

gas inside the bulb. A small fraction of a millionth would be sufficient, and this might escape detection by the pressure gauge, on account of the necessary compression in the gauge head causing absorption by the glass. Again, etherion must always be present to some extent in all 'vacuum tubes' (as well as in my own conduction bulb), on account of its long continued evolution from glass, and may be the medium of propagation of the Röntgen rays in the vacuum glass and air.

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FORESTRY.*

EVER since the American Forestry Association was formed at Cincinnati, in 1882, the need of providing for forestry education has been a favorite topic at the meetings. There were those who wished to make the subject a part of the studies in the public schools, and others who desired the establishment of special schools, either separate or in connection with other educational institutions.

Fortunately for our public schools and over-burdened school teachers, who are struggling not always quite successfully to do justice to their legitimate functions, the schemes of our enthusiastic forestry reformers in the first direction have not matured beyond the introduction of an Arbor Day celebration, perhaps an occasional reading or talk, quite sufficient to call the attention of the young mind to the existence and significance of the subject.

Those who had higher aims and expected that the existence of technically educated foresters would pave the way to the application of their art contemplated, in their philanthropic desires, the sacrifice of the individual to the cause; for unless the students issuing from such forestry schools

* Read before the American Forestry Association at Boston, August, 1898.

had other means of subsistence, their bread, if they could earn it, would hardly have been buttered through their knowledge of forestry.

It may be set down as an axiom that the employment of any specialist in a technical art comes, as a rule, when the economic conditions are ripe for such employment.

In the United States the exploitation of all resources has, as in every newly-settled country, been carried on without the technically educated specialist; until 1870 or thereabout mining engineers were a rarity, and the exploitation of the soil by agriculture has only just begun to be considered an art; agricultural rapine is still largely the practice, just as the natural resources of the forest are and will be still for some time the object of the lumberman's rapine.

When does the time for a change come? When does it become necessary to employ skill and art in the use of our resources? These are difficult questions to answer. In a general way, from the standpoint of the individual the answer can only be one, namely, 'when it pays;' a consideration of supply and market conditions determines for him when his financial interests are best subserved by the use of greater skill and knowledge. He may not always recognize the right moment, but it would be a profit calculation which would have to be employed to persuade him of its arrival.

From the standpoint of the community, the State, the financial consideration may be quite secondary; the interest in the preservation of certain favorable conditions may justify an expenditure, a sacrifice of the present for the sake of the future.

It was the recognition that such an interest existed which induced the State of New York to take a first step with regard to her forest resources thirteen years ago by ceasing to dispose of the forest lands which the State had unwillingly acquired through

non-payment of taxes by the owners. A further recognition of the importance of this interest followed two years ago by establishing the policy of land purchases for the increase of this area, under which policy one million dollars was expended last year and half a million is at the disposal of the Forest Preserve Board this year, while it is expected by further purchases to increase the State forest property to three million acres, more or less. This year a further, logical step in the pursuit of this State policy was made by establishing a forestry school for the professional education of the managers of this State property and an experimental forest area, in which the method of managing the property might be developed and elaborated.

This school, the New York State College of Forestry, has the distinction of being the first institution of its kind in this country where a professional study of the whole subject of forestry in all its phases may be pursued with opportunities almost equal to the best in European forestry schools, except for the absence of object lessons, which it will take some time to create.

Thus, while the art of forestry is as yet hardly practiced, a place for the study of the science, which must underlie the application of the art, is established; and this entails the moral obligation upon the State to proceed on its path to a technical management of its forest property.

We may recall that the original forestry law of New York, which was mainly drafted by the writer and passed in 1885, contemplated a technical forest management of the State property and hence conferred upon the then established Forest Commission the right to cut and sell wood.

But no professional foresters were employed and no technical forest management was attempted; the right to cut and sell was exercised simply in selling stumpage of spruce to lumbermen.

The public, laboring under the mistaken notion that forest preservation required cessation of all cutting of trees, and not trusting to the discretion of its officers—rightly or wrongly—attempted to remedy the absence of technical advice by inserting into the constitution of the State a clause which prevents all cutting of wood on State lands—a foolish provision from the forester's point of view, but perhaps, from the standpoint of expediency at the time, not entirely reprehensible.

It became apparent that, before a rational forest management could be secured, it was still necessary to educate the people first to a true conception of what that involves; that an object lesson was needed in order to show that forest preservation did not mean 'Woodman, spare that tree,' but 'Woodman, cut those trees judiciously;' in other words, that forest utilization and forest preservation by means of forest reproduction were not incompatible.

Imbued with this idea, the Superintendent of the reorganized or consolidated Fisheries, Game and Forest Commission, in his report for 1896, suggested the establishment of such a demonstration of technical forest management.

Governor Black, taking interest in the proposition, conceived the idea that such an experiment, requiring a long time of continuous, unchanged policy, had best be removed from the ever-changing influences of politics and should be entrusted to a strong and stable educational institution.

This thought suggested the desirability of going a step farther, namely, to provide at the same time for the education of professional foresters, the future managers of the State's forest property, when, with the accomplished demonstration and the existence of competent technical advice, the constitutional bar to rational forestry might be removed.

Cornell University was selected to under-

take the experiment; a bill was drafted and introduced into the Legislature early in February, was passed and received the Governor's signature in April; and on the 16th of that month, by action of the Board of Trustees, the University accepted the responsibility and established the college by election of the writer as its director.

Although a State institution, and as such dependent upon appropriations provided by the Legislature, the College, while having its own separate faculty organization, is organically connected with the University and has the benefit of the entire apparatus of the same with the 180 or more professors and instructors, at least 30 of whom will be called upon to furnish instruction to students of the College in fundamental and supplementary sciences.

In thus connecting the forestry school with a fully equipped university the most advanced German ideas in forestry education are realized. While in that country, in which forestry is most advanced, only three of the nine higher schools of forestry are located at universities, it has become more and more apparent to the educators, even to the directors of the separate institutions, that the advantages derived from the broader education and fuller equipments of universities far outweigh the advantages of the separate academy, which were mainly seen in their location near the woods and demonstration areas. It is now recognized that with modern methods of communication the woods can be more readily reached from a railroad center; that at any rate only a limited amount of practical instruction is possible at the school, wherever situated, the practice coming preferably after a thorough theoretical instruction; and, finally, that the local isolation of the academy is a detriment both to professors and students by its mental isolation. At the university the courses in fundamental and supplementary sciences, which include

mathematics, physics, chemistry, geology, botany, zoology, political economy, engineering, law, can naturally be more thoroughly provided.

For the present there are three teachers of forestry provided at the new college, namely, the director and two instructors, with the possibility of using the manager of the demonstration or college forest to assist, although the distance of the latter would make such participation of the manager in educational lines possible only during summer courses and on excursions to the school forest.

This teaching force is equal to the lowest requirements and can be satisfactory only in the beginning, while the college is in its infancy. The best German institutions have four and five full professors, and only the less favored are satisfied with two full professors of forestry, who are then not burdened with administrative functions.

The University of Munich has six professors of forestry, of whom two, however, are teachers of dendrology and soil physics, which are not exactly forestry branches, but form fundamentals to be taught in the departments of botany and geology.

A satisfactory organization which would do justice both to the teaching and the investigation work, such as is here even more needed than abroad, would require three full professors with at least two instructors or assistants corresponding to the three groups into which forestry subjects can be divided according to their bases, namely: those which are mainly based upon natural sciences and are concerned with forest crop production—silviculture, forest protection, timber physics; those which are mainly based upon mathematics and engineering knowledge and are concerned with the practical management of a forest property—forest exploitation, forest mensuration and forest regulation; those which are mainly of a philosophical character, requir-

ing a full appreciation of all the bearings of the subject, under which head forest administration, forest valuation and statics, history, statistics and forestry politics may be grouped.

The assistants would find ample work in aiding the professors in the lecture room, on excursions or practical demonstrations and in carrying on special investigations.

In spite of the present deficiency in the faculty, which is, moreover, on account of the deficient appropriations—\$10,000 for the first year—limited to the director and only one assistant professor, who acts also as forest manager, the courses of studies announced have been nevertheless made full, comprising twelve courses, the expectation being that no students for the senior year will be ready before the deficiency in the faculty may be supplied under increased appropriations.

The course of studies leading to the degree of Bachelor in the Science of Forestry has been made to cover four years, corresponding in this particular also not to the general practice, but to the most advanced ideas of German educators in forestry. In this course the first two years are entirely given up to studies of the fundamental sciences, while forestry subjects and supplemental studies are left for the last two years. This arrangement has the advantage that forestry students may lay their foundations at any other institution, and, also, should any entering upon the course for some reason desire to abandon their purpose they will not have wasted any time on the specialty, but find themselves prepared for any other study involving natural sciences as a basis.

The required fundamental and supplemental courses comprise altogether about 1,270 hours, to which 450 hours' supplemental work are added as elective but desirable, while the forestry branches represent about 600 hours, of which 130 are

optional, making an average of about 17 hours per week of required and elective work.

In the fundamental branches, botany, chemistry and geology, with allied sciences, require the foremost attention, while a considerable amount of time is given to mathematics, entomology, political economy and engineering, especially map-making and road-building. It is also proposed to add a course on pisciculture and venery, since the future forest managers, at least on the State property, will undoubtedly have charge of the taking care of fish and game, which generally or often form parts of a forest property.

While these full courses are designed to equip, as completely as may be, managers of large properties on which wood-cropping is to be carried on as a business, the College will also endeavor to satisfy other classes of students who desire only a more or less cursory knowledge of the subject or some of its branches, such as students of political economy, or owners of timber lands, who wish to practice at least silviculture. Finally, the requirement of the law, which prescribes that the College shall impart the results of the management of the demonstration forest, will be construed to mean that the function of the College is to pull up the stumps of ignorance regarding forestry wherever they present themselves; the University Extension spirit will prevail.

Later, it may also establish summer schools designed to educate foremen and under-foresters in the principles of forestry, an educational move which is as much needed as that for the training of forest managers, for which the College is originally designed to provide.

The one drawback under which the College will labor at first and for some time to come is the absence of object lessons in the field, the demonstration of principles applied in practice. To be sure, a demonstra-

tion area of 30,000 acres has been set aside in the Adirondacks, which will in time supply the deficiency—sooner in some directions, later in others, since results in forest management are as slow to accomplish as the slowness of the crop would lead us to expect.

Since, however, the conditions in the Adirondacks are special, not only on account of the topography and climate, but because of the few species of timber trees involved, this one demonstration area cannot suffice, and in order to get variety of conditions other areas will have to be secured.

This does not necessarily imply purchase of such areas by the State; it will be possible by and by to secure the cooperation of private timber-land owners, who may permit the College to prepare working plans for their lands and may be willing to apply forestry principles in their management, first, in that generous spirit by which all our educational movements are supported, and finally because of the financial benefits they may derive from it.

There are now some such attempts at forest management to be found in various parts of the country which may be visited by the students during excursions in vacation time. Finally, a visit to the European forests under management will be found profitable to students at the end of their studies, and with full theoretical knowledge to guide them even a brief visit will be full of interest and educational value.

The demonstration in the Adirondacks, as far as forest regulation and administration is concerned, may be made to form a pattern for almost any other region; as far as *silvicultural* methods are concerned, its teachings will be applicable not only to the entire Adirondacks, but to a large part of the New England forest areas, in which spruce is or has been the principal timber tree.

It may be interesting and useful for a fuller conception of what is involved in forest management to point out briefly what the policy and *modus operandi* to be pursued in the college forest is to be.

The leading thought in the management of a forest property is *permanency*, for it contemplates the devotion of the soil to the continued production of a crop, which it takes a century, more or less, to mature. Hence all plans and all operations must take into consideration a long future and all preparations must be made, as for a stable, permanent conduct of a business, unlike those of the lumberman, who exploits the forest only as a speculation, who is not in the business of forest or wood production, but is a mere harvester, the difference being similar to that between the breeder of cattle and the butcher.

The first business of the forester, then, is to become thoroughly acquainted with all the details of his property. He must study its topography, with special reference to the possibilities of making every part accessible to market at any time for its various products. He must know its soil conditions to judge of the variable productiveness of each acre; its forest conditions, to give an insight as to the kind of operations required in each part, in order that the forest may be brought into most productive condition; its contents of merchantable material and rate of growth to determine the amount of annual harvest, which a conservative management will permit. This forest survey is made in connection with or preferably on the basis of a topographical survey.

Next comes the task of preparing the property for an orderly and systematic business conduct by dividing it into subdivisions or compartments of smaller or larger area, business units, which may be designated by letters or numbers, just as the blocks and houses in a city or the rooms in a hotel are numbered for con-

venient administration. The subdivisions, based on topography, difference of soil, forest conditions and other business and silvicultural considerations, may or may not at first be permanently designated in the forest, but finally they will be so fixed, not only on the map, but on the ground, and, possibly, by opening lanes between the compartments, which are preferably so located that they can be used as roads. In the end, the ideal organized, managed forest will look not unlike a city with streets, making every part of the property readily accessible. In practice this ideal may never be quite attained and temporary means of transportation, like rope-ways, movable railways, log-slides, etc., may be substituted for the roadways, where more practicable, just as elevators supplant the stairs in the apartment and business house.

While this more or less geometrical and arithmetical basis for management is laid and partly, as a result of these data, collected, the general policy of management is determined upon and finally its progress is regulated by working plans, for a more distant future in general and for the nearest future in detail.

The manner in which this forest regulation proceeds may be as follows:

We have to deal in the Adirondacks with a mixed forest of hardwoods, birch, maple and beech, in which spruce forms a prominent admixture, sometimes at high elevations, the latter occupying the ground almost exclusively; and of other useful species, not merely weeds, white pine, fir, cedar and aspen occur more or less scattered or in groups.

We come to the conclusion that, all points considered, the spruce in these mountains is the most valuable timber, with the other conifers desirable concomitants, the hardwoods, although now in preponderance, being less readily marketable; and we also consider that this relative value of the

species will continue for the future, since the use of the spruce for paper pulp, with few desirable substitutes known, promises continued market for even the inferior material.

Hence we formulate our silvicultural policy: The management is to be based for spruce. It is to be the endeavor to change from the present condition of hardwoods with an admixture of spruce to spruce with an admixture of hardwoods, the admixture being considered desirable for various reasons, among which specially counts the danger to which the shallow-rooted spruce is exposed from winds, which is alleviated by association with other species.

To carry out this policy it is evident the hardwoods must be numerically reduced, the conditions for the reproduction of spruce made favorable and the young growth of spruce favored by subduing its competitors—operations which require the highest skill of the silviculturist.

At the same time the administrator's care is to secure a market for the hardwoods and the means of transporting the same cheaply enough to at least pay for their removal. In this respect it is not enough to sit still and wait for the consumer to come, but active canvass and perhaps reform in the methods of the market and the utilization of the product may be necessary. There are as wasteful methods still to be found in the market and the manufacture of wood materials as in the exploitation in the forest, and reform in the latter direction depends largely on reform in the former. A study of the market, therefore, of its requirements and possibilities of change is most essential for the successful forest manager.

A further formulation of silvicultural policy is as to the kind or system of management under which the reproduction is to be secured. There are two general classes possible. Cutting away the old growth and

planting a new crop just as wanted appears the simplest system. Yet, aside from other flaws which adhere to this method, it would under our conditions of labor be too expensive to employ, except on such areas as are now denuded or devoid of desirable species, or else for demonstration of methods and results. In such cases other species adapted to the locality and promising both silvicultural and financial success, among which especially is the white pine, would be favored.

The other class of management for reproduction, which depends upon natural seeding from the trees on or near the area to be reproduced, offers several methods, among which the method of selection in which mature trees here and there selected through the forest, or certain parts of it, are taken resembles most the lumbermen's present method, except that he is influenced only by the marketableness of his trees, while the forester keeps foremost the benefit to the young growth that is left. This method is especially adapted to those portions which are situated on the high elevations, crags and heads and wherever it is dangerous to expose the soil. Modifications of this system, for instance one in which groups of trees are removed and the reproduction, therefore, is secured by clumps rather than by single individuals, may be acceptable in other parts of the property, and finally for the sake of demonstration all other systems of management, such as the strip system, the nurse-tree system, etc., may be practiced on smaller or larger areas.

One of the most difficult and important questions to be determined, especially with regard to financial results, is the rotation, *i. e.*, the age to which the crop is to be allowed to grow before utilizing it. Unlike other crops, the harvest time of which is determined by natural limits, their ripeness, the harvest of the wood crop is not so

circumscribed. There is a choice as to when to harvest it, into the making of which a number of considerations enter. First, of course, useful size is the main consideration; the production of hoop poles, hop poles, vineyard stakes may be satisfied by a ten to twenty years' growth; railroad ties may be secured in thirty to forty years, and so on. Where reproduction from seed is expected, the age at which frequent and prolific seed production takes place, maturity in the sense accepted for animals will set the lowest limit; finally, however, since the business of forest production is mainly carried on for financial results, the financial rotation must be determined, *i. e.*, that time at which it pays best to harvest the crop. Quantity of production as well as change in quality, both of which are variable with age of the crop and market conditions, influence its choice. A series of measurements of the rate of growth of the wood crop and calculations based on them and on cost of production and administration and consideration of market requirements, present and conjectured future ones, lead to the adoption of this regulator of the time element in reproduction.

These calculations may lead us to adopt a rotation of eighty years for parts of our school forest of spruce with hardwoods and 100 years or more for other parts; that means we would distribute our fellings in such a manner that by annually or periodically equal or nearly equal amounts we remove all the wood that has been produced during the period of 80 or 100 years respectively, taking care that as much wood is left to form what is called the normal stock of wood, the working capital of wood necessary to secure by annual accretions the most desirable and profitable production of which the property is capable.

These calculations also lead finally to the conclusion as to the amount of wood that may be annually or periodically cut without

reducing the normal stock or wood capital and representing, as it were, the interest. We may, for instance, come to the conclusion that on our 30,000-acre tract an annual felling budget of two to three million feet, B. M., of logs and eight to ten thousand cords of wood may be indicated, for which we must secure a market. It may also be found that the working capital of wood, an accumulation of capital and interest for centuries as found in the virgin forest, is unnecessarily large, beyond the normal, and hence should, for good business reasons, be as quickly reduced as it can be done profitably, or else if we have to deal with cutover lands we may have to reduce our annual cut, saving gradually enough to first establish the desirable working capital.

Finally, when all these bases for operation are ascertained we may formulate the working plans and decide not only on the quantities to be cut, the operations of improvement required, the manner of conducting the whole management, but also determine in what portions of the property the principal activity is to be exercised during the first ten or twenty years, leaving it to the future manager to modify the plans as experience and changes of condition indicate.

That a well-planned bookkeeping is necessary if we would want to know how our business progresses is self-understood. Not only is it necessary to keep those accounts of financial transactions which any business requires, but each compartment in the forest must be kept account of, with a separate ledger account to show what material it has furnished, what stock remains in it, what operations it has required and whatever position in the general scheme it takes.

A demonstration and experimental area, as the proposed school forest is to be, will, to be sure, entail many operations which in a mere business forest might be dispensed with or delayed to more opportune time.

Hence its financial results on the whole may not satisfy the financier. No such experiment, it may be asserted, can be made to demonstrate the profitableness of a business; it can only serve to show methods and their results and to furnish the basis and elements for profit calculations. Nevertheless it is expected that the experiment will pay for itself, while furnishing the desirable object lessons both to the students and timberland owners, the citizens of the State of New York, owners of the great State Park, included.

When this experiment is established, and has demonstrated that rational forest management is possible in this country as well as in the older countries, the constitutional bar will undoubtedly be removed and the entire State holdings placed under proper technical administration, with the students from the State College of Forestry its managers.

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GEOLOGY AND GEOGRAPHY AT THE AMERICAN ASSOCIATION MEETING.

II.

14. *Another Episode in the History of Niagara River.* By J. W. SPENCER, Washington, D. C. This paper is a sequel to one read before the American Association four years ago, on the duration of Niagara Falls. It announces the discovery that while the falls were receding from Foster's flats to the locality of the railway bridges the fall of the river reached its maximum of 420 feet by the retreat of the Ontario waters to the north. The return to the present amount of 326 feet was interrupted by the rising of the level of the lake in the gorge to a height of 75 feet above its present level, thus reducing the actual fall of the river to 250 feet. The evidence of this is preserved in the remains of a terrace deposit opposite the foot of Foster's flats and