

## *Harvard Forest*

TO THE PROVOST OF THE UNIVERSITY:

SIR, — The following is a report on the Harvard Forest for the year ending June 30, 1951.

### *Staff*

The staff of the Harvard Forest has undergone some changes during the year. Dr. Stephen H. Spurr tendered his resignation, effective December 31, 1950. Dr. Spurr spent the latter part of the summer and the autumn on a trip in the British Isles and Europe, visiting forestry schools and research institutions. Upon his return he went directly to a new position in the School of Forestry at the University of Minnesota. Dr. Scott S. Pauley remained in residence at the Forest throughout the year, continuing his research in forest genetics under the auspices of the Maria Moors Cabot Foundation.

Mr. Earl P. Stephens returned to the Forest in June of 1950, and served admirably as technical assistant during the year. He has had most of the responsibility for managing the woods operations and maintaining the permanent records of them. At the same time he has instituted a rather detailed study of forest development in a part of the Tom Swamp Tract.

In October 1950, Mr. Ernest M. Gould joined our staff as a research fellow in forest economics. Mr. Gould initiated a more or less detailed study of our accumulated records of woods operations. He moved to the Forest and remained in residence throughout the remainder of the year.

I gave a course in plant geography at the University in Cambridge during the fall term. This necessitated my spending about half of each week there. In February and March, I made another journey to Honduras to review the reforestation work of the United Fruit Company. Except for these interruptions, I was at the Forest continuously throughout the year.

Mr. Charles F. Upham has continued as woods superintendent, with a crew of four additional men.

### *Buildings, Equipment, and Operations*

The only addition to buildings made during the year was an extension of the foundation and floor of the structure which houses our saw-

mill. It was made to provide space for lumber storage, and was constructed entirely with our own materials and labor. Other than this there have been only routine improvement maintenance and minor alterations.

Woods operations during the year have consisted of improvement cuttings and thinnings in Compartment V of the Prospect Hill Tract, and in the pruning and thinning of coniferous plantations in Compartments I and II of the same tract. During the winter a tract of swamp-land in Compartment V was clearcut. It had been untouched for many years, and was covered with poorly formed hemlocks, yellow birch, red maple, and black ash. The operation was set up as an experiment in the natural regeneration of a better forest type on land of this kind. At the same time a parcel of land on the nearby slope of Prospect Hill was also clearcut for a study in hardwood regeneration. This area had been badly damaged in the hurricane of 1938, and had not been salvaged. Another part of Compartment V was covered with a rather open stand of poorly formed white pine. This also was clearcut, and the lumber sawed and sold from our mill. Hardwood advance growth under the pine was carefully studied, and will constitute material for a series of experiments in regeneration.

Early spring thaws in March made it impossible to continue operations in the more remote parts of the Prospect Hill Tract. The woods crew was then moved to the coniferous plantation areas in Compartments I and II immediately back of the headquarters buildings. Thinnings and improvement cuttings were made in these plantations during April, May, and a part of June. The plantations are primarily of white and red pine, and Norway and white spruce. Most of them were established in the middle 1920's as experiments in the compatibility of the various species when planted in mixtures. The current year's operations were designed to continue these experiments as they were originally established. It was found that some of the red pine plantations would yield poles that could be sold to tobacco farmers in the Connecticut Valley, and something over 600 of these poles were cut and peeled for delivery later in the summer.

Except for the white pine lumber cut from Compartment V and the tobacco poles from the plantations, most of the product of the year's operations has been in the form of cordwood, which will be used for fuel to heat our buildings. A small amount of fuelwood will be sold in the town of Petersham.

An important addition to the Forest equipment during the year has



been a small, one-man chain saw. A larger chain saw, acquired about three years ago, had considerably increased the efficiency of the cutting operations, and the smaller new one has made further notable improvements. Both of these saws have been deposited with us by their manufacturers for trial.

### *Instruction and Special Research*

Three of our students of the year 1949-50 availed themselves of a course in tropical botany offered by the Department of Biology during the summer of 1950. Mr. Earl E. Smith, who served with us as technical assistant in 1949-50, also took the course. This group, consisting of eight students in all, spent the month of July at the Atkins Garden and Research Laboratory in Cuba, and the first two weeks in August on a conducted tour of the United Fruit Company's plantations in Honduras.

During the academic year, we had one new student as candidate for the master's degree in forestry. He was a graduate of the University of Maine and did excellent work here. As a research project for his thesis, he has prepared an account of forest distribution and development in an area with which he was familiar in west central Maine.

During the year we had a large number of visitors. About 1750 have signed the guest book in the museum, and we have given demonstrations of one kind or another to about 600. The number of outside institutions using the Harvard Forest for demonstration shows a steady increase. During the year we have had groups from the School of Forestry at Yale University, the New York State College of Forestry at Syracuse, the forestry departments of the state universities of Connecticut, Rhode Island, and Massachusetts. We have also had groups from the Biology Department of Tufts College, from the Worcester Natural History Museum, and from various clubs and other organizations concerned with the conservation movement.

Two special research projects begun in the summer of 1950 with financial support from the Cabot Foundation were continued during the year. These projects were mentioned in my report for 1949-50. Mr. Frank Raymond, a graduate student in biology, lived at the Forest during the summer of 1950, making collections of the native fungi of the soils. He cultured these fungi in our laboratory, and during the following year continued their study at the University in Cambridge. This project is a long-term one, and will require a number of years for

completion. I believe that it should make a significant contribution to our knowledge of the biology of forest soils.

The second project, initiated in the summer of 1950 by Mr. David Hackett, is concerned with the use of herbicides in the control of hardwood stump sprouts. Mr. Hackett laid out a series of experiments, utilizing hormone-like poisons in varying concentrations and with varying methods of application. He applied them to many different species growing under different conditions. He not only applied them to carefully measured and labeled test plots, but also under field conditions. These experiments show considerable promise for the successful control of hardwoods. The poisons killed back the sprouts treated in the summer of 1950 without difficulty, and in the spring of 1951 the stumps showed almost no sign of putting out new shoots. Another year of observations will be necessary before we can be confident that the kill has been complete. Even with the partial success shown to date, however, the method looks extremely promising and probably will come into wide use.

Mr. Gould's research in forest economics is producing much of use and interest to our entire research program. He is analyzing our records of operations with a view to comparing the input of labor and materials to the output of forest products. It becomes quite clear that although the records of the Harvard Forest do not contain figures that are directly applicable to commercial operations, yet they are of such a nature that they can be adjusted for use in the judgment of practicability for many silvicultural operations.

Dr. Pauley has expanded his test plots for hybrid and selected poplars on land secured by loan on the Quabbin Reservation just south of the Tom Swamp Tract. Also, in the spring of 1951 he secured nursery stock of white and red pines from widely scattered stations in the United States and Canada. These stations were selected in such a way as to represent the natural ranges of the two species. The stock was planted in the Prospect Hill Tract, on land that was formerly in unsuccessful plantations. The old plantations were cleared away for the purpose. The experiment is designed to demonstrate the natural variability of the two species, and the behavior of the various geographic strains when planted in this region.

#### *Finances and Administration*

When the Stillman bequests of the Black Rock Forest and the Black Rock Forest Trust Fund were acquired during the fiscal year of 1949—



50, the Black Rock Forest was set up as a subdepartment of the Harvard Forest, with funds administered from the Harvard Forest. During the past fiscal year the University has established what is known as the Harvard Black Rock Forest Corporation under the laws of the State of New York. The Black Rock Forest Trust Fund, held by the Treasurer of the University, has been voted by the Corporation to be considered as non-departmental. The new corporation in New York now administers the Black Rock Forest with funds voted for the purpose by the governing boards of the University. Income from the Black Rock Forest Trust Fund to be used by the Harvard Forest is acquired by the same means. Although the Black Rock Forest thus becomes technically separate from the Harvard Forest, it will continue to function in the manner originally designed, for it will continue under combined directorship with the Harvard Forest. The total Harvard Forest budget for the fiscal year 1950-51 was \$61,519, and that of the Black Rock Forest \$18,795. During the year the Harvard Forest received gifts for immediate expenditure of \$6,962. With these gifts and the new income from the Black Rock Forest Trust Fund the Harvard Forest was able to end the fiscal year in a good financial position.

It is highly desirable that the Forest increase as rapidly as possible its income derived from the sale of wood products. In the nature of things, this cannot go forward quickly because of damage done by the hurricane of 1938. However, during the past year we have realized a value of about \$6,200 from cordwood and lumber. About \$3,400 of this was in cash, and the remainder in the form of fuel for the heating of our own buildings.

### *General Considerations*

During the past fiscal year some notable changes have been made in our system of instruction. These changes are to a certain extent experimental in nature, and are made possible by the flexibility of our traditional program of research and instruction.

The primary aim of the Harvard Forest is to develop men who can initiate and carry out research in methods for growing wood — wood for all uses and wherever it is needed. Emphasis upon the field of silviculture, and upon research in this field, are a logical continuation of basic policies which were settled upon by Mr. Fisher during his lifetime. These policies appear to be as sound now as they were then, in terms both of fundamental needs in forestry and of Harvard's resources.

The Forest itself, maintained as an efficient productive institution, and utilizing all its University relationships, should serve principally as a training ground for research men. This training should not be limited to the production of trees in New England, but should develop in students a philosophy of investigation which will be applicable wherever the need arises.

The accomplishment of our educational aim has required decision and action on several fronts. First, it has been necessary to define clearly our academic status in the University, and to establish workable procedures for the handling of students. Second, many persons familiar with the problems of forestry education in general, and with Harvard's resources in this field, have felt that we should be able to draw graduate students from wider and more varied sources than we have in the past. This need follows logically from the long-continued increase of emphasis upon research, and from the steadily broadening research aims of the Forest. It is desirable that we draw students not only from undergraduate professional schools, but also from colleges of liberal arts, and that we have both groups represented here at the same time. To do this has required that we broaden the subject matter of our training program. Finally, it is highly desirable that we have the goodwill of the profession of forestry in our venture.

When I became Director of the Forest in 1946, and for many years prior to that time, the system by which our students were selected and given their degrees was somewhat anomalous so far as the rest of the Harvard Graduate School was concerned. No material improvement was made until the spring of 1949 when the Provost of the University appointed a committee in the Department of Biology to explore the whole question. As a result of this committee's deliberations we now have a policy which brings our graduate student relationships completely within the orbit of the Graduate School of Arts and Sciences, wherein they function through the Department of Biology or the Department of Economics.

All applications for admission are now made to the Graduate School of Arts and Sciences. They are then processed by the Graduate Committee of the Department of Biology or by that of the Department of Economics, in company with the staff of the Forest. Degrees are granted upon advice from the staff of the Forest and from the appropriate department.

During the past year we have altered the basic requirements for the admission of graduate students so that we can accept men from colleges



of liberal arts as well as those from undergraduate forestry schools. At the same time we have changed our residence requirements and our program of study to meet the new situation. Minimum residence for the M. F. degree is now one academic year and its two adjacent summers. The training program has been broadened to satisfy the needs of men who have had no previous technical instruction.

One of the outstanding results of the new scheme has been to raise somewhat the academic level of incoming graduate students. Through a regularized relationship with the Department of Biology, we now have an excellent source of advice and a much sounder base for judgment of students. The scheme accomplishes another important result. It has become increasingly clear that we should have a means whereby promising students could take a doctor's degree in problems pertaining to silviculture. Two of our men in the past couple of years have been pursuing such a program. It is particularly desirable that they should have opportunity to do Ph.D. work in the biological and economic problems of silviculture through the Departments of Biology and Economics. In order to do so, they should be acceptable at the outset as Ph.D. candidates in the Graduate School, and this means a more careful selection such as is now possible.

Complete endorsement of the present educational program of the Harvard Forest by the forestry profession can be expected only when we have produced men who demonstrate the high capacity expected of them. This will be a slow process, although the way can be prepared somewhat by demonstration at the Forest to interested professional men and students who come to see what we are doing.

HUGH M. RAUP, *Director*

## *Harvard Forest*

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*To the Provost of the University:*

Sir, — The following is a report on the Harvard Forest for the year ending June 30, 1952.

### *Staff*

The staff of the Forest, during the past year, has had only minor changes except for the addition of one research associate who came in the summer of 1951. Dr. Scott S. Pauley has continued his research in forest genetics, partly under the aegis of the Cabot Foundation. Mr. Earl P. Stephens has remained as research associate, working primarily on a research project in forest history. Dr. Ernest M. Gould, Jr., has pursued his studies of forest economics. The addition mentioned above, Dr. John C. Goodlett, has been carrying on research in forest soils. Mr. Herschel G. Abbott, working as part-time assistant, has had the general supervision of woods operations; and Mr. Wang Chi-wu, a Chinese student working at his doctoral dissertation, has served as part-time assistant with the Forest records. Mr. Charles F. Upham has continued to give excellent service as woods superintendent, with four other full-time men and one at about half time. Miss Elizabeth Carpenter has continued as business secretary, and Mrs. Marion S. Hambleton has served the Forest in a part-time capacity in the office.

### *Buildings, Equipment, and Woods Operations*

The only change in our woods equipment during the year was the addition of another one-man chain saw. The one-man chain saws are highly successful in speeding up our cutting operations. We have found that the crew operates to best advantage in two 3-man groups, each served by one saw.

Dr. Pauley has been sorely in need of greenhouse facilities



here at the Forest. He has been dependent upon the greenhouses at the Arnold Arboretum for such propagation work as he needed. During the past year he has bought and installed, with funds from the Cabot Foundation, a small portable greenhouse, which is established just south of Shaler Hall.

In January, 1952, the Forest received, as a gift from Mrs. Charles Jackson of Boston, a house in the village of Petersham. This house has been unused for several years, but is in sound condition. It consists of 15 rooms. With the gradually developing staff of the Forest, the appearance of married students from time to time, and the need for housing that can be used by visiting research personnel, we have been hard put for accommodations during the past few years. Consequently this house comes at an opportune time. Eventually, as the gift is completed, we will have, in addition to the house, about 25 acres of land. It is our intention to make four housekeeping apartments in the house, which is so arranged that this can be done with comparative ease so far as walls and partitions are concerned. During the winter and spring we made some progress on the renovation, and have three of the apartments ready for at least summer occupancy. Further work will have to be done as we have funds for the purpose. It is expected that we will eventually sell off about 23 acres of the adjacent land and use the proceeds on the house itself.

Most of our woods work during the year consisted of thinning and improvement cuttings in Compartment VI of the Prospect Hill Tract. This compartment is at the extreme north-eastern corner of the Forest, and has had no attention for many years. Parts of it were badly damaged by the hurricane, but there are sizable areas of young mixed hardwoods of fair quality. Most of the product of these operations has been cordwood, though a few logs have come out. The work in Compartment VI will nearly finish the general improvement operations in the Prospect Hill Tract which have been under way for several years. There still remain some treatments in coniferous plantations which will be carried on as the need for them arises.

During the winter a considerable number of large old white pines were cut in various parts of the Forest. These pines were relics of the hurricane, many of them standing alone. They had already served whatever function they may have had as seed

trees, and it seemed wise to remove them before they were further damaged by exposure.

### *Research and Instruction*

The long-term research projects of the Forest are being continued as nearly as possible in the patterns originally laid out. In addition, various projects of a shorter-term nature have gone forward.

Mr. Stephens has selected a small area in Compartment VI of the Tom Swamp Tract for an intensive study of forest history and development. There he has been devising and using methods that appear to be more or less unique. The results bid fair to tell us much more than we have ever known about the natural trends of change that go on in the woods, but which move at such a slow rate that we cannot define them by ordinary observation.

Dr. Goodlett, when he came to the Forest in the summer of 1951, immediately began the investigation of some problems in forest soils. One of these is concerned with the behavior of water tables in the soils when observed over a period of time. Another deals with the physical nature of the loam soils which blanket the uplands hereabout. It seems evident that much of the fine-textured material in these loams was deposited by wind. The identity, distribution, and quality of the wind-blown material is of considerable importance in the eventual mapping of forest production potential. Still another phase of Dr. Goodlett's work has to do with the influence of microrelief on the depth of frost penetration. Preliminary results suggest that variations in frost activity related to undulations in the forest floor influence the local distribution of trees, directly by producing different intensities of disturbance in the soil, and indirectly by helping maintain the existing microrelief.

Dr. Gould has continued his analysis of our accumulated Forest records. His principal purpose has been the use of these records in attempts to determine the input of labor and materials on various silvicultural operations, and the output of materials derived from them. During most of the winter he has been collaborating with Dr. Solon Barraclough, of the Northeastern Forest Experiment Station, in the preparation of a paper dealing with the problem of records of economic significance on forest



operations. In the spring of 1952 Dr. Gould and the Harvard Forest were awarded a research grant of \$4000 from the Committee on Research in the Social Sciences at Harvard for a field study of some of the economic problems of forest owners who are carrying on woods operations in New England. This project will deal primarily with the motivations of forest owners, and with possible alternatives which might increase the returns from their forest lands. Funds for the grant came from the Federal Reserve Bank of Boston.

In the past two years we have been carrying on experiments to test the use of poison sprays for the control of hardwood sprouts. These experiments have consisted primarily of tests of the effectiveness of the hormone-like chemicals 2,4,D and 2,4,5,T, in killing or at least seriously discouraging the sprouts. The results have been very promising indeed. However, the field trials did not yield usable data on operational costs. In the spring of 1952 the staff of the Forest set up further experiments to compare the costs of hardwood control by poisons with those of control by axe work.

During most of the year there were three students in residence at the Forest. Two of them were full-time men, working toward the degree of Master in Forestry. The third, Mr. Abbott, while working as technical assistant part time, carried on a series of short-term research projects in partial preparation for his further work toward the doctorate in Cambridge. Two new students came in June, 1952, to begin their studies for the master's degree.

A small educational venture in September of 1951 proved, we believe, to be highly significant. A seminar in the University in recent years has been devoted to forest and agricultural land-use problems, and has been conducted in the Littauer Center in Cambridge. Annually for a number of years this seminar group has visited the Forest for a week-end in October. In 1951 a group of men from the Conservation subsection of the seminar were asked to appear one week before regular registration for the Fall Term, and were brought out to the Forest for that week. There were seven of them, and we gave them a rigorous review of the biological and economic problems confronting forest production and land use in this region, using the research of the Harvard Forest as a base.

*Visitors to the Forest*

Visitors to the Forest continue to increase in numbers. In addition to those who came to the Museum, there were various groups from the University in Cambridge and from other institutions throughout this part of the country. In the summer of 1951, in addition to a meeting of alumni which I shall mention later, there was a group from the Society of American Foresters on a tour of Eastern institutions. In the autumn Mr. Kenneth Barraclough, Extension Forester in New Hampshire, brought down all his county foresters. Likewise in the autumn we had a group of students and instructors from the Yale School of Forestry. In the spring we had our annual visit of students from the New York State College of Forestry at Syracuse. The number of these visitors who come to see the actual work of the Forest steadily increases, and is one of the best indications we have that what we are doing continues to be significant to the profession and to forestry education.

The alumni of the Harvard Forest had never been organized as a group. They are now widely scattered, and although we have kept a list of them and their addresses pretty well up to date, the Forest has never had adequate contact with them except when a few individuals have paid occasional visits here. In the summer of 1951 we invited the alumni to be our guests for two days during the last week of July. This turned out to be a pleasant and profitable meeting, and although only about a dozen came they formed the nucleus of an organization while they were here. We have extended a similar invitation for a meeting during the summer of 1952.

The U. S. Forest Service came to us in the autumn of 1951 requesting facilities for two of their men who would be working at a regional forest survey in southern New England. This is part of a nation-wide survey of existing forests, done with the aid of aerial photographs. We have made a contribution to the survey by giving the Forest Service a room in our building to be used as an office by these two men. They came in the autumn, and will be here for a year or more.



*Training in Tropical Forestry*

During the year I drew up a prospectus in which it is proposed that Harvard University, chiefly through the agency of the Harvard Forest, should undertake a program for the training of men in tropical forestry. It is clearly understood that this program would be established on an experimental basis, that it would make no pretense of completeness, and that it would remain on a modest scale at least through a trial period of several years.

There are certain basic ideas and premises that should be recognized at the outset in any such venture as this. There is no body of codified knowledge with which to train tropical foresters, and consequently no material with which to develop a curriculum. At the base of any program, therefore, there must be a research attitude on the part of all concerned. The forest situation in the tropics is such that forest production should be given emphasis equal to or greater than that on utilization. A program, to be effective, should be designed to promote coordinated research in silvics, forest geography, soils, the morphology and physiology of the trees, the properties of woods, and the economics of both production and utilization. Because there is so little that can be "taught" to students for tropical work, much of the time in training should be in apprenticeship spent in the tropics rather than in schools in this country.

I have proposed a 3- or 4-year program arranged as follows: (1) a 2-months preliminary trip in the tropics; (2) a year at the Harvard Forest, with full use being made also of training facilities in Cambridge; (3) a period of about 22 months at one or more stations in the tropics; and (4) (for students who wish to take a doctor's degree) a final year of residence in Cambridge. For the preliminary trip we would utilize our existing summer course in tropical botany. The training at Petersham would consist primarily of "orientation," and would involve apprenticeship to our research program, with the insertion of such tropical materials as we could gather together. The success of the program would depend upon the use of such facilities in the tropics as are available at the Atkins Garden in Cuba, the U. S. Forest Service stations in Puerto Rico, the British research sta-

tions in the island of Trinidad and in the United Fruit Company's operations in Honduras and elsewhere.

In the spring of 1952 the United Fruit Company manifested considerable interest in the prospectus, and agreed to finance one fellowship for the support of a student in the 4-year program. They will make funds available in the amount of \$3,000 per year.

### *Harvard Black Rock Forest*

Operations at the Harvard Black Rock Forest have continued under the efficient management of Mr. Benjamin B. Stout, our resident silviculturist there. Mr. Stout supervises a woods crew of four full-time men, and at the same time has made notable progress in the reorganization of the Forest's long-term research work.

Woods operations have consisted of two parts. The wind storm which occurred in late November of 1950 blew down a great many trees in the Forest. Actual cutting operations during the past year have been concerned primarily with the salvage of blowdowns. In a few places the damage was so great that clear-cutting was inevitable. In one of the clear-cut areas experiments have been set up for the control of stump sprouts by hormone sprays, in an effort to raise the average quality of natural regeneration. About 300 cords of wood resulted from the year's cutting.

The other phase of the woods operations was road maintenance and road building. This occupied most of the summer of 1951, and probably will continue to be a regular summer occupation for the woods crew.

During the year Mr. Stout completed a new map of the Forest, with a rearrangement of its compartment boundaries. This rearrangement consisted mainly of the subdivision of some of the old compartments which were too large for convenient handling. Following the completion of the map, the accumulated records of operations were reorganized, adjusted to the new map, and indexed in such a way that the preparation of case histories is greatly facilitated.

### *Finances*

The financial structure of the Forest has remained essentially unchanged. The total Harvard Forest budget for the year



1951-52 was \$65,621. That for the Harvard Black Rock Forest was \$20,020. Gifts to the Harvard Forest for immediate use totaled \$7,017. With these gifts and with miscellaneous income from sales and rentals, we were able to meet expenses without difficulty.

### *General Considerations*

Our primary purpose at the Harvard Forest is the training of men who will be capable of dealing intelligently with the long-range problems of forest production. With this as a basic aim, and using the methods of training that are traditional at the Forest, an active and soundly conceived research program becomes our most important single educational tool. I take this occasion to outline a little more fully than I have in previous reports the nature of our current research program.

Research at the Harvard Forest is based upon two major premises. A basic one is that we believe forestry in America is moving gradually into a new phase. It involves forest production in contrast to a long phase which has involved primarily the liquidation of forests and the recovery of wood from unmanaged stands. The second premise is that the biology and economy of forest enterprises can no longer be considered as a self-contained field, fenced in by the boundaries of woodlots, whether the latter be small or very large. In other words, forest enterprises are so closely related to other uses of the land that they cannot be kept in separate compartments.

The basic problems in learning to grow trees are biological, for there are biological limits, or "ceilings," to forest production which have not been determined. These ceilings differ widely with different sites, forest types, and intensities of management. We know only a few elementary facts about the nature of site and the selection of species for sites. The degree of biological control we can have over the forests is still infinitesimal, and will remain so until we learn a great deal more about site. Call this "control" by any of a number of terms — "management," "silviculture," or any combination of the various common subdivisions of forestry — the fundamental biological ceilings are still there and still unknown, and the cost of exercising even meager controls is still unknown.

In the old period of plenty, when we had so much wood in

America that it seemed inexhaustible, decisions on what to do with forests were easy. Biological problems of production could be pushed into the background, and business decisions could safely be based upon our growing experience with the recovery and utilization of wood. If we were at the other extreme — in a wood famine — decisions would also be relatively easy, as they are now in many parts of Europe and the British Isles. Society as a whole would recognize that we had to have productive forests, no matter what they cost, and would pour its collective energy and money into them. Actually, we are somewhere between these extremes, where decisions are much more difficult. We still have, as a nation, a great deal of wild forest to cut, but we know that it cannot last forever at the rate we are using it. We know that we have to learn to produce forests; but the biological and economic experiments that are needed cannot be financed on a "famine" or "disaster" basis. The trees must be grown by the owners of the land, and within the present economic structure. This involves the owners in difficult economic decisions concerning the allocation of resources, and brings us to the second premise upon which we base our work.

Most of the forest lands in the United States are privately owned and operated, many of them as adjuncts to farms, country residences, camps, or to complex manufacturing enterprises. Here in New England a small landowner may have from 50 to 1,000 acres or more of woods. He may be a dairy farmer, or someone who works in a factory and has bought the land as a home, or he may be a business man who holds the land as an investment or for recreational purposes. A great number of people seem to own land simply for the satisfaction of owning it. The values attached to such properties are almost infinitely variable, as are also the resources that can be brought to bear on forest management by the owners. Similar variability can be found for larger holdings such as those of the wood-using industries, and those of the municipal, state, and federal governments. Separate balance sheets for these lands, considering them simply as forest enterprises, are relatively meaningless; for there are too many different values and resources combined in any single woodland operating unit.

Owners of woodland throughout the country are becoming increasingly conscious of the significance of forests to them-



selves and to society. There is increasing demand for knowledge of what to do with forest land—knowledge of what can be done that will make the forests more useful for whatever purpose is desired. Whether holdings are large or small, in the hands of individual farmers, business people, large industrial concerns, or the public, their demands are for what might be thought of as “recipes” for productive use of the land. The development of such recipes is not simple. The complexity begins with the wide variation in what people want from their land, and at the other end are problems of what *can* be done, with our present knowledge, to achieve their ends.

Before realistic recipes can be drawn up for the use of forest lands, it is necessary to know what is biologically feasible on the land. What is biologically possible may or may not be economically possible for the owner of the land, whether his holdings are large or small. Biological feasibility therefore has to be proposed in terms of alternative plans, the economic implications of which must be spelled out in such a way that the owner can make a choice that will fit his wishes, capacities, and concepts of value. Needless to say, the biological and economic aspects of such problems are inseparable.

A considerable part of research in forest production must of necessity be on a simple trial and error basis. Because it takes a long time to grow trees, there has to be a certain element of continuity and stability in the general plan. On the other hand, there is always a danger that the program will become a “blueprint” which might so determine the course of events that new ideas could not be brought in. In its general structure, therefore, our program involves a compromise between the maintenance of enough stability to insure the ordered completion of long range experiments, and of enough flexibility to permit infinite variety in attacks upon problems of forest production.

Our research program has two parts that are not truly separable. We have some hundreds of long-range experiments in the behavior of trees under various kinds of treatment. These experiments constitute a sort of “research overhead,” to the maintenance of which a certain portion of our resources must be committed. The experiments must be kept under constant review, so that their original designs can be realized. From time to time we start new ones; but we do this with great care, be-

cause each one makes an addition to our "overhead" that will continue for many years. The cost of starting it may be only a small part of the cost of seeing it through to useful results.

The second part of the program revolves around the question of why and how the trees behave as they do. Here are problems in the structure and physiology of trees, the relations of trees to one another in mixed stands, the history of forest stands and the present trends in their development, the way in which forests are related to soils and climates, and the effects of present and past treatment of the forests and soils. These problems involve observation, experiment, and all the imagination we can bring to them. They arise in the minds of the people who are working at the Forest and follow no preconceived patterns. Together they make up a great area of flexibility in the program as a whole.

In designing a research program that will bring us nearer to the recipes that are needed, we cannot deal, at any one time, with more than a fraction of the problems that arise. At the present time, influenced greatly by the natural behavior of our forests in what we have come to think of as the white pine-hardwood succession—the phenomenon that demolished the Forest's earlier basis for sustained yield—we are trying to find out where we stand in natural trends of forest development. This is a biological problem of many facets. Mr. Stephens' current work in Compartment VI of the Tom Swamp Tract is an example of it. During the past three years we have been attempting to learn something about the aspects of site that are related to soils. This research, now being carried on by Dr. Goodlett, has led us away from the more conventional approaches to problems in forest soils, and into methods used by geomorphologists for the study of land forms. The economic aspects of forest production, in terms of existing social and biological realities, and applied to specific cases, form the material for Dr. Gould's research. Here also we are following an unconventional path, wherein forest economics is looked upon not as an isolated field concerned only with forests, but as a part of the total use of the land.

HUGH M. RAUP  
*Director*



## *Harvard Forest*

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*To the Dean of the Faculty of Arts and Sciences:*

Sir, — The following is a report on the Harvard Forest for the year ending June 30, 1953.

### *Staff*

The technical staff of the Forest has remained essentially unchanged although there have been two alterations of position. Dr. John C. Goodlett, Mr. Earl P. Stephens, and Mr. Shelley W. Potter, Jr. continue as Research Associates. Dr. Ernest M. Gould, Jr., who has been here since 1950 as Research Associate, has now been given a five-year appointment as Forest Economist. He also holds a lectureship in the Department of Economics in the University at Cambridge. Dr. Wang Chi-Wu, who was here as a half-time Research Associate for two years while he was finishing his dissertation for the doctorate, completed this work in February and received his degree. He now remains on our staff as a full-time Research Associate.

### *Buildings, Equipment, and Woods Operations*

The buildings in the neighborhood of the Forest Headquarters continue to be in reasonably good condition, but not without the usual repairs and replacements, expected and unexpected. Among the expected items has been the routine painting of the Community House. An unexpected item was caused by the failure of the boiler in the heating system of the Forest Cottage. A new boiler had to be installed at considerable expense. No changes have been made in the Higginson House during the past year. This house will reach its greatest usefulness only when we can supply it with a heating plant.

A house near the Forest was given to the University by Mrs. Frederick Winsor, for the benefit of the Harvard Forest, on January 1 of this year. We did not consider it justifiable to receive this house for use, and therefore received it with the understanding it would be sold and the proceeds used by the Forest.

The sale of the house is being handled by the Treasurer of the University.

Woods operations during the fall and winter of 1952-53 continued to be centered in Compartment VI of the Prospect Hill Tract. We have now opened up this compartment with a small but effective network of woods roads that will enable it to be managed much more effectively in the future. The timber was generally of low quality, and the operation consisted mainly of salvage and improvement cutting. Most of the work was finished there by early spring, and netted sufficient cordwood for the Forest's own use and for sales in the coming fall and winter. We also derived a few logs which will be sawed into lumber at the mill. With the cutting operations so well advanced by spring, it was thought that our men could carry on a series of experimental operations, particularly in pruning, during the summer and early fall. After the tornado of June 9 it was advisable to get out immediately such pine logs as were blown down, to save them from attack by boring insects. Consequently most of the summer had to be spent at this work, not only salvaging the logs but sawing them into lumber.

### *Finances*

The financial structure of the Forest has remained essentially unchanged. The total Harvard Forest budget for the year 1952-53 was \$73,270. Gifts for immediate use totaled \$9,882. With these gifts, together with endowment income and proceeds from miscellaneous sales and rentals, the Forest was able to finish the year in a satisfactory financial condition.

### *Visitors*

The stream of visitors to the Forest continues to enlarge. There was a relatively quiet period in mid-winter, but otherwise there has been a succession of visiting individuals and groups. This does not count the casual visitors to the museum, 1580 of whom signed the book during the past fiscal year. The ones I wish to refer to especially are those with whom we have spent time in discussion or demonstration.

In July 1952 the alumni of the Forest held a 2-day meeting here. This gives evidence of becoming an annual event. In September a group of five Conservation Fellows from the graduate



schools of Economics and Public Administration at Harvard were here for a little over a week. During that week we gave them a general review of the forests and forest problems, both biological and economic, of this region, and took them for a two-day trip in northern New England in order to give them a general view of the forest situation in which we are located. These men came from widely scattered localities in the United States, and represented both federal and state public services.

In October we had our usual week end with the Conservation Seminar which is conducted each year at the University in Cambridge. Also during the fall we had a class of students for half a day from the Yale School of Forestry. In October there was a two-day meeting of the Board of Overseers' Committee to Visit the Harvard Forest. In November a class of students in General Ecology from the Department of Biology in Cambridge came for a day. In the fall term of 1952-53 I gave my regular course in the University at Cambridge and used the Harvard Forest for field work in connection with it. I brought students from this course to the Forest on four consecutive week ends.

In the spring we had another round of visiting student groups both from the University in Cambridge and from other schools. Students in a course in the conservation of natural resources given in the Department of Government in Cambridge came for a week end. Later we had two groups of students from the New York State College of Forestry at Syracuse. There were about 20 in each of these, coming a week apart and staying for a night and a day each. Also in the spring we had another forestry class from Yale. The largest group from another school that we have ever had came early in June from the University of Maine. There were about 35 of them.

In the latter part of June the Research Advisory Council to the Northeastern Forest Experiment Station held its annual meeting at Amherst, and came to the Harvard Forest for a field trip and luncheon. This was a very welcome group, for it brought faculty representatives from several forestry schools, as well as a group of industrial and government research executives.

In addition to the groups already mentioned there have been many representing primary and secondary schools in the general vicinity of Petersham. Many of these have come under the auspices of the Audubon Society's school training program which

centers at Cook's Canyon in Barre. Not only have the visitors from Cook's Canyon involved school children, but also groups of nature study teachers who come to the Cook's Canyon sanctuary for special training.

In the late spring of 1953 the Forest gave what assistance it could in the formulation of the summer's program at the F. Harold Daniels School of Forestry and Conservation in the town of Rutland. This school is operated by the Worcester Museum of Natural History. The men chosen to operate it for the summer were sent to the Forest for three days, during which time they were given a short course of training in the local forest scene.

### *Research*

Work on forest soils, begun several years ago in an effort to use and evaluate our forest soils maps, continues to grow both in volume and significance. Dr. Goodlett has continued his work on the physical characteristics of deeper soil profiles, on his studies of the effect of frost in the soils, and on a general review of all the soils research that has been done here in past years. Mr. Stephens has continued his investigation of a small plot of forest land in Compartment VI of the Tom Swamp Tract. Dr. Gould received a research grant during the year from the Committee on Research in the Social Sciences at Harvard, and with it is undertaking an investigation of forest cutting practices in New England, particularly as regards the purposes and motivations of these cutting practices. Also during the year he has continued his collaboration with Dr. Solon Barraclough of the Northeastern Forest Experiment Station in a searching review of the materials available to foresters and forest owners whereby they can make predictions in forest production. Mr. Potter, since coming to the Forest last July, has devoted a great deal of his time to the management of woods operations, and has been highly successful at it. He has also begun a rather elaborate program of research in the effects of pruning, and in the methods of pruning. Dr. Wang, since he finished his thesis in February, has become involved with research having to do with natural variation in some of our common forest trees. This work will make use of materials and ideas not only from the field of forest genetics, but also from forest ecology and taxonomy.



Collaborative work with other institutions continues in much the same manner that it has in past years. We continue to give office space to the U. S. Forest Service for use in its forest survey operations in this part of New England. Work by the U. S. Geological Survey on the Athol Quadrangle, which was begun in the summer of 1952, was continued in June of 1953. It was originally designed to be done in two years, but at least one additional summer will be necessary. We have supplied housing for Dr. Donald F. Eschman who is engaged in this work, and have given him what other assistance we could.

I have only a few remarks to make about our research program in general. They are an outgrowth of continued efforts to understand the actual course of events in the program, and particularly to recognize some of the motivations that are behind it. Many are now familiar with the Forest's research in its efforts to regenerate the white pine, and in its failure to do this on the uplands within the present or foreseeable economic situation. I have come to look upon the natural phenomenon of the white pine-hardwood sequence as a basic motivating influence in our research. It began to be effective when the realization of it dawned upon the people at the Forest during the early 1920's. A large part of our work since that time, perhaps most of it, has been related in one way or another to efforts at understanding this phenomenon, in the hope that an understanding of it would lead to some measure of control. The major part of the Forest's soils research during the past 30 years has been closely identified with it, and most of the impulses that led to our land use research grew out of it. The institution's 30-year progress report, published in 1947, shows clearly to what extent the phenomenon overshadowed all of the Forest's work.

I am now suggesting that another and quite different natural phenomenon bids fair to influence our research for some time to come. This was the hurricane of 1938. In the 15 years since the hurricane much theorizing has been done as to its effects upon the forests and the forest economy. However, the shock of the event itself was so great that it prevented a clear view of the long-term results. Only now, with our increasing consciousness of the biological, economic, and social aspects of forest production, and with our recent research upon the actual effects of the wind upon the trees themselves and upon the long-term develop-

ment of both the forests and the soils, are we beginning to see the full implications of what happened. We are perhaps still too close to the event fully to realize it.

It has become very clear that large parts of the forests of this region have been blown down repeatedly during the past few hundred years. The evidence for this is in the historical records of great storms, but more particularly in the woods themselves. The blowdowns have destroyed the forests and have at the same time stirred the soils by the uprooting of the trees. The recent researches of Dr. Goodlett in Pennsylvania and of Mr. Stephens here in Petersham thoroughly document this history. The effective winds have been of various kinds. Some, like the recent tornado, have been effective locally, while probably the most significant have been the great hurricanes of tropical origin. How far we shall be able to generalize with the concept as a whole we do not know. But there is abundant evidence of major blowdowns throughout most of the eastern part of the deciduous forest region of North America, extending from the Ozarks and the southern Appalachians to Cape Breton Island. There certainly are differing intensities of the effects over so large a region, but what these differences will be is yet to be discovered. A basic concept arising from these studies — a concept that may well have far-reaching significance for long-range planning in the development and use of forests — is that the forests and the soils on which they grow are relatively unstable things, and that any long-term plan based upon long-continued stability is unrealistic. This idea appears to open a vast new field in the study of forest production.

### *Instruction*

The Forest's program of instruction is difficult to describe and classify, for a great deal of it is by way of demonstration to visitors. We have had during the year two regular students who are candidates for the master's degree in forestry. They have been in residence since June of last year. The three students who were here in the preceding year are all continuing at Harvard as candidates for the doctorate in biology. Two of them will remain in residence in Cambridge for the coming academic year, while the third finished his residence requirement in June of 1953 and has taken a teaching position where he will continue to work



on his thesis. Two men have received their doctor's degrees in biology during the past year with their research concentrated in the field of forestry. One is Dr. Wang Chi-Wu who wrote his dissertation on the Forest Vegetation of Eastern Asia, and the other is Dr. Earl E. Smith who wrote a paper on the Forest Resources of Cuba.

I wish to call attention to what appears to be a significant trend in our academic training program. Until the past four or five years by far the commonest procedure for the individual student was to come for one year, take a master's degree in forestry and go immediately into professional work. Within the past five years the greater proportion of our students have continued at Harvard as candidates for the doctorate in biology with emphasis upon silvicultural research. With one exception, all of those who have been here during the past three years have done so.

One new resident student was selected for the year 1953-54, and was awarded our United Fruit Company Fellowship in Tropical Forestry. He began his work in June, when he went immediately for a summer trip to Cuba and Honduras. He will return here in September where he will remain in residence for about a year. After that he will return to the tropics for approximately two years.

### *The Tornado of June 9, 1953*

The Harvard Forest was fortunate in escaping serious damage from the tornado of June 9, 1953. This storm seems to have begun its course of damage in the western part of the town of Petersham. The damaged area is a narrow strip running in a southeasterly direction, crossing the Hardwick Road and South Street about a mile south of the village of Petersham, and crossing the Worcester road (Route 122) at Connor's Pond. It continued southeastward through the north part of the town of Barre, through Rutland, and into Holden where it began to do its most serious damage to housing and people. In its Petersham course it went through parts of Compartments VII and VIII of our Slab City Tract, but damaged only timber that had already been more or less decimated by the hurricane of 1938. At Connor's Pond it took down a small stand of pine on land that we own on the west side of the pond. In its course across this valley it

barely missed our best old-growth stands, which are located in Compartments IX and X of the Slab City Tract.

### HARVARD BLACK ROCK FOREST

The work of the Harvard Black Rock Forest continues under the capable direction of Mr. Benjamin B. Stout who is resident silviculturist there. Woods operations are carried on by a crew of four full-time men.

In the summer of 1952 the crew spent most of its time on the maintenance of the Forest's road system, and on the construction of a short length of new road which will greatly facilitate haulage of equipment and wood products. Cutting operations during the winter consisted of a thinning in a stand of hardwoods in the valley of Black Rock Brook near the northern boundary of the Forest. This thinning was very carefully planned, and full records of it were kept. In the same place further experiments were set up for the testing of hormone sprays in the control of hardwood sprouting. During the spring the crew moved to a rather poor hardwood stand in one of the higher parts of the Forest west of Tamarack Pond. Here the operation was a clear-cutting, with judicious use of sprays for sprout control. Forest growth at these high levels, where the soils are thin and bedrock outcrops are common, is very slow and the trees are of poor form. This cutting was designed as an experiment in regeneration that would test the possibility of encouraging a better grade of growing stock.

In the summer of 1952 Mr. Stout continued his studies of the form and distribution of the root systems of trees. The excavation of the roots is a difficult and time-consuming project, and is done by hydraulic methods. The work on roots has been financed in part by a grant of funds from the Maria Moors Cabot Foundation for Botanical Research. By the end of the summer some 26 trees had been excavated and their root systems carefully described and mapped.

The use of the Black Rock Forest as a base for study and research on the part of students and staff from Petersham will develop gradually as our operations increase there. In the fall of 1952 two students from Petersham spent a fortnight with Mr. Stout, gaining experience and training in the marking of a stand



for thinning. These students had an active part in the measurement of the trees to be taken and left, and in the actual selection of the trees to be removed.

The financial status at the Harvard Black Rock Forest remains approximately as it was last year. Its budget for the year was \$20,159. Most of the operating expenses were derived from the income of the Black Rock Forest Trust Fund, but a small part came from the sale of wood products.

HUGH M. RAUP  
*Director*

## *Harvard Forest*

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*To the Dean of the Faculty of Arts and Sciences:*

Sir, — The following is a report on the Harvard Forest for the year ending June 30, 1954.

### STAFF

The technical staff of the Harvard Forest has remained unchanged during the year.

### BUILDINGS AND EQUIPMENT

The Winsor House, a dwelling in Petersham that was given to the University for the benefit of the Harvard Forest in January of 1953, was sold in April of 1954. Of the net proceeds from this sale a little less than half has been put into capital, to form the Winsor Fund. The remainder is to be used for improvements at our Higginson House in the village of Petersham.

The only new construction undertaken during the year was a lath house for seedbed and nursery stock. This was put up in the field north of the Community House. It was made from materials turned out in our own sawmill, and was constructed by our woods crew. Its immediate purpose is to serve some experimental work, but in the long run it will be the site for the production of growing stock that may be needed for plantations. The Forest has had no nursery for some years, largely because there has been no need for planting stock. However, we can foresee that such need will arise in the not too distant future.

The large single addition to equipment during the year



was a new bulldozer purchased for use in our woods operations. Need for it was brought to a head in the clean-up work which arose after the tornado of June, 1953. During the year the Forest also acquired an additional chain saw.

### WOODS OPERATIONS

The principal operations of the woods crew during the fall and winter were in certain experimental plots laid out for a cooperative research program with the Bureau of Entomology and Plant Quarantine. This program is concerned with the study and control of the white pine weevil which is the most damaging pest affecting the white pine in this region. The portion of the experiment allotted to the Harvard Forest, other than the use of the land, was the woods labor involved. Further account of this experiment will be found in another part of the present report.

Other than routine maintenance and the construction of the lath house previously mentioned, the woods crew found time in the spring and early summer to continue the tornado salvage in Compartments VII and VIII of the Slab City Tract. Most of the damage there was to miscellaneous hardwood stands of poor form and quality which had been decimated in the hurricane of 1938. The principal product of these operations will be cordwood for fuel.

It is of note that this year shows another sizable increase in the financial returns from the sale of wood products. Cash sales amounted to \$6,024.75, and the value of materials used in the forest itself came to approximately \$2,102.38, making a total of \$8,127.13. During this year we ventured for the first time into the production of railroad ties. Our ordinary salvage and improvement cuttings and thinnings yield a certain number of hardwood logs sufficiently large to make ties and at the same time to yield a modest quantity of clear lumber from the sidewood. A market for the sidewood has not yet

been found, but the production of ties seems to be a worthwhile undertaking in itself.

### FINANCES

The total budget of the Harvard Forest for the fiscal year was \$77,165. Gifts for immediate use totaled \$9,937, of which \$3,000 was for a fellowship. These gifts did not quite make up the deficit, but the year ended with the Forest in reasonably good financial condition.

### RESEARCH

The research program of the Forest continues as in past years. Considerable progress has been made with routine inventory of plantations, especially those of white pine. For three months in the winter we had with us a young Danish forester, Mr. Ravn Mortensen, who came as an American-Scandinavian Foundation trainee. While he was here he measured most of our white pine plantations.

Dr. Ernest M. Gould, Jr. has spent much of the year preparing the final draft of his bulletin on the economics of the management of small farm woodlots. This has been done in collaboration with Dr. Solon L. Barraclough, formerly of the Northeastern Forest Experiment Station. During the spring Dr. Gould began active work on a research project concerned with the individual motivation of woodlot owners who have had cutting done on their lands during the past few years. Financial assistance for this project is in the form of a generous grant from the Federal Reserve Bank of Boston.

Dr. John C. Goodlett spent most of the summer and fall of 1953 working in the field with Dr. Donald F. Eschman of the U. S. Geological Survey. In this period he made large contributions to our knowledge of the distribution of individual species and forest types in the neighborhood of the Harvard Forest. With our steadily increasing knowledge of local site



differences, this kind of meticulous mapping work becomes essential for an understanding of our forest-site relationships. Also during the fall, winter and spring Dr. Goodlett continued his studies of soil-frost phenomena, following the behavior of soils under the influence of alternate freezing and thawing from day to day and from week to week. In the spring of 1954 he was appointed a collaborator with the U. S. Department of Agriculture, and spent about a month in field work in northeastern Pennsylvania and adjacent New York. Here he was associated with men from the Bureau of the Soil Survey and the Geological Survey, in mapping forest types in relation to soils and glacial deposits.

Mr. Earl P. Stephens has continued his detailed investigations of a small tract of forest in Compartment VI of the Tom Swamp Tract. Most of his time has been spent at office work, in the analysis of the vast amount of specific information that he has accumulated.

Mr. Shelley W. Potter, Jr. has carried forward his investigations of pruning. In the summer of 1953 he initiated a series of experiments in the pruning of red pine in our plantations. These experiments involve the effects of pruning at various intensities, and the effects of different techniques upon the healing of wounds.

Dr. Wang Chi-Wu gave most of his time during the year to study of ecotypic and racial differentiation among some of our common forest trees. His experiments and observations spread from central Maine to southern New York State. He has made a study of ecotypic differentiation within the limited geographic area of the Harvard Forest, initiated studies of geographic races among the white birches, started experiments in the variation of photoperiodic response in the white birch, and has begun some intra- and interspecific crosses among the birches. In addition to this work he has made a study of the seed origins of red pine in the Harvard Forest plantations.

As noted above, the Forest has undertaken a collaborative research project with the Bureau of Entomology and Plant

Quarantine on the control of the white pine weevil. Preliminary experiments in the silvicultural control of the weevil were started here under similar auspices soon after the hurricane of 1938; but they failed, due in large measure to inadequate methods for the control of hardwood sprouts. The recent advent of hormone-like sprays for the control of hardwoods gives promise that more precise control measures are now possible. The experiments recently set up involve two major divisions. First is a study of the biology of the weevil itself — its habits and development as related to local conditions such as climate, shade, and predators. The second part is designed for the experimental control of stand composition and form as related to the incidence of weeviling.

Four areas of four to five acres each were selected, and carefully described. The areas were selected for their general similarity as nearly as this could be accomplished. All of them contain hardwood stands in which there is a considerable amount of understory pine. One was left untreated as a control, a second was clear-cut of everything but the young pine which had appeared under the hardwood cover, and in a third about half of the hardwood cover was removed. In the fourth the larger hardwood trees were girdled, and all hardwood seedling and sprout growth was given a treatment with basal spray. The stumps were also sprayed in the clear-cut and partially-cut areas. Site variation in the Forest, particularly with regard to soils, is so great that truly comparable areas cannot be found. All results will have to be interpreted in light of these differences. The experiment as it stands now is expected to run for at least five years.

The work of Dr. Donald F. Eschman on the geology of the Athol Quadrangle continued during the summer of 1953, and was carried forward again in the spring of 1954. The Forest's contribution to the project, which is sponsored entirely by the U. S. Geological Survey, has been in providing housing for Dr. Eschman during the summer, and in giving him what field assistance we could.



## INSTRUCTION

Two students who came to us in the summer of 1952 finished their residence and thesis requirements for the master's degree in September of 1953. One of these immediately took up study in Cambridge to complete residence for the doctorate in biology. The other took a job for a year, and is now expecting to return to Harvard in the fall of 1954 for more advanced study. One student was in residence throughout most of the fiscal year. He is the recipient of our United Fruit Company Fellowship in Tropical Forestry. After spending the summer of 1953 on a trip to Cuba and Honduras, he came to us in September to remain for a year. During this time he has been treated as one of our regular graduate students, and is now preparing a thesis for the degree of Master in Forestry. The plan is for him to remain at Petersham until the fall of 1954, and then to go back to the tropics. Two new students arrived at the Forest in June of 1954 to begin their fifteen months residence for the master's degree.

The use of the Forest's facilities for short-term instruction of students from other parts of the University continues to grow and to assume greater significance. A group of ten students from the Graduate School of Public Administration came to us about mid-September for ten days of "indoctrination" prior to their regular studies in Cambridge. They were the Conservation Fellows drawn from various government agencies throughout the country, and were in general charge of Dr. Ayers Brinser. After several days of intensive demonstration at the Forest they were taken on a four-day field trip in northern New England. This is a program that we have been developing during the past few years, and plans are made for its continuance in the fall of 1954.

Other groups from the University in Cambridge have also continued to use the Forest. Most of them are from the Department of Biology, but some are from other departments. In the summer of 1954 we have a graduate student in zoology

in residence at the Forest for field studies. This is a use of the Forest which I wish to encourage, and I hope that it may be repeated in future.

Students from other schools also continue to have the Harvard Forest on their regular schedules of spring and autumn field trips. During the year we have had groups from Yale, the universities of Maine and of Massachusetts, and from the New York State College of Forestry. In addition we have had a great many visitors who have come for demonstration of our work.

### HARVARD CONFERENCE ON FOREST PRODUCTION

In the fall of 1953 we held at the Forest a conference devoted to the problems of the use of the land for the production of wood. Fifteen professional foresters attended the conference, which occupied the last two weeks of October. These men came from various parts of the country — the Northeast, the Lake States, the South, and the Northwest Coast. Ten of them represented the wood-using industries, primarily in pulp and paper production. One came from a university, two from the Northeastern Forest Experiment Station of the U. S. Forest Service, one from the Massachusetts Department of Conservation, and one from the New Hampshire Forest Extension Service.

The theme of the conference was "Forestry in Transition." It proposed that forestry is at the beginning of a period of change from complete dependence upon the harvesting of wild stands to the growth of forests through various kinds of management. Throughout most of the conference the base of operations was the Harvard Forest itself, but at no time was the Forest used except as a point of departure for discussion. Its own experiments in silviculture were looked upon as a case history in the kind of research that will be necessary if the transition is to be accomplished equitably. Throughout



the conference both biological and economic problems were considered together.

Although the Forest had been experimenting with this use of its facilities, the Conference of 1953 was the first on such a large scale. It was not considered as a "course of study," but rather as a situation in which mutual problems could be discussed. It carried no academic credit, and only enough charges were made to cover the direct cost to the Forest.

### PUBLICATIONS

The regular publications from the Harvard Forest, its "Bulletin" and the "Harvard Forest Papers," have been few since before the war. Since I became director in 1946 I have made no attempt to "force" the publication of research papers, preferring to allow such things to develop slowly as our staff and students produced material for them. Since 1946 three Papers and two Bulletins have been published, but all of these except one Bulletin were based upon research done prior to the war. The one based upon later research is that of Mr. Benjamin B. Stout on "Species Distribution and Soils in the Harvard Forest" (Bulletin No. 24).

Material for publication is now beginning to accumulate rapidly, and we attach first importance to getting it into print and distributed so that it can be used. Needless to say the problem of financing has become acute. The budgeting of funds for publications was for many years no serious difficulty for the Forest because Dr. E. G. Stillman personally financed them. Consequently, there has not been a large "traditional" item for publication in our budget.

We have, currently, two Harvard Forest Bulletins in press. They are now in proof, and should be issued during the fall. One is by Dr. Goodlett, and deals with research carried on by him in collaboration with the U. S. Geological Survey and the Bureau of Soil Survey in Potter County, Pennsylvania. It deals with the distribution of forests as related to soils, rock

formations, land-use history, and stand history in that region. This will come out as Bulletin No. 25. Bulletin No. 26 will be an "Economic Analysis of Farm Forest Operating Units." It was prepared by Dr. E. M. Gould, Jr. and Dr. Solon L. Barracrough. The research for this paper was financed jointly by the Northeastern Forest Experiment Station, the Committee on Research in the Social Sciences at Harvard, and the Harvard Forest. The cost of its publication will be met jointly by the Forest and the Committee on Research in the Social Sciences.

Another publication which has been closely related to the Forest's work is a paper on "The Forests of Cuba." This has been printed under the auspices of the Maria Moors Cabot Foundation as its Publication No. 2. Both the research and the publication have been supported jointly by the Cabot Foundation, the Harvard Forest, and the Atkins Garden and Research Laboratory in Cuba.

There are three manuscripts on hand that should be published under the auspices of the Harvard Forest as soon as possible. One of these is the second part of our Thirty-Year Progress Report. It deals with four case histories in Compartment IX of the Tom Swamp Tract, the so-called Adams-Fay Lot. It has been prepared by A. C. Cline and R. J. Lutz, and is essentially ready for the printer. We have had this manuscript on hand for a year or more, and during that time it has been critically read not only by our staff but by others particularly interested in the culture of white pine.

A second paper of some magnitude has been prepared by Dr. Herbert H. Rasche on "Temperature Differences in Harvard Forest and Their Significance." This paper is of great value to us in our silvicultural research, and no doubt will continue to be for many years. Research for it was done at the Forest in 1947 and 1948 while Dr. Rasche was a graduate student at Harvard. It was done under the auspices of the Research and Development Division of the Army Quartermaster Corps, in which Dr. Rasche was and is an officer.



A third manuscript is a short one by Mr. William H. Hatheway. It is on "The Influence of Soil Moisture on Site in Tom Swamp I." This paper is Mr. Hatheway's thesis, presented when he was a candidate for a master's degree at the Forest. It is an excellent piece of work, and is an important link in our recent soils research. It would be suitable for publication as one of our shorter "Papers."

The preceding three papers are ready or nearly ready for printing. A fourth is by Mr. Benjamin B. Stout and deals with his studies of tree root structure in the Black Rock Forest. This should be published from the Harvard Black Rock Forest rather than from the Harvard Forest at Peterham. Current research will yield before many months another large paper which should be published as soon as it is finished. This will be the work of Mr. Earl P. Stephens of our staff on his detailed studies of forest history.

In our use of the Forest for demonstration and for conferences on silvicultural problems we have found that one of our most valuable assets is our ability to present actual case histories of forest stands. These cases are derived from our accumulating records and from other historical studies. The nucleus for them was in the first part of the Thirty-Year Progress Report, but we have developed many more since that was written, and have brought some of the earlier ones up to date. We have about 36 of these case histories currently in use, all of them in mimeograph form for distribution to people who come for demonstrations. The unit cost of such "temporary" publications is not great, but in the aggregate they make a sizable charge which can be counted upon to increase.

All of this makes it clear that the Harvard Forest will have to allocate more funds for publication in future than it has in the past. Such allocation, within our present financial structure, can be done only at the expense of our research program itself. I am hesitant to use this method, and would prefer to find new funds if this is at all possible.

Responses to the appeal for funds sent to the Friends of the

Forest each year have always been generous. They have totaled, annually, between \$1,700 and \$2,000. The amount budgeted in the current fiscal year for publication is \$2,300, though in view of the manuscript we now have on hand or in prospect for the near future, this sum should be considerably increased. In past years annual gifts from the Friends have been put into general funds and used for various purposes. I have proposed recently that gifts from the Friends, at least in the next few years, be designated specifically as a publication fund. I have proposed further that suitable acknowledgment of the source of the fund, the "Friends of the Harvard Forest," be made in the publications themselves.

### THE HARVARD BLACK ROCK FOREST

The management of the Harvard Black Rock Forest remains in the capable hands of Mr. Benjamin B. Stout who is resident silviculturist there. Woods operations have continued during the year, and are performed by a crew of four full-time men. An addition to the staff was made during the spring of 1954 in the person of Mr. John Rippe, Jr. He serves in a semi-technical capacity, assisting and taking a portion of the responsibility for woods operations, and at the same time serving as technical assistant to Mr. Stout.

In the summer of 1953 the crew spent most of its time in road maintenance, and in bringing to completion a short length of new road. The winter's cutting operations were a continuation of those started in the preceding year in Compartment XXV. This is a clearcutting of poorly formed and slow growing hardwoods on one of the higher parts of the forest where the soils are thin and scattered. A part of this area was treated with chemical sprays for the control of hardwood sprout growth, in an effort to raise the quality of the new growing stock. Further work with chemical sprays was carried on in the stand of hardwoods in the valley of Black Rock Brook which was thinned in the winter of 1952-53.



Dendrometer studies on growth in this stand were continued.

Visitors to the Black Rock Forest increase in numbers each year. In addition to those who come for demonstration of the Forest's research, there are many conducted tours for science teachers, wild life groups, and garden clubs.

The operating budget of the Harvard Black Rock Forest for the year was increased somewhat over the year 1952-53, and totaled \$21,274. Most of the operating expenses were paid from the income of the Black Rock Forest Trust Fund, but a small part came from the sale of wood products.

Housing for our staff and visitors at the Black Rock Forest has been something of a problem since we acquired the property in 1950. We do not have adequate facilities on our own land, and consequently have had to rent the necessary space. A change in rentals had to be made in the autumn of 1953, and by a fortunate train of circumstances, we acquired a five-year lease on a house sufficiently large and well situated to take care of Mr. Stout and his family and the Forest Office, and at the same time to accommodate a few visitors. This house is the property of Mrs. Elizabeth Williams who has generously given us the use of it rent-free with the provision that we make the changes necessary for its year-round occupancy. These changes were made at modest cost.

HUGH M. RAUP  
*Director*

## *Harvard Forest*

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*To the Dean of the Faculty of Arts and Sciences:*

Sir, — The following is a report on the Harvard Forest for the year ending June 30, 1955.

### STAFF

The staff of the Harvard Forest has been variously altered during the year, with two resignations and one advance in position. Dr. Wang Chi-Wu, who was serving as Research Associate, left the Forest in August of 1954 to take a position as Interim Assistant Professor of Forest Genetics at the University of Florida. Part of Dr. Wang's research program in the occurrence and distribution of the races of eastern forest trees is being continued, and he returned to the Forest for two weeks in the spring of 1955 to care for it. Mr. Earl P. Stephens, who had been on our staff for several years as Research Associate, and at the same time had been completing a dissertation for his doctorate in Biology, resigned in June of 1955 to take a position in forestry teaching and research at the Ohio Agricultural Experiment Station at Wooster, Ohio. Dr. John C. Goodlett, who has been serving since 1951 as Research Associate, was voted a five-year appointment as Forest Geographer at the Harvard Forest and Lecturer in Forest Biology, effective July 1, 1955.

Two other changes in the personnel at the Harvard Forest should be mentioned. Dr. Scott S. Pauley, employed since 1947 by the Forest and the Cabot Foundation, and stationed at the Harvard Forest, resigned in June of 1955 to take a position in the School of Forestry at the University of Minnesota. In July of 1954 came Dr. Martin Zimmermann, formerly of



the Department of General Botany at the Swiss Federal Institute of Technology, Zurich. Dr. Zimmermann is employed by the Cabot Foundation, with the titles of Tree Physiologist and Lecturer in Biology. He is stationed here and has the use of our laboratory and other facilities for his chosen research.

### BUILDINGS AND WOODS OPERATIONS

The principal building improvement undertaken during the year was the installation of a heating system in the Higginson House located in the village of Petersham. The system was extended to two of the apartments now in use, and is so designed that it can serve a third apartment when the latter is made ready for occupancy. The only other large item of building maintenance was the painting of the trim on Shaler Hall and the Fisher Museum, and the garage that serves these buildings.

Woods operations, with one exception, were much as in the preceding year. Cordwood sales showed an increase of about 50 cords. The cut of railroad ties was about twice that of the year 1953-54, and appears to be a profitable venture. It is being made possible by the slow but steady increment in our comparatively young stands of hardwood. Sidewood from the ties, though of high quality, is of necessity in small dimensions. Even so, we have managed to sell it to the furniture industry at a good price. In addition to ties and cordwood there has been a certain amount of white pine that has been turned into lumber at our mill and partially disposed of. Some of this has gone into the furniture industry, but the larger proportion has gone into wooden boxes. The market outlet for boxboard lumber declined during the winter, but began to come back in late spring. This left us with a considerable inventory in this class of material at the end of our fiscal year.

Most of the woods operations in the Harvard Forest during

the year consisted of salvage and improvement cuttings, and were located in Compartments VII and VIII of the Slab City Tract, in Compartment VII of the Tom Swamp Tract, and to a small extent in Compartment IV of the Tom Swamp Tract. In the first of these the operations finished the clean-up of damage done by the tornado of June 9, 1953.

The exception mentioned above is concerned with operations in our Matthews Plantations in the town of Hamilton, Massachusetts. These plantations are on land bequeathed to the University in 1929. They consist mainly of miscellaneous stands of coniferous trees, both native and exotic. During the past few years little has been necessary except to give them time to grow. However, some of them are beginning to need thinning. The hurricanes of the late summer of 1954 did considerable damage to the area, and it became necessary to clean out wind-thrown or damaged trees. To do this I engaged the services of Mr. Fred Hunt, a young forester who has developed a business of the thinning and improvement of plantations. In addition to the clean-up and salvage, Mr. Hunt did some of the necessary thinning. A certain amount of this thinning had been done prior to the hurricane under the guidance of our staff, and under the supervision of Mr. Standish Bradford who resides in the vicinity. Funds to support all of these operations have come from the accumulated income of a small endowment given to the University for the support of the plantations.

In the course of the salvage and improvement work, a considerable amount of mature white pine scattered in various places on the land was cut. Due to widespread damage by the hurricanes in this region, local markets for pine logs were glutted. Consequently, the logs were hauled to our mill at the Harvard Forest and there sawed into lumber. This has added considerably to our inventory, and will be disposed of during the coming year. Income from it will be divided between the Harvard Forest and the Matthews Plantation Fund.



### FINANCES

The total operating budget for 1954-55 was \$91,758. Gifts for immediate use totaled \$10,901. With endowment income, sales, rental income, the above gifts, and the use of income and gifts not spent in previous years, the Forest closed the year without a deficit.

### VISITORS

Visitors to the Forest continue to be numerous, many of them coming for demonstrations of one kind or another. A small meeting of alumni was held for two days in July of 1954. The annual field day for the Friends of the Harvard Forest, scheduled early in September, was poorly attended because it coincided with one of the hurricanes.

### INSTRUCTION

Two new students were in residence during the year, beginning in mid-June of 1954, and two new ones were accepted in June of 1955. The two in residence during the year, in addition to carrying on their work at the Forest, commuted to Cambridge two or three times a week to attend classes there. This is the first time in many years that such an arrangement has been made, and it appears to have been successful. Improvement in roads and transportation, particularly within the last two or three years, has greatly facilitated commuting. I gave my regular course at the Biological Laboratories in Cambridge during the fall and early winter of 1954-55, and accomplished it entirely by driving in to Cambridge on two or three days a week. I believe that these developments have considerable significance, for they illustrate the gradual dissolution of the geographic isolation that has always troubled the Forest in its relations with the University in Cambridge.

Visiting classes from the University in Cambridge and from other schools have made extensive use of the Forest during the year. In September of 1954 eight Conservation Fellows from the Graduate School of Public Administration came here for a few days of demonstration prior to registration. In addition to their visit here, they were given long field trips in northeastern New York State and in New England. The Harvard Forest staff and students collaborated in this program, which covered, in all, a period of about ten days. Plans are made to repeat it in the fall of 1955. During the autumn I used the Forest for two week-end field trips of my class in plant geography. Also in the autumn came a class in land-use economics, and one in general ecology from the University in Cambridge. In November we had a class from the Yale School of Forestry.

The heaviest concentration of visiting students came, as usual, in the spring. During the month of May and the first ten days of June about 150 students were given demonstrations at the Forest. Most of them were here for at least a day and a night. They came from classes in our own university and from the forestry schools of Yale, the University of Maine, and the New York State University.

A second Harvard Conference on Forest Production was held here between October 10 and 23, 1954. Fifteen practicing foresters came for field demonstrations and discussion of mutual problems. They came from the eastern half of the United States wherein they represented the principal forest regions. Further, they formed a good representation of the profession of forestry, coming from the universities, the industries, state and federal services, and from private consulting agencies. This conference, as did that of 1953, appeared to be successful, and we look forward to making it an annual event. Our entire staff and student group has taken part in it, and in addition to stating problems of widespread interest to everyone, it has been extremely stimulating to our own people.



## RESEARCH

Dr. Ernest M. Gould, Jr. has continued his research on the economics of small woodlot management in New England. He spent a considerable part of the year collecting and analyzing information derived from a number of sources on the motivation for woods operations in these small holdings. This study was financed in part by a grant of funds from the Federal Reserve Bank of Boston. In the spring and early summer of 1955 Dr. Gould became involved in a further project along these lines in New Hampshire. For this project the Harvard Forest has entered into collaboration with the Cooperative Extension Service in New Hampshire, the Northeastern Forest Experiment Station, the Federal Reserve Bank of Boston, and the Soil Conservation Service. Initial funds for it are coming from the Sears, Roebuck Foundation. The program involves some 50 case studies of pilot farm forest operating units, scattered throughout the state of New Hampshire. The study is designed to extend over a five-year period.

Dr. John C. Goodlett spent the winter writing up his field work of the preceding two years. Part of this covered his work on frost phenomena in the Harvard Forest soils, and part of it his studies in eastern Pennsylvania made during the summer of 1954. In the latter work he served as a collaborator with the U.S. Department of Agriculture, operating in company with a geologist and a soil scientist. Results of this work will be published by the Bureau of the Soil Survey or the Geological Survey. In the spring of 1955 he entered into collaboration with the U.S. Geological Survey in western Virginia, spending several weeks in the field there in company with Dr. John T. Hack of the Survey.

Mr. Earl P. Stephens finished his doctoral dissertation in June of 1955, based upon work carried on during the past three and a half years in Compartment VI of the Tom Swamp Tract. This thesis brings together and correlates a large

amount of field observation on the history and development of a specific forest stand. It is, I believe, a unique contribution, and we plan to publish it as a Harvard Forest Paper in the near future.

Mr. Shelley W. Potter, Jr. has continued his research on the pruning of red pine in our plantations. This work was started about two years ago, and has required time for the results of various kinds of pruning to be apparent. Mr. Potter has also continued to supervise our woods operations and to handle the marketing of our wood products.

The collaborative research project with the Bureau of Entomology and Plant Quarantine on the silvicultural control of the white pine weevil continues. Personnel from the Bureau have visited the study areas from time to time, keeping records of infestation and the general behavior of the young pines and the insects under the varying treatments that were given them at the beginning.

In the spring of 1939 there was initiated a special study of forest soil mapping problems under the aegis of the Bureau of the Soil Survey. As a result of these plans, detailed maps of the soils in our three principal tracts at Petersham were constructed by surveyors sent here in the field seasons of 1939, '40, and '41. The criteria used in the maps were those then in use by the Survey for mapping agricultural soils. It was planned that these should be tested for use in silvicultural production, and the Harvard Forest was selected as a study area because of the volume of research data already accumulated here.

During the years since the maps were constructed, numerous attempts have been made to correlate them with such forest types as have been defined here, or with the behavior of plantations and other managed stands. These attempts have met with only partial success. Correlations are fairly good on very wet and very dry soils, but on our abundant well- to moderately-drained soils the correlations have not been good. These facts have been clearly stated during the



past five years by those of our people who have carried on research in this field. The work of Mr. Benjamin B. Stout, published in Harvard Forest Bulletin No. 24, grew out of his efforts at correlation, and a paper read by Dr. Goodlett two years ago at the Northeastern Forest Soils Conference stated the problem again in a general review of all soils research that has been carried on here since the founding of the Forest. Mr. Stout's work brought out the existence of certain differences in the underlying glacial tills upon which our soils are developed. These differences, and their significance to the behavior of water in the soils, were not detected when the maps were made. They give promise of correlation with the distribution of our principal forest types.

In the summer of 1954 we held a small conference here with representatives of the Bureau of the Soil Survey, and it was decided to reopen the project as originally planned in 1939. The Bureau will send two of their most experienced men here in the fall of 1955 for a restudy, in detail, of certain problem areas that will be chosen for the purpose. It is hoped that from this work will come a better understanding of the problems with which the student of forest soils has to deal.

In the summer of 1954 we continued to give assistance to Dr. Donald F. Eschman of the U.S. Geological Survey in his work on the Athol Quadrangle. He has used Harvard Forest living quarters, and such field assistance as we could give. He returned in June of 1955 for a final summer on the project.

Staff and students at the Forest continue to work out case histories for specific stands that have been under management for many years. This is part of a general program to get into succinct and usable form the information that has been accumulating here since 1908. Only in rare instances do the cases summarize completed research. Rather they are reports of progress to date; and even though incomplete, they begin to show useful results. Further, they facilitate the planning of future operations in our long-term research program.

## PUBLICATIONS

Two Harvard Forest bulletins have been published during the past year. The first of these is by Dr. John C. Goodlett on "Vegetation Adjacent to the Border of the Wisconsin Drift in Potter County, Pennsylvania," and the second is by Dr. Ernest M. Gould, Jr. and Dr. Solon L. Barraclough on "Economic Analysis of Farm Forest Operating Units." Another publication, by Earl P. Stephens, is on "Research in the Biological Aspects of Forest Production." It appeared in the JOURNAL OF FORESTRY for March, 1955.

## THE HARVARD BLACK ROCK FOREST

Mr. Benjamin B. Stout continues as resident manager of the Harvard Black Rock Forest. During the year he was voted concurrent five-year appointments as Forester in the University and Supervisor of the Harvard Black Rock Forest. Mr. John Rippe continues as technical assistant, with a woods crew of four men.

Cordwood cutting operations in Compartment XXV were continued during the fall and winter. This is a clear-cutting operation, accompanied by the use of sprays for the control of hardwood sprouts. It is planned that this area will be the scene of experiments in improving the quality of hardwood growing stock on some of the poorer sites in the Black Rock Forest. It is on a high, rolling plateau where the soils are thin and scattered. In addition to encouraging natural seedling stock, Mr. Stout expects to plant oaks from various other sites there. Further work during the year was carried on in the Black Rock Brook area on the lower north slopes of the Forest (Compartment IV). Here the operations are on some of our best sites, with good growing stock and good growth rates. Experiments in heavy thinning begun here two years ago are being extended to larger areas, with some variation in treatment.



During the year Mr. Stout and his assistant have relocated and remeasured all of the permanent sample plots that had been established in the Forest in the 22 years prior to 1950 when we acquired the land. Studies of these measurements, together with studies carried out during the past three years on tree root systems, have suggested that thinnings in hardwood stands on the better sites have not been sufficiently heavy. These studies also suggest that root competition in such stands is of considerably greater importance than usually has been attached to it. In one of the study areas, therefore, we are attempting to reduce root competition by a vigorous campaign for the elimination of all undergrowth in stands that have been thinned heavily. This is being done with poison sprays.

A notable addition to woods equipment during the year was a new caterpillar bulldozer with winch. The old bulldozer that came to us with the Forest finally became unrepairable, and had to be replaced. In addition, Mr. Stout and the woods crew have built some pieces of equipment for the handling of logs and cordwood. It is expected that this new equipment will greatly facilitate woods operations.

Students from Petersham visited the Black Rock Forest for several days in the summer of 1954. One of these men, Mr. Philip Ross, a graduate student in biology at Harvard, conceived a project for the study of local climates in the Black Rock Forest. He prepared for our approval a plan of operations, and it has been accepted. The project as planned, however, will require a considerable amount of equipment which is beyond the existing resources available to us. We have therefore approached the Research and Development Division of the Quartermaster Corps in Natick, Massachusetts, for assistance. The project has been tentatively approved by their officers, and funds and equipment are expected to become available in the fall of 1955. Mr. Ross took up residence at the Black Rock Forest in June of 1955 and expects to spend about one and a half years in the field there. This research

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is somewhat akin to that done by Col. Herbert H. Rasche of the Quartermaster Corps at the Harvard Forest in 1947 and '48. It is a highly desirable program, and one that should yield valuable data for use in planning the research and operations at Black Rock.

HUGH M. RAUP  
*Director*



## *Harvard Forest*

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*To the Dean of the Faculty of Arts and Sciences:*

Sir, — The following is a report on the Harvard Forest for the year ending June 30, 1956.

### STAFF

The staff of the Harvard Forest has had two changes during the year. Mr. William F. Murison, who completed his residence and thesis for the degree of Master in Forestry in the late summer of 1955, was employed by the Forest for the year beginning September 1, 1955. Mr. Murison served ably as research associate during the remainder of the year. Mr. Shelley W. Potter resigned his position here, effective June 30, 1956. Mr. Potter came to us in July, 1952, and has been a valued member of the staff, serving as research associate. He has carried on some excellent individual research, and at the same time has been the manager of our woods operations. In the latter capacity he has made an outstanding contribution to the general welfare of the Forest. He has gone to take a position as Forester-in-Charge of a forest and experiment station operated by the College of Forestry of the State University of New York at Syracuse.

Related to the Forest's research has been the coming of Dr. William B. Critchfield as Forest Geneticist to the Maria Moors Cabot Foundation. Dr. Critchfield takes the place of Dr. Scott S. Pauley who resigned from this position in June of 1955. For the time being he is maintaining an office in Cambridge, and using the Forest as a research station. Dr. Martin Zimmermann, Physiologist to the Cabot Foundation, continues to live at the Forest, and to use its laboratory facilities in his research.

### WOODS OPERATIONS

Woods operations during the year covered about 65 acres. The last of the tornado salvage was accomplished in the Slab City

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Tract on about 19 acres; harvest and improvement cuttings were done on about 17 acres in the Prospect Hill and Tom Swamp Tracts, while thinning and improvement cuttings covered an additional 20 acres in the same tracts. About two acres of plantations were treated, and seven acres of special experimental cuttings were made. These operations produced about 210 cords of fuelwood, 690 posts, and 18,000 board feet of sawlogs. About 165 cords of fuelwood were left in the woods to season, and 170 cords left last year were removed and used. The logs were sawn in our own mill, and most of the lumber has been sold. The woods crew has also devoted considerable time to general maintenance.

## FINANCES

The operating budget for the Harvard Forest during the year was \$83,210. Income was received from the following sources: gifts for immediate use, \$8,894; income from sales, rents, etc., \$18,712; endowment income, \$55,604. Total expenses were \$76,747; thus the Forest ended the fiscal year with a substantial credit balance. This balance is due in considerable part to increased income from the sale of wood products, which totaled \$11,917 for the year. Part of the increase came from the sale of inventories left from the preceding year. However, income from the sale of wood products usually fluctuates from year to year. Over the past ten years, though, the sale of wood products has shown a general increase, reflecting the gradual increment in the growing stock of the Forest, and increased efficiency in the harvest and sale of the products.

## INSTRUCTION

One new resident student who came in June 1955 was here during the year, and expects to finish his work in the summer of 1956. A second student came in February of 1956, thus beginning his residence in the second term. He should finish his studies in the spring of 1957. Another was accepted for June of



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1956, to begin his residence which will be finished in the late summer of 1957.

The facilities of the Forest were again utilized in September of 1955 by the Fellows who later attended the Seminar on Land Use and Conservation at the Graduate School of Public Administration. These men came to us for three days of study and demonstration early in the second week of September, and were then taken on field tours of New England and adjacent New York. The principal material for the seminar during the year is drawn from the natural resource base of New England as a whole, and the field trips were designed to show the men the character of these resources. The Forest was used as an initial case study.

During the year the Forest was also used by many students from other schools in the northeastern part of the country, as well as by other groups from the University in Cambridge. There was a week-end field trip here by a class in the Department of Government at Harvard, concerned with public policies for the conservation of natural resources. In May and June of 1956 there were student classes from Yale, New York State College of Forestry, Connecticut College for Women, Rutgers University, and the University of Maine. The largest of these groups came from the New York State College, with about sixty students.

## RESEARCH

The long-term research projects of the Forest were serviced as needed during the year, and one new one was started. Individual staff members at the same time carried on projects of a shorter term nature. One new collaborative program was set up involving agencies outside the Forest.

Dr. John C. Goodlett, Forest Geographer on our staff, continued his collaborative research with the U.S. Geological Survey in western Virginia. Materials derived from his field work there in the summer of 1955 were compiled and studied during the winter, and he returned to Virginia for a few weeks in April and May of 1956. In March of 1956 Dr. Goodlett received a grant

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from the Cabot Foundation partially to defray the costs of a forest mapping program which he began in June of 1956. Using techniques that he has developed for his work in past years in Pennsylvania and Virginia, he proposed to make new maps of the distribution of the principal forest trees of New England. This type of map has long been needed, and will supply information of great value for a variety of research programs.

Dr. Ernest M. Gould, Jr., our Forest Economist, has spent a great deal of his time during the year on the Pilot Woodland Management Project in the State of New Hampshire. The essential features of this project were mentioned in my report for last year. Dr. Gould completed about half of the work on initial inventories of some fifty operating units in the summer and fall of 1955, and completed the remainder of them in the spring and early summer of 1956.

During the year Dr. Gould has also devoted a part of his time to a review of inventories and growing stocks made at the Harvard Forest from the time of its organization to the present. The Forest staff is now engaged in the development of a new inventory such as has been made at intervals of about ten years. Before going far into the new inventory, it was thought wise to stabilize the method, and reassess, in light of changing needs, the techniques that have been used in the past. Mr. William F. Murison has accomplished much of the preliminary work for the new inventory. He has checked all of the maps of the Forest, and has started the renewal of all boundary markers.

Mr. Murison's research as a student was concerned with an infection of our coniferous plantations (notably red pine) by a fungus known as *Fomes annosus*. This fungus attacks the roots of trees and is usually lethal. The disease is widespread in southern New England and is causing a great deal of damage in some areas. Pathologists of the U.S. Forest Service have been much interested in learning more about the nature of the fungus; and when they became aware of Mr. Murison's work here, they immediately proposed that a series of experiments on the nature and control of the disease be started in our red pine plantations.



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Plans were made for these experiments in December of 1955, and put into effect in May of 1956. Mr. Murison was the member of our staff who worked with the Forest Service people in the planning and carrying out of the work.

Mr. Shelley W. Potter devoted a great deal of his time during the year to his experiment in the pruning of red pine. This work has been going on for the past three years, and is beginning to show some valuable results. Mr. Potter completed the field work necessary to the project before he left the Forest at the end of June, and he can be expected to finish the analysis of the data and the presentation of results.

Another experiment, carried on in collaboration with the Forest Service, is on the biology and control of the white pine weevil. This has been described in preceding reports. During the past year the principal work on the experiment has been in the form of field observations made by Forest Service representatives, and the continued control of the stands of trees by our woods crew.

Some detailed research on forest soils, described in its planning stages in my report of last year, was put into effect in October, 1955. Mr. Walter Lyford, Soil Scientist of the U.S. Soil Conservation Service, and Mr. William Coates, of the Soil Conservation Service in Massachusetts, spent two weeks making a detailed examination of soils in the western part of Compartment I of the Tom Swamp Tract. This area has already been the scene of some water table studies by our staff and students during the past few years. Results of the work done in the fall of 1955 are not yet in presentable form, nor is the field work finished. Mr. Lyford expects to spend another two weeks here in the fall of 1956.

A new long-term research project was started in the spring and early summer of 1956 in the eastern part of Compartment I, Tom Swamp Tract. This area has been the scene of some of our most intensive management in young hardwood stands. Silvicultural operations, principally thinnings, have always involved the method of "high" thinning, which concerns itself with the crowns of the trees in the upper part of the canopy of the forest. Some

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research carried on by Mr. Benjamin Stout at the Harvard Black Rock Forest has emphasized the significance of root competition in such hardwood stands. Mr. Stout has started some experiments with "low thinnings" in that Forest, and we have now begun detailed plot studies here. In this experiment the canopy of the forest is left alone, and everything in the understory, including shrubs as well as small trees, is eliminated by cutting and poisoning. The growth rates in the canopy trees will be recorded for a period of years and compared with those in neighboring areas that are untreated.

During the spring and early summer of 1956 I availed myself of the opportunity to make a journey in northwestern Europe and in the United Kingdom. The principal purpose was to visit some of the older managed forests and to talk with the foresters who are responsible for their operation. I sailed from New York on April 11, and returned on July 24. I visited forests in Sweden, Denmark, southern Germany (the region of the Black Forest), northern Switzerland, eastern France, England, and Scotland. The journey was extremely profitable in giving me a view of modern silviculture in these countries, and some insight into the relationship of forests to the total economy. Without exception I met with the finest of hospitality, and the greatest willingness to share the results of experiments.

Scientific forestry in America is much younger than that of northwestern Europe, and has much to learn from it. Most of the basic ideas that have been used in the development of American forestry in the last fifty years came from European experience prior to 1900, and it has seemed to me that many of these ideas have been applied in America without due regard to the different socio-economic milieu from which they came. Furthermore, it has seemed that in the past fifty years American forestry has not adequately adjusted to its own situation what it took from Europe. My observations in Europe have tended to confirm these opinions, and have led me to believe that a basic need in America is a restudy and reevaluation of our forest practice and research in light of actual conditions with regard to all land use in America.



## HARVARD FOREST

### CONFERENCE ON FOREST PRODUCTION

The Harvard Conference on Forest Production was repeated in the first two weeks of October 1955. Fourteen foresters were in attendance, representing the wood-using industries, schools of forestry, and state and federal forest services. They came from as far west as western Montana, as far south as Central America, and as far to the northeast as the University of New Brunswick. As in past conferences, the Harvard Forest and its research program were used as a case study illustrating the economic and biological problems that are met with by those responsible for the production of wood on the land. A principal feature of the conference was a series of informal discussions, mostly in the woods, dealing with these problems, and utilizing the wealth of ideas that come from men who are active in the application of such research results. Not the least of the advantages that come from the discussions is the opportunity for the men themselves to compare their experiences. At the same time they serve as a stimulus to the staff of the Harvard Forest. A similar conference is planned for the autumn of 1956.

### HARVARD BLACK ROCK FOREST

The Harvard Black Rock Forest continues in the capable hands of its Supervisor, Mr. Benjamin B. Stout. Mr. John Rippe, who had been serving as Technical Assistant since May of 1954, resigned his position as of December 1, 1955. Other than this and minor changes in the woods labor force, the staff has remained unchanged.

The usual yearly pattern of activities for the woods crew is now fairly well established. The summer is devoted to work on the forest roads, either to maintenance or new construction. The winter months are used to carry on experimental cuttings, while fall and spring are given over to miscellaneous tasks of general maintenance and, where needed, assistance in short-term research projects. When the University received the Black Rock Forest, there was already a network of excellent roads. However,

## HARVARD UNIVERSITY

the network was incomplete, particularly for some of the best woodlands which are on the lower north and northwest slopes of the Forest area. During the past few years we have been extending roads into this district. The summer of 1955 saw very little progress in new construction because of the large amount of maintenance and reconstruction necessary on the older roads. Part of this was due to damage caused by heavy trucking involved in the recovery of an Army aircraft that fell into one of our ponds. Later in the summer, in August and September, there were unusually heavy rains which caused a great deal of further damage. Construction on the new roads got underway again in the early summer of 1956.

A major problem in the operation of the Harvard Black Rock Forest, as well as in that of the Harvard Forest at Petersham, is the handling of cordwood. The rocky terrain makes extremely difficult such mechanization as is used in some other regions. During the past year Mr. Stout has accomplished a great deal in this direction by devising a bundling sling by which quantities of wood can be drawn from the woods to the roadside with the elimination of two handlings. The economy thus achieved quickly appears in the reduction of cost in time and labor, and in the increased income from sales.

As noted in a previous report, all of the earlier sample plots that were established in the late 20's and early 30's were re-measured in the fall of 1954. Mr. Stout and Mr. Rippe made an analysis of these records during 1955.

Forty-three plots were laid out in the clearcut area of Compartment XXV. As noted in a previous report, this area was to be planted with red oak from various sources to see whether the quality of the growing stock could be improved on one of the poorer sites. Compartment XXV is at a relatively high altitude in the Forest, with a rocky surface and thin, patchy soils. In the fall of 1955 red oak acorns collected in Compartment V, some 800 feet lower in elevation, were planted in the 43 plots. It was planned to fill still other plots with acorns from a source farther south in the eastern United States. However, it turned out that the red



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oak did not bear sufficient seed in the central Appalachians this year to make possible the necessary collection. This further seeding will be done at the first opportunity. Heavy thinnings were continued during the year in Compartment IV on the lower north slopes of the Forest. Criteria for decisions on these thinnings have been derived chiefly from two sources: Observations, made during previous cuttings, on the extent of decay in stands that are mainly of sprout origin; and studies of the lateral extent of tree root systems.

Students from the Harvard Forest visited the Harvard Black Rock Forest for several days in the spring of 1956. A graduate student in biology, Mr. Philip Ross, moved to Cornwall in June of 1955 to begin work on a research project in local climates. It was hoped that he could begin his studies during the summer of 1955, but unavoidable delays in acquiring the necessary instruments made it impossible to get his field work under way until the spring of 1956. This project is being supported under a contract with the Research and Development Division of the Army Quartermaster Corps in Natick, Massachusetts. This organization is supplying most of the instruments necessary for the study, as well as affording direct financial support.

HUGH M. RAUP  
*Director*

## *Harvard Forest and Harvard Black Rock Forest*

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*To the Dean of the Faculty of Arts and Sciences:*

Sir, — The following is a report on the Harvard Forest and the Harvard Black Rock Forest for the year ending June 30, 1957.

### HARVARD FOREST

#### STAFF

The staff of the Harvard Forest has included throughout the year, in addition to the Director, Dr. Ernest M. Gould, Jr., Forest Economist, and Dr. John C. Goodlett, Forest Geographer. Mr. James H. Patric, who was a graduate student at the Forest from June 1955 to the end of August 1956, continued as a research assistant until late December 1956. At that time he left to take a position with the United States Forest Service in California. The position vacated by Mr. Shelley W. Potter, Jr. on July 1, 1956 remained unfilled until February 1, 1957. At that time Mr. Karl W. Woodward, Jr. was employed as a research associate whose primary duties at the Forest consist in the management of its woods operations. During the interim prior to the coming of Mr. Woodward, Dr. Gould carried the responsibility for this management along with his other duties and his research. Mr. William F. Murison, a former student, remained on the staff as a research assistant from September 1955 to August 1956. At that time he left to become a resident student for the doctorate at the University of British Columbia.

During most of the year our woods operations were performed by four full-time men. Miss Elizabeth Carpenter has



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continued as business secretary and librarian, and Mrs. Marion S. Hambleton as part-time secretary to the Forest and part-time assistant to the Director.

### WOODS OPERATIONS

Woods work in the year 1956-57 was done on about 61 acres of the Forest's land. The principal operations were a combination of improvement and partial harvest cuttings on about 50 acres of mixed pine, hemlock and hardwoods in Compartments II, III, IV and VI of the Prospect Hill Tract, and in Compartments IV, VI and VII of the Tom Swamp Tract. Cuttings were also made in cleaning up around the sawmill and the gravel pit, on areas totaling about one acre. Approximately 10 acres received special experimental treatment. The combined output from these operations totaled about 23,600 board feet of lumber and about 310 cords of fuelwood. Inventory at the beginning of the fiscal year included about 31,700 board feet of lumber and about 211 cords of fuelwood. Sales during the year totaled 28,637 board feet of lumber and 318 cords of wood. Thus our inventory on July 1, 1957 included about 26,600 board feet and about 203 cords of wood.

A new system for the control of woods operations was installed during the year, to give a more detailed record of time and costs, and to promote more effective use of labor and equipment. Work programs are now made for weekly and monthly intervals, while records of time and other costs are kept on no less than 39 different operational items. In spite of its apparent complexity, the new system appears to be working smoothly, with a minimum of bookkeeping. Much of the credit for its effectiveness should go to our woods superintendent, Mr. Charles F. Upham, upon whom falls most of the responsibility for keeping the records in the woods.

On May 1, 1957, the Forest experienced the largest fire since its acquisition by the University. During the month of April, before the leaves of the trees had emerged, there was a prolonged

*During the summer it was found that most of the trees in the Prospect Hill tract were killed. Also many of the trees in the Tom Swamp tract were killed. The cause of the fire was not determined.*

drought so that the ground cover in the woods was tinder dry. The fire started along State Route 32 on neighboring land north of the Forest Headquarters, and despite prompt detection it was spread in a southeasterly direction by a high wind. Quick action by the Petersham Fire Department, by our own people, by departments from surrounding towns and by State Forest personnel confined the fire within a few hours. This was not accomplished, however, before about 80 acres of the Prospect Hill Tract had been burned over. The burned area included 24 acres of coniferous plantations which were destroyed, and about 56 acres of natural stands. Loss in the latter, which are composed mainly of deciduous trees, was largely confined to reproduction. The total damage cannot be assessed adequately until another growing season has passed. The only area of special interest that was badly affected was an experiment in the control of young hardwoods by poison sprays. However, much of the experimental value of this area had already been realized. Fortunately the fire just missed an older red pine plantation that was being used for current experiments, and did only a small amount of damage to another.

## FINANCES

Funds accruing during the year, and available for the use of the Harvard Forest totaled \$82,082. Income used was received from the following sources: endowment funds, \$58,179; income from sales, rents, etc., \$13,718; gifts and grants for immediate use, \$10,185. Total expenses were \$78,773.

## INSTRUCTION

Two graduate students were in residence during all or part of the year. One of these, Mr. Brayton F. Wilson, Jr., finished his thesis for the master's degree in February 1957, and continued his research at the Forest until May 1. He is a recipient of a Fulbright Fellowship to study in Australia during the year 1957-58. Dr. Fulvio Baldassini came to the Forest in July of 1956 as a graduate student doing research work on mycorrhizal fungi



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in the Forest. Dr. Baldassini was making excellent progress with his work, but had to relinquish it in late December of that year on account of illness.

In September of 1956 the staff of the Forest devoted two weeks to an intensive preregistration training period for nine Fellows selected from the public services to attend the Harvard Graduate School of Public Administration for the academic year 1956-57. These men were at the Forest in charge of Dr. Ayers Brinser. They were given a general view of the natural resource base in New England. The Forest itself was used for about three days as a case study in resource management and development, and then the men were taken on two field trips through northern and central New England. In the autumn these Fellows registered for the Seminar on Land Use and Conservation, and for various courses in government and economics at the Graduate School of Public Administration in Cambridge. All of them were finally awarded the M.P.A. in the following June. During the year Dr. Gould and I were regular participants in the Seminar discussions in Cambridge.

Groups of visiting forestry students have come from the Yale School of Forestry, the College of Forestry at the University of the State of New York at Syracuse, and the Department of Forestry at the University of Maine. In addition, field trips were arranged for groups from the Massachusetts Audubon Society, and for others interested in various phases of natural science. In all, field discussions and demonstrations were held for about 100 students from other institutions.

## RESEARCH

The decennial inventory of the growing stock of the Forest, mentioned in my report of last year as having been begun by Dr. Gould and Mr. Murison, was finished during the autumn and early winter by Mr. Patric. A recently devised cruising technique was used in this inventory, and tested for application to the administration of an experimental forest. The cruise indi-

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cates that the Harvard Forest presently has growing stock totaling about 3,011,600 board feet of sawlogs in trees ten inches d.b.h. and larger, and about 13,900 cords of wood in trees between six and ten inches d.b.h. This inventory will greatly facilitate the planning of woods operations during the next ten years.

Dr. Gould continued his work on the Pilot Woodland Management Program in the State of New Hampshire. All of the initial inventories on 50 forest land holdings in that state, and interviews with their owners, were completed in the summer of 1956. Statements of management alternatives, with suitable maps, were finished and given to the cooperating owners during the spring and summer of 1957. Copies of these also went to the local County Foresters, who are expected to assist the owners in carrying out the selected plans during the next five years. This pilot study has been a large and time-consuming operation, but it should produce a great deal of much needed information on the actual costs and returns involved in small woodlot management and operation. Because so little of this kind of information is available, and because the quantity of forest land in the United States that exists in small ownerships is proportionally so great, the significance of this research looms large in the assessment of the real woodland values of the country.

Dr. Goodlett continued work on his forest mapping program. The purpose of this project is to map the local distribution of selected tree species native to New England. During the summer of 1956 an area of nearly 2500 square miles in central and western Massachusetts and adjacent New Hampshire and Vermont was mapped. This field work was made possible by a grant from the Maria Moors Cabot Foundation. In the fall and winter Dr. Goodlett and Dr. John T. Hack of the U. S. Geological Survey completed a manuscript presenting the results of a collaborative geological and botanical research project carried out under the aegis of the Survey in Western Virginia during parts of 1955 and 1956. This report has been submitted to the U. S. Geo-



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logical Survey and will be published by the Survey as a Professional Paper.

In October of 1956 Mr. Walter Lyford, Soils Coordinator for the Northeastern States, U. S. Soil Conservation Service, and Mr. William Coates of the Soil Conservation Service in Massachusetts, continued their intensive study of soils in Compartment I of the Tom Swamp Tract. They did some further field work, and have prepared a manuscript report. This research constitutes a continuation of studies of soils mapping in the Harvard Forest begun by the U. S. Soil Survey in 1939. It is expected that Mr. Lyford and Mr. Coates will return to the Forest again in 1957 for detailed studies on another part of our lands.

Cooperative research on a fungus disease in red pine (caused by *Fomes annosus*) and on the control of the white pine weevil, both joint studies by the Forest and the U. S. Forest Service, was continued by routine observations during the year. These observations were made at intervals by Forest Service personnel. The experiments on the control of *Fomes annosus* were damaged to a small extent by the fire which occurred in the Forest on May 1, 1957.

## PUBLICATIONS

*Harvard Forest Bulletin No. 27* was published in May 1957. This bulletin is entitled "Results of the First Thirty Years of Experimentation in Silviculture in the Harvard Forest, 1908-1938. Part II. Natural Reproduction Methods in White Pine-Hemlock Stands on Light, Sandy Soils." It was prepared by Mr. Albert C. Cline, my predecessor as Director of the Forest, and Mr. Russell J. Lutz, who served here as Assistant to the Director prior to the last war. It embodies the second part of what was originally designed to be the Forest's thirty-year progress report, and carries a discussion of four case histories in the regeneration of white pine and hemlock on the sand and gravel soils of Compartment IX of the Tom Swamp Tract (long known as the Adams-Fay Lot). These experiments were so badly damaged by the hurricane of 1938 that it was thought for some time they would have

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to be discontinued. Relocation and study of the old experimental plots in 1949 and 1950, however, indicated that it would be highly desirable to extend the experiments to the present time, and re-interpret the results. *Bulletin No. 27* details these later studies and relates them to the original experiments.

A manuscript on local temperature climates in the Harvard Forest by Colonel Herbert H. Rasche of the Quartermaster Corps, U. S. Army, was finished in the winter of 1956-57, and is now in press. Field work for this study was done while Colonel Rasche was a graduate student in geography at Harvard in 1947 and 1948, and the resulting paper constitutes his dissertation for the doctorate at Harvard. This paper will be of great value to present and future research at the Forest, for it contains specific information on the extraordinary variability in the distribution of temperatures as related to our rolling topography and to the miscellaneous kinds of forest that grow here. It will be published as a "Harvard Forest Paper."

## CONFERENCES AND SYMPOSIA

The fourth Harvard Conference on Forest Production was held at Petersham between October 7 and 19, 1956. Fifteen practising foresters were in attendance. As in previous years, they were representatives of forestry schools, federal and state public services, and the wood-using industries. Most of the work of the Conference was done in the field, using the Harvard Forest as a case study in management research. From the beginning of these conferences in 1953, we have looked upon them as an experiment in the use of the Forest's resources for clarification of some basic problems in the development and management of woodlands in this country. We believe they have had some measure of success, and we expect to continue them.

In April of 1957 the Harvard Forest was host to a group of men invited by the Maria Moors Cabot Foundation to participate in a symposium on tree physiology. There were 28 regular attendants at the symposium, which occupied five days. The participants came from various institutions throughout the United States, and

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there were representatives from Australia, Canada, New Zealand, Norway, and West Germany. Papers given were limited in number and length so that there was ample time for discussion. Both the papers and the discussion will be published in book form by the Cabot Foundation.

## HARVARD BLACK ROCK FOREST

### WOODS OPERATIONS

The Harvard Black Rock Forest is owned and administered by a separate educational corporation in New York State. It is supported by funds held in trust for the purpose by the President and Fellows of Harvard College. Operations in this Forest were carried on during the year by a crew of three men working full time, and one man part time. Mr. Benjamin B. Stout has continued as resident supervisor, planning and managing the operations and at the same time pursuing both long- and short-term research projects. Cutting was done principally in Compartment IV, on the lower north slopes of Black Rock Hill, and was the main work of the crew during the fall, winter and spring. The total cut was 322 standard cords in six-foot lengths. Though the Forest has a small local sale of fuelwood, most of its product goes to a New York City buyer of wood for fuel and other uses.

In the summer of 1956 about one fourth of all the roads were resurfaced with gravel, and all needed grading was done. New road construction in the northwest quarter of the Forest was continued; and, except for surfacing, about two thirds of the needed length was completed. In early June of 1957 the woods crew returned to the road work, and were expected to finish most of the new construction by autumn. The new road, when completed, will give access to a large area of excellent sites and good growing stock that never have been properly utilized.

In my report for 1955-56 I mentioned Mr. Stout's success in speeding up the handling of cordwood. Another large item of cost in the extraction of this wood goes into splitting it, either in four- or six-foot lengths. In the winter and spring of 1957 Mr.



## HARVARD FOREST

Stout constructed a machine of his own design which has greatly reduced the labor and cost of splitting. By the end of June he had built a duplicate of it for use at the Harvard Forest in Petersham.

On December 14, 1956 the Forest experienced one of the heaviest ice storms in many years. It has long been known that southeastern New York, southern New England, and northern Pennsylvania are in a climatic "belt" that favors the accumulation of ice from freezing rain. Careful notes were made on the damage done in the Black Rock Forest by this storm, and it was found that most of the breakage occurred in the smaller trees — those not in the main canopy of the woods. The worst damage was done in a plantation of European larch, which was essentially eliminated by the storm. Up to this time the European larch had been regarded as one of the most promising conifers for planting in this area.

## RESEARCH AND INSTRUCTION

The cutting operations are carefully planned experimental thinnings in the predominantly hardwood forests that clothe the area. Mr. Stout is continuing his investigations of the effects of heavy thinnings, wherein 50 to 60 per cent of the volume is removed. Records are kept, with ample plot data, on volumes cut and left; and there are descriptions and measurements of the trees released by the thinnings, including data on species, total height, diameter, and form. These experiments are on some of the best sites in the Forest, where the soils are deep and relatively moist.

Previous research on the nature and distribution of soils and forest composition in the Black Rock Forest has emphasized, as it has at Petersham, the significance of water availability. To test this Mr. Stout has initiated an irrigation experiment in one of the heavily thinned stands on the lower north slopes. Though the experiment was started in the summer of 1956, unusually heavy rains in that summer made it ineffective. It was started again in time to cover the growing season of 1957.

In addition to these research projects, Mr. Stout has carried

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on two other studies that are of particular interest. Evidence of damage to the forest by winds of gale or hurricane force is abundant, as it is at Petersham. It is clear that these winds have been effective for centuries, and that they are of great significance in assessing risks to growing stock. Mr. Stout has made a detailed study of the windthrow resulting from a major storm in 1950, and from lesser storms that have occurred since then. His recent studies of soils and root systems have enabled him to make some significant observations on the varying susceptibility of species to windthrow on differing sites. Another study deals with an enigma in the local distributions of species that has been a subject of discussions for many years. This concerns the presence and distribution of some old white oak trees on the rocky uplands of the Forest. Again using his recent studies of root systems, soils and windthrow, Mr. Stout has proposed a new hypothesis to account for the presence of these ancient trees in areas that have been blown down, cut over, or burned repeatedly in the last few centuries.

In 1932 and 1940 experimental plantings of Korean chestnut were established in the Forest. At the request of the Bureau of Plant Industry at Beltsville, Maryland, a survey of these plantations was made in the summer of 1956. Of some 10,000 seedlings that were planted only about 100 survive. Though some of these are producing fruit, none of them appear to be promising as wood-producing trees. Sprouts of the American chestnut continue to be plentiful in most of the Forest, but they rarely reach a diameter of more than three or four inches before they are killed back by the blight. However, in a part of Compartment XX, where the forest had been blown down in the windstorm of 1950, an unusually vigorous growth of chestnut sprouts appeared, and by the summer of 1956 they were as large as any that had been seen previously. Furthermore, they produced an abundance of nuts in the autumn of that year which were sent promptly to the Bureau of Plant Industry for experiment.

*Bulletin No. 15* from the Black Rock Forest was published in May 1957. It was prepared by Mr. Stout and is entitled "Studies

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of the root systems of deciduous trees." The research upon which it is based was begun in 1951, and was supported in part by grants from the Maria Moors Cabot Foundation. This foundation has also shared the cost of publication.

Mr. Philip Ross, a graduate student in biology at Harvard, has continued his research on the local climates of the Black Rock Forest. As noted in a previous report, he is supported in part under a contract with the Research and Development Command of the Army Quartermaster Corps in Natick, Massachusetts. His field observations began in the spring of 1956 and will continue uninterruptedly until August of 1957. He has established ten weather stations in areas that represent the major topographic features of the Forest, and is attempting to relate his findings to the local distribution of trees and to their growth rates and forms.

The Black Rock Forest continues to attract students and many other visitors and investigators who come for study or demonstration. Its excellent road system, its active research, and its readily accessible records make it attractive not only to foresters but to persons interested in many other aspects of natural science.

## CONCLUDING REMARKS

In my annual reports during the past ten years, I have attempted at various times to outline what I thought were some of the basic problems in forestry, and assess the position of Harvard's institutions of forestry with relation to the need for dealing with these problems. Experience of the four conferences we have held indicates that there is a conflict between theory and practice in forest production. Ideologies and techniques with which the young forester is furnished in his formal training are far from adequate to deal with the realities that he meets when he finds work in the public services or in wood-using industries. The purpose of our conferences on forest production has crystalized gradually into attempts to bridge this gap. We have found that the need for such a bridge is particularly acute in comparatively young foresters who have had from five to fifteen years of job experience.



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On several occasions I have emphasized that much of American thinking on the development and use of the forest resource was predicated upon a concept of scarcity in the resource itself, while in reality the forest resource in America has been and still is abundant. This I believe to be the root of the conflict mentioned above. Historically most of American theory in this field was derived from that of Western Europe wherein scarcity has been the rule for at least a century and a half. Because of this scarcity, and the stability and remunerativeness of the market for wood products, it has been possible to attract large investment capital to the management of Western European forests. On the other hand, because of the abundance of wood in America, together with the uncertainty of markets and our highly developed technologies for wood utilization and for the development of substitutes, large investment in forest management has not been attractive. Although certain kinds of wood are now scarce in some parts of our country, our technologies and our transportation systems have served to cushion the impact of the scarcities so that they are not effective in attracting investment capital. Exceptions to this have developed recently in southeastern United States, where considerable sums are now going into pulpwood plantations.

The principal theme of the four Harvard Conferences on Forest Production, held at Petersham in the last four years, has been "Forestry in Transition." Discussions of this theme have aimed at clarification of our actual relationships to the forest resource, and have been based upon the assumption that we are at the beginning of a situation in which larger investment will have to be made in the development of the forest, rather than merely for its harvest as a wild crop. The same theme, more widely applied, has been implicit in much of the work of the Seminar on Land Use and Conservation conducted in the Graduate School of Public Administration. It will be noted that the staff of the Harvard Forest has had an increasing role in the work of this seminar. From studies in the Conferences and in the Seminar it seems clear that the development and use of the forest resource cannot be dealt with adequately in terms only of the forest and its utiliza-

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tion. Rather, our forests must be considered as part of our total problem of the use of the land, with all of the historical and modern social and economic influences that condition it.

The existing relationships of man in America to the forest resource show many dislocations which are evidence of the unresolved conflict with which he started, and of his failure to integrate his thinking and his actions. Whether these dislocations are concerned with publicly or privately controlled forests, and whether they involve shortages or surpluses, they need for their solution some method by which the basic conflict between theory and practice can be understood and eliminated.

Another way of saying this is that one of our basic needs is correlative thinking with knowledge from both the natural and social sciences, and the development of a framework in which this thinking can be brought effectively to bear at specific points. Such correlative thinking is by nature extremely complex, and involves the problem of multiple interacting variables. The best that can be hoped for are partial solutions and a method of analysis that will enable us to recognize and interpret coincidences among relevant patterns of fact.

The physical and biological possibilities of the forest resource are derived from studies in the natural sciences. A constant flow of materials and ideas is needed from research in such fields as biology, soils, geology, and some phases of engineering, if decisions for the efficient management of forests are to have a firm foundation in reality. In turn, assessment of these possibilities in terms of economic and social values is a function of research in history, political science, economics, and business administration. This research is essential if physical and biological knowledge is to be applied to management decisions in actual situations.

I believe that Harvard University is peculiarly well equipped in materials, personal skills, and in its basic philosophy of education to deal with the broad problem of efficiency in the use and development of renewable natural resources. In the Harvard Forest, with its continuous record of nearly fifty years' experience with research and training in silviculture, we have an invaluable

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series of case histories dealing with one of these natural resources. In its close ties with Harvard research and training in economics and government, as well as in other phases of biology, we have an excellent opportunity to make a significant contribution toward a fusion of thought among students in the natural and social sciences.

Plans now being matured for a closer integration of the work of the Forest with that of the Seminar on Land Use and Conservation thus have, I believe, a sound foundation in the developments that have occurred at the Forest and in the Seminar during the past decade.

HUGH M. RAUP  
*Director*



## *Harvard Forest and Harvard Black Rock Forest*

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*To the Dean of the Faculty of Arts and Sciences:*

Sir, — The following is a report on the Harvard Forest and the Harvard Black Rock Forest for the year ending June 30, 1958.

### HARVARD FOREST

#### STAFF

The staff of the Harvard Forest has remained unchanged during the year. It consists of the following, in addition to the Director: Dr. Ernest M. Gould, Jr., Forest Economist and Lecturer on Economics; Dr. John C. Goodlett, Forest Geographer and Lecturer on Forest Biology; Mr. Karl W. Woodward, Jr., Research Associate; Mr. Charles F. Upham, Woods Superintendent; Miss Elizabeth Carpenter, Business Secretary and Librarian. Mrs. Marion S. Hambleton has continued part time as secretary to the Forest and part time as assistant to the Director. Most of the woods operations were carried on by the Superintendent and three additional full-time men.

#### FINANCES

Funds accruing during this fiscal year, and available for the use of the Harvard Forest, totaled \$78,742. Income used was received from the following sources: endowment funds, \$62,788; income from sales, rents, etc., \$12,727; gifts and grants for immediate use, \$8,513. Total expenses were \$76,050.

#### WOODS OPERATIONS

The winter of 1957-58 was a rigorous one, with heavy snows and much cold weather. Cutting operations in the woods were

## BOTANICAL ACTIVITIES

well ahead of schedule until the Christmas holidays, but thereafter they were slow and interrupted. Much of the time of the woods crew had to be used in merely keeping essential roads open. Time that could not be spent in the forest was put to good use, however, at a variety of maintenance work about the buildings, and in operating the sawmill.

Cutting operations in the year 1957-58 were done on about 46 acres of the Forest's land. As in past years, they were a combination of improvement and partial harvest cutting, in this case on some 15 acres of mixed hardwoods in Compartments III, IV, V, and VI of the Tom Swamp Tract. Salvage cuttings were made in Compartments III and IV of the Prospect Hill Tract, with partial harvest and improvement cuttings in Compartment II. The combined output from these operations totaled about 34,200 board feet of lumber and about 300 cords of fuelwood. Inventory at the beginning of the fiscal year included about 26,700 board feet of lumber and 200 cords of fuelwood. Sales during the year totaled 22,700 board feet of lumber and 309 cords of wood. Thus our inventory on July 1, 1958 included about 38,200 board feet of lumber and about 191 cords of wood.

## RESEARCH

The long-term research program on the behavior of our forests under varying kinds and intensities of management has continued to be served throughout the year. Extensive records of all operations, including the purposes for which they were done, the expenditures of labor and materials involved, and the amounts of products realized, have been inserted in our files in such a way that they can be readily found and utilized in future studies. At the same time the various members of the staff have carried on their individual research projects. The following paragraphs contain brief accounts of these projects.

During the summer of 1957 Dr. Goodlett continued mapping the distribution of forest trees in New England. Field expenses for this work were met by a grant from the Cabot Foundation.

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To date Dr. Goodlett has traveled some 10,000 miles studying the local distribution of selected species of trees. The mapped data have enabled him to outline in detail the range boundaries of the species and to gain some understanding of factors determining their local distribution in an area of about 13,000 square miles. Major boundaries have been roughed out for approximately another 9,000 square miles. This work has been confined mainly to Massachusetts, Vermont, and New Hampshire. He devoted most of the winter of 1957-58 to the preparation of a manuscript on a history and analysis of the studies of forest site evaluation that have been carried on at the Harvard Forest since its founding in 1907. Notable advances made in this field, both here and elsewhere within the past decade, have required a review that will enable us to put our recent work into perspective, and to make more intelligent decisions on the future course of research.

In addition to these projects, Dr. Goodlett has made contributions to three collaborative research programs with which he has been concerned for several years. One of these, mentioned in my report of last year, has resulted in a paper on the geomorphology and vegetation of a mountainous area in western Virginia based on research under the joint auspices of the U.S. Geological Survey and the Harvard Forest. In May of 1958 Dr. John T. Hack, of the Geological Survey, and Dr. Goodlett conducted a two-day demonstration of their work at a field meeting of geologists and botanists. Another collaborative program has been centered in the Finger Lakes region of western New York State, where Dr. Goodlett has contributed vegetational studies to a joint project by Dr. C. S. Denny of the Geological Survey and Mr. Walter H. Lyford of the Division of Soil Survey in the Soil Conservation Service. The third joint project is in the Harvard Forest, and was also mentioned in my report for last year. Dr. Goodlett spent about three weeks in the autumn of 1957 working with Mr. Lyford and Mr. William H. Coates of the Soil Conservation Service on a study of mapping techniques for forest soils in Compartment I of our Tom Swamp Tract.

Dr. Gould continued his work on the Pilot Woodland Man-



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agement Program in the State of New Hampshire. During the past year he has written a summary of all procedures, and on the basis of it has revised the record system in light of the first two years of the program. He has presented short articles describing the program at the New Hampshire Forestry Field Day, and for publication in the Monthly Review of the Federal Reserve Bank of Boston. He has also published a technical paper in the *Journal of Forestry* on the Harvard Forest Prism Holder which was developed by him for use in the inventory of the cooperators' woodlands.

Several years ago Dr. Gould began a study of the personal motivations that determine the way in which owners of small forest holdings manage their lands. The research was supported in part by the Federal Reserve Bank of Boston. A large quantity of data was gathered in the answers to questions addressed to some 2,500 owners of small woodlots in Massachusetts and southern New Hampshire. Analysis of these data was then postponed when Dr. Gould became involved in the pilot management research in New Hampshire. During the past year he has returned to the motivation research, which is currently in progress.

Dr. Gould has devoted a great deal of time throughout the academic year to assisting in the work of the Seminar on Land Use and Conservation. I shall have more to say about this seminar in another place. He has worked with the student committees set up within the seminar, supervising the analyses of their problems and the preparation of their reports. At the same time he has assisted in the editing of the research papers that are the general result of the seminar program.

Out of a series of Harvard studies finished or in progress during recent years relating to the economics of small woodlot ownership, there begin to emerge materials with which to draw up policy statements that should be of use to private owners of forest land. Such studies are those of Dr. Solon L. Barracough on the nature of forest land ownership in New England, of Gould and Barracough on some case studies of small woodlot management, and the current programs of the pilot management and motivation

## HARVARD FOREST

research projects. In order to place this recent work in perspective, Dr. Gould devoted several weeks during the past winter to the historical background of forestry and forest policy in America. His findings in this field are closely related to those of Dr. Goodlett on the development of site evaluation research.

Mr. Woodward has given what time he could spare from the supervision of current woods operations to some preliminary studies of the coniferous plantations of the Forest. We have on our lands some 134 experimental plantations of conifers that were put in over a period of about twenty-five years. The youngest of these are now about twenty years old. An increasingly pressing problem is some attempt to evaluate the varying success of these plantations, with an effort to arrive at causes for success or failure and to estimate costs and possible returns. Research along these lines will no doubt continue for some years to come.

Collaborative research with other institutions continues. I have already mentioned the work of Lyford and Coates on the identification and mapping of soils. They again spent two weeks at the Forest in October of 1957 making further field studies and working at their manuscript report. Cooperative research with the U.S. Forest Service on the disease of Red Pine caused by the fungus *Fomes annosus*, and on the biology of the White Pine weevil were also continued during the year.

My personal research, though not directly involved with Harvard Forest materials, has considerable bearing upon some of its basic problems. For many years, and dating from long before I became Director of the Forest, I have been a student of the vegetation, soils, and landforms of arctic and subarctic America. Most of these features of the landscape in the far North are relatively young, and are in the early stages of formation following the disappearance of glaciers and the amelioration of periglacial climates. I have been concerned particularly with the processes by which they are coming about. Studies of Harvard Forest landforms and soils during the past twenty years, and particularly in the last decade, have shown that they bear the marks of an origin and development that is to be found now only in the North.

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Some evidence is accumulating from studies in the Harvard Forest that certain of the characteristics of our soils and micro-relief, features that are closely related to the present distribution of forest site values, are holdovers from processes that were active only while the glaciers were retreating from these lands. I think it probable that many aspects of our forest sites can be understood only in this context. My most recent work along these lines has been in northeastern Greenland, where I spent five weeks in the summer of 1957 and a few days in the summer of 1956. There I was fortunate in being able to collaborate in the field with Dr. A. L. Washburn who is making detailed studies of the geomorphic processes by which the soils and microrelief are forming. My work was supported in part by a grant from the Milton Fund at Harvard and in part by the Dartmouth East Greenland Expedition, of which Dr. Washburn is the leader.

## PUBLICATIONS

*Harvard Forest Paper No. 4* was issued in June of 1958. It was mentioned in my report for last year, and is called "Temperature Differences in Harvard Forest and Their Significance," by Colonel Herbert H. Rasche of the Quartermaster Research and Development Command, U. S. Army. Its publication was supported jointly by the Harvard Forest and the Quartermaster Corps. The Forest's share of the cost was met from funds generously given by the Friends of the Harvard Forest.

## THE DEGREE OF MASTER IN FOREST SCIENCE

In December of 1957 I proposed that the name of the forestry degree granted by Harvard be changed from "Master in Forestry" to "Master in Forest Science." The reasons for the proposal are as follows:

Forestry education in America is comparatively new, for it has had nearly all of its growth and development within the past sixty years. Graduate instruction in particular has developed slowly and somewhat haphazardly. For many years there was but little uniformity among schools, either in the names of degrees



## HARVARD FOREST

or in the requirements made for them. Harvard's experience, in variety and change, is analogous to that of other institutions.

There has appeared, gradually, in American forestry schools the rather widely accepted concept that the degrees of "Master in Forestry" and "Master of Science in Forestry" are technical or professional degrees, based almost solely upon formal course work, with little or no emphasis upon research. In contrast, degrees for which original research is required usually are called "Master of Science" or "Master of Arts", with no designation of the field in which they are given. Whatever may have been the earlier meanings of these titles, in American forestry education they are now customarily defined as noted above.

It seems desirable that the title of our master's degree should include a designation of the special field in which it is granted. From the standpoint of tradition, "Master of Science in Forestry" would be entirely appropriate, but this term is in effect preempted under its definition as a purely professional degree, usually requiring little or no research. "Master of Science in Silviculture" is a possibility, but it would be satisfactory to us only under a definition of "silviculture" that is much broader than that commonly used in forestry curricula. "Master in Forest Science" is unequivocal in its designation of field, is sufficiently broad to cover the parts of forestry in which we at Harvard wish to carry on instruction, and at the same time allows of interpretation broad enough to cover any parts of the field in which the institution is at all likely to work in future. The change would apply only to the title of the degree. Requirements for it, and the manner of its administration, would remain as they are.

The proposal was approved by the Department of Biology in January, 1958, and in April by the Faculty of Arts and Sciences and the Corporation of the University.

## CONFERENCE ON FOREST PRODUCTION

The fifth annual Harvard Conference on Forest Production was held at Petersham, October 6-18, 1957. Twelve practicing forest-

## BOTANICAL ACTIVITIES

ers were in attendance, together with our own staff and Mr. Benjamin B. Stout, who is Supervisor of the Harvard Black Rock Forest. The U.S. Forest Service was represented by two men, and the state services by three. Two men came from the Soil Conservation Service, and one from a state forestry extension organization. Two were from pulp and paper industries, and one from a forestry school of a state university. Finally, there was a forester from the State of Saxony Forest Service in West Germany, who was in this country for a year under a personnel exchange arrangement. States represented were Maine, New Hampshire, Massachusetts, New York, Pennsylvania, Michigan, Minnesota, South Dakota, Washington, and Alabama.

The theme of the 1957 conference was oriented to the problem of investment analysis as applied to the forest resource. Our purpose was to identify some parts of this problem, and to throw some light upon the significant factors affecting investment in forest management.

There has never been a large flow of investment capital into the management of American forests, probably because of the abundance of wood that grew without management. If more productive management is to be achieved in the future, investment in this field will have to be made far more attractive than it has been in the past. Ultimate success in this cannot be assured without a better understanding than we now possess of the behavior of the basic resource itself — the forest — under management. The problem is further complicated by the fact that investment in forest production is concerned with several factors other than the management of the woods. It involves the costs of land and the recovery of wood, and in the case of industrial ownerships, investment in processing plants.

The Harvard Forest and the region immediately around it supply an abundance of materials with which to develop this theme. Most of the time of the Conference was spent in the field, where problems could be seen as well as discussed. Guests representing various disciplines came at times during the Conference.



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### SEMINAR ON LAND USE AND CONSERVATION

The staff of the Harvard Forest has a steadily increasing role in the work of this Seminar, which was described in my report for 1956-57. Likewise the Forest itself, and its research program, are continuing to serve as a base for initial orientation of the Seminar participants. Thus, early in their Harvard experience these men come into contact with actual problems on the land and begin to see relationships between theory and practice as applied to a specific landscape. They become aware of some of the frontiers of knowledge in both the natural and social sciences, limits of knowledge within which they must work in their own areas of activity. At the same time they see something of the points of view and methods used by people who are attempting to advance the frontiers, and are encouraged to try their hands along these lines.

The Seminar group in the autumn of 1957 consisted of eleven men, all of them from the public services. Two were from the Agricultural Extension Service (Maryland and Kentucky); two came from the Soil Conservation Service (Tennessee and Oregon); two were from the U.S. Forest Service (Alabama and Arizona); one each came from the Bureau of Land Management (Washington, D.C.), the Water Resources Branch of the U.S. Geological Survey (Oklahoma), a state forestry organization (Utah), and a state university (Montana). The eleventh was a Conservator of Forests in the British service, from Kenya, East Africa, in America for a year on a Commonwealth Fellowship.

This group came to the Forest on September 8, in the charge of Dr. Ayers Brinser. The ensuing two weeks were devoted by Dr. Brinser and the staff of the Forest to a series of discussions, demonstrations, and field trips in the Forest and in northern and western New England.

### OTHER VISITING GROUPS

Eight other groups of visitors came to the Forest for discussion and demonstration during the year. The annual Field Day for the



## BOTANICAL ACTIVITIES

Friends of the Harvard Forest was held on September 7, with 56 persons present. On the week end of October 26-27, sixteen natural science teachers were at the Forest. They were from the Harvard Graduate School of Education where they were studying for a year under National Science Foundation grants. Twenty woodland management foresters of the Soil Conservation Service held their annual "work shop" meeting at the Forest for four days early in November. These men represented all the major regional units of the Service throughout the United States. A week end in mid-December was devoted to a class of students from the University's Department of Government. The course involved deals with public policies for the conservation of natural resources, and is in the charge of Professor Arthur A. Maass. In January a group of geographers came from the Environmental Protection Division of the U.S. Quartermaster Research and Development Command. They were here for a day of discussion given over to arctic environments, with particular reference to northeastern Greenland where I had done some field work. The Harvard Board of Overseers' Committee to Visit the Harvard Forest came on April 21 to receive a report on the status of the institution and its activities. They were given a brief field trip in our coniferous plantations, largely as a basis for discussion of some of the economic problems that arise when intensive forest management is attempted. In May some forty students of forestry from the University of the State of New York were at the Forest. They came in two groups, each of which was here for a night and a day. Early in June twenty-nine similar students came from the University of Maine Forestry School.

The above list is not a complete one, but it contains the major groups of visitors to which the staff of the Forest has devoted time. Together with our activities in the Conferences on Forest Production and in the Land-use Seminars, I believe it indicates a trend of development in the use of the institution which has great promise.

## HARVARD BLACK ROCK FOREST

The Harvard Black Rock Forest is owned and administered by a separate educational corporation in New York State. It is supported by funds held in trust for the purpose by the President and Fellows of Harvard College. Locally it is managed by Mr. Benjamin B. Stout, Resident Supervisor.

### WOODS OPERATIONS

The principal cutting operation of the year was in Compartment III, on the north slopes of the Forest area. This cutting (No. 57a) was completed, and consisted of the removal of all trees larger than 2.5 inches d.b.h. on an area of about eight acres. Examination of the land in 1957 showed that a good crop of oak seedlings one to three years old was present, while the older trees of the stand were of relatively poor quality. It was decided to make the area into a regeneration experiment, and the operation was designed to test whether the abundant seedlings would survive and grow under the cover provided by the undergrowth of shrubs and small trees left standing. The cutting during the year yielded about 320 cords of wood, which were sold to a New York buyer.

Road work, other than routine maintenance, was confined to the completion of a road connecting the central part of the Forest directly with the north boundary. This was done by the reconstruction of an old roadway originally built in Revolutionary times, but long since fallen into disrepair. The new road will greatly facilitate our use of a large section of the better sites on the north slopes of the Forest.

### ICE STORMS

In my report for last year, I mentioned a heavy ice storm that occurred in December of 1956, and included some remarks on the probable significance of these storms to the management of forests in this region. The winter of 1957-58 brought three more such storms, all of them of equal or greater severity. They were heavy

## BOTANICAL ACTIVITIES

enough to uproot many trees, and to tear away varying amounts of the crowns of many more. These events have emphasized the remarks I made on their importance last year, and it is evident that they must be given large consideration in any plan for the long-term management of the woodlands of the region. The damage done by the ice is currently being studied in detail for the light it may throw upon management problems.

### RESEARCH

An irrigation study begun by Mr. Stout in the summer of 1956 has been continued to the present, and will be carried at least through the growing season of 1958. The experiment was designed to test the effectiveness of an adequate water supply given to areas in a thinned stand of hardwoods that had had varying treatments for the removal of underbrush. It was thought this might throw some light on the efficiency of management techniques that did or did not affect the abundant undergrowth which is characteristic of our forests. The first measurements of growth response to the irrigation were made after the growing season of 1957. Although some positive results have begun to emerge, at least one more season will be necessary to determine their validity.

A major problem in the management of hardwood trees for the production of high quality sawtimber is the control of epicormic branching. When a closed stand of trees is opened by a thinning operation, the clean stems of the potential crop trees that are left commonly develop new branches which mar the quality of the resulting logs. It is common observation that some of the trees in a stand produce these branches while others do not, but the cause of the difference is uncertain. It is thought that the size and condition of the crowns of the trees at the time of thinning may be significant. To test this theory, Mr. Stout has initiated some "pruning" experiments, wherein the crowns of a group of trees have been variously mistreated to see whether epicormic branching can be produced.

A research project on the local climates of the Black Rock Forest was completed by Dr. Philip Ross in the summer of 1957. The



## HARVARD BLACK ROCK FOREST

resulting paper constituted Dr. Ross' thesis for the doctorate in biology at Harvard, and is now in press. It will be published as *Black Rock Forest Paper No. 24*, and was prepared with the joint support of the Forest and the Quartermaster Research and Development Command of the U.S. Army.

### TOWN AND FOREST RELATIONS

The Black Rock Forest area contains five ponds, four of which are small reservoirs formed by the damming of small streams. Three of the reservoirs are so placed that their contents drain into the water supply of the neighboring town of Cornwall. The dams were built by Dr. E. G. Stillman, the former owner of the Forest, and the reservoirs have become an important part of the town's supply. Dr. Stillman, in effect, gave the water to the town, and we have continued to do so since we acquired the Forest in 1950. About six years ago the village of Cornwall-on-Hudson, which is a part of the town and has controlled the distribution of water, petitioned the Harvard Black Rock Forest with a view to acquiring title to the reservoirs and to rights of way for their drainage and pipelines. We countered this proposal with one involving a 99-year lease that would accomplish the essential purposes that the village authorities had in mind, and would leave the Forest with a measure of control over access lands and the forests growing on them. It would also release the Forest from responsibility for maintenance of the dams and for the policing of the reservoirs. Our proposal was immediately accepted in principle, but negotiations have been slow and complex. The lease was finally agreed upon in June, 1958.

HUGH M. RAUP  
*Director*

## *Harvard Forest and Harvard Black Rock Forest*

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*To the Dean of the Faculty of Arts and Sciences:*

*Sir,*—The following is a report on the Harvard Forest and the Harvard Black Rock Forest for the year ending June 30, 1959.

### HARVARD FOREST

#### STAFF

With one exception, the staff of the Harvard Forest remained unchanged during the year. Dr. Ernest M. Gould, Jr., continued as Forest Economist and Dr. John C. Goodlett as Forest Geographer. Mr. Karl W. Woodward, Jr., Research Associate, resigned his position as of June 1, 1959. His principal function was the general management of the woods operations and the maintenance of the record system which is essential to the Forest's long-term research program. He was immediately replaced in this capacity by Mr. Jack J. Karnig. Mr. Karnig's appointment is a joint one with the Harvard Black Rock Forest, and I shall have more to say about it in my report on that institution. Mr. Charles F. Upham has continued as woods superintendent, Miss Elizabeth Carpenter as business secretary and librarian, and Mrs. Marion S. Hambleton as part-time secretary to the Forest and part-time assistant to the Director.

#### WOODS OPERATIONS

The partial harvest and improvement cuttings begun in preceding years in Compartments III, IV, and V of the Tom Swamp Tract and in Compartment II of the Prospect Hill Tract were completed during the year. These operations covered, in all,

## BOTANICAL ACTIVITIES

about 21.5 acres. A similar operation was begun on about 9.5 acres in Compartment IV of the Prospect Hill Tract, while another, begun in a preceding year on about 6 acres in Compartment VI of the Tom Swamp Tract, was continued. Salvage of trees damaged by the fire of May 1, 1957 was completed on 11 acres in Compartments III and IV of the Prospect Hill Tract. An experimental cutting, involving a partial harvest to encourage the establishment of hemlock reproduction, was begun on 7 acres in Compartment IV of the Prospect Hill Tract. Crop trees in a small plantation of white spruce in Compartment I of the Prospect Hill Tract were pruned to 16.5 feet. This plantation, 1.5 acres in extent, was established in 1924. The pruning is in preparation for an experimental thinning.

The winter of 1958-59 produced an unusual amount of very cold weather that not only increased fuelwood consumption in our furnaces by about 20 percent, but also made outdoor work difficult. Nevertheless, our production of cordwood was increased by more than enough to take care of the additional need. A total of 56.6 acres were covered in the year's operations. They yielded about 12,900 board feet of sawlogs and about 377 cords of fuelwood. During the year about 21,500 board feet of lumber and approximately 316 cords of fuelwood were sold. Inventory on hand at the end of June 1959 included 28,500 board feet of lumber at the mill, and 231 cords of wood.

## RESEARCH

The long-term management research of the Forest continues to be maintained. Time, and records of the behavior of specific areas of forest over time, are of the essence in this research. The "clinical" knowledge and experience derived from such work are badly needed in American forestry as a practical guide in lieu of more fundamental knowledge of silvics which will no doubt be a long time in coming.

In line with our effort to bring our management experiments up to date, we have devoted considerable time during the year,



## HARVARD FOREST

notably during the summer seasons, to the reexamination and measurement of growth in coniferous plantations. The Forest has about 130 of these plantations, involving several species, planted singly or in mixtures, over the period between 1910 and 1938. They exhibit a wide range of variation in relative success so far as growth and form are concerned, and we have a mass of data from which we are beginning to derive estimates of their economic feasibility. All of them are of course relatively young, so that at best any studies we make of them can result only in reports of progress, or in partial solutions to the many problems that continually arise in them. Nevertheless, the results we have are in many cases salutary.

Dr. Goodlett continued his work during the summer of 1958 on the mapping of New England forest trees. During the ensuing winter he devoted considerable time to study of the relationships between the distribution of forests in Potter County, Pennsylvania, and distribution of soils as recently mapped in that county by the Bureau of the Soil Survey of the U. S. Department of Agriculture. He had done a great deal of field work there some years ago and had accumulated specific information on the distribution of the trees. From this study will come a much-needed critical review of the problem of map unit definition for use in the mapping of forest soils—a problem that troubles the Bureau of the Soil Survey continually. In the summer of 1958 Dr. Goodlett collaborated with Dr. Margaret S. Davis in a study of the relation between existing forest vegetation and the deposit of tree pollen in lake sediments. Dr. Davis is a well-known and skillful student of fossil pollens, and the question arises as to how well a given pollen-bearing stratum in a lake bed represents the vegetation in the vicinity at the time the stratum was deposited. During the winter Dr. Davis did the pollen analytical work connected with the study, and in the spring of 1959 a paper was prepared under their joint authorship. In December of 1958 Dr. Goodlett spent a week in Death Valley, California, where he served as botanical consultant to the U. S. Geological Survey.

## BOTANICAL ACTIVITIES

Dr. Gould has continued the work on the Pilot Woodland Management Program in New Hampshire that I have described in previous annual reports. He has analyzed the operations made by the 50 cooperators during the last three years. In this time they have cut over 1000 cords of fuel and pulpwood, and nearly one million four hundred thousand board feet of lumber. Dr. Gould also continued his Federal Reserve Bank Study of the factors that motivate the owners of small forest tracts to operate their lands. The analyses connected with this study are completed, and the final report is in preparation. In July of 1958 he traveled with Dr. Ayers Brinser, Director of the Seminar on Land Use and Conservation, to Western Montana, to the lands of the U. S. Forest and Park Services. There they began work on a problem of resource management along the North Fork of the Flathead River. It is expected that this study will develop into a research program for the Seminar, and the government agencies concerned are gathering data for it in accordance with the plans made during the summer trip.

Study of the operations of the Harvard Forest, both present and past, together with the investigation of records on many private forest ownerships, emphasizes the importance of risks and uncertainties in the formulation of forest management theory and policy. Too much of forest management policy in America has been designed without due consideration being given these imponderables. Dr. Gould devoted a great deal of time during the year to the devising of methods of analysis that will be useful to managers in reaching decisions about the use and development of the forest and allied resources under such difficult circumstances. As a part of his studies along this line he has made an unusually stimulating analysis of the economic history of the Harvard Forest, considering it merely as a privately owned "woodlot" managed as an investment in wood production for profit.

The collaborative experiment with the U. S. Forest Service on the control of *Fomes annosus*, a disease of the red pine, has con-

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tinued throughout the year. Regular reports of progress are supplied to the Forest twice a year on this work. Experiments on the control of the white pine weevil were finished during the current year, but no final report has yet been received on it from the Forest Service.

### CONFERENCE ON FOREST PRODUCTION

Fifteen professional foresters attended the Conference on Forest Production held at Petersham October 5-17, 1958. They represented the wood-using industries, state and federal public services, and private consulting firms. They came from regions extending from Maine to Georgia and from as far west as Arizona. The membership of the Conference was oversubscribed in 1958 and it was necessary to turn some applicants away. We feel that the discussions cannot be fully effective if there are more than about fifteen men in the group. As in the conference of 1957, the theme this year was oriented to the problem of investment analysis as applied to the forest resource. In the 1958 discussion we emphasized the problem of investment as it appears in small forest holdings rather than large ones. This is particularly apropos because of the current wide interest in the management and economics of small woodlots.

### SEMINAR ON LAND USE AND CONSERVATION

The staff of the Forest continued its collaboration with the Graduate School of Public Administration in the Seminar on Land Use and Conservation. This seminar is the core of a training program in the management of renewable resources, which I have described in some detail in previous annual reports.

Several schools and colleges throughout the country are now engaged in resource training programs, and the rationales and methodologies used in them are being discussed widely. In November of 1958 the Conservation Foundation of New York sponsored a general symposium on the subject at the University



## BOTANICAL ACTIVITIES

of California in Berkeley. Dr. Ayers Brinser and I attended this symposium, together with representatives from Yale and several of the state universities. Later in the year, in April of 1959, members of the Committee on Education of the Soil Conservation Society of America who were present at the Berkeley sessions met at the Harvard Forest to summarize the results of those sessions. All of these meetings and discussions have made it clear that our present system of training for the management of renewable natural resources leaves much to be desired. Any training program of this nature, if it is to be effective, must be interdisciplinary. This produces intellectual and administrative hazards that probably can best be overcome by experiment and compromise among people working in the universities and those working with practical problems on the land. There must, however, be some kind of rationale or working theory as a current test of validity. For many years this was a concept of "conservation," the reassessment and alteration of which is a major concern of the Harvard Seminar.

Harvard's Seminar on Land Use and Conservation has been financed for several years by generous grants from Resources for the Future of Washington, D.C. In the spring of 1959 an additional grant was made to continue the program for the year 1959-60.

## OTHER VISITING GROUPS

In addition to the groups previously mentioned, the Forest was used by many others during the year for training and research of various kinds. Forestry schools that sent their students here were the University of the State of New York, the University of Maine, the University of Massachusetts, and Yale University. The largest numbers came from New York (about 40 students) and Maine (30 students). Late in the spring of 1959 all of the county foresters of the Forest Extension Service of New Hampshire came here for a meeting. A development of recent years that has brought a new class of visitors to the Forest has

## HARVARD BLACK ROCK FOREST

been the institution of the National Science Foundation's teacher training programs at various schools. Groups of these teachers have come from three schools to date: the University of Rhode Island, the Harvard Graduate School of Education, and the Hatheway School operated by the Massachusetts Audubon Society.

## HARVARD BLACK ROCK FOREST

The Harvard Black Rock Forest is owned and administered by a separate educational corporation in New York State. It is supported by funds held in trust for the purpose by the President and Fellows of Harvard College. Locally, it has been managed by Mr. Benjamin B. Stout, Resident Supervisor.

### WOODS OPERATIONS

Cutting operations during the year took the form of experimental thinnings in Compartments III, IV, and XXIX. One of these, in Compartment IV (No. 56a), was a continuation of a thinning begun in 1956 and was completed in the summer of 1958. My reports of the past two years have mentioned the importance of damage to forests in this region resulting from snow and ice storms. Also I have noted that we have been experimenting with considerably heavier thinnings in hardwood stands than are common in this country. Thus far the increased damage from ice and snow expected in the heavier thinnings has not been great, but we have felt that further experiment along this line is in order. Part of the thinnings of 1958-59 were therefore designed with this in mind. Compartment XXIX is in the upland part of the Forest where ice damage is relatively great when storms occur, while Compartment III is on the lower north slope where it is relatively small. Two of the thinnings (Nos. 58b, 58c) were paired in these two compartments. They are of approximately the same age and density, and both are younger than other stands in which heavy thinnings have been made. Their

## BOTANICAL ACTIVITIES

behavior in subsequent storms may give some indication of the effect of altitude upon the extent of ice and snow damage in these forests.

Road work during the year was limited to routine maintenance. The road net of the Forest is in good condition, and continues to be a source of great satisfaction to us in the management of the property.

## STAFF

The resignation of Mr. Benjamin B. Stout, finally effective May 31, 1959, required that a replacement be found for him, and Mr. Jack J. Karnig took up his duties as Forest Manager on June 1. Mr. Stout had been resident manager and supervisor at the Black Rock Forest from the time it was first acquired by the University early in 1950, and was unusually effective in this post. He took a teaching position at the State University of New Jersey at Rutgers in February, 1959, but continued to manage the Forest on a part-time basis until the end of May.

Several circumstances appeared to make the spring of 1959 suitable for a general review of the research program of the Harvard Black Rock Forest, the woodland management problems of both this forest and the Harvard Forest at Petersham, and the interrelation of the two Forests in both research and woodland management. At this time the resignation of Mr. Woodward at the Harvard Forest was imminent, so that his function as woods manager there would have to be taken care of also. Furthermore, the management and research activities of Mr. Stout at Black Rock during his tenure had produced visible results many of which had a certain "completeness" and could be appraised in some perspective.

The road net, good as it was when we acquired the Black Rock Forest, did not serve adequately the better hardwood sites on the north slopes of the tract. Mr. Stout has corrected this situation by new construction and the judicious renovation of old roads. The "heart" of any good experimental forest is an ade-



## HARVARD BLACK ROCK FOREST

quate, usable record system. The one in use at Black Rock when we acquired it was based on that of the Harvard Forest of about 1928, when the Black Rock Forest was established. In 1947-48 the Harvard Forest system was completely renovated, and one of Mr. Stout's first tasks at Black Rock was a similar renovation of its records. This was done within a year or so after he went there, and has been working smoothly ever since. All of the long-term experiments in management begun between 1928 and 1950 have been relocated and remeasured. In addition to these "housekeeping" activities, new research has been initiated. In long-term management experiments this has taken the form of heavy thinnings and reproduction cuttings. In short-term research there have been Mr. Stout's notable studies on the root systems of hardwood trees, and later his work on cultural treatments of the understory in hardwood stands through irrigation studies. These short-term research projects are completed, and the results published or in press. The long-term experiments are on such a large scale, and involve so great a variety of stands and sites, that we can with propriety reduce the number of such experiments to be put in during the next few years, and merely watch results accumulate.

Taking all of the above developments into consideration, I believe that we can properly turn our management and research program at the Black Rock Forest into new directions. In doing this I believe we should have as a major purpose a closer liaison between the Forests at Petersham and Cornwall. In the area of woodland management our experience shows that the overseeing of woods operations and the maintenance of records is not a full-time job in either Forest. Therefore, in the employment of Mr. Karnig on June 1, 1959, I made him Forest Manager of both Forests. He will live at Cornwall, New York, and spend several days in each month at the Harvard Forest in Petersham. The arrangement of our record and other facilities at Petersham, and the general efficiency of our operating crew there make this possible. During the past few years our operations at Black Rock

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have been carried on mainly by our own woods crew, though in part by the sale of marked stumpage to a contractor. We propose to eliminate most of our own operations and increase to some extent the sale of marked stumpage. This will effect a notable saving of expense. From this saving, and by combining the woods management of the two Forests in one individual, we will have resources for a new research position. We propose to fill this position by the appointment of someone who will utilize the research facilities of both Forests.

HUGH M. RAUP  
*Director*

## *Harvard Forest and Harvard Black Rock Forest*

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*To the Dean of the Faculty of Arts and Sciences:*

Sir, — The following is a report on the Harvard Forest and the Harvard Black Rock Forest for the year ending June 30, 1960.

### HARVARD FOREST

#### STAFF

Dr. Ernest M. Gould, Jr. has continued to serve as Forest Economist at the Harvard Forest, and Mr. Jack J. Karnig as Forest Manager for both the Harvard and the Harvard Black Rock Forests. The appointment of Mr. Karnig as manager at the two forests on June 1, 1959, was discussed in my report of last year, and has proved highly satisfactory. Dr. John C. Goodlett resigned his position here in September, 1959, and took a post as Associate Professor of Plant Geography at Johns Hopkins University. Mr. Walter H. Lyford was appointed Soil Scientist at the Harvard Forest and took up this position on June 1, 1960. In my report on the year ending June 30, 1959, under heading of Staff at the Harvard Black Rock Forest, I discussed budgetary rearrangements at both the Harvard and the Black Rock Forests which made possible a new joint research appointment involving the two institutions. In accordance with this arrangement, Mr. William F. Murison was appointed Forest Biologist, effective November 1, 1959. Mr. Charles F. Upham has continued as Woods Superintendent, Miss Elizabeth Carpenter as Business Secretary and Librarian, and Mrs. Marion S. Hambleton as part-time secretary and part-time assistant to the Director. Beginning



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on January 1, 1960, Mrs. Hambleton became a full-time secretary at the Forest.

Funds for the support of the Seminar on Land Use and Conservation, which has been carried on jointly with the Graduate School of Public Administration, were lodged in the Harvard Forest for the year 1959-60. Dr. Ayers Brinser, Director of the Seminar, accordingly became a member of the Harvard Forest staff as Lecturer on Natural Resource Management and Development.

## CHARLES BULLARD PROFESSORSHIP OF FORESTRY

During the year a bequest of approximately three quarters of a million dollars, to be used for the development of the theory and practice of forestry, came to the University under the will of Katherine E. Bullard. The President and Fellows divided this bequest into two approximately equal parts. With one of these they established a new chair of forestry in the Faculty of Arts and Sciences. This was designated the Charles Bullard Professorship, and I was appointed its first incumbent. The other half of the bequest was set up as the Charles Bullard Fund for Forestry Research, the income from which is to be used for investigations in this field. The fund is to be administered by an inter-faculty committee drawn from those parts of the University whose interests impinge upon forestry.

The establishment of the Bullard Professorship is something of a landmark in forestry at Harvard. For the first time this field is formally represented by a full professorship in the faculty. It is also notable that the field is now established within the Faculty of Arts and Sciences rather than in a unit of professional education. This is well within the tradition of the Forest's relationship to the University established many years ago by its first director, Richard T. Fisher.

## RESEARCH AND PUBLICATIONS

The long-term management research in the manipulation of forest stands continued throughout the year under the super-

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vision of the staff as a whole. In particular, the remeasurement and reassessment of coniferous plantations was pursued vigorously. Most of the field work and computation of results was carried on by student assistants in the summers.

Dr. Gould's work on the Pilot Woodland Management Program in New Hampshire was continued, as was also his research on forest landowner motivation. In addition, he prepared for publication his paper on *Fifty Years of Management at the Harvard Forest* which went to press in the spring of 1960. This paper deals with the economic history of the Forest. Another paper reviewing the research at the Forest during the past fifty years, prepared by Dr. Goodlett, came off the press in the late spring of 1960. This paper, published as "Bulletin 28," is on *The Development of Site Concepts at the Harvard Forest and Their Impact upon Management Policy*. These two publications will serve as a summary and evaluation of much of the Forest's research during the first half century of its existence.

Experiments in the control of *Fomes annosus*, which causes mortality in our red pine plantations, were continued during the year. These experiments are done in collaboration with the U. S. Forest Service.

The Forest continues to profit greatly from the presence here of the Cabot Foundation's research in tree physiology. This research is in the hands of Dr. Martin H. Zimmermann, who lives at the Forest and utilizes its laboratory and field facilities. Because of the excellence and pioneering quality of Dr. Zimmermann's work, the Cabot Foundation and the Harvard Forest are becoming widely known as centers for research in the physiology of trees.

## CONFERENCE ON FOREST PRODUCTION

The Harvard Conference on Forest Production, held at Petersham October 11-23, 1959, was oversubscribed. Fifteen practicing foresters, representing the principal phases of the profession, were in attendance. As in past years, the Conference was devoted to the discussion of fundamental problems rather than

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techniques. The principal theme of the discussions was concerned with the economic aspects of silviculture and forest management.

### SEMINAR ON LAND USE AND CONSERVATION

The Harvard Forest was used in the autumn of 1959 as a base for preliminary field work and orientation for the Seminar on Land Use and Conservation, under the directorship of Dr. Ayers Brinser. Dr. Gould and I attended the sessions of the Seminar at the Graduate School of Public Administration in Cambridge throughout the year. Funds for the Seminar were derived from a generous grant made by Resources for the Future.

### OTHER VISITORS

Several schools used the Harvard Forest for demonstrations to their students during the year: Clark University, and the Universities of Maine, Massachusetts, Connecticut, and the State of New York. Other groups visiting the Forest for discussion and demonstration were the County Foresters of New Hampshire and New Jersey, and secondary school teachers in the National Science Foundation training programs at the University of Rhode Island, Harvard, and the Massachusetts Audubon Society. In all, approximately 300 students and practicing foresters made use of the Forest's facilities during the year. The Museum of Forestry attached to our institution at Petersham was visited also by many from the general public. The total number of these visitors to the museum is uncertain, but about 1,000 persons signed the guest book there.

### WOODS OPERATIONS AND BUILDING IMPROVEMENTS

Operations of various kinds were performed on 52.8 acres of the Forest's land during the year. Thinning and pruning were done in two plantations of white spruce in Compartment I of the Prospect Hill Tract, on a total of 1.9 acres. Both of these plantations were established in 1924, and the operations were



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designed to compare the results of infrequent heavy thinnings, more frequent light thinnings, and no intermediate thinning treatments. Fire salvage on 6.4 acres in Compartment III, Prospect Hill, finally completed the clean-up necessitated by the fire of May 1, 1957. Improvement and partial harvest cuttings were made on 16.5 acres in Compartment IV, Prospect Hill, on 10 acres in Compartment V of that tract, on 6 acres in Compartment VI, Tom Swamp Tract, and on 12 acres in Compartment III, Tom Swamp.

About 1,000 feet of road across the swamp in Compartments II and IV, Prospect Hill, were rebuilt, and about 1,400 feet of new road were constructed in Prospect Hill V. These roads will greatly facilitate future work in parts of the Prospect Hill Tract that hitherto have been inaccessible.

Inventory on hand at the beginning of the year amounted to about 231 cords of fuelwood and 28,536 board feet of sawn lumber. The year's operations produced about 266 cords of fuelwood and 19,896 feet of lumber. Sales for the year totaled 303 cords and 18,404 board feet.

Some notable improvements in our main buildings were accomplished in the spring and summer of 1960. Recent changes in fire regulations imposed by the Commonwealth of Massachusetts necessitated an emergency exit from the balcony of the Fisher Museum and a new door opening at the southern end of the first floor of Shaler Hall. The latter has made a valuable improvement, especially in view of the steadily increasing research activity in the laboratories in the south end of the building. The heating system in Shaler Hall has never been adequate. It is a steam system with the boiler located in the north end of the building, so that to get any heat at all into the distant south end a considerable amount of pressure is required. Maintenance of this pressure is unduly expensive, and is unnecessary for the heating of most other parts of the building. We have now installed equipment which converts the system in the entire south wing to circulating hot water, using the same boiler as a source of heat. A similar change has been made for the kitchen and housekeeper's

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apartment at the back of the north wing, an area that has also been poorly supplied in the past.

### HARVARD BLACK ROCK FOREST

The Harvard Black Rock Forest is owned and administered by a separate educational corporation in New York State. It is supported by funds held in trust for the purpose by the President and Fellows of Harvard College. Locally, it has been managed by Mr. Jack J. Karnig, Forest Manager.

Operations at the Black Rock Forest continued throughout the year under the supervision of Mr. Jack J. Karnig. Numerous visitors from forestry schools, the forestry profession, and from the general public, availed themselves of the opportunity to see the results of our research program. Harvard Forest personnel went to Cornwall on several occasions to assist in research and planning.

Our woodlands at Black Rock are composed mainly of hardwoods, among which several species of oak are the most prominent. All of these hardwood trees, when cut, sprout vigorously from the stumps, producing stems of poor form and usually of low timber quality. The general improvement of the hardwood stands, therefore, depends for its success upon the suppression or control of sprouts in favor of young seedling stems. The problem of how to accomplish this effectively and at reasonable cost is engaging the attention of foresters throughout much of the hardwood region of the country. Several experiments on it have been undertaken at both the Harvard and the Black Rock Forests during the past ten years, and during the past year Mr. Karnig has begun two more. He has established a series of permanent sample plots in Compartment IV for testing a foliage spray in which the effective chemical is 2-4-5-T. Another experiment involves the use of ammonium thiocyanate, a recently developed herbicide. Enough sample plots for a test of this herbicide were laid out in Compartment VIII, trying a wide range of applications and using the material in both liquid and crystal form.

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Woods operations during the year included the cutting of both cordwood and sawtimber. The cordwood (83 cords) came from a thinning on 9.5 acres in Compartment IV. Thirty-six thousand board feet of oak sawtimber were removed from Compartment III on the lower north slopes of the Forest. This was an improvement and partial harvest cutting in one of the older stands. All of these operations were performed on a contract basis. The sawtimber and about 110 cords of wood have been sold, leaving an inventory on July 1 of approximately 60 cords. During the spring and summer months extensive repairs and improvements were made on about two thirds of the Forest's roads.

In the spring of 1960 final arrangements were made whereby the Village of Highland Falls leased the land and water of Jims Pond as a part of its municipal water supply. This pond is on the southerly slopes of the Forest, and has been used by the Village for many years under an informal agreement. The lease is similar to one made in 1958 to formalize the use of water from the northerly slopes by the Village of Cornwall-on-Hudson.

HUGH M. RAUP  
*Director*