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NEW ENGLAND FORESTS: BIOLOGICAL FACTORS[1]

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The Original Climax Forest

WHEN settlements were first established on our coast, early in the seventeenth century, New England was almost entirely forested. The accompanying map indicates the general composition and the distribution of the tree species originally characteristic of the district. Broadly speaking, the occurrence of these regional units of forest is governed by the climate, physiography, and soils. Thus northern New England was in the main covered with spruce and fir and the so-called northern hardwoods: beech, yellow and white birch, and sugar maple. Southern New England was mainly dominated by a large variety of hardwood species more characteristic of the Middle States, in which a number of species of oak and hickory predominated. Between these two extremes was a large more or less transitional area, roughly described as "Central New England," where white pine and hemlock mingled in varying proportions both with species characteristic of the adjacent regions to the north and south, and with certain others, such as red oak and white ash, not originally so abundant in either. None of these regional units was sharply distinct, but each exhibited extensions due to the effect of elevation or of fundamental soil composition upon climate and moisture. Thus the northern forest extended well down into Berkshire and Hampshire counties into Massachusetts, along the higher elevations of the Berkshire Hills, and in a few elevated spots in Worcester County. Similarly the oak forests of southern New England came north for a considerable distance into the lowlands of southeastern Massachusetts and up the Connecticut River valley. Cape Cod, almost a climatic and geological unit by itself, bore a forest principally of pine and oak.

In size and outward appearance these so-called original forests were in marked contrast to most of the woods of today. In the main the stands were mixed, often containing a great variety of species of many sizes and ages. If we disregard extremes of situation—such as mountain summits, sand plains, or swamps—and consider only the preponderance of area where temperature and moisture were not subject to wide variations, the life history of these forests, whether in the north or south, was much the same. Over central New England, for example, one may picture a forest in which broad-leaved trees

[1] For notes see below, p. 222.

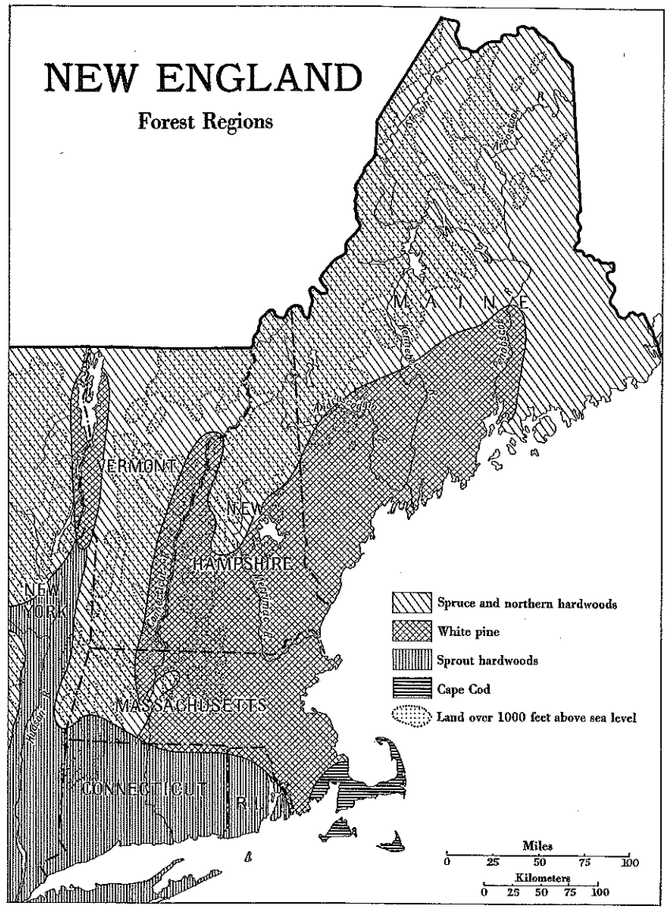

FIG. 1—Forest regions of New England. Based on map of forest regions of the northeastern United States, by P. W. Stickel, Northeastern Forest Experiment Station, Jan., 1927. Altitudes generalized from U. S. Geol. Survey's map of the United States, 1 : 2,500,000, 1914.

and hemlock formed a dense stand from eighty to one hundred feet high, above which, either by small groups or single trees and varying greatly in abundance, white pines reached a height of 150 feet or more. It is generally believed that such a forest was self-maintaining, in other words that the losses through old age or injury were recruited from younger and smaller trees gradually developing underneath, so

that over periods of centuries and on the average the representation of species remained about the same and the general size and appearance of the forest was unchanged. This condition of equilibrium is what is generally called a "climax forest." It means that if the stand is truly self-maintaining, all of the species represented are long-lived and more or less capable of reproducing and surviving for long periods under the heavy shade and prolonged suppression of the larger trees.

Changes in the Climax Forest

It is a popular if not a scientific idea that the primeval forest was almost as changeless as the hills. If the ordinary physical factors of temperature, rainfall, and the other manifestations of climate were regular in their operation and not complicated either by exceptional changes or by the influence of man, as on sheltered sites with deep soils, some forests might indeed remain unchanged for indefinite centuries. If, however, we study—as has recently been done[2]—the detailed records of life history in such original forests as still remain, we find evidence, even with no human factors in operation but the aboriginal Indian, that there must have been over long periods important changes in the distribution of species and the character of the forests within each of our climatic regions. Undoubtedly forest fires are more prevalent and destructive today than when the Pilgrims landed; but there is convincing evidence that everywhere fires were of periodic occurrence both from the practice of the Indians and occasionally from lightning. The principal difference between the aboriginal forest fires and those of today is that the earlier fires were probably less destructive in the larger woods and less prone to cover big tracts in a single burn. In addition to fires it is only necessary to consider longer stretches of time, such as centuries or more, to find unmistakable signs of other destructive agencies: windthrow, generally occurring on uplands or exposed ridges and often prostrating large areas of trees; lightning, which sometimes kills a dozen or fifteen trees with one bolt; ice storms, shattering many acres of tree tops; and, probably in the wake of these, fluctuating attacks from injurious forest insects or disease. It is likely, especially on drier and more exposed sites, that such periodic calamities as these, upsetting for a time and sometimes over large areas the equilibrium between local climate and soils and the natural requirements of tree species, were collectively the most powerful influence governing pre-Colonial forest history. Without the recurrence of fires we should not have had the heavy forests of pine in central New England reported in some localities by the early settlers. It is likely also that, without these periodic upsets providing breaks and exposures in the ancient forests, many of our short-lived, light-seeded species such as gray birch, pin cherry, and

aspen would have been even more rare and restricted in distribution than they actually were in the original forest. Thus, while areas of big timber certainly predominated in the early forests as traversed by the pioneers, there must also have occurred many areas where reversions to younger woods or shorter-lived species were in progress. As a background for the study and understanding of forest succession and growth, and for interpreting the many and varied forms of degeneration that have followed settlement and development, the original or climax forest is invaluable. It is unfortunate for scientific as well as economic reasons that today less than 5 per cent of existing forests date back to the settlement of New England.

To understand what has happened to the remaining 95 per cent of our original forest area, it is necessary to trace the progress of the use of land down to the present day.[3] In such a complicated development only the principal tendencies can be touched upon. As regards ultimate effect upon the forest, we may almost disregard the century from 1600 to 1700. This was in the main a period of pioneering. For the most part the settlements and clearings, at first mainly for agricultural purposes, were confined to coastal strips of a few leagues in width or to the bottom lands of important rivers, like the Connecticut. Aside from the initial clearing, such timber as was used and the little that was exported was culled at convenient distances from the sea or along the principal rivers. Furthermore, much of the land thus cut or cleared has continued to be devoted to agricultural, industrial, or residential uses and may be omitted from consideration of forest history in general. The bulk of the forest area, however, did not begin to be seriously altered until the early eighteenth century with the settlement and gradual development of the interior.

In the forest history of the last two hundred years we may distinguish two main types of land use: farming and lumbering. Although at the start and in the typical small community of the eighteenth century the two forms of use were combined, the lumber business as it became better organized spread into the wilder portions of Maine, New Hampshire, and Vermont, where farming was difficult or impossible. We may thus for simplicity consider southern New England, including roughly the area south of northern New Hampshire, central Maine, and northern Vermont, as a region primarily affected by agricultural settlement and the rest of the region, in general the wilder, colder, and more mountainous parts, as a district affected largely if not exclusively by lumbering. Each of these two main types of land use has had a profound effect upon the character and productiveness of the forests of today.

Forest History of the Farming District

In the farming district practically the entire area came to be covered by organized towns, most of them settled and incorporated

during the first half of the eighteenth century. A steadily increasing area was cleared for crops or grazing, and the remainder of the original forest was utilized little by little for lumber and building material, generally used locally and manufactured in the small water mills which were common in every town. Early census figures for Worcester County, Massachusetts,[4] whose history is typical of most of the region, show that the percentage of cleared land rose steadily until about 1830 and at its maximum included from 55 to 65 per cent of the total land area, exclusive of ponds, swamps, etc.

About 1850, with the opening of the West, the development of the principal railroads, and soon afterward with the drain of the Civil War, land abandonment set in in earnest. For a time the effect upon the area in farms was partly neutralized by the clearing of new land hitherto in forest; but the decline has continued down to the present day so that nearly seven million acres were thus left to revert to nature between 1880 and 1925. From 1850 on, while New England farming and farming populations were rapidly declining, the old fields and pastures were seeding up to new forest, much of it pure stands of white pine. Meanwhile, as the local supplies of original forest disappeared, wood-working industries, originating in the early towns and gradually developing with the improvement of markets and transportation, began to use these second-growth forests, many of which by 1890 had reached merchantable size. From that date to 1925, for wooden boxes and woodenware alone, fifteen billion feet of pine lumber have been cut, over 80 per cent of which originated on old farms abandoned since 1845.[5] At a fair average yield per acre of 10,000 feet, taking good stands with poor, this is equivalent to one and one-half million acres and represents a manufactured value of not less than four hundred million dollars. More than half of this generous sum went to the populations of the towns where the timber grew, an unearned income which in many communities has gone far to keep the remaining farms alive.[6]

Now that the use of old-field timber has been in progress for more than a generation, still a third phase of land use, or, perhaps more properly, disuse, is well advanced, and is represented by an immense and increasing extent of cut-over area, much of it covered with comparatively worthless stands of inferior hardwoods or underbrush, and much of it a frequent prey to forest fire. At the same time, especially in southern New England where hardwood forests predominated, great areas that had not been cleared for farms but were periodically cut for local wood supplies became more and more degenerate in composition and vigor through the drain of repeated sprouting from the same stumps with less and less renewal by new seedlings. Today in the upland farming districts of New England the amount of area to be classed only as woodland is at least 60 per cent, or a little more than what it

was a hundred years ago. Nature has produced a second crop of timber; but, according to any present or foreseeable use, the third crop is a liability rather than an asset.

Forest History of the Lumbering District

If we now consider the history of forests in the northern or lumbering district, we find a similar but less rapid decline in value and productiveness. In the earlier days of lumbering, especially in the state of Maine, only the larger, better trees were cut, at first white pine and later, as pine became exhausted about 1870, spruce, which was for a long time the principal building material in New England. Later, with the development of modern sawmills and more efficient logging methods, the forests were cut more heavily. Always there has been a steady reduction in the better species of timber trees; and, though the earlier partial cuttings had a tendency to allow replacements in the forest and thus keep it moderately productive, the lumber areas of the north as a whole showed a gradual increase in the relatively inferior hardwood element as compared with spruce and pine. Here also, as in the farming district, cut-over lands were apt to burn destructively and over large areas and thus occasion a serious deterioration in the quality and quantity of forest production.

Depletion of the Forests

Thus in two centuries the people of New England have used up all but a scant two million acres of an original forest covering thirty-nine of the forty million acres included in the six states. Not less than fifteen million of these acres became farm and pasture, of which at least ten million have been abandoned to revert to forest and thus accidentally to produce a supplementary crop of timber, the best of which has now also been cut down. There are still about twenty-seven million acres in woodland, but of this more than half is covered with comparatively valueless trees or undesirable species. For a region two fifths of which is probably unfit for anything but the growing of timber this situation is economically discouraging. But even less favorable as related to the problem of restoring forests for the future are the less obvious indirect effects produced by this period of destructive or neglectful use upon the physical and biological factors of the forest—for example, the condition and distribution of tree species, the prevalence of pests, the fertility of soils, the fluctuations of wild life.

Effects of Forest Weeds

Today perhaps the greatest natural obstacle of all to successful forestry, at least in central New England, is the extent to which forest weeds, both trees and underbrush, have multiplied as compared with

the species of greatest use and value. As long as most of the land was occupied either with tillage or pasture or by the still uncut areas of original forest in which only the long-lived and better timber trees survived, the weed element remained in abeyance. Thus, during the earlier abandonment of farm lands it was still white pine as the species most adapted to prompt reseeding that took possession of the fields and pastures; but, as time went on and more land was abandoned, the light-seeded, fast-growing species—gray birch, pin cherry, poplar, red maple, alder, to say nothing of many kinds of shrubs—were able to rival the pine and outstrip the larger, heavier-seeded hardwoods in spreading over vacant lands. Still further impetus was added to the spread and development of forest weeds after the pine wood lots began to be cut and left, as they almost invariably were, to come up to a thicket of hardwoods. In such thickets the stock of valuable seedlings that originated under the pine stand is gradually suppressed by the faster-growing shrubs and forest weeds. Less rapidly but nevertheless steadily a similar process has been going on in the wilder regions where lumbering has been the only treatment of land. Fires also, which only provide further areas more adapted to poor than to good species of trees, have aggravated the process. The increase in forest weeds as compared with desirable timber trees during the last two hundred years is beyond estimate. In central New England it is probable that there are at least five hundred acres of forest weeds to one of good timber, actual or prospective.

Deterioration of Soil

That our present woodland is so much of it intrinsically of little use is not the end of the trouble. Since the present associations of species occur almost wholly as results of farm abandonment, lumbering, or fire, they are often physiologically unsuited to the sites they occupy and therefore, in the absence of fire, tend gradually to revert to some other mixtures more adapted to the local factors of soil and climate. Conversely, these temporary or transitional forests may often have an injurious effect upon the current fertility of the soil, so that, even where a given kind of timber may be commercially valuable, it does not follow that it may be safely reckoned upon as a permanent forest crop for the land. A case in point is the large area of old-field pine already referred to, which has proved so valuable a raw material for local woodworking industries during the last generation. These stands, originating on medium to better soils often improved over their primitive condition by a century of farming or grazing, exhibited in early life a rapid growth. Experience and research at the Harvard Forest[7] have shown that such pine stands gradually arrest most of the organic decomposition that in a healthy forest tends to maintain soil fertility and at the same time exhaust

the original top soil, so that at fifty to sixty years of age their growth suddenly falls off. On the other hand, the replacement of such pine stands with certain associations of deciduous trees has proved beneficial by restoring under the more active influence of temperature, moisture, and light, the metabolism of organic materials that is indispensable to the productiveness of a forest soil. It is axiomatic that cultivation and fertilization as applied to agriculture will always be impracticable in forestry. The only way in which these processes can be kept up in forests is by the use of such species as will maintain the necessary decomposition of forest débris and favor the biological influences—earthworms, fungi, etc.—that supplement the action of physical factors. Not all natural forests accomplish this, since in all cases the general regional climate is the deciding factor; but many associations are beneficial, especially if properly managed. To build up a favorable forest soil may be the work of years. With our present inferior second-growth forests, soils have widely deteriorated: first, by the transition to unfavorable mixtures of species or stands of inadequate density; and second, and often repeatedly, because forest fires have consumed the organic element in the soil.

Insect Pests and Diseases

This general transition from mixed forests of older woods into smaller stands of short-lived or enfeebled trees has brought with it increasingly favorable conditions for insect pests and disease. In the original forests the absence of large areas of any one type of vegetation of uniform age or condition prevented the undue development of pests peculiar to any given species. In the woods of today we find immense tracts of relatively unhealthy forest running strongly to one type of mixture or often to pure stands and, in consequence of their life history, less vigorous than the forests they have replaced. How this has affected insects is indicated by the history of the white pine weevil, a native insect and now one of the most destructive pests of white pine plantations. Relatively harmless in the original forests, where pine did not often grow in continuous bodies and where the percentage of younger stands at any one time was low, this insect found in the period of farm abandonment and the widespread reversion of these lands to pure pine a favorable environment on an immense scale. Today the white pine weevil is so abundant and widespread as to destroy a large part of the value of most pine stands within its range.

Relation of Wild Life to Forest Environment

Among biologists the essential control of wild life by the character of the environment is admitted, if not yet understood in detail. A significant example may be found in the way in which the known

fluctuations of the partridge and the woodcock in central New England have followed the progress of land abandonment, reversion to pine wood, and subsequently to various mixtures of hardwood. Neither of these species was naturally abundant in the heavy forests of early New England; but from 1870 to 1900, during the period of most rapid reversion of old fields to forest, both species reached the greatest abundance recorded by sportsmen. That the partridge has since steadily declined in abundance and the woodcock, at least recently and locally, increased may well be accounted for by the changes that have taken place in the character of the cover and attendant food supply.[8]

The pine wood developed on old fields and pastures, together with more or less hawthorn, running blackberry, viburnum, blueberry, apple trees, and birches. The process of change from shrubby field to forest was gradual, and during the first twenty to thirty years the combination of vegetation was ideal for the partridge—increasing shelter, varied food plants, and open dusting places. From then on the pine rapidly closed up; and most of the food plants, even the old apple trees, were killed out. Since the bulk of the pine woodlands reached this condition twenty to thirty years ago, the favorable cover was reduced to the margins where the pine gave way to brushy openings or birch thickets more characteristic of recently abandoned fields. Thus there was going on a progressive reduction in good cover even before the logging activities of the last generation.

But if the maturing and removal of the old-field pine has deprived the partridge of more and more of his best habitat, the process has, in many cases, accomplished the opposite for the woodcock. This came about through the soil changes referred to above. In the soil under a pine wood there are no earthworms. With the change to certain species of hardwood, if the situation is not too wet or too dry, the original bed of leaf litter disappears in from fifteen to twenty years, the current fall of hardwood leaves decays almost annually, and the resulting fine humus merges with the mineral soil, sometimes to a depth of ten inches or more. There results a rich brown loam in which earthworms are characteristically abundant. On many such areas, once the new forest has begun to close up, breeding woodcock have appeared in numbers. This transformation is not universal but is apparently confined to certain combinations of sites and tree species. In sum total, however, the change has taken place in favorable spots over wide areas. Thus, there would seem to be reason for the recent abundance of woodcock in northeastern covers.

The Future of New England Forests

Looking to the future it is plain that, even though rapid changes in utilization and the recent decline in the demand for native timber

make it difficult to predict what kinds of forest should be the objective of forestry in the several regions, nevertheless, it is safe to expect that from one fourth to one third of New England's area must be used, if at all, as forest. If it is to be used as forest, its permanence and productiveness, whether for wood, safeguarding of stream flow, protection of wild life, or recreation, will have to be secured by a proper understanding and control of the biological and physical factors that have hitherto been so seriously upset. Much of the knowledge necessary for this kind of management is still lacking. The required principles, however, are evident. In many ways the conditions obtaining in the original virgin forests were favorable, but reproducing the complexities of their life history will not make a productive forest. Their very stability involved also an undue slowness of growth, a high percentage of defect, and, as compared with ideal conditions, relatively inactive soils. On the other hand, although much of our second-growth timber has had periods of excellent commercial value and has exhibited very rapid growth—as in the case of the white pine wood lot—such types do not offer a safe model for sound forestry. Being in nearly every case the product of human interference with natural conditions, these types are almost invariably unstable, both as to composition of species and soil conditions. The silviculture of the future will copy the virgin forest by selecting the most valuable, fast-growing, or hardy species so mingled as to secure the greatest possible mutual protection from insects and disease, and the best influence upon soil metabolism and upon the quality of wood. It will follow to some extent also the more uniform density and concentrated production shown by the best of the second-growth forests, in which, for brief periods at least and for certain types, timely exposures of the soil and the predominance of certain beneficial species have produced high yields of wood as well as active fertility. Whatever may prove to be the economic or social objectives of New England forest policy, it will be necessary in the long run to understand and control an essential equilibrium of biological factors, on the one hand to avoid the wasteful complications of the natural process and, on the other, to restore and maintain the resources in good timber and productive soil that human occupation has by now so greatly reduced.

NOTES

[1] For additional bibliographical data see the notes to Dean H. S. Graves's paper entitled *Forest Economics and Policy in New England*, in the present volume, pp. 224–236, below. For a general description of New England forests see R. C. Hawley and A. F. Hawes, *Forestry in New England: A Handbook of Eastern Forest Management*, New York, 1912; the same, *Manual of Forestry for the Northeastern United States, Being Vol. 1 of "Forestry in New England," Revised*, New York, 1918, 1925.—EDIT.

[2] *Life History of the Climax Forest on the Pisgah Tract, Winchester, New Hampshire*, Harvard Forest Study (unpublished manuscript).

[3] A. C. Cline and C. R. Lockard, *Mixed White Pine and Hardwood*, Petersham, Mass., 1925 (*Harvard Forest Bull. No. 8*). [See also R. M. Harper, *Changes in the Forest Area of New England in Three Centuries*, in *Journ. of Forestry*, Vol. 16, 1918, pp. 442–451.—EDIT.]

[4] Early decadal census of Worcester County, Massachusetts (original in possession of the American Antiquarian Society, Worcester, Mass.).

[5] *Analysis of the Wooden Box Industry in New England: A Study Made for the New Hampshire Lumbermen's Association by the Harvard Forest, Distributed Among Members of the Industry by the New England Council*, 1926.

[6] R. W. Averill, W. B. Averill, and W. I. Stevens, *A Statistical Forest Survey of Seven Towns in Central Massachusetts*, Petersham, Mass., 1923 (*Harvard Forest Bull. No. 6*).

[7] B. G. Griffith, E. W. Hartwell, and T. E. Shaw, *The Evolution of Soils as Affected by the Old Field White Pine-Mixed Hardwood Succession in Central New England*, Petersham, Mass., 1930 (*Harvard Forest Bull. No. 15*).

[8] R. T. Fisher, *Our Wild Life and the Changing Forest*, in *The Sportsman*, Vol. 5, March, 1929, p. 65.