's production (Prestemon & Abt, 2002).

Many of these private forests are intensively managed to produce profits from pines. Forest managers working with industrial private forest landowners (such as corporations and investment companies) select seedlings of superior genetic stock, apply fertilizer once or twice during the forest cycle to supplement the soil nutrients, manage ***understory*** competition, and watch carefully for evidence of insects and disease. Depending upon the forest and the location, trees can be ***harvested*** for pulp and paper in as few as 15 years or after 25 years, with appropriate management, for lumber.



About 40 percent of the landscape in the southeastern U.S. is forested.

Non-industrial private forest landowners include families who own land and may have cared for that property for generations. They may also grow trees for profit, though they usually invest fewer resources than the industrial landowners and it may take longer for trees to reach a marketable size. If the price of wood is low, these landowners might keep growing the trees in the hope that their value will increase in the future. They also may enjoy hunting on their property and managing the land to maximize ***conservation*** values.

The activities in this section help convey opportunities for adapting pine forest management to climate change.

Many of the managed pine forest acres of the southeastern U.S. have been regenerated using superior genetic planting stock, which is the result of tree improvement research programs that began in the 1950s. These programs have selected superior parent trees and bred them to produce ***progeny*** with better stem form, growth rates, and disease resistance. Genetic tree improvement is one ***forest management*** tool that can be combined with other ***silvicultural*** treatments to improve the overall yield, quality of products, and health of forests in this region (Zobel & Talbert, 1984).

Climate variability and uncertainty, of course, also play a role in forest management. Changes in temperature and ***precipitation*** patterns resulting from ***climate change*** will likely influence ***forest health***. While forests normally encounter disturbances, such as storms, ***wildfire***, and insect and disease outbreaks, these disturbances may become more frequent and intense in a future climate. In addition, trees and plants require specific climatic conditions to grow, and as climate changes so might the types of species that grow in certain locations.

How the forest is managed may increase its health and ***resilience*** to a changing climate, enabling the trees to withstand less rain, hotter summers, shorter winters, or more insect pests. Since trees grow for many years, forest landowners do not have the option of changing the crop they plant from year to year. In addition, forests cover many acres and are not irrigated. Forest landowners, therefore, must develop strategies to adapt practices to ***weather*** and climate over the duration of the forest management cycle.

ACTIVITY 4: The Changing Forests introduces students to the effects of changes in climate on southeastern forest ***ecosystems*** and forest management. This activity highlights current monitoring and research activities of forest scientists reported in five, two-page articles from the U.S. Forest Service's Southern Research Station magazine, *Compass*. In groups, students read one of these articles, communicate the key points to their classmates, and then summarize ways that climate change might affect southeastern forests and the role of forest management and science in responding to those changes.

ACTIVITY 5: Managing Forests for Change invites students to collectively develop a ***casual loop diagram*** (also called a systems diagram) of a forest, recalling factors that affect tree growth. Information about the priorities and opportunities that landowners use to manage their forests is provided through a short video about a private family landowner. This information is also provided in a student page. After learning about this forest, students receive management strategy cards and climate scenarios. Students use their systems diagram to explain how climate change may affect tree growth and how management options may help the forest thrive. The students' diagrams should be useful tools for showing relationships between forests, climate change impacts, and strategies people can use to manage forests. Students may wish to return to these diagrams during the summary activities in Section 5.

ACTIVITY 6: Mapping Seed Sources introduces students to ongoing research into the genetics of loblolly pine (*Pinus taeda*). Because of genetic variations between the eastern and western populations of native loblolly pines, some trees grow faster than others and some resist drought better. Students are asked to graph survival and height data from six different ***families*** of trees that share the same genetic lineage growing on three sites to determine which traits are associated with which population. Of course, if a combination of these ideal traits, such as fast growth and drought tolerance, were found in one tree, the seedlings would be well suited for wood production despite a future climate of less rainfall.

The activities in this section help convey opportunities for adapting pine forest management to climate change and for continuing to produce wood products from forests in the Southeast.

Potential Areas of Confusion

There are several topics in this section that may be sources of confusion for students, which may be based on their assumptions, prior experiences, or existing knowledge. You may be able to use questions to uncover this confusion and steer students toward the clarifications provided in the table.

Assumption or Confusion	More Adequate Conception
Nature knows best. Leaving forests alone is the best way for them to grow.	There are many advantages to wild, natural forests, and although they may not appear to be managed, many actually are. Management activities help keep forests healthy and enable people to enjoy the trails and views. In addition, if landowners wish to maximize certain components of their forests, such as wildlife habitat or timber, the forest can better meet those objectives with management. For instance, shrubs that provide berries for birds and tree seedlings with superior ***genes*** could be planted. In the face of climate change, additional management activities may be needed if natural evolution cannot accommodate the potential changes over a short period of time.
Foresters know best. Trained professionals can determine how to make any property profitable.	Professional ***foresters*** and researchers have many methods for increasing the growth of trees and making forests more profitable, as well as improving the forest for other objectives. In some areas, such as where soil nutrients are inherently limited, management may help but still not overcome severe problems. As climate varies, changes such as insect pests, endemic and exotic diseases, hurricanes, drought, and flood will make it challenging to predict successful strategies. For this reason, researchers and foresters are exploring multiple strategies to help forests resist problems and flourish despite the projected changes.
Forests are here for everyone.	The forested landscape provides many ecosystem services from which everyone benefits, such as improved air quality, ***groundwater*** recharge, and ***biodiversity***. Many forests in the Southeast are privately owned, however, and those landowners determine how to manage their forests. They may want a patch of wild nature for their family or steady income from harvesting timber. In the United States, private landowners determine what happens on their property, unless the landowners have entered their property into a land trust or conservation easement.
Genetically modified organisms are harmful.	A plant with a gene inserted using genetic engineering is known as a genetically modified organism (GMO). These plants are tested before being released to the general public. Examples of GMO crops that are commonly planted include Round-up Ready® soybeans that are herbicide resistant and Bt-corn that contains genes from a soil bacterium that are fatal to munching caterpillars. GMO methodology has not yet been applied to commercially available native pines, although it can and may eventually be a practical way to introduce resistance to diseases. Researchers currently use selection and breeding to improve genetic stock. Farmers have been selecting and breeding the best plants and domestic animals for thousands of years. Forest and horticultural geneticists use traditional plant breeding methods to select traits, fertilize flowers with selected pollen, and save the seedlings with the best form, fastest growth, and resistance to insects and disease. Most crops that provide food for millions of people and many of the trees planted in wildland and urban areas have been grown from selected varieties and seeds.

Forests can be managed for multiple objectives, including timber products, recreation, and wildlife habitat.

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Key Concepts in This Section

- Southeastern pine forests are highly productive, and most are privately owned by forest industry or individuals.
- Scientists are currently working to understand how climate change might affect forests.
- Forest management strategies are used to increase tree growth and enhance forest health.
- In an uncertain climate future, ***thinned*** forests should be more resilient.
- Through selection and breeding, tree breeders and forest researchers are producing improved seedlings that could have inherited genes conveying tolerance to drought and disease or good growth and form.

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