Tree Seed Working Group News Bulletin

78

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Canadian Forest Genetics Association
Association canadienne de génétique forestière

SEED COLLECTION

Featured in this Issue

Armchair report

Hello, may the seeds be with you in 2026. Our theme focuses on the critical stage of "Seed Collection" and the associated stages of identifying potential crops, harvesting seed containing structures at the correct time and handling this material appropriately. Performing these one-time activities correctly should be thought of as an investment that will be captured for the entire life of a seedlot. These one-time activities are not the time to be cheap or cut corners as those 'savings' will cost you in the long run. It's analogous to the older quote I'm not sure who to originally attribute it to "Good seed doesn't cost – it pays".

Thank you to everyone who has contributed to this edition and shared their experiences. I believe that our efforts contribute to a Community of Practice for those involved with tree seed from forecasting all the way to use in nurseries or for genetic conservation activities. We can all learn something new or be enlightened with a new perspective. Our next News Bulletin theme is "Genetic Conservation" focused on activities, results, benefits and limitation in the use of tree seed. Although we try and have a general theme for each edition that does not mean that every article needs to be on that topic, so anything related to tree seeds is a welcome contribution. It will be our 2027 New Year edition, and we will be requesting articles by early to mid-December.

This News Bulletin crossed paths with a webinar put on by the BC Seed Orchard Association (BCSOA) and formed the framework for articles included from Geoff Bradley and myself. The seminar series will continue in the fall and if you want to be on their distribution list for this series and the 2027 BCSOA meeting go to this link.

Many of the same messages and more (=more time) are included in a talk on Cone Maturation, Collection, Handling and Storage from the 2014 BCSOA meeting. I'll also bring to readers attention the presentations and resources from our 2018 Cone Collection workshop in BC. You will also find a whole host of other seed-related resources there.

There are a few facility anniversaries this year. The BC Tree Seed Centre is celebrating 70 years of operation with 30 years in Duncan and 40 years at its current site in Surrey. New Brunswick is celebrating 50 years of tree improvement this year. The grandparent facility still operating is the Berthier nursery and seed centre that is looking at its 100-year anniversary in 2028 – Wow!

There are a few retirements to celebrate in BC. Don Pigott is retiring and selling off his equipment and seed inventory. As one of his last contributions Don is producing a Technical Report outlining "Guidelines for Collecting and Processing Ex Situ Seed samples for Genetic Conservation in British Columbia". Although relevant to this editions theme it is not ready for distribution. See the enclosed article for an overview of Don's retirement party. In keeping with this News Bulletin theme here is a link to Don's first cone collection in 1968 – times certainly have changed. Dr. Alvin Yanchik recently retired after 38 years with the BC Forest Service. He was the official and unofficial leader and prophet for the BC forest genetics section and an Adjunct Professor at the University of Victoria. He will be greatly missed for his contributions across the entire spectrum of forest genetics and tree improvement activities in BC. The other significant retirement in BC is Bevin Wigmore who has been involved in nursery, research and seed orchard activities in BC for over 35 years.

Rob Keen who co-hosted last summers workshop in Ottawa has also recently retired. Rob was a visionary in creating the Canadian Tree Nursery Association (CTNA) and passionately represented that group and the entire reforestation industry at many venues across the country. Before this Rob was CEO of Forests Ontario and was involved in many organizations that championed the sustainability and stewardship of Canada's forests.

My least favourite part of my editorial is making people aware of those that have passed away since our last News Bulletin. Sherry Collins who worked at the BC Tree Seed Centre from 1990 to 2015 passed away this past winter. Sherry was one of those 'glue' people who could maintain humour at the workplace and still be the hardest working person there. Al McDonald passed away on February 13th and here is a link to his obituary. Al ran the Saanich test nursery helping to develop nursery methods the industry uses today. He was also instrumental in building our Seed Planning and Registry (SPAR) system and in managing and securing seed for BC timber Sales, especially during the devastation of the mountain pine beetle epidemic. My condolences to friends and family of both.

Although unable to provide an article on their latest developments, I'd still like to spotlight OutReach Robotics for their drone-based equipment development. They have recently developed a prototype for large-scale cone collection on black spruce and if that is of interest, please contact them - it isn't on their webpage yet. The mechanism I'm most excited about is the DeLeaves tree sampling tool which I think would be great for scion collection activities, especially from remote and/or large trees. They have indicated it has been successfully operated at temperatures as low as -10°C and as long as the batteries are kept warm right up until takeoff, you will not encounter any issues.

In the last Armchair report, I was interested in our readers oldest tree seed collections, whether they still reside in storage and if you have any long -term germination results. I'm still interested and we are now in a show me yours and I'll show you my situation. Our seedling request totals in BC took a small increase this past year going from 222.7 M last year to 226.4 M this year. Not a big change, but in the correct direction. Seed orchard seed accounted for 70.8% of the seedlings ordered for BC in 2026.

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Tree Seed Working Group Distribution List

The Tree Seed Working Group uses a google group (https://groups.google.com/g/tswgcanada) as a discussion forum and as a distribution list for our News Bulletin and tree seed related postings. You can sign up for our distribution list at https://cfga-acgf.com or e-mail one of our team members directly (Darren, Dave, Fabienne or Kerry).

There are two ways to become a new member of the list:

- You have a gmail e-mail address then you can be added directly
- If you have another service for your e-mail, you will receive an invitation from us and once you accept it, you will be added to the list automatically.

There has been a large backlog of those invited to the list but have not accepted.

Our goal is to ensure that all authors receive a copy of the News Bulletin they have contributed to. It is easier and less time-consuming for us to have only one list and not maintain a separate bcc list for those that have indicated an interest in the past but not accepted the invitation. If you did not receive an invitation but feel you signed up - apologies – please express your interest again by sending an email to one of the TSWG committee.

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Reproductive Biology Resources

Many are familiar with my concern regarding the amount of research currently being conducted and expertise available regarding the reproductive biology of tree species. It seems like the assumption is that we have all the information we need on this topic and that climate change will not impact tree reproduction? I simply find it odd with more than 100 seed orchards in BC that there is no one dedicated to research (basic or applied) in this area. My recent mantra for tree seed science & technology "**no funding, no research, no people, no teaching, no progress**" seems appropriate and we are probably in a worse situation for tree reproductive biology.

The News Bulletin has past editions that are relevant to this topic with edition #33 themed "Reproductive Biology"; #58 themed "From Seed Collection To Storage"; and edition #61 had an article reviewing "Collection Timing and Post-Collection Handling". All past editions can be found here; https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/tree-seed/tree-seed-centre/cone-seed-improvement-program/tree-seed-working-group. The actual presentations from our 2013

Tree Seed workshop on Reproductive Biology summarized in edition 33 can be found here: https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/tree-seed/events .

This article has a definite BC flavour as that is the literature and species we deal with and have the most familiarity with. Unravelling the basic species specific information has been led by the University of Victoria with Dr. John Owens and more recently Dr. Patrick von Aderkas. They are the most well known heavy hitters, but have received a great deal of support from graduate students, post-doctoral fellows and other peers.

I've grouped the references into a few categories and sorted them by publication year within each category. The list is an entry point and focuses on significant proceedings, summaries and books and each provides references to the literature available at the time of printing. I make no claim the list is exhaustive and if your favourite reference has been omitted, please let me know.

Historical Guides

These are generally considered foundational writings on reproductive biology with an emphasis on gymnosperms and that is my bias. With advances in science some of the details have been updated or corrected, but quite a lot was known 50 or more years ago. For those dealing with angiosperm tree species what is your go to l guide for reproductive biology?

Chamberlain, C.J. 1935. Gymnosperms: Structure and Evolution. University of Chicago Press. 484 pp.

Kozlowski, T.T. 1972. Seed Biology Volume I: Importance, Development, and Germination. Academic Press. New York and London. 430 pp.

Allen, G.S. and J.N. Owens. 1972. The Life History of Douglas Fir. Dep. Environ, Can., Ca. Forest Serv. Ottawa. 139 pp

Singh, H. 1978. Embryology of Gymnosperms. Gerbrüder Borntraeger, Berlin. 302 pp.

Edwards, D.G.W. 1980. Maturity and quality of tree seeds – a state-of-the- art review. Seed Sci. & Technol. 8:625-657.

"Modern" Knowledge Summaries

There are some who would put some of these in the historic category, but it's my summary. Many would agree the 1980's and 1990's were the golden age of research efforts into conifer reproductive biology.

Owens, J.N. and M.D. Blake.1985. Forest Tree Seed Production. A review of literature and recommendations for future research. Can. For. Serv. Inf. Rep. PI-X-53. 61 p.

Webber, J.E., J.N. Owens, and M.U. Stoehr (Eds). 1995. Biology and Control of Reproductive Processes in Forest Trees (1993 event). Tree Physiology 15

Suszka, B., C. Muller and Marc Bonnet-Masimbert. (Translated from 1994 French version by Andy Gordon).1996. Seeds of Forest Broadleaves. INRA, Paris. 295 pp.

Owens, J.N., T. Takaso and C.J. Runions. 1998. Pollination in conifers. Trends in Plant Science 3: 479-485.

Tomlinson, P.B. and T. Takaso. 2002. Seed cone structure in conifers in relation to development and pollination: a biological approach. Can. J. Bot. 80:1250-273.

Gelbart, G. and P. von Aderkas.2002. Ovular secretions as part of pollination mechanisms in conifers. Ann. For. Sci. 59:345-357.

Philippe, G., P. Baldet, B.Héois, and C. Ginisty. 2006. Reproduction sexuée des conifers et production de semances en vergers à granies. Cemagref. 571 pp.

Kong, L. and P. von Aderkas. 2007. Plant growth regulators and cone induction in Pinaceae. 27 pp. https://forestgeneticsbc.ca/wp-content/uploads/2020/07/Plant-Growth-Regulators-and-Cone-Induction-in-Pinaceae-2007.pdf

Williams, C.G. 2009. Conifer Reproductive Biology. Springer. Germany. 170 pp

Crain, B., Cregg, B. Regulation and Management of Cone Induction in Temperate Conifers. For. Sci. 64, 82–101 (2018). https://doi.org/10.5849/FS-20l6-131

Practical Guides

Eremko, R.D., D, G.W. Edwards and D. Wallinger. 1989. A guide to collecting cones of British Columbia Conifers. Joint publication of Forestry Canada and the British

Columbia Ministry of Forests. 114 pp. http://library.nrs.gov.bc.ca/digipub/Frr055.pdf

Portlock, F.T. (compiler). 1996. A field guide to collecting cones of British Columbia conifers. British Columbia Tree Seed dealers' Association91 pp. https://a100.gov.bc.ca/pub/eirs/finishDownloadDocument.do?subdocumentId=13309

Banerjee, S.M., K. Creasey, and Diane Douglas Gertzen. 2001. Native Woody Plant seed collection guide for British Columbia. BC Ministry of Forests Tree Improvement Branch.147 pp. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/tree-seed/tree-seed-publications/native_woody_plant_seed_collection_guide.pdf

Forest Gene Conservation Association of Ontario. 2024. Seeds of Ontario & Eastern Canada: A manual for tree and shrub forecasting and collection. Canada (2nd Ed.) 281 pp. copies can be purchased from www.fgca.net

Species Specific Information

The first thing that comes to mind are the species specific Reproductive Biology or cycle publications that were produced by Dr. John Owens. These are the summaries of many conifer reproductive biology referred journal articles into a format more easily digestible for the practitioner.

Owens, J.N. 2006. The reproductive biology of lodgepole pine. FGC extension note: 07. Prepared for Forest Genetics Council of British Columbia. 62 pp. https://forestgeneticsbc.ca/wp-content/uploads/bsk-pdf-manager/2020/07/ExtNote7-Final-web.pdf

Owens, J.N., 2004. The reproductive biology of western white pine. FGC extension note 04. Prepared for Forest Genetics Council of British Columbia. 40 pp. https://forestgeneticsbc.ca/wp-content/uploads/bsk-pdf-manager/2020/07/ExtNote4-Final-Web.pdf

Owens, J.N and M. Molder. 1985. The reproductive cycles of true firs. BC Ministry of Forests publication. 35 pp. https://library.nrs.gov.bc.ca/digipub/20260617085004641.pdf

Owens, J.N and M. Molder. 1984. The reproductive cycle of interior spruce. BC Ministry of Forests publication. 30 pp. http://library.nrs.gov.bc.ca/digipub/bib2256.pdf

Owens, J.N and M. Molder. 1984. The reproductive cycles of western and mountain hemlock. BC Ministry of Forests publication. 34 pp. http://library.nrs.gov.bc.ca/digipub/bib36928.pdf

Owens, J.N and M. Molder. 1984. The reproductive cycle of western redcedar and yellow cedar. BC Ministry of Forests publication. 28 pp. http://library.nrs.gov.bc.ca/digipub/bib36928.pdf

Allen, G.S. and J.N. Owens. 1972. The Life history of Douglas fir. Dep. Environ. Can., Can. For. Serv. Ottawa. 139 pp. https://archive.org/details/lifehistoryofdou0000geor

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Maturation Indices

Once a potential healthy seed crop has been identified the critical decision will be when to collect the crop. Seed maturity can vary greatly from year-to-year and generally thought to be degree-day or temperature driven. There are many papers and facilities that track growing degree days (GDD) and these can be very informative on how a crop is likely to develop compared to other years. Better data is generally available from seed orchards where a crop will be collected for decades from the same location while wild stand crops may not have as much information linking seed maturity to annual climate variability. In addition to crop size the GDD progression in any given year can be a helpful tool in planning the timing of resource and labour needs. Most calculations use a 5° C threshold in the summation of GDD, but cereal crops use 0° C. You may also see reference to thermal units (TU) or crop heat units (CHU) and although similar to GDD they employ a different set of calculations and put a cap on on upper temperature limit as well as a lower threshold temperature. While GDD calculations are fairly standard, the TU or CHU calculations I have seen can vary greatly, but all consider reducing unit accumulation above a certain temperature as reactions may cease or slow down above this temperature. For those interested in additional information on this topic check out the overview provided by Abdulqadir *et al*. (2025).

Just a small tangent as I'm always interested in GDD research but surprised by the almost universal acceptance of 5° C as the default threshold temperatures. Have any of you had seed germination in your cooler that was below 5 C? Obviously, the threshold would need to be less than 5°C. I'm not aware of much work with seed germination or reproductive bud flushing, but there certainly are references indicating tree species and provenance variability in threshold temperatures for vegetative flushing (Worrall 1983). I'm very interested in other work in this area.

Another way to look at GDD is to use an indicator plant that is believed to be synchronized with seed maturity and that integrates other environmental variables increases its reliability. This relationship was established for *Picea glauca* and fireweed (*Epilobium angustifolium)* (Mercier and Langlois 1993). They found that fireweed phenology and its progression could be used as a tool to forecast optimal collection timing.

For most people maturation is gauged by visually assessing cone and/or fruit characteristics as a first step followed by an assessment of the actual seed contents. As early as 1953 Crossley used cone flexibility, cone firmness, seed coat colour and seed brittleness to assess maturity in white spruce. These characteristics are quite subjective and rarely used today to assess maturity. In conifers, the colour of the cone can certainly indicate progression of seed maturity, tissue dehydrations and lignification of cone scales, but are not good criteria for timing collections. Another test utilized in BC is the cone axis test where the cone is cut longitudinally and the axis examined for the presence of moisture. If the axis is dry and brown it is assumed that connection to the tree has been severed and can guide timing of cone collection. One related and often overlooked characteristic is the seed wing separates from the ovuliferous scale at seed maturity. This is a simple method to determine when the seeds become independent from the cone or fruiting structure.

Most conifer seed collectors will perform cutting tests on individual seeds to evaluate seed maturity. This is best done as a longitudinal cut to maximize a visualization of the contents but can be challenging for very small-seeded species (Figure 1).

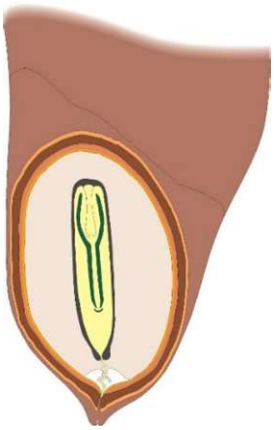

Figure 1: Longitudinal section of a mature conifer seed.

The main criteria we use in BC is that the embryo should occupy 90% of the corrosion cavity in which the embryo sits. Cutting tests also allow one to assess the consistency or firmness of the megagametophyte as this will change from being jelly-like and opaque to firm and white in most species. The meat of the coconut has often been used as an analogy to describe mature megagametophyte tissue. Cutting tests can be done on dry freezer ready seed (<8% moisture content) but at our facility we find imbibing the seed overnight allows for a better assessment of seed condition (Figure 2) and used as our final seed cuts before submitting a seedlot for testing. Although currently not practiced at our facility it has also been indicated that if the megagametophyte from cut seeds does not shrink overnight at room temperature that the seed is mature (Edwards 1980).

Figure 2: Comparison of a cutting test performed on dry seed (<8% moisture content) and fully imbibed seed (roughly 30% moisture content) in *Pinus ponderosa*.

Some of the earliest maturation indicators were based on the specific gravity of cones which is cumbersome to measure quickly. Cones at high moisture content (immature) would sink evaluated by immersing them in some type of liquid that corresponds to mature cones. This was a simple field method, but many of the fluids used (e.g. kerosene or motor oil) posed issues in the disposal of these liquids. I think there may still be applicability of this technique through the adjustment of the specific gravity of water through the addition of sugar. We may want to turn to our friendly beermaker to adjust specific gravity considering the sugar needed as well as the solution temperature.

References

Abdulqadir, A.S., E.N. Godfrey and A.M. Paul. 2025.An overview of growing degree days & heat units application in crop production. International Journal of Agriculture and Earth Science 11: 83-102.

Crossley, D.I. 1953. Seed maturity in white spruce. Canada Dept. of Res. and Devel.. Forestry Branch. Silviculture Research note No. 104 16 pp.

Edwards, D.G.W. 1980. Maturity and quality of tree seeds – a state-of-the- art review. Seed Sci. & Technol. 8:625-657.

Mercier, S. and C-G Langlois. 1993. Relationship between Epilobium angustifolium phenology and Picea glauca seed maturation. Relationship between *Epilobium angustifolium* phenology and *Picea glauca* seed maturation. Forest Ecology and Management 59:115-125.

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Expanding tree seed supply in the U.S. Pacific Northwest

There is growing recognition of the need for increased reforestation capacity to aid recovery from larger and more frequent forest fires in the western U.S. The foundation of any reforestation effort is a reliable and genetically appropriate seed supply. With climate change, the need to source seed from areas beyond traditional local jurisdictions has become important to support climate-adjusted planting programs. The U.S. Forest Service (USFS) has a large network of seed orchards in Washington & Oregon, mostly established in the 1980s or early 1990s, that can help meet this need (see Figure 1). For eastern Washington and eastern Oregon lands, these are often the only orchards that exist for their zones. However, after decades of budget limitations and reduced staffing, these orchards need restoration work to reduce vulnerability to loss from fire and insect outbreaks, and to restore them to a condition favorable to seed production. Staff with expertise in genetics and seed production from both the USFS and Washington State Department of Natural Resources (DNR) have been collaborating to restore these seed orchards to a more productive condition, so that both organizations can have access to a more reliable seed supply.

The Good Neighbor Authority (GNA), enacted by the U.S. Congress, allows the USFS and States to work together to manage National Forest lands. The Washington State Legislature, using revenue generated by Washington's Climate Commitment Act, provided funding to DNR to do the orchard restoration work. DNR staff conduct inventories and create thinning plans for each orchard, then review those plans with USFS staff to get their approval. Operational work is accomplished using DNR contracts. Restoration work includes (1) thinning trees to keep crowns well separated, (2) pruning trees and removing tall shrubs to minimize ladder fuels, and (3) masticating woody debris, stumps, and vegetation to reduce fire intensity in the event of a fire and also to allow efficient use of lifts for cone picking. To date, we have completed work in 14 orchards, and are actively working on additional orchards to be thinned this year (see Figures 2 & 3). Results have already been encouraging. As orchard managers know, maintaining full light on tree crowns is favorable for flowering, and we have seen a response of cone crops in some of the first orchards we thinned. We collected cones from 8 orchard blocks across 3 orchard sites in fall 2025. We are hopeful that orchards thinned a year later will have viable cone crops this coming fall, and we will be checking on those soon.

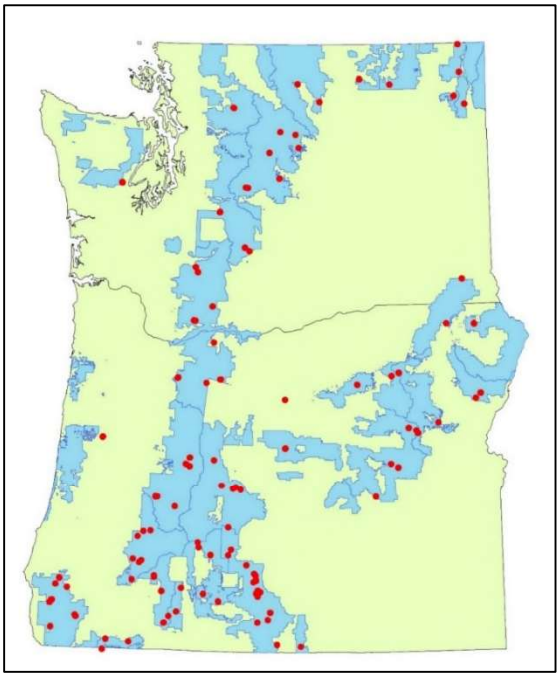

Figure 1. National Forests in Oregon and Washington shown in blue, with locations of USFS seed orchards shown as red dots.

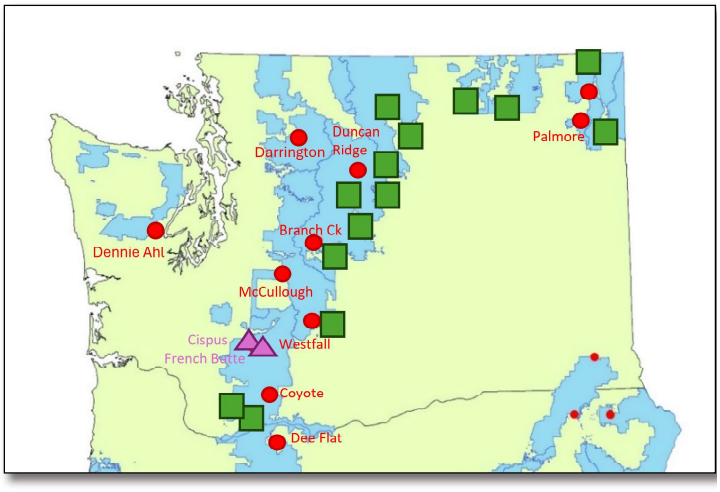

Figure 2. Current status of USFS orchard restoration in Washington as of June 2026, with completed orchards shown as green squares, and orchards fully prepared for thinning shown as purple triangles.

Figure 3: Brown's Mountain seed orchard before and after restoration work.

We encountered several challenges as we began work on this project. The first was ensuring that we had the right information about orchard design and composition. After 25 years of staff reduction and turnover, along with limited funding, some sites were not well monumented. For others it was difficult to find the datasets to work with. USFS staff did a great job of digging through old files to find whatever information still existed. Remarkably, between remaining monumentation, datasets, and old maps, we were able to reconstruct the design of almost every orchard. A second challenge has been what to do with the thinned stems. In many of the areas where we are working, there is no longer local mill capacity, and the haul distances are so great that the cost of hauling exceeds

the value of any otherwise merchantable logs. Especially with ponderosa pine, we cannot simply leave logs decked because of the risk of beetle populations building up and killing the leave trees and surrounding forest areas. As a result, we have ended up with a mix of strategies. In some cases, we have been able to sell the logs where a market existed. In other cases, the only viable option was masticating the trees entirely to avoid creating beetle habitat. While this is a higher cost option than simply logging the stems and masticating the tops and limbs, it allowed us to bring orchards back into good condition where markets didn't allow normal thinning operations.

Beyond orchard restoration, another aspect of opening up seed supply is more administrative. While we are often focused on the challenges of finding cone crops to pick and enough contractors to pick them, an additional challenge can be the difficulty of working across organizations to expand work capacity and make cone harvest more economical by increasing scale. To help facilitate more cooperative cone collections, we have worked with other forest managers and the Western Forestry and Conservation Association (WFCA) to create the Seed Orchard Crop Management Cooperative (SOCMC). Despite its name, this cooperative is designed to facilitate cooperative cone picking anywhere, not exclusively in seed orchards. There are no fees or obligations to be part of the SOCMC, and members simply pay their share of any cone collections in which they choose to participate. When we find a pickable cone crop, each organization submits their seed goals, and those are combined to set the overall target as well as the percentages for each organization that determine how much of the collection cost they pay and how much of the resulting seed they receive. Over the past four years, the SOCMC has collected over 2500 lbs of seed across 8 orchard sites, providing seed for 15 cooperators. We continue to add cooperators, and are hoping for another successful year in 2026.

While we still have a ways to go in terms of opening up seed supply, we feel that we are taking important steps in the right direction and look forward to continuing collaborative work going forward.

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Quercus Collecting Notes

Collecting recalcitrant seeds of nut bearing species presents unique challenges that are somewhat different from collecting orthodox seeds.

The most well-known recalcitrant genera is *Quercus*, with *Carya* and *Corylus* generally understood to have these seed traits as well as other nut producing species. A lesser-known category of seed behavior is "sub-orthodox" which is useful for describing seeds with high lipid content such as those of *Fagus grandifolia* and *Sassafras albidum*, which can be stored more successfully than *Quercus* spp. seeds but are still not nearly as robust in multi-year storage as well-known orthodox genera.

This article will focus on collecting Acorns; perhaps these experiences can also inform working with some of those other genera.

I base these observations on a few decades of working with Oaks; my peak season involved supplying 3,000 kilograms of Acorns to nurseries and seed dealers, which required about one complete month of my full-time collecting and processing labor but also a significant amount of scouting work in advance of that month.

Quercus genetics: I first must note that it has been said of *Quercus* that it is still "evolving in front of our eyes." Where I live in the northern lower peninsula of Michigan, the local members of the Red species group (those with Acorns requiring 2 years to mature, as with the cones and seed of Pine species) *Quercus rubra*, *velutina*, and *ellipsoidalis*, can have particularly tangled genetics. Although I rarely see clear, pure F1 50/50 hybrids of 2 Quercus species I do commonly see what I presume to be F2 or F3 specimens showing signs of genetic introgression from another species in characters such as bud pubescence and Acorn cap traits, assumedly from one of their cousins in the near past. One of my specialty tasks is assessing purity in *Quercus ellipsoidalis* (probably the toughest of the Red species group, in terms of tolerance to a cold climate and dry soil sites). Introgression is also occasionally seen in the White species group (one year Acorn development), particularly amongst *Q. macrocarpa*, *bicolor*, and *lyrata*; the last is a more southern species less likely of interest in Canada.

Forecasting & Scouting

The two-year development process for Acorns in the Red Oak group does allow crop forecasting a full year in

advance if one has direct access to the twigs; that can be difficult from the ground while leaves are still on the tree. In practice I have rarely ever put that into use as the presence of the small year-old Acorns doesn't fully guarantee a quality crop on the tree a year later. And for me this is also because I live in the Great Lakes, where we frequently have a distinct crop condition inland vs. along shorelines. Sometimes those are in sync but other years only one of the two macro areas might have crop success.

That in turn also informs my scouting work - I don't really attempt to scout collecting sites until the month of August despite the presence of small acorns the previous 2 months. Once the acorns are large and generally yellow-green, sites can be scouted quickly, often while still driving, and much more ground can be covered in late summer rather than earlier.

Where to collect Oak

The easiest collection sites are anywhere with mowed grass beneath the tree. Yes, I know, this -could- mean the tree was planted and thus best-possible-local-adaptation-traits may be in doubt. However the difference in efficiency between collecting on a human site vs a natural site is so vast that millions of Oak trees have been successfully outplanted from Acorns originating on mother trees growing over manicured surfaces.

The best mowed grass sites are probably Cemeteries, with public Parks a close 2nd. Many cemeteries are some of the best tree seed orchards that one can find outside of an actual tree seed orchard. The managers of the Cemetery (Sextons, as they are known) are often tasked with removing Acorns, eventually, anyway, and in my experience are always quite happy to have someone remove them for free. In Parks there may be more of an expectation that Acorns should be left for wildlife; a much deeper conversation. Where I work we have begun gently pushing back on seedling customers who do not allow seed collection on their properties.

The worst mowed grass sites are those of private residences, even though these can be incredibly productive. And most often the Oak tree involved is of natural origin, where homes (or Cemeteries & Parks) were built in an area of natural Oak forest communities. However home owners are often not observant of the -current- activities of plants. At one time I advertised to offer "Free Acorn Clean-up" but ultimately I had to discontinue this technique due to repeated experiences with an all too common seed collecting scenario: "I don't know what happened, last year there were so many Acorns we couldn't walk through here," said when looking at a yard now devoid of any Acorns in the current growing season. Home owners can also be quite finicky, such as expecting removal of a dozen Acorns every 2 days rather than all in a single visit later in the drop season. They also can struggle to differentiate even the most basic Red Oak vs. White Oak identification. Hint: Red Oak Acorns look like Basketballs while White Oak Acorns look like Footballs.

The best time to collect

Best time is when the twigs are largely holding empty caps. The Acorns that are good for seedling production are the ones that fall out of the cap naturally, which are also usually the last to fall from the tree. Acorns that reach the ground still attached to the cap are almost never usable. This is also true of Acorns that fall early, as Oaks will often abort a large or small portion of their Acorns to varying degree, beginning in mid-summer. Acorns can be collected for many weeks after their natural fall, but collecting just before the majority of caps also fall (a few days after the majority of their Acorns) will help reduce the volume of material to process after collection. The information to watch for collection timing as the Acorns ripen is wind speed forecasts.

Risks of collection date

Acorns actively transpire through the top of the Acorn and if it is a dry period between Acorn fall and collection some portion of them may begin to lose viability, particularly on the south side of trees where Acorns may be laying in direct sunlight for long periods each day. Prompt floatation can sometimes restore viability % if acorns are allowed to soak for a period of time. The other risk is losses to wildlife, which can occur quite quickly/daily in a low mast year; also species in the White Oak group will be consumed first by wildlife and should be prioritized for collection over species in the Red Oak group.

Masting

This is a beloved topic among non-seed collectors. I can't tell you how many times I have heard an autumn declared a "Mast Year" followed by a bunch of psuedo-expert 'splaining of the concept of Masting (much of it quite overly anthromorphic), just because the plant lover saw

some Acorns on the ground, under one tree. I pay zero attention to such people.

How to collect the Acorns?

Two basic techniques exist. Simple to expensive rolling basket devices facilitate collecting nuts from relatively clean ground surfaces; these are more intended/marketed for commonly edible species such as Pecans but will work fine with Acorns. I prefer a simpler method of just raking the Acorns into piles. I will note that is a very good upper body workout in comparison to the roller devices and is quite effective and much less demanding of clean ground conditions compared to rolling devices. It doesn't take long to intuitively grasp the fine details of raking technique needed to skim off light material such as leaves, grass clippings, etc., and be moving mostly just Acorns. A light touch moves the light material over and away from the heavy Acorns, a more forceful stroke moves the Acorns, etc.

A routine hazard of Acorn collection: Deer droppings. They are round and will roll right along with Acorns. They can largely be avoided simply enough - but not perfectly. Gloves should always be worn when handling Acorn collections.

How to create a clean seed lot?

Floatation is the primary standard technique. This helps reduce non-Acorn material, removes fully/partially hollow Acorns which never developed a healthy kernel, and also helps detect and remove Acorns excessively damaged by grubs which hatch inside the Acorn.

The necessary work is simple and low-tech but has caveats. Some people will simply float the entire collection; my preference is to remove light material first, leaving much less material to put in water and then remove from the water. For that I simply repeatedly pour collected material from one bucket to another in a strong air flow from a larger blower / "squirrel cage" fan. An additional processing step but one that shortens the time then needed for floatation.

My most key Acorn tool: a strainer.

I use a common kitchen strainer to pull up a few quarts of Acorns at a time from a tub of water, after skimming off any floating material. My current favorite is a one-piece plastic pasta strainer with a particularly convenient and durable handle. Acorns hesitant to instantly float or instantly sink are best just kept with the discarded floating material.

Handling Acorns after floating

Depends on destination. Acorns being shipped commercially will be inside sealed containers and need to be briefly surface dried to reduce risk of mold during transportation. Red Oak group Acorns moving direct from being floated to the nursery planting them should be left in 5 gallon buckets, still wet, to help reduce moisture loss. That is as compared to burlap or Onion sacks, which are acceptable if Acorns are to be planted quickly, but can begin to allow moisture loss over time while awaiting planting. Buckets of wet Acorns should be kept in cool/shaded temperatures and where rodents can't reach them, which can be a tricky combination to site. See below for White Oak concerns.

High quality Acorn lots

I must note that collection and processing timing is never exact in terms of absolute best possible seed health and purity, afterwards. This is because a normal filled/healthy Acorn can sometimes detach from its cap -before- a grub, or multiple grubs inside have even hatched from their egg capsule on the surface of the kernel. The result of this is an Acorn that passes an initial float test (sinks) but is then revealed to have a grub exit hole a few weeks later while awaiting planting (and now floats). Thus it can at times be worth floating a collection a second time, 2-3 weeks after an initial float. Each float will help keep the kernels properly hydrated while awaiting planting, and a 2nd float can at times help remove up to an additional 5% of less ideal Acorns remaining from the first float. That won't make a very noticeable difference in outdoor bare-root production but could in other production systems.

Rocks: these will sometimes be present in an Acorn collection and must be removed from a post-floatation lot by hand. The best way to avoid this problem is to not rake Acorns where gravel is present, unless necessary for quantity goals. Post-flotation seed lots can have other non-viable debris as well, largely organic material that was already well saturated with water when collected (often wet caps in particular), or things like Acorns smashed by tires, partially eaten ones, etc. will also sink.

Acorns with grub exit holes will often still sprout. The cotyledons will be randomly malformed but a healthy seedling can often still result. Thus when a collection is smaller than hoped in that case sufficiently heavy feeling

Acorns, albeit with a grub hole, may still help a collection reach a seedling production target.

White Oak

Those species require more focus. The overall best practice is for the Acorns to be collected, immediately processed, and then immediately delivered to their planting site for immediate sowing. The fewer "middlemen" the better, by far, and also the absolute fewest possible middle days between natural drop and planting is best.

The future seedling can handle unfortunate events including even radicle breakage and a small bit of drying, but the more things that happen to a White Oak Acorn before sowing the more challenges the seedling will face later. One thing to note is that White Oak Acorns should not be held for anything beyond a very short collecting period in buckets and not at all after processing as the core of the lot inside will be unable to dissipate heat even in cold storage, and this will accelerate radicle emergence and growth. I prefer Onion sacks (sometimes doubled) for White Oak transport as a handy aid in heat dispersal. Also note that the various species in the White Oak group behave differently in terms of radicle emergence; *Q. alba* germinates the fastest while some species have much less challenge in this regard, but still should have more concern used regarding their temperature than Acorns from the Red Oak group.

Storage

Many author and experimenter has attempted to discover conditions under which *Quercus* seed can successfully be stored for future use. I have no particular research or technique to recommend, and I expect future investigators will continue to attempt this. Cold & moist winter storage followed by Spring sowing can be performed successfully enough though with some slight loss of viability % as compared to basic post-collection sowing, the far more common practice. The exact loss will vary from year to year and seed lot to seed lot, probably related to the hydration state of the Acorn which would be set by the unique weather conditions prior to collecting.

My innate understanding of all the many research attempts is that the viability decline is routine, gradual, and inescapable. The ultimate goal is usually to find a way to get Acorns all the way through the next growing season for sowing when the subsequent acorn crop fails. To my knowledge this has never been achieved with a significant degree of success. Working against the goal is the bulky nature of Acorns and the cost of cold storage for the resulting quite large seed lots. I have yet to meet a grower who attempts next-summer storage despite the routine wish that could work. Meanwhile Oak species have large ranges and a local crop failure will usually be covered by simply using a seed lot from further away. Alternatively, when a particular Oak species is unavailable for planting due to a previous local crop failure the work-around is using a 2nd choice Oak species for a planting. Most natural plant communities I am aware of can host multiple Oak species.

References

Overlease, W. R., 1991. Genetic relationships between three species of oaks as determined by common garden studies with populations from Michigan, Indiana and Wisconsin. **Journal of the Pennsylvania Academy of Science 65(2): 71-74**

See also Andrew Hipp (Morton Arboretum) ResearchGate page

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From Cone Collection to Reforestation: Gathering Seeds for the Future of Tłı̨chǫ Lands

Seed collection is one of the least visible stages of reforestation, yet it forms the foundation of everything that follows. The species selected, the location where seed is collected, the quality of the material gathered, and how the seed is processed and stored all influence the forests that will grow decades into the future.

The Tłı̨chǫ Government's reforestation initiative in the Northwest Territories (see maps) began with cones and seeds collected from local trees growing near Edzo, one of the neighbourhoods that make up the Tłı̨chǫ community of Behchokǫ̀. Before planting prescriptions were finalized and before seedlings began their journey north, crews were already out on the land gathering the seeds that would make the project possible.

The collection effort supported a broader restoration initiative aimed at re-establishing forests on Tłı̨chǫ lands, while ensuring that future seedlings originated from seed adapted to local conditions. The project was guided by a Two-Eyed Seeing approach, bringing Indigenous Knowledge and Western science together. As part of that approach, Elders emphasized the importance of using plant material from within Tłı̨chǫ territory rather than introducing seed from outside the region.

What began as a local cone collection effort would eventually provide enough seed to grow more than two million seedlings.

Starting with Local Seed

In the summer and fall of 2023 and 2024, crews worked within the Tłı̨chǫ boundary near Edzo to collect cones and seeds from local tree species. The collection included white spruce, black spruce, tamarack, trembling aspen, and paper birch. These species were selected to support future restoration goals and maintain a forest composition suited to the region. (see images A, B, C, D)

Different collection methods were used depending on the species and site conditions. Black spruce was collected using pole saws to cut cone-bearing tops from seed trees. Helicopter access was used for white spruce and tamarack collection. Birch and aspen seed were collected by hand.

Seed collection in the North comes with its own realities. Remote access, variable weather, and short seasonal windows all shape the process. Collection planning must also consider seed zones and local adaptation, particularly in landscapes where climate, growing conditions, and future restoration needs can vary across large distances.

Tłı̨chǫ crew members played a central role in the work, contributing approximately 57 person-days during the 2023 and 2024 collection seasons. The National Tree Seed Centre was also consulted and offered to visit the community in 2025 to provide further training for community members. Alongside supporting reforestation, the project is creating opportunities connected to environmental monitoring, field assessments, and long-term forest management capacity within the community.

From Forest to Nursery

Seed gathered on Tłı̨chǫ lands was shipped to PRT Growing Services Ltd.'s facility in Prince Albert, Saskatchewan, for extraction, testing, and storage. There, cones were processed to separate and clean the seed, helping ensure high-quality stock for nursery production.

The seeds extracted from the collected cones were grown into approximately 2.73 million seedlings for upcoming planting seasons. High-quality seed helps produce more uniform seedlings, supporting better and more predictable outcomes once trees are planted on the landscape.

In 2025, seedlings travelled back north in refrigerated trucks before being planted across areas near Behchokǫ̀ and James Lake. Another 200,000 seedlings are en route for planting this year. The scale of the work is significant. Summer 2025 planting plans included approximately 1.73 million trees across roughly 1,440 hectares. Planting in 2026 continues restoration efforts closer to the community, including the use of lower-flammability species such as trembling aspen and paper birch in some areas.

Looking Ahead

Tree planting is often the most visible part of reforestation, but projects like this show how much work happens long before a seedling enters the ground.

Seed collection, processing, storage, nursery production, site assessments, planting prescriptions, monitoring, and community collaboration are all part of the restoration process. Each stage helps build the foundation for forests that can continue supporting wildlife, communities, and ecological functions into the future.

For the partners involved in this work, the project is not only about responding to recent wildfire impacts. It is also about preparing for what comes next: using local seed, local knowledge, and long-term planning to support the recovery of northern forests in a changing climate.

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Splitrock Environnemental

Áma sťíqswa! Welcome to a very special place in British Columbia: Sekw'el'was (Cayoose Creek), part of the St'át'imc Nation, home to our native plant nursery at Splitrock Environmental.

Splitrock Environmental is proudly owned and operated by the Sekw'el'was band, located just south of Lillooet, BC. In the St'át'imcets language, Sekw'el'was—meaning "split rock"—refers to the towering cliffs parted by the waters of Cayoosh Creek. These waters plunge into beautiful crystal-clear pools before joining the mighty Fraser River.

Our climate in Lillooet is unique—a true microclimate that can sometimes feel like desert conditions, even as we remain surrounded by mountains and rivers. This distinct environment shapes everything we grow and how we restore the land.

View of “Splitrock”

My name is Courtney Andrews and I’m a proud Metis woman. I’ve had the privilege of working at Splitrock as the nursery manager for seven years now. In that time, I’ve learned so much from the St'át'imc people —their deep love for the land and their traditions have profoundly shaped my view of the natural world and deepened my connection to my own Indigenous heritage. I work alongside an amazing team. Ashely Peters is our new nursery manager and St'át'imc woman from Ts'kw'aylaxw community. Odin Scholz is our Senior Biologist, and has been with Splitrock from our modest beginnings. He is very enthusiastic in sharing his wealth of knowledge and experience in restoration work.

For the St'át'imc people, life has always been inseparable from the land. For generations they have hosted trade with other Indigenous communities and cultivated forest gardens to sustain and nurture future generations. Our work at Splitrock has been enriched by the guidance of the Sekw'el'was elders, whose traditional ecological knowledge has been preserved and passed down through generations. This ancestral knowledge is focused on observing and tending to the land - an approach that recognizes the deep, reciprocal relationship between people and the environment. Learning from elders has provided us with an invaluable perspective that complements scientific understanding. They teach us not just *what* to do, but *how* to be in a relationship with the territory, respecting its cycles, and ensuring its long-term health and vitality.

Under the direction of the Sekw'el'was band, Splitrock has taken on the sacred responsibility of land stewardship. This includes caring for spawning channel grounds to support salmon migration and preservation. Our targeted restoration efforts involve planting a variety of native tree and plant species along the channels, paired with detailed monitoring of salmon and their environment. Many of these species are relevant for restoration of the lands of the St'át'imc people after being ravaged by fires and floods due to climate changes.

Since its establishment in 2012, our nursery has seen years of significant growth with an increased demand for locally adapted species needed for restoration efforts in the region. Our operations now encompass ethical seed collection, cleaning, and storage. In addition, we grow over 100 species of trees, shrubs, forbs, and grasses that are plentiful in this area and have been used for hundreds

of years as food, medicine, and tools by many Indigenous peoples. We are currently in the process of building a second greenhouse and a seed storage facility. This facility's primary function is to provide a seed storage hub for shrub, forb, and grass seed species. Through our involvement in the National Tree Seed Centre's Indigenous Seed Collection Program (ISCP) we have seen a growing need and interest from Indigenous communities to store key species in preparation for their restoration initiatives.

To support these goals, we are establishing a seed orchard in the Sekw'el'was community. This orchard will serve as a resource for our knowledge keepers to mentor and educate our youth, centering on the traditional food and medicinal plants that hold deep significance for our elders and the broader community. A key contributor to this effort is Fred Sheep, an elder who has dedicated years to our nursery. Fred helped us distinguish a specific variety of Saskatoon (*Amelanchier alnifolia)* shrubs—known as puk-puk in the St'át'imc language—which produces exceptionally flavorful and nutrient-dense berries. Fred has a lifelong connection to these berries, having foraged for them with his family for their prized nutritional qualities and delicious flavor.

Outreach educational day with school kids and Stat'mic elders.

Our collaboration with Natasha Ramroop Singh, a professor at Thompson River University (TRU), has been instrumental in evaluating the nutritional profiles of our local Saskatoon and Soopolallie (*Shepherdia canadensis*) berries. These findings, alongside other culturally significant shrubs and plants, will inform the future plantings in our community seed orchard. This endeavor will support understanding the importance of proper nutrition in our community and highlight food sovereignty for our future generations.

In 2024-25 we collaborated with the Siska band (Lytton), focusing on cultivating locally adapted tree, shrub, forb, and grass species to aid in the recovery of their territory following devastating fires. A few species include Ponderosa Pine (*Pinus ponderosa),* Interior Douglas-fir (*Pseudotsuga menziesii*), Soopolallie (*Shepherdia canadensis*), Douglas maple (*Acer glabrum*), Kinnikinnick (*Arctostaphylos uva-ursi*), and June grass (*Koeleria macrantha*). While the tree seeds were acquired from our excess stock stored at the Langley Tree Seed Centre and cultivated at a separate nursery, all other species were grown directly at our own Splitrock native plant nursery. We are proud to share that the restoration initiative has proven successful. We are seeing a robust return of numerous native species, which are now becoming firmly established throughout the designated restoration sites.

Odin has been instrumental in leading the Whitebark Pine (*Pinus albicaulis*) (WBP) seed collection for Splitrock's restoration work; he has also provided support to Ashley and I throughout the WBP growing process. We recognize the profound cultural and ecological significance of Whitebark Pine, particularly within the traditional territories of the St'át'imc Nation. The tree's highly nutritious seeds were a vital food source, traditionally eaten roasted over a fire, ground into flour, or preserved for the winter months when provisions were scarce. The knowledge systems of the St'át'imc Nation are invaluable in understanding the long-term health and management of this ecologically threatened species.

Odin with Darwyn John, St'át'imc Elder, discussing Whitebark Pine in the field.

Whitebark pine is a subalpine species that is federally listed under SARA Schedule 1 (Endangered)(2012) and is a provincial blue listed species. The endangered listing is primarily due to the high rate of die back from the introduced fungal disease white pine blister rust (*Cronartium ribicola*). Stressors also include the effects of mountain pine beetle (*Dendroctonus ponderosae*), wildfires along with their suppression, and species competition as a result of climate change. Other human threats include logging and habitat loss due to logging, mining, pipeline and powerline development.

Ashley and I have had some challenges in growing Whitebark Pine seedlings, due to lack of information, as well as climate challenges. The low elevation and peak summer temperatures that can reach 50°C in Lillooet, subject WBP seedlings to significant stress. This often causes the seedlings to enter dormancy prematurely during the summer months, hindering their full establishment. This stress compromises root growth and negatively impacts the overall vigor of the WBP seedlings. Despite these hurdles, Splitrock remains one of the few nurseries dedicated to growing this species. Our current whitebark pine restoration efforts are focused on cone collection to bolster the WBP seed supply, a critical step toward cultivating a greater number of potentially rust-resistant trees. We also played a key role in assisting whitebark Pine biologist Randy Moody, in establishing and remeasuring stand health monitoring plots throughout the region.

Throughout our journey, we have been privileged to collaborate with and learn from various individuals and organizations dedicated to restoration and seed conservation, particularly our neighboring First Nation communities and the Indigenous Seed Collection Program (ISCP). We remain committed to expanding our expertise and warmly invite others to visit us at Splitrock Environmental to experience the amazing history and unmatched beauty of this territory.

Kukwstum̓ckáĺap - Thank you, from one to many.

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Turning Thinning Operations into Seed Collection Opportunities in southern Ontario

A recent seed sourcing project for the Petawawa Research Forest required the Forest Gene Conservation Association (FGCA) to acquire red pine (*Pinus resinosa*) seed from southern Ontario. This was a challenging task considering the inconsistent masting behaviour, lower seed set in recent years and the absence of naturally occurring red pine in this part of the province.

Red pine is a high demand species for tree nurseries and planting agencies across the province, particularly those partners operating in the managed forest. However, it can be difficult to find high quality seed from known provenances. In southern Ontario, a significant component of red pine can be found in plantations on public and private lands, under differing management regimes, limited site access and significant recreation use.

When procuring seed for operational forestry or research trials, the FGCA looks to collect from natural and healthy populations, however in this case, mature red pine plantations with proven performance, established in the early 1900s provided the solution. Common afforestation practice in the 1930s (which preceded the existence of the Ontario Seed Zone Policy and the current Ontario Tree Seed Transfer Policy) led by the provincial government, was to utilize local provenances. This suggests many of the red pine plantations in southern Ontario (private and public) were established using local natural provenances at that time.

For this project in particular, the FGCA reached out to municipal partners that have forest management plans and sustainably manage red pine, and obtained a list of stands within our target area that were being thinned. This

provided an opportunity to align cone forecasting and collections with harvesting operations.

While collections following a harvest is a tried and true practice in the boreal, it is somewhat of a novice or forgotten practice for southern Ontario, where collections typically take place along forest edges, in parks or in more accessible locations.

Cut test for quality control on site prior to collection

This particular collection was opportunistic, and came together within a week of our first contact with the partner. We mobilized quickly to take advantage of the available seed crop while it was still viable and so not to lose seed on the forest floor. While it is not always the case, this operation occurred during optimal maturity and during a rare cone crop year.

Pre-cleaned collection.

Cones drying at Sommerville

What we learned through this experience is that aligning collections with harvesting is potentially an untapped resource in southern Ontario, especially for species like red pine which is in significant demand in the province. In this case, connecting with forest management professionals to learn about harvesting schedules that align with seed crops and collection timelines, on sites that have proven performance red pine, created the right recipe for collections. Another win for climate-based seed procurement.

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Seed Technology and Continuous Improvement.

Parkindale Seed Orchard extends across 270 acres of spruce and pine orchards in southern New Brunswick. Increasing demand from reforestation programs has driven the need for a reliable, long-term supply of high-quality seed. Orchard performance plays a critical role in nursery production and overall crop success. By prioritizing the highest standards of care, the orchard ensures seedlings can establish more quickly into healthy, functional forests while better supporting forest ecosystems.

Historically, seed collection at the orchard focused on larger crop years and was often constrained by labour availability. However, rising demand for seedlings has made it necessary to shift toward consistent, annual cone collection. This shift requires not only greater volumes of cones, but also improved seed quality to maximize yield and reduce cost per seed.

A continuous improvement approach was identified with several key priorities to meet current and future demands:

1. Increasing crop harvest volume
2. Improving sowing accuracy
3. Reducing seed waste
4. Enhancing germination rates

One significant challenge had been limited local labour availability for the short, 4–6 week collection window, which coincides with peak field season. To address this, the orchard implemented the use of experienced tree planters working on a piece-rate basis. This enabled the orchard to achieve its largest cone harvest on record in 2024, despite the crop being evaluated as medium sized.

Maximizing the value of that harvest depended on improving seed yield and quality. This was supported through the use of advanced processing techniques designed to remove empty, damaged, or non-viable seeds, along with debris. The introduction of a new piece of processing equipment—the Petkus Selecta HC 3.0—marked a significant advancement. This equipment delivers more precise sizing and separation, improving overall seed uniformity.

As a result, sowing accuracy has increased from typically below 96% to consistently above 96%. Improved processing has also enhanced seed use efficiency, leading to reduced waste and better utilization of available seed. These same advancements have contributed to stronger germination outcomes. With improved removal of non-viable seed, average germination rates have increased across multiple seedlots.

Together, these improvements in cone collection and seed processing have strengthened the orchard's overall seed production processing. Parkindale Seed Orchard is now better positioned to deliver high-quality seed to nurseries, supporting successful reforestation efforts and the long-term health of forest landscapes.

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An Ambitious Action Plan to Optimize the Quality and Quantity of Cone Harvests in Quebec

The General Direction of Forest Seed and Seedling Production of the Ministry of Natural Resources and Forests is responsible for managing the inventory of Quebec's forest tree seed bank. The provincial network includes 63 productive seed orchards, of which 41 are in natural forests and 22 in public nurseries. Establishing seed orchards on public nurseries' sites, offer several advantages, including easier monitoring of development and maintenance and cone harvesting by available and competent staff.

Each spring, once seed allocations have been finalized, planning for seed harvesting projects begins. This planification is done by the Expertise and Coordination Direction (ECD) and begins by identifying seed sources for each species in the product portfolio where reserves fall below the five-year average usage. Orchard managers are then asked to assess seed set for these sources. Priority sources—those offering the highest genetic gain or intended for specific areas of use—are also included, even if the seed bank is well stocked. These sources are harvested annually whenever there is a good seed set and seed harvest is possible. Once harvested, all the tree seeds required for the *Ministry of Natural Resources and*

Forests' reforestation needs are received, processed and shipped by the Berthier Tree Seed Center (BTSC), the forest tree seed center of the province of Quebec.

Since the BTSC is ISO 9001 certified (see another article in this newsletter), every seed or cone lot harvested and sent to the BTSC must be documented. The criteria include lot cleanliness, absence or presence of insect damage, accuracy of volume measurements, and correct identification labeling. However, year after year, several non-conformities related to one or more of these criteria have been identified, and improvements have not materialized as expected. During the 2024 BTSC external audit, the auditor issued a non-conformity regarding "inadequate control of input quality." To address this issue, the BTSC and ECD collaborated to develop a harvest action plan with three key objectives: improving the quality of harvested cones and seeds, developing a pool of skilled harvesters, and enhancing the predictability of harvest volumes.

This action plan was implemented through a series of meetings with regional and nursery source managers. The objectives of these meetings were:

1. To present the action plan and explain the method for evaluating seed set
2. To emphasize the importance of ensuring that lots sent to the BFSC are clean.
3. To describe the methods for measuring volumes and storing cones and seeds prior to shipment to the BFSC.

In 2025, cones from each selected source were sent to the BTSC for analysis to verify seed set, detect insect presence, and, when possible, direct harvesting efforts toward the most productive areas. A total of 22 sources were sampled: black spruce (5), white spruce (3), Norway spruce (2), tamarack (4), eastern white pine (1), jack pine (4), red pine (2), and eastern red cedar (1). Three of the four tamarack lots analyzed were rejected due to low yield. In the case of one jack pine source, harvesters were directed to the most productive areas, accelerating the achievement of harvesting objectives.

Another component of the action plan is to stabilize the annual harvest volume at around 1,500 hectolitres of hardwoods and softwoods combined, to optimize BTSC activities. Moreover, a predictable season supports staff retention and help to maintain their expertise.

Processing of the 2025 harvest is not yet complete. However, several positive developments have already been observed, including the establishment of an effective communication network between orchard managers and the BTSC, the systematic submission of samples to assess seed set, determine optimal harvest timing, and reduce non-conformities.

The 2026 seed harvest season begins with the objectives of building on last year's achievements and continuing to improve this critical supply chain for Quebec's reforestation program.

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Across the finish line: an IPM guide to the cone crop marathon

Introduction

Imagine for a moment that it's a sunny Saturday morning in early October and you are lacing up your shoes to participate in your local 'Turkey Trot 10K' trail race. This annual event is the highlight of your local running scene and lots of folks will be taking part in the race. The race committee has been planning since the last year for today's event. Dozens of volunteers are there to help with the logistics, and a local paper has a photographer on scene eager to capture the details.

While there is no one correct way to train for a 10k race, we can all agree that if we want to do our best, we wouldn't expect to just show up on the day of the race

without having put in any training and expect a good result. Our effort on the day of the event is important, but it is the work that we do in the lead-up that gives us the best chance of good performance.

Every year our harvests are a lot like the 'Turkey Trot 10K", we have the logistics of picking, tracking results and lots of eager seed users waiting to find out how the season turned out. The end result - the seedlot in storage for end users to plant - is partly a result of how well we perform over the few intense weeks of the harvest season (managing pick timing; efficient crews;, conditioning and storage, cone processing and more), but much like our race the preparation and work that we put into the months leading up to the main event are ultimately what determines if we are going to be successful.

Whether we think about preparing for a 10k or a cone crop, it's usually the basic things done well that will make the biggest difference to meeting our goals so let's look at our Integrate Pest Management (IPM) through the lens of prepping for a 10k and identify the important basics that we need to nail to hit our pick PR. As we consider the remember is that just like not every runner will train the same way, there is no one size fits all orchard management plan as every orchard will have its own unique mix of pests, environmental factors and other considerations. This article focuses on IPM in a seed orchard setting, but the principles also apply to monitoring for crops for wild-stand harvest so whether you are planning a road race or a trail run, hopefully you will find something useful.

Finally, before we begin, pesticide regulations vary across jurisdictions and so I will avoid making specific pesticide recommendations in this article, consult your local specialist for further information.

Setting season goals

Before starting to train for a race we first need to set our overall goal and pick our race. Are we going to try and run every race we can, are we planning to focus on just one event? Looking to set a personal best or a new record? In much the same way, one of the very first things that we need to do before we commit to our orchard season is to assess our seed needs for the orchards we are managing. As I think about pest management in orchards during a crop production season, one of the first questions that I will always consider is how important is this seed, how much effort and expense does this crop justify? Knowing how important a particular crop is to your seed production goals is a critical element in the decision-making process for the rest of the year. In certain instances, the value beyond monetary, of the seed may be high enough, that any measures to produce additional seed may be warranted, even if the costs are higher than the recovered value of any additional seed. In other instances, we may have enough seed available that no additional pest management effort is warranted or a crop may not be needed for harvest.

To train for our chosen race we need a plan. Our plan will need to change from the start of training through to race day. It will need to focus on some important basics, then it will need to adjust and increase in intensity as we get closer to the race. There will be some periodization and hopefully it will taper as we get closer to the big day. A similar pattern will apply to IPM planning for our crops. Having our plan established early, with key activities identified including timing and estimates of labour time will keep us on track and help avoid panicked moments later on. Creating a written plan or Gantt chart for each orchard will further strengthen your IPM planning and help with knowledge transfer and communication amongst staff.

As we move through the season it can be helpful to keep in mind what the main objectives of our pest monitoring and management plan are in each portion of the year. We may add on some extras along the way, but these are the basics that will give us the biggest return and that will be the foundation of our pest management plan. Let's break down each portion of the growing season and look at our main goals as well as some potential pitfalls for each season.

Pre-Season – Prior to cone receptivity and bud break

<u>Crop estimation</u>

I already touched on the importance of identifying the crops in being able to make effective IPM decisions, the second portion of this that really comes into play in the pre-season is early and accurate crop estimates. These will help us to refine and revise our strategies for pest management in our crops. This can include follow-up assessments after events such as late frosts or extreme winter weather. For example, a decrease in crop size due to a hard frost may mean that suddenly there is a lot less tolerance for pest damage than originally expected or crops may cease to be worth picking, either of which will drastically change our IPM strategies for the year. For example, in the winter of 2023-24 British Columbia had a

record cold-snap which caused severe losses of female cones in many Douglas-fir orchards. These losses did not appear until the spring of 2024 and resulted in losses ranging from approximately 25% to as high as 95%. In orchards with 25-40% losses, protecting the remaining crops became a very high priority, while in crops with 90% loss the remaining cones were left unmanaged and no crop was harvested.

Conversely, in mast years the number of cones may vastly exceed the pest numbers, and so treatment may not be required as the crop will tolerate losses and harvestable volume will not be affected.

Planning pheromone traps

The early season is also time to start planning your pheromone trapping for the season. Consider your most common pests of concern and when the flight windows for each. Having a good plan and your needed supplies early will help make sure that you are able to get your traps out on time and avoid unnecessary scrambling later in the year. Think of this as buying new shoes and running gear. Get what you will need in place so that having the right equipment isn't a barrier when it's time to hit the ground running.

Whenever possible, we want to make sure that our pheromone traps are out a few weeks before we expect to see any initial flights of pests. Several trap checks with no detection prior to our first catch gives us confidence that we are not missing early flights of pests of interest.

Pest monitoring – overwintering pests

Monitoring during this time of year is largely for pests that stay on the tree for their overwintering stages. Monitoring now helps get a good start to the season and means that when things get busy during receptivity we have fewer IPM tasks to worry about. Since this time of year the pests are dormant, the window for these assessments is generally relatively large and they can be done any time the weather co-operates through the late winter and early spring. Pests that we would be looking for at this time of year tend to be tree-health pests such as adelgids, mites or European Pine Shoot Moth (*Rhyacionia buoliana*), rather than cone pests. Addressing these pests early in the season can help to keep these pest pressures low and reduce the need for more interventions later.

Spider Mites and Rust Mites

In the late winter/early spring visual surveys for mite eggs can be conducted to determine how much carry-over of these pests you are likely to see in the orchard. Monitoring in young trees or trees in holding areas or other high-density plantings is particularly important. Treatment is most effective when there are active stages of the pests, so if initial surveys show high presence of eggs follow-up surveys to determine when hatch is occurring should be done to help dial-in timing of interventions such as sprays or biocontrol release for when pests are active.

Adelgids and aphids

Surveys for species such as *Adelges cooleyii, A. lariciatus, A. picea, or A. tsugae* can be completed in the late winter or very early spring. If high population of adelgids are detected, follow-up monitoring to time applications of spray treatment when most eggs have hatched and nymphs are active should be planned.

Early Season

For the purposes of the current discussion the term early season will refer to the period of the growing season during which cones are receptive for pollination. The calendar dates for this period will vary with orchard species and location. For example, early-season activities in western redcedar in coastal BC may occur in February, vs receptivity for spruce in Alberta in May.

Regardless of the time of year that these early season activities are occurring, this is a critical period for success in managing pests in our crops. To return to the metaphor of our race training, this is the foundation training that builds the base of fitness; if we miss the window on this portion of our plan it can put us behind too far to recover later in the year.

For those who are wild-stand collecting and are not managing crops in an orchard this also remains a critical time of year as knowing what the infestation rates are at this time of year will allow a window of planning for harvesting operations.

When cones are open for pollination during receptivity is the prime window for many pests to lay eggs in or on our cones. If these pests are not managed in a timely manner many of them can cause severe losses to crops to the

extent that they may be no longer profitable to harvest and process.

Early season pests include cone midges (such as *Contarinia oregonensis, Mayetiola thujae, Kaltenbachiola rachiphaga,* and *Resseliella spp.*), Douglas-fir cone moth (*Barbara colfaxiana*), seed worms (*Cydia spp.*), cone maggots (*Strobilomyia spp.*) and seed chalcids (*Megastigmus spp.*).

Cone dissections are perhaps the most useful tool for monitoring for many of these species. Collected conelets are dissected under a microscope or other magnification and the number of eggs or larvae observed are recorded. A typical cone dissection sample size would be 1 conelet from a minimum of 50 trees throughout the orchard. For seed worm and cone maggot a combined average of 0.3 eggs per cone is the recommended threshold for treatment.

In recent years an increase in the presence of seed chalcids (*Megastigmus spp.*) has been observed in both wild-stand and orchard-harvested Douglas-fir cones in BC and Washington. Infestation rates have typically been much lower in orchard cones, likely due to a combination of the effects of treating for other orchard pests as well as the reduction of pest carry-over due to annual harvesting and removal of crops. At high levels this pest reduces viable seed and makes seed cleaning more difficult. Monitoring and treatment for this pest remain challenging.

Conducting assessments beginning when the majority of conelets are finished receptivity will provide an estimate of the pest pressure to inform management or harvest decisions. In orchards or stands with known history of *Strobilomyia* or *Cydia,* an additional earlier assessment may be warranted. As most of the detected pests at this time will be enclosed in the conelets, systemic pesticides will generally be required to effectively treat them.

Some of the pests of concern for this time of year have pheromone lures available to allow for pheromone trap monitoring of their flights, specifically *Contarinia oregonensis, Barbara colfaxiana,* and *Mayetiola thujae.* Pheromone trapping can provide extra information on when to time cone dissections and can provide insight into the level of likely pest pressure based on trap counts. In addition, some promising work has been done on controlling western redcedar cone midge and Douglas-fir cone gall midge by targeting flying adult stages using pheromone traps to direct timing of contact insecticides rather than systemic pesticides. This approach targets a more exposed stage of these pests and is less time-intensive than conducting cone dissections.

One additional step that we can take during the early season in orchards with a history of fungal seed contamination issues to maximize the success of our crops is to be aware of this window for potential fungal contamination. A simple change that we can make to reduce risk of fungal contamination is to avoid mowing during receptivity. The fungal species of most concern for seed contamination including *Fusarium spp.* are commonly soil-borne. Mowing can throw dust into the air, sending fungal spores airborne and potentially resulting in seed contamination. Waiting until after receptivity is over and cones are closed can reduce this risk with minimal operational impact in most cases.

Mid- season

Just as we need to change and increase our training as we get closer to race day, as we move from the early season and into mid-season (for the purposes of this article from the end of receptivity until shortly before harvest) we need to start modifying our IPM activities to keep on top of changing pests and stages of cone development.

Throughout this period pheromone traps remain an important tool for monitoring pest populations and guiding other IPM. Trap counts alone are seldom sufficient to determine if pest treatment is needed, they do however provide valuable information and should be used to help inform visual surveys and other checks.

For pheromone monitoring to be effective it is important to have sufficient traps in an orchard to avoid false negatives. For BC Ministry of Forests-run orchards, the most commonly used trapping scheme for *Dioryctria* monitoring is five traps deployed across the width of an orchard deployed across a single orchard row. This method is based on the work of Adams et al. from 2017 on coddling moth monitoring and in-house testing done in BC orchards. This method provides good coverage, and reduced time needed for checking traps.

At the Kalamalka Seed Orchard in Vernon BC, where I am based, we have a western larch orchard in which we have placed five traps for *Dioryctria abietivorella* in the same locations for the past several years. There is one trapping location that across all years has had little to no trap catch, even when other traps in the orchard consistently catch many target insects. If this position was used as the location for a single trap, it is likely that it

would regularly miss trapping flights which would be detected by a trap in another location or having multiple traps deployed across the orchard. A single trap may not catch low densities of pests and its placement becomes very critical. Even in when using multiple traps per orchard, trap placement remains essential to getting maximum effectiveness. Important considerations include the prevailing winds, proximity to edges and to other sources of pests and even how dusty a location may be. Knowing your target pests' life cycle will also help to inform your trap positioning. For example for species such as *Contarina oregonensis* which drop to the soil to pupate low trap placement to intercept them as they emerge may be beneficial vs. placement in upper parts of the crown near cones for species such as *Dioryctria abietivorella.* One final note on pheromone traps, ensuring that lures are replaced at suitable intervals will make sure that they remain maximally effective. Consult with your supplier to determine the effective lifespan of your specific lures.

In the field, visual surveys of cones are another crucial tool throughout the mid-season. Typically, weekly surveys of 100 random cones in the field from observations across the orchard can provide enough information for confident decisions on pest treatment and will be frequent enough to stay ahead of pest outbreaks. Visual surveys should look for signs of damage as well as presence of pest insects. Knowing the specific pests of concern will help staff conducting surveys to know what signs to be looking for in their surveys and be as effective as possible. An extra item that it can be valuable to observe and record in visual surveys is the presence of beneficial insects; knowing what species you have an in what numbers can also help to guide pest management decisions.

Pheromone trap catches can be used to help guide visual survey activity and the two combined should be used to guide management decisions. For example, larval feeding damage from *Dioryctria* will often trail trap catches by weeks, as mating, egg lay and egg development all occur after the initial flight of emerging males. A sudden increase in trap catch can be used as a sign to increase surveillance in the orchard so that if needed a spray targeting hatching and early feeding can be accurately timed.

As we train for our race there may be days where we simply don't have the time or energy to do our full planned training. On those days getting a 3km run in when we planned 6km is better than not running at all. Similarly, weekly 100 cone surveys are ideal, but if all you are operationally able to do is a 50 cone survey, or even an informal survey while doing other orchard activities, that is far superior to no monitoring.

Leptoglossus occidentalis surveys also usually start during the mid-season. Weekly visual surveys for nymphs and adults should be conducted in all high-value orchards. Remember that nymphs are much more voracious feeders than adults and as such high nymph populations will be more damaging. High adult populations early in the season can be an indicator of a potential large nymph population to come. Insecticide applications for control of *Leptoglossus* are generally very effective.

Tapering – the lead-up to the big day

As we near race day our training will taper for the last couple of weeks leading up to race day. In the same way, in the last couple of weeks before harvest most of what we can do to manage pests will already be done. We can't coast completely, but as we approach harvest any new pest outbreaks becomes less impactful as we will harvest and hopefully process the cones before any new pests can cause much damage.

Dioryctria is one of the pests that we need to stay vigilant for right up until and after harvest as developing larvae will feed from cone to cone in sacks or bins even after harvest. Late infestations can be treated with contact or translaminar pesticides, many of which have very short Re-Entry Intervals (REI) prior to harvest. Make sure to consult the pesticide label and confirm the safe REI and appropriate practices for any treatment.

Leptoglossus populations often continue to grow throughout the summer and into harvest and should continue to be monitored since as cones are removed from the orchard it is common to see *Leptoglossus* populations move to the remaining cones which can concentrate their impact. In pine species once current year crops are removed, feeding will often concentrate on the developing conelets for next year's crop. Heavy feeding, particularly by nymphs, can result in conelet abortion (Bates et al. 2002). As such, high residual *Leptoglossus* populations on first year cones may warrant treatment post-harvest.

Race Day – Harvest time

It's the big day. The whole season has been building towards the harvest and we are now off and running. We've done all we can to prepare for the big event but there are a few things we can think about on race day to help us get the most out of our performance.

One late in the game pest management intervention that we can undertake to deal with late *Dioryctria* detections in the orchard is priority processing of infested seedlots. As previously mentioned *Dioryctria* can continue to feed in harvested cones causing additional damage. When pre-harvest treatment has not been able to eliminate coneworms in your crop or if harvest activities preclude treatment of a late flight, expediting extraction of the cones will minimize this additional damage; co-ordination with your seed extractory is key to this process.

A final thing we can do during harvest to get the most we can from our crop is to once again consider fungal contamination. Fungal contamination is a problem on our seed but it is also a major issue in tree nut harvest where contamination can lead to mycotoxin contamination which is a human health risk. Since many of the fungi of concern such as *Fusarium* in conifers and *Aspergillus* in tree nuts are soil-borne, minimizing ground contact by the crop is considered good practice in tree nut harvest (Boutrif 1998). With simple modification our workflows we can follow this lead and minimize contact of cones and sacks with the ground. Placing filled sacks on a tarp or pallet, up off the ground and prompt collection and processing of cone are all simple practices to incorporate into our harvest if you are not already doing so. This, in conjunction with proper dry-down can help to reduce the likelihood of fungal contamination of our crops which can improve the end quality of the seedlot for our users.

Using Training tools

If you are a runner you know that there is an ever-growing ecosystem of training tools that you can use to help optimize your training from Garmin watches and Fitbits, to Strava or other apps. Similarly there are many tools available for use in IPM such as GIS programs, GPS based tools and remote monitoring tools. These can be assist in data capture, handling and visualization and can help us to quantify what is going on in our orchards. I won't review or suggest any specific tools but I will provide a few general thoughts.

Firstly, just like with training for our run, fancy tools may provide an improvement but having a plan and sticking to it consistently are what will provide the majority of our IPM success. The best tools are the ones that you will actually use and that can be easily be added to your existing routine. High-tech equipment can add to our IPM program but will rarely replace basic pest and plant monitoring. Look for tools that can augment what you are already doing.

Just like in training for our run, tracking our results will let us know if what we are doing is actually working. Annual tracking is incredibly useful and important and helps with planning, institutional knowledge retention and staff training. Having a system in place that staff can access for site-specific pest information is well worth the investment.

One simple tool that is particularly useful is tracking Growing Degree Days (GDD). Keeping ongoing reference of the GDD on your site will help with tracking tree and pest development within the season and will help to provide a solid reference for when to expect activities to occur that is usually much more informative than simply using calendar dates.

Summary

At this point we've made it through the race. It's time to look back and assess how it went and whether we met our goals. Annual review of your IPM practices, considering what worked and what didn't is an important aspect of continual improvement.

Just like training for a 10K race successful seed orchard IPM depends on thoughtful preparation, consistent effort, and well-timed actions throughout the growing season. Just as race performance is shaped long before race day, the quality and yield of seed crops are strongly influenced by our planning and work throughout the season. Establishing clear goals, building a structured plan, and focusing on fundamental practices provide the foundation for effective decision-making and efficient use of resources. Ultimately, attention to basic practices, and adapting to site-specific conditions are central to successful IPM.

While prepping for a harvest can be like training for a race, managing orchards over their lifespan is an ultra-marathon that spans years. Annual review and continuous improvement are key, as orchard management is a long-term endeavor influenced by both controllable factors and

unpredictable events. By focusing on planning and fundamentals managers can maximize seed crop outcomes over the long haul.

References

Adams, CG., McGhee, P.S., Schenker, J.H., Gut, L.J., Brunner, J.F, and Miller, J.R., 2017. *Line-Trapping of Codling Moth (Lepidoptera: Tortricidae): A Novel Approach to Improving the Precision of Capture Numbers in Traps Monitoring* Pest Density. Journal of Economic Entomology 110:4 p1508-1511

Bates, S.L., Strong, W.B, Borden, J.H., 2002. *Abortion and Seed Set in Lodgepole and Western White Pine Conelets Following Feeding by Leptoglossus occidentalis (*Heteroptera: Coreidae*)*. Environmental Entomology 31:6, pg1023-1029

Boutrif, E, 1998. *Prevention of aflatoxin in pistachios*. https://www.fao.org/4/W9474t/W9474t06.pdf

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Impact of ISO 9001 Certification on Operations at the Berthier Tree Seed Centre (Quebec)

The Berthier Tree Seed Centre (BTSC; Quebec Ministry of Natural Resources and Forests) is ISO 9001 certified since 2011. To our knowledge, it is the only centre of this kind to have applied for, obtained, and maintained this certification.

Why certification?

The BTSC is the only forest tree seed center in the province of Quebec. It receives, processes, stores, and ships all the tree seeds required for the *Ministry of Natural Resources and Forests'* reforestation needs. Each year, around 1 500 hl of cones/seeds are processed, and 260 M seeds sent to the private and public forest nurseries.

The managers at the time decided to undertake the process of ISO 9001 certification to validate the quality of operations at the seed center.

The current quality policy is: *Through the continuous improvement of its operational processes, the BTSC intends to actively contribute to the Ministry of Natural Resources and Forests' sustainable forest management strategy by ensuring the production of top-quality forest tree seeds, tailored to users' needs and at the best possible cost*.

Implementation involved a great deal of work to standardise operational procedures, as well as rigorous quality monitoring.

What does this entail?

The certification process is based on an analysis of all factors that may influence the quality of our product (forest tree seeds). This covers issues related to human resources, users' requirements, equipment maintenance, quality of inputs (seed harvests; see the other article on the harvest action plan implemented by our team on page 19), methods used (detailed procedures for all operations), and quality of the final product (germination and lot purity).

An impartial external auditor reviews the BTSC's processes annually against the standard's requirements. Certification cycles are three years long: certification in year one, followed by two years of monitoring. This cycle then repeats. The ISO 9001 standard is evolving; a new version is coming out in 2026 and will slightly modify the requirements, necessitating adaptation to new criteria.

Ambitious Targets

BTSC must set targets for the various selected criteria: seeds or cone lot cleanliness upon receipt, germination, and purity. Whenever one of these criteria is not met, a detailed analysis of the processes—through a non-conformity management system— is conducted to understand why this result occurred and what steps to take to improve it.

For example, for each cone lot received, a representative sample is taken before operational extraction. If, at the end of the extraction and cleaning process, the germination target is not met, this reference sample is manually extracted. If the germination result of the reference is like that of the operational lot, then it is concluded that its intrinsic quality does not allow to meet the BTSC's target. If it is higher, an analysis of the

process is initiated to understand why such a difference occurred and at which stage of the process the alteration might have taken place.

What are the results?

After 15 years of certification, results are clearly positive. Systematic analysis of non-conformities allow us to refine BTSC's methods and improve seed extraction yields. Combined with the management of improvement opportunities, this allows us to maintain a clear record of the tests conducted.

Average germination rates are on the rise, while the number of non-conformities related to seed/cone lots quality is decreasing.

BTSC has a very extensive library of procedures covering everything from how to qualify seeds upon receipt to the sequence of operations. This wealth of information also has the advantage of ensuring the continuity of knowledge and facilitating a smooth transition when employees retire.

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Working Together for Conservation

The National Tree Seed Centre's (NTSC) mandate expanded significantly following its relocation to the Atlantic Forestry Centre in 1996, particularly in response to Canada's commitments under the Convention on Biological Diversity. The NTSC's primary objective today is to collect and preserve a representative sample of seed from every native tree and shrub species across Canada, ensuring that genetic diversity is maintained as a foundation for ecosystem resilience and future restoration efforts.

To achieve this objective, the NTSC follows internationally recognized conservation standards and collection protocols developed by organizations such as the Centre for Plant Conservation and the Food and Agriculture Organization. Its collection strategy focuses on maximizing the breadth, depth, and genetic health of its inventory by sampling across ecoregions using Canada's Terrestrial Ecological Framework. To capture a representative sample of genetic variation, seeds from individual trees are collected from targeted ecodistricts that fall within every ecoregion covering each species natural range. Recognizing the critical importance of biodiversity conservation, the NTSC prioritizes species at risk and is working with national and international partners to obtain collections and develop advanced conservation techniques such as cryopreservation and tissue culture.

The Wildlife Conservation Society (WCS) and Nature Serve Canada did a great job summarizing Canada's globally and nationally listed at-risk trees in a report entitled *State of Canada's Trees 2023*. This report noted that out of Canada's 234 native tree species, approximately 25% have been identified as being at risk. The NTSC is currently using this WCS list to prioritize tree species for its collection. Currently NTSC has accessions from 26 of these listed species, representing nearly half of the currently listed tree species. While these accessions account for roughly 20% of NTSC's total number of stored seedlots, **more seeds from more locations and more species are still required** to ensure adequate *ex situ* conservation levels are met.

Increasing threats from climate change, habitat loss, and invasive species coupled with the vast Canadian landscape, make it nearly impossible for any single organization to effectively meet forest conservation targets in isolation. Developing relationships and partnering with other organizations is a significant part of NTSC's conservation mandate. For example, the NTSC is currently working with the Invasive Species Centre, Ministry of Natural Resources, and the Forest Gene Conservation Association in Ontario on black ash (*Fraxinus nigra*) seed conservation efforts. Seed collections made through the Black Ash Community Action Network (https://www.invasivespeciescentre.ca/take-action/community-science-program/black-ash-community-action-network/) will be sent to NTSC for long-term storage. If you are interested in getting involved in this citizen conservation initiative, please visit the website for additional details. **The website also provides a detailed protocol for collection of black ash seed.**

Another excellent partnership being developed this year is through Nature Trust New Brunswick's (NTNB) Habitat Health Watch Initiative. In anticipation of a heavy

seed production year, this project was also designed to target black ash seed collection. Although black ash is a fall seeding species, NTSC (Figure 1)and NTNB staff have already been working together locally to collect conservation seedlots from a variety of spring seeding species from quite a few NTNB's conservation properties.

Figure 1: Nature Trust Seed Collection team from left to right: Shraddhaben Vadgama, Alicia Higney, Courtney le Roux, Grace MacLean, Ben Horst (back), Abbie Gingles, Dara Sutton

The Indigenous Seed Collection Program (ISCP) is another significant example of how NTSC is working with Indigenous communities and organizations across the country to rebuild capacity for seed conservation work for cultural, medicinal, spiritual, and economic importance to the Indigenous people of Turtle Island. Officially launched on the spring equinox of 2022, the ISCP has since held 41 in-field seed collection and 15 laboratory seed processing training sessions for more than 100 communities and organizations. While harvested seed remains under the ownership of its Indigenous collectors, NTSC is happy to support this work through our training and has also provided the necessary infrastructure to store many valuable seedlots through established Memorandums of Understanding (MOUs) with 12 communities.

The unfortunate reality is that our planet is changing at an unprecedented rate due to human activity. These human induced problems require human developed solutions and there are many organizations and people already working on these critical resolutions. The projects and programs noted above are just a few examples of conservation relationships that NTSC is building, however we are always looking to create new opportunities. If you belong to an organization or community that is already working with or is considering long term storage of tree and shrub seed within your conservation planning, the NTSC is here to help with expert guidance and information. Similarly, if you are collecting tree and/or shrub seed **especially from species at risk** and you are willing to donate seed for long-term conservation, the NTSC would greatly appreciate connecting with you. Working together for conservation makes all our efforts stronger.

For more information, please email

NTSC at ntsc-cnsf@nrcan-rncan.gc.ca

ISCP at iscp-pcsa@nrcan-rncan.gc.ca

Wildlife Conservation Society (WCS) Canada & NatureServe Canada. 2023. State of Canada's trees 2023 (version 1.0), in SHAPE of Nature. SHAPE of Nature: Globally threatened ecosystems | WCS Canada

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Cryogenics at the National Tree Seed Centre

The National Tree Seed Centre (NTSC) is based at the Atlantic Forestry Centre (AFC), a Canadian Forest Service research facility in Fredericton, New Brunswick. The National Tree Seed Centre (NTSC) safeguards Canada's forest biodiversity by maintaining a large collection of genetic resources, with over 13279 unique seedlots representing more than 267 tree and shrub species.

Cryogenics at AFC began in the 1990s, when its researchers were among the early pioneers developing somatic embryogenesis as a cloning technique used to propagate trees with desirable traits. Today, many of those original clonal lines remain preserved within AFC's cryogenic storage, highlighting decades of innovation in forest conservation and biotechnology.

NTSC staff started utilizing the cryogenic storage facility in the early 2000's. Storage experiments were started to compare the viability of whole seed from several orthodox species stored in liquid nitrogen with those stored at -20°C and +4°C storage. Many of these experiments remain in storage today and will be sampled for testing in the coming years.

While most seeds can be dried and stored long-term in freezers at −20°C (i.e. orthodox seed), others cannot be dried down or frozen without losing viability (i.e. recalcitrant). Seeds from recalcitrant species (such as the entire *Quercus* genus) require specialized protocols for long term storage. Some species such as *Salix* spp. and *Pinus albicaulis* are intermediate and may not remain viable long enough under conventional storage conditions to be a viable long-term plan. To preserve recalcitrant and intermediate species, NTSC staff are experimenting with storage in liquid nitrogen at −196°C. At these temperatures, the metabolic and biochemical processes that typically lead to seed deterioration are effectively halted. These approaches range from controlled drying to more complex methods like embryo extraction and cryopreservation treatments, ensuring these valuable genetic resources are protected for the future.

In addition to placing its own materials into cryogenic storage, NTSC also serves as a backup site for partner organizations. Currently, three cryogenic tanks containing conifer embryogenic lines from improved trees are being maintained on behalf of a major forestry company. Agriculture and Agri-Food Canada's Potato Research Centre is set to begin storing germplasm at AFC this year. At the same time, the Forest Gene Conservation Association of Ontario has also initiated investments to establish its own cryogenic storage capacity with NTSC.

Figure 1: Image of NTSC staff member Matt Brophy filling cryogenic storage tanks with liquid nitrogen

Butternut (*Juglans cinerea*)

In the early 2000s, the Centre broadened its focus beyond commercial conifer species like spruces and pines, to prioritize the conservation of hardwoods and other species at risk. One of the first species studied under this shift was butternut (*Juglans cinerea*). Researchers at AFC developed a specialized cryopreservation protocol that involves carefully drying the seeds, then extracting the embryonic axis containing the radicle and meristem. This process reduces the size of the stored material, allowing more samples to be held in limited cryogenic space and also enables faster cooling and thawing times to minimize potential damage from ice formation.

Since 2010 butternut seed has been collected across New Brunswick, resulting in representation from most ecodistricts where the species occurs. Genomic Research and Development Initiative (NRCan) funding secured for 2024–2028 will continue to support efforts to expand collections into Ontario and Quebec. Despite ongoing challenges with the species' declining health and a particularly dry growing season in 2025, four collections from the Ottawa region were successfully added to storage last year with support from the Rideau Valley Conservation Authority. With 2 years of funding remaining, NTSC remains optimistic about further expanding its collections.

Whitebark pine and Limber pine

Whitebark pine (*Pinus albicaulis*) and Limber pine (*Pinus flexilis)* are listed as endangered under Alberta's Wildlife Act. Whitebark pine is also listed federally under the Species at Risk Act. Both species face significant threats from white pine blister rust (*Cronartium ribicola*) and the mountain pine beetle (*Dendroctonus ponderosae*). Due to climate change, the beetle is expanding its range into higher elevations where these five-needle pines grow.

The long-term viability of some high elevation five-needle pine seeds stored at conventional freezer temperatures (−20 °C) remains uncertain compared to that of other conifers. Cryogenic storage in liquid nitrogen offers a potentially more effective conservation approach.

In 2023, seeds of Whitebark pine were donated by Parks Canada to evaluate survival following exposure to liquid nitrogen. For each of 4 seedlots chosen, 25 seeds were sealed in foil-laminate bags and submerged in liquid nitrogen for 24 hours. Following cryogenic exposure, seeds were thawed at room temperature prior to germination. An equal number of untreated seeds from each seedlot served as controls that were not exposed to liquid nitrogen.

Seeds exposed to liquid nitrogen temperatures germinated as well as or better than control seeds, with all but one seedlot showing higher germination after liquid nitrogen exposure. Survival following 24 hours of exposure to liquid nitrogen temperatures is a promising result that may indicate cryogenic storage is a viable ex situ storage solution for Whitebark pine seeds. However, long-term survival in cryogenic storage must be tested further to be certain. To this end, a second trial was started in 2025 that included both Limber pine and White bark pine to study survival in liquid nitrogen for 1, 2, 5,10, and 20 years. All seed was donated by the Whitebark Pine Ecosystem Foundation of Canada.

American beech

American beech (*Fagus grandifolia*) has been under persistent threat from Beech Bark Disease (*Neonectria* fungal spp.) since the introduction of the beech scale insect (*Cryptococcus fagisuga*) to Nova Scotia in the 1890s. This can lead to tree mortality and reduced seed production. Conservation efforts are further complicated by the species' seed biology, limiting conventional storage opportunities. This has historically been attributed to a perceived inability of beech seed to survive the desiccation required to prevent damaging ice crystal formation at freezing temperatures.

In 2024, beech seeds from 5 different collections in New Brunswick were dried for various durations before being exposed to liquid nitrogen for 24 hours. Germination trials were then conducted to assess survival rates following cryopreservation.

Mean survival rates across all tested seedlots and drying durations indicated that seeds dried for 24 hours to moisture contents between 10.5% and 16.9%, exhibited the highest survival following liquid nitrogen exposure. This result also showed that beech seed could tolerate drying better than previously believed, as no significant reduction in viability was observed among control seeds not exposed to liquid nitrogen. Further drying may enhance cryotolerance.

The results of this trial support the potential for long-term cryogenic storage of beech seeds. Future work will involve repeating the trial and incorporating more precise drying protocols, such as the use of lithium chloride solutions to target specific moisture contents. Another priority in future testing will be testing *in vitro* germination methods that would allow for storage of embryonic axes removed from the seed offering the same advantages as butternut seed noted above. In addition, Beech seed cotyledons are rich in oils that can degrade and contribute to seed deterioration during cryostorage. Removing them may improve long-term viability.

Garry Oak Pollen Collection

Storing the genetic diversity of threatened species such as the Garry oak (*Quercus garryana*) is vital for their long-term survival. However, oak seeds are extremely recalcitrant and very difficult to store because they are highly sensitive to drying and freezing. While researchers around the world are working to develop methods for preserving oak embryos through freezing, progress has so far been limited. In response, scientists have initiated a Global Oak Pollen Bank to study how oak pollen tolerates drying and freezing. While seed is the gold standard in gene banking as they can create a plant on their own, pollen does have value. As urban development continues to fragment Garry oak ecosystems, preserved pollen could

play a crucial role in restoring genetic diversity to small or isolated populations in the future.

This spring, Garry oak flowers were collected by volunteers in British Columbia (Carrina Maslovat, BC Ministry of Land, Water, and Stewardship; Michael Brett, Professor Emeritus, University of Alberta) and shipped to the NTSC for processing. Once received, pollen was isolated from the flowers, and viability testing was done both before freezing and after samples were stored in liquid nitrogen for three days.

Figure 2: Image of Gary Oak pollen tubules growing after cryogenic storage at NTSC

Because pollen work is a relatively new initiative at NTSC, viability was assessed using a simple classification of viable or non-viable. Observation of successful pollen tubule production before and after freezing demonstrated that the collection, shipping, drying, and cryogenic storage methods were effective. Although this initial trial was limited in scale, the results are promising. Future work will continue to build on these efforts with Garry oak, while expanding to include Red oak and Bur oak, both native to New Brunswick.

If you are interested in obtaining more information or would like to contribute to NTSC's ongoing efforts, please email the NTSC at ntsc-cnsf@nrcan-rncan.gc.ca

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Forests Canada's Tree Seed Business

Over the past two decades, the tree seed business in Ontario has changed significantly. Forests Canada has been involved in seed procurement since starting its large-scale tree restoration program in 2007. The program's initial mandate was to plant 50 million trees by 2025 – a goal we achieved in the fall of that year.

Although we knew the target number and timeline, it was still a complex process to determine what seed requirements were needed. That said, there was always an appreciation that securing high-quality seeds was vital to running a successful tree planting program, and that need continues to this day.

Initially, Forests Canada's planting projects were composed of ~85+% conifer species and the balance deciduous hardwoods. Due to the time sensitivity of sowing many hardwood species, our nursery partners worked directly with seed collectors. Seed supply for conifers relied heavily on the provincially funded Ontario Tree Seed Plant (OTSP) in Angus.

Since the OTSP was in operation, Forests Canada did not invest heavily in seed procurement at the start of our restoration program. But what we did target were collections in very specific areas of interest, such as the Oak Ridges Moraine and other areas in the Greenbelt.

With our mandate of collecting local and planting local, it was important that we also had locally adapted seed sources for these areas of interest. For a decade, this was how our seed procurement business model worked. In 2018, the Ontario Ministry of Natural Resources and Forestry closed the OTSP, and this greatly impacted the access to quality seed sources for many.

The closure of the seed plant shook the foundation of the stakeholders, and everyone scrambled to figure out how to move forward. Forests Canada was very fortunate to work with partners that were willing to pick up many of the seed services lost when the OTSP closed its doors. But it also meant that we needed to take a much more active role in setting collection targets and working directly with an established network of collectors. Continuing seed procurement was essential to the success of our restoration program. The risk was high; if the seed yield or germination capacity was low, we needed to contend with those outcomes versus buying seed from a

supplier where you can pick and choose which seedlots to invest in.

Fast forward to 2020 and beyond. Forests Canada continues to use a similar seed procurement model as in past years but now face shifting environmental conditions and an evolving collector demographic. Our conifer collections rely heavily on collecting from squirrel caches. With warmer, drier falls, many tree species open and disperse seed before the squirrels can cut and cache. Because we rely heavily on natural forested areas and not seed orchards, we are missing crops of some species such as tamarack (*Larix larcinia*) and white spruce (*Picea glauca*). These are two of the first, time-sensitive, conifer species available to collect in August, but in our experience, squirrels rarely cut and/or cache these species before seed dispersal.

To mitigate some of these challenging scenarios, we have developed several strategies. First and foremost, we have hired an established seed collector part time to act as a Seed Advisor to Forests Canada. This individual is involved with mentorship and tailgate training, crop forecasting, directing and deploying collectors to specific locations, and entering potential collection sites and forecast information into our Seed Acquisition Tool (SAT).

We have become very deliberate about some of our collections, especially species where our seed inventory has been depleted. With these collections, much time is spent sourcing and ground truthing sites, acquiring access and any insurance requirements, projecting collection timing, coordinating collectors, and implementing the actual collection. While it has been a significant investment in time and funding, we are also very pleased that these targeted collections have proven fruitful.

Several of our seed collectors are now close to retiring. Some of these individuals prefer to focus on collecting from caches, relying less on the sources that involve collecting directly from trees. Through ongoing mentorship and tailgate training, we have created and fostered opportunities to work with new collectors, most of which have completed the Certified Seed Collector Course offered by the Forest Gene Conservation Association. We support this base of knowledge by adding boots-on-the-ground implementation and providing the experience necessary to grow and foster this vital area of the forest sector.

A couple undertakings Forests Canada lead after the OTSP closure, was the development of two web-based database tools. The first database was developed to capture vital seed collection details, storage information, germination testing, and cost tracking through the entire chain of custody. Because it is web based, clients can log in and manage their own seed inventory directly or have processing facilities populate this information. The second tool developed was the Seed Acquisition Tool (SAT). This database allows users to enter site details (species, quantity, stand details, forecasts, etc) for future collection opportunities. The information captured can be used to identify the best opportunities for future collections as well as determine where collectors should be directed. We are hopeful this will increase efficiency, improve collection success, and reduce unnecessary travel spent searching for qualified crops.

Forests Canada is fortunate to have a successful seed and restoration program, and we know that it takes a dedicated community to make this possible. We cannot do the work we do without our trusted partner network and are grateful for our shared commitment to the long-term health and resilience of Canada's forests.

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A Douglas-fir seed-derived Trichoderma strain reduces Fusarium root rot under nursery conditions: First operational trial results

Tree planting and reforestation depend on a continuous supply of high-quality seedlings, including those with improved genetic gains for volume growth and climate adaptation. Throughout this production pipeline, seedlings are vulnerable to seed-borne pathogens that cause substantial economic losses and threaten the investment made in selecting and producing high-performance seed. Although many seed-associated fungi (the "seed mycobiome") have minimal impact on tree performance, others can cause serious damage. Several *Fusarium* species, for instance, are responsible for root rot

and damping-off in conifers, resulting in significant losses during seedling production. The phytosanitary risk is particularly elevated in nursery environments, where high humidity, elevated temperatures, overhead irrigation systems, and dense plantings create ideal conditions for disease spread. To manage these risks, nurseries bear the cost of preventive measures such as pre-sowing hydrogen peroxide seed treatments and repeated application of expensive, often toxic fungicides, while absorbing losses caused by infection.

Interestingly, not all seed-associated fungi are harmful; Some are benign or even protective, suggesting that the seed mycobiome may itself hold solutions to the pest management challenge. In a previous project funded through Canada's 2 Billion Trees program, we screened approximately 6,000 seeds from six conifer species, isolating around 600 fungal cultures spanning a broad range of ecological strategies, from saprotrophs and symbionts to plant pathogens and hyperparasites. From this last category, we identified a highly competitive strain of the fungus *Trichoderma paraviridescens* (T2) isolated directly from a coastal Douglas-fir seed, which showed strong potential to protect Douglas-fir germinants against Fusarium root rot (Fig. 1). Unlike commercially available biocontrol agents, usually developed for agricultural contexts, T2 is a natural constituent of the Douglas-fir seed mycobiome, and its long association with this host likely gives it a biological advantage for stable establishment in nursery environments.

Figure 1: *In vitro* bioassay demonstrating the bioprotective potential of *Trichoderma paraviridescens* T2 against Fusarium root rot. (Left) Douglas-fir seedling inoculated with *Fusarium proliferatum* 15 days post-inoculation (dpi), showing severe damping-off and root necrosis. (Right) Douglas-fir seedling co-inoculated with *F. proliferatum* and T2 at 15 dpi, showing healthy shoot and root development.

In spring 2025, we conducted our first operational trial of T2 at Arbutus Grove Nursery in North Saanich, BC. This study was our first attempt to move from lab-testing of T2 and try to deliver the biocontrol in a forest nursery operational setting to test its efficiency in reducing Fusarium root-rot disease in real conditions. The experiment ran over six-months during the growing season (May 2 to October 6) and involved 3,360 Douglas-fir seedlings grown operationally in a commercial forest nursery greenhouse from a coastal Douglas-fir seed lot previously confirmed to carry 12.2% *Fusarium* contamination (seed lot 17R17701). Six treatments were tested, combining two seed sanitation approaches (1 hour soak in 3% hydrogen peroxide versus no sanitation) with three biocontrol treatments: T2 (0.9 gr / L^{-1} of potting mix), the commercial product Root Shield® (RS) that contains the well-know *T. harzianum* T22 strain (0.9 gr / L^{-1}), and an untreated control (Table 1). Styroblock containers (412B; Beaver Thermal Solutions, Acheson, AB) were randomly distributed across a nursery bench

and root-rot disease, germination, and growth were monitored at four time points during the growing season. Data were analyzed using a split-plot mixed-effects model, with hydrogen peroxide sanitation as a whole-plot factor and fungal treatment as a subplot factor; treatment means were compared using estimated marginal means and post hoc contrasts.

Table 1. Sanitation and fungal treatments applied to Douglas-fir seeds in this experiment.

Treatment code	Seed sanitation treatment	Fungal treatment
RS + HP	Hydrogen peroxide (1h soak – 3%)	Root Shield® (*Trichoderma harzianum* T22)
T2 + HP	Hydrogen peroxide (1h soak – 3%)	*Trichoderma paraviridescens* T2
C + HP	Hydrogen peroxide (1h soak – 3%)	No fungal treatment
RS	No hydrogen peroxide	Root Shield® (*T. harzianum* T22)
T2	No hydrogen peroxide	*T. paraviridescens* T2
C	No hydrogen peroxide	No fungal treatment

Overall results were encouraging. T2 showed no adverse effects on seedling development, and its efficacy against *Fusarium* root rot, while promising, depended on seed sanitation conditions. Germination rates and growth metrics, including foliage dry mass, root dry mass, and root surface area, did not differ significantly between treatments, confirming that T2 had no negative effect on seedling development. Fusarium root-rot disease development, measured as the area under the disease progress curve (AUDPC, corresponding to % disease x days), differed among treatments depending on whether seeds were sanitized with HP prior to sowing (Fig. 2A).

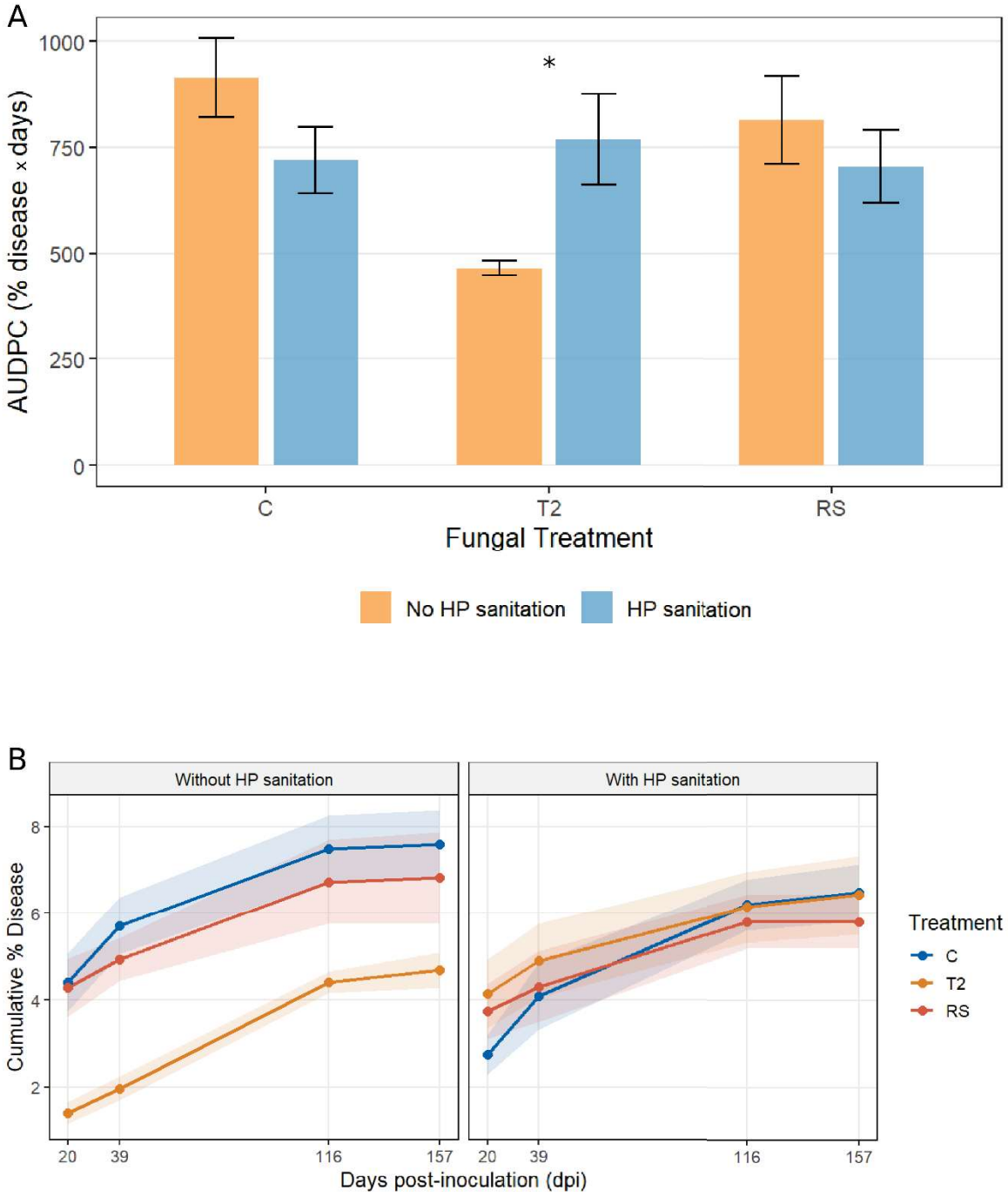

Figure 2. *Trichoderma paraviridescens* T2 reduces Fusarium root rot under nursery conditions. A, Area under the disease progress curve (AUDPC; % disease severity × days) for Fusarium root rot across fungal treatments, *T. paraviridescens* T2, and Root Shield® (RS), and unteated control (C) with and without hydrogen peroxide (HP) sanitation. Bars represent means ± SE (n = 5 blocks). Asterisk (*) indicates a significant difference ($p < 0.05$) between HP sanitation treatments within T2. B, Fusarium root rot progress curves showing cumulative disease (%) over time for the untreated control (C), *T. paraviridescens* T2, and Root Shield® (RS), with and without HP sanitation. Shaded areas represent ± SE.

A split-plot ANOVA detected a significant HP × fungal treatment interaction ($F_{2,20}$ = 4.77, p = 0.020), indicating that treatment effects depended on the sanitation regime. Neither HP alone ($F_{1,20}$ = 0.0001, p = 0.99) nor fungal

treatment alone ($F_{2,20}$ = 2.87, p = 0.08) significantly affected AUDPC. In the absence of HP sanitation, T2 substantially reduced disease development. AUDPC values were approximately 49% lower relative to the untreated control (464 vs. 914; p = 0.0029) and 43% lower than Root Shield® (464 vs. 814; p = 0.0284). This effect was consistent throughout the assessment period, with T2 slowing disease progression relative to the other treatments (Fig. 2B, left). However, this benefit was lost when T2 was combined with HP, and disease progression converged across treatments (Fig. 2B, right). Disease levels were similar among treatments under HP sanitation (all contrasts $p \geq 0.88$), and the reduction observed under non-sanitized conditions was no longer apparent. Within the T2 treatment, HP sanitation was associated with significantly greater disease incidence (p = 0.0215; Fig. 2A). Root Shield® did not significantly reduce disease relative to the untreated control under either sanitation regime (no HP: p = 0.63; with HP: p = 0.98), although a small, non-significant improvement was observed when combined with HP.

From an operational perspective, these results highlight both the promise and the limitations of biological control under nursery conditions. Notably, these findings are based on a single seed lot from which at least five pathogenic *Fusarium* species were recovered from diseased seedlings post-germination (data not shown), reflecting a diverse infection community whose representativeness of typical operational conditions remains uncertain. Results should be interpreted with that caveat in mind. T2 shows clear potential to reduce Fusarium root rot when applied in the absence of strong oxidizing sanitation treatments; its application will need to be aligned with nursery sanitation practices, as hydrogen peroxide seed treatments may interfere with its efficacy. Optimizing application strategies will therefore be essential, particularly refining timing and sequencing to determine whether separating HP sanitation and T2 application can preserve biocontrol activity, alongside further testing under operational nursery workflows. Validation across additional seed lots with varying infection levels and *Fusarium* species compositions will be a critical next step before broader operational deployment can be recommended.

This work was conducted in partnership with Steven Kiiskila (Arbutus Grove Nursery Ltd.), with phenotyping contributions from colleagues at PFC: Dr. Joey Tanney, Ciaran Woods, Jessica Walker, and Ben Drugmand, and funding from the Pest Management Research Program of the Canadian Forest Service.

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Love You to the Moon and Back

At 6:35PM EDT on April 1, 2026 four RS-25 rocket engines and 2 solid rocket boosters ignited beneath the Orion space capsule, ending a 53-year moratorium on crewed lunar missions leaving planet Earth. Under the command of astronaut Reid Wiseman, the launch of this 10 day Artemis II mission was significant for several historic reasons. Christina Koch and Victor Glover were the first woman and first African American astronauts respectively to fly in cislunar space. In addition, Jeremey Hansen also became the first Canadian and first non-American to travel beyond low Earth orbit. However, there was also another little piece of Canada riding onboard this historic mission – a package of 2 592 seeds sent from Canada's National Tree Seed Centre (NTSC).

As one can imagine, real estate on board the tiny Orion capsule was quite restricted and prevented experimentation like the APEX-CSA2 white spruce project that the Canadian Forest Service previously supported onboard the Internation Space Station back in 2010. Confined to a heat-sealed foil packaging resembling 5 aluminum ravioli stuck together, a total of 4.7g of seed from 5 different Canadian tree species was prepared for this 1.12-million-kilometre symbolic journey. Species were selected that covered a range of geographic, ecological, and cultural significance and included lodgepole pine, eastern white pine, eastern white cedar, red maple, and white birch.

While the importance of seed and its critical ecological role in supporting forest renewal and conservation was certainly the front-page message of this project, another equally important and deeply personal story was emerging quietly in the background. Unknown to all but a few, the white birch seedlot chosen for this mission was collected on September 28, 2021 by Melissa Spearing.

* * *

Anyone who knew Melissa Spearing knew she had many passions in life. Some of her biggest were seeds, sharing knowledge with others, and building community. The Tree Seed Working Group (TSWG) was a place where she could explore these passions simultaneously. Melissa worked with seed long before her professional career working with tree seed. Growing up on a farm she was familiar in working with the seasons, appreciating the wise words of the "farmers creed", loved working in the garden with her sister Rachel, and bringing her community together for a fresh meal after a hard day's work.

Melissa explored more than one career path and eventually followed in her parents' footsteps, landing at the Niagara Parks School of Horticulture. While she was there, she participated in a special project called Seed Exchange where native seeds were collected and exchanged with other institutions around the world. Melissa had the freedom to explore the world of seed in this space, and that is exactly what she did. She changed and improved the program, learned as she went, and was passionate about bringing other people along with her seed related adventures.

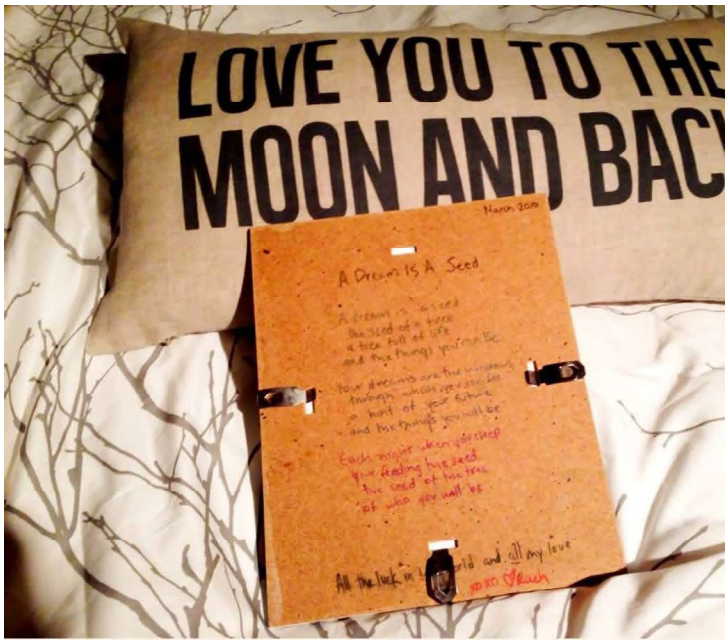
Every opportunity to learn she took. She became a Certified Seed Collector, took an intensive course at KEW Millenium Seed Bank, and gathered an extensive book collection on all things related to tree seed. If she couldn't find someone to teach her, then she taught herself. One of Melissa's proudest accomplishments was the creation of the *Seeds of Ontario Trees and Shrubs Field Manual for Crop Forecasting and Collecting.* Melissa spent countless hours drawing on the knowledge of experienced collectors to compile this seed manual, which has been appreciated across North America by both professional seed collectors and people curious about seed. It also became the primary teaching tool for the Certified Seed Collector course, for which she brought her knowledge and passion to when she began teaching it while working for the Forest Gene Conservation Association (FGCA).

Eventually Melissa took an opportunity to work at the NTSC, where she brought her passion for seed and community building to the national and international scale. If someone had a seed-related question and she couldn't answer it, then she would find someone who could. Her passion for knowledge sharing in the tree seed space was the exact reason she took on the editor role of the TSWG bulletin. Despite not always having the time she wanted to dedicate to the bulletin, she was committed to creating the best quality bulletin by curating new and valuable information for readers across Canada and the world. While gathering articles and information for the bulletin she regularly connected people together so they could continue sharing knowledge and building their own community around seed.

* * *

Melissa (aka Missy to family) was true to her Irish roots. Though not born a firecracker redhead, she chose to grow into one blessed by her sheer determination. Although her caring spirit and intensity drove her lifelong pursuit of excellence in all aspects of work and play, she often found life a challenging balancing act. Finding and managing this balance was greatly impacted after her sister Rachel's suicide in 2011. From that point onward she made every day count, just as Rachel had in her jam-packed 23 years.

The photo of Rachel (right) and Missy (left) together, along with the poem Rachel wrote on the back, travelled everywhere Melissa went. Thankfully, this cherished family keepsake was recovered from her NTSC office after she passed away. It always stood as a gentle reminder to dream of a future full of purposeful adventures in all things green and growing. In her messages and cards, Rachel would often sign off "love you to the moon and back". That particular saying became much loved amongst many in the family. After finding Missy a soft pillow meant to comfort her especially when missing home, I would also add the words "and back again too".



Fast forward to January of this year. We received NTSC 's surprise email about the Artemis II mission, and this collaboration included Missy's handiwork! After shedding happy tears, experiencing over-the-moon blissful joy, and bursting with pride on launch day, I could hardly wait to share this exciting news with Missy's people who are so dearly missing her.

It brought us an exhilarating hope when needed most. Beyond our wildest dreams, none of us would have thought of Missy's seed flying to the moon! For all us earthlings left behind on that bright April launch day, it truly became a heart warming and unforgettable sign from above. April 22 is Earth Day and Rachel's birthday, so I'm certain her spirit was also onboard for that special lift-off!

We are forever grateful to the NTSC, The Canadian Space Agency, NASA, and Jeremy Hansen and his much-loved crew. There were so many others behind the scenes of this mission too. You have pulled off the unthinkable for humanity, our beautiful planet, and for generations of people chasing their dreams and purposeful adventures. On a deeply personal level for all those in Melissa and Rachel's orbits, the tiny package of seed carried all our emotions behind the scenes. It took us all on one more magical galactic ride together.

There is a dark side of the moon though, with many craters falling to various depths. Depression is like this as well. Navigating through the darkness of space to find the bright side involves a lot of risk and forces you to confront many fears. To make it back to Earth, it's so important to reach out and ask for help from others along the way to achieve your goals. Working together with their monumental accomplishment, the Artemis II mission has inspired, empowered, and highlighted this for everyone and to not give up when all seems impossible.

Take great care of yourselves in your own journey wherever it may lead you.

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Sowing seeds of hope: How the Nature Trust's seed collection project is safeguarding endangered trees for future generations

As we scan the canopy of Sasokatokuk Nature Preserve in Carleton County, hundreds of featherlike, tiny bunches of white seed float around us. These fuzzy bundles belong to trees of the *Populus* genus, primarily the poplar tree. This patch of Appalachian Hardwood Forest is a particularly productive site for poplar, along with black ash (*Fraxinus nigra*), basswood (*Tilia americana*) and willow trees

(including *Salix bebbiana* and *Salix nigra*)—and that's exactly why we're here.

Staff from the Nature Trust of New Brunswick's stewardship team walks alongside Darren Derbowka from the National Tree Seed Centre (NTSC, part of Natural Resources Canada), squinting as we determine which trees have produced viable seed.

New Brunswick is home to over 30 native trees that form the foundation of our forests, floodplains and riparian habitats. But critical species like black ash, white ash (*Fraxinus americana*), butternut (*Juglans cinerea*), Eastern hemlock (*Tsuga canadens*is) and bur oak (*Quercus macrocarpa*) are declining under pressure from invasive species, disease, and climate stressors.

At the same time, restoration efforts face another challenge: access to locally-adapted native seed.

That's what brought the Nature Trust of New Brunswick and the National Tree Seed Centre (NTSC) together this year through a native seed collection project designed to preserve regional biodiversity and promote resilient forests.

"When I reflect on the conservation mandates of many different organizations across the country, I think that no single organization can accomplish those conservation goals on its own," says Derbowka, coordinator with the NTSC in Fredericton.

"The significance of [this partnership with the Nature Trust] is that we're working together and mutually achieving these goals of protecting the genetic diversity of forests in New Brunswick as well as across the country."

The NTSC, Canada's only national seed bank, plays a key role in preserving native seed and maintaining genetic diversity in our forests. By collecting and storing viable seed now, the centre creates future opportunities for restoration, research, and long-term conservation.

But seed collection isn't just a walk in the woods.

Many tree species only produce viable seed within a highly limited time frame. For *Populus* (poplar, aspen and cottonwood) and *Salix* (willow) species, opportunities can last anywhere from a couple days to two weeks.

But hope springs—or seeds—eternal. We come across an abundance of seeding Bebb's willow (*Salix bebbiana*) and set to work, tracing each branch back to the trunk to determine which seeds belong to which tree—and making sure to not disturb resting ladybugs in the process.

As the afternoon sun reaches its peak, we count out approximately 19 litres of seed capsules, which amounts to millions of individual seeds which can be extracted, dried, and stored at the NTSC.

This outing marked our fifth field day with the NTSC. Our team has collected mostly trembling aspen and Bebb's willow seeds across eight nature preserves to date. These aren't priority seeds for the project, but they're species which seed in the spring, and they provided the perfect training opportunity for our team to learn the ropes before priority species, such as black ash, butternut and bur oak, go to seed in the fall.

One thing we learned in a hurry: seed collection is surprisingly technical work.

It's time intensive and requires an awareness of which species produce seed at a given time, where to find healthy and genetically representative populations, access to those sites at the right time, and how to handle and store seed properly once collected.

"The difficulties in seed collection are that we live in such a vast country, it's difficult for us to get to all of these places at the right time," Derbowka says. "It's one of the reasons that threatened species are in peril, because some of them, like black ash, only go into seed every six to nine years. So the opportunities to collect the seed and execute conservation are very small to begin with."

That challenge makes the predicted 2026 ash mast year especially important.

Mast years are a phenomenon wherein perennial species produce unusually large seed crops. For black ash—already under intense pressure from the emerald ash borer insect—this represents a crucial and rare opportunity to collect viable seed from healthy trees before widespread mortality occurs.

If successful, seed we collect this fall could become a long-term conservation resource. Seed from a single healthy ash tree can support hectare-scale restoration

efforts. Preserving this genetic material now creates opportunities for future riparian and forest rehabilitation and supports ecosystems to become more resilient to rising temperatures, invasive species, and habitat loss.

Black ash, also an especially significant tree for New Brunswick's Indigenous communities, is just one example.

"In Canada, there are 234 different species of trees," Derbowka says. "Fifty-seven are currently listed either federally, provincially, or globally as a threatened species. That's roughly 25% of all of Canada's tree species that are threatened in some way."

In New Brunswick, butternut and hemlock populations are also under increasing pressure, respectively, from butternut canker, an infection caused by a pathogenic fungus, and hemlock woolly adelgid, an invasive insect which feeds upon hemlock and spruce.

Proximity to people, in a sense, is another obstacle to restoring these species. What we plant in our backyards and along city streets matters more than you might think.

"In our cityscapes, we tend to be planting non-native species," Derbowka says. "As ornamentals hybridize with native species ... that breaking up of gene flow, all of that has impact on genetic diversity."

That's another reason the NTSC is excited about this partnership with the Nature Trust.

"Everyone is desperate for seed, but nobody has anywhere to collect it," says Courtney le Roux, the Nature Trust's Stewardship Manager. "That's a gap the Nature Trust can fill. Our preserves provide continuous access to healthy native tree populations, and we can collect seed that can be preserved by the NTSC and distributed for restoration and research."

With 100 nature preserves across multiple ecoregions in New Brunswick—and tools such drone-supported and on-the-ground reconnaissance, advanced mapping techniques, and ethical seed collection protocols—our team, project partners and volunteers can identify productive trees, verify mast conditions, and coordinate efficient and effective seed collection.

"This relationship we're building with the Nature Trust is really building opportunities to collect species that become very difficult to obtain seed from as populations diminish," Derbowka says.

"I'm hoping that the work we're doing here stimulates interest in working with other organizations, not just in New Brunswick but around the Maritimes and across the country, doing significant conservation work like this."

What can you do to support our Native Seed Collection Project? Learn more about seed collection and planting native species with our seed collection recipe cards, outlining how and when to collect, store and germinate seeds from 14 native trees and shrubs. You can get out in the field with us by signing up to volunteer—this summer we'll be removing invasive species from our nature preserves, planting native species in their place, maintaining hiking trails, and more across our network of 100 nature preserves. Or, consider donating to support our work protecting the places New Brunswickers love.

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Don Pigott's Retirement Party

Some of us had the good fortune of being able to celebrate Don Pigott's retirement on May 6, 2026. Don gained

much of his tree improvement, nursery and seed orchard experience during his 14 years with MacMillan Bloedel. He then founded Yellow Point Propagation Ltd which has been offering tree seed collection and processing, native plant, Christmas tree, tree improvement, silviculture and ecological restoration activities and consulting for the past 44 years. Don has his fingerprints on all of the coastal tree breeding programs, some of the interior ones and has had a hand in collecting many range-wide seed collections for provenance testing. He has supplied BC seed worldwide and run an operational seed processing facility and several seed orchards.

In BC, many paths seed related generally flow to or from Don – whether its acquiring tree or native plant seed, building a new seed extractory, consulting on seed related topics, practical field implementation of tree improvement programs or helping recovery efforts for whitebark pine. Don has contributed greatly to seed science and technology. Some of it due to his presence and ecological appreciation in the field, some with his abilities to frugally construct processing equipment and some with his stubborn will to get things done efficiently.

At the event many spoke about working with Don over the past 59 years. Most were amazed by his photographic memory of events, places, routes and restaurants. His BC dining guide was used by many and there are probably few roads in BC that Don has not travelled in search of seed. Don has been a keen educator and enjoys sharing the knowledge he has obtained over his long and varied career. He has been recognized by a wide range of organizations: receiving the Canadian Institute of Forestry National Volunteer award; Coastal Silviculturist of the Year; the Forest Nursery Association of BC Green Timbers award; Honourary membership in the Association of BC Forest Professionals and at the event we made him an Honourary Tree Seed Centre conehead. He is co-founder of the BC Tree Seed Dealers Association, Whitebark Pine Ecosystem Foundation of Canada and BC Seed Orchard Managers Association in addition to his participation in the International Seed Federation and involvement in Coastal Silviculture Committee which he has participated in since 1982!

Irreplaceable and they don't make them like that anymore are sentiments that come up with many of us who have worked with Don. It was great opportunity to thank Don for his contributions to BC forestry and beyond. Thank you to Sandy McKellar and Tree Frog Forestry News for recording and making available a video of Don's retirement party which you can view here.

Don, I wish you the very best in retirement. Thank you for your friendship and all your contributions.

Dave Kolotelo

Bevin Wigmore retirement party

On Friday June 12 a retirement open house was hosted at Mount Newton Seed Orchard (Mosaic Forest Management) for Tree Improvement Manager, Bevin Wigmore RPBio. After 22 years with Mosaic and its predecessor companies, Bevin has decided to hang up her hat as manager and retire to Shawnigan lake with her husband Brad, dog Murphy and cat Percy. In her time with Mosaic she was an integral part of the team that produced enough seed for 224 million trees, many of which are happily growing on our landscape in coastal BC and abroad.
We wish Bevin all the best in her retirement and welcome Corey Mathieson RPF as Acting Seed Orchard Manager at Mount Newton Seed Orchard.

UPCOMING MEETINGS

Forest Nursery Association of BC (FNABC)
September 22-24, 2026
Prince George, BC
https://www.fnabc.com/2026-fnabc-agm

BC Seed Orchard Association (BCSOA)
Webinar Series
https://forestgeneticsbc.ca/bcsoa/ OR
https://mailchi.mp/90477603f8e3/bcsoa-signup to get on their mailing list

RECENT PUBLICATIONS

Córdova, José Pablo Prado, Pascual, Gustavo; Monjaras, Sergio Osorio; Gálvez, Kimberly Sucely Solares; Delgado, Paola del Carmen Mateo; Palacios, Mario; Osorio, Luis Rodolfo Montes; Ruiz-Chután, José Alejandroet. 2026. Locally Sourced Seed Procurement Dovetails with Convivial Forestry in a Fir-Dominant Landscape in Guatemala. Small-scale Forestry. (2026): doi: https://doi.org/10.1007/s11842-025-09614-5

Chevreuil, Larissa R, Calderon, Leonardo de A.; de Carvalho, Josiane C.; de Souza, Diego P.; Fernandes, Andreia V.; Schimpl, Flávia C.; Ramos, Márcio V.; Araújo, Wagner L.; Gonçalves, José Francisco de C. 2025. Understanding the Germination and Post-Germination from the Peptidases Metabolism in Parkia Multijuga Benth.: An Amazonian Dominant Legume Tree Species. Braz. J. Bot. doi: https://doi.org/10.1007/s40415-024-01047-2

Darcha, Girmay, Tsehaye, Yemane; Taye, Gebeyehu; Emiru Birhane. 2026. Pod Production and Seed Viability of a Keystone Tree Species in Parkland Agroforestry Systems of Ethiopia. Forest Ecology and Management. doi: https://doi.org/10.1016/j.foreco.2025.123390

Davies, T. Jonathan, Janneke Hille Ris Lambers, and E.M Wolkovich. 2025. The Janzen–Connell Hypothesis and Seed Masting. Trends in Ecology & Evolution. doi: https://doi.org/10.1016/j.tree.2025.09.021

Dykstra, Emelie, Stobbs, Jarvis A.; Galeano, Esteban; Thomas, Barb R. 2025. Revealing the Application of Synchrotron-Based X-Ray Computed Tomography in Healthy Versus Unhealthy Interior Lodgepole Pine (Pinus Contorta Var. Latifolia) Conelets. Plant Direct. doi: https://doi.org/10.1002/pld3.70117

Engert, Jayden E, Middleby, Kali; Vogado, Nara; Laurance, Susan G.W. 2026. Seed Collection Practices in Tropical Rainforest Restoration and Implications for Provenance Research. Forest Ecology and Management. doi: https://doi.org/10.1016/j.foreco.2025.123376

Foest, Jessie J, Szymkowiak, Jakub; Dyderski, Marcin K.; Jastrzębowski, Szymon; Fuchs, Hanna; Ratajczak, Ewelina; Hacket-Pain, Andrew; Bogdziewicz, Michał. 2025. No Refuge at the Edge for European Beech as Climate Warming Disproportionately Reduces Masting at Colder Margins. Ecology Letters. (2025): doi: https://doi.org/10.1111/ele.70284

Geras'kin, Stanislav A, Vasiliyev, Denis V.; Prazyan, Alexander A.; Lychenkova, Maria A. 2025. Increased Frequency of Cytogenetic Abnormalities and Abortive Seeds in Scots Pine Populations from the Most Contaminated Sites of the Polesie State Radiation-Ecological Reserve, Belarus. Environ Sci Pollut Res. doi: https://doi.org/10.1007/s11356-025-37304-4

Germano, MónicaSaihueque , Matías; Kun, Marcelo ; Kandrachoff , Martin; Dalla Salda, Guillermina; Silva , Carmelina; Sergent, Anne-Sophi. 2025. First Detection of the Douglas-Fir Chalcid Megastigmus Spermotrophus (Hymenoptera: Megastigmidae) in Patagonia, Argentina. Biol Invasions. doi: https://doi.org/10.1007/s10530-025-03700-7

Hernández-Pazmiño, Nathalia, María D Jiménez, and Juan A Delgado. 2026. Is Fruit Plasticity Greater in an Alien than in a Native Tree? A Case Study of the Tree of Heaven and the Narrow-Leaved Ash. Plant Ecol. doi: https://doi.org/10.1007/s11258-025-01589-9

Hirsch, Mareike, Puhlmann, Heike; Klemmt, Hans-Joachim; Seifert, Thomasl. 2025. Modelling Fructification Intensity at the Tree Level Reveals Species-Specific Effects of Tree Age, Social Status and Crown Defoliation across Major European Tree Species. Eur J Forest Res. doi: https://doi.org/10.1007/s10342-025-01822-0

Huynh, Ngan Bao, Schmidt, Axel; Pennanen, Taina; Gershenzon, Jonathan; Mageroy, Melissa H. 2026. Methyl Jasmonate Seed Treatment Enhances Norway Spruce Seedling Resistance to Botrytis Cinerea via a Multitude of Defense Responses. Plant Physiology and Biochemistry. doi: https://doi.org/10.1016/j.plaphy.2025.110497

Jiao, Si-Qian, Li, Meiyu; Li, Zhi-Chao; Bao, Yu-Tao; Zhang, Hui-Jin; Yang, Xiao-Lei; El-Kassaby, Yousry Aly; Cheng, Shi-Ping; Mao, Jian-Feng et al. 2026. Integrating Parental Breeding Value, Genetic Gain, and Gamete Contribution for Elite Family Selection in Platycladus Orientalis. J. For. Res. doi: https://doi.org/10.1007/s11676-025-01943-7

Liu, Puyuan, Chen, Yixin; Ma, Gelu; Zhou, Zhezhe; Yang, Qinsong; Li, Guole. 2026. Cold Stratification Remodels Carbohydrate Metabolism to Lower Heat Requirements for Epicotyl Dormancy Release in Chinese Cork Oak (Quercus Variabilis). Plant Physiology and Biochemistry. doi: https://doi.org/10.1016/j.plaphy.2025.110770

Luo, Jun, Dai, Xiaoyong; Yang, Bing; Chen, Jin; He, Shuang. 2025. Analysis of Phenotypic Diversity in Pods and Seeds Traits of Natural Populations of Gleditsia Sinensis in Guizhou Province, China. Journal of Applied Research on Medicinal and Aromatic Plants. doi: https://doi.org/10.1016/j.jarmap.2025.100666

Motbaynor, Kirubiel, Alemu, Asmamaw; Gebremariam, Yohannis; Gebeye, Amare; Taju, Muhabaw. 2025. Fruit Characterization and Seed Germination of Selected Dry Forest Wild Edible Fruit Tree Species in North West Ethiopia. Forest Science and Technology. doi: https://doi.org/10.1080/21580103.2025.2522712

Reitschmiedová, Erik, Mudrák, Ondřej; Dvorščík, Petr; Frouz, Jan. 2026. Seed Production, Dispersion and Tree Mortality of Salix Caprea L. in Early Stages in Unassisted Post-Mining Sites Eur J Forest Res. doi: https://doi.org/10.1007/s10342-025-01844-8

Salazar, Ana, and Katherine Heineman. 2025. Seed Moisture and Dispersal Mode as Predictors of Germination in Neotropical Savanna Woody Species. Plant Ecol. https://doi.org/10.1007/s11258-025-01566-2

Šimůnek, Václav, Trojan, Václav; Vacek, Zdeněk; Vacek, Stanislav; Cukor, Jan; Bledý, Michal; Podrázský, Vilém; Stejskal, Jan; Hájek, Vojtěch; Gallo, Josef; Brabec, Pavel; Lehnerová, Lenka; Pařízková, Alžběta. 2026. Effect of Weather Cycles on Cone Harvesting for Six Coniferous Species in Czech Forest Management. Forest Ecology and Management. (2026): doi: https://doi.org/10.1016/j.foreco.2026.123524

Szymkowiak, Jakub, Bogdziewicz, Michał; Celary, Waldemar; Piechnik, Łukasz; Ledwoń, Mateusz; Szarek-Łukaszewska, Grażyna; Seget, Barbara; Kondrat, Katarzyna; Zubek, Karol; Żywiec, Magdalena. 2026. Dynamic Pollinator Networks Maintain Pollination Efficiency during Mast Flowering in an Insect-pollinated Tree. Oikos. doi: https://doi.org/10.1002/oik.11682

Varon-Garcia, Daniela, Sarmiento, Carolina; Arnold, A. Elizabeth; Dalling, James W.; Davis, Adam S.; Bowman, Elizabeth A.; Zalamea, Paul-Camilo. 2026. Seed Survival in Tropical Pioneer Trees Is Unrelated to Conspecific Distance but Linked to Fungal Infection. Oikos. doi: https://doi.org/10.1002/oik.11758

Vindušková, O, Šimáňová, D.; Reitshmiedová, E.; Černý, J.; Frouz, J. 2025. Natural Regeneration of Norway Spruce under Pioneer Trees Outperforms Conventional Reclamation on Post-Mining Sites. Ecological Engineering. doi: https://doi.org/10.1016/j.ecoleng.2025.107812

Yang, Wanxia, Cen, Yuting; Cui, Yichen; Lu, Xiaoqiang; Fang, Shengzuol. 2026. Range-Wide Phenotypic Variation in Fruit and Seed Traits of Cyclocarya Paliurus across Environmental Gradients in China. Plant Ecol. doi: https://doi.org/10.1007/s11258-026-01608-3

Younessi-Hamzekhanlu, Mehdi, Abdul Razzak, and Rastislav Jakuš. 2026. Utilizing Diverse Propagation Approaches to Advance Norway Spruce Breeding and Reforestation. J. For. Res.. doi: https://doi.org/10.1007/s11676-025-01983-z

Young, Derek J. N, Venuti, Nina E.; Greene, David F.; Latimer, Andrew M. 2025. Canopy Seed Survival through Extreme Fire in Non-serotinous Conifers: An Unexpected Source of Forest Resilience. Ecological Applications. doi: https://doi.org/10.1002/eap.70142

Zas, Rafaelópez-Villamor, Adrián; Cao, Ana; Touza, Roberto; Sampedro, Luis; Lema, Margarita. 2026. Impact of Resin-Tapping on Growth, Defences and Reproduction of 40 Yr-Old Maritime Pines in NW-Spain. Forest Ecology and Management doi: https://doi.org/10.1016/j.foreco.2025.123497