HARVARD FOREST

MEMORANDUM

Date 19

To PRG

From WS

Subject .....

Would appreciate your suggestions on this. One thing needs clarifying: I don't propose to add 4 men in the depts at Cambridge - but 2: one in Economics - Bus Law, one in Industrial & Public Admin'n

(1)

WS

Confidential-
not for release

Petersham, Mass.
25 June 1936

PLANS FOR DEVELOPING THE HARVARD FOREST
AND THE HARVARD FOREST SCHOOL

Forestry instruction at Harvard.

The following statement of plans is tentative and is subject to the formal approval of the President and the Corporation of Harvard University. These plans have, however, been discussed with the President and other officials and may be regarded as pointing the way to future developments, contingent on adequate financing. The strengthening of the school does not mean the creation of a large self-contained institution, but rather in part an increasingly effective use of the Harvard Forest and in part the strengthening of other departments of the University, such as economics, business administration, etc., in order to develop the forestry phases of their work.

ENDOWMENT

The carrying out of these plans, in whole or in part, will require considerable additional endowment. The University is already promised a sufficient sum to construct a new school plant at Petersham together with a museum in memory of Richard Thornton Fisher, which will house the models described in the enclosed pamphlet as well as numerous other collections.

THE HARVARD FOREST

The Harvard Forest has been under continuous sustained yield management for about 30 years. Its total area of twenty-two hundred acres contains a wide diversity of forest types, representing the transition from convergence of the northern pine-spruce-hemlock forest with the central hardwood forest. The rich diversity of silvicultural experimentation has already contributed greatly to the progress of

forestry, not only in the Northeast but in other parts of the country, and forms an ideal field laboratory in silviculture and allied subjects.

Because of lack of funds in the past, a great deal remains to be done to bring the Forest up to the highest condition of administration and silvicultural condition.

A complete re-inventory of the whole forest, accurately showing the amount of merchantable timber and growing stock, the silvicultural condition of the 500 stands that compose the Forest, and the silvicultural treatment required for each, is urgently needed. A small start will be made this summer toward this re-inventory.

At the same time, considerable headway will be made in re-measuring and recording the numerous sample plots and experimental areas, which to be effective must be continuously up to date. In connection with this work, the detailed records both of sample plots and of extensive silvicultural treatments through the harvesting of timber must be made current in order that none of the scientific usefulness of the total silvicultural management of the Forest may be lost.

No complete and accurate transit survey of the Forest boundary and the compartment boundaries has ever been made. Such a survey is needed in order to give an accurate areal control to silvicultural operations. In connection with this survey, the forest boundaries and the compartment boundaries must be permanently marked with suitable monuments and all the principal silvicultural treatments should have explanatory signs for the guidance of visitors.

An essential element for the management of such a forest is a system of permanent woods roads, trails, and fire breaks, and an integral plan for the development of such a system is to be undertaken in the near future. This work, requiring a considerable capital

investment, must necessarily be spread over a period of years.

Based on the forest re-inventory, it is proposed to give extensive silvicultural treatment as rapidly as possible to the entire forest. Hitherto the emphasis has been placed on harvesting mature timber, and extensive areas of the forest containing intermediate age classes have received little or no silvicultural treatment. Both for the future productivity of the Forest as a whole and for its highest scientific usefulness all stands of whatever age must receive continuously the silvicultural treatments which they require. This work will require the development of new and larger markets, especially for cordwood.

HARVARD FOREST ADDITIONAL PERSONNEL

As a minimum there must be added to the Harvard Forest staff one technical forester, two clerks, and four permanent woods workers. Considerable additional logging, fire protection, and roadbuilding equipment is needed as well as a small electrically-driven sawmill.

THE HARVARD FOREST SCHOOL

Principally on account of the small staff, inadequate buildings, equipment, and library, and insufficient publication of results of experimental work, the Harvard Forest School was ranked thirteenth in the rating of forest schools recently made by the Society of American Foresters. It is significant, however, that in rating the schools according to the rank and distinction of alumni, Harvard stood alone with The Yale Forest School with a rating of 100%. This rating is attributable in part to the genius of Professor Fisher as a teacher, and in part to the fact that the Harvard Forest School is unique in teaching the science and art of forestry largely in the woods instead of in the classroom. This unique quality of education

must be preserved, not only in the biological phases of forestry which will continue to be taught largely at Petersham, but also in the economic and business phases.

FOREST BIOLOGY

This work, as in the past, will be concentrated largely in Petersham, though considerable work will also be done in the biological laboratories at Cambridge. An immediate need is to place on a permanent basis the important work in soil nutrition and plant nutrition conducted here by Dr. Gast.

EXTENSION WORK

Intermediate between biology and economics is the field of extension, which is inadequately developed at the Harvard Forest. Though the Forest annually has some 300 visitors, they are mostly foresters. This educational function of the Forest should be continued and strengthened. There is, however, a large and undeveloped field of demonstration to public officials and other leaders in connection with the development of the forest and soil conservation programs. The agricultural extension and conservation programs, have, for example, given entirely insufficient emphasis to the role of forestry in agricultural reconstruction, and the Harvard Forest has already taken steps looking to the inclusion of farm woodland improvement for benefit payments under the new Soil Conservation and Domestic Allotment Act. It is proposed to organize visits to the Forest by prominent public officials and agricultural experts in these fields.

The forest extension work of the Dept. of Agriculture is inadequate both in number of personnel and in the methods of educational work used. There is usually only one extension forester to a state,

and county agents as a whole are untrained in forestry. With the shortage of personnel, the methods used are perforce rather generalized propaganda. To be most effective, extension work must be directed to the formation of local forest marketing and silvicultural associations composed of forest owners and with a resident forester in charge of each. It is proposed to appoint an extension forester experienced in this type of extension at the Harvard Forest to develop a cooperative association and to use this cooperative for the training of extension workers in this new technique of extension.

FOREST ECONOMICS, LAW, AND BUSINESS AND PUBLIC ADMINISTRATION

The biological and extension work of the Harvard Forest School must be balanced by an equally realistic attack in the field of economics, legislation, business administration, and public administration. The science of forest economics is largely undeveloped in America in any realistic sense, being based on the classical and largely inapplicable forest economic theories developed in Europe during the past century. It is a just criticism by leaders of the forest industries that the forestry profession as a whole has little or no grasp of the complicated business, economic, and financial problems which confront those industries. The general adoption of good forest management by the forest industries is in considerable measure contingent on the solution of these economic-financial problems, and the forestry profession should be in a position to furnish expert guidance to the industries in these fields.

It is therefore proposed to attach to the Department of Economics of Harvard University an expert in the practical living problems of forest-industrial economics and to give advanced training to competent students by working on specific problems confronting the industries in various parts of the country. Such work would be largely field

work in immediate contact with the problem to be studied, a system which will preserve the method worked out at Petersham of dealing directly with problems on the ground instead of secondhand in the classroom. Such problems as forest credit, forest taxation and insurance, costs of sustained yield forestry, the formation of sustained yield management pools, lumber transportation rates, tariffs, and similar problems are indicative of the field.

The field of forest law, both European and American, needs thorough investigation, and should play an important part in advanced forestry education. It is therefore proposed to attach an expert in this field to the Harvard Law School, and to give advanced work in this field to selected students and also to men who are majoring in economics or public administration.

The forest industries are faced with the alternative of liquidation or of adopting permanent forest management. To aid toward the latter objective, it is desirable that men with a background of forestry training be given opportunities for advanced training in business administration. It is therefore proposed to attach to the Harvard Graduate School of Business Administration an expert in forest industrial management, in order to teach and do research in the field of forest industrial management, finance, and marketing problems.

Harvard University is about to establish an institute for the training of public officials. This training, as yet formulated only in general terms, will not be confined to the techniques of administration but will require also a broad training in the social sciences and in the broad philosophy of government. The administration of public forests and governmental cooperation with private forest owners is occupying a larger and larger part in the total forest conservation movement, and the training of leaders for such administration can no longer be safely entrusted to the purely practictioner level of

forestry education. There must be conscious advanced training for the whole field of public administration, with a broad background in the social sciences, in economics, government, and forest law. It is proposed to attach to the new institute an expert in the field of public forest administration.

OBJECTIVES OF THE HARVARD FOREST SCHOOL

With relatively few exceptions, the training of foresters in the United States is on the practitioner level and largely in the biological field. What might be called the political side of forestry, namely the ways to human action to assure the wide and rapid adoption of good silvicultural practices--is largely neglected, and the leaders who have emerged in these fields have done so largely accidentally and without a sufficient preparation in economics, business administration, legislation, social philosophy, and government. The rapid development of conservation that is now taking place and that seems certain to continue demands an even more realistic, arduous, and adequately equipped intellectual leadership. It is planned to use the Harvard Forest School exclusively for advanced training and not for training at the practitioner level.

It is not planned, as has been the case in the past, to confine ~~candidates to~~ students at the Harvard Forest School to graduates of forest schools. In the fields of economics, government, public administration, business administration, and law, it is desirable to choose men who have had a broad training in the fundamental subjects in their respective fields rather than in the biology of forestry, so that such men will be prepared to go deeply into the special phases of their subjects that are applicable to what has been defined above as the political aspects of the forest problem. Such men in the course of their advanced

training covering a period of from one to three years would be systematically given sufficient background of forest biology and silviculture to be at home on that side of their work.

Nor is it intended to select candidates exclusively from younger men. It is hoped through substantial fellowships to make it possible for mature men engaged in public, industrial, educational, or other forestry work to spend a period of advanced study in their field at the Harvard School.

These proposed changes in the entrance requirements will greatly broaden the range of choice of students and will insure the selection of men of outstanding personal and intellectual qualifications.

It is not expected that the Harvard Forest School will be developed into a large institution. The advanced training of some 5 or 10 men a year is contemplated. This should lead to the desirable result of giving the entire staff the opportunity for a lrge amount of advanced research in their fields.

Director

last 1½ yr. report Feb. 1936

FOREST PROTECTION

The forester's first consideration in the growing of a tree crop is its protection and security against destructive agencies throughout its life. Because of the extremely unstable conditions of the existing forest cover types, brought about through man's violent disruption of the balance in nature, the establishment of many artificial stands by planting, frequently of a single species or exotics, and the continued accidental introduction of foreign insect pests and diseases to which our native trees are especially susceptible, problems of forest protection are of ever increasing moment. Thus far in New England more money has been spent on insect and disease control measures than on all other phases of forestry combined.

Since the Forest staff does not include either a forest entomologist or a forest pathologist, it has been highly desirable to develop contacts with these specialists and insofar as possible to encourage the undertaking of cooperative studies of insects and fungi on the Forest itself. Singular success has thus far marked such relations.

Gypsy Moth Studies:

In 1936 the study of the distribution and feeding habits of the gypsy moth in the Town of Petersham, begun the previous year as a joint undertaking with the Division of Forest Insects, Bureau of Entomology and Plant Quarantine, was continued and enlarged. Results of the 1935 study, by W. L. Baker and A. C. Cline, were published during 1936, as well as a bulletin on "Silvicultural Control of the Gypsy Moth," by C. E. Behre, of the Northeastern

Forest Experiment Station, A. C. Cline, and W. L. Baker. The latter was published by the Massachusetts Forest and Park Association, making four different cooperating agencies in the project. It is fair to say that this work, which involved very largely a study of the feeding habits of the insect in relation to local forest cover types, and which was initiated by Cline in 1934, already has resulted in greatly increased interest and action in natural or silvicultural control measures, as contrasted with the costly direct methods of creosoting and spraying so commonly used for the past thirty years or more. For it was shown by the Petersham studies that heavy defoliation takes place only where certain highly favored food species, namely, gray birch, aspen and oak, comprise more than 50 percent of the stand; also that, since gray birch and aspen are weed species and much of the oak too coarse and crooked to make good crop trees, improvement cuttings and gypsy moth control cuttings might be advantageously combined and adequate protection afforded at little or no extra cost.

In order to follow more closely the feeding habits of the insect in varying mixtures of hardwoods containing both favored and unfavored food species, six sample plots were established in 1936 on Compartment I of the Tom Swamp Block. Here detailed records are being taken each year of the amount of defoliation by species. Since all six plots are within the same stand, but are so situated as to encompass the full range of differences in the relative proportions of the several species present, a much better knowledge of feeding habits and of control through altered composition eventually will be available.

In 1937 cooperative studies were further extended through the assignment of Dr. H. M. Bess of the Division of Forest Insects

to undertake the establishment of additional sample plots on the Harvard Forest for the purpose of intensive ecological studies of the gypsy moth over a period of at least ten year. The periodic natural rise and fall of local moth colonies, and the current rate of feeding and mortality, as influenced by weather conditions, parasitic and predacious insects, birds, bacteria, etc., will be followed by means of ground trays to catch the droppings (a measure of feeding rate) and dead caterpillars, self-recording meteorological instruments, counts of egg masses and hatches, and quantitative analyses of the effect of all organisms playing a part in the natural control of the insect. Four sample plots were established; two in oak stands on Tom Swamp, Compartment VII, and two in aspen on Tom Swamp, Compartment VIII. Special significance attaches to this project since it is believed that similar ecological studies must be made for all insect pests before any scientifically sound and economically practicable methods of control can be developed.

Partial analysis of the data collected during the feeding season of 1937 shows certain extremes of weather conditions to cause high mortality of the caterpillars. Parasitic insects also were much more effective than previously supposed, particularly in the pupal stage.

Decay Hazards in Hardwood Sprouts:

By virtue of repeated clear-cuttings and the ability of hardwoods to sprout vigorously, the present forests of central New England are more than ever before composed of trees originating as sprouts from stumps. There are tens of thousands of acres of hardwood coppice which will require some form of improvement cutting, if

anything better than cordwood is to be produced. While it has been known in a general way that stump sprouts are subject to decay and therefore risky to hold for a sawtimber rotation, until recently almost no working knowledge was available as to the action of the various wood-rotting fungi in relation to tree species, size of the parent stump, position of the sprouts on the stump, or to the cut stubs left in sprout clump thinning.

The Forest staff has been fully aware of the urgent need for studies of this subject, and in 1937 succeeded in interesting the Division of Forest Pathology of the Bureau of Plant Industry in the assignment of a member of its staff to work on decay hazards in the more important New England hardwoods. During the field season of 1937, Dr. W. A. Campbell in cooperation with A. C. Cline undertook the dissection and analysis of paper birch and white ash sprouts on the Harvard Forest and elsewhere in the region where stands suitable for study were available. Sample areas supporting sprout growth of several different ages were clear-cut, and the stems cross-sectioned and examined for the presence of decay organisms and their means of entrance. In the case of paper birch sufficient data were collected on which to base preliminary recommendations for sprout treatment. In general, decay hazards are much greater in this species than in oak or ash. Among other things it was discovered that the so-called "red heart" is not heart wood at all, but presumably is due to the action of some organism which alters the character of the wood, increasing its moisture content. For further light on this question a number of paper birches containing only white wood were inoculated with Torula sp., an organism suspected of being the cause of red heart.

These inoculated trees will be re-examined periodically to see if red heart develops in the vicinity of the inoculum.

The dissection of white ash sprouts showed this species to be highly resistant to decay. On the Tom Swamp Block, Compartment IV, it was possible to study a case offering the maximum chance for decay, namely, origin from very large stumps, and old age. In a 70-80-year-old stand, twenty-two ash sprout clumps were cut close to the ground and stumps and stems carefully examined. Although incipient decay or butt rot was present in 65 percent of the stems, which had entered chiefly through open wounds in the parent stump, it extended up the stem only three feet as an average.

The findings of this study will bring a modification of the former policy of limiting choice of ash crop trees in young stands of sprout origin to stems from stumps less than two to three inches in diameter. The safe use of selected stems from clumps arising frm larger stumps greatly increases the opportunity to develop good sawtimber stands on many cutover areas.

FOREST INFLUENCES

Although it is generally recognized that forest cover retards run-off and promotes more equable stream flow, there has been very little research done of such character as to permit evaluation of these influences in concrete terms for any given forest region or cover type. It is obvious that all forest types do not possess the same water-conserving powers; and, furthermore, even within a given cover type such factors as the density and age of the trees unquestionably influence the disposition of the water received as predipitation. The interrelations of climate, soil and vegetative

cover in the light of run-off and flood hazards are indeed highly complex.

Mr. B. C. Goodell, a graduate student working under the direction of Dr. Gast and Mr. Cline, made an investigation of the influence of four contrasting types of vegetative cover on run-off during winter and spring (1936-37), the seasons during which floods commonly occur in New England. After much search, four cover types desirable for study were found on adjoining areas having essentially uniform conditions with respect to elevation, slope, aspect, soil and drainage. They were (1) a 70-year-old white pine stand, (2) a 35-year-old mixed hardwood stand, (3) a 20-year-old red pine plantation, and (4) an open abandoned field. The general plan of procedure consisted of the measurement of the individual factors by which vegetative cover influences run-off, then, following their evaluation, algebraic summation to determine their sum total effect. The factors included for measurement were air temperature, soil temperature (at varying depths from the surface to two feet), snow depth, frost depth, permeability of frozen soil to surface water, and the moisture content of frozen soil. Considerable time was devoted to the development of suitable instruments. Insulation of the soil thermometers was accomplished by the use of heavy, waterproofed cardboard tubes. A soil borer of original design efficiently extracted a small core of frozen soil. An improved method of extracting a sample of frozen soil and testing its permeability was developed.

Weather conditions during the period of field tests chanced to be very unusual, with much rain, very little snow, and higher than normal temperature average.

The results of the investigation may be summarized as follows:

1. Air temperatures were found to average higher under the hardwood cover than under either the white or red pine cover.

2. After the freezing of the soil in early winter, soil temperatures were generally higher in the hardwoods and in the open field than in the two pine types.

3. The two pine covers were better conservers of snow than either the hardwoods or the open field.

4. The least frost and earliest thawing occurred under the hardwoods; the deepest freezing and the latest thawing under the red pine plantation.

5. No percolation in perceptible quantities took place through duff, humus, or mineral soil when these layers were frozen.

6. High percentages of gravitational water were held as ice in all cases. The greatest amounts were held by the hardwood and white pine soils. The water so held in the organic layers of the soil apparently reduced in a large measure the insulating value of these layers against loss of soil heat.

Under conditions of light snowfall, heavy rain and cold weather, the depth and duration of soil in the frozen state are thought to be the most important factors affecting run-off. Since insolation is the chief deterrent to soil freezing and the principal aid to early soil thawing under such conditions, the hardwoods, because of their open canopy, appear to provide a better cover than conifers in retarding run-off. Under conditions of heavy snows, however, coniferous covers are probably more favorably effective than hardwoods, because of the snow-intercepting capacity of their crowns and the greater protection against sun and wind which they afford. Coniferous covers better conserve what snow reaches the

forest floor, thus giving more protection to the soil against freezing on the one hand or rapid melting on the other. Conservation of snow or retardation of melt means lessened flood hazards in winters of heavy snowfall. Thus, coniferous forests may in general be best-suited to amelioration of flood factors in the north, where snow is deep, and the hardwood forests may best serve these same ends in southern New England, where snow is largely replaced by rain. The primeval distribution of the New England forests--spruce and fir predomination in the north, and oak, chestnut and hickory in the south,--may afford the best possible control of winter and spring run-off.

LAND USE PLANNING

Through the medium of the Worcester County Land Use Planning Project, sponsored by the Department of Economics of Harvard University, the Harvard Forest, Massachusetts State College, and the U. S. Department of Agriculture, students at the Forest for the first time are taking an active part in a concerted effort by agricultural economists, agronomists, soil scientists, and foresters to analyze the complex conditions of land use in a representative New England town and to determine the most advantageous plan or reorganization. Work during the present academic year is centered in the Town of Hardwick, and is being participated in by graduate students Munster, Lutz and Raymond under the direction of members of the Forest staff, together with students or staff members of the other cooperating agencies.

Approach to the problems of land use in Hardwick, a dairying

community, is through the study of the individual operating unit, in this case the farm. It is believed that such a thoroughgoing analysis of the farm enterprise has never before been undertaken in this country, and that it will bring into sharper focus the weaknesses of the present agricultural extension program and show the way to a sounder and more prosperous agriculture.

The gathering of data in the field takes the form of four kinds of records: (1) a detailed map of the farm showing the location and area of each individual field, pasture, orchard and patch of woodland; (2) a detailed soil type map supplemented by chemical analysis of soil samples taken from each unit of crop and pasture land; (3) a complete budgetary analysis of the individual farm business; and (4) a cruise of the growing stock of each stand in the farm woodlot. At the present writing, forty farms, averaging some 130 acres in size, have been covered, and a start has been made in drafting individual plans of farm management based on the correlated use of the collected data, and the most economic employment of both soil and human resources as determined by the group of specialists after careful study of the existing physical plant, improved agricultural and forestry practices, the requirements of the market for farm products, and the ability and needs of the owner.

The forestry phase of the project is divided between studies of the existing forest growing stocks, greatly deteriorated in both composition and quality, and needed silvicultural treatments for their restoration, and studies of both present and prospective market outlets for such low quality products as will result from the application of stand improvement practices. The growing stocks are analyzed on the basis of their need for silvicultural treatment and

potential work as timber crops. Thus, weeds and crop trees are separately tallied, making it possible to determine the exact nature and quantity of the material to be removed and of that to be left. It is the most detailed analysis of forest growing stocks ever made in this region.

The close cooperation of specialists trained in the several fields of land use, with the interchange of knowledge and ideas and group concentration on specific cases and concrete problems, has already proved to be of great educational value to those participating. It is planned to complete the study of the Town of Hardwick during the present academic year, following which two or more additional towns representative of portions of Worcester County will be singled out for similar treatment.

THE FOREST MODELS

During the past two years important additions were made to the unique series of small-scale models being made for the Forest by the Guernsey and Pitman Studio through the generosity of an anonymous donor. The three models showing thinning in a 50-year-old mixed pine and hardwood stand, improvement cutting and girdling in a middle-aged stand on cutover land, and shelterwood cuttings in mature pine and hardwoods on light soil were completed, and good progress made in the construction of two models illustrating the cause and control of soil erosion and certain aspects of wildlife management. Three more models are now in the designing stage, and with their construction the collection will be complete.

FINANCIAL NEEDS OF THE FOREST

The Forest was acquired in 1907 through the generosity of John S. Ames, '01, with the understanding that it should be self-supporting. For a number of years the price of lumber was sufficiently high to meet this requirement; but with the decline of the local wood-using industries and the influx of southern and western lumber, stumpage values declined, and it was no longer possible to carry on the work at Petersham without a deficit. This condition became more acute with the onset of the business depression in 1929; and for the past ten years substantial deficits have been incurred in all but three years, despite the efforts of the Director to offset such losses through gifts for current use. The continued generosity of friends of the Forest during these years prevented considerably larger deficits.

Under the plan herewith proposed, the minimum working budget for the Forest would be approximately as follows:

	H.F. funds	Cabot Fndtn	
Staff salaries	$9,600.*	7,200x	
Forest crew wages**	5,750.		
Transportation & travel	750.		
Building maintenance, inc. cook and janitor	1,200.		
Office expenditures	400.		
Equipment and supplies for research	400.		
Library	250.		
Forest operating equipment, supplies and maintenance	675.		
Miscellaneous	1,400.		
	$20,425.	7,200.	$27,625.

* includes Director, Asst. to Dir., Business sec., stenog. (part time) and tech. asst. (part time).

x includes Asst. Prof. [illegible]

** includes Supt. and three men

Expenditures for the maintenance of the outlying properties, namely, the Pisgah old growth forest, the Nathan Matthews plantations at Hamilton, and the Schwarz tract in Petersham, are not included, since they are taken care of by special endowment funds.

In the way of dependable revenue, the Forest receives the annual income from the following endowments:

FPR ($100,000)	$4,200.
HF endowment ($200,000)	8,200.
Bliss Fund - scholarships ($25,000)	1,375.
Bliss Fund - salaries ($25,000)	1,375.
Harvard Endowment ($1,500?)	60.

Through the generosity of a friend of the Forest, the following sum has been made available for several years as a contribution toward salaries: 1,500.

The third source of income is that received in the form of current gifts to be used at the discretion of the Director. For the most part these have been made by local people who have been interested in the Forest for many years. A fair estimate of the amount which may reasonably be expected from such sources is 1,500.

Since a very large part of the merchantable timber was blown down by the hurricane, the only income from the sale of forest products for many years ~~to come~~ will be that from ~~the sale of~~ fuel wood. This source of income will probably last not longer than five years at an average rate per year of 600.

Miscellaneous income:	room rent	400.
	miscellaneous sales	100.
		$19,310.
		1,375.
	Net available income for staff activities and forest operations	$17,935.
	Deficit	2,490.

AN EXPERIMENT STATION FOR RESEARCH IN FORESTRY AND ALLIED FIELDS

When the Forest was first established, it was the only institution in the region which could in any way be considered a forest experiment station, and this position lasted until the creation, by the federal government, of the regional forest experiment stations under the U. S. Forest Service. ~~First located~~ Established in 1923 at Massachusetts State College, in 1923 (?), and later moved to New Haven, the Northeastern Forest Experiment Station has developed a comprehensive program of work entrusted to a staff of some 20 persons. It has two experimental tracts in the White Mountains, one at Alfred, Maine, one at Williamstown, Mass., and others in New York State. On these experimental forests research in silviculture is conducted along approximately the same lines as at Petersham, though not with any relation to the instruction of students. There is, however, no duplication of effort, for the reason that the experimental forests operated by the Station are located in other parts of the region, where conditions are quite unlike those at Petersham. Here we are extremely fortunate in being located in a transition zone, marked by the overlapping of the northern forest and the central hardwood forest, and where land use history falls into sharply defined stages of unusual significance to forestry. The Harvard Forest, because of its location, its unequalled length of time under intensive treatment, and its unbroken series of records can continue to make outstanding contributions in research. Nor, as has already been demonstrated, is the application of the findings of such research at Petersham limited to the central New England region. Methods in silviculture developed at the Forest have been found useful in many parts of the country.

In the underlying fields of soil science, tree physiology and forest genetics work being done at the Forest under the Cabot Foundation, and the resources possessed by the University in related fields, such as botany, zoology, physiology, etc., afford the actual or potential basic support to research in silviculture which cannot be found in the case of any other experimental forest. In the biological phases of forestry the Harvard Forest should excel.

On the other hand, the federal forest experiment stations will conduct research in other fields of forestry, such as mensuration (forest measurements), wood utilization, forest protection, marketing of forest products, wildlife management, flood and erosion control, etc. which will receive only minor or incidental attention at Petersham. It is the obligation of an experiment station supported by public funds to work on all aspects of the forestry problem. But at the Harvard Forest there should be a strong and persistent concentration in silviculture and the underlying sciences, in this way making the most of its strategic geographical location, its accumulated records, and the excellent resources of the Department of Biology.

In the opinion of many foresters who are familiar with the situation at the Forest, research in the methodology of silviculture should stand out strongly at Petersham, adequately supported by work in the underlying sciences. For this a small forest is equally as useful as a large one. The prime requisites are extreme care and thoroughness in the planning, executing and recording of experimental treatments, plus continuity of treatment over a period of time sufficiently long to give conclusive results. Most fortunately, nearly all of the young stands established since 1908, when the first silvicultural treatment was carried out, suffered no more than slight damage from the hurricane, and the original plans can

be carried along without serious interruption.

Incidentally, during the past year two important supports to the foundation for continued research in silviculture have been added. Dr. Raup, of the Arnold Arboretum staff, has completed an historical study of land occupancy and use for the tracts which comprise the Forest. Mr. Charles Simmons, of the Bureau of Soil Survey, is well along in making a detailed soils map for the Forest.

Research in silviculture should be broadly oriented from the standpoint of economic wood production, from the considerations of profitable enterprise associated with private ownership. The silvicultural procedures and techniques approved and recommended by the Forest, as a result of research, always have been required to meet the test of soundness and worth from a business standpoint. Research in silviculture so oriented best fits the needs of instruction of candidates for the professional degree (M.F.), and contributes towards the most effective collaboration with workers in forest economics at Cambridge.

In general, research of the descriptive and empirical type (still greatly needed and in no way inferior to fundamental research) should be carried on in connection with the training of candidates for the M. F. degree, while research of the more exact and fundamental type, in such fields as soil science, tree physiology, etc., should be the province of candidates for the Ph.D. degree.

Research in silviculture, as well as in the fundamental sciences, must necessarily be largely of the continuing type, and conducted by staff members who can follow through year after year in making observations and records. Students may, of course, participate in such research and collaborate with staff members in the preparation of either progress or final reports. And certain research projects may lend themselves to completion in a single year,

but, by and large, silviculture is the one field of forestry most dependent upon long term research, which in turn requires long-continued ownership and operation of an experimental forest, assured financial support over a long period of time, and continuity of research plans. For successful endeavor under such conditions a privately endowed institution has many advantages over one supported by annual appropriations from the public treasury.

It should be pointed out too that in a privately supported institution there is much greater flexibility and promptness of action in initiating new projects and following promising leads than in one supported by either the federal or state government. The Forest has amply demonstrated this fact in numerous cases, where its leadership served to encourage other research agencies to continue along the lines developed here. This greater freedom of thought and action which results in such fruitful studies being taken up and carried forward by larger agencies should be protected and encouraged.

Continued cooperation with public research agencies is highly desirable. Excellent results have attended the collaboration of members of the Harvard Forest staff with members of the Division of Forest Insects of the U. S. Bureau of Entomology and Plant Quarantine and of the Division of Forest Pathology of the Bureau of Plant Industry. Several cooperative experiments are now being conducted in the Forest, including a very important one dealing with the food habits of the gypsy moth, one of the most destructive of forest insect pests. Such contacts and joint efforts with scientists in fields closely related to forestry are of the utmost importance to staff members.

Continued collaboration with the Department of Economics in the University also gives promise of fruitful results. Research

in the economics of farm forestry in particular is greatly needed at the present time, and highly satisfactory results have come from the work of recent students undertaking projects under the joint direction of the Department of Economics and the Forest. These studies have bearings on both silviculture and agricultural economics, and bid fair to find wide usefulness throughout the farm woodlot sections of the country.

Research

It has been remarked that the outstanding progress in research made by the forest in its first decades were the fortunate result of perception, imagination and insight, a flexible and adaptable program. As information increases and becomes more precise, understanding becomes more complicated: the small variations in the many factors must all be weighed and evaluation becomes more difficult. It is no longer possible for one person to understand the whole; specialization follows. So it is now with many of the subjects to which the forest was able to make effective contributions in the earlier days.

~~Furthermore~~, when the Forest was first established, it was the only institution which could in any way be considered a forest experiment station.

In the last fifteen years numerous
experiment stations have been established,
A chain of federal regional experiment stations
includes a well staffed Northeastern
Forest Experiment Station of some 20
technicians at New Haven, Conn.
The need for experimental tracts has
been recognized by acquisitions in various parts of the region.
of experimental forests. None of these
~~stations~~, however, duplicate the
unique qualities of the Harvard Forest.

~~The Harvard Forest, because of its~~
location, its ~~unexcelled~~ length of time
under intensive treatment, and its unbroken
series of records can continue to make
outstanding contributions in research.

The Forest at Petersham is
fortunately located
is

tion follows. So it is now with many of the subjects to which the Harvard Forest was able to make effective contributions in the earlier days, contributions which were the result of insight and imagination, a flexible program which enabled us to follow promising leads, and the availability of the essential facilities which were relatively crude.

It now becomes our task to fix upon the subjects in which we can make the greatest contribution in the near future, and to provide the facilities which, as the scientific work advances, become necessary to do outstanding work in these subjects. Out of the many possibilities which could be encouraged, we choose silviculture and certain aspects of soil science, tree physiology and genetics. These subjects are not separate, but complementary: the art of applying forest biology to the woods and a selection from the basic sciences on which forest biology is grounded.

There follows a recommended plan of work under each of the three traditional phases of instruction, research and demonstration.

Forest Research Needs of New England

A Statement for the Congressional Hearing

This statement is concerned chiefly with the activities of the Northeastern Forest Experiment Station during the next ten-year period. It is recognized at the outset that the field of forestry is so large and forest conditions in New England so complex that no single experiment station can be expected to attack simultaneously and with equal vigor the scores of problems pressing for solution. From time to time there should be a concentration of efforts in certain directions, as circumstances dictate. Furthermore, forest research projects being carried on by other agencies in the region, such as state agricultural experiment stations, state and private educational institutions, forest schools, etc., should influence the program of work of the federal experiment station for any given period.

For present purposes all forest research associated with commercial timber growing may be divided into three classes: (1) Forest Production, which deals with the growing and tending of tree crops up till the time of harvesting, (2) Forest Products, which deals with the extraction of products from the forest and their utilization, and (3) Forest Economics, which deals with income and profit, apply and demand, and such matters as the marketing of forest products and the organization of forest-owners for co-operative enterprise.

The Northeastern Forest Experiment Station is at present undertaking numerous projects in Forest Production (or Management, as it is known at the Station), a single project in Forest Economics (the

work at Cooperstown, N.Y.), and perhaps one in Forest Products. Without in any way suggesting that research in Forest Production should be lessened, it is urged that work in Forest Products and Forest Economics be strengthened. There are good reasons for such a request.

It is our belief that during the next decade growth in the application of forestry will take place chiefly in the densely populated industrial zone of southern New England and in the farm woodlot zone, which roughly comprises central New England. Forestry in the sparsely settled areas of northern New England will be slower to develop and much more extensive in chracter. In the first-mentioned portions of the region forest ownership is divided among thousands of farmers, summer estate owners, state, town and municipal tracts, institutional holdings and the like. With few exceptions the ownerships are small, the average size probably being scarcely more than 100 acres. As individuals, most of the owners have never been able to practice forestry profitably, for the reason that they have little or no knowledge of wood utilization or marketing, are wholly unorganized, and are therefore at the mercy of portable sawmill operators and fuelwood dealers, who for the most part serve only the least exacting demands of the local markets and manufacture only the crudest of products, such as round-edged, rough, ungraded lumber and cordwood.

Yet in all other respects there is every reason why forestry should take root and prosper. There is an unexcelled network of roads of all classes, a demand for forest products far in excess of the local supply, an ample supply of woods labor, a large area of land in forest and good for nothing else, and growth conditions favorable for a large variety of commercially valuable timber

species. Furthermore, from the social standpoint, the wider and more intensive application of forestry would increase the productivity of the land; the work thus provided would help stabilize income of both rural and industrial laborers; the tax base of rural towns would be enlarged; there would be a better general appreciation of forest values, with attendant gains in measures to protect the forests and forest lands against fire, erosion, grazing and other losses.

In order to bring to pass this happy state of affairs, however, there must be solved one outstanding problem, namely, the utilization of low grade trees, with which our New England forests are now cluttered. Although mature has been extremely generous in restocking both abandoned farms and cutover land, repeated clear cuttings, forest fires and grazing over a long period of years have resulted in deteriorated forest growing stocks--stands made up in part of short-lived weed species and crooked, limby and otherwise defective individuals of all kinds. In order to get rid of this weed element and give the better trees of crop tree species and form a chance to grow, improvement cuttings and thinning are everywhere needed. But they cannot and will not be made on any scale until there is a better market for the material to be removed. Hundreds of thousands of cords of hardwood could be taken out in such cuttings and the residual growing stocks greatly improved thereby. Furthermore, with adequate and profitable outlets, the forests could be rehabilitated very largely with the farmers' own labor and without loss in the case of owners who were obliged to hire labor. Direct subsidies would be unnecessary. We believe the situation calls for no huge investment of public funds to bring about a magical transformation overnight but rather, to begin with, a thoroughgoing

study of certain aspects of the utilization and marketing of this vast accumulation of low grade material. And the nature of such studies is such that the regional forest experiment station must carry the greater share part of the load. Notable efforts have been made, especially in Connecticut, to solve the fuelwood problem. Wood-burning stoves and furnaces of greatly improved design are being tried out in a small way, a specific wood fuel, hogged wood is being used experimentally in competition with coal at a state institution, and some studies are being made of charcoal production and of the preservative treatment of wooden posts, but state and private funds for such research are extremely meager and doubtless will continue to be so.

The Committee recommends that the work of the Northeastern Forest Experiment Station be expanded along the following lines:

Forest Products Research

A division of forest products research should be added as a new part of the Station. Such a division should not deal with the more basic studies, such as new uses for wood, the making of plastics, methods of pulping, fermentation processes, the use of lignin, etc. Such research comes within the province of the Forest Products Laboratory at Madison, Wisconsin, and should be much more liberally supported than at present, so that faster progress can be made. In this connection, it should be pointed out that farmers and other small owners would benefit by this kind of research fully as much as the large industries. The regional station might well undertake production cost studies aimed to develop improved and cheaper methods of harvesting, extracting, transporting and processing New England forest products, both lumber and cordwood, to determine the net conversion values of logs of various kinds,

sizes and grades when sawed into various products or combinations of products, such as lumber, ties, small dimension, etc., and, in particular, to discover means of increasing the usefulness of low grade hardwood as a source of heat and power. It is suggested that a study of the use of wood gas as a substitute for gasoline on farms gives promise of being very much worth while.

At least $10,000 is needed to make a start in forest products research.

Forest Economics Research

The small size of the forest holdings, referred to above, makes desirable the organization of cooperative management and utilization groups. It is believed that forest cooperatives will be found essential to the orderly and profitable marketing of wood products from small, scattered ownerships, regardless of consumer demand. New England is following the experiment at Cooperstown, N.Y., conducted by the Northeastern Forest Experiment Station, with a great deal of interest, and this Committee urges that the Cooperstown project be given sufficient working capital and other support to assure its continuance in an efficient manner.

So promising is this experiment in cooperative management and utilization that it is suggested that at least one similar experiment be set up at once in New England, either in the white pine region or in the oak-hickory region. In time such experiments should be under way in both of these regions, and in the spruce region as well. Preliminary to the establishment of such a unit there should be a study made of the adequacy of market outlets for the expectable products of the unit, including home consumption, needs of local processing plants, etc. It may be necessary to make preliminary

as are favored by the gypsy moth. The number of such destructive organisms is now so many that the attempt to combat each individually means increasing confusion and expense. Measures adopted for control of insects and diseases attacking a given species of tree or regional forest type should be coordinated.

Such coordination as is attempted for forest pest and disease control should be based on fundamental information on forest ecology and physiology which is not now available. It is generally held that all plants and animals are subject to disease because they lack immunity or because of low vitality. As yet we have no knowledge of how low vitality in forest trees may be determined, nor what limits may be placed on our attempts to improve disease and pest resistance by qualities of soil and site, and tree which are beyond our control.

But here is a field of study in which the Regional Office of Forest Insects of the Bureau of Entomology and Plant Quarantine, the Regional Office of Forest Pathology of the Bureau of Plant Industry and the Northeastern Forest Experiment Station should cooperate. A series of ecological studies, involving also a study of the physiology of the most thrifty forest stands, should be undertaken. These would serve as the basis for a coordinated scheme of remedial measures-direct or indirect, natural or artificial, biological or silvicultural-undertaken for several diseases and insect pests. Thus could be developed the knowledge of the effect of stand composition, form, density and similar controllable factors on soil fertility and the plant society. The manipulation of the controllable factors offers the only economic means of controlling thoroughly established insect pests and diseases.

It is believed that from $10,000 to $20,000 could be advantageous used for such research.

studies of the properties and uses of certain local woods about which little is known. And, with the selection of a suitable locality for the establishment of the cooperative, there should be initiated studies of all the important phases of the technical, economic and social factors involved. There should be a separate staff of technicians and economists for each experimental unit.

It is understood that the sum of $250,000 is needed for each such project in cooperative management and utilization.

capital — maintenance

Forest Protection Research

The forests of New England have suffered severely from the ravages of insect pests and diseases, many of them accidentally introduced from abroad. To date these pests and diseases have been studied largely as separate entities, and in some cases special organizations have been formed to deal solely with the control of a particular organism. Thus the blister rust organization combats the white pine blister rust, regardless of the white pine weevil or any other enemies of the white pine; and the gypsy moth organization combats the gypsy moth, regardless of other insects or diseases which may be attacking the same tree species as are favored by the gypsy moth. The time has now arrived when the number of such destructive organisms is so great that attempts to settle the score with each individually to limit the action of each ~~one individually~~ can only lead to greater and greater confusion and expense. There is need for a coordination of control measures, whether direct or indirect, natural or artificial, biological or silvicultural, or what not; and to accomplish this a series of ecological studies should be inaugurated by the Regional Office of Forest Insects of the Bureau of Entomology and Plant Quarantine and by the Regional Office of Forest Pathology of the Bureau of Plant Industry. Such

studies, made in cooperation with research foresters from other agencies, would aim to disclose the relationship of the most important insect pests and diseases to various common forest environments and to other destructive organisms, to the end that the stand composition, form, density or other controllable factors might be so altered by proper cuttings as to reduce the severity of attack or minimize the extent of the injury. It is now recognized that the only economic means of controlling thoroughly established insect pests and diseases is through silvicultural measures.

It is believed that from $10,000 to $20,000 could be advantageously used for such research.

Forest Influences Research

The inadequacy of information on the factors influencing run-off, floods, erosion, etc. is well known to every worker in this or related fields. In New England the recurrence of disastrous floods affords ample justification for the initiation by the Northeastern Forest Experiment Station of a number of much-needed studies in forest influences. In particular, quantitative information on the relative amounts of run-off under different conditions of forest and brush cover is urgently needed in making plans for storage reservoirs and other flood engineering constructions, as well as in developing measures of control through forest cover.

Serious consideration should be given to adding a division of forest influences research to the station. To carry on such research effectively upwards of $25,000 per year is needed.

The Forest Survey

The Forest Survey of the United States, authorized by the

McSweeney-McNary Forest Research Act of 1928, should be extended to include the Northeast as soon as possible. Forest resource data is needed for nearly all kinds of forestry projects, and is especially useful in connection with land use planning and the organization of cooperative management and utilization units. The Survey determins the extent, quantity, kinds and quality of timber on all classes of forest land; rate of depletion through cutting, fire, insects, disease; and other causes; current and probable future rate of timber growth; present and probable future requirements for forest products. It is realized that the greatest good will come from this project by rapidly pushing the work to completion.

It is urged that sufficient funds be made available to start the Survey in New England and New York without further delay, approximately $25,000 per year.

A Field Laboratory for the Instruction of Graduate Students

Since 1915, instruction in forestry at Harvard leading to the Master in Forestry degree has been confined to students who possess a bachelor's degree in forestry. Ordinarily students complete the requirements for the master's degree in one academic year. By giving up the two-year graduate course offered prior to 1915, intended for men having no previous forestry training and requiring the teaching of elementary forestry subjects common to an undergraduate course, the Forest staff was free to concentrate its efforts on advanced work and specialization. Under the guidance of a staff member, students undertook research projects in a great variety of subjects, including silviculture, forest management, utilization and marketing, growth and yield, forest entomology, forest pathology, forest economics, soil science, tree physiology, forest genetics, and, for a time, wildlife management. The research project method of instruction is still being followed.

For a number of years past, however, it has become increasingly clear that, with a small staff and limited funds, adequate instruction could not be given in all of the professional forestry subjects, and that the Forest should very definitely draw a line between those subjects in which advanced instruction was offered and those in which it was not.

Those subjects in which the staff believes specialization should now be offered at Petersham are silviculture and certain of the underlying sciences, namely, soil science, tree physiology, and forest genetics. In cooperation with other members of the Department of Biology at Cambridge or of other units in the University, advanced work also should be offered (by special arrangement) in such subjects as forest entomology, forest pathology, forest ecology, and forest

economics. Specialization in any of these subjects, as well as in silviculture, is considered acceptable for candidates for the Master in Forestry degree, provided at least two months of the academic year are spent in general forestry instruction at Petersham. For such candidates adequate grounding in the professional forestry subjects should continue to be assured by admitting only men who possess a bachelor's degree from a forestry school accredited by the Society of American Foresters. With such a background, a student may be given sufficient instruction within two months' time at Petersham in the history, culture, protection, use, and economic importance of the local forests adequately to serve as orientation for specialized study occupying the remainder of the academic year. At the same time this period of instruction should be used to test in a general way and to round out the candidate's knowledge of the principal professional forestry subjects. It is, of course, obligatory for any school granting the M.F. degree (a professional degree) to be assured that the candidate possesses adequate knowledge of those subjects considered essential to successful professional practice, namely, silviculture, management, utilization, protection, and economics.

Specialization by candidates for the M.F. degree cannot but be looked upon with favor by the profession of forestry. Nor can any fault be found with a small school which can offer specialization in but a few of the many subjects which now constitute the ever-enlarging field of forestry, particularly so where specialization of a high grade can be offered in a subject as fundamental to forestry as silviculture at an institution where excellent supporting work in the whole field of biology also is being conducted.

Forestry is suffering from a large oversupply of poorly trained field foresters - men who have an inadequate training in biology, who lack the "biological feel" so necessary in a practising forester, who

are unable to analyze the extremely complex forest conditions of today, and who, therefore, are unable to determine the proper silvicultural treatments to be applied. The actual contact with the living forest and with the methods in silviculture developed over a period of thirty years, together with an appreciation of the work being conducted in the underlying sciences, such as soil science, tree physiology, etc., are outstanding advantages offered at Petersham.

For students specializing in silviculture, as contrasted with such subjects as forest entomology, forest pathology, etc., and who are planning a career in practice, the research project method of instruction, in which the student necessarily spends most of his time working in a small sector of a limited field, should be replaced by one in which the student is required to study intensively and prepare a written report on a selected area of the Forest. This should contain such a representation of conditions as will afford an insight into local land use history and forest succession, the influence of these and other factors on the present character of the stands, and the kind of silvicultural treatments applicable. With the close guidance of a staff member, such a method should greatly improve the student's ability to analyze and interpret the various factors bearing on existing stand conditions, diagnose present silvicultural needs, and prescribe suitable treatments. The instructor will find opportunity to bring in the importance and influence of local wood utilization and markets, of economic considerations in general, of destructive insects and diseases, and of numerous other factors which must be taken into account in making forest plans. In this way it is believed the student can best obtain within a short period of time an understanding of the complex interrelations of biologic and economic factors involved in the application of forestry. This is essentially the plan of instruction in silviculture followed by the

late Director Fisher when working in the field with his students.

The selection of research problems for M.F. candidates other than those specializing in silviculture also should be influenced by the professional character of the degree, holders of which are expected to be competent practitioners of forestry, and furthermore, by consideration of the student's choice between a career in practice or in research or teaching. In general, the M.F. thesis problem should be broad rather than narrow, emphasizing the interrelations of the various subjects which come into play in the solution of the problem. This should hold regardless of whether the student intends later to become a candidate for the doctorate, unquestionably a desirable aim in the case of those planning a career in research or teaching.

For the Doctor of Philosophy degree the thesis problem ordinarily will be in soil science, tree physiology, or forest genetics, except as collaboration with other members of the Department of Biology may make available the facilities for instruction in other subjects related to forestry.

Opportunity at Petersham for work leading to the doctorate will be provided through participation in the continuing research projects in forest soils and related work on tree nutrition and growth, and in projects in forest genetics, carried on with the support of the Cabot Foundation for Botanical Research. It is desirable that this work in certain of the fundamental sciences be maintained at such a high level as to attract research men from the federal forest experiment stations and elsewhere on leave of absence for the purpose of learning the most advanced techniques in research in these fields.

There is a generally recognized need at present for men trained in forest economics to deal with the problems arising out of the depletion of our forest resources and the difficulties involved in passing from a long period of forest exploitation to one of conserva-

tive use. Continued collaboration between the Forest and the Department of Economics in the instruction of candidates for the M.F. degree is very desirable. The courses in economics now being offered by Professor John D. Black and the seminar conducted by him in Agricultural, Forestry, and Land Use Policy under the new School of Public Administration are attracting forestry students throughout the country, and the Forest is receiving numerous inquiries relative to specializing in forest economics.

Instruction and facilities for research at the Forest should continue to be made available to candidates for the degree of Master of Arts or Doctor of Philosophy who undertake studies in such subjects as botany, zoology, physiology, or economics which bear on forest culture or utilization.

An Experiment Station for Research

When the Harvard Forest was first established in 1907, it was the only institution in the region which could in any way be considered a forest experiment station, and this condition lasted until 1923, when the regional forest experiment stations under the U. S. Forest Service were established. The federal work in New England was first located at Massachusetts State College and later moved to New Haven, where the Northeastern Forest Experiment Station has since developed a comprehensive program of work entrusted to a technical staff of some 25 persons. It has two experimental tracts in the White Mountains, one at Alfred, Maine, one at Williamstown, Massachusetts, and others in New York State. On these experimental forests, research in silviculture has been conducted along approximately the same lines as at Petersham, though without any relation to the instruction of students. There is, however, little duplication of effort, for the reason that the experimental forests operated by the Station

are located in other parts of the region, where conditions are quite unlike those at Petersham. Here we are fortunate in being located in the "transition zone", marked by the overlapping of the northern forest and the central hardwood forest, and where land use history falls into sharply defined stages of unusual significance. The Harvard Forest, because of its location, its unequaled length of time under intensive treatment, and its unbroken series of records, can continue to make valuable contributions in research. Nor, as has already been demonstrated, is the application of the findings of such research at Petersham limited to the central New England region. Methods in silviculture developed at the Forest have been found useful in many parts of the country.

In the underlying fields of soil science, tree physiology, and forest genetics, work being done at the Forest under the Cabot Foundation, and elsewhere in the University in related fields, such as botany, ecology, physiology, etc., afford the basic support to research in silviculture which does not exist in the case of any other experimental forest. In the biological phases of forestry, the Harvard Forest should excel.

On the other hand, the federal forest experiment stations will conduct research in other fields of forestry, such as mensuration (forest measurements), wood utilization, forest protection, marketing of forest products, wildlife management, flood and erosion control, etc., which will receive only minor or incidental attention at Petersham. It is the obligation of an experiment station supported by public funds to work on all aspects of the forestry problem. But at the Harvard Forest there should be a strong and persistent concentration in silviculture and the underlying sciences, in this way making the most of its strategic geographical location, its accumulated experience and records, and the resources of the Department of Biology of Harvard University.

In the opinion of many foresters who are familiar with the situation at the Forest, research in the methodology of silviculture should stand out strongly at Petersham. For this a small forest is equally as useful as a large one. The prime requisites are care and thoroughness in the planning, executing, and recording of experimental treatments, plus continuity of treatment over a period of time sufficiently long to give conclusive results. Most fortunately, nearly all of the young stands established since the Forest was first put under management suffered no more than slight damage from the hurricane, and the original plans can be carried along without drastic changes.

Incidentally, during the past year two important supports to the foundation for continued research in silviculture have been added. Dr. Hugh M. Raup, of the Arnold Arboretum staff, has completed an historical study of land occupancy and use for the tracts which comprise the Forest. Mr. Charles Simmons, of the U. S. Bureau of Soil Survey, is well advanced in making a detailed soils map of the Forest.

Research in silviculture should be broadly oriented from the standpoint of economic wood production, from the considerations of profitable enterprise associated with private ownership. The silvicultural methods and techniques approved and recommended by the Forest as a result of research always have been required to meet the test of soundness and worth from a business standpoint. Research in silviculture so oriented best fits the needs of instruction of candidates for the professional degree (M.F.) and contributes towards the most effective collaboration with workers in forest economics at Cambridge.

In general, research of the descriptive and empirical type should be carried on in connection with the training of candidates for the M.F. degree; while research of the more exact and fundamental type, in such fields as soil science, tree physiology, etc. should be the

province of candidates for the Ph.D. degree.

Research in silviculture, as well as in the fundamental sciences, must necessarily be largely of the continuing type and conducted by staff members who can follow through year after year in making observations and records. Students should, of course, participate in such research and collaborate with staff members in the preparation of either progress or final reports. And certain research projects may lend themselves to completion in a single academic year; but, by and large, silviculture is the one field of forestry most dependent upon long term research, which in turn requires long-continued ownership and operation of an experimental forest, steady financial support over an equally long period, and continuity of research plans. For successful endeavor under such conditions, a privately endowed institution has many advantages over one supported by annual appropriations from the public treasury.

It should be pointed out too that in a privately supported institution there is much greater flexibility and promptness of action in initiating new projects and following promising leads than in one supported by either the federal or state government. The Forest has amply demonstrated this fact in several cases, where its leadership served to encourage other research agencies to continue along the lines developed here. This greater freedom of thought and action, which results in promising studies being taken up and carried forward by larger agencies, should be protected and encouraged.

Continued collaboration with the Department of Economics in the University is highly desirable. Research in the economics of farm forestry in particular is greatly needed at the present time, and encouraging results have come from the work of recent students undertaking projects under the joint direction of the Department of Economics and the Forest. These studies have bearings on both silvi-

culture and agricultural economics, and bid fair to find wide usefulness throughout the farm woodlot sections of the country.

There should be continued cooperation with public forest research agencies working in the region. Excellent results have come from the collaboration of members of the Harvard Forest staff with members of the Division of Forest Insects of the U. S. Bureau of Entomology and Plant Quarantine and of the Division of Forest Pathology of the Bureau of Plant Industry. Several experiments are now being conducted in the Forest, in both entomology and pathology. Such joint undertakings with scientists in fields closely related to forestry are of great value to both Forest staff members and students.

A Model Forest for the Demonstration of Forestry

As a result of the hurricane, which destroyed no less than two-thirds of the merchantable timber on the Forest, and of greatly reduced income from the sale of forest products for a number of years to come, it is realized that some important changes in the management of the Forest as a demonstration area are in order. However, there should be no departure from the fundamental purpose and objective of a demonstration forest as laid down by the late Director Fisher at the start. A forest such as was visualized by him, for the use of students, professional foresters, woodland owners, and the general public, and which, in the form of the Harvard Forest, was so ably guided by him in the initial stages of its development, is of even greater usefulness today than in 1908. Nearly ten years ago Professor Fisher recognized the demonstrational value of the Harvard Forest in the following words: "But although the Forest has provided a field for countless exercises by students and the material for many bulletins and papers, it is not these but the forest itself which has translated the developing technique of management into realizable and

convincing terms. It speaks the only language which can be understood both by the wise and the simple - visible results."

Slow progress in the application of forestry to private holdings in America is due in part to so few demonstrations of silvicultural methods and techniques which have stood the test of time and are ready for adoption. The Harvard Forest is one of the few places where time has permitted such tests. In continuity of intensive silviculture its history is longer than that of any other forest in America. For 31 years it has annually carried on a wide variety of silvicultural treatments and maintained a record system in the form of detailed maps of every part of the Forest, hundreds of photographs tracing stand history, descriptions of all silvicultural operations, periodic inventories of the Forest growing stock for purposes of regulating the annual cut, statements of time and costs for each individual operation, an accounting of all products harvested, and a complete record of all experimental plots, cooperative research projects and advice given to woodland owners.

The Forest is visited by from three to four hundred persons annually, many of them students from other schools, professional foresters, scientists working in fields allied to forestry, and others interested in forestry, conservation, or outdoor life - people who have come to see how forestry is practised in central New England and who have gone away with a better appreciation of this rapidly growing field of work. To many visiting professional foresters a trip through the Forest has strengthened their faith in the value of their work. W. B. Greeley, formerly Chief Forester of the U. S. Forest Service, said, "The two days at Petersham...stand out as red letter events for many reasons, among them that I felt closer on that occasion to native American silviculture than at any other time in my life."

Only under conditions of stable ownership, dependable support, and continuity of silvicultural policy is such a contribution possible. One might think that such conditions existed in the case of many state, town, and municipal forests in the region; but this is not true. Silvicultural work done in such forests is almost invariably involved with unemployment relief. Expenditures per acre for forest improvement treatments have been so great, the amount of work done so excessive, and the supervision so faulty, that these public forests in many cases are not only of little value as demonstrations for the guidance of private woodland owners, but are harmful in that they give rise to the mistaken notion that forestry is very costly and out of reach of the average woodland owner. It is of the utmost importance that demonstration forests whose work is oriented from the standpoint of private enterprise be continued, if forestry as a private undertaking is to be encouraged and economically sound and practical methods in silviculture are to be demonstrated.

Bearing on this same point, silvicultural methods thus far applied on both public and private forests have generally proved to be too expensive in the light of present or expectable economic conditions. For the most part, many of the practices recommended in the early years of forestry, and which still attract wide support on the part of the public, had their genesis in the methods of growing agricultural crops. The layman thinks of forestry in terms of setting out uniformly spaced rows of trees on cleared land, much the same as planting a crop of corn or setting out an apple orchard. These artificial stands have already proved the wisdom of those few early American foresters, like the late Director Fisher, who foresaw costly maintenance, unsatisfactory outcome and an eventual swing towards the natural associations of trees. Not only has their unbalanced condition subjected such plantations to destructive attacks by insects and diseases, but the

initial costs of establishment plus protection have been too high to give promise of any profit. More and more it is becoming recognized that the philosophy of working in close harmony with nature, as exemplified by the silvicultural methods developed at Petersham by Professor Fisher, is eminently sound and practicable from the standpoint of economic timber production. It is the demonstration of these relatively cheap methods of improving the existing volunteer growing stocks through weedings, improvement cuttings and the like, as against the costly artificial establishment of stands by planting, which is most needed today, and around which the program of experimentation and demonstration in the forest itself should now center. This is not to say that no further planting should be done; but any such enterprises should very definitely be for the purpose of acquiring new knowledge and and not for routine purposes of timber growing.

Up till the time of the hurricane, the Forest afforded an unusual demonstration of sustained yield management, having such a distribution of ages of timber, from young to old, as to make possible sizeable annual cuts year after year without depleting the capital growing stock. Such an organization of production also was a great financial aid to the Forest in that substantial annual incomes from the sale of forest products were realized. However, it was not the demonstration of sustained yield management, as such, which attracted visitors, but rather the demonstration of the application of the art of silviculture to local conditions in such an evidently practical way as to leave a conviction in the visitor's mind that here native American silviculture was taking root. Nor was the demonstration of logging and lumbering methods of particular interest to most visitors, for the reason that they were essentially the same as those practised by lumbermen generally in the region and might be seen in use elsewhere. Similarly, very little in the way of new methods in wood utilization or in the process-

ing of wood products was demonstrated, since in this case also the Forest found it a practical necessity to conform with local practices and to provide the sort of lumber demanded by local industries. With a sufficiently large staff of technicians and increased finances, experimentation might have been undertaken in the past in these lines of work with fruitful results. But, for the future, the development of improved methods in wood utilization and processing, logging and lumbering and the like should be left largely to those agencies which are best equipped to carry it on efficiently, such as the Forest Products Laboratory at Madison, Wisconsin, and the regional forest experiment stations.

While there is no need or desire to abandon the policy of sustained yield management, existing circumstances necessitate putting less emphasis on this aspect of the Forest as a demonstration area for the next few decades. The one outstanding kind of demonstration which promises a continuing growth in value and interest is the methodology of silviculture. Even under existing financial circumstances it is feasible to develop and demonstrate improved methods and techniques in this field. For this purpose small areas will suffice. There is no need for extending a given treatment over a large tract in order to supply convincing evidence. Some of the most effective demonstrations in the Forest have involved areas of only a few acres. With the limited funds now available for cultural treatments, there should be a concentration of effort on a comparatively few stands having conditions of particular interest and significance from the standpoint of silvicultural treatment. Moreover, as previously stated, there should be strong emphasis on the natural methods of regeneration and in general on those methods of stand establishment and improvement most in accord with natural tendencies. A larger share of such cultural work might well be done by students under the

guidance of a staff member, rather than becoming largely routine operations carried out by a paid crew.

Since 69 per cent of the young stands remaining after the hurricane (not more than moderately damaged and not more than 30 years of age) are of planted conifers, there should be a complete cessation of coniferous planting other than on a strictly experimental basis. Much more experimentation in the planting of hardwoods is desirable. A much smaller forest nursery will suffice for future needs.

The whole scale of forest operations must necessarily be brought into conformity with the present limitations in funds and technical staff. Certain portions of the Forest destroyed by the hurricane and of comparatively little interest at the present time must be left untouched for the time being. It may well be that nature's own methods of forest restoration on such areas will be of greater value from a research standpoint than though money were available to apply cultural methods to every acre of the Forest. One weakness in past procedure under a policy of sustained yield which aimed towards regularizing the production of the Forest at constantly increasing levels was that too much emphasis was placed on growing timber, as such, with necessarily some loss in the development of new or improved methods through outright experimentation. Under a considerably reduced program of forest operations there should be greater flexibility in trying out new ideas, and greater care should be possible in planning, executing, and recording the various treatments than in the past.

December 1939

A PLAN FOR THE HARVARD FOREST

There is a french proverb to the effect that the more institutions and persons change, the easier it is to identify the constant characters ~~which are constants~~. Throughout the thirty-six year history of ~~the Harvard Forest~~ forestry at Harvard is evident the constant effort to adapt itself to the rapid development of forest education and the increased activities of public agencies which have advanced forestry throughout the country. very recognition of the Harvard Forest.

Such changes as the discontinuance of elementary instruction and concentration upon advanced specialized study, focussing research attention on such subjects as marketing, forest fire insurance, contributing to studies of pales weevil, white pine weevil, forest fire weather, forest soil and tree nutrition, and emphasizing the results of the findings of these various projects in field excursions and demonstrations reveal the modifications of policy and subject matter which have contributed to usefulness and strength of the Harvard Forest.

The changes have not always been independent of changes within the University. The affiliations with the Bussey Institution and with the School of Business Administration were advantageous associations with developing activities which provided mutually helpful assistance.

The effect of the hurricane on the forest properties and the recent failure to realize the hope of increasing the endowment necessitate a review of the past and the development of plans for the immediate future and, say, the next decade.

In reviewing the reasons for the past strength one is impressed by the importance of past ability to adjust to clearly recognized needs in forest education and knowledge rather than to attempt to carry on a traditional educational enterprise. The past success

was due to insight and imagination, a flexible program which enabled us to follow promising leads, and the availability of the essential facilities which were essentially crude.

The present outstanding need in forestry we believe to be more working biology. Throughout the ranks of the public agencies and the private foresters, in the elementary instruction in forestry, and in the attempts to demonstrate to the lay public desirable forest practices, there is to be observed a notable lack of attention to biology. There seems to be little recognition that although forestry may need more able administration and is impeded by economic factors, yet there can be no forestry without the biological base.

Assistance in the development of more able public forest administrators can come through participation in the program of the Littauer School of Public Administration, by providing students who contemplate a career in land-use administration with understanding of the natural laws of biology which cannot be transgressed. By the leaven of such training and of demonstration, it may be possible to permeate the public forest agencies with a sense of the importance of the living material with which they are dealing: silviculture as the art of applying forest biology to the woods and basic sciences on which forest biology is grounded.

The work at the Harvard Forest should therefore concern itself with silviculture and certain aspects of soil science, tree physiology, and genetics. This field of concentration is not advocated because it was the earliest concern of the Harvard Forest and the one to which it has made outstanding contribution, although this is an important matter. Nor is it chosen because the facilities and interests of the Department of Biology in many places touch very closely on this field and may well make possible outstanding

joint contribution, although such might be important considerations. The resolve to concentrate in silviculture and the complementary fundamental sciences arises from the observation that this program would/ contribute ~~most~~ to the immediate progress of sound forestry.

The manner in which such a concentration of activity will affect the Harvard Forest program is, in the following, treated under each of the three traditional phases of instruction, research, and demonstration.

A FIELD LABORATORY FOR THE INSTRUCTION OF GRADUATE STUDENTS IN FORESTRY AND ALLIED FIELDS

Since 1915 instruction in forestry, leading to the Master in Forestry degree, has been confined to students who possess a bachelor's degree in forestry from a forestry school of recognized standing. Ordinarily students complete the requirements for the degree in one academic year. Also, since 1915 the research method of instruction, under close supervision by or in collaboration with a staff member, has been continuously in force.

By giving up the two-year graduate course, offered prior to 1915, of formal instruction intended for men having no previous forestry training and requiring the teaching of the elementary forestry subjects common to an undergraduate forestry course, the Forest staff was free to concentrate its efforts on advanced work and specialization. Students undertook research projects in silviculture, forest management, utilization and marketing, growth and yield, forest entomology, forest pathology, forest economics, soil science, tree physiology, forest genetics, and, for a time, wildlife management.

For a number of years past, however, it has become increasingly clear that, with a small staff, adequate instruction could not be given in all of the professional forestry subjects, and that the Forest should very definitely draw a line between those subjects in which advanced instruction should be offered and those in which it should not.

Those subjects in which specialization should now be offered at Petersham are silviculture and certain of the underlying sciences, particularly soil science, tree physiology, and forest genetics.

In cooperation with other members of the Department of Biology or of other units in the University advanced work also should be offered in such forestry subjects as forest entomology, forest pathology, forest ecology, and forest economics. Specialization in any of these subjects, as well as in silviculture, should be considered acceptable for candidates for the Master in Forestry degree, provided at least one-quarter of the academic year is spent at the Forest, as stated below. For the Doctor of Philosophy degree the thesis problem ordinarily will be in soil science, tree physiology or forest genetics, except as collaboration with other members of the Department of Biology may make available the facilities for instruction in other subjects related to forestry.

In the case of candidates for the Master in Forestry degree (a professional degree) adequate grounding in the professional forestry subjects should continue to be assured by admitting only men who possess a bachelor's degree from a forestry school of recognized standing approved by the Society of American Foresters. With such a background, a candidate for the Master in Forestry degree may be given sufficient instruction within two months' time at Petersham in the history, culture, protection, use and economic importance of the local forests adequately to serve as orientation for a project ~~in research~~ occupying the remainder of the academic year. At the same time this period of instruction should be used to test in a general way the candidate's knowledge of the five major professional forestry subjects, namely, silviculture, management, utilization, protection and economics. It is, of course, obligatory upon any school granting the M. F. degree to be assured that the candidate possesses adequate knowledge of those subjects considered essential to successful professional practice.

Specialization on the part of candidates for the M. F. degree cannot but be looked upon with favor by the profession of forestry. Nor can any fault be found with a small school which can offer specialization in but a few of the many subjects which now constitute the field of forestry, particularly so where specialization of a high grade can be offered in a subject as fundamental to forestry as silviculture, and where excellent supporting work in the whole field of biology also is being conducted. Forestry is suffering from a large oversupply of poorly trained foresters--men who have a wholly inadequate training in biology, who lack the "biological feel" so necessary in a forester, who are unable to analyze and diagnose the extremely complex forest conditions of today, and who therefore are unable to determine the proper silvicultural treatment or to develop sound silvicultural policies. The actual contact with the living forest, and with the methods in silviculture developed over a period of 30 years, together with an appreciation of the work being conducted in the underlying sciences, such as soil science, tree physiology, etc., are outstanding advantages at Petersham. The Forest has enjoyed the reputation of affording excellent training in silviculture, and this reputation can be maintained and enhanced.

When and if increased funds and facilities for instruction become available at Petersham, advanced study and specialization may be offered in other subjects and the number of students increased. But for the present no expansion in either of these respects can be undertaken.

The selection of research problems for candidates for the M. F. degree should be influenced by the fact that this is a professional degree, holders of which are required to be competent practitioners of the profession; also, but to a lesser degree, by consideration

of the student's choice between a career in administrative work or in research or teaching. In general, the M. F. thesis problem should be broad rather than narrow, emphasizing the interrelations of the various subjects which come into play in the solution of the problem. For students specializing in silviculture, as contrasted with such subjects as forest entomology, forest pathology, etc., and who are planning a career in practice, rather than research, the research method of instruction should be replaced by one in which the student is required to study and report on an area of the Forest containing such a representation of stand conditions as will afford an insight into local forest history and succession, the influence of man's use of the forest on its present character, the kind of silvicultural treatment applicable, and the development of a plan for future care and handling. With the necessary guidance of a staff member such a method should greatly increase the student's ability to analyze and interpret the various factors bearing on existing stand conditions, to make a diagnosis of present silvicultural needs and to prepare a plan of management embodying the results of his field studies. Such a method also will give the instructor an excellent opportunity to bring in during the course of discussions on silviculture the importance and influence of local forest insects and diseases, of local economic factors and of numerous other factors which must be taken into account in the making of forest plans. Only by such a method can the student obtain within a short period of time an understanding of the complex interrelations of biologic and economic factors involved in the application of forestry. This is essentially the plan of instruction followed by the late Director Fisher whenever in the field with the students, and in a large measure accounts for their superior training in the art of silviculture.

As previously stated, opportunity at the Forest for work leading to the doctorate is provided through participation in the continuing research projects in forest soils and related work on tree nutrition and growth, and in projects in forest genetics, carried on with the support of the Cabot Foundation for Botanical Research. It is desirable that the facilities for ~~this~~ work in ~~certain of~~ these fundamental sciences be ~~maintained at~~ such ~~a high level~~ as to attract research men from the federal forest experiment stations and elsewhere on leave of absence for the purpose of learning the most advanced techniques in research in these fields.

Instruction and facilities for research at the Forest should continue to be made available to candidates for the degree of Master of Arts or Doctor of Philosophy who undertake studies in such subjects as botany, zoology, physiology or economics which bear on forest culture or utilization. Candidates for these degrees must meet the requirements of the Division of the Faculty of Arts and Sciences concerned.

There is a recognized need at present for men trained in Forest Economics to grapple with the problems arising out of the misuse of our natural resources and the extreme difficulties involved in passing from a long period of forest exploitation to one of conservative use. Continued collaboration between the Forest and the Department of Economics in the instruction of students in forest economics should be encouraged. The courses in economics now being offered by Professor John D. Black of the Department of Economics, and the seminar conducted by him in Agricultural, Forestry, and Land-Use Policy under the new School of Public Administration have attracted the attention of students throughout the country, and the Forest is receiving numerous inquiries relative to undertaking work in forest economics.

An Experiment Station for Research in Forestry and Allied Fields

When the Forest was first established, it was the only institution in the region which could in any way be considered a forest experiment station, and this position lasted until the creation of the regional forest experiment stations under the U. S. Forest Service. First located at Massachusetts State College, in 1923, and later moved to New Haven, the Northeastern Forest Experiment Station has developed a comprehensive program of work entrusted to a staff of some 20 persons. It has two experimental tracts in the White Mountains, one at Alfred, Maine, one at Williamstown, Massachusetts, and others in New York State. On these experimental forests research in silviculture has been conducted along approximately the same lines as at Petersham, though without any relation to the instruction of students. There is, however, no duplication of effort, for the reason that the experimental forests operated by the Station are located in other parts of the region, where conditions are quite unlike those at Petersham. Here we are extremely fortunate in being located in a transition zone, marked by the overlapping of the northern forest and the central hardwood forest, and where land use history falls into sharply defined stages of unusual significance. The Harvard Forest, because of its location, its unequaled length of time under intensive treatment, and its unbroken series of records can continue to make outstanding contributions in research. Nor, as has already been demonstrated, is the application of the findings of such research at Petersham limited to the central New England region. Methods in silviculture developed at the Forest have been found useful in many parts of the country.

In the underlying fields of soil science, tree physiology and forest genetics work being done at the Forest under the Cabot Foundation, and the resources possessed by the University in related fields, such as botany, zoology, physiology, etc., afford the basic support to research in silviculture which cannot be found in the case of any other experimental forest. In the biological phases of forestry the Harvard Forest should excell.

On the other hand, the federal forest experiment stations will conduct research in other fields of forestry, such as mensuration (forest measurements), wood utilization, forest protection, marketing of forest products, wild life management, flood and erosion control, etc. which will receive only minor or incidental attention at Petersham. It is the obligation of an experiment station supported by public funds to work on all aspects of the forestry problem. But at the Harvard Forest there should be a strong and persistent concentration in silviculture and the underlying sciences, in this way making the most of its strategic geographical location, its accumulated experience and records, and the excellent resources of the Department of Biology.

In the opinion of many foresters who are familiar with the situation at the Forest, research in the methodology of silviculture should stand out strongly at Petersham, adequately supported by work in the underlying sciences. For this a small forest is equally as useful as a large one. The prime requisites are extreme care and thoroughness in the planning, executing and recording of experimental treatments, plus continuity of treatment over a period of time sufficiently long to give conclusive results. Most fortunately, nearly all of the young stands established since 1908, when the Forest was first put under management, suffered no more

than slight damage from the hurricane, and the original plans can be carried along without drastic change.

Incidentally, during the past year two important supports to the foundation for continued research in silviculture have been added. Dr. Raup, of the Arnold Arboretum staff, has completed an historical study of land occupancy and use for the tracts which comprise the Forest. Mr. Charles Simmons, of the Bureau of Soil Survey, is well along in making a detailed soils map for the Forest.

Research in silviculture should be broadly oriented from the standpoint of economic wood production, from the considerations of profitable enterprise associated with private ownership. The silvicultural methods and techniques approved and recommended by the Forest, as a result of research, always have been required to meet the test of soundness and worth from a business standpoint. Research in silviculture so oriented best fits the needs of instruction of candidates for the professional degree (M.F.) planning a career in practice, and contributes towards the most effective collaboration with workers in forest economics at Cambridge.

In general, research of the descriptive and empirical type should be carried on in connection with the training of candidates for the M.F. degree, while research of the more exact and fundamental type, in such fields as soil science, tree physiology, etc., should be the province of candidates for the Ph.D. degree.

Research in silviculture, as well as in the fundamental sciences, must necessarily be largely of the continuing type, and conducted by staff members who can follow through year after year in making observations and records. Students should, of course, participate in such research and collaborate with staff members in the preparation of either progress or final reports. And certain

research projects may lend themselves to completion in a single academic year, but, by and large, silviculture is the one field of forestry most dependent upon long term research, which in turn requires long-continued ownership and operation of an experimental forest, steady financial support over an equally long period, and continuity of research plans. For successful endeavor under such conditions a privately endowed institution has many advantages over one supported by annual appropriations from the public treasury.

It should be pointed out too that in a privately supported institution there is much greater flexibility and promptness of action in initiating new projects and following promising leads than in one supported by either the federal or state government. The Forest has amply demonstrated this fact in numerous cases, where its leadership served to encourage other research agencies to continue along the lines developed here. This greater freedom of thought and action which results in such fruitful studies being taken up and carried forward by larger agencies should be protected and encouraged.

Continued cooperation with public research agencies is highly desirable. Excellent results have attended the collaboration of members of the Harvard Forest staff with members of the Division of Forest Insects of the U. S. Bureau of Entomology and Plant Quarantine and of the Division of Forest Pathology of the Bureau of Plant Industry. Several cooperative experiments are now being conducted in the Forest, in both entomology and pathology. Such joint undertakings with scientists in fields closely related to forestry are of great value to Forest staff members.

Continued collaboration with the Department of Economics in the University gives promise of fruitful results. Research in

the economics of farm forestry in particular is greatly needed at the present time, and highly satisfactory results have come from the work of recent students undertaking projects under the joint direction of the Department of Economics and the Forest. These studies have bearings on both silviculture and agricultural economics, and bid fair to find wide usefulness throughout the farm woodlot sections of the country.

A Field Laboratory for the Instruction of Graduate Students in Forestry and Allied Fields

Since 1915, instruction in forestry at Harvard, leading to the Master in Forestry degree, has been confined to students who possess a bachelor's degree in forestry from a school of recognized standing. Ordinarily students complete the requirements for the Master's degree in one academic year. By giving up the two-year graduate course of formal instruction, offered prior to 1915, intended for men having no previous forestry training and requiring the teaching of the elementary forestry subjects common to an undergraduate course, the Forest staff was free to concentrate its efforts on advanced work and specialization. Under supervision by or in collaboration with staff members students undertook research projects in silviculture, ~~forest~~ management, utilization and marketing, growth and yield, ~~forest~~ entomology, ~~forest~~ pathology, ~~forest~~ economics, soil science, tree physiology, ~~forest~~ genetics, and, for a time, wild life management. This research method of instruction is still followed.

For a number of years past, however, it has become increasingly clear that, with a small staff, adequate instruction could not be given in all of the professional forestry subjects, and that the Forest should very definitely draw a line between those subjects in which advanced instruction was offered and those in which it was not.

Those subjects in which the staff believes specialization should now be offered at Petersham are silviculture and certain of the underlying sciences, particularly soil science, tree physiology, and forest genetics. In cooperation with other membersof the Department of Biology or of other units in the University advanced work also should

be offered (by special arrangement) in such subjects as forest entomology, forest pathology, forest ecology, and forest economics. Specialization in any of these forestry subjects, as well as in silviculture, is considered acceptable for candidates for the Master in Forestry degree, provided at least the first two months of the academic year are spent at the Forest, as stated below. For the Doctor of Philosophy degree the thesis problem ordinarily will be in soil science, tree physiology or forest genetics, except as collaboration with other members of the Department of Biology may make available the facilities for instruction in other subjects related to forestry.

In the case of candidates for the M.F. degree (a professional degree) adequate grounding in the professional forestry subjects should continue to be assured by admitting only men who possess a bachelor's degree from a forestry school of recognized standing approved by the Society of American Foresters. With such a background, a student may be given sufficient instruction within two months' time at Petersham in the history, culture, protection, use and economic importance of the local forests adequately to serve as orientation for specialized study occupying the remainder of the academic year. At the same time this period of instruction should be used to test in a general way and to round out the candidate's knowledge of the principal professional forestry subjects. It is, of course, obligatory of any school granting the M.F. degree to be assured that the candidate possesses adequate knowledge of those subjects considered essential to successful professional practice, namely, silviculture, management, utilization, protection and economics.

Specialization on the part of candidates for the M.F. degree cannot but be looked upon with favor by the profession of forestry.

Nor can any fault be found with a small school which can offer specialization in but a few of the many subjects which now constitute the ever enlarging field of forestry, particularly so where specialization of a high grade can be offered in a subject as fundamental to forestry as silviculture, and where excellent supporting work in the whole field of biology also is being conducted. Forestry is suffering from a large oversupply of poorly trained foresters--men who have an inadequate training in biology, who lack the "biological feel" so necessary in a forester, who are unable to analyze the extremely complex forest conditions of today, and who therefore are unable to determine the proper silvicultural treatments to be applied. The actual contact with the living forest, and with the methods in silviculture developed over a period of 30 years, together with an appreciation of the work being conducted in the underlying sciences, such as soil science, tree physiology, etc., are outstanding advantages at Petersham. The Forest has enjoyed the reputation of affording excellent training in silviculture, and this reputation can be maintained and enhanced.

When and if increased funds and facilities for instruction become available at Petersham, advanced study and specialization may be offered in other subjects and the number of students increased. But for the present no expansion in either of these respects can be undertaken.

The selection of research problems for candidates for the M.F. degree should be influenced by the fact that it is a professional degree, holders of which are required to be competent practitioners of the profession; also, but to a lesser degree, by consideration of the student's choice between a career in administrative work or

in research or teaching. In general, the M.F. thesis problem should be broad rather than narrow, emphasizing the interrelations of the various subjects which come into play in the solution of the problem.

For students specializing in silviculture, as contrasted with such subjects as forest entomology, forest pathology, etc., and who are planning a career in practice, the research method of instruction should be replaced by one in which the student is required to study and report on an area of the Forest containing such a representation of conditions as will afford an insight into local land use history and forest succession, the influence of these and other factors on the present character of the stands and the kind of silvicultural treatments applicable. With the necessary guidance of a staff member such a method should greatly increase the student's ability to analyze and interpret the various factors bearing on existing stand conditions, to make a diagnosis of present silvicultural needs and to prepare a plan of handling embodying the results of his field studies. Such a method will also give the instructor an excellent opportunity to bring in the importance and influence of local wood utilization and markets, of economic considerations in general, of destructive insects and diseases, and of numerous other factors which must be taken into account in the making of forest plans. Only by such a method can the student obtain within a short period of time an understanding of the complex interrelations of biologic and economic factors involved in the application of forestry. This is essentially the plan of instruction followed by the late Director Fisher whenever in the field with the students, and in a large measure accounts for their superior training in silviculture.

As previously stated, opportunity at the Forest for work leading to the doctorate will be provided through particupation in the con-

tinuing research projects in forest soils and related work on tree nutrition and growth, and in projects in forest genetics, carried on with the support of the Cabot Foundation for Botanical Research. It is desirable that this work in certain of the fundamental sciences be maintained at such a high level as to attract research men from the federal forest experiment stations and elsewhere on leave of absence for the purpose of learning the most advanced techniques in research in these fields.

Instruction and facilities for research at the Forest should continue to be made available to candidates for the degree of Master of Arts or Doctor of Philosophy who undertake studies in such subjects as botany, zoology, physiology or economics which bear on forest culture or utilization.

There is a recognized need at present for men trained in Forest Economics to deal with the problems arising out of the depletion of our forest resources and the difficulties involved in passing from a long period of forest exploitation to one of conservative use. Continued collaboration between the Forest and the Department of Economics in the instruction of students in forest economics is very desirable. The courses in economics now being offered by Professor John D. Black of the Department of Economics, and the seminar conducted by him in Agricultural, Forestry, and Land_Use Policy under the new School of Public Administration have attracted students throughout the country, and the Forest is receiving numerous inquiries relative to undertaking work in forest economics.

Conclusion

4-1 New PRG

A Model Forest for the Demonstration of Forestry

As a result of the hurricane, which destroyed no less than two-thirds of the merchantable timber on the Forest, and of greatly reduced income from the sale of forest products for a number of years to come, it is recognized that some important changes in the management of the Forest as a demonstration area are in order. However, there should be no departure from the fundamental purpose and objective of a demonstration forest as laid down by the late Director Fisher at the start. A forest such as was visualized by him, for the use of students, professional foresters, woodland owners, and the general public, and which, in the form of the Harvard Forest, was so ably guided by him in the initial stages of its development, is of even greater usefulness today than in 1908. Nearly ten years ago Professor Fisher gave recognition to the demonstrational value of the Harvard Forest in the following words: "But although the Forest has provided a field for countless exercises by students and the material for many bulletins and papers, it is not these but the forest itself which has translated the developing technique of management into realizable and convincing terms. It speaks the only language which can be understood both by the wise and the simple--visible results."

Slow progress in the application of forestry to private holdings in America is due in part to so few demonstrations of silvicultural methods and techniques which have stood the test of time and are ready for adoption. The Harvard Forest is one of the few places where time has permitted such tests. In continuity of intensive silviculture its history is longer than that of any forest in America. For 31 years it has annually carried on a wide variety

of silvicultural treatments and maintained a record system in the form of detailed maps of every part of the Forest, hundreds of photographs tracing stand history, descriptions of all silvicultural operations, periodic inventories of the Forest growing stock for purposes of regulating the annual cut, statements of time and costs for each individual operation, an accounting of all products harvested, and a complete record of all experimental plots, cooperative research projects and advice given to woodland owners. The number of recorded silvicultural treatments runs into the thousands.

The Forest is visited by from three to four hundred persons annually, many of them students from other schools, professional foresters, scientists working in fields allied to forestry and others interested in forestry, conservation or outdoor life--people who have come to see how forestry is practiced in central New England and who have gone away with a better appreciation of this new and rapidly growing field of work. To many visiting professional foresters a trip through the Forest has strengthened their faith in the value of their work. W. B. Greeley, formerly Chief Forester of the U. S. Forest Service, said, "The two days at Petersham....stand out as red letter events for many reasons, among them that I felt closer on that occasion to native American silviculture than at any other time in my life."

Only under conditions of stable ownership, dependable support and continuity of silvicultural policy is such a contribution possible. One might think that such conditions existed in the case of many state, town and municipal forests in the region, but this is not true. Silvicultural work done in such forests is almost

invariably involved with unemployment relief. Expenditures per acre for forest improvement treatments have been so great, the amount of work done so excessive, and the supervision so faulty, that these public forests in many cases are not only worthless as demonstrations for the guidance of private woodland owners, but are harmful in that they give rise to the mistaken notion that forestry is costly and takes the form of "cleaning up the woods" to resemble a park. It is of the utmost importance that demonstration forests whose work is oriented from the standpoint of private enterprise be continued, if forestry as a private undertaking is to be encouraged and economically sound and practical methods in silviculture are to be demonstrated.

Bearing on this same point, silvicultural methods thus far applied on both public and private forests have generally proved to be too expensive in the light of present or expectable economic conditions. For the most part, many of the practices recommended in the early years of forestry, and which still attract wide support on the part of the public, had their genesis in the methods of growing agricultural crops. The layman thinks of forestry in terms of setting out uniformly spaced rows of trees on cleared land, much the same as planting a crop of corn or setting out an apple orchard. These artificial stands have already proved the wisdom of those few early American foresters, like the late Director Fisher, who foresaw costly maintenance, unsatisfactory outcome and an eventual swing towards the natural associations of trees. Not only has their unbalanced condition subjected such plantations to destructive attacks by insects and diseases, but the initial costs of establishment plus protection have been too high to give promise of any profit. More and more it is becoming recognized that the philosophy of working in

new

close harmony with nature, as exemplified by the silvicultural methods developed at Petersham by Professor Fisher, is eminently sound and practicable from the standpoint of economic timber production. It is the demonstration of these relatively cheap methods of improving the existing volunteer growing stocks through weedings, improvement cuttings and the like, as against the costly artificial establishment of stands by planting, which is most needed today, and around which the program of experimentation and demonstration in the forest itself should center. This is not to say that no further planting should be done; but any such should very definitely be for the purpose of acquiring new knowledge and not for routine purposes of timber growing.

Up till the time of the hurricane the Forest afforded an unusual demonstration of sustained yield management, having such a distribution of ages of timber, from young to old, as to make possible sizable annual cuts year after year without depleting the capital growing stock. Such an organization of production also was a great financial aid to the Forest in that substantial annual incomes from the sale of forest products were realized. However, it was not the demonstration of sustained yield management, as such, which attracted visitors, but rather the demonstration of the application of the art of silviculture to local conditions in such an evidently practical way as to leave a conviction in the visitor's mind that here native American silviculture was taking root. Nor was the demonstration of logging and lumbering methods of any special interest to most visitors, for the reason that they were essentially the same as practiced by lumbermen generally in the region and might be seen in use elsewhere. Similarly, very little in the way of new methods in wood utilization or in the processing of ~~the~~ wood products

was demonstrated, since in this case also the Forest found it a practical necessity to conform with local practices and to provide the sort of lumber demanded by local industries. The same holds in the case of the nursery operated by the Forest for many years. At one time it was valuable in teaching students how to raise seedlings, but the Forest staff could not hope to develop new methods of nursery culture and at the same time advance knowledge in the numerous other activities being undertaken. With a sufficiently large staff of technicians and greatly increased finances, experimentation might have been undertaken in the past in these lines of work with fruitful results. But, for the future, work in such lines as wood utilization and processing, logging and lumbering and the like should be left to those agencies which are best equipped to carry it on efficiently, such as the Forest Products Laboratory at Madison, Wisconsin, and the regional forest experiment stations.

While there is no need or desire to abandon the policy of working toward sustained yield management, existing circumstances necessitate putting less emphasis on this aspect of the Forest as a demonstration area for a few decades. The one outstanding kind of demonstration which promises a continuing growth in value and interest is the methodology of silviculture. Even under existing financial circumstances it is feasible to develop and demonstrate improved methods and techniques in this field. For this purpose small areas will suffice. There is no need for extending a given treatment over a large tract in order to supply convincing evidence. Some of the most effective demonstrations on the Forest have involved areas of only a few acres. With the limited funds now available for cultural treatments, there should be a concentration of effort on a comparatively few stands having conditions of particular interest and significance from the

standpoint of silvicultural treatment. Moreover, as previously stated, there should be strong emphasis on the natural methods of regeneration and in general on those methods of stand establishment and improvement most in accord with natural tendencies. A larger share of such cultural work can be done by students under the guidance of a staff member, rather than becoming largely routine operations carried out by a paid crew.

Since 69 percent of the young stands remaining after the hurricane (not more than moderately damaged and not more than 30 years of age) are planted conifers, there should be a complete cessation of coniferous planting other than on a strictly experimental basis. Much more experimentation in the planting of hardwoods is desirable. A much smaller forest nursery will suffice for future needs.

The whole scale of forest operations must necessarily be brought into conformity with the present limitations in funds and technical staff. Certain portions of the Forest destroyed by the hurricane and of comparatively little interest at the present time should be left untouched. It may well be that nature's own methods of forest restoration on such areas will be of greater value from a research standpoint than though money were available to apply cultural methods to every acre of the Forest. One weakness in past procedure under a policy of sustained yield, which aimed towards regularizing the production of the Forest at constantly increasing levels, was that too much emphasis was placed on growing timber, as such, with necessarily some loss in the development of new methods through outright experimentation. Under a considerably reduced program of forest operations there should be greater flexibility in trying out new ideas, and greater care should be possible in planning, executing and recording the various treatments than in the past.

INSTRUCTION

The limitations on advanced work undertaken at the Forest will require the student to sharpen the definition of his goal. Although instruction at Petersham would be limited to silviculture and cognate sciences, cooperation with other members of the Department of Biology or of Economics would permit of work in certain phases of entomology, pathology, ecology and economics. Specialization in these latter subjects, as well as in silviculture, should be considered acceptable for candidates for the Master in Forestry degree, provided there is ample demonstration of proficiency in the essential technical subjects. ((Ordinarily this would be arranged by registration suited to the individual student.))

A change of emphasis is proposed for students majoring in silviculture who do not propose to proceed beyond the M.F. When the two-year graduate course of formal instruction intended for men having no previous forestry training was dropped in 1915, the research project method was adopted for advanced study in special fields. The student undertook the exploration of a small sector of a limited field, and was thereby encouraged to deal with that aspect of forestry which most interested him and might lead to a career. There resulted contributions to novel questions or problems which were receiving little attention.

In some cases, such specialized study does not give sufficient opportunity to develop the desired competence in the analysis of forest conditions and a feeling of confidence in the student that he can prepare an adequate plan of management detailing the necessary silvicultural operations to suit present needs. It is proposed that for certain men, those who are candidates for the M.F. in silviculture, the use of a system of "survey cases" be developed. Such have occasionally been used successfully in the past. Their

more consistent use will require the student to exhibit his insight into local forest history and succession, the influence of man's use of the forest on its present character, the silvicultural treatments applicable, and the development of a plan for future care and handling. Such a plan will also require consideration of the importance of local forest insect pests and diseases, of economic and other social factors which must be taken into account.

Candidates in fields other than silviculture would also be required to exhibit a similar proficiency, but would not be required to discuss as large a variety of survey cases. All would enjoy a common training in local land use and forest history announced for the first part of the autumn term. Thereafter the students in physiology would undertake their studies in the special fields of physiology, genetics or soil science, participating, for instance, in phases of research undertaken under the Maria Moors Cabot Foundation for Botanical Research or similar continuing work. Such men would mostly be candidates for the Ph.D., and they would receive the broad training required of doctoral candidates in the Department of Biology.

Students in fields in which other disciplines are of co-equal importance with the biological phases would nevertheless have to demonstrate a satisfactory knowledge of forestry if their record of competence is to bear the certifying characterization of forest ecology, forest pathology, forest entomology, or forest economics.

RESEARCH

It has been remarked that the outstanding progress in research made by the Forest in its first decades was the fortunate result of perception, imagination and insight, of which the highest use followed because of a flexible and adaptable program.

Another circumstance which added to the effectiveness was its pioneer character. When the Forest was first established, it was the only institution which could in any way be considered a forest experiment station.

Forest research has passed its adolescence and now there are numerous agencies engaged in contributing to knowledge. The fields in which the Harvard Forest can make the greatest contribution must be considered in the light of these changed circumstances.

As knowledge increases, the minute details become more important, and the association of results with their causes becomes more complicated. The familiar specialization of knowledge results. The Harvard Forest can no longer blaze trails in virgin areas of forestry but must choose certain fields for intensive working.

In spite of the extensive chain of regional forest experiment stations, the Forest enjoys a unique advantage in its location. Its situation in the transition zone, where species of the northern forest and central hardwood forest intergrade into one another, provide opportunity for a study of the interplay between climate, the species of tree, and the soil.

This advantage of situation, the long series of records covering an unequaled length of time under intensive management, the biological information already bearing fruit, and the promise of further valuable information lead to a single conclusion. The opinion of foresters most familiar with the situation at Petersham

agrees with our views. Research in the methodology of silviculture, adequately complemented by work in the underlying sciences, would be the most effective activity at the Harvard Forest.

The work in the fundamental biological sciences is essential to a developing silviculture. In anticipating the effects of a silvicultural treatment or assessing the probable thriftiness of stands, it is necessary to draw upon the knowledge of physiology and tree characteristics which have resulted from the experimental sciences. These furnish the charts to which the silviculturist refers in explaining the presence or absence of trees, poorer or better growth, susceptibility or immunity to disease and insects. As such fundamental knowledge becomes more sure, so does the assurance of success in treatment of the forest.

Research in silviculture should be broadly oriented from the standpoint of economic wood production, from the considerations of profitable enterprise associated with private ownership. The silvicultural procedures and techniques approved and recommended by the Forest, as a result of research, always have been required to meet the test of soundness and worth from a business standpoint. Research in silviculture so oriented best fits the needs of instruction of candidates for the professional degree (M.F.), and contributes towards the most effective collaboration with workers in forest economics at Cambridge.

DEMONSTRATION

The forest stands which were used as the research material were naturally studied intensively; these, together with the areas under routine development toward sustained yield, have become highly valuable for demonstration to the lay public and to the professional visitor. These exhibits of silvicultural practices and of discoveries in soils and tree physiology of Professor Fisher,"..... translated the developing technique of

H.F., Jan. 6, 1940

Memorandum: PHYSIOLOGY IS FUNDAMENTAL TO SILVICULTURE.

We speak of the "art of silviculture" and the "science of tree physiology." The essential difference between an art and a science is the precision of the prediction--the certainty with which one is able to state that a given cause produces a given effect. Of all the applied sciences probably the electrical industry is the most precise. That is, when we design an electric motor, we can state with a high degree of accuracy that, given so many feet or miles of copper wire wound in a certain way on so much iron of a given magnetic quality, a given number of kilowatts will be used to produce a certain starting torque and a given brake horsepower. Similarly, for electric lamps, radio equipment, etc. the electrical designer can, on the basis of his drawings and his computations, get a given result. As we go into other applied technologies--chemistry--there is more uncertainty in result. Factors of temperature, pressure, time, concentrations of reacting substances, etc. give rise to greater uncertainty. This arises because of the fact that there are more factors involved; these factors are mutually interdependent and, taken together, comparatively slight deviations in each combine to give a major variation in the end result. As we pass from electrical engineering to chemical engineering, to mechanical engineering, to meteorology, to biology, the uncertainties increase.

How then do the underlying sciences help? I think it is because they furnish certain background patterns against which we project any given situation and thus adjust the working concepts against our understanding of the fundamental design. Perhaps I can illustrate this best by an example from the experience of my sister while an interne in the Albany Hospital. She related an incident concerning a hysterical woman who was brought to the hospital after three days of giggling and laughing and was nearing the point of complete ex-

haustion. It was decided that oxygen treatments might help, but apparently there was a secondary condition which prevented the usual use of oxygen. It was necessary to use varied mixtures of nitrogen and oxygen. My sister related how as she manipulated the valves for changing the tensions of gas being given to the woman there came to her mind a picture of a student experiment on a guinea pig in the laboratory. It seemed that as an experiment they had connected an electrocardiograph and a respirometer and several other devices to the guinea pig as they changed the oxygen and nitrogen tensions and observed the changes. (The results of the changes had been graphed in various ways. My sister said that as she worked with the patient, she saw mental graphs of the effects on the guinea pig as the tensions were adjusted. The mental picture of these graphs formed the background against which she projected the reactions of the patient on the table in the operating room.

To my mind the data on tree physiology and morphology form the background in the mind of the silviculturist against which he projects his picture of what a given silvicultural operation will do to the stand.

Thus we may list on one hand a series of silvicultural concepts and on the other certain concepts from physiology or morphology which form the background:

Silviculture	Physiology or Morphology
Reproduction	Mycorrhizae
-Early hardiness	Water uptake
-Tolerance	Transpiration
-Site quality	Mineral nutrient uptake
(water supply)	Growth efficiency
)soil fertility)	for each nutrient element
Stand composition	for solar radiation
Afforestation	Composition of foliage
-Form	Litter decomposition
-Density	by soil flora
	by soil fauna
	Auxins
	Phototropism

The concepts listed under physiology and morphology are so interdependent that it is impossible to discuss completely any single silvicultural concept with the aid of but a single concept taken from physiology.

Thus when we attempt to discuss methods of obtaining reproduction, we have to consider the possible effects of mycorrhizae and water uptake and mineral nutrient uptake, the growth efficiency for solar radiation and the probable balance between the rate of photosynthesis and the rate of respiration. Under certain conditions, if water is presumed to be the limiting factor in obtaining reproduction, we have to introduce the concept of water uptake and rate of transpiration. If the mechanical condition of the seedbed is important, then the composition of the previous stand and its effect on mechanical structure and the availability of the various mineral nutrients which were due to the composition of the litter and its destruction by soil flora and soil fauna all become important. In anticipating the probable effect of a thinning as a preparation for reproduction, all these concepts of the fundamental botanical science have to pass through the mind of the silviculturist, and he must be prepared to estimate the importance of each and every one of them in its influence on the desired result. Since these factors are so numerous and each of them is known with such little uncertainty, forestry is therefore an art and not a science. The success of the silviculturist when confronted with problems of intensive silviculture will depend upon his ability to combine the fundamental science and experience.

If the fundamental science is wrong, for instance, if he has learned and still believes that the nutrients of the tree are taken up through root hairs and not by mycorrhizae, he will have no picture

of the possible influence of changing light intensity on the nutrition of the mycorrhizae and will therefore say that the light intensity is of no importance whatsoever in obtaining reproduction. He will insist that the whole question is one of water supply and that trench plot experiments prove this conclusively.

Or in a discussion of hardiness of seedlings, he will entirely neglect the complex of mycorrhizae, mineral nutrient uptake, the concentration of the nutrients in the plant substance, growth efficiency for the important nutrient elements--all of which influence the osmotic pressure of the tissues and thereby influence the frost resistance of the tissues. Under such circumstances the background information used in determining which the possible frost hardiness of material planted in a given locality is determined will be quite misleading. The previous history of the plant material in the nursery will have been ignored, and nothing except the possible factors of exposure to cold air and the probable influence of mechanical shelter will be considered.

In considering tree form one is apt to think wholly of the light well in which the tree is growing. One unfamiliar with tree physiology would neglect such factors as the probable difference in tree races as to their form. This in turn is probably based on a difference of rate of auxin production in the growing points of the branches and numerous present unknown factors which have to do with the relative rate of growth substance destruction by light in various tree species and races, the possible differences in concentration which may affect branch development, and a whole chapter of plant morphology which Professor Wetmore tells me has been taken for granted but which on examination he finds to be full of unsound assumptions.

In talking glibly of site quality, we are up against one of the most complex pictures with which we have to deal. With the possible

exception of phototropism, each of the concepts listed under physiology and morphology comes in.

As I see it, the task of the forest tree physiologist is to expound the fundamental facts of his science and thus to place in the hands of the teacher of silviculture the material which he can use to make more clear to the student the background against which the student as a working silviculturist must assess the operations which he plans. Only if the student has a correct fundamental background can he correctly attempt to explain what a given operation has done to the stand and thus rationalize his experience so that as he becomes older the experience can be assimilated and utilized in meeting new situations where appropriate silvicultural operations are to be used.

"morgan report"
PRG Dec. 9, 1939.

N.B. Not smoothed words duplicated etc.

Since work in forestry was introduced at Harvard University in 1903 the activities have taken several different forms. Each change was designed to accomodate the program to the rapidly changing development of forest education in other institutions and the activities/program/undertakings/work of the United States Forest Service. During these thirty-six years continuous readjustments have been made in the three parts into which the forestry program has somewhat arbitrarily been divided: instruction od students, rsearch for the advancement of knowledge, and demonstration of improved practices to the lay public and to professional foresters.

(1)

Instruction in all the branches of forestry required for the professional degree of Master of Forestry was offered from 1 1903 to 1915. During this period the resources/of the Forest School//at Yale//University // and several other universities/ were notably increased. The work at Harvard was therefor altered to provide for advanced study in special fields, and elementary instructin tion in all branches was discontinued.

The proprties at Petersham were acquired in 1907. As an institution for "clinical" instruction and for research it was unique. At that time there was no other forest experiment station in the region and no school offered/ such ample to the student contacts with a working forest. Its reputation has grown steadily and to name the Harvard Forest brings to the mind of foresters everywhere the thought of a high development of the art of silviculture and progressive contribution to the fundamental sciences.

The abandonment ~~in 1915~~ of undergraduate instruction

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in 1915 led to the use of student research as a method of instruction. There resulted contributions to new questions or problems which were receiving little attention. In bulletins and journal papers appeared reports on methods for the treatment of young hardwood stands ariginating as volunteer growth after cutting, the reclamation of pine plantations affected by the weevil /(pissodes)/, the planning of ⊕pertaions for local wood-using industries, the markets for locally grown lumber and the kinds and amounts brought in from other parts of the country, the rate of growth and the production per acre of various species locally important, actuarial information necessary to consideration of insurance of forests against fires. These are examples of the professional problems in phases technically designated as silviculture, forest managment, utilization and marketing, forest mensuration (measurement of growth and yield).

(((Note: Alternative style:
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In such underlying sciences as entomology and ?? pathology ?? , soil science, tree physiology and genetics, and the associated field of wildlife management were contributions to our understanding of the life history of the weevil attacking young seedlings and small twigs (pales weevil), the common weevil attacking the leading shoot of pines(pissodes weevil), the gypsy moth, wood borers,

soil changes under pine and coniferous forests, the function of the curious symbiotic a ssociation of tree root and fungus in the morphological structure called a "mycorrhiza" , the chemical elements necessary for growth and effects of differeing amounts of solar radiation, the food habits of deer and grouse.

When many of these contributions appeared they were pioneer studies. As in all new work, it is first necessary to see the need for information, define the problem, and determine the elementary facts. Later, as information increases, and ~~xxxxxxxxxxxxxxxx~~ becomes more precise, minor variations become more important. It is no longer possible for one person to understand the whole: specialization follows. So it now is with many of the subjects to which the Harvard Forest was able to make effective contributions in the earlier days.

It now becomes our task to assess the/possibilities/ directions in which we can make the greatest contribution in the near future. Our past contributions were the result of insight and imagination, a flexible program which enabled us to follow promising leads and the availability of the essential facilities which were relatively crude. The same acumen ///ability to see and define problems we trust we still have. The flexibility and adaptability we wish to cherish. One of our problems is to provide the facilities which, as the scientific work advances, become necessary to attract the outstanding students and collaborators we would welcome at Petersham.

Out of the many possibilities which could be encouraged, we choose as most worthy of development work in silviculture and certain as pects of soil science and tree physiology. These subjects are not separate, they are merely

the applied and basic science aspects
the art of developing forest biology sciences.
the applied/and a selection from the basic science aspects
of forest biology. In them notable achievement/appears // is //
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Before passing to ~~those facts~~ a discussion of the resources necessary to an increasingly effective program, there is introduced a short discussion of the suggested development of each the three traditional phases of research, instruction and demonstration.

<u>An experiment station for research in forestry and allied fields.</u>

December 1939

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A PLAN FOR THE HARVARD FOREST

Since instruction in forestry was first offered at Harvard in 1903 the work has taken several different forms. Each change was designed to accommodate the program to the rapid development of forest education throughout the country and to the increasing activities of public ~~research~~ and demonstration agencies. During these thirty-six years continuous readjustments have been made within the three parts into which the forestry program has somewhat arbitrarily been divided: instruction of students, research for the advancement of knowledge, and demonstration of improved practices to the lay public and to professional foresters.

Instruction in all the branches of forestry required for the professional degree of Master in Forestry was offered from 1903 to 1915. During this period numerous educational institutions established courses in forestry, most of them undergraduate. The work at Harvard was therefore altered to provide for advanced study in special fields; and elementary instruction in all branches was discontinued.

The properties at Petersham were acquired in 1907. As an institution for "clinical" instruction and for research it was unique. At that time there was no other forest experiment station in the region, and no school offered to the student such ample contacts with an organized forest. Its reputation has grown steadily, and to name the Harvard Forest brings to the mind of foresters everywhere the thought of a high development of the art of silviculture and progressive contribution to the fundamental sciences.

Student research as a method of instruction was substituted

for elementary instruction in 1915. There resulted contributions to new questions or problems which were receiving little attention. In bulletins and journal papers students and staff members working together reported on methods for the treatment of young stands originating on cutover land, the control of the white pine weevil through silvicultural measures, the planning of cutting operations for local wood-using industries, the marketing of locally grown lumber, the rate of growth and yield of various species locally important, and actuarial information on the insurance of forests against fire. These are examples of the professional problems in phases of forestry technically designated as silviculture, forest management, utilization and marketing, mensuration (measurement of growth and yield), and economics.

In such fields as entomology and pathology, in the underlying sciences--soil science, tree physiology and genetics--and in the associated field of wild life management there were contributions to a knowledge of the weevil attacking young seedlings (Pales weevil), the Pissodes weevil, the gypsy moth, wood borers, and wood-destroying fungi, of soil changes under pine and hardwood stands, the function of the curious symbiotic association of tree root and fungus in the structure called a mycorrhiza, the chemical elements necessary for tree growth and the effects of differing amounts of solar radiation, and the food habits of deer and grouse.

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tion follows. So it is now with many of the subjects to which the Harvard Forest was able to make effective contributions in the earlier days, contributions which were the result of insight and imagination, a flexible program which enabled us to follow promising leads, and the availability of the essential facilities which were relatively crude.

It now becomes our task to fix upon the subjects in which we can make the greatest contribution in the near future. Out of the many possibilities, all of which are represented in our past interests/ contributions/ we would choose silviculture and certain aspects of soil science, tree physiology, and genetics.

This field of concentration is not advocated because it was the earliest concern of the Harvard Forest and the one to which it has made outstanding contribution, although this is an important matter. Nor is it chosen because the facilities and interests of the Department of Biology in many places touch very closely on this field and may well make possible outstanding joint contribution, although such might be important considerations. The resolve to concentrate in silviculture and the complementary fundamental sciences arises from the observation that there is an urgent need in the forestry profession of more of working biology.

Thruout the ranks of the public agencies and the private foresters, in the elementary instruction in forestry, and in the attempts to demonstrate to the lay public desirable forest practices, there is to be observed a notable lack of attention to biology. There seems to be little recognition that although forestry may need more able administration and is impeded by economic factors, yet there can be no forestry without the biological base.

Assistance in the development of more able public forest administrators can come through participation in the program of the

Littauer School of Public Administration, by providing to its students an understanding of the natural laws of biology which cannot be transgressed. By the leaven of such training and of demonstration, it may be possible to permeate the public forest agencies with a sense of the importance of the living material ~~/ biology /~~ with which they are dealing: silviculture as the art of applying forest biology to the woods and basic sciences on which forest biology is grounded.

The manner in which such a concentration of activity will affect the Harvard Forest program is, in the following, treated under each of the three traditional phases of instruction, research, and demonstration.

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In the course of such studies, forest stands were studied intensively and certain treatments initiated. These, together with areas under routine development toward sustained yield, have become highly valuable in demonstrating silvicultural practices and the discoveries in soils and tree physiology.

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