

Wisconsin Forest Tree Improvement Program 2006 Annual Report



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Introduction

The Wisconsin Department of Natural Resources' (WDNR) forest nursery program produced and distributed 14,800,000 tree seedlings in 2006, reforesting approximately 19,000 acres of public and private lands in Wisconsin. The use of genetically improved seed is an important part of this annual reforestation effort by ensuring that WDNR seedlings are well-adapted to Wisconsin growing conditions and have a high potential for survival and growth. The Wisconsin tree improvement program, through the long-term support of the state nurseries, continues to develop and manage seed orchards using a combination of parent tree and family selection, progeny testing, and selective breeding. First generation seed orchards currently are established for white pine, jack pine, red pine, white spruce, red oak, and black walnut. Second-generation seed orchards are established for jack pine.

Seed orchards are the primary mechanism used to produce genetically improved seed in quantities large enough to support nursery production. We continue to expand and develop our seed orchards for white pine, jack pine, red pine, white spruce, red oak, and black walnut (Table 1). Priorities for 2006 included completing a set of controlled pollinations at the Ladysmith jack pine breeding population currently owned by Plum Creek, collecting five year height measurements at the Lake Tomahawk white pine family test, and development of grafted (clonal) banks of black walnut and red oak. Our work continues to emphasize critical maintenance and intensive management of seed orchards to facilitate the production of greater quantities of improved seed.

Table 1. WDNR seed orchard acreage by species.

Species	Acreage	Counties with Major Orchards
Jack Pine	20	Rusk, Waushara, Wood
Red Pine	45	Iowa, Oneida, Wood
White Pine	52	Jackson, Oneida, Washburn
White Spruce	34	Marathon, Oneida, Washburn
Black Walnut	14	Crawford, Green
Red Oak	13	Crawford, Dane

This report highlights the 2006 program activities and accomplishments for our primary tree improvement species. Please feel free to contact the report's authors if you have any questions or comments.

2006 Program Highlights

Jack Pine

Selection and breeding for a third generation continued in four populations of jack pine growing at the Ten Mile Creek Seed Orchard (Wood Co.). Height measurements in conjunction with scores for incidence of pine-oak gall rust (*Cronartium quercuum*) were used to select superior trees for breeding using a polycross mating scheme to produce progeny for third generation populations. Controlled pollinations were completed in the spring of 2005, producing 352 cones from which 4,997 seeds were extracted this past fall. This completes the breeding for our third generation at the Ten Mile Creek 'index' populations. Three of the 80 families were not precocious enough to produce adequate seed and will need to be supplemented with open pollinated seed. Seed will be sown this winter in containers at the UW-Madison Walnut Street greenhouses.

The Black River State Forest planting site identified for establishing the third generation index populations was staked and cleared this summer. Due to the prolonged summer drought in the area, herbicide treatment of hardwood sprouts on this formerly forested site was not possible. The site will be treated in the summer of 2007 and a Fecon Bull Hog brush cutter will be used to grind all residual slash on the site in preparation for a spring 2008 planting.

The Ten Mile Creek index populations were thinned in 2006 following completion of breeding. Fifty percent of the planting (1700 trees) was removed to provide more space for crown expansion and facilitate development of a production seed orchard. Further thinning and pollarding of trees to control height growth will take place during the winter of 2007 and 2008.

Breeding efforts began in 2006 at the Ladysmith (Rusk County) second generation breeding population that is currently managed by Plum Creek Timber Company. Superior trees were selected based on year 2000 height measurements and a polycross mating scheme was used to produce progeny for third generation populations. Over 200 flowers were pollinated and early conelet counts indicate that all but one family had at least one successful cross. Pollinations will continue in 2007 focusing on trees that did not produce flowers for crosses in 2006.

Finally, six bushels of cones were harvested at the Greenwood second generation seed orchard (Waushara County) for use in the WDNR nurseries. Additional rogueing will take place at this site during the winter to improve spacing within the orchard.

Eastern White Pine

Information on the extent and patterning of genetic variation in Wisconsin's eastern white pine populations will be obtained from two provenance/family tests established during 2002-2003. Relatively little is known about the genetics of eastern white pine in the Lake States other than on blister rust tolerance/resistance. These tests were established to provide basic information on other variables, especially those related to growth rates, for this historically important species.



Figure 1. David Stevens removing bud caps from trees at the Lake Tomahawk white pine family test in Oneida County.

The Lake Tomahawk family test was measured for survival and fifth-year height during the fall of 2006. Both plantings were maintained by mowing through the growing season and bud caps were attached to all trees in the late fall to discourage deer browsing.

The short-term benefit of this research will be the identification of eastern white pine seed sources appropriate for reforestation efforts; the long-term benefits will be the development of two seedling seed orchards for future seed production and genetic resource conservation of Lake States white pine.

This was another poor seed year for white pine across northern Wisconsin. No cones were collected at the Sawyer Creek blister rust resistant orchard.

We have analyzed the data on early survival and third-year height for both of these plantings and can already observe patterns of variation related to provenance and planting location. For example, seed collected from populations in eastern Upper Peninsula Michigan (EUP) performed very poorly at the Lake Tomahawk site (Figure 2), as did several provenances from Minnesota. In general, the best performing families at Lake Tomahawk came from Wisconsin counties south and west of the planting site in Oneida County. At the Black River Falls site, EUP seed sources also fared poorly, as did some from Iron, Vilas and other northern Wisconsin counties (Figure 3). In general, the best performers at Black River Falls were those sources originating in Jackson, Monroe, Sauk and Burnett counties. Results after three years are inadequate for predicting long-term success, but these patterns are clearly different for north vs. central Wisconsin, suggesting that some care should be taken with the choice of eastern white pine seed source for reforestation even within Wisconsin.

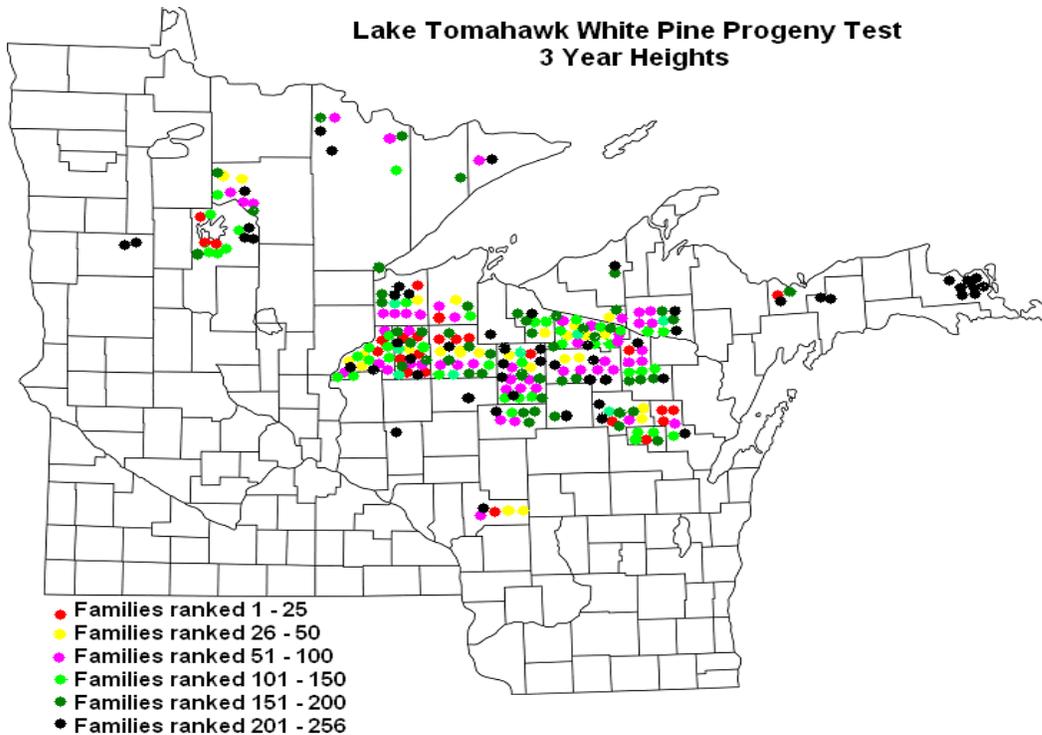


Figure 2. Ranking of EWP provenances (dots indicate origin) by height at three years of age at the Lake Tomahawk site (Oneida County).

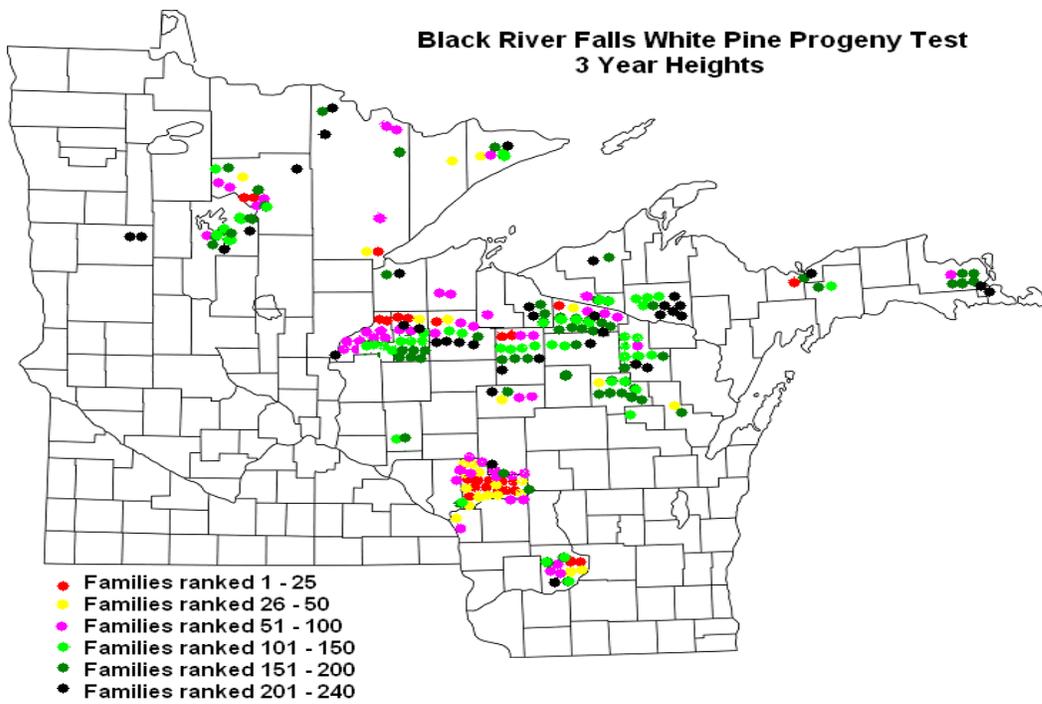


Figure 3. Ranking of EWP provenances (dots indicate origin) by height at three years of age at the Black River Falls site (Jackson County).

Red Pine

Three 15-acre seedling seed orchards consisting of 310 families from native Wisconsin stands were established in 1970 at Avoca (Iowa Co.), Lake Tomahawk (Oneida Co.), and Ten Mile Creek (Wood Co.). These seed orchards have been thinned twice using height data to retain the tallest families and best-formed trees for seed production.

The 'best' individuals from within the tallest 125 families at each orchard were identified during 2003-04 using diameter measurements (in lieu of height – the trees are now 60+ feet tall) and stem form ratings. These select trees are surveyed for flowering and cones each year at all three orchards, but cone production has been poor during recent years. Cones have been harvested from some trees in previous years, but no cones were harvested this year at any of the orchards. If available, seed will be collected from the remaining selections in 2007 and used to establish progeny tests and a second generation seed orchard.

The Avoca seed orchard was thinned in the spring of 2006 to improve crown development for increased flowering and cone production and to facilitate seed collection efforts. The other two orchards were thinned in 2004 and 2005.

White Spruce

White spruce tree improvement efforts continue to focus on the intensive management of seed orchards and evaluation of progeny tests in order to supply improved seed for WDNR nursery production. State funding was secured to build an improved greenhouse and propagation facility at the WDNR South Central Regional Headquarters in Fitchburg. This facility will greatly improve our ability to develop second generation grafted/clonal seed orchards. Greenhouse plans were developed this summer and construction should begin in 2007.

Seventeen-year height and diameter measurements for the 10-acre Sawyer Creek progeny test (Washburn Co.) were analyzed and ranked according to tree volume. This test contains selected materials from 168 different families throughout the Lake States region and the Ottawa Valley of Ontario, Canada. Superior parents identified in this analysis will be incorporated into the grafting program to expand clonal seed orchards. The progeny test will be marked and thinned this winter to retain only the 'best' individuals and families and to improve crown development for increased seed production.

The 6-acre Lake Tomahawk [Northern Highland-American Legion State Forest] seedling seed orchard established in 1969 was heavily defoliated by spruce budworm during 2004. Due to this defoliation, no cones were produced in 2005 and the overall health of the trees declined. The site was aerial sprayed with Bt (*Bacillus thuringiensis*) and Asana™ during the spring of 2005. The trees seem to have recovered nicely and appear healthy this year.

The 6-acre Mead Wildlife Area (Marathon County) seedling seed orchard was marked for thinning in 2004 based on 1997 height data. This orchard consists of 175 families representing materials from the Ottawa Valley and selections

from the Lake States region made by the USDA Forest Service. The shortest 30% of this population will be thinned out in 2007 to allow greater access into the orchard for future cone harvests as well as to improve crown development. The cone crop was excellent this fall and select tops were pollarded from heavy cone-bearing trees using a 40-foot lift truck and a power pole pruner. The tops were transported to the Griffith State Nursery in Wisconsin Rapids where workers removed 79 bushels of cones. In addition, 34 bushels of cones were picked by Hayward State Nursery staff at the Bean Brook white spruce orchard.

Black Walnut

Black Walnut remains a species of great importance to landowners and the forest products industry in southern Wisconsin. To date, our efforts have focused on identifying superior quality trees in natural stands and grafting scions from those trees into clonal seed orchards to facilitate testing and future breeding. Scion wood was collected during the winter from 7 trees originating in Grant and Jefferson (Wisconsin) counties as well as Putnam, Bureau and Whiteside (Illinois) counties. A total of 138 grafts were made at the UW-Madison Walnut Street greenhouses with 58 surviving to transplant. This marked a dramatic increase in the grafting success rate for our walnut program due to the incorporation of new black walnut grafting techniques acquired from the Hardwood Tree Improvement and Regeneration Center at Purdue University.

Thirteen grafted black walnuts originating from superior Wisconsin trees were planted in the seed orchard at Bell Center (Crawford County). These clones will be used for future seed production and genetic resource conservation of black walnut.

Red Oak

Seventy-nine grafted red oaks originating from superior Wisconsin trees were also planted in the orchard at Bell Center (Crawford County). These clones will be used for future seed production and genetic resource conservation of northern red oak.

Reforestation Issues

Reforestation Monitoring – Year 2

Last year we described a new reforestation and invasive species monitoring program being implemented by the state nursery program. Wisconsin landowners plant 20-30 million tree seedlings and spend an estimated \$10 million annually on reforestation practices. Despite this large investment in time and money, comparatively small efforts are made to monitor planting success. By monitoring tree plantings each year, we will be able to look at long-term trends, detect problems early, and improve reforestation methods. Beginning in 2006, a portion of reforestation plantings on private, industrial, state, and county lands were surveyed to determine stocking levels, survival, growth, the extent of weed competition, the success of different planting techniques, the incidence of insects and diseases, and the presence of invasive species. Ultimately, data from the monitoring will be used to determine the reasons for planting success or failure. In 2006, our initial pilot surveys

inventoried 27 sites in 9 counties. The mean survival rate in southwestern Wisconsin was 81% for conifer plantings and 76% for mixed hardwood/conifer plantings. However, the mean survival of conifer plantings in northwestern Wisconsin was only 69%. This difference was attributed to the regional summer drought that continued across northern Wisconsin during 2006. The two most common planting mistakes identified by survey crews were planting conifers too deep and excessive pruning of roots.



Figure 4. Richland County mixed hardwood-conifer plantation. Note the heavily browsed hardwood seedlings located between the conifer rows.

In addition to these monitoring efforts, we also conducted a special survey of 11-16 year old hardwood plantations established on private lands under the Conservation Reserve Program (CRP). A total of 57 mixed hardwood-conifer plantings in 8 counties established between 1990 and 1995 were surveyed during 2006 for survival, height growth, and deer browse. Survival of both conifers and hardwoods was highly variable resulting in residual tree densities between zero and 646 trees per acre (Figure 4). Significant deer browse damage was observed at many sites, especially on red oak

(Figure 5), while some other species showed little or no evidence of browse damage. Since these trees were already 11-16 years old, it is possible that browse did occur in some of these plantings at younger ages, contributing to early mortality, but our data does not provide evidence for this.

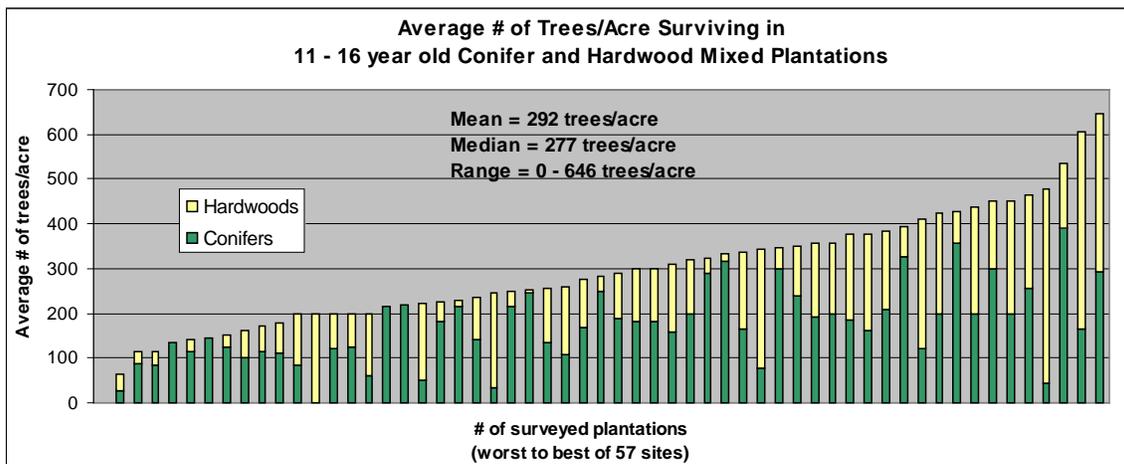


Figure 5. Average number of trees/acre surviving in 57 conifer and hardwood mixed plantations in the Conservation Reserve Program.

In mixed conifer-hardwood plantings, preferential browsing seemed to retard hardwood growth thereby enabling conifers to become dominant. These plantings were not established to test such a hypothesis, but the overall success of conifers relative to hardwoods in many plantings suggests this sequence of events. A study that monitored several mixed plantings during their early development would be required to document the selective impact of browsing on the success of conifers in such mixed plantings. As deer populations continue at high levels across the state, effective deer control measures will be critical for successful hardwood reforestation.

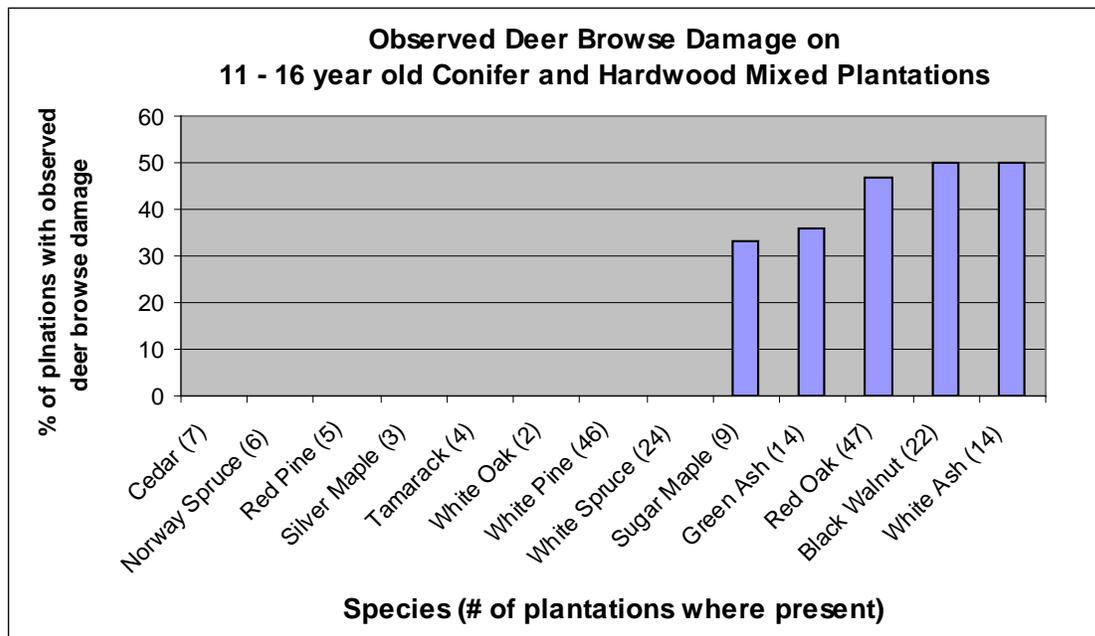


Figure 6. Percent of planting sites with observed deer browse damage, by species, on 11-16 year old conifer and hardwood mixed plantations.

Summary of 2006 Program Activities

Jack Pine

- Completed 205 controlled pollinations at the Ladysmith (Rusk County) 2nd generation breeding population.
- Harvested 352 cones containing 4997 seeds from the 2005 controlled crosses at Ten Mile Creek (Wood County) 2nd generation index populations.
- Removed 1700 trees from the Ten Mile Creek 2nd generation index populations to promote crown development and seed production. Completed chipping of all trees and surrounding volunteer vegetation.
- Staked and continued clearing site for 3rd generation index populations on the Black River State Forest.
- Sprayed Ten Mile Creek index populations with Asana™ to control jack pine budworm outbreak. Conducted egg mass survey in fall of 2006.
- Harvested 6.3 bushels of cones from Greenwood 2nd generation seed orchard.

White Pine

- Maintained 14-acre family test at the Lake Tomahawk seed orchard complex and 10-acre family test on the Black River State Forest. Maintenance activities included removal of 2005 bud caps and application of 2006 bud caps. Each site was mowed to reduce grass competition and rodent damage.
- Measured five-year height and survival at the Lake Tomahawk family test. Analyzed data to identify family differences.
- Mowed Sawyer Creek blister rust resistant seed orchard – Hayward staff.

Red Pine

- Commercially thinned Avoca seed orchard and chipped slash.
- Completed chipping of slash and volunteer vegetation at Ten Mile seed orchard.
- Completed pedigree database.

White Spruce

- Mowed 6-acre Lake Tomahawk seedling seed orchard to remove invading volunteer vegetation.
- Completed white spruce provenance database.
- Harvested 79 bushels of cones from Mead seed orchard and 34 bushels from Bean Brook seed orchard.
- Investigated commercial thinning options for Sawyer Creek seed orchard.

Red Oak and Black Walnut

- Out-planted 79 red oak and 13 black walnut grafts at the Bell Center seed orchard.
- Expanded deer fence around Bell Center planting to provide protection to another 172 grafts.
- Mowed Deansville Wildlife Area and Bell Center seed orchards.
- Produced 58 grafted black walnut trees from 7 superior parent trees.
- Controlled weed competition and applied tree wrap at Bell Center seed orchard.
- Staked planting site for cooperative grafted walnut study with the Hardwood Tree Improvement and Regeneration Center at Purdue University.

Miscellaneous

- Conducted pilot reforestation monitoring survey of 27 newly planted sites in 9 counties on private, industrial, state, and county lands.
- Conducted survey of 11-16 year old hardwood plantations established on private lands under the Conservation Reserve Program (CRP). A total of 57 mixed hardwood-conifer plantings in 8 counties were surveyed during 2006 for survival, height growth, and deer browse.
- Ray Guries presented an update on Wisconsin tree improvement at the 3rd Conference of the Northern Forest Genetics Association.