Managing Red Pine Plantations for Utility Poles

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Introduction

Among the conifers that grow in Michigan's forests, red pine (also called Norway pine) has the greatest usefulness as a timber tree. Red pine grows rapidly on a wide range of well drained soils and produces wood that is highly useful for a variety of purposes. Accordingly, it has been widely planted throughout the state, especially in the northern Lower Peninsula and throughout the Upper Peninsula. Most of the older plantations in the state were made by the Civilian Conservation Corps beginning in the 1930s, but planting has continued unabated since then. Red pine plantations usually have high survival, and once established, trees continue to grow well for many years. Furthermore, few serious insect or disease problems threaten this valuable tree.

Michigan has 623,000 acres of red pine plantations, 98 percent of which are less than 60 years of age. These plantings make up nearly 70 percent of the forest area classified as the red pine type and are a valuable timber resource (Leatherberry and Spencer, 1996). Though some of them have been well managed - especially those on U.S. Forest Service, Department of Natural Resources and forest industry land - many plantations on private land are in need of more intensive management to maximize their potential for value growth and economic return.

Traditionally, red pine was considered a tree to be grown to large size for sawlogs or cabin logs. Trees removed in thinnings or other small trees were used for pulpwood, fuelwood or posts. New technologies have broadened the available markets for red pine timber of all sizes. Small-diameter logs now can be made into 2 by 4 or 4 by 4 dimension lumber in computerized chip-and-saw mills or chipped for production of the oriented strand boards now widely used for sheathing and flooring. The development of copper chromium arsenate (CCA) as a wood preservative has led to an expansion of the number of plants producing pressure-treated dimension lumber for outdoor applications such as decks, docks and landscape construction. In addition, CCA-treated poles have become widely accepted for use by utility companies. Red pine produces an excellent treated pole, and the demand for and value of such material have increased significantly.

The purpose of this bulletin is to provide information and silvicultural management recommendations for producing high-quality utility poles in red pine plantations. Utility poles are the **highest value product** that can be produced from red pine trees (fig. 2).

Fig. 1 Thousands of acres of red pine in Michigan are suitable for management for high-quality timber products, including utility poles.

Fig. 2. Because of their high value, utility poles represent an important source of potential income for a landowner who manages for them.

For a number of years, stumpage prices (the price paid for trees as they stand in the plantation or woodlot) for utility pole-grade trees have been approximately two times what these same trees would be worth as sawlogs. For example, at current prices the stumpage value of a 14-inch dbh tree (dbh =diameter at breast height, or 4.5 feet above the ground) would be $19 if it were sold for sawlogs but $34 if it were sold as a pole(1). As shown by Grossman and Potter-Witter (1991), economic returns to the landowner from managing red pine plantations for increased utility pole production can be substantial. This fact should be more widely known by owners of red pine plantations. Because the specifications for logs sold as utility poles are quite stringent compared with those for other products, silvicultural management of plantations must be specifically directed towards maximizing the percentage of high-quality trees that meet these specifications.

Utility Pole Specifications

Specifications for utility poles are set by the American National Standards Institute, Inc., and were developed by extensive testing in cooperation with utility companies and other users of poles. The various factors that contribute to pole specifications are shown in Table 1. The ratio of stem circumference or diameter to pole height (which indicates the degree of stem taper), stem straightness, frequency and size of knots, and defects are the most critical factors (Fig. 3).

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(1) Prices paid for stumpage fluctuate greatly over time and over geographic region. The dollar amounts given here are simply to give the reader some idea of the relative value of red pine trees sold for different end uses.

Table 1. Red pine utility pole specifications[1]

Pole size[2] (feet)	Diameter class (inches)	Circumference 6 feet up from butt (inches)	Top diameter inside bark (inches)	Allowable single sweep[3] above 6 feet (inches)	Sum of knot diameters over 1/2 inch in any 1-foot section (inches)	Maximum single knot diameter (inches)	
						Top 1/2	Bottom 1/2
30	10	30.0 - 33.9	6 - 8	2.4	8	4	2
35	11	34.0 - 35.9	6 - 8	2.9	8	4	2
40	12	36.0 -42.9	6 - 8	3.4	8	4	2
45	14	43.0 - 46.9	7 - 8	3.9	8	4	2
50	16	47.0 - 54.0	8 - 9	4.4	10	6	4

[1] Poles must be free of defects such as crooks, forks, rot, insect damage, fire scars and lightning damage.

[2] The actual pole harvested is 2 feet longer to allow for trimming at each end.

[3] Sweep refers to curvature of the tree trunk. On a double or S sweep, the trunk must stay within a straight line drawn from the midpoint at ground line (6 feet from the butt) to the midpoint at the top (allow 1 inch on each side for bark and peeling loss).

Courtesy of Hydrolake Leasing & Service Co., McBain, Mich.

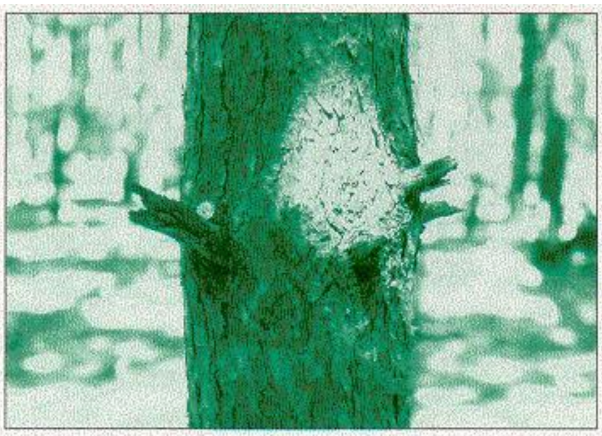

Fig. 3. Pole buyers use tightly written specifications which will disqualify a tree as a pole if it has too many large diameter branches (knots).

Pole buyers are very particular when evaluating standing trees or logs for their suitability as poles, and they will reject any that don't meet the specifications listed in Table 1. Landowners who plan for the marketing of their trees and follow proper management practices can increase the number of high-grade poles produced on each acre of land and so maximize their economic returns.

Managing Plantations to Meet Pole Specifications

Before starting a pole management program, the landowner must first assess the current condition of the plantation - its age, the number of live trees per acre, the size of the trees and previous management practices. When this information has been collected and evaluated, a silvicultural management plan for increasing pole production over the life of the plantation can be developed.

Determining current stand conditions

The quantification of current conditions in a plantation or any other forest stand is referred to by foresters as an inventory. During an inventory, tree heights and diameters are measured and the amount of wood volume per acre usually is estimated. Wood volume can be expressed either as cords, cubic feet or board feet (in thousands), depending on the product being grown and local conventions. Stand density, an absolute measure of the tree cover growing on a unit of land area, also is estimated during an inventory. Stand density is especially important in management for poles. Inventories usually are not done until plantations are 25 to 30 years old because most trees have little or no commercial value prior to this age.

Stand density is measured by determining either the number of trees per acre or basal area per acre - the cumulative cross-sectional areas of tree stems at 4.5 feet above the ground, expressed as square feet. Basal area is most often used by foresters as a measure of stand density because it integrates the number of trees per acre and their stem diameter or circumference into a single value. Furthermore, basal area also is an excellent indicator of a stand's potential for producing poles

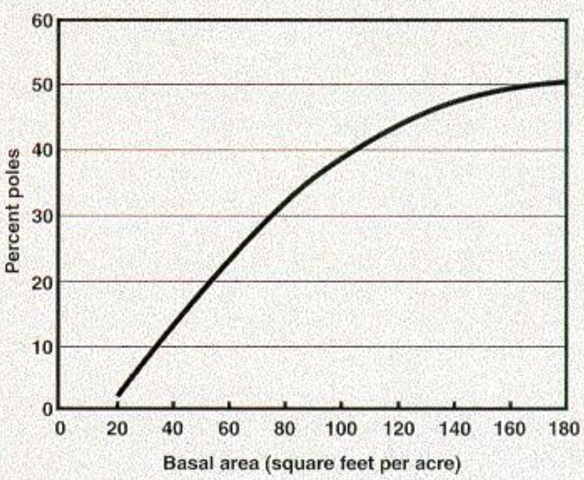

Fig. 4. Proportion of red pine trees in a plantation classified as poles or potential poles based on its current basal area. Redrawn from Guilkey, 1958.

The simplest and most common way to determine stand density is to establish sample points on the ground in a plantation around which variable-radius plots are centered. Then simple tree counts are taken at each point using an angle gauge or prism to determine which trees are within each plot. (See MSU Extension bulletin E-1578, "Improving Hardwood Timber stands", or E-1757, "Point Sampling", for more information on using angle gauges and prisms.) Usually trees less than 4 inches dbh are not counted because such trees have little economic

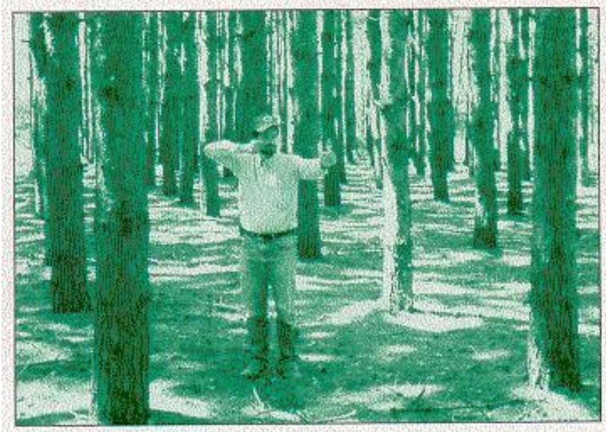

Fig. 5. Measuring stand density on a sampling point in a plantation using an angle gauge.

value. All trees 4 inches dbh or greater should be counted, with each species recorded separately, although in most plantations the vast majority of trees will be red pine. The dbh of each tree counted in a plot also should be measured to the nearest inch using a diameter tape, Biltmore stick or caliper.

Use Table 2 to determine the number of points to establish in a plantation. Points can be randomly located within the plantation or, more conveniently, located on a systematic grid. To avoid the misleading influence of large edge trees, points should be located at least 60 feet in from the edge of the plantation or from roads and other openings.

The tree count at each point is converted to basal area by multiplying it by the basal area factor or BAF of the prism or angle gauge.

Table 2. Number of points to establish for sampling red pine plantations (from Marty, 1984).

Size of plantation (acres)	Number of sample points
10 acres or less	10
11 to 40	1 point for every acre
41 to 80	40 + (no. of acres - 40)/2
81 to 240	60 + (no. of acres - 80)/4
>240	100

In Michigan, the BAF usually is 10, but it may be 20 in dense or older plantations. For example, using a BAF of 10, a tree count of 12 at a sample point converts to a basal area estimate of 120 square feet per acre at that point. The dbh of each tree in the plot is needed to determine number of trees per acre because each size tree has a different "expansion factor" Table 3

Table 3. Expansion factors* for determining number of trees per acre in point sampling using a 10-factor prism or angle gauge (from Marty, 1984).

Dbh (inches)	Expansion factor (no. of trees per acre)
4	115
5	73
6	51
7	37
8	29
9	23
10	18
11	15
12	13
13	11
14	9
15	8
16	7
17	6
18	6
19	5
20	5
21	4
22	4

* These expansion factors must be doubled if a 20-factor prism or angle gauge is used; for example, in an older plantation where average dbh is relatively large.

For example, if three trees in the 12-inch dbh class (11.6-12.5 inches) are counted in a plot, each tree expands to 13, giving 39 trees per acre in the 12-inch class. Adding the expanded values for all tree diameters measured in the plot gives an estimation of the total number of trees per acre or the number of trees in each dbh class.

When the data from all points have been compiled and density and volume at each estimated, they are averaged to give a composite picture of the whole plantation. A stand table also could be constructed for the plantation by listing the average number of trees in each dbh class in ascending order, Table 4.

Table 4. A stand table for a 38-year-old red pine plantation growing on a sandy soil in northern lower Michigan. The plantation was thinned once by removing every third row; basal area is 160 square feet per acre.

Dbh class	Number of trees per acre
4	85
5	142
6	265
7	168
8	78
9	8
10	7
Total	753

Though constructing a stand table is optional, it nonetheless gives a very informative picture of the plantation. For those interested in computer-assisted compilation of inventory data, the Forest Resources Systems Institute (FORS) provides forest inventory processing software at a nominal cost. This software can be downloaded from the FORS World Wide Web home page at

http://www.uga.edu/~soforext/fors/homepage.html.

Plantations less than 30 years old

The key to good management of plantations for utility poles is to maintain the proper stand density at all stages in the life of the plantation. During the early years, trees should be crowded - no fewer than about 900 trees per acre - so that they grow straight with a minimum of taper, and so the lower branches die early and begin to self-prune. Plantations initially established at a wide spacing (e.g., 8 by 10 feet or wider) and those where early mortality increased spacing among trees and produced relatively low stand densities are unlikely to produce a high proportion of poles.

The specifications in Table 1 indicate that the number and size of knots are major factors in determining a tree's suitability as a pole. Therefore, lower branches must be encouraged to die when they are small - preferably less than

1 inch in diameter - by maintaining high stand densities early in the life of the plantation. Red pine prunes well naturally, so branches that die fall off the tree within a few years. Letting natural pruning take its course, therefore, is the simplest and most economical choice except in wide-spaced plantations or with trees along the edge of the plantation, where natural pruning does not readily occur. Nonetheless, a landowner might want to prune trees by hand, even though there may be little or no economic return from it. The benefits of early hand pruning are that plantations look better, they are easier to travel though, a greater range of products can be marketed from them and pruning is good exercise.

If hand pruning is done, it is important to do it correctly - otherwise the effort is wasted or trees may be harmed. Several rules of thumb apply to this practice. First, pruning should be done only during late fall through early spring; actually, pruning is a great winter-time activity. Never prune during the growing season because the bark is loose then and will easily strip away from the trunk, creating a large wound. Second, never prune off more than the lower one-third of the live branches and try to maintain the upper half of the tree in live branches. The live branches supply the photosynthetic power that drives growth; excessive pruning can seriously diminish it.

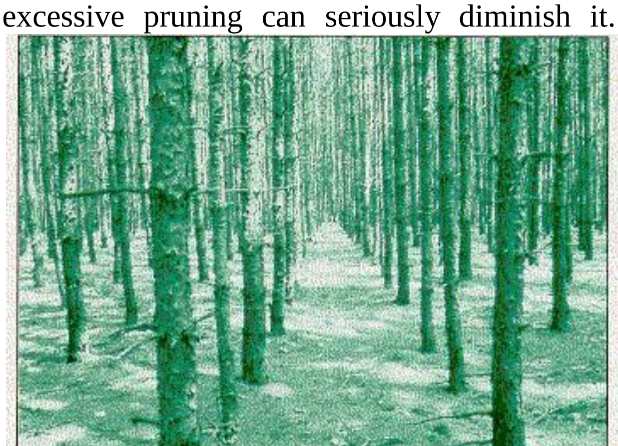

Fig. 6. Early crowding reduces knot size, but thinning should be done when basal area exceeds 180 square feet per acre.

Dead branches can be pruned off at any time, but the sooner, the better. Third, prune branches off flush with the stem and do not leave stubs, which can attract harmful insects and allow disease organisms to infest. Fourth, prune only the largest diameter, best formed trees because these trees will provide the greatest potential return on the investment in pruning.

Pruning can begin anytime in the early life of a plantation as long as the rules of thumb are followed, but usually it is initiated before the crowns of trees close together. The wider the trees in a plantation are spaced, the earlier pruning should begin. A single pruning can be done, or pruning can be accomplished in several stages, starting when the trees are quite young. It is impractical and just plain hard work to prune higher than 15 feet. Strictly in terms of pole production, there is no benefit to pruning plantations where lower branches already have died and natural pruning has begun. However, pruning still may be done for other reasons.

Plantations greater than 30 years old

Beginning at age 30 to 35, a series of thinnings is initiated to reduce stand density and promote diameter growth on the remaining trees. These thinnings are the essence of silvicultural management for poles. They also can be an important source of income for the landowner. Quantitative data from a plantation inventory should be in hand before a decision is made to thin or not.

If the current plantation basal area is **at least 180 square feet per acre**, a thinning is possible (Fig. 6). Plantations with basal areas less than 180 should be left alone until they accumulate at least that minimum level. On an average site, a 30-year-old plantation currently carrying a basal area of 150 square feet per acre should grow to 180 square feet per acre in about five years. On the other hand, plantations older than 40 years that have never been thinned may carry basal areas well in excess of 200 square feet per acre and tree diameter growth rates will be slow; in these cases, an immediate thinning should be completed.

The **first thinning** in any plantation is simple - whole rows are removed to open up the stand. This stimulates diameter growth on the residual trees and creates corridors of access for further management. If most of the trees in the plantation are straight and without crooks or forks, every third row can be removed. This treatment will reduce the basal area by one-third. If there are a number of crooked, forked or large, thick-branched trees in the plantation, every fourth row should be cut, with trees unsuitable for poles selectively marked for cutting in the remaining rows. Trees other than red pine also should be marked. In this case, residual basal areas following thinning should be **120 to 140 square feet per acre.**

The **second thinning** should take place about 7 to 10 years after the first row thinning - depending on the quality of the site - or when the basal area has grown back to at least 180 square feet per acre. Now the strategy is to selectively mark for cutting those trees that may have been damaged in the first thinning, defective or non-red pine trees, and small, spindly or slow-growing trees. Some trees that have already attained utility-pole status also could be marked. The best formed, fastest growing trees will make up the residual stand, which again should have a basal area of 120 to 140 square feet per acre (Fig. 7). The monetary rate of return to the landowner on growth that occurs from this point onward will be high.

Fig. 7 Residual basal area of 120 to 140 square feet per acre following thinning will produce accelerated diameter growth and maintain pole specifications.

The **third thinning** can be done after another 7 to 10 years have passed. This thinning will be very profitable for the landowner because many of the trees marked for cutting will be in the larger utility pole classes - 40, 45 and 50 footers. Residual basal area after this cutting can be lower than after the previous thinnings (maybe less than 100 square feet per acre), but no firm basal area target need be set. Basically, the amount of basal area removed depends on the number of mature poles available. Any tree that could attain a higher pole class with further growth should be left to increase rate of return (Fig. 8). If the plantation is growing on a very good site or if it was relatively old when the first thinning was done, a complete removal of all trees could be done at this stage and the stand regenerated (see section on establishing a new stand below).

Fig. 8 A final thinning can reduce basal areas to 100 square feet per acre or less, leaving residual trees that could attain a higher pole class with further growth.

Thinnings can be marked by the landowner, a consulting forester or a forester from a pole producing company. It is the buyer of the poles, however, who makes the final decision on which trees qualify as utility poles. For row thinnings, only the first tree in each row to be cut need be marked. In selective thinnings, each tree to be cut must be individually marked with paint, preferably at breast height on two sides and again at the base below the stump line (so the landowner can check later to see if only marked trees were cut). Tree marking paint can be obtained from any forestry or horticultural supply catalog.

The final harvest and establishing a new stand

Eventually a point is reached in plantation management where all of the remaining trees, most of which will be utility poles or sawlogs, can be removed. This harvest also will be quite profitable for the landowner.

The objectives of the final harvest of a plantation are not restricted to liquidating the standing timber for financial gain, however - regeneration of a new forest stand and protection of the site from environmental degradation also are important. The latter two objectives, though easy to understand, are not always easy to achieve. Thus, professional advice from a trained forester is highly recommended before all the timber finally is removed. As an alternative, the landowner may choose to maintain some older pines on the site for aesthetic reasons and forgo the final harvest or simply do a final light thinning.

Fig. 9. For eventual pole production, plantations should be established with no fewer than 900 trees per acre, e.g., a 6- by 8-foot spacing.

Though expensive, the surest way to regenerate a harvested plantation of red pine is to replant the site (Fig 9). Red pine seedlings are widely available from nurseries, and usually their survival in a plantation is high. Nonetheless, certain principles have been developed through research and experience that should be followed to increase the probability of a successful plantation. These principles are presented in MSU Extension bulletin E-771, "Tree Planting in Michigan" and will not be discussed in detail in this bulletin. However, they are summarized in the **plantation establishment triangle** (Fig.10).

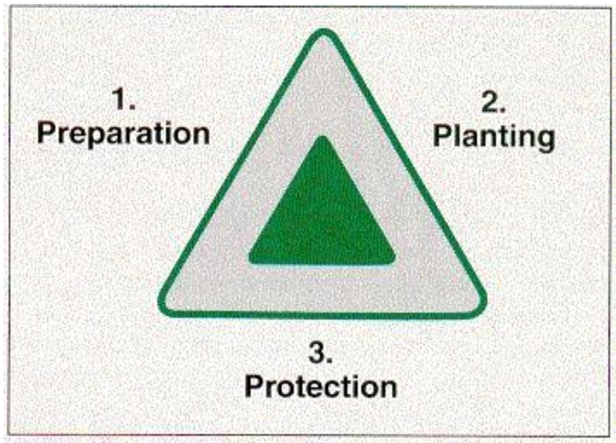

Fig. 10. The plantation establishment triangle.

Preparation first involves planning a new plantation in detail and well in advance. At this stage, advice from a professional forester can be very beneficial. Second, the planting site should be prepared to reduce logging debris (also called slash) and to suppress competing vegetation. Especially on the better sites, an understory, consisting mostly of young hardwood trees and shrubs, will become established below the canopy of red pine following later thinnings. This vegetation can severely reduce the growth and survival of young red pine trees and must be controlled, either through cutting, a hot prescribed fire, or the use of herbicides before the trees are planted.

Next, proper procedures should be followed in selecting the source and type of planting stock, storing and transporting it, and then planting it in the ground on site, Side 2 (Fig. 10). Finally, the young plantation must be protected from reinvasion by unwanted woody and non-woody weeds, insects and fire, Side 3 (Fig. 10). A plantation represents a considerable investment of time and money - lack of protection could seriously jeopardize this investment.

A second alternative to regenerating red pine is to foster natural seeding by remaining trees in the original stand. Though less expensive than planting, natural regeneration also is more risky

- in some cases it may not work at all. Again, advice from a professional forester who has experience in naturally regenerating red pine is essential.

Many of the same principles embodied in the plantation establishment triangle also apply to natural regeneration, but there are a few additional considerations. First, instead of a final harvest of all trees, the plantation should be thinned heavily, leaving a residual basal area of about 50 square feet per acre. The residual stand is known as a shelterwood. It provides seed and shelter for the germination and development of young seedlings. Second, it is essential to conduct this shelterwood cutting during a year when trees are bearing many cones to assure a plentiful seed supply. Third, some bare mineral soil must be exposed to provide a favorable seedbed. Whole-tree skidding when the soil is not frozen, prescribed burning or scarifying with a disk or chisel plow under the shelterwood will satisfy this requirement. These treatments are effective in reducing competing vegetation, too. Fourth, when seedlings have become established and grown to about 3 feet in height, the shelterwood overstory should be removed. This logging operation must be conducted carefully, usually during the winter, to minimize damage to the seedlings.

Marketing and Selling Poles and Other Products

The supplemental income derived from marketing red pine timber as stumpage is a real inducement for a landowner to manage a plantation. Seller beware, however - pitfalls exist that could turn an expected monetary return into a ruin. In the worst case, an unscrupulous logger could pay far less than the timber is worth and leave the plantation a mess. To be fair, many loggers are honest and careful, but how is one to know? We highly recommend that marketing of timber and administration of timber sales be done through a reputable timber buyer or by an experienced consulting forester hired by the landowner. The seller will usually pay 10 to 20 percent of the stumpage proceeds for the service of a consulting forester, though some can be hired by the hour or for a flat rate. In many cases, the additional revenues that can be gained by a professional experienced in the marketing of timber will more than offset this cost.

The recommended steps in marketing timber are covered in MSU Extension publications E-1265, "Marketing Timber from the Private Woodland," and E-2454, "Lakes States Woodlands: Marketing Timber." Several key points from these publications must be emphasized. First, stumpage has no set value - the price paid is whatever seller and buyer agree to. So the same tract of red pine timber could be sold for very different amounts, depending on how the parties involved negotiate the sale. The second point is that a timber sale should be widely advertised and sealed bids solicited. In particular, don't be too eager to jump at the first offer that is made. It is not unusual for the high bid for an advertised sale to be two or even three times the low bid! Be especially wary of an unsolicited buyer who knocks on your door out of the blue and offers to buy your timber, unless they can produce references or show examples of previous work. Third, price is not everything. Contracting with a logger who does not give the highest bid but who has a reputation for clean and careful work might be a very sound decision. This is an especially important point for thinning sales, where excessive damage to the lower bark and crowns of residual trees can negate the value of the thinning, especially if the stand is managed for a high-value product such as poles. And fourth, always prepare a written contract for each sale that will be signed by all parties (see MSU Extension publication E-1656, "Timber Sales Contracts"). It is especially important to stipulate in the contract how payment(s) will be made. Proof of workers compensation or general liability can also be stipulated.

Final Thoughts

The market for red pine utility poles should remain strong well into the future, reinforcing a landowner's decision to actively manage for this product. Even in the unlikely event that the pole market collapses, large-diameter, high-quality trees will always be in demand for other uses. Following the guidelines in this bulletin should substantially increase the outflow of poles from a plantation, from thinnings through a final clear felling. Landowners will not only receive a handsome income from these harvests but gain the satisfaction that their land is being put to a highly productive use. Following the establishment of a new pine plantation or naturally regenerated stand, this cycle can then repeat itself through succeeding generations.

Acknowledgments

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