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A Variable Thinning Approach to Aspen Management in the Superior Clay Plain

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Introduction

Photo 1. Shetlterwood harvests in aspen stands are designed to capture much of the economic value of the mature aspen while hastening succession to shade tolerant species. Such harvests may be more acceptable to landowners concerned about the aesthetic or ecological impact of clear-cutting.

Lake Superior Clay Plain

The Superior Clay Plain of northern Wisconsin lies adjacent to Lake Superior extending from Duluth, Minnesota to Hurley, Wisconsin. The soils are predominantly clayey lacustrine till formed in ice-margin lakes during periods of glacial retreat. Areas of well-drained sand and outwash gravel occur in correlation with beach ridges and lake and river terraces. The soils are predominantly poorly-drained, but areas can be well- to excessively-drained depending upon outwash deposition.

Land survey records indicate the Superior Clay Plain supported a conifer-dominated forest prior to European settlement and the cutover of the turn of the 20th century (Finley, 1976). Areas with poorly-drained clay supported a mix of balsam fir, white spruce, white pine, white cedar, red maple, and black ash. Upland areas with better drainage supported white pine, white spruce, and northern hardwoods. Like most of northern Wisconsin, the forest cover was drastically changed by the cut-over and subsequent slash-fires. The long-lived shade-tolerant conifers and un-even aged stands were replaced by even-aged stands of shade-intolerant species like aspen, birch, and oak.

Since the cut-over, a combination of natural forest succession and forest management practices has resulted in two distinct forest types. The more intensively managed upland areas are predominately a mix of aspen, red maple, and balsam fir, while the incised drainages common throughout the Clay Plain have a mix of white pine, white spruce, cedar, aspen, and northern hardwoods—more typical of the pre-settlement forest condition.

The predominant management practice for aspen dominated upland stands in the Clay Plain is even-age regeneration through clear-cutting. This practice often conflicts with the aesthetic goals of landowners and, when practiced on a large-scale within a watershed, can result in elevated peak flows and consequent increased streambank erosion and downstream sedimentation. As a result, there is interest in developing alternative management practices for aspen dominated stands that meet the visual and conservation objectives of the landowner while not losing all the economic value of the aspen.

Aspen Shelterwood and the Managed Forest Law

Active forest management and timber harvesting is a key economic sector in northern Wisconsin. Recognizing that much of the forestland in the region is owned by non-industrial private landowners, the State of Wisconsin supports and enables forest management on these private lands through tax incentives available through the Managed Forest Law Program (MFL). Through MFL, landowners received tax incentives (technically, tax deferments), in exchange for developing and implementing a forest management plan over a 25 or 50 year period. By statute, the forest management plans and forest management activities, such as a timber harvest, must follow the guidelines and prescriptions outlined in the WI DNR's Silviculture and Forest Aesthetics Handbook (Handbook).

For aspen dominated stands, the Handbook recommends even-age regeneration at stand maturity via overstory removal (clear-cutting). For landowners wanting to maintain some overstory trees for aesthetic or ecological reasons, the Handbook does allow a number of different options including Coppice with Standards, Aspen Reserve Management, and Two-Age Aspen Management. All three are designed to regenerate aspen, but retain variable amounts of overstory trees as a means to promote colonization and growth of non-aspen species.

Such options are not commonly used in the Superior Clay Plain due to concerns by land managers about future forest condition. First, there is concern the economic value of any retained aspen would be lost through windfall or aging. Second, there is concern regeneration of aspen or non-aspen trees would be insufficient to fully stock the stand and, as a result, the stand could be lost to dogwoods, raspberries, hazel, or ironwood. Third, aspen is commercially valuable and there is concern other species may be less productive or less economically valuable.

To address these concerns and provide forest managers with field experience with alternative aspen management strategies, a long-term aspen management trial was established in 2005 on private land about 10 miles west of Ashland. The purpose of the trial was to evaluate an aspen shelterwood harvest on tree regeneration and retained aspen.

Methods

The trial was established in 2005 on private property enrolled in the Managed Forest Law Program. The trial had two units. The west unit was primarily 40-50 year old aspen with a minor component of balsam fir, red maple, white spruce, and white pine. The east unit was primarily aspen. Both units are Type 3 aspen stands as characterized by Niese and Clark (2000). Prior to harvest, the stand was marked with leave-tree marking to follow the mandatory practice as specified in the MFL plan, which stated:

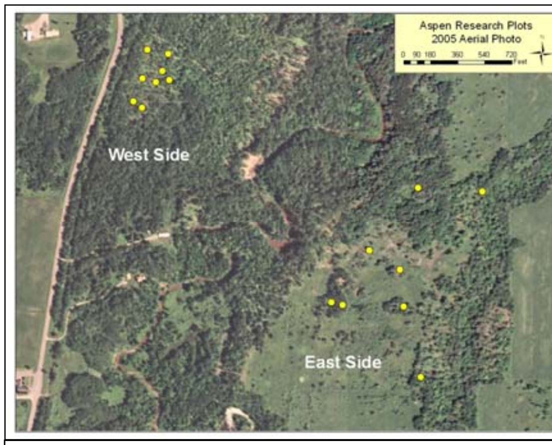

Photo 2. Aerial photo of the study site showing the two units. The east side is predominantly aspen growing along field edge. The west side is a more diverse mix with aspen, red maple, balsam fir, and some white pine and white spruce.

> *"Complete a shelterwood type harvest reducing crown closure to around 60%. The goal is to discourage aspen regeneration but allow more light to reach the understory to encourage natural and planted mixed pine/hardwood seedlings. Leave conifers for a seed source. Complete by 2012. Then within 5 years of the shelterwood harvest, establish an understory of seedlings of 900 seedlings per acre in conifer or hardwood seedlings other than aspen. May need to plant in order to do this. If understory meets stocking requirement, remove part or all of the remaining overstory where it can be done without damage to the understory. If understory stocking does not meet requirements, remove entire overstory to regenerate aspen. Cut all trees down to 2 inches DBH. Any healthy pine or spruce may be left. Snag and den trees may be left for wildlife."*

The stands were harvested in the winter of 2005 by a logger cutting by hand and forwarding with a skidder. Data plots were established in each unit using aerial photography and GIS with the goal of placing each plot in areas with primarily aspen. Plots were excluded if they landed on skid trails. Each plot consisted of two fixed radius individual plots with the same center point. The larger plot of 1/10th acre was used to collect overstory tree data. The smaller plot of 1/300th acre was used to collect seedling and sapling data. In the larger plot, basal area, percent canopy cover, and the species, dbh, and merchantable height of all trees with a dbh greater than 3.9" were recorded. Individual aspen tree merchantable volume was calculated with the formula: $Vp = .2075 + .04384\ D^{1.8713}\ pH^{.8546}$, where Vp = volume of pulpwood (ft^3), pH = pulpwood merchantable height (ft), and D = diameter at breast height. The plots were established in the west unit prior to harvest and in the east unit after the harvest. As such, in the east unit the removed species and diameters could be determined from stumps, but merchantable height and volume could only be determined for residual trees.

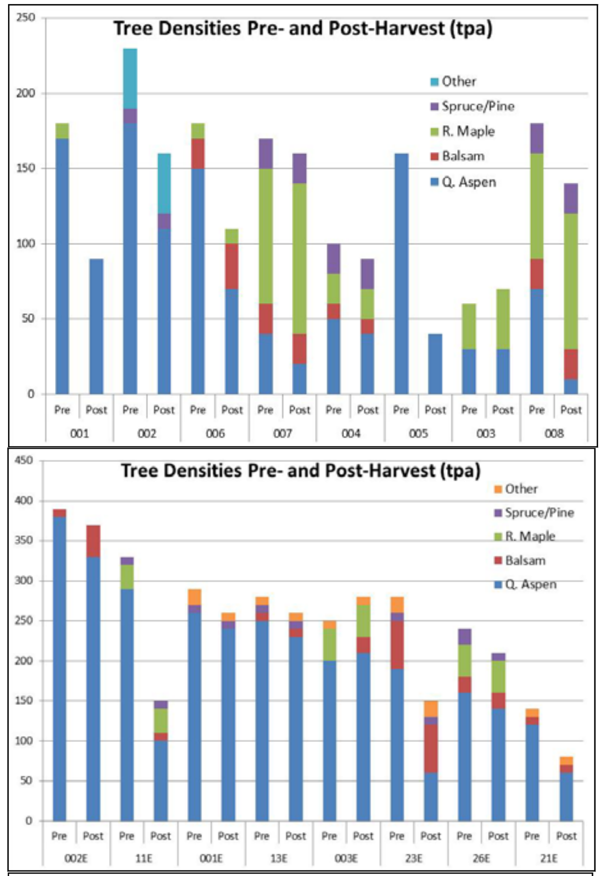

Figure 1. Pre– and post-harvest overstory tree densities in the west (top) and east (bottom) units.

In the 1/300th acre plot, the number and species of all tree and shrub saplings and seedlings were recorded. Trees 2ft and taller with a dbh of less than 1 inch were tallied as seedlings and trees with a dbh of 1-3.9 inches were tallied as saplings. The data in both plots were collected prior to harvest and in the spring after harvest. Seedling and sapling data were collected in each plot again in 2006. In 2012, both the tree and seedling and sapling data were collected.

The stand was marked with the goal of removing as much aspen as possible while leaving sufficient aspen to promote growth and/or colonization of shade tolerant tree species, primarily red maple, balsam fir, white spruce, white pine, and ash. For analysis of the seedling/ sapling data, the plots were assigned to one of three categories based on the hypothesized change in future forest condition. Plots that started with more than 80% aspen in the overstory, less than 10% shade-tolerant species in the understory, and had more than 50% of the aspen removed by the harvest were assigned to Category 1. These plots were expected to regenerate aspen through sprouting. Plots that started with at least 20% non-aspen tree species in either the overstory or understory and that had more than 30% but less than 50% of the overstory trees removed in the harvest were assigned to Category 2. These plots were expected to succeed to shade-tolerant species through release of the existing shade-tolerant trees. Plots that started with at least 50% aspen in the overstory, no shade-tolerant trees in the understory, and that had less than 30% of the overstory trees removed in the harvest were assigned to Category 3. These plots were expected to succeed to shade-tolerant species through natural recruitment of shade-tolerant seedling into the understory.

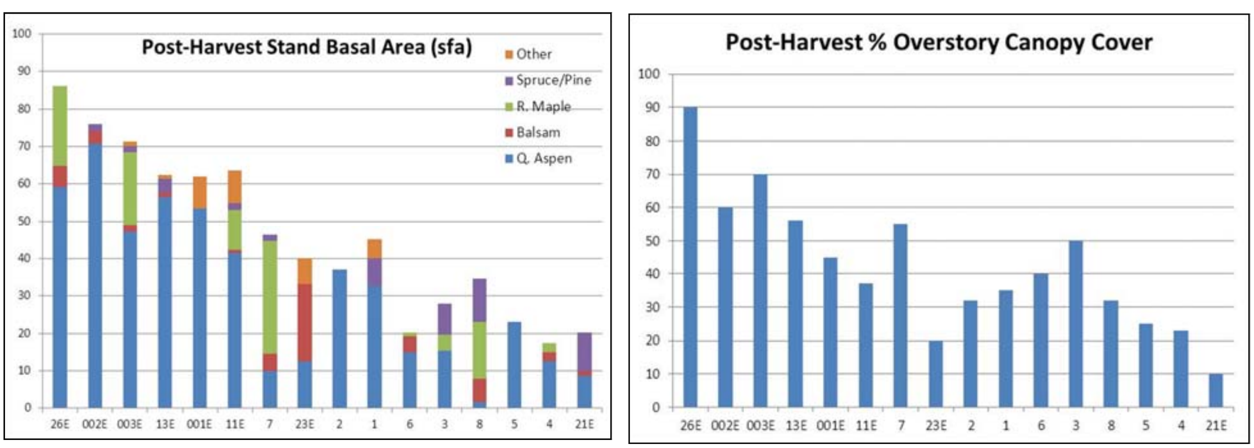

Figure 2. Post-harvest basal area and overstory canopy cover.

Results and Discussion

Pre– and Post-Harvest Stand Condition

Figure 1 shows the overstory tree densities in the east and west side plots before and after harvest. Figure 2 shows the post-harvest canopy cover and stand basal area for each of the plots. As the figures show, the plots encompass the range of diversity in starting stand condition and reflect a wide range in tree removals. As such, the plots allow for a robust evaluation of treatment response.

Interestingly, the post-harvest overstory canopy cover varied widely from 90 to 10 percent with an average across both units of 42 percent. This variation is perhaps indicative of the limitation of a stand-wide shelterwood prescription. When marking the timber sale, the foresters used a site-specific approach to favor non-aspen tree species while also harvesting as much aspen as possible. The amount of overstory removed depended on composition of both the overstory and understory at each specific location. The result is a patchwork of variable tree densities and canopy closures, rather than a more uniform canopy closure typical of a shelterwood harvest in an oak stand. This patchwork can create compliance challenges if the DNR or consulting foresters are evaluating implementation of a management action using a stand-wide average canopy closure or basal area measurement. Instead, the success of a site-specific aspen shelterwood harvest should be evaluated based on tree regeneration and post-harvest stocking.

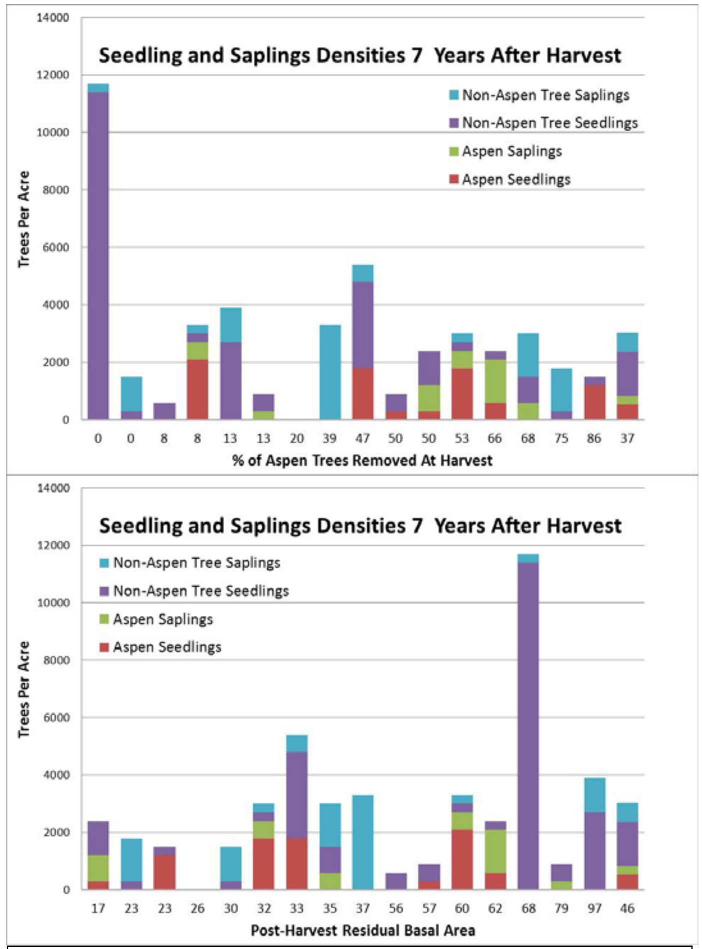

Figure 3. Total tree seedling and sapling densities 7 years after harvest as correlated with percentage of aspen trees removed at harvest (top) and total post-harvest residual basal area (bottom). Right most column is the average of all plots.

Seedling and Saplings

Figure 3 shows the tree seedling and sapling densities7 years after harvest as correlated with both percentage of aspen trees removed at harvest and residual stand basal area. For the purposes of meeting the MFL prescription, all but two of the plots would meet the required minimum seedling stocking density of 900 trees per acre. Averaged across all plots, the seedling/sapling density 7 years after harvest was 3040 trees per acre, more than 3 times that required by MFL.

There was no clear correlation between 7-year seedling or sapling density and percentage of aspen removed or residual basal area. In other words, removing more overstory aspen or reducing stand basal area did not necessarily result in more aspen regeneration. Instead, seedling and sapling density, and thus, future forest condition was more strongly correlated with the matrix of pre-harvest overstory species composition, intensity of overstory removal, and existing understory regeneration.

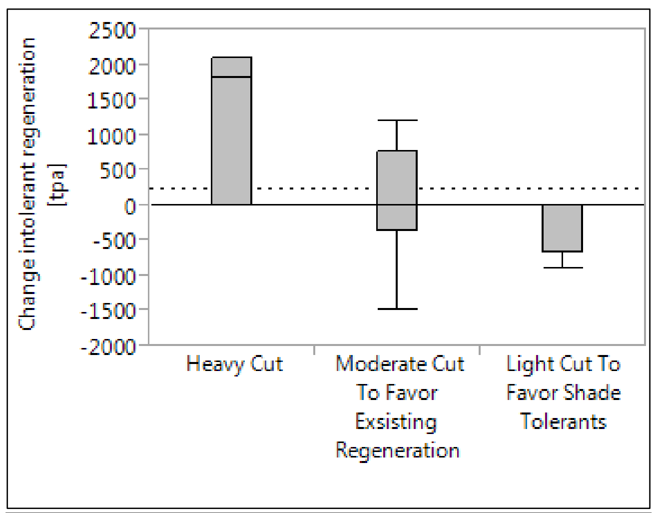

Figure 4. The change in aspen seedling/saplings density 7 years after harvest as affected by a site-specific variable thinning approach.

Figure 4 shows the change in aspen seedling and sapling density 7 years after harvest as analyzed with the plots assigned to the expected future forest condition categories. As expected for the category 1 plots, removing more than half of the aspen in an aspen-dominated stand resulted in an increase in aspen regeneration. There was a slight increase in aspen regeneration in the Category 2 plots, and in the category 3 plots, where little overstory was removed, there was a slight loss of aspen seedling/saplings. With the exception of a few plots there was little to no increase in density of shade tolerant species (data not shown), suggesting that more time is needed for recruitment to occur. That said, as Figure 3 illustrates, there was considerable abundance of shade tolerant species prior to harvest and the category 2 and 3 harvest approach is intended to retain those trees.

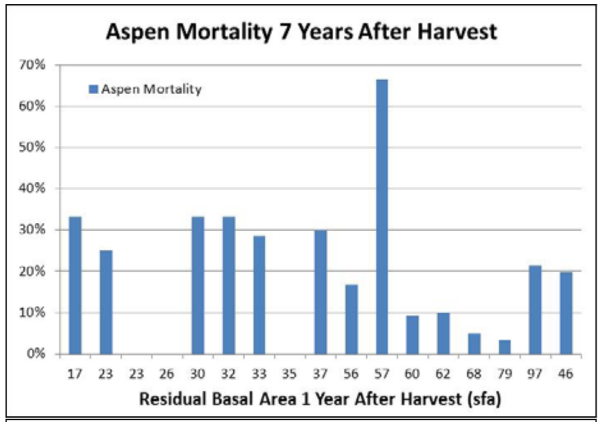

Figure 5. Mortality of retained aspen 7 years after harvest. Right column is average of all plots.

The variability in regeneration response to the harvest is indicative of the challenge of plot-level data collection in a stand treated with essentially a variable thinning harvest. The overstory conditions in the 1/10th acre plot may not be solely responsible for understory conditions in the 1/300th acre plot due to differing overstory conditions immediately adjacent to the 1/10th acre plot. Likewise, more time must pass to fully understand what is happening in the understory.

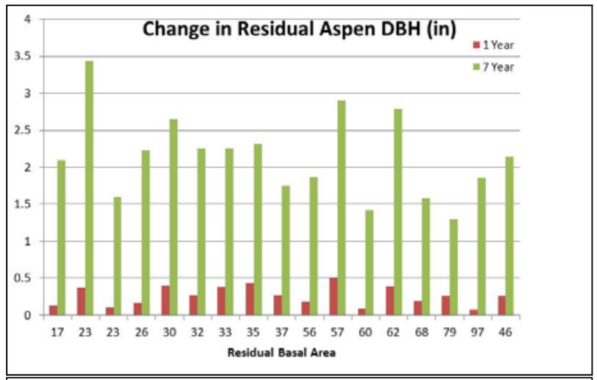

Figure 6. Change in dbh of retained aspen 1 and 7 years after harvest.

<u>Post-Harvest Aspen Condition</u>
Figure 5 shows the mortality of retained aspen 7 years after the harvest. Mortality ranged from 0 to 65% with the average mortality across all plots of 20%. Mortality was not correlated with post-harvest residual basal area. Figure 6 shows the change in average dbh of the retained aspen 1 and 7 years after harvest. All plots showed an increase in aspen diameter growth despite loss of some aspen. The change in diameter was also not correlated with post-harvest residual basal area. Figure 7 shows the standing post-harvest and accrued aspen volume 7 years after harvest. In this trial, the retained aspen shelterwood increased in both dbh and volume, suggesting that land managers should not necessarily assume thinnings or shelterwood-type harvests will result in loss of the retained aspen.

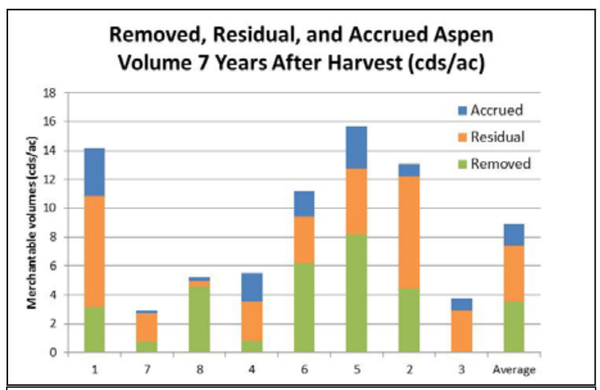

Figure 7. Aspen volume removed at harvest, retained at harvest, and accrued on retained trees since harvest.

Conclusion

The results of this trial suggest a shelterwood-type harvest is a viable option for aspen dominated stands in the Superior Clay Plain. Post-harvest regeneration was sufficient to meet stocking requirements of MFL and the retained aspen in the overstory continues to accrue in value 7 years after the initial harvest. The impact of the harvest on the type of regeneration, and thus, the future species composition and forest condition, was influenced by both existing conditions and intensity of tree removal, suggesting a site-specific approach to an aspen shelterwood, both in implementation, and compliance inspection, is a more viable approach than a uniform canopy coverage prescription. Such a harvest as implemented in this trial might better be characterized as a variable density transitional thinning harvest. Such a prescription would allow managers to implement site-specific adaptive management responsive to conditions at a 1/10th acre scale or less.

Considerations for Shelterwood Removal

In a shelterwood harvest, the retained overstory is typically removed 5-10 years after the initial harvest, but a removal decision must weigh the benefits of capturing the economic value against the damage likely to occur to the regeneration due to the re-entry. Another consideration is the type of regeneration. If the regeneration is primarily aspen sprouts than removing the overstory is necessary to release the aspen. Any damage to the regeneration would likely be off-set by new suckering caused by the overstory removal. If regeneration of shade-tolerant species has occurred, then damage to such seedlings and saplings would likely not be worth the overstory removal and could work against the goal of promoting stand succession by causing new aspen suckering. Perhaps a better follow-up prescription to an initial variable density transitional thinning harvest is a "shelterwood removal with reserves". This would allow the manager with the flexibility to remove the overstory based on understory conditions.

Future Work

Although trial suggests that a site-specific variable thinning approach to aspen management in the Superior Clay Plain is a viable option, additional research is needed. The next step would be to repeat the trial using a replicated block design where the 3 categories of aspen removal could be implemented on larger blocks of land with mensuration plots within each block. Specifically, the category 2 and 3 approach to aspen management needs to be evaluated at a larger scale and over a longer period of time.

Acknowledgements

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