Transitioning Conifer Plantations to Natural Forests – in Press
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Starting in the early 1900s, afforestation programs were developed in southern Ontario to stabilize land degraded by agriculture, restore natural and hydrologic functions, and generate timber revenue. These plantations have been generally managed by periodical thinning, with the eventual development of a natural understory/forest.

In southwestern Ontario, intermediate-tolerant species like oaks and natural eastern white pine (Pw) have suffered from high-grading or diameter-limit cutting in northern hardwood stands where dominant oaks and white pines were preferentially harvested. Ongoing health problems like spongy moth, oak decline, white pine blister rust and weevil, and regeneration challenges with the single-tree-selection system have contributed to their decline. Regenerating northern hardwood (NH) associates like oaks, white pine, and hickories is easier and more economical in plantations than in natural forests. Managing conifer plantations to encourage the regeneration of these species provides an excellent opportunity to increase their presence in the landscape.

Sugar maple and black cherry regeneration develops naturally in managed plantations as their wind- or bird-dispersed seeds establish as the canopy opens. However, oaks, hickories, and others require a nearby seed source. Under-represented species, often intermediate in shade tolerance, can be introduced after thinnings to provide opportunities for enhancement planting in gaps or under the thinned canopy.

The author has been successful for 25 years using a 3-year enhancement process to establish these species in gaps and the understory, centered around a thinning. It starts with stand assessment, tree marking, and invasive species control, followed by thinning and then enhancement planting in canopy gaps; repeat for subsequent thinnings. Enhancement plantings should occur just after a thinning, *before* competing shrubs dominate. This scenario can be adjusted based on plantation conditions, and landowner objectives and resources.

This process varies by plantation species, age, health, soil/site conditions, and successional dynamics as understory development differs among species and site conditions. Most soils in southwestern Ontario are glacial tills, windblown silts and sand, or water-deposited soils (sedimentary or lacustrine), with a relatively high pH because the parent materials are mostly limestone-based (Chapman and Putnam1951). Pw and Norway spruce (SN) are better adapted to higher pH soils and a wide variety of soil conditions, while red pine (Pr) and white spruce (Sw) do well in a narrower range of site conditions.. Successional dynamics are related to how well each species develops under partial canopy and site conditions with different dominant tree species and canopy closure characteristics (Taylor and Jones, 1986).

Underplanting in Pw plantations can start after a first thinning, ahead of often-dense establishment of elderberry and other shrubs or small trees as the stand often start to open up early because of mortality from blister rust. Thinning early is also important in Pw plantations to salvage better trees infected with blister rust and poorly-formed trees that have been attacked by white pine weevil.

The process in Pr plantations usually starts with a second or third thinning, as these plantations tend to have a higher stocking density and narrower diameter distribution because of a narrower genetic base. They also grow better on a narrower range of site conditions and on more acidic soils (lower pH). Decline problems with Pr often occur where there is shallow soil depth to free carbonates or other rooting limitations where soils were eroded from agriculture or there is poor drainage. Pr plantations are also more susceptible to stagnation if thinnings are delayed, and may decline or collapse from Pr pocket decline in tight spacings. If the health of a Pr plantation declines prematurely, plantings should start as soon as .

Norway spruce is a European species that does well on high pH soils over a wide range of site conditions, with a site index range about 15% higher than Pw. While some users don't prefer SN wood, planting success is very good, volume growth seems to be about 50% higher than Pw, and the stumpage price is about the same as other species in southern Ontario. Williams & Associates incorporates SN into most afforestation plantings, often because its fast growth enables earlier thinnings (Gordon et al, 1988,Williams and Gordon 1990).

Example layout for afforestation project

Mixed plantations have been planted in alternating rows, pairs or groups of rows, or by mixing a variety of species across the area. The author has developed plantation layouts that facilitate economical thinning and diversification by alternating one or more rows of fast-growing species like SN with rows of mixed-species that are desirable in a natural mixed forest (e.g., rows of white pine mixed with deciduous species (Figure 1).

The end goal of the process is to conduct commercial thinnings as early as feasible to foster the growth of mixed rows and underplanted seedlings. Near the planned maturity of the plantation, most of the SN would have been harvested, leaving a viable two- or multi-aged mixed stand of dominant Pw with other species.

Figure 1 shows an example layout for a 68-acre plantation, planted in 2011 on imperfectly to poorly-drained loamy soils. The layout considers planned thinning at ages 23, 35, and 50, removing rows of SN to release the Pw and mixed-species rows, while conducting improvement thinning on both sides of the harvested rows. Enhancement plantings could be started after the second or third thinning. depending on the arrangement of canopy gaps.

Figure 1. Planting and management strategy for 68 acres of hay field.

- 2 m spacing within rows, 2.5 m between rows.
- Row layout from field edge on left (S=SN M=Mixed species)
  Norway Spruce Rows – 65% of total seedlings planted
  Mixed Rows – 50% white pine
  23% Balsam Fir,
  12% red/silver maple & bur oak.
- Enhancement planting in openings from thinning, do not plant trees in travel rows.
- ***S*** - rows to remove
- ***T*** - Travel rows
- ***P*** - Enhancement plant in abandoned travel rows.

Planting year S S S M M S S S S S M M S S …

Thinning 1, Year 23 S S ***s*** M M S ***s*** S S ***s*** M M S S …

Remove Spruce row on 1 side of Mixed rows, 1 row from Spruce block, thin between as appropriate; consider planting in openings.

Thinning 2, Year 36 S S ***T*** M M S ***P*** S S ***T*** M M ***P*** S …

Remove row on other side of Mixed rows, thin between as appropriate, underplant openings in thinned parts; invasive control if necessary

Thinning 3, Year 50 S S ***T*** M M S _ S S ***T*** MM _ S …

Re-use the travel rows from year 36. Thin between as appropriate, underplant openings and abandoned travel rows and control invasives as necessary.

Literature Cited:

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