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OUR FORESTS: WHAT THEY ARE AND WHAT THEY MEAN TO US

By CHARLES E. RANDALL and MARIE FOOTE HEISLEY, *Division of Information and Education, Forest Service*

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INTRODUCTION

The history of the United States is staged against a forest background. From earliest colonial times the forest has played a most important part in the life of the country. Although the early settlers had to wrest from it the land upon which to grow their crops, it furnished the timber vitally needed in building their homes and industries. Some of the first colonial exports were forest products, such as planks and staves, pitch, and tar. The tall pines of New England furnished masts and spars for many a ship, which by the time of the Revolution were carrying canvas on all the seven seas.

As the country expanded the forest provided most of the sinews of commerce and trade. The prairie schooners and canal boats of the pioneers were made of wood, and the early railroads which followed them, like those of today, were laid on wooden ties. Numberless communities sprang up, subsisting mainly upon the bounty of the forest. Each decade saw more and more forests cut away with the extravagance born of the idea that America's forests were inexhaustible. More and more forest land was laid bare, to be developed into towns and farms or to be left lying idle and unproductive. The exploitation of our forests, however, probably reached its peak during the last 30

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years of the nineteenth century, when the country's greatest source of softwood timber was the extensive white pine forests of the Lake States. In fact, it has been said that the forests of the Lake States made possible the opening up and rapid development of the great West.

Although the forests of the North contributed largely to the rapid development of our Nation, it was the great pine woods of the Southern States that complemented the extraordinary industrial expansion during the first part of the present century. Considerable cutting was done in parts of this region during the early days of American history, and after the War between the States the lumber industry developed on a fairly large scale on the southeastern coast. The southern lumbering industry did not reach foremost importance, however, until the decline of the industry in the Lake States late in the nineteenth century. At that time southern pine became the leading lumber-producing species in the United States and has held an important position ever since. Nevertheless, these magnificent forests have passed their peak of production. Much of the timber used in the United States today comes from the Pacific coast. The forests of this region, together with such new growth as may develop in the South and other parts of the country, under forest protection and good management, are those that will meet the timber needs of the next century.

The forests have been and still are one of the Nation's most important natural resources. Not only do they play a leading part in the economic and industrial life of the Nation today, they serve us in many other ways. By checking the rains and melting snows, they help to prevent erosion and floods and insure a steady flow of water for power and domestic use; they are the source of many products besides lumber; they are the home of much of our game and wildlife; they furnish innumerable opportunities for recreation; and last, but not least, they make this country a pleasanter and more beautiful place in which to live. If we were to be totally deprived of forests, we would suffer economically, physically, and esthetically. In fact, it is doubtful if we could survive as a nation. It is therefore important that we know how to handle our forest wealth so that it may be used to fill our countless needs and at the same time continue a permanent natural resource. This can be done only by learning the ways of trees and forests, what forestry is, and what the practice of it means to the American people.

WHAT THE FOREST IS

The Forest Community

A forest is far more than a mere group of trees. It is a highly organized community of plants and animals living in close association and in varying degrees of interdependence. The law of life in the forest is the survival of the fittest, and the competition for existence is keen. The forest itself is beautiful and useful, and has played a vital part in the development of the human race.

How a Tree Lives

Trees are woody plants, growing from the ground usually with a single stem. They are the largest members of the plant world, rang-

ing in height from 20 to 300 feet or more, according to species and conditions of growth. Trees may be said to consist of three parts: (1) The roots, which hold the tree in place and take up from the soil water and certain mineral substances needed in the tree's growth; (2) the trunk or stem, which supports the crown and supplies it with water and food from the roots; and (3) the crown, which has much to do with the life of a tree, for in this part take place the most important processes in the digestion of its food and the reproduction of the tree (fig. 1).

The materials upon which a tree feeds are derived from the soil and from the air. Those from the soil are collected by the roots, which extend down into the ground. At the ends of the roots and rootlets are countless root hairs reaching out between particles of soil for water and the various substances which it holds in solution. The water and food materials thus collected move upward through numerous channels in the roots, trunk, and branches to the leaves.

The leaves serve as factories where the foods necessary for the tree's growth are manufactured. This food-making takes place in numberless tiny cells of the leaf where by aid of chlorophyll bodies and the action of sunlight, the carbonic acid gas taken from the air is broken up into its elements, oxygen and carbon. While the oxygen is returned to the air, the carbon, still through the action of sunlight and chlorophyll, is combined with the oxygen and hydrogen of the water from the roots, forming new chemical compounds, in which nitrogen and various earthy substances from the water are present. Thus the raw food materials which reach the tree through the roots and the leaves are digested in the leaves somewhat as food is digested in the human body. They are then sent to all living parts of the roots, stem, and crown, where they are either used at once in growth or stored away for later use.

Like all other plants and like animals, trees breathe. This breathing process goes on both day and night. The breathing is done through the leaves and through tiny openings in the bark called lenticels.

The amount of water taken up by the roots is usually very much larger than is required in the chemical processes which go on in the leaves. There is thus a surplus of water which cannot be held in the leaves, but must make way for fresh supplies carrying the mineral constituents necessary to the tree's growth. The tree rids itself of this unused water by a process known as transpiration, which is the evaporation of water from all parts of the tree above the ground, but principally from the leaves. In this way trees give off great quantities of water vapor, which tends to keep the air in the forests humid and favorable to growth.

How a Tree Grows

Most trees grow in height and spread of branches by sending out shoots formed by the development of new wood cells. The growth in height each year is made at the terminal bud of the main stem or stems. The "candles" of the pines are showy evidences of this new growth.

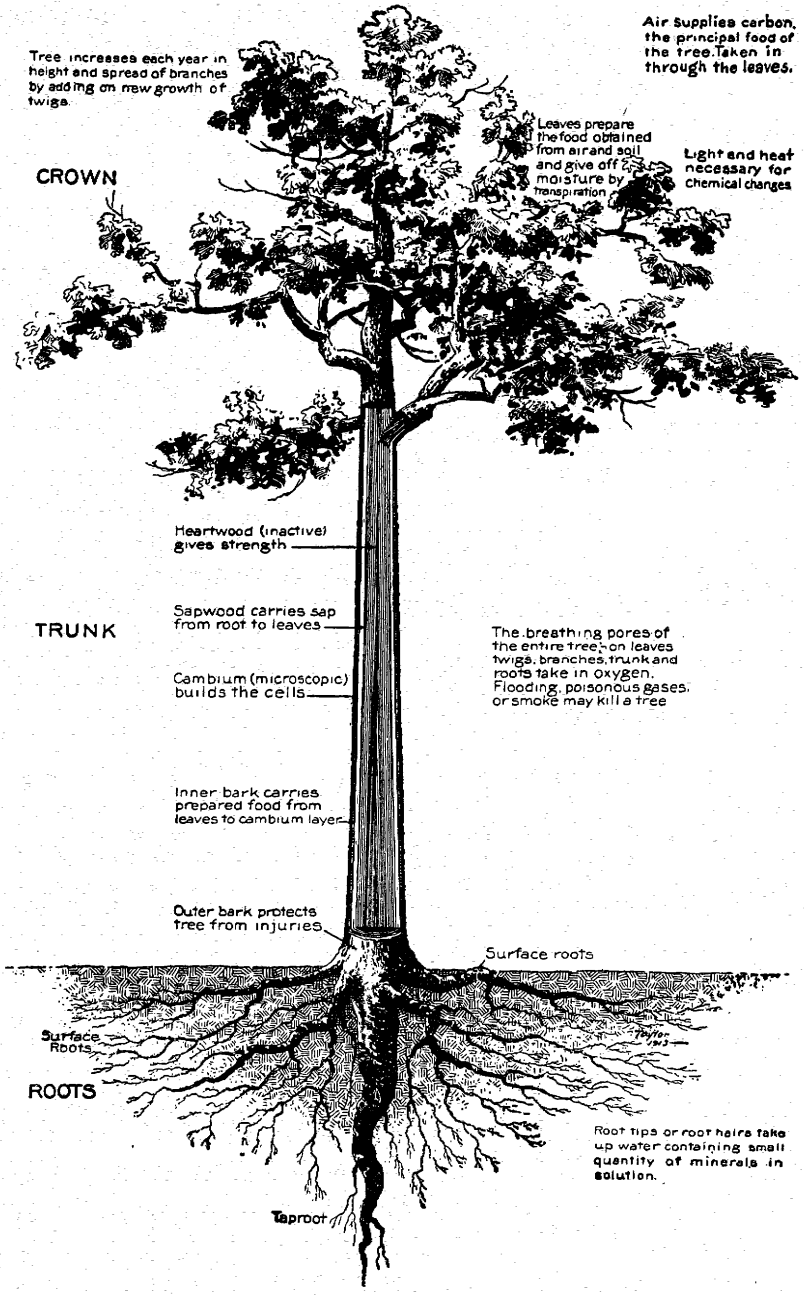

FIGURE 1.—How a tree grows.

The buds, root tips, and cambium layer are the growing parts of the tree. Water containing a small quantity of minerals in solution is absorbed by the roots, carried up through the sapwood to the leaves and there combined with carbon from the air to make food. This food is carried by the inner bark to all growing parts of the tree, even down to the root tips.

A tree grows in thickness or girth through the addition each year of a coat of new wood cells (fig. 2). The layer of wood thus developed is known as an annual ring, which, after it is once formed, does not change in size or place during the life of the tree. The annual rings as a rule may be clearly seen on a cross section of the tree trunk. In the center is the pith. Around the pith is the ring formed the first year; around the first year's growth is the ring formed the second year, and so on. The wood nearest the bark is often lighter than that in the center. This lighter wood is known as the sapwood, because it is the living wood through which the water taken up by the roots passes on its way to the crown. After it has

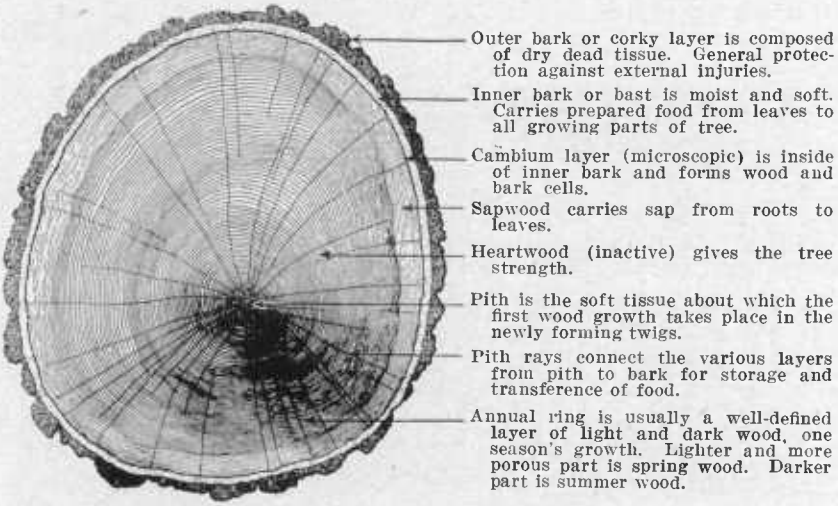

FIGURE 2.—How a tree trunk grows.

Annual rings are formed around the pithy growth of the first year, and in most trees can be plainly seen. Usually they show a lighter color for the spring growth and a darker color for the summer growth. The growing takes place in the cambium layer, where the cells develop and divide, part forming the sapwood and part the inner bark. As the tree increases in size, the sapwood nearest the center changes and becomes heartwood, and the cells of the inner bark harden and become dry, adding to the thickness of the outer bark.

served for a number of years carrying on these life processes, the sapwood gradually changes to heartwood. Through infiltration of chemical substance and certain changes in the character of the cell walls, the wood becomes darker in color and wholly lifeless. The one function of the heartwood is mechanical; it serves only to support the living parts of the tree. This is why hollow trees may still flourish and bear fruit.

The cells between the last layer of the sapwood and the bark make up what is known as the cambium layer. It is here that new growth takes place. The inner side of the cambium layer forms new wood and the outer side new bark. In addition to the true cambium, which forms both wood and bark, there is another cambium which makes the outer corky bark and nothing else. Like the true cambium, this cork cambium may encase the whole tree, or it may form

little separate films in the bark. In either case it dies from time to time, and is re-formed nearer the wood.

Trees, like many other plants, bear flowers and reproduce by means of seed. When the tree enters on its long winter rest, it has its next year's buds already formed. With the coming of spring, these buds expand and grow until they finally open into flowers or leaves. Some trees, like the elm and red maple, blossom and set fruit before the leaves open. The pussy willow and alder catkins burst forth before the frost is fairly out of the ground. Other trees wait until their leaves are partly grown before producing their blossoms, while still others, such as the chestnut and basswood, do not flower until early summer.

Most of the cone-bearing trees, such as the pines, spruces, and firs, also blossom in the early spring. The staminate (male) and pistil-

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FIGURE 3.—An abundant seeding of yellow-poplar.

Nature has to make a bounteous provision for the survival of her tree families, for only a small proportion of the seed scattered germinates. A still smaller proportion of the seedlings live to reach maturity.

late (female) flowers are usually found on the same tree, and their color varies in the different species from yellow and orange to shades of pink, rose, or purple. The pines, especially, produce large quantities of pollen which is scattered by the wind. Geologically, the conifers are very old, being contemporary with the plant growth from which the coal deposits of today were formed. They still retain the simplicity of floral structure which marked the vegetation of those early times.

Some trees mature their seeds rapidly and scatter them early in the growing season. This gives the seedlings a long summer for their first season's growth. Others, such as the nut trees, slowly

prepare their seeds for fall sowing. The members of the red-oak group and many of the cone-bearing trees take 2 years to mature their seed crops.

The seeds of many trees are winged and are easily scattered by the wind. The maples and the American elm are among those that belong in this class. The lighter seeds, like those of the elm, may be borne long distances. The seeds of the maples, however, are comparatively heavy for fliers and consequently do not get very far from the parent tree. Heavier seeds, such as the nuts and acorns, may be carried away from the parent tree by birds and small animals which feed upon them.

Most trees provide great quantities of seed, but when the seeds have fallen from the tree their fate becomes a matter of chance, and out of thousands perhaps only one will take root where it can grow to be a tree and in its turn bear seed (fig. 3).

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FIGURE 4.—Young and old members of tree families.

Young trees are growing up under the protection of their parents.

RELATIONSHIPS OF TREES

Forest trees are in many ways dependent upon their neighbors. They increase the fertility of the soil in which they grow; and their combined shade keeps the soil about their roots cooler in summer than it would be if each tree stood alone. Their interlacing crowns form a canopy under which the seedlings of all members of the forest community are sheltered in early youth (fig. 4).

At the same time there goes on in the forest a vigorous struggle for the prime necessities of tree life—water, sunlight, soil nourishment, and space in which to grow. Battling to get ahead of each other, the large trees push up towards the light, without which their leaves cannot

digest the food necessary for growth. Their crowns may fill the space overhead. Their lower branches, thus shut away from the sunlight, die and drop off, and in this way is developed the typical forest tree with long clean trunk, or great upward-stretching branches, and narrow crown high above the ground. Such trees make the best lumber. Trees grown in the open develop widespreading branches, and their lower limbs branch out from the trunk nearer to the ground.

Like their elders, the younger generations of trees have to fight for their existence. Openings in the forest are usually thickly filled with young growth shooting up from the ground or sprouting from the stumps of old trees which have died or have been cut. Some of the seedlings have outstripped their companions in growth and have full benefit of the sunlight which filters down to them. These the forester calls dominant, while those coming on, still in the thick of the fight, he calls intermediate. Other seedlings, not being able to keep pace with the vigorous ones, lag behind in the race. These the forester calls suppressed trees and, unless a fortunate chance gives them light and growing space, they will develop into unhealthy and crooked trees, or perhaps die out altogether. Thus from beginning to end the life of a tree is a struggle for a place in the sun.

Forest Soil

Next to sunlight, the forest soil is perhaps the most important influence in the life of young trees. If they are to develop into a thrifty and upstanding older generation, the soil must furnish them plenty of water and the various food elements that tree growth demands from it; the soil must be porous, and not hard packed, so that it may be easily penetrated by water.

Although trees make demands upon the soil, they also help to enrich it and increase its power to absorb and store water. The litter on the forest floor is made up of fallen leaves and needles, of dead branches, down trunks, and other vegetable remains. By the gradual processes of decay and chemical change and through the agency of water, microorganisms, and various animals that trample and otherwise disturb the surface of the ground, this forest litter disintegrates into humus. Largely with the help of percolating water, fine particles of humus work down into the mineral soil beneath. Here they are further broken down by bacteria and other organisms into various nitrogenous products.

Humus also improves the physical condition of soil. It makes a compact soil looser and a sandy or light soil more stable by causing the particles to form into crumbs. A crumb structure allows the most space for the two elements vital to plant growth—air and water. It takes the addition of only a small percent of humus to the soil to increase greatly its ability to absorb water. The combination of porous mineral soil with the interlacing roots of the trees and other forest plants, overlaid by a spongy mass of humus, makes the forest a prime factor in the control of stream flow.

Animals of the Forest Community

Not only does the forest contain myriad varieties of plant life but it is also the home of countless members of the animal kingdom. The timid deer cropping vegetation in the woodland, the stealthy cougar, the bear in a tree stealing honey from the bees, the sly fox, the busy squirrel, the inquisitive bobcat, the grouse upon his mossy log, the musical thrush, the tiny wood folk beneath the leaf litter, the raccoon dipping his forepaws cautiously into the cool waters of a running stream or searching for grubs along a rotting log, the moose browsing along a lake shore, the busy beaver cutting willows for a dam, the gamey fish in the streams, are as much a part of the forest as the trees themselves (fig. 5). Wild game and fur-bearing animals, which the forests harbor, are valuable resources.

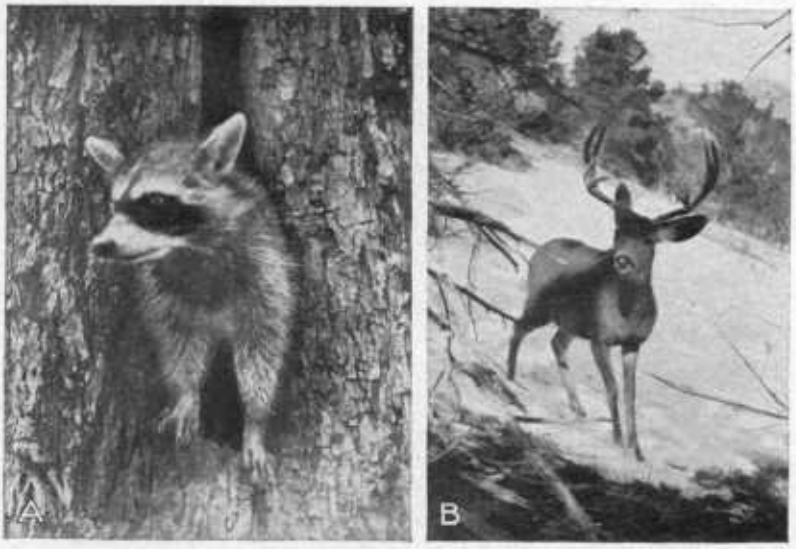

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FIGURE 5.—Some residents of the forest community.
A, Raccoon; *B*, mule deer.

FOREST REGIONS OF THE UNITED STATES

Originally forests covered the entire eastern half of the United States, stretching in a practically unbroken area from the Atlantic seaboard to the Great Plains. West of the Great Plains they were in more isolated groups, lying mostly in the Rocky Mountains and the mountainous parts of the territory now occupied by the Pacific Coast States. The area of the original forests is estimated to have been more than 820,000,000 acres, or about 42 percent of the land area of the United States.

It is estimated that there are about 462,000,000 acres of forest land in continental United States capable of producing timber in commercial quantities. An additional 168,000,000 acres consist of noncommercial forest land or low-grade forest and scrub. Less than one-half of the total acreage of commercial forest land bears saw

timber. An additional 100,000,000 acres bear some timber, but it is mostly too small for sawlog production although large enough for cordwood. Of the remainder, some 71,000,000 acres have young growth in varying amounts, but there are nearly 77,000,000 acres of land suitable for producing commercially valuable timber that are now almost entirely deforested and nonproductive. All told, our 462,000,000 million acres of commercial forest land are growing only about half as much timber as they could.

Three-fifths of our forest land, including most of the second-growth and denuded areas, lies east of the Great Plains. That region, however, now contains only about one-third of all our remaining timber of merchantable size. The whole eastern half of the country now has only about as much saw timber as the 6 percent of our forest area in the coastal regions of Oregon and Washington.

There are five principal forest regions in the United States—the northern, hardwood, southern, Rocky Mountain, and Pacific coast (fig. 6). In addition we have a small tropical-forest area.

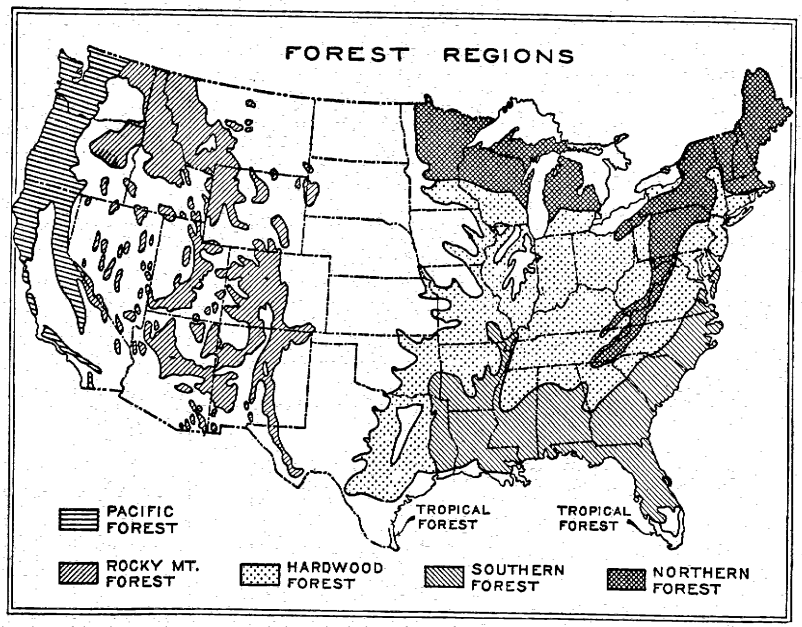

FIGURE 6.—Principal forest regions of the United States.

NORTHERN FOREST REGION

The northern forests of mixed conifers and hardwoods extend from the Atlantic coast through New England westward across New York and the upper Lake States region to the Great Plains, and southward from New York along the Appalachian Mountains to northern Georgia. Characteristic of the forests of this region is the mixture of pine, spruce, and hemlock with the hardwood types.

In the northern part of this region the most important commercial trees have been the eastern white pine, hemlock, and spruce. It was

the white-pine forest of the Northeastern and Lake States that formed the backbone of the softwood-lumber industry in this country from colonial times almost to the beginning of the twentieth century. The original stands of this species, however, have almost entirely disappeared. Of the original growth of hemlock, only a small portion remains, and the spruce forests even in the less accessible regions have been heavily cut.

In the southern part of the region (along the Appalachian Mountains) eastern hardwoods attain their highest development. Yellow-poplar is perhaps the outstanding hardwood species of this area, but many others are to be found here. American chestnut, once an important timber species here, has been practically wiped out by blight. Although the bulk of the virgin timber is gone from the southern Appalachians, this section contains a vast aggregate of second-growth and restocking areas. Commercially this section should, if its forests are properly protected and managed, become one of the great permanent forest areas of the United States because of the large amount of nonagricultural land, the valuable species of hardwoods it can produce, and its proximity to the large markets for forest products.

Many other species are found in the northern forest region. Those characteristic of the northern portion include red, black, and white spruces; balsam fir; eastern white, red, jack, and pitch pines; hemlock; sugar and red maples; beech; northern red, white, black, and scarlet oaks; yellow, paper, black and gray birches; several species of as en and cottonwood; basswood; elms; ashes; northern white-cedar; and tamarack. The species of the southern Appalachian portion include white, northern red, chestnut, black, and scarlet oaks; hemlock; eastern white, shortleaf, pitch, and Virginia pines; black and yellow birches; basswood; sugar and red maples; beech; red spruce; Fraser fir; cucumbertree; black cherry; hickories; black locust; black tupelo ("blackgum"); and buckeye.

Hardwood Forest Region

The hardwood region (sometimes called the central hardwood region) is the most extensive of the forest regions. It covers the piedmont section east of the Appalachian Mountains, the greater part of the drainage basins of the Mississippi and Ohio Rivers, and extends southwestward through Oklahoma over central Texas. It may be divided into three portions—northern, southern, and Texas.

Three-fourths of the timber-producing acreage in this forest region is in farm woodlands, generally 10 to 40 acres in extent, and only one-fourth is in comparatively large tracts of practically continuous forest. The largest forest stands are found in the hilly sections, mainly on lands not well suited for farming, in southern Ohio, Illinois, and Indiana, the Highland Rim of Kentucky and Tennessee, and the Ozark Plateau in Missouri and Arkansas. The farm woodlands are scattered more thickly throughout the better-developed agricultural sections (fig. 7).

The present stands of timber in the hardwood region are largely the culled remnants of former splendid hardwood forests. Continued cutting of the best species and individuals, forest fires, and the heavy pasturing of woodlands have worked havoc, but a few scattered virgin stands are still in existence.

The hardwood forest region has a large variety of hardwood species. The northern portion of the region contains white, black, northern red, scarlet, bur, chestnut, and chinquapin oaks; shagbark, whiteheart, pignut, and bitternut hickories; white, blue, green, and red ashes; American, rock, and slippery elms; red and silver maples; beech; pitch, shortleaf, and Virginia pines; yellow-poplar; sycamore; chestnut; black walnut; cottonwood; hackberry; black cherry; basswood; buckeye; and redcedar. The species of the southern portion include white, post, southern red, blackjack, chestnut, swamp chestnut, and pin oaks; red and black gums; whiteheart, pignut, and southern shagbark hickories; shortleaf and Virginia pines; white, blue, and red ashes; yellow-poplar; black locust; elms; sycamore; black walnut; silver and red maples; beech; buckeye; dogwood; persimmon; cottonwoods and willows; redcedar and Osage-orange. The Texas portion includes post, southern red, and blackjack oaks; and mountain and other cedars.

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FIGURE 7.—A stand of mixed hardwoods in the central hardwood region (Illinois).

SOUTHERN FOREST REGION

South of the hardwood region lies the southern forest, extending through all of the South Atlantic and Gulf States from eastern Texas to the southeast corner of Virginia, and including all of Florida except the southern tip. It takes in the southern and eastern parts of Arkansas and the extreme southeastern corner of Missouri. It is composed mostly of pinelands and alluvial bottoms and swamps.

Most important in the southern forest are its pinelands, where grow the four pines for which the South is famous—longleaf, slash, shortleaf, and loblolly (fig. 8). Lumber from these pines is all marketed as southern yellow pine, which since the decline of the white pine

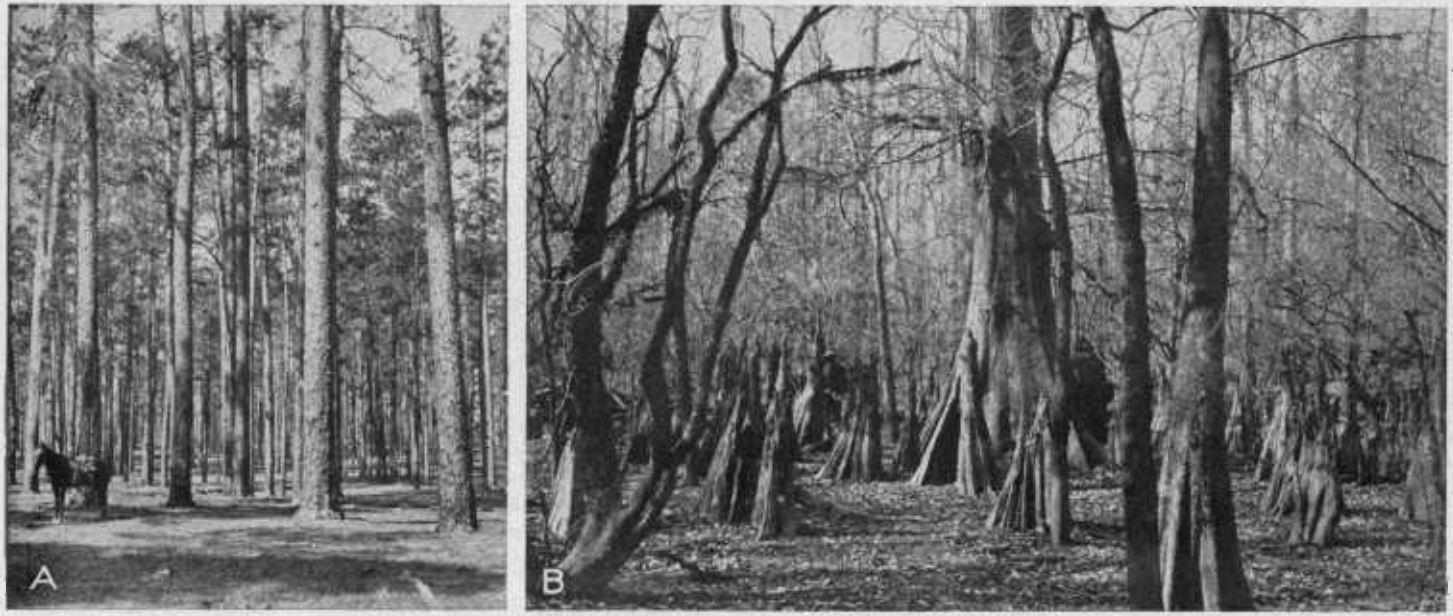

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FIGURE 8.—Some important species of the southern forest.

A, A virgin longleaf pine forest in Louisiana. Longleaf is one of the four important southern yellow pines. *B*, Southern cypress (Texas), showing the characteristic growth of "knees." The cypress is an important timber tree of the swamplands.

forests of the North has been the mainstay of the eastern and central lumber markets. The production of high-quality southern yellow pine, however, has passed its peak. In addition to being valuable timber trees, the longleaf and slash pines are highly important as the source of the gum from which turpentine and rosin are manufactured. Other species found in the pinelands are southern red, turkey, black, post, laurel, and willow oaks blackgum; pond, spruce, and sand pines.

Another tree of commercial importance, found in the southern forest, is the baldcypress. It grows mostly in the swamps and lowlands and is one of the few coniferous trees that shed their leaves in the fall (fig. 8, *B*). The supply of this species also is gradually dwindling after years of heavy cutting.

Perhaps the most important hardwood tree of the southern forest is sweetgum, or red gum. At one time its wood was considered of little importance because of its tendency to warp and twist. With the introduction of proper seasoning methods and the diminishing supply of finishing woods, the sweetgum has risen from a position of comparative obscurity to a rank of seventh among all lumber-producing trees (1942). Sweetgum is second only to Douglas-fir in the production of veneer and ranks second among all woods as a source of slack cooperage. It also goes into many other products.

Both baldcypress and sweetgum are inhabitants of the alluvial bottoms and swamps. Also growing in bottom-land portions of the southern forest region are tupelo and blackgums; water, laurel, live, overcup, Texas red, and swamp white oaks; yellow-poplar; hickories (including pecan); beech; ashes; red and silver maples; cottonwood and willows; elms; sycamore; hackberry, honeylocust; bays; magnolias; spruce pine; and southern white-cedar.

Tropical Forest Region

The tropical forest region is so small as to be of almost negligible commercial importance. It consists of two fringes of forest along the coast in extreme southern Florida and extreme southern coastal Texas. Its total area is probably not more than 400,000 acres and the density of the forest varies greatly. Many kinds of hardwoods are found in this region, but most of them are small and bear evergreen leaves and pulpy berries or stone fruit. A few, like the mastic or "wild olive," are of some commercial or economic importance. The mangrove is also valuable because the impenetrable thickets it forms hold the muddy banks, cause new land to be built up, and act as a windbreak against tropical hurricanes.

The principal trees of the tropical forest region are mangrove, royal and thatch palms, Florida yew, wild fig, pigeon plum, blolly, wild tamarind, gumbo limbo, poisonwood, inkwood, buttonwood, mastic or wild olive, Jamaica dogwood, and cabbage palmetto (fig. 9). The tropical species in this region are at the northern limits of their natural ranges which include mostly some or all of the West Indies, the Bahamas, Central America, and South America. The trees probably grew from seed washed ashore during storms or distributed by birds.

Rocky Mountain Forest Region

The forests of the Rocky Mountain region occupy the high elevations of the various ranges of the Rocky Mountain system between

the Great Plains and the Sierra Nevada, from Mexico to Canada. They are broken by many treeless valleys or plateaus. Because of rough topography and inaccessibility to transportation routes, it is

FIGURE 9.—Cabbage palmetto.
A characteristic tree of the Florida landscape.

likely that forests of parts of this region, together with the less accessible of the mountain forests near the Pacific coast, will be the last to be cut. Many forests in the Rocky Mountain region, however,

by protecting the sources of water utilized for irrigation, for city water supplies, and for other purposes, are performing a function of even higher value to the Nation than the production of wood (fig. 10). Wisely managed, they can continue to perform both functions—protection of watersheds and production of timber.

The species most utilized are the valuable western white pine of the northern Rockies and the ponderosa pine which is scattered throughout the whole Rocky Mountain region.

Rocky Mountain forests are made up mostly of coniferous species. Among these, in addition to the two just mentioned, are Douglas-fir; western larch; western redcedar; western and mountain hemlock; lodgepole, limber, whitebark, bristlecone, and piñon pines; alpine,

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FIGURE 10.—A forest-covered watershed in the Rocky Mountains. The forests of this region play an important part in watershed protection.

white, and lowland white firs; Engelmann, blue, and white spruces; junipers; cedars; and cypresses. Aspens, cottonwoods, oaks, walnut, sycamore, alder, and boxelder are some of the few hardwoods of this region.

PACIFIC COAST FOREST REGION

The Pacific coast forest region extends from the Canadian border through the western half of Washington and Oregon and into California. In the southern portion of California the timbered lands are on the higher elevations, surrounded by areas of low brush-type forest or chaparral.

What are perhaps the heaviest stands of timber in the world are to be found in the Pacific Coast States. They contain the last great commercial bodies of softwood virgin timber remaining in the United

States. Each year sees further inroads on this last stand of old-growth timber. The three Pacific Coast States furnished about 40 percent of the country's total lumber production in 1942.

FIGURE 11.—A forest of Douglas-fir.

This species reaches its greatest development in the Pacific northwest, although it is found to a large extent also in the Rocky Mountain region.

The two most important commercial species of the Pacific coast region are Douglas-fir and redwood. In the amount of lumber produced in the United States Douglas-fir (fig. 11) ranks second only to southern

yellow pine. Western white pine, sugar pine, and western hemlock also are valuable timber trees of this region.

In California grow the celebrated giant sequoias ("bigtrees") and redwoods. The redwoods are found in a strip 20 to 30 miles wide along the coast, extending from the southern borders of Oregon into Monterey County, Calif. The bigtrees grow farther inland on the western slope of the Sierra Nevada. Because of the comparatively small number remaining, practically no lumber is now cut from the bigtrees.

Other species found in the Pacific coast region are mountain hemlock; noble, silver, lowland white, white, and Shasta red firs; Western redcedar, incense, Port Orford, and Alaska cedars; Sitka, Engelmann, and bigcone spruces; western and Lyall larches; lodgepole, knobcone, and Digger pines; Monterey and Gowan cypresses; western and California junipers; single-leaf piñon; oaks; ash; maples; alders; cottonwood; buckeye; laurel; and madroña.

HOW OUR FORESTS SERVE US

Forest Products

For many of us the forest is no longer close at hand. Nevertheless, it has continued to contribute more and more to our needs until today the uses to which its resources and products are put are legion.

The principal forest product, of course, is wood—one of the world's most useful raw materials. Wood provides us with shelter, implements, furniture, and many other articles intimately associated with our daily lives are made of it. It gives us most of the paper that goes into our newspapers and books. Our railroads are laid on wooden ties, and in millions of homes throughout the country wood is still the sole or principal fuel used. It is also used in mining the coal and drilling for the oil which heat countless other homes and provide power for industries and transportation systems. In short, nearly all of the products used by the American people, whether vegetable, animal, or mineral, use wood somewhere in the process of production, distribution, or utilization.

During World War II, wood was one of the most critically important war materials, needed in enormous quantities for barracks and cantonments, for war factories and housing for war workers, for wharves, ships, aircraft, truck bodies, gunstocks, explosives, and hundreds of other war requirements. Vast amounts were used for boxing and crating ammunition and supplies for shipment to the men at the fighting fronts. The armed forces actually used more tons of wood than of steel. The war brought home as never before the fact that wood is an indispensable material.

As a result of our enormous demand for wood, there has developed a large group of industries engaged in the manufacture of forest products. Foremost among these is the lumber industry, which has to do with felling the trees, cutting them into logs, and getting the logs to the sawmill, where they are sawed into boards and rough lumber (fig. 12). Planing mills remanufacture some of the rough lumber into finished lumber, sash, doors, blinds, and other products. Still other plants use the rough lumber for the manufacture of shoe lasts, spools and bobbins, woodenware novelties, toys, and other turned-

wood products. The veneer industry cuts from logs the thin sheets of wood used in the making of baskets, berry boxes, and other containers. High grade veneers are used extensively by the furniture industry, which also employs other forms of wood; and veneers are used to make up plywood, a material that has had increasing usage in recent years. The cooperage industry employs wood in the form of bolts for the manufacture of barrels, kegs, buckets, etc. There are many other industries which manufacture the numerous wooden articles in common use. The products manufactured by primary forest industries have a yearly value of about 2 billion dollars, not including paper and paper products.

From the forest also comes the raw material used in the manufacture of paper and numerous other wood-pulp products. The basis of paper is pulp made from fibers of cellulose, that remarkable material

FIGURE 12.—Lumber seasoning at the mills.

Felled trees are cut into logs for transportation to the mill, where they are trimmed and cut into boards. After the boards have been edged and trimmed they are sorted and sent to the lumber yard to be piled and seasoned.

which forms the cell walls of plants. Wood is the most abundant source of commercially used cellulose in the plant world, for more than one-half of its substance is cellulose fiber.

Four commercial processes of making paper from wood are in general use: three chemical—the sulfite, sulfate, and soda processes; and one mechanical—the ground-wood process. In each of the chemical processes the chipped wood is cooked with a chemical under steam pressure in a specially designed cooker, or digester. This process removes the portion of the wood known as lignin, which is the material that binds the cellulose fibers together. In the ground-wood process the uncooked wood is ground into a pulp. Each process is adapted to the manufacture of certain grades of paper or to the pulping of certain woods, the

stronger and better grades coming from the three chemical processes. Among the woods suitable for pulping are spruce, hemlock, southern yellow pine, poplar, balsam, fir, jack pine, white fir, beech, birch, maple, gum, and larch.

The United States uses more paper than all the rest of the world. In 1940 our consumption of paper products amounted to no less than 16½ million tons, or 250 pounds for every man, woman, and child in the country. This amount of paper was equivalent to more than 16 million cords of pulpwood.

The paper industry is distributed in 37 States. It was first established in the Northeast, and is still an important industry in that region. From there, however, the industry has spread to the Lake States, the Central States, the Pacific coast, and in recent years throughout the South, from Virginia to Texas.

There are several reasons for this expansion of the pulp and paper industry in the Southern States. For one thing the supply of Northern pulping woods has been steadily diminishing. There has also been an increased need for the heavy type of product known as kraft paper, for which Southern pine pulp is extensively used. Southern pines can be cheaply pulped, and the South has an available supply of cheap wood, plenty of water, abundant labor, and an all-year working climate, all of which are favorable to the extensive development of the industry.

Another product of wood pulp is rayon, that soft silky textile which in recent years has come into extensive use as a clothing material. It is made from some form of plant cellulose, preferably cotton or wood, and at present more than 60 percent of the rayon produced is said to come from wood cellulose. In the manufacture of rayon the cellulose is modified by various chemicals, which differ with the process employed, and the thick sirupy solution resulting is forced through minute apertures corresponding to the spinnerets of the silk worm. The fine threads, or filaments, coming through these openings are coagulated either in a fixing bath or by a process of evaporation, and several of them formed simultaneously are twisted into the strand for spinning. The annual production of rayon now amounts to about 730 million pounds.

From wood pulp also comes much of that widely used transparent wrapping known as cellophane. Like paper and rayon it is a cellulose product, and its manufacture is similar to that of rayon, except that the viscous solution is forced through a narrow slot.

Various other products are made by combining certain chemicals with sawdust or wood flour. These are known as plastics and are gaining in use daily. Fountain pens, telephone parts, radio and automobile trimmings, combs, and a thousand other articles are being made of plastics.

After wood, the most important forest products are perhaps turpentine and rosin. They are obtained by the distillation of the gum that exudes from the longleaf and slash pines of the South. The gum is drained from the trees and carried to a still, where it is cooked in closed iron retorts. The turpentine is given off in the form of a vapor which is collected and condensed in a condensing worm. The rosin is the part of the gum left after the turpentine has been distilled off. The name "naval stores" was originally given to these products because for many years they were used chiefly in shipbuilding. Naval stores

now serve numerous other purposes and in 1941 yielded raw materials worth about 18 million dollars.

Not so valuable commercially, but with a domestic importance all their own, are the sugar and sirup made from the sap of the sugar maple and its close relative, the black maple. The trees are tapped in February or March by boring small holes in the sapwood. A spout is inserted in each hole and a bucket hung beneath it to catch the sap which drips out. The collected sap is carried to the sugar house, where it is boiled down to the proper consistency for sirup or sugar. Most of the maple products come from the Northeastern and Northern States, but a few other States also produce them in commercial quantities.

There are also numerous other forest products of more or less importance. The bark blisters of the balsam fir produce a resin which when refined has sold for as much as $40 a gallon in recent years. In spite of all the work and skill of the chemists, wood and bark remain the chief sources of tannins; and dyes from various trees, such as black oak and Osage-orange, are still to be found in trade channels. Many kinds of edible nuts and fruit, crude drugs, and Christmas greens also come from our forests.

Forests and Our Water Supply

Forests give invaluable service to man through the protection of watersheds and the regulation of stream flow. The thick crowns of the forest trees, which sometimes almost entirely shut the sunlight from the forest floor, also break the fall of the rain. Down on the forest floor the water from rain or melting snow is likewise intercepted by the leaf litter. It sinks gradually into the soft absorbent soil beneath, and some of it eventually finds its way underground to the springs and streams (fig. 13). The checking of surface waters tends to make stream flow regular and continuous throughout the year. Where watersheds are not protected, rains fall on bare soil, and the water rushes down the slopes, with the result that streams rise quickly to flood height and as quickly dwindle away.

Adequate watershed protection insures an abundance of water for use in homes, for irrigation of cultivated lands, and for river navigation. It helps to make constant the power which turns the wheels of many a factory and furnishes electric current for numberless uses. It keeps the rains from washing away huge quantities of rich soil, leaving hillsides bare and unproductive and chocking river beds and bottoms with heavy deposits of mud.

One-half of our forest area exercises a major influence on stream flow and an additional quarter a moderate influence. The area of major influence, however, feeds streams that flow through nearly every other part of the country. Therefore, practically our entire population directly or indirectly benefits from forest-protected waters.

Other Uses of the Forest

Forests have still other protective uses. They help to prevent landslides and snowslides; they protect homes, fields, and orchards from cold and destructive winds; and in some parts of our country they give permanent form to sand dunes, which otherwise would be con-

stantly shifting from place to place, sometimes burying fences, roads, and railways.

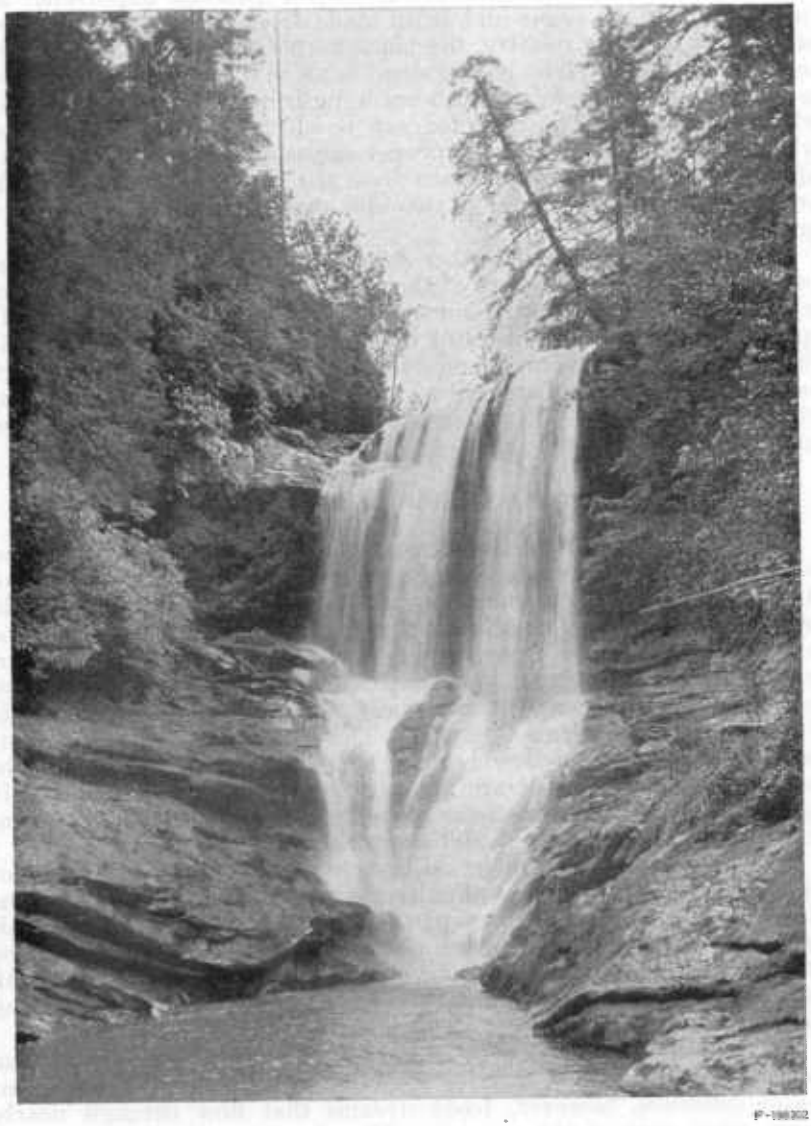

FIGURE 13.—The white cascade of a forest stream. Forest-protected hillsides mean a constant flow of water, pure and fresh for drinking purposes, and abundant for power and other domestic and industrial uses.

Besides serving us in these various ways the forest offers opportunity for pleasure and recreation for both young and old. It is, of course, an ideal camping place; it furnishes playgrounds and shaded resorts for picnics and excursions; its streams and lakes are the delight of the fisherman; and its dusky recesses are the mecca of the

naturalist. The beauty and splendor of the forest, its atmosphere of peace and quiet, and the glimpses of its wildlife have an irresistible appeal for all of us. Just how great this appeal may be is shown by the numbers of recreationists who visit the forests. On the national forests alone it is estimated this number has exceeded 35,000,000 a year. The visitors include residents who have established summer homes in the forests, hotel and resort guests, campers, picknickers, and motorists. For the convenience of visitors the Forest Service has established more than 4,200 public campgrounds and picnic areas, and 254 winter sports areas in the national forests. Some large cities, notably Los Angeles, Oakland, Berkeley, and San Francisco, have built permanent municipal camps for their citizens on nearby national forests and the Forest Service maintains some 50 organization camps where various groups, for a nominal sum, may find rest and recreation.

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FIGURE 14.—The "red enemy" at its worst. A crown fire destroys everything in its path.

All that is asked of visitors is that they bring to the forest the care and thoughtfulness they give to their own homes; that in seeking recreation in the forests, whether national, State, or private, they be careful not to abuse the hospitality of the woods.

ENEMIES OF THE FOREST

FIRE—THE ARCH-DESTROYER

Although the forest is prey to many foes, its greatest single enemy is fire.

A yearly average of more than 200,000 fires, burning over more than 30,000,000 acres, has occurred in the United States during the last few years. About nine-tenths of these fires were caused by human carelessness, or indifference, through such agencies as campers,

smokers, debris burners, and railroads. Many of these fires have been of incendiary origin. Only too common in this country are great fires which sweep over the forest, consuming the largest trees, killing game and other wildlife, destroying human habitations and sometimes taking a high toll in human life. Such a fire is likely to result when high wind whips the flames into the treetops (fig. 14).

Not all fires are of this crown type, however. Frequently fires burn over the surface of the ground but do not reach the treetops. Such fires may not kill the bigger trees, and for this reason some persons have thought them not worth worrying about. But these fires that burn over the surface are very harmful to the forest. By scorching the bases of the big trees, they open wounds through which

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FIGURE 15.—Result of fire and hurricane. Coeur d'Alene National Forest, Idaho.

wood rot enters, which depreciates the value of the lumber and increases the likelihood of the trees being broken by the wind. Surface fires, too, kill the young trees that would grow up to perpetuate the forest; they burn the leaves and other litter on the forest floor and destroy the fertility of the soil. They burn the coverts and nests of game animals and birds and the ashes sometimes make the streams uninhabitable for fish. If repeated often enough, such fires gradually turn the green forests into a waste—ugly, desolate, and unprofitable for any purpose (fig. 15).

In general, forest fires, whether large or small, mean loss not only to the owner of the land but in some measure to everyone. They mean that so much more of our forest land will not be working for us; that there will be fewer trees to supply the wood necessary to build our houses, run our railroads, and make our furniture, and number-

less other things that give us comfort; that watershed protection has been impaired; and that just so many more acres of forest playgrounds have been taken from us. Is it not therefore the duty of every good citizen to be careful of fire when in the woods?

Six simple rules to prevent fires in the woods are:

1. MATCHES.—Be sure your match is out. Break it in two before you throw it away.

2. TOBACCO.—Be sure that pipe ashes and cigar or cigarette stubs are dead before throwing them away. Never throw them into brush, leaves, or needles.

3. MAKING A CAMPFIRE.—Before building a campfire scrape away all inflammable material from a spot 10 feet in diameter. Dig a hole in the center and in it build your fire. Keep your fire small. Never build it against trees or logs, or near brush.

4. BREAKING CAMP.—Never break camp until your fire is out—dead out—cold.

5. HOW TO PUT OUT A CAMPFIRE.—Stir the coals while soaking them with water. Turn charred sticks and drench both sides. Wet the ground around the fire. Be sure the last spark is dead.

6. BRUSH BURNING.—Get a burning permit from the ranger or fire warden if your State law requires it. Have plenty of help and fire-fighting tools handy. Never burn slash or grass or brush in windy weather, or while there is the slightest danger that the fire will get away.

INSECTS

Insects are constantly injuring the forest, just as year by year they bring loss to the farm. Occasionally their ravages attain enormous proportions. Conifers are much more likely to suffer seriously from the attacks of insects than are broadleaf trees. This is especially true of some of the pines of the West and South which have been greatly damaged by bark beetles. The western pine beetle is to be found in the ponderosa-pine forests of the Rocky Mountain and Pacific Coast States. It generally attacks the trees in swarms and burrows into the living bark. The female insects excavate galleries in the inner layer of bark and deposit their eggs. After the eggs hatch, the larvae in turn bore their way through the bark until they have completed their growth. Their galleries serve to cut off the natural movement of the sap and kill the trees by completely girdling them. The larvae then bore into the outer corky bark, where they make little cells in which they are transformed, first to the pupa and later to the adult stage. The adults work their way out through the bark and fly in swarms to living trees, there to continue their depredations. The southern pine beetle, closely related to the western pine beetle, works in much the same way. It attacks and kills pines of all species occurring within its range, which includes the Southeastern and Gulf States.

Another extremely bad example of insect attack is that of the gipsy moth, which many years ago became established in New England. It attacks the oaks and several other broadleaf trees and destroys mixed woodlands if not checked. The tent caterpillars, the spruce budworm, pine tipmoth, and various borers are other insects that cause losses to the forests.

Fungus Diseases

Fungi attack the forest in many ways. Some kill the roots of the trees; some grow upward from the ground into the trees and change the sound wood of the trunks to a useless rotten mass. The chestnut bark disease, or chestnut blight, has ravaged the native chestnut in this country. It is a parasitic fungus, introduced from Asia on small nursery stock before this country had enacted plant quarantine laws. Its minute spores float through the air and spread the disease. The spores find lodgment in the bark and the fungus gradually grows down through it, eventually causing the death of the tree. As yet no practicable means of controlling the chestnut bark disease has been found.

Another fungus disease is the white pine blister rust which, strange as it may seem, lives alternately on the pine and on currant and gooseberry plants. The disease enters the white pines through the needles and grows into the bark. Diseased areas in the bark are called cankers. About 3 years after a tree becomes infected orange-yellow blisters break from the cankers. In the spring millions of spores from these blisters are scattered by the wind over long distances, infecting the leaves of currant and gooseberry bushes. The disease cannot go directly from one pine to another, but must first go to currants or gooseberries. It is the spores produced on the leaves of these plants that are dangerous to the pine trees. Since these spores are delicate and short-lived their infecting range is limited to relatively short distances. Thus it is possible to control the disease locally by destroying currants and gooseberries in the vicinity of white pines.

Other Enemies

Animals grazing in the woods can do serious damage to both the mature trees and the young growth. The older trees may be injured by having their roots trampled and wounded and by having the soil around them compacted to such an extent that it is nearly impervious to water. Young growth is often entirely destroyed. Cattle, horses, sheep, and goats browse young seedlings, particularly the hardwoods, trample them down, or brush against them and break them. Hogs eat the seed of certain trees and thus prevent new growth from starting. They actually root pine seedlings out of the ground and eat the inner bark. Grazing in woodlands should therefore be carefully regulated if the stand is to remain productive.

In localities where trees are shallow-rooted, or the ground is soft because it is soaked with water, or where trees have been weakened by fire or other agencies, windstorms can cause extensive damage. The New England hurricane of 1938 blew down millions of board feet of timber over wide areas; the huge timber salvage job which followed lasted several years. A bad blow-down may become a fire menace, as well as a waste of valuable timber.

Snow and sleet may also be very harmful, especially to young trees. It often loads them down, breaks, or deforms them, especially if wet snow falls heavily before the broadleaf trees have shed their foliage in the fall. In east Texas in 1944 an ice storm damaged timber on several million acres. In many regions, however, snow is so useful in protecting the soil and the young trees that the harm it does is offset by its benefits.

FORESTRY IN THE UNITED STATES

What Forestry Is

Forestry is the handling of forest land in such a way that it will produce repeated crops of timber and will exert to the fullest the bene-

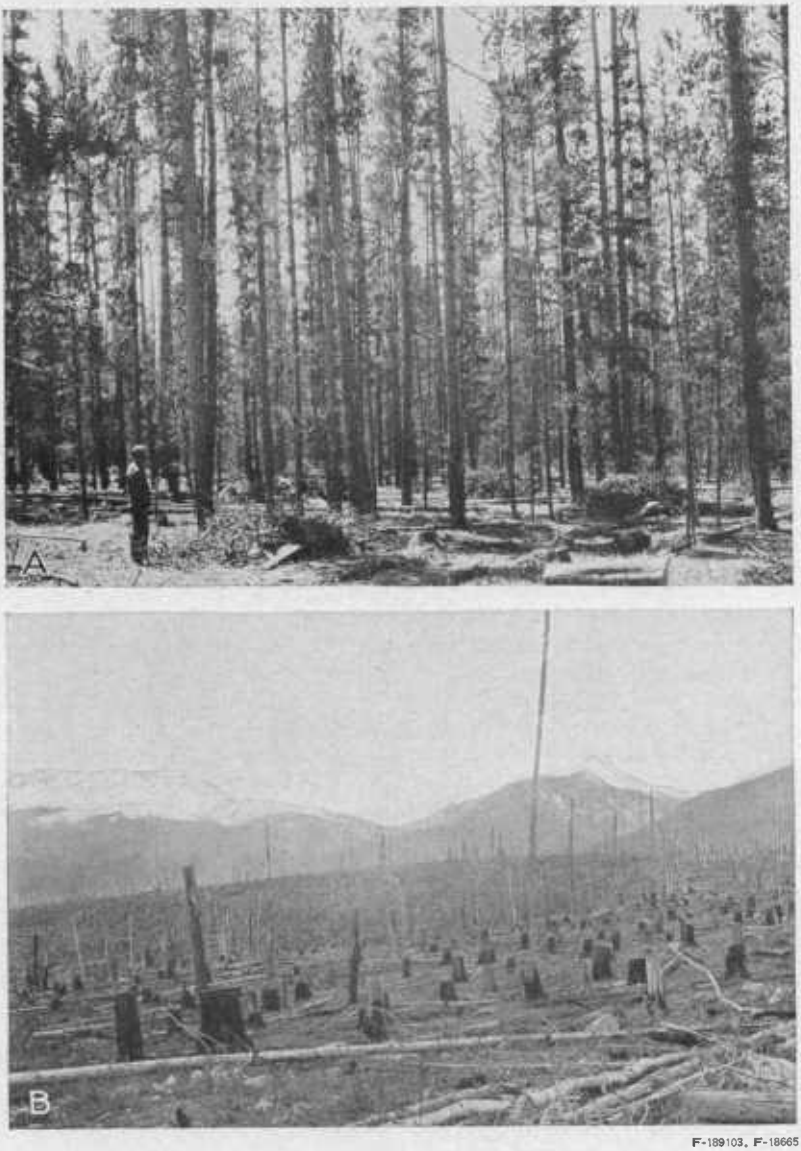

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FIGURE 16.—Good forestry practice conserves the forests.

A, Good forestry practice on a national-forest timber area. Only mature trees have been cut, young trees having been left to form the basis for future cuttings and to insure reproduction. Brush and slash are piled for disposal. *B*, No forestry practiced here. Land cut over and burned. Unless this land is artificially reforested, it will probably revert to worthless brush.

ficial influences of the healthy forest on soil and stream flow, on wildlife and human life. Lands that can best produce forest crops should be kept at work growing trees.

The forester endeavors not merely to grow repeated crops of timber on the land, he endeavors to grow the greatest possible amount of timber of the most valuable kinds. He also studies how to harvest timber to the best advantage. He is careful in harvesting to see that the loggers get all the good timber possible out of each tree by cutting low stumps and using as much of the tops as they can, to leave the slash in such condition that there will be the least possible danger of fire, and to leave young trees and seed trees for a new crop (fig. 16).

While growing timber crops, the forester does not neglect other benefits of the forest. He sees to it that, so far as possible, the value of the forest for protecting water supplies, for preventing the washing away of soil, for recreation, and as a home for wildlife is not diminished.

Federal Forestry

Forestry work by the Federal Government had its beginning in 1876, when an agent was appointed in the Department of Agriculture to study general forest conditions. In 1881 a division of forestry was created, but its staff was so small that it could do little more than attempt to gather information and give advice.

In these early years the forests on the vast public domain of the West had no protection and in the latter part of the last century were threatened with extinction by fire and reckless cutting. Congress sought to remedy this condition by conferring upon the President in 1891 the right to establish forest reserves. This act, however, made no provision for the protection of the forests. It was not until 1897 that Congress passed another act providing for the systematic management of the reserves, which at that time were under administration of the Secretary of the Interior.

It was soon apparent that scientific forestry was necessary for the proper management of the reserves, and officials of the Department of the Interior requested the aid of the experts in the Bureau of Forestry in the Department of Agriculture in the solution of technical problems. Later they recommended the transfer of the reserves to the Department of Agriculture. In 1905 the reserves were transferred to the Bureau of Forestry, which then became the Forest Service. Two years later the reserves were designated "national forests," and were grouped for administrative purposes into several districts. There are now 10 of these groups, known as national-forest regions, with a regional forester in charge of each.

The Chief of the Forest Service is administrator of all the regions, and is responsible directly to the Secretary of Agriculture. His staff consists of six Assistant Chiefs and a Chief of Fiscal Control. The regional foresters are also responsible to the Chief, and their offices follow the same organization plan as the Chief's in Washington.

There are 152 national forests, covering approximately 180,000,000 acres. Most of these forests are in the West and were set aside from lands already owned by the Government. Under the Weeks law, passed in 1911, the Government has purchased lands for the purpose

of protecting the headwaters of navigable streams and for timber growing. From these lands and from comparatively small areas of public land have been formed the national forests of the East and South. In 1924, the Weeks law was amended by the Clarke-McNary Act, broadening the authorization under which purchases of land for national-forest purposes may be made.

National-Forest Administration

National forests are in reality huge timber farms, operated for the benefit of the Nation as a whole. Located as they are in all the forest regions of the country, they contain some representation of most of the important commercial timber species. The production of timber is one of the main reasons for their establishment, and the forests are managed so that they will produce a continuous supply. In them are, therefore, found stands of trees ranging from tiny seedlings to veterans of perhaps several hundred years' growth. Mature or ripe standing timber, which is not growing at a profitable rate and which should be cut to make room for the younger generation of trees, may be advertised and sold on the open market to the highest bidder. All cutting, however, must be done according to forestry principles, trees being left to form the basis of future crops. Care is taken not to cut to such an extent as to destroy scenic beauty or to impair the protective cover that the forest affords on the watersheds of streams, for the national forests are as important to the Nation as conservators of water as they are for the production of timber. They also serve the public in many other ways—as grazing grounds for millions of cattle and sheep, as recreation grounds, and as homes for wildlife.

The general manager in charge of each of Uncle Sam's timber farms is known as the forest supervisor. The supervisor is directly responsible to the regional forester and with the latter plans the work of his forest. Upon the supervisor devolves the successful administration of the forest. He must see that a continuous supply of timber is produced and that the proper use is made of all other forest resources. And, too, he is responsible for the effective operation of the system of fire protection and control worked out for his forest.

Every national forest is divided into smaller units, or ranger districts, each under the supervision of a district ranger. The rangers manage their districts in accordance with the general administrative plans made by the supervisor and perform the detailed work required in the supervision of timber sales, grazing, free uses, and special uses of the forest. They also look after the construction of roads, trails, bridges, telephone lines, and other permanent improvements. Rangers have supervision over the recreational features of the forests and see to it that recreationists do not abuse the privileges granted them. The most constant and difficult phase of the rangers' work, however, is that involved in protecting the forest from fire. The forest ranger is therefore of necessity a hard-working, highly useful citizen and public officer upon whom rests much of the responsibility for the successful management of the national forests (fig. 17).

In order to prevent delays in the administration of the Forest Service work and to keep in closer touch with problems as they arise in the field, the country has been divided into 10 national forest regions

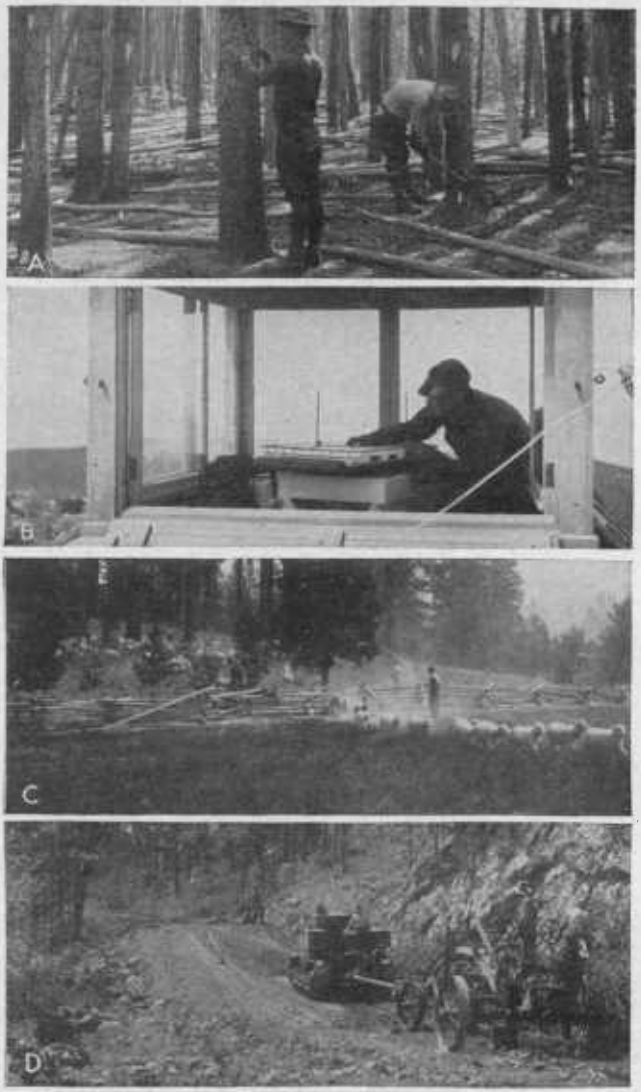

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FIGURE 17.—Some of the varied duties of forest officers.

A, Before national-forest timber is advertised for sale, the trees to be cut must be marked by rangers. *B*, When the ever-watchful lookout discovers a spiral of smoke, he locates the fire on his map by means of the alidade and protractor. The location of the blaze is then phoned to the nearest fire station, and fire fighters are sent to the scene of action. *C*, Grazing of sheep and cattle is allowed under permit on the national forests. In order that the range lands may not become overgrazed, the number of stock allowed each year is limited to what the range will carry without permanent injury. The rangers therefore keep a check on all animals entering their districts. *D*, It is highly important that all parts of the national forest where fire danger exists be accessible to fire fighters, and each year the Forest Service is adding to its mileage of roads and trails. Forest officers oversee and frequently take part in road-construction work.

with a regional forester in charge of each. Their respective headquarters are as follows:

Region 1. Northern region (Montana, northeastern Washington, northern Idaho, and northwestern South Dakota), Missoula, Mont.
Region 2. Rocky Mountain region (Colorado, Wyoming, South Dakota, Nebraska, and Kansas), Denver, Colo.
Region 3. Southwestern region (Arizona and New Mexico), Albuquerque, N. Mex.
Region 4. Intermountain region (Utah, southern Idaho, Western Wyoming, and Nevada), Ogden, Utah.
Region 5. California region (California and southwestern Nevada), San Francisco, Calif.
Region 6. Pacific Northwest region (Washington and Oregon), Portland, Oreg.
Region 7. Eastern region (Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, West Virginia, and Kentucky), Philadelphia, Pa.
Region 8. Southern region (North Carolina, Tennessee, South Carolina, Georgia, Alabama, Mississippi, Florida, Arkansas, Louisiana, Texas, and Oklahoma), Atlanta, Ga.
Region 9. North Central region (Michigan, Wisconsin, Minnesota, North Dakota, Iowa, Missouri, Illinois, Indiana, and Ohio), Milwaukee, Wis.
Region 10. Alaska Region, Juneau, Alaska.

RESEARCH

The Government's forest work does not end with the administration of the national forests. Among other things, the Forest Service conducts many investigations designed to promote the best use of the forests of the United States, whether in public or private ownership. Some of these investigations concern the growth, management, and protection of forests, and others the utilization of their products. Studies of economic problems involved in forestry, and of management of range lands for livestock grazing, are also made.

Through the 12 regional forest and range experiment stations maintained by the Forest Service, intensive studies are made of such things as the rates of growth and yields of the different tree species; what methods of cutting under varying conditions will be followed by the best reproduction of the most desirable kinds of trees; the best methods of nursery practice and of tree planting; and how best to protect the forests from fire and other damaging agencies. The relation of forests to climate, stream flow, and erosion is also investigated, and studies are made of range conditions and management. In this work the stations cooperate closely with the national-forest organization, with other Government bureaus, State foresters, and agricultural colleges, experiment stations, and universities.

The regional Forest Service experiment stations are located as follows:

Northeastern Forest Experiment Station, Upper Darby, Pa.
Southeastern Forest and Range Experiment Station, Asheville, N. C.
California Forest and Range Experiment Station, Berkeley, Calif.
Central States Forest Experiment Station, Columbus, Ohio.
Intermountain Forest and Range Experiment Station, Ogden, Utah.
Lake States Forest Experiment Station, University Farm, St. Paul, Minn.
Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Mont.
Pacific Northwest Forest and Range Experiment Station, Portland, Oreg.
Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.
Southern Forest and Range Experiment Station, New Orleans, La.
Southwestern Forest and Range Experiment Station, Tucson, Ariz.
Tropical Forest Experiment Station, Rio Piedras, Puerto Rico.

Important research work is done by the Forest Products Laboratory at Madison, Wis. There, in cooperation with the University of Wisconsin, the Forest Service carries on intensive studies of the physical, mechanical, and chemical properties of wood and other forest products. Tests are made of the strength of American woods of commercial importance: investigations are conducted in seasoning and kiln drying; wood preservation; the manufacture of paper pulp, fiberboard, and the like; the production of alcohol, turpentine, rosin, tar; and other chemical products. The results of this work help the wood-consuming industries to find the most suitable raw materials and to develop methods of utilizing waste products. They also assist timberland owners to find new markets for forest products. Another important part of the Laboratory's work is to discover ways of using woods which, though often abundant, have been considered of little or no value, and to develop new uses for the products of the forest. During the war the Forest Products Laboratory worked almost wholly on war uses of wood and gave vital help on the problems of packaging military supplies, use of wood for aircraft, boats, etc.

Investigations in forest economics cover the entire range of the economic and social problems involved in the production of forests and in the utilization of forest resources. Under its economic program, the Forest Service is conducting a survey of the forest resources and requirements of the whole country. This Nation-wide project includes studies of all problems relating to forests and forest-land use and management, as well as analyses of the relations of its findings to one another and to other related social and economic factors. The results of this survey will be used as bases for formulating policies, principles, and plans for the management and use of both public and private forest land. Other important projects in forest economics deal with equitable methods of forest taxation, the extent of tax delinquency and reversion of forest land to public ownership, and the practicability of remedial measures.

COOPERATION WITH THE STATES

The Federal Government is cooperating with the States in the prevention and suppression of forest fires. This cooperation was first authorized by the Weeks law, which provided for Federal aid in protecting forested watersheds from fire to any State that would spend in the same year an amount at least equal to the Federal expenditure. Since 1924, however, cooperation with the States has been carried on under the provisions of the Clarke-McNary Act, considered one of the most forward steps in forestry taken since the passage of the Weeks law. This act provides for cooperation with such States as have State or other forestry organizations in the protection of forests from fire, in assisting farmers in the handling of their woods, and in the growing and distribution of young trees for farm-woodland or shelterbelt planting. Funds necessary to carry on the work under the Clarke-McNary Act are furnished jointly by the Federal Government and the States, and in the fire-protection work private owners also contribute. A 1949 amendment to the act authorized increases in this work.

State Forestry

State interest in forestry antedated Federal forestry by many years. As early as 1777, North Carolina, and in 1787, South Carolina enacted laws against willful and careless woods burning. In 1867, Michigan and Wisconsin both made inquiries into conditions and needs of their forests. In 1869, the Maine Board of Agriculture appointed a committee to report on a forest policy for the State, and in 1872 the Maine Legislature enacted a law "for the encouragement of the growth of trees." By this law, lands planted with trees were exempt from taxation for 20 years. Laws offering tree planters either bounties or tax exemption were passed between 1868 and 1872 in Connecticut, New York, Minnesota, Wisconsin, Iowa, Missouri, Dakota, Nebraska, Kansas, and Nevada. In fact, most of the Eastern States gave early legislative attention to their forest resources, although the actions taken were far from adequate to meet the growing problem of forest depletion.

As early as 1872, New York created a commission to consider ownership of the "wild lands lying northward of the Mohawk," and the definite building up of the present Adirondack and Catskill State Forest Preserves dates from 1885. When Colorado became a State in 1876, its constitution provided that the general assembly enact laws to preserve the forests on the State's lands. California created a State board of forestry in 1885. A number of other States established forestry bureaus or commissions in the eighties.

Today, nearly all States have forestry agencies. The States own in the aggregate about 28,000,000 acres of forest land, and most of them maintain State forests or parks. Some have forest nurseries, where trees are grown from seed for forest or shelterbelt planting and for planting along roadsides. One of the most important projects of State forestry administration, of course, is the suppression of fire. Many States have therefore developed excellent systems of forest-fire prevention and control. State forestry agencies give farmers and other private forest owners advice and assistance in the handling of their timberlands. They also extend cooperation to schools, clubs, and other associations interested in the spreading of forestry education. Courses in forestry are given at many of the State agricultural colleges.

Forty-six States and Puerto Rico have extension foresters. These forestry specialists are in most cases attached to the extension departments of the agricultural colleges and work with the county agricultural agents and farmers in much the same way as do the extension specialists in other lines of agriculture. Forestry information and advice can therefore be obtained in nearly every State either from the extension forester or the State forestry department.

The passage of the Clarke-McNary Act gave an added impetus to State forestry work, and many States are now cooperating with the Forest Service under this law. Forty-three States and Hawaii have cooperative protective systems for the prevention and suppression of forest fires, and 41 States, Puerto Rico, and Hawaii are growing and distributing planting stock, with the cooperation of the Federal Gov-

ernment, for the purpose of establishing field windbreaks, shelterbelts, and farm woodlands on denuded or nonforested lands.

Farm Forestry

About one-third of the forest land in the United States is in farm woodlands. These are mostly small and frequently isolated, and 95 percent of them lie east of the Great Plains. Because they comprise some of the best forest lands, their productive possibilities probably average as high as those of any class of timberland in the country.

Properly handled, a farm woodland is in most cases a valuable asset to its owner. Besides the salable products it may produce, such as sawlogs, piling, pulpwood, posts, and cross ties, it will provide its

Figure 18.—Farm woodlands.

A, A South Dakota prairie farmstead protected from the prevailing high winds of that region by a windbreak of planted trees; *B*, 50-year-old white oak timber in an Ohio woodland.

owner with wood for fuel, fencing, and the many other needs of the farm. This means a saving in the outlay of money for the upkeep of the place, as well as a tangible income such as may be derived from any other farm crop. The woods may also utilize and make productive parts of the farm not suitable for other crops, that is, the rough, steep, rocky, and worn-out lands (fig. 18). And the harvesting of the farm timber crop is usually done in the winter, when the regular work of the farmer is slack.

It is estimated that one-third of the cut of timber of all kinds comes from farms. According to late statistics, farm forest products rank ninth among a total of 50 different crops in the amount of cash income they produce. The gross value of farm timber products, both used on the farm and sold, amounted to some $200,000,000 to $300,000,000 a year before the war.

To get the best results from his woods the farmer should adopt good forestry practices which aim to produce a continuous supply of the most valuable timber at the fastest rate. When he takes out his merchantable trees, he should as a general rule cut lightly—never clear-cut the stand—so that he can come back often for similar light harvests. Thus he will always maintain a good stand of trees—capital in his woods "savings bank." Trees of the less desirable kinds, the smaller, overcrowded ones, and those that are broken, crooked, large-limbed, or diseased, should also be cut and used for farm purposes or sold. This will allow light and growing space for the main-crop trees, and the younger generations fighting for a place in the sun will be helped to become the straight, thrifty, larger trees that produce high-grade and high-priced forest products.

Since every woodland cannot be managed to the best advantage in the same way, the owner will do well to consult a forester as to what his woods will best produce and how they should be handled. He may obtain information of this sort from his local Farm Forestry Project representative, State extension forester, or from his State forester.

Most of the woodlands found on farms are of natural growth, but in the prairie regions, where there was little native growth, some farm woodlands have been planted. These plantations usually take the form of field or farmstead windbreaks or shelterbelts which, besides being a source of timber products, protect crops and farm buildings from the winds that have a clear sweep across the flat country. Windbreaks also give protection from extremes of heat and cold, conserve the water from rains and melting snow, and tend to prevent the quick drying and subsequent blowing of soils. By checking the movement of the topsoil, they help to prevent duststorms. It has been demonstrated that 40 acres of trees planted in narrow strips crosswise to the direction of prevailing winds will protect 600 acres of farm land.

To help extend the beneficial effects of tree planting in the Plains region, the Forest Service launched a special Prairie States Forestry Project in 1935. The Service cooperated with farmers in the establishment of field and farmstead windbreaks, the farmer furnishing the land and fencing materials and the Forest Service supplying planting stock and planting the trees. The work was begun only after a Forest Service officer had looked over the proposed site, and had made a favorable report on location, condition of soil, etc. By 1942 plantings under the Prairie States Forestry Project had been made on approximately 29,000 farms in North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas.

The species selected for planting were, for the most part, those which through many generations have become adjusted to the climate and soils of the western Great Plains region. The planting stock was grown in Government-owned nurseries or others leased for that purpose. In 7 years, a total of more than 200,000,000 trees and shrubs were planted in 17,000 miles of field windbreaks. Some strips planted in 1935 were large enough within 3 or 4 years to yield several hundred posts per mile as thinnings, without injuring the value of the windbreaks in tempering the winds. The Forest Service believes that trees will lessen the disastrous effects of drought in the Plains

region, and in short, make that part of the country a better place in which to live.

In 1942 the shelterbelt planting program in the Plains region was transferred to the Soil Conservation Service.

Commercial Forestry

Commercial or industrial forestry is the business of growing timber as a crop to supply industrial needs. In the past, few of the private concerns which had extensive forest holdings did more than exploit their mature timber, and gave little heed to the permanent production of the raw materials necessary for the continuance of their operations.

That some degree of forest culture be given the forest lands in private ownership is of prime importance to the welfare of this country. Much of our choicest forest land is included in the vast timber holdings of private companies and individuals. Numerous industries and even communities are dependent upon them for existence. Forest lands in private ownership produce most of our lumber and forest products.

One big question in the handling of all private forest lands is, of course, "Will forestry pay?" The experience of many progressive owners who have tried it shows that it will, under good average conditions of climate or soil, and accessibility to markets. A number of lumber and logging companies, pulp and paper concerns, coal companies, railroads, and other users of wood in large quantities, are instituting measures that look to the growing of their own forest products as a continuing crop. A number of them employ trained foresters to handle their forest lands, and some are artificially reforesting lands which have become denuded.

Two factors which have to some extent discouraged private timber growing are high taxes and forest fires. The forest crop requires a longer period to reach maturity than other crops; and under ordinary systems of taxation, a high annual tax on private forest lands may therefore prove too heavy a burden to the owner while he waits for his timber crop to grow. Such lands require a system of taxation whereby the private owner may carry a fair share of the tax burden and at the same time realize an adequate profit on his long-term investment. Some States, realizing this, have revised their forest-tax rates in recent years.

Fire is another risk the private timber grower has to take, for within a short space of time it can eat up the profits derived from years of growth. Some private owners have established excellent systems of fire suppression on their timber holdings in cooperation with the Federal Government and the States. To make possible cooperation between all of these agencies was one of the reasons for the enactment of the Clarke-McNary Act.

The practice of commercial forestry ought to be greatly expanded as the old-growth forests become scarcer. Otherwise, many of our commercial forest enterprises will be doomed through the exhaustion of raw materials. Research carried on by the Forest Service and other forest agencies is constantly adding to the knowledge required to apply sound principles of forestry profitable to privately owned timberlands.

TIMBER, A VITAL NATIONAL RESOURCE

The forest, unlike many other natural resources, can be renewed after the original supply has been consumed. When given a chance, Nature herself can take care of the renewal. Seed trees or young growth judiciously left after cutting will provide for the restocking of a lumbered area, and if fire is kept out the forest will come back. But when the forest is totally destroyed, the land, which in many cases is not suited to other crops, lies idle. There are millions of acres of such lands in the United States, largely the result of destructive logging, fire, or both.

The amount of deforested land in the United States has been increasing every year. Since 1909 our total volume of standing saw timber has been reduced some forty percent. We still fail to grow timber as fast as we are cutting it.

Our Nation has made notable strides in forest conservation in the last half century, but we have as yet failed to stop the downward trend in our forest wealth. Much more remains to be done if real forest conservation is to be achieved.

To protect the public interest, the Department of Agriculture and the Forest Service have recommended a 3-point Nation-wide forest-conservation program:

1. *Expansion of public aid to private forest landowners.* Every encouragement should be given to forest landowners to practice scientific forestry and manage their timberlands for maximum, continuing returns. More trained forestry specialists should be employed to help and advise owners on their timber-management and marketing problems. Research work should continue on an intensified scale to work out the best answers to the many problems of timber growing, forest protection, and efficient utilization. Cooperative protection against fire should be extended (only about three-fourths of our total area of forest land is as yet under organized protection, and much of this protection is still inadequate). Cooperative aid should be provided in combating destructive forest insects and diseases.

2. *Public acquisition of a large acreage of forest land now in private ownership.* Large areas of forest land are so low in productivity that they offer little or no attraction for private investment in timber growing, or so depleted that the owners are unwilling to undertake the long-term job of restoration. These include lands that have been reduced to nonproductive condition by erosion, destructive forest practices, fire, and misuse; and other lands plainly submarginal for permanent private ownership. For such lands, many of which are tax delinquent, public ownership seems to be the best solution. Some of them might best be purchased by the Federal Government for addition to the national-forest system; others might best serve as State or community forests. For certain other areas where acute problems of watershed protection, or need for protection or development of scenic or recreational values or other public interests are paramount, public ownership also may be desirable.

3. *Effective public regulation of timber cutting and other forest practices to stop further destruction and keep forest lands reasonably*

productive. Federal leadership should provide the general standards of forest practices needed to make sure that forest lands will be left in condition to keep producing timber. The States could prescribe the specific rules suitable for each region and see to it that all timber cutting conformed to these rules. Direct Federal participation would be needed in those States which fail to enact and administer regulations consistent with the Nation-wide standards.

Some 90 percent of our timber cut comes from private lands. Even after the needed public acquisition is accomplished, private lands will always remain the main source of timber supply. Despite excellent forestry practices by many private owners, the great bulk of the private cutting is done without conscious regard for keeping the lands reasonably productive. It is fully as important to stop destructive cutting as it is to prevent destruction by fire, insects, and disease.

Not only must we stop further forest deterioration, but we have a big job of rehabilitation to do on forest lands already depleted. Millions of acres have been entirely deprived of the ability to reforest themselves, and to bring them back to any degree of productivity man must lend a hand by planting young trees. Millions of other acres are now growing only a fraction of the timber they should, and their productivity could be greatly increased by cultural work and improvements.

Timber is a vital national resource. Wood is a basic raw material without adequate supplies of which we would be unable to maintain our present standards of living. New uses and demands for wood are constantly developing. A conservative estimate places this country's future requirements at 21½ billion cubic feet a year. To sustain production at this level we shall practically have to double our present annual rate of timber growth.

The vast extent of its forests has helped to make the United States the great industrial nation it is today, but improvident and unregulated exploitation has made severe inroads upon this source of prosperity. The annual drain on our forests exceeds the annual growth. If this continues, it will mean that eventually there will be serious shortages of wood and other forest products. As forests will always be necessary both to the economic and social life of this country, we must make sure that they are kept green and growing. Nothing can replace them as sources of industrial wealth, as conservators of water and soil, as recreation grounds, and the home of wildlife and game. It will, therefore, always be essential that the people of the United States maintain a forest growth sufficient to meet the demands of the various forms of forest use. To do this, our remaining forests must be used wisely, and our depleted forest lands must be restored to productivity. Only in this way can we expect to maintain for all time an adequate portion of that forest wealth which has had such a vital influence in shaping the destiny of the Nation.

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