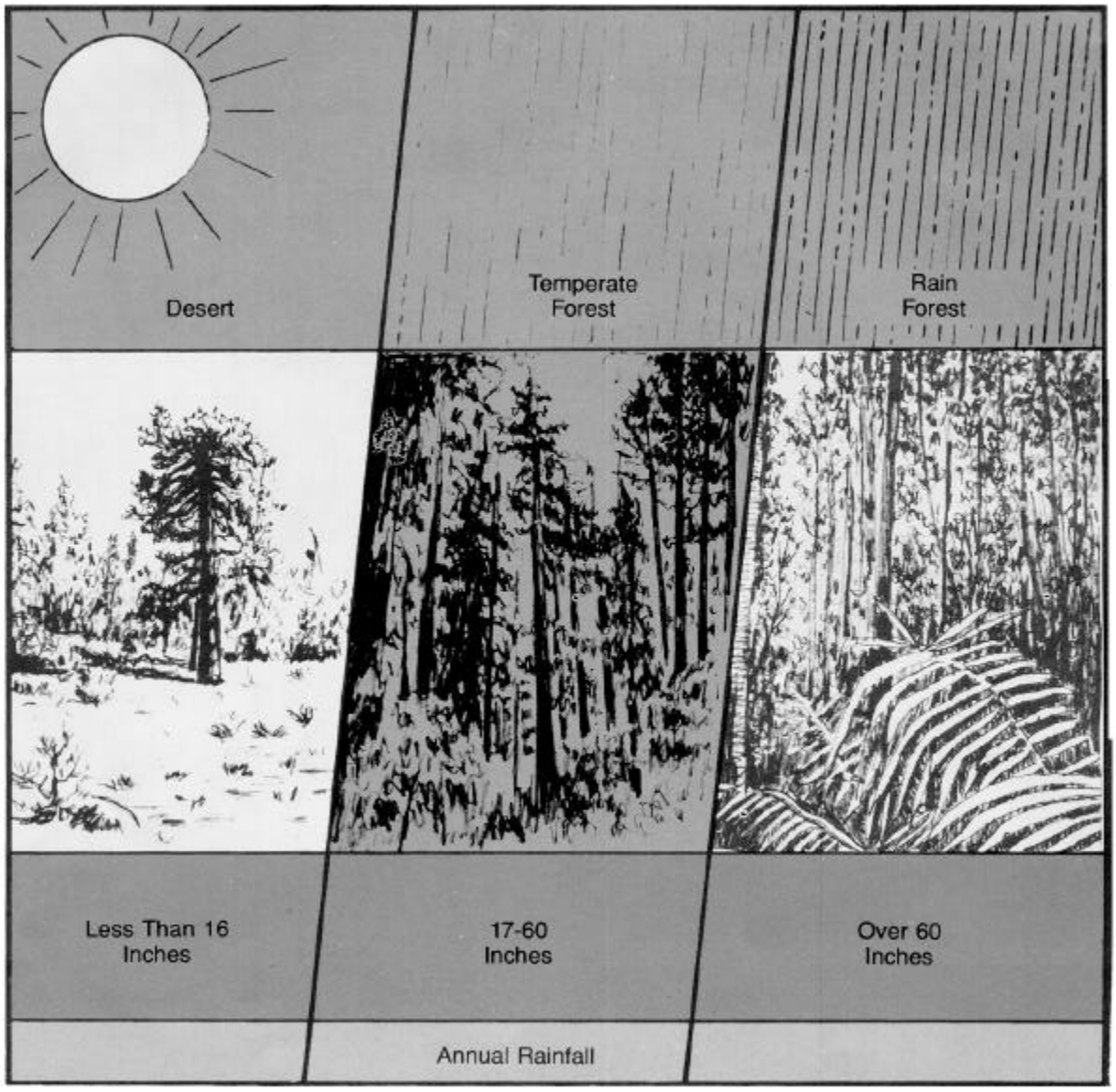
Within the forest are a variety of microclimates or "mini-climates." These can change the local conditions. In different places within the same forest you may find a difference in temperature, sunlight and moisture. For example, review what happened in Unit A when you took temperature readings in the sun and the shade, and at different heights above ground level.

The ancestors of all our trees were tropical plants. Most tropical plants are evergreens. They grow whenever there is enough moisture, and where they are not easily damaged by cold weather. Trees that live in the temperate zones had to adapt to the seasons. They had to begin new growth in the spring and to spread their seeds to reproduce. This process took many generations before the trees that we are familiar with today finally evolved.

Trees are accustomed to grow best in certain climatic zones. If a tree species is moved from one zone to another, it may not be able to grow in its new location. Trees that grow inland may not be able to grow on the seacoast. Trees that grow in a warm valley may not be able to grow at higher elevations where the air is cooler.

If the climate should change suddenly, many trees in the forest could suffer. Think what would happen if there were two or three years of drought in the Western forests, or if the Southern forests were struck by a tremendous ice storm in the spring. What might happen to forest growth in the Northern forests if many warm sunny days occurred in late summer and early fall? Would the broadleaf trees still "shut down" for the winter as they usually do? Remember our example of how a few extra warm days in the spring produced

How Much Rain Do Forest Areas Receive?



enough sawflies to eat up much of the foliage of the jack pine forests?

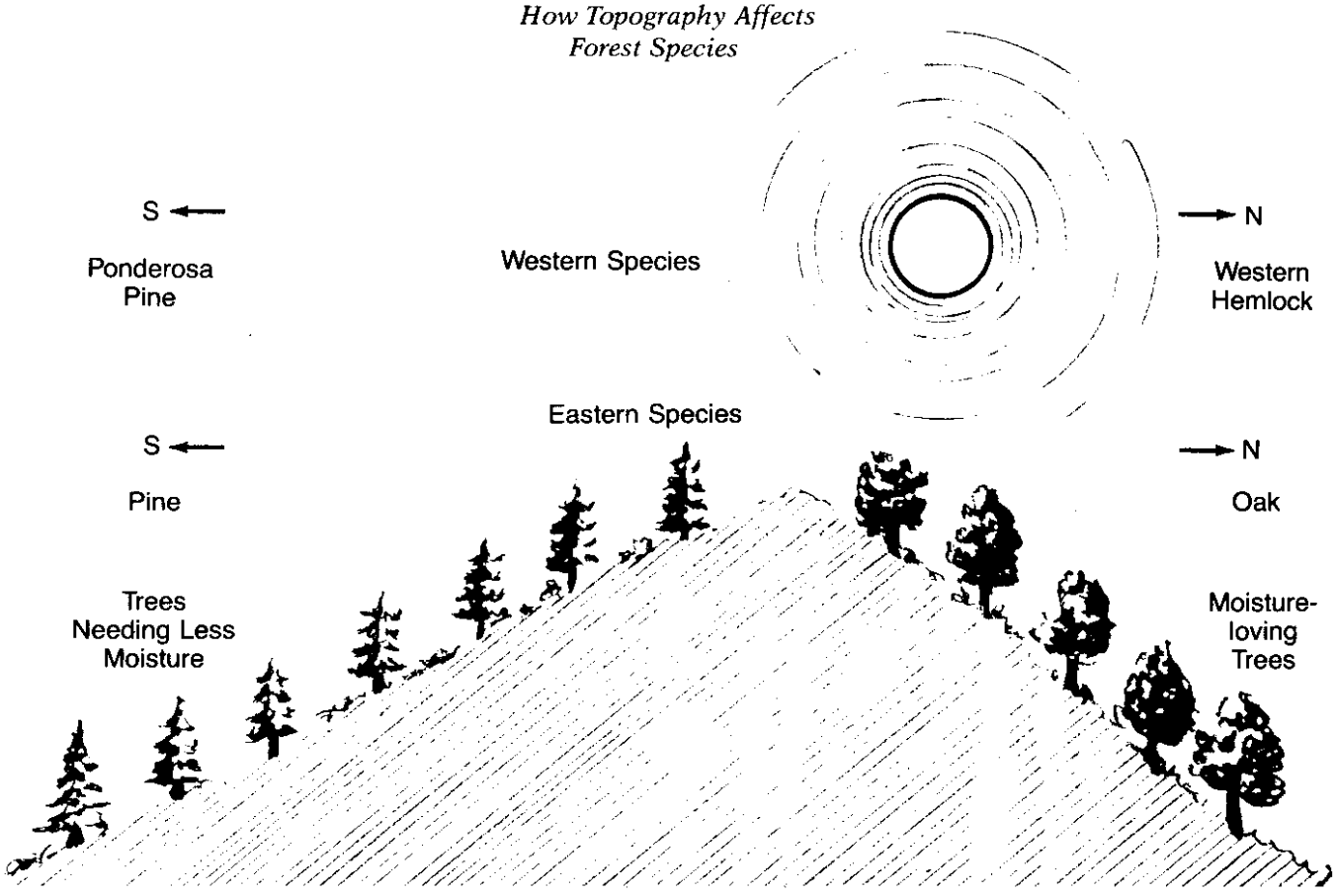
One example of extreme climatic conditions in the forest is fire. Although many forest fires are started due to people's carelessness, fire also occurs naturally. When the forest floor is very dry in times of drought, or when a lightning storm strikes, fire can start and spread very quickly in the forest. Uncontrolled fire can cause much destruction within hours. But controlled fires are actually helpful in some forests. Control led fire can eliminate unwanted tree species, or allow another species to reproduce. Some trees, such as the lodgepole pine and the jack pine, need fire to reproduce. Their seed cones will open only under intense heat. Fire also does some of the work involved with the food chain of decay. Although wildfire is a horrible event to much of the forest, it is one of nature's ways to produce changes that may be needed in the forest ecosystem. Later in the manual we will see how controlled fire can be a useful management tool.

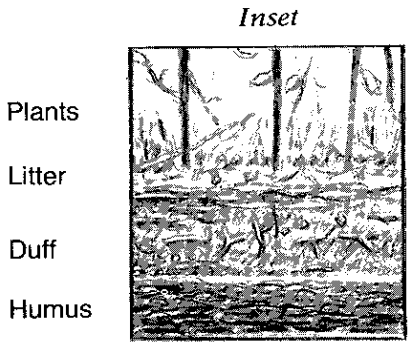
Land and Soil

The "lay of the land" and its soil structure also affect forest growth. Some lands are naturally better for growing a forest than for other uses. Their climates and soils are right for what forest plants and animals need. For instance, the North Woods of Minnesota and Wisconsin are much more suitable for coniferous forests than for agriculture or for cities. The shape of the land's surface, or its topography, helps to determine where and how well trees grow. Forests in mountainous areas high above sea level are different from those that grow in flat areas with low elevation. The land forms are different and the soil types are different.

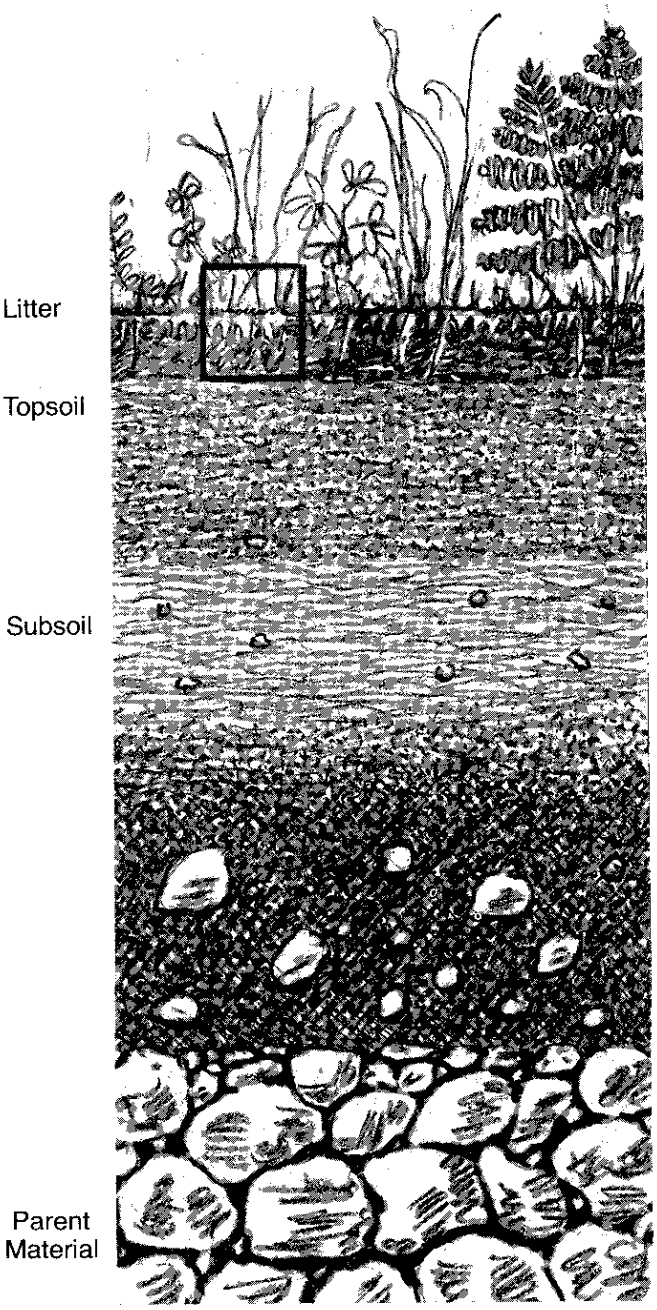
The soil is the medium for plant growth, and holds many of the nutrients that trees need. It becomes like a natural sponge made up of four layers. The top layer is *litter,* made of undecayed leaves or twigs. The layer of decaying leaves under the litter is called duff. The next layer is *humus,* made of further decayed duff and mineral soil. In this layer the remains of the leaves can no longer be identified. The color is dark. Below this is the *parent soil,* which holds or anchors the roots. Parent soil contains most of the minerals that plants use. In this layer are holes made by old roots, animals and insects. The holes allow water to sink deeper into the soil. Forest litter, humus and roots allow the forest soil to hold more water and to resist being broken apart by erosion. Well developed forest soil is usually crumbly and porous.

How Topography Affects Forest Species





Soil Layers



If soil is rich in nutrients, it has a lot of decomposers—the earthworms, bacteria, fungi and micro-organisms that help break down decaying organic matter. Some soils hold the right amount of water and enough of the nutrients that plants need in the topsoil. Other soils hold either too much or not enough moisture and therefore limit plant growth.

Over a period of time trees have adapted themselves to particular types of soil. Many trees grow on very specific soils. The longleaf pine of the South needs little water and grows best in sandy soil. But most species need fairly deep and well-drained soil. The baldcypress trees likes the heavy mucky soils of swamps. The red maple of the Eastern forests can grow in dry clay soils or in swampy peat bogs. This tree has a better chance of adapting to future changes in soil content than trees that need a specific soil type. To see the relationship between soil moisture and forest cover types, turn ahead to **Table 1 on page ??.**

Things You Can Do

1. Find examples of micro-climates in your forest. Look around for changes in moisture and temperature. If you did not measure forest temperature in Unit A, take a thermometer with you to record the temperature at different places on the forest floor. Take readings in a sunny spot between the trees, in a meadow or other open area, then under a thick canopy of high trees. Also measure the temperature at different heights off the ground. If your results are different, explain why.

2. Draw a picture of what your forest area would look like if an ice age came and there was never any summer. Think about what tree species would become extinct and which ones would adapt. How could the ice age affect other life forms in the forest?

3. Visit a spot that was once damaged by fire. List what plants grew in the spot before the fire and what grows there now. Make a display of the different effects of fire, both good and bad. If a fire tower is located nearby, visit with the lookout to learn how fires are spotted.

4. Find a tree identification book for your state or region. Identify trees and other plants that grow in your forest area. Which trees grow on flat land and which grow on hills? Which ones grow on mineral soils without litter, duff or humus?

5. What happens to the soil in your back yard or park after it rains? In your notebook describe a place where plants are growing and a spot that is bare. Compare the two places. In which spot is the soil being washed away? Find a place in your forest where the same thing is happening.

Meeting 5
How Animals, Insects and Plant Factors Affect Forest Growth

Other main factors affecting forest growth are. . .

Animals and Insects

In a forest, wildlife and plant communities depend upon each other for survival. The animals and insects benefit from living in the forest in many ways. The forest provides them with food and shelter and a place to raise their young.

Some animals live only in certain trees. In Northern Michigan a bird called the Kirtland warbler nests only in jack pine. Lately the number of jack pines in the forest has decreased because of fewer fires. (Remember how the jack pine needs fire to reproduce?) With fewer places to nest, this bird is now on the endangered species list. It may become extinct.

Animals and insects affect how plants grow. They help trees in some ways and hurt them in others. Some plants rely on wildlife to carry their seeds or pollen so that they can reproduce in other areas of the forest. Plants obviously cannot walk around to do this for themselves. Birds such as the woodpecker, the pine marten and the owl help trees by eating insects or animals that may harm the trees.

Some wildlife species may limit forest growth. Bear and elk can damage trees by rubbing themselves against the bark. Deer eat seedlings and also feed on the leaves and twigs of older trees. Porcupines feed on the inner bark of both conifers and broadleaf trees. Smaller animals like rabbits, mice and chipmunks eat seeds and very young trees. Farm animals, such as cattle and sheep, eat away the low vegetation. They also trample the ground with their hooves, and make the soil of the forest floor so hard that water cannot soak in easily. Birds such as the yellow-bellied sapsucker damage trees by pecking into the sapwood. This leaves the trees more open to diseases and weakens the future timber taken from them.

But when these animals leave their waste behind, or when they die, they actually help to fertilize the soil. Better soil makes for better trees. This is another example of the balance in the ecosystem that we studied earlier.

Harmful insects may eat away forests. The gypsy moth larvae feed on the leaves or needles of trees in our eastern forests. Blown by the wind, these insects can actually eat away many tree leaves for miles around. Sometimes the only trees to survive are those least tasty to the insects.

All plant eaters have enemies called *natural predators.* The plant eaters rarely destroy an entire forest, because the natural predators limit their numbers when they are present. Some of these predators are animals. Some are insects I ike the wasp and the praying mantis, who may eat the adults or the larvae of the plant-eating insect population. In well managed forests a variety of natural predators exist to keep the ecosystem working well. (Some harmful insects recently brought into our country, including the gypsy moth, still do not have natural enemies here and so must be fought in other ways. Scientists have developed chemical pesticides and, more recently, have discovered bacteria, fungi and viruses to help fight these harmful insects.)

Remember how the food chain works when you think about how wildlife affects forest growth. How could an increase in the-number of foxes help forest growth? What changes might occur in the forest if the hunting season on animals lasted longer than it does now? These changes may be helpful in some forests and harmful in others.

Plant Factors

How is it that the giant redwood tree in California can grow as high as 360 feet or more? How can the bristlecone pine grow to be over 5,000 years old? The trees around them remain much smaller or die much younger, even though they have the same climate, land form, soil and wildlife species. Why can't they grow as tall or live as long as the redwoods and the bristlecone pine?

Forest growth also depends upon the needs of the individual species. Different trees need different amounts of water, sunlight, warmth and nutrients to grow. Some trees have more growth power or hormones to help them to grow long plant shoots. Some plants are more likely than others to suffer from the attack of certain kinds of insects or certain kinds of disease. Some trees have better methods of spreading their seeds than others. For example, compare the way the jack pine spreads its seeds with the way of the dogwood.

Foresters call these traits *silvicultural characteristics.* The word "silviculture" comes from Latin. "Silva" means forest and "culture" comes from a word meaning to cultivate, or to prepare the ground for growing plants. Each species has its own silvicultural characteristics which makes it different from all other tree species. Foresters use the known silvicultural characteristics of various tree species in their management practices.

Plants in the forest must compete with each other for survival. Trees that need ful I sum ight to grow are called *intolerant* species, because they

cannot survive in the shade. the Douglas-fir is one example of an intolerant species. Trees such as the red alder, which can grow more quickly than the Douglas-fir in early years, have an advantage over the Douglas-fir in the fight for light and space.

Things You Can Do

1. When you visit your forest, think more about the different influences upon it. Look for the following . . .

a. a place where animals or insects have eaten plant growth

b. a place where insects have laid their eggs

c. some plant or animal matter in the process of decaying

2. Find at least one example each of organisms that live in the forest soil, on the forest floor, in the undergrowth and in the trees. Record this information in your notebook.

3. Describe what evidence of animal activities you find in and around trees. Look especially for animal tracks, and learn how to make a plaster casting. In your notebook, list the animal, the kind of tree affected and what the animal did. You may want to use a camera to record some of your findings.

4. Construct an exhibit or display on forest insects. Show how natural predator insects are beneficial to the forest ecosystem and to humans, and show how harmful insects destroy forest growth.

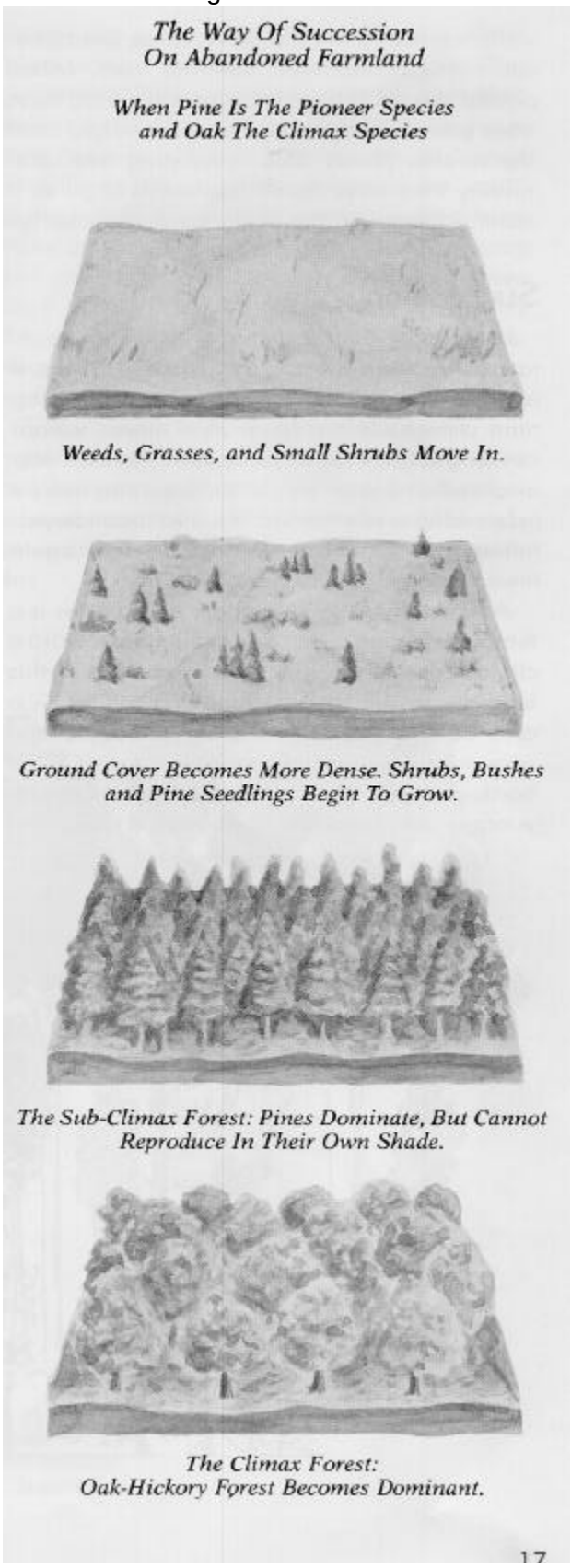
5. Make an exhibit of common forest tree diseases (such as Dutch Elm disease) including their effects on forests and methods of treatment.

B-3 Forest Development and Forest Regions

Meeting 6

How Forests Age

Just as an individual tree has a history, so does a forest. At some point in time your forest started on bare ground. The bare ground may have been a natural opening, or one made by humans, without any plant cover. But then lichens and similar plants started growing on bare rock or soil. Slowly moss began to grow, too. Ferns and then short grasses and shrubs probably followed, growing on the soil. Gradually a mixed plant life grew. Large shrubs became intermixed with the first trees, called pioneer *species.* If there was enough water, these trees grew quickly, and shut out sunlight from the smaller plants. This developing tree community may have lasted thousands of years if natural forces like fire or storms did not change it.



Succession

If the forest reaches the stage where the vegetation stays the same over a long period of time, it is then called a climax forest. The process of long term changes in the forest as it moves toward climax growth is called *succession.* For instance, an area that was once a climax forest may now be in farmland or another use. If it is left abandoned, nature may reclaim this land and move again toward climax growth.

A forest made up of pioneer tree species is a temporary stage in nature's movementtoward a climax forest. Let's look at an example of this kind of growth. Loblolly pine is a conifer—a cone-bearing tree. After it is harvested, the land may not grow another conifer but rather some hardwood tree. The hardwood tree has an advantage over the conifer because it is tolerant of shade. This hardwood may have been lying in the understory until the pine died or was harvested. The hardwood can still grow with less light, and can "shut down" its growth process during the winter season. A hardwood tree, like the beech, might adapt itself better to conditions than the pine tree. The Loblolly pine in this case is called a *sub-climax* species and eventually would be replaced by the climax species, the beech, if it is not quickly replanted by foresters.

Climax forest ecosystems are very resistant to widespread change. Insect attacks, diseases and other disturbances generally do not hurt these forests as much as they do sub-climax forests. Climax forests are also less affected by the loss of a single plant or animal species, because there are enough other species to take their place. But climax forests contain timber that is sometimes less valuable in a commercial sense. It takes longer for the trees in a climax forest to grow a mature stand. Some of the trees may be very old and decayed. Sub-climax forests may grow more usable timber, but are more likely to be heavily damaged by the forces of nature because the trees are usually even-aged (meaning all the same age).

Ground fires may keep a forest in a sub-climax stage for a long time. A few years back, fires swept through the Blue Mountains of Oregon. Each time after they were finally controlled, the white fir, a climax species that is tolerant to shade, slowly began to take over many areas of ponderosa pine forest, which is a sub-climax species. The ponderosa pine needs full sunlight to grow well. It was "shaded out" by the white fir. But as new fires flared up across the land every 10 years or so, the white fir trees were burned. The ponderosa pines kept growing because they were not destroyed by fire, and won out over the white fir. So, because of fire the forest remained in a sub-climax stage.