FORESTS AND MANKIND

Photo by A. G. Varela

CHARLES LATHROP PACK
AND TOM GILL

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By

CHARLES LATHROP PACK

President of the American Tree Association

and

TOM GILL

Forester, Charles Lathrop Pack Forestry Trust

"An excellent book—clear, informing, convincing, adequate. The authors reveal not only a comprehensive grasp of their great subject in its historical, technical, economic, and social relationships, but ability to state the case in a way at once appealing to the student, the forester, and the general reader. For one who is seeking information and guidance on a national question of conspicuous importance, it is a book to own and to read time and again."—*A. R. Mann, Dean of Cornell University.*

"The book fills a much needed place in American forest literature. It presents in a very readable form the story of the life of trees and forests, their service to human welfare and progress, the problems of practical forestry, and the advance of the forestry movement in this country. It is a book which everyone interested in forestry should read and have on his shelf."—*Henry S. Graves, Dean of Yale School of Forestry.*

Mr. Pack is undoubtedly the best known exponent of popular education in forestry in the United States. He is past president of the American Forestry Association, honorary member of the Society of American Foresters, and the author of numerous books and articles on forestry subjects.

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FORESTS AND MANKIND

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FORESTS AND MANKIND

By
CHARLES LATHROP PACK
and
TOM GILL

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A FOREWORD

To tell the story of our forests is to tell the story of man's loyal ally in his long and perilous pilgrimage from cave-dweller to master of the civilized world. Trees from the first have been our staunch and constant friends.

Here in America our forests present a unique background to man's conquest of the new world. Without abundant wood, without the far-reaching effects of widespread forests, the history of this country would certainly have been tremendously modified. The American pioneer could never have made this continent his own so quickly, or so easily, without the existence of those forest allies of his.

And the story of these forests, the intimate tale of what trees are, what they have done and how they have influenced human development is all part of the epic of man. It is a story that has to do with the forests of yesterday, today, and tomorrow, with the ever changing aspects of the earth, the ceaseless, but varying relationships between men and trees, and with that very mysterious thing we call life. It is a story that began as far back as the beginning of humanity and that will not end until the end of time itself.

In one sense the story of our forests is a reaffirming of old Biblical wisdom, that tells us, "As ye sow, so shall ye also reap." Not even from the great bountiful mother nature can we always take away and never replace. Some day comes a reckoning. In America we have reaped, but we have not planted. We

have cut lavishly the timber heritage we found here, but we have given little thought to a new crop. Yet, just as man has emerged from an era when wild game and wild fruit were sufficient sources of his daily food, so is he emerging from an era when he can depend on the wild forests for his lumber, his paper, his turpentine, and his fuel.

Tomorrow he enters an age of man-made forests and the tale of how this came to be and how he is responding to these new conditions is one of the most colorful pages of man's development.

All this, together with a glimpse of what the future holds in our eternal partnership of man and trees, go to make up this story of the forests.

Charles Lathrop Pack
Tom Gill

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THE TREE—MASTERPIECE OF THE PLANT WORLD

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THE TREE—MASTERPIECE OF THE PLANT WORLD

Trees and rocks will teach what thou canst not hear from a master.
—St. Bernard.

Everything in this world—every material thing—has been placed by science into one of two great classes or kingdoms. These are the kingdoms of the living and of the lifeless—the animate and the inanimate. Into the first class science systematically gathers together all the earth's dwellers that contain the mysterious spark called life. All plants, insects, birds, the smallest germ, the tiniest seed—man himself. These, we say, belong to the kingdom of the living. In the other class falls everything that is without life, the rocks, the waters of the earth, the metals in the earth, the atmosphere that surrounds it.

The kingdom of living things has been still further divided into animal life and plant life. It is a convenient division and apparently definite and clear cut, but as a matter of fact, no one has yet been able to say just where one division ends and the others begins. The boundaries shift back and forth and grow indistinct. For, so far as science has been able to learn all living substance is basically the same and among the exceedingly minute forms of life it is not always possible to tell animal from plant. The microscope has revealed living things so perplexing in form and structure that no one can say whether

they are plants or animals. Scientists call them plant-animals and animal-plants, for they resemble both and they exist along that shadowy borderline between the two—a borderline that some day as we penetrate deeper into this baffling question of life forms may disappear.

And after all, these divisions of plant life and animal life are relatively unimportant. It is much more important to realize that both plants and animals are living, growing things and often dependent for their welfare and existence one on the other. Without plants animal life would disappear from the earth and without animal life our plants would be different in many ways. Some plants would even cease to exist. For many of our flowers depend on bees and nectar-seeking insects to spread their pollen to other flowers and form fertile life-bearing seeds. Without bees such plants would soon become extinct and without their nectar, life for the bees would become impossible. So in a sense all nature is a vast partnership to preserve eternally both in animal and plant that vital force called life.

The secret of this life force—its origin, its nature, its ultimate manifestations, still lies in the dark realm of the unknown. We only know that it is handed down from generation to generation of plants and animals throughout all the changing world. And even when nature seems cruel, even when a thousand seedlings die that one may live, or when the weaker animal must serve as food for the stronger, even then one may see beyond all this a plan that seeks even at the expense of the individual to preserve the thing that is infinitely more precious and important than the individual—life itself.

Constantly both animals and plants are seeking out and creating surroundings that will make it possible for them to

Photographed by A. Gaskill

FOREST DEPTHS

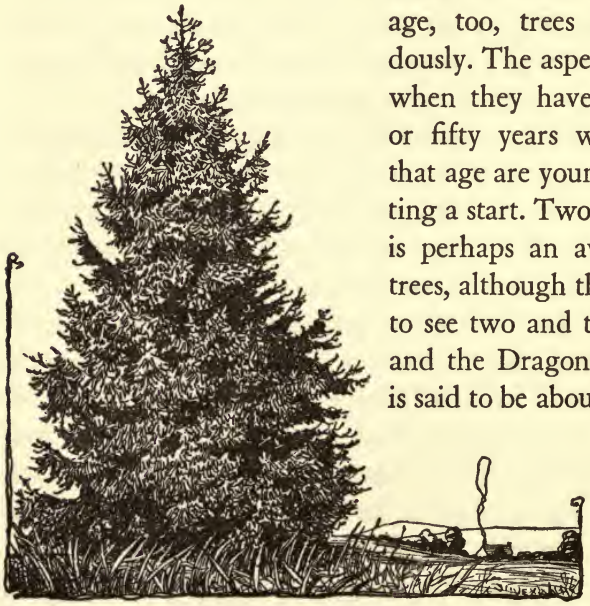
fulfill the highest life of which they are capable. Each can be helped in this search of theirs and each can be injured and killed. The farmer with his ploughing, fertilizing, and irrigating makes conditions most favorable for the growth of food plants. The forester helps nature develop the most useful trees. Man has entered very fundamentally, both for good and bad into this partnership of nature.

The manifestations of life are wonderfully varied. Certain species in both plant and animal kingdoms seem to possess this spark of life more abundantly. They are more alive, more complex in their nature, better able to adapt themselves to the changes that take place in the world about them, and better able to perpetuate their kind. These we have come to think of as the higher animals and the higher plants. And just as among animals, man is the highest manifestation of nature's power, so in the world of plants the tree is the most majestic creation that the long centuries have produced.

We have come to think of trees as plants that surpass all other vegetative growth in height and that usually have a single wooden stem or trunk branching at the top. This may serve as a practical definition, although it is well to remember that in different regions trees vary and the tall spruce of our eastern seacoast may be only a struggling shrub a few inches high in the bleak, cold uplands of the north. It is exactly the same kind of tree botanically but so bitter is the struggle to live, battling the cold and storms, starving in sterile soil, that it has just barely been able to exist. It has not been able to reach the size of its more fortunate brothers farther south. So our definition of a tree must be broad enough to include the lowly dogwood that raises its flowering crown hardly twenty feet

from the earth, no less than the sequoia that looks down over all the forest from more than ten times that height.

Trees differ very widely in both size and appearance—in bark, leaves, wood structure and habit of growth. Some trees have fragrant flowers like the magnolia, cherry or basswood. Others, such as the elm and the pines, have flowers that are quite odorless and so small they are rarely noticed. The leaves of some turn red in autumn like the maples and sumachs, others yellow like the ash and tulip tree. Some have leaves so gigantic they could be wrapped about one like a robe and others leaves that are hardly bigger than your fingernail. Some trees have wood so soft you can tear it apart in your hands and others wood so hard no nail can pierce it and so heavy it sinks in water like a stone. In age, too, trees differ tremendously. The aspens are old trees when they have reached forty or fifty years while others at that age are youngsters just getting a start. Two hundred years is perhaps an average age for trees, although the sequoia lives to see two and three thousand, and the Dragon Tree of India is said to be about five thousand years old.



Even in the same locality trees vary enor-

mously in structure and habit of growth and it is by these characteristics that botanists divide them into different species, genera, and families. The very fact that trees do possess such widely-differing characteristics of growth, fruit, bark, and wood has always enabled them to serve widely and well the various and numerous needs of man.

Yet all trees, different as they seem to be in structure and habit are governed by the same laws of life and growth, and in spite of their outward differences are closely akin in their need for food, in their manner of growth and living. Nor are these needs so greatly different from man's needs. Both men and trees come into being with the power of growth and of creating their own kind. Both require food, air, and moisture. Both struggle to conquer all obstacles that come between them and their destinies—and both at the end must die. Yet with the trees old age seems more a question of size than of years. For some, like the spruces, may live under dense shade cut off from the sunlight and hardly able to grow at all. A century may go by and the tree will be barely thicker than a man's wrist. Then, if the larger trees are cut from about it, this same spruce will put on rapid growth and become as large as its unshaded fellows. But after it has reached its full growth, it remains stationary for some years, then from one cause or another dies.

Trees by growing and by producing seed bring a twofold

gift to man. The products of their growth give him timber and firewood, paper, turpentine and rosin, tannin and maple sugar, fruits and nuts. By their seeds trees provide forever renewable crops of all those forest products that have become such intimate parts of our existence.

Not always has man thought of trees as crops. Yet they are crops just as corn or wheat. When the time comes that the trees of a forest have reached full growth and have borne seed, they are mature and ready to be harvested. If they are not used, the day will come when some storm brings them crashing to the ground weak with disease and decay, a prey to insects and fungus. They will rot and all the energy of the sunlight, all the years of patient growth have been wasted. It is far better then that these ripe full-grown trees be used and that the ground they occupied be filled again with young and growing trees. And although some trees, such as orchard or shade trees serve man best by living on undisturbed, the great army of trees, the soldiers of the forests best fulfill their fate and purpose when they are harvested by man just as a field of corn or wheat is harvested. It is the forester's problem to harvest wisely and understandingly so that forest may succeed forest of ever increasing usefulness and value.

CHAPTER 2

HOW TREES GROW

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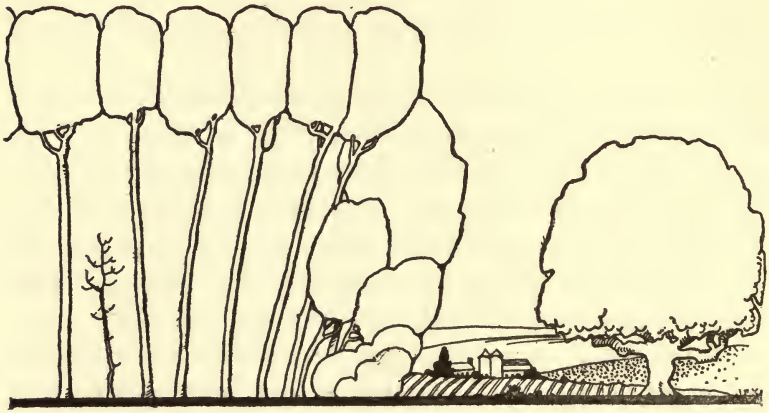
HOW TREES GROW

The friend of the tree is the friend of the race.—John Burroughs.

For countless generations mankind has wondered about nature and the innumerable processes of life and growth. From the infancy of his race he has contemplated with each succeeding springtime the slowly unfolding leaves and the blossoming of flowers. He watched the steady transformation of seedling to sapling and to mature tree. Regeneration, decay and death were ever before him as baffling, unexplained miracles.

Only in very recent times has this attitude of wondering contemplation given way to study and experimentation, with the result that gradually the boundaries of these unknown realms have been pushed back. It will always be infinite this realm of the unknown, but during the past hundred years man has thrown more light upon it than in all the millions of generations that have gone before. By painstaking study and constant experimentation our knowledge of nature's workings is increasing at a tremendous pace, yet almost all we rightly know of tree growth has been gained within the last half dozen generations. We are still feeling our way. We stumble but we do learn, and year after year these dark frontiers retreat before the light of science. The miracles of yesterday become the explained facts of today.

Even that subtle, complex process by which wood is made from such intangible materials as air, sunlight, and water is opening up its secrets. We are coming to know a little more of how in the form of seeds, small trees are formed and packed within protective coverings, then broadcast within the forest world to distribute and so perpetuate their own independent spark of life.



THE FIGHT FOR LIGHT

Forest trees are crowded about by their fellows in a race for the life-giving sunlight. They must grow to survive. Those that fall behind in the race are cut off from the light and die.

Trees of the field have no such competition. With abundant light from all sides they remain short and low branching throughout their lives.

A tree seed is essentially a minute tree, with the beginnings of root, stem, and leaf already formed and surrounded by some kind of protective coat. With this embryo tree is packed a supply of food derived from the parent tree, on which it lives and grows until old enough to shift for itself. Seeds are of different shapes and many sizes, but whether they be small as

a bead, or large as a football, they contain those two necessary elements, a young tree and stored food. From its parent tree the seed has also derived certain structures and the power to grow if conditions are favorable. Thus equipped it is cast forth.

But conditions, in the world of trees are seldom favorable. Most of these millions of seeds scattered throughout a forest find it impossible even to begin the first processes of growth. Some fall in dry, sun-baked earth, or rocky ground, or on impenetrable mats of grass or beneath dense shade. There they die. But some more fortunate seed may find itself one day in early spring deeply embedded in a patch of moist earth on some sunny hillside. From the soil, water soaks into the seed. It swells and finally bursts its covering. Oxygen diffuses through its tissues and many chemical processes take place with great rapidity. The starchy food stored up in the seed becomes digested. The starch changes to sugar and these sugar solutions attract more water from the outside, thus increasing the swelling. Energy is set free by the action of oxygen on the sugar and promotes growth in many ways, but most of the energy is derived from the seedling's surroundings, much more than by the slow burning of the food stored within it. Soon the delicate first root emerges and elongates into the soil beneath. The materials that go to make up this root are derived from the seed and the soil water. During all this time heat is absorbed from the soil and air. And this heat, together with the energy set free from chemical changes in the seed makes the little seed machine operate just as the energy of burned coal makes a steam engine operate.

No matter in what direction the root is pointed when it first emerges from the broken seed coat, its tip soon points down-

ward. This capacity of the root to turn vertically down is caused by a small mechanism in the very tip that operates somewhat as a spirit level, making the rootlet sensitive to the pull of gravitation. A little after the first root emerges, our seed pushes out its bud and the minute, tender leaves of the embryo enlarge and unfold. At first these leaves are white or yellowish like the root itself, but soon they turn green by virtue of a pigment called chlorophyll, a Greek word for leaf-green. Chlorophyll is in many respects like the red pigment of animals. It is often said to be the most important substance in the world, for practically all food on earth is primarily based on its presence in green leaves, and without it all plants would die.

Until now our seedling has been living and growing on food derived from its parent, but as soon as these young leaves become green a new chemical process begins, a process by which water from the soil and carbon dioxide from the air are decomposed and made over, producing sugar and oxygen. This process we know as photosynthesis. It can go on only in light, for light is its energy source, in much the same way as light supplies the energy for chemical changes that take place in a photographic plate, or the chemical changes that make dyes fade when exposed to sunlight. This ability of the plant to produce food from its surrounding elements is made possible by the power of the leaves to absorb and use the sun's rays. In the last analysis the sun is the source of all energy and activity on earth, for without it no leaf could manufacture food and all living things would perish. Even the coal that we burn today is the imprisoned sunlight of bygone ages,—energy taken from the sun's rays in the earlier days of the world by leaves of trees long dead. The sugar thus formed in the leaves

AMONG THE REDWOODS

moves to other parts of the plant and is the basis for the formation of all other foods. The oxygen escapes to the surrounding air.

But not all of the sun 's energy absorbed by the leaf is put to work making food. Sometimes a leaf takes up fifty times as much sunshine and energy as it can use for food making. The rest is used to evaporate the water in the leaf, a process known as transpiration. The amount of water given off by a tree through transpiration is enormous. A white oak, of average size, during a single summer day will give off 150 gallons of water. A forest of such trees must give out as much moisture as a river and quite probably a wind blowing over the forest will absorb even more moisture than if it had blown over a lake of equal size.

Plants require the same kinds of food as do animals, with the important difference that the plant manufactures its own food and animals obtain theirs by browsing on plants or devouring flesh of other animals. In one sense, and a very true sense, the tree is a factory where starches and sugars are manufactured out of substances the tree finds in the earth beneath it, in the air above, and in the sunlight. There are just three principal groups of food for both plants and animals,—carbohydrates, fats and proteins. These are all formed in the living plant, primarily from the simple sugars.

Just as animals can get food, only by taking it in from the outside, so the plant, once its stored-up food is exhausted, can make its own food only by taking-in the necessary substances from its surroundings. It takes its carbon dioxide from the air. The supply of water comes from the soil, entering into the roots and moving upward to the leaf. The soil holds its water

in films between the particles, and as the roots extend between the soil grains they draw this water in. Soil water, of course, is not pure. It contains many mineral substances, some of which are necessary for the continued growth of our seedling. These mineral substances are derived from the soil grains, which are partly particles of rock and partly the remains of dead plants and animals.

A great deal of water and small amounts of these mineral salts are absorbed by the growing and expanding root system of the plant and are conducted to all parts of the tree. Most of the water is soon lost by evaporation through the leaves, but the other substances remain and take part in the young tree's chemical processes.

So through spring and summer and late into autumn our seedling manufactures food for its growing roots, stem and branches. When winter comes it is already several inches tall and with roots developed and tightly embedded in the soil, the tree ceases from food making. It enters upon its long winter sleep, lying dormant except for these roots, which still continue to put on some growth.

But already the tree has prepared for the coming of another spring. At the end of each branch it has fashioned a bud, within which tightly folded and protected, are new leaves for the coming year. Winter blasts may sweep the forest and bitter cold grip the woods, but through it all the tree waits dormant and changeless, and when once again with the returning sun the days grow warmer, the soil water is no longer frozen and again life stirs. The roots again absorb water and the leaves unfold ready to begin once more their work of making food.

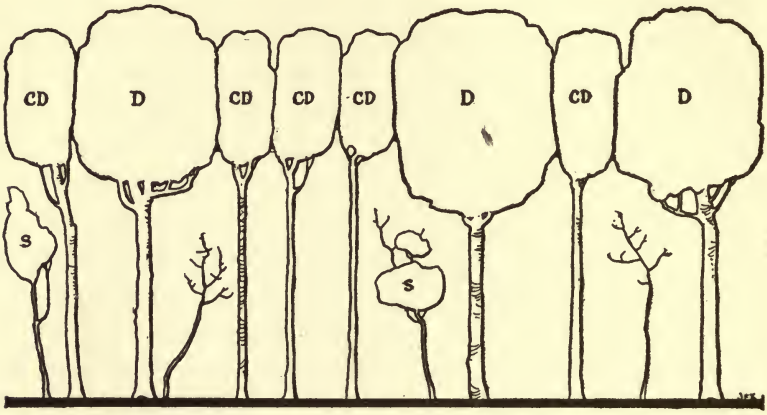
As time passes our seedling forest tree grows and branches

rapidly, forming a complex root system extending through the soil, continually advancing into new spaces between the soil grains. A crown of leaves raised on a stem above the earth's surface is now exposed freely to light and air. Through numerous channels in the roots, stem, and branches and leaf veins the water and salts from the soil move upward and supply all living parts. The sugars and other substances formed in the leaves move downward.

Because trees give off water by evaporation at a very rapid rate, the supply must be kept up or the leaves wilt and die. Water is constantly supplied to these leaves, taking the place of the water that is lost by the air and used by the plant. Just what forces operate to secure this rise of water to the tops of the trees have not yet been clearly worked out. The water is in general pulled up from above, and its rise depends fundamentally on two well known properties of water, cohesion and adhesion. Some trees are different in their microscopic structure and are able to raise water higher than others and it is possible that the height of any tree species is limited by this ability to raise soil water to the leaves. That may be why the dogwood can grow only to a scant twenty feet high, while the sequoia rears its head three hundred feet and more above the ground.

Drawn up by these still obscure forces, the water rises into the leaves, the tree's laboratories for making sugar, and these newly made sugars move downward from the leaves building up the many growing parts of the plant. From the sugars other necessary foods, such as fats and proteins are made and go to form the tissues and structures of the living tree. By this patient addition year after year of millions of microscopically small

wood cells the tree grows in diameter and height. So as the years pass periods of growth and rest follow each other and the limits of each year's growth become marked in the wood of the trunk, where they appear as ever enlarging rings. By counting their number one can very closely tell the age of a tree. These rings also tell something of the changing conditions under which the tree lived. Some rings show years when the



TREE CLASSES

Foresters divide the trees of the forest into three main classes. The mature trees that are the tallest of the forest, he calls Dominant (D) trees. Those not quite tall enough to reach this class yet able to crowd into the sunlight are the co-dominant (CD). The trees that have fallen behind in the race and are cut off from the sunlight, the forester calls Suppressed (S).

It is from the Dominant class that the bulk of the world's timber comes.

tree grew rapidly and some in which it put on hardly any growth at all—years when drouth may have prevented growth, or when some overshading tree stunted it. It has even been claimed that by the rings of the age-old sequoias, the oldest living things in the new world, we can read records of the dry years chronicled in the Bible.

For some years all the wood throughout the trunk of our young tree helps to conduct sap up and down and because of this function it is called sapwood. But gradually there forms in the inner portion a cylinder of harder wood usually dark in color. The walls of the cells of this wood have been hardened and the living elements have died. This inner core is known as heartwood and is darker because of organic materials in the wood cell walls. No longer is it a living part of the tree. It no longer serves as a passage for sap, and its use now is to give strength and support to the trunk. Yet from man's standpoint, this heartwood is the most valued part of the tree. For from it comes the durable, strong lumber for which man has countless needs. Should the heartwood remain soft, as it does in the willow, it rots easily and the tree may become hollow and weakened, and its wood of little service.

This formation of heartwood begins at varying ages of a tree's life—fifteen years in the oak and forty in the ash. But as the tree grows older the inner rings of sapwood turn to heartwood and a new layer of sapwood is formed each year next to the bark. So as the tree ages, its trunk grows thicker, and the heartwood increases in thickness, but the thickness of the sapwood remains about the same.

In addition to the formation of wood each year, the tree forms a layer of bark. This bark often becomes quite thick, sometimes a foot or more through, as in the sequoias. Sometimes, as in the sycamore, it scales off as rapidly as it is formed and remains like a thin envelope about the tree. Were it not for this tendency of the bark to peel, we could tell a tree's age by counting the bark layers just as readily as by counting the annual layers of wood.

As the years pass our tree grows taller, puts forth branches and at last takes its place with the other trees of the forest. It is now ready in its turn to produce seed and scatter them over the land—to spread and perpetuate the life that came to it from its own parent. These tree seeds are formed in the same way as in the smaller plants—by means of the union of two cells formed in the tree-flowers. On most trees, as the elm or pine, these flowers are so inconspicuous we seldom notice them. On other species, the horsechestnut and magnolia, the flowers are so large that the trees when in bloom look like huge bouquets.

Big, brightly colored flowers may be one of nature's advertising schemes, for they attract bees and other insects, and these, as they brush against the flowers in search of food help distribute pollen to other trees and aid in producing fertile seed. Other flowers depend on perfume for their attraction to insects. But big or little, seen or unseen, these flowers bloom high up in the tree top and in them the union of reproductive cells occurs, the germ of life is born, and a fertile seed formed. They are many shapes and sizes, these seeds. Sometimes they hang singly among the branches as in the acorns of the oak, sometimes within a cone, as in the pines and spruces, sometimes in a fruit as the apple or pear. But each seed has within it almost microscopically small this tiny tree of its own species and a supply of food that will provide energy for growth until it begins to manufacture food for itself.

Numberless seeds each year are formed and sent forth—carried by wind and rain, by streams and even by animals. The squirrel himself is one of nature's best foresters for he often gathers twice as many cones as he will eat, and the surplus that he has hidden away, may form a new grove of pine trees.

But only those seeds fortunate enough to find a friendly conspiracy of soil, sunlight, and moisture win through to begin the new forest. And even for them the battle is only just begun. Before them lies a long century of battle against other trees, against storm, drought, disease and fire. And the later fortunes of these bits of tree life become part of the story of the forests themselves.

CHAPTER 3

THE FOREST

CHAPTER 3

THE FOREST

A virgin forest is a battle ground where varied and multitudinous forces meet and fight for supremacy.—JULIA ELLEN ROGERS.

SOMEWHAT as men have come together to live with one another in villages and cities, rather than pursue solitary existences, so trees over large areas are found growing in close contact with their neighbors. These associations of trees we call forests.

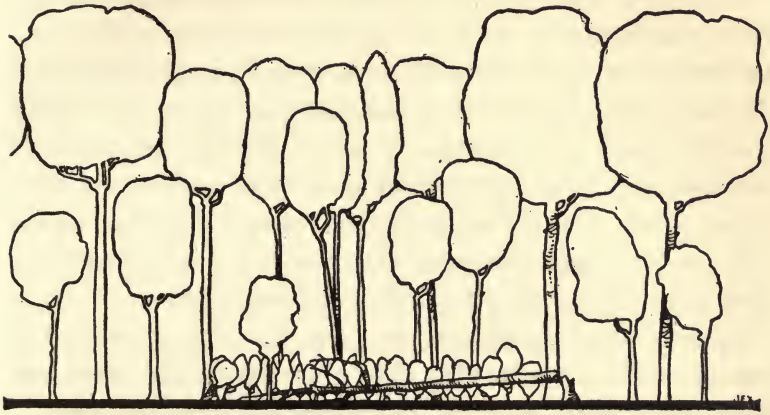
But it would be a mistake to think of a forest as merely a piece of land with trees growing on it. It is much more complex than that. There is an interplay of forces, a setting up of new conditions that make the forest a distinct unit in nature. And between all these contending and coöperating forms of life that go to make up a forest there is also a very delicate balance. Every tree is affected for good or bad by the trees that surround it. Even the soil in a forest is different from the soil outside. It teems with countless living things, some made visible only by powerful microscopes. Without this soil life the forest could not live, for it helps provide the tree roots with certain needed foods. Neither could these soil dwellers live without the forest and although we know very little about this form of life, we do know that in some way these microscopic organisms are as necessary to forest growth as the sunlight or rain.

The innumerable insects, the rarer forms of wild life, big and little, that find shelter and food within the forest, make their own contributions by helping in seed fertilization and in carrying seeds beyond the shadow of the mother tree.

A forest then is essentially a partnership of trees, plants, and animal life. It is a portion of the earth where trees, soil life, animals, and plants are living in close association and have come to depend in varying degrees on each other for their welfare, even though in another sense they are often at war, one with the other. One might think of them as friendly enemies. Under forest conditions trees themselves are constantly waging war with each other—the large trees bully the little ones and the little ones fight among themselves. The reason is evident. In forest life, much as in human life, there are not enough of life's necessary things to go around. There is only just so much open sunlight above, and so much soil moisture and fertility beneath, and only to the strongest and most vigorous trees the rewards of the struggle fall. And, as in man's life, so in the forest many contenders drop by the wayside and fail. They had not the stuff to succeed. They were not well equipped for the struggle, or they were handicapped by the many accidents that life brings.

To trace the growth of a forest from the time the first seeds open until the trees grow old and decay is to tell the life story of a tree community. And to reduce that life story to its utmost simplicity one may imagine that a thick growth of pine and maple and oak trees has been cleared of every tree for a mile square within the heart of the forest. Fire too may have burned over this area so fiercely that everything—trees and seedlings and even the seeds that lay in the ground—had been destroyed.

It is now a desolate area without life. But about the edges the old forest remains untouched by axe or fire and the trees from this will scatter seed for short distances into the burned area. Squirrels and birds venturing still further will carry acorns from the oak and seed from the pines and maple and about the edges of this wilderness the same kinds of trees that grew there before will soon spring up again.



An All-Aged Forest

Nature's forests are usually made up of trees of all ages from seedlings to veterans. The death of the old fellow in the foreground has opened up a space seized upon by hundreds of seedlings. On both sides are full grown dominant trees and crowded between them is a thrifty grove of younger trees fighting for light and root space.

But that is only a fringe. It would take many years, perhaps centuries, before the inner part of the burned forest could be covered with trees if nature had to depend on this slow method of reforesting and by that time the soil would be so baked with the hot sun and washed by the heavy rains that tree seeds would have difficulty in finding hospitable abiding places. Nature has a quicker means. Fortunately there are certain trees

with very light seeds well adapted to travelling great distances in the wind—poplar, birch, and sycamore. So within a few years our burned and cut area probably has become completely covered with a thick growth of trees quite different from the ones that the fires and axe had destroyed. Poplar seeds and birch seeds, have blown in, perhaps from many miles away, and the young seedlings of these species are springing up thick as bristles on a brush. They are not very valuable for lumber, these trees, but they serve a very useful purpose in that they protect the soil against hot sun and driving rain, and each year dropping their leaves they help to build up the soil and make it more fertile. At this stage in the regeneration of our tract we have in place of the original pine, maple and oak, a thick young forest of birch and poplar and around the edges of the old forest a fringe of young oak, maple and pine that have sprung up from seeds cast by the neighboring trees.

Gradually during the next twenty or fifty years, scattered by one agency or another, seeds of pine and maple and beech find their way throughout the area. Birds bring some. Squirrels others. Streams and wind may carry still others and so the seeds of the original forest trees make their way, not with any regularity, but scattered here and there back into the waste places. These newly-born trees are protected from drying out and from being withered by the hot sun because of the protecting shade cast by the poplar and birch. These act from now on as nurse trees to the young pines and hardwoods.

Beneath the light shade of these nurse trees the new seedlings have ample light for growth and in a few years they spring up about their former nurses and overshadow them. At this stage we find a scattered stand of pine and maple and oak

thrusting its way above a lower story of birch and poplar. Gradually the higher trees deprive this lower story of light. The stand of poplar and birch is being crowded out and will soon be gone. A little later, the pines, maples, and oaks sow their own seeds over the area and in the next tree generation they will have crowded out all other species. Once again nature has brought back the same forest that grew there before the days of the cutting and burning.

Long and roundabout is this process of restoring the original forest trees after destructive cutting and heavy fires. Sometimes it is centuries before replacement is complete. In parts of the Adirondacks where fires have burned not only the trees but destroyed the soil itself many hundreds of years will pass before trees of any kind can grow there.

When undisturbed by man or fire, nature works constantly toward the perpetuation of certain forest types. These are called climax types, for they represent the type of forest best fitted to survive in that particular place. Although this climax type changes with the region, with altitude, and often with the soil, it is the ultimate type that nature will grow in that particular environment. Even on opposite sides of the same hill we may find different types of climax forest. In some regions it may be our mixture of pine, oak and maple. In others a mixture of white and red pine and in still others, as over a great portion of the west, yellow pine alone is the climax type.

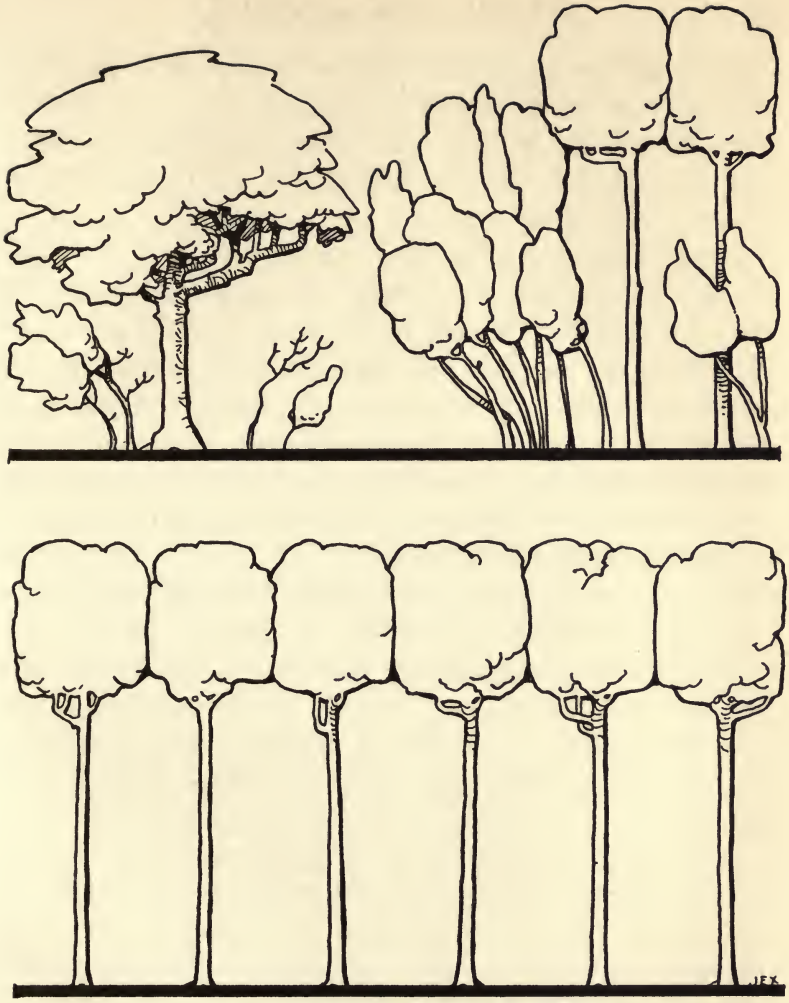
But for each locality and soil type, there is a species or combination of species that does best there—the so called climax type. Toward this type nature is constantly working. Man or fire may for a time overthrow nature's purpose and other trees may come in and temporarily seize the soil, but gradually if

undisturbed the climax type for that locality will come back and reconquer its old home.

Now if our suppositional forest is left without further interference from man, the trees will mature and at last become decadent with age. Perhaps this year or next a pine will crash down, heavy with old age, or the wind will overthrow some decayed and aged oak. Each fallen tree opens a little space in the forest and in each such opening, seedlings of the surrounding trees spring up and soon our forest will have trees of all ages growing within it as other trees die and fall. So throughout the centuries growth keeps pace with decay and death. This forest of ours has become what we call an "all-age forest." Trees of all ages compose it. And it is this type of forest which is most frequently met in nature.

In the forest the battle of life begins early. At first in the openings left by fallen trees and in the greater spaces created by man and fire, the seedlings that spring up have enough light for their leaves and moisture and soil room for their roots. Each is free to grow without interference by its neighbors. The life and death fight for supremacy has not yet begun, but as the trees grow, their roots reach out to invade each other's supply of moisture and soil food, their branches begin to touch and cut off each other's light From now on it is a merciless fight for life—a fight that continues without ceasing until the battle is lost or won.

During this early competitive stage seedlings put all their energy into growing tall that they may receive the life-giving sunlight and not be overshadowed by some faster-growing neighbor. Little hope exists for the stragglers. The branches of their victorious fellows close above them and, deprived of light,



IMPROVING ON NATURE

Nature, unaided, is often an indifferent forester. In a natural forest many trees are stunted and suppressed beneath wide spreading trees. In other parts of the forest may be large spaces without tree growth at all.

In forests planted by man, trees are equally spaced and the trees are uniform in size and growth. Every foot of soil is used. So a well planted acre of forest produces several times as much wood as a natural forest.

the vanquished trees become dwarfed, sickly and die. Of all the trees that may begin in this race for life on an acre of forest soil—sometimes a hundred thousand at the very start—only a very few, perhaps only two or three, survive to form a part of the mature forest.

So trees battle against one another in a life and death struggle for sunlight and moisture. Yet they help one another too, in affording mutual protection from wind and storm and from breakage by heavy wet snows. In keeping the ground beneath them moist and soft they create conditions favorable to tree growth and tree reproduction not only for themselves, but for their neighbors. And always, so far as man is concerned, this close association of trees in the forest with its necessity for rapid height growth serves the useful purpose of crowding the trees so that early in life their lower branches are cut off from light and die. Trees of the forest are often free of limbs for a hundred feet above the ground. The tree that grows alone and receives light from all sides is usually shorter than its forest-born neighbor. It produces knotty lumber, it is bushier, and its trunk is thicker just above the roots and tapers more rapidly.

Although more picturesque, open grown trees are of little use for lumber. Our forest tree, competing with its neighbor in an everlasting search for sunlight grows tall to escape being overshadowed and killed and so produces a long straight trunk that gives man his most valuable timber.

The forest types of the world differ enormously. They differ in rate of growth, in size, density, species, and in a dozen other ways. We have one kind of forest here and another there, changing as the climate, altitude and soil changes. We have as

FORESTED MOUNTAINSIDE

we have seen, transition types where one form of forest merges into another. From north to south, from coast to mountain top, the traveller finds the forests changing.

Differences between the types are often profound. Some tropical forests are so dense the explorer must literally carve his path with axe and knife. On the other extreme forests in parts of our Rocky Mountain states are so scattered one can drive a car through them. In the Orient are the "dwarf forests," whose tree tops come no higher than a tall man's head—in California and Australia are forests two and three hundred feet high.

Some trees grow only in narrowly restricted regions like the cypress which is found over a very small part of the United States, or the sequoia which grows only on the coast of northern California. Others are the wanderers of the tree kingdom—the willow and aspen. One finds them from coast to coast and from the shadow of the Arctic Circle to far south of the snow line.

The number of different tree species varies enormously throughout the world. Some regions possess many species, some few. Over that great stretch of country covered by north Russia, Sweden, and Norway, the forests contain only about half a dozen tree species. In the hardwood forests of the East, one can find ten times that many in an afternoon's walk. Tropical forests have thousands of known species and perhaps hundreds more not yet discovered. About eight hundred different tree species grow in the United States. Some of them are practically useless to man and are classed as forest weeds. It is one of the objects of forestry to replace these weeds of the forest with trees of greater value and usefulness.

Some trees are more exacting than others. These we find

only in the best localities—they are the aristocrats of the forest world. They need deep, well-watered, fertile soil and direct sunlight. Others less ambitious, more philosophic, are able to get along with very little of nature's favor. We find them out in the arid places and on steep hillsides or even clinging to the barren rock. And some others that have been unable to grow tall and reach the sunlight, like their more hardy companions have learned to get along without. The dogwood or the beech, for example,—we find them quite thrifty and apparently contented doing well with the few patches of light that fall from between the crowns of their more lofty companions.

These we call tolerant trees for they are able to tolerate deep shade. They form the understory of the forest while above them tower the taller trees that are intolerant of shade and that form the dominant trees of the forest.

The presence of species of varying tolerance makes the forest a many-storied structure rising from the low tolerant species, up through the intermediate trees to the great dominant top story—the trees that reach up into the open sunlight and lord it over all the forest world. It is from these dominant trees that man obtains his most valuable lumber.

CHAPTER 4

THE FORESTS OF LONG AGO

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The true pages of the past are the rocks of the earth's crust.—Berry.

The forests of the world are constantly changing—although the changes are perceptible only over centuries. Since their far-away beginnings they have been changing in extent, in appearance and in the species composing them. Their boundaries have moved back and forth like the tides of great seas. Existing in a world that, itself has never remained the same, this power to change has been necessary to forest life. For every living thing, animal or plant, must adapt itself to changing environment or perish. Nothing is static. Temperatures rise and fall. Rainfall increases or grows less. The soil itself changes. And with all these shifting conditions plants and trees, if they are to survive, must keep pace and adapt themselves by changing too.

When plant life first began in the world, it probably started under much more simple and uniform conditions than now exist. Probably the cradle of life was on the warm shores of some shallow sea, with abundant rainfall, hot sunlight, and an almost constant temperature. Every condition was favorable for life and so the first organisms were simple. There was no need for them to be complex at first—not until later. Later as plants spread to less hospitable places, or as conditions of life grew

more difficult a need arose for more specialized structures—more complex machinery for existence.

So all the trend of nature seems to be from simple structures to complex. The earliest plant of which we have any knowledge is a little water plant, a relative of the seaweed of today. It was a simple organism, undeveloped as to roots, stem, or leaf, but the struggle for life and food in its chosen environment was not intense and this lowly plant was able to survive and reproduce itself abundantly in those far-off days of the world's infancy. Geologists still find its fossil remains back in the oldest rocks that show traces of any remains of life. Then with the passing centuries, as conditions grew more varied, and as life began spreading to various parts of the world, both animals and plants were faced with the necessity of keeping pace with their surroundings. That is why we have so many kinds of fishes, animals, and plants—different environments, or different adaptations to the same environment have called into being hosts of families and species each different one from the other. As portions of the earth became colder, animals developed heavy fur to protect them; as other portions became drier many plants found ways of storing up water in their leaves and stems. One locality calls forth one characteristic, another demands something entirely different. And just as we find the ancestors of modern man had different characteristics caused by different environment, so the ancestors of the modern tree are, for the same reason, profoundly varied in appearance and in structure.

It is here we touch one of the basic laws of life itself. For in any study of plants or animals one is confronted over and over again with the fact that all life is engaged in a perpetual task

A Forest of Long Ago

The forests of past ages were very different from the forests of today. None of the tree forms that grow now were then in existence. In those far off days gigantic club mosses flourished. One of these, the Lepidendron or scale tree has the general appearance of a forest tree. The reptiles and gigantic dragon flies that inhabited these moist swamp forests have vanished from the earth as completely as the trees themselves.

of preserving itself in the face of conditions that are forever in a state of change. Sometimes these changes are so great or so sudden that they overwhelm life. Usually they are extremely slow and the various forms of life are constantly changing, too—making adaptations. One sees that a tree in the dense forest will grow tall and slender to reach the light. But the same kind of tree in the open spaces does not have to adapt itself to this life and death struggle for light and so does not grow tall. Plants of the desert country where rainfall is scarce must conserve their moisture and have created special methods for storing up the moisture they are able to raise from the dry, reluctant soil. At the other extreme the palms in the rainy portions of South America get too much water and have produced huge leaves that drain the rainfall outward and so keep the water away from their roots. Both are useful adaptations.

When conditions change too rapidly for a plant or animal species to keep pace, it dies. We say it has become extinct. It has failed to make corresponding changes with its changing world and so falls out of the race. Many thousands of species have fallen by the wayside since the dawn of time and probably the number of tree species that exists today is only a small remnant compared with the numberless kinds that no longer live.

One may better understand the forests of today by learning something of the ancestral forests that gave them birth. One gains a sense of continuity down long ages of skillful adjustments. Yet in doing this one must travel in a few pages across many million years getting just a passing glimpse of the changing world of past ages, and of the changing trees. If all these changes seem rapid and sweeping it is only because of

the rapidity of our glimpse—somewhat as if a motion picture were speeded up before our eyes. Actually these changes were often no more rapid than the changes going on today.

In all this study of the remote past one is able to look back through the years into the earlier days of the world because of the rocks that preserve for us remnants of leaves, seeds, twigs, and sometimes whole trees, that have been lifeless now for millions of years. These remnants of tree life give us a more or less continuous picture, although here and there wide breaks exist. It is a little like reading a book from which sometimes pages and sometimes whole chapters have been torn.

These rocks begin their story for us back at the earliest traces of living things for the plant is the oldest form of life. Millions of years before the first tree existed, long before man walked the earth, or any land animal lived, the rocks show us that early forms of plant life were in existence. Some are remote but recognizable ancestors of trees and among them are the great club mosses and the early fern-like plants.

From these forms of life, from the tree ferns and cycads came the early trees. First the conifers—the cone-bearing trees—gradually developed and became the world's most important type of vegetation. These ancestors of our present pines and spruces are of enormous antiquity and are present in the oldest rocks in which any of the land plants have been preserved to us. Gradually these cone bearers spread over the world. Men speak today of that era as the "Age of Conifers," for during that time the world possessed a greater abundance and variety of conifers than has ever existed before or since. For ages they held sovereignty over the world of plants and at the end of this era came the beginning of the modern forest trees.

Back in those earlier days of tree life, the continent of North America looked quite different and possessed a more temperate climate. Rainfall was more abundant. The weather was warmer, more uniform in temperature and there was a total absence of frost. The Rocky Mountains had not yet been formed and the whole continent was low and heavily wooded from coast to coast. At that time there were no regions of treeless areas like our Great Plains, neither was there any abrupt difference between the forests of the east and the west. Greater uniformity existed both in the climate and topography and conditions were everywhere favorable to tree life. The cold, inhospitable wastes of the Arctic in those days were warm tree-covered areas where even the heat-loving fig and palm found favorable conditions and conifers flourished and grew over all the land. It was an ideal world for them. They were the highest form of plant life in it.

Time passed. Many thousands of years. The outlines of North America had meanwhile been changing. The Gulf of Mexico and the Arctic Ocean mingled their waters by means of a great inland sea that cut through the continent. Gradually this inland sea subsided and a large variety of tropical plants invaded the Gulf region from the south.

Then came a great and important change. Following the conifers arose a class of trees that are commonly called broad-leaf trees because their leaves are not needle-like, such as the leaves of the spruce and the pine, but broad and flat like the maple and hickory. These broad-leaf trees were of a later type. They were more complex in their nature than the cone bearers and better able to survive and establish themselves and their descendants. They were the "moderns" of the plant world and

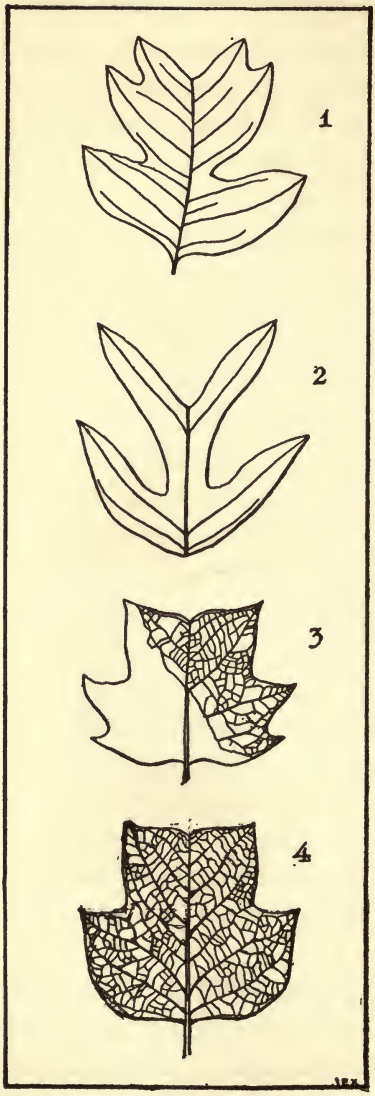
YOUNG PINE PLANTATION

their coming brought profound changes to all forest life. They invaded the land and as the centuries passed they have gradually taken possession of the world's most favorable portions, forcing the pine and spruce and the fir back until they occupy now the less fertile places, the high mountainous countries, the dry sandy soils, and the desert's edge.

In a sense the world has become and still is an immense battle-field between the cone-bearers and the trees with broad leaves. Gradually the cone-bearers are losing and being forced out. During those times of the broad-leaf trees first invasions lived a few trees that exist in our forest today—the sequoia, the bald cypress, and the ghinko. The rest—the thousands of others—have perished and been replaced by more recent species. Meanwhile the Rockies were being pushed up into existence bringing about important changes in climate, for when that tremendous barrier cut off the moisture-laden winds from the Pacific, the country just east of them became too dry for tree growth and so the plains country came into being.

But this long period of warmth when the fig and the palm grew far to the north and when tropical forests flourished in Alaska did not last. It was followed by a glacial period, an age of ice. A great ice cap moved down out of the north, forcing both animal and plant life before it, grinding everything in its way to extinction. We believe there were four distant ice invasions and between each the climate was about as we know it today.

This ice sheet was a tremendous modifier of tree species. Some species were able to keep ahead of the ice, for their seeds borne by the winds or carried by rivers, birds, or animals were scattered to the south of the ice flow and so the species was



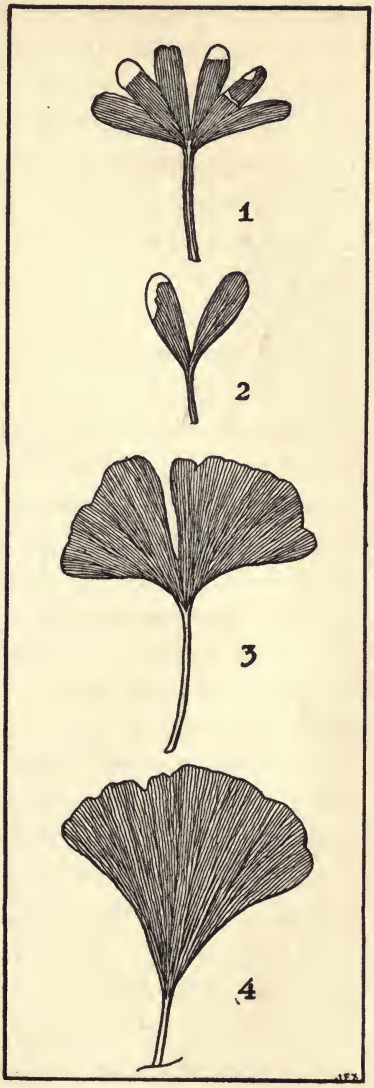
saved from extinction. Many that were unable to migrate in this way, or could not cross barriers of water and mountains became extinct. Some, like the sequoia, were almost totally engulfed, but in a few protected places managed to survive. Then the ice moved back and the great wealth of plant life in the south gradually followed the retreating glaciers northward. Years passed, centuries, and another sheet of ice came down out of the north. And as each successive blanket of ice returned, there were corresponding waves of plant and animal life moving back and forth and ever changing as the climate and other conditions changed. It must have brought multitudes of new species into existence just as it must have ex-

EXTINCT SPECIES OF TULIP POPLAR

Specimens 1, 2 and 3 are fossil leaves of a species closely resembling our own tulip poplar (Liriodendron tulipifera), whose leaf is shown as number 4. The others have become extinct.

terminated multitudes. One faces the fact that the present type of plants and trees inhabiting the earth today is only one of the many different types that must have existed since plants began.

This, then, in briefest outline is the epic of plant life in this world of ours. The beginning of it all extends back many millions of years—it is a continuous pageant of life passing across the centuries. First the simplest kinds of tiny water plants, later the ferns and club mosses, then the more highly specialized cone-bearing trees and last and most complex of all, the broad-leaf trees, the highest forms of plant life in the world today. These changes still go on for just as the climate is changing slowly,



Ginkgo Leaves—Past and Present

The three upper leaves (1-2-3) are fossil remains of leaves from the ancestors of the maidenhair tree or ginkgo biloba. The lower leaf (4) is a modern specimen.

hardly perceptibly, so the trees are changing. Behind the veil of the future may lie tree forms of which man has never dreamed, higher forms still better equipped to live and multiply. For that is the way life seems to be working, always toward organisms that will carry the spark of life safely on and perpetuate it in the face of adverse conditions.

But not to tree species alone are these forest changes confined. Tree areas, too, are shrinking and expanding today no less than in the remote past. Forests are invading the desert in one region and retreating before adverse conditions in another. The cypress, for example, last living representative of its race, seems to be slowly shrinking in its area of distribution. Others are thrusting their boundaries forward—seizing ground once held by other species.

The species of our older trees have become less numerous. Once the sun never set on the *liriodendron,* that magnificent tree we variously call tulip tree, tulip poplar, yellow poplar, and white wood. It grew once in all parts of the globe and at least nine different species have been found. Now there are only two species left, one in America and the other in far-off China. From the rest of the world the tulip tree has vanished utterly. So it seems that the older forms die and new ones take their place. Changing conditions—changing forms.

And although in our modern forest we have here and there isolated types like the sequoia, successful survivals that have held their own in spite of ceaseless change, still the woods of today are quite different from those of other days and these too are constantly changing. Only a few, the sequoia, ginkgo, and one or two others remain like vestiges of the remote past to link our forests of today with the forests of long ago.

CHAPTER 5

FORESTS OF THE WORLD

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Forests are important in the life of every nation because of their influence on the water supply, on agriculture, and on the general welfare.
—Raphael Zon.

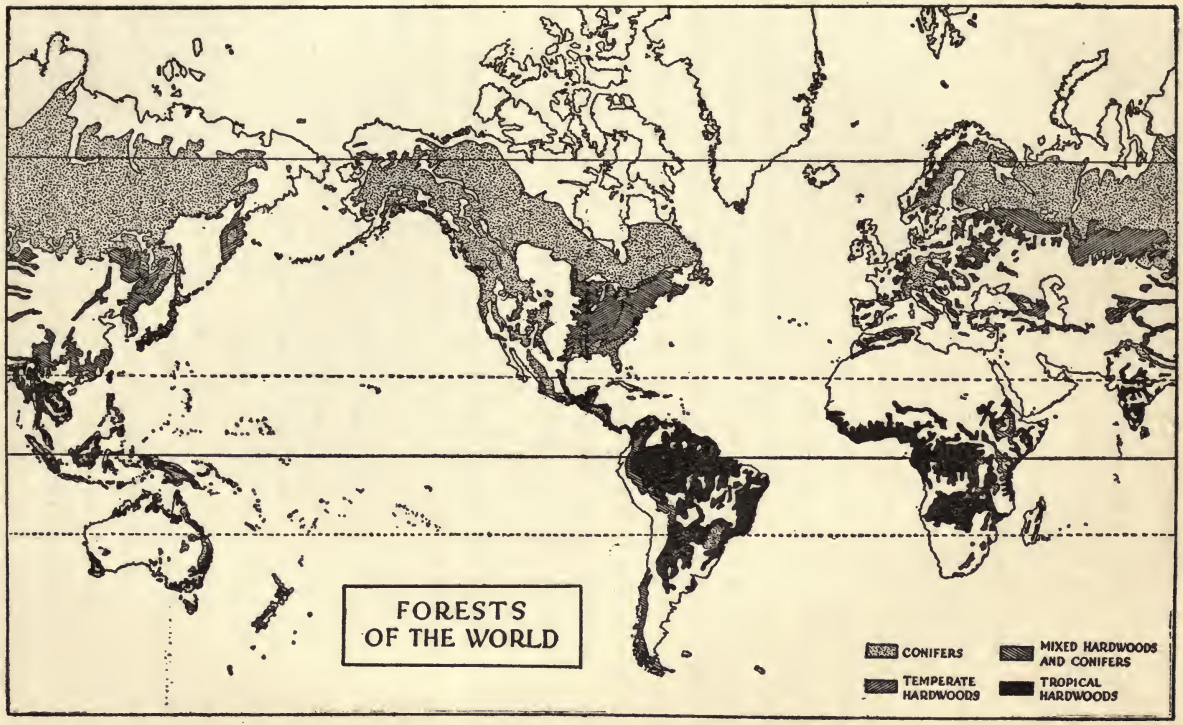
Except for the Polar regions, we know less about the timbered portions of our world than any other. Perhaps one reason for this is the fact that when early man began migrating over the face of the earth, he kept to the coasts and the waterways, leaving the interiors of the dark, trackless forests severely alone. Then too, the superstitions of early man, and of many primitive tribes today cause him to avoid the forests. Priests and medicine men still tell fearsome tales that picture the forests as the abiding places of monsters and evil spirits. The Black Hills, the only forested portion of South Dakota was once looked on by the Indians as haunted ground and only visited in search of food.

Perhaps, a little of this heritage comes down to us, for at first, most of us feel a certain misgiving when we go into the deep forest. We talk in lower tones; we are not quite at ease. But the open places within the forest have always been hospitable to man. They hold grass for his flocks and sunlight for his crops. Man is not essentially a forest dweller, but rather a creature of the open lands near the forest. He is dependent on

the forest for a great part of his living, yet spends most of his time just outside its borders.

Until a very few years ago we had no definite idea of the extent or composition of the world's forests. Until rather recently it was not important that we should have this knowledge for the forests of the Amazon, or of north Russia were so remote from the crowded places where man most needed wood that it made little difference whether those far away portions of the globe were forested, or as treeless as the Sahara. But times change. Each hour that we are able to cut from the schedule of train and steamer, each penny that we can save in freight charges bring us nearer the rest of the world and make the products of other countries more important. Today no civilized nation is independent of other countries. There is a constant interchange of products throughout the world and the amount of timber in the forests of Russia or South America has now a part to play in the world's economy. For in these days of cheap transportation, timber is being shipped across the earth and already the treeless countries are tapping the forest wealth of lands thousands of miles distant.

Although the forests like all other living things have been constantly changing they have changed most rapidly since man made his appearance in the world. Man has been the big disturbing factor in modifying the face of the earth. In prehistoric times the forest undoubtedly covered a greater part of the globe than now. For his crops man has cleared away much of the earth's surface. He has burned over large areas that he may have grass for his flocks and herds. In some regions he has completely annihilated the forest. In Great Britain ninety-five percent of her original great forests is gone. In the still


FORESTS
OF THE WORLD
CONIFERS
MIXED HARDWOODS AND CONIFERS
TEMPERATE HARDWOODS
TROPICAL HARDWOODS

older countries of France and Italy and Greece, between eighty per cent and ninety per cent of the forests are destroyed. Sweden and Finland are the only countries of the Old World that still have as much as half of their original forests left. We are passing through an age of rapid forest destruction.

Some of this destruction was inevitable. Some was necessary and right. It is good economy to clear tree growth from the fertile lands to raise the world's foodstuffs. Today the world's forests cover about seven and a half billion acres, or about one-fifth of the earth's land area. It is hardly possible to conceive of an area of that magnitude, but much of this so-called forest in reality is composed of brush and low, scrubby timber such as grows in the Arctic Circle. It will never be of importance to man and the really productive forests of the world cover a much smaller area—about sixteen per cent of the land surface, or three and two-tenths acres of forest land for every human being in the world.

Russia has the most extensive forests of any country. Next come the British Empire, third Brazil, and fourth, the United States. These countries together have within their borders nearly two-thirds of the forest land of the world. The remaining third is divided among more than fifty nations.

The continents have been unequally placed from the standpoint of the world's timber supply. North America has about twenty per cent. Africa and Europe with their thickly inhabited countries have only ten per cent apiece. South America and Asia each have about twenty-eight per cent but the situation in these two continents is entirely different, since Asia teems with people and South America is very sparsely populated. From the standpoint of national development the amount of

Photographed by W. S. Clime

SKIDWAYS OF LOGS IN THE FOREST

timber in a country is less important than the amount per inhabitant, and Asia, in spite of her great forest areas, possesses only two and a half acres for each of her people, while South America has thirty acres of timber for every man, woman, or child. Of the European countries, Finland, Sweden, and Russia are richest in forest wealth.

Canada has the largest forest area on the North American continent, but a large part of it is in the far north where growth is slow and the timber of little value. In Mexico only about fifteen per cent of the country is forested. Once she possessed extensive forests, but more than a thousand years ago an Indian civilization flourished there and before it disappeared from the face of the earth deforested millions of acres of Mexico's woodlands.

In the United States about one-sixth of our original forest land now bears virgin timber. In three centuries our forests have retreated westward and are now so distant from the centers of demand that today we pay two hundred and fifty millions of dollars as our yearly freight bill to transport wood from the far off forest to the lumber yard.

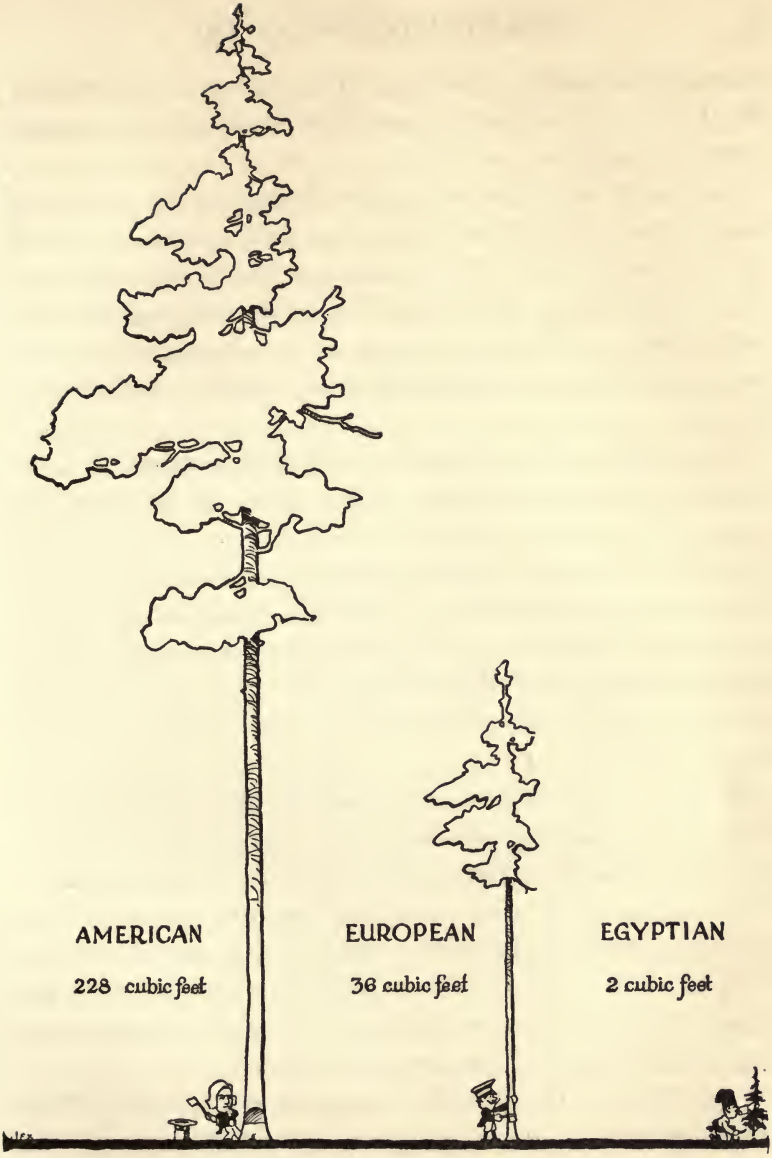
As the number of people increases in the world there will be a tendency for forested areas to further decrease to make more open land for food crops. The proportion of forested land will vary with the region. The poorer, unfertile lands, as well as the lands whose climate is unfavorable to agriculture, will always remain in forest. Low level countries will be able to get along with a smaller portion of their land in forest than the mountainous nations. But for both there will be limits of deforestation beyond which it will be unsafe to go. The limits of safety of deforestation are governed by other factors than the

problem of wood supply. Rainfall, stream flow, humidity and temperature all seem to be adversely affected by deforestation.

Each year the world cuts about fifty-six billion cubic feet of wood. Of this a little less than half is of the size and quality that make it suitable for sawing lumber—the lumber we use for building and for general construction. The rest—more than half—is small, inferior material cut chiefly for firewood. North America produces half of the wood cut in the world, and the conifers or softwoods supply about three-fourths of the sawing timber. It is the conifers, then, whose perpetuation is essential so that the world may continue to be kept in timber.

How much wood is grown each year in the world's forests? That is a hard question to answer. We believe that it is much less than the amount consumed and it is certainly much less than could be grown if the forests were properly handled. In the virgin forests of the world such as the great forests of the Amazon and of north Russia, the amount of wood that grows each year is balanced by death and decay. So far as adding to the world's wood supply, these forests produce nothing. They are not creating great reserves of timber against our future need—they are merely holding their own.

Foresters estimate that about thirty-eight billion cubic feet is grown yearly. They believe that if all the forests of the world were placed in a condition of ideal growth, they could probably be made to produce as much as three hundred and fifty billion feet. But the world's forests will never reach the maximum production for even though scientific forestry may someday greatly increase the rate of growth of valuable species the area of forest is bound to decrease. In the face of this certain decrease of forest area throughout the world it becomes an in-



World Wood Choppers

We Americans are lavish wood users. Each year for every man, woman and child we average 228 cubic feet of wood, enough to make a solid cube of wood six feet on a side.

creasingly important problem to so manage the remaining forests that they will produce more than they possibly can under natural conditions.

Compared to other countries, we Americans are a nation of lavish wood users. The average citizen of the world uses thirty-two cubic feet a year. We in America require two hundred and twenty-eight cubic feet. Finland exceeds even that, for there each person consumes an average of three hundred cubic feet yearly. Man for man America uses five times as much wood as Europe.

The amount of wood used by a nation depends on many things. It depends on racial habits, standards of living, and stage of development. Countries like Egypt, use only about two cubic feet per person. With the exception of Sweden alone, the United States sends more of its timber to foreign countries than any nation in the world. At the same time, it imports about as much as it sends out. North Europe and northern North America ship large quantities of conifers for construction to all the other continents.

It is not always the most heavily-timbered countries that send the greatest quantities of wood to foreign ports. South America which among all the regions of the world is best provided with forests imports twice as much as she exports. That is partly because it is cheaper for her to buy timber abroad than to go back into the still inaccessible forests of her own continent and partly because the kinds of wood she requires are not found abundantly in her own land.

The forests of the world fall into three main groups: conifers or softwoods, temperate hardwoods, and tropical hardwoods. The last two groups might be combined into one great class of

hardwoods, but so very different are the hardwoods of the temperate zone and those of the tropics that it makes for clarity to divide them. The conifers are the most important for general construction timber and for paper making; the hardwoods, both temperate and tropical, are used principally for high grade furniture and special materials. The temperate and tropical hardwoods seldom mingle, but the demarcations between conifers and temperate hardwoods are not always distinct since they often occupy the same forest soil over large areas. Such forests we call mixed forests, or mixed hardwoods and softwoods. Forests that contain only one kind of tree we call pure forests—thus an area occupied entirely by pine is a pure pine forest.

For the world as a whole, conifers occupy thirty-five per cent of the forest area, temperate hardwoods sixteen per cent, and tropical hardwoods forty-nine per cent. Almost half of the earth's forest area is covered with tropical hardwoods, but since three-fourths of the people of the world live in the temperate zone, it is natural that the conifers and the temperate hardwoods should be better known and that they should have suffered most at the hands of man. On the forests of the North Temperate Zone alone, the world depends for over ninety per cent of its construction materials.

The tropical hardwoods are destined to become important forests of tomorrow. When we come to learn what they contain and the many uses to which they may be put, tropical timbers will be shipped in greater quantities to those countries of the world now needing wood. It is doubtful, however, if they can ever take the place of the softwoods for construction timber in the world's market.

Forest statistics are subject to error and any prophecies based upon them must be based on uncertainties. But it is probable that today we have in the world more than enough forests to supply, under proper management, the world's wood needs. Theoretically there is no deficiency. But practically, forestry must concern itself, not with the amount of existing forests, but with the amount and kind of forests available for current practical use. Here we find the great centers of civilization very deficient indeed. So from this standpoint the problem of forestry begins to assume the aspect of seeking some means for perpetuating and increasing the growth and quality of those forests most available and most useful to man.

CHAPTER 6

FORESTS OF THE UNITED STATES

CHAPTER 6

FORESTS OF THE UNITED STATES

The American people have not yet acquired the sense of timber as a crop.—WARD SHEPARD.

THE forests of the United States are unrivaled, among the world's timberlands, for the number of commercially important tree species they contain. In Russia one finds greater expanses of solid, unbroken timber but in our country alone, exist such enormously great areas of forest made up of so many distinct species of tree growth. Over eight hundred and fifty species reach tree size, and in addition to these species are a number of tree varieties and hybrids that bring the total different forms of tree life close to twelve hundred. Today over one hundred and eighty have economic importance and as time passes, this number constantly increases, for new uses are being found for species that yesterday were considered valueless.

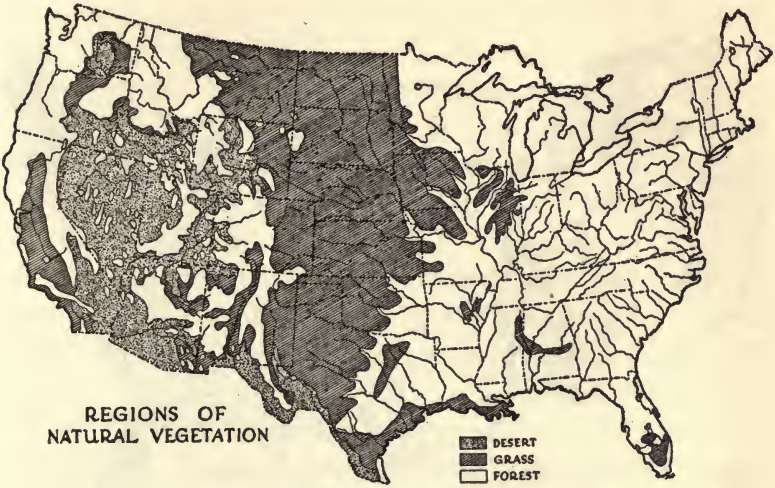
This multitude of tree species and of forest types in the United States is partly the result of our great range in climate, elevation, and soil. All these varying factors were bound to result in a great diversity of natural vegetation. But the supreme dictator of the general type of vegetation to be found in a region is rainfall. Very deficient rainfall produces deserts;—sparse rainfall, grassland. Only where we have fairly abundant rain is a region able to support trees.

For the United States as a whole, grass land occupies thirty per cent of our land area, desert twenty-two per cent, and forest land forty-eight per cent. The forests themselves form two broad belts of tree life, one a belt of western forests extending inland from the Pacific and the other a belt of eastern forests bordering the Atlantic. In the central United States a broad prairie of grass land lies between these two belts, known as the Great Plains. This area in ages past fostered tree growth, and today is treeless probably as the result of many factors—chiefly climatic changes that decreased the rainfall. Fires of long ago may also have played a rôle here in preventing invasions of tree growth that would bring these plains back to forest. But whatever caused these great expanses of grass land, they have effectually acted as a broad barrier to keep the species of east and west from mingling and so have been one cause of the differences in the composition of our eastern and western forests.

Originally four fifths of our forests were in the eastern United States. But because settlement began on the Atlantic Coast and because the East today supports eighty per cent of our total population, the eastern forests have suffered greater and much more rapid depletion than the western. Not until the partial exhaustion of our eastern forests through lumbering and fire were men forced to go south and west for their wood.

These two forest belts are quite dissimilar in extent, as well as composition. Along the eastern seaboard, the first settlers in this country found a heavy, unbroken forest extending over more than a million square miles. The western forests are much less extensive, covering about two hundred thousand square miles almost equally divided into two parts, one in the

Rocky Mountain region and the other in the Pacific Northwest. The eastern forests were made up chiefly of broad-leaf trees and covered mountains and valleys in a great unbroken mantle of green. The western forests, on the other hand, are composed principally of softwoods and are interrupted by many treeless



NATURAL VEGETATION OF THE U. S.

The three great divisions of natural vegetation in the United States are forest, grass and desert. Rainfall is the most important factor in the creation of these regions.

valleys. In them, unlike the eastern forests, we find very abrupt changes in species.

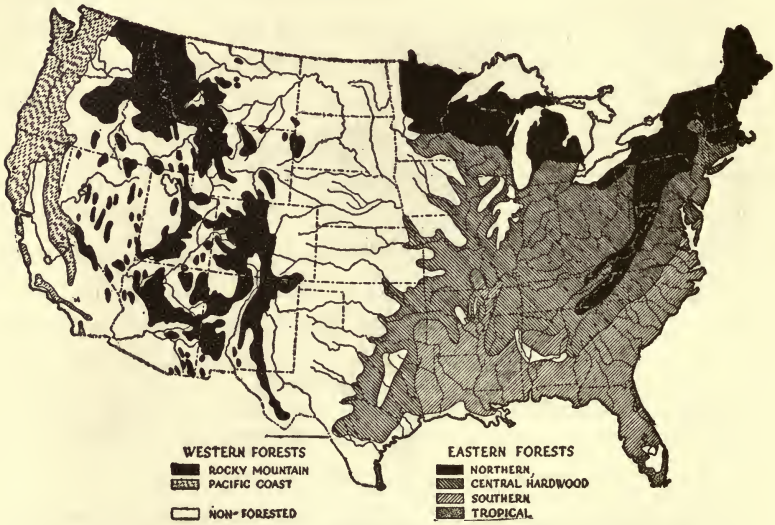
The eastern forests contain over four hundred species of broad-leaf trees. Many of them extend over large areas and have high market value. The Western forests have about one hundred broad-leaf species, very few of them valuable to man.

The western forests are essentially softwood or evergreen

growth and contain over twice as many conifers as the eastern forests.

A few, a very few, species grow in both regions, such as the Canadian spruce and box elder.

As a whole, the forests of the United States, both eastern and western, are in poor condition. They have suffered so greatly



TIMBER REGIONS OF THE U. S.

from lumbering and from forest fires that today they produce a pitifully small fraction of their full capacity. About seventeen per cent, only, remains uncut. Forty-three per cent has been cleared for farm lands. Thirty per cent has been cut, but is again restocking and ten per cent or more than eighty million acres has been so cut and burned that only sparse inferior growth is slowly reclaiming the land.

The forests of east and west have been further subdivided into five regions—three in the east and two in the west.

Eastern Forests
- Northeast
- Central
- South

Western Forests
- Rocky Mountain
- Pacific Coast

The Northeastern Forest:

This region once held the most important forests in the United States and for many years more timber was cut from it than from all the rest of the country. Today as a timber producing region, it is negligible—it is like a mine that has been worked out.

The original forest contained more softwoods than hardwoods, the most important species being white pine and red spruce. These two valuable species have been cut until very little remains. On the more fertile and moister sites the hardwoods—beech, birch and maple predominate. As a result of lumbering much of the original pine has been replaced by pure second growth stands of poplar, birch and aspen.

It is this region that within the next decade will probably see a great deal of intensive forestry to bring back by means of man-made plantations the valuable tree species that once grew there.

Central Forest:

Unlike the region of the northeast this central forest is a forest of hardwoods. It contains some very valuable species. The oaks are the most abundant and the most valuable, but, in addition to these are hickory, yellow poplar, ash, elm, and

several hundred other species. This central forest contains more different kinds of trees than any other in North America. A few pines grow here, sometimes in pure stands, but usually mixed in among the hardwoods. Shortleaf pine is the most important conifer in this forest. Several pitch pines also occur and red cedar, but the great distinguishing feature of this central region lies in its being a forest of hardwoods, for all the other forest areas are regions either of pure softwoods, or of softwoods with a scattering mixture of hardwoods.

Of this region, not more than five per cent of the original forest now exists. A great deal has been cleared for farm land, for it contains some of the most fertile and well-watered soil in the United States. The forests that still remain have been cut over so often for the best timber that only the poorer material remains.

Southern Forest:

This is a forest of yellow pine. By far the most important are longleaf pine, loblolly pine, and shortleaf pine forming pure stands over wide areas. These three pines have made the southern states one of the greatest timber producing regions of the world. They not only provide valuable timber, but, from their resin are extracted turpentine and rosin.

Hardwoods occur among the pine, but they are of secondary importance. Where lands are flooded part of the year cypress and tupelo grow—both valuable trees. The forests of this region have suffered heavily both from lumbering and fire and today in twenty-five per cent of this area, natural regeneration of valuable trees is prevented by frequent forest fires and the

Photographed by E. S. Shipp

A FORESTER'S CABIN

absence of proper forest management. Here the practice of forestry should bring rich rewards, for in no portion of the United States is tree growth so rapid.

Rocky Mountain Forest:

In this forest the most important tree, by far, is western yellow pine. Growing largely in open, scattered stands it extends over almost all this region except the Central Rockies. Mixed in with the pine, and over small areas growing in pure stands are Douglas fir, white fir, lodgepole pine, engelman spruce and western larch. In this region the forests occur very unevenly, largely because of the great difference in land elevations. The forest is not unbroken as in the east, but occurs at the higher elevation like islands of trees surrounded at their base by broad valleys of dry, treeless lowlands and topped above by bare mountain tops too high for tree growth. This region has not suffered greatly from logging, but destructive fires have laid waste large areas. More than half of this forest still bears virgin timber.

Pacific Coast Forest:

The largest timber in all North America and perhaps in the world is found in the forests of the Pacific Coast. This forest is composed principally of softwoods with a few scattered hardwoods of no great importance. In all this region Douglas fir is the most important timber tree and is only surpassed in size by the redwood. Here, too, large quantities of yellow pine exist, together with some western hemlock and several species of fir. Redwood grows there and on the coast of northern California is an exceedingly important timber tree.

Today this region is the outstanding lumber-producing region in the United States. It contains the last great stand of timber yet untouched by the axe. When the forests of this region are exhausted, there will be no other region in the United States to which we may turn for great virgin areas of wood. When that day comes, the only areas of virgin timber toward which we may look, will be Canada, the Tropics and Alaska. But the forests of Canada are slow growing and over wide areas they are of inferior quality and small size. The forests of the Tropics are still an unsolved enigma.

The forests of Alaska contain storehouses of timber some of which are yet unexplored. As a whole, Alaska is not a timber country for the interior is covered with only a sparse stand of stunted inferior species. Along the larger streams, birch and spruce attain fair size, but as we leave the streams we find the trees become both smaller and scarcer. The interior forests are suffering greatly from fire for the coming of the white man has been attended by this enemy of the forest and practically no efforts are being made to provide fire protection.

In the coast forests of Alaska valuable timber grows, chiefly Sitka spruce, western hemlock, red and yellow cedar. Douglas fir, although abundant further south, is absent. The individual trees are smaller than in the Pacific Coast forest, but much larger than the trees of the eastern forest. This narrow coast belt of heavy timber extends for a thousand miles along the Pacific.

At some future time, when the eastern spruce now used for paper has become exhausted, this hemlock and Sitka spruce of Alaska will probably be called on to take its place. And when that time comes, Alaska's forests will assume a new im-

portance, for foresters believe that enough spruce grows there to supply perpetually one-third of the raw material needed for paper making in the United States. Already private interests are buying timber for paper pulp from the two Alaskan National Forests.

So our forest history has been one of lavish use, and rapidly diminishing resources. Beginning with a country plentifully supplied with timber we have destroyed this forest heritage with fire and axe until only about one-fourth remains. Each day this remnant diminishes. To fulfill the needs of a rapidly growing nation we have cut out region after region and now we are beginning on the last region of all—the Pacific Northwest. Worst of all we have treated our forests like a mine that once exhausted has finished forever its service to mankind—a needlessly wasteful thing to do. And we have done this in the face of what the nations of Europe have learned. For with a little care and a little vision, the forests of the United States could be made to produce far more than they produce now—far more, in fact, than they have ever produced. And they can be kept productive forever. That is the heart of America's forest problem. To build up and restore the productive capacity of her forest lands.

CHAPTER 7

WHAT FORESTRY IS

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WHAT FORESTRY IS

Practical forestry means both the use and the preservation of the forest.—GIFFORD PINCHOT.

THAT natural resources are inexhaustible must have been one of the oldest beliefs of man. It is certainly one of the most mistaken. A few—a very few—of life's gifts come to us without labor, and serve us without diminishing, like sunlight and air. Other of life's gifts were for a long time ours for the mere labor of acquiring as the grass that man's early herds consumed and the wood he used for his shelter and fires. So abundant were these natural resources men fixed no value upon them. They were nobody's property and they were everybody's property.

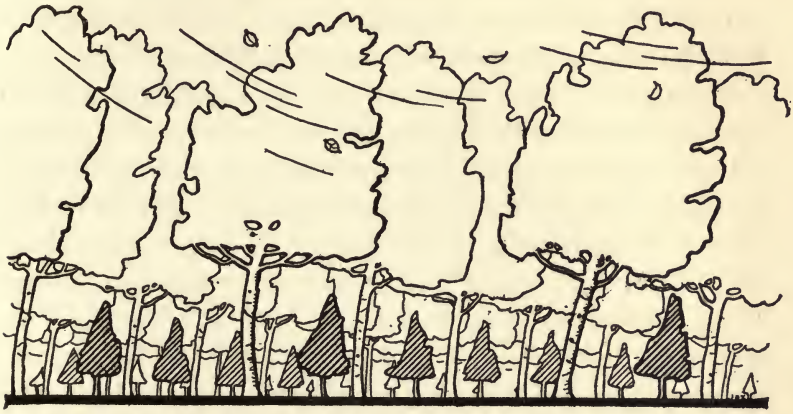
Naturally, so long as trees were plentiful, men gave no thought toward perpetuating them. The earlier peoples had looked on the woods as a free, perpetual gift of nature, like the soil itself. Until very recent times the forests seemed so numerous and covered such wide areas, men thought and spoke of them as inexhaustible. Man used wood lavishly and destroyed great forested areas with axe and fire and no one thought about it. There would always be more. Trees were so numerous—often for the farmer and settler they were too numerous.

But gradually as populations increased, the forests, through cutting and fire were pushed farther back and wood, especially in the centers of civilization, grew scarce. So trees began to take on value and forest ownership came into existence. Nations and states set aside large areas within which timber cutting was unlawful—man was beginning to think of fostering tree growth and protecting trees from destruction. This early effort, really more of a puzzled groping than actual effort, was the world's first foreshadowings of forestry.

Time passed and the more thickly settled nations began to find that protection alone was not enough. It was very necessary to protect, but to insure a future wood supply it was also necessary to learn how to grow trees on lands already cut over. Nature unaided proved an uncertain ally. Men found that sometimes nature herself replaced the forests they had taken away—and sometimes not. They saw, too, that in place of the valuable forests they had cut, nature often brought in trees for which man had little use.

It all seemed a very complex, very perplexing problem, and men became eager to learn how woodlands should be treated that they might produce continuous and still greater quantities of wood. Already necessity existed to improve on nature's husbandry because more timber was becoming needed each year. Yet each year less forest soil remained to produce it since cities and farms now occupied much land that had once been forested. Through this science of the forests—through forestry—men hoped to learn some means of helping nature produce on one acre what formerly she had produced on two or three. He hoped also to replace the less valuable species with woods of greater usefulness.

So, in addition to this fundamental idea of forest protection from fire and waste, there came into being a science of forest culture that has been given the name of forestry. And the purpose of forestry, reduced to its fundamental terms, is to help nature produce perpetually, on a given area, the greatest quantities of the most valuable forest products. It has to do, not so much with the individual tree, as with that complex community of trees we call the forest.



NURSE TREES

Aspen, birch, poplar and other trees with open foliage often protect seedlings of other more valuable species from wind and drought.

Foresters look on a forest as the farmer looks on a field of wheat. Both are crops of the soil and both produce harvests of varying usefulness to man. In deciding between barley, wheat, rye, or any other agricultural crop, the farmer selects what he will grow, both on the basis of what his lands will best produce and what crop will prove most profitable. In the same

way, although within narrower limits, the forester decides what he will grow. It may be best to grow oak for ties, cedar for fence posts, pine for box boards, or hickory and ash for tools and vehicles. Usually he chooses his species from among the trees that naturally grow there. And if he finds it necessary to plant, the forester will usually select a tree that nature has already proved will grow successfully in that region. A forester will not try to grow redwood plantations in New England, or Southern pine in Michigan. Each tree species is best adapted to certain localities and when taken out of their natural habitat often grow very slowly or die before reaching maturity.

The idea of managing a forest as a farmer manages a farm is of relatively modern origin and in a sense forestry is a young science. The care of trees however dates back into history's misty beginnings. China had a Department of Mountain Forests nearly two thousand years ago. The ancient Greeks wrote long treatises on the care of woodlands. Each country had its legends and its more or less rules of thumb regarding forest lore.

Yet all nations approach forestry with reluctance and only when impelled by necessity. They are driven to forestry by different paths. Some countries are forced to forestry by lack of water supply, others to save their hillsides from being gullied and beaten by the rains. Still other countries seek forests to protect them from floods and drought, others to provide their peoples with lumber and fuel.

France took up forestry only when the destruction of most of her forests was followed by heavy floods and the washing away of her hillsides. Need for wood first caused the Germans to think of forestry for there, where winters are long and

Photographed by W. I. Hutchinson

FOREST FIRE LOOKOUT

severe, fuel wood is almost as much a necessity as food itself.

Not so many hundreds of years ago each nation had to depend largely on its own timber to satisfy the ordinary needs of its population. Today, modern transportation permits timber to be marketed at great distances from its source. Wood has developed long legs. China obtains large amounts of timber from North America and South Africa gets much of hers from northern Europe. But in the long run it is the best economy for a nation to grow timber on its own soil and to put to use those rough, less fertile sections where for one reason or another agriculture is either impossible or unprofitable. That in part is what the practice of forestry is doing. It is making these poorer lands profitable by growing trees.

And even aside from man's need for wood and from the part that forestry plays in solving the problem of land use it seems inevitable that all civilized countries must come at last to manage their forest land rationally and systematically. For history has taught, in lessons of varied severity, that few countries can afford to reduce their forests much below one-third their total land area. Nations that have done this usually suffer from extremes of climate, from drought and from alternate periods of abnormally high and low water.

A nation that cuts her forests without a thought to future crops of wood is treating her woodlands as a mine—as a source of wealth capable of supplying only so much material and after that to be abandoned as if it were played out and useless. But it is an economic crime to treat forests so. For if forests are cut properly and protected properly they need never play out. On the contrary they will usually increase both in value and

volume and supply timber, fuel and other products for all time.

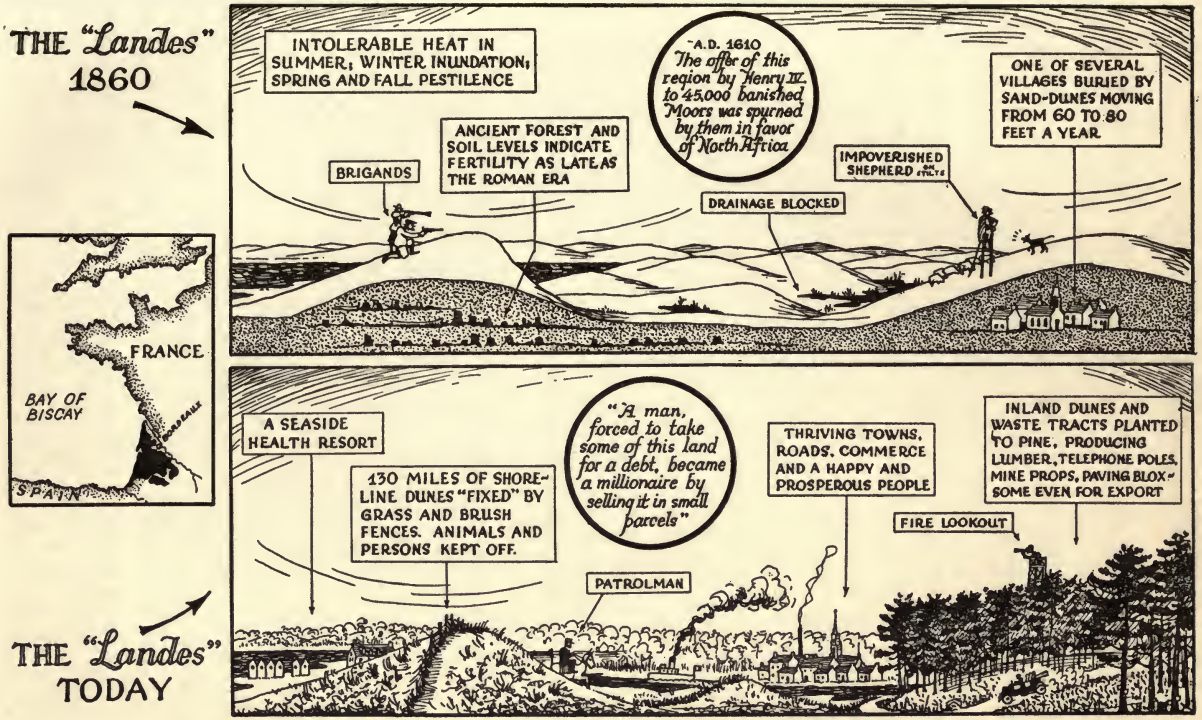
That is the highest ideal of forestry—to make timber lands permanently productive. To bring a forest up to its stage of greatest usefulness to man and always keep it there.

In forestry, perhaps, more than in any other field of human activity it is true that history repeats itself. Almost invariably civilized countries repeat the same steps and make the same blunders in regard to their timber lands. First, a time exists when the forests are everywhere and possess no value. No one owns them. No one cares to own them. Settlers cut and burn to get them out of the way, so that they can plant crops, or produce grass for their herds. It is an era of unrestricted forest devastation. Later, as the forests become scarce and wood is hard to obtain, laws are passed seeking to protect the forest from fire and from unrestricted cutting. Last of all when protection alone is found to be not enough, measures are taken to plant the lands made barren and to cut more carefully the forests that remain.

Not all nations reach these stages at the same time.

In some corner of the world today, each act in this drama of forest exhaustion is being played. In parts of the tropics men are still in the first stage where the forests are almost limitless and without value. France, Sweden and Germany have reached the third stage and are practicing scientific forestry. It is upon this final stage that the United States is slowly entering.

It is natural that governments rather than individuals should have taken the lead in forestry, since timber crops are long-time crops and require years rather than days to mature.



FORESTS AND PROSPERITY

How France created a prosperous thriving region out of a desolate, sand driven waste is one of the best lessons in the value of forests and forestry.

Governments and states possess longer vision than individual and the undertakings they support are not subject to all the hazards that attend private enterprise. So governments can afford to foster projects that will not come to harvest for twenty fifty, or even a hundred years. Almost invariably it has been on Government lands that forestry is first practiced when nations take up this new science. In countries more advanced in forest practice, private citizens following Governmental precedent are protecting their own timber lands, employing foresters and providing for future crops. It is to these private owners of forests that we must look for the practical success of forestry. Governments may point the way, states and municipalities may keep their own lands productive, but for the great wood consuming nations of the world the bulk of forest lands is in private ownership. Until forestry is practiced on them, we can have no real solution to our problem of perpetual wood supply.

There is no lack of instances showing how lands once worthless have been turned into thriving, productive properties. In France, not so long ago stretched a region of over twelve million acres of marsh and shifting sands where only a few useless shrubs were able to make a bare living. It had been completely deforested. It was adding nothing to the wealth of France—it was worth nothing. Finally the Government planted trees throughout the region, put them in care of their foresters, and today, this once worthless, abandoned piece of land, is worth over a hundred million dollars and supports prosperous communities. Each year the products of the forest are cut and sold, enriching both the government and the woods workers. Each year, too, the forests become more useful and

valuable to the community. That is one example of what forestry has done.

Germany, a country that probably leads the world today in the practice of forestry, was once so devastated of trees by wasteful cutting that in certain regions she adopted drastic measures to ward off timber famine. The cutting of May trees was prohibited. The number of wooden houses in a community was limited. Fences were supplanted by hedges and ditches. Extreme measures these, and only justified by absolute forest poverty. Then forestry came into practice and the German forests have been brought to a high state of productivity. But in spite of all she can do Germany is unable to produce enough timber for her people. Each year she is forced to import millions of tons of lumber. It is simply a case of needing more wood than her available forest lands are able to produce.

France for a time destroyed her forests recklessly, especially during the long debauch of wealth and resources that attended the revolution. Soon she began to suffer, both from a scarcity of building timber and from destructive floods. Today she, too, practices forestry and, possessing a more favorable climate than Germany, is able to grow more wood on an acre of forest land than her great rival.

Great Britain, although she has practically no forests in the British Isles, has placed large areas of her colonial forests under scientific management. India has one of the best forestry departments in the world. The bulk of Canada's forests are on lands owned by the Crown and government foresters manage these woodlands on forestry principles.

But forestry is far from being a universal practice throughout the world. Even with increasing demand for lumber and with

the lessons of history behind us, only about ten or fifteen per cent of the world's timber lands is being handled as a renewable crop. The other ninety per cent still receives little or no protection. In many parts of the world economic conditions make it extremely unlikely that forestry will be practiced for years,—economic conditions and man's reluctance to change past habits. Even where there already exists a pressing need for reforestation and forest protection, we are very slow in accepting the inevitable. We put off as long as we can the day when we may no longer receive nature's bounty without helping her replenish the forest wealth of the world.

In the face of our enormous use of wood it will not be so many years before this day arrives. Already we are passing out of the carefree times when apparently limitless resources made it unnecessary to think of economy or replacement. Here in the United States the days of free wood are passing forever behind us. We must provide for future crops, or go without. It is the universal law, true here and throughout the world. It is the great law of *land use* that ultimately for the welfare of the nations, each acre must be made to produce the crop best suited to that acre, whether it be wheat, grass, or wood.

CHAPTER 8

HOW THE FORESTER WORKS

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HOW THE FORESTER WORKS

The underlying idea of forestry is continuity of use.
—Henry Solon Graves.

Everything that is done to increase the growth, value, or productivity of the woods belongs in the realm of forestry. Everything done with a view to securing or improving future forest crops, whether by planting or fire protection or scientific methods of cutting, is all part of the art and science of forestry.

Too many people believe that forestry confines itself to tree planting. But that is only one part of the story. It is an important part, but often no more so than other measures used by foresters to secure reforestation. Forestry is much more complex than tree planting—much more various. Such simple matters as pruning and freeing young trees from overshadowing brush—methods practiced even before the Christian era—belong in the scheme of forestry. Matters so abstruse and relatively recent as calculating the rate of growth for a forest one hundred years hence—that, too, belongs to forestry. And although the word is comparatively new, forestry itself, to some extent, and in one form or another, has long been known. Belonging to the city of Zurich is a forest that has been cut and regenerated under forestry principles for more than six hundred years. Year after year this forest has furnished timber

and occupation to the people for over six centuries, and today it is more productive and more valuable than ever before.

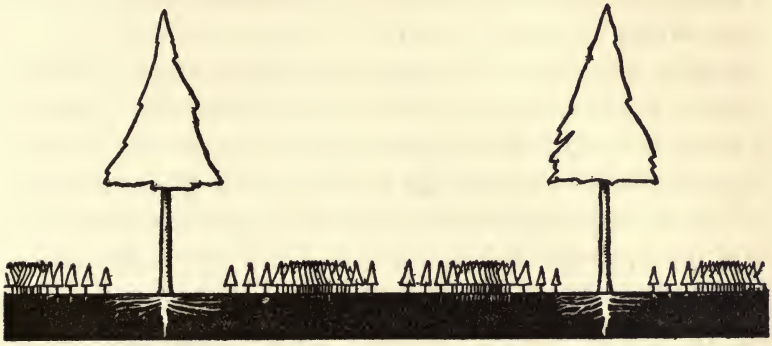
With the passing years man has been constantly discovering new benefits from the forests and new uses for its products. With these new discoveries, and new values forestry itself has broadened until today it is a widely diversified profession. Forestry has had to cover a wide field because it has to do with all gradations of climates and soils, different kinds of forests, different products and methods of utilization, and different economic conditions. With changing industrial and social conditions the problems of the forester have multiplied and their proper solution has taken on greater public importance. One result of this has been that foresters are finding it necessary to divide the field and specialize on certain phases of their ever-widening profession.

Forestry is becoming many sided and the practice of forestry itself, in different regions has become widely diversified in both its methods and in the results it seeks. In the western states protecting forests from fire is the forester's big problem. In New England planting is most important. In parts of Italy the forester is most concerned with bringing back forest growth on steep hillsides. In southern France his chief problem is to establish on the shifting sand dunes, forests whose roots will anchor them in place.

Yet behind all these outward differences, the fundamental purpose of forestry is everywhere the same—to make the forests most useful to mankind. It includes planting trees when planting is needed, helping valuable species in their struggles against underbrush, harvesting the trees that are ripe to cut and establishing cutting methods that will leave cut-over land

in such condition that within as short time as may be they will again produce valuable products.

One of the problems that a forester commonly meets in taking charge of a property is the building up of a forest that has been cut over and exploited of its best timber. In such forests practically everything of value has been cut or burned. Here it will often be necessary to plant young trees, otherwise many



SEED TREES

To secure a new forest after cutting the old, foresters commonly leave two or three mature trees on each acre to cast seed. Some seeds are scattered great distances, others only a few yards. Usually the seedlings cluster most thickly just beyond the crowns of the mother trees where they receive full sunlight and are not deprived of soil moisture by the seed trees' roots.

years might pass before nature could again cover these empty spaces with valuable forest growth. First, the forester will probably establish a nursery and raise from seed the kinds of trees best suited to form the new forest. Attempts have been made to sow seed direct in the forest, but this method although cheaper than planting young trees gives very uncertain results. Unless both soil and weather conditions are favorable, direct seeding fails to produce a satisfactory crop of trees. It is much

safer to start the trees in nurseries. When these have grown large enough in the nursery and are able to withstand the less favorable conditions that will surround them out in the forest, they are dug up, carefully packed, taken out and planted about twelve hundred to the acre. But planting is a difficult and costly operation and fortunately foresters are not forced to rely on this method except when lands have been cut so bare or burned so fiercely that nature herself is powerless to reforest them within a reasonable time.

A forest that has not yet been cut presents a quite different problem to the forester. Usually trees of all sizes and ages are growing there and the forester's task is to take out all trees large enough for cutting, that can be spared. Here and there he may leave a thrifty tree to cast seed and fill up with seedlings the bare spots left by the removal of their companions. Even though, already, there are many small seedlings springing up, some seed trees are usually left. For seedlings are so easily injured that drought or even the lightest type of forest fire destroys them. In a sense these seed trees serve as fire insurance and should flames kill the young growth about them, they will provide seeds for still another crop and so eliminate the costly necessity of planting.

Some trees in this forest, usually the older ones, may be diseased or attacked by beetles or mistletoe. These, whenever possible, the forester cuts so that the healthy trees about them will not be infected.

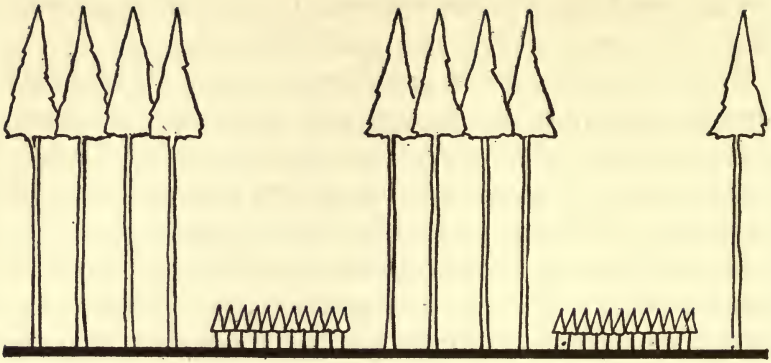
To reduce the danger of fire, the dry, tinder-like tops and branches left after logging are usually piled and later when snow or rain comes, the forester causes these piles to be burned. In other places where fire danger is not so great this brush is

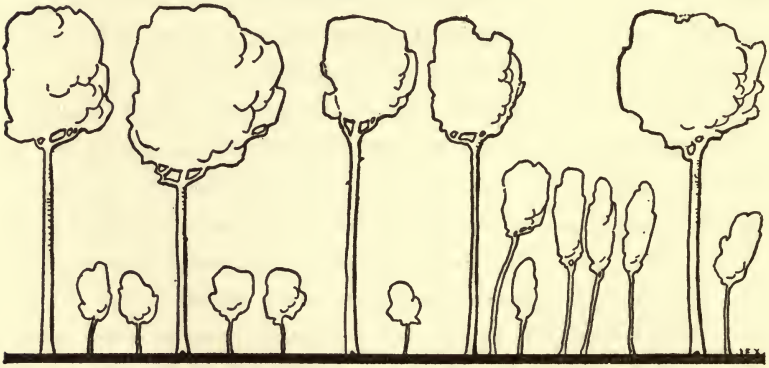
cut into small pieces so that they will lie close to the ground, where they may rot and become part of the soil again.

Different species and different climates require different forestry methods. In certain regions, as in the Douglas fir forests of the Northwest, where almost every tree is cut during lumbering, the area is set on fire and burned over as soon as the logs are removed. This fire destroys the heavy underbrush and allows sunlight to fall on the millions of fir seeds that have been accumulating for years in the top soil. Under the direct sunlight they spring up and fill the area with a new thick Douglas fir forest. Without this fire the seeds might never have sprouted, or at best the seedlings would face a long and perhaps losing struggle with the underbrush. But from now on it is vitally important to protect this area from fire, for should flames again sweep through and destroy the young trees there would be no more living seeds stored in the soil, and planting would be the only means of securing future trees.

In forests that have been cut over without proper disposal of the limbs and tops, the foresters' problems are many. Such places are usually firetraps of the most imflammable materials since pine needles, leaves and branches have been dried out by wind and sun until they are like tinder. Here and there young trees are already springing up, but some of them are being choked back by underbrush and by weed trees. In such cases whenever it is economically justifiable the forester cuts away these competing inferior species to release the more valuable ones to the sunlight.

On the steeper hillsides the forester often will not allow trees to be cut at all, since the removal of even a few may so loosen the forest soil that heavy rains will begin washing the earth





Forestry Cutting Methods

The pine forest above has been cut in strips and seeds from the old timber are reforesting the cut portions.

Below is a hardwood forest after cutting on a "shelterwood" system. Enough trees are left to form a shelter of leaves for young trees. When these young trees are old enough the overstory will be cut.

way. Once started this washing action is a difficult and costly process to stop. If lumbering has already stripped these steep hillsides before they were put under the forester's care, his first step will probably be to plant trees there to form a protection forest. In Europe are many such protection forests. Their purpose is not to supply logs but to protect the soil against beating rains.

Scattered throughout forested areas the forester often finds pure stands of pine of the same age. This type of forest often springs up when fires destroy the original climax types. In these even aged forests, instead of cutting trees here and there the forester may cut narrow bands through the forest leaving alternate bands of untouched timber. This method is known as clear cutting by the strip method. In later years seed from the pine on the uncut strips will reforest the clear cut portions.

But there are many cutting methods and combinations of methods—modifications to suit varying conditions. Beneath them all—the same purpose exists—to bring back as quickly as may be a forest capable of producing valuable products *at the least cost.*

For forestry, although not wholly a matter of dollars and cents, is an economic undertaking and for the most part foresters are only justified in making expenditures that they believe will be rewarded by later financial returns. Naturally more costly methods can be used in forests that have products of high value and in forests close to markets than in those not so well situated. It might, for example, be perfectly good economics to spend large sums for planting in certain cases where quick growth and great demand for forest products give reasonable certainty of ample financial rewards. In other forests,

as in parts of the northern Rockies, where growth is slow and markets far distant, it is not economically possible to practice even the most elementary forestry except fire protection.

In some localities and with certain species the forester can begin cutting when the forest is quite young and thin out trees that are growing too close together. These thinnings are helpful to the trees that remain since they can now obtain more light and soil space. But thinning can only be made profitable where there is a market for small material, such as fence posts, or fuel wood. It is by these intensive methods, whenever they are possible, that the forester attains his goal of improving on nature herself.

For, after all, nature is far from being a perfect forester. Her methods are too leisurely for a busy world and too wasteful for a wood-hungry generation. A wild forest contains many open, unused places that good management demands should be filled with trees. In some parts of a forest individual trees are so crowded together they can scarcely grow. In other parts they are so widely separated they will produce low grade, knotty lumber. Valuable species are often overtopped and killed by valueless neighbors. Large areas are often encumbered by trees of little or no use. All these conditions exist in the wild forests of nature.

In improving on nature's work the real art of the forester comes into play. By judicial cutting, by a little planting, by thinning out certain species early and allowing others to go to seed, the forester makes an acre of land produce much more than it would under nature's unaided guidance. Just as a sculptor creates beauty and values by the wisdom and skill he employs in what he takes away, so the forester by removing a

A FOREST RANGER

tree here and a clump there brings the forest to its highest usefulness and value. But he must know what to do and how to do it. For some species respond to one form of treatment and others to something quite different. Trees are as varied in their response to changing conditions as are people. By knowing these characteristics a forester is able to mould his forest and increase its usefulness. He can favor one species at the expense of another. If in a forest of mixed pine and hemlock, for example, the forester should want hemlock to predominate after lumbering, he would cut very sparingly and be careful that not enough light should reach the forest floor to stimulate the growth of pine. For hemlock is able to get along with less light and reproduces thickly under those conditions. But if he should want to choke out the hemlock and favor the more valuable pine, he would cut more heavily and allow enough light in for pine to spring up and overshadow the slower growing hemlock. Yet here too he must show nice judgment, for should too much light be let in a wild growth of grass and weeds may seize the soil and allow no trees to reproduce at all. If, on the other hand, there is not enough light, neither pine nor hemlock will come up.

And the forester must be guided by nature ever when he is modifying and improving the work of nature. He must know what treatment different species need for their best development, and what products they will be most valuable for. He must decide at the very beginning, whether to grow lumber, pulp for paper, railroad ties, or something else. The by-products of the forest become more numerous each day and it is an important part of the forester's profession to know how to increase the value of his woodlands by taking advantage of

them. Thus the material he removes in releasing closely competing trees—the thinnings—may be used for charcoal, for fuel wood, or if they are large enough, for poles and fence posts. A competent forester will study, not only his forests, but the changing markets for his products, thus turning the lands in his care to their highest value.

But not all of a forest's value lies in the timber or by-products it produces. Along the steep banks of streams it is often important that lands should remain in their original condition, for there, trees help hold the banks from slipping and washing away, and so here, too, the forester will withhold his axe. Along roads or lakes or bordering picturesque pathways foresters may decide not to cut a single tree. There they will leave the forests as nature has created them, so that people may enjoy their shade and beauty and protection.

So it is that in this varied and many-sided science of forestry one value must be weighed against another and a decision made in favor of the greater. The forester guided by knowledge, study and experience must steer his ship between two extremes, both of which mean waste. On one side, he must not cut too heavily for this impoverishes his forest and may impair its productivity in future years. Neither must he withhold the axe when trees are ripe and ready for harvest. This, too, is waste, since ultimately the tree dies and decays, and unused wood serves no useful end.

Between these two extremes forestry with all the art and science it possesses, strives to make the woodlands perpetually productive of their greatest values to man.

CHAPTER 9

FORESTRY IN THE UNITED STATES

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FORESTRY IN THE UNITED STATES

Not to use less—but to waste less. Not restriction, but replacement. These should be our goal in forestry.—CHARLES LATHROP PACK.

To the first settler who reached these shores the forests from which he hewed his cabin logs must have seemed without end. Hardwoods and softwoods stretched endlessly back from the Atlantic coast north into Canada and south to the little known Gulf country. The eastern mountains were forest covered. Trees grew down to the very river banks. Trees covered the fertile valleys. They had heard, these early settlers, that on the Pacific coast were tall forests, just as inexhaustible and even more majestic. There was no reason then to suspect that the entire country was not forest-covered from coast to coast and from the Arctic Circle to the Gulf.

So the first problem of our early pioneers was not to preserve the forests, but to get rid of them in the swiftest way possible. To make room for villages, to let in sunlight for farm crops and to provide pasture lands for horses and cattle. Trees were an obstacle and a menace. Those dark silent forests gave shelter to hostile Indians and to beasts that preyed on the settlers' stock. So, with fire and axe Pilgrims and Puritan Fathers alike forced back the boundary of the forests as rapidly and as far as they were able.

Yet even in those early days it was not long before timber shortage became a troublesome problem. It was not a general shortage, affecting entire regions, but local scarcity, centering about the thickly populated districts. In those days when all wood for fences, timber or fuel had to be slowly hauled by oxen over almost impassable roads, it was necessary that sources of wood supply should be near at hand. Transportation of wood over long distances was then undreamed of.

So far as the early settlers in Connecticut or Massachusetts were concerned, the great pine forests of the south, or the untouched white pine in the Lake States might just as well not exist. They were as remote from their economic scheme as the forests of the Amazon Valley.

Even in those youthful days of our nation's life, forestry laws were passed in one colony after another, providing for the perpetuation of the forests. William Penn imposed simple forestry laws on his colony and New England's early statute books contain a number of forest conservation regulations. Supplies for naval construction had already become a concern of the mother country and later of the new Confederation of States. Unsuccessful and half-hearted attempts were made to protect by law the live oak from which the best of these naval supplies came and as early as 1828 the Federal Government set aside a reservation of live oak and made a feeble effort at planting and caring for trees of this species.

But in spite of these sporadic and largely ineffectual attempts at forest protection, we had not yet conceived any idea of a nation-wide policy of forestry. We had not yet awakened to any real need for giving thought to the perpetuation of this vital heritage on anything approaching a national scale. As with

other nations, it was going to be necessary for us to first feel the pinch of timber shortage before we should interest ourselves in so academic a subject as forestry.

As a matter of fact, the immediate need of our new nation, at that time, was to develop its resources, not conserve them. In the early days of the past century our government found itself with enormous tracts of undeveloped lands on its hands. This great area known as the public domain included practically all land not in private ownership. The immediate problem was to encourage settlement on this land, to bring in industries, railroads, sawmills and ranches. In furthering this policy the government displayed a degree of generosity in giving away land to railroads, industries and settlers that from today's viewpoint amounted to profligacy. Little thought was given to the wastage that might attend so liberal a policy, or what effect it might have on coming generations. The federal government, the owner and custodian of these thousands of square miles of public domain, was unable to protect them against theft, and billions of feet of timber in the Lake States and in the West were stolen from these public lands under pretense and fraud.

Meanwhile a few men, foreseeing the time when we should need all this timber, raised their voices against these wholesale thefts and wasteful methods, but they were unheeded voices calling in the wilderness. It was urged more than once that the federal timber lands should be given to the States for protection and management. There existed more than one valid reason for this change, since the States at least were in a position to protect and administer the timber within their own boundaries, while the far-off government in Washington

seemed unable in any way to redeem its responsibilities of ownership.

Other factors were beginning to set the stage for a more or less reluctant acceptance of the principles of conservation. Immigrants pouring into this country brought with them a knowledge of how necessary forestry is to a nation. Many of them had experienced the privations and evil that followed forest destruction in the lands of their birth. Meanwhile railroads were stretching back into the central portions of the land and settlers moving into the treeless regions lamented the absence of trees about their new homes. Following the Civil War settlements sprang up throughout the West like mushrooms. Wood in greater and greater quantities was needed and now louder than before the note of alarm again was sounded. We were using up and burning up our timber with frightful rapidity.

From Europe scholars were returning who had seen what the older nations were able to make of their forest lands. They told how France, Germany, and other countries were able to have the penny and the cake both: how they were able to cut timber from their forests year after year and still have increasing quantities. All these things were gradually developing an appreciation of our forest heritage and a stronger undercurrent of desire to preserve them.

In 1873 a Committee on Forestry of the American Association for the Advancement of Science presented a report to Congress stressing the importance of preserving our forests and in answer to this the first significant step forward was made by the Federal Government. It appointed a forest agent to investi-

Photographed by W. I. Hutchinson

A MODERN SAWMILL

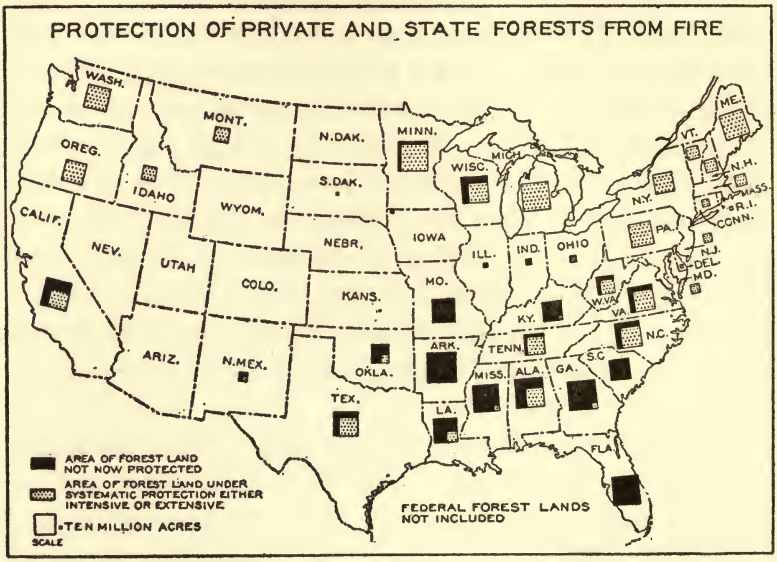
gate conditions. Later this position expanded and grew into the Division of Forestry.

Each year the increase of idle, cut-over land in the wake of the lumber industry was becoming more menacing. Until the last quarter of the past century, lands cut-over for their timber had been put to work growing farm crops and no economic loss followed so long as there was greater need for farm lands than for forest land. But soon the lumberman began cutting in regions where farms were not profitable—where soil and altitude and climate all conspired to make for low farm values. It was on these lands that forestry had to be practiced if they were to be good for anything. If they could be lumbered less destructively and protected from fire, nature would help restore them to forest. But year after year this No Man's Land increased by millions of acres. It constituted a menace to our very prosperity. We could not grow farms on it and we would not grow trees.

Meanwhile fire after fire swept over these treeless wastes and rain washed their fertility away. They were fast becoming good for nothing. During this time several States had already awakened to the need of Forestry. New York, Wisconsin and other States passed acts for the encouragement of timber growth. Arbor Day first celebrated in 1872 in Nebraska helped direct attention to tree planting. A few years later California established a Board of Forestry. By this time, although the Federal Government was relatively inactive, the States were making a beginning in the new art of forestry.

In 1891, a step forward was taken leading to the greatest single contribution our government had yet made to the cause

of forestry—the establishment of the National Forests. This definitely placed the Government in advance of the States as an agent of forest protection. Until this time the President had been without authority to set aside land for timber growing. The new law now gave him the power to create forest



FIRE PROTECTION—STATE AND PRIVATE

In addition to the National Forests, all of which are given fire protection, private and state forests are being protected in varying degrees.

In the northwest and northeast some degree of fire protection is almost universal. In the south very little is being done to protect their valuable forests.

reserves—later to be known as National Forests—from public lands wholly or partially covered with forests. It was under this authority that more than one hundred and ninety-one million acres of land have at one time or another been set aside for timber protection, and the whole system of the Forest

Service begun. The detailed working out of this system is the subject of a later chapter.

With this Federal Forest Service as a precedent the States themselves began setting aside portions of their own wooded areas and today over eight-and-a-half million acres of forest land have been placed in State forests. The States, too, have come to see their own need for forest departments and thirty-three of the thirty-nine forested States have organized forestry divisions. The states vary widely in their acceptance of forestry. In some, forestry is still the football of predatory politics. Others have adopted more advanced methods than the federal government itself. More important still, they are finding that money spent for forest lands and for reforestation is a good investment. Pennsylvania, for example, one of the pioneer forestry States, owns more than a million acres of forest land, bought from private owners with State funds. Today these lands are worth five times the amount they cost.

During recent years tree planting has received great stimulus in the States largely because of the help that the Federal Government has been able to give. In 1925 only thirteen States were distributing planting stock to its citizens. Thirty-two States are now engaged in this activity. Nevertheless it is going to be necessary to speed up America's planting program at least ten times in order to reforest our denuded lands with reasonable promptness.

The fire problem, the greatest single obstacle to forestry, is being attacked by States and Federal governments and private timber owners. Under recent legislation the Federal Government and thirty-three State governments are presenting a united front in this long and bitter battle against forest fires.

It is a battle that is far from won and never can be won until foresters, state, federal and private, are so equipped and so organized that they can cope on more even terms with years of high fire danger. It calls for money, for planning and for everlasting coöperation. Today coöperation is the key-note of forestry in America. Forestry is becoming recognized as a joint responsibility. The private owners will not by themselves, bring about fire protection, or forest practice on a nation-wide scale. Neither will the States, or even the Federal Government. All must join hands and it is on this basis of mutual help and concerted effort that forestry gives greatest promise of going forward. The individual private timber owner plays a tremendously important role in the forest drama and without his help progress will be slow and insecure for he is the owner of two thirds of our forest land. How best to secure the practice of forestry on those lands of his is the big unsolved problem of forestry today.

Legally, of course, a timber owner can do with his property much as he pleases. He can hack and destroy the forest and leave it a shambles incapable of further usefulness. Some lumbermen are doing this. Their only desire is to cut the timber as quickly and cheaply as possible and abandon the land once the logs are removed. Others are seriously and earnestly trying even in the face of economic obstacles to keep their land productive. The question has been raised as to whether any individual has the right to treat even his own property in such a way that it becomes a public liability. One group of foresters believe that the Federal Government should exercise its police powers to the end that destructive methods of lumbering be modified and that fire protection and some form of forestry

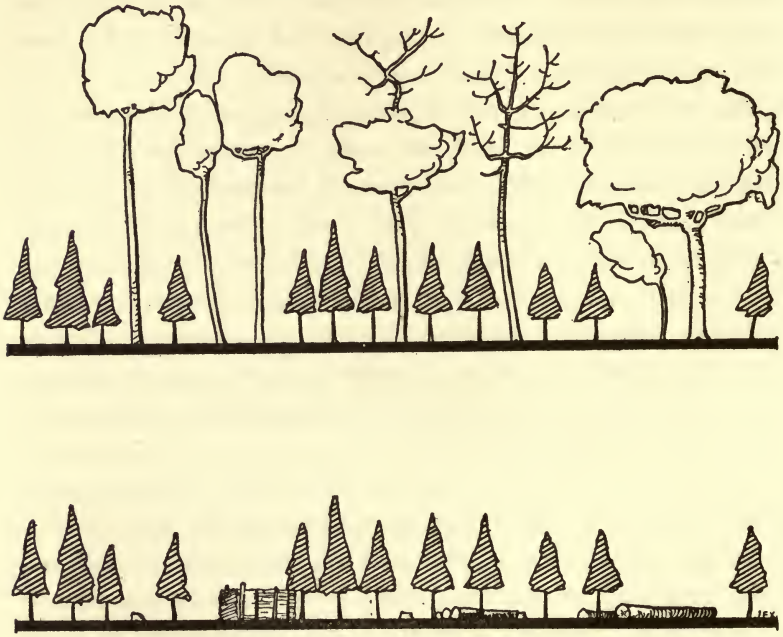
be undertaken on these lands if need be by compulsion. Another group believes that by encouragement and coöperation and good precedent the Federal Government can make greater progress than by shaking the Big Stick. The question is still unanswered but meanwhile the forests shrink before fire and axe and replacement goes at a snail's pace.

All great movements must await their time to be born. No nation in the world has been ready to accept forestry until grim necessity brought a realization of the need, through wood scarcity and high priced timber. Early attempts at forestry in the United States had been made and died without bearing fruit largely because the need for forestry had not been established in public consciousness. No one man, or group of men, can successfully launch and carry through a great national movement without the support of an awakened and enthusiastic public behind it.

Fortunately, two great leaders in this country began preaching forestry at a time when the nation was receptive to this doctrine—Theodore Roosevelt and Gifford Pinchot. Both active, magnetic personalities; both whole-hearted believers in conservation, these two served the cause of forestry long and well. Without Pinchot's genius of organization and his gift of leadership, the Federal Forest Service would never have become the great force for forestry that today it is. Without Roosevelt's enthusiastic backing as President, the Government could not have made its immense strides forward between 1900 and 1910.

Helping them in their crusade was the popular interest that the forestry associations had been able to arouse. Oldest of these is the American Forestry Association which still exists

and is today still active and militant in defense of our forests and in helping formulate wise Federal and State legislation. A more recent organization is the American Tree Association,



A Liberation Cutting

Before and after cutting a forest of young valuable pine with an overstory of older hardwoods having little value.

Above the hardwoods are cutting off the light from the pine and stunting their growth.

Below the hardwoods have been felled and cut up for cordwood, posts and poles. The young pines now liberated will put on added growth.

dedicated to the perpetual productivity of our forests and especially active in the preparation and distribution of educational material on forestry.

Besides these educational organizations is the Society of

American Foresters, an organization composed of professional foresters. Sections now exist all over the United States.

With the beginning of forestry as a recognized profession in America came a sudden need for foresters. Almost overnight the President had created millions of acres of National Forests and Congress had appropriated money to administer them. The nation needed men technically trained in the science of managing woodlands to take care of these Federal forests. There were very few such men in America. Worse still, there were no schools in which to train them. In France, and Germany schools existed where forestry was taught just as other professions, but not until 1898 was this important step in forest education taken in North America and in that year Cornell established the first American forest school. Yale and Michigan followed close after, and today, there are over twenty schools of forestry in the United States to train professional foresters.

It is becoming increasingly important that the best technical instruction be available, for after all, managing forests that they may be kept at a high point of productivity is a difficult art. Even today with thirty years of forest education and research behind us, all too little is known about the ways of trees and tree families. Here in America we are still in the pioneer stages of scientific forestry. More or less adequate fire protection and conservative cutting represents the extent of federal and state forest practice. As a result even our National Forests are producing only a fraction of what they could produce with the application of intensive forestry methods.

The last five years have seen important changes in the forestry situation in America.

State forestry has gone forward until today all but a few of our forested states have provided for forestry departments. Federal forestry has been stimulated by the passage of laws providing for the purchase of deforested lands, for fire protection and for scientific study of our timber species. Private owners of timberland, here and there, are testing out the possibilities of applying forest management to their own lands. Education and demonstration forests are bringing home to the people what forestry is and what it can do.

All that means progress. But, on the other side of the ledger, remains the distressing fact that we are still falling behind. Federal forestry is still handicapped by spasmodic fits of false economy that sometimes force the abandonment of important research projects and prevent the conquest of forest fires. Tree planting is scarcely more than a gesture. Yearly our forests are decreasing in extent and productivity. Lumber prices are mounting and the areas of devastation grow more vast. America has not yet found the way out. As a nation we have not yet moved wholeheartedly and in concert to solve the problem of our vanishing forests.

CHAPTER 10

OUR NATIONAL FORESTS

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OUR NATIONAL FORESTS

When you help to preserve our forests or to plant new ones you are acting the part of good citizens—THEODORE ROOSEVELT.

THE National Forests, owned and operated by the Federal Government, present the greatest single demonstration we have today of what the practice of forestry can accomplish when applied over large areas. Small areas of forest exist, particularly in the east, where more intensive examples of forestry may be found than on the National Forests. The Harvard Forest in Massachusetts, the Yale Forest in New Hampshire, the Charles Lathrop Pack Demonstration Forests—all these are profoundly instructive examples of what forestry can do, to make profitable and productive small tracts of woodland. But, in the creation and successful administration of those one hundred and sixty million acres of public timber land by the Forest Service of the Federal Government, we have the greatest single step forward that has been made in the history of American forestry.

The withdrawal of these forests for public use not only saved the timber within their boundaries from private exploitation, but provided a practical demonstration of the practice of forestry and the results of forestry in every important timber region in the United States. Not without a struggle were these

forests taken from the bargain counter of private exploitation and set aside for public use. For many years there was very definite opposition to this administration of timber land by the Government. Their purposes were deliberately distorted and misunderstood. Their dual purpose was to supply timber in perpetuity and to protect the purity of streams—terms that must have sounded rather visionary and impractical to our busy, rapidly-expanding nation back in the late eighteen hundreds.

In the early days of western settlement the Government's policy in regard to its public lands had been a policy of gift and sale—get them into private ownership as quickly as possible. This, of course, was a logical, an inevitable policy for a nation with many square miles of undeveloped land and billions of dollars worth of natural resources still untouched.

To become powerful and prosperous we needed to encourage the building of railroads and the extension of industries and settlement into the waste places of the west. To obtain these things we had to offer special inducements to private enterprise and the one inducement that the Government could hold out was the gift of land. So, to the railroads it offered and gave millions of acres in return for their pioneering in building transcontinental lines. To the western settler it gave large areas in exchange for cultivating the soil and for building homes.

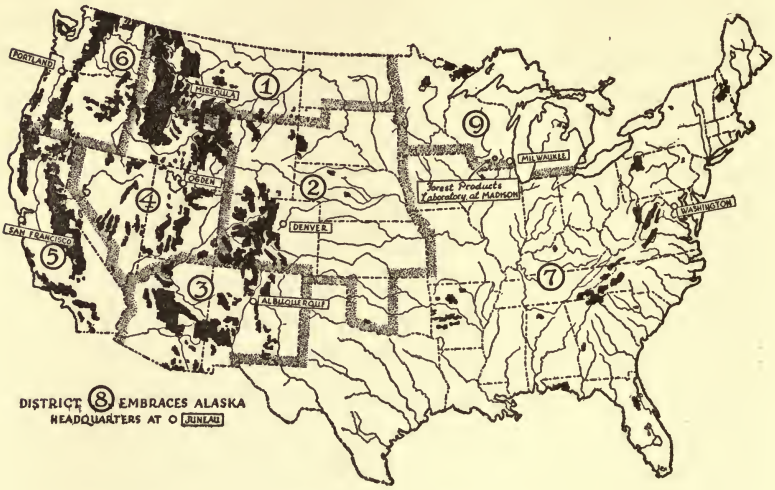
Gradually, as the years passed, a mass of makeshift laws came into existence having to do with methods of acquiring and exchanging Government land by individuals and companies until a crazy-quilt patchwork of uncoördinated and often conflicting legislation had been spread over our entire public domain. So far as the public timberlands were concerned

these laws hampered rather than advanced development and actually resulted in making timber theft the most practical way of utilizing the western timber lands.

So it came about in 1895 the National Academy of Science, which at that time held the place of scientific advisor to the Government, investigated the forest situation and suggested a more rational policy for the forested public lands of the United States. Already the nation possessed about twenty million acres of forest reserves that had been set aside from time to time, but there existed neither funds nor machinery to protect them from fire and hardly any police powers were exercised to protect them from theft. The public was being plundered yearly by both fire and trespass. After an investigation the committee recommended to Congress the creation of a Forestry Bureau, an agency to take adequate care of the public reserves. It also suggested the immediate addition of twenty million acres more of Federal forests and a further examination of our public lands with a view to deciding what land should be placed in future reserves. Ultimately after long delay and many a bitter fight all of these provisions were carried out and today we have not only a system of National Forests that dot the country from Maine to Florida and from the State of Washington to the Mexican line, but we have also a Federal Forest Service in control of them—a body of trained foresters that includes many of the leaders in the profession of forestry. First known as Forest Reserves, the name was changed in 1900 to National Forests to better emphasize the fact that the resources within their boundaries are not reserved, but are being put to use.

The struggle to get and to hold these timber lands against predatory interests that regard public resources as fair loot

had been a long, hard fight and may not yet be over. But, today these National Forests stand more secure than ever as an outward token of the great principle of public service and wise use of an absolutely vital resource.



OUR NATIONAL FORESTS

Scattered throughout the United States and Alaska are more than one hundred and fifty federal forests. Their area covers about one hundred and fifty million acres. For administration nine National Forest Districts have been established each in charge of a District Forester with headquarters in some important city.

Usually these National Forests are pictured as unbroken tracts of timber-covered wilderness and although they do include many tracts of heavy uncut timber, the National Forests, themselves, represent much more than tree-covered areas. They are being developed as going, progressive concerns. The practice of forestry requires roads, camps, telephones, and trails and it has been part of the policy of the Forest Service to sup-

ply these in order that forestry and particularly fire control can be made possible.

All this has required an organization and in the practical working out of the system of National Forests, the country has been divided into nine districts, eight in the United States, and one in Alaska. In charge of all the National Forests in each district is a District Forester, with headquarters usually in the most important city in his territory. Aiding him are experts in charge of lumbering, grazing, fire protection, and other activities. Directly responsible for the administration of each forest and living either within it, or close to it, is the Supervisor. He is the official in immediate charge of his particular forest and beneath him is a corps of rangers, an office force, and sometimes a number of timber sale experts. The forest itself is divided into ranger districts, each administered by a District Ranger.

So the whole Forest Service fabric is based on a system of direct responsibility to superior officers all the way up the line. The District Ranger is responsible to the Forest Supervisor for his Ranger District. The Supervisor is responsible to the District Forester for his Forest, and the District Forester reports directly to the Chief Forester in Washington concerning the activities within his particular district.

Here in America, and especially in so far as our National Forests are concerned we are still in the pioneer stage of developing transportation and fire protection on these forests. Federal foresters have not yet reached the point where they can put as much attention as they should like to their main job of growing timber. There is as yet hardly a beginning of forest culture on the National Forests. There is scarcely any planting.

Scientific forestry as the term is understood in Europe has received scant attention on the federal forest lands. The Supervisor in charge of a National Forest has many immediate problems that give him little opportunity to solve the many and difficult problems of tree growth.

In the first place he has been given responsibility for protecting his timber from fire. That is his one great task and often it is the most difficult task of all. On many of the high points in his forest lookout men must be stationed in towers throughout the fire season to report signs of smoke. Tools with which to fight fires must be placed at strategic points in the forests and kept ever ready. Trails and roads must be built, telephone lines stretched and maintained and buildings kept in order. Maps must be made, bridges built, game laws enforced. All these things are very necessary and must be done before our forest can be placed in a condition where the greater part of a forester's time can be devoted to their main purpose—providing a perpetual supply of timber. The Supervisor has still other responsibilities not directly connected with tree growing. In the open, grassy portions of the forest, cattle and sheep graze under Forest Service permit and it is part of his job to see that only the permitted number are allowed within the forest and that all stock is grazing on the portions allotted them.

Settlers in and about the forest need fuel wood and logs for domestic use and these they can obtain free, or at small cost, from the Forest Service. The actual working out of these various special uses lies with the Supervisor. But the day is not far distant when in place of crude "protection-forestry" the

Photographed by A. G. Varela

THE FALLEN MONARCH

most intensive scientific methods will be necessary on the National Forests, both to demonstrate by example the practicability of forestry and to furnish their share of wood to the nation.

In addition to providing timber perpetually for the nation, another important object of the National Forests is to aid the localities about them in prosperity and in permanence. This purpose is being accomplished. Instead of temporary towns constructed about a big mill that will in a few years cut out the timber and be gone, towns supported by the woods industry of the National Forests are on a permanent basis. These towns have assurance that provisions are being made for future crops of timber and that they can reasonably count on continuous activity. They know that timber will be always available. They know that in grazing their herds, it is not permitted to overstock the range and destroy the value of these Government grasslands. All these things are being carried out with an eye to the sound rational development of every resource within the forest and to its future permanency. With this feeling of permanence come municipal pride, better schools, thrift and unmistakably higher standards of living.

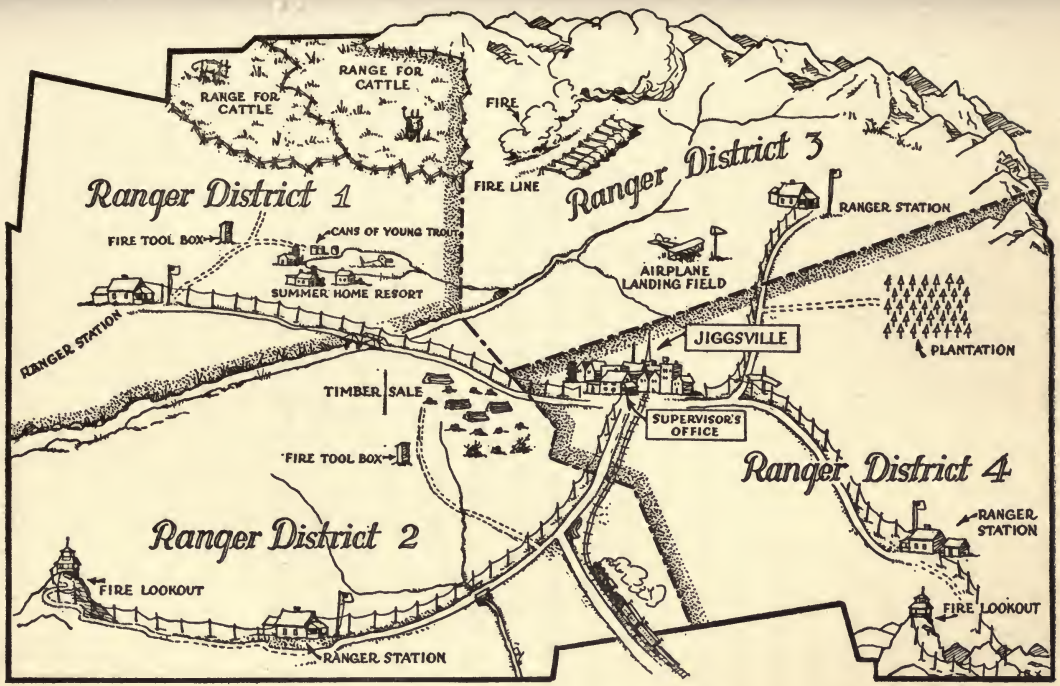
Timber, of course, is the main resource of the forests. This timber, when ripe, is for sale to the highest bidder and when sold is cut and removed in such a way that the woodlands are left as safe as possible from fire and in a condition favorable for the natural reproduction of new crops. Usually every tree that may be cut down is blazed by foresters with long experience in that particular type of timber. The logs are later measured by forest officers as a basis for payment and sold at so

much the board foot, if the product is timber, or so much a cord if pulp wood or fuel. Ties and posts are valued at so much per piece, or per linear foot.

So the National Forests are just as much a going business as a manufacturing plant for automobiles or radio sets. They are manufacturing plants whose product is wood and this wood, as soon as it is ready, is put on the market. Nothing is held back except what is necessary to insure future growth, or to protect the land.

Not all the forest may be cut over. Spots of beauty about lake shores, or areas where for one reason or another people love to come for recreation—such places are kept as natural playgrounds and no lumbering may be carried on there. For recreation is still another gift of the forest—a very important one and the Forest Service is working out a system of playgrounds throughout the nation where people may come and for a time breathe the peace of the woodland.

The National Forests, then are lands owned and operated by the federal government where timber is growing for the benefit of all the people, and where forestry is to be practiced as an example of what scientific methods can do toward raising continuous crops of timber. It is a very concrete and forceful way of taking the leadership in establishing the practicability of forestry as a business undertaking. It is showing what forestry applied over large areas can accomplish. But the National Forests cannot produce all the timber we are going to need. They are not large enough and never will be. In the long run one of their most valuable functions will probably be to serve as great demonstration areas and by the force of example persuade states and private owners to place their own timber



EAGLE'S EYE VIEW OF A NATIONAL FOREST

The forest is divided into ranger districts each in charge of a ranger. The ranger stations are in direct communication with the supervisor who has charge of the entire forest. Some of the rangers have fire lookouts perched on high peaks in their districts to report forest fires. The ranger in District 3 has just cut a fire line in front of a forest fire. Ranger 2 is selling some of Uncle Sam's ripe timber, and ranger 1 is stocking a lake with trout.

lands on a basis of perpetual productivity. Thus the lands that the Forest Service is buying in the east and in the Lake States can never add an important amount of timber to the nation's wealth but it is serving as an incentive and as an example to private timber owners. Only the wide-spread practice of forestry on private land can reach the ultimate solution of our timber supply.

The National Forest movement is giving reality to forestry. That is its great contribution. Twenty years ago forestry in the United States was an experiment. Today it is an established and successful fact. Already one can point to tracts that have been cut over, under Government supervision and are now ready for another cutting. Already one can find where careful lumbering and fire protection is resulting in thrifty acres of healthy young trees. It is a practical and emphatic answer to the question so often asked, "Will forestry work?"

Even with insufficient funds and scant scientific background it *is* working on the one hundred and fifty National Forests. It is working in regions as dissimilar as Maine, California, Florida and Alaska. In fact, so far as our future forests are concerned, forestry is the only thing that will work in the long run.

CHAPTER 11

HOW THE FORESTS HELP MANKIND

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Next to the earth itself the forest is the most useful servant of man.
—GIFFORD PINCHOT.

THE early races of men were probably not forest dwellers —at least very few remains of our prehistoric ancestors have been found in densely forested regions. But, although the forest is not the cradle of mankind, humanity has always been dependent upon its varied gifts for, next to food, wood is man's greatest necessity. And, although in his wanderings over the face of the earth, man has often strayed far from the forest, yet he must ever return to it and replenish his supply of those very needful things that only the forests can give. The Eskimo himself, living far from forests in the frozen Arctic is not independent of the forest's gifts, for his igloos extend no further north than where the shifting tides bring driftwood. Beyond that point he dare not go.

As a matter of fact the forests bring many benefits to mankind in addition to wood, nuts, turpentine and other material products. It is with some of those less material, but no less real benefits of the forest we deal here.

For the weaker peoples, for the driven and the oppressed, the forest has always been a place of refuge. Even today in Africa and in South America we find in the dense forest jungles races that once lived out in the open country near the coasts,

but have been driven back by more powerful neighbors, into the protecting shelter of the forests.

Forests from the beginning have affected man socially and spiritually. The very existence of trees has exerted a profound influence on every human being and on his surroundings. Almost without exception these influences of the forest have made for the greater comfort, security, and spiritual advancement of the human race. They have provided him with game, hidden him from his enemies, protected the pure sources of his streams, and sheltered him from an often pitiless sun. They were the abode of many of his Gods.

And aside from the unchallenged effects that forests have had on the peoples of the world, and on their development, there exists a still unsettled controversy regarding the rôle played by forests in modifying the world itself. The effect of forests on rainfall, for example, is a much fought over subject and to this day it has never been definitely and scientifically proven that cutting the forests of a country is followed by a decrease in rainfall. There is, however, good ground for believing that a forest has the same effect on the winds that blow over it as a body of water. For the wind absorbs at least as much moisture from a square mile of forest in passing over it as from a square mile of water. It would seem likely, then, that winds gathering moisture after blowing across forested areas would deposit their burden in the form of rainfall over localities where without forests no rain might occur. Some students of the subject say that forests cause a difference of over ten per cent in the rainfall of a locality, but so many other factors enter here that these statements are far from certain.

But many forest influences are closely proven. We know be-

Photographed by K. D. Swan

A LOG CHUTE

yond doubt that forests make a land more temperate—less subject to sudden changes. A forested country is neither so hot in the day, nor so cold at night. During the day the sun's heat falling upon the forest is largely absorbed by the leaves so that less heat is available to raise the temperature of the earth's surface. Much of this heat that the tree absorbs is used for growth and to form new wood. So in a sense, the wood of a tree is stored-up heat and when we burn it we are again releasing the imprisoned warmth of long past summer days. This heat, then, the forest stores up and prevents it from raising the temperature of the earth's surface. When night comes and the air cools quickly, the forest leaves slowly return some of this heat into the atmosphere and so the nights tend to remain warmer. This is why a desert country is visited by greater extremes of temperature than a forested region.

Forests serve another useful end when, as windbreaks, they prevent the hot winds of summer from drying out the soil and killing farm crops. For this reason in treeless regions long belts of lombardy poplar, locust, or evergreens are often planted about farm houses and between cultivated fields. They prevent, too, the great damage sometimes caused by sand dunes, those areas of shifting sands which, blown by the wind, move across the country destroying farm lands and covering highways and buildings. Once trees can get a foothold in such areas as these, they destroy the force of the wind and by holding the soil with their roots, at last make these shifting sands prisoner and keep them motionless for all time.

Forests have a tremendously important influence on the flow of streams. To understand best just how this influence is exerted, one may imagine two tracts of land on two adjacent

FORESTS EQUALIZE STREAM FLOW

Snowbanks protected from the sun by forests melt more slowly and last longer. They supply water in more even quantities and feed streams far into the summer.

Snows on barren slopes melt quickly under the spring sun, produce a rush of water for a few weeks and then are done. Springs and streams from barren country dry long before forested streams have finished supplying water to the valleys below.

mountain sides. They are both exactly alike, except that one is covered with forest, and the other is bare. Over both areas bursts a heavy storm. On the treeless slope with its surface baked by the sun's rays, the rainfall pours down, but does not sink into the soil. Instead it runs over the surface of the earth with increasing swiftness and rushing down the stream beds in a wild torrent, carries along great quantities of the most fertile soil and with the force of its headlong course carves out deep channels over the countryside. If these streams flow into reservoirs, as in the West, all this fertile earth washed away by the storm is not only lost but actually becomes a menace to agriculture. For after each heavy rain tons on tons of earth are deposited in reservoirs that many localities depend on for irrigation and only at great expense and effort can these reservoirs be kept from filling with silt. If the rain is sudden and severe, these muddy rivulets may combine to form a raging torrent, rushing wildly down the mountain and perhaps washing out roads and destroying bridges. So under these conditions the rainfall has not served the country in any beneficial way. On the other hand, it has brought damage to bridges, reservoirs, roads and to the soil itself.

Something quite different is happening over on our forest-covered mountain side. In the first place the force of the rain has been broken by the branches and leaves and the raindrops fall gently to the ground or run down the tree trunks. Part of the rain, too, is absorbed by the leaves and in light summer showers very often no water reaches the ground—it is all absorbed. But the rain that finally falls upon the soil finds a soft cover of leaves and loose earth which like a great sponge absorbs most of the water and later, days later sometimes,

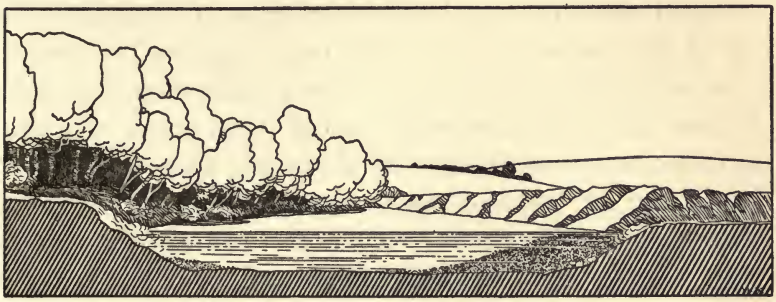
allows it to come again to the surface in the form of springs and steadily running streams. Of course, if the storm is heavy and of long duration, not all of the water is absorbed. As the soil becomes saturated, the rain no longer sinks in—it runs over the earth's surface and down the stream beds. But there is no sudden destructive rush—no carrying away of great quantities of fertile soil, and no silting up of reservoirs. And although the forest cover can not, of itself, prevent floods, it is an important factor in decreasing their severity, especially on heavy clay soils. In Europe foresters and engineers have learned that one of the most important steps in controlling floods is to reforest the steep banks of their streams.

In winter the snows that fall beneath the shade of our forested mountainside remain unmelted much longer than snow exposed to the direct heat of the sun. So when spring comes and the sun's rays become hotter, the snow in the open spaces shrinks rapidly and the water goes off quickly. So for the rest of the summer, unless there are heavy rains, the streams are dry. But under the leafy protection of the forest, snowbanks melt much more slowly and even in July or August are giving off their precious moisture to the agricultural land beneath them. As a result, the streams on which whole communities may depend are fed by the forest snows until later summer and the droughts that occur in the open country are often avoided. This water, so valuable in regions that depend wholly on irrigation for their farm crops is one of the things made possible by the forest shade.

The streams that supply drinking water for cities must above all be kept clean and pure, and to this end our forests play the great rôle of guardian of our health. For the forest streams are

cold and clear and pure, and many cities are now reforesting and protecting the lands that lie above the headwaters of the streams from which their drinking water comes.

In addition to all this the forest, every day it grows, is making the soil beneath it more fertile. For, instead of being exposed to the baking rays of the sun and to the drying and cracking action of the winds, forest soil is continuously enriched by



How Forests Save the Soil

Forests protect the shores of lakes and the edges of streams against beating rains. For this reason the forest stream at the left is clear and carries little mud and silt. But the barren shore on the right is washing away under heavy rains and its streams are charged with mud which quickly fills up lakes and reservoirs.

falling leaves, and by the important, but little known microscopic life that grows about the roots of the trees.

In these many ways, then, the forests make the world a better place for man—better in body and spirit. And besides all these, the forests bring man still another service more difficult to put into words, but none the less real. This is the pleasure and peace that trees and forests give us just to look at, to wander among and to play in.

It is a very natural thing that we should love the woods. It

is part of our heritage just as our love of sunlight and air. After all, for a few centuries only have we been city dwellers, and behind those relatively few years stretch untold ages when we lived on the border of the forests and filled our various needs from them. So trees are among our oldest friends and it is back to them, as to old friends we go when we are tired of the noise and hurry of the city. We rest and play and are born again. We find there something civilization and its crowded places can never give us—a sense of fulfillment and joy of life. A sense of peace. This, too, is a gift of the trees.

So when all is said, the forests mean much more to us than to serve just as mines of timber and of wood—more even than as protectors of our streams and of our soil. Trees are all these. But if they were none of these—if only it were for the beauty they bring, and for the renewed life that man can find among their shadows, trees would still be one of nature's richest gifts to man.

CHAPTER 12

WOOD—GREATEST GIFT OF THE FOREST

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WOOD—GREATEST GIFT OF THE FOREST

We had better be without gold than without timber.—JOHN EVELYN.

THE first settler in America was the first lumberman. Probably the first board was split laboriously with the help of axe and wedge. From these small far-off beginnings, our forests have come to support an industry whose development is unequaled in the history of our country. The rise and expansion of American lumbering is a very colorful epic, perhaps the most colorful that has ever attended modern industry. Its methods and tools have been evolved out of conditions hitherto unmet. The giant sawmills of today are the most representative of American institutions. They have come about out of our immediate need to cope with the new and difficult conditions that confronted the American pioneer in his task of building a nation.

To our earliest settlers wood was as great and immediate a necessity as food or clothing. Quite early in our colonial history we hear of small sawmills springing up about the growing centers of settlement—mills of small capacity, entirely dependent for their existence on the lumber demands of the countryside close about them. They were designed to furnish local needs, for at this time the transportation of timber over great distances was a thing unknown. These earlier mills were run

by waterpower and later, when steam had become a source of energy, this new power was adopted by the sawmills with great improvement to their output.

Even in those days many of the rapidly expanding centers of civilization went through local timber famines that forecasted in a small way the great drama of forest exhaustion that we are witnessing on a national scale today. This process of progressive timber exhaustion usually presented the same aspects. A sawmill, when first set up in a community, made use only of the best and most accessible timber and only one or two favorite species were thought worthy to be cut. Then, when the countryside had been combed over once, it became necessary for the mill operator to cover the ground again and select this time less perfect individuals and take less-favored species. Early forms of transportation imposed very definite and restricted limits to the distance it was profitable to bring logs to a mill. Consequently, unless a community happened to be on a seaport or navigable stream, it began to suffer from a scarcity of wood as soon as its surrounding forest had been cleared for a distance of twenty miles or less. In some regions, local shortages of timber caused the early inhabitants to pass measures for timber regeneration and protection. Very few of these ever bore fruit.

All this time, of course, there was enough timber throughout the country to satisfy everyone's needs—more than enough—but until the development of railroads only the forests along the river banks were of a practical value for distant transportation. So it was along the streams that the first large sawmills came into being, when the days of timber cutting began on more than a local scale. For with the expansion of towns into

cities and the rapid clearing of ground for agricultural purposes, it soon became impossible for communities to obtain their wood locally.

From this time on yearly drives of logs came down out of the forests of Maine and later of Pennsylvania and New York. It was the beginning of lumbering as a national industry. Each year when the snows melted into the streams of the Northeast, mile after mile of log rafts came floating down to the cities. Prodding them from the banks, loosening them when they jammed, keeping them ever moving, lumberjacks of the north woods worked night and day to see that the drive might not lag behind the high water. A new occupation was being born to the world—the trade of the lumberjack. He was to see many changes of methods, forests, and locality during the next hundred years of his colorful and turbulent existence. Today the "White River Boys," the men who drove those logs down the eastern rivers to market, are almost as scarce as the buffalo. The long, fragrant rafts of white pine are gone perhaps forever. Yet behind them these men have left a tradition and a memory that will always remain an imperishable part of our conquest of the wilderness.

Maine was the first state to begin a wholesale exploitation of her forests and during the middle eighteen hundreds white pine and spruce timbers were shipped from her ports all over the world. First she cut only the finest of her pine. Next she took the poorer individuals and after that her lumbermen had to content themselves with hemlock and spruce. When these were exhausted even the formerly valueless hardwoods were cut.

As the New England forests began to play out, New York

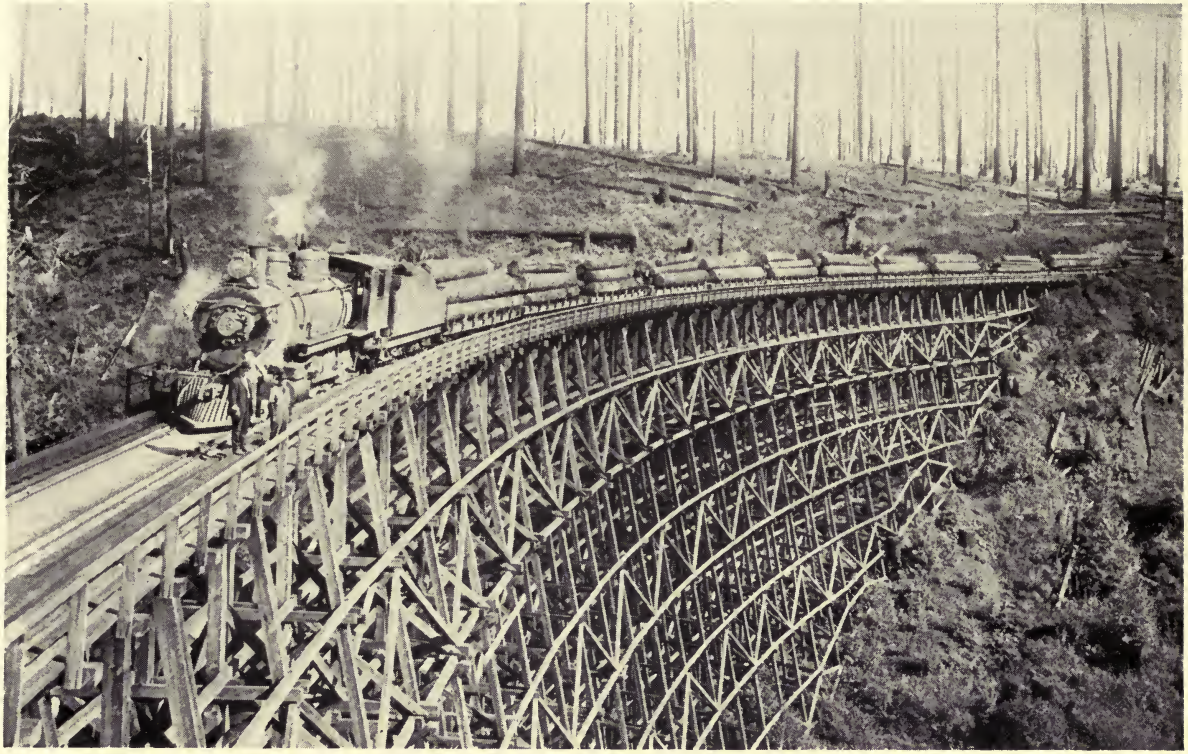
brought forward her own forest wealth and for a time surpassed all the states in the production of lumber. Soon after, Pennsylvania took the lead and contributed the cream of her own forests, the growth of long centuries, to the upbuilding of the eastern states. Meanwhile the country was growing rapidly. Railroads were making it possible to ship great quantities of lumber over distances before undreamed of. Mills had no longer to depend on the existence of streams for transportation, but in their search for timber could reach back with logging railroads into the very heart of the forests.

By 1880 the forests of the Northeast had been bled of the best of their timber and Michigan next forged to the front as the foremost lumber-producing state.

Wisconsin followed and for a time the Lake States held brief lumber sovereignty and at last, when their lofty forests of white and red pine had vanished, the Southern states took up the burden of supplying wood to a swiftly growing nation. Our whole civilization seemed to be formed on wood. It was a necessity with us. Also, it was cheap and plentiful.

No country had ever used wood to the extent that we were using it. The Middle West was developing, towns were springing up like mushrooms, villages dotted the railroads and soon grew into cities. Everyone was building and boom times spread. The sawmills of the country were keeping pace with the need. Mills of capacity never before known sprang into existence. Day and night the song of the saw was heard. Our demand for wood was more than ten times that of all France.

We were using lumber more than the rest of the world put together. We were also using lumber many times faster than nature was able to replace it. On the rich pineries of the South



Photographed by Gifford & Prentice

HAULING LOGS TO THE MILL

now fell the main burden of supplying a wood-hungry nation. Carload after carload of straight-grained lumber went north and west. Ships, heavy with cargoes of yellow pine followed one another to Europe and Asia. Then once again, as before, all went well until—the impossible happened. The "inexhaustible" forests of the South were playing out. Yellow pine was getting scarce. Before high-powered machinery and keen demand, the Southern forests were melting like snow in a summer sun.

So as region after region became deforested, saw and axe went further and further from the centers of population. From Maine to New York, west to Pennsylvania and the Lake States, then south to the great stretches of pine. Only a few years ago the peak of production passed over that region and today the mills of the lumber industry are beginning to make their last migration of all—their long, final trek to the Douglas fir forests of the Northwest. For out there is the ultimate great stand of timber in America and there the mills are mobilizing in their last attack on the wild natural forest.

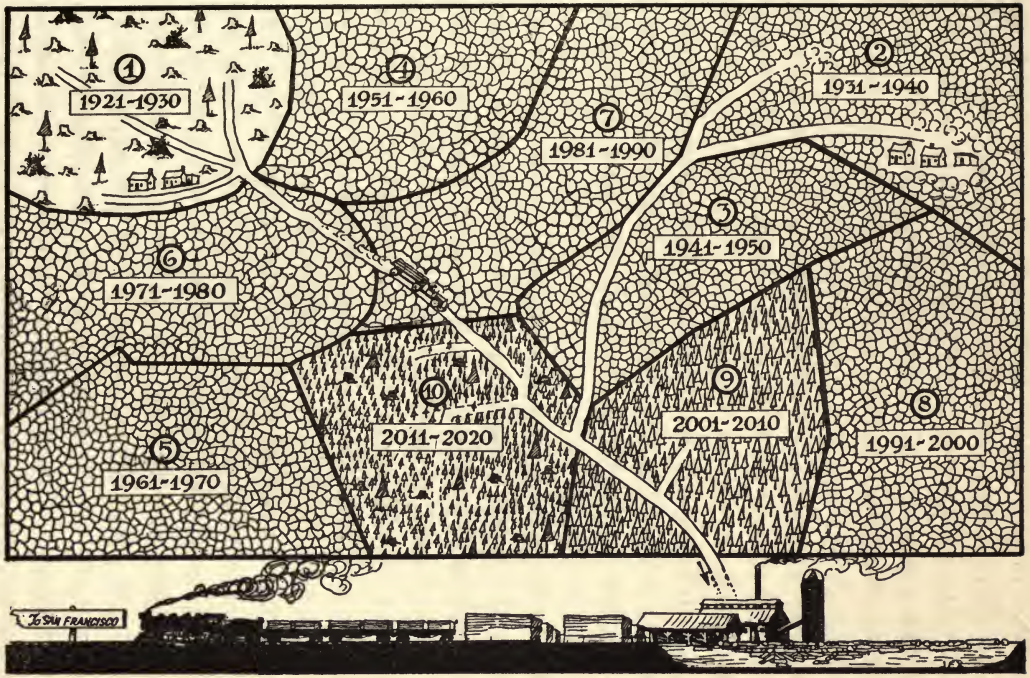
In its pursuit of the retreating forests the lumber industry has resembled those bands of early people who spent their days following about the great herds of wild caribou. It is to this era of primitive exploitation that our lumber industry has belonged. Lumbering has been essentially a migratory industry remaining in a region only so long as the forest remained, pushing on into new virgin forests when the exhaustion of the old make it necessary. Almost invariably each forest region has repeated the same history. First come the small mills that cut only for local use and cut only the trees immediately about them. Then follow the great high speed mills of enormous

power and capacity before whose saws the forests shrink with appalling rapidity. Last of all when the country has been cut over, these great mills move on, and once again come the smaller mills cleaning up the isolated patches of timber and seeking out whatever discarded material may happen to remain.

So there has been no permanency either in the mills or in the mill towns that sprang up about them. Everyone knew that after a time, a few years or many, the timber would be exhausted and the mills abandoned or moved to new localities. It was not a tradition that made either for good social environment or for any care in the treatment of the forest region left behind.

But in later years, within the past decade for the most part, a new note has crept in. Here and there mills are being built with the basic idea of obtaining timber from one locality for all time. This means, of course, that enough timber will be controlled by that mill so that each year's growth of wood will equal each year's cut. Reduced to its simplest terms, the problem might be stated thus:

A mill has one hundred square miles of timber under its control. It takes one hundred years for the timber to reach a size profitable to cut. If, then, the mill is of such size and capacity that it cuts the merchantable timber on a square mile each year, it will take a century for the entire tract of one hundred square miles to be cut over. By that time the timber on the first square mile that was cut one hundred years ago will be again ready for the saws. A mill so situated need never move for lack of timber since such a forest will produce a yearly harvest for all time. If you think of the forest as the lumber capital, the



A Perpetual Forest

To give this mill timber perpetually, the forest above is divided into ten parts, to cut ten years in each, successively. Part 1 has just been cut over (1921-1930) except seed trees. Roads and camps are already being built into Part 2 for cutting next, and have been abandoned in Part 10, cut last in 1911-1920. Here the new seedlings among stumps and seed trees will be ready for cutting again in one hundred years.

yearly growth of wood becomes the annual interest. So long as the mill cuts no more than this annual interest, the forest capital remains the same and the mill can continue forever. Men call this a perpetual yield and its attainment is ideal both for the lumber industry and for the forest itself. The mill so assured of future yields can provide for permanent homes and schools for its employees, as well as permanent markets for its products. Into this era of stability the lumber industry must inevitably come.

The large mill of today is a temporary passing type and will vanish with the last of the big timber. The mills of the future will be smaller, equipped for closer use of timber and guilty of less waste.

But before the majority of lumbermen can afford to look favorably on any plan of perpetual timber cutting and perpetual forest ownership equitable taxes must be assured them. Unless the system of taxing timber is just and reasonable, no lumberman cares to think in terms of perpetual yield. Instead he is often faced with the necessity of cutting out his timber more quickly than he actually wants in order to prevent taxes from eating up the profits. The hazard of unjust taxes is like fire—it is a menace and an obstacle to forestry. Many States tax their growing timber each year compelling the owner of a half-grown stand of timber to pay taxes on that one crop of trees twenty to forty times before he can sell it. During all these years it is bringing him in no revenue. Such a method is comparable to taxing a crop of wheat or oats every week. Some States seeing the inequality of this method are already providing less burdensome and juster methods. The Federal Government is conducting an investigation that may lead to the

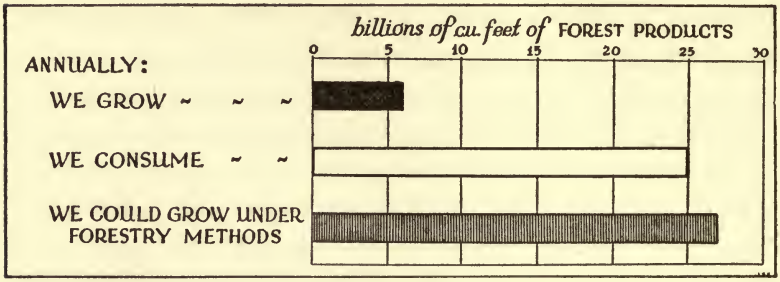
formulation of sound principles for the taxation of forest land. It is a difficult, but very important problem.

A great deal has been said and written on the evil caused by this migratory, wasteful, and destructive method of lumbering that in less than a hundred years has denuded region after region of its forests often leaving them in such condition that nature unaided will not be able to bring back trees. It is very human to seek out some one class of men to blame for errors in whose inception everyone is to blame. The lumberman has long been held up as a waster who, for personal gain has ravaged a great public resource and jeopardized the future welfare of a nation. As a matter of fact, the lumberman was the product of his times and of his environment no less than any other class. Times, conditions, national necessities, the state of our public and political conscience all conspired. Perhaps it was inevitable that we should pass through a period of wasteful exploitation in order to learn our lesson. Nor is it well to forget that at a time when the country demanded cheap and abundant wood, and ever more wood, the lumber industry provided it. Without wood and without the lumber industry, today the third greatest industry in the country, the rapid expansion and settlement of this country would have been quite impossible.

The times called for rapid mass production of huge quantities of lumber and these the mills provided. That they did so at a great waste and left behind them wrecked forests belongs to the times and to the needs of those times. Blaming any class of men or any industry is always a futile and usually an unintelligent undertaking. The important thing is to make it impossible for the public welfare to be jeopardized by any class of men or by any industry. In the present case, it should

be made possible and necessary for the lumber industry to so exploit its timber that the lands cut over be left in a condition capable of continuous production. With the example of the past behind us, we can see more clearly now and plan for the lumber industry for the future.

For the romantic, colorful epic of bygone days is doomed. The end of our wild areas of original timber is in sight. To-



MATHEMATICS OF OUR PREDICAMENT

It is not difficult to state America's forest problem.

Briefly and simply we are using up our forests nearly five times as fast as nature is replacing it. To continue is to make us a nation of timber paupers.

Yet foresters tell us there is no need for suffering a timber famine since under forestry methods we could grow even more than we use.

morrow we enter upon an era when the wood we cut must be man-grown and cared for, in order to replace the wood that nature gave us and that we used so lavishly. We have to enter upon an era of scientific cutting, of plantations, and of rigid fire protection. An era of timber crops, perpetual mills, and modern mill towns permanently established and forever free from the cloud of migration or abandonment.

But before we can bring this timber of the new age to maturity, we shall have exhausted our old timber. Those will

be the times of real timber famine and on its edge we already stand.

The longer we delay the beginnings of this timber crop, the further off will be the harvesting and the greater the famine's severity. To tide it over we shall probably use less wood—we are already using less wood—and we shall probably import much timber from the tropics. But our mainstay, our only permanent solution to the problem of our wood supply, will have to come from our own forests—domestic wood grown and protected under forestry principles.

CHAPTER 13

WHERE OUR PAPER COMES FROM

CHAPTER 13

WHERE OUR PAPER COMES FROM

With abundant paper the intellectual life of the world entered upon a new phase.—H. G. Wells.

It would be hard to picture a world without paper. In one form or another paper has come to be an ever-present necessity either as writing paper, wrapping paper, books, newspapers, or a dozen other commodities. We have come to take it for granted as something civilization has always known. Yet not so very long ago this was a paperless world and were it not for wood, paper might still be an exceedingly scarce and costly thing.

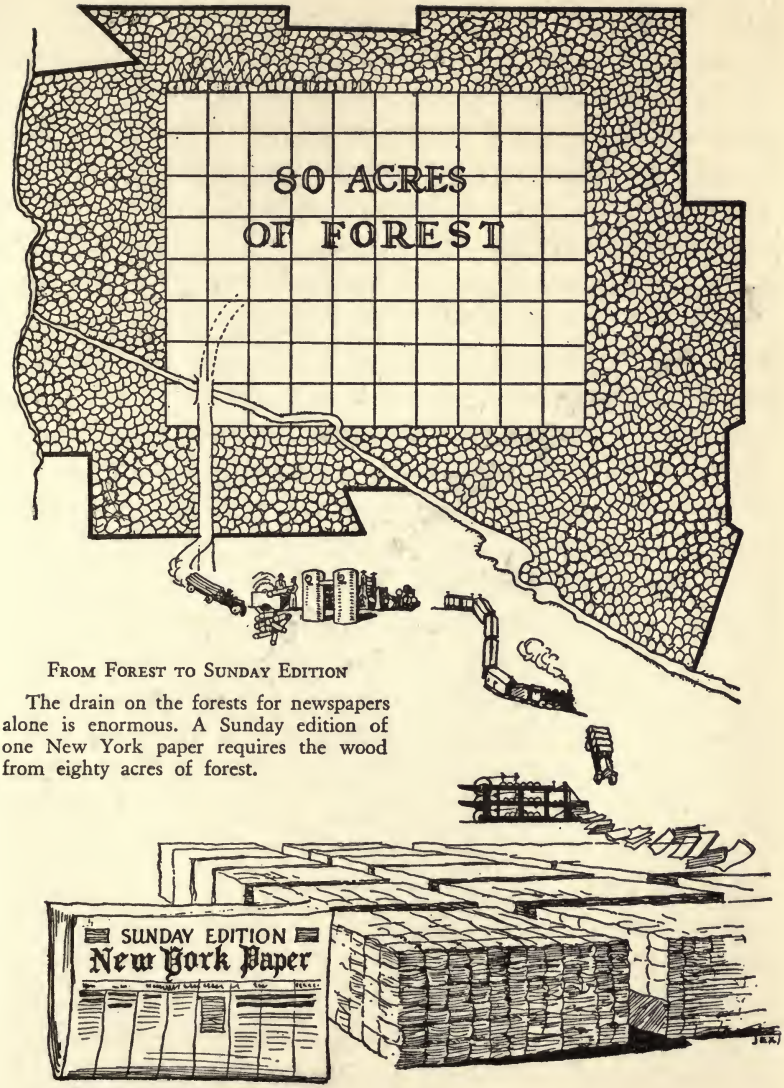
Ancient civilizations carved their laws and history in stone and upon rocks. Brick, wood and skin have all at one time or another been called into use to perpetuate the events or thoughts man sought to make more permanent than the spoken word. Papyrus, the nearest approach to modern paper was a substance made by early peoples from the Egyptian paper weed. As far back as 3500 B.C. its use was known and it continued to be valued for writing material by the Arabs in Egypt down to the eighth or ninth century when the secret of paper making began to spread out of China and across the world.

In strict reality the first paper makers were not men, but insects. The wasps first learned the secret of manufacturing

paper from wood and those round, grey nests so commonly hanging from house eaves and trees are really made from wood into a rough paper. The wasps' simple process of manufacture consists in chewing a mouthful of dry wood until it becomes a little ball of paper pulp. Then it is flattened out into tiny sheets of paper,—just as truly paper as the sheets that make up this book. Man has improved on the process and modified the product, but he has not fundamentally changed it. In the eighteenth century a Frenchman had studied the methods of the wasp and was struck with the possibility of making paper from wood, but almost down to the time of the Civil War flax, linen, and even cotton rags were the materials from which Europe and America made its paper. So it is probably to the wasp that we must give credit for first suggesting the possibility of using trees as a raw material for paper making. Today, nine-tenths of our paper is manufactured from wood.

A story is told illustrating how quickly trees can be turned into a newspaper. In Germany three trees were cut down at 7:55 in the morning. They were taken to the nearest paper mill, manufactured into paper and made ready for the news presses a few minutes after 9:00. Immediately the presses began turning and by 10:00 o'clock the newsboys were selling these papers in the streets. A little over two hours from the forest to the printed page!

As a matter of fact, paper making became possible in its present tremendous volume only with the use of wood. The discovery that paper could be made from this abundant raw material revolutionized the industry through the entire world. Today in the United States paper ranks next to lumber in importance as a forest product. The industry employs one



FROM FOREST TO SUNDAY EDITION

The drain on the forests for newspapers alone is enormous. A Sunday edition of one New York paper requires the wood from eighty acres of forest.

hundred and fifty thousand people and its annual output is valued at nine hundred million dollars. The amount of wood used is enormous. One Sunday edition of a big city newspaper, alone, requires the timber on eighty acres of forest—an area of more than five city blocks—all this to produce one edition of a newspaper.

There are several methods of making paper from wood and a number of grades of paper are now produced. The differences are not fundamental. All of them are directed to utilizing the wood fibers in trees and treating them in such a way that they will mat together into a tough smooth surface. That is essentially all paper is—a mass of entangled fibers of wood pressed flat and in some cases bleached and given a glossy surface.

When the wood arrives at the paper mill it is cut into two foot bolts and held against rapidly revolving knives until the bark is cut away. Low grade paper, such as we use for newspaper, is made up largely from wood fibers that have been ground fine, by placing these bolts of wood against a revolving stone. For higher grade paper the bolt is next chopped into small pieces and cooked in certain chemicals to separate the fibers and dissolve out substances in the wood that are not desired in the finished product. Under this treatment the wood becomes a pulpy mass, called wood pulp, and is either dried and stored for future use in thick, rough sheets or is run through a beater where the pulp is thoroughly mixed until it reaches uniform consistency and where clay and other substances are often added to give body and gloss. The pulp, still in a liquid stage, passes over screens which draw away the water, then on to presses which press flat the fibers in the pulp and remove most of the remaining moisture. Heated rolls, over which the

Photographed by E. S. Shipp

STACKING LOGS FOR PAPER PULP

paper next passes, dry it completely. The finished product is then wound on large rolls and is ready for shipping.

There are, of course, many modifications of this method and many additional details, such as bleaching, coloring, and providing a high polish. But the basic processes are the same and although a wasp gazing at this page would probably not recognize any similarity to his handiwork, the fundamental methods of grinding the wood to a pulp, wetting it, and pressing it out into paper are employed both by the insect and by man.

The uses we are finding for paper are enormous. A bare list would occupy pages. The people of the United States consume more than eight million tons of paper a year—more than all the other countries of the world combined. Over one million tons goes into wrapping paper, alone. It is hard to realize how greatly wood pulp has contributed to the abundant and cheap paper that has made such widespread use possible. During the days when linen and rags were our only raw material for paper, periods of great scarcity occurred and the mills were often unable to get rags in sufficient quantity to keep running. Appeals were made to the public to save rags, and linen, for paper making. During the Revolution, American officers could not always obtain the small amount of paper needed for military orders. Newspaper editors were often forced to print even the margins of their papers so scarce was this commodity that today we have in such abundance.

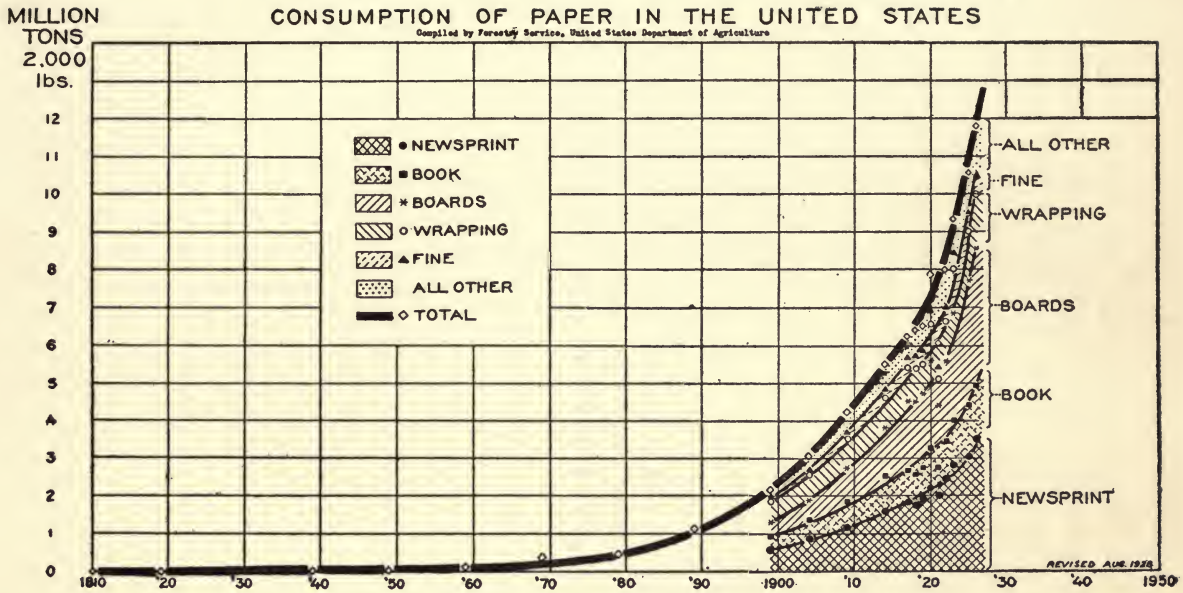
The miraculous difference is solely due to the use of wood, but it might be wise to look behind the scenes at the forest, the source of all this, and see what is happening there. Necessarily all these newspapers, books, and magazines are making great inroads on our vanishing forests.

There are only a few species of trees that may be profitably used at present for paper making. We are slowly finding new ways of utilizing additional species, but today two-thirds of our pulp comes from spruce, fir, and hemlock. Of these three important trees we have not nearly enough to support the drain of the paper industry and we have now reached the stage where many pulp and paper mills either possess no timber of their own, or only very limited supplies. Today more than half of the wood used for paper in the United States comes from outside our boundaries—chiefly from the spruce forests of Canada. We must depend on foreign imports for millions of cords of wood and wood pulp. This is not through any failure of our own forests' ability to produce these species in abundance, for with our vast area of forest land we could grow more wood for paper than we shall need for many years. The great fertility of our forest soils should make cheap domestic sources of raw material entirely practicable. So far we have made no serious effort to become self-supporting. Yet the time is not far off when we shall have to adopt some nation-wide program for raising these species, valuable for paper making, or our industry will have to depend almost entirely on imports from foreign countries.

This enormous demand for paper which today consumes ten million cords of wood yearly is bound to increase. To offset this, it is of course quite possible that methods will be discovered for using many additional tree species. But the main reliance for abundantly and fully meeting our pulp wood requirements must be placed ultimately on ourselves growing our paper producing species. Alaska, with her practically untouched forests, will supply two million cords annually, or

Photographed by Turrill & Miller

UNLOADING LOGS AT THE LUMBER MILL



OUR INCREASING PAPER NEEDS

The use of paper in the United States is growing at an unbelievable rate.

We were using in 1929 almost twice as much as in 1915 and over four times as much as in 1900.

To support this tremendously important industry many millions of forested acres must be devoted. Only through forestry methods can we hope to supply wood-pulp in the quantities needed for all time.

one-fifth of our present needs. And, since these forests are owned by the Government, they will be so cut that they can produce this amount year after year forever. But Alaska is a long way from our pulp and paper mills which, for the most part are clustered about the North Atlantic Seaboard.

Here again the time is past when we can continue using our forests without thought of tomorrow. The magnitude and importance of the paper industry demand that they shall be assured an abundant source of raw products locally available. We can not well afford to be dependent upon other nations for wood pulp. Neither can we afford to scrap our paper-making mills when the present timber is cut out. Only through forestry—only through a rational and plan-wise providing for the future can we hope to create a permanent domestic paper industry that shall be founded on a perpetual supply of home-grown timber.

CHAPTER 14

OTHER GIFTS OF THE FOREST

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OTHER GIFTS OF THE FOREST

Of all things a useless soul and a useless acre are the most useless.
—J. T. Rothrock.

Lumber is only one of the many gifts the forests have to offer. Long before boards had ever been thought of, the early peoples of the world had learned to make use of many other products of the forest. In the tropics they built their homes of palm leaves and made spears and arrows of the hard, heavy woods. Throughout the world they had learned to hollow logs for canoes. It may be that with dry sticks man first made fire his servant.

From the leaves and bark and fruit of forest trees come many of the well known medicines that man through the long ages has used to cure his ills. Even today witch doctors and medicine men of the primitive tribes obtain most of their medical stores directly from the trees. Rubber, that tremendously important substance, was first derived from 'tapping' trees discovered in the tropical forests of the Amazon and the great bulk of 'chicle' used for making chewing gum is bled from tall zapote trees that grow in the dark jungles of Central America and southern Mexico.

Two products of the forest were of service to man long before the making of paper from paper pulp and even before the lumber industry came into being. These forest products

we now call "naval stores" and, under this collective name are included both rosin and turpentine. In the United States their main source is the sap of the longleaf pine and slash pines of the South. The name "naval stores" dates back to the time when this resinous sap was cooked into pitch or used raw to build and repair ships in the old days of wooden vessels. Noah, one remembers, was commanded to "pitch the Ark within and without." Pitch and its products have had other ancient uses. The varnish that helped Egyptian mummies to resist the decay of centuries was made from the oil of turpentine that came from sap of resinous trees. Today the use of rosin and turpentine covers a much wider field than shipbuilding, but the name "naval stores" still remains.

The business of manufacturing rosin and turpentine has become a tremendously important industry, employing about forty thousand persons and each year producing materials to the value of forty million dollars. By far the great bulk of our naval stores comes from the longleaf pine in the southern States. Practically all the rest is produced from slash pine, although the sap of western yellow pine can be used for this purpose.

The first step in the manufacture of turpentine and rosin is collecting the gum from the trees. The early, wasteful method was to cut a deep notch in the base of the tree known as the box. This box held the turpentine that flowed down the tree trunk from a narrow, shallow wound made by "chipping." Once a week a chip was cut through the bark above the box, each successive chip made directly above the other. These caused the tree to "bleed" or exude sap and all during the summer the trees were periodically chipped the sap flowing

MEN AND TREES

In tropical countries primitive man is almost entirely dependent for his living on trees.

His huts are made from the palm, his boats are hollowed trees, his food comes largely from trees. When he chooses to work it is usually to the forest he goes to bleed the trees of chicle for chewing gum or raw rubber or to cut down some of the prized forest trees—mahogany, cedar and rosewood.

down into the box where it was collected. The tapping season lasts for about seven months. This method of "boxing" the tree has always been unsatisfactory since it is wasteful of wood that might later be made into lumber and the box, if cut deep, tends to weaken the tree and make it a victim to high winds. During later years this box has been supplanted by small cups hung over the base of the tree into which small tin drains lead, that conduct the sap to the cups. Aside from the initial cost of cups and drains this method is in every way better.

Whatever method is used the sap is collected from the boxes or cups and taken to stills where it is converted by cooking and distillation into spirits of turpentine and rosin.

In America collecting resin from pine trees to make tar and pitch began as far back as 1600. Methods remained extremely primitive until the middle of the Nineteenth century, when copper kettles and condensing worms came into use and from that time on the production of turpentine has leaped until, in many sections of the South, it is the leading industry. Today three-fourths of the world's naval stores are produced in our Southern States and find their way into every important market of the globe. The rosin is used for gum, varnish, soap, and the manufacture of sealing wax. Turpentine finds uses for paints, varnishes, coloring, and in manufacturing a large number of chemicals and medicines.

As in lumbering the manufacturing of naval stores can be unjustifiably wasteful. Fortunately, however, manufacturers are being converted away from the old "box" method and are learning to make smaller chips. Usually trees are cupped for three or four years, then cut for lumber. With the introduction

of better methods a tree can be cupped much longer and still produce valuable wood for boards.

The Indians taught us to make and enjoy maple sugar. In northern Minnesota one tribe still continues this ancestral industry, selling pure maple sugar in birch bark containers, much the same as their forefathers made before the coming of the white man. Today the chief center of production is in the Northeastern States.

Both the sugar and syrup are products of the hard maple or sugar maple (*Acer saccharum*). The method of extracting the sap and making it into the finished product is simple.

Tapping the tree begins about the middle of March and sap flows for the following month or six weeks. Two holes, less than a half inch in diameter are bored about two inches deep in the trunk and a wooden spigot is inserted in these holes to conduct the sap to a bucket directly beneath. This sap is then collected, poured into great iron kettles and boiled to a syrup. Cooking longer, until the syrup is brought to the consistency of wax, produces maple sugar. An average tree provides over twenty gallons of sap each season and this can be boiled down to about four pounds of sugar or two quarts of syrup. Proper tapping is not injurious to the trees.

As certain woods increased in value wood veneers have become another important forest product. Some kinds of wood are so valuable and are becoming so scarce that it pays to cut them into very thin sheets, or slices and glue them to a backing of some more common and cheaper wood. For furniture or cabinet work these thin pieces or veneer present the same appearance as if they were of solid construction, but this piecing together has other advantages than economy. Drawers, for

example, made up of several layers of veneer are stronger and less likely to warp and crack then if they were all of one piece.

Most veneers are made by first boiling a log for some hours to soften it and then revolving the log, by machinery, against a sharp knife. As it turns the knife bites into the wood and a long thin sheet of veneer is peeled away. Woods chiefly used for this purpose are the highly-priced species, such as mahogany, Spanish cedar, and Circassian walnut. But increasing numbers of woods are becoming acceptable for veneer stock as our supplies of valuable hardwood species get scarcer.

In the process of changing raw hide into leather the tannin used is extracted from the wood and bark of hemlock and oak. It is this extract that makes leather durable and pliable. During the summer the bark is peeled from these species and transported to plants where the tannin is extracted. At one time the tan-bark industry was so important that in the eastern United States hemlock trees were cut and stripped for the bark alone, leaving the wood to rot. Today the scarcity of hemlock trees and the introduction of other tannin materials have curtailed the industry seriously.

A great deal of wood is used for the manufacture of receptacles such as barrels, casks, tubs, and kegs. These and similar containers are bulked together under the term of cooperage and for these purposes, red oak, white oak, cypress, and gum are the species most frequently used. Excelsior is still another valuable forest product, and is used for shipping fragile material and even for mattresses and rugs. Basswood makes the best excelsior and cotton wood, poplar, and white pine are also used.

The uses of wood are far from ended. Spools, box boards,

IN THE TURPENTINE WOODS

willow, ware, toys, implements, tool handles, shuttles—a list would take up many pages. Indeed, over four thousand distinct uses for wood have been listed.

But only one more product of the forest is important enough for separate mention here—the Christmas tree. For the Christmas tree is the great winter crop of the forest and it is one of the forest's oldest gifts. Its history extends so far back into the mists of antiquity that its origin is hard to trace. Some say the custom arose with the Egyptians, who each year in December decorated their doors with branches of the date palm, the symbol of life triumphant over death. Or, it may be connected with the great tree of Norse mythology, the Tree of Time within whose roots and branches Heaven and Earth are bound.

To us, in America, the term Christmas tree is an all-inclusive term for a number of different species of trees. The kind of Christmas tree you think of depends on your locality. For we use firs, spruces, cedars, even magnolia. On the Pacific Coast white fir is used. In Ohio, Norway spruce. In Maryland and Virginia the scrub pine and further south, cedar and holly. Hemlock, too, is a beautiful Christmas tree, but drops its needles very soon. But perhaps, most widely loved of all for Christmas trees is the balsam fir, with its long horizontal branches, its deep green foliage, and aromatic fragrance. Nikko fir, a beautiful native tree of Japan, has recently found favor in this country.

The question is often asked if this Christmas tree custom is not a wasteful drain on our forests. Foresters reply that the Christmas trees used by every person in the land could be grown on a few thousand acres of land and that their use has practically no effect on the present drain on our forests. Grow-

ing trees for the holidays is becoming an important industry. The Government in recent years has been selling Christmas trees thinned out from crowded stands of timber, thus leaving the remaining trees with more room and light. This is actually a conservation measure and good forestry, for the forest is better off after these trees have been taken out. After all, so far as our wood supply is concerned it would be more important, to stop using toothpicks than Christmas trees, for each year six times as much area is cut over by the toothpick industry, as for Christmas trees.

A picturesque custom that has taken hold in portions of the country is to dig or buy one's Christmas tree, root and all, plant it in a box or tub, for use in the house during the holidays and later transplant it in the garden. There within a few years, one has a succession of trees of varying ages and sizes, each one a living reminder of a Christmas of past years.

CHAPTER 15

FORESTS AND WILD LIFE

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FORESTS AND WILD LIFE

Human life is absolutely dependent upon wild life and forests. Without these things we would become extinct as a race.

—James Oliver Curwood.

Necessary as are the forests to the welfare and comfort of man, there are other forms of life that depend for their very existence on these wooded areas. To many species of animals and birds, forests represent food, shelter and abode. Yet not all of them are forest dwellers. The mountain sheep or bison, seldom seek the shelter of the woods—but the great bulk of animals that go to make up our wild life depend largely on the forest for concealment, breeding ground, and food. It is so with the birds. Many species live a portion or all of their life in the open fields, but for even greater numbers, the tree-covered areas is their natural abode.

In Europe back in the days when hunting was the unique sport of kings and nobles, large tracts of timber land were kept inviolate to public use because they were the abiding places of deer, elk, boar, and other game. Foresters in those days were guardians of the wild life. They were officers of the king, charged with the duty of protecting forest trees so that these in turn would provide refuge for the animals that sought shelter there.

So guardianship over the forest dwellers has become part of

the forester's tradition, part of his heritage. And today, although modern foresters are occupied with many more problems than the protection of game, nevertheless, it often becomes part of their duties to look after the welfare of these forest wards. They are, after all, just as truly products of the forests as boards, turpentine, or paper pulp. Only the most restricted view would limit the products of a forest to the amount of wood it grows. And because the existence of these beasts and birds and fishes is tied up so intimately with the welfare of our forests, we are confronted with still another reason why these forests should be made perpetual by wise use. For, when our trees go, a great part of our wild things must inevitably go with them. Deer, elk, moose, grouse, beaver, and bears—all the many varied, colorful kinds of life that make the forest a place of absorbing interest will be swept away with the trees.

One would think that animals reach their best development and greatest numbers in the wilderness, where man has never interfered with nature. Many woodsmen too believe that any tree cutting, no matter how conservative renders the land less fit for wild life. Yet, foresters and naturalists, both, have piled up much convincing evidence to prove that game animals actually increase most rapidly where forestry is being practiced. The German forests, those great and perpetual wooded areas have been cut over and cut over for many hundred years, but today, more deer and other game abound there than ever before. This, too, in a region where a hundred and fifty years ago game was practically unknown.

Forestry, sound conservative forestry, which seeks after the perpetual productivity of the woods, actually brings about conditions beneficial to the wild life that these woods harbor. As

a matter of fact, deer and elk, instead of fleeing from cutting operations, actually follow them about, for they find that on lands carefully cut over conditions have been created that provide greater food supply and more secure covert, than even a

After the Fire

virgin forest. After all, the important factor that governs the abundance of game in any country is the available food supply. If we have proper bag limits, hunting seasons, and favorable breeding conditions, game will always increase up to the quantity of its available food supply—*and no further*. Cut this supply in half and you automatically condemn half of the wild

life to death or migration. So forestry, by opening up the woods through the removal of large trees and by clearing fire lines and trails, lets sunlight fall on the forest floor aiding the growth of young seedlings and food plants on which the forest animals find forage.

In many regions where forestry is being practiced, as on National and State forests, tracts of land have been set aside here and there where game may live and raise their young in perpetual security. Some of the National Forests have been made bird and game refuges, for just these purposes. They will serve as areas where wild life may breed and replenish the country about them. They are sanctuaries to the birds in their migrations and to game animals. They will serve too, as wild life museums, since animals protected from the chase learn in a short time to lose their fear of man and here, in their native haunts it will be possible to watch them, enjoy their companionship, and study their ways of living.

In another and entirely different way, too, forestry is proving itself a good friend of the wild things. Forest fires mean destruction of wild life. Forestry means fire protection. Fire is the great enemy of the forest dweller—bird, animal, and fish. It is also the great enemy of the forester. The first duty of the forester, whether in the employ of Government, private owner, or state, is to stop forest fires and every victory for the forester over this destructive enemy of his means a more abundant wild life for the forest.

It is no new discovery that fire is the great scourge of the wild things. Joel said thousands of years ago, *"Yea, the beasts of the field pant unto thee, for a fire devoureth before them and behind them, a flame burneth; the land is as a Garden of*

AIRPLANE VIEW OF FOREST FIRE

Eden before them and behind them a desolate wilderness."

The forest rangers know what havoc fire wages among bird and beast. Each year tells pitiful tales of blackened nests and eggs, of charred remains of fauns, young antelope and elk in coverts where wild things went for shelter, but where the devouring flames sought them out. It is no unusual thing after severe fires to find grouse, elk, deer, bear, cougar and lynx, and literally thousands of squirrels; all victims of the flames. Deer and elk, terror stricken, have been seen to rush frantically into the thick of the fire and perish.

Yet, while it is pitifully true that fires surround and destroy animals and birds, even greater damage is caused by the destruction of the eggs and young, and by the ruin of coverts and hiding places. What these losses amount to, no one can say. It must be tremendous and forestry and foresters are doing their share to prevent it.

The fisherman, too, has just as much at stake and loses just as heavily as the hunter and nature lover because of fire and deforestation. Fires are great fish killers. After the flames have finished their destructive work and the charred stumps and gray ashes have cooled, rain falls and washes into stream and lake tons on tons of alkali ashes. From the slightly acid content, normal to good trout streams, the waters are changed to alkaline. Fish cannot endure this fundamental change and as a result die by thousands.

In Louisiana is a large cypress lake used for a long time by State officials in propagating fish. During the drought of several summers ago its level fell and a fire raged for weeks at the upper end of the lake until all vegetation there had been

Why Foresters Dislike Porcupines

Foresters are not very enthusiastic about this animated pincushion. His appetite is responsible for the death of too many thrifty pine trees.

destroyed. Then the rains of autumn came and again raised the level of the lake until it flooded the burned area, and mixed in its waters large quantities of ashes left by the fire. Great numbers of fish died and the lake will long be useless for fish propagation.

Foresters, themselves, are taking a very clear view of their own responsibility for contributing to the welfare of their forest wards. This is partly because foresters, more than any other class of men, know wild life intimately. They live among them and sympathetically study them. Today, more than a thousand Federal forest officers are acting as deputy State wardens without one penny's increase in salary and are helping to carry out State game laws. That is one reason why game is increasing on the National Forests.

The history of the Old World has proven that forestry and the welfare of our wild life are closely interrelated. The wild things befriended and protected return real benefits to the forester. Unconsciously many are themselves good foresters. Birds and squirrels often scatter seed over large areas and many a fire-scarred region would remain treeless for long years were it not for the seeds brought in by beast and bird.

Foresters are coming to realize that just as timber is a forest product, so is game, and that in Nature's complete economy it is just as important to work for the perpetuation of wild life as for the rest of the beneficial things our forests give. So forestry is, and always will be a helpful factor in the continuation of wild life and the forester will always be the ally of his forest friends. It is part of his tradition and an increasingly important part of his profession to see that this great, varied, colorful life of animals and birds shall never pass away.

CHAPTER 16

FOREST ENEMIES

CHAPTER 16

FOREST ENEMIES

Any fool can destroy trees.—JOHN MUIR.

ALL life seems hedged about with enemies—with living things whose very existence depends on their ability to harm or destroy other creatures also endowed with life. The strong prey upon the weak, the big upon the little—every living organism is battling with whatever defensive and offensive weapons nature gave it to preserve life for itself and for its kind.

To this universal law, the forest is no exception. It has a host of enemies although not all of them possess life. Snow and ice often break away branches; high winds may level long stretches of forest to the ground; shifting sands have sometimes buried whole groves. Coal smoke breathes death to woodlands and lightning strips away the bark and shatters many a tree to splinters.

But all these enemies are negligible compared to the damage caused by the great army of tiny, living things—insects and fungi. Insect enemies are always present in the forest and would soon annihilate tree growth, were it not that following the law these insects, too, have their own enemies that ordinarily serve to keep their numbers from increasing. Ants, for example, help keep down the number of harmful forest insects.

The inhabitants of a large sized ant hill may destroy a hundred thousand forest enemies in a good day's hunting.

Protecting our forests from these harmful organisms is an important phase in man's conquest of the earth. It is part of the battle that man is waging against hostile insect life throughout the world. Some writers believe the fate of all mankind hinges upon his ability to conquer his insect enemies. They believe the world will some day become a battleground between man with his scientific equipment on one hand, and insects with their enormous powers of reproduction on the other. Whether or not that critical time will ever come belongs to the future. But it is a matter of history that many parts of the tropics remained uninhabitable to white men until certain harmful insects were destroyed. And there is no doubt that today foresters in their fight for forest perpetuation are finding it increasingly important to wage warfare against injurious forest insects.

The question naturally suggests itself. "But why has it suddenly become necessary for man to protect the forests from insects? What happened when no men were here to protect them?"

In those days very probably, large areas of timberland were from time to time stripped of forest growth by insects as they rose in sudden waves of invasion. Slowly nature seeded in those areas and the results of the ravages disappeared. Such invasions probably happened whenever conditions became for the time especially favorable to the rapid multiplication of any particular kind of injurious insect. Later their numbers decreased again because of increased activity on the part of their enemies, or because those favorable conditions ceased to exist.

FIGHTING FIRE

So probably from the earliest times forest trees have paid tribute to the invasion of insects. How serious or how frequent these invasions were we can never know. Whole species may have been wiped out of existence.

But today the forest is even more susceptible to insects than ever before. Unskillful lumbering and the killing of many birds that once fed on these injurious pests have made conditions more and more favorable for the multiplication of insects. And today we can not afford to let these invasions arrive and take their destructive course before dying down again. We have not the wood to waste. We are under the necessity of combatting these forest enemies whenever they attack one of our valuable tree species. So far we have not been able to devote enough funds, or man power to this fight and for that reason we have not been able to claim any great victories. Our defeats, on the other hand, have been numerous. The spruce bud worm, an insect working in the young shoots of spruce and balsam has killed over fifty million dollars worth of timber in the last ten years. The chestnut blight has practically wiped out the chestnut. The white pine blister rust is working its destructive way among the white pine on both our coasts. Government scientists who have studied the depredations of forest insects over the entire country say that collectively these tiny enemies of the forest destroy each year ten times as much timber as fire.

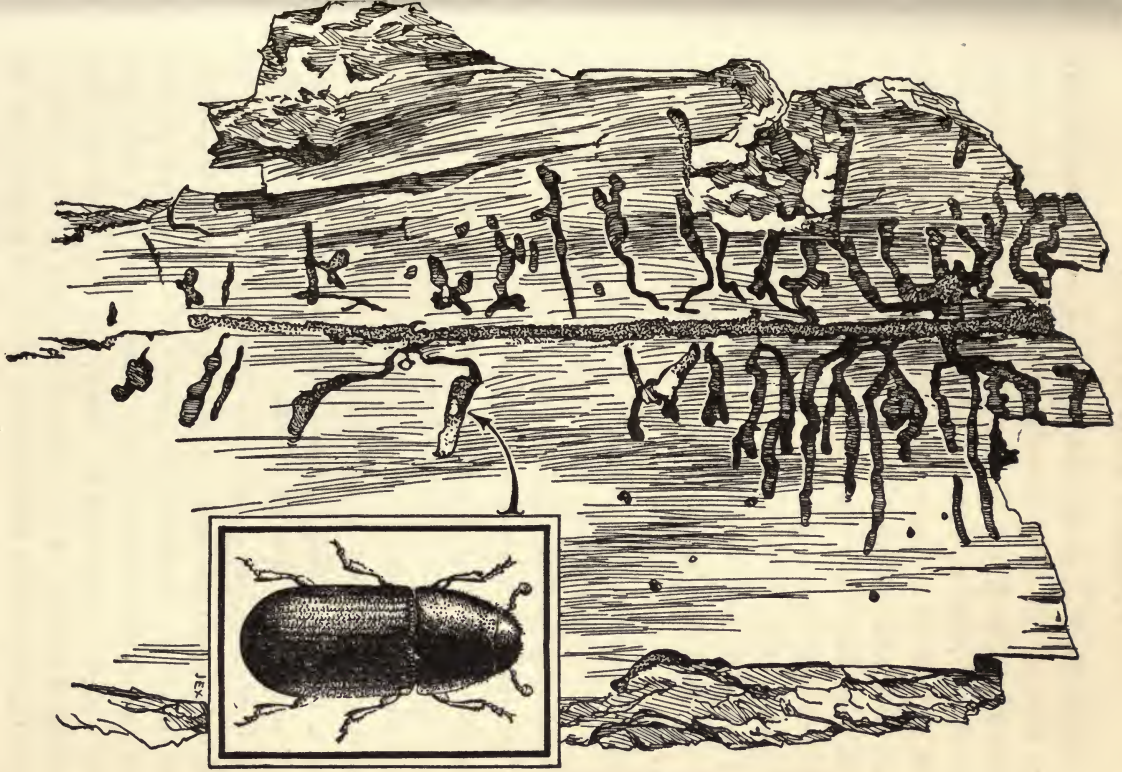
The number of different kinds of forest insects is enormous. Many hundreds probably, are still unknown, although the most destructive have been classified and studied. They work in different ways and usually each kind of insect has a certain tree species, or a group of closely-related species that it attacks.

The bark beetle, for instance, probably the most widely-destructive insect pest the forest has ever known, includes more than four hundred distinct species in America. Some of these beetles attack only one species, others have several victims.

Their methods are essentially the same. A pair of beetles select a tree through whose bark they dig a tunnel. There the female lays a number of eggs. Time passes. The parents die. The eggs hatch into small white worms that eat tunnels of their own beneath the bark. Later they develop into beetles and work their way out where they swarm to other trees, mate, and repeat the destructive life cycle. The tree's death is brought about by these tunnels which carved by numerous beetles finally girdle the tree and prevent the sap's rising just as effectively as if the tree had been cut with an axe. It only requires about ten beetles to the square foot to kill a vigorous tree of average size.

Hardly a tree exists that is not susceptible to the attack of, at least one species of beetle. Certain trees, such as western yellow pine and western white pine, have suffered great losses from bark beetle alone. Some beetles work in the roots, others in the twigs and others, like the bark beetle, in the soft living wood just beneath the outer bark.

There is no single remedy for all insect pests and just as the physician studies our bodily enemies, that he may learn the best way of ridding man of their attack, so the lives and habits of these forest insects have been studied in an effort to arrive at the best means of controlling them. It would be impractical economically and probably impossible actually to exterminate any one of them. Controlling their activities by keeping down their number seems the only possible plan. So



THE BARK BEETLE AND HIS WORK

Chief among the forest's insect enemies are bark beetles. These minute destroyers burrow beneath the bark of a tree and either kill or greatly weaken it. Many thousands of dollars have been spent to protect the forests from these pests.

far the methods of doing this are based on two well-known facts. First it has been observed that when a forest is kept vigorous and healthy and as nearly approaching its natural condition as possible, insects usually do not increase. Second, when in spite of, or in the absence of, precautionary measures these insects do multiply to the point that they become a menace special means must be sought to reduce their numbers to where their own natural enemies can keep them under normal control. Beyond this it seems impossible to go. Every forest then has, and probably will always have, its insect enemies just as the human body normally carries about the germs of many diseases.

Without the insects and birds that live on these tree enemies and which usually keep their numbers down to the point where damage is negligible, we should probably have no forests. Normally they preserve a balance. It is only when conditions cease to be normal and the balance between insect and insect enemy is disturbed that these forest pests multiply until, in the course of a few years, certain localities are infested with their destructive hordes. Many things can make for such conditions. Even very slight climatic changes may make it suddenly possible for destructive insects to increase enormously. After lumbering, the ground may be left covered by a litter of dead trees, brush and tops, all creating ideal conditions for the breeding of certain destructive insects. Fire, too, may weaken the resistance of the forest, opening scars in the bark and exposing the trees to insect attacks. Something may occur to reduce the natural enemies of the insects. Birds may be driven out by fire or hunters and in their absence the forest enemies are left free to breed unmolested until in a few years they reach appal-

ling numbers. Again insects and fungi may be brought in from foreign countries—some of the most destructive enemies our forests have known were introduced in this way. The chestnut blight probably came from China, the Japanese beetle from Japan.

With insects, as with forest fires, prevention is better than suppression and the goal of the forester is to prevent their outbreaks. This they can help bring about by care of the forest during all woods operations. Forest sanitation—it might be called. It consists in keeping the forest in such vigorous, healthy condition that insects can not breed in great quantities. Burning the brush after logging, cutting out the unhealthy and diseased trees of the forest while lumbering or thinning is carried on, keeping the forest itself, in a natural state and keeping *natural forests*—all these help prevent outbreaks of insect pests.

When the forester speaks of a natural forest, he means a forest where the kinds of trees are the same as those that naturally grow there. Natural forests are, as a rule, safest from insect attack—they are the climax forest of a region, the ultimate survival of a species or combination of species that can best endure on that particular soil and in that particular locality.

Man-made forests that differ too widely from natural forests are likely to be dangerous experiments. In a region where white pine naturally occurs in mixtures with hardwoods such as oak and maple, it would be hazardous to set out a plantation of pure white pine alone. Insect attack is always worse in a forest composed solely of one species since conditions there are ideal, for the feeding and breeding of the natural enemies of that species.

In New England where white pine plantations are common, but where in nature these pines usually occur in small groups scattered among the hardwoods, foresters are fighting a hard fight against the white pine weevil which lives on the main twigs of the pine and seriously damages these plantations. Here a rather remarkable observation has been made. On areas of pure white pine beetles swarm to the attack in large numbers, but when among the pine a few taller hardwoods are scattered, the beetles fly over without attacking. It is as if the presence of the taller hardwoods serve as a kind of protecting camouflage against the beetle air raid.

Control methods against the hosts of forest enemies vary with the particular type of insect. In the case of beetles, the usual method of control is to cut down infected trees, peel them, and burn the bark while the broods of beetles are still inside. The Government has done a great deal of this work in its fight against the destructive western yellow pine beetle.

But bark beetles are not the only important insect enemy. There is another great class of insect marauders known as the leaf eaters. They include certain butterflies and moths, as well as insects belonging to the same families as the wasp and bee. To these leaf eaters or defoliators belong pests that have caused many millions of dollars worth of damage and for whose control much money and human effort have been spent.

The gypsy moth, the browntail moth, the spruce bud worm—already more than ten million dollars has been spent in the fight against them. These defoliating insects usually lay their eggs in the trees and the caterpillars hatching out feed on the leaves and often strip a tree of its foliage completely stopping growth and in extreme cases killing thousands of

THE TENT CATERPILLAR

Hundreds of these destructive pests come out of their tent-like nest and eat the leaves of many forest species during early summer. Winter is spent in a brown egg mass shown at the left. In June the caterpillars turn to moths.

forest and city shade trees. Today the Japanese beetle, a newly imported defoliator looms as a gigantic menace to our Eastern city and forest trees.

The spruce bud worm which lays its eggs in the needles of balsam spruce has destroyed timber throughout hundreds of square miles in Eastern Canada. The tent caterpillar is a familiar pest in the Eastern states.

For this class of insects control measures vary. In the case of lawn and street trees, spraying the leaves with poison is successful in killing many of the caterpillars, but for forest trees such intensive measures are usually out of the question. Plantations have been successfully sprayed by airplane but in the forest little real progress has been made in the technique of control against this class of insect attack. The cost is prohibitive. Probably the best progress will be made in seeking out the insect enemies of these pests and setting them loose to breed and prey upon the defoliators.

Fungi, too, take toll of the forest. The chestnut blight that a few years ago practically exterminated our chestnut and killed over fifty million dollars worth of timber is a fungus disease. It attacks only chestnut, but of this doomed species it has spared practically none. This fungus spread by wind and birds works in through the bark of the tree, works rapidly about the trunk, and at last cuts off the flow of sap.

The various rots in trees—heart rot, white rot, white pine blister rust, all the many diseases that form toadstools on the trunks and branches are fungus diseases. Actually we know no practical way of combating them. About the only method of defending the forest against their attacks is to cut the infected trees and remove them before they spread disease to their

neighbors. They are ordinarily no great menace to a healthy forest. And fortunately not all fungi attack living trees. Some, on the other hand, perform a very useful function, for they bring about the decay of dead wood in the forest and allow it to rot back into the soil again.

There are still other enemies. Mistletoe is a parasitic growth that has caused great damage in the south and west especially among the magnificent white oaks of California. Porcupines should be numbered among our forest enemies, for many trees, especially the western pines, have been stripped of their bark by hungry porcupines. But most of these enemies—beetles, leaf-eaters, parasites, fungi—except in periods of unusual activity direct their attacks against trees already weak and many can only gain their points of entrance where the bark has been broken or where fires have burned.

All this has emphasized to the forester the importance of securing and maintaining a healthy forest—a forest able to resist attacks. For these enemies themselves are in league with each other and create conditions that are mutually helpful. Thus, the bark beetle weakens the tree and makes it more vulnerable to the defoliators; a porcupine gnaws the bark and allows entrance to some destructive fungus.

In all this it is not well to let our view of the forest situation become distorted. When we read of all these insects, fungi, and parasites, all these living things that continually beset the forest, the outlook for our future trees may seem black. But here one should remember the tremendous vitality of nature. To offset these innumerable enemies, the unpredictable accidents, the hostile forces of earth and air, nature puts forth a hundred thousand seeds in order to bring one tree to matur-

ity. Neither have we seriously begun, as yet, to fight these forest enemies. We have first to conquer fire and destructive logging. Once these are conquered, and behind us, the importance of controlling insects and diseases will be, perhaps, the most important problem for perpetuating the forests of tomorrow.

CHAPTER 17

FIRE—THE GREAT DESTROYER

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Forest fires are the greatest single obstacle to reforestation and effective forest management.—CALVIN COOLIDGE.

THE greatest curse of the forest is fire.

More than axe or saw, probably more than insects and disease, fire has been the implacable enemy of the forest and over larger areas, has put an end to forest life.

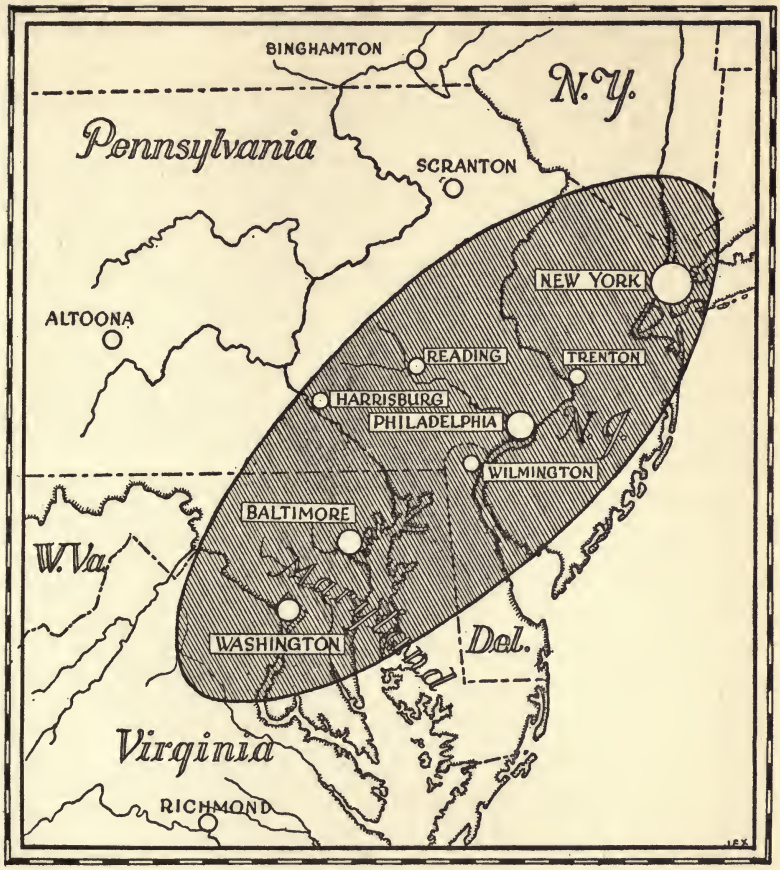
Long before the coming of the white man, fires ran through our woodlands. Doubtless the greatest number of these were caused by lightning, but it is certain the Indians often set fire to the woods when warring against hostile tribes, or when, on annual hunts they burned the underbrush to drive game out into the open. We have records of fires that devastated wide stretches of forests before the coming of Columbus. And the records of these fires are very accurate and readable for they have been kept by the trees themselves.

Provided a tree is not killed after it has been scarred by fire, a layer of new wood is laid down around the burned area within a year. Next year another layer forms, each bit of growth aiding in covering the old scar, until with the passing of time a protective covering of new wood has completely encased the wound. By counting these successive layers, or rings, one may compute with accuracy the time at which these

fires occurred and we find that some of them burned many hundreds of years ago. In the records kept by the age old sequoias of California we find the histories of great fires in the years 245, 1441, 1581 and 1797.

So we can not blame the white man for the presence of fire in our forests. But it is unfortunately true that since settlement, fires have increased, both in number and in area burned. Even from the first the white men were lavish in their use of fire. Hunters, settlers, and prospectors all preferred open, park-like forests without young trees, or undergrowth and the easiest way to bring about this result was to run fire through the woods. For many years there was no public sentiment against setting fires to the woodlands. On the contrary it was a settled custom in many regions to burn the timber lands each spring. Old ways are hard to change and in spite of every effort to stamp out this evil the number of fires is still increasing. Each year over fifty thousand sweep across our forests. Each year they burn an average of twelve million acres. In the United States alone over three thousand victims have been sacrificed to the forest fire God.

Not all of these thousands of fires are equally destructive—some do great damage, some little, but of one thing we can be quite sure—each one of the fifty thousand fires has caused some damage, whether it be great or small. Each has left the country a little poorer, a little less livable, than it was before. In the Northwest and in the northern Rockies especially, forest fires are often terrific tempests of flame that run destructively over vast areas killing in their paths every tree, big or little, burning and destroying beasts and birds alike, drying out the soil and shriveling up even the seeds that are in the soil.



THE YEARLY FIRE SCAR

Each year about twenty thousand forest fires sweep across an area of more than 12 million acres. Bulked together these fires would create annually a blackened desolate region extending throughout the heart of America.

Each year fires like these take toll of human lives, of property, of livestock, crops in the field, and sometimes whole towns. These are the great dramatic fires that fill the papers

and whose smoke obscures the sun for miles, but they are not the only destructive fires.

Even the light fires that run along the ground just scorching the bark of the larger trees and then dying, even these are injuring the forests of today. But they are injuring still more the forests of tomorrow. For the larger trees are able, partially, to protect themselves by the thick bark that grows about the base of their trunks, but the seedlings—the trees that are a year old or five years old,—the infants of the forest communities, these, even the lightest of fires destroy utterly. And, even though next year a new crop springs up, even then nature's past work has all been wasted and she must begin again and this time under less favorable conditions.

Even the larger trees that are not killed by the average fire, are weakened and scarred and rendered less resistant to their enemies. For most trees have a long, hard struggle to survive, even when unhandicapped and, ever so slight a fire may turn the tide against a tree and be the deciding adverse factor in its struggle for life. Fungus and insects enter the fire wounds bringing diseases and decay. Fire-scarred trees are less valuable, less productive trees for the flames have taken away some of their strength. Fire-damage is often a cumulative process. The first fire may just scar the tree a little, perhaps, not even burning through its protective bark, but the next fire burns with a hotter flame, for it is fed by the resinous gum that the tree has exuded to cover the first scar. So as fire follows fire, the tree may at length be burned through and through. Then a sudden savage wind storm and a snap and the tree crashes to the ground just as truly a victim of the flames as if it had been burned to ashes in one great conflagration. Today in a very

real sense, we are paying toll for the fires of past centuries since even in the uncut forests, fires over many a square mile have impaired the growth of trees, reduced their density, and degraded the quality of their wood. There is a great difference between what nature produces on the average forested acre, and what she should produce if fires were kept from marring the perfection of her work. We are paying for that difference in the increased cost of every forest product.

Fires in a sense brew fires. The effect of each fire, no matter how light, is to prepare the land for another, since each successive burning leaves dead trees, and charred limbs behind it, that under the hot summer sun dry out like tinder and furnish more and more fuel for the flames that follow, until at last the land becomes a barren waste, unfit for tree growth, unfit for anything but to serve as a reminder and a warning.

Nor is vegetation the only thing that suffers from fire. Under repeated burning the very ground soon becomes impoverished, for fires consume the leaf litter and the microscopic soil life, and so completely change natural conditions that trees at best exist with difficulty and often give up the struggle. In parts of the Adirondacks fires have burned trees, leaf litter and soil down to the bare rock, utterly destroying both the forest and the possibility of future forests.

Fires tend to increase the worthless brush-covered areas. Here and there, especially in the West, a ceaseless battle for supremacy is being waged between brush growth and forest. Gradually, if undisturbed, the forest will succeed in crowding out the undergrowth, but forest fires by destroying the young tree reproduction may turn the battle in favor of the brush and delay or doom the forest's victory.

There are three distinct kinds of forest fires. Those that run along the surface of the ground are by far the most common. They are known as surface fires and vary widely in intensity. depending on the strength of the wind and the condition of the forest floor. Sometimes they burn fiercely about the base of the larger trees, killing many, injuring others, and almost always consuming the seedlings and small saplings. Where the forest is more open and the surface litter sparse, the fire licks its way over the ground doing little more than scorching the bark of the larger trees and killing the younger seedlings.

Another, and much more destructive type, is the crown fire. Fortunately they are far less numerous and are usually caused by strong winds whipping the flames of a surface fire into the tree tops, where they roar through the forest canopy leaping rivers and canyons, scattering sparks for miles about their paths. They are particularly prevalent in forests whose trees are close spaced and have branches extending to the ground.

A crown fire with a high wind behind it can cover great areas at incredible speed. Everything in its path, tree, animal, ranch or village is doomed. It is the crown fire that causes the greatest loss of human life.

They are almost impossible to fight and during the periods of hot dry winds that often last for days in the western States crown fires burn sometimes until the smoke darkens the sunlight as far east as the Atlantic Coast. Such fires sweep whole mountain sides in a morning and by evening are devouring forests twenty miles away. They burn with so hot a flame that no living thing remains in the region they have devastated. The West is scarred with the havoc of these destructive crown fires.

AFTER FIRE

A third class is known as the ground fire. It burns beneath the surface of the ground in regions where the years have accumulated twigs, leaves, and vegetation forming a peaty, spongy mass that once afire often smolders for days and months. They cause little damage and are not important.

Apart from the actual enormous waste of wood, one of the great evils of fire is its retarding influence on the practice of forestry. It is the one great factor that prevents a wider application of the perpetual crop idea to our American forests. For, after all, it is useless to spend money for planting and for other methods of securing future crops of timber if these crops are in grave danger of burning up before they may be reaped.

So, in this country, the greatest problem in all forestry, today, is to find some way of preventing and controlling forest fires.

Fire presents a dual problem—first to prevent them from starting and second to put out quickly and cheaply the fires that do start. The first—fire prevention—means the long difficult task of making the American people realize that fires are a too-expensive luxury.

Foresters have not yet been successful in doing this. Fires are increasing, partly because more and more people are using the forests each year and partly because lumbering leaves forest areas in a condition to invite fire. There is a long, hard task ahead before each one who visits the woods will observe reasonable caution to prevent fire.

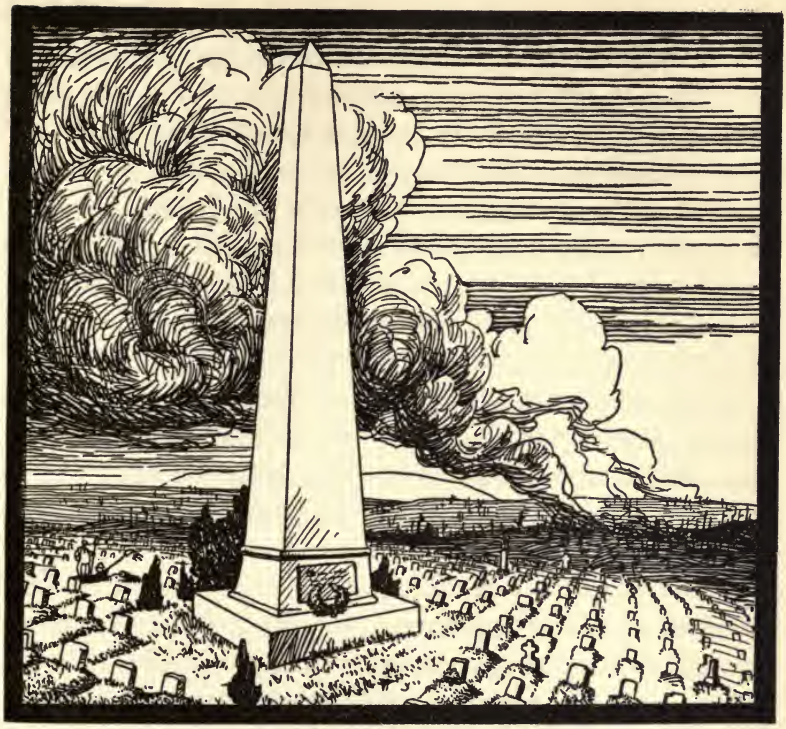
In the actual fighting of forest fires some progress is being made. The United States Forest Service particularly, has developed a technique and an organization that functions effectively during normal fire years. But it can never cope with years of great hazard until it is better equipped and more adequately

financed. The Forest Service puts fire suppression before all other duties. Every forest officer knows that on sighting fire he is to drop whatever he has been doing and fight fire until it is out, or until he is relieved. Throughout the National Forests, fire lookouts are established on the high points of vantage and there during the season of dry weather all the country is watched for telltale signs of smoke. Once seen these smokes are located on especially prepared fire maps, and their location at once telephoned to the nearest ranger or guard. It is his duty to leave immediately for the fire.

Usually fires are fought by cutting a line in front of them and digging a trench down to the mineral soil in front of the flames. Once they reach the trench, fires have no more fuel to feed on and go out. But it is not always so simple. Frequently fires will jump across the best fire lines that man can make and under heavy winds sparks from crown fires have been known to leap across great distances and start fires far in the rear of the fighters. In certain regions notably in Canada and our Pacific Coast airplanes patrol the forest in search of fire and often aid by giving forest officers a bird's eye view of large fires during the battle.

The usefulness of airplanes for fire detection varies with the locality. It will probably never supplant the stationary lookout or fire tower, but will serve as an added means of detection.

Above all other weapons in the long fight against forest fires, roads and trails stand out as all-important. It does little good to detect a fire immediately if days must elapse before fire fighters can reach it. Recognizing this, foresters are building roads and trails into the regions of greatest fire danger,



FIRE'S AFTERMATH

Forest fires in the United States have burned to death over three thousand people. No one knows how many billions of dollars worth of wood has been reduced to smoke and ashes. It must make at least one tall monument of solid gold.

making it possible to move men and supplies quickly when the need comes.

The Government is not the only timber owner that is attacking the fire problem. The States are protecting their forest lands with greater effectiveness each year and in the Northwest private companies are banding together for the protection of their merchantable timber.

Yet even today federal and state support of fire protection is not one half what it should be and private support is even less. Fire losses are still increasing and whenever drought sets the stage for destructive fires federal and state foresters alike find themselves helpless. The fires of 1910 swept the West unhindered by the heroic but poorly equipped fire fighters.

Nor in twenty years has the picture greatly changed. The fires of 1929 destroyed billions of feet of ripe timber, took the life of a forest officer and after a disastrous career which cost the country millions only surrendered to heavy rains.

To conquer the fire evil requires men and money, fire-towers, trails, roads and rapid transportation. It requires eternal vigilance and organized defenses for fires come quickly. In 1929 one lightning storm alone set over four hundred fires. To deal with such situations requires much more complete organization and equipment than will ever be possible until this nation can be moved to spend sums more in keeping with the gravity of the situation and the value of our forests.

In all this vitally important problem of forest fires sooner or later we can not escape the question—what are we going to do about it? After all, the responsibility for this annual sacrifice of twenty million dollars rests on each of us since each of us is directly affected. We have little enough timber here in America. Not nearly enough to cover our needs for lumber, paper, and the many other products that depend on wood for their existence. Certainly we have not enough to sacrifice yearly to the flames for even if forest fires were stamped out, we should still be using more timber than we are growing. We should still need forestry. But we should be in an immeasur-

ably better position to practice forestry and to plan for future forests if we knew they were safe from fire.

Nearly every forest fire could have been prevented. Only two out of every hundred are caused by lightning. The other ninety-eight are set intentionally or carelessly by the hand of man. Sparks from lumber mills, brush burners, railroads, smokers, campers, hunters—these are some of the causes.

The man-caused fire presents the chief difficulty. Government and State foresters can cope with the fires set by lightning. It is the ninety-eight per cent man-caused fires that breaks down their defenses and costs us millions of dollars and hundreds of human lives. Laws imposing penalties on all who allow fire to escape are helping make people careful. Educational campaigns are helping. But not until we resolve, as a nation, that we will not tolerate this costly waste, can we free ourselves from the fire burden.

When that day comes, when we need no longer fear the menacing threat of fire, then forestry will take a great forward step. The fire hazard, more than all other obstacles, combined has worked to hold back the practice of forestry. The main reason why today planting is proceeding at such a pitifully slow rate, both on and off the National Forests is because planting has had to wait for better fire protection. There is no virtue in planting trees unless you can prevent their burning up. If fire were conquered the sums of money that could be released for constructive forest measures and the added confidence that it would give in the profitable outcome of forestry would make this country a great timber growing nation. Foresters could devote all their energies to really productive ends—to actual

planting, thinning and research. Individuals would no longer hesitate to spend money on future forests and gradually each acre would be built up to its highest productivity.

A forest without fire is comparable to what the human race might be without disease—capable of attaining a usefulness that today we can only hopefully dream of.

CHAPTER 18

THE WAR AGAINST WOOD WASTE

CHAPTER 18

THE WAR AGAINST WOOD WASTE

A tree saved is a tree grown.—CALVIN COOLIDGE.

SINCE we have less than enough wood in the United States to fulfill our present and future needs, we certainly have not enough to waste. Nevertheless, we do waste quantities. We actually waste more of the wood that grows in the forest than we use. Very little of the total contents of a forest goes into finished lumber.

This process of converting a forest into boards is essentially a process of elimination and the actual amount that finally becomes a finished product is a very small fraction of the whole. In the average forest about ten per cent of the trees are small and defective and these are not even cut. Fifteen per cent more of the wood is left in the forest in the form of tops, stumps, and brush. Ten per cent more is bark. The saw itself eats up another ten per cent and turns it into sawdust. Nearly twenty per cent more is removed in the form of slabs and edgings when the boards are cut out of the log. Later still some of the wood is wasted and lost in seasoning. Finally when all these operations are completed, only thirty per cent, or a little less than one-third of the wood in a normal forest has become lumber.

Usually not all of this lumber gets used—sometimes very little of it. For if the boards are destined to be resawn and made

WHERE THE FOREST GOES

Less than a third of the wood in a mature forest finally becomes lumber. The chart tells what happens to it in the process of logging and manufacture.

into furniture, about one-half of the wood they contain is wasted in the processes of remanufacture. So, in many cases, only a very small part of the wood that nature has been slowly

producing for hundreds of years finally becomes of use to man.

Fortunately only in very wasteful mills would all this material be thrown away. Wood is too valuable and is becoming too scarce not to make use of every available piece. As wood increases in values, more and more careful measures are taken to prevent waste. Not so long ago, each large sawmill possessed as part of its equipment a tall cylindrical tower called a refuse burner. At the base of this cylinder a fire burned, and to it the slabs, edgings, sawdust, bark and other odds and ends of wood were taken and burned. A great deal of the profits went up in smoke with those odds and ends, and as mills have devised more careful methods and found new uses for parts, formerly burned, the fires in these refuse burners are less bright and some of them have gone out forever.

Foresters and the lumber industry together are waging war on wood waste in industry. Each year the many kinds of waste that attend the manufacture of logs into lumber eat up hundreds of millions of dollars worth of wood. But each year waste is decreasing. Parts of pine and fir, that not so long ago went to the refuse burner, are being used today for laths; pieces of hardwoods that once were thrown away are being converted into furniture stock, handles, woodenware, toys and other small objects.

Sawdust was once a burdensome thing to mill operators, something that was a problem to get rid of. They couldn't give it away. Now industry is finding many uses for it. Sawdust serves as fuel to keep the mill furnaces going; it is used for packing and for refrigeration, and Uncle Sam has even learned how to make a food out of it that cattle eat and thrive

on. The amount of sawdust, itself, has been greatly reduced by using thinner saws which, in the process of cutting make less sawdust than the thicker saws.

Building up wood from odds and ends formerly discarded is another practical economy and some mills are gluing together small pieces of wood and building them up to do the work of larger, higher grade material. These built-up pieces serve just as well as the sawed pieces and, as a matter of fact, the glued joints are often stronger than the wood itself.

In other cases wood not used for lumber is converted into charcoal and into wood alcohol. This is an important use of waste material for from twenty to twenty-five gallons of alcohol can be produced from a ton of dry coniferous wood. From material now wasted at the mills, probably some three hundred million gallons of alcohol could be made each year. This promises to become an increasingly valuable product, since wood alcohol is yearly more and more important as a fuel for motors.

Composition boards for partitions and interior walls are increasing in popularity and these are frequently made of wood ground from waste pieces.

So all the industries that use wood as a raw product are helping the forester by eliminating waste and finding uses for parts that once were discarded or fed to the burners. After all, to save the timber in a thousand trees by more careful methods of manufacturing is just as much a step forward in conservation as it is to grow a thousand trees. And although the day of complete utilization is far off, industry is constantly working toward the time when they will use all of a tree but "the knotholes and the whispering among the branches."

Photographed by W. S. Clime

PLANTING ON THE NATIONAL FORESTS

But not all of our forest waste is to be found in the lumber mill—in fact, only a small part. Fire we have already called the greatest waster of all. Each year fire reduces to smoke and ashes enough wood to have built thousands of homes. Without doubt fires have destroyed far more timber since the settlement of this country than men have used. Tree killing insects cause tremendous waste of wood. Our ignorance of the values of woods for certain purposes is another source of waste. We have wasted millions of feet of hickory because we believed that the red heartwood was inferior to the white sapwood. Actually they are equally serviceable. To use perishable species for poles or fenceposts or weak species when strength is required—this, too, means waste. But there is still another kind of waste that goes on day and night before our eyes. It is not as spectacular as forest fires. It is not so easily controlled and corrected as the waste of industry, but it is responsible for nearly two-thirds of all the destruction of lumber in the land. It is decay.

Of course decay is the ultimate end of all living organisms. We can do little to prevent it, but in the case of wood especially we can delay it for many years. When wood is in contact with the ground, as it is in fence posts, poles, railroad ties, or when it is exposed to the air, as in boardwalks or buildings, decay sooner or later enters. Decay in wood is the result of various kinds of fungus growth that attack the substance of the wood cells and break them down, destroying the strength of the wood and rendering it useless.

Some woods are easily susceptible to the entrance of fungi and are completely destroyed within a few years. Others resist the entrance of this destructive enemy for great periods of time.

Three things are necessary to these fungi in order that they may destroy: food, moisture and air. If we can remove any one of those necessities we can prevent decay. Thus, when we thoroughly dry a piece of wood we remove the moisture and fungus can not live in it. When a piece of wood is submerged, air is excluded, and the wood can not decay. Paint and varnish on the surface of wood prevent the entrance of decay.

But the most effective method of fighting the decay fungi is by poisoning their food supply. For this purpose wood users have selected various preservatives which depend, for their effectiveness on poisoning the wood tissues. Usually the wood is either covered or impregnated with creosote or some other substance poisonous to the fungi. In more thorough methods of wood preservation, as in treating railroad ties, the ties are first seasoned carefully, then stacked in cars and rolled into large cylinders where live steam is admitted under pressure. After the wood is softened by this steam a vacuum is created to suck the air and moisture out of the wood cells. Next the preservative, usually creosote or zinc chloride, is forced into the cylinder and kept under pressure until enough has been absorbed by the wood to protect it. Twenty-five to thirty-five pounds of preservatives are often forced into each tie. By this treatment the life of a tie which untreated would be about seven years may be increased to more than fifteen.

But the actual saving means more than simply doubling the life of a tie. It means that railroads, instead of relying solely on certain durable species like white oak or cypress—species now getting scarce—can make use of a number of other kinds of wood that untreated would be valueless, because they rot so quickly.

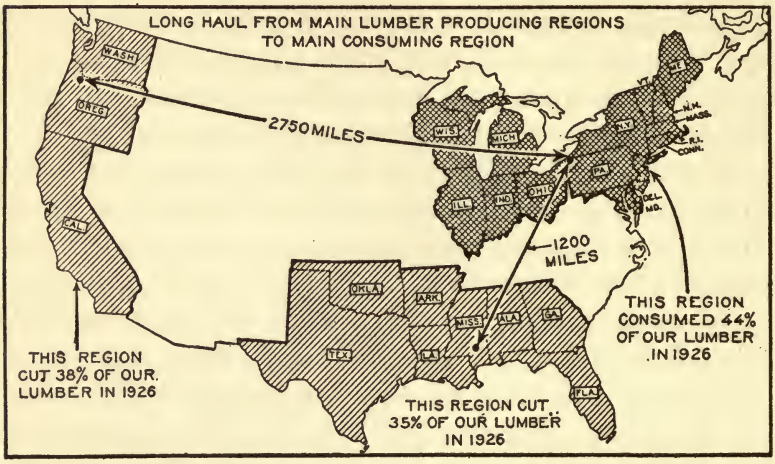
So successful have been these preservatives that creosoted ties of species which without treatment would decay in a few years often last longer than an untreated tie of the most durable species. Since about ninety million untreated railroad ties are in use today, this class of material alone, offers a possible saving to the nation and to industry of nearly two billion board feet of wood annually. Protecting wood from decay becomes increasingly important as our timber supply wanes and the cost of wood rises. Each year preservatives are cheating decay of millions of feet of wood in ties, piling, fence posts, and poles, wherever wood structures are exposed to earth and air.

Even beneath the surface of the water where wood is safe from the decay fungus, it is not safe from destruction. In salt water wood has an especially active enemy, the Teredo or ship worm. These worms make long, cylindrical tunnels in the wood, often so closely crowded together that only a very thin film of wood structure remains between them. The pile of wharf, or whatever the structure soon becomes weakened under this attack and finally breaks. In the harbor of San Francisco the appetite of the Teredo costs millions of dollars yearly.

Government specialists are still working on some effective and practical means of cheating these ship worms of the millions of feet of wood they annually consume. Here, too, the chief reliance is placed on substances that can be forced into the wood and render it poisonous or unpalatable to the Teredo.

In this war against wood waste, probably more constructive progress has been made by the scientists at the Forest Products Laboratory of the U. S. Government than by all other investigators. The prevention of waste in the wood industry is one of the real reasons for the laboratory's existence. It is the center

of the scientific crusade to decrease the wastage of wood substance, whether it be caused by decay, poor mill practice, or by the waste that comes from using species poorly adapted to a particular purpose, or from any other preventable cause. Among other things, the laboratory is learning ways of making sturdier, more efficient crates and boxes, to prevent the very con-



THE LONG HAUL

Our remaining forest are so far from the great centers of supply that each year we pay an enormous freight bill for lumber alone.

Each year the south produces a smaller per cent. of our lumber and the long haul grows longer.

siderable waste that comes from breakage and from using two boards where one will do. They are finding uses for tree species that, in the past, industry has discarded as useless or inferior. They are speeding up nature in many ways, especially in seasoning. For while nature requires one to two years in which to season boards and often makes a rather bad job of it, these

Government men have learned how to season boards in a few weeks without splitting or warping.

All this work, of course, dovetails in with the forester's efforts to decrease waste in the woods itself.

In the woods, the forester is teaching and practicing careful cutting to prevent the waste that comes from leaving high stumps, or from discarding parts of the tree that should be utilized. And the forester, too, is speeding up nature by aiding the trees to get more light and by planting those acres that nature is powerless to reach.

In all this tale of tree growth and tree waste, we may get some idea of the vast effort nature must put forth to produce a little wood. At the beginning of a forest, a hundred thousand seedlings may start and spring into being on a single acre. One by one, crowding, competition, windfall, drought, and disease take their toll and of the final, mature stand, not over ten trees may be left to make the harvest. Of these, in the process of manufacture, perhaps three will become lumber and at last one or two may find their way to the finished product. Two out of a hundred thousand! Small wonder, then, that the forester and lumberman, everyone who uses wood has a very definite interest in this unceasing war against wood waste.

We who are the greatest nation of wood users in the world can not afford to be the greatest nation of wood wasters.

CHAPTER 19

FORESTRY AND THE FARMER

CHAPTER 19

FORESTRY AND THE FARMER

The tree of the field is man's life.—Bible.

The farmer is our greatest wood user. He is also one of our great wood owners and today about one-third of the forested land of the United States is on the farm. In the eastern United States alone, the area of woodlands on farms aggregates nearly seven times the forested land of all France. So from their very magnitude it follows that what happens to these farm woods has an important bearing on our future timber supplies. No discussion of our forest problem, or of our forest possessions can be in any sense complete without considering the important rôle of the farmer and his woodlands.

These are days when a great deal is being said about making our farmlands more productive. Farm science and farm practice have steadily directed their efforts toward making the soil produce agricultural crops most abundantly. And to do that is a vitally important thing for the soil is the cradle of all life. But it is also well to remember that one of the most important agricultural crops is firewood. Whatever will increase the value and productivity of the farmers' woods means greater prosperity to the farmer.

Foresters have long realized that the farm woodland is a great neglected asset which actually the farmer can not afford

to neglect any more than he can afford to neglect his cows or his corn. No modern farmer would allow his cornfield to crowd itself to death in one portion, have great open spaces in another and be choked everywhere with weeds. He would not tolerate this in his fields, but he does in his woods. He allows weed trees to choke out his more valuable species and he permits scattered straggling stands of timber to encumber land that should be producing five and ten times the amount of wood they actually grow.

It would be a rather poor farmer, too, who produced only ten bushels of wheat to the acre on soil that was capable of producing twenty-five, yet farm woodlands as a whole are today yielding only one-half to one-third the amount they could be made to produce if given a little management and care. From one standpoint, this is not surprising, for after all the woodland owner is a farmer, not a forester. His chief concern is with his agricultural crops. Yet, the following of a few practical fundamental principles would allow him to double and treble his wood crop.

The neglect of farm woodlands is commonly brought about by the fact that many farmers do not realize the value of the products from their forests. When a farmer sells his trees or fence posts, he may get less than one-tenth of what they are worth and when he uses them he often uses one species where another would be more durable and economical. Quite naturally all this tends to make him value these products too lightly. The tale is told of a farmer who sold a black walnut tree for fifty dollars. It seemed a very fair price to him and he was well content with the bargain. The buyer felled the tree at a cost of fifteen dollars and without moving it sold the logs for

one hundred and thirty-eight dollars. A little later it was resold, still on the same spot for one hundred and sixty-four dollars. This is not at all an exceptional occurrence, but it would be highly unlikely that the same farmer should sell his wheat at fifty cents a bushel if it were bringing a dollar and a half on the market.

In any nation-wide planning for the forests of tomorrow these farm woodlands must be given an important place.

A Wind Break

To protect crops from drying and from destructive winds farmers sometimes surround their farms with lines of tall trees. Lombardy poplar is a favorite for this purpose or alternate poplars and cedars.

Teaching the farmer the value of his woodland crop and teaching him to bring it to the same high degree of productivity that European farmers have attained is all part of our forest problem. This ought not be difficult for the woodlands of this country are capable of reaching and even passing the degree of productiveness normally secured on the continent.

Whatever happens on this enormous forest acreage in farm ownership is important to the country as a whole. There is so much of it, that to lie idle or partially idle, is bound to produce

a direct effect on the general forest situation. The timber growth on an average acre of farm woodland with reasonable care should be worth at least two dollars and often four dollars a year. With good forest practice it should easily be worth twice that. Yet, on many, indeed on most of the farm woodlands, the rate of annual growth is not one-tenth this amount. The farmer is somewhat in the position of a man who, owning a house, is content to rent it at one hundred dollars a year, when with a few repairs, with a little expenditure of time and money, he could rent the same house for a thousand.

We need only review the history of any one of our farm woods to learn why they are producing only a small portion of their possibilities. In almost every case, most farm woods were originally logged over long before the country was opened up to farming. This meant that the best timber was taken out and the poorer species and individuals spared. With the passing of time young trees sprang up and the best of these were again taken for local use, cut perhaps, to furnish timbers when the farm house was built. Each year, whenever material is needed for repairs, the farmer goes to his woodland and takes from it enough to meet his needs—usually cutting the best trees. So before many years pass, the woodlands become little more than an area of diseased and ill-formed, rejected specimens. A forest of culls and inferior species in no way resembling the thrifty valuable woods they might be.

In many regions the farmer allows his cattle, horses, or sheep and, worse still, his goats or hogs to graze within his woodlands. The damage they do to forests is always severe and often fatal. They bruise the wood of the young growth, trample it

Photographed by Block

FORESTS AND FARM LANDS

down, break it off, and absolutely prevent the start of a new forest.

Nor does the damage stop there. Cattle and horses pack the earth with their feet until the soft mulch that holds the water is destroyed and conditions within the forest so changed that after a time some of the older or weaker trees lose their foliage and die. The death of these allows light to fall on the earth which, in turn encourages a growth of grasses and weeds bringing in more cattle and definitely sealing the fate of the forest. There are many woodlands today in just this condition, weedy, grassy areas dotted with the decaying remains of what once were trees.

Now all this is far from saying that the farmer should not use his land for pasture. It all depends on what form of land use is most profitable to him. If his woodland, in a certain locality, can profitably be turned into pasture, the trees should be cut and sold and the area converted to grassland. But the attempt at making woodlands serve the dual purpose of pasture and wood factory is doomed to failure. The better way is to divide the farm into agricultural land and pasture land, and to preserve in woodland the higher, steep and rocky portions of the farm that are unfit either for good pasture or for agricultural crops.

Some day the farmer will be a farm forester. After all, he is in an excellent position to practice forestry with profit. He, of all classes of landowners, can best afford to be a forester. He can not afford not to be. He can not afford to neglect the returns that a few, simple forestry measures hold out to him and this is true even though the farmer never sells a stick of timber from his woodland. For fuel, for fence posts, and ma-

terial needed in the repair work that is always necessary on a farm, his woodlands will more than repay him for the time and effort he spends there. After all, he already owns the land. Usually it is land too poor to grow farm crops, but decidedly too good to give away. If it can be made to produce six or eight dollars an acre yearly, to the farmer's bank account, it becomes in a very real sense a valuable money crop.

Another important advantage the farmer possesses over the average landowner is that he can apply his efforts at forestry during the slack season. Winter is the best time to work in the woods, to cut and to thin, and it is this time of year that the farmer can best spare from the care of his agricultural crops. Wood is the one commodity that the farmer can raise as a spare time crop and many a farm that would not support a family by its agricultural harvests alone can be made to pay, because of its winter crop of posts, firewood and lumber.

Better roads are increasing the value of the farm woods and allowing the farmer to market materials that ten years ago were worthless. Here, too, the farmer as a forester enjoys an advantage not possessed by either state, government, or large timber owner. For the farmer's forest land is near the great centers of population, and with the costly problem of long distance transportation he has nothing to do. Neither is he forced, like the lumberman, to cut regardless of the conditions of the market. He may keep his woods intact until they will bring in a fair return, secure in the knowledge that, like money at interest, his trees are day by day putting on added value.

But, in order to sell intelligently, the farmer must keep in touch with the trends of the market. Here the State Forester will often give him aid and advice. Many of the states are

very effectively helping the farmer market his wood crop more profitably. Their trained foresters familiar both with local markets and with good forestry practice are giving him personal advice regarding the value of his products and right methods of cutting. They will tell him what he should cut in order to leave the woods in the best condition, what he can most profitably sell, and about what he should get for it. Some states are doing more. Others supply free, or at slight cost, seeds for planting and even seedlings for windbreaks or for planting up the open spaces in his woods. Even the Federal Government has made provision in its forest legislation for distributing planting stock to the farmers of the country.

So the farmer is on the way to becoming a forester and his woodland crop is destined to play no small part in the final solution of our forest problem. In fact, if on every farm in the country every acre of forest soil were today producing wood to its utmost capacity, we should have little to fear from a timber famine.

In addition to the actual wood products that can be grown, trees are beneficial to the farmer in many ways. They serve as windbreaks, protecting his crops from drying out in the hot winds of summer and sheltering his livestock and his farm house from the severe blizzards of winter. Trees are continually building up the soil, adding to its fertility. They are making the farm more healthful and better to live on. Some of them are supplying nuts, some maple sugar, and all of them are giving protection and friendly shade.

The farmer who practices a few rudimentary principles of forestry will be rewarded to a degree he never thought possible. Those woods of his will respond surprisingly to a little

care, to protection from fire and livestock, and to a little wisdom in methods of cutting. After all, that is not much to ask of a property that without cultivating, without fertilizing, will return crop after crop perpetually and each year for good measure is enriching the soil while it beautifies and benefits the countryside.

CHAPTER 20

INDUSTRIAL FORESTRY

CHAPTER 20

INDUSTRIAL FORESTRY

Forestry is becoming the cheapest source of timber.
—W. B. Greeley.

Industrial forestry, or the practice of forestry on privately owned land by private enterprise, emphasizes one phase of the forest problem that only receives minor consideration when forestry is practiced by States or Government. It is the problem of money returns for money expended. Industrial forestry, like any other business undertaking, is an activity conducted purely and simply for financial profit.

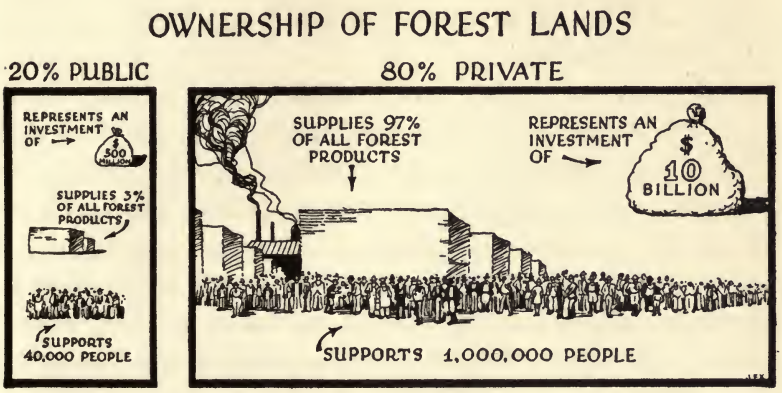
"Will it Pay?" That is the one question that must be satisfactorily answered before private capital is ever likely, of its own volition, to become interested in the practice of forestry. It is a money matter—a matter of cold hard finance. Governments and States may embark on projects for the benefit of generations still unborn. They can and do make expenditures for the sake of indirect benefits to the public at large. They need not think solely in terms of profit and loss. This is not true of business. Stockholders are not philanthropists and their purpose in undertaking any enterprise is to get back money returns for money expended. Every foot of privately owned land, whether it be a city lot, a farm, or a forest is a problem in economics to its owner. Unless forestry can be made an

attractive financial venture, we shall not reasonably expect private capital to be used for growing trees.

Nevertheless it is of supreme importance to the welfare of our country that some degree of forest culture and protection be practiced on these privately owned timberlands, for they represent two-thirds of the forest lands of our nation and produce about 97 per cent of our lumber and forest products. Moreover these private holdings are usually the more valuable, highly productive forest lands, for the areas in Government and State ownership are the mountainous, more rugged, and generally less productive tracts. Forests in private ownership constitute a tremendous domain. They represent an investment of about ten billions of dollars and provide employment for over a million people. They contribute directly to the support of ten millions more. So what happens to these forests—this source of a gigantic industry, is a matter of national concern. In a very real sense the future of forestry in America lies today in the hands of these private individuals, who, as business men, are interested in paying ventures, whether it be forestry or shipping, or manufacturing. The immediate problem, then, is one of learning whether or not forestry under present conditions pays and, if not, how to change these conditions until it can be made to pay.

In the long run whether or not forestry pays depends largely on the value of the finished product—lumber, paper pulp, charcoal, or whatever it may be. While our wild forests existed in large quantities, the price of lumber was largely dictated by the cost of logging and transportation. Timber on the stump sold for next to nothing. During those days it would have been out of the question to raise a man-made forest that might

compete with the forests we had inherited and which we were throwing so lavishly on the nation's bargain counter. But inevitably as the wild forests were cut in the East and South, transportation costs began mounting and today with our last big body of timber in the Northwest and our great centers of



FOREST USE—PUBLIC AND PRIVATE

One fifth of our forests are publicly owned—property of state or federal government.

The other four-fifths is under private ownership and from this come practically all the products of the forest. Cutting is going on much more rapidly on these private forests and many of them are reaching the end. Government foresters are cutting more conservatively with a view to making the public forests produce increasingly valuable products for all time.

consumption in the East, it costs between fifteen to twenty dollars a thousand board feet for transportation alone. Naturally, this must be borne by the user of lumber and naturally, too, it is making the few forests accessible to markets take on a real value. These rising costs have made it possible under favorable conditions to plant a forest and to bring it to maturity profitably. This is the real reason why industry is today be-

coming interested in forestry—it has become, in many localities, a money making venture.

Primarily the lumberman is interested in tree growing because forestry seems the only way of perpetuating his business. Yet, although the area of forest destruction increases annually, actual accomplishment in private forestry is not moving as swiftly as the state of forest depletion requires. For this there are several reasons.

Fire risk is one. High taxes is another. And still another is the natural hesitation timber owners may have for beginning a new and unfamiliar venture. Yet here and there a start is being made in industrial reforestation. In the redwood country on the Pacific Coast a number of lumber companies have established nurseries and are planting young redwood trees. Redwood, under good conditions, will grow to saw-log producing trees in forty years and their rapid growth should insure good profits.

In the Southern pine region one of the largest lumber companies is planting thousands of pines each year. By the time their mature timber is cut, these seedlings will have grown to merchantable size and be ready for the harvest. In the Northeast are many privately owned plantations of varying sizes that are proving to be very attractive investments. Large tracts are being cut under forestry principles—seed trees are left, fire kept out, and conditions made favorable for vigorous, healthy tree growth. In the higher mountainous regions, practically no private forestry has been attempted—growth is too slow there and it is too far from the large centers of utilization.

For the United States as a whole the acres of privately owned

HARVEST TIME IN THE FOREST

forest land that are being protected and put on a productive basis is still a drop in the bucket compared with the millions of acres where more or less destructive lumbering is the rule. Many foresters believe that this condition will correct itself as economic conditions change, while other foresters hold that some form of government regulation will be necessary before forestry on private lands is generally adopted.

This much is certain. Private forestry will be generally adopted under one of two conditions—when it becomes mandatory or—when it can be shown to pay.

But the question "Will forestry pay?" must be answered like so many questions in life, "It all depends." Under good average conditions of climate, soil and accessibility to markets *forestry will pay*. That can not be said too emphatically. Forestry is rapidly becoming the cheapest source of forest products. It will some day be the only source. Of course there will always be certain favored localities where forestry will pay richly and there private forestry is already taking hold. There will also always be remote infertile regions where private forestry can never hope to pay and where it will probably be the function of Government to grow timber crops if the land is to be used at all.

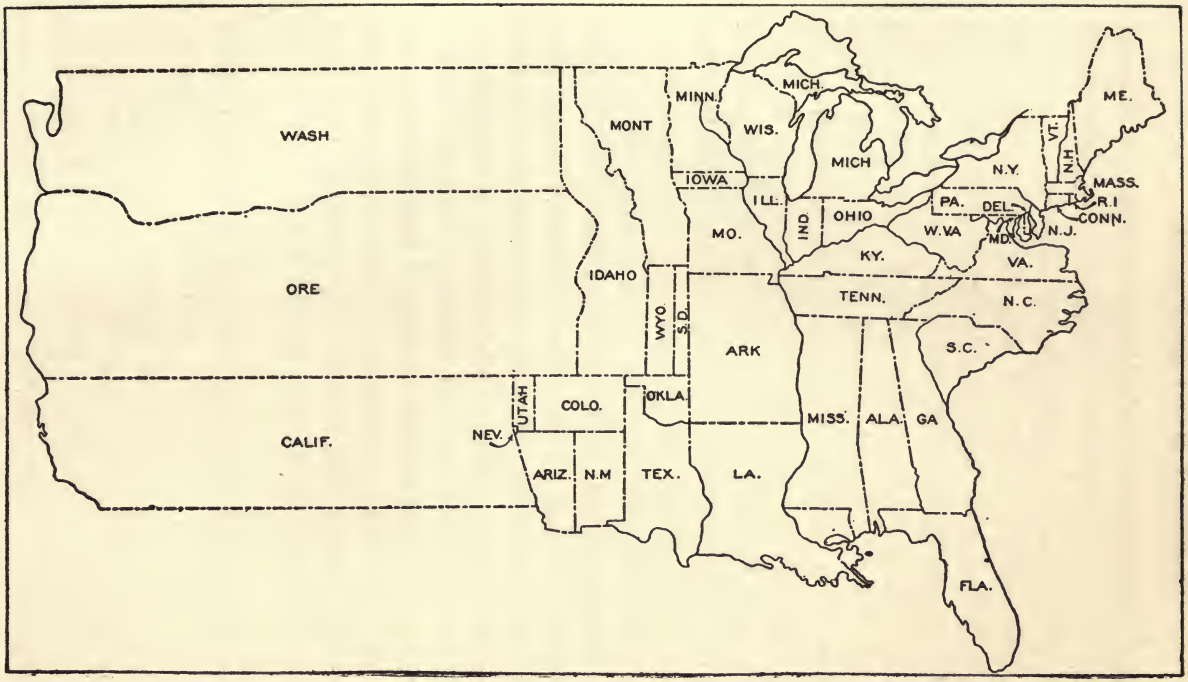
But between these two extremes lie millions of acres covering every degree of forest condition and location where private forestry will offer more or less attractive financial opportunities. The picture of tomorrow will probably resemble conditions that today exist in European forests. There the material that takes a short time to grow, such as ties, mine props, posts, and small size lumber, is grown on private forests. But the

larger timber trees that require nearly a century to mature are grown for the most part by Government, since it alone is free from the burdens of taxation and interest.

Meanwhile, in this country a number of companies are already protecting their timber lands from fire, and leaving seed trees to supply another crop. These are the first elementary steps of forestry and although they will not, of themselves, produce ideal forests, they are, nevertheless true conservation measures for forestry begins with fire protection. Other companies are limiting fire protection to the uncut timber and leaving the cut-over areas and young growth to shift for themselves. This is not to be confused with forestry. It will not add one tree to our next crop of timber. It is merely a form of timber insurance.

Private enterprise is already making important contributions toward forest problems in the field of research. Through study and experimentation they are learning new uses for unused species and are yearly perfecting methods of manufacture to reduce waste.

Investigations into methods of logging often result in discoveries that not only mean a saving for the lumber company, but leave the ground in better condition for forest renewal. Not long ago a federal forester made an investigation for a lumber company into the cost of cutting and manufacturing lumber from trees of various sizes. His report showed that by leaving trees below a certain size the company could save money; that every log they cut and manufactured below this size resulted in financial loss. The company adopted the forester's suggestions at a saving of about two hundred thousand dollars a year. The small trees previously taken are now left to mature and serve as seed trees and as the nucleus of a



IF EACH STATE'S TIMBER GOVERNED ITS SIZE

This map shows how the United States would look if the size of each state corresponded to the amount of timber in it. It also brings home that most of our remaining timber is far from the great centers of consumption. Pennsylvania, New York and Michigan—states that once led the nation in timber production—have shrunk to insignificance.

When the timber in the three western states is cut—what?

future cut. It is this sort of thing that helps bring forestry out of the realm of mere academic interest for the lumberman and place it among practical business enterprise.

Many large lumber companies are employing technically trained foresters. These men are conducting planting operations, making studies of growth and forest renewal and sometimes taking charge of the timber cutting. They are making estimates of the timber and helping formulate policies for more conservative cutting. They are even laying plans for perpetual yields where the tracts of the company are large enough to make it possible. This combination of forester and lumberman is doubly helpful and on it will probably be based the bulk of forestry's future progress.

Lumber companies are not alone in finding the practice of forestry a necessary thing for the continuation of their business. Water companies for a number of years have been planting trees about the headwaters of their stream sources and have adopted forestry as a sideline. Their thought in creating and maintaining a cover of forest trees about reservoirs and streams is to preserve the clarity of their water and keep the reservoirs from silting after heavy downpours. These companies, too, are employing foresters who, through the sale of forest products from these lands are more than paying for the expense of forestry.

Coal companies, railroads, and other users of large quantities of wood in one form, or another, are finding it increasingly profitable to raise their own forest products. Paper pulp companies are employing foresters in an effort to grow more wood and to enable them to remain in business without the necessity of importing their raw material over long distances.

In the face of our increasing dependence on foreign sources of paper pulp supply, forestry takes on the quality of necessity for paper companies are importing wood pulp in larger quantities each year. Even some of our lumber companies are beginning to find it necessary to import. One mill in the South has cut out its local timber and is now bringing redwood logs down the California coast through the Canal and across the Gulf. Only in this way can it continue to exist. Other mills in the South are importing logs from Mexico and Central America and, as the years pass, they will probably import increasing quantities. But it is not an economical measure. It is from many standpoints an unsatisfactory and temporary measure. Yet, it can be corrected by one thing only—the growing of sufficient wood crops nearer at home. Forestry undertaken in time would have insured a far cheaper and more accessible source of supply.

So private forestry is increasing. It is bound to increase, although, in certain regions it will find favor much faster than in others. Naturally, it will come most rapidly where financial returns promise to be greatest. Today it seems to be waiting on the exhaustion, partial or complete, of the wild sources of supply that in the past have kept the prices of forest products below the possibility of timber growing. For private forestry first and last is an economic venture. Yet it is entirely practical. It is more than that. It is inescapable because forestry is the cheapest method of producing that world-wide necessity—wood.

CHAPTER 21

THE TASK AHEAD

CHAPTER 21

THE TASK AHEAD

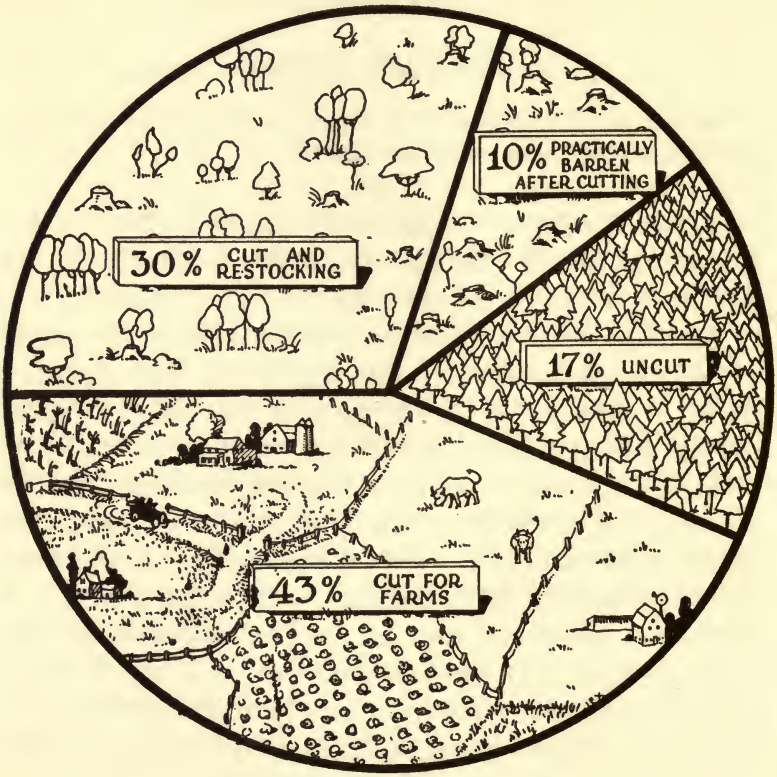
The welfare of the nation is to a large extent dependent on the perpetuation of our forests.—Herbert Hoover.

It requires no gift of prophecy to tell which way a man is headed who spends five times his income. So far as our forest income is concerned, we Americans, typify that man.

We are headed toward forest bankruptcy. Each year we are using this forest capital of ours nearly five times as fast as nature is able to declare dividends in the form of annual growth. Each year finds us with less wood and fewer forests than before. Inevitably that sort of thing has an ending. We can not go on as we have, using wood many times faster than we are replacing it. One of three things will have to be done—decrease our use of wood, import it from foreign countries, or grow more timber at home. To use less wood than we have actual need for is to lower our standards of living. It would mean the enforced acceptance of more, or less, unsatisfactory substitutes. To depend on foreign imports is to subject ourselves to the hazards of high duties and uncertainty of supply. The only really practical answer to the dilemna of our vanishing forests is to roll up our sleeves and grow more timber at home.

Profligacy with forests is no new thing among the nations of the world. Many countries have travelled the broad, easy

road of forest destruction. The pity of it is that we in America have had to learn by our own bitter experience, rather than profit by the experience of others. For the lesson is plain and



WHERE OUR ORIGINAL FORESTS WENT

Of the more than eight hundred million forest acres that grew here originally almost half has been cut to make farms.

It is with the other portions—the cut, the devastated and the uncut that our forest policy must concern itself. Before it is too late we must put into effect a national policy of conservative cutting for the forests that remain and of reforestation for the lands that have been cut.

many times repeated. Just as other nations have been forced by economic necessity to emerge from an era of destructive timber mining into an era of planting and scientific harvesting, so must we.

We cannot escape the simple mathematics of our predicament.

Our remaining forests are being cut over at the rate of about ten million acres a year. Natural growth falls short by seventy-five per cent of replacing it. Planting progresses at a snail's pace, for during the time we have created a hundred million acres of man-made waste out of virgin forests we have planted little more than one and one-half million acres. Each year we plant about the same area that the lumber industry cuts over in scarcely more than four days. Lumbering has had no permanency in any region. The rate of cutting so far exceeds the rate of natural growth and of artificial planting that timber exhaustion soon follows exploitation and lumber mills have been forced to move about in nomadic search of new supplies. Yet, we can not afford to let lumbering remain a migratory business, for it is one of our basic and most important industries. It has done much toward the rapid upbuilding of our nation. It deserves the stabilization that can only come from establishing perpetual timber crops.

After all there is no need for us to become a nation of timber paupers. There is no need of our going into forest bankruptcy. We have millions of acres of fertile soil and we are the wealthiest nation on earth. We can well afford to invest in American timber futures. We have the experience and knowledge of the past to guide us. We can undo what we have done. We can turn our liabilities of waste land into rich

forests again and become a nation of timber growers. We have simply to frankly acknowledge that we have passed out of the era when lumber came as a free gift of nature and must enter now into an era when timber is to be produced by the husbandry of man.

But how?

That is the task that lies ahead. It is not difficult to state in broad terms the general principles to be followed. First of all we must seek for a continuous and sufficient supply of wood for our needs. On only one-fifth of our forest land is this practically assured. One-fifth of our timber is already in public ownership and the timber there has every prospect of being handled as a continuous, renewable crop. It is about the remaining four-fifths of our timber land, the portion in the hands of private owners, that our problem centers. We must see that this, too, is treated no longer as a mine to be exploited and abandoned but as a source of perpetual crops. Forestry will not be economically feasible, as a business venture, on all of this,—at least not yet. There are localities where tree growth is slow, where the species are of little value, or where the products are inaccessible to markets. In such places the only answer seems to be for the State or Government to buy these lands and bring them into public ownership. This is far from meaning that these forest lands will be financial burdens to the public. For, although they may have no present prospect of returning dollar for dollar from timber growth alone, they will serve other public ends such as game refuges, or as protection forests for our streams, or soil stabilizers and recreation sites. Without doubt there are additional areas that the States will want in public ownership. Some States have al-

Photographed by W. I. Hutchinson

FORESTERS IN WINTER CAMP

ready adopted definite policies of acquiring forest land. Pennsylvania has three million acres and plans on ultimately placing twenty per cent of her forest land in public ownership. New York State possesses two million acres and has raised five million dollars for future purchases.

Increasing our public forests—State and National—is one step in solving our forest problem. But ownership means assuming responsibilities for proper management. It means the appropriation of funds that these public forests shall supply wood perpetually and shall be perpetual demonstration areas of the highest scientific practices. In the case of federal forests it means that the Forest Service must be given more funds for research and for the intelligent application of the fruits of research than it has ever possessed in the past.

Beyond this many foresters believe that the public has a right to demand that all timber land, even when privately owned, should be left after cutting, not as a brush-covered, fire-inviting waste, but in such condition that one can reasonably expect it will restock itself to trees. These foresters feel that the public has a right to require this on private forests just as it has a right to require sanitary and fire-preventive precautions in private industrial plants of any other character. But the public also has a very definite responsibility in first doing every reasonable thing to make such demands practical, economic possibilities. It has a responsibility in helping provide protection against forest fires.

Fire protection is an immediate necessity. This is especially true of the timber land already cut over. Our present acreage of second growth and young timber is more than twice that of our remaining virgin timber and this area we must protect

if we are to insure the safety of tomorrow's forest. Here the State, with her police powers and facilities for administration and education, must function.

The State has another responsibility. It must provide a just method of taxing forest crops and forest land. With adequate fire protection and fair taxation accomplished facts, the public will be in a better position to go to the private owner and ask him to clean house.

House-cleaning will mean various things in various places. It will mean brush disposal and the leaving of seed trees in certain regions, clean cutting and planting in other regions, and other methods of forest perpetuation somewhere else. But, for every timber type it will mean provision for a future crop of trees. There will be purely local problems that must be solved in purely local ways and no one set of rules will apply over very large areas.

The areas already devastated with fire and axe so disastrously that nature has been unable to restock them—and there must be in all, between fifty and one hundred million acres of these—will probably have to be replanted. It is going to be a difficult and expensive project that probably the Government itself will have to undertake over many millions of acres. Other areas that have been cut over, or burned over, or both, are producing only haphazard, sparse, second growth of limited commercial value. These must first of all receive adequate fire protection and then the benefits of as intensive forest measures as we can give them.

Naturally not all of these areas can be cared for at the same time. Those in danger of rapid deterioration and those nearest the great centers of wood use will be the ones on which to con-

centrate first. After all the location of a forest is one of the most important factors that makes for its value and usefulness. It is especially important that timber be grown reasonably close to where it is going to be used and so prevent the waste that comes from transporting lumber from coast to coast. For accomplishing this we are in a favorable situation since three-fourths of the land available for timber growing is east of the Great Plains and at the very door of our great centers of consumption.

Constantly increasing prices for forest products are having their effect on the outlook for profitable timber growing. Since 1845 timber prices have advanced three and a half times as fast as the average price of other stable commodities. These higher prices, which we might note in passing are the unmistakable thumb prints of a lumber shortage, have already begun to be reflected in decreased per capita use. In 1906 each person in the United States used 516 board feet of timber. Since that high level it has fallen forty per cent. Our total wood use, as a nation, has remained about the same since our increased population just about compensates for decreased per capita use. The significant point is that this enforced decrease in wood use represents neither conservation nor economy. It is not desirable that our use of wood should decrease except in so far as we are able to find better and cheaper substitutes. Usually the substitutes we have been forced to use in the past are not so good as wood and only a little cheaper.

Intensive utilization is all very well and waste is bad, but the degree of intensiveness that some countries have reached can be predicated only on dire need and on a degree of timber scarcity that would be regarded in this country as a very real

calamity. In some foreign countries the need for fuel wood drives thousands of city dwellers into the woods to pick up twigs, branches, and pine cones and carry them home.

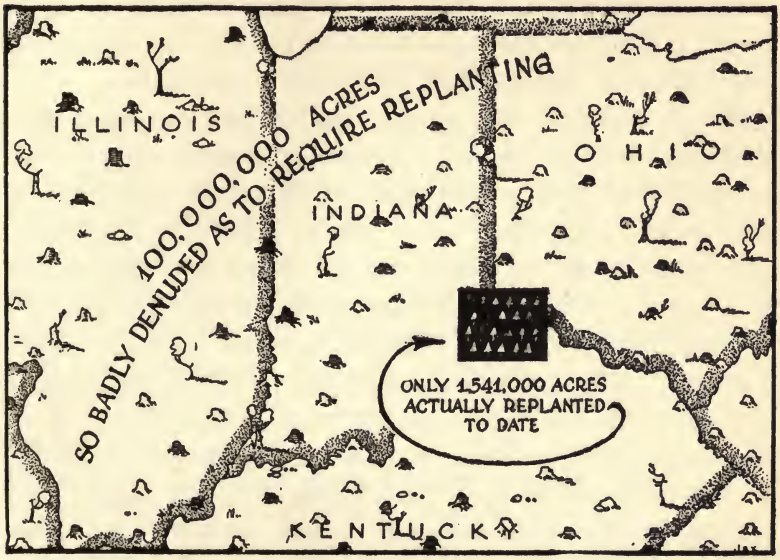
As wood becomes scarcer it is inevitable that prices must further advance until we reach the day when the products from man-planted forests begin to stabilize the price of wood. One thing is certain. The day of cheap wild timber is forever behind us. Wood will never be so cheap, nor so plentifully used, as in the past. Future prices and future supply will depend on the coöperation of wood users, the wood manufacturer, and the wood producer. It will depend on the coöperation of State Government, Federal Government, and private industries. Today coöperation seems the key to open up the future of forestry in this country. Legislation has broadened the coöperative scope of the Federal Government so that now it can work with the State and with the private owner in forest fire protection. Cooperative legislation makes it possible for seeds and tree plants to be distributed to farmers for windbreaks and plantations. It is this spirit of mutual helpfulness, of attacking the problem from all sides and in the interest of all that seems to offer the greatest possibilities for the forestry of tomorrow.

The way out of our dilemma then lies in securing fire protection, wiser methods of taxation, more public forests, proper care in lumbering, and research into better methods of wood growing and wood using. Ultimately it lies in growing timber on every acre of available forest soil. That will not be a bit too much. Even with all our forest acres growing trees, we shall have an annual wood crop of possibly twenty-seven billion cubic feet and that is only very little more than we use today.

Photographed by H. D. Cochrane

A FOREST TREE NURSERY

As part of any adequate program we must learn the best ways of growing timber and the best ways of using timber. We must direct the light of scientific investigation into the secrets of tree growth for even today, with over a half century



OUR MAN MADE DESERT

Some of our forests have been cut and burned so severely that it will have to be replanted before it can again produce valuable timber. Between eighty and one hundred million acres are estimated to be in this condition—a vast area that would cover several large states.

In the meantime actual forest planting proceeds at a snail's pace. Only one and a half million acres of forest have been replanted to date.

Reforesting our man-made desert and preventing further destruction is the heart of America's forest problem.

of forest practice behind us, we know very little of even our most important species.

Already we have waited over long. We can not delay until the forests are exhausted and remedy the situation over night,

or in a few years, or even decades. If we started full speed ahead today, there would still be a time of privation, a time of suffering from insufficient forests before these new man-caused forests can reach maturity.

It is important that we delay no longer with a program that sooner or later we must inevitably carry out. The longer we delay the more burdensome this program becomes.

We, in America, talk a great deal and write a great deal about making this country the most advanced nation in the world. It is a worthy ambition. Directly ahead of us lies one way of beginning this task. It lies in formulating and adequately supporting a program that will balance timber growth and timber use. It lies in covering again our hills with forests, banishing the fire menace and cutting down waste. The way is before us of creating great areas to supply our increasing need for wood and for the many varied gifts the forests give. It means turning millions of acres now partially or wholly desolate into cool friendly woodlands that will protect our streams, hold back the soil in flood time, provide pure water through the drought of hot summer days, and for all time furnish playgrounds for our hours of recreation. And besides all this, these forests will be giving us year in, and year out, that greatest of all nature's gifts—wood.

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