CONTEMPORARY LOGGING TECHNOLOGY FOR HARVESTING YOUNG CENTRAL HARDWOODS[1]

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Abstract.--Thinning young central hardwood stands presents an opportunity for increasing the growth and yield of quality sawtimber. Planners, loggers, and managers need to know what types of logging technology are available for treating young stands. In this paper, three types of logging technology applicable to young central hardwoods are presented.

INTRODUCTION

Commercial harvesting of forest products is a key linkage in managing young central hardwoods. If forest management is to be intensified, managers and planners must become familiar with the types of logging technology available to them. The costs of operating such technology also must be documented and particular attention must be given to how individual site and stand variables impact logging costs. Planners and managers also should understand the impact of individual silvicultural treatments on logging cost. The distance that wood must be transported to landings and then on to sawmills or other processing centers also impacts logging costs and must be accounted for in planning treatments for young stands (LeDoux 1988).

A wide array of harvesting machinery is available for conducting thinning operations in young central hardwoods. These include cable systems, ground-based systems, and portable bunching winches. It is beyond the scope of this paper to deal with all of the available logging systems. In this paper, we present three logging technologies and specific machine types applicable to thinning young central hardwoods. We also demonstrate the impact of select stand attributes such as d.b.h. of trees removed, the total volume removed, and stump-to-landing distance (slope yarding/skidding/winching distance) on logging costs.

CABLE SYSTEMS

Cable logging systems are generally used to harvest timber on steep, difficult, or environmentally sensitive sites. A wide range of cable machines from small, relatively inexpensive to very large and expensive machines are available (LeDoux 1985, LeDoux 1987). Cable systems generally require more crew training as well as on the ground planning layout to maintain economical production levels. The two cable machines discussed are capable of operating under most young central hardwood site conditions and handling potential volume removals. The Bitterroot[3] is a small, relatively inexpensive machine with a low production rate designed to operate in stands with average tree d.b.h. of 7 to 9 inches (fig. 1). The second machine, the Clearwater Yarder, is a slightly larger machine with higher cost and higher production capable of operating in stands with an average tree d.b.h. of 9 to 12 inches. The costs are projected using ECOST version 2.0 (LeDoux 1988[4]). Although the smaller Bitterroot could operate in larger d.b.h. stands, it is not recommended to do so if production levels, costs, and related stand damge are to remain at an acceptable level.

Stump-to-landing costs decrease with increasing average cut-tree d.b.h. for each volume removal (fig. 1). Total stump-to-landing costs increase with increasing volume removal because we simply have more wood to remove. However, combinations of

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[3]The use of trade, firm, or corporation names in this paper is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

[4]LeDoux, Chris B. 1988. ECOST - Version 2 - Stump-to-mill production cost equations and computer program. Unpubl. report on file at U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, 180 Canfield St., Morgantown, WV. 26505.

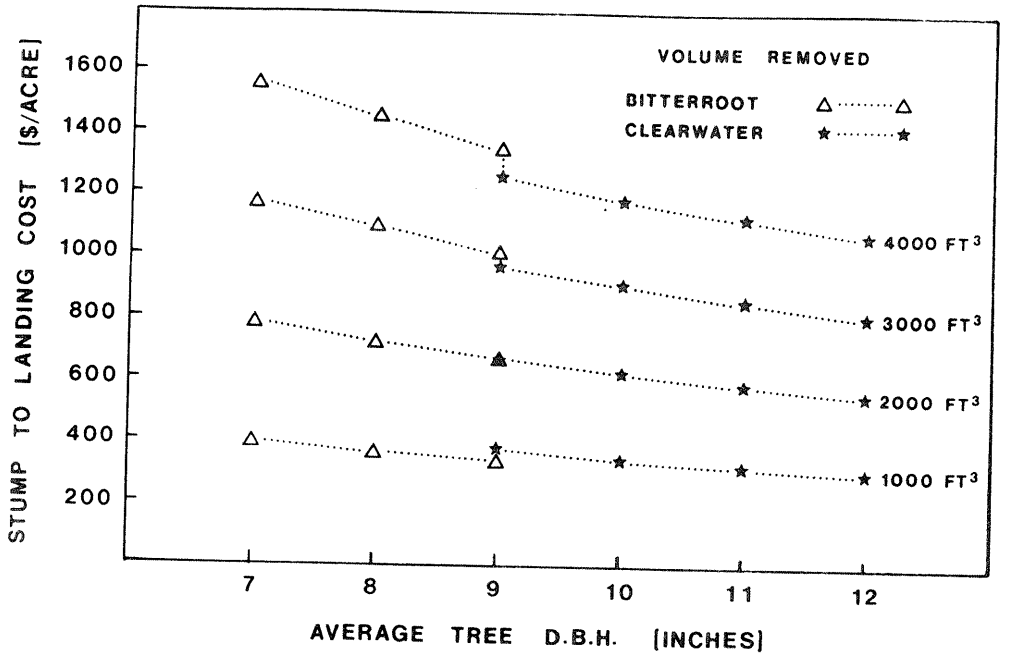

Figure 1.--Simulated stump-to-landing cost for the Bitterroot and Clearwater cable yarders by average cut-tree d.b.h. and volume removed per acre.

high volume removals and large d.b.h. trees are most desirable when all costs (stump-to-mill) are included. The stump-to-landing costs would normally continue to decrease with increasing d.b.h., but we must remember that in this application, we have shifted from a small inexpensive machine to a large expensive yarder for removal of trees larger than 9-inches d.b.h.

GROUND-BASED SYSTEMS

Ground-based systems are generally used to harvest timber on gentle terrain. A large assortment of machines exist including skidders, forwarders, tractors, and small 4-wheel drive units. The machines can be track or rubber-tired based and can be pulled behind a larger unit or can be self-propelled. A wide range of sizes and related costs and production rates are available to select from. One of the most widely used ground-based systems is the 4-wheel drive rubber-tired skidder with either a grapple or chokers to transport the load. In this paper, we highlight a John Deere 540B rubber-tired skidder with chokers that is capable of operating in most young central hardwood stands.

Skidding costs per unit production decrease with increasing average cut-tree d.b.h. and volume removed (fig. 2). For example, the cost at 1,000 ft^3 removal and d.b.h. of 7 inches is $0.32/$ft^3$ and decreases to $0.189 at 12 inches, which is about a 41 percent decrease in cost. This illustrates the added cost of harvesting smaller d.b.h. trees from thinnings. As with cable systems, combinations of heavy volume removals and large cut-tree diameters favored by loggers provide the minimum stump-to-landing costs. Information such as that in figure 2 can be used by planners and managers to better understand the impact of tree size and volume removals on logging cost and stumpage returns.

PORTABLE WINCHING SYSTEMS

Many times logging machinery is unable to develop full payloads when operating in young stands where the average piece size is small. This generally occurs in young thinnings because the pieces are small and scattered, making development of a full payload difficult if not impossible. A partial solution to this challenge is to use portable and fixed bunching winches to bunch the pieces along the extraction path allowing the larger, more expensive yarder, skidder, or forwarder to develop a full payload taking best advantage of its capability. Bunching winches are

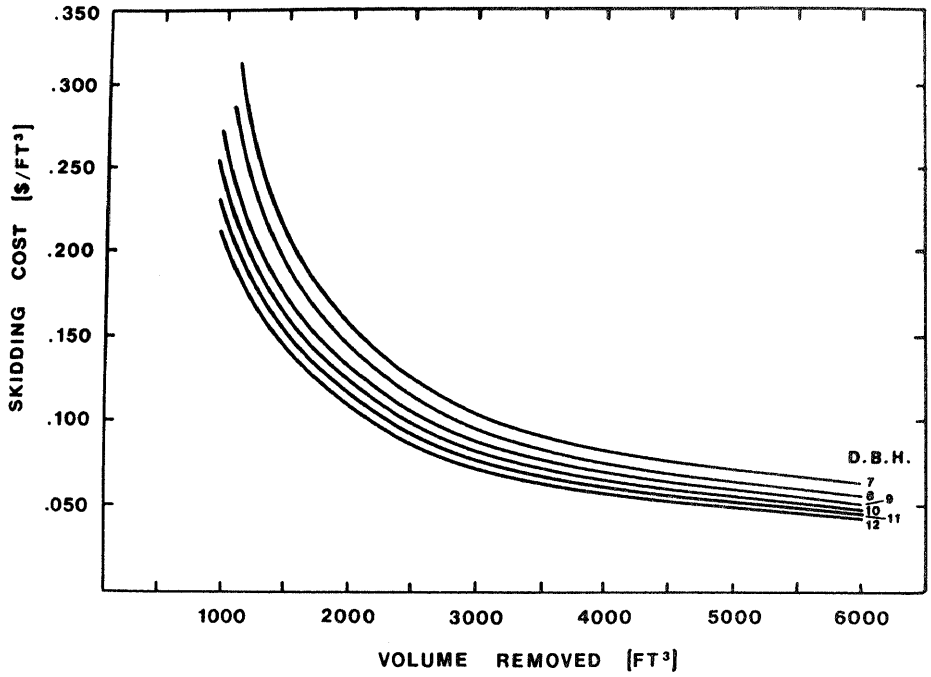

Figure 2.--Simulated skidding cost for the John Deere 540B skidder by volume removed per acre and average cut-tree d.b.h.

generally cheaper to own and operate than conventional skidders or cable yarders. Many types of winches are available to select from. In this article, we highlight the Radio Horse 9 Winch (LeDoux et al. 1987).

The impact of average cut-tree d.b.h. and volume removal on bunching cost for the Radio Horse 9 is shown in figure 3. The bunching costs range from a high of $0.313/ft^3 at d.b.h. of 4 inches and volume removal of 500 ft^3/acre to low of $0.024/ft^3 at 12 inches d.b.h. and volume removal of 700 ft^3/acre. The impact of average cut-tree d.b.h. on bunching cost is shown in the following example. The bunching cost at 4 inches d.b.h. and 500 ft^3 removal is $0.313/ft^3, and decreases to $0.036/ft^3 at 12 inches d.b.h., which is an 88 percent decrease for the same volume removal. Again, as for the previous systems, operating in small d.b.h. stands with low volume removals makes harvesting marginal.

SLOPE YARDING DISTANCE

Stump-to-landing distance will significantly affect productivity and costs. Figure 4 shows the impact of distance on the costs of bunching, skidding, and yarding. Generally, for all logging systems, removal costs rise with increasing distance. Although comparisons among machines based on slope yarding distance alone are difficult and could be misleading, we show the relative affect of slope yarding distance on the systems mentioned previously. One would not expect cable systems in hardwood applications to reach farther than about 900 feet, ground-based systems about 1/3 mile, and bunching winches about 150 feet. Obviously, these systems could reach farther on select applications resulting in excessively high removal costs.

For example, the cost of using the Bitterroot yarder at a slope yarding distance of 350 feet is $0.159/ft^3 increasing to $0.228/ft^3 at a distance of 750 feet, which is an increase of about 43 percent. Careful attention to logging unit layout,

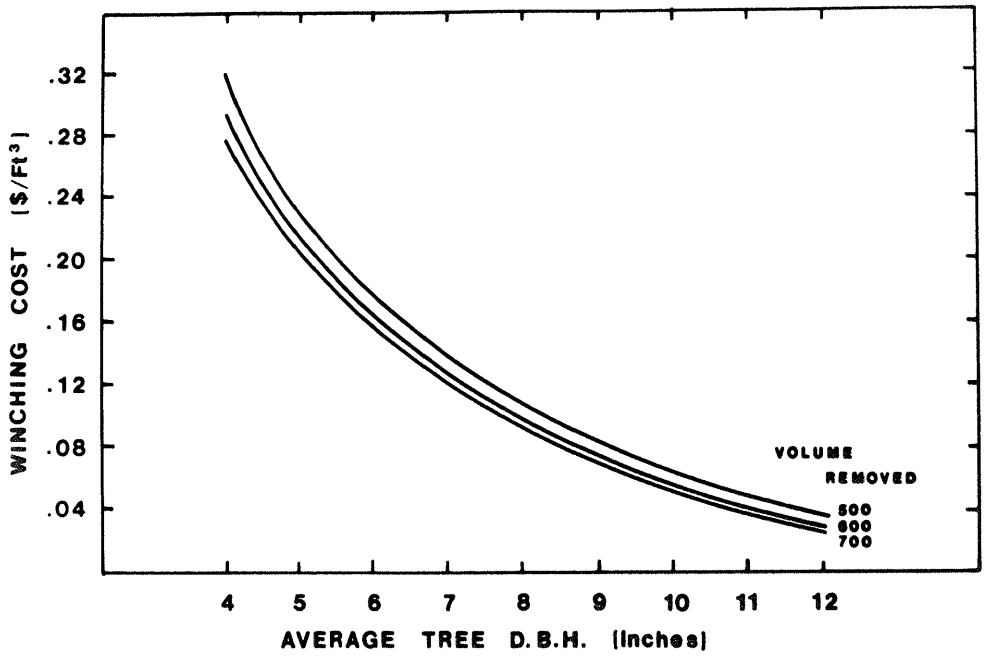

Figure 3.--Simulated winching cost for the Radio Horse 9 prebunching winch by average cut-tree d.b.h. and volume removed per acre.

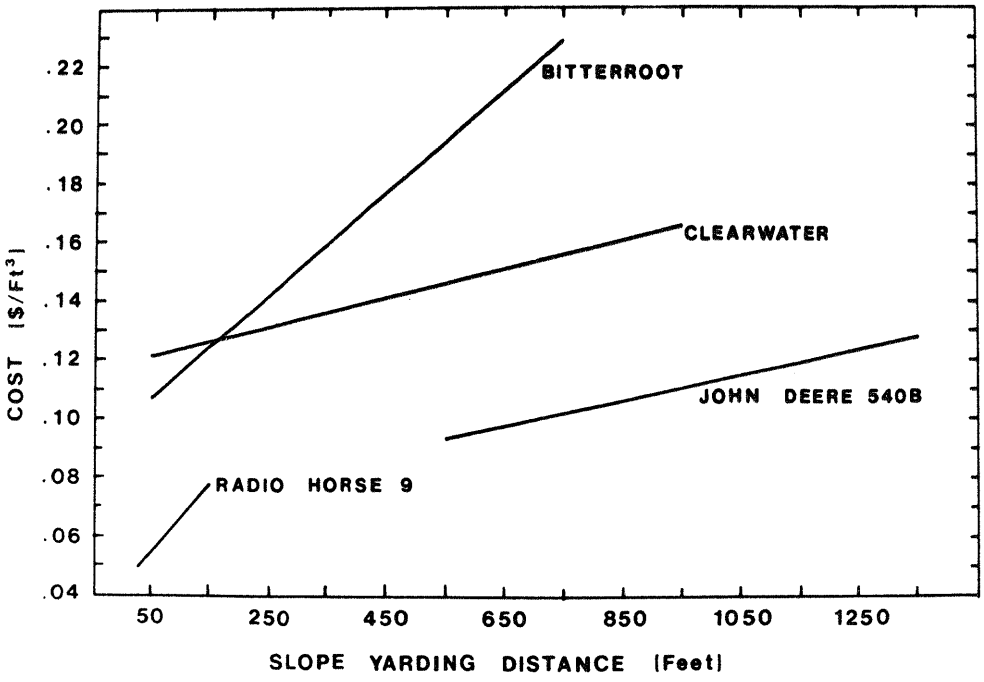

Figure 4.--Simulated yarding/skidding/winch costs for the Bitterroot and Clearwater yarders, the John Deere 540B skidder, and the Radio Horse 9 bunching winch by slope yarding distance. Conditions: average cut d.b.h., 9 inches for all systems; volume removed per acre, 700 ft^3/acre for the Radio Horse 9, 3,000 ft^3/acre for all other systems.

road and landing location, and piece size constraints can help keep removal costs within economical bounds (LeDoux 1984, Baumgras 1987).

LOGGING SYSTEM COMPARISON

The type of logging technology selected for removing young hardwood logs can undoubtedly affect the production rate and cost of that effort. Figure 5 shows the relative cost difference of wood removal using the three harvesting technologies described in this paper. In all situations, removal costs decrease with increasing average cut-tree d.b.h. The Radio Horse 9 winch is competitive with the John Deer 540B skidder in the 7 to 8 inch d.b.h. range. Otherwise, the Radio Horse 9 winch is the most economical to operate, followed by the John Deere 540B skidder, and next the more expensive cable systems, the Bitterroot and Clearwater yarders.

For example, at an average cut-tree d.b.h. of 9 inches, the Radio Horse 9 cost is $0.067/ft^3 which is about 26 percent less expensive than the John Deere 540B cost of $0.091/ft^3, which is about 55 percent less than the Bitterroot yarder cost of $0.150/ft^3. The John Deere 540B cost at average cut-tree d.b.h. of 7 inches is $0.113/ft^3, which is about 35 percent less than the Bitterroot yarder cost of $0.175/ft^3. These relative cost differences can be used as estimates of environmental protection cost. Clearly, to harvest timber on steep, difficult, environmentally sensitive sites will cost more as more expensive logging technology is used. Comparisons such as those shown in Figure 5 allow the managers and planners to visualize the cost differences of using alternative logging technologies.

CONSIDERATIONS FOR MANAGERS

Simulations presented here show the difference in cost of alternative logging technologies. Before deciding to log an area, the managers and planners must consider the interaction of logging equipment and site and stand specific variables such as average cut d.b.h., volume removed, and slope yarding distances required. Also considered should be

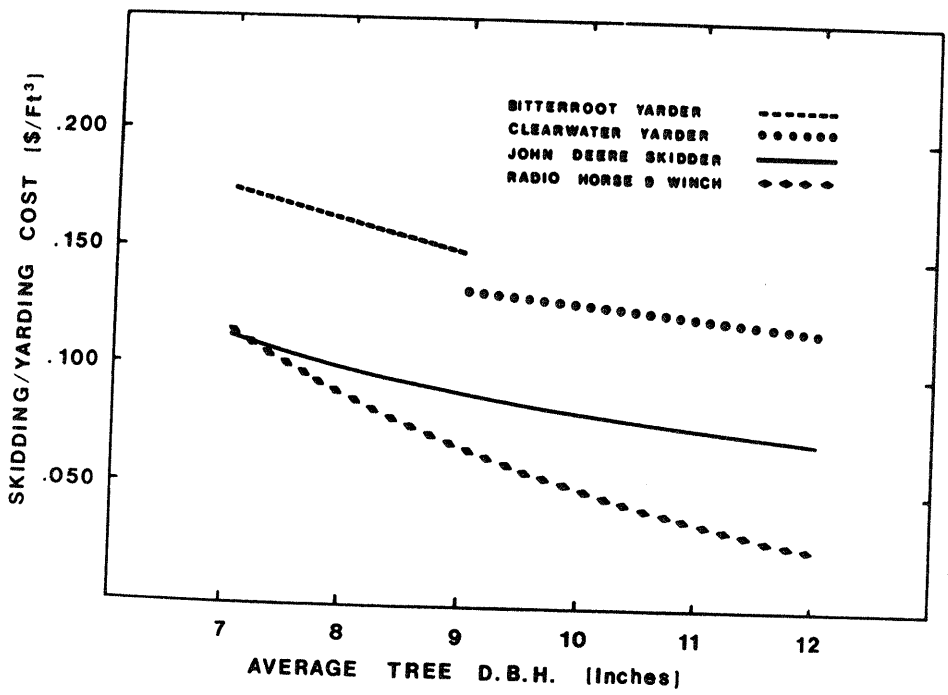

Figure 5.--Simulated comparative yarding/skidding/winching costs for the Bitterroot and Clearwater yarders, the John Deere 540B skidder, and the Radio Horse 9 bunching winch by average cut-tree d.b.h. Conditions: slope yarding distance, 300 feet for the Bitterroot and Clearwater, 100 feet for the Radio Horse 9, 500 feet for the John Deere 540B; volume removed, 3,000 ft^3/acre for the Bitterroot, Clearwater and John Deere 540B, 700 ft^3/acre for the Radio Horse 9.

primary product markets and the product mix available from the trees to be harvested, the topic of a companion paper in this same proceedings (Baumgras and LeDoux 1988). The logging manager also should be aware of other logging technologies and their comparative costs.

The simulated results summarized in figures 1 to 5 span the range of potential forest harvest site conditions. Clearly, for many applications, particularly in thinning young stands some of the combinations of average cut-tree diameter and volume removed shown in the above figures will not exist. The results however, do show the relative shifts in logging costs due to such volume cut and average tree size diameter combinations.

Simulations such as those presented here do not provide all the answers on which equipment to select or how to apply it. However, these methods illustrate the different types of harvesting technology available to thin young central hardwoods and help pinpoint the variables involved and their interaction so that loggers, planners, and managers can choose the best systems for treating young hardwood stands or final harvest operations.

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