

Wisconsin's Reforestation Programs 2018 Annual Report



Late November sunset through the white spruce at Mead Wildlife Area

Wisconsin Department of Natural Resources
State Reforestation Program and
Forest Genetics Program
and
University of Wisconsin-Madison
Department of Forest and Wildlife Ecology



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Introduction

The Wisconsin Department of Natural Resources' (WDNR) Reforestation Program is comprised of three linked efforts:

- 1) **The Reforestation Monitoring Program** monitors reforestation efforts, primarily through the periodic assessment of seedling survival, growth, and long-term health and productivity. The information obtained from this data is used to inform tree growers on the best planting practices and strategies for producing optimal reforestation results;
- 2) **The State Forest Nursery Operations** produces and ships forest tree seedlings for reforestation and conservation purposes to customers throughout Wisconsin. Seed is also sold for direct seeding, and to private nurseries for the production of tree seedlings for reforestation in Wisconsin;
- 3) **The Tree Improvement Program (TIP)** is a WDNR collaboration with the UW-Madison Department of Forest and Wildlife Ecology to conduct forest genetics research and 'applied tree improvement' via the establishment of tree seed orchards and supporting progeny tests. The trees in these seed orchards have been selected for superior performance and for being well-adapted to Wisconsin growing conditions. Seed from the seed orchards is utilized by the State Reforestation Program.

Reforestation Program

Reforestation Monitoring

Introduction

Since 2007, the Division of Forestry's Reforestation staff has examined a sample of Wisconsin's forest plantations during their initial year of establishment to assess the successes and failures of tree planting throughout the state of Wisconsin. A subset of these sites was selected for further monitoring after the 3rd and 7th year of establishment to examine the health and vitality of the seedlings and plantations. The sites included both publicly and privately-owned plantings, large and small acreages, and single species or mixed species plantings. This monitoring also allows for interactions and discussions with landowners and land managers beyond any conversations at the time of planting.

Personnel

The Regeneration Specialist, Jeremiah Auer, directs a team of limited term employees (LTEs). In 2018, we rehired Michael Ard and brought in a new forester, Kendra Preusser to assist with this effort. This duo quickly melded into an effective team and traveled the state, visiting new plantations and establishing regeneration monitoring sites. On occasion, they were accompanied by Bradley Schmidt, another Reforestation Program employee working at the Griffith Nursery.

Weather Conditions

Planting and growing conditions during 2018 were variable statewide. The early spring and summer brought good growing conditions with adequate rainfall and cooler temperatures. As the summer progressed, many areas in central and southern Wisconsin began to experience very dry to droughty conditions. Then, as summer waned, most of these areas were inundated with storms and flooding. The northern portions of the state were more seasonable throughout the summer.

Landowners

In 2018, the majority of seedlings purchased were sold to private landowners, planting on private lands; 1,280,839 seedlings. Private landowners also had the greatest number of orders, 1,034. Federal, state, county, tribal and municipal forest property managers purchased fewer trees, 1,034,882 seedlings; these properties accounted for 60 orders. Seedlings purchased or provided by the Reforestation program for Arbor Day, research, inter-state exchange, youth groups or promotional events, a total of 82,255 seedlings, were not included in these totals, but found their way onto the greater Wisconsin landscape.

Site Selection and Plot Installation

Sites are selected from among those owned by landowners who order a minimum of 3000 seedlings, a volume that can cover approximately 3 acres of land. The landowner's main objective must be to establish a forested environment. Other goals, including wildlife habitat and erosion mitigation plantings, could be included, but the management techniques must focus on developing a forest and not simply performing a landscaping function.

After the site is selected, plots are installed randomly within the planted area. Areas greater than 10 acres receive 6 plots and sites with 3 – 10 acres receive 3 plots. Each plot center is marked with a wooden stake and orange flagging. The corners are established at 20.87 ft. at bearings of SW, NW, NE, and SE and marked

using a nail and flagging, the same as plot center. Each seedling within the plot is marked with an identification whisker (the first of which is blue, with pink whiskers designating the other seedlings) and is mapped to facilitate data collection in the 3rd and 7th years.

Plot Installation 2018

After an initial training phase, the crew became quite proficient in plot surveys. Plots were established on 30 sites, representing 29 different ownerships, established in the spring of 2018 (Year “0”). Of these sites, 13 were located on public lands and 17 were on private property. The sites were located in several counties



Figure 1: White pine within a newly established plantation

(Adams – 1, Ashland-1 Barron-1, Bayfield-1, Burnett-2, Chippewa-1, Clark-1, Columbia-1, Crawford-1, Door-1, Douglas-1, Dunn-1, Iowa-1, Jackson-2, Jefferson-1, Juneau-1, Manitowoc-1, Marathon-1, Marinette-1, Monroe-1, Ozaukee-1, Polk-1, Racine-1, Sawyer-1, Sheboygan-1, Trempealeau-1, and Vilas-2) scattered throughout the state. This allowed us to monitor the development of seedlings across a wide variety of soils and forest communities.

After the growing season, staff also remeasured monitoring sites on plantations from 2016, after their 3rd growing season. Again, these sites were scattered across Wisconsin’s counties; (Bayfield-1, Burnett-1, Calumet-1, Clark-1, Columbia-1, Dodge-1, Door-1, Douglas-1, Dunn-1, Eau Claire-1, Forest-1, Grant-1, Iowa-1, Jackson-1, Juneau-1, Kewaunee-1, Marathon-1, Marinette-2, Polk-1, Portage-1, Richland-1, Rock-1, Shawano-1, Sheboygan-1, Vilas-3, Walworth-1 and Washington-1). This included 17 public lands sites and 13 private lands sites. The remeasure allows us to determine how well individual seedlings performed.

Staff then visited 24 sites previously evaluated in 2012 and 2014, using the previous protocol, that had completed their 7th year of growth (Brown-1, Clark-2, Door-1, Douglas-2, Florence-1, Green Lake-1, Juneau-3, Kewaunee-1, Marathon-1, Oneida-1, Outagamie-2,

Taylor-1, Vilas-4, Waupaca-1 and Waushara-2). These sites represented 10 publicly owned sites and 14 privately owned. These older sites were not established using the new protocol, so it is not possible to directly follow the progress of individual seedlings. However, we can still draw some conclusions as to the health and development of the tree seedlings and plantations overall.

Data Analysis

Year “0”

Overall: Data was collected on the 2,169 newly planted seedlings. Of these, 66.3% were considered healthy, 15.5% were lightly damaged (indicating the surveyor felt the seedling, while impacted by an assortment of different damaging agents (mechanical impacts, incorrect planting, insect or disease, etc.), would overcome this challenge and survive, 5.1% suffered some form of heavy damage (indicating the surveyor felt the

seedling would not be able to recover and would be dead when surveyed again after the 3rd growing season), and 13.1% were already dead. Over 81% of all seedlings planted were living or had only minor damage. However, if two large plantings, both of which were planted in dry, sandy soils, with the seedlings planted deeper than suggested, are omitted from the dataset, the healthy and lightly damaged seedlings jump to over 85%. In comparison to previous years, 2018 was slightly below average in survival, but within the norm.

Public lands: Public land sites are typically planted with more conifers than hardwoods. In 2018, this trend continued. Of the 1072 seedlings from which data was collected, 72% were pine, spruce, and cedar, with over half being jack pine. These conifers performed well, with over 80% healthy or lightly damaged. As previously mentioned, two large, red pine plantations, planted on dry sand soils reduced the overall survival rate. If that data is omitted, the rate of healthy/slightly damaged seedlings jumps to 88%. Of the 13 public lands sites surveyed, only 4 contained any planted hardwoods. These seedlings fared just as well as the conifers, with over 80% survival. These included a variety of species, but most are oak (37%). It is not easy to estimate the impact of browse or girdling during the early summer when the data is collected; as conifers are not usually browsed until the mid- to late winter months and there is so much other herbaceous material available for browsing. However, as far as impacts evidenced by mid-summer, 22% of the planted hardwoods were subject to moderate to heavy herbivory.

Private lands: Private land owners planted an even higher percentage of conifers than the public land managers, 77%. Landowners had slightly better overall conifer survival at just over 86% of seedlings being healthy or slightly damaged. The hardwoods did worse in comparison to the public lands, with only 69% of seedlings seemingly healthy or slightly damaged. However, this estimate was impacted by poor survival in a rather large black walnut planting that was planted in late May, which reduced the hardwood seedling survival considerably. If that order is omitted, the percentage of healthy and lightly damaged hardwood seedlings jumps to almost 86%. The impacts and effects of browse and girdling was discussed earlier, and the same activity exists on private lands. On private lands, 19% of hardwoods that are more prone to browse (aspen, oak, maple), experienced moderate to heavy levels of herbivory.

Year “3”

These 30 sites represented 27 ownerships (13 privately owned, 17 publicly owned) scattered throughout Wisconsin. The past 3 growing seasons have had relatively good growing conditions, with only a few areas with extended periods of dry weather. These sites were established in 2016 under the new protocol and were resurveyed in 2018. Staff returned to the plot centers and assessed seedlings previously measured. In most cases, returning to the site was easy as we had maps and markings for each plot and tree.

In Year 0, the overall seedling survival was 92%, including all seedling healthy and slightly damaged. This dropped to 65% in Year 3. Both conifers and hardwoods exhibited the same 29% drop in survival. The competition from grasses, herbaceous species and woody plants increased in intensity by 46%. It is common for landowners to control the competition for the first year and then gradually decrease these efforts. This can impact the seedlings, especially if the competition from grasses and broadleaves becomes fierce. Browse showed an increase as well; from 5% of all living, palatable seedlings browsed, to 16%. This again, tends to be more of a problem with hardwoods. However, in certain areas, conifers can experience just as much browse as hardwoods, especially in cold, snowy, long winters in the north. One site in Burnett county, had most of its red pine browsed, a relatively surprising occurrence as red pine tends to be unpalatable to deer. The species that showed the most susceptibility to browse were the oaks; bur, red, swamp white and white. Over 21% of oaks showed signs of moderate to severe browsing.

Overall, the seedlings from 2016 did not prosper as well as expected, considering how well they were established in their first year.

Year “7”

Originally, 97 sites were visited and surveyed in 2012. Then, in 2014, 38 of those sites were revisited to ascertain seedling survival and growth after their 3rd growing season. All these sites were measured using the previous protocol; no permanent plot or tree marking, stocking, etc. The 7th year measurements were made on 24 of the previously mentioned sites using the new protocol. The staff attempted to visit all those sites measured at the 3rd growing year, but landowner denials and land changes limited that effort. Using the new protocol makes direct comparisons difficult, but we can make general statements.

Overall, of the 24 sites, 10 are publicly owned and 14 were privately owned. Growing conditions were generally quite favorable during the past seven growing seasons across most of the state. However, in the year of establishment (2012), the southern and eastern portions of the state dealt with a moderate drought from June through early August. This did impact some of the plantations, but a majority avoided this trouble.

The staff is charged with determining whether a site has been successfully regenerated. This designation is established by analyzing a site with regard to present stocking level, seedling distribution within the planting, and whether the seedlings are free to grow (seedling height is above existing competition, deer and rodent damage). Professional judgement influenced by landowner goals where appropriate are also included in a final assessment.

We conclude that among the public sites 6 were considered successfully regenerated while 4 were unsuccessful. The private sites have 7 successful sites and 7 unsuccessful. This represents a success rate of 60% on public lands and 50% on private lands; with an overall rate of 54%. Seedlings competing with heavy vegetation competition and deer browse are the main challenges to survival and plantation success. We provide some recommendations below for dealing with these problems.

Future Considerations

We believe that the reforestation monitoring protocol is working well. We continue to adjust techniques and find better plot marking materials, but no major changes are being considered.

Conclusions

The Reforestation Monitoring effort has proven useful and allows the Reforestation program to gather information about seedling performance and plantation establishment statewide. In addition, we can stay abreast of any challenges that arise. In addition to providing valuable data on plantation performance, customers and staff can interact and exchange ideas and offer advice to landowners. The 2018 planting and growing season was a success for plantations. Data collection and analysis will continue to provide the information needed to assist landowners and property managers maintain and grow their forests.

Regeneration Trials

Introduction

In addition to supplying landowners and managers with quality nursery stock, the Reforestation program also endeavors to be a reservoir of information and experience in all things concerning reforestation. To that end, at times, we will create experiments to test chemicals used in site preparation, deer browse mitigation

equipment, seedling lifting and storage techniques, etc. In 2018, the Reforestation program repeated an herbicide trial and attempted to establish a planting trial.

Herbicide

The herbicide clopyralid (tradenames include Transline and Stinger) can be sprayed prior to planting or sprayed over existing seedlings. It is meant to control some common plantation weeds, including thistles, knapweeds, horsetail, alfalfa, clovers, and others. However, it has been known to also negatively impact some tree and shrub species. The current trend in planting is to incorporate a wide variety of species through a plantation. This can make utilizing a clopyralid product difficult. Reforestation staff wanted to determine if there was a safe spray rate that would impact weed growth, but not the trees or shrubs, and which, if any species, are more sensitive than others.

Reforestation staff planted 12 blocks of seedlings at the Hayward Nursery in the spring of 2017. Each block held 10 individuals of 26 species (white cedar 3-0, balsam fir 3-0, eastern hemlock 3-0, jack pine 2-0, white pine 2-0, black spruce 2-0, white spruce 2-0, tamarack 2-0, aspen spp. 1-0, river birch 1-0, butternut 1-0, black cherry 1-0, hackberry 1-0, bitternut hickory 2-0, shagbark hickory 3-0, red maple 2-0, silver maple 2-0, sugar maple 2-0, bur oak 1-0, red oak 1-0, swamp white oak 1-0, white oak 1-0, black walnut 1-0, highbush cranberry 2-0, American hazelnut 1-0, and ninebark 2-0). The seedlings were planted in May, allowed to grow for a month and then sprayed with varying rates of clopyralid. The experiment was replicated three times, so that three of the twelve blocks were selected randomly and each either treated with no herbicide (control), 4 oz./acre, 12 oz. acre, or 20 oz./acre. Staff visited the blocks three times, once two weeks prior to spraying, two days after spraying and 10 days after spraying to ascertain the health of the seedlings. The results showed that none of the seedlings sprayed with any of the three different chemical rates exhibited negative impacts.

In spring 2018, these same seedlings were still growing at the Hayward Nursery. We again sprayed them using a clopyralid product. However, rather than waiting for the seedlings to be established and set their leaves, we sprayed much earlier in the growing season, just as most seedlings were unfolding their leaves.

A final report on the results is being edited and will be available on the Reforestation website, but anecdotal evidence suggests that even at the highest rate (20 oz/acre) only a few species, highbush cranberry, ninebark, hackberry and white oak, showed any negative impacts. And these seedlings eventually grew out of the misshapen appearance and slight chlorosis that occurred from the spraying. It should be noted that red pine was not included in this study due to lack of availability.

Extended Summer Storage

The Emerald Ash Borer (EAB) has become prevalent within the forests of Wisconsin. The native white ash (*Fraxinus americana*), green ash (*F. pennsylvanica*), black ash (*F. nigra*) and blue ash (*F. quadrangulata*) are quickly vanishing from the landscape, either by the activity of the insect or through discriminatory management practices by forestry professionals. While it is typically found as a small component of many forest cover types, in some settings, especially large wetland forests of the north or along river bottoms, *Fraxinus* can make up a very high percentage of the forest. To preserve these sites in forestlands, it will be important to encourage species that have similar site requirements as ash. However, if these species are not present, they will need to be introduced via some reforestation effort; either direct seeding or artificial regeneration techniques. Wisconsin state nursery seedlings are typically distributed in the spring for planting. Unfortunately, this time usually coincides with very wet conditions in the aforementioned ash sites. To mitigate the flooding challenge, the seedlings could be planted after the sites have dried; typically, during the early summer. It has been documented that seedlings, especially hardwoods, can survive extended

periods of cold storage and remain viable. This experiment will test the viability and growth of seedlings after extended cold storage. Seedlings will be lifted during the early spring, graded, packed and then stored in cold storage until mid-to-late June. Half of the seedlings will be stored with sphagnum moss, an oft used medium to retain moisture around delicate roots and known to possess antibacterial properties. The experiment was to have started in the spring of 2018. Unfortunately, the Wilson State Nursery cooler shut off over the Memorial Day weekend. The heater then started warming the cooler. By the time it was discovered, the temperature was over 100°F. It was uncertain whether the seedlings were viable after this incident, and so they were discarded with the intent to try again in 2019.



Figure 2: Ripening red osier dogwood fruit at Hayward State Nursery

Seed Collection

The spring of 2018 was challenging for seed production and collection. Once again, the silver and red maple crop failed in southern Wisconsin. The central part of the state did have seed, but it took considerable effort to retrieve it. Weather conditions hampered efforts as a few poorly timed storms sent much river birch seed into the ditches and waterways. The following autumn brought a good supply of mast crops, including white, red, swamp white and bur oak, and walnut. American plum, Juneberry and all the dogwoods (red osier, gray, and silky) had terrific fruit production. The northwoods had another terrific crop of hazelnuts, thankfully, as the central and south were again barren. Shagbark hickory was difficult to find, but we did get some to fill a small portion of our needs. A few species, desperately needed, proved elusive again. Our seed stores are empty of yellow birch and hemlock. Hopefully we will find 2019 a better year for these seed.

Seed Sales

In addition to seed collected and stored for use in producing nursery stock, any seed volumes above our need threshold (typically 7 years for conifers, 3 years for hardwoods), are made available for direct seeding efforts on public or private lands, nursery stock destined for reforestation efforts or research efforts. As previously mentioned, the autumn of 2018 was good for mast crops. The reforestation program provided over 400 lbs. of stored seed (mostly conifer, with a small amount of hardwood) and over 80 bushels of fall produced seed (acorns, hickory nuts, and black walnuts) to county and state forest managers, university research projects, private and public nurseries and private landowners.

Nursery Production

Introduction

The WDNR Division of Forestry maintains three seedling nurseries at Hayward State Nursery in Hayward, Griffith State Nursery in Wisconsin Rapids, and Wilson State Nursery in Boscobel. At present Wilson State Nursery is the only property actively producing seedlings. Work at a production nursery is dictated by the seasons, which can be broken down into four basic time periods: 1) Spring lifting and distribution; 2) Summer stock maintenance and production; 3) Fall seed collection and sowing; and 4) Winter layoff of seasonal employees, seedling order processing and preparation for next year.

Spring

Similar to recent years, contract labor was utilized to perform the seedling lifting. Grading duties were split between the same contract crew, a small LTE crew hired from the Boscobel area, and two inmate crews located across the highway from the nursery, at the maximum-security Wisconsin Secure Program Facility. Total distribution for the year was 2.4 million seedlings. See 2018 Distribution Report for more details.

The year 2018 brought several changes to the seedling distribution process. With production now fully consolidated at the Wilson Nursery, staff from Hayward and Griffith nurseries travelled to Boscobel to help run various distribution operations. They filled key positions in an effort to maximize the skills of the individuals on the team, as well as help cover a vacant technician position at Wilson State Nursery. The visiting staff also brought knowledge gained from years of experience, which proved very useful in improving Wilson State Nursery's processes and work flow. Many of the changes implemented were relatively minor, such as moving crates of stock on carts versus moving with a forklift, but even minor changes can yield big gains in efficiency and safety over the course of a season.

The highlight of the 2018 lifting season was the unpredictable weather. March was warm so lifting operations were able to begin on March 25. Most stock was lifted by mid-April, well ahead of breaking dormancy. The first truck shipped to southeast Wisconsin on April 11. However, winter returned in full force, burying much of central and northern Wisconsin under heavy snow and cold temperatures. After much shuffling of the trucking schedule, the last county truck was delivered on May 3.

Spring 2018 was also the first harvest of any seedlings from the multi-year fumigant comparison trial at Wilson State Nursery. This study is an attempt to quantify operational performance of three commonly used soil fumigants under typical forest nursery conditions. Multiple .15 acre plots were treated with either metam sodium, methyl bromide/chloropicrin mix, straight chloropicrin, or left unfumigated in late summer 2016. These plots were sown in fall 2016 with white oak, jack pine, red pine, and white pine. All jack pine and white oak seedlings were harvested this spring as 1-0 seedlings, as is normal operational practice at Wilson State Nursery. Due to poor germination, the white oak beds were too thin to yield valid data and were removed from the study with no further data collected. A subset of each jack pine block was measured for height and caliper. They were then severed at the root collar and dried to assess average dry weight of tops and roots for each plot. The red and white pine will be harvested in spring 2019 as 2-0 seedlings, and similar data will be collected and analyzed at that time. Once all the seedlings are harvested and the data is collected and analyzed, a report will be prepared to show the results.

Summer

The summer season starts in May with the germination of seeds in the fall-sown nursery beds. The winter of 2017-2018 was not good from a nursery standpoint. Poor snow cover and erratic temperatures led to a complete loss of the seed for some species and very poor germination for others. All 'shade' conifers failed, except balsam fir. White spruce, black spruce, white cedar, hemlock, and tamarack were a total loss. On the hardwood side, white oak was a total failure, while swamp white oak, bur oak, black cherry, and hickory missed target densities by over 50%. Interestingly, the red oak crop was excellent.

Following the poor spring germination, an attempt was made to re-seed white spruce, black spruce, and tamarack. The tamarack and black spruce were successfully sown on July 2 after 17 days of stratification. The white spruce was sown on July 10 after being stratified for 24. Germination was again very poor. It seems likely that stratification should have been extended for at least one more week.

We typically sow the seed for many species into the nursery beds in the spring. Silver maple, red maple, and river birch are always spring sown, since that is when these species disperse seed. Aspen is produced by 'sowing' root cuttings collected as part of the normal grading and root pruning of aspen seedlings in the spring. A portion of the yellow birch seed was also held back for spring seeding, since fall-seeded birch has always been problematic due to wind erosion over the winter months.

During the fall of 2017 sowing, we experimented with three different varieties of hydro-mulch covering. We used our old existing stock of Mat-Bled, which is a 60/40 blend of wood fiber and recycled paper, plus ConWeb Fibers Hydromulch 1000 and Hydromulch 2000. The Hydromulch products are both 100% aspen fiber, with the 2000 having the benefit of a 'tackifier' to help bond the fibers together. These aspen fiber products are applied to the newly planted beds as a wet slurry which dries and hardens to form a protective "crust" over the bed. This helps provide a little insulation and protects the shallow seed beds from wind and raindrop erosion until snow cover arrives. We made no effort to quantify how well each product weathered, but all were gone by spring. Comparison of June germination data in side-by-side trials showed no measurable difference in performance between the three products during our test.

Another solution to winter erosion that we are experimenting with is the use of germination fabric (DeWitt .5 oz. Frost Protection and Germination Blanket). This strong, white fabric covers the seedbed, protecting it from wind and rain splash and creating a warm micro-climate to speed germination and hold moisture. It is water and sunlight permeable, and is a weed-free alternative to mulching with straw for shallow-sown species. It looks very promising for small-seeded species like the birches and many of the wildlife shrubs. However, our trials with red maple did poorly, indicating that it is less effective for large-seeded species. We are still experimenting to discover the ideal time to remove the fabric. Removal too early leads to desiccation of the seedlings, and removal too late leads to mechanical damage of the seedlings as the fabric rubs against them in windy conditions. We are experimenting with planting winter wheat or sorghum with the tree seed to act as 'tent poles' to help lift the fabric off the germinating seed. Results have been mixed so far, but promising enough to justify further trials.

Besides the winterkill problems in the seedbeds, the summer was overall quite conducive to seedling growth with warm conditions and reliable rains. However, the moist conditions were great for breeding fungal pathogens, but they were kept largely in check with regularly scheduled prophylactic fungicide applications. Extensive *Diplodia* sampling of our red pine beds, done annually by the DNR Forest Health staff, once again revealed very low asymptomatic infection rates. No symptomatic seedlings were observed by nursery staff

over the course of the summer. We did sustain some losses in the newly germinated conifer beds due to suspected cut worm damage. Jack pine was hit particularly hard. This pest will be monitored more closely next spring to make sure it does not return.

In addition to the normal stock maintenance challenges, the summer of 2018 saw the Reforestation Program hosting two large tours in and around Wilson Nursery. On June 27, the Division of Forestry's Bureau of Applied Forestry toured the nursery as part of the all-bureau summer meeting. This was a chance for the Reforestation Program to show off what we do to our bureau colleagues, and the event was very well received.

On August 15-16, we again hosted a large group. This time it was the Reforestation Training class which was held at Wilson State Nursery. This two-day class gave approximately 30 new foresters in-depth classroom and field training on all aspects of artificial regeneration and what to expect when planting season rolls around.

Fall

10.5 acres at Wilson State Nursery were successfully fumigated in August with a 67:33 mixture of methyl bromide and chloropicrin. An additional 1.5 acres were fumigated with 100% chloropicrin. Actual sowing of the 2019 crop began October 2, and after several delays and lost days due to wet conditions seeding was completed on October 30. All white oak rows except two were mulched with approximately 0.5-2 inches of chopped straw and then Hydromulched. This is not a new method, but it uses up to nearly 3 times as much straw as we have used in the past. The heavy straw layer is to provide some insulation in case of more snow-free conditions. The Hydromulch provides a bit more insulation and binds the straw together so that it does not blow away. On the two white oak rows which were not straw mulched, we experimented with germination fabric as a mulch (DeWitt .5 oz. Frost Protection and Germination Blanket). It will be removed at the first sign of seedling germination.

We also continued our practice of sowing winter wheat into the seedbed on most species. This wheat germinates in the fall and provides some protection from winter and spring winds. It will be sprayed with glyphosate in the spring prior to germination of the crop trees. Any wheat missed by the glyphosate will be sprayed after germination of the crop with a grass selective herbicide or will be removed by hand weeding.

Some species, such as the viburnums, basswood, hawthorn, and winterberry are two-year germinants. This means that they are sown in the fall and will remain dormant in the soil until the second spring after planting. This leads to numerous problems with erosion of the seedbed and weeds establishing in the beds prior to germination. This year we covered all two-year germinants with heavy germination fabric to keep the seedbed protected and hopefully weed-free until the seed breaks dormancy. The product we used, DeWitt 1.5 oz. Supreme Frost Blanket, costs approximately \$.05/sq. ft. to install. We will not know if we succeeded until spring of 2020, but it looks like an inexpensive and promising solution to a perennial problem.

In October, we put several bushels of white oak acorns into cold storage to save for spring seeding as insurance against another hard winter and poor germination. We have never attempted spring seeding white oak before, but it is being successfully done by the Iowa DNR and they shared their expertise. Additionally, we will be seeding 50,000 red oak in spring 2019 to compensate for higher than anticipated red oak sales this

winter. The seed used was collected last fall in northwest Wisconsin (Eau Claire area) by a regional professional collector and stored in his facility. This will be our first attempt at spring seeding red oak as well.

Tree Improvement Program

2018 Highlights

The 2018 year was marked by a strong effort to connect and coordinate with forest genetics groups outside of the Wisconsin Tree Improvement Program. The Reforestation Team met with a USFS team concerning a proposed butternut canker trial at Bell Center. Stuart Seaborne attended the Northern Forest Genetic Association meeting in Michigan. Reforestation Team Leader Joe Vande Hey and Stuart attended a tree orchard management workshop sponsored by the Minnesota Tree Improvement Cooperative (MTIC), and met with Andy David and Julie Hendrikson of MTIC afterwards to discuss the benefits of joining the co-op. All of these meetings are attempts to explore partnerships and projects to further the goals of the Wisconsin Tree Improvement Program.

The Strategic Plan for 2019-2029 has been written after a planning process which began in the fall of 2018. An *ad hoc* committee of DNR forestry professionals of diverse specialties met twice in order to gather a variety of perspectives and expertise for developing the plan. The goal is to more clearly define the future direction of the program and the projects to which we commit. As part of this, we are evaluating the value of future breeding efforts, conservation actions, and research with the program's four conifer and three hardwood species. New initiatives and potential collaborations are also being considered as part of this plan.

Cone collection is always an important activity for the program. In terms of quantity collected, this was not an especially bountiful year. There were almost no cones in our white spruce orchards, meaning three of the past four years have yielded little or no production at our three white spruce orchards. A trial collection of cones for seed was conducted at the Greenwood jack pine orchard. We wanted to quantify the labor required for harvesting whole trees and snipping the cones off of all the branches, and then calculate how much seed was collected per person hour. This differs from a method previously used of cutting out one or more leader branches to collect jack pine cones. We will use this to inform our cone harvesting strategy going forward.

Two plantings were scheduled to be thinned in 2018: the Black River Falls jack pine and the Black River Falls white pine. The jack pine was successfully thinned with a Fecon in November, 2018, and the spacing is excellent for the development of the planting into a seed orchard. The white pine was marked for thinning in May 2018, but we are still waiting to find a contractor willing to do the actual tree removal.

Maintenance is an ongoing need to reduce the competition from understory growth and create clear access to the trees for equipment use and cone collection activities. It consumes much of the field work time during the growing season. The year 2018 was another productive year for staying current with the needed mowing at many of the planting sites, as well as the long-term investment of removing dead side-branches for increased efficiency and access. In conjunction with the thinning operations over the past several years, the maintenance status has been much improved at most sites since 2015.

Height, gall rust, and stem form data were collected in July from the Hayward jack pine progeny test planted in 2014. Little rust was noted. Another round of data collection will be done in either 2021 or before the first thinning is undertaken.

The *2019 Tree Improvement Work Plan* is a companion document to this report. It explains in greater detail the background, work accomplished, and tasks planned for each orchard. A summary of the plan is at the end of this report.



James Jacobs, Roger Bohringer, Jeremiah Auer, Joe VandeHey, Paul Berang, Scott Rogers, and Stuart Seaborne (not pictured) met in May at the Bell Center Orchard to discuss a new butternut canker trial to be located here.

The following sections will discuss some specific 2018 tree improvement activities in greater detail.

Collaborations

The Reforestation Team has met with other tree genetics and forestry professionals to share expertise and resources in 2018, especially with the need to create a new Strategic Plan at hand. We are also investigating the possibility for joining an existing tree improvement cooperative or becoming part of a new tree improvement group that would help provide needed expertise or allow us to pursue new initiatives. The following are collaborations we were part of in 2019.

USFS Butternut Canker Trial

The U.S. Forest Service Hardwood Tree Improvement and Regeneration Center (HTIRC) at Purdue University has proposed a 5-acre butternut canker trial to be located at Bell Center. This is the site of a smaller trial currently managed by our program which has been severely damaged by buck rubbing on the young trees' trunks. Paul Berang (USFS-geneticist), Scott Rogers (USFS-seed orchard manager), and James Jacobs (USFS-forest pathologist) met with Joe Vande Hey, Jeremiah Auer, Roger Bohringer and Stuart Seaborne in June at Bell Center to discuss placing the new trial there. The purpose of the trial is to determine whether durable

resistance to butternut canker exists in native butternut trees. The group agreed the site was a suitable location for a butternut canker trial, as it is an ideal environment for infection and it is located within butternut's native range. James Jacobs has secured funding for an expanded fence, and the DNR Fish and Wildlife Area-Bell Center Unit has approved the expansion of the existing orchard, doubling the area currently managed. USFS personnel will be primarily responsible for the planting of the trial. Staff at Wilson Nursery in Boscobel will work with Stuart to help prepare the site, plant a cover crop, and participate in routine mowing and maintenance. The anticipated planting date of the trial is early May, 2019.

Minnesota Tree Improvement Cooperative

The Seed Orchard Management workshop sponsored by the Minnesota Tree Improvement Cooperative (MTIC) in Cloquet, MN. on October 10 was attended by Joe Vande Hey and Stuart Seaborne. Besides visiting the orchards there and observing management strategies for tree seed production, Joe and Stuart met with Andy David (MTIC geneticist) and Julie Hendrikson (MTIC specialist) to discuss how joining the co-op might benefit the Wisconsin TIP. We are still in the process of weighing whether MTIC can contribute enough to our program to justify the cost of joining the cooperative. Regardless, we anticipate continued communication and sharing of information with MTIC.

Northern Forests Genetics Association Annual Meeting

Stuart attended this year's meeting of the Northern Forest Genetics Association on August 28-29 at Kellogg Experimental Forest in Augusta, MI. Being a member of this group not only helps establish and maintain our relationships with other forest genetics professionals in the region, but also informs the Reforestation and Tree Improvement Programs about research and projects in which other groups are engaged. The meeting included updates from Carrie Pike (USFS) on Reforestation, Nurseries, and Genetic Resources (RNGR), and a planned Eastern States Tree Breeding Coalition. Also, Mary Mason from Ohio State provided a presentation on their team's work with resistance to emerald ash borer, and Songlin Fei from Purdue spoke on Macrosystems Ecology.

Strategic Plan 2019-2029

The Wisconsin Tree Improvement Program and State Reforestation Program will present to the WDNR Department of Forestry's Strategic Leadership Team the 2019-2029 Strategic Plan for the Tree Improvement Program in March 2019. An *ad hoc* committee led by Joe Vande Hey was formed in fall of 2018 to provide input into the direction of the program for the next ten years and suggest potential new initiatives to pursue. The committee consisted of Joe, Jeremiah Auer, Roger Bohringer, Ray Guries, Stuart Seaborne, Carrie Pike (USFS – Regeneration Specialist), Andrea Diss-Torrance (WDNR – Invasive Forest Insects Program), Greg Edge (WDNR – Silviculture), Andy Stoltman (WDNR – Forest Inventory Analyst), and Don Kissinger (WDNR – Urban Forestry). The committee met twice, and each member contributed their perspective of how tree improvement could be used within his or her area of expertise. Included in the discussion was breeding for disease and pest resistance, establishing seed collection areas, identifying under-utilized native species adapted to urban environments, improving wood specific gravity in white pine, hardwood regeneration trials, assisted migration of tree species native to areas just south of Wisconsin, and partnership opportunities. The results from this process will be published as the *Strategic Plan 2019-2029* in 2019.

Data Collection and Analysis

Collection and recording of height measurements, and sometimes form and disease scores, allows us to identify the best performing families and 'elite' trees within each jack pine family. This information has typically been used for selection of trees to keep within our progeny tests as they are thinned to ultimately create seed orchards. The measurements and scores are used to rank trees and families within a given orchard, allowing us to identify the genetics we wish to propagate for new progeny tests or for making controlled crosses. Data analysis also enables us to determine patterns of regional variation for height growth at different Wisconsin sites.

In 2018, Stuart Seaborne and Stan Klais (DNR-Hayward) surveyed the height, form and incidence of oak-pine gall rust for the jack pine at Hayward Nursery planted in 2014. Along with the jack pine at Black River Falls, these 3rd generation orchards represent the most advanced generations of jack pine in our program.

While working with the Black River Falls white pine height data to create a thinning map for marking trees there for roguing, we did some analysis between the BRF white pine and the Lake Tomahawk white pine comparing height averages based on origin by state and also by Wisconsin region. The data shows that the trees from Wisconsin have outperformed the trees from Minnesota and the Upper Peninsula of Michigan at both locations. It also documents that the trees from the west-central region of Wisconsin did best at Black River Falls, while the trees from the northwestern and northeastern regions did best at Lake Tomahawk. This demonstrates the advantage of using locally sourced seed to achieve better performance and adaptation with white pine.



Stan Klais holds the measuring stick used to collect height data for the Hayward jack pine.

Orchard Thinning

Thinning progeny tests in a timely fashion is necessary to create orchard trees that are healthy and more productive. Two plantings that needed to have trees removed were the Black River Falls jack pine and the Black River Falls white pine. The BRF jack pine was initially marked for thinning in 2017, and they were remarked for better visibility this year before the operation began. In November, we were able to use a

Bobcat with a Fecon head to rogue about 50% of the jack pine in just one week. This planting is now much better spaced for future growth and cone production.

The Black River Falls white pine orchard had been thinned once before in 2014, but needed another 50% of the remaining trees removed. The data to determine which trees to keep was analyzed in February 2018, and in May the trees to be cut out were marked. Unfortunately, these white pines are too big to remove with a Fecon, and the local DNR Forester has not been able to find a contractor willing to conduct the thinning operation for us. We will continue to search for ways to remove the marked trees for more optimal spacing.

Maintenance

Ongoing maintenance by mowing grasses and flowers, brush and volunteer saplings is always a major part of the annual field work. We use a Kubota tractor with a brush hog for mowing around the orchards and in more open areas, and a walk-behind brush hog for tighter spacing and close to the trees. The DR walk-behind brush hog purchased last year was traded in for a model with a wider deck in June, improving efficiency. Mowing was completed at the Bell Center hardwood orchard (multiple times), and the Mead white spruce, Greenwood jack pine, and Black River Falls jack pine orchards. The mowing of red pine at Ten Mile Creek started last year was finished, and understory control was done in the Ten Mile jack pine along with the side-branch removal there.

A long-term maintenance project has been to remove dead side-branches in various orchards in order to make cone collection operations easier and routine mowing more efficient and thorough. In 2018, most of this work was done in the jack pine orchard at Ten Mile Creek II. Many days in early spring were spent on this, and another couple of weeks in December. Over 75% of the jack pine at Ten Mile II have now been pruned, and access within the orchard has dramatically improved over the past several years.

The old plastic fence built in 2011 that protected the jack pine at Black River Falls from deer browse had fallen into complete disrepair. With the help of a prison crew and two DNR staff, the fence was disassembled, fence posts stacked and saved, and the plastic disposed of.



Jack pine at Black River Falls after thinning December 2018



Jack pine at Greenwood after mowing September 2018

Overview of Tree Improvement Work Plan for 2019

A detailed Tree Improvement *Work Plan for 2019* is available that outlines specific tasks to be accomplished in 2019 and projects where assistance from the Reforestation program will be requested. This plan has been submitted to the WDNR along with the *Annual Report for 2018* as part of the State Reforestation Program. Below is a summary of the *Work Plan* and its primary goals for 2019.

Butternut Canker Trial

The USFS research team from the Hardwood Tree Improvement and Regeneration Center (HTRIC, Purdue Univ.) plan to plant the 5-acre butternut canker trial at Bell Center in early May. The Reforestation program will prepare the site for planting and lay out the rows with flags. An extension of the existing fence needs to be bid out and constructed shortly after planting. As a new project of considerable size, it will be a focus of work for the spring and early summer.

Spring and Early Summer Field Work

Heavy winter snow may delay the start of some work in early spring. The oak regrowth under the Ten Mile red and jack pine orchards is very vigorous and requires constant mowing to control. We plan to mow the whole area in the spring and spray the scrub oak understory with Garlon herbicide in late summer or early fall. Other spring maintenance work includes lopping dead side-branches from jack pine and white spruce and using a Fecon to remove dense understory growth under the Lake Tomahawk white spruce.

Collecting Height Measurements

There are two plantings we will measure this year. The jack pine at Hauer Springs are 20 years old and fairly tall. We plan to measure these in the spring. The 5-year old red pine at former Hayward Nursery are much smaller and we will measure height and gall rust for these trees in the fall.

Propagation

Plans are being made to pot up white spruce saplings from Wilson Nursery and have them grow for a year. In February or March of 2020 these potted saplings will be used as rootstock for grafting scions collected from our three mature white spruce orchards. They will be added to the small orchard of grafted white spruce planted at former Hayward Nursery in 2015. The goal is to have some annual production of grafted white spruce to plant out and eventually replace the aging white spruce orchards we use for seed.

Thinning

The white spruce at Mead needs to be thinned to promote better flower and cone production in the remaining trees. It is planned to be done this year, and an as-yet-to-be-determined number of trees harvested. The hope is that it will coincide with decent cone and seed production so that we can take advantage of the tree harvest for ease of collecting cones.

Cone Collection

While the actual collection of cones occurs in the last two weeks of August or early September, scouting and preparation begin in late spring and early summer. Cone production has been very limited in our three white spruce orchards in recent years. If there is a good crop this year, especially at Mead Wildlife Area, then we would focus our collection resources on this species. Sawyer Creek and Lake Tomahawk are the other two white spruce orchards where cone collection could occur. Jack pine will be monitored for flower and cone

formation at the Greenwood and Ten Mile orchards. If warranted, a cone crop may be harvested at one of these sites.

Fall Maintenance

Fall is an optimal time for mowing, especially the grassier sites, so once seed collection activities end the mowing begins. The Kubota tractor with a brush hog is used for the aisles and perimeter of plantings, and the DR mower is used in tighter spacings. The plantings are dispersed around the state and multiple days are required to completely mow each site, so it is a major focus of work up until the snow comes. Lopping dead side-branches still needs to be completed at several locations, and that work is also done in the fall.

Administration

There are a variety of tasks required to administer the program. Creating and updating files as new data is collected is essential, as is good record keeping. Communicating with other members of the Reforestation team is frequent, and includes regular phone conversations, email and in-person meetings. Coordination with other DNR staff to accomplish certain projects such as cone collection and thinning of plantings requires timely communication and planning. Collaborations and meetings with other tree improvement professionals, such as with the butternut canker trial, also requires preparation and regular communications. Writing and compiling the *Work Plan* and the *Reforestation Programs Annual Report*, and this year the *Strategic Plan 2019-2029*, are the focus during the winter months of January and February.