FOREST CROP SECURITY: THE RIGHT TREE ON THE RIGHT SITE¹

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STAND VIGOR, THE KEY TO HEALTHY FORESTS

The widespread damage forest pests have inflicted on our northern forests in recent years has undoubtedly deterred private forestry practice in this region. With insects and disease looming up as a threat to their investment, timberland owners hesitate to spend their earnings for better forestry.

Yet, in the light of present knowledge, investment in good forestry practices may be the cheapest and most effective way to successfully abate or eliminate many of these recurrent threats. Studies have shown that stand resistance to numerous forest pests can be developed through silvicultural measures aimed at maintaining healthy, vigorous stands and favoring the mixtures that are less vulnerable to attack. By use of proper silviculture, not only can the composition and thrift of the forest be improved, but the forest soil upon which the timber is so dependent can be maintained at its greatest fertility. Healthful fast-growing forests are an excellent defense against many damaging pests.

Silviculturists believe that the attainment of productive, resistant forests can be greatly facilitated by striving for stand compositions that are natural to the sites in question. These stable tree associations characteristic of climax types culminate through the interplay of natural forces. Silviculturists reason that such forests are best adjusted to meet the impact of antagonistic factors. They are inherently healthy and are easily maintained in a state of high vigor by good management; thus they have a greater capacity to resist damage from those insects and diseases that depend upon reduced host vigor for the opportunity to build up to epidemic proportions. Many forest pests, including the majority of those insects and diseases native to this country, fall into this category.

This does not mean that forest management is a panacea for all the ills that afflict a forest. Certain virulent pests are not amenable to control through any form of management. For example, chestnut blight, caused by a fungus parasite imported from the Orient, is considered to be one of the greatest forest catastrophes affecting North American forests. It is almost certain that this disease could not have been controlled or materially delayed by any form of forest management.

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FACTORS UNDERMINING THE FORESTS' HEALTH

Violation of natural laws in planting

There is an increasing assurance among forest entomologists, pathologists, and silviculturists that, in planting, one must consider future pest damage and control as well as normal survival and crop possibilities.

The principle of fitting the tree to the soil is often disregarded. The most flagrant examples are found in plantations. Artificial compositions duplicated nowhere by nature are not uncommon; species are planted on sites where they never occur naturally. The folly of such attempts is usually reflected in poor development of plantations. Such plantings, particularly extensive, pure ones, are especially subject to damage from disease and insects. We need only point to parts of Germany where repeated crops of pure spruce on natural hardwood sites have harmed both the soil and the forest.

In the northeastern United States one can find classic examples of what happens when natural laws are violated this way. One is the damage done to pure white pine and Norway spruce stands by the white-pine weevil. Another is the damage to red pine by the European pine shoot moth and the *Tympanis* canker when this species is planted south of its natural range. Within its natural range, the damage done by these two pests is not of economic importance, either in planted or natural stands. Other examples are the severe damage to white pine and red pine by resinosis and *Polyporus schweinitzii* in southern New York when these species are planted on soils with a high pH and high colloidal and calcium content and that to Norway spruce by *Cytospora* canker when this species is planted on shallow soils.

In the climax association where these species normally occur in mixture with hardwoods and other softwoods, damage from forest pests is much less. Indeed, there are many thousands of acres of natural young mixed stands of white pine and hardwoods in the pine country in Massachusetts and southern New Hampshire and Maine where the white-pine weevil is of little importance. Only a small amount of judicious weeding is necessary to bring the pine in such a mixed stand through to a valuable crop. Yet pure plantations nearby are seriously damaged.

Radical disturbance of the original forest cover

In studying the biology of forest insects, entomologists have found that in mixed forests there are environmental conditions ideal for maintaining natural control agents such as parasites, predators and birds that attack a variety of forest insects. Consequently these agents are already present in considerable numbers whenever any one noxious insect species suddenly increases to epidemic proportions. These natural factors may multiply enough to help check an infestation. There is evidence that such natural control agents were an important reason for the decline of the spruce budworm infestation in northern New York in 1947-48. Defoliators—especially in their early larval stages, when they may be wind-borne—may also suffer heavy losses in mixed forests because many of them cannot reach their true host trees.

But when the original forest cover is radically disturbed, these natural controls are partially lost. Fire, poor logging practices, cultivation or other disrupting agents may bring about a stand that is wholly unrelated in composition to the original forest. Because of changed site conditions, species that were unable to maintain themselves in the original associations become established. In the absence of vigorous competitors, these intruders take possession of extensive areas, often in relatively pure stands outside their natural range, and on sites to which they are only temporarily well adapted. Such stands are especially susceptible to forest pests and other damaging agents.

Dangerous situations arise when cutting practices, continued persistently and over a long period, favor species other than those characteristic of the site. Under incorrect cutting methods, stand composition and quality deteriorate and the forests become easy prey to a host of enemies.

Spruce budworm:

A good example is the spruce-fir forests. In the past loggers were persistent in cutting spruce only, and this has undoubtedly increased the susceptibility of these forests to budworm attack. The causes leading up to such a development should perhaps be mentioned at this point.

Although the balsam fir forest can be considered a climax type in portions of its range, the fact remains that the original coniferous forests in the northeastern United States and eastern Canada were composed chiefly of pine, spruce, hemlock and a scattering of balsam fir. Logging in the early days was extremely selective—only the best pines were removed. As time went on, the remaining large pines and the best spruces were taken. Since balsam fir was seldom cut for lumber and there was yet no market for pulpwood, trees of this species remained as holdovers in the stand. This practice increased the percentage of balsam fir; and, because fir produces seed prolifically, the end product was a forest predominantly of balsam fir. It was extremely susceptible to budworm attack.

Small wonder that budworm outbreaks followed these widespread logging practices! Later these old logged areas were clear-cut for pulpwood. Studies by the Northeastern Station (3) show that this type of cutting greatly increased balsam fir at the expense of spruce, thus setting the stage for later budworm outbreaks.

Craighead (1) recognized the need for forest practices to prevent this condition when he stated in 1925 that "the only alternative is to keep the future forests in condition least susceptible to the effects of defoliation. It is believed . . . this can be accomplished by maintaining thrifty and vigorous stands." The need for reducing the volume of merchantable balsam fir, as a means of developing stands resistant to budworm attack, has long been recognized. DeGryse (2) has aptly stated, "This does not imply the eradication of balsam, but rather its rationalized utilization. Elimination of mature and overmature stands of balsam, utilization of younger stands on short rotation, and fostering of the reproduction of better species are the principal points in such a program."

Attainment of these objectives involves important problems in silviculture. It calls for management techniques that will change vulnerable stands into resistant ones without jeopardizing the basic silvicultural objectives of increased growth and assured reproduction. Techniques aimed at accomplishing these goals have recently been described in detail by Westveld (4).

To be practical and inviting to the timberland owner, any measures for preventing damage must be developed along lines that will not increase, to any great extent, the cost of existing management practices. Our research, to date, indicates that short-cycle cutting is the answer. According to Westveld (4), light cuts at 10-year intervals instead of heavy clear-cutting at intervals of 40 to 60 years promise to double the yield of pulpwood. Thus there is every encouragement for the pulp industry to adopt short-cycle cutting as standard procedure in its wood-procurement operations. The U.S. Forest Service, in cooperation with the Bureau of Entomology and Plant Quarantine, is testing this type of cutting on a commercial scale on numerous experimental areas throughout the spruce-fir region of the Northeastern States. These areas contain all degrees of balsam-fir representation. So far as the spruce budworm is concerned, there is every reason to believe that prevention or limitation of severe damage can be attained through good forest management.

Eastern spruce beetle:

The eastern spruce beetle is another pest which should be considered when planning for forest crop security. Here is an insect that is not aggressive even though it is generally considered as primary. Much of the damage from it occurs in mature and overmature timber. Normally only the largest overmature or dying trees are attacked, but during an outbreak living trees of all diameters down to about 7 inches are susceptible. Injury may be as prevalent in mixed hardwood and spruce stands as in those predominantly spruce. Wise cutting measures and management, to reduce the volume of the larger, susceptible trees and to keep the stand in a healthful, vigorous condition, will do much to prevent widespread damage by this insect.

Disease and insect pests of northern hardwoods:

Another example of the results of changes made in the original forest cover is the present situation in the northern hardwood forests of the Northeast. Nectria canker, birch "dieback", and beech mortality caused by the joint attacks of a scale insect and Nectria probably have been immeasurably intensified by mismanagement or lack of management of northern hardwood stands.

One of the principal reasons for the high incidence of Nectria canker in extensive areas of northern hardwoods is that these stands occupy sites that originally supported pure softwoods or softwood-hardwood mixtures. Cutting of the softwoods and subsequent fires created pure or nearly pure hardwood stands that are now subject to severe Nectria infections. Control can be secured by reconvertng these sites to their original stand composition and improving the soil through the prevention of fires.

The excessive dying of mature and overmature yellow and paper birch trees in extensive areas of Maine and the Maritime Provinces may have been

initiated by similar lack of management. Many studies have been made during the past 15 years in an attempt to determine the causes of deterioration of birch stands, particularly with regard to the "dieback" phases of the problem. At least a part of this deterioration has been due to post-logging decadence and to physiological disturbances such as extremes of temperature and reduced rainfall. The relation of insect and disease attacks to this excessive dying is now being investigated but it is believed by many that they are secondary factors in the general deterioration. There is general agreement that the bronze birch borer can successfully attack and kill weakened trees that might otherwise recover but considerable doubt that it can successfully attack and kill healthy trees. Similarly, it is believed that many of the fungi found on low vigor or moribund birch trees are incapable of attacking trees in good condition. Complete understanding of the factors of primary importance in creating conditions favorable for the development of insects and fungi found in dying birch has not been attained but it is highly probable that unnatural stand composition and failure to harvest forest crops at maturity are fundamental.

Attacks by the beech scale and associated *Nectria* have severely injured or destroyed most of the stands of merchantable-sized beech in the Maritime Provinces and in Maine and are now a major factor in the better beech stands of New Hampshire. The scale itself has just been discovered in Vermont and both the insect and the fungus are well established in the beech stands of the Catskill Mountain region in New York. Even though the scale is an European insect and the *Nectria* probably an importation from that continent also, it is conceivable that management of beech stands on a shorter rotation, along with the elimination of overmature, low-vigor culls, may offer a sound method of combatting the combined attacks of these two pests.

Studies are now in progress in both Canada and the United States to determine the best methods of managing the remaining better northern hardwood stands and of rehabilitating stands already injured. It seems highly probable that if past mistakes can be avoided in the future, the causes of excessive dying of both birch and beech can be successfully controlled through forest management.

NATURAL FOREST TYPES AS A SILVICULTURE GUIDE

What does all this add up to? Does it mean that we should go all out for re-establishment of the climax associations?

Silviculturally such a goal may be desirable and, under favorable circumstances, readily attainable. However, other factors make attainment of this goal over large areas impractical—even undesirable. Over extensive areas in the Northeast the conditions that produced the climax associations have changed radically. Fire, repeated clear-cutting and cultivation have altered soil conditions to the extent that early establishment of species natural to the site may be difficult or impossible. Furthermore, the impact of introduced foreign pests may force us to strive for compositions different from those that characterized the original site.

But despite the obstacles encountered, compositions characteristic of climax associations should be used as guides for setting up silvicultural objectives. Such a guide is a sound approach, for it recognizes the natural potentialities and tendencies of the site in question. Such silviculture produces healthy, vigorous stands, the surest defense against many forest pests.

These goals should not rule out attempts based on sound forestry to strive for subclimax species that have higher market value than the original mixtures. Maintenance of subclimax types such as eastern white pine, some of the southern pines and Douglas fir are fully justified.

The fact that species of the climax association such as hardwoods become established where pine is the objective should not be regarded as a silvicultural defeat. Conscious effort toward attainment of such mixture is patent evidence of silvicultural skill and foresight. The skilled forester seeks every legitimate opportunity to work with nature rather than against her. He recognizes the limitations that site conditions impose on his silviculture and he adjusts his management practices accordingly.

ATTAINING THE SILVICULTURAL GOAL—CROP SECURITY

By and large, the forester must rely heavily on silviculture as a practical and inexpensive means of working toward crop security. For naturally regenerated stands, this calls for cutting practices that will avoid soil deterioration, fire and erosion, and that will maintain as nearly as possible the composition of the plant community that originally occupied the site; and thinings, wherever they are needed, to maintain the best stocking for both form and vigor. For planted stands the same practices should be followed. In addition, the species planted should be suitable to the site, adapted to the region, and from seed of desirable parent trees from the same locality.

Such methods will not only tend to control insect and disease infestations; they will also ensure maintenance and improvement of site conditions. This not only results in better yields, both in volume and quality, but also will ensure improved watershed conditions that are so vital to flood control, watershed management, fish and wildlife and recreation. The public interest in this national problem is increasing rapidly.

In striving for this silvicultural goal, there are certain practical considerations that must be reckoned with.

Markets and accessibility

Questionable silvicultural practices are frequently the result of economic pressure. Often the choice of species and cutting methods is based not on site-type tendencies, but almost wholly on present or anticipated market demands. Such a policy in the long run is both economically and silviculturally unsound. To force a stand into a composition unsuited to the site is costly and may be disastrous. As indicated earlier, such stands are likely to be highly vulnerable to insects, diseases and other damaging agents. Rather than forcing the forest to adapt itself to industry, the long-range objective should be to develop industries whose raw-material requirements call for the species that make up the normal composition of the forest upon which they depend.

Crop security is too often complicated by inaccessibility of stands. Crop security in its fullest sense can be realized only when there exists an adequate road system supported by an active, steady market for diversified wood products. This will make possible early and frequent improvement cuttings, which may be exactly the control measure needed to prevent an insect or a disease from assuming serious proportions. In the final analysis, market and transportation factors determine the degree to which sound silvicultural policies can be put in force. Only through their existence can the frequent cuttings so essential to the maintenance of stand thrift and the prompt development of pest-resistant mixtures be accomplished. We have not yet reached the stage in forest-crop economies that justifies any considerable expense for control of adverse agents through the use of fertilizers, sprays or tillage. In recent years, however, there have been outstanding developments in spraying insect infested forests with concentrated sprays from aircraft. They give promise—under conditions of severe outbreaks—of saving timber from destruction at much lower cost than has previously been possible by direct control methods.

It is true that accessibility, market demands and the needs of dependent industries should be considered when silvicultural policies are being formulated. But when such factors threaten to block the goal of crop security, the silvicultural policy should be altered so the goal can be reached.

The importance of proper cutting practices

Establishment of sound silvicultural goals, though basic and of first importance, does not in itself assure their attainment. We need, in addition, the application of cutting practices silviculturally and economically appropriate to each site condition. We are prone to think of forest practices as being either good or bad, whereas several intensities or levels of forestry should be recognized. Which level is best for any given situation depends on the silvicultural requirements of the site, accessibility, markets, and other economic and physical limitations.

At the Northeastern Station, we are attempting to solve this problem through pilot-plant studies. The Green River Management Area in northern New Brunswick is a step in the same direction. True, sample plots in the past have yielded valuable leads and suggestions on the effectiveness of various treatments and measures. But such information is too restrictive. One plot yields information on thinning, another on weeding, a third provides guides for pruning, still another appraises the value of partial cutting. Through this means a wealth of information has been marshalled of what constitutes effective and ineffective practices at various stages in the life of a stand.

Little, however, is known regarding the cumulative biological and silvicultural effects of long-term application of different levels or intensities of forest practices and their financial feasibility. On our experimental forests we are dedicating groups of compartments to poor, fair, good and high-order forestry practices. Ultimately it should be possible to determine for a given

set of forest conditions the required level or intensity of forest practice for maximum returns.

The results of these studies should bring into view the full range of forest-management possibilities and do much to raise the level of forest-management practices in our northern forests. Application of forestry measures through the climax approach remains the key to forest crop security. But, unless good silviculture is backed up by proper forest planning, attainment of this goal will be fraught with many difficulties.

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