Historical Perspective on Diameter-Limit Cutting in Northeastern Forests

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Abstract

The use of diameter-limit cutting and high-grading is currently a concern for long-term sustainability of forests in the Northeastern United States and surrounding areas. This paper reviews historical information about the kinds of harvesting used in this region from 1620 to 1950, to provide a context for current discussions. Throughout this period, most timber harvests removed all trees that were in demand and that could be transported. Thus, nearly all harvests consisted of some type of diameter-limit cut, but the minimum diameter and the desired species varied so much that the harvests ranged from light partial cuts to nearly complete clearcuts. A period of widespread clearcutting from 1850 to 1920 to support the industrialization of the region created opposition to this practice, which resulted in attempts to shift most harvesting to some form of partial cutting. Thus, selection cutting (which often in practice was simply diameter-limit cutting or high-grading) became the method promoted by forest managers and silvicultural researchers for most forests in the early twentieth century.

Introduction

Throughout much of history, societies have obtained most wood products by cutting trees from accessible forests without providing for sustainable production of new trees (Perlin 1991). This kind of exploitative harvesting nearly always consists of a diameter-limit cut in which trees larger than a given diameter (based on the products needed) are harvested (Helms 1998). If large beams, posts, and boards are required, the diameter limit is generally set at 10 to 16 inches, producing a harvest entirely of sawlog-size trees. The limit is not necessarily uniform, but can vary among species and stem forms. If only desirable species of good stem quality above the minimum diameter are cut, this kind of selective cutting is often referred to as high-grading. In other situations where fuelwood, pulpwood, or similar products are in demand, the minimum diameter is set very low. These may amount to a clearcut harvest, although undesirable species are sometimes left standing. This kind of harvest is often called commercial clearcutting to distinguish it from the clearcutting regeneration method in which other site preparation or regeneration treatments would be incorporated.

This paper presents an overview of the methods of timber harvesting in the forests of the Northeastern United States from 1620 to 1950. The objective is to provide a historical context for current discussions about appropriate cutting methods for the region, particularly regarding the use of diameter-limit cutting. The paper focuses on the region encompassing the five New England states, plus New York, New Jersey, and Pennsylvania, but the general trends apply to surrounding areas as well. Figure 1 summarizes the types of harvesting generally used for the main species throughout this period. The range of harvests has been simplified to diameter-limit cutting for sawlogs vs. clearcutting in Figure 1. The diagram can give only a general outline of harvesting trends; details are provided in the text.

Agricultural and Early Industrial Eras (1620-1850)

Harvesting trees in the Northeast began as soon as settlements were established by English colonists in the 1620s. Native American peoples living in the region had modified the forest landscape through burning and clearing for agriculture, but they lacked the technology for widespread harvesting of trees (Cronon 1983).

The earliest colonial timber harvests were to supply products for local use--for building houses and other structures and for fuelwood. However, the North American forests contained trees that were larger and far more abundant than in English forests, so an export market developed very quickly. Much has been written about the trade in large white pines (*Pinus strobus*) for masts for the British Navy, and this was certainly an important aspect of the early timber industry, but these were not the first timber products exported. The first

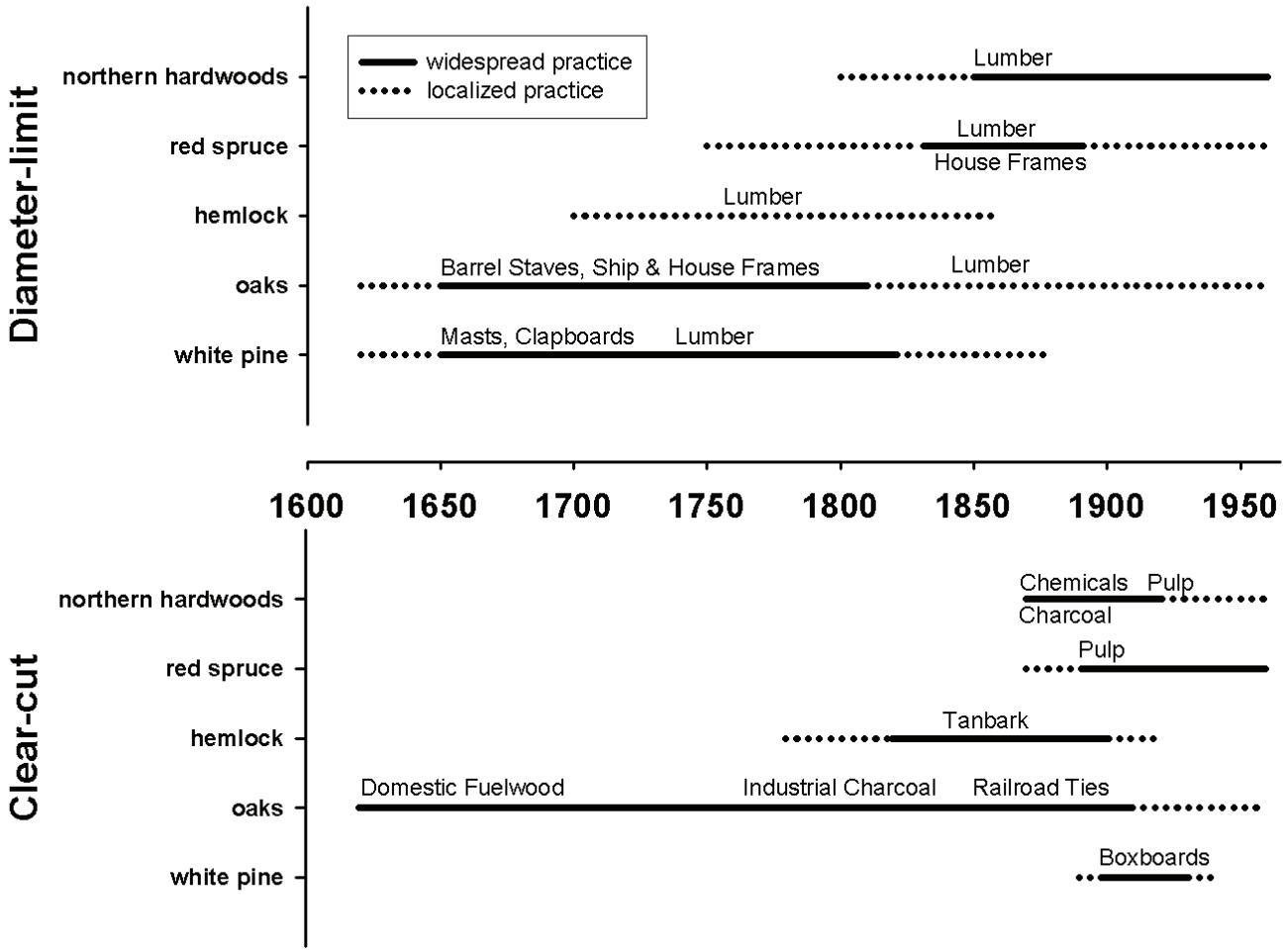

Figure 1.—Time line summarizing the types of exploitative harvesting generally used for the main tree species in the Northeastern United States from 1620-1950. Harvesting types are simplified into "diameter limit," which refers to cuts that removed only sawlog-size trees, and "clearcut," which refers to cuts that removed nearly all trees.

ships carrying goods from the North American colonies to England included a load of white pine clapboards (Whitney 1994) and oak barrel staves (Hawes 1923). This was in 1622-23, before sawmills were in operation, so the products had been made with hand tools.

By the 1630s, the first sawmills had been established along the coast of Maine, and their numbers expanded quickly in the following decades until most coastal rivers had multiple mills (Hobbs 1906; Perlin 1991). The main species harvested and the principal products were as follows: white oak (*Quercus alba*) for barrel staves for transporting liquid contents (mainly wine), and for beams and boards for shipbuilding and house construction; red oak (*Quercus rubra*) for barrel staves for transporting solid or gel contents (sugar and molasses), and beams and boards for house construction; white pine and red spruce (*Picea rubens*) for shingles, clapboards, boards, and for ship masts and yardarms; and Atlantic white-cedar (*Chamaecyparis thyoides*) for shingles (Perlin 1991; Gordon 1998; Irland 1999). The availability of large timbers in the American colonies for shipbuilding was so important that much shipbuilding shifted from England to New England (Perlin 1991; Gordon 1998). One interesting problem was that the stems of large white oak trees in New England were generally so straight that it was difficult to find the large stem-branch sections with curved grain to be used for the ships "knees" (Irland 1999), but this was not a major impediment.

The selection of pines for ship masts had particularly exacting requirements, because a mast was ideally made

from a single tree. Masts needed to be made from conifers, because they required strength, yet had to be light and flexible. The British Navy had made use of Scots pine (*Pinus sylvestris*) from Norway and other northern European countries, but the large trees in those forests had already been cut, so masts had to be fabricated from pieces of smaller Scots pine (Manning 1979). The availability of single-tree masts from white pines in the North American colonies (some greater than 36 inches in diameter and 100 feet tall) was a great advantage over European sources. Mast logs had been shipped to England as early as the 1630s, but the trade began at a large scale in 1651. The famous Broad Arrow policy was put in place in a series of acts beginning in 1691, and it continued in effect until the Revolution in 1775. The Broad Arrow symbol was used by the British Navy to mark all of its property, and in this case, was used to designate all straight white pine trees 24 inches in diameter and larger (Manning 1979). Mast trees were the object of considerable controversy--the Navy's mast agents had to compete with the colonial timber cutters who would ignore the laws, and turn mast trees into clapboards, shingles, and boards at their sawmills (Perlin 1991).

The harvesting of mast trees was clearly a case of selective diameter-limit cutting (Whitney 1994). White pine occurred as a component in mixed stands containing hardwoods and hemlock (*Tsuga canadensis*). The mast harvesting focused on the emergent white pines that rose above the main overstory canopy. Initially, the harvesting of these selected pines was confined to the areas near the coast, but progressively moved up the coastal rivers.

Much more information exists about the kinds of products harvested in this era than about the original stand structure or the residual stand structure left following harvests. Although the special export products (barrel staves and ship masts) have received much attention, the wide range of wood products exported from Northeastern forests is revealed in accounts of two catastrophes: the destruction by fire of the cities of London, England in 1666 and Bridgeton, Barbados in 1668 (Perlin 1991). In both cases, most of the supply of beams, boards, clapboards, and shingles to rebuild these cities was provided by the New England colonies. They had clearly become a major source of general oak and pine construction materials. These products would have nearly all been a result of selective diameter-limit cutting of trees of sawtimber size of the desired species.

However, not all harvesting was of that type. Fuelwood was needed in great quantities in towns and cities; stands in the surrounding areas were heavily cut for this purpose after large trees had been removed for other products. These stands regenerated by sprouting, especially if chestnut (*Castanea dentata*) was prevalent, and as they were harvested again, even-aged coppice stands developed. Overland transportation of wood was so expensive that the area for fuelwood production was limited to 5-20 mile radii around settlements (Whitney 1994). Local stands were unable to supply the fuelwood needs of Boston and other cities within decades of settlement, and fuelwood was generally scarce in heavily populated areas of the east coast by 1800 (Whitney 1994). Much fuelwood was transported by ship to these areas from remote forests.

The forest structure left by timber and fuelwood cutting would have varied geographically with accessibility and distance to towns. At the most distant points from population centers were forests that had been lightly high-graded for mast pines. In more accessible areas, a heavier diameter-limit cutting of oaks, pines, and other species would have occurred for boards, beams, shingles, and barrel staves. The areas closest to settlements consisted of agricultural land and woodlots that would have ranged from high-graded stands to nearly even-aged coppice stands. These zones progressively spread outward over time, as population and agricultural areas expanded; however, remote areas of the Northeast still had much of their virgin timber intact in 1850, 200 years after initial European settlement, largely because of the difficulties of overland transportation.

Silvicultural Ideas, Practices, and Policies

Few laws or regulations controlled timber harvesting in this era, except for those that specified ownership of land or trees. The Broad Arrow policies were designed

to reserve mast trees for the Navy, not to plan for sustained production of those kinds of trees. There were some laws that protected smaller trees from cutting, to provide growing stock for future harvests; one example is an order for the town of Woburn, Massachusetts in 1640 that protected oaks less than 8 inches in diameter from cutting, thus mandating diameter-limit cutting to maintain trees for the future (Hawes 1923). However, there is little evidence that such laws were widespread. The main practice in use in settled areas at this time was a rough kind of coppice harvest with a rotation of about 25 years (Whitney 1994).

Era of Clearcutting for Wood-Based Industries (1850-1910)

The Industrial Revolution during the mid-nineteenth century broadened the kinds of wood being used from the forests in the Northeast and increased the volumes needed to sustain the growing industries, cities, and populations within the region. In particular, the development of industries such as pulp and paper, industrial charcoal, and boxboards, which utilized large volumes of lower quality wood, shifted the focus of timber harvesting activities in much of the Northeast from the selective cutting of large, high quality trees to heavy cuttings in which nearly every tree was considered merchantable.

The timing of the increase in industrial uses of wood varied across the region. It began earliest near the population centers along the Atlantic coast and the major rivers, where there had already been more than one wave of diameter-limit cutting, as well as coppice cutting for fuelwood in some cases. The shift in cutting practices from diameter-limit cutting of sawlogs to clearcutting occurred much later in the northern and western portions of the Northeast. Much of this area, including the Adirondacks, northern Maine, and central and western Pennsylvania had been largely inaccessible prior to the 1850s (Whitney 1994). With the advent of the railroad in the 1830s (Muir 2000), the logging industry was able to expand into these remote areas, resulting in a new wave of diameter-limit cutting for sawlogs, but this shifted to clearcutting quickly. The process of this shift is described separately for the four main forest types, which were controlled by different markets.

Oak-Pine Forest Type

Extensive agricultural abandonment in the 1850s resulted in the development of large expanses of white pine forests on former agricultural fields, mainly in southern New England (Foster and O'Keefe 2000). In areas that had remained forested during agricultural expansion, repeated diameter-limit harvesting for sawlogs and extensive cutting for fuelwood created stands containing predominantly coppice hardwoods or low value hemlocks. While the amount of forested area greatly expanded in the region during this time period, the size and quality of the trees were much lower than what had supplied earlier forest industries.

An industry formed around these second-growth stands, which ranged from 50 to 100% white pine, and were even-aged, but of poor quality (Westveld 1935; Gould 1960). The trees had many large branches, and were deformed by the white pine weevil (*Pissodes strobi*), but they were still perfectly acceptable for boxboards—the short boards used for many types of shipping containers (crates and boxes). These were generally harvested with nearly complete clearcuts that left only advance regeneration hardwoods. This industry grew to its largest extent from 1890 to 1920.

Cordwood of various hardwood species was the only source of home heating until coal and coal stoves became readily available in the early 1800s. Coal stoves became numerous enough to have a substantial effect on fuelwood demand in cities by 1830, and there was a steady shift from wood to coal as a percent of the energy source used in the region (Whitney 1994). However, even as this shift occurred, the increased heating demand for all energy sources from the growing population meant that wood use for domestic heating reached a peak in 1870. Despite this peak in the late 1800s, there was still significant cordwood cut for use in rural areas as late as the 1920s.

Industrial charcoal added to the demand for fuelwood to be used for iron, brass, lime, and brick production. Although it was not nearly as important as domestic heating in total use of cordwood supplies, it had significant effects on regions where these industries were located, including southern New England, northern New

Jersey, and western Pennsylvania. Iron furnaces had very large fuelsheds, and often these operations continued widespread clearcutting until the wood supply was exhausted, leaving large areas of young sprout hardwood regeneration.

Hardwood railroad ties also gained importance at this time. Each mile of new railroad and trolley track needed more than 2500 ties, mostly made of oak (Gordon 1998). These could be obtained from small trees as part of heavy fuelwood cutting.

Hemlock Forest Types

Hemlock was a component species of many forest types throughout the Northeast, and was the most abundant species in many cases. It was less desirable than pine or spruce as a timber species, but the larger hemlocks were sometimes cut with the other conifers in diameter-limit harvests. A major shift in the demand for hemlock came when it was discovered that its bark was an excellent source of tannins for treating leather. The earliest tanneries in the United States were small operations in southern New England that had only local importance (Bürgi et al. 2000). They initially used oak bark as the source of tannins, following the European methods that relied on oak and spruce. However, hemlock became the main source in the Northeast by 1800 (Millen 1995).

Large tannery operations were established in the Catskills in the 1820s because of the predominance of hemlock in the area. Hemlocks were felled and the bark was peeled and hauled on sleds to tannery sites, with the hemlock logs generally left in the woods. By 1850, the hemlock supply was declining in the region, with much of the land having been clearcut. The industry moved to the Adirondacks, Maine, and Pennsylvania where hemlock was still abundant. A major center for tanneries was in north-central Pennsylvania (Irland 1999). Logging in that region had begun in 1850 to selectively remove the large pines. As the pine was depleted, hemlock was cut for lumber production; then the harvesting for tanneries began, with both bark and logs being used. Large water-powered tanneries were established in the 1870s, and surrounding stands were cut so clean that settlers easily converted many of the post-harvest areas to farms. These were not restricted to areas with good river transportation; tanneries were also distributed along the railroads of the area. Tanbark was shipped out by rail to operations in other regions, as well as for use by local tanneries. The operations in this region declined as the hemlock supply was exhausted, and the leather finishing process changed to the use of chrome salts instead of tannins in the 1890s.

Spruce-Fir Forest Type

The history of diameter-limit harvesting of red spruce in northern New England and the Adirondacks was quite different from that of other species. In contrast to the moderately tolerant white pine and oak, which typically failed to regenerate high quality stems after diameter-limit harvesting, the shade tolerance and abundant advance regeneration characterizing red spruce allowed it to survive and develop in height following these harvests (Westveld 1939). Early diameter-limit harvesting of red spruce focused primarily on procuring sawlogs to fuel the thriving lumber industry throughout the Northeast (Whitney 1994; Welsh 1995; Gove 2003). While much of this industry had been built on white pine lumber, red spruce was quickly recognized as a valuable substitute for this much-depleted resource (Whitney 1994). Red spruce quickly replaced white pine as the major species being cut for lumber in the Adirondacks and Maine by 1850-90 (Cary 1896; Welsh 1995). Early sawlog harvests of red spruce focused solely on larger diameter trees above 12-16 inches (Linn 1918; Churchill 1929; Dana 1930; Seymour 1992; Welsh 1995). These large-diameter trees quickly became rare, but improving markets for spruce lumber (Gove 2003) resulted in repeated cutting of these stands to successively lower diameter limits (Seymour 1992). By the 1890s all trees above a stump diameter of 8-10 inches were being harvested (Churchill 1929; Seymour 1992; Welsh 1995).

A technological development then changed the demand and harvest methods for red spruce. The northern hardwood-red spruce type extends south into the Berkshire Plateau region of western Massachusetts. This overlap between the heavily industrialized part of southern New England and a supply of spruce led to the early use of wood for paper production. The first wood-based pulp mill in the United States was established in a converted textile mill in the town of Lee,

MA in 1867 (Gordon 1998). The harvesting method consisted of removal of all red spruce and balsam fir (*Abies balsamea*). The number of pulp mills in this area expanded so rapidly that the spruce and fir supply was exhausted by 1890 and the mills began to close. The paper industry shifted east to mills in the city of Holyoke on the Connecticut River, and the pulpwood harvest moved to Vermont and New Hampshire, with the spruce and fir pulpwood being driven on the River to the mills (Whitney 1994; Muir 2000).

This increased emphasis on harvesting pulpwood resulted in continued lowering of the diameter-limit to levels as low as 5 inches in places such as the Adirondacks (Churchill 1929; Juvenal 1906 cited in Welsh 1995). In addition to these lower diameter limits, balsam fir, a species primarily ignored in earlier spruce harvests, was also cut for pulpwood (Oosting and Reed 1944). As the demand for pulp increased and new, previously inaccessible areas of forest were opened to logging via railroad expansion, harvesting practices changed to extensive clear-cutting for pulpwood throughout the region (Westveld 1928; Dana 1930; Oosting and Reed 1944; White and Cogbill 1992; Welsh 1995).

Northern Hardwood Forest Type

Diameter-limit cutting was less widespread in the northern hardwood forests of northern New England and the Adirondacks during the industrial era. Logging during this period was generally restricted to the most accessible hardwood stands because hardwood logs do not float; this changed with the advent of widespread railroad systems (Linn 1918; Dana 1930; Blum and Filip 1963). Harvesting within these stands was very selective and typically only removed the larger, well-formed hardwoods for use in furniture making and other construction purposes (McQuilkin 1957; Gilbert and Jensen 1958; Blum and Filip 1963). In addition to these diameter-limit harvests, accessible northern hardwood stands were also clearcut during this period for fuelwood, as well as to supply the charcoal and chemical distillation industries (Gilbert and Jensen 1958).

In areas of the Northeast where these northern hardwood stands contained a red spruce component, such as New Hampshire and Vermont, diameter-limit harvesting of red spruce was a widespread practice (Linn 1918; Dana 1930). Initial harvests in these stands during the late nineteenth century focused solely on selectively removing red spruce, with a minimum diameter limit of 12-14 inches (Linn 1918; Bormann et al. 1970; White and Cogbill 1992). However, in most cases these harvests served to increase the proportion of hardwood species in the stand at the expense of spruce (Linn 1918; McCarthy 1919). The use of logging railroads in these regions (Oosting and Reed 1944; White and Cogbill 1992) and the introduction of new markets for hardwood species and smaller diameter red spruce resulted in clearcutting of these stands in subsequent harvests. As a result, clearcutting was practiced extensively in these mixed species forest types (as in the spruce-fir type) at the turn of the nineteenth century and beginning of twentieth century (Oosting and Reed 1944; Bormann et al. 1970; White and Cogbill 1992; Schwarz et al. 2001).

Silvicultural Ideas, Practices, and Policies

The hardwood charcoal production for the iron industry in Pennsylvania and the white pine boxboard industry in southern New England led to some of the first attempts at industrial forest management in the United States to use managed coppice and shelterwood methods. However, the greatest response to the heavy industrial clearcutting was a call to reserve valuable trees on the sites rather than to simply cut all commercial stems. This was focused on red spruce, likely because of the speed with which this species was harvested.

Slash fires, extensive damage to residual trees, and the failure of red spruce to successfully regenerate following clearcutting resulted in several early calls of concern regarding clearcutting in the spruce-fir region at the turn of the nineteenth century (Cary 1894; Pinchot 1898; Ayres 1903; Merrill 1959). Early foresters such as Gifford Pinchot and Austin Cary advocated harvesting systems that cut red spruce only above a set diameter limit between 10-14 inches due to the previous success of diameter-limit cutting in regenerating red spruce (Cary 1894; Pinchot 1898). Large-scale clearcutting in the spruce-fir forests of Vermont led the governor to include in his address to the state in 1894 a recommendation for the implementation of a 10-inch diameter limit in spruce

forests (Merrill 1959). Similarly, the New Hampshire legislature discussed proposals during the 1890s for laws restricting harvesting spruce below a given diameter limit (Ayres 1903). Thus, a major initial impetus for forest conservation in the 1890s was the shift from partial cutting of spruce stands to clearcutting, with the proposed solution being to reinstate diameter-limit cutting as the preferred harvest method.

Era of Early Silviculture and Forest Conservation (1910-1950)

Oak-Pine Forest Type

In the early twentieth century, most of the market demand that had led to clearcutting in the oak-pine type began to disappear. Domestic fuelwood, industrial charcoal, tanbark, and chemical wood were all being replaced by coal, oil, and petroleum-based chemicals. The pine boxboard market continued through the 1950s and beyond, but at a much reduced scale due to the effects of the 1938 hurricane and the development of cardboard packaging. Much of the landscape was covered with young even-aged stands, having few trees of merchantable size for sawlogs.

In contrast, the value of high-grade hardwoods and pine was increasing at that time for furniture, flooring, and finish material (Gordon 1998). A substantial demand also continued for lower grade hardwood for railroad and trolley ties. These market conditions would be expected to lead to cutting methods that either favored the production of larger timber through thinning, or focused on cutting only sawlog trees. However, clearcutting continued to be common. This was in part simply because it was a "deeply ingrained practice" in the region (Cline 1944). Also, most milling was done with portable sawmills, and once set up, the crews insisted on cutting every merchantable tree in the area (Hawes 1929). Forested land had such low value in southern New England, that timber sales sometimes included the land itself, and the sawmill crews generally clearcut the tract. If only the timber was included in a sale, it was generally specified that the cutting rights were for trees greater than a specified diameter, thus requiring a diameter-limit cut; these practices continued through the 1950s (D.M. Smith, personal communication, 2005).

However, there were economic arguments being developed in this period that called into question the financial benefits of clearcutting. The general rule at the time was to cut every tree that met the minimum merchantable criteria for the available market. Time and motion studies and sawmill yield analyses led to the conclusion that "often there is no profit, but instead a loss, in cutting small trees even though of size to give merchantable products" (Hawley 1938). Hawley noted that this was not news to professional foresters, but it had not been communicated widely. An example of research on this topic was that of Cunningham and Ferguson (1946) on harvesting hardwoods for railroad ties in Connecticut; the conclusion was that ties should be made from trees 18 inches and larger, rather than using trees as small as 10 inches, as was commonly done.

In addition, foresters and legislators were advocating selection cutting at that time (see further discussion below), even though much of the cutting that was described as selection was diameter-limit or high-grading. Thus, a combination of clearcutting, diameter-limit cutting, and high-grading continued in the pine-oak region throughout the period.

Spruce-Fir Forest Type

Despite early concern regarding the sustainability of clearcutting practices within the spruce-fir region at the turn of the nineteenth century, this continued to be the predominant mode of harvesting during the early and mid 1900s (Westveld 1928, 1939; Oosting and Reed 1944; White and Cogbill 1992; Welsh 1995). This was motivated primarily by the needs of a thriving pulp and paper industry in the Adirondacks and northern New England (Harper 1947; Oosting and Reed 1944; Welsh 1995). The development of harvesting technology such as logging trucks and tractors in the 1920s (Oosting and Reed 1944; Welsh 1995) and chainsaws and rubber-tired skidders in the 1940s and 1950s (Cogbill and White 1992; Welsh 1995) increased the efficiency with which remote areas within this region could be harvested to supply the large demand for pulpwood.

Within the spruce-fir forests of Maine, much of the red spruce diameter-limit harvests in the late 1800s had

resulted in an increase in balsam fir in residual stands by the early 1900s (Zon 1914; Seymour 1992). As a result of the artificially high abundance of fir on the landscape, an extensive spruce budworm (*Choristoneura fumiferana*) outbreak occurred from 1913-1919, causing widespread mortality of merchantable spruce and fir throughout the region (Seymour 1992). To forestall pulpwood shortages, harvesting operations following these outbreaks in the 1920s covered extensive areas, salvaging damaged stands and clearcutting stands that had survived the outbreak (Seymour 1992).

The devastating impacts of the budworm on the long-term pulpwood supplies combined with continued criticisms of clearcutting resulted in a reevaluation of the silvicultural systems most appropriate for spruce-fir stands (Murphy 1917; Dana 1930; Westveld 1939; Harper 1947; Westveld 1953). In many cases, suggestions included the use of true selection systems to promote spruce and fir reproduction and maintain a greater amount of merchantable growing stock (Zon 1914; Murphy 1917; Harper 1947; Westveld 1953). However, these suggestions were often misapplied in the form of diameter-limit harvests (Murphy 1917) or criticized due to the propensity of residual stands to windthrow damage (McCarthy 1919; Dana 1930; Fletcher 1944). To avoid these losses to windthrow, diameter-limit cutting to a very small diameter was suggested as an alternative to selection systems, particularly in situations such as spruce flats where spruce and fir advance regeneration were abundant and risk of windthrow was high (Linn 1918; Westveld 1928; Dana 1930); this kind of cut would now be called an overstory removal (i.e., a clearcut that reserves advance regeneration). As a result of these suggestions, both overstory removal and diameter-limit harvests of sawtimber red spruce became the predominant modes of harvesting from the 1940s through the 1960s (Oosting and Reed 1944; Harper 1947; Hart 1963).

Northern Hardwood Forest Type

Improvements in logging technology and the development of new markets for hardwood veneer and pulp resulted in increased utilization of northern hardwood forests from the 1910s through the 1950s (Dana 1930; McQuilkin 1957; Blum and Filip 1963). Harvesting practices in these forest types over this period ranged from large-scale clearcutting for pulpwood and chemical wood to diameter-limit harvests of high quality veneer logs from previously inaccessible old-growth stands (Dana 1930; Gilbert and Jensen 1958; Blum and Filip 1963). In many cases, large diameter hardwoods were selectively removed from stands that had previously been harvested for red spruce during the late 1800s and early 1900s (Blum and Filip 1963; Bormann et al. 1970). By the 1950s, these harvesting practices had resulted in much of the hardwood forests in the region existing in a fairly degraded state. Despite earlier management guidelines advising the removal of cull or 'wolf' trees during diameter-limit harvests (Dana 1930), most stands subject to repeated diameter-limit harvests were now predominantly composed of large, poor quality stems interspersed with smaller, non-merchantable trees (Westveld 1956; Gilbert and Jensen 1958; Blum and Filip 1963).

Despite the degraded state of many northern hardwood stands, the strong markets for large veneer-quality hardwood logs necessitated the development of silvicultural guidelines for sustainably managing these stands (e.g., Gilbert and Jensen 1958; Blum and Filip 1963). In general, selection systems became the preferred approach for northern hardwood stands (Blum and Filip 1963). While these management recommendations included the removal of cull hardwoods, the misapplication of these selection systems resulted in the continued degradation of many old-growth stands in the region (MacAdam 1950).

Silvicultural Ideas, Practices, and Policies

The early calls for using diameter-limit cutting for red spruce in the 1890s (as an alternative to clearcutting) were continued in the early twentieth century, and expanded to other forest types. Gifford Pinchot advocated selection harvesting, which was acceptable to the logging industry because it was economically feasible (Boyce and Oliver 1999). The harvesting was often actually diameter-limit cutting or high-grading, but it was a clear improvement over widespread clearcutting. Forestry journals and textbooks (e.g., Hawley 1946; Meyer 1952) began to add the ideas and experience

from Swiss and German selection forestry to the simple approach of partial cutting. A good deal of U.S. Forest Service research was focused on growth-and-yield and regeneration in partially cut stands, and selection cutting was promoted in advice given to private landowners (e.g., Hawley and Goodspeed 1932). Foresters devised many variants of the method; the terms "economic selection", "improvement selection", "maturity selection", "war-timber selection", and "businessman's selection" (as well as "single-tree" and "group" selection) were all discussed in the Journal of Forestry in the 1930s-50s. Some of these were creative applications of selection principles to specific forest types to promote regeneration and long-term economic goals; others were devised to meet short-term financial goals.

In the Northeast, any kind of partial cutting was seen as an improvement over the clearcutting that had been prevalent. For example, Cline (1944) noted that: "This very practice of clearcutting has been the largest single factor contributing to the decline of Massachusetts forests during the past 50 years." Some of the opposition to clearcutting resulted from associating the drastic overcutting that was occurring at a landscape scale with the clearcut harvest method being used. The possibility of federal regulation of cutting on private lands was being considered, and New England states were debating and in some cases passing state regulations as an alternative (Lambert 1944; Merrill 1959). Some of these sought to reduce clearcutting, but with minor requirements such as retaining seed trees.

An example of the lack of discrimination concerning the kind of partial cutting to be promoted is found in a brochure of The New Hampshire Forestry and Recreation Commission (1947) that dealt with forestry problems in the state. Two photographs (Fig. 2) show the harvesting method to be avoided (a clearcut lot) in contrast to the appropriate method (a selectively cut lot). Close inspection of the photographs shows that the residual stand left after selective cutting is made up of tall, thin trees with small crowns, recently of suppressed or intermediate crown classes, scattered among large stumps. This appears to be a ill-conceived diameter-limit cut of an even-aged stand, yet is presented as a harvesting method to be emulated.

Hawley (1938) considered partial cutting as an easy way to introduce private landowners to forest management, similar to Pinchot's use for initially engaging forest industry in improving their practices. However, Hawley did not consider it the best alternative for all stands. He wrote: "…in the effort to take advantage of partial cutting and selective logging as a bait for leading private owners into the practice of forestry, professional foresters have in some instances attempted to extend this style of cutting to situations outside its legitimate range. It has in some cases amounted almost to a deification of partial as contrasted to complete cutting of the stand."

The period of 1920-50 had clearly become a time when selection harvesting had gained the support of most of the forestry profession, but in many ways the choices of harvest method (as actually practiced) had not advanced very far beyond clearcutting vs. diameter-limit cutting for sawlogs. The landscape-level problems with clearcutting were clear, and there was interest in re-vegetating watersheds, restoring and maintaining landscape aesthetics, and producing large high quality timber. But Hawley gave one of the strongest warnings about shifting without question to the other alternative, when he wrote: "Let us … envision the future results of any partial cutting … not only on the basis of the immediate financial profit of the operation, but also upon its ultimate consequences. Use the propaganda value of selective logging for all it is worth, but be honest with yourself and do not be led into thinking that partial cutting or selective logging is a panacea which will solve all the problems of silviculture."

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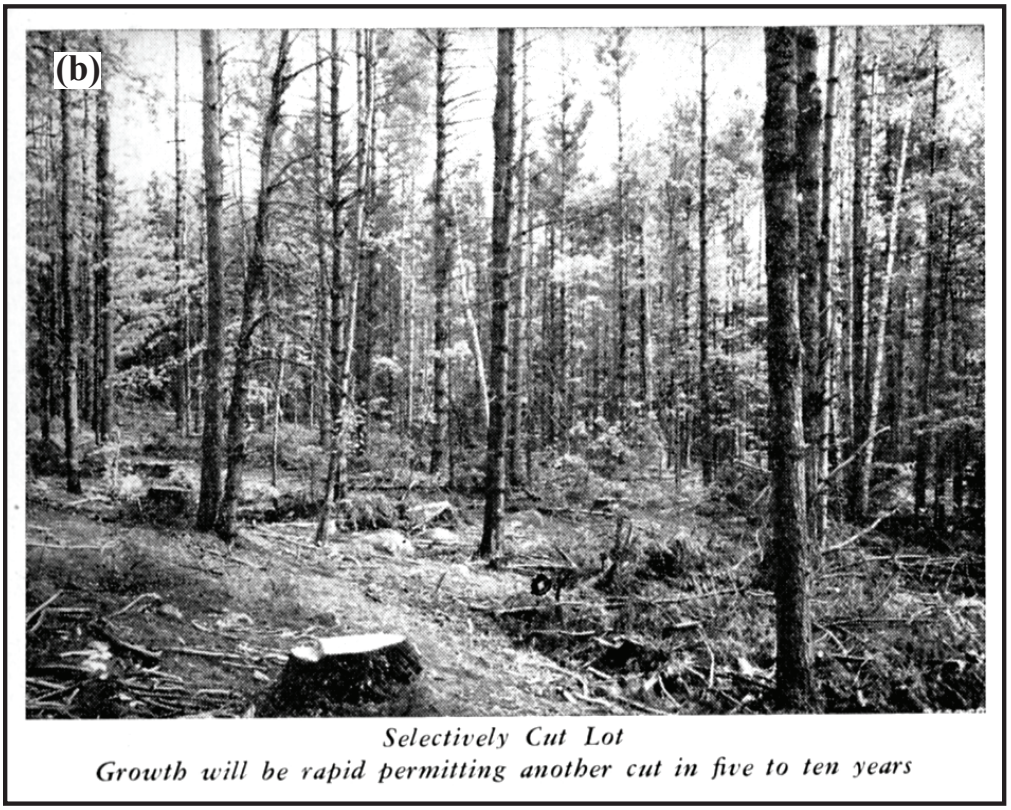

Figure 2.—Photographs originally presented by the New Hampshire Forestry and Recreation Commission (1947) indicating the ideas about preferred harvesting methods that were generally held in the first half of the 20th century. According to these ideas, clearcutting (A) was to be avoided in favor of selective cutting (B). However, many of the very heavy cuts tended to produce the best regeneration, whereas many selectively cut stands were left with poor-quality residual trees.

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