Good Silviculture will Increase Productivity and Value over Time: A 72-Year History in a Northern Hardwood Forest

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Abstract.—A 27,000-acre forest in northern New Hampshire provides a case study for evaluating the long-term outcomes of silvicultural prescriptions and cutting practices on forest growth and quality. This 214-year ownership has harvested timber since 1828 and maintained inventory data since 1947. The hardwood inventory data collected in 1947, 1967, 1986, 1998, and 2018 indicates that the practice of sound silviculture has not only upgraded products for increased value but has increased overall productivity allowing an increased sustainable yield. The study considers how exploitive cutting and diameter limit cutting in the early years led to a significant decrease in sawlog volume and an increase in pulpwood volume. The changing of silvicultural practices, in the late 1980s, to a single tree and group selection method, resulted in improved residual volumes of sawlog and decreases in pulpwood volume. Comparisons of consecutive hardwood inventories since 1947 show a significant increase in the amount of hardwood sawlogs and decrease in the amount of pulpwood on the property.

INTRODUCTION

In heavily forested rural areas, it is important to practice excellent forestry to cultivate high quality hardwood forest products to provide a continuous resource for a robust hardwood sawmill industry. Poor management practices, such as overcutting, creates declines in resource availability, reduces healthy habitats for wildlife, and pushes owners to capture nonforest product-based values (renewable energy development [windmills] and real estate values). This entire region has experienced a decrease in sawlog potential in the northern hardwood forest for years. Presently there is much consideration about rehabilitation of these forests following exploitive practices instead of a focus on good management to maintain high stocks of sawtimber stands.

The Second College Grant property (hereafter referred to as "the Grant") owned by Dartmouth College has been utilized for timber since the mid-1800s. Inventories have been performed periodically on this forest since 1947; cruises were completed in 1947, 1967, 1986, 1998, and 2018.

METHODS

To prepare a fair analysis of impacts to hardwood stands from our treatments, past inventories had to be adjusted to make them comparable with current. First, all hardwood sawlogs and pulpwood volumes from all hardwood species were combined into a total volume (thousand board feet; MBF) and number of cords for the individual cruises, with no regard to individual species and/or products. This created a total number of board feet of logs and cords of pulpwood for the previous inventory. Harvest history data were then analyzed to determine the cutting methods used during that decade; detailed cutting records have been kept since 1970, while data for the 1950s and 1960s were found in harvest history maps and confirmed through conversations with foresters familiar with the Grant during this time period. Of note, hardwood harvesting was suspended from 1975

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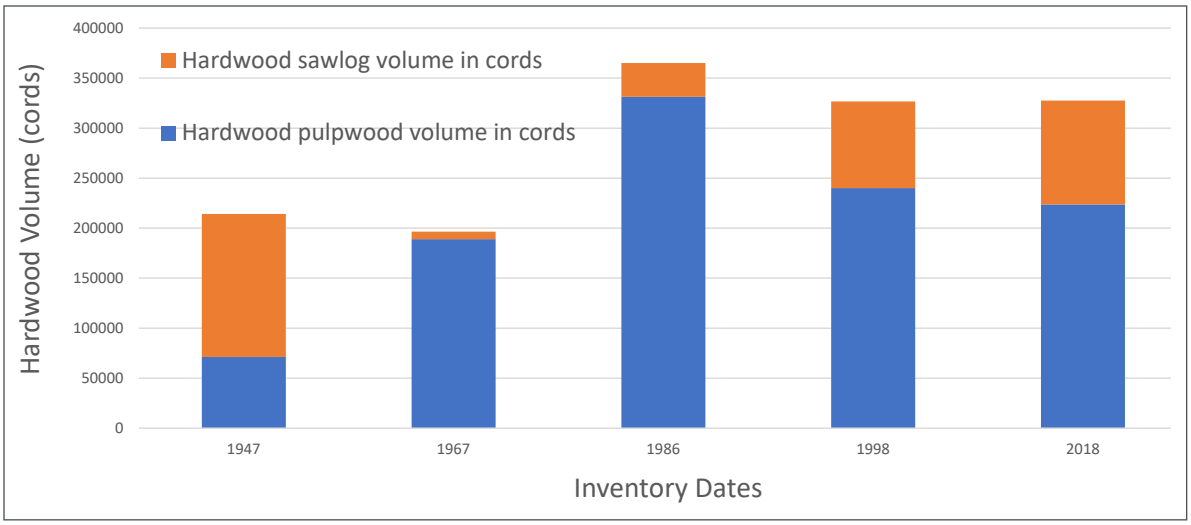

Figure 1.—Hardwood volumes (in cords) for both pulpwood and sawlogs 1947 to 2018.

to 1985 due to a severe spruce budworm outbreak, which led to a concentration of management efforts on the Grant's softwood resources.

In 1998, an inventory was designed to utilize log descriptions based on diameter and clear faces rather than any year's current commercial specifications. Inventories prior to 1998 were stratified by merchantable products at the time of inventory and used inconsistent product codes over time, which limited the ability to describe the development of species and product classes over time. The 1998 and 2018 cruises were redesigned using a 15 × 7.5 chain grid over the entire property (1803 plots) for easy replication every 20 years. Consistency between the 1998 and 2018 cruises in plot locations, sampling protocols, and inventory software, allowed for a more indepth analysis of changes in forest conditions across the Grant over these two decades.

RESULTS AND DISCUSSION

Mid-20th century treatments in the hardwood stands at the Grant included removal of large volumes of mature trees using diameter-limit cutting and sawlog-only harvests. This is evidenced by a significant reduction in hardwood sawlog volume between 1947 (at 77 million board feet; MMBF) and 1967 (at 3 MMBF), while pulpwood volumes increased from 71,000 cords to 188,000 cords during that same period (Fig. 1). All volumes refer to residual volume on property at time of inventory. This approach continued through 1987, although most cutting was diameter-limit treatments (14 inches and up); however, volumes were low enough at this time to see increased growth back into sawlogs (16 MMBF) and an increase in pulpwood to 330,000 cords. These overall trends indicated sawlogs were solely being harvested with pulp left behind.

In 1986 the College hired a full-time forester and wrote a new management plan. That plan mandated management focused on a reduction in the volume of hardwood pulp and an increase in sawlog volumes. The same focus was repeated in the plan revision in 2000. Most of the cutting was designed to improve the percentage of hardwood sawlog volumes while reducing pulp volumes. Harvest volume goals were 10,000 cords per year from 1986 to 1996 and then reduced to 7500 to 8000 cords for the period 1998 to 2008. Silvicultural prescriptions required the stands to be marked to a basal area of 75 to 85 ft^2/acre following a desired diameter distribution with an additional goal to retain as many sawlogs as possible with a planned return interval of 20 years. Most harvests (80 to 85 percent) were single-tree and group selection cuts (openings no larger than one-half acre) with some small (average size 2 acres) clear cuts.

Table 1.—Inventory data for hardwood volumes by product 1998 and 2018 inventories

Product	1998 Volume	2018 Volume	Change
Veneer	1,034.3 MBF	2,696.2 MBF	1,661.9 MBF
Sawlog 1	7,530.5 MBF	4,814.4 MBF	(2,716.1) MBF
Sawlog 2	22,821.7 MBF	22,008.3 MBF	(813.4) MBF
Pallet logs	9,006.1 MBF	20,109.1 MBF	11,103.0 MBF
Pulp	240,067.0 cords	222,859.4 cords	19,948.4 cords

The inventory data from the 1998 and 2018 cruises show how successful treatments have been at increasing hardwood sawlog volume and reducing hardwood pulpwood volume. In 1998, hardwood sawlogs had grown to 40 MMBF and pulpwood was reduced to 240,000 cords. This trend continued through 2018 with sawlog volumes increasing another 10 MMBF and pulpwood reduction to 223,000 cords. This translated to an average volume increase from 18.6 to 20.6 cords per acre, or an increase of 19 percent in hardwood sawlogs. Figure 1 shows the inventory data split between sawlogs and pulpwood.

Further comparisons between the 1998 and 2018 volumes indicate that veneer volume (logs 11 inches d.b.h. with four clear faces) went from 1.0 to 2.6 MMBF over the 20-year period (Table 1). Sawlog 1 (logs 14+ inches in diameter with three clear faces) volume decreased significantly, from 7.5 MMBF to 4.8 MMBF. This may be due to a high mortality rate of some of the larger trees that were carried past rotation to ensure adequate stocking in that portion of our target diameter distribution (based on Arbogast structure). In particular, hardwood mortality rates, estimated from a concentrated set of CFI plots, was 0.345 cords per acre per year in 2003, but this was reduced to 0.154 cords per acre per year in 2018. Sawlog 2 is defined as logs 10 inches in diameter or greater with two clear faces. Logs in this product category have stayed relatively stable through the years. There is a small hump in the diameter distribution for this size class reflecting its stability. The stability in this class may reflect the reluctance of foresters to mark good quality 8- to 12-inch trees since they can anticipate further growth and increased value in the future. Pallet logs are defined as 8+ inch trees with at least one clear face. Pallet volumes have increased dramatically, likely due to sapling ingrowth into the pallet size class. These number should balance themselves out over time as some of the 8- to 12-inch trees grow into the sawlog 1 size class. The other trend that is still rewarding is the overall reduction in our pulpwood volumes from ~240,000 cords to ~223,000 cords, all the while keeping the same hardwood volume on the property as we had in 1986 when we started using these silvicultural practices. During the inventory period from 1998 to 2018, 130,000 cords of sawlogs and pulp (both hardwood and softwood volume) were harvested at the Grant. Table 1 presents all hardwood products in a comparison of the 1998 and 2018 inventories.

CONCLUSIONS

This case study provides strong field evidence that good forestry does increase value over time. Mid-century high grading and sawlog-only cutting had greatly reduced volumes and values between 1947 and 1986. As soon as the correct silvicultural practices were applied to the right acres, significant volumes, value, and productivity increased. The hardwood resource in 1947 (hardwood volume divided by total acres) was 8.1 cords per acre and it has increased to 12.0 cords per acre in 2018. Growth rate in 1967 (first time there is a growth rate reference in management plan) was 0.158 cords per acre per year, whereas it was 0.210 cords per acre per year in 2018. In the period from 1998 to 2018, 60,000+ cords of wood were added to the total volume at the Grant.

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