Biomass Removal Study on the George Washington and Jefferson National Forests

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Abstract
A study was installed on the George Washington National Forest to gather hardwood harvesting production data. The silvicultural prescription for the harvested unit was shelterwood with reserves. There was no biomass removal component included in this study. One purpose of this study was to gather baseline harvesting data for future comparisons of production impacts from harvesting similar stands with and without biomass included as a marketable product. The harvesting operation was comprised of traditional ground-based harvesting equipment (feller-buncher and grapple skidder). The average felling cycle time was 55 seconds. The average production rate was 90 tons/productive machine hour. The average total travel distance per skidding cycle was 753 feet, with an average production rate of 45 tons/productive machine hour.

Keywords: Production rates, cycle analysis, hardwood harvesting, ground-based harvesting

Introduction

Removal of woody biomass from the George Washington and Jefferson National Forests is planned in an effort to achieve the goals and objectives of the Lower Cowpasture Restoration and Management Decision Notice. Recent construction of a biomass boiler, located a short distance from the project area, resulted in a new local demand for biomass. This new market opened additional opportunities for forest managers to remove previously non-merchantable material to attain their desired future forest conditions.

A research study was proposed to help forest managers understand some of the differences between traditional forest operations and those that include biomass removals. This paper reports the results of a baseline harvesting operation on the Porter's Mill Timber Sale. The harvesting unit does not include a biomass component. The purpose of this paper is to present data that may be used for comparing the impact of including a biomass component on future harvesting production rates.

Study Site

The harvesting unit was located on the Warm Springs Ranger District of the George Washington and Jefferson National Forests. The silvicultural prescription implemented through the harvesting operation was shelterwood with reserves. The 16.3 acre unit, unit 6 of the timber sale, had an average diameter at breast height (DBH) of 11.6 inches with a range of

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1 to 40 inches. The average number of trees per acre (TPA) was 188. Primary species included scarlet oak (*Quercus coccinea*), white oak (*Quercus alba*), and chestnut oak (*Quercus montana*). Other species present were northern red oak (*Quercus rubra*), red maple (*Acer rubrum*), black oak (*Quercus velutina*), tupelo (*Nyssa sylvatica*), yellow poplar (*Liriodendron tulipifera*) and ash (*Fraxinus* sp.). The minimum merchantable DBH for the timber sale was 6 inches. Unmerchantable stems were cut, skidded to the landing, and piled.

The terrain ranged from flat to 25% slopes. There weren't any streams within the unit to impact traffic patterns. All residual (reserve) trees were located in large clumps that were scattered across the unit. Pre-harvest data was collected in November 2016 and harvesting occurred in June 2017. Harvesting was initially planned to occur during winter months, but was delayed due to weather.

Equipment

The harvesting crew consisted of a skidder operator with 5 years of experience, a feller-buncher operator with 9 years of experience and a loader operator/owner with over 50 years of experience. The equipment included a 2006 John Deere[3] 843H rubber-tired feller-buncher equipped with a FD 22 saw head. The grapple skidder was a 2013 John Deere 748H grapple skidder with rubber tires. The loader was a 2010 model John Deere 437 D. A slasher saw, coupled with the loader, was used on the landing to cut stems to merchantable log lengths prior to loading them onto trucks. A dozer (Caterpillar 650 J) was also on site.

Methodology

Two felling plots were installed in the unit. Due to harvesting delays, only one felling plot has been analyzed and is reported in this paper. A 100% cruise was performed in the 0.617 acre felling plot (Figure 1). Merchantable trees within the plot were measured and painted with individual tree numbers. Active felling operations were recorded by a digital video camera. Video was later analyzed using TimerPro professional software from Applied Computer Services, Inc. Volumes were estimated using the cruise data coupled with Clark et al (1986).

Skidder data was observed during active operations. Cycle elements were determined, then cycle data was collected using a stopwatch.

[3] The use of trade or firm names in this publication is for reader information and does not imply endorsement of any product or service by the U.S. Department of Agriculture or other organizations represented here.

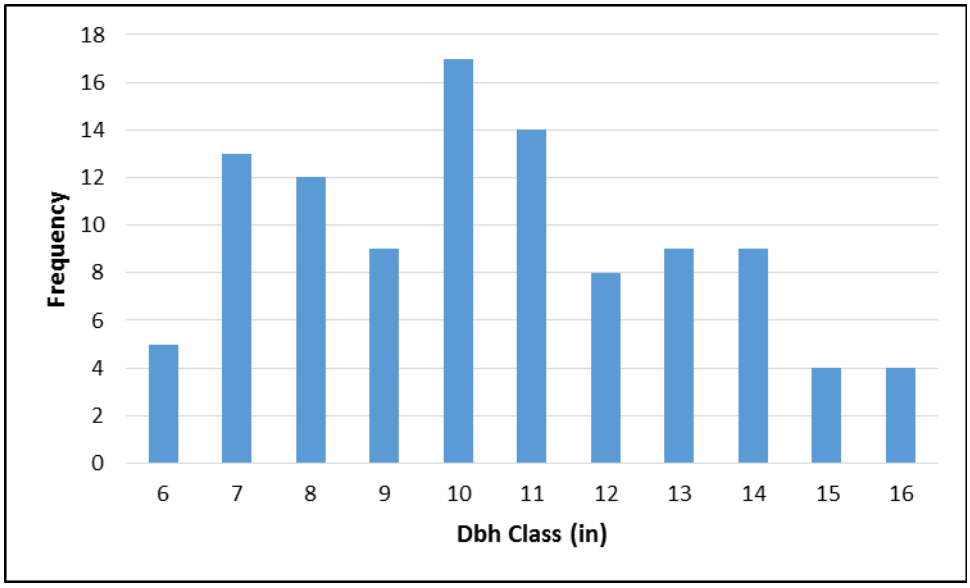

Figure 1. Tree size distribution for felling plot 1.

Results and Discussion

Felling

Felling cycle tasks were atypical and included the following elements: move to first tree, cut, move between trees, reposition head, move to dump, dump, delimb, align butts, push trees, cut unmerchantable trees, cut dead trees, and trim stumps. The feller-buncher operator would not always completely sever a tree in a single cut. For example, after partially severing a stem, the operator would move to other trees, sever them, then return to the partially severed tree to completely cut it down. Once large trees were felled, the operator would orient the feller-buncher to straddle the stem, tilt the cutting head forward, and drive up the stem, trimming off large branches along the way. The delimbing cycle also included instances where multiple stems were bunched, then delimbed in a group. The cycle elements of align butts and push trees were the operator's attempt to bunch trees ahead of the skidder. In eight of the observed cycles, the operator stopped and trimmed stumps to a shorter height, presumably to meet contract specifications. A total of 82 felling cycles were observed.

Figure 2 displays the large percentage of time spent in the delimbing element. The crew did not include a chainsaw operator. All employees worked inside a machine cab. The delimbing cycle usually occurred after several trees were felled, so that the delimbing cycle often included more than one tree, delimbed individually, or as a bunch. Delimbing occurred in 61% of the total observed cycles. Move to first tree is the next most time-consuming cycle element. This element often included the time it took for the operator to drive from the last delimbed stems back to the remaining standing stems.

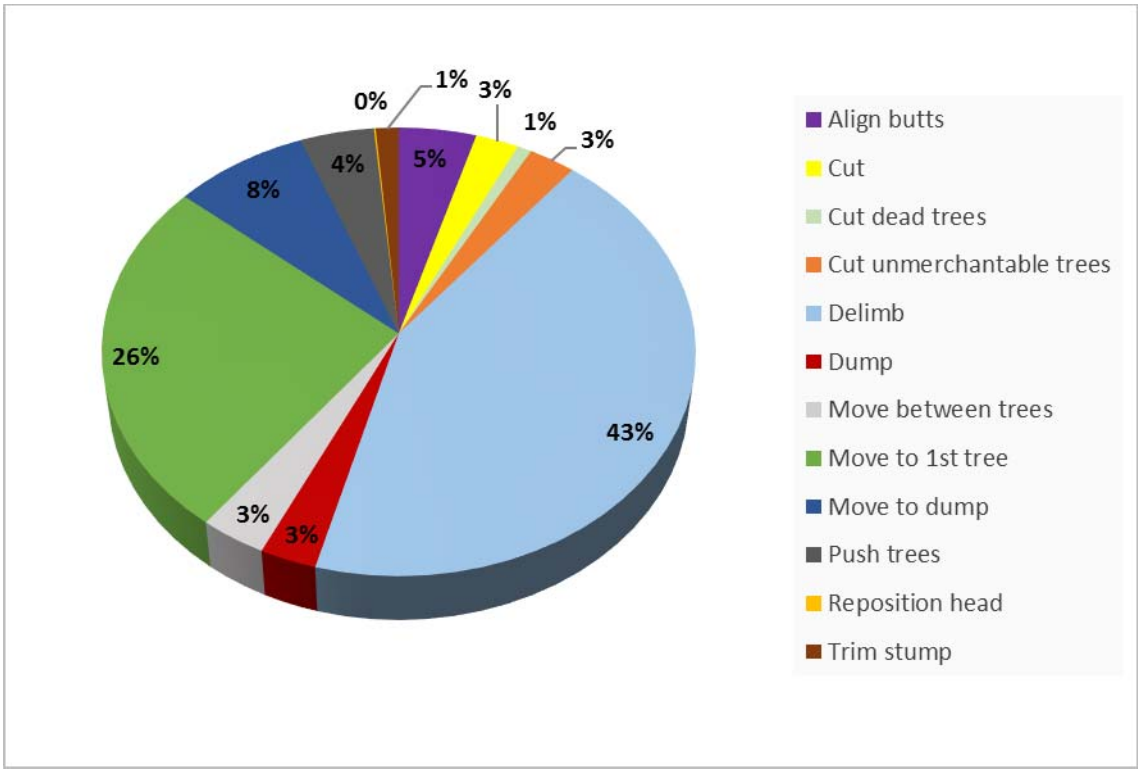

Figure 2. Felling cycle elements as a percentage of total cycle time. (N=82)

The average cycle time was 55 seconds. The total range of cycle times was 10 to 173 seconds. The average production rate for felling was 90 tons/productive machine hour (PMH) with a range of 12 to 328 tons/PMH.

Skidding

Skidding cycle elements included: travel empty, position, grapple, intermediate travel, travel loaded, ungrapple, and pile trees. After completing the ungrapple element, the skidder operator would push the trees into a pile beside the loader to keep the landing organized. A total of 30 skidder cycles were observed. Skidding cycles included trees that were both within the felling plot and from other areas of the stand. DBH was sampled to obtain volume information for those cycles that included trees outside of the felling plot.

The average cycle time was 8 minutes with a range from 2 to 12 minutes. Figure 3 displays the percentage of time spent in each skidding cycle element.

Two cycle elements consumed over half (66%) of the total skidder cycle time: travel loaded and travel empty. Total cycle distance (travel loaded and travel empty combined) ranged from 102 to 1845 feet, with an average of 753 feet.

The average number of stems per skidder cycle was 6 stems, with a range from 1 to 12 stems. The average volume per turn was 5.4 tons, with a range from 2 to 11 tons. The average production was 45 tons/PMH (range of 11 to 128 tons/PMH). Two cycles were observed that

included only one stem each. These single stems were among the larger trees (15 inch DBH) and resulted in turn volumes of 1.76 tons each.

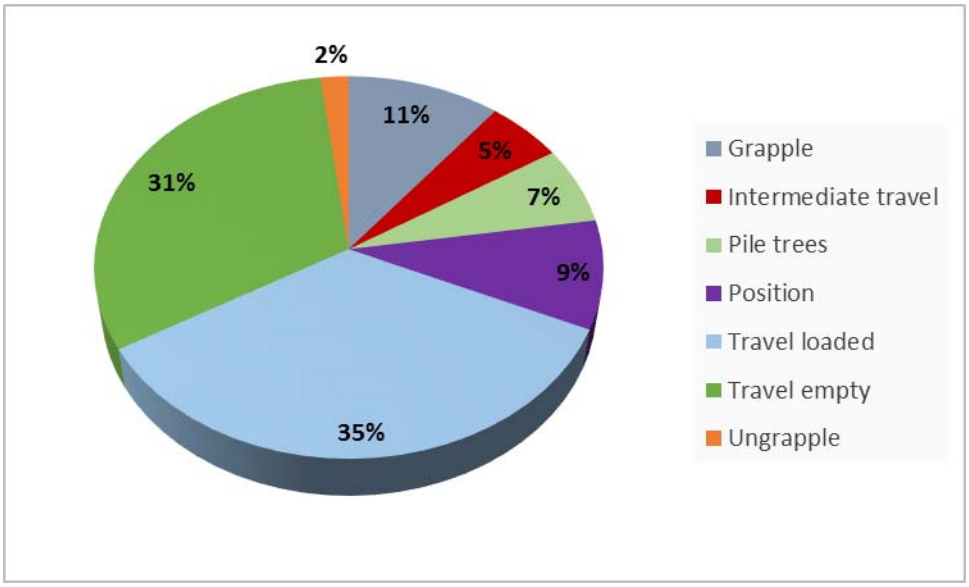

Figure 3. Skidder cycle elements as a percentage of total time.

Conclusion

A hardwood stand was harvested using ground-based conventional equipment. The feller-buncher performed delimbing prior to skidding. This task comprised the largest percentage of feller-buncher productive time. The average felling cycle time was 55 seconds. The average production rate was 90 tons/PMH. Travel time (loaded and empty) accounted for 66% of the total skidder cycle time. The average total travel distance per cycle was 753 feet. Average skidder production was 45 tons/PMH.

This study was intended to provide baseline data to compare to other hardwood harvesting operations, including those that include a biomass component. The operator in this study cut and skidded unmerchantable stems, even though they were not utilized. Future studies could explore operational characteristics of other hardwood logging operations, methods to improve the delimbing task, or examine the impacts of adding a biomass chipper.

References

Clark, A. III, J.R. Saucier, and W.H. McNab. 1986. Total-tree weight, stem weight, and volume tables for hardwood species in the southeast. Georgia Forest Research Paper 60. Georgia Forestry Commission.