

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY,
Washington, D. C., December 4, 1897.

SIR: I have the honor to recommend that the two articles contributed by me to the Yearbooks for 1894 and for 1895 on forestry for farmers be reprinted as a Farmers' Bulletin. The articles contain information in popular form regarding the growth of trees, the planting of a forest, treatment of the wood lot, the cultivation of the wood crop, influence of trees, etc. A wider distribution of this information, for which there is still considerable demand, would, I believe, result in acquainting farmers with a subject the importance of which has not always been duly recognized.

Very respectfully,

B. E. FERNOW, *Chief.*

Approved:

JAMES WILSON, *Secretary.*

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FORESTRY FOR FARMERS.

The following five chapters have been written with the view of aiding farmers who own small timber tracts or wood lots, or who wish to plant some part of their land to forest. This country varies so greatly in soil, climate, and flora that it is only possible, within the limits assigned for the present discussion, to outline general principles everywhere applicable. Nevertheless, wherever suggestions have approximated the laying down of rules of practice, the writer has had mainly in mind the conditions prevalent in our northeastern States. Moreover, for the reason already referred to, limitation of space, it has not been possible to give more than a comprehensive view, without much detail.

The succeeding chapters should be read connectedly, as they are more or less interdependent. The first treats of the behavior of a forest plant; the second, of the principles which should guide the planter in setting a crop; the third, of the manner in which a natural forest crop should be produced; the fourth points out how the crop should be managed afterwards in order to secure the best results in quantity and quality of material; while the fifth chapter is devoted to a consideration of the relation of forests to farms.

1. HOW TREES GROW.

Trees, like most other plants, originate from seed, build up a body of cell tissues, form foliage, flower, and fruit, and take up food material from the soil and air, which they convert into cellulose and other compounds, from which all their parts are formed. They rely, like other plants, upon moisture, heat, and light as the means of performing the functions of growth. Yet there are some peculiarities in their behavior, their life and growth, which require special attention on the part of a tree grower or forest planter, and these we shall briefly discuss.

FOOD MATERIALS AND CONDITIONS OF GROWTH.

Trees derive their food and solid substance in part from the air and in part from the soil. The solid part of their bodies is made up of cellulose, which consists largely of carbon (44 per cent of its weight), with hydrogen and oxygen added in almost the same proportions as in water. The carbon is derived from the carbonic acid of the air, which

enters into the leaves and, under the influence of light, air, and water, is there decomposed; the oxygen is exhaled; the carbon is retained and combined with elements derived from the water, forming compounds, such as starch, sugar, etc., which are used as food materials, passing down the tree through its outer layers to the very tips of the roots, making new wood all along the branches, trunk, and roots.

This process of food preparation, called "assimilation," can be carried on only in the green parts, and in these only when exposed to light and air; hence foliage, air, and light at the top are essential prerequisites for tree growth, and hence, other conditions being favorable, the more foliage and the better developed it is, and the more light this foliage has at its disposal for its work, the more vigorously will the tree grow.

In general, therefore, pruning, since it reduces the amount of foliage, reduces also, for the time, the amount of wood formed; and just so shading, reducing the activity of foliage, reduces the growth of wood.

SOIL CONDITIONS.

From the soil trees take mainly water, which enters through the roots and is carried through the younger part of the tree to the leaves, to be used in part on its passage for food and wood formation and in part to be given up to the air by transpiration.

In a vigorously growing tree the solid wood substance itself will contain half its weight in the form of water chemically combined, and the tree, in addition, will contain from 40 to 65 per cent and more of its dry weight in water mechanically or "hygroscopically" held. This last, when the tree is cut, very largely evaporates; yet well-seasoned wood still contains 10 to 12 per cent of such water. The weight of a green tree, a pine, for instance, is made up, in round numbers, of about 30 per cent of carbon and 70 per cent of water, either chemically or hygroscopically held, while a birch contains a still larger percentage of water.

The largest part of the water which passes through the tree is transpired—i. e., given off to the air in vapor. The amounts thus transpired during the season vary greatly with the species of tree, its age, the amount of foliage at work, the amount of light at its disposal, the climatic conditions (rain, temperature, winds, relative humidity), and the season. These amounts are, however, very large when compared with the quantity retained; so that while an acre of forest may store in its trees, say, 1,000 pounds of carbon, 15 to 20 pounds of mineral substances, and 5,000 pounds of water in a year, it will have transpired—taken up from the soil and returned to the air—from 500,000 to 1,500,000 pounds of water (one-quarter to one-half as much as agricultural crops).

Mineral substances are taken up only in very small quantities, and these are mostly the commoner sorts, such as lime, potash, magnesia, and nitrogen. These are carried in solution to the leaves, where they are used (as perhaps also on their passage through the tree), with a

part of the water, in food preparation. The main part of the mineral substances taken up remains, however, as the water transpires, in the leaves and young twigs, and is returned to the soil when the leaves are shed or when the tree is cut and the brush left to decompose and make humus.

Hence the improvement of the fertility of the soil by wood crops is explained, the minerals being returned in more soluble form to the soil; as also the fact that wood crops do not exhaust the soil of its minerals, provided the leaves and litter are allowed to remain on the ground.

For this reason there is no necessity of alternating wood crops, as far as their mineral needs are concerned; the same kind of trees can be grown on the same soil continuously, provided the soil is not allowed to deteriorate from other causes.

As the foliage can perform its work of food assimilation only when sufficient water is at its disposal, the amount of growth is also dependent not only on the presence of sufficient sources of supply, but also on the opportunity had by the roots to utilize the supply, and this opportunity is dependent upon the condition of the soil. If the soil is compact, so that the rain water can not penetrate readily, and runs off superficially, or if it is of coarse grain and so deep that the water rapidly sinks out of reach of the roots and can not be drawn up by capillary action, the water supply is of no avail to the plants; but if the soil is porous and moderately deep (depth being the distance from the surface to the impenetrable subsoil, rock, or ground water) the water not only can penetrate but also can readily be reached and taken up by the roots.

The moisture of the soil being the most important element in it for tree growth, the greatest attention must be given to its conservation and most advantageous distribution through the soil.

No trees grow to the best advantage in very dry or very wet soil, although some can live and almost thrive in such unfavorable situations. A moderately but evenly moist soil, porous and deep enough or fissured enough to be well drained, and yet of such a structure that the water supplies from the depths can readily be drawn up and become available to the roots—that is the soil on which all trees grow most thriftily.

The agriculturist procures this condition of the soil as far as possible by plowing, drainage, and irrigation, and he tries by cultivating to keep the soil from compacting again, as it does under the influence of the beating rain and of the drying out of the upper layers by sun and wind.

The forest grower can not rely upon such methods, because they are either too expensive or entirely impracticable. He may, indeed, plow for his first planting, and cultivate the young trees, but in a few years this last operation will become impossible and the effects of the first operation will be lost. He must, therefore, attain his object in another manner, namely, by shading and mulching the soil. The shading is

done at first by planting very closely, so that the ground may be protected as soon as possible from sun and wind, and by maintaining the shade well throughout the period of growth. This shade is maintained, if necessary, by more planting, and in case the main crop in later life thins out inordinately in the crowns or tops, or by the accidental death of trees, it may even become desirable to introduce an underbrush.

The mulching is done by allowing the fallen leaves and twigs to remain and decay, and form a cover of rich mold or humus. This protective cover permits the rain and snow waters to penetrate without at the same time compacting the soil, keeping it granular and in best condition for conducting water, and at the same time preventing evaporation at the surface.

The soil moisture, therefore, is best maintained by proper soil-cover, which, however, is needful only in naturally dry soils. Wet soils, although supporting tree growth, do not, if constantly wet, produce satisfactory wood crops, the growth being very slow. Hence they must be drained and their water level sunk below the depth of the root system.

Irrigation is generally too expensive to be applied to wood crops, except perhaps in the arid regions, where the benefit of the shelter belt may warrant the expense.

Attention to favorable moisture conditions in the soil requires the selection of such kinds of trees as shade well for a long time, to plant closely, to protect the woody undergrowth (but not weeds), and to leave the litter on the ground as a mulch.

Different species, to be sure, adapt themselves to different degrees of soil moisture, and the crop should therefore be selected with reference to its adaptation to available moisture supplies.

While, as stated, all trees thrive best with a moderate and even supply of moisture, some can get along with very little, like the conifers, especially pines; others can exist even with an excessive supply, as the bald cypress, honey locust, some oaks, etc. The climate, however, must also be considered in this connection, for a tree species, although succeeding well enough on a dry soil in an atmosphere which does not require much transpiration, may not do so in a drier climate on the same soil.

In the selection of different kinds of trees for different soils, the water conditions of the soil should, therefore, determine the choice.

LIGHT CONDITIONS.

To insure the largest amount of growth, full enjoyment of sunlight is needed. But as light is almost always accompanied by heat and relative dryness of air, which demands water from the plant, and may increase transpiration from the leaves inordinately, making them pump too hard, as it were, young seedlings of tree species whose foliage is not built for such strains require partial shading for the first year or two. The conifers belong to this class.

In later life the light conditions exert a threefold influence on the development of the tree, namely, with reference to soil conditions, with reference to form development, and with reference to amount of growth.

The art of the forester consists in regulating the light conditions so as to secure the full benefit of the stimulating effect of light on growth, without its deteriorating influences on the soil and on form development.

As we have seen, shade is desirable in order to preserve soil moisture. Now, while young trees of all kinds, during the "brush" stage of development, have a rather dense foliage, as they grow older they vary in habit, especially when growing in the forest. Some, like the beech, the sugar maple, the hemlock, and the spruce, keep up a dense crown; others, like the chestnut, the oaks, the walnut, the tulip tree, and the white pine, thin out more and more, and when fully grown have a much less dense foliage; finally, there are some which do not keep up a dense shade for any length of time, like the black and honey locust, with their small, thin leaves; the catalpa, with its large but few leaves at the end of the branchlets only, and the larch, with its short, scattered bunches of needles. So we can establish a comparative scale of trees with reference to the amount of shade which they can give continuously, as densely foliated and thinly foliated, in various gradations. If we planted all beech or sugar maple, the desirable shading of the soil would never be lacking, while if we planted all locust or catalpa the sun would soon reach the soil and dry it out, or permit a growth of grass or weeds, which is worse, because these transpire still larger quantities of water than the bare ground evaporates or an undergrowth of woody plants would transpire. Of course, a densely foliated tree has many more leaves to shed than a thinly foliated one, and therefore makes more litter, which increases the favorable mulch cover of the soil. Another reason for keeping the ground well shaded is that the litter then decomposes slowly, but into a desirable humus, which acts favorably upon the soil, while if the litter is exposed to light, an undesirable, partly decomposed "raw" humus is apt to be formed.

Favorable soil conditions, then, require shade, while wood growth is increased by full enjoyment of light; to satisfy both requirements, mixed planting, with proper selection of shade-enduring and light-needing species, is resorted to.

As the different species afford shade in different degrees, so they require for their development different degrees of light. The dense foliage of the beech, with a large number of leaves in the interior of the crown, proves that the leaves can exist and perform their work with a small amount of light; the beech is a shade-enduring tree. The scanty foliage of the birches, poplars, or pines shows that these are light-needing trees; hence they are never found under the dense shade of the former, while the shade-enduring can develop satisfactorily

under the light shade of the thin-foliaged kinds. Very favorable soil conditions increase the shade endurance of the latter, and climatic conditions also modify their relative position in the scale.

All trees ultimately thrive best—i. e., grow most vigorously—in the full enjoyment of light, but their energy then goes into branching. Crowded together, with the side light cut off, the lower lateral branches soon die and fall, while the main energy of growth is put into the shaft and the height growth is stimulated. The denser shade of the shade-enduring kinds, if placed as neighbors to light-needing ones, is most effective in producing this result, provided that the light is not cut off at the top; and thus, in practice, advantage is taken of the relative requirements for light of the various species.¹

The forester finds in close planting and in mixed growth a means of securing tall, clear trunks, free from knots, and he is able, moreover, by proper regulation of light conditions, to influence the form development, and also the quality of his crop, since slow growth and rapid growth produce wood of different character.

There are some species which, although light foliaged and giving comparatively little shade, are yet shade enduring—i. e., can subsist, although not develop favorably, under shade; the oaks are examples of this kind. Others, like the black cherry, bear a dense crown for the first twenty years, perhaps, seemingly indicating great shade endurance; but the fact that the species named soon clears itself of its branches and finally has a thin crown, indicates that it is light needing, though a good shader for the first period of its life. Others, again, like the catalpa, which is shady and shade enduring, as the difficulty with which it clears itself indicates, leaf out so late and lose their foliage so early that their shading value is thereby impaired. Black locust and honey locust, on the other hand, leave no doubt either as to their light-needing or their inferior shading quality.

That soil conditions and climatic conditions also modify crown development and shade endurance has been well recognized abroad, but in our country this influence is of much more importance on account of the great variation in those conditions. Thus the box elder, an excellent shader in certain portions of the West, is a failure as soil cover in others where it nevertheless will grow.

We see, then, that in determining the shading value as well as the shade endurance of one species in comparison with another, with reference to forestry purposes, not only soil and climate but also the character of foliage and its length of season must be considered.

¹This relation of the different species to varying light conditions, their comparative shading value and shade endurance, is one of the most important facts to be observed and utilized by the forester. European foresters have done this, but since they had to deal with only a few species and over a limited territory, they could quite readily classify their trees with reference to their shade endurance, and take it for granted that shade endurance and density of foliage or shading value were more or less identical. With our great wealth of useful species it will be necessary and profitable to be more exact in the classification.

As we have seen, root and foliage are the main life organs of the tree. The trunk and branches serve to carry the crown upward and expose it to the light, which is necessary in order to prepare the food and increase the volume of the tree, and also as conductors of food materials up and down between root and foliage. A large part of the roots, too, aside from giving stability to the tree, serve only as conductors of water and food material; only the youngest parts, the fibrous roots, beset with innumerable fine hairs, serve to take up the water and minerals from the soil. These fine roots, root hairs, and young parts are therefore the essential portion of the root system. A tree may have a fine, vigorous-looking root system, yet if the young parts and fibrous roots are cut off or allowed to dry out, which they readily do—some kinds more so than others—thereby losing their power to take up water, such a tree is apt to die. Under very favorable moisture and temperature conditions, however, the old roots may throw out new sprouts and replace the fibrous roots. Some species, like the willows, poplars, locusts, and others, are especially capable of doing so. All trees that “transplant easily” probably possess this capacity of renewing the fibrous roots readily, or else are less subject to drying out. But it may be stated as a probable fact that most transplanted trees which die soon after the planting do so because the fibrous roots have been curtailed too much in taking up, or else have been allowed to dry out on the way from the nursery or forest to the place of planting; they were really dead before being set. Conifers—pines, spruces, etc.—are especially sensitive; maples, oaks, catalpas, and apples will, in this respect, stand a good deal of abuse.

Hence, in transplanting, the first and foremost care of the forest grower, besides taking the sapling up with least injury, is the proper protection of its root fibers against drying out.

The water, with the minerals in solution, is taken up by the roots when the soil is warm enough, but to enable the roots to act they must be closely packed with the soil. It is conveyed mostly through the outer, which are the younger, layers of the wood of root, trunk, and branches to the leaves. Here, as we have seen, under the influence of light and heat it is in large part transpired and in part combined with the carbon into organic compounds, sugar, etc., which serve as food materials. These travel from the leaf into the branchlet, and down through the outer layers of the trunk to the very tips of the root, forming new wood all the way, new buds, which lengthen into shoots, leaves, and flowers, and also new rootlets. To live and grow, therefore, the roots need the food elaborated in the leaves, just as the leaves need the water sent up from the roots.

Hence the interdependence of root system and crown, which must be kept in proportion when transplanting. At least, the root system must be sufficient to supply the needs of the crown.

"SAP UP AND SAP DOWN."

The growing tree, in all its parts, is more or less saturated with water, and as the leaves, under the influence of sun and wind and atmospheric conditions generally transpire, new supplies are taken in through the roots and conveyed to the crown. This movement takes place even in winter, in a slight degree, to supply the loss of water by evaporation from the branches. In the growing season it is so active as

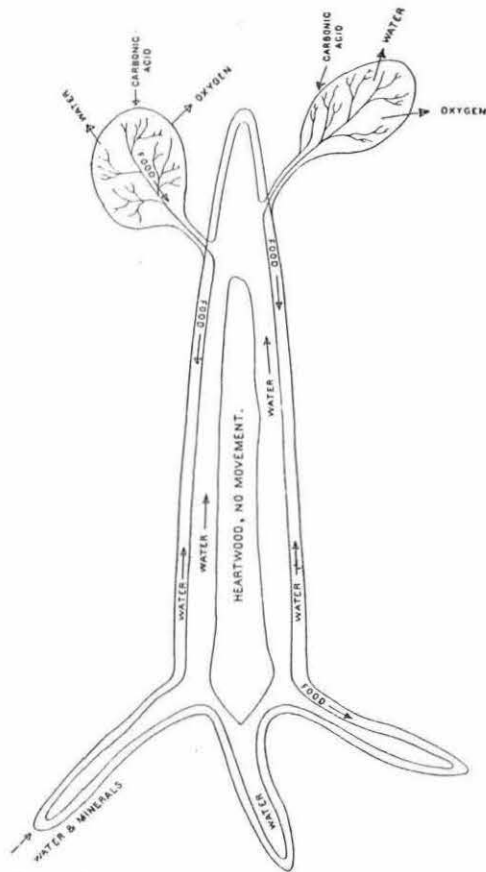


FIG. 1.—Physiological importance of different parts of the tree; pathways of water and food materials. (Schematic.)

combined with nitrogenous substances to make the cell-forming material, protoplasm (fig. 1).

In the fall, when the leaves cease to elaborate food, both the upward and the downward movement, more or less simultaneously, come to rest (the surplus of food materials, as starch, and sometimes as sugar, being stored for the winter in certain cell tissues), to begin again simultaneously when in spring the temperature is high enough to reawaken

to become noticeable; hence the saying that the sap is "up," or "rising," and when, toward the end of the season, the movement becomes less, the sap is said to be "down." But this movement of water is always upward; hence the notion that there is a stream upward at one season and in one part of the tree, and a stream downward at another season and perhaps in another part of the tree, is erroneous. The downward movement is of food materials, and the two movements of water upward and food downward take place simultaneously, and depend, in part at least, one upon the other, the food being carried to the young parts, wherever required, by a process of diffusion from cell to cell known as "osmosis."

These food materials are, by the life processes of the active cells, changed in chemical composition as need be, from sugar, which is soluble, into starch, which is insoluble, and back into sugar, and com-

activity, when the stored food of last year is dissolved and started on its voyage. The exact manner in which this movement of water upward and food materials downward takes place, and the forces at work, are not yet fully understood, nor is there absolute certainty as to the parts of the tree in which the movement takes place. It appears, however, that while all the so-called "sapwood" is capable of conducting water (the heartwood is probably not), the most active movement of both water and food materials takes place in the cambium (the growing cells immediately beneath the bark) and youngest parts of the bark.

The deductions from these processes important to the planter are: That injury to the living bark or bast means injury to growth, if not destruction to life; that during the period of vegetation transplanting can be done only with great caution; that the best time to move trees is in the fall, when the leaves have dropped and the movement of water and food materials has mostly ceased, or in spring, before the movement begins again, the winter being objectionable only because of the difficulty of working the soil and of keeping the roots protected against frost. All things considered, spring planting, before activity in the tree has begun, is the best, although it is not impossible to plant at other times.

PROGRESS OF DEVELOPMENT.

Like the wheat or corn plant, the tree seed require as conditions for sprouting sufficient moisture, warmth, and air. Tree seeds, however, differ from grain in that most of the kinds lose their power of germination easily; with few exceptions (locust, pine, spruce), they can not be kept for any length of time.

The first leaves formed often differ essentially in shape from those of the mature tree, which may cause their being confounded with other plants, weeds, etc.

The little seedlings of many, especially the conifers, are quite delicate, and remain very small the first season; they need, therefore, the protecting shade of mother trees, or artificial shading, and also protection against weeds. The amount of light or shade given requires careful regulation for some of them; too much light and heat will kill them, and so will too much shade. This accounts for the failure of many seedlings that spring up in the virgin forest.

The planter, then, is required to know the nature and the needs of the various kinds of seeds and seedlings, so as to provide favorable conditions, when he will avoid sowing in the open field such as require the care which it is impracticable to give outside of the nursery.

GROWTH IN LENGTH AND RAMIFICATION.

While the stalk of wheat or corn grows for one season, exhausts itself in seed production, and then dies, the tree continues to grow from season to season, in length as well as in thickness. The growth

in length of shaft and branches proceeds from buds, made up of cell tissues, which can subdivide and lengthen into shoots, as well as make leaves. These buds are formed during summer, and when winter begins contain embryo leaves, more or less developed, under the protecting cover of scales (fig. 3). When spring stimulates the young plant to new activity, the buds swell, shed their scales, dis-

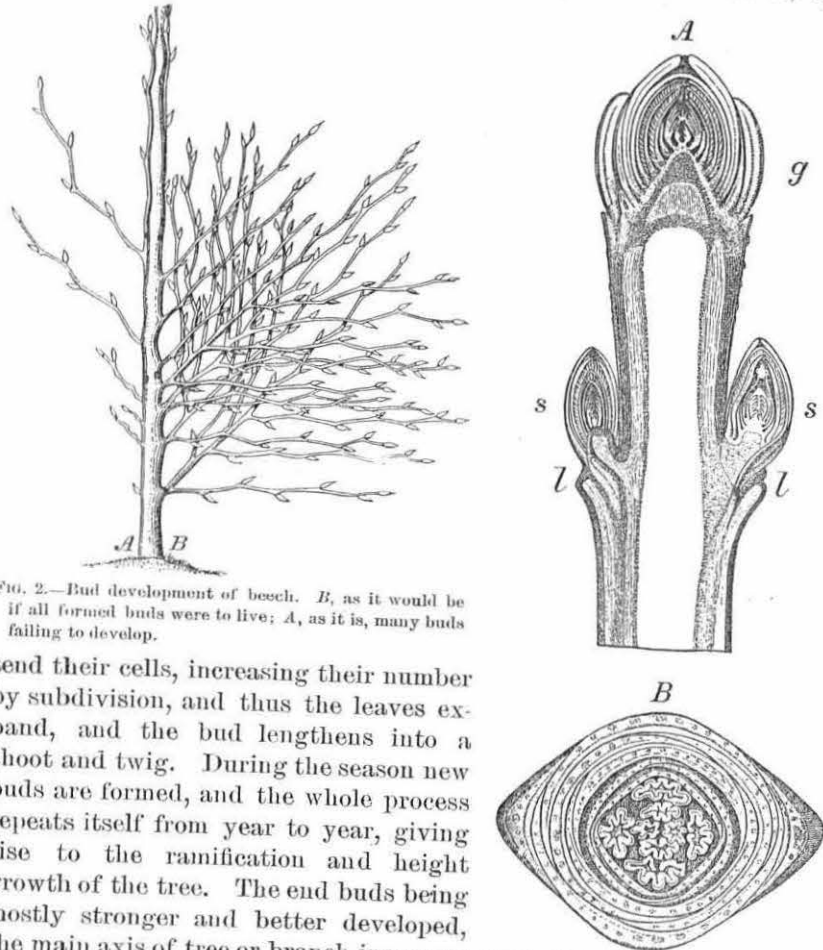


FIG. 2.—Bud development of beech. *B*, as it would be if all formed buds were to live; *A*, as it is, many buds failing to develop.

tend their cells, increasing their number by subdivision, and thus the leaves expand, and the bud lengthens into a shoot and twig. During the season new buds are formed, and the whole process repeats itself from year to year, giving rise to the ramification and height growth of the tree. The end buds being mostly stronger and better developed, the main axis of tree or branch increases more rapidly than the rest. All these buds originate from the youngest, central part of the shoot, the pith, and hence when the tree grows in thickness, envel-

oping the base of the limbs, their connection with the pith can always be traced. This is the usual manner of bud formation; in addition, so-called "adventitious" buds may be formed from the young living wood in later life, which are not connected with the pith. Such buds are those which develop into sprouts from the stump when the tree is

FIG. 3.—Buds of maple. *A*, longitudinal section through tip of a maple twig; *g*, end bud; *s*, lateral buds; *l*, scars of leaves of last season. *B*, cross section through end bud, showing folded leaves in center and scales surrounding them.

cut; also those which give rise to what are known as "water sprouts." Many buds, although formed, are, however, not developed at once, and perhaps not at all, especially as the tree grows older; these either die or remain "dormant," often for a hundred years, to spring into life when necessary (fig. 4).

The fact that each ordinary limb starts as a bud from the pith is an important one to the timber grower; it explains knotty timber and gives him the hint that in order to obtain clear timber the branches

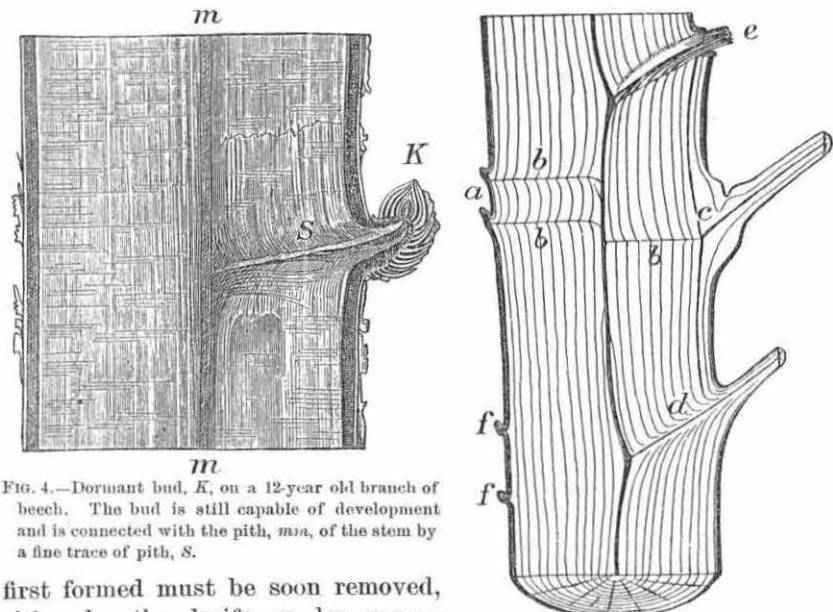


FIG. 4.—Dormant bud, *K*, on a 12-year old branch of beech. The bud is still capable of development and is connected with the pith, *m*, of the stem by a fine trace of pith, *s*.

first formed must be soon removed, either by the knife or by proper shading, which kills the branches and thus "clears" the shaft.

The planter has it also in his power to influence the form development of the tree by removing some of the buds, giving thereby better chance to the remaining ones. This pruning of buds is, where practicable, often better practice than the pruning of limbs.

Since the tree does not grow in length except by its buds it is evident that a limb which started to grow at the height of 6 feet has its base always 6 feet from the ground, and if allowed to grow to size, must be surrounded by the wood which accumulates on the main stem or trunk. If a limb is killed and broken off early, only a slender stub composed entirely of rapidly decaying sapwood, is left, occasioning, therefore, only a small defect in the heart of the tree; but if left to grow to considerable age, the base of the limb is incased by the wood of the stem, which, when the tree is cut into lumber, appears as a knot.

The longer the limb has been allowed to grow, the farther out is the timber knotty and the thicker is the knot. If the limb remained alive, the knot is "sound," closely grown together with the fibers of the tree. If the limb died off, the remaining stub may behave in different ways. In pines it will be largely composed of heartwood, very resinous and durable; separated from the fibers of the overgrowing wood, it forms a "loose" knot, which is apt to fall out of a board, leaving a hole.

In broad-leaved trees, where no resin assists in the process of healing, the stub is apt to decay, and this decay, caused by the growth of fungi, is apt to penetrate into the tree (fig. 6). In parks and orchards, pruning is resorted to, and the cuts are painted or tarred to avoid the decay. In well-managed forests and dense woods in general, the light is cut off, the limb is killed when young and breaks away, the shaft "clears itself," and the sound trunk furnishes a good grade of material. The difference in development of the branch system, whether in full

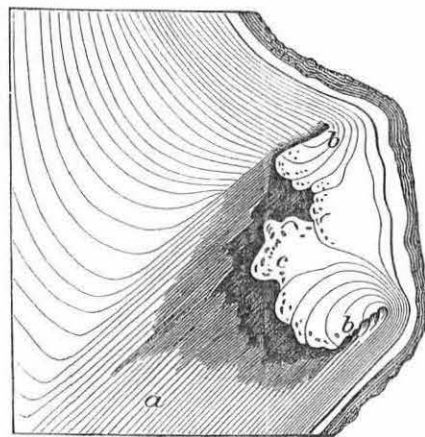


FIG. 6.—Section through a partly decayed knot in oak wood. *a*, wood of the knot; *b* and *c*, wood callus of the stem covering the wound; shaded portion, decayed wood; black part, a cavity remaining.

in heavier shading. Since the branches grow in more or less regular whorls, several knots, stumps, or limbs are met every 6 to 24 inches through the entire stem.

Hence, in forest planting, trees are placed and kept for some time close together, in order to decrease the branching in the lower part of the tree and thus produce a clean bole and clear lumber.

GROWTH IN THICKNESS.

The young seedling and the young shoot of the older tree much resemble in interior structure that of any herbaceous plant, being composed of a large amount of pith, loose squarish cells, and a few bundles of long fibers symmetrically distributed about the center, the whole covered with a thin skin or epidermis. Each strand or bundle of

fibers, called fibro-vascular (fiber-vessel) bundles, consists of two kinds, namely, wood fibers on the inner side and bast fibers of different structure on the outer-side. Between these two sets of fibers, the bast and the wood, there is a row of cells which form the really active, growing part of the plantlet, the cambium. The cambium cells are actively subdividing and expanding, giving off wood cells to the interior and bast cells to the exterior, and extending at the same time side-wise, until at the end of the season not only are the wood and bast portions increased in lines radiating from the center, but the cambium layer, the wood cells, and the bast cells of all the bundles (scattered at the beginning) join at the sides to form a complete ring, or rather hollow cylinder, around the central pith. Only here and there the pith cells remain, interrupting the wood cylinder and giving rise to the system of cells known as medullary rays. The cross section now shows a comparatively small amount of pith and bast or bark and a larger body of strong wood fibers. The new shoot at the end, to be sure, has the same appearance and arrangement as the young plantlet had, the pith preponderating, and the continuous cylinder of cambium, bast, and wood being separated into strands or bundles.

Both trees start alike; the one retains its branches, the other loses them gradually, the stubs being in time overgrown; finally the second has a clear shaft, with a crown concentrated at the top, while the first is beset with branches and branch stubs for its whole length (fig. 8).

When ripped open lengthwise, the interior exhibits the condition shown in figure 9, the dead parts of the knot being indicated

fibers, called fibro-vascular (fiber-vessel) bundles, consists of two kinds, namely, wood fibers on the inner side and bast fibers of different structure on the outer-side. Between these two sets of fibers, the bast and the wood, there is a row of cells which form the really active, growing part of the plantlet, the cambium. The cambium cells are actively subdividing and expanding, giving off wood cells to the interior and bast cells to the exterior, and extending at the same time side-wise, until at the end of the season not only are the wood and bast portions increased in lines radiating from the center, but the cambium layer, the wood cells, and the bast cells of all the bundles (scattered at the beginning) join at the sides to form a complete ring, or rather hollow cylinder, around the central pith. Only here and there the pith cells remain, interrupting the wood cylinder and giving rise to the system of cells known as medullary rays. The cross section now shows a comparatively small amount of pith and bast or bark and a larger body of strong wood fibers. The new shoot at the end, to be sure, has the same appearance and arrangement as the young plantlet had, the pith preponderating, and the continuous cylinder of cambium, bast, and wood being separated into strands or bundles.

During the season, through the activity of the cambial part of the bundles, the same changes take place in the new shoot as did the previous year in the young seedling, while at the same time the cambium in the yearling part also actively subdivides, forming new wood and bast cells, and thus a second ring, or rather cylinder, is formed. The cambium of the young shoot is always a continuation of that of the ring or cylinder formed the year before, and this cambium cylinder always keeps moving outward, so that at the end of the season, when activity ceases, it is always the last minute layer of cells on the outside of the wood, between wood proper and

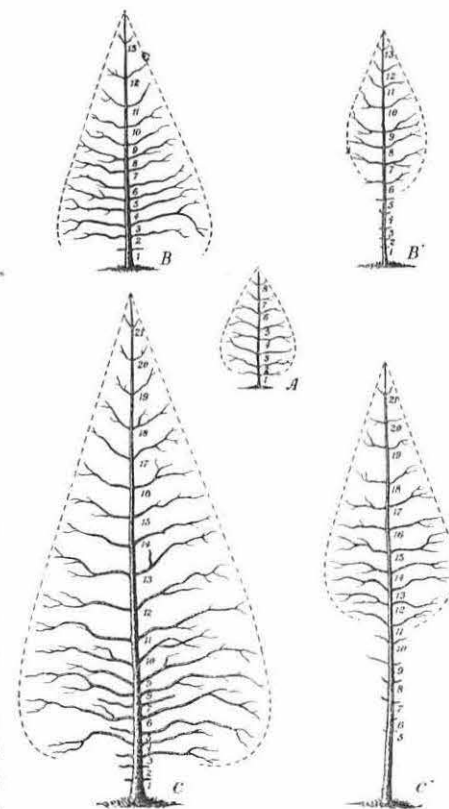


FIG. 7.—Development in and out of the forest. *A*, young tree alike in both cases; *B* and *C*, successive stages of tree grown in the open; *B'* and *C'*, corresponding stages of the tree grown in the forest. Numbers refer to annual growth in height.

During the season, through the activity of the cambial part of the bundles, the same changes take place in the new shoot as did the previous year in the young seedling, while at the same time the cambium in the yearling part also actively subdivides, forming new wood and bast cells, and thus a second ring, or rather cylinder, is formed. The cambium of the young shoot is always a continuation of that of the ring or cylinder formed the year before, and this cambium cylinder always keeps moving outward, so that at the end of the season, when activity ceases, it is always the last minute layer of cells on the outside of the wood, between wood proper and

bark. It is here, therefore, that the life of the tree lies, and any injury to the cambium must interfere with the growth and life of the tree.

The first wood cells which the cambium forms in the spring are usually or always of a more open structure, thin walled, and with a large opening or "lumen," comparable to a blown-up paper bag; so large, in fact, sometimes, is the "lumen" that the width of the cells can be seen on a cross section with the naked eye, as, for instance, in oak, ash, elm, the so-called "pores" are this open wood formed in spring. The

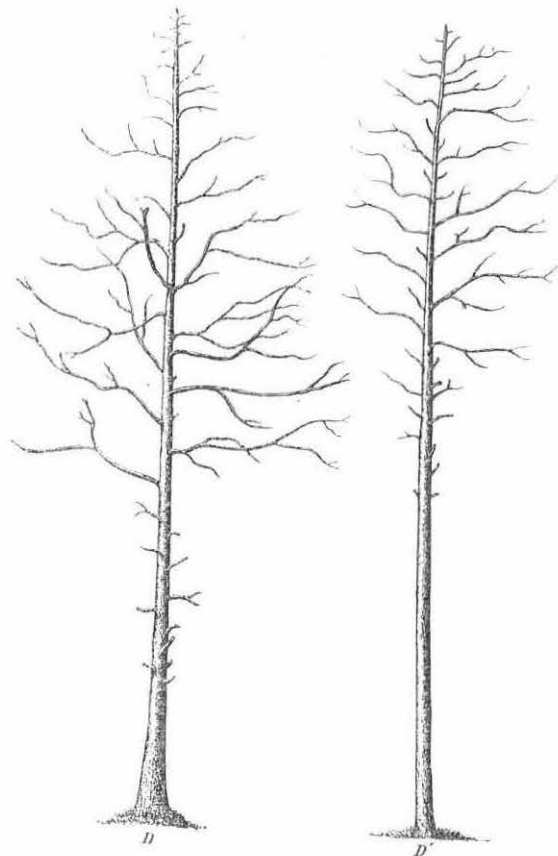


FIG. 8.—Trees in and out of the forest. *D*, tree grown in the open; *D'*, tree grown in the forest.

cells, which are formed later in summer, have mostly thick walls, are closely crowded and compressed, and show a very small opening or "lumen," being comparable, perhaps, to a very thick wooden box. They appear in the cross section not only denser but of a deeper color, on account of their crowded, compressed condition and thicker walls. Since at the beginning of the next season again thin-walled cells with wide openings or lumina are formed, this difference in the appearance of "spring wood" and "summer wood" enables us to distinguish the layer of wood formed each year. This "annual ring" is more conspicuous in some kinds than in others. In the so-called "ring porous" woods, like oak, ash, elm, the rings are easily distinguished by the open spring wood; in the conifers, especially pines, by the dark-colored summer wood; while in maple, birch, tulip, etc., only a thin line of flattened, hence darker and regularly aligned, summer cells, often hardly recognizable, distinguishes the rings from each other. Cutting through a tree, therefore, we can not only ascertain its age by counting its annual layers in the cross section, but also determine how much wood is formed each year (fig. 10). We

can, in fact, retrace the history of its growth, the vicissitudes through which it has passed, by the record preserved in its ring growth.

To ascertain the age of a tree correctly, however, we must cut so near to the ground as to include the growth of the first year's little plantlet; any section higher up shows as many years too few as it took the tree to reach that height.

This annual-ring formation is the rule in all countries which have distinct seasons of summer and winter and temporary cessation of growth. Only exceptionally a tree may fail to make its growth throughout its whole length on account of loss of foliage or other causes; and occasionally, when its growth has been disturbed during the season, a "secondary" ring, resembling the annual ring, and distinguishable only by the expert, may appear and mar the record.

To the forest planter this chapter on ring growth is of great importance, because not only does this feature of tree life afford the means of watching the progress of his crop, calculating the amount of wood formed, and therefrom determining when it is most profitable for him to harvest (namely, when the annual or periodic wood growth falls below a certain amount), but since the proportion of summer wood and spring wood determines largely the quality of the timber, and since he has it in his power to influence the preponderance of the one or other by adaptation of species to soils and by their management, ring growth furnishes an index for regulating the quality of his crop.

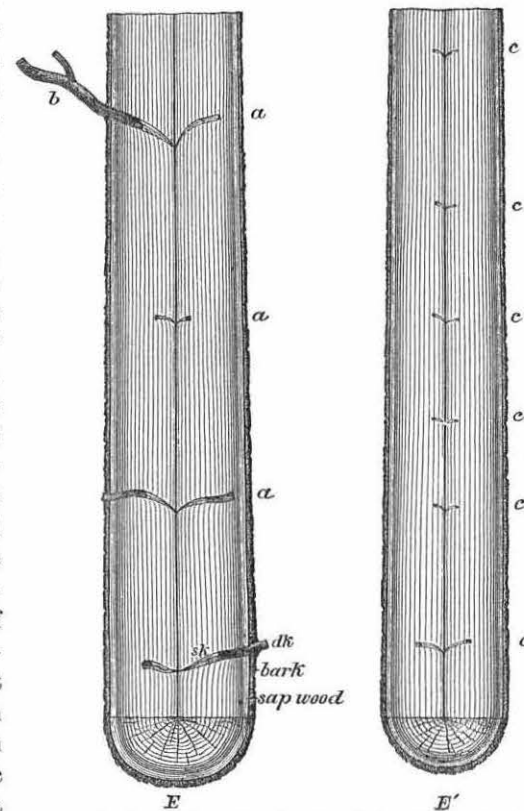


FIG. 9.—Sections of logs showing the relative development of knots. *E*, from tree grown in the open; *E'*, from tree grown in a dense forest; *a* and *c*, whorls of knots; *b*, dead limb; *sk*, "sound knot;" *dk*, "dead knot."

FORM DEVELOPMENT.

If a tree is allowed to grow in the open, it has a tendency to branch, and makes a low and spreading crown. In order to lengthen its shaft and to reduce the number of branches it is necessary to narrow its

growing space, to shade its sides so that the lower branches and their foliage do not receive light enough to perform their functions. When the side shade is dense enough, these branches die and finally break off under the influence of winds and fungous growth; wood then forms

over the scars and we get a clean shaft which carries a crown high up beyond the reach of shade from neighbors.

The branches being prevented from spreading out, the shaft is forced to grow upward, and hence, when crowded by others, trees become taller and more cylindrical in form, while in the open, where they can spread, they remain lower and more conical in form (figs. 11, 12).

There are, to be sure, different natural types of development, some, like the walnuts, oaks, beeches, and the broad-leaved trees generally, having greater tendency to spread than others, like spruces, firs, and conifers in general, which lengthen their shaft in preference to spreading, even in the open. This tendency to spreading is also influenced by soil conditions and climate, as well as by the age of the tree. When the trees cease to grow in height, their crowns broaden, and this takes place sooner in shallow soils than in deep, moist ones; but the tendency can be checked and all can be made to develop the shaft at the expense of the branches by proper shading from the sides.

It follows that the forest planter, who desires to produce long and clean shafts and best working quality of timber, must secure and maintain side shade by a close stand, while the landscape gardener, who desires characteristic form, must maintain an open stand and full enjoyment of light for his trees.

Now, as we have seen, different species afford different amounts of shade, and in proportion to the shade which they afford

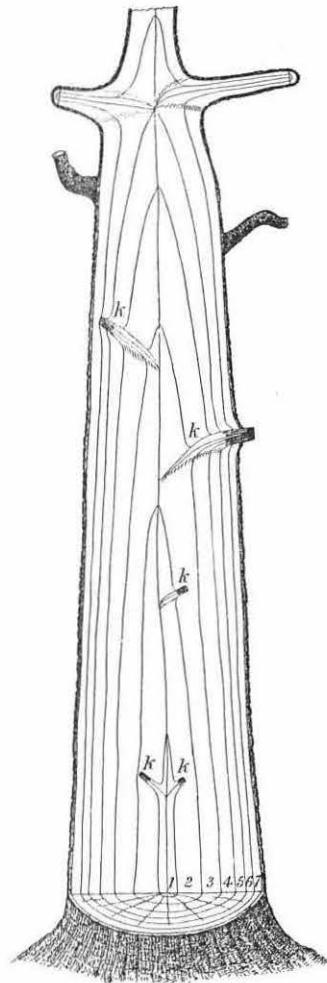


FIG. 10.—Scheme to illustrate the arrangement of annual growth. 1, 2, 3, etc., represent the parts of the stem grown during the first, second, third, etc., twenty years of the life of the tree. *k*, knots; the shaded part of each is the "dead knot" of lumber.

can they endure shade. The beech or sugar maple or spruce, which maintain a large amount of foliage under the dense shade of their own crown, show that their leaves can live and functionate with a small amount of light. They are shade-enduring trees. On the other hand,

the black walnut, the locust, the catalpa, the poplars, and the larch show by the manner in which their crowns thin out, the foliage being confined to the ends of the branches, that their leaves require more light—they are light-needing trees; so that the scale which arranges the trees according to the amount of shade they exert serves also to measure their shade endurance.

In making, therefore, mixed plantations, the different kinds must be so grouped and managed that the shady trees will not outgrow and overtop the light-needing; the latter must either have the start of the former or must be quicker growers.

RATE OF GROWTH.

Not only do different species grow more or less rapidly in height and girth, but there is in each species a difference in the rate of growth during different periods of life, and a difference in the persistence of growth.

It stands to reason that trees grow differently in different soils and situations, and hence we can not compare different species with respect



FIG. 11.—Oak tree grown in the open.

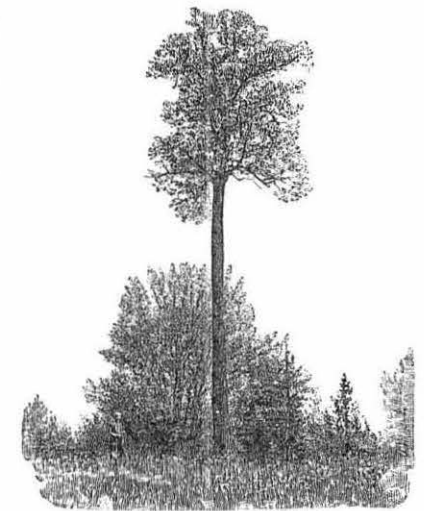


FIG. 12.—Maple tree grown in the forest.

to their rate of growth except as they grow under the same conditions.

Thus the black walnut may grow as fast as or faster than the ash on a rich, deep, moist, warm soil, but will soon fall to the rear in a wetter, colder, and shallower soil.

Given the same conditions, some species will start on a rapid upward growth at once, like the poplars, aspen, locust, and silver maple, making rapid progress (the most rapid from their tenth to their fifteenth year), but decreasing soon in rate and reaching their maximum height early. Others, like the spruce, beech, and sugar maple, will begin slowly, often occupying several, sometimes as many as 10 to 15, years before they appear to grow at all, their energy all going into root growth. Then comes a period of more and more accelerated growth, which reaches its maximum rate at 25 or 30 years; and when the cottonwood or aspen

has reached the end of its growth in height the spruce or pine is still at its best rate, and continues to grow for a long time at that rate; in later life the rate decreases, yet height growth sometimes does not cease altogether for centuries. As a rule, the light-needing species are the ones which show the rapid height growth at the start, while the shade-enduring are slow at the start, but persistent growers.

This fact is important in explaining the alternations of forest growth in nature; the persistent shade-enduring species crowd out the light-needing, and the latter rapidly take possession of any openings that fire or storm has made. It is also important with reference to the management of wood crops and starting of mixed plantations; the light-needing species must be mixed only with such shade-enduring species as are slower growers than themselves.

The diameter growth shows also periodic changes in its rate, and is, of course, influenced in the same way by soil, climate, and light conditions, as the height growth.

In the juvenile or brush stage, lasting 6 to 10 years in light-needing and 20 to 40 years in shade-enduring species, the diameter grows comparatively little, all energy being directed to height growth and root growth. When the crown has been definitely formed, more food material is available for wood formation, and the increase in foliage is accompanied by a more rapid increase of trunk diameter; in favorable situations, the highest rate occurs between the fortieth and sixtieth years; in the poorer situations, between the fiftieth and eightieth years, which rate continues for some time. Then comes a period of slower rate, which finally in old age dwindles down almost to zero.

But neither the diameter growth nor the width of the annual rings alone tells us directly what amount of wood is forming. The outer rings, being laid over a larger circumference, although thinner than the preceding rings, may yet have greater cubic contents. The statements of diameter growth are, therefore, misleading if we are interested in knowing how much wood is forming.

Accordingly the growth in volume must be considered separately, as determined by the enlargement of the cross-section area and the height. The growth in volume or mass accretion is quite small in young trees, so that when wood is cut young the smallest amount of crop per year is harvested, while, if it is allowed to grow, an increase more than proportionate to the number of years may be obtained.

Only when the tree has a fully developed crown does it begin to make much wood. Its volume growth progresses then at a uniform rate, and continues to do so for decades, and sometimes for a century or more.

On poorer sites the rate is slower, but remains longer on the increase, while on good sites the maximum rate is soon reached.

Of course, in a forest, where light conditions are not most favorable, because form development and soil conditions require shade, the total wood formation is less than in an isolated tree, favorably placed. Just

so the dominant trees in a forest—i. e., those which have their crowns above all others—show, of course, the advantage they have over the inferior trees which are suffering from the shade of their neighbors.

Finally, if we would take into consideration an entire forest growth, and determine, for instance, how much wood an acre of such forest produces at different periods, we must not overlook the fact that the number of trees per acre changes as the trees grow older. Some of them are overshadowed and crowded out by the others, so that a young growth of spruce might start with 100,000 little seedlings to the acre, of which in the twentieth year only 10,000 would be alive, while in the fortieth year the number would be reduced to 1,200, and in the hundredth year to 280. Hence the rate of growth of any single tree gives no idea of what the acre of forest will do.

Thus, while a single good white pine might grow the fastest in volume when about one hundred years old, then making wood at the rate of, say, 1.5 cubic feet per year, an acre of pine on good soil, containing about 1,600 trees, may make the most wood in the thirtieth year, then growing at the rate of 170 cubic feet per acre, while in the hundredth year the rate would not exceed 70 cubic feet; and an acre of pine in a poorer location, with about 1,400 trees, may make the most wood in the fortieth year, at the rate of 100 cubic feet per acre.

From the consideration of the relation of light conditions to soil conditions, to form development, and to rate of growth, we may make the following deductions of interest to the forest planter:

In order to secure the best results in wood production, in quantity and quality, at the same time preserving favorable soil conditions, the forest should be composed of various species, a mixture of light-needing and shade-enduring kinds. The light-needing ones should be of quicker growth; the shady ones, in larger numbers, should be slower growers. For the first fifteen to twenty-five years the plantation should be kept as dense as possible, to secure clear shafts and good growth in height; then it should be thinned, to increase crown development and diameter growth; the thinning, however, is not to be so severe that the crowns can not close up again in two or three years; the thinning is to be repeated again and again, always favoring the best developed trees.

REPRODUCTION.

All trees reproduce themselves naturally from seed. Man can secure their reproduction also from cuttings or layers; and some kinds can reproduce themselves by shoots from the stump when the parent tree has been cut. This latter capacity is possessed in a varying degree by different species; chestnuts, oaks, elms, maples, poplars, and willows are most excellent sprouters; most conifers do not sprout at all, and the shoots of those that do sprout soon die (Sequoia or California redwood seems to be an exception). Sprouts of broad-leaved trees develop differently from seedlings, growing very rapidly at first, but soon lessening in the rate of growth and never attaining the height and perhaps not

the diameter of trees grown from the seed; they are also shorter lived. With age the stumps lose their capacity for sprouting. To secure best results, the parent tree should be cut close to the ground in early spring, avoiding severe frost, and a sharp cut should be made which will not sever the bark from the trunk.

Not all trees bear seed every year, and plentiful seed production, especially in a forest, occurs, as a rule, periodically. The periods differ with species, climate, and season.

Not all seeds can germinate, and in some species the number of seeds that can germinate is very small, and they lose their power of germination when kept a few hours, like the willows. Others, if kept till they have become dry, will "lie over" in the soil a year or more before germinating. The same thing will occur if they are covered too deep in the soil, provided they germinate at all under such conditions.

In order to germinate, seeds must have warmth, air, and moisture. The preparation of a seed bed is, therefore, necessary in order to supply these conditions in most favorable combination. In the natural forest millions of seeds rot or dry without sprouting, and millions of seedlings sprout, but soon perish under the too dense shade of the mother trees.

Man, desiring to reproduce a valuable wood crop, can not afford to be as lavish as nature, and must therefore improve upon nature's methods, making more careful preparation for the production of his crop, either by growing the seedlings in nurseries and transplanting them, or else by cutting away the old growth in such a manner as to secure to the young self-grown crop better chances for life and development.

2. HOW TO PLANT A FOREST.

Forest planting and tree planting are two different things. The orchardist, who plants for fruit; the landscape gardener, who plants for form; the roadside planter, who plants for shade, all have objects in view different from that of the forest planter, and therefore select and use their plant material differently. They deal with single individual trees, each one by itself destined for a definite purpose. The forester, on the other hand, plants a crop like the farmer; he deals not with the single seed or plant, but with masses of trees; the individual tree has value to him only as a part of the whole. It may come to harvest for its timber, or it may not come to harvest, and yet have answered its purpose as a part of the whole in shading the ground, or acting as nurse or "forwarder" as long as it was necessary.

His object is not to grow trees, but to produce wood, the largest amount of the best quality per acre, whether it be stored in one tree or in many, and his methods must be directed to that end.

As far as the manner of setting out plants or sowing seeds is concerned, the same general principles and the same care in manipulation are applicable as in any other planting, except as the cost of operating

on so large a scale may necessitate less careful methods than the gardener or nurseryman can afford to apply; the nearer, however, the performance of planting can be brought to the careful manner of the gardener, the surer the success. The principles underlying such methods have been discussed in the chapter "How trees grow;" in the present chapter it is proposed to point out briefly the special considerations which should guide the forest planter in particular.

WHAT TREES TO PLANT.

Adaptability to climate is the first requisite in the species to be planted.

It is best to choose from the native growth of the region which is known to be adapted to it. With regard to species not native, the reliance must be placed upon the experience of neighboring planters and upon experiment (at first on a small scale), after study of the requirements of the kinds proposed for trial.

Adaptation must be studied, not only with reference to temperature ranges and rainfall, but especially with reference to atmospheric humidity and requirements of transpiration.

Many species have a wide range of natural distribution, and hence of climatic adaptation. If such are to be used, it is important to secure seeds from that part of the range of natural distribution where the plants must be hardiest, i. e., the coldest and driest region in which it occurs, which insures hardy qualities in the offspring. For instance, the Douglas spruce from the humid and evenly tempered Pacific Slope will not be as hardy as that grown from seed collected on the dry and frigid slopes of the Rockies. Lack of attention to this requisite accounts for many failures. It must also be kept in mind that, while a species may be able to grow in another than its native climate, its wood may not there have the same valuable qualities which it develops in its native habitat.

Adaptability to soil must be studied less with reference to mineral constituents than to physical condition. Depth and moisture conditions, and the structure of the soil, which influences the movement of water in it, are the most important elements. While all trees thrive best in a moist to "fresh" soil of moderate depth (from 2 to 4 feet) and granular structure, some can adapt themselves to drier or wetter, shallow, and compact soils. Fissures in rocks into which the roots can penetrate often stand for depth of soil, and usually aid in maintaining favorable moisture conditions. In soils of great depth (i. e., from the surface to the impenetrable subsoil) and of coarse structure water may drain away so fast as not to be available to the roots.

Soil moisture must always be studied in conjunction with atmospheric moisture; for, while a species may thrive in an arid soil, when the demands of transpiration are not great, it may not do so when aridity

of atmosphere is added. Trees of the swamp are apt to be indifferent to soil moisture and to thrive quite well, if not better, in drier soils.

Adaptability to site.—While a species may be well adapted to the general climatic conditions of a region, and in general to the soil, there still remains to be considered its adaptability to the particular "site," under which term we may comprise the total effect of general climate, local climate, and soil. The general climatic conditions are locally influenced, especially by the slope, exposure, or aspect, and the surroundings. Thus we know that eastern exposures are more liable to frost, western exposures more liable to damage from winds, southern more apt to be hot and to dry out, and northern to be cooler and damper, having in consequence a shorter period of vegetation. Hollows and lowlands are more exposed to frosts and more subject to variations in soil moisture, etc.

Hence for these various situations it is advisable to select species which can best withstand such local dangers.

The use value, or utility, of the species is next to be considered. This must be done with reference to the commercial and domestic demand, and the length of time it takes the species to attain its value. The greater variety of purposes a wood may serve—i. e., the greater its general utility—and the sooner it attains its use value the better. White pine for the northeastern States as a wood is like the apple among fruits, making an all-round useful material in large quantities per acre in short time. Tulip poplar, applicable to a wider climatic range, is almost as valuable, while oak, ash, and hickory are standard woods in the market. Other woods are of limited application. Thus the black locust, which grows most quickly into useful posts, has only a limited market, much more limited than it should have; hickory soon furnishes valuable hoop poles from the thinnings, and later the best wagon material, not, however, large quantities in a short time; while black walnut of good quality is very high in price, the market is also limited, and the dark color of the heartwood, for which it is prized, is attained only by old trees. The black cherry, used for similar purposes, attains its value much sooner.

By planting various species together, variety of usefulness may be secured and the certainty of a market increased.

The forest value of the species is only in part expressed by its use value. As has been shown in another place, the composition of the crop must be such as to insure maintenance of favorable soil conditions, as well as satisfactory development of the crop itself. Some species, although of high use value, like ash, oak, etc., are poor preservers of soil conditions, allowing grass and weeds to enter the plantation and to deteriorate the soil under their thin foliage. Others, like beech, sugar maple, box elder, etc., although of less use value, being dense foliaged and preserving a shady crown for a long time, are of great forest value as soil improvers.

Again, as the value of logs depends largely on their freedom from knots, straightness, and length, it is of importance to secure these qualities. Some valuable species, if grown by themselves, make crooked trunks, do not clean their shafts of branches, and are apt to spread rather than lengthen. If planted in close companionship with others, they are forced by these "nurses or forwarders" to make better growths and clean their shafts of branches.

Furthermore, from financial considerations, it is well to know that some species develop more rapidly and produce larger quantities of useful material per acre than others; thus the white pine is a "big cropper," and, combining with this a tolerably good shading quality, and being in addition capable of easy reproduction, it is of highest "forest value."

Hence, as the object of forestry is to make money from continued wood crops, use value and forest value must both be considered in the selection of materials for forest planting.

Mutual relationship of different species, with reference especially to their relative height growth and their relative light requirements, must be considered in starting a mixed plantation.

Mixed forest plantations (made of several kinds) have so many advantages over pure plantations (made of one kind) that they should be preferred, except for very particular reasons. Mixed plantations are capable of producing larger quantities of better and more varied material, preserve soil conditions better, are less liable to damage from winds, fires, and insects, and can be more readily reproduced.

The following general rules should guide in making up the composition of a mixed plantation:

- a. Shade-enduring kinds should form the bulk (five-eighths to seven-eighths) of the plantation, except on specially favored soils where no deterioration is to be feared from planting only light-needing kinds, and in which case these may even be planted by themselves.
- b. The light-needing trees should be surrounded by shade-enduring of slower growth, so that the former may not be overtopped, but have the necessary light and be forced by side shade to straight growth.
- c. Shade-enduring species may be grown in admixture with each other when their rate of height growth is about equal, or when the slower-growing kind can be protected against the quicker-growing (for instance, by planting a larger proportion of the former in groups or by cutting back the latter).
- d. The more valuable timber trees which are to form the main crop should be so disposed individually, and planted in such numbers among the secondary crop or nurse crop, that the latter can be thinned out first without disturbing the former.

Where a plantation of light-foliaged trees has been made (black walnut, for instance), it can be greatly improved by "underplanting" densely with a shade-enduring kind, which will choke out weed growth, improve the soil, and thereby advance the growth of the plantation.

The selection and proper combination of species with reference to this mutual relationship to each other and to the soil are the most important elements of success.

Availability of the species also still needs consideration in this country; for, although a species may be very well adapted to the purpose in hand, it may be too difficult to obtain material for planting in quantity or at reasonable prices. While the beech is one of the best species for shade endurance, and hence for soil cover, seedlings can not be had as yet in quantity. Western conifers, although promising good material for forest planting, are at present too high priced for general use. Some eastern trees can be secured readily—either their seed or seedlings—from the native woods; others must be grown in nurseries before they can be placed in the field.

Whether to procure seeds or plants, and if the latter, what kind, depends upon a number of considerations. The main crop, that which is to furnish the better timber, had best be planted with nursery-grown plants, if of slow-growing kinds, perhaps once transplanted, with well-developed root systems, the plants in no case to be more than 2 to 3 years old. The secondary or nurse crop may then be sown or planted with younger and less costly material taken from the woods or grown in seed beds, or else cuttings may be used.

In some localities—for instance, the Western plains—the germinating of seeds in the open field is so uncertain, and the life of the young seedlings for the first year or two so precarious, that the use of seeds in the field can not be recommended. In such locations careful selection and treatment of the planting material according to the hardships which it must encounter can alone insure success.

Seedlings from 6 to 12 inches high furnish the best material. The planting of large-sized trees is not excluded, but is expensive and hence often impracticable, besides being less sure of success, since the larger-sized tree is apt to lose a greater proportion of its roots in transplanting.

METHODS OF PLANTING.

Preparation of soil is for the purpose of securing a favorable start for the young crop; its effects are lost after the first few years. Most land that is to be devoted to forest planting does not admit of as careful preparation as for agricultural crops, nor is it necessary where the climate is not too severe and the soil not too compact to prevent the young crop from establishing itself. Thousands of acres in Germany are planted annually without any soil preparation, yearling pine seedlings being set with a dibble in the unprepared ground. This absence of preparation is even necessary in sandy soils, like that encountered in the sandhills of Nebraska, which may, if disturbed, be blown out and shifted. In other cases a partial removal of a too rank undergrowth or soil cover and a shallow scarifying or hoeing is resorted to, or else furrows are thrown up and the trees set out in them.

In land that has been tilled, deep plowing (10 to 12 inches) and thorough pulverizing give the best chances for the young crop to start. For special conditions, very dry or very moist situations, special

methods are required. The best methods for planting in the semiarid regions of the far West have not yet been developed. Thorough cultivation, as for agricultural crops, with subsequent culture, is successful, but expensive. A plan which might be tried would consist in breaking the raw prairie in June and turning over a shallow sod, sowing a crop of oats or alfalfa, harvesting it with a high stubble, then opening furrows for planting and leaving the ground between furrows undisturbed, so as to secure the largest amount of drainage into the furrows and a mulch between the rows.

The time for planting depends on climatic and soil conditions and the convenience of the planter. Spring planting is preferable except in southern latitudes, especially in the West, where the winters are severe and the fall apt to be dry, the soil therefore not in favorable condition for planting.

The time for fall planting is after the leaves have fallen; for spring planting, before or just when life begins anew. In order to be ready in time for spring planting, it is a good practice to take up the plants in the fall and "heel them in" over winter (covering them, closely packed, in a dry trench of soil). Conifers can be planted later in spring and earlier in fall than broad-leaved trees.

The density of the trees is a matter in which most planters fail. The advantages of close planting lie in the quicker shading of the soil, hence the better preservation of its moisture and improved growth and form development of the crop. These advantages must be balanced against the increased cost of close planting. The closer the planting, the sooner will the plantation be self-sustaining and the surer the success.

If planted in squares, or, better still, in quincunx order (the trees in every other row alternating at equal distances), which is most desirable on account of the more systematic work possible and the more complete cover which it makes, the distance should not be more than 4 feet, unless for special reasons and conditions, while 2 feet apart is not too close, and still closer planting is done by nature with the best success.

The following numbers of trees per acre are required when planting at distances as indicated:

1½ by 1½ feet.....	19,360	2 by 4 feet	5,445
1½ by 2 feet.....	14,520	3 by 3 feet	4,840
2 by 2 feet.....	10,890	3 by 4 feet	3,630
2 by 3 feet.....	7,260	4 by 4 feet	2,722

To decrease expense, the bulk of the plantation may be made of the cheapest kinds of trees that may serve as soil cover and secondary or nurse crop, the main crop of from 300 to 600 trees to consist of better kinds, and with better planting material, mainly of light-needing species. These should be evenly disposed through the plantation, each closely surrounded by the nurse crop. It is, of course, understood that not all trees grow up; a constant change in numbers by the death (or else timely removal) of the overshadowed takes place, so that the final crop shows at 100 years a close cover, with hardly 300 trees to the acre.

After-culture is not entirely avoidable, especially under unfavorable climatic conditions, and if the planting was not close enough. Shallow cultivation between the rows is needed to prevent weed growth and to keep the soil open, until it is shaded by the young trees, which may take a year with close planting and two or three years with rows 4 by 4 feet apart, the time varying also with the species.

It is rare that a plantation succeeds in all its parts; gaps or fail places occur, as a rule, and must be filled in by additional planting as soon as possible, if of larger extent than can be closed up in a few years by the neighboring growth.

When the soil is protected by a complete leaf canopy, the forest crop may be considered as established, and the after-treatment will consist of judicious thinning.

3. HOW TO TREAT THE WOOD LOT.

In the northeastern States it is the custom to have connected with the farm a piece of virgin woodland, commonly called the wood lot. Its object primarily is to supply the farmer with the firewood, fence material, and such dimension timbers as he may need from time to time for repairs on buildings, wagons, etc.

As a rule, the wood lot occupies, as it ought to, the poorer part of the farm, the rocky or stony, the dry or the wet portions, which are not well fitted for agricultural crops. As a rule, it is treated as it ought not to be, if the intention is to have it serve its purpose continuously; it is cut and culled without regard to its reproduction.

As far as firewood supplies go, the careful farmer will first use the dead and dying trees, broken limbs, and leavings, which is quite proper. The careless man avoids the extra labor which such material requires, and takes whatever splits best, no matter whether the material could be used for better purposes or not.

When it comes to the cutting of other material, fence rails, posts, or dimension timber, the general rule is to go into the lot and select the best trees of the best kind for the purpose. This looks at first sight like the natural, most practical way of doing. It is the method which the lumberman pursues when he "culls" the forest, and is, from his point of view perhaps, justifiable, for he only desires to secure at once what is most profitable in the forest. But for the farmer, who proposes to use his wood lot continuously for supplies of this kind, it is a method detrimental to his object, and in time it leaves him with a lot of poor, useless timber which encumbers the ground and prevents the growth of a better crop.

Our woods are mostly composed of many species of trees; they are mixed woods. Some of the species are valuable for some special purposes, others are applicable to a variety of purposes, and again others furnish but poor material for anything but firewood, and even for that use they may not be of the best.

Among the most valuable in the northeastern woods we should mention the white pine—king of all—the white ash, white and chestnut oak, hickories, tulip tree, black walnut, and black cherry, the last three being now nearly exhausted; next, spruce and hemlock, red pine, sugar maple, chestnut, various oaks of the black or red oak tribe, several species of ash and birch, black locust; lastly, elms and soft maples, basswood, poplars, and sycamore.

Now, by the common practice of culling the best it is evident that gradually all the best trees of the best kinds are taken out, leaving only inferior trees or inferior kinds—the weeds among trees, if one may call them such—and thus the wood lot becomes well-nigh useless.

It does not supply that for which it was intended; the soil, which was of little use for anything but a timber crop before, is still further deteriorated under this treatment, and being compacted by the constant running of cattle, the starting of a crop of seedlings is made nearly impossible. It would not pay to turn it into tillage ground or pasture; the farm has by so much lost in value. In other words, instead of using the interest on his capital, interest and capital have been used up together; the goose that laid the golden egg has been killed.

This is not necessary if only a little system is brought into the management of the wood lot and the smallest care is taken to avoid deterioration and secure reproduction.

IMPROVEMENT CUTTINGS.

The first care should be to improve the crop in its composition. Instead of culling it of its best material, it should be culled of its weeds, the poor kinds, which we do not care to reproduce, and which, like all other weeds, propagate themselves only too readily. This weeding must not, however, be done all at once, as it could be in a field crop, for in a full-grown piece of woodland each tree has a value, even the weed trees, as soil cover.

The great secret of success in all crop production lies in the regulating of water supplies; the manuring in part and the cultivating entirely, as well as drainage and irrigation, are means to this end. In forestry these means are usually not practicable, and hence other means are resorted to. The principal of these is to keep the soil as much as possible under cover, either by the shade which the foliage of the tall trees furnishes, or by that from the underbrush, or by the litter which accumulates and in decaying forms a humus cover, a most excellent mulch.

A combination of these three conditions, viz, a dense crown cover, woody underbrush where the crown cover is interrupted, and a heavy layer of well-decomposed humus, gives the best result. Under such conditions, first of all, the rain, being intercepted by the foliage and litter, reaches the ground only gradually, and therefore does not compact the soil as it does in the open field, but leaves it granular and open, so that the water can readily penetrate and move in the soil. Secondly, the surface evaporation is considerably reduced by the shade

and lack of air circulation in the dense woods, so that more moisture remains for the use of the trees. When the shade of the crowns overhead (the so-called "crown cover," or "canopy,") is perfect, but little undergrowth will be seen; but where the crown cover is interrupted or imperfect, an undergrowth will appear. If this is composed of young trees, or even shrubs, it is an advantage, but if of weeds, and especially grass, it is a misfortune, because these transpire a great deal more water than the woody plants and allow the soil to deteriorate in structure and therefore in water capacity.

Some weeds and grasses, to be sure, are capable of existing where but little light reaches the soil. When they appear it is a sign to the forester that he must be careful not to thin out the crown cover any more. When the more light-needing weeds and grasses appear it is a sign that too much light reaches the ground, and that the soil is already deteriorated. If this state continues, the heavy drain which the transpiration of these weeds makes upon the soil moisture, without any appreciable conservative action by their shade, will injure the soil still further.

The overhead shade or crown cover may be imperfect because there are not enough trees on the ground to close up the interspaces with their crowns, or else because the kinds of trees which make up the forest do not yield much shade; thus it can easily be observed that a beech, a sugar maple, a hemlock, is so densely foliated that but little light reaches the soil through its crown canopy, while an ash, an oak, a larch, when full grown, in the forest, allows a good deal of light to penetrate.

Hence, in our weeding process for the improvement of the wood crop, we must be careful not to interrupt the crown cover too much, and thereby deteriorate the soil conditions. And for the same reason, in the selection of the kinds that are to be left or to be taken out, we shall not only consider their use value but also their shading value, trying to bring about such a mixture of shady and less shady kinds as will insure a continuously satisfactory crown cover, the shade-enduring kinds to occupy the lower stratum in the crown canopy, and to be more numerous than the light-needing.

The forester, therefore, watches first the conditions of his soil cover, and his next care is for the condition of the overhead shade, the "crown cover;" for a change in the condition of the latter brings change into his soil conditions, and, inversely, from the changes in the plant cover of the soil he judges whether he may or may not change the light conditions. The changes of the soil cover teach him more often when "to let alone" than when to go on with his operations of thinning out; that is to say, he can rarely stop short of that condition which is most favorable. Hence the improvement cuttings must be made with caution and only very gradually, so that no deterioration of the soil conditions be invited. We have repeated this injunction again and again, because

all success in the management of future wood crops depends upon the care bestowed upon the maintenance of favorable soil conditions.

As the object of this weeding is not only to remove the undesirable kinds from the present crop, but to prevent as much as possible their reappearance in subsequent crops, it may be advisable to cut such kinds as sprout readily from the stump in summer time—June or July—when the stumps are likely to die without sprouting.

It may take several years' cutting to bring the composition of the main crop into such a condition as to satisfy us.

METHODS OF REPRODUCING THE WOOD CROP.

Then comes the period of utilizing the main crop. As we propose to keep the wood lot as such, and desire to reproduce a satisfactory wood crop in place of the old one, this latter must be cut always with a view to that reproduction. There are various methods pursued for this purpose in large forestry operations which are not practicable on small areas, especially when these are expected to yield only small amounts of timber, and these little by little as required. It is possible, to be sure, to cut the entire crop and replant a new one, or else to use the ax skillfully and bring about a natural reproduction in a few years; but we want in the present case to lengthen out the period during which the old crop is cut, and hence must resort to other methods. There are three methods practicable.

We may clear narrow strips or bands entirely, expecting the neighboring growth to furnish the seed for covering the strip with a new crop—"the strip method;" or we can take out single trees here and there, relying again on an after-growth from seed shed by the surrounding trees—the "selection method;" or, finally, instead of single trees, we may cut entire groups of trees here and there in the same manner, the gaps to be filled, as in the other cases, with a young crop from the seed of the surrounding trees, and this we may call the "group method."

In *the strip method*, in order to secure sufficient seeding of the cleared strip, the latter must not be so broad that the seed from the neighboring growth can not be carried over it by the wind. In order to get the best results from the carrying power of the wind (as well as to avoid windfalls when the old growth is suddenly opened on the windward side) the strips should be located on the side opposite the prevailing winds. Oaks, beech, hickory, and nut trees in general with heavy seeds will not seed over any considerable breadth of strip, while with maple and ash the breadth may be made twice as great as the height of the timber, and the mother trees with lighter seeds, like spruce and pine, or birch and elm, may be able to cover strips of a breadth of 3 or 4 and even 8 times their height. But such broad strips are hazardous, since with insufficient seed fall, or fail years in the seed, the strip may remain exposed to sun and wind for several years without a good cover and deteriorate. It is safer, therefore, to make the strips no broader than just the height of the neighboring timber, in which case not only has the seed better

chance of covering the ground, but the soil and seedlings have more protection from the mother crop. In hilly country the strips must not be made in the direction of the slope, for the water would wash out soil and seed.

Every year, then, or from time to time, a new strip is to be cleared and "regenerated." But if the first strip failed to cover itself satisfactorily, the operation is stopped, for it would be unwise to remove the seed trees further by an additional clearing. Accordingly, this method should be

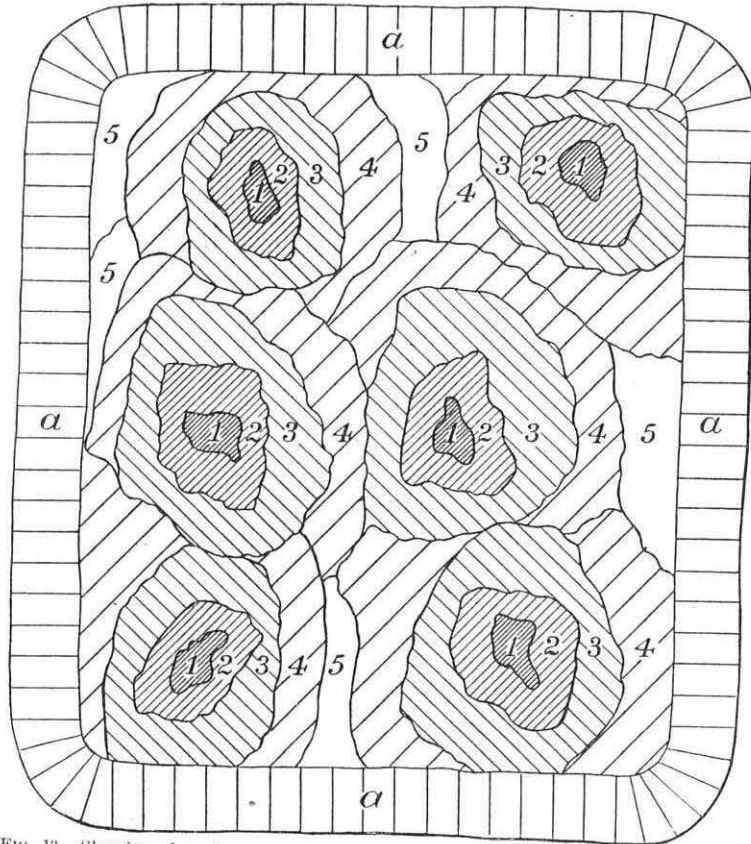


FIG. 13.—Showing plan of group system in regenerating a forest crop. 1, 2, 3, 4, successive groups of young timber, 1 being the oldest, 4 the youngest, 5 old timber; a, wind mantle, specially managed to secure protection.

used only where the kinds composing the mother crop are frequent and abundant seeders and give assurance of reseeding the strips quickly and successfully.

The other two methods have greater chances of success in that they preserve the soil conditions more surely, and there is more assurance of seeding from the neighboring trees on all sides.

The selection method, by which single trees are taken out all over the forest, is the same as has been practiced by the farmer and lumberman

hitherto, only they have forgotten to look after the young crop. Millions of seed may fall to the ground and germinate, but perish from the excessive shade of the mother trees. If we wish to be successful in establishing a new crop, it will be necessary to be ready with the ax all the time and give light as needed by the young crop. The openings made by taking out single trees are so small that there is great danger of the young crop being lost, or at least impeded in its development, because it is impracticable to come in time to its relief with the ax.

The best method, therefore, in all respects, is the "group method," which not only secures continuous soil cover, chances for full seeding, and more satisfactory light conditions, but requires less careful attention, or at least permits more freedom of movement and adaptation to local conditions (fig. 13).

It is especially adapted to mixed woods, as it permits securing for each species the most desirable light conditions by making the openings larger or smaller, according as the species we wish to favor in a particular group demand more or less shade. Further, when different species are ripe for regeneration at different times, this plan makes it possible to take them in hand as needed. Again, we can begin with one group or we can take in hand several groups simultaneously, as may be desirable and practicable.

We start our groups of new crop either where a young growth is already on the ground, enlarging around it, or where old timber has reached its highest usefulness and should be cut in order that we may not lose the larger growth which young trees would make; or else we choose a place which is but poorly stocked, where, if it is not regenerated, the soil is likely to deteriorate further. The choice is affected further by the consideration that dry situations should be taken in hand earlier than those in which the soil and site are more favorable, and that some species reach maturity and highest use value earlier than others and should therefore be reproduced earlier. In short, we begin the regeneration when and where the necessity for it exists, or where the young crop has the best chance to start most satisfactorily with the least artificial aid. Of course, advantage should be taken of the occurrence of seed years, which come at different intervals with different species.

If we begin with a group of young growth already on the ground, our plan is to remove gradually the old trees standing over them when no longer required for shade, and then to cut away the adjoining old growth and enlarge the opening in successive narrow bands around the young growth. When the first band has seeded itself satisfactorily, and the young growth has come to require more light (which may take several years), we remove another band around it, and thus the regeneration progresses. Where no young growth already exists, of course the first opening is made to afford a start, and afterwards the enlargement follows as occasion requires.

SIZE OF OPENINGS.

The size of the openings and the rapidity with which they should be enlarged vary, of course, with local conditions and the species which is to be favored, the light-needing species requiring larger openings and quicker light additions than the shade-enduring. It is difficult to give any rules, since the modifications due to local conditions are so manifold, requiring observation and judgment. Caution in not opening too much at a time and too quickly may avoid failure in securing good stands.

In general, the first openings may contain from one-fourth to one-half an acre or more, and the gradual enlarging may progress by clearing bands of a breadth not to exceed the height of the surrounding timber.

The time of the year when the cutting is to be done is naturally in winter, when the farmer has the most leisure, and when the wood seasons best after felling and is also most readily moved. Since it is expected that the seed fallen in the autumn will sprout in the spring, all wood should, of course, be removed from the seed ground.

The first opening, as well as the enlargement of the groups, should not be made at once, but by gradual thinning out, if the soil is not in good condition to receive and germinate the seed and it is impracticable to put it in such condition by artificial means—hoeing or plowing.

It is, of course, quite practicable—nay, sometimes very desirable—to prepare the soil for the reception and germination of the seed. Where undesirable undergrowth has started, it should be cut out, and where the soil is deteriorated with weed growth or compacted by the tramping of cattle, it should be hoed or otherwise scarified, so that the seed may find favorable conditions. To let pigs do the plowing and the covering of acorns is not an uncommon practice abroad.

It is also quite proper, if the reproduction from the seed of the surrounding mother trees does not progress satisfactorily, to assist, when an opportunity is afforded, by planting such desirable species as were or were not in the composition of the original crop.

It may require ten, twenty, or forty years or more to secure the reproduction of a wood lot in this way. A new growth, denser and better than the old, with timber of varying age, will be the result. The progress of the regeneration in groups is shown on the accompanying plan, the different shadings showing the successive additions of young crop, the darkest denoting the oldest parts, first regenerated. If we should make a section through any one of the groups, this, ideally represented, would be like figure 14, the old growth on the outside, the youngest new crop adjoining it, and tiers of older growths of varying height toward the center of the group.

WIND MANTLE.

On the plan there will be noted a strip specially shaded, surrounding the entire plat (fig. 13, *a*), representing a strip of timber which should surround the farmer's wood lot, and which he should keep as dense as

possible, especially favoring undergrowth. This part, if practicable, should be kept reproduced as coppice or by the method of selection, i. e., by taking out trees here and there. When gaps are made, they should be filled, if possible, by introducing shade-enduring kinds, which, like the spruces and firs and beech, retain their branches down to the foot for a long time. This mantle is intended to protect the interior against the drying influence of winds, which are bound to enter the small wood lot and deteriorate the soil. The smaller the lot, the more necessary and desirable it is to maintain such a protective cover or windbreak.

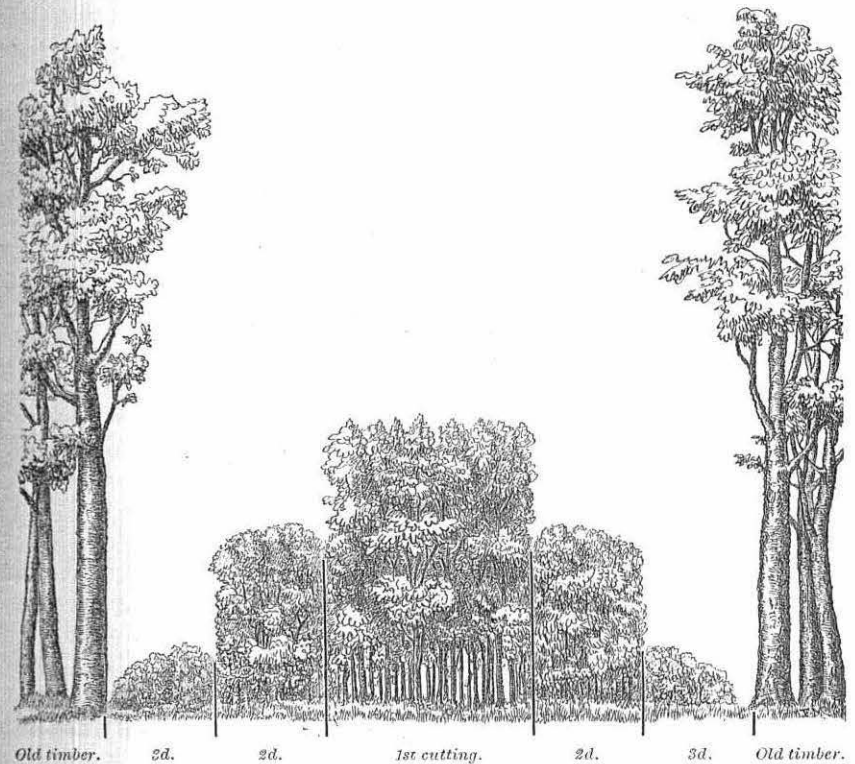


FIG. 14.—Appearance of regeneration by group method.

COPPICE.

Besides reproducing a wood crop from the seed of mother trees or by planting, there is another reproduction possible by sprouts from the stump. This, to be sure, can be done only with broad-leaved species, since conifers, with but few exceptions, do not sprout from the stump. When a wood lot is cut over and over again, the reproduction taking place by such sprouts we call coppice.

Most wooded areas in the Eastern States have been so cut that reproduction from seed could not take place, and hence we have large areas

of coppice, with very few seedling trees interspersed. As we have seen in the chapter on "How trees grow," the sprouts do not develop into as good trees as the seedlings. They grow faster, to be sure, in the beginning, but do not grow as tall and are apt to be shorter lived.

For the production of firewood, fence, and post material, coppice management may suffice, but not for dimension timber. And even to keep the coppice in good reproductive condition, care should be taken to secure a certain proportion of seedling trees, since the old stumps, after repeated cutting, fail to sprout and die out.

Soil and climate influence the success of the coppice; shallow soils produce weaker but more numerous sprouts and are more readily deteriorated by the repeated laying bare of the soil; a mild climate is most favorable to a continuance of the reproductive power of the stump.

Some species sprout more readily than others; hence the composition of the crop will change, unless attention is paid to it. In the coppice, as in any other management of a natural wood crop, a desirable composition must first be secured, which is done by timely improvement cuttings, as described in a previous section.

The best trees for coppice in the northeastern States are the chestnut, various oaks, hickory, ash, elm, maples, basswood, and black locust, which are all good sprouters.

When cutting is done for reproduction, the time and manner are the main care. The best results are probably obtained, both financially and with regard to satisfactory reproduction, when the coppice is cut between the twentieth and thirtieth years. All cutting must be done in early spring or in winter, avoiding, however, days of severe frost, which is apt to sever the bark from the trunk and to kill the cambium. Cutting in summer kills the stump, as a rule. The cut should be made slanting downward, and as smooth as possible, to prevent collection of moisture on the stump and the resulting decay, and as close as possible to the ground, where the stump is less exposed to injuries, and the new sprouts, starting close to the ground, may strike independent roots.

Fail places or gaps should be filled by planting. This can be readily done by bending to the ground some of the neighboring sprouts, when 2 to 3 years old, notching, fastening them down with a wooden hook or a stone, and covering them with soil a short distance (4 to 6 inches) from the end. The sprout will then strike root, and after a year or so may be severed from the mother stock by a sharp cut (fig. 15).

For the recuperation of the crop, it is desirable to maintain a supply of seedling trees, which may be secured either by the natural seeding of a few mother trees of the old crop which are left, or by planting. This kind of management, coppice with seedling or standard trees intermixed, if the latter are left regularly and well distributed over the wood lot, leads to a management called "standard coppice." In this it is attempted to avoid the drawbacks of the coppice, viz, failure to produce dimension material and running out of the stocks. The former

object is, however, only partially accomplished, as the trees grown without sufficient side shading are apt to produce branchy boles and hence knotty timber, besides injuring the coppice by their shade.

PLAN OF MANAGEMENT.

In order to harmonize the requirements of the wood lot from a sylvicultural point of view, and the needs of the farmer for wood supplies, the cutting must follow some systematic plan.

The improvement cuttings need not, in point of time, have been made all over the lot before beginning the cuttings for regeneration, provided they have been made in those parts which are to be regenerated. Both the cuttings may go on simultaneously, and this enables the farmer to gauge the amount of cutting to his consumption. According to the

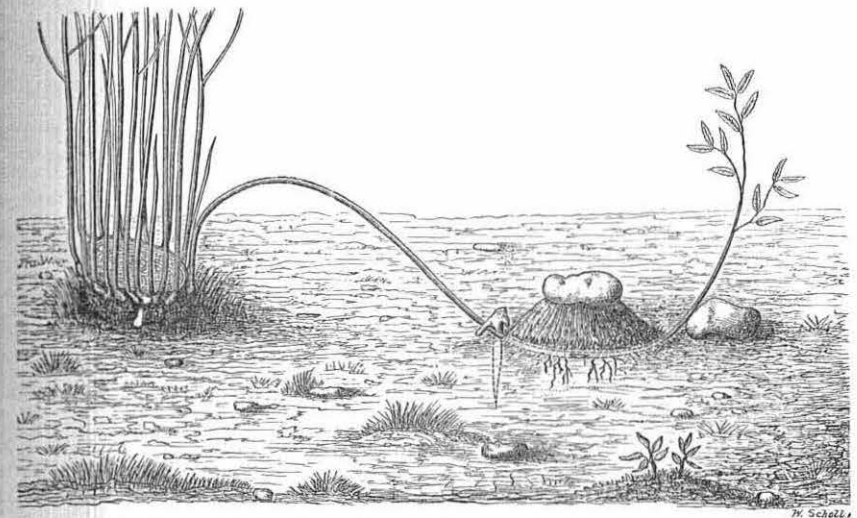


FIG. 15.—Method of layering to produce new stocks in coppice wood.

amount of wood needed, one or more groups may be started at the same time. It is, however, desirable, for the sake of renewing the crop systematically, to arrange the groups in a regular order over the lot.

4. HOW TO CULTIVATE THE WOOD CROP.

Where only firewood is desired, i. e., wood without special form, size, or quality, no attention to the crop is necessary, except to insure that it covers the ground completely. Nevertheless, even in such a crop, which is usually managed as coppice,¹ some of the operations described in this chapter may prove advantageous. Where, however, not only quantity but useful quality of the crop is also to be secured, the development of the wood crop may be advantageously influenced by controlling the supply of light available to the individual trees.

¹ See page 35 for description of coppice.

It may be proper to repeat here briefly what has been explained in previous pages regarding the influence of light on tree development.

EFFECT OF LIGHT ON WOOD PRODUCTION.

Dense shade preserves soil moisture, the most essential element for wood production; a close stand of suitable kinds of trees secures this shading and prevents the surface evaporation of soil moisture, making it available for wood production. But a close stand also cuts off side light and confines the lateral growing space, and hence prevents the development of side branches and forces the growth energy of the soil to expend itself in height growth; the crown is carried up, and long, cylindrical shafts, clear of branches, are developed; a close stand thus secures desirable form and quality. Yet, since the quality of wood production or accretion (other things being equal) is in direct proportion to the amount of foliage and the available light, and since an open position promotes the development of a larger crown and of more foliage, an open stand tends to secure a larger amount of wood accretion on each tree. On the other hand, a tree grown in the open, besides producing more branches, deposits a larger proportion of wood at the base, so that the shape of the bole becomes more conical, a form which in sawing proves unprofitable; whereas a tree grown in the dense forest both lengthens its shaft at the expense of branch growth and makes a more even deposit of wood over the whole trunk, thus attaining a more cylindrical form. While, then, the total amount of wood production per acre may be as large in a close stand of trees as in an open one (within limits), the distribution of this amount among a larger or smaller number of individual trees produces different results in the quality of the crop. And since the size of a tree or log is important in determining its usefulness and value, the sooner the individual trees reach useful size, without suffering in other points of quality, the more profitable the whole crop.

NUMBER OF TREES PER ACRE.

The care of the forester, then, should be to maintain the smallest number of individuals on the ground which will secure the greatest amount of wood growth in the most desirable form of which the soil and climate are capable, without deteriorating the soil conditions. He tries to secure the most advantageous individual development of single trees without suffering the disadvantages resulting from too open stand. The solution of this problem requires the greatest skill and judgment, and rules can hardly be formulated with precision, since for every species or combination of species and conditions these rules must be modified.

In a well-established young crop the number of seedlings per acre varies greatly, from 3,000 to 100,000, according to soil, species, and the manner in which it originated, whether planted, sown, or seeded

naturally.¹ Left to themselves, the seedlings, as they develop, begin to crowd each other. At first this crowding results only in increasing the height growth and in preventing the spread and full development of side branches; by and by the lower branches failing to receive sufficient light finally die and break off—the shaft “clears itself.” Then a distinct development of definite crowns takes place, and after some years a difference of height growth in different individuals becomes marked. Not a few trees fail to reach the general upper crown surface, and, being more or less overtopped, we can readily classify them according to height and development of crown, the superior or “dominating” ones growing more and more vigorously, the inferior or “dominated” trees falling more and more behind, and finally dying for lack of light, and thus a natural reduction in numbers, or thinning, takes place. This natural thinning goes on with varying rates at different ages continuing through the entire life of the crop, so that, while only 4,000 trees per acre may be required in the tenth year to make a dense crown cover or normally close stand, untouched by man, in the fortieth year 1,200 would suffice to make the same dense cover, in the eightieth year 350 would be a full stand, and in the one hundredth not more than 250, according to soil and species, more or less. As we can discern three stages in the development of a single tree—the juvenile, adolescent, and mature—so, in the development of a forest growth, we may distinguish three corresponding stages, namely, the “thicket” or brushwood, the “pole-wood” or sapling, and the “timber” stage. During the thicket stage, in which the trees have a bushy appearance, allowing hardly any distinction of stem and crown, the height growth is most rapid. This period may last, according to conditions and species, from 5 or 10 to 30 and even 40 years—longer on poor soils and with shade-enduring species, shorter with light-needing species on good soils—and, while it lasts, it is in the interest of the wood grower to maintain the close stand, which produces the long shaft, clear of branches, on which at a later period the wood that makes valuable, clear timber, may accumulate. Form development is now most important. The lower branches are to die and break off before they become too large. (See illustrations of the progress of “clearing,” on pp. 15 and 16.) With light-needing species and with deciduous trees generally this dying off is accomplished more easily than with conifers. The spruces and even the white pine require very dense shading to “clear” the shaft. During this period it is only necessary to weed out the undesirable kinds, such as trees infested by insect and fungus, shrubs, sickly, stunted, or bushy trees which are apt to overtop and prevent the development of their better neighbors. In short, our attention is now devoted mainly to improving the composition of the crop.

¹If the crop does not, at 3 to 5 years of age, shade the ground well, with a complete crown cover, or canopy, it can not be said to be well established and should be filled out by planting.

WEEDING AND CLEANING THE CROP.

This weeding or cleaning is easily done with shears when the crop is from 3 to 5 years old. Later, mere cutting back of the undesirable trees with a knife or hatchet may be practiced. In well-made artificial plantations this weeding is rarely needed until about the eighth or tenth year. But in natural growths the young crop is sometimes so dense as to inordinately interfere with the development of the individual trees. The stems then remain so slender that there is danger of their being bent or broken by storm or snow when the growth is thinned out later. In such cases timely thinning is indicated to stimulate more rapid development of the rest of the crop. This can be done most cheaply by cutting swaths or lanes one yard wide and as far apart through the crop, leaving strips standing. The outer trees of the strip, at least, will then shoot ahead and become the main crop. These weeding or improvement cuttings, which must be made gradually and be repeated every two or three years, are best performed during the summer months, or in August and September, when it is easy to judge what should be taken out.

METHODS OF THINNING.

During the "thicket" stage, then, which may last from 10 to 25 and more years, the crop is gradually brought into proper composition and condition. When the "pole-wood" stage is reached, most of the saplings being now from 3 to 6 inches in diameter and from 15 to 25 feet in height, the variation in sizes and in appearance becomes more and more marked. Some of the taller trees begin to show a long, clear shaft and a definite crown. The trees can be more or less readily classified into height and size classes. The rate at which the height growth has progressed begins to fall off and diameter growth increases. Now comes the time when attention must be given to increasing this diameter growth by reducing the number of individuals and thus having all the wood which the soil can produce deposited on fewer individuals. This is done by judicious and often repeated thinning, taking out some of the trees and thereby giving more light and increasing the foliage of those remaining; and as the crowns expand, so do the trunks increase their diameter in direct proportion. These thinnings must, however, be made cautiously lest at the same time the soil is exposed too much or the branch growth of those trees which are to become timber wood is too much stimulated. So varying are the conditions to be considered, according to soil, site, species, and development of the crop, that it is well-nigh impossible, without a long and detailed discussion, to lay down rules for the proper procedure. In addition the opinions of authorities differ largely both as to manner and degree of thinning, the old school advising moderate, and the new school severer thinnings.

For the farmer, who can give personal attention to detail and whose object is to grow a variety of sizes and kinds of wood, the following general method may perhaps be most useful:

First determine which trees are to be treated as the main crop or "final harvest" crop. For this 300 to 500 trees per acre of the best grown and most useful kinds may be selected, which should be distributed as uniformly as possible over the acre. These, then—or as many as may live till the final harvest—are destined to grow into timber and are to form the special favorites as much as possible. They may at first be marked to insure recognition; later on they will be readily distinguished by their superior development. The rest, which we will call the "subordinate" crop, is then to serve merely as filler, nurse, and soil cover.

WHAT TREES TO REMOVE.

It is now necessary, by careful observation of the surroundings of each of the "final harvest" crop trees, or "superiors," as we may call them, to determine what trees of the "subordinate" crop trees, or "inferiors," must be removed. All nurse trees that threaten to overtop the superiors must either be cut out or cut back and topped, if that is practicable, so that the crown of the superiors can develop freely. Those that are only narrowing in the superiors from the side, without preventing their free top development, need not be interfered with, especially while they are still useful in preventing the formation and spreading of side branches on the superiors. As soon as the latter have fully cleared their shafts, these crowding inferiors must be removed. Care must be taken, however, not to remove too many at a time, thus opening the crown cover too severely and thereby exposing the soil to the drying influence of the sun. Gradually, as the crowns of inferiors standing farther away begin to interfere with those of the superiors, the inferiors are removed, and thus the full effect of the light is secured in the accretion of the main harvest crop; at the same time the branch growth has been prevented and the soil has been kept shaded. Meanwhile thinnings may also be made in the subordinate crop, in order to secure also the most material from this part of the crop. This is done by cutting out all trees that threaten to be killed by their neighbors. In this way many a useful stick is saved and the dead material, only good for firewood, lessened. It is evident that trees which in the struggle for existence have fallen behind, so as to be overtopped by their neighbors, can not, either by their presence or by their removal, influence the remaining growth. They are removed only in order to utilize their wood before it decays.

It may be well to remark again that an undergrowth of woody plants interferes in no way with the development of the main crop, but, on the contrary, aids by its shade in preserving favorable moisture conditions. Its existence, however, shows in most cases that the crown cover is not

as dense as it should be, and hence that thinning is not required. Grass and weed growth, on the other hand, is emphatically disadvantageous and shows that the crown cover is dangerously open.

The answer to the three questions, When to begin the thinnings, How severely to thin, and How often to repeat the operation, must always depend upon the varying appearance of the growth and the necessities in each case. The first necessity for interference may arise with light-needing species as early as the twelfth or fifteenth year; with shade-enduring, not before the twentieth or twenty-fifth year. The necessary severity of the thinning and the repetition are somewhat interdependent. It is better to thin carefully and repeat the operation oftener than to open up so severely at once as to jeopardize the soil conditions. Especially in younger growths and on poorer soil, it is best never to open a continuous crown cover so that it could not close up again within 3 to 5 years; rather repeat the operation oftener. Later, when the trees have attained heights of 50 to 60 feet and clear boles (which may be in 40 to 50 years, according to soil and kind) the thinning may be more severe, so as to require repetition only every 6 to 10 years.

The condition of the crown cover, then, is the criterion which directs the ax. As soon as the crowns again touch or interlace, the time has arrived to thin again. In mixed growths it must not be overlooked that light-needing species must be specially protected against shadier neighbors. Shade-enduring trees, such as the spruces, beech, sugar maple, and hickories, bear overtopping for a time and will then grow vigorously when more light is given, while light-needing species, like the pines, larch, oaks, and ash, when once suppressed, may never be able to recover.

Particular attention is called to the necessity of leaving a rather denser "wind mantle" all around small groves. In this part of the grove the thinning must be less severe, unless coniferous trees on the outside can be encouraged by severe thinning to hold their branches low down, thus increasing their value as windbreaks.

The thinnings, then, while giving to the "final harvest" crop all the advantage of light for promoting its rapid development into serviceable timber size, furnish also better material from the subordinate crop. At 60 to 70 years of age the latter may have been entirely removed and only the originally selected "superiors" remain on the ground, or as many of them as have not died and been removed; 250 to 400 of these per acre will make a perfect stand of most valuable form and size, ready for the final harvest, which should be made as indicated in the preceding chapter.

5.—THE RELATION OF FORESTS TO FARMS.

That all things in nature are related to each other and interdependent is a common saying, a fact doubted by nobody, yet often forgotten or neglected in practical life. The reason is partly indifference and partly ignorance as to the actual nature of the relationship; hence we suffer, deservedly or not.

The farmer's business, more than any other, perhaps, depends for its success upon a true estimate of and careful regard for this interrelation. He adapts his crop to the nature of the soil, the manner of its cultivation to the changes of the seasons, and altogether he shapes conditions and places them in their proper relations to each other and adapts himself to them.

Soil, moisture, and heat are the three factors which, if properly related and utilized, combine to produce his crops. In some directions he can control these factors more or less readily; in others they are withdrawn from his immediate influence, and he is seemingly helpless. He can maintain the fertility of the soil by manuring, by proper rotation of crops, and by deep culture; he can remove surplus moisture by ditching and draining; he can, by irrigation systems, bring water to his crops, and by timely cultivation prevent excessive evaporation, thereby rendering more water available to the crop; but he can not control the rainfall nor the temperature changes of the seasons. Recent attempts to control the rainfall by direct means exhibit one of the greatest follies and misconceptions of natural forces we have witnessed during this age. Nevertheless, by indirect means the farmer has it in his power to exercise much greater control over these forces than he has attempted hitherto. He can prevent or reduce the unfavorable effects of temperature changes; he can increase the available water supplies, and prevent the evil effects of excessive rainfall; he can so manage the waters which fall as to get the most benefit from them and avoid the harm which they are able to inflict.

Before attempting to control the rainfall itself by artifice, we should study how to secure the best use of that which falls, as it comes within reach of human agencies and becomes available by natural causes.

How poorly we understand the use of these water supplies is evidenced yearly by destructive freshets and floods, with the accompanying washing of soil, followed by droughts, low waters, and deterioration of agricultural lands. It is claimed that annually in the United States about 200 square miles of fertile soil are washed into brooks and rivers, a loss of soil capital which can not be repaired for centuries. At the same time millions of dollars are appropriated yearly in the river and harbor bills to dig out the lost farms from the rivers, and many thousands of dollars' worth of crops and other property are destroyed by floods and overflows; not to count the large loss from

droughts which this country suffers yearly in one part or the other, and which, undoubtedly, could be largely avoided, if we knew how to manage the available water supplies.

The regulation, proper distribution, and utilization of the rain waters in humid as well as in arid regions—water management—is to be the great problem of successful agriculture in the future.

One of the most powerful means for such water management lies in the proper distribution and maintenance of forest areas. Nay, we can say that the most successful water management is not possible without forest management.

THE FOREST WATERS THE FARM.

Whether forests increase the amount of precipitation within or near their limits is still an open question, although there are indications that under certain conditions large, dense forest areas may have such an effect. At any rate, the water transpired by the foliage is certain, in some degree, to increase the relative humidity near the forest, and thereby increase directly or indirectly the water supplies in its neighborhood. This much we can assert, also, that while extended plains and fields, heated by the sun, and hence giving rise to warm currents of air, have the tendency to prevent condensation of the passing moisture-bearing currents, forest areas, with their cooler, moister air strata, do not have such a tendency, and local showers may therefore become more frequent in their neighborhood. But, though no increase in the amount of rainfall may be secured by forest areas, the availability of whatever falls is increased for the locality by a well-kept and properly located forest growth. The foliage, twigs, and branches break the fall of the raindrops, and so does the litter of the forest floor, hence the soil under this cover is not compacted as in the open field, but kept loose and granular, so that the water can readily penetrate and percolate; the water thus reaches the ground more slowly, dripping gradually from the leaves, branches, and trunks, and allowing more time for it to sink into the soil. This percolation is also made easier by the channels along the many roots. Similarly, on account of the open structure of the soil and the slower melting of the snow under a forest cover in spring, where it lies a fortnight to a month longer than in exposed positions and melts with less waste from evaporation, the snow waters more fully penetrate the ground. Again, more snow is caught and preserved under the forest cover than on the wind-swept fields and prairies.

All these conditions operate together, with the result that larger amounts of the water sink into the forest soil and to greater depths than in open fields. This moisture is conserved because of the reduced evaporation in the cool and still forest air, being protected from the two great moisture-dissipating agents, sun and wind. By these conditions alone the water supplies available in the soil are increased from

50 to 60 per cent over those available on the open field. Owing to these two causes, then—increased percolation and decreased evaporation—larger amounts of moisture become available to feed the springs and subsoil waters, and these become finally available to the farm, if the forest is located at a higher elevation than the field. The great importance of the subsoil water especially and the influence of forest areas upon it has so far received too little attention and appreciation. It is the subsoil water that is capable of supplying the needed moisture in times of drought.

THE FOREST TEMPERS THE FARM.

Another method by which a forest belt becomes a conservator of moisture lies in its wind-breaking capacity, by which both velocity and temperature of winds are modified and evaporation from the fields to the leeward is reduced.

On the prairie, wind swept every day and every hour, the farmer has learned to plant a wind-break around his buildings and orchards, often only a single row of trees, and finds even that a desirable shelter, tempering both the hot winds of summer and the cold blasts of winter. The fields he usually leaves unprotected; yet a wind-break around his crops to the windward would bring him increased yield, and a timber belt would act still more effectively. Says a farmer from Illinois:

My experience is that now in cold and stormy winters fields protected by timber belts yield full crops, while fields not protected yield only one-third of a crop. Twenty-five or thirty years ago we never had any wheat killed by winter frost, and every year we had a full crop of peaches, which is now very rare. At that time we had plenty of timber around our fields and orchards, now cleared away.

Not only is the temperature of the winds modified by passing over and through the shaded and cooler spaces of protecting timber belts disposed toward the windward and alternating with the fields, but their velocity is broken and moderated, and since with reduced velocity the evaporative power of the winds is very greatly reduced, so more water is left available for crops. Every foot in height of a forest growth will protect 1 rod in distance, and several belts in succession would probably greatly increase the effective distance. By preventing deep freezing of the soil the winter cold is not so much prolonged, and the frequent fogs and mists that hover near forest areas prevent many frosts. That stock will thrive better where it can find protection from the cold blasts of winter and from the heat of the sun in summer is a well-established fact.

THE FOREST PROTECTS THE FARM.

On the sandy plains, where the winds are apt to blow the sand, shifting it hither and thither, a forest belt to the windward is the only means to keep the farm protected.

In the mountain and hill country the farms are apt to suffer from heavy rains washing away the soil. Where the tops and slopes are bared of their forest cover, the litter of the forest floor burnt up, the soil trampled and compacted by cattle and by the pattering of the raindrops, the water can not penetrate the soil readily, but is carried off superficially, especially when the soil is of clay and naturally compact. As a result the waters, rushing over the surface down the hill, run together in rivulets and streams and acquire such a force as to be able to move loose particles and even stones; the ground becomes furrowed with gullies and runs; the fertile soil is washed away; the fields below are covered with silt; the roads are damaged; the water courses tear their banks, and later run dry because the waters that should feed them by subterranean channels have been carried away in the flood.

The forest cover on the hilltops and steep hillsides which are not fit for cultivation prevents this erosive action of the waters by the same influence by which it increases available water supplies. The important effects of a forest cover, then, are retention of larger quantities of water and carrying them off under ground and giving them up gradually, thus extending the time of their usefulness and preventing their destructive action.

In order to be thoroughly effective, the forest growth must be dense, and, especially, the forest floor must not be robbed of its accumulations of foliage, surface mulch and litter, or its underbrush by fire, nor must it be compacted by the trampling of cattle.

On the gentler slopes, which are devoted to cultivation, methods of underdraining, such as horizontal ditches partly filled with stones and covered with soil, terracing, and contour plowing, deep cultivation, sodding, and proper rotation of crops, must be employed to prevent damage from surface waters.

THE FOREST SUPPLIES THE FARM WITH USEFUL MATERIAL.

All the benefits derived from the favorable influence of forest belts upon water conditions can be had without losing any of the useful material that the forest produces. The forest grows to be cut and to be utilized; it is a crop to be harvested. It is a crop which, if properly managed, does not need to be replanted; it reproduces itself.

When once established, the ax, if properly guided by skillful hands, is the only tool necessary to cultivate it and to reproduce it. There is no necessity of planting unless the wood lot has been mismanaged.

The wood lot, then, if properly managed, is not only the guardian of the farm, but it is the savings bank from which fair interest can be annually drawn, utilizing for the purpose the poorest part of the farm. Nor does the wood lot require much attention; it is to the farm what the workbasket is to the good housewife—a means with which to

improve the odds and ends of time, especially during the winter, when other farm business is at a standstill.

It may be added that the material which the farmer can secure from the wood lot, besides the other advantages recited above, is of far greater importance and value than is generally admitted.

On a well-regulated farm of 160 acres, with its 4 miles and more of fencing and with its wood fires in range and stove, at least 25 cords of wood are required annually, besides material for repair of buildings, or altogether the annual product of probably 40 to 50 acres of well-stocked forest is needed. The product may represent, according to location, an actual stumpage value of from \$1 to \$3 per acre, a sure crop coming every year without regard to weather, without trouble and work, and raised on the poorest part of the farm. It is questionable whether such net results could be secured with the same steadiness from any other crop. Nor must it be overlooked that the work in harvesting this crop falls into a time when little else could be done.

Wire fences and coal fires are, no doubt, good substitutes, but they require ready cash, and often the distance of haulage makes them rather expensive. Presently, too, when the virgin woods have been still further culled of their valuable stores, the farmer who has preserved a sufficiently large and well-tended wood lot will be able to derive a comfortable money revenue from it by supplying the market with wood of various kinds and sizes. The German State forests, with their complicated administrations, which eat up 4 per cent of the gross income, yield, with prices of wood about the same as in our country, an annual net revenue of from \$1 to \$4 and more per acre. Why should not the farmer, who does not pay salaries to managers, overseers, and forest guards, make at least as much money out of this crop when he is within reach of a market?

With varying conditions the methods would of course vary. In a general way, if he happens to have a virgin growth of mixed woods, the first care would be to improve the composition of the wood lot by cutting out the less desirable kinds, the weeds of tree growth, and the poorly grown trees which impede the development of more deserving neighbors.

The wood thus cut he will use as firewood or in any other way, and, even if he could not use it at all, and had to burn it up, the operation would pay indirectly by leaving him a better crop. Then he may use the rest of the crop, gradually cutting the trees as needed, but he must take care that the openings are not made too large, so that they can readily fill out with young growth from the seed of the remaining trees, and he must also pay attention to the young aftergrowth, giving it light as needed. Thus without ever resorting to planting he may harvest the old timber and have a new crop taking its place and perpetuate the wood lot without in any way curtailing his use of the same.

TITLE: BERNHARD EDUARD FERNOW (1851-1923) — THE PERSON, THE PROFESSIONAL FORESTER, AND THE "SHADY SIDES" OF THE DEMOCRATIC SYSTEM.

"...The main service, the principle object of the forest has nothing to do with beauty or pleasure. It is not, except incidentally, an object of aesthetics, but an object of economics." Fernow (1896)

Letter to Editor The Forester (Vol. 2) p. 45

INTRODUCTION

Fernow — A Historical Sketch and Some of His Accomplishments. Bernhard Fernow was born of aristocratic lineage in Inowraclaw, Prussia in 1851. He selected the forestry profession as a career and completed the program for aspiring government foresters at Muenden Forest Academy. Such training and the power-prestige of his family assured him of entry and advancement in a German forestry bureaucracy that was over a hundred years old.

But the Gods work in strange ways. Bernhard met and fell in love with Olivia Reynolds who was visiting the continent from Brooklyn, New York. Against the advice of many of his friends and family (and probably against the council of the rational part of himself nurtured in his German heritage and forestry education) Bernhard went to New York, married Olivia in 1879, stayed there, and thus became the first professionally trained forester in North America. He made America his country and its forests, forestry, and foresters his consuming concern.

Fernow quickly became involved in the American forest conservation, becoming secretary of the American Forestry Association (America's first forest conservation agency formed in 1875). In 1886 President Cleveland appointed him Chief of the Division of Forestry (predecessor of the U.S. Forest Service). He remained there twelve years, a constant supporter of a national forest system to be managed and administered by a professionally trained, scientifically-oriented

forestry corp (just like the old country). Fernow was part of the small, clandestine group that slipped Section 24 into the 1891 Public Lands Bill, providing presidential power to reserve lands as National Forests. He also proposed to Congress that West Point become a professional forestry as well as a professional military academy. This again followed the Prussian model, but Congress rejected the idea.

Bernhard Fernow instigated and was part of many of the forces that began forestry education in the U.S. and Canada. He was head of North America's first professional forestry school at Cornell (1898-1903) and became Dean of the faculty of Forestry at University of Toronto in 1907. It's no wonder American and Canadian forestry and foresters resemble the Prussian model.

Fernow also wrote the first textbook of forest economics (Economics of Forestry. 1902. New York: T.Y. Crowell and Co., 520 pp.), instigated and was the editor of the first professional forestry journal (Forestry Quarterly from 1902-16), and first editor of its successor: the Journal of Forestry begun in 1911. A Closer Look at Fernow, the Person. Rationality, order and control are personal or institutional attributes highly regarded by some individuals and some societies of our planet. German people and German institutions are often stereotyped as valuing such attributes.

Fernow was raised in an aristocratic Prussian family, was educated in the proper academies of the day, and selected a proud and respected school for his professional forestry training. Since the Prussian Forest Service was part of the military (as is our Army Corp of Engineers), his professional training was probably quite paramilitary.

Prussian professionals in the 1800's had certain images of how the world should be organized and operated. And essential elements of their images were the attributes of rationality, science, power of the state, importance of the trained professional, and maintaining order in the conduct of human affairs.

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BERNHARD EDUARD FERNOW

¹Reproduced from the cover page of the April 1923 issue of the Journal of Forestry that was almost completely devoted to the memory of the recently departed Fernow.

There was also little debate in Prussia of Fernow's day that wood was an essential and scarce material, that the state should ensure this critical resource was adequately provided, and that professional foresters were best able to make the important decisions about these forestry problems.

Much of Fernow's teaching has a simplicity and order reflective of his background. Some of his basic principles of forestry (Senate of University of Toronto, 1923:313) are an example:

"Save by intelligent use.
We must protect in order to practice.
Forestry is a function of the state."

I detect a ring of authority and certainty here reminiscent of my old catechisms and ROTC manuals.

I offer an equally no-nonsense quote on the proper role of forestry from his Economics of Forestry (Fernow 1902:85-86):

"The first and foremost purpose of a forest growth is to supply us with wood material; it is the substance of the trees itself, not their fruit, their beauty, their shade, their shelter . . .

With the settlement of the country and the growing needs of civilization this use must and will attach as an essential predicate, a fundamental requisite . . .

Thus if the state of New York withdraws from such use a large woodland area in the Adirondacks (referring to the Adirondacks State Forest Reserve)* to subserve solely other purposes (recreation, landscape amenities, etc.)*, this can be only a temporary withdrawal from its main purpose (wood production)* which time and intelligent conception of rational economy will reverse."

Ah, for the good ole days of forestry fundamentalism.

*Comments in brackets are mine.

The Tupper Lake Controversy -- Laymen vs. the Professional Forester. In 1898 Fernow began North America's first University program of forestry at Cornell University. But the new New York State College of Forestry was only to last five years before ending in Fernow's greatest personal and professional tragedy. It was a kind of Greek Tragedy that North American foresters seem compelled to replay in honor of Fernow and our ancient professional ancestors. I will briefly review the incident.

ACT ONE: Began long ago with the cultural baggage and images that Fernow "brought off the boat" when he arrived in Brooklyn. We have discussed this baggage of Prussian and professional forestry images above.

ACT TWO: At Fernow's encouragement the state of New York purchased an old cut-over forest near Tupper Lake. The purpose of this timber stand was a college experimental and laboratory forest; it happened to be located in a popular summer resort area of the Adirondack Mountains.

The Tupper Lake Forest had been cut over several times in the last 100 years, removing almost all softwood and valuable hardwoods. It was in derelict condition common of most forests of eastern United States in those times. So Fernow followed his professional instincts and began a silvicultural prescription of clearcutting the low value hardwood stands and replacing them with more promising conifer plantations. It was to be one of North America's first examples of good, efficient, practical forestry. It was to be a lesson to forestry students and the public!

When logging of low quality hardwood stands commenced in 1903 some wealthy and influential summer residents protested the radical change in their scenery. They were not mollified when informed they were witnessing rational, scientific forestry in the capable hands of a professional forester.

ACT THREE: Upon returning to Cornell University, Fernow discovered some angry and influential Adirondack summer home residents had persuaded the governor to veto the New York State College of Forestry's budget (Duerr 1966).

Fernow was dismissed. One of North America's first examples of good, efficient forestry became a lesson of another sort. The New York State College of Forestry was moved to Syracuse University, where it became the largest professional forestry school on our planet.

EPILOGUE: Bernhard Fernow, disappointed and humiliated, wrote "home" to a character from Act I (Doctor Schwappach — one of his professors at Eberswalde). He related the tragedy of professional American forestry at Tupper Lake to Professor Schwappach and sought council. The professor's reply was reprinted in the Forestry Quarterly.

Fernow (1903:44) begins by giving some background:

"While (Professor Schwappach was)* not acquainted with the local conditions (of Tupper Lake)* by personal inspection, the description of these, given in the reports of the Director of the College, would enable any competent forester to diagnose and prescribe."

The article continues with Professor Schwappach's letter; a portion of which reads (Fernow 1903:44):

"With the principles which are developed (in these reports)* for the management of the College Forest, I am entirely in accord. It is indeed impossible (professionally)* under the stated conditions to *for you to* prescribe or do anything else. To us Europeans it is entirely unintelligible that a committee of laymen, who have never seen a managed forest, should be able to pronounce competent judgment regarding the procedures of professional men. These are the 'shady sides' of the much-praised democratic system." *in America*

Ah, for the good ole days of forestry fundamentalism.

*Comments in brackets are mine.

Some Closing Remarks. The Tupper Lake incident illustrates an old problem we professionals encounter in dealing with social and political realities. Like so much of life's drama, there are no heroes that are totally right; no villains that are totally wrong. And there's the lingering suspicion that if the characters would have "gotten together" something might have been worked out, and possibly much of the conflict reduced.

Like you and me, Bernhard Fernow had his hang-ups. Yet he did many admirable things for his adopted land and its people. The cause of forest conservation and its heritage we enjoy today would have been much less without him.

Most of the April 1923 issue of the Journal of Forestry is devoted to Fernow's memory. Few foresters have the senate of major universities pass resolutions in their memory as did the University of Toronto (it is reproduced in the April 1923 issue). And there are numerous recollections of students and friends that indicate Fernow was a special human being as well as an important professional forester.

MODULE OBJECTIVES

1. To introduce you to one of the most influential persons in shaping American-Canadian images and institutions of forestry and foresters.
2. Through a better understanding of general Prussian cultural influences and professional forestry training that molded Bernhard Fernow, to appreciate the origin of many of the images of good forestry and a good professional forester that were imported to North America.
3. In the Tupper Lake tale, to present the dilemma of professional judgments, rights of laymen, impasses possible in value-conflicts, and the "shady sides of democracy" that are part of forestry past, present, and (probably) future.

4. To have students reflect on the roots of their professional images (be it forestry, range, outdoor recreation or wildlife) and how these images might instigate natural resource conflicts in their life.

LEARNING PLAN

1. Read introduction to this handout once; think about it.
2. Read introduction to this handout again, trying to put yourself in the place of Fernow and think about: (a) how and where you picked up your cultural images; (b) how such images may be an asset to you and your profession at times; and (c) also how they can be a liability at times.
3. Look over the study questions. We will discuss some in class and you might see something similar on an exam.

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- Fernow, B. E. 1902. Economics of Forestry. New York: T. Y. Crowell & Co. (520 pp.)
- Senate of University of Toronto. 1923. "Dr. B. E. Fernow - An Appreciation of His Services." Forestry Quarterly 21(4):311-15 — There are many more articles in this special issue dedicated to the memory of Fernow.

STUDY QUESTIONS

1. The first professional, university forestry program began in Prussia in 1763. By the time we signed the Declaration of Independence, most Prussian universities had forestry professors on their staff. Bernhard Fernow incorporated much of this German forestry tradition into the first North American forestry school at Cornell University, beginning in 1898. He later carried this tradition to the University of Toronto (in 1901).

Why did it take Americans about 135 years longer to begin its first university forestry program? Why (a) physical-environmental situations; and (b) cultural-political images caused this?
2. List, define, and give examples of certain Prussian cultural attributes that were incorporated into American image of what was: (a) a good forest; (b) good forestry practice; and (c) a proper professional forester.

Ferry West
author
2-91

FERNOW, BERNHARD EDUARD (Jan. 7, 1851 - Feb. 6, 1923), pioneer professional forester in North America, one of 13 children, was born in the province of Posen, Prussia (now Poland), to Eduard Fernow, who opted for law and government service rather than managing the family estate, and to Clara Nordman, the second of Eduard's three wives.

In his youth, Fernow spent time with his uncle, Frederick Edmund Fernow, who managed the family property, including a large forest holding. Following secondary school, at age 19, before beginning his classroom studies at the Munden Forest Academy in the province of Hanover, Fernow spent a year in practical woods work with the Prussian forest department. His forestry education was interrupted in 1870 by military service as an army lieutenant during the Franco-Prussian War. Before graduating from forestry school, he met Olivia Reynolds, a U.S. citizen who had accompanied her brother during his university studies in Germany. Olivia was hired to teach Fernow English. When they became engaged and left for the United States in 1876, his family, expecting him to follow in his uncle's footsteps, was upset at his departure. Married in 1879, Olivia gave birth to five children and outlived her husband by 17 years.

Fernow arrived in the United States professionally trained in forestry and offered his services as a consulting forest engineer, a novel profession in a nation where forestry as planned management of woodlands was uncommon. The lack of demand for his speciality led him to work at a variety of jobs (bookkeeping, German tutor, law clerk) until 1878 when he became manager (until 1885) of 15,000 acres of Pennsylvania woodland, a wood source for the charcoal used in the foundry furnaces of Cooper Hewitt and Company. This job and his membership in the American Institute of Mining Engineers linked Fernow with Abraham S. Hewitt--president of the institute, member of Congress, and eventually mayor of New York City.

The foundry forest work exposed Fernow to American forest conditions. Alarmed by his own observations and reports of forest decline found in works such as Charles S. Sargent's 1884 Report on the Forests of North America, Fernow spoke out on the need for protective legislation and economical management of America's forest resources. As a professional forester, he saw his position as objectively balancing between the extremes of protectionists who wanted to lock up the land as parks and wholesale exploiters.

In 1883, the year he became a U.S. citizen, Fernow was elected to secretary of the American Forestry Association (AFA); in 1888 he moved up to chair the executive committee of the AFA and did so for the next 10 years. The AFA was active in the first American Forestry Congress in 1882 in Cincinnati, Ohio. The work of this congress--and later ones--led to increased public awareness of the plight of the nation's forestlands, leading to an organized movement of conservationists seeking legislation in state and federal governments to protect forests.

The highly visible Fernow was recommended by Abraham S. Hewitt to President Grover Cleveland to be appointed the third (after Franklin B. Hough and Nathaniel H. Egleston) chief of the Division of Forestry of the U.S. Department of Agriculture on March 15, 1886. Limited budgets constrained the work of the Division during his tenure, yet he and his staff, during his 12-year tenure, produced over 200 articles and 50 bulletins on forests and forestry for the public. He did much to make forestry a science in the United States with his major contribution of founding within the USDA Division of Forestry a timber

physics research program (forest products) and a study of wood and forest growth.

Fernow, more a scientist than a politician, left the Division of Forestry in 1898 to head the newly founded forestry school at Cornell University, the first four-year program of forestry in the United States. A dispute over forestry practices on the school forest by adjacent estate owners ended with Fernow departing for Canada, where in 1907 he started the first Canadian forestry school at the University of Toronto.

His many contributions to fostering forestry as a profession merit for Fernow the title of "father of professional forestry in North America." His most enduring legacy rests on his role in drafting the language of the Forest Reserve Act of 1891, which laid the basis for public land reserves, the beginning of the National Forest System, and his influence on the Forest Management Act of 1897, which defined the purpose of the federal forest reserves and provided for their management by what is now known as the U. S. Forest Service.

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Personal papers (1885-1930) are archived in the Department of Manuscripts and University Archives, Cornell University, Ithaca, New York; letters sent by the Division of Forestry, 1886-1899, in the Record Group 95, National Archives; and American Forestry Congress Records (1883-1889), in the Department of Manuscripts and University Archives, Cornell University, Ithaca, New York. A biography by Andrew Denny Rogers III is Bernhard Eduard Fernow: A Story of North American Forestry, originally published in 1951 by Princeton University Press (Princeton, New Jersey), a forthcoming (1991) reprint by Duke University Press is being organized by the Forest History Society. An obituary and comments are found in "Dr. Fernow, the Pioneer" by W.B. Greeley in the *Journal of Forestry*, Vol. 21, No. 4. Pp. 306-337, 1923. Charles Edgar Randall is author of a summary essay "Fernow, the Man Who Brought Forestry to America" in *American Forests*, Vol. 70. No. 4., April 1964. Bernhard E. Fernow wrote his views in the book Economics of Forestry, Third Edition, New York, Thomas Y. Crowell & Co., 1902.



DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20250

1680 History

Claude Conyers
Project Director
American National Biography
Oxford University Press
2001 Evans Road
Cary, NC 27513

15 December 1990

Dear Mr. Conyers:

I am writing to accept the offer to write an entry on Bernhard E. Fernow for the forthcoming American National Biography. Because I am a government employee I am unable to accept the proposed honorarium. Please send me the formal agreement and manuscript guideline.

Sincerely,

Terry West

Terry West
USDA Forest Service
History Unit

AMERICAN NATIONAL BIOGRAPHY

To be published under the auspices of the AMERICAN COUNCIL OF LEARNED SOCIETIES



4 April 1991

Mr. Terry West
USDA Forest Service
Independence Ave. between 12th
and 14th Streets SW
Washington, DC 20250

Dear Mr. West:

Your manuscript for the article on Bernhard Eduard Fernow arrived 8 March 1991 at the Cary office of the *American National Biography*. Thank you very much for your prompt response.

Sincerely yours,

A handwritten signature in cursive script that reads 'Sara E. Lawrence'.

Sara E. Lawrence
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AGREEMENT made this 11 day of February 1991
between the AMERICAN COUNCIL OF LEARNED SOCIETIES, 288 East 45th Street, New York, New York 10017, a private, nonprofit organization founded in 1919 and incorporated in the District of Columbia in 1924 (hereinafter called the "Proprietor"), and

Mr. Terry West
USDA Forest Service
Independence Ave. between 12th
and 14th Streets SW
Washington, DC 20250

(hereinafter called the "Contributor"), with respect to written material to be prepared for publication in a work provisionally entitled *American National Biography* (hereinafter called the "Work"), to be published by OXFORD UNIVERSITY PRESS, INC., 200 Madison Avenue, New York, New York 10016, a nonprofit organization incorporated under the laws of the state of Delaware (hereinafter called the "Publisher").

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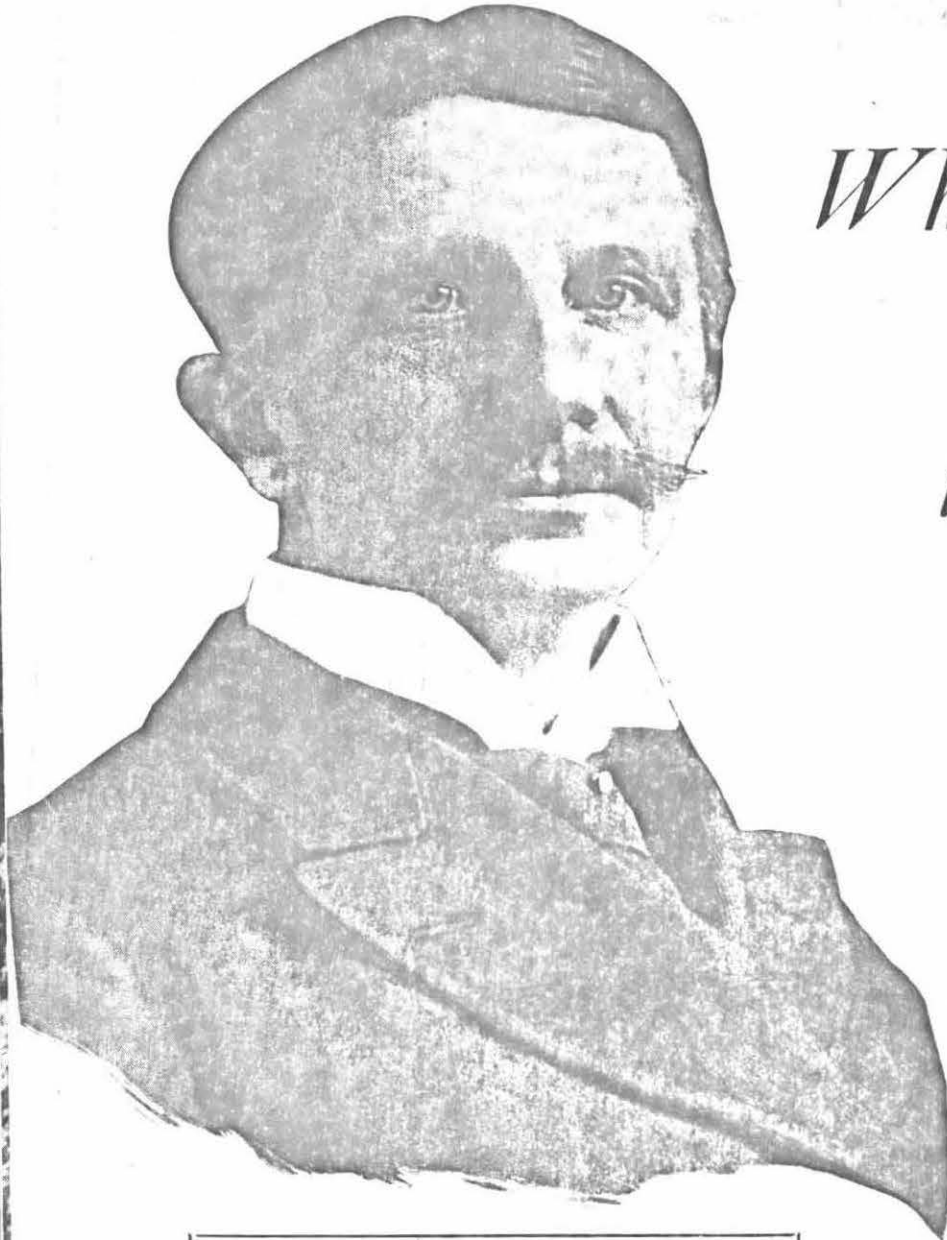
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AMERICAN FORESTS
V. 70 No. 4
APRIL, 1964

FERNOW,

The Man Who Brought Forestry to America

By CHARLES EDGAR RANDALL



AFA Announces FERNOW AWARD Plan

With Wolfgang Kochler, Forestry Attache of the German Embassy serving as liaison, AFA announces that plans are going forward in cooperation with the German Forestry Association for the establishment of a FERNOW AWARD to be given to foresters who have made international contributions to forestry.

AMERICA'S first forester was an alien who came to this country an unknown German immigrant, without job or funds within a dozen years he was the recognized leader of the forestry movement in America.

Bernhard Eduard Fernow was a remarkable man who first suggested many—perhaps most—of the ideas from which grew our forestry institutions, policies, and activities of today. Our first professionally-trained forester, he established the profession here, first instituted professional forestry education at the college level, both in the U. S. and Canada, and largely through his efforts legislation was passed establishing the national forest system. He started research projects in silviculture and forest products that foreshadowed the development of our nationwide system of forest experiment stations and our famous Forest Products Laboratory.

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AFA's Debt To Fernow

The American Forestry Association owes him a special debt. He served as an officer or director for four decades, and played a leading part in its organization, growth, and development as an important voice in American conservation.

Inevitably, and surely with justification, Fernow has been called the "Father of American Forestry." There were others, notably Dr. Franklin B. Hough, the first U. S. Forestry Commissioner, who preceded him in raising their voices to save the forests. But it was Fernow who first advanced forestry, the management of forest lands for continuous production, as a science, as a practical idea, and as a goal for America's forests.

Fernow was born in Inowrazlaw, in the province of Posen, Prussia, on January 17, 1851, one of thirteen children but a scion of an aristocratic family. His grandfather, Graf Karl Frederick Leopold von Ferno, owned a large estate in East Prussia. Bernhard's father, however, had relinquished his right to the estate as eldest son, in order to take up the profession of law, and had risen to a prominent position in the Prussian government. His father was a man of culture. His home was visited frequently by distinguished musicians of the time. Bernhard himself received a good musical education, and became an accomplished pianist.

An uncle, who had taken up the care of the family property, took an interest in young Bernhard, and the boy spent much time on the estate. Here he learned about farming and livestock breeding, and became especially interested in the management of the estate's extensive forests. Following his early education at the gymnasium at Bromberg, Bernhard, at the age of 19, entered the forest service. He spent a year in woods work, then passed his examinations and entered the Münden Forest Academy in Hanover. His forestry studies were interrupted by a year of service as a lieutenant in the army during the Franco-Prussian War. Then he devoted a year to the study of law at the University of Königsberg. Returning to the academy, he got his forestry license, and went into forest work, first in Silesia, then in Brandenburg, then in East Prussia.

American Girl Brings Us Our First Forester

It was while Fernow was a student at the forest academy that he met Olivia Reynolds. She had come to Germany to keep house for her brother John, while he attended the University of Göttingen. She gave Fernow lessons in English. He and Miss Reynolds became engaged—against the wishes of Fernow's family. It had been understood that the young forester was to be made heir to the family estate. His training, both in forestry and in law, was considered to be suitable preparation for managing the inherited properties. Nevertheless, Bernhard Fernow, as his father had done before him, gave up his heritage. When Olivia Reynolds came back to America, Bernhard came too.

This was in 1876. In the New World there were no openings for a forester. "What is a forester?" people asked. Fernow worked at a variety of jobs—clerk in a New York law office, giving private lessons in the German language, bookkeeping for a hardware firm. He invented an electrical process for removing the tin coating from tin cans, and tried, unsuccessfully, to establish a business based on his invention.

But Fernow was here to stay. The year after his arrival he declared his intention to become a U.S. citizen and in 1883 he was to become naturalized.

Through a friend of the Reynolds family, Fernow in 1878 got a job with Cooper, Hewitt & Company, owners of iron works in New Jersey and Pennsylvania. Next year he was assigned to manage the company's Lehigh Furnace, including a large forest property in east-central Pennsylvania, source of charcoal for the furnaces.

Fernow and Olivia Reynolds were married in 1879. The marriage ceremony was performed by Dr. Henry Ward Beecher, noted pastor of the Plymouth Congregational Church in Brooklyn. Fernow brought his bride to a stone house in the milling community of Slatedale, Pa., where they lived for the next four years, and where the first three of their five children were born. With Olivia's help, he improved his English, and began his firsthand acquaintanceship with American forests.

Soon his articles on forestry were

published in the *American Journal of Mining* and a periodical published by the Association of Charcoal Iron Workers. The editors of these publications were among the early advocates of forest conservation. Other articles found wider audiences, and soon Fernow was attracting the attention of many scientists and save-the-forests enthusiasts. He began to get letters asking his opinion or advice—the beginning of a voluminous correspondence that he conducted throughout the remainder of his life.

Fernow Finds A Home

In 1875, the year before Fernow came to America, Dr. John Axton Warder, an Ohio physician, and a group of associates had formed The American Forestry Association. In April, 1882, with the fanfare of a parade and an Arbor Day ceremonial tree planting, the first American Forest Congress was held in Cincinnati. This Congress originated as an affair separate from those of The American Forestry Association, but leading members of the Association were active and instrumental in its inception, and at a second Congress meeting in Montreal later in the same year, the two organizations were merged. Annual meetings of the Congress were held for the following seven years. In 1889 the combined organizations assumed the name of The American Forestry Association, and under that name it has continued to the present day.

Fernow took part in both the Cincinnati and Montreal meetings. At Montreal he was a member of the committee named to effect the merger of The American Forestry Association and the Congress. Next year, he was named corresponding secretary of the organization. During the next few years, when the interest of many of the early supporters began to dwindle, he worked hard to keep the forestry organization alive. He served as corresponding secretary until 1888, when he became chairman of the executive committee. Throughout the remainder of his life, Fernow took an active part in the Association, and in later years served as an honorary vice-president of the Association.

Fernow later said that the American Forest Congress of 1882 launched the real forestry movement in America. This might well be true. Forest work in the federal gov-

ernment had begun six years earlier, with the appointment in 1876 of Dr. Hough as a forestry agent. But Dr. Hough had been able to accomplish little, in spite of his prodigious labors and the preparation of three monumental reports. The 1882 Congress at Cincinnati set in motion sentiments and pressures that led to the enactment of forestry legislation in several states, and to stepped-up forestry activity in the U. S. government. The Montreal meeting led to enactment of fire prevention, land classification, and other forestry measures in Canada.

Fernow was the key figure in the development of forest management. Most of the scores of papers presented at the Cincinnati and Montreal meetings in 1882 were concerned with tree planting, the qualities of individual species, or forest influences on flood control. "The real science of forestry, questions pertaining to the management of forests," Fernow reported, "did not find much consideration." In fact, his voice was almost the only one to bring forth the idea of managing forests for a continuing yield. At Cincinnati he presented a paper on forest policy in Germany; at Montreal his paper offered some basic rules for forest management.

Fernow's advice was sought in drafting the legislation enacted by the New York state legislature in 1885 for the administration of the State's forest preserve lands. In the same year he helped to organize a New York state forestry association. While engaged in these efforts, Fernow met a young New York Assemblyman named Theodore Roosevelt—a meeting that was to have far-reaching consequences. It generated ideas that were to become major policies in Roosevelt's presidential administration in the early 1900's.

Democrat Names Republican

In 1886, only ten years after Fernow had arrived in the United States, he was appointed to head the forestry work of the U. S. Government. Fernow was known as a Republican; his selection by the new Democratic President, Grover Cleveland, was in recognition of the fact that he was the only man in the country professionally qualified for the job. Fernow was named as chief of the Division of Forestry in the U. S. Department of Agriculture, succeeding Nathaniel H. Egleston, a Massachusetts preacher with a sincere interest in, but little knowledge of forestry, who had headed the Divi-

sion since 1883. Congress gave the Division statutory rank on July 1 of the year Fernow took over, but it granted the Division no increase in funds. The \$10,000 appropriated for the next fiscal year allowed Fernow little opportunity for expansion of staff or program. He did acquire a competent dendrologist, George B. Sudworth, who came to the Division from the University of Michigan that year, and who was to give valuable service to government forestry work for the next four decades.

Until after 1890, the annual appropriations for the Division of Forestry remained at \$10,000. During the twelve years Fernow was in charge, they never exceeded \$33,520. But even with these meager funds, he made the work of the Forestry Division known far and wide. The Division issued numerous reports and bulletins, many of them authored by Fernow himself. He traveled extensively, sometimes at his own expense, and spoke frequently at meetings and colleges. Many interests consulted him and he helped to promote state legislation for fire protection and other forestry work, instituted cooperative forest species studies by several universities, and advised young men to go to Europe to study forestry. One who followed his advice was named Gifford Pinchot.

In the Division, work on what he called "timber physics" was the beginning of what later developed into a broad program of forest products research. Attention was focused on the influences of forests on water supply and flood control, shelterbelt planting in the Great Plains, and annual reports which outlined plans for forestry work that could now serve as blueprints for our broad forestry program.

In annual reports and in nearly every speech he made, Fernow attacked the neglect of the forests on the public domain. Again and again he urged reservation and management of these forests. Legislation for the reservation of public timberlands had been introduced in Congress as early as 1876, but it had received little attention. In 1887, Fernow helped to draft a new bill which was approved by the American Forest Congress, and, at that organization's request, was introduced by Senator Hale of Maine.

Move To Set Apart

Pressure for enactment of the Hale bill mounted, much of it generated by Fernow's many speeches, writings, and letters to the develop-

ing state forestry associations. An address by Fernow before the American Association for the Advancement of Science in Toronto in 1889 resulted in a petition to Congress asking for the withdrawal of public domain forests. But in March, 1891, another session of Congress was about to close, and still no action had been taken. Supporters of the bill in Congress, with the connivance of Secretary of the Interior John W. Noble, Fernow, and others, did manage to insert into a draft of a bill revising land laws, a new Section 24. It was a hastily written, incomplete sentence which provided:

"That the President of the United States may, from time to time, set apart and reserve, in any State or Territory having public lands wholly, or in part covered with timber or undergrowth, whether of commercial value or not, as public reservations, and the President shall, by public proclamation, declare the establishment of such reservations and the limits thereof."

During the next two years, President Benjamin Harrison set aside forest reservations totaling 13-million acres. Presidents Cleveland, McKinley, and Theodore Roosevelt added more. Development of our national forest system was under way.

The Hale bill would have provided for administration of the forest reserves as well as for their establishment. But the hasty proviso of 1891 did not provide for foresters to protect and manage the public forests. Fernow began at once to remedy this. He described objectives of administration—a system of management that today would be called "multiple use," and it was not until 1897 that the needed legislation was passed. Again, it got through Congress as a last-minute rider to another bill.

In 1895, Fernow appeared before a House of Representatives committee to advocate increased federal aid to the land-grant colleges so that they could give courses in forestry. Eight years earlier, he had delivered the first course of technical forestry lectures in America at Massachusetts Agricultural College. Repeatedly he urged that forestry education be made available, to provide the professionally-trained men that would be needed for federal, state, and private forestry work.

In 1898, the opportunity came to Fernow to organize the first school of forestry at the collegiate level in

(Turn to page 41)

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Fernow, The Man Who Brought Forestry To America

(From page 16)

this country. He resigned his position as chief of the Division of Forestry in the U. S. Department of Agriculture to become director of the New York State College of Forestry at Cornell University. At the Department of Agriculture he was succeeded by Gifford Pinchot, the young forester he had advised, who would build large on the foundations Fernow had laid.

At Cornell, on a September morning, Fernow addressed his class: "You are the first students of silviculture in America; I congratulate you."

Aided By Roth, Gifford

He had recruited two other faculty members: Elibert Roth, who had been with him in the Division of Forestry and would later head the department of forestry at the University of Michigan; and John Gifford, an American with European forestry training who had been employed with the New Jersey Geological Survey. The new College of Forestry was in cramped quarters. Its enrollment was small. But many of its early students would soon be

among the leaders in professional forestry in America. They included such now well-known names as Ralph C. Bryant, Walter Mulford, Raphael Zon, Philip Ayres, and Clyde Leavitt.

When the state legislature authorized the establishment of the New York State College of Forestry, it provided that the college should administer a 30,000-acre tract in the Adirondack Mountains as a demonstration and experimental forest. Fernow prepared management plans for the tract. He contracted with the Brooklyn Cooperage Company to build a plant in the area to provide an outlet for timber cut from the forest.

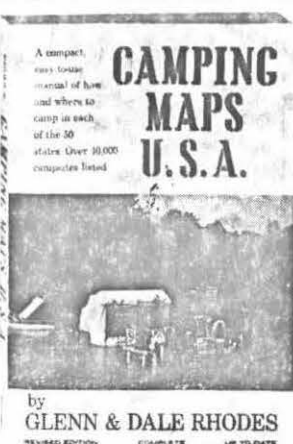
His College of Forestry was in trouble over the experimental forest almost from the start. To many forest enthusiasts at that time, any kind of timber cutting was destructive. And when Fernow's first large sale of timber to the Brooklyn Cooperage Company called for clear cutting of hardwoods to increase the proportion of spruce, this appeared to them to be horrible denudation. Influential owners of summer

homes and estates, furthermore, were not happy about having a commercial wood-using plant in the area.

Mounting criticism led to an investigation and an unfavorable report by a legislative committee. In 1903, the Governor vetoed the appropriation for the forestry school at Cornell. Five years after it had opened, Fernow's College of Forestry had to close its doors.

When the state legislature authorized reestablishment of a New York State College of Forestry in 1911, it was located at Syracuse University rather than at Cornell. In 1910, however, a Department of Forestry was organized at Cornell as a part of the College of Agriculture. Over the entrance of Cornell University's Forestry Building, a tablet, unveiled in 1922, still marks the building's name today, "Fernow Hall."

Fernow continued to live in Ithaca for the next three years. Private consulting practice took him on trips to the West Indies and Mexico. He conducted courses at the Yale Forest School in 1904 and 1905, and was one of the directors of the American



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Forest Congress in Washington in 1905.

At Cornell, Fernow and his students in 1902 had started publication of a technical journal, the *Forestry Quarterly*. After the College of Forestry closed, Fernow continued to edit and publish this periodical as a private enterprise. He continued to publish it until 1917 when it was amalgamated with the *Proceedings of the Society of American Foresters* under the title of *Journal of Forestry*. Then Fernow became editor of the *Journal*, and continued in this capacity until his death in 1923.

Moves On To Penn State

In 1907, Fernow accepted an invitation to organize a department of forestry at Pennsylvania State College. He started the forestry curriculum and began teaching there in the spring term. At the end of the year came another invitation, to establish and administer a department of forestry at the University of Toronto.

Fernow served as dean of the forestry faculty at Toronto with honor and distinction until his retirement in 1919. Opening with only five students enrolled, his was the first professional forestry school north of the border. Soon it was supplying the trained personnel for the growing Dominion and provincial forestry services. Fernow himself was responsible, directly or indirectly, for much of the increased attention to forestry matters, and served as advisor to the government and several provinces, and also to the big pulp and paper companies. He was appointed a member of the Canadian conservation commission and helped organize and became the first president of the Canadian Society of Forest Engineers. He spearheaded the drive for better forest fire control, for enactment of the Dominion Forest Reserves and Parks Act (1913), and for the development of forest research programs in Canada.

During his eleven years at the University of Toronto, Fernow still maintained close touch with forestry in the United States and was elected president of the Society of American Foresters in 1916, and made a Fellow of the Society in 1918. He kept his U. S. citizenship, and maintained a summer home at Point Breeze, New York, on Lake Ontario.

After his retirement in 1919, Fernow continued as emeritus professor, in close association with the for-

estry school he had founded. Honors and recognition continued to come to him. His books, *Economics of Forestry*, *History of Forestry*, and *The Care of Trees in Lawn, Street, and Park*, were standard texts in most of the schools of forestry. He was made an honorary member of the Swedish Forestry Association. The University of Toronto conferred on him the honorary degree of doctor of laws (some years earlier he had been similarly honored by the University of Wisconsin).

But his health was failing. Although he kept up his writing and correspondence, he had to turn down the invitations to address meetings that continued to come. On February 26, 1923, in Toronto, death came to Bernhard Fernow.

Andrew Denny Rodgers III, a Fernow biographer (*Bernhard Edward Fernow: A Story of North American Forestry*, Princeton University Press, 1951) called Dr. Fernow "First Forester of North America." "Forestry made its first strong start in America," he said, "when Fernow came to this country."

Roth Pens Tribute

The April, 1920, issue of this magazine, then called *American Forestry*, published a tribute to Dr. Fernow on the occasion of his retirement. It was written by Filibert Roth. "Fernow," he said, "as few men have ever done, blazed trails in the wilderness . . . he led the way in forest education of our people and our foresters; he laid plans and began the great task of gathering the information on which forestry in North America must base its work; he secured the first important forest legislation for the nation and directed most of the pioneer legislation in our states; he gave us a forestry journal ranking with the best; he planted in the New World the right ideals without which forestry will never succeed in any country."

Before he died, Dr. Fernow was able to say: "I have been unusually lucky in living to see the results of my work. I have been a plowman who hardly expected to see the crop greening, yet fate has been good to me in letting me catch at least a glimpse of the ripening harvest."

We today can see in far wider vista, in the millions of acres of forests under management, in the far-reaching programs of many agencies, the fruition of the work of Bernhard Fernow, the man who brought forestry to America.

GREAT TEACHER OF FORESTRY RETIRES

BY FILIBERT ROTH

DEAN OF FORESTRY, UNIVERSITY OF MICHIGAN

AMERICAN FORESTRY

V. 24 No. 316

APRIL 1920

1883-98

1888-98

Now AME FORESTS

PROFESSOR H. E. FERNOW, having passed the retiring age, has resigned as Dean of the Forest School of Toronto University with the title of Professor Emeritus. The Nestor of foresters in America has thus relinquished active service. Our masterbuilder in forestry has laid down his pencil and square.

For over forty years Fernow has worked uninter-uptedly to bring forestry into our American woods; to further the science of forestry; to develop right legislation with regard to forestry as a basic industry, and last, but not least, to prepare men for a profession whose task is to build up and care for the forests of North America.

With thorough schooling; with forest training at Hanover-Münden, under the famous Heyer and others; with experience as regular forester, Fernow came to this country in 1876, a young man of fine presence, an athlete, scholar, enthusiast; able to see things clearly and in large lines; able to state the case convincingly, and able to pick out the things to do, the things of importance and of real value to the great movement in forestry. During the years 1878-1885, he had charge of 15,000 acres of hardwoods in Pennsylvania, supplying the charcoal-iron works of Cooper-Hewitt Company, and other furnaces. While thus engaged

in one of the pioneer efforts in the practice of forestry in the United States he found time to write on forestry for *Birkenbine's Journal of Charcoal Iron Workers*. During the early years of this period, being located in New York, he took an active part in starting the forestry movement in that State, and in 1885 formulated for Senator Lowe the legislation which established the forest reserve in the Adirondacks and the State Forestry Commission, embodying in that legislation also the first forest fire warden organization.

In 1882 he assisted in the forming of the American Forestry Association at Cincinnati and Montreal, and

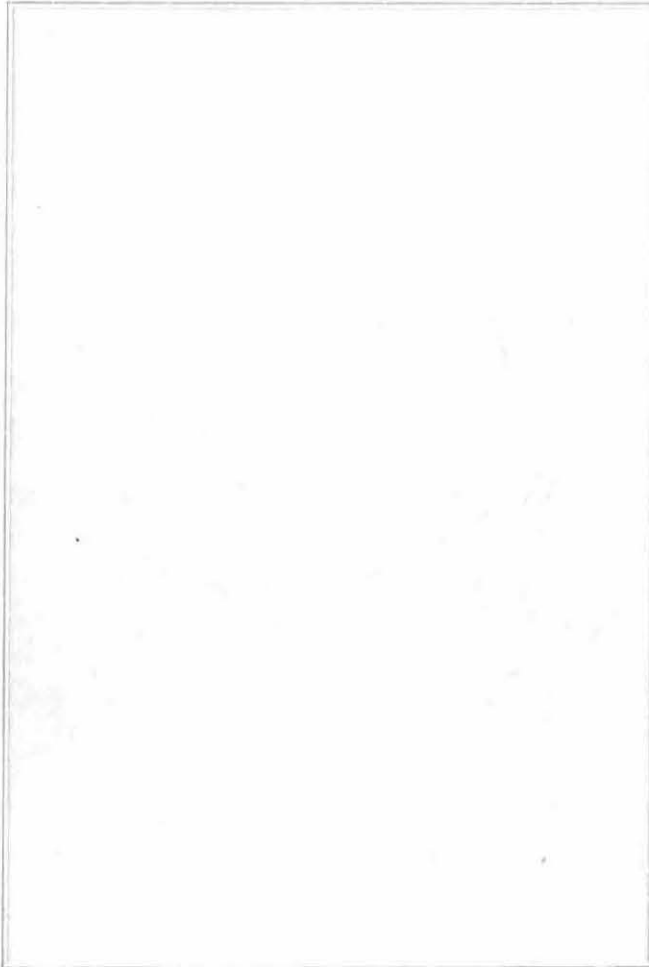
for fifteen years acted as Secretary and Chairman of the Executive Committee of this Association. The Association being short of funds in the earlier years he published, as a private venture, several bulletins on forestry, and from 1885 to 1898 he was editor of the *Proceedings of the Forestry Association*, and of its journal, under the title *The Forester*. To this task of secretary-chairman-editor he devoted much time and

effort, directing the work of the Association along definite, well-planned lines, and thus enabling the Association, in spite of its insignificant numerical and financial strength, and in spite of its composition, in which timber owners and representatives of the wood-using industries were almost lacking, to accomplish most astonishing results. The most notable of these was the greatest piece of forest legislation so far adopted in our country, the law of 1891, authorizing the President of the United States to establish National Forest Reserves.

This great act which led to the creation of our present-day "National Forests," and saved to our people an area of forests greater than the combined forest areas of France, Germany and Austria was primarily due to the work of three men whose names should and will live in the history of our nation: Dr. Fernow,

Edward A. Bowers, at one time Assistant Commissioner of the Land Office, and Secretary of the Interior Noble, one of our real statesmen who appreciated the importance of the enterprise and was convinced by the clear and concise statement made by Dr. Fernow as the spokesman of a little group of members of the American Forestry Association.

Dr. Fernow's great work for the nation really began in 1886, when he accepted the position of organizer and director of the forestry work of the government in the Department of Agriculture, a position which he occupied until 1898. At that time lumbering was in its glory; there



DR. BERNARD EDWARD FERNOW

was no thought of timber exhaustion; Michigan white pine went clear to Texas; Sargent's "Tenth Census" figures were disputed; anyone considering them seriously was a "denudatic" (harmless maniac) in the parlance of the practical experts. There was no use in asking a timber owner to engage in forestry when all his competitors were exploiting on the basis of "cheap logs," at least cost and with the invariable result of utter forest devastation. All this Fernow saw as clearly as anyone. His keen sense of justice, his love for plain truth and accuracy did not allow him to find fault with the men of the industry; but neither could he compromise the sound principles of forestry. To him forestry never was and never could be lumbering; his knowledge of forestry was too thorough, his ideals too firmly implanted, and his dislike of all bill poster work was instinctive. To a smaller man the task of starting a useful Forestry Division would have seemed hopeless. Not so with Fernow. With a rare grasp of the situation, he started work at once and along six important and useful lines of action: the spread of forestry information among the people; forest legislation by States and nation; gathering reliable information regarding our trees and forests; experiments to determine the technical properties of our principal species of timber; the stimulating of tree planting on the plains, and finally the education of college students in forestry as a science and industry. With unusual powers for work, almost single-handed, and under the most discouraging conditions of money and equipment, he started this great work.

His first act (1887) was the introduction of the "Hale" bill, providing for National Forest Reserves and their administration; this effort was followed up until it succeeded in 1891. Since no provision for an administration of the National Forests was made in 1891, more effort was required to provide for such; the "Paddock" bill in the Senate in 1892, and the "McRae" bill in the House in 1894, did not succeed, although the latter passed both Houses and failed to become law by mere accident. It was not until 1897 that a definite administration was provided and thus the National Forests actually established as a working enterprise.

During the twelve years at Washington Fernow kept in close touch with the forestry work in the various states, and there was little of state forest legislation passed during this time in which his opinion was not consulted. In spite of the most meager appropriations he succeeded in making a good start in forest and timber research; he secured the co-operation of many prominent men of science; and the numerous bulletins and circulars, including monographs on White Pine, the Southern Timber Pines; results of tests and studies in Timber Physics, the first complete discussion of the metal railway tie as a possible substitute; studies on timber impregnation, and other subjects, all of immediate value in wood utilization, are evidence today of the painstaking work of the guiding spirit which directed them and edited their results for publication. An appropriation for rain-making, turned over to his

a scientific inquiry into existing information with discussions by the heads of the Weather Bureau and other competent authorities was published as "Forest Influences," the first of its kind in this country.

Throughout the twelve years in the Department, he never ceased to write articles and addresses, and to go out to deliver lectures wherever opportunity offered. It was in these years that the larger part of his over 200 articles and addresses, over 50 circulars and over 30 bulletins and reports were prepared or edited. The first series of twelve technical lectures to a body of students was delivered at Massachusetts Agricultural College in (1887), others followed at Nebraska University, Colorado, Wisconsin and California. In 1898 Fernow was called to Cornell to organize the first forestry school in the New World. It was a state school, maintained by regular appropriations by the legislature, and the state provided a school forest of 30,000 acres in the Adirondacks. Here he inaugurated the beginnings of professional education. The school grew rapidly until in 1903 it was discontinued by a veto of the governor, owing to misunderstandings developed in connection, not with the school at all, but with the tract in the Adirondacks. While at Cornell Fernow published his "Economics of Forestry;" delivered a series of lectures at Queen's University, at Kingston, Ontario, which were published in French in book form as "La Forêt," by the Department of Lands of Quebec, and in English by the Department of Lands of Ontario as well as by the University. In addition he started the *Forestry Quarterly*, now the *Journal of Forestry*, the only technical forestry journal in the country.

For four years (1903-1907), after leaving Cornell, Fernow worked as consulting forester; kept several timber cruisers and surveyors going summer and winter; did more forest consulting work than had ever been done by any forester in the United States; examined large properties; carried his work into Cuba, Mexico, the South and the Northeast, and demonstrated, in a way quite surprising to some of his acquaintances, his great versatility, and his capacity in business, which had long secured for him a standing among large business men, such as no forester had ever enjoyed. During these four years he continued the *Quarterly*; delivered two courses of lectures at Yale University, and started the forest school at Pennsylvania State College. In 1907 Dr. Fernow accepted an invitation to Toronto University and organized the first forest school in the Dominion, where his work was well known and where he was received by many personal friends, among these Dr. Saunders, of Ottawa, and Sir Henry Joly de Lotbiniere, of Quebec. From this school he has now resigned, with the title of Professor Emeritus, after twelve years of unquestioned success. During these twelve years he did not confine his work only to teaching at the college; he published his well known "History of Forestry," a masterpiece of its kind, covering the subject for both the Old and New

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Park," a most useful book. In addition he continued the publication of the *Quarterly*, acted as editor for the *Journal*, became a member of the Conservation Commission of Canada, in which capacity he, with his colleagues, White and Howe, conducted some very important field studies, notably the "Forest Survey of Nova Scotia," and the "Survey of the Trent Watershed," both published in book form by the Commission.

Fernow, as few men have ever done, blazed trails in the wilderness; he did his work well, the trails are now traveled by many, the wilderness is opening up. New conditions of supply and demand, of industry and transportation; conditions long foreseen and foretold by the master, are now extending the trails, and expanding them into broad highways, where travel is comfortable and work does not require the self-sacrifice and special abilities of the pioneer; he led the way in forest education of our people and our foresters; he laid plans and began the great task of gathering the information on which forestry in North America must base its work; he secured the first important forest legislation for the nation and directed most of the pioneer legislation in our states; he gave us a forestry journal ranking with the best; he planted in the New World the right ideals without which forestry will never succeed in any country.

To know Fernow, the man, one must have had the privilege of seeing him in his home, on trips in the woods, on water, on the ice, with his family and friends; must have walked with him in the forest; or climbed Mt. Lafayette; have seen him in a company of scientific men, whether mining engineers or entomologists; have heard him among the foresters and economists of the world gathered at the international congress at Brussels; have heard him discuss philosophy with Dr. Ward, and more than all, have seen him seated at his piano, playing, enraptured, far away in another, gentler world.

For having enjoyed this privilege for years, the writer expresses his gratitude to his wise friend and patient teacher.

What Dr. Fernow meant to his students in college is best stated by a few, among the many.

Walter Mulford, Professor of Forestry at the University of California:

To those of us who have had the good fortune to have been long in Dr. Fernow's class room, there is no need to speak of what he did for us there. To the less fortunate one we can only say that we regret their loss in not coming in contact as students with the strength and the beauty of his leadership. It is the leadership of the best great teacher of forestry in the western hemisphere.

C. R. Pettis, State Forester of New York:

Dr. Fernow not only "blazed the trails" in American forestry, but, through his untiring efforts, he established principles and left forest monuments which make him the foremost American forester. His wonderful knowledge and enthusiasm made him a great teacher; his individual personality is admired by all; his kind helpfulness appreciated by all with whom he came in con-

tact, and his work something that cannot yet be fully measured, but, as time passes, will be found a basis for our silvicultural work.

E. A. Sterling, of James D. Lacey and Company, New York, Timberbrokers:

Each receding year emphasizes the value of the associations made and the relationships established while in college, so, in looking back to the days spent at Cornell in the pursuit of forestry knowledge, under Dr. Fernow, one of the most vivid and treasured memories is the strength of his personality and the value of his guidance and inspiration.

The scholastic things we were supposed to acquire have merged into a broad background of subsequent experience, but the personal associations gained during those years stand out more prominently and assume new importance as time goes on. The problems in forest finance and the involved theory of some old world teacher are long forgotten, but the personality of the man who patiently labored with his students to make them both foresters and men, will never be erased, nor can he wholly appreciate the helpful influence which he exerted.

So to Dr. Fernow, as Dean of the forestry profession in America, as he was Dean of Forestry at Cornell, goes the most heartfelt appreciation of his work, both as a teacher and as an educator in the much broader field which has been covered by his activities. Two decades have demonstrated the soundness of his vision in building up the foundation of a forestry profession at a time when it seemed unneeded, and of little practical application, and not only laying the foundations, but in helping rear the structure which gradually rose from it. He has exerted an influence which is appreciated not only by those fortunate enough to have been his students, but by all who think broadly and see clearly.

Philip W. Ayers, Forester of the Society for the Protection of New Hampshire Forests:

To have been a student under Dr. Fernow is a life-long inspiration. Not only the breadth of his scholarship in forestry, but also his enthusiastic devotion to the subject, his belief in it, his sense of its usefulness, were all impressive. To each of us personally he was kindness itself; the hospitality of Dr. and Mrs. Fernow can never be forgotten. To both my earnest, best wishes.

Raphael Zon, U. S. Forest Service, Chief, Forest Investigations:

The appointment of B. E. Fernow as Professor Emeritus at the University of Toronto, and his retirement from active teaching, marks not merely a change in his private life but also an epoch in the development of forestry in North America. While the period which Dr. Fernow typifies is rapidly becoming history, his teachings and his contributions have the quality of permanence. They have been always a source of inspiration and guidance to the pioneers of forestry; they will be infinitely more so to the actual managers of our forest lands as soon as real woods forestry comes into general practice. As with any great teacher, it is not the kind of theory that he happens to advocate that really counts, but the ability to teach how to think in his particular field. Theories come and go, but the ability to orient oneself in the details of complex problems is a lasting asset; he who teaches to meet ever-changing problems, not by a ready-made theory or hypothesis, but by a critical attitude and ability to discern between the essential and non-essential, is building on a solid foundation.

As a student under Dr. Fernow, I am personally indebted to him for whatever mental equipment in forestry

I possess, and particularly for my attitude toward the forestry movement as a whole. I consider it an exceptionally good fortune which permitted me to sit at the feet of so great a teacher, with whom forestry was not merely theory but a movement ever changing as life itself, and for whom problems became soluble not in ready-made formulas, but in the forces, economic and natural, that are at work.

— *Clyde Leavitt, Forester to the Commission of Conservation of Canada:*

While Dr. Fernow's invaluable services as the pioneer of technical forestry in the United States are becoming increasingly recognized, there is as yet but inadequate public recognition of the similar part he has played in Canada. It was through his course of lectures at Kingston, Ontario, while he was still connected with Cornell University, that a really wide public interest in forestry first began to be aroused, resulting later in the establishment of forest schools and leading up to the employment of trained foresters by public and private agencies. In his remarkably active work in the field of forestry in Canada, Dr. Fernow has rendered notable public service as Dean of the Faculty of Forestry at the University of Toronto, as one of the members of the Commission of Conservation of Canada, as a member and Director of the Canadian Forestry Association, and as one of the progenitors of the Canadian Society of Forest Engineers. So extended have been his activities and so wide his influence that he may in all truth be termed the father of technical forestry in Canada, as well as in the United States.

ANÆSTHETICS FOR TREES

SIR Jagadis Chandra Bose gave recently at the India Office some account of his investigations into the secrets of plant life and of the discoveries he has made therein, says the *London Times*.

Sir Jagadis said he had discovered that it was possible to transplant trees without injuring them if the operation were performed while they were subject to the effects of an anæsthetic. A tree so treated shed its leaves after transplanting in the summer instead of in the autumn, but it very soon recovers itself and became normal.

The most intense activity of life was often imperceptible, and it was only by making the unseen visible that the mystery of growth and movements of life would become revealed. He showed that by the crescograph the highest powers of the microscope were magnified 10,000 times. No experimental conditions for exhibition of growth could have been more difficult than in the depth of English winter, when plants were in their period of hibernation. In spite of this they were made to shake off their torpor, and the rate of growth was exhibited by the indicating spot of light rushing across a ten-foot scale in the course of twelve seconds, the actual rate being about a hundred-thousandth part of an inch per second. With the crescograph to guide him, the life-activity of the plant became subservient to the will of the experimenter.

A depressing chemical agent was applied and the march of life was slowed down; a timely application of a con-

growth-activity to many times the normal rate. The possibility of modifying the rate of growth was a matter of great practical importance, for the world's supply of food depended on the growth of plants. The rule-of-thumb method hitherto employed in the application of a few chemical stimulants and of electricity had not been found uniformly successful. Researches by means of the crescograph showed that a very important factor was the dose of application, any excess above the critical point bringing about a result diametrically opposite to what was expected. Thus while a particular intensity of electrical current accelerated growth an excess of current retarded it. The same was true of chemical stimulants.

GREAT BRITAIN'S FORESTRY COMMISSION

IN a letter to the editor of *AMERICAN FORESTRY Magazine*, Colonel John Sutherland, of the Forestry Commission at Edinburgh, says: "We have now had the Forestry Commission established in Britain, consisting of Lord Lovat, chairman; Right Hon. E. D. Acland, Sir John Stirling-Maxwell, Col. W. Stewart Fotheringham, Lord Clinton, Mr. L. Forestier-Walker, Mr. T. B. Ponsonby and Mr. R. L. Robinson. We are now engaged in preparing afforestation schemes and hope that by April we may have some acres planted, but we cannot achieve nearly as much as we would like in the first year as we have only now really got to work.

"I hope the proposals which are so admirably described in the *AMERICAN FORESTRY Magazine* for the reafforestation of the United States may take root and that Colonel Graves may receive all the support that is necessary to assure America of a good crop of trees for the future. It seems to me that it is very necessary both for America and for Britain that afforestation should be well established so that a sufficient supply of timber in both countries will be available within the next fifty years.

"It is very desirable that we should keep in touch with your work in America, and I will be glad, if you desire it, from time to time to let you know what we are doing at home.

"I retain many pleasant recollections of my association with the Forestry Engineers in France, and will always remember the excellent co-operation and assistance which was rendered to us by Colonel Graves, Colonel Greeley, Colonel Woolsey, Major Bruce and many others who were associated with us in procuring timber for the armies. Major Frederick S. Kellogg was the Officer in Charge of the First Company of Engineers which were lent to the British Directorate of Forestry, and to him and his staff we were indebted for the formation of an excellent operation in Les Landes.

"If you are in touch with any of these officers, I will be glad if you will convey to them my best regards."



Photo in Bios-Photo section.

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Forest Service/Hist. Off.

Bernhard Eduard Fernow

A fortuitous combination of events climaxed by a romance brought the considerable talents of Bernhard Fernow, America's first professionally trained forester, to the United States. Variouslly called the "True Pioneer of American Forestry", "The Master Builder in Forestry", "The Driving Force of Forestry in American", Fernow was born into a family of landed German aristocracy. He was a product of the 2nd of his father's three marriages, each marriage having produced several children. So despite considerable family wealth, their very number required all the children to become somewhat self-suffient as adults. Fernow was born January 7, 1851, in ~~Ironclaw~~^{Inowracław}, Province of Posen, in Prussia, later a part of Poland. His father was Ernst Leopold Fernow.

Bernhard Fernow was fortunate in that his enthusiasm for Forestry and Agriculture as a youth was of interest to his uncle, the administrator of the family estate. His uncle, being childless, desired an able blood relation to care for the estate after his death. Young Fernow had acquired, while growing up, the requisite farming, breeding and livestock knowledge to manage the estate. But, to assume eventual tenureship, as administrator he was required to gain a professional education in law and forestry.

He began forestry studies in 1869, at the age of 19, after graduation from the gymnasium at Bromberg. He entered the prestigious forest academy at Muenden, in western Prussia, Province of Hanover, after successfully completing an examination and a year's work in the woods under forest de-

partment guidance. His studies at Mueden were interrupted by a year's service as a lieutenant in the Franco-Prussian War, and the following year spent as a law student at the University of Knigsberg, East Prussia (now in Russia). After completing his studies at Mueden, Fernow began forestry work. And, but for the intrudance of fate, he might have lived out his days practicing forestry ^{/in his homeland} on his family estate or elsewhere, where forestry was a a well-established and respected profession.

Fate appeared in the form of Olivia Reynolds, an American girl tending house for her brother, a student at the University of Gottingen. She was engaged to give Fernow English lessons. Soon, despite the disapproval Fernow's family, the young couple became engaged. Soon after, Olivia, in 1876 returned with her brother to the United States. Bernhard, much to the dismay of his family, followed her the same year and thus lost any source of income which he might have received from them. His visit, which became permanent, coincided with the Centennial being celebrated in Philadelphia. Thus, America's first professional forester arrived in the United States.* On June 20, 1879, the two were married by Dr. Henry Ward Beecher, the well known pastor of PlymouthMassachusetts, Congregational Church. Five children were to result from this union.

Fernow quickly found that forestry had not yet become a paying profession in the United States. To make his living he was required to work at a variety of jobs: clerk in a New York law office, giving private German lessons, bookkeeping for a hardware firm all the while promoting his services as a "consulting forest engineer." In 1878 Bernhard had the good fortune to become an associate of the American Institute of Mining Engineers under the auspices of Rossiter W. Raymond, a friend of his wife's

Preceded by Fred J. Ebert, who settled in Colorado and placed forestry into its Constituti

family and secretary of the Institute. The Institute's interest in forests as a supply source for charcoal to feed foundry furnaces provided forester Fernow with a limited forum to exercise his training as a forest engineer. He addressed the Institute on such matters as the "advantages of red charcoal over black charcoal from the standpoint of fuel saving for blast furnace work; in 1878, he also discovered an electrical process for removing the tin coating from iron cans. He sought to market the discovery commercially but was unsuccessful.

However, his association with Rossiter Raymond was fruitful. Raymond, long associated with mining, both as a private consulting mining engineer and as United States Commissioner of Mines and Mining from 1868 to 1878, was also a keen observer of our public forest lands. During his often extensive travels West, to gather information for annual reports, Raymond viewed and wrote of the destruction of much valuable timber in the mining districts of the West and warned of the necessity of protecting western forest lands. From Raymond, Fernow garnered much valuable data on western forest lands. Raymond also enabled him to obtain a job with Cooper, Hewitt and Co. Abraham S. Hewitt, president of the American Institute of Mining Engineers, U.S. Congressman, eventual Mayor of New York city and politician of reformist persuasion, took an interest in Fernow. He encouraged Fernow's forestry activities and was a powerful ally in his later endeavors.

Bernhard, as an employee of Cooper, Hewitt and Co., was put in charge of a furnace on the Lehigh river, in east-central Pennsylvania. An adjacent 15,000-acre forest, supplied wood for the making of charcoal. It was on the Lehigh, in the Blue Mountains of Pennsylvania, that Fernow began to study, first-hand, American forest conditions. The results of his studies

were published in the American Journal of Mining and a periodical of the Association of Charcoal and Iron Workers whose editors were early advocates of forest conservation. From his own observations and through study of such documents as Henry Brewer's 1870 Census of American Forests, Charles Sprague Sargent's 1880 Report on the Forests of North America, Fernow became alarmed at the rapid and unnecessary diminution of American forest resources. He argued for protective legislation to protect woodlands for future generations and for "economical management of these gifts" of nature. Fernow's outspokenness soon brought him to the attention of resource minded people, running the gamut from preservationists, or the so-called "denudists" of that era, to the wholesale resource exploiters. He saw the need for an objective viewpoint: that of a professional forester. He abhorred waste but advocated scientific forest management.

In 1883, Bernhar Fernow became a U.S. citizen. He also was named corresponding secretary of the American Forestry Association; a position he held until 1888, when he became chairman of the executive committee, serving there for ten years. Members of the American Forestry Association were instrumental in organizing the first American Forestry Congress in 1882 at Cincinnati, which had a large forest-minded German population. This Congress and subsequent annual congresses acted as symposiums for the dissemination of forest knowledge. They helped to establish forestry as an organized movement in the U.S., creating an impetus for forest legislation in state and federal government. Fernow's intention, from the very start, was to promote scientific forest management among those attending the forestry Congresses. Professional forestry was conceived by many to be merely an extension of tree planting, tree and watershed protection efforts and arbor day rites. His first paper, Historical Sketches of the

Development of the Forest Policy in Germany, traced one country's evolution from verdure, to senseless waste, to economic utilization of remaining forest reserves via a system of scientific forest management. The paper appealed to the "Patriots" desiring the "preservation of America's forests." His next paper on Conditions of Forest Growth delivered in Montreal, was a more specific offering of basic principles underlying forest growth and general rules for forest management. Fernow's work with the Forestry Congress, his work in drafting legislation for the administration of New York state's new forest preserve lands, and his help in organizing the New York State Forestry Association (assisted by his employer Abraham Hewitt) brought Fernow a modicum of national attention. Fernow opposed the "forever wild" designation of the New York preserve, believing the Preserves should be managed to produce timber.

In 1886, President Grover Cleveland, a former governor of New York state, consulted Abraham Hewitt on prospects for a new head for the still embryonic forestry division of the Department of Agriculture. Despite his Republican political background, Fernow's burgeoning reputation, coupled with Hewitt's recommendation, secured him the appointment. He assumed the duties of Chief March 15, 1886, a Republican in a Democratic administration, another indicator of his increasing prominence in the forestry movement. Although he was required to retain his predecessor, Nathaniel H. Egleston, "a reverend white-haired gentleman," and felt that the post called more for a politician than a forester, Fernow nevertheless served as Chief of the Division for 12 years, until 1898 when he left to organize a forestry school at Cornell University. Egleston, a minister, had succeeded Franklin B. Hough in 1883.

Handicapped by limited funds-an appropriation of \$10,000 annually for the first four years and never more than \$33,520 thereafter-the farseeing Fernow nevertheless did much to lay the foundation of the present day Forest Service. Under his direction a widespread and effective campaign to educate the public to the need for forest conservation was mounted. A major portion of his over 200 articles, addresses, monographs, over 50 circulars and bulletins were prepared during this period. They laid the groundwork for scientific forestry in the United States. His Timber Physics research program involved scientific study of wood and forest growth. The sciences of engineering, chemistry, physics, botany, soil research (in itself, a new and controversial field), and forestry were to be drawn upon to evolve maximum economy and function in the growth and utilization of wood Tree-planting experiments in the Plains were begun by the division to see whether climatic conditions could be altered for agricultural purposes; another indicator of Fernow's continuing efforts to establish forestry on a scientific basis.

Fernow's most enduring legacy and the basis for today's National Forest System was the Forest Reserve Act of 1891 authorizing the President to create forest reserves from the public domain. Carl Schurz, former Secretary of Interior and resource minded forestry advocate, had long supported such a move, as had leaders of the American Forestry Association. One impetus for the act was the Hale bill introduced in Congress, ^{by Senator Hale of Maine in} January, 1888. The bill, drafted by Fernow, provided for both the establishment and management of forest reserves under a commissioner of forests in the Department of Interior. Despite considerable pressure for passage of the bill (much of it generated by Fernow) congressional opposition prevented enactment. The 1891 Forest Reserve Act, a last-minute rider attached to a

bill revising land laws, was a compromise providing only for Presidential authority to set aside forest reserves on the public domain, but did not provide for professional management. By 1898, Fernow was able to see the basic provisions of the Hale bill become fact. The federal forest reserve policy was firmly established by the Forest Reserve Act. And, under authority of yet another rider, passed June 4, 1897, the General Land Office of the Interior Department issued rules and regulations by which the reservations were to be managed. This act of June 4, with later amendments, is the one under which the National Forests are now being administered by the Forest Service, U.S. Department of Agriculture, although the transfer was not made until 1905.

Bernhard Fernow left the Forestry Division in 1898 to organize the New York State College of Forestry at Cornell University. The first college-level school of forestry in the Western Hemisphere, Cornell listed among its students such later notables in the forestry field as Philip Ayres, Raphael Zon, Clyde Leavitt and Ralph C. Bryant. Ironically the school was closed in 1903 due to dispute over the 30,000-acre demonstration and experimental forest maintained by the college. Fernow's intention was to use the forest to demonstrate the practicality of scientific management, including clearcutting. His intentions were anathema to many misguided forest enthusiasts, who equated use (cutting) with desecration. Criticism by wealthy and influential adjacent summer estate owners, unhappy over commercial lumbering in the area, brought the issue to a head. The result was a veto of appropriations for the forestry school by the Governor.

While at Cornell, Fernow found time to publish his Economics of Forestry. (1902). He also started the Forest Quarterly, ^{in 1903} later to become the Journal of Forestry (19) and for many years, the only technical forestry journal in the country.

Fernow was a consistent supporter of forestry education, citing the need for professionally trained foresters to implement and maintain forest reserves. He had delivered the first lecture course in technical forestry in the United States at the Massachusetts Agricultural College in 1887. * ?

Fernow, however, was not so convinced ^{in 1888} of the ^{status} future of forestry in the United States as to recommend it ^{then to} as a secure profession to be undertaken ^{by itself} by a young man with an eye to the future. ^{He advised broader study which would allow employment in related work if} This was the advice he gave ^{2 necess} the young Gifford Pinchot, future forester and conservation leader, who ^{ed} was to recall Fernow's shortsightedness.

The four years following his departure from Cornell, Fernow worked as a consulting forester. His work took him to Canada and Mexico. In 1907, he was invited to organize a department of forestry at Pennsylvania State College. Lectures in forestry had been offered at the college since 1889 by a Professor William Buckhout but forestry as a profession was not ² thought. Having laid the framework for the forestry department at the Pennsylvania College, Fernow was similarly invited, later in the year, to establish and administer a school of forestry at the University of Toronto, Canada. For the next 12 years, until his retirement as Professor Emeritus in 1919, Fernow served as dean of the Canadian University's forestry department. While at Toronto he published his History of Forestry and Care of Trees in Lawn and Street. He was a member of Conservation Commission of Canada for whom he conducted field surveys. He helped organize and was the first president of the Canadian Society of Forest Engineers. He, in short, thoroughly immersed himself in Canadian forestry matters, heralding, in the process, an increased awareness of forestry in Canada. Always fully up to date and in touch with United States Forestry, Fernow, in 1916, was elected president of the professional organization, the Society of American For-

* This is denied by Henry Clepper and Herbert Smith. See Journal of Forestry - 1922 1034 - 1924 22

esters.

Fernow's last years in retirement were spent in writing and corresspon-
dence. A host of honors and recognition were conferred upon him including
the ~~William~~ ^{Schlich} award. Our ¹ first professional forester, Bernhard Fernow,
passed away February 25⁶, 1923 but this "true pioneer of American Forestry"
lived to see his profession take root in the consciousness of a new land.

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Leaders in Conservation - Henry Clepper

see Dana, Forest Range Policy, p. 86

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life Society, the Ecological Society of America, and the Soil Conservation Society. He is noted for his work in the methods of preserving and maintaining natural areas and in analysis and management of natural vegetation.

MARY JEAN CLEVELAND

American Men of Science (The Physical and Biological Sciences), 10th ed., 1955.

FERNOW, BERNHARD EDUARD (1851-1923)

Born January 7, 1851 in the province of Posen, Prussia. Studied law at the University of Königsberg; then completed the prescribed curriculum in forestry for government service at Hanover-Muenden Academy and was licensed in 1869; University of Wisconsin, LL.D. 1896; Queen's University, LL.D. 1903; University of Toronto, LL.D. 1920. Prior to his arrival in the United States in 1876, he had been with the Prussian Forest Service. From 1878 to 1885, he managed a large private forest in Pennsylvania and became active in public forestry causes, and from 1883 to 1895, he was also secretary of the American Forestry Association. In 1886 he was appointed chief of the Division of Forestry, United States Department of Agriculture, and served until 1898. He was largely responsible for the law of 1891 that authorized the President to set apart portions of the timbered public domain as forest reserves; this was the basic act from which the present national forest system evolved. As chief forester he laid the foundations on which were built the present organization of the United States Forest Service. In addition, he created an intelligent public interest in forestry and in the need for education and research. From 1898 to 1903, he was director of the New York State College of Forestry at Cornell University, where he organized the first professional forestry curriculum in the Western Hemisphere. In 1904 he gave a series of lectures on forestry at Yale University, engaged also in consulting practice, and in 1907 helped start the Department of Forestry at Pennsylvania State College. He then went to the University of Toronto in 1907 where he organized the Faculty of Forestry, and in 1919 retired with emeritus status.

corresponding
secretary,
1883-1888.
Chairman of
Executive
committee,
1888-1898.
Editor of its
Proceedings,
1885-98.

In 1902, while at Cornell, he was responsible for the establishment of *Forestry Quarterly* of which he was editor from 1903 to 1916. After its merger with the *Proceedings* of the Society of American Foresters to become the *Journal of Forestry* he was editor-in-chief from 1917 to 1923. His contributions to the literature of forestry were exceptional in number and quality; his bibliography totals 250 published papers, bulletins, and three books: *Economics of Forestry*, 1902; *A Brief History of Forestry*, 1913; and *Care of Trees*, 1910. Fernow Hall at Cornell was named for him and dedicated in his honor in 1922. One of the pioneer leaders of the profession of forestry in America, he had a dominant role as administrator, educator, author, and editor. He gave the New World its start in education for the profession and remained the educational leader for as long as he lived. Died February 6, 1923.

his death in
 Received Wm. Solich Award from SAF.

HENRY CLEPPER

Dictionary of American Biography. 1931.

Journal of Forestry. Obituary, 21:306-37. 1923.

RODGERS, ANDREW DENNY, III, *Bernhard Eduard Fernow: A Study of North American Forestry*, Princeton, N.J.: 1951.

FISHER, JOSEPH LYMAN (1914-)

Born January 11, 1914 in Pawtucket, Rhode Island. Bowdoin College, B.S. 1935; Harvard University, M.A. 1938, Ph.D. (economics) 1947; George Washington University, M.A. (education) 1951. He taught economics at Allegheny College, 1938-40. From 1939 to 1943, he was a planning technician with the National Resources Planning Board, in field offices, and in the latter year was an economist with the Department of State. After service in the Army, 1943-46, he was instructor in economics at Harvard for a year, then was economist and executive officer of the Council of Economic Advisers in the Executive Office of the President, 1947-53. Appointed associate director of Resources for the Future, Inc., Washington, D. C. in 1954, he became president in 1959. Resources for the Future, a nonprofit research and educational foundation concerned with the development of natural resources, is an affiliate

Chief

Early history of Forest Service, or forestry work in USDA

30
August 15, 1876, Dr. Franklin B. Hough (pronounced Huff) was appointed to conduct forestry investigations. In 1881, the office was reorganized into a forestry Division. Two years later, in 1883, Hough was succeeded by Nathaniel H. Egleston.

On March 15, 1886, Dr. Bernhard E. Fernow became head of the Forestry Division, and remained so for 12 years.

On June 30, 1886, the Division was given permanent statutory rank. The new Chief of Division, in his first annual report, made this significant declaration:

It is not the control of the government over private property, it is not the exercise of eminent domain, it is not police regulations and restrictions that have produced desirable results upon private forestry abroad, but simply the example of a systematic and successful management of its own forests, and the opportunity offered by the government to the private forest owner of availing himself of the advice and guidance of well-qualified forestry officials.

(1898)
Twelve years later, Gifford Pinchot became head of the Division. On July 1, 1901, the Division of Forestry became the Bureau of Forestry.

*Improved
Revised
Version for Chief
RM Peterson, Feb-March 1983*

Bernhard Eduard Fernow (1851-1923)

America's First Forester

Third Chief of USDA Division of Forestry (1886-1898)

Founder of First Forestry Schools in United States and Canada

Bernhard Fernow, a German native, was the first professional forester to practice in North America. He did more to advance the profession in the United States and Canada in its early years than any other man. Fernow was born January 7, 1851, in the province of Posen, then in Prussia, one of the many independent German States. He received training and experience in the Prussian Forest Academy at Munden and with the Prussian forest department. Fernow married an American girl and emigrated to America in 1876. In 1878 he became manager for the Cooper Hewitt Company's 15,000 acres of woodland in Pennsylvania, used for making charcoal.

Fernow was a leader in the American Forestry Congress and in its 1882 merger with the American Forestry Association. He served as secretary of the Association, as the combined group was named, from 1883 to 1895, as chairman of its editorial committee, and in other positions. President Grover Cleveland made him Chief of the Division of Forestry in the Department of Agriculture in 1886. He quickly assembled a qualified staff, and started research in silviculture, pathology, wood technology, forest products, and in tree planting on the Great Plains. He eventually prepared over 200 articles, addresses, and monographs, and over 50 circulars and bulletins which laid the groundwork for forestry in North America. He traveled and wrote and spoke widely to scientists, farmers, students, and the public. He was perhaps the first in America to emphasize that forestry meant management to allow natural

regeneration and provide a sustained yield of products, and that forestry must be economically practical. Federal and State governments should, he believed, manage their forest holdings, serving as a guide to lumbermen and farmers, as in Europe.

Fernow strongly urged college instruction in forestry, and he started and directed the first four-year forestry school in the United States (in 1898 at Cornell University) and in Canada (in 1907 at University of Toronto).

Also in 1907 Fernow taught forestry briefly at Pennsylvania State College. He lectured at Gifford Pinchot's new Yale Forest School in 1904. He was a major figure in promoting and establishing the Adirondack Forest Preserve and the New York State Forest Commission in 1885, and in securing Federal legislation in 1891 for setting aside forest reserves and in 1897 for managing them. Using legal training gained in Germany, Fernow drafted model bills for all this legislation and for forestry laws in other States, including laws for fire protection and setting up State forestry agencies. Fernow's attempt to combine practical commercial forestry on a demonstration forest in the Adirondacks with his forestry school at Cornell led to a dispute with influential owners of neighboring estates who succeeded in closing his school in 1903 by persuading the Governor to veto its appropriation. From 1903 to 1907 Fernow was active as a consulting forester in the Northwest, the South, Cuba, and Mexico.

Fernow started the Forestry Quarterly in 1902 and was its editor until its merger with the Proceedings of the Society of American Foresters (SAF) in 1916, whereupon he became editor of the combined publication, the Journal of Forestry. He wrote three books which became standard texts: The Economics of Forestry (1902), A Brief History of Forestry (1907, 438 pages), and The Care of Trees in Lawn, Street, and Park (1910). He served as president of the SAF in 1914 and 1916, and was made a fellow in 1918. He helped organize and was first president of the Canadian Society of Forest Engineers in 1908, and after 1910 he served for 13 years on the Canadian Conservation Commission. He led a drive for more parks, reserves, and research, and for better forest fire control in Canada. He was elected a vice-president of the American Association for the Advancement of Science in 1895. He received

honorary LL.D. degrees from three universities (Wisconsin, 1896; Queen's, 1903; and Toronto, 1920). A forestry building at Cornell is named for him. Fernow died in Toronto on February 6, 1923, in his 73rd year.

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Charles E. Randall, "Fernow, the Man Who Brought Forestry to America," American Forests 70 (April 1964): 14-16, 44, 46. Andrew Denny Rodgers III, Bernhard Eduard Fernow: A Story of North American Forestry (1951).

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--Frank J. Harmon

CHAPTER II. THE WATERSHED OF THE NINETIES

The 1860s was a watershed - the Homestead Act, land grants to transcontinental railroads and institutions of higher learning, and creation of the Department of Agriculture. So was the 1890s. Americans were interested in reform - "restless, full of questioning." Prior to the nineties, America was predominately agricultural but by 1900 it was an industrial, urban nation "experiencing profound changes in population, social institutions, economy, and technology." The decade saw the Sherman Anti-trust Act, debates on free silver, labor riots, Coxe's Army, and the Spanish-American War at the apex of American imperialism. Remembered as the Gay Nineties; actually the 1893 Worlds' Fair generated the most gaiety and for only three months at that.¹ It was at the fair that a group of professors heard a junior colleague offer an explanation for much of what was happening.

by whom?

Chicago was hot that July 12, 1893, but by evening the breeze off Lake Michigan lowered temperatures to a more tolerable level. Professor Frederick Jackson Turner, age 31, faced his learned audience and read a paper, which he had worked on right up to his time on the program, "The Significance of the Frontier in American History." Turner elaborated on the thesis contained in his title, that America's democratic institutions owed much of their identity to the western frontier.²

Turner referred to the 1890 census, which had celebrated the centennial of American census - taking by proclaiming, prematurely perhaps, that Western settlement was dense enough to eliminate officially a continuous north-south line demarking the frontier. After explaining

how key American traits were related to the existence of a frontier, he predicted a "major shift in the national psychology." Ending of the frontier meant a lessening of cheap resources; "Americans must learn to adjust their economy, their politics, their daily lives to life in a closed-space world."³ For sure Americans saw free land becoming a scarce commodity; look at the pandemonium surrounding opening the Cherokee Strip in Oklahoma - also in 1893.

In another building, surrounded by exhibits designed to appeal to a much broader audience than the one that heard Turner, Bernhard E. Fernow manned the station for his agency. As chief of the Division of Forestry, United States Department of Agriculture, Fernow chatted with visitors about forestry - developing and teaching forestry as a science was the overall theme on display. The Lumber and Forestry Building had a colonade of tree trunks, one from each state, symbolizing the federal structure of American government. The Chicago exposition celebrated the five-hundredth anniversary of Columbus' discovery of North America; both Turner and Fernow looked at conditions they believed to be uniquely American - at least from certain vantage points, they were correct.⁴

Bernhard Eduard Fernow replaced Nathaniel Egleston as chief of the Division of Forestry on March 15, 1886. On July 1, Congress gave full statutory recognition to the division; no longer would it exist at the whim of the commissioner of agriculture. Although Congress provided stability, it was still parsimonious - the State of New York had appropriated \$15,000 for forestry that year, recognizing the efforts of Hough and others, but funds for Fernow's federal agency

totaled only \$10,000. Responsibility for forested regions of the public domain still lay with the Department of the Interior.

Fernow had attended the American Forestry Congress held in Philadelphia during the national centennial celebration, [accompanying Richard von Steuben, descendant of General von Steuben, who had participated in the defeat of Cornwallis at the Battle of Yorktown.] *deleted* Holder of a German forestry license since 1869, Fernow stayed on in the United States after marrying his American sweetheart. He worked as a forestry consultant to a Pennsylvania firm and became an active participant in forestry affairs, generally. Proceedings of the American Forest Congress show his increasing importance; there is much evidence of his associating with both Hough and Egleston for these events. Fernow's abilities did not go unnoticed, and he was recommended to President Grover Cleveland to be Egleston's successor. As far as Fernow was concerned, Egleston bore him no ill will but instead was relieved to be free of the responsibilities. "We have been and continue to be on the best of terms."⁵

While Fernow was getting settled in his new surroundings at the Department of Agriculture, public forest lands were under siege. General Land Office Commissioner William Sparks had denounced blatant timber frauds in northern California. A lumber company had openly used farmers, sailors - any available person - to file under the notorious Timber and Stone Act. These benign conspirators sold their claims for a modest sum and went about their business. A year before, Sparks in desperation, had suspended all entries in order to gain control of the rampant land fraud. One of his agents reported that the going rate for dummy entrymen ranged from \$50 to \$125—you could buy a witness for \$25.

The same agent estimated that three quarters of the claims filed with him were fraudulent; a more optimistic colleague guessed that 50 percent was a better figure.⁶

As Land Office staff watched reports of fraud and depredation pour in, seemingly without end, a pattern emerged. As the price of timber increased, so did timber fraud. The meaning was clear. Unfortunately for the entrymen, the price of timber frequently dropped before they could clear the claim. One can imagine much grumbling about so much government red tape that an honest man couldn't make a living. Agents for Interior's Division P investigated thousands of fraud and trespass cases every year but were unable to stem the tide. As John Ise has put it, fraud was a frontier way of life.⁷

Not everyone was complacent about timber land problems; efforts for corrective legislation continued. One of Fernow's first assignments was to draft a bill for Senator Eugene Hale of Maine. As was frequently the case, Fernow acted in his capacity as an officer of the American Forestry Congress, not as chief. The bill managed only to elicit opposition instead of support. Kansas Senator Preston B. Plumb, usually a friend of forest protection, objected having the bill referred to the Committee on Agriculture and Forestry. After all, the bill did provide for creation of a commissioner of forests in Interior. Fernow probably was little concerned about which committee heard the bill; he saw the difficulties involved in getting control of the forests away from the General Land Office and assessed the administrative capability of his department as inadequate for the management task.⁸ At the time Agriculture lacked cabinet rank.

The Hale bill died in committee, but it did provide a general blueprint for later legislation. Hale had proposed to suspend entry

on all federal forest land until it could be examined and classified. The secretary of the interior could recommend to the president which lands should be reserved. The commissioner of the General Land Office would appoint rangers and make regulations for logging, grazing, and other uses on the reservations.⁹ Whatever other defects members of Congress may have seen in the Hale bill, it was too ambitious for the times. To propose both forest reserves and the means to administer them was unrealistic. Progress would have to travel a much longer and indirect route.

There were repeated attempts to deal with public forest lands, but adequate congressional support was lacking.¹⁰ The Department of the Interior was limited to policing trespass and investigating fraudulent entries under a myriad of laws. Then, as with the 1876 seed-distribution rider that authorized a forestry agent in the Department of Agriculture, Congress almost accidentally made a major advance toward ^{protecting} forest lands. Much of the original documentation has been lost, if it ever existed, for what is now called the Forest Reserve Act of 1891. It is unfortunate that one of the most important legislative actions in the history of conservation is so obscure.

Section 24 of this law authorized the president to reserve certain forest lands from the public domain.¹¹ The reservation clause had a lengthy list of precedents but in the main it began two years earlier. In April 1889, the law committee of the American Forestry Association, Fernow, Egleston, and Edward A. Bowers of the General Land Office, met with President Benjamin Harrison. Egleston was spokesman. They presented a petition advocating adoption of an efficient forest policy. The president was cordial but took no noticeable action. The following year, after Fernow's prompting, the American Association for the Advancement of Science memorialized Congress to make reservations and provide a

commission to administer them.^{12.}

The same American Forestry Association committee made an appointment to see Secretary of the Interior John W. Noble. Fernow, Bowers, and Egleston were joined by John Wesley Powell of the Geological Survey and others. Years later, Fernow remembered Powell dominating the meeting, trying to convince Noble "that the best thing to do for the Rocky Mountain forests was to burn them down." Fernow used the brief time remaining to impress the secretary of his responsibilities to protect the public domain.^{13.} That this meeting with Secretary Noble took place is well-documented, although accounts vary as to what actually transpired - who said what. Fernow insisted that as a result of the meeting Noble personally intervened with a congressional conference committee at the eleventh hour to get Section 24 added. One scholar, however, casts doubt upon Noble's specific role and whether Fernow was even aware that the amendment was under consideration.^{14.}

To meet as objection by Henry Clipper was changed 1st revision to: "It is generally accepted" Deleted

That this presidential authorization to create forest reserves was added in a House/Senate conference committee and not referred back to the originating committees for their consideration has been noted by several authors. Historians have given much attention to this deviation from standard procedure. That Section 24 became law of the land improperly has also been well emphasized, as well as the fact that Congress passed this most important bill without being aware of its content. These views distort the legislative history of the law of 1891, so important to the history of the Forest Service.

The main purpose of the bill was to reform a *series* of land laws. Debates in Congress on this subject had been common during the 1880s. Mark Dunnell, who had only returned to Congress in 1888 after 3-term absence, opposed attaching forest reserve legislation to general land

reform; he believed that forestry was important enough to warrant its own measure. Too, he was upset that the Timber-Culture Act of 1873, which he had ^{originally} introduced in the House, was one of the laws scheduled for repeal. It is not clear from the record, but apparently Dunnell remained forestry's champion, even though he opposed addition of Section 24 as a rider. Others on the Public Lands Committee overrode Dunnell's objections and the clause stayed.¹⁶ In retrospect, Dunnell's tactics at least assured that his congressional colleagues were aware - even familiar - with the substance of Section 24. It is most likely that few if any could imagine the impact of what was to follow.

President Harrison wasted no time in exercising his new powers. He first set aside the Yellowstone National Park ^{Timberland} Reserve; by the end of 1892, mostly to protect water supplies, he had created fifteen reserves containing over thirteen million acres. President Cleveland added five million acres more - then he stopped. Until Congress provided the means to protect the forest reserves, he would set aside no more. After all, without protection, the reserves fared no better than unreserved lands in the public domain.

There was no delay in advocating protective legislation for the reserves. In his 1891 report, the General Land Office commissioner pointed out the need for managing the new reserves, as did the American Forestry Association and others. Secretary Noble "urgently recommended that Congress take proper action to have the reservations... established as national parks" or to be granted to the states for public use. He was supported by the General Land Office commissioner, Thomas H. Carter. The American Forestry Association, having made detailed recommendations for areas to be reserved, asked for "a wise and just system" that would be scrupulously and rigorously enforced. The conservationists feared

that the administrative procedure of requiring cutting permits from the Land Office would do little to protect the reserves. At the same session of the forestry association, Fernow read a paper entitled, "The Proper Administration of Forest Reserves."¹⁷.

When Grover Cleveland returned to the White House in 1893 after a 4-year absence, he named Hoke Smith as his secretary of the interior, bringing a mind more imaginative than Noble's to that office. Smith had actively sought the appointment, and Cleveland, with some misgivings, consented. The president believed that Smith would take hard line against raiders of the public domain. Although Noble had been influential in getting the reserves established, he had viewed them as an augmentation to the national park system. Smith, however, immediately recommended legislation to provide a "comprehensive forestry system" and creation of a forestry commission to advise the commissioner of the General Land Office.¹⁸.

There was broad support both within and without government for legislation to deal specifically with administration of the forest reserves. Within two weeks of the 1891 law's passage, Fernow was advising that his agency would cooperate with the American Forestry Association on implementation. He saw need for data on proposed reserves and new regulations for the Department of the Interior to regulate timber cutting. In his annual report, Fernow explained that more national parks were not the intent of the law; the goals were protection of public property and production of revenue. He reminded his readers that the Division of Forestry had no jurisdiction over public forests, the General Land Office administered what regulations there were. Fernow also supported Cleveland's nomination of J. Sterling Morton to

be Secretary of Agriculture. The secretaries were frequently presidents of the American Forestry Association, Morton was no exception. He had acknowledged prior to his senatorial confirmation that as secretary he could do much to advance the interests of forestry.^{19.}

Senator Algernon S. Paddock, chairman of the Committee on Agriculture and Forestry, introduced a bill "For the Protection and Administration of the Public Forest Reservations" in March 1892. Expanded in committee the bill was reintroduced providing for withdrawal of all public timber lands and placing them under military protection, also for returning agricultural land to the public domain for disposal under existing legislation. Paddock provided for administration of the reserves to be under the Department of Agriculture. Fernow enthusiastically favored the Paddock bill, even though he correctly surmised that it asked for too much. He would settle for less.^{20.}

Concurrently with the Paddock proposal, Congress was considering HR 119, the sort of bill Fernow believed to be more realistic. Congressman Thomas R. McRae, chairman of the House Committee on Public Lands and a member of the American Forestry Association, introduced his bill "To Protect Forest Reservations" in 1893. Later he would give Fernow credit for convincing him that forestry meant use of forests, not prevention from use. McRae's bill bore strong resemblance to the Hale bill of 1888, drafted by Fernow, providing for sale of timber to the highest bidder. The Department of the Interior would administer the reserves.^{21.}

McRae had support from Secretary Smith, Fernow, and the American Forestry Association. Opposition was western, both for opening the reserves to logging, thus jeopardizing water supplies, and for impeding the miner and stockman. There was strong sentiment for providing free

timber to settlers; sales would be a dangerous precedent. McRae revised his proposal and brought it back to the floor of the House, this time with a favorable Public Land Committee report. Settlers could get free timber. A favorable motion passed 117 to 54, but lacking quorum this effort failed, too. His third version allowed mining on the reserves, ending western opposition. The 159 to 53 vote reflected strong western support.^{22.}

When HR 119 was referred to the Senate, Henry M. Teller of Colorado, who had been secretary of the interior in 1882-1885, substituted his own version. Teller wanted to limit the requirements for reserve creation to water protection only; timber supply was not a proper justification. He moved his proposal quietly through the Senate, but the two bills died in conference.^{23.} Although Congress would eventually adopt the main feature of McRae's proposal, it would happen by less straightforward means.

As early as 1889, the American Forestry Association advocated a special commission to study public timber lands and recommend how they should be treated. In fact, John Muir and Carl Schurz had proposed such a commission in the 1870s. Support for the idea increased as the reserves remained unprotected. Fernow could see no reason for further study. It was readily apparent that the reserves needed protection. Why waste time with a study; instead, all energy should be aimed at getting legislation. But within the American Forestry Association developed strong backing for a commission.^{24.}

In June 1895, Walcott Gibbs, Charles S. Sargent, and Gifford Pinchot met at Sargent's home in Boston. Pinchot was a young forester with boundless enthusiasm, Sargent was an eminent botanist, and Gibbs was president of the National Academy of Science. The trio decided to use the

organization to bypass Congress, ^{which was} reluctant to establish a forestry commission. At a meeting of the American Forestry Association that fall, a commission gained support over Fernow's protests that further study was unnecessary. "The time was ripe for action," Fernow insisted, a commission would be a backward step. However, Pinchot and journalist Robert U. Johnson succeeded in carrying the meeting and won a resolution favoring a forestry commission. Fernow was on the association's executive committee and managed a statement at the next regular meeting branding such action as "prejudicial to the passage of the definite legislation now before Congress."²⁵

Needed was a letter to be signed by Secretary Hoke Smith requesting the National Academy of Sciences to appoint a forestry commission. In November 1895, Pinchot noted in his diary that he had drafted such a letter, which was reviewed. However, another draft, dated December 1895 and unquestionably in Fernow's handwriting, contains precise phraseology used in the letter signed the following February by Smith, lending strong support to Fernow's later contention that he, through the American Forestry Association, was instrumental in creating the commission. Pinchot, too, takes full credit. More important, however, is the fact that Smith signed a formal request to the National Academy of Sciences on February 15, 1896.²⁶

The letter asked the academy to study the forests on the public domain and report back in time to send the information to Congress during the current session. The commission was to determine whether fire protection and permanent forests were practical on the public domain, the influence of forests on climate, soil, and water, and what specific legislation was needed. Gibbs explained that the assignment was the largest the academy had every received from the government; the report

would be impossible to complete before Congress adjourned. Gibbs named Sargent as chairman and Alexander Agassiz, Henry L. Abbott, William H. Brewer, Arnold Hague, and Pinchot to the commission, Pinchot was the only one who was not a member of the academy. Armed with a \$25,000 appropriation, the commission headed west to study the forest reserves.^{27.}

Sargent was awed by his commission's assignment. The reserves already included 20 million acres and he suspected that local residents would be uncooperative. He admitted to having "more on my hands than I can manage" but immodestly pointed out that there was no one else with his knowledge to head the project. He glumly predicted that Congress would ignore the final report, anyway. Pinchot did not share Sargent's view of himself, noting that the chairman was "utterly without plan or capacity to decide on plans submitted." As committee work progressed, Pinchot's disenchantment grew.^{28.}

Fernow's biographer justifies leaving the chief of the Division of Forestry off the commission, as it would have meant Fernow could have swayed the report to validate his policies. However, as the commission was to study the reserves in Interior and Fernow worked in Agriculture, his exclusion seems unjustified. Fernow, himself, was bitter.

Abbott Kinney wrote to Fernow, reporting on the commission's brief in inspection of the forest reserves in southern California. Why wasn't Fernow a member, Kinney wanted to know. The Californian regretted that the group had been unable to see examples of major flood damage in a reservoir. With sarcasm, Fernow explained that the committeemen had "imagination enough to describe the conditions from reports of others sufficiently well for the sake of argument for to secure legislation." Fernow then told Kinney that he had been instrumental in the commission's

creation, having written the letter for Hoke Smith's signature. He pointed out that this information was an "inside history" of the executive committee of the American Forestry Association. "Nevertheless, I have been neither consulted nor in any way asked to contribute my share, nor recognized in my existence as the representative of the Government on this question." But, he philosophized, "Such is life, and such are people." What counted to Fernow were the ultimate results.^{30.}

As the study neared completion, interested citizens asked Fernow what the report would say. To one inquiry, he wrote that the commission had left him "severely alone." To another he explained that he had no indication of content, even though he had asked for information. Fernow expected, however, that the recommendations would not vary much from the programs advanced by the American Forestry Association over the years.^{31.}

But it did. Fernow and the American Forestry Association had accepted the political realities of western opposition to forest reserves. Therefore, they supported a slow, gradual reservation program to avoid triggering strong protests. The commission, however, had full support from the new secretary of the interior, David R. Francis, who endorsed their recommendation for immediate creation of thirteen forest reserves covering 21 million acres. Gibbs' letter of transmittal to President Grover Cleveland suggested that Washington's birthday on February 22, 1897, would be an appropriate date for the proclamations. President Cleveland obliged and set off the furor Fernow had feared.^{32.}

Furor indeed. Cleveland exercised his authority under the 1891 law and created thirteen reserves. Five days later, Fernow wrote NAS commissioner Arnold Hague that he was not surprised by the

"howl" raised over the president's action, and he predicted more. As to the thirteen reserves, Fernow added, "I want to claim a good share of the credit in this for the Forestry Association as having paved the way towards making it possible to secure not only reservations but the committee itself."³³.

The howl Fernow described grew louder. Scarcely a week after Cleveland's precipitous act, Fernow told a colleague that the situation "has changed most unexpectedly and most seriously." To another he lamented, "Alas! our forward steps have frequently to be taken back..." He described Cleveland's act as "injudicious" as it made no provision for managing the reserves. The proclamation had "stirred up such an antagonism as we have never had before."³⁴.

Typical of western outrage was a Seattle Chamber of Commerce memorial to Congress. The northwesterners fumed that they were being treated as a "mere dependency" and their further economic development was being prohibited by the "gratuitous suggestions of three irresponsible strangers [NAS committee], after a flying visit of a couple of days..." The whole episode was a "galling insult to [our] local sovereignty." Pulling out all stops, the chamber raged that "...King George had never attempted so high-handed an invasion upon the rights..." of Americans.³⁵.

Buried under an avalanche of similar protests, congressmen moved to appease constituents. An amendment to the Sundry Civil Bill restoring the entire area to the public domain passed the Senate. Fernow labored behind the scenes and got the House conference committee to insert an amendment giving the secretary of the interior authority to establish a division to protect and

manage the forest reserves; management included the right to sell timber, something he had tried for years to achieve. The effort was only partially successful; President Cleveland refused to sign the bill because of other defects.^{36.}

Secretary of the Interior Francis left us with his recollections of Cleveland's refusal. The appropriations measure cleared Congress and arrived at the White House on the day of McKinley's inauguration. The president asked each member of the Cabinet to comment, in order of rank. Francis was second to last, being senior only to Secretary of Agriculture Morton. When his turn came Francis pointed out that the measure revoked the proclamation that had created the 21 million acres of reserves. At that moment a messenger interrupted to announce that McKinley had arrived. Cleveland hesitated, then threw the Sundry Civil Appropriations measure on the floor saying, "I'll be damned if I sign the bill."^{37.}

Cleveland's pocket veto of the appropriations measure left the government without funds for the new fiscal year. McKinley quickly called Congress into extra session. The country needed appropriations. Forces concerned about forest reserves rallied. The opposition made full use of its momentum, but defection by Senator Richard Pettigrew of South Dakota eventually turned the tide in favor of the reserves. This powerful member of the Senate public lands committee had been a staunch foe of Cleveland's "Washington Birthday" reserves, but Charles D. Walcott of the U. S. Geological Survey won him over.^{38.}

Walcott persuaded Pettigrew to sponsor an amendment to the new Sundry Civil Appropriations bill. Walcott drafted the amendment,

modelling it after McRae's much-battered HR 119. The amendment specified the criteria for reserve designation - water protection and timber production - and excluded mineral and agricultural land. Also, settlers could have free timber and stone. Walcott convinced Pettigrew to add another clause, suspending the new reserves for nine months. The suspension clause was a clever tactic to overcome western demands for total elimination. Under this clause, those entering the designated reserves could transfer their claim, within nine months, to other parts of the public domain.³⁹ They could select new tracts in lieu of the original claim - the so-called lieu-selection process. [It is true that much misuse followed, but compared with fraudulent practices then in vogue, they seem mild indeed.]

Walcott met with NAS committee members and others to plan strategy. After convincing McKinley's newly appointed secretary of the interior, Cornelius Bliss, they approached the president. McKinley, although not wanting to alienate any congressmen at this early date in his administration and facing much greater and more important demands to go to war with Spain, was cordial and strongly supportive of the forest reserves. It would have been easier for him to rescind Cleveland's besieged proclamations, but McKinley agreed to let them stand, although he could not offer open support.⁴⁰

The Pettigrew amendment to the Sundry Civil Appropriations bill won handily in the Senate, with strong western backing. That the measure was favored by opponents of conservation probably resulted from western concern over unmanaged, locked-up reserves. Now that the reserves would be open for use took away the main reason for opposition. Ironically, McRae, whose HR 119 had been the

pattern for the Pettigrew amendment, fought acceptance in the House. He believed that use would jeopardize the reserve's flood control qualities. The House adopted the measure and a conference committee ironed out differences. The only important conference change was a modest reduction in the lieu-selection generosity. With congressional approval, President McKinley signed the bill on June 4, 1897.⁴¹ Thus the third major piece of forestry legislation moved through Congress as an amendment, never having had to surmount full legislative process.

The victory belongs to many. Fernow, certainly deserves major credit. The American Forestry Association provided its good offices for forestry advocates, bringing together foresters, legislators, and others concerned about the reserves. Sargent, Pinchot, and the National Academy of Science commission were able to bring presidential intervention into a congressional stalemate. Several members of congress - McRae, Pettigrew, Paddock - made contributions of their own. The achievement itself may be judged on its own merits.

What some historians call the Pettigrew Amendment turned out to be the basis of federal forest reserve management ^{for 63 years -} until revised in 1960. The law authorized the U. S. Geological Survey to examine the forest reserves. It stipulated that no reserve could be established "except to improve and protect the forest within the reservation, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use of the necessities of citizens of the United States;..." Further, the secretary of the interior was directed to make rules and regulations for the protection of the reserves. Perhaps most significant, in terms of what Fernow, Pinchot, and others had sought,

sale of timber was also authorized. Timber selected for sale had to be appraised, advertised, sold at or above appraised value, "marked and designated" prior to cutting, and supervised during cutting. Within three weeks, field agents of the General Land Office had been instructed how to proceed under the new law.^{42.}

Two of the most important legislative events in the history of the Forest Service took place during the watershed of the nineties, the laws of 1891 and 1897. The nation now had forest reserves and the means to protect and manage them. More adjustments would take place, but the basic elements of federal forestry were intact. The temptation to examine these two laws, then skip on to subsequent events is great. To do so, however, would leave an unbalanced view of Forest Service history. As a matter of fact, most of the agency's energies were devoted to non-legislative tasks.

When Fernow took over as chief of the Division of Forestry from Eggleston in the Spring of 1886, the agency still lacked permanent status. The commissioner of agriculture could decide to not continue the meager effort. On June 30, however, Congress gave the division full, statutory status. But status was not full recognition of importance; as we have seen New York State had appropriated \$15,000 for its 1886 forestry efforts, but Congress set aside only \$10,000 for Fernow's use. Inadequate financial resources were apparently not the issue - Congress was concurrently wrestling with huge budgetary surpluses - \$10,000 was obviously enough to congressional minds for forestry matters.

Fernow had been hesitant to accept the federal appointment, writing a colleague that he had accepted the position "after all." For ten years he had worked at a variety of consulting jobs. Now he

was looking for "useful" things to do, but first he had to file a report in a few months. Fernow offered to pay his associate's expenses for gathering information on federal timberlands in Colorado. Fernow wanted a map, too.^{43.}

Fernow furiously scrounged forestry literature for information. Writing to V. M. Spalding that he had been in office only three days, Fernow explained that he wanted to place the division on a "more scientific and systematic basis," but priorities dictated a report by July 1. He hinted that perhaps Spalding's work on white pine could be far enough along for inclusion. To another correspondent, Fernow briefly outlined his hopes that the division would bring into closer connection all agricultural schools, forestry associations, and horticultural societies. He closed with a plea for data on federal forest lands in Minnesota; he could pay travel expenses.^{44.}

Fernow's hurried efforts produced a sound statement of forestry principles. He made the usual references to the influence of forests on streamflow and climate and noted the exhaustibility of supply. Eastern forests, he predicted, would be depleted in fifty years and even the stupendous western forests would ultimately share the same fate.^{45.} Fernow's most important contribution, one that introduced modern professional forestry concepts, dealt with economics.

To Fernow, the basic deficiency in handling forest resources was the failure to distinguish between interest and capital. Sustained yield, after all, was based upon the notion of harvesting annual or periodic growth increment - the interest. Overcutting occurred when the resource base [capital] was depleted to a point

oversimplified

where the desired growth could not be maintained. Cutting into forest capital reserves would in the long run lead to exhaustion.^{46.}

Fernow perceived overcutting as unnecessary as well as undesirable. Oversupply of lumber was the problem; solve it and the threat of exhaustion would disappear while the lumbermen's profits would increase. Utopia? Not at all. Railroad land grants had made available vast amounts of low-cost timberland for speculative purchases. The flood of low-cost timber yielded low-cost lumber, forcing prices lower and lower. Lower prices meant that the lumberman had to sell - therefore produce - more lumber to meet fixed costs, and contributed even further to an already glutted market. Fernow believed that the lumber industry was unique in that the laws of supply and demand worked only to its detriment. The industry was unable to cope with a fluctuating market price and needed "the fostering care of a far-seeing governmental policy."^{47.}

Fernow offered no specifics given the American tradition of property rights, but he did propose that government timber be withheld as a means to alleviate oversupply. He hoped that examples of good forestry on federal reserves would be adequate to start the industry on the right track, obviating a potential need for government force.^{48.} Over-simplified in many respects, the report was an amazing effort for the thirty-five year old chief, having spent only four months on the job.

That out of the way, Fernow wrote to the commissioner of agriculture proposing changes in the division's organization, which by now had statutory permanence. He listed Egleston and Best as his assistants and eight clerks shown on the division roster.

He complained that six of the clerks were not under his jurisdiction, one was sick, and the eighth only worked part-time. Fernow asked that all of the clerks be taken off his payroll, [as they were of little use.]

He apologized to his superior for complaining about clerical inefficiency in the staff he had inherited, but none knew botany or forestry, had command of a foreign language, were skilled in research technique, or could operate a typewriter. [Small wonder at his wish to be rid of the lot.] He also asked that either Best or Egleston be removed; he didn't care which.^{49.}

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Fernow's requests were modest, indeed. If he could only have "a small plot of ground;" perhaps the Bureau of Animal Husbandry could spare some space at its station. For a clerk, he wanted a recent college graduate botanist, who could be "a young lady with knowledge of typewriting." This botanist clerk would be paid \$900 per year. His total budget was \$8,000; \$3,500 for the division headquarters and \$4,500 to support special agents studying western forests.^{50.}

Fernow divided the work of the division into four categories: general and statistical, economical, forest botany, and forestry proper. Under general and statistical he included studies of the forests of Colorado and California by Edgar T. Ensign and Abbot Kinney, as well as reviewing the scientific arguments on the effects of forests on climate. The economic studies would focus on the wood-using industries - charcoal, iron, mining, lumber, and railroads - "especially those directly controlling forest property." Fernow listed thirteen timber types or species as deserving investigation under biological studies; commercial value was obviously of prime importance. Finally he proposed to publish manuals on tree seed, nurseries, and thinning, which he thought

would be "exceedingly valuable" for educational purposes. All totalled, an ambitious program for a division with an \$8,000 budget and recently swept clean of most of its staff.⁵¹

His own house in order, Fernow looked at the broader problems of American forestry.

Edward A. Bowers joined the Department of the Interior as an inspector of public lands in 1886, the same year Fernow became Chief of the Division of Forestry in the Department of Agriculture. The two were well-acquainted, having been leaders in the American Forestry Congress. Bowers asked Fernow to propose policies for government-owned forest lands.

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[Fernow proposed a definite policy, believing that reforms were urgently needed.] To him, the forest was a valuable national property exposed to "reckless and shameful deterioration and depredation." Opposition to reform could stem only from ignorance or by "people not wholly disinterested in the thieveries upon the public domain." The issue was simple: "How shall we preserve for legitimate and economic use" the remnants of the public domain? Sustained yield was Fernow's answer.

He calculated that federally owned timber was conservatively worth 280 million dollars. At 5 percent, annual income from public forests would be at least 14 million dollars. Certainly as a straight business investment the government could well afford to set up an effective management program - a program he modelled after his earlier Prussian experience. First, withdraw all forest land from sale. Land found suitable for agriculture could be restored, later. Second, create an enforcement bureau in the Department of the Interior, probably in the General Land Office.

The bureau would have a central headquarters with district offices in the field convenient to forested areas. Each district office would use inspectors to assure compliance with policy by rangers, his title for those responsible for the smallest administrative units. Policy would emanate from the central office; staff would be required to make field inspections at least once annually. Timber prices and sales would be based on local conditions and local demand should receive "primary consideration."^{52.}

Fernow made little headway reforming either Interior or inspiring his own Department of Agriculture. He sadly came to the conclusion "that under present conditions no practical work will be done and we might as well satisfy ourselves, that all we can do is talk." Perhaps it was just as well, after all he needed much specific information about American forests "before we can even judiciously suggest" a correct management system.^{53.}

At the opening ceremonies of the Pennsylvania Forestry Association Fernow suggested what those interested in promoting forestry ought to do, while waiting for the national movement to coalesce into strong, federal programs. It would be "in vain" to ask a lumberman to cut fewer trees, as he was absorbed in supplying a sawmill. The most productive target, according to Fernow, would be the farmer who owned a small woodlot. Fernow told his audience that the individual would show little concern for forest destruction in general; whatever message was used it would have to deal with the specific property in question.

Forestry manuals would not suffice; a farmer might read a brief, clearly written article but not a manual. The most fruitful method would be for a "competent plain-spoken man" to address the farmer face to face. Fernow encouraged the association to raise funds in

order to support "travelling teachers." He predicted that the teachers would build support for remedial forestry legislation, needed in Pennsylvania and many other states.^{54.}

Back in Washington, Fernow sat at his desk with a sense of achievement. He had been able to reorganize his staff satisfactorily. By his second year, he had ^{hired} two field agents, and ^{was} Egleston helping in the office. Each earned \$1,500 per year. Fernow was especially pleased with his new assistant, George Sudworth, and he recommended giving him a 20 percent increase in salary. [Considering his earlier anguish] - a marked improvement in Fernow's peace of mind over the previous year.^{55.} He then told Assistant Secretary of Agriculture Edwin Willets that the Division of Forestry should have executive responsibilities, that is, it should be managing forests owned or controlled by the federal government. His office was mainly educational, since without forests, it could act only as a "bureau of information and advice." Fernow could not know that two years later the first forest reserves would be established, or he might have pressed the justification for his agency to manage forests with more vigor. Instead, he seemingly resigned himself to his educational fate and delineated for his superior how he gathered forestry information and which groups used it.^{56.}

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He made some progress, but Fernow was still vexed. Not only did he administer a small-budget bureau in a department oriented to serve farmers, he saw others as posing threats to what little he had. Fernow viewed John Wesley Powell as dangerous, because of his interest in forests, and asked: "Has Major Powell such a surplus of friends at his disposal that he must go into the forests to relieve himself of them?" Were not the Geological Survey and Bureau

attitude toward?

of Ethnology enough for his ambition? Although the famous explorer reportedly later helped convince Secretary Noble of need for the 1891 Forest Reserve Act, others shared Fernow's distrust of Powell and offered to join in the fight against "Powellism". Powell had joined forces with another who Fernow thought of as an opponent, Henry Gannett of the Geological Survey.⁵⁷

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Fernow could be caustic when his agency or its work received less than praise. One critic's name was "Burnt into my record of knownothings" for "slandering" certain research projects. Fernow acted in a similar vein when he clashed with Gannett over the need for a stronger federal forest policy. In an article carried by a Washington, D. C. newspaper, Gannett claimed that the relation between forests and climate, soil, and water was little proven. He added that forests, although diminished from the original amount, were growing faster than they were being cut. To him the "'laissez faire' policy seems to be the best." Public interest in forestry should be limited to improving transportation systems to aid forest commerce.⁵⁸

Fernow was aboard the steamship Allet, bound for Germany to assist his mother country plan its exhibit for the 1893 Chicago fair. He had been away since coming to America in 1876. A shipboard friend showed him Gannett's article; another wrote describing it as "stupid." Fernow agreed and counter-attacked. He acknowledged that the relation of forests to climate had been exaggerated and much more information was needed on relations with soil and water. Branding Gannett's presentation as a dangerous collection of half-truths, Fernow charged that "any observant logger" could quickly spot the inaccuracies. He was discouraged that a man in high position like Gannett would ignore their responsibility for

careful reporting and dismissed the geographer's preference for 'laissez faire' government as unwarranted.^{59.}

[The two had quarreled before.] Fernow was disappointed when Gannett failed to utilize fully the resources of the 1890 census in gathering forestry statistics. Charles Sargent had made an impressive contribution to forestry in the 1880 census, showing the potential of the national inventory at the beginning of each decade. Their spat continued when Gannett's Division of Geography and Forestry acquired functions overlapping those of Fernow's agency. Resolution of differences between the two departments occurred after Fernow resigned his post; his successor was a great fan of Gannett.^{60.}

Not all of Fernow's problems were external. His Prussian temperament and scientific training made it difficult for him to accept the indignities of being a minor bureaucrat in a department that did not achieve cabinet status until 1889. (Agriculture) had

Secretary of Agriculture J. Sterling Morton sent a memo to all of his division chiefs, instructing them to keep a daily time record for all employees and submit it to the chief clerk. Absences, the secretary ordered, were to be charged to annual leave. He added that "fabrication" would result in dismissal. Instead of assigning a clerk to this task and going about his work, Fernow elected to be offended. He expressed his "great regret" to Morton that he evidently intended "to reduce chief of divisions to the levels of clerks and time servers." Fernow protested that division chiefs were finally achieving a degree of respect, and he resented the "insinuation" that he was not giving all the time and energy he could spare to his work. Fernow believed the secretary's suggestion that a chief

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might falsify his reports was "so degrading that no self-respecting man will allow it to go without protest..."⁶¹.

As intemperate as this response might seem, it represented self-control on Fernow's part. His first reaction to Morton's order was to lash out that he was being made subordinate to the chief clerk. Under those circumstances Fernow demanded that Morton "consider at once my resignation...as I do not desire to hold a position as clerk subject to the dictation of any indiscreet underlying that may from time to time be invested with such unheard-of authority."⁶².

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Fernow continued to protest what he believed to be a reduction in status. An exasperated Morton asked the attorney general to rule on the relation between the chief clerk of the department and the chiefs of divisions. The secretary, hoping to settle the matter, told Fernow that he had confidence in the chief forester's ability to "accommodate himself to the attorney general's interpretation cheerfully and manfully." But Fernow was not satisfied with the interpretation and pleaded with Morton to make a final ruling. Fernow acknowledged Morton's authority to subordinate an officer to a clerk but could not believe that he really intended to do so. Fernow wrote the secretary that surely he did not mean to "degrade" him and "thereby compel the retirement" of Fernow and other division chiefs. Morton, showing great patience, responded that the attorney general's interpretation had clearly specified the relations between the chief clerk and division chiefs. He asked Fernow to specify ambiguities in the interpretation, but the forester let the matter rest.⁶³.

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[The chief clerk of the Department of Agriculture continued to plague Fernow, Noticing a smaller than usual paycheck, Fernow went

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to Morton for an answer. The secretary explained if Fernow had only notified the chief clerk that he had been away from his desk on official business, he would not have been docked for leave without pay. If Fernow would fill out the proper forms, he could collect his back salary. Unfortunately for Fernow's besieged ego, the form had to be submitted to the clerk, and the instructions on the form said it should be sent to the employee's immediate superior. Fernow returned the request for back pay, after crossing out "chief clerk" and writing in "Secretary." Morton returned the form to Fernow, explaining that to fill it out properly did not represent a demotion below the level of clerk. Fernow said that it did too mean demotion, because the instructions specified transmittal to his immediate superior. Morton must have thrown up his hands at the whole, ludicrous situation, for he let the clerk deal with Fernow directly. In a terse ultimatum, the clerk gave Fernow one day to fill out the request for back pay or face permanent salary suspension for the days in question. Furthermore, continued "defiance of the rules of the Department will necessitate my recommending the secretary to ask for your resignation."⁵⁴ Knowledge that Morton had authorized this direct order caused Fernow to let the matter drop. The record does not show whether Fernow received his back pay.

Despite his petty disputes over recognition and status, Fernow carried on an admirable technical program. As we have seen, Fernow began his term as chief of the Division of Forestry by inviting men already engaged in forestry studies to participate in the federal program. In addition to the work accomplished by these field agents, Fernow and his staff produced many worthwhile contributions. To use his own terms, during Fernow's twelve year administration, the Division of Forestry published approximately six thousand pages of technical material

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for a total appropriation of \$230,000. This figured to be about 24 dollars per page; not a bad price considering the values involved, calculated Fernow.^{65.}

Publications of the division covered a range of topics, reflecting Fernow's particular interests and the important uses of wood during that period. The drain on forests by railroads was the subject of several monographs, timber physics - the mechanical properties of wood, a favorite of Fernow - occupied many pages of the six thousand total, forest conditions in several states or regions, growth characteristics of several tree species, as well as many miscellaneous guides for farmers made up the remainder. Despite its small size, the research program received popular support; division files contain thousands of requests for information or copies of publications.

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No 41 Railroads in particular appreciated the research results and provided free passes for Fernow and his staff to travel on official business.^{66.}

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Within the Department of Agriculture, however, all were not satisfied with Fernow's accomplishments. Over the years he had been saddled with secretaries disinterested in substantive investigations, preferring instead that the Division of Forestry send seed packets to mollify congressional constituency or engage in rainmaking experiments. Fernow's timber testing studies, conducted painstakingly, brought criticism because he published only after acquiring large quantities of data. Publish more quickly he was told by Morton's assistant secretary.^{67.}

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When the division's timber testing in St. Louis was labelled "impractical experimentation," ex-secretary Morton concurred. [He belittled the efforts by saying, "The world was not asleep on timber tests until awakened by Fernow and [J.B.] Johnson." Not only was Morton dismayed in retrospect for permitting Fernow to fund timber testing, but he believed he must have been dozing when he ordered tree-planting research.] Then Morton jibed Fernow directly by referring to him as one who was "presumed to know something of the theories of European forestry." Fernow heard of this criticism and was naturally hurt. He told Morton that he had known him to be "thoroughly inconsiderate, injudicious and irresponsible" but had always believed him to be "fair, just and sincere." Fernow was grieved to be mistaken. Typically, he offered Morton the opportunity to apologize. Receiving none, he knew "what to think of you and this, I suppose, ends the matter."⁶⁸

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Fernow received a further slight when he summarized the efforts of twelve years. In his letter of transmittal, the new secretary of agriculture, James Wilson, called special attention to the fact that Fernow's successor was working in "distinctly different channels." He added, "These plans meet with my full approval."⁶⁹

Gifford Pinchot, of course, was this successor who was charting new courses. His selection must have surprised Fernow, who as late as mid-April 1898, believed that his assistant, Charles Keffer, would be named to replace him. Fernow had drafted a bill for the New York legislature to establish a forestry school at Cornell with a 30,000-acre experimental forest; on April 15, 1898 he was elected director of the new college. He was jubilant. "It is my intention to take the timber physics work with me and I hope by and by it will

thrive to the glory of another institution than the one in which I have tried in vain to bring it to recognition.⁷⁰

Fernow began the first professional forestry school in America in the fall of 1898. Within a few years, controversy prompted the New York State Legislature to cancel the program; whether or not Fernow's application of forestry to state lands caused the cancellation is still a matter of debate. In 1907, Fernow moved to the University of Toronto as head of the newly organized forestry faculty. He retired from teaching in 1919. Between 1902 and 1916 he was editor of Forestry Quarterly, which he founded. In 1917 the Quarterly merged with the Proceedings of the Society of American Foresters to become the Journal of Forestry. Fernow was editor-in-chief until 1923. In addition to his editorial achievements he published over 250 articles and bulletins and three books. His Economics of Forestry in 1902 clearly demonstrates a sophisticated grasp of modern forestry concepts. A Brief History of Forestry, in three editions, although dated in some respects, has yet to be fully replaced. He also wrote Care of Trees.⁷¹

Fernow's influence in key legislation cannot be denied, nor can his contributions to technical forestry subjects. He was a cultured, highly educated scientist, out of place in rustic America with its partisan politics and spoils system. Being overly sensitive to real or imagined slights reduced his potential as chief of the Division of Forestry. But despite accusations that he advocated adoption of European forestry methods in America, Fernow fully understood the forestry needs of the time and set out to achieve them.

Fernow suffered much neglect and abuse at the hands of those who wished to give his successor credit for nearly every early

his death

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advance in American forestry. Pinchot, himself, contributed significantly to Fernow's diminished reputation. At his retirement, Fernow must have been pleased to receive widespread praise. Two letters in particular were especially apt: "No other man has been such a potent force in the advancement of forestry in this country and the wonderful foundation laid by you will always endure." From a fellow immigrant whom Fernow had fostered, "You have been more than a teacher of forestry; ...you were a leader of life."⁷² Fernow died on February 6, 1923.

FOOTNOTES. Chapter II

1. Henry Steele Commager, The American Mind: An Interpretation of American Thought and Character Since the 1880's (New Haven: Yale University Press, 1959), p. 41; Harold U. Faulkner, Politics, Reform and Expansion, 1890-1900, (New York: Harper & Row, Torchbook edition, 1959), p. xiii.
2. Roy Allen Billington, Frederick Jackson Turner: Historian, Scholar, Teacher (New York: Oxford University Press, 1973), p. 127.
3. Billington, Frederick Jackson Turner, p. 128.
4. Andrew Denny Rodgers, Bernhard Eduard Fernow: A Story of North American Forestry (Princeton: Princeton University Press, 1951), pp. 198-200.
5. Fernow to Edgar T. Ensign, March 24, 1886, Outgoing Letters, Records of the Forest Service, Record Group 95, National Archives.
6. John Ise, The United States Forest Policy (New Haven: Yale University Press, 1920), pp. 74-75; U. S. Department of the Interior, Annual Report of the Secretary, 1886, pp. 95, 200, 213.
7. Interior Report, 1888, p. 85. For example in 1889, 55 agents spent 30 man years investigating 3,307 cases. Five hundred eighty-one of these cases were for timber trespass, valued at \$3-6 million, Interior Report, 1889, pp 275-280; Ise, Forest Policy, p. 79.
8. Rodgers, Fernow, pp. 115-116; Jenks Cameron, The Development of Governmental Forest Control in the United States (Baltimore: Johns Hopkins Press, 1928), pp. 203-204.
9. Rodgers, Fernow, p. 115; Cameron, Governmental Forest Control, p. 220.

10. For a listing of over 220 forestry bills introduced between 1872 and 1897, see: American Forestry Association, Proceedings, 1897, pp. 43-64.
11. 26 Stat 1095 (March 3, 1891), Section 24: "That the President of the United States may, from time to time, set apart and reserve, in any State or Territory having public land bearing forests, in any part of the public lands wholly or in part covered with timber or undergrowth, whether of commercial value or not, as public reservations, and the President shall, by public proclamation, declare the establishment of such reservations and the limits thereof."
12. Rodgers, Fernow, pp. 142-143; Congressional Record, 51 Cong 1, Pt. 3 pp. 2537-2538.
13. Rodgers, Fernow, pp. 154-155, 199; Fernow's version of the meeting is contrary to Powell's, see Carroll Lane Fenton and Mildred Ann Fenton, The Story of the Great Geologists (New York; Doubleday, 1945) pp. 232 ff.
14. Rodgers, Fernow, pp. 154-155. Most historians have accepted Fernow's version which is supported by John Ise, but see Herbert D. Kirkland, "The American Forests, 1864-1898: A Trend Toward Conservation," Ph.D. dissertation, University of Florida, 1971, pp. 171-175. The papers of Secretary Noble have yet to be located; if they exist possibly additional light would be shed on his role. R. E. Pettigrew on the Senate Public Lands Committee remembered immodestly thirty years later that it was he who added Section 24 in conference, leading "to one of the most bitterly fought parliamentary struggles in which I have ever participated," in R. E. Pettigrew's Triumphant Plutocracy:

- The Story of American Public Life from 1870 to 1920 (New York: Academy Press, 1921), pp. 11-12. In a rather garbled account, Robert Underwood Johnson takes credit for alerting Noble of the need to protect forest land and describes Bowers as the probable author of Section 24, see Remembered Yesterdays (Boston: Little, Brown, 1923), pp. 293-294.
15. Ise, Forest Policy, p. 117; Samuel T. Dana, Forest and Range Policy (New McGraw Hill, 1956), p. 101.
 16. For detailed descriptions of events in Congress, see: Kirkland, "American Forests," pp. 140-187, and Joseph A. Miller, "Congress and the Origins of Conservation: Natural Resources Policy, 1865-1900," Ph.D. Dissertation, University of Minnesota, 1973, pp. 230-238.
 17. Interior, Report, 1891, p. xiv, 55; American Forestry Association, Proceedings, 1891, pp. 16-18; Rodgers, Fernow, pp. 158-159.
 18. Rexford Guy Tugwell, Grover Cleveland: A Biography... (New York: Macmillan, 1968), p. 191; Interior, Report, 1893, p. lx.
 19. Fernow to George H. Parsons, March 24, 1891, Letters Sent, Records of the Forest Service; Division of Forestry, Annual Report, 1891, p. 224; 1893, p. 31; James C. Olson, J. Sterling Morton (Lincoln: University of Nebraska Press, 1942) pp. 350-351.
 20. Kirkland, "American Forests," pp. 201-203; Interior, Report, 1895, pp. cxxvii-cxxix.
 21. Kirkland, "American Forests," pp. 204-208; American Forestry Association, Proceedings, 1895, p. 62.
 22. Kirkland, "American Forests", pp. 208-212; Ise, Forest Policy, pp. 124-126.
 23. Ise, Forest Policy, pp. 127-128.
 24. Interior, Report, 1889, p. xxxvi; Kirkland "American Forests", p. 212.

25. Gifford Pinchot, Diaries, June 5, Sept. 4, 1895. Papers of Gifford Pinchot, Library of Congress, microfilm copy at Forest History Society, Santa Cruz, CA. S. B. Sutton, Charles Sprague Sargent and the Arnold Arboretum (Cambridge: Harvard University Press, 1970), pp. 159; American Forestry Association, Proceedings, Special 1895 meeting, p. 35; 1896, p. 41.
26. Pinchot, Diaries, November 18, 1895; Smith to Gibbs, Fernow draft dated December 1895. Curiously, a notation not in Fernow's handwriting at the top of the draft reads: "Original draft of letter for Sec'y Hoke Smith, calling on Academy of Science for advice Dec. 1895." This notation was probably added after the fact in order to confirm Fernow's claim of primacy. For Pinchot's version see: Breaking New Ground (New York: Harcourt Bruce, 1947) pp. 86-90; See also Rodgers, Fernow, p. 220; Robert Underwood remembered his own key role in convincing Smith to write the letters, Remembered Yesterdays, p. 297.
27. Copy of Smith to Gibbs, February 15, 1896 in Rodgers, Fernow, p. 220; Kirkland, "American Forests", pp. 222-223, Sutton, Sargent, p. 159; Johnson takes credit for obtaining the appropriation by his influence with Joseph Cannon, chairman of the House Appropriations Committee. Johnson used George P. Marsh's, The Earth As Modified By Human Action to convince Cannon; Remembered Yesterdays, pp. 297-298.
28. Sargent to Thiselton - Dyer, quoted in Sutton, Sargent, p. 160; Pinchot, Diaries, May 16, 1896 and passim.
29. Rodgers, Fernow, p. 221.
30. Kinney to Fernow, October 7, 1896; Incoming Letters; Fernow to Kinney, October 9, 1896, Outgoing Letters; Records of the Forest Service.

31. Fernow to George P. Ahern, January 16, 1897; Fernow to J. D. Barrett, January 9, 1897, Outgoing Letters, Records of the Forest Service.
32. Cameron, Governmental Control, p. 207; Rodgers, Fernow, p. 223; Sutton, Sargent, pp. 163-164; Francis to Sargent, October 2, 1896, Box 578, Papers of Gifford Pinchot; Fernow via the American Forestry Association acknowledged at this point that a sudden increase to the reserve system could dramatize the need for regulatory legislation and prompt congressional action: See Proceedings, 1897, p. 31.
33. Fernow to Hague, February 27, 1897, letters sent, Records of the Forest Service.
34. Fernow to W. G. Steel, March 1, 1897; Fernow to H. G. deLotbiniere, March 6, 1897, **Letters Sent**, Records of the Forest Service.
35. U. S. Congress, Senate. Doc 68, 55 Cong 1. May 6, 1897, p. 9
36. Fernow to H. G. deLotbiniere, March 6, 1897, op cit.
37. Stevens, Walter B., "When a Missourian Forced a Special Session of Congress", Missouri Historical Revue 23 (November, 1928), pp. 46-47. Another account, as related to R. U. Johnson, quotes Cleveland as saying, "I will veto the whole damned Sundry Civil Bill," see Remembered Yesterdays, p. 300.
38. Pettigrew, Triumphant Plutocracy, p. 207; Charles D. Walcott, "Forestry Legislation of 1897" n.d., copy in Box 73, Records of Society of American Foresters, Forest History Society. This is apparently a draft of a memo Walcott wrote to John Ise on April 2, 1919, the original is in the Pinchot Papers. Ise also uses the substance of the memo in his Forest Policy, pp. 132-133.
39. Ise, Forest Policy, pp. 132 ff; Walcott memo (April 2, 1919);

Pettigrew, Triumphant Plutocracy, p. 208.

40. Pinchot, Diary, March 5, 1897; Sutton, Sargent, pp. 166-169; Walcott memo.
41. Ise, Forest Policy, pp. 137-138.
42. 30 Stat 34-36 (June 4, 1897). The Multiple Use Act of 1960, 74 Stat 215, is considered to be supplemental to the 1897 law. The recent Izaak Walton v. Butz, which was decided in favor of the plaintiffs, declared clearcutting practices of the U. S. Forest Service on the Monogahila National Forest to be in violation of the intent of the 1897 law; General Land Office Circular, June 30, 1897, in Interior, Report, 1897, pp. cix-cxiv.
43. Fernow to Edgar Ensign, March 18, 1886, Outgoing Letters, Records of the Forest Service.
44. Fernow to V. M. Spalding, March 17, 1886; Fernow to J. Fletcher Williams, March 22, 1886, Outgoing Letters, Records of the Forest Service.
45. Department of Agriculture, Annual Report of the Secretary, 1886, pp. 151-158; in 1879 Secretary of the Interior Schurz had estimated a twenty-year supply nationally.
46. Agriculture, Report, 1886, p. 155.
47. Agriculture, Report, 1886, p. 168.
48. Agriculture, Report, 1886, p. 166.
49. Fernow to Norman J. Coleman, July 1, 1886, Outgoing Letters, Records of the Forest Service.
50. Fernow to Coleman, July 1, 1886, Outgoing Letters, Records of the Forest Service; apparently Coleman had reserved \$2,000 of the \$10,000 appropriation for departmental use.

51. Fernow to Coleman, July 1, 1886, Outgoing Letters, Records of the Forest Service.
52. Fernow to Edward A. Bowers, December 19, 1886, Outgoing Letters, Records of the Forest Service. Fernow's proposed forestry agency bears striking resemblance to the modern Forest Service.
53. Fernow to J. G. Kern, March 10, 1887; Fernow to Kinney, April 6, 1887, Outgoing Letters, Records of the Forest Service.
54. Copy of speech in Papers of Bernhard E. Fernow, Cornell University.
55. Fernow to Coleman, June 29, 1887, Outgoing Letters, Records of the Forest Service.
56. Fernow to Edwin Willits, September 25, 1889, Fernow Papers.
57. Fernow to _____, November 16, 1886, Outgoing Letters; Kinney to Fernow, August 30, 1893, Incoming Letters, Records of the Forest Service. Although many historians list Powell as an important contributor to conservation, Fernow thought of him as holding a cavalier attitude toward forestry; See Rodgers, Fernow, p. 154.
58. Fernow to _____, draft of letter [1890] in FHS Clipping file; Washington Evening Post, April 1, 1893.
59. Rodger^s, Fernow, p. 200; E. P. Martin to Fernow, March 3, 1893, Incoming Letters, Records of the Forest Service; Fernow to Morton, April 5, 1893, reprinted in, Agriculture, Annual Report, 1893, pp. 313-315.
60. Rodgers, Fernow, pp. 200-201; Agriculture, Annual Report, 1890, p. 193.
61. Morton to Division Chiefs, January 1, 1894; Fernow to Morton, [n.d.], Fernow Papers Forest History Society Collection.

62. Fernow to Morton, [n.d.], draft in Fernow Papers, FHS.
63. Morton to Fernow, February 1, 1894; Fernow to Morton, February 4, 1894; Morton to Fernow, February 5, 1894, Fernow Papers, FHS.
64. Morton to Fernow, September 9, 1895; Morton to Fernow, October 28, 1895; Morton to Fernow, November 11, 1895, Morton to Fernow, December 17, 1895; Fernow to Morton, December 19, 1895; Clerk to Fernow, December 20, 1895, Fernow Papers, FHS.
65. Fernow, B.E., Report Upon the Forestry Investigations of the Department of Agriculture, 1877-1898, U. S. House of Representative Document No. 181, 55 Cong 3, 1899, p. 7.
66. Fernow, Forestry Investigations, pp. 40-44; Fernow to Alfred Sulley, January 31, 1887, Outgoing Letters, Records of the Forest Service.
67. Charles Dabney to Fernow, November 30, 1896, Incoming Letters, Records of the Forest Service.
68. Morton to R. L. O'Brien, April 25, 1898; Morton to O'Brien, April 8, 1898; Fernow to Morton, April 29, 1898; Fernow to Morton, May 10, 1898, Fernow Collection, FHS.
69. Fernow, Forestry Investigations, p. 3.
70. Fernow to Charles W. Garfield, April 18, 1898; Fernow to W. M. Hays, April 19, 1898; Fernow to S. T. Nelley, April 18, 1898, Outgoing Letters, Records of the Forest Service.
71. Fernow, B. E., Economics of Forestry (New York: Thomas Y. Crowell, 1902); A Brief History of Forestry in Europe, The United States and Other Countries (Toronto: University of Toronto Press, 1907, 1911); Care of Trees (New York: Henry Holt, 1910).
72. R. G. Bryant to Fernow, September 17, 1919; Raphael Zon to Fernow, August 15, 1919, Fernow Papers, Cornell University.