THE BLACK ROCK FOREST

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HENRY H. TRYON, *Director*

PRACTICAL FORESTRY IN THE HUDSON HIGHLANDS

By

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INTRODUCTION

AFTER nearly half a century of increasingly vigorous educational effort in the field of conservative forest management, the belief is still widely held amongst woodland owners that the application of the principles of technical forest management to the farm woodlot is a costly and time-consuming practice which seldom shows much on the credit side of the ledger. Such a belief may well arise in part from a lack of knowledge or appreciation of the many biological factors involved or of Nature's vast, latent, potential ability to aid in the production of forest crops. Furthermore, the scanty returns (so frequently seen) from the establishment of costly coniferous plantings on lands clearly much better suited to the production of crops of hardwood timber have undoubtedly helped to crystallize the belief that "forestry is expensive business."

Such an opinion has probably been caused, also in part, by the quite natural errors in judgment made in the past by various conservation agencies. Considering the comparative youth of the profession of forestry in the U. S., no one should, in reason, expect these agencies and departments to be 100% correct all of the time. There still remains a great array of investigative and experimental work to be done. And it is indeed unfortunate that our political set-up should make it a seemingly vital necessity for a bureau or a department to feel that there must be inserted in the annual report something to the effect that so many million conifers were grown and distributed the past year for reforestation or for afforestation—and yet, in the same document to say little or nothing regarding the subsequent development of these same seedlings.

How many thousands were planted on unsuitable sites? How many were smothered by the more vigorous native hardwoods? How many plantations have perhaps been decimated by insect or fungus attack arising through planting in pure stands?

Take the case of the well-meaning farmer who has had little or no practical advice on the question of the selection of proper planting sites but who courageously goes ahead and follows the urgings of his state conservation department. In a few years he often finds that he must spend considerable time tending and weeding his forest crop if it is to produce anything worth while. Can he be blamed for feeling that someone has erred?

Much of the propaganda of the conservation movement has been aimed at planting little trees, chiefly conifers. It is not difficult to account for this. The early 1900's saw the period of peak production of "old field" white pine timber which had seeded down on abandoned fields. These natural stands frequently furnished a substantial cash return, and the quite natural psychological effect on our early foresters was to cause them to regard the establishment of coniferous plantations as the correct procedure. This concept was widely applied, but with considerable subsequent difficulty, for it shortly became disagreeably clear that something was radically wrong. In many cases such plantings either winked out entirely or had to be given repeated expensive weedings to prevent their being completely smothered out by aggressive volunteer native hardwoods. Insect and disease attack also played their part. In general, the results were discouraging.

The chief reason for this erroneous concept was the curious lack of basic ecological knowledge of our forest type successions. Much forestry work was conducted along the lines of trial and error, with the latter usually being in the majority. It has taken us several decades to learn that you cannot plant the wrong species on the

wrong site and expect good results. (9) It is by no means the writer's intent to create the impression that coniferous plantations are always incorrect tactics. On certain soil sites they do very well indeed; but in the particular district with which this paper is concerned they are almost invariably a venture of doubtful value.

But our ecological knowledge is increasing and our view is becoming broader. We are daily learning more of the fallacies which underlie these coniferous failures. Few foresters of today hold to the old concept that forestry means the widespread planting of various evergreen species. More and more is the attitude that of seeking further knowledge, chiefly in the direction of determining which species belong to a given site. We must look to Nature for our teachings. We must first ascertain what she wishes to grow; and then plan our effort along helpful, harmonious lines. By far the wisest, the most effective, and the least expensive management policy is to work to improve the natural timber stands. This basic philosophy of working in harmony, rather than in conflict with Nature has been proven to be sound, correct,—and practical.

How best to apply the foregoing is the purpose of this paper. It is a proven fact that the profitable handling of woodlands must follow Nature's wishes as closely as is economically practicable. Even a slight deviation from Nature's plans as evidenced by what is now growing on the site, any attempt at the familiar project of converting a hardwood stand into an evergreen forest will almost certainly result in increased expense of establishment and maintenance, with a proportionately reduced return at maturity.

Experimental

During the past 15 years a considerable number of experimental operations, varying from light thinnings to clear cuttings have been carried on here. In the wake of

these there has gradually appeared an array of interesting reactions which have been periodically scrutinized and from which it now appears reasonable to hazard certain conclusions.

The purposes of this paper are three-fold. First, to set forth the apparent local ecological trends as we have been privileged to observe them; second, to outline, as the current conditions indicate, what now appear to be the generally sound management practices for lands similar to this Forest; and, third, to lay great stress upon the practical importance, for such sound management purposes, of a rather thorough and accurate knowledge *of the local type successions.* We hold it to be axiomatic that without such knowledge the practice of applied silviculture can be no better than shrewd guesswork.

For present purposes, the local forest cover types fall rather readily into two broad classifications such as (1) the temporary associations and (2) the climax and near-climax types. Temporary types are, for example, the quick-growing, short-lived, prolific stands of gray birch and red maple which are so quick to invade abandoned fields or which appear as the result of some outside interference with the natural conditions such as a cutting, a fire or an ice-storm. The natural tendency is to develop from one temporary type into another until the climax association becomes established. Such temporary associations will pass in time into the sub-climax and later the climax associations, two examples of which are the hemlock-beech-yellow birch-sugar maple mixture occasionally found in cool, moist, fertile, north-facing ravines; and the much more common red oak-white oak-sugar maple or hickory mixture so frequently encountered on the well-drained slopes of the Highlands.

These, and several other forest cover types common here will be discussed in detail later in this paper. Their occurrence is most closely linked with soil, climate, and exposure. The two foregoing types are cited merely as

examples. It must be borne in mind that all such types represent definite stages in Nature's effort to protect the soil with a tree growth of some sort. Land which is completely covered by tree growth is, in Nature's opinion, adequately protected. But if this protective shelter be removed, the soil beneath it may deteriorate rapidly due principally to extreme exposure to the sun's rays with resultant drying out. And on steep slopes the soil itself may actually wash away. So Nature is forever seeking to protect her soils with some sort of a leafy cover.

In short, as we get to know our forests better, we are realizing that both the expense and the hazard of applied forestry can be sharply diminished by a careful correlation of forest practice with the natural factors operating within the forest itself. Here in the Highlands, as in many other forest regions of the U. S., some acquaintance with forest ecology, and more specifically, a fairly sharply defined knowledge of the local forest cover types *and their place in the successions* is the key to successful forest management.

THE ORIGINAL FOREST COVER TYPES

WHEN intensive management of this Forest was begun in the autumn of 1927, one problem overshadowed all the others. What was the composition of our pre-colonial forests? And next, what are the various successional stages in this area progressing from the old-field or the clear-cut stage to the climax type?

During the past 15 years a number of these successional stages have been fully identified and described, and much has been learned of their habits and their response to various forms of cutting treatment. But as yet little definite information has been collected on the local climax types. Perhaps it would be well to insert here a brief definition of these. (3, 4, 19.) Foresters agree that the climax represents the adult or mature stage in the succession—the fully developed tree community. It is a stable stand, wholly adapted to the soil supporting it, and immune against invasion by other tree species save through injury by some outside factor such as fire, ice-storm, windthrow or cutting.

But to date insufficient evidence has been accumulated to afford a sound basis for a clear-cut description of the various forest cover types encountered by the first settlers in this region. No areas of true undisturbed old growth have been found as yet; and, despite a rather wide search, but little reliable material has been found in the early records. The pros and cons of several possible climax associations have already been discussed in considerable detail in previous publications of this forest (14, 15, 20, 21).

Scholz and Tryon agree that the original forest probably differed in several particulars from its present

rather degenerate successor. Raup takes somewhat the opposed view, thus; "there is some evidence that the present arrangement and content of the timber types—have persisted from pre-colonial times." This view is based on "the present configuration of type boundaries, the nature of advance growth in the present stands, the known effects of recent disturbances, the general condition of the soils, the distribution and form of very old trees, and the relation of the present types to their regional geographic distribution in eastern North America."

Evidence favorable to both hypotheses undoubtedly exists, but neither side has been able, as yet, to make out a particularly strong case. At the Forest headquarters the general opinion is that in the early days the same tree species were present, but their distribution was sharply different from conditions today. (13.) Furthermore, it is felt that hemlock and white pine, especially the former, were more common hereabouts (8). Hemlock, frequently in pure stands, occurred on the sites usually associated therewith—along the streams and slope bottoms and in scattered moist pockets higher up on the slopes, with a tendency to congregate on north exposures. White pine is rarely, if ever, visualized as occurring in pure stands (20). Perhaps a few such patches existed, growing doubtless on some gravelly, porous, well-drained knoll. But such evidence as we now possess, especially as regards our soils, makes this occurrence seem unlikely, for such knolls are practically non-existent in this particular area. Rather does it now seem probable that occasional single white pines grew in mixture with the local hardwood species. These were trees of good height and of fine form which had germinated in an opening made by fire, windthrow or other outside agency. The chief reason for believing that much of this Forest and the adjoining wooded area is still composed of temporary forest cover types is the hard fact that nearly every single ex-

ploitable acre of the tract has been cut hard (and usually well burned as well) at some time during the past 80 years (13). From what our ecological studies of forest types show to date, this interval is far too short a time for this Forest to progress, untended, through the various successional stages which are bound to occur between a clear cutting (and perhaps a burning) and the natural restablishment of the local climax or near-climax types (6).

One point which should be noted here, in view of Raup's use of the advance growth as evidence of the apparent stability of the existing types is that on many of the good sites here, particularly those with a north, northwest or northeast exposure, sugar maple is today strongly represented in the understory. This would appear to be reliable evidence that Nature is planning a change in the tree population on such sites. Such a change is by no means to be anticipated as a shift to the beech-birch-maple climax of the northern hardwood forest. Sugar maple is clearly coming back in the advance growth, but its ultimate position in the local stands is not visualized as that of a dominant species. It is expected to be rather plentiful numerically, but, silviculturally speaking, it will usually be found in the intermediate crown classes. Only on particularly fertile sites is it expected to become dominant.

The search of the early documents for pertinent information has not been too successful, but data on early utilization have been found which give some definite clues. Shipbuilding and wagon construction, with the attendant sawmilling flourished in this region together with cooperage, charcoal and fuelwood operations. The general picture of forest utilization from 1700 on is moderately well defined, though we are still somewhat in the dark as to which species were chiefly exploited. But the early "wind-jammers" were fitted with masts, and white pine was the best mast timber that ever grew. Means of

travel and communication were of course in the primitive stages, and it seems almost unthinkable to argue that white pine of sizes suitable for shipmast timber was ever brought any great distance to the pioneer shipyards then operating in New Windsor, Newburgh, and Poughkeepsie. It is historical data such as the foregoing, combined with the now fairly large array of ecological evidence derived from our quadrat surveys of ground cover, underbrush and natural regeneration which give us to look kindly on the Scholz-Tryon theory outlined above. The results of these quadrat surveys, with especial reference to reproduction, are the chief basis for our current belief that much of the cover on this Forest is still in a temporary stage.

But, turning resolutely aside from this fascinating but controversial topic, this writer agrees with other foresters and ecologists that the artificial destruction of the climax dominants will initiate a distinct change in the type composition (12). In final support of this, Tansley's comprehensive summary is quoted below (17), and the opinion is here advanced, despite published opposition in some ecological quarters, that the known steady and abusive exploitation of the Forest up to the early 1920's has left the growing stock in such a generally upset condition that it now represents a patchwork of subseres (3, 10, 15). All of these can, by careful study, observation and management be brought around to their true climax associations. ". . . Many of the practical problems set to the ecologist and to the forester are cases of the initiation of a sub-sere by artificial destruction of the climax dominants . . ." This excerpt from Messrs. Tansley and Chipp sounds the keynote of this Bulletin.

For the present, for practical working purposes, the pre-colonial stands are pictured somewhat as follows, with the species listed in the estimated order of frequency of occurrence. Chestnut is today generally considered to be out of the picture entirely, but it is felt that the results

of observations made on this Forest during the past 15 years should be briefly reviewed here before proceeding with the descriptions of the early stands.

Since 1927 it has been noticed that chestnut sprouts (21) have been appearing in quite considerable numbers. Rarely, during the first part of this period, did these reach more than shoulder height before being attacked by the chestnut blight. Today, however, where soil conditions are suitable and where plenty of full sunlight is available, we are finding seedling native chestnuts reaching heights of 20-30 feet before becoming infected. There probably are several causes for this. Possibly the fungus is decreasing in virulence or in quantity of spore yield; perhaps some sort of favorable mutation is taking place in the local chestnut strain; or it may be all or none of the foregoing, plus perhaps other factors on which we are as yet uninformed.

Suffice it to say that on this Forest for the present chestnut cannot be wholly disregarded, for on certain favorable sites it assuredly occupies a definite position in the shrubby crown level of the stand.

The Principal Original Types

Moist to Wet Areas

Hemlock, some sugar maple and beech, red oak and occasional basswood.

Coves and Lower Slopes

Red oak, occasional white oak, hemlock, sugar maple, basswood, possibly a white pine on a well-drained hummock, perhaps an occasional sycamore or white ash of poor form.

Mid Slopes

Red oak, sugar maple, some white oak and hickory on warm, southern exposures, with now and then a black oak and perhaps a white pine.

Upper Slopes and Ridge Tops

Chestnut oak, pitch pine, red cedar, scrub oak, scarlet oak.

The foregoing are by no means proffered as a final verdict. They represent our best estimate to date, and until they prove faulty we shall continue to employ them as our objectives in the management of this Forest.

WHAT HAPPENS WHEN YOU MAKE A CUTTING

"It is essential to emphasize the fact that a forest is an exceedingly complicated biological unit. It comprises not only a more or less diversified aggregation of trees, but numerous species of shrubby and herbaceous plants, fungi, insects, herbivorous animals and a complex soil fauna and flora. In other words, it consists of a very large number of mutually interacting organisms which are affected by, and which themselves affect, a complex of environmental factors (1)."

This meaty quotation gives some idea of what confronts us when we contemplate any sort of artificial change in our woodlands. The number of factors involved is large; and the degree of interaction between them is high. Let us glance at a few.

First on the list come moisture supply and light. Our tree species cannot exist without an adequate supply of each. Then there is the question of foods for the tree. These are taken from the soil in various chemical forms. Obviously some soils set a better table than others; and it is trite to repeat here that many tree species are quite choosy as to where they will grow best. White oak, for example, is found growing on a number of different soils; but all of us have noticed that it does best on rather good, warm, well-drained loams of limestone origin. In contrast, red maple and gray birch will do fairly well almost anywhere. Also, while speaking of light, we should not omit mention of the factor of shade. Some tree species such as beech, hemlock or sugar maple can grow in sturdy fashion under rather deep shade. Other species demand

a far greater supply of direct sunlight if they are to make their optimum growth.

Take now the question of soil fauna and flora. The minute organisms found living in forest soils are legion; their functions are by no means completely defined as yet, but we do know that if a forest soil be suddenly exposed to excessive sunlight a drying out and compacting usually follows, both of which make life much harder for these small and useful neighbors. As a result, they die out and their former location almost invariably suffers a considerable loss of fertility, of good tilth, and of the dark, rich color and the mellow, crumbly structure so characteristic of good forest soils here.

Turn now to the question of plant foods. Trees take from the soil the substances they need for growth. Certain chemical elements derived from the soil are, at the end of each growing season, deposited in the leaves, and are later, through leaf-fall and natural decaying processes eventually returned to the soil in available form for use by the forest community. While trees are equipped with remarkable chemical equipment about which we are not yet fully informed, it has been repeatedly proven that while a given soil may be rich in nitrogen, this element may be bound up in some organic chemical compound which renders it unavailable to the majority of tree species. Obviously, in dealing with such an area it becomes only logical to favor thereon such tree species as are known to do well on a diet low in nitrogen, and which can, after several season's operation of this returning of nutrients back into the soil, render the area again suitable to support the less efficient, but usually more valuable species.

Trees possessing these helpful and cooperative qualities really do exist. Aspen, to take one example, is a short-lived tree, very fond of invading quickly, and growing well on burned areas where, owing to the fire, the nitrogen loss has been terrific. The prompt appearance

of this species on such devastated sites is only further proof of Nature's desire to put the stand back to work in the shortest possible order. But the valuable commercial species cannot thrive on such devitalized areas. So the fast-growing aspen has been provided to step in in great profusion. This quick cover will soon cast a light shade which will reduce the loss of soil moisture and invasion by briers and other undesirable weeds. Furthermore, the continued annual deposit of aspen leaves, with their load of easily available nitrogen, will gradually rebuild the available nitrogen content of the soils, for aspen is a notoriously efficient feeder on poor sites. Other nutrient elements such as lime, phosphorous and the like are similarly handled.

While the foregoing are only the high spots, it is easy to see that it all makes a fascinating and complicated picture. Left to itself, a forest will progress gradually, and rather slowly, to its climax association. Having reached this stage, it will remain stable practically permanently unless it be disturbed by some extraneous agency. Such a disturbance, be it ice-storm, fire, cutting or what-not, immediately changes, and usually for the worse, the living conditions for the great multitude of interacting, living organisms making up the community. The degree of change is almost exactly proportional to the severity of the disturbance.

Hence, without pursuing this complicated topic further, be careful not to over-cut. It is far simpler to come back and remove a few more trees than it is to put back trees already taken.

THE PRESENT COVER TYPES

TABLE I below lists the chief tree species growing here, with brief notes on their occurrence, tolerance, germination percent and their place in the local successions.

TABLE I

PIONEER SPECIES

ASPEN: *Populus tremuloides Michx.;* on well drained, acid sites. Common, heavy seeder, intolerant.

GRAY BIRCH: *Betula populifolia Marsh;* common, intolerant, short-lived, very prolific, efficient feeder, good nurse or trainer. Prefers acid soils.

RED CEDAR: *Juniperus virginiana L.;* common, chiefly in primary old-field association, much less so on suddenly exposed forest soils. Slow-growing, prefers a high pH. Intolerant.

CHERRY: *Prunus serotina Ehrb.;* common on exposed, parched soils. Intolerant, prolific, efficient feeder, prefers acid soils.

RED MAPLE: *Acer rubrum;* very common, ubiquitous on this Forest, a pioneer on exposed forest soils. Prolific, seemingly not a climax species. Probably a sub-climax. Moderately tolerant.

SUMACH: *Rhus typhina L.;* invades old fields, fast growing, prolific, intolerant.

SASSAFRASS: *Sassafras variifolium (Salisb.) Kuntze;* often forms pure stands on old fields. Intolerant, short-lived.

SECONDARY SPECIES

BLACK BIRCH: *Betula lenta L.;* ubiquitous, never a climax, rather intolerant, susceptible to fungus attack. Invades clear cuttings freely in secondary stage. Rapid height growth first twenty years. Intolerant.

YELLOW BIRCH: *Betula lutea Michx.;* quite common, intolerant, rapid height growth for first two decades. Invades clear cuttings rather freely following appearance of pioneer species.

Occasionally a near-climax in old stands on fresh, north exposures.

BLACK GUM: *Nyssa sylvatica Marsh;* infrequent, rather tolerant, prolific, seldom more than near-climax, invades clear cuttings rather freely after other pioneer species have appeared therein. Often called "pepperidge."

NEAR-CLIMAX SPECIES

BLACK ASH: *Fraxinus nigra Marsh;* rare, unimportant, perhaps a climax on moist to wet cove sites.

WHITE ASH: *Fraxinus americana L.;* prolific, prefers a high pH, frequently appears in true pioneer thickets. Can not maintain its position in mixture with hard maple. Intolerant.

BLUE BEECH: *Carpinus caroliniana Walt.;* tolerant, seizes on open or partially-shaded areas, especially moist, fertile sites. Could be classed as an understory climax.

HOP HORNBEAM: *Ostrya virginana (Mill.) Koch.;* common, intermediate tolerance, a true understory climax.

PIN OAK: *Quercus palustris Muench.;* common, a poor tree, dry sites, clearly a near-climax, intolerant.

SCARLET OAK: *Quercus coccinea Muench;* similar to pin oak.

YELLOW POPLAR: *Liriodendron tulipifera L.;* fairly common, demands excellent sites, rich and well-drained. Good growth on such. Often found with hard maple, medium tolerant. Often persists until climax is firmly set. Prolific seeder, but very low germination percentage. Sometimes called "whitewood."

WHITE PINE: *Pinus strobus L.;* only scattering here, classed pro tem as near-climax with hardwoods on gravelly, quick draining, rather poor sites. Tolerant when young.

CLIMAX SPECIES

BEECH: *Fagus grandifolia Ehrh.;* rare, south of its normal range. Highly tolerant.

DOGWOOD: *Cornus florida L.;* common, tolerant, an underwood climax, an aggressive sprouter.

HEMLOCK: *Tsuga canadensis (L.) Carr;* common, tolerant, prolific, coves and lower slopes. Germinates well on cool, moist, acid, north exposures—also on rotting wood. Given good light the height growth is greater than is popularly supposed.

HICKORY: Sp.; medium tolerant, fairly common on better, well-drained sites. Generally a near-climax species, but might be ranked as climax in the restricted white oak-hickory belts enjoying a warm southeast-southwest exposure.

HARD MAPLE: *Acer saccharum Marsh;* common on good sites, hardy, tolerant, prolific, slow growing. Well-defined climax species, able to hold its own with even hemlock or beech.

BLACK OAK: *Quercus velutina Lam.;* somewhat infrequent, tolerant, a climax species on warm, south, midslopes.

CHESTNUT OAK: *Quercus montana Willd.;* very common, intermediate tolerance, a climax on dry, upper slopes and ridges. Shoestring fungus and the 2-lined chestnut borer are thinning its ranks here.

RED OAK: *Quercus borealis Michx.;* very common, tolerant, prolific, good germination percentage, excellent growth, clear-cut climax species on lower to upper slope sites.

SCRUB OAK: *Quercus ilicifolia Wangh.;* a common climax on high, dry, rocky ridges.

WHITE OAK: *Quercus alba L.;* common, tolerant, climax species on warm, fertile sites between cove and lower ridge levels.

PITCH PINE: *Pinus rigida, Mill.;* uncommon, low tolerance, a climax species with scrub oak on very dry sites.

SYCAMORE: *Platanus occidentalis Linn.;* infrequent, unimportant. Possibly a climax along brooks at low altitudes.

BASSWOOD: *Tilia americana Mill.;* fairly frequent, hardly common and then only in coves and on lower slopes. Good seeder, but very low germination percentage. Very tolerant; given good light makes good height growth. Perhaps a climax species on cold, moist, north exposures.

TABLE II

DESCRIPTION OF THE LOCAL TYPES (AFTER WESTVELD, 22)

Type No.	*Forest Type*	*Area Occupied* [1]	*Commercial Value* [1]	*Sites Occupied*	*Associated Species*		*Place in the Succession*
					Major [2]	*Minor* [2]	
1	Chestnut oak	Medium	Medium to low	Dry ridges, upper slopes, especially where soil is thin and rock outcrops are frequent.	Chestnut oak, often pure.	Scarlet oak, pitch pine, scrub oak, red maple, black birch, white oak, black oak, hickory sp.	Climax
2	Scarlet oak—black oak	Medium	Low	Warm, dry ridges and upper slopes.	Scarlet oak, black oak, hickory sp.	Chestnut oak, pitch pine, white oak, black birch.	Climax
3	White oak—red oak—black oak	Secondary	Medium to high	Well-drained, rather warm, fertile slopes.	White oak, red oak, black oak.	Hickory sp., black birch, black gum, white ash, yellow poplar, red maple, sugar maple, scarlet oak.	Near-climax; unstable; gives way to an association containing more red oak, sugar maple and an occasional hemlock.
4	White oak	Large	High	Well-drained loams; good sites, usually warm ones.	White oak, either pure or predominant.	Red oak, yellow poplar, white ash, hickory sp., red maple.	Same as No. 3; possibly a climax on certain good sites of limestone origin.

5	Red oak	Large	High	Well-drained, fertile sites.	Red oak, pure or predominant.	Scarlet oak, chestnut oak, yellow poplar, white ash, sugar maple, red maple, occasional hemlock on fresh sites.	Climax
6	Red oak, white ash, basswood	Medium	High	Fresh to moist, deep, fertile soils.	Red oak, white ash, basswood, hemlock.	Sugar maple, yellow poplar, yellow birch, black birch, white oak, American elm.	A near-climax, yielding to red oak, sugar maple, hemlock.
7	Hemlock—hardwood.	Small	Medium	Fresh to moist coves, deep soils.	Hemlock predominant, red oak, sugar maple.	Basswood, white ash, red maple, black birch, yellow birch, white oak, occasional beech.	Climax
8	Cherry	Small	Low	Fertile, well-drained.	Choke cherry predominant.	Red oak, red maple, white oak, white ash, hickory sp.	Temporary: may follow clear cutting or burning; yields to the red oak association. (No. 5).
9	Scrub oak	Small	Nil	Dry ridges, thin soils.	Scrub oak	Pitch pine, red cedar, scarlet oak, chestnut oak.	A climax on very dry ridges.

[1] The terms "area occupied" and "commercial value" apply only to the Hudson Highlands and similar areas.

[2] The term "major" denotes the species predominating in their order of numerical frequency in any given association. The "minor" species are not necessarily numerically plentiful. They are merely concomitant association members, usually present, but not always in any large numbers.

TABLE II (*Continued*)

DESCRIPTION OF THE LOCAL TYPES (AFTER WESTVELD, 22)

Type No.	*Forest Type*	*Area Occupied* [1]	*Commercial Value* [1]	*Sites Occupied*	*Associated Species*		*Place in the Succession*
					Major [2]	*Minor* [2]	
10	Red cedar	Small	Medium	Dry uplands; abandoned pastures. Prefers alkaline sites.	Red cedar, gray birch, red maple, white ash.	Aspen, American elm, sumach, pitch pine.	A temporary type, yielding in time to white ash, red oak and red maple.
11	Sugar maple—beech	Very small	Medium	Well-drained, fresh, fertile soils.	Sugar maple, beech, hemlock, red oak, basswood.	White oak, red maple, American elm, hickory sp., yellow birch.	Climax
12	Gray birch—red maple	Medium	Low	Various dry, sandy soils.	Gray birch, red maple.	Red cedar, red oak, white ash, sumach.	Temporary: a short-lived, old-field association.
13	Black birch	Small	Medium	Various fresh soils.	Black birch, white ash, yellow birch, sugar maple.	Dogwood, ironwood, hop hornbeam, red maple.	Temporary: invades clear cuttings, over-heavy thinnings or burns.
14	Ironwood	Small	Low	Fresh to moist soils.	Ironwood	Dogwood, hop hornbeam, gray birch, hemlock.	Temporary type: similar to No. 13 as regards invasion tendencies.

15	Aspen	Small	Low	Various dry sites.	Aspen	Red maple, sumach.	Temporary, short-lived pioneer. Yields to red oak (No. 5) on fertile soils.
16	White ash	Medium	High	Moist, fertile soils.	White ash	Red maple, cherry, aspen, red maple, red cedar.	Temporary: appears in clear cuttings or on abandoned fields of good fertility. Usually followed by No. 5 or No. 6.

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DISCUSSION

EACH of the 16 types listed above will now be taken up in some detail as regards occurrence, soil preference, commercial value, area occupied, utilization practice, suggestions for proper and profitable management and the probable reaction to various forms of cutting treatment.

It must be constantly remembered that the great majority of our local timberlands has been repeatedly cut and probably often burned. Seldom are the existing stands of the true climax composition. Hence the proper management of these woodlands is, for the most part, a cleaning-up problem—it is the job of removing the present poor stands as rapidly as is commercially possible and at the same time, of re-establishing, by careful improvement cuttings, dense natural regeneration of the near-climax or climax associations. At first this may seem to be a complicated and technical matter. It isn't. It can be accomplished with good success and very little expense if the operator be interested and observant.

As regards management generally, it should be remembered that the near-climax type is not infrequently more valuable than the climax for a given site, and should be maintained thereon. From the economic standpoint the near-climax types are often the most desirable, for it costs so little to produce them. Contrast, for example, the cost of $15-30 per acre to establish a red pine plantation (which can in no sense be called a climax) against the nearly zero outlay in reproducing a stand of native mixed hardwoods. Less disease and insect attack will occur in the near-climax mixture, frost damage and windthrow will be reduced, while the larger variety of

species and age-classes present will make for added protection against market changes. At the same time, a greater variety of products is made available, rendering market fluctuations less calamitous.

"In general, the forester has the maximum control over the forest composition when the near or sub-climax types exist and are maintained. Through varying the intensity and frequency of the cutting operations he is able to hasten the trend toward, or to maintain, a given composition. In central New England, thru a knowledge of successional trends and modifications to be expected due to local conditions it is possible to control, within certain limits, the proportion of the various species in the final stand" (16). This statement is equally applicable to the woodlands of the Highlands.

In brief, to accomplish the objective of creating and maintaining either a climax or near-climax association, it is essential to know with considerable accuracy what the composition of the desired stage of cover type should be. In the ensuing discussion the writer seeks to make clear where each of these 16 types occurs in the succession.

Type No. 1; Chestnut Oak

The chestnut oak association, usually associated with upper slopes and ridges may be classed as a well-defined ridge climax. It is an association characteristic of drier sites, where the soils are more friable, porous and shallow, and where the hard, granite ledges and outcrops lie very close to the surface. The majority of the commonly associated species—pitch pine, scarlet oak, black oak, scrub oak and the like are distinctly dry-site trees.

Seldom do such stands offer any considerable commercial value. More often than not the trees are ill-shaped and short-bodied with gnarled and twisted crowns, all of which combine to make for expensive chopping with a low yield per acre. Furthermore, these ridge stands

are often the least accessible and consequently the most costly to start out. Probably, in most cases, the best use for this type is a protection forest to conserve rainfall, to reduce or prevent soil erosion and to help to maintain a more constant supply of moisture for the areas lying below.

As to a proper cutting system, where such work can be done without financial loss, it is believed that such stands can be maintained in good condition, first by keeping out all fires and, when the main overwood is maturing (i.e., when its growth rate is nearing the point where it is no longer profitable to hold this portion of the stand as an investment) by making one or two quite light thinnings, spaced perhaps 3-5 years apart, each to be made during a good seed year. A good growth rate for chestnut oak on such a site would be about $\frac{1}{8}''$ per annual ring. Bear in mind that you are dealing with a tree which is rather intolerant after the first five years, but which can endure considerable shade during this first period. Take advantage of this by thinning lightly and often. Such treatment will admit sufficient light to stimulate germination of the seed thrown by the parent trees, yet should not let in enough light to cause the stump sprouts (which of course follow any cutting operation) to become so rampant as to shade out or stunt the subsequent seedling reproduction. It is a delicate point to define. Generally speaking, the removal of 3, perhaps 4, or, in rare cases, 5 cords per acre in each thinning is all that can be safely taken from such stands. Cutting a larger volume per acre is very apt to fill your cutting with great heads of low-value sprouts which may effectively hold down and even kill out any good natural seedling reproduction that you may have obtained.

The second thinning can follow in perhaps 3-5 years. Be certain that you pick a good seed year for this job as well. The final cutting—when the remaining overwood is taken—should occur when the new young stand is at

least shoulder height or even more. These operations will naturally do some damage to the young growth. This is only to be expected. The best answer to this, and the best form of insurance against excessive damage is to coax in so much new seedling growth that the felling damage can be but a small part of the total.

All of the foregoing suggestions are intended to apply only when market prices and cutting and hauling costs are such that profit can be had. This will rarely occur in the case of these high, hard-to-reach and hard-to-haul chestnut oak stands. While such stands can be occasionally thinned at a profit, the most sensible and practical function for many such areas is to serve mainly as cover for game and to keep the ridges from drying out too fast.

Type No. 2; Scarlet Oak—Black Oak

Another rather inferior mixture, fortunately of not too wide occurrence. Scarlet oak is a poor tree, yielding only somewhat mediocre fuel, while black oak is a strong, hard, wood, useful in various ways and making high-grade cordwood. Both of these species are rather slow-growing even on good soil sites, and if it appears possible to reduce their percentage in the stand by judicious thinning operations and by coaxing in seedling reproduction of white oak, red oak, or hickory of various species, the successful accomplishment of this will perceptibly increase the stumpage value.

If seed trees of the desired species are scarce or of poor quality, it is no great task to spot in a few pounds of good seed. (See Appendix.)

This association is characteristic of warm, dry, upper slopes. Both the major and minor associated species are fairly prolific seeders. This combination of site and associated species makes it essential to avoid over-heavy thinnings. Such treatment is dangerously likely to bring in dense mats of huckleberry and blueberry which can

effectively slow down the reproduction of the desirable species listed above.

Type No. 3; White Oak—Red Oak—Black Oak

A valuable mixture, but one which occupies no very large acreage. As with Type No. 2, this stand is most frequently found on warm, well-drained slopes, but, in contrast, the associated soils are usually of somewhat higher fertility.

The cutting treatment should be aimed at reducing the percentage of black oak and increasing that of white oak. Again, successive thinnings, these to be as light as is commercially practicable, seem to be the correct procedure. Too heavy cutting, with the consequent over-exposure and parching of the soils will react in favor of introducing more of the weed species than of the valuable kinds. Few, if any, of the associated species will respond favorably to treatment. These trees will grow on such sites, but their form will be generally poor and their growth rate slow. Seek to eliminate them from the stand. Favor the red and white oaks by leaving them as seed trees.

Type No. 4; White Oak

A highly valuable stand which will repay careful study and cultivation. White oak is rather wide in its occurrence, its best growth being usually found on warm, fertile, well-drained sites, especially those of limestone derivation. White oak is rated as one of the slowest-growing of the local commercial species, while practically all of the species associated with it in this type will make wood at a considerably higher rate. Hence, in managing this type, a definite allowance must be made for the time differential between the maturing of the two sets of species. Reproduction can be successfully brought in under the parent stand by a series of light thinnings made in good seed years; but, as the parent stand is re-

moved, the seedlings of the faster-growing associated species will forge ahead of those of white oak. This should cause no alarm, as the latter will progress quite well under shade. The answer is to plan to carry the new stand along as a two-storied forest with the faster-growing species forming the main canopy or "overwood", and the slower-growing white oak coming along beneath as the "underwood". Obviously the overwood must be harvested some time in advance of the white oak. This is no great obstacle; it can usually be accomplished by a series of cordwood thinnings each taking an increasing number of sawlogs and a decreasing amount of fuelwood as the main stand increases in diameter. It will pay to examine the area closely now and then as here and there you will undoubtedly find dense settings of fine young white oak which will be greatly benefited by the careful and sometimes prompt and complete removal of the overwood earlier than would be wise on other sections where the reproduction is not so well set. Eliminating the shade cast over such young white oak stands will accelerate their height growth. Affording full or nearly full sunlight to such areas should be done just as soon as is financially possible, provided always that the ground be so well set with young trees that the sudden admission of this added light will not too greatly stimulate the invasion of weed trees or shrubs. In other words, avoid setting the sere back too far. What you are seeking is a stand chiefly of white oak; if you act too hastily, you may easily upset the local conditions so severely that you will be confronted with an invasion of undesirable pioneer species whose artificial removal will be far too expensive.

As to the associated species, it is recommended that favorable attention be paid only to red oak, white ash, yellow poplar and perhaps hickory.

Type No. 5; Red Oak

Probably the most common association and the one oc-

cupying the largest area. The commercial value is high, and the response to sound cutting practice can be pleasingly prompt and sure. Good crops of seed are thrown every 3-5 years, and heavy crops may be expected about once in 4-7 years. Of the associated species, white ash, yellow poplar and sugar maple are the most valuable. Hemlock, while of lower commercial value, is an excellent tree to have scattered through the area where the soil moisture is adequate, as this tree will prune the hardwoods, producing long, clean, knot-free stems of high value.

Red oak is markedly tolerant; rather more so than any of the associated species save hemlock and sugar maple. Excellent natural reproduction can be quite easily obtained by thinning lightly and often. Too heavy a thinning, as with Type No. 4 and others, will almost invariably set the sere back to one of the earlier secondary (or even pioneer) stages where red maple, dogwood, ironwood, gray birch and other aggressive, fast-growing weeds may invade the area.

Thanks to its comparatively high tolerance, it is not difficult to increase the percentage of red oak in a stand located on a good site. In addition, the growth rate is fast; this species will not be found far behind white ash or yellow poplar if your improvement cutting work has been done cautiously and shrewdly. Where, however, a thinning admits excessive light, the white ash and yellow poplar will make extremely rapid height growth which can result in smothering or retarding the red oak reproduction. But if such thinnings be made in gingerly fashion, the shade cast by the remaining overwood should be sufficient to slow down, without shade-killing, the less tolerant associated species, while the tolerant red oak will keep abreast of the procession. This high shade cast by the overwood is the chief factor. You cannot control or regulate the soil moisture or the temperature; but it is possible, by skillful selection of the trees to be cut, to re-

move the diseased, dying or dead stems and to leave, as sources of seed, those of the desired species which have the finest form and the best crowns. Seldom is it possible to remove every undesirable stem in one cutting. Such practice is usually far too severe. It will make much too large breaks in the main crown canopy through which an excessive amount of sunlight may enter, causing the disagreeable results already noted. The correct practice is best set forth by the general recommendation that you make successive, fairly frequent, light thinnings, choosing good seed years for each operation, until the area is well set with young red oak and the other species desired. Incidentally, the term "well set" means not less than one good seedling to every square yard. By the time this condition is reached, it is usually possible to consider the removal of the balance of the old stand. Such procedure should give you a good crop of fine hardwood seedlings, chiefly red oak with a fairly good representation of the associated species in the mixture. Do not attempt to produce a stand which is 100% red oak—*or any other single species for that matter.* A mixed stand is healthier, sturdier and far more immune to insect and fungus attack and damage. Furthermore, the soils supporting a mixed stand will remain in a healthier condition than those carrying a stand which is all, or very nearly all, of one species. And the more dense the young seedling stand, the better will be both the yield and the profit from the area. You will harvest less cordwood and more sawlogs, and the quality of both products will be in direct proportion to the density of the young stand. (See Appendix).

Type No. 6; Red Oak—White Ash—Basswood

An association of only moderate extent, of high value, usually occurring not far from streams where the soils are deep, fertile and well watered. Of the associated

species, only sugar maple, yellow poplar, white ash and hemlock should be favored.

As a rule, this association may be managed as a two-storied affair with red oak, white ash, basswood and yellow poplar forming the overwood and the more tolerant hemlock and sugar maple making a well-defined understory. These two last species are much slower-growing than the major species, and you cannot expect them to keep up.

As for the actual cutting procedure, it is again a matter of successive light thinnings, all to be made in years when the species desired are throwing good crops of seed. With the exception of white ash and yellow poplar, you will be dealing with tolerant trees, and it is recommended that these two less tolerant species do not receive too much attention. Model the cutting to favor the red oak, basswood and hemlock—in other words, do not open the stand too drastically. If this should happen, you may very likely find too much white ash, together with a deal of unwanted red maple, ironwood, hop hornbeam, black and yellow birch and possibly some elm taking possession of those portions of the area where the cutting has been too severe.

Careful judgment in marking for the cutting should make it possible to establish adequate reproduction of the good species after two light thinnings. But this does not mean that the remaining parent stand can then be immediately cut. Even after the new seedling crop is well set, it would be well to hold off the final cutting until the new crop is about shoulder high. This suggestion is made since this type does best on rather well-watered soils, and the removal of the last of the old stand too soon—i.e., while the new crop is still too small and too short to cast sufficient shade—may dry the ground out to an extent that your young trees may be seriously retarded in their growth. You may even lose a good number of them through this decrease in the supply of soil moisture.

Type No. 7; Hemlock and Hardwood

A well-known mixture of fair value, and usually occupying no very large acreage. Limited almost wholly to stream banks and benches, low flats and other sites where soils are deep and moist.

Such areas should best be handled, we believe, to hold them about as they are now, except that it would be good business to re-arrange the hardwood composition somewhat so as to include more of the major associated species (red oak and sugar maple) and less of the minor associated species. To accomplish this, these minor species must be removed as rapidly as possible to prevent their seeding down more of their kind. On the other hand, while it is wise to retain as many stems of the desirable species as possible, the hemlocks present may cast such dense shade that these latter species can neither germinate or grow. Hence it is frequently necessary to cut enough of the hemlocks to admit enough extra light to insure such germination and growth.

A stand which runs around 75% good hardwoods, with the balance scattered hemlock can produce fine quality sawtimber. The dense, deep evergreen crowns will exclude nearly 100% sunlight from the hardwood stems, thus effectively preventing side sprouts and producing boles almost entirely free of knots and hence of high value.

As before, the cutting procedure should be "light and often." Take out enough product each time to net a profit; but do not seek to transform the existing stand into a perfect mixture in one operation. Such effort will undoubtedly run you into the old trouble consequent on opening the stand too much; you will be harassed by an invasion of weed species of little or no value, probably chiefly ironwood, black birch and red maple, and there is no commercially practicable method known of getting rid

of such invaders. So go light on the thinnings; be content with a few cords less. It will pay you in the end.

Type No. 8; Cherry

A pioneer mixture, appearing on abandoned fields, on burns, and following clear cuttings. Often occurs in pure stands, but more generally in mixture with red oak, red maple, white ash, white oak and hickory. It is a vigorous-growing tree, and an aggressive sprouter. It is not financially practicable to try to remove the young cherry stands by cutting them out. The sprouting capacity is far too great. You will note that such stands are usually short-lived (as is the case with nearly all pioneer species) and that the good species indigenous to the site, chiefly red and white oak, will be quick to start seeding in under the pioneer crop. In time the cherries will die out and the climax association will take over. This can be a lengthy process if left to make its way untended. But it is sometimes possible to hasten the "taking over" by the more valuable species by carefully watching developments and quickly dropping or girdling any pioneer trees showing the first signs of old age or general poor health. As your crop of young hardwoods increases in height and casts wider and denser shade you will find it possible to bear down on the cherry stems a little harder, since this increasing shade will help to stunt and to deform the unavoidable cherry sprouts.

Such cuttings of small cherry stems cannot be expected to yield any immediate financial return. The product is too small. The actual return will come later in the shape of a much quicker saleable maturity on the part of the good species which have been released by hastening the removal of the cherry canopy. This cherry association should be regarded solely as a temporary filler, and one whose removal should be accomplished as rapidly as possible consistent with workman-like bringing through of the good species seeding in beneath.

Type No. 9; Scrub Oak

Of no commercial value. Thus far we know of no practical method of converting this hardy tree mixture to a more valuable association. Leave it to grow.

Type No. 10; Red Cedar

A rather long-lived, temporary association, occurring on abandoned fields and dry uplands. Usually in mixture with red maple, gray birch, aspen, white ash, sometimes sumach and elm. Given time, it will yield to a mixture of white ash, red maple, white and red oak. This natural process may be quite lengthy, yet, as with Type No. 8, it may often be possible to hurry up the disappearance of the pioneer stand. The area should be watched with some care; it will not be long before the better, near-climax and climax species will appear under the cedars. As this invasion develops, the pioneer cover should be gone over now and then to select, and to remove therefrom, such stems as are dead, dying, diseased, or otherwise unhealthy, or which are overtopping or otherwise menacing patches of good reproduction. The gradual but steady artificial removal of the sickly weeds will hasten the day when your understory of good species will be released, in the clear, and free to grow at their maximum rate. As for the cedar itself, it would seem wise to hold the largest, fastest-growing, and best-formed stems for a crop of posts at some future date. Cedar crowns are rather narrow and do not cast a great spread of shade, while good cedar posts often bring a good price.

Type No. 11; Sugar Maple—Beech

A climax mixture, rather rare in the Hudson Highlands, save on occasional well-watered, fertile, cold northern exposures. Owing to utilization practices prevailing in this region, the commercial value is no higher than medium. For the best cash returns, it would seem wisest to manage such stands in such fashion as gradually to re-

move the maple and beech and to favor the establishment of red and white oak and perhaps some white ash and hemlock. This is an excellent example of the near-climax type being more valuable than the climax.

It is not too difficult to convert the mixture to the near-climax, though this cannot be safely done in one operation. Successive thinnings are the answer, these to be made in years when the seed crop of the desired species is heavy, and that of the unwanted climax species is light. The cutting should be planned to favor the red and white oak and white ash, and to establish around each well-formed seed tree of these species a carefully-thinned area to receive the expected seed. There is not much point in opening up the stand where you have no seed trees of the desired species.

Type No. 12; Gray Birch—Red Maple

A familiar sight. A short-lived, temporary type which appears promptly following a hard cutting; often found invading abandoned fields. Of low commercial value, mediocre fuelwood being the only product.

This distinctly pioneer association, if left to its own devices, will occupy the site for 20 to 40 years, gradually giving way to a much more valuable mixture of red and white oak and white ash. Here again, this natural trend in the composition can be greatly accelerated by periodic study and occasional cleanings. By the time the gray birch has reached a height of 10 feet or over, you will find more of the desired species forming a low understory each year, and more of the pioneer stems showing signs of infection, decay, ice and snow damage and general weariness. Such trees should be promptly felled, and, as their cordwood value is normally nil, it is wise, under such market conditions, to cut them into several pieces to bring them into close contact with the ground. This will hasten the natural decaying processes which in turn will restore to the soil the various useful chemical compounds

secreted in these cut stems. The felling will give the understory of valuable species a better chance to grow.

As a practical suggestion, this accelerative process can be helped considerably by gathering a few pounds of red or white oak or white ash seed to be spotted in under the pioneer stand. Be sure these are gathered from high-grade trees of good height and fine form. The sooner you can get the near-climax or the climax mixture started under the thin, but protective shade of the birches and maples, the sooner can you start the improvement cuttings. Naturally you will not begin such work before the understory of good species has begun to appear. It is not at all necessary to delay until the entire area is stocked up with these; if the good reproduction is patchy, your improvement work may be limited to such patches, with your artificial sowing of seed serving to bring the unplanted portions into shape for treatment.

It is a fascinating undertaking which usually shows results in a short time. Be careful to avoid over-cutting; it is far better to err on the side of under-cutting. You can always come back and take out a little more if you decide that your first operation was too light.

Type No. 13; Black Birch

Also a short-lived pioneer mixture, often appearing in very dense thickets on clear cuttings, over-heavy thinnings, and occasionally on burns. This tree, with its associated species, will thrive on various soil sites, seeming to seize in great numbers on somewhat fresh forest soils which have been suddenly exposed to excessive sunlight.

Its natural trend is to yield in time to a mixture of red and white oak, white ash, red and sugar maple. This trend can be accelerated somewhat, as with the gray birch-red maple association, except that black birch has some commercial value as fuel. Moreover, black birch enjoys a rather rapid growth rate for its first 20 years, after which it slows down perceptibly. The better species

for such sites—red and white oak, white ash, perhaps yellow poplar and sugar maple—will usually be found gradually establishing themselves beneath the birch.

Weighing these several factors together, it seems clear that no profitable thinnings can be made until the pioneer stand has reached 20 years of age, or thereabouts. Any cultural work, such as the releasing of promising climax seedlings, can only be regarded as a further investment in the stand. You will note, when the birch thickets are perhaps shoulder high or over, that the good oak and sugar maple seedlings are beginning to appear under the dense birch shade, while the white ash and yellow poplar will be found only in the more open areas where the shade is perceptibly less. By the time the birch has reached the slowing-down point it would seem reasonable to plan on a series of rather heavy cordwood thinnings. These should of course greatly reduce the number of birch stems and the shade cast thereby, thus releasing the valuable understory. You should be able to produce a fine stand of straight young hardwoods of great promise.

Type No. 14; Ironwood

Of no commercial value. A wholly temporary type, quick to invade the moist portions of clear cuttings or of too heavy thinnings. In the natural course of events, this association will give way to a mixture of red and white oak, white ash and red and sugar maple. It is an aggressive sprouter, and if it once gets a foothold, it is usually financially impossible to dislodge it. Under such circumstances, you will simply have to stand by and let Nature take its course. Under normal market conditions you cannot afford to keep the sprouts cut back to permit something better to come in. About the only step to be recommended is to underplant with good seed of red and white oak, basswood, sugar maple and perhaps hemlock, although basswood and hemlock are difficult customers to get to germinate.

Type No. 15; Aspen

A short-lived pioneer, of no particular value in this section. Very quick to succeed a clear cutting or a fire. Where the soils are good, it will yield to the red oak type (No. 5). This yielding proces can be hastened by seed-spotting beneath the aspen canopy, and by the removal of the aspen stems as rapidly as they become sickly. In this area, aspen rarely reaches a diameter of 7″-8″ without being attacked by a fungus which is almost invariably fatal. But the work of the fungus is somewhat slower than if you attend to the removal yourself. If the product of such cleanings is not saleable, be sure to cut up the stems as recommended in the case of gray birch. (Type No. 12.)

Type No. 16; White Ash

An aggressive pioneer species, very quick to form dense and promising thickets on clear-cut areas of good fertility and moisture supply and on abandoned fields of similar description. Not infrequently does it form stands nearly 100% pure ash. Some red maple, red cedar, cherry and aspen are often intermingled. The total area occupied is not overly large, but the financial returns look to be high.

This association is a definite near-climax; the growth is rapid, the trees prune themselves naturally and well, the leaves are one of the favorite foods of earthworms (very desirable tenants to have in your forest soils), the response to a little thoughtful attention is prompt, and the market value of good grades of white ash logs is usually at a good level in New York State.

This type is an outstanding example of the near-climax being easier to establish and to maintain, and possessing decidedly higher cash values than the climax. Given an opening in the forest or perhaps an abandoned meadow, and this association will take over and occupy the area with curious and striking inexorability. It is impossible

to keep it out of such areas except at prohibitive expense.

Left untended, such natural temporary associations will in time change over to either Type No. 5 or No. 6. This natural process is a lengthy affair and the market value of the climax crop is not, as a rule, as attractive as that of the ash mixture. It would seem to be only good business sense to keep the area in ash.

Thus far we have not had sufficient time to carry our experimental ash areas through to commercial maturity, but we are willing to hazard some management suggestions for such thickets.

First, always bear in mind that you are dealing with an intolerant species whose sales value is directly proportional to the amount of clear length. This is peculiarly true of white ash, which is used in large quantities for handles and for certain types of athletic equipment, all of which call for long, clear pieces of no great cross-sectional size. Clear logs, even in the smallish diameter sizes are generally a worth-while crop. So it is well to maintain a dense stand. Such a condition will prune the ash stems early in life, giving you much fewer knots in the logs. Artificial pruning is possible, but it is a rather slow operation and may run you into a good many man-hours. Natural pruning is far cheaper and nearly as effective.

Do not start the cultural work too soon unless you find that occasional weed trees (red maple especially) are forging ahead of the good ash and are threatening to stunt or deform the latter by overtopping. Such aggressive weeds should be cut back close to the ground without delay, that the shade from the remaining ash crowns may act to hold back any subsequent stump sprouts.

By the time the ash stand is around 10 feet high, and not before, it should be ready for the first treatment. The competition for light will manifest itself in the different heights attained by the sturdy, or the weaker trees. Those which have lost out in the race for survival, or those

which are obviously about to do so through becoming overtopped by their more vigorous neighbors can now be cut, for they will never regain their position in the dominant crown class. Do not cut these close to the ground. Leave the stumps about 4 feet high. This is recommended since trees so cut will promptly develop small, low, bushy crowns which will generally live on for a few seasons. Such overtopped crowns will not harm your "crop" trees; rather will they be of distinct help, for they will drop leaves to some extent, they will keep the soils moist, and their shade will aid further in pruning the choice stems. And, by the time these high cut stems die out, the holes made in the main crown canopy by their removal will, in most cases, be fairly well filled in by the increased lateral growth of the crowns of the good trees you have left standing. Such a selective cutting in young stuff cannot yield anything saleable. The stems are far too small. But the beneficial effect on the value of the stand will be very marked.

Several seasons later,—perhaps five or so,—this process should be repeated. But this time the job should yield you some small firewood. Seek to leave the finest, straightest and most vigorous trees. This time you can probably cut more drastically. The main stand by now should have developed thick, strong crowns, and you can risk cutting all trees in the overtopped class and a good many in the intermediate category. You should take these right down close to the ground as their shade will, in most cases, be no longer needed for pruning purposes, and moreover, you don't want to waste good firewood. The completion of this second step should leave you with a very promising stand of clean, thrifty, well-formed ash.

We are not yet prepared to give tested advice beyond this point, for we have had no practical experience on which to draw. But our guess is that such a stand can be brought to highly profitable maturity by not more than two such selective thinnings in the lower crown classes,

followed eventually by a clear cutting, both these jobs to be done in a heavy seed year. Such procedure will, we believe, keep the area in the ash type.

A final word of caution. Never thin white ash very heavily. This will only bring you trouble in the form of excessive stump sprout growth as well as side sprouts on your good trees. And side sprouts mean knots later on. So try to keep the trunks of your crop trees shaded. Also, never cut back undesirable trees standing on the edge of the ash area, unless you cut them fairly close to the ground. Usually such trees get a good supply of light, and if cut to a high stump, they are likely to sprout so vigorously that they will soon be again bothering the crop trees. Stems which are inside the stand, even only perhaps 6-8 feet from the outside edge, can be safely cut high up. The interior of the stand is usually dark enough to keep them from making too rampant height growth. It is a good general rule to go light on cuttings around the outer edge of an ash stand. There is always danger of admitting too much light to the inside.

TENDING THE NEW CROP

In a number of the types just discussed, shrewd cutting can produce an excellent setting of the near-climax or climax species. But it is not safe to consider this condition as the final goal for the job is not yet finished. It is seldom possible to obtain such a setting with exactly the desired composition. Usually there will be present amongst the good trees too many trees of weed species and weed characteristics, such as red maple. In addition, the sprout problem will appear to some extent. The latter will manifest itself in the form of extremely fast-growing weed sprouts which, if left untended, will quickly overtop and injure your good young trees. Such intruders, be they seedlings or sprouts, should be removed.

Such work pays no immediate cash dividends. Any time spent at this must be regarded as money "ploughed into the final crop." The work itself offers no great problem to the woodland owner who knows the different trees and is genuinely interested in making the most out of his forest land. In a few words, these offending stems must be kept down where their crowns will not interfere with the prompt development of the good trees. Cutting the weeds back is the most practical plan. A light axe will do; but an 18″ machete is by far the most efficient tool.

Such cultural work demands occasional, careful, rod-by-rod examination of the area. Each patch of good reproduction should be thoroughly scrutinized, as it is easy to overlook the slim, whip-like weed trees which, if left to grow, may in a very short time develop heavy, sprangled crowns which can work great damage either by merely shading, or by actual rubbing and even breaking the leading shoots of the better stems.

A word of caution. Do not start such work too soon. Delay this, if possible, until the seedlings are of such height that the unwanted stems, when cut back, will be well below the level of the good crowns and will hence be so handicappd by either partial or complete shading that they will never again be able to catch up with and overtop or otherwise interfere with your good seedings (22). It is not always possible to wait until precisely this situation has materialized. The sprouts and seedlings of weed species can often make such rampant height growth that the damage to the good stand becomes imminent or is actually occurring before such "handicapping" is 100% possible. So it is sometimes necessary to make two treatments. In this region the first releasing can generally be made to good effect about 4-5 seasons following the final cutting. Just when the second treatment should be applied cannot be defined by any hard and fast rule. It is best determined by occasional careful examination of the area. Generally speaking, it is wise to refrain entirely from any releasing for as long a time as is compatible with the health and form of the crop species. Make your release cuttings only when the latter are in danger of damage to their leading shoots.

Such occasional light release cuttings will work wonders for both the composition and the quality and hence the maturity value of a mixed hardwood stand. And it is only by bringing in good, dense stands of good species that we can expect to convert our present ill-formed, diseased patches of much-abused woodland to their full and rightful productive condition.

Conclusions

1. Hardwood timber of good quality is nearly always saleable.
2. Planting little trees on soils to which they are not suited is bad practice and an expensive investment.

It is far better to try to improve the young, native stands.

3. The most practical and the least expensive form of practical, applied forestry is the one which seeks to work in harmony with Nature's plans and wishes.
4. To do this efficiently we must identify the various forest types in a region and learn just where each type fits in the vegetative succession.
5. No clearly established examples of virgin timber are known hereabouts; hence we are offering herein our best estimate of the composition of the original climax types.
6. The tree species now found hereabouts were undoubtedly growing here in colonial days, but it is believed that their distribution at that time was quite different.
7. White pine was rarely, if ever, found here in pure stands. It occurred chiefly as single trees of high quality in mixture with the native hardwoods, usually on well-drained sites.
8. Much of this Forest and similar territory is today carrying a temporary type of some sort.
9. Sugar maple seems due to become numerically much more plentiful here, although it is not expected to assume a dominant position in the crown levels save in occasional cold, fertile, north-facing ravines.
10. It is believed that formerly hemlock was much more plentiful, and white pine perceptibly more frequent.
11. Cuttings, fires, or other extraneous influences invariably upset the forest and its allied and interacting biological factors in almost direct proportion to the severity of the disturbance.
12. The native chestnut appears to be making a strong bid to re-establish itself locally.
13. A forest is a highly complicated biological unit with a great many interacting factors affecting it.
14. The oaks throw seed practically every year; heavy crops come only every 4-5 years.

15. Not infrequently, owing to economic conditions, the near-climax types are of higher value than the climax. Such types, or stages, are usually easier to establish and to maintain than are the true climaxes for the area in question.
16. Any improvement cutting made in this section should be done cautiously to avoid (1) over-exposure and parching of the forest floor and (2) the stimulation of strongly competitive weed or sprout growth.
17. When the wood and timber market is strong is the best time to improve the woodlot, for at such times low-grade products can be profitably disposed of. But avoid over-cutting.
18. For making release cuttings in young, limber stands, an 18-inch machete is the most efficient tool.
19. If possible, all cleanings or other cuttings (excepting perhaps final cuttings), should be made in a good seed year.
20. Above all, make sure of an outlet for your products.

APPENDIX

Hints on Sowing Forest Tree Seed (18)

EXCEPTING red maple, all of the commercial species discussed herein throw seed in the autumn. For forest sowing, the best results will be had if the seed be gathered in the fall, properly stored over the winter and sown the following spring. Be sure that you collect your seed from healthy trees, especially those of good height and of fine form. As a rule, crooked trees are apt to produce crooked offspring.

For storage over the winter, it is recommended that any box or barrel which is rodent-proof be used. Fill these with alternate layers of sand and seed; cover the top with small mesh chicken wire; wet the contents well and leave the whole affair out of doors until planting time. Do not place it under shelter; the winter snow and rain, with alternate freezing and thawing are what is needed to soften the hard outer shell borne by many kinds of seed, thus helping germination.

Another method is to place the seed in wire baskets or coarse sacks. Anchor these securely in the bed of a moderately rapid stream. The seed should be completely submerged. Avoid stagnant waters or very cold springs for this form of storage.

As to the planting, this can be done during the last week in March or the first week in April. Remove the seed from storage, making sure that this is done before sprouting starts, and spot them about in the area selected. It is best to scrape the leaf-litter away a bit to make sure that the seed are in direct contact with the mineral soil; it is also well partly to cover the seed with this litter (5). Press the seed lightly into the ground, being careful not

to crush them. Do not attempt to follow regular rows in such planting; if you establish seedspots having at least 2 seeds each every 3-4 feet, you should obtain adequate density of stocking.

Pure Stands vs. Mixed Stands

In most cases mixed stands are to be preferred. Pure stands seldom maintain or increase the soil fertility. This is especially true of the thin-foliaged species. Moreover, in a pure stand the danger of damage by fire, wind, insects, fungi and other external agencies is far greater. Such stands are less likely to occupy the site completely, making for less volume when the product is harvested. The advantages of pure stands are largely economic—and at the future expense of the productivity of the area (2).

Mixed stands, in contrast, possess certain distinct biological advantages which are widely accepted as offsetting, in the long run, any temporary economic benefits which a pure stand may offer. While a mixed forest undoubtedly calls for more detailed and skilful management, the complex biological processes so essential to continuous good growth and ample yield are well maintained with proportionately better conditions in the litter and the upper soil layers where most of the feeding roots of the trees will be found. For example, it has been clearly proven that under a mixed hardwood and white pine stand the soils are in far better condition than under pure white pine (7). Furthermore, as has already been stated, a mixed forest provides a much more diversified product.

GLOSSARY (10)

Advance growth: young trees growing spontaneously in openings in the forest or under the forest cover, in advance of any fellings or cuttings.

Annual ring: the circular layer of wood laid on annually by all Northeastern tree species.

Cleaning: Cuttings, usually in sapling stands, made to remove trees of undesirable form or species.

Climax: for a given site, the ultimate, stable stage of the succession of temporary types.

Crown class: all the trees in a stand occupying a similar position in the crown cover. Usually designated as *dominant, co-dominant, intermediate* and *overtopped.*

Ecology: In forestry, the study of the life-history and environment of trees and plants.

Exposure: the direction toward which a slope faces.

Final cutting: the operation whereby the last of the remaining old stand is cut.

Forest cover type: the mixture of trees now occupying the ground.

Improvement cutting: cuttings, usually in stands past the sapling stage, designed to remove trees of undesirable form, condition, or species.

Intolerant: Incapable of enduring much shade.

Management: the practice or application of forestry in the conduct of a forest business.

Near-climax: for a given site, that association of tree species immediately preceding the climax association.

Overwood: in a two-storied forest, the upper crown level.

pH indicates the degree of soil acidity or alkalinity. Usually expressed by some number, thus pH 6.3. The number 7.0 denotes a neutral soil; numbers below 7.0 denote an acid or "sour" condition; numbers above 7.0, an alkaline, or "sweet" soil.

Pioneer species: those tree species which are the first to appear on clear cuttings, abandoned fields, burns, and other areas formerly forested but now laid bare by some outside agency.

Release cutting: a cutting, usually made in young sapling stands, designed to free the valuable young growth from injury by larger trees.

Reproduction: the process by which a forest is renewed.

Reproduction cutting: a cutting made to invite or to assist reproduction.

Secondary species: those tree species which usually follow the pioneer species on clear cuttings, abandoned fields, burns, and the like.

Seedling: a tree grown from seed.

Silviculture: the art of producing, tending, and maintaining a forest.

Site: the combination of climatic and soil conditions of an area considered with reference to its timber-producing power.

Sprout: a tree grown from a stump or a root.

Stage: a definite point in the type succession.

Succession: the several stages through which an area of forest land will pass while attaining its climax cover type.

Thinning: a cutting, made usually after the sapling stage is passed, to increase the growth rate of the remaining trees.

Tolerant: capable of enduring more or less heavy shade.

Two-storied forest: a stand of trees containing two well-defined height classes, usually of different ages.

Underwood: in a two-storied forest, the lower crown level.

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