Bulletin

Harvard Forestry Club

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AN ACCOUNT OF OPERATIONS IN THE HARVARD FOREST, 1908–09

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THE operations here described constitute the first year's cut from the Harvard Forest. They were carried out between December and March, 1908–09. At the outset, pending the completion of the working plan, the amount of the cut was determined partly by a rough measurement of the growing stock and estimate of the growth, and partly by silvicultural condition, salability, and considerations of local policy. It was decided to cut about 200,000 feet of lumber (which was well within the annual increment from the tract), and 200 cords of firewood. In planning the operation, a permanent site was chosen for a portable mill, to which all logs over an area of 150 acres could be hauled down hill. In this way the woods work and the sawmill work could be kept entirely separate. The intention was to do just as much improvement cutting, yielding an inferior grade of lumber, as was consistent with securing a fair price for the main cut of mature timber. Three adjacent areas were taken in hand, all lying on a gentle to fairly steep westerly slope and distant between one-half and three-quarters of a mile from the mill-yard. All saw timber, both good and poor, was piled together in the mill-yard, where, at the end of the winter's work, it was sold in the log. The cord-wood was sold as it lay after cutting. The hauling both of wood and logs was done either with the wooden scoot or jumper, or the iron-shod two-sled, according to the nature of the ground surface and the condition of the going. The chopping was contracted for wholly by the cord and by the thousand feet. Thus it was possible to have the trees taken out in thinnings cut for the same price as those which were cut clean; and to a lesser degree the same plan was followed with the cord-wood.

Following are descriptions of the forest conditions and the nature of the treatment for each of the three compartments: —

COMPARTMENT 1*a*. Quality II. — The forest on Compartment 1*a* consisted of a dense, even-aged stand of white pine, with about 10% by area of red maple, black birch, red oak, and poplar, occurring principally in small groups. The average age was 60 years, and the stand per acre amounted to approximately 40,000 feet board measure. The condition of the crop was poor, the trees having stood much too dense. The growth for the past 20 years had been extremely slow, and though the crowns of the trees were abnormally short, there was scarcely any clear length, and a considerable amount of red rot (Tramites pini) had begun to appear, chiefly among the over-topped and suppressed trees. There was very little ground-cover, except needles and a thin humus, but throughout most of the compartment a partial reproduction of hardwood seedlings, chiefly white ash, sugar maple, black cherry, red oak, and chestnut, had already started. In view of these conditions a thinning was determined upon, with the expectation that, as the autumn of 1908 was a heavy seed year, the reproduction of pine might be started, and that the increment of the remaining trees would be stimulated. This thinning was to constitute a combination of preparatory and seed cutting under a Shelter-wood System with Uniform Cuttings. It included all over-topped and suppressed pines, a good many of the intermediate, and such dominant trees as were in poor condition, or excessively wide-crowned. At the same time the scattered hardwoods were all cut, except where their removal would leave too large an opening. Owing to the density of the stand, the amount of slash and tops left after cutting was very small, and when the pine cord-wood was taken out of it, what remained was not sufficient either to hinder reproduction or to constitute a serious risk from fire. (See illustrations of Compartment 1*a*.)

In the autumn of 1909, when one growing season had passed, the area was examined for results of the reproduction. Pine seedlings were found to have come in abundantly almost all over the cutting. In a series of counts taken on plots 8 feet square, the lowest number was 16 and the highest was 65. In color and

COMPARTMENT 1a. — Pure White Pine 60 years old. Upper picture before, lower picture after, first cutting under the Stand Method.

condition the plants were slightly less healthy than the normal, owing mainly to the bed of needles through which the rootlets were not easily able to reach the mineral soil, and in part to the reduced light.

In spite of the prevailing drought, this reproduction survived the summer of 1910 with increasing vigor, and at the present writing, the end of May, 1911, the season's shoots have already grown from one to two inches. Considering only density and health, the new crop is already effectively established. The effect of removing the old stand, with the attendant damage and increase of light, has yet to be demonstrated.

Compartment 1*b*. Quality II. — This compartment was covered with an irregular stand of mixed hardwoods representing the gradual extension of a temporary type over land which fifty years ago was partly pasture. Thus the stand was made up of small areas of fairly dense and even pole-and-sapling growth, and other areas where scattered, large wolf trees stood over thickets of valuable seedling and sapling growth. The species represented were chiefly red maple, large-toothed poplar, gray and paper birch, chestnut, red oak, and hard maple, with scattering white pine. Almost everywhere there was an excellent reproduction of valuable hardwoods and white pine, some of it already in the sapling stage. The treatment applied here consisted of improvement cuttings for the utilization of the deteriorating, mature trees, and the release and stimulation of young growth. The groups of dense, half-grown hardwoods were thinned, the scattered, old hardwoods were cut, and the poplar, which was, most of it, a little past maturity, was culled over the compartment. This treatment involved in some places such a very heavy cut that a considerable proportion of the young growth was unavoidably damaged, but for all that, enough to justify the operation was saved, and even that injured was left in condition to sprout again. The slash, which was mainly of poplar and red maple, was left scattered on the ground. (See illustrations of Compartment 1*b*.)

Compartment 2. Quality I. — The stand here was a dense mixed forest of white pine and hardwood, 60 years old, and ranging in height from 80 to 90 feet. Seventy-five per cent was pine,

COMPARTMENT 1*b*. — Upper picture before, lower picture after cutting.

and the rest chestnut, black cherry, red oak, white ash, and black birch. As a whole it was mature, and a small amount of red rot had appeared. The leaf litter was 3″ to 6″ in depth, and the humus 2″ to 4″. There was already a large reproduction of well-distributed hardwood seedlings on the ground, of which white ash, black cherry, red oak, and chestnut were the chief species. Moreover, these seedlings were for the most part less than a foot high, and consequently not likely to be seriously injured in the logging. Reproduction of pine was practically wanting, as is usually the case in such heavy, dark stands, but the autumn of 1908, as already stated, was marked by a very heavy fall of pine seed. It was therefore expected that by cutting the stand clear, and burning the heaviest of the slash, a reproduction of mixed pine and hardwoods would be secured. Such a mixture is without question the most valuable and productive for good situations, both in the quantity of wood produced, and in the quality of the timber. The certainty of the reproduction, of course, cannot be guaranteed, but in many cases, where a similar operation has coincided with a seed year, a satisfactory new crop has followed, even without any attempt to dispose of slash. In any event, from one-third to one-half of a full stocking will be furnished by the hardwood reproduction, and in case of a failure of the pine, seedlings can be very cheaply planted next the stumps of the old trees, thereby securing a favorable spot for growth, and partial freedom from possible suppression by hardwood sprouts.

The results of this clear cutting were as successful as the unfavorable growing season of 1909 would lead one to expect. By the end of June a count showed from two to a dozen exceptionally thrifty white pine seedlings to the plot of 8 feet square. The rest of the summer was abnormally dry, and by autumn nearly half of the seedlings had dried out and died. Those still living, many of which had made remarkable growth, were situated either where the leaf litter and humus had been well mixed with the mineral soil, in small moist depressions, or where there had been side shade from weeds or the adjacent woods during the hot part of the day. The plants which had died had stood chiefly on the south side of small hummocks or where the thick mat of

needles and humus had not been disturbed. In ordinary seasons a sufficient number of seedlings to restock the ground would probably have survived.

Although this method of natural reproduction by clear cutting may fairly be called uncertain, a good case can none the less be made out for it. *First*, it involves the lowest possible cost of operation. *Second*, the necessary burning of slash makes for protection, and is (certainly in part, if not entirely) chargeable to that account, and to the cost of formation of the new

COMPARTMENT 2. — White Pine and Hardwoods 60 years old, with abundant hardwood reproduction

crop. *Third*, the form of the stand and the mixed crop with which it is to be replaced make any method by partial cutting almost impracticable. If scattered seed trees from such a dense tall forest are left, they are very apt to blow down, and before they have finished seeding up the ground, the hardwood reproduction has got too great a start. Group or Shelter-wood cuttings tend unduly to increase the percentage of hardwoods, and Selection cutting is still more unsuited to the silvics of the

desirable species, pine and chestnut. On the other hand, when such a forest as this is cut down immediately after a fall of seed, from one half to a full stocking for the ground is assured, supplementary planting (if needful) is cheaply done, and the resulting combined crop begins effective growth almost at once.

A summary of the financial aspect of these three operations is given in the following table: —

Location	Area Acres	Product	Yield		Costs per Unit Volume				Total Costs per Unit Volume	Selling Price		Net Return	
			Per Acre	Total	Chopping	Skidding	Yarding	Disposal Brush		Basis	Amount	Per unit Volume	Total
Compartment 1a	6.5	Pine Box Boards .	6150 B.M.	40,000 B.M.	$1.00	. .	$3.56	. .	$4.56	Log	$11.25	$6.69	$267.60
		Hardwood Cord-wood	4 cds. 2 ft.	27 cds. 7 ft.	.90	. .	. .	. .	.90	Cut	2.00	1.10	30.68
		Pine Cord-wood .	2 " 4 "	16 "	.90	. .	. .	. .	.90	"	1.25	.35	5.60
Compartment 1a	16.7	Poplar Box Boards	1900 B.M.	33,000 B.M.	1.00	$2.50	1.53	. .	5.03	Log	11.25	6.22	205.26
	3.3	Birch and Maple Cord-wood . .	10 cds. 4 ft.	35 cds. 1 ft.	.90	. .	. .	. .	.90	Cut	2.00	1.10	38.64
	16.7	Poplar Cord-wood	1 " 6 "	29 "	.90	. .	. .	. .	.90	"	1.25	.35	10.15
Compartment 2	3.75	Pine, 30% Box Boards	38,400 B.M.	144,000 B.M.	1.00	. .	1.77	$0.30	3.07	Log	11.25	8.18	1177.92
		Hardwood Cord-wood	22 cds. 1 ft.	83 cds.	.90	. .	. .	. .	.90	Cut	2.00	1.10	91.30
		Pine Cord-wood .	7 " 2 "	27 " 4 ft.	.90	. .	. .	. .	.90	"	1.00	.10	2.75

TREES AND OTHER WOODY PLANTS FOUND IN THE HARVARD FOREST, PETERSHAM, MASSACHUSETTS

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THE following enumeration of the trees and other ligneous plants found growing naturally or naturalized in the Harvard Forest or proximity, in Petersham, Massachusetts, is issued primarily as a reference or hand list for the convenience of students in the Harvard Forest School.

As the forest has not been thoroughly examined in the short period since it was acquired, other species will undoubtedly be found, so that the present list may be regarded as a provisional one.

Since the line between herbaceous and ligneous or shrubby plants cannot be sharply drawn and is a purely arbitrary matter, some plants may be found in this list which would be left out by some dendrologists, while consistency might compel the inclusion of some species not here enumerated, such as species of Lycopodium.

The question of nomenclature is a troublesome one because American botanists are not united upon rules for the names of plants. As many of the students in forestry plan to enter the United States Forest Service, the rules for botanical nomenclature adopted by the Forest Service have generally been followed in the names of both trees and shrubs, the oldest clear specific or varietal name being used, dating from the foundation of binomial nomenclature by Linnaeus in his "Species Plantarum," published in 1753. The more commonly used synonyms are given and, as a matter of historical interest, the original combinations of genera and species and the dates of publication are added.

Following the rules adopted by Sudworth in his "Check List of the Forest Trees of the United States" (Bulletin, No. 17, Division of Forestry, 1898), and by zoölogists generally, all specific and varietal names are written with a small initial letter both in names adopted here and also in quotation of synonyms used by other authors. See Sudworth's "Nomenclature of the Arborescent Flora of the United States" (Bulletin, No. 14, Division of Forestry, 1897), pp. 341–355, for laws and codes of nomenclature adopted by the Forest Service as a standard for scientific names of plants.

SPERMATOPHYTA. Seed Plants.

GYMNOSPERMAE.

Taxaceae. Yew Family.

Taxus Linnaeus. Yew.

Taxus canadensis Marshall. Ground Hemlock, American Yew.
Shady woods, frequent.

Pinaceae. Pine Family.

Pinus Linnaeus. Pine.

Pinus strobus Linnaeus. White Pine, Weymouth Pine.
Most important commercial species in the Harvard Forest. Found abundant in almost all situations except deep swamps.

Pinus rigida Miller. Pitch Pine.
Occurs in a few small colonies in dry situations. Of little economic importance in this region.

Pinus resinosa Aiton. Red Pine, Norway Pine.
Rare in Harvard Forest, a small colony in Prospect Hill tract and individuals in other parts. Other small groups in the vicinity of Petersham.

Larix Miller. Larch.

Larix laricina (Du Roi) Koch. American Larch, Black Larch, Tamarack, Hackmatack.
Pinus laricina Du Roi. [1771.]
Larix americana Michaux. [1803.]
Found in groups or scattered individuals on swamps or bogs, usually small.

Larix larix (L.) Karsten. European Larch.
Pinus larix Linnaeus. [1753.]
Larix decidua Miller. [1768.]
Larix europaea De Candolle. [1805.]
Planted in Petersham, rarely escaped.

Picea Link. Spruce.

Picea rubens Sargent. Red Spruce.
Picea nigra rubra Engelmann.
Picea rubra (Poir.) Dieterich.
Abies rubra Poiret.
Probably once abundant in Northeast tract, now nearly all cut off. Slopes of Prospect Hill and adjacent swamps also in Meadow Water tract.
There is much disagreement as to the proper specific name to be applied to this tree. The name used by Sudworth in his "Check List" and by Professor C. S. Sargent in his "Manual of the Trees of North America" is here retained though some authorities prefer the older *Picea rubra*.

Picea mariana (Mill.) B.S.P. Black Spruce, Swamp Spruce.
Abies mariana Miller.
Common on bogs in surrounding country but rare in Harvard Forest. In swamp on Meadow Water tract where it cannot be described as exactly typical but appears as if in transition from Red to Black Spruce as the former extends from dry slopes into the swamp.

Picea abies (L.) Karsten. Norway Spruce.
Pinus abies Linnaeus [1753.]
Picea excelsa (Lam.) Link.
Pinus excelsa Lamarck. [1778.]
Planted in Petersham and rarely naturalized.

Abies Hill. Fir.

Abies balsamea (L.) Miller. Balsam Fir, Balm of Gilead Fir.
Planted in Petersham, probably native although not yet found in Harvard Forest. Is native in adjoining towns.

Tsuga (Endl.) Carr. Hemlock.

Tsuga canadensis (L.) Carrière. Hemlock.
Common on cool north situations and occasionally as an understory to White Pine.

Thuya Linnaeus. Arbor Vitae.

Thuya occidentalis Linnaeus. Arbor Vitae, White Cedar.
Planted in Petersham.

Juniperus Linnaeus. Juniper.

Juniperus virginiana Linnaeus. Red Cedar, Savin.
Rather rare. In pastures.

Juniperus nana Willdenow. [1806.]
Juniperus communis of many writers. Common Juniper. Prostrate Juniper.
In abandoned pastures.

ANGIOSPERMAE.

DICOTYLEDONEAE.

Salicaceae. Willow Family.

Salix Linnaeus. Willow, Osier.

Salix lucida Muhlenberg. Shining Willow, Glossy Willow.
Rather rare in Harvard Forest.

Salix fragilis Linnaeus. Crash Willow, Brittle Willow.
Native of Europe. Planted in Petersham.

Salix alba Linnaeus. White Willow.
Native of Europe. Planted in Petersham.

Salix cordata Muhlenberg. Heart-leaved Willow.
Common. Wet ground.

Salix discolor Muhlenberg. Glaucous Willow, Pussy Willow.
Very common. Roadsides and low places.

Salix humilis Marshall. Prairie Willow.
Dry ground. Not uncommon.

Salix sericea Marshall. Silky Willow.
Common. Usually near streams or in wet situations.

Salix petiolaris J. E. Smith. Slender Willow.
Occasional. On wet ground.

Salix bebbiana Sargent. Beaked Willow.
Salix rostrata Richardson.
Common. Moist and dry situations.

Populus Linnaeus. Poplar, Aspen.

Populus alba Linnaeus. White or Silver-leaved Poplar, Abele, White Park.
Introduced in Petersham. A European species.

Populus tremuloides Michaux. American or Quaking Aspen, Poplar, Popple, Quiver-leaf.
Very common. Clearings and dry ground.

Populus grandidenta Michaux. Large-toothed Aspen, Poplar, Popple.
Common. Clearings, roadsides, dry and wet ground.

Populus candicans Aiton. [1789.] Balm of Gilead.
Populus balsamifera candicans (Ait.) Gray.
Introduced in Petersham and found reproducing itself by root sprouts near old house sites, etc.

Myricaceae. Sweet Gale Family.

Myrica Linnaeus.

Myrica gale Linnaeus. Sweet Gale.
In swamps and borders of ponds and streams.

Myrica carolinensis Miller. Bayberry, Candlewood, Waxberry.
In pastures and abandoned fields.
This species is found in most Manuals and Floras of eastern North America under the name of *Myrica cerifera* which is now restricted to a more southern type.

Comptonia Banks.

Comptonia peregrina (L.) Coulter. Sweet Fern.
Liquidambar peregrina Linnaeus. [1753.]
Myrica asplenifolia Linnaeus. [1753.]
Comptonia asplenifolia (L.) Gaertner.
Common, chiefly in pastures and abandoned fields, a weed.

Juglandaceae. Walnut Family.

Juglans Linnaeus. Walnut.

Juglans cinerea Linnaeus. Butternut, White Walnut, Oil Nut.
Frequent, woods and roadsides.
Juglans nigra Linnaeus. Black Walnut.
Rare, planted in Petersham.

Hicoria. Hickory.

Hicoria ovata (Mill.) Britton. Shagbark or Shellbark Hickory.
Juglans ovata Miller [1768.]
Carya ovata (Mill.) K. Koch.
Carya alba Nutt. [1818.]
Not common in Harvard Forest but found more or less abundantly in neighboring woods and fields.
Hicoria glabra (Mill.) Britton. Pignut, Broom Hickory.
Juglans glabra Miller. [1768.]
Carya glabra (Mill.) Spach.
Carya porcina Nuttall. [1818.]
Not very common, sometimes found associated with Shagbark Hickory.
Hicoria microcarpa (Nutt.) Britton. Small-fruited Hickory.
Carya microcarpa Nuttall.
A single tree of what appears to be this species occurs on the Waldo farm in Petersham. Its classification is difficult, as is the case with many of the hickory trees found in New England, especially those in the Pignut group.

Betulaceae. Birch Family.

Corylus Linnaeus. Hazelnut, Filbert.

Corylus americana Walter. Common Hazelnut.
Rare in Harvard Forest.
Corylus rostrata Aiton. Beaked Hazelnut, Filbert.
Common, roadsides, woods, and thickets.

Ostrya Scopoli. Hop Hornbeam, Ironwood.

Ostrya virginiana (Mill.) K. Koch.
Carpinus virginiana Miller. [1768.]
Ostrya virginica Willdenow. [1805.] American Hop Hornbeam, Leverwood, Ironwood, Deerwood.
Frequent in the Harvard Forest.

Carpinus Linnaeus. Hornbeam, Ironwood.

Carpinus caroliniana Walter. [1788.]
Carpinus americana Michaux. [1803.] American Hornbeam, Blue or Water Beech.
Local, not common as the Hop Hornbeam.

Betula Linnaeus. Birch.

Betula populifolia Marshall. Gray Birch, Old Field Birch.
Very common. A forest weed, on pastures, clearings, and in woods.

Betula papyrifera Marshall. [1785.] White, Canoe, or Paper Birch.
Betula alba papyrifera (Marsh.) Spach.
Betula papyracea Aiton. [1789.]
Frequent, most abundant in Meadow Water tract.

Betula lenta Linnaeus. Black, Cherry, or Sweet Birch.
Common on well-drained soils.

Betula lutea Michaux fils. Yellow Birch, Silver Birch.
Frequent on rich moist or wet situations.

Alnus Hill. Alder.

Alnus incanus (L.) Moench. Speckled or Hoary Alder.
Common on wet ground, swamps and borders of streams.
Form here is not so typically gray tomentose beneath as occurs further north and in some other regions.

Alnus rugosa (Du Roi) Sprenger. Smooth Alder.
Betula alnus rugosa Du Roi [1771.]
Alnus serrulata Willdenow. [1805.]
Less common than *A. incana.*
Plants with characters intermediate between these two alders are common in Petersham.

Fagaceae. Beech Family.

Fagus Linnaeus. Beech.

Fagus grandifolia Ehrhart. [1788.] Beech, American Beech.
Fagus ferruginea Aiton. [1789.]
Fagus americana Sweet. [1826.]
Occasional as individuals or groups in well-drained woods.

Castanea Hill. Chestnut.

Castanea dentata (Marsh.) Borkhausen. [1800.] American Chestnut.
Fagus castanea dentata Marshall. [1785.]
Castanea sativa americana Sargent.
Castanea vesca americana Michaux. [1803.]
Common and important tree.

Quercus Linnaeus. Oak.

Quercus alba Linnaeus. White Oak.
Common, in various soils and situations.

Quercus prinus Linnaeus. Chestnut Oak.
Found near Petersham (Shutesbury) but not yet noted in Harvard Forest.

Quercus rubra Linnaeus. Red Oak.
Common, especially in rich soil and protected situations.
Of commercial importance in Harvard Forest.

Quercus coccinea Muenchhausen. Scarlet Oak.
Rather rarely found in Harvard Forest.

Quercus velutina Lamarck. [1783.] Yellow Oak, Black Oak.
Quercus tinctoria Bartram. [1791.]
Quercus coccinea tinctoria (Bartr.) A. De Candolle.
Common throughout the drier or better drained parts of the forest.

Ulmaceae. Elm Family.

Ulmus Linnaeus. Elm.

Ulmus americana Linnaeus. American Elm, White Elm.
Common, woods and fields.

Ulmus fulva Michaux. Slippery Elm, Red Elm.
Ulmus pubescens Walter [1788] has been taken by some authors for this species but is generally ignored because Walter's description is inadequate and leaves uncertainty as to the tree he attempted to name.
Rather rare, planted in Petersham and apparently native in vicinity of the Harvard Forest.

Ulmus campestris Linnaeus. English Elm.
This native of Europe is planted in Petersham and is rarely found escaped from cultivation. Other foreign species of elms or hybrids are also planted.

Berberidaceae. Barberry Family.

Berberis Linnaeus. Barberry.

Berberis vulgaris Linnaeus. Common Barberry.
Native of Europe. Planted in Petersham and occasionally naturalized in Harvard Forest.

Lauraceae. Laurel Family.

Sassafras Nees.

Sassafras sassafras (L.) Karsten. Sassafras.
Laurus sassafras Linnaeus. [1753.]
Sassafras variifolium (Salisb.) Kuntze.
Laurus variifolia Salisbury. [1796.]
Sassafras officinale Nees and Ebermeir. [1830.]
Rather rare, on dry ground, usually small.

Benzoin Fabricius.

Benzoin aestivale (L.) Nees. Spine Bush, Fever Bush.
Laurus aestivalis Linnaeus. [1753.]
Lindera benzoin (L.) Blume.
Laurus benzoin Linnaeus. [1753.]
Benzoin benzoin (L.) Coulter.
Frequent, in moist or wet places.

Saxifragaceae. Saxifrage Family.

Ribes Linnaeus. Currant, Gooseberry.

Ribes cynosbati Linnaeus. Prickly Gooseberry.
Occasionally found in woods and along fences.

Ribes vulgare Lamarck. Red Currant.
Native of Europe, cultivated in gardens and occasionally found escaped in woods. Has been called *Ribes rubrum*, which name, however, properly belongs to another species.

Philadelphus Linnaeus. Mock Orange, Syringa.

Philadelphus coronarius Linnaeus. Mock Orange.
Old World species, planted and occasionally escaped from cultivation.

Hamamelidaceae. Witch Hazel Family.

Hamamelis Linnaeus. Witch Hazel.

Hamamelis virginiana Linnaeus. Witch Hazel.
A common shrub, found in both moist and moderately dry situations, chiefly in shady woods.

Platanaceae. Plane Tree Family.

Platanus Lindley. Buttonwood, Sycamore.

Platanus occidentalis Linnaeus.
Very rare in Harvard Forest, rich soil.

Rosaceae. Rose Family.

Spiraea Linnaeus.

Spiraea latifolia (Ait.) Borkhausen. Meadow-sweet.
Formerly called *Spiraea salicifolia* by many writers on the flora of Northeastern America, but that is a distinct species not known to occur within this range.
Common, pastures, open woods, moist ground, roadsides.

Spiraea tomentosa Linnaeus. Hardhack.
Common, pastures, low grounds.
Various introduced Spiraeas are planted in Petersham or rarely found near home sites in the Harvard Forest. The hybrid *Spiraea vanhouttei* is one of these.

Malus Hill. Apple.

Malus malus (L.) Britton. Common Apple.
Pyrus malus Linnaeus. [1753.]
Malus sylvestris Miller. [1768.]
This native of the Old World is very generally escaped from cultivation and has become naturalized along roadsides, in fields, and in woods, showing great variation in fruit and other characters. *Malus soulardi* (Bailey) Britton. Soulard Crab. *Pyrus soulardi* Bailey. An interesting apparent hybrid between the Common Apple of the Old World and *Malus ioensis*, a crab apple native in the Middle States. It was planted on the Prospect Hill tract, with other apples, by former owners.

Pyrus Linnaeus. Pear Family.

Pyrus communis Linnaeus. Common Pear.

This native of the Old World has been planted and rarely escaped from cultivation.

Cydonia Miller. Quince.

Cydonia cydonia (L.) Persoon. Common Quince.

Pyrus cydonia Linnaeus. [1753.]

Cydonia vulgaris Persoon. [1807.]

Introduced and persisting in abandoned orchards, Prospect Hill tract.

Aronia Persoon. Chokeberry, Dogberry.

Aronia atropurpurea Britton. Purple-fruited Chokeberry.

Pyrus arbutifolia atropurpurea (Britton) Robinson.

Frequent.

Aronia nigra (Med.) Dippel. Black Chokeberry.

Hahnia arbutifolia nigra Medicus. [1793.]

Pyrus nigra (Med.) Sargent.

Sorbus melanocarpa (Willd.) Heynhold.

Pyrus melanocarpa (Mich.) Willdenow.

Mespilus arbutifolia melanocarpa Michaux. [1803.]

Very common. The chokeberries in this region show a great deal of variation, so that other species or varieties may yet be separated.

Sorbus americana Marshall. [1785.] American Mountain Ash.

Pyrus americana (Marsh.) De Candolle.

Rather rare, in woods and along roadsides, sometimes planted for ornament.

Amelanchier Medicus. Juneberry, Serviceberry, Shadbush.

Amelanchier canadensis (L.) Medicus. Juneberry, Serviceberry.

Mespilus canadensis Linnaeus. [1753.]

Common, usually in dry or well-drained woods, usually small or shrub-like, rarely becoming large with a trunk approaching a foot in diameter and attaining 50 feet or more in height.

Amelanchier oblongifolia (T. & G.) Roemer. Swamp Shadbush.

Amelanchier canadensis oblongifolia Torrey & Gray. [1840.]

Frequent, usually on moist or wet ground.

Amelanchier spicata (Lam.) C. Koch.

Uncommon, Prospect Hill tract and other places.

There is much variation among the Juneberries of this region and it is possible one or two additional species may be segregated.

Crataegus Linnaeus. Hawthorn, White.

Crataegus rotundifolia Moench. [1785.]

Crataegus coccinea rotundifolia (Moench.) Sargent.

Occasional.

Crataegus pastorum Sargent. Pasture Thorn.

Frequent, neglected pastures, open woods, along fences and roads.

Crataegus monogyna Jacquin. English Hawthorn, White Thorn.

Rarely escaped from cultivation. By American writers often called

C. oxyacantha, a name properly belonging to another species.

It is probable that more so-called species of Crataegus may be found in the Harvard Forest and vicinity. There is much confusion among authors in regard to the specific limits and nomenclature.

Rubus Linnaeus. Raspberry, Blackberry, Bramble.

Rubus odoratus Linnaeus. Purple Flowering Raspberry.
Not common, occurs on the different tracts of the Harvard Forest.

Rubus strigosus Michaux. Wild Raspberry.
Common.

Rubus occidentalis Linnaeus. Thimbleberry, Black Cap Raspberry.
Frequent.

Rubus triflorus Richards.
Common. Wet woods.

Rubus allegheniensis Porter. High Blackberry.
Common.

Rubus recurvans Blanchard.
Occasional. Roadsides.

Rubus canadensis Linnaeus.
Barre Road, banks of Swift River.

Rubus setosus Bigelow.
Near Brooks's Pond.

Rubus hispidus Linnaeus.
Common. Low woods.

Rubus villosus Aiton. Dewberry.
Common. Open places.

Rosa Linnaeus. Rose.

Rosa nitida Willdenow.
In Meadow Water swamp.

Rosa rubiginosa Linnaeus. Sweetbrier.
Occasional, escaped from cultivation into old pastures.

Rosa cinnamomea Linnaeus. Cinnamon Rose.
This Old World rose, with semidouble flowers, occurs on the Meadow Water tract and other parts near sites of former homesteads.

Prunus Linnaeus. Plum, Cherry, Peach.

Prunus serotina Ehrhart. Wild Black Cherry, Rum Cherry.
Common, in woods, along roadsides, and in pastures.
Becomes of good timber size in moist situations in mixture with white ash, yellow birch, red maple, etc.

Prunus virginiana Linnaeus. Choke Cherry.
Frequent in open woods and along roadsides.

Prunus pennsylvanica Linnaeus fils. Wild Red Cherry, Bird, Pin, or Fire Cherry.
Very common on old pastures, on old burned areas, along roadsides, and in open woods with quaking aspen, etc.

Prunus avium Linnaeus. Sweet, Black, or Mazzard Cherry.
Introduced from Europe, the common Garden Cherry of New England, occasionally found escaped in woods.

Prunus cerasus Linnaeus. Sour or Morello Cherry.

From Europe, cultivated and occasionally becoming wild along fences, roadsides, etc.

Prunus nigra Aiton. Canada Plum, Horse Plum.

Occasional along roadsides and fences. Probably escaped from cultivation and not strictly native in this locality.

Prunus persica (L.) Stokes. Peach.

Amygdalus persica Linnaeus.

In abandoned orchards and escaped from cultivation.

Leguminosae. Pulse Family.

Robinia Linnaeus. Locust.

Robinia pseudacacia Linnaeus. Locust, Common, Black, Yellow, and White Locust, False Acacia.

Escaped from cultivation and naturalized in Harvard Forest and other parts of Petersham.

Anacardiaceae. Cashew Family.

Rhus Linnaeus. Sumachs.

Rhus hirta (L.) Sudworth. Staghorn Sumach.

Datisca hirta Linnaeus. [1753.]

Rhus typhina Linnaeus. [1760.]

Common in old fields, clearings, and along roads and fences.

Rhus glabra Linnaeus. Smooth Sumach.

Often occurs with Staghorn Sumach and about equally common.

An apparent hybrid between *R. typhina* and *R. glabra* occurs on the Prospect Hill tract. It is a pistillate plant.

Rhus copallina Linnaeus. Mountain Sumach, Dwarf Sumach.

Not common, in old pastures and open woods.

Rhus vernix Linnaeus. [1753.] Poison Sumach, Poison Dogwood, Poison Elder.

Rhus venenata De Candolle. [1825.]

Frequent on wet ground or swamps.

Rhus toxicodendron Linnaeus. Poison Ivy, Poison Oak.

Very common, usually trailing or climbing, sometimes bushy or shrub-like.

Aquifoliaceae. Holly Family.

Ilex Linnaeus. Holly.

Ilex verticillata (L.) A. Gray. Winterberry, Black Alder.

Prinos verticillata Linnaeus.

Very common, usually in moist or wet ground; very variable.

Ilex laevigata (Pursh.) A. Gray. Smooth Winterberry.

Prinos laevigata Pursh.

Local but common in some swamps, Prospect Hill tract, also Meadow Water.

Ilicioides Dumont.

Ilicioides mucronata (L.) Britton. Mountain Holly.

Vaccinium mucronatum Linnaeus. [1753.]

Nemopanthus mucronata (L.) Trelease.
Nemopanthus canadensis De Candolle. [1821.]
Common in swamps or wet ground in woods.
While the generic name Nemopanthus of Rafinesque [1819] has been used most often it seems proper that the older Ilicioides [1802] should be followed.

Celastraceae. Staff Tree Family.

Celastrus Linnaeus.

Celastrus scandens Linnaeus. Waxwork, Climbing Bitter-sweet.
Occasional, Prospect Hill tract and other places.

Euonymus Linnaeus. Spindle Tree.

Euonymus atropurpureus Jacquin. Burning Bush. Wahoo.
Planted and naturalized at Harvard House, Prospect Hill tract.

Aceraceae. Maple Family.

Acer Linnaeus. Maple.

Acer pennsylvanicum Linnaeus. Striped Maple, Moosewood.
Occurs scattered through woods, frequent.
Acer spicatum Lamarck. Spiked Maple, Mountain Maple.
Much less abundant than the Striped Maple.
Acer saccharum Marshall. [1785.] Sugar Maple, Rock Maple.
Acer saccharinum Wangenheim [1787], not Linnaeus [1753].
Common, attaining good size and of commercial importance.
Acer rubrum Linnaeus. Red, Swamp, or Soft Maple.
Very common, especially in low ground. Valued as cord-wood.
Acer saccharinum Linnaeus [1753], not Wangenheim [1787]. White or Silver Maple also Soft Maple.
Acer dasycarpum Ehrhart. [1789.]
Planted but not indigenous in this locality.
Acer negundo Linnaeus. [1753.] Ash-leaved Maple, Box Elder.
Negundo aceroides Moench. [1794.]
Planted occasionally but not native in this region.
Acer platanoides Linnaeus. Norway Maple.
Native of Europe, planted in Petersham as a street or shade tree.
Other species of Maples are rarely planted in the town.

Hippocastanaceae. Horsechestnut Family.

Aesculus Linnaeus. Horsechestnut, Buckeye.

Aesculus hippocastanum Linnaeus. Horsechestnut.
Native of Europe, planted for ornament and occasionally escaped in woods.

Rhamnaceae. Buckthorn Family.

Rhamnus Linnaeus. Buckthorn.

Rhamnus cathartica Linnaeus. Common Buckthorn.
Native of Europe, planted and frequently become naturalized.

Vitaceae. Grape Family.

Vitis Linnaeus. Grape.

Vitis labrusca Linnaeus. Common Wild Grape, Northern Fox Grape.
Common.

Vitis aestivalis Michaux. Summer Grape.
On stone walls, apparently native.

Vitis vulpina Linnaeus. [1753.] River-bank Grape.
Vitis riparia Michaux. [1803.]
Occasionally on stone walls or fences, seeming native.
Grapes of various varieties were formerly planted along stone walls and fences by members of the Adonai Showo community and perhaps others. These plants now have the appearance of being at least half wild. They are north on the Prospect Hill tract.

Psedera Necker (Ampelopsis). Virginia Creeper, American Woodbine.

Psedera quinquefolia (L.) Greene.
Hedera quinquefolia Linnaeus. [1753.]
Ampelopsis quinquefolia (L.) Michaux. [1803.]
Parthenocissus quinquefolia (L.) Planchon. [1887.]
Common.

Psedera vitaceae Greene.
Roadsides, apparently native, perhaps escaped from cultivation.

Tiliaceae. Linden Family.

Tilia Linnaeus. Linden, Basswood.

Tilia americana Linnaeus. Basswood, American Linden, Whitewood.
Occurs in mixture with other deciduous trees of Harvard Forest in rich situations.

Phymelaeceae. Mezereum Family.

Dirca Linnaeus. Leatherwood.

Dirca palustris Linnaeus. Wicopy, Leatherwood, Moosewood.
Rare. Found along roadside, Slab City tract.

Araliaceae. Ginseng Family.

Aralia Linnaeus.

Aralia hispida Ventenat. Bristly Sarsaparilla.
Occasional.

Cornaceae. Dogwood Family.

Cornus Linnaeus. Cornel, Dogwood.

Cornus florida Linnaeus. Flowering Dogwood, Boxwood.
Local in Petersham, not yet found wild in Harvard Forest.

Cornus rugosa Lamarck. [1786.] Round-leaved Cornel.
Cornus circinata L'Heritier. [1788.]
Occasional, roadsides and open woods.

Cornus amomum Miller. [1768.] Silky Cornel.
Cornus sericea Linnaeus. [1771.]
Rather rare in Harvard Forest, on moist ground.

Cornus obliqua Rafinesque. [1819.] Narrow-leaved Silky Cornel.
Cornus purpusi Koehne. [1899.]
Rare in Harvard Forest, moist ground and liable to be confused with *C. amomum*.

Cornus stolonifera Michaux. Red-osier Dogwood.
Planted in Petersham but not yet recognized as wild there.

Cornus racemosa Lamarck. [1786.] Panicled Cornel.
Cornus paniculata L'Heritier. [1788.]
Cornus candidissima (?) Marshall. [1785.]
Frequent, along roadsides and in woods.

Cornus alternifolia Linnaeus fils. Alternate-leaved Dogwood.
Common along roadsides and in open woods.

Nyssa Linnaeus. Tupelo, Pepperidge, Sour Gum.

Nyssa sylvatica Marshall. [1785.]
Nyssa multiflora Wangenheim. [1787.]
Frequent, chiefly in moist or wet ground.

Ericaceae. Heath Family.

Rhododendron Linnaeus.

Rhododendron viscosum (L.) Torrey. Clammy Azalea, White Swamp Azalea, or Honeysuckle.
Azalea viscosa Linnaeus.
Uncommon in swampy situations.

Rhododendron canescens (Mich.] Porter. Purple, Pink, or Wild Azalea or "Honeysuckle."
Azalea canescens Michaux.
Common in swamps, also in drier ground.
This is the *Azalea nudiflora* or *Rhododendron nudiflorum* of various Manuals and Floras of eastern North America.
The true *R. nudiflorum* however, which closely resembles *R. canescens*, is not known to occur in this locality.

Rhododendron canadense (L.) B.S.P. Rhodora.
Rhodora canadensis Linnaeus. [1762.]
Rhododendron rhodora D. Don. [1834.]
Common in a few localities in Harvard Forest and other parts of Petersham.

Kalmia Linnaeus.

Kalmia latifolia Linnaeus. Mountain Laurel, Calico Bush.
Plentiful in a few localities and frequent scattered individuals. In woods and thickets especially under shade of overwood.

Kalmia angustifolia Linnaeus. Sheep Laurel, Lambkill.
Old fields and wet ground, common.

Kalmia polifolia Wangenheim. [1787.] Pale or Swamp Laurel.
Kalmia glauca Aiton. [1811.]
Occasional, in cold sphagnum swamps.

Leucothoe D. Don. Fetter Bush.

Leucothoe racemosa (L.) Gray.
Andromeda racemosa Linnaeus. [1753.]
Uncommon or rare, wet places.

Andromeda Linnaeus.

Andromeda glaucophylla Link. Bog or Marsh Rosemary.
Rare or local in cold wet bogs or "muskegs," not yet noticed in Harvard Forest. This is enumerated as *Andromeda polifolia* Linnaeus in many Manuals and Floras of North America but that name applies to the European species which is now generally regarded as distinct.

Lyonia Nuttall.

Lyonia ligustrina (L.) De Candolle.
Vaccinium ligustrinum Linnaeus. [1753.]
Andromeda ligustrina (L.) Muhlenberg.
Xolisma ligustrina (L.) Britton.
Common throughout the region, preferring moist or wet places.

Chamaedaphne Moench.

Chamaedaphne calyculata (L.) Moench. Leather Leaf, Cassandra.
Andromeda calyculata Linnaeus. [1753.]
Cassandra calyculata (L.) D. Don.
Wet sphagnum swamps. Very abundant on Meadow Water tract covering many acres of the shallower parts of the pond.

Epigaea Linnaeus. Mayflower, Trailing Arbutus.

Epigaea repens Linnaeus. Mayflower.
Plentiful in localities.

Gaultheria Linnaeus.

Gaultheria procumbens Linnaeus. Checkerberry, Teaberry.
Abundant in localities, woods and clearings.

Chiogenes Salisbury.

Chiogenes hispidula (L.) Torrey & Gray. Creeping Snowberry.
Vaccinium hispidulum Linnaeus
Occurs on sphagnum in cold wet bogs.

Vaccinium Linnaeus. Blueberry, Cranberry.

Vaccinium pennsylvanicum Lamarck. Dwarf or Early Blueberry.
Common, dry situations, fields and woods.
Vaccinium vacillans Kaln. Late Low Blueberry.
Common, dry soil.
Vaccinium canadense Kalm. Canade Blueberry.
Apparently uncommon, wet places.
Vaccinium corymbosum Linnaeus. High-bush or Tall Blueberry.
Common, swamps or drier situations.
Vaccinium atrococcum (Gray) Heller. Black High Blueberry.
Vaccinium corymbosum atrococcum Gray.
Occasional. It seems doubtful whether this blueberry should be considered specifically distinct from V. corymbosum.
Vaccinium oxycoccus Linnaeus. Small-fruited Cranberry.
Uncommon. Meadow Water tract.

Vaccinium macrocarpon Aiton. Large-fruited Cranberry.
Oxycoccus macrocarpus (Ait.) Pursh.
Plentiful on some sphagnum-covered bogs and wet places.

Gaylussacia Humboldt Bonpland & Knuth. Huckleberry.

Gaylussacia baccata (Wang.) K. Koch. Black Huckleberry.
Andromeda baccata Wangenheim. [1787.]
Vaccinium resinosum Aiton. [1789.]
Gaylussacia resinosa (Ait.) Torrey & Gray.
Common, both wet and dry situations, old pastures, etc.

Oleaceae. Olive Family.

Fraxinus Linnaeus. Ash.

Fraxinus americana Linnaeus. White Ash.
Common, in rich soils. Of commercial importance in Harvard Forest.

Fraxinus nigra Marshall. [1785.] Black Ash.
Fraxinus sambucifolia Lamarck. [1786.]
Occurs in swamps, not plentiful and of little economic importance here.

Syringa Linnaeus. Lilac.

Syringa vulgaris Linnaeus. Common Lilac.
Escaped from cultivation, abandoned homesteads, etc.

Ligustrum Linnaeus. Privet.

Ligustrum vulgare Linnaeus. Common Privet.
Rarely naturalized from cultivated plants.

Solanaceae. Nightshade Family.

Solanum dulcamara Linnaeus. Bittersweet.
Occasional. Naturalized from Europe.

Bignoniaceae. Trumpet Creeper Family.

Tecoma Jussieu.

Tecoma radicans (L.) De Candolle. Trumpet Creeper.
Bignonia radicans Linnaeus. [1753.]
Escaped from cultivation, old house site on Prospect Hill tract.

Rubiaceae. Madder Family.

Cephalanthus Linnaeus.

Cephalanthus occidentalis Linnaeus. Button-bush.
Very wet boggy places, Meadow Water tract, etc.

Caprifoliaceae. Honeysuckle Family.

Diervilla Moench.

Diervilla diervilla (L.) MacMillan. Bush Honeysuckle.
Lonicera diervilla Linnaeus. [1753.]
Diervilla lonicera Miller. [1759.]
Diervilla trifida Moench. [1794.]
Common, dry woods, roadsides, and old fields.

Lonicera Linnaeus. Honeysuckle.

Lonicera coerulea Linnaeus. Blue-fruited Honeysuckle.
Common on wet meadows or swamps.
This species of Honeysuckle is found in some of its forms in the northern parts of Europe and Asia as well as North America. Our form is sometimes differentiated as *Lonicera coerulea villosa.*

Lonicera canadensis Marshall. [1785.] Canadian Honeysuckle.
Lonicera ciliata Muhlenberg. [1813.]
In woods, occasional.

Lonicera dioica Linnaeus. [1753.] Glaucous Honeysuckle.
Lonicera glauca Hill. [1769.]
In woods, rare.

Lonicera tartarica Linnaeus. Tartarian Honeysuckle.
Is rarely found escaped from cultivation.

Symphoricarpos Jussieu.

Symphoricarpos racemosus laevigatus Fernald. Snowberry.
Escaped from cultivation, rare.

Viburnum Linnaeus.

Viburnum alnifolium Marshall. [1785.] Hobble-bush. Witch Hobble.
Viburnum lantanoides Michaux. [1803.]
Numerous colonies and individuals, mainly in rich shady woods.

Viburnum acerifolium Linnaeus. Maple-leaved Viburnum or Arrow-wood.
Common, dry woods, openings, and roadsides.

Viburnum dentatum Linnaeus. Arrow-wood.
Common, open woods, roadsides.

Viburnum cassinoides Linnaeus. Withe-rod.
Very common. Chiefly rich moist soils and swamps.

Sambucus Linnaeus. Elder.

Sambucus canadensis Linnaeus. Common or Black-Berried Elder.
Common in moist places.

Sambucus pubens Michaux. Red-berried Elder.
Sambucus racemosa is the name sometimes given to our Red-berried Elder by American authors but it is here restricted to the European plant which was named by Linnaeus and which closely resembles ours.

NOTES ON THE GROWTH OF WESTERN YELLOW PINE IN THE BLACK HILLS

GORDON PARKER

THE only tree of commercial importance in the Black Hills of South Dakota is the Western Yellow Pine (*Pinus ponderosa scopulorum*, Engelm.). There are a few other trees in that section which sometimes attain timber size, notably white spruce (*Picea canadensis*, [Mill.] B.S.P.), quaking aspen (*Populus tremuloides*, Michx.), and in one very small area a little lodgepole pine (*Pinus murrayana*, "Oreg. Com."), but they are all either so poor in quality or so small in quantity that they practically never appear in the local markets.

Last summer a study was undertaken in the Black Hills National Forest to determine a definite relation between the age of this western yellow pine and its diameter at breast height for that region. The writer assisted in collecting and working up the data on this study. A brief account of the work and of its results may be of interest.

The data was collected on ten different sections in five townships, thus largely obviating the effect of any one set of factors of locality since average figures were desired. Several logging operations in different places afforded an excellent opportunity for the work on trees of timber size (twelve inches D B H and up), and sufficient trees of smaller sizes were cut to give at least twelve trees in each inch class of D B H down to six inches.

There was little or no variation of stump height according to the size of the tree. The stumps were usually cut about as low as the nature of the ground would permit, the average height of stump of 366 trees being 1.28 feet, or 15.36 inches.

An analysis of seedlings up to eighteen inches high was made on a total of 313 trees, the measurement being total height growth for age. The results gave the following table: —

Height inches	Age years	Height inches	Age years	Height inches	Age years
1	1.2	7	7.8	13	12.6
2	2.2	8	8.9	14	13.3
3	3.3	9	9.7	15	13.9
4	4.5	10	10.5	16	14.5
5	5.7	11	11.3	17	15.4
6	6.7	12	12.0	18	16.2

And from this table it is seen that the average age of a stump 15.36 inches high is just over fourteen years.

Stump analyses were made in the regulation way on 367 trees, the annual rings being counted from the outside in along the average radius, every tenth ring being marked, and the measurements then being taken from the center out to each marked ring, accurate to the nearest fortieth of an inch. DBH measurements also were carefully taken on each tree. Although notes were made as to situation, slope, tree class, etc., those facts were not considered in working up the data. It was thought that by combining all the trees in a single set of figures the results would be fairly typical of the stands on any large areas in this region, since such stands always contain a more or less constant proportion of faster and slower growing trees.

The average age at the stump, taken from 366 trees, was 169 years. Adding the seedling age to this figure gives 183 years as the average total age of the trees analyzed. The youngest tree was 65 years old at the stump, and the oldest 368 years.

Great variation in the rate of growth of individual trees was found. The extremes noted were 170 years of age with a stump diameter inside bark of 6.2 inches, and 194 years of age with a stump diameter of 33.8 inches. The average tree of average age, 183 years, should have a stump diameter of 15.3 inches.

The DBH measurements were plotted on DIB at stump and the relation between them was thus established. This gave the following table based on 351 trees.

D I B at stump inches	D B H inches	D I B at stump inches	D B H inches	D I B at stump inches	D B H inches
6	6.0	14	14.1	22	21.2
7	6.9	15	15.0	23	22.1
8	7.8	16	15.9	24	22.9
9	8.8	17	16.8	25	23.7
10	9.9	18	17.7	26	24.5
11	11.0	19	18.6	27	25.3
12	12.1	20	19.5	28	26.2
13	13.2	21	20.4		

Then the radial measurements were plotted on age, the results carefully averaged, and the slight irregularities removed by a curve. Through this set of figures the following table was obtained: —

Actual age years	Age at stump years	Radius inside bark on stump inches	D I B at stump inches	D B H inches
10	..	..	..	..
20	6	.3	.6	..
30	16	.9	1.8	..
40	26	1.5	3.0	..
50	36	2.15	4.3	..
60	46	2.8	5.6	..
70	56	3.45	6.9	6.8
80	66	4.0	8.0	7.8
90	76	4.5	9.0	8.8
100	86	4.95	9.9	9.8
110	96	5.4	10.8	10.8
120	106	5.8	11.6	11.7
130	116	6.15	12.3	12.4
140	126	6.5	13.0	13.2
150	136	6.8	13.6	13.8
160	146	7.1	14.2	14.3
170	156	7.35	14.7	14.8
180	166	7.6	15.2	15.2
190	176	7.8	15.6	15.6
200	186	8.0	16.0	15.9
210	196	8.2	16.4	16.3
220	206	8.4	16.8	16.7
230	216	8.6	17.2	17.0
240	226	8.8	17.6	17.4
250	236	9.0	18.0	17.7
260	246	9.2	18.4	18.1
270	256	9.4	18.8	18.4
280	266	9.6	19.2	18.8
290	276	9.8	19.6	19.1
300	286	9.95	19.9	19.4
310	296	10.15	20.3	19.8

Finally plotting these D B H figures on age and smoothing out the curve the final table was secured.

Age years	D B H inches	Age years	D B H inches	Age years	D B H inches
60	5.8	130	12.4	228	17.0
62	6.0	138	13.0	230	17.1
70	6.8	140	13.2	240	17.4
72	7.0	150	13.8	250	17.7
80	7.8	154	14.0	257	18.0
82	8.0	160	14.3	260	18.1
90	8.8	170	14.8	270	18.4
92	9.0	175	15.0	280	18.8
100	9.8	180	15.2	286	19.0
102	10.0	190	15.6	290	19.1
110	10.8	200	16.0	300	19.5
118	11.0	210	16.3	310	19.8
120	11.6	220	16.7	316	20.0
124	12.0				

LUMBER FLUMES

FRANCIS R. STEEL

FLUMES are used very commonly in the Far West for the transportation of lumber from a saw-mill, located usually in the mountains, to the shipping point on a railroad or navigable waterway. In California, especially, this form of transportation is very common. Here the flumes average about five miles in length, with one, that of the Hume-Bennett Lumber Company, seventy miles long. The main advantages of this system as compared with railroad transportation — the only other possible method for large operations in the West — are: first, lower cost of construction (the difference increasing with the grade and the roughness of the country); and second, rather lower operation and maintenance cost. On the other hand, a flume cannot be run without a plentiful water supply, and it gives no means of transporting camp and mill supplies up to the woods. Then, too, in a flume operation the saw-mill must be located at some distance from the source of supplies, *i. e.* the railroad or the waterway, thus increasing the cost of sawing. Again, as the fluming roughens planed boards in such a way as to reduce their value, the planing mill must be located at a separate plant from the saw-mill. The same thing applies to the lumber yard, dry kilns, etc. Nevertheless, there are a great many situations where a flume is by far the most economical method of transportation.

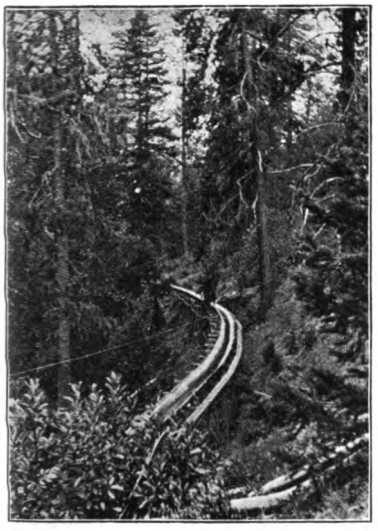
There are two main kinds of lumber flumes: first, the box flume, in which the trough is rectangular in cross section; and second the V-flume, in which the trough is V-shaped in cross section. This latter kind commonly, but not necessarily, has a "backbone" running lengthwise along the bottom, which makes a flat-bottom trough with outward slanting sides. Box flumes carry as a rule more water than V-flumes, and for this reason need to be built heavier and stronger, thus increasing the cost.

For ties a plain V-flume without "backbone" works the best, requiring less water, less watching, and costing less to build than either a box or backbone V-flume. For running boards and planks, as well as shingle bolts, etc., a box flume will, with plenty of water, transport a greater amount of lumber than any other type. For rather limited water supply, and to handle a mixed cut — both boards and dimension stuff — a backbone V-flume gives the most satisfactory service. The capacity of V-flumes is commonly from thirty to fifty M per day, while the maximum for this type so far is about one hundred M per day. Box flumes, however, are in use that carry as high as three hundred M per day — the lumber in this case being clamped together and dogged end to end.

A flume is located by an engineer in the same way that a railroad is. It is usually constructed from the upper end downwards in order to use the completed portion of the flume to transport lumber from the mill to the point of construction. The engineering costs usually about one hundred and forty dollars per mile and the construction, including labor, material, and right of way, varies from one to three thousand dollars per mile according to the height of trestles and depth of cuts necessary (a flume usually not having "cuts" of any depth, however, as they cost too much). The varying price of labor also affects the cost of construction. The safe maximum degree of curve has to be carefully determined in locating a flume, in the same way as with a railroad location. The following table has been given me by Mr. John P. Van Orsdel, a well-known logging engineer of Portland, Oregon.

Maximum Length of Lumber to be run	Safe Maximum Degree of Curve
40 feet	10 degrees
60 "	8 "
80 "	6 "
100–120 "	4 "

The safe maximum curve also varies with the per cent of grade. With a grade of over three per cent this factor may safely be neglected, but with grades under three per cent the safe maximum degree of curve diminishes rapidly with the per cent of grade.



Through fir timber.

Riding the lumber.

Trestle on a flume in Oregon.

The following table is, I think, about right for the safe minimum grade.

Degree of Curve	Safe Minimum Grade
Straight	0.5%
4 degrees	1.0%
6 "	1.5%
8 "	2.0%
10 "	2.5%

The optimum grade for a flume is from three per cent up for a straight flume, and correspondingly higher on curves. There is practically no maximum limit of grade, as long as the upper and lower ends of the steep pitches are put in with vertical tapers. The Three Pines Lumber Company, in Oregon, successfully operates a twelve-mile flume with a maximum grade of about forty-five per cent.

In operating a flume the determining factor is the water supply. If this is unlimited, the flume can be run full continuously and lumber put in and " run " whenever desired. This is the easiest method of operation. After the lumber is put into the flume at the upper end it is watched on the way down by " flume runners " stationed on certain beats along the places where the lumber is most likely to " jam." These jams usually occur at the sharpest curves, especially if the grade at that place is too low (which sometimes cannot be avoided). Jams are also likely to occur where the transition from a high to a low grade is too abrupt. Running different widths and thicknesses of lumber together makes the run much more liable to jam than if the different sizes are taken down in separate runs. The flume runners usually carry " pickeroons " to enable them to handle the lumber more easily and quickly. The speed at which the lumber travels varies greatly with its size and shape, and with the grade of the flume. On steep pitches all lumber travels faster than the water, the ties and dimensions running faster than boards or plank. On low grades the reverse is true; the water runs away from the lumber and the small stuff goes better than ties or timbers. The behavior in the flume of the different classes of lumber run should be carefully studied for a given flume before determining the best method of running it. This is especially true when the

water supply is limited so that it is necessary to get out the greatest possible amount of lumber on the least water. This last matter too — the economy of water — will be greatly improved if the flume is kept in as nearly as possible water-tight condition. This will require pretty constant, although not expensive, repair work.

LAND SURVEYING IN FORESTRY

WILLIAM GIBBS HOWARD, M. F. (Harvard) 1908

THE importance of a knowledge of land surveying to the forester cannot be over estimated. In every branch of woods work surveying plays an important part, for an accurate survey is essential as a basis for the proper handling of any forest tract, be it large or small. It is obviously impossible to estimate timber without a more or less definite idea of area, both of the whole tract to be covered and of the various subdivisions which may be made to facilitate the estimate. The same principles are applicable in nearly all scientific forest work, either on a small scale, as in sample-plot or yield-table studies, or on a large scale, as in reconnoissance work.

That branch of surveying which deals with the re-location of old surveys and the retracing of lines run through the woods many years ago is a science in itself. The knowledge necessary to do this work well cannot be gained entirely from books. A man must have his book learning and his college engineering training supplemented by actual experience in the woods. I have seen township and lot lines run in the woods by a competent city surveyor. This man had had much experience in the city, but the lines which he marked out in the woods were in many cases several rods away from the true lines.

It is interesting to note the difference between the United States Government surveys in the West and the much older and more primitive surveys — some of them made in colonial times — in the eastern states. Before going further I will state that my observations are based upon personal experiences, in the West in the Sierra Nevada mountains of California, and in the East in the Adirondack region of New York State.

The Government surveys of the West differ from the state or private surveys of the East in that they are much more regular and systematic. Let us compare the map of California with

that of New York. We see at a glance that in the western state base lines and reference meridians have been located to which the various township and section lines are referred. The whole state, with the exception of regions occupied by impassable mountain ranges, is divided into more or less regular rectangles. All lines are based upon the *true* north and south meridian.

In New York, on the other hand, the map is cut up by lines running in every direction. This is due to the fact that large grants of land were made to different persons, and these grants were sub-divided under different systems. All lines are referred to the *magnetic* north. Some of the meridians run north and south, while others — the so-called " ten o'clock " and " four o'clock " lines — run some thirty degrees east of north and west of south. This results in the large number of triangles and " gores " seen on the map. Inaccurate work by the original surveyors is the cause of irregularities both in the West and in the East.

Whatever the system of surveys under which the country was first laid out, the duty of the man in the field, who is trying to re-locate the old lines, is the same. That man must endeavor to reproduce on the ground the line of the original survey. It matters not if that survey was carelessly run out and the corners wrongly set. If the original line blazes and corner monuments can be found, they serve to definitely locate the old survey.

The graft which existed in some of the United States Government surveys is a matter of history, and it is well known that there are thousands of acres of land in California that were never surveyed on the ground at all. Field notes were " faked " and maps made in the city of San Francisco. However, where the lines were run out in the field they were usually run by transit and the corners fairly well monumented and witnessed. It may be noted here that the government surveyors in the West paid most of their attention to marking the corners, while the lines between the corners were only marked at infrequent intervals. In the old Adirondack surveys, on the contrary, the lines were carefully marked out, while the corners were merely marked on trees or wooden stakes which soon decayed.

As a rule, the government survey corner consists of either a squared stake surrounded by a pile of stones, or a square stone

with or without other stones around it. In the case of township or section corners there are four witness trees, one in each quadrant around the corner. Each witness tree bears a blaze facing in towards the corner, and the number of the section in which the tree stands is scribed in the blaze. In the case of quarter-section corners there are two witness trees, one in each section bounded by the line in which the corner stands. The original field notes contain the distance and direction from the corner to the various witness trees. In case the corner has been destroyed or overgrown with vegetation, its position can be determined from the witness trees.

The corners of the old Adirondack surveys consist usually of stakes or standing trees blazed on four sides and scribed with the proper township and lot numbers. From two to six witness trees are marked. The witness mark is three horizontal notches one above another close to the ground, and facing in towards the corner. The old field notes seldom refer to the witness trees.

The best instrument for retracing the government survey lines is a light mountain-transit. Copies of the field notes of the original survey should be obtained and the course of the line to be run computed. The start must, of course, be made from a corner the location of which has been previously ascertained. A random line should be run on the computed course as far as the next section corner. The proper correction must then be calculated from the length of the line as chained and the length of the right angle offset from the line to the corner, and the true line run out and properly marked. If original line trees are found between the two corners, the true line should be made to run through or near them, even though this may mean substituting a crooked line for a straight one. This matter will be taken up more in detail in the discussion of Adirondack lines.

The problem of retracing a line in the Adirondack forests is somewhat different. In the first place, a compass is more suitable for this work than a transit. Either the so-called "Pocket Vernier Compass" ($4\frac{1}{2}$" needle) or the "Railroad Compass," both manufactured by W. & L. E. Gurley, are satisfactory instruments. They may be used with jacob's-staff or tripod.

Let us suppose a surveyor wishes to retrace the lines of a lot

in the woods, one side of which is in the township line. He should start his survey at one of the two corners in the township line, and we will suppose that he knows the location of one of these corners. Since the lines are run on magnetic bearings very little computation is necessary to calculate the course of the line. The original bearing and the date of the original survey known, it is a simple matter to determine the present bearing of the line. In the Adirondack region the magnetic variation has been increasing at the rate of about three minutes a year for the last one hundred and fifty years, and as a compass is to be used it is sufficient to calculate the bearing of the line to the nearest fifteen minutes.

The compass is set up at the starting point, and the correct course of the line, as calculated, turned off. So far the procedure has not differed materially from that followed in running out the lines of a city lot; but from now on the surveyor will need to call upon his knowledge of woodsmanship for guidance. He must examine every tree along the line to locate the original line trees. The line which he wishes to follow has probably been surveyed several times. Some of the newer lines have been blazed by lumbermen who merely followed through from corner to corner with a pocket-compass and marked convenient trees. The task of our surveyor is to distinguish the blazes of the first surveyor from amongst the maze of newer blazes. In the case of a line surveyed a hundred years or more ago this requires a sharp eye and a knowledge of what a very old blaze looks like. In our north woods forests the spruces and the hemlocks show plainest the marks of the old surveys. I have cut into trees of these species and found blazes a hundred and thirteen years old. The only sign of a blaze on the outside of the bark was a slight irregularity in the surface, which upon minute examination showed the mark of an axe blade. Of the hardwoods, the birches show the old marks the best. The maples and beeches are the worst trees of all in this respect. Even on the birches it is difficult to discover a very old mark. The mark is often more easily distinguished when one is fifteen or twenty feet away from the tree than when one examines the bark closely. I once found a blaze one hundred and ten years old on a birch

tree by standing some distance away from the tree and directing my axeman to move his hand up and down the trunk until he covered the mark. From where the axeman stood the mark was not distinguishable; but upon chopping into the tree we found the blaze about four inches beneath the surface of the bark.

When the surveyor comes upon a tree which he thinks bears the original blazes he should chop out a blaze and count the number of annual rings formed since it was made. In this way he can ascertain the exact year of the survey of which that blaze is a mark; and by reference to his field notes he can tell whether or not that is the original survey. In retracing these old lines care should be taken to note the chainage from the corner to each line tree. After a few of the original blazes have been chopped out the surveyor will find that he can distinguish them from the newer marks by their external appearances.

It frequently happens that a line run on the computed course swings away from the old line after following it for a short distance. If the surveyor finds that this is the case he should offset at right-angles and set up as nearly as possible on the old line. He should mark his trial line plainly by stakes, but should not mark any trees if he can avoid it. When he has run his trial line through to the next corner he must go back and mark the correct line, following as nearly as possible the line of the original trees.

The line as finally marked will oftentimes be far from straight. Most of the old surveys were run without regard to any local attraction of the compass needle. The compassman would sight ahead and locate a tree in line; then he would pick up his compass and walk up to that tree, setting up again on the farther side of it. The chainmen and axemen followed him, the latter marking out the line. Unless the local attraction was very strong indeed no backsights were taken. The result was that, where there were only a few degrees of local attraction, the line would swing around in a large arc, resuming the proper course after the area of " local " was passed.

It is of the utmost importance to endeavor to find some trace of the original corner or its witness trees. The latter will often be found lying half rotten upon the ground; but by examining

them closely one can usually find the old marks even though they be hidden under the moss and decayed wood. In case all marks of the original corner are missing, the surveyor must relocate the corner. He will frequently be able to fix its position by prolonging the four lot lines until they intersect. It sometimes happens that all four lines have to be entirely re-run and chained in order that the location of the corner may be definitely established. I have known a competent wood surveyor to spend two days in locating the corner from which he wished to start his survey.

One thing which the surveyor should bear in mind is the importance of marking his lines and corners in a plain and permanent manner. Line trees should be blazed at frequent intervals. Corners should be clearly witnessed, and the corner monument should contain two or three stones if there is any rock within reach.

In the foregoing lines I have tried to give an idea of a few of the problems which the woods surveyor must prepare to meet when he goes out into the field. His task may seem difficult, but when he thinks of the men who went over the same ground a century or more ago, he is bound to be infused with the spirit of those men who went out fearlessly to do their work in what was then a vast wilderness. The field notes of some of the old surveys make interesting reading, and show us some of the difficulties and dangers encountered by the men in the field. It is to perpetuate their work that we are sending our surveyors into the woods today.

A FOREST FIRE WAGON FOR MASSACHUSETTS TOWNS

HAROLD O. COOK, M. F. (Harvard) 1907

LAST spring the Legislature passed a bill which provided that if any town having a valuation of less than one and one half millions of dollars should appropriate a sum, not exceeding $500, to purchase forest fire equipment approved by the State Forester, the Commonwealth would pay back to the town fifty per cent of the amount spent. The reimbursement being conditioned on the approval of the State Forester, it was necessary for him to make plain what he considered an ideal or standard outfit for such a purpose. Fortunately two years previously this office made a study of the subject of forest fire fighting and the equipment used for this purpose in such towns as employed anything of the kind. This study showed that there were certain essential elements in the make-up of a successful fire fighting machine and that it was only necessary to combine these in the proper way, add a few improvements looking to convenient and quick handling, and obtain an ideal forest fire fighting equipment. These elements were a good strong wagon, chemical fire extinguishers, cans for holding water, spare chemical charges, rakes, shovels, mattocks, axes, etc.

This office has had built two model wagons, one designed for two horses and to carry six or eight men, and a one-horse outfit carrying three or four men. The larger wagon cost, with the equipment, $500 and the smaller $300. The two-horse wagon is cut-under, mounted on platform springs, rigid body, and has wide-tired savin wheels. It is the finest type made by wagon builders and with the addition of some fancy metal work and gold paint would equal a hose wagon in a city fire department. Fourteen chemical extinguishers are placed in racks along the sides so that they cannot tip over. At the back on each corner

are two cases containing six removable drawers with bail handles. These drawers contain the spare chemical charges, the acid being in bottles already to slip into the extinguisher and the soda in cans, one charge to a can. About eighty spare charges are carried in this way. Underneath the body of the wagon are two racks, each holding five shovels and three rakes. The body of the wagon is occupied by fourteen five-gallon galvanized iron cans, each can holding water enough to refill an extinguisher twice, so that each of the extinguishers can be used three times before it is necessary to send for more water. These cans have bail handles so that they can be carried by one or two men and the stopper is so devised that two bottles of acid can be inserted in it. By having the soda already mixed with the water everything is complete in each can to refill the extinguishers, an important improvement when it becomes necessary to carry them for a distance into the woods. There are also on the wagon two kerosene sprayers which are useful in starting back fires. These are carried under the seat together with the grub-hoes and six pails. On the sides of the wagon are two axes and two fire department lanterns.

The single-horse wagon is cut-under but has semi-elliptical instead of platform springs. The spare chemical charges are carried in drawers under the seat. It has all the equipment of the larger wagon, but about one third less in amount and was designed to accommodate communities where it might not be easy to get hold of a pair of horses.

Towns where an equipment of this nature has been in use for some time are enthusiastic in their praise and are buying more. By adding a small extension ladder to the equipment they have been able to use it at building fires as well as at forest fires. Such a wagon takes the place of the chemical engine in the city which puts out the blaze of three quarters of the alarms that are rung in. To a town without water service it is indispensable, and it is a valuable piece of equipment to any community looking at it from the standpoint of building fires alone, whereas for forest fires, it is the only practical outfit that a town can secure.

SOME PRELIMINARY INVESTIGATIONS CONCERNING THE RATIO BETWEEN *DBH* AND *DIB* AT STUMP FOR WHITE PINE IN MASSACHUSETTS

HARRY F. GOULD, M. F. (Harvard) 1908

THE purpose of the work described below was to obtain from data already at hand in the State Forester's Office a reasonably correct table giving the DIB–DBH ratios for different sized trees of the species White Pine (*Pinus strobus*).

The usefulness of such a table is apparent in many instances. Whereas volume tables are almost without exception constructed on a DBH basis, yet many cases come within the timber estimator's experience where he cannot obtain the DBH directly. Such a situation is more likely than not to exist when the estimator is called upon to decide a lawsuit. The chances are that the timber has been cut and removed, leaving only the stumps to go by in taking measurements.

Then there is the case of suit for trespass where the owner claims timber to have been unlawfully removed; to say nothing of fire damage which may require immediate cutting of the dead trees and so make it impossible to measure DBH directly.

The table given herewith was prepared from data obtained in various sections of Massachusetts by measuring representative stands of pine and is recommended for use in this state only, inasmuch as foresters are becoming more and more convinced of the impropriety of generalizing data and trying to apply it over too large a territory.

One hundred and eighty-eight trees were used, ranging in diameter from 6 inches to 35 inches, and these were separated into stump-height classes of 6 inches (76 trees), 12 inches (75 trees), and 18 inches (37 trees). The points were then plotted on cross-section paper and three curves drawn through them, one for each stump height.

The table was made by reading the values from these curves using the DIB as a basis, since this forms the most useful table.

In its final form, then, the table indicates for each of the three stump-height classes the number of inches to be subtracted from a given DIB to give the desired corresponding DBH.

Several suppositions which common sense leads us to suspect but which are not otherwise proved are shown by this table to be true: —

1st. The lower the stump the greater the DIB–DBH difference, for a given diameter.

2d. The larger the diameter, the more rapid the increase in DIB–DBH difference for a given stump height, after 12 inches DBH has been exceeded.

And another point which is not quite so evident, following from the above: —

The *increase* in the DIB–DBH difference for trees of from 4 inches to 12 inches DBH is practically 0, whether for a 6-inch or a 12-inch stump.

Another interesting fact shown by the curves though not by the table is that there is much greater conformity to these curves among individual trees than might be supposed, the variation being scarcely over 5% for any given tree.

It is hoped that in future further data will be obtained which may serve as a check on the figures given in the table, which follows: —

Stump height	DIB at stump																												
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	Amount to be subtracted to get DBH for each DIB corresponding																												
6″	2	2	2	2	2	2	2	2	2	2.1	2.2	2.2	2.3	2.4	2.5	2.6													
12″	1	1	1	1	1	1	1	1	1.1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.1	2.3	2.5	2.7	3							
18″											.2	.3	.4	.5	.6	.8	1	1.2	1.4	1.6	1.8	2	2.3	2.6	2.9	3.2	3.5	3.8	4.2