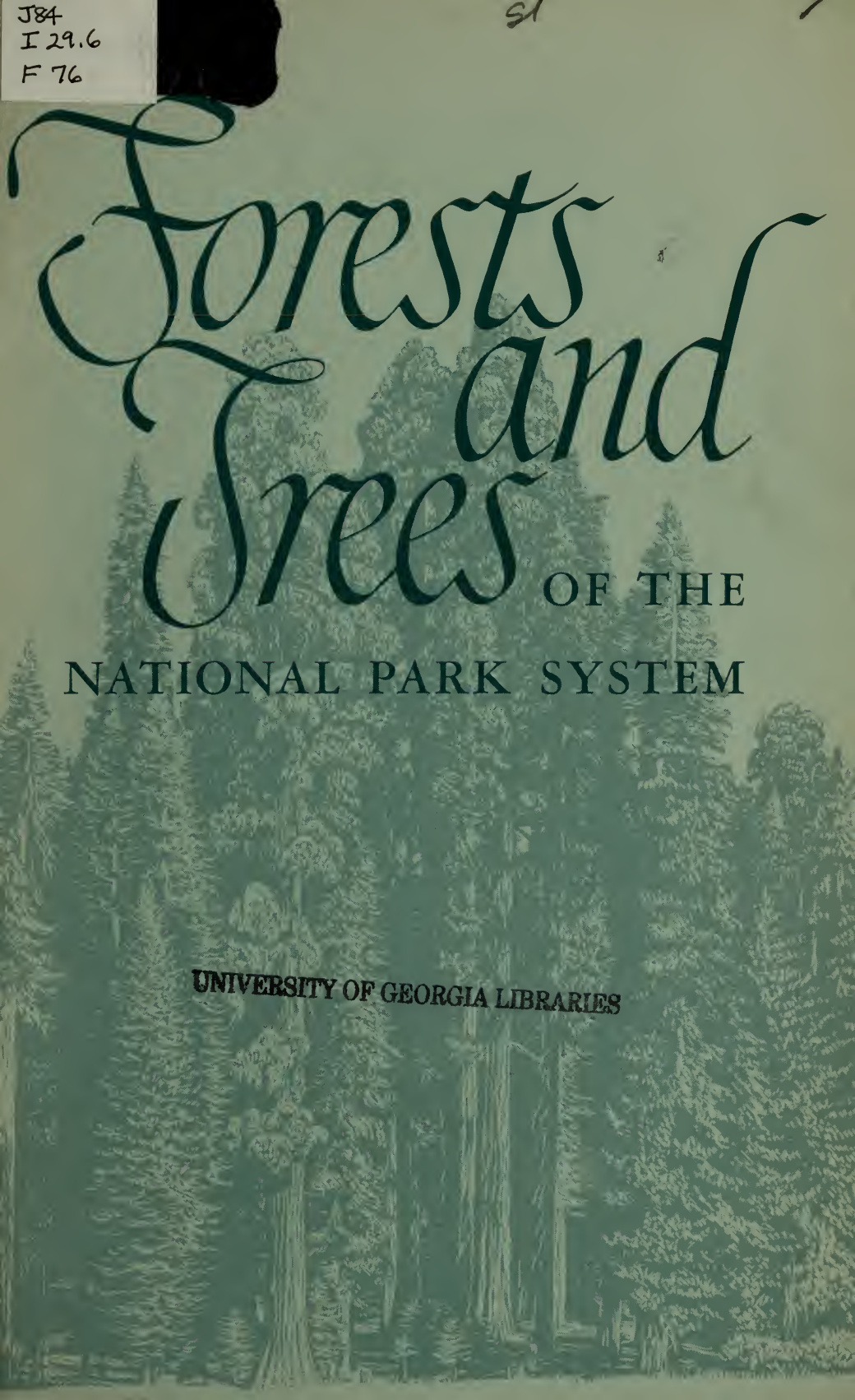

Forests and Trees OF THE NATIONAL PARK SYSTEM

UNITED STATES DEPARTMENT OF THE INTERIOR

Douglas McKay, *Secretary*

NATIONAL PARK SERVICE, Conrad L. Wirth, *Director*

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Forests and Trees

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NATIONAL PARK SYSTEM

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Washington, D. C., 1954

Contents

Introduction

WITH THE PROGRESSIVE REDUCTION and disappearance of the natural and undisturbed forests of the United States through lumbering and forest fires, the primeval stands preserved within the national parks and monuments become of greater value and importance. By wise provision of Congress, the forests of the National Park System are withdrawn from commercial exploitation. The act of August 25, 1916, establishing the National Park Service, enjoins the Service "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The forests of the National Park System form a magnificent framework to the mountains, lakes, streams, and other geological features of the parks and monuments, adding immeasurably to their inspirational appeal. Likewise, the recreational values of these areas are enhanced mightily by the presence of trees. It would be difficult to imagine the present popularity of camping and travel within the national parks and monuments should they by any misfortune be denuded of their forests or tree growth. What are now our most attractive campgrounds would be abandoned; even at timberline the loss of the gnarled, windswept trees battling for existence would remove one of the prized features of high mountain scenery.

The forested lands at the higher elevations within the National Park System are located within the "protection forest" belt, so called because their chief value is watershed protection, including the regulation of streamflow and prevention of erosion and avalanches. In addition to those values, these forests are important as wildlife habitat and for recreation and scenery.

In a number of instances the national parks include, at the lower elevations, portions of forests of high commercial value, as for example in Great Smoky Mountains, Yosemite, Sequoia, and Olympic National

Parks. An aroused and insistent public urged the preservation of these forested areas, and the question was carefully weighed by Congress before these areas were set aside as national parks or parts thereof. In the East, several of the States have participated in the purchase of private forested lands for inclusion in national parks within State boundaries. The Rockefeller philanthropies have likewise assisted in such acquisition for national park purposes both in the East and in the West. As the remnants of our original forest disappear under the axe or become modified by commercial enterprise, these natural areas will become increasingly important for the study and enjoyment of Nature in its undisturbed state.

It is estimated that when the first colonies were established in America, forests occupied 937 million acres of the land now included in the 48 States of this Nation. Over this area, virgin forests have been reduced to approximately 5.4 percent of their original extent, now represented in large part in the National Park System, in the less accessible areas of the national forests, and in State parks and preserves. Of the total area of 22,278,502 acres in the National Park System (as of June 30, 1952), 8,109,945 acres are forested; 7,482,069 acres of this forest land are located within the 48 States. This is approximately 1.2 percent of the present forested area of 622 million acres in the continental United States.

What is a Tree?

The line of distinction between trees and shrubs is not altogether clear-cut and therefore varies with different authors. For our purpose a tree may be defined as a woody plant with a single stem or trunk and a more or less definite crown, and attaining a height of at least 12 feet.

Omitting the intricacies of strict botanical classification, the tree species of the National Park System may be divided, in a broad sense, into three categories. In the first two listed below, growth in diameter is due to the addition of new layers of wood inside the cambium, which lies beneath the bark. This growth produces annual rings.

Conifers, or Cone-bearing Trees.—These trees are also known as evergreens and softwoods. Common examples of this group are pines, firs, spruces, hemlocks, and junipers.

Broadleaf, or Deciduous, Trees.—Also termed hardwoods. Common examples are oaks, maples, sycamores, and elms.

There are exceptions to these distinguishing characteristics in both groups. For example, among the conifers the larch and baldcypress are deciduous, shedding all their needles in the fall; and some of the

southern pines, which are conifers, have wood which is harder than that of some of the so-called hardwoods. Furthermore, the yew, an evergreen with leaves similar to those of conifers, has a fruit which is a berry rather than a cone. In the broadleaf group are some species which are evergreen, such as hollies, live oaks, and some magnolias.

Palms, Yuccas, and Cacti.—Palms have their bundles of water- and food-conducting cells with strong fibers scattered through the softer tissue, usually much closer together toward the outer edge than in the center. The wood, especially in the outer part of the trunk, may be very dense and hard. Palm trunks have no true cambium, do not continue diameter growth from year to year by the addition of new layers of cells, and are mostly unbranched. There is but one main growing point—the terminal bud.

The trunks of the Joshua-tree (a yucca) and the saguaro (a giant cactus) become branched. Tree yuccas, with light and fibrous wood, also have separate conducting bundles but these are arranged in more or less concentric layers, new growth being laid down by a special kind of cambium.

In the saguaro and other tree cacti, the wood consists of elongated, somewhat latticelike, cylinders of dense fibers occurring in circles, and imbedded in more or less fleshy pulp. Tree cacti trunks enlarge their diameter yearly by laying down additional layers of pulp and woody tissue. After the death of the plant, the pulp decomposes, leaving a skeleton of woody cylinders.

These three types of trees are of limited occurrence in the National Park System, but are of unique interest. The Florida royalpalm and cabbage palmetto are found in Everglades National Park in southern Florida; California washingtonia, or California-palm, and Joshua-tree, in Joshua Tree National Monument in southern California; and the saguaro, in Saguaro and Organ Pipe Cactus National Monuments in Arizona.

Forest Types and Life Zones

Plants and animals tend to group themselves into definite associations, based primarily on climate, physiography, and soil conditions. Some biologists refer to these natural biotic provinces as life zones. Ecologists, however, prefer a terminology of biomes for the major categories in the classification of communities of interdependent living things—plant and animal—in and with their environment. Many foresters prefer a descriptive name of the vegetative type, possibly supplemented by the name of the corresponding life zone. This latter method is used in this treatise so far as possible.

In the use of the phrase "life zones," it is necessary to remember that the boundaries of these zones vary with conditions of temperature, moisture, exposure, and soil, so that they are quite variable as related to lines of elevation or latitude. There is a merging of the species and types of one zone with those of the adjacent zone along their common boundaries. Thus one author may differ from another in the designation of the life zone where the line of separation is indistinct.

Zones of altitude on a mountain may be compared to the zones of latitude on the surface of the earth which have comparable conditions of temperature, moisture, exposure, and soil. Thus a mountain of great height at the equator might offer at its different elevations the general variations in environment that would be encountered during a journey from the equator to the Arctic Circle. In general, the altitude of timberline, where tree growth stops, decreases as the latitude north increases.

Because of the marked differences between vegetative types of the Western and Eastern United States, these two sections of the country are discussed separately.

WESTERN FOREST TYPES

The western forests are predominantly coniferous except at the lowest elevations in the Southwest. There the desert species that attain tree size are mostly spiny deciduous species or giant yuccas and cacti.

Starting at the Mexicon border and proceeding northward we encounter the following types:[1]

The *desert vegetative type* is found in the *Lower Sonoran Life Zone,* the lowest and driest regions, in which mesquite, catclaw acacia, paloverde, saguaro, and Joshua-tree attain tree size and creosotebush and desert saltbush are characteristic shrub species. Into this category fall the lowest elevations of Big Bend and Grand Canyon National Parks and of Oregon Pipe Cactus, Saguaro, Joshua Tree, and Death Valley National Monuments. However, not all of the above-named species occur in every one of these areas.

Pinyon-juniper woodland, oak woodland, chaparral, and sagebrush are various types that occur in the *Upper Sonoran Life Zone,* in which pinyon and several species of juniper and oak are characteristic tree species, and scrub live oak, sagebrush, manzanita, sumac, cliffrose, and ceanothus are representative shrub species. These types occur at the elevations immediately above those of the desert type in the areas listed in the preceding paragraph, and also in Zion National Park. A good illustration of the pinyon-juniper type occurs in Mesa Verde National Park,

[1] Various representative areas of the National Park System are given in which the types referred to are found. Not all areas of the National Park System where these types occur are mentioned by name.

and of the chaparral type on the lower western slopes of Sequoia National Park.

The *Transition Life Zone* is the next higher zone, with a greater amount of rainfall. It includes many of the most interesting and varied species and types of our western forests. In this zone are found the giant sequoia groves of the Sierras, with white fir, sugar pine, ponderosa pine, and incense-cedar as associated species; the redwood forests of California and the Olympic rain forest in Washington, both of which occur within the more humid coastal areas of this life zone; and the ponderosa pine forests, which are considered typical of the *Transition Life Zone.* Ponderosa pine has one of the most extensive ranges of the western conifers.

The ponderosa forest is represented excellently in Grand Canyon National Park, where, on the North Rim especially, it forms a beautiful open stand interspersed with aspen, and with occasional meadows in which large numbers of mule deer may be seen grazing. The white-tailed Kaibab squirrel is also a resident of this area. The combination of open forest, into which one can see readily, and abundant animal life makes this one of the most attractive recreational forests of the National Park System.

Ponderosa pine reaches its optimum growth in the Sierra forests of California and, in mixture with sugar pine, white fir, and incense-cedar, is well represented in Sequoia, Kings Canyon, and Yosemite National Parks. It occurs also in Lassen Volcanic National Park and in the southeast portion of Crater Lake National Park.

In the Rocky Mountain region a good sample of the ponderosa pine forest is found in the western part of Glacier National Park. It also occurs on the lower elevations of the east side of Rocky Mountain National Park, but does not extend up into Yellowstone and Grand Teton National Parks. It is somewhat surprising to find a ponderosa pine forest of approximately 8,000 acres on the higher portion of Saguaro National Monument, with some mixture of Douglas-fir and limber pine. Ponderosa pine grows also in Dinosaur National Monument and in Bryce Canyon, Zion, Mesa Verde, Carlsbad Caverns, and Big Bend National Parks.

Douglas-fir forests are typical of the next higher zone, known as the *Canadian Life Zone.* Douglas-fir reaches its maximum development, both in size and quantity, in the Northwest. The Douglas-fir type species of the Pacific coast forests is distinguishable from that of the Rocky Mountain region, the latter designated as *Pseudotsuga taxifolia* var. *glauca.* Douglas-fir forests are prominent in Olympic and Mount Rainier National Parks, and the species occurs to a lesser extent in mixture with Western white pine and red fir in Crater Lake, Lassen Volcanic, and Yosemite National Parks. In the Rocky Mountain region, Douglas-fir extends from Glacier National Park, at the

Canadian line, to Big Bend National Park, at the Mexican boundary. In the Rockies it is found in pure stands or mixed with other Rocky Mountain conifers.

Lodgepole pine forests are also prominent in the *Canadian Life Zone* and extend into the next higher *Hudsonian Life Zone.* Lodgepole forests are very extensive in Glacier and Yellowstone National Parks. In the latter park they form three-quarters of the forest stand over a vast area. Lodgepole stands are also important in Grand Teton, Rocky Mountain, and Crater Lake National Parks, and, to a lesser extent, in the high country of Lassen Volcanic, Yosemite, and Sequoia National Parks.

A number of other interesting species, such as Jeffrey pine, limber pine, foxtail pine, whitebark pine, blue spruce, Engelmann spruce, mountain hemlock, balsam fir, alpine fir, and white fir are found in various parts of the *Canadian Life Zone.* Some of these extend up into the *Hudsonian Life Zone,* and a number extend down into the *Transition Life Zone.*

Within the western forests of the *Transition* and *Canadian Life Zones,* interspersed stands of quaking aspen, with their broader, shimmering leaves of lighter color, add materially to the scenic attractiveness of the coniferous forests. In the autumn, especially in the Rocky Mountain region, the golden aspen, in mixture with the green conifers, creates landscapes of great beauty. In Washington, Oregon, and California, the vivid coloring of the Pacific dogwood adds another attractive element to the scene, as does that of the vine maple.

The *spruce-fir forest,* in which Engelmann spruce, alpine fir, and white and black spruce are index species, is characteristic of the forest just below timberline, in the *Hudsonian Life Zone.* This type is found on numerous high mountains in the western national parks. In Mount McKinley National Park, in Alaska, white spruce is the dominant forest species.

Above timberline on the high mountains, dwarf shrubs of willow, birch, and alder are representative woody species in the vegetative cover adapted to the rigorous growing conditions in the *Alpine Life Zone.* In the arctic region, treeless expanses, or *tundra,* support a turf of prostrate shrubs of the foregoing species, together with various grasses, sedges, lichens, and moss. Arctic tundra is well represented in Mount McKinley National Park.

FORESTS OF HAWAII NATIONAL PARK

These forests differ so greatly from those of the continental United States that they require a separate description. This volcanic park is divided between the islands of Hawaii and Maui. The Kilauea-Mauna Loa section of the park, in the southeastern portion of the Island of

LARGEST AND PROBABLY THE OLDEST LIVING THINGS ARE THE GIANT SEQUOIAS (SEQUOIA GIGANTEA). MAGNIFICENT GROVES OF THESE ANCIENT TREES ARE PROTECTED IN SEQUOIA, KINGS CANYON, AND YOSEMITE NATIONAL PARKS, CALIF. THOSE SHOWN ARE IN YOSEMITE'S MARIPOSA GROVE.

SUGAR PINES, IN FOREGROUND AND AT RIGHT, AND PONDEROSA PINES ARE ASSOCIATES OF THE GIANT SEQUOIAS ON THE SLOPES OF CALIFORNIA'S SIERRA NEVADA. THESE ARE IN THE CARL INN AREA, JUST INSIDE THE WESTERN BOUNDARY OF YOSEMITE NATIONAL PARK.

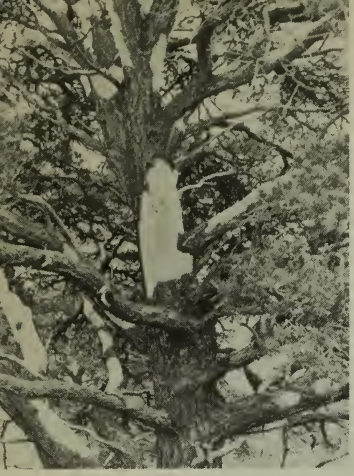
SITKA SPRUCE GROWS BIGGEST IN THE RAIN FOREST OF THE WESTERN SLOPES OF THE OLYMPIC MOUNTAINS IN WASHINGTON. THIS NOTABLE GROUP IN OLYMPIC NATIONAL PARK IS FOUND IN THE HOH RIVER VALLEY. ASSOCIATED WITH THE SPRUCE ARE DOUGLAS-FIR, WESTERN REDCEDAR AND WESTERN HEMLOCK.

Above: REDWOODS (SEQUOIA SEMPERVIRENS) GROWING IN REDWOOD CANYON, MUIR WOODS NATIONAL MONUMENT, ACROSS THE GOLDEN GATE FROM SAN FRANCISCO. *Below:* AN ENGELMANN SPRUCE, GNARLED, TWISTED, DWARFED, AND PROSTRATE—BUT STUBBORNLY ALIVE—NEAR TIMBERLINE IN ROCKY MOUNTAIN NATIONAL PARK, COLO.

MUCH OF THE LONGMIRE ENTRANCE ROAD, MOUNT RAINIER NATIONAL PARK, WASH., IS LINED BY DENSE OLD-GROWTH DOUGLAS-FIR (MOST MAJESTIC OF PACIFIC NORTHWEST TREES) AND WESTERN REDCEDAR.

SERENE FORESTS OF PINE AND ASPEN BEDECK THE NORTH RIM, GRAND CANYON NATIONAL PARK, ARIZ. IN AUTUMN, THE BRIGHT GREEN OF THE ASPEN LEAVES TURNS TO GOLDEN YELLOW; ITS COLOR GLORIFIES MOUNTAIN SLOPES ALL OVER THE SOUTHWEST.

Above: PAPER BIRCH, IN CENTER, AND SPRUCE, AT LEFT, FRAME A VIEW OF THE SHORES OF BELLE ISLE, ISLE ROYALE NATIONAL PARK, MICH., WITH ITS FOREST OF MIXED CONIFERS AND HARDWOODS. *Below:* MOUNTAIN-LAUREL AND DENSE FOREST LEND BEAUTY TO THIS SWIFT-RUNNING STREAM IN GREAT SMOKY MOUNTAINS NATIONAL PARK, TENN.—N. C.



Left: PORCUPINES HAVE BEEN KNOWN TO KILL OFF EXTENSIVE STANDS OF YOUNG FOREST. THIS PINYON, IN MESA VERDE NATIONAL PARK, COLO., SHOWS THE NATURE OF PORCUPINE DAMAGE. *Below:* LOOKING TOWARD MOUNT OLYMPUS, OLYMPIC NATIONAL PARK, WASH., WITH TYPICAL FOREST CARPETING OF THE LOWER ELEVATIONS.

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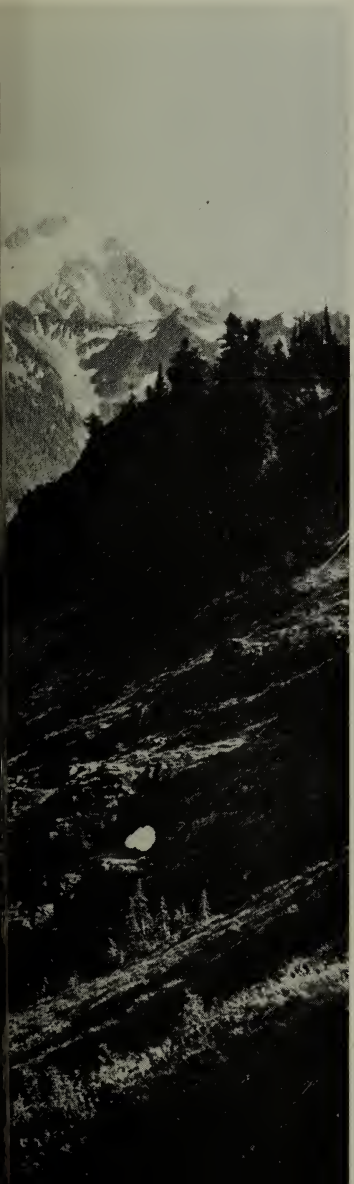
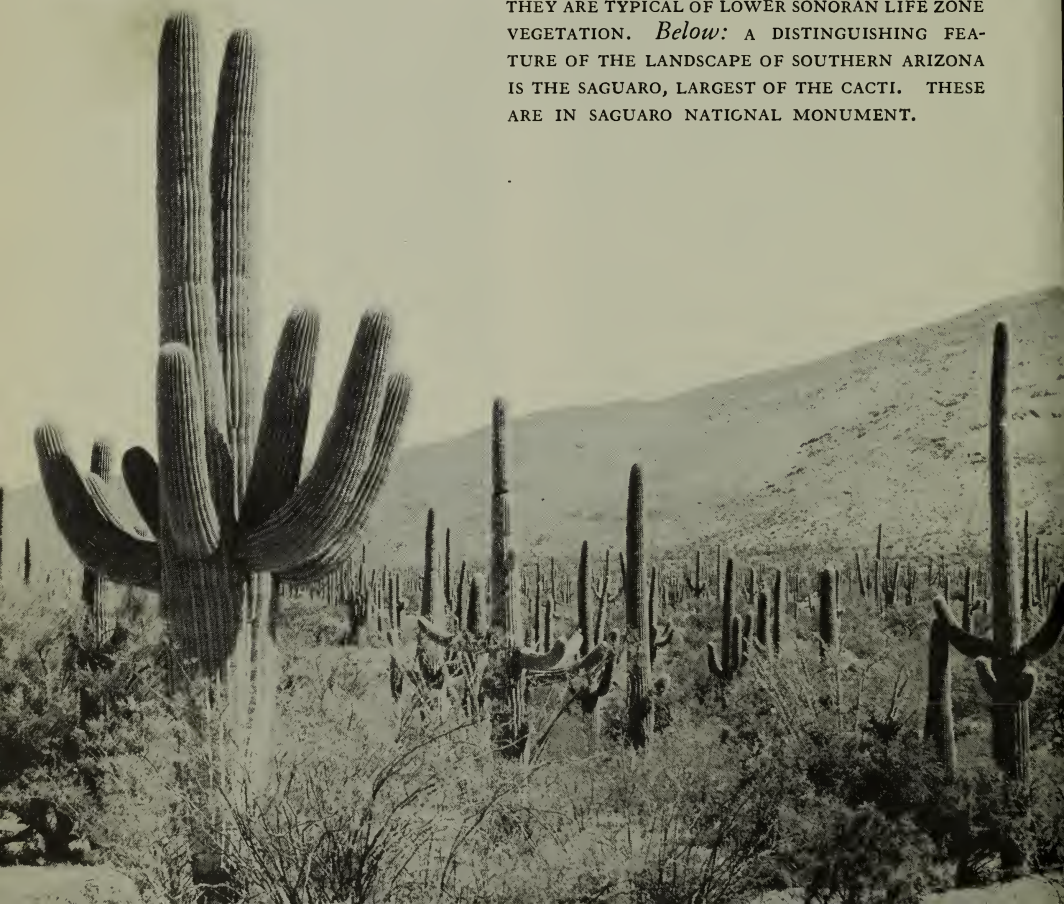


Above: WITCH HOLE POND, ACADIA NATIONAL PARK, MAINE. TREE AND PLANT ASSOCIATIONS ON THE FRINGES OF SUCH PONDS ARE OF SPECIAL INTEREST TO STUDENTS OF PLANT COMMUNITIES. *Below:* CLOUDS OVER THE SMOKIES SUGGEST THE ABUNDANT MOISTURE WHICH HELPS TO NOURISH THE SPLENDID FORESTS CLOTHING THESE MOUNTAINS.

MANY SPECIES OF TREES AND SHRUBS GROW TO GREAT SIZE IN GREAT SMOKY MOUNTAINS NATIONAL PARK. THE LARGEST KNOWN EXAMPLES OF 16 SPECIES OF TREES ARE FOUND IN THIS PARK. AT THE LEFT, ABOVE, IS A GIANT HEMLOCK; AT THE RIGHT, A HUGE TULIP POPLAR.

Above: JOSHUA-TREES, FOUND HERE IN JOSHUA TREE NATIONAL MONUMENT, CALIF., AND LAKE MEAD NATIONAL RECREATION AREA, ARIZ.–NEV., ARE YUCCAS, MEMBERS OF THE LILY FAMILY. THEY ARE TYPICAL OF LOWER SONORAN LIFE ZONE VEGETATION. *Below:* A DISTINGUISHING FEATURE OF THE LANDSCAPE OF SOUTHERN ARIZONA IS THE SAGUARO, LARGEST OF THE CACTI. THESE ARE IN SAGUARO NATIONAL MONUMENT.



Above: ROYAL PALMS (ROYSTONEA FLORIDANA) LOOM ABOVE THE OTHER TREES OF ROYAL PALM HAMMOCK, EVERGLADES NATIONAL PARK, FLA. THIS HAMMOCK WAS FORMERLY PART OF A FLORIDA STATE PARK. *Below:* CONTROL OF FIRE REQUIRES ETERNAL VIGILANCE, CAREFUL TRAINING, AND SOUND PLANNING. WHEN FIRE THREATENS, HUNDREDS OF SUCH LOOKOUTS AS THESE ARE MANNED BY SHARP-EYED MEN AND WOMEN.

THERE IS SOMETHING FEARSOME ABOUT GREAT CLOUDS OF SMOKE BILLOWING ABOVE A FOREST FIRE.

Above: FIREFIGHTING IS HOT, HARD, AND SOMETIMES DANGEROUS WORK. *Below:* WHERE FIRE HAS PASSED, NOT ONLY ARE TREES DEAD BUT GROUND COVER HAS BEEN BURNED AWAY AND THE SOIL EXPOSED TO EROSION.

A CAMPING PLACE WITHOUT TREES IS HARDLY A CAMPING PLACE AT ALL, AS THESE BOY SCOUTS UNDER YOSEMITE'S PINES WELL KNOW.

Hawaii, extends from sea level to an elevation of 13,680 feet at the summit of Mauna Loa and therefore includes the maximum number of types. On the windward side of the park the trade winds bring about 100 inches of rain annually, while on the lee side the annual rainfall is about 15 inches near the coast. This great range in moisture is reflected in the character of the vegetation, but temperature is the controlling factor on the higher slopes of Mauna Loa. The stage of decomposition of the lava flows is also reflected in the types of vegetation. Lava flows and ash deposits have repeatedly destroyed areas of vegetation in their paths. Wherever vegetative development has thus been interrupted the process begins anew.

Strange as it may seem, a large portion of the coastal-lowland area of the park is in the driest of all the park zones of vegetation, because it is on the leeward side. Much of the land is barren lava, but, where vegetation has gained a foothold, it is mostly of brush and grass species. A small area of rain forest exists on the rainy portion of the coastal lowland, in which the kukui, or candlenut tree, and the hala, or screw pine, are typical of the native tree species. The candlenut tree is so named because its fruit was used by the Hawaiians as a source of illumination, either by using the kernels of the kukui nuts or the oil extracted from the nuts.

Above the coastal-lowland forest, at elevations from 2,000 to 4,000 feet in the portion of the park where the rainfall averages about 100 inches, ohia lehua and tree ferns are type species. The ohia lehua also extends into the dry formation between those elevations.

Koa, mamani, and ohia lehua are typical tree species between 4,000 and 7,000 feet on the southeastern slope of Mauna Loa. The ohia lehua grows on the more recent lava flows. The seedlings of koa and mamani are very palatable as forage for cattle and goats, and these species have been greatly reduced, even eliminated from some areas, by grazing. Fortunately, all cattle grazing has been eliminated from the park and the koa is making a vigorous comeback.

Above the 7,000-foot elevation there is a subalpine shrub formation which extends to about 9,000 feet. There are no coniferous species within this park.

EASTERN FOREST TYPES

In the East, and particularly in the Southeast, the life zones are not as readily traceable as those in the West. This is due in part to the fact that in past geologic periods successive great ice sheets from the north advanced as far south as New Jersey and Pennsylvania and pushed some of the northern species southward. In the Southeast, the Gulf Stream and proximity to the *Tropic Life Zone* are responsible for the

subtropical type of vegetation in southern Florida. Furthermore, the eastern forests are characterized by a much greater variety of broadleaf species than are those of the West. For these reasons the eastern forest types are more conveniently tied to eastern physiographic regions than to the life zones used for the western forest types.

Subtropical Forest Type.—Everglades National Park, located in southern Florida, within the Coastal Plain, is remarkable for its subtropical bird life and forest types. The swamps bordering the coastline and inlets support a tree growth made up principally of three species of mangrove. Inland are vast areas of sawgrass dotted with hammocks, which are low, rounded knolls supporting a growth of broadleaf trees and shrubs. Among these are gumbo-limbo, live oak, strangler fig, West Indies mahogany, and cabbage palmetto. Slash pine grows in pure stands on the drier sites of the park, and pond-cypress occurs in strands of stunted trees on low areas. The Florida royalpalm is indigenous to Paradise Key within the park. Numerous other subtropical species of trees of botanical interest, because of their rarity in this country, are also native to the park area.

The *Appalachian forests* embrace the areas included in Great Smoky Mountains National Park, Blue Ridge Parkway, and Shenandoah National Park. Great Smoky Mountains National Park is the meeting ground of the northern and southern hardwood forest species. Consequently, it has a larger number of known tree species, mostly broadleaf, represented in its forests than in any other area of the National Park System, and possibly more than any other natural area of the continental United States. A total of 131 native tree species are known to occur in this area. A number of these, such as eastern hemlock, silverbell, red spruce, yellow buckeye, and mountain-ash, grow to record size for those species, while still others become giants. The stands of red spruce and Fraser fir crowning the highest peaks and ridges are an interesting coniferous type which represents a southern extension of the *Canadian Life Zone.*

The large variety of broadleaf species in the forests of Great Smoky Mountains National Park, Blue Ridge Parkway, and Shenandoah National Park, numbers of them with conspicuous blossoms, together with the undergrowth of azalea, rhododendron, mountain laurel, and other flowering plants, makes these areas a great attraction in the spring when the blossoms and new foliage put in their appearance and in the autumn when the leaves are brilliantly colored. A trip over the scenic highways of these areas during the height of the spring wildflower exhibit, or during the display of autumn colors, is an experience never to be forgotten.

Chestnut, formerly one of the principal broadleaf components of these eastern hardwood forests, is now represented only by the grey skeletons of the dead trees and by sprouts from the roots and stumps.

The old trees have been killed by the chestnut blight, caused by an exotic fungus, native to Asia, which was first observed in this country in 1904. The blight kills the chestnut sprouts about the time they reach an age when they begin to bear fruit. Many of these large, dead trees are hollow and furnish homes for numerous birds and mammals.

The most northerly forests in the eastern national parks are those in Acadia National Park, on the southeast coast of Maine, and in Isle Royale National Park, in Lake Superior. Both of these areas lie within the belt in which the upper *Transition Life Zone* types merge with those of the lower *Canadian Life Zone.* In each of these parks there are mixed conifer and hardwood types.

UNUSUAL FORESTS

In addition to the forest types already discussed, a number of other individual types and species found in the National Park System are of such great interest that they deserve special mention.

Sequoia.—This ancient genus is represented by two species in California—the redwood, *Sequoia sempervirens,* along the coast, and the giant sequoia, *Sequoia gigantea,* in the Sierra Nevada. The latter species produces the largest trees in the world, while the redwood, of lesser maximum diameter, produces the tallest.

The redwood occurs in the fog belt along the northwest coast of California and extends a short distance into Oregon. This strip is approximately 450 miles in length and has an average width of 15 miles. The redwood is represented in the National Park System in only one area—Muir Woods National Monument, located at the foot of Mount Tamalpais and approximately 10 miles northwest of San Francisco. Fortunately, some of the finest of the redwood groves are preserved in the California State Park System. The redwood is our only coniferous species that has the habit of reproducing freely by stump sprouts.

The giant sequoia is found only on the western slopes of the Sierra Nevada, in central California, at elevations of 4,000 to 8,000 feet. The groves are scattered through a narrow belt extending north and south for a distance of about 250 miles, within which lie Yosemite, Kings Canyon, and Sequoia National Parks. The General Sherman Tree, located in Giant Forest in Sequoia National Park, is often referred to as the oldest and largest living thing. This specimen has a basal diameter of 30.7 feet and a height of 272.4 feet. Its age has been variously estimated at 3,000 to 3,500 years.

Standing in the midst of a sequoia grove with its tremendous tree columns like cathedral pillars reaching to the sky, the shafts of the

sun's rays alternating with the shadows of the tree trunks, and stillness pervading the scene, one is reverently conscious of the presence of the Creator in the midst of His glorious handiwork.

Sugar Pine.—Associated with the giant sequoias in the Sierras, and somewhat larger than the ponderosa pine in its maximum dimensions, is this white pine species. It is one of the finest and certainly the most picturesque of the pines, with its greatly elongated branches, from the ends of which the long cones hang. The appearance presented has been compared to the apostles with extended arms bestowing the benediction. The sugar pine attains a diameter of 10 feet at breast height (4½ feet above the ground) and a height of 245 feet, and reaches an age of 500 years or more.

In addition to its association with the giant sequoia, the sugar pine extends through other portions of the forests in Yosemite, Kings Canyon, and Sequoia National Parks. It is found also in Lassen Volcanic National Park in mixture with ponderosa pine, white fir, and incense-cedar.

Olympic Rain Forest.—Next to the sequoias, the rain forest of the Olympic Peninsula, in the State of Washington, is the most spectacular forest type represented in the National Park System. In this forest there is an association of Sitka spruce, western redcedar, western hemlock and Douglas-fir, all reaching large dimensions, with an understory of bigleaf maple, from whose branches hang draperies of green moss and lichen. The forest floor is lush and green with a carpet of oxalis, bunchberry dogwood, ferns and moss, and the whole ensemble, like the sequoia groves, reminds one of a glorious cathedral. The high rainfall of this section—up to 140 inches a year—and the equable climate of the lowlands produce a luxurious verdure which many visitors compare with the tropics.

Saguaro.—In strange contrast to the Olympic rain forest are the saguaro forests of Saguaro and Organ Pipe Cactus National Monuments in Arizona—leafless forests of massive columnal cacti spread over the undulating desert. The saguaro is the product of severe arid conditions under which the plants have survived by developing water storage organs and by reducing to a minimum the loss of moisture from their bodies. The stem of the saguaro is composed of a skeleton of 12 to 30 slender vertical ribs supporting a mass of spongy tissues. Following soaking rains, the root system of the cactus draws up immense quantities of water which are absorbed by the spongelike pulp. A mature plant, with a height up to 50 feet and weighing from 6 to 10 tons, may take up as much as a ton of water following a rain. During dry weather the saguaro gradually uses its stored water, shrinks in girth and weight, and develops a wrinkled appearance due to the

drawing together of the vertical ribs. In spring the fluted columns of the saguaro are crowned with creamy white blooms which later produce brilliant scarlet fruits that are edible.

Forest Enemies

Fire is the greatest single destructive force threatening the park forests. During the 20-year period from 1930 to 1949, inclusive, the area of forest, brush, and grass burned over annually within the National Park System averaged 10,990 acres—less than two-tenths of 1 percent of the acreage requiring intensive fire protection. During this 20-year period the average number of fires per annum was 349, of which 234, or 67 percent, were man-caused, and 114, or 33 percent, were set by lightning.

Little can be done to prevent lightning fires, although research has been suggested to determine to what extent the build-up of clouds toward electrical storms can either be dissipated or diverted into normal rain storms without lightning by seeding the clouds with dry ice or some other reactor at the proper time.

As for man-caused fires, every effort is being made, in cooperation with State, private, and other Federal forest protection organizations, to impress upon the public the danger of fire and the means of preventing forest fires.

The Service has developed a well-trained and well-equipped fire control organization, of which the park ranger organizations constitute the backbone. These are augmented by fire lookout observers and fire control aids. In periods of emergency all other personnel of the parks are called on to assist, and, if necessary, additional fire fighters are employed from outside the parks. The fire control record of the Service compares very favorably with that of any other forest protection agency, despite the tremendous number of visitors.

Forest insects take a considerable toll of the forest trees, especially when unfavorable conditions, such as prolonged drought, reduce their vitality and their resistance to the attacks of destructive insects, enabling the latter to build up into epidemic proportions. Within the national parks the chief agents of this type of damage are the bark beetles, which girdle and kill the trees by their galleries in the cambium layer. Other destructive insects are found among the leaf feeders, such as the spruce budworm, the hemlock looper, the needle miner, the tent caterpillar, and the fall webworm. When epidemics develop, they result in widespread destruction and require large sums of money for control. The policy of the National Park Service, therefore, is to maintain a very careful watch for any observable build-up of infestation beyond the

normal condition and take corrective measures to prevent the development of serious epidemics.

Tree diseases.—Some of the native fungi and viruses may at times erupt into serious epidemics, as the oak wilt at present. However, the worst troubles in this line have been from introduced diseases. Examples of these are the chestnut blight, which has practically wiped out the native chestnut in the eastern forests; the Dutch elm disease, which is killing large numbers of elms in the East; and the white pine blister rust, a fungus disease introduced on both the Atlantic and Pacific coasts on imported nursery stock.

To preserve representative stands of white or 5-needled pine species in 14 areas of the National Park System, both East and West, the Service is carrying out intensive operations to control the white pine blister rust. These areas contain representative stands of one or more of the following species: eastern white pine, western white pine, whitebark pine, limber pine, foxtail pine, and sugar pine. This white pine blister rust fungus has alternate hosts—a white pine species in one stage of the infection and ribes (currants and gooseberries) during the other stage. The fungus spreads by means of tiny wind-borne spores. When a pine is infected, cankers develop in the bark. Infected pines die when the fungus completely girdles the main stem or trunk or when many of the branches are killed by girdling. The rust cannot be transmitted directly from one pine tree to another but the spores developed by the rust on the pines infect the currants and gooseberries, and the spores from these species in turn infect the white pines. Control for the preservation of the white pines is therefore accomplished by eradication of the ribes.

Insects and tree diseases together are today responsible for greater losses of forest trees than is fire.

Man.—Taking this country as a whole, the human species is the agent responsible for the greatest forest losses. A large share of this is due to man's carelessness with fire, such as throwing away burning matches or tobacco; leaving unextinguished campfires; and failing to prevent the spread of debris-burning fires. Other contributing causes, originating with man, are logging operations, sparks from locomotives, and incendiarism. In commercial forests, failure to leave seed trees or to protect reproduction while logging, or from fire thereafter, has resulted in millions of acres of unproductive forest land. Man is also responsible for much of the forest destruction by diseases and insects by the introductions of foreign pests through inadequate precautions. Fortunately, the areas of the National Park System are exempt from logging operations, and they have experienced a very low ratio of man-caused fires in comparison with the millions of people who visit them. This care on the part of park visitors is a great aid in the protection of national park values.

As previously set forth, Congress wisely prescribed that the national parks and monuments are to be administered in such manner as will leave them unimpaired for the enjoyment of future generations. Many of the laws establishing national parks contain specific provisions for the retention of their forests in a natural, undisturbed condition.

It is the intent of this legislation that interference with the normal processes of Nature within the forests of the national parks and monuments shall be limited to that necessary to provide for their use and enjoyment by the public, and to provide for the protection of the areas from fire and from devastating epidemics of insects and tree diseases. The maintenance of natural conditions precludes commercial forestry practices such as logging, pruning, thinning, and discrimination against so-called inferior species. These practices, designed to produce the most valuable crops of commercial products, are foreign to the purposes for which the national parks were set aside. Within the parks all native species have a proper place in the natural picture and may not be disturbed except for essential development or protection.

Forests are not static, but are communities of many species of living plants and the habitat of many species of animal life, from the microscopic creatures within the soil to the mighty moose and grizzlies that roam through some of them. All of these elements combine to form a complex living community in which each species has its place and adapts itself to its environment if it is to survive.

It is self-evident that all trees will die in the natural course of events. The openings thereby created in the forest will be filled by young trees, and thus the life of the forest will be continued without interruption. Decaying trees furnish homes for many species of birds and mammals. The destruction of these habitats over wide areas may even result in the extinction of some species, as is proving to be the case with regard to the ivory-billed woodpecker.

The forests of the National Park System, maintained in their natural state and allowing the natural processes of growth and decay free play, constitute great outdoor museums in which natural relations between plants and animals may be studied. This, in fact, is one of the important functions of national park forests. In order that they may be suitable laboratories of Nature it is essential that they constitute complete biotic units.

Use of these forests for scientific studies does not prevent their enjoyment for recreational use and for inspiration and beauty. They form the setting for many of the superlative scenic attractions of the Nation.

There are those who believe it wasteful to permit large and valuable

trees to die, fall down, and rot when they could have been used commercially. Such persons have in numerous instances advocated selective logging in the national parks in order to utilize the mature and overmature trees while they are still merchantable. Such logging, no matter how selective or restrictive it may be or how carefully it is accomplished, changes the complex forest community, and the area no longer exists as a natural forest.

> The time is coming when there will be no more virgin forest except that preserved in the National Parks . . . then the demands for the virgin forest in the national parks will become more insistent. But it will be more important with each passing year to protect from encroachments all of the National Parks and Monuments, which comprise only about one percent of the area of the continental United States. If we lower our standards and relax our vigilance we may lose the heritage which the wisdom of our forefathers bequeathed to us.
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> —*Editorial, American Planning and Civic Comment.*

Illustrations

Except as shown below, the illustrations in this publication are from National Park Service photographs.

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