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ECONOMIC PROBLEMS OF MANAGING SMALL WOODLAND HOLDINGS IN NEW ENGLAND

By

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FOREWORD

This appraisal of the economic problems of managing small woodland holdings is based primarily on the New England Dairy Farm Management Project. The generous support of the Charles H. Hood Dairy Foundation has made it possible for the Harvard University Committee on Research in the Social Sciences to carry on this investigation of management adjustments on New England dairy farms.

Dr. John D. Black has liberally contributed to the planning and general supervision of the project while Dr. Richard G. Wheeler has carried on the actual direction of the work. Since this project has involved a cooperative approach to the problems of farm management many people have contributed to its success. In addition to the cooperating farmers the county, state and federal agricultural-program workers have rendered gratifying assistance. County, state and extension foresters have also been generous with their advice and with direct help in the field. Several co-workers have participated in the farm planning phases of this work. They include Dr. W. Herbert Brown, Mr. Bradford D. Crossman, Mr. John H. Peasley, Jr., and Mr. Thomas K. Jones. Dr. Solon L. Barraclough has been of invaluable assistance with the analyses of Chapter VII and Appendix A. Miss Althea MacDonald, secretary of the Committee on Research in the Social Sciences, has speeded the work of this study in many ways, especially by the solution of administrative problems. The author is deeply grateful to all of these persons and agencies for their generous cooperation and assistance.

Summary

ECONOMIC PROBLEMS OF MANAGING SMALL

WOODLAND HOLDINGS IN NEW ENGLAND

by Ernest M. Gould, Jr.

Although the forests are New England's most extensive natural resource there is ample evidence that their productivity is not at the most desirable level. A long history of vigorous exploitation has resulted in second growth stands that produce an estimated average annual increment per acre of only about 29 cubic feet. The estimated yearly drain on softwood sawtimber far exceeds growth and the region is forced to import a large and increasing proportion of the high grade sawtimber consumed by industry and used in construction. Although inventories of standing hardwood sawtimber and all pulpwood-sized trees are accumulating the economic utilization of many of these stands is impossible under present techniques. Developments in pulpwood processing hold out considerable hope for increasing the future utilization of low grade products, but this is unlikely to alleviate the shortage of high grade sawtimber. Definite improvement of the management practices used on a large segment of New England woodland is necessary before any appreciable increase in over-all productivity or the relief of present and prospective shortages is possible.

A study of forest land ownership indicates that government agencies and the owners of tracts of more than 5,000 acres each, control about 45 percent of the region's commercial forest area. The rest of the acreage is held in thousands of small ownerships. In general, government lands are well managed on a multiple-use basis, while the large industrial owners are gradually starting management programs that will maintain or

increase the productivity of their lands.

The management problems of the small owners, controlling over half of the region's forestry resource, have been attacked by the Extension Service and the Norris-Doxey farm foresters. However, considerable research is needed in adapting the techniques of forest management to the needs of these small owners. The case study method and budgetary analysis seem to offer a fruitful approach to this hard core of New England's forestry problem.

Although farmers constitute less than half of the small owners they are usually in a favorable position to practice improved forestry. As a rule they are residents on or near their holdings and can at least oversee operations. Frequently the equipment, labor and managerial ability used in the other farm enterprises can also be used in woods work. There are definite complementary and supplementary relationships between forest and agricultural activities and the several enterprises must compete for the use of limited resources. Thus an over-all view of the farm business is necessary in studying farm forestry and the woodlot must be considered as an integral part of the operating uint.

The woodland management plans discussed in this study were made for a large sample of New England dairy farms as part of a complete study of farm management adjustments. These farm plans explored the alternative management adjustments in both the combination of enterprises and the intensities of management that were open to the owners of the study farms. The planning was done with the operator as an active participant and the proposed plans embody not only the technical possibilities but also the farmer's desires and hopes, tempered by an estimate of his managerial

capabilities. Each farm plan was finally expressed in terms of a budget of estimated cash income, expense, and net return. Thus a rational basis for choice among the feasible alternatives was provided to guide the management decisions of the operator.

The chief land use decision involving forestry on most of the study farms was whether to improve brushy pastures for roughage prodution or to allow them to revert to forest cover. The land capabilities and the forage needs of the business unit were the primary factors in deciding this question. Planting seldom appeared to be necessary on the land which was to revert to forest production, as the simple elimination of grazing could be expected to insure ample seeding in most cases.

Most of the study farms were well equipped with the simple hand tools necessary for woods work and the team or farm tractor seemed capable of performing most forest operations. The major problem was one of utilizing the available labor force in the woods without a loss of efficiency in the other farm enterprises. On about half of the study farms the regular labor force seemed able to carry out an improved forestry program during periods when other work was not pressing. On the other half of the farms, however, an intensive forestry program would necessitate hiring some extra woods labor. On a fifth of the farms all forestry work would have to be done with special contract labor, or by means of marked stumpage sales. On these farms it appeared likely that gains from using the regular labor force for woods work would be offset by losses in the efficiency of operation on the other enterprises.

In all instances it will be most advantageous to use harvest practices that at least encourage prompt and valuable reproduction. With more labor

and management available it will be worthwhile to use partial-cutting methods that not only favor reproduction but also improve the growth rate and quality of the standing timber and promote closer utilization of low grade materials. The combination of the above practices best suited to an operating unit will vary with the size of the forestry and farm enterprises in relation to the available labor force and the management capacity of the operator. On the whole, it was determined that the improved practices that can be adopted with advantage will eventually increase the productivity of the woodlots by about 75 percent, without an appreciable reduction in the present rate of cutting.

Some farms were found where the forestry enterprise offered an attractive means of expanding the size of the business unit and increasing returns. A method of intensive analysis was devised to project the probable woodland returns, during ten year intervals, for nine decades into the future. It was then possible to compare the budgetary results of different intensities of forest management. Under the conditions studied an intensive program of partial-cuttings offered the most stable and the largest returns during the planning period.

The forestry possibilities of three adjoining properties in central Massachusetts were also studied using this same projection system. Two of these owners were business men while the third was a farmer; their holdings totaled about 1,900 acres of young, poor-quality woodland. No method of management offered sufficient income to cover taxes until after the growing stock had been built up for about 20 years. An intensive

analysis of 96 alternative plans was used to explore the budgetary effects of different intensities of management, varying interest rates, market conditions and cost-price relationships. Under most of the assumed conditions it was found that improved harvesting practices would be more advantageous than customary clear-cutting and high-grading. With either rising prices for wood products or low interest rates or both, more intensive forestry would yield the greatest returns; however, new operating arrangements would have to be worked out to allow the three properties to function as a single unit.

It is clear from this study that improved harvesting practices can be used to advantage by practically all small forest owners. Under many conditions a rather intensive program of partial-cutting will yield the greatest returns, especially when woodlands constitute one enterprise of a farming unit. More research is needed in the actual operation of non-farm woodland units to discover the solution to many of their forestry and economic problems.

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Chapter I

INTRODUCTION

The residents of New England have acquired a reputation for immovable conservatism but the region's history is vibrant with the changes and adjustments necessary to survive in a dynamic environment. The somewhat meager natural resources of the area forced even the early colonists to seek out and employ the methods of production that seemed to yield the greatest returns. There have been many maladjustments and the adoption of improved techniques has often been long delayed, but the fact that New England has survived as an important segment of the nation's industrial economy with a vigorous agriculture is an indication of its ability to accept change.

Of all the systems of land use, probably forestry has been least affected by the passage of time. The forests themselves have changed radically and some of the products required by industry are different from those of colonial times, but the methods of harvesting are still quite primitive. The hand-saw and axe are the primary tools of the trade; mechanization of felling, limbing and bucking is only in its infancy. Horses and wooden scoots are still the dominant motive power in the woods although the use of tractors is spreading rapidly, especially on large operations. The picturesque river drives of long-logs are a thing of the past; most of the logs and bolts now move by truck or railroad. The greatest changes have come in the mechanical methods of moving bulky forest products, a process much more amenable to standardization than that of harvesting trees where each stem presents individual problems.

"Clear-cutting" and "high-grading" harvesting methods1/ were well adapted to early market requirements and to the conditions of virgin forests but they are still in almost universal use despite knowledge of more productive systems of cutting and changed market and forest conditions. Industrial development has been along the lines of single-product firms making either lumber, pulp, veneer, or turned stock and the like. These systems of utilization and harvesting have given each other mutual support and make future adjustments more difficult than they might be otherwise. Integrated utilization that channels each log to its highest use would require either close cooperation between present companies, now diversified processing units or some other radical change.

The full benefits of improved cutting practices cannot usually be realized unless markets for all sorts of forest products are available in the same locality. It is then possible for a forest manager to dispose of intermediate or improvement cuttings as well as his final harvest of mature trees. The present single-product concerns usually will not buy the lowest grades of logs and bolts unless they are "sweetened" with a liberal addition of high grade materials. These market requirements can place a definite limit on the silvicultural operations of forest owners.

The present study was undertaken to determine what changes in forest management and organization would lead to more successful operations by

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1/ "Clear-cutting" removes all the usable trees in one operation. Many small stems are cut merely to get them out of the way. The windrows of heavy brush often inhibit the growth of seedlings and create a dangerous fire hazard.
"High-grading" removes all of the better trees leaving only the less valuable species and poorly formed individuals to make up the next crop.

small woodland owners in New England. The two major phases of the investigation are, first, the problems of farmers who can handle their woodland as part of an agricultural enterprise, and second, the problems of other small forest owners who may hold their land for some reason other than its forest production. This latter group includes persons who own woodland as an adjunct to camps, summer homes, ancestral homesteads and the like and whose primary source of income is often completely unrelated to land use.

Many of the individual problems of woodland management have already been analysed but more study is needed of the ways and means of combining forestry and farming to form an integrated operation. Since a wide variety of forest and agricultural conditions are found on the farms of New England no single analysis of an "average" situation can be expected to suggest all of the necessary management adjustments. Probably the most promising approach is through case studies of a cross section of similar types of farms. The forest problems of two hundred and forty-one New England dairy farms were analysed using the budgetary analysis method. This phase of the research was done as part of a complete farm planning project[2/] in which each farm was treated as a separate case and the woodland was considered to be an integral part of the farm business. The management adjustments proposed for each farm depended on the physical conditions of the operating unit and the managerial capacity and desires of the owner. The patterns of adjustment that were discovered can be

2/ New England Dairy Farm Management Project started in 1945 and supervised by Dr. John D. Black, chairman of the Committee on Research in the Social Sciences at Harvard University.

more widely applied to similar situations elsewhere.

A more detailed analysis was made of the results of forest management adjustments over a period of ninety years on some of these farms. The same type of analysis was also applied to a large block of land in Petersham, Massachusetts to determine how it might be managed most advantageously by its farm and part-time resident owners. Since only one example of this latter type of ownership is included in the study, the analysis can only illustrate some of the problems encountered in managing this type of holding.

Any consideration of woodland management adjustments in New England must be made within the framework of the regional forest environment. The immutable natural forces governing forest growth and the historical development of the economic and social systems impinging on woodland practices must be explored as a foundation for the intelligent adjustment of management methods. A knowledge of what has happened in the past to create present conditions is essential to successfully meeting the challenge of the future.

That the forests are New England's most extensive natural resource is quickly apparent to even the most casual visitor. Trees dominate practically every landscape and lend some of the charm that draws tourists from all parts of the country. In their scenic capacity, and by providing a friendly habitat for fish and game, forests are an integral part of the region's half billion dollar recreational trade. Trees help prevent disastrous erosion and actually enrich many of the soils on which they grow. The protective cover of leaves and the layer of duff and litter on the forest floor absorbs rain and snow water so that run-off is

retarded and stream flow regulated to moderate floods and relieve droughts. The value of these contributions to the welfare of New England's eight million inhabitants is inestimable.

Forests also have functions whose importance is easier to measure. They provide the base for more than three thousand primary, wood-using industries in the region furnishing employment for over eighty-three thousand people.[3] The total payroll is nearly one hundred million dollars. These plants add a value by manufacture that is eight and one-half percent of the total value added by all New England industries. Although a local supply of forest products was responsible for the establishment of most of these plants, today less than half of the lumber used in the region is grown locally.

All except six-tenths of one percent of the commercial forest area has been cut over at least once and some of it two, three or more times. As Table 1.1 shows, less than half of the area supports sawtimber stands and eleven percent is so poorly stocked that it will not produce merchantable trees until it is either planted or reseeded by long-time natural processes. Only two tenths of the forest land is operated by methods classed as "good" and the management of one-third of the area is classed as "poor" or "destructive" (Table 3.6).

Many overall estimates have been made of what could be produced from the forests by the application of improved methods of management.[4] The

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3/ Henry I. Baldwin, Wooden Dollars, Boston, 1949.

4/ For examples of such estimates see: Forests and the National Prosperity, Bulletin No. 668, United States Forest Service, 1949; A National Plan for American Forestry, Senate Document No. 12, 1933; and The Coming Age of Wood, Egon Glesinger, New York, 1949.

Table 1.1

DISTRIBUTION OF COMMERCIAL FOREST LAND ACREAGE IN NEW ENGLAND BY CHARACTER OF FOREST GROWTH[1]

States	Saw Timber	Pole Timber	Seedling and Sapling	Poorly Stocked, Seedling and Sapling, and Denuded	Totals by States Acres	Percent
	Thousands of Acres					
Maine	9,339	3,650	2,275	1,421	16,685	54.0
New Hampshire	1,589	1,399	1,109	625	4,722	15.3
Vermont	1,604	1,145	600	471	3,820	12.4
Massachusetts	952	968	574	523	3,297	10.8
Rhode Island	28	100	255	64	447	1.4
Connecticut	403	874	390	233	1,900	6.1
Total Acres	13,895	8,116	5,503	3,337	30,851	
Total Percent	45.0	26.3	17.8	10.9	100.0	100.0

1/ Table 2, Basic Forest Statistics, as of January 1945, U.S.D.A., Washington, July 1946.

precise results of such changes are impossible to predict but it seems certain that the sustained yield of forest products could be increased several fold with a commensurate increase in the less tangible values of erosion and flood control, wildlife production, scenic attraction and the like. The costs of such management are also hard to assess but would certainly be far less than the ultimate benefits.

If the above estimates are true, why then has the utilization of this natural resource sunk to a level so far below that which is technically possible? It may also be asked how all or part of this apparent discrepancy can be practically eliminated. A complete answer to these questions is far beyond the scope of this study. It is the object here to provide specific answers to the management problems of individual woodland owners and analyse these answers to discover patterns of adjustment that may have wider application.

A forester, who started his professional career under Mr. Gifford Pinchot, once remarked to the author that any successful study of forest management must answer three questions. 1. "What do we have?" 2. "What do we want?" 3. "How do we get what we want from what we have?" This is an over-simplification, but it at least has the merit of being easily understood. In actual practice the solution of a great number of complex and interrelated problems is required before an answer can be given to any one of these questions. Perhaps, however, these questions will serve as useful pegs on which to hang our arguments.

An enormous amount of time, money and energy has been spent in attempts to answer question number one. Unfortunately much of it has apparently been done on the naive assumption that if enough detailed

information is assembled about the present inventories of growing stock the answers to questions two and three will automatically appear. The gathering of facts is an essential step in any economic analysis but the crucial point is how these facts are interpreted; they only gain relevance as they are connected with some theory of behavior. Thus any complete answer to question one must discover not only what the present forests are, but also what the underlying physical, human and economic forces are that have created them.

With this information in hand, question two can be answered for the operating unit by determining what intensity of management will maximize the net returns. This involves finding out not only what land will be used for crops, pasture, and forest[5] but also with what intensity labor and capital will be applied to each acre. A comparison of the net results of the various alternative methods and intensities of management will indicate the most favorable goals for the future. Management that gets the greatest net return from the forest resources need not be synonymous with that which yields the greatest amount of wood products. In fact, any serious consideration of the problem indicates that several levels of intensity must be used to successfully manage even small forest holdings.[6]

Having answered the first two questions the dimensions of the answer to number three will have become more apparent. The management decisions for each of the thousands of operating woodland units that make up the whole of New England's forests are made by their individual operators and

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5/ Black, Clawson, Sayre and Wilcox, Farm Management, New York, 1947.

6/ The Forest Service in its Reappraisal Reports used four levels of management intensity and the use of two levels was recommended for the future.

owners. New England land operators are characteristically landowners and taken all together they control the future of the forest resources. It is with this latter phase of planning individual adjustments in land-use that this study is primarily concerned.

Chapter II

THE FORESTS OF NEW ENGLAND

The localities containing the farms chosen for study in this project are shown on Map 2.1. They were picked with the primary purpose of getting case studies that would represent a cross section of New England dairy farming. Thus, the forest land sample does not necessarily represent farm woodlot conditions throughout the region. Wheeler and Brown[1/] have given extended coverage to the methods employed in sampling the dairy farm universe so a mere sketch is appropriate here to cast light on the representativeness of the woodlot sample. The available sources of statistical information, such as the census, state publications and the like, were consulted to determine the prevalence of specialized dairy farms, acres of roughage crops per cow, cow population, herd size, type of farming areas, etc. The region was then divided into areas of rough similarity on the basis of the several factors that were judged to affect dairying. With the assistance of the County Extension Agents and other persons familiar with local conditions a sample of farms was chosen in each of fourteen different localities.

The project leader and the County Agent then visited each of the chosen farms to enlist the cooperation of the owner in the planning process. Although some farms were eliminated by various peculiar circumstances, few farmers refused to help in the project. An effort was made

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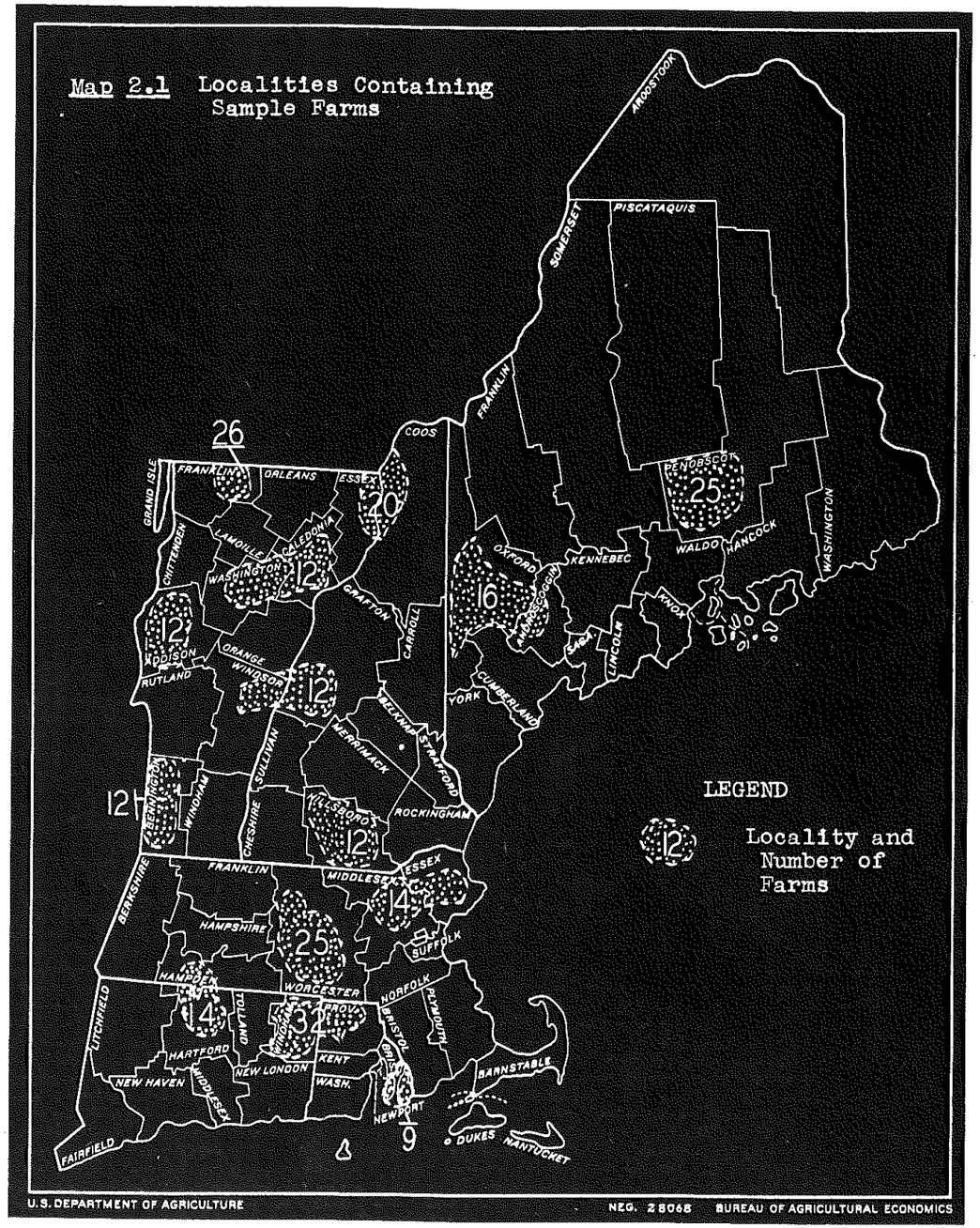
1/ R. G. Wheeler, Economic Problems of Dairy Farm Organization in Northern New England, Doctoral Thesis, Harvard University, 1949. W. E. Brown, Economics of Dairy Farming in Southern New England, Doctoral Thesis, Harvard University, 1949.



to get cooperators who were young, aggressive and interested enough to have a good chance of carrying out the suggested management adjustments. Thus the farms are not a random sample, but are some sort of a stratified, judgment sample. Under these conditions it would appear that the intensive application of statistical methods, based on the laws of probability, is not appropriate.

A study of maps 2.1 through 2.7 shows that the sample farms cover all of the region's major forest types and a variety of forest marketing, climate and growing conditions. Since work was purposely done on commercial farms, the large number of part-time and residential farms, those producing primarily for home use, and farms in the "fringe areas" where agricultural production is waning are too lightly represented to properly reflect the total universe of all farm owners. Many of the problems of these other forest owners are similar to those analyzed, but important factors may prevent generalizing the results of this study to cover all of these groups. However, the same methods of analysis are applicable to these operating units.

The Forests of New England[2/]

At this point it will be well to discover what forces have been at work to create the present New England forest situation and to determine how they have impinged on the cases studied. The location of the sample

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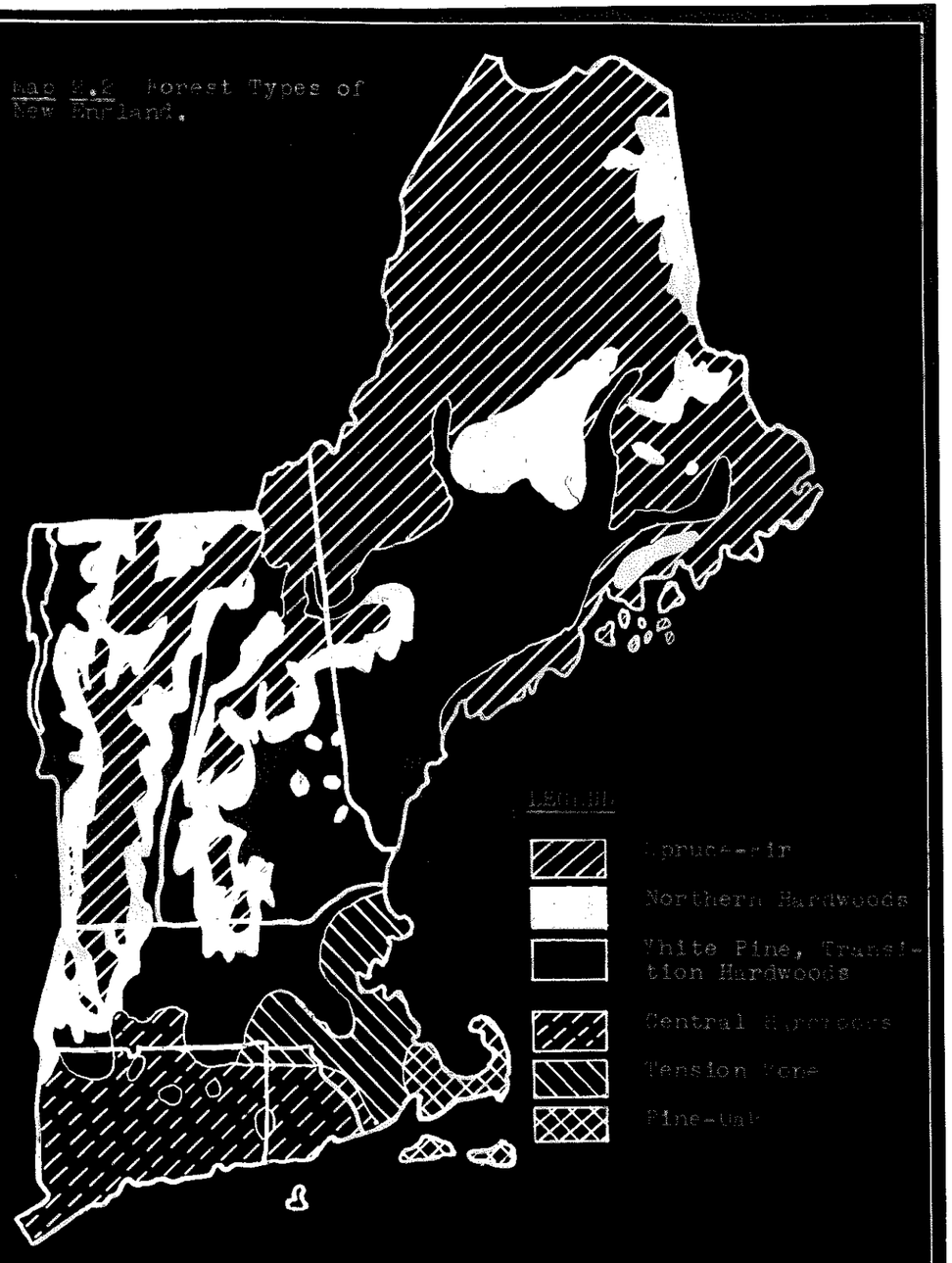
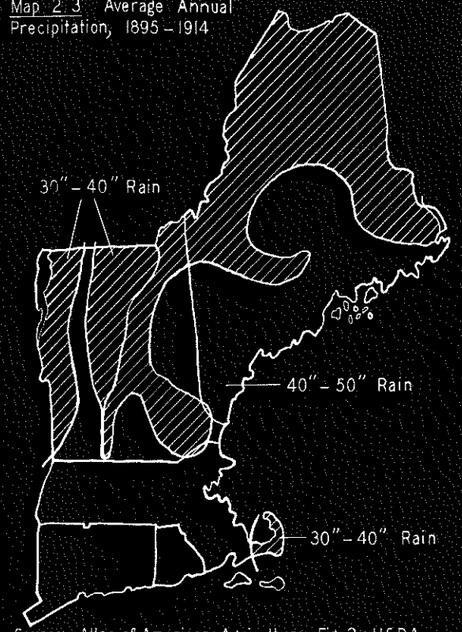
2/ Background material for this discussion is drawn from the following publications: American Geographical Society, New England's Prospects 1933, Boston, 1933; National Resources Planning Board, Forestry in New England, Boston, 1942; Raup and Carlson, The History of Land Use in the Harvard Forest, Petersham, 1941; Federal Reserve Bank of Boston, Wooden Dollars, Boston, 1949.

Map 2.2 Forest Types of New England.



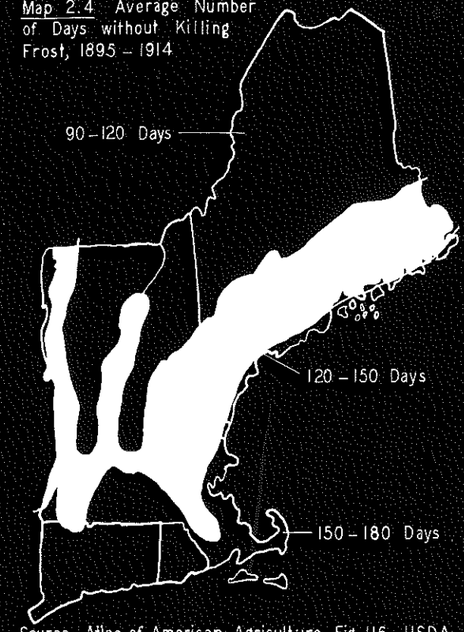
Source: Northeastern Forest Experiment Station

Map 2.3 Average Annual Precipitation, 1895 – 1914



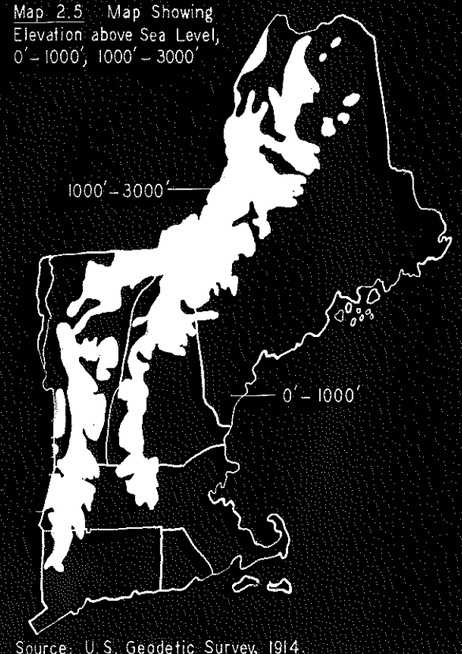
Source: Atlas of American Agriculture, Fig. 2, USDA, Washington, 1936.

Map 2.4 Average Number of Days without Killing Frost, 1895 – 1914



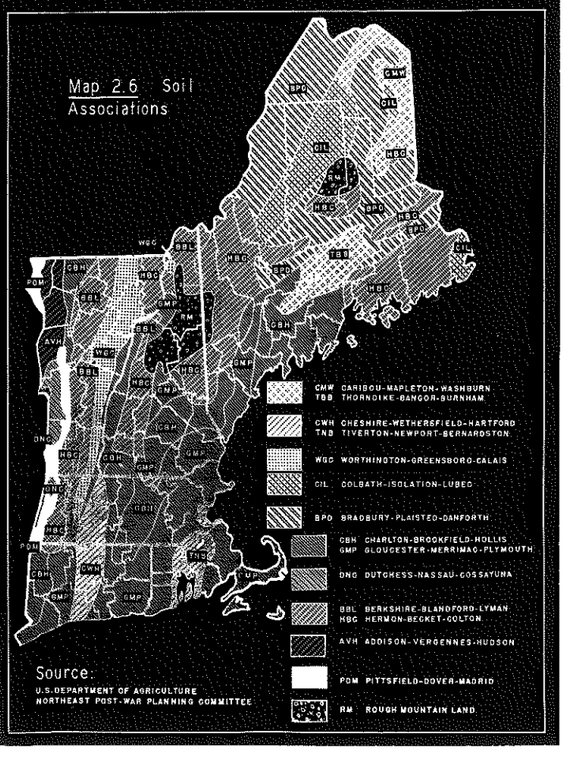
Source: Atlas of American Agriculture, Fig. 116, USDA, Washington, 1936.

Map 2.5 Map Showing Elevation above Sea Level, 0' – 1000', 1000' – 3000'



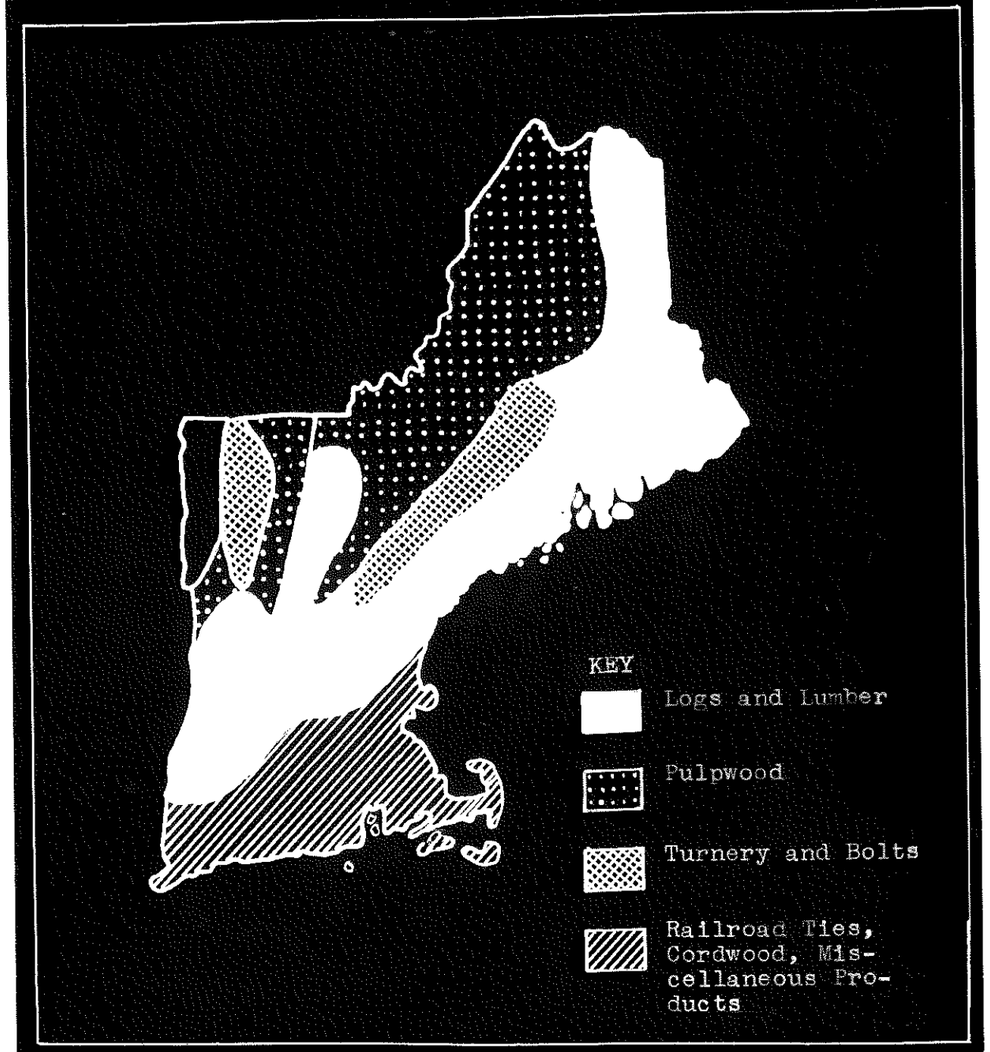
Source: U.S. Geodetic Survey, 1914

Map 2.6 Soil Associations



Source:
U.S. DEPARTMENT OF AGRICULTURE
NORTHEAST POST-WAR PLANNING COMMITTEE

Map 2.7 Wood Utilization Regions of New England



Source: H. I. Baldwin, Wooden Dollars, Boston, 1949.

farms should be kept in mind by the reader and particularly relevant points will be discussed as they apply to each locality.

The forests of New England form a biological community that has existed since at least the end of the last glacial period. In a time sense, man has affected only the last few lines of a very long history of development. But in that short span, vast changes have been made. The earliest colonial records indicate that the forests found by the first settlers were mostly mixed stands of broadleaved and coniferous trees. Except for some minor areas burned by the Indians, bare mountain tops and a few other natural openings, practically all of New England supported what closely approximated a climax forest,[3] that had evolved from centuries of growth. The forces of nature continually worked to establish a relatively stable group of compatible species particularly well adapted to any given site.

The climax forests of the north contained spruce and fir as the dominant softwoods mingled with beech, birch and maple. Across the southern tier of states spread stands of chestnut, oak, hickory, basswood and other species more characteristic of the middle Atlantic states. Between these sections, in central New England, were stands of many hardwoods mixed with white pine and hemlock. Most of the trees were eighty to one hundred feet tall but here and there white pines towered to one hundred and fifty feet or more.[4]

3/ R. T. Fisher in New England's Prospects, 1933 described a climax forest as one that was "self maintaining ... on the average the representation of species remained about the same and the general size and appearance of the forest was unchanged."

4/ These magnificent pines were reserved for the Royal Navy by one of the earliest colonial forest laws.

commercial farming possible as the cities demanded meat animals, hides and wool. The peak of land clearing was reached in the mid-eighteen hundreds when beef and wool were the major crops. The booming industrial development not only furnished ready markets for these products but also demanded tremendous quantities of fuel and lumber. Thus, the wood cleared from land needed for pasture could be profitably sold, providing a double stimulus to clear-cutting. By this time some towns, such as Petersham, Massachusetts, had cleared as much as eighty-five percent of the land for tillage and pasture.5/ However, only a relatively small amount of open land ever went under the plow.

The opening of the Erie Canal brought the produce from the rolling plains of the mid-west into brisk competition with the products of New England farms. For a time the region turned to the production of wool; but the "sheep mania" soon passed. An agricultural depression, the lure of free land in the west and attractive wages in the mushrooming industrial centers all drew farmers away from the soil. The younger people left the farms for the "old folks" to carry on, but often active farming was completely discontinued. This gradual abandonment, of first the more remote and poorer fields and then the poorest farms, started a contraction of cleared land that has continued almost to the present day. The land upon which intensive agriculture was abandoned continued in private ownership and the best fields were often incorporated with neighboring farms as changes in technique made it possible to operate larger acreages. Since any land not aggressively farmed was taken over by trees, it is estimated

5/ Raup and Carlson, The History of Land Use in the Harvard Forest, Petersham, 1941.

The historical development of forest land has followed two quite distinct patterns. The bulk of New England passed through some type of agricultural settlement before reaching its present condition. Some parts of the north, however, were never cleared for farming. These lands make up the present wilderness areas of Maine, New Hampshire and Vermont. These two patterns will be discussed in the order mentioned above.

Although the old-growth forests furnished all of the wood products and game animals needed by the colonists, they were generally considered a hindrance to settlement. Because of the scarcity of open land and the acute need for food, woodland was held in low esteem; besides, although a few local shortages of fuel wood and high grade sawlogs for ship building developed early, the supply of forest land seemed inexhaustible. Trees were cut by the millions in land clearing; often they were merely burned to get them out of the way and only the ashes were used for fertilizer or in making soap. This seemingly wasteful utilization was inevitable because of poor milling facilities and lack of transportation to the distant and limited markets. Early records show that only the very best timber brought enough to pay for the difficulties of transportation. Some of the orders from England specified boards three feet wide and thirty feet long, without a knot or blemish.

The first century of pioneer and subsistence settlement was concentrated along the coast and principal rivers and had little effect on today's woodland. Most of the areas then cleared are still open land used in cities, villages and farms. Later, with an expanding population and improving roads, farms spread rapidly over most of the region except northern Maine, New Hampshire and Vermont. Better communication made

that this recession of agriculture from the lands least adapted to modern farming has returned about seven million acres to the forests.6/

The results of this abandonment process are particularly noticeable in the sample localities south of Windsor and Grafton Counties in Vermont and New Hampshire. The more northerly districts were settled later and much less adjustment of cleared land has taken place. Franklin and Addison Counties in Vermont show a very high percentage of open land since late settlement brought them into production during the pasture era and little abandonment has taken place since that time.

Due to seed and soil conditions peculiar to the times, most of this abandoned land grew up to dense, pure stands of white pine.7/ It was not realized for many years that this type was a temporary, transitional stage through which the woodlands passed on their evolution toward a more stable climax forest. Toward the end of the eighteen hundreds, harvesting of these "old-field-pines" began on a large scale. The relatively knotty lumber produced gave a great stimulus to the establishment of many of the box, pail, kit, barrel and other woodworking plants that now exist in New England. Since these plants could use almost any sized tree, they encouraged clear-cutting which, combined with the 1938 hurricane, has greatly reduced the acreage of white pine. The sample farms in Eastern

6/ R. T. Fisher in New England's Prospects, 1933. The magnitude of change is apparent when it is realized that this area is seven percent greater than the total land reported used for crops and pasture in 1944.

7/ The white pine succession is typical of central and southern parts of New England. In the north spruce and fir took the role of pine, while in the south cedar and hardwoods took over some of the old fields.

Massachusetts and Southern New Hampshire, particularly, show the effects of this pine era. Many forest owners consider white pine to be the only tree worth growing and scoff at the volunteer hardwoods that now grow in such profusion. Many manufacturing plants adapted to white pine still persist in the area. One of the box companies in Worcester county, for example, can look back on over one hundred years of continuous operation. However, the future looks dim because of the increased transportation charges necessary to bring logs from great distances.

The pure white pine stands were succeeded on the heavier soils by stands of mixed hardwoods, many of which were cut at an early age for fuel wood, especially near the centers of population in the three southern states. The hardwoods sprouted quickly, but trees from this origin are very susceptible to rot and repeated cuttings reduced their quality and vigor. Wide-spread fires in the early days further contributed to the poor quality of present stands. Extensive areas of pure pine and the predominance of certain hardwoods encouraged epidemic attacks of diseases and insects that had seldom occurred in the original mixed forests. Losses from death and the lowering of quality caused by this means have far exceeded the loss from all other natural hazards.

The idea held by many present day forest owners that if their lands are left alone, they will eventually produce a valuable crop of timber can probably be traced to the experience of many land-owners during the old-field-pine era. The fact that much of their land now supports an inferior hardwood stand that is much less likely to produce good sawlogs without cultural treatment has not been fully realized. The patch work pattern of land ownership developed by the early settlers has also

continued to the present day with relatively small and irregularly shaped farms, many of whose fields have reverted to the forests, plus small woodlots scattered over the more rugged sections of each town.

The history of the northern part of the region that was never cleared for agriculture, is quite different from that outlined above. The land was sold in large blocks and the early lumber operations in these remote tracts were highly selective. At first only the best pine was cut, but as the supply of this virgin timber ran low the industry turned to spruce. This latter species was the chief building material used in New England for many years. Enormous old spruces also furnished "piano butts" that were cut into sounding boards. With increased demands from the expanding industrial centers to the south and better milling facilities, smaller and lower grade logs were cut. Finally the use of spruce and then fir for paper pulp started clear-cuttings that have almost eliminated the softwoods from many areas, leaving residual hardwoods in possession of the site. Many of these old and decadent hardwoods now retard the growth of more valuable trees. No sample farms are located in areas with this background since they are still largely non-agricultural. However, a good deal of similar cutting took place in Penobscot, Oxford and Androscoggin Counties, Maine and in Coos County, New Hampshire along the border of the wilderness areas.

The net effect of past operations has been a general increase in the proportion of hardwoods, especially the light seeded weed species that have little market value. Disease and insect damage is also greater today than in the past, more than offsetting the gains made through improved fire control. Of course, the average age and size of the forest trees

has been greatly decreased, while the form and vigor of the over-present stump sprouts is less desirable than that of trees from seedling origin. The species found today are essentially the same as those of the original forest, except for chestnut that was wiped out by blight. However, the proportions of the various species are greatly changed. Among the most outstanding differences is the increase in the quantity of fir and birch in the northern and several species of oak[8/] in the southern states.

The location of the dominant forest types[9/] is primarily determined by the length of growing season, amount of precipitation and soil types. All of these are closely associated with changes in elevation. Study of Maps 2.2 through 2.6 will show how these factors have combined, in the large, to determine the range of the major New England forest types. The relationships illustrated are not very close because of their generalized nature and because sufficiently accurate data are not available to show exactly how these forces control forest growth.

Within this framework of natural forces, man has worked his changes on the forests. The rest of this chapter will be devoted to determining what these interacting elements have left in the woods for present and future operations. From this inventory of resources will come the forests and forest products of tomorrow regardless of what treatment the woods receive.

8/ Fir is relatively short lived due to heavy attack by the spruce bud worm and heart rot. Birch is rapidly dying in Maine due to a complex of disease and insect attacks. The death of chestnut, a very valuable species, has allowed coarse growing and aggressive oaks to dominate many sites in Southern New England.

9/ As used here, forest type refers to a loose association of tree species found growing together often enough to form a recognizable normal group.

The most recent government estimates[10] state that 77 percent of New England is covered by commercial forests[11]. Furthermore, 45 percent of this area is covered by sawtimber[12], 44 percent by pole timber, seedlings and saplings[13] and 11 percent is denuded.[14] (Table 1.1) Map 2.8 shows that the most densely forested townships are concentrated in the less accessible areas of the north or in the mountains but that practically the entire region has at least 30 to 50 percent of its land under trees. The sample farms are well distributed throughout the towns with various percentages of wooded land. However, as Table 2.1 shows, the sample farms have a smaller proportion of the older age classes than is found in the total New England forest. This is especially true in Southern New England. An even greater discrepancy would show if the

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10/ U.S.D.A., Forest Service, Reappraisal of the Forest Situation, Washington, D. C., 1948, several reports.

11/ "Commercial forest land is that capable of producing timber of commercial quality and quantity now or prospectively available for commercial use."

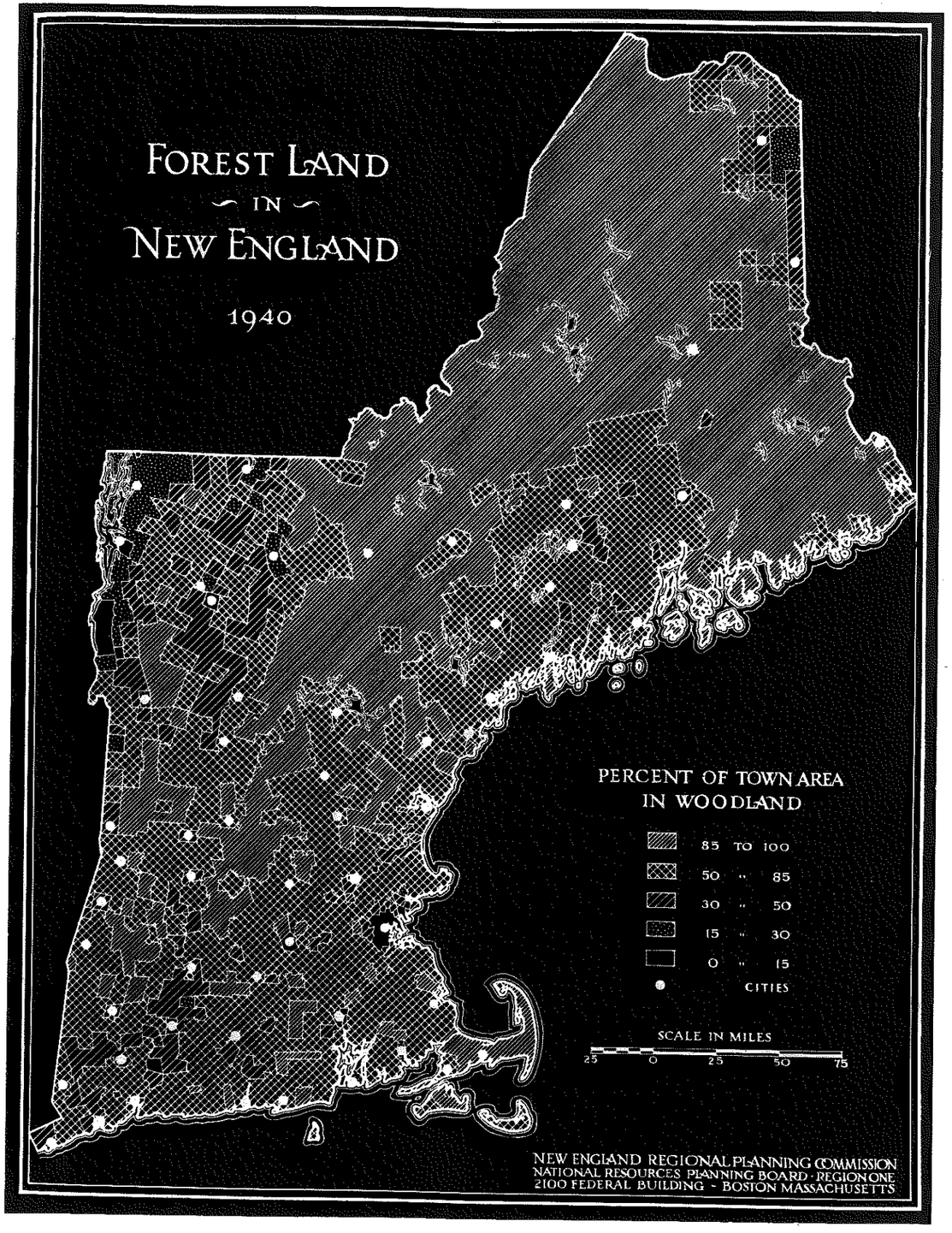
12/ "Saw timber must have 2,000 board feet per acre in softwoods 9" d.b.h. and larger and 11" d.b.h. and larger in hardwoods."

13/ "Pole timber areas are characterized by timber too small for saw-log operations but large enough for cordwood (5" d.b.h. and larger) regardless of whether the stand is cut for this use or held for saw timber. Timber of pole size or larger must occupy at least ten percent of the area....with a minimum volume of two cords per acre." "Seedling and sapling areas are those on which at least forty percent of the growing space is occupied by commercial species predominantly below pole timber size and below minimum volume per acre for saw timber or for pole timber."

14/ "Poorly stocked seedling and sapling and denuded areas are those that do not qualify in any previous class."

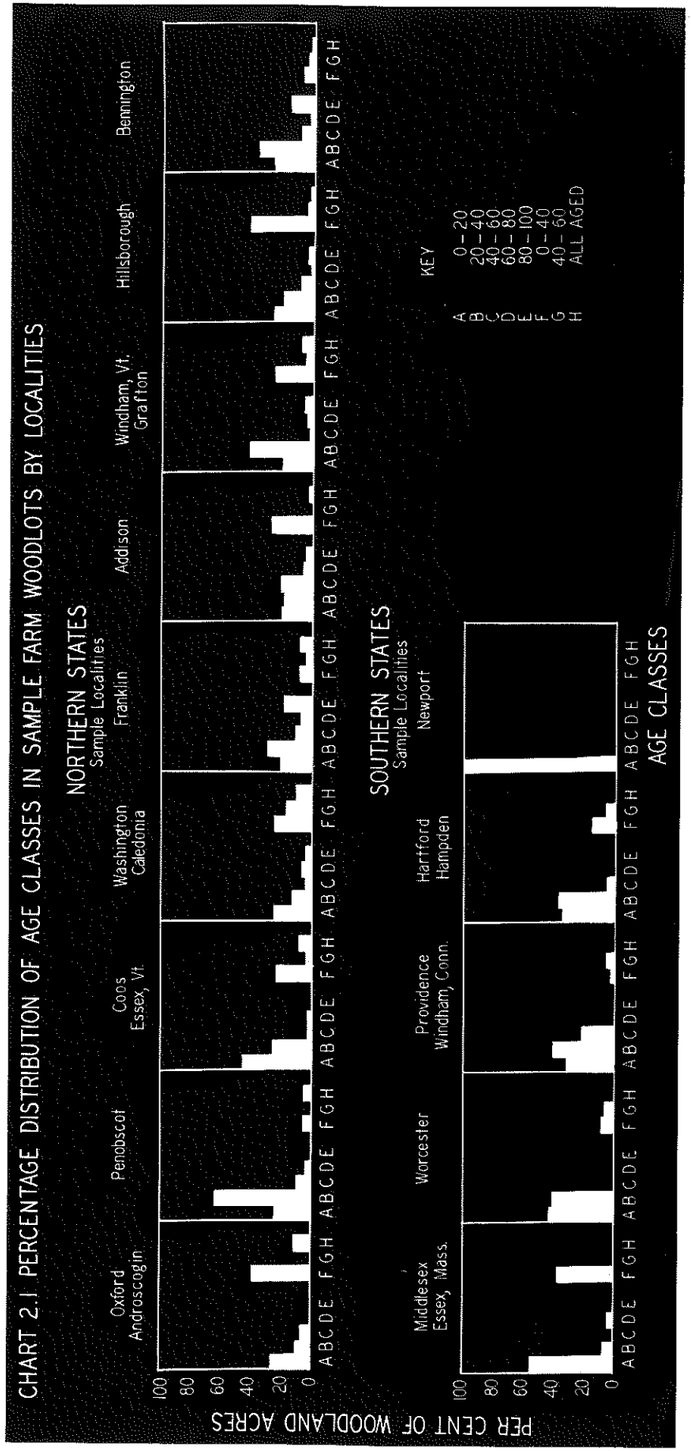
All of the above definitions are from reference 10.

Map 2.8



old sugar bushes were eliminated from consideration as timber reserves, since they include practically all the sample farm stands over sixty years of age. The concentration of farm woodlands in the young and middle age classes is not surprising when it is considered that these areas are among the most accessible in the region and that most of the sawtimber inventoried by the Forest Service was found on the non-agricultural, large holdings of the north. A scarcity of mature trees and an abundance of young growing stock is probably characteristic of most small holdings.

Chart 2.1 indicates the percentage distribution of age classes in the sample farm woodlands of each locality. The predominance of young, even-aged stands under forty years old is apparent in all localities, especially in the three southern states and in the pulp areas of Maine and New Hampshire. Most of these stands have resulted from clear-cutting for single products. The uneven-aged stands from zero to forty years old usually have their origin in high-grading operations in Maine and hurricane salvage in New Hampshire and Eastern Massachusetts. The greater representation of older age classes on the Vermont farms is mainly due to the preservation of maple orchards. Chart 2.2 bears out the difference in ages between Northern and Southern New England and shows no great variation of ages between different sized holdings. Apparently about the same practices have produced similar stands regardless of the number of acres operated. Although no tabular evidence is presented, inspection of the sample farms shows that about 60 to 70 percent of the woodland acreage is understocked by 30 percent or more. Reproduction on these lands seems to be adequate to keep them under tree cover, given time enough.



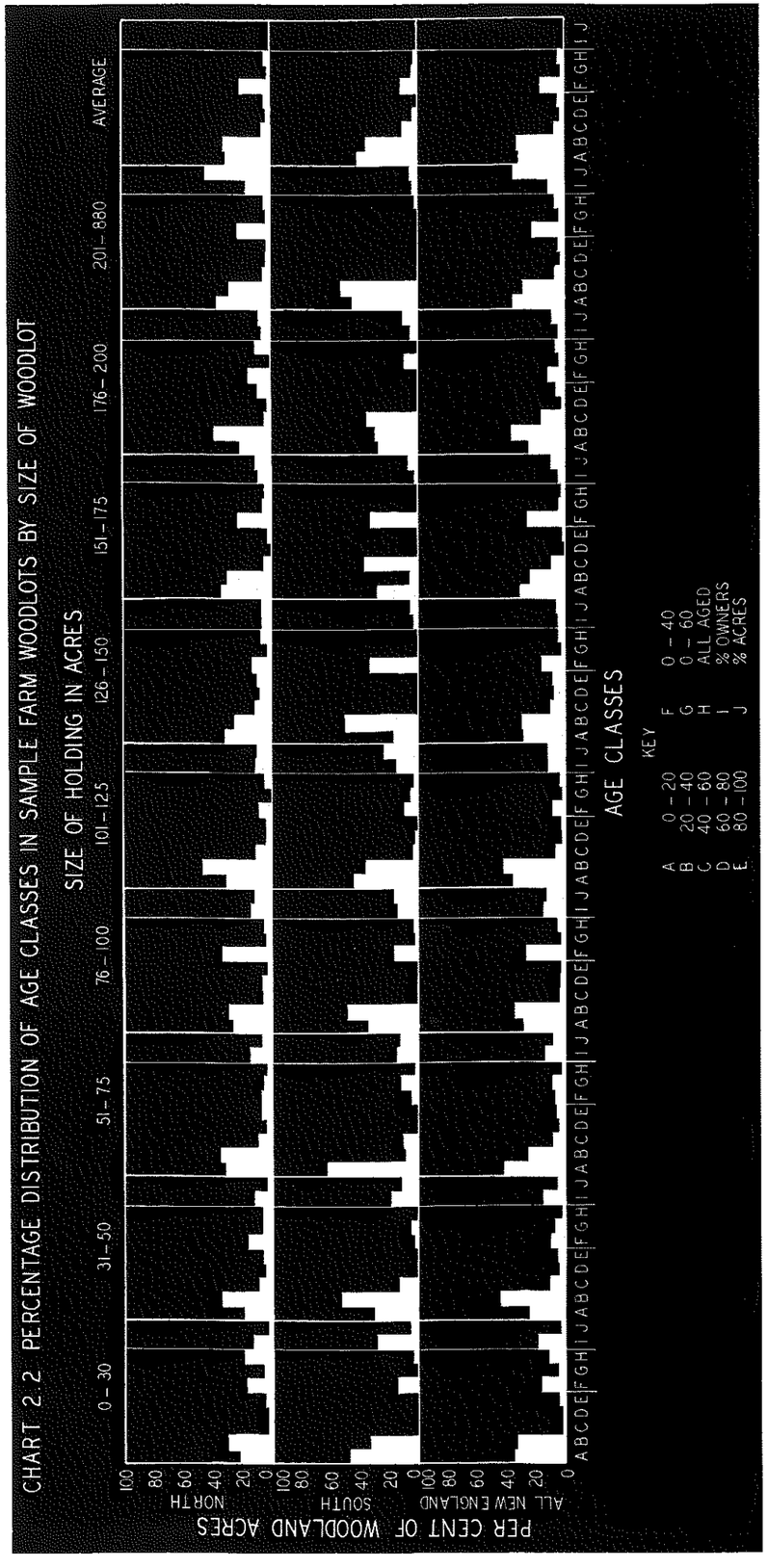


Table 2.1

DISTRIBUTION OF FOREST ACREAGES BY AGE CLASS OF GROWING STOCK

Age Class	Sample Farms			New England[1/]
	North	South	All	
	%	%	%	%
0-20	30	39	32	36
21-60	58	58	58	28
61-up	12	3	10	36

1/ Estimates by H. I. Baldwin, Forestry in New England, Boston.

Table 1.1 shows that less than 20 percent of the woodland acreage is located in the three southern states and that Maine alone has over half of the forest lands and more than its share of the sawtimber acreage. Chart 2.3, showing the cubic volume of saw and pole timber, emphasizes this pattern of acreage distribution. Maine has over 60 percent of these volumes and Southern New England has less than 15 percent. No conclusions about the relative volumes of wood per acre can be drawn from these figures, since 15 percent of the saw timber volume occurs on land that is not classified as "sawtimber acreage." It will be observed that the total pole timber volume, which will produce the sawlogs of the future, contains a smaller proportion of softwoods than the present sawtimber. However, this reduction is evident only in Maine and Massachusetts, the other states are either holding their present proportion of softwood or increasing it. This increase of hardwood acreages is probably due to the fact that hardwood usually follows the clear cutting of old-field-pine on the heavier soils and also because pulp cuttings have often taken all of the spruce and fir leaving broadleaved trees in possession of the

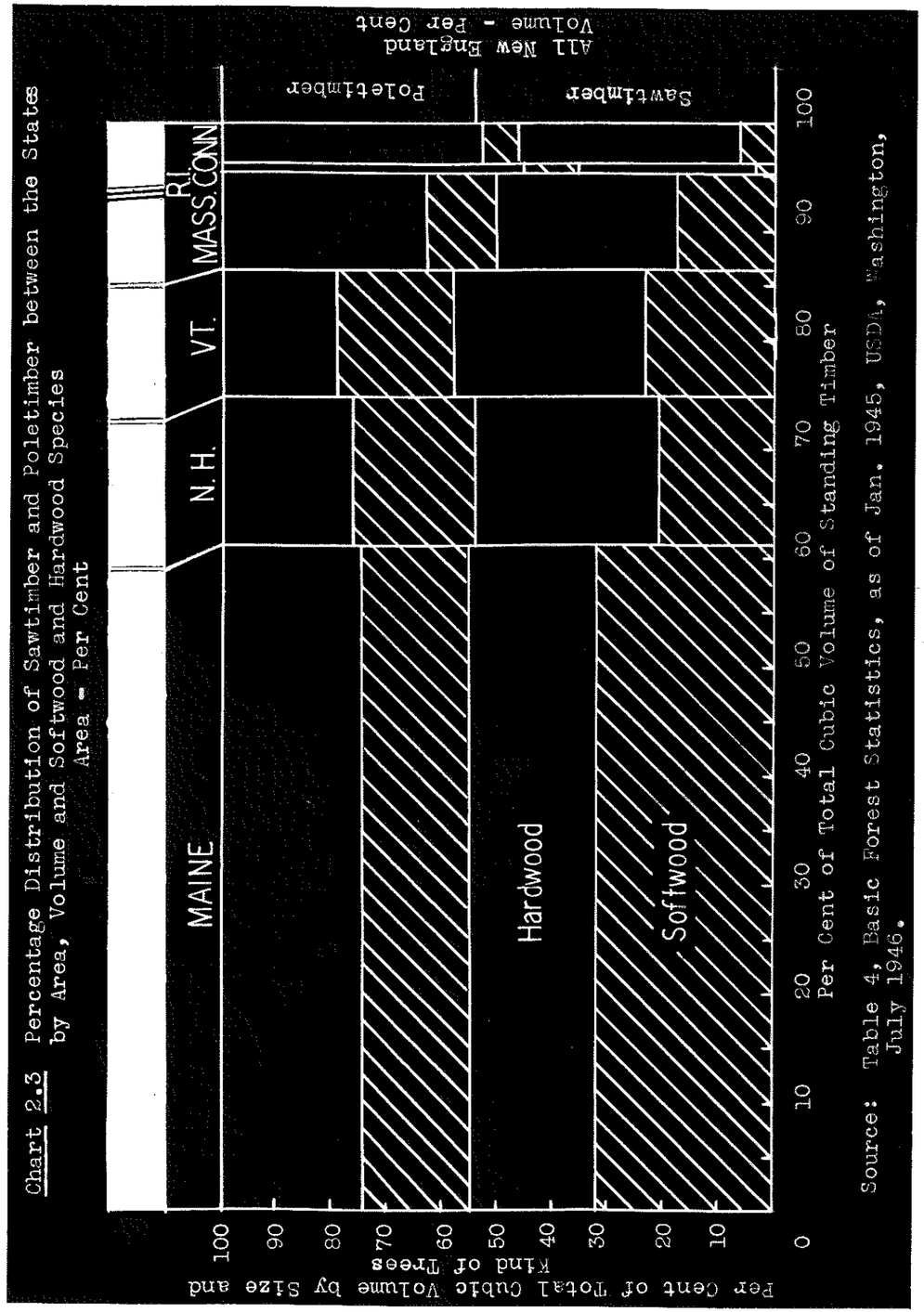


Chart 2.3 Percentage Distribution of Sawtimber and Poletimber between the States by Area, Volume and Softwood and Hardwood Species
Area - Per Cent

Source: Table 4, Basic Forest Statistics, as of Jan. 1945, USDA, Washington, July 1946.

site. It is probable that a study of the stands smaller than pole timber would show a drastic reduction in the proportion of softwoods in all states. The young stands on all the farms in the three southern states were almost exclusively central and transition hardwoods. The Grafton County, New Hampshire and the Vermont farms contained young northern hardwood stands, except that some of the farms in Essex, Washington and Caledonia Counties had many young spruce and fir stands. There was also good spruce and fir reproduction in Coos County, New Hampshire and on the Maine farms. The best young pine stands were found on the light, sandy soils of Hillsborough County, New Hampshire and Oxford County, Maine.

A very large proportion of the sawtimber land is in the sparsely settled, unorganized towns in Northern and Eastern Maine and in the mountainous areas of New Hampshire and Vermont and therefore was not sampled. It is here that the large pulp and lumber company holdings are concentrated. The area is the least accessible in New England and probably much of it can only be operated by large scale methods. Unfortunately, much of the spruce and fir sawtimber, especially on the pulp company holdings, is more likely to end up as paper than as lumber. Usually, everything cut in a pulp operation goes into paper and little, if any, effort is made to save suitable sawlogs for milling into boards. Twenty and one-half billion board[15/] feet of spruce and fir sawtimber fall in this class. Table 2.2 shows the location and volume of sawtimber by species.

Much of the 15 percent of the sawtimber volume mentioned above as being on lands with less than two thousand board feet per acre is too

15/ H. I. Baldwin, Wooden Dollars, Boston, 1949.

Table 2.2

VOLUME OF SAW TIMBER IN NEW ENGLAND BY SPECIES[1]

MILLION BOARD FEET

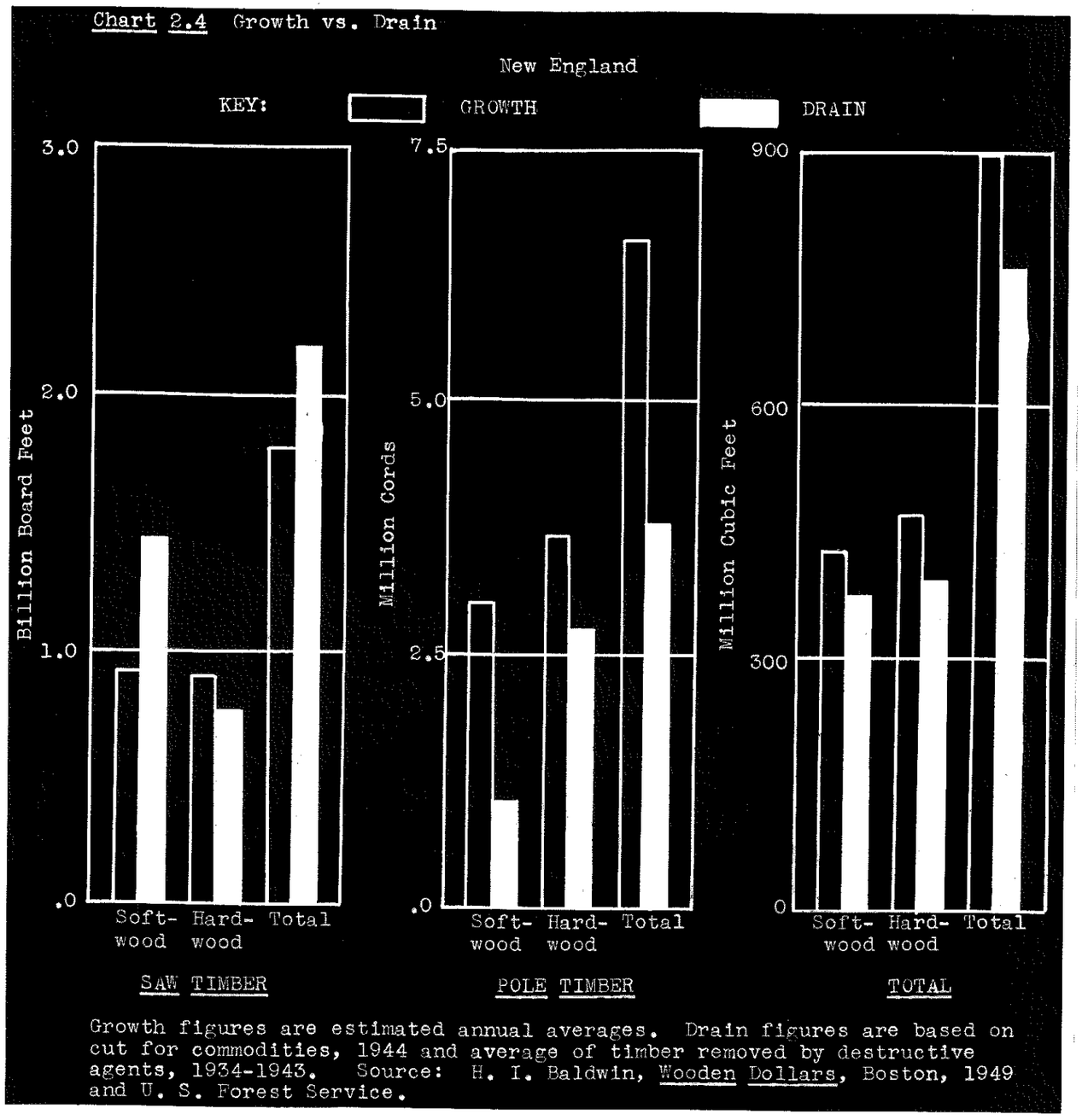
State	Softwood						Hardwood					Total All Species
	White & Norway Pine	Pitch Pine	Spruce and Fir	Hemlock	Other Softwoods	Total Softwoods	Oak	Birch Beech Maple	Aspen	Yellow Poplar	Other	Total Hardwoods	
Maine	4,091		16,554	2,362	1,272	24,279	139	11,046	1,234		89	12,508	36,787
New Hampshire	1,332	23	1,902	152	15	3,424	76	3,973	23		114	4,186	7,610
Vermont	800		2,056	408	70	3,334	70	3,800	61		70	4,001	7,335
Massachusetts	993	117	136	681	19	1,946	1,036	1,497	54	28	109	2,724	4,670
Rhode Island	21			1		22	114	9			8	131	153
Connecticut	93	2	1	160	2	258	830	415	13	28	98	1,384	1,642
New England	**7,330**	**142**	**20,649**	**3,764**	**1,378**	**33,263**	**2,265**	**20,740**	**1,385**	**56**	**488**	**24,934**	**58,197**

[1] Estimate as of January 1, 1945, by United States Forest Service Reappraisal.
Volume does not include bark (about 12% of gross volume).
Includes trees large enough for saw logs (9 inches for softwoods, 11 inches for hardwoods in diameter breast high) regardless of actual present use. Volumes on basis of lumber tally.

scattered to be economically harvested under present conditions. Many of these trees are over-mature and will deteriorate before sufficient volume grows on the area to make a cutting practicable. Thus it would seem that at least half of the fifty-eight billion feet of standing sawtimber will not be made into lumber either because it will find some other use, is too scattered or too inaccessible. Thus the major source of sawtimber is from the 7.3 billion board feet of standing white pine sawtimber. As indicated above, there are only limited areas where this species will reproduce itself so that future supplies will be more restricted after this relatively small balance of old-field-pine is cut. Until some scheme is devised for shunting suitable softwoods from pulp operations into lumber, the prospective supply of such sawtimber seems small indeed.

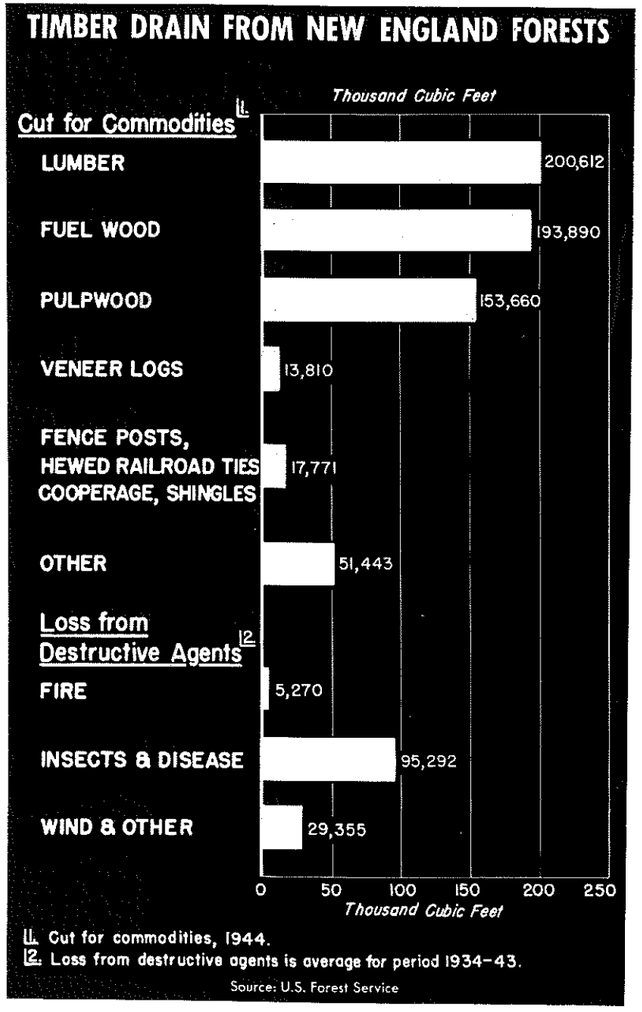
No figures are currently available about the quality of the standing timber in New England. Lumbermen can judge the availability of high quality sawlogs in their own locality, but no over-all data have been compiled. However, the market figures and lumbermen agree that good quality softwood and hardwood logs are no longer plentiful, and the Reappraisal estimates, stated above, indicate the likelihood of an increasing scarcity. Already wood imports to the region have risen considerably.

The most recent estimates of the growth and drain of New England's forest resources are shown in Chart 2.4. The drain by commodities is shown in Chart 2.5. It is apparent that the softwood sawtimber drain exceeds the growth by 58 percent. The reverse situation is true of hardwood sawtimber since growth is 14 percent greater than drain. Pole timber



Growth figures are estimated annual averages. Drain figures are based on cut for commodities, 1944 and average of timber removed by destructive agents, 1934-1943. Source: H. I. Baldwin, Wooden Dollars, Boston, 1949 and U. S. Forest Service.

Chart 2.5



of both types is growing faster than it is cut or destroyed and will eventually furnish sawtimber sized products. It is doubtful whether this will happen in time to prevent drastic depletion of our softwood sawtimber. It may be asked why is there an apparent excess of hardwood growth? The answer lies in the fact that industry has not developed a profitable use for, or a method of handling, this material that is not of the highest quality. The lack of a market for poor logs and bolts also prevents the silvicultural cuttings necessary to improve the quality of future sawlogs. Strangely enough, when lumbermen are asked about using low quality materials, they usually say that they could be used but the supply is too uncertain or limited to warrant investment in the necessary equipment. The result is that low-grade material isn't cut because no market exists and the market isn't developed because the material isn't cut. On the solution of this paradox depends much of the success of forestry in the future.

The great bulk of the planned cut on the sample farms over the next ten or fifteen years will be in the form of fuel or pulp wood under any sort of management, this follows as a direct consequence of the young average age of the growing stock. In areas where no markets for this material exist, it is doubtful whether the cuttings can be made except in quantities that can be consumed on the farm for fuel and posts. Unfortunately, the poorest hardwood stands, that must have improvement cuttings if they are to produce merchantable trees, are in Southern New England where markets are extremely limited and less wood is burned than in the North. An extension of the hardwood pulp market available in Connecticut through the "Connwood" cooperative would help considerably to alleviate

this difficulty provided it did not cause indiscriminate clear-cutting. There is also a limited fuelwood market available in the cities and towns that can be developed by enterprising individuals; however, only three of the southern sample farms sold any significant quantity of fuelwood. This same situation applies to the Southern and Central New Hampshire farms.

The Northern New Hampshire, Maine and Vermont farms have fairly steady outlets for both hardwood and softwood pulp, while local turneries buy considerable quantities of hardwood bolts. There is thus a good chance to sell most of the products of cuttings made to improve the future yield of the woodlands. More of the farmers in the northern areas burn cordwood for heat and cooking and can use their own production of fuel. In Northwestern Vermont the maple product business provides not only a good supplementary farm enterprise but sap boiling consumes much of the fuelwood that might otherwise have no market.

The extent to which local production of forest products falls short of industrial needs can be judged, but not exactly measured, by the following figures.[16/] The apparent net regional deficit between production and consumption, after a small adjustment for exports, is about five hundred million board feet of softwood and sixty million board feet of hardwood lumber. About five hundred thousand cords of pulp wood are also imported in addition to a relatively small quantity of raw pulp. Some of these latter imports are partially balanced by exports and most of them are probably due more to favorable foreign prices rather than to

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16/ R. I. Baldwin, Wooden Dollars, Boston, 1949.

absolute shortages of pulp at home. The real deficit is in the board feet of quality lumber for building and industrial use. If the situation on the sample farms is representative of widespread forest conditions, it will take at least twenty years of improvement cuttings to affect an appreciable increase in the quantity of good quality sawlogs. Present regional reserves of high-grade sawtimber may well have been exhausted before this new production can take place.

This picture of a shortage of sawtimber is part of the same national problem. With the approaching exhaustion of virgin timber and increasing transportation charges, the indefinite continuation of present regional imports is in considerable doubt. Unless New England is to lose many of its three thousand wood-using industries, more desirable material must be produced locally. Of course, a simple balance of growth and drain at a low level of productivity will be attained by the present methods of utilization, but this will not yield the greatest returns to society. Changes in forest practices are capable in time of at least doubling the present net returns to land owners with an increase in output sufficient to continue and considerably expand the present wood-using industries, but the production of high quality sawlogs on a large scale cannot be accomplished without silvicultural treatment of the young stands. This brings us back to the previous paradox because these treatments normally won't be made unless the low grade products they yield can be sold for at least enough to pay for the operation.

Chapter III

THE OWNERSHIP AND MANAGEMENT OF NEW ENGLAND'S FOREST LAND

The last chapter outlined the physical state of New England's forest growing stock and some of the major natural forces affecting growth. It is now germane to inquire what other forces determine how this resource will be utilized. It will be necessary to discover what the present operating units are, who establishes the management policies used and what factors affect these decisions. It is apparent from Table 3.1 that 95 percent of the region's commercial forest land is privately owned. Forest operations on over half of this area are physically accomplished by, or are under the direction of, the owners. The type of forestry practiced on the balance of the area can usually be controlled by the land holder if he so desires. Within very wide limits the management of any tract is the sole responsibility of its owner since society has placed few restrictions on operating methods. Unlimited burning, that threatens the property of others, is not permitted and some regulations govern operations during extreme fire hazard periods, but beyond that there are few taboos. Some of the states require that seed trees be left on an operated area or that notice be filed with the state before a cutting is made. As actually administered, these laws place no practical limits on the owner's freedom to choose how he will manage his forest land. The public, through property taxes, does place a financial burden on forest land that may have considerable effect on its management, but this usually is not

the purpose of the levy.[1] If taxes take away all, or a large portion, of the revenue that can be realized by conservative management, forest growing-stock may be liquidated and woodland may become an unattractive investment. In most instances, taxes do not place any stringent limits on the forest operations of small owners.

What then, are the factors that affect the choice of a management plan by any given owner? This question cannot be answered exactly except by a study of each owner and his special problems, truly an enormous task. However, a good many facts have been collected that will indicate the major forces activating certain broad groups of more or less similar land holders. Information from the Reappraisal Reports can be supplemented by other studies to throw considerable light on the questions of, "Who owns our forest land?" and, "What factors motivate their management policies?"[2] It might be said that since this study is concerned only with specific case studies, it makes no difference how the rest of the forest land is controlled. But the actions of any individual are affected by the habits, customs and institutions of his fellows, and only by observing the actions of all forest land owners is it possible to find

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1/ The State of New Hampshire has recently exempted "growing wood and timber" from all taxes except a 10 percent yield tax. A 5 percent rebate is provided if cutting is carried out in a fashion calculated to improve or maintain forest production. It is hoped that this law will improve the forest practices used in the state.

2/ General background for this chapter has been obtained from the following: U. S. Forest Service, USDA, Reappraisal of the Forest Situation, reports 1 and 2, Washington, D. C., 1946; Basic Forest Statistics for the United States, same agency, Washington, D. C., 1946; M. I. Baldwin, Federal Reserve Bank of Boston, Wooden Dollars, Boston, 1949; Selon L. Barraclough, Forest Land Ownership in New England, Doctoral Thesis, Harvard University, Cambridge, 1949.

the external factors limiting the area of decision available to any one operator.

The over-all division of forest land ownership is given in Table 3.1. A further refinement of these figures, Chart 3.1, shows the distribution of this land by states. One of the more outstanding facts shown here is that only 5 percent of the forest land is owned by government units, which puts the fate of New England's woodlands squarely in the hands of private owners. No amount of well planned production that confines itself to government holdings can have more than a local effect, except as it may point the way to be taken by private individuals. The management of government forest land had no discernible effect on any of the farm woodlots studied. More complete figures on government acreages are given in Table 3.2.

Table 3.1

OWNERSHIP OF COMMERCIAL FOREST LAND IN NEW ENGLAND[3]

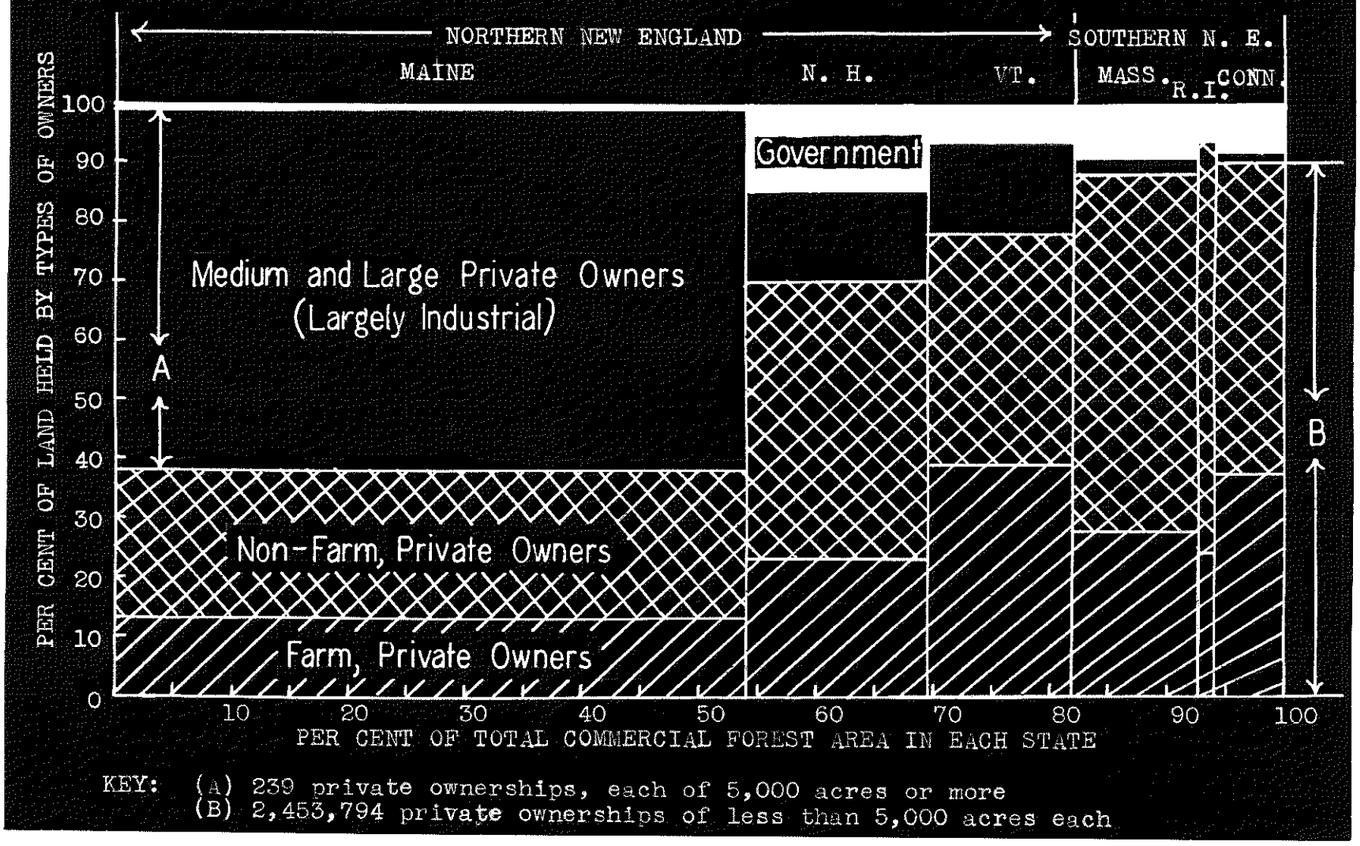
	All Ownerships	Govt. Owned	All Private	Small Private[4] Farm	Small Private[4] Other	Medium and Large Industrial[5]
M Acres	30,861	1,567	29,294	6,477	11,184	11,633
Percent	100	5	95	21	36	38

3/ Source: U. S. Forest Service, USDA, Table 21, Reappraisal of the Forest Situation, Report 1, Washington, D. C., 1946; and M. I. Baldwin, Table 17, Wooden Dollars, Boston, 1949.

4/ Holdings less than 5,000 acres each.

5/ Holdings 5,000 acres to 50,000 - Medium; 50,000 and up - Large.

Chart 3.1 Percentage Distribution of the Ownership of Commercial Forest Land in New England, by Types of Owners and States



KEY: (A) 239 private ownerships, each of 5,000 acres or more
(B) 2,453,794 private ownerships of less than 5,000 acres each

Table 3.2

AREAS OF PUBLICLY OWNED FOREST LAND IN NEW ENGLAND (1)

	Maine Acres	N.H. Acres	Vermont Acres	Mass. Acres	R.I. Acres	Conn. Acres	N.E. Acres
FEDERAL							
National forest	49,062(2)	649,000	168,138	1,625(3)			867,825
National parks	32,824				2,000		34,824
Other federal(4)	26,534	8,000	1,582	5,000	10,699	11,733	63,548
Total	108,420	657,000	169,720	6,625	12,699	11,733	966,197
STATE							
State forests	21,000(5)	21,767	71,712	170,000	3,407	120,296	408,181
State parks	89,251	32,053	6,871	3,967	3,794	15,400	151,246
State college	3,747	1,142	551	756			6,196
Miscellaneous(6)	46,474	3,848		89,800	13,826	17,551(8)	171,499
Total	160,472	55,939	79,134	264,523	20,937	153,247	734,252
County		3,925			11,430		15,355
Town and city							
Town and municipal forest	3,500	55,086(9)	10,500	131,500	164	503	201,253
Other town forest land				3,000			3,000
Watershed forests	10,000	9,581	5,020	38,000	11,758	40,000	114,359
Total	13,500	64,667	15,570	172,500	11,922	40,503	318,662
TOTAL - ALL PUBLIC FOREST LANDS	282,392	781,531	264,374	443,648	56,988	204,483	2,033,416

(1) Based on Table 26 in Forestry in New England, National Resources Planning Board Publication, 1942, and brought up to date from information furnished by Dr. Henry I. Baldwin, New Hampshire State Forestry and Recreation Commission, and from data supplied by the State Foresters.
(2) Includes Massabesic Forest Experiment Station.
(3) Hopkins Experimental Forest.
(4) Army Bombing Range, Flood Control Projects, etc.
(5) Indian Township - held in trust by State of Maine for Passamaquody Indian Tribe.
(6) 7,000 acres forested.
(7) Includes Baxter Forest Park of 77,205 acres.
(8) 5,256 acres forested.
(9) See Table 6.

Federal Lands

The federal government owns or operates nearly half of the total public lands, and 90 percent of this acreage is concentrated in the White and Green Mountain national forests. The management of these areas is on a multiple-use basis that takes into consideration such public values as erosion and flood control, recreation and esthetic values and the conservation of wildlife, as well as timber production. Since measures to promote better forest production usually increase these other less tangible values, considerable progress has been made toward well balanced management. Many indirect benefits have accrued locally because of national forest development in addition to the direct expenditure of money for administration and operation. Local wood-using industries have acquired a firmer base because of sustained yield management and the markets for forest products are less disturbed by erratic supplies of raw materials. A good deal of the highly developed recreational trade of the mountain areas can be directly attributed to the excellent facilities made possible by the Forest Service.

State and Community Lands

The bulk of the state and community forest land is managed for special purposes such as recreation and watershed protection. The land dedicated to forest production is usually handled on a multiple-use system similar to that used on the National Forests. Several factors such as poor stocking, unstable administration and lack of funds have inhibited the full attainment of management goals. Because of these difficulties and limited area, the state and community woodlands can

make only a small contribution to the solution of forest management problems in New England.

Private Lands

Private individuals and corporations own 95 percent of New England's forest land and therefore control the future of this resource through their management policies. Within this broad group there are over two hundred and forty-three thousand individuals owning a total of more than twenty-nine million acres of woodland. Since these people come from all walks of life, there is tremendous variation in the size of their holdings, their purpose of ownership and their financial, managerial and physical abilities. It is possible, however, to find broad sub-groups of owners that are relatively homogeneous in respect to size of holding and occupation, and therefore show some consistency of behavior.

Perhaps one of the most significant primary divisions of forest owners can be made on the basis of size of holding. Certainly the amount of land under a single manager places severe limits on the policies that can be carried out. The owner of ten acres can afford neither the technical help nor the production methods that make for the successful operation of a ten thousand acre property. The question of how to employ the optimum intensity of management on fifty thousand acres may be a very serious and pressing problem to its owner because investment and carrying charges are heavy. However, the management used by the owner of fifty acres may be of minor importance to him since it can have little effect on his total income, no matter what is done.

Large Holdings

Large woodland holdings are here classified as those of five thousand acres or more under a single ownership. Table 3.3 shows that only two hundred and thirty-nine ownerships of this type include nearly 40 percent of the private commercial woodland in New England. Investigation[6] has shown that this land is seldom broken up and forms a sizeable core of land under stable ownership, managed for forest production. Chart 3.1 shows that most of this land is in Maine where it constitutes 62 percent of the state's commercial forest area. Table 3.4 reinforces the conclusion that the management of large holdings is almost exclusively the problem of the "north countree." Most of these holdings are located in the remote wilderness areas and support stands of spruce, fir and northern hardwoods. The construction of roads and other improvements necessary to operate these areas requires such heavy investment that most of the land could not be managed except as large holdings with considerable financial ability.

It is also apparent from table 3.4 that the great bulk of the large holdings are owned by pulp and paper companies or are held as investments which are often closely allied with the wood pulp industries. The pulp and paper companies are characterized by a heavy plant investment (over 592 million dollars in 1947[7]) and a high degree of vertical integration[8].

6/ Solon Barraclough, Forest Land Ownership in New England, Doctoral Thesis, Harvard University, 1949.

7/ N. I. Baldwin, Wooden Dollars, Boston, 1949.

8/ J. A. Guthrie, The Newsprint Paper Industry, an Economic Analysis, Cambridge, 1941.

Table 3.3

DISTRIBUTION OF ALL PRIVATE COMMERCIAL FOREST LAND IN NEW ENGLAND BY SIZE OF HOLDING

Size of Forest Holding	Number of Owners		Acres of Forest Land Held		Cumulative Percentage by Size of Holding	
Acres	Number	Percent	Thousands of Acres	Percent	No. Owners	Thousands of Acres
50,000 & up	45	.02	9,485	52.57	.02	52.57
5,000-49,999	194	.07	2,150	7.34	.09	59.71
2,500-4,999	49	.03	286	.97	.12	60.68
1,000-2,499	244	.10	385	1.32	.22	62.00
500-999	707	.29	517	1.77	.51	63.77
250-499	4,168	1.70	1,807	6.17	2.21	69.94
100-249	30,099	12.34	5,529	18.86	14.55	88.80
50-99	60,930	24.98	4,811	16.43	39.53	85.23
10-49	122,248	50.11	4,127	14.09	89.64	99.32
0-9	25,274	10.36	199	.68	100.00	100.00
Total	243,719	100.00	17,861	100.00		

Source: Based on U. S. Forest Service Report, Reappraisal of the Forest Situation, Washington, D. C., 1946.

Table 3.4

PRIVATE OWNERSHIP OF COMMERCIAL FOREST LAND IN NEW ENGLAND INCLUDING 50,000 ACRES OR MORE, BY TYPE OF OWNERSHIP[1]

Type of Ownership	Number	Percent	Thousands of Acres	Percent
Pulp and paper	20	44.45	6,207	65.4
Lumber Company	6	11.10	215	2.2
Investment	20	44.45	3,061	32.4
Total	45 [2]	100.00	9,483	100.0

1/ Based on U. S. Forest Service Reappraisal Data. From Solon Barraclough, Forest Land Ownership in New England.

2/ All Holdings in Maine, New Hampshire and Vermont.

Because they require a steady supply of raw material to maintain their production, these companies have an awakening interest in forest management. Most of them already employ trained foresters who have a varying amount of influence over woods operations. Some companies have started management experiments.[9] Several members of the industry have cooperated with the New Hampshire Extension Service during the past few years by sponsoring a pulpwood cutting contest among the farmers of the state.[10]

Most of the pulp companies feel that they can purchase their raw material cheaper than they can cut it from their own lands. However, company woodland provides a necessary insurance against a pulp famine. This feeling about the cost of operation has promoted a policy of cutting lightly at home and buying as much as possible from the land of other owners. Company buyers obtain bolts or stumpage directly from landowners or through contractors and timber operators. The efforts of buyers to make each purchase as large as possible probably encourage the use of clear-cutting methods. At present about one-fourth of the yearly amount of pulpwood is imported from abroad, Table 3.5, and about one-half of the domestic supply comes from lands owned by other people, a large part of whom are farmers.

The Reappraisal estimates of management practices, Table 3.6,

9/ The International Pulp and Paper Company has set up a several thousand acre pilot-operation at Philip's Brook in New Hampshire. This area will be used to test out the practicality of partial cutting methods and their results on the woodland growing stock.

10/ The companies finance the contest and the County Foresters and the Extension Forester organize it. Contestants are judged on the basis of how closely they adhered to good forestry practices in their cuttings. Both state and county winners are given prizes and considerable publicity.

Table 3.5

PRODUCTION, CONSUMPTION AND IMPORTS OF PULPWOOD IN NEW ENGLAND[1]

Cords

Year	Consumption	Imports	Apparent Local Production[2]
1943	2,150,085	466,253	1,683,830
1944	1,980,140	525,061	1,455,079
1945	2,074,947	529,239	1,545,708
1946	2,272,413	502,087	1,770,326

1/ Source: M. I. Baldwin, Wooden Dollars, 1949.

2/ Includes wood used from stockpiles plus new wood delivered to mill and consumed during the year. Data supplied by American Paper and Pulp Association, 1947.

Table 3.6

CLASSIFICATION OF COMMERCIAL FOREST LAND BY OWNERSHIP AND TYPE OF MANAGEMENT[1]

Type of Owner	Land under Intensive[2] Management		Land under Extensive[3] Management		Land without Management 4/		Non-Operating Forest Land 5/		Total		Percent of All Forest Land
	M.Acs.	%	M.Acs.	%	M.Acs.	%	M.Acs.	%	M.Acs.	%	%
Small Owners											
Farm	-	-	2,999	46.3	3,316	51.2	162	2.5	6,477	100	21.0
Non-Farm	-	-	4,372	43.5	5,857	52.4	455	4.1	11,184	100	36.3
Total	-	-	7,871	44.6	9,173	51.9	617	3.5	17,661	100	57.3
Medium and Large Owners Industrial and Other	17	.1	10,823	93.1	683	5.9	110	.9	11,633	100	37.7
All Private	17	.1	18,694	63.8	9,856	33.6	727	2.6	29,294	100	95.0
Government	34	2.2	1,350	86.6	19	1.2	154	10.0	1,557	100	5.0
GRAND TOTAL	51	.2	20,044	65.0	9,875	32.0	881	2.8	30,851	100	100.0

1/ Source: U.S.D.A., Forest Service, Report No. 3 from A Reappraisal of the Forest Situation, Washington, D. C., 1946.

2/ Intensive Management - requires high order cutting and good fire protection.

3/ Extensive Management - requires at least fair cutting and fair fire protection.

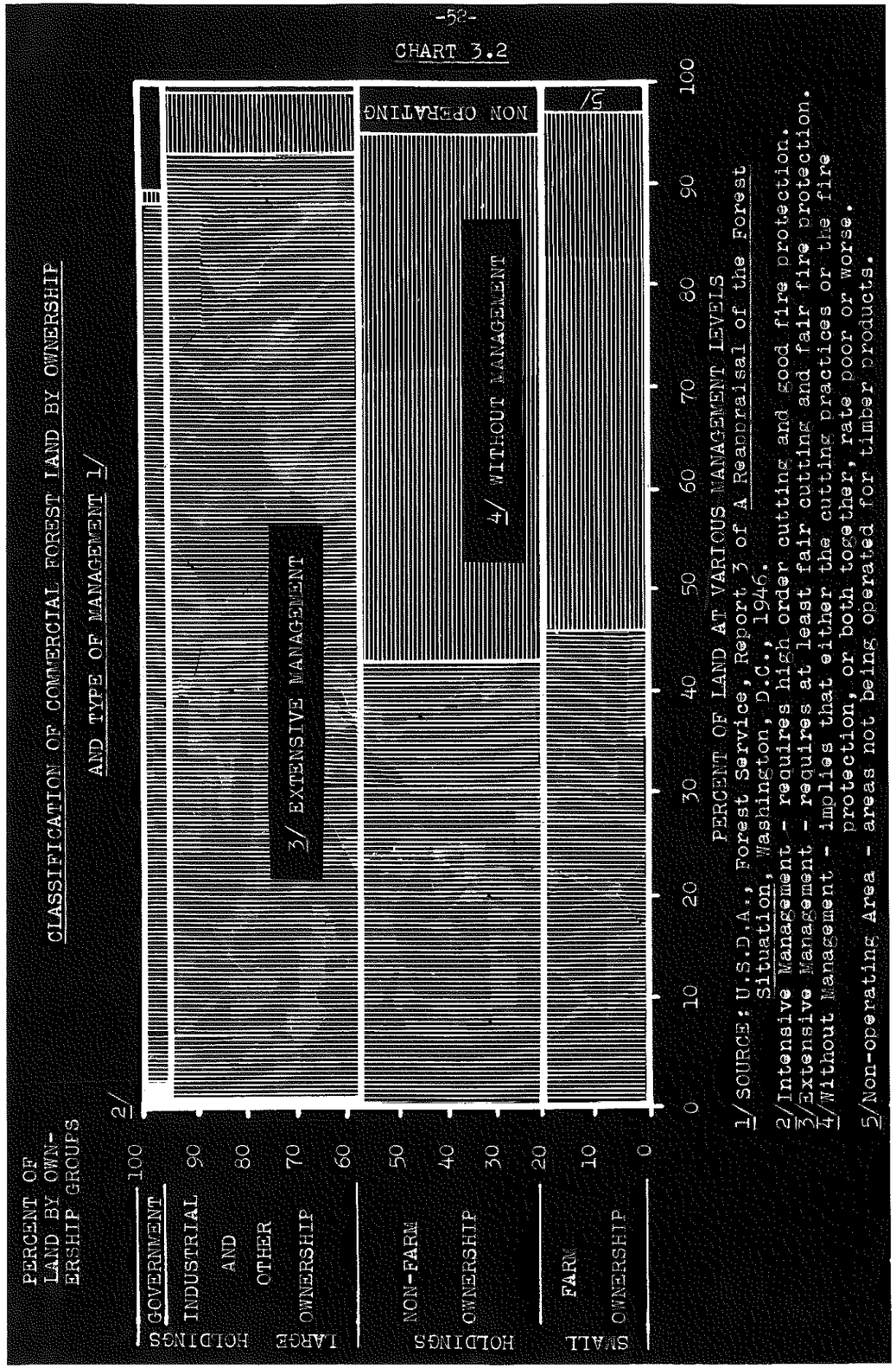
4/ Without Management - implies that either the cutting practices or the fire protection, or both together, rate poor or worse.

5/ Non-Operating Area - areas not being operated for timber products.

classify 97 percent of the pulp company lands as being under "extensive management" and only a little over 2 percent as being "without management." These are included with the "Industrial and Other" holdings. On this basis of classification the large owners employ silvicultural practices that are second only to those used on government holdings (Chart 3.2). Actually this is somewhat misleading in that it is primarily based on practices that will perpetuate or improve forest growing stock rather than upon any economic criteria. Many of the better ratings attained by the large owners may be due to the policy of buying from others and not cutting their own lands or to types of "high-grading" that leave a vigorous tree cover that is largely made up of relatively undesirable species. Even after any necessary corrections the figures still show that the large ownerships are better managed silviculturally than most other private lands.

Company foresters find the adoption of new practices blocked by the lack of definite and well proven figures, showing the benefits that will accrue from changed management policies, with which they can impress a board of directors. The other major obstacle has been an inability to start integrated logging operations that channel each product harvested into its highest use. On present single-product cuttings everything goes into pulp, regardless of whether it might be suitable for some more valuable use. Integrated logging has been very successful in Sweden and other European countries where pulp and paper mills operate in conjunction with saw mills and other wood-using industries. Some changes of plant equipment and location may be necessary before the full benefits of this type of utilization can be realized in New England. The single-product

CHART 3.2



system of cutting tends to reduce the potential softwood sawlog inventory, since over twenty of the fifty-eight billion board feet of standing sawtimber are spruce and fir, the favorite pulp species.

The effect of the buying methods and business activity of the pulp companies is readily discernible on the case studies in Maine, Northern New Hampshire and Northeastern Vermont. Farm woodlots have been systematically worked over for spruce and fir and heavy cuts have been made during periods of high pulp prices or during agricultural depressions when every dollar was needed to keep the farm family going. Since the price of pulpwood may vary considerably and purchases may be cut off at any time due to business anticipations or a water shortage, there is a tendency for landowners to cut as heavily as possible when prices are considered favorable, regardless of how this may affect future yields. Many farmers, their friends or their woods labor in the northern areas have worked at one time or another on large company operations. In the past these cuttings have left few standing trees behind because a large volume was needed to pay off the costs of extraction from remote areas. Frequent cuttings were not usually considered practical. The clear-cutting methods and operating habits acquired on these jobs are carried over to smaller operations and form a traditional method of cutting that is difficult to change.

The last and smallest group of large owners is made up of lumber companies. Actually, only one-fourth of their lands are in blocks of five thousand acres or larger. Table 3.7 shows that the lumber companies face a problem of managing many small holdings. The Reappraisal figures show that nearly half of their lands are "without management," which is

Table 3.7

DISTRIBUTION OF LUMBER COMPANY LANDS BY SIZE OF HOLDING AND NUMBER OF OWNERS 1/

Size of Holding in Acres	Number of Owners		Acreage of Land		Cumulative Number of Owners		Cumulative Acreage	
	No.	%	Thous.A.	%	No.	%	Thous.A.	%
50,000 & up	5	.05	215	9.81	5	.05	215	9.81
5,000-49,999	21	.23	297	13.56	26	.28	512	23.37
2,500- 4,999	49	.52	286	13.05	75	.80	798	36.42
1,000- 2,499	122	1.30	221	10.08	197	2.10	1,019	46.50
500- 999	-		-		-		-	
260- 499	951	10.15	429	19.58	1,148	12.26	1,448	66.08
100- 249	1,584	16.92	351	16.02	2,732	29.18	1,799	82.10
50- 99	2,900	30.98	265	12.10	5,632	60.16	2,064	94.20
10- 49	3,217	34.37	124	5.66	8,849	94.53	2,188	99.86
0- 9	512	5.47	3	.14	9,361	100.00	2,191	100.00
	9,361 2/	100.0	2,191 3/	100.0				

1/ Based on number of owners and acreages in "Reappraisal Sample Areas." "Blown up" to represent New England conditions.

2/ 9,361 owners represent 3.84% of all New England private owners.

3/ 2,191,000 acres represent 7.48% of all New England commercial forest acres.

a poorer showing than any other group except small owners, Table 3.6. Many lumber company areas have been bought merely to be stripped of the standing merchantable growth and resold, if a buyer could be found. There has often been no intention of holding the land for future production. The few large owners usually have a high plant investment and need a steady supply of raw material, much as do the pulp and paper companies. Many of the small sawmills, on the other hand, that buy lots solely for the present cut they contain, are characterized by a relatively light investment, as is shown in Table 3.8. This fact does not stimulate a long term interest in forest management.

Many of the wood-using industries classed as lumber companies own small scattered holdings. Taken as a group, they often present an opportunity for coordinated management since a large number of the lots are in accessible areas near enough together to be handled as a single property. Some of the companies are interested in working out management schemes that will change these cut-over lands from a liability to an asset. Here again, single-product operations prove a handicap to improved utilization, since many of the lots are only suited to growing hardwoods while their owners use only white pine.

In summary, where large blocks of land are held by companies with a long term interest in forest production, they are gradually working toward management plans that will maintain both the public and private forest values at a satisfactory level. These owners are well equipped with the financial and physical facilities necessary to carry out policies that will maximize the returns from forest land. The small holdings of lumber companies, aggregating only about 4 percent of all

Table 3.8

INVESTMENTS AND WORKING CAPITAL IN SAWMILLS IN NEW ENGLAND[1]

Mill Class[2]	1947 Replacement Cost per Mill Including Power Unit	No. Mills	Total Value (1947)	Working Capital per Mill (1947)	Total Working Capital (1947)
0	$ 800	366	$ 292,800	$ 100	$ 36,600
1-2	800	754	603,200	500	377,000
3	1,500	309	463,500	2,000	618,000
4	2,500	348	870,000	3,000	1,044,000
5	4,000	30	120,000	5,000	150,000
6	6,000	6	36,000	8,000	48,000
7-8	20,000	1	20,000	12,000	20,000
Total		1,814	$2,405,500		$ 2,293,600

1/ Source: H. I. Baldwin, Wooden Dollars, 1949.

Estimates supplied by Northeastern Forest Experiment Station, U.S. Forest Service, 1947.

2/

Class	Annual Production	Class	Annual Production
0	Under 50 M. bd. ft.	5	5,000-4,999 M. bd. ft.
1	50-199 " " "	6	5,000-9,999 " " "
2	200-499 " " "	7	10,000-14,999" " "
3	500-999 " " "	8	15,000-24,999" " "
4	1,000-2,999" " "		

Mills in classes 0, 1 and 2 are not operated full time.

commercial forests, present the knottiest problem included in this group of owners. A good deal more specific research is needed in the problems of individual large owners, especially in the fields of forest production and integrated management, before any final conclusions can be made on the contribution of this group to forest production. But it is obvious that they constitute an important segment of the forestry problem, subject to concentrated attack through a few individuals and companies. The forest industries are, of course, of vital importance to all woodland owners since they provide the all essential markets for forest products.

Small Holdings

The "small owners," those holding less than five thousand acres apiece, are the group with which this study is primarily concerned. That they hold a dominant position in the New England forestry picture is readily apparent since together they hold over half the woodland acreage, 17,661 thousand out of 30,651 thousand acres, Table 3.1. They are also numerous enough to be impressive, outnumbering all other owners twenty-four to one. At first glance there seems to be little homogeneity within the group; their holdings vary from one to five thousand acres and they include members of practically every occupation and social strata of our society. Small holdings are prevalent all over New England but they are particularly important in the three southern states where they contain about 90 percent of the forest land. Even in Maine, New Hampshire and Vermont small holdings are very significant, comprising 57, 69 and 78 percent of the respective states' commercial woodland, Chart 3.1. That small owners control a great portion of Southern New England is not

surprising when it is remembered that most of their holdings have originated from old farmsteads and woodlots. The ancient methods of dividing land among settlers by successive "draws" or "pitches" set the patchwork pattern of small holdings that exists to the present time. Most of the area once cleared and then abandoned to forest growth is now in small ownerships. Map 3.1 shows the existing land divisions in the town of Durham, New Hampshire. This highly irregular pattern of ownership is typical of the sample farms in Central and Southern New England. Those studied in the northern areas, where settlement started at a later date, follow a much more regular layout and less adjustment in area has taken place by sale, inheritance and abandonment. That the management of small holdings is far below the optimum silvicultural intensity is indicated by the fact that the Forest Service rated 81.9 percent of it as being "without management."[11/] Chart 3.2 clearly shows that over half of the small owners use forest practices that will not perpetuate a valuable supply of forest products.

The breakdown of small owners by size groups will shed some light on the broader problems of management. The lumber company holdings have already been discussed and their removal takes out all owners of over twenty-five hundred acres. Of those remaining, it is significant that 61 percent of all small woodland owners have less than 50 acres each and their aggregate acreage is 26 percent of the area in small forest holdings, Table 3.3. Units from 50-99 acres in size include 26 percent of the

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11/ It may be noted that this rating is due to "poor or destructive" cutting practices since no land in this group has less than "fair" fire protection.

Map 3.1

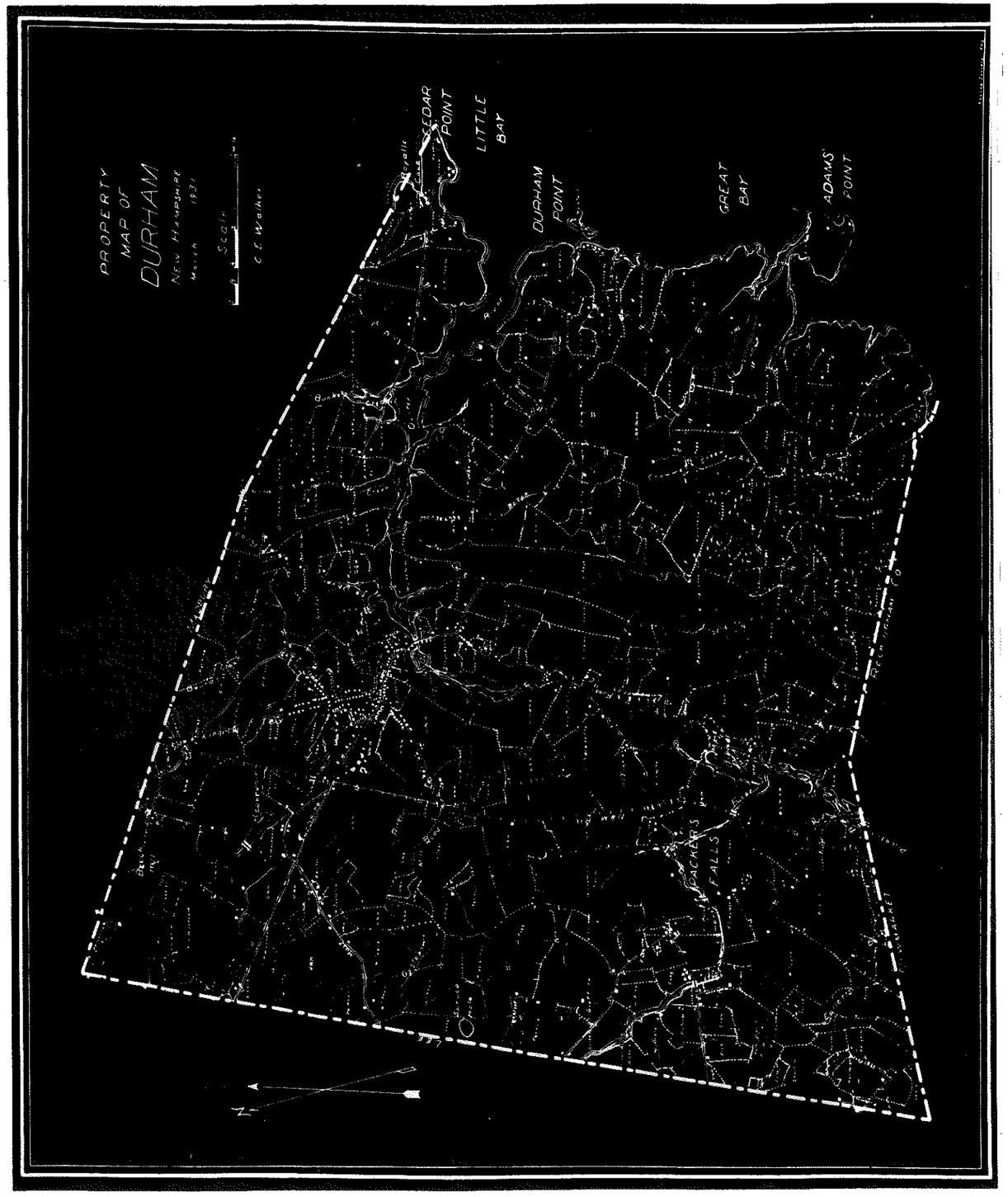


Table 3.9

DISTRIBUTION OF SMALL OWNERSHIPS BY SIZE OF HOLDING AND NUMBER OF OWNERS1/

Size of Holding In Acres	Number of Owners		Acreage of Land		Cumulative Number of Owners		Cumulative Acreage	
	No.	%	Thous.A.	%	No.	%	Thous.A.	%
1,000-2,499	122	.05	164	1.03	122	.05	164	1.03
500- 999	707	.30	517	3.24	829	.35	681	4.27
250- 499	3,217	1.37	1,378	8.63	4,046	1.72	2,059	12.90
100- 249	28,466	12.15	5,166	32.35	32,512	13.87	7,225	45.25
50- 99	58,030	24.77	4,546	28.49	90,542	38.64	11,771	73.74
10- 49	118,958	50.79	3,996	25.03	209,500	89.43	15,767	98.77
0- 9	24,762	10.57	196	1.25	234,262	100.00	15,963	100.00
	234,262 2/	100.00	15,963 3/	100.00				

1/ Based on number of owners and acreages in "Reappraisal Sample Areas." "Blown up" to represent New England conditions.

2/ 234,262 owners represent 90.38% of all New England small owners.

3/ 15,963,000 acres represent 96.12% of all New England commercial forest land in small holdings.

owners and 28 percent of the small forest holdings. Owners of less than 100 acres have thus accounted for 86 percent of the number of owners and 56 percent of the total forest land held in small ownerships. The rest of the small owners, holding from 100 to 2,500 acres each, include 14 percent of the numbers and 45 percent of the acreage of small holdings. Out of this total, most of the owners, and most of the area, are found in lots of 100 to 260 acres.

From the standpoint of size alone, the problems of small owners are often thought of in terms of many thousands of people owning about sixty-two acres apiece.[12/] The figures cited above indicate that although holdings of this size include about one-half of the small ownerships, they control less than one-fifth of the total forest acreage. Nearly half of the land in small ownerships is held in blocks of 100 acres or more and any programs designed to foster improved forestry must take this into account. In terms of all forest holdings, it would seem that management adjustments made by only 40 percent of the owners can affect 85 percent of the forest land.

The occupation of a forest owner can affect both his ability and desire to manage his woodland. By affecting the motives of ownership and the values received from woodland, occupation also has a strong bearing on what management practices will maximize personal returns. There are several other factors having a direct bearing on management that can be discussed by occupational groups. The age of the owner, tenure, method

12/ U.S.D.A., Forest Service, Forests and National Prosperity, Miscellaneous Publication No. 668, Washington, 1948.

of acquiring land, whether or not he has, or expects to receive, any income from his land and many other factors have direct and indirect effects on management decisions.[13/]

Farmers

The Reappraisal estimates of the number of farmers owning woodland are based on their own sampling process, adjusted to agree with census figures. There seem to be good reasons for believing that there are only about half as many farms being aggressively operated on a commercial basis, and that they control about two-thirds as much forest land, as the Forest Service's estimate.[14/] However, for lack of better information this discussion will be based on the official figures and the above qualification must be carried in the mind of the reader.

The importance of this distinction between active farms and part-time and residence farms is apparent when it is realized that the labor, equipment and managerial capacity used on an active farm can often be used in woods work. If these prerequisites are missing, as they usually are on part-time and residence farms, forestry cannot be carried out as a complementary or supplementary enterprise and the owner faces the same problems as do the non-farm owners. Of course, there are active farms where forestry doesn't fit neatly into the budget of operations, alternative activities may be more attractive or remunerative, or

13/ Solon Barraclough, Forest Land Ownership in New England, Doctoral Thesis, Harvard University, 1949.

14/ Census definitions of the unit that constitutes a farm indicate that many of them are too small or poorly equipped to carry on full-time commercial farming.

farming may absorb the total capabilities of the manager. Again, some farm woodlots are so far removed from the homestead that they cannot be handled as part of the farm business, but this is not a general condition.

Some indication of the distribution of forest land by farms and size of holding can be obtained by simply "blowing up" the Reappraisal farm samples to fit the New England totals. This is not a valid statistical procedure since the samples were not designed for this treatment, but no large degree of error is introduced. Table 3.10 presents the woodland sizes of the sample farms for comparison with Table 3.9. There is a noticeably greater proportion of sample farms and woodland acres with holdings over fifty acres than is shown by the Reappraisal figures and of course the smaller holdings are lightly represented by the study farms. However, the sample farms do give many interesting examples of woodland holdings from fifty to ninety-nine acres, an intermediate size that may or may not be capable of making a worth while contribution to total income, depending on individual circumstances. There are also included many instances of larger woodland enterprises that may form a substantial part of the farm business.

Table 3.10 also shows that the Southern New England sample farms contain more small woodland holdings associated with commercial farms than do those in the North. Forty-three percent of the northern sample farms have over one hundred acre woodlots as opposed to 22 percent in the South. It is significant for any forestry program designed to reach the farm woodland owners that over 40 percent of the acreage is owned by only 13 percent of the farmers, in holdings of over one hundred acres. Since the number of owners is relatively small, a sizeable area can be

Table 3.10

DISTRIBUTION OF WOODLAND HOLDINGS ON SAMPLE FARMS, BY SIZE OF HOLDING

Size Class Acres	Number of Farms		Total No. of Acres		Cumulative No. of Farms		Cumulative No. of Acres	
	No.	%	Acres	Percent	No.	%	Acres	Percent
			All New England					
500-999	3	1.2	2,100	8.9	3	1.2	2,100	8.9
250-499	13	5.4	4,542	19.3	16	6.6	6,642	28.2
100-249	69	28.6	10,319	43.9	85	35.2	16,961	72.1
50-99	62	25.7	4,574	19.5	147	60.9	21,535	91.6
10-49	63	26.2	1,918	8.2	210	87.1	23,453	99.8
0-9	31	12.9	54	.2	241	100.0	23,507	100.0
Total	241	100.0	23,507	100.0				
			Northern New England					
500-999	3	2.0	2,100	11.6	3	2.0	2,100	11.6
250-499	12	8.2	4,252	23.6	15	10.2	6,352	35.2
100-249	49	33.3	7,601	42.2	64	43.5	13,953	77.4
50-99	40	27.2	3,041	16.9	104	70.7	16,994	94.3
10-49	32	21.8	1,017	5.6	136	92.5	18,011	99.9
0-9	11	7.5	22	.1	147	100.0	18,033	100.0
Total	147	100.0	18,033	100.0				
			Southern New England					
500-999	-	-	-	-				
250-499	1	1.1	290	5.3	1	1.1	290	5.3
100-249	20	21.3	2,718	49.7	21	22.4	3,008	55.0
50-99	22	23.3	1,533	28.0	43	45.7	4,541	83.0
10-49	31	33.0	901	16.4	74	78.7	5,442	99.4
0-9	20	21.3	32	.6	94	100.0	5,474	100.0
Total	94	100.0	5,474	100.0				

reached through this group with a minimum effort. Chart 3.2, showing the sample farm woodland acreage associated with the total farm acreage, reinforces the conclusion that Southern New England sample farms contain a smaller proportion of woodland than do those in the North.

Table 3.11 shows the distribution of farm types, determined by the source of fifty percent of their income. It can be seen that farms producing primarily for home consumption account for 40 percent of the total number of census farms and only about 4 percent of the value of forest products sold by farmers. "Forest Farms" probably are those that happened to sell off their woodlots in the census year and are really not cropping their woodlands continuously. This situation is also likely to be true of the woodland sales reported by other farm types. Only about 3 percent of the number of farms are "forest farms" but they account for 39 percent of the value of forest products sold. Dairy and poultry farms are the most numerous specialized farms selling about 32 percent of the forest products, while "general" farms sell an additional 14 percent. It will be noticed that of the farms selling forest products, more than three hundred dollars worth were sold by all types except those producing primarily for home use. Thus, although only 14.8 percent of these census farms reported sales of forest products, the sales made fairly substantial contributions to farm incomes during the census year. If the benefits from wood used on the farm could be measured and added to this total it would make a much more impressive figure.

Maps 3.2 and 3.3 show the average value of forest products sold by farms, per acre of all farm woodland, and the percent of farms reporting the sale of forest products by counties during 1939 and 1944 (as reported

Chart 3.3 Total Acres of Woodland Associated with Total Farm Acres on Northern and Southern New England Sample Farms

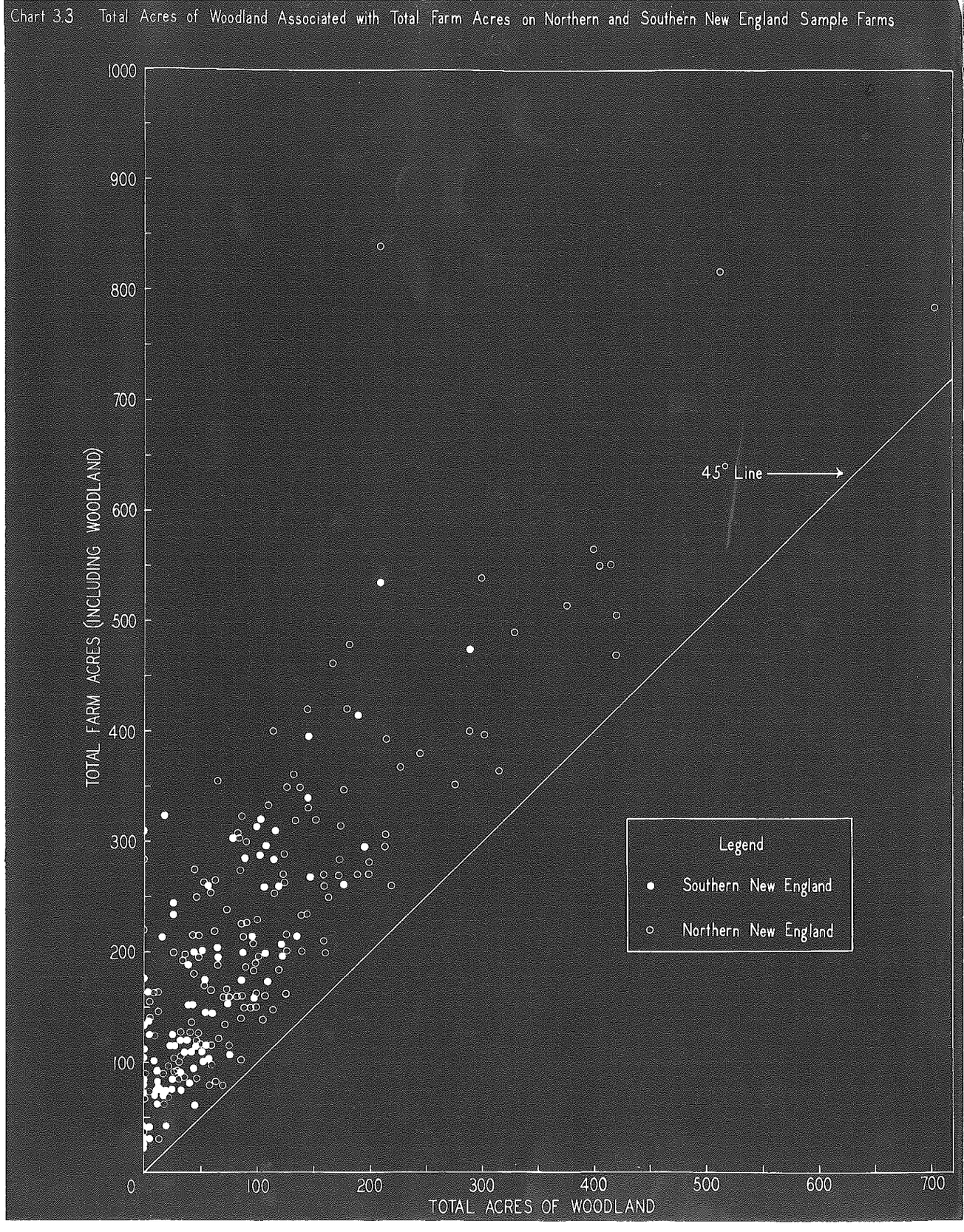


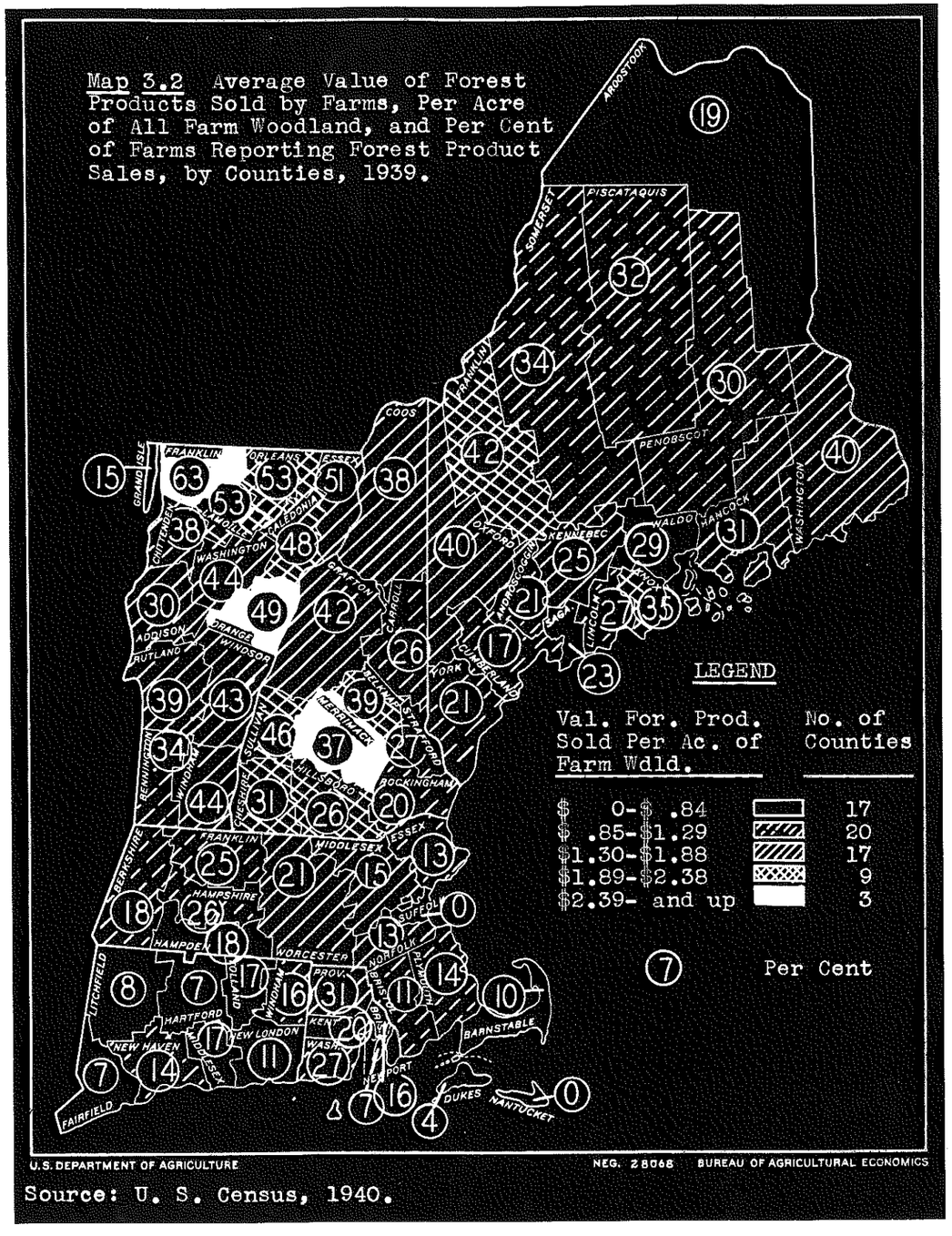
Table 3.11

DISTRIBUTION OF NEW ENGLAND CENSUS FARMS, BY TYPE AND VALUE OF FOREST PRODUCTS REPORTED SOLD, 1944[1]

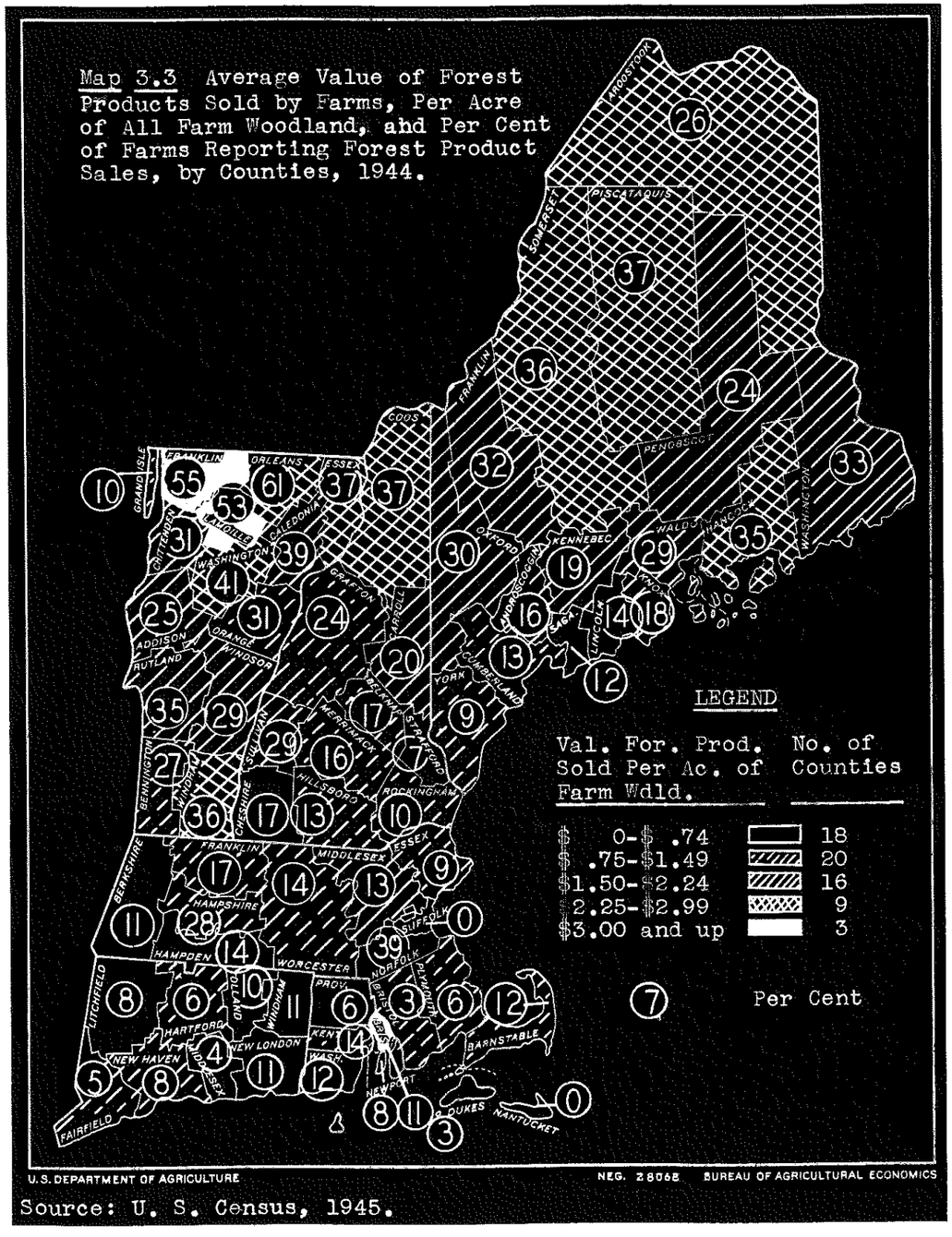
Type of Farm[2]	Farms of Each Type No.	Farms of Each Type Percent	No. Farms Reporting Sales of Forest Prod.	Value of Forest Products Reported Sold Dollars	Value of Forest Products Reported Sold Percent	Average Value of Forest Products Sold, Per Farm Reporting Such Sales-Dollars
Farms Producing Primarily for Sale						
Fruit & Nut	3,390	2.3	286	104,603	.9	366
Vegetable	4,120	2.8	256	80,620	.7	315
Horticultural Specialty	1,356	.9	31	30,369	.3	979
All-other-crop	14,518	10.0	1,606	826,573	7.3	515
Dairy	30,690	21.0	7,640	3,297,490	29.3	431
Poultry	18,341	12.6	1,082	317,327	2.8	307
Livestock	4,059	2.8	554	166,699	1.5	301
Forest-Product	4,318	3.0	4,318	4,389,294	39.0	1,016
General Farms	6,451	4.4	2,820	1,621,484	14.4	575
Total	87,243	59.9	18,542	10,834,449	96.2	
Farms Producing Primarily for Home Use	58,520	40.1	2,986	429,041	3.8	144
GRAND TOTAL	145,763	100.0	21,528	11,263,490	100.0	523

1/ Source: U.S.D.C., U. S. Census of Agriculture, 1945.

2/ Classified according to the source of 50% of its income.



Source: U. S. Census, 1940.

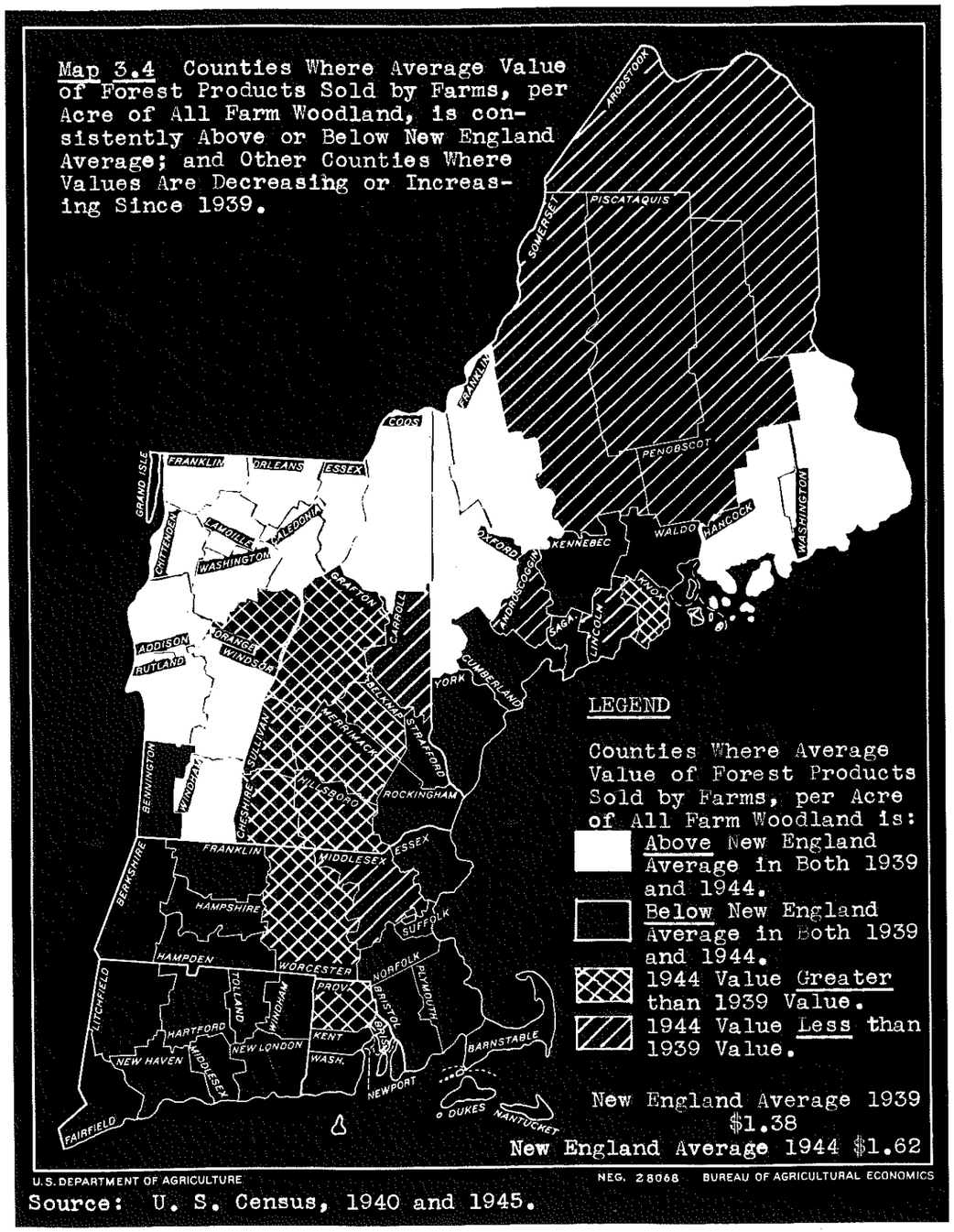


Source: U. S. Census, 1945.

in the Census of 1940 and 1945). The counties are ranked in order of values per acre to show the leading counties despite the change in price levels that took place over the five year period. It is interesting to note that Northern New England leads the southern states in both years, but the center of high values has shifted northward. The high values of central New Hampshire and Massachusetts in 1939 probably reflect the cleaning up of white pine after the hurricane of 1938. This disaster forced the premature harvesting of trees that would have normally been cut over many years and a low value per acre can be expected until the woods have had time to recover. The high values of Northwestern Vermont are due to the returns from maple products that are included with other forest products. It will be noted that there is a natural correspondence between the value per acre from forest products and the percent of farms reporting sales.

Map 3.4 shows that the three southern states and the northern coastal counties have had a value per acre consistently below the New England average in both years, while the reverse is true of most of Vermont. The balance of the northern area has an increasing average value since 1939, except for the decrease shown in the hurricane area. Increased values probably reflect greater activity in the paper pulp areas. It will be noted that the sample farms are well spread over the area, representing counties with a variation of per acre values.

That most farm woodlots are not managed at an optimum silvicultural intensity is indicated by Table 3.6 which shows 51.2 percent of the land as being operated in a fashion that will not perpetuate valuable tree cover. This can be attributed to several causes, the lack of



Source: U. S. Census, 1940 and 1945.

knowledge about the means of maximizing returns, institutional selling policies that encourage clear-cutting, paying extra labor by the cord or thousand board feet cut, need for money, lack of proper credit facilities and the like. The causes in each instance cannot be determined without individual study.

A recent study has shown that the bulk of the farmers are under sixty years of age but that older men hold more than their proportional share of forest land. Advancing age may have some effect on forest management if no younger man is available to carry on the farm work. It has been argued that with declining physical ability the woodlot is often sold off to bolster farm income. The force of this argument is weakened if the value of woodland is a recognized factor in the evaluation of the farm when it is sold. It has been proposed that an older man has less incentive to practice good forest management since he has less chance of living long enough to "make a crop." However, no such tendency was observed among the sample farms, in fact, two of the oldest farmers used the best forest practices and seemed little concerned about whether they or their heirs would reap the greatest benefit.

It has also been discovered that most farmers hold their forest lands to grow wood for sale and home consumption or to use as pasture. The latter use will gradually lose its significance as more and more farmers improve their pastures and realize that woods-pasture contributes little feed value or wood growth.[15/] Most farmers have received some income from their woodlands and expect to do so again. More of them also consider their woodlots as financial assets than do "other" owners. Most farmers are also residents on or near their forest land and can manage it personally.

15/ Although pasturing may cause serious damage to forest growth, the prevalence of this practice is probably less than census figures indicate. Much of the "woodland pasture" reported is either brushy pasture that hasn't grown up to trees or is too lightly pastured to do extensive harm.

Of the small owners, farmers are in the best position to properly manage their woodlands from the standpoint of physical and managerial ability. The primary problem is one of successfully integrating the woodlot with the farm business so that the total returns of the entire enterprise will be maximized. Since most farmers consider their woodlots primarily as factors of production and are in a competitive position with other small owners, a financial analysis based on the theory of the firm can be used to establish the practices that will be most desirable. However, due allowance must be made for the fact that the use of family labor may be largely influenced by the theory of the household where subjective costs and satisfactions may not be measured in terms of net cash returns.

Other Small Owners

The last group of owners to be discussed are called "other" owners for lack of a better title; they have no characteristic occupation to serve as a tag. They make up at least 54 percent of all owners and own over 32 percent of all the forest land. These figures would be increased if some of the part-time and residence farmers were added to them, as they perhaps should be. Table 3.12 shows that their distribution by size classes is not much different from the farm group, although there is a somewhat larger percentage of the area in holdings of more than one hundred acres.

The interesting points about these owners are that they come from all walks of life and have their land for a wide variety of reasons. They generally have small capacity for forest management and often don't

Table 3.12

DISTRIBUTION OF FARM AND NON-FARM SMALL HOLDINGS BY SIZE OF HOLDING IN NEW ENGLAND[1]

Size of Holding in Acres	Farm Small Holdings				Non-Farm Small Holdings			
	No. of Acres		No. of Owners		No. of Acres		No. of Owners	
	Thous.A.	%	Number	%	Thous.A.	%	Number	%
1,000-2,499	-		-		164	1.7	122	.1
500-999	162	2.5	206	.2	355	3.7	501	.4
260-499	382	5.9	1,031	1.0	996	10.5	2,186	1.7
100-249	2,099	32.4	12,061	11.7	3,067	32.3	16,406	12.5
50-99	2,027	31.3	27,421	26.6	2,519	26.6	30,609	23.3
10-49	1,729	26.7	51,853	50.3	2,267	23.9	67,105	51.1
0-9	78	1.2	10,515	10.2	118	1.3	14,247	10.9
Total	6,477	100.0	103,087	100.0	9,486	100.0	131,175	100.0
% of All Private Holdings	22.11		42.25		32.38		53.82	

1/ Source: Based on owners and acreages in "Reappraisal Sample Areas". "Blown up" to represent New England conditions.

live near their land. A surprising number don't even know exactly where their land is or what its boundaries are, and some have never even seen it. Their silvicultural practices are about the same as those of the farming group, Table 3.6, and many are poorly equipped to do any sort of forest operation.

The characteristics of these "other" small owners, summarized in Tables 3.13 and 3.14, throw some light on what and who these people are. Of the twelve categories of owners, the first four include over 70 percent of the numbers and 66 percent of the area involved. The rest are a very miscellaneous group that would probably expand or contract if different areas were sampled. Only about half the owners are residents on their land, the major exception being the labor and clerical group with 72 percent residents. This may be the result of the increasing dispersion of workers' homes to points outside the cities and towns. If this is true, they might well be classed with the resident farms. Only 27 percent of the business and professional groups are residents, probably reflecting an expansion of the number of summer homes, camps and cottages owned by city workers. The same study from which Table 3.13 is taken further indicates that seventy-three percent of the forest land was obtained by purchase and over half of the owners have held more than two-thirds of the land for more than ten years. Although a ten year period is a relatively short time in terms of forest growth, it indicates a comparatively stable tenure and continued interest in land ownership. Three-fourths of the owners consider their land to be a financial asset, although only about half have sold any forest products or expect to do so in the near future. This would indicate that there are some compelling

Table 3.13

FOREST HOLDINGS OF "OTHER" SMALL OWNERS IN TWENTY-THREE SAMPLE NEW ENGLAND TOWNS, CLASSIFIED BY OCCUPATION GROUPS AND TOWN OF RESIDENCE[1]

Occupational Groupings	No. of Owners	Acres Owned	% Owners	% Acres	Owners Residents of Same Town No.	%
Business or Professional	383	51,736	23.3	28.9	106	27
Labor or Clerical	374	23,418	22.7	13.1	270	72
Housewife	209	16,859	12.7	9.4	97	46
Retired	214	26,648	13.1	14.9	134	63
Dealer in land or stumpage	80	8,824	4.9	4.9	19	32
Recreational Establishment	37	5,158	2.2	2.9	25	68
Bank or other financial	6	1,077	.4	.6	0	0
Public Utility	8	8,972	.5	5.0	0	0
Club or Institution	15	9,432	.8	5.3	5	39
Unsettled Estate	67	7,115	4.1	4.0	28	42
Student	9	1,047	.5	.5	6	67
Unknown	244	18,873	14.8	10.5	102	42
Total	1,644	179,159	100.0	100.0	792	48 Average

1/ Source: Solon Barraclough, Forest Land Ownership in New England, Doctoral Thesis, Harvard University, 1949.

Table 3.14

PRIMARY MOTIVES OF OWNERSHIP OF A SAMPLE OF "OTHER" SMALL OWNERS WHO REPLIED TO A MAILED QUESTIONNAIRE IN 23 NEW ENGLAND TOWNS 1/

Occupational Groupings	To Produce Forest Prod. for Sale or Use	To Use for Pasture	To Use for Recreational Purposes	To Use for Residential Purposes	To Sell Later at a Higher Price	For Satisfaction of Owning Land	Other	These Indicating No Purpose	Total No. Respondents 2/
Business & Professional	58	6	72	49	35	40	16	-	204
Labor & Clerical	55	9	14	20	12	23	10	-	114
Housewife	31	5	15	21	21	19	16	1	100
Retired	26	1	13	18	16	20	5	2	70
Dealer in land or stumpage	5	-	1	1	3	-	-	-	9
Recreational establishment	1	-	11	1	-	-	1	-	12
Bank or other financial institution	-	-	-	-	2	-	-	-	2
Public utility	-	-	-	-	-	-	2	-	2
Club or institution	3	-	4	-	-	-	-	-	7
Unsettled estate	1	1	-	1	-	-	-	-	3
Student	2	-	2	1	-	2	-	-	7
Unknown	5	2	1	2	3	2	1	-	12
Total	187	24	133	114	92	106	51	3	542

1/ Source: Solon Barraclough, Forest Land Ownership in New England, Doctoral Thesis, Harvard University, 1949.

2/ Many owners gave more than one primary motive of ownership, resulting in some double counting.

reasons for ownership other than the possible monetary returns.

The primary motives for owning land can throw some light on this subject but they are very difficult to determine. Perhaps, the reasons for ownership are best thought of as a "bundle of motives" that is quite fluid and highly variable between owners. Table 3.14 shows that only about 55 percent of the owners sampled held their land for the production of wood products and many of these have some other equally important reasons. About one-fourth of the business and professional group, one-half of the laborer and clerical group and one-third of the housewife and retired groups give this as one primary purpose of holding land. Most of the others have some other reason. However, the majority of the owners sampled expressed interest in forest management, especially if it can be done at a minimum of cost and bother to themselves. Perhaps, with full knowledge of alternative management methods, many owners would show more interest in making their lands productive.

There is a tendency for larger holdings to be retained for the production of forest products and also more of the people inheriting their land have this primary motive. Perhaps, the latter is true because they have obtained the land free and taxes are small so they feel justified in holding it for what it may produce. Most of the owners under forty years of age have their land for forest production. More owners in Northern New England hold their land for forest production than do in the south. The presence of ready and fairly stable markets and a history of forest production may account for this tendency.

The total meaning of this picture is that any measures to maximize the returns from woodland held by "other" owners must take account of

the intangible benefits that accrue from ownership. Many owners view their forest land somewhat in the light of a consumption good, which may invalidate value judgments based on an analysis of operations oriented purely along production lines. Fortunately most of the practices that will increase the production of forest products will, or can be designed to, increase the less tangible values at the same time. But these adjustments must be made on an individual operating unit basis, tailored to fit each situation.

That progress can be made with this group is indicated by the success of the New England Forestry Foundation. This organization has worked mostly with the larger owners in the "small" group, who are more financially stable and better fitted for long-term planning and improvement, however they point the way for other people and organizations. The complete type of management service furnished by the Foundation is perhaps one of the best ways to induce many of these property owners to practice the intensity of management that will maximize their financial returns in the long-run.

A recent study has stated that, "The bargaining position of the active farm operator is greatly weakened by the fact that he must market his timber in competition with people who have only a minor interest in the timber producing values of their lands."[16/] The sentiment of this statement is obvious, but it must be remembered that many "other" forest owners receive much of the return from their woodland holdings

16/ J. C. Bettis, W. C. Banks, C. E. Doverspike, Preliminary Survey of the Marketing of Farm Woodland Products in the Northern New England States, Northeastern Forest Exper. Station, Station Paper No. 25, May 1949.

in the form of intangible values and satisfactions and can thus sell forest products for a lower cash price than can a farmer who may consider that all the costs of production must be allocated to the materials harvested. Except for the rather large amount of underselling done through inexperience and ignorance of such matters, the producer who thinks of forest land ownership in terms of a consumption good can be considered merely as a more efficient producer of timber products. This is likely to be a permanent feature of forest production in New England.

Chapter IV

FACTORS ESSENTIAL TO THE PLANNING OF FARM WOODLANDS

Constructing a plan to guide the conduct of an actual farm is a highly complex problem. This is particularly true since the unit is engaged in manipulating dynamic and only partly controlled natural forces to produce goods for an ever-changing economy. Despite the many uncertainties, farmers and other woodland owners are constantly making choices between alternative methods of utilizing their physical and human resources. These decisions are often made in ignorance of the possible alternatives or by default, or less frequently they are based on informal analysis and comparison of the probable results of different courses of action. The accuracy of these estimates and the validity of the conclusions reached, varies tremendously among individuals. The budgetary analyses and farm plans in this study were designed to furnish a rational basis for such decision making.

Budget statements for each operating unit present the probable income, expense and net return under the present organization and after specified changes in its enterprises or operating methods. These changes are the ones that seem feasible and desirable to the operator and the analyst after a thorough appraisal of the unit's resources. The requirements and problems of the adjustment period, while the planned changes are being accomplished, are also thoroughly investigated and presented in the final plan. The operator then is able to consider not only the probable returns but also the elements of risk, managerial requirements

and his own and family preferences when deciding which alternative plan best suits his circumstances.

The farm woodland plans considered not only the forests but also the operating unit of which they were commonly only a small part. There are complementary and supplementary relationships between the woodlot and the rest of the farm that make an over-all view essential to good planning. This approach is particularly important since the different enterprises may compete with each other in the utilization of limited resources. Changes in the land, labor and capital used in one enterprise often require compensating adjustments in the organization or efficiency of other enterprises. These inter-relationships call for careful study, and their effects must be reflected in the farm plan and its accompanying budget. This aspect of the planning process will receive more attention in the next chapter.

Before a budgetary analysis of forest operations can be made, it is essential to discover as much as possible about the production functions of the woodland enterprise. The available data on this subject are far from complete and the analyst must estimate many of the input-output relationships needed for planning. This makes mandatory a thorough understanding of the factors affecting these relationships. In the remainder of this chapter some of the major factors affecting the costs and returns of farm woodlands will be discussed along with the value estimates and the expedients used in the present analysis.

Intangible Returns

Before going further a slight divergence is appropriate to explain

more about the intangible values, previously alluded to, that may be produced by woodlands. These can have an effect on the returns of the operating unit. Although such returns cannot be measured and included in the budget, they may be very important and must be given due consideration in the complete plan.

Some of these elusive values are received primarily by the general public rather than by specific individuals. Intangibles of this kind have been much discussed in connection with a variety of topics including the utility of forests for flood and erosion control, the preservation of natural beauty, the maintenance of wood reserves for national defense and to meet the needs of the nation's economy. It is often impossible for such benefits to accrue directly to the forest owner; further their maintenance at a high level may be incompatible with other direct values so that the "public interests" are sometimes neglected or destroyed by private management. This point must provide the justification for most of the public subsidy and control suggested for private forestry.

There are, however, other intangible values intimately connected with forest land ownership. These benefits are annexed by the owner but are not easily defined or evaluated. Professor Harry Woodworth, of the University of New Hampshire, illustrated this facet of forest value when he made the following statement about commercial agricultural land values in certain parts of New Hampshire.1/

> To a large extent in these areas, land as a productive factor in commercial agriculture has been outweighed and superceded by the demand for land as a consumption good, or as a producers' good for certain intangible things, difficult to describe and measure.

1/ Address before the American Farm Economics Association, 1937.

A recent study2/ has grouped these intangibles under the following headings. "Pride of Ownership, Sentimental Attachment, and Other Ownership Motives." Certainly the "Other Motives" must include the nebulous returns that result when forest land is held for residential or recreational purposes. Another value that might be included under this heading is the insurance against a pulpwood or timber shortage received by many companies from their large land holdings.

Thus it seems that woodland owners may receive returns from their land simply by owning it, whether forest products are harvested or not. It is possible that in many instances these returns completely offset the cash costs of ownership. Under these circumstances the landowner may have little incentive to increase his returns by improved forest practices. If, however, complete information were available about the operating requirements, costs and returns of forestry methods better practices might be adopted. Data on the monetary aspects of different forest programs might assist many owners in choosing a system of land management that will meet their individual needs and still be compatible with any intangible considerations that personal circumstances might dictate.

Tangible Returns

Most of the tangible returns of the forest result from growing and harvesting useable wood products. There are some other minor forest products but these will be considered later. Forest growth has two

2/ Bolon Barraclough, Forest Land Ownership in New England, Doctoral Thesis, Harvard University, 1949.

characteristics whose importance distinguishes it from most other processes of production. These features have a profound effect on the economic aspects of forestry and must be carefully considered in any study of management adjustments. The first factor is the very long production period needed to raise merchantable wood products. Growth is a biological activity chiefly affected by the natural characteristics of the several tree species, the site where the forest is grown and the management practices used. Of course, the specifications of the raw material required by wood-using industries can also affect the length of the production period. Of these variables, only management practices are under the complete control of the usual small forest owner.3/

The second factor is that the trees are not only the "factory" producing new wood but are also the "warehouse" where the wood from past years is stored. Harvesting trees, therefore, not only removes past growth but also destroys the "factory" that can produce more wood. If a sustained annual yield is desirable, a careful balance between inventory and cut must be found so that enough "factory" is left to insure future supplies. This requires the maintenance of a relatively high ratio of standing timber to annual cut.4/

It is thus apparent that forestry has both short and long-run

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3/ For a more complete discussion along these lines see J. V. Zivnuska's article in Land Economics, Madison, Wisconsin, May 1949, entitled "Some Aspects of the Economic Theory of Forestry."

4/ The U. S. Forest Service's Reappraisal Report Number 1 estimates that sustained yield for the nation would require a ratio of standing timber to yearly harvest on the order of 25 to 1. This assumes active management and a good distribution of age classes.

aspects that are inextricably related. There is a general opinion among foresters that in the long-run a given stand will produce about the same amount of wood, regardless of the forest practices used. If this is true, management can primarily affect only the form in which this growth occurs, the amount of it that is utilized and the time when the different products are available. In order to understand this a slight digression is necessary to explain the way in which a forest grows.

The bulk of New England's forest stands are even-aged and display characteristic, general principles of growth. A new stand contains hundreds or thousands of seedling and sprout stems per acre that compete vigorously for food and light. Growth during the first couple of decades is primarily in height as the plants reach for a "place in the sun." The rapidity and extent of this height growth are mainly determined by the favorability of the site and cannot be substantially affected by management. Within three or four decades competition kills or stagnates the less vigorous stems leaving relatively few of the strongest in possession of the area; height growth starts to slow up and the remaining trees begin to expand their crowns and grow more rapidly in diameter. At about this time the total stand is not only increasing in volume at its most rapid rate but also the trees are reaching sawlog size. These two factors combine so that between 40 and 60 years the annual value increment is greater than at any other time in the history of the stand. After six or seven decades diameter growth starts to slow down and volume increment is eventually balanced by the losses from old age.

Forest management can aid and direct these natural forces by judicious

cutting. Thus, in the early stages the poorest stems can be removed to allow the better ones room to grow. This same general principle can be followed throughout the life of the stand; later cuts will remove trees containing fuel or pulpwood and finally sawlogs, before the final crop is harvested. In effect about the same volume is salvaged as would otherwise die and be wasted and the full growing capacity of the site is concentrated on the better trees.

These intermediate cuttings, made before the final harvest, are called partial-cuttings. They should be made at intervals of from five to twenty years, depending on stand conditions. As a rule the harvest of the mature crop should also be made by partial-cuttings so that gradual opening of the stand will encourage prompt, valuable reproduction without severe drying of the soil. Simply using this harvest system will usually avoid considerable loss of time in starting the new generation and will generally improve the quality and stocking of the stand. These improved cutting practices call for additional management effort and some investment in the form of deferred harvesting. Often the gains from growth during the waiting period will offset any added expenses.

The forest practices generally used in the region today consist of clear-cutting or high-grading a stand of timber whenever it contains a large enough volume of sawlogs, pulp or fuelwood to attract a buyer. No thought is given to establishing reproduction and new stands are often considerably delayed in starting. Among the hardwoods, they usually tend to contain a high percentage of stump-sprouts or other undesirable elements. The discussion thus far has been in terms of average

conditions and no mention has been made of the numerous special cases that will be found in actual practice.

The forestry principles outlined above have been used as a basis for the three general levels of forest management intensity used in this study. The first is a continuation of present destructive practices. The second envisions improved cutting practices being used in the harvest operations to encourage valuable reproduction. The third will include partial-cuttings to improve the stand quality, combined with improved harvesting methods. The first step toward applying these intensities of management in planning was to make a careful appraisal of the farm woodlot and divide it into homogeneous stands. Then a prescription for the proposed management was written for each stand. The suggestions were those that appeared most promising, not only for the stand alone but also for the total woodland enterprise as a part of the farm operation.

An estimate of the amount and kind of product that would be cut from each stand during the next five or ten years, under the proposed management plan, was made during the ground inspection. This provided a basis for estimating the inputs and outputs that were included in the farm budget. However, since most of the farm planning related to adjustments that could reasonably be accomplished in the relatively short period of five or ten years, the "proposed" budgets reflect only the short-run results of the forestry program. In order to indicate the full value of the proposed woodland plan some further comparisons are necessary. This was accomplished by a statement of the average annual inputs and outputs that will probably result when a level of forest productivity compatible with the suggested management has been reached.

Cost-Price Relationships

The physical inputs and outputs of the woodland enterprise must be converted to dollars and incorporated in the unit's budget before they attain economic significance. This requires the use of unit costs and prices. Since the farm budgets in this study were made primarily to compare the net returns of different management plans, only one set of cost-price relationships was used. Different dollar values could be applied, however, to the physical data to find the most advantageous adjustments for other cost-price structures.

Many difficulties are encountered in any effort to determine the cost-price relationships that will prevail over a period of five or ten years in the future. For the purpose of choosing between alternative management plans a prediction of the actual dollar values of productive factors and of products is not necessary, but the relative values must be determined as nearly as possible. Actual dollar values, of course, can be very important when credit arrangements and interest on investment are considered, so every effort must be made to obtain the best possible estimates. This study has used a cost level for productive factors equal to the 1943-45 average. The prices of farm and forest products are those judged to be compatible with the assumed cost figures. A complete list of these values is shown in Table 4.1. All of the forest product prices are calculated to apply to woods-run logs or bolts delivered at a drivable roadside. It must be emphasized again that these figures are not predictions of things to come, but in the light of past experience they do represent relationships that it seems reasonable to expect may prevail over the next decade. The long-run returns of forest management

Table 4.1

PROPOSED PRICE GUIDES

Item	Southern New England 1910-14	1935-39	1943-45	Est. Parity	Proposed	Northern New England 1910-14	1935-39	1943-45	Est. Parity	Proposed
Milk (4% at plant)	2.40	2.70	4.45	4.00	4.00*	1.60	1.90	3.85	2.70	3.40*
butterfat diff.			.06+		.05			.06+		.05
Eggs (doz.)wholesale		.31	.44		.40		.31	.44		.40
Chickens (lb.)		.17	.28		.25		.19	.27		.25
Beef (cwt.)	6.20	5.20	9.50	10.00	9.00		5.20	9.50	10.00	9.00
Hogs (cwt.)	8.60	8.50	13.50	14.50	13.00		8.50	13.00	14.50	13.00
Lambs (cwt.)					12.00	8.00	8.00	12.60	13.50	12.00
Wool (lb.)					.33	.22		.44	.37	.33
Pot. (bu.)	.90	.93	1.90	1.65 1/	1.50	.70	.93	1.90	1.65 1/	1.50 2/
Apples (bu.)	1.08			1.60	1.80					
Hay (T.)	21.00	17.00	25.00		$15-30	15.00	10.00	18.00		$12-20
Sweet corn (T.) (in husk)						18.00	16.00	28.00	27.00	24.00
Canning peas (T.)								90.00		65.00
Dry beans (cwt.)						4.60	5.50	8.00	7.80	7.00
Shell beans (T.)								100.00		80.00
Pulpwood (rough cord)							6.00	14.00		9.00
Fuelwood (cord)					9.00					9.00
Sawlogs (woods run, M.b.f.)					18.00					18.00
Syrup						1.00	1.46	2.92	2.00 3/	2.50
Dairy Grain (ton)		39.00	60.00		60.00		39.00	60.00		60.00
Poultry Grain		43.00	65.00		65.00		43.00	65.00		65.00
Labor/mk without bd			26.00		$20-30			24.00		$20-30
Fert 8-16-16/ton			48.00		48.00			50.00		50.00
0-47-0			55.00		55.00			57.00		57.00
0- 0-60			44.00		44.00			46.00		46.00
0-20-0			27.00		27.00			29.00		29.00
0-20-20			46.00		46.00			48.00		48.00
5-10-10			36.00		36.00			38.00		38.00

* At farm
1/ 1919-28 base
2/ $1.00 in Central Maine
3/ 1920-29 base

are compared in physical terms and no costs or prices were estimated for the far distant future.

Labor Inputs

There are many details of forest inputs, but the bulk of the problem is concerned with the efficiency with which labor and machinery can be used to get forest products ready for sale. The growth implications of the different methods of operating are primarily long-run aspects of forest management. The processes of extraction can be considered in more or less chronological order as follows: felling, limbing, bucking,[5] and skidding or yarding to a drivable road and then hauling the raw materials to the mill, rail-head or river. In this study the products are carried only to the roadside. The physical features of the forest terrain, the type, kind and amount of timber to be cut[6] can all affect the efficiency of extraction, but they must be considered separately on each operating unit.

The available figures on labor and machinery inputs are based on operations over level or gently sloping terrain, and the best data concern the harvesting of softwoods in fairly well stocked, mature stands. These basic figures must be altered to fit the existing conditions of any particular site or forest stand. Two of the most thorough investigations that have been published on this subject indicate the labor inputs for harvesting white pine sawlogs and spruce and fir

5/ Bucking is the process of cutting the whole tree into merchantable logs, bolts or sticks. The unmerchantable portions of the tree are usually left in the woods.

6/ Collectively, these features are referred to as the "logging chance."

pulpwood.[7] The chief variable affecting the output per unit of input was found to be the size of the tree cut. It takes more small trees to make a thousand board feet or a cord of wood, and it takes longer to handle and process the greater number of sticks. Table 4.2 indicates the number of trees of various diameters needed to make a cord of wood or thousand board feet of timber. Charts 4.1 and 4.2 show the production information in graphic form.[8]

No similar figures are available on harvesting hardwoods. No doubt some additional time will be consumed handling the heavier hardwood sticks and logs, but removing the larger and harder limbs will probably require the greatest amount of extra work. It seems reasonable to assume that the hardwood production curves for making logs and bolts and skidding them four hundred feet will be about twenty percent higher than the comparable softwood curves.

The sawlog study concluded that the method of cutting has little effect on the amount of labor required per thousand board feet extracted from the woods. Although slightly more time is needed to make the logs on a partial-cutting than on a clear-cutting, the difference is usually

7/ V. S. Jensen, C. E. Behre, A. O. Benson, Cost of Producing White Pine Lumber in New England, Circular No. 557, U.S.D.A., Wash., D. C., July, 1940. V. S. Jensen, Cost of Producing Pulpwood on Farm Woodland in the Upper Connecticut River Valley, U.S.D.A., Northeastern Forest Experiment Station, Occasional Paper No. 9, New Haven, April, 1940.

8/ Two recent studies have provided data showing close agreement with these figures. William House, Selective Cutting and the Logger, Society for the Protection of New Hampshire Forests, Unpublished Manuscript, 1950, and Henry I. Baldwin, Analysis of Forestry Operations, 1948-49, Fox State Forest, Unpublished Manuscript, 1950.

Table 4.2

AVERAGE NUMBER OF TREES OF DIFFERENT DIAMETER CLASSES REQUIRED TO MAKE A CORD, 128 CUBIC FEET[1]

Diameter of Tree Breast High, Outside Bark	Northern Hardwood	Softwood
Inches		
4	-	74
5	35	44
6	20	28
7	15	20
8	11	13
9	8	10
10	6	8
11	5	7
12	4	6
13	3.5	4.5
14	3	3.7
15	2.5	3
16	2	2.5
17	1.7	2.1
18	1.5	1.9
19	1.3	1.6
20	1.2	1.6
21	1.	1.4
22	.9	1.2
23	.8	1.1
24	.7	1

1/ Source: Bulletin 763, U.S.D.A., 1919 and Extension Bulletin No. 55, University of New Hampshire, 1938.

APPROXIMATE NUMBER OF TREES OF VARIOUS DIAMETER CLASSES REQUIRED TO MAKE A THOUSAND BOARD FEET[2]

Diameter of Tree Breast High, Outside Bark	Number of 16 foot logs	Number of trees per M. b. f.
Inches		
6	1	70
8	1	45
10	1.5	21
12	1.5	14
14	2	8
16	2.6	5
18	3	4
20	3.5	2

2/ Source: Based on Cubic Foot volumes of Form Class 77 from Occasional Paper No. 111, Southern Forest Experiment Station, 1947. Conversion factor - 1 c.f. equals 6 b.f.

Chart 4.1

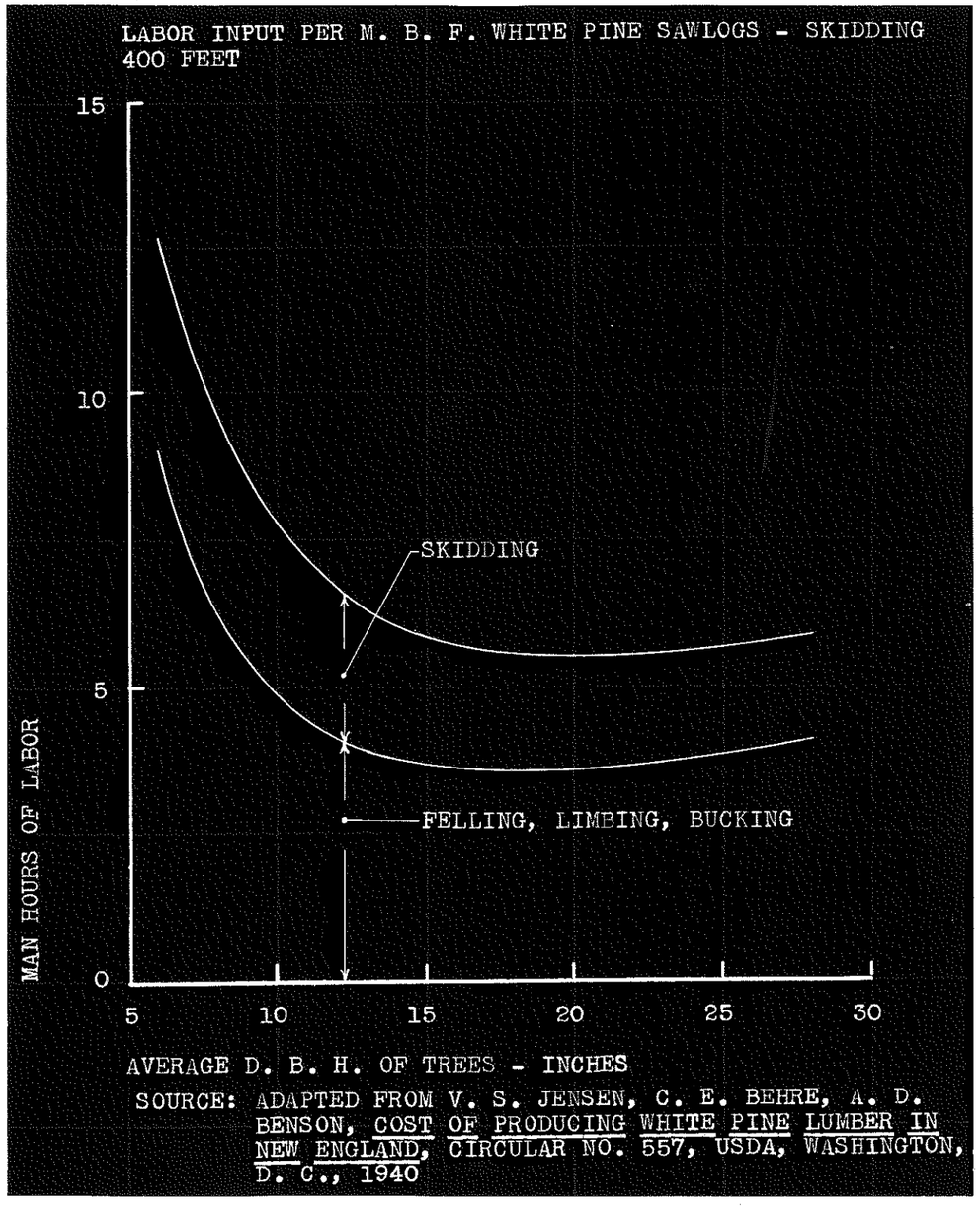
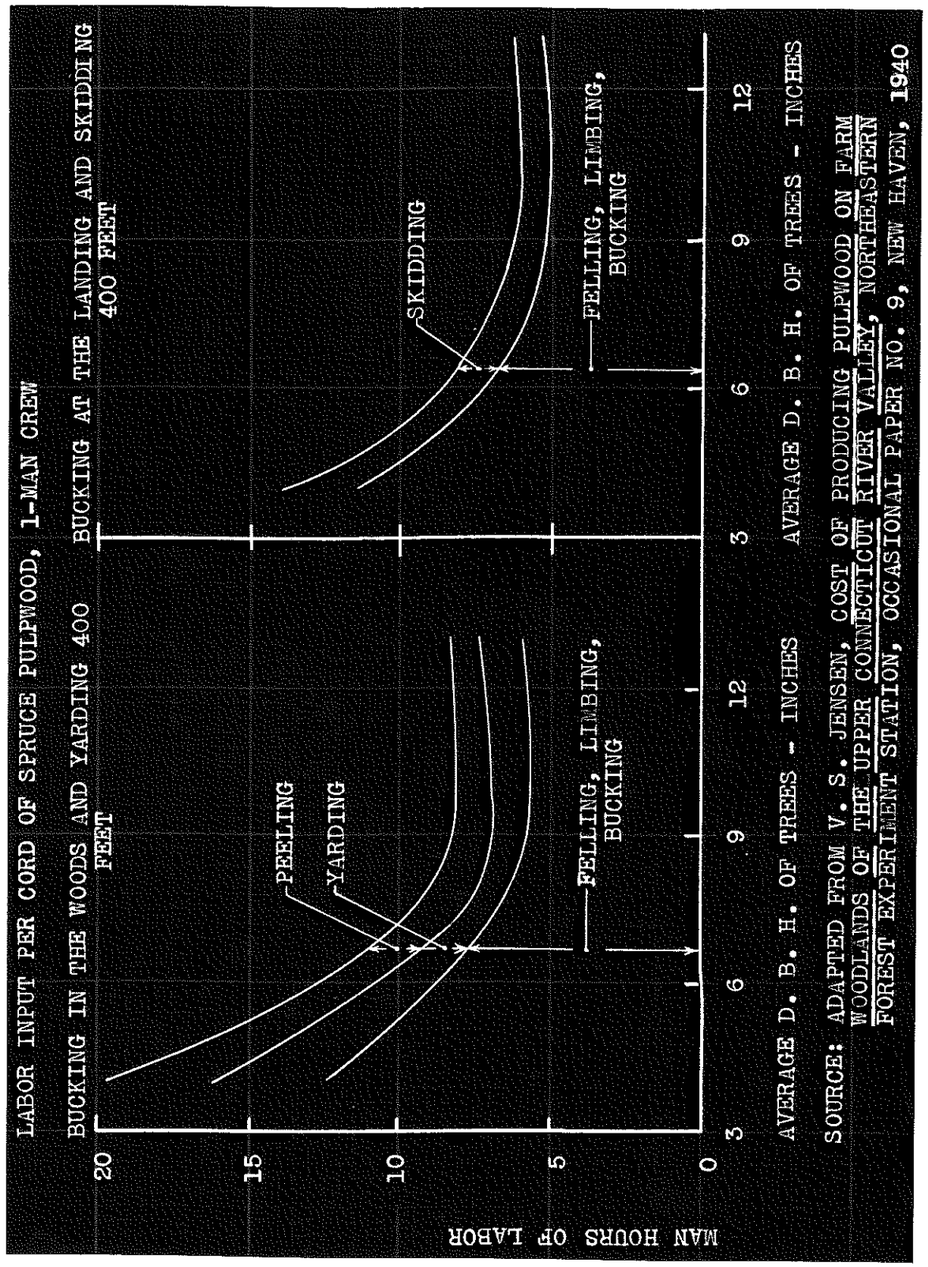


Chart 4.2



offset by easier skidding. It is also apparent that if a lower proportion of small trees is taken out in a partial-cutting, less time will be required than on a clear-cutting where practically all the trees are removed. These conclusions are borne out by the pulpwood study which states:

> In selection-cutting the time required for felling, limbing and peeling trees of a given size is somewhat higher than in the usual commercial clear-cutting----This handicap is, however, more than offset if the diameter of the average tree in selection-cutting is only one inch greater than would be obtained in clear-cutting.

Thus it seems that, contrary to the general opinion of many lumbermen, there is no substantial difference between the costs of partial and clear-cutting in most instances, provided the job is well laid out. It is clear, however, that early thinnings will be more expensive than customary fuel or pulpwood operations in comparable stands, when smaller trees are cut. Later thinnings will remove trees larger than the average that might otherwise be cut and a greater return will be realized. The final stand of crop trees resulting from intensive management will also have a larger average diameter than a wild stand of the same age and will be easier to operate so that an actual saving may result in the long-run.

There is also a direct relationship between the quality and width of lumber than can be cut from different sized trees.9/ The total amount

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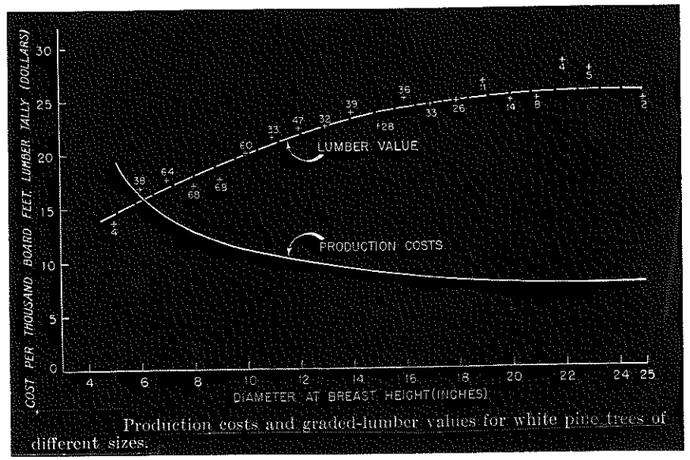
9/ R. T. Patton, A Study of Growth and Yield, Harvard Forest Bulletin No. 4, Petersham, 1922. Patton discovered that the price of oak plank reached a maximum at an average width of 10 inches. He set up the following approximate scale of values, based on 10 inch plank values as 100 percent.

Average Width	Price as Percent of Highest Value
10"	100
9"	95-97
8"	89-92
7"	77-82
6"	53-62
5"	5-22

and the proportion of better quality lumber increases directly with log diameter. Thus production costs go down and the value of product goes up as tree size increases. Chart 4.5 illustrates this point. These considerations must enter both the short-run decision of what trees to cut from a given stand and the long-run decision of what sized tree shall be the goal of management. The figures do not imply that small logs in the tops of trees should be left in the woods. They are properly considered a by-product of the operation and under New England conditions can usually be utilized to advantage. The figures do show, however, that careful consideration must be given to the average size of trees to be cut in any operation.

Both short and long-run labor inputs for forest operations on the bulk of the two-hundred and forty-one dairy farms were based not only on the above data but also on estimates made by the people most familiar with forestry in the localities concerned. The final estimates were calculated to apply to average farm conditions and were altered as seemed necessary to fit the individual circumstances of each farm. For the northern areas, where woods labor and farmers are accustomed to this type of work, an average of 1.25 man days per cord and 2 man days per thousand board feet of sawlogs were considered enough to get logs or bolts made and delivered to a drivable roadside on an average logging chance. The comparable figures for the southern states were 1.5 and 2 man days. It was thought that the ordinary farmer in this area is neither so well equipped nor so accustomed to cutting fuel and pulpwood as the northerner. The average woods haul in both areas was estimated to be about four hundred feet.

Chart 4.3



Production costs and graded-lumber values for white pine trees of different sizes.

Source: U.S.D.A., Circular No 557, Cost of Producing White Pine Lumber in New England, Washington, D.C., 1940

The last of the above estimates are in accord with those worked out by the Harvard Forest and the United States Forest Service for general use in the Worcester County, Massachusetts Land Use Planning Project. It is apparent that these figures are somewhat conservative when compared to the data in Charts 4.1 and 4.2. However, if the graphed figures are adjusted to include the team hours used in skidding as man day equivalents, the greatest amount of the discrepancy is removed. It must also be remembered that the curves are based on the output of professional woods workers. Greater familiarity with forest production can be expected to increase the efficiency of farm woods work over time, but no adjustment was made for this factor in the woodlot plans. One consequence of the assumed data is that with cost-price relationships of six dollars per man day for hired labor and nine dollars per cord for rough pulp or fuelwood, there is no profit margin or net income for the southern New England landowner from these operations unless he can collect the day wages himself. Experience may indicate that these conservative estimates should be altered to show a more favorable return.

Before leaving the subject of labor efficiency it will be well to note that there is a tremendous difference between the production of "average" and "good" woods labor. It is not uncommon for an energetic and aggressive woodsman to cut and pile two to four times the amount of pulpwood produced by a less ambitious or dexterous man. Thus the success or failure of many forest operations depends to a great extent on the persons actually doing the work.

The two labor studies cited above cast some light on the organization of working crews. The pulpwood study shows that a one-man crew is

most effective for this type of work. This is also true of most of the individual woods operations, unless the material is too heavy for one man to handle effectively. General safety precautions usually dictate, however, that two men work at least within earshot of each other. For extracting logs, a two or three-man crew seems to be best suited to the heavier handling job.

In most instances, the simple hand logging tools needed are available on farms. Although no exact figures are available there are indications that mechanized bucking in a yard will increase labor efficiency, if the operation is properly organized and equipped. New portable power saws offer considerable savings once they have been perfected, but as yet good time studies aren't available. The problem of whether horse or tractor power is most efficient will be determined by the circumstances of each farm. The logging chance, the method of logging, road network, length of haul, etc., and the question of supplementary relationships with other enterprises are the chief variables affecting these decisions.

Forest Improvements

Another important problem with both short and long-run implications is the construction of forest improvements such as roads and bridges. If a forest area is readily accessible, frequent operations are possible without a large expense for getting the products out of the woods. It is then possible to make partial-cuttings to improve future yields and reduce the losses from natural hazards by timely salvage of decadent trees. Fire risks are also greatly lessened if roads are available for detection and suppression work.

If, however, a large investment must be put into roads before any work can be done, and the entire amount paid off from current operations, a heavy cut per acre is usually necessary. This will naturally reduce or eliminate yields for many years. Since most of the study farms are in areas that are, or have been, thickly settled the bulk of the woodlots are quite accessible. No great outlay is necessary for new road construction; a good network can usually be developed by a minimum of improvement work done gradually as the different stands are operated. On some of the northern woodlands, however, a good deal of development work is needed before the back areas can be operated at frequent intervals.

If the landowner has sufficient financial stability to amortize forest improvements over a long period it will often be possible to use some form of partial-cutting that will improve the long-run returns of the woodland. This is one way in which forest credit might help owners increase the over-all returns from their holdings, by providing long-term, low-interest loans for such operations. The increased productivity and value made possible by the improvement work could provide a basis for the loan. The risk of loss from natural hazards would also be considerably reduced by such a program of development. This principle might also be extended to loans for early cultural treatments that yield an insufficient income to pay for themselves.

Taxes and Interest

It has already been mentioned that some states have laws exempting growing wood and timber from taxation, but that few landowners have taken advantage of them. Therefore the bulk of the growing wood and

timber in New England, except in New Hampshire, carries an annual tax burden. The bare land is taxed in all states. The amounts actually paid in many localities do not constitute a very formidable sum, but it sometimes happens that poorly-stocked stands or those growing on unfavorable sites cannot clear a large enough return to pay even a very modest tax, unless some of the intangible returns from forest land can be charged against this burden. A more frequent situation is that which occurs with a young forest where no income will result for many decades to offset the yearly taxes.

On a farm that is to operate continuously taxes are a cash cost of doing business with the given operating unit. Since farms plans and budgets were made for the entire operating unit, a single entry for taxes was made under expenses. No attempt was made to allocate a portion of the tax bill to the woodland.

The budgets were constructed on a cash basis and no provision was made for charging interest on the total investment in farm resources. However, since interest paid on borrowed money is a cash expense it was included in the budget along with interest on the added investment that would be required under the proposed plans.

Management

A brief word is needed concerning the amount of management needed by different intensities of forestry. Little effort is required to carry on present practices. If the lot is sold for a lump sum the owner will only have to bargain out the terms of the sale. As often as not he may not even have to search out a buyer. Operators have a habit of

noticing stands that are "ripe." Stumpage sales require some additional checking to insure that the terms of the agreement are kept, but management requirements are still low.

If logs are sold at the roadside the owner must either contract the job with an operator or hire a crew to get the wood out. Since a fixed payment is usually made for each cord or thousand board feet cut or skidded, little supervision and direction is needed to keep the men occupied. No large demand for management is made as long as the operation follows customary lines that are familiar to workers. Of course, if the cutting is done by the regular farm labor force, considerable planning and direction may be required. Special adjustments in the working schedule are needed, perhaps with some supplementary outside labor, to insure not only that woods work is effective but also that farm work continues without a detrimental loss of efficiency.

If improved cutting practices are introduced, greater supervision and technical knowledge will be required, at least until the operating techniques become more familiar. In many localities a county forester will either mark the stands for cutting or will show the farmer how to do it. In some localities the forester will help find a reliable buyer and will also give some degree of supervision to the job. All of this is done without charge.[10/] Whatever arrangements are made, more responsibility for supervision and planning will devolve to the owner than would be true with customary practices. If labor is hired for the job a premium wage may be required and certainly frequent checking of the operation will be needed.

10/ Only in South Carolina is a nominal fee charged for the services of the County Forester.

If a full program of partial-cutting is undertaken the job of management will be somewhat greater than it is when only better harvesting methods are used. Woods operations will be more frequent and the technical knowledge required will be greater. Once the general principles of such a system are grasped most owners should be able to carry it on with a minimum of outside advice and guidance. All told, considerably greater demands will be made on managerial ability if the most intensive types of forestry are practiced.

Short-Run Output

The short-run output available from a given woodlot is dependent first, on the condition of the growing stock and second, on the type of forest management used. On most of the study farms the owners did not feel that they were able to carry on any sizeable forestry operations that could not be immediately profitable, or at least pay their own way. Thus the market demand for forest products is a strong governing factor over operations. If there is no outlet for fuelwood, none will be cut beyond that amount that may be needed on the farm. However, most of the more intensive management plans require no rigid cutting schedule and operations can be timed to take advantage of good markets as they arise. Uncertainty about the future, unfortunately, may make it difficult to resist liquidating all the growing stock that can be sold on an active market. Thus the investment in deferred harvesting required by good cutting practices sometimes creates a difficult problem.

When partial-cuttings to improve the residual stand are made the yield is most frequently in the form of fuel, pulpwood or low-grade

The problem of estimating the forest growth that will result over the years from different management practices is a very difficult one. Many decades are required to grow merchantable forest products and silvicultural research must advance slowly. At the present moment, only fragmentary data are available covering a few decades of the life of managed stands. Some growth figures from managed European forests cover periods of a century or more, but they are not directly applicable to New England conditions. Thus it is necessary to fall back on estimates of growth capacity based on unmanaged, wild stands, logical extrapolations of partially completed experiments and common sense deductions from the experience of persons familiar with forest conditions.

A complete discussion of the intensive system of prediction used on a few farms will be found in Appendix A. A simple rule of thumb was devised for general use on the bulk of the study farms. A canvass of foresters familiar with a wide range of New England conditions revealed their considered estimates of the physical yields that can be reasonably expected from intensive forest management. This composite of several estimates is probably conservative and may tend to understate the actual results. The basic figures arrived at for average woodland were a sustained yield, once full productivity had been reached, of from one-half to one cord of wood per acre per year. Probably the higher figure would only be reached on the better sites and under favorable conditions. It was further postulated that at least half of this yield would be in the form of sawlogs. The general opinion was also expressed that there would be no substantial difference in these figures between softwoods and hardwoods on average sites. Knowledge of the growing conditions of each

sawlogs. In fact, this type of management salvages a good deal of cordwood that would otherwise die and be wasted. But unless market conditions are favorable these products may find no buyer unless "sweetened" with some higher-quality products. Thus partial-cuttings must be made on a compromise basis between that which seems best silviculturally and that which will meet market requirements. The primary problem is to prevent partial-cuttings from becoming a system of cutting the best trees and leaving the trash.

As previously pointed out, the estimates of yields during the next five to ten years were made from on-the-ground inspection. These calculations took into consideration the present growing stock and operating conditions, along with the over-all forestry enterprise and the other farm operations. Present and prospective market conditions were also considered. Whenever possible the estimates were made with the farmer, or local forester who was familiar with local conditions. Thus the estimates were based on the combined judgment and experience of the analyst and local cooperators.

Long-Run Input-Output

The same input factors were used in both the long and short-run. Thus the previously discussed labor requirements were assumed to remain unchanged in the future. These do not take account of any of the benefits that may accrue from future technological advances, labor saving devices, better operating methods and the like. When applied to conditions over a very long time span it is likely that these figures will give conservative results.

woodlot was used as a guide in choosing the most appropriate growth per acre to represent the productivity that would probably be attained by the proposed management.

The same foresters who estimated yields resulting from improved management, held the opinion that customary practices result in average yields of from one-fifth to one-half cord per acre per year, depending on the condition of the growing stock and site. Yields will also be erratic in their timing and, under most conditions, will tend to be made up of increasingly inferior species. Improved management on the other hand will probably result in more regular returns and a gradual increase in the proportion of valuable species and sawlogs, so that the growing stock will become a more valuable part of farm resources.

Chapter V

PLANNING THE FARM WOODLAND

Some of the factors relevant to making farm woodland plans and budgets have been presented in the previous chapters. Much of the discussion has concerned the inputs and outputs of forestry and the variation in these factors due to different intensities of management. Before these data can be used in budgeting, however, a great deal must be known about the resources of the operating unit and the aims of the operator. Dr. John D. Black of Harvard University has stated that,

> ...programs for improved land use must be developed in terms of management units. It is ordinarily not possible to say what use for a given piece of land is its best use until we decide the size and form of organization of the unit in which it is to be managed.... Given such use and units for it, then and only then can one determine the combination of soil management and other practices that provides optimum return.1/

Although the above statement was made with reference to fitting soil conserving practices into the farm economy, it is equally true of forest management practices. To furnish the most useful guide for management decisions, a woodland plan must be an integral part of a plan for the entire operating unit. The analyst and the operator must together explore the alternative means of utilizing physical and managerial resources. Then plans and budgets can be prepared for the most promising combinations of enterprises and management practice intensities.

Such a procedure has been followed in planning the desirable

1/ J. D. Black, Farm Management Plans, United Nations Economic and Social Council, E/CONF.7/EC/W/303, 13 June 1949.

adjustments to be made on a sample of 241 New England dairy farms. The forestry problems encountered in making the woodland part of these plans will be discussed in the balance of this chapter. These problems cannot be considered in complete isolation since the woodlot has important supplementary and complementary relationships with the other farm enterprises. It is essential that plans and budgets correctly evaluate these factors. Only after a careful appraisal of the farm resources, including the woodland, can their use be integrated in the various farm enterprises.

Land Use

One of the first decisions to be reached in planning an operating unit is that of what cover to maintain on each piece of land. The allocation of land to different uses is determined not only by soil capabilities and efficient farm layout, but also by the production needs of the type and size of business to be developed. On the study farms, it was found that open arable land could ordinarily, as one would expect, be used to the greatest advantage for crop production, most commonly hay in New England. Sometimes, however, an open field is so inconveniently located that it can best be used for tree growth. Shifts from open land to trees have been made extensively in the past and probably will be needed to a limited extent in the future.

More often today, however, the adjustment called for is the other way, clearing trees from productive soils for more intensive use in agriculture. Such land improvement is best undertaken if the crops produced from the area are needed to round out the farm business, if a desirable field arrangement will result, and if other suitable land cannot be purchased for less than the cost of clearing and improvement.

Farm A

One of the study farms in southern New Hampshire illustrates the need for clearing woodland to complete a satisfactory dairy farming unit. For a number of years this farm was operated as a combination dairy and fruit farm by the father of the present operator. Subsequently the property was divided among three children. The present operator owns the barn and 65 acres of land including 5 acres of former alfalfa mixture now pastured, 7 acres of orchard, 8 acres of open pasture, and 47 acres of woodland including 15 in a separate tract that is not grazed. The farmer also has the use of 5 acres of his sister's hayland (Field H19) and exchanges the use of his orchard for the use of 15 acres of his brother's cropland (Fields J15-J17).

The livestock enterprise includes a milking herd of 8 cows, plus more than enough young stock to furnish replacements. Milk production has averaged 8,000 pounds of 3.8 percent milk, with grain feeding of about 8,200 pounds per cow. The operator has not been able to harvest enough roughage for winter feeding on the land operated, and about ten tons of hay have been purchased. The trouble has been partly one of finding time at the proper season to do work on roughage crops. A large part of the pasture has been supplied by Field 10, but most of the permanent pasture near the barn is ledgy or poorly-drained. A bulldozer has been used to start clearing a small section of woodland pasture (part of Field 5), but the area is still in rough shape, covered with piles of debris and topsoil.

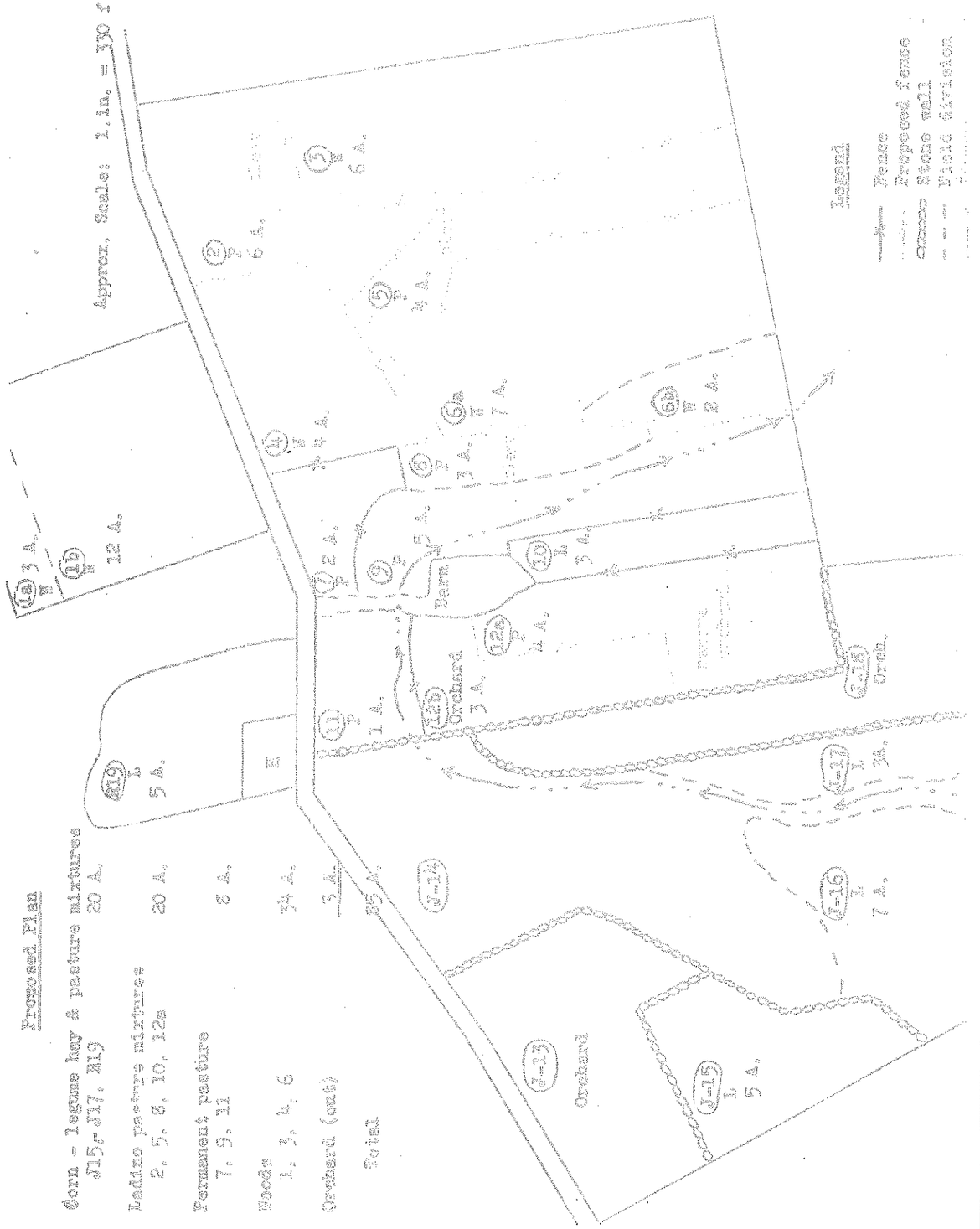
The 36 x 45-foot barn has a row of tie-ups for 15 cows along the north side of the main floor, with space for young stock and grain along

the south side and a manure cellar underneath. Equipment includes a medium-sized general purpose tractor with plows, harrow, and cultivator; a manure spreader; tractor mower; corn planter; ensilage cutter; single unit milker; and an eight-can cooler. The barn lacks water-bowls at present, and hay is loaded by hand.

It is evident that the method of dividing the former farm among the three heirs has complicated the problem of achieving good land use and a dairy enterprise that will yield a satisfactory income. The operator has a barn but only a limited amount of land in condition for roughage production. The soils on a substantial part of the pastured woodland would be suitable for permanent pasture if cleared of trees and improved. The present forest cover on part of the area is restocking after the hurricane and can make little contribution to farm income for several decades. The rest of the woodlot supports middle-aged hardwood stands and two thrifty pine stands in Areas 4 and 6b. Clearing reproduction, stumps and remnant seed trees to improve 13 acres of woodland for pasture production would permit expanding the dairy herd to 15 or 20 cows. The use of good harvesting methods and a small amount of improvement cutting on the balance of the woodlot will furnish most of the forest products used on the farm. It is evident that substantial changes are in order if income under the assumed prices is to reach a level satisfactory to the operator.

Plan I, a transitional plan, provides a means for the operator to gain experience and start reasonable development of present resources with little added investment, by raising all of the roughage needed for the present herd. Apple trees will be removed from Field 12a. This field and Number 10 will then be reseeded to ladino clover to provide liberal summer

Map 5.1
Farm A



pasture. Fertilization and reseeding of the other fields will be stepped up, and care of roughage crops will take place on a more timely schedule. Investment will probably be increased by no more than $100. It is anticipated that the provision of more and better roughage will increase milk production by 500 pounds annually with no increase in grain feeding. Although the productivity of the land will be considerably increased in this plan it is unlikely that it will support any expansion of the milking herd. The size of business developed still falls far short of the owner's ultimate goal.

Plan II is a longer range program and might well follow all or part of the accomplishment of Plan I. Under this plan the milking herd will be increased to 15 and with the help of the Soil Conservation Service the 15 acres of woodland will be cleared and seeded to ladino clover pasture mixtures. This, done at a cost of about $100 per acre, provides the only practical means for expanding pasture, since no other suitable land is for sale in the neighborhood. Although the field layout developed is not ideal it can be used to advantage for rotation pasture. The woodland stands will be fenced so that grazing can be controlled. Careful consideration of soils and growing stock along with pasture needs has made it possible to leave the better stands in the woodlot to grow forest products for farm needs. Fertilizer will be used more liberally than in Plan I and milk production will be at the same rate. A side-delivery rake and hayloader will be purchased, and eventually the barn will be remodeled. Investment will then be increased by about $4,500.

A financial summary of these different plans is shown in Table 5.1. It is evident that clearing woodland to permit expansion of the dairy herd

Table 5.1

Farm A

FINANCIAL SUMMARY

	Present	Transitional Plan (I)	Long-Range Plan (II)
Receipts			
Milk	$2,070	$2,220	$4,400
Cows	400	400	300
Calves	12	12	40
Eggs	400	--	--
Poultry	150	--	--
ACP refund	50	50	50
TOTAL	$3,082	$2,682	$4,790
Expenses			
Grain	$1,435	$1,023	$1,725
Hay	250	--	--
Labor	--	--	130
Seed	25	50	70
Misc. dairy	100	100	180
Chicks	60	12	12
Misc. poultry	25	--	--
Fertilizer and lime	92	176	351
Elec. and tel.	84	84	100
Gas, oil and grease Other truck & tractor exp.	200	220	250
Bldg. upkeep and repairs Equip. upkeep and repairs	175	180	200
Taxes	35	35	40
Rent of young stock pasture	12	--	--
Insurance	43	43	50
Interest	80	85	307
Deprec. machinery	100	100	180
Deprec. buildings added	--	--	50
TOTAL	$2,716	$2,108	$3,585
NET FARM INCOME	$ 366	$ 574	$1,205

has made it possible to increase net farm income to a level that was previously unattainable. While Plan I represents a gain of only $215 in net farm income, Plan II shows a gain of over $1,100, including the amount set aside for payment of interest on the added investment. Although the contribution of land clearing to farm income and organization is not always so striking, this case served to show some of the principal considerations.

Another kind of land use problem involving forestry on the study farms is how to treat the brushy pastures commonly found on the rougher soils. The judicious use of lime, fertilizer and a bog harrow for reseeding can maintain a good pasture mixture on relatively stony soils that otherwise might be suitable only for woodland. Here again the roughage demands of the dairy enterprise and the development of an efficient farm layout are paramount in deciding whether to maintain a pasture or woodland cover. Typically, adjustments of this kind are made on brushy pastures that are frequently in the process of reverting to forest land. A modest effort in clearing brush and stones will often smooth the area enough to make improved pasture production possible.

Table 5.2 summarizes the average land use changes planned on 239 of the study farms. It is apparent that the average area of "seeded pasture mixtures" and "fertilized pasture" will increase by about sixteen acres. Some of this change will come from improving the brush pasture mentioned above. That a considerable amount of brush land will find a different use is indicated by the fact that the area called "other pasture" will be reduced by about twenty-two acres. Some of this reduction is due to pasture improvement and some to allocating the land to forest uses.

Table 5.2

CHANGES IN LAND USE PLANNED ON FARMS COOPERATING IN THE NEW ENGLAND DAIRY FARM MANAGEMENT PROJECT

Item	Northern States (146 farms)		Southern States (93 farms)		New England (239 farms)	
	Present	Proposed	Present	Proposed	Present	Proposed
Land Use			Acres per farm			
Forage crops						
Corn for silage or fodder	3.3	2.8	10.2	9.3	6.0	5.4
Hay & pasture crops	55.2	56.1	39.1	42.6	47.6	50.8
Grains	2.7	2.5	0.3	0.3	1.8	1.7
Cash crops	3.2	2.4	3.4	3.2	3.3	2.7
Idle cropland	0.8	-	-	-	0.5	-
Total cropland	65.2	63.8	53.0	55.4	59.2	60.6
Seeded pasture mixtures	1.1	7.1	3.3	19.2	1.9	11.8
Other fertilized pasture	2.7	11.2	5.3	8.9	3.7	10.3
Total improved land	67	82	62	83	65	83
Woodland pasture	64	5	35	-	52	3
Other pasture	60	42	57	28	59	37
Woods not pastured	62	123	20	55	46	96
Other land	4	4	6	7	5	5
Total land operated	257	256	180	173	227	224
Land Improvement						
Cleared for seeding		3.4		8.2		5.3
Smoothed for pasture		2.7		2.2		2.5
Rented cropland (inc.above)	4.8	3.4	11.6	10.7	7.4	6.3
" pasture " "	6.1	2.8	18.8	11.5	10.9	6.2
New legume seedings " "	5.6	10.0	6.3	10.9	6.9	10.3
Forage production			Tons of hay equivalent per farm			
Silage	12	24	27	34	18	28
Hay	68	86	54	77	62	83
Pasture	54	78	57	85	55	81
Total	134	188	138	196	135	192
Forage Yields on Cropland and Seeded Pasture	1.6	2.2	Tons of hay equivalent per acre 1.9	2.4	1.7	2.3
Fertilization of Improved Land			Pounds per acre			
Nitrogen (N)	36	46	55	58	43	51
Phosphoric Acid (P_2O_5)	46	75	61	90	52	81
Potash (K_2O)	45	85	65	117	52	97
Ground limestone	315	346	436	432	360	380

This immediately raises the question of how such land can be best converted to forestry production. Most of these marginal pasture areas in New England are already seeding in from surrounding trees. Commonly, all that is needed to complete the reproduction of satisfactory forest cover is the cessation of grazing. There are instances, however, where the absence of a desirable seed source may make tree planting advantageous.

When planting is done the area should be relatively free of competing seedlings and brush; otherwise expensive weeding will be necessary to insure survival of the plantation. Tree planting has been recommended on a few of the study farms, but most of it has been suggested to reduce erosion by quickly establishing forest cover on steep slopes. The other use is spot-planting to fill in persistent gaps in the young forest canopy.

The grazing of woodland presents another problem in this area of decision between forest and crop use of land. The practice of letting livestock, especially young stock and dry cows, roam the woods for forage is widespread throughout the region. A great deal has been said and written about the harmful effects on forest production of this dual use of land. Undoubtedly, heavy grazing creates conditions unfavorable for tree growth by compacting forest soils; also hardwood reproduction is destroyed because of the preferential food habits of livestock. Also the feed available in most woodlots is very scarce; in effect, many woodlots are merely exercise lots. This is particularly true toward the end of the summer, since the amount of grass falls off rapidly during the dryer part of the pasture season.

As the importance of an improved pasture program becomes more generally appreciated by farmers, the practice of grazing woodlands is

likely to be used less frequently. Table 5.2 indicates that practically all of the present woodland pasture will either be improved for roughage or retired to forest use. This doesn't mean that all cattle will be kept out of the woods immediately; such a goal will be attained only gradually. Frequently even the limited feed on the woodlot is needed by the dairy enterprise until other adjustments can be made. As pastures are improved, roughage production will increase and the woodlot feed may no longer be necessary.

The amount of fencing required to implement this program will depend on the field layout of the particular farm. Occasionally the cost of fencing will be more than the probable damages. It has been the author's observation that when good feed is plentiful on improved pastures, cattle pay little attention to woodland pasture and little grazing damage results if livestock merely use the edge of the woods for shade. The Soil Conservation Service often suggests planting a hedge of multiflora rose in lieu of fencing. This may provide an attractive alternative in some instances if it can prevent woodland grazing and provide wildlife cover at the same time.

One beneficial effect of woodland grazing was observed on some of the lighter soils in the southern counties of Maine. In this area white pine can frequently reproduce itself after cutting, provided hardwood competition is not too great. Moderate grazing for a few years after harvesting a pine lot will often keep the hardwoods down and allow white pine to take over the site.

The most disastrous effect of grazing was noted in the central counties of Vermont. A slow-growing weed species known locally as

"hardhack" (Ostrya virginiana) is spread throughout the area. Cattle will eat all the other local hardwood seedlings so that this one has been allowed to take over many brushy pastures. Years will pass before these dense thickets produce even low-grade fuelwood; otherwise expensive clearing may be needed to get rid of this species to make room for more desirable trees or for improved pasture.

Once a decision has been reached about the land to be devoted to woods, the forester can start making plans for its management. His decisions must still be tempered, however, by the rest of the farm activity, particularly by the use of equipment and labor.

Equipment

In general, the study farms were well equipped with the simple tools such as axes, saws, scoots, etc., needed for woods operations. Portable power saws have been developed in recent years and many farmers are considering the desirability of purchasing one. Ordinarily, the need of such equipment is limited to situations with enough work to keep the saw usefully employed much of the time. Custom work off the farm may provide such employment. Since the saw is expensive and easily damaged by careless handling, the owner, or someone he can trust should normally be available to run it.

In order to take full advantage of the labor-saving possibilities of a portable power saw, the work crew should be large enough to allow nearly continuous operation while on the job. A great deal of time can be lost if the saw must be started and stopped frequently. One way of doing this advantageously is to organize the operation so that the saw is

used to buck long logs at the roadside or landing rather than in the woods. This operating method has several advantages that frequently make it more efficient than the customary one of bucking in the woods and yarding to a driveable road.

Occasionally the use of power equipment will make woods work seem more attractive than it might be otherwise. Some people do not like chopping or hand sawing and a machine may make these operations appear less arduous. A little experience, however, is likely to diminish the force of this appeal.

The horse or tractor power available on the study farms appeared useable for woods work in most instances. Usually if horses are needed for logging and are not available on the farm, they can be rented. In a few instances it seemed advisable to keep horses especially for use in the woods. This decision depends primarily on the forest operating conditions, the possibility of hiring teams, and the preferences of the owner. In addition, the advantages of keeping more cattle in place of horses have to be considered. Farm B illustrates one solution of this problem when the horses were eliminated.

Farm B

This 239-acre farm was purchased about five years ago and the owner is attempting to build up its capacity for milk production. He hopes to develop a business that will profitably employ the family labor force. His two sons, aged 12 and 14, will help increasingly as time goes on and one or both may want to go into partnership with him.

The milking herd of mixed breeds has averaged 14 cows during the

last year. The operator is gradually trying to build up a herd of Brown Swiss; thus some replacements are being purchased and the number of young stock being raised is hardly enough for normal replacements. Roughage production from the 25 acres of cropland, 16 acres of open pasture and 48 acres of brush pasture has not been adequate for the present herd plus the team of horses; some hay was purchased in 1947.

Barn space is also being used to capacity, but it is far from satisfactory even for the present enterprise. The stalls are too narrow and too short for the Brown Swiss, and arrangements for feeding are inconvenient. Part of the main floor is occupied by the 12-foot square silo and by stalls for the horses. Eventually new barn facilities must be provided if the herd is to expand.

The equipment includes a 10-20 standard tractor on steel which, together with the horses, has been used to get out the equivalent of about 40 M.b.f. of sawlogs in each of the past two years. Woodland operating conditions are favorable to tractor work since most of the area is level or gently sloping. Tractor power has also been the mainstay of the land improvement program vigorously carried out by the operator.

Since tractor power is physically capable of carrying on the farm work it seems that a desirable adjustment will be to replace the horses with a small general-purpose tractor. This will release some barn space and roughage that is badly needed by the milking herd and young stock. This one adjustment is part of a general program of land improvement, herd expansion and improvement, and barn construction that constitutes the proposed plan. The new plan includes more roughage production from

stepped-up fertilization and reseeding, purchase of the rented land, expanding the herd to 22 milkers, and intensified forest management. When all of this program is accomplished it is estimated that net farm income will be increased by about $760 annually.

In this instance neither the field work nor the woods work required horse power, and several advantages could be realized by switching to tractor power. In other instances, operating conditions may require the use of horses. One illustration of this will be found in Farm C discussed later.

Labor

A little has already been said about integrating the use of labor on the woodland with the demands of the other farm enterprises. The knotty problem of doing an effective day's work in the woods and still taking adequate care of a milking herd is frequently hard to solve. This is particularly true on a so-called one-man farm. During the slack season in the winter, farm labor can often be usefully employed in the woods, but commonly temporary woods workers, contracting, or stumpage sales are necessary to carry out a desirable forestry program. All of these methods of operating make special demands on the managerial capacity of the farmer; no single "best" system is suitable to meet all circumstances.

The demands of different operating plans on both labor and management have been outlined in Chapter IV. It is clear that the choice of the optimum intensity of forest management is intimately connected with the utilization of labor and management ability. Table 5.3 indicates the

Table 5.3

PERCENTAGE DISTRIBUTION OF STUDY FARMS BY PROBABLE SOURCE OF FOREST LABOR INPUTS DURING THE NEXT DECADE

Section of New England	Percentage of Farms Doing Forest Operations by Means of: Regular Farm Labor Force	Regular Farm Labor Force Plus Hired Woods Labor	Hired Woods Labor or Contract Sales	Farms with No Planned Forest Operation	Total
Southern	60	15	3	22	100
Northern	52	26	11	11	100
All N. E.	55	22	8	15	100

source of labor inputs planned for the woodland of the study farms during the next decade. Over half of the farms will be able to carry out the proposed forestry plan with the regular farm labor force, about a fifth will need some supplementary woods labor or contract sales, and less than a tenth will do all woodland work with special hired labor or by contract sales. A careful review of the individual farms shows no fixed relationship between the size of the forestry enterprise, as measured by the volume of annual cut, and the need for extra labor or contracting. However, if the cut is less than 10 cords it can usually be handled by the regular labor force. When the cut is larger the important factor is the amount of woods work that can be done by the farm labor force after taking care of the other farm enterprises. This in turn depends not only on the size of the farm business but also to a large extent on the effectiveness of management in integrating activities. Perhaps the most useful way to observe the interaction of all these factors will be through the discussion of specific cases taken from the study farms.

Size of the Forestry Enterprise

The acreage of woodland and condition of the growing stock are the two major physical factors limiting the size of the forestry enterprise. Small acreage alone can so restrict the contribution of woodland to the farm that forestry is of minor importance. Thirty of the 241 sample farms had less than five acres of forest land. These small areas of trees could be used to advantage as shade for the cattle and could furnish a small amount of forest products for home use. Any necessary work could be easily handled by the regular farm labor force.

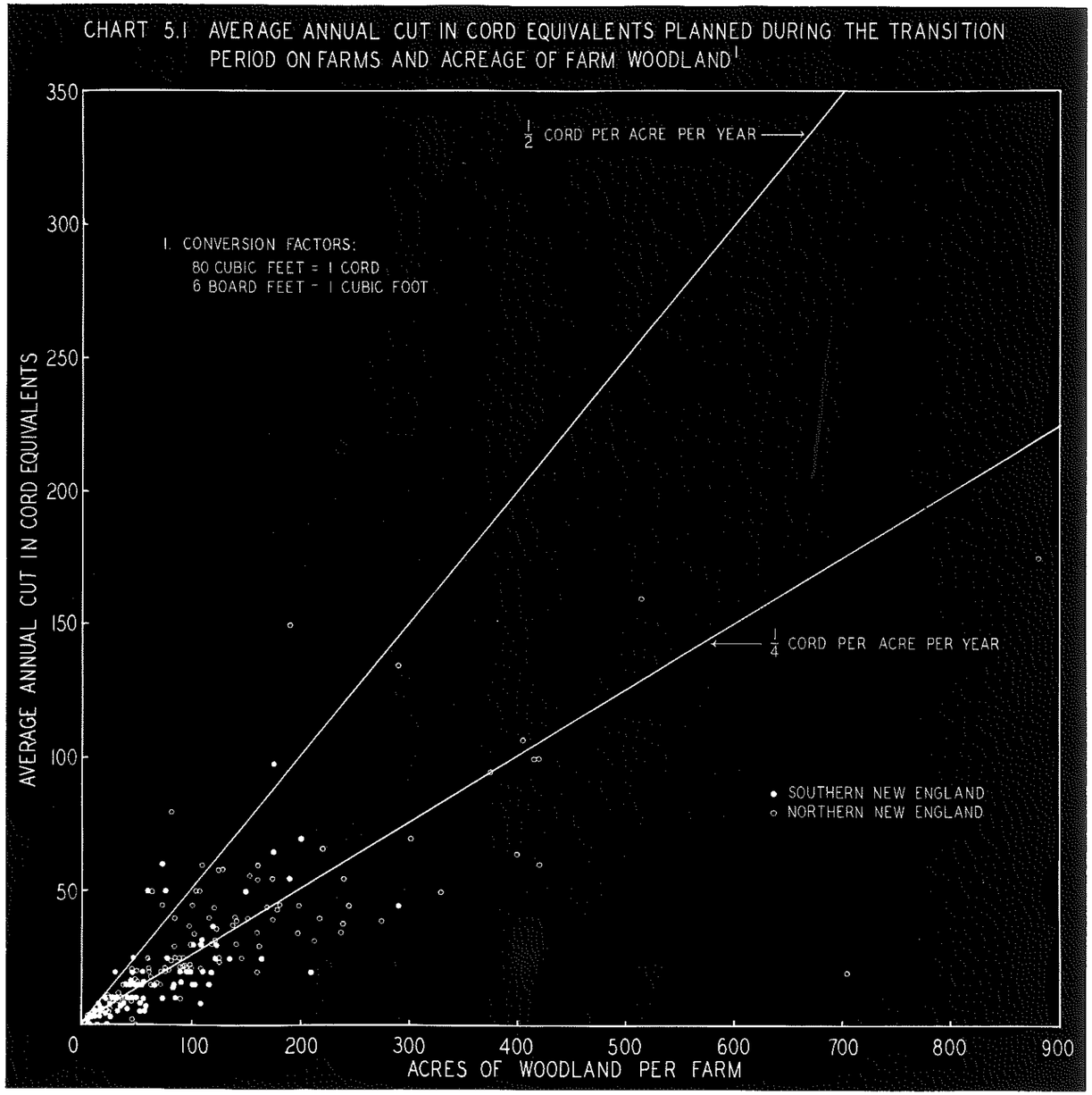
A similar situation of very low input and output during the next few decades was found on some larger woodlots. Thus one farm in Essex County, Vermont, had over 700 acres of recently cut-over woodland. The original growing stock had been completely liquidated to pay off part of the farm mortgage, a procedure frequently followed in the northern areas. Enough salvageable trees were left standing to provide farm fuelwood for the next few years. The labor required could easily be done in the winter months by the farmer and his son. After a few decades when useable materials start to be available in the young stands the problem of integrating alternative management intensities with other farm activities must be reconsidered.

The differences in planned annual cut found among woodlots of the same acreage in Chart 5.1 are due primarily to variations in growing stock. The average yearly cuts scheduled for the next decade cluster about one-quarter cord equivalent per acre (about 20 cubic feet). The higher cuts are usually the result of liquidating mature stands that have grown in the past and do not necessarily represent any sustained improvement in productivity. It can be seen that the volume produced by the forest enterprise grows rather slowly as acreage increases. It is probable that when the effect of improved forest practices becomes evident the average annual cuts will more nearly center about one-half a cord equivalent per acre.

The "Farm Woodlot"

The problem of managing farm woodland is frequently posed within the framework of the so-called "farm woodlot." This phrase has given rise to

CHART 5.1 AVERAGE ANNUAL CUT IN CORD EQUIVALENTS PLANNED DURING THE TRANSITION PERIOD ON FARMS AND ACREAGE OF FARM WOODLAND[1]



a popular notion that farm woodlands are held in small blocks that are or can be managed in such a way as to produce substantially all of the forest products needed in the operation of the farm business, plus a small amount for sale.2/ The previous chapters have shown that the size distribution of farm woodlots is very wide. It is probable that the "farm woodlot" thus defined actually represents something less than a fifth of the acreage of woodland in farm holdings. However, the management problems of smaller holdings are important even if their solution will not clear up all of the farm forestry problems.

In the Worcester County, Massachusetts, Land Use Planning Project it was estimated that an average farm in the area used about 1,400 cubic feet of wood each year. The anticipated average annual yield from careful management on the study farms is about 20 cubic feet per acre during the next decade. These figures indicate that with average yields a "farm woodlot" should contain about 70 acres in order to meet the wood requirements of the farm. Increasing productivity will eventually provide a surplus for sale if the suggested management practices are followed.

It is frequently possible to practice an intensive form of forest management on small holdings by making only minor adjustments in the present cutting program. Since inputs are small they can be provided by the regular farm labor and equipment at a low marginal cost during the

2/ The following statement found in Report No. 1 From a Reappraisal of the Forest Situation can easily impart this impression. "About half of the acreage in small holdings is on farms. Farmers, in fact, comprise more than three-fourths of the small woodland owners. They average only 41 acres of woodland each. While such small forest acreage cannot provide the main source of income to the owner, it can contribute to farm living by supplying fuel, posts, or lumber for farm use as well as some supplementary cash income."

winter or other slack seasons. When the products are used at home the farm business receives a large part of the market value of the materials that would otherwise have to be purchased. These values, however, are not specifically shown in the farm budgets worked out in this study, since these contain only cash items. One instance where minor adjustments in cutting practices appear most advantageous is illustrated below.

Farm C

This 150-acre farm includes 27 acres of cropland, 25 acres of open pasture, and 5 acres of woodland at home, together with a 6-acre mowing and 90 acres of woodland in three separate tracts one or two miles from the home farm. Seven cows are kept, and two calves a year are usually raised for replacements. A five-acre orchard has received considerable attention for spraying and pruning, but yields have been low. The rest of the cropland is used for hay or cropland pasture, with an acre of millet grown for green feed. Fertilization of field crops has been limited to farm manure. Yields have been low and a few tons of standing hay have been needed. Fuelwood and a few logs for home use have been harvested from the woodland. Forestry practices have followed the customary pattern of clear-cutting an area large enough to furnish the required amount of wood. The average area worked over each year has been about one acre. Although these plots are restocking gradually, there has been more delay and the species are less desirable than would have resulted if improved harvesting methods had been used.

The operator's age and health do not permit him to work as rapidly as a younger man, but his accomplishments in the last few years have been sizeable, especially in view of his limited equipment. A new

28 x 56-foot barn was built with tie-ups for 12 head, adequate hay storage, and a milk room. Part of the labor was hired, but much of it was done by the operator. His 12-year old son takes an active interest in the farm, and a 17-year old daughter also helps with the work. A neighbor's tractor is hired for plowing and spraying and a horse is borrowed for part of the summer work. A pick-up truck, single-unit milker, and a 4-can cooler complete the major items of equipment.

The proposed plan calls for making some additional capital investment. The milking herd will be increased to 14 cows, with 4 calves started each year. A stepped-up program of liming, fertilizing and reseeding to ladino clover mixtures will provide adequate good-quality roughage for the herd. Tie-ups for the additional livestock and water bowls will be installed. A buckrake and lime and fertilizer spreader will be purchased, and eventually a silo will be built for grass silage. Use of the neighbor's tractor will continue on a hired or exchange basis.

Woodland management will be intensified by adopting better harvesting methods and partial-cuttings to improve stand quality and growth. Actually this will involve little departure from the present operating plan. The usual harvest of about 20 cords of firewood and a few logs for home use will be obtained from partial-cuttings on five or six acres, rather than from clear-cutting on about one acre. This will allow work to be done on all of the stands about once every 10 to 15 years with little if any added labor input. In the long run, growth and yields will be increased and the quality of the stands will improve. A considerable volume will be salvaged that would otherwise be wasted. In addition, these operations will promote prompt and valuable reproduction

to insure the continued productivity of the woodlot. The one month of woods labor input needed during each of the next five or ten years will be furnished by the operator and his family. Eventually output will increase to the equivalent of about 45 cords per year with a labor input of about two months. This will provide some future cash income from the sale of surplus products. It is doubtful that productivity under present practices would increase much above the present level.

The financial summary shows that when the proposed changes in farm operation are effected, annual net farm income will increase by about $485. Benefits from the forestry enterprise are assumed to be equal in both the present and proposed budgets since no increase in yields is anticipated for at least a decade.

In contrast with Farm C, even the small woodlot of Farm D raises difficult problems of integration. Farm labor can be almost fully employed without woods work. It is estimated that any substantial diversion of labor from other farm operations is likely to result in a loss of efficiency and income greater than the probable gains from forest products.

Farm D

This farm was part of a larger unit until the death of the operator's father several years ago. Division among the heirs in 1946 created the present farm of 200 acres plus a 40-acre separate woodlot. The milking herd of 38 Holstein cows has produced an average of 7,000 pounds of 3.5 percent milk, with annual grain feeding of about 1,500 pounds per cow. The normal practice has been to raise most replacements, but young stock numbers were upset in the property division, and the number raised in the

past two years has not been sufficient for normal replacements.

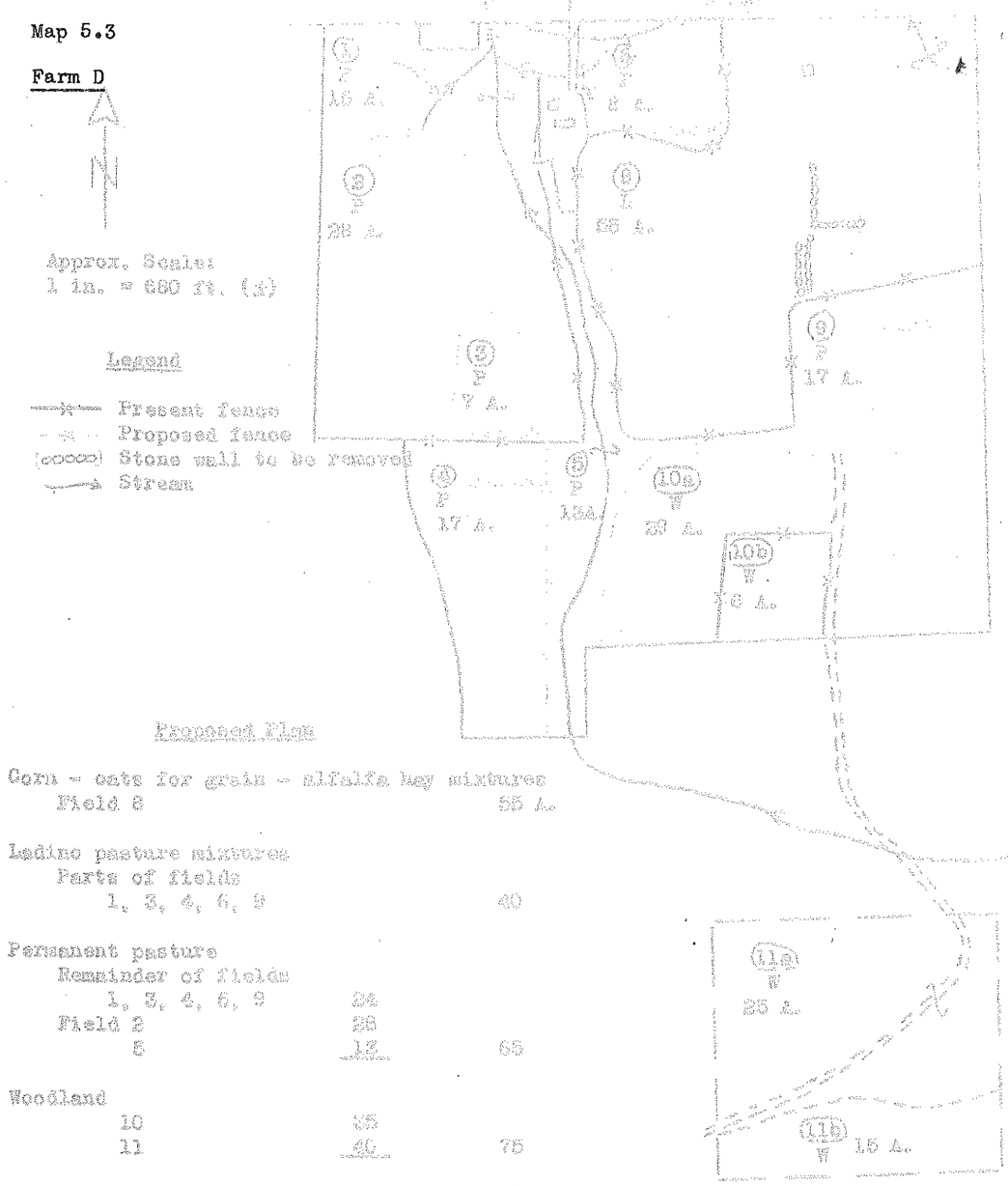
The division of the property also upset the former land-use and rotation pattern. The former crop fields had been used for pasture and only about 55 acres (Field 8) had been kept in the crop rotation of corn-oats for grain-alfalfa hay mixtures. No new seedings were made in 1946. To provide winter roughage for the herd during the past two years, the operator has grown a sizeable acreage of corn silage and has purchased a considerable tonnage of hay, mostly standing. Occasionally a small acreage of corn has been husked for grain. There are about 105 acres of open pasture, of which 40 or more were formerly cropped. Superphosphate has been applied as topdressing on part of this area. There are also 29 acres of woodland in the pasture, and a 6-acre pine plantation which is not grazed.

The farm is well equipped with a large general purpose tractor, tractor tillage implements, a pick-up truck, a trailer-type manure spreader, lime sower, tractor mower, side-delivery rake, push-bar hayloader, corn planter, corn binder, ensilage cutter and two double-unit milkers. The main barn provides tie-ups for 38 cows, three box stalls and adequate hay storage overhead. Moderate remodeling could provide room for 50 cows and a gutter cleaner. A new tile silo recently replaced the old wooden one. A separate barn and shed house 10 heifers and 400 layers and provide room for machinery storage.

One man is hired full time and a 74-year old carpenter helps with maintenance in return for his room and board. A few extra days of help are hired at silo filling and haying time, and about 50 tons of hay were baled by a custom baler in 1947. In recent years little if any woods work has been done.

Map 5.3

Farm D



The combination of enterprises is well adjusted to the land, buildings and labor force available. Some adjustments in the cropping program will be desirable to increase the quantity of roughage grown, improve its quality, and promote conservation on the 8- to 25-percent slopes found on most of the cropland. The present business represents a high level of accomplishment for the labor force involved, in comparison with other New England dairy farms.

The main changes suggested in the proposed plan are a moderate reduction in the acreage of silage corn, the reseeding of about 40 acres of pasture to ladino pasture mixtures grazed in rotation, and a slight increase in the number of young stock replacements raised. With liberal fertilization, all roughage can be grown on the farm, although it may be more economical to plan slightly lower fertilization if good quality standing hay is available at moderate cost. The small amount of farm labor and managerial time available for the forestry enterprise will be used to the greatest advantage by a combination of partial-cuttings and marked stumpage sales.

The manure produced by 60 animal units will be supplemented by purchased materials to provide about 40 pounds of nitrogen (N), 104 pounds of phosphoric acid (P_2O_5), and 133 pounds of potash (K_2O) for each acre of cropland and ladino pasture (95 acres). This compares with 58 pounds of nitrogen, 59 pounds of phosphoric acid, and 60 pounds of potash per acre of cropland (55 acres) under the present plan.

With top-quality pasture available for five or more summer months, with heavy fertilization of cropland seeded to desirable species of legumes and grasses, and with earlier harvesting of hay, some further

increase in the average quality of roughage can be expected. This will tend to increase roughage consumption; an increase in milk production or a decrease in grain feeding should follow. Whether or not to maintain the present rate of grain feeding will depend on how well the cows respond to the additional nutrients provided. The plan assumes that milk production per cow can be increased 500 pounds annually with no change in grain feeding.

In order to reach the highest level of forest productivity compatible with the amount of labor and management available on this farm, a combination of partial-cuttings and improved harvesting methods is suggested. Partial-cuttings will be made to increase stand quality and vigor to the extent that the farm labor force is able to carry them out. Stumpage sales will be made on a marked basis with the aid of the County Forester to harvest mature stands. Farm labor will concentrate on the stands that are not commercially attractive logging chances.

The following outline indicates the present condition of the wooded areas of this farm together with suggestions for a reasonable forest management plan.

Stand No.	Acres	Present Condition	Suggested Treatment
11a	25	Even-aged, 40 to 60 year old stand of hard maple, red oak, white birch and some white ash, basswood and beech. There are a few 0 to 20 year old groups resulting from cordwood cuttings. Medium to high density and good reproduction. Well stocked with high quality trees.	Make partial cuttings every 10 years to remove poorly shaped trees and inferior species along with mature trees that will make turning stock or sawlogs. This will help increase the growth of the best trees left behind. If the work cannot be accomplished by the available farm labor force, occasional stumpage sales of trees marked by the County Forester will serve the purpose.

Stand No.	Acres	Present Condition	Suggested Treatment
10b	6	Eight to ten year old plantation of red, scotch and white pine overtopped by poplar and gray birch.	Removal of the overtopping hardwoods is essential if the investment already made in the plantation is to be productive. This will require only about 10 days' work by the farm labor force. The best pines should be pruned to two-thirds of their height or 16 feet above the stump so that future growth will add clear wood.
10a	29	Even-aged, 20 to 40 year old stand of hard and red maple, white birch and hardhack. Medium to high density and poor reproduction. There are some cut-over areas.	Eliminate grazing to aid restocking. Make partial-cuttings as outlined above. Yields in the immediate future will be primarily for fuel and some turning stock.
11b	15	Even-aged, 20 to 40 year old stand similar in composition to stand 11a except that there is a high proportion of beech. This is a poor growing site and the trees are of relatively poor form. Density is medium to high and reproduction is fair.	Make partial-cuttings as outlined above. Yields in the near future will be primarily fuel.

Stands 11a and 10b contain a large number of crop trees capable of putting on rapid high-quality growth in response to the practices outlined above. These stands should have first priority on available labor, and Stand 11a can be improved by a stumpage sale of marked trees. Stands 10a and 11b have a fewer number of crop trees. To the extent that the operator can find time and help for this work, and a use or market for cordwood, it will be desirable to make partial-cuttings to increase the growth rates of better trees.

If some timber is sold as marked stumpage and a limited amount of farm labor is used to make improvement cuttings where they will be most helpful in stepping up growth rates, the total out over the next 10 years will be about 100 cords of turning bolts and cordwood and 50 M.b.f. of sawlogs. This will require an average of about 15 days' work annually by the farm labor force. As the stands mature and reach full productivity, the yearly harvest will gradually increase to about 40 cords of material, about half of which would be suitable for marked stumpage sale. The labor input would then be about 30 man-days per year.

It is estimated that in the long-run returns from the above program will be about double those of infrequent clear-cuttings. The presence of a vigorous and fully stocked woodlot will add to the value of the entire farm.

The main item of additional investment involved in carrying out this farm plan will be an increase of $300 in livestock inventory as the number of young stock is increased. A limited amount of contract work in smoothing land and in stone wall removal may prove helpful, but the total investment in this work will probably not exceed $500. No credit problem will be involved. The financial benefits of the suggested changes will be dependent on the operator's success in stepping up roughage quality and converting this into larger milk production. Under the assumptions outlined above, the financial summary (Table 5.4) indicates that net farm income will be increased by more than $360 annually.

Larger Woodlots

Chart 5.1 shows that many of the sample farms include a much larger

Table 5.4

Farm D

FINANCIAL SUMMARY

	Present	Proposed
Receipts		
Milk	$7,953	$8,550
Cows	560	480
Calves	150	140
Eggs	1,040	1,040
Poultry	750	750
ACP refund	160	160
Cordwood or Bolts		(10 cd.) 90
Sawlogs M.b.f.		(5 stpg.) 30
TOTAL	$10,613	$11,240
Expenses		
Grain	$ 2,590	$ 2,746
Hay 40 Tons	400	--
Labor 14 Mo.	1,920	1,920
Seed	180	180
Cows	420	--
Other stock - 2 pigs	10	10
Misc. dairy	200	220
Chicks	200	200
Misc. poultry	40	40
Fertilizer and lime	331	1,159
Elec. and tel.	212	212
Gas, oil and grease	500	500
Other truck & tractor exp.	300	300
Bldg. upkeep and repairs / Equip. upkeep and repairs	500	500
Taxes	341	350
Rent of young stock pasture	15	--
Insurance	173	173
Interest	233	233
Baling and Combining	350	350
Misc.	50	50
TOTAL	$ 8,845	$ 9,023
NET FARM INCOME	$ 1,768	$ 2,097

forest acreage than is needed to produce wood for home consumption if the growing stock is of average quality or better. On these farms the woodlot can make a more or less important contribution to cash income through the sale of forest products. There were many sample farms in the northern states where analysis showed forestry could become an important segment of the farm enterprise, but there were fewer such farms in the southern sample areas. There are several factors that may account for this difference. Most of the northern species find a ready outlet through existing commercial channels, while in the next few decades many of the southern farms can produce only low-grade hardwoods that command very limited markets. Many southern farmers are also less skilled in woods operations than northern farmers. It is also probable that the more open southern winters make operating conditions in the woods more difficult than those farther north where frozen ground and a dependable snow cover make skidding and yarding relatively easy. The more even year-round milk production and nearby markets frequently found in southern New England may make it possible to keep farm labor profitably employed all the time without woods work. All of these factors may combine to make the forestry enterprise less attractive on the southern New England sample farms than it seems in the rest of the region.

As the woodlot grows in size, with average stocking, the total yield increases with a concomitant increase in cash return and in labor inputs. The intensifying competition between forestry and agriculture for the use of limited resources makes the problem of integrating these enterprises into a single operating unit more acute. At this point personal desires often come into play and the question of how the farm family

wishes to economize on the use of its labor can have a great effect. It is frequently possible to absorb labor that would otherwise be less usefully employed in the winter by intensifying dairy herd management. The gains from such a program may be greater than those from using the same labor in forestry. This is very likely to be true if the whole labor force is needed for milking and barn chores and any substantial amount of time is needed to reach the cutting job so that actual productive time in the woods is reduced to a few hours between milkings.

It may also happen that having worked hard all summer the family wants to let up in the winter when field work is less pressing. Any of these circumstances may make hiring choppers or selling stumpage more attractive than the possible gains from using farm labor in forestry. Good silvicultural practices can be carried out through either of these above alternatives, but the first needs close supervision and the latter requires a salable product, attractive to local timber or pulpwood operators. This generally limits forest operations to those that are immediately self-liquidating or profitable. Few farmers feel that they can afford to wait for a return on cash invested in silviculture, although some are willing to invest the small marginal cost of their own time during slack seasons in stand improvements that pay future returns. The problem is to get the greatest benefit possible under the conditions peculiar to the individual operating unit. The following farm will illustrate one solution of a typical woodlot problem.

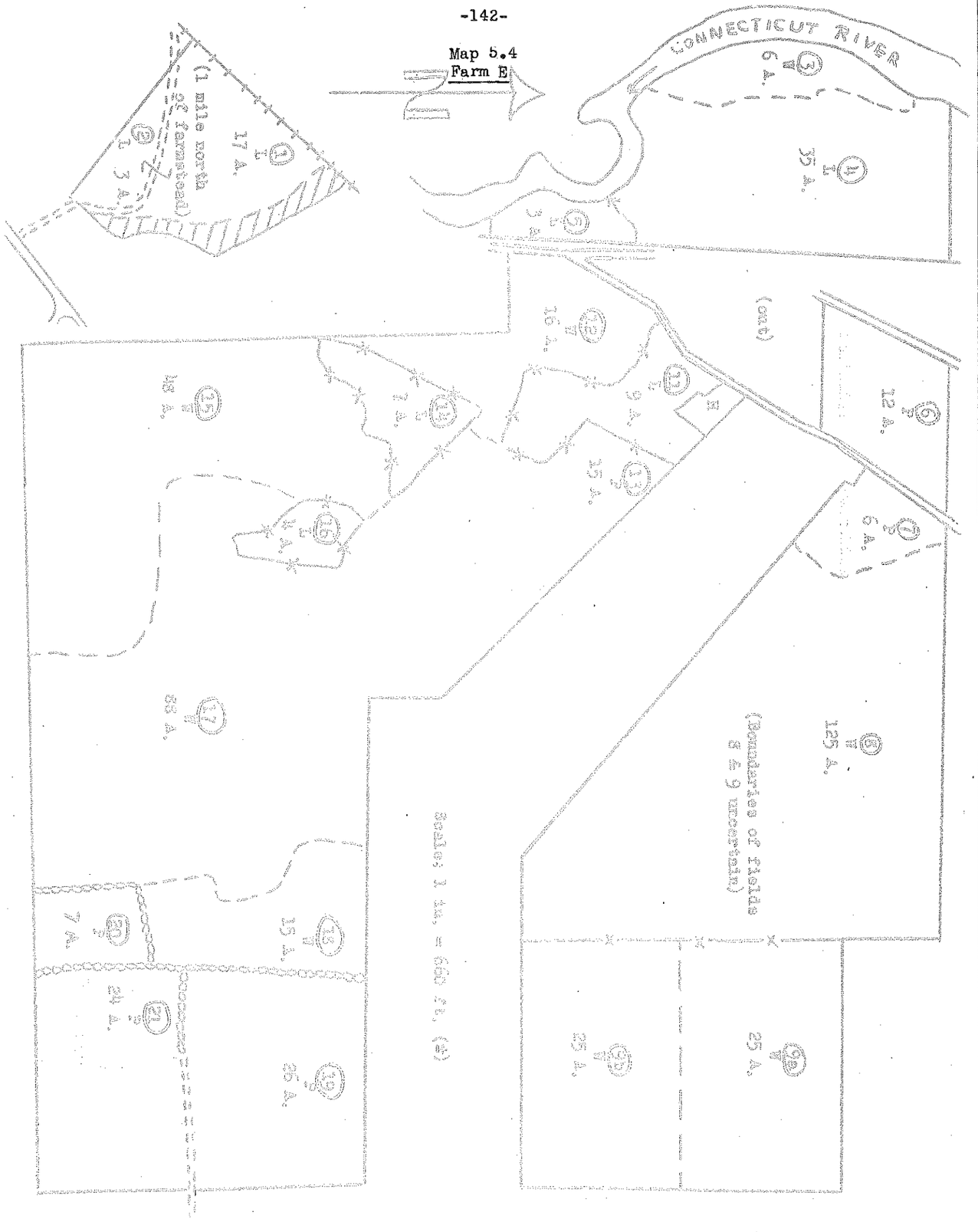
Farm E

This farm of somewhat over 500 acres has five separate tracts. One

30-acre piece of cut-over woodland was recently taken over for the payment of taxes due. Two other tracts, one a quarter mile west and the other a mile north of the home farm, contain about 58 acres of cropland and 6 acres of woods. A fourth tract of 193 acres near the home place contains only 18 acres of open pasture, the balance being wooded or recently cut over. The 270-acre home place was originally two farms. The farm buildings with about 20 acres of cropland and 15 acres of open pasture are at the western end of this tract. At the easterly end, about a mile distant, are 57 acres of open land now used for pasture. A wooded mountain top lies between these two areas of open land. Roughage crops have averaged 8 acres of ensilage corn, 9 acres of oats for grain with a legume seeding, a similar acreage in legume hay and 50 acres of additional hay. Increased fertilization of pasture and cropland and more legume seedings have contributed additional roughage for an expanding dairy herd.

Widening and extension of the original barn has provided stanchions for 40 cows and tie-ups for 21 additional head. There are two square silos (13x13x30 ft.) inside the barn. Hay storage is inadequate for the present herd, with 35 tons being stored on another farm. In 1946 there were 44 Jersey and Holstein cows and sufficient young stock were being started to allow for the annual sale of two heifers or expansion of the herd. Average annual milk production per cow was about 5,500 pounds of 4.8 percent milk, with grain feeding of about one ton per cow. The operator keeps a bull and is also a member of the artificial breeding association and the D.H.I.A. Three horses, two pigs and 40 layers are also kept.

Map 5.4
Farm E



The operator and his two sons, aged 10 and 16, constitute the regular labor force, plus about three months of hired help for haying and silo filling. Equipment is modern including a new 1½-ton, stake-body truck, and a new Farmall H tractor with plow, harrow, saw rig and manure loader. The mower is horse-drawn. A side-delivery rake, hayloader, hay fork, and a new grass and corn ensilage cutter are available for hay and corn harvesting. Exchange work has resulted in baling a sizeable portion of the hay and the use of a corn binder. Other equipment includes a manure spreader, milking machine and milk cooler.

Although no regular woods work has been done recently, about $1,100 worth of stumpage was sold from Stands 8 and 9a in 1944 and lumber for the barn alterations came from the farm woods. Forestry operations on the home farm have been carefully handled for many years; most of the cuttings have been made on small areas to a relatively high diameter limit. This form of partial-cutting has maintained a good rate of productivity in uneven-aged stands. The operator believes that he should carry on cuttings of this nature to the maximum extent possible with the farm labor and supervision. The balance of the area he intends to sell on a stumpage basis.

Two general courses of action are open to the operator for the development of this farm. First, the present dairy enterprise can be continued and made more efficient. Second, the herd can be expanded to about 60 cows; the operator is already considering this latter course. However, the herd has been expanded to the point where additional livestock cannot be conveniently housed on the barn's first floor. There are several factors having an unfavorable bearing on further expansion of

the herd. Extensive barn changes will be needed; it will be difficult to increase roughage production sufficiently; even if roughage production can be increased to meet the needs of a 60-cow herd, a large part of the pasturage will be at some distance from the barn; it will be necessary to hire most of the additional labor needed, as the present enterprise is a large undertaking for the family labor force. Moreover, there is an extra risk in investing in dairy buildings much larger than the normal carrying-capacity of the nearby land.

Under the proposed plan, efforts will be concentrated on improving roughage quality, and on providing adequate pasture near the barn. About 20 acres of the smoother parts of Fields 6, 7 and 13 will be limed and topdressed annually with fertilizer. Treatments on about 10 acres in Fields 19-21 will be continued, but these areas will be used only to pasture young stock and dry cows. The cropland in Fields 11, 14 and 16 will be used freely to supplement the improved permanent pasture near the barn. Part of the hay crop will be harvested in the form of grass silage. Custom baling of a large share of the remainder will permit storing more hay at home. Oats will be pastured or ensiled instead of being harvested for grain. Six months of labor will be hired for haying, silo filling and woods work.

The proposed changes in crop management and increased fertilization should increase the quantity and quality of the roughage produced. This will affect milk production. It seems reasonable to assume that milk production per cow can be increased 500 pounds annually with a reduction in grain feeding of 500 pounds per cow

Less than half of the woodland area supports stands that will require

attention or yield useable forest products for at least a decade. The forest stands can be used to the greatest advantage by means of partial-cuttings and improved harvesting methods. This will not involve any great departure from past practices except that future stumpage sales will be on a marked basis with the aid of the County Forester. The farm labor force plus some hired help can carry out woods operations for at least the next decade.

The following outline indicates the present condition of the wooded areas of this farm together with suggestions for a reasonable forest management plan.

Stand No.	Acres	Present Condition	Suggested Treatment
3, 12	22	Even-aged, 0 to 20 year old stand of mixed softwoods and hardwoods. Medium density and fair reproduction, predominantly of hardwoods.	Make partial-cuttings every 5 to 10 years starting when merchantable products can be cut. Remove about 1/3 of the volume at each cutting. Cut fir when 8" in diameter, breast high, and spruce 14" d.b.h.
8, 9a	160	Recent cut-over land restocking to spruce and fir.	No treatment until merchantable products can be harvested by partial-cuttings.
9b	26	Even-aged, 30 to 40 year old stand of hardwoods. Medium density and fair reproduction.	Make partial-cuttings every 8 to 10 years. Favor hard maple for sawlogs at 14"-16" d.b.h. and cut birch at 10"-12" d.b.h.
15, 18	63	Uneven-aged, 0 to 40 year old stand of spruce and fir resulting from cutting of small areas. Medium to high density and fair reproduction, predominantly of softwoods.	Make partial-cuttings as outlined for Stand 8.

Stand No.	Acres	Present Condition	Suggested Treatment
17	88	Uneven-aged, 0 to 60 year old stand of spruce, fir and some hardwoods resulting from cutting of small areas. Medium to high density and fair reproduction, predominantly of softwoods.	Make partial-cuttings as outlined for Stand 3.
22 (Not mapped)	30	This stand not surveyed.	The same principles of cutting should be applied here as those suggested for the areas above.

The proposed method of management differs little from the system that has been used on Stands 15, 17 and 18. The annual cut for the next five to ten years under this system will contain about 60 cords of material for sale plus about 25 cords of material for use on the farm. This will require a labor input of about 4 man-months. As all the stands mature, the annual harvest will increase until it approximates 180 cords of pulpwood or its equivalent in other products. This will require about 9 months of labor each year. At this time some adjustment in operating methods may be necessary to accomplish the total amount of work; probably marked stumpage sales can take care of much of the harvest operation. It is estimated that over a period of years the returns from the suggested forestry program will be about twice those of infrequent clear-cuttings. The value of the entire farm will also be enhanced by the increased productivity of the woodlands.

The possibilities of expanding the herd to 60 cows have also been explored. Such a plan, assuming the construction of a pen stable, more land improvement, heavier fertilization and more reseeding, and the woodland plan outlined above, has been made. This plan calls for an

added investment of about $6,000. The budgetary results of these several plans will be found in the financial summary (Table 5.5).

Many of the study farms where home labor can handle the woods work in the near future will eventually have to meet problems similar to those illustrated above. This comes about because much of the present woodland is occupied by young stands that require little attention, but with the passage of time larger inputs will be required than can be furnished by the farm labor force. This situation will often come about earlier than a forestry analysis would indicate since the operator with the aid of a farm plan may expand the agricultural enterprise more rapidly than the woodland enterprise. It seems likely that this will eventually happen on at least half of the study farms. The most rational adjustment to this situation appears to be to concentrate hired labor and stumpage sales on the more mature stands that will yield immediate net returns, while farm labor is used to make investment in stand improvements.

Another phase of adjustment that can assume considerable importance in many areas of New England is that of expanding the volume of farm output and the regular farm labor force of a unit by more intensive management of the woodlands. Some sample farms were found where various factors affected agricultural expansion and limited the farm business to a smaller size than the owner wished to develop. It was sometimes possible to round out an operating unit with an income more satisfactory to the owner and with a larger labor force by full development of the forestry enterprise. At the present moment this particular combination is more likely to succeed in the northern states where wood markets are

Table 5.5

Farm E

FINANCIAL SUMMARY

		Present		45 Cows Plan I		60 Cows Plan II
Receipts						
Milk		$ 8,968		$10,032		$13,433
Cows and heifers		810		810		855
Calves		69		72		105
Eggs		148		148		148
Poultry		25		25		25
AGP refund		120		120		120
Hay		160		--		--
Forest products	(30 ed.)	270	(60 ed.)	540	(60 ed.)	540
TOTAL		$10,570		$11,747		$15,226
Expenses						
Grain		$ 3,254		$ 2,837		$ 3,620
Labor	(5 Mo.)	625	(6 Mo.)	750	(15 Mo.)	1,875
Seed		120		120		156
Other stock		30		30		30
Misc. dairy		156		180		270
Chicks		12		12		12
Misc. poultry		10		10		10
Fertilizer and lime		543		1,076		1,312
Elec. and tel.		120		130		155
Gas, oil and grease		210		240		300
Other truck & tractor exp.		130		140		190
Bldg. upkeep and repairs		100		100		150
Equip. upkeep and repairs		200		200		250
Taxes		440		440		475
Insurance		109		110		135
Interest on added investment		--		--		270
Deprec. horses		50		40		40
Deprec. machinery		300		300		300
Deprec. buildings		150		150		250
TOTAL		$ 6,558		$ 6,868		$ 9,799
NET FARM INCOME		$ 4,012		$ 4,882		$ 5,427

more reliable than in the south. This, however, is not necessarily a limiting factor since any deficiencies may well be overcome by enterprising and aggressive management. A Maine farm illustrates the use of woodland in building up a two-man business.

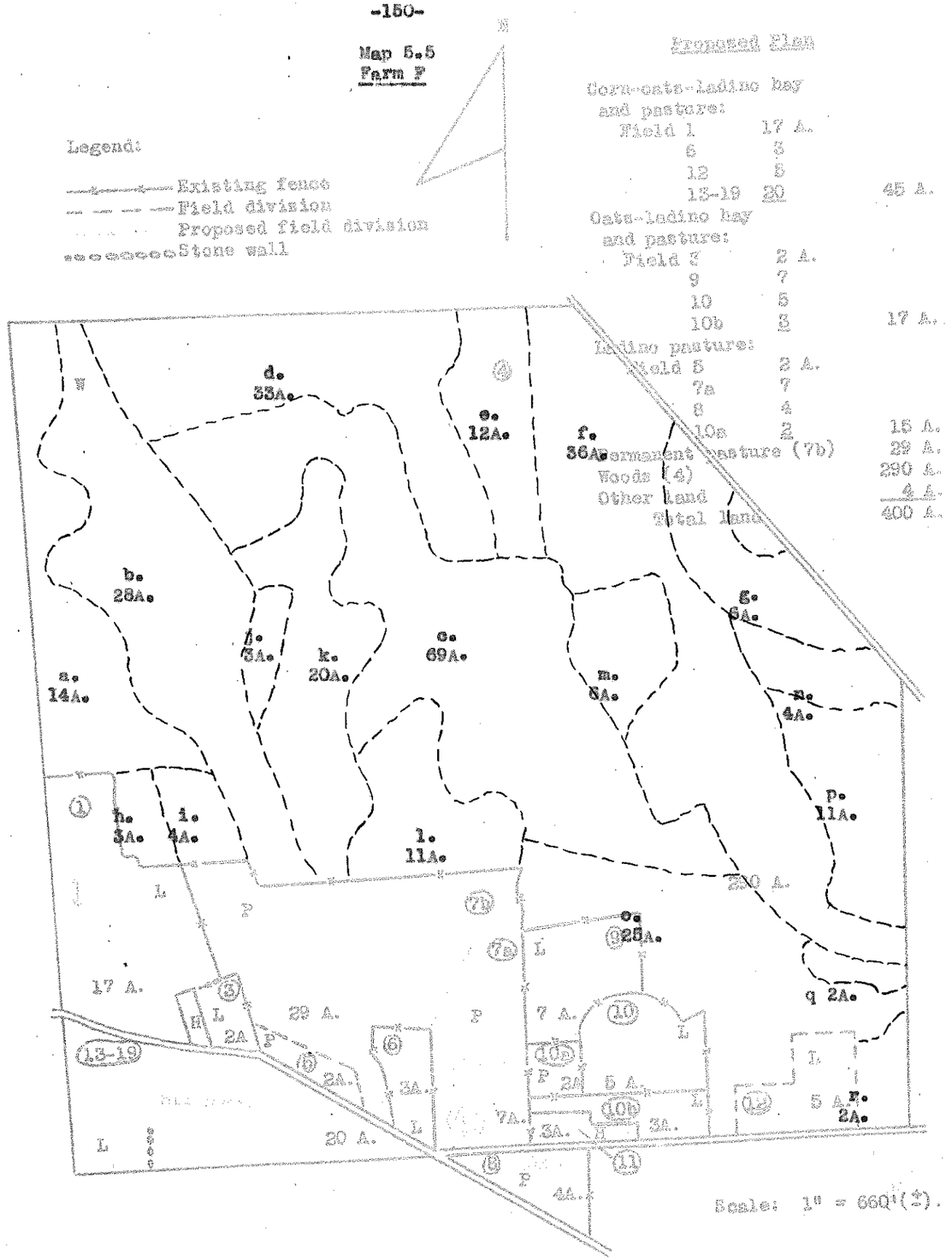
Farm F

This is a combination dairy and canning-crop farm. Twenty grade Holstein cows are milked and replacement heifers are normally raised. At present there are 47 acres of cropland, 19 acres of open pasture, 40 acres of brushy pasture, and 290 acres of woods. The cropland is used to grow 8 acres of sweet corn, 7 acres of oats, and 32 acres of hay and cropland pasture. About 12 acres of hayland have been seeded to ladino clover mixtures. Average herd production has been only about 4,300 pounds of 3.4 percent milk. Grain feeding has been low (about 1,500 pounds per cow) and roughage has been limited in both quantity and quality.

No full time labor is hired. Three months of seasonal help are hired for haying and picking sweet corn. A team of horses has been used for all field work, but a small tractor was purchased recently. Hay is harvested with a side-delivery rake and hayloader. Sweet corn stover is harvested for silage with a corn binder. Oats are threshed for stock feed. The woodland includes both mature spruce and cedar and middle-aged hardwoods and softwoods. There is a good local market for sawlogs, turning bolts and pulpwood. Two hundred cords of pulpwood were sold last year on a stumpage basis.

This farm could be developed into a 40-cow, two-man farm by clearing woodland and stony pasture for cropland and using all the cropland to

Map 5.5
Farm F



Proposed Plan

Corn-oats-ladino hay and pasture:		
Field 1	17 A.	
6	3	
12	5	
13-19	20	45 A.
Oats-ladino hay and pasture:		
Field 7	2 A.	
9	7	
10	5	
10b	3	17 A.
Ladino pasture:		
Field 5	2 A.	
7a	7	
8	4	
10a	2	15 A.
Permanent pasture (7b)		29 A.
Woods (4)		290 A.
Other land		4 A.
Total land		400 A.

grow roughage. Such an enlargement of the farm business would require large capital expenditures financed by borrowed money. The operator is not interested in this sort of expansion for the near future. Moreover, cropping and feeding changes will permit a considerably higher income than under the present plan, without any increase in cow numbers. The forest enterprise also presents attractive opportunities for rounding out a satisfactory operating unit.

With the market situation outlined above there are several alternative forest operating plans open for consideration. The major choices are outlined below.

A. Continue the customary harvesting methods of clear-cutting and high-grading.
   1. Manage all of the softwood stands on a pulpwood rotation and hardwood stands on a sawtimber rotation.
      a. Sell products on the stump whenever sufficient volume and quality are available to attract a buyer.
      b. Sell products roadside; the logging job to be done by the farm labor force, hired labor or contract or by some combination of these.
   2. Manage all suitable stands on a sawtimber rotation.
      a. Sell products on the stump.
      b. Sell products at the roadside.

B. Change harvesting methods to those that will promote valuable natural reproduction.
   1. Manage all softwood stands on a pulpwood rotation and hardwood stands on a sawtimber rotation.
      a. Sell products on the stump.
      b. Sell products at the roadside.
   2. Manage all suitable stands on a sawtimber rotation.
      a. Sell products on the stump.
      b. Sell products at the roadside.

C. Adopt harvesting practices of B and make partial cuttings to improve stand quality and growth. Weeding and pruning will be done when silviculturally desirable.
   1. Manage all softwood stands on a pulpwood rotation and hardwood stands on a sawtimber rotation.
      a. Sell products at the roadside. It is probably impossible to sell many of these cuttings on a stumpage basis.
   2. Manage all suitable stands on a sawtimber rotation.
      a. Sell products at the roadside. It is probably impossible to sell many of these cuttings on a stumpage basis.

The average annual inputs and outputs under each of these operating plans is shown in Table 5.6. The methods used in estimating these figures are discussed in Chapter IV and Appendix A. The gross value of product from each method of sale is also shown, assuming the following prices constant throughout the 90 year planning period.

Item and Unit	Price
Sawlogs, roadside, per M.b.f.	$18-21
Sawlogs, stumpage, per M.b.f.	6
Pulpwood, roadside, per rough cord	9
Pulpwood, stumpage, per rough cord	2.50

It was further assumed that after twenty years of the most intensive management (C) that sawlog quality would be increased enough to command the higher roadside price, otherwise the lower price was used. The data from Table 5.6 can now be included in the farm budget for different operating plans. It is apparent that the yields of present practices (Plan A1) will be about half the size of the most recent stumpage sales during the next two decades. Plan C2 yields the greatest net return, not only in the next decade but also over the planning period. This plan also provides useful employment for enough labor to round out the farm organization and has been chosen as the "proposed plan." All of the other plans yield incomes that fluctuate more widely from decade to decade than those of Plans C1 and C2. Of course, the plans calling for stumpage sales require no labor input on the part of the farm help and no benefit is possible from the integrated use of this resource. Plans A2 and B2 using sawlog rotations require postponing income until sawtimber stands are available. Plan C2, on the other hand, uses frequent partial-cuttings that utilize trees for sawlogs as soon as they are individually

Table 5.6

AVERAGE ANNUAL INPUTS AND OUTPUTS OF THE FORESTRY ENTERPRISE, BY DECADES, UNDER ALTERNATIVE INTENSITIES OF MANAGEMENT, AND STUMPAGE AND ROADSIDE VALUES OF THE PRODUCTS

Decades	Average Annual Outputs: M.b.f.	Average Annual Outputs: Additional Rough Cords	Gross Stumpage Value of Products	Man Months of Labor Input	Gross Roadside Value of Products
A1--Continuing Customary Clear-Cutting and High-Grading Harvesting Practices; All Softwood Stands on a Pulpwood Rotation:					
0-10	0	110	$275	4	$990
11-20	0	119	298	5	1,071
21-30	0	0	0	0	0
31-40	0	101	253	6	909
41-50	104	128	944	12	3,024
51-60	25	27	206	3	657
61-70	96	215	1,114	15	3,663
71-80	0	0	0	0	0
81-90	0	121	303	5	1,089
Total Value of Harvest for Period			$33,930		$114,030
Increased stumpage value of Residual Stand			- 336		- 336
Total Value for 90 Years			$33,594		$113,694
A2--Continuing Customary Clear-Cutting and High-Grading Harvesting Practices; All Suitable Stands on a Sawtimber Rotation:					
0-10	0	40	$100	2	$360
11-20	0	0	0	0	0
21-30	0	0	0	0	0
31-40	62	10	387	4	1,206
41-50	234	149	1,776	20	5,585
51-60	25	27	206	3	657
61-70	155	159	1,386	17	4,401
71-80	0	0	0	0	0
81-90	0	0	0	0	0
Total Value of Harvest for Period			$38,670		$121,770
Increased Stumpage Value of Residual Stand			2,912		2,912
Total Value during 90 Years			$41,582		$124,682

Table 5.6
(continued)

Decades	Average Annual Outputs: M.b.f.	Average Annual Outputs: Additional Rough Cords	Gross Stumpage Value of Products	Man Months of Labor Input	Gross Roadside Value of Products
B1--Changing to Use Improved Harvesting Methods; All Softwood Stands and Pulpwood Rotation:					
0-10	0	47	$118	2	$425
11-20	0	113	282	5	1,017
21-30	0	54	135	2	486
31-40	0	50	125	3	450
41-50	55	122	635	9	2,088
51-60	60	70	535	6	1,710
61-70	59	152	734	11	2,430
71-80	61	289	1,088	18	3,699
81-90	0	113	282	5	1,017
Total Value of Harvest for Period			$32,340		$133,200
Increased Stumpage Value of Residual Stand			5,709		5,709
Total Value for 90 Years			$45,049		$138,909
B2--Changing to Use Improved Harvesting Methods; All Suitable Stands and Sawtimber Rotation:					
0-10	0	17	$42	.5	$153
11-20	0	25	62	1	225
21-30	0	0	0	0	0
31-40	31	6	198	2	603
41-50	152	79	1,110	12	3,447
51-60	139	94	1,069	12	3,348
61-70	95	105	852	10	2,655
71-80	86	107	784	9	2,511
81-90	0	0	0	0	0
Total Value of Harvest for Period			$40,970		$129,420
Increased Stumpage Value of Residual Stand			10,486		10,486
Total Value for 90 Years			$51,456		$139,906

Table 5.6
(continued)

Decades	Average Annual Outputs: M.b.f.	Average Annual Outputs: Additional Rough Cords	Gross Stumpage Value of Products	Man Months of Labor Input	Gross Roadside Value of Products
C1--Changing to Use Improved Harvesting Methods and Partial-Cuttings; All Softwood Stands on a Pulpwood Rotation:					
0-10	20	242	It is unlikely that much of this kind of forest cutting can be done by stumpage sales.	16	$2,535
11-20	19	262		16	2,699
21-30	36	100		7	1,046
31-40	27	89		4	1,184
41-50	114	116		10	3,430
51-60	139	102		11	3,812
61-70	76	323		26	4,507
71-80	79	445		25	6,662
81-90	27	205		11	2,419
Total Value of Harvest for Period					$275,050
Increased Stumpage Value of Residual Stand					7,362
Total Value for 90 Years					$286,412
C2--Changing to Use Improved Harvesting Methods and Partial-Cuttings; All Suitable Stands on a Sawtimber Rotation:					
0-10	21	264	It is unlikely that much of this kind of forest cutting can be done by stumpage sales.	17	$2,755
11-20	51	193		14	2,655
21-30	76	42		6	1,967
31-40	80	26		5	1,922
41-50	237	72		15	5,624
51-60	204	67		13	4,885
61-70	112	222		24	4,345
71-80	118	280		20	5,000
81-90	27	61		5	1,122
Total Value of Harvest for Period					$302,730
Increased Stumpage Value of Residual Stand					10,068
Total Value for 90 Years					$312,798

mature; with the present growing stock little if any postponement is necessary. Plan C2 will also allow a greater freedom of choice in the future in making adjustments of the forestry enterprise to meet changed market, price or other conditions.

Estimated milk production under the proposed plan is nearly double the present, with no change in cow numbers and only moderate investment in land improvement. It is to be attained by producing and feeding more and better roughage. This will be accomplished by clearing 11 acres of pasture, using more fertilizer, and doing more reseeding. Sweet corn will be increased to 10 acres and about 10 acres of oats will be harvested for grain annually. Including reseeding of pasture, about 13 acres of new seeding will be made annually.

The ladino clover fields nearest the barn will be used mostly for pasture. These fields will be grazed in rotation allowing two weeks between grazings in May and June, and three weeks in July and August. The fields further from the barn will be used primarily for hay though some of them will be grazed in late summer instead of being cut for hay the second time. Until the ladino clover rotation is well established, oats will be pastured. After most of the land has been reseeded, it will be possible to harvest oats for grain without running short of good pasture.

Increased use of fertilizer will be combined with the above management practices to produce more and better hay and pasture. It is estimated that when roughage production is improved, milk production can be increased to 7,800 pounds per cow without an increase in grain feeding. Until this better hay and pasture is available, however, a considerable increase in grain feeding will be profitable. The operator plans to renew

his membership in the D.H.I.A. This will help in achieving the most economical rate of feeding and better herd management.

It is estimated that all of the agricultural and woods work can be carried out using the new tractor for power. Therefore the team will be eliminated, thus making some feed, barn space and possibly some labor available for use in other enterprises. Horses are available for hire in the neighborhood to meet any temporary need for this kind of power.

Woodland Plan

To take full advantage of the productive capabilities of the woodland the system of partial cuttings outlined in Plan C2 is recommended. Operations on each stand at five- or ten-year intervals will harvest trees when they have reached their most profitable stage of growth. The practice of making frequent partial-cuttings has several advantages over infrequent clear-cutting. First, it salvages a number of trees which would otherwise die and be wasted. Second, it removes inferior species or individuals which compete with the more valuable crop trees. These crop trees will then increase more rapidly in volume and value. Third, the small openings left by partial cuttings will fill in more rapidly than the large openings left after clear cutting. Frequently it is possible to leave a complete cover of vigorously growing trees capable of adding a large volume of high quality production. Even if small openings without cover are left, there is less drying of the soil and a new seeding will be established more rapidly.

The following outline indicates the present condition of the wooded areas of this farm together with suggestions for a reasonable forest management plan.

Stand No.	Acres	Present Condition	Suggested Treatment
4f	36	Even-aged, 50 to 60 year old spruce-fir stand with a little mixed cedar and hardwoods. Over 500 trees per acre from 6" to 14" d.b.h., about 2700 cubic feet per acre. Sparse softwood reproduction. Northern 18 acres dominantly fir.	Northern area: Gradually harvest for pulpwood by clear cutting small areas of 1/4 acre or less. Spread out over the next 10-15 years. Southern area: Make partial cuttings at 5-10 year intervals to thin stand and remove fir for pulpwood. Favor spruce for sawlogs at 14" to 18" d.b.h. Start to harvest in about 30-40 years.
4b,4h,4l	42	Even-aged 40 to 50 year old spruce-fir stand. About 800 trees per acre from 4" to 12" d.b.h., and about 1500 cubic feet per acre. Sparse softwood reproduction.	Make partial cuttings every 5 to 10 years to remove fir and inferior trees for pulpwood. Favor spruce for sawlogs at 14" to 18" d.b.h. Start to harvest in about 40-50 years.
4g,4i,4o	35	Even-aged 20-30 year old spruce-fir stand originating from old cutting. Stocking about 50% of normal.	Start partial cuttings as above in about 20 years as soon as pulpwood is available. Favor spruce for sawlogs at 14" to 18" d.b.h.
4a,4c,4e,4j	98	Even-aged 40 to 50 year old stand of mixed northern hardwoods. Over 400 trees per acre from 4" to 10" d.b.h. and about 1100 cubic feet per acre. Plentiful hardwood reproduction.	Start partial cuttings at 5-10 year intervals to remove inferior trees for fuel, pulpwood and turning stock. Favor best ash, basswood and hard maple for sawlogs at 18"-20" d.b.h. Start harvest in about 40-50 years.
4p,4q,4r	15	Even-aged 20 to 30 year old stand of northern hardwoods with a few groups of spruce and fir. Stocking is about 65% of normal.	Start partial cuttings as outlined immediately above. Develop softwood groups and hardwood groups rather than a mixture of all species. Favor ash, basswood and hard maple for sawlogs at 18"-20" d.b.h. and spruce at 14"-18" d.b.h.
4d,4k,4m,4n	63	Even-aged 10 to 20 year old stand of northern hardwood reproducing on an old cutting.	Start partial cuttings as outlined above in about 10 to 20 years. Favor best trees for sawlogs.

It is assumed that enough technical aid to carry out the above plan can be obtained free of charge from the Extension Service. A useable road network will be developed gradually by improving and extending the present roads. The average annual inputs and outputs by decades are shown in Table 5.6, Plan C2. During the next decade annual sales will be about 240 cords of fuel and pulpwood and 20 M.b.f. of sawlogs. Labor inputs for woods work will be about 17 man months per year. The operator can provide supervision and the equivalent of about 2 months of labor in the woods, leaving about 15 months of labor to be hired. This input plus about 3 months of help needed on the rest of the farm can be supplied by a full-time hired man and about 6 months of temporary help. Woods labor will be used most effectively by skidding long logs (tree length) to a system of driveable roads for bucking and loading. The use of Plan C2 will allow for expansion of the farm business and labor force by maximum use of the forestry enterprise and the gradual, long-term improvement of the woodland stands will add to the value of the farm.

After the operator has gained a little more experience and has gotten the forestry program under way, he might consider purchasing a portable power saw. This will add about $300 to the investment. However, effective utilization of the saw might reduce labor inputs.

The financial summary, Table 5.7, shows that net farm income from the proposed plan is just over $1,500 greater than that of the present plan. This gain has been accomplished with a minimum of investment by minor adjustments in the dairy enterprise and full utilization of the forestry potentialities of the unit. A plan such as the one proposed offers a means of enlarging the farm business without the necessity of

Table 5.7

Farm F
FINANCIAL SUMMARY

	Present		Proposed
Receipts			
Milk	$2,600		$4,690
Cows	280		280
Calves	48		48
Eggs	160		160
ACP refund	100		100
Sweet corn	720		960
Pulpwood (200 cd. Stumpage)	500	(240 cd. Rough	2,160
Sawlogs	--	(20 M.b.f.)	360
TOTAL	$4,308		$8,758
Expenses			
Grain	$ 885		$ 810
Silage	30		--
Labor (3 Months)	400	(18 Months)	2,400
Seed	85		170
Other stock	12		12
Misc. dairy	75		100
Chicks	11		11
Fertilizer and lime	230		944
Elec. and tel.	110		110
Gas, oil and grease Other truck & tractor exp.	210		325
Bldg. upkeep and repairs	60		75
Equip. upkeep and repairs	100		125
Taxes	276		276
Insurance	32		32
Interest	55		55
Deprec. horses	30		--
Deprec. machinery	60		180
TOTAL	$2,661		$5,605
NET FARM INCOME	$1,647		$3,153

large borrowings to expand the dairy enterprise.

Farm G

Farm G, in central Vermont, illustrates a slightly different situation. The operator is running a one-man farm and wants to expand to a two-man operation. However, lack of land suitable for dairying is a limiting factor in this case.

This upland farm of 216 acres includes 30 acres of cropland, about 60 acres of open pasture, and 116 acres of woodland including a sugar bush. The soils are mostly shallow ledgy glacial till derived from impure limestone. Some of the areas of better sod in the pastures have been top-dressed with fertilizer, and last fall three or four acres were bulldozed in preparation for seeding. The woodland is not fenced from the pasture.

The Jersey herd of 15 milkers produced about 6,000 pounds of milk per cow during the year 1947-48, with average grain feeding of 1,800 pounds per cow. Grain feeding and milk production were at a somewhat higher rate in the early part of 1947 when the milk-grain price ratio was more favorable. These figures represent a high rate of output in relation to the land resources of the farm, and thus reflect the benefits of good management of the land and the herd over a period of years. The policy for a number of years has been to raise all replacements. A bull has been kept, although the operator now plans to change to artificial breeding.

Two horses are the main source of power on the farm; horse-drawn equipment includes manure spreader, mower and dump rake. Equipment for filling the 12x30-foot silo is borrowed. There is a milking machine with one double unit, a four-can cooler, and a water heater. The operator has

neither tractor nor truck. The sugar house is equipped with a 3x12-foot evaporator. About 475 buckets have been hung in the sugar bush.

Returns from the present business have been favorable, but the one-man organization is confining, and working alone with limited equipment is difficult. A second man is needed anyway during syrup and haying time, and the operator would like to plan an organization providing year-round employment for a hired man. The dairy barn could be remodeled to care for a larger herd, but the land resources offer only limited opportunity for expanding roughage production, and the chance for adding other open land nearby is questionable. Eliminating the horses by purchase of a tractor would release some barn space and roughage and permit a small expansion of the milking herd. However, the rough character of the fields and woodlands requires horse power for effective work and this adjustment does not seem feasible. Increased poultry production would be another possibility.

Perhaps the best opportunity for building up a two-man unit lies in expanding the woodland enterprise. Many of the present stands contain merchantable products that can be harvested. The operator has a choice of about the same alternative operating plans as were outlined for Farm F. The forest stands on this farm are all well adapted to sawlog production so that pulpwood rotations are not very attractive. The major choice is among the three intensities of management, A2, B2 and C2, and between selling the products on a stumpage or roadside basis. Since one objective is to employ more labor profitably, stumpage sales need not receive more than passing attention. The physical inputs and outputs and gross value of product from these several operating plans are shown in Table 5.8.

Table 5.8

AVERAGE ANNUAL INPUTS AND OUTPUTS OF THE FORESTRY ENTERPRISE, BY DECADES, UNDER ALTERNATIVE INTENSITIES OF MANAGEMENT; AND STUMPAGE AND ROADSIDE VALUES OF THE PRODUCTS

Decades	Average Annual Outputs: M.b.f.	Average Annual Outputs: Additional Rough Cords	Gross Stumpage Value of Products	Man Months of Labor Input	Gross Roadside Value of Products
A2--Continuing Customary Clear-Cutting and High-Grading Harvesting Practices:					
0-10	18	1	$110	1	$335
11-20	28	17	210	2	657
21-30	51	24	366	4	1,134
31-40	0	0	0	0	0
41-50	98	13	960	6	1,701
51-60	0	0	0	0	0
61-70	0	0	0	0	0
71-80	61	36	456	5	1,422
81-90	16	7	114	1	351
Total Value of Harvest for Period			$15,160		$55,080
Increased Stumpage Value of Residual Stand			821		821
Total Value for 90 Years			$15,981		$56,301
B2--Changing to Use Improved Harvesting Methods:					
0-10	14	0	$84	1	$252
11-20	18	9	130	1	405
21-30	40	19	288	4	891
31-40	26	15	186	2	585
41-50	44	7	282	3	855
51-60	45	7	288	3	873
61-70	0	0	0	0	0
71-80	31	18	251	3	720
81-90	45	24	350	4	1,026
Total Value of Harvest for Period			$15,210		$56,607
Increased Stumpage Value of Residual Stand			4,427		4,427
Total Value for 90 Years			$22,637		$61,034

Table 5.8
(continued)

Decades	Average Annual Outputs M.B.F.	Average Annual Outputs Additional Rough Cords	Gross Stumpage Value of Products	Man Months of Labor Input	Gross Roadside Value of Products
C2--Changing to Use Improved Harvesting Methods and Partial-Cuttings:					
0-10	41	22	It is unlikely that much of this kind of forest cutting can be done on a stumpage sale basis.	3	$935
11-20	21	21		2	565
21-30	36	75		6	1,414
31-40	57	22		4	1,403
41-50	48	18		3	1,165
51-60	55	52		6	1,586
61-70	55	49		4	1,128
71-80	58	20		4	1,246
81-90	55	28		4	1,409
Total Value of Harvest for Period					$108,670
Increased Stumpage Value of Residual Stand					4,867
Total Value for 90 Years					$113,537

Plan C2 seems to offer not only the greatest opportunity to employ labor to advantage but also the greatest return in both the short and long run. Only about three months of labor are needed each year, even with the most intensive use of the woodlands. However, the cut scheduled for the first decade can be concentrated during the first five years, doubling both output and labor input. After that operations would have to proceede at a reduced scale.

It would also be possible to expand the syrup operation (not included in the above calculations) by renting an adjoining bush and hanging about 1,500 buckets. Eventually the maples on the owned land can be developed to replace the rented bush. This expanded syrup operation would require about three additional months of labor; this plus the other labor input will provide work enough to justify a regular hired man. After about five years when woodland work is less, a further expansion of the woodland holdings or of the syrup operation would be possibilities for continuing the two-man enterprise.

The proposed plan assumes the hiring of a full-time man, and a substantial increase in the amount of woods work performed. Harvesting of pulpwood and sawlogs will be stepped up during the next five years to the maximum level consistent with the long-run improvement of Plan C2. The expansion of the sugar bush to 1,500 buckets will be accomplished by leasing the adjoining bush. This will require additional buckets and other equipment.

Some further increase in roughage production will be made. About five acres of the permanent pasture including the area recently bulldozed will be smoothed and seeded to ladino mixtures. Field 6 also will be

used mainly for ladino pasture. Regular topdressing of at least 10 acres of the permanent pasture will be continued in addition. It may be possible to add Field 8 to cropland if drainage can be improved as planned in cooperation with the Soil Conservation Service. As this change will depend on establishing an outlet across a neighboring farm, it is not assumed as part of the proposed plan.

Artificial breeding will be used in the dairy herd and no bull will be kept. With these changes, enough additional roughage will be available to keep three more cows. (The herd will not be increased, however, until adequate roughage is assured.) Continued use of the present stable is planned for the time being, but when reflooring and other extensive repairs become necessary it will probably be advisable to provide pen stabling or a conventional tie-up in the basement. Meanwhile, water bowls and a barn hay fork will be installed, with a door for unloading hay from the outside at one end of the barn. A side-delivery rake and a hayloader will be added to equipment.

The manure produced from 26 animal units and the stepped-up purchase of artificial fertilizers will provide about 50 pounds of nitrogen (N), 80 pounds of phosphoric acid (P_2O_5), and 100 pounds of potash (K_2O) for each acre of cropland and ladino pasture (56 acres). This compares with 50 pounds of nitrogen, 55 pounds of phosphoric acid and 55 pounds of potash per acre of cropland under the present plan.

The operator is already getting a high rate of milk production per cow in relation to the level of feeding. This is probably due partly to pasture improvement in the last few years. No further increase in the rate of milk production is assumed in the proposed plan. Over a period

of years, however, a gradual increase is to be hoped for resulting from an improved breeding program.

Woodland Plan

The same forestry program (C2) as that outlined for Farm F will be followed to take full advantage of the productive capabilities of the woodland. The following outline indicates the present condition of the wooded areas of this farm together with suggestions for a reasonable forest management plan.

Stand No.	Acres	Present Condition	Suggested Treatment
1d,1e,5b	17	Even-aged 50 to 60 year old stand of spruce with a little hardwood in the understory. About 250 trees per acre from 6" to 16" d.b.h. and about 2700 cubic feet per acre. Fair spruce and hemlock reproduction.	Make partial cutting to remove older trees over 12" d.b.h. Start harvesting in about 20 to 30 years.
9b,9e	22	Even aged 40 to 50 year old stand of pure spruce. Over 700 trees per acre from 4" to 14" d.b.h., about 2000 cubic feet per acre. No reproduction.	Make partial cuttings every 5 to 10 years to remove least valuable or mature trees. Stand needs thinning to speed growth and start reproduction. Favor best spruce for sawlogs at 14" to 16" d.b.h.
1f,2b,13	11	Well-stocked spruce stands less than 15 years of age, except area 13. Some planting is advisable to establish forest cover on the 5 acres of area 13.	Weed out few overtopping hardwoods to favor spruce. Start partial cutting as soon as pulpwood is available in the stands. Favor spruce for sawlogs at 14" to 18" d.b.h.
9f	5	Old growth stand of spruce and hemlock. About 150 trees per acre from 6" to 24" d.b.h., and over 5,000 cubic feet per acre. Good softwood reproduction.	Start gradually harvesting the larger trees in this stand. Spread cutting over 5 or 10 years. Materials for barn alterstion can be cut here.

Stand No.	Acres	Present Condition	Suggested Treatment
9e	18	Even-aged 70 to 80 year old stand of spruce and northern hardwood. Over 250 trees per acre from 6" to 28" d.b.h. and about 2800 cubic feet per acre. Fair reproduction.	Make partial cutting to remove trees over 14" d.b.h. Start harvesting in about 15 to 20 years.
9a	3	Old growth stand of northern hardwoods and some hemlock. Over 150 trees per acre from 6" to 24" d.b.h., and about 2800 cubic feet per acre. Fair softwood reproduction plus some beech.	Start harvesting this stand gradually to promote good reproduction. Remove largest trees first.
1a,1c,9d	16	Even-aged 70 to 80 year old stand of northern hardwoods. About 240 trees per acre from 6" to 20" d.b.h., and over 1800 cubic feet per acre. Fair hemlock and hardwood reproduction.	Make partial cuttings every 5 to 10 years to remove the larger and the least desirable trees. Favor hard maple, ash, birch and hemlock for sawlogs at 14" to 18" d.b.h. Start harvesting in about 20 years.
1b	16	Good northern hardwood reproduction is taking over this area.	Weed in 5 to 10 years to release best stems. Start partial cuttings when useable products are available. Favor best trees for sawlogs.
9g	16	Uneven-aged, 0 to 80 year old sugar bush considerably damaged by the hurricane. There are about 150 trees per acre 6" or more in d.b.h., and 75 smaller ones. Reproduction is sparse due to grazing and is mostly softwoods or hardhack.	Cut out all trees except hard maple and develop a spacing of about 10' between maple crowns to encourage growth. Fence out cattle to permit maple to seed into open areas. Most of the sugar wood needs can be cut in the bush. When fully developed this bush should hang about 2,000 buckets.

Map 5.6

Farm G

Proposed Plan

Corn - legume hay & pasture mixtures			
Field	3	6 A.	
	10	1	
	12	19	26 A.
Ladino pasture mixture			
	6	5	
parts of	2a		
&	5a	5	10
Permanent pasture			
bal. of	2a		
&	5a	35	
	7	6	
	8	6	49
Woodland			
	1	41	
	2b	4	
	5b	4	
	9	70	
	13	5	124
Other land			0
Total			216 A.

Legend:

- Fence
- Wall
- Proposed fence
- Fence to be removed
- Field division
- Proposed field division
- Proposed diversion ditch

If the cutting outlined above is accomplished over the next five years the average annual inputs and outputs will approximate twice those shown in Table 5.8 for the first decade of Plan G2. The present sugar bush plus the rented one will yield about 500 gallons of syrup each year and absorb a little over three months of labor. Thus all woodland operations will require an input of about ten months of labor during each of the next five years. After that it will be necessary to obtain about 150 to 200 additional acres of similar woodland or expand the sugar operation by an additional 500 to 1,000 buckets and add about 100 acres of woodland to continue about the same volume of employment. Yields under the first alternative would total about 60 to 70 cords of wood and a like number of thousands of board feet of sawlogs plus the present 300 gallons of syrup. Under the second alternative yields would be about 40 to 50 M.b.f. of sawlogs plus about 500 gallons of syrup.

The financial summary, Table 5.9, indicates that the proposed plan will increase net farm income by about $1,000 a year. About $150 of this may be needed for interest on the added investment, part of which was made to expand the land resources of the operating unit.

Summary

It must be abundantly clear by now that to speak of farm woodlots in terms of a single average can be very misleading. Nonetheless, it may be of interest to summarize some of the aspects of the forest enterprises of the study farms. Table 5.10 shows by states and for the region the distribution of the number of sample farm woodlots by size classes. Two hundred and eleven of the farms had five acres or more of forest land. The Maine and New Hampshire farms tend to have more woodland than those

Table 5.9

Farm G

FINANCIAL SUMMARY

		Present		Proposed
Receipts				
Milk		$3,150		$3,850
Cows		400		480
Calves		32		40
Eggs		80		80
Poultry		50		50
ACP refund		100		100
Off-farm work		70		70
Syrup	(60 gals.)	180	(300 gals.)	750
Sawlogs		--	(80 M.)	1,440
Pulpwood and Bolts		--	(40 cd.)	360
TOTAL		$4,052		$7,200
Expenses				
Grain		$1,245		$1,422
Hay	2 Tons	30		--
Labor	6 weeks	200	(52 weeks)	1,560
Seed		40		50
Bedding Misc. dairy		100		200
Chicks		15		15
Misc. poultry		10		10
Fertilizer and lime		197		344
Elec. and tel.		120		125
Gas, oil and grease		100		120
Bldg. upkeep and repairs Equip. upkeep and repairs		200		250
Taxes		--		50
Rent		600		650
Interest on added investment		--		150
Tractor hire		25		25
Deprec. horses		20		30
Deprec. machinery added		--		200
TOTAL		$2,902		$5,231
NET FARM INCOME		$1,150		$1,969

Table 5.10

NE: ENGLAND DAIRY FARM MANAGEMENT PROJECT

Summary of Woodland Analysis

		Me.	N.H.	Vt.	Mass.	R.I.	Conn.	Total
No. farms by acres of woodland								
	5 - 49	9	3	23	16	3	13	67
	50 - 99	10	9	22	10	2	9	62
	100 - 299	18	12	18	13	3	6	69
	300 and over	2	7	4	-	-	-	13
	Total	39	31	67	39	7	28	211
Acres woodland per farm by types and age classes								
Mixed hardwoods	0 - 20	11	9	10	30	28	21	16
	20 - 40	17	17	18	21	57	18	19
	40 & over	4	4	7	9	-	18	8
	Sugarbush	-	5	11	-	-	-	4
Red maple, etc.	0 - 20	2	3	2	4	3	1	2
	20 - 40	1	2	-	7	1	4	2
Hardwood-softwood								
	0 - 20	14	18	14	-	-	1	10
	20 - 40	31	59	17	-	-	3	20
	40 & over	8	8	5	-	-	1	4
Mixed softwoods								
	0 - 20	6	33	4	-	3	1	8
	20 - 40	26	25	8	1	-	-	11
	40 & over	5	4	4	-	1	1	3
Total		125	187	100	72	93	69	197
Planned annual cut per farm (Cd. equiv.)								
a) Transition period (5-10 years)		44	41	26	14	20	23	29
b) Long-range (40 to 80 years)		62	90	41	33	60	42	51
Buckets per farm hung in sugar orchards in transition			148	476				
Annual labor requirement per farm (man days								
a) Transition period		55	90	41	23	25	34	41
b) Long-range		77	133	62	46	55	57	69
Cash return from forest products per farm in transition period		$300	$740	$341	$11	$90	$38	$218

in the rest of the area. Vermont is the only northern state with a large number of sample farm woodlots in the 5 to 49 acre class, but it still has a larger percentage with 50 acres or more than any of the southern New England states.

The size of the average sample farm woodlot by states and for the region is shown, together with the average distribution of the acreages of different forest types by age classes. It is apparent that softwoods are more prevalent in the north, while hardwoods predominate in the southern states. It is interesting to note that over 80 percent of the forest stands are less than 40 years of age, indicating that it will be several decades before a large proportion of the area supports mature and merchantable stands.

The planned annual cut per farm is expressed in cord equivalents and is considerably lower in the southern states during the next decade than it is in the northern ones. This fact is reflected in the annual labor input per farm. Although the suggested forestry programs promise to increase the average annual cut (output) by about 75 percent in the long run, labor inputs will only be raised by about 70 percent. This difference does not indicate much change in operating efficiency, but is due primarily to the increasing proportion of sawlogs in the future. Less labor input is needed per cord equivalent of wood harvested in the form of sawlogs than per unit harvested in the form of fuel or pulpwood.

The only sample farms producing maple syrup were in Vermont and New Hampshire. The great bulk of these were actually concentrated in northwestern Vermont.

The cash return from forest products per farm in the transition period

indicates that the average southern sample farm woodlot contributes little cash income; these figures do not include the value of the forest products used at home. The average amount used per farm falls between 15 and 20 cord-equivalents per year. Despite the small amount of cash income from the southern woodlands the average of all sample farms is still $218 per year. This is a sum large enough to be worthy of consideration by most New England farmers.

Chapter VI

MISCELLANEOUS FOREST PRODUCTS

The discussion thus far has concerned the more important forest products harvested on New England farms. There are, however, many other items of minor importance in the total forest economy that may nevertheless furnish a substantial part of the woodland income on individual farms. Some of the economic aspects of a few of these products will be discussed in this chapter.

Wood Products

As indicated in Chart 2.5, lumber, fuel and pulpwood are the three most important wood products in New England. Table 6.1 shows, however, that an estimated 85 million cubic feet of wood was harvested in the form of miscellaneous forest products in 1944. It is probable that a large volume of the material converted into fence posts and other farm uses never reached the market.

Cedar is the preferred species for posts and poles, although a considerable volume of hardwood is used for these purposes. In recent years simple methods for treating posts with a chemical preservative have been used to a limited extent. Fence posts are particularly important to a dairy enterprise for controlling grazing, while longer posts are used to support the tobacco cloth used over shade tobacco grown in the Connecticut Valley. These constitute the most important local uses of this type of product.

The "other" category in Table 6.1 includes such items as bolts for turning, furniture, wooden heels and the like. One farm was found in

Table 6.1

CUT OF MISCELLANEOUS FOREST PRODUCTS IN NEW ENGLAND, 1944[1/]

Product	Softwood	Hardwood	Total
	Thousands of Cubic Feet		
Veneer	940	12,870	13,810
Cooperage	2,568	1,319	3,887
Shingles	865		865
Posts and Poles	3,442	1,477	4,919
Hewn Ties	8,100		8,100
Other	2,295	49,138	51,433
Total	18,210	64,804	83,014

1/ Source: Estimate by U. S. Forest Service Reappraisal, 1945
From H. I. Baldwin, Wooden Dollars, 1949

Connecticut selling long hickory piles for use in the Cape Cod net fisheries. These piles were of special dimensions and sold on the stump for 50 to 75 cents each.

The input-output relationships for harvesting these miscellaneous forest products are the same as those used for sawlogs or cordwood unless some extra farm processing is required. In this latter instance the experience of the farmer was used as a guide for adjusting estimates. On the whole, these products were of relatively small importance on the study farms.

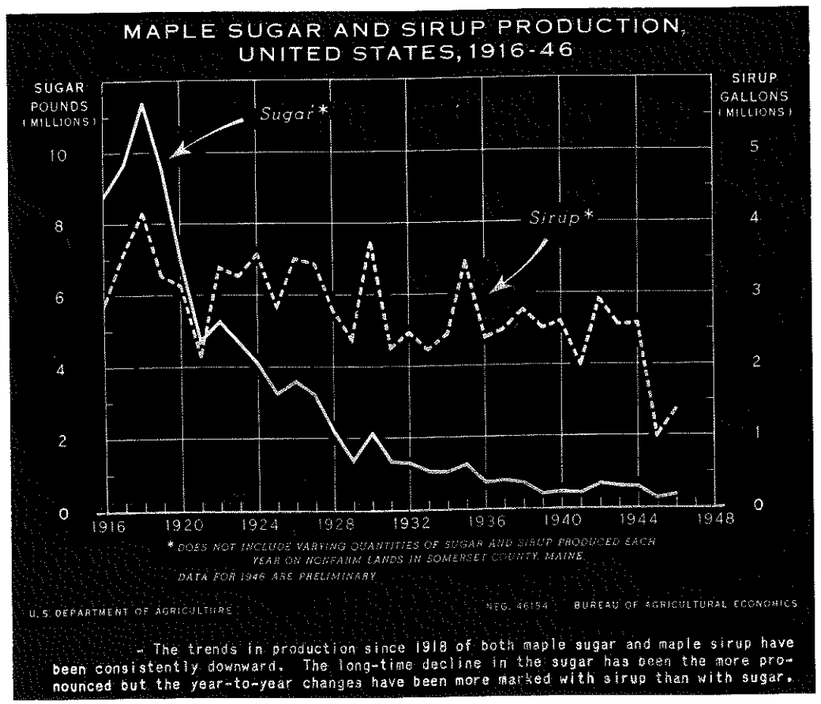
Maple Products

Maple syrup and sugar are two forest products that are almost exclusively farm crops. There are only a few non-farm sugar bushes in Vermont and in some sections of Maine. Chart 6.1 indicates that maple sugar and syrup production in the United States has gradually declined since the peak year of 1918. It is also evident that sugar constitutes a decreasing proportion of the total crop. Most farms now produce syrup exclusively. A good deal of this syrup is later converted into various forms of sugar by candy companies but these quantities are not included in the above data.

Chart 6.2 shows the United States average yield of maple sugar equivalent per tree tapped.[1/] Most of the year-to-year variation is due to weather conditions during the tapping season. Ideal conditions for a heavy flow of sap include temperatures of 45° to 50° F. during the

1/ One gallon (11 pounds) of syrup equals about 7.5-8.0 pounds of sugar.

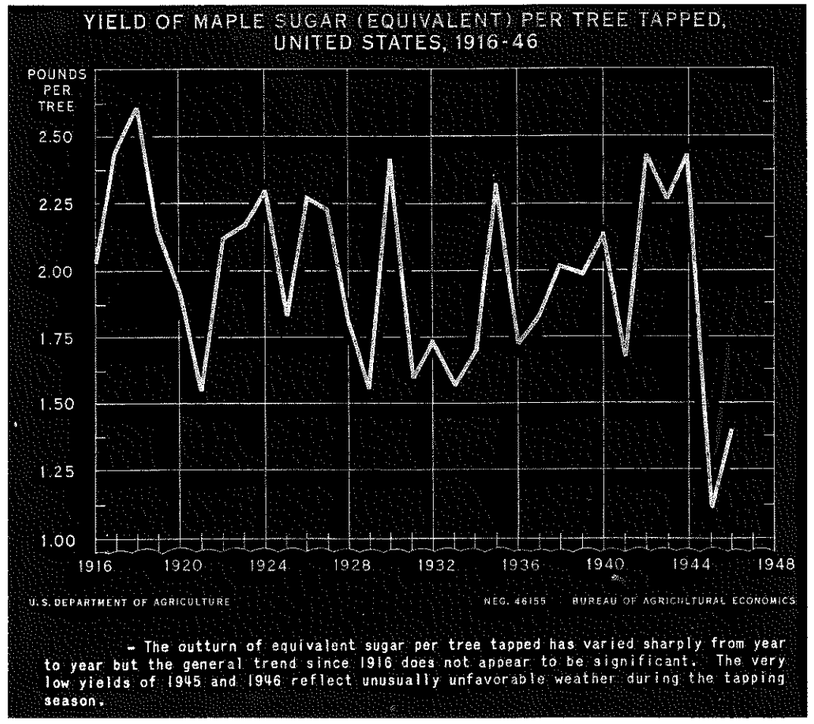
Chart 6.1



- The trends in production since 1918 of both maple sugar and maple sirup have been consistently downward. The long-time decline in the sugar has been the more pronounced but the year-to-year changes have been more marked with sirup than with sugar.

Source: U.S.D.A., Bureau of Agricultural Economics, Crop Reporting Board, Maple Products, 1916-46, Washington, D.C., 1946.

Chart 6.2



- The outturn of equivalent sugar per tree tapped has varied sharply from year to year but the general trend since 1916 does not appear to be significant. The very low yields of 1945 and 1946 reflect unusually unfavorable weather during the tapping season.

Source: U.S.D.A., Bureau of Agricultural Economics, Crop Reporting Board, Maple Products, 1916-46, Washington, D.C., 1946.

day and 25° or 30° F. at night. Alternate freezing and thawing prolongs the flow of sap and retards bud development. Extended periods of freezing temperatures will stop the run. Warm weather without freezing nights also stops the flow and hastens the development of buds, thus discoloring the sap and imparting a disagreeable taste to the syrup.

A glance at Map 6.1 will show that over 80 percent of New England's 1929 maple production originated in Vermont. New Hampshire was second with about 5 percent and Massachusetts and Maine each produced about 3 percent of the total crop. Some syrup or sugar is made on farms in practically all counties. There have probably been some shifts in production among the counties since 1929 but later census figures indicate that these changes have had little effect on the distribution of the crop among the states. Maple production in general follows the natural range of the sugar maple and the area where good "sugar weather" is common.[2/]

The production process needed to get maximum yields of high-quality syrup has been outlined in several publications so that only the more important points need emphasis here. Tapping must be on a timely schedule to take full advantage of early runs that produce the best syrup. The sap must also be handled expeditiously. Several kinds of bacteria are known to multiply rapidly in sap with a temperature of 32° F. or more. These cause discoloration and souring. Foreign matter

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2/ The best producing tree species is called by several common names including sugar, hard or rock maple. The scientific name is Acer saccharum. Some red maples are also tapped but the sap is considered to be inferior in taste and to have a lower sugar content than that of the sugar maple. Red maple is also called soft or white maple; the scientific name is Acer rubrum.

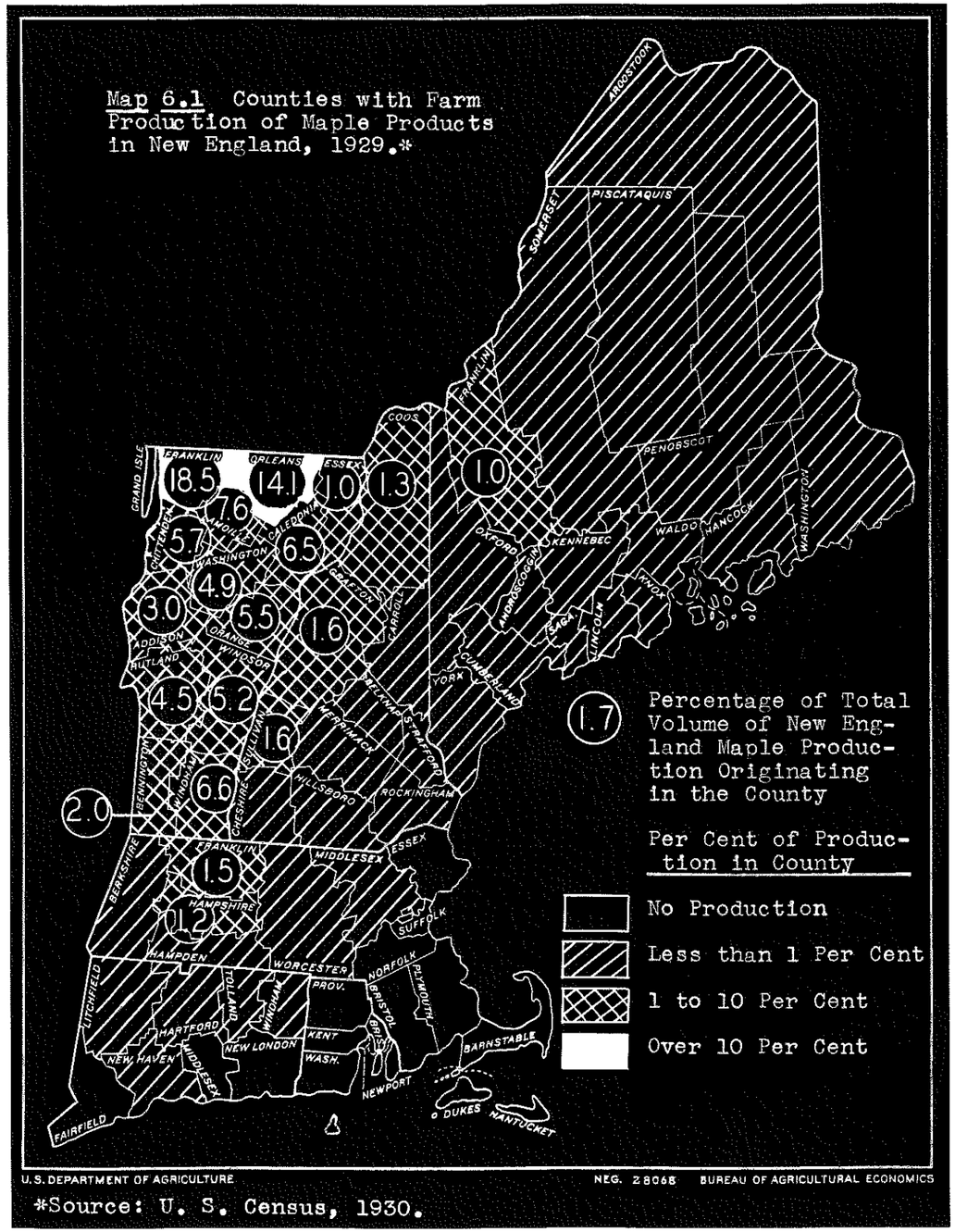
should also be kept out of the sap by bucket covers and straining. The boiling process itself should be rapid to prevent excessive caramelizing and dark color.

The work schedule is thus dictated primarily by weather conditions and is not as flexible as that of most other woods operations. This may create a difficult problem in planning farm work. Fortunately the sap flow and "sugaring off" usually come at a time when other work is not pressing. It is too early for field work, and frequently forest cutting operations are slowed down by poor road conditions. The major competing activity is the dairy herd. Usually no more than a few weeks of work are involved, although early and late runs may spread the season over one or two months. Many farms can handle the job by lengthening the working day while others add some temporary hired labor.

Some investment in specialized equipment is needed for efficient operation of a sugar bush. Chart 6.3 indicates a good floor plan for a sugarhouse. A suggested list of equipment and its value at 1947 prices is also shown for a 1,200 bucket bush. Although the listed equipment averages $2.33 per bucket, over 35 percent is in the estimated value of the building. Much of this might be supplied by the use of farm labor and materials at a relatively low cash cost.

It is extremely difficult to find average input-output data for the production of syrup since the actual figures vary greatly from bush to bush and with differences in the weather, operating efficiency and the like. However, the following data seem applicable to an average sugar bush during a year of normal operating conditions.

About one cord of dry wood should be on hand at the beginning of the



*Source: U. S. Census, 1930.

Chart 6.3

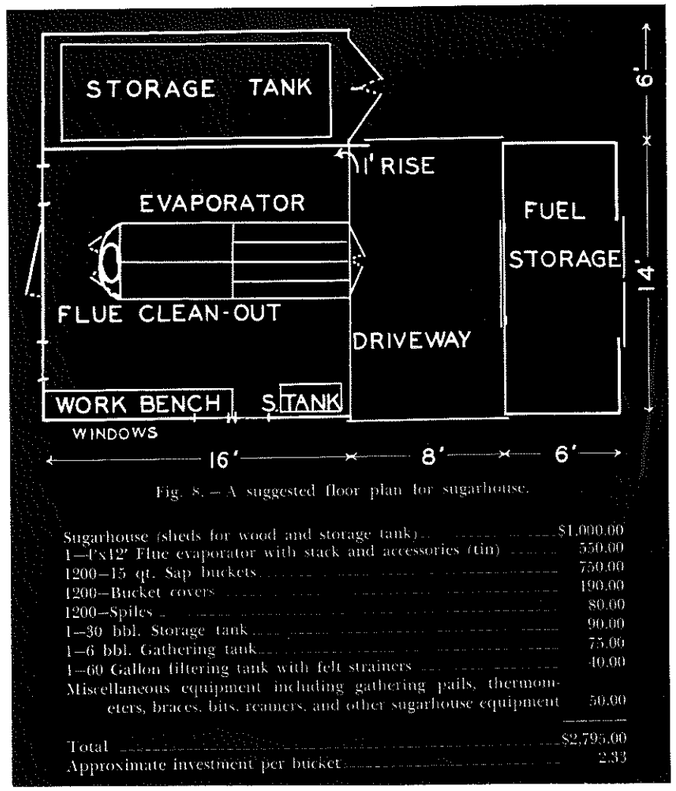


Fig. 8.—A suggested floor plan for sugarhouse.

Sugarhouse (sheds for wood and storage tank)	$1,000.00
1—8'x12' Flue evaporator with stack and accessories (tin)	550.00
1200—15 qt. Sap buckets	750.00
1200—Bucket covers	190.00
1200—Spiles	80.00
1—30 bbl. Storage tank	90.00
1—6 bbl. Gathering tank	75.00
1—60 Gallon filtering tank with felt strainers	40.00
Miscellaneous equipment including gathering pails, thermometers, braces, bits, reamers, and other sugarhouse equipment	50.00
Total	$2,795.00
Approximate investment per bucket	2.33

Source: Pennsylvania State College, School of Agriculture, Circular 310, Making Maple Syrup, State College, 1947

season for every 60 to 70 buckets hung. This can ordinarily be obtained from thinning and salvage operations required in the bush itself. Labor inputs will be somewhat greater than for the production of cordwood since some splitting and fitting will be required. In many localities, slabs and turning cores are available for a small cost and farmers use them for fuel.

Once the run has started one man is needed constantly at the evaporator unless the bush is quite small. The gathering of sap will normally require at least another man and team or tractor. Carefully laid-out roads and the judicious use of feeder pipe lines can considerably speed up the job of collection. A few bushes are equipped with complete pipe-line systems to carry the sap from the tree to the sugar house. Successful use of this system depends on having sufficient slope for gravity drainage from the bush to the sugarhouse and on having the trees close enough together for efficient pipe-line layout.

A rule of thumb indicates that the average labor input for gathering and evaporating the sap is about one man hour for every three buckets hung. However, this will vary considerably from year to year and among different bushes. If an average flow lasts for two to three weeks two men can efficiently work about 1,200 buckets. Circumstances are so variable, however, that two men sometimes work as many as 2,000 buckets. A team or tractor will be needed for one-third to one-half of the time for collecting. Unless the ground is unusually smooth and roads are well laid out, horses can function more effectively than the usual farm tractor, especially if the snow is deep.

The greatest sap flow is usually obtained on a southerly exposure

that warms up early. Northerly slopes will run later in the season. For evenness of the work load and good yields, it is probably advantageous to have some of each slope in a single bush. Protection from the drying of prevailing westerly winds is also beneficial. Frequently this can be provided by a fringe of conifers on the western edge of the bush. However, the dense shade of conifers on maple boles will reduce sap flow; therefore spruce, fir and hemlock should be cut out of the interior of the stand.

Sap flow is more or less proportional to the total leaf surface of the tree; hence the best results are obtained from trees with wide and deep crowns. Such trees can best be grown free from the competition of surrounding trees. This fact dictates the silvicultural policy used in developing a good sugar bush from a young stand. Frequent partial-cuttings at five or ten-year intervals are used to give the selected crop trees plenty of room to expand their crowns. About five or ten feet of clear space around the crown will allow room for growth and provide side light to encourage the development of a deep crown extending well down the bole.

Such a program should aim at leaving about 50 to 60 crop trees well spaced over an acre. Ordinarily this stocking should not be attained at once in a young bush. Such severe opening of the canopy encourages soil drying, sun scald damage of the trees and wind throw. It also makes no provision for probable losses. A gradual reduction in the number of trees per acre is most desirable; all tree species other than maple should be cut out first.

Well-shaped specimens of other valuable species are frequently present in the bush. These can often be kept until they grow to sawlog

size with only a slight sacrifice of maple crown development. This dual use of the sugar bush is particularly well adapted to growing a few high grade white ash logs or other species that are not space demanding.

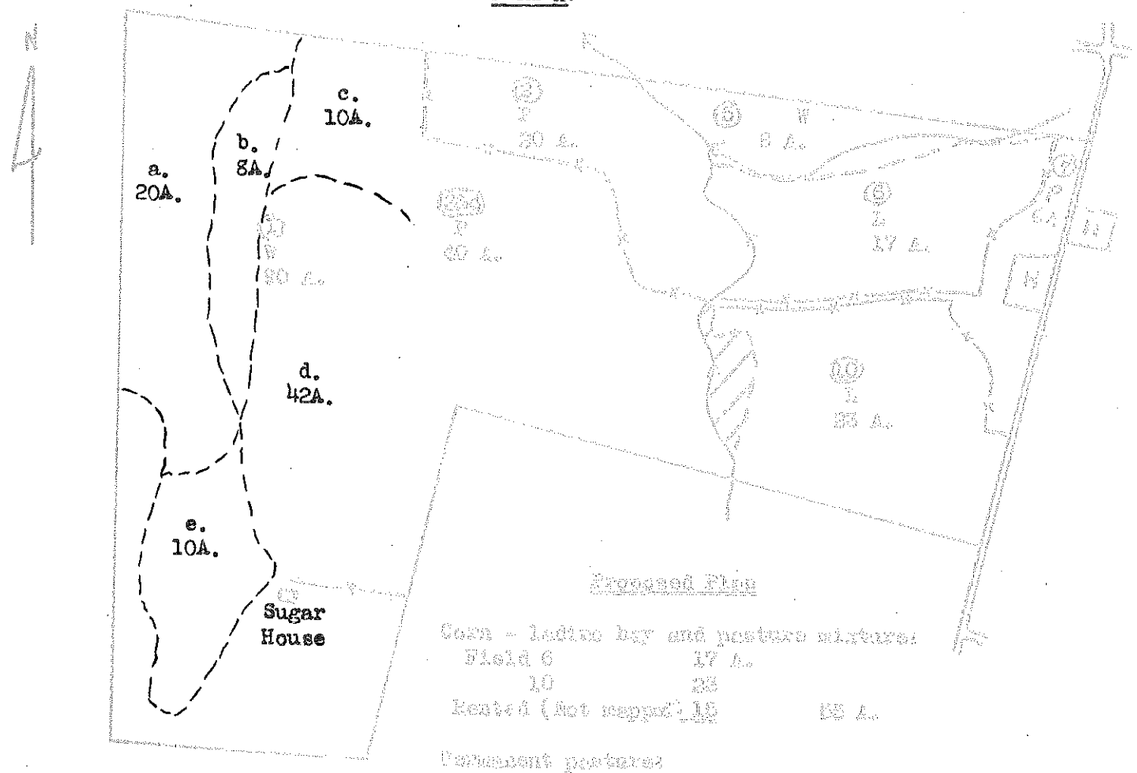
Although some sugar bushes have been producing for decades, the trees must eventually die out or be killed by wind, lightning, insects, etc. To provide for replacements and continuous production, smaller trees should be started. Ample reproduction will start from natural seeding as long as the bush is not grazed. Cattle, however, can effectively browse off all maple seedlings until the bush appears barren and park-like. This is especially undesirable if it allows hardhack and softwoods to form an understory.

If cattle are fenced out, a moderate amount of weeding will be needed. This can be done with a machete or brush hook to keep the understory open enough for easy working and to select desirable stems for replacements. Ordinarily about one-half a man day per acre every four or five years should be sufficient for such work.

Farm H

Vermont Farm H has a syrup enterprise typical of the area. This 209-acre farm includes about 40 acres of cropland, 66 acres of open pasture and 98 acres of woodland including a 42-acre sugar bush. Fifteen acres of additional cropland are rented in three nearby tracts. The milking herd has averaged about 31 purebred Holstein cows. Milk production per cow has been about 9,100 pounds of 3.5 percent milk, with grain feeding of about 2,200 pounds. Roughage quality has been improved by moderate fertilization, addition of ladino clover to the seeding mixture, and early haying. Crop fields have been built up to a relatively high

Map 6.2
Farm H.



level of productivity, but only a limited amount of pasture improvement has been done.

The operator and his older son work full time and have done all of the work with the aid of only a few days of hired labor. The farm is equipped with a tractor and tractor tillage equipment, side-delivery rake, and hayloader. A team of horses is kept mainly for work in the sugar bush and woods. The annual cut has consisted of enough fuel wood for home use and for sugaring. About 1,250 buckets have been hung, yielding an average of about 240 gallons of syrup.

No major reorganization is suggested in the proposed plans. The principal question is whether work can be organized to permit larger accomplishments with no greater effort. The rate of cropland fertilization will be increased slightly, and space for additional young stock will be made available by remodeling the barn across the road. Custom baling of part of the hay will permit easier storage in this young stock barn. About 20 acres of permanent pasture will be leveled with a bog harrow or bulldozer, fertilized and reseeded. By purchasing 18 tons of hay, about 40 tons of additional roughage (hay equivalent) will be available. This will be enough to raise 8 more young stock (Plan I), raise 2 more young stock and keep 6 more cows (Plan II), or add some other combination of cows and young stock. No change in average milk production or grain feeding per cow is planned.

The forestry program embodies partial-cuttings, improved harvesting practices and the sugar bush management previously discussed. The following outline indicates the present condition of the wooded areas of this farm together with suggested stand treatment.

Stand No.	Acres	Present Condition	Suggested Treatment
1a	20	Even-aged, 0-20 year old stand of soft maple, gray and white birch. Medium to high density and fair reproduction.	No treatment until useable products can be cut. Then make partial-cuttings every 5 to 10 years to remove gray birch and poorly shaped trees. Favor best maple; it may be possible to convert parts of this area to sugar bush.
1b	8	Even-aged, 40-60 year old stand of hemlock and oak on a steep slope. Medium to high density and fair reproduction.	Make partial-cuttings every 5 to 10 years in parts that are accessible for work. Cut no more than 1/3 of the volume in one operation. Favor best oak and hemlock for sawlogs at 14" to 16" d.b.h.
1c	10	Brush pasture.	Fence out cattle and allow to restock.
1d	42	Uneven-aged, 60-100 year old sugar bush. Medium to low density and fair to poor reproduction. Some hemlock is mixed with the maple.	Fence out cattle to promote seeding of sugar maple. Cut out species other than maple, especially hemlocks that shade the maples and cause them to run late. Remove hardhack whenever possible.
1e	10	Partly brush pasture with a fringe of dense soft and sugar maples, 0 to 20 years old.	Thin out the stand, favoring sugar maple whenever possible to develop large-crowned trees for a sugar bush.

The problem here is principally one of improving the composition and yield of the sugar bush, developing stands to add to it, and managing the softwood areas to yield lumber for farm repairs. Other than syrup operations, the annual yield for the next five or ten years is estimated at about 10 to 15 cords of fuel and a few logs for home use. This will require about 15 to 20 man days of labor. When all the areas are fully

stocked and productive the yearly harvest will be about 20 cords of wood with an increasing proportion of sawlogs so that total labor input will not increase greatly.

The two regular workers handle the present 1,250 bucket syrup operation. The stand improvements outlined above should make it possible eventually to expand the bush to about 2,000 buckets. Some hired help may be necessary at this time, but it seems likely that labor can then be used more efficiently and inputs will not be much greater than at present. Yields should increase from the present 240 gallon level to about 400 gallons.

It is estimated that over a period of years returns from the suggested treatment will be nearly double those of customary practices. Syrup income will be nearly double also and the improved productivity will add to the value of the entire farm. The financial summary, Table 6.2, indicates that net farm income will be increased $66 under Plan I and $285 under Plan II. Woodland income is held constant for all plans since no drastic increase in productivity is likely to result until some time after the five year budget period. Increased syrup output should eventually add about $400 to cash income.

There is another alternative that may deserve further consideration if the operator wants to cut down on strenuous farm work or if the price of syrup takes an unfavorable drop. This would involve abandoning the syrup operation, making it possible to eliminate the team of horses and keep more cows. The sugar bush could be handled on a sawlog rotation by marked stumpage sales. This adjustment cannot be easily reversed since it may take a long time to develop another sugar bush once the present

Table 6.2

Farm H
FINANCIAL SUMMARY

	Present	Plan I	Plan II
Receipts			
Milk	$8,584	$8,426	$10,256
Cows and young stock	800	2,400	960
Calves	126	85	140
Eggs	20	20	20
AGR Refund	125	125	125
Maple Syrup (240 gals.)	562	562	562
Truck and tractor work	160	160	160
TOTAL	$10,376	$11,778	$12,223
Expenses			
Grain	$ 2,661	$ 3,021	$ 3,147
Hay	---	360	360
Labor	25	100	100
Seed	115	115	115
Bedding Misc. dairy Chicks Misc. poultry	325 50	375 50	475 50
Fertilizer and lime	277	480	480
Misc. and tel.	333	333	333
Gas, oil and grease	150	150	150
Other truck & tractor exp.	200	200	200
Bldg. upkeep and repairs	300	525	525
Equip. upkeep and repairs	110	110	110
Taxes	492	525	525
Rent of cropland & pasture	73	73	73
Insurance	65	65	65
Interest	--	80	80
Baling hay	--	150	150
Miscellaneous	60	50	60
Depreс. horses	20	20	20
Depreс. machinery	300	300	300
TOTAL	$ 5,556	$ 6,892	$ 7,118
NET FARM INCOME	$ 4,820	$ 4,886	$ 5,105

one is cut off. It is significant that only a relatively small change in syrup-milk price relationships would make the above changes financially attractive.

Special Forest Products

There are several other forest products that might be classed as specialty crops. The production of Christmas trees and greens is one of the more important of these enterprises. Most of the small trees and greens come from the spruce-fir region in northern Maine, New Hampshire and Vermont. The great bulk of these materials in New Hampshire and Vermont are cut from brushy pastures that are seeding in to conifers from surrounding older trees. Much of the Maine harvest originates on old cut-over lands.

Fir is the preferred species since it retains its needles longest. However, a fairly substantial proportion of white spruce is usually accepted in a large shipment. Little if any additional cost or effort is needed to grow the trees; the only input involved is in preparing the crop for market. Selecting, cutting, bundling and hauling the material to a road or railroad requires considerable time. In general the trees are sold to buyers either bundled or on the stump. Cutting rights are frequently sold by a farmer and the buyer contracts with him to do at least part of the hauling with farm equipment. Buyers sometimes prefer to do the cutting with their own crews.

Prices fluctuate widely from year to year but recently stumpage has been worth about 25 to 50 cents per bundle. A bundle usually contains from three to five trees. No good input-output data is available on this type of operation. Normally the work is carried out during a few weeks

in November and early December.

Near population centers in some of the New England states it may be profitable to plant trees for the Christmas trade. The area to be planted should be open and free of brush, so that the trees will grow symmetrically, and should be easily guarded against theft. The greatest advantage can be gotten if the plantation is near a road and the trees can be retailed by the owner. A lot where the customer can pick out his own tree, see it cut and carry it home seems to have considerable appeal to both the buyer and owner.

There are several other miscellaneous products that were not found on any of the study farms and need only be mentioned. Black birch brush is collected and sold by the ton in some localities for use in the manufacture of flavoring. Witch hazel is also sold for use in medicine and there is a limited market for essential oils distilled from spruce, fir and hemlock. Of course, bark from this latter species was used for years as a source of tannin, but today there is little market for bark in New England.

Perhaps a final word should be said about developing the wildlife productivity of farm woodlands. The Soil Conservation Service lays considerable emphasis on this phase of forestry and recommends growing food plants in wildlife areas, hedge rows and the like. As a rule any sort of a forestry program that employs at least improved cutting practices or, even better, frequent partial-cuttings will at the same time create a favorable environment for game animals and birds. It is often difficult, however, for the average New England farmer to sell hunting or fishing rights on his property. The usual farmer does not control a large enough

area to make this practical and it is hard to guarantee exclusive hunting rights to any buyer unless constant patrols are maintained for poachers. This, of course, does not stop the farmer from benefiting personally from the improved hunting and fishing on his own property. But it seems unlikely that most New England farmers can derive any great financial benefit from the direct sale of wildlife under present conditions.

Chapter VII

MANAGEMENT PROBLEMS IN A LOCALITY OF PREDOMINANTLY NON-FARM WOODLAND HOLDINGS

This phase of the study is concerned with some of the management choices faced by a sample of woodland owners who are essentially neither farmers nor large industrial owners, although one farmer is included in the group studied. As previously indicated, "other" small owners hold about 35 percent of New England's private, commercial forest land. Individual holdings vary in size from a few acres up to twenty-five hundred or more and include some of the most accessible and potentially productive woodlands in the region. Many of these owners hold their land in conjunction with family homesteads, summer camps, country estates and the like. Often the owner is a non-resident and only sees his property at infrequent intervals. He is also likely to get his living from a business that has little if any connection with the management of forest land. In addition, he often lacks the labor, equipment and managerial experience necessary to carry on a forestry enterprise. Because of these handicaps, management decisions are frequently made by default or in ignorance of the possible alternatives.

Local Conditions

Since about 1880 the town of Petersham, Massachusetts has had a large proportion of transient "summer people," many of whom have purchased old farms as summer homes or estates. It was thought that a study of the forest management alternatives available to a few of these

owners would shed considerable light on the dilemma facing other similar owners in southern New England. It was hoped that the presence of the Harvard Forest and some local experience with cooperative action in the 1938 hurricane salvage operations would have stimulated owner interest in exploring the possibilities of forestry.

A word is appropriate here concerning the history and physical background of the Petersham locality. Settlement began in 1733 and land clearing expanded rapidly until in the 1840's about 85 percent of the area was cleared for tillage and pasture. A steady decline in agricultural activity since that time has left only about 25 percent of the area open. The "old-field-pine" era, beginning in 1880 and reaching a peak in 1909, removed much of the volunteer pine from the abandoned fields and the 1938 hurricane destroyed most of the remainder. On the heavier upland soils the bulk of these cut-over and blown-down areas are restocking with hardwoods. On some of the lighter soils, white pine seems likely to form the next generation.

Petersham is located in north-central Massachusetts and enjoys a humid and temperate climate. Marked seasonal variations produce cold, snowy winters and comparatively short cool summers. The soils are predominantly fairly productive glacial tills, and rock outcrops are common. The town is located in the so-called Transition Zone, and a great variety of tree species is found. The beech, birch and maples of the north mingle with the oaks and hickories of the central region. White pine is found either alone or in mixture with the hardwoods. Lutz and Cline state:

> There are, however, well-defined natural forest cover types, their composition being influenced markedly by differences in elevation, soil and exposure. For example, mixed stands of white pine, hemlock, beech, birch and maple on cool northern sites contrast with oak and hickory on sunny upper slopes, with pitch pine on light outwash soils (sand plains), with spruce and larch in sphagnum bogs, and red maple and white ash growing in swales. It is on the intermediate sites, middle elevations and moderate exposures that intermingling of the northern and central species occurs to the maximum degree;...."[1]

Agriculture has been discontinued on many of the farms in the region and the land has rapidly returned to forest. However, non-residents have purchased many of these "abandoned" lands which has tended to maintain the value of these holdings, based on their recreational or residential values rather than on agricultural productivity. The problems of town financing have been acute and most of the forest land is now evaluated, for tax purposes, at ten dollars per acre. In the minds of the tax assessors this figure is perhaps established more by an estimate of the owner's ability to pay than by any consideration of forest productivity or other values.

At the present time markets for forest products are somewhat spotty. There is a steady demand for white pine sawlogs of all grades, either on a stumpage basis or at the roadside, for use in the nearby toy, pail and box plants. Low grade hardwood sawlogs do not command such a ready market, but the better quality logs of the more valuable species can be moved easily through normal trade channels. It seems probable that improved sawing and grading and a steady supply in the future might develop an outlet for other grades of hardwood through the large furniture factories in Gardner.

Local opinion indicates that a market for several hundred cords of fuelwood, on a roadside basis, could be developed without any great

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1/ R. J. Lutz and A. C. Cline, Results of the First Thirty Years of Experimentation in Silviculture in the Harvard Forest, Harvard Forest Bulletin No. 23, Petersham, 1947.

difficulty, but there is little if any demand for cordwood stumpage. As yet, there is no local outlet for pulpwood. Continued technological advances in the making of hardwood pulp and an expanding demand for its products, combined with the exploitation of many of the present pulpwood supply areas make it almost certain that a pulpwood market will develop in southern New England within a few decades. Other industries using the lower grades of hardwood are also likely to expand so that it seems reasonable to anticipate a market for hardwood cordwood and bolts during a 90 year planning period.

The local supply of skilled woods labor is definitely limited. Most of the residents who might be employed during the short seasons are mill workers and have little experience in the woods. A local cooperative, formed for hurricane salvage, found that for efficient operation it was necessary to import about three hundred workers from the Tupper Lake region of New York. However, it seems likely that by careful selection and some simple training an efficient woods crew nucleus could be assembled. Temporary hired labor might then be effectively employed under good supervision.

Characteristics of the Ownerships Studied

Three land holdings along the southeastern boundary between Petersham and Barre were chosen for study. Their aggregate area totaled over 2,000 contiguous acres, including about 1,900 acres of forest land. This acreage is divided into almost equal holdings and covers the better part of two hills and the intervening brook valley. Several old farmsteads are included within the area; the old town and logging roads make

practically all of it readily accessible. Only a little improvement work will be needed to complete an adequate road network.

Mr. A has 771 acres, of which 680 are woodland. He is a prominent Boston lawyer and visits his Petersham holdings at infrequent intervals. A farmer is hired to live in and maintain the buildings, care for a vegetable garden and keep up the fields, using horse-drawn equipment. Agricultural operations are not on a commercial scale.

Mr. B is the only commercial farmer in the group, owning 645 acres that include 605 acres of woodland. His farm has about 160 acres of old pastures that are in the process of seeding in to trees. On his 40 acres of good crop and pasture land he operates a dairy enterprise with about 29 head of stock and keeps a team of horses. This activity takes up most of his and his family's time so that little woods work is done beyond getting out fuel and a few logs for farm use.

Mr. C, the third owner, operates a prosperous florist business in Framingham, Massachusetts. His 645 acres include 580 acres of woodland and 38 acres of pond and swamp. He uses the house as a summer residence and carries on no agricultural enterprises. One man is employed as caretaker during the summer months.

Thus one of the owners is essentially a non-resident, one a part-time resident and one a farmer whose time is at present fully employed in agriculture. Past forestry activities have been very limited. Mr. A has 31 acres of white pine plantations and both he and Mr. B salvaged the timber blown down by the hurricane. Mr. C has carried on no woods work, beyond clearing trails. All of these owners were interviewed and expressed an interest in having the forest management possibilities of

their lands studied. How far they are willing to go toward adopting any recommendations is not known at this time.

Present Growing Stock

An extensive cruise was made of the forest growing stock to determine what is now on the area. Recent aerial photographs were available covering the entire area and these were used to delimit homogeneous stands and to guide the ground cruise. All of the major stands were inspected and sample plots were taken to record the number, dimensions and species of the trees. Notes were also made on the logging chance and the abundance and kind of reproduction present. Altogether, about 100 fifth-acre plots were taken to get data adequate for planning purposes. (The value of such a sample is likely to be somewhat greater than that of one obtained from the same percentage cruise made on the conventional "line-plot" system. See Appendix B for sample field tally sheets.) The stands were then classified into twenty-two homogeneous groups to serve as a basis for planning. A brief description and maps showing the location of these stands will be found at the end of this chapter.

The over-all characteristics of the forest areas are shown in Table 7.1. It is apparent that about half of the area supports seedling and sapling stands that contain no measurable volume of wood. Most of these stands are made up of hardwoods, except on Mr. B's place, where nearly two-thirds are pine. The other half of the total area supports middle-aged poletimber stands about two-thirds of which are hardwood. Only 3 percent of the area contains sawtimber stands and these are concentrated on Mr. A's property. About 17 percent of the area supports stands of red maple swale and swamp types, having a low potential for

TABLE 7.1

Present Forest Stands Classified by Ownership, Type, and Size Class1/

Size Class	Owner A				Owner B				Owner C				Total			
	Softwd.		Hardwd.		Softwd.		Hardwd.		Softwd.		Hardwd.		All Softwd.		All Hardwd.	
	A.	%	A.	%	A.	%	A.	%	A.	%	A.	%	A.	%	A.	%
Sawtimber	65	6	-	-	1	1	-	-	-	-	-	-	49	3	-	-
Poletimber	55	10	236	35	111	18	187	31	-	-	-	-	260	14	649	54
Seedling and sapling	95	14	235	35	193	32	111	18	-	-	-	-	366	19	535	28
TOTAL	209	30	471	70	305	51	298	49	-	-	-	-	675	36	1184	62
Nonproductive	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	209	30	471	70	305	51	298	49	-	-	-	-	675	36	1184	62

Size Class	Total Soft+Hard. A.	%
Sawtimber	49	3
Poletimber	909	48
Seedling and sapling	901	47
TOTAL	1859	98
Nonproductive	38	2
TOTAL	1901	100

1/Petersham, Mass. study area.
A. = Acres

sawlog production. Mr. C owns over half of these latter stands. The average stocking of the present stands is only about 50 percent of normal, which will not only affect the probable yields but also will lower the quality of the sawlogs produced. The average age of the pole-timber and sawtimber stands is about 35 to 40 years, while the seedling and sapling stands on the other half of the area vary from 0 to 15 years of age.

Problems and Possibilities

The problem presented by these three properties is one of discovering what sort of forest management promises to make the greatest returns to the owners. In order that rational choices may be made, it is necessary to measure the relative merits of the feasible management plans. It is obviously impossible to reduce to exact figures the subjective values that any plan may have to a given owner, but other values can be expressed in a schedule of probable costs and returns. These can be prepared for each plan and when supplemented by statements of labor, capital, managerial and organizational requirements, should furnish a rational basis for guiding choices among future operating plans.

In order to provide the data just outlined, a great many inter-dependent problems must be solved. For the sake of clarity these will first be discussed separately. Perhaps, the first decision that must be made in a study of this kind is the length of the planning period to be used in comparing different forestry plans. Since the woodland growing stock is both the "factory" and "warehouse" of forest products the full effects of any form of management are only apparent over a considerable time span. Destructive methods of utilization may have immediate

advantages over more conservative forestry practices, but these advantages may disappear in the long-run. Intensive forestry may require considerable investment, not only in physical inputs but also in deferred harvests of salable products, and the increased yields of such operations may not accrue for some time. If a rational comparison of alternatives is to be made, the planning period must be long enough for these changes in productivity to become effective. In this study a 90 year planning period was used. This is slightly longer than the time usually considered to be a normal economic rotation and probably exceeds the planning horizon of most owners. However, such a span is necessary to adequately reflect the results of management, especially when the growing stock being considered is predominantly young and understocked. Even then, the comparative advantages of different plans depends to some extent on an estimate of the value of the residual growing stock at the end of the period.

Market Considerations

In the final analysis the type of forest products demanded by the market governs the forestry operations of any woodland tract. Therefore, the available markets were the first consideration in determining feasible management plans, and two general sets of conditions were postulated. The first closely parallels present markets in the area, assuming that both hardwood and softwood sawlogs can be sold on the stump or at the roadside and that no cordwood can be sold standing. However, it was assumed that a roadside market for cordwood could be found to absorb about five hundred cords per year. Under these conditions three different operating plans appear practical.

The second set of market conditions assumed that unlimited quantities

of sawlogs can be sold, either on the stump or at the roadside and that any amount of cordwood can be sold at the roadside. In the light of the previous discussion it seems likely that such conditions may be substantially realized during the next nine decades. Four different operating plans seem most practical under these circumstances. An eighth plan envisions no sale of forest products but the value of the residual stand is determined by the market demand assumed at the end of the period.

Alternative Plans of Operation

Before going further it will be well to pause and discuss more of the operating and organizational details of these different plans. The exposition starts with the lowest degree of management intensity and works toward the highest degree possible under the assumed market conditions.

Plan 8

This plan envisions the least possible action on the part of the owner, beyond that necessary to keep possession of his land. Taxes will be paid but no cuttings of any kind will be made. Public agencies will be relied upon for all protective measures. The trees will grow under wild conditions; the only input will be taxes and the only output will be the value of the residual stand, plus whatever subjective values the owner may derive. This truly represents a "do-nothing" policy involving the lowest degree of forest management intensity, hereafter referred to as intensity D.

Plans Assuming Sale of Sawlogs and Limited Sale of Cordwood

Plan 7

This plan is a projection of the best results that seem likely to

come from management practices referred to in the Forest Service's Reappraisal Report as "poor or destructive." The plan is a continuation of the prevalent practices of selling all merchantable sawlogs on a stumpage basis whenever there is sufficient volume and quality of logs to attract a buyer. This means that most white pine will be clear-cut between 60 and 80 years while most hardwood and mixed stands will be either clear-cut or high-graded between 70 and 90 years of age. Such cutting takes no measures to encourage prompt and valuable reproduction. The plan requires a minimum investment in either labor, management or deferred harvests. This intensity of management will be called C. Practically, the estimated income from this plan is more optimistic than current experience warrants since it assumes that a buyer can always be found when logs are ready for sale and, more important, it assumes that the owner will always receive the full market price for the full scale of logs cut. There is nothing inherent in this operating system to prevent an owner from carrying it out on his own land or cooperatively with his neighbors.

Silviculturally, this plan is likely to result in poor-stocking becoming even more general than now, and succeeding stands will tend to be of increasingly inferior quality and species. The written plan, however, makes no allowance for this gradual decline and calls for residual stands about 60 percent stocked.

Plan 6

This plan assumes stumpage sales of sawlogs similar to those of plan 7, but harvest cuts will be made in such a way as to promote adequate, valuable reproduction. It is assumed that enough public forestry aid

will be available to lay out cutting plans at no added cost. It is also considered that timber buyers will be willing to purchase stands harvested in this manner. This plan too can be implemented by each of the owners separately or by some form of joint action.

There is ample reason to believe that if these better cutting practices are followed the entire area eventually will be adequately stocked with desirable reproduction. While this plan requires a slightly greater investment than number 7, by deferring final cuts, this may be more than compensated by the value of the added growth during the period of postponement. The full value of this plan will be only partially reflected in added net cash income during the planning period. The balance of the gain will show up in the increased value of the residual stand. This degree of management intensity is hereafter called B.

Plan 6

This plan uses the most intensive forest management that appears practical under the assumption of limited cordwood sales. The plan calls for about half of the area being managed in accordance with management intensity B, as outlined in plan 6. These stands will in general be the least promising ones on poorer sites, those that are relatively inaccessible or those that are poorly stocked with trees of desirable quality or species. Naturally, any time that market or other conditions make it desirable to do so these stands could be put under more intensive management.

The most promising stands will receive more attention. Partial-cuttings to improve stand quality and tree growth will be made at intervals throughout the stand's history. The object of these operations will

be to eliminate the least desirable trees in favor of the chosen crop trees and to salvage stems that might otherwise die and be wasted. The growth potential of the area will be concentrated on the best trees. Weeding and pruning will be done in the young stands when silviculturally desirable, and harvesting will be done in such a way as to promote valuable reproduction. A listing of the stands to be handled under each intensity will be found at the end of this chapter.

Plan 5 calls for the gradual development of a permanent road network. The operating skill required to carry out this plan probably can be obtained only by hiring a permanent two man crew, including a foreman with considerable judgment and capacity. Additional labor will also be required at times to meet the peak work loads. Minimum equipment for such a crew will include a power chain-saw, cut-off saw, a light truck or "jeep" and various woodsman's tools. A team will also be needed part of the time for skidding. At present it is impossible to hire such a crew and equipment with the requisite skill on a part-time basis.

A manager capable of laying out woods operations, finding markets and directing sales will also be needed on a part-time basis. It is likely that a competent consulting forester can be found to do this. The need for outside management, a capable woods crew and equipment to carry out this plan indicates that the owners must operate their holdings in concert. No one of them has land enough to keep such a crew profitably employed. Some sort of group action will be required.

This plan will result in more complete utilization of the forest's growing capacity. The quantity and quality of merchantable sawlogs will be increased and the limited cordwood market will be exploited as a means

of paying for many stand improvement operations. It is assumed that after the plan has been in operation for 20 years the logs produced from the intensively managed stands will have improved in quality enough to command a 15 percent greater roadside price.

Plans Assuming Unlimited Sale of All Forest Products

Plan 4

Like plan 7, this program calls for use of forest management intensity C. Customary clear-cutting and high-grading practices will be used with the same silvicultural results as under plan 7. However, some operating changes are needed to take advantage of the roadside market for cordwood. It will be necessary either to hire a crew of men by the day to get the logs and cordwood to the roadside or to hire a contractor to do the same thing. It has been assumed that the costs will be substantially the same however the job is done. For purposes of computation this cost has been figured in terms of the necessary eight-hour man work days needed to cut and skid the products to a drivable road. An allowance is included in these figures for other variable physical inputs. There is again, no inherent reason why this plan cannot be successfully followed by the owners either singly or together.

Plan 3

This plan is similar to the last one except that management intensity B is used so that cutting will be done in such a manner as to promote desirable reproduction. As in plan 6, it is also assumed that free public forestry assistance will be adequate to meet the needs of this plan. Again, cutting will be done either by a contractor or on a wage basis

and the costs are assumed to be about the same. It is not believed that the labor cost per unit of product under plan 3 will be significantly different from that of plan 4. All available studies indicate that there are no marked differences in operating costs when a stand is cut according to good forestry standards, if the job is well laid out. This plan also can be adopted by one or all of the owners together.

Plan 2

This plan resembles plan 5 in that it uses management intensities A and B on the stands previously outlined. However, in this program all products will be sold at the roadside. Thus products from the stands under intensity B, that were previously sold on a stumpage basis, will now be sold roadside, as outlined in plan 3. The management requirements, size of operating unit, investment in equipment and the size of permanent crew are all the same as in plan 5.

Plan 1

This is the most intensive plan analysed. All of the stands will be treated with forest management intensity A, as outlined for the better stands in plans 5 and 2. Improvement cutting, thinning, weeding and pruning will be done when silviculturally desirable. Since a good market for cordwood is assumed, the cost of all but the earliest weedings and improvement cuttings will be covered by receipts, under the assumed price relationships. Thus nearly all of the merchantable volume will be harvested throughout the life of a stand and there will be relatively little waste of forest growth such as occurs under the less intensive plans where many trees die and decay as the stands mature.

Execution of the plan requires hiring a skilled forester at least half time to lay out operations, find the most advantageous markets and direct sales. A permanent crew of at least three men will be needed, including a very capable foreman. In addition, considerable temporary labor will be needed from time to time. The investment in equipment will be at least double that of plans 5 or 2. Besides standard logging tools, a power chain-saw, cut-off saw and light truck, preferably with 4-wheel drive, will be needed. Horses must also be available for skidding during the first forty years. The volume of operations and the heavy log loads after that time indicate the need for a small crawler tractor with bull-dozer blade. Despite good management it is probable that this equipment will not always be employed to full capacity, but this seems unavoidable because of inherent discontinuities in the size of efficient assemblies of operating equipment, work areas and managerial ability. Certainly this type of operation will only be economically feasible if all three ownerships are operated together.

This plan will produce the greatest amounts of both high quality sawlogs and cordwood over the planning period. Annual cordwood production during some decades will be more than twenty-five hundred cords. At the end of 90 years the entire area will be well stocked with desirable trees managed in such a way as to contain the maximum number of good logs. Investment in the form of labor, management and operating equipment will have been higher than under any other plan. Investment in deferred harvests will be no greater than that of plans 2, 3, 5 and 6. A summary of the chief characteristics of these several operating plans will be found in Table 7.2.

Table 7.2 PRINCIPAL OPERATING FEATURES OF ALTERNATIVE MANAGEMENT PLANS

Plan Number	Management/1 Intensity	Method of Sales	Operating Organization	Added Labor Requirements	Added Management	Added Equip. Investment
Plans assuming unlimited markets for sawlogs and cordwood						
1	A	Roadside	Integrated Unit	5-man permanent crew + day labor	Part-time manager	$ 3,500 /2
2	A-42% of area B-58% of area	Roadside	Integrated Unit	2-man permanent crew + day labor	Part-time manager	- $ 1,500
3	B	Roadside	Integrated Unit or Independently	Day labor	Public forestry assistance	None
4	C	Roadside	Independently	Day labor	None	None
Plans assuming an unlimited market for sawlogs and a limited market for cordwood						
5	A-42% of area B-58% of area	Roadside & stumpage	Integrated Unit	2-man permanent crew + day labor	Part-time manager	$ 1,500
6	B	Stumpage	Integrated Unit or Independently	None	Public forestry assistance	None
7	C	Stumpage	Independently	None	None	None
8	D	No sales	Independently	None	None	None

/1 Intensity D - No woods operations
Intensity C - Customary practice - clear cutting and high-grading
Intensity B - Harvest cuttings made so as to promote desirable reproduction
Intensity A - Intensity B plus improvement cuttings, thinnings & other cultural operations

/2 After the first 40 years this added investment will be $7,000.

Physical Inputs and Outputs

In order to project the probable outputs of forest products resulting from the different intensities of management during the planning period some basis of estimation was needed. Forest management intensities B, C and D do not attempt to stimulate growth during the rotation and it was thought that the stands would develop under essentially wild conditions. Normal Yield Tables, showing the growth of fully-stocked, wild stands over the years, were considered applicable. A special formula was used to adapt these tables for use with under-stocked stands.

No tables for estimating the growth of stands receiving the suggested partial-cuttings of intensity A have been developed from forestry experience. It was therefore necessary to construct yield tables that would apply to these stands. On the basis of experience at the Harvard Forest and elsewhere, an estimate was made of the tree dimensions likely to be achieved by this type of management during the life of the stand. These estimates served as the basis for tables showing expected yields from the most intensively managed stands. A full discussion of these prediction systems will be found in Appendix A.

The method used to determine the labor inputs for felling, limbing, bucking and skidding has already been discussed in Chapter IV. All of the other physical inputs such as team or tractor hours, labor for road maintenance, incidentals and the like have been assumed to vary directly with the volume of product harvested. These items have been reduced to man day equivalents and constitute about 20 percent of the labor figures. These other operating inputs might constitute a slightly higher proportion of total inputs under the more intensive management plans, but this

probably would be more than compensated for by the added efficiency of operation and total inputs would be about the same. No physical inputs are required by plans 6, 7 and 8 since forest products are either sold on a stumpage basis or are not sold at all. Table 7.3 shows, by decades, the probable inputs of labor and outputs of merchantable products that will result from the seven operating plans. The decadal increment in stand volume under plan 6 is not shown.

Table 7.4 summarizes the average annual physical inputs of labor and outputs of board feet and cords per acre for the different plans. The cubic feet of standing timber per acre of woodland at the beginning and end of the period are also shown. These figures do not reflect the economic advantages of the plans but they do show how physical output increases with physical input.

Economic Comparisons

From an economic point of view the comparison of various operating plans in terms of physical inputs and outputs is in itself meaningless. Unit costs and prices serve the important function of determining which combinations of factors are most or least profitable; thus largely directing the allocation of resources. By applying costs and prices to the physical units just outlined and making allowances for fixed charges budgets are prepared for each plan so that they can be compared in economic terms.

Before this process can be carried out it is essential to answer the question - "What costs and prices will be used?" Naturally, no one can say just what these values will be over the next 90 years, but fortunately this is not strictly necessary in order to make valid comparisons.

Table 7.3

PROBABLE FUTURE
INPUTS OF MAN DAYS OF LABOR /1 AND OUTPUTS OF THOUSANDS OF BOARD FEET
OF SAWLOGS AND CORDS OF WOOD BY DECADES RESULTING FROM DIFFERENT MANAGEMENT PLANS

Owner and Unit	Years in the Future 0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	Total
PLAN NO. 7										
A mbf	404	0	1,488	0	4,573	0	1,419	1,668	783	10,335
B "	43	0	977	630	3,508	0	2,259	2,196	1,885	11,498
C "	0	0	273	0	3,788	0	918	1,524	967	7,470
Total "	447	0	2,738	630	11,869	0	4,596	5,388	3,635	29,303
PLAN NO. 6										
A mbf	34	64	953	1,161	3,527	1,149	1,030	2,397	774	11,089
B "	17	32	488	1,548	2,732	560	1,771	3,006	1,825	11,999
C "	0	0	137	546	2,033	1,441	724	1,509	864	7,254
Total "	51	96	1,578	3,255	8,292	3,170	3,525	6,912	3,463	30,342
PLAN NO. 5										
Sold Stumpage										
A mbf	34	64	0	102	1,880	543	0	43	53	2,724
B "	17	32	455	878	1,686	59[illegible]	0	138	186	3,972
C "	0	0	137	546	1,895	1,441	0	138	170	4,327
Sold Roadside										
A mbf	399	533	1,108	1,437	1,287	2,29[illegible]	1,177	2,528	1,006	11,767
B "	138	280	240	1,061	1,273	1,40[illegible]	2,029	2,953	1,793	11,176
C "	16	13	90	300	360	40[illegible]	892	1,903	646	4,623
Total "	604	922	2,030	4,324	8,381	6,67[illegible]	4,098	7,703	3,854	38,589
Sold Roadside										
A cds.	1,632	1,172	1,660	1,337	652	1,272	3,456	2,451	1,551	15,183
B "	959	823	751	1,106	920	1,284	2,668	2,282	998	11,791
C "	93	781	862	414	334	445	738	665	324	4,656
Total "	2,684	2,776	3,273	2,857	1,906	3,001	6,862	5,398	2,873	31,630
Man Days										
A md	3,262	3,034	3,376	3,229	2,237	4,550	7,787	6,011	3,538	37,024
B "	1,879	2,205	1,357	2,725	2,574	3,256	6,716	5,960	2,962	29,634
C "	183	1,983	1,340	896	831	998	1,917	2,836	1,011	11,995
Total "	5,324	7,222	6,073	6,850	5,642	8,804	16,420	14,807	7,511	78,653

1/ Power and Equipment costs, converted to man-day equivalents, are included.

Table 7.3 (continued)

Owner and Unit	Years in the Future 0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	Total
PLAN NO. 4										
A mbf	404	0	1,488	0	4,573	0	1,419	1,668	783	10,335
B "	43	0	977	630	3,508	0	2,259	2,196	1,885	11,498
C "	0	0	273	0	3,788	0	918	1,524	967	7,470
Total "	447	0	2,738	630	11,869	0	4,596	5,388	3,635	29,303
A cds	0	335	0	0	7,252	470	1,313	3,098	413	12,881
B "	0	0	0	564	5,353	0	2,920	1,866	949	11,652
C "	0	1,139	0	0	6,304	0	2,076	1,614	398	11,531
Total "	0	1,474	0	564	18,909	470	6,309	6,578	1,760	36,064
Man Days										
A md	408	435	1,511	0	16,372	658	3,068	6,195	1,316	29,963
B "	43	0	1,165	1,398	11,773	0	6,112	4,828	3,119	28,438
C "	0	1,479	328	0	13,766	0	3,754	3,914	1,506	24,747
Total	451	1,914	3,004	1,398	41,911	658	12,934	14,937	5,941	83,148
PLAN NO. 3										
A mbf	34	64	953	1,161	3,527	1,149	1,030	2,397	774	11,089
B "	17	32	488	1,548	2,732	560	1,771	3,006	1,825	11,999
C "	0	0	137	546	2,033	1,441	724	1,509	864	7,254
Total "	51	96	1,578	3,255	8,292	3,170	3,525	6,912	3,463	30,342
A cds	0	335	0	150	6,981	741	1,013	2,149	432	11,801
B "	0	0	0	839	4,586	749	1,141	3,168	992	11,520
C "	0	1,139	0	288	4,331	1,966	1,605	1,850	416	11,595
Total "	0	1,474	0	1,277	15,898	3,501	3,759	7,167	1,840	34,916
Man Days										
A md	34	499	965	1,376	14,145	2,718	2,282	5,295	1,289	28,603
B "	17	32	581	2,809	9,792	1,725	3,138	6,189	5,305	29,588
C "	0	1,479	163	1,030	9,006	4,281	2,762	4,635	1,372	24,728
Total "	51	2,010	1,709	5,215	32,943	8,724	8,182	16,119	7,966	82,919

Table 7.3 (continued)

Owner & Unit	Years in the Future									
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	Total
PLAN NO. 2										
A mbf	433	597	1,108	1,539	3,167	2,840	1,177	2,571	1,059	14,491
B "	155	312	695	1,939	2,959	1,989	2,029	3,091	1,979	15,148
C "	16	13	227	846	2,255	1,844	892	2,041	816	8,950
Total	604	922	2,030	4,324	8,381	6,673	4,098	7,703	3,854	38,589
A cds	1,632	1,507	1,660	1,487	6,140	2,013	3,791	3,451	1,551	22,232
B "	959	823	751	1,371	4,150	2,078	2,668	2,282	998	16,080
C "	93	1,920	862	702	4,487	2,411	1,877	665	324	13,341
Total	2,684	4,250	3,273	3,560	14,777	6,502	8,336	6,398	2,873	51,653
Man Days										
A md	3,296	3,533	3,376	3,545	12,029	6,168	8,222	6,067	3,596	49,832
B "	1,896	2,237	1,901	4,076	9,275	4,981	6,716	6,139	3,165	40,386
C "	183	3,462	1,503	1,926	9,440	5,279	3,396	3,015	1,198	29,402
Total	5,375	9,232	6,780	9,547	30,744	16,428	18,334	15,221	7,959	119,620
PLAN NO. 1										
A mbf	536	854	1,383	1,587	3,938	3,040	1,194	2,847	1,925	17,304
B "	404	648	899	1,984	2,904	2,786	2,108	3,339	2,560	17,632
C "	166	382	468	1,057	2,669	2,368	790	2,191	1,679	11,770
Total	1,106	1,884	2,750	4,628	9,511	8,194	4,092	8,377	6,164	46,706
A cds	3,806	1,868	1,901	1,553	5,182	1,190	7,121	8,861	2,668	34,145
B "	3,183	1,343	1,255	1,752	3,050	1,709	5,219	7,117	2,076	26,704
C "	3,344	2,582	1,402	1,089	3,825	964	2,850	9,612	2,225	27,893
Total	10,333	5,793	4,558	4,394	12,057	3,863	15,190	25,590	6,964	88,742
Man Days										
A md	7,113	4,352	4,289	3,657	11,042	4,867	16,480	17,165	6,189	75,154
B "	5,756	3,301	2,678	4,387	7,458	5,229	12,562	15,006	5,361	61,798
C "	5,531	4,777	2,477	2,474	8,712	3,838	5,545	20,209	4,860	58,423
Total	18,400	12,430	9,444	10,518	27,212	13,934	34,587	52,440	16,410	195,375

Table 7.4

Average Cubic Feet of Standing Timber per Acre of Woodland at the Beginning and End of the 90 Year Planning Period and the Average Number of Board Feet and Cords Harvested and Man Days of Labor Used per Acre During the Period, Under Alternative Management Plans

Plan No.	Av. Cu.Ft. per Wdld Acre at Beginning	Av. No. Bd.Ft. Harvested per Wdld Acre per Year	Av. No. Cds Harvested/ Wdld Acre per Year	Av. No. Man Days Spent per Acre per Year 1/	Av. No. Cu.Ft. per Acre Wdld Left at End
8	1,067	0	0	0	2,500
7	1,067	171	0	0	1,248
6	1,067	177	0	0	2,001
5	1,067	226	0.10	0.5	2,069
4	1,067	171	0.21	0.5	1,248
3	1,067	177	0.20	0.5	2,001
2	1,067	226	0.30	0.7	2,069
1	1,067	273	0.52	1.1	1,678

1/ Power and equipment costs, converted to man-day equivalents, are included.

as long as the relationships between the cost of inputs and the prices of outputs are about correct. A doubling of the general price level, for instance, will have little effect on the relative profitableness of the different plans, except to the extent that interest charges on additional investments do not vary proportionately with other costs. It will be seen later that this factor may be very important during the long planning period. On the other hand, a change in the relative cost of labor and the price of forest products might completely alter the relative returns of the different plans.

For the first analysis it was assumed that the average 1943-45 cost level of productive factors would prevail throughout the planning period. Prices compatible with these costs were also assumed to remain unchanged. In money terms this means a roadside price of eighteen to twenty-one dollars per thousand board feet of sawlogs and nine dollars per rough cord of fuel or pulpwood. Labor costs would be about six dollars per man day, making stumpage prices about six dollars per thousand board feet of sawlogs. These relationships may not prevail, but if they do, even roughly, one analysis shows the resulting net cash incomes and residual values of the different plans.

What happens to the relative returns of different management plans if cost-price relationships become more favorable for sawlog production, as it seems reasonable to assume they may during the 90 year planning period? The price of lumber has been held relatively low for generations during the exploitation of western timber reserves. These trees were grown free of charge, so to speak, and the price of lumber reflects little of the cost of reproduction. Now the world is confronted with

a growing scarcity of timber of sufficient size and quality to make good lumber. Meanwhile, population continues to increase and the demand for lumber for housing and a myriad of other uses increases almost proportionately. So too does the demand for pulp and chemical wood increase, but it will be a great many decades before these products are as scarce as good sawlogs are now or promise to be in the near future. As the demand for sawlogs increases and available supplies decrease[2/] an upward adjustment in their price with respect to the costs involved and the prices of other products may be expected. Competitive products such as bricks, steel, plastics and the like will tend to keep this increase in price within limits, but unless a very large elasticity of substitution for lumber is assumed they will not prevent a substantial rise in log prices.

For the purposes of comparison, another set of budgets has been worked out assuming a conservative increase in the price of sawlogs in relation to other costs and prices. No changes were scheduled to take place during the first thirty years, but during the following thirty years it was assumed that roadside sawlog prices would increase one-third, and during the last thirty years prices would increase again by the same amount. Thus sawlog prices at the end of the period will have risen by two-thirds. This results in the following schedule of prices:

Item	0-30 years	31-60 years	61-90 years
Sawlogs, roadside, per M b.f.	$18-21	$24-27	$30-34
Sawlogs, stumpage, per M b.f.	6	12	18
Fuel and Pulpwood, per rough cord	9	9	9
Labor, per man day	6	6	6

2/ See U. S. Forest Service's Reappraisal of the Forest Situation, reports 1 and 3 for a careful consideration of this problem.

The effect of this new price schedule is to give a greater premium to the production of sawlogs and to increase the comparative value of residual stands containing the largest proportion of sawtimber.

Fixed Costs

In addition to the variable costs just discussed, there are certain other costs that are unchanged by fluctuations in production. For the more intensive plans, 1, 2 and 5, these include charges for the replacement of machinery and equipment, registration and insurance of vehicles, and hired management. Under certain circumstances property taxes may also be considered a fixed cost common to all plans. When this is included the current rate of 46 cents per acre per year is used. It is possible that this amount might be increased as the growing stock improves. If by this process taxes should become too burdensome the owners can probably get relief by classifying their land.3/ It is assumed that the resulting tax will be about equal to the present 46 cent rate. The fixed charges applicable to each plan are shown in Table 7.5.

It is appropriate at this point to inquire what costs should be included in the budgets if they are to provide the most useful basis of judgment in choosing a forest operating plan. Since the owners already have the land and pay its taxes, and from all indications will continue to do so regardless of its productivity, perhaps for the most pertinent comparison budgets should include only the added costs due to the kind of

3/ Under the Massachusetts Forest Tax Law, land used for forestry may be so classified and annual taxes will be charged only on the value of the bare land. A severance tax of 5 percent of the stumpage value will be collected at the time of cutting.

Table 7.5

ANNUAL FIXED CHARGES
USED IN EACH MANAGEMENT PLAN OVER THE 90 YEAR PERIOD

Plan No.	Taxes	Annual Equipment Charges 1/	Additional Management
8	$874.00	$ 0	$ 0
7	"	0	0
6	"	0	0
5	"	400.00	600.00
4	"	0	0
3	"	0	0
2	"	400.00 2/	600.00
1	"	1st 40 yrs. - 600.00 3/ last 50 yrs. - 1060.00	1200.00

1/ Includes $100 for vehicle insurance and registration.
Depreciation provides for equipment being replaced every five years.

2/ Equipment: Power chain-saw and cut-off saw $400
Power Unit (2nd hand light truck) 800
Miscellaneous woods equipment for use of 2-man crew 300
Total... $1500

3/ Equipment: Power chain-saw and cut-off saw.....$400
Light truck or jeep 2500
Miscellaneous woods equipment for use of 3-man crew 600
Total... $3500

Small crawler type tractor and blade..... 3500
(Will not be purchased until after the 1st 40 yrs.)

Total... $7000

management used. Calculations on this basis will provide cost figures showing the amount that any plan will require them to spend, in addition to what they are already willing to pay in the form of taxes.

On the other hand, the owners might consider the possibility of reducing their tax bills by selling the land, or they might look at their land as a forest investment that must pay all its own expenses. In this instance they will wish to compare operating plan budgets that include taxes as an annual expense. Budgets have been made on both bases, one set excluding taxes and another set including taxes as one of the fixed costs of management.

Interest

One additional factor must be introduced before the budgets can be prepared; this is the question of interest. As it will appear later, some of the plans show annual deficits, especially during the first few decades. It is assumed that these initial deficits will be paid as soon as positive income is available.4/ However, the financing of initial deficits will probably require the payment of compound interest. It should be remembered also that equipment and machinery must be purchased at the start and that no income will accrue to make these purchases until after some years have passed. When the cost of equipment is amortised by a regular depreciation fund, interest will accrue on the sums outstanding. If the owners finance annual deficits and investment in equipment with their own money they might be content with a low rate of interest; on the other hand, commercial lenders might require a higher rate. Budgets have been worked out to cover a range of possibilities. The limiting case of a zero rate of interest provides one extreme, a 3 percent rate represents a middle course, while a 6 percent rate indicates the results of a high interest rate.

4/ The occasional deficits calculated for periods after repayment of initial deficits can probably be avoided by minor adjustments in the cutting program.

The effects of the several factors just discussed on the operating plan budgets may be summarized as follows:

1. Four intensities of management and two sets of market conditions have been postulated. These produce eight feasible operating plans.

2. Two sets of cost-price relationships require sixteen budgets, two for each operating plan.

3. Two sets of costs were used, one showing the added costs of management, excluding taxes, the other showing total costs, including taxes. This requires thirty-two budgets, two variations for each of the previous sixteen.

4. Three rates of compound interest on deficits and investment in machinery and equipment were considered, zero, three and six percent. This requires ninety-six budgets, three for each of the previous thirty-two.

These various budgets have been worked out and the results of the calculations are presented in tabular form, showing the average annual net cash income by decades, the total net cash income during the planning period, the increment in value of the residual stand plus the value of any added operating equipment. The total net cash income and the increase in residual value are added to make up the total net return of each plan.

Plan No.	NET INCOME BY TEN YEAR PERIODS 0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	Total Net Cash Income For Period	Increase in Residual Value	Total Net Return For Period
A. Average Annual Net Income, assuming constant prices												
8	$ ---	$ ---	$ ---	$ ---	$ ---	$ ---	$ ---	$ ---	$ ---	$ ---	$ 41,750	$ 41,750
7	268	---	1,642	378	7,120	---	2,757	3,232	2,181	175,780	3,041	178,821
6	31	57	946	1,952	4,975	1,902	2,114	4,146	2,078	182,010	29,655	211,665
5	-1,119	-2,120	552	3,471	6,538	6,378	3,729	10,471	4,358	322,560	37,315	359,875
4	535	178	3,125	802	13,235	28	6,190	6,656	4,562	353,110	3,041	356,151
3	61	293	1,815	3,879	9,467	3,622	4,818	9,220	3,109	362,840	29,655	392,495
2	-1,084	-1,838	990	4,502	9,614	8,037	3,907	10,606	4,580	393,140	37,315	430,455
1	-1,872	-1,488	1,513	4,736	11,887	10,063	-748	6,898	7,105	380,940	55,285	436,225
Average Annual Net Income, assuming rising sawlog prices												
8	---	---	---	---	---	---	---	---	---	---	125,238	125,238
7	268	---	1,642	756	14,242	---	8,272	9,698	6,542	414,200	9,123	423,323
6	31	57	946	3,905	9,950	3,803	6,344	12,441	6,233	437,100	88,965	526,065
5	-1,119	-2,120	552	6,473	11,859	8,392	9,466	21,192	9,672	643,650	108,945	752,595
4	535	178	3,125	1,180	20,357	28	11,705	13,121	8,924	591,530	9,123	600,653
3	61	293	1,815	5,832	14,443	5,524	9,048	17,514	7,265	617,950	88,965	706,915
2	-1,084	-1,838	990	7,427	14,935	10,051	9,645	21,326	9,894	713,460	108,945	822,405
1	-1,872	-1,488	1,513	7,998	18,544	15,799	4,980	18,626	15,735	798,350	151,855	950,205
B. Cumulative Net Income at end of each Decade, assuming constant prices												
8	---	---	---	---	---	---	---	---	---	---	---	---
7	2,680	2,680	19,100	28,880	94,080	94,080	121,650	153,970	175,780	---	---	---
6	310	880	10,340	29,860	79,610	79,610	119,770	161,230	182,010	---	---	---
5	-11,190	-32,390	-26,890	7,820	73,200	136,980	174,270	278,980	322,560	---	---	---
4	5,350	7,130	38,380	46,400	178,750	179,030	240,930	307,490	353,110	---	---	---
3	610	3,540	21,690	60,480	155,150	191,370	239,550	331,750	362,840	---	---	---
2	-10,840	-29,220	-19,320	25,700	121,840	202,210	241,280	347,340	393,140	---	---	---
1	-18,720	-33,600	-18,470	28,890	147,760	248,390	240,910	309,890	380,940	---	---	---
Cumulative Net Income at end of each Decade, assuming rising sawlog prices												
8	---	---	---	---	---	---	---	---	---	---	---	---
7	2,680	2,680	19,100	26,660	169,080	169,080	251,800	348,780	414,200	---	---	---
6	310	880	10,340	49,390	148,890	186,920	250,360	374,770	437,100	---	---	---
5	-11,190	-32,390	-26,890	37,840	156,430	240,350	335,010	546,930	643,650	---	---	---
4	5,350	7,130	38,380	50,180	253,750	254,030	371,080	502,290	591,530	---	---	---
3	610	3,540	21,690	80,010	224,440	279,680	370,160	545,300	617,950	---	---	---
2	-10,840	-29,220	-19,320	54,950	204,300	304,810	401,260	614,520	713,460	---	---	---
1	-18,720	-33,600	-18,470	61,510	246,950	404,940	454,780	641,000	798,350	---	---	---

Table 7.7

NET CASH INCOME BY DECADES AND FOR 90 YEAR PERIOD; INCREASE IN RESIDUAL VALUE AND TOTAL NET RETURN FROM ALTERNATIVE MANAGEMENT PLANS - TAXES NOT INCLUDED IN EXPENSE AND 3% INTEREST COMPOUNDED ON DEFICITS

Table 7.8

NET CASH INCOME BY DECADES AND FOR 90 YEAR PERIOD; INCREASE IN RESIDUAL VALUE AND TOTAL NET RETURN FROM ALTERNATIVE MANAGEMENT PLANS - TAXES NOT INCLUDED IN EXPENSE AND 6% INTEREST COMPOUNDED ON DEFICITS

Plan No.	NET INCOME BY TEN-YEAR PERIODS 0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	Total Net Cash Income For Period	Increase in Residual Value	Total Net Return For Period
A. Average Annual Net Income, assuming constant prices												
8	$ ---	$ ---	$ ---	$ ---	$ ---	$ ---	$ ---	$ ---	$ ---	$ ---	$ 41,750	$ 41,750
7	268	---	1,642	378	7,120	---	2,757	3,232	2,181	175,780	3,041	178,821
6	31	57	946	1,952	4,975	1,902	2,114	4,146	2,078	182,010	29,655	211,665
5	-1,286	-3,012	-1,483	741	4,692	6,096	3,729	10,471	4,358	243,060	37,315	280,375
4	535	178	3,125	802	13,235	28	6,190	6,656	4,562	353,110	3,041	356,151
3	61	293	1,815	3,879	9,467	3,622	4,818	9,220	3,109	362,840	29,655	392,495
2	-1,247	-2,669	-802	2,696	8,967	8,037	3,907	10,606	4,518	340,130	37,315	377,445
1	-2,152	-2,673	-747	2,816	10,171	10,063	-748	6,898	7,105	307,330	55,285	362,615
Average Annual Net Income, assuming rising sawlog prices												
8	---	---	---	---	---	---	---	---	---	---	125,238	125,238
7	268	---	1,642	756	14,242	---	8,272	9,698	6,542	414,200	9,123	423,323
6	31	57	946	3,905	9,950	3,803	6,344	12,441	6,233	437,100	88,965	526,065
5	-1,286	-3,012	-1,483	4,529	11,361	8,392	9,466	21,192	9,672	588,310	108,945	697,255
4	535	178	3,125	1,180	20,357	28	11,705	13,121	8,924	591,530	9,123	600,653
3	61	293	1,815	5,832	14,443	5,524	9,048	17,514	7,265	617,950	88,965	706,915
2	-1,247	-2,669	-802	6,241	14,935	10,051	9,645	21,326	9,894	673,740	108,945	782,685
1	-2,152	-2,673	-747	6,550	18,194	15,799	4,980	18,626	15,735	743,120	151,855	894,975
B. Cumulative Net Income at end of each Decade, assuming constant prices												
8	---	---	---	---	---	---	---	---	---	---	---	---
7	2,680	2,680	19,100	22,880	94,080	94,080	121,650	153,970	175,780	---	---	---
6	310	880	10,340	29,860	79,610	98,630	119,770	161,230	182,010	---	---	---
5	-12,860	-42,980	-57,810	-50,400	-3,480	57,480	94,770	199,480	243,060	---	---	---
4	5,350	7,130	38,380	46,400	178,750	179,030	240,930	307,490	353,110	---	---	---
3	610	3,540	21,690	60,480	155,150	191,370	239,550	331,750	362,840	---	---	---
2	-12,470	-39,160	-47,180	-20,220	69,450	149,820	188,890	294,950	340,130	---	---	---
1	-21,520	-48,250	-55,720	-27,560	74,150	174,780	167,300	236,280	307,330	---	---	---
Cumulative Net Income at end of each Decade, assuming rising sawlog prices												
8	---	---	---	---	---	---	---	---	---	---	---	---
7	2,680	2,680	19,100	26,660	169,080	169,080	251,800	348,780	414,200	---	---	---
6	310	880	10,340	49,390	148,890	186,920	250,360	374,770	437,100	---	---	---
5	-12,860	-42,980	-57,810	-12,520	101,090	186,010	279,670	491,590	588,310	---	---	---
4	5,350	7,130	38,380	50,180	253,750	254,030	371,080	502,290	591,530	---	---	---
3	610	3,540	21,690	80,010	224,440	279,680	370,160	545,300	617,950	---	---	---
2	-12,470	-39,160	-47,180	15,230	164,580	265,090	361,540	574,800	673,740	---	---	---
1	-21,520	-48,250	-55,720	9,780	191,720	349,710	399,510	585,770	743,120	---	---	---

Table 7.9

NET CASH INCOME BY DECADES AND FOR 90 YEAR PERIOD; INCREASE IN RESIDUAL VALUE AND TOTAL NET RETURN FROM ALTERNATIVE MANAGEMENT PLANS - TAXES INCLUDED IN EXPENSE AND NO INTREST CHARGED ON DEFICITS

Plan No.	NET INCOME BY TEN-YEAR PERIODS 0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	Total Net Cash Income For Period	Increase in Residual Value	Total Net Return For Period
A. Average Annual Net Incomes, assuming constant prices												
8	$ -874	$ -874	$ -874	$ -874	$ -874	$ -874	$ -874	$ -874	$ -874	$-78,660	$ 41,750	$-36,910
7	-606	-874	768	-496	6,246	-874	1,883	2,358	1,307	97,120	3,041	100,161
6	-843	-817	72	1,078	4,101	1,028	1,240	3,272	1,204	103,350	29,655	133,005
5	-1,827	-2,365	602	3,178	5,514	5,504	2,855	9,597	3,484	265,420	37,315	302,735
4	-339	-696	2,251	-72	12,361	-846	5,316	5,782	3,688	274,450	3,041	277,491
3	-813	-581	941	3,005	8,593	2,748	3,944	8,346	2,235	284,180	29,655	313,845
2	-1,797	-2,129	889	3,874	8,740	7,163	3,033	9,732	3,706	332,110	37,315	369,425
1	-2,424	-1,528	1,536	4,238	11,013	9,189	-1,622	6,024	6,231	327,570	55,285	382,855
Average Annual Net Income, assuming rising sawlog prices												
8	-874	-874	-874	-874	-874	-874	-874	-874	-874	-78,660	125,238	46,578
7	-606	-874	768	-118	13,368	-874	7,398	8,824	5,668	335,540	9,123	344,663
6	-843	-817	72	3,031	9,076	2,929	5,470	11,567	5,359	358,440	88,965	447,405
5	-1,827	-2,365	602	5,902	10,985	7,518	8,592	20,318	8,798	585,230	108,945	694,175
4	-339	-696	2,251	306	19,483	-846	10,831	12,247	8,050	512,870	9,123	521,993
3	-813	-581	941	4,958	13,569	4,650	8,174	16,640	6,391	539,290	88,965	628,255
2	-1,797	-2,129	889	6,748	14,061	9,177	8,771	20,452	9,020	651,920	108,945	760,865
1	-2,424	-1,528	1,536	7,578	17,670	14,925	4,106	17,752	14,861	744,760	151,855	896,615
B. Cumulative Net Income at end of each Decade, assuming constant prices												
8	-8,740	-17,480	-26,220	-34,960	-43,700	-52,440	-61,180	-69,920	-78,660	---	---	---
7	-6,060	-14,800	-7,120	-12,080	50,380	41,640	60,470	84,050	97,120	---	---	---
6	-8,430	-16,600	-15,880	-5,100	35,910	46,190	58,590	91,310	103,350	---	---	---
5	-18,270	-41,920	-35,900	-4,120	51,020	106,060	134,610	230,580	265,420	---	---	---
4	-3,390	-10,350	-12,160	11,440	135,050	126,590	179,750	237,570	274,450	---	---	---
3	-8,130	-13,940	-4,530	25,520	111,450	138,930	178,370	261,830	284,180	---	---	---
2	-17,970	-39,260	-30,370	8,370	95,770	167,400	197,730	295,050	332,110	---	---	---
1	-24,240	-39,520	-24,160	19,220	129,350	221,240	205,020	265,260	327,570	---	---	---
Cumulative Net Income at end of each Decade, assuming rising sawlog prices												
8	-8,740	-17,480	-26,220	-34,960	-43,700	-52,440	-61,180	-69,920	-78,660	---	---	---
7	-6,060	-14,800	-7,120	-8,300	125,380	116,640	190,620	278,860	335,540	---	---	---
6	-8,430	-16,600	-15,880	14,430	105,190	134,480	189,180	304,850	358,440	---	---	---
5	-18,270	-41,920	-35,900	23,120	132,970	208,550	294,070	497,250	585,230	---	---	---
4	-3,390	-10,350	12,160	15,220	210,050	201,590	309,900	432,370	512,870	---	---	---
3	-8,130	-13,940	-4,530	45,050	180,740	227,240	308,980	475,380	539,290	---	---	---
2	-17,970	-39,260	-30,370	37,110	177,720	269,490	357,370	561,720	651,920	---	---	---
1	-24,240	-39,520	-24,160	51,620	228,320	377,570	418,630	596,150	744,760	---	---	---

Table 7.10

NET CASH INCOME BY DECADES AND FOR 90 YEAR PERIOD; INCREASE IN RESIDUAL VALUE AND TOTAL NET RETURN FROM ALTERNATIVE MANAGEMENT PLANS - TAXES INCLUDED IN EXPENSE AND 3% INTEREST COMPOUNDED ON DEFICITS

Plan No.	NET INCOME BY TEN-YEAR PERIODS 0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	Total Net Cash Income For Period	Increase in Total Net Residual Value	Return For Period
A. Average Annual Net Income, assuming constant prices												
8	$-1,002	$-1,347	$-1,810	$-2,432	$-3,268	$-4,392	$-5,903	$-7,933	$-10,662	$-387,490	$ 41,750	$-345,740
7	-695	-1,241	215	-1,161	5,980	-874	1,883	2,358	1,307	77,720	3,041	80,761
6	-966	-1,269	-686	231	3,749	1,028	1,240	3,272	1,204	78,030	29,655	107,685
5	-2,121	-3,466	-1,257	1,264	4,539	4,709	2,855	9,597	3,484	196,040	37,315	233,355
4	-389	-931	2,322	-72	12,361	-846	5,316	5,782	3,688	272,310	3,041	275,351
3	-932	-987	419	2,859	8,593	2,748	3,944	8,346	2,235	272,250	29,655	301,905
2	-2,086	-3,184	-819	2,493	6,758	7,163	3,033	9,732	3,706	267,960	37,315	305,275
1	-2,874	-2,834	-297	3,214	9,943	9,189	-1,622	6,024	6,231	269,790	55,285	325,026
Average Annual Net Income, assuming rising sawlog prices												
8	-1,002	-1,347	-1,810	-2,432	-3,268	-4,392	-5,903	-7,933	-10,662	-387,490	69,305	-316,185
7	-695	-1,241	215	-727	13,259	-874	7,398	8,824	5,668	318,270	9,123	327,393
6	-966	-1,269	-686	2,470	9,062	2,929	5,470	11,567	5,359	339,360	88,965	428,325
5	-2,121	-3,466	-1,257	4,558	10,485	7,518	8,592	20,318	8,798	534,250	108,945	643,195
4	-389	-931	2,322	31	19,483	-846	10,831	12,247	8,050	507,980	9,123	517,103
3	-932	-987	419	4,864	13,569	4,650	8,174	16,640	6,391	527,880	88,965	616,845
2	-2,086	-3,184	-819	5,788	13,737	9,177	8,771	20,452	9,020	608,560	108,945	717,505
1	-2,874	-2,834	-297	6,296	17,670	14,925	4,106	17,752	14,861	695,600	151,855	847,455
B. Cumulative Net Income at end of each Decade, assuming constant prices												
8	-10,020	-23,490	-41,590	-65,910	-98,590	-142,510	-201,540	-280,870	-387,490			
7	-6,950	-19,360	-17,210	-28,820	30,980	22,240	41,070	64,650	77,720			
6	-9,660	-22,350	-29,210	-26,900	10,590	20,870	33,270	65,990	78,030			
5	-21,210	-55,870	-68,440	-55,800	-10,410	36,680	65,230	161,200	196,040			
4	-3,890	-13,200	10,020	9,300	132,910	124,450	177,610	235,430	272,310			
3	-9,320	-19,190	-15,000	13,590	99,520	127,000	166,440	249,900	272,250			
2	-20,860	-52,700	-60,890	-35,960	31,620	103,250	133,580	230,900	267,960			
1	-28,740	-57,080	-60,050	-27,910	71,520	163,410	147,190	207,430	269,740			
Cumulative Net Income at end of each Decade, assuming rising sawlog prices												
8	-10,020	-23,490	-41,590	-65,910	-98,590	-142,510	-201,540	-280,870	-387,490			
7	-6,950	-19,360	-17,210	-24,480	108,110	99,370	173,350	261,590	318,270			
6	-9,660	-22,350	-29,210	-4,510	86,110	115,400	170,100	285,770	339,360			
5	-21,210	-55,870	-68,440	-22,860	81,990	157,170	243,090	446,270	534,250			
4	-3,890	-13,200	10,020	10,330	205,160	196,700	305,010	427,480	507,980			
3	-9,320	-19,190	-15,000	33,640	169,330	215,830	297,570	463,970	527,880			
2	-20,860	-52,700	-60,890	-3,010	134,360	226,130	313,840	518,360	608,560			
1	-28,740	-57,080	-60,050	2,460	173,160	328,410	389,470	546,990	695,600			

Table 7.11

NET CASH INCOME BY DECADES AND FOR 90 YEAR PERIOD; INCREASE IN RESIDUAL VALUE AND TOTAL NET RETURN FROM ALTERNATIVE MANAGEMENT PLANS - TAXES INCLUDED IN EXPENSE AND 6% INTEREST COMPOUNDED ON DEFICITS

Plan No.	NET INCOME BY TEN-YEAR PERIODS 0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	Total Net Cash Income For Period	Increase in Total Net Residual Value	Return For Period
A. Average Annual Net Income, assuming constant prices												
8	$-1,152	$-2,063	$-3,695	$-6,616	$-11,849	$-21,220	$-38,001	$-68,056	$-121,881	$-2,745,330	$ 41,750	$-2,730,580
7	-799	-1,784	-1,030	-3,510	2,837	-4,540	-4,497	-7,427	-14,686	-354,360	3,041	-351,319
6	-1,111	-1,956	-2,330	-2,847	-1,114	-6,045	-10,546	-16,208	-31,752	-739,090	29,655	-709,435
5	-2,438	-5,075	-5,177	-5,875	-7,245	-13,812	-27,109	-39,653	-79,068	-1,848,220	37,315	-1,810,905
4	-447	-1,271	1,609	-181	12,344	-846	5,316	5,782	3,688	259,940	3,041	262,981
3	-1,072	-1,613	-833	1,140	8,287	2,748	3,944	8,346	2,235	231,320	29,655	260,975
2	-2,399	-4,732	-4,497	-3,920	-805	-3,516	-11,752	-12,209	-29,807	736,370	37,315	-699,055
1	-3,304	-4,736	-4,442	-3,800	1,739	248	-13,802	-14,641	-25,946	-686,840	55,285	-631,555
Average Annual Net Income, assuming rising sawlog prices												
8	-1,152	-2,063	-3,695	-6,616	-11,849	-21,220	-38,001	-68,056	121,881	-2,745,330	125,238	-2,620,092
7	-799	-1,784	-1,030	-3,008	11,901	-874	7,398	8,824	5,668	262,960	9,123	272,083
6	-1,111	-1,956	-2,330	-273	7,432	2,929	5,470	11,567	5,359	270,870	88,965	359,835
5	-2,438	-5,075	-5,177	-2,087	2,764	-1,989	215	14,976	8,798	99,870	108,945	208,815
4	-447	-1,271	1,609	292	19,483	-846	10,831	12,247	8,050	499,480	9,123	508,603
3	-1,072	-1,613	-833	3,714	13,569	4,650	8,174	16,640	6,391	495,700	88,965	584,665
2	-2,399	-4,732	-4,497	-132	9,204	8,194	8,771	20,452	9,020	438,810	108,945	547,755
1	-3,304	-4,736	-4,442	470	13,389	14,925	4,106	17,775	14,861	530,440	151,855	682,295
B. Cumulative Net Income at end of each Decade, assuming constant prices												
8	-11,520	-32,150	-69,100	-135,260	-253,750	-465,950	-845,960	-1,526,520	-2,745,330			
7	-7,990	-25,830	-36,130	-71,230	-42,860	-88,260	-133,230	-207,500	-354,360			
6	-11,110	-30,670	-53,970	-82,440	-93,580	-154,030	-259,490	-421,570	-739,090			
5	-24,380	-75,130	-126,900	-185,650	-258,100	-389,920	-661,010	-1,057,540	-1,848,220			
4	-4,470	-17,180	-1,090	-2,900	120,540	112,080	165,240	223,061	259,940			
3	-10,720	-26,850	-35,680	-24,280	58,590	86,070	125,510	208,970	231,320			
2	-23,990	-71,310	-116,280	-155,480	-163,530	-198,690	-316,210	-438,300	-736,370			
1	-33,040	-80,400	-124,820	-162,820	-145,430	-142,950	-280,970	-427,380	-686,840			
Cumulative Net Income at end of each Decade, assuming rising sawlog prices												
8	-11,520	-32,150	-69,100	-135,260	-253,750	-465,950	-845,960	-1,526,520	-2,745,330			
7	-7,990	-25,830	-36,130	-66,210	52,800	44,060	118,040	206,280	262,960			
6	-11,110	-30,670	-53,970	-56,700	17,620	46,910	101,610	217,280	270,870			
5	-24,380	-75,130	-126,900	-147,770	-120,130	-140,020	-137,870	11,890	99,870			
4	-4,470	-17,180	-1,090	1,830	196,660	188,200	296,510	418,980	499,480			
3	-10,720	-26,850	-35,680	1,460	137,150	183,650	265,390	431,790	495,700			
2	-23,990	-71,310	-116,280	-117,600	-25,560	56,380	144,090	348,610	438,810			
1	-33,040	-80,400	-124,820	-120,120	13,770	163,020	204,080	381,830	530,440			

Table 7.12

TOTAL NET RETURN DURING 90 YEAR PERIOD FROM ALTERNATIVE MANAGEMENT PLANS, WITH INTEREST ON DEFICITS COMPOUNDED AT SPECIFIED RATES[1]

Plan Number	Total Net Returns with Taxes Not Included as an Expense and Interest on Deficits at the Given Rate			Total Net Returns with Taxes Included as an Expense and Interest on Deficits at the Given Rate		
	No Interest	3 percent	6 percent	No interest	3 percent	6 percent
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
	Assuming Constant Prices					
8	41,750	41,750	41,750	-36,010	-345,746	-2,730,580
7	178,821	178,821	178,821	100,161	60,761	-351,319
6	211,665	211,665	211,665	153,006	107,685	-709,435
5	381,395	359,875	280,575	302,735	238,855	-1,610,905
4	356,151	356,151	356,151	277,491	275,351	262,981
3	392,495	392,495	392,495	313,845	301,905	260,975
2	448,085	430,455	377,445	369,425	305,275	-699,055
1	461,515	436,225	362,619	382,855	325,025	-651,555
	Assuming Rising Sawlog Prices					
8	125,238	125,238	125,238	46,578	-318,185	-2,620,092
7	423,323	423,323	423,323	344,663	327,393	272,083
6	526,065	526,065	526,065	447,405	428,325	359,835
5	772,635	752,595	697,255	694,175	648,195	298,815
4	600,653	600,653	600,653	521,993	517,103	508,603
3	706,915	706,915	706,915	628,255	616,845	584,665
2	839,525	822,405	782,685	760,865	717,505	547,755
1	975,275	950,205	894,975	896,615	847,455	682,295

1. Early deficits and compound interest were assumed to be repaid from positive net income of subsequent years. Increased value of residual stand and operating equipment plus net incomes, constitute Net Return.

Tables 7.6, 7.7 and 7.8 present this data when taxes are excluded from costs and interest is at the specified rate. Tables 7.9, 7.10 and 7.11 present the same information when taxes are included in costs. The total net returns of the various budgets during the 90 year period are shown in Table 7.12.

All of these figures show the income and net return accruing from the entire 1900 acres of woodland. Although the share due each owner isn't indicated, it would be roughly proportionate to his land acreage. These data present a confusing array and probably their meaning can be understood best if they are interpreted from the viewpoint of an owner, operating under the different conditions postulated.

Comparison of the Income and Return of Alternative Operating Plans

Budgets Excluding Taxes

If the owners will continue to hold their land and pay taxes regardless of the returns from the forests, then comparison of budgets including only the added costs of different operating plans is relevant. Most farm and many non-farm, small owners will find budgets of this kind helpful in reaching management decisions. The following conclusions can be drawn from Tables 7.6, 7.7 and 7.8 and from columns 2, 3 and 4 of Table 7.12.

The first and most obvious conclusion is that any sort of cutting program will yield greater returns than plan 8, which contemplates letting the trees grow undisturbed and unharvested. As would be expected, the customary harvesting methods used in plans 4 and 7 yield the greatest income during the early years only to fall behind the other plans after a few decades. Rising prices, it will be noted, considerably increase

the returns from all plans but favor those that produce the greatest amount of good quality sawlogs.

An owner operating with limited markets, similar to the present ones, can increase his total net return in the long-run if he uses the better harvesting practices of plan 6 rather than the customary ones of plan 7. If sawlog prices go up he stands to make an additional gain. The same is true if unlimited markets should develop, only the gains will be greater. All of these gains can be made without changing the present pattern of separate operating units.

If the owners want returns greater than those possible from plans 3 or 6 they must work out a program of cooperative action that will make one of the operating plans using more intensive management possible. Any of these will involve making some investment for 20 or 30 years in machinery, labor and management while the growing stock is being built up to yield positive net incomes. The amount of this investment depends to some extent on the rate of interest paid for financing. It will also take longer to pay off these debts at higher rates of interest; under the most favorable circumstances about 30 years will be required while under the least favorable circumstances 40 to 50 years will be needed. However, it is clear that some long-run gains can be made by using plan 5, under limited marketing conditions, even if interest is at 6 percent. If unlimited cordwood markets should develop then it will pay to expand the area under management intensity A to include all stands, as in plan 1. The one exception to this situation is when prices remain constant and high interest must be paid. In this instance cooperative action is really not needed since plan 3 gives the greatest return in the long-run.

Budgets Including Taxes

Budgets that include all of the cash costs of the forest enterprise would be relevant if the owners considered buying the forest land and wanted to calculate the returns left to pay for risk, profit and interest on the investment in land and growing stock. This figure might also be compared to the probable returns if it were possible to sell the present holdings and reinvest the money in some other enterprise. Tables 7.9, 7.10 and 7.11 and columns 5, 6 and 7 of Table 7.12 present the results of these budgets.

It is apparent that all of the incomes and net returns are lower than those of the previous budgets by at least the amount of taxes. This is exactly true if no interest is paid on deficits or on machinery investment. However, since none of the plans produce enough income to cover costs during the first few decades the rate of interest paid will affect the returns considerably. Again it seems that any sort of active forest management yields higher long-run returns than plan 8. In fact, only under the most favorable conditions of no interest and rising prices can this plan avoid large losses.

As before, an owner operating alone can gain the most by using improved cutting practices rather than the customary clear-cutting and high-grading. This is true regardless of market outlets, with one exception. If interest charges are high and prices remain constant, then plans 4 or 7 making the quickest returns will yield somewhat larger net returns in the long-run. It is interesting to note that with limited markets and high interest all plans show negative net returns.

If the owners should decide to cooperate in order to practice more

intensive management they would find it to their advantage when markets are limited, unless interest rates are high. With unlimited markets the greater management intensity of plan 1 would also yield the greatest net return in the long-run, except when high interest is paid. Rising prices, however, place plan 1 ahead of the others despite the cost of 6 percent interest.

Present Worth of the Returns of Alternative Operating Plans

For simplicity of exposition it is perhaps unfortunate that people usually have some sort of time preference schedule that they use in considering the desirability of future income. The prospect of receiving money at increasingly distant dates may hold a diminishing attraction for them. It is possible to approximate the effect of this time preference by reducing future incomes and residual values to their present worth. The results of applying a uniform 3 percent compound discount rate to these budget values are shown in Table 7.13. It should be remembered that the discounting process increases the relative importance of early income or investment and greatly diminishes the value of later income, thus placing a heavy burden on the more intensive types of management that call for initial sacrifices in order to build up later returns.

Present Worth of Budgets Excluding Taxes

If the owners operate independently, the order of preference among different plans is not greatly changed by reducing the net returns to their present worth. Plans using better harvesting practices are still more attractive than those using customary methods, although the amount of gain is considerably reduced. But if the owners cooperate to use more

Table 7.13

PRESENT WORTH OF NET RETURNS DURING THE 90 YEAR PERIOD FROM ALTERNATIVE MANAGEMENT PLANS WITH INTEREST ON DEFICITS COMPOUNDED AT SPECIFIED RATES -- DISCOUNT RATE 3 PER CENT 1/

Plan Number	Present Worth of Total Net Returns with Taxes Not Included as an Expense and Interest on Deficits at the Given Rate			Present Worth of Total Net Return with Taxes Included as an Expense and Interest on Deficits at the Given Rate		
	No Interest	3 Percent	6 percent	No interest	3 percent	6 percent
	Assuming Constant Prices					
8	2,918	2,918	2,918	-24,179	-74,009	-320,210
7	24,854	24,854	24,854	12,331	3,597	-62,728
6	38,573	38,573	38,573	12,635	1,447	-118,692
5	55,338	34,095	12,425	26,394	-681	-285,260
4	68,816	68,816	68,816	50,646	49,264	42,815
3	73,108	73,108	73,108	50,770	44,199	26,040
2	78,319	63,730	40,562	46,224	18,956	-145,918
1	78,657	64,956	33,137	51,808	24,374	-140,244
	Assuming Rising Sawlog Prices					
8	8,754	8,754	8,754	-18,343	-68,173	-236,722
7	73,334	73,334	73,334	61,987	41,001	21,248
6	84,793	84,793	84,793	58,924	49,442	22,177
5	112,399	101,804	76,772	85,345	61,037	-50,123
4	107,641	107,641	107,641	89,673	87,125	82,021
3	119,224	119,224	119,224	95,886	86,540	75,139
2	130,379	120,968	101,538	103,283	81,832	17,391
1	155,213	139,589	118,001	126,365	99,288	35,085

1/ Early deficits and compound interest were assumed to be repaid from positive net income of subsequent years. Present worth of net incomes and of increased value of residual stand and operating equipment is included in the above.

intensive management the picture is changed considerably. If prices are constant, plans 1 and 5 have the greatest present worth only with a zero rate of interest on added investment. If prices rise, however, these plans are most attractive even when the interest rates charged on added investment are as high as 3 percent.

Present Worth of Budgets Including Taxes

If the owners act separately and prices are constant, the present worth of plans using better harvesting practices is about the same as that of the ones using customary methods only when interest on investments is at a zero rate. At higher rates of interest the value of the earlier returns of plans 4 and 7 offsets the later benefits of plans 3 and 6. If prices rise, however, the above is true only when markets are unlimited.

The owners can gain by cooperating in more intensive management when prices are constant only if interest on added investment is at a zero rate. If prices rise, however, plans 1 and 5 have the greatest present worth as long as such interest is 3 percent or less.

It is apparent that when this rough allowance is made for time preference, the relative value of the different plans is drastically affected by the rate of interest charged on added investment in equipment and deficits. The present worth of plans using better harvesting practices is still more attractive than that of less intensive plans, by a modest margin, except when taxes are included as an expense and interest rates are high. There is some incentive to undertake more intensive management practices when interest on added investment is zero or if it is anticipated that sawlog prices will rise and interest paid is at a low or moderate rate.

Other Considerations

There are several other problems that have not been discussed thus far. Among these is the one presented in actually organizing the forest enterprise for production. In reality, this area is not truly a 1900 acre unit, but only three individual adjacent ownerships, each a little over 600 acres. How does this affect the plans which have been analysed? It is obvious that it makes little difference to plans 4, 7 and 8 whether the owners act separately or together. Little could be gained by integration save in tempting a timber buyer to purchase a small stand in conjunction with the purchase of a neighbor's larger stand. Plans 6 and 3 are essentially similar to plans 7 and 4 with respect to operating the stands. There would, however, be sizable benefits from integration and coordination in getting management and market assistance and in jointly supporting an operator willing to cut stands in such a way as to promote valuable reproduction.

Plans 1, 2 and 5 depend on integration of the holdings for their success. Of course, this type of management could be carried out by one owner alone, but the difficulties and costs would be much greater than those included in the analysis. Marketing, management, labor and equipment can all be used more effectively on the larger unit. The labor requirements and product sales of a single holding would be quite erratic, but these inequalities tend to smooth out when the 1900 acres are worked as a whole.

However, the implication of the analysis is very strong that even this unit would not be of optimum size. Returns from these 1900 acres of poorly-stocked, young woodlands will not justify the full time of a

professional manager even under the more intensive management plans. Unless a competent man can be hired on a part-time basis, none of the plans is feasible. There is also reason to believe that the equipment needed for intensive management will not always be used to full capacity, especially during the first few decades. Only the most intensive plan, number 1, promises enough returns under some conditions to support a tractor, and then only after about forty years. While these 1900 acres constitute a conceivable and workable operating unit, the indications are that about five thousand acres of this land would make a better unit. If the owners decide to take joint action it would be advisable to explore the ways and means of expanding the area to be placed under one management.

There are still other difficulties connected with the operation of the properties as an integrated unit since many if not most of the net returns from more intensive management occur some years in the future. There must be some assurance that the three holdings can be worked together long enough for these benefits to accrue, or at least that the other owners will be compensated if one dies, withdraws or sells out. Similarly, there must be guarantees that management decisions will be followed by all the owners. Many of the costs of the integrated unit will be joint costs, and at least some of the returns should be joint returns; some way of handling their apportionment must be worked out.

These difficulties are not insurmountable. A legally binding cooperative agreement might be written, or the land might be exchanged for stock in a forest land holding and operating company. Or it might be operated on a contract basis with some outside agency such as the New England Forestry Foundation, the joint costs being split up on a service

basis. However, the ownership motives of the people involved are widely divergent and each of the suggested solutions to this problem presents its own special difficulties. These can only be worked out by the individual owners.

Another very important consideration brought out by the analysis is the fact that none of the plans promise enough income to cover taxes and other costs during the next thirty years, while the more intensive plans call for considerable early additional investment. This naturally follows from the fact that the growing stock is predominantly young. In the present instance this timing of investment and returns can have considerable effect on the desirability of each plan to the different owners. There is a large disparity among the incomes and ownership motives of the people involved. While Mr. A and Mr. C, who both have outside incomes, might agree on a management plan and business organization for their holdings, it is doubtful that Mr. B could go along with any scheme requiring additional early investment in the form of cash outlays, regardless of how attractive future returns might seem. Of course, this does not preclude some arrangement allowing Mr. B to contribute his share of the investment in the form of labor, equipment and supervision.

There are possible alternatives for utilizing these woodlands that have not been fully investigated. For instance, Mr. B might well explore the possibilities of building his farm up to a two man dairy-forestry enterprise. Such a project quite conceivably might offer him better returns than any of the plans so far analysed. There is still another enterprise that has not been considered, that of a use for

Mr. C's pond. With a good supply of water it might be possible to build up a commercial fish hatchery and game fishing preserve to a point of making profitable returns. For that matter, the wildlife potentialities of the whole area might advantageously be developed. Such an enterprise might provide enough extra work to utilize the full time of a trained forester. In this profession it is quite possible to hire a man well trained in both forestry and wildlife management.

In a like manner, the possibilities of adding a sawmill business to the woods operation should be explored. This would be another way of profitably using the full-time services of a manager and also of the crew and equipment needed for intensive forestry. However, this type of business is highly specialized and difficult to operate successfully, and losses might easily offset the possible gains.

In this discussion no more than an outline of the possibilities available to the owners has been presented. There is, obviously, no "best plan" in the simple sense. There are several alternatives, each one with its separate problems. Some of these plans offer long-range returns with very little effort on the part of the owner. Other plans with more financial promise under some conditions, require considerable outlays and risks and also require giving up to some degree the owner's "rights." Whether the probable added returns are sufficiently great to stimulate the owners to work out the operating methods and institutional arrangements necessary to adopt one of these more promising plans remains to be seen.

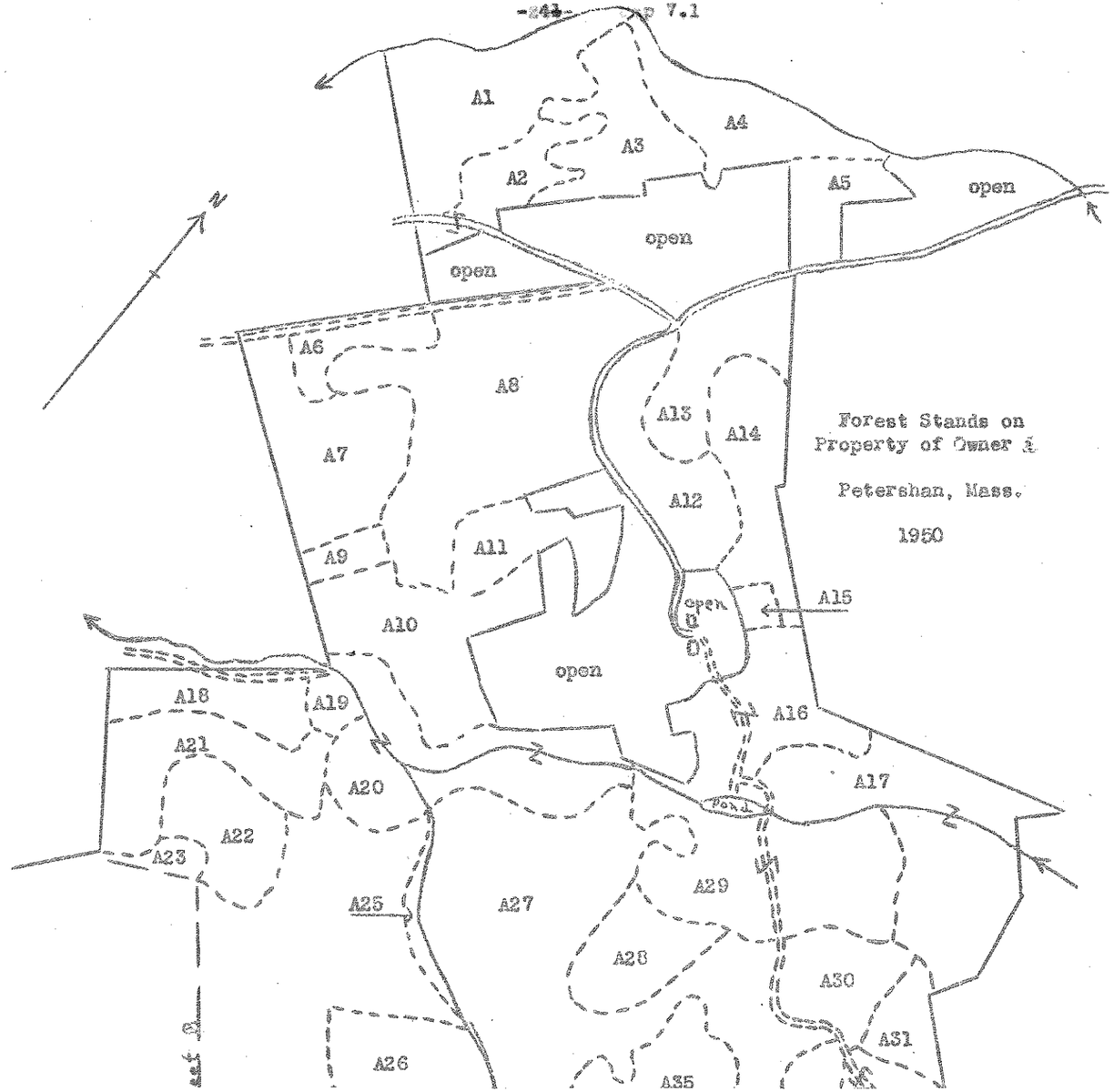
Table 7.14

ACREAGE IN EACH FOREST STAND, BY OWNER; AND ACREAGE OF EACH STAND HANDLED UNDER MANAGEMENT INTENSITY A OR B IN PLANS 5 AND 2

OWNER A				OWNER B				OWNER C			
Stand No.	Total Acres	Management Intensity A	Management Intensity B	Stand No.	Total Acres	Management Intensity A	Management Intensity B	Stand No.	Total Acres	Management Intensity A	Management Intensity B
A 1	20	-	20	B 1	3	3	-	C 1	4	-	4
A 2	9	9	-	B 2	53	-	53	C 2	8	-	8
A 3	12	-	12	B 3	15	15	-	C 3	69	55	14
A 4	12	12	-	B 4	90	45	45	C 4	12	12	-
A 5	7	7	-	B 5	1	-	1	C 5	8	-	8
A 6	5	2	3	B 6	9	-	9	C 6	3	-	3
A 7	18	9	9	B 7	29	29	-	C 7	4	-	4
A 8	38	38	-	B 8	62	62	-	C 8	7	-	7
A 9	3	3	-	B 9	47	47	-	C 9	6	-	6
A10	18	18	-	B10	19	-	19	C10	8	-	8
A11	9	9	-	B11	13	13	-	C11	4	-	4
A12	14	14	-	B12	5	5	-	C12	7	-	7
A13	12	-	12	B13	2	2	-	C13	7	-	7
A14	14	7	7	B14	15	15	-	C14	5	5	-
A15	2	2	-	B15	12	-	12	C15	41	-	41
A16	15	-	15	B16	2	-	2	C16	6	-	6
A17	28	28	-	B17	8	-	8	C17	2	-	2
A18	10	-	10	B18	10	10	-	C18	6	-	6
A19	2	-	2	B19	4	-	4	C19	5	5	-
A20	23	18	5	B20	10	-	10	C20	4	-	4
A21	14	14	-	B21	4	-	4	C21	4	-	4
A22	10	-	10	B22	7	-	7	C22	35	35	-
A23	2	-	2	B23	5	5	-	C23	3	3	-
A24	110	55	55	B24	16	-	16	C24	3	-	3
A25	2	2	-	B25	7	6	1	C25	3	-	3
A26	14	-	14	B26	6	-	6	C26	34	-	34
A27	79	-	79	B27	19	19	-	C27	35	-	35
A28	9	-	9	B28	4	4	-	C28	10	-	10
A29	25	25	-	B29	12	12	-	C29	7	7	-
A30	9	9	-	B30	12	12	-	C30	34	-	34
A31	5	5	-	B31	4	-	4	C31	52	-	52
A32	5	-	5	B32	15	-	15	C32	3	3	-
A33	12	12	-	B33	11	-	11	C33	30	15	15
A34	25	-	25	B34	17	17	-	C34	12	-	12
A35	11	-	11	B35	15	-	15	C35	89	-	89
A36	2	-	2	B36	8	4	4	C36	5	5	-
A37	13	-	13	B37	3	-	3	C37	5	-	5
A38	10	-	10	B38	3	-	3	Swamp			
A39	28	28	-	B39	1	1	-	& Pond	38	-	38
A40	7	-	7	B40	5	-	5				
A41	17	-	17	B41	6	-	6				
				B42	14	-	14				
Total	680	326	354	Total	603	336	277	Total	618	145	473
Open	91	(48%)	(52%)	Open	42	(65%)	(35%)	Open	27	(24%)	(76%)
All	771			All	645			All	645		

Total area under Intensity A - 797 acres - 42%
Total area under Intensity B - 1104 acres - 58%

Map 7.1



Forest Stands on
Property of Owner A

Petersham, Mass.

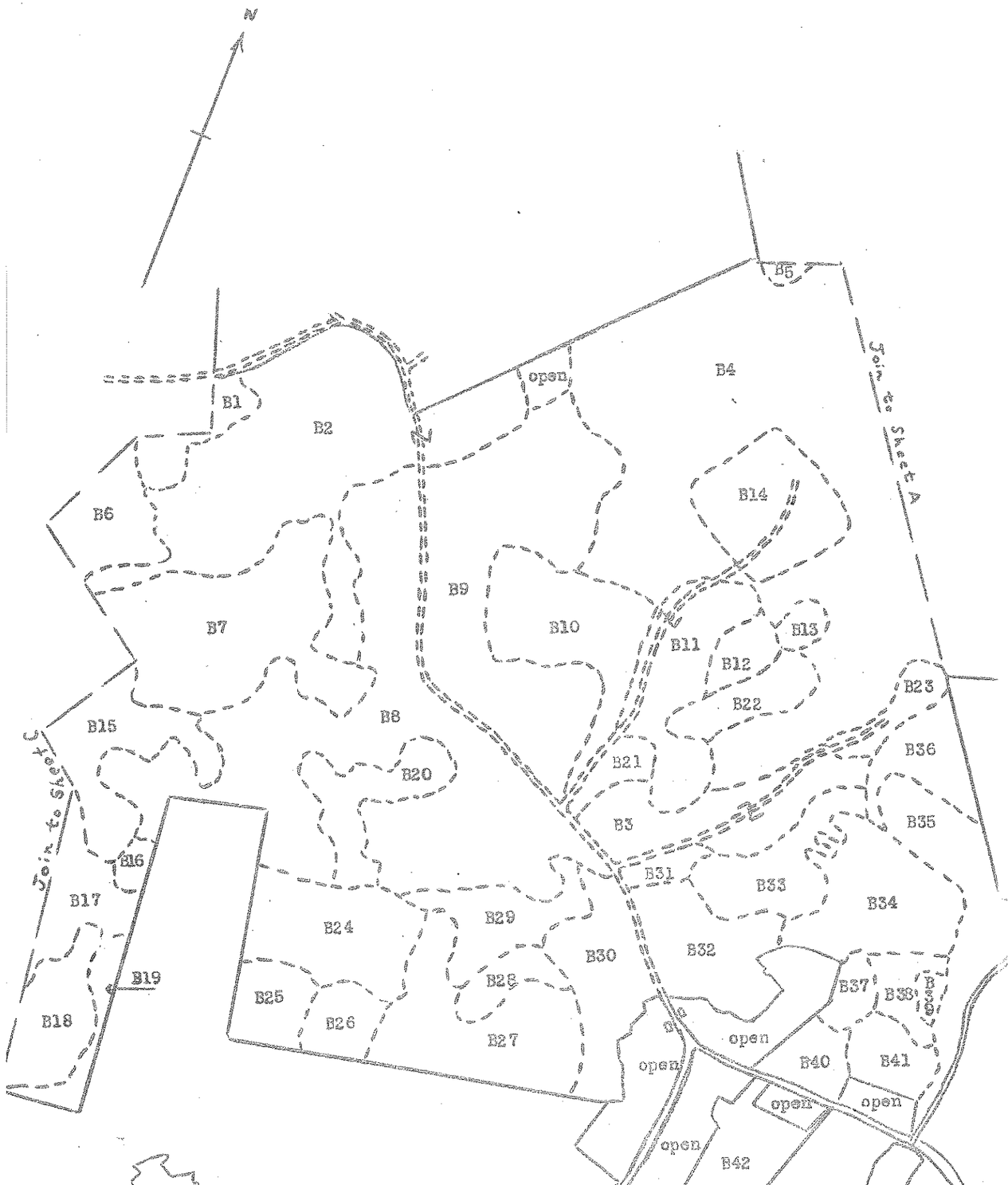
1950

Map 7.2

Forest Stands on Property of Owner B

Petersham, Massachusetts

1950



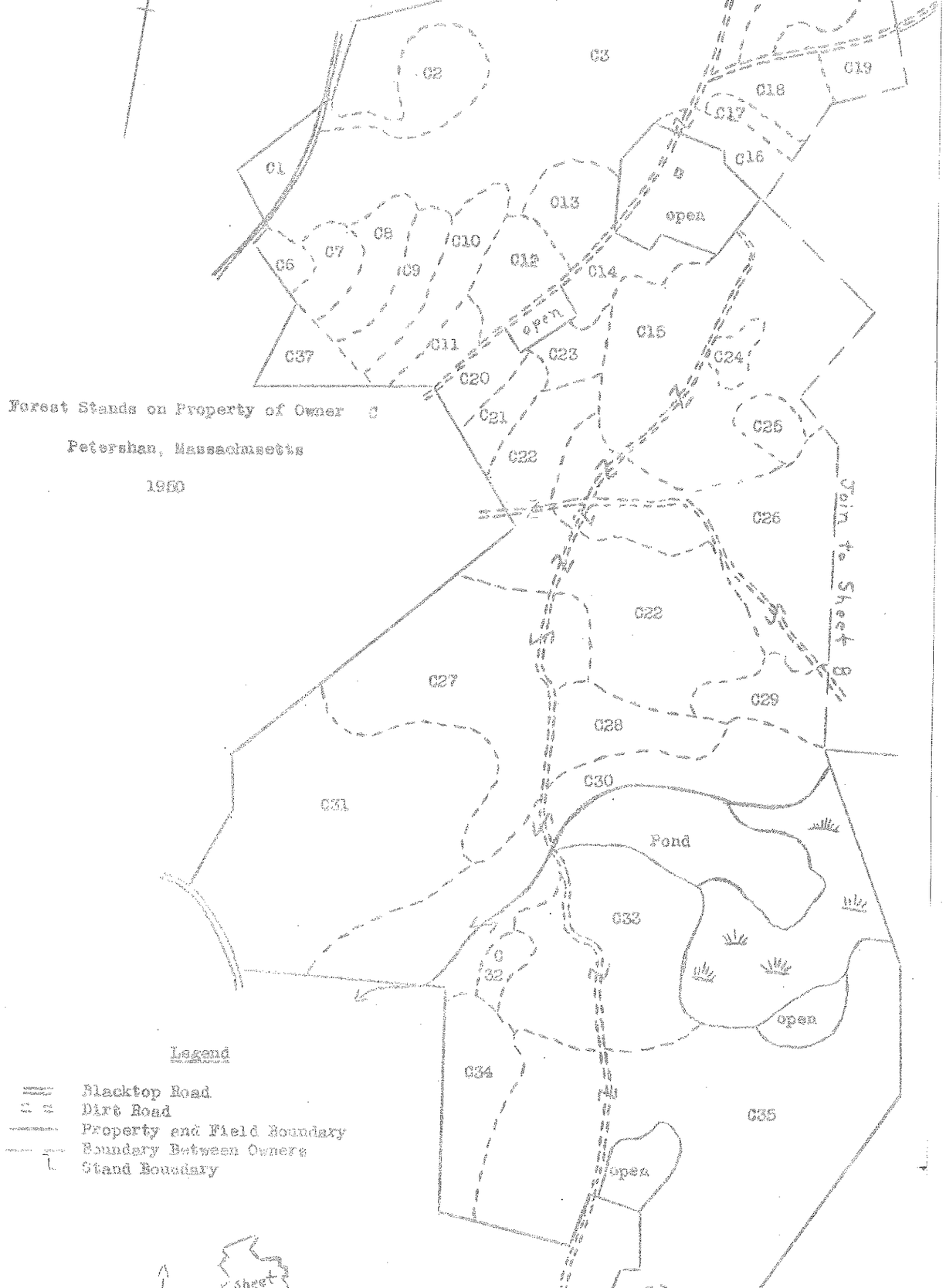


Table 7.15

DESCRIPTION OF GROWING STOCK ON FOREST STANDS
OF PETERSHAM LAND HOLDINGS

Stand No.	Per Stand Acres	Acres	Description of Growing Stock
Hardwood Stands:			
A 6	5		
A 7	18		Mixed stand of red oak, white ash, hard and soft maple with a few white pines, about 50 years of age. Stocking is about 52% of normal (2032 cf/A) with 352 trees per acre over 4" d.b.h. including about 116 potential crop trees. Reproduction is fairly abundant and the site is No. I.
A24	110	147	
B 4	90		
B36	8	98	
		245	
A13	12	12	Mixed stand of red oak and red maple with some scattered white pine and hemlock, about 40 years of age. Stocking is about 36% of normal (790 cf/A) with 270 trees per acre over 4" d.b.h. including about 150 potential crop trees. Reproduction is fairly abundant and the site is No. I.
C 7	4		
C 8	7	11	
		23	
A37	13	13	Mixed stand of red oak, red maple, yellow birch with a few hemlocks, about 35 years of age. Stocking is about 48% of normal (1251 cf/A) with about 290 trees per acre over 4" d.b.h., including 105 potential crop trees. Reproduction is abundant and the site is No. I.
C28	10	10	
		23	
B 3	15		Mixed stand of red oak, red maple with a few white pines, about 50 years of age. Stocking is about 59% of normal (2315 cf/A) with about 217 trees per acre over 4" d.b.h., including 91 potential crop trees. Reproduction is abundant and the site is No. I.
B12	5	20	
C23	3		
C36	5	8	
		28	
A 1	20		
A28	9		
(A34)	(15)		
A38	10	54	Stand of soft maple mixed with hard maple, yellow birch and a few red oaks, about 40 years of age. Stocking is about 67% of normal (2062 cf/A) with about 403 trees per acre over 4" d.b.h., including 73 potential crop trees. Reproduction is abundant and the site is No. I but swaley.
B 2	53		
B31	4		
B37	3		
B38	3		
B41	6	69	
C 2	8		
(C10)	(4)		
C13	7		
C15	41		
C21	4		

(Cont.)

Table 7.15 (Continued)

b.

Stand No.	Acres Per Stand	Acres Totals	Description of Growing Stock
C24	3		
C25	3		
(C30)	(24)		
(C35)	(69)	163	
		286	
(A24)	(10)	10	Red maple swamp about 40 years of age. Stocking is about 67% of normal (2062 cf/A) with no trees suitable for sowlays. Reproduction is sparse and the site is very wet.
(C10)	(4)		
(C30)	(10)		
(C35)	(20)	34	
		44	
B14	15	15	Mixed stand of red oak and hemlock, about 50 years of age. Stocking is about 77% of normal (3435 cf/A) with about 395 trees per acre over 4" d.b.h., including 255 potential crop trees. Reproduction is sparse and the site is No. I.
"C"	38	38	Swamp and pond.

Softwood Stands:

(A17)	(5)		Predominantly hemlock stand with a few white pines, about 50 years of age. Stocking is about 64% of normal (4031 cf/A) with about 440 trees per acre over 4" d.b.h., including 230 potential crop trees. There is no reproduction and the site is No. II.
A25	2	7	
B13	2	2	
C 1	4	4	
		13	
A21	14	14	Mixed stand of white pine, hemlock, black birch, red oak and soft maple, about 70 years of age. Stocking is about 63% of normal (5696 cf/A), with about 245 trees per acre over 4" d.b.h., including 155 potential crop trees. Reproduction is sparse and the site is No. I. Stand is mostly groups of hardwoods mingled with groups of softwood trees.
A 2	9	9	Stand of old field white pine, about 45 years of age. Stocking is about 57% of normal (4627 cf/A), with about 260 trees per acre over 4" d.b.h., including 85 potential crop trees. There is no reproduction and the site is No. I.

(Cont.)

Table 7.15 (Continued)

c.

STAND No.	Acres Per Stand	Acres Totals	Description of Growing Stock
A19	2	2	Old field white pine stand, about 85 years of age. Stocking is about 78% of normal (8191 cf/A), with about 135 trees per acre over 8" d.b.h., including 55 potential crop trees. Hardwood reproduction is abundant and the site is No. I.
(B25)	(1)	1	
		3	
A 5	7		White pine stand, about 55 years of age. Stocking is about 58% of normal (4131 cf/A), with about 305 trees per acre over 4" d.b.h., including 190 potential crop trees. Hardwood reproduction is sparse and the site is No. II. Most of the trees have been pruned up 5 or 7 feet.
A29	25	32	
B10	19		Old field white pine stand, about 50 years of age. Stocking is about 45% of normal (2843 cf/A), with about 550 trees per acre over 4" d.b.h., including about 135 potential crop trees. There is no reproduction and the site is No. II.
B15	12		
B21	4		
B40	5	40	
C 9	6		
C10	6	12	
		52	
B32	15	15	Old field white pine, about 35 years of age. Stocking is about 39% of normal (1474 cf/A), with about 169 trees per acre over 4" d.b.h., including 63 potential crop trees. Mixed pine and hardwood reproduction is sparse, and the site is No. II. Many trees are so bushy that they are nearly worthless as sowlays.
C 5	8		
C 6	3		
C18	6		
C20	4	21	
		36	
(A20)	(5)	5	White pine seed tree areas similar to the stands described immediately above.
B16	2		
B19	4		
B20	10	16	
C11	4		
C12	7		
C37	5	16	
		37	
A 9	3		White pine plantations, about 25 years of age. Stocking is about 80% of normal (2216 cf/A), a great many of the trees have been badly damaged by weevils. A few potential crop trees can still be found. Reproduction is not present, and the site is No. II.
A15	2		
A30	9		
A31	5		
A33	12	31	

(Cont.)

Table 7.15 (continued)

Stand No.	Acres Per Stand	Acres Totals	Description of Growing Stock
A35	11		Mixed stand of white pine and hemlock with some hardwoods, about 30 years of age. Stocking is about 59% of normal (1252 cf/A), with about 320 trees per acre over 4" d.b.h., including 140 potential crop trees. Hemlock and hardwood reproduction is fairly abundant, and the site is No. II.
A36	2	13	
B22	7		
B24	16	23	
C27	35	35	
		71	
Reproduction Stands:			
A40	7		Stands consist of inferior hardwood species restocking the area after cutting or blow-down about 10 years of age. Stocking is about 50% of normal, containing no measurable volume. Very few if any tree species present suitable for sowlays.
A41	17	24	
B 6	3		
B17	8		
B35	15	32	
C17	2		
C26	34		
C31	52		
(C33)	(15)	103	
		159	
A 3	12		Stands similar to those described immediately above, except that the stocking is only about 30% of normal and the site is No. I.
A16	15		
A18	10		
A22	10		
A23	2		
A26	14		
A27	79		
A32	5	147	
B 5	1		
B26	6		
B33	11		
B42	14	32	
C34	12		
(C 3)	(14)	26	
		205	
A 4	12		Better hardwoods restocking the area after cutting, about 10 years old. Stocking is about 80% of normal, many trees suitable for sawtimber production. Site is No. I.
A 8	38		
A12	14	64	
B11	13		
B23	5		
B29	12		

(Cont.)

Table 7.15 (continued)

Stand No.	Acres Per Stand	Acres Totals	Description of Growing Stock
B34	17		
B39	1	48	
(C 3)	(56)		
C14	5	60	
		172	
(A17)	(23)	23	White pine restocking the area after cutting or blowdown, about 5 years of age. Stocking is about 80% of normal, site in No. I.
(B25)	(0)		
B27	19		
B28	4	29	
C 4	12	12	
		64	
A10	18		Old fields restocking to white pine. Stocking varies from 0 to 60% of normal. Site is No. I.
A11	9		
(A20)	(18)		
A39	28	73	
B 1	3		
B 7	29		
B 8	62		
B 9	47		
B18	10		
B30	12	163	
C19	5		
C22	35		
C29	7		
C32	3		
(C33)	(15)	65	
		3301	

N.B. Parentheses indicate that stand is split between two or more forest types.

Chapter VIII

SUMMARY AND CONCLUSIONS

Forests constitute New England's most extensive natural resource, covering seventy-seven percent of the land area. Residents of the region derive many intangible benefits from woodland; not the least of these is the scenic charm of a tree-covered countryside. These pleasant landscapes have a definite place in the region's alleged "half billion dollar" recreational trade. Other more direct values are derived from a forest based industry employing over 100,000 workers and creating about eight percent of the total value added by New England manufactures.

Most of the present trees are second-growth. Practically all of the accessible virgin timber has been removed during a long logging history. Much of the area has been cut over two or more times, particularly near the centers of population where a great deal of fuelwood has been used. Forty-five percent of the present stands are classified as sawtimber, 44 percent are poletimber or smaller, and 11 percent of the timberland is denuded. The bulk of the sawtimber and over half of the commercial forest land is in Maine; much of it is concentrated under large industrial ownership in the wilderness areas of the north. Most of the woodland further south is split up among many small holdings of less than 5,000 acres each.

The average annual growth per acre is estimated at only 29 cubic feet, not because growth capacity is poor but primarily because the average volume of growing stock per acre of woodland is low. Scarcity of high quality sawlogs has forced New England industry to import large

quantities to meet its needs. Trees are both the "factory" and "warehouse" of wood and productivity cannot be increased without building up the growing stock. It is estimated that the annual drain on softwood sawtimber exceeds annual growth while the reverse is true of hardwood sawtimber and of all poletimber-sized trees. Volume is accumulating in these size classes chiefly because the trees are so small or of such poor quality, or are so scattered or inaccessible, that industry has found no profitable way of using them. If useable production is to be increased, not only must the volume of growing stock per acre be raised but also the quality must be improved. Although the art of silviculture is comparatively young, general principles have been established indicating that in the long-run it is possible at least to double the productivity of New England's woodland and at the same time greatly improve the quality of product. A considerable volume of relatively small low-grade material will be the inevitable early product of any such cutting program.

Any adjustments in forest management must recognize the influence of New England's long history of development. Most of the present wood-using industries were originally based on the exploitation of a large timber reserve and they have grown along single-product lines. Each company is equipped to process a single type of raw material such as pulpwood, veneer logs, softwood sawlogs or turning bolts and the like. It has so far been unprofitable for each company to sort the several types of materials usually found on a cutting job and channel each to the use for which it is best suited. Standardized log grading rules have not been widely adopted except for a few specialized products. Having markets for only limited types of materials imposes limitations on the kind of cutting

that is economically feasible in many areas.

Customary methods of harvesting forest products are another heritage from the past that have a great effect on forest management. High-grading was admirably suited to harvesting virgin timber under the conditions of a colonial economy. Continued use of such cutting, however, gradually eliminates all high-quality growth and may leave worthless trees in possession of the site. Clear-cutting developed for land clearing, harvesting old field pine, fuel and pulpwood; but stands following such cutting are frequently understocked and of inferior quality. Although these harvesting methods are still needed in special situations, partial-cuttings can usually meet present market demands and can also work a gradual improvement in forest composition and growth rates. This type of management can be used to the greatest advantage when markets are available for a variety of wood products. Widespread adoption of such forestry practices are thus intimately connected with the development of integrated wood-using industries.

The colonial system of forest land ownership has also continued with only minor changes to the present day. Only about five percent of the commercial woodland area of New England is now government owned, about 38 percent is in large industrial holdings in the far north and the rest is mostly in small ownerships of less than 5,000 acres. Among these small ownerships, farmers hold about 21 percent of the total commercial forest while a mixed group of non-farm owners hold the rest, about 36 percent of the total acreage. Government holdings are fairly well managed on a multiple-use basis, but they constitute such a small percentage of the total forest area that they can have little more than a

local effect on the productivity of the region's woodland. The management practices used on these lands can perhaps point the way that private owners may follow.

The forest management problems of New England are primarily those of the small private owner. There is considerable evidence that the large industrial owners, especially the pulp companies, are beginning to take steps toward improved forest practices. They are well equipped with the resources and ability to work out their own programs. Those companies with a large plant investment are likely to have long-run forest interests closely parallel to those of the public.

Thus a major part of the problem is adapting improved forestry techniques to the requirements of the small owner. The effect of their woodland on total productivity is important since they control over half of the commercial forest area. Much of this land is located in the more densely populated areas and is the most accessible and potentially productive woodland in the region.

There are thousands of small forest holdings ranging in size from one to 5,000 acres, owned by people from all walks of life. The distribution of these small holdings by size of woodlot is of considerable importance. The aggregate holdings of nearly 60 percent of the forest owners contain only about 25 percent of the commercial forest land. This area is broken up in individual woodlots of less than 50 acres. It is likely that the potential income from these woodlots is so small that forest management may be of little interest to the owners. Another 25 percent of the owners hold about 28 percent of the forest land. Their lots range from 50 to 99 acres in area. These lands have income

possibilities that may be more important. The remaining 45 percent of the land is held by only 14 percent of the owners in lots of 100 acres or more. This relatively small group thus controls a substantial portion of the small woodland holdings in lots that are capable of eventually making significant income contributions. Any action program designed to improve New England forest practices should take cognizance of this fact in order to get the greatest return for a minimum of effort.

Owners usually have a more direct interest in the forest productivity of their lands than do the timber operators, especially those operators with only a small plant investment. Since there are few government regulations, the landowner is in a position to determine his own management policies. The owner has a wide range of choice among alternative forest operating plans. Unfortunately information is often lacking on the input, output and organizational requirements of different plans. The case study method and budgetary analyses provide one means of determining the effect of different operating plans on net returns and of providing a rational basis of choice between alternatives.

Woodland adjustments were planned for a sample of 241 New England dairy farms. The farm forestry enterprise has definite supplementary and complementary relationships with other farm enterprises; they all compete in the utilization of limited resources. It is therefore important that woodland adjustments be incorporated as an integral part of a total farm plan. Plans to maximize net farm income must integrate the use of the operating unit's resources.

Before a farm plan can be reduced to a budget or financial statement, physical input-output relationships must be determined. Although

the available information on this subject is somewhat sketchy, more or less satisfactory estimates are available on most phases except the long-run response of forest stands to different forestry practices. It has been necessary to devise a method for estimating long-run output based on whatever direct and indirect evidence is available. It is believed that the results of this projection system are not grossly misleading, but little more than that can be claimed for its accuracy. It is hoped that sufficient use, adjustment and correction will gradually improve the accuracy and speed of the system.

The prices of items bought and sold are used to translate physical input and output figures into economic terms. With one exception a single set of cost-price relationships have been used in this study. Thus the budgets show the effect on net farm income of adjustments in farm enterprises and management intensities.

In planning changes on the study farms, the first integration process was that of determining the cover type to be maintained on each piece of land. The most common adjustment was one of improving the best of the brushy pastures for roughage production and allowing the balance to revert to forest. Establishing tree cover in New England frequently requires little more than stopping grazing. Only a few situations seemed to require tree planting, to prevent erosion or to supplement natural seeding.

The practice of grazing young stock and dry cows in the woodlot must also be considered when fencing out areas to be reforested. Heavy grazing has considerable detrimental effect on forest growing stock and can completely eliminate hardwood reproduction. In some instances a

moderate amount of grazing may assist in establishing coniferous reproduction, but on the whole it is undesirable. The poor quality feed in a woodlot, especially in the dry part of the pasture season, also has an undesirable effect on the growth of cattle. It seems likely that as more pastures are improved woodland grazing will be gradually abandoned.

Effective use of the labor force is essential to attaining maximum farm returns. The woodlot frequently offers a form of supplementary employment for labor that might otherwise be less profitably employed. Taking full advantage of the possibilities for integrated use of farm labor and equipment may make sizeable demands on the managerial ability of the operator. On at least half of the study farms it seemed most profitable to hire extra labor to carry out part or all of the forestry enterprise. This can be done successfully as long as there is enough excess management capacity to direct operations effectively. Stumpage sales embodying improved harvesting practices make a minimum demand on farm labor and management.

The more intensive forms of forest management require not only more labor input but also more skilled management. In general, farmers can acquire the necessary technical aid free of charge through the Extension Service or the County Forester. The special operating knowledge required can be gained gradually through experience. The most intensive programs of frequent partial-cuttings may also require some outside assistance in marketing the products that cannot be used on the farm.

Two hundred and eleven of the study farms had more than 5 acres of woodland; 60 percent of these had less than 100 acres each. In general the problems of these smaller owners are those of getting enough forest

products from the woodlot to meet farm needs. Full development of the productive capacity of the forest land will often provide a small surplus for sale. The value of forest products used at home does not appear in the cash budget, but the value will be about equal to the amount that would have been spent to purchase the materials in the open market.

On most of these small woodlots all of the forestry inputs could be supplied by the regular farm labor force and equipment. A few farms with small woodlots were found where it seemed necessary to hire special woods labor or to sell stumpage since the farm labor and management resources could be most profitably employed outside of the forestry enterprise. An intensive program of partial-cuttings could normally be instituted without much change in current practices. The major adjustment was that of spreading the year's cut over four or five times the usual area and leaving selected crop trees to put on high quality growth. It seems likely that this cutting can be done with little if any increase in labor input per unit of output.

Forty percent of the study farms had woodlots of 100 acres or more. Some growing stock was so depleted that no output would be available for several decades. However, the average stocking was such that a yield of around one-quarter cord equivalent per acre per year was ordinarily planned for the next decade. This usually provided some surplus for cash sale. Here again, whether inputs were furnished from within the regular farm organization or were obtained from the outside depended on the availability of other more profitable enterprises to absorb the labor and management of the farm. In only a fifth of the cases did it seem most advantageous to carry out all of the forestry program through marked

stumpage sales. On some farms it appeared likely that enough extra managerial ability was available to supervise cutting done by hired labor.

It is ordinarily not possible to make partial-cuttings in younger stands by means of stumpage sales. Normally only harvest cuts of mature sawlogs or pulpwood can be sold this way. A rational adjustment would be to use available farm labor to make partial-cuttings in younger stands. These operations will yield low value products but can be made with regular farm labor for a relatively small marginal cost. Specially hired labor and stumpage sales can then be used on more mature stands.

On some of the study farms where the volume of business, net returns and size of the labor force were smaller than the operator wanted, forest land offered an attractive means of expansion. Intensive analyses were made of the alternative forest operating plans open to two such owners to show the probable input, output, net farm income and organizational requirements. These factors were estimated by five-year periods over a 90-year planning period. The growing stock analyzed contained a fairly high proportion of mature pulpwood and sawlogs so that income was immediately available. The most intensive program of weeding, pruning, partial-cutting and improved harvesting practices required the greatest labor input. Net cash income in both the short and long run was also greater than that of the other plans tested. When a balanced mixture of age classes is present in the woodland growing stock, the postponed cutting of part of the mature trees required by improved harvesting methods may be compensated by the early harvest of sawlogs produced by partial-cuttings in younger stands.

An intensive analysis of the management alternatives open to three forest owners in central Massachusetts revealed some results contrasting with those of the above analyses. The three holdings were about equal in size and totaled about 1,900 contiguous acres. One owner was a farmer while two were business men holding their property in connection with a country estate or summer home. The growing stock on the area was predominantly young hardwood and of low density and inferior quality.

If only the added costs of different operating plans are considered, it seems advantageous under practically all the assumed conditions for each of the owners to use at least improved harvesting practices. Greater returns can be gained in the long run if they operate their property as a single unit and use more intensive forest management, even though this will require making some cash investment for about twenty years while the growing stock is built up. This program of partial-cuttings and improved harvesting methods makes particularly attractive returns if the price of sawlogs goes up and interest rates are low. Rising sawlog prices in the long run give a premium to the more intensive forms of management that produce the greatest volume of high-quality saw timber.

If, however, the owners view the forestry enterprise as an investment that must pay all costs including taxes, the picture changes. Interest rates charged on investment are now of greater importance. Six percent interest on a heavy initial investment will more than offset the gains of intensive management unless sawlog prices rise. Under most circumstances, greater returns can still be made by the use of improved harvesting methods than by the use of customary cutting methods. With a

depleted growing stock that requires early investment to build up its productivity, this medium intensity of forest management seems most attractive since it will keep investment and interest charges to the minimum commensurate with improved productivity.

With growing stock of the age and quality analyzed, the investment in deferred cut of mature timber required by improved harvesting practices is clearly apparent. The value of such management is represented primarily by the gradually accumulated volume and better quality of the growing stock. Depleted woodland may take a long time to build up to a more productive condition. The value that individual owners place on estimated future returns will depend on their personal rates of discount. If this rate is a moderate 3 percent the returns of medium or high intensities of management may still be attractive if investment can be kept down, interest rates are low or a rise in sawlog prices is anticipated.

It is apparent from the analysis of 96 alternative plans for the three holdings that the rate of interest paid on forest investments may be of vital importance to many woodland owners in choosing an operating plan. Rapidly accumulating charges encourage the earliest possible reduction of investment, usually by liquidation of the growing stock. This normally will be reflected in lower future productivity and quality. A program based on careful extension of long-term, low-interest loans for forest improvements and improvement cuttings would help many owners toward better forest management and an eventual increase in returns.

Closely allied with this problem is that of equitable taxation. It is probable that high rates and rapidly accumulating interest on taxes may either encourage premature liquidation of the growing stock or

discourage private investment in forest property. It will be interesting to observe the enforcement and the results of the recent New Hampshire tax legislation. If annual bare land taxes are held low enough and severance taxes are equitably administered, this law seems to offer considerable promise to forest owners.

The relatively low returns shown when growing stock is badly depleted indicate that there is probably some field for the expansion of government holdings, or need for some other arrangement to bridge the period of initial investment. It seems probable that the growing stock on some lands is either so depleted or the productivity is so inherently low that the investment is not attractive to private capital. It is difficult, however, to locate such areas since someone seems willing to own and pay taxes on practically all New England land. Perhaps the intangible returns are sufficient compensation, but whether private owners are willing or able to provide forest management that will yield returns compatible with the public interest remains to be discovered.

Further study of forest marketing seems necessary before any satisfactory solution of forest management problems is reached. It is clear that markets for many products are poorly developed in several areas. Before any sizeable program of partial-cuttings can be carried out, some profitable use must be found for the large quantities of low-grade materials that will be produced initially. Simply finding a market for this material will not insure improvement in present practices. Incentives must be provided simultaneously for increased production of high-grade materials. Otherwise it is likely that a good market for low-grade wood will merely encourage further degrading of the present growing

stock. If economic incentives are not provided for making partial-cuttings, then some sort of controlled marketing may be needed. The Commwood Cooperative in Connecticut is already supplying one type of market control; further study of its success and methods seems warranted.

It is apparent from the analyses that farmers are in a more favorable position to apply improved forestry techniques than are non-farm owners. But in order to carry out more intensive forestry they need technical guidance. Such service is at present available to many free of charge through the County Forester. Unless a large and permanent expansion of this program is envisioned to make it adequate to serve all small woodland owners, technical aid must be accompanied by a vigorous educational program. Landowners are capable of learning the rudiments of silviculture and one of the best methods of doing this is in the owner's woodlot. A good educational program might eventually make many woodland owners independent of outside technical aid.

To become fully effective a good program of forest education or technical aid will require more research. More woodland planning is needed that treats the entire farm enterprise as a carefully integrated business unit. It is likely that more improved forestry techniques will be adopted when owners can foresee the probable effect of management adjustments on their net farm income. A program of budgetary planning should be accompanied by a system of records to show actual accomplishments over the years and to see just how different operating plans work out in practice.

The management problems of non-farm, small forest owners require more research and understanding. Budgetary planning and pilot operations

of typical units would shed much light on the economic factors involved. Exploration of different legal arrangements and other means of forming operating units of desirable size is also essential. This type of information could well be gathered and tested out on the pilot operations suggested above.

It is essential that silviculturists and management specialists cooperate in furnishing the input-output data necessary for successful budgetary analyses. If figures based on the research and experience of these people can be assembled in a useful form much of the inherent difficulty of long-term estimates can be eliminated. Even the makeshift estimates used at present indicate that forest landowners have a considerable opportunity for adjusting management practices to increase their net returns and the productivity of New England woodlands.

APPENDIX A

Long-Run Forest Output Estimates

Woodland budgetary analyses require information showing the probable income and expenses that will result from alternative forest management programs. An essential part of this planning data is obtained by applying appropriate costs and prices to the physical inputs and outputs of the forestry enterprise. The methods used in this study for estimating cost-price relationships, physical inputs and short-run outputs have already been discussed; the problem of projecting the long-run physical outputs likely to result from different forest management programs remains to be solved. In order to furnish the information needed for planning, any system of estimating long-run outputs must be sensitive enough to show the quantity and quality of forest products that will be available, and when cutting is desirable. These estimates must take account not only of the management practices used but also of the various forest types, ages, quality of trees and density of stocking found in established stands growing on sites of different productive capacities. The following specific information is needed for each stand considered. The volume and quality of material to be cut, the approximate time when such cutting is most desirable and the amount and kind of material in the residual stand. In order to estimate the labor required for operating, it will also be necessary to know the average diameter of the trees removed. Other information on factors that affect operating costs will be determined from field information about the woodland and operating unit.

Intensity of Management

After considering the state of silvicultural knowledge, it was decided to study forest management programs at three general levels of intensity[1]. These levels correspond closely to those established by the United States Forest Service for use in the Forest Survey[2]. The programs differ, one from the other, chiefly in the amount of silvicultural treatment used, and have been called "high," "medium" and "low" degrees of management intensity. The terms "good" and "fair" have been avoided since under different circumstances any one of them may produce

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1/ Intensity of management is here defined in terms of the total amount of labor and capital applied per acre. See A. C. Bunce, The Economics of Soil Conservation, New York, 1940.

2/ The Forest Service has classified management programs according to two criteria, cutting practices and fire protection. These factors produce the following types of management.

1. Intensive Management requires good fire protection combined with high-order cutting. This "requires the best types of harvest cutting which will maintain quality and quantity yields consistent with the full productive capacity of the land. Whenever needed, it requires cultural practices such as planting, timber-stand-improvement cuttings, thinnings, and control of grazing."

2. Extensive Management requires fair fire protection and at least fair cutting.

   a. Good extensive requires cutting using "good silviculture that leaves the land in possession of desirable species in condition for vigorous growth in the immediate future. It is substantially better than fair cutting."

   b. Fair extensive requires fair cutting that "marks the beginning of cutting practices which will maintain on the land any reasonable stock of growing timber in species that are desirable and marketable."

3. Without Management means that either the fire protection or the cutting practices rate poor or worse. "Poor cutting leaves the land with a limited means for natural reproduction, often in the form of remnant seed trees. It often causes deterioration of species with consequent reduction in both quality and quantity of forest growth. Destructive cutting leaves the land without timber values and without means for natural reproduction."

The above quotations are from Forests and National Prosperity, Forest Service, U.S.D.A., Miscellaneous Publication No. 668, Washington, D. C., 1948.

the most desirable economic results. The specific forest practices required by each intensity of management and the timing of operations will depend on the conditions of the growing stock, operating unit and the available markets.

a. High Degree of Management Intensity - will include harvesting methods designed to promote prompt and valuable, natural reproduction. These will usually involve spreading the final cuts over a period of years. Partial-cuttings will be made as the stands mature to improve the growth of selected crop trees and to salvage trees that might otherwise die and be wasted. Weeding and pruning will be done in accordance with the demands of good silviculture.

b. Medium Degree of Management Intensity - will include the harvesting methods mentioned above, but none of the partial-cuttings or other practices designed to improve stand quality or tree growth.

c. Low Degree of Management Intensity - will include none of the above silvicultural measures. Harvesting will be done by customary clear-cutting or high-grading methods whenever sufficient volume is available to attract a buyer.

The next few paragraphs will present a general outline of the methods used in estimating the probable, long-run outputs resulting from these particular forestry programs. It is apparent that stands receiving "low" and "medium" degrees of management will develop under conditions similar to those of a wild forest. Normal Yield Tables have been compiled by foresters to indicate the maximum yields attainable from fully-stocked, undisturbed forests. These tables have been used to estimate the probable yields from "low" and "medium" management.

Although Normal Yield Tables apply only to even-aged stands this furnishes little impediment to their wide use, since the bulk of the forests in the region may be considered essentially even-aged. Some adjustment is necessary, however, if yields are projected for actual stands that are under-stocked. A special formula has been used to make allowance for growth variation due to the different degrees of stocking found in established stands.

Working out a system for predicting the yields from a "high" degree of management intensity has proved to be a difficult task. There is little information about the growth or quality response of forest stands to the proposed silvicultural operations and published data in a useful form is almost entirely lacking. This forces a resort to logical interpretation and extrapolation of the fragmentary data that do exist; a procedure fraught with many difficulties and dangers of error.

In order to get useable yield tables and information it was thought that a logically simple system would be most desirable. It is hoped that by bringing all assumptions out in the open, constructive criticism will be able to improve the accuracy of prediction. Since the volume and quality of the forest products in any stand depends on the number, dimensions and form of the component trees, these were taken as the basic building blocks for estimating yields. The simplest system of doing this seemed to be one of determining what the average dominant tree in a stand will look like at different ages, as it develops under the given management program. It was assumed that under favorable circumstances maximum yields would result if the entire area was covered by these dominant trees.

With the crown diameter estimated for a given age, simple mathematics

indicates the number of trees necessary to fully occupy an acre. As the trees grow older and the crowns expand, fewer and fewer will be needed for full-stocking. It was assumed that partial cuttings at the beginning of any period would reduce the number of stems to that required for crown closure at the end of the period. The estimated time between these cuttings varied from five to fifteen years, depending on the forest type.

Once the dimensions of the dominant tree have been determined the next problem is to measure its volume. This is a relatively simple problem and can be solved by standard forestry techniques. Tables are available giving the cubic foot volume of trees of a given height and diameter. It is also possible to estimate the number and dimensions of the sawlogs in a tree, once the diameter, clear and dead length are known. One inch was allowed for double bark thickness and a standard taper of one inch per eight lineal feet was assumed. Top logs were taken to a six inch diameter inside the bark at the small end, or up to the limit of dead length, whichever was reached first. The board foot content of these logs was determined by use of the International Log Rule. This board foot volume was converted to cubic feet and subtracted from the total cubic foot content of the tree. The balance remaining was considered to be cordwood whenever such a close degree of utilization seemed possible and desirable.

When this projection system is applied to established stands allowance must be made for the degree of stocking and quality of the trees actually present. This is accomplished by considering that once partial-cuttings have started, the trees in the main canopy will follow

the course of development just discussed for trees of the given diameter under "high" management intensity. Poor quality trees are assumed to follow a growth pattern similar to that of the crop trees, but their board foot volume must be reduced by making appropriate allowance for woods mull.

Although every effort has been made to devise a logically simple and straightforward system for projecting long-run forest yields a great many technical complications have been encountered in actual application.[3/] Obtaining data on which to base estimates of growth has been difficult; it is hoped that the present figures can be improved as experience indicates their deficiencies. Of course, any system attempting to standardize estimates of growth resulting from a highly variable and dynamic natural organism must be flexible. Considerable judgment and skill is needed to make all the adjustments necessary for valid results - only the major variables can be included in the projection tables. Attaining reasonable results still depends to a great extent on the experience and knowledge of the analyst.

The rest of the discussion is concerned with some of the specific problems encountered in constructing the basic tables. Although the decisions behind the actual estimates are important, perhaps the resulting figures and their manner of application are at least as vital a consideration.

3/ Leopold Infield discussed the distinction between logical and technical simplicity of theory. He said, "By removing artificial and unnecessary assumptions, we achieve greater logical simplicity. But then our deductions are longer and more tedious. We have assumed less and must therefore deduce more." Albert Einstein, New York, 1950.

Output from "Low" and "Medium" Degrees of Management Intensity

Fully-Stocked Stands

The origin and use of Normal Yield Tables for forecasting forest growth and yield is familiar to most foresters but a summary is perhaps appropriate at this point. These tables are designed to show the dimensions of a wild stand at five or ten year intervals from the time that it contains a measurable volume until a commercially mature product has been developed. They are made up for a given species or mixture of species growing on a site of given quality. The following information is usually shown on an acre basis. Number of trees per acre; average total height of dominant and co-dominant trees, or of all trees; the diameter of the average tree at breast height; and the total volume in cubic feet per acre, board feet and/or cords. Cubic volume per acre is used in this study as a measure of the degree of stocking.

The basic assumption of a Normal Yield Table is that the forest area is completely covered by vigorously growing, even-aged trees. Such a stand is called fully-stocked. The best way to obtain the needed data would be to carefully measure a large number of fully-stocked stands at five or ten year intervals throughout the life of each. However, this would take a long time and an approximation has been obtained in a different way. Many even-aged stands belonging to the different age classes have been measured. When these are arranged in chronological order they are assumed to represent the development of a single stand, over time. Of course, great care must be used to measure stands that are as nearly homogeneous as possible and the system of gathering and analyzing data contains many statistical problems as well as difficulties of defining

type, site and density of stocking. Grave doubts can also be raised as to whether the fully-stocked stands measured were always so densely stocked. Regardless of how great these doubts may be, normal yield tables probably represent the best data available today concerning the growth and yield of wild stands.

Two site classifications were considered adequate to cover the conditions found in the region with a degree of accuracy necessary for budgetary analysis. The following generalized forest types were also deemed adequate to classify the stands encountered in this study: Mixed Northern Hardwoods, Central Hardwoods, White Pine and Mixed Softwoods, Old Field Spruce-Fir and Old Field Red Spruce. The volume of a mixed hardwood and softwood stand was projected by combining the appropriate tables for each major component of the stand.

Under-Stocked Stands

Some question arises about the way of applying Normal Yield Tables to the prediction of growth from under-stocked stands. A frequently used assumption has been that an under-stocked stand will remain under-stocked by the same degree throughout its life. For example, a stand 60 percent stocked is assumed to always have 60 percent of the normal volume at any time in the future. There are some factors, however, that invalidate such an assumption. In a stand with less than normal stocking the individual trees have more room to grow and will probably lay on wood at a more rapid rate than is indicated by the Normal Yield Table. With advancing age, heavy mortality occurs in a normal stand and fewer trees are required to make up full-stocking; the under-stocked stand incurs a lower mortality rate so that the number of trees approaches "normal."

It seems likely that the combined effect of these factors will result in the volume of an under-stocked stand approaching that of a normal stand with increasing age. Gehrhardt3/ discovered that this "approach toward normality" could be approximately measured by the following formula.

g = Gd(1+K-Kd) when:
g equals the growth of the under-stocked stand in the next 10 years
G equals the growth of a normal stand during the same 10 years
d equals the density of the under-stocked stand as a percentage of the normal stand
K equals a constant that depends on the tolerance of the tree species involved.

On the basis of work done at the Lake States Forest Experiment Station it was estimated that the constant "K" will have the following values for the indicated forest types.4/

Forest Type	"K"
Mixed Hardwoods	.8
White Pine and Mixed Softwoods	.9
Old Field Spruce-Fir and Red Spruce	1.0

With "K" thus established, the values found at the top of the Normal Yield Tables were worked out from the formula d(1+K-Kd). These figures show the percent of "normal" growth that will be attained by an under-stocked stand during a ten year period, provided growth is undisturbed by forest management or other unusual factors. If growth prediction is needed for a longer period it can be calculated in ten year jumps. A new

3/ For a further discussion of this formula see: W. A. Duerr, "Comments on the General Application of Gehrhardt's Formula for Approach Toward Normality," Journal of Forestry, 36:600-604, 1938.

4/ W. A. Duerr, S. E. Gevorkiantz, Methods of Predicting Growth of Forest Stands, Lake States Forest Experiment Station, Economic Note No. 9, St. Paul, 1938.

percent of stocking must be found at the end of each period. Intermediate values and growth during part of the ten year period can be approximated by interpolation.

The number of board feet and cords, per cubic foot of final yield, is estimated to be the same as that shown in the Normal Yield Table. Factors indicating the number of board feet and additional cords per cubic foot of final yield are shown at the bottom of the tables. In applying these figures to actual stands an estimated reduction should be made in the board foot volume for woods cull.5/ Since this study carries logs only to the roadside no deduction is made for mill cull.

Field data on actual stands must include the following items if growth is to be estimated from Normal Yield Tables and Gehrhardt's formula.

a. Forest type - determined by the species present.
b. Site classification - determined from the height and age of the dominant trees.
c. Cubic foot volume per acre - this is a measure of the density of stocking.
d. An estimate of the probable quality of the final products - this forms a basis for woods cull.

Reproduction and Probable Yields from the Second Cutting Cycle

It is apparent from the above discussion that yields from established stands handled under "low" and "medium" degrees of management intensity

5/ Woods cull is the volume of stem wood lying between the stump and the merchantable sawlog height of the tree which is not usable for, nor made into, logs.

will not differ greatly. The yields from "medium" management will include the extra growth that occurs during the period when part of the harvest is postponed, but this will not be very sizeable. The major difference between these intensities will be manifest in the speed with which the stands are regenerated and the number and quality of stems in the second rotation stands.

The better cutting practices of "medium" management will promote full-stocking with desirable species. A "low" degree of management intensity, on the other hand, seems likely to encourage not only delays in reproduction but also the establishment of poorly-stocked stands containing a large proportion of undesirable trees. The degree of stocking, the species and the likely time of establishment of new stands after different harvesting methods must be estimated separately for each stand.

Yields during the second rotation can be estimated from Normal Yield Tables once this information is established. This method has been used not only to predict the second rotation growth and yields from "low" and "medium" degrees of management intensity but also to estimate the volume of the residual stand at the end of the planning period. This latter volume is taken from the Normal Yield Table for a stand of the appropriate type, age and degree of stocking, growing on the given site.

Tables A.1 through A.5 present the Normal Yield Tables used in this study.

Output from a "High" Degree of Management Intensity

The amount and kind of information available as a basis for estimating crop tree and stand specifications varies considerably among the different forest types. The actual estimates made, the assumptions used and the sources of information are given in the following discussion of the tables developed for each forest type.

Table A.1

DATA FOR COMPUTING YIELDS FROM MEDIUM AND LOW DEGREES OF MANAGEMENT INTENSITY

NORTHERN HARDWOODS

Present % of Stocking	10	20	30	40	50	60	70	80	90
% of Normal Growth during next 10 years 1/	17.2	32.8	46.8	59.2	70.0	79.2	86.8	92.8	97.2

Normal Yield Table Values 2/

	Site I					Site II				
Age Years	No. Trees Per Acre	Ave. Ht of all Trees Feet	Dbh Ave. Tree	Volume 3/ Per Acre Cu.Ft	Next 10 yr. Volume Increment Cu. Ft.	No. Trees Per Acre	Ave. Ht of all Trees Feet	Dbh Ave. Tree	Volume Per Acre Cu.Ft	Next 10 yr. Volume Increment Cu. Ft.
20	1250	27.1	3.11	1041	1109	-	-	-	-	-
25	1120	33.0	3.86	1625	1103	1360	27.8	2.84	982	816
30	1010	37.5	4.41	2150	908	1235	31.8	3.40	1380	800
35	900	41.5	4.94	2628	867	1125	34.8	3.86	1798	736
40	800	45.0	5.46	3058	840	1030	37.4	4.25	2180	648
45	700	48.2	6.05	3495	803	940	39.8	4.66	2534	584
50	610	50.7	6.69	3898	779	855	41.5	4.94	2828	547
55	525	53.1	7.37	4298	770	775	42.8	5.43	3118	520
60	450	55.4	8.14	4677	785	700	44.2	5.85	3375	520
65	390	57.8	8.91	5068	765	630	45.3	6.31	3638	508
70	340	59.8	9.72	5462	738	565	46.3	6.79	3895	495
75	300	61.9	10.61	5833	-	500	47.0	7.36	4146	-
80	270	64.0	11.25	6200	-	440	47.6	7.98	4390	-
	Final Yield Conversion Factors 4/ Board Feet - 3.77 Cords - .0044					Final Yield Conversion Factors Board Feet - 3.50 Cords - .0052				

1/ From Gehrhardt's Formula when K = .8

2/ J. N. Spaeth, Harvard Forest Bulletin No. 2, Table II, "All trees 2 inches D.b.h. and over."

3/ Volume of merchantable stem to a 2-inch diameter at the center of the stick, outside bark.

4/ Number of board feet and cords per cubic foot of final yield. Same values as those of original Normal Yield Tables. Conversion Factors used: 6 b.f. = 1 cu. ft., 80 cu. ft. = 1 cord.

Table A.3

DATA FOR COMPUTING YIELDS FROM MEDIUM AND LOW DEGREES OF MANAGEMENT INTENSITY

CENTRAL HARDWOODS

Present % of Stocking	10	20	30	40	50	60	70	80	90
% of Normal Growth during next 10 years 1/	17.2	32.8	46.8	59.2	70.0	79.2	86.8	92.8	97.2

Normal Yield Table Values 2/

	Site I					Site II				
Age Years	No. Trees Per Acre	Ave. Ht of all Trees Feet	Dbh Ave. Tree	Volume 3/ Per Acre Cu. Ft.	Next 10 yr. Volume Increment Cu. Ft.	No. Trees Per Acre	Ave. Ht of all Trees Feet	Dbh Ave. Tree	Volume Per Acre Cu. Ft	Next 10 yr. Volume Increment Cu. Ft.
20	1500	36	2.9	360	910	2520	23	2.2	70	470
25	"	42	"	815	865	"	28	"	305	510
30	743	48	4.6	1270	820	1246	33	3.4	540	550
35	"	54	"	1680	780	"	38	"	815	530
40	472	60	6.0	2090	740	789	42	4.5	1090	510
45	"	66	"	2460	695	"	46	"	1345	495
50	374	70	7.2	2830	650	623	50	5.3	1600	480
55	"	74	"	3155	600	"	53	"	1840	455
60	304	78	8.3	3480	550	507	56	6.1	2080	430
65	"	81	"	3755	515	"	58	"	2295	410
70	252	83	9.3	4030	480	419	60	6.9	2510	390
75	"	85	"	4270	"	"	61	"	2705	"
80	224	87	10.2	4510	"	375	62	7.5	2900	"

Final Yield Conversion Factors 4/	Final Yield Conversion Factors
Board Feet = 4.7	Board Feet = 3.6
Cords = .0027	Cords = .0047

1/ From Gehrhardt's Formula when K = .8
2/ Technical Bulletin 560, USDA, Table 2. Site I = Site Index 70; Site II = Site Index 50. All trees 0.6 inches D.b.h. and over.
3/ Volume of Merchantable stem to a 4-inch top, outside bark.
4/ Number of board feet and cords per cubic foot of final yield. Same values as those of original Normal Yield Tables. Conversion factors used: 6 b.f. = 1 cu. ft., 80 cu. ft. = 1 cord.

Table A.4

DATA FOR COMPUTING YIELDS FROM MEDIUM AND LOW DEGREES OF MANAGEMENT INTENSITY

WHITE PINE

Present % of Stocking	10	20	30	40	50	60	70	80	90
% of Normal Growth during next 10 years 1/	18.1	34.4	48.9	61.6	72.5	81.6	88.9	94.4	98.1

Normal Yield Table Values 2/

	Site I					Site II				
Age Years	No. Trees Per Acre	Ave. Ht of Dom Trees Feet	Dbh Ave. Tree	Volume 3/ Per Acre Cu. Ft.	Next 10 yr. Volume Increment Cu. Ft.	No. Trees Per Acre	Ave. Ht of Dom Trees Feet	Dbh Ave. Tree	Volume Per Acre Cu. Ft.	Next 10 yr. Volume Increment Cu. Ft.
25	1460	32	4.3	2770	1700	1620	27	3.9	2430	1355
30	1070	40	5.3	3620	1770	1230	34	4.7	2830	1820
35	820	48	6.3	4470	1650	950	41	5.7	3785	1680
40	660	40	7.3	5390	1290	750	47	6.8	4650	1640
45	560	61	8.1	6120	1230	600	53	7.9	5465	1630
50	480	65	8.9	6680	1300	500	58	9.0	6290	1570
55	420	70	9.6	7350	1270	440	63	9.8	7095	1490
60	370	75	10.3	7980	1080	380	67	10.8	7860	1455
65	335	79	11.0	8620	"	340	72	11.5	8585	"
70	310	82	11.5	9060	"	315	76	12.1	9315	"

Final Yield Conversion Factors 4/	Final Yield Conversion Factors
Board Feet = 4.87	Board Feet = 4.78
Cords = .0024	Cords = .0025

1/ From Gehrhardt's Formula when K = .9
2/ E. E. Tarbox & P. M. Reed, Harvard Forest Bulletin No. 7, Table 17.
3/ Total Volume includes bark, stump, and top.
4/ Number of board feet and cords per cubic foot of final yield, taken from the Normal Yield Table and adjusted to represent utilization to a 6-inch top. Board foot contents of sawlogs measured by the International, ¼", log rule rather than by the mill tally rule of the original study. Conversion Factors used: 6 b.f. = 1 cu. ft., 80 Cu. Ft. = 1 cord.

Table A.4

DATA FOR COMPUTING YIELDS FROM MEDIUM AND LOW DEGREES OF MANAGEMENT INTENSITY

OLD FIELD WHITE SPRUCE

Present % of Stocking	10	20	30	40	50	60	70	80	90
% of Normal Growth during next 10 years 1/	19	36	51	64	75	84	91	96	99

Normal Yield Table Values 2/

	Site I					Site II				
Age Years	Ave. No. Trees Per Acre	Ave. Ht. D & C.D. Trees Feet	Ave. Dbh	Volume 3/ Per Acre Cu.Ft.	Next 10 yr. Volume Increment Cu. Ft.	Ave. No. Trees Per Acre	Ave. Ht. D & C.D. Trees Feet	Ave. Dbh	Volume Per Acre Cu.Ft.	Next 10 yr. Volume Increment Cu. Ft.
20	-	11	-	143	747	-	9	-	90	450
30	363	25	4.4	890	1970	143	18	4.2	540	1210
40	790	38	5.1	2860	1780	535	26	4.5	1750	1090
50	983	50	5.9	4640	1100	903	34	4.9	2840	670
60	868	58	7.0	5740	680	1044	38	5.4	3510	410
70	666	62	8.2	6420	460	973	41	6.0	3920	290
80	566	66	9.1	6880	400	912	44	6.4	4210	240
90	533	68	9.5	7280	-	882	45	6.6	4450	-

Final Yield Conversion Factors 4/
Board Feet - 5.8
Cords - 0.0009

Final Yield Conversion Factors
Board Feet - 1.5
Cords - 0.0024

1/ From Gehrhardt's Formula when K = 1.0
2/ W. H. Meyer, Technical Bulletin #142, U.S.D.A. Site I = Site 60; Site II = Site 40; all trees 4" Dbh and over.
3/ Total cubic foot volume per acre of all trees above 0.6 inch in D.b.h.
4/ Number of board feet and cords per cubic foot of final yield. Same values as those of original Normal Yield Tables. Conversion factors used: 6.7 bd. ft. = 1 cu. ft., 95 cu. ft. = 1 cord.

Table A.5

DATA FOR COMPUTING YIELDS FROM MEDIUM AND LOW DEGREES OF MANAGEMENT INTENSITY

OLD FIELD RED SPRUCE

Present % of Stocking	10	20	30	40	50	60	70	80	90
% of Normal Growth during next 10 years 1/	19	36	51	64	75	84	91	96	99

Normal Yield Table Values 2/

	Site I					Site II				
Age Years	Ave. No. Trees Per Acre	Ave. Ht. D. & C.D Trees Feet	Ave. Dbh	Volume 3/ Per Acre Cu.Ft.	Next 10 yr. Volume Increment Cu. Ft.	Ave. No. Trees Per Acre	Ave. Ht. D. & C.D Trees Feet	Ave. Dbh	Volume Per Acre Cu.Ft.	Next 10 yr. Volume Increment Cu. Ft.
20	-	9	-	-	-	-	7	-	-	-
30	363	20	4.4	340	1310	143	13	4.2	88	512
40	790	34	5.1	1650	2120	535	20	4.5	600	1070
50	983	47	5.9	3770	1780	903	28	4.9	1670	1080
60	868	57	7.0	5550	1070	1044	35	5.4	2750	720
70	666	62	8.2	6620	660	973	39	6.0	3470	450
80	566	64	9.1	7280	370	912	42	6.4	3920	240
90	533	66	9.5	7650	-	882	44	6.6	4160	-

Final Yield Conversion Factors 4/
Board Feet - 5.6
Cords - 0.0017

Final Yield Conversion Factors
Board Feet - 2.9
Cords - 0.0045

1/ From Gehrhardt's Formula when K = 1.0
2/ W. H. Meyer, Technical Bulletin #142, U.S.D.A. Site I = Site 60; Site II = Site 40; all trees 4" Dbh. and over.
3/ Merchantable volume of all trees over 4 inches D.b.h., to a 3-inch top, inside bark.
4/ Number of board feet and cords per cubic foot of final yield. Same values as those of original Normal Yield Tables. Conversion Factors used: 6.7 b.f. = 1 cu. ft., 95 cu. ft. = 1 cord (peeled)

Hardwood Forest Types

There is considerable evidence indicating that the volume of a hardwood tree of given dimensions does not vary much among the several species.[6] Thus, it will do little violence to the facts if estimates are made in terms of average trees without regard to species.

a. Tree Dimensions

A recent publication[7], based on work at the Harvard Forest, has presented the probable dimensions that will be attained by red oak and white ash crop trees under a "high" degree of management intensity. The specific management program used envisioned maintaining a densely stocked stand until the trees are about fifty feet tall and the first log is cleared of branches; then partial-cuttings are made to keep the crowns of selected crop trees free to grow. It was discovered that a definite relationship between tree height and the other tree dimensions existed in the sample data. Therefore, tree height is used as the independent variable with which the other dimensions are compared. It is necessary in this study, however, to convert these variables to an age basis in the final tables.

Since red oak and white ash occupy opposite ends of the scale of tolerance[8] it was thought that an average between their dimensions would

6/ E. S. Carter, The Northern Hardwood Forest, U.S.D.A. Agriculture Bulletin No. 285, Washington, D. C., 1915.

7/ Torkel Nelsoe, The Relation of Tree Development to the Timing of the First Thinning in Even-Aged Hardwood Stands, Harvard Forest Papers, No. 2, Petersham, 1947.

8/ Tolerance as used here refers to the vigor with which tree species compete for light and growing space. Oak aggressively strives for room or is space-demanding, while ash is crowd-enduring and less aggressive in competition.

be a conservative representation of the crop trees developed by a "high" degree of management intensity. These figures served as a basis for the Northern Hardwood type on a site I, since all of the basic measurements were made on the best sites. It was assumed that the relationships between tree height, d.b.h. crown diameter and clear and dead length would be the same on the other sites and for other hardwood types. Thus, it only remained to estimate a height on age curve for these other sites and types.

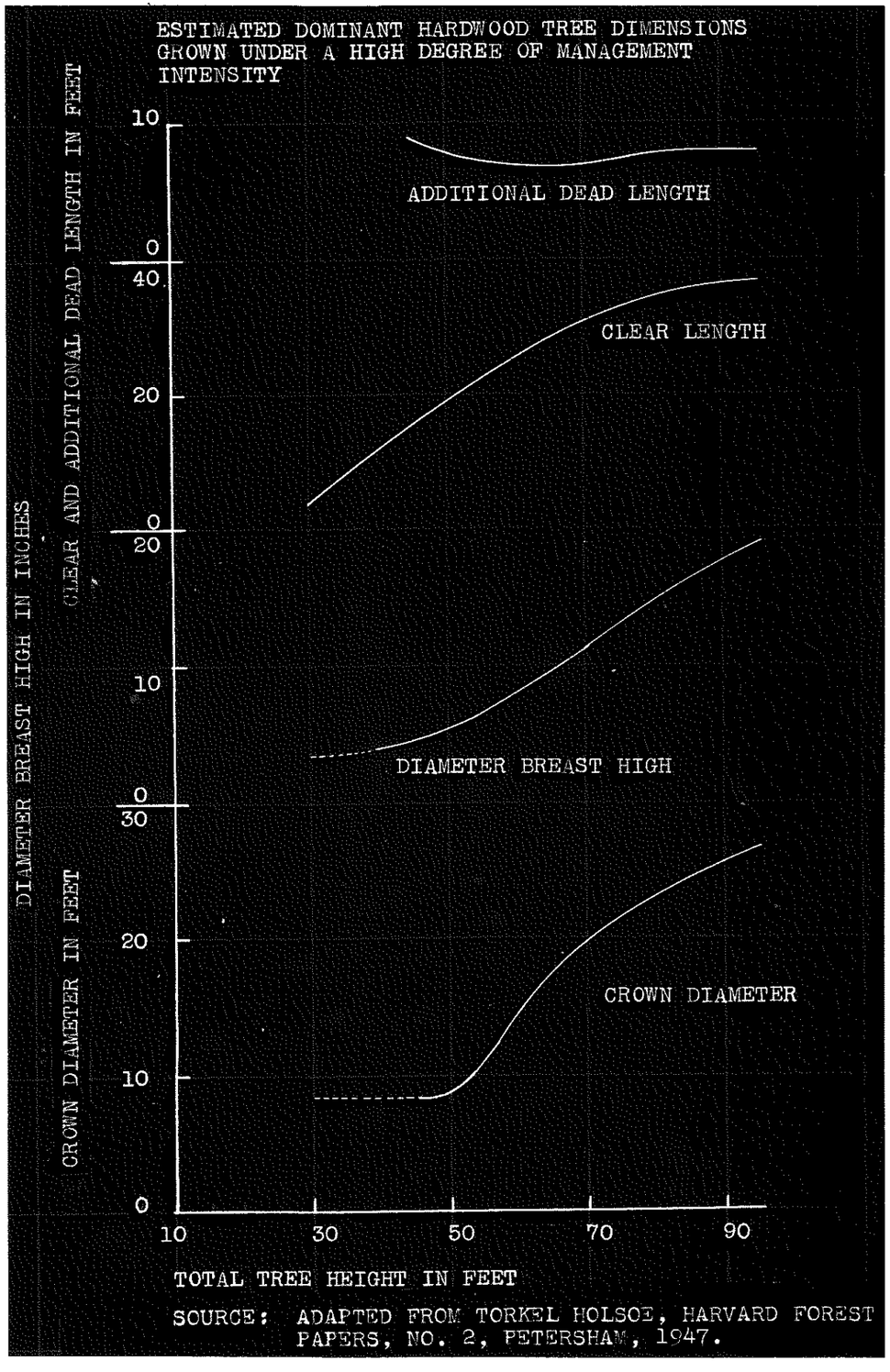
This curve for the Northern Hardwoods, Site II, was taken to bear the same percentage relationship to the Site I curve as was shown in a Normal Yield Table for the same type.[9] Thus if the Normal Yield Table showed Site II trees as five percent shorter than those on a site I at thirty years of age, the site II trees in the managed stand at that age were also assumed to be five percent shorter than those on a site I.

Height on age curves for sites I and II for Central Hardwoods were taken directly from a Normal Yield Table for sites 70 and 50.[10] The figures given in this table are for the "total height of average dominant and co-dominant oak" in the normal stand. It was thought that these heights could certainly be attained in managed stands since they actually occurred in wild stands. The tree dimensions assumed are shown in Charts A.1 and A.2 and also appear in Tables A.6 and A.7.

9/ J. N. Spaeth, Growth, Study and Normal Yield Tables for Second Growth Hardwood Stands in Central New England, Harvard Forest Bulletin No. 2, Petersham, 1920.

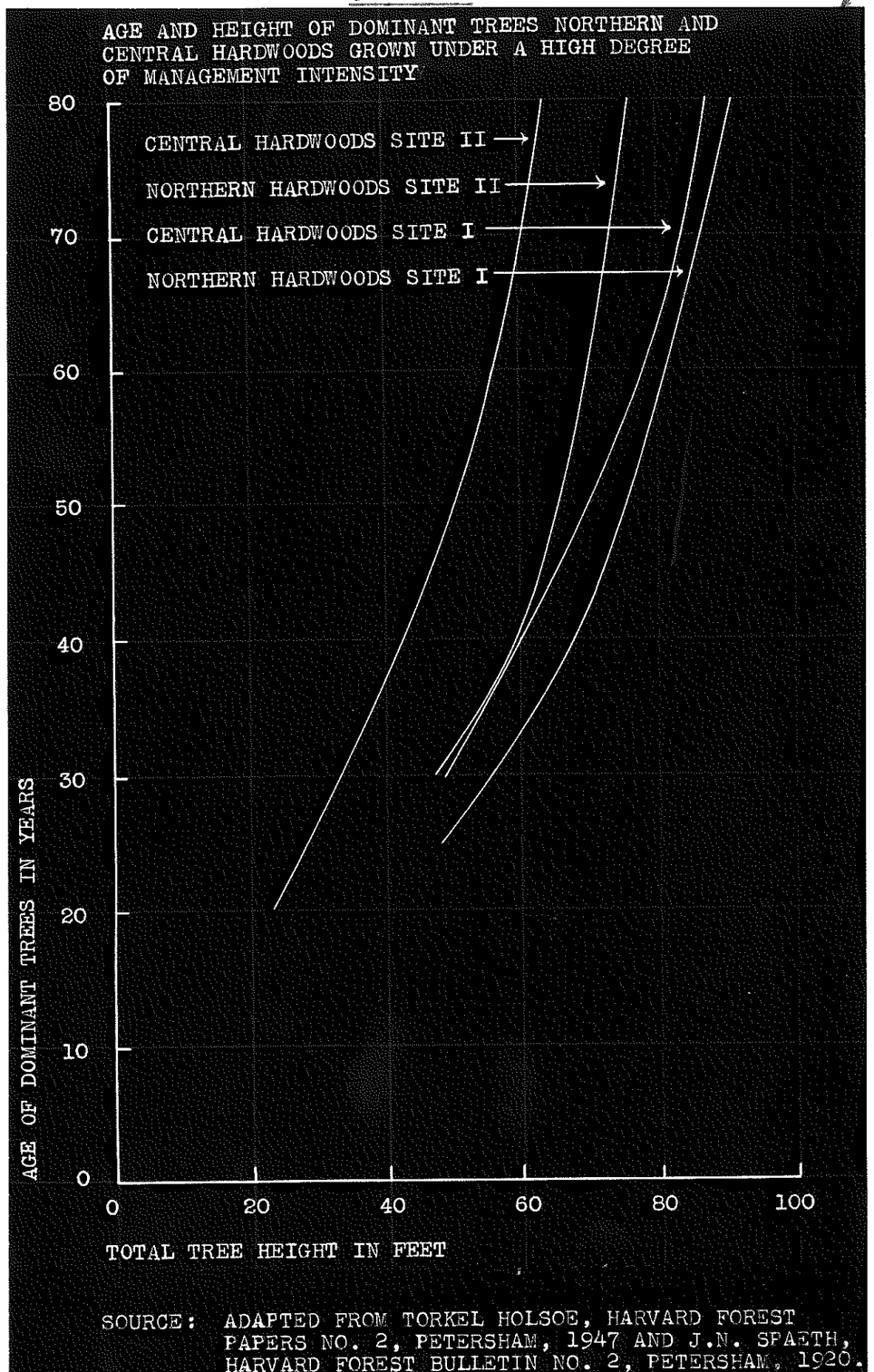
10/ C. L. Schnur, Yield, Stand and Volume Tables for Evenaged Upland Oak Forests, Allegheny Forest Experiment Station, Technical Bulletin No. 580, Forest Service, U.S.D.A., Washington, D. C., 1937.

Chart A.1



SOURCE: ADAPTED FROM TORKEL HOLSOE, HARVARD FOREST PAPERS, NO. 2, PETERSHAM, 1947.

Chart A.2



SOURCE: ADAPTED FROM TORKEL HOLSOE, HARVARD FOREST PAPERS NO. 2, PETERSHAM, 1947 AND J.N. SPAETH, HARVARD FOREST BULLETIN NO. 2, PETERSHAM, 1920.

Chart A.3

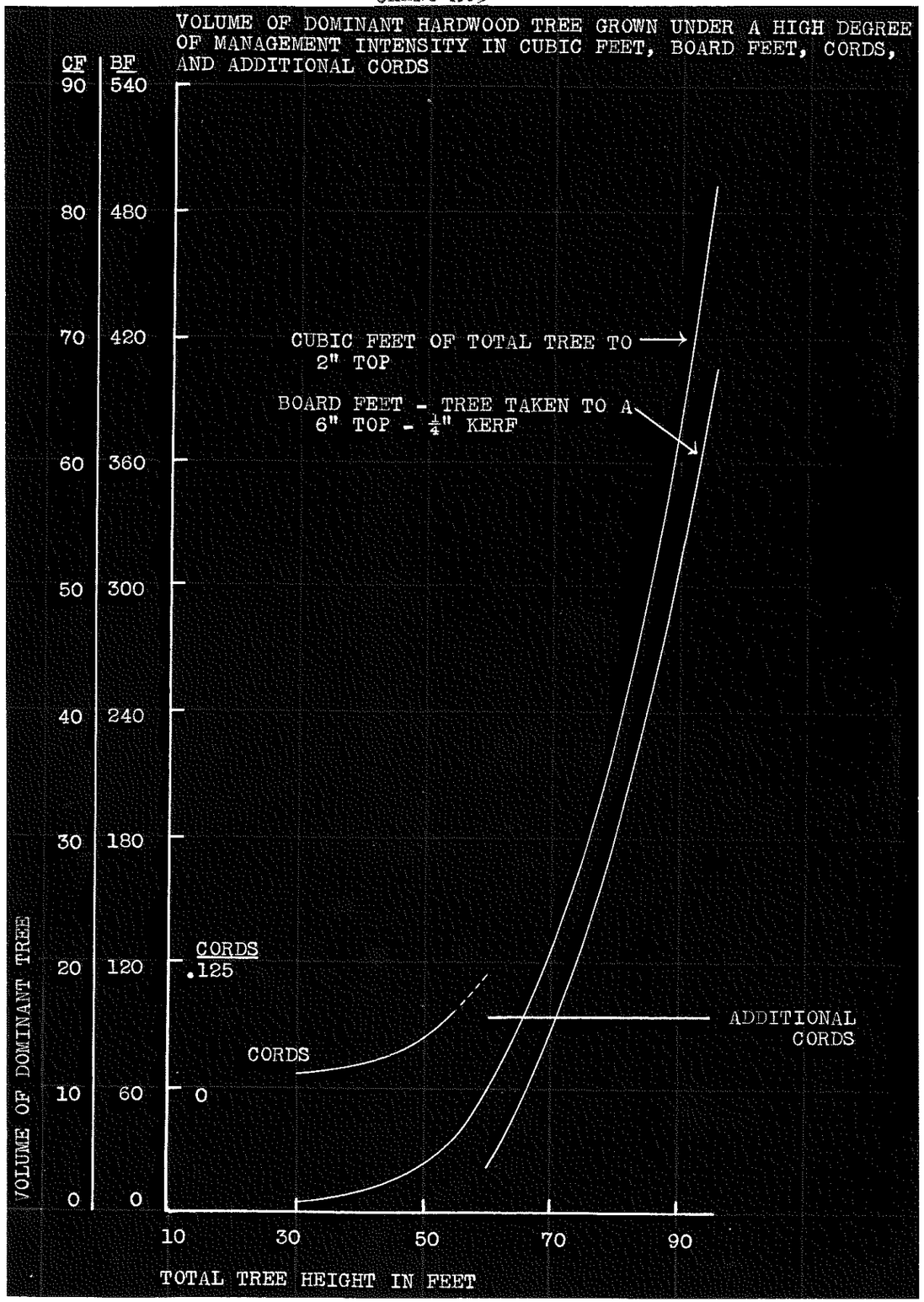


Table A.4

ESTIMATED YIELDS FROM INTENSIVELY MANAGED FULLY-STOCKED STANDS1/

NORTHERN HARDWOODS

Site I

Age	Crop Tree Height	Crop Tree D.b.h.	Leave				Cut2/			
			No. tr. per	Volume			No. tr. per	Volume		
Years	Feet	Inches	Acre	Cu.ft.	Bd.ft.	Cds.	Acre	Cu.ft.	Bd.ft.	Cds.
25	48.0	5.0	360	1116	-	15.7	370	1147	-	16.2
30	56.5	7.3	200	1500	-	18.0	160	1200	-	14.4
35	62.5	9.1	150	1875	4,950	10.5	50	625	1,650	3.5
40	68.0	10.8	130	2444	8,840	9.1	20	376	1,360	1.4
45	72.0	12.0	116	2830	11,948	8.1	14	342	1,442	1.0
50	75.5	13.1	109	3270	15,042	7.6	7	210	996	.5
55	78.0	14.0	102	3519	17,034	7.1	7	242	1,169	.5
60	81.0	14.8	95	3886	19,095	6.7	7	286	1,407	.5
65	83.5	15.6	90	4140	20,880	6.3	5	330	1,160	.4
70	86.0	16.3	86	4483	22,532	6.0	4	309	1,048	.3
75	88.5	17.1	83	4897	24,900	5.8	3	177	900	.2
80	91.0	17.7	-	-	-	-	83	5561	27,888	5.8
				Total Yield				10,605	38,990	44.7
				Intermediate Yield				5,044	11,102	38.9

Site II

Age	Crop Tree Height	Crop Tree D.b.h.	Leave				Cut2/			
			No.tr. per	Volume			No.tr. per	Volume		
Years	Feet	Inches	Acre	Cu.ft.	Bd.ft.	Cds.	Acre	Cu. ft.	Bd.ft.	Cds.
30	47.9	5.0	480	1380	-	19.6	272	816	-	11.6
35	54.6	6.7	245	1470	-	19.6	215	1290	-	17.2
40	60.0	8.4	189	1909	4,158	13.2	56	566	1,232	3.9
45	63.4	9.4	165	2211	6,270	11.6	24	322	912	1.7
50	65.8	10.2	149	2369	7,748	10.4	16	254	832	1.1
55	68.0	10.8	139	2599	9,452	9.7	10	187	680	.7
60	69.6	11.2	130	2730	10,400	911	9	189	720	.6
65	70.9	11.7	126	2848	11,456	8.8	4	90	364	.3
70	72.2	12.1	122	3060	12,932	8.5	4	100	424	.3
75	73.4	12.5	120	3240	14,400	8.4	2	54	240	.1
80	74.4	12.8	-	-	-	-	120	3420	15,480	8.4
				Total Yield				7,288	20,884	45.9
				Intermediate Yield				3,868	5,404	37.5

1/ Adapted from T. Nelson, Harvard Forest Paper No. 2, 1947, and J. N. Spaeth, Harvard Forest Bulletin No. 2, 1920.

2/ Trees removed in intermediate, partial cuttings plus final yield that may be harvested gradually to insure prompt and valuable reproduction.

Table A.7

ESTIMATED YIELDS FROM INTENSIVELY MANAGED FULLY-STOCKED STANDS1/

CENTRAL HARDWOODS

Site I

Age	Crop Tree Height	Crop Tree D.b.h.	Leave				Cut2/			
			No.tr. per	Volume			No.tr. per	Volume		
Years	Feet	Inches	Acre	Cu.ft.	Bd.ft.	Cds.	Acre	Cu.ft.	Bd.ft.	Cds.
30	48	5.0	480	1488	-	21.1	250	775	-	11.0
35	54	6.5	245	1396	-	15.6	235	1339	-	17.9
40	60	8.4	175	1767	3,850	12.2	70	707	1,540	4.9
45	65	9.8	138	2042	6,210	9.7	37	548	1,665	2.6
50	70	11.4	120	2544	9,960	8.4	18	382	1,494	1.3
55	74	12.6	110	3026	13,640	7.7	10	275	1,240	.7
60	78	13.8	102	3519	16,932	7.1	8	276	1,328	.6
65	81	14.7	96	3917	19,296	6.7	6	245	1,206	.4
70	83	15.4	93	4194	21,018	6.5	3	135	678	.2
75	85	16.0	90	4482	22,410	6.3	3	149	747	.2
80	87	16.6	-	-	-	-	90	4950	25,020	6.3
					Total Yield			9,781	34,918	46.1
					Intermediate Yield			4,031	9,898	39.8

Site II

Age	Crop Tree Height	Crop Tree D.b.h.	Leave				Cut2/			
			No.tr. per	Volume			No.tr. per	Volume		
Years	Feet	Inches	Acre	Cu.ft.	Bd.ft.	Cds.	Acre	Cu.ft.	Bd.ft.	Cds.
20	28	-	-							
25	28	3.4	-							
30	33	3.7	-							
35	38	4.0	-							
40	42	4.2	-							
45	46	4.7	-							
50	50	5.5	530	1961	-	28.0	185	684	-	9.8
55	53	6.3	390	2028	-	29.6	140	728	-	10.6
60	56	7.1	310	2170	4,340	21.7	80	560	1,120	5.6
65	58	7.7	245	2156	5,680	17.1	65	572	1,560	4.5
70	60	8.4	225	2317	7,200	15.7	20	206	640	1.4
75	61	8.7	205	2296	7,790	14.3	20	224	760	1.4
80	62	9.0	-	-	-	-	205	2460	9,020	14.3
					Total Yield			5434	13,100	47.6
					Intermediate Yield			2974	4,080	33.3

1/ Adapted from T. Holmes, Harvard Forest Paper No. 2, 1947 and C. L. Schnur, Technical Bulletin No 560, USDA, 1937.

2/ Trees removed in intermediate, partial cuttings plus final yield that may be harvested gradually to insure prompt and valuable reproduction.

b. Tree Volumes

The following tables and conversion factors were used in computing the volume of trees in accordance with the system previously mentioned. Cubic foot contents were estimated from tables specifically constructed to apply to hardwoods, regardless of species.11/ Board foot volumes were taken from the International Log Rule constructed for a ¼ inch saw kerf. A conversion factor of six board feet per cubic foot was also used. The number of cubic feet of solid wood per stacked rough cord was taken as that shown in a table based on the differences that occur because of variation in the size of stick cut.12/ The calculated volumes of the projected crop trees are shown in Chart A.5 and also in Tables A.6 and A.7.

White Pine and Mixed Softwoods

The silvicultural system used for White Pine and mixed Softwood stands is that outlined in a study at the Harvard Forest.13/ This plan assumes a rotation of about seventy to seventy-five years with two partial-cuttings at about fifteen year intervals, to improve stand composition and to stimulate the growth of crop trees. The first of these cuts is made at about forty years of age on a site I and forty-five years of age on a site II. Weeding and pruning in accordance with good silviculture is also assumed.

11/ H. C. Hawley, R. G. Wheaton, Studies of Connecticut Hardwoods, Yale University: School of Forestry, Bulletin No. 17, New Haven, 1926.

12/ H. H. Carter, The Northern Hardwood Forest, U.S.D.A. Agriculture Bulletin No. 285, Washington, D. C., 1915.

13/ S. N. Gevorkiants and H. H. Hawley, Form and Development of White Pine Stands in Relation to Growing Space, Harvard Forest Bulletin No. 13, Petersham, 1929.

a. Tree Dimensions

Gevorkiantz and Hosley show the average tree dimensions likely to be attained by this management in a stand growing on a good site. The average d.b.h., crown diameter and dead length associated with various tree heights were used in this study. Tarbox and Reed show the average height and age relationships attained by dominant trees in wild stands on sites I and II; these were used in combination with the other tree dimensions. The above relationships are shown in Charts A.4 and A.5 and in Table A.8.

b. Tree Volumes

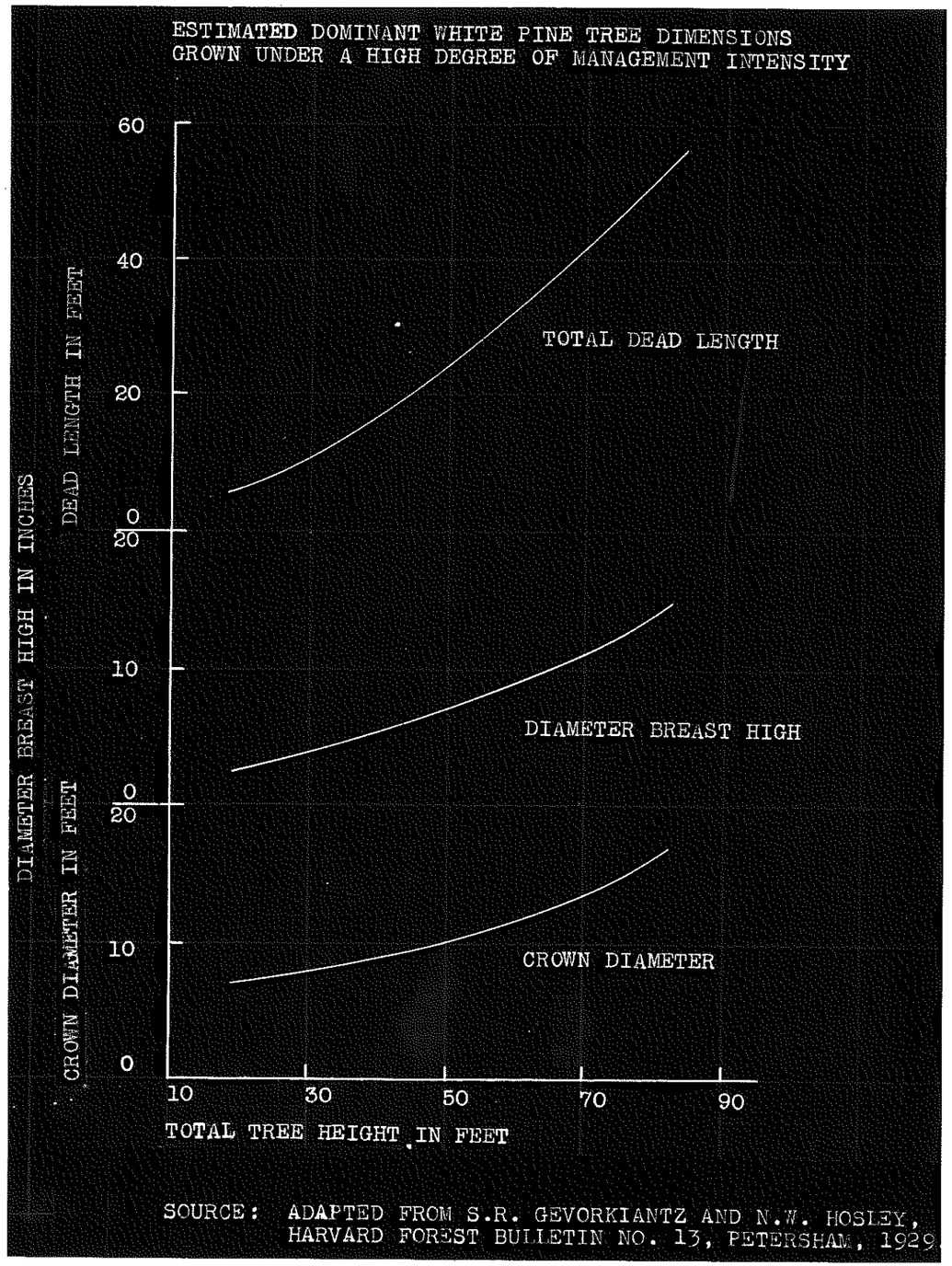
Cubic foot volume tables worked out by Gevorkiantz and Hosley were used to estimate the content of the trees. Form classes appropriate for the managed tree dimensions were estimated from Tables 9 and 10 of the above study, and Table 21 provided board foot-cubic foot conversion factors. These factors vary with the height and d.b.h. of the trees. Board foot volumes were estimated by dividing the trees into logs, as previously described, and measuring the contents in accordance with the International, ¼ inch, Log Rule. A conversion factor of eighty cubic feet of solid wood per rough cord of stacked wood was used. The results of these calculations are shown in Chart A.6 and Table A.8.

Old Field Spruce-Fir

A good deal of difficulty was encountered in finding information on which to base tree dimension estimates for spruce and fir stands. The publications consulted[14/] indicate that stands originating on old fields

14/ L. S. Murphy, The Red Spruce; Its Growth and Management, U.S.D.A. Bulletin No. 544, Washington, D. C., 1917. W. H. Meyer, Yields of Second-Growth Spruce and Fir in the Northeast, U.S.D.A., Technical Bulletin No. 142, Washington, D. C., 1928. W. Westveld, Yield Tables for Cut-Over, Spruce-Fir Stands in the Northeast, U.S.D.A., Northeastern Forest Experiment Station, Occasional Paper No. 12, New Haven, 1941.

Chart A.4



SOURCE: ADAPTED FROM S.R. GEVORKIANTZ AND N.W. HOSLEY, HARVARD FOREST BULLETIN NO. 13, PETERSHAM, 1929

Chart A.5

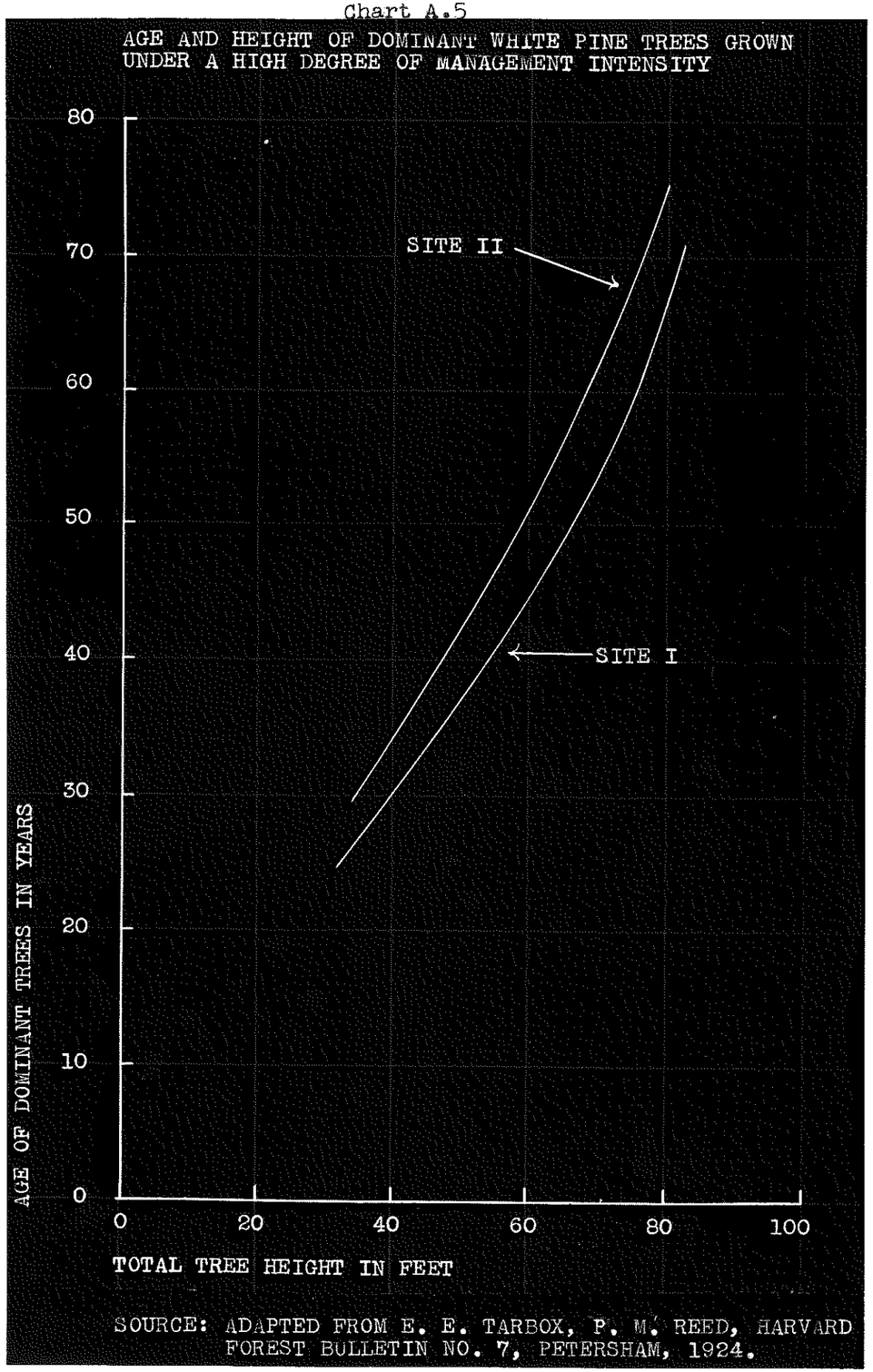


Chart A.6

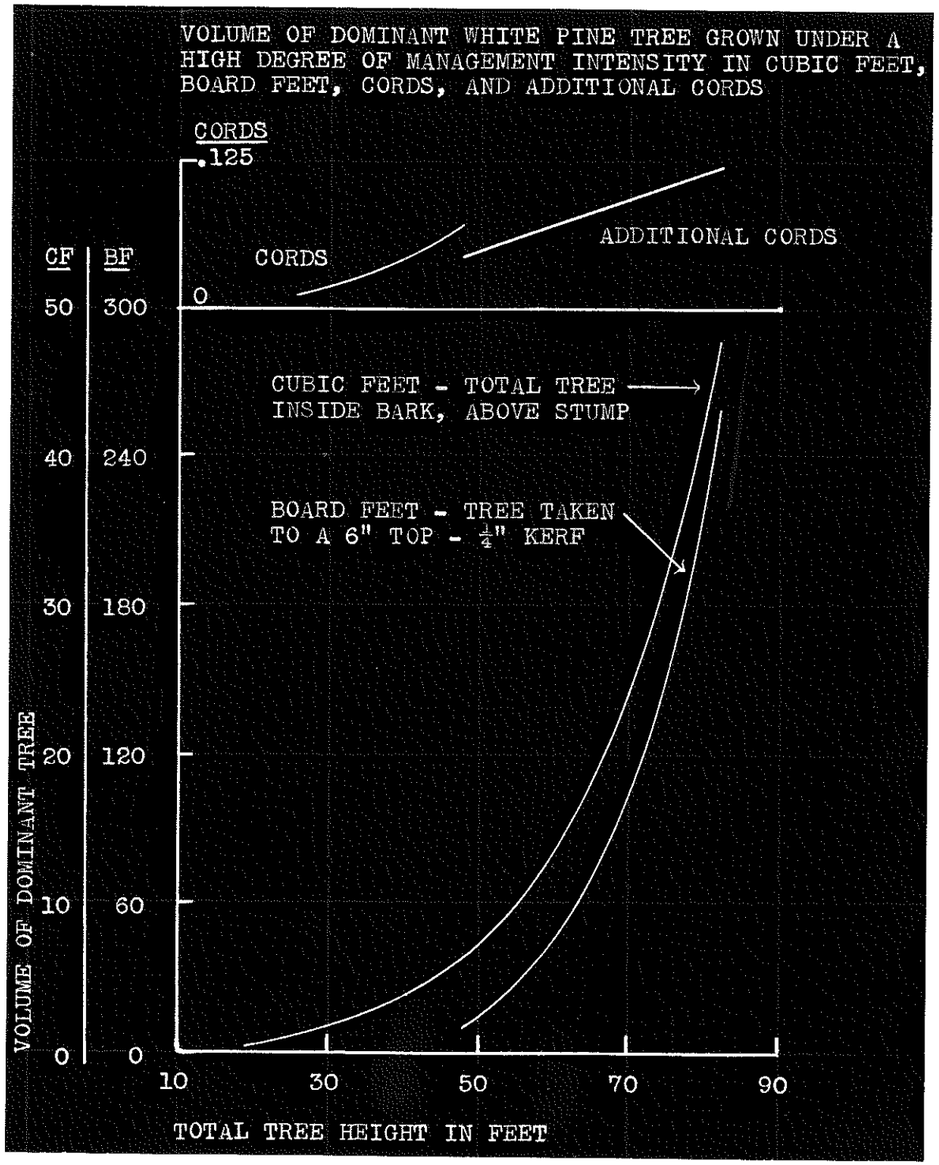


Table A.6

ESTIMATED YIELDS FROM INTENSIVELY MANAGED FULLY-STOCKED STANDS1/

WHITE PINE

Site I

Age	Crop Tree Height	Crop Tree D.b.h.	Leave				Cut2/			
			No.tr. per	Volume			No.tr. per	Volume		
Years	Feet	Inches	Acre	Cu.ft.	Bd.ft.	Cds.	Acre	Cu.ft.	Bd.ft.	Cds.
25	32	4.6	500	980	-	11.2	-			
30	40	5.8	500	1800	-	20.0	-			
35	48	7.0	500	3000	5,000	21.9	-			
40	55	8.2	280	2680	6,720	16.8	220	2090	5,280	13.2
45	61	9.5	280	4004	13,720	20.5	-			
50	65	10.6	280	5208	19,880	23.1	-			
55	70	11.6	180	4374	19,260	16.6	100	2430	10,700	9.2
60	75	12.8	180	5940	27,180	18.4	-			
65	79	13.9	180	7416	35,000	20.2	-			
70	82	14.8	-	-	-	-	180	8640	44,640	21.8
					Total Yield			13,160	60,620	44.2
					Intermediate Yield			4,520	15,980	22.4

Site II

Age	Crop Tree Height	Crop Tree D.b.h.	Leave				Cut2/			
			No.tr. per	Volume			No.tr. per	Volume		
Years	Feet	Inches	Acre	Cu.ft.	Bd.ft.	Cds.	Acre	Cu.ft.	Bd.ft.	Cds.
30	34	4.8	500	1000	-	10.2	-			
35	41	5.9	500	1950	-	21.2	-			
40	47	6.9	500	2700	4,000	20.0	-			
45	53	7.8	300	2460	5,700	16.4	200	1640	3,800	10.8
50	58	8.8	200	3540	10,500	19.1	-			
55	63	9.9	300	4800	18,000	22.9	-			
60	67	10.9	200	4120	17,000	17.2	100	2060	8,500	8.6
65	72	12.0	300	5660	24,600	19.5	-			
70	76	13.0	200	7000	18,400	21.2	-			
75	79.5	13.9	-	-	-	-	200	8400	41,200	22.8
					Total Yield			12,400	53,500	42.2
					Intermediate Yield			3,700	12,300	19.4

1/ Adapted from data presented by S. H. Gevorkiantz and N. W. Hosley in Harvard Bulletin 13, 1929, and E.E. Tarbox and F. N. Reed, Harvard Forest Bulletin # 7, 1924.

2/ Trees removed in intermediate, partial cuttings plus final yield that may be harvested gradually to insure prompt and valuable reproduction.

contain a much greater volume of wood than those originating under forest conditions. Since the farm woodlot stands included in this study grew up on abandoned fields the higher estimates were used.

It was also apparent that a considerable difference exists between stands that are predominantly Red Spruce, White Spruce or Balsam Fir. It was thought that estimates based on White Spruce would be most applicable to the farm woodlands actually considered.

The silvicultural program assumed for this forest type consists of partial-cuttings at approximately ten year intervals, starting at about thirty-five years of age on a site I and at fifty years of age on a site II. These cuttings will remove the poorer trees for pulpwood, allowing the best spruce to grow into sawlogs for harvesting after about eighty years. About one-fifth of the trees will be removed in each cutting. Weeding and pruning will also be done in accordance with good silvicultural practices.

a. Tree Dimensions

Little data is available to indicate the tree dimensions attainable under such a forestry program. The average heights of dominant, co-dominant and intermediate trees at various ages, shown by Murphy15/, on sites I and III, were taken to indicate the goals attainable by the above management practices. The d.b.h. reached by trees of a given height was estimated from data on wild stands.16/ The estimated number of trees per

15/ L. S. Murphy, The Red Spruce: Its Growth and Management, Table 5.

16/ The following height on diameter breast high curves were plotted:
1. Dominant and Co-dominant Red Spruce on Sites 40 and 60 from Tables 1 and 20, Meyer.
2. Average dominant and co-dominant and intermediate spruce

acre was based on the Normal Yield Table after taking account of the trees removed in partial-cuttings. All of the above data are shown in Charts A.7 and A.8 and in Table A.9.

b. Tree Volumes

The cubic foot and board foot contents of the estimated crop trees were determined from Tables 24 and 28 of Meyer's bulletin. These tables assume a form class of 75 and measure board feet by the International, 1/8 inch, Log Rule. The White Pine board foot-cubic foot ratios were used along with a ninety to one, cubic foot-rough cord ratio. These volume estimates for the projected crop tree are shown in Chart A.9 and Table A.9.

Application of Crop Tree Data to Actual Stands

To make allowance for the present stocking of a given stand, a special system was devised for applying the estimated crop tree development data. In taking the sample plots in woodland stands, the trees were carefully divided into stems suitable for "crop trees" and "other trees." An estimate was also made of the trees that should be removed in the first partial-cutting. The records thus show the number of trees by two-inch diameter classes, subdivided as to "crop" and "other" trees, on a "cut and leave basis." An example of the tally sheet appears in Appendix B.

16/ (continued)
on sites I, II and III, Table 5, Murphy.
3. Average height and d.b.h. of Norway Spruce in Germany, sites, I, II and III, table 18, Murphy.
A compromise curve, estimated by ocular inspection, was then drawn, using the above as a guide. This curve was used to show the height and d.b.h. relationship of crop trees under a "high" degree of management intensity.

Chart A.7

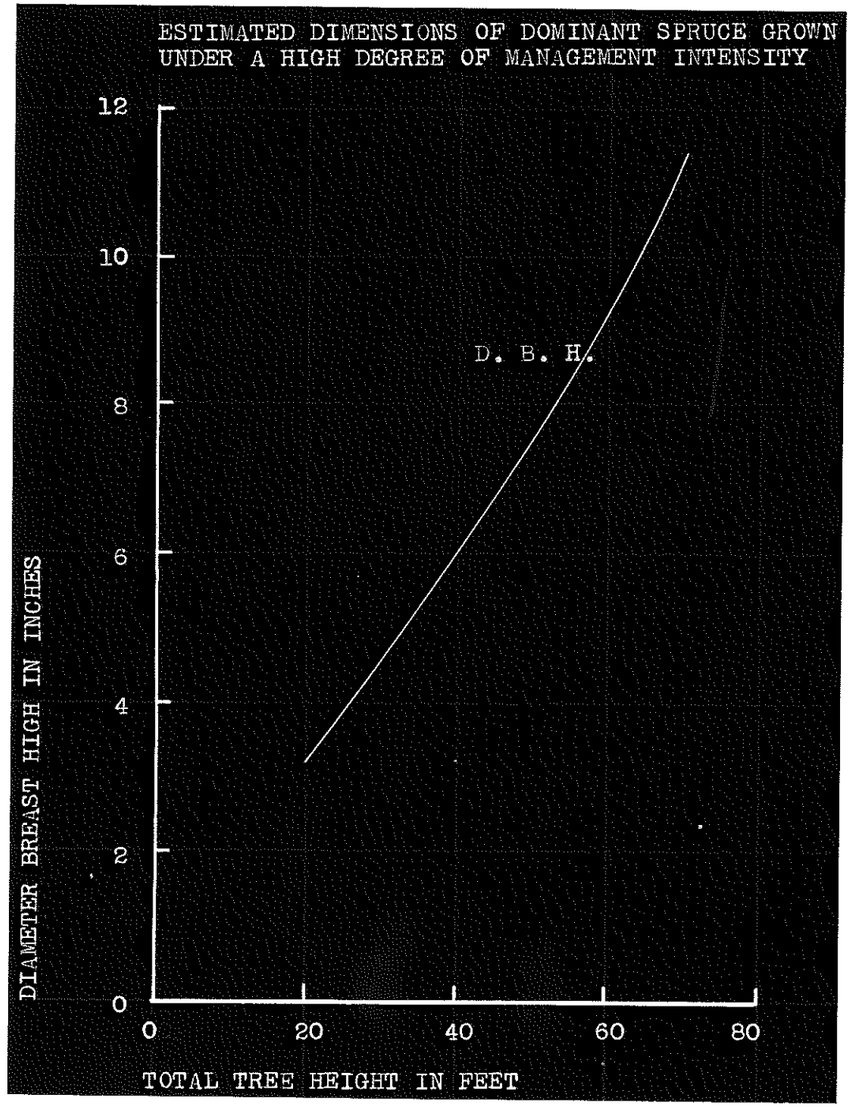
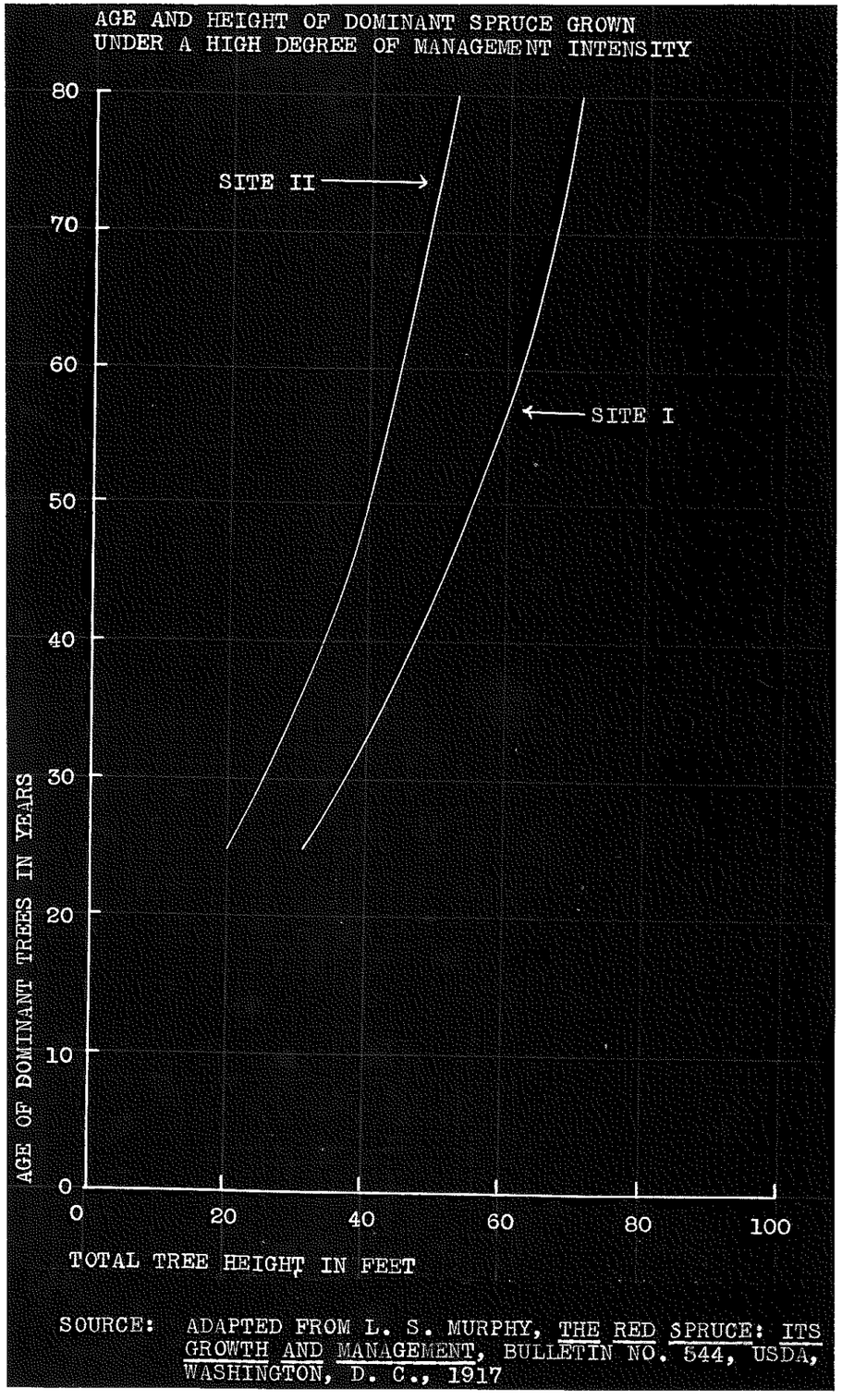


Chart A.8



SOURCE: ADAPTED FROM L. S. MURPHY, THE RED SPRUCE: ITS GROWTH AND MANAGEMENT, BULLETIN NO. 544, USDA, WASHINGTON, D. C., 1917

Chart A.9

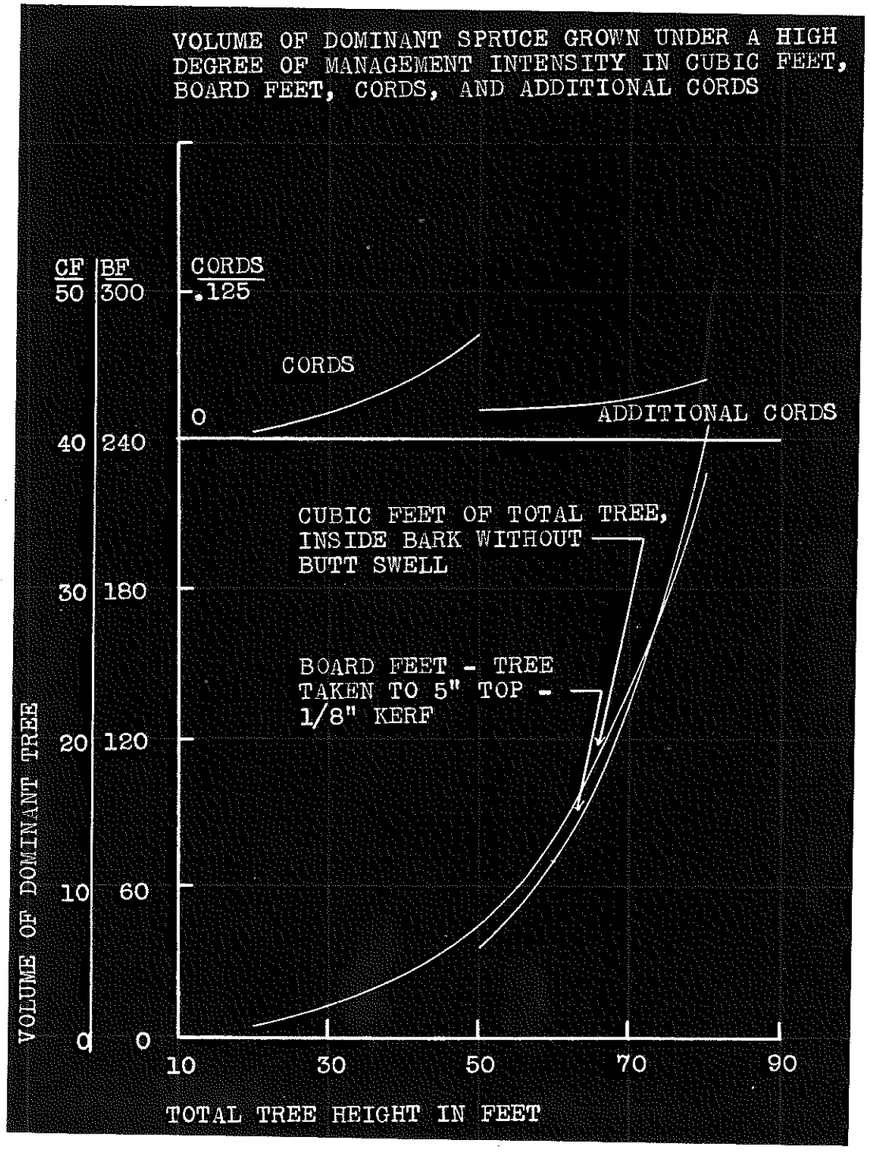


Table A.9

ESTIMATED YIELDS FROM INTENSIVELY MANAGED FULLY-STOCKED STANDS1/

OLD FIELD SPRUCE AND FIR

Site I

Age	Crop Tree Height	Crop Tree D.b.h.	Leave				Cut2/			
			No.tr. per	Volume			No.tr. per	Volume		
Years	Feet	Inches	Acre	Cu.ft.	Bd.ft.	Cds.	Acre	Cu.ft.	Bd.ft.	Cds.
25	31.5	4.9	850	-	-	-	-	-	-	-
30	37.9	5.7	720	2304	-	24.0	-	-	-	-
35	42.0	6.5	535	2675	-	28.0	115	575	-	6.0
40	46.5	7.2	535	3026	-	32.8	-	-	-	-
45	51.0	7.8	445	3871	16,910	10.5	90	783	3420	2.0
50	55.0	8.4	445	4895	21,360	11.1	-	-	-	-
55	58.2	8.9	370	4773	22,940	9.2	75	968	4650	2.0
60	61.0	9.5	370	5560	28.490	9.2	-	-	-	-
65	64.0	10.0	300	5130	27,900	7.9	70	1197	6510	1.8
70	66.0	10.4	300	5730	31,800	8.3	-	-	-	-
75	68.0	10.8	300	6330	36,000	9.0	-	-	-	-
80	70.0	11.4	-	-	-	-	300	7110	40800	9.7
					Total Yield			10,633	55390	21.5
					Intermediate Yield			3523	14580	11.8

Site II

Age	Crop Tree Height	Crop Tree D.b.h.	Leave				Cut2/			
			No.tr. per	Volume			No.tr. per	Volume		
Years	Feet	Inches	Acre	Cu.ft.	Bd.ft.	Cds.	Acre	Cu.ft.	Bd.ft.	Cds.
25	20.0	3.2	1700	-						
30	25.0	3.9	1290	-						
35	30.0	4.7	890	-						
40	34.0	5.3	780	-						
45	37.0	5.7	720	2304	-	24.0				
50	40.0	6.2	560	2408	-	27.0	110	473	-	5.2
55	42.5	6.6	560	2856	-	31.0	-	-	-	-
60	45.0	6.9	470	2820	-	30.0	90	540	-	5.7
65	47.0	7.2	470	3390	-	36.2	-	-	-	-
70	48.5	7.4	400	3040	-	33.0	70	532	-	5.7
75	50.4	7.7	400	3400	14,800	10.0	-	-	-	-
80	52.0	8.0	-	-	-	-	400	3880	16,400	9.5
					Total Yield			5225	16,400	26.1
					Intermediate Yield			1545	-	16.6

1/ Adapted from L. S. Murphy, The Red Spruce: Its Growth and Management, Bulletin No. 644, U.S.D.A., Washington, D.C., 1917. And W. H. Meyer, Yields of Second-Growth Spruce and Fir in the Northeast, Technical Bulletin No. 142, U.S.D.A., Washington, D.C., 1929.

2/ Trees removed in intermediate, partial cuttings plus final yield that may be harvested gradually to insure prompt and valuable reproduction.

In estimating yields, only trees in the main canopy were considered. It was thought that the suppressed trees would probably die, or if cut that their volume would be negligible. It was then assumed that, once partial-cuttings had started, all of the trees would respond so that their growth would be like that estimated for the crop trees, of the given initial d.b.h.17/ Thus, all trees six inches in d.b.h. are assumed to follow the course of growth shown in the previous discussion for the appropriate forest type. The same is assumed for trees now eight, ten, twelve, etc. inches in diameter. Tables A.10 through A.17 have been constructed from the previous charts. They show the course of development followed by crop trees of various initial starting diameters, at five year intervals after partial-cuttings begin.

If trees not classified as crop trees are cut, an appropriate cull factor is applied to the board foot contents shown in these tables. Of course, the volumes of trees cut during the first operation after cruising can be determined directly from the field tally sheets.

Application of Tables to Second Rotation

It is thought that the cutting practices used with a "high" degree of management intensity will result in the prompt establishment of reproduction. This regeneration will probably result in fully-stocked stands amply supplied with desirable species. It was assumed that the second

17/ The response of trees of different crown classes to partial-cuttings is discussed by C. B. Stott in an article entitled "Grade Labeling Tree Vigor in Forest Management," Journal of Forestry, 47;11:900-903, November, 1949.

Table A.10

ESTIMATED CROP TREE DIMENSIONS AND VOLUMES IN INTENSIVELY-MANAGED, FULLY-STOCKED STANDS BY SUCCESSIVE FIVE YEAR PERIODS[1]/

NORTHERN HARDWOODS

	Site I											
	Starting D.b.h. [illegible]											
	4" [illegible]				6" [illegible]				8" [illegible]			
5 Year Periods	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.
0-5	4.0	40	-	.023	6.0	52	-	.064	8.0	59	-	.106
5-10	5.5	50	-	.053	8.0	59	-	.106	9.8	65	45	.070
10-15	7.7	58	-	.100	9.8	65	45	.070	11.4	70	83	.070
15-20	9.6	64	40	.070	11.4	70	83	.070	12.6	74	124	.070
20-25	11.1	69	175	.070	12.6	74	124	.070	13.6	77	155	.070
25-30	12.3	73	113	.070	13.6	77	156	.070	14.5	80	190	.070
30-35	13.3	76	144	.070	14.5	80	190	.070	15.1	82	213	.070
35-40	14.2	79	178	.070	15.1	82	213	.070	15.8	84	237	.070
40-45	14.8	81	201	.070	15.8	84	237	.070	16.6	87	278	.070
45-50	15.6	84	238	.070	16.6	87	278	.070	17.4	89	306	.070
50-55	16.4	86	264	.070	17.4	89	306	.070	18.0	91	336	.070
55-60	17.3	89	306	.070	18.0	91	336	.070	-	-	-	-
60-65	17.8	91	336	.070	-	-	-	-	-	-	-	-
	10" [illegible]				12" [illegible]				14" [illegible]			
0-5	10.0	65	45	.070	12.0	72	102	.070	14.0	78	167	.070
5-10	11.4	70	83	.070	13.1	75	133	.070	14.8	81	201	.070
10-15	12.6	74	124	.070	13.8	78	167	.070	15.5	83	225	.070
15-20	13.6	77	155	.070	14.8	81	201	.070	16.4	86	264	.070
20-25	14.5	80	190	.070	15.5	83	225	.070	17.1	88	294	.070
25-30	15.1	82	213	.070	16.4	86	264	.070	18.0	91	336	.070
30-35	15.8	84	237	.070	17.1	88	294	.070				
35-40	16.6	87	278	.070	18.0	91	336	.070				
40-45	17.4	89	306	.070								
45-50	18.0	91	336	.070								
	16" [illegible]											
0-5	16.0	85	249	.070								
5-10	16.7	87	266	.070								
10-15	17.5	90	322	.070								

NUMBER OF CROP TREES PER ACRE FOR FULL-STOCKING												
Age in Years	25	30	35	40	45	50	55	60	65	70	75	80
No. trees per acre	360	200	150	130	116	109	102	95	90	86	83	83

1/ Adapted from T. Nelsoe, Harvard Forest Paper No. 2, 1947, and J. N. Spaeth, Harvard Forest Bulletin No. 2, 1920.

Table A.11

ESTIMATED CROP TREE DIMENSIONS AND VOLUMES IN INTENSIVELY-MANAGED FULLY STOCKED STANDS BY SUCCESSIVE FIVE YEAR PERIODS[1]

NORTHERN HARDWOODS

	Site II											
	Starting D.b.h.											
	4"				6"				8"			
5 Year Periods	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.	D.b.h. Inched	Ht Feet	Volume Bd.ft.	Volume Cds.
0-5	4.0	38.5	-	.022	6.0	52.0	-	.064	8.0	59.0	-	.106
5-10	4.7	46.2	-	.037	7.7	58.0	-	.100	9.3	63.0	35	.070
10-15	6.3	53.0	-	.071	9.1	62.3	32	.070	10.0	65.4	48	.070
15-20	8.0	59.0	-	.106	9.8	65.0	45	.070	10.7	67.5	64	.070
20-25	9.3	63.0	35	.070	10.5	67.0	60	.070	11.3	69.4	78	.070
25-30	10.0	65.4	48	.070	11.1	69.0	75	.070	11.7	70.8	90	.070
30-35	10.7	67.5	64	.070	11.5	70.4	87	.070	12.0	72.0	102	.070
35-40	11.3	69.4	78	.070	12.0	71.8	100	.070	12.3	73.2	115	.070
40-45	11.7	70.8	90	.070	12.3	73.0	113	.070	12.6	74.2	126	.070
45-50	12.0	72.0	102	.070	12.6	74.0	124	.070				
50-55	12.3	73.2	115	.070								
55-60	12.6	74.2	126	.070								
		10"				12"						
0-5	10.0	65.4	48	.070	12.0	72.0	102	.070				
5-10	10.7	67.5	64	.070	12.3	73.2	115	.070				
10-15	11.3	69.4	78	.070	12.6	74.2	126	.070				
15-20	11.7	70.8	90	.070								
20-25	12.0	72.0	102	.070								
25-30	12.3	73.2	115	.070								
30-35	12.6	74.2	126	.070								

NUMBER OF CROP TREES PER ACRE FOR FULL-STOCKING												
Age in Years	30	35	40	45	50	55	60	65	70	75	80	
No. trees per acre	460	245	189	165	149	139	130	126	122	120	120	

1. Adapted from T. Nelsoe, Harvard Forest Paper No. 2, 1947, and J. N. Spaeth, Harvard Forest Bulletin No. 2, 1920.

Table A-12

ESTIMATED CROP TREE DIMENSIONS AND VOLUMES IN INTENSIVELY-MANAGED, FULLY STOCKED STANDS BY SUCCESSIVE FIVE YEAR PERIODS 1/

CENTRAL HARDWOODS

Site I

5 Year Periods	Starting D.b.h. 4" D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Cds.	6" D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Cds.	8" D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Cds.
0-5	4.0	39.0	-	.021	6.0	51.5	-	.062	8.0	59.0	-	.106
5-10	4.6	45.8	-	.034	7.5	57.4	-	.098	9.7	64.4	42	.070
10-15	6.0	51.5	-	.062	9.4	63.5	37	.070	11.2	69.2	76	.070
15-20	7.5	57.4	-	.098	11.0	68.3	69	.070	12.4	73.3	116	.070
20-25	9.4	63.5	37	.070	12.3	72.6	110	.070	13.6	77.3	158	.070
25-30	11.0	68.3	69	.070	13.4	76.6	150	.070	14.5	80.2	192	.070
30-35	12.3	72.6	110	.070	14.4	79.6	184	.070	15.2	82.5	220	.070
35-40	13.4	76.6	150	.070	15.1	82.0	213	.070	16.0	85.0	249	.070
40-45	14.4	79.6	184	.070	15.9	84.4	243	.070	16.5	86.8	276	.070
45-50	15.1	82.0	213	.070	16.4	86.3	267	.070				
50-55	15.9	84.4	243	.070								
55-60	16.4	86.3	267	.070								
	10"				12"				14"			
0-5	10.0	65.4	48	.070	12.0	72.0	103	.070	14.0	78.5	171	.070
5-10	11.4	70.0	83	.070	13.2	75.9	143	.070	14.7	81.0	201	.070
10-15	12.6	74.2	124	.070	14.3	79.0	178	.070	15.5	83.6	231	.070
15-20	13.9	78.0	166	.070	14.9	81.6	206	.070	16.3	85.7	258	.070
20-25	15.0	81.8	210	.070	15.6	84.0	233	.070	16.7	87.2	280	.070
25-30	15.4	85.0	225	.070	16.3	86.0	263	.070				
30-35	16.1	85.2	252	.070								
35-40	16.6	87.0	278	.070								
	16"											
0-5	16.0	85.0	249	.070								
5-10	16.5	86.8	276	.070								

NUMBER OF CROP TREES PER ACRE FOR FULL-STOCKING

Age in years	30	35	40	45	50	55	60	65	70	75	80
No. trees per acre	480	245	175	138	120	110	102	96	93	90	90

1/ Adapted from T. Helsoe, Harvard Forest Paper No. 2, 1947 and C. L. Schnur, Technical Bulletin No. 560, USDA, 1937.

Table A-13

ESTIMATED CROP TREE DIMENSIONS AND VOLUMES IN INTENSIVELY-MANAGED, FULLY STOCKED STANDS BY SUCCESSIVE FIVE YEAR PERIODS 1/

CENTRAL HARDWOODS

Site II

5 Year Periods	Starting D.b.h. 4" D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Cds.	6" D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Cds.	8" D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Cds.
0-5	4.0	39.0	-	.022	6.0	51.5	-	.062	8.0	59.0	-	.106
5-10	4.3	43.0	-	.026	6.6	54.2	-	.078	8.6	60.7	25	.070
10-15	4.7	47.0	-	.039	7.4	56.8	-	.092	8.9	61.9	30	.070
15-20	5.7	50.5	-	.058	8.0	58.9	-	.105				
20-25	6.4	53.5	-	.075	8.5	60.3	23	.070				
25-30	7.3	56.2	-	.089	8.8	61.5	28	.070				
30-35	7.9	58.5	-	.102	9.0	62.1	31	.070				
35-40	8.4	60.2	23	.070								
40-45	8.7	61.3	27	.070								
45-50	9.0	62.0	30	.070								

NUMBER OF CROP TREES PER ACRE FOR FULL-STOCKING

Age in Years	50	55	60	65	70	75	80
No. trees per acre	530	390	310	245	225	205	205

1/ Adapted from T. Helsoe, Harvard Forest Paper No. 2, 1947 and C. L. Schnur, Technical Bulletin No. 560, USDA, 1937.

Table A.14

ESTIMATED CROP TREE DIMENSIONS AND VOLUMES IN INTENSIVELY-MANAGED FULLY STOCKED STANDS BY SUCCESSIVE FIVE YEAR PERIODS 1/

WHITE PINE

Site I

	Starting D.b.h. 4"				Starting D.b.h. 6"				Starting D.b.h. 8"			
5 Year Periods	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.
0-5	4.0	28.0	-	.013	6.0	40.0	-	.041	8.0	54.0	21	.055
5-10	5.0	35.0	-	.026	7.2	48.0	11	.041	9.2	60.0	44	.069
10-15	6.3	43.0	-	.049	8.1	55.0	24	.059	10.3	64.5	69	.080
15-20	7.5	51.0	15	.050	9.4	61.0	49	.072	11.4	69.0	100	.089
20-25	8.6	57.5	33	.062	10.4	65.0	72	.081	12.5	74.0	140	.101
25-30	9.9	63.0	60	.076	11.6	70.0	107	.092	13.6	78.2	188	.112
30-35	10.8	67.0	84	.086	12.7	75.0	151	.102	14.6	81.5	240	.116
35-40	12.1	72.0	124	.099	14.0	79.0	200	.112				
40-45	13.2	76.5	167	.107								
45-50	14.3	80.2	222	.115								
	10"				12"							
0-5	10.0	63.0	60	.076	12.0	72.0	124	.099				
5-10	10.8	67.0	84	.086	13.2	76.5	167	.107				
10-15	12.1	72.0	124	.099	14.3	80.2	222	.115				
15-20	13.2	76.5	167	.107								
20-25	14.3	80.2	222	.115								

NUMBER OF CROP TREES PER ACRE FOR FULL-STOCKING

Age in Years	25	30	35	40	45	50	55	60	65	70
No. trees per acre	500	500	500	280	280	280	180	180	180	180

1/ Adapted from data presented by S. R. Gevorkiantz and N. W. Hosley in Harvard Bulletin 13, 1929, and E. E. Terbox and P. M. Reed, Harvard Forest Bulletin No. 7, 1924.

Table A.15

ESTIMATED CROP TREE DIMENSIONS AND VOLUMES IN INTENSIVELY-MANAGED FULLY STOCKED STANDS BY SUCCESSIVE FIVE YEAR PERIODS 1/

WHITE PINE

Site II

	Starting D.b.h. 4"				Starting D.b.h. 6"				Starting D.b.h. 8"			
5 Year Periods	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.
0-5	4.0	28.0	-	.0135	6.0	41.5	-	.0450	8.0	54.0	20	.0525
5-10	5.0	35.0	-	.0252	6.9	47.0	9	.0400	8.9	59.0	38	.0662
10-15	6.1	42.0	-	.0462	7.7	53.0	18	.0525	10.1	63.8	65	.0762
15-20	7.1	48.1	10	.0438	8.7	58.0	35	.0650	11.2	68.1	92	.0875
20-25	8.0	54.0	20	.0525	10.0	63.0	65	.0775	12.4	72.6	129	.0988
25-30	8.9	59.0	38	.0662	10.8	67.0	78	.0850	13.2	76.6	168	.1087
30-35	10.1	63.8	65	.0762	12.1	72.0	123	.0980	14.2	80.0	215	.1150
35-40	11.2	68.1	92	.0875	13.0	76.0	162	.1075				
40-45	12.4	72.6	129	.0988	14.1	79.5	210	.1138				
45-50	13.2	76.6	168	.1087								
50-55	14.2	80.0	215	.1150								
	10"				12"							
0-5	10.0	63.0	65	.0775	12.0	71.9	122	.0980				
5-10	10.8	67.0	78	.0850	13.0	76.0	162	.1075				
10-15	12.1	72.0	123	.0980	14.1	79.5	210	.1138				
15-20	12.6	76.0	162	.1076								
20-25	14.1	79.5	210	.1138								

NUMBER OF CROP TREES PER ACRE FOR FULL-STOCKING

Age in years	30	35	40	45	50	55	60	65	70	75
No. trees per acre	500	500	500	300	300	300	200	200	200	200

1/ Adapted from data presented by S. R. Gevorkiantz and N. W. Hosley in Harvard Bulletin #13, 1929, and E. E. Terbox and P. M. Reed, Harvard Forest Bulletin No. 7, 1924.

Table A.16

ESTIMATED CROP TREE DIMENSIONS AND VOLUMES IN INTENSIVELY-MANAGED, FULLY STOCKED STANDS BY SUCCESSIVE FIVE YEAR PERIODS1/

OLD FIELD SPRUCE AND FIR

	Site I											
	Starting D.b.h.											
	4"				6"				8"			
5 Year Periods	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.
0-5	4.0	25.5	-	.0125	6.0	39.0	-	.0438	8.0	62.1	42	.0249
5-10	5.1	32.5	-	.0250	6.7	43.5	-	.0600	8.7	66.1	52	.0251
10-15	5.9	38.0	-	.0382	7.4	48.5	-	.0825	9.3	69.5	75	.0254
15-20	6.6	43.0	-	.0668	8.0	52.1	42	.0249	9.7	62.5	84	.0260
20-25	7.3	47.5	-	.0762	8.7	56.2	54	.0251	10.2	65.0	97	.0270
25-30	7.9	51.5	39	.0248	9.2	59.5	75	.0254	10.6	67.0	112	.0280
30-35	8.5	55.5	51	.0250	9.7	62.5	84	.0260	11.0	69.0	126	.0312
35-40	9.1	59.0	66	.0252	10.2	65.0	97	.0270				
40-45	9.6	61.5	79	.0258	10.6	67.0	112	.0280				
45-50	10.1	64.5	94	.0262	11.0	69.0	126	.0312				
50-55	10.5	66.5	108	.0275								
55-60	10.9	68.5	123	.0306								
60-65	11.2	70.3	137	.0312								
	10"											
0-5	10.0	64.0	90	.0261								
5-10	10.4	66.0	106	.0270								
10-15	10.8	68.0	120	.0300								
15-20	11.2	70.0	136	.0312								

NUMBER OF TREES NEEDED FOR FULL-STOCKING

Age in years	25	30	35	40	45	50	55	60	65	70	75	80
No. trees per acre	850	720	555	539	445	445	370	370	300	300	300	300

1/ Adapted from L. S. Murphy, The Red Spruce: Its Growth and Management, Bulletin No. 544, U.S.D.A., Washington, D.C., 1917. And W. H. Meyer, Yields of Second-Growth Spruce and Fir in the Northeast, Technical Bulletin No. 142, U.S.D.A., Washington, D.C., 1929.

Table A.17

ESTIMATED CROP TREE DIMENSIONS AND VOLUMES IN INTENSIVELY-MANAGED, FULLY STOCKED STANDS BY SUCCESSIVE FIVE YEAR PERIODS1/

OLD FIELD SPRUCE AND FIR

	Site II							
	Starting D.b.h.							
	4"				6"			
5 Year Periods	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.	D.b.h. Inches	Ht. Feet	Volume Bd.ft.	Volume Cds.
0-5	4.0	25.5	-	.0125	6.0	38.5	-	.0310
5-10	4.7	30.0	-	.0200	6.4	40.5	-	.0488
10-15	5.3	34.0	-	.0262	6.8	44.0	-	.0612
15-20	5.7	37.0	-	.0362	7.1	46.0	-	.0712
20-25	6.2	40.0	-	.0475	7.4	48.0	-	.0787
25-30	6.5	42.5	-	.0550	7.6	49.5	-	.0862
30-35	6.9	45.0	-	.0638	7.9	51.5	39	.0248
35-40	7.2	47.0	-	.0750				
40-45	7.5	48.5	-	.0825				
45-50	7.8	50.5	37	.0247				
50-55	8.0	52.9	40	.0248				

NUMBER OF TREES PER ACRE NEEDED FOR FULL-STOCKING

Age in Years	25	30	35	40	45	50	55	60	65	70	75	80
No. trees per acre	1700	1290	890	780	720	560	560	470	470	400	400	400

1/ Adapted from L. S. Murphy, The Red Spruce: Its Growth and Management, Bulletin No. 544, U.S.D.A., Washington, D.C., 1917. And W. H. Meyer, Yields of Second-Growth Spruce and Fir in the Northeast, Technical Bulletin No. 142, U.S.D.A., Washington, D.C., 1929.

rotation yields can be projected as 100 percent of those shown in the managed yield tables. The volume remaining at the end of the planning period can also be estimated from these tables. The worth of the residual stand must be estimated for each property, since the board foot content of the stands will vary with their age.

Future Development

In 1941 the author drew up a set of growth prediction tables that furnished some of the ground work for those just discussed. Perhaps the word of warning that accompanied this initial effort can well be repeated at this point. "Data upon which to base even fairly reliable estimates of this type are not available. Sufficiently long experience with permanent sample plots - the best possible guide for probing into the uncertain future-is totally lacking. Nor has there been built up in this locality a satisfactory body of tables and rules based on observation of present stands. Even methodology is uncertain and unstandardized, we do not know, and can only estimate in the roughest way, what volumes of timber to expect in managed stands at rotation age in this locality, how fast the timber is likely to grow during the intermediate periods, preceding final harvest, what amount of mortality to expect in those periods, and many other factors vital to a valid estimate. Furthermore, shortage of time and funds prevented the collection, in this study, of much data that would have been infinitely helpful. The methods of prediction described here are necessarily, therefore, a makeshift. They are believed to have produced estimates which are roughly indicative of possibilities and are not grossly misleading. But more than this cannot be claimed for them."

Although the present tables are believed to be an improvement over the ones mentioned above, the statement just made is still applicable. It is hoped that continuous checking against sample plots in both wild and managed stands, the use of unpublished records and discussion with experienced foresters will gradually affect a considerable improvement in the figures that have been used. The data presented are first approximations that will serve as a convenient point of departure in eventually developing tables of greater accuracy. Of course, considerable flexibility is needed in applying any systematic approach to the predicting of growth from a dynamic, natural organism. Only the major variables can be incorporated in projection tables and the validity of any estimate will always depend to a great extent on the skill, knowledge and perception of the analyst.

APPENDIX B

FIELD TALLY SHEET

Job: _____

Plot No. _____ Stand No. _____

Type: _____

Site: _____ Age: _____

Height: Dom. tr. _____ Ave: _____ Other: _____

Reproduction: Species _____

Abundance _____

Dominant Tree:
D.b.h. _____ Age _____

Growth last 10 yrs. _____

Species _____

Operability: _____

Remarks:

Date: _____ Cruised by: _____

FIELD PROJECTION SHEET

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