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FOREST MANAGEMENT IN NEW JERSEY

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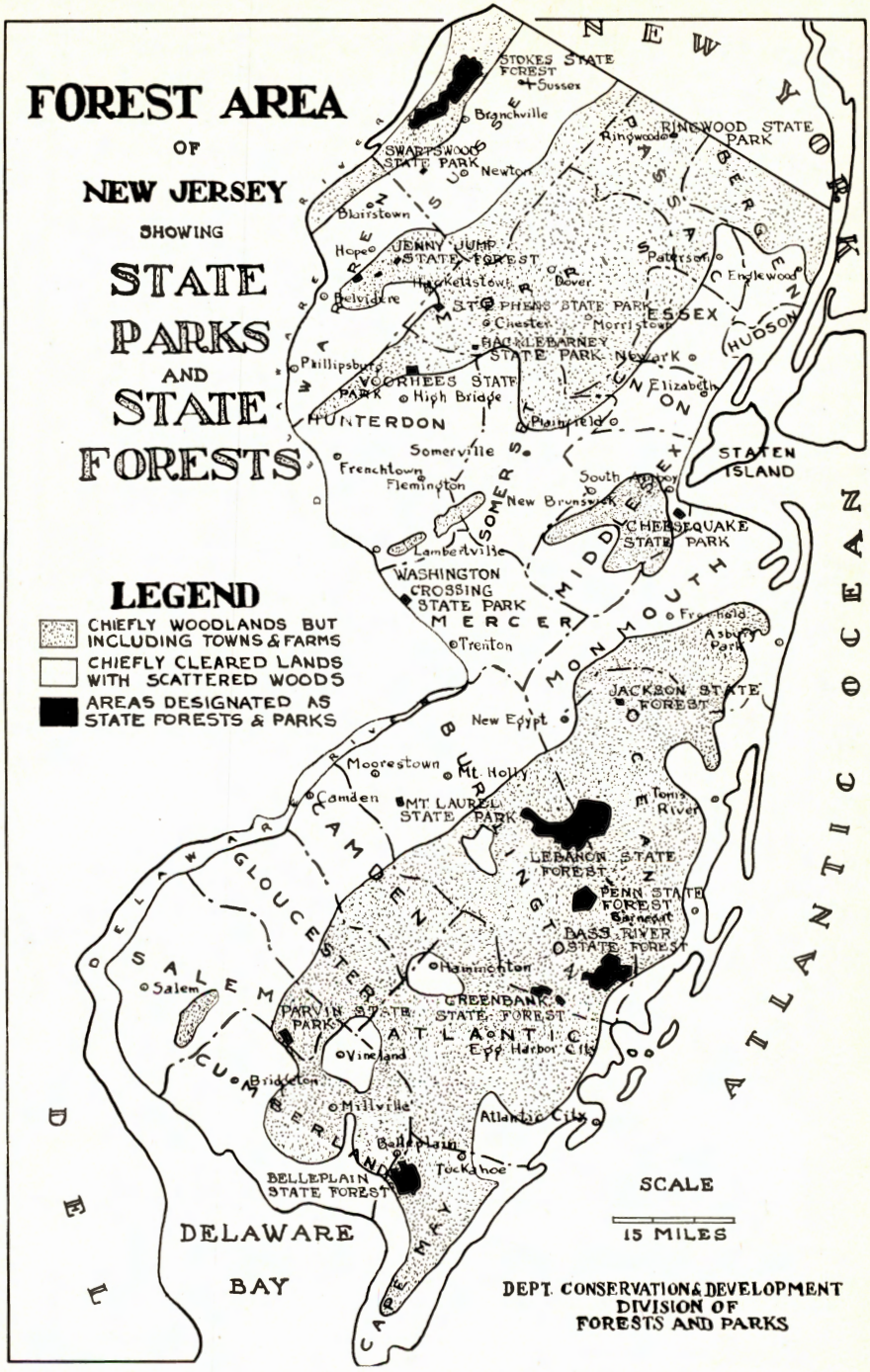

Fig. 1. *Two million acres or about 46 percent of New Jersey is forest land. North Jersey and the Delaware Valley consists principally of oak and other hardwood species. In South Jersey the uplands are covered with pine and oak. In the swamps are southern white cedar, red maple, gum and magnolia.*

STATE OF NEW JERSEY

DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF FORESTS AND PARKS

FOREST MANAGEMENT IN NEW JERSEY

By E. B. Moore
Assistant Forester



Trenton, New Jersey
1939

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FOREWORD

By CHARLES P. WILBER

Director, and Chief of Division of Forests and Parks

Land use is one of New Jersey's outstanding problems and one which has been given less interest and attention than most of the problems confronting the State. The fact that nearly one-half of the area of the State is wild land and that a large proportion of this domain is wasteland at the present time, presents a situation which of itself challenges the attention of all those who are thinking of the best interests and development of the State. It is not surprising that the great part of it is, and for years has been, tax delinquent and that what has paid taxes has paid on a valuation too low to be of any great help in carrying the public expenses. The fact that this area has never been developed for agriculture, industry, home sites and similar more intensive uses and that it is growing rather than shrinking as the years go by, make it imperative that the State consider what can be done with it to put it back into circulation as an asset rather than to let it lie as a useless drag on local municipalities, counties and the State as a whole as it has been doing for so long.

Little of this wild land will be absorbed by agriculture or other such uses. It is a function of the forestry movement to redeem it from idleness and put it to more profitable use again. It is a physical possibility to do this. In the first place, little, if any of it, is land which cannot be brought back to timber production. In the second place, there is more and more demand each year for more of it for public recreation, with our own immense and increasing population and the major center of population of the United States within and round about this area. In the third place, its rehabilitation will pay dividends in increased and improved water supplies, in bettered wild life conditions and population, in soil conservation and in enriched general economic conditions in and around the areas concerned.

The reclamation of this area, like that of the swamps, or the flood lands or the deserts of other parts of the United States, unquestionably depends upon public participation in the program. The risks are high, the time period involved is long, the returns will be low. Public ownership is apparently the only first approach which is likely to bring results within anything like a reasonable time.

Private ownership of timber lands should be encouraged and the operation of private timber lands under forestry management is a possibility in many locations and for many types of ownership. This approach to the forest problem is the logical solution wherever it is possible. It is the desirable way in which to meet the situation so far as can be. However, it must be mixed with a large percentage of public ownership to cover areas of a character or location or extent which preclude private initiative;

where private capital has not and cannot be expected to be the reconstruction agent.

The public has more at stake in this problem than any owner or all other owners. The public has permitted the wastage and abuse of these natural resources. The public properly has assumed the protection of the areas from fire and natural enemies. The public can realize values from the reclamation of our waste lands, which no private interest can. The State must lead the way in forest ownership and rehabilitation.

FOREST MANAGEMENT IN NEW JERSEY

By E. B. Moore
Assistant Forester

Part I

CONSERVATION — A LAND POLICY

The conservation of natural resources is a policy of land use. It is a policy directed toward a sustained continuity of use, and toward this end restricts the methods of handling land which exhaust and deplete it. Conservation is most commonly thought of in connection with renewable resources such as the forests, wildlife and water, but it is also applicable to non-renewable resources like the soil. Conservation does not "lock up" resources but regulates their use so that they may remain permanently productive. It collects the "interest" but guards the "capital".

Conservation of natural resources was not necessary in the early days of America, when the principal need was to clear a place in the wilderness where a civilization might develop. For this reason the land policy of the government during the 19th century was directed toward a speedy transfer of the public domain to private hands on the assumption that in serving his own interests the individual would serve those of society as well. It was an era of expansion and with a continent to settle the right of the individual to do as he pleased with his land was complete and unquestioned.

The continent has been settled and a civilization built, but at a shocking cost of wasted resources. The forests have been devastated, the wildlife destroyed, the land depleted by unwise cropping and erosion. Fifteen per cent of the total land area of the United States has lost more than three-fourths of its surface soil. This is equivalent to an area nine times the size of the State of New York, and each year still more is washed down the rivers. This soil cannot be replaced, it is gone forever, and with it some of the standards of living for the future.

The beginnings of a reaction against the evil effects of this land policy appeared in the 70's and 80's when public sentiment became aroused over the rapid destruction of the forests. This opposition led finally to an Act of Congress in 1891 which empowered the President to reserve forest lands in the Public Domain from further alienation. This Act inaugurated a new land policy in America. In the years which have followed, this policy has evolved and expanded; forestry, flood control, water supply, wildlife management, soil conservation and public recreation, all have come to be recognized as having a part in the new program.



Fig. 2. *This land has been ruined for agriculture by bad management and the fields are reverting to forest.*

The presence of the frontier was long a factor in American thoughts and ways of living. Permanent occupancy was never an accepted fact so long as new land was available "out West", which could be taken up when the old farms in the East became exhausted. But the frontier is gone and the pioneer stage and its usages are changing. We are here to stay, Americans are beginning to develop roots, and conservation of our resources is one of these roots. We are becoming land-conscious, too, conscious that the United States is not the sole property of a single generation to exploit as it pleases, without regard for those who come afterward. It is a permanent home where generation after generation of people will have to live. The maintenance and permanent productivity of our resources is, therefore, the concern of all Americans.

The part which New Jersey is taking in the conservation movement is discussed in the following pages.



Fig. 3. *Another result of bad land management. The stream is choked with soil washed from cultivated fields.*

PART II

NEW JERSEY — ITS PHYSIOGRAPHIC DIVISIONS, FORESTS AND LAND USES

Physiographically the Atlantic slope of the United States falls into two major divisions—the relatively level Coastal Plain bordering on the ocean and the higher, rougher Appalachian province to the west.* Part of New Jersey is included within each of these divisions, the boundary between them extending in a northeasterly direction across the State from Trenton to the vicinity of Perth Amboy. (Fig. 4).

Northern New Jersey

Physiographic Divisions.—In northern New Jersey the Appalachian province is separated into three sub-divisions:

(1) The Piedmont, which borders on the Coastal Plain, consists of more or less rolling country rising from sea level at Newark Bay to elevations of about 400 feet along the Highlands to the west. It covers approximately 1500 square miles and is characterized over much of its area by red shale soils. The land has been extensively cleared, except for trap outcrops such as the Watchungs, Rocky Hill and Sourland Mountains. The northwestern section includes the metropolitan district and is densely populated, while the unglaciated southwestern portion is largely devoted to agriculture and country estates.

(2) The Highlands of New Jersey are part of the Appalachian Mountain system, which crosses the State in a belt ranging from 10 to 25 miles in width. It consists of a series of parallel flat-topped ridges and valleys which have an average elevation of about 1000 feet. The mountains are principally schists and gneiss and the valleys limestone. The northern parts of the Highlands were glaciated and the stony soil is poorly adapted to agriculture, so that nearly 70 per cent is still in forest. Below the terminal moraine 70 per cent of the land has been cleared for farming and many large estates are located here.

(3) The Appalachian Valley is the name applied to a chain of parallel mountains and valleys extending from New York State to Georgia. Part of this system passes through northwestern New Jersey (Fig. 4), and includes the long rocky rampart of Kittatinny Mountain, which further south is known as the Blue Ridge. Kittatinny Mountain and its foothills are largely sandstone and conglomerates, while the valley lands to the east are limestone and shales. Approximately 536 square miles of Sussex and Warren Counties are included in this area which contains some of the most important dairying sections in the State. As much as 75 per cent

* All of the information on the physiographic divisions here outlined is taken from *The Geology of New Jersey*. Bull. No. 14, Geol. Surv. of New Jersey, 1915.

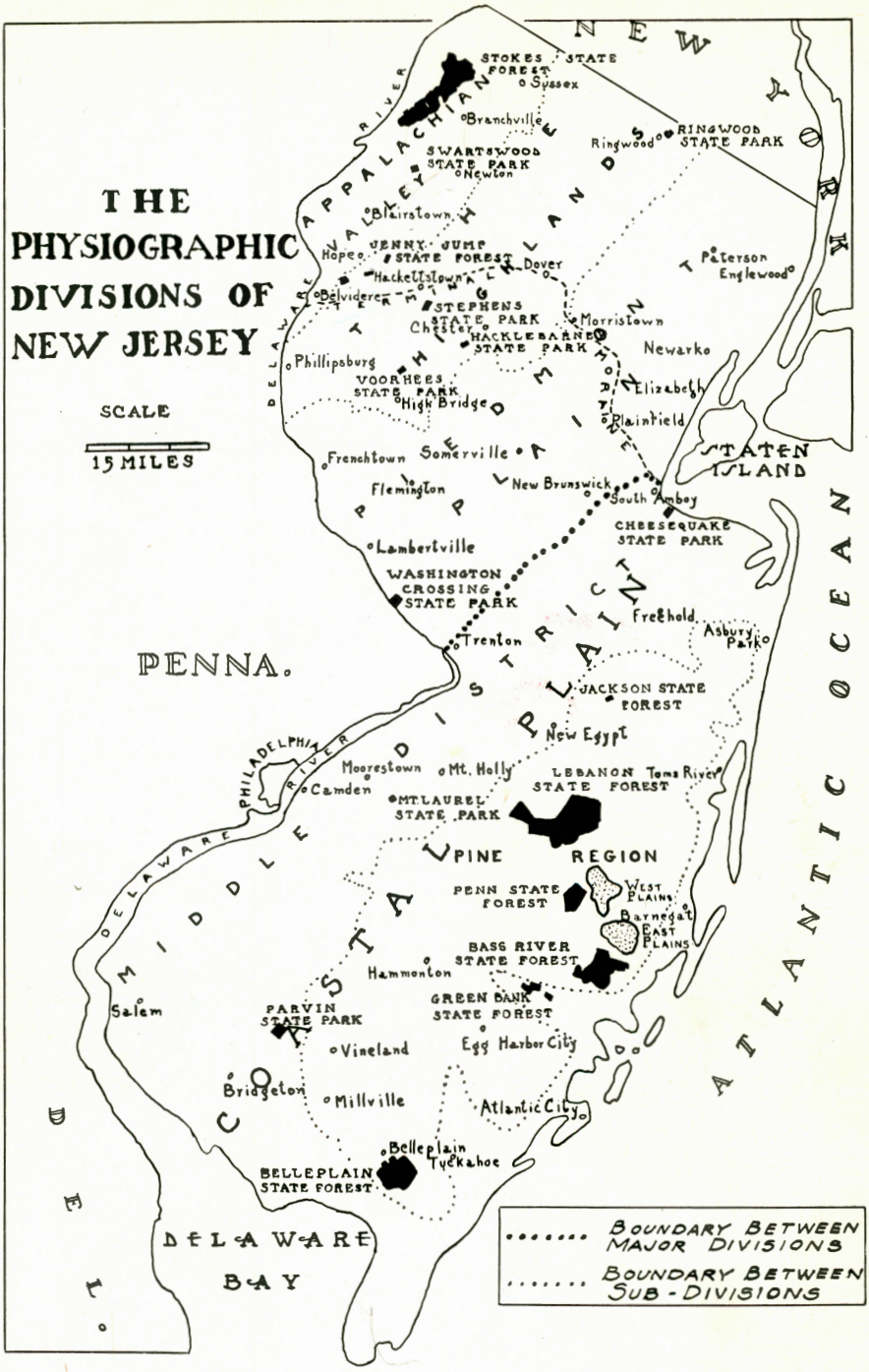

Fig. 4. *New Jersey falls into two main divisions,* (1) *The Appalachian Province, including the Appalachian Valley, the Highlands and the Piedmont; and* (2) *The Coastal Plain, which includes the Middle District and the Pine Region.*

Source Note: Physiography of North Jersey from Bull. No. 14, *Geol. Survey of New Jersey; Delineation of the Pine Region from Stone's "The Plants of Southern New Jersey". Location of the Plains by N. J. Dep. of Conservation and Development.*

of the land here was cleared at one time but in recent years considerable acreage in the rougher portions has reverted to forest.

The Forests.—The forests of North Jersey consist principally of mixed hardwoods in which oak predominates, with maple, ash, hickory, tulip, birch, sassafras and other species. Hemlock and white pine formerly rather abundant in the more northern portions are now much less common. Pitch pine occurs on some of the poorer soils of Kittatinny Mountain and the ridges of the glaciated Highlands where fires have been an important factor in the past. American larch and southern white cedar were originally present in some of the swamps, but have been almost entirely eliminated by cutting and fire. Prior to 1912, chestnut was one of the most valuable and widely distributed trees in northern New Jersey but in the intervening years it has been destroyed by the blight. Altho its sprouts may still be frequently seen in the woods, they are invariably killed back after a few years' growth, and it appears that the only chance for the survival of this magnificent tree lies in the bare possibility of its developing a natural resistance to the blight.

According to old records the virgin forests of North Jersey contained excellent timber, the best of which occurred in the Piedmont and in the valleys of the Highlands. Trees from three to four feet in diameter and up to 100 feet in height were found, and stands 250 to 300 years old were not uncommon. The second growth forests of today are understocked due to loss of the chestnut and to excessive cutting. The combination of fire and bad management have also lowered their vigor as is shown by



Fig. 5. *Rolling country characterizes much of the Piedmont Plain in North Jersey. Approximately 70 percent of this section has been cleared.*

the fact that the few stands which have reached 100 years of age frequently have a high percentage of butt rot, with heavy mortality among the larger trees.

Land Uses.—The original forests of northern New Jersey were cleared for agriculture wherever the physical condition of the soil made such use possible. The red shales of the Piedmont and the limestone valleys of the Highlands were brought under cultivation first, while the Kittatinny Valley which was more exposed to raiding parties of Iroquois, was not taken up until later. As the pressure of population increased, the clearings were pushed further up the hills on to poorer lands. The character of some of these mountain farms with their rock-strewn fields—now abandoned and growing up to brush—and their miles of stone walls falling to ruin, testify to the energy and the land hunger of the early settlers.

Lumbering was an important local industry in early days and many water-driven sawmills were operated throughout New Jersey. Wood was the universal fuel and large quantities were consumed locally or hauled into New York. The numerous forges and iron foundries needed charcoal for smelting and thousands of acres of timberland were cut over to meet this demand.

The years from 1850 to 1860 was the period of maximum deforestation in the northern part of the State, and during these years extensive areas throughout the Highlands were practically denuded of forest.* The common practice was to cut a piece of woodland as soon as the trees had become large enough for cordwood, which often meant cuttings at 20 to 25 year intervals. Repeated coppice on such short rotation exhausted the sprouts without giving trees of seed-bearing age opportunity to develop, and so in the absence of seedling replacements the stands suffered rapid deterioration. The introduction of coal as a fuel about 1850 presently brought about a change and the demand for cordwood fell off. It is interesting to observe, however, that at the time of the forest survey in 1894, the lack of timber over 50 years of age and the abundance of younger stands, was particularly noted. Since 1900 cuttings have been carried out along different lines, i.e., culling out the heavier products such as poles, piling and saw logs.

The present land uses in North Jersey vary with the physical characteristics of the soil and the distance from the metropolitan areas. In the Piedmont, as already noted, the northern portions are largely devoted to residential and industrial development, the southern to agriculture and country homes. The glaciated Highlands are the principal sources of water supply for the metropolitan district, and with the increase in population, its conservation becomes more and more important. Recreational use of the land here also is increasing, and numerous lakes have been constructed for swimming and boating. In the Appalachian Valley dairying occupies first place on the better soils, with recreation and timber production on the poorer ones.

Southern New Jersey

Physiographic Divisions and Land Use. —More than one-half of New Jersey lies in the Coastal Plain, a region of low relief, with most eleva-

* C. C. Vermeule. *The Forests of New Jersey.* Ann. Rep. State Geologist. 1899.



Fig. 6. *Mature forest of oak and pine in the Pine Region of South Jersey. Compare the poor form of the oak with the taller and straighter pine in the background. This land is being managed to increase the percentage of pine over the oak. Lebanon State Forest.*

tions less than 100 feet above sea level. This part of the State falls into two sub-divisions:

(1) The Middle District occupies a strip through the central part of the State and also includes the lower Delaware Valley and Bay region. The soils here are unconsolidated sands, clays and marls, and are of high fertility. Along the Delaware River the land has been extensively cleared, and the woodlots do not occupy more than 15 per cent of the area. In Cape May and western Cumberland Counties agriculture is less developed and more than half of the land is still in forest.

The earliest settlements in New Jersey were made along the lower Delaware and in this section market gardening and fruit growing are carried on intensively. Most of the trees here are the same as those occurring in North Jersey, but in addition a number of typically southern species are also found. These include Spanish, water and willow oaks, holly, magnolia, shortleaf and scrub pine. Some of the woodlots in the vicinity of Trenton and south toward Salem contain excellent timber, and the rate of growth in this section is the best in the State.

(2) The Pine Region covers approximately 2000 square miles in the eastern portion of the Coastal Plain, and is one of the few large wilderness areas remaining in the eastern United States. The soils are sandy and low in fertility with hardpan underlying some of the areas. With

the exception of a few "islands" the region as a whole is not adapted to farming, and the most important agricultural development is in connection with cranberry and blueberry bogs. The flora is distinctly unlike that of the rest of the State, and contains many plants characteristic of highly acid soils. The forest consists of a mixture of pitch and shortleaf pine with various oaks, and the ground cover is predominantly huckleberry and blueberry. Pure pine stands occur locally on old fields or on moist "savannahs". Tree heights range from 50 to 70 feet at maturity. Southern white cedar occurs in many of the swamps and a mixture of red maple, black gum and magnolia in others. The woods everywhere have been heavily cut over and burned and are in very poor condition.

Within the Pine Region are a number of areas of scrub forest known as the "Plains". While there are several smaller areas of this type, the two largest—known as the East and West Plains—are located close to the Ocean-Burlington County line near Warren Grove. Altogether about 15,000 acres are covered by these scrubby stands. The principal tree species occurring on the "Plains" are pitch pine and scrub oak, with occasional blackjack and post oaks, and the heights range from 4 to 6 feet. Most of the trees have assumed a prostrate growth habit and all show evidences of having sprouted repeatedly. While many of the distorted stumps are old, ring counts of the aerial portions show that these are young, averaging less than 15 years. Chemical analyses of the soils



Fig. 7. *The Plains. These areas of scrubby growth occur within the Pine Region, and are the result of repeated fires. The growth consists of sprouts of pitch pine, black-jack and scrub oak. Ring counts show that these "dwarf" forest are young—mostly* 10-15 *years.*

show no essential differences from those of the adjoining Pine Region,* and the consensus of opinion among most foresters and botanists who have made a special study of these areas is that fire has been the primary factor involved in their development.† This belief finds support from the fact that in relatively recent years similar areas have been found in the process of development elsewhere. The "Plains" represent an advanced stage of the exhaustion and deterioration resulting from repeated forest fires.

* Pinchot, Gifford. *A Study of Forest Fires and Wood Production in Southern New Jersey.* Appendix to Annual Report of the State Geologist. pp 39-43. 1898.

† Lutz, Harold J. *Ecological Relationships in the Pitch Pine Plains of Southern New Jersey.* Yale Univ. School of Forestry. Bull. No. 38. 1934.



Fig. 8. *Stand of southern white cedar, 30-years old. This species frequently occurs in dense even-aged stands along the creeks of the Coastal Plain.*

Part III

NEW JERSEY'S CONSERVATION PROBLEMS

Although New Jersey has been settled for nearly three hundred years, approximately 2,000,000 acres or 46 per cent of the land area of the State is still in forest or "wildland". The woodlands, however, have been heavily cut-over and repeatedly burned and are in very poor condition. Because of New Jersey's location adjoining the two most densely populated metropolitan districts in America, the forests of the State have very definite possibilities for financial, esthetic and recreational development under proper management. In bringing about such conditions the following problems must be considered:

1. Control of forest fires.
2. A permanent land policy for the Pine Region.
3. Management of private forests.
4. Utilization of abandoned farm lands.
5. Conservation of water and soil.
6. Recreational use of land.

1. **Control of Forest Fires.**—Forest fires are a major cause of injury and destruction. They ruin merchantable timber, kill back natural reproduction, and injure the soil. They cause widespread destruction of wildlife, particularly if they occur during the periods when the young are in a helpless condition. By killing trees along streams they expose the water to direct sunlight, raise its temperature and reduce its habitability for trout. Fires destroy the beauty of a forest and lower its values for camping and recreation. Unless fires are controlled other improvement work in the woods is useless. This is the basic problem of conservation in New Jersey.

2. **A Permanent Land Policy for the Pine Region.**—The South Jersey Pine Region covers approximately 1,300,000 acres. The soils are sandy, very low in fertility and mostly sub-marginal from the standpoint of agriculture. The forests have been destroyed again and again by heavy cuttings and fire, and are in an extremely exhausted condition. Many small communities which formerly existed here have been abandoned, and one-third of the area is tax delinquent. This kind of land cannot stand exploitation without being wrecked as a result—and the greater part of the region today is a vast exhibit of the evils of land misuse.

What is needed here is public ownership and a permanent land policy adapted to the capacities of the soil. This is a problem which the State cannot afford to ignore, for if present conditions continue we shall ultimately have a desert on our hands. This is the major "problem area" of New Jersey.

3. **Management of Private Forests.**—Most of the privately-owned forests in the northern and central parts of the State are also in poor condi-



Fig. 9. *This South Jersey land once produced good timber. Repeated fires have reduced it to this. It can be restored if properly managed.*

tion, for they too have been "mined". Fires have been less destructive here, however. The soils are good, and if the woods are properly handled they can produce high quality hardwoods on a sustained yield basis. Most of the land is held for purposes other than timber production, but the high valuations make any net returns that may be obtained without injury to the woods, most desirable. The fact that good forestry promotes esthetic values is an important consideration here, where woodland in good condition is a decided asset to property.

4. **Utilization of Abandoned Farm Lands.**—There are approximately 400,000 acres of abandoned farms in New Jersey. Many of these fields are on rough land which should have been left in forest. Some are due to the displacement of the horse and the consequent reduction in hay land acreage, while others have been eroded and depleted of their fertility. These areas are in all stages of succession—grass, sumach, scattered cedar and birch, oak and hickory saplings. Of little use at present these lands have high potential values for forestry, recreation and wildlife. Food and cover for birds and animals, and trees for timber can be grown together and these idle acres made productive.

5. **Conservation of Water and Soil.**—The densely populated centers of New Jersey need potable water. That the present high demands are already exceeding our resources in certain areas is shown by the fact that during the last 40 years the water levels in some of the wells along the coast have dropped 100 feet, while the heavy withdrawals from the shallower ones

New Jersey State Library

have caused the infiltration of salt water. These conditions make the protection of surface supplies the more important.

Soil erosion due to bad agricultural practices or the cutting of timber on steep slopes is another problem. Sheet erosion which removes thin layers of soil from the surface is not easily recognized by untrained eyes, although it is the richest portions that are being skimmed off. Decreasing yields and the subsequent development of gullies follow this insidious type of erosion.

The solution of these problems lies in management of the vegetative cover on all watersheds, and this means better forestry and better agricultural practices.

6. **Recreational Use of Land.**—In a state as thickly populated and highly industrialized as New Jersey, the provision of adequate facilities for public recreation in the out-of-doors is becoming increasingly necessary from the standpoint of social health. The excellent network of State highways has made sections which were formerly remote, readily accessible to the thousands who pour out of the metropolitan districts on week ends, but the lack of sufficient suitable areas for recreation prevents large numbers of people from enjoying themselves in natural surroundings. Areas of wild land are needed where people can get away from the tensions of modern life and relax, where they can camp and hike or hunt and fish without fear of being ordered off as trespassers. The State Forests and Parks offer opportunities along these lines but they are now totally inadequate in area.



Fig. 10. *Stand of pitch and shortleaf pine, 60-70 years old, growing on abandoned farm land in Ocean County.*

Part IV

WHAT NEW JERSEY IS DOING IN CONSERVATION

Historical Review.—The need for undertaking specific measures to protect New Jersey's forests was brought to the attention of the Legislature in the Report of the State Geologist for 1885. The State was being surveyed at this time, and part of the work included the mapping of all wooded areas over ten acres in extent. This permitted an accurate determination of the location and acreage of the forests as well as the farm lands and was the basis from which the information shown in Table 10 was compiled.

In 1894 a special survey of the forests was authorized by the Legislature to determine their general condition, the effects of fire and the possibilities for practising forestry. Among the men taking part in this work were Henry S. Graves and Gifford Pinchot—both of whom later became Chiefs of the United States Forest Service; C. C. Vermeule, John Gifford and Arthur Hollick. The results were published in the Annual Reports of the State Geologist from 1894 to 1899.

On the basis of this survey it was recommended that a State forester be engaged and a permanent organization set up for the purpose of combatting fires and encouraging the practice of forestry on private lands. It was also suggested that the State begin the acquisition of public forest reserves to serve as demonstration areas and as game preserves.

Acting upon these recommendations, the Legislature, in 1905, authorized the Governor to appoint a Forest Park Reservation Commission with power to acquire land for State forests and to combat fires. The first acquisitions under this Act were made in the same year, and several tracts were acquired near New Gretna and Mays Landing. In 1907 a technical forester was engaged to handle the work for the Commission.

In 1915 the State Department of Conservation and Development was created to supersede this Commission by Act of the Legislature. This Department now includes the Divisions of Forests and Parks, Geology and Topography and the State Museum. It is custodian of the Delaware and Raritan Canal, and has charge of the retained portions of the old Morris Canal. The Department is under the jurisdiction of a Board of eight members who are appointed by the Governor and serve without pay. The Director is either the State Forester or the State Geologist.

Among the work handled by the Department, that which pertains to the management of forests and non-agricultural lands falls within six categories, as follows:

1. Forest fire suppression.
2. Administration of State Forests and Parks.
3. Operation of the State Nurseries and assistance in reforesting idle land.
4. Studies in management practice.
5. Cooperative assistance to private land owners.
6. Information and education.



Fig. 11. *Camp sites for public use are equipped with tent platform, table, fireplace, water and sanitary facilities. Stokes State Forest.*

Forest Fire Suppression.—The Forest Fire Service is organized specifically for the prevention and suppression of forest fires in New Jersey. It is under the direction of a State Firewarden and a permanent staff with headquarters at Trenton.

The State has been divided into three Divisions for fire fighting work. Division A covers the portion from the New York line to the Raritan River, and its headquarters is at Butler. Division B covers central New Jersey between the Raritan and the Mullica Rivers, with headquarters at Toms River. Division C covers the State south of the Mullica River and has headquarters at Mays Landing. Each Division is divided into from 8 to 13 Sections, and each Section into from 4 to 26 Districts. The District constitutes the local unit for fire fighting and the District Warden with a regular crew of men is on call for service at any time.

A system of 21 fire towers has been established covering the wooded areas and when a fire is detected its location is immediately reported to the nearest warden who assembles his crew and gets to the spot as quickly as possible. In severe fires an airplane is often used for reconnoitering and keeping the men on the ground informed as to how the work is progressing. The plane and all towers and cars used by Division Headquarters are equipped with two-way short wave radio sets which enable contact to be maintained at all times. Specially-built trucks with water tanks and power pumps have been recently introduced and are proving very efficient. Studies of humidity, the relation of weather conditions to fires and their rate of spread are being carried on with the object of

further increasing the efficiency of this important branch of conservation.

Administration of State Forests and Parks.—Eight State Forests and twelve State Parks are administered by the Department of Conservation and Development. The State Forests total 55,000 acres and their location is shown in Fig. 1. They are managed for public recreation, the production of timber and wildlife, and the protection of water supplies. Roads and trails have been built both to protect and make the forests more accessible, and lakes, cabins and camp sites constructed for use of the public. Hunting and fishing are permitted except on certain areas which are reserved for more intensive forms of recreation.

The Forests are managed for the production of high grade timber, and cuttings and plantings directed toward this end have been carried out on an extensive scale. The Forests also serve as laboratories and demonstration areas where certain problems are studied and different methods of management tried out. Wildlife is an important source of public recreation, both for hunters and those who enjoy observing it in its natural surroundings. Since birds and animals are intimately affected by changes in their environment, forestry and wildlife management are coordinated on the State Forests so that both may benefit.

A total area of 4459 acres are included in State Parks administered by the Department. The Parks are generally smaller than the Forests, and are managed solely for recreational purposes, with the main emphasis on picnicking, hiking and nature study. Fishing is allowed but hunting is not permitted.



Fig. 12. *Fishing thru the ice is one of the winter sports in North Jersey. Swartswood State Park.*



Fig. 13. *Deer are usually hunted by "driving" in New Jersey. This shows a hunting club after a successful day on the Lebanon State Forest. Note the claxon horns used in driving.*

Operation of the State Nurseries and Assistance in Reforestation.—Two forest tree nurseries are operated by the State to supply seedlings for reforestation purposes. At Washington Crossing, red, white and Scotch pine and Norway spruce are grown for use in North Jersey. At Green Bank, in Burlington County, pitch, shortleaf and loblolly pine are raised for planting on the Coastal Plain. Two-year seedlings and three-year transplants are produced.

This stock is used on the State Forests and is also sold at approximately cost price to land owners for reforestation purposes in lots of one thousand and more. The State also offers the assistance of its foresters in advising owners as to the species of trees best suited to their soils and to the approximate costs involved in establishing a plantation. Individuals who are interested in this phase of land-use should write the Department of Conservation and Development for detailed information.

Studies in Management Practice.—Studies of the different phases of forest management are conducted on the State Forests and on certain private lands where the conditions permit. Growth and yield, and the effects of thinnings and improvement cuttings are studied on permanent sample plots where measurements are taken at periodic intervals and compared with those from untreated plots. The methods under which timber products can be most advantageously cut and marketed are also investigated. Censuses are taken of the deer and other game forms on the State Forests to determine the effects which forest management has upon them, and how and

where adjustments should be made. In cooperation with the National Audubon Society and the State Department of Agriculture, studies are being conducted as to how the songbird population may be raised on certain areas where insect infestations have been especially destructive to forest and shade trees.

Cooperative Assistance to Private Land Owners.—New Jersey offers advice and assistance to private owners of the State in the management of non-agricultural lands. Timber appraisals and specific recommendations as to cutting practices and methods of marketing are given. A list of the lumber operators and wood-using industries of the State is maintained by the Department and owners who wish to dispose of merchantable timber are put in touch with buyers of such material. Persons in need of help along any of these lines should get in touch with the Department.

Information and Education.—Information and educational matter on forestry and the management of wild lands in New Jersey is furnished by the Department. Descriptive circulars of each of the State Forests and Parks, and bulletins on fire protection, planting methods, forest management, the care of shade trees and historical material pertaining to conservation are available. Technical notes on the results of various experiments are put out in mimeograph form from time to time. Illustrated talks on forestry and the management of non-agricultural lands, historic trees of the State and kindred topics are given by members of the Department staff.



Fig. 14. *A good stand of mixed hardwoods averaging* 8400 *board feet per acre, International Rule. This is a privately-owned tract in North Jersey, and is managed with the co-operation of the State foresters.*

Part V

GENERAL PRINCIPLES OF LAND MANAGEMENT

Objectives.—The question is often asked whether forestry is financially practicable for the private owner in northern New Jersey where land values are ordinarily high. The answer is that it certainly would not pay an individual to buy land at the prices which ordinarily prevail here if his main object was that of raising timber. Where the land has been acquired for some other purpose, however, such as a country estate or a farm, proper management of the woods will produce a *sustained net* income and help meet the carrying charges on the property.

Most tracts of woodland in New Jersey are in very poor condition due to past neglect and abuse, and the returns from them have been so small and uncertain that many owners have not felt enough interest to introduce better methods. These areas respond to treatment, however, and as will be shown later, the rate of growth on many sites can be more than doubled.

Aside from the angle of dollars and cents, some owners are interested in developing the woods from an esthetic standpoint or for wildlife purposes, and such objectives can be furthered by careful cutting practices. Some of the principles which enter into the management of non-agricultural land are discussed below.

Plant Succession.—The type of vegetation on a given area does not usually remain the same but constantly changes. Beginning with bare land, a series of different plant associations follow one another in a definite sequence—weeds, grass, brush and finally forest. Fire or cuttings check this development and either hold the vegetation at a given stage or set it back into an earlier one. If there are no interruptions succession continues until the "climax" association is reached, which is the final stage possible under the existing climate. If this stage is completely destroyed, the process must start over again.

Throughout most of New Jersey the upland "climax" type appears to be made up predominantly of a mixture of hardwoods with an interspersion of white pine and hemlock in the north, and of pitch, shortleaf and scrub pine in the south. It is believed that the pine stands of the Coastal Plain do not represent the final stage of undisturbed development for most of that region, but a "sub-climax" in which the normal processes of succession have been arrested by the constantly recurring fires. The "climax" association does not by any means always represent the most desirable type from man's point of view. On the contrary management techniques are often directed toward the maintenance of one of the "sub-climax" stages instead. As an illustration of this condition, the pure, even-aged forests of Douglas fir in the Pacific Northwest may be cited. These forests are definitely a "temporary" stage and if allowed to develop undisturbed, ultimately give way to a "climax" containing a high percentage of hemlock and other less desirable species. For this reason forest man-

agement in that region is directed toward holding succession in the predominantly Douglas fir stages.

Plant succession may be seen at work everywhere. Abandoned fields are usually occupied first by a variety of weeds, then by the brown clumps of "Indian grass". Later dew berries spread their thorny vines over the ground and patches of sumach appear. Black cherry, red cedar, gray birch and red gum follow, and at last the heavy-seeded oaks and hickories work in under the others.

Plant succession is accompanied by corresponding changes in the wildlife populations, and the species of birds and animals present in the early stages are replaced by others in later ones. Thus in South Jersey, quail usually occur about the edges of old fields as long as they are open enough for grass and partridge pea to grow, but when the forest develops and kills out the herbaceous plants, the quail move out and brown thrashers and towhees move in.

Land management really consists in manipulating the various stages of plant succession to achieve certain desired ends.

The Influence of Site.—The quality of land can usually be judged by the height attained by the dominant trees. In the eastern United States the height at 50 years of age is taken as the basis of comparison. Thus a 60-foot site would be one on which the dominant trees reached 60 feet in 50 years.



Fig. 15. *Uneven-aged hardwoods in the Highlands. Note the range of diameter classes. Stands of this type are adapted to management under group selection and will yield a cut of at least* 1500 *board feet per acre at* 10*-year intervals.*

In North Jersey the site qualities range from 40 feet on the ridges to 60 or 70 feet on the moist coves. In the Middle District some 80-feet sites may be found while in most of the Pine Region the trees reach only 40 to 45 feet in 50 years.

In general, more intensive management is justified on better sites than on poor ones.

Even-Aged Forests and Management.—An even-aged forest is the result of a catastrophe that occurred to the former stand and is a temporary condition. Thus after a killing fire or a clear-cutting the reproduction of the new stand all starts at about the same time and the resulting forest is even-aged. If it is not disturbed this stand will ultimately change over into the uneven-aged form, through the gradual death of old trees and the development of younger stock in the openings so made.

A forest made up of groups of trees of different ages permits cuttings to be made at short intervals and is well adapted to management on most sites in New Jersey. It provides a more varied and accessible food supply and better cover for wildlife, and also favors greater infiltration of water and more obstructions to surface run-off. In swamps or on other sites where the trees are shallow-rooted and there is danger from windthrow, even-aged stands should always be encouraged.

Reproduction of Forests.—Hardwood trees reproduce themselves both by seed and by sprouts. Sprouting is an emergency method which helps tide the species over an adverse period and trees which originate in this way are generally less desirable and more subject to root rot than seedlings. Sprouting capacity is most vigorous in early life, declines with age and generally is lost altogether after the 70th or 80th year. Forests which have been subjected to repeated sprouting from too frequent cutting ultimately become exhausted and have to be replaced by natural reproduction or by planting.

In northern New Jersey an abundance of seedlings is nearly always present under hardwood stands which have reached seed-bearing age. As long as the forest canopy remains closed most of this reproduction does not develop much beyond the seedling stage, but undergoes a heavy turnover. After cuttings have opened up the stand and admitted light, some of this reproduction starts active growth and fills up the vacant areas.

In the Pine Region, the hardwoods are nearly all of sprout origin, with the trees showing marked signs of decadence due to frequent cutting and fire. Seedling reproduction of oak is relatively scarce under most of these sprout stands, due possibly—among other causes—to weakened seed. Pine reproduces readily from seed in South Jersey and pitch pine sprouts vigorously as well. Shortleaf pine also sprouts but to a less extent.

Effects of Light on Tree Form.—The form which a tree assumes is largely due to the amount of light it receives. Trees grown in dense stands are usually tall and straight, with clear trunks from which the branches have been killed off by shade. Such trees produce lumber free from knots. Open-grown trees are generally limby with wide-spreading crowns and produce poor lumber.

The tolerance of shade varies with different species and with the age of the tree. Hemlock, beech, maple and southern white cedar are tolerant and can grow in shade which would soon kill pitch pine, white oak or tulip.

Forestry and Wildlife.—Forest cuttings and plantings have a direct effect on the wildlife population and must be considered in land management. Wildlife occurs most commonly along the edges separating woods and open fields, between cultivated land and marsh, or between different age groups within a forest. These edges are the boundaries between vegetation in different stages of succession, and provide a greater variety of plants for use as food and cover. Other things being equal, a ten-acre tract which contains an interspersion of forest, brush, cultivated land and marsh will support more wildlife than the same area in any one of the types alone. This is a basic fact to remember where birds and animals are concerned.

Winter is the critical period for wildlife and with the loss of leaves in the fall there normally occurs a "shuffle" of population as the resident forms try to locate themselves on the most favorable winter territories. Some losses always occur before spring and the number of individual birds or animals which survive is closely related to the abundance of winter food and cover. This number is surprisingly constant over a period of years for any one species and is used as a convenient yardstick for measuring the carrying capacity of that particular territory.

Where wildlife is concerned, the object of management is to increase the carrying capacity through various kinds of cuttings and plantings.



Fig. 16. *Nine-year old white pine plantation in North Jersey. Many abandoned fields are being used in this way to grow timber and provide cover for wildlife.*

Part VI

FOREST MANAGEMENT IN NORTHERN NEW JERSEY

Present Forest Practices.—In New Jersey timber is generally sold on the stump to lumber operators who have the equipment necessary for handling heavy products like piling and saw logs. In these transactions the timber is sold either by the tract, by the board foot or by the individual tree. Under the first system a lump sum is paid for the cutting rights on a given area, frequently without any restrictions as to the amount which may be taken or the methods used. In the second case, payment is made on the basis of the volume cut, with the Doyle log rule as the usual unit of measure. Where individual trees are sold, the buyer usually has some specific product in mind for which the timber in question is particularly well suited.

There is no standard price which can be applied to standing timber under all conditions. Such factors as accessibility, roads, topography, the volume per acre and the quality all have some bearing on the selling price. During the last twenty years hardwood stumpage has usually sold for amounts ranging from $6.00 to $15.00 per thousand board feet, by the Doyle log rule.*

In present day timber sales the policy of "mining" the tract nearly always prevails with immediate financial aspects predominating, and little or no thought given to the welfare of the forest as a permanently productive unit. From the standpoint of silviculture the results of this practice have been uniformly bad. When tracts are sold for a lump sum, many young, vigorous trees which are making rapid growth, are cut for the single railroad tie which they may contain instead of being left to grow into more valuable two-tie stock. In sales by the board foot, the cutting operations are concentrated on the best trees of certain species—oak, ash and tulip—while the less desirable ones like red maple and black gum are left to scatter seed over the area and lower the quality and volume of the ensuing stand. This practice when repeatedly carried out results in progressively poorer yields of merchantable material.

The principal products obtained from the hardwood stands of North Jersey are oak piling and saw logs. The logs are usually sawed up into boards, planks or ties at portable or semi-permanent mills. Tulip and red gum are used in the manufacture of veneer for fruit baskets as well as for lumber. Mine timbers, furnace poles used in the reduction of ore, boat fenders and cordwood are less important products.

In spite of the fact that hard coal and oil are widely used as fuels throughout New Jersey, from 8,000 to 10,000 cords of firewood are sold annually in the northern metropolitan district alone, and appreciable amounts are consumed locally elsewhere in the State.

A comparison of the yields formerly obtained from New Jersey's forests with those of today is of interest as a measure of the deterioration which has resulted from disease, fire and bad management. In 1889 eleven tracts of original timber in the Piedmont yielded from 5,800 to 38,000

* The inaccuracies of the Doyle log rule are discussed on pages 50-51 in the Appendix.

board feet per acre, while the cut on 8,300 acres averaged 5,000 board feet per acre. At the time of the forest survey in the 90's it was commonly stated that the hardwood stands in the northern part of the State produced about one cord of wood per acre annually. Today the rate of growth is approximately one-half that (Table 13), and surveys of cut-over lands indicate that the average cut of saw timber is less than 2,000 board feet per acre.

Some Tax Considerations.—The practical utility of forest management for the private owner of woodland is well brought out by a consideration of the tax situation in North Jersey. In the glaciated Highlands, for example, there are large blocks of rough, stony land which are not adapted to agriculture. The taxes on the woodland in parts of this section reflect the residential and recreational possibilities resulting from the proximity of the metropolitan district, and frequently amount to as much as $1.50 per acre annually. These lands are held primarily for purposes other than timber production, but any net income which may be derived from the forests will help to lessen the overhead on the property and is well worth consideration. In their present depleted condition most of these tracts are not in shape to produce much revenue but if built up and conservatively managed on a permanent basis, they are capable of making appreciable net contributions toward the carrying charges.

The average annual rate of growth on unmanaged forests in North Jersey is shown in Table 13. These figures indicate that merchantable saw timber is growing at the rate of 100 to 130 board feet per acre each year. With an average stumpage price of $7.50 per thousand,* these yields are equivalent to a net annual return of $0.75 to $0.95 per acre. On permanent sample plots under management in North Jersey on which periodic measurements are taken, current annual yields as high as 370 board feet per acre have been obtained. The data from two such plots are shown below in Table 1.

TABLE 1. SHOWING GROWTH MADE UNDER MANAGEMENT BY NORTH JERSEY HARDWOODS OVER A 5-YEAR PERIOD

Age	Number of Trees per Acre	Height of Average Dominant Trees	Average DBH	†Volume per Acre	Current Annual Growth per acre	Net Annual Income per Acre
		ft.	in.	bd. ft.	bd. ft.	
Before Thinning 55 yrs.	420	60	6.4	4576		
After Thinning 55 yrs.	128	60	9.5	4156		
60 yrs.	126	65	10.4	6028	374	$2.80

SHOWING GROWTH MADE UNDER MANAGEMENT BY NORTH JERSEY HARDWOODS OVER A 10-YEAR PERIOD

Age	Number of Trees per Acre	Height of Average Dominant Trees	Average DBH	†Volume per Acre	Current Annual Growth per acre	Net Annual Income per Acre
		ft.	in.	bd. ft.	bd. ft.	
Before Thinning 50 yrs.	449	60	6.2	3631		
After Thinning 50 yrs.	175	60	8.2	3000		
55 yrs.	170	64	8.8	4028	205	$1.53
60 yrs.	162	67	9.4	5438	282	2.11

† International Log Rule, ¼ inch kerf.

* This stumpage price is based on the International Log Rule, ¼" kerf, not on the Doyle Rule. See Appendix, pages 50-51 for discussion of units of measure.

Controlling the Cut.—The methods used in harvesting major timber products have a profound influence on the character and quality of the succeeding stand, and forest management as such is largely a matter of regulating the cut in accordance with the rate of growth.

Whether a forest property will be handled as a crop or "mined" to the limit, is a matter which is entirely the responsibility of the owner. It is, of course, unreasonable to lay the blame for destruction on the lumber operator who buys the timber and does the cutting, for he can hardly be expected to evince an interest in the future of a piece of land belonging to someone else, particularly if it involves leaving some merchantable timber standing and thereby raising his own unit costs of operation. This is the land owner's problem, and if he is willing to accept a smaller immediate return for the sake of developing his forest into a permanent "going concern", he is in position to prescribe the methods of cutting.

The unsightly slashings and broken trees left after the usual logging operation have done much to prejudice land owners against all timber cutting. It should be distinctly remembered, however, that where the work is done in accordance with conservative practice, the saw and axe are important tools for maintaining healthy conditions and increasing the rate of growth without disturbing the esthetic values.

In cutting timber the best practice is for the owner to do the work himself and sell the logs and other products in the woods or stacked along the roadside. Before starting to cut he should familiarize himself with the possible markets for his material by getting in touch with several lumber buyers and sawmills. After learning the type of products and lengths usually desired, he should cut his logs accordingly. The details of sawmill operation are such as to require experience and skill for successful handling and it is better for the individual forest owner not to embark on this phase of the work.

During the last ten years hardwood log prices in New Jersey have ranged from $20.00 to $70.00 per thousand board feet, depending on the species. Tulip logs for basket stock have brought the highest price, while oak has been from $30.00 to $35.00 per thousand board feet. From these figures it can be seen that the forest owner will obtain a much higher rate of return per acre where he disposes of the cut products than by selling them on the stump. In addition to this his forest will be left in better condition for future growth if he does the cutting himself.

Where it is impracticable for the owner to handle this work himself, the next best method is to contract for the cutting and skidding to be done at so much per thousand board feet. Under this system the trees to be removed should be marked and bids solicited from several logging operators. Penalty clauses in the contract should guard against cutting unmarked trees and damage due to careless felling or skidding. As in the former case, the owner should always investigate the possibilities for disposing of his products before cutting them.

From the silvicultural standpoint the sale of timber on the stump is the least satisfactory method and offers the most difficulties of controlling the cut. Good results may be obtained, however, by carefully following up the operation as it proceeds and seeing that the provisions of the contract are observed to the letter. In selling stumpage by the board foot or by individual trees it is important that all trees to be cut should be plainly

marked by blazes both at breast height and on the stump. The stump blaze should then be stamped with a die hammer. This procedure helps to eliminate misunderstandings and simplifies the adjustment of mistakes where penalties are included in the contract for the cutting of any trees whose stumps have not been properly stamped.

Conservative Cutting Methods.—(1) Group Selection: The best practice to use in making timber cuttings on most of the upland sites in North Jersey is to spread the cut lightly over all diameters from 8 inches up, being careful to reserve some of the better trees in each class. Over-mature and decadent individuals which are recognizable by the presence of dead limbs in *the tops* of the crowns, should be removed, but since there is a general lack of trees of large size, particular attention should be given to retaining at least some of the *sound* veterans 15 inches and over in diameter.

This method usually results in the cutting of small groups of trees throughout the entire stand and leaves openings of ¼ acre or so in which a new age class soon develops. It is referred to as the "group selection" method and should not remove more than 30 or 35 percent of the board foot volume. In the 8 to 12 inch diameter classes the cut should be directed mainly toward taking out the less desirable trees and leaving the better ones to grow into larger sizes. In the diameters over 12 inches the cut should be just heavy enough to "sweeten" the operation and make it practicable from the economic standpoint. Most stands are in need of building-up, and for this reason the cut should be kept below the rate of growth until the growing stock or "capital" has been increased. On most cove and slope sites a cut not exceeding 1000 board feet per acre can generally be made at 12 or 15 year intervals under the "group selection" method without lowering either the productivity of the stand or its esthetic values.

(2) Diameter Limit: Under conditions where the owner or his agent is not able to keep in constant touch with the logging operation, a simpler and less desirable method from the silvicultural standpoint may have to be used, namely, cutting to a diameter limit, under which all trees over a set diameter on the stump are cut.

From studies and observations by the foresters of the Department of Conservation and Development of the results obtained by this method, a diameter of 14 or 15 inches inside the bark one foot above ground is advised as productive of fairly conservative results which will leave the stand in much better condition for permanent production than any of the exploitation practices described above. In using the diameter limit it is particularly desirable that the cut should not be confined to oak and tulip but that all the maple, black gum and other species which are above the limit be taken as well. This type of operation has the merit of simplicity and is relatively easy to control through penalty clauses for trees cut below the limit or for leaving any undesirable species above it. Cuts to a 14 or 15 inch diameter can usually be made at 20 to 25 year intervals, removing 1500 to 2000 board feet per acre. Table 2 shows the average rate of diameter growth made over a 10-year period in North Jersey.

TABLE 2. SHOWING THE RATE OF DIAMETER GROWTH MADE BY OAK ON AVERAGE UPLAND SITES IN NORTH JERSEY

Diameter Breast High	Diameter Growth Over 10-Yr. Period	No. of Yrs. to Grow 1 Inch	Diameter Breast High	Diameter Growth Over 10-Yr. Period	No. of Yrs. to Grow 1 Inch
inches			inches		
2	1.0	10	12	1.5	7
4	1.0	10	14	1.6	6
6	1.1	9	16	1.7	6
8	1.2	8	18	1.8	6
10	1.4	7	20	1.8	6

(3) Other Methods: Under certain conditions clear-cutting is the best method to use. In swamp hardwoods, for example, the shallow rooting habit of the trees makes them particularly subject to windthrow if the stand is opened up much by partial cutting. Occasionally on good upland sites where timber of particularly high quality can be produced, even-aged stands might be grown and managed under the shelterwood system which removes the timber in two cuttings about ten years apart. The first of these opens up the stand and encourages the development of advance reproduction. After the new crop is well established and seed trees are no longer needed the remainder of the overwood is removed.

On the rocky ridges which commonly occur throughout the glaciated Highlands and in the Kittatinny Mountain section, the forest consists mainly of short-stemmed and usually crooked chestnut oak. Most of these trees are best suited for such products as cordwood and boat fenders. Their slow rate of growth together with their relative inaccessability makes these areas of little present value from the standpoint of timber production. Both white and pitch pine sometimes occur in mixture with the oak on these sites and are able to make faster growth and produce larger and better-formed trees. The proper practice is to increase the percentage of both pines in the mixture; and the State foresters are investigating methods by which this may best be done.

Intermediate Cuttings.—In improving the quality and volume of major forest products such as saw logs and piling, supplementary cuttings are often made. These, in effect, are weedings directed toward the improvement of the final crop.

Most woods are encumbered with many unmerchantable trees—the left-overs from former cuttings. These not only absorb the nutrients which might better be used by younger stock, but also overtop and suppress them. These "wolf" trees should be gotten rid of so that more useful individuals can replace them. If the full productivity of a stand is to be obtained any of the commercial cuttings described above should be followed up by an improvement cutting which would remove the badly-formed or broken trees left behind because of their unmerchantability as saw timber. Red maple, black gum and sassafras generally make up the majority of such trees. Undesirable individuals of all species in the smaller diameter classes should be cut at the same time so that the entire growing capacity of the soil may be concentrated on the best and most promising trees instead of being dissipated over numerous worthless members, many of which will die before reaching maturity.

Even-aged stands which are managed for high quality timber should be thinned at intervals of ten to twenty years. In these cases the over-topped

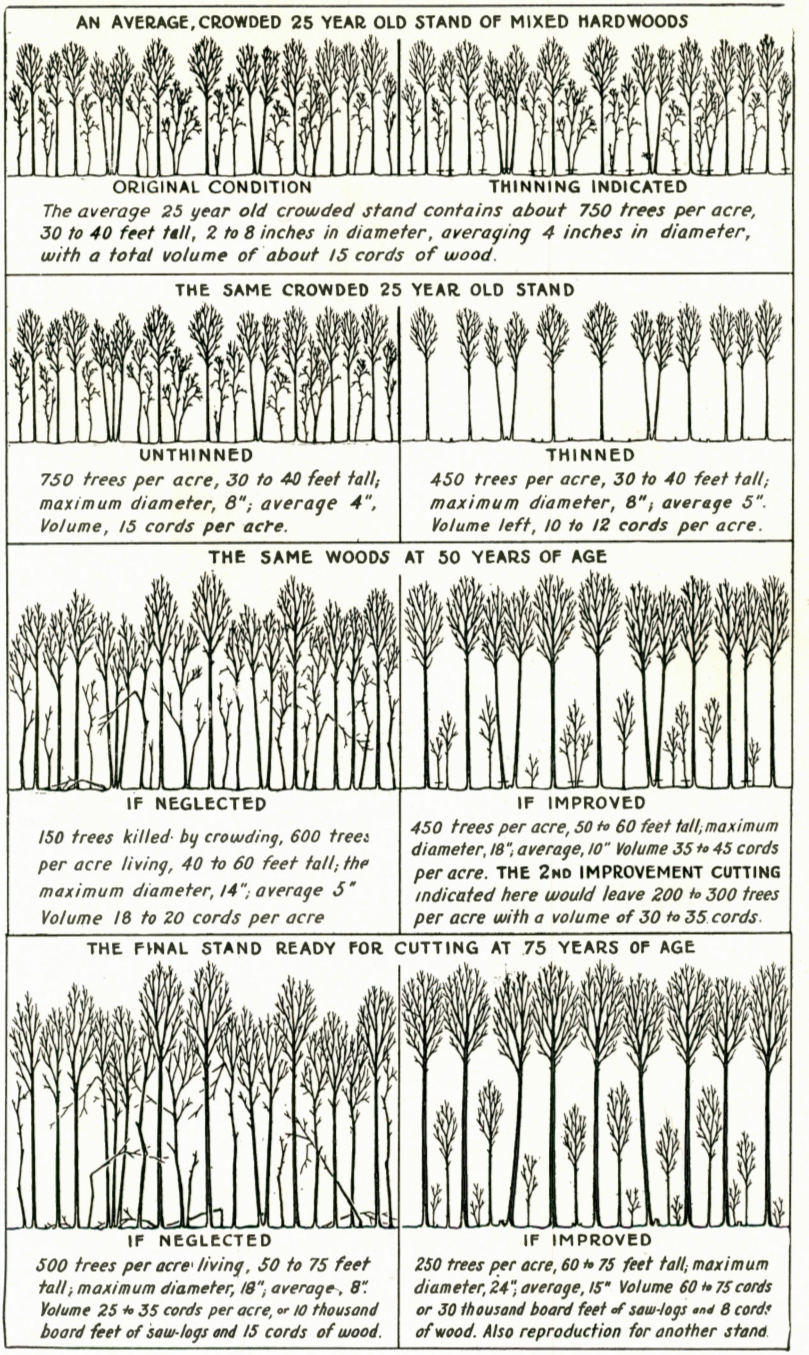

Fig. 17. *Diagram showing the results of thinnings and improvement cuttings in hardwoods.*

New Jersey State Library

and suppressed trees should be taken out in favor of the dominants. The resulting reduction in competition stimulates an increased rate of growth on the remainder of the stand so that merchantable saw timber and piling is produced at an earlier age. As the stand becomes older the thinnings admit light to the forest floor and advance reproduction has opportunity to develop, so that when the final cutting is made another crop of younger trees is already established.

The Department of Conservation and Development is carrying on a series of experimental thinnings in North Jersey to determine just how much increased growth may be expected from such practice, and Table 3 presents some of the results obtained over a ten-year period. In this case it will be seen that the percent of growth on the thinned plot has been almost twice that of the unthinned plot.

TABLE 3. SHOWING INCREASED RATE OF GROWTH FOLLOWING A THINNING IN YOUNG EVEN-AGED HARDWOODS IN NORTH JERSEY (COVE SITE)

Plots	Age	Number of Trees per Acre	Height of Average Dominant Tree	Ave. DBH	Volume per Acre	Current Annual Growth per Acre	Growth Percent
			ft.	in.	cords	cords	
Plot No. 1 Before Thinning	25 yrs.	872	35	4.1	14.4		
After Thinning	25 yrs.	452	35	4.9	11.8		
	30 yrs.	416	41	5.8	20.3	1.7	16.1
Plot No. 2 Not Thinned	25 yrs.	780	35	3.9	12.2		
	30 yrs.	632	41	4.7	15.3	0.6	5.1

Note: If the volume of wood left after thinning is considered as the capital, and the growth made over the period as the interest, this table shows that the thinned pot has made more than three times as much interest as the untreated plot.

Thinnings and improvement cuttings produce cordwood and fence posts. On farms and in sections where wood is used as fuel these operations can often be made to pay for themselves. Thus on a piece work basis choppers are usually paid $2.00 a cord for making thinnings or working up the tops of trees which were cut for saw logs. Sometimes, however, where the wood consists largely of species like red maple, elm or black gum, it has little or no market value and is often given away to needy individuals in return for its cutting. In some instances the State has been able to make arrangements with local relief agencies for doing such work on private lands. In these operations the State foresters marked the trees to be cut and maintained general supervision of the crews who were under the immediate direction of a foreman supplied by the local relief administration. Approximately 2000 acres of woodland in the northern and central part of the State have been improved under such arrangements.

The Disposal of Slash.—The disposal of slash from hardwood operations does not present a serious problem in North Jersey. While the accumulation of brush increases the fire hazard it can be greatly reduced by taking a few simple precautions. Thus for a distance of 50 feet back from well-traveled roads the brush should be placed in small piles and burned in openings where it will not injure the remaining trees. Elsewhere it should either be lopped into 8 or 10 foot lengths so it will lie close to the

ground, or placed in small piles 2 or 3 feet high. In either case it soon becomes pressed down under snow and decays rapidly.

Effect of Cuttings on Wildlife.—Forest management unavoidably affects wildlife by changing the conditions of food and cover in the woods and along their edges. Whether these changes are beneficial or detrimental depends on the type of operation and how it is carried out.

Cuttings made by either the group selection method or to a diameter limit result in the development of a more or less uneven-aged stand, and provides a series of "edges" between the different age-groups. The opening up of the crowns permits light to reach the forest floor and favors the establishment of such plants as the tick trefoils (Desmodium), bush clover (Lespedeza), blackberry and hazelnut. These conditions are much more favorable to wildlife than large blocks of even-age, and deer, rabbits, ruffed grouse and songbirds will be benefited by such management.

Management of Abandoned Farm Lands.—In North Jersey the utilization of abandoned fields for a combination of forestry and wildlife is the best use to which most of these idle lands can be put. Scattered clumps of hardwood saplings and brush are frequently present on these areas, and if plantations of conifers are established in the openings between them a desirable interspersion of hardwood and softwood species may be obtained, which will favor the development of wildlife at the same time that a stand of timber is being grown.

Altho none of the pine plantations which have been made in Northern New Jersey are old enough to produce lumber as yet, measurements taken



Fig. 18. *Even-aged hardwoods in the glaciated Piedmont Plain. This stand is 45-50 years old and in need of thinning.*



Fig. 19. *Even-aged hardwoods in the Piedmont region following a thinning. The overtopped trees have been taken out and future growth will be concentrated on the better individuals which remain. Another thinning should be made in about* 10 *years.*

on some of them show that they are growing well and indicate what may be expected from them. Table 4 presents data from two such plantations.

TABLE 4. SHOWING DEVELOPMENT OF TWO PINE PLANTATIONS ON OLD FIELDS IN NORTH JERSEY

	Age Yrs	No. Trees per Acre	Height of Average Dominant Tree	Average DBH	Volume per Acre	Current Annual Growth per Acre	Growth Percent
			ft.	in.	cords	cords	
Plot No. 1	20	768	33	5.3	20.7		
White Pine	25	719	42	6.2	31.6	2.4	5.2
Plot No. 2	20	942	33	5.1	24.4		
Red Pine	25	921	40	5.8	34.4	2.0	4.1

The edges of coniferous stands are the parts which are most intensively used by wildlife, and the interior portions—more than 400 feet from the margins—are relatively deserted. Small blocks 2 or 3 acres in extent, or strips planted along contours with intervening open land give better results from the standpoint of birds and animals than where a large area is planted up as a single unit. Fire lines 10 to 15 feet wide plowed along the edges of a coniferous stand serve the double purpose of protection and affording herbaceous annual plants the opportunity to volunteer and provide a source

of food. A few rows of corn or a small patch of buckwheat sown at intervals along such a strip will further improve the carrying capacity for game.

Winter feeding of birds and animals is desirable, particularly during periods of cold weather and deep snow, and can often be advantageously carried out along the sheltering edge of a coniferous plantation. Rough wooden hoppers of the self-feeding type and holding half a bushel of shelled corn are good. They should be placed close to cover and protected by a lean-to of poles and brush or corn fodder, (Fig. 21), which faces toward the south. Feeding stations of this type are used on the State Forests and usually require restocking at two-week intervals.

Sustained Yield Units on Private Lands.—The foregoing discussion of forest management has indicated the general methods which should be used in handling wild land in northern New Jersey. These methods are applicable to both large and small properties where the owners are interested in conservation. Forestry, however, is a longtime proposition and for this reason its actual practice is closely connected with the character of land ownership. Public and semi-public properties, because of their permanence, lend themselves more readily to forest management than those belonging to private individuals, where both the ownership and policy is subject to change. Certain types of holdings, however, such as farms, private estates, corporate properties and educational institutions are apt to be more stable



Fig. 20. *Even-aged hardwoods in the Highlands of North Jersey following a thinning. This is privately-owned land and was thinned by Emergency Relief labor under the direction of State foresters. This is a cove site and the stand is 35 years old. Note the prevalence of tulip trees.*

in tenure and offer good opportunities for practising forestry on a sustained yield basis.

The requirements necessary for sustained yield forestry is the availability of a sufficient number of trees of different diameter classes so that an annual cut of merchantable material may be maintained on a permanent basis. This means that the amount cut must be balanced against the growth, and the area under management must be large enough to furnish the volume necessary for a practicable operation without reducing the growing stock. It is a clear case of utilizing the "interest" and protecting the "capital".

These conditions cannot be realized on small holdings operating independently, but by combining a number of different properties into a unit for management purposes, a sufficiently wide range of stock is made available. A sustained yield unit of this type is necessarily a cooperative affair and such organizations have recently been formed in New York State and New England, and others are being developed in Maryland and Pennsylvania. In these forestry cooperatives individual members may own as little as ten acres of woodland, but when these small parcels are included as part of the working unit, they help to make a sustained operation over the entire area possible and all share in the advantages resulting from better forest practice and the cooperative marketing of the products. Each proprietor receives the income from his own timber less his proportional share of the handling costs.

Among the advantages of the forestry cooperative is its stabilizing effect on lumber operations in the area. In place of a disorganized group of forest owners and timber buyers working at cross purposes and devastating the woodlands, a somewhat smaller but sustained output is obtained on a permanent basis.

This type of organization appears well adapted to conditions in parts of northern New Jersey, and warrants the serious consideration of all forest owners interested in the profitable use of their woodland.



Fig. 21. *Winter feeding station for wildlife. Small openings should be left in the sides and rear to prevent birds or animals from being cornered by predators.*

Part VII

FOREST MANAGEMENT IN SOUTHERN NEW JERSEY

The Middle District.—It has already been pointed out that South Jersey falls into two broad sub-divisions based on soil quality and the character of the native vegetation. These are (1) the Pine Region and (2) the rest of the Coastal Plain. In describing this part of the State, Stone says:*

> "As we cross southern New Jersey from west to east we are first struck by the sharp line of demarcation between the farming district of West Jersey and the Pine Barrens; crossing the latter we find on the coast a narrow belt separating the Pines from the maratime marshes, which has essentially the same flora as the West Jersey region . . . Southward in the Cape May peninsular we find the West Jersey and coast strips coming together to the partial extinction of the Pine Barrens . . . "

The Pine Region is, therefore, actually an "island" of poor sandy soils and supports a type of vegetation which is markedly unlike that of the surrounding territory.

In West Jersey or the "Middle District" about 85 per cent of the land has been cleared, and the woodlots are largely confined to the poorly drained sites which are not adapted to cultivation. While the water table is high on most of these areas, the soils are fertile and excellent stands of hardwood can be produced under management. The rate of growth in the regions between Hightstown and Camden is particularly good and Table 5 shows the results obtained on one of the tracts in this section on which thinnings have been carried out.

TABLE 5. SHOWING GROWTH FOLLOWING THINNING IN A HARDWOOD STAND IN WESTERN BURLINGTON COUNTY

Stand Thinned at 40 Years of Age	Age	No. of Trees per Acre	Height of Average Dominant Trees	Ave. DBH	Volume* per Acre	Current Annual Growth per Acre	Value† per Acre, Stumpage
			ft.	in.	bd. ft.	bd. ft.	
Before Thinning	40 yrs.	400	70	7.0	6,244		
After Thinning	40 yrs.	148	70	9.5	6,012		$60.00
	50 yrs.	138	80	11.1	10,216	420	$102.00

* International Log Rule, ¼ inch kerf.
† The stumpage value of $10.00 per thousand board feet is very conservative for this stand in view of the quality of the timber and its accessibility.

While this stand is rather understocked due to careless handling in its younger stages, the above figures show that it has averaged 7 percent in

* Stone, Witmer. *The Plants of Southern New Jersey with Especial Reference to the Flora of the Pine Barrens.* Annual Rep. of New Jersey State Museum, 1910.



Fig. 22. *Oak in the Delaware Valley following a heavy thinning to stimulate reproduction. This is privately-owned land and was thinned by Emergency Relief labor under the direction of State foresters. This is a cove site, the stand is 75 years old and contains about 10,000 board feet per acre by the International Log Rule. The large tree in the mid-background is 18 inches in diameter, 95-feet tall. This stand should be clear-cut at 85 years of age.*

growth each year, equivalent to an annual return of $4.20 per acre over the 10-year period studied. Another light thinning should be made in five years to further concentrate the growth on the best trees and at 75 years of age the stand should be clear-cut. At that time it should yield 20,000 board feet per acre of high class hardwoods.

In general the woodlots of West Jersey are best adapted to management in even-aged stands, because of the danger of windthrow which is apt to occur if they are opened up too much on these wet sites by selection cuttings. However, thinnings should be made at 10-15 year intervals removing the over-topped and weakened trees which can be utilized as cordwood and fence posts or sawed into boards for home use. Grazing is very detrimental to woodland, destroying the ground cover and permitting winds to sweep through. The trampling of livestock also compacts the soil and makes it more impervious to water.

In those portions of the Middle District adjoining the Pine Region on the south and east the soils are less productive than in West Jersey and a smaller percentage of land has been brought under cultivation. Scrub pine (Pinus virginiana) commonly occurs here, both in pure stands and in mixture with hardwoods. The forests as a whole have suffered severely from over-cutting and fire, and, in some respects, resemble those of the Pine Region. Permanent plots, however, which have been established both in Cape May County and in the Coastal Strip near New Gretna show that the yields and the rate of growth are definitely better than within the "Pines" As the problems of management in both of these areas are essentially the same, the methods of handling them will be discussed together under the oak-pine type.

The Soils and Land Uses of the Pine Region.—The "Pines" cover an area of approximately 1,300,000 acres. Altho located within two hours by car from New York City and one from Philadelphia, this part of New Jersey is virtually a wilderness—unsuited for cultivation and sparsely populated.

The soils are generally sandy, and a considerable proportion belong to the group known as podzols. Podzols are characterized by a bleached surface layer from which the organic matter, clay and iron have been leached out and transferred to deeper layers.* Frequently hardpan is also formed in the zone where these materials are deposited. In driving through the "Pines" this interesting podzol formation may be easily recognized in the cuts by the layer of white sand on the surface and the dark colored "horizons" below it. The leaves and needles which accumulate on soils of this type do not decay readily but tend to form a mat which is held together by threads of fungus. Wherever earthworms are present they feed on fallen leaves, pull them into their burrows and help transform them into "mull" humus. In the white sands of the "Pines," however, where surface temperatures reach† 160°, few earthworms can be found and so where fires do not consume the litter, it accumulates on top of the ground in loose mats of "raw" humus.

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* Joffe, J. S. *Soil Profile Studies*: III. *The Process of Podzolization. Soil Science* XXXII; 4; 1931.

† Lutz, Harold J. *Ecological Relations in the Pitch Pine Plains of Southern New Jersey,* Yale University, School of Forestry Bull. No. 38; 1934.

The flora of the "Pines" is characteristic of distinctly acid soils and includes many interesting plants. Stone* lists 386 species as typical of this region, including two—the resinous boneset (Eupatorium resinosum) and the New Jersey rush (Juncus caesariensis)—which do not occur anywhere else in the world. Among the forms found here are the turkey-beard (Xerophyllum asphodeloides), bearberry (Arctostaphylos uva-ursi), sand myrtle (Leiophyllum buxifolium), crowberry (Corema conradii), pyxie moss (Pyxidanthera barbulata), pine-barren heather (Hudsonia ericoides), bog asphodel (Narthecium Americanum), and several orchids including the white-fringed species (Habenaria blephariglottis).

The upland forest consists of a mixture of pitch and shortleaf pine with a variety of oaks, the most common of which are black, white, scarlet, chestnut and black-jack. This entire region has been so repeatedly cut over and burned that the woods have become seriously run down and the rate of growth very much reduced, as is shown by the fact that the average annual growth of the mixed oak-pine forest ranges between .2 and .3 of a cord, representing a yearly return of 20-30 cents per acre. Such conditions combined with the high forest fire hazard do not encourage the private ownership of land, and have brought about a chronic state of tax delinquency, with some 350,000 acres or 33 percent of the region in process of reversion to the townships.† With the exception of the wet soils suited to the cultivation of cranberries and blueberries, it is obvious that most of the land here is not adapted to private ownership and the efforts to maintain it in such status have resulted in devastation of the resources and the impoverishment of individuals.

Management of the Oak-Pine Type.—According to early reports‡ most of southeastern New Jersey was originally covered with a predominantly pine forest. On the poorer sites pitch pine occurred in pure stands, while the better ones supported a mixture of shortleaf pine and oak. Studies made in these virgin stands in 1895 showed that even in the mixed forest pine was the important tree, with most of the oak occurring as an understory. Table 6 gives a picture of the original conditions as reported by Pinchot.

TABLE 6. SHOWING TYPICAL CONDITIONS OBTAINING IN ORIGINAL FOREST OF THE PINE REGION*

Age Range 120-200 Years	No. of Trees per Acre	Height of Average Tree	Basal† Area per Acre	Average DBH	Volume per Acre	
		ft.	sq. ft.	in.	cords	bd. ft.
Pine	72	65	49.18	11.2	17	7200
Oak	208	40	33.43	5.4	7	550

* The above table represents the average of two stands of virgin forest, one at New Lisbon and the other near Winslow. They were surveyed by Pinchot in 1895.
† Basal area is the total cross-sectional area of all trees at breast height. It is the best index of stand density.

* Stone, Witmer. *The Plants of Southern New Jersey.* Annual Report of the New Jersey State Museum, 1910.

† Report of New Jersey State Planning Board; 1938.

‡ Pinchot, Gifford, *A Study of Forest Fires and Wood Production in Southern New Jersey.* Ann. Rep. State Geologist, 1898.



Fig. 23. *Pure shortleaf pine in South Jersey. These trees are* 45-50 *years old and average about* 50 *feet in height. Note the understory of oak at the left. If this pine is improperly managed the following stand will contain more oak and be much less valuable.*



Fig. 24. *Seed trees left after cutting a pine stand in South Jersey. Note the scattered oak seedlings. Fires would cause these oak to sprout vigorously and reduce the chances for successful regeneration of pine seedlings on this area. Jackson State Forest.*

In the development of a forest of this type, fire certainly played an important role and it is believed highly probable that the Indians were in the habit of setting them at frequent intervals in order to drive out the game and make the woods more open and accessible for hunting. In virgin stands containing many large trees such fires would ordinarily be light and burn mostly in the litter and undergrowth. Since pine with its thicker bark is less susceptible to injury than oak, it would undoubtedly be favored by this sort of treatment and predominate in the overstory.

When the white men came and cutting began, fires occurred with increasing frequency and an entirely different set of factors was introduced. Young trees with thin bark are much more easily damaged than old ones and as the reproduction which sprang up on the cut-over lands was killed back it was converted into stands of sprouts. Where the Indian fires in the virgin forest had favored pine, the combination of cutting and fire in young stands favored oak because of its more vigorous sprouting capacity and rapid juvenile height growth. It was a common saying among the settlers that "oak follows pine," and the truth of this may be seen today wherever tracts of second growth pine are cut. Such stands usually contain a few scattered oak seedlings in the understory which grow vigorously as soon as the overwood is removed. If fires follow the cutting, these seedlings are converted into multiple sprouts with each cluster dominating a wide area and considerably reducing the chances for pine reproduction to survive.

As a result of these conditions oak has spread over a much wider range than it formerly occupied* while the area of pine has been reduced.

From the standpoint of forest management, pine is distinctly the more desirable tree for it is able to make better use of the poor growing conditions than the oak. Pine produces material suitable for saw logs and piling, attains larger size in less time, is more resistant to fire, and when given the opportunity reproduces itself readily from seed. While it reached diameters up to 30 inches in the original forest† the second growth stands today usually range from 12-15 inches at 60-70 years. Throughout most of the region heights of 45-55 feet at 50 years are the most common.

The best stands of pure pine today are those which have seeded in on abandoned fields and on some of these the yields exceed those of the original forest as reported by Pinchot. Table 7 presents the data collected over a 15-year period on one of these tracts which now contains approximately 13,000 board feet per acre at 45 years of age. Measurements taken by the State foresters show that the current annual growth here has averaged 485 board feet per acre, equivalent to a net yearly return of $2.20 per acre during the last 15 years.

TABLE 7. SHOWING INCREMENT MADE BY SECOND GROWTH SHORTLEAF PINE ON ABANDONED FARMLAND NEAR ATSION

Age	Number of Trees per Acre	Height of Average Dominant Trees	Average DBH	Volume per Acre		Value per Acre†
yrs.		ft.	in.	cords	bd. ft.*	
30	452	43	6.9	24	5500	$22.00
45	319	58	8.8	39	12800	$51.00

* International Rule, ¼ inch kerf.
† Stumpage price at $4.00 per thousand board feet by International Log Rule. This stand had grown at the rate of 8.7 percent during the last 15 years.

Pure stands of pine should be thinned to prevent stagnation and to favor the development of the best individuals. Experiments have shown that such work gives best results if done between the ages of 15 and 40 years. In final-cutting stands of even-aged pine, from 10-20 seed trees per acre should be left well distributed over the area. While some seed is produced each year, abundant crops are borne at intervals of 8-10 years, and since natural reproduction usually occurs wherever the seed can reach mineral soil, any method which breaks up the mat of "raw" humus will aid in the establishment of a new stand. Different means by which this may be accomplished most effectively are being studied by the State foresters.

Pure stands of pitch pine occur over considerable areas of poorly-drained soils known as "St. Johns sands". The trees here are generally sprouts—crooked and of poor quality—due to killing back by fire during the juvenile period. It is possible that these sites may ultimately be converted over into white cedar land through the control of fire and this problem is under investigation.

* Baker, Willis M. *Management of the Coastal Plain Forests of Southern New Jersey.* Unpublished Ms. 1923.

† Pinchot, Gifford. *A Study of Forest Fires and Wood Production in Southern New Jersey.* Ann. Rep. of State Geologist, 1898.



Fig. 25. *Part of the same area shown in Fig. 20, 11 years later. Note how the pine has re-seeded itself. No fires have occurred and as a result the oak is still an unimportant element in the new stand. Jackson State Forest.*

Some good oak timber was cut from the original forests in the Pine Region but today it produces little except cordwood. Everywhere in this section the hardwood stands are made up of sprouts which have lost much of their vigor from repeated coppice. Trees cannot maintain themselves indefinitely by this form of reproduction and that the present stands are approaching exhaustion is shown by the swollen and deformed stumps and the prevalence of decay and borer work. At 40-50 years stagnation generally sets in with diameters of 8-10 inches and heights of 40-50 feet, and at 60 years considerable mortality develops. While apparently unable to supply trees of this size with the necessary nutrients, the stumps are still able to produce another crop of sprouts if the stand is cut at 40-50 years, altho each succeeding generation becomes weaker. The oak here does not reproduce so readily from seed as in other parts of the State, and it seems

reasonable to suppose that the progressive deterioration of the parent stands may be reflected in a corresponding loss of vigor in the seed produced, rendering them less resistant to insect and fungus attack, and resulting in seedlings which are less able to cope with the adverse soil and moisture conditions which obtain here. In this connection Wood* has definitely shown that insects and rodents destroy a considerable percentage of the acorn crop and that among those which survive, the rate of germination is usually low.

Studies by the State Foresters show that the yields in mixed stands of oak and pine varies in direct proportion to the amount of pine present.† This is illustrated in the three plots shown in Table 8 which were laid out in various parts of the same 35-year old stand on the Jackson State Forest near Cassville.

TABLE 8. SHOWING HOW THE INCREASE OF PINE AFFECTS THE YIELD OF MIXED OAK-PINE STANDS

Age 35 Years		No. of Trees per Acre	Average Height	Average DBH	Volume per Acre	Mean Annual Growth per Acre
			ft.	in.	cords	cords
Plot No. 1	Pine	251	30	4.2	3.4	0.10
Chiefly Oak	Oak	802	25	3.1	5.9	0.17
Plot No. 2	Pine	461	30	4.2	6.1	0.17
50-50 mixture	Oak	483	27	3.5	4.8	0.13
Plot No. 3	Pine	819	32	4.4	13.4	0.38
Chiefly Pine	Oak	178	25	3.1	1.3	0.04

Note: The mean annual growth of Plot 3 is almost double that of Plot 1.

With pine more desirable than oak, the major problem of management is to change the present composition of the forest to one containing more pine and less oak. Complete conversion to conifers is not desirable but it is believed that a ratio of 5 or 6 to 1 in the dominant stand 10 inches in diameter and over should be the objective. This would approximate the conditions in the original forest as shown in Pinchot's stand tallies.

On the State Forests the Department of Conservation and Development has been carrying out practices directed toward this end since 1922.† The work is done in two ways. Under the first, the oak is clear-cut when it reaches size merchantable for cordwood, usually at about 40 years. Pitch, shortleaf and loblolly pine seedlings are then planted over the area at the rate of about 500 per acre. Since the oak sprouts which develop would soon suppress the seedlings, it is necessary to keep them cut back until the planted stock has become tall enough to maintain its dominance without further aid. Usually four or five such "cleanings" are required during the first 8-10 years. The second method used in changing the composition of the forest consists of thinning the oak and underplanting with pine in the openings. In this case the hardwood sprouts must also be cut back. The

* Wood, O. M. *Seedling Reproduction of Oak in Southern New Jersey. Ecol.* 19:2; April, 1938.

† Baker, Willis M. *Management of the Coastal Plain Forests of Southern New Jersey.* Unpublished Ms. 1923.



Fig. 26. *Managing the oak-pine type. The loblolly pine in the background was planted eleven years ago on cut-over oak land. The hardwood sprouts have been cut back three times to prevent them from suppressing the pine, which is now well established. Bass River State Forest.*

remaining overwood should be removed 10-12 years after the thinning at which time the planted stock will have become well established.

The practice of thinning out the hardwoods in mixed stands of oak and pine is recommended wherever the latter can be helped by so doing, but experiments have shown that thinnings in pure oak are not justified because the exhausted coppice is not able to make sufficient response to the treatment.

Management of Southern White Cedar.—Southern white cedar occurs in pure dense stands of even-age in many of the swamps of South Jersey. Considerable areas of the "spungs" and "savannahs" separating the swamps from the adjoining upland, and now occupied by sprout stands of pitch pine, at one time probably supported cedar, but by cutting and fire have been converted into their present condition.

Southern white cedar is very tolerant of shade and the dense stands produce straight-stemmed trees with little taper. The wood is used for boat boards, shingles and lath, and in the round for bean poles, shade tree stakes, arbor poles, fence posts, poles and cabin logs. In southern New Jersey heights of 40-45 feet are usually reached at 50 years of age.

Because of the market for small sized products, white cedar can be profitably thinned, and such work has been carried out on the State Forests at an average net profit of $35.00 per acre. In making thinnings an untreated

strip 20-30 feet wide should be left along the margins of the stand to prevent windthrow, to which this species is very susceptible.

Cedar responds well to thinning and its rate of growth can be appreciably increased even if these are made as late as 50 years of age. Table 9 presents data taken on permanent sample plots which illustrate this condition.

TABLE 9. SHOWING INCREASED GROWTH FOLLOWING THINNING IN SOUTHERN WHITE CEDAR

Plot Description	Age	Number of Trees per Acre	Height of Average Dominant	Basal Area per Acre	Average DBH	Volume per Acre	Current Annual Growth per Acre	Growth Percent
			ft.	sq. ft.	in.	cords	cords	
Plot No. 1								
Before Thinning	50 yrs.	2380	40	249	4.4	57.0		
After Thinning	50 yrs.	1050	40	162	5.3	39.0		
	60 yrs.	1020	49	220	6.3	70.6	3.2	8.1
Plot No. 2								
Not Thinned	50 yrs.	1940	40	247	4.8	58.4		
	60 yrs.	1240	49	260	6.2	83.2	2.5	4.2

Note: The growth percent has been approximately twice as great on the thinned as on the unthinned plot.

Ordinarily cedar stands in New Jersey should be clear-cut at 70-80 years of age, and if the slash is burned the first winter following logging satisfactory natural reproduction will usually follow and restock the area.* Cedar seed is borne in abundance and remains viable for many years in the wet peaty soil under the stand. It germinates readily when the overwood is removed.

White cedar is very susceptible to fire injury and easily killed, and the conversion of much cedar land to pine or swamp hardwoods has undoubtedly been brought about by this means.

Seedlings of white cedar have been planted experimentally on wet lands in both North and South Jersey by the Department of Conservation and Development with a fair degree of success. The tendency of the seed to delay germination, however, makes the growing of nursery stock rather uncertain.

Wildlife Management in the Pines.—As with the forests, the wildlife of the Pines has suffered severely from commercial exploitation. Market hunting which was carried on extensively in early days, persisted up until the latter part of the 19th century and was largely responsible for the destruction of the "vast stores" of game originally occurring here.

Among the birds which have been exterminated from New Jersey, the wild turkey, passenger pigeon and heath hen were all at one time abundant throughout the southern part of the State. The heath hen, in fact, was so common on the "Plains" of Burlington and Ocean Counties that these sections were known as the "Grous Plains"† and were rated as the best

* Korstian, C. F. and Brush, W. D. *Southern White Cedar.* U. S. Dept. Agric. Tech. Bull. 251; Sept. 1931.

† *Doughty's Cabinet of Natural History.* 1832

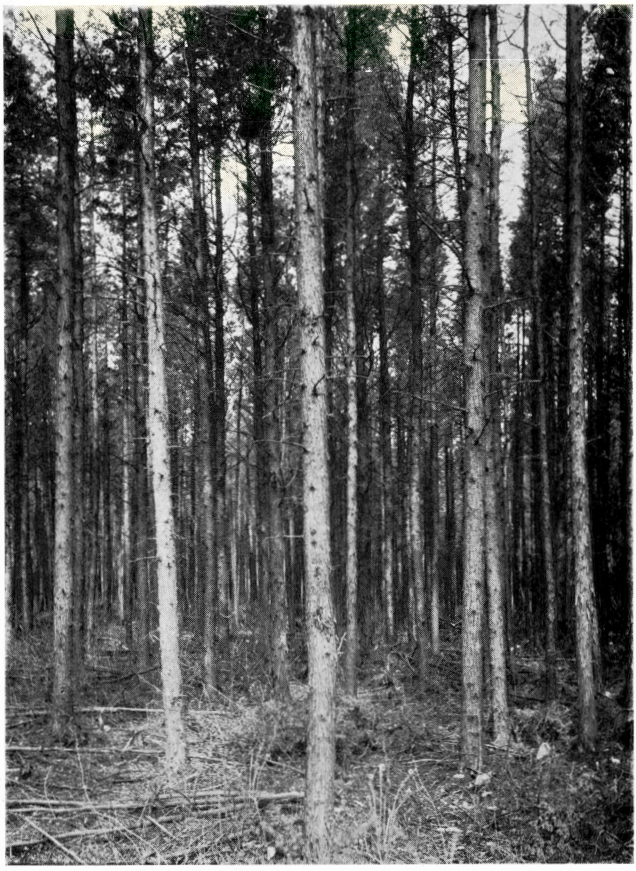

Fig. 27. *Southern white cedar, 50 years old, following a thinning. Permanent sample plots show that the percent of growth can be doubled by this sort of treatment.*

hunting grounds for this bird east of the Alleghenies. The species was destroyed in New Jersey about 1880.

Waterfowl formerly bred in countless numbers in the tidal marshes of the coast and along some of the streams. Great Egg Harbor and Little Egg Harbor Rivers derived their names from the thousands of nests of ducks, geese and swans which used to be found along their shores.* Deer were plentiful and were often taken in huge iron traps or by set-guns until these means were finally outlawed as "common nuisances to mankind". These were the days when venison sold for 18 pence the quarter in the settlements along the Delaware.

In the Pine Region the principle of multiple use in land management is

* Gabriel Thomas. *An Historical and Geographical Account of the Province and County of Pennsylvania and of West New Jersey in America.* 1698.

of especial importance; and recreation, timber production and wildlife management must all be included in the program.

The wildlife population of any section of the country reflects the conditions of food and cover obtaining there and this is brought out very clearly in the Pines. Here the uneven-aged character of the upland forests have made woody brouse abundant and accessible, but the long stretches of continuous woodland afford few openings or "edges" where herbaceous flora can develop. As a result of these conditions deer are plentiful today but most other forms are scarce.

A recent wildlife census which covered 3500 acres on the Lebanon State Forest showed the following results:

Deer: one animal per 17 acres.

Quail: one bird per 13 acres of "habitable range," or one per 60 acres of total range.

Ruffed Grouse: one bird per 350 acres.

The distribution of the quail population as shown by the census was particularly significant and points the way toward the environment changes necessary to encourage the spread of this species. Of the sixteen blocks censused, quail were found on only four. The predominating cover on these four blocks was the same as on the other twelve, i.e., an open forest of oak and pine. However, each of the four "habitable" blocks also contained some open land—an old field, a cranberry bog, a railroad right-of-way or a broad state highway. Here were "edges" where herbaceous vegetation was growing—food close to cover—and here were quail and rabbits.



Fig. 28. *Land managed for forestry and wildlife in South Jersey. This strip ploughed along the edges of a pine plantation provides a fire break and also favors the development of herbaceous plants which have food value for wildlife. Note the excellent cover on the left. Belleplain State Forest.*



Fig. 29. *Strips cleared through the woods in South Jersey provide fire protection and furnish food for wildlife. These strips are disced at 3-4 year intervals to keep brush from developing. Belleplain State Forest.*

In the Pines food is the limiting factor for most wildlife and the basic principle of management, therefore, is to break up the present widespread uniformity of cover and develop an interspersion of forest and openings which will provide "edges' so that the blank areas may become "habitable" range. To this end all old fields should be retained as such and not allowed to revert to woods. Strips, from 25 to 50 feet in width, plowed along their borders, will replace the useless broom sedge with other more valuable food plants. The old fields, however, are too few and scattered here to leaven the extensive forest areas which surround them, and these large blocks should be broken up into smaller units by means of cleared and plowed strips where new food supplies of herbaceous plants may develop and which will also provide the travel lanes necessary for the disperal of wildlife more uniformly over the area.

This same type of work has given good results in the pine-scrub oak type of some of the southeastern states and is now being carried out on the State Forests of South Jersey. Projects are begun at known centers of quail and rabbit population and from there "fan out" through the surrounding woods. Small clearings up to 2 acres in extent are constructed at intervals along the strips to provide headquarters for new population units. Artificial cover of stumps, poles and brush are constructed at intervals along the lanes and planted to wild grape and cat brier.

A number of the legumes and grasses native to the Pine Region are valuable food plants. These include partridge-pea, tick trefoil, bush clover, goat's rue, wild indigo and some of the panic and paspalum grasses which often volunteer along roadsides or in openings. The seeds of these plants are gathered and sown on the strips and clearings.

Coordinating Forestry and Wildlife Management.—In the coordination of forestry and wildlife management in South Jersey, fire control plays an important part. On the State Forests a network of gravel roads divides the area into blocks of various size up to about 400 acres. On either side of these roads "safety strips" are maintained. These consist of one hundred foot strips from which all undergrowth is removed while all the trees are retained. These strips provide the "fronts" along which back-fires may be set in case of need.

The cleared food lanes are constructed along the outer margins of these "safety strips," and additional ones are opened through the interior portions of the blocks, breaking them up into units of 20 to 30 acres. These food lanes not only provide additional "fronts" from which fires may be attacked but they also reduce the areas burned over by back-fires—an important item in this section.

The location of the Pine Region with respect to the densely populated metropolitan centers calls for the best possible use of its potentialities. To realize these the natural resources must be built up and conditions approximating those of the original forest restored as nearly as possible and maintained on a sustained yield basis. This cannot be done by individuals. It is a matter for State ownership and administration. Forestry, wildlife, recreation, with the development of lakes, picnic sites and cabins—these are the uses to which this region is adapted and under which the Pines can become a permanent asset to the people of New Jersey.

SUMMARY

In concluding this survey of New Jersey's land management problems, certain significant points should be borne in mind.

1. Two million acres or 46 percent of the land area of the State is still in forest.

2. The soil and topographic conditions on these areas indicate that most of it will remain permanently in forest or be waste land.

3. In the past the woods have been "mined" and repeatedly burned and as a result are in a badly run-down condition.

4. It would be to the interest of everyone in New Jersey if these 2,000,000 acres of forest land should be placed under definite management and handled as a permanent crop.

5. Forests which are conservatively "cropped" can be used simultaneously for recreation and the conservation of water and wildlife.

6. In northern New Jersey the growing of high-grade oak piling and saw timber is possible on a sustained yield basis, and under such management could make definite net contributions to help meet the high carrying charges which obtain on many of the properties in this section.

7. Because of the limited size of most private properties in North Jersey, the formation of forestry cooperatives would be desirable. With a number of owners pooling their forest resources, better management and marketing practices could be introduced.

8. In the pine region of South Jersey, poor soils and the high fire hazard make the private ownership of large areas of land unattractive. The solution here lies in State ownership and management.

9. The State has undertaken the policy of acquiring areas of wildland throughout New Jersey as State Forests and Parks. These are being managed by the Department of Conservation and Development for public recreation, forestry, wildlife and the conservation of soil and water. They are also valuable as experimental laboratories for working out and testing methods of land management.

10. The Department of Conservation and Development operates two forest tree nurseries where seedlings are raised for distribution to private land owners for reforestation purposes. The advice and assistance of State foresters is available to persons desiring to plant up their idle lands.

11. The Department of Conservation and Development offers help to residents of New Jersey in connection with the handling of their woodlands, including timber appraisals, marketing of the products and general management practices.

APPENDIX

TABLE 10. SHOWING AREAS OF FOREST IN NEW JERSEY, BY COUNTIES*

Counties	Total Upland Area. Acres	Cleared Upland Area. Acres	Forest Acres	Percentage of Upland in Forest
Atlantic	307,409	35,711	271,638	88
Bergen	143,470	85,879	57,591	40
Burlington	511,756	207,979	303,777	59
Camden	139,101	72,513	66,588	48
Cape May	110,674	29,823	80,851	73
Cumberland	267,580	101,316	166,264	62
Essex	76,746	52,507	24,239	32
Gloucester	201,503	125,685	74,818	37
Hudson	15,786	15,073	713	05
Hunterdon	279,919	240,438	39,481	14
Mercer	144,229	128,400	15,829	11
Middlesex	191,440	131,276	60,164	31
Monmouth	300,999	211,288	89,711	30
Morris	303,910	163,809	140,101	46
Ocean	360,171	47,084	313,087	87
Passaic	125,488	50,284	75,204	60
Salem	188,138	138,081	50,057	27
Somerset	194,965	166,352	28,613	15
Sussex	338,393	201,855	136,538	40
Union	61,304	46,954	14,350	23
Warren	231,769	171,564	60,205	26
The State	4,494,567	2,424,748	2,069,819	46

* Report of State Geologist for 1895; Vol. IV.

Note: The areas in tide marsh, beach and water surface are not included in the above acreage. Although some of the land which was in forest at the time when this survey was made, has since been cleared, other areas then under cultivation or in pasture have been allowed to revert to forest. Thus while it is probable that the acreage of woodland in such counties as Hudson, Essex and Union has declined, it is believed that today the total forest area in the State is even greater than that given in the table.

TABLE 11. SHOWING CHANGES IN THE AREA OF FARM LAND IN NEW JERSEY FROM 1850 TO 1930*

Year	Total Land in Farms Acres	Improved Land in Farms Acres
1850	2,752,946	1,767,991
1860	2,983,525	1,942,281
1870	2,989,511	1,978,067
1880	2,929,773	2,097,719
1890	2,662,009	1,999,117
1900	2,840,966	1,977,042
1910	2,573,857	1,803,336
1920	2,282,585	1,555,607
1930	1,758,027	987,315

* From U. S. Census Reports.

TABLE 12. * SHOWING PERCENTAGE OF TAX DELINQUENT RURAL LANDS IN NEW JERSEY, 1929-1934

Counties	County Acreage	Average Tax Delinquent Rural Lands†	Percent of Tax Delinquent Land
Atlantic	361,952	129,537	36
Bergen	150,451	8,755	6
Burlington	524,352	108,964	21
Camden	142,163	37,095	26
Cape May	169,600	46,696	27
Cumberland	321,536	64,586	20
Essex	81,562	2,502	3
Gloucester	210,323	46,561	22
Hudson	28,224	2,152	8
Hunterdon	279,680	44,664	16
Mercer	144,640	23,836	16
Middlesex	197,632	44,495	23
Monmouth	304,000	26,872	9
Morris	305,728	40,996	13
Ocean	410,240	136,245	33
Passaic	123,008	3,042	2
Salem	219,533	32,764	15
Somerset	195,264	27,363	14
Sussex	336,832	33,228	10
Union	66,169	4,473	7
Warren	231,680	24,359	11
THE STATE	4,804,569	889,185	18

* The New Jersey State Planning Board, 1938.

† Exclusive of properties less than 10 acres in size.

TABLE 13. AVERAGE ANNUAL GROWTH PER ACRE OF HARDWOOD STANDS IN NEW JERSEY

NORTH JERSEY					MIDDLE DISTRICT				
Age	Cove Sites		Slope Sites		Age	Cove Sites		Slope Sites	
In Years	Cords	Bd. Ft.	Cords	Bd. Ft.	In Years	Cords	Bd. Ft.	Cords	Bd. Ft.
20	.3	0	.3	0	20	.4	5	.3	0
30	.5	20	.4	5	30	.5	50	.4	35
40	.6	50	.5	50	40	.6	120	.5	60
50	.6	100	.5	75	50	.7	175	.6	120
60	.5	110	.4	95	60	.7	195	.5	145
70	.5	120	.4	100	70	.6	200	.5	150
80	.4	125	.3	105	80	.6	205	.4	155
90	.4	128	.3	108	90	.5	208	.4	158
100	.3	130	.3	110	100	.4	210	.4	160

Note: The above table is based on data taken by the State foresters on 683 plots. The board foot volumes are in the International Log Rule, ¼-inch kerf.

TABLE 14. SHOWING YIELDS ON SOME OF THE BEST HARDWOOD STANDS IN NEW JERSEY

Location of Stand	County	Age Class	No. of Trees per Acre	Height Avg. Dominant	Basal Area per Acre	Average DBH*	Volume† per Acre
		yrs.		ft.	sq. ft.	in.	bd. ft.
Mt. Arlington	Morris	21-40	1244	47	99	3.8	800
Northfield Center	Essex	21-40	632	41	78	4.7	800
Washington	Warren	21-40	349	50	52	5.2	1100
Morris Plains	Morris	21-40	610	55	84	5.0	2500
West Portal	Hunterdon	41-60	263	65	79	7.4	6000
Georgetown	Burlington	41-60	400	70	107	7.0	6200
Denville	Morris	41-60	367	75	110	7.3	7500
Plainsboro	Middlesex	41-60	206	80	93	9.1	8900
North Plainfield	Somerset	61-80	220	75	123	10.1	9300
Franklin Twp.	Somerset	61-80	244	70	111	9.1	11100
Plainsboro	Middlesex	61-80	215	90	112	9.8	12400
Moorestown	Burlington	81-100	161	90	103	11.0	12900
Ewing	Mercer	81-100	112	90	142	15.2	21300
Ringoes	Hunterdon	Uneven	241	75	96	8.5	8900
Morristown	Morris	Uneven	316	70	107	7.9	10000
Bordentown	Burlington	Uneven	181	90	125	11.3	15600

* Diameter breast high, 4½ feet above the ground.

† Board foot volumes in terms of the International Log Rule with ¼" kerf. Includes trees 8" dbh and up.

Note: These sixteen stands were selected as representing rather better than average stands in New Jersey today. They have not been under management. The stands from 41 to 100 years of age show an average annual growth of approximately 150 board feet per acre. At an average stumpage price of $7.50 per thousand board feet this is equivalent to a net yearly income of $1.12 per acre. Under proper management this rate of income could be doubled.

UNITS OF MEASURE

Board Measure.—Sawed lumber is generally measured by the board foot, which is a board one inch thick and one foot square, or its equivalent.

Log Measure.—Logs are the raw material from which lumber is produced and strangely enough are also measured in terms of the finished product, i.e., board feet of lumber. This peculiar situation which has grown up in the United States along with the lumber industry is a common source of error and misunderstanding.

Many different rules have been developed for measuring logs in order to determine their contents in board feet. Some of these are relatively accurate, others the reverse. None of them are absolute measures of the number of board feet of lumber that can be sawed from a given log, because this varies as to whether the products cut are 1-inch boards, 2-inch plank or dimension material.

The Doyle Log Rule is the common unit used by timber operators in New Jersey and, unfortunately, is one of the most inaccurate. It derives the volumes of logs by the formula $\left(\frac{D-4}{4}\right)^2 L$, in which D is the diameter in inches at the small end of the log, and L the length in feet. Mill studies have been made in which the volume of logs as given by the Doyle Rule were checked against the volume of 1-inch boards sawed from them. The results show that this rule gives short measure for all logs up to 23-inches

in diameter, and overscales larger ones. It is customary among most lumber operators when measuring logs of these larger sizes to use still another rule—the Scribner— which gives smaller values for logs 23-inches and up than the Doyle. Since most of the logs cut in New Jersey are less than 23-inches in diameter, it means that in selling timber the woodlot owner is not paid for all the lumber which his logs actually contain.

The International Log Rule gives values which more closely approximate the volume of 1-inch boards that can be sawed from logs of various dimensions, and this rule is used by foresters whenever accuracy in the board foot unit is required. Table 15 compares the values as given by the Doyle and International Log Rules with the amount of lumber actually sawed from sound 12-foot logs. From these figures it is puite evident that the use of the Doyle Rule involves very serious errors, particularly in the smaller diameters and explains the many objections made to its use.

TABLE 15. SHOWING RELATIVE ACCURACIES OF THE DOYLE AND INTERNATIONAL LOG RULES COMPARED WITH THE AMOUNT OF LUMBER ACTUALLY SAWED OUT OF 12-FOOT LOGS *

Diameter of Log Inside Bark at Small End	Actual Output of One-inch Lumber	Scale by Doyle Log Rule	Scale by International Log Rule
inches	bd. ft.	bd. ft.	bd. ft.
6	14	3	15
8	30	12	25
10	50	27	45
12	76	48	70
14	108	75	100
16	144	108	130
18	186	147	170
20	234	192	210

* This table was derived from Chapman, H. H. and Demeritt, D. W. Elements of Forest Mensuration; p. 193.

In order to mitigate the very obvious defects of the Doyle Rule, local adjustments have been made from time to time and in New Jersey it is customary to take the diameter measurement at the middle point of the log inside the bark, instead of at the small end. While this gives values closer to what the log contains it still falls well below the actual volume.

Volume Tables and Stumpage Values.—Volume tables show the contents of standing trees of different sizes, and many be prepared in any unit desired. Table 16 shows the volumes of hardwood trees in northern New Jersey in the Doyle and International Log Rules, ¼ inch kerf. Since the most common practice of lumber operators in New Jersey is to cut tree-length logs to a 5 or 6-inch top diameter wherever possible, the Doyle values given in Table 16 were obtained by scaling such lengths at their mid-point inside bark. The International values were scaled in 16-foot log lengths with a trimming allowance of about 4-inches per log. Additional top sections were scaled as fractions of a 16-foot log.

Table 16 shows that the relation between the two log rules varies with the diameter and height of the tree, but that on the whole the Doyle scale gives short measure for trees less than 18-inches in diameter.

Most New Jersey timber that goes into piling, ties or saw logs is cut from trees ranging from 12 to 18 inches in diameter at breast height out-

side bark. Tallies taken of stands throughout the northern and central parts of the State indicate that trees 14 inches in diameter and 60-feet tall represent the weighted average tree falling within these limits. Table 16 shows that for trees of these dimensions the Doyle Rule gives approximately 75 percent of the International scale, or that on the average every 1000 board feet, Doyle, corresponds to about 1330 board feet, International. This means that when a woodlot owner sells his standing timber for $10.00 per thousand by the Doyle Rule, he is actually receiving only about $7.500 per thousand for it by the International scale.

TABLE 16. BOARD-FOOT VOLUME TABLES FOR MIXED HARDWOODS IN NEW JERSEY SHOWING COMPARISON OF VALUES IN THE DOYLE AND INTERNATIONAL ¼" LOG RULES

DBH	Total Heights of Tree—feet													
	40		50		60		70		80		90		100	
	Volume in board feet, to a 6-inch top													
	Doyle Rule	Inter. Rule	Doyle Rule	Inter. Rule	Doyle Rule	Inter. Rule	Doyle Rule	Inter. Rule	Doyle Rule	Inter. Rule	Doyle Rule	Inter. Rule	Doyle Rule	Inter. Rule
8	3	10	4	15	4	20	5	25						
9	8	20	9	25	14	30	12	40	18	45				
10	12	30	13	35	16	40	20	50	23	60				
11	17	35	25	45	27	50	30	65	37	75				
12	24	45	30	55	35	65	40	80	52	95				
13			45	65	55	80	63	100	70	115	92	130		
14			65	75	75	100	87	115	97	135	118	160		
15			80	85	92	115	111	135	125	165	143	190		
16			100	100	113	135	135	155	151	195	175	225		
17					137	155	158	180	182	230	208	255		
18					167	175	195	210	227	265	254	300		
19					200	200	235	240	270	310	302	340		
20					236	225	274	275	315	340	357	380		
21					275	255	323	310	370	380	413	420		
22							373	345	425	420	473	475		
23							422	380	475	470	533	530	595	595
24							475	415	533	515	593	585	668	660
25									590	555	660	645	740	725
26									665	605	750	700	840	795
27											835	760	935	860
28											912	830	1015	925

Scaled from taper curves after Hawley and Wheaton* for trees of Form Class 0.65. Values curved to smooth out irregularities.

* Hawley, R. C. and Wheaton, R. G. The Form of Hardwoods and Volume Tables on a Form Quotient Basis. Yale University School of Forestry Bull. No. 17. New Haven, 1926.

