CRAWFORD NOTCH, LOOKING SOUTH. *Photo. by B. W. Kilburn, Littleton.*

COMPLIMENTS OF

MR. KENT

STATE OF NEW HAMPSHIRE

BIENNIAL REPORT

OF THE

FORESTRY COMMISSION

FOR THE YEARS

1903-1904

CONCORD
NOVEMBER, 1904

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MEMBERS OF THE COMMISSION.

HENRY O. KENT, Lancaster, *President.*
GEORGE E. BALES, Wilton.
MARSHALL C. WENTWORTH, Jackson.
GEORGE H. MOSES, Concord, *Secretary.*

REPORT.

To His Excellency the Governor and the Honorable Council:

In presenting the report of work in their department during the past biennial term, the Forestry Commissioners again take occasion to call attention to the remarkably rapid spread of public interest in forestry in our state. The movement, which a few years since seemed entirely confined to theorists and sentimentalists, now commands the attention of the most practical and conservative of our people, a fact which is in strict corroboration of the sentiments expressed by this board in one of its earliest declarations, wherein it was predicted that the sentimental side of the forestry movement could not fail soon to be entirely overshadowed by the practical aspects involved in every discussion of the question.

Forests Grow to be Used.

There are, of course, not lacking many whose interest in forestry still is, and from the very nature of the case must always remain, wholly sentimental; this class of forestry advocates being, naturally, found chiefly among those who seek New Hampshire for a brief period each summer during the vacation season. But even these are cognizant of the great fundamental fact of forestry, that forests grow to be used; and while they may continue to decry any timber cutting in certain isolated locations, they nevertheless realize the necessity for utilizing the timber crop to its utmost.

The agencies which we have referred to in previous reports as being most important in carrying forward the agitation of true forestry in New Hampshire, have lost none of their interest in the subject, and to the Order of Patrons of Husbandry, the Woman's Clubs, the boards of trade, the Appalachian Mountain Club and the Society for the Protection of New Hampshire Forests, all true friends of forestry in this state are under renewed obligations.

The Work of the Commission.

Investigation into physical conditions of the forest problem has been considerably extended since our last report. We have examined more closely and with added intelligence in some sections; in others we have entered upon new and interesting fields, and the entire forest area of the state, save a few limited localities, has been under our immediate personal observation.

That section of Central and Southwestern New Hampshire, covered by secondary growth, has largely received attention. The incoming of summer residents, occupying places of vantage, has served, in some instances, to change the face of nature and presented new problems for consideration.

We have remarked that a greater percentage of our area was doubtless now under forest cover than at any time during the half century; this conclusion is emphasized in our experience. Where two generations ago were hillside farms of arable land and pasturage are now great spaces of second growth, some sufficiently matured to attract the lumbermen, with stone walls of former fields and pastures curiously out of place among the heavy growth. The droves of cattle from over the Massachusetts border, that annually found luscious sustenance on our mountain grasses, giving an important increment of income to our southern tiers of towns, have vanished and sites of many rugged farms are now valuable chiefly for their lumber and forest cover; for their scenic beauty and health-giving attractions. Rockingham, Hillsborough, Cheshire and Sullivan counties abound in instances of such metamorphoses. The incoming of summer and of more permanent visitors seeking restful homes amid these haunts of nature, changing the utilities of desirable locations, alters also their income and makes very practical the question of forest protection outside of lumber values alone, as a source of revenue to the state. Many neglected hillsides and forest slopes are now valuable for their scenic perfections. With new colonies, such spots are yearly yielding better returns upon the investment in them than those in the days of elemental agriculture.

From this condition comes effort for development and for checking devastation through the establishment of parks under state laws, several of which have been projected: one of the new questions demanding attention of the commission.

Forestry Legislation of 1903.

The Legislature of 1903 enacted important laws relative to forestry. It perfected existing law; declared for the establishment of a National Park in the White Mountain region; for tree protection and culture; and for the survey of a large section of the state as preliminary to active work for the actual setting aside of lands for a park system.

The sum of $5,000 was appropriated and placed at the disposal of the commission, so much thereof to be used as should be thought necessary upon conference with the governor and council for an actual field survey of that great forest section in the counties of Coös, Grafton and Carroll, ascertaining its hydrographic possibilities, the density, character and growth of timber, the trend of streams, rainfall and elemental facts essential to an intelligent consideration of the problem. The work of the survey was to be done under the direction of this commission by employees of the United States Bureau of Forestry at Washington. The text of the law is as follows:

CHAPTER 139, LAWS OF 1903.

JOINT RESOLUTION TO PROVIDE FOR A FOREST EXAMINATION OF THE WHITE MOUNTAIN REGION.

Resolved by the Senate and House of Representatives in General Court convened:

That the forestry commission be and hereby is anthorized and directed to procure, upon terms to be approved by the governor and council, a general examination of the forest lands of the White Mountain region by employees of the bureau of forestry in the department of agriculture at Washington, whose report shall be laid before the next session of the general court; and the governor is hereby empowered to draw his warrant for a sum not exceeding five thousand dollars upon any money in the treasury not otherwise appropriated to meet the expense of such examination.

[Approved February 24, 1903.]

THE WORK OF THE SURVEY.

Soon after the adjournment of the Legislature and in April, the commission was in conference with the forestry bureau at Washington and preliminary plans were adopted. Immediately on its return the scheme was presented to His Excellency the Governor. It was determined to begin the field work as early as the condition of the ground in the deep woods, then heavy from the winter's snows, would admit, and in fact the work did commence early in May. The devastating fires of June following impeded, but it was steadily continued until autumn. Mr. A. K. Chittenden of the forestry bureau was the officer in charge, with experts in the several branches to which enquiries were directed. The parties numbered a dozen different people, whose work covered the ground from the Canadian border south to the north parallel of Lake Winnipesaukee, save only the alluvial towns in the Connecticut valley. During the progress of the survey the commissioners were in constant communication and frequent contact with the working parties in the woods. Mr. Chittenden, whose report is incorporated herewith, proved to be an accomplished director of the task in hand, securing excellent results. Of the $5,000 set aside by the state for the purpose named, $2,000 still remains unexpended. Something less than $3,000 has been expended in the survey itself and accompanying observations.

Observations still continue as to stream flow and other essential data. The expense of this work is borne jointly by the state and the federal treasuries through an arrangement with the Bureau of Hydrography in the United States Geological Survey. By the terms of this arrangement an equal amount of money to that furnished by New Hampshire is spent by the Geological Survey in the accomplishment of this joint work.

The state has received consideration and generous treatment from the Department of Agriculture, and it is reasonably certain that should the Legislature authorize further expenditures along the same line to secure a like survey with attendant maps of the entire state, like assistance would be continued in its accomplishment.

The commission regards the reports of Mr. Chittenden from the forestry bureau, here presented, as of exceeding value, and earnestly recommends a continuance of the work to embrace, under like conditions, the remaining part of the state.

Financial Statement.

Appended is a brief summary relative to the $5,000 appropriation indicated, the expenditure therefrom, and the amount yet available:

Appropriation by state for use of forest survey		$5,000.00
Paid over to Forestry Commission:		
May 14, 1903, by state treasurer	$1,500.00	
Aug. 19, 1903, by state treasurer	2,500.00	
		4,000.00
Undrawn and in state treasury . .		$1,000.00

Drawn by commission from treasury . .		$4,000.00
Expended in survey proper by A. K. Chittenden	$2,229.82	
Expended on hydrographic work since close of survey proper, as arranged with bureau of forestry and Chittenden (the U. S. paying an equal sum to voucher No. 41 inclusive)	562.15	
		2,791.97
Balance unexpended		$1,208.03
To which may be added balance of the appropriation intact in treasury . . .		1,000.00
Funds available for continuation of work		$2,208.03

This balance may be somewhat lessened at final settlement, as the commission is still meeting the expenses of hydrographic observations; thus all commission expenses may equal but not exceed $3,000.

Our financial arrangements have been very simple. The president of the board consented to act as disbursing officer. All expenses were incurred by Mr. Chittenden of the forestry bureau of the Department of Agriculture. A sum was placed at his disposal on the order of the forestry bureau at Washington to be checked out by the head of the working force in the field as needed. All vouchers submitted to and approved at Washington were certified to this board and, thus verified, charged off against the appropriation. The preceding statement exhibits an analysis of the appropriation, the amount paid to the commission, the expenditures and the funds available for future work. It will be seen that something less than one half the appropriation presumed necessary was expended in the work of the survey proper, while, with the collection of a mass of essential hydrographic and other data, the entire expenditure for the two years' work has been less than $3,000.

Field Inspections by the Board.

In July, 1903, a comprehensive trip to the region later covered by Mr. Chittenden's survey was made by the entire board and in connection with him, punctuated by frequent consultations and decisions as to pending operations. The Connecticut Lake region, the Diamond Pond waters, Dixville Notch, at the north, were considered. We noted the great benefit of the state roads through Dixville, together with the increase of traffic from Colebrook on the Upper Coös Railroad, through that gorge to the Androscoggin and Magalloway waters with their chain of lumber camps, which has been made possible, more expeditious and less expensive by this route through the once almost impassable desolation of the Dixville chasm; and we observed the added thrift of the region consequent upon these improvements. Passing the Crawford Notch to Jackson, to the lower and eastern side of the Presidential Range, policy and route, camps and plans were determined for practical work.

In October of the same year the commission again visited Corbin Park, taking up matters left over from a previous visit, crossed the ridge to Cornish Flat, proceeding down through the attractive summer colonies in Plainfield and Cornish, that for several years have enrolled notable artists, authors and men of affairs among the votaries of these lovely reaches of the mid-Connecticut valley, along the base of Mount Ascutney, just across in Windsor county, Vermont.

Thence we proceeded through the broadening reaches of the great intervales in Claremont, Charlestown (old No. 4), Walpole, to Bellows Falls, climbing up and through the Cold River Valley and over the divide to the Ashuelot waters at Keene, a section beautiful for situation, thrifty in development and, of later years, by its added railroad facilities, so connected with Central and Eastern New Hampshire as to strengthen its prosperity.

To the southwest reaches the Ashuelot Valley, touching Vermont at South Vernon and Massachusetts at Hinsdale, its streams weary with the labor of productive industry; to the southeast the higher lands lead up through Troy and Fitzwilliam to where Monadnock dominates the landscape and the evidences of summer congregations crown every elevation.

The Rhododendron Grove.

Our special desire was an examination of the remarkable and isolated grove of rhododendrons in the borders of Fitzwilliam, six miles from Troy. This grove, donated by Miss Mary L. Ware to the Appalachian Mountain Club, for public enjoyment, is in a depression among the hills and in a second growth of sapling pines, which were being logged when the grove was secured for preservation. The growth is perhaps five acres in area, of luxuriant beauty, its glossy leaves and magnificent blossoms unique in rich splendor. It is presumed that the present unsightly and dangerous undergrowth and débris will be cleared and the growth protected and made more accessible. With such attention this grove will be known as one of the most attractive and valuable of the state's public reservations.

Skirting the northeastern shoulder of Monadnock, we observe numerous establishments in Dublin, a summer colony celebrated for cultivated expenditure in grounds and mansion houses, crowning points of vantage on the mountain itself, embowered in preserved forests or, as perhaps the culmination, situate on the shores of the beautiful sheet of water at the mountain's northerly base, where are estates exceeding in cultivated surroundings and artistic completeness perhaps any others of like character in New Hampshire.

The village of Dublin and the several Jaffreys are of great altitude, some surpassing Bethlehem and Jefferson in our northern country. Five miles easterly of Lake Monadnock is the ancient and self-poised town of Peterborough, thrifty in manufacturing, prosperous in business, interesting from its historic associations and notable children. Cradled between the two Monadnocks it attracts those favored by fortune and lovers of the peacefully beautiful, who have covered its rounded hills with delightful estates.

Going down the decline through the Souhegan watershed, we stop in passing to ascend the notable mountain, Pack Monadnock, its summit accessible by a carriage road and adorned by an abandoned hostelry. This elevation is 2,100 feet, the view unique, affording a key to the topography of a large area. The summit is bare of vegetation, looking out over concentric chains of hills that ring the landscape. The eye easily follows the highlands and winding valleys, disclosing field and forest with the regularity of a map. The growth in this region is all secondary, mostly pine, and again we note the extent of the forest cover, even where the primal growth has disappeared.

Pack Monadnock is a state reservation, or at least a considerable acreage on its summit is so preserved, "Miller Park" being its official name, christened for the doughty Gen. James Miller, hero of Lundy's Lane, who said that he would try to take that battery and, trying, succeeded, proving to the doubter who questioned his ability that the result was certain as at the time he "had the written order in his pocket!"

Resting at the thriving village of Wilton and riding among its interesting surroundings of wooded growth, manufacturing plants and fine estates, we continued toward the sea through the fertile farm lands of Milford, where the commission, after viewing its prosperity, were entertained by the notables of the place, alive to learn its mission and anxious to protect the trees whose grateful shade made beautiful the roadways, showing with recurrent regularity the disks, "N. H.," to the eye; thence down to the Merrimack and the Capital.

A New Departure.

The law of 1893, establishing the Forestry Commission, among its other provisions enumerated that:

Sect. 4. Whenever any person or persons shall supply the necessary funds therefor, so that no cost or expenses shall accrue to the state, the Forestry Commission is hereby authorized to buy any tract of land and devote the same to the purposes of a public park. If they cannot agree with the owners thereof as to the price, they may condemn the same under the powers of eminent domain, and the value shall be determined as in the case of lands taken for highways, with the same rights of appeal and jury trial. On the payment of the value as finally determined, the land so taken shall be vested in the state and forever held for the purposes of a public park. The persons furnishing the money to buy such land shall be at liberty to lay out such roads and paths on the land, and otherwise improve the same under the direction of the Forestry Commission, and the tract shall at all times be open to the use of the public.

Sect. 5. It shall be the duty of the Forestry Commission to make such rules and regulations as may be required to protect and preserve all lands which are required by the state under the provisions of Section 4 from injury or disfigurement, all said rules and regulations to be posted upon said property and at two public places in the town or towns in which any part of such land may be located.

Sect. 6. If any person shall violate any such rule or regulation of the Forestry Commission, he shall be fined not exceeding twenty dollars or be imprisoned not exceeding six months.

For ten years thereafter this law was not invoked. In the autumn of 1903 Dr. L. Vernon Briggs of Boston, a summer resident of the town of Hancock in Hillsborough county, petitioned the commission for the purchase or condemnation of a tract of land to be used, under the terms of the statute, for a public park.

The spot in question was known as Juggernaut Pond, with a strip of land surrounding. The area specified comprehended about eighty acres, of which about twenty acres was the pond, the balance the steep hillside, beneath which the little town was sequestered. It lies perhaps two miles from Hancock village and at an elevation of 1,100 feet above tide water and was known to some degree as a resort of picnickers, but of late had acquired a neighborhood of residents from out the state who had erected and who proposed to erect summer houses, drawn thither by the secluded and wild beauties of the pond and surroundings.

The growth was largely pine, some of considerable size. The landowners had *permitted* contractors and operations had commenced. The case involved the presumed policy of the state in presenting scenic attractions to proposed residents and placing a check in possible or necessary cases upon a spirit of speculation that might seek control of desirable forest spots, especially in Southwestern New Hampshire.

A hearing was had upon the petition at Hancock, December 22, 1903, the petitioner being represented by counsel, James F. Brennan, Esq., of Peterborough, and the landowners by the Hon. Charles H. Burns of Wilton. After hearing evidence and arguments and viewing the premises, the board issued the following order:

STATE OF NEW HAMPSHIRE.

IN BOARD OF FORESTRY COMMISSIONERS.

In the matter of the petition of L. Vernon Briggs for the condemnation of a strip of land five hundred feet in width upon the shore line of Juggernaut Pond, so called, in the town of Hancock, the board, having given a hearing upon the same, at which all parties in interest were present with counsel, to wit, at said Hancock, on the twenty-second day of December, 1903, is of the opinion that the taking of the described land for the purposes of a public park would be for the public good; and therefore decides that the prayer of said petition be granted, unless the board is able to agree with the owners of the said land as to the price thereof.

By vote of the board, Commissioner George E. Bales is authorized to negotiate for the purchase of said land as provided by statute.

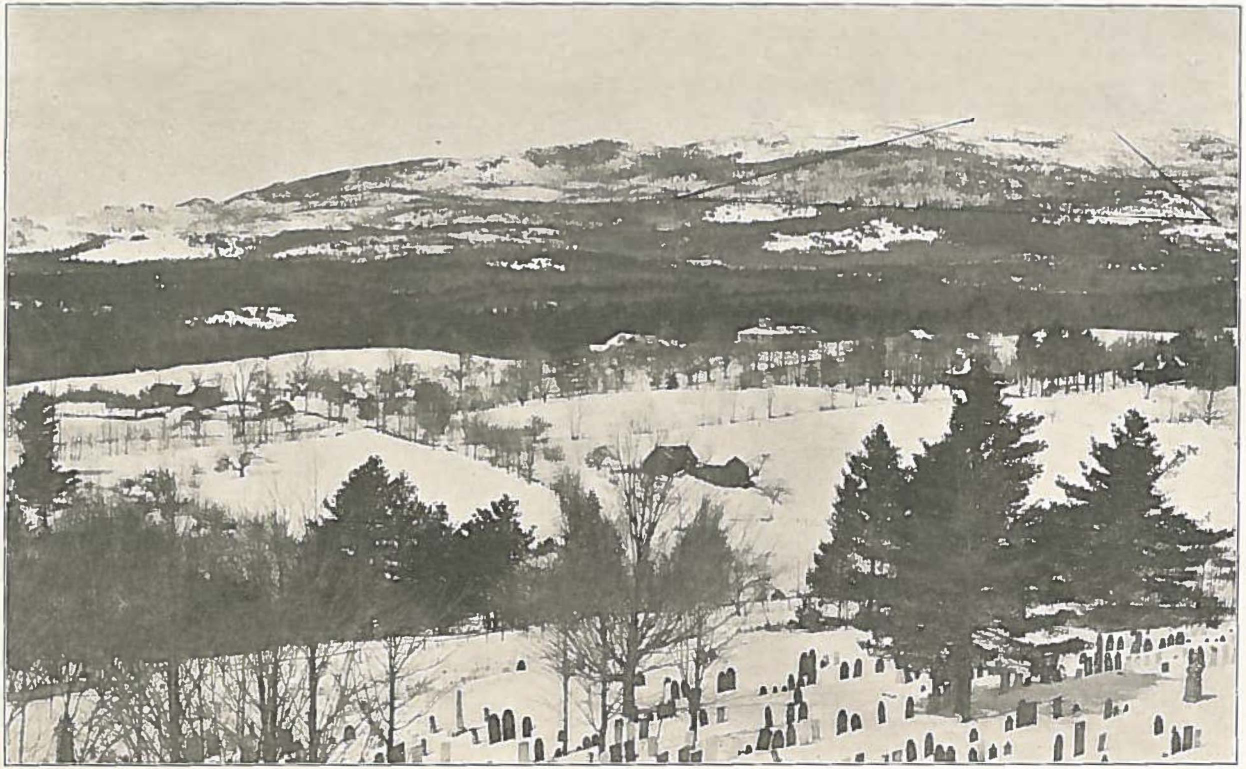
It is ordered that the petitioner forthwith file with the board a bond to the state of New Hampshire, with sufficient sureties, in the sum of Five Thousand Dollars for the carrying out of the intent of his petition and this order thereon.

HENRY O. KENT,
GEO. E. BALES,
GEO. H. MOSES,
Forestry Commissioners.

Hancock, N. H., December 22, 1903.

The petitioner promptly complied with the order of the board, and Commissioner Bales proceeded to negotiate for the purchase of the land in question. All his attempts failing, the matter was carried to the board of selectmen of Hancock on a petition for an assessment of damages, and a hearing was set for Monday, October 17, 1904.

The counsel for the landowners had previously suggested their desire to have a case agreed upon in order that the supreme court might pass upon the question of the constitutionality of the statute, to which both the petitioner and the commission agreed; and in order to formulate such a case it had been arranged that an injunction should be issued, forbidding the landowners removing any timber from the designated area. Upon this injunction the case was to be taken to the supreme court. Without waiting for the procuring of the injunction, although a petition had been drawn and was in the hands of the court, the owner of the timber growth, presumably by advice of his counsel, entered upon the tract and partially denuded it, ceasing only upon the service of the injunction. This course the commission deemed to be a violation of good faith, although it had no remedy which it could apply. It is probable that the case will now be agreed upon and go to the supreme court for an early hearing.



PROPOSED MONADNOCK RESERVATION.

Reservation on Mount Monadnock.

Mount Monadnock rises in Southwestern New Hampshire, largely in the towns of Dublin and Jaffrey, to an elevation of 3,100 feet. On its western and northern slopes are colonies of summer residents and visitors. On the west slope, toward Troy and Fitzwilliam, the mountain presents a dome of rock, grand in outline. On the eastern slope, in Jaffrey, the forests extend further up the slope, indeed nearly to its precipitous crest, which crest was purchased in 1883 by the town of Jaffrey as a reservation, the first, it is understood, thus established in the state.

On this eastern slope, well up toward the ledges, quite a growth of timber—spruce and hardwood—had replaced the old fields and pastures, whereof the stone wall boundaries reach out through close woods. The timber on part of this slope had been sold for lumber and portable mills had been at work to strip the mountain side. Great interest was manifested by summer residents and owners of property occupied for summer purposes. To prevent further cutting, the remaining timber on part of the mountain side was purchased. These purchasers, alleging that further protection was demanded for the public good, in the summer of 1904 petitioned the commission to set apart about five hundred acres, under the statute, as a public park. Preliminaries having been complied with, a hearing was held by the full board at Jaffrey Center, September 21. The petitioners and all parties in interest appeared by counsel, when an exhaustive and prolonged hearing was holden, followed by an actual view and inspection by the commission of the tract in question.

The decision of the board being unanimously in favor of granting the prayer of the petition, the following order was made:

STATE OF NEW HAMPSHIRE.

IN BOARD OF FORESTRY COMMISSIONERS.

In the matter of the petition of Isaac Sprague, Louis Cabot, Joel H. Pool and Arthur E. Pool for the purchase or condemnation of certain adjoining described tracts of land, containing five hundred acres, more or less, at the base of Monadnock Mountain, in the town of Jaffrey, in the county of Cheshire, the same to be devoted to the purpose of a public park as the statute provides.

The board having given a hearing upon the same, at which the parties in interest were present with counsel, to wit, at said Jaffrey, on the 21st day of September, 1904, is of the opinion that the taking of the described lands for the purpose of a public park would be for the public good, and, therefore, decides that the prayer of said petition be granted.

By vote of the board, Commissioner George H. Moses is authorized to negotiate for the purchase of said lands as provided by statute.

It is ordered that the petitioners forthwith file with the board a bond to the state of New Hampshire, with sufficient sureties, in the sum of eight thousand dollars ($8,000) for the carrying out of the intent of the petition and this decision thereon.

HENRY O. KENT,
M. C. WENTWORTH,
GEO. H. MOSES,
GEO. E. BALES,
Forestry Commissioners.

Concord, N. H., September 24, 1904.

Negotiations for the purchase of this tract are now in progress, under the terms of the commissioners' order. Elsewhere in this report will be found a map showing the reservation at Juggernaut Pond in Hancock and a photograph indicating approximately the location, size and character of the tract on Mount Monadnock. Of this latter tract it is competent to say here that it adjoins the reservation, already referred to, of 200 acres on the summit of Mount Monadnock set aside by purchase by the town of Jaffrey more than twenty years ago for a public park.

A Tour of the Woods.

During the summer of 1904, deeming it desirable—because of pending national legislation to which more extended reference will be made later in this report—the commission invited the members of the state congressional delegation to accompany the board on a tour of the main portion of our grand North Woods; and was so fortunate as to secure Senator Burnham and Congressman Currier therefor, Senator Gallinger and Congressman Sulloway being held by engagements from joining the party. By reason of his early and abiding interest in the forestry problem and his intimate knowledge of the region, we were glad to include ex-Governor Jordan in our number.

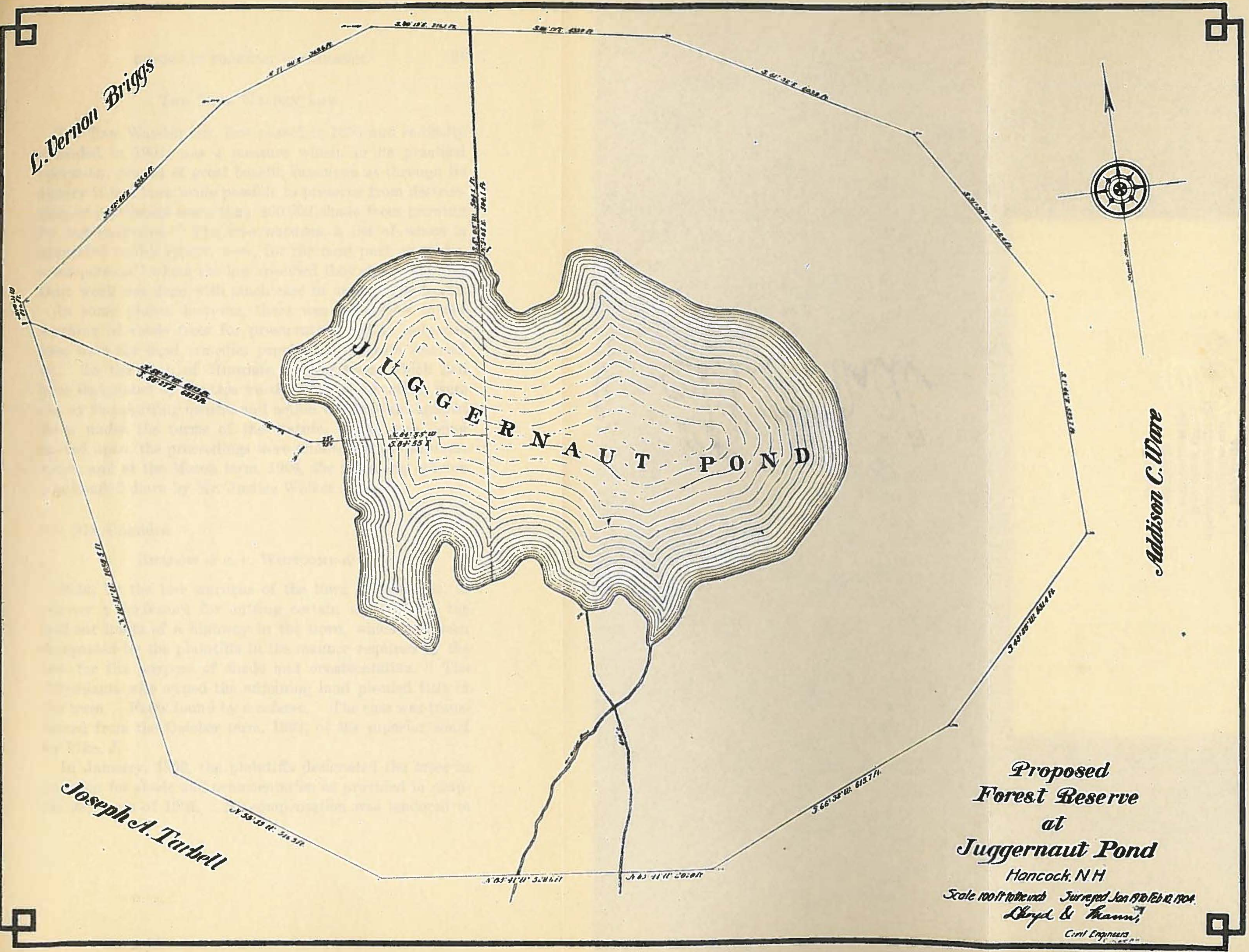
The area visited embraced the head waters of the Connecticut, the First, Second and Third Lakes in Pittsburg, and the waters of the Diamond, the main tributary of the Magalloway, itself the chief feeder of the Androscoggin, both being in the great north forest, stretching from the Canadian border south to Dixville Notch; also including the forest area between the Androscoggin at Errol, Dummer and Milan to the alluvial lands on the Upper Ammonoosuc and Connecticut. In this area are the Diamond Ponds, becoming a notable resort for fishermen and tourists; Dixville Notch with its lakes, cascades, the profile, the remarkable state road through the gorge to the Androscoggin, five miles below its outlet from Umbagog Lake, and the new road opened by Mr. Hale of The Balsams to Millsfield Ponds, two miles back from the river and 28 miles above Berlin.

The route of this trip proceeded thence down the Connecticut Valley to Lancaster; up the valley of the Israel's and Ammonoosuc Rivers to Fabyans and Bretton Woods, having passed over portions of the new state roads around the western base of the great range and affording an opportunity to observe the young nursery of forest trees near the Mount Washington Hotel, started by the enterprising manager of that caravansary. Here the night was spent, with a consultation with His Excellency Governor Bachelder, who joined us there for our further progress. The next day we passed through Crawford Notch, observing the source of the Saco, its affluents and forests, as far as Jackson, one of the most famous of summer resorts. Here we were driven over the excellent roads among the hills, noting the added erections of residences and the growth of attendant business.

The next day the party separated, some going over the railroads down the Pemigewasset and Merrimack Valleys, the remainder continuing along the Saco to North Conway, there taking rail south to the country of the Cocheco and Piscataqua.

Through the medium of this trip a degree of familiarity with the region was acquired and a knowledge of actual conditions obtained relative to the legislation referred to, not attainable save through actual observation.

We do not deem it irrelevant to comment upon the marked improvement in the highways of the North Country, both in extent and excellence, so far as to the remote Second Connecticut Lake; to Diamond Ponds; through the gorge at Dixville; to the Androscoggin at Errol; down the river to Berlin; along the Connecticut valley; over the highlands of Jefferson and Carroll to Bretton Woods; through the Crawford Notch; through the Jefferson Notch; from Fabyan to the Twin and Crawford's and around Jackson. The roads are broad, dry and smooth, fitted for any vehicle and superior to the average road in Central or Southern New Hampshire.



L. Vernon Briggs
Addison C. Ware
Joseph A. Tarbell
JUGGERNAUT POND
Proposed
Forest Reserve
at
Juggernaut Pond
Hancock, N.H
Lloyd & Mann,
Civil Engineers

The Tree Warden Law.

The Tree Warden law, first passed in 1895 and radically amended in 1901, was a measure which, in its practical operation, proved of great benefit, inasmuch as through its agency it had been made possible to preserve from destruction or mutilation more than 400,000 shade trees growing by our roadsides. The tree wardens, a list of whom is appended to this report, were, for the most part, the "discreet persons" whom the law specified they should be, and their work was done with much care in most of the towns.

In some places, however, there was opposition to the marking of shade trees for preservation, but in only one case were the legal remedies provided by statute resorted to. In the town of Hinsdale, certain trees, which had been designated by the tree wardens for preservation, were cut by the abutting owners and action was brought against them under the terms of the statute. The case being agreed upon, the proceedings were removed to the supreme court, and at the March term, 1904, the following opinion was handed down by Mr. Justice Walker:

No. 313 Cheshire.

Bigelow *& a. v.* Whitcomb *& a.*

Debt, by the tree wardens of the town of Hinsdale, to recover a forfeiture for cutting certain trees within the laid-out limits of a highway in the town, which had been designated by the plaintiffs in the manner required by the law for the purpose of shade and ornamentation. The defendants who owned the adjoining land pleaded title in the trees. Facts found by a referee. The case was transferred from the October term, 1903, of the superior court by Pike, J.

In January, 1902, the plaintiffs designated the trees in question for shade and ornamentation as provided in chapter 98, Laws of 1901. No compensation was tendered to the defendants by the plaintiffs for the trees. In the following March the defendants cut down the trees.

John E. Allen, Charles H. Hersey and Streeter & Hollis for the plaintiffs.

Cain & Benton and John M. Mitchell for the defendants.

Walker, J. This action is brought under chapter 98, Laws 1901, relating to the protection and preservation of ornamental and shade trees in highways. It provides (s. 1) that one or more tree wardens shall be appointed by the mayors of cities and the selectmen of towns; (s. 2) that "Towns and cities shall have control of all shade and ornamental trees situated in any public way or ground within their limits, which the tree warden deems reasonably necessary for the purpose of shade and ornamentation; and it shall be the duty of the tree wardens, as soon as possible after their appointment, to carefully examine the trees, situated as aforesaid, and to plainly mark such trees as they think should be controlled by their municipality, for the purposes aforesaid, by driving into each tree, at a point not less than three nor more than six feet from the ground on the side toward the highway, a nail or spike, with the letters 'N. H.' cut or cast upon the head. * * * They shall also have the power to designate from time to time, in the manner as hereinbefore directed, such other trees within the limits of the public ways and grounds as in his (their) judgment should be preserved for ornament or shade;" (s. 3) that "If any of the trees designated as aforesaid should prove to be private property, and the owners thereof refused to release or convey their interest therein to the municipality, the tree warden shall acquire them for the use of the city or town, by purchase, if it can be done at a fair price. Failing in this he may, on petition for that purpose, acquire them in the same way and manner and with the same right of appeal to their owners as in the case of land taken for a highway;" (s. 4) that towns and cities may appropriate money "to be used by the tree warden in planting, pruning, protecting and whenever necessary, acquiring shade and ornamental trees within the limits of their public ways and grounds;" (s. 5) that such trees shall not be removed except after a public hearing, etc.; (s. 6) that "It shall be unlawful to cut, destroy, injure, deface, or break any public shade or ornamental tree * * *"; and (s. 8) that "Persons violating any of the provisions of this act shall forfeit not less than five nor more than one hundred dollars to be recovered in an action of debt by the tree warden * * *."

It is apparent that the Legislature in enacting this statute recognized that there might be a private ownership in trees located within the limits of highways, and provided the means by which such private ownership might be legally terminated by the public upon due compensation therefor. *McCarthy v. Boston,* 135 Mass. 197, 200. No attempt is made to authorize the warden to appropriate trees standing in the highway, without a hearing and compensation, unless they are public property. Private property in such trees, when it exists, is fully protected. Hence the question in this case is, not whether the statute is constitutional but whether the plaintiffs, as tree wardens, have observed the statute in attempting to appropriate the trees in question to the public use of shade and ornamentation. Their proceedings in the premises have been based entirely upon the theory that the trees were not private property and that the defendants had no legal rights thereto; in other words, that the trees were public property, for the greater protection and preservation of which it was only necessary that they should be marked in the prescribed way.

It is assumed, in the absence of a finding to the contrary, that the trees in question stood on the side of a country road and that their ownership was not peculiar, but depended upon the legal effect of the laying out of ancient highways upon the property rights of the landowner. If, when the highway was laid out, the public acquired the right, not only to construct and maintain a road over the land and to pass and repass thereon, but the right to deprive the landowner of the natural growth upon the side of the traveled path whenever a later public sentiment might require it for ornamentation or comfort, the landowner's title to such growth is not an absolute one, and the public may terminate his limited and qualified right at pleasure and without further compensation. And it is the plaintiff's contention that from the time when the highway was laid out, early in the last century, until they marked the trees, as provided in the statute, in 1902, the defendants, or their ancestors in title, might have legally cut down the trees and used the logs and wood for their own purposes, by virtue of their ownership of the adjoining land; but that after the trees were designated by the tree wardens for shade and ornament, their right to appropriate the trees as their property ceased or was in abeyance, by virtue of an original right which was vested in the public when the highway was laid out. This theory might not be inaccurately stated to be that the public acquired the right to use the natural growth of the land, with a permissive right in, or license to, the abutter to use and consume it, until such time as the public might indicate its desire to use it for some highway purpose. On the other hand it is denied that the public acquired any right to the products of the soil, as the grass and trees naturally growing thereon, except to remove them from the ground when necessary for the convenience or safety of public travel over the way; and that so long as they do not constitute an obstruction or menace to travelers, the abutter has an absolute right to have them grow there, and an equally unlimited right to remove them.

It is a general principle, which is not controverted in this case, that, "In highways laid out through the lands of individuals in pursuance of statutes, the public has only an easement, a right of passage; the soil and freehold remain in the individual, whose lands have been taken for that purpose." *Makepeace v. Warden,* 1 N. H. 16. And it was held in that case that if surveyors of highways in making or repairing roads cut and convert to their own use wood growing thereon, they are trespassers. "The right acquired by the public in a highway legally established for the public use is only an easement, a right of passage over the land. * * * This right consists in the power to make the road and to keep it in repair suitable for travel, and in its free use by the public for all proper purposes, until discontinued. In making or repairing highways, however, nothing can be taken from the land over which they are laid, by the town authorities, for any purposes except the legitimate end of constructing the roads. Everything growing or standing upon the land, the trees, timber, etc., belongs to the owner; and everything that goes to form the land itself also belongs to him, except what is necessary to be actually used in the making or repairing the highway." *Rowe v. Addison*, 34 N. H. 306, 311, 312. See, also, *State v. New Boston*, 11 N. H. 407, 409; *Troy v. Railroad*, 23 N. H. 83, 93; *Blake v. Rich*, 34 N. H. 282; *Graves v. Shattuck*, 35 N. H. 257; *Winchester v. Capron*, 63 N. H. 605; *Bailey v. Sweeney*, 64 N. H. 296; *Jackson v. Hathaway*, 15 Johns. 447, 453; *Perley v. Chandler*, 6 Mass. 454, 456. "The owner of the land, therefore, retains his title in trees, grass, growing crops, buildings and fences standing in the highway at the time of the laying out (unless he fails to remove them within a reasonable time after notice to do so), as well as in mines or quarries beneath, which are not part of the surface of the earth upon and of which the highway is made." *Denniston v. Clark*, 125 Mass. 216, 221. He "owns the trees growing upon it and may maintain trespass against any one cutting them, or gathering their fruit, or for any other invasion of his possession. But of course the proper public guardian of the highway may cut down any tree which is a permanent obstruction to the use by the public of any part of the highway." Jones, Easements, s. 479; *Turner v. Highway Board*, L. R. 9 Eq. 418.

In *Baker v. Shephard*, 24 N. H. 208, it was held that by the laying out of a highway, the public acquire no right to use the trees growing upon the land to build or repair the road. In the opinion of the court, Judge Bell says (page 215): "The question is, whether the trees growing upon the land laid out for a highway are all to be deemed materials subject to the same rules as sand, gravel, etc., liable to be cut down at the discretion of the agent for building the road, and to be used for the repairs of the road. If they are not, then the question is whether the agent or surveyor has a right to cut down any trees growing in the highway land, except such as it is necessary to cut down and remove for the purpose of building and repairing the road in a reasonable and proper way; and whether the trees properly cut down for this purpose can be deemed materials, and applied, at the pleasure of the agent or surveyor, to the construction or repair of the traveled way." After showing the difficulty of assessing damages occasioned by the acquisition by the public of such rights in trees growing by the side of a highway, he proceeds (page 217): "The appraisal must have been made of the trees as they were. Their increased size and value is derived from their being permitted to occupy and draw their nourishment from the soil of the landowner, to the profits of which, subject to the public easement, he is exclusively entitled. Can the trees be taken and applied to the public use without allowing him anything for their increased value? For how many years may the public leave the trees, in which they are supposed to have a right, to grow upon the highway and then deprive the owner of the profits of his land? It is this circumstance, that the increase of growing timber makes a part of the natural profits of the soil, which marks a clear line of distinction between trees and the inanimate sand and gravel, which are always materials liable to be used upon the highways." And he concludes that the only right the public "acquire in relation to such trees, is that of cutting down and removing to a convenient distance, for the use of the owner, such trees as it is necessary to remove in order to the making or repair of the road in a proper and reasonable manner. In this conclusion we are supported by the ancient authorities.''

A similar result was reached in *Tucker v. Eldred,* 6 R. I. 404, where it was held that, in opening a new highway or amending an old one, the town sergeant or surveyor may under the law remove growing trees or brushwood from the space appropriated to the highway, but has no right, as included in the original assessment of damages, or the easement of the public, to use such trees or underbrush in the building or amendment of the roadway; and that if he does so use them he becomes a trespasser. In *Suffield v. Hathaway,* 44 Conn. 521, it was held that the selectmen of a town have no right as against the owner of land on the highway to divert the water from a spring on such owner's side of the road to a public watering trough on the other side. The court say ''as between the public and the respondent, the owner of the spring, the latter is entitled to any and all uses of it which do not interfere with the public safety, do not obstruct or hinder public travel and do not increase the public burden of making repairs. * * * The right of the owner to the use of the spring under these limitations takes precedence of the right of the officers to divert it to the lands of others, if in so doing their sole motive is to establish a public watering place. Of course, such places afford great relief to man and beast; but, commendable as is the act of establishing them, towns have no right to take private property without compensation for that purpose.'' In *Deaton v. County,* 9 Iowa 594, the question arose upon an assessment of damages in the laying out of a highway, the plaintiff claiming that he was entitled to compensation for timber growing in the highway; but the court held that his title to the trees was not divested or affected by the condemnation proceedings. For the same reason it has been held that the public acquire no right to remove stones embedded in the ground below the grade of a highway and to use them in repairing the road. *Rich v. Minneapolis,* 37 Minn. 423; *Overman v. May,* 35 Iowa 89, 97; *Winter v. Peterson,* 4 Zab. 524; Statute 7, George III, c. 42 s. 3; Statute 13, George III, c. 78, s. 16; *Ib.,* c. 78, s. 27.

On the other hand it was decided in *Felch v. Gilman,* 22 Vt. 38, that the highway officers may use trees growing in the highway in repairing the road; but the reasoning of the court is not so convincing as to warrant a re-examination of the decision in *Baker v. Shephard, supra,* or to weaken the force of the numerous authorities to the contrary. *Phifer v. Cox,* 21 Ohio St. 248, 255.

Upon this examination of the authorities the question presented whether in laying out a highway under statutory authority the public acquires a right to prohibit the landowner from removing the trees standing in the highway next to his land, for the purpose of preserving them for shade and ornamentation. If the public cannot deprive the owner of his trees by using them in constructing or repairing the road, can they deprive him of his property right in them by preventing him from cutting them down and using them in such a manner as he sees fit? It is no more a deprivation of his property right to cut down his trees and devote them to the useful and necessary work of road construction, than it is to appropriate them standing for the purpose of shade and ornamentation. An effective prohibition against one's use and enjoyment of his property in a usual and otherwise appropriate manner deprives him of his property, as much as its actual taking or asportation against his will. *Eaton v. Railroad,* 51 N. H. 504, 511, 512. By the act of the plaintiffs, if valid, the defendant's common right to remove the trees is destroyed, his right of user is materially curtailed—and his property is taken. "Before the public can assume to say that a man cannot cut down his own trees, they must have acquired an interest therein by purchase or by the right of eminent domain. To prevent a man from using his property is virtually taking it from him, to a certain extent; and this cannot be done without compensation.'' *Lancaster v. Richardson,* 4 Lans. 136, 141. Moreover the additional servitude is imposed upon the owner's land of supporting the trees for a public purpose. Their future growth and nourishment is to be derived from his soil. He is not only deprived of the valuable right to convert the trees into lumber and wood, which may be called the natural profits of the land, but he must allow the trees to remain upon the land and draw their sustenance therefrom. If he desires to cut off the branches of fruit trees standing on his side of the highway (*Stackpole v. Healey,* 16 Mass. 33, 36), for the purpose of grafting them and thus of increasing his income from the land, he is met with the refusal of the public to allow the arboreal symmetry of the road to be thus impaired. He finds that his right of property in the trees is practically superseded by the public right of preserving them for shade or ornament or both.

If such a right was acquired when the road was originally laid out, and if damages were assessed therefor, the statutes authorizing the laying out of highways furnish little convincing evidence in support of that contention. By the act of February 8, 1791, it was enacted, ''That at any time hereafter, when there shall be occasion for any new highways or private roads to be laid out in any town or place in this state, the selectmen of such town or place be, and hereby are, empowered, on application made to them, if they see cause, to lay out the same, * * * and, if such road be for the benefit of the town or public, due recompense shall be made by the town to the owners of land through which such road is laid out for all damages such owners sustain thereby.'' Laws, ed. 1792, p. 278; ed. 1797, p. 309; ed. 1805, p. 328; ed. 1815, p. 385.

The first section of the act of July 3, 1829, is a re-enactment of the first part of the statute above quoted, with some additions not material to the present inquiry, while section two provides ''that when the selectmen of any town shall lay out a highway, they shall make return thereof, in which the way shall be particularly described and the width thereof stated, and shall cause the same to be recorded by the clerk. And such selectmen shall assess the damages thereby sustained by the owners of the land and shall insert in the record the sums so assessed." Laws 1829, c. 52. In R. S., c. 49, s. 13 and in C. S., c. 52, s. 16, the language used is, that "Such selectmen shall assess the damages sustained by each owner of the land required for such highway, and insert the same in their return." In the revision of 1867 it is provided that the selectmen "shall assess the damages sustained by each owner of the land or other property taken for such highway and insert the same in their return." G. S., c. 61, s. 15. This language also occurs in G. L., c. 67, s. 19, and in P. S., c. 67, s. 18. In the highway legislation of the state no attempt appears to have been made to state specifically the property right taken for highways or the elements of the damages sustained by the landowner. But the court has frequently been called upon to define the extent of the power conferred for which damages are assessable and the rights retained by the landowner for which he is not entitled to damages. In 1816 it was decided in *Makepeace v. Warden, supra,* that the public have only a right of passage in highways, that is, an easement only. In 1827 a similar holding was announced in *Avery v. Maxwell,* 4 N. H. 36. The decision in *Baker v. Shephard, supra,* was announced in 1851, to the effect that the public did not acquire, by the laying out of a highway, right to use the timber growing therein for its construction or repair. These decisions, and others of a similar import, give a restricted interpretation to the language of the Legislature authorizing the taking of private property for highway purposes (Angell, Highways, s. 83), and have been recognized by successive Legislatures without any substantial modification. The legislative intention in these respects having been determined so long ago and acted upon for so many years, cannot now be treated as an open question. The general principle underlying these decisions seems to be that the landowner was deprived of such rights only and was paid for such rights only as were reasonably necessary for the construction and maintenance of a way for public travel. "The compensation originally paid him for the taking of land for the road was computed upon the basis that the road would be built in a manner suited to the then existing circumstances." *Hinckley v. Franklin*, 69 N. H. 614, 615.

No logical argument in favor of the plaintiff's contention can be drawn from the undoubted fact that upon the laying out of a highway under the statute, the public acquired the right to use the soil within the limits of the way for its construction and repair, and thus to deprive the owner of the profits of the land, which he might otherwise enjoy. As it has been shown in *Titus v. Boston*, 149 Mass. 164, 165, 166, "It has from the earliest times been the practical construction of our laws authorizing land to be taken for public use, that the towns or corporations had the right, as one of the incidents of the taking, to use the gravel or soil of one part of a way for construction of another part * * * ." See also *Denniston v. Clark*, 125 Mass. 216, 222, 223; *New Haven v. Sargent*, 38 Conn. 50. The practically universal understanding and construction of the public right to use the soil of the way, for more than a hundred years, is evidence of great force upon the question whether it was in fact acquired and paid for when the way was laid out; and for a similar reason the fact that, anciently, arboreal shade and ornamentation of rural highways was not deemed a matter of much importance is equally strong evidence that the public, by laying out a highway, did not acquire a right to compel the abutter to suffer his trees to remain for that purpose. The evidence of such an intention is wanting. "The *locus in quo*, although a part of the turnpike road, is the soil and freehold of the plaintiff. He has the exclusive right of property in the land, subject, however, to the easement or rights incident to a public highway; such as the right of passage over it and the right which the turnpike corporation has to construct a convenient pathway and to keep it always in good repair. To accomplish these purposes the corporation may dig up and remove from place to place, within the limits laid out for the road, any earth, sand and gravel, and may dig and cut up sods and turf; but it by no means follows that the corporation has the right of herbage, which is the exclusive property of the owner of the soil as well as all trees, mines, etc.'' *Dudley v. Emerson,* 6 Pick. 57, 58; *Bailey v. Sweeney,* 64 N. H. 296; *Cole v. Drew,* 44 Vt. 49.

If the public highway easement for travel and communication authorizes the construction and operation, either on, above or below the road-bed of horse, electric or steam railways, without the consent of the adjacent landowners whose title extends to the center of the way (*Pierce v. Drew,* 136 Mass. 75; *Sears v. Crocker* [Mass.] 69 N. E. 327), it does not follow that a right to appropriate the natural profits of that part of the way which is not actually used for travel, to the public use of ornamentation of rural highways, was originally taken and paid for. The right to use the way for public travel may include the right to use it in all reasonable ways for the convenient accomplishment of that purpose, but it is an unwarranted inference to say that it also includes a right to use property for the æsthetic purpose of highway ornamentation, which had never before been deemed a constituent part of the road for travel and which could not even be used in repairing the road-bed. *Johnson v. Railroad,* 35 N. H. 569, 572. The kind of vehicles the public use in passing over the way may not determine the question of the right of passage—the right under the easement may justify the use of many modes of conveyance, of which the men who laid out the way had not, and could not have had, the slightest conception. But property, like trees standing in the highway, which had no useful connection with the public passage over the way, and which when constituting an obstruction to such passage was necessarily removed as a nuisance, cannot be deemed to have been taken at the laying out of the road. If it had been taken and used for some public highway purpose, it may be it could have been subsequently used for a somewhat different public purpose. Trees and herbage in the highway which do not interfere with, or obstruct, the public use of the road and which are the natural profits of the unused land, were not taken because they were not needed for highway purposes. Hence they cannot now be used by the public without compensation to the owner. 3 Kent, Com. 433; *State v. New Boston,* 11 N. H. 407, 409; *Perley v. Chandler,* 6 Mass. 454, 456; *Overman v. Way,* 35 Iowa, 89, 97; *Woodruff v. Neal,* 26 Conn. 165.

The idea of providing for the shade and ornamentation of highways is of comparatively modern origin. It does not seem to have commanded the attention of the people in the early part of the last century. In 1858, the mayor and aldermen of Portsmouth were "authorized to set out and maintain trees and shrubbery on public squares and highways at the expense of the city." (Laws 1858, c. 2,128, s. 1) and the next year similar authority was conferred on the mayor and aldermen of Dover. Laws 1859, c. 2,258. In 1861 a general statute was passed for the preservation and protection of shade trees, which provided (s. 1) "That any town or city shall have full control of the shade trees situated within the limits of any public street or highway in, or passing through any town or city; and shall have full power to make such laws, from time to time, as may be deemed necessary for the protection and preservation of the same"; (s. 2) "If the owners of real estate in any town or city shall desire to remove any shade tree or trees, situate between the carriage path and sidewalk, or within the limits of any public street, he shall obtain leave of the selectmen of the town or mayor and aldermen of the city wherein the trees may be located, or conform to laws which the town or city may have provided relative to shade trees;" (s. 3) "Nothing in the foregoing shall be construed to debar the owner of real estate to plant, rear and protect any tree or trees between the carriage path and sidewalk in any public street or highway on which his estate is situate, if it do not interfere with the public travel.'' Laws 1861, c. 2,502; G. S., c. 34, ss. 9, 10, 11. It will be observed that these provisions recognize the property right of the abutter in the shade trees in the highway, subjecting them merely to certain regulations as to their removal. No attempt was made to deprive him of his ownership of the trees. By section 6, chapter 1, Laws 1868, towns were authorized to raise money for the planting of shade trees, and in 1875 such an abatement of taxes was authorized ''to any person who shall set out and protect shade trees by any street or highway adjoining his land, as the said mayor and aldermen or selectmen shall deem just and equitable.'' Laws 1875, c. 39, s. 2; G. L., c. 37, ss. 9, 10, 11; Laws 1889, c. 82. These statutes were embodied in P. S., c. 40, ss. 4, 9, 10, 11, without any material change. In 1895 it was enacted that the mayor and aldermen of cities and the selectmen of towns be authorized ''to designate and preserve trees standing and growing in the limits of highways for the purpose of shade or ornament,'' and that ''whoever shall wantonly or intentionally injure or deface any trees thus designated * * * shall forfeit not less than five nor more than one hundred dollars * * * .'' Laws 1895, c. 86. At the next session the Legislature authorized selectmen to set out nursery trees, which might be presented to them, in such highways as the donor should indicate, but provided that ''nothing in this act shall be construed to compel any party to have trees in the highway on the side next his land without his consent.'' Laws 1897, c. 44.

From this examination of legislation previous to the act of 1901, it is apparent that it was not part of the legislative purpose to deprive abutters on highways of their property in the trees growing therein, but to more effectually guard and preserve such trees (*Chase v. Lowell,* 149 Mass.

85) so long as they were permitted to remain in the highway. The provision in section 2, c. 98, Laws 1901, that "towns and cities shall have control of all shade and ornamental trees situated in any public way or ground within their limits," was not intended to have a more extensive meaning or to be more expressive of the purpose to appropriate private property to a public use than language of similar import used in s. 1, c. 2,258, Laws 1861, where the rights of abutters on highways were recognized and protected. The Legislature has thus furnished evidence of a public policy based on an assumption or recognition of the fact that in laying out highways the abutter retained his property in the trees therein, which, not being obstructions, were allowed to stand in the untraveled part of the way. This practical, contemporaneous construction of the rights of the landowner is evidence of great weight upon the question whether the public acquired the right, when the way was laid out, to terminate at any subsequent time his proprietary dominion of trees in the highway. That such a power has not been directly recognized in the legislation upon the subject, which is readily susceptible of a construction excluding its existence, is a very significant evidentiary fact.

Whether a different result might not be reached in the case of the laying out of a street in a city or populous community, where all the land taken is required for actual present use (2 Dill, Mun. Corp., s. 688; *Chesapeake, etc., Gaslight Co. v. Mackenzie,* 74 Md. 36, 47; *Bloomfield, etc., Gaslight Co. v. Calkins,* 62 N. Y. 378; *Boston v. Richardson,* 13 Allen 146, 159), it is unnecessary to consider; for it seems plain that trees growing by the side of an ancient rural highway upon land not required for the accommodation of actual travel belong to the owner of the adjacent land, who cannot be deprived of his rights as owner without compensation, after a legal hearing. *Winchester v. Capron,* 63 N. H. 605. Whether the trees are useful for shade and add to the beauty of the way, or whether they are only useful for lumber and wood, cannot determine the question of his ownership. If they are his property, he is entitled to the beneficial use of them, subject to such reasonable regulations as the public use of the highway may require. *White v. Godfrey,* 97 Mass. 472, 475; *Bliss v. Bell,* 99 Mass. 597; *Clark v. Dasso,* 34 Mich. 86; *Bills v. Belknap,* 36 Iowa 583; *Everett v. Council Bluffs,* 46 Iowa 66. But to permanently deprive him of the beneficial use of his property or of the profits or income usually derivable therefrom, is not a reasonable regulation but is an extinction of his right without corresponding compensation and amounts to confiscation. As this proceeding is based upon the theory that the defendants had no right, under any condition, to cut down the trees in question—in effect, that their property right in the trees had been legally divested and fully paid for, and as the plaintiffs have not proceeded to divest the defendants of their title in the manner pointed out in s. 3 of the act, the result is that the prosecution cannot be maintained.

Case discharged. All concurred.

Existing Law Should be Continued.

From the foregoing it is evident that the tree warden law in its present form will prove inoperative unless the abutting owners consent to the marking of their trees for preservation, or unless the towns themselves are willing to subject themselves to the expense of paying for the trees thus preserved. So far as we have been able to learn, no town has expressed a willingness to tax itself for this purpose, and since the date of the rendering of the opinion above quoted we have instructed tree wardens to procure the consent of the abutter in advance of the attachment of any of the tree tags. In most cases this consent has been readily obtained.

It may be possible to obviate one serious source of embarrassment in this matter by enacting a provision whereby the right to recover damages for designated trees shall be made contingent upon the action of the abutting owner.

That is to say that no right to recover shall continue beyond a stated period, not to exceed sixty or ninety days, after the tree has been tagged. Such legislation would destroy no property rights now existing and would merely shift the burden of procedure from the state to the individual owner.

At any rate the existing law should be retained and made more workable if may be. It has already resulted in no little benefit and, if rightly enforced, will add much to the attractiveness of our highways, which are now the object of so much attention.

List of Tree Wardens.

Below is a list of tree wardens in the state, so far as they have been appointed by the selectmen:

S. B. Sleeper,	Alexandria.
C. H. Cooke,	Alstead.
Horace Howell,	Amherst.
Frank A. Holbrook,	Amherst.
John H. Dodge,	Amherst.
E. Burt Thompson,	East Andover.
William Morrill,	Andover.
Horace B. Tuttle,	Antrim.
George P. Dow,	Atkinson.
John George,	Center Barnstead.
Harry H. Hall,	Bath.
Allen F. King,	Bedford.
Samuel W. Knowles,	Belmont.
H. J. Burtt,	Bennington.
William Kendall,	Benton.
F. C. Abbe,	Bethlehem.
John E. French,	Bradford.
Charles S. Dunbar,	Brookline.
Leroy A. Glines,	Canterbury Depot.
Dr. L. B. Morrill,	Center Harbor.
John E. Hodgdon,	Ossipee.
William Swan,	Charlestown.
George W. Stevens,	Claremont.
G. H. Haines,	North Chichester.
William W. Balloch,	Cornish (Windsor, Vt. P. O.).

John S. Allen,	Danbury.
John P. Webster,	Danville.
James S. Craine,	Deering.
Charles W. Forsaithe,	Deering.
Charles Bartlett,	Derry.
George W. Rowen,	Dorchester.
Milton D. Mason,	Dublin.
Cyrus P. Keay,	Effingham.
Burley O. Avery,	Ellsworth.
William A. Saunders,	Enfield.
James D. Whittemore,	Epping.
Newell S. Tilton,	Exeter.
John H. Waldron,	Farmington.
William B. Chase,	Franconia.
Henry C. Tenney,	Fitzwilliam.
Charles N. Emerson,	Franklin.
Rev. Henry C. McDougall,	Franklin Falls.
Edward C. Fox,	Freedom.
Thomas Cogswell,	Gilmanton Iron Works.
William H. Stinson,	Goffstown.
Frank A. Parker,	Goffstown.
Charles A. Chandler,	Gorham.
George B. Kimball,	Grafton.
William H. Packer,	Greenland.
F. W. Ely,	Greenville.
George W. Clyde,	Hudson.
William C. Russ,	Hopkinton.
Fred E. Stevens,	Hooksett.
Emmons C. Newman,	Hillsborough Bridge.
Charles P. Cowdrey,	Henniker.
Charles P. Heywood,	East Harrisville.
Henry F. Robinson,	Hancock (Elmwood P. O.).
Edward L. Clifford,	Hanover.
A. P. McPherson,	Hanover (Etna P. O.).
Ransom S. Cross,	Hanover (Enfield P. O.).
Frank F. Perry,	South Hampton.
George J. Penner,	Hampstead.
George B. Shaw,	Kensington (Exeter P. O.).
Arthur E. Poole,	Jaffrey.
Harlan P. Scheileng,	Kingston.
William D. Veazey,	Laconia.
D. C. Remich,	Littleton.
R. P. Peckett,	Franconia.
Bert Osgood,	Loudon.
Payson E. Fairfield,	Lyme.

George E. Bates,	Mt. Vernon.
Parkman A. Moulton,	Moultonborough.
Lewis A. Sibley,	Moultonborough.
James W. Rogers,	Mill Village.
Clarence L. Trow,	Milford.
Charles W. Needham,	Milford.
Andrew J. Felker,	Meredith Center.
Anson S. Longa,	Merrimack (Reed's Ferry P. O.).
Hermon Whittaker,	Mason.
Charles A. Bemis,	Marlborough.
Martin V. B. Felker,	Madbury.
J. J. Doyle,	Chairman Board of Public Works, Nashua.
Conrad Push,	Newcastle.
Eben E. Berry,	New Durham.
Horace Clough,	Newfields.
Thomas F. Pickering,	Newington.
I. E. Aldrich,	New Ipswich (Smithville P. O.).
Arthur C. Bradley,	Newport.
William H. Wright,	Newport.
Edward Hayford,	Newton.
Frank Peverly,	Tilton.
Charles F. Buell,	Tilton.
Gawn E. Gorrell,	Tilton.
William Tasker,	Northwood.
Oliver B. Tuttle,	North Nottingham.
E. Harvey Edmonds,	Plymouth.
Frank S. Jenkins,	Pittsfield.
Frank D. Osgood,	Pittsfield.
Charles W. Abbott,	Peterborough.
Charles W. Cass,	Plaistow.
Frank M. Woodbury,	Pelham.
Almon A. Davis,	Roxbury (Keene P. O.).
Charles E. Lowe,	Randolph.
Charles E. Hunt,	Randolph.
John Leavitt Brown,	Seabrook.
Frank W. Chase,	Seabrook.
William H. Walton,	Smithtown.
Thomas D. Merrick,	Somersworth.
George S. Hoyt,	Center Sandwich.
Adoniram C. Davis,	North Sutton.
John D. Campbell,	Sunapee.
James E. Handy,	West Swanzey.
Joel F. Whittemore,	Stoddard.

Fred H. Noyes,	Stewartstown.
Prescott Coburn,	Stratham.
James Simpson,	Shelburne.
M. B. Stevens,	West Salisbury.
G. S. Sanborn,	Sandown.
Jacob W. Kelley,	Salem (Methuen, Mass., P. O.).
George F. Batchelder.	Tamworth.
Frank H. Carle,	Tamworth (Chocorua P. O.).
E. E. Colburn,	Temple.
Arthur S. Browne,	West Thornton.
Christopher F. Lawson,	Troy.
Charles O. Doe,	Wolfeborough.
W. L. E. Hunt,	North Woodstock.
James H. Bliss,	Winchester.
Carlos C. Davis,	Winchester.
Henry Sheldrick,	Wilton.
George H. Woodward,	Wilmot.
James A. Goodwin,	Whitefield.
Harry M. Turner,	Wentworth.
Ira P. Whittier,	Webster (Contoocook P. O.).
Joseph L. Tuttle,	Waterville.
Fred Bean,	Warner.
E. L. Houghton,	Warren.
James Tucker,	Wakefield.

Reforestation.

At the last session of the Legislature measures were taken to secure state co-operation in the reclaiming to forest uses of the abandoned lands in the state, and it was enacted that such lands, planted with timber trees under certain conditions, should have almost complete exemption from taxation for a period of thirty years; while, to facilitate such action, the Forestry Commission was authorized to contract with reputable nurserymen for a supply, at reduced price, of such seeds and seedlings as were necessary for this purpose.

This last provision was hastily drafted near the close of the session as a substitute for a pending measure, which provided for the establishment by the state of a forest nursery at an initial expense of ten thousand dollars. The nursery bill failing to secure passage, the provision above cited was drawn, as stated, as a substitute measure, with the idea that a public demand for forest nursery products might be developed during the ensuing two years.

The commission have been unable to carry out the intent of this enactment. No nurserymen have been found willing to enter upon such a contract without a guarantee from the state of a minimum purchase of seeds or seedlings. Such a guarantee we were unable to furnish and no contract was therefore made.

On the other hand, it should be said in all fairness, that no application for seeds or seedlings has been made to us under the terms of the enactment. It does not follow, however, that there is no demand for seeds and seedlings for forest planting, because we well know the fact to be to the contrary.

In one or two instances reforestation has been attempted by certain landowners, who have either raised their own stock for planting or have purchased it from established nurseries. In the first class are the Blue Mountain Forest Park Association at Newport and the Mount Pleasant Hotel Company at Bretton Woods; while in the latter class is Mr. Rosecrans W. Pillsbury, who has planted a considerable tract to white pine on his farm in Londonderry.

A Forest Nursery.

We have no doubt that if a forest nursery existed in New Hampshire for the supply of reliable seeds and seedlings, a considerable acreage of land, now valueless, could be brought under forest cover. We are not, however, inclined at present to recommend the establishment of such a nursery at state expense, because, if the venture should prove a failure, the state would probably find itself in possession of property for which there would be no use whatever.

We believe, however, that it is possible to meet every legitimate demand of this character without subjecting the state to any expenditure in a permanent nursery fund.

At Bretton Woods, the Mount Pleasant Hotel Company has already established a forest nursery for the propagation of seedlings for use on its own estate. This nursery is in charge of a trained forester from the federal Bureau of Forestry, and the seedlings there produced are used for planting on the hotel property, aggregating 10,000 acres in area, in accordance with a working plan of the Bureau of Forestry.

At the Blue Mountain Forest Park a similar working plan is now being carried out under the direction of another trained forester. It is altogether likely that the state could make a reasonable arrangement with either the Mount Pleasant Hotel Company, the Blue Mountain Forest Park Association or some individual for the supply of such seeds and seedlings as might be needed—an arrangement which would relieve the state from any expense beyond such contribution to the annual charges of the existing nurseries as might be determined upon. We therefore recommend that authority be given to enter into some such arrangement for a period sufficient to determine whether there is a permanent demand for such an institution.

Within the last fifty years more than 1,750,000 acres of our area, or substantially one fourth part of the state, has reverted from an improved to an unimproved condition. This land is chiefly worthless in its present condition and is fit only for bearing trees. If it could be reforested with some of the more desirable species of timber trees it would add immeasurably to the future taxable inventory of the state and would give permanence to many local woodworking industries which must otherwise soon confront the problem of extermination.

The National White Mountain Park.

As the result of the efforts of the commission and associate organizations, notably the Society for the Protection of New Hampshire Forests and of the Appalachian Mountain Club, public attention during the past two years has been earnestly directed toward the movement for the establishment of a National Forest Reserve in the White Mountain region. It had become evident that private effort could not stay the devastation wrought even by the best conducted lumbering among the primal growth. It was also evident that interstate commercial reasons gave the location national import, inasmuch as the headwaters of five New England rivers, the Connecticut, the Androscoggin, the Saco, the Merrimac, the Piscataqua, turning myriads of spindles and giving life to important industrial communities, were among these mountains, the demolition of whose forests would bring serious consequences to New England, aside from the very great detriment to summer travel, because they yield so much pleasure and health-giving recreation to citizens of the entire country and financial aid to railroads, steamboats and hotel properties, which in turn are large purchasers of the surplus products and labor of our people.

The commission in its last report, as sponsor, presented this question to the Legislature and procured the passage of the following memorial to congress:

JOINT RESOLUTION FAVORING THE ESTABLISHMENT OF A NATIONAL FOREST RESERVE IN THE WHITE MOUNTAIN REGION.

WHEREAS, certain permanent and summer residents of this state have taken steps to memorialize congress for the establishment of a national forest reserve in the White Mountain region; and

WHEREAS, the establishment of such a reserve would perpetuate valuable forest growths and forever preserve the headwaters of several important streams and thus benefit the commerce, industry and agriculture of all the New England states, save one; and

WHEREAS, the White Mountain region is of increasing importance as a pleasure resort to fully one quarter of the entire population of the country who reside within easy reach of it; therefore be it

Resolved by the Senate and House of Representatives in General Court convened:

That the Legislature of New Hampshire hereby expresses its approval of the proposition to establish a White Mountain national forest reserve.

That the consent of the state of New Hampshire be and is hereby given to the acquisition by the United States by purchase, gift or condemnation according to law, of such lands in this state as in the opinion of the federal government may be needed for the establishment of a national forest reserve in the White Mountain region.

That power is hereby conferred upon congress to pass such laws as it may deem necessary to the acquisition of lands in this state for the purposes of such a national forest reserve.

That power is hereby conferred upon congress to pass such laws and to make, and provide for the making of, such rules and regulations of both civil and criminal nature, and provide punishment for the violation thereof, as, in its judgment, may be necessary for the management, control and protection of such land as may from time to time be acquired by the United States under the provisions of this joint resolution: Provided, That the state of New Hampshire shall retain a concurrent jurisdiction with the United States in and over such lands so far that civil process in all cases, and such criminal process as may issue under the authority of the state against any person charged with the commission of crime without or within said jurisdiction, may be executed thereon in like manner as if this joint resolution had not been passed.

That the senators and representatives in congress from this state are hereby requested to urge upon congress the importance of prompt and favorable action on behalf of the proposition to establish a White Mountain national forest reserve.

[Approved January 20, 1903.]

In furtherance of the idea was procured the appropriation for the White Mountain forest survey, of which we have heretofore spoken, and as a result of which it was expected to procure evidence supporting the claim of the White Mountain region upon congressional attention.

After consultation with our delegation in congress, with the societies referred to and with friends of the work throughout New England and the country, and as the result of the information derived from the forest survey conducted through the year, the commission determined to present a bill at the opening of the second session of the Fifty-eighth Congress.

After consideration, a measure, drawn upon the lines of the one pending, presented by the central-southern states and known as the Southern Appalachian bill, was decided upon, as embodying the essentials of legislation most likely to invite support and to disarm opposition.

This bill, prepared by us, was introduced in the Senate by Senator Gallinger soon after the opening of the session of congress in December and is as follows:

A BILL.

FOR THE PURCHASE OF A NATIONAL FOREST RESERVE IN THE WHITE MOUNTAINS, TO BE KNOWN AS THE NATIONAL WHITE MOUNTAIN FOREST RESERVE.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled:

That the Secretary of Agriculture is hereby authorized and empowered, in his discretion, to purchase land suited to the purposes of a national forest reserve in the White Mountains, within the State of New Hampshire, in total extent not to exceed one million acres, and to care for, protect, use and make accessible the said reserve, the same to be known as the "National White Mountain Forest Reserve."

SECT. 2. That the Secretary of Agriculture shall advertise in the State of New Hampshire for lands to be purchased under the provisions hereof, and as between lands of equal value, for the purposes of this act the lowest bids shall be accepted: *Provided*, That the Secretary of Agriculture is hereby authorized and empowered, in his discretion, to contract for the purchase of lands, exclusive of the timber thereon, of kinds and sizes to be specified in the contract, said timber to be cut and removed under the supervision of the Secretary of Agriculture in accordance with rules and regulations to be established by him for that purpose: *Provided further*, That the Secretary of Agriculture is hereby authorized and empowered, in his discretion, to contract for the purchase of lands, exclusive of the mineral rights therein; and on such lands so acquired mineral deposits may be mined under such rules and regulations as the Secretary of Agriculture may prescribe, and which rules and regulations, as provided in this section for cutting and removal of timber and mining for minerals, shall be embodied in the contract for purchase and conveyance of title.

SECT. 3. That in the acquirement of lands for the purposes of this act the Secretary of Agriculture shall conform to the conditions prescribed in the present or future act or acts of the Legislature of the State of New Hampshire ceding to the United States the right to acquire and control such lands: *Provided*, That when the owners of lands sought to be acquired for the purposes of this act are unwilling to sell the same on terms satisfactory to the Secretary of Agriculture, condemnation proceedings for the acquirement of such lands shall not be had so long as the said owner shall protect and perpetuate the forests on said lands, under such regulations as may be prescribed by the Secretary of Agriculture for the control of the forests on other lands purchased by the government under this act, so far as the same may be applicable.

SECT. 4. That the Secretary of Agriculture is hereby authorthorized and empowered to accept gifts of land for the purposes of this act, and such lands shall thereafter be known by such names as the donors, with the approval of the Secretary of Agriculture, may prescribe.

SECT. 5. That the Secretary of Agriculture may do all things necessary to secure the safe title in the United States to the lands herein provided to be purchased; but no payment shall be made for any land purchased under this act until the title to such land shall be satisfactory to the Attorney-General and conveyance thereof duly executed and accepted.

SECT. 6. That the Secretary of Agriculture shall make provision for the reforesting of clearings on lands purchased under the provisions of this act, whenever such planting shall be necessary for the protection of the soil or water supply.

SECT. 7. That the Secretary of Agriculture is hereby empowered and directed to make such rules and regulations and establish such service as he may deem necessary for the care, protection, control and use of such forest reserve, and to sell such wood, timber and other products as may be removed without injury to the forest: *Provided*, That no wood, timber or other products shall be sold otherwise than under such rules and regulations as shall be prescribed by the Secretary of Agriculture, but no sale of such products shall be made at less than the appraised value thereof: *And provided further*, That the proceeds of such sale shall be covered into the treasury of the United States.

SECT. 8. That the Secretary of Agriculture is hereby authorized and empowered to make contracts for the purchase of lands and accept conveyance thereof in accordance with the provisions of this act to the amount of not to exceed five million dollars; and the sum of one million dollars thereof, to be available immediately and until the expiration of the year ending June thirtieth,

nineteen hundred and six, is hereby appropriated, out of any moneys in the treasury not otherwise appropriated, for the purchase of lands for a national forest reserve and otherwise to carry out the provisions of this act: *Provided*, That the Secretary of Agriculture shall each year make a detailed report to congress of his doings in the premises: *And provided further*, That no part of said sum hereby appropriated shall be expended for the purchase of land in the State of New Hampshire under the provisions of this act until a valid title to the same shall be vested in the United States, and until the said state shall have ceded to the United States exclusive jurisdiction of the same during the time the United States shall be or remain the owner thereof, for all purposes except the administration of the criminal laws of said state and the service of any civil process therein.

Support for the Measure.

The bill was referred to the Senate committee on forest reservations and preservation of game.

Through the instrumentality of the commission a prompt and vigorous movement was soon under way to petition congress in favor of the measure, and more than 500 petitions, signed by more than 10,000 persons, were presented to congress by our senators and representatives.

In April, 1904, as the session of congress was approaching its close, the president and secretary of the commission visited Washington on behalf of the White Mountain Reserve bill, and, as a result of a brief but vigorous campaign, were enabled to procure a favorable report on the measure from the committee to whom it had been referred. The report will be prepared by Senator Burnham of our own state, one of the members of the committee, and will be filed at an early day in the approaching session of congress.

While it is impossible to predict immediate favorable action by congress upon this subject, we are, nevertheless, encouraged to believe that at some time, probably not remote, a National White Mountain Forest Reserve will be established. It will be necessary, however, to continue the agitation vigorously in order to induce congress to act favorably on the measure.

The efforts of the commission in this direction will not be relaxed. The campaign of petitions, already so well begun, will be continued more energetically than before; and in addition we shall utilize all means within our power to engage the favorable attention of individual members of both houses of congress to the tremendous importance of this measure to New England's most vital interests.

Our Delegation Active.

Our senators and representatives in congress are ardently enlisted on behalf of the White Mountain Reserve. To Senator Gallinger all friends of the measure owe an especial debt of gratitude for his prompt sponsorship of the bill and for his energetic and helpful labors in aid of its favorable reporting from its committee. Senator Burnham, a member of the committee, has been in a position to render the measure great assistance and has the further opportunity successfully to attempt its early passage through the Senate. In the House, Congressman Currier's labors have been of high value in securing concord of opinion between the friends of the White Mountain bill and the friends of a similar measure for the Southern Appalachians. This latter proposition was favorably considered in the Senate during the Fifty-seventh Congress, but failed of passage in the House. Its friends have hitherto claimed for it a legislative priority over the White Mountain measure; but, thanks to Mr. Currier's good management, the House advocates of both measures are now ready to act upon them at the same time, a circumstance which leads to the hope that our relief by congressional action may not be as remote as some have thought.

Congressman Sulloway has given to the bill the benefit of all the support and influence which his long service in congress now permits him to enjoy and his energies in its behalf promise no small degree of support for it.

In our last report we published a full outline of the general argument in favor of the White Mountain Forest Reserve and we do not deem it necessary to multiply the present pages by a repetition of it.

It had been expected that the results of the examination of the White Mountain region, previously referred to, would produce many facts tending to emphasize the great desirability of favorable action on the part of congress. The report of the examining party, as printed elsewhere in this report, provides such argument.

Continuation of Hydrographic Work.

In one respect, however, it is incomplete. The hydrographic portion of the examination, by means of which is to be determined the relation of the New Hampshire forest cover to the great water courses of the several states of New England originating within our state, must necessarily cover a more extended period of time than has been possible since the beginning of the examination in May, 1903.

The arrangement made with the Bureau of Hydrography of the United States Geological Survey was that the funds of the bureau should supplement the state appropriation, dollar for dollar, in every expenditure made in New Hampshire, and we have thus been enabled to procure a considerable body of data at little expense.

In carrying forward this work several gage stations have been established at different points on our water courses, and readings are now being taken continuously. It is not the purpose of the Geological Survey to continue these readings, however, unless New Hampshire desires it. The officials of the Survey express an entire willingness to go on with the work under present conditions if authority can be obtained for so doing. We therefore recommend that provision be made also for carrying on the hydrographic examination for the ensuing two years.

Completion of Forest Map.

The success attending the forest examination of the White Mountain region is so great and the value of the results secured is so obvious, that we recommend the extension of a similar examination to all the other forested areas of the state.

Within the territory in New Hampshire lying south of the limits covered by Mr. Chittenden and his party much field work has already been done by the federal Bureau of Forestry, and a considerable amount of data is now available concerning the secondary forest area. While the area to be explored is considerably larger than that covered by the Chittenden field party, it is obvious that, by reason of the work already done, of the smaller proportion of area covered by actual forest, of the facility of movement within the designated territory and of the more favorable topography, a forest survey of that portion of the state could be made very rapidly. We therefore recommend that the Legislature authorize the expenditure of the balance now remaining in our hands from the appropriation of 1903, together with such sum as is necessary to make a total of three thousand dollars, for the extension of the forest survey over that portion of the state not already covered.

Two highly desirable results would be secured by such action: (1) The forest map of the state, now complete as regards the White Mountain region, could be perfected with reference to our entire area; and (2) the work of examination could be made to include an investigation of soil and topographical conditions, which would enable the people of the state to know what of the waste lands which we now have could be best utilized in forest culture.

Improvements in Forestry Work.

Since our last report there has been great improvement in forest conditions and in the manner of presenting forestry interests to the public. Lurid editorials, once filling distant and poorly informed journals, have disappeared; sensational correspondence from mountain and forest resorts has given place to sensible and interesting statements of actual conditions.

The relations between the great interests involved in forest preservation and culture have become better known and understood, so that the diverse and somewhat complex undertaking, involving capital and skilled labor, a higher degree of proficiency in the management of lumber operations, the construction of roads and even the erection of places of entertainment, have become blended into an interdependent system, wherein all plans combine for forest protection, personal enjoyment, commercial and æsthetic profit.

Much as has been accomplished, there yet remains much to do in like direction. We have not yet recovered from the devastating fires of 1903. Great areas were then destroyed, that can never in the life of living man be replaced. Attention must yet be concentrated on preventive measures, with forest patrols and municipal control to save repetition of dire disaster. It is beyond doubt that last year's fires were widely scattered along railway lines, operated both for timber purposes and ordinary traffic. It is to be presumed that the managers of these roads will constantly seek for protection from self interest alone through any practical devices. All aid available from the Legislature should be granted.

There are spots in our wooded domain that should be put beyond risk of cutting, if possible, at an early day. Such spots as the slopes of Mt. Adams in the Presidential Range, the growth around Glen Ellis Falls and at salient points in the mountain region should emphasize the need of immediate action. As the commission has no funds, voluntary contributions or Legislative action alone can prevent devastation, pending action by the congress.

With the more complete understanding of the subject that now obtains, there has undoubtedly grown better, more economical and less wasteful methods of lumbering.

New Hampshire's Forest Cover.

The state may be broadly divided into three classes of land under forest cover: (1) Those areas everywhere that have been cut over—the great tracts in the lumber woods, exterminated or ruthlessly cut, to grow up into sprout land in a few years, remaining as palpable traces of devastation on mountain side and valley, but which are robbed of their commercial value; (2) those detached groups of second growth, scattered over the southern, western and southwestern parts of the state; and (3) the lessening area of primeval forest growth.

Time alone can hide by young growth the deep scars in the northern region and among the great mountains and valleys; the incoming of summer residents and lovers of nature to all the hillsides and points of attraction in lower New Hampshire has checked through purchase, and will continue to check in like manner, destruction in that section; while the right to apply to the state to condemn, in flagrant cases of spoiliation, will prove a potent factor to retain spots of natural beauty and forest cover.

There is no manner of doubt that our forest cover of all kinds increases year by year and we may conclude that its scenic value adds to the material wealth of the state.

There is, however, one thing against which we may not contend successfully unless strengthened by the federal power. Intelligent landowners and even promoters will preserve their land for recurring crops of timber. The summer guest and lover of the beautiful may secure minor areas by purchase or in extreme instances through the drastic course of condemnation, but against the demands of printing press and paper mill there is little protest possible. The state is not in condition to buy up all its forest land or to exercise the right of eminent domain, to be followed of course by compensation.

Our natural hope seems to be with congress through the establishment of reservations that will protect our water supply, the source of power for manufacturing enterprises, furnishing employment to labor and investment to capital, and establishing a natural sanatorium to which may come the weary and the pleasure seeker for the pure air, glancing waters, crisp breezes and a touch of mother earth in her best estate.

We have devoted our efforts toward the establishment of this national park. We respectfully submit that with local problems entirely within your control, the preservation of the forests and forest cover of Southern New Hampshire is found in the self interest of owners of smaller areas, while the establishment of a national park or parks among the mountains and lakes of the great north forests of our upper counties will alone afford preservation and development of the deeper woods and those grander landscapes possible of attainment.

Further Recommendations.

The report of Mr. Chittenden, to which such frequent allusion has been made, embraces, in addition to the detailed results of his examination, two important recommendations:

1. There should be a chief fire warden, who should also be state forester, who should maintain a state forest nursery for the distribution at cost of forest seeds and seedlings, and should bring about, by lectures and instruction on the ground, a better management of forest lands within the state.

2. Since an excellent opening exists for the creation of a state reserve by the purchase of cut-over land in the mountains, the adoption of a policy looking to this end is recommended.

That portion of Mr. Chittenden's recommendation relating to the establishment of a forest nursery we have already discussed. We are of the opinion that, in the present condition of the state revenues and expenditures, it would be unwise for New Hampshire to undertake to invest even so small a sum as ten thousand dollars in a plant which may prove in a few years of little or no value; but we are earnestly in favor of some arrangement being made whereby existing nurseries can be used for the general good of all our citizens.

Mr. Chittenden's second recommendation, looking toward the creation of a state reserve by the purchase of cutover lands in the mountains, need not be seriously considered at present. The "excellent opening" for the creation of such a reserve to which he refers, will not immediately disappear, and it will be ample time after the failure of the present vigorous movement for the establishment of a national reserve to discuss ways and means for the creation of a state reserve upon any basis whatsoever.

The recommendation for a state fire warden, who should be the state forester, brings up the entire question of the reorganization of the forestry department.

As we have elsewhere said in this report, the present forestry commission was established at a time when the forestry movement was wholly in a sentimental stage, although the board in its first report, in all succeeding reports, and in all its work, has endeavored to lay emphasis more especially on the practical side of forestry. At that time, too, there were few, if any, trained foresters in New Hampshire, there being no demand for them. There was then no forest school in this country, and little or no attempt was made by any landowner to gather his timber crop in any but the most expensive and wasteful of methods.

In the last ten years all this has changed. There are now several schools of forestry in the country, two of them being in New England; there is a large body of trained foresters available for forestry work; timber landowners are coming to realize the absolute necessity for the adoption of rational forestry if they are to continue in business; and the recasting and enforcement of our forest fire laws probably makes it of some importance that New Hampshire should now consider whether its forestry department should not be in some degree reorganized.

We are not certain that it would be wise to create a single-headed department such as a state forester would be, but we think some course might be readily devised which would secure all the advantages of trained forestry service in the department and at the same time preserve to the state its traditional method of procedure.

For example: If a bi-partisan commission of two members could be established, clothed wholly with administrative power and its members authorized to appoint a forester, probably a satisfactory solution of the problem would be reached. Such a course has one important argument in its favor: Under the present forestry laws, the forestry commission sits in a quasi-judicial capacity in hearings on petitions for the taking of land for public parks. Such hearings, involving as they do many disputed points of public policy and local necessity, ought not to be decided by one mind. Our experience has shown, however, that a commission the size of the present one is too large, because of the difficulty of securing a quorum to sit in such cases at the desired times. We give it as our opinion, therefore, that a commission of two, authorized to appoint a forester, might serve all the purposes of the case. The commission could then exercise the administrative and judicial functions now devolving upon the present board, while the forester could assume the duties of a fire warden and could carry on the educational work heretofore referred to.

In the event of such a reorganization of the department, we venture to suggest that the commissioners should not be required to serve without pay. While there are no doubt many disinterested and high-minded citizens who would be willing to assume the duties of the office without compensation, the experience of the present board in such matters has been such as to warrant the assertion that if the services of any man are worth having they are worth paying for.

We therefore suggest that if such reorganization as we have indicated is undertaken, provision be made for suitable compensation for the commissioners, the same as for a forester. It might be possible to provide for a small salary for the commissioners and for the forester without materially increasing the expense of the department over what it has been in some years under the present system.

HENRY O. KENT, *President,*
GEORGE H. MOSES, *Secretary,*
GEORGE E. BALES,
MARSHALL C. WENTWORTH,
Forestry Commissioners.

CONCORD, October 30, 1904.

APPENDIX.

FOREST CONDITIONS OF NORTHERN NEW HAMPSHIRE.

BY

ALFRED K. CHITTENDEN,

Assistant Forest Inspector,

Bureau of Forestry.

CONTENTS.

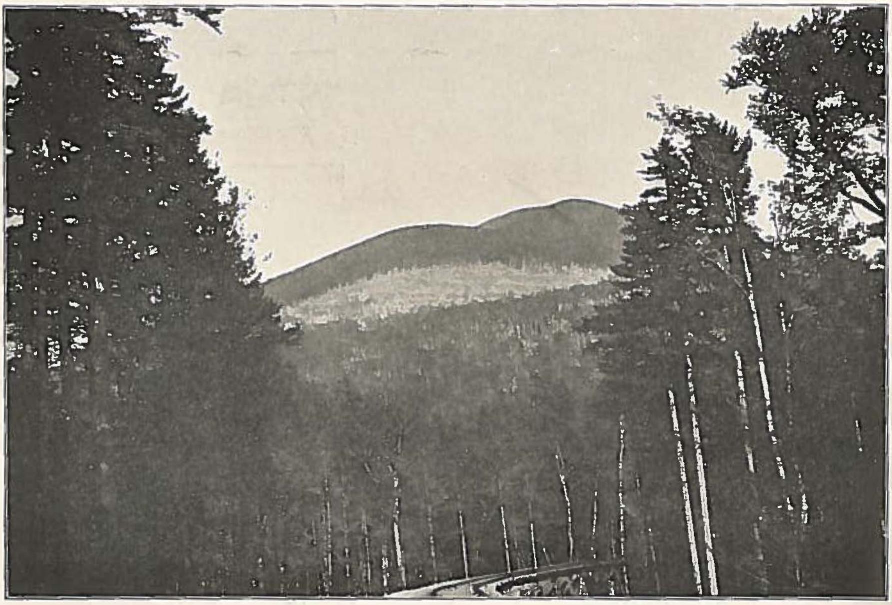


FIG. 1.—MT. BOND, SHOWING CLEAR CUTTING ON UPPER SLOPES.

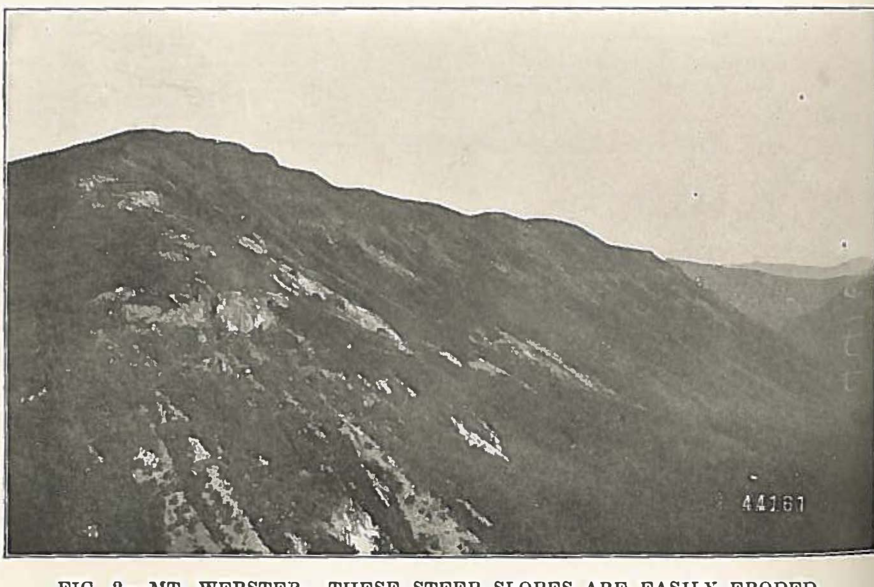


FIG. 2.—MT. WEBSTER. THESE STEEP SLOPES ARE EASILY ERODED.

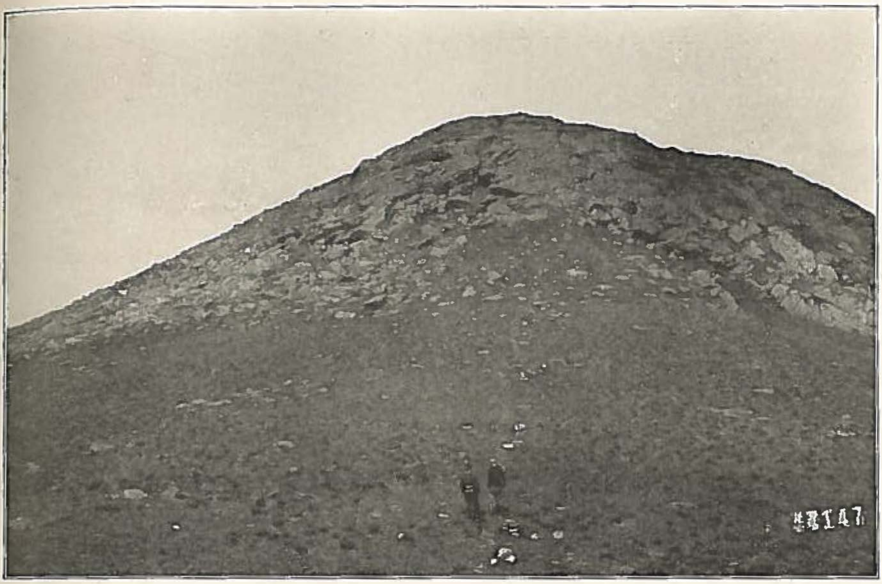


FIG. 1.—NORTH PEAK OF MT. CLAY. ELEVATION, 5,334 FEET.

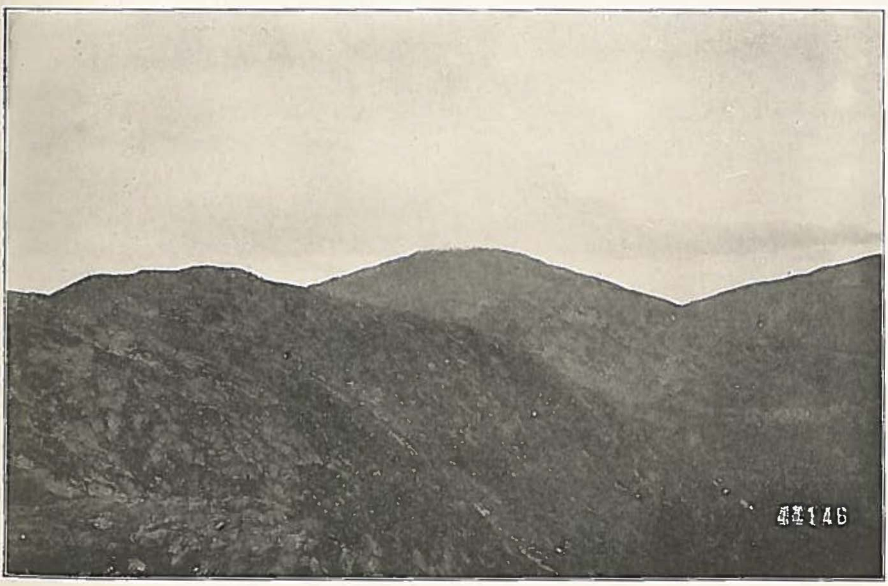


FIG. 2.—PRESIDENTIAL RANGE. MTS. CLAY AND JEFFERSON.

FOREST CONDITIONS OF NORTHERN NEW HAMPSHIRE.

INTRODUCTION.

Early in 1903 the Legislature of New Hampshire passed the following resolution:

Resolved by the Senate and House of Representatives in General Court convened:

That the forestry commission be and hereby is authorized and directed to procure, upon terms to be approved by the governor and council, a general examination of the forest lands of the White Mountain region by employees of the Bureau of Forestry in the Department of Agriculture at Washington, whose report shall be laid before the next session of the General Court; and the governor is hereby empowered to draw his warrant for a sum not exceeding five thousand dollars upon any money in the treasury not otherwise appropriated to meet the expense of such examination.

Approved February 24, 1903.

The examination authorized by this resolution was begun in May of the same year and prosecuted during the summer months.

The lines of investigation followed were those laid down, after consultation with the State Commission, in the following extract from a letter from the Secretary of Agriculture to the Commission:

The specific purpose of this work will be to determine by a thorough study on the ground of the conditions existing in the forest and the causes of those conditions; to estimate the cost and devise the methods necessary to the preservation of the forest of the White Mountain region and ultimately of the whole state; and to forecast the character and the value of its results.

The following lines of investigation commend themselves to me as the more important:

1. A study of the composition and quality of the forest and an estimate of the present stand, results which would be used partly in the completion of the forest map of New Hampshire, published in 1894.

2. A study of the characteristics of the more important trees and of the conditions necessary to their successful reproduction.

3. A study of the methods and extent of lumbering, of its effect upon the forest, and of those modifications which are practicable in order to improve the condition of cut-over lands.

4. An investigation of the value of the forest as a conserver of the water supply, in which I hope to obtain the assistance of the U. S. Geological Survey. This would include the determination of the size and condition of the watersheds tributary to large streams rising within the White Mountain region; of the effect of forest destruction upon the flow of these streams; and of the value and amount of water power which is available at different seasons of the year or which is already in use.

5. A study leading to a statement of the size, the value, and the character of the lumber industry of the state of New Hampshire.

The timber map, which accompanies the present report, presents a part of the results of these investigations. It covers the entire state north of Squam Lake as far west as the farm lands along the Connecticut River, embracing in all an area of 3,050 square miles, or 32 per cent. of the area of the state. This map shows the extent and present condition of the forest. It is as accurate as careful field work in the short time available could make it. It is not designed, however, to show the exact amount of timber on small areas, but rather the present condition of the forest throughout the region examined.

The study of forest fires, which are without doubt the greatest danger confronting the forests of New Hampshire today, was carried on with a view to devising some adequate system of fire protection for the state. Without efficient protection of the forest from fire, the attempt to carry on a conservative system of lumbering will fail all along the line, since both the commercial productiveness and the permanent preservation of the forest depend upon it.

The study of the wood industries embodied in this bulletin was made by Mr. J. Girvin Peters, forest assistant in the Bureau of Forestry.

The co-operation of the Division of Hydrography of the U. S. Geological Survey resulted in the accompanying preliminary report upon its work.

Resume of Conclusions.

The conclusions and recommendations based upon the study of forest conditions in Northern New Hampshire by the Bureau of Forestry are given in detail at the end of this report. They may be briefly summarized as follows:

1. Unless the forests are effectively protected from fire, the value of Northern New Hampshire both as a summer resort, now the source of an annual revenue of approximately eight million dollars, and as a source of timber supply, will be seriously affected.

2. Safety from forest fires is impossible without the organization of a fire service. Detailed recommendations for this are made elsewhere in this report.

3. Conservative lumbering under the supervision of trained foresters would pay the large lumber and pulp companies operating in Northern New Hampshire better than the present method.

4. The conservative management of farm woodlots is practicable and greatly to be desired.

5. Forest planting upon denuded lands unsuited for agriculture promises good returns.

6. There should be a Chief Fire Warden, who should also be State Forester, who should maintain a state forest nursery for the distribution at cost of forest seeds and seedlings, and should bring about by lectures and instruction on the ground a better management of forest lands within the state.

7. Since an excellent opening exists for the creation of a forest reserve by the purchase of cut-over lands in the mountains, the adoption of a policy looking to this end is recommended.

THE REGION.

Physiography.

The territory covered by this report is that part of the state north of Squam Lake, and west as far as the agricultural lands along the Connecticut River. It includes the northern portions of Grafton and Carroll counties and the whole of Coös county, and embraces in all a total area of 1,951,977 acres, or 32 per cent. of the entire state. It contains the entire White Mountain region, and is drained by four large river systems, the Connecticut, the Pemigewasset, the Saco, and the Androscoggin, all of which have their origin within the territory under examination.

Topography.

The White Mountain region occupies the southern and larger portion of this area. The country is very rough and rugged, broken up, as it is, into many short mountain ranges and deep, narrow valleys. The northern part of the area is flatter, and contains many lakes and low mountains, with wide, rolling valleys between. The entire region is essentially a forest country. That the land is, for the most part, better suited to forest production than to agricultural use is evidenced by the thousands of acres of abandoned farms, which have now largely come up to dense forests of second-growth spruce and pine. Where repeated fires have not kept back the young growth, these give good promise for the future.

The White Mountains cover about 812,000 acres, or 42 per cent. of the entire area examined, lying in northern Grafton and Carroll counties and southern Coös county. Seventy-four mountains reach a height of over 3,000 feet, and of these 11 are over 5,000 feet in height. The tallest, Mt. Washington, rises to an altitude of 6,290 feet above the sea, and is the second tallest peak east of the Mississippi River.

FIG. 1.—MT. WASHINGTON AND HEAD OF THE GREAT GULF.

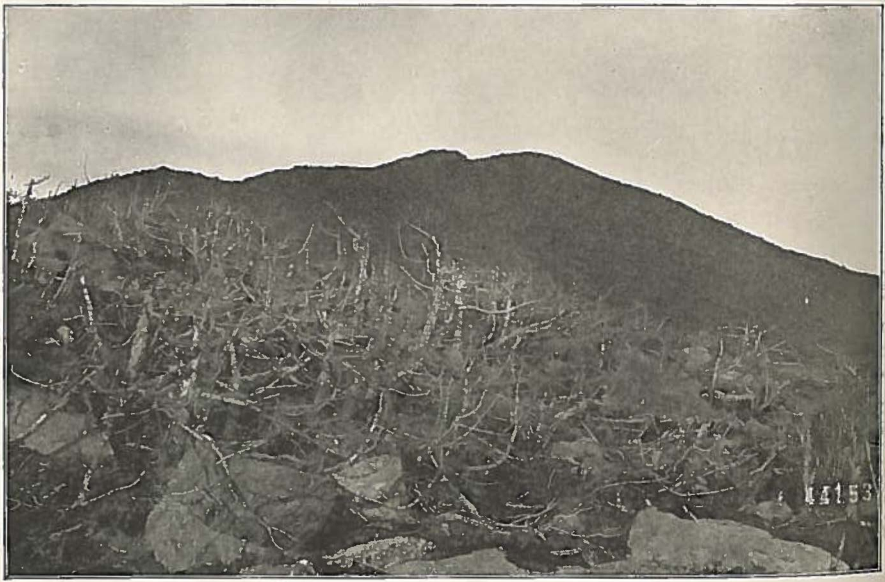


FIG. 2.—SUMMIT OF MT. SAM ADAMS. ELEVATION, 5,585 FEET.

PLATE IV.

FIG. 1.—GRANITE QUARRY AT REDSTONE.

FIG. 2.—CASTELLATED RIDGE, MT. JEFFERSON.

A characteristic of the topography is the great irregularity of arrangement of the mountains. With the exception of the Presidential Range there are no long ranges. The greater number of peaks are in irregular groups or isolated. The three main ranges, the Presidential, the Carter-Moriah and the Franconia, have a general northeast and southwest direction. The first of these, which contains the tallest peaks of the region, is about 20 miles in length. The high peaks in Waterville and Albany and Mt. Moosilauke, on the western border of the region, are isolated mountains.

The general base level varies from 700 to 1,500 feet elevation, and from this level the mountains rise, for the most part, very abruptly. The slopes are generally steep and the intervening valleys narrow and sloping, with occasional wide intervales. The intervales are flat, and the soil is deep and fertile, furnishing the best farming land in the region.

GEOLOGY.

During the Paleozoic, or tropical, period preceding the ice age, it is probable that the White Mountain region was covered for the most part with forests of beech, basswood, buckeye, pepperidge, and cinnamon. This is indicated by the fact that fossils of these species are found at Brandon, Vt. Long before this period, however, the mountains had been formed. The bases are a porphyritic gneiss, possibly of the later Laurentian period, together with several groups of granite from the early Huronian, the whole having been forced to a high elevation by lateral pressure. The general direction of the ranges is northeast and southwest. The Paleozoic period was succeeded by the ice age, or Cenozoic period, in which no vegetation could have endured. To this period, together with the atmospheric influences upon the mountains since that time, are due the formation of soils throughout the region.

The continental ice sheet advanced from the northwest, the highest mountains offering no barrier to its advance. By grinding the rocks it deposited over the mountains a layer of gravel and sand, varying from a few feet to 30 feet or more in depth, and fertile because of the potash which is essential to plant life and which is a constituent of gneiss and granite. This action is well illustrated on Mt. Moosilauke. The great stretches of sand extending over Madison, Ossipee, and adjoining townships are a deposit of the ice age. On the Presidential Range large blocks of stone were carried from the northern slopes to the summits, covering the finer earth deposited earlier. As the continental sheet disappeared, it seems to have left glaciers radiating from the mountains in all directions. These carried large boulders with them, which now strew the ground thickly in places, and deposited at frequent intervals lateral and terminal moraines. The finer grinding of the glaciers has deposited the clays which occur in places, but the coarser deposits have rendered much of the land too rocky for agriculture.

One of these glaciers, from two to three thousand feet in thickness, swept the sides of Mts. Moosilauke and Ascutney, in the Connecticut Valley. Other independent glaciers moved down the Pemigewasset and Androscoggin valleys, up the valley of the Peabody River, and down the Crawford Notch and the Saco valley. The even slopes of the hills about the village of Jackson are composed of drift supposed to have come from the earlier sheet, while the boulders deposited upon it are due to the later glacial action.

Throughout the mountains the glacial moraines across the valleys have caused many of the small lakes and ponds. These deposits, being often gravelly, have sometimes been broken through, letting out the water. In some cases this has taken place since the settlement of the country. The bog and swamps bearing spruce, larch, and balsam have similar origin. Bogs rich in peat are not infrequent. Several bogs, however, owe their presence to dams made by beavers. Considerable areas of the higher summits are often covered with peat, which affords a foothold for the shallow roots of spruce and balsam.

Erosion, due to heat, frost, and water, has played an important part both in the formation and particularly in the removal of mountain soil on steep slopes. The decaying mosses and lichens soaked in water form an acid that disintegrates the rocks. Heat and frost aid the process. The Androscoggin Valley, for instance, for two miles below Gorham is filled with rocks and debris cracked off from the surrounding hills. The slides on so many of the mountains, as on Washington, Osceola, Carter, and Tripyramid, the recent fatal slide on Cherry Mountain, and that on Mt. Willey in the early part of the last century, are another form of erosion. Erosion is constantly going on in the mountains, particularly on the high slopes where the timber has been removed by the prevailing method of clear cutting. Here the run-off is far more rapid, often laying bare the rocks and occasionally causing destructive floods below.

Climate.

The climate of New Hampshire varies in no essential from that of the other New England states. The precipitation of approximately 40 inches is ample for all agricultural crops and forest trees suited to the climate. The humidity, averaging at 8 o'clock readings, over 75 per cent. of saturation throughout the year, is very high, although somewhat lower than at certain points on the New England coast. This high degree of humidity greatly conserves the moisture available for vegetative growth, since it checks very markedly both the direct evaporation of moisture from the soil and the excessive transpiration of vegetation in general. The amount of precipitation that falls as snow is very variable, the annual snowfall being not infrequently 40 per cent. above or below the average.

The temperature is on the whole exceedingly favorable for all kinds of forest growth. It is not characterized by extreme variations of heat and cold, although the winters are long. Late frosts in the spring and early frosts in the fall are to be reckoned with. They frequently do great damage to farm crops.

The following table shows the average monthly mean temperature and rainfall in this region, as shown by the records of the Weather Bureau:

TABLE I.—CLIMATE OF NORTHERN NEW HAMPSHIRE.

Month.	Average temperature.	Average precipitation.
	° F.	*Inches.*
January	16.0	2.96
February	17.4	3.58
March	26.4	3.18
April	40.7	2.07
May	53.9	3.15
June	63.8	3.74
July	67.2	3.68
August	65.0	3.95
September	57.2	3.12
October	45.6	2.91
November	32.2	3.65
December	21.0	2.93

Drainage.

Of the four main streams which drain Northern New Hampshire, the Connecticut, the Saco, the Pemigewasset, and the Androscoggin, two, the Saco and Pemigewasset, rise in the White Mountains. The Connecticut has its source in the lakes of the same name in the northern part of the state, and the Androscoggin is formed by the junction of the Magalloway and the outlet of Umbagog Lake, the lower of the large chain of lakes in Maine known as the Rangeley Lakes. Though the Androscoggin flows for some distance through the state, the principal source of its water is in Maine.

The areas of these drainage basins in the territory examined are as follows:

Connecticut River	683,758	acres.
Saco River	444.435	"
Pemigewasset River	343,512	"
Androscoggin River	480,272	"
Total	1,951,977	acres.

Each of these main river basins is divided up into numerous smaller basins formed by their tributaries. New Hampshire is an excellently watered state. There are innumerable streams and small brooks, springs, ponds, and miniature lakes, as well as a number of larger ones, chief of which, within the section examined, are the Connecticut Lakes in the extreme northern part of the state. There are very few large areas of swamps; aside from a number of small bogs, the country is generally well drained.

Ownership of the Land.

The greater part of the territory examined is forest land, owned for the most part by large lumber and paper companies. There are also a large number of lumber companies holding comparatively small tracts, and a great deal of land is held in lots of hundred acres more or less by private owners.

The following is approximately the ownership of the area examined:

Large lumber and pulp companies	900,000 acres.
Hotel companies	28,000 "
Small holders of forest land	756,000 "
Agricultural land, small holdings	244,000 "
Total	1,928,000 acres.

Value of the Land.

Up to 1869 the state owned the greater part of the White Mountain region and Coös county. The policy of the state was to dispose of its public lands as fast as possible, and large tracts were sold for almost nothing. During recent times, however, the value of land has increased very rapidly and now, owing to the growing scarcity of spruce in the state, good forest land commands an excellent price.

The best spruce land brings from $20 to $30 per acre, according to the stand and quality of the spruce and its accessibility for lumbering. The greater part of the country, however, is cut over, and much of it badly burned. Such land, with little or no merchantable spruce and covered with hardwoods, is worth from $2 to $4 per acre. Burned or abandoned land can be bought for from $1 to $2 per acre. Such land often has a good second growth of spruce and balsam. The best second-growth spruce land is rapidly increasing in value, and is being bought up by the large lumber and pulp companies.

Classification of the Land.

The area considered by this report has been mapped with respect to the following natural conditions:

- Softwood growth:
  - Five thousand to ten thousand board feet per acre;
  - Under five thousand board feet per acre.
- Pine.
- Hardwood growth:
  - Fifteen cords and over per acre;
  - Under 15 cords per acre.
- Waste land.
- Agricultural land.
- Barren land.
- Burns.

Softwood Growth.

This includes all merchantable stands of timber yielding over 1,000 board feet of softwoods per acre. The growth consists chiefly of spruce, with balsam, hemlock, and pine in mixture, the last two occurring more or less scatteringly. Hardwoods, chiefly yellow and paper birch, sugar and red maple, popple, and beech, occur in softwood growth in varying proportion, generally predominating in stands averaging less than 5,000 board feet per acre of softwoods.

The reason for considering so small a stand of softwoods as 1,000 board feet per acre, and actually classing it as softwood growth, when as a matter of fact the preponderance of growth is hardwoods, is to realize one of the chief objects of this report; namely, to obtain the total stand of softwoods in the region under consideration, which, as previously stated, is principally spruce.

For convenience and expediency in estimating, the softwood growth has been divided up into classes according as the yield is, which yield respectively 10,000 board feet and over, from 5,000 to 10,000 board feet, or under 5,000 board feet per acre.

Ten thousand board feet and over per acre.—This includes the most extensive virgin stands of merchantable softwoods, chiefly spruce and balsam. There is very little cut-over land in this class. It is found usually below an elevation of 3,000 feet, and is almost entirely owned by a few large lumber and pulp companies.

Five thousand to ten thousand board feet per acre.—This class includes a large amount of cut-over land from which sawlogs only have been removed, and also considerable areas of virgin forest on the upper slopes, occurring in a zone above the best class of softwoods, and reaching an average altitude of about 3,700 feet. The virgin and cut-over areas of this class can generally be distinguished by their comparatively high or low elevations, although frequently the two areas are contiguous. Such instances are the result of the lower slopes, where the stand of spruce was originally very heavy, having been logged for sawlogs only, while the upper slopes, where the stand was not so good, remained untouched.

Under five thousand board feet per acre.—This division includes all cut-over lands now averaging from 1,000 to 5,000 board feet per acre, and a certain amount of virgin land which forms a narrow belt on some of the upper slopes, immediately below the scrub growth. This division is largely represented in the valleys, which, easily accessible, have in some cases been logged several times. When this class occurs on the high mountain slopes it marks the limit of merchantable timber, and reaches an elevation of about 4,000 feet. On the cut-over areas hardwoods, as a rule, form the bulk of the stand; on the virgin areas balsam predominates over spruce. The area covered by virgin forest is, however, very limited.

PINE.

This land is situated almost entirely in the southeastern portion of the territory examined. For the most part the stands are almost pure white pine, though with a slight mixture of red pine, and, with the exception of a limited area near Intervale, are entirely second-growth, which has come up chiefly on abandoned farms.

HARDWOOD GROWTH.

This has been separated into two divisions: Fifteen cords and over per acre, and under 15 cords. A division of this sort is essential in order to distinguish between the better class and the very poor growth of hardwoods which comes in immediately after cutting and fires. As the one grades almost imperceptibly into the other, and as there are practically no pure virgin hardwood lands in the region, no convenient basis other than that of yield can be found.

Fifteen cords and over per acre.—For the most part this division includes the large areas from which softwoods have been culled until less than 1,000 board feet remain, and those areas clean cut or burned sufficiently long ago for them to yield now at least 15 cords per acre. In the first case the growth consists of an open stand of mature hardwoods, chiefly yellow and paper birch, sugar maple, and dense stand of popple, birch, maples, and beech, with often quality. In the second case the growth consists of a rather dense stand of popple, birch, maples, and beech, with often a little spruce in mixture.

Under this division is also included a small area, but nevertheless worth noting, of almost pure virgin hardwoods in the vicinity of Bartlett village.

Under fifteen cords per acre.—This division includes practically all land burned over within the last twenty

PLATE V.

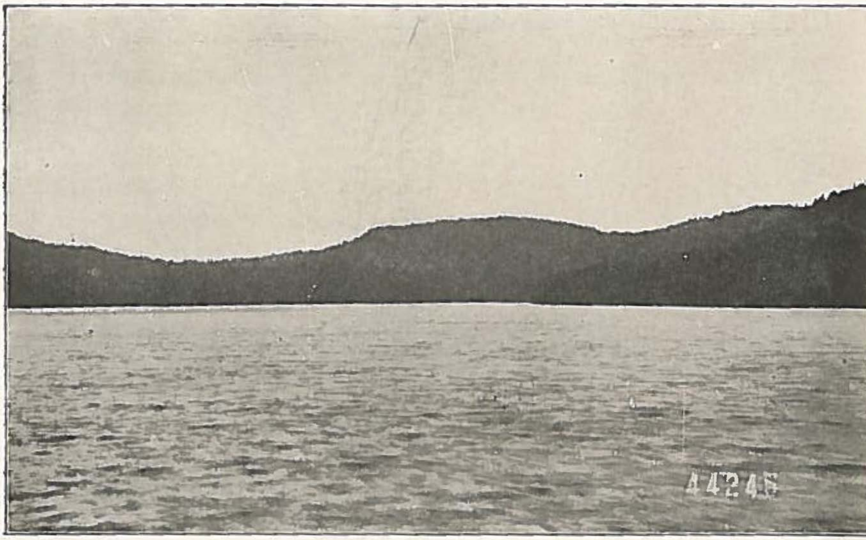


FIG. 1.—THIRD CONNECTICUT LAKE. CANADIAN BOUNDARY LINE RUNS ALONG HEIGHT OF LAND.

FIG. 2.—AMMONOOSUC VALLEY NEAR TWIN MOUNTAIN.

PLATE VI.

FIG. 1.—VIRGIN SPRUCE WITH DENSE BALSAM REPRODUCTION. MT. JACKSON.

FIG. 2.—VIRGIN SPRUCE FOREST WITH HEMLOCK IN MIXTURE.

years, and land from which the timber has been clean cut. The predominating species are bird cherry, popple, and birch. There is often considerable sugar and red maple and beech, the latter species increasing in proportion every year after cutting. This class is merely an earlier stage of the first class of hardwoods. Often on the higher slopes there is considerable spruce reproduction as well.

Waste Land.

This embraces those areas that produce an absolutely valueless growth, such, for instance, as that found on the poorer quality of abandoned land, unmerchantable swamps, and the scrubby growth on the high mountain slopes. On the map the abandoned land and the scrub growth may be distinguished by the relatively low and high situations they occupy. A considerable area in the southeastern townships covered with pitch pine is classed as waste land. The pine occurs in more or less open growth or in small groups, usually with a dense undergrowth of scrub oak. The scrub growth on the upper slopes consists of balsam, spruce, and yellow and paper birch, varying in size from trees which just miss being merchantable to the prostrate shrub at timber line.

Agricultural Land.

Practically all the accessible valley lands are given up to agriculture. The great bulk of the farm land lies along the southern and western borders of the region and along the lines of railway. The township of Colebrook is considered the best farming land in the state.

Barren Land.

This includes the rocky summits of many mountains above timber line, where less than one third of the ground is covered with scrub growth. The most extensive area is on the crest of the Presidential Range.

Burns.

Areas run over by fire were mapped to indicate whether the fire occurred in the year 1903 or previously. This distinction was made to show the extent of the forest fires which swept over New Hampshire in the spring immediately preceding the examination. Attention was also paid in the case of each burn to the growth which came up after the fire and which, in every instance, is practically all hardwoods. On the map this is indicated by a hatched color, the color indicating the succeeding growth.

The burns of 1903 are distinguished on the map from previous burns by hatching unaccompanied by any color, no growth having yet manifested itself on the newly burned areas. Unfortunately, the map does not show the relative area of this year's burns in comparison with earlier ones, since a great part of the area burned last spring had been previously burned over, in some instances several times.

For the most part, the fires have started upon and have been confined to cut-over land. The virgin forest is strikingly free from any trace of fire. The subject of forest fires is considered in detail in another part of this report.

Area of Land of Each Class and Stand of Timber, by Drainage Basins.

To secure a convenient basis for an estimate of the amount of land of the different classes and the stand of timber in the region, a subdivision of the entire area was made by drainage basins, under the following heads: Saco, Pemigewasset, Ammonoosuc, Israel and Upper Ammonoosuc, Androscoggin, Magalloway and Upper Connecticut. Of these, the Ammonoosuc, Israel and Upper Ammonoosuc, and Upper Connecticut are parts of the Connecticut drainage basin, while the Magalloway basin is that part of the basin of the Maine river of the same name which lies in New Hampshire, and which is tributary to the Androscoggin. A detailed description of each of these drainage basins is made in another part of this report.

The area of land of each class in the whole region was carefully mapped. The estimate of timber was made by eye, checked from time to time by taking sample acres in various localities, 219 acres being measured in all. The estimated stand includes all trees six inches and over in diameter breasthigh. To obtain a definite figure for the best class of softwood land, that over 10,000 board feet, 52 acres of this type were measured in various places from Waterville to northern Pittsburg. The average of these, allowing liberally for cull, was found to be 16,000 board feet per acre. Accordingly this figure has been used in working up the estimate. No attempt has been made to distinguish between spruce and balsam. The latter forms from one to 20 per cent. of the total stand according to situation; probably 10 per cent. would be a liberal average for all localities. In mapping the hardwoods the division into classes of over and under 15 cords per acre was made rather to show the condition of the growth and the relative ages of the cuttings than as an estimate, although it serves the latter purpose as well. The pine was not estimated, as it is practically all second-growth and usually not of merchantable size.

TABLE II.—AREAS AND YIELDS OF NORTHERN NEW HAMPSHIRE DRAINAGE BASINS.

Class of land.	Saco.	Pemigewasset.	Ammonoosuc.	Israel and Upper Ammonoosuc.	Androscoggin.	Magalloway.	Upper Connecticut.	Total.
SOFTWOODS:	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Under 5,000 board feet per acre	47,025	124,451	33,240	87,443	95,562	69,000	154,920	611,641
5,000-10,000 board feet per acre.............	47,931	36,430	20,596	24,717	86,129	36,320	42,880	295,003
Over 10,000 board feet per acre.	5,786	30,274	4,004	2,571	5,673	25,360	9,280	82,948
Pine......................	32,216	256	....	520	720	....	1,040	34,752
HARDWOODS:								
Under 15 cords per acre...........	39,067	17,886	14.428	10,987	68,977	800	10,440	162,585
Over 15 cords per acre	154,448	51,712	16,633	31,115	38,619	....	....	292,527
Agricultural land........	44 409	40,422	29,571	16,356	24,678	1,320	87,280	244,036
Burns—1903...............	11,658	6,351	13,831	36,221	10,314	200	5,680	84,255
Waste land...............	53,581	33,452	8,972	7,944	5,368	1,120	4,080	114,517
Barren land.............	1,420	717	1,264	585	1,992	....	....	5,978
Water....................	6,894	1,561	....	2,040	6,280	1,840	5,120	23,735
Total.................	444,435	348,512	142,539	220.499	344.312	135,960	320,720	1,951,977

YIELD OF SOFTWOODS—MILLION BOARD FEET.

	546	1,007	285	402	928	816	780	4,764

From this table it will be seen that the stand of softwoods in Northern New Hampshire is estimated at 4,764 million board feet.

Better to illustrate the present forest conditions, the following table has been prepared, bringing out the relative areas of cut-over and virgin forest in this region.

TABLE III.—AREA OF NORTHERN NEW HAMPSHIRE LAND AND WATER.

Virgin merchantable forest	200,000	acres.
Cut-over or culled land......	1,368,711	"
Barren and waste land..	120,495	"
Total forest land......................	1,684,206	"
Agricultural land..	244 036	"
Water..	23,785	"
Total..	1,951,977	"

From this it will be seen that virgin forest forms only about 12 per cent. of the total forest area examined.

FIG. 1.—PURE GROWTH OF UNMERCHANTABLE BALSAM AT 3,800 FEET ELEVATION ON MT. WEBSTER.

FIG. 2.—BALSAM AT 5,211 FEET ELEVATION.

FIG. 1.—SPRUCE FLAT NEAR THE CONNECTICUT LAKES. THE BALSAM REPRODUCTION ON THESE FLATS IS VERY DENSE.

FIG. 2.—SPRUCE SLOPE, MT. MAGALLOWAY.

DESCRIPTION OF THE FOREST.

FOREST CONDITIONS.

In the state of New Hampshire as a whole two broadly distinguished types of forest occur. On the basis of these types the state divides itself into what may for convenience be called the northern and the southern divisions. Strictly speaking, these terms are not entirely accurate, for elevation, quite as much as latitude, laid down the boundary between them; on the east and west the southern division extends up the lowlands as far as the Saco and Ammonoosuc rivers, respectively, while the northern includes, in addition to Coös county, the whole of the White Mountain region, extending as far south as the towns of Waterville and Albany. The original forest of the southern division was mainly hardwoods and pine, with the hardwoods preponderating—a preponderance which the early lumbering of the pine has largely increased. Both white pine and hemlock, however, are more abundant here at the present time than farther north. But hardwoods are the characteristic species.

Originally the entire northern division was covered with a dense forest of conifers. It was primarily a spruce country, and the spruce here attained fine dimensions. White pine, too, covered large areas and was mixed with spruce over much of the region. Balsam occurred in mixture on the upper slopes and in the lower, moister localities. There was originally very little pure hardwood forest in the northern part of the state, where it was confined to the lower slopes, with spruce in mixture.

The best spruce grew on hardwood land, where the soil is deeper and richer than on the steeper slopes. These lower slopes were, moreover, most easy of access to the lumberman, and in consequence were among the first to be cut after the land in the valleys had been lumbered. Owing to presence of the hardwoods in mixture on these slopes, the growth that came up after lumbering was not spruce or balsam, but hardwoods. Where fire has once run over such a slope after lumbering, the growth of sprouts that comes in is very dense, and the character of the forest is materially changed.

The most characteristic trees of the northern division are the red and white spruce, balsam, sugar maple, beech, and white cedar.

In the region examined the southern division takes on somewhat the character of a transition zone between the northern and southern parts of the state. Some of the southern species, like the white and red oaks, here reach their northern limits, and mingle with those more characteristic of the north. But the hardwoods still remain dominant. Of typical northern trees, the white spruce and cedar do not occur in the south.

In the White Mountain region red spruce and balsam are the prevailing species, and reach the highest elevations on the mountains. North of the White Mountains, these trees with white cedar and, around the Connecticut Lakes, with white spruce, are the chief conifers. Lumbering has brought about a great change in the species. Hemlock and white pine, once common at low elevations and along the valleys, are now of but little importance in the forest. Of the hardwoods, yellow birch, sugar maple, and beech are the commonest, and have greatly increased in numbers on the cut-over land. But little of the original forest is now left. Where was formerly a heavy stand of spruce and balsam is now a hardwood forest, with a little spruce in mixture. Where fires have occurred, there is a tangle of bird cherry, yellow birch, and aspen.

Forest Types.

The original forest types of the region examined consisted of spruce flat; hardwood land and spruce slope. Of these the spruce slopes covered by far the greater part of the country. These types, while generally holding good, show considerable variation in different localities.

Spruce Flat.—Spruce flats occur in the moister, lower situations, on the level or rolling land around lakes and streams and in the valleys. Spruce and balsam are the chief species; and on the wetter soils, black spruce, white cedar, and larch are also common. There is often considerable yellow birch and red maple. Spruce does not form as good a timber tree on these flats as on higher ground. White pine and hemlock formerly occurred in great abundance on these lowlands, but have been almost entirely cut out. Windfall is particularly common; exceptionally tall trees are very liable to be thrown.

Spruce flat is a very common type in New Hampshire, especially in the country north of the White Mountain district. Owing, however, to their accessibility, they have been almost entirely cut over, and but little virgin forest of this type now remains. Second growth on these flats is usually excellent, softwoods greatly predominating over the hardwoods.

The following table shows the average stand on this type in virgin forest in Coös county:

TABLE IV.—SPRUCE FLAT.—PITTSBURG TOWNSHIP.

[Average of 10 acres.]

Diameter breasthigh.	Number of trees per acre.							
	Spruce.	Balsam.	Yellow birch.	Paper birch.	Sugar maple.	Black ash.	Mountain ash.	Mountain maple.
Inches.								
2	6.90	63.80	0.40	0.60	....	....	0.80	0.90
3	12.40	56.60	.90	1.70	....	....	.80	....
4	12.50	41.00	.30	1.50	....	.10	.60	....
5	16.10	31.50	.70	5.00	....	....	.10	....
6	14.30	18.60	.30	3.20	....	....	....	....
7	14.90	19.20	.30	2.10	....	....	....	....
8	17.30	15.80	.30	2.40	....	....	....	....
9	16.40	9.00	....	2.30	....	....	....	....
10	16.00	7.90	.40	1.40	....	....	....	....
11	13.70	4.50	....	.70	....	....	....	....
12	12.00	3.90	.10	.30	....	....	....	....
13	10.10	1.10	.30	.80	.10	....	....	....
14	8.90	1.00	.40	.60	....	....	....	....
15	7.50	.70	.40	.20	....	....	....	....
16	6.50	.10	.20	.10	....	....	....	....
17	5.50	.30	.20	....	....	....	....	....
18	3.40	....	.20	....	....	....	....	....
19	1.50	....	.30	....	....	....	....	....
20	1.60	....	.20	....	....	....	....	....
21	1.20	....	.10	....	....	....	....	....
22	.40	....	.10	....	....	....	....	....
23	.50	....	....	....	....	....	....	....
24	.10	....	....	....	....	....	....	....
25	.10	....	....	....	....	....	....	....
35	....	....	.10	....	....	....	....	....
Total.........	199.80	275.00	6.20	22.90	.10	.10	2.30	.90

TREES 10 INCHES AND OVER IN DIAMETER BREASTHIGH.

....	89.00	19.50	3.00	4.10	.10	....	....	....

Hardwood Land.—On the lower slopes and deeper, better soils, hardwoods form a large part of the growth. Here yellow birch, sugar maple, and beech are the characteristic trees, with considerable spruce in mixture. The spruce forms a better timber tree on these lower slopes than in any other situations.

These hardwood slopes rarely extend above an altitude of 2,400 feet. The forest is, as a rule, dense and clean, with a heavy shade. The ground cover consists chiefly of witch hobble, mountain maple and mountain ash. The shade is too heavy for good softwood reproduction, but the hardwood reproduction, particularly sugar maple and beech, is often very thick, with a dense matting of small

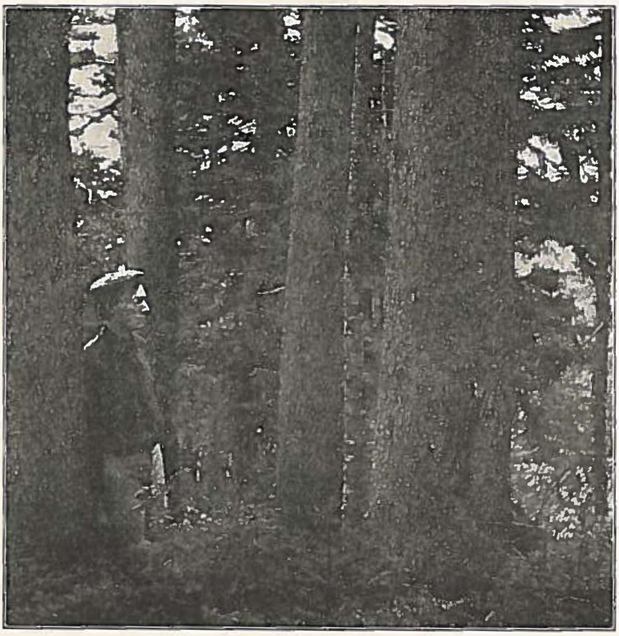


FIG. 1.—SPRUCE AT 2,900 FEET ELEVATION. MT. WEBSTER.

FIG. 2.—UPPER SPRUCE SLOPE. MT. WEBSTER. BALSAM DEAD AND DYING.

FIG. 1.—APPALACHIAN MOUNTAIN CLUB'S CABIN NEAR SUMMIT OF MT. MADISON.

FIG. 2.—UPPER SLOPES OF THE PRESIDENTIAL RANGE.

seedlings covering the ground. Very little of this type is now left in virgin forest, except in the upper part of the Magalloway watershed, since it was easily lumbered.

The following tables show the stand on this type in various parts of the state:

TABLE V.—HARDWOOD LAND.—WATERVILLE TOWNSHIP.

[Average of 50 acres.]

Diameter breast-high.	Number of trees per acre.										
	Spruce.	Balsam.	Hemlock.	Yellow birch.	Sugar maple.	Beech.	Paper birch.	Red maple.	White ash.	Mountain ash.	Other species.
Inches.											
2	26.44	5.48	.18	4.48	3.98	14.08	......	.02	.02	.02	15.50
3	6.00	1.30	.08	1.48	.86	3.36	......	......	......	.02	2.08
4	7.14	1.60	.14	2.22	.86	4.56	......	.04	......	......	.56
5	6.00	.98	.18	2.68	.86	4.42	.02	.06	.02	......	.42
6	6.40	.52	.12	2.10	.50	3.72	.02	.12	......	......	.14
7	4.40	.34	.12	1.94	.62	2.82	.10	.02	......	......	.08
8	4.12	.10	.14	2.06	.54	3.36	.08	......	.04	.02	.08
9	3.76	.14	.12	1.66	.36	3.36	.04	......	.04	......	......
10	3 24	.02	.26	1.98	.44	3.28	.08	.08	......	......	......
11	3.00	.10	.02	2.02	.52	3.36	.10	.08	......	......	......
12	2.84	.06	.06	2.08	.58	3.76	.10	.08	.04	......	......
13	2.28	.02	.18	1.86	.66	3.72	.04	.04	......	......	......
14	2.04	......	.20	2.20	.64	4.26	.08	.02	.02	......	......
15	1.86	.02	.12	1.56	.32	3.38	.04	......	......	......	......
16	1.84	......	.18	1.48	.56	2.36	.02	.02	......	......	......
17	1.70	......	.16	1.16	.50	1.74	......	.06	......	......	......
18	1.30	......	.20	1.14	.36	1.74	......	.02	......	......	......
19	.62	......	.12	1.10	.38	1.14	......	......	.02	......	......
20	.88	......	.12	.82	.26	.98	.02	.02	......	......	......
21	1.00	......	.16	.84	.38	.70	......	......	......	......	......
22	.62	......	.14	.80	.42	.36	......	......	......	......	......
23	.18	......	.10	.88	.28	.04	......	......	......	......	......
24	.20	......	.16	.58	.30	.06	......	......	......	......	......
25	.10	......	.06	.30	.22	.04	......	......	......	......	......
26	.04	......	.12	.40	.20	.02	......	......	......	......	......
27	.06	......	.12	.18	.14	......	......	......	......	......	......
28	.04	......	......	.16	.14	......	......	......	......	......	......
29	.02	......	.02	.12	......	......	......	......	......	......	......
30	......	......	.10	.16	.04	......	......	......	......	......	......
31	......	......	.02	.08	......	......	......	......	......	......	......
32	......	......	.04	.08	.02	......	......	......	......	......	......
33	......	......	......	.02	......	......	......	......	......	......	......
34	......	......	......	.04	......	......	......	......	......	......	......
35	......	......	......	.02	......	......	......	......	......	......	......
36	......	......	.02	.08	......	......	......	......	......	......	......
37	......	......	.02	.02	......	......	......	......	......	......	......
38	......	......	......	.04	......	......	......	......	......	......	......
39	......	......	......	......	......	......	......	......	......	......	......
40	......	......	......	......	......	......	......	......	......	......	......
41	......	......	......	......	......	......	......	......	......	......	......
42	......	......	......	.02	......	......	......	......	......	......	......
Total.........	88.12	10.68	3.78	40.84	15.94	70.62	.74	.68	.20	.06	18.86

TREES 10 INCHES AND OVER IN DIAMETER BREASTHIGH.

....	23.86	.22	2.70	22.22	7.36	30.94	.48	.42	.08	......	......

TABLE VI.—HARDWOOD LAND.—PITTSBURG TOWNSHIP.

[Average of 12 acres.]

Diameter breast-high.	Number of trees per acre.									
	Spruce.	Balsam.	Yellow birch.	Sugar maple.	Beech.	Black ash.	Paper birch.	White ash.	White elm.	Other species.
Inches.										
2	2.58	7.00	1.25	10.67	.83	.17	......	......	......	2.83
3	2.00	11.50	2.00	8.17	.83	.33	......	......	......	1.08
4	2.42	14.83	1.33	10.00	1.33	......	......	......	......	......
5	2.08	12.92	2.08	7.58	1.42	.33	.08	......	......	......
6	2.17	9.56	2.08	6.50	1.00	.17	......	.08	......	......
7	.92	5.42	2.17	5.67	1.17	.67	......	......	......	.08
8	1.67	4.50	1.50	6.06	1.00	.25	.17	......	......	......
9	1.38	2.75	2.42	5.42	.92	.42	......	......	......	......
10	1.67	2.08	1.83	6.25	.75	.08	......	......	......	......
11	1.08	1.17	1.83	5.75	.17	.58	......	......	......	......
12	1.00	.50	1.50	4.67	.08	.08	.08	......	......	......
13	1.25	.17	2.00	4.00	......	.25	......	......	......	......
14	1.00	.25	1.67	4.75	.17	.17	.08	......	......	......
15	.75	.08	2.00	3.00	.08	.17	......	......	......	......
16	.75	......	1.50	3.42	......	.08	......	......	......	......
17	.58	......	1.33	3.17	......	.08	......	......	......	......
18	.58	......	1.42	1.88	......	.08	......	......	......	......
19	.25	......	1.25	1.58	......	......	......	......	......	......
20	.33	......	1.50	1.33	......	......	......	......	......	......
21	.25	......	.67	1.00	......	......	......	......	......	......
22	.17	......	.92	.42	......	......	......	......	......	......
23	.08	......	.75	.17	......	......	......	......	......	......
24	.08	......	.33	.25	......	......	......	......	.08	......
25	.08	......	.33	.08	......	......	......	......	......	......
26	......	......	.42	......	......	......	......	......	......	......
27	......	......	.50	......	......	......	......	......	......	......
28	......	......	.08	......	......	......	......	......	......	......
29	......	......	.08	......	......	......	......	......	......	......
30	......	......	.42	......	......	......	......	......	......	......
35	......	......	.08	......	......	......	......	......	......	......
Total.........	25.07	72.78	37.24	101.76	9.25	8.91	.41	.08	.08	3.99

TREES 10 INCHES AND OVER IN DIAMETER BREASTHIGH.

....	9.90	4.25	22.41	41.67	1.25	1.57	.16	......	.08	......

Spruce Slope.—This type occurs on the steeper slopes where the soil is shallow and the hardwoods do not thrive so well. The principal species are spruce and balsam, in varying proportions, and yellow birch, changing often to paper birch on the upper slopes. This type merges on the upper side into unmerchantable spruce and balsam, and finally runs out into a scrubby growth near the summits.

The stand is usually dense. Where the forest has been undisturbed, the ground cover is moss. The balsam reproduction is often very thick, and the spruce reproduction generally fair.

Spruce slopes cover the greatest area of any of the forest types in Northern New Hampshire. Where these slopes are cut over, if fire is kept out, the softwoods return in the second growth. Where fire runs over the ground after lumbering, in many cases the entire soil is burned and washed away and the process of return to forest conditions is very slow. In some cases, as on the Sugar Loaves in the township of Carroll, it will never be complete.

The following tables show the average stand on spruce slopes and on upper spruce slopes in various parts of the state:

TABLE VII.—HARDWOOD LAND.—LOW AND BURBANK GRANT.

[Average of 5 acres.]

Diameter breast-high.	Number of trees per acre.									
	Spruce.	Balsam.	Hemlock.	Yellow birch.	Sugar maple.	Beech.	Paper birch.	Mountain maple.	Striped maple.	Other species.
Inches.										
2	17.60	10.40	.80	23.00	18.40	10.00	......	27.00	28.40	.20
3	11.60	7.80	.80	11.80	6.40	6.20	.20	15.40	14.80	......
4	7.20	5.80	.60	7.40	5.80	5.60	......	3.00	5.20	.80
5	6.00	4.00	.60	5.40	4.20	4.20	......	.40	1.80	.20
6	6.80	1.60	.80	1.80	2.60	3.80	.20	.20	1.00	.40
7	6.60	.60	.60	1.80	1.40	3.20	.20	......	.40	.20
8	3.80	.80	.60	1.40	.20	2.60	......	......	......	......
9	5.80	.60	......	1.20	.80	3.60	.20	......	.20	......
10	3.80	1.00	.20	.80	.60	2.20	......	......	......	......
11	2.80	.20	1.00	.80	......	2.60	......	......	......	......
12	4.00	.20	......	.40	.40	2.20	.20	......	......	......
13	2.20	.20	.40	1.20	.20	2.20	......	......	......	......
14	4.40	......	.60	1.20	.80	1.40	.20	......	......	......
15	2.20	.20	.20	.40	.40	1.20	......	......	.20	.20
16	2.20	......	.20	.80	.20	3.20	......	......	......	......
17	3.80	......	.20	1.60	.60	1.60	......	......	......	......
18	2.10	......	......	2.00	......	.80	......	......	......	......
19	1.80	......	.60	1.80	.20	.20	......	......	.20	......
20	.60	......	......	.60	.20	.40	......	......	......	......
21	.20	......	......	.80	......	......	.20	......	......	......
22	.40	......	.20	1.60	......	......	......	......	......	......
23	.40	......	......	.80	.20	......	......	......	......	......
24	......	......	......	......	......	......	.20	......	......	......
25	......	......	......	......	......	......	......	......	......	......
26	.60	......	......	.60	.20	......	......	......	......	......
27	......	......	.20	.20	......	......	......	......	......	......
28	......	......	......	1.00	......	......	......	......	......	......
29	.40	......	......	......	......	......	......	......	......	......
30	......	......	......	......	......	......	......	......	......	......
31	......	......	.20	......	......	......	......	......	......	......
Total.......	97.30	33.40	8.80	70.40	43.80	57.20	1.60	46.00	52.20	2.00

TREES 10 INCHES AND OVER IN DIAMETER BREASTHIGH.

....	31.90	1.80	4.00	16.60	4.00	18.00	.80	......	.40	.20

TABLE VIII.—SPRUCE SLOPE.—WATERVILLE TOWNSHIP.

[Average of 65 acres.]

Diameter breast-high.	Number of trees per acre.									
	Spruce.	Balsam.	Hemlock.	White pine.	Yellow birch.	Sugar maple.	Beech.	Paper birch.	Red maple.	Other species.
Inches.										
2	22.20	13.06	.14	....	3.52	.42	.65	.19	.12	1.86
3	15.51	5.89	.11	....	4.28	.32	.40	.38	.15	.48
4	14.28	4.94	.15	....	4.86	.12	.35	1.17	.26	.28
5	12.94	8.46	.32	....	4.58	.28	.85	1.31	.20	.14
6	11.20	2.87	.28	....	3.40	.22	.35	1.41	.17	.06
7	10.48	1.71	.14	....	2.88	.15	.28	1.25	.29	.06
8	10.45	1.60	.23	....	2.72	.17	.26	1.69	.14	.02
9	11.14	.97	.23	.02	2.14	.20	.22	1.17	.28	......
10	11.03	.65	.32	.02	2.46	.28	.31	1.18	.22	......
11	10.29	.29	.28	....	1.57	.17	.23	.85	.18	......
12	10.88	.87	.11	....	1.57	.09	.35	.54	.03	.02
13	9.12	.25	.11	....	1.52	.09	.29	.85	.03	......
14	9.22	.05	.17	....	1.40	.20	.29	.25	.08	......
15	7.52	.08	.06	.02	1.28	.09	.18	.14	.06	......
16	7.89	.08	.15	.02	1.09	.06	.18	.09	......	......
17	5.80	......	.12	....	.86	.09	.09	.05	......	......
18	5.12	......	.06	....	.91	....	.09	.05	......	......
19	3.40	......	.08	....	.75	.02	.02	.08	......	......
20	2.48	.02	.06	....	.80	.08	.02	.02	......	......
21	2.84	......	.08	....	.68	.03	......	.05	......	......
22	1.18	......	.05	....	.57	.02	......	.02	......	......
23	.68	......	.02	.02	.25	.02	......	......	......	......
24	.45	......	.08	....	.28	.02	......	......	......	......
25	.29	......	.06	....	.12	....	......	......	......	......
26	.11	......	.03	....	.20	....	......	......	......	......
27	.15	......	.03	....	.09	....	......	......	......	......
28	.09	......	.02	....	.02	....	......	......	......	......
29	....	......	.02	....	.08	....	......	......	......	......
30	....	......	......	....	.05	....	......	......	......	......
31	....	......	......	....	.02	....	......	......	......	......
32	....	......	......	....	....	....	......	......	......	......
33	....	......	......	....	.02	....	......	......	......	......
34	....	......	......	....	.02	....	......	......	......	......
35	....	......	......	....	.02	....	......	......	......	......
40	....	......	......	....	.02	....	......	......	......	......
Total........	195.74	35.74	3.41	0.10	44.93	2.99	4.91	12.19	2.16	2.87

TREES 10 INCHES AND OVER IN DIAMETER BREASTHIGH.

....	37.54	1.74	1.36	.08	16.55	1.16	2.05	3.62	.60	.02

TABLE IX.—SPRUCE SLOPE.—PRESIDENTIAL RANGE.

[Average of 35½ acres.]

Diameter breast-high.	Number of trees per acre.									
	Spruce.	Balsam.	Hemlock.	Yellow birch.	Paper birch.	Sugar maple.	Red maple.	Beech.	Mountain ash.	Other species.
Inches.										
2	24.72	46.72	.45	2.87	.68	.19	.34	......	2.26	5.69
3	16.15	25 66	.49	3.77	1.40	.08	.08	......	1.40	2.60
4	15.77	17.43	.64	2.87	1.74	.15	......	......	.60	.46
5	11 62	13.77	.26	3.09	2.23	.15	.04	......	.53	.12
6	8.68	8.56	.37	1.61	1.52	.11	......	.03	.25	.06
7	6.25	6.70	.45	1.41	2.17	.06	......	......	.17	.03
8	7.35	5.01	.34	1.44	1.72	.06	.03	......	.14	......
9	7.04	3.72	.39	.99	1.46	.06	......	......	......	......
10	6.82	2.82	.34	.96	1.86	......	......	.03	......	......
11	6 70	1.52	.23	.96	.93	......	......	.06	......	......
12	6.42	1.04	.45	.62	1.04	.11	......	......	......	......
13	6.93	.82	.14	.70	.76	......	......	......	......	......
14	6.85	.42	.11	.59	.45	.03	......	......	......	......
15	6.28	.31	.20	.51	.28	......	......	......	......	......
16	6.00	.14	.20	.59	.25	.03	......	......	......	......
17	4 76	.14	.20	.54	.17	......	......	......	......	......
18	4.39	.03	.03	.68	.20	......	......	......	......	......
19	2.85	......	.14	.34	.06	......	......	......	......	......
20	2.99	.06	.17	.23	......	......	......	......	......	......
21	2.03	......	.06	.23	.03	......	......	......	......	......
22	1.80	.03	......	.17	......	......	......	......	......	......
23	1.75	......	.03	.14	......	......	......	......	......	......
24	.59	......	.06	.14	......	......	......	......	......	......
25	.56	......	......	.06	......	......	......	......	......	......
26	.28	......	.03	.03	......	......	......	......	......	......
27	.08	......	......	.03	......	......	......	......	......	......
28	......	......	.03	.06	......	......	......	......	......	......
29	.08	......	......	.06	......	......	......	......	......	......
30	......	......	.03	......	......	......	......	......	......	......
31	......	......	......	......	......	......	......	......	......	......
32	......	......	......	.03	......	......	......	......	......	......
33	......	......	......	......	......	......	......	......	......	......
34	......	......	.03	.03	......	......	......	......	......	......
Total.......	165.74	134.90	5.87	25.75	18.95	1.03	.49	.12	5.35	8.96

TREES 10 INCHES AND OVER IN DIAMETER BREASTHIGH.

....	68.16	7.33	2.48	7.70	6.03	.17	......	.09	......	......

TABLE X.—SPRUCE SLOPE—PITTSBURG TOWNSHIP.

[Average of 10 acres.]

Diameter breasthigh.	Number of trees per acre.					
	Spruce.	Balsam.	Yellow birch.	Paper birch.	Mountain ash.	Mountain maple.
Inches.						
2	2.80	31.30	1.00	0.90	1.40	1.70
3	5.90	38.50	2.10	2.10	.30	....
4	6.20	34.50	2.40	1.70	.60	....
5	7.30	25.50	2.10	6.00	.20	....
6	7.00	18.80	2 00	3.30	.10	....
7	7.70	13.10	1.20	1.70	....	....
8	9.20	12.40	2.20	3.50	....	....
9	9.70	8.10	1.60	3.30	....	....
10	11.20	6.40	1.50	2.70	....	....
11	7.40	3.00	1.50	1.20	....	....
12	12.40	2.70	.80	1.10	....	....
13	8.90	1.70	.90	1.20	....	....
14	8.30	.60	.90	.40	....	....
15	7.50	.40	.90	.30	....	....
16	6.80	.30	1.00	.10	....	....
17	5.50	....	1.00	.40	....	....
18	5.00	....	.60	.20	....	....
19	3.10	....	.30	.10	....	....
20	4.20	....	.40	....	....	....
21	2.50	....	.60	....	....	....
22	1.90	....	.10	....	....	....
23	.70	....	.10	....	....	....
24	.30	....	....	....	....	....
25	.20	....	.10	....	....	....
26	.10	....	.20	....	....	....
27	.20	....	....	....	....	....
30	.10	....	....	....	....	....
Total...........	140.10	187.30	25.50	30.20	2.60	1.70

TREES 10 INCHES AND OVER IN DIAMETER BREASTHIGH.

	86.30	15.10	10.90	7.70	....	....

TABLE XI.—UPPER SPRUCE SLOPE—WATERVILLE TOWNSHIP.

[Average of 5 acres.]

Diameter Breasthigh.	Average number of trees per acre.				
	Spruce.	Balsam.	Paper birch.	Yellow birch.	Mountain ash.
Inches.					
2	83.60	236.20	.60	3.00	.20
3	29.00	160.40	2.00	5.20	.20
4	36.20	111.20	4.20	1.20	.40
5	37.00	79.00	5.20	1.00	.20
6	60.20	55.00	5.00	.40	....
7	11.20	20.40	1.20	.20	....
8	22.20	14.80	3.00	....	....
9	18.60	11.00	1.60	....	....
10	18.20	4.80	1.60	....	....
11	3.40	1.00	.40	....	....
12	6.00	1.00	.60	.20	....
13	1.60	....	.40	....	....
14	.60	.20	.40	.40	....
15	.60	....	....	....	....
16	1.00	....	....	....	....
Total	329.40	695.00	26.20	11.60	1.00

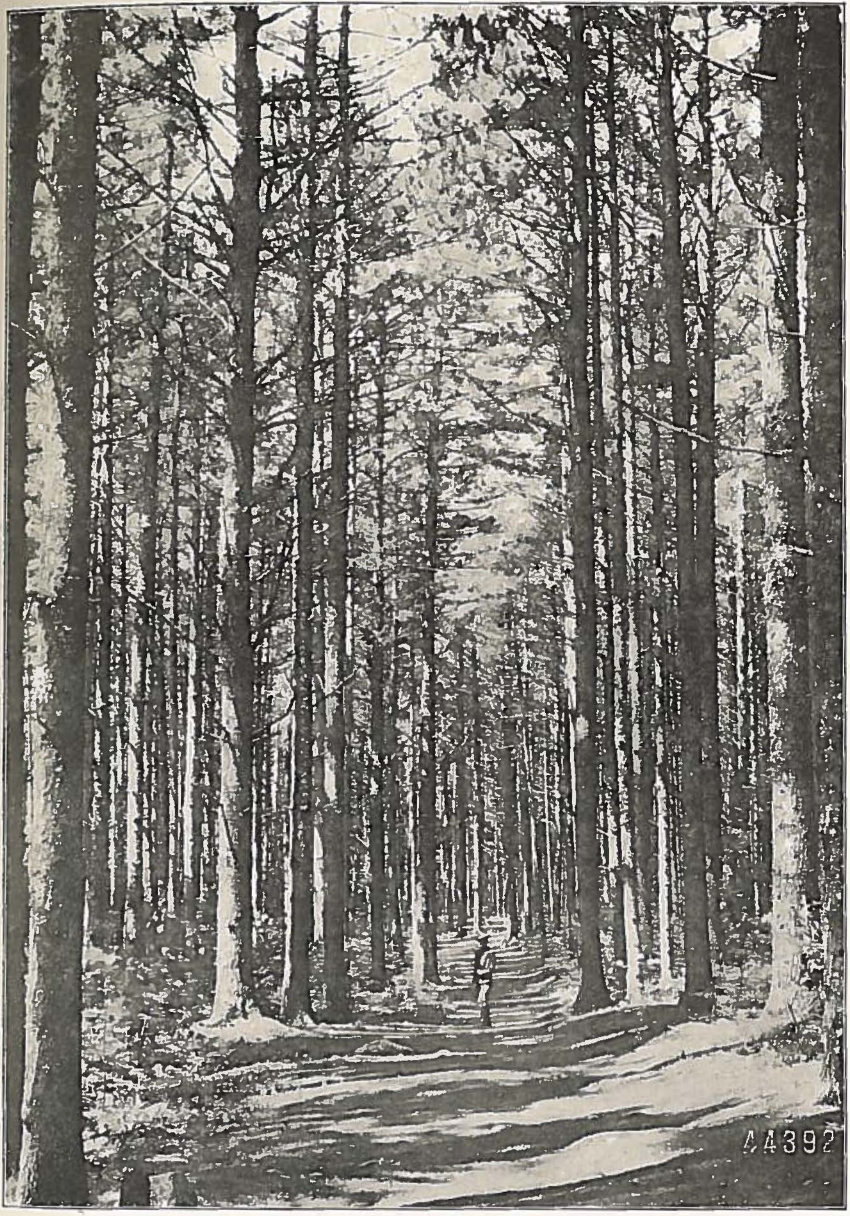
TREES 10 INCHES AND OVER IN DIAMETER BREASTHIGH.

	31.40	7.00	3.40	.60	....

PLATE XI.

FIG. 1.—STUNTED GROWTH OF SPRUCE AND BALSAM ON SUMMIT OF MT. WEBSTER. ELEVATION, 3,876 FEET.

FIG. 2.—DENSE MATTING OF SPRUCE ON MT. ADAMS AT AN ELEVATION OF 5,200 FEET.



VIRGIN WHITE PINE AT INTERVALE.

TABLE XII.—UPPER SPRUCE SLOPE—LOW AND BURBANK GRANT.

[Average of 1½ acres.]

Diameter Breasthigh.	Number of trees per acre.				
	Spruce.	Balsam.	Paper birch.	Yellow birch.	Mountain ash.
Inches.					
2	66.00	174.67	37.33	2.00	2.00
3	49.33	202.67	77.33	.67	2.00
4	18.33	140.00	70.67	.67	.67
5	3 00	84.67	36.00	....	1.33
6	2.67	46.67	30.67	....	2.00
7	1.33	24.67	18.33	....	.67
8	....	10.00	5.33	....	.67
9	....	4.00	5.33	....	....
10	.67	4.67	4.67	....	....
11	.67	2.00	4.00	....	....
12	....	.67	2.00	....	....
13	....	.67	4.00	....	....
14	....	.67	.67	....	....
15	....	....	2.67	....	....
16	....	....	....	....	....
17	....	....	.67	....	....
Total	142.00	700.03	296.67	3.34	9.34

TREES 10 INCHES AND OVER IN DIAMETER BREASTHIGH.

	1.34	8.68	18.68	....	....

Aside from these main types there are several others covering comparatively small areas. Tracts of low, level, sandy land along the Saco River bear, in places, a nearly pure growth of pitch pine, and large areas in the same section that were originally white pine land have now come up to good stands of second-growth white pine.

There is practically no real swamp land in Northern New Hampshire, although in places the spruce flats approach such a type. There are, however, small areas of swamp or spruce bogs, occurring chiefly in the northern part of Coös county. These have a very dense, scrubby growth of black and red spruce and balsam. Such areas are, however, too small in extent to constitute a general type.

The original types are often greatly confused and changed by lumbering. Over large areas that once had a heavy stand of spruce or pine there is now a poor growth of hardwoods. But, in general, the type will be evident in the reproduction and the forest will eventually revert to the original condition. On the hardwood land, however, the spruce, once removed, will never return in large numbers.

DESCRIPTION BY TOPOGRAPHIC SUBDIVISIONS.

As has already been said, the entire area under discussion was subdivided into drainage basins, the aggregate of which constitutes the Northern New Hampshire region as examined. A detailed description of each of these basins will presently be given; but preliminary to this the forests of the Presidential and Carter Mountain ranges will be separately described. It will be understood, however, that these forests are parts of those to be presently considered under their several drainage basins, and are here selected for particular description, not as constituting areas distinct from the various watersheds there described, but because their character is such as to make it convenient to take them up by themselves.

FORESTS OF THE PRESIDENTIAL RANGE.

Physiography.—The Presidential Range is, topographically, the most important range in the White Mountains. In it are included nine peaks with elevations of over 5,000 feet. The range has a general northeast and southwest direction. It is popularly considered as extending only from Mt. Madison on the north to Mt. Webster on the south, and includes the following peaks: Madison, the three Adamses, Jefferson, Clay, Washington, Monroe, Franklin, Pleasant Dome, Clinton, and Webster This stretch of country is about 15 miles long by five miles in breadth, and contains about 50,000 acres. Pine Mountain in the north and Rocky Branch and Montalban Ridges in the south, extending to the villages of Bartlett and Jericho, are properly also parts of the range. If these are included, the area is approximately 150,000 acres.

Drainage.—This range is the source of five rivers by which it is drained: The Saco, Ammonoosuc, Israel, Moose and Peabody. The country south of a line drawn from Crawford's to the summit of Mt. Washington is drained by the Saco River, with several good-sized tributaries, Dry River, Rocky Branch, and Glen Ellis River. North of this line the drainage is by the Ammonoosuc and Israel, flowing northwest into the Connecticut River, and the Moose and Peabody, flowing northeast into the Androscoggin River.

Soil.—The underlying rock is granitic gneiss. By disintegration and mixture with organic matter it forms a loamy sand. The depth of the soil varies with the elevation, aspect and gradient. In the valleys and on the lower slopes, the soil is generally deep, and there is very little outcropping rock. With ascent in altitude and increase in gradient, the depth of soil gradually decreases, till on the steep upper slopes there is to be seen only immense masses of bare outcropping rock and scattered boulders. On southern and western aspects the exposure to sun and wind is more severe than on northern and eastern slopes. This causes a more rapid dissipation of the organic soil, which results in the belt of deep soil being lower on the former than on the latter aspects. These facts have an important bearing on the distribution of the forest.

The Forest.—Complexity and variation in forest conditions are the natural outcome of variety in slope and aspect and great latitude in elevation. As in topography, so also in forest conditions the Presidential Range offers the greatest differences. This complexity has been augmented by fire and lumbering, which often greatly change the original character of the forest. In general, however, the nature of the forest varies with the altitude. Four forest belts may thus be distinguished:

1. Under 1,800 feet elevation, where lower slopes and valleys occur, typical hardwood land is found. Sugar maple, yellow birch, beech and spruce are the prevailing species.

2. From 1,800 to 3,500 feet elevation the forest is characterized by the prevalence of spruce in mixture with balsam and yellow and paper birch. This is the regular spruce slope type.

3. From 3,500 to 4,200 feet elevation the growth is spruce and balsam, with some paper birch. It is mostly unmerchantable, being under forty feet in height.

4. At 4,200 feet scrub growth begins, and extends up to the limit of tree growth, which varies from 4,500 to 5,200 feet in altitude according to exposure and gradient. Above this, the bare rocks extend to the summits.

The elevations given for these belts are purely averages and not in the least fixed. The character of the growth also changes somewhat with the aspect and gradient, as well as with the elevation. Thus, on a steep, rocky southwest slope, the scrub line would be lower than on a northeastern exposure of moderate incline.

The lower slopes of the Presidential Range have been almost entirely cut over, but there is still much virgin timber left above the valleys, notably in the Low and

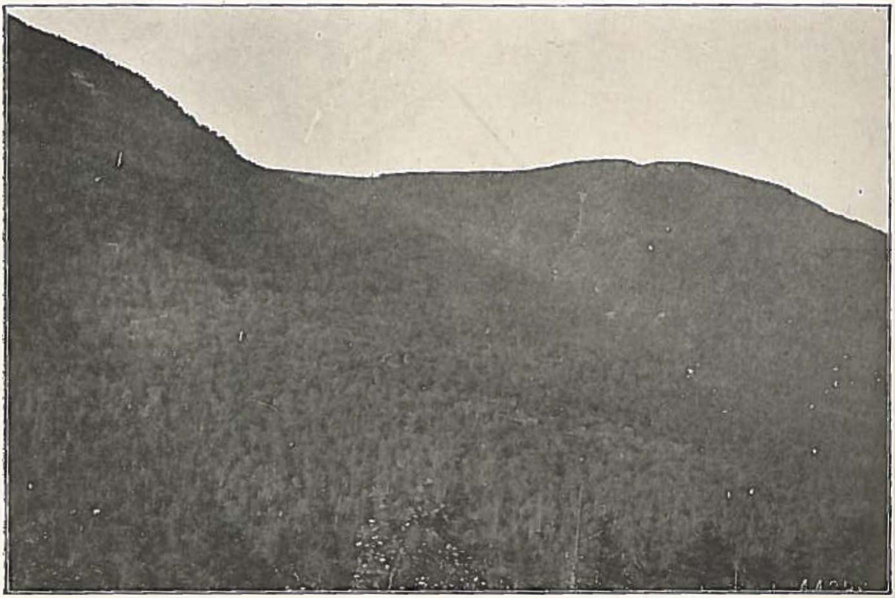


FIG. 1.—THE SLOPES OF THE CRAWFORD NOTCH ARE NOW COVERED WITH HARDWOOD FOREST.

FIG. 2.—HARDWOOD FOREST OF THE CRAWFORD NOTCH.

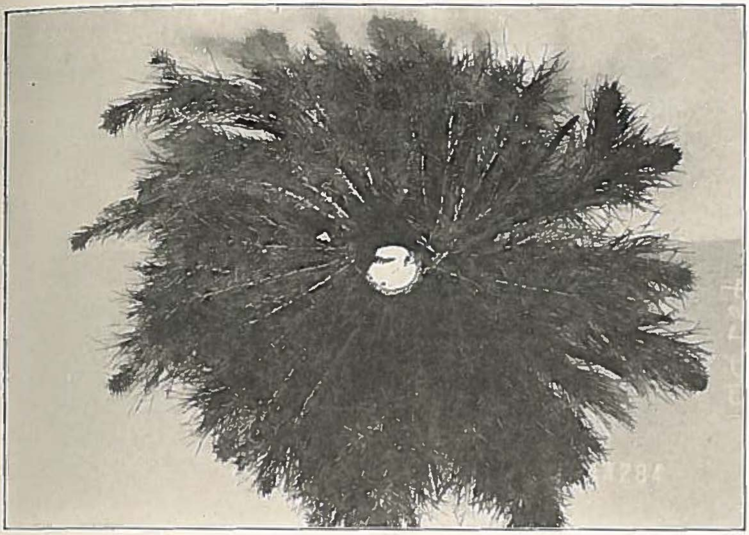


FIG. 1.—THE PITCH PINE OFTEN SPROUTS FROM THE ROOT COLLAR AFTER FIRE.

FIG. 2.—PITCH PINE LAND REPEATEDLY BURNED, WITH UNDERGROWTH OF SCRUB OAK.

Burbank Grant, where lumbering operations have only just commenced. The effect of lumbering on the lower slopes is to increase the proportion of hardwoods in the second growth.

FORESTS OF THE CARTER RANGE.

Physiography.—The Carter Range runs parallel to the Presidential Range, and is separated from it by the Glen Ellis and Peabody Rivers. This range forms a striking counterpart of the Presidential Range. The highest peak is Carter Dome, with an elevation of 4,860 feet, and there are eight peaks in all with elevations of over 4,000 feet. It includes the Carter, Moriah, and Wildcat Mountains, and extends from the Androscoggin River in Shelburne to the village of Jackson in the south. It is 20 miles long and two to seven miles wide.

The range is entirely surrounded by the five rivers by which it is drained, the Peabody and Glen Ellis Rivers on the west, the Wild and the East Branch of the Saco on the east and south, and the Androscoggin on the north. The Peabody and Wild Rivers flow northeast into the Androscoggin, and the Glen Ellis flows into the Saco.

Soil.—The general character of the soil and underlying rock is the same as on the Presidential Range. It is, however, important to note that the elevation of the belt of great rock exposure is lower on the Carter than on the Presidential Range. The soil plays out at a lower altitude on the former than on the latter because of the difference in elevation between the two. Consequently the belt of scrub forest growth extends to lower elevations on the Carter Range.

The Forest.—The same belts of forest prevail here as on the Presidential Range. In general, the forest below 1,500 feet elevation is the hardwood type, with yellow birch, sugar maple, beech, and spruce as the characteristic species. In the sandy flats along the rivers, especially on the Androscoggin, there is considerable second-growth pine land, with spruce and balsam in mixture. Above the hardwood land the spruce slope extends up to about 3,200 feet elevation. Above this the trees rapidly decrease in size and run out into a scrubby growth of spruce and balsam which extends up to about 4,400 feet elevation.

The forests of the Carter Range have been heavily lumbered. At first the lumbering was only for saw logs on the lower, more accessible slopes. Later the higher slopes were taken and cut for both saw and pulp logs, and forests, which had been culled before for saw logs only, were cut again for pulp. At present, the higher the slope the cleaner the cutting, both because the growth is more purely coniferous and also because the exposure becomes so severe that trees which are left will be wind-thrown. The cutting on this range now extends up as far as there is merchantable growth, to 3,500 feet elevation on the average.

The slopes draining into the Glen Ellis River, from the village of Jackson to Wildcat Mountain, have been stripped of all coniferous growth. The present stand is now an inferior growth of hardwoods. The whole south spur of Wildcat Mountain is covered, however, with a virgin spruce forest. The slopes here are very steep, and the difficulty in lumbering has so far kept the lumberman away.

The southeastern slopes of the range, drained by the Wild River, have been pretty well cut over by the Hastings Lumber Company. A logging road was run the entire length of the valley, and the lower slopes were cut over first for saw logs only, and now contain an irregular forest of hardwoods, with considerable spruce suitable for pulpwood. The more recent lumbering, as that in the Moriah Brook Valley, has been severe, taking both saw and pulp logs. A scattering hardwood growth is all that remains, aside from a few small patches of virgin spruce on the upper and more inaccessible slopes.

The upper part of the Wild River Valley was severely burned in the spring of 1903, and but little growth now remains.

The north and west slopes of the range contain considerable areas of uncut timber on the upper portions. The lower slopes have been entirely culled of softwoods and are now being lumbered to some extent for the hardwoods.

Forests of the Saco River Basin.

The Saco River watershed covers the southeastern portion of the White Mountain region. The river has its source in a small pond at the head of the Crawford Notch, on the west slope of the Presidential Range and flows in a general southeasterly direction for about thirty miles, when it crosses the Maine state line. The area of the watershed covered by the examination is 444,435 acres.

The character of the country varies greatly in this river basin, and two distinct types are apparent. The upper portion of the river and its tributaries lie in a mountainous country cut up into deep valleys, with many high mountains crowded close together. Parts of the Presidential and Carter Ranges are in this watershed, and also the high mountains in Waterville and Albany. In the southern and southeastern parts, however, the country becomes comparatively flat, and the plain level is about 480 feet. The country is here characterized by low, rounded chains of hills and a few isolated mountains, none, however, reaching great height. The soil is very sandy, and there are numerous small lakes and ponds.

Agricultural Land.—The farm land lies chiefly in the eastern and southern portions. The soil is sandy and poor, and, except right along the streams, the farming is not good. The principal crops are clover and timothy hay, oats, rye, wheat, corn, potatoes, peas and beans. There are a few orchards, usually overgrown and neglected. The farming industry of this entire section has steadily declined and is now reduced simply to meeting the needs of the inhabitants. The area under cultivation is much smaller now than fifty years ago. Many farms have been abandoned and many have passed into other hands and been allowed to run to waste. A large area once cleared and tilled has thus reverted to forest, and much more is in process of reversion. This area, containing as yet no merchantable timber, is classed as waste land on the map, although a large part of it is better adapted to forest growth than to anything else.

The hardwoods of this region show great energy in seeding up old pastures and abandoned fields, and the reversion to forest conditions is very rapid. The most energetic and persistent tree in this respect is gray birch, many old fields coming up to a pure stand of this species. On low sandy situations in the neighborhood of seed trees, pine seedlings come in thickly, either as a pure stand or in mixture with the hardwoods.

The Forest.—The forest varies with the locality. In the northern part of the watershed, on the steep mountain slopes, spruce forests predominate. On the lower, sandy plains, pine is the chief species.

The northwestern part, or upper portion of the Saco basin, is in the high mountains of the Presidential and Carter Ranges. The greater part of this section has been heavily lumbered and much of it severely burnt in the past, and in consequence the present growth consists almost entirely of hardwoods.

The eastern part of the Sandwich Range lies in this watershed, the divide running over Sandwich Dome and Tripyramid. There is a great deal of virgin forest on the mountain slopes in this section, and in Albany and Waterville the stand of spruce is the heaviest in New Hampshire. The best stands are on the slopes of Tripyramid and Passaconaway, at an elevation of 2,500 to 2,800 feet, and on the east slope of Sandwich Dome, between 2,200 and 3,000 feet elevation. The latter stand consists of 90 per cent. spruce, with about eight per cent. yellow birch and a very little balsam in mixture. The mature spruce range from eight to 24 inches in diameter and 80 to 90 feet in height. The slope is steep, with numerous rock outcroppings and a thin, loamy soil, but without moss.

PLATE XV.

FIG. 1.—CLEAN CUT SLOPE, LINCOLN TOWNSHIP. THIS LAND CUT OVER 18,000 BOARD FEET PER ACRE.

FIG. 2.—CLEAN CUTTING ON THE STEEP SLOPES, LINCOLN.

FIG. 1.—GROWTH OF ASPEN, WHITE BIRCH, YELLOW BIRCH, AND MOUNTAIN MAPLE ON AN OLD BURN.

FIG. 2.—NORTH SLOPE OF PRESIDENTIAL RANGE AT RANDOLPH.

There is consequently a fair exposure of mineral soil, and the reproduction of spruce and balsam is good.

This stand merges into an upper spruce slope type on the upper side, and at an elevation of 3,500 feet consists of about 75 per cent. spruce, with 15 per cent. balsam and much yellow birch. The forest here contains many dead trees and bare poles, but has a fair density. The mature spruce are rather scrubby, and seldom over 50 feet in height. There is a thick layer of moss, and the reproduction is dense, consisting almost entirely of balsam.

Above this type the forest assumes a decidedly scrubby character, with a very dense growth of balsam, up to an elevation of 3,800 to 4,000 feet. Beyond this the peaks of the Sandwich Range rise as bare granite ledges, with no vegetation save where a few stunted balsam and spruce, hardly more than bushes, find a footing in the crevices of the rocks.

Hardwood Lands.—The hardwood areas of the valley section represent either old waste lands, or cut-over lands where the stand has attained merchantable size, or land whose original growth was hardwoods. The latter is usually on gentle slopes or low rolling hills where the soil is of good depth.

The composition of the hardwood forests varies greatly. Often it is an almost pure stand of sugar maple, beech or birch, or these species in mixture with spruce, pine or hemlock. Much of the hardwood land has been freely logged for cordwood and birch bolts, and the greater part of the large timber has been removed. Large areas of second-growth hardwoods are found around Jackson and through the entire watershed.

Pine Lands.—Throughout the lower part of the Saco basin there are considerable stretches of low, level, sandy country where the original growth was pure stands of pine. The old growth was cut from 40 to 120 years ago. The conditions, however, are remarkably well adapted to pine reproduction, and the second growth consists of practically pure white pine. Much of this second-growth also has been cut over. In many places the white pine is mixed with red pine in varying proportions, and occasionally, over small areas, the red pine occurs pure. The only virgin growth of white pine now remaining is at Intervale. This is the last remnant of a pure growth which once covered this entire section.

Pitch Pine Land.—The country around Silver Lake in the township of Madison, and extending north to Albany and Center Conway, originally contained a heavy growth of pitch pine. This area consists of fairly level, rolling stretches, becoming more hilly toward the north and with a deep soil of very coarse sand. It was heavily cut over 30 to 40 years ago, and much of it has been severely burned since. The growth now consists of pitch pine poles and saplings, three to eight inches in diameter and 25 to 30 feet in height, either widely scattered or in small isolated groups. The ground is covered with a very dense growth of scrub oak (*Quercus pumila*) four to five feet in height, which chokes out nearly all other growth. Beneath the oak there is, over most of the area, a dense matting of sweet fern. Through much of this area there are evidences of repeated fires. Where these have occurred there is no reproduction and nearly all the scrub oaks have two or three feet of dead tops. The lower half of the pines are burned and scarred, and though they are still living their growth and vitality are seriously impaired. Where fires have been kept out the conditions are somewhat better. There is a good reproduction of pitch pine and a thrifty seedling growth of gray birch, sugar maple, popple and red maple, but the stand is as yet of little value.

Forests of the Pemigewasset River Basin.

This covers the southwest portion of the White Mountain region, and includes an area of 343,512 acres. The Pemigewasset River rises in the Franconia Notch. Flowing due south, it receives the drainage of Lake Winnipiseogee and forms the Merrimack River. The chief tributaries in the region examined are the East Branch and the Mad River. The former drains the township of Lincoln, and the latter Waterville.

The entire watershed is a decidedly mountainous country; the valleys are narrow and there is very little level land. It is bounded on all sides by high mountains and includes in its area Mts. Lincoln and Liberty, the former over 5,000 feet in elevation. Mts. Tecumseh and Osceola in Waterville are within this basin and also the low range of hills called the Squam Mountains, just north of Squam Lake. On the west, Mt. Moosilauke, reaching an altitude of 4,810 feet, is the highest peak.

Agricultural Land.—The agricultural land in this watershed lies chiefly around the southern and eastern borders of the region examined, along the line of the Boston & Maine Railroad. There is also considerable farming land in the Pemigewasset and Mad River valleys.

The Forest.—The entire watershed was originally covered with a spruce forest. Of this original growth but little now remains. The largest areas that have not yet been logged are in the townships of Lincoln and Waterville. Along the East Branch of the Pemigewasset, in the former township, between Mts. Lincoln and Liberty on the west and Mts. Bond and Carrigain on the east, is a heavy forest of spruce. The composition of this forest consists of spruce with a strong admixture of hardwoods and balsam, the percentage of the latter increasing with the altitude. A few old pines still remain, and in the swampy places there are patches of white cedar.

Generally the best spruce land is below an altitude of 2,800 feet, while white pine is of commercial importance only below 1,500 feet. The best stands of spruce are usually found on the north and northeast slopes of the mountains, above 1,000 feet elevation. Below this the white pine and hardwoods are able to occupy the ground.

Lumbering has been carried on only in the more accessible portions of the township of Waterville, especially along the lower course of Mad River. Fully 60 per cent. of the township still contains a fair merchantable stand of spruce, and a great deal of virgin timber still remains on Mts. Tripyramid, Kancamagus and Osceola.

There are large areas over the entire watershed that have been lightly cut over, or cut years ago, and now have a fair merchantable growth of spruce pulpwood. These stands are usually well mixed with hardwoods, maples, beech, yellow birch, and popple, and considerable balsam.

Nearly all the pure hardwood forests are second-growth, and are due to a change of species after lumbering and fires. Along the valley of the Hancock Branch, in Lincoln, the forest was completely logged. The upper and steeper slopes were clean cut, the unmerchantable stuff being used as skids and shear poles, down which the merchantable timber was rolled to the nearest logging road. These slopes have grown up to a thicket of hardwoods and balsam, with very little spruce. Popple, bird cherry, and yellow birch are the chief species. This grades off into more mature stands on the older cuttings, which often contain also considerable young spruce and balsam. Hemlock is common on the lower slopes.

The largest area of hardwood land is around Mt. Carr in the townships of Warren, Ellsworth, Rumney and Wentworth. The spruce was taken out, leaving the mature hardwoods, and now good second-growth hardwoods have come in. In addition to the usual sugar and red maples, beech, and yellow birch, there is also a large amount of red oak in this section, and considerable white ash.

Many fires have occurred in this watershed, in the Zealand Valley and also in the vicinity of North Woodstock; and throughout on the old cuttings there are traces of fires in the past. On these areas the softwoods are usually lacking, and there is a prevalence of popple and birch, and, on the more recent burns, dense thickets of bird cherry.

FORESTS OF THE AMMONOOSUC RIVER BASIN.

The Ammonoosuc River rises in the Lake of the Clouds on the upper slopes of the Presidential Range and flows into the Connecticut at Woodsville. The portion of this river basin examined includes the western slope of the Presidential Range, from Mt. Clinton to Mt. Adams, the southern slopes of the Dartmouth Range and Cherry Mountain, and the north and west slopes of the divide between the Connecticut and the Pemigewasset watersheds. Its area is 142,539 acres. The western portion of the drainage basin, consisting chiefly of farming land along the Connecticut River, was excluded.

The upper portions of this basin are very high. From Mt. Moosilauke on the south to Mt. Adams on the northeast there is a continuous series of peaks and mountains from 3,000 to 6,000 feet in altitude. The upper slopes are steep and barren, often totally devoid of growth, while merchantable timber ceases at about 3,500 feet elevation.

Agricultural Land.—Around Franconia and Bethlehem farm land predominates, and the forest becomes of only secondary importance. There are also large areas of agricultural land in Easton.

The Forest.—There is practically no virgin forest left in this watershed, save a very few isolated patches on the upper slopes. The country has been entirely cut over and subject to severe fires. Where these have occurred, as on Cherry Mountain and in the Zealand Valley, the growth consists chiefly of bird cherry, popple, and yellow and paper birch. Balsam and spruce show a tendency to come in as the other species die out, but where sugar maple and beech gain a footing a hardwood forest is the result.

On the low land spruce and balsam form a large part of the second-growth, but on the lower slopes hardwoods predominate.

Extensive areas of culled forest exist in Franconia, and on the slopes of Mt. Garfield and the Twin Mountains considerable spruce is left. The western slope of Mt. Moosilauke also has a considerable growth of spruce. In general, however, the greater part of this watershed is coming up to second-growth hardwoods.

Forests of the Israel and Upper Ammonoosuc River Basins.

The Israel and Upper Ammonoosuc Rivers are both tributaries of the Connecticut, the former flowing into it at Lancaster and the latter near Groveton. The area of the two watersheds examined is 220,499 acres. The Israel drains the northwest slopes of Mts. Adams and Jefferson in the Presidential Range, the north slopes of Cherry Mountain and the Dartmouth Range, and the south slopes of the Jefferson Mountains. The Upper Ammonoosuc rises in Randolph, on the northwest slope of the Crescent Mountains, and flows northwest.

These two basins, therefore, include the entire Pliny and Pilot Ranges and extend as far north as the Dixville Mountains, and east to the divide of the Androscoggin watershed. The greater parts of the townships of Lancaster and Northumberland were excluded from the examination, since they consist chiefly of farm land.

The country is mountainous, but for the most part the slopes are moderate. The highest peaks are Mts. Adams and Jefferson, rising nearly 1,000 feet above timber line. The tallest, Mt. Jefferson, reaches an altitude of 5,725 feet.

Agricultural Land.—There is a considerable area of cleared and improved land along the Israel River and on the lower slopes of the Jefferson Mountains. Further north there is a strip of cleared land along the line of the Grand Trunk Railroad.

The Forest.—These two watersheds have been heavily cut over at periods during the past fifty years. The only virgin forest now remaining is an area in Erving's Location and a strip on the slopes of Mts. Adams, Jefferson and Bowman, in the Low and Burbank Grant. Erving's Location is a small, well-wooded tract in the southeastern part of the

Dixville Mountains. Owing to its being near no stream suitable for driving, it has escaped lumbering. It is not, however, a very good spruce country, and hardwoods predominate, except on the upper slopes. On the northwest slopes of Mts. Adams and Jefferson, in the Presidential Range, between the altitudes of 2,500 and 3,500 feet, is a virgin spruce slope. With these two exceptions the entire region has been cut over and the predominating growth is now hardwoods.

Severe fires have occurred on the slopes of Cherry Mountain and the Dartmouth Range, and on these old burns the growth is very poor. A large fire occurred in the spring of 1903 in the townships of Kilkenny and Berlin, which burned over about 18,000 acres.

The Pliny Mountains in Jefferson consist of three peaks, the tallest of which is 4,029 feet in height. The lower slopes are covered with hardwood coppice, the result of lumbering and fire, while the upper slopes have considerable spruce and balsam. There is a large area of waste land on the summits.

Over a great deal of the lumbered land in these basins there is very little growth but hardwoods, as on the Randolph Hills, while in the country between Crescent and Round Mountains and through the northern parts of the basins there is considerable spruce and balsam left. Here the chief species are balsam, spruce, yellow and paper birch, hemlock and sugar maple. This represents an original forest of mixed hardwoods and spruce, in which the spruce probably formed 50 per cent. of the entire growth. The reproduction of spruce and balsam is generally good, forming 30 to 50 per cent. of the entire reproduction.

The characteristic growth, which springs up after logging on trails and clearings, is mountain and red maple, with some black and bird cherry, striped maple, and gray and yellow birch. Spruce and balsam usually gain a slight foothold later, and come in as a subsequent growth on such spots, the balsam predominating.

On the gentle slopes there were originally large quantities of white pine, which is still abundant in the second growth.

Forests of the Androscoggin River Basin.

The Androscoggin River is the natural outlet of the Rangeley Lake system. This is a chain of six lakes in Maine, the lowest of which, Umbagog Lake, lies two thirds in New Hampshire. The Androscoggin, flowing out of this lake, receives the Magalloway River drainage, and then flows in a southerly direction until, striking the White Mountains, it turns east into Maine. Thus, though the river starts in New Hampshire, it receives its chief water supply from Maine.

The area of this watershed in New Hampshire is 344,312 acres, of which 6,280 acres are lakes and ponds. It includes the northern slopes of the Presidential and Carter-Moriah ranges in the White Mountains, and extends north in a strip approximately ten miles wide to the Dixville Mountains. Its chief tributaries in the White Mountain section are the Peabody and Moose Rivers, which rise on the slopes of the Presidential Range.

Agricultural Land.—There is a considerable area of farm land in this watershed, lying chiefly in the valley of the Androscoggin River. The greater part is in Gorham and Shelburne. There are also many abandoned fields, which are coming up now to a second growth of softwoods.

The Forest.—The largest areas of virgin forest in this basin lie on the north slope of the Presidential Range, in the Low and Burbank Grant and the Thompson and Meserve Purchase. Aside from this the entire watershed has been cut over more or less heavily.

Extensive fires have occurred. The Wild River valley, on the east slope of the Carter Range, was badly burned over in the spring of 1903, and Pine Mountain in the township of Gorham has been repeatedly burned.

Originally a heavy stand of white pine covered the whole of the Androscoggin Valley, but of this nothing now re-

FIG. 1.—REPRODUCTION OF BALSAM, YELLOW BIRCH, AND CEDAR ON LAND LOGGED FIFTEEN YEARS AGO. PITTSBURG.

FIG. 2.—SPRUCE BOG. LOGGED FIFTEEN YEARS AGO AND COMING UP TO DENSE STAND OF BALSAM.

FIG. 1.—A HEAVY STAND OF SPRUCE WITH THICK BALSAM REPRODUCTION.

FIG. 2.—DRIVE HUNG UP TWELVE YEARS AGO ON THE INLET TO SECOND LAKE.

mains but a few scattered trees. Considerable areas of second-growth pine occur, however, at the lower elevations, and it often comes in with great energy on old fields and abandoned pastures.

The country throughout the townships of Berlin and Success has been most heavily lumbered and badly burnt. It contains at present very little growth of any value. There was formerly considerable larch on the low, swampy land, but an invasion of the larch saw-fly in 1885 killed off all the old growth not already cut. On some of these areas, however, there is now a thick larch reproduction mixed with balsam.

The softwood reproduction in the northern section is generally good, spruce and balsam maintaining themselves fairly well on the cut-over land, and usually forming 10 to 20 per cent. of the young growth.

The townships of Errol and Cambridge were logged 35 to 40 years ago for white pine, and 25 to 30 years ago for spruce saw logs, only the best spruce being taken. Comparatively little cutting has been done there since. There is now a good growth of softwoods, balsam predominating. The popple is very abundant throughout, with considerable yellow and paper birch, beech and sugar and red maples in mixture.

There are small areas of swampy land near the Androscoggin River. The principal growth in these places is an open stand of scrubby black spruce, running up to nine inches in diamater and 40 to 50 feet in height. There is also some white cedar and balsam on these spruce bogs.

Above Errol and along the Magalloway River and Clear Stream, the country is cut up into small tracts owned principally by farmers and small lumbermen, and has been very generally logged over within the last twelve years.

Forests of the Magalloway River Basin.

The country drained by the Magalloway River lies in the northeastern corner of the state. The river itself lies just across the state line in Maine and, flowing slightly southwest, crosses into New Hampshire just above Umbagog Lake, where, receiving the drainage of the entire Rangeley Lake system, it forms the Androscoggin River.

The area drained by the Magalloway River in New Hampshire covers 135,960 acres. It includes the east slopes of Mts. Magalloway and Pisgah and the eastern and southern slopes of the Crystal Mountains. Its chief tributaries are the Dead Diamond and the Swift Diamond Rivers.

The country is rough, with many low ridges and low mountains, and is well watered, with innumerable brooks and small streams. The general base level varies from 1,200 to 1,800 feet, and there are no mountains over 3,700 feet in height. As a result, there are no peaks above timber line, and with the exception of Mts. Magalloway and Carmel, the mountains are all covered with merchantable growth.

Agricultural Land.—There is practically no cleared land in this drainage basin, and there are no towns or settlements save the lumber camps.

The Forest.—This entire region is a spruce country and is, at present, the best timbered watershed in New Hampshire. The southern half has been practically all cut over at one time or another, but as a rule the cutting has been light, and there is much merchantable stuff left, while the entire northern part of the basin is still virgin forest.

The country lying along the Swift Diamond River and its tributaries, and extending up to an elevation of 2,500 feet on the bordering mountains, contained originally two distinct types of forest. The first, found along the main stream and the lower courses of its tributaries, and rarely running to an elevation of over 1,800 feet on the mountain sam, with a little white spruce in mixture. Above this type came the second, a hardwood slope extending up to the divides. The chief growth was sugar maple and yellow birch, with considerable spruce and balsam in mixture.

This country has been heavily logged by the Berlin Mills Company within the past 20 years. All of the valley softwoods have been cut, and the slopes below 2,000 feet have also been logged. The virgin forest remaining lies on the southern slopes of the Crystal Mountains. It consists of a scattered growth of tall, well-formed spruce, in mixture with a predominating growth of hardwoods.

On the cut-over land considerable small spruce has been left, mostly under eight inches in diameter. The softwood reproduction, particularly balsam, is good in the valleys but poor on the slopes, where, with the exception of a thick balsam reproduction on a few steep, mossy ledges, the young growth is principally hardwoods.

The country along the Little Dead Diamond Stream, in the Atkinson and Gilmanton Academy Grant, has also been logged over by the Berlin Mills Company. The cutting has been very conservative. Considerable spruce remains, and there is excellent softwood reproduction on the lower slopes. North of this the drainage basin has not been lumbered, and the forest consists of virgin spruce land.

Along the valleys the forest consists of spruce flats. This type follows the streams closely, rarely running up the moderate slopes of their basins to an elevation of more than 100 or 200 feet above the bed of the stream and occupying in general the lower and more poorly drained areas of the region. The forest of this type is a dense, almost pure stand of mature softwoods. Black and white spruce, with some red spruce and a little balsam and white cedar, are the principal species. The trees are mostly small in diameter, slender and tall in form. The ground is covered with a heavy matting of moss, bearing a moderately heavy reproduction of balsam and black spruce, with a scattering of the other species. On the drier valley bottoms red spruce forms the dominant growth. The trees here are larger and better formed, running from eight to 24 inches in diameter, while the stands on the swampy ground will not average more than 12 to 13 inches in diameter. The spruce flats represent the densest softwood forest of the region, but not the best individual development of the trees.

Just above this spruce flat type, and extending up the moderate slopes often to an elvation of 2,200 to 2,300 feet, are the spruce slopes. These slopes have a fairly deep soil and good drainage. The individual development of the trees is better than on the flats, the spruce running from eight to 28 inches in diameter, and occasionally reaching a a height of 95 feet. In marked distinction from the flats, the chief conifer here is the red spruce, there being little balsam and almost no white spruce, while the hardwoods form from 25 to 40 per cent. of the stand. Yellow birch and sugar maple, with some paper birch and beech, are the chief hardwood species. In consequence of the decreased density of the forest as a whole, the ground cover is correspondingly heavier and is more shrubby and herbaceous than in the preceding type.

Above these lower spruce slopes come the hardwood slopes. A heavy growth of fine, mature hardwoods forms in this region the typical forest of the moderate middle slopes, running up to the summits of the low, rolling hills. Rarely, on the higher mountains, it rises above an altitude of 2,400 feet. These slopes have a moderate gradient, good drainage, and a fairly rich, loamy soil of good depth. When these conditions are present, the chief growth is usually hardwoods, though spruce slopes occasionally occupy areas of the same character, owing probably to especially favorable conditions for the distribution of seed.

The hardwoods on these slopes are yellow birch, sugar maple, paper birch, and beech, forming together 60 to 75 per cent. of the entire stand. Spruce and balsam form the remainder of the growth. This mixture with hardwoods seems to favor the development of straight, fullboled trees of good height, making excellent timber. The reproduction is almost entirely hardwoods.

Throughout this type the spruce and balsam occur widely

FIG. 1.—FIRST CONNECTICUT LAKE. EFFECT OF CONSTANT FLOODING FOR STORAGE PURPOSE.

FIG. 2.—TIMBER KILLED BY FLOODING.

FIG. 1.—REPRODUCTION OF WHITE AND NORWAY PINES UNDER SEED TREES. CHATHAM.

FIG. 2.—SECOND GROWTH OF WHITE PINE ON ABANDONED LAND.

scattered or in small groups of a few trees. Frequently, however, on the steeper and higher slopes, rather small areas of dense softwood growth are found, with few or no hardwoods in mixture. These areas occur chiefly on the steep, thin-soiled, rocky ledges or precipitous slopes which are found frequently in this region, often the result of glacial erosion. Almost pure spruce and balsam occupy these places, where the gradient is too steep and the soil too thin and poor for hardwoods. The trees are short and scrubby, seldom over 50 feet in height. Often in the more exposed situations the chief species will be balsam, with but little spruce and some yellow birch. Such growth occurs on the summits of Crystal and Magalloway Mountains. These forests have suffered a great deal from windfall and death of the balsam. In general, however, there is very little scrub growth in this watershed.

Forests of the Upper Connecticut River Basin.

The drainage basin here called the Upper Connecticut consists of the entire Connecticut drainage area in New Hampshire as far south as Groveton Junction, where the drainage basin of the Upper Ammonoosuc River joins it. The area of this basin examined was 320,720 acres, of which 5,120 acres are water, consisting chiefly of the Connecticut Lakes. The township of Colebrook and a large part of Stewartstown and Columbia, consisting, as they do, for the greater part of agricultural land, were not examined.

The country in general consists of low, rolling hills. The chief mountains are Mts. Pisgah and Magalloway on the east and the Dixville Mountains and other low ranges in the south. The country immediately around the lakes is flat, and there are a few bogs and swamps, although none of large extent.

Agricultural Land.—South of the First Lake there is a great deal of cleared and improved land along the valley. The farming land in the townships of Colebrook and Stewartstown is considered as good as any in the state.

The Forest.—With the exception of a small area in the extreme north and a narrow strip in the northeast, the whole of this river basin has been logged. The virgin forest consists of a strip about six miles wide on the north of Pittsburg township and a narrow strip on the western slopes of Mts. Carmel, Magalloway and Pisgah. The forest here is essentially the same as the virgin forest in the Magalloway basin adjoining. There is no scrubby growth save on the summit of Mt. Magalloway. The principal types are spruce slope and hardwood land, this being a region of slopes and ridges with few flat valley bottoms. The spruce flat type is confined to a narrow strip along the East Inlet, the Connecticut River and the East Fork. Its most typical form along these streams is a swampy or bog land growth, consisting of dense stands of black spruce, with considerable red spruce and balsam in mixture. The rest of this drainage basin consists of cut-over or culled land and second growth.

The country was cut over first for pine and then for spruce, although but little pulpwood was taken in the northern part. The growth now, through Pittsburg, consists chiefly of mature hardwoods, yellow birch, sugar maple, and beech, with considerable small spruce and balsam. Through the southern part of the watershed the stand is almost pure hardwoods, with only a little spruce, balsam, and hemlock remaining.

The second growth throughout the valley is excellent, and is almost entirely softwood. Spruce, pine and balsam come in very rapidly on abandoned fields and pastures. On the moister soils the typical growth is larch, cedar and balsam, with some spruce and red maple scattered through. The second growth shows an excellent promise for the future of this region.

SECOND GROWTH AND REPRODUCTION.

The problem of second growth in New Hampshire is easily next to the fire problem in importance. In fact, the chief service of fire laws will be to keep fire from the second growth after lumbering. All intelligent recommendations in regard to the silvicultural treatment of the forest must be based on a thorough knowledge of second growth and reproduction. Special studies of the characteristics of the different forest trees must be supplemented and co-ordinated by a general study of the competition which takes place between them for a place in the forest, the conditions which determine its make-up under different circumstances, and the effect of man's interference. When it is known what will happen, for example, after lumbering in a particular locality, the operation can be planned with reference to the effect on the future stand of timber. Recommendations of high economic importance in the cutting of the forest can be made only when the conditions governing second growth are known.

The value of second growth is well illustrated by the stumpage price of the so-called sapling pine, which averages $3.25 per thousand at an age of 40 to 50 years. This often cuts 20,000 board feet to the acre, and sometimes as high as 40,000 feet of boxwood lumber. The stumpage price of second-growth spruce and balsam for pulp is $2.00 to $2.50 per cord. The value of popple and paper birch, which are rapid-growing trees coming up on cleared land, is nearly as high as that of spruce and balsam, and they become merchantable in 25 to 30 years.

Occurrence.—The general nature of the second growth varies with the forest region. Pine is the most important second-growth species. In the White Mountain region and the northern part of the state, spruce, balsam, paper birch and popple are all-important second-growth trees. The nature of the growth differs more particularly according as it is found: (1) in the forest; (2) on lumbered land; (3) in pastures and abandoned fields; (4) on burns. The subject will be considered under these heads.

Growth in the Forest.—In a virgin forest reproduction and succeeding growth are extremely slow. Suppressed seedlings of tolerant species continue to exist under dense shade, but their growth is scarcely perceptible. When openings are made in the forest by the decay and death of the veteran trees, these suppressed seedlings begin to grow more rapidly under the stimulus of increased light. Reproduction of the more intolerant or light-demanding species also takes place in the natural openings formed and these make up for lack of tolerance in rapidity of growth. Vacant places in the forest are thus soon filled up with a flourishing succeeding growth of tolerant and intolerant species, struggling against each other for a place in the new stand.

The tolerant species, whose seedlings continue to grow under the shade of the mature trees, are: spruce, balsam, hemlock, sugar maple and beech. As these are the only species which can endure dense shade for any length of time, they constitute the prevailing reproduction in the unculled forest. Birches, cherry, popple, and mountain ash, intolerant and rapid growing, seed profusely in the openings.

The character of the reproduction varies also with the forest type. Counts on three sixteenth-acre plots on spruce slope, the same number on hardwood land, and one square rod in a windfall on spruce slope, gave the following average results:

TABLE XIII.—REPRODUCTION IN VIRGIN FOREST.

Species.	Average number of seedlings per one-sixteenth acre.		
	Hardwood land.	Spruce slope.	Spruce slope windfall.
Beech	2,902	......	......
Maples	1,671	49	......
Paper birch	......	......	1,285
Spruce	25	353	108
Balsam	......	103	141
Yellow birch	46	14	......
Mountain ash	......	......	3
Hemlock	......	1	......
Total	4,644	520	1,537

FIG. 1.—BALSAM AND SPRUCE REPRODUCTION ON A SPRUCE SLOPE. ELEVATION, 3,000 FEET.

FIG. 2.—BEECH AND HARD MAPLE SEEDLINGS IN HARDWOOD FOREST. ELEVATION, 1,200 FEET.

FIG. 1.—OLD FIELD GROWING UP TO JUNIPER AND WHITE PINE.

FIG. 2.—GROWTH OF WHITE PINE ON AN OLD FIELD.

On hardwood lands beech and sugar maple seedlings constitute almost the entire young growth. The thick ground cover of undecomposed hardwood litter on this type is unfavorable to coniferous germination, but forms a suitable seedbed for sugar maple and beech. For this reason such land when cut over always comes up to hardwoods, which are already on the ground waiting for an access of light to start active growth.

On the spruce slope type there is good reproduction of conifers. The seedbed—coniferous duff covered with moisture-holding moss—is better suited to their germination than that on hardwood land. On the upper portions of this type windfall is often quite common.

The character of the stand on these windfalls is changed, for a time at least. A one sixteenth-acre plot taken on a 50-year-old windfall showed the following stand of trees:

TABLE XIV.—REPRODUCTION ON ONE-SIXTEENTH ACRE OF 50-YEAR-OLD WINDFALL ON SPRUCE SLOPE.

Species.	Number of trees.	Average diameter breasthigh.
		Inches.
Paper birch	12	6.8
Spruce	11	5.2
Balsam	3	4.2
Yellow birch	1	6.0

Upper spruce slopes have almost entirely softwood reproduction, particularly balsam. The softwoods are able to hold their own on this type after windfall or lumbering. Where landslides occur on the steep, forest-clad slopes and everything is carried off down to the bare underlying rock, natural reforestation is extremely slow and depends on the gradual accumulation of soil.

On coniferous flats reproduction and second growth of those conifers which are the prevailing species are excellent. The mossy ground cover which is generally present is best suited to balsam.

Growth on Lumbered Land.—In the White Mountain region most of the lumbering has been done on the lower slopes. The effect is to increase the proportion of hardwoods, for a time at least, in the succeeding stand. The proportion of conifers increases with the elevation and gradient, in the growth after cutting as well as in the original forest.

The results from sample plots, one rod square, on lumbered areas, are given in the following table:

TABLE XV.—REPRODUCTION ON CUT-OVER LAND.

Species.	Average number of seedlings per one-sixteenth acre.		
	Hardwood land cut clean 2 years ago.	Spruce slope cut clean 6 years ago.	Spruce flat cut clean 7 years ago.
Yellow birch	38	170	35
Bird cherry	65	18	10
Witch hobble	30		
Sugar maple	25		
Red maple			5
Ash			3
Aspen			3
Total	158	188	56

On coniferous flats there is abundant hardwood reproduction immediately following lumbering, but there is usually sufficient young coniferous growth already on the ground to make up for this, so that the stand will in the end be mainly softwoods. On the spruce slope and spruce flat given in Table XV there were left after the logging 250 and 135 spruce and 20 and 53 balsam, respectively. That these softwood seedlings eventually crowd out the hardwoods is shown in the following table:

TABLE XVI.—STAND ON A FLAT CUT CLEAN 40 YEARS AGO.

Diameter breasthigh.	Number of trees on one-sixteenth acre.				
	Spruce.	Balsam.	Paper birch.	Yellow birch.	Maples.
Inches.					
1	5	3	....	3	9
2	....	2	2	2	2
3	1	4	1	1	3
4	....	....	....	1	....
5	1	3	1	....	3
6	....	....	1	....	1
7	....	1	....	....	1
8	....	2	....	....	....
9	2	1	....	....	....
10	1	....	....	....	....
12	....	3	....	....	....
13	....	1	....	....	....
19	....	1	....	....	....
Total	10	21	5	7	19

These tables indicate that the conifers are able to hold their own after lumbering on the spruce slopes and flats, but not on the hardwood lands.

Growth on Pastures and Abandoned Fields.—A large area in New Hampshire is covered with forest growth on lands originally cleared for pasture and agricultural purposes, but subsequently abandoned as unprofitable. In the white pine region along the Saco River there are numerous stands of excellent pasture pine which yield, when cut, as high as 40,000 board feet of box-board lumber to the acre. In the White Mountain region and in the extreme northern part of the state the abandoned land is often covered with a thrifty growth of spruce and balsam. A certain amount of grazing is beneficial to the growth of the conifers, for it tends to keep down the hardwood seedlings and sprouts. The cattle eat the broadleaf foliage, and this is one reason why the second growth on pastures is mainly coniferous. There is frequently a considerable admixture of the birches, popple, and aspen, which form good nurse trees for the softwoods.

The following sample plots serve as an indication of the stand of spruce and balsam at different ages in pastures, and will give an idea of what kind of a yield may be expected, in the course of time, from old-field growth:

TABLE XVII.—REPRODUCTION ON OLD FIELDS AND PASTURES.

Plot No.	Area.	Age.	Species.	Number of trees.	Average height.	Average diameter.
	Acres.	*Years.*			*Feet.*	*Inches.*
1	1-16	5-15	Spruce	88	6	Not on
			Balsam	25	8	survey.
			Total	113		
2	1-16	15-20	Spruce	65	20	1.5
			Balsam	114	for dominant	2.0
			White pine	13	trees.	2.8
			Total	192		
3	1-16	20-25	Spruce	13	30	4.2
			Balsam	60	for dominant	3.6
			Others	3	trees.	1.4
			Total	76		
4	1-16	25-30	Spruce	35	30-40 for dom-	2.0
			Balsam	57	inant trees,	3.1
			White pine	31	pine and	2.8
			Hemlock	33	balsam.	1.9
			Maple	30		2.4
			Total	186		
5	1-16	30-35	Spruce	44	35	5.5
			Balsam	9	for dominant	4.0
			Hardwoods	10	trees.	2.3
			Total	63		
6	1-16	35-40	Spruce	68	35-40 for dom-	3.9
			Balsam	19	inant trees.	5.1
			Hardwoods	17		1.8
			Total	104		
7	1-4	40-45	Spruce	99	50	8.3
			Balsam	8	for dominant	6.2
			White pine	5	trees.	7.6
			Total	112		

Where grazing is very slight the pasture sometimes grows up first to the hardwoods with light-winged seed, as is the case after fires. The conifers gradually creep in under these light-foliaged, intolerant species; they are only slightly suppressed by them, and in time will crowd them out altogether. The following sixteenth-acre plot illustrates how under such conditions softwoods come up under the hardwood growth.

TABLE XVIII.—REPRODUCTION ON LIGHTLY GRAZED LAND.

Species.	Number of trees.	Average height.	Average diameter breasthigh.
		Feet.	*Inches.*
Spruce	38	15	2.0
Balsam	12	20	2.3
Hemlock	31	15	1.6
Popple	4	45	6.4
Yellow birch	3	20	2.4
Paper birch	46	35	4.1
Red maple	18	25	2.7
White pine	1	10	1.0
Total	153		

The height growth of seedling spruce and balsam in pastures and old fields is very different from that in the forest. The following table shows the average growth in height in the former situations of four of the principal old-field species:

TABLE XIX.—HEIGHT GROWTH ON OLD FIELDS.

Species.	Age—Years.							
	5	10	15	20	25	30	35	40
	Height—Feet.							
Spruce	.8	2.4	6.0	10.0	16.0	28.0	35.0	
Balsam	1.2	3.7	10.6	18.3				
Popple	9.0	16.0	23.0					
White pine	1.2	8.0	15.0	22.4	30.0	38.0	45.6	53.0

In the white pine country, as along the Saco River south of the Crawford Notch, white pine is the most important and valuable old-field growth. It comes up almost pure, in mixture with gray birch and popple, or with pitch or red pine.

The following sample plots show the growth of white pine stands at different ages under favorable conditions:

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TABLE XX.—WHITE PINE ON OLD FIELDS.

Plot No.	Area.	Age.	Species.	Number of trees.	Average height.	Average diameter breasthigh.
	Acres.	*Years.*			*Feet.*	*Inches.*
1	1-2	8-10	White pine ...	804	5	... .
			Others	108	....	....
2	1-2	10-15	White pine ...	1,640	7	....
			Others	280	....	....
3	1-2	15-20	White pine ...	1,020	20	3.0
			Others	240	....	2.5
4	1-2	25-30	White pine ...	525	25	4.1
			Others	55	....	3.0
5	1-2	30-35	White pine ...	355	40	6.2
			Others	4	....	....
6	1-2	35-40	White pine ...	187	55	7.0
			Others	34	....	2.5
7	1-2	40-45	White pine ...	170	65	8.7
			Others	25	....	6.0
8	1-2	45-50	White pine ...	175	70	9.0
			Others	60	....	8.0
9	1-2	50-55	White pine ...	180	75	11.0
			Others	....	....	....
10	1-2	60-65	White pine ...	137	80	12.6
			Others	5	....	....
11	1-2	65-70	White pine ...	300	85	12.5
			Others	5	....	....

Growth on Burns.—The effects of fire on growth is discussed more in detail under another heading. In general the effect is to kill all young coniferous growth which has been left in lumbering. The burn is immediately seeded up by intolerant, rapid-growing hardwoods with light-winged seeds, capable of being carried long distances by the wind, such as the birches, popple, and aspen. Frequently it comes up to a thick growth of bird cherry from seeds already in the ground, collected there for many years from deposits of birds.

When the burns are seeded up to a good growth of paper birch and popple, the expectation value of the stand is all that could be wished, as these species become merchantable in 25 to 30 years and pay good stumpage. A thick growth of cherry is absolutely worthless and, what is more, keeps out all the valuable species for 10 or 15 years. A count of 2,116 bird cherry seedlings was made on one square rod of a 1903 burn. This is equal to 338,560 to the acre.

When coniferous seed trees are adjacent to the burn, softwood seedlings begin to appear within five years at least. These are suppressed for a time by the more rapid-growing hardwoods, but if the land was originally of a coniferous type, the softwoods will finally become dominant. On types approaching hardwood land the conifers will probably never return.

One square rod taken on an area burned 11 years ago, followed by another fire two years ago, had 22 popple and 122 cherry two-year-old sprouts on it, respectively four and three feet tall.

Sixteenth-acre plots, one on each type, gave the following results:

TABLE XXI.—REPRODUCTION ON BURNED-OVER LAND.

[1-16-acre plots.]

Species.	Slope. Burned 12 years ago.		Flat. Burned 30 years ago.	
	Number of trees.	Average height.	Number of trees.	Average diameter breasthigh.
		Feet.		*Inches.*
Yellow birch	187	15	2	1.0
Sugar maple	123	3		
Mountain maple	92	15		
Wild red cherry	74	20		
Spruce			22	2.5
Paper birch			20	3.1
Aspen	19	20	3	3.9
Balsam	1	1	18	4.2
Red maple	2	3	14	3.8
Striped maple	13	5	3	1.0
Mountain ash	5	15		
Shadbush			5	1.0
Beech	1	1		
Willow	1	15		
Total	518		87	

TREES OF NORTHERN NEW HAMPSHIRE.

Red Spruce.

The red spruce is the characteristic tree of northern New Hampshire. It is found on all types and in a variety of mixtures. It occurs most frequently on a sandy loam soil, with fair moisture content. It cannot tolerate pure sand as the white pine does, but it will grow on soil of scarcely any depth, and in every variety of situation from the banks of rivers to the mountain tops. On the best loamy soils it has been known to reach a diameter of four feet breast-high, and a height of 100 feet; the average mature tree, however, is about 18 inches in diameter and 80 feet in height.

In form spruce varies with age and situation. Trees in the open have long, conical boles, with lateral branches extending almost to the ground. In the forest the boles are more cylindrical, and a third or more of their length is clear. During the period of greatest growth spruce develops a long, narrow conical crown, which in age tends to become broad and flat. The root system is very flat and shallow, made up of many small, branching, lateral roots. It is adapted to very shallow soils, but is not at all wind-firm.

Spruce produces some seed every year, but seeds very abundantly only about once in eight years. The seed does not germinate nearly so readily as that of balsam, and is more exacting in regard to the condition of the seed bed. Its requisites in this respect are: (1) a suitable degree of moisture and (2) sufficient soil, either organic or mineral. There is no special light requirement. The best spruce reproduction is found where the above conditions are best fulfilled, and this is on old decaying logs covered with moisture-gathering moss. There is very little spruce reproduction on hardwood land, where the soil is covered with a thick matting of hardwood litter. On spruce flats and slopes the reproduction is generally good, as the ground is

FIG. 1.—PURE STAND OF NORWAY PINE, BADLY IN NEED OF THINNING.

FIG. 2.—REPRODUCTION OF SPRUCE ON ABANDONED LAND, NEAR SEED TREES.

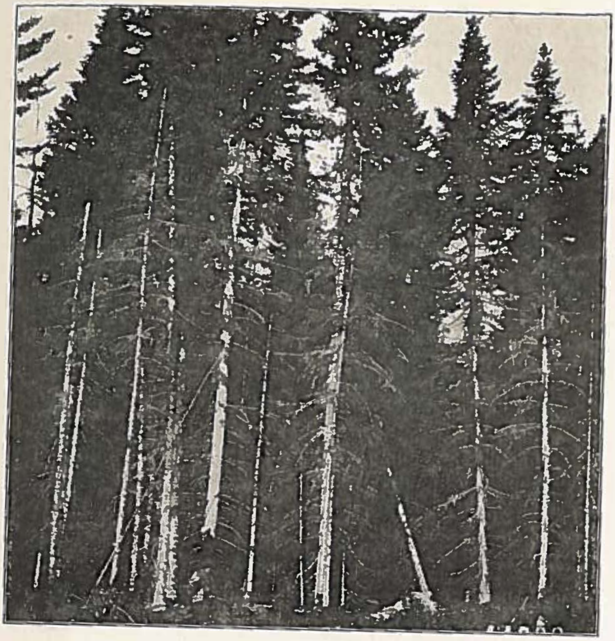


FIG. 1.—SECOND GROWTH SPRUCE AND BALSAM.

FIG. 2.—SECOND GROWTH WHITE AND NORWAY PINE. THIS STAND HAS BEEN THINNED AND THE TREES PRUNED TO A HEIGHT OF EIGHT FEET.

covered more or less with moss and there is considerable organic soil exposed. On the bare, moist mineral soil near streams there is often excellent reproduction. The seed is light and winged, and is easily carried considerable distances from the trees by the wind.

Spruce is one of the most tolerant of the coniferous species; that is, it can continue to exist with little sunlight, although it requires abundant light for rapid development. Germinating in the dense shade of the forest, it often continues to grow as a suppressed seedling for fifty years or more without reaching a height of over five feet. As soon as light is admitted, however, its rate of growth rapidly increases. It is this great tolerance and tenacity of the spruce in youth which makes up for its slow growth and causes it to be so generally distributed.

Spruce does not reproduce well on lumbered areas, because the more rapid-growing hardwoods get in ahead of it and seed up the ground. On spruce land, however, there is usually sufficient young spruce already on the ground to take the place of that cut. This growth may be suppressed for a time by the hardwoods, but it will in the end form a large part of the stand.

Balsam.

Balsam occurs in mixture with spruce throughout northern New Hampshire and is found chiefly on the spruce flats, in swamps, and on the upper spruce slopes, often occurring nearly pure. It is not found to any extent on the hardwood land or lower slopes.

Very shallow-rooted, and needing only moss to germinate on, it can grow almost on the bare rock, and is the last form of tree growth to disappear on the summits of the high mountains, for it is found as a prostrate shrub at high altitudes. Balsam, at such elevations, rarely matures its seed, reproduction being dependent on seed blown up from below and on the layering of the trees themselves. Branches so layered are often found growing as independent trees, the connecting branch having decayed. The rooting always proceeds from dormant buds. Prostrate balsam occurs at an altitude of 5,500 feet on the Presidential Range, where it reproduces almost entirely by layering. At an elevation of 4,900 feet cones are borne sparingly, but even here reproduction by layering exists. The scrub form extends down to about 4,500 feet elevation, and the upper limit of merchantable size is at 4,000 feet.

Individual fir trees seed as a rule every third year. This is, however, varied in some cases by seeding in alternate years, and even in successive years. The more vigorous the tree, the more frequent the seeding. The pollen matures on the last year's shoot and the cones on that of the year before; thus, in 1902, a good seed year, the pollen occurred on 1901 wood and the cones on that of 1900. The shoot made on the branches bearing pollen, the year the pollen matures, is usually markedly dwarfed.

The balsam prefers a mossy ground cover for a seed bed. Seedlings are usually very plentiful on old moss-covered logs and on the upper slopes. They are able to endure rather heavy shade and will live for years in a suppressed condition, ready to start into active growth on the removal of the old forest. Reproduction is best on the spruce flats and the upper slopes.

Balsam is not a long-lived tree; few individuals are found over 150 years old. It is easily thrown by the wind, and, growing as it does on very shallow soil at high elevations, the constant swaying of the tree in the wind may sever the connection of the rootlets, breaking and tearing them and thus causing the tree gradually to dry out and die for no apparent reason. Often large areas of such dead and dying trees are found on the upper slopes.

In second growth balsam takes a prominent part, especially on flats and on the moister ground. It is also very common on old burns, clearings and wind-falls at high elevations, and with yellow birch often forms the chief reproduction.

While balsam occurs over the entire region, it reaches better development and forms larger individual trees in the upper Connecticut and Magalloway watersheds than farther south.

White Pine.

White pine was originally abundant in New Hampshire and was found in nearly all situations below 1,500 feet elevation. Practically all the old growth has been cut, and only a few scattered trees remain. The second growth however, is good, particularly in the Saco watershed and the southern townships. The tree prefers a rather sandy and fairly moist soil and has under favorable conditions an extremely rapid growth in height and diameter. Reproduction at present is confined almost entirely to old fields, which yield in 30 to 50 years almost incredibly large amounts of timber. In this length of time it is not rare for an acre of second-growth pine to produce 40,000 to 50,000 board feet.

The tree is intolerant of shade and, chiefly for this reason, it thrives best in even-aged, pure stands, such as come up on abandoned land when there are seed trees in the vicinity. White pine is fairly free from injuries, although up to its fourteenth year it is susceptible to attacks from the weevil, which deprives the tree of its leading shoot. This injury, when prevalent, has serious results, producing distorted trees which are of little value.

Red Pine.

The red, or Norway, pine is most abundant in the Saco drainage basin, where it originally occurred mixed with white pine, or often in small pure stands. It is not found in the mountains and only extends as far north as the lower Androscoggin. It prefers a sandy soil, such as that in Conway and Chatham, where it is most abundant. In both height and diameter growth it is very similar to the white pine, although having a slight advantage in early youth. It is not, however, quite as tolerant of shade as the white pine, and prefers a rather open seedbed. In abandoned fields and pastures it often comes in very densely. In habit it is gregarious and is usually found in groups of a few trees or in pure stands over small areas. Restricted as it is to low localities with a sandy soil, it has not a wide distribution in the state, and is practically confined to the low lands around the Saco. A few scattered trees are also found in the townships of Thornton and Warren, and along the Mad River.

Pitch Pine.

Pitch pine occurs chiefly in the Saco watershed, on level, sandy soils. It is most plentiful in the township of Madison, around Silver Lake, and in the neighborhood of Ossipee Lake, Conway is its northern limit. It forms pure, open stands, often with an undergrowth of scrub oak *(Quercus pumila)* and some gray birch. It reproduces along roadsides and in openings in the woods, but requires a great deal of light.

It resists fire remarkably well, often sprouting to some extent when burned. The greater part of the pitch pine land has been repeatedly burned over. Pitch pine never reaches a large size, although individuals are occasionally found 14 inches in diameter. It is usually short and stunted.

Jack Pine.

This species (*Pinus divaricata*) occurs on the rocky, thin-soiled slopes and summits of the small mountains in the southern townships. It is short and scrubby and of absolutely no commercial value.

Hemlock.

Hemlock was formerly very abundant in the central part of the state, but has been almost entirely taken out for the

FIG. 1.—BALSAM ON THE UPPER SLOPES OF MT. WEBSTER. THE LARGER TREES ARE MOSTLY DEAD.

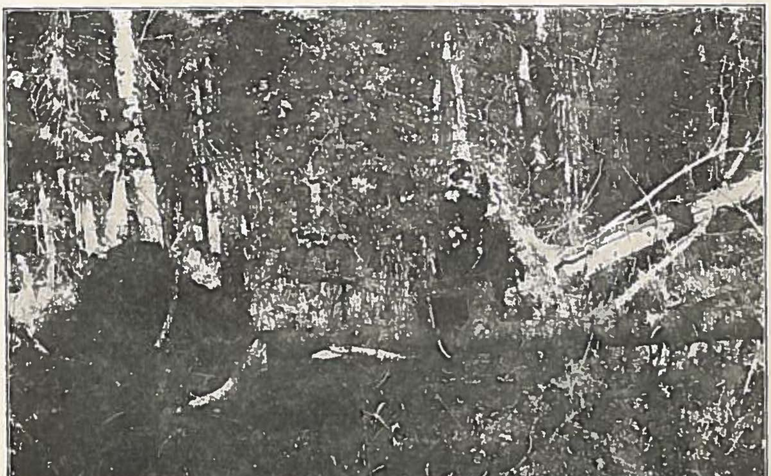


FIG. 2.—BALSAM IS EASILY THROWN BY THE WIND ON THE FLATS.

FIG. 1.—YOUNG GROWTH OF WHITE BIRCH AND POPLAR.

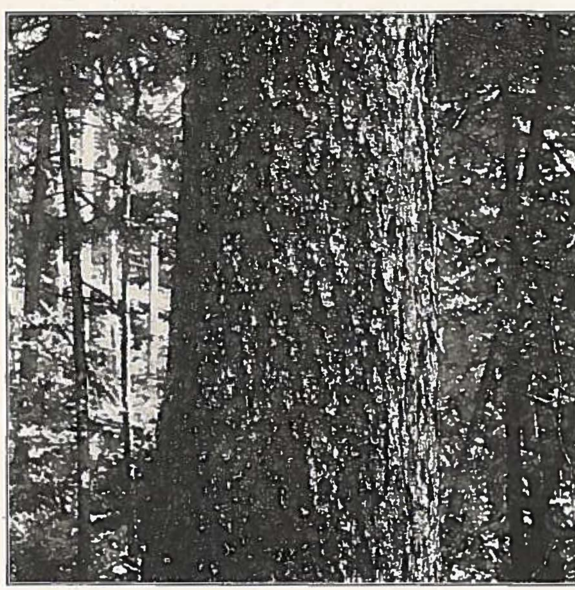


FIG. 2.—BARK OF RED SPRUCE.

bark. It occurs on the lower slopes of the Presidential Range below an altitude of 2,400 feet, and reaches its northern limit in the mountains of central Coös county.

Hemlock attains its best development on the lowlands along the streams and on the lower slopes, where it grows in mixture with hardwoods and white pine. The average diameter of mature trees is 16 to 20 inches, although many are found over 40 inches in diameter. Its growth is slow, and, although it is able to withstand very dense shade, the reproduction is very poor. The best reproduction is found along streams and in low, moist situations.

White Spruce.

White spruce (*Picea canadensis*) is found only in the northermost part of the state, in the Connecticut Lake district. It here reaches its southern limit and replaces the red spruce to some extent in the forest. In height and diameter growth it is very similar to the red spruce, which it closely resembles in its characteristics.

Black Spruce.

Where spruce occurs in swamps it is usually not the red but the black spruce (*Picea mariana*), which is better adapted to wet places. It is distinguished by its shorter and more scrubby development, darker bark and a slightly deeper green cast of foliage. The cones also are smaller and more persistent.

Larch.

Larch, or tamarack, is scatteringly distributed over the state, rarely occurring at elevations exceeding 1,300 feet. It prefers low, moist situations, where frequently the reproduction is pure and dense. The comparatively few swamps in the state explain in part the slight occurrence of the tree. It is one of the most intolerant species in the north woods and, in the White Mountain region at least, is short-lived. It rarely reaches a diameter of eight inches.

Larch is extremely sensitive to fire—a fact of which there are striking illustrations in the valley of the Israel River in the township of Jefferson. Its chief enemy is the larch sawfly, which in the past has destroyed large areas of larch, but at present is not very much in evidence.

White Cedar.

White cedar, one of the less abundant species and one which rarely occurs in the southern part of the state, is the typical tree of the cold swamps in the north, where it frequently grows in dense patches. Ordinarily the size of the tree is small, 10 inches through and 50 feet high being unusual. Its reproduction is prolific wherever there is a suitable seedbed. This must be thoroughly moist and fairly deep. The seed is distributed to some extent by the agency of water. It is found on the shores of lakes and streams and is common on Third Connecticut Lake and also on the East Branch of the Pemigewasset River.

Sugar Maple.

Sugar maple occurs over the entire state and, with yellow birch, is the commonest of the hardwoods. It reaches its best development on the deep, fresh soil of the hardwood slopes and is seldom found at elevations of over 2,600 feet. It never grows in swamps or on wet flats. It forms a long, clear bole with a small crown, and reaches a maximum height of 90 feet and a diameter of 30 inches, although the average for mature trees is much smaller. Growing in a dense forest in mixture with spruce, yellow birch and beech, it makes a heavy shade. In such places its reproduction is excellent; a thick matting of sugar maple seedlings covers the ground. It reproduces best on a seedbed of leaf litter where there is little underbrush. The seedlings are able to endure heavy shade.

Sugar maple is also very abundant along roadsides and on cut-over land. It is one of the first trees to come in after lumbering wherever the soil is sufficiently good to support it, and by its dense shade and faster growth during youth keeps out the softwoods.

Yellow Birch.

Yellow birch has the widest distribution of any of the hardwoods in Northern New Hampshire. It occurs on every situation from the low, wet flats to the upper limit of tree growth on the mountains, but finds its best development on the lower slopes and drier flats, where it often reaches a height of 80 feet and a diameter of 36 inches. The trees of the largest diameter are, however, apt to be short, with widespreading or broken tops. The root system is shallow and well adapted to thin soil. Although the yellow birch will grow on rocky, shallow soil on the steep slopes, it is not found extensively above an altitude of 3,000 feet, although individual trees are common up to the limit of tree growth.

The yellow birch seeds abundantly and the seedlings are able to grow in rather heavy shade, although they are not so tolerant in this respect as the sugar maple. The best seedbed is moss, old logs, and decayed stumps. In second growth and windfalls the yellow birch comes in very densely, often to the exclusion of other species, and, owing to its adaptability to all soils, forms a large part of the forest in every situation.

Beech.

Beech occurs throughout the state. With sugar maple and yellow birch it forms the chief hardwood of the country. It grows best on the lower slopes and along the valleys and streams, and is rarely found above an elevation of 2,400 feet. On cut-over land it is very abundant and after burns reproduces by sprouts. On the hardwood slopes, where it reaches its best development, it reproduces profusely, preferring a seedbed of mineral soil or leaf litter not densely overgrown with underbrush. Beech is very tolerant, equaling the sugar maple in this respect, and the seedlings are able to live in heavy shade.

The beech does not form a very sound tree in this region and is apt to decay at an early period.

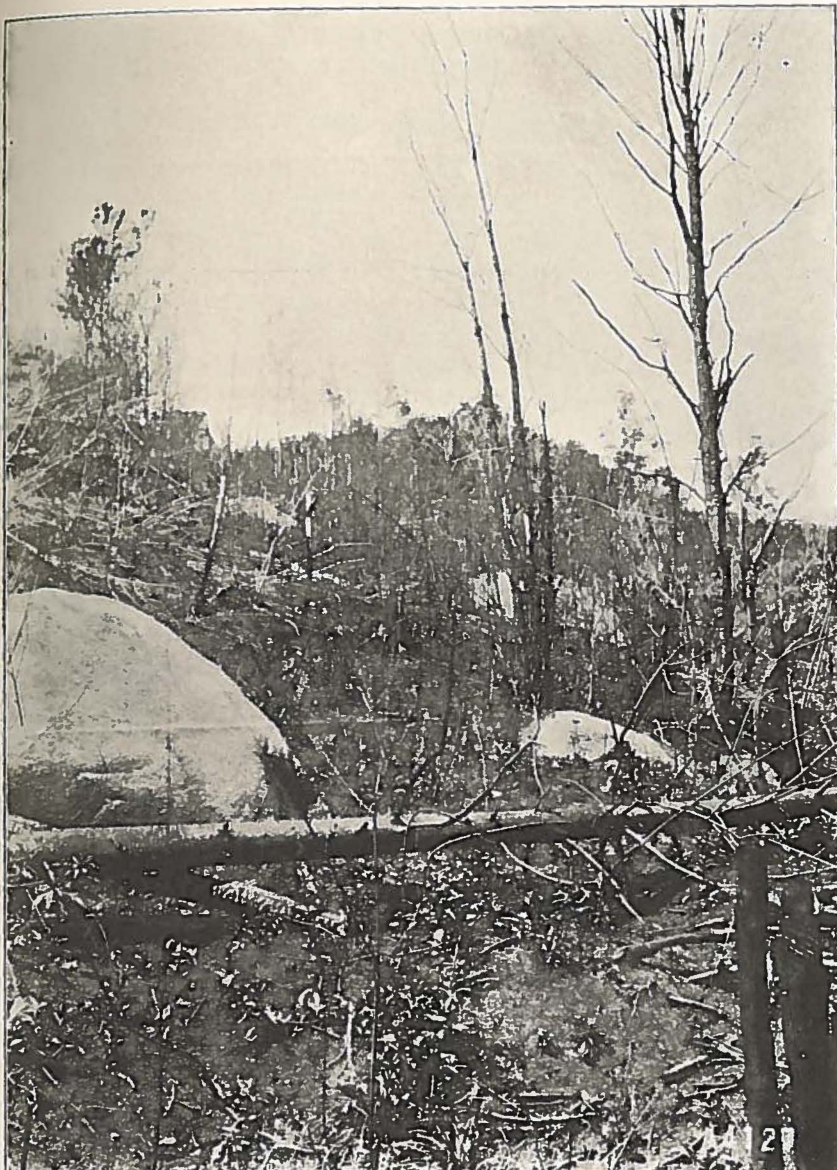
Paper Birch.

Paper, or white, birch is widely distributed over the state and is particularly abundant in the White Mountain region, where it occurs at all elevations from valley to timber line. Its occurrence above and below an altitude of about 3,000 feet presents a marked contrast. Up to this elevation it grows scatteringly, apparently crowded out by other hardwoods and spruce, all of which generally attain a greater height than the paper birch. Above 3,000 feet the tree vies with the balsam for the first place in the forest, where its white, exfoliating bark renders it the more in evidence. Its abundance at high elevations is due rather to the fact that the soil is too poor to support other trees than to its particular preference for such situations. At an elevation of 5,700 feet on Mt. Washington it occurs as a prostrate shrub.

Paper birch attains its best development, however, in mixture with spruce at medium elevations, producing a clear merchantable stem topped by a comparatively short crown. Compared with its associating hardwoods it is short-lived, generally evidencing a lack of thrift before it reaches its hundred and twenty-fifth year. Its reproduction in the forest at the lower elevations is noticeably scattering, which is explained by its intolerance of shade. At the higher elevations, however, where the other hardwoods practically cease and where the height of the tree has materially decreased, paper birch reproduces prolifically. On lumbered areas, burns, and windfalls the reproduction is frequently dense; this, however, depends upon the proxim-

FIG. 1.—HARDWOOD FOREST CULLED OF SPRUCE.

FIG. 2.—VIRGIN HARDWOOD LAND.



EFFECT OF FIRE ON CUT-OVER LAND.

ity of seed trees. It is not root-firm, and when a portion of the forest is removed it falls an easy prey to the wind.

Red Maple.

The red maple is abundant in New Hampshire. It prefers moist soils and is seldom found on the mountains above an elevation of 2,500 feet, although individual trees are occasionally seen at 2,700 feet. It is one of the commonest trees on cut-over land at low elevations, and is very conspicuous in second growth, owing to its ready tendency to coppice. The red maple reproduces easily. It is not so tolerant of shade as the sugar maple but makes rather faster height growth.

Popple and Aspen.

These two species, *Populus granidentata* and *Populus tremuloides,* have practically the same silvicultural characteristics and commercial value. They differ slightly in distribution, popple, or largetooth aspen, being confined mostly to the southern half of the state, while aspen has a general distribution over the entire state.

Popple is extremely rapid-growing but short-lived. It shoots up like a weed, growing on the average 18 feet in height in the first 11 years. It will not grow on the poorest qualities of soil and is generally found in the better localities. The aspens have a light-winged seed that can be easily carried for long distances by the wind and any land is apt to be seeded up to a thick stand of these species wherever there is sufficient light, as on burns, after lumbering, or on abandoned fields. The trees seldom get beyond 50 years in age, by which time they have reached a large size. Extreme intolerance of shade is usually, however, the cause of their early death. Commercially, popple is a valuable tree. Its use is chiefly for soda pulp and excelsior. After fire or lumbering the aspens are very desirable species to have come up, as they become merchantable in 20 years and yield a large stand to the acre.

Bird Cherry.

Bird, or wild red, cherry (*Prunus pennsylvanica*) is the common successor of fires and comes up with great energy, especially where the land has been burned over more than once. It is fast in growth, but never reaches large size, and is absolutely worthless. The densest stands are to be found on Cherry Mountain and in the Zealand Valley, in the townships of Carroll and Bethlehem, and on Pine Mountain in Gorham. All these tracts have been repeatedly burned over. It occurs over the entire state, coming up on old logging roads and on cut-over land, but to attain its best development requires fire.

The seed are almost wholly distributed by birds, which are very fond of the fruit. The seed may remain in the humus for long periods before germinating. When a fire runs over the area all seeds not killed are brought into direct contact with the capillary moisture of the mineral soil by the burning away of the organic matter on which the seed rested. The seed coat is very thick and so is able to withstand a very hot fire, while considerable moisture is required to start germination. The access of light that follows a fire or cutting is also necessary, for the cherry is very intolerant of shade.

After a fire, practically every uninjured cherry seed that is properly covered by soil germinates, and makes a very rapid growth the first year, having in the case of a severe burn, little or no competition. A height growth of three or four feet and even more is common. If the area is again burned over, each seedling sprouts with great energy. The result is a dense stand of bird cherry. It grows very rapidly at first but its height growth is limited and at the end of 30 years becomes very slow. Other species then quickly crowd it out. Few trees are found over 50 years old.

White Oak.

White oak, though common in southern New Hampshire, occurs in the region examined only as scattered individuals over a small area. It extends as far north as Plymouth, Squam Lake and the Ossipee Lakes, but is seldom found at an elevation of over 500 feet, and in the section of the state examined is a tree of merely botanical interest.

Red Oak.

Red oak also is a typical tree of the southern part of the state. It is the hardiest of the oaks and extends as far north as the Israel River on the east and the lower Androscoggin on the west, but is not found in the White Mountains proper. It is most abundant in the townships of Warren, Wentworth and Rumney in the Pemigewasset watershed, where it forms a large part of the hardwood forest. In the township of Eaton, on the slopes north of Robertson's Pond, it occurs as an almost pure stand, with some ironwood in mixture. It is common on Mt. Hayes, in Gorham, up to an elevation of 2,500 feet, but is not usually found at such elevations, rarely occurring in large numbers above 1,500 feet.

The red oak coppices readily and is fairly tolerant of shade.

White Ash.

White ash, scatteringly distributed in the region considered by this report, exhibits a marked increase in occurrence and size from north to south. It generally seeks moist, alluvial soil along streams, but was found, though as a straggler, at an elevation of 2,300 feet on Mt. Hayes, in the township of Gorham. In the White Mountain region specimens of large size are uncommon. Though the tree sprouts freely at the stump, reproduction from seed is poor. Intolerance of shade is a characteristic of the white ash and becomes more pronounced with age.

Black Ash.

This species occurs in moist situations below 2,000 feet elevation. It is found in the valleys where the soil is fertile and deep, and along small streams. It is not of frequent occurrence.

Elm.

The white, or American, elm, although of wide distribution and common over the entire state, does not occur anywhere in great abundance. It is found on deep alluvial soils along the streams and in meadows, but is not found to any great extent in the forest. Owing to its requirement for deep, moist soil, it occurs only at low altitudes.

Black Cherry.

Black cherry is not common in Northern New Hampshire, and no large trees are found. It reaches its best development on fresh, deep soil and on the lower slopes and valleys. It occurs chiefly as individuals along roadsides. It was found in greatest abundance at low elevations in the townships of Chatham and Eaton and along the Androscoggin. The reproduction is very poor and but few seedlings are found.

Gray Birch.

Gray birch, often called "white birch," but to be distinguished from the paper, or white, birch, has about the same distribution as white pine. It occurs plentifully in the southern townships of the state, in fields and pastures. It is of little commercial value except for cordwood.

Black Birch.

Black birch occurs but seldom in the region examined. It is found chiefly on the small mountains in the southern townships, but rapidly disappears northwards. It prefers moist, cool situations.

Basswood.

This species is often found in hardwood forests under 2,000 feet in elevation in the southern half of the state. It prefers moist, well-drained, fertile soils, and is not common in Northern New Hampshire.

Butternut.

Butternut is chiefly found in the southern part of New Hampshire and occurs only as scattered individuals in the northern townships, in fields and along roads. It is of little commercial value.

TABLE XXII.—AVERAGE HEIGHT OF THE IMPORTANT SPECIES.

Diameter breasthigh.	Height—Feet.					
	Spruce.	Balsam.	Sugar maple.	Beech.	Yellow birch.	Paper birch.
Inches.						
6	41	46	46	53	45	48
8	49	53	53	59	51	56
10	55	59	57	63	56	61
12	60	63	59	65	58	63
14	64	67	60	67	60	65
16	67	70	61	68	61	67
18	70	73	62	69	62	69
20	73	76	63	70	63	72
22	76	78	64	71	64	74
24	78	80	65	72	65	76

FOREST FIRES.

The general topography of New Hampshire is sufficiently hilly to preclude the possibility of a catastrophe by fire commensurate with that which occurred in the Miramichi Valley of New Brunswick in 1825, or in Wisconsin or Michigan in the early seventies. Forest fires, however, of greater or less extent and severity have been the common accompaniment of lumbering and the clearing of land since the earliest days. In recent decades the introduction of the steam locomotive as a common carrier and as an adjunct to the lumberman's logging outfit has greatly increased their number. The same is true of the increase in the number of persons who frequent the woods for pleasure. The extension from year to year of the total area which has been burned and appreciation of the facts that the great bulk of this land has failed to develop a valuable forest growth, that indeed much of it remains an absolute waste, and that the forest resources of the state are being rapidly depleted, has forced on all thoughtful persons interested financially or otherwise, the recognition of the fire question as the question of first importance to the forests of the state.

Damage and Extent.—For a number of years preceding 1903, New Hampshire has been comparatively free from destructive fires, although almost every year added a considerable, and some years a very large contribution to the total area burned over. These fires ran as a rule over lumbered land, but occasionally they destroyed considerable areas of virgin forest. One of the most destructive of them, within the White Mountain region, was that in the Zealand Valley in 1888. This valley had been lumbered for spruce saw-timber by J. E. Henry & Sons, the spruce being taken to a diameter of about 10 inches on the stump. The fire, starting, as is supposed, from a burning match dropped by a smoker, ran over some 12,000 acres, destroying the hardwoods and the remaining spruce, together with about two million board feet of saw-logs on the skidways. The loss in stumpage was estimated at the time at $50,000 on the pulpwood standing. The hardwoods had at the time practically no sale value. One hundred thousand dollars would be a conservative estimate of the present stumpage value of this spruce had it not burned, without taking into account the value of the large growth increment which would have accumulated during the 15 years since the fire.

In 1903 84,255 acres were burned over. The amount of damage varied greatly in different localities, but a conservative estimate would place it at something over $200,000. The spring of 1903 was particularly favorable for forest fires. The precipitation between April 17 and June 6 in the White Mountain region averaged about 0.3 of an inch, as compared with five inches normal rainfall for this time.

The winds averaged somewhat above the normal and the same was true of the percentage of sunshine, all combining to bring about a season of unprecedented danger. New Hampshire suffered greatly in destruction of her mountain soils. The loss of stumpage, however, considering the area burned over, was inconsiderable, while the loss to settlements was fortunately very slight. In the latter respect New Hampshire has been very fortunate, for although vast property interests have been threatened in her forest fires, comparatively little burning of buildings or improvements has taken place.

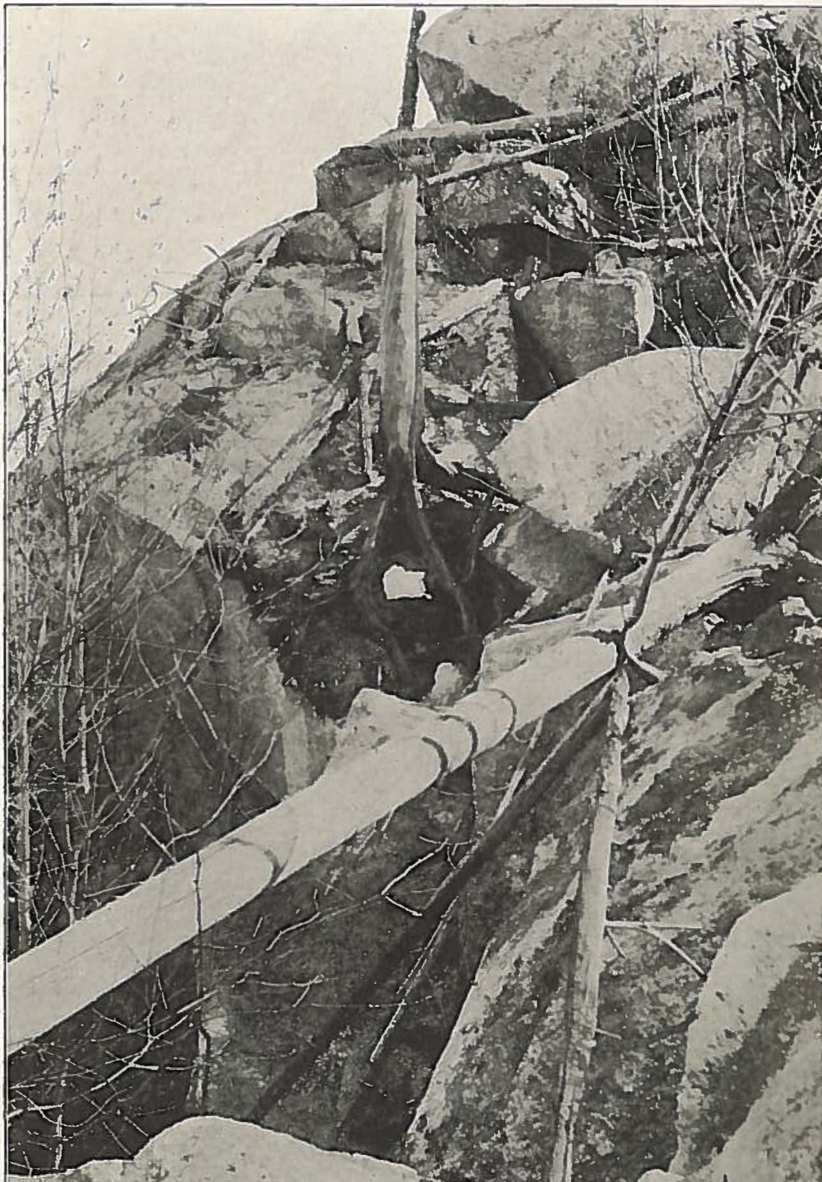
In injury to standing timber, the loss has been far greater. The amount of injury done in any particular case depends on the character of the stand and the intensity of the fire. The latter in turn depends on a variety of circumstances, chief among which are the velocity of the wind at the time, the gradient and exposure of the area burned, the character of the ground cover, the moisture conditions and the start the fire has gotten.

In this connection the effect of the elevation on the wind velocity is of importance. It is well known that normally the air movement increases very markedly with increase of elevation above the earth's surface. The result of this increased air movement depends very largely on the total height, gradient and form of the hill, and to a still larger extent on the height of the neighboring hills. The data taken at different points on Mt. Washington by the U. S. Weather Bureau indicates an increase of about nine or ten per cent. in the wind velocity per 100 feet increase in elevation. This may be regarded as approximately correct for unsheltered hillsides. But at the comparatively low elevations at which most fires originate the increase is in almost all cases very much greater. Fires from railroads, fishermen and campers originate, as a rule, in valleys, where at 100 feet elevation on the leeward side the wind velocity may be easily double or treble that obtaining where the fire started.

Exposure and gradient also play a considerable part in determining the severity of the fire. In general, south and west slopes and slopes which face the prevailing winds are more apt to be visited by severe fires than those less exposed to drying influences. Especially important is the exposure of a hillside in relation to the direction of the wind at the time of the fire. The more nearly a slope faces the direction of the wind, the more favorable the chances for the development of a severe fire, and the steeper the gradient, the more rapid and the more complete will be the conflagration.

Surface Fires.—In light surface fires the most important consideration is the character of the ground cover. In pine forest the inflammable character of the dead needles which cover the ground makes such surface fires very likely to occur, especially in April, with its light rainfall and high winds. On hardwood lands the débris is normally much less inflammable than under pines. In early spring, however, when the rainfall is light and the winds are high, the fact that the trees are without foliage makes the danger of ground fires here second only to that on pine lands, the absence of foliage permitting direct drying and heating by the sun's rays and giving the wind a much more effective sweep. These surface fires may spread quite regardless of the moisture condition of the soil, and are sometimes to be seen running over the ground in the immediate neighborhood of banks of yet unmelted snow, so effective are wind and sun, during the long days of the latter part of April and May, on the unshaded floor of the hardwood forest.

These surface fires are, as a rule, more injurious to the prospect of future crops than to the mature timber of the stand. They are, nevertheless, always more or less injurious to the mature timber. The various hardwoods as well as spruce and balsam are frequently injured by the death of the bark in spots at the base of the trunk or on a root. This, in the case of the hardwoods and balsam in-



TOTAL DESTRUCTION OF SOIL CAUSED BY FIRE FOLLOWING LUMBERING.
SUGAR LOAF MOUNTAIN.

FIG. 1.—YOUNG CONIFERS KILLED BY SEVERE GROUND FIRE.

FIG. 2.—GROWTH OF BIRD CHERRY ON THIS YEAR'S BURN.

variably, and with the spruce usually, results in defective timber, the injury providing a favorable opportunity for attack by the wood-destroying fungi. The growth of the stand is checked by the destruction of the mulch of leaves which is nature's protection against direct evaporation of moisture from the surface of the soil and against the development of moisture-robbing weeds on the forest floor. The stand suffers also by the deterioration in the fertility of the soil due to the destruction of the humus.

Should the soil itself be dry, the results are at once more evident and more serious. This is due to the fact that forest soils normally contain a sufficient amount of organic matter to burn more or less deeply in a dry season. This soil burning varies in severity according to the depth of the organic matter, the dryness, etc., but is very destructive to standing timber even when comparatively slight. Trees having a superficial root system are naturally the greatest sufferers.

Such fires may, when drought has not been excessive, or before the ground has become very dry, kill the timber in spots only, burning superficially or not at all over the remaining area. Such fires are often not regarded seriously because of the small proportion of the total area injured. They sometimes prove, however, almost as disastrous in the end as a more general burning, for the places where the trees are killed make very favorable points of attack for both wind and insects.

A severe ground fire will certainly kill all the standing timber, and may ruin the soil. It will not, however, destroy the timber which it kills. This timber may be saved if removed during the same season without injury to its quality or value, aside from any inconvenience arising from the necessity of its utilization at once. A crown fire, on the other hand, such as is liable to occur in coniferous stands under favorable conditions, almost invariably injures the market value of the timber, and may consume the trees altogether.

Virgin Forest.—On virgin hardwood land fires are not of frequent occurrence, and when they do occur they are usually of the light surface type. Virgin spruce lands in New Hampshire have not suffered greatly from fire. Occasionally fires from cut-over lands, driven by strong winds, have caught in the tops of virgin spruce and swept over considerable areas. Ground fires resulting from carelessness of campers and other causes have been known, after days of slow burning, to develop under favorable conditions into fierce conflagrations. Such a fire was that which destroyed the virgin spruce and balsam stand in King's Ravine, on the north slope of Mt. Adams.

Fires on Lumbered Lands.—Fires on cut-over lands of all kinds present much the same characteristics. Once a fire gets a start on such lands, with wind and weather at all favorable to its spread, it is usually quite impossible to combat it with any success. Where the cut has been heavy and the resulting débris correspondingly large, all the difficulties of fire fighting are proportionately increased. All kinds of waste material left in the woods supply food for the flames, but the leaving of large, unlopped softwood tops on the ground adds enormously to the fury of a brush fire, and greatly prolongs the length of time that a slash remains a menace to its own and surrounding areas. These large tops, propped up from the soil by their branches, are very slow to decay and become very dry. A large area in the Zealand Valley, which escaped the fire of 1888, was burned over in 1903, eleven years after the last lumbering. This valley had been lumbered for spruce sawlogs only, no trees under 10 inches on the stump being taken. This fire, which ran over about 10,000 acres, shows that the length of time that cut-over areas must be specially protected against fire is great, even when a very considerable proportion of the stand is left after lumbering.

Fires on cut-over lands usually kill all standing timber left on the area burned, as well as all the young growth. Until market conditions shall make it possible greatly to reduce the amount of waste material which is at present left on the ground after the average lumber job, the only safety for such lands is in an efficient fire patrol during the dangerous season. Unfortunately, the owner of lands severely cut over usually has not, or thinks he has not, a sufficient financial interest at stake to provide for this. This circumstance, and the fact that the state has the greatest interest in the protection of the land for the production of crops which shall be harvested by a succeeding generation, point to the desirability of its providing such patrol, towards defraying the expense of which taxes on timberlands may well be made to contribute.

Fires and Future Crops.—The influence of fire on the production of future crops of timber has chiefly to do with the change brought about in the species present and the effect of burning on the soil capacity. Of all the influences affecting the distribution of forest trees in New Hampshire within the last century, none has produced anything like so profound an impression as fire. The magnitude of this change depends naturally on the character, especially the severity, of the burn. Even a slight surface fire is exceedingly destructive to young growth and to the seeds of trees which may be present in the soil covering. Naturally some species are more susceptible to injury by a very light fire than others. This gives the species that is the most resistant a very decided advantage over the others. Hardwoods when burned over will generally sprout, and this gives these species a tremendous advantage on burned areas.

The influence of fire on the soil is due almost wholly to the destruction of the humus and other organic matter in the soil. The importance of the accumulation of organic matter as a constituent of forest soil can hardly be overestimated. Where least important, on deep, rich soils, it still serves as a mulch on the surface to prevent direct evaporation of moisture. Its presence also greatly increases the moisture-holding capacity of the soil by increasing both its hygroscopic and its mechanical retaining powers. It also acts as a fertilizer. The burning of this humus liberates the nitrogen of the organic matter as free nitrogen, thereby destroying absolutely the most valuable plant food constituent contained in the soil. The potash and phosphoric acid compounds which stand next in importance are mostly converted into soluble salts which are very rapidly leached away by succeeding rains.

The importance of the humic content of the soil increases with increasing gradient. In fact it is the only thing which makes the presence of forest growth on the steeper mountain slopes a possibility. This is true not only under the extreme conditions of high altitudes, where the trees are short and scrubby, although here, to be sure, the fact is more evident. On many slopes bearing the finest spruce, the presence of any forest growth whatever is due to the accumulation through the ages of a mass of organic matter which held the mineral particles of rock as they were gradually disintegrated, preventing their being washed to the bottom of the slope. The soil that obtains today on such areas is very largely organic matter, and when fire swept, if dry, is so nearly completely consumed, especially by repeated fires, that the remaining mineral particles heretofore held firmly for perhaps thousands of years are, together with the ash resulting from the burning of the organic matter, washed away until nothing but bare rocks remain. Many hundreds of acres of such lands are to be seen in the White Mountain region of New Hampshire. In some cases the trunks of trees upwards of a foot in diameter remain standing on the barren rocks from which every other sign of a former and every hope of a future timber growth has been burned and washed away.

After a severe fire on these steep slopes, the intricate network of fine rootlets, which constitutes the major part of the humus, having been burned, the rain falling on the bare soil quickly carries away in solution not only all the soluble mineral plant food liberated by the fire but also

FIG. 1. EROSION FOLLOWING FIRE ON STEEP SLOPES. ELEVATION, 2,200 FEET.

FIG. 2.—SCRUB GROWTH KILLED BY FIRE ON THE UPPER SLOPES OF MT. ADAMS.

FIG. 1.—NORTH SUGAR LOAF, ONCE HEAVILY TIMBERED, NOW PRACTICALLY BARREN.

FIG. 2.—DESTRUCTION OF SOIL CAUSED BY FIRE AND EROSION.

the finest and most valuable particles of the soil itself. The extent to which this erosion may be carried depends on the amount of precipitation, the character of the soil, the gradient and the length of time before new growth starts. The leaching out of soluble plant food and the washing away of the finer particles of the soil may continue, however, long after the slope has again become covered by vegetation. Slopes of this type, owing to the rapidity of the erosion and the slowness with which they become reseeded to forest trees, are usually lost to forest production.

Character of Growth Following Fires.—Trees and other plants have different ways of gaining a foothold on a burned area. A few species produce seed that are capable of a greater or less resistance to fire. Some seed find safety by being deeply imbedded in the moss, which is rarely completely consumed over the entire area. The greater number, however, are brought in from neighboring areas by the agency of wind or animals. If the soil has not been deeply burned, most of the hardwoods will sprout from the root collar. Some, even when the soil is very severely burned, are capable of sprouting from portions of the roots which may have escaped death. Among herbs the development of shoots from roots and root stocks is by far the most common mode of reproduction after a fire.

Of the species whose seed are able to survive a considerable degree of heat, bird cherry and the common raspberry are the most noteworthy. The sumach (*Rhus glabra*) also comes up after fires from seed already in the ground, but it is of only local distribution. The seeds of the bird cherry are by far the most resistant, and survive wherever the humus is not entirely destroyed.

The bird cherry, therefore, by virtue of its presence on the ground and readiness to germinate as soon as the fire is over, together with its vigorous growth the first season and the fact that its best development takes place in direct sunlight, is one of the most characteristic features of the new growth on recently burned areas. Should the burned area be in close proximity to land previously burned and now covered with cherry trees bearing fruit, the number of seedlings of this species which will spring up on the new burn will be very great. Birds, after feeding on the cherries, drop the seed in the forest and when this is cut or burned over, the seed, unless killed, germinate at once. As many as 1,200 of these cherry trees have been counted to a square rod. Where the growth is anything like so dense all other growth is for a time excluded, until some shade-enduring species gets a foothold under the cherry.

Yellow and paper birch seed occasionally survive a fire when they are well imbedded in moss, but they are usually carried in after fire by the wind.

The aspen (*Populus tremuloides*) and large-tooth aspen, or popple (*P. grandidentata*), are characteristic features of the growth following burns. The former is by far the more common on the poorer soils and higher elevations, while the latter is more at home on the deeper, richer soils of the valleys. The seeds of these trees are wholly dependent on the wind for distribution. That any seed present before the fire should survive is highly improbable, as a simple drying destroys their vitality, and their appendages would prevent any deep penetration of the moss where they might find safety. The willows resemble the popples in time of maturity, distribution and germination of their seed, and are frequently found on burns. The species which occur are of no commercial and little silvicultural significance.

When the burning of the soil itself has not been sufficiently severe to kill the roots of the trees, reproduction by sprouts from the root collar of the broad-leaved trees usually occurs. The resulting stand is at best very inferior. In many cases it is largely composed of mountain and striped maple, and pure stands of the former are sometimes seen, although bird cherry generally forms a large part of the growth.

The reappearance of conifers on burned areas is entirely dependent upon the presence of seed trees sufficiently near to admit of the blowing in of the seed. It is of interest to note that where seed is available the spruce reproduces best where the soil has been most thoroughly burned; that is, where the seedlings have the best opportunity to reach the mineral soil at once. Balsam, on the other hand, prefers to germinate on a mossy spot. The result of this is, that on land thoroughly burned and afterwards well seeded by spruce and balsam the former will usually outnumber the latter fully five-fold in the succeeding growth, while on a mossy seed-bed the balsam reproduction far outnumbers the spruce. These conifers, however, seldom appear on a burn in large numbers, being crowded out by the faster-growing hardwoods which occupy the ground first. They come in slowly under the shade of the latter and gradually become a part of the stand. The spruce and balsam remain, as a rule, under the shade of the popple sufficiently long to permit the latter to develop to a merchantable size before its ascendency is threatened. Where the land has grown up to a broad-leaved coppice, as on hardwood land, in which the maples, beech or yellow birch are prominent, the conifers make little headway and a pure hardwood forest is the inevitable result.

On pine lands a single fire is less serious than in any other type of forest. The soil rarely burns deeply enough to kill the roots of the mature trees and their fire-resisting bark protects them above ground. The soil is not usually liable to excessive erosion, because of the slight gradient, and in most places is quite free from undesirable species of undergrowth. The chief effect is the killing of all reproduction and seedling growth. Repeated burnings are, however, common on the sandy plains and where this occurs no reproduction can take place and sand barrens with a few scattered, scrubby pines are the result. On the pitch pine areas near Silver Lake, repeated fires have occurred, and there is now a dense ground cover of worthless barren oak *(Quercus pumila)* which prevents all other reproduction.

On much of the burned area in northern New Hampshire fires have occurred more than once. The tendency of a repeated burn is to increase the number of hardwoods present. Bird cherry and the popple, when burned, sprout freely from the roots, or even from parts of a root that is burned through in places. The number of sprouts usually exceeds the number of trees in the stand before the fire. Neither of the above species gains any advantage over the other by repeated burnings when two or more years elapse between the fires. When, however, fires follow each other in successive years the popple is almost totally destroyed, while the cherry sprouts as vigorously as ever. The practical extermination of the popple on several different areas in the mountains is traceable to this cause. Almost the entire growth of popple and bird cherry after second and subsequent fires is by sprouts. Any popple seed which may have blown in are at too great a disadvantage in competition with the coppice and weed growth. The same would be true of cherry seedlings, but as those first established have not as a rule reached fruiting age between the fires, and as birds would not frequent the area, it is improbable that any seed of the cherry are available.

Seedlings of paper and yellow birch rarely come in after a second fire. If the second burning is light, the birch will reproduce vigorously by shoots from the root collar; if severe, the area is usually practically destitute of birch reproduction.

Light subsequent fires on sprout land do not materially change the composition of the stand. The growth of the intervening years is, of course, lost, the trees being killed to the ground. In the subsequent sprouting the number of sprouts will probably be increased, but with a corresponding decrease in their prospective value. The latter, however, is not serious, for little else than firewood can be expected. But it must be remembered that with each repeated burning the softwood species are killed and the chance of their appearing in the new growth is materially lessened.

FIG. 1.—LAND LOGGED AND BURNED TEN YEARS AGO. NOW COVERED WITH ASPEN, WHITE BIRCH, AND BIRD CHERRY.

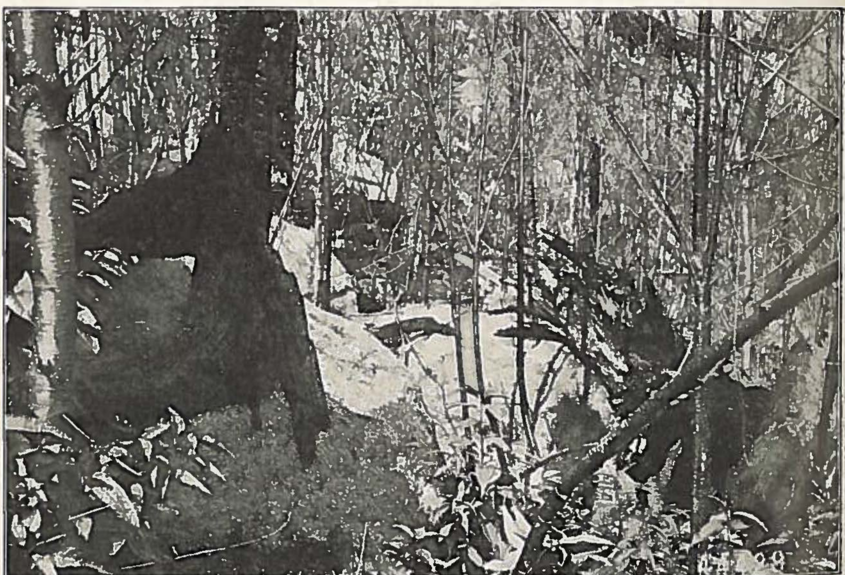


FIG. 2.—SEVERE BURN ON CUT-OVER LAND. COMING UP TO BIRD CHERRY.

FIG. 1.—LOGGING CAMP OF J. E. HENRY & SONS, LINCOLN.

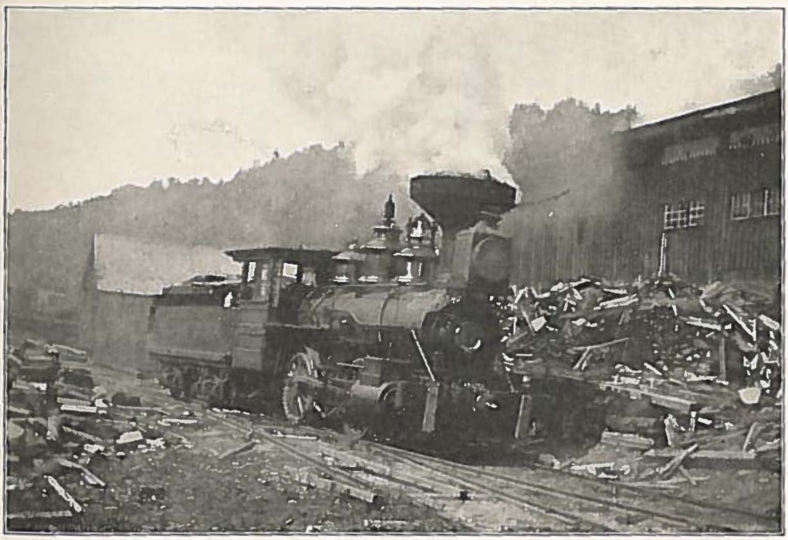


FIG. 2.—WOOD BURNING LOGGING ENGINE WITH AN EXCELLENT SPARK ARRESTER.

The development of herbaceous growth, which is uniformly an accompaniment of repeated fires, is one of their most serious features. The soil, after it has once been thoroughly depleted of its organic matter, is never burned sufficiently deeply by subsequent fires to destroy the roots and root-stocks of the perennial herbs and grasses which have found their way in. The result is that with each succeeding fire the possibility of reproduction by seed of any valuable forest tree becomes more and more hopeless, and the land is with each burning given over more completely to inferior sprout and weed growth. The chief perennials, which are found on such lands, are raspberry, fireweed, blueberry, sorrel, pigeonberry, blackberry, goldenrod and brake fern.

Causes of Fires.—The principal causes of forest fires, in the order of their importance, are railroads, carelessness in clearing land, fishermen and campers and maliciousness.

Railroads undoubtedly set very many more fires than are due to any other single source. That the aggregate amount of damage done is very great cannot be better illustrated than by the fact that a division superintendent of a railroad operating in the White Mountain region had in his office on September 12, 1903, 554 separate reports of fires causing a greater or less amount of damage to neighboring property during the season of 1903. These fires originate either from sparks from the smoke stack or from hot coals dropped from the ash pan. That this latter method is a very effective way of setting a fire was well shown at Carroll in July. The Maine Central express, in rounding the curve at this point, dropped a quantity of glowing coals, some of which were thrown as much as eight feet beyond the rail by the centrifugal force exerted as the engine rounded the curve, and instantly started a number of fires in the grass and litter for a distance along the line of more than forty yards.

Fires from coals from the ash pan are invariably near the track, and are usually at once conspicuous. Those originating from sparks from the smoke stack may occur at a considerable distance from the track and may smoulder for a long time before being discovered. On this account they are more dangerous. They are also probably more frequent. There seems to be no entirely satisfactory spark arrester on the market, but that the danger can be very greatly lessened by the use of the best one available is certain. There can be no excuse for the dropping of coals from the ash pan when the train is running at high speed. This is simply a matter of carelessness.

The substitution of oil for coal as a fuel for locomotives, or the use of electric motive power, would mean absolute safety. The success of the former on an Adirondack railway and the very marked reduction in operating expenses by the latter substitution on the lines of the Interborough Rapid Transit Company of New York commend them to the consideration alike of the railroad companies operating in the forest lands and to the state legislators.

Among the numerous causes of forest fires the getting beyond control of fires set for the purpose of clearing land occupies a prominent place. There are many persons among the farming community who do not appreciate the danger of burning brush in the neighborhood of woodlands during a dry time. Unfortunately the danger from this source is not due entirely to ignorance or simply to thoughtlessness. There are many persons who will not consult the safety of their neighbor's property in this matter, even if the danger has been clearly pointed out. The evil clearly calls for both educational and restrictive measures.

Fires caused by fishermen and others who build camp fires in the woods are not infrequent, and many of the most disastrous fires have been attributed to this cause. It is a common practice for fishermen to build fires for warming coffee, etc., or to keep away flies and mosquitoes. Many who indulge in this practice have little or no knowledge of the precautions to be observed in kindling and extinguishing fires in woodlands. This is more serious in the case of fishermen than in that of most other campers because of the fact that the best fishing season happens to be at the time of year that the danger of forest fires is most imminent. The places where these fires are kindled are usually far away in the woods and are not infrequently in obscure places along small streams where it is very improbable that they will be seen, and then probably only after they have got beyond control. It is not surprising, therefore, that timberland owners dread the camp fires of the fishermen perhaps more than any other cause of fire, since it is one of the causes over which they have no control and for the damage from which there is no recourse in case of loss.

Among the minor causes of fire, carelessness of smokers in dropping burning matches and cigar stubs probably takes first place. The setting of fires to improve the berry crops is also of not infrequent occurrence. Fires are also occasionally set for revenge or out of pure maliciousness.

Dangerous Seasons for Fires.—In New Hampshire there are two seasons when the danger of forest fires is much greater than at other times. The first and most dangerous fire season is due to begin soon after the snow melts in the spring and continues till the leaves come out. The second begins about the middle of September and continues till the last of October. These dangerous seasons are due to a combination of meteorological and physiological conditions. The meteorological conditions in the order of their importance are rainfall, air movement, humidity, sun and temperature. The physiological conditions are the opening and the fall of the leaves and the springing up and maturing of the herbaceous vegetation.

The physiological factors vary but slightly from year to year, and then only in regard to the time of their occurrence. Thus, while there are two especially dangerous seasons, a period of danger may develop outside the limits of these should a very abnormal deficiency in rainfall occur; and while the two danger seasons normally begin and end at the time mentioned, either may begin or end earlier or later according to the weather and season. In some years there may be no danger season at all.

The humidity of the atmosphere has a very important bearing on the fire seasons. The lower the humidity, the greater the absorption of moisture from the forest floor by the atmosphere. April has an extremely low relative humidity, and May and even June are both below the average. The rainfall in the spring months is also below the average. April has an average precipitation of less than 2.1 inches, as compared with nearly four inches in the month of August. May has a fair rainfall, but also below the average, while the wind movement for these months greatly exceeds that in the summer. The absence of green herbaceous growth on the ground, and of leaves on the broad-leaf trees, allow the full sweep of the wind and the heating and drying of the leaf litter by the direct rays of the sun. With the increased rainfall in June and the development of the leaves, the danger season passes away and during the summer months fires are the exception rather than the rule.

The fall fire season, although rarely as dangerous as that of the spring, frequently witnesses very disastrous fires. The rainfall of about four inches in August decreases to a little over three inches in September, and to still less in October, which ranks as one of the driest months of the year. The air movement meanwhile increases from a minimum of 140 miles per day in August to 175 miles per day in October. The leaves also are rapidly falling and the herbaceous vegetation is for the most part mature. The conditions, therefore, closely resemble those in the spring, although not quite so extreme.

Prevention of Fires.—The prevention rather than the extinguishing of fire must be the object of any successful attempt at fire protection, and on the success which it meets depends the possibility of forestry, and with it the possibility of continued lumbering.

Fire protection is essentially a function of the state. The utilization of the township as a working unit for fire protection has been tried in many states, with little or no success. New Hampshire, not being a land-owning state, the direct loss in stumpage values by fire falls wholly on individuals and lumber companies. It is nevertheless true that such loss is essentially a state loss. The destruction of the soil by fires that follow lumbering may not greatly concern the individual who owns the land but who does not hope to live to reap a second crop. To the state, however, it is of first importance that the natural resources represented by the soil capacity should not be deteriorated or destroyed.

This consideration points to a duty on the part of the state to organize and direct the work of fire prevention and fire fighting. The first duty of the state in this direction is to educate the public sentiment concerning the seriousness of the fire question and to inform the public in regard to fire laws, but it shall also maintain a force for the prevention and fighting of forest fires. It is worth consideration also whether the state may not fairly require reasonable precautions to be taken by forest owners to prevent the existence of conditions which constitute a menace to surrounding property. This protection could very properly be furnished by an increased tax on cut-over land where all the timber has been removed, as here danger from fire is most severe. The taxes on the land might be very properly remitted altogether when the owner provides for fire protection to the satisfaction of the chief fire warden. So thoroughly alive are the lumbermen of New Hampshire to the necessity and value of efficient fire protection that no serious objection to a tax of this kind is anticipated. Should such develop, however, it is evident that if the lumbering of forest areas is not yielding a sufficient profit to the operators to enable them to pay without hardship half the cost of protecting themselves and the community from the danger created by their operations, it is not good policy that the lands should be lumbered, and the tax would then

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serve the valuable function of conserving the forests until the stumpage value advanced sufficiently to pay for the risk incurred by the lumbering. The exact amount of this tax can be easily adjusted to suit the requirements of the service.

Considerable areas of forest lands in New Hampshire are held by hotel companies which are especially interested in the prevention of fire in their neighborhood. It is very possible for such companies to provide for a system of trails covering the tract, which could at any time be utilized as a means of communication and transportation between headquarters and a point of danger. In an emergency they could be used as fire lines, and at other times they would provide pleasant walks for the guests. Should a railroad pass through the tract, a trail should parallel it on either side at a distance of about 50 to 75 feet from the track, and all brush and other débris between the trail and the railroad should be piled and burned at a safe time. Where feasible, trails should follow the crests of any low ridges, which are particularly favorable places at which to make a stand in fighting fire. A number of the trails should be sufficiently open to admit of transportation of tools and provisions by pack horses, and all should be carefully mapped. In the building of such trails, old logging roads should be utilized so far as possible. They can be very cheaply transformed into excellent paths and make very effective fire lines.

The extensive use of the steam railroad in logging operations in New Hampshire calls for some special attention in connection with this subject. A number of the lumber companies using this means of transportation are exceedingly careful in their management, and have been very successful in the prevention of fires. The chief points to be observed are as follows: A strip about 30 feet wide on each side of the track should be cut clean and all brush carefully burned. The grass and weeds should be cut on this strip at least twice during the season and removed or burned. A strip of forest land about 300 feet wide should be left untouched on each side of the track between the cleared strip and the area where logging is carried on. The timber on these strips can be taken quite as satisfactorily at the end as at the beginning of the job, and they provide at no cost whatever a very effective fire line.

Water barrels should be placed at frequent intervals. These may be filled from the engine tank. They provide a supply of water for the patrol, who should follow up the train during a dry time.

The patrolling of the line during the danger season is of the utmost importance. A four-wheeled railway bicycle is very convenient for the purpose. The patrol should follow up every train during the dry season, extinguishing any incipient fire with a pail of water which is carried on the hand car and which can be replenished from time to time from the barrels along the track.

A long hose which can be attached to the engine tank should be available. It is very useful in wetting out a fire near the road, that is under control but smouldering in a duffy soil.

The use of the most approved spark arresters and devices to prevent the dropping of coals from the ash pan are, of course, of primary importance. The use of coal in preference to wood for fuel is good fire insurance, even when the extra cost is considerable. If the season is especially dry it may be necessary to run the engine at night only, or to discontinue using it altogether until rain falls.

Methods of Fighting Fires.—Promptness of action on the discovery of a woods fire is quite as essential to success as in fighting any other kind of fire. Should a fire be spreading, the most essential thing is to stop it. This may often be done by vigorously beating it out with spruce or balsam boughs. If water is at hand, that is, of course, the next resort. A hoe, spade or shovel may be used to excellent advantage in throwing mineral soil from in front on the burning margin. This checks the flames and at the same time makes more or less of a fire line. Having stopped the spread of the fire, a fire line must next be made around the area by the removal of any inflammable material from a narrow strip, after which attention may be given to the extinguishing of the fire on the area itself. If water be at hand it will greatly simplify the matter; if not, the only recourse is to bury the burning matter with mineral soil.

Aside from fires on cut-over lands, where large quantities of brush make it possible for a fire, once well started, to run at any hour of the day or night, forest fires do not usually begin to run until about ten o'clock in the morning and die down again towards evening. The dead leaves, twigs, humus, etc., are all very hydroscopic and absorb moisture from the atmosphere very rapidly as their temperature falls toward evening. This, together with the decrease of the wind, soon brings the ordinary forest fire under control, and there is little danger of a fresh outbreak until the following day.

When a forest fire with a good start is running before a strong wind, it is usually impossible to do any very effective work in front of it, and attention should be given to fire lines along the sides to prevent its spread laterally, as the wind may change at any time and drive the fire in another direction. This is especially imperative if valuable property should be threatened by such a change of wind. As soon as the fire can be checked in the evening, every effort must be made to complete the fire line around the area before ten o'clock the next morning.

The character of the fire line to be made around a burning area depends on the character of the fire. If it is a light surface fire running over a moist soil, it is sufficient simply to remove all inflammable material from the surface of the ground in a strip three to six feet wide. If, however, the soil itself is dry, as is often the case, a trench must also be dug through the organic soil or duff. The soil removed should be thrown on the side of the trench towards the fire.

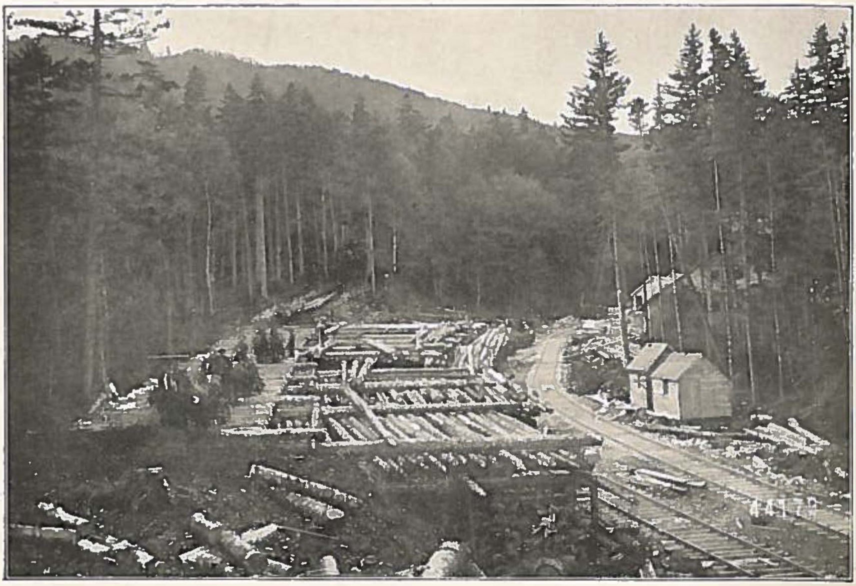


FIG. 1.—SKIDWAY AT J. E. HENRY & SONS, CAMP NO. 12.

FIG. 2.—LOGGING TRAIN, LINCOLN.

FIG. 1.—FELLING A THIRTY-INCH SPRUCE ON MT. BOWMAN.

FIG. 2.—YARDING LOGS ON MT. BOWMAN.

After the fire is under control the fire lines should be patrolled night and day until absolute safety is assured, or until rain falls. This is of the first importance in order to make sure that no fire gets across the fire line. A fire may smoulder away for days and even weeks after it is pronounced out, only to break out with as great fury as ever on some especially favorable day. Even a fairly heavy rain may not entirely extinguish a duff fire.

Care should be taken to fell burning stubs, after fire is under control. These can best be seen at night and are particularly dangerous because of the distances to which they may throw their sparks.

The number of men required to handle a fire is the number needed to prepare an efficient fire line around the area, and this will necessarily vary in nearly every case. In the organization of the force it is rarely possible for one boss to handle more than ten men satisfactorily, and on night work the number should be reduced to five. The axe, hoe and shovel are the tools which must be relied upon for fire fighting under most circumstances. Occasionally it is possible to use a plow in making a fire line, and it should be used whenever practicable because of the great saving in time and labor. Pails should always be available and may, when near a water supply, be used to great advantage.

As a means of combating a running fire, back firing is rarely practicable, and when the wind is very high it may be entirely out of the question. However, if a road, good trail or brook be available as a fire line, with plenty of men to prevent the back fire itself from getting across the line, it may be possible to do something. Usually its use is limited to checking the spreading of a fire laterally from the direction of the wind and in the protection of valuable property at the sides of the fire. In any case the first essential is a good fire line and the next a sufficient force of men to keep the fire on the right side of the line. Indiscriminate attempts at back firing can only increase the destruction.

The prompt payment of the men employed in fire fighting and patrol is of prime importance. The lack of it always has been and still is one of the most serious drawbacks to efficient fire protection in several of the states which have, otherwise, well organized systems. The time required to close the accounts varies in different states from several months to more than a year. Such delays in payments make it difficult to get together a force of men to fight fires even if the pay is high.

FOREST INDUSTRIES.

Lumbering in New Hampshire.

From the first settlement of the region lumbering has been a leading industry. There was always a demand for building material and ship timber from the towns along the coast. The first settlements were in the broad valleys of the main rivers, the Connecticut, the Saco and the Androscoggin. The forest was looked on as more or less of an obstruction to agriculture, but the immense veteran white pines were always recognized as valuable. Extracts from the history of the early settlements are of interest. That of the settlement of Shelburne, on the Androscoggin, in 1800, records: ''For some years clearing land and raising food was the principal industry. The largest and straightest trees were reserved for the frames of the new houses; shingles were rived from the clearest pine; baskets, chair bottoms, cattle bows, etc., were made from brown ash butts; all the rest of the timber cleared was piled and burned on the spot. Logging was always a standard industry and the timber holds out like a widow's meal and oil. All the pines went first; nothing else was fit for building purposes in those days; tables were made two and one half feet wide from single boards without knot or blemish.''

In a memoir of Lucy Crawford on the early settlement of Conway, in the latter part of the eighteenth century, we read: "They soon began the lumbering business by floating logs and masts down the Saco to its mouth, where they received bread stuff and other necessaries of life in exchange."

By 1852 the lumber industry had become well established. A gazette of that year records: "In the town of Berlin there are three large sawmills, two furnishing employment to 50 to 60 men and a third for about 40. There are several others employing 5 to 10." And further on it says: "In the town of Errol several big streams unite with the Androscoggin, and upon this stream have been expended quite recently more than $100,000 in erecting dams, etc., for the purpose of holding back the water so as to enable the companies engaged in the enterprise to drive logs from the upper lakes to market through the whole season."

These extracts give an indication of the growth of the lumber industry. The present lumbering in the region can best be described under three heads: (1) in the southern townships, where the cutting is all of so-called second growth; (2) in the White Mountain region proper, where there are still considerable areas of uncut land; (3) in the north country, where there are vast stretches of lightly culled and virgin forest.

Lumbering in the Southern Townships.—The lumbering here has adapted itself to the change in forest conditions. There are no extensive tracts of unculled timber which would keep a large mill running. Numerous small mills scattered over the country cut the second growth as it becomes merchantable. The manufactured product is very varied; everything is made, from rough boards to excelsior, from flooring to handles and bobbins. Every kind of timber is utilized, the largest percentage being of second-growth white pine and spruce for boards and dimension stuff. The hardwoods are used for flooring, cordwood, bobbins, shoe pegs, etc.

There are many small water-power mills which do custom sawing for farmers in the vicinity. There are also portable mills which are moved into the tracts of second growth and cut it into boards on the spot. There are also many small stationary steam mills, which get sufficient stumpage from the surrounding woodlots for a continuous supply. The lumbering in this region is on a small scale, but also on a permanent intensive basis.

Where the company owns its own timberland, the cutting is usually conservative and careful; but when buying stumpage, they usually cut as clean as is profitable and pay no attention to injury of young growth. The character of the cutting also greatly depends upon whether the mill is portable or stationary. The portable mills are transported right into the midst of a 50- or 100-acre woodlot, so there is only the cost of cutting and yarding and no long haul. Hence it is profitable to cut everything which can be converted into a board and the cutting is accordingly clean.

Stationary water-power mills, which do mostly custom sawing for farmers, are most conducive to conservative lumbering. The cost and running expenses of the mill are slight, and it can accordingly be run at irregular intervals when there are logs to be cut. Stationary steam mills are more expensive, and have to do more sawing to realize a proper interest on the capital invested. The policy of these mills, however, is generally to cut conservatively, on their own land at least, so as to obtain the most possible timber in the long run and a continuous supply.

Lumbering in the Mountains.—Logging in the mountains is all by large companies and on a large scale. The timberlands are owned almost entirely by seven large companies. The Berlin Mills Company, the International Paper Company and J. E. Henry & Sons are the largest concerns operating in this region. These large concerns cut upwards of 75 million board feet a year, mostly of virgin timberland. About two thirds of this goes into lumber and the other third into pulp. The policy of all the com-

FIG. 1.—STABLE AT CAMP NO. 10, LINCOLN.

FIG. 2.—LOADING CARS AT LOG LANDING.

FIG. 1.—LAND CUT OVER TWENTY YEARS AGO TO A DIAMETER LIMIT OF FOURTEEN INCHES. NOW READY FOR ANOTHER CUT.

FIG. 2.—SPRUCE FLAT, CUT OVER TO A DIAMETER LIMIT OF FOURTEEN INCHES TWENTY YEARS AGO AND AGAIN IN 1903. EXCELLENT YOUNG GROWTH LEFT.

panies is to hold the land after cutting. Most of the large concerns desire to cut conservatively if possible, or at least to save the young growth for a future crop. This policy is, however, seldom carried out in the mountains.

Clean cutting is practised on all the steeper slopes and little is left after lumbering. One reason for this is that windfall is very severe and any trees left standing are almost certain to be windthrown. On the lands of one company in particular no thought is given to a second crop; everything on the steep slopes is cut. The logs are rolled down the slope to the road below, over the non-merchantable stuff and the hardwoods, which are felled down the slope and form a good rolling bed. The result is a veritable fire trap that lasts for years. On the more moderate slopes the softwoods are got out without cutting the hardwoods. The policy of this company is to cut all their timber and then move into the west, where it already owns large tracts of forest.

The most conservative cutting in the White Mountains has been done by D. and C. G. Saunders in Livermore, who cut simply to supply their own mill. This has an output of only four million board feet per year. The Messrs. Saunders cut to a rough diameter limit of 10 inches on the stump and has been over the same ground twice, having cut the first time to a limit of 14 inches. It must be remembered, however, that no pulpwood is cut on this land.

The general policy of the International Paper Company is to cut fairly conservatively, so that the same area may be again cut within 30 to 60 years, but in the absence of careful inspection the policy is not well carried out. Most of the logging is let out to jobbers who bring the logs to the bank of the stream where they are to be driven, or to the railroad. There are stipulations in the contracts between the jobbers and the company in regard to the cutting, but without more stringent inspection they are not fully effective.

Lumbering in the North.—In the northern part of the state nearly all the lumbering is carried on by the Connecticut Valley Lumber Company, the Berlin Mills Company and the International Paper Company. Upwards of 100 million board feet of logs are taken out yearly by these companies, almost exclusively spruce, mixed with about 10 per cent. balsam. The lumbering here is characterized by long hauls and long drives, the mills being located at a considerable distance from the source of supply. There are no large mills in the region.

The Berlin Mills Company cuts the most conservatively of any in this region, and is the only one which employs an expert forester. His duties are to inspect the various cuttings to determine the amount of unnecessary waste, to look out for diseased and infected timber which should be cut immediately in order not to be a total loss, and to make topographic maps of the company's lands, useful in logging operations.

The Connecticut Valley Lumber Company cuts chiefly for sawlogs and in consequence considerable young stuff is left on their lands after lumbering.

In general, lumbering in the north can be put on a more conservative basis than in the higher mountains where the slopes are steeper and windfall more severe. But even there much can and should be done to prevent needless waste in logging and exposure of the cut-over lands to fire. No policy of conservative cutting, however, will be satisfactory unless it is wisely conceived and properly carried out.

THE WOOD INDUSTRIES.

The wood-consuming industries in the region considered by this report manufacture paper and wood pulp, lumber, bobbins, shoe pegs, crutches, excelsior, spools, rakes, handles, chairs, racket frames, picket sticks, wood shanks, veneer and ladder rounds.

The paper and wood pulp, lumber, bobbin, shoe peg and crutch industries each comprise three or four establishments. The remaining industries each comprise one or two establishments. They are below described collectively under the head of miscellaneous industries.

The amount of wood consumed by the wood industries, and also the amount of wood cut in the region for the year ending June 30, 1903, are shown in the two following tables:

TABLE XXIII.—TIMBER CUT IN NORTHERN NEW HAMPSHIRE, JULY 1, 1902, TO JUNE 30, 1903.

Industry.	Total.	Spruce.	Pine.	Hemlock.	Hardwoods.
	1000 board feet.	*1000 board feet.*	*1000 board feet.*	*1000 board feet.*	*1000 board feet.*
Paper and pulp	105,552	105,552	....	....	....
Lumber	155,570	120,195	17,218	6,679	11,488
Bobbin	6,709	....	....	....	6,709
Shoe peg	3,081	....	....	....	3,081
Crutch	150	....	....	....	150
Miscellaneous	2,500	....	....	....	2,500
Total	273,562	225,747	17,218	6,679	23,928
Per cent	100.0	82.5	6.3	2.4	8.8

TABLE XXIV.—WOOD CONSUMED BY MILLS IN NORTHERN NEW HAMPSHIRE, JULY 1, 1902, TO JUNE 30, 1903.

Industry.	Number of establishments.	Total.	Spruce.	Pine.	Hemlock.	Hardwoods.
		1000 board feet.	*1000 board feet.*	*1000 board feet.*	*1000 board feet.*	*1000 board feet.*
Paper and pulp	6	167,070	167,070	....	....	....
Lumber	65	131,685	98,185	16,128	6,334	10,988
Bobbin	9	6,709	....	....	....	6,709
Shoe peg	3	2,781	....	....	....	2,781
Crutch	4	150	....	....	....	150
Miscellaneous	9	2,500	....	....	....	2,500
Total	96	310,795	265,255	16,128	6,334	28,078
Per cent	....	100.0	85.4	5.2	2.0	7.4

A comparison of these two tables shows that the total amount of wood consumed by the mills in this region exceeds the total cut by over 37 million board feet. Moreover, a large part, over 24 million board feet, of the wood cut goes to outside mills; therefore, the actual excess of wood consumed over the amount received from this region is over 61 million board feet, and constitutes nearly 20 per cent. of the wood consumed in northern New Hampshire. This is explained by the fact that most of the pulp companies are preserving their own supply of timber, preferring to draw upon an outside source, chiefly Canada, and that the demand for wood, especially spruce, is greatly in excess of the supply.

The chief commercial species is spruce, which represents 82.5 per cent. of the total cut of all species. Mixed with spruce is balsam to the amount of about 10 per cent. Chief among other conifers are white pine and hemlock. The principal hardwoods are paper and yellow birch and sugar maple. Practically all species find a market in some form of product, as is shown in the following table:

FIG. 1.—LARGE LANDING ON LOGGING RAILROAD.

FIG. 2.—GRADED LOGGING ROAD, LINCOLN.

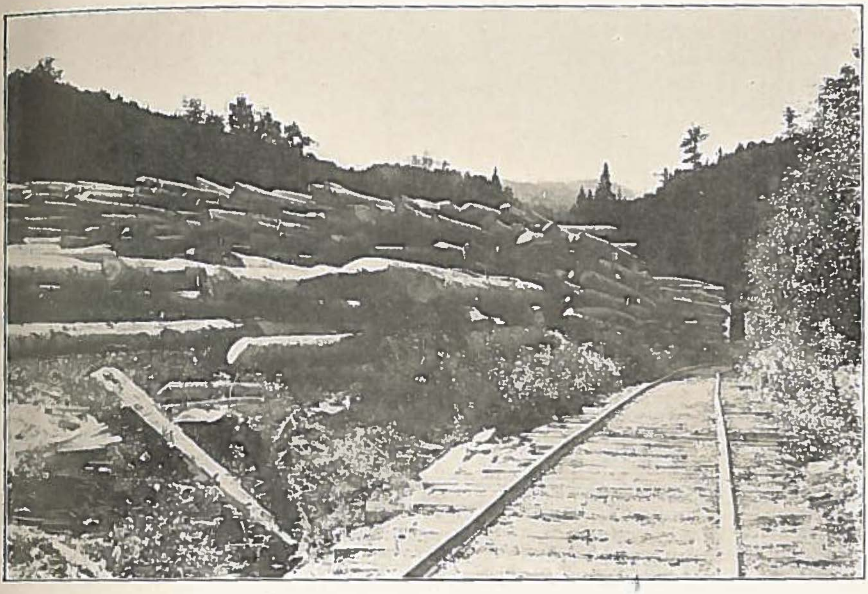


FIG. 1.—SPRUCE LOGS ON SKIDWAY. LIVERMORE.

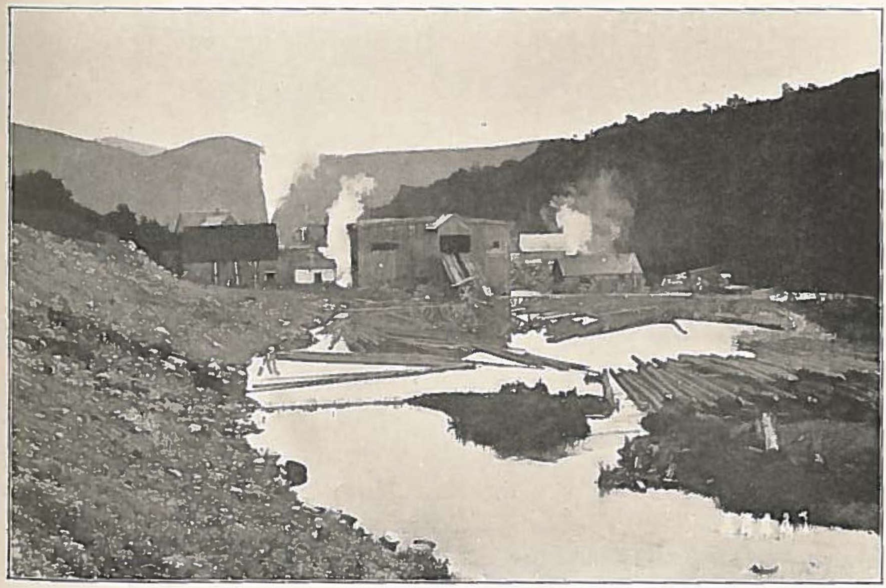


FIG. 2.—MILL AT LIVERMORE.

TABLE XXV.—USES OF THE COMMERCIAL SPECIES.

Spruce.

- Pulp
- Lumber
  - Dimension
  - Plank
  - Boards
  - Flooring
  - Ceiling
  - Clapboards
  - Shingles
  - Lath
  - Box shooks
  - Piano boards
  - Pump tubing

Hemlock.

- Lumber
  - Dimension
  - Plank
  - Boards
  - Flooring
  - Ceiling
  - Shingles
  - Lath
  - Box shooks
- Pulp

Sugar Maple.

- Lumber
  - Dimension
  - Flooring
- Bobbin stock
  - Bobbins
  - Speeders
  - Quills
- Crutches
- Staves
- Dowels
- Chair stock
- Piano backs
- Handles
- Veneer

White Ash.

- Handles
- Picket sticks
- Racket frames
- Rakes
- Staves
- Ladder rounds

Red Pine.

- Lumber (together with white pine)

Balsam.

- Pulp
- Lumber
  - Plank
  - Boards
  - Flooring
  - Ceiling
  - Shingles
  - Lath
  - Box shooks
- Excelsior

Paper Birch.

- Lumber
  - Flooring
  - Dimension
- Bobbin stock
  - Bobbins
  - Speeders
  - Quills
- Shoe pegs
- Spools
- Crutches
- Shoe shanks
- Staves
- Veneer
- Rake teeth
- Dowels
- Chair stock

Beech.

- Rough lumber
- Bobbin stock
  - Bobbins
  - Speeders
  - Quills
- Chair backs
- Staves
- Piano backs
- Dowels

Basswood.

- Excelsior
- Boxes

Tamarack.

- Rough lumber

Red Oak

- Chair stock
- Ladder rounds

White Pine.

- Lumber
  - Dimension
  - Plank
  - Boards
  - Flooring
  - Ceiling
  - Shingles
  - Lath
  - Box shooks
  - Clapboards

Yellow Birch

- Lumber
  - Flooring
  - Dimension
- Bobbin stock
  - Bobbins
  - Speeders
  - Quills
- Spools
- Crutches
- Shoe shanks
- Staves
- Veneer
- Dowels
- Chair stock
- Piano backs

Popple or Aspen.

- Excelsior
- Pulp
- Boxes
- Veneer

Silver Birch.

- Bobbin stock
- Shoe pegs
- Spools

Cedar.

- Shingles

Red Maple.

- Veneer
- Chair stock

Gray Birch.

- Bobbins

"Silver" birch in the above table is merely a local name for second-growth yellow birch. Its chief value is its minimum amount of heartwood, which makes it especially desirable for peg wood. Paper birch is known also as white birch.

Stumpage and log values of the commercial species are shown in Table XXVI, which was compiled from the various mills in the several industries. The values were arranged according to the amount of timber of each species consumed by each mill. The values per cord represent the averages of actual prices paid per cord, and were not deduced from the values per 1,000 board feet.

TABLE XXVI.—AVERAGE VALUE OF THE COMMERCIAL SPECIES.

	On stump.		Delivered at mill.	
	Per 1,000 board feet.	Per cord.	Per 1,000 board feet.	Per cord.
Spruce	$3.77	....	$10.18	$6.43
White pine	3.74	....	8.32	....
Hemlock	2.90	....	7.28	....
Paper birch	2.97	$1.77	10.05	7.46
Yellow birch	2.96	1.68	9.97	6.75
Sugar maple	2.99	1.39	10.06	6.07
Beech	2.90	1.10	8.00	5.95
Popple	....	1.60	....	5.13
White ash	10.00	....	21.57	....
Cedar	3.00	....	9.00	....
Red oak	....	....	12.67	....
Basswood	....	....	....	4.50
Tamarack	....	....	9.00	....
Red maple	....	....	8.00	....

A glance at the figures given for paper and yellow birch and sugar maple in the above table shows a seeming discrepancy in the values per 1,000 board feet and per cord, in that the values per 1,000 board feet for the three species are practically the same, whereas their values per cord differ considerably. The explanation of this is that the lumber industry regards the three species indiscriminately; hence their almost equal values per 1,000 board feet. On the other hand, of those industries which buy by the cord, the peg-wood industry has a decided preference for paper birch and "silver" birch, must have selected stock and so pays for it accordingly. As a matter of fact, the comparative values of these three hardwoods is better shown by the price per cord delivered at the mill.

The data from which the values for beech, popple, ash, cedar, oak, basswood, tamarack and red maple were computed were decidedly meagre, owing to the small amounts of these species used within this region. However, it is believed that their comparative values are fairly well shown by the figures here given.

In 1900 the relative positions of the lumber and paper industries among the various industries in New Hampshire were respectively third and fifth. Cotton and print cloth and boots and shoes were respectively first and second, and woolen goods fourth.

The Paper and Wood Pulp Industry.

Until about 1870 practically all paper was made from rags. Since then, in the making of many grades of paper, especially newspaper, wood fibers have been almost completely substituted. The wood fibers are transformed into pulp by two processes—mechanical and chemical. By the mechanical process, blocks of wood are held against a revolving stone by means of hydraulic pressure and the fibers ground into a pulp. The product is known as ground wood pulp. There are two chief chemical processes—the caustic soda and the bisulphite processes. The latter only concerns this report.

By the "bisulphite" process, the wood is cooked in a solution of sulphurous acid and water under conditions of high temperature and pressure. The product is known as sulphite pulp. The grinding process produces a short fiber, whereas the "sulphite" process produces a relatively long fiber which is practically intact and gives to newspaper the essential quality of strength. The latter process also produces fiber of a better quality, because free from resinous matter found in pulp prepared by grinding. Ground wood and sulphite fiber, the latter forming from 15 to 25 per cent. of the mixture, produce most of the newspaper made in the United States.

The growth of the paper and wood pulp industry in New

Hampshire during the decade between the census years 1890 and 1900 eclipses that of any other state in the Union. During this period the value of its product has multiplied nearly six times and the amount of capital invested nearly seven times.

TABLE XXVII.—THE PAPER AND WOOD PULP INDUSTRY OF NEW HAMPSHIRE.

[From Twelfth Census.]

Year.	Number of establishments.	Average number of wage earners.	Total wages.	Total capital.	Value of product.
1890.	15	520	$220,122	$1,221,491	$1,282,022
1900.	29	2,391	1,036,856	8,163,081	7,244,733

The nearest approach to this increase of any of the leading pulp-producing states is shown in the census figures for Maine, where in the corresponding decade the capital invested and the value of the product have each multiplied more than four times. In 1890 the relative position of New Hampshire among other states in the value of its product and invested capital was respectively thirteenth and fourteenth; in 1900, its position with respect to both product and capital was sixth. The term "establishment" is used as representing a mill or mills owned by one individual, firm or corporation, when located in the same town.

The advance of New Hampshire to one of the leading states in this industry is attributable to the greatly increased use of wood pulp in the manufacture of paper, to its large supply of spruce—the preferred wood for pulp—and to its nearness to supply from Canada and Maine. In 1900 the total cost of all materials used in New Hampshire in the manufacture of paper was nearly $4,000,000; of this, less than $300,000 represents the total outlay for rags, waste paper and manila stock, while over $2,000,000 was paid for wood and wood pulp. Rags and similar materials play a very small part in the manufacture of paper in the state and in the region considered by this report absolutely no part whatever.

The following table shows the quantity and cost of the various materials used in the paper industry in New Hampshire in 1900:

TABLE XXVIII.—MATERIALS USED BY THE PAPER AND PULP MILLS OF NEW HAMPSHIRE IN 1900.

[From Twelfth Census.]

Materials.	Cords.	Tons.	Cost.
Wood:			
Domestic spruce—			
For ground wood	41,035	....	$242,055
For sulphite fiber	68,006	....	413,141
Canadian spruce—			
For ground wood	4,089	....	24,756
For sulphite fiber	83,050	....	474,578
Other pulp wood, for ground wood	720	....	3,430
Total	196,900	....	$1,157,960
Rags, including cotton and flaxwaste and sweepings	....	2,700	61,578
Old or waste paper	....	6,327	121,466
Manila stock, including jute, bagging, rope, waste, threads, etc	....	2,947	64,684
Total	....	11,974	$247,728
Fiber:			
Ground wood pulp purchased	....	21,266	338,316
Soda wood fiber purchased	....	2,396	95,946
Sulphite wood fiber purchased	....	12,123	418,680
Other chemical fiber purchased	....	21	372
Total	....	35,806	$853,314
Chemicals	....	....	459,308
Clay	....	....	52,902
Colors	....	....	24,000
Sizing	....	....	11,421
All other stock	....	....	36,759
Fuel, rent of power and heat, mill supplies, freight, and all other materials	....	....	1,109,952
Total for New Hampshire	196,900	47,780	$3,953,334
Total for United States	1,986,310	1,701,819	70,580,286

The county of Coös is the great paper and pulp producing region in the state. In 1900 it had more than 61 per cent. of the total capital invested, bought over 65 per cent., in value, of the materials used, and yielded, in value, more than 68 per cent. of the products. Four of the six establishments in the region examined are in Coös county.

TABLE XXIX.—TIMBER CUT IN NEW HAMPSHIRE FOR PULP, DURING THE YEAR ENDING JUNE 30, 1903.

Source of supply.	Cords.	Board feet.
Northern New Hampshire	172.020	105,552,000
Cut for mills in northern New Hampshire	138,131	84,934,000
Cut for mills elsewhere in New Hampshire and in Vermont	33,889	20,618,000
All cut for mills outside northern New Hampshire	4,640	3,093,000
Total for New Hampshire	176,660	108,645,000

An important showing of the above table is the comparison possible of the amount of wood cut for pulp in the region considerd by this report with that cut in the rest of the state. Of the total for the whole state, 97.4 per cent. comes from this region, and of the total for this region 80.3 per cent. is consumed by mills located in it. The estimate in board feet is chiefly for a basis of comparison with the amount of wood consumed by the other industries. In the case of some mills, this estimate was not available and had to be deduced from the estimate per cord. This was accomplished by a converting factor, according to the particular log rule used. The Blodgett (115 cubic feet) and the Bangor Rules allow 1⅝ cords per 1,000 board feet, the Scribner Rule, 1 2-3 cords. Obviously, such estimates are only approximately correct, but sufficiently so, nevertheless, for this purpose.

As previously stated, spruce is the chief species used for wood pulp. Balsam to the amount of 10 per cent. is generally allowed and, by some mills, a very little hemlock and popple, the aggregate of which is inconsiderably small. Of the total cut of spruce for pulp in northern New Hampshire, balsam forms 9.1 per cent.; in the rest of the state, from 1 to 5 per cent. The pulp mills owning timberland or buying stumpage as a rule cut balsam along with spruce; but when buying wood delivered at the mill, they want pure spruce and will rarely accept any balsam. One large paper company, which owns perhaps the finest body of timber in the region, cuts absolutely no balsam for pulp. Spruce is especially desirable for wood pulp owing to its long fiber and fredom from pitch. Some of the chief objections to other species are listed below:

Balsam:

Pitch.—Partially eliminated by the chemical process; not eliminated by the mechanical process, and in consequence "pitch" the wire screens of the pulp machines.

Short fiber.—Making a relatively weaker paper.

Hemlock:

Short, brittle fiber.—Working poorly on the pulp cylinders by not "sheeting," or holding together well.

Discoloration (reddish tinge).—Partially eliminated by the chemical process. This sometimes causes the pulp to be mistaken for poorly cooked spruce.

Knotty.—Hard to work.

Popple:

Too soft for newspaper.
Short fiber.
Lack of strength.

The extent of the manufacture of wood pulp in the region considered by this report is shown in the two following tables, which give, besides the output for the year ending June 30, 1903, the amount of wood consumed in producing the output and the sources from which the wood was obtained.

TABLE XXX.—OUTPUT AND CONSUMPTION OF PULP MILLS IN NORTHERN NEW HAMPSHIRE, JULY 1, 1902, TO JUNE 30, 1903.

Number of establishments.	Output.		Wood consumed in producing output.
	Ground wood.	Sulphite fiber.	
	Tons.	*Tons.*	*Cords.*
3	45,175	....	51,693
4	....	125,010	219 911
Total 7	45,175	125,010	271,604

It is to the purpose here to make mention of the new pulp and paper mill now being erected at Berlin by the Berlin Mills Company. The mill is expected to be in operation by June, 1904. Its daily capacity is reported to be 60 tons of sulphite fiber and 125 tons of ground wood pulp, to produce which will require over 225 cords of wood per day.

TABLE XXXI.—WOOD CONSUMED BY PULP MILLS IN NORTHERN NEW HAMPSHIRE, JULY 1, 1902, TO JUNE 30, 1903.

Source of supply.	Cords.	Per cent.
Northern New Hampshire	138,131	50.9
Canada	101,911	37.5
Maine	31,562	11.6
Total	271,604	100.0

According to Table XXX, there are apparently seven establishments, but as a matter of fact there are only six, since one establishment manufactures both kinds of pulp. From this table can be determined the amount of wood pulp produced by one cord of spruce and balsam (the latter not to exceed 10 per cent. of the total), which, in ground wood, is 1,752 pounds; in sulphite fiber, 1,137 pounds.

The interesting feature in Table XXXI is the large amount of wood which comes from Canada—37.5 per cent. of the total used in Northern New Hampshire. The twelfth census reports that of the Canadian wood of all kinds imported for pulp, which forms about one fifth of the entire supply of wood used for pulp in the United States, New Hampshire and New York together use two thirds.

During the last three years the increased use of wood for pulp by the pulp mills throughout the state has been enormous. This is shown in the following table, constructed from Tables XXVIII, XXIX and XXXI.

PLATE XLI.

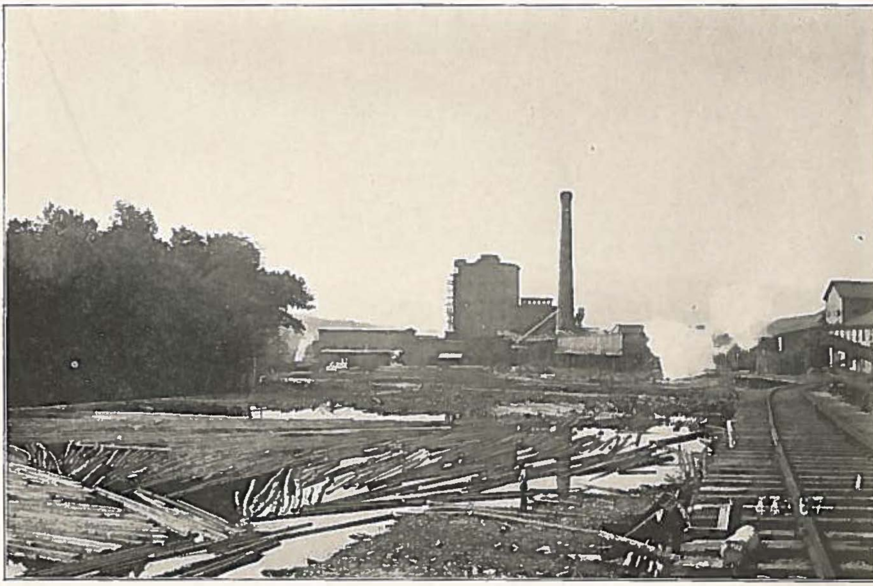


FIG. 1.—PULP AND PAPER MILL AND LOG POND. LINCOLN.

FIG. 2.—INTERIOR OF PULP BLOCKING MILL. LINCOLN.

FIG. 1.—SAWMILL AT LINCOLN.

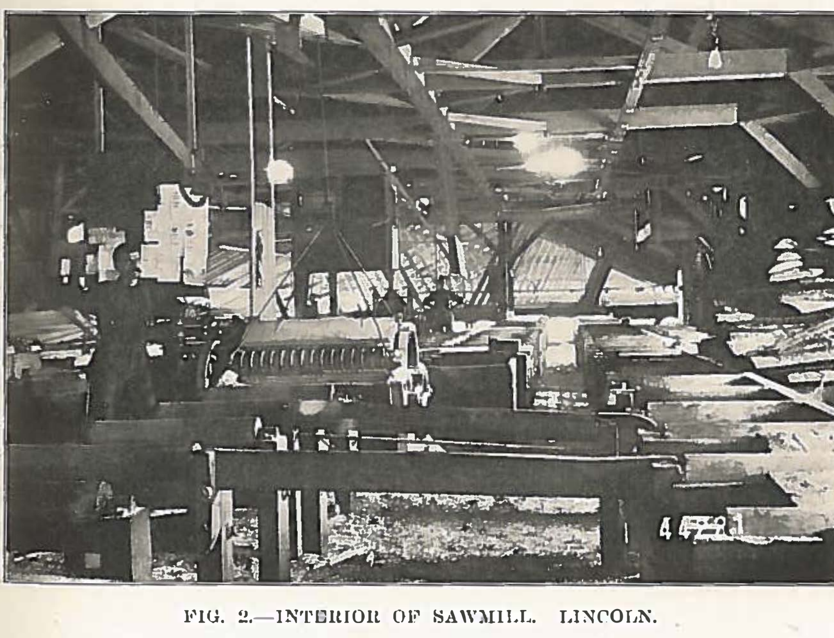


FIG. 2.—INTERIOR OF SAWMILL, LINCOLN.

TABLE XXXII.—DEMAND FOR PULP WOOD IN NEW HAMPSHIRE, 1900 AND 1903.

Source of supply.	1900.	1903.
	Cords.	*Cords.*
New Hampshire	109,761	163,035
Canada	87,139	101,911
Maine	....	31,562
Total	196,900	296,508

The paper mills in northern New Hampshire, included in four establishments, produced during the year ending June 30, 1903, 69,600 tons of paper. These mills use practically all of the ground wood pulp produced in the region, and a very small part, less than 15 per cent., of the sulphite fiber produced there. The bulk of the sulphite fiber goes to other New England paper mills. During the past year the paper mills in the section examined received a small part of their supply of pulp, amounting to about 15,000 tons, from foreign sources—Maine and Canada.

The chief product of the paper mills is newspaper, which finds a market in this country and abroad. A small part of the product includes manila, bag and wall paper.

The chief waste products are ''screenings'' and ''sulphite liquor.'' Screenings consist of the unground and uncooked fibers which fail to pass through the screens in the pulp mills. For the most part this waste is used for fuel. Sulphite liquor is the waste liquor from the sulphite process, for which, according to an eminent authority, there has as yet been evolved no satisfactory application. In this region the liquor is neutralized and allowed to run off into nearby streams.

The combined holdings of timberland of pulp and paper mills in Northern New Hampshire are 488,290 acres. This acreage includes the great bulk of virgin timberland in the region. The policy of the paper companies, with a single exception, is to log their timber conservatively and hold the land for a second growth. That at times they fully disregard conservative logging cannot be denied. That is, for the most part, determined by the situation of the timber, particularly on high, steep slopes, where danger from windfall precludes the hope of leaving even a fair percentage of the original stand. The owners are thoroughly alive to the importance and far-sightedness of a policy of perpetuating their supply of timber, and, as a means to this end, with a view to cutting as little as possible from their own land at present, they are getting a large part of their supply from farmers' woodlots and Canada. This statement with regard to Canada is substantiated by the figures in Table XXXI. An evil of no mean extent, caused indirectly by the paper companies looking for a supply from New Hampshire outside of their own holdings, is the complete and ruthless clearing of small holdings. The farmer is usually the sufferer, who, as a rule poor, will "skin" his land and ship the wood to a pulp mill for any reasonable price.

The question was asked the various pulp mill owners as to the length of time the present supply of spruce might be expected to last, and also as to the substitution of another species for pulp when the supply should have been exhausted. Their replies certainly indicate that they are not anticipating a spruce famine in the near future and that they will not worry over a substitute for spruce until the available supply of spruce in Canada is exhausted.

THE LUMBER INDUSTRY.

The relative position of New Hampshire among the various states as to capital invested and value of product in the lumber industry is respectively 19 and 25, according to the census of 1900. The census includes in the lumber industry its various auxiliary industries also, of which those represented in northern New Hampshire, such as the bobbin, the shoe-peg, etc., are separately described in this report, chiefly for the purpose of showing the relative amounts of wood consumed by each.

The state is completely overshadowed by the Lake states and such states as Pennsylvania, California and Washington. However, it is the most intensively lumbered, per acre of wooded area, of any of the states in the above table. The wooded area of New Hampshire in 1900 was estimated at 3,228,000 acres; the total amount of timber cut for lumber was 570,357,000 board feet; or 177 board feet per acre of wooded area. Wisconsin follows with 175 board feet per acre; Pennsylvania with 163; Ohio with 161; and so on down to Texas, with but 15 board feet cut per acre of wooded area. Obviously, these figures show fairly accurately the extent to which the lumber industry is using the forest resources of a state. From these figures, New Hampshire is certainly using hers at a rapid rate, but the important question is, how nearly the annual cut is offset by the growth in the forest and on cut-over land. Unfortunately no data exist for ascertaining this, but the opinion of many well-informed men in the state is that New Hampshire, as a whole, is producing more timber in yearly growth than is being cut out. Their opinion is based, and correctly, upon the very large number of abandoned fields throughout the state which, 40 to 50 years ago given entirely to agriculture, are now covered with dense and thrifty stands of timber. It may be well to add, however, that this condition of affairs is not so marked in northern New Hampshire as in the rest of the state.

The value of the lumber product in New Hampshire has multiplied nine times in the last half century and has nearly doubled in the decade 1890-1900, as shown in the table below. The decrease in the value of product between 1870 and 1880, and the general decline of the industry in this period, may be explained, in part, by the exodus of many eastern lumbermen to the pineries of the Lake states. An interesting feature of the table is the gradual decrease since 1870 in the number of establishments, which is chiefly due to the concentration of small holdings into a single ownership.

TABLE XXXIII.—THE LUMBER INDUSTRY OF NEW HAMPSHIRE.

[From the Twelfth Census.]

Year.	Number of establishments.	Capital.	Average number of wage earners.	Total wages.	Cost of materials used.*	Value of products.
1850	....	....	....	....	....	$1,099,492
1860	....	....	....	....	....	1,208,629
1870	723	$2,428,193	3,398	$725,304	$2,471,427	4,286,142
1880	680	3,745,790	3,104	548,556	2,272,991	3,842,012
1890	570	7,592,167	5,370	1,600,993	2,607,473	5,641,445
1900	553	11,382,114	4,188	1,654,965	4,927,399	9,218,310

* In 1890 and 1900, for purposes of comparison, "Cost of materials used" includes wages reported under the heads of "Logging" and "Cost of keep of animals."

The lumber industry in the region under consideration is represented at present by 65 sawmills, as shown below, varying in daily capacity from 3,000 to 140,000 board feet, and in yearly output from 25,000 to 42,000,000 board feet.

TABLE XXXIV.—SAWMILLS IN NORTHERN NEW HAMPSHIRE.

Mills with annual output of:	
Less than 100.000 board feet	8
100,000 to 500,000 board feet	27
500.000 to 1,000,000 board feet	9
1,000,000 to 5,000,000 board feet	16
5,000,000 to 10,000,000 board feet	3
25,000,000 board feet and over	2
Portable mills	8
Idle mills	7
Mills outside northern New Hampshire but supplied in part from it	5
Total	65

Coös county contains the greatest number of mills and produces the largest amount of lumber of the three counties in the district. Coös and Grafton contain the largest mills, the average output per mill in each county, for the year ending June 30, 1903, being about two and a half million board feet, while the average in Carroll was about one half million board feet, as shown in the following table. The mills of Coös cut the greatest amount of spruce and hardwoods; Grafton, hemlock; and Carroll, pine. The total amount of spruce sawed is nearly three times the combined product of all other species. Mixed with spruce is balsam to the amount of about four per cent. Practically no mills separate balsam and spruce, the percentage of balsam varying, according to the location of the particular mill, from one to 20 per cent. The mills of Coös saw by far the largest percentage of balsam.

TABLE XXXV.—OUTPUT OF THE SAWMILLS OF NORTHERN NEW HAMPSHIRE, JULY 1, 1902, TO JUNE 30, 1903.

County.	Number of establishments.	Output—1,000 board feet.					Number of shingles.
		Total.	Spruce.	White pine.	Hemlock.	Hardwoods.	
Coös	25	67,300	55,800	4,820	1,825	5,855	9,125,000
Grafton	21	52,965	42,220	3,588	3,289	3,868	1,210,000
Carroll	19	11,370	665	8,220	1,220	1,265	2,065,000
Total	65	131,635	98,185	16,128	6,334	10,988	12,400,000

A very small part of the supply of the mills contained in the above table comes from a source outside of this region, as shown below.

TABLE XXXVI.—LUMBER FROM OUTSIDE SOURCES SAWED IN NORTHERN NEW HAMPSHIRE.

Spruce	2,800,000	board feet.
White pine	1,025,000	"
Hemlock	200,000	"
Hardwoods	875,000	"
Total	3,900,000	"

Practically all the above comes from Vermont and goes to mills in Coös county. A large amount of the timber cut in northern New Hampshire goes to outside mills, as shown below.

TABLE XXXVII.—TIMBER CUT FOR LUMBER IN NORTHERN NEW HAMPSHIRE.

Mills.	Per cent.	Total.	Spruce.	White pine.	Hem-lock.	Hard-woods.
		1,000 board feet.	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*
Within northern New Hampshire..........	82.1	127,785	95,885	15,103	6,184	10,618
Outside northern New Hampshire....	17.9	27,885	24,310	2,110	545	870
Total..............	100.0	155,570	120,195	17,218	6,679	11,488

Of the 65 mills in this region, 52 manufacture spruce lumber; 40 manufacture pine; 35, hemlock; and 39 hardwoods. Logs are transported to three mills by drive, to eight mills by railroad, to 54 mills by team.

The bulk of the logs are scaled by the Blodgett or New Hampshire Rule, a caliper rule. Fifty-three mills use this rule; six use the Bangor Rule; four, the Scribner Rule; one scales by the stacked cord and one relies only on the mill survey. Blodgett's is the legal rule of the state. It is based upon a stick of timber 16 inches in diameter and 12 inches in length, which, by the statutes of the state, is made equivalent to one cubic foot, 100 cubic feet being equivalent to 1,000 board feet. As a matter of fact, however, 115 cubic feet are allowed per 1,000 board feet, though in large operations this must be specified in the contract. The consensus of opinion is that Blodgett's is a very fair rule, fair alike for buyer and seller; that while the actual amount of lumber sawed from large logs will overrun the scale, that from small logs will fall short of the scale, the one case offsetting the other. For the most part, the log constitutes the full length of the tree, taken to six inches at the top, and is scaled according to its middle diameter.

Ninety per cent. of the mills using spruce manufacture dimension timber and this is the chief product of the lumber industry. Practically all goes to Boston, where the bulk sold in 1903 at $19 per 1,000 board feet, which includes a freight rate of $2 to $3 per thousand. Hemlock is manufactured chiefly into dimension stuff; pine, mostly second growth, into rough lumber for box-boards, and hardwoods into flooring. Practically all the lumber is air dried. Of the 65 mills, 25, or about 40 per cent., manufacture shingles, chiefly pine, spruce, hemlock and balsam. Comparatively few mills do any custom sawing, the average charge for which, per 1,000 board feet, is, for softwoods, $2.75; for hardwoods, $3.25.

With few exceptions, the mills are of an old, unimproved type, exhibiting a general lack of time and labor-saving devices. Within the past ten years only five mills have seen fit to install any modern machinery. Thirty-five are operated by steam power, 30 by water power. The length of time each runs varies from one to two months in the spring to the full year. Only seven mills operate during the entire twelve months; more than 50 per cent. of the mills, less than six months.

A matter of comparatively recent importance to the White Mountain lumber mill, at least, is the utilization of waste products. Formerly what was in excess over that used for fuel by the steam mills was conveyed to a waste pile and burned. Now, however, the greater part of this, which is made up of edgings, trimmings, etc., is sold per cord locally or shipped even as far as Boston. At the mills it brings now $1.50 to $1.75 per cord. One large company, which operates both a lumber and a pulp mill, has ceased manufacturing laths, now using the entire barked slab for pulpwood. Sawdust, if used at all, is used chiefly as fuel, but, by many of the water mills which have no way of utilizing it, it is allowed to float down the stream.

Thirty-four mills own timberland, in the aggregate about 380,000 acres, over 259,000 acres of which is included also in the acreage of timberland owned by pulp and paper companies. Of the above 34 mills, 17, or 50 per cent., lumber conservatively. This consists chiefly in cutting under a simple selective system, taking out trees from eight to 12 inches and over in diameter, except on steep slopes, which are cut clean; for, owing to danger from wind, etc., if enough of the stand is cut to make the operation pay, all might as well be cut. Of these 17 mills, 12 will hold their land indefinitely for future cuttings; five will sell after having cut their land so as to leave at least a salable stand. Fortunately for the region, the portable sawmills are in a very small minority. Here, as elsewhere, the average portable mill moves from woodlot to woodlot, making a clean sweep in practically every case. Its proximity to the supply and in consequence the relatively low cost of hauling the supply to the mill, are the chief factors in making this profitable.

The tax rate on timberlands is generally low, and has practically no bearing upon conservative lumbering.

As for any precaution against fire in the dry season, only five, or less than 15 per cent. of the 34 mills owning timberland, seem to think it worth while. The land of these five mills is traversed or skirted by some railroad which makes every precaution imperative. One of the chief arguments against conservative lumbering is the liability of cut-over land to fire. Lumbermen argue, Why not cut everything now, since it is only a matter of time when fire will run over the land and burn what remains? In not a few cases last spring, when fire ran over thousands of acres in the mountains, this argument was substantiated. On the whole, however, there is a general willingness among timberland owners to stand a reasonable part of the outlay for any efficient fire system by either the state or the town, and a desire to see such a system put in operation.

The demand for softwood saw logs is far in excess of the supply, the decrease in which is reflected in the general lack of improvement in the sawmills. The greatly diminished supply of large spruce timber is fairly well shown by the decrease in the manufacture of clapboards. This class of lumber is made from four-foot butts, which must be at least 16 inches in diameter at the small end. In compara-

FIG. 1.—BLOCKING MILL FOR PULPWOOD BEFORE LOADING IT ON CARS. MT. BOWMAN.

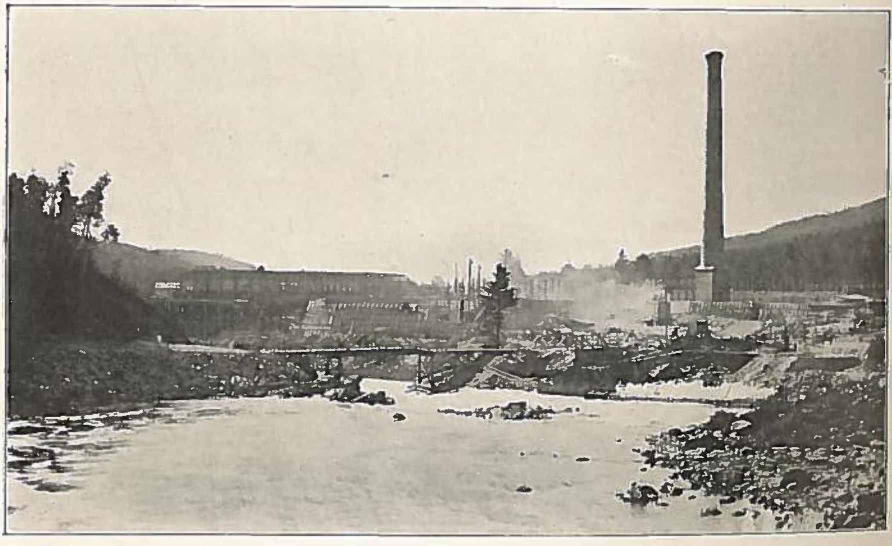


FIG. 2.—FOUNDATION OF THE NEW PAPER AND PULP MILL ON THE ANDROSCOGGIN RIVER BELOW BERLIN.

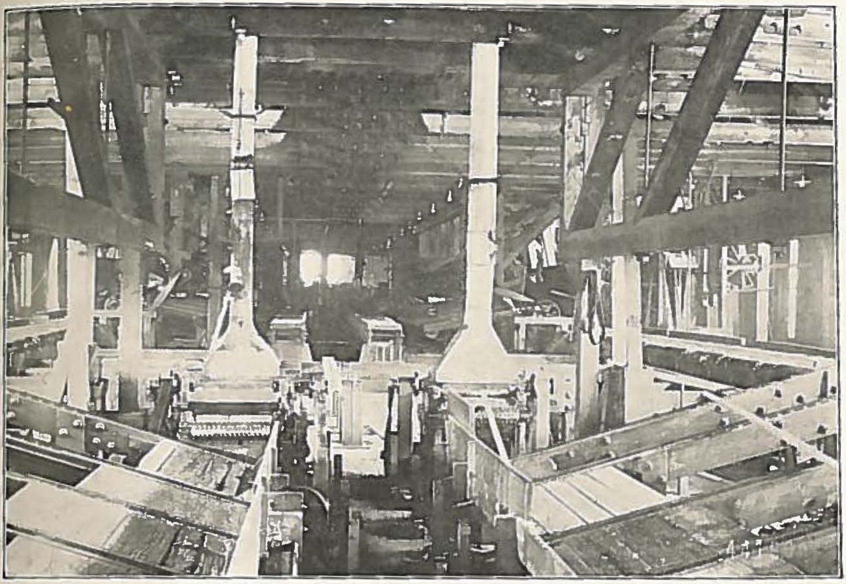


FIG. 1.—INTERIOR OF SAWMILL. BERLIN FALLS.

FIG. 2.—INTERIOR OF PAPER MILL. LINCOLN.

tively recent years nearly every mill in the region made clapboards; now only nine mills of the 65 make them. It is perfectly clear that the increased use of spruce for pulp is influential nowadays in decreasing the available spruce for lumber. The growing tendency on the part of lumbermen is to sell out their entire land holdings to pulp companies.

The Bobbin Industry.

The bobbin industry in northern New Hampshire is represented by nine mills, requiring a total of 10,845 cords of wood to produce about 47 million bobbins, speeders, quills and rolls, all of which are included under the single head of bobbins. The manufactured product is rough bobbins, as distinguished from the final product subsequently turned out by the various finishing mills. There is no mill in the region which produces the finished bobbin. The species used are paper birch, yellow birch, sugar maple, beech and gray birch.

TABLE XXXVIII.—THE BOBBIN INDUSTRY OF NORTHERN NEW HAMPSHIRE, JULY 1, 1902, TO JUNE 30, 1903.

Number of establishments	9.
Average period of operation	9 months.
Total output	46,975,000 bobbins.
Wood consumed in producing output	10,845 cords.
Average price per cord, delivered at mill	$6.15.

Of the 10,845 cords consumed in this industry for the year ending June 30, 1903, 700 came from Canada and 500 from Vermont and from New Hampshire outside of the region considered by this report. Of the nine mills listed but two own timberland, the total acreage of which is estimated at 25,000 acres. In each case it is the intention of the owner to hold the land indefinitely for a second cutting. Cordwood sticks for bobbins must be at least five inches, and for some buyers six inches, in diameter at the small end, which ordinarily means the removal of trees with a stem not less than five or six inches at the top.

Paper and yellow birch and sugar maple are used indiscriminately in the manufacture of bobbins. A large amount of beech is run into speeders chiefly, and gray birch is used to a very limited extent, since it is accepted by only one mill. The maximum price paid for bobbin wood during the past year was $8 per cord for extra quality paper birch logs with a minimum diameter of nine inches at the top end.

The bulk of bobbin wood is scaled, per cord, in the log by the Fabian Caliper Rule. This rule is based upon a log 12 feet long with a middle diameter of 12 inches, yielding 12 cubic feet, 128 cubic feet being allowed to the cord. The Blodgett and Bangor Rules are also used.

The bulk of the product of these mills goes to the U. S. Bobbin & Shuttle Company of Providence, Rhode Island, from which point it is distributed to their various finishing mills.

THE SHOE PEG INDUSTRY.

But three peg mills are operating within the area included by this report, all located in the southern part of the region. Paper birch and yellow birch are the species used.

TABLE XXXIX.—THE SHOE-PEG INDUSTRY OF NORTHERN NEW HAMPSHIRE, JULY 1, 1902, TO JUNE 30, 1903.

Number of establishments	3.
Average period of operation	10.5 months.
Total output of pegs	175,300 bushels.
Wood consumed in producing output	3,506 cords.
Average price per cord, delivered at mill	$8.71.

A comparison of the total output and the total number of cords consumed shows that one cord will produce on the average 50 bushels of pegs. Of the two species used, paper birch forms at least 85 per cent., from the highest quality of which the best pegs are manufactured. Yellow birch here is the so-called silver birch, or second-growth yellow birch, which contains a minimum amount of heartwood.

Besides the total number of cords given in the above table, as used by the mills of northern New Hampshire, 450 cords go to outside mills, making the total cut of peg wood in the region 3,956 cords.

Pegwood is bought by the stacked cord, usually in four-foot lengths, the following specifications being strictly adhered to:

> Must be straight and free from knots, bunches, black streak and dead wood.
>
> Must be not less than six, or, as in the case of one mill, seven inches in diameter at the smallest place.
>
> Redheart to be not over one-third of the diameter, and in the center of the stick.

Heartwood is entirely discarded and forms the bulk of the waste. Owing to the non-availability of pegwood, due rather to the unwillingness of neighboring timberland owners to cut than to the scarcity of the species, it has become necessary for at least two of the mills to suspend operations, in some instances for several months at a time.

The chief market for the product of these mills is Europe, Germany being the principal distributing point.

The Crutch Industry.

The crutch industry in this region is represented by four mills, all in the township of Rumney. The species used are sugar maple, yellow birch and paper birch

TABLE XL.—THE CRUTCH INDUSTRY OF NORTHERN NEW HAMPSHIRE, JULY 1, 1902, TO JUNE 30, 1903.

Number of establishments	4.
Average period of operation	12 months.
Total output of crutches	6,400 dozen pairs.
Wood consumed in producing output	150,000 board feet.
Average price per 1,000 board feet, delivered at mill	$11.97.

The above table shows that 150,000 board feet will produce 6,400 dozen pairs of crutches, which is about 43 dozen pairs to the 1,000 board feet. In addition to the indigenous species used in this industry, two tropical hardwoods, rosewood and lancewood, are used, though to a very limited extent. The best crutches are made from the highest grade of sugar maple.

The crutches manufactured at these mills find a market in all parts of the United States, from the Atlantic to the Pacific. A limited number go to Canada and Germany.

Miscellaneous Industries.

These industries include the manufacture of excelsior, spools, rakes, handles, chairs, racket frames, picket stakes, wood shanks, veneer and ladder rounds. The species used are popple, paper and yellow birch, white ash, sugar and red maple, beech, red oak, balsam and basswood.

TABLE XLI.—THE MISCELLANEOUS INDUSTRIES OF NORTHERN NEW HAMPSHIRE, JULY 1, 1902, TO JUNE 30, 1903.

Number of establishments	9.
Average period of operation	10.7 months.
Wood consumed:	
Board feet	483,000.
Cords	2,650.

The stock for excelsior, spools, wood shanks and veneer is bought by the cord. The total number of cords consumed is 2,650, as shown above, which equals approximately 2,060,000 board feet. This, added to the number of board feet consumed in the manufacture of chairs, rakes, etc., makes a total of about two and a half million board feet used by miscellaneous industries, more than 50 per cent. of which is manufactured into excelsior.

CONCLUSIONS AND RECOMMENDATIONS.

The study made by the Bureau of Forestry shows conclusively that the forest plays a most important part in northern New Hampshire, and that a definite change in present policy and methods is necessary. Northern New Hampshire contains large areas of land, valueless for other purposes, upon which a forest of some kind will continue to grow even under the most careless methods, but the highest value of these lands can be realized only under conservative forest management.

It is estimated that visitors to the mountains leave annually in New Hampshire approximately eight million dollars, or about one half of the value of the total annual lumber production of the state. It is true that lumbering does not permanently affect the attractiveness of the mountain region as a summer resort, since cut-over lands, if protected from fire, soon become almost as attractive to the eye as virgin forest. But the very existence of the region as a summer resort depends directly upon the protection of the forest from fire, which absolutely destroys the beauty of the landscape. Conservative lumbering will also show a decided advantage over present methods in preserving natural forest conditions. The virgin forest still remaining in the White Mountains is practically confined to two localities: one, the northern slope of the Presidential Range, and the other that of Waterville. Clear cutting of this virgin growth will undoubtedly result in the slackening of the summer trade for a time in these localities, and it would appear to be to the interest of the state that they should be preserved intact, or at least lumbered conservatively.

Forest Fires.—At present fires are the greatest danger threatening the forests of New Hampshire and their dependent industries. The fact that the land burned has for the most part been cut over decreases but little the actual damage done. The area burned over in 1903 was 84,255 acres. Legislation for the organization of an adequate fire service and active and faithful work on the ground are absolutely necessary before forest fires in New Hampshire can be stopped.

It is strongly recommended that the governor be given power to appoint a state forester. The state forester should be a professional forester and should act as chief fire warden. The governor should also be given power to appoint the necessary district fire wardens. The state forester should receive a suitable annual salary and all actual and necessary living and traveling expenses while in the field. The district fire wardens should receive a monthly salary and all actual and necessary living and traveling expenses while in the field during periods in which there is danger from forest fires, but should hold office throughout the year. It should be the duty of the state forester to divide into districts that portion of the state in need of protection from forest fires and to recommend for appointment by the governor a district fire warden to take charge of each district, and the removal of district fire wardens not satisfactorily fulfilling their duties. During seasons of danger the state forester should inspect the work of the district fire wardens on the ground. He should prepare and furnish to the district fire wardens fire notices to be posted along all roads and trails in the forest. He should be given power to designate areas upon which, between April 15 and June 10, camping or fishing would not be permitted without a written permit from the district fire warden. He should approve for payment all accounts for salary, expenses and the employment of labor, rendered by district fire wardens.

The district wardens should report to the state forester, should have the power to arrest without warrant for violation of the law and should be authorized to call out for fire patrol or fire fighting any able-bodied male resident of the district in which fire occurs or which is threatened by fire. The district wardens should issue permits for the burning of brush, prohibited except under permits, and for camping or fishing on wild land between April 15 and June 10, and, subject to the approval of the forester, should organize fire patrols whenever necessary within their districts. They should see that their districts are properly provided with fire notices and should secure evidence in case of fire. It should be their duty to see that fires are actually prevented, not merely to report them, and their retention in office should be determined by their efficiency in accomplishing this. Men employed to patrol a district or fight fire should be paid by the hour. Delay in making these payments should be carefully avoided.

Conservative Lumbering.—There are approximately 1,684,000 acres of forest land in the region examined, of which only 200,000 are virgin forest. The northern half of the state contains about 4,760 million feet board measure of softwoods. The lumbering now going on in northern New Hampshire is chiefly by large pulp and lumber companies who intend to hold their lands for a second crop. To this end, both a definite forest policy and the application of conservative methods in lumbering are necessary. The employment of trained foresters by these large companies is highly desirable. They should make the study on the ground necessary to determine the best methods of conservative lumbering and they should put those methods into effect. It should be clearly understood that no general instructions can be given which will cover the varying forest problems. The details must be worked out on the ground. The principal sources of waste at present are in cutting high stumps, in leaving good lumber in the tops, in leaving logs and lodged trees in the woods, in the failure to utilize wind-thrown and dead timber which is still merchantable, in leaving standing merchantable trees which are sure to be wind-thrown, in the failure to leave seed trees in favorable localities and in the lack of protection of young growth in lumbering operations.

A considerable area of the state is occupied by farm woodlots. Many small mill owners draw their timber from second-growth woodlots and there is a growing movement on the part of lumbermen toward the purchase of tracts of second growth. These woodlots offer for the most part an excellent opportunity for the practice of forestry with profit. A thrifty woodlot is a most valuable adjunct to the farm. The labor required to keep it in good condition involves no further outlay than a few days' work each year. The returns in firewood, fence posts and material for other uses pay many times the cost of growing it.

Forest Planting.—Forest planting upon wholly denuded lands or to supplement incomplete natural reproduction is already profitable in New Hampshire, when land can be protected from fire. The best species for planting are white pine, Norway pine and Norway spruce. The white and Norway pine are adapted to the sandy soils, the Norway spruce to the loamy soils. The latter is preferable to the red spruce because it grows more rapidly, makes a larger tree and yields the same quality of timber. At least 1,200 trees should be planted to the acre, which makes a spacing of about six feet each way. The cost of planting per acre, including cost of plants, should not exceed eight dollars, when the plants are grown from seed or purchased at cost.

It is recommended that the state establish and maintain a forest nursery under the direction of the state forester, and distribute seedlings and forest tree seeds at cost to farmers and others who may desire to plant. By offering encouragement in this way large areas of waste land suitable only for forest can be rendered productive.

A Forest Reserve.—Cut-over lands in the mountain region should be acquired for reserve purposes without delay. This is a measure of great importance. Such land can at present be bought for from $1 to $3 per acre and its value under efficient fire protection will increase rapidly. Its purchase is a better business venture than that of virgin timberland under present prices, in view of the possibility of waiting a comparatively long time for returns under public ownership.

A State Forester.—As recommended, the state chief fire warden should be a trained forester. It should be his duty to establish and maintain a state forest nursery for the distribution, at cost, of plants and seeds to farmers and lumbermen, to assist landowners in forest planting and in the conservative management of their forest lands, to lecture at public meetings and to publish and circulate information regarding state forest lands and forest problems.

SHRUBS AND SMALL TREES IN NORTHERN NEW HAMPSHIRE.

Striped maple	*Acer pennsylvanicum.*
Mountain maple	*Acer spicatum.*
Speckled alder	*Alnus incana.*
Mountain alder	*Alnus alnobetula.*
Juneberry	*Amelanchier canadensis.*
Shadbush	*Amelanchier botryapium.*
Oblong fruited juneberry	*Amelanchier oligocarpa.*
Red chokeberry	*Aronia arbutifolia.*
Black chokeberry	*Aronia nigra.*
Swamp pink	*Azalea viscosa.*
Scrub birch	*Betula grandulosa.*
Scrub paper birch	*Betula papyrifera minor.*
Moss plant (Alpine)	*Cassiope hypnoides.*
Alpine azalea	*Chamaecistus procumbens.*
Leather leaf	*Chamaedaphne calyculata.*
Creeping snowberry	*Chiogenes hispidula.*
Sweet fern	*Comptonia peregrina.*
Round-leaved dogwood	*Cornus circinata.*
Silky cornel	*Cornus amomum.*
Red-osier dogwood	*Cornus stolonifera.*
Alternate-leaved dogwood	*Cornus alternifolia.*
Scarlet haw	*Crataegus coccinea.*
Diapensia (Alpine)	*Diapensia lapponica.*
Bush honeysuckle	*Diervilla diervilla.*
Creeping wintergreen	*Gaultheria procumbens.*

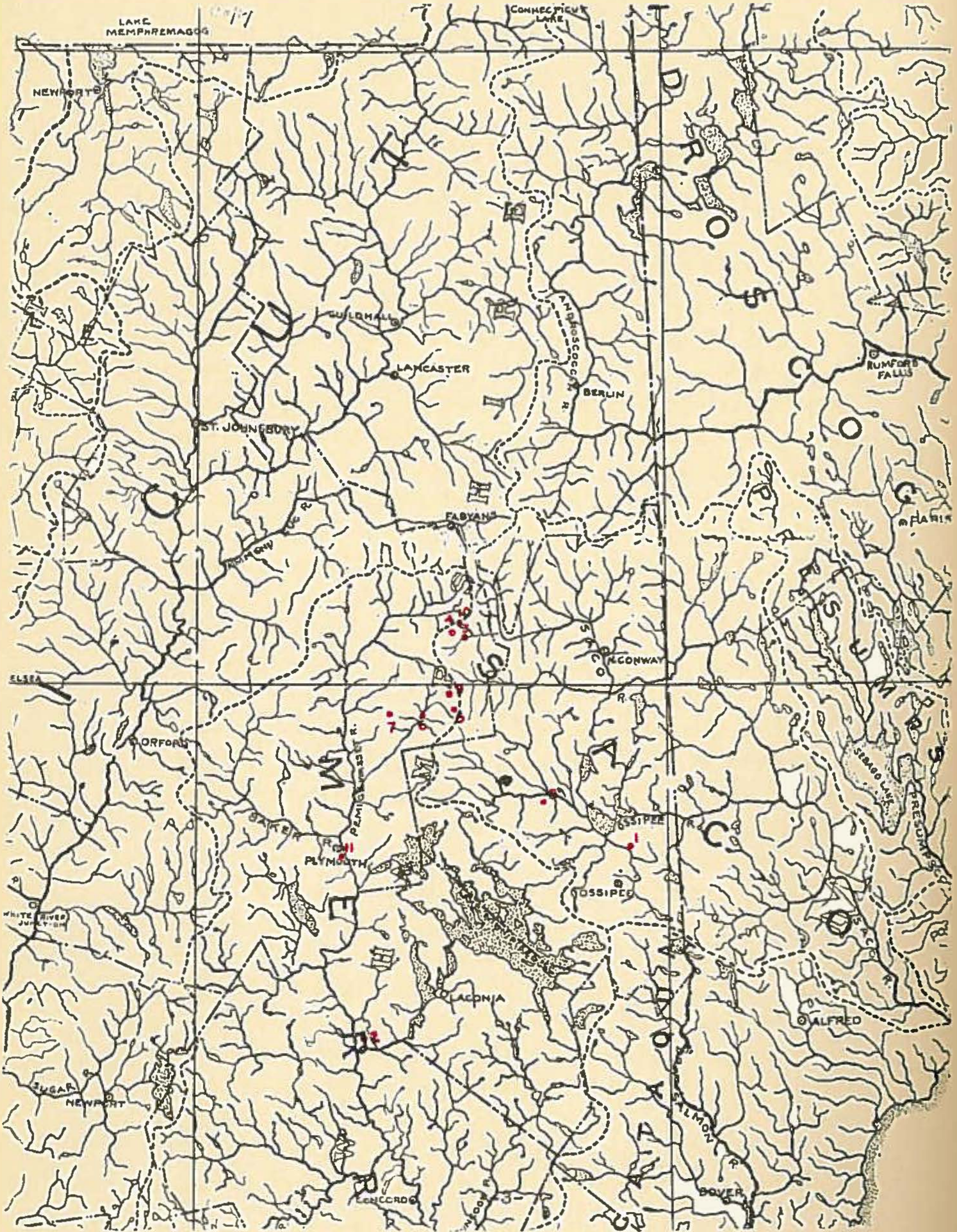
Witch hazel	*Hamamelis virginiana.*
Common juniper	*Juniperus communis.*
Swamp laurel	*Kalmia glauca.*
Sheep laurel	*Kalmia angustifolia.*
Labrador tea	*Ledum groenlandicum.*
American fly honeysuckle	*Lonicera ciliata.*
Sweet gale	*Myrica gale.*
Mountain holly	*Nemopanthes fascicularis.*
Ironwood	*Ostrya virginiana.*
Mountain heath	*Phyllodoce coerulea.*
Choke cherry	*Prunus virginiana.*
Mountain ash	*Pyrus americana.*
Scrub oak	*Quercus nana.*
Rhodora	*Rhodora canadensis.*
Lapland rose bay	*Rhododendron lapponicum.*
Staghorn sumach	*Rhus hirta.*
Dwarf sumach	*Rhus copallina.*
Poison sumach	*Rhus vernix.*
Swamp gooseberry	*Ribes lacustre.*
Fetid currant	*Ribes prostratum.*
Northern gooseberry	*Ribes oxyacanthoides.*
Sweetbrier	*Rosa rubiginosa.*
Northeastern rose	*Rosa nitida.*
Purple flowering raspberry	*Rubus odoratus.*
Dwarf raspberry	*Rubus triflorus.*
Red raspberry	*Rubus strigosus.*
Highbush blackberry	*Rubus villosus.*
Millspaugh's blackberry	*Rubus millspaughii.*
Running swamp blackberry	*Rubus hispidus.*
Bebb's willow	*Salix bebbiana.*
Crack willow	*Salix fragilis.*
Silver willow	*Salix argyrocarpa.*
Balsam willow	*Salix balsamifera.*
Shining willow	*Salix lucida.*
Bearberry willow	*Salix uva-ursi.*
Tea-leaved willow	*Salix phylicifolia.*
American elder	*Sambucus canadensis.*
Red-berried elder	*Sambucus pubens.*
Meadow sweet	*Spiraea salicifolia.*
Steeple bush	*Spiraea tomentosa.*
American yew (ground hemlock)	*Taxus minor.*
Dwarf blueberry	*Vaccinium pennsylvanicum var. angustifolium.*

Canada blueberry...........*Vaccinium canadense.*
Dwarf bildberry.............*Vaccinium caespitosum.*
Mountain cranberry.........*Vaccinium vitis-idaea.*
Low blueberry..............*Vaccinium vacillans.*
Great bildberry.............*Vaccinium uliginosum.*
Hobble bush................*Viburnum alnifolium.*
Withe-rod ....*Viburnum cassinoides.*
Maple-leaved arrow-wood....*Viburnum acerifolium.*
Few-flowered cranberry tree.*Viburnum pauciflorum.*
Northern fox grape..........*Vitis labrusca.*
Riverside grape.............*Vitis vulpina.*
Summer grape..............*Vitis aestivalis.*
Privet andromeda...........*Xolisma ligustrina.*

HYDROGRAPHY OF THE WHITE MOUNTAIN REGION.

BY

N. C. GROVER AND H. K. BARROWS.



LAKE MEMPHREMAGOG
CONNECTICUT LAKE
NEWPORT
GUILDHALL
LANCASTER
BERLIN
ANDROSCOGGIN R.
RUMFORD FALLS
ST. JOHNSBURY
FABYANS
PARIS
N. CONWAY
SACO
ORFORD
PEMIGEWASSET R.
BAKER R.
PLYMOUTH
OSSIPEE R.
OSSIPEE
SEBAGO LAKE
PRESUMPSCOT
WHITE RIVER JUNCTION
LACONIA
ALFRED
SUGAR
NEWPORT
SALMON R.
CONCORD
DOVER

HYDROGRAPHY OF THE WHITE MOUNTAIN REGION.

The principal interest in the hydrography of the White Mountain region arises from the fact that it is a collecting basin for four large rivers of New England, viz., Connecticut, Merrimack, Saco and Androscoggin, all of which are extensively used for water power. The brooks and small rivers, which drain this mountainous district, are not of sufficient size to be in themselves of great importance for power purposes, although a few small lumber mills have been and are still located on their banks. Their slopes are invariably steep and many excellent sites for dams are available, but the small amount of water flowing at low stages, together with the considerable distance to large cities, render them of comparatively little value.

Their principal importance arises then from their effect on the flow of the large rivers to which they are tributary, and the value of these larger rivers to the several states of New England depends on the maintenance of their waters in undiminished quantities.

Androscoggin and Merrimack Rivers stand out preëminently as water power streams, being of medium size and having their great fall concentrated at a few localities where in the natural development of the country manufacturing towns of importance have been built. The Rangeley Lakes in the upper basin of the Androscoggin serve as natural regulators of its flow. On these lakes the storage of freshet waters has been largely increased by the construction of dams; and the release of these waters during periods of drought serves to increase the low water flow of the river to a quantity far above the natural amount. Likewise, Winnipesaukee Lake, on which the natural control of surplus waters has also been largely increased by dams, serves as a regulator of the flow of the Merrimack. These storage basins are not, however, so located that they completely regulate the freshet flows from their respective river basins. The water runs from large areas without other control than that offered by nature. Moreover, Saco and Connecticut Rivers have no extensive lake surfaces within their basins and consequently no great amount of artificial storage has been used to control freshet and augment low water flow.

There is a well founded popular belief that forests act naturally as great regulators of rivers, and one has only to observe and compare conditions within and without their borders in springtime to convince himself that their influence on snow storage and consequently on spring freshets is very material. The magnitude of this effect and its value as a regulator of flow of streams as well as the effect of forests on the control of water, which falls as rain, is still uncertain.

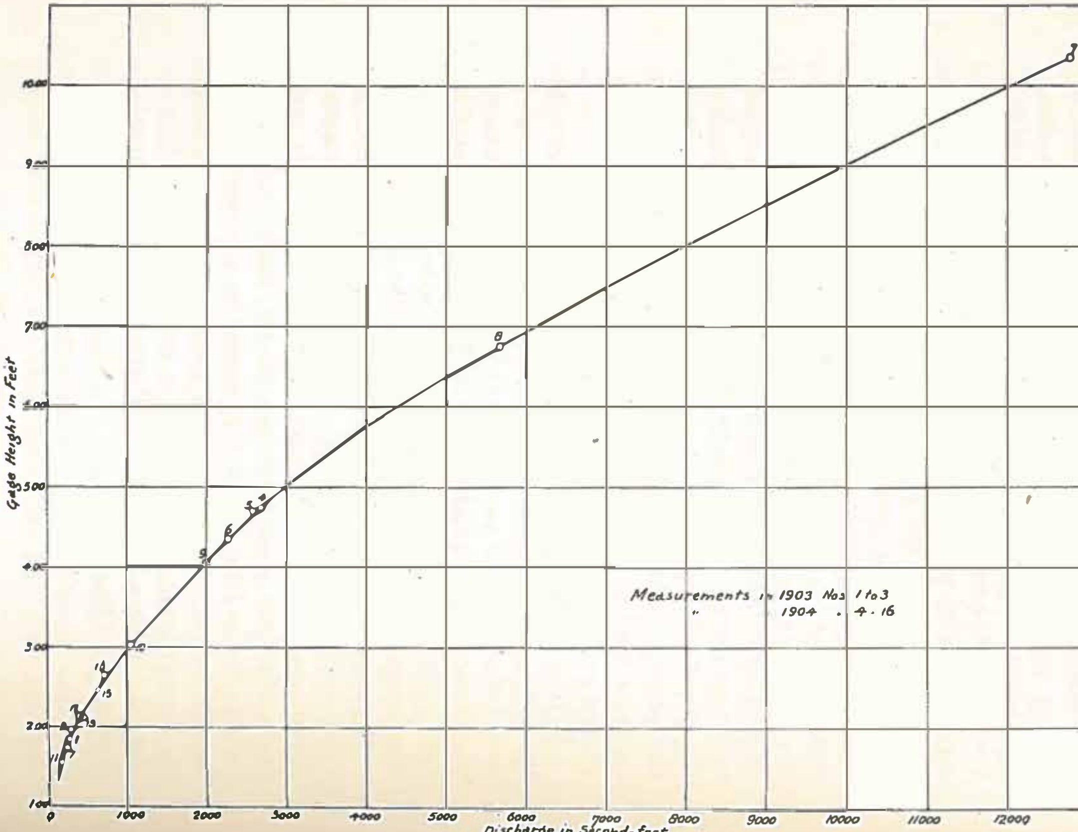
Under these conditions and with large interests at stake on the several rivers, the last state Legislature made a special appropriation for the investigations of forest conditions in New Hampshire and the United States Geological Survey has been asked to assist by studying the effect of deforestation upon the streams. In making this investigation the method for determining the daily flow of the rivers has been that usually followed by the Survey and which is outlined below. A gage for observing the stage of the river is established at a bridge or other place where the record of flow is to be made. This gage is a vertical staff or some device by which the height of water may be observed and is read, usually twice each day, by a person living near by. The average of the gage readings in any day is used as the mean gage height for that day.

At various stages of the river the station is visited by one of the hydrographers of the Survey, who measures the amount of water flowing by means of a current meter, which is primarily an instrument for measuring the velocity of moving water. The essential part of this meter is a wheel with vanes, which may be shaped like those of a windmill or a screw or with cups like those of an anemometer, the necessary qualification being that moving water shall readily cause the wheel of the meter to turn. The type generally used by the U. S. Geological Survey is known as the Price meter and is described in detail in *Water Supply and Irrigation*, Paper No. 94, published by the U. S. Geological Survey. Each meter has been rated before use. This is done by moving it through still water at various observed speeds to determine the relation between the velocity with which the meter moves through the water and the revolutions of the wheel. This relation having been determined, the meter is used in running water, the revolutions per unit of time noted and the velocity of water computed.

At the time that observations for velocity are made with the meter, soundings are taken and from these the area of cross section of each portion of the water is computed; each partial area multiplied by the velocity observed in that area gives a partial discharge. The sum of the partial discharges gives the total discharge for the stream.

Measurements of flow are made, as stated above, at various stages of the river. When several measurements, covering a considerable range of gage height, have been made, they are plotted on co-ordinate paper with gage heights for ordinates and discharges for abscissas, and a smooth curve, called the rating curve, is drawn through the several points. The curve so constructed for the station on Pemigewasset River at Plymouth, New Hampshire, is shown on Plate I.

PLATE I.



Rating Curve
Pemigewasset River at Plymouth N.H.

From the rating curve for any station is made its rating table, which gives the discharge for any gage height. The rating table for the curve shown in Plate I is given on page 174. The use of the rating curve and its corresponding rating table is based on the assumption that for any given gage height the quantity of water flowing past the gage is always the same. As long as conditions above and below the gage for some distance, and at the gage, remain substantially constant, this assumption will be a correct one. This means, then, that the river bed and banks must be of a permanent nature—rocky or of firm gravel—in order that at times of floods, when the current is very swift, there will not be changes of any consequence in the width, depth and character of the channel. During the winter, when, in this latitude, the rivers are frozen over for several months, the conditions of flow are different from those in summer; consequently the regular rating curve cannot be used but a new curve must be developed by means of current meter measurements made through holes cut in the ice. No ice measurements of this kind have been made at any of the White Mountain gaging stations as yet, although the reading of gage heights at these stations has been continued through the winter.

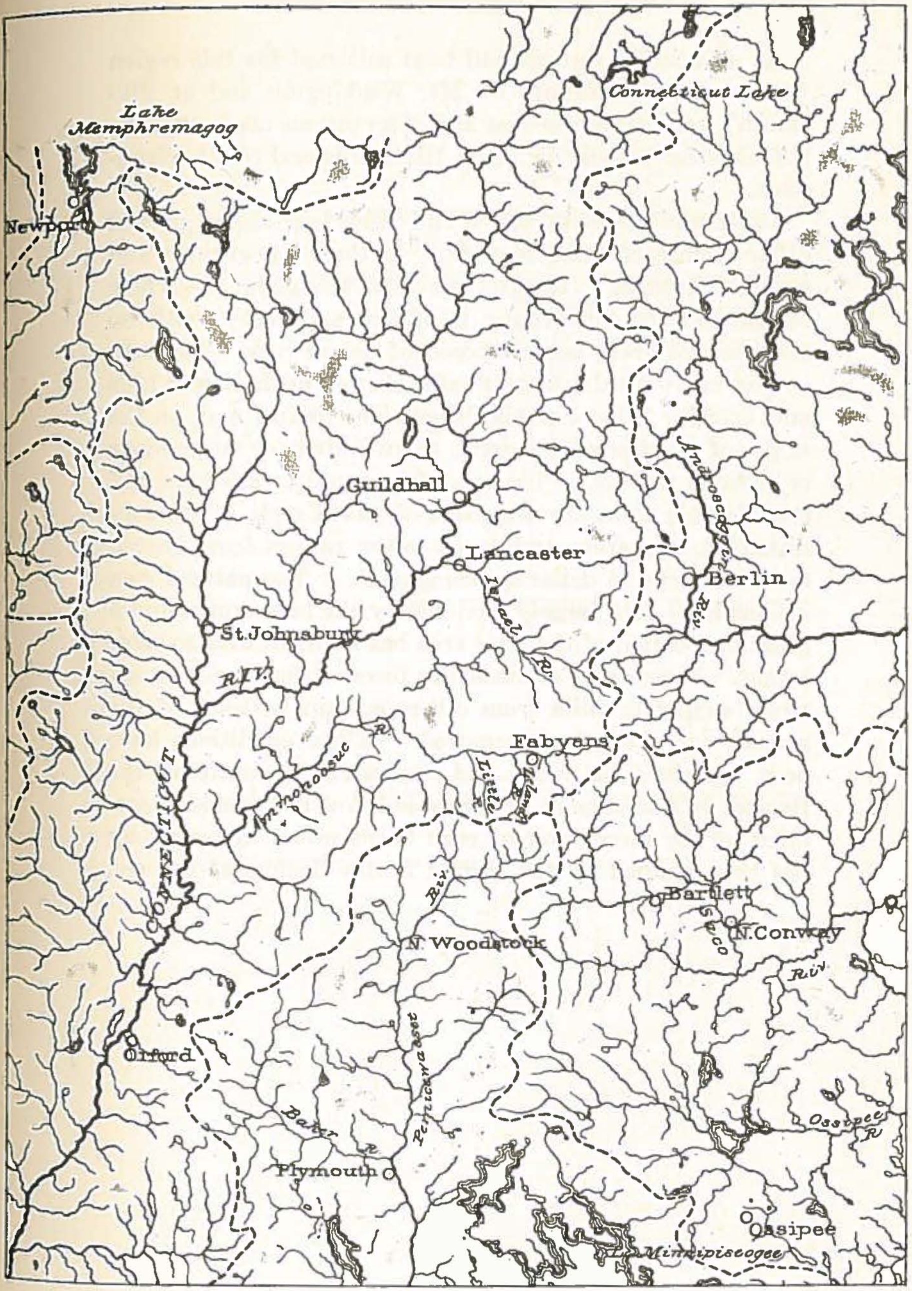
From the record of daily gage heights and the rating table for any station, estimates of the mean daily discharge are made; and from these estimates the table of mean monthly discharge and other dependent data is determined. This latter table gives in condensed form a summary of the results obtained from the observations made during the year at the station. In order to explain this table the following definitions are given:

The term "second-feet" (Sec.-ft.) is an abbreviation for "Cubic feet per second." It is the number of cubic feet of water flowing by the gaging station every second. The column headed "Maximum" gives the mean flow for the day when the mean gage height was the highest and it is the flow as given in the rating table for that mean gage height. As the gage height is the mean for the day, there might have been short periods when the water was higher and the corresponding discharge larger than given in this column. Likewise in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow for each second during the month. Upon this the computations for the three remaining columns in the table are based. The expression "second feet per square mile" means the number of cubic feet of water flowing each second from every square mile of drainage area. "Depth in inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rainfall, which quantity is usually given in depth in inches.

In making a study of the hydrography of this region, with special attention to the effect of deforestation upon stream flow, the short time available has been a serious handicap. In order to draw definite conclusions as to such effects, records should extend over several years, but it has been hoped that, by choosing with care our several gaging stations, some indications of effect on run-off could be observed by the end of the year. With these several conditions in view, river stations were established at the following places:

1. Saco River at Conway Center.
2. Pemigewasset River at Plymouth.
3. Israel (above South Branch) River at Randolph.
4. Israel (below South Branch) River at Jefferson Highlands.
5. Ammonoosuc River at Bretton Woods.
6. Zealand River at Twin Mountain.
7. Little River at Twin Mountain.

Descriptions of these several stations, together with a statement of work done and results obtained at each, are given below. Their location is shown on Plate II.


Lake Memphremagog
Connecticut Lake
Newport
Guildhall
Lancaster
Berlin
Androscoggin Riv.
St. Johnsbury
Israel R.
RIV.
CONNECTICUT
Fabyans
Ammonoosuc R.
Little
Ammonoosuc
Bartlett
Saco
N. Conway
Riv.
Riv.
N. Woodstock
Pemigewasset
Orford
Baker R.
Plymouth
Ossipee R.
Ossipee
L. Winnipiseogee

As no rainfall records had been collected for this region (except for the stations on Mt. Washington and at Plymouth), rain gages were set and observations made at Bartlett, Bretton Woods, Jefferson Highlands and North Woodstock.

The river basins in the White Mountain region do not differ from each other materially in their topographic and geologic features. Granite prevails throughout the whole region and the topography is broken and rocky, with no considerable areas are composed of naked rock. The concut by narrow valleys, gradually change to the lower hills and broader valleys of the large river basins, and, as the slopes of all streams are great, there is little or no pondage or natural storage. The mountain summits are bare and considerable areas are composed of naked rock. The condition of vegetation and forest cover ranges from barren mountain tops to dense spruce growth. The natural conditions have been largely modified by the lumbermen and a great proportion of the total area has been cut over to some extent. From some sections the forest cover has been entirely stripped, while from others certain portions of the growth only have been removed. These conditions have been examined in detail and accurately reported by the Bureau of Forestry. In the table below is a concise statement of the forestation of each basin whose hydrography has been studied by the United States Geological Survey.

TABLE SHOWING FOREST CONDITIONS ON DRAINAGE AREAS.

Classification.*	Drainage.—Area.					
	Pemigewasset at Plymouth.	Israel (above South branch.)	Israel (below South branch.)	Ammonoosuc at Bretton Woods.	Zealand at mouth.	Little at mouth.
Soft Woods (evergreens).						
Over 2 M ft. per acre	25.4	27.3	21.8	51.3	18.2	21.5
Under 2 M ft. per acre	20.9	6.2	14.1	11.6	0.5	......
Total	46.3	33.5	35.9	62.9	18.7	......
Hard Woods (deciduous)	9.7	37.5	29.6	6.1	2.4	20.1
Waste and barren land	9.3	18.0	12.3	15.2	2.7	13.7
Agricultural, clean cut and burns	13.4	11.0	22.2	15.8	31.2	42.6
Water	0.3	......	......	......	......	......
Not classified	21.0	......	......	......	......	2.1
Total per cent	100.00	100.00	100.00	100.00	100.00	100.0

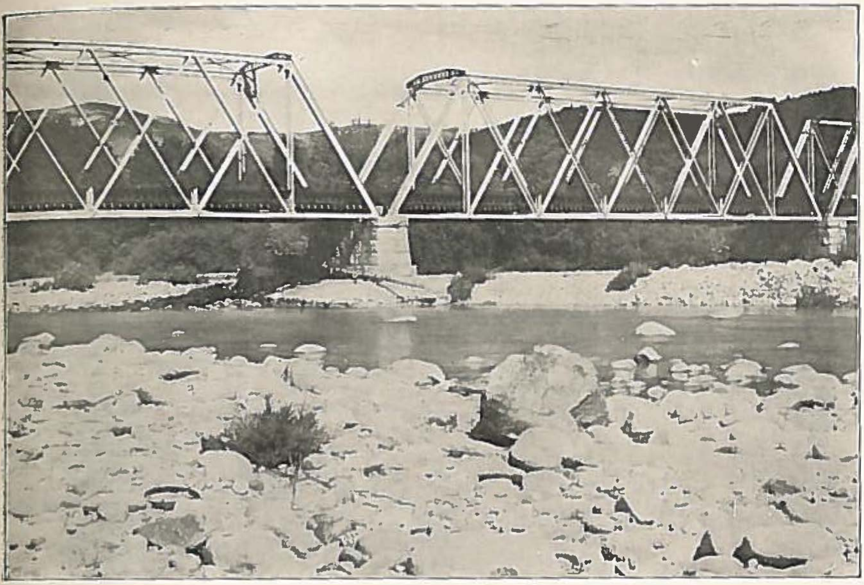
* Field work done by the Bureau of Forestry in 1903.

SACO RIVER DRAINAGE BASIN.

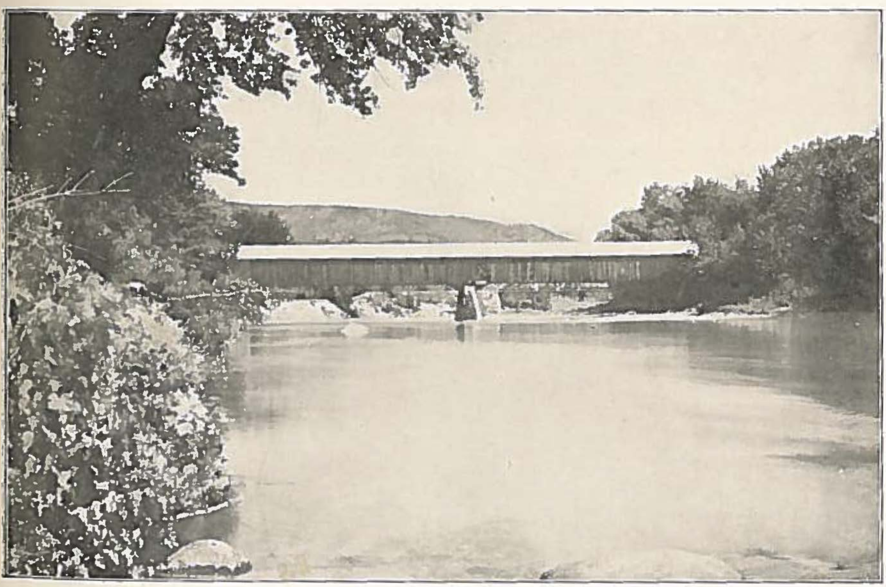
This river receives its headwaters from the valleys and slopes of the White Mountains at elevations of 4,000 to 5,000 feet. It drains an area of 1,720 square miles, of which 900 square miles lie in New Hampshire and the remainder in Maine. The slopes at the headwaters are very steep, with no lake storage. In Plate III are shown two typical views of this river. In the lower river are many good water powers, part of which are in use. The upper portions of the basin are generally in forest, but much of the large growth has been cut, and over large areas the evergreen trees have been entirely removed. In the lower basin are many farms and villages. The underlying rock is generally granite, appearing at the surface in many mountain summits.

SACO RIVER AT CENTER CONWAY, N. H.

This station, shown on Plate III, was established August 26, 1903, by N. C. Grover. It is located at the wooden highway bridge between Center Conway and Redstone and about two miles from either place. The drainage basin at this point has an area of 385 square miles. A standard chain gage is attached to the floor of the bridge; length of chain, 30.44 feet. It is referred to bench marks as follows: (1) Marked point on lower chord of bridge near gage, elevation 27.72 feet; (2) South end of top of west abutment, elevation, 25.14 feet. The channel is straight, 2,000 feet above and 300 feet below the station, is about 200 feet wide at ordinary stages, broken by one pier. The banks are high and are not liable to overflow, except in very extreme freshets. The bed is of sand and gravel and is permanent. Low water measurements are usually made by wading about 400 feet above the bridge. The gage is read twice daily by Albert P. Davidson.



SACO RIVER ABOVE GLEN.



GAGING STATION ON SACO RIVER, NEAR CONWAY CENTER.

LIST OF DISCHARGE MEASUREMENTS OF SACO RIVER, AT CENTRE CONWAY, N. H.

No.	Date.	Hydrographer.	Width. Feet.	Area of sec. Sq. ft.	Mean veloc. Ft. per sec.	Gage height. Feet.	Dis-charge Sec.-ft.	Remarks.
	1903							
1	Aug. 26	H. K. Barrows.	167	429	1.18	4.81	504	....
2	Aug. 27	H. K. Barrows.	277	294	1.30	4.18	382	By wading.
3	Sept. 19	H. K. Barrows.	275	295	1.22	3.92	359	By wading.
	1904							
4	April 19	N. C. Grover ..	227	738	2.20	5.87	1623	....
5	May 2	S. K. Clapp	251	1477	3.88	9.00	5730	....
6	May 18	S. K. Clapp	235	986	2.83	7.00	2786	....
7	May 26	N. C. Grover ..	224	740	2.12	5.76	1567	....
8	June 14	S. K. Clapp	144	417	1.17	4.11	488	....
9	July 21	S. K. Clapp	230	119	1.27	3.39	151	By wading.
10	Aug. 9	S. K. Clapp	200	141	1.31	3.45	185	....
11	Oct. 11	T. W. Norcross	280	321	1.14	3.38	366	By wading.

MEAN DAILY GAGE HEIGHT, IN FEET, OF SACO RIVER, AT CONWAY CENTER, N. H., FOR 1903.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	......	......	......	......	......	3.94	3.54	4.01	......
2	......	......	......	......	......	......	......	......	3.94	3.50	4.00	......
3	......	......	......	......	......	......	......	......	3.93	3.50	4.02	......
4	......	......	......	......	......	......	......	......	3.90	3.51	3.90	......
5	......	......	......	......	......	......	......	......	3.92	3.52	3.92	......
6	......	......	......	......	......	......	......	......	3.91	3.55	4.05	3.90
7	......	......	......	......	......	......	......	......	3.80	3.53	3.96	......
8	......	......	......	......	......	......	......	......	3.67	3.62	3.95	......
9	......	......	......	......	......	......	......	......	3.68	5.12	3.88	......
10	......	......	......	......	......	......	......	......	3.67	5.65	3.85	......
11	......	......	......	......	......	......	......	......	3.70	4.82	3.85	......
12	......	......	......	......	......	......	......	......	3.65	4.40	3.80	4.00
13	......	......	......	......	......	......	......	......	3.65	4.32	3.78	......
14	......	......	......	......	......	......	......	......	3.62	4.22	3.72	......
15	......	......	......	......	......	......	......	......	3.55	4.05	3.75	......
16	......	......	......	......	......	......	......	......	3.54	4.02	3.80	......
17	......	......	......	......	......	......	......	......	3.62	4.00	3.78	......
18	......	......	......	......	......	......	......	......	4.06	6.52	4.18	......
19	......	......	......	......	......	......	......	......	3.52	5.30	4.00	4.50
20	......	......	......	......	......	......	......	......	3.71	4.70	3.78	......
21	......	......	......	......	......	......	......	......	3.60	4.45	3.79	......
22	......	......	......	......	......	......	......	......	3.60	4.25	3.61	......
23	......	......	......	......	......	......	......	......	3.50	4.22	3.88	......
24	......	......	......	......	......	......	......	......	3.48	4.30	3.72	......
25	......	......	......	......	......	......	......	......	3.50	4.22	3.90	......
26	......	......	......	......	......	......	......	4.31	3.50	4.28	4.10	......
27	......	......	......	......	......	......	......	4.13	3.52	4.22	*	......
28	......	......	......	......	......	......	......	3.98	3.55	4.00	......	......
29	......	......	......	......	......	......	......	3.92	3.58	4.00	......	......
30	......	......	......	......	......	......	......	3.95	3.55	3.98	......	......
31	......	......	......	......	......	......	......	3.95	......	4.08	......	......

* Readings from November 27 to December 31 through ice.

MEAN DAILY GAGE HEIGHT, IN FEET, OF SACO RIVER, AT CONWAY CENTER, N. H., FOR 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	5.75	9.90	4.70	4.10	3.45	3.33	5.46	4.36	......
2	......	......	......	5.50	9.22	4.65	4.38	3.46	3.37	4.94	4.62	......
3	7.10	......	......	5.55	8.60	4.58	4.18	3.56	3.37	4.68	4.30	......
4	......	......	......	5.30	8.82	4.52	3.98	3.67	3.82	4.50	4.25	......
5	.....	......	......	5.28	9.02	4.52	3.84	3.60	3.76	4.26	4.14	......
6	......	......	7.50	5.75	8.48	4.68	3.78	3.54	3.54	4.19	......	......
7	6.10	......	......	6.18	7.72	4.72	3.74	3.52	3.45	4.26	......	......
8	......	......	......	5.98	7.72	4.61	3.66	3.45	3.41	3.98	......	......
9	......	......	......	7.10	7.58	4.47	3.62	3.42	3.37	3.94	......	......
10	7.00	......	......	9.70	8.85	4.38	3.58	3.42	3.41	3.93	......	......
11	......	......	......	8.68	9.10	4.28	3.57	3.44	3.36	4.04	......	......
12	......	......	......	7.75	7.68	4.20	3.60	3.48	3.32	3.89	......	......
13	......	......	......	7.08	7.04	4.15	3.70	3.46	3.32	3.89	......	......
14	......	6.40	......	6.60	6.68	4.12	3.62	3.47	3.26	3.57	......	......
15	... .	......	......	6.20	7.10	4.07	3.58	3.44	5.34	3.86	......	......
16	......	......	......	6.05	8.94	4.05	3.54	3.44	5.43	3.85	......	......
17	7.00	......	......	5.70	8.06	3.58	3.45	3.42	4.41	3.92	......	......
18	......	......	......	5.70	7.53	3.92	3.46	3.42	4.05	3.92	......	......
19	......	......	......	5.82	9.24	3.84	3.42	3.35	3.90	3.83	......	......
20	......	......	......	6.20	9.58	3.33	3.42	3.54	3.86	3.88	......	......
21	......	6.20	......	5.83	7.78	3.75	3.40	6.18	3.92	8.13	......	......
22	......	......	......	5.72	6.98	3.83	3.38	4.48	4.05	5.86	......	......
23	......	......	.....	5.94	6.16	3.95	3.38	4.04	3.68	5.86	......	......
24	7.00	......	......	6.35	6.28	3.83	3.40	3.62	3.76	5.25	......	......
25	......	.....	......	7.20	6.01	3.75	3.46	3.72	4.75	4.92	......	......
26	.....	......	.....	7.90	5.78	3.70	3.52	3.63	4.34	5.12	......	....
27	......	......	......	7.75	5.58	3.70	3.56	3.56	4.20	4.90	......	...
28	......	6.70	......	7.78	5.35	3.65	3.74	3.54	4.42	4.56	......	...
29	......	......	......	10.02	5.01	3.71	3.58	3.48	4.00	4.49	......	.....
30	......	......	......	10.32	4.91	3.70	3.51	3.44	5.88	4.45	......	......
31	6.75	.. ...	6.52	......	4.75	......	3.48	3.42	......	4.46	......	......

River frozen January 1–March 30.

RATING TABLE FOR SACO RIVER AT CONWAY CENTER, N. H., FROM AUGUST 27, 1903, TO DECEMBER 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
.....	.....	4.00	380	5.00	935	6.00	1,765	7.00	2,790	8.00	4,120	9.00	5,730	10.00	7,555
.....	.....	4.10	425	5.10	1,005	6.10	1,855	7.10	2,910	8.10	4,270	9.10	5,900	10.10	7,745
.....	.....	4.20	475	5.20	1,080	6.20	1,950	7.20	3,030	8.20	4,420	9.20	6,080	10.20	7,935
3.30	133	4.30	525	5.30	1,160	6.30	2,050	7.30	3,150	8.30	4,580	9.30	6,260	10.30	8,125
3.40	166	4.40	575	5.40	1,240	6.40	2,150	7.40	3,280	8.40	4,740	9.40	6,440	10.40	8,315
3.50	200	4.50	625	5.50	1,320	6.50	2,250	7.50	3,410	8.50	4,900	9.50	6,620	10.50	8,510
3.60	235	4.60	675	5.60	1,405	6.60	2,350	7.60	3,545	8.60	5,060	9.60	6,800	10.60	8,710
3.70	271	4.70	730	5.70	1,495	6.70	2,460	7.70	3,685	8.70	5,220	9.70	6,985	10.70	8,910
3.80	307	4.80	795	5.80	1,585	6.80	2,570	7.80	3,825	8.80	5,390	9.80	7,175	10.80	9,110
3.90	343	4.90	865	5.90	1,675	6.90	2,680	7.90	3,970	8.90	5,560	9.90	7,365	.....	......

This table is applicable only for open channel. It is based upon discharge measurements made during 1903 and 1904. The table is well defined between gage heights 3.40 and 9.00 feet. Outside these limits it has been extended by interpolation. The table has been applied to the nearest hundredth up to 7.00 feet gage height; above gage height 7.00 it has been applied to the nearest half-tenth.

ESTIMATED MONTHLY DISCHARGE OF SACO RIVER AT CONWAY CENTER, N. H., FOR 1903 AND 1904.

(Drainage area, 385 square miles.)

MONTH.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1903.							
August 26-31	530	350	402	1.04	.23	....	....
September	405	193	264	.69	.77	.54	1.43
October	2,270	200	550	1.43	1.65	.51	3.26
November 1-26	465	239	339	.88	.85	....	1.20
December	....	....	....	....	....	....	5.09
1904.							
January	....	....	....	....	....	....	3.72
February	....	....	....	....	....	....	2.75
March	....	....	....	....	....	....	4.16
April	9,110	1,160	2,815	7.31	8.16	2.10	3.95
May	7,365	760	3,682	9.56	11.02	2.20	5.05
June	742	228	451	1.17	1.31	.74	1.78
July	565	159	250	.65	.75	.38	1.99
August	1,930	149	276	.72	.83	.20	4.05
September	1,657	120	411	1.07	1.19	.22	5.53
October	4,345	224	754	1.96	2.26	.73	3.11

River frozen November 27, 1903, to March 30, 1904.
Rainfall records for Bartlett, N. H.

MERRIMACK RIVER DRAINAGE BASIN.

This basin, which has a total drainage area of 5,015 square miles, lies in the states of New Hampshire and Massachusetts; of this, 3,815 square miles are in the former state and 1,200 square miles in the latter. Merrimack River is formed at Franklin, N. H., by the junction of Pemigewasset and Winnipesaukee Rivers. The headwaters of the Pemigewasset lie in the White Mountain region at elevations of approximately 2,000 feet; thence they flow southerly through New Hampshire with very steep slopes. On this branch of the Merrimack there is very little lake storage. Squam and Newfound Lakes, aggregating about 20 square miles of surface area, are the only bodies of water of any importance. Above Plymouth probably 85 per cent. of the basin is in heavy forest. A very insignificant amount of water power is utilized. The total drainage area of the Pemigewasset River is 1,085 square miles.

PEMIGEWASSET RIVER AT PLYMOUTH, N. H.

This station was established September 5, 1903, by N. C. Grover. It is located at the wooden highway bridge below the mouth of Baker's River in the town of Plymouth. The drainage area at this point is 615 square miles. The headwaters of the river lie in the mountainous country to the west of Mount Washington, at elevations of more than 2,000 feet. At North Woodstock, Pemigewasset River is formed by the junction of East Branch, Middle Branch and Moosilauke Brook, at an elevation of about 700 feet. Thence the waters flow south, receiving Mad River from the east and Baker's River from the west, until, at Plymouth, about 20 miles below North Woodstock, the elevation is between 400 and 500 feet. The underlying rock in this basin is usually granite, exposed in the mountain summits. The basin contains some of the best spruce standing in New England. Large areas in the basin of East Branch are still in virgin forest; other areas have been practically stripped, especially on Hancock Brook, a tributary of East Branch, and in the basin of Middle Branch. A statement in detail of the forest conditions on this drainage area will be found on page 143.

The height of water at Plymouth has been recorded daily since January 1, 1886, during which time extensive deforestation in the basin above has taken place. This record of gage height, which has been kindly given to the United States Geological Survey by Locks and Canals Company of Lowell, Mass., has been used as a basis for the estimates of daily discharge of the river since that date. The original observations were made once daily to the nearest quarter inch and have been reduced to the nearest hundreth foot and applied to the rating table, which is based on meter measurements made in 1903 and 1904. During this period of 17 years the gage has been carefully maintained and read; there has been no change in its datum.

A standard chain gage has been installed by the United States Geological Survey and is attached to the guard rail of the sidewalk of the bridge on the upstream side; length of chain, 34.69 feet. It is referred to bench marks as follows: (1) Marked point on rail of bridge near gage; elevation, 34 feet; (2) North corner of intermediate cast-iron gage attached to a granite post and set by Locks and Canals Company of Lowell, Mass., elevation 13.27 feet; (3) North corner of lowest cast-iron gage set by same company, elevation, 7.11 feet. All elevations refer to the datum of the gage. The initial point for soundings is at the top of the face of the right abutment on the upstream side. The channel is straight for 1,000 feet above and 1,000 feet below the bridge, and is about 180 feet wide at ordinary stages, broken by one pier. The banks are high and rocky. The bed is permanent; it is rocky in the right half and gravelly in the left. The velocity is rapid in the right and sluggish in the left half. At low water the measurements of flow through the left channel are made by wading. The gage is read twice daily by Frank Morton. The rating curve for this station is shown on Plate I.

LIST OF DISCHARGE MEASUREMENTS OF PEMIGEWASSET RIVER AT PLYMOUTH, N. H.

No.	Date.	Hydrographer.	Width. (Feet.)	Area of sec. (Sq. ft.)	Mean veloc. (Ft. per sec.)	Gage height. (Feet.)	Dis-charge. (Sec. ft.)	Remarks.
	1903.							
1	Sept. 5	N. C. Grover....	....	250	1.08	1.85	270	..
2	Sept. 22	H. K. Barrows..	....	238	1.00	1.74	238	..
3	Oct. 9	N. C. Grover....	....	243	1.17	1.98	285	..
	1904.							
4	Apr. 14	N. C. Grover....	215	931	2.88	4.75	2,680	..
5	Apr. 14	N. C. Grover....	215	920	2.80	4.70	2,580	..
6	Apr. 20	S. K. Clapp......	205	836	2.70	4.34	2,257	..
7	Apr. 30	S. K. Clapp......	234	2,043	5.65	10.86	12,800	*
8	May 21	S. K. Clapp......	220	1,360	4.17	6.75	5,675	†
9	May 25	N. C. Grover....	203	782	2.55	4.06	2,000	..
10	June 9	N. C. Grover....	190	559	1.86	3.02	1,042	..
11	July 26	S. K. Clapp......	85	197	0.91	1.55	179	..
12	July 5	S. K. Clapp......	185	288	1.45	2.12	419	..
13	Aug. 5	S. K. Clapp......	135	278	1.61	2.11	448	..
14	Aug. 23	H. K. Barrows...	....	....	....	3.15	....	..
15	Sept. 28	....	146	350	1.84	2.47	642	..
16	Oct. 14	T. W. Norcross..	166	399	1.81	2.65	722	..

* (Corrected meter, 10 per cent. off.) 1 ft. depth. Coefficient, 0.90.

† 1 ft. depth. Coefficient, 0.90.

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1886.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.60	4.35	6.10	9.77	4.60	8.68	2.43	......	2.77	8.85	5.85	4.02
2	9.10	4.10	5.93	17.10	4.60	8.43	2.43	2.10	2.43	2.93	4.10	4.68
3	7.27	8.93	5.77	6.60	4.52	3.27	2.43	2.68	2.85	......	8.52	3.60
4	6.48	4.93	5.77	6.10	4.43	4.48	......	2.48	2.02	2.52	8.27	4.27
5	8.77	4.77	5.77	5.35	4.60	3.68	2.43	2.27	......	2.43	8.10	......
6	15.27	4.60	5.77	5.85	4.93	......	2.10	2.10	1.85	2.43	2.98	4.27
7	8.52	4.85	5.77	5.68	4.43	8.18	2.10	2.10	1.77	2.27	......	4.77
8	6.10	4.10	5.77	4.93	4.10	3.10	2.10	......	1.77	2.27	5.60	4.98
9	5.35	3.93	5.68	4.60	6.85	3.10	2.10	2.10	1.68	2.18	4.27	4.77
10	5.10	3.93	5.60	5.43	4.93	3.10	2.10	2.10	1.60	......	......	4.60
11	4.60	8.93	5.60	5.27	4.48	2.93	......	2.10	1.68	2.10	3.77	4.43
12	5.60	3.93	5.60	5.35	4.27	2.77	2.10	2.10	......	2.10	3.52	......
13	5.60	4.27	5.60	4.85	4.10	......	2.10	2.10	1.68	2.10	3.35	4.10
14	5.60	16.85	5.60	6.60	4.02	2.77	2.10	2.10	1.68	2.18	3.35	4.10
15	5.60	13.93	5.60	8.60	3.85	8.93	2.10	......	1.77	2.18	......	3.93
16	5.60	12.27	5.60	9.27	4.52	3.68	2.10	2.10	1.77	2.77	8.10	3.85
17	5.52	11.60	5.48	7.48	5.93	8.27	8.77	2.52	1.98	......	3.02	3.60
18	5.43	9.77	5.27	9.35	4.43	3.10	......	3.43	2.60	2.18	2.68	3.60
19	5.27	9.27	5.18	10.60	4.02	2.98	2.68	2.68	......	2.18	4.43	......
20	5.10	8.10	5.10	10.43	3.85	......	2.60	2.35	2.27	2.10	11.77	3.77
21	5.10	7.27	4.98	9.68	3.85	2.52	2.43	2.10	2.85	2.10	6.27	8.77
22	5.10	7.10	4.93	9.43	3.60	2.52	2.48	......	2.85	2.10	......	8.77
23	4.93	7.10	5.02	6.77	......	2.43	2.27	2.10	2.10	2.10	4.52	3.77
24	4.85	6.93	4.77	6.77	8.85	2.48	2.10	2.10	2.02	......	4.18	8.77
25	4.77	6.27	4.60	6.27	3.18	2.43	......	2.10	2.02	2.02	5.02	4.10
26	4.60	6.27	4.60	5.77	4.60	2.52	2.10	2.10	......	2.02	5.18	......
27	4.27	6.10	4.93	5.27	4.77	......	2.10	2.10	2.02	2.18	.....	4.85
28	4.27	6.10	5.18	5.02	4.77	3.18	2.43	2.10	2.27	8.52	4.27	4.52
29	4.48	......	5.10	4.85	4.60	2.68	2.48	......	4.98	8.43	3.85	4.10
30	4.60	.....	5.43	4.85	......	.....	2.27	1.93	4.43	2.93	3.68	3.85
31	4.48	......	6.60	......	3.85	......	2.10	1.93	......	......	......	3.85

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1887.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.02	6.18	4.43	4.43	9.43	4.68	3.43	3.68	2.60	2.02	2.10	4.27
2	......	5.60	4.43	4.43	9.02	5.43	3.27	8.35	2.60	......	2.10	4.27
3	5.02	5.27	4.52	4.43	9.60	5.10	3.15	8.10	2.52	2.10	2.02	5.10
4	4.43	5.27	4.52	4.43	9.85	7.35	3.02	2.93	......	2.10	2.02	4.93
5	4.02	5.10	4.52	5.10	12.10	5.52	2.93	2.85	2.43	2.27	2.10	4.60
6	4.02	......	.....	6.10	9.93	4.93	2.85	......	2.35	2.52	......	4.60
7	4.02	4.77	4.52	5.85	9.10	4.52	4.68	.....	2.85	2.27	2.10	3.93
8	3.85	4.77	4.60	5.35	7.77	4.27	3.77	3.60	2.52	2.10	2.10	3.77
9	......	4.60	4.77	4.27	9.85	3.93	8.43	3.10	2.52	......	2.10	3.43
10	3.68	4.43	4.77	5.68	9.68	3.77	3.52	2.93	2.52	2.02	2.10	......
11	3.68	4.43	4.77	9.60	9.68	3.85	3.60	2.77	......	2.10	2.10	6.10
12	3.60	4.43	4.68	13.10	7.52	3.43	5.43	3.43	2.27	2.27	2.27	8.02
13	3.60	......	......	12.10	6.18	3.18	4.10	3.10	2.68	2.10	......	6.18
14	3.60	4.27	4.85	9.10	5.60	3.18	3.18	......	2.68	2.10	2.27	5.02
15	3.60	4.27	4.93	7.68	5.35	3.02	3.10	2.60	2.85	2.10	2.18	4.43
16	......	4.27	4.93	6.43	5.77	2.93	2.93	2.52	2.68	......	5.18	4.10
17	3.60	4.43	4.85	6.10	6.18	3.35	2.77	2.43	2.60	2.02	3.85	3.60
18	8.60	4.60	4.77	5.35	6.02	3.35	2.68	2.43	......	2.02	8.27	3.35
19	8.60	4.60	4.77	4.93	5.85	2.93	3.10	3.27	2.27	2.02	......	3.48
20	3.60	......	......	4.77	5.35	2.77	2.93	2.93	2.35	2.02	4.18	3.43
21	3.60	4.60	4.93	5.68	5.85	2.68	2.77	......	2.27	2.02	4.43	3.43
22	3.60	4 60	5.10	6.77	4.68	2.77	2.68	2.48	2.18	8.27	3.60	3.85
23	......	4.60	5.35	7.77	4.60	4.18	3.35	2.60	2.18	......	3.10	8.93
24	3.77	4.60	4.85	10.10	4.52	14.02	6.18	3.68	......	2.52	3.02	4.10
25	5.27	4.60	4.85	10.10	4.27	9.10	6.60	4.10	2.10	2.43	2.85	4.27
26	6.10	4.43	4.77	8.68	7.52	5.85	8.52	3.60	......	2.35	2.85	4.18
27	4.93	......	......	7.52	8.60	5.02	5.52	3.02	2.02	2.27	3.85	4.10
28	4.77	4.43	4.60	7.10	6.10	4.43	4.60	......	2.02	2.18	5.27	4.02
29	5.10	......	4.68	7.68	7.10	4.02	4.10	2.60	2.02	2.18	5.93	4.52
30	......	......	......	11.77	6.60	8.77	4.10	2.52	2.02	......	4.48	4.77
31	7.10	......	......	......	5.27	......	......	2.52	......	2.10	.....	4.68

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1888.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	3.93	4.68	......	12.93	5.35	......	2.10	2.27	8.60	4.35	4.52
2	5.10	3.93	4.85	7.27	10.60	5.68	3.10	2.43	2.85	4.10	4.35	8.93
3	6.02	3.93	4.77	7.10	8.18	......	2.93	2.10	2.52	4.27	4.27	3.93
4	5.77	3.93	......	6.77	8.10	4.60	2.85	2.02	2.27	3.85	5.43	3.77
5	5.48	......	4.80	8.60	6.85	4.27	2.60	.....	2.18	8.52	4.60	3.80
6	5.27	3.93	4.52	6.43	......	4.18	2.52	2.02	2.18	3.35	4.27	3.52
7	5.10	3.93	4.80	8.85	9.27	4.27	2.43	2.02	2.10	7.10	4.10	3.27
8	......	4.02	4.52	......	9.02	4.02	.....	1.93	2.02	8.77	3.93	3.27
9	4.98	4.02	4.43	5.98	9.10	8.88	2.27	2.10	4.88	5.18	4.18	8.18
10	4.77	8.93	4.52	5.60	11.68	......	......	2.43	3.85	4.60	7.52	3.10
11	4.68	3.93	.....	4.68	11.27	3.27	2.27	2.10	8.10	4.18	7.10	3.10
12	4.48	......	4.43	4.10	11.35	3.18	2.60	......	2.85	4.02	5.85	8.10
13	4.27	3.93	4.43	4.60	13.85	3.10	8.60	2.02	2.68	8.93	4.93	2.60
14	4.10	8.93	4.27	4.18	12.43	2.93	3.88	4.10	2.68	4.35	4.52	2.77
15	......	4.10	4.68	......	9.68	2.98	......	3.85	2.52	4.18	4.27	2.93
16	4.48	4.10	4.77	3.93	8.10	3.18	2.77	2.77	2.43	4.02	5.85	8.85
17	4.27	4.10	4.77	4.18	7.27	......	2.60	2.52	2.85	3.85	5.18	4.27
18	4.27	4.10	......	4.60	6.43	2.85	2.52	3.60	4.02	5.27	4.85	7.10
19	4.10	.....	4.68	4.27	5.93	2.52	2.48	.....	6.18	4.52	4.10	5.85
20	4.10	4.10	4.68	4.93	6.85	2.52	2.43	2.60	4.35	4.35	5.80	4.10
21	4.10	4.35	4.85	4.60	7.02	2.52	2.52	2.35	4.02	4.80	4.27	3.52
22	......	4.77	7.27	... ..	5.77	2.85	......	2.52	7.10	4.27	4.10	8.43
23	4.02	8.27	11.02	4.85	5.88	2.02	2.27	8.80	5.27	4.02	8.52	5.60
24	4.02	5.77	7.52	4.98	6.85	......	2.18	2.98	4.85	8.77	8.77	5.43
25	4.02	5.85	......	4.43	6.48	6.80	2.18	2.60	3.85	5.52	3.85	5.35
26	4.02	......	7.10	4.93	6.85	5.77	2.10	......	8.52	4.60	3.80	5.52
27	4.85	5.27	6.77	5.77	......	5.10	2.10	2.43	7.85	4.18	4.98	6.10
28	4.85	5.10	8.85	8.10	5.85	4.10	2.10	2.52	5.02	8.60	8.85	8.77
29	......	4.98	7.85	12.85	8.93	3.60	......	2.35	4.18	8.85	5.88	5.85
30	4.85	......	10.85	15.10	8.77	8.35	2.10	2.27	3.85	5.68	4.85	4.43
31	4.85	......	8.27	......	5.98	.....	2.02	2.18	......	4.77	......	4.85

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1889.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.35	4.60	3.52	3.35	5.60	2.85	2.68	4.85	......	3.10	3.43	......
2	3.35	4.52	3.52	3.10	4.93	9.60	2.52	7.93	1.93	6.60	3.10	3.43
3	3.52	......	......	3.18	4.43	6.02	2.43	5.27	2.02	5.52	......	3.27
4	3.27	4.27	3.52	3.18	4.35	4.43	4.52	4.93	1.77	4.43	......	3.10
5	3.18	4.27	3.77	3.93	......	4.18	5.10	4.27	1.77	4.02	......	3.10
6	3.43	4.52	4.68	3.77	4.10	4.27	3.68	4.27	1.77	......	......	3.43
7	3.35	4.77	6.77	......	4.43	4.27	......	3.77	2.27	6.43	4.27	3.60
8	5.77	4.43	5.93	4.77	4.43	3.93	2.77	3.27	......	3.35	3.93	......
9	4.27	4.43	5.27	......	4.43	4.77	2.77	3.18	2.27	5.60	3.77	5.10
10	3.93	3.27	......	5.18	4.35	5.43	2.68	3.10	2.10	4.52	......	3.60
11	5.52	4.10	4.60	4.93	4.27	6.60	2.60	......	2.02	4.27	3.52	5.60
12	4.60	4.10	4.27	5.35	......	4.93	2.77	3.27	1.35	3.93	3.35	6.68
13	3.68	4.10	4.27	6.27	3.43	4.35	2.68	3.02	1.35	......	3.27	5.27
14	3.52	3.35	4.27	......	3.43	3.35	......	2.93	1.35	3.52	......	4.52
15	3.10	3.35	4.10	4.35	3.77	3.60	2.68	3.10	......	3.35	3.43	......
16	3.10	3.35	4.10	4.60	3.52	......	2.52	3.35	2.18	3.18	3.10	4.10
17	3.68	......	......	5.18	3.35	3.60	2.43	3.10	2.27	3.10	......	3.35
18	6.35	3.35	4.60	5.93	3.27	3.35	2.43	......	3.60	3.02	2.93	3.68
19	4.10	3.35	5.18	7.60	......	3.60	2 85	2.68	3.60	2.93	2.93	4.10
20	3.60	3.35	4.85	3.43	2.93	3.27	5.18	2.60	7.52	......	3.02	5.77
21	3.27	3.68	4.02	7.35	4.02	3.10	7.77	2.52	4.60	2.68	4.43	5.10
22	6.68	3.60	3.35	7.77	7.68	2.85	4.85	2.52	......	2.68	4.52	......
23	5.85	3.60	4.18	5.43	5.60	......	3.93	2.43	3.35	2.60	5.35	4.27
24	5.85	......	......	4.68	4.43	2.60	3.68	2.35	3.60	2.60	......	4.10
25	5.35	3.60	4.93	4.43	4.02	2.60	3.35	......	3.18	2.60	3.93	3.93
26	5.85	3.52	4.43	5.77	......	2.52	3.02	2.18	3.02	2.52	3.60	3.77
27	5.27	3.52	3.77	6.93	3.52	2.60	2.35	2.10	4.43	......	3.43	3.77
28	5.10	3.52	3.52	7.43	3.35	3.68	3.10	2.10	3.77	3.27	3.43	3.43
29	4.93	......	3.77	3.27	3.43	3.60	2.93	2.10	......	4.27	4.60	......
30	4.60	......	3.77	6.60	3.10	......	7.10	2.02	3.10	4.10	3.93	2.93
31	4.60	......	......	......	2.93	......	6.35	2.02	......	2.60	......	3.68

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1890.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.27	4.85	6.68	4.43	6.93	......	2.60	2.43	5.52	3.18	3.52	2.77
2	4.77	......	......	4.18	3.27	4.18	2.52	2.60	4.60	3.02	......	4.10
3	6.10	4.60	5.60	3.93	6.68	3.93	2.60	......	4.02	2.93	3.60	3.77
4	5.93	4.60	5.60	3.85	......	3.77	7.77	2.18	3.60	2.93	3.60	3.60
5	......	4.60	5.60	6.60	10.27	4.43	4.77	2.10	3.85	......	3.85	4.10
6	6.10	5.27	4.93	......	10.10	5.60	......	2.02	3.18	3.85	3.18	4.10
7	6.60	5.10	4.60	5.27	12.60	5.18	3.85	2.93	......	3.10	3.10	......
8	6.43	4.68	4.43	5.60	3.27	.....	3.18	2.85	3.02	3.27	3.10	3.77
9	7.10	......	......	5.18	6.60	......	3.02	2.18	2.85	4.27	......	3.60
10	6.60	5.77	4.43	4.93	5.93	4.02	3.02	......	3.60	3.85	3.43	3.52
11	6.68	5.10	4.43	5.68	7.68	3.77	2.77	2.10	3.18	3.60	3.93	3.52
12	......	4.85	4.43	4.93	6.77	3.77	2.60	2.02	3.27	......	3.43	3.43
13	6.93	4.85	4.77	......	5.77	3.68	......	1.93	3.85	3.35	3.35	3.27
14	6.68	4.60	7.27	3.27	6.27	4.85	2.43	1.93	11.60	3.18	3.18	......
15	6.43	4.68	7.02	10.85	7.10	......	2.85	1.85	6.68	3.52	3.10	3.27
16	6.60	.....	......	3.10	6.60	4.02	3.43	1.85	5.85	3.93	......	3.27
17	6.43	5.85	5.43	7.10	6.18	3.60	2.85	......	10.68	3.60	3.85	3.27
18	6.85	5.27	5.43	6.68	......	3.43	2.52	1.85	10.02	......	5.85	3.85
19	......	4.85	5.10	5.52	4.93	3.18	2.85	2.10	7.35	......	5.68	3.52
20	6.27	4.60	4.77	......	7.43	3.10	......	2.27	5.60	7.60	4.77	3.10
21	6.02	4.27	5.10	6.93	12.10	2.93	2.85	2.85	......	6.77	4.18	......
22	6.02	4.27	5.52	6.02	6.77	......	2.27	2.52	4.27	5.85	3.85	3.10
23	5.77	......	.....	6.60	5.60	2.77	2.18	3.60	3.93	4.77	......	3.10
24	5.85	4.27	5.60	3.27	5.10	2.77	2.10	3.27	3.77	4.43	3.60	3.10
25	5.10	4.60	5.10	3.52	....	3.10	2.10	5.35	3.60	4.43	3.43	3.10
26	......	5.43	5.10	6.77	4.85	3.85	4.60	4.02	3.85	......	3.85	3.10
27	5.27	......	5.10	......	3.43*	3.02	......	7.15†	3.85	3.85	3.10	3.10
28	4.93	7.02	4.85	6.10	3.68	3.02	3.10	9.85	......	3.77	2.77	......
29	4.93	......	4.43	6.10	6.43	......	2.60	5.52	3.85	3.60	2.77	3.10
30	5.10	......	......	5.85	5.52	2.60	2.43	4.52	3.85	3.77	......	3.10
31	4.85	......	4.43	......	4.85	......	2.85	......	......	3.68	......	3.10

* Highest for day, 11.60.
† Highest for day, 10.77.

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1891.

ay.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.18	......	......	5.48	4.93	......	2.85	3.02	2.85	1.60	......	3.77
2	8.18	5.27	5.60	5.85	5.85	3.60	2.85	......	3.02	1.52	1.68	3.60
3	8.35	4.93	5.43	5.10	......	3.43	2.27	3.27	2.93	1.52	1.77	3.43
4	......	4.93	5.35	4.77	6.10	3.77	2.18	2.18	2.68	......	1.60	2.85
5	3.52	4.27	5.18	......	5.18	4.43	......	2.10	2.52	1.60	1.43	7.10
6	8.52	4.27	5.10	4.18	4.60	3.60	2.85	2.02	......	1.52	1.48	.....
7	3.43	4.43	5.02	4.10	4.18	......	2.77	2.35	3.35	1.52	1.43	4.10
8	3.43	......	......	3.93	5.02	.....	2.77	2.27	3.02	1.68	......	3.60
9	8.43	4.35	5.02	8.85	3.85	......	8.52	......	2.68	2.18	1.60	8.10
10	8.43	4.85	5.35	8.27	......	2.77	2.77	2.02	2.43	1.85	1.60	8.10
11	......	4.43	6.68	4.60	5.60	2.68	2.52	1.98	2.85	......	1.68	2.85
12	8.85	......	6.10	10.60	5.77	2.60	......	1.85	2.27	1.60	4.02	2.60
18	7.68	......	5.93	8.60	5.02	2.60	2.27	1.98	......	1.60	8.10	......
14	6.60	4.18	7.85	7.10	4.68	.....	2.10	2.02	2.10	1.68	2.60	2.60
15	5.77	......	......	8.60	4.60	2.43	2.02	1.85	2.10	1.77	......	2.85
16	5.27	4.10	6.43	8.43	4.27	2.85	2.02	......	2.02	1.68	2.10	8.52
17	4.93	4.35	5.68	7.85	4.10	2.27	2.02	2.27	2.02	1.68	2.10	8.27
18	......	5.18	5.43	8.77	5.52	4.18	1.98	2.18	1.98	......	5.60	8.60
19	4.93	5.10	5.27	10.60	4.60	4.10	5.85	2.02	2.02	1.60	8.35	8.48
20	4.77	4.85	5.02	11.60	4.18	8.85	4.02	2.02	......	1.60	2.77	......
21	4.52	4.43	4.85	9.10	4.18	......	2.93	1.85	1.93	2.02	2.77	8.35
22	4.52	......	......	8.10	5.68	2.77	2.85	4.02	1.93	2.43	......	8.18
23	7.43	4.60	10.68	10.10	5.10	4.43	2.85	.....	1.85	2.10	2.68	8.10
24	8.60	4.60	13.52	10.68	......	3.52	2.18	8.18	1.85	1.85	8.27	5.27
25	......	4.68	12.10	7.43	8.93	3.35	3.35	3.02	1.85	......	5.85	8.27
26	6.48	8.60	6.77	......	8.93	8.02	.....	2.77	1.77	1.68	3.93	6.85
27	6.10	9.43	5.60	5.35	8.77	2.77	2.77	2.48	......	1.77	8.52	......
28	5.60	7.35	5.35	5.60	8.52	......	2.48	8.35	1.68	1.68	8.27	4.60
29	5.35	......	......	6.10	3.35	2.43	2.27	5.10	1.68	1.68	......	8.60
80	5.18	......	6.10	5.10	4.52	2.43	2.85	......	1.60	1.68	8.85	8.10
31	5.10	......	5.60	.....	......	......	2.85	8.18	......	1.60	.....	6.85

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1892.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.60	4.60	2.85	2.85	......	4.98	6.85	2.02	8.85	2.18	2.43	2.77
2	4.52	4.43	2.85	8.52	8.48	4.52	4.93	......	3.18	......	2.85	2.85
8	14.10	4.27	2.85	......	8.93	4.18	......	......	2.85	2.02	2.52	2.85
4	7.48	4.02	2.60	7.10	5.85	3.98	8.85	1.93	......	2.10	4.43	......
5	5.85	3.85	2.52	7.27	6.60	......	6.85	2.02	2.52	2.48	2.85	2.45
6	4.85	8.52	......	7.10	4.68	4.43	5.02	2.27	2.48	2.27	......	2.10
7	4.27	......	2.27	8.85	4.16	4.18	4.43	......	2.60	2.10	8.10	2.60
8	8.85	3.35	2.27	5.77	......	4.10	4.85	1.60	2.48	2.18	8.10	2.52
9	8.48	8.85	2.35	5.85	8.48	8.60	8.68	1.77	2.35	......	5.68	2.43
10	......	8.35	2.85	......	8.48	......	......	2.02	2.18	2.27	4.10	2.68
11	4.60	8.27	8.98	4.27	8.48	8.10	8.85	2.02	......	2.18	8.85	......
12	4.77	3.27	3.52	8.85	5.10	......	8.10	2.85	2.02	2.10	8.85	2.35
18	4.85	3.10	......	3.48	6.02	2.85	2.93	4.43	2.02	......	......	2.27
14	9.52	......	8.48	8.85	5.10	2 68	2.68	......	2.02	......	8.10	2.10
15	11.10	3.27	8.10	8.18	......	2.60	2.60	3.43	8.85	......	8.10	2.35
16	5.60	3.10	2.60	8.10	6.10	2.60	2.52	2.85	3.52	......	8.60	2.18
17	......	3.27	2.35	......	6.35	2.52	......	2.52	8.52	......	11.85	2.10
18	4.27	3.10	2.35	2.93	4.60	2.27	2.27	2.27	......	......	7.10	......
19	4.27	3.10	2.18	2.85	4.10	......	2.35	2.10	2.77	......	9.10	2.10
20	4.48	......	......	2.85	8.77	2.68	2.27	8.10	2.60	2.35	......	2.02
21	3.77	......	1.85	2.85	4.18	8.85	2.10	......	2.60	2.48	4.85	1.85
22	8.60	3.10	2.10	8.27	6.10	3.35	2.10	2.85	2.52	2.43	4.48	1.77
23	3.60	3.10	1.93	4.60	6.48	2.98	2.02	2.43	2.35	......	4.02	1.68
24	......	8.48	2.02	......	7.52	2.68	......	2.18	2.27	2.02	8.43	......
25	8.43	3.35	2.10	3.85	5.85	3.35	2.02	2.10	......	8.48†	8.39	1.68
26	8.77	3.27	1.85	3.52	5.60	7.52	2.02	5.85	2.18	2.18	......	1.52
27	4.60	......	......	8.18	5.10	6.10	2.02	5.85	8.02	......	......	......
28	4.60	......	2.48	8.10	6.85	9.10*	1.85	7.10	2.85	2.18	3.02	1.43
29	4.85	3.02	2.60	4.68	......	8.52	1.85	4.85	2.48	2.10	2.85	1.35
30	5.10	......	2.52	4.18	4.60	5.27	2.10	8.85	2.27	......	2.85	1.35
81	......	......	2.60	......	5.85	......	......	8.35	......	2.60	......	1.35

* Highest for day, 11.10.
† Highest for day, 4.98.

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	1.43	2.02	3.60	7.10	8.18	2.10	1.60	8.18	......	8.85	8.52
2	2.60	1.60	2.02	......	6.85	3.10	......	1.85	2.85	2.02	3.43	2.85
3	8.18	1.52	1.85	4.10	6.85	8.02	2.10	1.77	......	1.98	6.27	......
4	8.10	1.48	1.85	4.02	7.48	......	2.02	1.68	2.85	1.93	8.10	8.85
5	8.10	......	......	4.10	12.48	8.02	1.98	1.60	2.27	1.85	......	4.10
6	2.60	1.43	1.85	4.85	8.48	2.85	2.02	......	2.18	1.93	2.85	4.60
7	2.27	1.48	1.85	4.85	......	2.85	1.93	1.60	2.10	1.85	2.77	4.60
8	......	1.43	1.85	4.60	7.10	2.60	1.98	2.93	2.85	......	2.60	4.85
9	1.85	1.43	1.85	......	7.10	2.60	1.85	2.52	2.93	2.48	2.43	4.10
10	1.68	1.43	2.02	6.85	7.48	......	1.77	2.02	......	2.27	2.48	......
11	1.68	2.35	1.85	6.10	9.85	......	1.77	1.68	2.18	2.10	2.43	8.85
12	1.52	......	......	6.60	10.60	4.85	1.77	1.60	2.02	2.02	......	8.60
13	1.52	4.10	4.27	7.48	10.68	8.85	1.77	......	1.98	1.85	2.85	8.60
14	1.52	8.85	6.43	6.85	......	8.18	1.60	1.60	1.85	2.02	2.27	8.85
15	......	3.85	6.10	6.68	8.52	2.85	1.52	1.52	1.85	7.10	2.85	8.10
16	1.43	4.10	5.27	......	7.48	8.18	......	1.52	2.48	4.48	2.10	8.43
17	1.48	8.77	5.27	4.60	10.98*	2.85	1.52	1.52	......	3.35	2.10	......
18	1.43	8.60	5.27	4.27	10.85	......	1.60	1.52	8.60	3.02	2.10	8.85
19	1.43	......	......	4.10	7.68	2.52	1.68	1.98	3.10	2.85	......	8.60
20	1.48	8.52	4.85	4.27	6.85	2.85	1.52	......	2.85	2.60	2.18	8.52
21	1.43	2.85	4.60	4.48	......	2.52	1.52	1.98	2.52	2.52	2.02	8.48
22	......	3.10	4.43	4.10	6.85	2.18	1.52	1.85	2.35	......	2.10	8.48
23	1.48	2.68	4.27	......	6.02	2.10	......	2.18	2.85	2.48	2.85	8.35
24	1.43	2.43	4.02	4.68	6.60	2.60	1.85	2.02	......	5.48†	2.60	......
25	1.48	2.10	4.10	5.52	5.35	......	1.77	4.10	2.10	6.60	2.27	8.10
26	1.48	......	......	4.85	4.85	2.68	1.60	8.60	2.10	4.43	......	8.60
27	1.48	2.10	4.60	5.85	4.85	2.43	1.60	......	2.48	8.60	2.10	8.35
28	1.48	2.10	4.48	4.60	......	2.35	1.68	2.48	2.27	7.76‡	2.35	8.85
29	.....	......	4.02	5.85	8.85	2.18	1.68	2.27	2.10	7.48	5.85	8.18
30	1.48	......	4.10	......	8.60	2.10	......	7.48	2.10	5.10	4.85	8.10
31	1.48	......	8.85	......	8.52	.....	1.60	4.10	......	4.10	......	......

* Highest for day, 18.60.
† Highest for day, 8.10.
‡ Highest for day, 10.10.

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.10	3.10	3.18	.....	4.68	4.68	......	1.52	1.43	1.68	3.60	2.85
2	3.10	3.10	3.10	4.60	5.60	4.60	2.43	1.52	......	1.68	3.43	.....
3	3.10	3.10	3.85	3.68	6.10	7.10	2.43	1.60	1.43	1.68	2.85	2.68
4	3.02	......	......	3.60	5.18	5.85	2.68	1.85	1.43	1.68	6.10	2.68
5	3.10	3.10	3.50	3.43	4.52	4.43	2.52	......	1.43	1.85	4.43	2.68
6	3.43	3.10	3.85	3.68	......	4.18	2.52	1.52	1.43	1.85	3.85	2.68
7	......	3.10	5.10	3.60	4.68	3.93	2.68	1.52	1.43	......	3.27	2.68
8	3.85	3.10	7.52	.....	4.68	3.60	......	1.43	1.43	1.68	3.10	2.43
9	3.29	3.10	7.43	3.85	4.60	3.85	2.52	1.43	......	1.68	2.65	......
10	3.10	3.10	6.60	3.65	3.68	......	2.43	1.43	1.43	1.85	25.77	2.27
11	3.10	......	......	3.85	3.27	2.85	2.27	1.43	5.93	3.60	......	2.85
12	3.02	3.10	6.68	3.10	3.18	2.52	2.18	......	2.93	3.18	2.60	2.85
13	2.85	3.10	7.10	3.43	......	2.60	2.10	1.60	2.18	2.85	2.85	5.60
14	......	3.10	6.85	3.68	2.85	2.52	2.85	1.52	1.93	4.60	2.60	6.18
15	2.85	3.10	5.85	......	2.85	2.43	......	1.52	1.68	3.85	2.52	4.85
16	3.10	3.10	5.18	4.85	2.68	2.85	2.27	1.60	......	3.10	2.85	......
17	3.10	3.10	5.02	5.43	2.60	......	2.10	1.60	1.60	2.85	2.43	4.10
18	3.10	......	......	6.10	2.52	2.27	2.02	1.60	1.52	3.10	......	3.60
19	3.10	3.43	4.02	6.43	2.77	3.10	1.85	.....	1.43	2.77	2.60	3.43
20	3.10	3.60	7.02	7.10	......	4.43	1.77	1.68	1.52	2.52	2.10	3.60
21	......	3.60	5.60	8.43	3.43	3.18	1.68	1.68	6.02	......	2.27	3.85
22	3.10	3.43	4.85	13.10	3.10	3.18	......	1.60	3.60	2.85	2.43	3.68
23	3.10	3.43	5.18	10.10	2.65	2.85	1.68	1.52	......	2.27	2.85	......
24	3.10	3.10	4.52	8.60	2.85	......	1.68	1.52	2.85	2.18	2.43	2.02
25	3.27	.....	.....	7.85	3.10	2.43	1.85	1.43	2.18	2.18	......	3.10
26	3.77	2.93	3.85	6.43	4.18	2.27	1.77	......	2.02	2.10	2.85	3.10
27	3.77	3.10	3.43	5.85	......	2.52	1.68	1.43	1.93	2.10	2.10	3.02
28	......	3.27	3.85	6.10	3.85	2.43	1.60	1.43	1.85	......	2.27	3.02
29	3.85	......	3.10	......	11.27	2.60	......	1.43	1.85	2.10	2.60	2.85
30	3.85	......	3.10	4.93	9.60	2.52	1.52	1.43	......	2.02	2.68	......
31	......	......	3.10	......	5.60	.....	1.52	1.43	......	2.02	......	3.10

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1895.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.10	2.77	2.43	2.10	6.02	8.18	2.52	2.85	......	4.18	2.85	......
2	8.10	2.68	2.43	2.10	5.27	......	2.85	2.16	2.85	2.93	8.85	8.43
3	8.10	......	......	2.10	5.18	2.85	2.85	2.10	2.10	2.48	......	7.85
4	2.85	2.68	2.52	2.18	6.10	2.27	2.27	......	1.93	2.27	2.68	4.60
5	2.85	2.68	2.52	2.10	......	8.02	2.10	2.85	1.85	2.18	2.52	4.18
6	......	2.60	2.48	2.10	5.85	8.16	2.02	2.52	1.85	......	2.60	8.85
7	2.85	2.60	2.43	......	5.43	8.85	......	2.18	1.77	2.02	2.60	8.52
8	2.85	2.48	2.43	2.85	4.85	8.27	2.27	2.10	......	2.02	2.93	......
9	2.85	2.43	2.43	5.68	4.93	......	2.10	2.10	1.77	2.10	8.10	8.85
10	2.85	......	......	18.52	4.48	2.77	2.18	1.93	1.77	2.02	6.60	8.60
11	2.85	2.43	2.43	8.85	8.10	2.60	2.18	......	1.68	1.93	5.18	4.85
12	8.18	2.52	2.48	5.85	......	2.52	2.02	1.85	1.93	1.93	4.02	4.85
13	......	2.52	2.43	5.85	7.10	2.48	1.93	8.18	2.60	......	2.48	4.85
14	8.60	2.52	2.48	20.10	4.85	8.18	......	2.35	2.02	4.27	3.18	4.48
15	8.43	2.52	2.27	25.10	4.27	8.10	2.18	2.18	......	4.02	8.02	......
16	8.27	2.52	2.27	10.81	4.02	......	2.10	2.02	1.77	8.10	5.85	4.18
17	8.18	......	......	7.85	4.02	2.52	2.10	1.85	1.85	2.77	......	8.68
18	8.10	2.52	2.10	7.85	8.60	2.85	2.02	......	1.85	2.68	8.85	8.48
19	2.02	2.52	2.10	7.85	......	2.27	1.93	8.10	1.77	2.52	8.48	8.48
20	......	2.52	2.10	7.85	8.27	2.27	1.85	2.48	1.77	......	8.48	8.60
21	2.85	2.52	2.10	......	8.10	2.10	......	2.18	1.77	2.85	5.18	8.60
22	2.85	2.52	2.10	7.85	8.02	2.85	1.77	2.02	......	2.27	4.10	10.10
23	2.85	2.48	2.10	7.10	2.85	......	1.85	1.98	1.68	2.27	8.60	6.60
24	2.85	......	......	6.60	2.77	2.98	1.68	1.85	1.68	2.18	......	4.68
25	2.85	2.48	2.10	6.10	2.68	2.98	1.68	......	1.68	2.18	8.85	4.10
26	2.68	2.43	2.10	7.10	......	2.43	1.68	1.77	1.68	2.10	8.68	8.68
27	......	2.48	2.10	6.10	2.60	2.60	1.68	1.77	1.60	......	11.10	*7.64
28	2.85	2.85	2.10	......	8.85	2.60	......	1.77	1.60	2.02	6.60	6.85
29	2.85	......	2.10	5.43	4.60	2.93	2.60	1.85	......	2.10	5.10	......
30	2.85	......	2.10	5.85	8.93	......	2.27	2.62	2.18	2.10	4.48	4.10
31	2.85	......	......	......	8.48	......	2.18	2.85	......	2.10	......	†10.02

* Highest for day, 10.48.
† Highest for day, 18.60.

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1896.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.94	2.85	21.10	5.18	4.85	8.27	1.77	2.10	1.85	8.48	......	4.52
2	5.85	......	15.85	4.85	4.18	2.93	1.77	.....	1.85	2.85	8.18	8.85
8	4.77	2.85	7.48	4.10	......	2.77	1.68	2.02	1.85	8.10	8.10	8.35
4	4.18	2.85	5.85	8.85	4.60	2.60	1.60	2.02	1.98	......	2.85	8.10
5	......	2.85	5.60	......	4.60	2.48	......	1.85	2.43	2.60	2.98	8.48
6	4.60	2.85	6.60	8.35	4.68	2.85	2.68	2.52	......	2.48	18.60	......
7	4.52	5.98*	6.35	8.35	4.10	.....	2.18	2.98	7.10	2.35	7.85	8.35
8	4.35	5.77	......	3.10	8.85	2.60	2.10	2.68	4.10	2.68	......	8.10
9	4.35	......	5.35	8.85	8.60	8.10	2.18	......	8.18	3.02	5.52	2.98
10	4.35	3.60	4.85	4.35	......	8.68	2.02	2.10	2.85	2.68	4.52	8.10
11	4.35	4.10	8.85	4.43	8.85	8.68	1.85	2.02	2.68	......	4.10	8.10
12	......	3.85	8.85	......	8.85	3.18	.....	1.98	2.43	2.48	8.85	8.18
18	8.68	8.85	8.60	6.60	8.48	8.10	1.68	1.85	.....	2.35	8.85	......
14	8.85	8.85	8 60	10.68	8.18	......	1.68	1.77	4.10	2.93	8.85	2.85
15	8.85	8.60	......	8.85	3.10	2.60	1.68	2.52	8.18	5.77	......	2.85
16	8.68	......	8.48	12.10	2.98	2.68	1.68	......	2.77	4.10	8.85	2.48
17	8.68	8.35	8.48	18.10	......	2.52	1.68	2.10	2.52	8.43	8.27	2.60
18	8.52	8.35	8.35	11.85	2.77	2.43	1.68	2.60	2.85	......	8.10	2.52
19	......	8.18	8.27	......	2.77	2.48	......	2.18	8.02	8.10	8.18	2.52
20	8.85	8.18	8.68	10.10	2.77	2.48	1.60	2.10	6.60	8.10	8.10	......
21	8.35	8.18	7.10	9.02	2.77	......	5.27	1.98	4.43	8.10	8.10	2.35
22	8.18	8.10	......	7.10	2.60	2.10	8.77	1.85	8.48	9.60	......	2.60
23	8.10	......	4.48	6.60	2.60	2.18	2.85	.....	8.10	5.60	8.10	2.60
24	8.10	8.10	8.85	5.52	......	2.02	2.52	3.35	2.85	4.68	8.02	2.52
25	2.85	8.10	8.60	5.35	2.48	1.98	2.35	2.85	2.68	......	8.10	2.27
26	.....	8.10	8.52	......	2.43	2.02	......	2.43	2.60	4.27	8.10	2.27
27	8.10	8.10	4.85	4.68	2.85	1.85	2.02	2.10	......	4.02	8.85	......
28	8.10	8.10	5.52	4.85	2.68	......	2.10	2.10	2.35	8.68	8.50	2.35
29	2.98	8.10	......	4.60	2.60	1.77	2.27	2.10	2.85	8.48	......	2.35
80	2.85	......	8.85	4.85	8.35	1.77	2.10	......	2.85	8.68	8.60	2.35
81	2.85	......	4.60	......	......	......	2.10	1.85	......	8.60	......	2.35

* Highest for day, 7.10.

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1897.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.85	2.85	2.85	4.48	7.10	8.85	5.10	......	2.02	1.68	1.68	8.60
2	2.85	2.85	2.85	4.85	......	8.43	8.85	8.10	1.98	1.68	2.18	8.48
3	......	2.85	8.02	5.80	8.43	8.85	8.85	2.98	1.85	......	8.85	8.18
4	2.10	2.85	8.10	......	8.85	8.43	......	2.68	1.85	1.52	4.48	8.10
5	2.52	2.85	8.10	4.80	8.60	4.10	2.85	2.68	......	1.80	8.52	......
6	8.43	2.85	8.85	5.85	6.02	......	2.68	2.60	1.85	1.60	8.10	5.80
7	7.10	.....	......	7.10	5.85	8.85	4.43	2.80	1.77	1.80	......	4.85
8	8.10	5.85	8.52	7.10	4.52	8.48	8.85	.....	1.77	1.52	2.85	4.10
9	5.10	6.27	8.52	8.43	.....	8.85	8.10	2.85	1.68	1.52	2.88	4.10
10	......	4.85	8.43	5.85	4.10	10.84*	2.52	2.80	1.77	......	4.60	8.85
11	4.85	4.27	8.52	......	4.85	10.10	......	2.48	1.60	1.52	8.68	8.60
12	4.68	8.85	4.10	4.18	4.52	6.60	2.52	2.80	......	1.80	8.18	......
13	4.27	8.60	4.52	4.88	6.88	.....	8.85	2.52	1.88	4.80	8.18	8.10
14	8.48	......	......	4.68	14.85	5.10	14.10	2.48	1.68	2.85	......	4.85
15	8.18	8.52	8.85	5.98	8.10	4.85	18.85	.....	1.68	2.85	2.88	8.85
16	8.85	8.85	8.60	9.80	......	4.85	8.88	2.10	1.88	2.18	2.77	12.10
17	......	8.85	8.85	9.10	5.18	8.85	8.48	2.80	1.68	......	4.52	7.10
18	8.85	8.10	8.43	.....	4.80	8.80	......	8.85	1.88	2.43	4.10	5.48
19	8.85	8.18	8.48	7.85	4.42	8.85	4.60	2.85	......	2.85	8.48	......
20	2.85	8.10	8.85	7.10	8.85	......	4.10	2.60	1.88	2.02	8.27	8.48
21	2.80	......	......	5.88	8.80	4.48	8.85	2.88	2.02	2.02	......	5.85
22	2.80	8.10	8.77	5.18	8.85	8.88	8.85	......	2.18	1.85	8.85	5.80
23	2.85	8.10	4.10	5.85	......	8.85	4.98	2.85	2.02	1.85	2.85	5.80
24	......	8.10	5.85	8.60	8.85	8.10	6.02	2.10	1.85	......	2.60	5.48
25	2.85	8.18	5.85	......	8.85	5.85	......	2.85	1.85	1.77	2.48	5.10
26	2.85	8.18	4.85	10.85	6.10	8.68	6.10	2.88	......	1.77	2.85	......
27	2.85	8.18	4.85	8.85	4.80	......	4.88	2.85	1.85	1.68	8.44†	5.10
28	2.85	......	......	8.60	4.85	2.85	4.02	2.48	2.02	1.68	.....	4.85
29	2.85	......	8.60	6.10	5.68	2.85	8.85	......	1.85	1.68	4.80	4.68
30	2.85	......	8.77	5.93	......	2.85	8.80	2.10	1.68	1.68	4.27	4.85
31	......	......	4.85	......	4.48	......	8.85	2.10	......	......	......	4.85

* Highest for day, 12.43.
† Highest for day, 7.52.

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.10	2.68	2.68	5.85	......	8.85	2.52	1.48	1.60	2.02	8.18	2.85
2	......	2.68	2.68	5.10	5.27	8.60	2.48	1.68	1.52	......	8.02	8.02
3	8.68	2.52	2.68	......	5.18	8.48	......	2.10	1.52	1.85	2.85	2.85
4	8.43	2.52	2.68	8.98	4.98	8.18	2.85	1.85	......	1.85	2.68	......
5	8.10	2.52	2.68	4.10	4.85	......	2.10	1.85	1.68	1.93	2.60	2.60
6	3.10	......	......	8.85	5.18	8.02	2.10	2.52	1.77	2.10	......	2.93
7	8.10	2.52	2.68	8.77	5.02	2.85	2.10	......	1.68	2.27	2.85	2.85
8	8.10	2.52	2.68	8.60	......	2.85	1.98	1.85	1.98	2.10	2.85	25.17
9	......	2.60	2.85	3.85	4.60	2.85	1.93	1.85	2.02	......	2.60	2.48
10	8.10	2.60	2.85	......	4.85	8.18	......	1.85	1.77	2.18	2.52	2.85
11	3.10	2.85	2.85	4.68	4.85	2.77	1.65	1.68	......	2.02	4.10	......
12	8.10	2.85	8.48	5.60	5.52	......	1.85	1.68	1.52	1.98	4.42	2.60
13	8.43	......	......	6.68	11.10	8.68	1.77	1.60	1.52	2.02	......	2.48
14	4.60	8.10	7.85	6.85	6.85	8.85	1.77	......	1.52	2.02	8.27	2.48
15	4.52	8.85	7.10	6.85	......	5.85	1.68	1.52	1.48	2.10	8.27	2.48
16	......	8.10	6.10	6.85	5.85	8.35	1.68	1.52	1.48	.....	8.10	2.60
17	8.85	2.85	4.68	......	4.65	8.85	......	1.52	1.48	2.77	8.18	2.60
18	3.60	2.68	4.85	7.10	4.85	8.27	1.60	1.52	......	2.43	8.18	......
19	8.85	2.68	5.10	6.60	4.60	......	1.60	1.60	1.43	2.85	8.68	2.60
20	8.85	......	......	5.68	5.10	5.85	1.60	2.68	1.48	2.52	.....	2.60
21	8.85	2.68	9.10	5.48	5.85	4.48	1.77	......	1.48	8.18	5.18	2.60
22	8.85	2.68	6.48	5.85	......	4.02	2.10	1.85	1.48	8.10	4.27	2.60
23	......	2.68	5.85	5.10	4.48	4.68	1.85	7.98	1.52	......	8.68	2.85
24	8.10	2.68	6.10	......	4.48	8.85	......	2.02	8.18	4.43	8.43	4.60
25	8.10	2.68	5.85	9.68	5.60	8.85	1.60	2.27	......	8.02	8.85	......
26	8.10	2.68	5.52	8.52	5.85	......	1.60	2.85	8.10	2.85	8.10	8.85
27	8.10	......	......	6.60	5.18	8.02	1.60	2.10	2.60	7.85*	......	2.85
28	2.85	2.68	6.85	5.85	5.85	2.85	1.60	......	2.68	6.10	2.85	2.85
29	2.85	......	6.60	5.85	......	2.68	1.52	1.77	2.48	4.43	2.85	2.85
30	... ..	......	7.68	5.10	4.48	2.60	1.52	1.60	2.18	......	2.85	2.85
31	2.68	......	7.10	......	4.10	......	......	1.60	......	8.48	......	2.85

* Highest per day, 9.43.

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	2.60	8.10	4.85	11.10	2.85	1.77	1.68	1.43	......	2.68	2.02
2	8.10	2.60	8.43	......	11.93	2.68	......	1.68	1.85	1.85	5.18	1.98
3	8.10	2.60	8.48	4.27	11.10	2.52	1.60	2.27	......	1.77	8.60	......
4	2.85	2.60	8.85	8.85	8.60	......	1.60	2.27	1.60	1.60	2.94	2.60
5	2.65	......	......	8.85	6.68	2.85	1.60	1.85	1.43	1.60	......	2.85
6	2.85	2.60	8.85	8.85	6.10	2.85	1.60	......	1.48	1.60	2.68	2.48
7	2.85	2.60	4.43	4.27	......	2.18	1.60	1.77	1.27	1.52	2.60	2.48
8	......	2.60	8.52	4.60	6.18	2.18	2.10	1.60	1.27	......	2.48	2.85
9	2.85	2.60	8.98	......	5.43	2.18	......	1.60	1.27	1.52	2.28	2.85
10	2.65	2.60	8.77	5.68	5.48	2.10	2.77	1.52	......	1.52	2.18	......
11	2.60	2.48	8.60	5.48	4.84	......	2.52	1.60	1.27	1.48	2.18	2.27
12	2.60	......	......	4.85	4.84	1.85	2.10	1.66	1.27	1.43	......	2.27
13	2.60	2.48	4.10	4.18	4.84	1.65	1.93	......	1.27	1.48	1.60	8.27
14	2.60	2.27	5.85	4.68	......	1.85	1.85	1.77	1.27	1.48	1.68	4.60
15	......	2.48	5.85	6.48	4.18	1.85	1.68	1.68	1.27	......	1.93	8.60
16	8.85	2.48	4.60	7.10	8.84	8.18	......	1.52	1.27	1.85	2.10	8.10
17	8.10	2.48	4.27	6.27	8.27	2.98	1.77	1.43	......	1.85	2.10	......
18	8.10	2.48	8.85	6.60	8.27	......	2.10	1.48	1.27	1.48	2.10	2.98
19	2.65	......	......	7.35	8.85	2.10	1.98	1.43	1.27	1.60	......	2.98
20	2.85	2.60	4.10	8.85	8.85	2.02	1.77	......	1.85	1.86	2.27	4.85
21	2.60	2.60	8.85	6.85	......	2.27	1.77	1.43	1.43	1.77	2.68	4.10
22	......	2.77	8.85	7.10	8.85	2.02	1.77	1.85	1.66	......	2.48	8.60
23	2.60	2.85	8.85	8.48	8.27	1.98	......	1.48	1.60	1.60	2.48	8.18
24	2.60	2.85	8.85	10.60	8.18	1.85	2.02	1.48	......	1.60	2.48	......
25	2.60	2.85	8.68	10.10	8 02	......	1.85	1.48	1.52	1.52	2.85	2.98
26	2.60	......	......	10.48	8.02	1.85	1.77	1.43	1.52	1.52	......	2.98
27	2.60	2.85	8.68	11.85	2.93	1.85	2.85	......	2.77	1.52	2.10	2.60
28	2.60	8.10	8.68	9.68	......	1.77	2.18	1.48	2.52	1.77	2.10	2.48
29	......	......	8.98	9.85	8.48	1.85	1.65	1.48	2.10	......	2.10	2.48
30	2.60	......	5.60	9.60	8.10	1.98	......	1.48	1.85	4.85	2.02	2.48
31	2.60	......	5.48	......	8.02	......	1.77	1.48	......	3.02	......	......

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	8.35	9.10	......	8.02	8.68	......	1.60	1.44	1.94	1.86	8.43
2	2.10	8.43	9.98	8.02	6.10	3.52	1.85	1.60	......	1.85	1.85	......
3	2.10	8.43	11.10	8.27	5.35	......	1.77	1.60	1.43	1.77	1.35	8.10
4	2.10	......	......	8.35	8.52	8.60	1.77	1.60	1.43	1.68	......	8.02
5	2.35	8.43	9.52	8.10	6.18	8.35	1.68	......	1.43	1.68	1.85	4.10
6	2.35	8.85	8.85	7.52	......	7.18	1.68	1.52	1.44	1.77	1.78	3.10
7	......	4.10	8.85	7.52	4.78	8.02	1.60	1.52	1.44	......	1.77	8.27
8	2.10	8.93	8.85	.....	4.52	2.86	......	1.60	1.43	1.98	2.18	2.94
9	2.10	8.93	8.27	5.27	4.85	2.94	1.68	1.68	......	8.68	7.48	......
10	2.10	4.18	8.27	4.85	5.60	.....	1.68	1.68	1.48	2.77	7.85	2.68
11	2.10	......	......	4.18	4.52	2.60	1.68	1.60	1.52	5.60	......	2.60
12	2.10	8.94	7.98	4.94	4.27	2.60	1.60	......	1.44	4.18	4.18	2.77
13	2.18	4.10	7.98	4.52	......	2.48	1.77	1.68	1.43	8.27	8.85	2.77
14	......	19.10	7.85	4.93	5.02	2.44	1.94	1.60	1.86	.....	8.60	2.68
15	2.27	10.10	7.77	......	6.85	8.02	......	2.85	1.48	2.77	8.27	2.85
16	2.27	8.27	7.68	5.94	8.27	2.60	1.77	2.02	......	8.02	8.10	......
17	2.27	7.60	7.60	7.10	5.68	......	1.77	2.27	1.86	2.35	2.85	2.43
18	2.27	......	......	8.52	5.27	2.27	1.78	2.27	1.86	2.77	......	2.43
19	2.27	8.77	7.85	11.43	4.94	2.10	1.68	......	1.86	2.60	2.77	2.60
20	2.27	8.77	7.52	18.60	10.43	2.27	1.68	1.98	1.43	2.52	4.18	2.60
21	7.10	8.60	7.52	11.68	6.98	2.02	1.68	1.85	1.44	......	6.10	2.52
22	5.68	8.60	7.43	......	5.68	1.93	......	1.77	2.60	2.27	6.98	2.52
23	5.02	8.60	7.48	10.60	5.10	2.10	1.68	1.68	......	2.18	4.35	.....
24	4.10	8.44	8.10	10.68	4.98	......	1.60	1.68	1.85	2.10	4.27	2.68
25	8.85	......	......	9.85	4.86	1.98	1.60	1.68	1.78	2.52	......	5.93
26	8.77	11.35	7.98	7.77	4.60	1.98	8.10	......	1.68	2.35	4.68	4.85
27	8.60	9.85	7.93	6.98	......	1.85	2.27	1.68	1.68	2.27	5.77	4.68
28	......	9.85	7.98	5.77	4.27	1.68	1.94	1.52	2.48	......	4.85	4.68
29	8.85	......	7.93	......	8.85	1.77	......	1.52	2.10	2.02	4.10	4.52
30	8.27	......	7.60	6.02	8.68	1.77	1.68	1.52	......	1.98	8.77	......
31	8.43	......	7.60	......	8.60	......	1.68	1.44	......	1.98	......	8.43

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.27	2.27	2.85	4.10	5.77	4.98	2.10	8.10	......	1.98	2.10	......
2	8.48	2.85	2.85	4.10	5.52	....	2.02	2.85	1.85	1.85	2.02	2.10
3	8.43	......	......	4.85	5.18	4.85	2.02	2.52	1.77	1.77	......	2.02
4	8.44	2.85	2.10	8.10	4.85	4.68	1.98	......	1.85	1.85	1.98	1.98
5	8.48	2.27	2.27	7.48	......	4.18	1.98	2.77	1.78	1.85	1.98	1.98
6	......	2.10	2.18	6.18	4.10	8.85	6.02	2.27	1.77	......	1.98	1.86
7	8.10	2.10	2.18	9.10	8.85	8.52	......	2.60	1.68	1.77	1.85	1.85
8	2.93	2.18	2.27	11.06	4.85	8.77	2.60	7.10	......	1.68	1.85	......
9	2.85	2.18	2.27	8.78	4.68	......	2.27	4.27	1.60	1.85	1.93	2.10
10	2.77	......	......	7.52	4.52	8.85	2.27	8.98	1.60	1.78	......	2.60
11	2.68	2.18	2.85	7.18	6.56*	8.60	2.10	......	1.60	1.68	1.77	4.85
12	2.68	2.27	8.85	6.85	......	8.27	2.10	8.10	1.60	1.68	1.98	4.48
13	......	2.27	8.18	6.68	6.10	8.10	2.02	2.98	1.68	......	2.60	8.85
14	2.77	2.85	8.10	......	5.52	2.85	......	2.85	1.85	2.10	2.85	8.85
15	2.68	2.85	8.10	7.85	4.77	2.77	1.94	2.68	.....	5.60	2.27	......
16	2.60	2.85	8.10	6.85	4.85	......	1.98	8.85	2.02	4.52	2.18	15.60
17	2.77	.....	......	6.27	8.85	2.52	1.98	8.77	2.10	8.68	......	6.60
18	2.85	2.27	8.02	7.85	3.77	2.85	2.60	......	2.10	8.10	2.02	4.10
19	8.48	2.27	2.98	6.60	......	2.27	8.02	2.68	2.02	2.77	1.94	4.10
20	......	2.27	2.98	6.52	10.10	2.85	2.52	2.48	1.94	......	2.10	8.93
21	8.52	2.18	8.10	......	7.27	2.27	......	2.85	1.98	2.68	2.10	8.85
22	8.48	2.18	5.22	9.48	5.85	2.27	2.18	2.27	......	2.60	2.02	......
23	8.27	2.18	7.10	10.85	4.77	......	2.02	2.27	1.85	2.85	2.02	4.02
24	8.10	......	......	8.68	4.77	2.60	1.98	2.18	1.78	2.27	......	4.02
25	2.85	2.27	5.60	7.52	5.85	2.77	1.98	......	1.77	2.60	2.27	4.27
26	2.85	2.27	5.68	6.98	......	2.85	1.85	2.10	1.77	2.52	2.68	4.18
27	......	2.48	7.48	6.10	......	2.85	1.85	2.10	1.68	.....	2.85	8.98
28	2.68	2.48	9.52	......	6.60	2.18	......	2.02	1.68	2.27	2.18	8.60
29	2.60	......	7.10	5.85	6.98	2.10	8.60	1.98	......	2.18	2.18	......
30	2.60	......	6.18	6.60	6.10	......	8.27	1.98	1.85	2.18	2.10	5.60
31	2.85	......	......	......	5.18	......	4.60	1.85	......	2.10	......	4.85

* Highest for day, 8.10.

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1902.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept	Oct.	Nov.	Dec.
1	4.27	4.98	8.60	7.85	10.10	......	8.48	2.48	2.02	8.60	4.48	2.77
2	8.98	......	......	6.85	7.77	8.10	8.85	2.27	2.02	8.52	......	2.77
8	8.60	4.48	18.10	6.68	6.27	4.18	3.68	......	2.02	8.85	4.18	2.78
4	8.68	8.85	11.27	5.27	......	4.02	5.18	2.27	1.98	8.10	3.98	2.77
5	......	3.77	6.10	4.77	5.52	4.10	4.43	2.48	2.48	......	8.85	2.68
6	8.77	8.60	5.85	......	6.10	8.85	......	2.27	2.85	8.10	8.68	2.68
7	8.77	8.60	4.60	4.27	5.98	8.68	8.60	2.60	......	4.77	8.60	......
8	8.68	8.52	4.18	4.18	5.60	......	8.85	2.52	2.52	8.77	8.52	2.68
9	8.68	......	......	4.10	5.10	5.02	8.10	2.68	2.52	8.85	......	2.60
10	8.68	8.43	8.02	7.10	4.48	4.27	8.02	......	6.10	8.18	8.18	2.60
11	8.68	8.27	8.85	5.68	......	8.93	8.35	2.48	4.60	8.18	8.18	2.60
12	......	8.18	8.60	5.18	8.77	8.60	8.18	8.10	8.18	......	3.10	2.52
18	8.52	8.18	6.48	......	8.10	8.52	......	3.85	2.85	8.02	8.18	2.52
14	8.48	8.18	7.60	4.85	8.10	3.52	2.98	8.02	......	8.02	8.77	......
15	8.86	3.10	5.98	4.48	2.98	......	8.85	8.18	8.98	2.98	8.60	2.52
16	8.85	......	......	4.10	2.77	8.48	8.60	2.68	8.35	2.98	......	2.44
17	8.27	8.10	7.27	4.10	2.27	7.10	8.85	......	8.18	2.85	8.48	4.68
18	8.18	8.10	9.68	4.10	......	4.85	8.18	2.48	2.85	2.68	8.85	7 10
19	......	8.10	6.02	4.02	1.93	4.27	8.10	8.85	2.52	......	8.27	5.02
20	8.02	8.02	5.18	......	8.10	3.68	......	8.35	8.98	5.48	8.18	4.60
21	8.02	2.93	5.18	4.85	8.10	3.43	8.68	2.27	......	4.60	8.18	......
22	8.48	2.93	6.10	4.52	8.02	......	8.52	2.77	8.48	4.10	8.18	5.18
28	9.52	......	......	5.18	2.77	8.85	8.85	2.60	2.98	3.68	......	4.85
24	6.10	2.93	6.43	6.27	2.68	8.85	8.77	......	2.77	8.48	3.10	7.48
25	4.60	2.85	5.85	5.10	......	3.18	8.77	2.27	2.60	3.85	2.93	5.98
26	......	2.77	5.02	5.68	4.60	4.10	8.27	2.18	2.43	......	2.94	......
27	4.85	2.77	4.98	......	7.10	6.02	......	2.18	2.85	8.18	2.98	6.02
28	5.10	4.10	4.98	7.10	10.10	4.52	2.98	2.10	......	9.10	2.98	......
29	5.02	......	6.43	5.60	8.60	......	2.85	2.10	8.52	18.10	2.85	5.77
80	5.18	......	......	5.77	6.60	8.48	2.77	2.10	4.02	7.52	......	5.85
81	5.18	......	8.52	......	5.10	.....	2.60	......	......	5.35	.....	5.27

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1903.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.02	......	......	7.52	5.52	2.18	2.85	2.48	2.27	1.75	2.20	1.80
2	4.85	4.85	8.43	5.35	4.85	2.10	2.68	......	2.18	1.62	2.10	1.75
3	4.77	4.77	6.60	5.27	......	2.10	2.60	2.27	2.18	1.52	2.10	1.70
4	......	4.77	6.02	6.85	3.85	2.10	2.43	2.18	1.90*	1.45	2.05	1.72
5	4.85	4.68	5.93	......	4.02	2.02	......	2.13	1.92	1.62	2.00	1.70
6	4.77	4.60	5.77	5.68	3.77	2.02	2.27	2.18	1.90	1.78	2.35	1.75
7	4.60	4.43	5.68	5.35	3.68	......	2.27	2.35	2.02	1.98	2.52	1.78
8	4.52	......	......	5.35	3.68	2.02	2.18	2.27	2.05	1.82	2.35	1.80
9	4.48	4.43	8.60	6.02	3.93	2.43	2.18	......	1.90	2.20	2.15	1.75
10	4.43	4.35	11.52	6.10	......	2.52	2.10	2.18	1.90	2.78	2.05	1.80
11	......	4.27	12.10	5.18	3.85	2.85	2.10	2.18	1.78	2.40	2.10	1.82
12	4.27	4.10	16.60	......	3.60	2.36	.....	3.52	1.82	2.20	2.00	1.80
13	4.18	4.27	9.10	4.93	3.60	9.43	2.10	3.35	1.60	2.10	1.98	1.90
14	4.18	5.27	8.52	4.77	3.35	......	2.10	3.18	1.62	2.10	1.90	2.42
15	4.10	......	......	4.68	3.27	5.52	2.02	2.93	1.60	2.00	1.95	2.55
16	4.10	4.85	6.68	4.60	3.27	4.35	1.94	......	1.52	1.88	1.90	2.48
17	4.10	4.77	5.85	4.60	......	3.85	1.94	2.68	1.42	1.88	2.02	2.40
18	......	4.77	6.27	4.43	2.93	3.35	2.18	2.52	1.72	3.65	2.42	2.22
19	4.02	4.68	6.18	......	2.85	3.35	......	2.43	2.10	3.65	2.60	2.28
20	8.93	4.60	8.43	2.02	2.85	3.10	2.10	2.43	2.00	2.78	2.45	2.90
21	4.60	4.43	12.18	3.85	2.77	......	4.93	4.27	1.82	2.58	2.10	6.40
22	4.35	......	......	3.77	2.60	8.60	4.02	3.18	1.72	2.48	2.10	7.18
23	4.10	4.35	8.52	3.68	2.52	5.68	8.52	......	1.65	2.30	2.05	6.52
24	4.10	3.93	10.27	3.60	......	4.52	3.18	2.52	1.62	2.38	2.15	6.48
25	......	3.77	10.93	3.43	2.43	3.68	2.93	2.43	1.58	2.30	2.38	6.32
26	4.18	3.68	8.68	......	2.35	4.02	......	2.35	1.52	2.12	2.30	6.00
27	4.18	3.60	8.60	3.52	2.10	3.52	2.60	2.35	1.45	2.15	1.90	5.90
28	4.10	4.10	6.27	3.52	2.10	......	2.52	2.27	1.50	2.05	1.78	5.80
29	4.10	......	......	3.35	2.10	3.18	2.85	2.85	1.82	1.95	1.70	5.65
30	4.27	......	4.93	5.10	2.27	2.93	2.52	......	1.78	2.10	1.80	5.40
31	4.52	......	4.68	......	......	......	2.52	2.28	......	2.10	......	5.20

* New gage installed on September 4, 1903.
Ice December 21-31.

MEAN DAILY GAGE HEIGHT, IN FEET, OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.20	3.90	......	......	8.85	2.85	2.05	1.78	1.32	5.55	2.82	......
2	5.15	......	......	6.70	7.85	2.80	3.00	1.88	1.90	4.55	2.72	......
3	......	......	......	......	6.83	2.62	3.00	1.98	1.72	3.90	2.70	......
4	4.75	......	4.65	......	7.12	2.48	2.55	2.48	2.20	3.50	2.62	......
5	......	3.65	......	6.12	7.30	2.40	2.10	2.00	2.35	3.20	2.55	......
6	......	......	......	3.42	6.75	2.72	2.06	1.98	1.90	3.05	......	......
7	......	......	4.60	5.80	5.80	2.98	2.01	1.80	1.90	2.90	......	......
8	3.90	4.25	......	5.50	6.00	3.20	1.85	1.82	1.88	2.88	......	......
9	......	......	3.60	7.20	5.68	3.15	1.88	1.72	1.30	2.70	......	......
10	......	......	......	9.40	6.45	2.78	1.80	1.70	1.80	2.75	......	......
11	4.20	......	......	7.88	3.25	2.55	1.78	1.70	1.45	2.82	......	......
12	......	3.30	6.70	6.45	6.45	2.35	1.72	2.10	1.80	2.95	......	......
13	......	......	......	5.55	5.28	2.32	1.82	2.05	1.62	2.82	......	......
14	......	......	6.65	4.78	4.82	2.25	1.92	1.85	1.62	2.83	......	......
15	4.40	4.10	......	4.48	4.70	2.15	1.82	1.80	4.65	2.72	......	......
16	......	......	......	4.18	8.02	2.00	1.72	2.05	4.82	2.60	......	......
17	......	......	......	3.95	9.90	1.88	1.70	1.98	3.40	2.50	......	......
18	4.30	......	......	3.80	6.28	1.95	1.62	1.92	2.95	2.35	......	......
19	......	4.15	4.30	4.05	6.82	1.90	1.68	1.90	2.60	2.50	......	......
20	......	......	......	4.28	9.50	1.90	1.60	2.30	2.50	2.35	......	......
21	......	......	......	3.92	6.62	1.95	1.62	6.62	2.80	3.20	......	......
22	4.10	4.20	5.10	3.92	5.40	2.00	1.58	3.80	2.85	7.88	......	......
23	......	......	......	4.32	4.75	2.12	1.52	3.22	2.48	5.60	......	......
24	......	......	......	5.25	4.35	2.00	1.45	2.85	2.40	3.88	......	......
25	4.20	......	......	6.70	3.98	1.98	1.58	2.50	5.30	3.42	......	......
26	......	......	3.30	7.52	3.80	1.95	1.58	2.32	3.75	3.35	......	......
27	......	4.50	12.45	7.28	3.48	1.90	1.98	2.20	3.72	4.23	......	......
28	......	......	......	7.82	3.42	1.38	2.50	2.00	3.20	3.62	......	......
29	4.30	4.55	10.00	3.88	3.30	1.92	2.05	1.90	3.00	3.25	......	......
30	......	......	......	9.68	3.08	1.93	2.32	1.85	7.22	3.15	......	......
31	......	......	3.40	......	2.95	......	1.35	1.85	......	2.98	......	......

Ice January 1 to April 4.

RATING TABLE FOR PEMIGEWASSET RIVER AT PLYMOUTH, N. H., FROM JANUARY 1, 1886, TO DECEMBER 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
....	......	2.00	340	3.00	1,020	4.00	1,920	5.00	2,980	6.00	4,400
....	......	2.10	395	3.10	1,110	4.10	2,020	5.10	3,100	6.10	4,560
....	......	2.20	455	3.20	1,200	4.20	2,120	5.20	3,220	6.20	4,720
1.30	124	2.30	515	3.30	1,290	4.30	2,220	5.30	3,350	6.30	4,890
1.40	140	2.40	575	3.40	1,380	4.40	2,320	5.40	3,480	6.40	5,060
1.50	160	2.50	640	3.50	1,470	4.50	2,420	5.50	3,620	6.50	5,230
1.60	185	2.60	710	3.60	1,560	4.60	2,530	5.60	3,770	6.60	5,400
1.70	215	2.70	780	3.70	1,650	4.70	2,640	5.70	3,920	6.70	5,570
1.80	250	2.80	860	3.80	1,740	4.80	2,750	5.80	4,080	6.80	5,750
1.90	290	2.90	940	3.90	1,830	4.90	2,860	5.90	4,240	6.90	5,930

RATING TABLE FOR PEMIGEWASSET RIVER AT PLYMOUTH, N. H.—*Concluded.*

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
7.00	6,110	8.00	7,970	9.00	9,970	10.00	12,050	11.00	14,150	12.00	16,250
7.10	6,290	8.10	8,170	9.10	10,170	......	....	......	....	......	....
7.20	6,470	8.20	8,370	9.20	10,370	10.20	12,470	11.20	14,570	12.20	16,670
7.30	6,650	8.30	8,570	9.30	10,580	......	....	......	....	......	....
7.40	6,830	8.40	8,770	9.40	10,790	10.40	12,890	11.40	14,990	12.40	17,090
7.50	7,020	8.50	8,970	9.50	11,000	......	....	......	....	......	....
7.60	7,210	8.60	9,170	9.60	11,210	10.60	13,310	11.60	15,410	12.60	17,510
7.70	7,400	8.70	9,370	9.70	11,420	......	....	......	....	......	....
7.80	7,590	8.80	9,570	9.80	11,630	10.80	13,730	11.80	15,830	12.80	....
7.90	7,780	8.90	9,770	9.90	11,840	......	....	......	....	......	17,930
......	......	......	......	......	....	......	....	......	....	13.00	18,350
......	......	......	......	......	....	......	....	......	....	14.00	20,450
......	......	......	......	......	....	......	....	......	....	15.00	22,550
......	......	......	......	......	....	......	....	......	....	16.00	24,650
......	......	......	......	......	....	......	....	......	....	17.00	26,750
......	......	......	......	......	....	......	....	......	....	18.00	28,850

The above table is applicable only for open channel conditions. It is based upon discharge measurements made between September 4, 1903, and November 1, 1904, and is well defined. It has been applied to the nearest hundreth up to five-foot gage height, to the nearest half tenth from five-foot to nine-foot gage height, and to the nearest tenth to gage heights above nine feet.

ESTIMATED MONTHLY DISCHARGE OF PEMIGEWASSET RIVER AT PLYMOUTH, N. H., FOR 1886 AND 1887.

(Drainage area, 615 square miles.)

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1886.					
April 16-30	13,810	2,805	7,247	11.78	6.57
May	4,975	1,182	2,334	3.80	4.38
June	2,350	598	1,085	1.76	1.96
July	1,713	395	551	.90	1.04
August	1,407	305	475	.77	.89
September	2,896	185	540	.88	.98
October	2,070	350	658	1.06	1.22
November 1-15	3,770	964	1,828	2.97	1.66
1887.					
April 16-30	15,725	2,717	7,295	11.86	6.62
May	16,460	2,190	6,871	11.17	12.88
June	20,450	766	3,006	4.89	5.46
July	8,970	766	2,002	3.26	3.76
August	2,020	598	1,040	1.69	1.95
September	900	350	565	.92	1.03
October	1,268	350	478	.77	.89
November 1-15	497	350	418	.67	.37

Sundays interpolated.

ESTIMATED MONTHLY DISCHARGE OF PEMIGEWASSET RIVER, AT PLYMOUTH, N. H., FOR 1888 AND 1889.

(Drainage area, 615 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1888.							
April 16-30......	22,760	1,858	5,309	8.64	4.82	....	....
May............	20,135	3,415	8,756	14.24	16.42	....	....
June	5,400	350	1,867	3.04	3.39	107	3.17
July............	1,632	350	697	1.13	1.30	82	1.58
August.........	2,020	305	684	1.11	1.28	33	3.91
September......	7,685	350	1,816	2.95	3.29	41	8.06
October.........	6,290	1,835	2,729	4.44	5.12	99	5.18
November 1-15..	7,020	1,857	3,066	4.99	2.78	....	5.28
December	....	....	....	....	....	....	2.28
The period...	....	....	....	....	....	....	29.46
1889.							
January.........	....	....	....	....	....	....	4.29
February.......	....	....	....	.... ..	....	....	2.86
March..........	....	....	....	....	....	....	2.24
April 16-30	8,870	2,850	5,315	8.64	4.82	....	1.60
May............	7,400	964	2,092	3.40	3.92	180	2.21
June	11,210	654	2,183	3.55	3.96	86	4.61
July............	7,495	545	1,700	2.76	3.18	68	4.67
August..........	7,875	350	1,362	2.21	2.55	80	3.17
September	7,020	289	1,077	1.75	1.95	42	4.63
October.........	8,670	654	2,018	3.28	3.78	91	4.14
November 1-15..	2,190	1,110	1,548	2.52	1.40	....	4.66
December.......	....	....	....	....	....	....	5.09
The year......	....	....	....	....	....	....	44.17

Sundays interpolated.
Rainfall at Plymouth, N. H.

ESTIMATED MONTHLY DISCHARGE OF PEMIGEWASSET RIVER AT PLYMOUTH, N. H., FOR 1890 AND 1891.

(Drainage area, 615 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1890.							
January	....	....	....	....	....	....	3.85
February........	....	....	....	....	....	....	4.82
March........	....	....	....	....	....	....	4.41
April 16-30......	8,970	3,620	5,714	9.29	5.18	....	2.19
May............	17,570	2,270	6,619	10.76	12.41	200	6.24
June	3,770	710	1,690	2.75	3.07	100	2.95
July............	7,495	395	1,154	1.88	2.17	49	4.46
August	10,685	270	1,671	2.72	3.14	56	5.60
September......	15,410	900	3,302	5.37	5.99	110	5.63
October........	7,210	964	2,101	3.42	3.94	80	4.93
November 1-15..	1,857	1,110	1,360	2.21	1.24	....	2.05
December.......	....	....	....	....	....	....	3.94
The year......	....	....	....	....	....	....	51.07
1891.							
January	....	....	....	....	....	....	6.09
February	....	....	....	....	....	....	3.35
March..........	....	....	....	....	....	....	3.85
April 16-30......	15,410	3,100	8,380	13.63	7.60	....	2.31
May............	4,560	1,335	2,705	4.40	5.07	220	2.28
June............	2,350	493	1,190	1.93	2.15	75	2.36
July............	3,415	305	783	1.27	1.46	26	5.58
August	3,100	270	809	1.32	1.52	29	5.29
September......	1,835	185	515	.84	.94	76	1.23
October.........	593	165	234	.38	.44	26	1.66
November 1-15..	1,940	145	421	.63	.38	....	3.26
December.......	....	....	....	....	....	....	5.45
The year......	....	....	....	....	....	....	43.21

Sundays interpolated.
Rainfall at Plymouth, N. H.

ESTIMATED MONTHLY DISCHARGE OF PEMIGEWASSET RIVER AT PLYMOUTH, N. H., FOR 1892 AND 1893.

(Drainage area, 615 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1892.							
January	....	....	....	....	....	....	5.01
February	....	....	....	....	....	....	1.98
March	....	....	....	....	....	....	1.67
April 16-30	2,618	900	1,467	2.39	1.38	....	1.04
May	7,020	1,407	8,277	5.33	6.18	110	5.53
June	10,170	497	2,290	3.72	4.15	61	6.76
July	9,670	270	1,695	2.76	3.18	190	1.66
August	6,290	185	1,211	1.97	2.27	21	10.85
September	9,670	350	1,029	1.67	1.86	170	1.10
October	710	327	466	.76	.88	46	1.90
November 1-15	3,920	545	1,385	2.25	1.25	....	4.29
December	....	....	....	....	....	....	0.95
The year	....	....	....	....	....	....	42.69
1893.							
January	....	....	....	....	....	....	2.48
February	....	....	....	....	....	....	5.78
March	....	....	....	....	....	....	2.78
April 16-30	5,280	2,020	2,928	4.75	2.65	....	2.42
May	17,195	1,488	7,117	11.57	13.34	290	4.61
June	2,805	395	958	1.56	1.74	91	1.92
July	895	165	241	.39	.45	20	2.27
August	6,925	165	692	1.13	1.30	22	6.01
September	1,560	270	619	1.01	1.13	59	1.92
October	6,925	270	1,648	2.68	3.09	57	5.46
November 1-15	1,785	497	864	1.41	.79	....	2.57
December	....	....	....	....	....	....	4.02
The year	....	....	....	....	....	....	42.19

Sundays interpolated.
Rainfall at Plymouth, N. H.

ESTIMATED MONTHLY DISCHARGE OF PEMIGEWASSET RIVER AT PLYMOUTH, N. H., FOR 1894 AND 1895.

(Drainage area, 615 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1894.							
January	....	....	....	....	....	....	2.01
February	....	....	....	....	....	....	2.75
March	....	....	....	....	....	....	1.84
April 16-30	18,560	2,805	6,513	10.59	5.91	....	1.67
May	14,675	654	2,519	4.10	4.73	110	4.36
June	6,290	497	1,380	2.24	2.50	68	3.70
July	766	165	419	.68	.78	32	2.48
August	270	145	170	.28	.32	10	3.12
September	4,400	145	598	.97	1.08	25	4.32
October	2,530	209	635	1.03	1.19	31	3.83
November 1-15.	4,560	545	1,337	2.17	1.21	....	2.27
December	....	....	....	....	....	....	1.88
The year	....	....	....	....	....	....	34.18
1895.							
January	....	....	....	....	....	....	2.47
February	....	....	....	....	....	....	0.30
March	....	....	....	....	....	....	1.66
April 16-30	13,730	3,415	6,432	10.46	5.84	....	7.21
May	6,290	710	2,318	3.76	4.33	180	2.46
June	1,735	395	845	1.37	1.53	41	3.75
July	710	209	388	.63	.73	23	3.12
August	1,132	239	469	.76	.88	22	3.99
September	710	185	294	.48	.54	15	3.53
October	2,190	305	677	1.10	1.27	64	2.00
November 1-15.	5,400	545	1,457	2.37	1.32	....	5.26
December	....	....	....	....	....	....	5.52
The year	....	....	....	....	....	....	41.27

Sundays interpolated.
Rainfall at Plymouth, N. H.

ESTIMATED MONTHLY DISCHARGE OF PEMIGEWASSET RIVER AT PLYMOUTH, N. H., FOR 1896 AND 1897.

(Drainage area, 615 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1896.							
January	....	....	....	....	....	....	0.39
February	....	....	....	....	....	....	5.51
March	....	....	....	....	....	....	7.83
April 16-30	18,560	2,530	7,986	12.99	7.25	....	0.94
May	2,618	598	1,358	2.21	2.55	150	1.69
June	1,632	239	716	1.16	1.29	96	1.34
July	8,285	185	497	.81	.93	32	2.92
August	1,335	239	493	.80	.92	25	3.61
September	6,290	270	1,298	2.11	2.35	42	5.55
October	11,210	545	1,738	2.83	3.26	64	5.09
November 1-15	19,610	900	3,560	5.79	3.23	....	5.26
December	....	....	....	....	....	....	1.07
The year	....	....	....	....	....	....	41.20
1897.							
January	....	....	....	....	....	....	3.27
February	....	....	....	....	....	....	2.79
March	....	....	....	....	....	....	3.49
April 16-30	18,835	3,220	7,497	12.19	6.80	....	1.60
May	22,285	1,885	4,085	6.64	7.66	167	4.57
June	18,415	900	2,658	4.32	4.82	88	5.49
July	30,685	654	3,878	6.31	7.27	107	6.77
August	1,335	395	698	1.13	1.30	51	2.53
September	448	185	259	.42	.47	51	0.92
October	2,580	165	363	.59	.68	36	1.87
November 1-15	5,840	209	1,498	2.43	1.36	....	5.17
December	....	....	....	....	....	....	4.80
The year	....	....	....	....	....	....	43.27

Sundays interpolated.
Rainfall at Plymouth, N. H.

ESTIMATED MONTHLY DISCHARGE OF PEMIGEWASSET RIVER AT PLYMOUTH, N. H., FOR 1898 AND 1899.

(Drainage area, 615 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1898.							
January	....	....	....	....	....	....	5.38
February	....	....	....	....	....	....	3.56
March	....	....	....	....	....	....	1.26
April 16-30	11,420	3,100	5,395	8.77	4.89	....	2.83
May	14,360	2,020	3,460	5.63	6.49	220	2.90
June	4,160	710	1,517	2.47	2.76	95	2.92
July	654	156	290	.47	.54	23	2.31
August	769	145	302	.49	.56	11	5.29
September	1,182	145	341	.55	.61	14	4.47
October	7,685	270	1,122	1.82	2.11	53	3.98
November 1-15	2,340	654	1,147	1.37	1.04	....	3.64
December	....	....	....	....	....	....	1.72
The year	....	....	....	....	....	....	40.26
1899.							
January	....	....	....	....	....	....	2.88
February	....	....	....	....	....	....	2.06
March	....	....	....	....	....	....	5.70
April 16-30	14,885	4,805	9,448	15.36	8.57	....	1.77
May	16,145	964	3,680	5.98	6.89	590	1.17
June	1,182	239	453	.74	.83	30	2.74
July	836	185	317	.52	.60	17	3.44
August	497	132	197	.32	.37	13	2.87
September	836	120	193	.32	.36	12	3.09
October	2,270	132	307	.50	.58	33	1.73
November 1-15	3,220	185	788	1.28	.71	....	1.54
December	....	....	....	....	....	....	1.78
The year	....	....	....	....	....	....	30.77

Sundays interpolated.
Rainfall at Plymouth, N. H.

ESTIMATED MONTHLY DISCHARGE OF PEMIGEWASSET RIVER AT PLYMOUTH, N. H., FOR 1900 AND 1901.

(Drainage area, 615 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1900.							
January	....	....	....	....	....	....	4.86
February	....	....	....	....	....	....	6.44
March	....	....	....	....	....	....	4.75
April 16-30	19,610	4,000	9,870	16.05	9.25	....	0.65
May	12,995	1,560	3,953	6.42	7.40	430	1.72
June	6,470	209	900	1.46	1.63	67	2.44
July	1,110	185	263	.43	.50	16	3.22
August	900	147	250	.41	.47	19	2.42
September	710	134	215	.35	.39	24	1.61
October	3,770	209	730	1.19	1.37	35	3.94
November 1-15	7,685	239	1,866	3.03	1.69	....	6.15
December	....	....	....	....	....	....	0.97
The period	....	....	....	....	....	....	39.17
1901.							
January	....	....	....	....	....	....	1.52
February	....	....	....	....	....	....	0.42
March	....	....	....	....	....	....	4.30
April 16-30	12,785	4,160	6,706	10.90	6.08	....	4.48
May	12,260	1,713	3,895	6.33	7.30	134	5.44
June	2,896	395	1,170	1.90	2.12	121	1.75
July	2,530	270	571	.93	1.07	16	6.79
August	6,290	270	1,016	1.65	1.90	43	4.37
September	395	185	259	.42	.47	19	2.42
October	3,770	209	660	1.07	1.23	90	1.37
November 1-15	710	239	361	.59	.33	....	1.77
December	....	....	....	....	....	....	6.20
The period	....	....	....	....	....	....	41.33

Sundays interpolated.
Rainfall at Plymouth, N. H.

ESTIMATED MONTHLY DISCHARGE OF PEMIGEWASSET RIVER AT PLYMOUTH, N. H., FOR 1902 AND 1903.

(Drainage area, 615 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1902.							
January	....	....	....	....	....	....	2.27
February	....	....	....	....	....	....	1.83
March	....	....	....	....	....	....	4.37
April 16–30	6,290	1,940	3,266	5.31	2.96	....	3.41
May	12,260	305	3,377	5.49	6.33	210	3.02
June	6,290	1,110	2,044	3.32	3.70	82	4.52
July	3,220	710	1,431	2.33	2.69	84	3.20
August	1,335	365	696	1.13	1.30	34	3.86
September	4,560	305	1,128	1,83	2.04	36	5.72
October	18,560	766	2,538	4.13	4.76	110	4.27
November 1–15	2,350	1,110	1,617	2.63	1.47	....	1.16
December	....	....	....	....	....	....	5.22
1903.							
January	....	....	....	....	....	....	3.92
February	....	....	....	....	....	....	....
March	....	....	....	....	....	....	5.29
April 16–30	3,100	350	1,729	2.81	1.56	....	1.88
May	3,620	395	1,285	2.09	2.41	1,600	0.15
June	10,895	350	2,099	3.41	3.80	60	6.34
July	2,896	310	725	1.18	1.36	31	4.44
August	2,190	443	758	1.23	1.42	43	3.28
September	497	144	264	0.40	0.45	58	0.78
October	1,605	149	486	0.79	0.91	26	3.44
November	710	215	412	0.67	0.75	50	1.50
December 1–20*	940	215	376	0.61	0.45	....	2.53

Sundays interpolated.
Rainfall at Plymouth, N. H.
* Frozen, December 21–31.

ESTIMATED MONTHLY DISCHARGE OF PEMIGEWASSET RIVER AT PLYMOUTH, N. H., FOR 1904.

(Drainage area, 615 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1904.							
January........	....	....	....	....	....	....	2.05
February........	....	....	....	....	....	....	1.82
March........	....	....	....	....	....	....	2.84
April 5-30*.......	11,420	1,898	4,607	7.49	7.24	....	5.58
May............	11,840	980	4,741	7.71	8.89	170	5.14
June............	1,200	282	587	0.87	0.97	48	2.26
July............	1,020	149	888	0.55	0.63	15	4.14
August..........	5,400	215	594	0.97	1.12	27	4.18
September......	6,470	149	1,045	1.70	1.90	30	6.40
October.........	7,780	545	1,528	2.48	2.86	94	3.04

* Ice, December 21, 1903, to April 4, 1904.
Rainfall at Plymouth, N. H.

CONNECTICUT RIVER DRAINAGE BASIN.

Connecticut River has its source in Connecticut Lake, in northern New Hampshire. Its extreme headwaters, however, lie in the province of Quebec and in the mountains on the northern boundary of New Hampshire; thence the river flows in a southerly direction between New Hampshire and Vermont and through Massachusetts and Connecticut into Long Island Sound. The total drainage area is 11,085 square miles, of which 155 square miles lie in the province of Quebec. Its total length from Connecticut Lake to Long Island Sound is 345 miles. On its banks are many cities and towns of importance. It is in general closely followed by one or more railroad lines. Water power is used at several points, notably at Windsor Locks in Connecticut, Holyoke and Turner's Falls in Massachusetts and Bellows Falls and Wilder in Vermont. The valley of Connecticut River proper is very generally in farm lands. Many of its tributary basins, however, especially in the northern portions, are heavily wooded.

DRAINAGE AREA OF CONNECTICUT RIVER AND TRIBUTARIES.

River.	Locality.	Area—square miles.
Connecticut	Mouth	11,085
Connecticut	Hartford, Conn.	10,235
Connecticut	Orford, N. H	8,305
Connecticut	In Canada	155
Ashuelot	Winchester, N. H	885
White	Sharon, Vt	680
Ammonoosuc	Bretton Woods, N. H	34
Zealand	Mouth	14
Israel	Below South Branch	21.2
Israel	Above South Branch	8.7
Passumpsic	St. Johnsbury Center, Vt	390

ISRAEL RIVER (ABOVE SOUTH BRANCH) NEAR JEFFERSON HIGHLANDS, N. H.

This station, shown on Plate IV, was established September 2, 1903, by N. C. Grover. It is located at a small wooden highway bridge in the town of Randolph, about half way between the railway stations of Jefferson Highlands and Bowman and two and one half miles from either place. The drainage basin at this point has an area of 8.7 square miles. The headwaters of the river lie on the slopes of Mount Adams and Mount Jefferson, at elevations approximating 5,000 feet. The length of the river from its source to the gaging station is about five miles. The elevation at the gaging station is about 1,400 feet. All slopes are steep; many are precipitous. There is no pondage or artificial storage of the water. The underlying rock is granite, exposed in the mountain tops. The basin was generally in virgin forest when this station was established but a considerable area was cut during the winter of 1903-'04. A statement in detail of the forest conditions on this drainage area will be found on page 143.

A standard chain gage is attached to the upstream truss of the bridge; length of chain, 15.43 feet. It is referred to bench marks as follows: (1) Marked point on east end of cross timber of bridge, elevation 8.58 feet; (2) Top of boulder, 150 feet east of bridge, 30 feet south of river, elevation, 11.99 feet. Elevations are above datum of gage. The channel is straight for 100 feet above and 50 feet below the station and is about 20 feet wide. The banks are subject to overflow in extreme freshet. Low water measurements are made by wading about 20 feet above the bridge. The bed is gravelly and permanent. The gage is read once daily by E. A. Crawford of Jefferson Highlands.

LIST OF DISCHARGE MEASUREMENTS OF ISRAEL RIVER, ABOVE SOUTH BRANCH, AT RANDOLPH, N. H.

No.	Date.	Hydrographer.	Area of sec. (Sq. ft.)	Mean veloc. (Ft. per sec.)	Gage height. (Feet.)	Discharge. (Sec. ft.)
	1903.					
1	Sept. 2	H. K. Barrows.......	14.1	0.67	1.20	9.4
2	Sept. 18	H. K. Barrows.......	14.1	0.57	1.17	8.1
3	Oct. 9	N. C. Grover.........	12.6	0.46	1.15	5.8
	1904.					
4	Apr. 16	N. C. Grover.........	23	0.94	1.44	22
5	Apr. 18	N. C. Grover.........	24	0.92	1.48	22
6	May 1	S. K. Clapp	46	2.18	2.33	100
7	May 11	S. K. Clapp	48	2.44	2.35	117
8	May 25	S. K. Clapp	29	1.14	1.60	33
9	June 15	S. K. Clapp	16	0.41	1.08	6.6
10	July 22	S. K. Clapp	3.1	1.26	1.04	3.9
11	Aug. 10	S. K. Clapp	3.0	1.43	1.04	4.3
12	Sept. 24	H. K. Barrows.......	17	1.04	1.41	18
13	Oct. 13	T. W. Norcross......	17	0.75	1.32	12

MEAN DAILY GAGE HEIGHT, IN FEET, OF ISRAEL RIVER, ABOVE SOUTH BRANCH, JEFFERSON HIGHLANDS, N. H., FOR 1903.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	......	......	......	......	......	......	1.08	1.22	1.08
2	......	......	......	......	......	......	......	......	1.20	1.15	1.20	1.08
3	......	......	......	......	......	......	......	......	1.20	1.12	1.20	1.20
4	......	......	......	......	......	......	......	......	1.20	1.10	1.20	1.80
5	......	......	......	......	......	......	......	......	1.20	1.58	1.22	1.60
6	......	......	......	......	......	......	......	......	1.20	1.20	1.88	1.70
7	......	......	......	......	......	......	......	......	1.20	1.15	1.82	1.70
8	......	......	......	......	......	......	......	......	1.10	1.15	1.20	1.60
9	......	......	......	......	......	......	......	......	1.10	1.20	1.08	1.50
10	......	......	......	......	......	......	......	......	1.10	1.15	1.08	1.80
11	......	......	......	......	......	......	......	......	1.10	1.10	1.10	1.20
12	......	......	......	......	......	......	......	......	1.10	1.10	1.20	1.20
13	......	......	......	......	......	......	......	......	1.10	1.20	1.20	1.40
14	......	......	......	......	......	......	......	......	1.10	1.20	1.18	2.20
15	......	......	......	......	......	......	......	......	1.10	1.20	1.18	2.20
16	......	......	......	......	......	......	......	......	1.10	1.18	1.18	2.00
17	......	......	......	......	......	......	......	......	1.10	1.18	1.18	1.80
18	......	......	......	......	......	......	......	......	1.18	1.50	*1.32	1.60
19	......	......	......	......	......	......	......	......	1.10	1.28	1.55	1.40
20	......	......	......	......	......	......	......	......	1.10	1.25	1.55	1.40
21	......	......	......	......	......	......	......	......	1.10	1.20	1.60	2.20
22	......	......	......	......	......	......	......	......	1.10	1.20	1.60	2.40
23	......	......	......	......	......	......	......	......	1.10	1.20	1.32	2.50
24	......	......	......	......	......	......	......	......	1.10	1.80	1.12	2.50
25	......	......	......	......	......	......	......	......	1.10	1.25	1.62	2.40
26	......	......	......	......	......	......	......	......	1.08	1.20	1.40	2.00
27	......	......	......	......	......	......	......	......	1.08	1.15	1.30	2.00
28	......	......	......	......	......	......	......	......	1.15	1.15	1.35	1.10
29	......	......	......	......	......	......	......	......	1.10	1.18	1.88	1.40
30	......	......	......	......	......	......	......	......	1.10	1.25	1.08	1.40
31	......	......	......	......	......	......	......	......	......	1.22	......	1.20

*Anchor ice from November 18-December 31.

MEAN DAILY GAGE HEIGHT, IN FEET, OF ISRAEL RIVER, ABOVE SOUTH BRANCH, JEFFERSON HIGHLANDS, N. H., FOR 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.20	.80	.80	1.40	2.35	1.35	1.10	1.20	1.10	1.60	1.45	......
2	1.20	.80	.80	1.30	2.00	1.30	1.10	1.18	1.32	1.60	1.45	......
3	1.10	.80	.80	1.30	1.90	1.40	1.45	1.30	1.60	1.60	1.40	......
4	1.05	.78	.80	1.30	2.10	1.35	1.45	1.30	1.55	1.50	1.35	......
5	1.00	.78	.80	1.30	2.10	1.30	1.30	1.20	1.50	1.50	1.35	......
6	1.00	.78	.80	1.25	2.00	1.30	1.25	1.15	1.40	1.60	......	......
7	.90	1.80	.80	1.65	2.10	1.45	1.20	1.10	1.40	1.60	......	......
8	.90	2.50	.80	1.60	2.10	1.40	1.15	1.05	1.35	1.60	......	......
9	.85	2.80	.80	1.50	2.00	1.35	1.10	1.00	1.30	1.55	......	......
10	.85	3.00	.80	1.50	1.90	1.30	1.05	1.00	1.30	1.50	......	......
11	.85	2.50	.80	1.50	2.35	1.25	1.00	1.05	1.25	1.50	......	......
12	.85	1.50	.80	1.50	1.80	1.20	.95	1.10	1.20	1.40	......	......
13	.82	1.30	.80	1.70	1.70	1.15	1.20	1.35	1.15	1.35	......	......
14	.82	1.10	2.00	1.70	1.70	1.15	1.10	1.30	1.15	1.30	......	......
15	.82	1.00	3.20	1.50	1.65	1.12	1.08	1.62	2.15	1.30	......	......
16	.80	1.00	3.00	1.45	2.00	1.12	1.05	1.55	1.60	1.30	......	......
17	.80	.95	2.70	1.40	3.20	1.10	1.00	1.50	1.60	1.30	......	......
18	.80	.92	2.40	1.40	2.10	1.10	.98	1.40	1.30	1.30	......	......
19	.80	.90	3.20	1.45	2.25	1.05	.98	1.30	1.20	1.28	......	......
20	.80	.88	4.30	1.45	2.30	1.00	.98	1.25	1.70	1.20	......	......
21	.80	.88	4.00	1.50	2.00	.95	.98	1.68	1.60	1.28	......	......
22	.80	.88	3.40	1.50	2.00	1.35	.95	1.62	1.60	1.25	......	......
23	.80	.88	3.00	1.60	1.80	1.25	.95	1.60	1.50	2.00	......	......
24	.80	.85	4.40	1.68	1.75	1.25	.98	1.55	1.40	1.90	......	......
25	.80	.85	4.80	2.70	1.60	1.30	1.00	1.50	1.60	1.80	......	......
26	.80	.85	4.70	1.70	1.65	1.25	1.20	1.40	1.60	1.70	......	......
27	.80	.82	4.00	1.70	1.65	1.10	1.20	1.30	1.50	1.75	......	......
28	.80	.82	2.00	1.90	1.55	1.10	1.15	1.20	1.40	1.70	......	......
29	.80	.82	1.70	2.90	1.50	1.15	1.18	1.15	2.00	1.60	......	......
30	.80	......	1.40	2.30	1.45	1.15	1.20	1.15	1.90	1.55	......	......
31	.80	......	1.40	......	1.40	.....	1.15	1.10	......	1.55	......	......

RATING TABLE FOR ISRAEL RIVER, ABOVE SOUTH BRANCH, NEAR RANDOLPH, N. H., FROM SEPTEMBER 2, 1903, TO DECEMBER 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
....	....	1.00	3.0	2.00	67	3.00	230	4.00	410
....	....	1.05	4.0	2.05	78	....	....	....	....
....	....	1.10	5.3	2.10	79	3.10	248	4.10	428
....	....	1.15	6.8	2.15	86	....	....	....	....
....	....	1.20	8.6	2.20	93	3.20	266	4.20	446
....	....	1.25	10.5	2.25	100	....	....	....	....
....	....	1.30	13	2.30	108	3.30	284	4.30	464
....	....	1.35	15	2.35	116	....	....	....	....
....	....	1.40	18	2.40	124	3.40	302	4.40	482
....	....	1.45	21	2.45	132	....	....	....	....
....	....	1.50	24	2.50	140	3.50	320	4.50	500
....	....	1.55	27	2.55	149	....	....	....	....
....	....	1.60	30	2.60	158	3.60	338	4.60	518
....	....	1.65	34	2.65	167	....	....	....	....
....	....	1.70	38	2.70	176	3.70	356	4.70	536
....	....	1.75	42	2.75	185	....	....	....	....
0.80	1.0	1.80	46	2.80	194	3.80	374	4.80	554
0.85	1.2	1.85	50	2.85	203	....	....	....	....
0.90	1.6	1.90	55	2.90	212	3.90	392	....	....
0.95	2.2	1.95	61	2.95	221	....	....	....	....

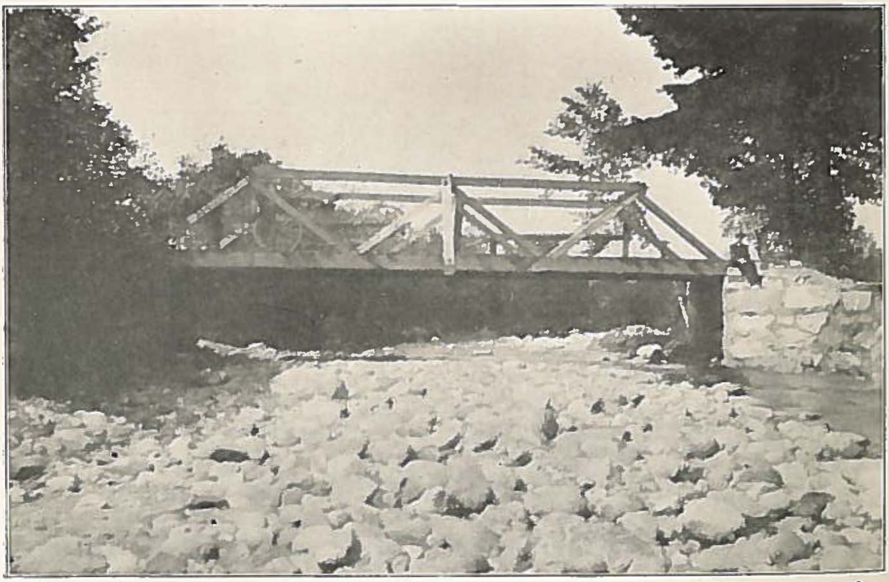
This table is applicable only for open channel. It is based upon discharge measurements of 1903 and 1904. It is well defined between gage heights 1.0 and 2.4 feet. Outside these limits it has been extended by interpolation. It is tangent at 2.5 feet gage height with a difference of 9 per tenth. The table has been applied to the nearest hundredth foot gage height.

ESTIMATED MONTHLY DISCHARGE OF ISRAEL RIVER, ABOVE SOUTH BRANCH, AT JEFFERSON HIGHLANDS, N. H., FOR 1903-'04.

(Drainage area, 8.7 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1903.							
September 2-30..	8.6	4.8	6.1	.70	.75	....	....
October.........	29	4.8	9.3	1.07	1.23	51	2.43
November 1-17..	17.0	4.8	8.7	1.00	.63	....	1.41
December	....	....	....	....	....	....	2.02
1904.							
January.........	....	....	....	....	....	....	2.58
February........	....	....	....	....	....	....	1.22
March 14-31.....	554	18.0	259	29.77	19.93	....	2.31
April............	212	10.6	39	4.48	5.00	150	3.37
May....	266	21	66	7.59	8.75	200	4.46
June.	21	2.2	10.1	1.16	1.29	65	1.97
July	21	2.2	6.5	.75	.86	23	3.66
August..........	36	8.0	14.3	1.64	1.89	36	5.32
September	86	5.3	24.7	2.84	3.17	52	6.06
October.........	67	10.6	26.4	3.03	3.49	134	2.60

GAGING STATION ON ISRAEL RIVER AT RANDOLPH (ABOVE SOUTH BRANCH).



GAGING STATION ON ISRAEL RIVER AT JEFFERSON HIGHLANDS (BELOW SOUTH BRANCH).

ISRAEL RIVER (BELOW SOUTH BRANCH) NEAR JEFFERSON HIGHLANDS, NEW HAMPSHIRE.

This station, shown on Plate IV, was established September 2, 1903, by N. C. Grover. It is located at a small wooden highway bridge about two miles from the railway station at Jefferson Highlands, in the town of Jefferson. The drainage basin at this point is 21.2 square miles. South Branch of Israel River has its mouth above this station and below the station previously described. South Branch drains an area of 10.5 square miles; its headwaters are on the slopes of Mount Jefferson and Mount Dartmouth, at elevations of 3,000 to 5,000 feet. The extreme length from its source to its mouth is about five miles. The elevation at its mouth is about 1,350 feet. As all the slopes are steep, there is little or no storage of water. The underlying rock is granite, exposed in the mountain peaks. The basin has been generally "hard cut," as the lumbermen say, but has not been burned. A statement in detail of the forest conditions on this drainage area will be found on page 143.

A standard chain gage is attached to the down stream side of the truss of the bridge, length of chain, 12.99 feet. It is referred to bench marks as follows: (1) Marked point on center cross timber of bridge, elevation 8.14 feet; (2) Top of boulder, 50 feet north of bridge, 15 feet west of highway, elevation 5.20 feet. Elevations are above datum of gage. The channel is straight for 100 feet above and 100 feet below the station and is about 20 feet wide. The bed is rough and rocky but permanent. The banks are subject to overflow in extreme freshets. Depths average at low water about one foot. Gage is read once daily by E. A. Crawford of Jefferson Highlands.

LIST OF DISCHARGE MEASUREMENTS OF ISRAEL RIVER, BELOW SOUTH BRANCH, NEAR JEFFERSON HIGHLANDS, N. H.

No.	Date.	Hydrographer.	Width. Feet.	Area of sec. Sq. ft.	Mean veloc. Ft. per sec.	Gage height. Feet.	Discharge Sec.-ft.
	1903						
1	Sept. 2	H. K. Barrows........	....	13.3	1.35	1.13	17.9
2	Sept. 18	H. K. Barrows........	....	12.3	1.21	1.10	14.9
3	Oct. 9	N. C. Grover........	....	10.4	1.11	1.03	11.5
	1904						
4	April 16	N. C. Grover........	....	16	2.55	1.43	42
5	April 18	N. C. Grover........	....	18	2.87	1.49	52
6	April 30	S. K. Clapp........	....	64	4.75	2.55	304
7	May 1	S. K. Clapp........	....	54	4.29	2.28	232
8	May 11	S. K. Clapp........	....	57	4.80	2.40	373
9	May 25	S. K. Clapp........	....	24	3.33	1.64	80
10	June 15	S. K. Clapp........	....	12	1.25	1.09	15
11	July 22	S. K. Clapp........	....	10.4	0.79	0.94	8.2
12	Aug. 10	S. K. Clapp........	....	11.5	0.82	1.00	9.4
13	Sept. 24	H. K. Barrows T. W. Norcross........	....	18.5	1.99	1.40	37
14	Oct. 13	T. W. Norcross........	....	17	1.63	1.36	28

MEAN DAILY GAGE HEIGHT, IN FEET, OF ISRAEL RIVER, BELOW SOUTH BRANCH, AT JEFFERSON HIGHLANDS, N. H., FOR 1903.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	......	......	......	......	......	......	1.00	1.12	1.18
2	......	......	......	......	......	......	......	......	1.10	1.12	1.05	1.18
3	......	......	......	......	......	......	......	......	1.10	1.02	1.05	1.18
4	......	......	......	......	......	......	......	......	1.10	1.00	1.05	1.18
5	......	......	......	......	......	......	......	......	1.20	1.42	1.12	1.18
6	......	......	......	......	......	......	......	......	1.10	1.15	1.80	1.18
7	......	......	......	......	......	......	......	......	1.10	1.08	1.28	1.18
8	......	......	......	......	......	......	......	......	1.10	1.05	1.20	1.15
9	......	......	......	......	......	......	......	......	1.10	1.05	1.10	1.15
10	......	......	......	......	......	......	......	......	1.10	1.02	1.10	1.12
11	......	......	......	......	......	......	......	......	1.10	1.00	1.10	1.12
12	......	......	......	......	......	......	......	......	1.10	1.00	1.10	1.12
13	......	......	......	......	......	......	......	......	1.00	1.10	1.10	1.80
14	......	......	......	......	......	......	......	......	1.00	1.05	1.10	2.20
15	......	......	......	......	......	......	......	......	1.00	1.05	1.10	2.20
16	......	......	......	......	......	......	......	......	1.00	1.02	1.12	1.80
17	......	......	......	......	......	......	......	......	1.00	1.02	1.15	1.60
18	......	......	......	......	......	......	......	......	1.10	1.55	1.28	1.40
19	......	......	......	......	......	......	......	......	1.02	1.25	1.28	1.40
20	......	......	......	......	......	......	......	......	1.02	1.22	1.28	1.80
21	......	......	......	......	......	......	......	......	1.00	1.10	1.28	2.50
22	......	......	......	......	......	......	......	......	1.00	1.08	*1.58	2.60
23	......	......	......	......	......	......	......	......	1.00	1.08	1.80	2.80
24	......	......	......	......	......	......	......	......	1.00	1.20	1.02	2.10
25	......	......	......	......	......	......	......	......	1.00	1.10	1.60	2.10
26	......	......	......	......	......	......	......	......	.98	1.08	1.92	2.70
27	......	......	......	......	......	......	......	......	.95	1.05	1.58	2.50
28	......	......	......	......	......	......	......	......	1.05	1.05	1.68	2.10
29	......	......	......	......	......	......	......	......	1.00	1.05	1.50	1.10
30	......	......	......	......	......	......	......	......	1.00	1.15	1.18	1.60
31	......	......	......	......	......	......	......	......	......	1.12	......	1.60

* Anchor ice from November 22 to December 31.

MEAN DAILY GAGE HEIGHT, IN FEET, OF ISRAEL RIVER, BELOW SOUTH BRANCH, AT JEFFERSON HIGHLANDS, N. H., FOR 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.60	.85	.85	1.40	2.85	1.85	1.10	1.20	1.10	1.60	1.45	......
2	1.40	.85	.85	1.85	2.00	1.80	1.10	1.15	1.80	1.60	1.45	......
3	1.10	.82	.82	1.85	1.90	1.40	1.45	1.80	1.60	1.60	1.40	......
4	1.08	.82	.82	1.85	2.10	1.35	1.40	1.80	1.60	1.60	1.85	......
5	1.00	.82	.82	1.80	2.10	1.30	1.80	1.20	1.50	1.50	1.35	......
6	1.00	.82	.82	1.80	1.90	1.80	1.25	1.10	1.45	1.50	......	......
7	.95	1.90	.82	1.70	2.10	1.45	1.20	1.05	1.45	1.60	......	......
8	.92	2.70	.80	1.60	2.00	1.40	1.15	1.05	1.40	1.60	......	......
9	.90	8.80	.80	1.60	1.90	1.85	1.10	1.00	1.35	1.55	......	......
10	.90	8.00	.80	1.50	1.90	1.80	1.05	1.00	1.80	1.50	......	......
11	.90	2.10	.80	1.50	2.40	1.25	1.00	1.10	1.25	1.50	......	......
12	.90	1.20	.80	1.50	1.85	1.20	.95	1.10	1.20	1.40	......	......
13	.88	1.20	.80	1.70	1.75	1.15	1.20	1.80	1.15	1.85	......	......
14	.88	1.10	2.40	1.70	1.70	1.15	1.10	1.20	1.15	1.30	......	......
15	.88	1.00	8.50	1.50	2.05	1.12	1.08	1.60	2.22	1.80	......	......
16	.85	1.00	8.40	1.45	2.10	1.12	1.05	1.50	1.60	1.28	......	......
17	.85	.90	8.00	1.40	8.25	1.10	1.00	1.40	1.60	1.28	......	......
18	.85	.90	8.70	1.40	2.05	1.10	.98	1.30	1.85	1.28	......	......
19	.85	.90	8.70	1.45	2.80	1.05	.98	1.20	1.20	1.25	......	......
20	.85	.90	3.70	1.45	2.85	1.00	.98	1.15	1.70	1.25	......	......
21	.85	.90	4.40	1.50	2.10	.95	.98	1.70	1.60	1.25	......	......
22	.85	.88	4.20	1.50	2.00	1.85	.95	1.60	1.50	2.00	......	......
23	.85	.88	8.70	1.60	1.80	1.30	.95	1.60	1.40	2.00	......	......
24	.85	.88	8.00	1.70	1.70	1.25	.98	1.50	1.40	1.92	......	......
25	.85	.88	4.70	2.70	1.65	1.80	1.00	1.40	1.60	1.85	......	......
26	.85	.85	5.20	1.90	1.65	1.25	1.20	1.80	1.60	1.70	......	......
27	.85	.85	5.00	1.80	1.75	1.15	1.20	1.25	1.50	1.70	......	......
28	.85	.85	4.00	1.90	1.55	1.15	1.10	1.20	1.40	1.60	......	......
29	.85	.85	2.20	2.70	1.50	1.10	1.80	1.15	2.05	1.50	......	......
30	.85	......	1.70	2.80	1.45	1.10	1.20	1.15	1.90	1.50	......	......
31	.85	......	1.40	......	1.40	......	1.15	1.10	......	1.48	......	......

Ice January 1–March 18.

RATING TABLE FOR ISRAEL RIVER, BELOW SOUTH BRANCH, NEAR JEFFERSON HIGHLANDS, N. H., FROM SEPTEMBER 2, 1903, TO DECEMBER 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
......	......	1.00	10	2.00	157	3.00	436	4.00	716	5.00	996
......	......	1.05	13	2.05	170	3.05	450	4.05	730	5.05	1,010
......	......	1.10	16	2.10	184	3.10	464	4.10	744	5.10	1,024
......	......	1.15	19	2.15	198	3.15	478	4.15	758	5.15	1,038
......	......	1.20	22	2.20	212	3.20	492	4.20	772	5.20	1,052
......	......	1.25	26	2.25	226	3.25	506	4.25	786	......	......
......	......	1.30	30	2.30	240	3.30	520	4.30	800	......	......
......	......	1.35	35	2.35	254	3.35	534	4.35	814	......	......
......	......	1.40	40	2.40	268	3.40	548	4.40	828	......	......
......	......	1.45	46	2.45	282	3.45	562	4.45	842	......	......
......	......	1.50	52	2.50	296	3.50	576	4.50	856	......	......
......	......	1.55	59	2.55	310	3.55	590	4.55	870	......	......
......	......	1.60	67	2.60	324	3.60	604	4.60	884	......	......
......	......	1.65	76	2.65	338	3.65	618	4.65	898	......	......
......	......	1.70	86	2.70	352	3.70	632	4.70	912	......	......
......	......	1.75	97	2.75	366	3.75	646	4.75	926	......	......
0.80	2.5	1.80	108	2.80	380	3.80	660	4.80	940	......	......
0.85	3.7	1.85	120	2.85	394	3.85	674	4.85	954	......	......
0.90	5.3	1.90	132	2.90	408	3.90	688	4.90	968	......	......
0.95	7.4	1.95	144	2.95	422	3.95	702	4.95	982	......	......

This table is applicable only for open channel. It is based upon discharge measurements of 1903 and 1904. It is well determined between gage heights .9 and 2.6 feet. Outside these limits it has been extended by interpolation. It is tangent at 2.1 feet gage height with a difference of 28 per tenth. The table has been applied to the nearest hundredth foot gage height.

ESTIMATED MONTHLY DISCHARGE OF ISRAEL RIVER, BELOW SOUTH BRANCH, AT JEFFERSON HIGHLANDS, N. H., FOR 1903-1904.

(Drainage area 21.2 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1903.							
September 2-30.	22	7	18	.61	.66	....	....
October.........	59	10	17	.80	.92	38	2.43
November 1-17.	30	13	18	.85	.54	....	1.41
December......	....	....	....	....	....	....	2.02
The period ...	....	....	....	....	....	....	....
1904.							
January.........	....	....	....	....	....	....	2.58
February........	....	....	....	....	....	....	1.22
March 14-31.....	1,052	40	578	27.26	18.25	....	2.31
April............	352	30	87	4.10	4.57	140	3.37
May.............	506	40	152	7.17	8.27	190	4.46
June............	46	7.4	25	1.18	1.32	67	1.97
July.............	46	7.4	17.4	.82	.95	26	3.66
August..........	86	10	30	1.42	1.64	31	5.32
September......	218	16	57	2.69	3.00	50	6.06
October.........	157	26	62	2.92	3.37	130	2.60

Ice November 22, 1903, to March 18, 1904.
Rainfall records for Jefferson Highlands, N. H.

The discharge at the upper station on Israel River has been subtracted from that at the lower station to obtain the run-off from the area tributary to the river between the two stations. The results are shown in the following table:

ESTIMATED MONTHLY DISCHARGE OF ISRAEL RIVER AT JEFFERSON HIGHLANDS, N. H., FOR 1903 AND 1904.

(Drainage area, 12.5 square miles.)

Month.	Mean discharge in second-feet.	Run-off.			Rainfall. (Inches.)
		Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1903.					
September 2–30	6.9	.55	.59	....	....
October	7.7	.62	.71	29	2.43
November 1–17	9.3	.74	.47	....	1.41
December	....	....	....	....	2.02
1904.					
January	....	....	....	....	2.53
February	....	....	....	....	1.22
March 14–31	319	25.52	17.08	....	2.31
April	48	3.84	4.28	130	3.37
May	86	6.88	7.93	180	4.46
June	14.9	1.19	1.33	68	1.97
July	10.9	.87	1.00	27	3.66
August	15.7	1.26	1.45	27	5.32
September	32	2.56	2.86	47	6.06
October	36	2.88	3.32	130	2.6

AMMONOOSUC RIVER AT BRETTON WOODS, N. H.

This station was established August 28, 1903, by N. C. Grover. It is located at the steel highway bridge near Mount Pleasant House at Bretton Woods. The drainage area at this point is 34 square miles. The headwaters of the river come from the westerly slopes of Mount Jefferson and Mount Washington and the lesser peaks of the White Mountains lying to the south. The underlying rock is granite, which is exposed at points in the river bed and on the various mountain summits. The slopes and valleys are usually well forested, with a preponderance of evergreen growth. Much of the area has been cut for spruce several years ago, but there is now a thick forest cover. A statement in detail of the forest conditions on this drainage area will be found on page 143. There is no pondage or artificial storage. The slope of the river is steep. A typical view on this river is shown on Plate V.

A standard chain gage is attached to the floor on the down stream side of the bridge; length of chain, 18.86 feet. It is referred to the following described bench marks: (1) Marked point on bridge near gage, elevation 17.36 feet; (2) Northwest corner of east abutment, elevation 14.46 feet; (3) Top of boulder, 100 feet below bridge and between the river and tracks of Boston & Maine Railroad, elevation 17.11 feet. Elevations are above datum of gage. Measurements of flow are made from a footbridge located about 300 feet down stream from the gage. The channel is straight for 300 feet above and 200 feet below this bridge and is about 35 feet wide. The banks are high and not subject to overflow, except in extreme freshets. The bed is somewhat rocky, but permanent. Low water measurements are made by wading about 100 feet above the footbridge on account of small velocity at the station.

LIST OF DISCHARGE MEASUREMENTS OF AMMONOOSUC RIVER AT BRETTON WOODS, N. H.

No.	Date.	Hydrographer.	Width. (Ft.)	Area of sec. (Sq. ft.)	Mean veloc. (Ft. per sec.)	Gage height. (Ft.)	Discharge. (Sec.-ft.)	Remarks.
	1903.							
1	Aug. 28	H. K. Barrows...	....	......	......	1.65	45	
2	Sept. 2	H. K. Barrows...	....	......	......	1.50	31	
3	Sept. 3	H. K. Barrows...	....	......	......	1.48	29	
4	Sept. 17	H. K. Barrows...	....	......	......	1.26	15	
5	Sept. 17	H. K. Barrows...	....	......	......	1.26	16	
6	Oct. 10	N. C. Grover.....	....	......	......	1.64	40	
	1904.							
7	Apr. 15	N. C. Grover.....	37	94	0.95	2.00	89	
8	Apr. 30	S. K. Clapp......	40	172	3.22	3.45	554	Discarded. Meter [out of order.
9	May 2	S. K. Clapp......	40	166	2.81	3.20	467	
10	May 9	S. K. Clapp......	40	175	3.62	3.47	634	
11	May 10	S. K. Clapp......	40	175	3.58	3.51	627	
12	May 20	S. K. Clapp......	39	167	2.99	3.15	499	
13	May 25	S. K. Clapp......	32	91	1.35	2.19	123	
14	June 10	S. K. Clapp......	30	66	0.65	1.60	43	
15	July 21	S. K. Clapp......	14	16	1.12	1.24	18	Measurement 400' [above gage.
16	Aug. 9	S. K. Clapp......	14	17	1.36	1.30	23	Measurement 800' [above gage.
17	Aug. 23	H. K. Barrows...	35	82	0.82	1.89	67	
18	Aug. 24	H. K. Barrows...	22	25	1.76	1.67	44	Wading below [gage.
19	Sept. 25	H. K. Barrows... T. W. Norcross..	38	94	1.25	2.26	118	Footbridge below [gage.
20	Oct. 11	T. W. Norcross..	38	79	0.78	1.84	62	
21	Nov. 17	T. W. Norcross..	35	62	0.46	1.51	28	

MEAN DAILY GAGE HEIGHT, IN FEET, OF AMMONOOSUC RIVER, AT BRETTON WOODS, N. H., FOR 1903.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	......	......	......	......	......	1.55	1.35	1.70	1.30
2	......	......	......	......	......	......	......	......	1.55	1.42	1.62	1.30
3	......	......	......	......	......	......	......	......	1.48	1.38	1.58	1.30
4	......	......	......	......	......	......	......	......	1.42	1.35	1.50	1.35
5	......	......	......	......	......	......	......	......	1.52	1.52	1.58	1.35
6	......	......	......	......	......	......	......	......	1.48	1.52	2.05	1.35
7	......	......	......	......	......	......	......	......	1.44	1.45	1.55	1.35
8	......	......	......	......	......	......	......	......	1.44	1.48	1.55	1.35
9	......	......	......	......	......	......	......	......	1.40	1.65	1.55	1.35
10	......	......	......	......	......	......	......	......	1.40	1.70	1.55	1.40
11	......	......	......	......	......	......	......	......	1.40	1.65	1.50	1.40
12	......	......	......	......	......	......	......	......	1 32	1.60	1.50	1.35
13	......	......	......	......	......	......	......	......	1.32	1.52	1.50	1.52
14	......	......	......	......	......	......	......	......	1.32	1.50	1.50	2.12
15	......	......	......	......	......	......	......	......	1.32	1.45	1.50	......
16	......	......	......	......	......	......	......	......	1.28	1.45	1.50	......
17	......	......	......	......	......	......	......	......	1.28	1.45	1.50	......
18	......	......	......	......	......	......	......	......	1.55	2.60	1.68	......
19	......	......	......	......	......	......	......	......	1.40	1.95	1.65	1.50
20	......	......	......	......	......	......	......	......	1.38	1.75	1.60	......
21	......	......	......	......	......	......	......	......	1.35	1.60	1.55	2.82
22	......	......	......	......	......	......	......	......	1.32	1.60	1.50	2.62
23	......	......	......	......	......	......	......	......	1.30	1.68	1.50	2.22
24	......	......	......	......	......	......	......	......	1.30	1.78	1.48	1.78
25	......	......	......	......	......	......	......	......	1.30	1.65	1.45	1.60
26	......	......	......	......	......	......	......	......	1.30	1.65	1.40	1.60
27	......	......	......	......	......	......	......	......	1.30	1.60	1.40	1.65
28	......	......	......	......	......	......	......	1.60	1.40	1.55	1.35	1.70
29	......	......	......	......	......	......	......	......	1.38	1.55	1.30	1.65
30	......	......	......	......	......	......	......	1.52	1.35	1.60	1.32	1.60
31	......	......	......	......	......	......	......	1.55	......	1.65	......	1.60

Ice December 15–31.

MEAN DAILY GAGE HEIGHT, IN FEET, OF AMMONOOSUC RIVER, AT BRETTON WOODS, N. H., FOR 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.55	......	......	1.85	3.78	1.88	1.40	1.40	1.35	2.75	1.85	......
2	1.50	......	......	1.90	3.20	1.75	1.78	1.38	1.48	2.55	1.80	......
3	......	......	2.10	1.90	2.90	1.75	2.02	1.58	1.48	2.40	1.80	......
4	1.55	......	......	1.90	3.80	1.70	1.65	1.50	1.90	2.20	1.80	......
5	......	......	1.88	1.88	3.45	1.70	1.62	1.33	1.58	2.10	1.80	......
6	......	1.40	......	1.95	2.95	1.70	1.50	1.40	1.50	2.20	......	......
7	......	......	1.70	2.10	3.10	1.72	1.42	1.38	1.48	2.08	......	......
8	......	......	......	2.60	3.18	1.78	1.38	1.32	1.45	1.72	......	......
9	1.50	......	......	3.35	2.90	1.68	1.35	1.30	1.42	1.90	......	......
10	1.50	......	......	4.25	3.32	1.60	1.35	1.30	1.40	1.90	......	......
11	1.45	......	1.75	2.95	3.50	1.55	1.35	1.48	1.38	1.82	......	......
12	1.45	......	1.75	2.55	2.92	1.50	1.35	1.68	1.35	1.78	......	......
13	1.45	1.35	......	2.35	2.78	1.50	1.45	1.55	1.40	1.80	......	......
14	1.40	......	......	2.05	2.60	1.48	1.38	1.50	1.40	1.80	......	......
15	......	......	1.50	2.00	2.92	1.45	1.30	1.75	3.15	1.78	......	......
16	......	......	1.50	1.80	3.85	1.42	1.30	1.48	2.20	1.75	......	......
17	1.40	......	1.55	1.90	4.22	1.40	1.30	1.40	1.80	1.70	......	......
18	......	......	......	2.00	2.98	1.40	1.30	1.40	1.80	1.70	......	......
19	......	1.40	1.50	2.10	3.35	1.85	1.28	1.35	2.15	1.68	......	......
20	......	......	......	2.10	3.20	1.35	1.25	1.92	1.82	1.65	......	......
21	......	......	1.50	2.00	2.82	1.35	1.25	2.30	2.70	3.55	......	......
22	......	2.50	1.55	2.00	2.58	2.02	1.25	1.82	2.25	3.05	......	......
23	2.10	2.40	2.15	2.02	2.45	1.65	1.25	1.95	1.85	2.48	......	......
24	2.20	2.32	2.40	2.48	2.82	1.48	1.25	1.70	1.92	2.25	......	......
25	......	2.15	3.05	3.25	2.22	1.40	1.25	1.58	2.12	2.20	......	......
26	......	......	7.60	2.82	2.18	1.68	1.30	1.52	2.00	2.28	......	......
27	......	1.50	4.02	3.05	2.25	1.48	1.60	1.50	1.92	2.32	......	......
28	......	......	2.32	3.30	2.08	1.45	1.35	1.42	1.82	2.20	......	......
29	1.60	......	2.00	3.95	1.95	1.40	1.45	1.40	1.90	2.35	......	......
30	......	......	2.00	3.75	1.90	1.40	1.42	1.40	2.90	2.00	......	......
31	......	......	1.85	......	1.85	......	1.35	1.85	......	1.98	......	......

Ice January 1 to March 25.

RATING TABLE FOR AMMONOOSUC RIVER, NEAR BRETTON WOODS, N. H., FROM AUGUST 28, 1903, TO DECEMBER 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
.....	......	2.00	80	3.00	365	4.00	940	5.00	1,540	6.00	2,140
.....	......	2.05	86	3.05	390	......	....	......	....	......	....
.....	......	2.10	93	3.10	415	4.10	1,000	......	....	......	....
.....	......	2.15	100	3.15	440	......	....	......	....	......	....
.....	......	2.20	108	3.20	465	4.20	1,060	......	....	......	....
1.25	15	2.25	116	3.25	490	......	....	......	....	......	....
1.30	18	2.30	125	3.30	520	4.30	1,120	......	....	......	....
1.35	21	2.35	135	3.35	550	......	....	......	....	......	....
1.40	24	2.40	146	3.40	580	4.40	1,180	......	....	......	....
1.45	27	2.45	158	3.45	610	......	....	......	....	......	....
1.50	31	2.50	172	3.50	640	4.50	1,240	5.50	1,840	......	....
1.55	35	2.50	187	......	....	......	....	......	....	......	....
1.60	39	2.60	203	3.60	700	4.60	1,300	......	....	......	....
1.65	43	2.65	220	......	....	......	....	......	....	......	....
1.70	48	2.70	238	3.70	760	4.70	1,360	......	....	......	....
1.75	53	2.75	257	......	....	......	....	......	....	......	....
1.80	58	2.80	277	3.80	820	4.80	1,420	......	....	......	....
1.85	63	2.85	297	......	....	......	....	......	....	......	....
1.90	68	2.90	318	3.90	880	4.90	1,480	......	....	......	....
1.95	74	2.95	341	......	....	......	....	......	....	......	....

This table is applicable only for open channel. It is based upon discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.2 and 3.8 feet. Outside these limits it has been extended by interpolation. It is tangent at 3.5 feet gage height with a difference of 60 per tenth. The table has been applied to the nearest hundredth foot gage height.

ESTIMATED MONTHLY DISCHARGE OF AMMONOOSUC RIVER AT BRETTON WOODS, N. H., FOR 1903 AND 1904.

(Drainage area, 34 square miles.)

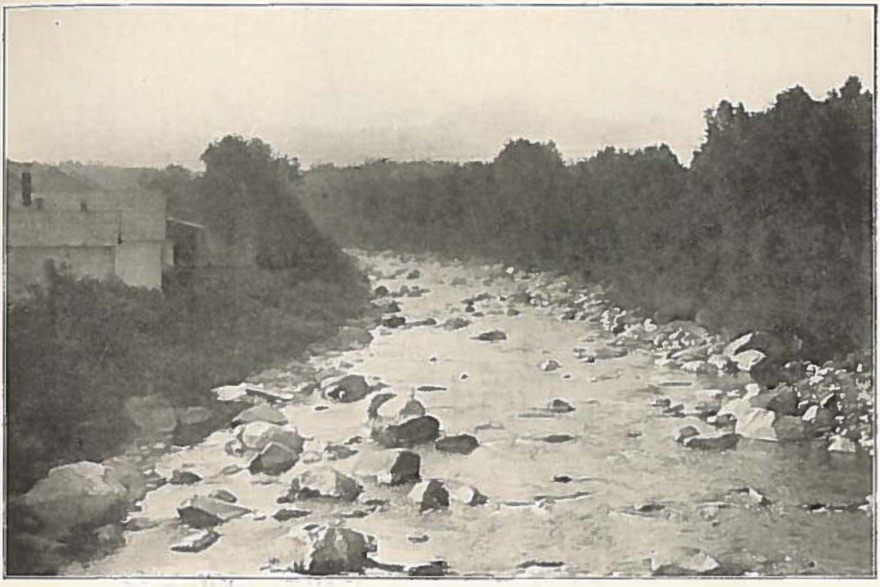
Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1903.							
September......	35	17	23	.68	.76	....	....
October.........	203	21	42	1.24	1.43	52	2.77
November......	86	18	34	1.00	1.12	97	1.16
December 1-14..	96	18	27	.80	.41	....	3.84
1904.							
January.........	....	....	....	....	....	....	1.94
February.......	....	....	....	....	....	....	0.48
March 26-31.....	8,100	63	734	21.59	4.82	....	2.53
April............	1,090	58	245	7.21	8.04	574	1.40
May............	1,072	63	362	10.65	12.28	419	2.93
June............	82	21	37	1.09	1.22	....	....
July.........	82	15	25	.74	.85	26	3.19
August..........	125	18	36	1.06	1.22	27	4.48
September......	440	21	80	2.35	2.62	34	7.81
October.........	670	43	123	3.62	4.17	212	3.72

River frozen, December 15, 1903, to March 25, 1904.
Rainfall records for Bretton Woods, N. H.

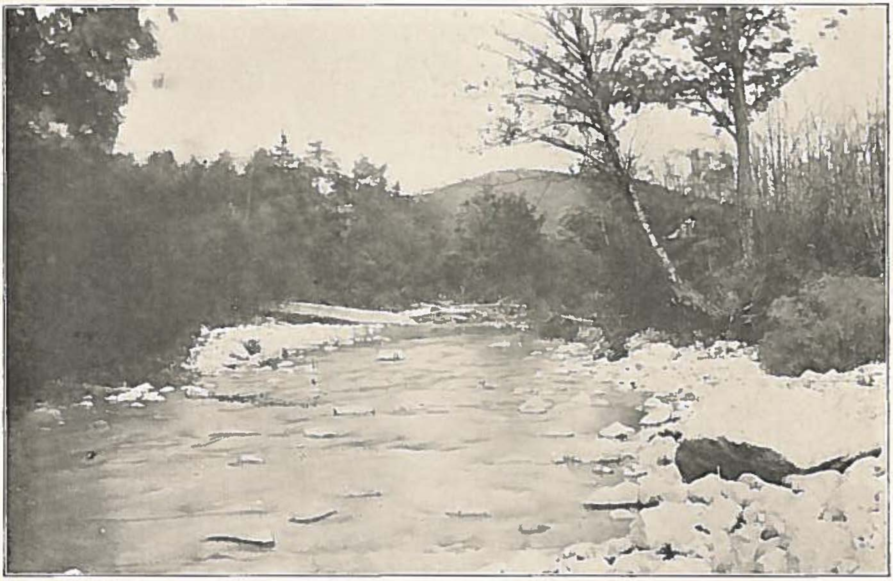
ZEALAND RIVER AT TWIN MOUNTAIN, N. H.

This gaging station, shown on Plate V, was established August 29, 1903, by N. C. Grover. It is located about 800 feet above the mouth of the river, which empties into the Ammonoosuc at a point midway between Fabyans and Twin Mountain and about two and one half miles from either place. The drainage basin at this point has an area of 14 square miles. The headwaters lie on the slopes of a spur of the White Mountains at elevations of 2,500 to 3,000 feet. The length of the river from its headquarters to its mouth is about seven miles, at which point the elevation is approximately 1,500 feet. All slopes within the basin are steep. There is no pondage or artificial storage of water. The underlying rock is granite, which is exposed in the mountain peaks. About ten or twelve years ago this basin was entirely deforested and burned over. At the present time there is a thick stand of deciduous growth of poplar and bird cherry, averaging 12 to 15 feet in height, which affords a thick covering during the summer months but practically no cover during the winter and spring. Within the basin we find the usual conditions of this stage of reforestation after a thorough burning. A statement in detail of the forest conditions on this drainage area will be found on page 143.

A standard chain gage is attached to trees on the bank. Length of chain is 13.40 feet. It is referred to bench marks as follows: (1) Top of large boulder under the gage, elevation 3.56 feet; (2) Drift bolt driven into the maple tree to which the gage is attached, elevation 11.32 feet. Elevations are above datum of gage. Low water measurements are made by wading. The bed is rough and rocky, but permanent. The banks are high and only subject to overflow in extreme freshets. The gage is read once a day by William Cote of Twin Mountain.



AMMONOOSUC RIVER AT BETHLEHEM JUNCTION.



ZEALAND RIVER AT GAGING STATION.

LIST OF DISCHARGE MEASUREMENTS OF ZEALAND RIVER, AT TWIN MOUNTAIN, N. H.

No.	Date.	Hydrographer.	Width.—Ft.	Area of sec. Sq. ft.	Mean veloc. Ft. per sec.	Gage height. Feet.	Discharge. Sec.-ft.	Remarks.
	1903							
1	Aug. 29	H. K. Barrows.	....	29.1	0.45	2.01	13.1	Wading 100' below gage.
2	Sept. 8	H. K. Barrows.	....	26.6	0.40	1.98	10.7	Wading 100' below gage.
3	Sept. 18	H. K. Barrows.	....	33.5	0.68	2.22	22.9	Wading 100' below gage.
4	Oct. 10	N. E. Grover..	....	35.5	0.76	2.29	27	Wading 200' below gage.
	1904							
5	Apr. 15	N. E. Grover..	....	25.3	1.88	2.52	47.5	Highway bridge, 500' below gage.
6	Apr. 30	S. K. Clapp....	....	79	4.09	3.55	323	From bridge.
7	May 10	S. K. Clapp....	....	56	3.25	3.00	182	From bridge.
8	May 19	S. K. Clapp....	....	80	4.60	3.60	368	From bridge.
9	May 20	S. K. Clapp....	....	54	3.37	3.08	182	From bridge.
10	May 25	S. K. Clapp....	....	21	2.10	2.49	44	From bridge.
11	June 10	S. K. Clapp....	....	10	2.10	2.18	21	From bridge.
12	July 21	S. K. Clapp....	....	6.8	1.12	2.04	7.6	From bridge.
13	Aug. 9	S. K. Clapp....	....	8.4	1.49	2.10	12.5	From bridge.
14	Aug. 23	H. K. Barrows.	....	40	0.95	2.55	38	Wading.
15	Sept. 25	H. K. Barrows. T. W. Norcross	....	46	1.48	2.81	68	Wading.
16	Oct. 12	T. W. Norcross	....	33	0.69	2.37	23	

MEAN DAILY GAGE HEIGHT, IN FEET, OF ZEALAND RIVER, AT TWIN MOUNTAIN, N. H., FOR 1903.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	......	......	......	......	......	2.00	1.90	2.20	2.20
2	......	......	......	......	......	......	......	......	2.00	1.90	2.20	2.15
3	......	......	......	......	......	......	......	......	2.00	1.90	2.30	2.10
4	......	......	......	......	......	......	......	......	1.90	1.90	2.20	2.20
5	......	......	......	......	......	......	......	......	2.20	2.00	2.20	2.20
6	......	......	......	......	......	......	......	......	2.00	2.00	2.20	2.30
7	......	......	......	......	......	......	......	......	2.00	1.95	2.20	2.30
8	......	......	......	......	......	......	......	......	2.00	1.95	2.30	2.25
9	......	......	......	......	......	......	......	......	1.90	2.00	2.30	2.20
10	......	......	......	......	......	......	......	......	1.90	2.00	2.20	2.30
11	......	......	......	......	......	......	......	......	1.90	2.00	2.20	2.40
12	......	......	......	......	......	......	......	......	1.90	2.00	2.20	2.40
13	......	......	......	......	......	......	......	......	1.90	2.00	2.30	2.30
14	......	......	......	......	......	......	......	......	1.90	2.00	2.30	2.25
15	......	......	......	......	......	......	......	......	1.90	2.00	2.30	2.20
16	......	......	......	......	......	......	......	......	1.90	2.00	2.20	2.20
17	......	......	......	......	......	......	......	......	2.00	2.00	2.20	2.30
18	......	......	......	......	......	......	......	......	2.20	2.40	2.30	2.50
19	......	......	......	......	......	......	......	......	2.00	2.40	2.30	2.50
20	......	......	......	......	......	......	......	......	2.00	2.30	2.25	2.40
21	......	......	......	......	......	......	......	......	2.00	2.30	2.20	2.40
22	......	......	......	......	......	......	......	......	1.90	2.20	2.20	2.40
23	......	......	......	......	......	......	......	......	1.90	2.20	2.20	2.30
24	......	......	......	......	......	......	......	......	1.90	2.20	2.10	2.30
25	......	......	......	......	......	......	......	......	1.90	2.20	2.30	2.30
26	......	......	......	......	......	......	......	......	1.90	2.30	2.30	2.40
27	......	......	......	......	......	......	......	......	1.90	2.30	2.20	2.40
28	......	......	......	......	......	......	......	......	2.00	2.25	2.20	2.40
29	......	......	......	......	......	......	......	2.01	2.00	2.20	2.15	*
30	......	......	......	......	......	......	......	2.20	1.90	2.20	2.10	......
31	......	......	......	......	......	......	......	2.20	......	2.30	......	......

* Frozen December 29 to 31.

MEAN DAILY GAGE HEIGHT, IN FEET, OF ZEALAND RIVER, AT TWIN MOUNTAIN, N. H., FOR 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	2.40	8.50	2.40	1.64	1.84	1.74	4.84	8.84	......
2	......	......	......	2.45	8.40	2.40	1.84	1.84	1.94	4.14	2.84	......
3	......	......	......	2.80	8.30	2.80	1.74	1.94	1.94	8.44	2.74	......
4	......	......	......	2.80	8.10	2.20	1.74	1.94	1.84	2.84	2.74	......
5	......	......	......	2.40	8.00	2.20	1.74	2.04	1.84	8.04	2.64	......
6	......	......	......	2.40	8.00	2.10	1.74	1.84	2.04	2.84	......	......
7	......	......	......	2.50	2.90	2.10	1.74	1.84	2.04	2.84	......	......
8	......	......	......	2.70	2.70	2.10	1.84	1.94	1.94	2.74	......	......
9	......	......	......	2.70	2.60	2.00	1.84	1.84	1.94	2.44	......	......
10	......	......	......	8.00	2.60	2.10	1.74	1.84	1.84	2.64	......	......
11	......	......	......	8.20	2.70	2.10	1.74	1.84	1.84	2.84	......	......
12	......	......	......	8.00	2.70	2.10	1.94	1.84	1.94	2.84	......	......
13	......	......	......	2.90	2.60	2.05	1.94	1.74	1.94	2.64	......	......
14	......	......	......	2.80	2.70	2.00	1.84	1.74	4.84	2.84	......	......
15	......	......	......	2.70	2.50	2.00	1.84	1.84	8.24	2.24	......	......
16	......	......	......	2.60	2.50	2.00	1.84	1.84	2.84	2.24	......	......
17	......	......	......	2.45	2.80	1.95	1.84	1.74	2.84	2.94	......	......
18	......	......	......	2.40	8.00	2.00	1.74	1.94	2.24	2.84	......	......
19	......	......	......	2.40	2.90	2.00	1.84	1.94	1.84	2.74	......	......
20	......	......	......	2.40	2.70	2.00	1.84	1.84	2.24	1.94	......	......
21	......	......	......	2.80	2.70	2.00	1.84	2.84	2.84	8.84	......	......
22	......	......	......	2.80	2.50	1.90	1.94	2.24	2.64	4.84	......	......
23	......	......	......	2.40	2.50	2.10	1.94	2.44	2.84	8.84	......	......
24	......	......	......	2.50	2.40	2.10	1.84	2.24	2.84	8.74	......	......
25	......	......	......	2.60	2.40	2.00	1.74	1.94	2.64	8.74	......	......
26	......	......	......	2.60	2.40	1.90	1.84	1.84	8.84	8.84	......	......
27	......	......	8.00	2.70	2.40	1.90	2.84	1.84	2.84	8.24	......	......
28	......	......	2.70	8.00	2.50	1.90	2.14	1.84	2.84	2.84	......	......
29	......	......	2.50	4.00	2.40	1.90	1.94	1.94	2.64	2.84	......	......
30	......	......	2.50	8.70	2.40	1.90	1.94	1.94	2.24	8.24	......	......
31	......	......	2.40	......	2.80	......	1.84	1.84	......	8.24	......	......

RATING TABLE FOR THE ZEALAND RIVER AT TWIN MOUNTAIN, N. H., FROM AUGUST 29, 1903, TO DECEMBER 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
		2.00	12	3.00	170	4.00	504
		2.05	14	3.05	186	4.05	521
		2.10	16	3.10	202	4.10	538
		2.15	19	3.15	218	4.15	555
		2.20	22	3.20	234	4.20	572
		2.25	25	3.25	250	4.25	589
		2.30	28	3.30	266	4.30	606
		2.35	31	3.35	283	4.35	623
		2.40	35	3.40	300		
		2.45	40	3.45	317		
		2.50	45	3.50	334		
		2.55	52	3.55	351		
		2.60	61	3.60	368		
		2.65	71	3.65	385		
		2.70	82	3.70	402		
1.75	4	2.75	95	3.75	419		
1.80	5	2.80	109	3.80	436		
1.85	6	2.85	124	3.85	453		
1.90	8	2.90	139	3.90	470		
1.95	10	2.95	154	3.95	487		

The above table is applicable only for open channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.9 feet and 3.6 feet. Outside these limits the table has been extended by interpolation. Above gage height 3.8 feet the rating curve is a tangent, the difference being 34 per tenth. The table has been applied to the nearest hundredth of a foot gage height.

ESTIMATED MONTHLY DISCHARGE OF ZEALAND RIVER AT TWIN MOUNTAIN, N. H., FOR 1903 AND 1904.

(Drainage area, 14 square miles.)

Month.	Discharge in second-feet.			Run-off.			Rainfall. (Inches.)
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Per cent. of rainfall.	
1903.							
September......	22	8	11	.79	.88	....	....
October.........	85	8	18	1.29	1.49	54	2.77
November......	28	16	24	1.71	1.91	160	1.16
December 1-28..	45	16	29	2.07	2.16	....	8.84
1904.							
January.........	....	....	....	....	....	....	1.94
February.......	....	....	....	....	....	....	0.48
March 27-31.....	170	85	75	5.86	1.00	....	2.58
April.............	504	28	98	7.00	7.81	560	1.40
May............	334	28	101	7.21	8.31	280	2.93
June.............	35	8	15.0	1.07	1.19	....	....
July.............	30	4	7.4	.53	.61	19	8.19
August..........	121	4	13.0	.93	1.07	24	4.48
September......	620	4	76	5.43	6.06	78	7.81
October.........	620	10	213	15.21	17.54	472	3.72

Ice, December 29, 1903, to March 26, 1904.
Rainfall records for Bretton Woods, N. H.

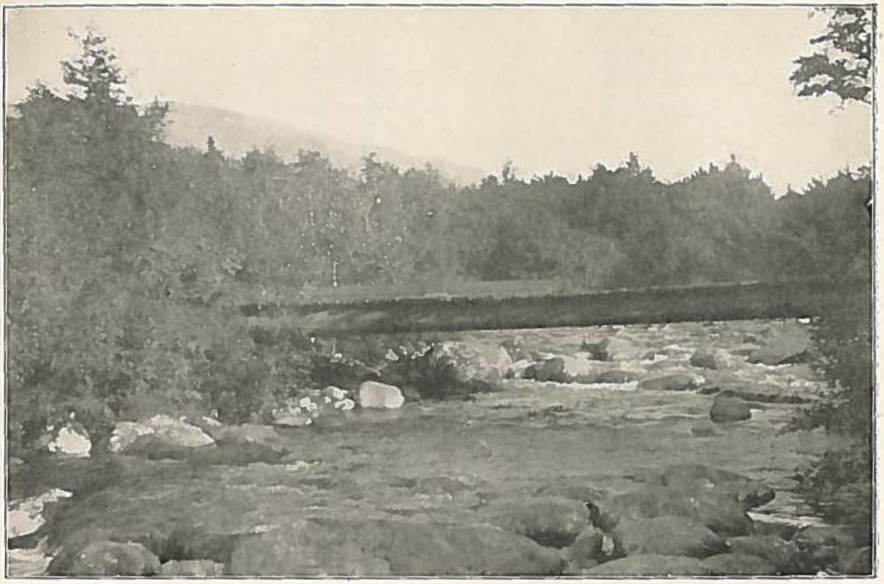
LITTLE RIVER AT TWIN MOUNTAIN, N. H.

This station, shown on Plate VI, was established January 21, 1904, by F. E. Pressey and was intended for a record of gage height only. The bed of the stream is too rough throughout all of its lower length for good current meter measurements. The river enters Ammonoosuc River from the south about a mile below Twin Mountain. Its basin is adjacent to that of Zealand River on the west and is of particular interest in this investigation from the fact that practically all forest cover has been removed. A statement in detail of the forest conditions on this drainage area will be found on page 143. The slopes are steep and there is no pondage or artificial storage.

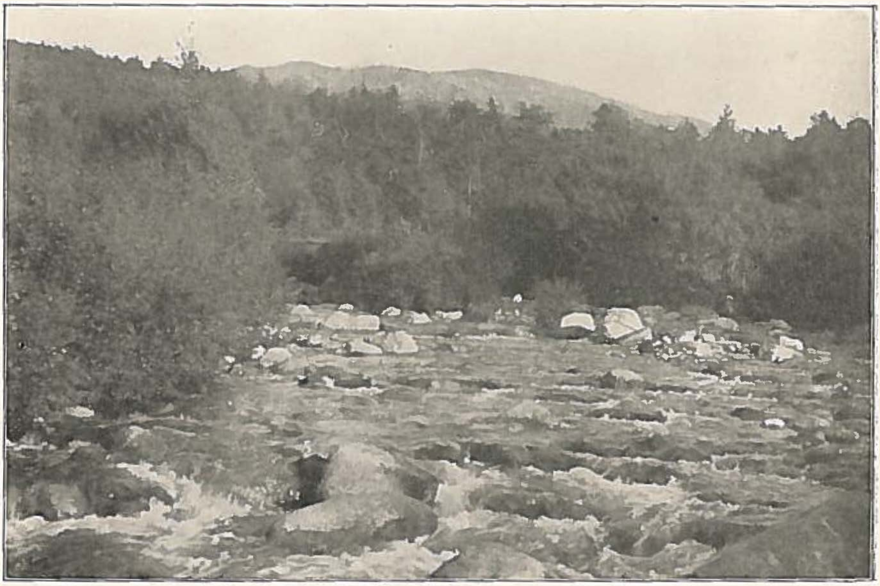
A standard chain gage is attached to the floor of a highway bridge near the residence of Edward Lynch and about one mile above the mouth of the river. Length of chain is 12.92 feet. It is referred to bench marks as follows: (1) On floor of bridge near zero of gage, elevation 11.42 feet; (2) Cross cut on boulder, 32 feet from end of gage on right bank, elevation 9.05 feet. The gage is read twice daily by Edward Lynch.

LIST OF DISCHARGE MEASUREMENTS OF LITTLE RIVER, AT TWIN MOUNTAIN, N. H.

No.	Date.	Hydrographer.	Width.—Ft.	Area of sec. Sq. ft.	Mean veloc. Ft. per sec.	Gage height. Feet.	Discharge. Sec.-ft.	Remarks.
	1904							
1	Aug. 23	H. K. Barrows.	22	26	2.04	5.58	53	Wading one mile below gage.
2	Sept. 25	H. K. Barrows. T. W. Norcross	22	32	2.06	5.75	66	Wading one mile below gage.
3	Oct. 12	T. W. Norcross	21	28	0.94	5.30	26	Wading one mile below gage.



GAGE ON LITTLE RIVER



LITTLE RIVER LOOKING UP-STREAM FROM GAGING STATION.

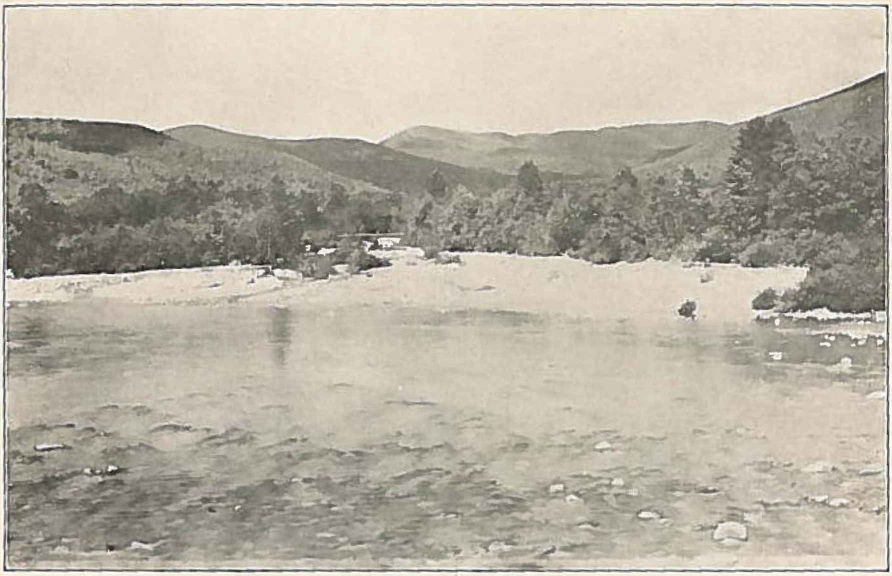
MEAN DAILY GAGE HEIGHT, IN FEET, OF LITTLE RIVER, AT TWIN MOUNTAIN, N. H., FOR 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	4.60	4.70	4.90	6.15	5.20	4.90	5.20	5.00	6.05	5.20	......
2	......	4.65	4.60	4.90	5.70	5.10	5.10	5.05	5.00	5.75	5.20	......
3	......	4.60	5.00	4.90	5.85	5.05	5.35	5.15	5.10	5.65	5.20	......
4	......	4.60	5.85	4.95	6.00	5.10	5.00	5.10	5.80	5.55	5.20	......
5	.....	4.65	5.05	5.05	6.10	5.00	5.25	5.10	5.15	5.45	5.20	......
6	.....	4.60	4.70	5.05	6.10	5.10	5.00	5.10	5.10	5.55	......	......
7	......	5.10	4.65	5.45	6.05	5.00	4.95	5.00	5.10	5.45	......	......
8	......	6.05	7.20	5.65	6.00	5.00	4.90	5.00	5.10	5.40	......	......
9	......	4.80	5.00	6.15	6.00	5.00	4.90	5.00	5.10	5.35	......	......
10	......	4.70	4.95	6.20	5.85	5.00	4.90	5.00	5.00	5.30	......	......
11	......	4.60	4.80	5.80	6.20	5.00	4.90	5.10	5.00	5.30	......	......
12	......	4.60	4.80	5.50	5.90	4.90	4.90	5.15	5.00	5.30	......	......
13	......	4.60	4.70	5.45	5.85	4.90	5.25	5.10	5.00	5.30	......	......
14	......	4.60	4.70	5.40	5.85	4.95	5.05	5.00	6.60	5.30	......	......
15	......	4.60	4.70	5.35	5.95	5.45	5.00	5.20	5.85	5.20	......	......
16	......	4.60	4.70	5.30	6.50	5.00	5.00	5.10	5.50	5.20	......	......
17	......	4.60	4.70	5.35	6.25	5.00	4.90	5.10	5.35	5.20	......	......
18	......	4.60	4.70	5.15	6.05	4.95	4.90	5.10	5.75	5.20	......	......
19	......	4.60	4.70	5.00	6.20	4.90	4.90	5.00	5.40	5.20	......	......
20	......	4.60	4.60	5.40	6.15	4.90	4.90	5.40	5.95	5.20	......	......
21	4.65	4.60	4.60	5.15	5.90	4.90	4.80	6.10	5.55	6.20	......	......
22	4.65	6.20	4.65	5.40	5.80	5.05	4.80	5.55	5.45	6.10	......	......
23	5.05	5.00	6.85	5.15	5.70	5.00	4.80	5.75	5.50	5.90	......	......
24	4.85	4.65	5.50	5.35	5.65	5.00	4.80	5.35	5.75	5.55	......	......
25	4.70	4.60	5.70	5.95	5.60	4.90	4.90	5.30	5.55	5.50	......	......
26	4.70	4.60	6.45	5.75	5.60	4.90	4.90	5.25	5.45	5.65	......	......
27	4.70	4.70	5.40	5.55	5.55	4.90	5.10	5.15	5.40	5.55	......	......
28	4.70	4.70	5.25	5.55	5.45	4.90	5.10	5.10	5.45	5.85	......	......
29	4.65	4.70	5.15	6.00	5.30	4.90	5.45	5.10	6.05	5.30	......	......
30	4.60	......	5.20	6.20	5.25	4.45	5.15	5.05	......	5.25	......	......
31	4.60	......	5.20	......	5.20	......	5.00	5.00	......	5.20	......	......

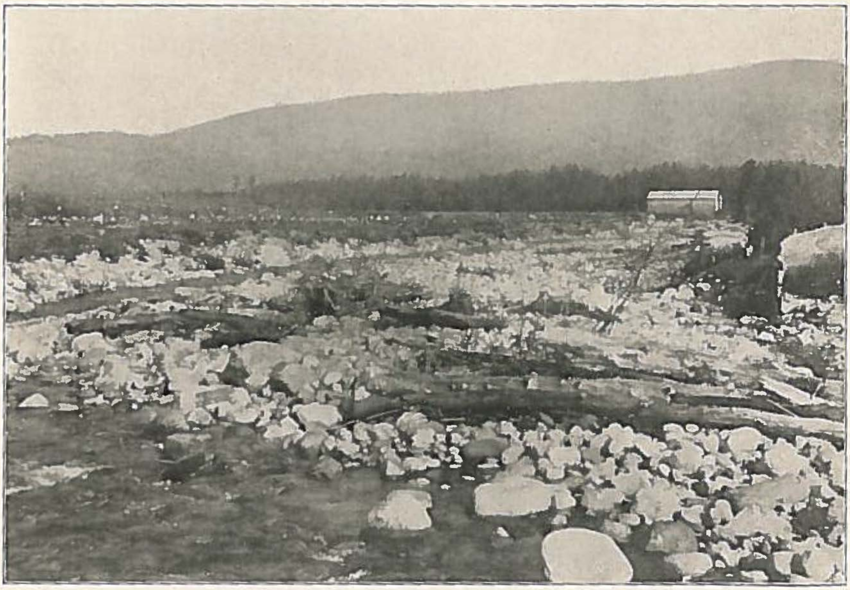
DISCUSSION OF RESULTS.

There have been presented in the preceding pages various hydrographic data for the White Mountain region, which are best considered in two parts. These are, first, the records for the drainage basin of Pemigewasset River, and, second, the data which have been collected in the several basins in this region since September, 1903. For the Pemigewasset Basin there are available the record of gage height of the river at Plymouth, extending from January 1, 1886, to date, the record of rainfall at Plymouth from June, 1888, to date, the record of rainfall at North Woodstock from September, 1903, to date, and 16 measurements of flow of the river. The record of gage height has been carefully made and there has been no change in the datum of the gage. The bed of the river at this place is practically permanent but may have shifted slightly near the left bank or within a short distance below the gaging station in such a way that conditions have changed somewhat at the gage and at the bridge from which the measurements of flow are made. The rating table for this station has been constructed from measurements of flow which have been made since September 4, 1903, but has nevertheless been applied to the gage readings since 1886. By so doing, estimates of flow, which otherwise could not have been made, are now available and it is believed that they do not contain serious error.

The record of rainfall for Plymouth, covering the 17 years from 1888 to date, has been used for comparison throughout the whole period, in preference to changing to the record obtained at North Woodstock during the last 15 months, even though the latter is doubtless more nearly representative for the basin. The former is consistent within itself and, while it does not represent truly the rainfall in the whole basin on account of the fact that the headwaters of the river flow from mountain areas on which the precipitation is greater than in the valleys, still it is a fair



MOUTH OF MOUNTAIN BROOK, EMPTYING INTO SACO RIVER NEAR GLEN.
BED OF GRAVEL AND ROLLING STONES.



LITTLE RIVER NEAR MOUTH.

assumption that rainfall collected at Plymouth will bear the same relation to that in the whole basin in one year as in another.

During the period of 19 years covered by the records of flow of the river considerable areas within the basin have been cut over for spruce or completely deforested.

In studying the data a table has been prepared, showing the ratio of run-off to rainfall in the five months from June to October, inclusive, for each year from 1888 to 1904. These five months have been chosen as the period in each year in which the ratios are probably most nearly comparable. The whole year could not well be considered on account of the fact that no rating curve has been constructed for ice conditions and consequently no definite estimate of the flow of the river during the winter could be made. Within the months from June to October there is little, if any effect, from snow storage, and consequently the run-off will most closely follow the rainfall. No account has been made of the condition of ground water, either at the beginning or end of this period in any year as no data were available.

PEMIGEWASSET RIVER AT PLYMOUTH, N. H.—TABLE SHOWING RATIO OF RUN-OFF TO RAINFALL FROM JUNE TO OCTOBER, INCLUSIVE, DURING THE PERIOD 1888 TO 1904.

Year.	Run-off. (Inches.)	Rainfall. (Inches.)	Per cent.
1888	14.89	21.90	0.66
1889	15.42	21.22	0.73
1890	18.81	23.57	0.77
1891	6.51	16.62	0.89
1892	12.84	22.27	0.55
1893	7.71	17.58	0.44
1894	5.87	17.40	0.84
1895	4.95	16.89	0.30
1896	8.75	18.51	0.47
1897	14.55	17.58	0.88
1898	6.58	18.97	0.35
1899	2.74	18.92	0.20
1900	4.86	13.63	0.82
1901	6.79	16.70	0.41
1902	14.49	21.57	0.67
1903	7.94	18.28	0.43
1904	7.48	20.02	0.87

This period of 17 years has been divided into three parts: 6 years, from 1888 to 1893, inclusive; 5 years, from 1894 to 1898, inclusive; and 6 years, from 1899 to 1904, inclusive. The average ratio of run-off to rainfall in the first period is .59; in the second period is .46 and in the third period is .40. It will be noticed that there are five years, 1888, 1889, 1890, 1897 and 1902, in which the ratio is abnormally high, possibly on account of exceptional conditions of ground water. Omitting these five years from the list and dividing the 12 remaining into two periods of six years each, we find the ratio of run-off to rainfall in the first is .42 and in the second is .35.

In the following table have been arranged in cubic feet per second per square mile the minimum recorded run-off in each year, the mean for the lowest month and the mean for the three lowest months. The years from 1896 to 1904 have been divided into three periods of six, seven and six years, respectively, and the average run-off in cubic feet per second per square mile for each period computed.

PEMIGEWASSET RIVER.

Year.	Minimum in cubic feet per second per sq. mile.	Mean for lowest month in cubic feet per second per sq. mile.	Average minimum for three low months in cubic feet per second per sq. mile.
1886	.30	.77	.85
1887	.57	.67	.79
1888	.57	1.11	1.73
1889	.89	1.75	2.24
1890	.44	1.88	2.45
1891	.24	.38	.63
1892	.30	.76	1.47
1893	.27	.39	.85
1894	.24	.28	.64
1895	.30	.48	.62
1896	.30	.80	.92
1897	.27	.42	.71
1898	.24	.47	.50
1899	.20	.32	.38
1900	.22	.35	.40
1901	.30	.42	.65
1902	.50	1.13	1.76
1903	.23	.40	.56
1904	.24	.55	.80
1st period (6 years)	.42	1.09	1.45
2d period (7 years)	.27	.51	.82
3d period (6 years)	.28	.53	.76

The data collected in this basin, as shown above, would seem to indicate that there has been a slight decrease in the discharge of the river within the time considered.

The statistics which have been collected since September, 1903, in the several basins in the White Mountain region consist of (*a*) records of gage height at the following river stations: Saco River at Conway Center, Pemigewasset River at Plymouth, Israel River above South Branch, Jefferson Highlands, Israel River below South Branch, Jefferson Highlands, Ammonoosuc River at Bretton Woods, Zealand River near Twin Mountain and Little River near Twin Mountain; (*b*) about 15 current meter measurements of flow at each of these stations except that on Little River, where three measurements have been made, and (*c*) records of rainfall at Bartlett, Bretton Woods, Jefferson Highlands and North Woodstock.

The measurements of flow have been plotted, a rating curve drawn and a rating table constructed for each station except that on Little River. From these rating tables and the records of gage height, estimates of flow have been made, as shown on previous pages. In order that these estimates may be easily compared with each other, certain data have been arranged below in three tables, as follows: The first shows the ratio of run-off to rainfall by months for the different drainage areas; the second shows the minimum recorded discharge in cubic feet per second per square mile for each of the three months, July, August and September, 1904, and the third shows the mean run-off in cubic feet per second per square mile for each of the stations for the months of July, August and September, 1904.

TABLE SHOWING RATIO OF RUN-OFF TO RAINFALL, BY MONTHS, FOR DIFFERENT DRAINAGE AREAS.

	1903.	1904.						
	Oct.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
Saco	0.51	2.10	2.20	0.74	0.38	0.20	0.22	0.78
Pemigewasset	0.26	......	1.70	0.48	0.15	0.27	0.30	0.94
Israel (above)	0.51	1.50	2.00	0.65	0.23	0.36	0.52	1.34
Israel (between)	0.29	1.30	1.30	0.58	0.27	0.27	0.47	1.30
Ammonoosuc	0.52	5.74	4.19	......	0.26	0.27	0.34	1.12
Zealand	0.54	5.60	2.30	......	0.19	0.24	0.78	4.72

TABLE SHOWING THE MINIMUM DAILY RUN-OFF IN CUBIC FEET PER SECOND PER SQUARE MILE FOR SEVERAL RIVER BASINS, FOR THE MONTHS OF JULY, AUGUST AND SEPTEMBER, 1904.

	Area.	July.	August.	September.
Saco	385	.41	.34	.31
Pemigewasset	615	.24	.35	.24
Israel (above)	3.7	.25	.345	.61
Israel (below)	21.2	.35	.47	.75
Ammonoosuc	34	.44	.53	.62
Zealand	14	.28	.28	.28

TABLE SHOWING MEAN MONTHLY RUN-OFF IN CUBIC FEET PER SECOND PER SQUARE MILE FOR SEVERAL RIVER BASINS, FOR THE MONTHS OF JULY, AUGUST AND SEPTEMBER, 1904.

	Area.	July.	August.	September.
Saco	885	.65	.72	1.07
Israel (above)	8.7	.75	1.64	2.84
Israel (below)	21.2	.82	1.42	2.69
Israel (between)	12.5	.87	1.26	2.56
Ammonoosuc	34	.74	1.06	2.35
Zealand	14	.53	.93	5.48
Pemigewasset	615	.55	.97	1.70

The first table indicates clearly that the rainfall data are not representative of the precipitation in the various basins in which they have been collected. In each case the rain gages are located on comparatively low portions of the basins and it is certain that at times the rainfall in the mountain areas is much greater. The ratio of run-off to rainfall in October, 1904, for several of the stations, shows clearly that the precipitation must have been much larger within the mountain areas, and there is no assurance that the relation between the amounts collected and the average rainfall in the several basins is the same. The first table is, therefore, probably of little value. The other two tables, which show the run-off per square mile, give results which are more nearly comparable with each other.

The basins of Ammonoosuc and Zealand Rivers are adjacent to each other and have in a general way the same topographic conditions. Ammonoosuc River, however, has its headwaters at considerably higher altitudes on the slopes of Mt. Washington. Its basin is, moreover, fairly well forested, as indicated in the definite statement of forest conditions, shown on another page. Zealand River basin has been largely deforested, but is now covered with a young growth of deciduous trees. It is noticeable that the run-off per square mile from the Zealand basin is considerably less than that from the Ammonoosuc.

The two stations on Israel River give information as to the run-off from two parts of that basin. These two portions have the same general topographic conditions, but that which is tributary above South Branch has its headwaters at a higher altitude than that which is tributary to South Branch. The forest conditions in the two sections are not so much different from each other as was supposed to be the case at the time the river stations were established. It will be noticed, however, that the percentage of cleared and burned area is greater in the lower basin than in the upper, also the percentage of area that is in deciduous and scattering evergreen growth is greater. An examination of the run-off above indicates, as a rule, a greater minimum run-off per square mile in the lower basin than in the upper, but a slightly less run-off for the low water months.

CONCLUSIONS.

The data available for discussion are not sufficiently accurate nor do they cover time enough to warrant definite conclusions. A general consideration of all the statistics at hand, however, seems to indicate a slight decrease in the run-off as deforestation progresses. If the several river stations are maintained for a term of years, it is believed that data may be collected from which conclusions can be drawn.