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SOME PROBLEMS OF FORESTRY.

BY
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So much has been written and said during the past ten or fifteen years concerning the practical benefits and the pressing need of systematic forestry in America that there are very few persons who are not more or less conversant with the subject, broadly considered. The advocates of the movement have been men of such strength of personality, and so earnest and persistent in their efforts to propagate it that their claims for it have come to be generally accepted as accurate and well established. Consequently, there is now a widespread popular belief in the desirability of a system of administration which shall conserve and replenish our wasted forests. One cannot escape the conviction, however, upon an analysis of the situation, that this popular belief rests more upon the strength of personality of the advocates of the movement than upon definite scientific demonstration of the facts. A study of the literature which has appeared during the last decade on forestry reveals much of general statement and comparatively little of data upon which the statement could be

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logically based; that is, the facts have been stated rather than demonstrated. This has given opportunity to the opponents of the movement in the United States for considerable adverse criticism, not only bringing into question the general utility of forests as a modifying agent in the regulation of stream flow and the distribution of atmospheric moisture, but also with respect to the economic features involved in the preservation and replenishment of wood supplies. In many cases there can be no doubt that this criticism has arisen among those who have been thwarted in wasteful methods of production of lumber or worse methods of procuring forest lands from the public domain. In other cases, it would seem that in fairness the opposition could not be assigned to any such axe-grinding motives. Without any attempt to further classify this criticism, for no matter what its source it can ultimately serve but one purpose,—that of more certainly establishing the truth,—I wish to consider for a part of the time at my disposal some of the general facts in the case, and to show as far as time will permit some of the data upon which their promulgation may be justified.

Let us first consider the economic side of the matter. Is the State of Pennsylvania or is the United States justified, from mere considerations of profit and loss, in using the public funds to preserve and replenish our forests? The contention of the critics here briefly stated is that the forest lands of the United States under existing methods will always prove a sufficient source of wood. It is true, they say, that we are now using more wood, several times over, than we are growing, but the rapid development of concrete and other substitutes for lumber will so decrease the demand in the next decade that the supply will always remain ample. If the money we are now expending for the preservation of forestry were to be used in experimenting with these substitutes, the solution of the problem of wood supply would be arrived at more quickly and with much greater and more lasting satisfaction. Structural timber, railroad ties, telegraph and telephone poles, cars, ships, together with a hundred other articles which have in the past been heavy in their demands upon forest products may be and even are more advantageously constructed of steel, concrete, and other alternative materials. The future will see still more rapid advances in this respect, and the contingency of an insufficient wood supply when the next

generation has arrived will have been found to be a mere bug-a-boo.

Now, as to the facts of the case. The only guide for the future in any line of action is judgment based on past experience and present facts.

The United States is using at present 23,000,000,000 cubic feet of wood per annum. This shows not only a greater aggregate consumption of lumber, but increased per capita consumption over ten years ago.

At the present rate of consumption, the supply of standing lumber in the United States, by a liberal estimate on the best available statistics, will last fifteen years or twenty years. This is in spite of the rapid development of concrete and steel construction which has been mentioned, and also in spite of a simultaneous deterioration of quality and rapid increase in price. We grow three-tenths as much lumber as we use and waste; the figures being 40 cubic feet per acre consumed, while 12 cubic feet per acre is grown. Under present administration, the production outside the government forests is decreasing and will continue to do so. Now, assuming that we shall have to depend twenty years from now upon the wood actually grown from year to year,—remembering that in the face of substitution of steel and concrete for wood the demand has increased in the past decade, and keeping in mind the many uses where wood can never be advantageously displaced by other substances,—each person is free to decide in his own mind whether a supply equal to less than three-tenths of the present demand will be sufficient. This problem is not a local one, but is world-wide. Those European countries which have gone farthest in the substitution of other structural materials for wood are importing at increasing cost large quantities of lumber. And with a single exception these countries are taking the greatest care to meet future demands by systematic forestry. Germany, France, and Austria are examples. The exception is England. She has hitherto been able to count with certainty upon outside aid from such near sources as Norway and Sweden. But even England has awakened to the grave problem involved in her future wood supply. In March, 1908, the function of the Royal Commission on Coast Erosion was enlarged so that it should inquire and report

"Whether in connection with reclaimed lands or otherwise, it is desirable to make an experiment in afforestation, and if so, by what authority and under what conditions such experiment should be conducted." The Commission reported at length on the matter in January, 1909. I should like to read portions of a summary of that report appearing in *Nature* (vol. 79, p. 359), as an expert opinion on such general phases of the matter as we are considering.

1. "The afforestation of suitable lands in the United Kingdom, if undertaken on an adequate scale and in accordance with well-recognized principles, should prove at present prices a sound and remunerative investment."

2. "In estimating the profits of silviculture, account must moreover be taken of two facts—the increased consumption of timber per capita throughout the world, in spite of the introduction of alternative materials, and, further, the exploitation, waste, and destruction by fire of the virgin forests, especially those yielding the more important building timbers. Already a noticeable shortage of timber supply has resulted, as is evidenced by steadily rising prices and depreciating qualities in all markets. It seems impossible to escape from the conclusion that this tendency will be continued and accentuated, and that a steady and a very considerable rise in prices may be looked for throughout the present century. The security which afforestation offers for investment is therefore likely to be an improving one, with a corresponding increase in profits. But, to avoid all that is speculative, this prospect has been disregarded in framing our estimates."

The report then proceeds to outline in detail a plan for afforesting a maximum area of 9,000,000 acres, at the rate of 150,000 acres per annum.

The same journal (vol. 79, p. 371) comments on the scheme as follows: "The value of the property in possession of the State at the consummation of the plan would be £562,075,000 or £106,993,000 in excess of the sum involved in its creation, and, allowing three per cent. compound interest on the initial capital expended, the annual revenue would be £17,411,000. These figures include the purchase price of the lands and costs of planting."

In the United States, there are 168,000,000 acres of land which could be utilized for forestry by private or public agency without economic loss. Using the figures of the Royal Commission as a basis this area would at the expiration of eighty years be yielding to the United States Government or its citizens the enormous sum of one and a half billions of dollars. This does not take into consideration the enormous benefits to subsidiary enterprises which depend upon the forests for their raw material.

I would like to show you some of the economic results forestry has achieved in European countries where it is practiced most scientifically.

TABLE I.—EXPENDITURES AND REVENUES OF NATIONAL FORESTS, SHOWING HIGHER PRODUCTIVENESS UNDER LARGER EXPENDITURES.¹

Country.	Total net revenue from Government forests.	Expenditure per acre.	Net revenue per acre.
Württemberg.....	\$ 3,098,428	\$2.05	\$6.60
Saxony.....	2,299,000	3.00	5.30
Baden.....	829,162	3.58	4.42
Hesse.....	744,209	1.25	4.29
Switzerland.....	237,663	1.32	2.55
Prussia.....	17,054,144	1.58	2.50
Bavaria.....	5,128,348	1.99	2.22
France.....	4,737,250	.95	1.75
Italy.....			.33
Hungary.....		.34	.32
Austria.....	5,313,000	.56	.21
Roumania.....	482,600		.18
Spain.....			.17
Sweden.....	1,677,672	.02	.09
Russia.....	21,500,000	.01	.032
United States.....	{ 1905-6	.007	.0001 ²
	{ 1906-7	.0093	.00086

¹ Prepared from the latest available data. ² Deficit.

There does not seem in the light of these facts to be the least doubt that forestry offers an exceptionally lucrative investment where the capital is at hand to establish it on a scale sufficiently large and when the returns may be deferred for a long term of years. These two considerations—large capital and long time—make it almost imperative that the work be done by government agencies.

Not the least of the advantages of systematic forestry would be the prevention of excessive waste of timber now standing, either by fire or in process of manufacture. For every 1000 feet

of timber now cut, 320 feet are actually used. Since 1870 forest fires have destroyed 50 lives and \$50,000,000 worth of merchantable timber per year. The value of young growth destroyed in the same time would now be greater than that of the merchantable timber. These fires could positively be prevented at a cost of one-fifth of the value of the merchantable timber destroyed.

The matter of the advantage or disadvantage of forestry in the modification of natural phenomena is by no means a simple one. Rainfall, drainage, and stream-flow, water storage, and evaporation are always so interrelated and so conditioned by variable circumstances that accurate data is very hard to procure, and even with this given, general deduction or laws applicable to remote regions and periods must be made only with extreme care. Very little accurate data on any of these phenomena as observed in this country is available, and forestry is entirely too young here to furnish much reliable empirical evidence. In Germany and some other European countries, however, a very careful study has been made of phenomena of this sort, and in many Continental countries there is much empirical evidence as to the effect of forests on stream-flow and related phenomena. Theoretically, the casual relation of forests to the modification of natural phenomena may be considered under two general heads,—viz. : influence of forests on general precipitation, and influence of forests on drainage. Either of these would, if considered in detail, occupy more time than I can give to the whole subject to-night.

I. INFLUENCE OF FORESTS ON GENERAL PRECIPITATION.

At the outset it must be admitted that the influence of forests upon precipitation is without definite quantitative solution. There are, however, certain indications both from theory and from direct observation that forests do have a definite modifying influence on the amount of rainfall, and that this influence is in the direction of an increase in the downfall. It is well established that the air strata above forest stations is moister and cooler than over field stations. We would infer, therefore, that the tendency to condensation in a body of air moving over a given stretch of land would be greater over a forest area than over open fields. Is this inference justified? Experience and measurements seem to sustain our reasoning.

TABLE 2.—INFLUENCE OF FOREST AREAS ON RAINFALL IN INDIA.

Name of place.	Distance from the sea.	Mean temperature.				Extreme maxima. ¹	Relative humidity.				Precipitation.			
		April	May	June	July		April	May	June	July	April	May	June	July
Woodless country:	Kms.										Cms.	Cms.	Cms.	Cms.
Lucknow.....	847	30.1	33.3	33.1	30.4	45.8	30	36	54	74	0.5	1.8	13.3	39.4
Benares.....	590	30.2	33.2	32.8	29.7	45.0	41	60	81	82	0.5	1.3	12.0	32.4
Patna.....	445	30.3	31.4	31.4	29.2	44.6					1.0	2.5	10.9	27.8
Barhampur.....	270	29.6	30.1	29.2	28.7	44.1	52	60	75	79	5.6	10.1	24.2	25.8
Wooded country:														
Goalpara.....	427	25.2	25.9	26.9	27.7	35.1	66	77	85	84	14.8	33.6	64.3	50.6
Sibsagar.....	555	23.5	23.3	28.2	28.5	35.6	81	82	83	83	25.9	30.8	39.5	40.6

¹ Mean of two years.

Unfortunately the altitude and slope of the country are not here shown. This incompleteness must necessarily influence the value of the observation, and might affect any deduction to the extent of absolutely reversing our conclusions as to cause and effect.

TABLE 3.—RESULTS OBTAINED IN BOHEMIA.

Time of observation.	Station A (forest glade), 380 metres.	Station B (forest verge), 240 metres.	Station C (field), 380 metres.
February to April.....	Cm. 15.9	Cm. 16.2	Cm. 14.9
May to July.....	18.9	17.1	16.6
August to October.....	20.7	17.2	15.7
November to January.....	21.2	18.8	17.7
Year.....	76.2	69.3	64.9

This table gives the average amount in rainfall for seven years, 1867 and 1868 and from 1873 to 1876 inclusive.

In the years 1879 to 1886, Dr. J. Studika made, in Bohemia, the most exhaustive study of this question which has ever been attempted. The observations were taken from over 700 stations situated at regular intervals throughout the Kingdom. The country was divided into isohyetal zones by lines connecting points of equal rainfall. Then, from the observed altitude and precipitation at a sufficient number of stations in each belt, he worked out the average effect of altitude upon precipitation. He found the mean increase to be 69 mm. for each 100 metres of elevation. He then used this result to determine the theoretical rainfall at each of the 700 stations as it should be if determined by the elevation factor alone, arguing that if the observed rainfall differed materially from the theoretical rainfall thus found, there

is an indication that special agencies other than elevation are at work. Of the 48 stations showing the greatest percentage observed in excess of the theoretical rainfall every one was situated in the most densely wooded portions of the kingdom. A number of other observations in different parts of the globe show apparently the same results. It would seem then as far as available facts are concerned the evidence is decidedly in favor of the theory that forests do increase the amount of rainfall.

II. INFLUENCE ON DRAINAGE.

The principal factor in determining the regularity of stream-flow with a given intermittent rainfall is the storage factor of the area forming the basin of the stream in question.

If the storage capacity of the soil and cover of the basin is large and there is a gradual release of the water stored, a very intermittent rainfall may find its way into the water-courses so slowly and gradually that there is little difference between the stream-flow in the wet season and the dry. If, on the other hand, the storage capacity is low, the water must run into the stream almost as it falls, giving rise to alternate periods of flood and low water.

TABLE 4.—AVERAGES OF WATER CAPACITY, EXPRESSED IN PERCENTAGES OF THE WEIGHT OF THE SOIL.

Depth.	SPRUCE.			Unshaded soil.
	25 years old.	60 years old.	120 years old.	
	Per cent.	Per cent.	Per cent.	Per cent.
0 to 2 inches.....	30.93	29.48	40.32	22.33
6 to 8 inches.....	19.19	18.99	19.30	20.62
12 to 14 inches.....	19.10	16.07	18.28	20.54
19 to 20 inches.....	18.40	16.26	20.16	20.14
30 to 32 inches.....	17.91	17.88	21.11	20.54
Average.....	18.65	17.30	19.71	20.46

If, therefore, the fact be established that forest soils and covers furnish greater storage capacity for water, and if there are no accompanying circumstances sufficiently powerful to offset this fact, then we have made a good case for forests in their relation to stream-flow.

In this table Ebermayer gives the average results of observation extending over a period of two years. Notice that if the top soil be left out of the consideration the averages as shown at

the bottom of the table are in favor of unshaded soil. If the upper layers be included, however, the figures are as follows: Spruce 25 years old, 24.79 per cent.; 60 years old, 23.39 per cent.; 120 years old, 30.01 per cent.; naked soil, 22.39 per cent. Hence, taken all together, the naked soil contains considerably less water than forest-covered soil. Add to this the storage-capacity of forest litter and of moss, which is exceedingly high, ranging from 45 to 80 per cent., we see that the facts are decidedly in favor of forestry. It is well, too, in this connection to remember that for us in the United States the discussion must not be confined to the difference between forest soil and agricultural soil, but must include differences between forest soil and no soil at all. For, in many instances, removal of trees has resulted in the soil being removed by fire and flood until the rock itself has been bared. In such cases, of course, the storage factor has been reduced to practically zero.

The two main accompanying factors are interception of rainfall by the trees, by which only from 80 per cent. to 86 per cent. of the rainfall reaches forest soils, and evaporation. Time will not permit me to consider these in any detail. Let it suffice to show by table the observed action of the latter factor.

FIG. 1.

Monthly evaporation in the fields (upper curve) and woods (lower curve).

This relates entirely to the evaporation from soil in the forests and the soil under the average agricultural cover. In regard to the amount of moisture evaporated by vegetation itself in the two cases, it may be stated that the results are decided in favor of the forests. The amount of moisture evaporated from the foliage of a deciduous forest rarely or never exceeds three times the amount evaporated from a level water surface. Evergreen forests evaporate less than this, while in an agricultural crop

like maize or alfalfa it may reach eight or nine times the amount given off by a flat water surface.

Careful measurements of rainfall and stream-flow were made in the San Bernardino Mountains, California, during the years 1899-1900.

TABLE 5.—PRECIPITATION AND RUN-OFF DURING DECEMBER, 1899.

Area of catchment basin.	Conditions as to cover.	Precipitation.	Run-off per square mile.	Run-off in percentage of precipitation.
Square miles		Inches	Acre-feet	Per cent.
0.70	Forested	19 +	36—	3
1.05	Forested	19 +	73 +	6
1.47	Forested	19 +	70—	6
.53	Nonforested	13—	312 +	40

TABLE 6.—RAINFALL AND RUN-OFF DURING JANUARY, FEBRUARY, AND MARCH, 1900.

Area of catchment basin.	Conditions as to cover.	Precipitation.	Run-off per square mile.	Run-off in percentage of precipitation.
Square miles		Inches	Acre-feet	Per cent.
0.70	Forested	24	452 +	35
1.05	Forested	24	428 +	33
1.47	Forested	24	557 +	43
.53	Nonforested	16	828 +	95

TABLE 7.—ANNUAL RAINFALL AND RUN-OFF ON FORESTED AND NON-FORESTED CATCHMENT AREAS IN THE SAN BERNARDINO MOUNTAINS, CALIFORNIA.

Area of catchment basin.	Conditions as to cover.	Precipitation.	Run-off per square mile.	Run-off in percentage of precipitation.
Square miles		Inches	Acre-feet	Per cent.
0.70	Forested	46	731	28
1.05	Forested	46	756	30
1.47	Forested	46	904	36
.53	Nonforested	33	1,192	69

TABLE 8.—RAPIDITY OF DECREASE IN RUN-OFF AFTER THE CLOSE OF THE RAINY SEASON.

Area of catchment basin.	Conditions as to cover.	Precipitation.	Apl. run-off per square mile.	May run-off per square mile.	June run-off per square mile.
Square miles		Inches	Acre-feet	Acre-feet	Acre-feet
0.70	Forested	1.6	153—	66—	25—
1.05	Forested	1.6	146—	70 +	30—
1.47	Forested	1.6	166 +	74 +	30 +
.53	Nonforested	1	56 +	2—	0

Comment on these figures seems unnecessary.

Switzerland, France, and Italy furnish abundant empirical evidence to corroborate the theoretical results. France, during the years immediately succeeding the Revolution ruthlessly destroyed her forests with the result that she suffered a period of almost unparalleled flood disasters; one thousand of the larger mountain streams became entirely uncontrollable. Eight hundred thousand acres of farm land were ruined or seriously injured. By gradually replacing the forest cover 164 of these are now entirely controlled, and over 600 of the others are showing the beneficial effects of the forests or their water-sheds.

In the deed by which the British Crown conveyed to William Penn and his heirs certain lands in the New World, the tract was called Penn's Sylvania—Penn's Woodland. And it was well-named, for the Pennsylvania of to-day with its great cities, its broad stretches of fertile farm lands, broken by the barren rocky slopes of its mountains and bound together by the vast steel net-work of its railroads, was then an immense forest, broken only by its natural water-courses. Its valleys and bottom lands were covered by dense growths of white and yellow pine interspersed with groves of hickory, poplar, and black walnut. Its mountain slopes bore mighty forests of hemlock, remnants of which still exist. The tops of its ridges in places were covered by hard wood growths of oak, maple, beech, and chestnut. The destruction of this great forest began with the advent of the first settlers. To them it was an enemy to be conquered. With fire and axe the land was cleared for the growing of crops, and, as the sun poured upon the virgin soil there sprang up fields of corn and wheat. Sheep and cattle grazed peacefully where fierce wild-beasts had roamed, and men busily plied the trades of civilized life where a race of wilder men had fought and hunted. Rapidly the clearings pushed toward the mountains, from the East and from the West, until their rocky slopes checked the ruthless slaughter of the trees.

At first very little of the lumber was used; all being burned except that utilized for constructing buildings and fences. Later, it acquired commercial value, and even in the mountains the destruction was more rapid than ever. To-day there is little if any of the State which has not been cut over one or more times.

The land thus cleared, where suitable for agriculture, has

been utilized for that purpose, but where it is steep or rocky it has been abandoned to the mercy of flood and fire. It has burned and eroded until the very bed rock in many places has been laid bare. The sinful waste of the past generation, and the present will be visited heavily upon the next and next and those that follow. Rich stores of coal, iron, petroleum, and gas have been prodigally wasted. But the waste most sinful and far-reaching in its train of evil consequences has been that of the trees and with them the very soil from which they sprang.

Neither the oak nor the hemlock can spring phoenix like from the ashes of its death. The century to grow the tree must wait upon the centuries to replace the soil. And in the meantime what has been the effect of this destruction upon the streams of the State? Scarcely a year goes by without its flood-time and its drought. Last autumn, because of drought, the coal and iron companies were hauling water by the train-load that they might not have to cease operations. Last week flood warnings were sent out along the Ohio and its tributaries that high water might not come upon the people unawares. Pittsburgh has become known as the flood city. The eastern section of the State is but little better. Streams which a few years ago ran with a fairly steady flow now show alternate periods of destructive flood and extremely low water. It would seem that we were in a fair way to repeat the experience of the French people.

The most destructive floods coming as a direct result of forest destruction are the spring floods. The snow accumulates in the mountains during the winter, and in the spring must be melted and carried away either into the soil or directly into the water-courses. In the absence of forests this snow lies exposed to the direct rays of the sun and the first south wind at the advent of spring. The result is that this snow water rushes directly into the water-courses, often before the ice on the stream has been sufficiently softened to pass out quietly. After a hard winter with heavy ice on the streams, and immense quantities of snow on the mountain slopes, these floods become extremely destructive. If the mountain slopes were fairly well covered with trees the snow would not melt away so rapidly, being protected from sun and wind, and, further, the soil being loose and soft would absorb more of the water. Thus the volume of the flood would be greatly reduced, and the water would be reserved for the summer months.

These floods affect directly only the persons and property in the immediate neighborhood of streams. Whatever affects the welfare of any large number of the people of our State, however, must be the concern of all. There are other ways, nevertheless, in which this matter affects very closely those of us who are not endangered personally by high water.

A very important feature is the increased amount of erosion which results from entirely cutting away the timber from the banks of streams and from steep hillsides, which is a direct menace to every citizen of the State. In the first case it results in the banks being eaten into and carried away by the current, in the other case it gives rise to land-slides during periods of excessive rainfall. Take a single glass of Schuylkill or Delaware water during a flood period and set it aside until it settles. Multiply the amount of sediment in the glass by the millions that would represent the number of glassfuls passing in a single hour, and then remember that all this sediment is deposited soon after tide-water is reached. You will then have a faint conception of one of the problems that must be solved in building and maintaining a 35 foot channel from the city to the sea. Now call to mind that at least one-half and possibly two-thirds of this erosion is due to lack of forests and tree protection to the banks of the Delaware and its tributaries and you ought to have a clue to at least a partial solution of the problem. The same argument is applicable to every stream in the State.

We in Pennsylvania and in the United States have sinned grievously in this matter of forests, as we have in many other lines to which our attention has been directed by the late movement toward conservation. Being convinced of our sin, what do we intend to do about it?

Robert Louis Stevenson has written a little fable which I should like to quote in this connection. It is called "The Penitent," and runs something as follows:

"A man met a lad, weeping. 'What do you weep for?' he asked.

" 'I am weeping for my sins,' said the lad.

" 'You must have little to do,' said the man.

"The next day they met again. Once more the lad was weeping. 'Why do you weep now?' asked the man.

" 'I am weeping because I have nothing to eat,' said the lad.

“‘I thought it would come to that,’ said the man.”

Now, being sorry for past wastefulness is not sufficient. Bad as conditions now are, they may become immeasurably worse, and the sooner the work of recovery is begun and the more rapidly it is carried on the more easily shall we meet the results of past indiscretions. We shall need some of the sentiment of Martin Chuzzlewit in this work. The following reads like a bit of inspired prophecy:

MARTIN CHUZZLEWIT ON AMERICA.

“Cheerily! lads, cheerily! Anchor weighed. Ship in full sail. Her sturdy bowsprit pointed true to England. America a cloud upon the sea behind them!

“‘Why, Cook, what are you thinking of so steadily?’ said Martin.

“‘Why, I am thinking, Sir,’ returned Mark, ‘that if I was a painter, and was called upon to paint the American Eagle, how should I do it?’

“‘Paint it as like an eagle as you could, I suppose.’

“‘No,’ said Mark, ‘that wouldn’t do for me, sir. I should want to draw it like a Bat, for its shortsightedness; like a Bantam, for its bragging; like a Magpie, for its honesty; like an Ostrich, for its putting its head in the mud, and thinking nobody sees it’——

“‘And like a phoenix, for its power of springing from the ashes of its faults and vices, and soaring up anew into the sky!’ said Martin. ‘Well, Mark, let us hope so.’”

There is in Pennsylvania several millions of acres of land which is not suitable for agriculture. Most of this land has had the original crop of timber cut from it, and very little of it is, in any adequate way, producing another. These conditions, with their inevitable results, which I have pointed out, are becoming increasingly evident, and it is high time something definite is done to meet and remedy them.

Indeed, work to this end is already begun and in some lines is well under way, and needs only the support and co-operation of the citizens of the State to make it still more effective.

There has been some discussion as to the agency for carrying on the work. Some have contended that it should be done solely by the Government, others, that it should be restricted to

the field of private enterprise. It seems very safe to assert that it could be most successfully accomplished by the hearty co-operation of the State and individual land owners.

In every agricultural community there are areas of greater or less extent not well adapted to cultivation. The banks of streams, rocky ridges, swamps, and steep hillsides all lend themselves to the growing of trees, if such were selected as would be adapted naturally to the environment. There is no doubt that this should be the care of the individual land owner, but since his work would result so largely in a common good, he ought to receive every possible encouragement from the State in its performance. The chief reason why it is so hard to get this work done by individuals is to be found in the lack of immediate financial returns. There is no doubt that money spent in this way would ultimately yield a good return on the investment. But it is just as certain that the average American citizen does not relish having to sit idly by, waiting fifty, seventy-five, or a hundred years for his crop to mature. Wheat or corn under the same conditions would suffer equal neglect. Whatever benefits the community would receive, however, would come while the crop was growing. Therefore, the community or the State could well afford to encourage tree cultivation on those small areas surrounded by improved and seated lands.

One of the ways by which such encouragement could be given is by the remission of taxes on land given over to silviculture. The Forestry Bureau has long advocated such a policy, pointing out that hundreds of thousands of acres of land have been cut over, then the title allowed to lapse because the owners were not willing to pay the taxes for the term of years necessary for re-foresting. It is these lands, largely, that are ravaged by fire, year after year, until the smoke from their burning hangs like a pall over the land. There are various other ways in which the individual might be assisted in this work, as, for instance, the necessary experimentation and selection of properly adapted trees. It would seem that the trees themselves might be furnished entirely at public expense or at least at reduced cost to the individual.

In the vast stretches of unseated forest lands which comprise that part of the state traversed by the Alleghany Mountains, the work is so stupendous and the results so far-reaching as to

demand government enterprise. Considered also from the point of view of water supply, it seems advisable that large tracts lying about the head-waters of our principal drainage systems should at least be under government supervision.

There is at present in the region I have mentioned stretching from Pike and Wayne Counties in the northeastern corner of the State to Somerset and Fayette near the southwestern corner some thirteen millions of acres of forest and uncultivated land. Every acre of it should at the present moment be under the administration of some fixed uniform policy of forestry. The State at present owns for Forest Reserve purposes 875,000 acres, at a cost somewhat under \$2.25 per acre. It is the policy of the State to largely increase these holdings, the present Commissioner of Forestry believing that the State should ultimately own not less than six million acres. This land is gradually to be acquired as it is advertised and sold for delinquent taxes.

Already difficulty is being experienced in obtaining funds for carrying on the work in the tracts already acquired and more particularly in obtaining men—properly trained, active forest administrators. To meet this latter difficulty a forest academy has been established at Mt. Alto on one of the State Reservations, and each year a group having received a special course of training is added to the men available for this work. But the demand is still much greater than the supply and it promises to become still greater and greater as the State adds more and more to its reserves, to say nothing of that demand which will be created by other States and the reserves of the National Government.

It would require more time than I have at my disposal to take up, except in the most superficial way, the work of the State in connection with these lands and its policy for their future development. Just a few words as to the most prominent features.

First and foremost is the care of the forests now standing and the various stages of growth. The tangle of brush, interwoven with slashings left by the lumbering operations is particularly susceptible to fires in the dry autumn month after the leaves are dried and fallen. Brush, dried tree-tops, and the humus of the very soil itself serve to feed the flames. Once started; unless precautions are taken beforehand, a fire in such a growth must be left to burn until a change of wind or heavy rainfall extinguishes it. To provide against this, fire wardens or rangers

are provided to see that persons guilty of setting such fires purposely or through carelessness are apprehended and properly punished. Also fire roads are cut and kept free from brush and inflammable material; as the flames reach the roads they either die from lack of fuel or are easily extinguished at such places as they may succeed in crossing. Also improvement cuttings are made. In doing this the trees are thinned out. Inferior or dead ones are removed and the lower branches are cut so that the trees may furnish longer logs free from knots when finally ready to be converted into lumber.

Where the land acquired has no suitable growth upon it, trees adapted to the soil and location are set out and cared for until they are able to take care of themselves in the struggle for existence. These trees are raised as seedlings at the nurseries maintained on the Reservations. Abandoned farms in the neighborhood of the Forest Reserves are being purchased by the State for the purpose of planting white pine, it being particularly adapted to this sort of soil. Great care should be exercised in this branch of the work, however, for there is a trend toward reclaiming many of the old farms, and it would be a mistake to take for this purpose land which could be used for agriculture to greater economic advantage when there are millions of acres lying waste which can never be utilized for any purpose save forestry.

I have said nothing concerning the esthetic side of this subject, not because it may in any way be considered as unimportant, but because the critics of forestry may be successfully met upon their own grounds. But everywhere Americans and Pennsylvanians in particular are becoming more and more appreciative of the beautiful things in life. Particularly is this true with respect to the beauties of Nature. The out-of-doors, the green grass, the trees, the hills, the lakes, and running streams are winning their place in care and appreciation of not only the cultured, but the great body of work-a-day people. In this city, at the time when two thousand acres were set aside to form Fairmount Park, the plan was thought to be the extravagant scheme of a dreamer, and met great opposition. To-day the city would cry out in protest at any attempt to reduce it. Indeed there is a strong sentiment in favor of setting aside other tracts to serve the same general purpose. I believe there is no large city in this

country which contributes a larger proportion of its people to the summer camps in the mountains than does the city of Philadelphia. The forest reserves of the State form an excellent nucleus for just such a playground for the people of the whole State as Fairmount Park does to the adults of this city, or as the plots set aside for that purpose do for children of any one locality of the city. Every year the Department of Forestry at Harrisburg is issuing an increasing number of permits for camps on the State Reserves, and this fact presents to the thoughtful, one of the most hopeful aspects of the whole forestry movement. For, even though forestry may be justified from the point of view of mere dollars and cents, it is especially gratifying that it makes a strong appeal to the people of the State on other than mercenary grounds.

GEOLOGY OF THE PHILADELPHIA DISTRICT.

THE Philadelphia folio of the geologic atlas of the United States, published by the United States Geological Survey as No. 162 of the series, is now ready for distribution.

The area described in this folio is the Philadelphia district, which consists of four quadrangles—the Germantown, Norristown, Philadelphia, and Chester. It lies in three States—Pennsylvania, New Jersey, and Delaware—and embraces in whole or in part ten counties, namely, Bucks, Montgomery, Philadelphia, Delaware, and Chester counties, Pennsylvania; Burlington, Camden, Gloucester, and Salem counties, New Jersey; and Newcastle county, Delaware. It covers an area of about 915 square miles and contains a population of more than a million and a half.

The Philadelphia district includes portions of two distinct geologic provinces—the Piedmont Plateau of the Appalachian province and the Coastal Plain—and rocks ranging in age from pre-Cambrian to Recent and in character from granites and gneisses to sandstones, shales, clays, and gravels. The streams of the area reach the ocean through Delaware River, and those in the Coastal Plain are tidal for half or more than half their lengths.

The geography, topography, and geology of this region are described and delineated in great detail in the maps and text of the folio, the authorship of which is divided among a number of geologists. In greater part the folio is the work of Dr. Florence Bascom, professor of geology at Bryn Mawr College, who was assisted by B. L. Miller; but important chapters were also contributed by N. H. Darton, of the U. S. Geological Survey; by H. B. Kümmel, State geologist of New Jersey; and by W. B. Clark, R. D. Salisbury, and G. N. Knapp, also connected with the New Jersey State Survey.

The folio comprises 23 pages of text and 10 map sheets, and is for sale by the Survey.