Wisconsin's Reforestation Programs
2012 Annual Report

Wisconsin Department of Natural Resources
State Forest Nursery Program and
Forest Genetics Program

and

University of Wisconsin-Madison
Department of Forest and Wildlife Ecology

Forest Genetics and Tree Improvement Program

Raymond P. Guries[1], Professor Emeritus, David Stevens[1], Tree Improvement Specialist, Kristin Peterson[2], Tree Improvement Program Assistant, and James K. Warren[3], Section Chief - Public Lands and Conservation Services

Nursery Program

Jim Storandt[4], Nursery Superintendent, Joe Vande Hey[5], Nursery Superintendent, and Pat Murphy[6], Nursery Team Leader

Reforestation Monitoring

[4]Jeremiah Auer, Assistant Nursery Manager and [5]Roger Bohringer, Assistant Nursery Manager

[1]Department of Forest and Wildlife Ecology,
University of Wisconsin – Madison
1630 Linden Drive, Madison, WI 53706

[2]Wisconsin Department of Natural Resources
3911 Fish Hatchery Road, Fitchburg, WI 53711

[3]Wisconsin Department of Natural Resources
101 S Webster Street, Madison, WI 53703

[4]Wisconsin Department of Natural Resources
473 Griffith Avenue, Wisconsin Rapids, WI 54494

[5]Wisconsin Department of Natural Resources
5350 Highway 133 E, Boscobel, WI 53805

[6]Wisconsin Department of Natural Resources
1300 W Clairemont Avenue, Eau Claire, WI, 54701

Introduction

The Wisconsin Department of Natural Resources' (WDNR) reforestation efforts consist of three linked programs; 1) the Tree Improvement Program, a WDNR collaboration with the U.W. - Madison Department of Forest and Wildlife Ecology which works to ensure WDNR tree seedlings are well adapted to Wisconsin growing conditions and have a high potential for survival and growth; 2) the State Forest Nursery Program which produces and ships native forest tree seedlings for reforestation projects from facilities in Boscobel, Wisconsin Rapids and Hayward to customers throughout Wisconsin; and 3) the Reforestation Monitoring Program which monitors out-planted seedlings to assess seedling survival, growth, and long-term health.

2012 Tree Improvement Program Highlights

The Wisconsin Forest Tree Improvement Program, with the long-term support of the state forest nurseries, continues to develop and manage tree 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 and third-generation seed orchards are established for jack pine.

Work on priority assignments completed during 2012 included 10-year measurements for height and blister rust incidence for the 240-family Black River Falls white pine progeny test, completion of 10-year height measurements for the 256-family Lake Tomahawk white pine progeny test, production of 46 grafted black walnut trees from superior wild selections, corrective pruning at the 80-family Black River Falls jack pine progeny test, and harvesting of 25 bushels of improved jack pine seed from the Ten Mile Creek 2nd -generation seed orchard. The program also continues to monitor seed orchards and progeny tests and collect data on variation in tolerance and resistance to various pathogens.

Seed orchards are the principle technology 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, black walnut, and butternut production (Table 1). Our work also emphasizes the critical maintenance and intensive management of seed orchards to facilitate the production of greater quantities of improved seed.

Species	Acreage	Counties with Major Orchards
Jack Pine	25	Jackson, 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, Grant, Green
Butternut	1	Crawford

Table 1. WDNR Genetics Plantings Acreage by Species

This report highlights the 2012 program activities and accomplishments for our principal tree improvement species. Please feel free to contact program staff if you have any questions or comments.

Jack Pine

Jack pine (*Pinus banksiana*) is one of the most widely-distributed conifers in Wisconsin and is the third most popular (by nursery sales) tree species produced by the DNR State Nursery Program. The species is characterized by large amounts of genetic variation for characters such as growth rate, stem form, and wood specific gravity. Opportunities for genetic improvement in these traits are exceptional as jack pine has a precocious flowering habit, produces regular cone crops, and is adapted to a wide range of sites.

Figure 1. **Black River Falls 3rd-generation jack pine selection/breeding population, July 2012 – 15 months after planting**
(Photo by Todd Lanigan, WDNR)

Black River Falls selection populations

The two-year-old, 80-family 3rd-generation jack pine selection and breeding population in the Black River State Forest (Jackson County) was monitored for insect, disease, and water stress throughout the growing season (Figure 1). On the whole, trees held up well, but the stress of this year's drought did take a toll, leading to 8% mortality within the 3200-tree planting. While water stress was the primary culprit, secondary stressors included redheaded pine sawfly, white grub root feeding, white pine tip weevil, and armillaria root disease. A one-time corrective pruning was also performed during the summer to encourage single leader development.

Ten Mile II breeding population

The Ten Mile II 2nd-generation jack pine population (Wood County) was thinned to seed orchard spacing in 2009, leaving only superior individuals from each of the 80 families while allowing more growing space for increased cone production and minimizing competition. In order to better facilitate future cone collection within the orchard, Tree

Improvement staff, along with Griffith State Nursery personnel, pollarded trees by removing the upper 1/3 from tree crowns within the orchard between 2009 and 2012. The removal of this portion of the tree forces flower production lower in the crown and makes the cones easier to access from the ground. The final 250 trees in the orchard were topped in 2012. Subsequently, staff collected 25 bushels of cones from the orchard which will be used to produce improved jack pine seedlings at the state nurseries beginning in 2014. The following is a summary of the jack pine tree improvement program and our expectations for the progeny derived from this planting.

Ten Mile II progeny-expected genetic gain

As part of a long-term genetic improvement program, in 1980, the Wisconsin Department of Natural Resources (WDNR), University of Wisconsin-Madison, and the USDA-Forest Service in Rhinelander, Wisconsin established a set of four jack pine research and breeding populations at the University's Hancock Research Station (Waushara County) for studies to guide tree improvement efforts. Each population contained 20 families drawn from wild jack pine seed sources in Wisconsin, Minnesota, and Michigan. In this context, a 'family' represents the progeny from a single wild tree. These 80 families (four populations) were planted in a fashion that permitted analysis of the degree of genetic control for various growth and yield properties. Populations were color coded (e.g., Green, Red, Yellow, Purple), and measurements were made for various metric traits (e.g., height) at 3, 6, 8, and 11 years of age.

In 1996, a 2nd-generation set of populations was created using controlled crosses between select individuals from within many of the families based on these measurements. These new progeny were planted at the Ten Mile Creek Seed Orchard Complex (Wood County). This planting, dubbed Ten Mile Creek II, repeated the original Hancock Station design and retained the color-coded population names. Tree height, stem form, and pine-oak gall rust (*Cronartium quercuum*) incidence data were collected at 3, 5, and 9 years of age. Data from the Yellow Population is used as an example here, but differences between 'average' and 'select' trees are shown for all populations (Figure 2).

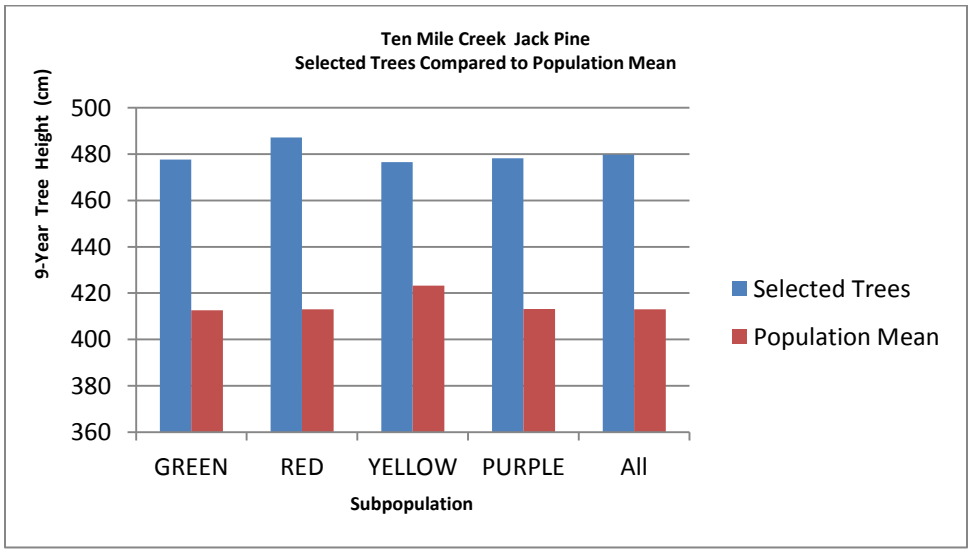


Figure 2. The average height of the residual trees in the Ten Mile Creek populations is about 20% greater than that of the original (unthinned) populations. As noted in the text, in order to improve stem form and gall rust tolerance, we retained some trees that were not among the tallest; this will reduce average height growth from its maximum possible value, but improve stem form and gall rust tolerance.

The Ten Mile Creek populations were recently converted to a seed orchard to produce improved jack pine seed. We expect seed from the Ten Mile Creek trees to produce trees 12-15% taller on average than nursery-run jack pine (Figure 2). This is less than the 20% difference in height shown above because we did not retain only the tallest trees (explained below), and the inheritance of height growth between generations is not perfect. While height growth and diameter growth are highly correlated, we expect total stem volume for trees grown from this seed to average more than 20% greater than nursery-run trees.

It is important to understand that two goals guide our jack pine improvement efforts: (1) that an increment of genetic improvement is achieved each generation; and (2) that genetic diversity be maintained to provide flexibility for future improvement as well as to ensure adaptability for future management decisions along with changing environments. Several breeding strategies were considered for our jack pine program, and 'within family selection' (making controlled crosses using the 'best' individuals from within each family) was chosen as the best strategy to satisfy our dual goals of achieving genetic improvement while maintaining flexibility for future efforts.

By age nine at Ten Mile Creek, the tallest trees in all families were greater than five meters tall, with large differences within and between families (Figure 3). Using height, stem form, and pine-oak gall rust incidence data, the 'best' individuals within each family were identified for breeding a third generation (established in 2011 at the Black River State Forest). Parents used emphasized growth rate; this represents a 'trade-off' of accepting slightly less improvement in height in any one generation in order to achieve some improvement for stem form and gall rust incidence. These latter traits are not as strongly controlled genetically, and we are limited in our ability to evaluate differences in gall rust tolerance where we rely on natural inoculation for screening.

These Ten Mile Creek data were also used to remove the poorest performing trees within each family (Figure 4) to convert the populations to a seed orchard for meeting some of the WDNR State Nursery Program's demand for improved jack pine seed. In all, 74% of the trees were removed (shortest trees, plus those with poor form and higher levels of gall rust) leaving a planting that can be managed for seed production into the future.

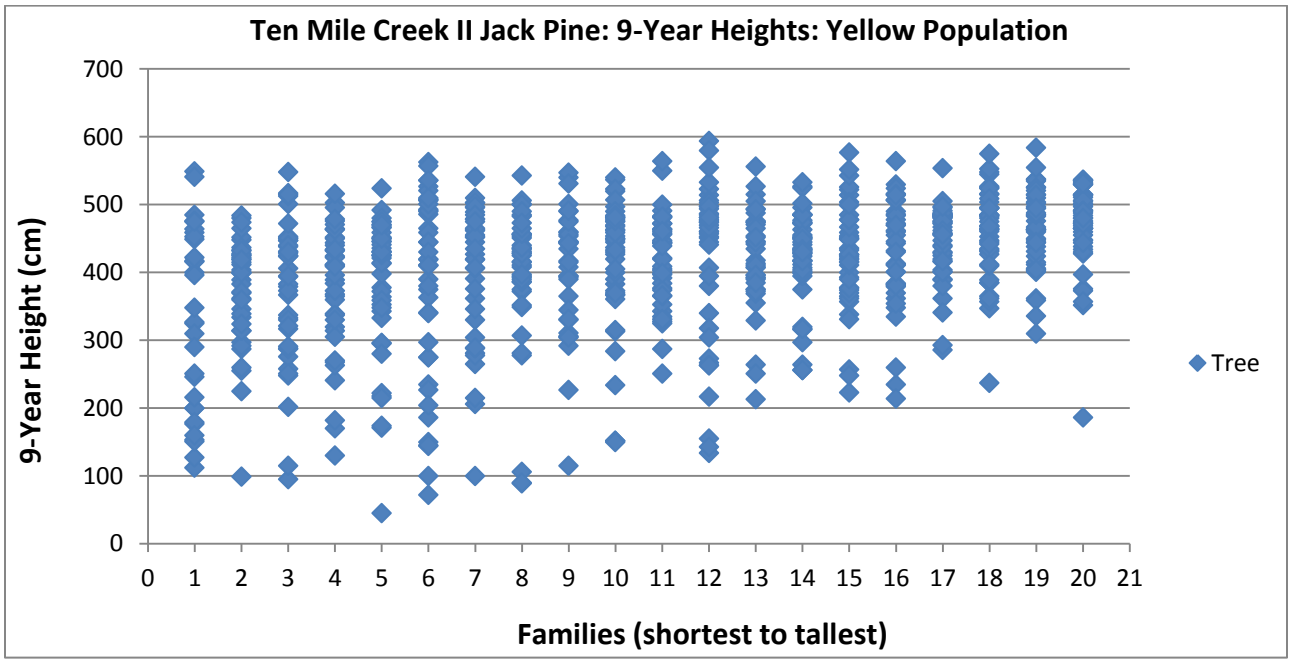


Figure 3. Distribution of individual tree heights for 20 jack pine families ranked from shortest to tallest at nine years of age. Note that even the shortest family (far left) has some individuals that are taller than many trees in the tallest families; this is one reason for using 'within family selection' with jack pine. Differences in height within each family are due to genetic factors affecting tree height, but also gall rust tolerance and stem form.

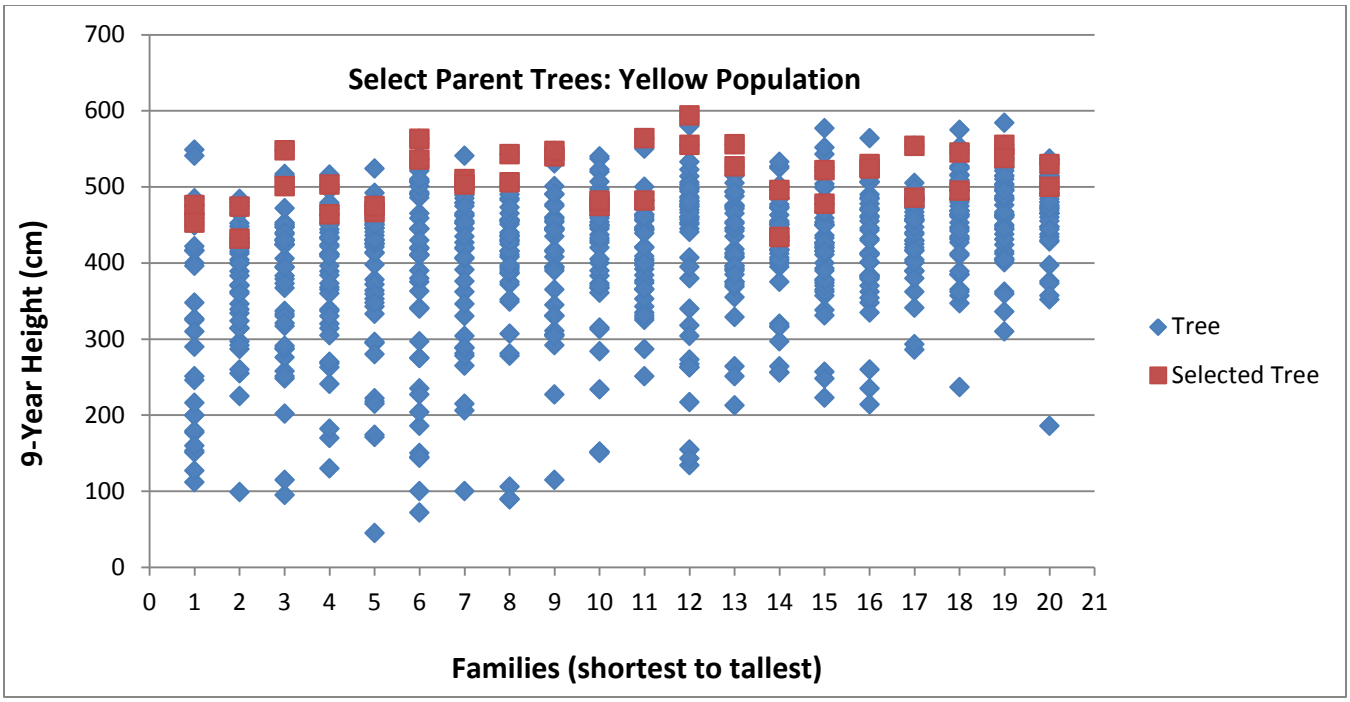


Figure 4. Same data as Figure 3, but red-colored squares indicate the trees within each family used as breeding parents for third generation. Note that these are not always the tallest trees – some tall trees had poor form, or a high incidence of gall rust, or no flowers. The substitution of other parents improved form and rust scores, but lowered the expected genetic improvement for height growth.

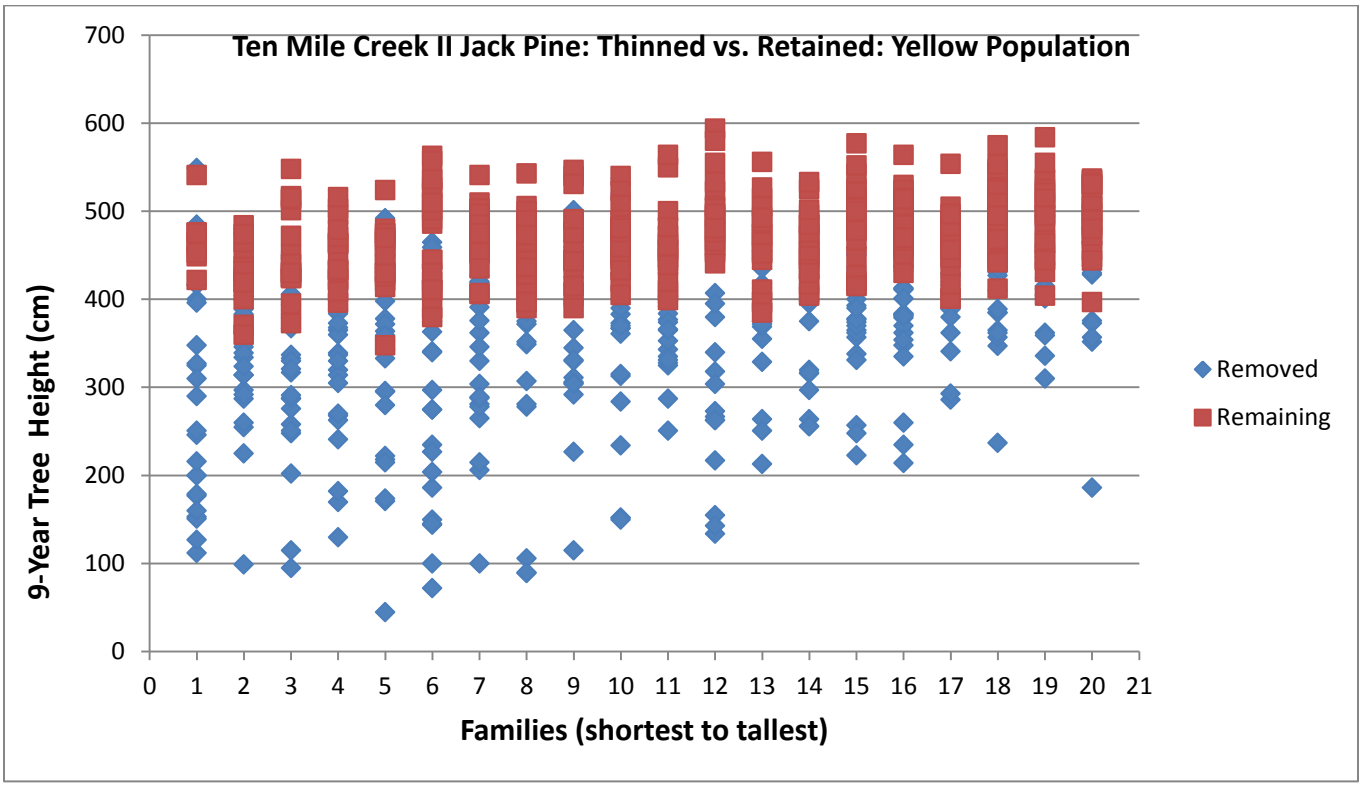


Figure 5. Same data as Figures 3 and 4; red squares identify the trees that were retained in the population when it was converted to a seed orchard following completion of breeding. Approximately 26% of the original population remains to produce seed. Note that thinning was heaviest in the shorter families.

Ten Mile III breeding population

This planting was established in 1999 (Wood County) and contains 2nd-generation trees from 20 families originating from controlled crosses made in two different Wisconsin breeding populations composed of trees drawn from the western Great Lakes states.

Using selection criteria based on superior tree growth, tolerance/resistance to pine-oak gall rust, and better stem form, superior parent trees were selected from each family and controlled crosses were started in 2009. During the summer, the final thirty-five controlled crosses were harvested and the seed extracted. The seeds from these and previous crosses will be used to generate a genetically-enhanced 3rd-generation breeding population.

Eastern White Pine

Lake Tomahawk test planting

Ten-year height re-measurements were completed in the early spring for the 15-acre, (10,000 tree) eastern white pine (*Pinus strobus*) family test planting located on the Northern Highland-American Legion State Forest near Lake Tomahawk, WI (Oneida Co.). The planting is composed of 256 unique families from Wisconsin, Minnesota, and the upper peninsula of Michigan. Widespread damage to tree leaders by white pine weevil (*Pissodes strobe)* has resulted in multi-leader trees and diminished overall heights. In spite of this, significant genetic growth rate differences were noted amongst families. The results are still being analyzed and will serve as a basis for thinning the planting beginning in 2013.

Black River Falls test planting

In 2003, a southern Wisconsin "sister planting" to the Lake Tomahawk planting was established on the Black River State Forest (Jackson County). Slightly smaller in size at ten acres, it is composed of 8000 trees from 240 unique families from Wisconsin, Minnesota, and the upper peninsula of Michigan.

Figure 6. **White pine blister rust at the Black River Falls white pine test planting, Spring 2012 (Photo by David Stevens, UW-Madison)**

In the spring of 2012, the planting was surveyed for white pine blister rust *(Cronartium ribicola)* by Tree Improvement staff with assistance from WDNR West Central Region forest pest specialist, Todd Lanigan. The trees were scored using a 0 to 4 scale (0 - no rust, 1 - one stem canker, 2 - two to three branch cankers, 3 – at least one stem canker and/or more than 3 branch cankers, 4 - mortality putatively associated with blister rust due to

stem cankers). The planting is naturally infected by basidiospores (Figure 6) from resident gooseberries (*Ribes sp.*) found in and around the planting, thus allowing an inherent non-uniformity to inoculation pressure within the planting. Despite this, significant differences in susceptibility were noted among families and overall infection rates have increased since the previous rating in 2010. Most families continue to show low to moderate infection rates with the planting average for families being 14% compared to 10% in 2010. Thirty-two families (13% of the planting) had an infection rate of 25% or higher, with three of those being above 50%. On the flip side, nineteen families (8% of the planting) continue to show no rust.

In the fall of 2012, 10-year height measurements were taken at this planting. Similar to the Lake Tomahawk planting, large scale white pine weevil feeding was noted throughout the planting, again resulting in multi-leader trees and diminished overall heights. The data will be analyzed and compared to earlier measurements that indicated significant regional and stand differences in juvenile growth rate; the current measurements will be used to substantiate genetic differences and serve as a basis for thinning the planting.

Red Pine

Three red pine (*Pinus resinosa*) 15-acre seedling seed orchards consisting of 310 families from native Wisconsin stands were established in 1970 at Avoca (Iowa County), Lake Tomahawk (Oneida County), and Ten Mile Creek (Wood County). These seed orchards were thinned in 1980 and again between 2004 and 2006 to retain the tallest families and best-formed trees for seed production.

In order to create a second-generation red pine seed orchard, the 'best' individuals from within the tallest 125 families at each orchard were identified during 2003-04. Between 2004 and 2009, open-pollinated cones were harvested from these trees as they became available. Over 18,000 seed from these collections, representing 185 families, were surface sterilized and placed into cold stratification in late November in preparation for greenhouse seeding in January of 2013. Plants generated from these seeds will be used to create a second-generation seed orchard to be sited at the DNR's Hayward State Nursery facility in 2014. This orchard will require intensive management, especially with respect to spacing, if it is to be productive.

White Spruce

White spruce (*Picea glauca*) 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. One important management practice in white spruce seed orchards is thinning to make the orchard more accessible for future machine-aided cone harvests. During the summer, thinning of the Mead Wildlife Area (Marathon County) orchard was resumed to take advantage of a modest cone crop. Tree Improvement staff mowed the orchard to remove encroaching understory woody invasives. Then, with the help of Griffith State Nursery staff, 39 previously marked trees were harvested from the orchard and five bushels of cones were collected from the downed trees to provide seed for use by the state nursery system.

Black Walnut

Black Walnut (*Juglans nigra*) remains a species of great importance to landowners and the forest products industry in southern Wisconsin. The black walnut resource in Wisconsin is estimated at 350 million board feet of saw timber, with an estimated value of more than $436 million (2010 dollars). To date, our efforts have focused on identifying superior quality trees in natural stands and grafting scion wood from those trees into clonal seed orchards. During the winter, forty-six successful grafts were propagated from eight superior trees originating in Wisconsin. These grafts will be added to the seven-acre Bell Center (Crawford County) clonal seed orchard in the spring of 2013.

Thousand Canker Disease (TCD) is a newly recognized disease complex caused by the combined activity of the fungus (*Geosmithia morbida*) and the walnut twig beetle (*Pityophthorus juglandis*) insect vector. Fungal spores are introduced into the tree by the beetles and subsequently cause canker development in the inner bark, which disrupts the flow of nutrients throughout the tree, eventually killing it. TCD has become endemic throughout the Western U.S. over the last decade and has now been found to be killing walnut in four eastern states (TN, NC, VA, and PA). To date, TCD has not been found in Wisconsin, however, both black walnut and butternut (*J. cinerea*) are susceptible.

A collaboration with the USDA-Forest Service was initiated in the late summer to study potential differences in TCD response among regional black walnut populations. As part of the study, Tree Improvement staff identified and collected seed from wild trees in five counties across the state. The seed will be used as part of a range-wide collection of black walnut families that will be screened to estimate genetic and geographic variation in TCD resistance. Once propagated, the subsequent trees will be planted out in three common garden plots in the southern, central, and northern portion of black walnut's range. It is hoped that the plantings will also demonstrate the impact of projected future climate change on black walnut's TCD resistance and ideally provide sources with identified TCD resistance to breed locally-adapted seed stock in the future.

Butternut

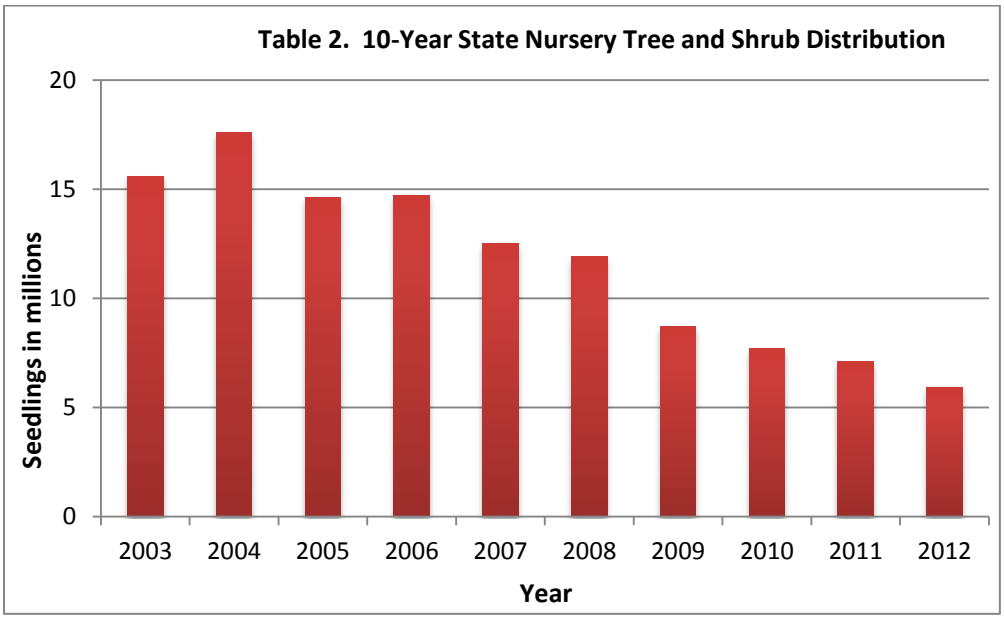
Butternut (*Juglans cinerea*), a close relative to black walnut and often referred to as white walnut, has been slowly dying off in Wisconsin since the exotic butternut canker disease (*Ophiognomonia clavigignenti-juglandacearum)* was first reported in the state in 1967. Trees infected with the fungus develop branch and stem cankers that eventually girdle and kill the tree. A native Wisconsin tree, butternut is found throughout the state, with the exception of the northern-most counties, and is prized for its quality lumber as well as its nuts for both wildlife and human consumption.

Beginning in the 1980's, an increasing number of disease-free trees have been identified growing alongside infected trees throughout the species range. While tolerance or resistance to the disease has yet to be confirmed, putative disease-free trees from infected areas have been screened and indicate there is a wide phenotypic variation in susceptibility to the disease. Along with this, recent studies have shown that there is a high level of genetic diversity present within butternut across its range. In an effort to conserve and propagate these potentially resistant trees, the Tree Improvement Program has partnered with the USDA-Forest Service to establish a butternut genetic conservation project. The Forest Service has provided both grafted clones and seedling progeny from disease-free Wisconsin selections to establish a seed orchard to study resistance. Forty-one additional grafted butternut from 12 Wisconsin selections were obtained from the USDA-Forest Service Oconto River Seed Orchard in the fall of 2012. These will be combined with previously received grafted clones to establish a one-acre conservation planting on the Hayward State Nursery property in the spring of 2013.

2012 Nursery Program Highlights

The state nursery program is proud to consistently produce high quality, well-adapted tree and shrub seedlings for the entire state. In 2012, the Wisconsin State Nursery Program distributed a total of 5,892,667 bare-root seedlings and shrubs (1,600,336,718 since its inception in 1911) to 2472 customers. Approximately 78% of the distribution total consisted of conifers with the balance made up of hardwoods and shrubs. Of the paid orders, 70% were distributed to private landowners followed by 21% to county forests.[1]

The 10-year trend (Table 2) for nursery distribution shows a continuing decline in trees and shrubs sent to customers. Factors affecting this decline include a general downturn in the economy, agricultural commodity price increases leading to land remaining in agricultural production, taxes on recreational land, changes in large (industrial) land ownerships across the state, county forest partners shifting to containerized stock from other sources, and declines in cost sharing programs that reduce incentives to plant trees.



Overall stock quality remains high. Since 2006, all three nurseries, in cooperation with forest health staff, have monitored red pine nursery stock for the fungus, *Diplodia pinea,* and have tested asymptomatic seedlings from each nursery for this pathogen. Management practices, including pesticide applications, remain in place with results influencing stock inventories available for sale from beds with less than a 10% infection rate. Infection rates appear to be related to local weather conditions, specifically humidity, temperature, and wind, during aeciospore dissemination.

Overall seed collection was successful in 2012. Seed purchases were made for balsam fir, jack and red pine, basswood, white birch, butternut, black cherry, walnut, sugar maple, shagbark hickory, oak (bur, red, swamp white, and white), and plum. Special collection emphasis was placed on black cherry and also on jack pine. Demand for jack pine seed for direct seeding applications continues to out-pace supply so we will continue to purchase seed of this species in the foreseeable future.

[1] Data source: State Nursery Tree Distribution & Tree Planting Report 2012, DNR

Griffith Nursery

This was a very unusual spring lifting season with unseasonably warm weather in March. The lifting start date was the earliest ever in Wisconsin Rapids, beginning on March 21st, with all beds frost-free at that time. Temperatures were in the 70's and 80's for a two-week period in March, resulting in hardwood bud break and early bud elongation. The warm temperatures also accelerated seed germination by at least three weeks earlier than normal. This early germination was problematic for several species (sugar maple, black cherry, basswood, silky dogwood, and red osier dogwood) leaving them susceptible to cold damage from subsequent spring frosts. Irrigation was used for frost protection on approximately six nights to minimize damage. Losses were minimal with the exception of some loss in newly germinated basswood and sugar maple seedlings.

Following this unseasonable warm period, temperatures cooled, slowing plant development and allowing stock to be lifted in good condition. Lifting was completed by April 9th which is about the normal start date for lifting. Following the lifting season, a contract applicator applied 70 tons of dolomitic lime to nursery fields in order to adjust the soil pH. The application went smoothly and was completed in roughly two hours. Fertilizer was also applied to the fields by nursery technicians whose ingenuity resulted in combining two 4' fertilizer spreaders onto one tool bar, allowing two rows to be fertilized in one pass. This improvised unit is a marked improvement over the previously used10' spreader which only treated one row per pass and whose clearance was too low to be used on older, taller seedlings. The technicians responsible for this adaptation are to be commended for their efforts.

The unseasonably warm spring was followed by a very hot, dry June and July which required almost daily irrigation to maintain stock vigor and growth. Unfortunately, five and six-year-old white cedar windbreaks in the nursery fell outside of the irrigation's reach and did not survive the summer conditions. They will be replaced in 2013.

The warm, early spring and subsequent summer heat also advanced seed maturation dates leading to early seed collection. Black cherry seed were available as early as August 3rd and white spruce cone started to mature as early as August 6th. The acorn crop was good in southern Wisconsin for bur and white oak while the central and northern portions of the state had a strong red oak crop. Acorns dropped about two weeks earlier than in an average year, and seed quotas were met on all oaks.

During 2012, Griffith State Nursery fumigated seven acres of new seedbeds with Metam Sodium for the first time. Metam Sodium is being looked at as a replacement for Methyl bromide whose use is being phased out by the nursery program. Metam Sodium is widely used in the potato industry and breaks down quickly in soil, making its use appropriate for many soil fumigation situations. The cost for the contracted application of Metam Sodium in place of Methyl bromide reduced Griffith Nursery's fumigation costs by approximately $20,000. The effectiveness of the chemical will be evaluated during the 2013 growing season.

On September 10th and 11th, Griffith Nursery hosted an Artificial Regeneration training session for a group of 23 foresters. The training session was a success and received positive evaluations from attendees. Other training at the nursery included Worker Protection training for three new seasonal workers.

Fall seeding was completed on approximately eight acres of seedbeds by October 11th. The seeding is expected to yield about five million bare-root seedlings.

Over the course of the summer and fall, nursery staff completed work on 12 tree planting machines brought in from various counties throughout the state. The nursery staff sand blasted, painted, repaired, and replaced worn parts on these machines. The outcome represents a positive effort for both the county programs and the nursery program. This effort is expected to continue into 2013.

Wilson Nursery

The year started off with a much warmer than average March that allowed the Wilson State Nursery to begin lifting nursery stock on March 14th. This is the second earliest start date in the nursery's history. The warm weather induced early bud elongation in the conifers and bud break in the hardwoods, making it challenging for the crews to lift and ship nursery stock while still dormant. By the last week of March, the weather cooled and gave the crews some much-needed relief. The majority of lifting was completed by April 5th.

Wilson Nursery again partnered with the Department of Corrections – Secure Program facility to grade and package seedlings. Roughly 25% of the nursery's stock was graded at the facility along with the packaging of 7,500 seedlings for distribution at a Milwaukee Brewer's baseball game as part of Green Week.

The warm spring weather also caused early germination in seedbeds. High bush cranberry was the earliest germinant, emerging on March 12th; this was followed by sugar maple, basswood, and jack pine the week of March 19th. Most species germinated two to three weeks ahead of normal. The return to seasonal conditions in April brought night-time temperatures well below freezing, requiring irrigation in an attempt to protect nursery stock from freezing. While most of the crop was uninjured, our basswood seedling crop was lost entirely and sugar maple and high bush cranberry have struggled to recover.

The warm spring weather also necessitated earlier weed suppression efforts. Nursery beds without ground cover were all successfully sprayed with pre-emergent herbicides prior to weed emergence. Beds with winter ground cover were treated prior to seedling emergence to minimize competition. The use of a winter ground cover was successful in controlling early germinating weeds while protecting seedbeds over winter.

The Wilson Nursery distributed approximately 4,300 larger bare root transplants to the State Park System as well as to other DNR properties. These larger stems are generally utilized in high foot traffic areas such as camp grounds, day use and parking areas where they tend to survive better than seedlings. This program is expected to grow over the next few years as the State Nursery Program partners with the State Park System in an effort to proactively maintain park tree canopies in the wake of increased tree mortality due to the spread of emerald ash bore and other invasive forest pests.

This year, the nursery also partnered with the USDA-Forest Service on an American elm project designed to introduce Dutch Elm Disease (DED) tolerance/resistance genes into native elm populations. Seed was collected from putative disease resistant trees of American elm and supplied to the Wilson Nursery. Once the stock is grown to the desired seedling size, it will be distributed to partners in the Minnesota, Iowa, and Wisconsin DNRs, along with the U.S. Army Corp of Engineers. These agencies will establish trial out-plantings to assess how the stock performs under normal reforestation conditions. There are about 7,500 seedlings currently growing in the nursery with some of those being ready for distribution in the spring of 2013.

Wilson Nursery continues to improve its Integrated Pest Management program using carefully timed fumigation, a variety of herbicides, proper plant nutrition, and hand weeding when needed. The nursery was able to eliminate the need to hand weed in walnut beds and drastically reduced the need for hand weeding in much of the 1-0 crop with proper fumigation and appropriate herbicide regimes.

While most of the summer was above normal for temperatures and below normal for rainfall, the above average growing degree days coupled with irrigation resulted in excellent stock growth.

Wilson Nursery fumigated about 8.25 acres of nursery beds with Chloropicrin for new seedbed preparation. Chloropicrin under tarps was used as a substitute for Methyl Bromide. Metam Sodium was also evaluated as a possible substitute for Methyl Bromide, but no applicators were available to make tarped applications of Metam Sodium. New EPA and DATCP laws mandate tarped applications within a quarter mile of "hard to evacuate facilities" such as daycare centers and prisons. Due to the close proximity of Wilson Nursery to a Department of Corrections facility and a daycare center, some portions of the nursery will need to be tarped if fumigated.

Seed collection also got off to an early start. There were great crops of white and bur oak in the southern part of the state. The nursery program was able to reach its seed buying goals on all species of hardwood with the exception of sugar maple and basswood. Wilson Nursery staff were also involved in seed collection and replenished inventories of several shrub species including high bush cranberry, hawthorn, prairie crab, and dogwoods.

Nursery staff made a significant improvement in the black walnut cleaning operation this year. The nursery processes 1,000 to 2,000 bushels of black walnut each year for sowing in seedbeds as well as for landowner direct seeding. Instead of hand feeding walnuts from a gravity box into a huller, an old lime spreader with a hydraulic feed belt was used in processing. This made the operation safer and more efficient, reducing the labor needed for the process.

Fall seeding on about eight acres was completed by mid-October with the remaining 0.25 acres to be completed in the spring of 2013. Winter wheat was sown as 'living mulch' in all hardwood and shrub seedbeds. Winter wheat has replaced hydromulch applications on hardwood and shrub beds, providing a considerable cost savings. Trials with winter wheat continue on conifer beds, especially white spruce, with the goal of replacing the shade cloth over young seedlings. We have been conducting trials for two years now with some success, but continue to fine tune the process to gain consistency.

Hayward Nursery

The Hayward State Nursery, built in 1935 by the U.S. Forest Service and purchased by the State of Wisconsin in 1981, has produced and distributed tens of millions of tree and shrub seedlings to regenerate thousands of acres of forest land in northern Wisconsin. Seedling production at the nursery will end in 2013, but its role in seed collection, cleaning, and storage, especially for conifer seed, will continue as will its function as a seedling distribution center for the northern part of the state. Former nursery beds will be utilized for tree improvement research plantings, seed orchards, shrub seed production areas, and herbicide trials. The property is cooperating with the Western Prairie Habitat Restoration Area project by safeguarding 39 endangered dotted blazing star prairie plants as part of the Stillwater bridge rehabilitation project across the St. Croix River.

With the unseasonably early arrival of warm spring temperatures, Hayward Nursery began lifting seedlings on March 26th and concluded on April 10th. Approximately 604,000 tree and shrub seedlings were harvested and shipped to the other two state nurseries for grading and packing.

Approximately 1,341 bushels of conifer cones were processed and seeds extracted in 2012. With the increased demand for jack pine seed for direct seeding, seed processing remains an important activity at Hayward. As a result, communications have been initiated with the USDA-Forest Service to acquire an unused seed extractor to upgrade the state nursery program's equipment.

Wheat and rye cover crops were harvested and yielded nearly 1,150 bushels of grain which was sold through the GovDeals program. In addition, over 2300 bales of straw were harvested and made available to WDNR programs with the excess offered for sale on the open market. Nursery beds not occupied with seedlings were again seeded to cover crops of wheat and rye in the fall.

Nursery Partnerships

Partnerships continue to be a valuable tool for expanding reforestation awareness across the state. Nursery personnel staffed a booth at the Green Bay Deer Expo in February. Education and outreach opportunities were maximized and staff came away feeling this was an excellent use of their time and good exposure for the program. Participation in similar venues will be expanded to different parts of the state in 2013.

Polar Bears International maintained its commitment to the "*Tree Planting for Climate Change"* initiative and funded establishment of a 134-acre conifer plantation on the Florence County Forest. Seedlings were purchased from the state nursery program.

In June, the nursery program hit another home run for a second year in a row with the Milwaukee Brewers baseball team. A total of 7,000 white spruce seedlings were distributed during the Green Week "*Root, Root, Root for the Brewers"* campaign. A reforestation message was printed in brochures and provided during pre-game announcements, and staff was introduced on-field.

Storm damage in northwest Wisconsin during 2011 brought an opportunity to reach out to landowners who had harvested their wind-damaged timber and were considering future management options. Informational handouts were developed for local foresters to provide to impacted landowners. In July, a landowner reforestation workshop was held in Siren; participation was low, but appreciation was high. Nursery staff was proactive in working with the National Arbor Day Foundation to secure reforestation grants for Douglas and Burnett County Forests.

Thanks to visionary park staff stationed at the Hank Aaron State Trail, white and bur oak acorns were collected from the Milwaukee Veterans Administration facility, a National Park Service National Historical Landmark, and planted at Wilson Nursery to launch a "*Heritage Tree Project*". The long term goals of the project are to begin replacement of the stately oaks at the facility said to be growing there since Abraham Lincoln's presidency, but now declining in vigor. Efforts are underway to have veterans at the VA center plant and care for the trees as part of their recovery therapy. This park stock will also be planted along the Hank Aaron State Trail and eventually at a new, adjacent 24-acre park of which WDNR is a partner. Reforestation messaging, in conjunction with urban

forestry, will be a strong component of the project and targeted at students attending the Milwaukee Urban Ecology Center.

The nursery program is working with the U.S. Army Corp of Engineers, the Minnesota DNR, and the Iowa DNR to pilot an American elm re-introduction project along the Mississippi Riverway. American elm seed were planted at Wilson Nursery in 2012 with the first mixed species out-plantings scheduled in 2013 in field locations managed by each entity.

County forests continue to be an important customer for the state nursery program. In the fall, 13 county forests were visited by nursery staff to understand local regeneration challenges and future needs; to seek feedback on state nursery products; to review technical services the nursery program provides; and to improve customer service. Findings and recommendations were developed and sent to the Division's Forestry Leadership Team and will be addressed by the nursery team in the coming months.

New Programs

A number of program changes occurred in 2012. After 40 years of dedicated service to the department, Hayward Nursery superintendent Gordy Christians retired. His innovative thinking and expertise will be missed by his peers.

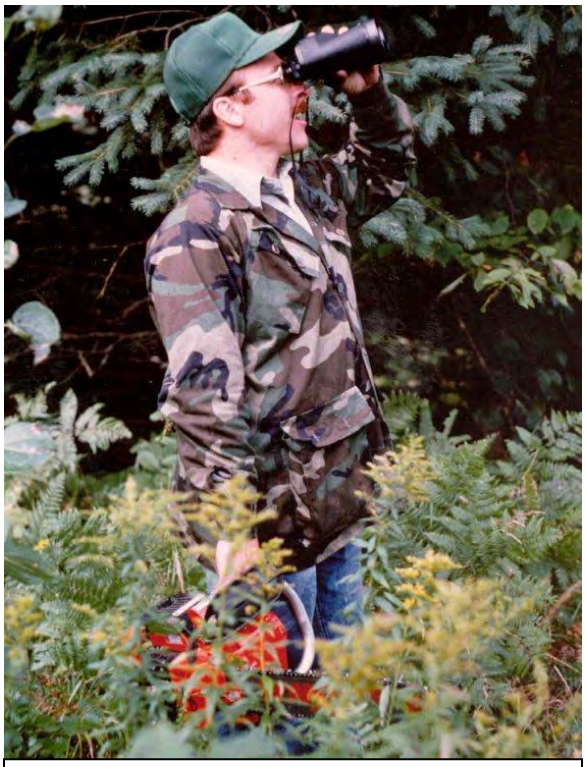


Figure 7. Gordy Christians on the lookout for a good cone crop (Photo DNR)

The Division of Forestry concluded its Strategic Direction planning and began implementation beginning July 1, 2012. As a result, the WDNR State Nursery Program is now supervised from the central office, rather than from the regions (districts) as was done in the past. Several field positions were cut leaving the program with a total of fourteen permanent staff spread across the three nurseries. The nursery coordinator position was converted to a team leader classification with supervisory responsibilities; tree improvement tasks were redirected to a new forest geneticist position no longer directly associated with the nursery program. Currently the program is fully staffed except for the Assistant Nursery Manager position at Hayward.

Landowners will have more flexibility when ordering packets for spring 2013 delivery. With the new "Build Your Own" option, customers may select their preferred species rather than have packet contents pre-determined. As the October ordering season began, the nursery program implemented a DNR trucking delivery system for 2013 to streamline transportation coordination and reduce costs for shipping to individual counties. This also will ensure that live nursery stock leaving the nursery is transported in refrigerated trucks. Customers who select DNR trucking will pay an additional $8.00 per 1000 seedlings or packet.

The Division of Forestry made an important rebuttal to Forest Stewardship Council auditors who wish to incorporate nurseries under the forest certification umbrella. This change would have major implications for pesticides usage in nursery production and would significantly impact the economics of growing seedlings for reforestation. The final decision is pending.

Reforestation Monitoring

Introduction

In the summer of 2012, the state nursery assistant managers visited 165 1st-year monitoring sites (Wilson Nursery staff visited 67 sites and Griffith Nursery staff visited 98 sites) and 39 3rd-year monitoring sites (Wilson-19 sites and Griffith-20 sites) to determine the status of new tree and shrub plantings made with WDNR nursery stock (Figure 8). These sites were scattered throughout all regions of the state on public and private properties. To increase landowner contacts over a larger geographic area, the nursery system hired a limited-term employee to help perform the visits.

Weather Conditions

Planting and growing conditions varied tremendously statewide. The season started extremely early as very warm temperatures in March caused nursery stock to begin breaking dormancy prior to lifting. Some landowners received seedlings that had started to break bud, especially tamarack and shrubs. The weather then turned cold and wet, providing ideal conditions for planting and early season growth. Unfortunately, after the first week of May, many areas in the southern two-thirds of the state experienced moderate to severe drought conditions. By the time sufficient rains fell widely over the region, many plantations, especially in the central sands and southeastern forests, had failed. Late season rains helped to partially replenish soil moisture in some areas, but the western one-third of Wisconsin remains under moderate drought conditions as of February, 2013.

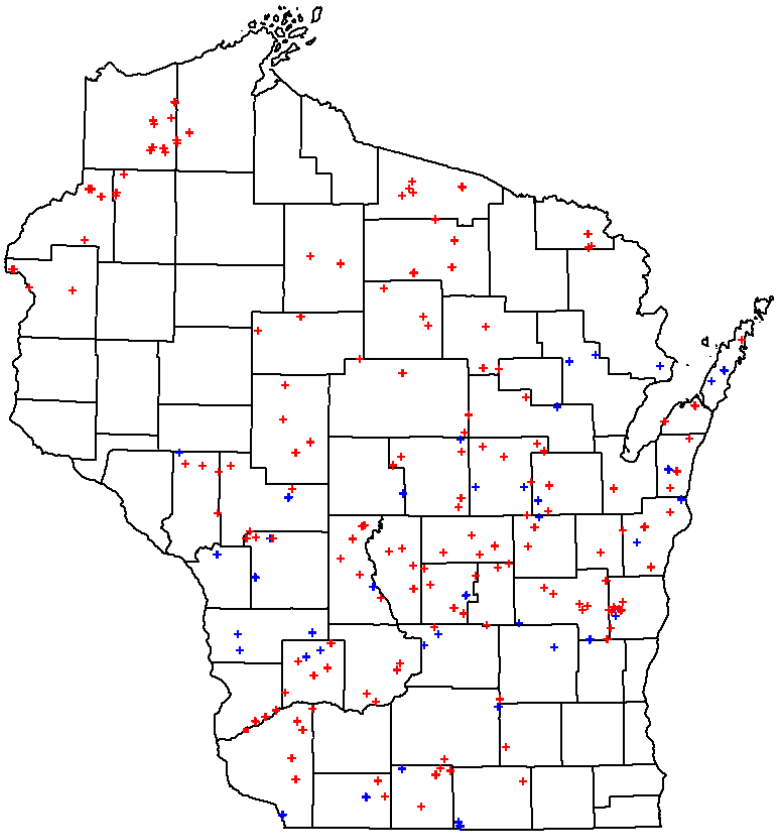


Figure 8. 2012 WI Reforestation Sites

+ 1st -Year Reforestation Sites
+ 3rd -Year Reforestation Sites

Landowners

As in years past, the majority of seedlings ordered are planted on public property, primarily state forest lands and county forests. However, the majority of sites visited are privately owned. Private landowners were very open to discussing and exhibiting their plantations. Many expressed frustration with the extremely dry conditions.

A few complained of stock quality, specifically receiving trees that had broken bud or arrived 'dry'. This mainly involved tamarack, white pine, and ninebark. No landowners denied access and many asked to be included in the visit. These requests are accommodated whenever possible, even though it is challenging to coordinate due to the increased plot survey time. Nevertheless, what is lost in efficiency is made up for in positive public relations.

Plot Data Wilson Nursery – 2012 Planting Surveys - Roger Bohringer

Counties with 1st-year site surveys completed between early June and late August include: Bayfield (3), Burnett (4), Crawford (4), Dodge (1), Douglas (2), Grant (7), Green (5), Jackson (3), Jefferson (1), Lafayette (2), Monroe (6), Polk (4), Richland (5), Rock (1), Sauk (4), Sheboygan (8), Trempealeau (4), and Washburn (3), for a total of 67 sites. Sites ranged from Conservation Reserve Program and Hardwood Regeneration Grant sites in the south to large industrial clear-cut and reforestation sites in the north. Along with these large planting projects, there were a surprising number of "do it yourself" tree plantings completed with little or no forester input. We found that DNR foresters occasionally had no maps or information about customers, and there were several occasions where they had never heard of the landowner. These customers may or may not want a formal management plan, but after investing thousands of dollars in a new planting, it is evident they have at least some interest in forestry. While we do not have any easy solution for reaching them, discernibly there are landowners that are not getting the message that the DNR has professional forestry assistance available.

Figure 9. Dead hardwoods in unsprayed row- sprayed pines doing great without sod competition - Richland County

The dominant theme for 2012 was drought. Drought-killed plantings were recorded from Monroe County to Sheboygan. Due to these conditions, we expected to report losses on sites with coarse textured soils, but the drought worsened as one moved south until even the deep silt loams of Lafayette County were struggling to support seedlings. This was a year where you had to do everything right just to have a chance of succeeding. Any planting with poorly handled stock, over-aggressive root pruning, or sloppy planting paid a price in terms of seedling losses. Failure to control the sod layer also led to the loss of many seedlings. However, broadleaf weeds may have actually benefitted some plantings by providing some shelter from wind and sun as drought conditions worsened.

Surprisingly, on most sites with adequate grass control, seedling survival was pretty good, especially for hardwoods. While few hardwood seedlings put on much growth this summer, they were able to survive. Overall, statewide survival of hardwoods was 90%. Conifers, with their shallower roots and generally sandier planting sites did not fare as well, having a 77% survival rate statewide. This statistic is bolstered by the fact that

much of the conifer planting occurred north or east of the intense drought area. Many landowners with conifer plantings in the southern counties would have been thrilled to achieve 77% survival.

Griffith Nursery – 2012 Planting Surveys – Jeremiah Auer

Counties with 1st–year site surveys completed during the 2012 field season include: Adams (5), Brown (1), Calumet (1), Clark (4), Door (3), Douglas (8), Florence (3), Fond du Lac (6), Green Lake (3), Juneau (6), Kewaunee (3), Langlade (3), Lincoln (3), Manitowoc (4), Marathon (3), Marquette (5), Oneida (4), Outagamie (2), Portage (5), Price (3), Shawano (1), Taylor (3), Vilas (6), Waupaca (6), Waushara (5), and Winnebago (2).

The creation of the 'statewide nursery distribution areas' coupled with the vacancy of the assistant manager position at Hayward required that the remaining assistant managers increase travel. The new territory included Douglas, Bayfield, Sawyer, Taylor, Price, Ashland, Iron, Vilas, Oneida, Forest, Florence, and Marinette counties for the Griffith Nursery assistant manager. While an increase in area can be a challenge, it is also an opportunity to monitor a number of sites that would not normally be visited.

Figure 10. Red Pine plantation in Marquette County (Photo by Jeremiah Auer, WDNR)

The plantations established in central Wisconsin started out very well. However, hot and dry conditions, beginning as early as mid-May in some areas, remained in place through late July and August. The heavy soils of the east were unforgiving and the clay baked hard and cracked. The central sands dried out making survival difficult for even the toughest weeds. Very few new plantations were able to survive these extreme conditions without some losses. The plantations farther north, specifically north of State Highway 29, fared much better as scattered rains fell throughout the summer and the warm conditions provided a great environment for seedling development. Overall, the seedling survival rate was 81%. However, this number is slightly deceptive as plantations in the south were doing well early in the season during monitoring, but likely experienced significant loss later. Competition was relatively well controlled area-wide; most seedlings experienced only minor grass and forb competition. However, more than a few plantations struggled with heavy grass competition. Planting depth seemed to be a problem, especially on the large county and state forests plantings. Seedlings hand planted by contract planters were consistently planted greater than 2" below the root collar, the suggested planting depth recommended by the nurseries. Vilas County had over 90% survival, but of the seedlings sampled, 75% were planted at least 2" deeper than recommended. Oneida and Florence County Forest and the American Legion-Northern Highland and Brule River State Forest struggled with planting depth as well. A smaller percentage of sites on private land experienced this problem. Herbivory due to wildlife, specifically white-tailed deer, was obvious on many out-planted oak, maple, and aspen seedlings throughout the survey area.

Twenty 3rd-year sites were surveyed during 2012 including: Door (2), Fond du Lac (2), Juneau (1), Kewaunee (1), Manitowoc (2), Marinette (1), Marquette (2), Oconto (2), Outagamie (1), Portage (1), Shawano (1), Waupaca (2), Winnebago (1), and Wood (1). The 2010 planting year was a terrific year to establish a tree plantation; cool planting weather, ample precipitation, and a warm summer combined to provide the seedlings with ideal growing conditions. The following year, 2011, was also very good with abundant precipitation and very warm weather. Most plantings established during these two years in the central and eastern part of the state fared quite well during the very hot and dry 2012 growing season. Unfortunately, not all plantations were able to overcome the oppressive conditions. Of the 20 sites visited, four had very high mortality. Those plantings on sandy soils in the central and southern part of the state were hardest hit. The plantation in Wood County was almost a 90% loss.

Figure 11. Three Year Old Red Pine Plantation in Waupaca County (Photo by Jeremiah Auer, WDNR)

Conclusions

The drought conditions of 2012 had a major impact on many new (2012) plantations, and the effects were seen even on plantings established in 2010. These impacts were lessened, as in past years, by those landowners that prepared the planting site well, took care of the seedlings before and during planting, and followed up with an effective management regime.

Hopefully, the increased interaction nursery staff has with landowners through the reforestation monitoring efforts will produce more successful plantings and more satisfied customers.