Tree Seed Working Group News Bulletin

Canadian Forest Genetics Association
l'Association canadienne de génétique forestière

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DIAMOND JUBILEE

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Armchair Report No. 75

The Diamond Jubilee of the TSWG News Bulletin – how exciting! It is an honour to see this accomplishment realized, with 75 News Bulletin editions published since 1983. That averages 1.83 editions per year, close to our advertised biannual distribution. The News Bulletin currently reaches over 500 interested individuals worldwide and continues to grow with a global resurgence in the demand for tree seed information for ambitious reforestation and genetic conservation goals. The News Bulletin would not have survived without our authors, so thank you to everyone who has contributed articles and please consider what your next contribution will be 😊. The structure of the TSWG is quite simple today: a Chairperson and an Editor. I must first acknowledge Melissa for bringing technological sophistication to our Working Group in terms of a revitalized News Bulletin design, virtual handling of workshops and web resources, and the persistent need to deep dive into the world of tree seeds. Today, our News Bulletin is only available electronically, while in 1983, it was only available as a hard copy – snail-mailed to subscribers!

Melissa was preceded by three long-term editors, in reverse order: Dale Simpson, Ron Smith and Hugh Schooley. In terms of committee Chairs, the following have also led this organization: Howard Frame, Guy Caron, Graham Powell, Yves Lamontagne and Ben Wang. The Working Group itself was not always so simple, as we previously had two subgroups under our umbrella, namely the Cone and Seed Insect Working Party (CSIWP) headed up by Peter de Groot, and the Tree Seed Processing and Testing Working Group, headed up by Dave Bewick and later myself. It seemed like these specific topics could be handled under a general Tree Seed Working Group, and so the groups were eventually dissolved, but their topics are still of great importance to this group.

Banner photo shows a global map of Tree Seed Working Group News Bulletin downloads and readers, from October 1, 2023 to March 31, 2024.

We always welcome new subscribers and contributors. Sign-up at https://cfga-acgf.com/

CFGA Tree Seed Working Group

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Deadline for Issue No. 76: October 30, 2024

The Tree Seed Working Group News Bulletin is published twice a year. We welcome any comments, suggestions and article submissions and will solicit active and new members for content. Submissions may be edited for length and clarity. Authors are responsible for the accuracy of the material in their submitted content. The mention of commercial products in this publication is solely for the information of the reader, and endorsement is not intended by the Canadian Forest Genetics Association (CFGA). All issues of the News Bulletin are freely available here.

The TSWG's objectives are to promote tree seed science and technology through:

1. Seed research from bud initiation to seed utilization
2. Identification of seed problems relating to tree improvement and forest management
3. The exchange of information on seed-related problems
4. Advising on implementation practices

In 2019, when it seemed all doom-and-gloom, we felt it necessary to theme our TSWG workshop "Reaffirming the Importance of Cone and Seed Services". This was due to North American facility closures and insufficient investment in research and education regarding tree seed. Five years later, it is good to see that there appears to be renewed investment in cone and seed infrastructure. Here are a few examples:

- Locally at our BC Tree Seed Centre, we are in the middle of a large capital project that duplicates our existing cooler and freezer areas (see enclosed article),
- The Vernon Seed Orchard Company has constructed a new cone and seed processing plant in Vernon, British Columbia (see enclosed article),
- The Washington State DNR is constructing a new Tree Seed Centre,
- The North Carolina University Christmas Tree Genetics Program and Upper Mountain Research Station are building a processing facility, and
- Sierra Pacific in California are also doing the same.

I am sure there are more examples, but I don't feel so gloomy about facility investments as the critical processes these facilities provide in the reforestation pipeline are better appreciated. I am also seeing an increase in tree seed-related webinars and other educational opportunities, although I am not seeing an upswing in funding available for research or interest in tree seed science from scientific or academic institutions. Rome wasn't built in a day.

I am interested in activities surrounding forestry education, specifically tree seed related, outside the recognized technical and university programs. One of our main extension products is the "Secret Life of Tree Seeds" poster, produced in 1999 by Dr. Carole Leadem as the content expert. It is our primary tour swag and a lovely tool to extend information on BC tree seeds to any audience. You can see it used below by the FORED BC Society (https://www.foredbc.org/) at the recent Vancouver School Board Sustainability Fair. If groups are interested in obtaining poster copies for use, just send me a quick email describing how it will be used.

Above: The BC Tree Seed Centre's "Secret Life of Tree Seeds" poster on display at the Vancouver Sustainability Fair. Photo credit: Cheryl Ziola, FORED BC Society.

The other 'project' I've been involved with over the past year is helping to develop a tree seed-cone kit to be used by teachers in support of BC National Forest Week. The idea is a set of cones and instructional materials that can be loaned to teachers interested in incorporating this information into their lessons. These are two simple examples, but I'm very interested in what else is happening out there to promote a better understanding of forestry and, specifically, initiatives related to cones, seed and reforestation.

In my enclosed article on BC's tree planting history, it is clear that we are in transition in BC. This transition does not diminish the recent celebration of planting 10 billion seedlings in BC. What used to be called the future mid-term timber supply gap in BC seems to be the "Now" timber supply gap, with sharp decreases in Allowable Annual Cut (AAC), actual harvest levels below allocated AAC levels and the subsequent reduction in required planting. This is not due to a lack of seed or seedlings, but simply a lack of available land as planted areas grow. Certainly our recent fire history is making more ground available for planting. One of our provincial objectives is to increase wildfire salvage and improve the Residual Fibre Utilization Policy to increase fibre security. One of the responses is to try and transform BC's forest industry from "high volume to high value", and our Minister has been assigned a new Parliamentary Secretary for Value-Added Manufacturing. Angkor Wat wasn't built in a day.

Since the last issue, the 2023 Tree Seed Workshop recordings have been posted to a CFGA YouTube playlist, along with all of the scientific conference videos. They are well worth watching if you haven't been able to make it out to our events in recent years, have interested students or new workers, or are a new member yourself. It's also never too early to pencil in Ottawa, Ontario, during the summer of 2025 for the next TSWG workshop. More details will be forthcoming.

All the best to everyone for this summer.

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Editor's Notes

Wow—75 Bulletins (over 1,550 pages), all about tree seed 🌱! I am proud to be a part of any Diamond Jubilee and the first woman to produce this Bulletin. This year also marks the 125th anniversary of the Canadian Forest Service and 100th anniversary of the International Seed Testing Association and International Seed Federation (see articles by Steve Jones and Ben Rivoire, respectively). On this occassion, I'd also like to raise a strong cup of tea to those who have set the bar high for women in seed science and operations: Judy Loo, Tannis Beardmore, Natalie Isabel, Shelagh McCartan, Elinor Breman, Kate Gold, Lindsay Robb, Ann Smreciu, Carole Leadem, Marilyn Cherry, Fabienne Colas, Anne Savary, Mary Myers, Carrie Pike, Sally Aitken, Barb Thomas, Michele Fullarton, Barb Boysen, Cathy Neilsen, Christina Walters, Valerie Pence, Fiona Hay, Kristl Walek, Carol Baskin, Kat Spencer, Jodie Krakowski, Liz Cobb, Andree Morneault, Charity Dobbs, Sarah Drabble-Bisgould, Helen Richardson, and last, but not least, the late Heather Rooke. We all stand on the shoulders of giants. While some above may not consider themselves as such, they have cleared paths and lit the way for decades to come. Thank you!

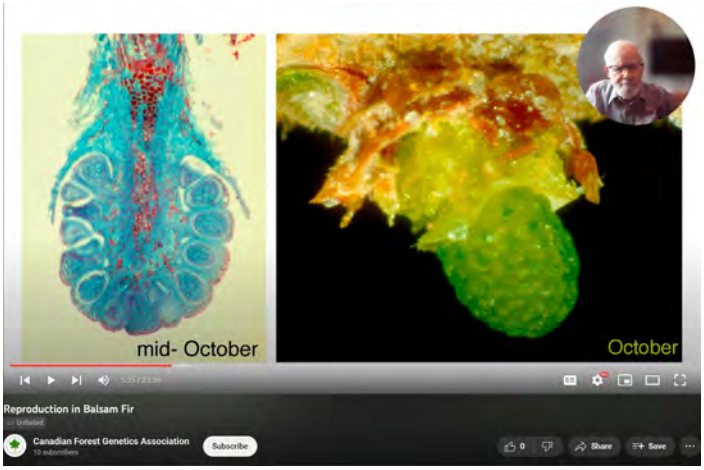
I also can't say it enough: being an active TSWG and Canadian Forest Genetics Association member has been the most practical education I've been offered or sought. I thoroughly enjoy learning what our members are doing or want, and keeping the TSWG evolving with the times. In this field, persistence pays off: my tin (10th) issue was perhaps the easiest time I've had soliciting articles and I am particularly pleased former Editor Ron Smith rose to the call. I hope readers enjoy all the milestones, wisdom and history shared, find a new topic to pique your interest, and are inspired by the investments being made. Please find a few minutes to send questions or thanks to our contributors; **extension and engagement keeps the Working Group alive!**

However, it's not all good news, as you'll see from Bill Schroeder's stark reminder on the risk of wildfire to seed orchards and genetic trials, as happened this spring in Saskatchewan. Readers and policymakers outside BC may also want to take stock of the November 2023 memo issued by the BC Chief Forester factoring this risk into seed planning needs. I wish you all an uneventful season when it comes to natural or man-made disasters, but 2023 was likely a harbinger of seed management challenges to come.

The next Bulletin is already filling up as well, with some submitted or promised articles focused on rare tree species' conservation and new expeditions to bank them. If you've got any other research or operational updates or stories to share, please let Dave and I know as soon as you can.

Are you feeling the upswing too? As a result of Dave, Fabienne Colas and I (and many others) trying to "reverse the red" in recent years, it seems we've all timed this Gartner Hype cycle right. The world has been reminded Canada is highly skilled in tree seed delivery systems, with proof in the 500–600M seedlings planted per year, from more than 50% improved seed in some jurisdictions. For those with fresh nature-based solutions (NbS) funding or corporate environmental-societal-governance (ESG) objectives, CFGA and TSWG online resources are ranking high in some search engines and artificial intelligence queries I've checked. I'm not surprised, given our proceedings on developing these solutions and resources goes back to 1937! Keywords change, but many roads lead to Rome.

Naturally, the next quick click some folks want is a reference list of the "Who's-Who" we trust to deliver these solutions to reforestation, reclamation, restoration and ex situ conservation programs. While some directories exist, (see 2019 review, No. 68) most except the RNGR.net National Reforestation and Restoration Directory are out of date and Canadian representation sparse. So, I feel we should revitalize a drive for an active TSWG Membership Directory to support our objectives and core members' expertise. The intake form will be hosted on the CFGA website, along with more active-members-only resources developed in advance of next summer's workshop. This may include an old-fashioned hard-copy for the truck or nursery office, for those who attend in-person. I will also circle back to the 49 people who consented to the 2019 Directory to see who is still working, especially in more specialized tree seed research or extension services. You will also have the option to share your or your organization's information with a more public Seed and Services tool in the works, in partnership with Forests Recovery Canada, the Forest Gene Conservation Association, and the National Tree Seed Centre, thanks to funding from Natural Resources Canada. Active TSWG members servicing Canada can be listed for new tree planting and forest landscape restoration projects seeking the right people, species, seed, nursery stock and equipment suppliers, including 2 Billion Tree Program partners.



Prerecorded lecture on reproduction in balsam fir by Dr. Graham R. Powell, Professor Emeritus from the University of New Brunswick, presented at the 2023 TSWG Workshop, Vernon BC.

Since the last issue, I'd also like to celebrate some notable members and tertiary tree seed champions passing onto the new chapters of their lives, or into the great beyond:

- **New Hires:** Congrats to Jesse Wildeman (Kalamalka Seed Orchard Manager), Dr. Hayley Tumas (BC Ministry of Forests, Lake Cowichan Research Station), Abbi Vernier and Sanya Nar (Seed Orchard Technicians, Mount Vernon Seed Orchard Company) on their new positions, as noted in the December 2023 FGC eNewsletter.
- **Retirements:** Pat Martin, RPF (BC Ministry of Forests), and Ken Farr and Dr. Alex Mosseler (Canadian Forest Service).
- **Condolences:** We heard Graham Powell's wife passed on since the last issue and are keeping him in our thoughts. If you wish to send condolences, his TSWG Membership email is still powell@unb.ca. I've kept his recorded lecture last summer in Vernon here as testament to his legacy in reproductive biology of coniferous species in eastern North America. His new book, *Lives of Maples, Birches and Ironwood* may also be released soon. We will share when available.
- **Condolences:** Glenn McLeod (1952–2024), a past TSWG workshop participant through the Ontario Ministry of Natural Resources in his role as Orono Nursery Superintendent. After Orono closed, Glenn continued tree planting and seed collection training with the Forest Gene Conservation Association, Northumberland Stewardship Council and Forests

Ontario. Glenn was my first mentor in tree seed forecasting, and the epitome of a "get'er'done" farmer, but always with a smile, laugh and mustache curl. Read a recent tribute here: https://watershedmagazine.com/departments/tribute-to-glenn-mcleod/

- Not a member but a name some may know: I learned George Argus passed away in late 2022. George was renowned botanist on rare Canadian plant and specific genera, specifically *Salix* species and hybrid complexes. Interestingly, he was also responsible for sealing the deal on the current accepted taxonomy of jack pine, from *Pinus divaricata* to P. *banksisana* in the early 1970s. Tribute here: https://doi.org/10.22621/cfn.v136i3.3125

In other Editorial matters, Dave prompted and several others submitted what were essentially "R&D Requests" (research and development) to our readers, and so I've made a potentially recurring new section for the Table of Contents, same as the "Seed Requests & Availability" can be when the time lines are long enough. While it's my judgment now, I may also use the CFGA website to capture external submissions going forward. I hope TSWG members providing submissions will spark the scientifically-minded amongst us to get funding to solve some of these emerging problems (see my article on TSWG Membership Needs, No. 73). For now, please submit Seed and R&D Requests to Dave or I, the TSWG Google Group or LinkedIn any time.

Lastly, since "teamwork makes the dream work", I again would like to engage some more generals for the TSWG army. While it is sometimes happening organically, I'm asking for 1–2 more active members to help diversify our perspectives and lightly shake the bushes with Dave and I, i.e. write or solicit Bulletin articles, organize workshop speakers and agendas, plug us in online forums, and share LinkedIn content. Please reach out to Dave and I if you have capacity or desire to do this.

PS: this is also the first Bulletin with emojis! You can thank Dave's submissions for this new font 😉.

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R&D Requests

Editor's Note: this section may be used for anyone to request TSWG expertise (scientific and/or applied operational experience). For new submissions, please indicate deadlines, so requests may be listed in order of priority. Requests may also be posted to the CFGA Tree Seed Working Group LinkedIn forum. If a TSWG reader, colleague or supplier you know can help answer a request, please respond directly to the author.

Indigenous-Led Native Seed Supply Systems Study Seeking Participants

My graduate research at the University of Victoria focuses on building the capacity and potential for meaningful land restoration by supporting Indigenous and community-led native seed supply and production in the Yukon, and across Canada.

Evaluation of supply and demand for native plant material shows consistent findings, particularly in northern regions like the Yukon Territory, where the shortage of native plant material is widely acknowledged as a significant obstacle to implementing restorative land action.

This research project has been collaboratively designed in partnership with Yukon Seed & Restoration Inc. (YSR), a First Nations-owned restoration company based in the territory. Established in 2018, YSR aims to address the scarcity of native seeds, improve revegetation practices through native plants, and enhance community representation in restorative land action.

To support YSR and the development of native seed supply systems throughout the Yukon and Canada, this project seeks to understand how Indigenous Knowledge(s) and Western scientific understanding of socio-ecological systems have and continue to foster the growth and success of Indigenous and community-led native seed supply systems across the country.

We want to highlight the different pathways that have allowed these groups and organizations to be successful and identify where ongoing support is needed for their continued progress. By sharing what we and others have learned with our peers, we hope to collectively work towards supporting the health of land, water, and our communities.

I am seeking to interview native seed and plant practitioners

from Indigenous or community-led organizations. Honorariums and authorship on published materials will be provided as compensation! Please let me know by December 1, 2024 if you'd like to participate.

Learn more about the project and how to get involved here: https://www.restorationscience.net/project-info.html

Visit Yukon Seed & Restoration's Website here: https://www.yukonseed.ca/

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Water Recycling and Sanitation

I see one of the functions of the News Bulletin as a place to query our readers for information on a specific topic and I have one.

With our freezer/cooler expansion project we are also looking carefully at water use and the potential for recycling water. At our facility, there are two main operational uses of large quantities of water. The first and most obvious is use in our running water soaks for seed stratification to reduce the amount of seed-borne contaminants from the seed coat. This has proven to be an effective means to reduce *Fusarium* spp. levels and potential disease losses at the nursery. The second source of water use is in our drying line, and it may be surprising to learn that a significant amount of water is used to cool the heating coil used in this set of chambers. This latter water use does not contact seed and recycling of water is a fairly simple engineering solution that we will implement. The recycling of water used in our running water soak tank is more complicated due to the need to sanitize the water prior to recycling to avoid cross-contaminating seedlots with pathogens.

I'm interested in any operational experience or research involving the removal of seed-borne pathogens from water to allow for water recycling. Our research is pointing us to a UV-based system (which is expensive), so we are also looking for the potential of alternative methods as we look to reduce water consumption at our facility. Please contact me directly for any information you may have. Thank you.

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Effective Seed Predator Deterrents during Research Trials?

The Northern Hardwood Research Institute Inc. / Institut de recherche sur les feuilles nordiques Inc. is conducting artificial regeneration trials and looking to improve our odds of success, particularly with seed of hardwood tree species.

We are scanning the literature and are seeking applied experiences on seed pretreatments to minimize predation during nursery sowing, research and field sowing trials. It does not matter if they are peer-review, theses or simply a list of promising ideas.

Please contact me if you have any advice or proven solutions.

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British Columbia Reforestation Milestone: 10 Billion Trees Planted

On April 15, 2024, British Columbia celebrated the 10 billionth tree planted in the province. Minister of Forests Bruce Ralston planted a ceremonial Douglas-fir tree to mark this milestone. The celebration took place at the Green Timbers Urban Forest Park, the site of the first permanent forest nursery in BC, Green Timbers Forest Nursery, established in 1930. Minister Ralston said, "Planting 10 billion trees means 10 billion carefully wielded shovels by 20 billion hands across almost 100 years. This is an accomplishment we can all be proud of, and it's an honour to play a small part in that number by planting this tree today." https://news.gov.bc.ca/releases/2024FOR0017-000565

Deputy Chief Forester Albert Nussbaum described the many steps involved in reforestation, from pre-harvest planning through cone collection and seed orchard establishment, seed

Above: On April 15, 2024, BC Minister of Forests Bruce Ralston (left) and Deputy Chief Forester Albert Nussbaum (right) share remarks at the celebration.

processing, seedlot registration and storage, stratification, nursery growing and extraction, and planting. Since the late 1950s, registered tree seed for planting stock has been handled by the BC Tree Seed Centre for testing, storage, and the vast majority of seed extraction and processing. The first billion trees were planted between 1932 and 1981. During the '70s and '80s, BC made a gradual shift from producing mostly bare root seedlings to predominantly growing and planting container-grown stock.

Attendees included staff from the Ministry of Forests (including the BC Tree Seed Centre and BC Timber Sales), City of Surrey, Green Timbers Heritage Society, Arbutus Grove Nursery, Vernon Seed Orchard Company, tree planting representatives, and others.

For further information on BC's reforestation history, see:

British Columbia Forest Service. 2011. Excellence in Cone and Seed Services—The First 50 Years BCFS Tree Seed Centre. Ministry of Forests and Range, 38 pp. Available from: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/tree-seed/tree-seed-centre/treeseedreport_web_august.pdf

Knight, E. 1990. Reforestation in British Columbia: a brief history. Pp 2–8 *In* Lavender, D.P., Parish, R., Johnson, C.M., Montgomery, G., Vyse, A., Willis, R.A., and Winston, D., eds. Regenerating British Columbia's Forests. UBC Press, 372 pp.

Above: On April 15, 2024, the 10 billionth tree planting ceremony took place at Green Timbers Urban Forest Park, BC, known as the "Birthplace of Reforestation" after the original forest nursery.

Above: A celebratory cake enjoyed by event guests.

Van Eerden, E. 2002. Forest nursery history in western Canada with special emphasis on the province of British Columbia. Pp 152-159 *In* Dumroese, R.K., Riley, L.E., and Landis, T.D., tech. coord. National Proceedings: Forest and Conservation Nursery Assoc. 1999, 2000, and 2001. USDA For. Serv. Rocky Mtn. Res. Station RMRSP-24.

Wells, T. 1940. Nursery practice at the Green Timbers Forest Nursery. For. Chron. 16(1): 94–98.

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Twenty-Five Years of Seedling Production in British Columbia

It appears like planting in British Columbia is finally feeling the full impact of the mountain pine beetle (MPB) epidemic[1] with a dwindling Annual Allowable Cut (AAC)[2] and planting program. I'll argue that reforestation of fire-burned areas is what has kept BC's reforestation floating near the 300-million seedling level for the past several years. There are other pressures on our reforestation program including the province's commitment to protect 30% of the land by 2030 (almost doubling existing levels), old growth deferrals, climate change, an aging workforce and achieving the objectives of BC's Declaration on the Rights of Indigenous Peoples Act (2019). It is certainly a time of transition for BC forestry.

The data used for this article comes from our Seed Planning and Registry (SPAR) system and reflects the quantity of seedlings ordered over the past 25 years. In the past several years, it would also include a minor amount of seed used for direct or pod seeding, but does not include all planting on private forested lands, which is a very small percent of BC's land base. The province also has a RESULTS system where actual planting numbers and other silvicultural practices are recorded, but that system is one year behind (after planting) and, therefore, would not reflect the current falldown. I believe the SPAR results provide a good view of trends in BC reforestation even if it reflects seedlings ordered versus the actual number of seedlings planted.

During the last 25 years, there have been an average of 250 M seedlings requested each year for BC reforestation (Fig. 1). You can see a significant decline in seedling demand in Figures 1 and 2 from 2008 to 2010, which was in direct response to the US sub-prime mortgage and international financial crisis. At that time, the emphasis was on corporate survival versus planting trees. The program reached its highest level in 2019 when 308 M seedlings were ordered. I was at provincial meetings in preparation for this total, which was predicted to reach 320 M seedlings. There was some increase in nursery capacity to accommodate that total, but it was never realized, and we have not reached 300 M seedlings again. 2024 marks another significant planting falldown with 241 M seedlings being requested. Is this our new normal? Or are we still on the downward spiral?

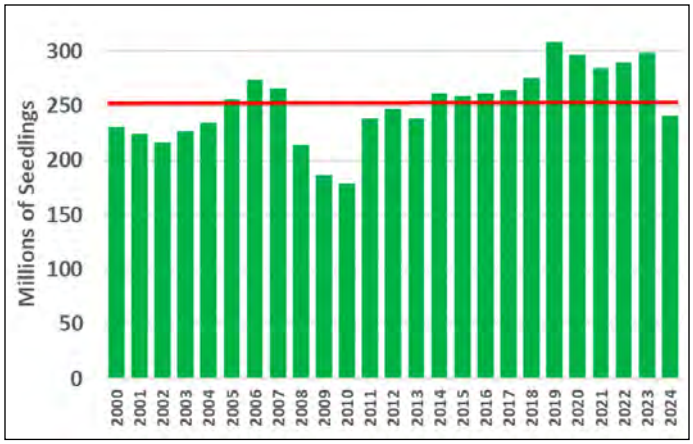

Figure 1. The 25-year pattern for seedlings requested in British Columbia (2000–2024), with red line as average for the period.

To investigate the seedling trends further, seedling requests have been divided into the five most planted species in BC (Fig. 2) with species codes in parenthesis and used throughout the article for brevity: Interior Lodgepole Pine (PLI); Interior Spruce (SX); Douglas-fir, both Coast and Interior varieties (FDC and FDI); Western Larch (LW) and Western Redcedar (CW). Over the last 25 years, these five species have accounted for 95% of the seedlings requested. The remaining 5% is divided among 15 additional species. British Columbia is conifer tree-dominated and that is reflected in the fact that 99.8% of the reforestation occurs with conifer species! Historically, PLI and SX have accounted for 75% of the seedlings requested, but the 2024 decrease is primarily due to a decrease in these two species; they account for 64% of the reduced total this year. The mountain pine beetle outbreak (1999–2015) fueled the predominance of PLI in BC reforestation efforts, with it accounting for more than 50% of seedlings produced in some years. For the 2024 season, we see a 30 M decrease in PLI seedlings requested versus 2023, bringing it down below 30% of the total. Until this year, SX had been on a steady increase as harvesting moves away from MPB-killed stands, but this year we saw a decrease of 24 M seedlings.

The proportion of seedlings currently produced from seed orchard seedlots is approximately 70%. The average genetic gain for volume (GVO) from these seedlots is 22%, meaning

1 https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/bark-beetles/history_of_the_mountain_pine_beetle_infestation.pdf

2 At the recent BC Council of Forest Industries (COFI) meeting the current wood harvest was presented as 32 M m^3 which is about half of what it was five years ago.

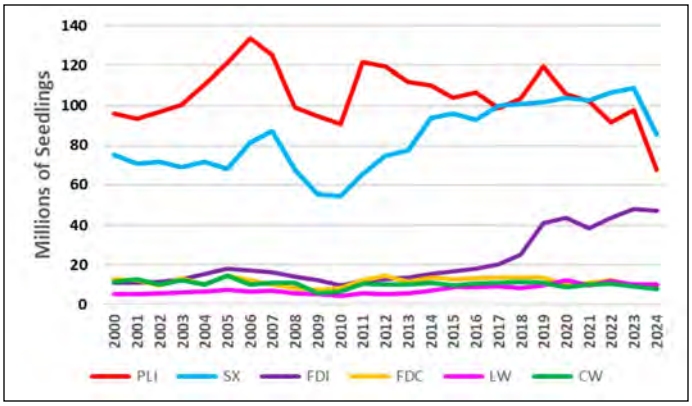

Figure 2. The 25-year trend for seedlings requested in Brtish Columbia for the top 5 planted species.

Figure 3. The trend in the average number of seedlots used to produce one million seedlings over the past 25 years.

that there should be 22% more volume at time of harvesting compared to a wild stand seedlot from the same area. Above-average gains are found in SX (25%); FDI (28%) and red alder (32%), although gains can vary between seedlots of the same species due to the existence of multiple breeding programs for different ecological niches. For some programs there are also gains for pest resistance and wood density. The planting of seed with genetic gain is considered to be the best silvicultural investment in BC to increase wood production. For public land reforestation, if a seedlot "has a genetic worth of 5 per cent or greater for the species and trait that best achieves the forest management objectives for the stand"[3] then that seed must be selected for use to try and increase the volume available for harvest and reduce the existing timber supply gap, primarily from the MPB infestation which impacted 18.3 M hectares of BC forests.

The other side of the coin from gain is genetic diversity and seedlot diversity standards exist in BC. The minimum effective population size (*Ne*) for seedlot registration is 10 and this is often criticized, but the reality is that the average *Ne* for seed orchard seedlots in storage is 32. Another trend is that with more seedlings being produced from seed orchard seed, the number of seedlots being used is diminishing. In Fig. 3, the average number of seedlots used to produce one million seedlings is used to illustrate how the average number of seedlots has decreased over the past 25 years. In 2000, there were 1,768 seedlots used, while in 2024 this number decreased to 812. This number varies by species, but it provides a statistic that can be compared across years and programs of greatly differing sizes.

The question many are asking is "what will the future demand for seed and seedlings in BC look like?". It is a difficult question even without wildfire, but that certainly throws a major complication into any predictions for seed need. Historically, five year average seedling request numbers were used, but about a decade ago it was recognized the past was no longer a good predictor of the future. The movement from a geographic based seed transfer system (GBST) to a climate-based seed transfer (CBST) system has only complicated predictions for the future. The BC response to this was to build a set of dashboards that could help determining future seed orchard infrastructure needs and to aid in seed planning. Background information includes a good history of cone production over the life of an orchard and realistic seed-to-seedling conversion factors. The dashboards can be found at this link: https://maps.forsite.ca/portal/apps/storymaps/stories/0b4c25a4ac8f4b918412dbcb24f82653. The key driver 'seed demand' is being updated this year as the current version uses older demand figures. I think the dashboards may be overwhelming to those unfamiliar with forestry in BC and our ecological classification system, but I think they clearly illustrate that the expression "It's complicated" is not used lightly in relation to future BC seed needs.

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3 Excerpt from the BC Chief Foresters Standards for Seed Use: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/tree-seed/legislation-standards/current-standards/consolidated_cf_stds__amended_1apr2022.pdf

Busy Q1 for New Canadian Tree Nursery Association

The Canadian Tree Nursery Association–Association Canadienne des Pépinières Forestières (CTNA–ACPF), established less than a year ago, aims to serves as the leading advocate for tree nurseries across Canada. It promotes the interests of its 58 members, each of which currently produce a minimum of one million native tree seedlings (Fig. 1). Collectively, our members produce over 95% of the country's seedlings used to support reforestation and restoration. As such, they require and use significant quantities of high quality tree seed.

Since the successful March 21st Spring Ahead forum, co-hosted with the National Tree Seed Centre and Canadian Institute of Forestry, the CTNA–ACPF has been busy advocating for our members. We've met with politicians and senior government staff in Alberta and British Columbia discussing the importance of the nursery sector and the critical need to commit to providing long-term support for the restoration of forests that have been destroyed by wildfires and insect infestations. If such commitments were in place, our members would be willing and able to grow the appropriate seedlings to support these restoration efforts. We also recently participated in the BC First Nations Forestry Conference in Penticton, BC, May 29 and30th. It was a great time meeting and involving youth in tree planting and having discussions about career opportunities in the forestry and nursery sectors.

Plans have been finalized for our eastern Canada tour in late June. Executive Director Rob Keen will be meeting with member nurseries, senior provincial forestry staff and politicians to engage in discussions and initiatives that will further support the nation's tree nursery industry.

We have also been fortunate to receive a 2-year 2 Billion Tree Capacity Grant to address the shortage of skilled labour in tree nursery production. This support is crucial as the demand for seed and seedlings increases during efforts to restore forests damaged by climate change, wildfires, insect infestations, and other environmental disasters. We'll be contacting our members, educational institutions, First Nations and other governments to build an informed and diverse network of expertise to initiate this effort.

Through such collaborative efforts, outreach and ongoing advocacy, the Association aims to foster a sustainable and thriving environment for tree nurseries across Canada. For further information please visit ctna-acpf.ca or contact us below.

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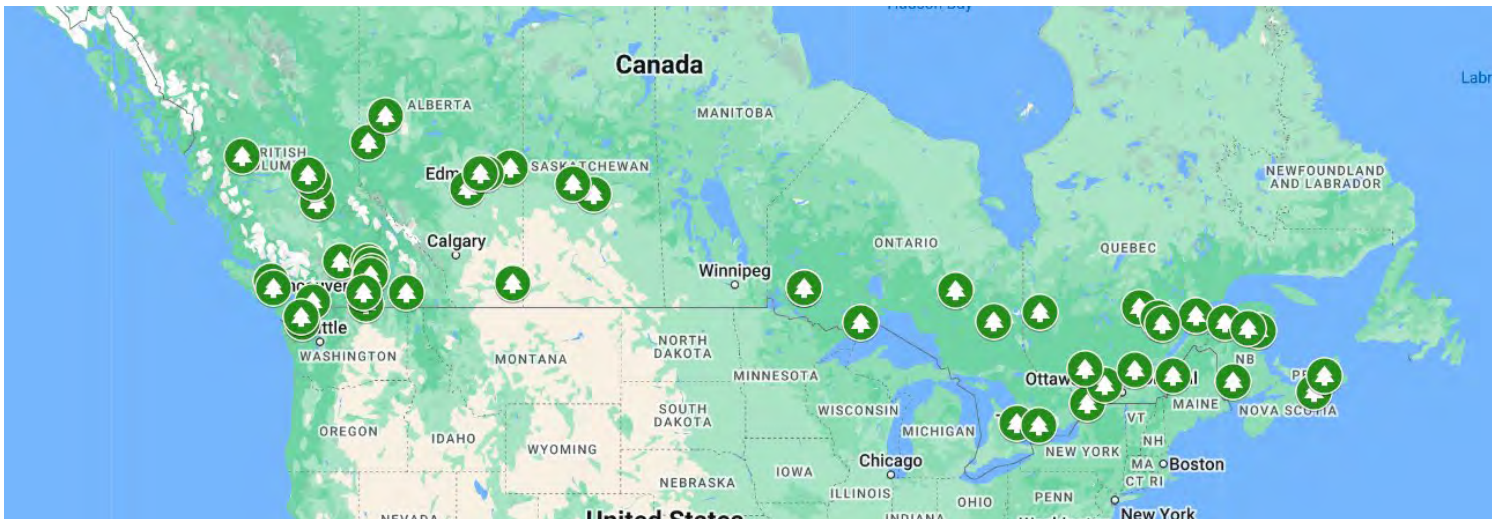

Figure 1. Map of current Canadian Tree Nursery Association-Association Canadienne des Pépinières Forestières (CTNA-ACPF) members. Membership information is available at https://ctna-acpf.ca/membership.

New BC Interior Extraction Facility Open

The Vernon Seed Orchard Company (VSOC), a Joint Venture (JV) company group consisting of West Fraser Mills, Canfor Forest Products and Lakeland Mills, is pleased to announce the completion of its Interior Extraction Facility.

VSOC initiated this capital expenditure in 2021 with the intention of reducing risk to seed, environmental impacts from transportation and shipping, and to have access to seed in a timelier manner. The creation of this facility made sense considering the scale of VSOC production that can reach more than 10,000 bags or 1,900 hectolitres in heavy crop years. The Interior Extraction Facility will reduce wait times and storage issues for VSOC in the future.

Since VSOC's establishment in 1989, our JV companies have been committed to investing in forestry and the Provincial Tree Improvement program, and will continue to be stewards on the land. A special thanks to Don Pigott (Yellow Point Propagation) for his commitment to assisting VSOC with this new facility.

For more information contact us below.

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Above: View from the western door, with the pre-tumbler to the left, bearing a dedication plaque to Don Pigott for his support.

Above: New signage at Vernon Seed Orchard Company to incorporate the new Interior Extraction Facility.

Above: View of the new extraction facility (lower middle).

Above: View along the seed extraction line, from the east door.

Above: The pre-tumbler was built using Don's cone tumbler which was originally used in the first provincial extraction facility; VSOC is "bringing the old into the new."

BC Tree Seed Centre Freezer/ Cooler Expansion Project

We are in the middle of a cooler and freezer expansion project at the BC Tree Seed Centre. This project has been in development for five years. Early in the process, it was decided to duplicate existing structures rather than try and retrofit, re-insulate and modernize our existing 38-year-old cold areas. The primary rationale was the risk to the province's $100+ million dollar tree seed inventory. Retrofitting with product in place was considered too risky, and moving the seed to trailers or another freezer facility was also unacceptable due to the constant need for access and the increased risk of damage.

The project represents a duplication and mirror image of our existing cooler and freezer space (5,550 ft^2 or 516 m^2). The two cooler units will have connected passageways and the freezers will be on either side of the coolers. In Figure 1, the light blue is the existing cooler/freezer and the green illustrates the add-on portion. After much planning and the hiring of an architectural firm (ph5 architecture) and builder (Jacob Bros Construction), we finally broke ground on September 19, 2023 (Fig. 2). For those embarking on similar projects, the planning part should not be underestimated, which included geotechnical soil surveys, arborist surveys, updated engineering surveys for costing (which can change radically during a multiyear project ☹), City of Surrey building permits, site requirements (i.e. tree protection) and ongoing inspections as the project progresses. As part of this project we are also replacing the entire roof of our 50,000 ft^2 (4,645 m^2) facility.

A few more photos as the work progressed: Figure 3 provides an overview of initial wall construction from ground level after all floor layers were in place. Figure 4 presents what to us was an eye-opening engineering trick with the use of hydraulic scaffolding to enable the rapid installation of the upper brick layers as the core of our new walls. In Figure 5, you can see the final building height, installation of water barrier on brick and placement of the rock wool insulation. The final exterior layer will be of wooden shakes. The vapour barrier, insulation and shakes are also being installed on the exterior walls of the existing freezers and cooler. The scaffolding in place is to facilitate construction of the roof, including existing freezers and cooler, to avoid poor weather

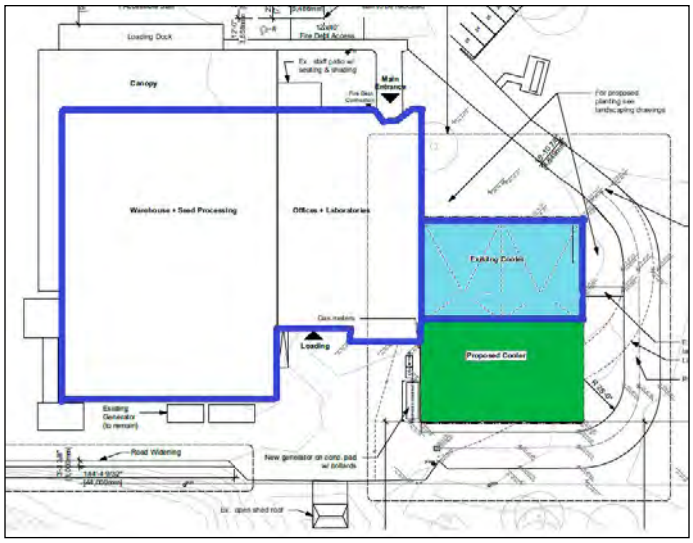

Figure 1. Schematic of the BC Tree Seed Centre footprint (ph5 architecture), where the portion in light blue represents the existing cooler/freezer and green the duplicated addition.

Figure 2. Breaking ground, September 19, 2023.

Figure 3. Initial interior and exterior wall construction, Fall 2023.

Figure 4. Hydraulic scaffolding used for rapid installation of bricks to build up the core walls of the new freezer/cooler.

Figure 5. Final new building height inside the scaffolding, as weatherproofing began.

from slowing or stopping the construction. The final photo (Fig. 6) is basically how the structure looks now with the roof tent on the scaffolding in place and each day more of the roof gets put in place.

This is simply a photographic overview of the progress to date. **However, I certainly want to thank and give credit to our Executives and Treasury Board who supported and promoted this project even during the trying and costly times of COVID – Thank YOU.** I think many people are better understanding the important role of Tree Seed Centre and the need for upgrading over time.

I look forward to showing you final photos in our next edition.

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Figure 6. Current stage of construction (May 2024), with wooden shake siding to be installed over all old and new freezer/cooler exterior walls, and a new roof to be installed over the entire facility (50,000 ft^2 or 4,645 m^2) in tandem with this expansion project.

You Never Know What Could Be Lost

For the past few years, moisture conditions have been below normal across much of southern Saskatchewan. In the Indian Head area, grass wildfires have occurred occasionally but nothing more than what normally occurs in a dry spring. Yet, in April 2024, a single spark during routine maintenance ignited a grass fire that quickly spread to a nearby 34-year-old Siberian larch planting at Agriculture and Agri-Food Canada's (AAFC) Indian Head Research Farm (Figs. 1–3). Firefighting crews were assembled, but by the time control efforts were underway the two-acre larch plantation was engulfed in flames. Fortunately, the flames did not reach the tree's crowns and the fire was contained before it could spread to adjacent green ash, Scots pine and poplar trials. Whether the larch trees will recover is not known at this time; AAFC staff will monitor the trees over the summer. An important lesson was learned about the importance of cleaning undergrowth. In the adjacent plantings, which had maintained undergrowth, the fire was easily extinguished.

Here is the history of the planting and the genetic material it contained. In October 1985, a joint Canadian Forest Service (CFS)/Prairie Farm Rehabilitation Administration (PFRA) seed collection mission to eastern Siberia was organized under the Canada/USSR Working Group on Forestry. Myself, along with Kit Yeatman, Tim Boyle from the CFS Petawawa, Jim Cayford and our interpreter Jerry Holowacz, were chosen to be on the Canadian team. During this mission, we were able to collect a number of Siberian larch (*Larix sibirica* Ledev) seedlots from natural stands in the Lake Baikal region of Siberia (Fig. 4). Additional seedlots were obtained through the Russian Ministry of Forestry and one seedlot originated from the Raivola forest in Finland.

These larch seedlots were planted in the fall of 1987 near Indian Head with 10 four-tree plots for each source (total of 40 trees per seedlot, Fig. 5, Table 1). The trees were arranged in non-contiguous plots so that the test could be later converted to a seed orchard.

What could be lost

To the best of our knowledge this collection of Siberian larch has not been replicated at other locations. Since 2013, there hasn't been an active larch breeding program at Indian Head,

Figure 1. The 34-year-old AAFC Siberian larch (*Larix sibirica*) trial, late September 2023, Indian Head, Saskatchewan.

Figure 2. AAFC Siberian larch trial on fire, April 2024.

Figure 3. Scorched Siberian larch after the April 2024 fire.

Figure 4. Progeny from this 300-year-old *Larix sibirica* in Siberia was included in the trial, with Tim Boyle (left) and Jerry Holowacz (right), circa 1985.

Figure 5. Indian Head seed orchard and trial layout, 2023.

Table 1. Provenances and accession ID numbers planted in the 1989 Siberian Larch trial, with number of trees alive last assessed in 2013.

Provenance	AAFC ID Number	# Trees (2013)
Volzhskiy, Ivanoco Oblast	4400	38
Ucholinskii, Leskhoz*	4401	35
Kochugskii, Leskhoz*	4402	32
Valtu, Estonia*	4403	40
Khakossia, Krasnoyarsk Krai	4404	35
Ivanovskaya, Oblast	4405	35
Usi-Kansk, Altai Krai	4406	35
Maloye Goloustonoye, Irkutsk Oblast	4409	36
Maloye Goloustonoye, Irkutsk Oblast	4420	36
Lake Baikal, Oblast	4421	37
Raivola Larch Forest, Finland*	4430	35
Tuva, ASSR	4431	14

*Seed orchard source

however interest in the genetics that had been assembled by the former Indian Head PFRA Shelterbelt Centre and nursery remained. The site is located on Agriculture and Agri-Food Canada property and the planting was still used occasionally for collection of Siberian larch seed.

When you lose a genetic collection such as this, it is almost impossible to replace. Over the years hundreds of genetic trials have been planted across Canada. Likely there are numerous vulnerable genetic collections that are unprotected nor maintained, and vulnerable to being lost across Canada. Be aware ***'You never know what could be lost'.***

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Improving Balsam Fir in the Northeast

Background on first-generation balsam fir tree improvement programs in the northeast

In the late 1980s, superior balsam fir Christmas trees were identified in New Brunswick and Nova Scotia by the New Brunswick Department of Natural Resources (DNR) and the Nova Scotia Department of Lands and Forests, respectively. These selections were identified in partnership with growers in the region. Similar work was ongoing in Quebec. Provincial grafted seed orchards were established in NB and NS and by private growers in Quebec. Good quality seed from these orchards has been the foundation for many of the Christmas tree plantations in the northeast for over 20 years.

The original plan was to test the quality of these first-generation selections using open-pollinated (or poly-cross) family tests. Unfortunately, this work was not done. The New Brunswick provincial balsam fir orchard only included trees with a strong balance of positive growth traits for the Christmas tree trade. The Nova Scotia orchard, on the other hand, did include some grafts from trees exceptionally strong for individual traits, with the concept that controlled crosses would be performed to examine if the traits might be positively combined in some of the resultant seedlings. These could then form selections for an improved second-generation seed orchard. Unfortunately, this work never progressed. Also, and not by plan, some trees were selected for the orchard that later were discovered to be from grafted exotic fir species which existed on a few private lots.

Second-generation improvement and climate change

The onset of climate change has brought new challenges to the Christmas tree industry. Climate change and the assorted issues around weather, and insects and diseases, has resulted in a renewed interest in reinvigorating the tree improvement programs. There is a general recognition that the trees that have grown well in the past may not be the best performers under climate change. This presents both a challenge and an opportunity.

Two traits that first-generation selections were not specifically assessed for were post-harvest needle retention and the timing of bud flush. Trees that flush later in the spring will generally be less susceptible to late spring frost damage, which is increasingly occurring in the northeast.

A formal breeding and testing program for the second-generation balsam fir Christmas trees is under development. The main objectives of this program will be to identify balsam fir trees that have growth characteristics (harden off early and flush late in the spring) that will be well-adapted to global warming and climate change with respect to both (a) direct weather impact on trees, and (b) increased threat from insects and diseases arising as a result of climate change. Partners from Quebec, New Brunswick and Nova Scotia have chosen to collaborate for the benefit of all growers in the region. Recently, growers from the northeastern US have expressed a willingness to partner with Eastern Canadian growers in this effort. Collaborative research is expanding for the Christmas tree trade, and was better organized through the development of the North Eastern Christmas Tree Research Alliance (NECTRA). The Alliance has grower members from Ontario to Nova Scotia, and scientific advisors from Canada to North Carolina.

The approach will be to test trees using common methodologies and to establish field trials in the different jurisdictions (site and climatic zones). Testing the same genetic material throughout the region will enable partners to identify parents well-suited to each zone. This field testing is essential to ensure that the next generation of Christmas trees will be well-adapted to the local climate now. An

additional advantage of this cooperative approach will be that by testing the same genetic material across the region, partners will be able to gain insights into what trees may perform well as local climatic conditions change.

Second-generation seed orchards

A second-generation balsam fir seed orchard has been established at the New Brunswick Department of Natural Resources and Energy nursery and seed orchard complex outside Fredericton. This orchard is over two-thirds established. Designed using the Computer Organized Orchard Layout (COOL) program, the numbers of clones and number of ramets for each are determined and then the computer generates a randomized planting map for all the plants. In this way, the distance between ramets of the same clone is maximized, thereby maximizing outcrossing during open pollination within the orchard. Selections based on bud flush and needle retention tests, as well as some of the 'best' selections from Nova Scotia (via Matt Wright, Collin Hunter and Murray Frank) and Quebec (via Larry Downey), were grafted and included in the Kingsclear orchard. These partners are also in the process of establishing their own seed orchards with some but not all of the same materials. For each orchard, the majority of clones are 'local selections'.

Over the next few years, the plan is to make open-pollinated seed collections from as many of the original parents as possible and establish family tests in New Brunswick, Nova Scotia and Quebec. The results from these family tests will be used to rogue orchards in the three respective provinces. This will be the first step in determining the genetic quality

Above: Ron Smith and Joel Tremblay, University of New Brunswick MScF candidate, discussing and showing samples of superior grafted selections chosen for needle retention and later bud flush timing. Photo taken September 2022.

Above: New second-generation balsam fir seed orchard in the first year of establishment. Photo taken September 2022.

Above: Balsam fir seed orchard establishment in Kings County, Nova Scotia. Left to right: Max, Murray Frank, Joel Tremblay and Ron Smith. Photo taken August 25, 2023.

Above: A superior balsam fir Christmas tree selection with exceptional needle retention post–harvest ("keepability"). This tree has never been sheared and the branching density and form carry through on all grafts. Photo taken October 2017.

Above: Ron Smith and Joel Tremblay speaking to visiting Danish growers, June 12, 2023. The tour stopped to discuss one of the superior wild trees from Quebec, New Brunswick and Nova Scotia being screened for needle retention for future climates and marketability.

Above: A replicated top-grafting trial to investigate the influence of rootstock on the timing of bud flush in new balsam fir selections. This trial was repeated in 2021 and 2022.

of the parents—in this case, estimates of general combining ability and the heritability of the traits of interest.

Following this approach, partners in the three Canadian provinces as well as in the northeastern US states will be able to identify trees that perform well under their respective conditions, thereby advancing the industry throughout northeastern North America. Regional cooperation with local delivery (via local seed orchards) should position growers to establish Christmas tree plantations comprised of trees that are well suited for our changing climate.

All photos in this article contributed by Matthew Wright. Thank you to the Real Christmas Tree Board (formerly the Christmas Tree Promotion Board) for funding this work. Note that the North Eastern Christmas Tree Research Alliance (NECTRA) is a recently formed advisory board.

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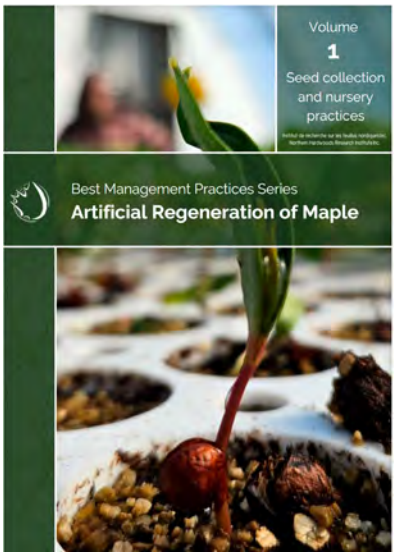
Artificial Regeneration of Maple in New Brunswick

Natural regeneration, guided by recommended silvicultural practices, is the preferred strategy for regenerating sugar maple. However, artificial regeneration becomes an important consideration in areas where historical practices have eradicated sufficient mature seed trees or where high-quality sugar maple stands are in decline. With the looming threat of climate change and the projected maladaptation of Acadian tree species, there's a growing interest in assisted migration trials, as a part of adaptive silviculture research. These trials aim to plant seed sources from future climate analogues, potentially offering a solution to mitigate the effects of changing environmental conditions.

The challenges of growing sugar maple plantations extend from natural obstacles like predator browsing and herbaceous competition to changing climate conditions. Artificial regeneration may offer more control over the prescription and initial stocking, but presents challenges like seed supply issues and the need for extensive nursery care. Although requiring an initial investment, the appeal of maple plantations stems from their promising potential for both high value returns and sustainability advantages. Particularly in warmer southern climates on ideal sites, high-value hardwood plantations such as black walnut can be established and managed with an investment of $5,000–$10,000 USD per hectare. Successful cultivation of hardwoods involves selecting the right stock, ensuring optimal site conditions, proper site preparation, and addressing predator threats. Overall, meticulous planning and attention to detail are essential for maple plantation success amid various establishment challenges.

The objective of the Artificial Regeneration of Maple (ARM) project is to establish best management practices for artificially regenerating sugar maple through planting and direct seeding. When AV Group and the New Brunswick Department of Natural Resources and Energy Development sought assistance from the Northern Hardwood Research Institute, we were aware of the challenges and costs involved in transitioning hardwood plantations from small to large-scale operations. However, the most significant obstacle we faced was the shortage of sugar maple seeds, which we hadn't anticipated despite knowing about the typical



Above: New NHRI Guidebook Series: *Artificial Regeneration of Maple–Volume 1: Seed Collection and Nursery Practices.*

collection frequency. Thanks to contributions from the National Tree Seed Centre and the Kingsclear Provincial Tree Nursery, we successfully grew and planted 3,000 sugar maple, 4,000 silver maple, and 2,000 red maple seedlings, along with direct-seeded red and sugar maple on License 1 in northern New Brunswick.

Our applied research led to the first publication in a guidebook series *Artificial Regeneration of Maple–Volume 1: Seed Collection and Nursery Practices*, available on our website https://hardwoodsnb.ca/pdfviewer/artificial-regeneration-of-maple-vol-1/. Volume 1 covers the comparative silvics, seed collection requirements, tools, and nursery production requirements of red, silver, and sugar maple, because each species posed unique challenges.

We had plans to establish new demonstration sites in 2024, but challenges with seed collection and capacity in Atlantic Canada have had an impact. As a result, we are helping to form the Atlantic Region Seed Supply Network as the liaison for New Brunswick. As far as next steps for the ARM project, our focus will shift to the seedlings already planted. *Volume 2: Plantation Establishment and Tending,* is expected to be released by the end of 2024.

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Ecotype Project's Network Map Enhances Seed Collaborations

In January 2023, in the United States, the National Academies of Sciences, Engineering, and Medicine released a report that found the country's current supply of native seeds is insufficient to meet the restoration needs of agencies like the US Forest Service and the Bureau of Land Management (BLM). This report came eight years after the publication of The National Seed Strategy for Rehabilitation and Restoration 2015–2020, a road map and funding stream developed by the Plant Conservation Alliance to fill this gap in production. Much has been accomplished in the Western states since, but the anticipated demand continues to outpace the rates of production. The situation is even more acute in states east of the Mississippi River.

The skewed distribution of federal land ownership in the US exacerbates this problem. To wit, the US government owns about 46% of the land in the 11 contiguous Western states, whereas its ownership averages only 4.6% in the remaining mainland states. Given that the US government is the primary purchaser of seed and plant material nationally for use in restoration programs on public lands, this demand serves as a strong signal for farmers and nursery professionals to ramp up production. In the Eastern states, where land ownership is predominantly divided among state governments and private individuals, procurement streams are less consolidated and coordinated. Particularly in the northeastern US, this is hindering the development and expansion of robust seed and plant material supply chains.

Wild-collecting and/or producing native seeds at scale in the northeastern US is often more expensive because farmers' landholdings and outputs are, on average, smaller and less efficient than in the Midwest or West. Despite this, many dedicated stakeholders, including the Mid-Atlantic Regional Seed Bank (MARS-B), the Native Plant Trust, The Ecotype Project, The Northeast Seed Collective, Pinelands Nursery, Planters' Choice, Highstead, Wild Seed Project, ReSeeding Rhode Island, and Hilltop Hanover Farm have been generating supplies of woody and herbaceous native seed and planting stock for the Northeast and northern Mid-Atlantic states. Strengthening the region's supply network to meet the growing demand for ecological restoration activities is too big of a job for any entity to tackle independently.

In March 2023, a collaborative group of regional stakeholders launched the Northeast Seed Network. This emerging social-ecological impact network, currently coordinated by the Native Plant Trust and Ecological Health Network (EHN) is focused on facilitating communication and knowledge to build communities of practice and enhance the availability and use of source-identified genetically diverse native seed and plant material for healthy, biodiverse landscapes in the Northeast and northern Mid-Atlantic states.

The network members are a diverse web of social actors, including government agencies, Tribal Nations, educational institutions, nonprofit organizations, botanic gardens, farmers, private companies, citizen groups and academic institutions. For its founding members, forming this network is a prerequisite to meeting the region's restoration goals, reversing ecosystem degradation, advancing equity, generating farmer income and improving the health and well-being of both humans and wildlife. One key step in partnership-building is raising awareness about network members, their roles, projects, goals, and potential contributions. This groundwork helps develop a transparent and cooperative structure that promotes communication, coordination, and self-organization.

To address a multitude of needs, The Ecotype Project designed an interactive online Network Map (Fig. 1): https://www.ecotypeproject.org/networkmap. The map's icons and filters can easily identify botanists, seed collectors, farmers, nursery professionals, seed banks, and processing facilities in this region. Users can also search specifically by Level III Ecoregions of the Continental United States, scope and scale of restoration projects, and even for specific species. With EHN's US Northeast Bioregion Program Director, Eve Allen providing guidance and outreach to the project, over 80 members of the Northeast Seed Network have asked to be listed on the map, including Canada's National Tree Seed Centre in New Brunswick and shared Acadian forest ecosystem.

The idea for this resource came through multiple channels. First, Ecotype Project co-founder Dina Brewster says, "I have long been interested in how to effectively weave together public and private collaboration for environmental work. I believe that the interests of private enterprises must align themselves with the public good as a matter of practice in order for us to make any real headway in the climate

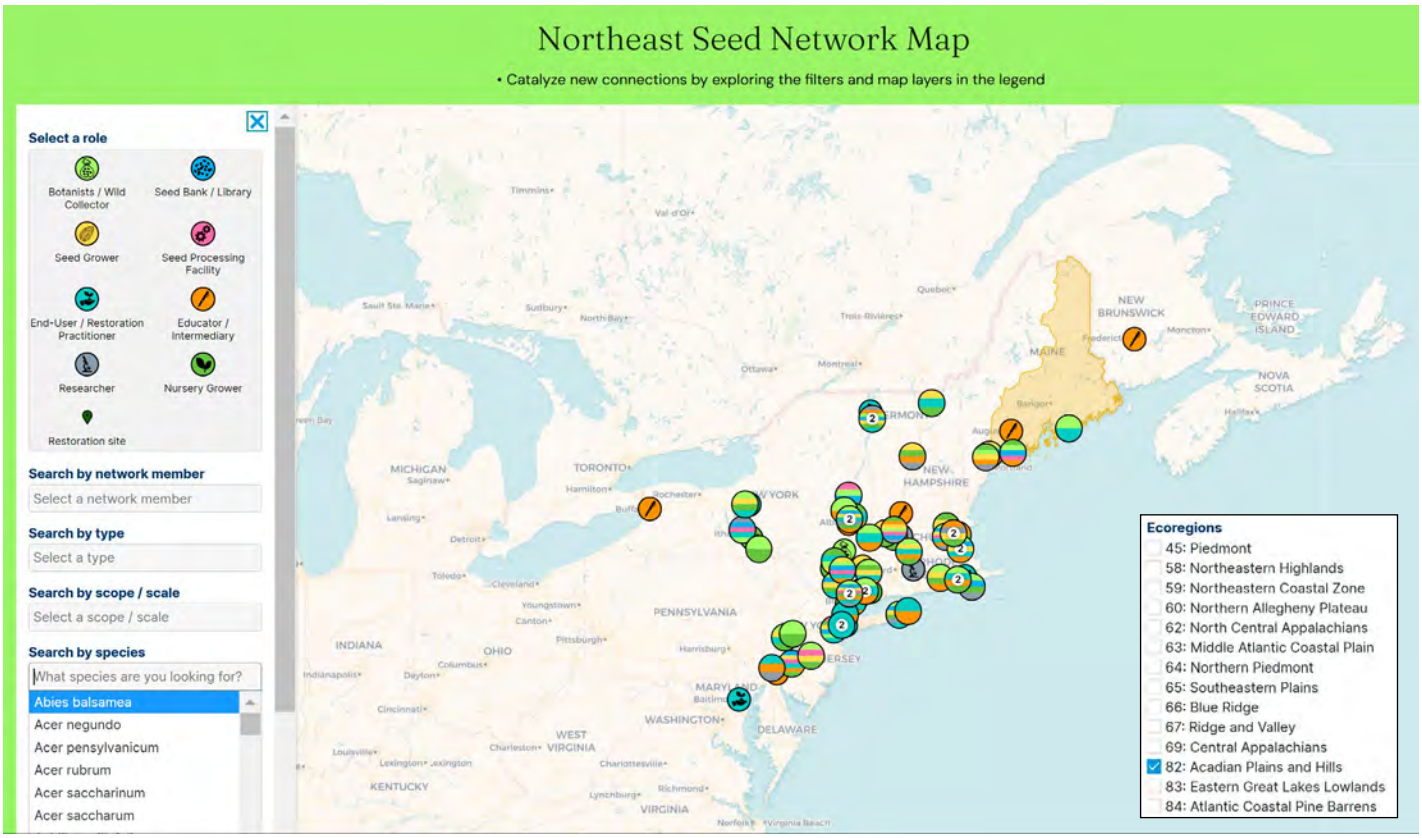

Figure 1. The newly launched Northeast Seed Network Map has the capacity to identify members with various filters (left): type of organizational structure (federal, municipal, public, private), scope or scale, species' expertise or ecoregion (inset right) The Ecotype Project is working to adopt the Level III North American Ecoregions to include adjacent Canadian provinces over the next two years.

crisis. But too often conservation groups see themselves in opposition to agricultural businesses and farms, when, in fact, it is only through fostering common-mission among unlikely partners, that we can build something positive and lasting." Brewster credits a Highstead publication, The Regional Conservation Partnership Network Handbook, as a resource for anyone interested in this framework. "I use the term 'fierce transparency' to set a tone for our collaboration. It has not always been an easy road—but it isn't long before you notice that farmers, seed-keepers, botanists, restoration practitioners, and nursery growers—we may drive in different lanes, but we all love plants, we all love the outdoors, and we all find ourselves working under the rain of threats and losses from climate change. That means our hearts are all tugging us in the same direction. And more importantly, that means we need each other."

To build the Network Map, The Ecotype Project employed a web development team out of Squamish, British Columbia (Visual Science). Adrian Jones, lead engineer, took the Ecotype Project from the network map's conception through to the training of those who would be entering data once it was built. "Adrian was an extraordinary partner/teacher, and fully grasps the complexities inherent in building 'fierce transparency' into our online Network," says Brewster.

Sefra Alexandra, an ethnobotanist known as The Seed Huntress, is the Ecotype Project's other co-founder. She has described one of her roles within this work as a switchboard operator building collaboration amongst, often siloed, organizations. She goes on to discuss the vision of the Network Map: "A famous adage of expedition contingency planning is if we don't know where you are, we can't help you. I am perennially reminded that the strength of a network lies in the connections of diverse partnerships. Utilizing design cues from the mycorrhizal network or the 'Wood Wide Web', as popularized by Suzanne Simard's work, the resilience of our work relies on connection. Together as we build this shared framework, we collectively enhance and amplify the proficiencies of all involved for the mission of place-based regeneration. The Network Map is now a resource that can be shared openly and widely with other

organizations looking to foster collaboration through transparency. Join us!"

One of the complexities of the Ecotype Project's Network Map is that anyone can be listed and the map makes no distinction between size of organization, resources available, or scale of production. Brewster views this as an asset. "Everyone has the same size dot on the map, and that is equitable access to information is an inherent goal for the Northeast Seed Network." Brewster adds that the map is fundamentally meant for use by seed production professionals. It is not a directory, meaning they do not share contact information for members. "Our goal is simply to paint a picture of 'who is doing what and where' and then see what naturally follows from openly sharing the efforts of these amazing organizations."

Any questions, or for TSWG readers interested in being listed on the map to enhance availability of source-identified tree and shrub seed and/or stock, please contact any of us below. Map listings will be updated quarterly.

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International Tree and Shrub Group (TAS): Seed Plays a Crucial Role

Editor's Note: This article was written to expand on the purpose and current topics of interest to the TAS group. Please see TAS leaflet for more information following the article.

The International Seed Federation (ISF) believes that the forest industry plays a pivotal role in providing resources for various sectors, including construction, paper production, and bioenergy. At a time of growing concerns about sustainability and environmental impact, the importance of seed contribution in the forest industry has gained attention. **Tree seeds are the foundational element of reforestation, serving as a cornerstone for sustainable forest management.**

The Significance of Seeds in Forest Sustainability

Seeds represent the origin of life in forests. They contain the genetic blueprint for future trees, influencing characteristics such as growth rate, wood quality, resistance to pests and diseases, and adaptation to environmental changes. As the forest industry moves toward sustainable practices, seeds play a central role in replenishing harvested areas and expanding forest cover in previously deforested or degraded regions.

Reforestation, which involves planting trees in areas where forests were recently cleared, and afforestation, which involves reestablishing forests on sites historically cleared, are critical for maintaining biodiversity, sequestering carbon, and supporting local ecosystems. Seeds ensure that these processes occur with a diverse genetic pool, promoting resilient forests that can withstand the pressures of climate change and human activity.

Challenges in Innovation, Seed Collection, Improvement and Distribution

One of the primary challenges in the forest industry is obtaining a reliable and diverse supply of seeds. This involves collecting seeds from a wide range of tree species and populations to ensure genetic diversity and ecological resilience. The process requires careful planning, considering factors such as the timing of seed collection, storage conditions, and quality control.

Moreover, it requires further work in the selection of the best trees and continuous improvement by tree breeders to anticipate the upcoming changes and deliver what is and would be needed for producers and foresters. The distribution of seeds must be strategically managed as seeds need to be planted in appropriate environments to maximize survival rates and promote healthy forest growth. This often involves partnerships between the forest industry, government agencies, public institutes, private companies and conservation organizations to coordinate tree seed collection, storage, and distribution efforts.

Innovations in Seed Technology

Advancements in seed technology are also transforming the forest industry's approach to reforestation and afforestation. Techniques such as seed coating, which involves applying protective layers to seeds to enhance germination and resist pests, are gaining traction. These innovations can improve the success rates of planting efforts, optimizing the need for chemical treatments and minimizing environmental impact.

Additionally, advances in genetic research allows for faster selective breeding of tree species, resulting in seedlots and orchards with desirable traits like faster growth rates, improved wood quality, and increased resistance to pests and diseases. These developments contribute to more efficient and sustainable forestry practices.

The Future of Seed Contribution to the Forest Industry

As the forest industry continues to embrace sustainability, the role of seed producers will become even more critical. The global tree seed industry must prioritize genetic diversity to ensure that forests can adapt to changing environmental conditions. This includes a focus on native tree species and traditional knowledge to maintain the ecological balance.

Moreover, collaboration among stakeholders will be essential to promote best practices in seed innovation, selection, collection, storage, and distribution. Governments, NGOs, public and private companies must work together to ensure that reforestation and afforestation efforts meet environmental and social objectives

In conclusion, seed contribution to the forest industry is a key component of sustainable forestry practices. By focusing on genetic diversity, embracing innovative seed technologies, and fostering collaboration, the industry can ensure a healthier, more resilient future for forests worldwide.

TAS Group Annual Meeting: Sante Fe, New Mexico, USA in August 2024

Please see the flyer for information on the annual meeting, also available here: https://worldseed.org/document/isf-tree-and-shrub-group-leaflet/

The International Seed Federation's Tree and Shrub group is looking for more North American members and participation. An ISF membership offers additional benefits such as:

- Fostering cooperation and collaboration amongst actors and members of the seed sector, and with identified partners/stakeholders,
- Settlement of disputes through mediation, conciliation and/or arbitration,
- Liability insurance,
- Trade and arbitration rules,
- Updates via the online members area.

Learn more about ISF and its members at: https://worldseed.org/about/what-we-do/

For more information on TAS membership or to attend the New Mexico meeting, please contact me below.

Ben Rivoire
International Seed Federation Focal Point
Nyon, Switzerland
Email: b.rivoire@worldseed.org.

International Seed Federation
Seed is Life

ISF Tree and Shrub Group (TAS)

The International Seed Federation (ISF) is a non-profit and non-political organization whose members are mainly national seed associations and seed companies. With members spread in close to 80 developed and developing countries, on all continents, ISF represents the majority of the world seed trade and plant breeders' community at a global level. ISF is the voice of the global seed sector and has official observer status in key international and intergovernmental organizations. ISF has several crop-based working groups and topic-oriented coordination groups. One of them within the ISF structure is the ISF Tree and Shrub Group.

ISF membership offers various benefits such as: fostering cooperation and collaboration amongst actors & members of the seed sector and with identified partners/ stakeholders, settlement of disputes through mediation, conciliation and/or arbitration, Liability insurance, Trade and arbitration rules, updates via the online members area. Learn more about ISF and its members at: https://worldseed.org/about/what-we-do/

Ben RIVOIRE
ISF focal point
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Who We Are

The ISF Tree and Shrub (TAS) Group consists of national associations and public and private companies which are active in the field of the tree and shrub seed trade. Currently 22 active members representing 18 countries are participating in this group and meet once per year for several days of conversations and excursions, hosted by one of the members in their home country. Generally, only ISF TAS members participate in the annual meetings and subsequent excursions; observers & external guests might be invited to join on an ad hoc basis. The chairperson of the group is elected among the members.

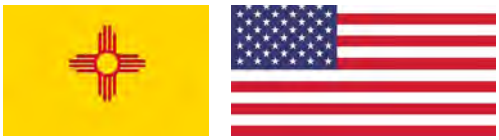
Purpose & Work

The TAS Group's primary focus revolves around matters pertinent to the sector, particularly concerning seed collection, treatment, and plant breeding. Additionally, this group plays a pivotal role in bolstering the ISF Working Groups by integrating crop-specific business insights into the broader global discourse on seed and plant material. In fostering a dynamic platform for dialogue, the Group convenes experts from diverse geographical locations, company scales, and crop specializations to engage in comprehensive multifaceted discussions, perspectives and solutions on topics such as:

- Horizontal issues impacting the work of the industry (plant breeding innovation, illegal seed practices, genetic resources, seed and plant health…)
- Access to market issues (including regional and national regulations on seed trade, measures to mitigate obstacles and improve movement of seeds and planting material)
- Seed crop information (based on data provided by members)
- Objectives for high quality seed production within the industry (e.g. guidelines and best practices)
- Latest developments in other international organizations (such as OECD forest schemes or ISTA seed testing rules)
- Technical matters relevant for the development and continuous improvement of the industry (technical and field visits…)
- Development of position paper to be heard as a coordinated voice of the industry
- Communication matters to raise on the importance of the industry in relation to global goals and challenges (e.g. UNSDGs)

Make Your Voice Heard!

ISF-TAS membership provides your company with a valuable opportunity to influence international organizations. Throughout the year, ISF TAS group members actively participate in meetings of prominent intergovernmental organizations such as the International Seed Testing Association (ISTA), The International Union of New Varieties of Plants (UPOV), the International Union for Forest Research Organizations (IUFRO), the International Plant Protection Convention (IPPC), and the OECD Forest Seed and Plant Scheme. These meetings focus on discussing regulations aimed at facilitating the trade of tree and shrub seeds. We have released several position papers addressing crucial trade-related topics such as amendments in the EU FRM directive, EU phytosanitary regulations, and international trade barriers. Our proactive engagement has led to the adaptation of several regulations in recent years. Currently, we are actively supporting the OptFOREST project, which addresses Forest Reproductive Material (FRM) issues in response to a changing climate.



Next Event – New Mexico, USA

The annual meeting typically draws commercial tree seed professionals from across the globe, facilitating discussions on various pertinent issues concerning tree and shrub seeds. Reputable external speakers are invited to share presentations on relevant subjects, enriching the discourse. Furthermore, participants and their joining partners are invited to enjoy immersive excursions to explore tree stands, orchards, nurseries, arboretums, model forests, and other sites related to tree cultivation. Beyond the formal proceedings, companies leverage the event as an important networking opportunity and information exchange with fellow industry players.

Join us in the picturesque state of New Mexico, USA, from August 26th - 28th 2024 for what promises to be an unforgettable event!

Membership

Membership of the ISF Tree & Shrub Group comes with a small membership fee of 607 CHF (Swiss Francs) per year. Participation costs for the annual meeting are additional. Prospective new members have the opportunity to attend one meeting as an observer. We extend a warm invitation for you to join the group.

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100 years of ISTA: The Evolution of Tree Seed Testing

The Formation of ISTA

The International Seed Testing Association (ISTA) was founded in July 1924 at the Fourth International Seed Testing Congress held at the National Institute of Agricultural Botany (NIAB) Cambridge, UK (Anon., 1924, Fig. 1). ISTA plans to revisit the Cambridge location in July 2024 for its annual meeting and to celebrate 100 years of ISTA (see https://www.seedtest.org/en/annual-events/annual-meeting-2024-product-10043.html).

The 1924 Congress in Cambridge started as a meeting to further the aims of the European Seed Testing Association formed in 1921, but early in the meeting, the idea of an international association was suggested. By the end of the meeting, the 26 member countries present (some from outside of Europe) had agreed in principle to form the International Seed Testing Association. A sub-committee formed during the meeting created a Constitution for ISTA and the people present elected Knud Dorph-Petersen (Denmark) as ISTA's first president. The meeting also elected Sir Lawrence Weaver (UK) and A. Volkart (Switzerland) as ISTA's first honorary members in recognition of their work in seed testing and the association. ISTA was born.

North American Links

In North America, the Association of Official Seed Analysts (AOSA) was formed in 1908 (https://analyzeseeds.com/about-us/) and people active in AOSA were also active in the then European-based international seed testing congresses. Although there was no official USA government representative at the 1924 meeting, M.T. Munn from AOSA and E. Brown from the United States Department of Agriculture (USDA) were present. At that time M.T. Munn was the President of AOSA and was acknowledged by the 1924 meeting as key to the development of seed testing and was a supporter of the idea of ISTA. G. H. Clarke (Seed Commissioner, Canada) was the only official government representative from North America at the 1924 meeting.

ISTA formed technical committees and continued to organize the three-yearly international seed testing congresses. When ISTA still had organizational members, AOSA was formally a member and since then, members of AOSA, the Society of Commercial Seed Technologists (SCST formed in 1922) and ISTA have members working together on different technical committees. The first ISTA International Seed Congress outside of Europe was hosted in Washington, D.C., USA in 1950. From 1954 to 1959 Walter A. Davidson (USA) became the first ISTA President from North America. Since then, there have been five ISTA Presidents from North America (three from the USA and two from Canada), with Ernest Allen from USDA due to become the 6th in 2025.

International Rules for Seed Testing (ISTA Rules)

Differences in seed testing methods between countries in North America and those in Europe were discussed and debated over the years from 1924 to 1931, but at the 1931 Congress in Wageningen, The Netherlands (ISTA, 1931a), the first edition of the International Rules for Seed Testing (ISTA Rules) were agreed and published (ISTA, 1931b). The 1931 edition of the ISTA Rules concentrated on 41 agricultural species with just four main technical chapters after an introduction: sampling, analytical purity, germination and additional determinations: sanitary condition, genuineness of variety, provenance, weight determination and moisture methods (ISTA, 1931b, Fig. 2).

Many of the methods developed for agricultural species were also applicable to woody plants, although seeds of trees and shrubs have not been domesticated to the same extent and tend to exhibit dormancy. Some tree species are deeply dormant, and others germinate well after a prechill. The prechill period in the laboratory is still lengthy compared to some agricultural species. For example, a dormant barley seedlot might germinate very well after just three days of moist prechilling at 5°C, while a shallowly dormant tree species like Sitka spruce (*Picea sitchensis*) would need three weeks at 5°C to achieve maximum germination under laboratory conditions (ISTA, 2024). Indeed, for other deeply dormant tree species, 18 months or more may be needed to overcome dormancy and achieve maximum laboratory germinations. Such timelines are often unrealistic for a testing laboratory and end user(s), so other methods indicative of viability were needed. Georg Lakon (Germany) pioneered the use of tetrazolium for viability testing, and others continued to develop the tetrazolium test for seed viability on a range of different species. In 1966 *Chapter 6:*

The biochemical test for viability: the topographical tetrazolium (TEZ or TZ test) was added to the ISTA Rules (Steiner, Kruse and Leist, 2013).

Georg Lakon was also the first Chair of the Committee on Examinations of Forest Seeds (abbreviated to CFS), formed at the 1928 International Seed Testing Congress in Rome. The first studies by the CFS started in 1930 and used *Picea excelsa*, syn. *Picea abies*, *Pinus sylvestris*, *Larix europaea* and *Pinus strobus* to develop methods and determine thousand seed weight, analytical purity, and germination and utility values (equivalent to normal germination).

They reported on progress in the 1931 proceedings, and then did follow-up work on just one species, *Picea excelsa*, applying the general principles of the now published ISTA Rules for 1931 (ISTA, 1931b). The studies continued and in 1934 they concluded that the standardization was not yet good enough. Further studies using *Picea abies* were reported in 1934, all aimed at ensuring uniformity in methods and the application of those methods in different laboratories. Steiner et al. (2009) summarized this early validation work with tree species very well. The scientists in the 1930s already applying the idea of method validation, which was formalized within ISTA in 2007 (ISTA, 2007).

Tree Seed Testing in the ISTA Rules

At the 1950 ISTA meeting in Washington D.C. the Forest Seed Committee presented test methods for 17 genera and 17 species of woody plants, with the recommendation to use tetrazolium testing for 14 species. At the 1950 meeting G.A. Elliot (Canada) took over as Chair of the CFS TCOM as Lakon was planning to retire after 40 years of work on tree species. Part of his legacy, along with support from other tree scientists, was that in 1954, woody plant species (28 genera/species) were added to the ISTA Rules. North American species were included, and the list of tree species included in the ISTA Rules continued to grow in the subsequent years.

Now in the 2024 edition of the ISTA Rules, methods for tree and shrub species are listed in several chapters. Seed lots and working sample weights are in *Chapter 2: Sampling*, pure seed definitions for tree and shrub seeds in *Chapter 3: The purity test*, germination methods in *Chapters 5: The germination test* and *Chapter 13: Testing by weighed replicates, Chapter 6: The biochemical test for viability: the topographical tetrazolium, Chapter 9: Determination of moisture content, Chapter 12: Excised embryo test for viability, Chapter 14: X-ray test*, as well as disease testing for forest species in *Chapter 7: Seed health testing* (ISTA, 2024). X-ray analysis of tree seed has always been important to determine the presence of damaged, empty and insect-filled seeds.

ISTA Forest Tree and Shrub Technical Committee

The Committee on Examinations of Forest Seeds has become the ISTA Forest Tree and Shrub Technical Committee (FTS TCOM) and now has 15 members from many different regions of the world (see https://www.seedtest.org/en/technical-committees/forest-tree-shrub-seed-committee.html). There are 22 ISTA accredited laboratories with germination testing of tree and shrub seeds on their scope of accreditation, and 19 with tetrazolium testing for tree and shrub seeds (see https://www.seedtest.org/en/membership/member-search.html).

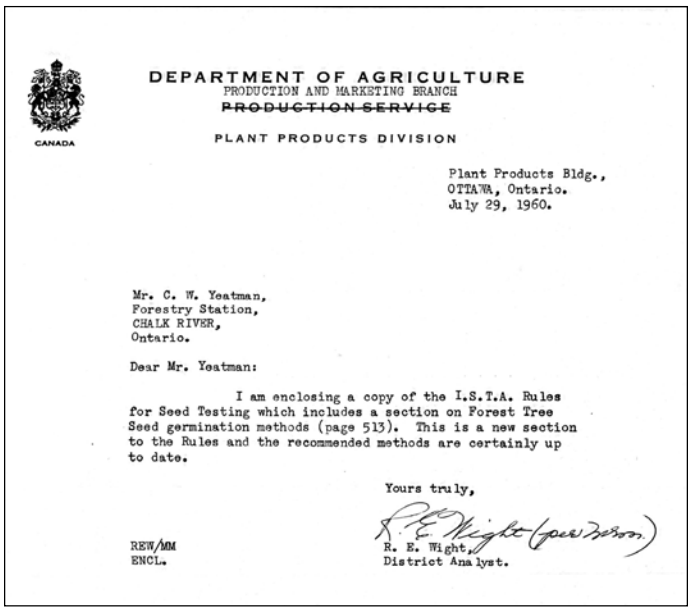
ISTA Orange International Seed Lot Certificates

The emphasis and need to issue an ISTA Orange International Seed Lot Certificate (OIC) to facilitate the export of tree seed around the world has changed over the years, especially when the Cooperation and Development (OECD) Forest Seed and Plant Scheme no longer required the issuance of an ISTA OIC for OECD forest tree seed lots. The ISTA OIC ensures traceability with sampling and testing under the control of an ISTA-accredited laboratory/sampling entity. The OIC first came into existence in 1931 along with the first edition of the ISTA Rules (ISTA, 1931c, Fig. 3). Although the need for results issued on an ISTA OIC might have declined for tree seeds, it has not for other species. Today, ISTA laboratories worldwide issue about 200,000 ISTA Certificates per year linked to about 80,000 exported seed lots (ISTA, 2023). ISTA plans to move to the option of using electronic certificates in 2024 (see https://www.youtube.com/watch?v=a--A55Z_yA4).

What has not changed for tree seed testing is the need for internationally agreed standard methods and the ISTA Rules continue to provide this, as only governmental representatives from the ISTA Designated Authorities (58 in 2023) can vote on changes to the ISTA Rules. Reliable and reproducible tests results can then be issued by ISTA accredited seed laboratories using these methods. With the

Figure 1. Group photograph from the 1924 meeting outside the National Institute of Agricultural Botany, Cambridge, United Kingdom.

Figure 3. Examples of the first ISTA Blue and Orange Certificates from 1931.



DEPARTMENT OF AGRICULTURE
PRODUCTION AND MARKETING BRANCH
~~PRODUCTION-SERVICE~~
PLANT PRODUCTS DIVISION

CANADA

Plant Products Bldg.,
OTTAWA, Ontario.
July 29, 1960.

Mr. C. W. Yeatman,
Forestry Station,
CHALK RIVER,
Ontario.

Dear Mr. Yeatman:

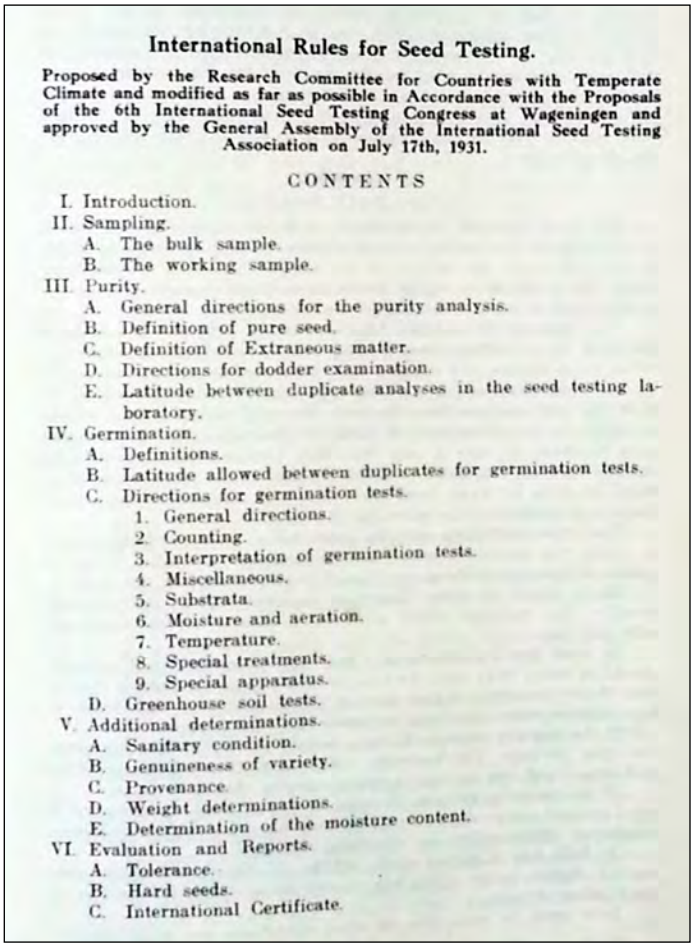
I am enclosing a copy of the I.S.T.A. Rules for Seed Testing which includes a section on Forest Tree Seed germination methods (page 513). This is a new section to the Rules and the recommended methods are certainly up to date.

Yours truly,

R. E. Wight (per Bross)

REW/MM
ENCL.

R. E. Wight,
District Analyst.



International Rules for Seed Testing.

Proposed by the Research Committee for Countries with Temperate Climate and modified as far as possible in Accordance with the Proposals of the 6th International Seed Testing Congress at Wageningen and approved by the General Assembly of the International Seed Testing Association on July 17th, 1931.

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D. Directions for dodder examination.
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Figure 2. The table of contents from the first (1931) edition of the ISTA Rules. Left: A letter addressed to Kit Yeatmen in 1960, from then-Department of Agriculture Plant Products Division (Ottawa, Canada), informing the Petawawa Forestry Station that tree seeds were newly included in the 1959 ISTA Rules. The letter was discovered by TSWG Editor, Melissa Spearing in the Atlantic Forestry Centre archives, January 2024.

push for reforestation, restoration, and conservation projects, as well as carbon capture by planting trees you could even say it is even more important to have reliable methods to ensure only viable tree seeds are being sold and planted. Seed buyers and end users should always ask to see the reports of seed tests to make informed decisions about germination, viability, dormancy, moisture and thousand seed weight.

The Next 100 Years

The future of ISTA has always relied on the dedicated work of people around the world collaborating for the common good. In agriculture, it is to help feed the world; in forestry it could be to help to save the world with carbon capture and conservation. For the next 100 years, I hope the people working on tree seeds will be able to continue at current levels, but that is a challenge as a number of people are now retiring and not all being replaced.

I first started to use the ISTA Rules when I joined the staff of the Official Seed Testing Station for Trees and Shrubs at the Forestry Commission's Research Station in the UK in 1988. I went on the post-ISTA Congress Forestry tour organized by my boss and then-Chair of the FTS TCOM, Peter Gosling, and this was the start of my journey with ISTA. In 2000 and by then working at NIAB, UK, I became the ISTA Rules Chair and later represented both the UK and Canada (after I moved to work for the Canadian Food Inspection Agency (CFIA)) on the ISTA Executive Committee. For 35+ years I have been involved with ISTA as an end-user of the ISTA Rules, or active on ISTA Committees and had the chance to visit different countries and meet lots of interesting people. I have enjoyed my time with ISTA and encourage others to become involved too.

The Young@ISTA initiative aims to involve the next generation of people in the world of seed testing and I hope tree seed testing will continue to be a part of that.

For more details about ISTA, visit https://www.seedtest.org/ and the ISTA YouTube channel at https://www.youtube.com/channel/UCkJ5b-hXLHbDtYTjzAtCeAA?view_as=subscriber.

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Update on Extended Stratification of A-class Interior Spruce Seedlots

Background

In Volume 70 of the Tree Seed Working Group News Bulletin, I summarized the results of a study of extended stratification of interior spruce (*Picea glauca* (Moench) Voss, *Picea engelmannii* Parry ex Engelm., and their hybrids) seedlots at the Tree Seed Centre (Lei 2021). To see if interior spruce (SX) seedlot germination could be improved by extending cold stratification beyond the default three weeks, 124 A-class (seed orchard-derived) SX seedlots were tested with an extended six weeks of stratification. Overall, there was only a 0.8% increase in germination and 0.2 in peak value (a measure of germination rate)[1]. However, 57% of the seedlots tested with 6-week stratification had an average increase of 3.2% in germination and 0.6 in peak value. There was no improvement in germination for the remaining 43% of seedlots tested; 3-week stratification test results were 2.7% higher in germination and 0.5 higher in peak value.

Since then, we have tested all new SX seedlots with both a 3-week (G10 test type) and 6-week (G12 test type) stratification, retested some of the seedlots used in the initial study, and also tested some B-class (wild stand) seedlots. Since the majority of SX seedling requests have been for A-class seed (94% on average over the last ten years), testing was focused on A-class seedlots. This article looks at results from lab germination tests, quality assurance tests, and nursery feedback since the 2020 request year to evaluate the effectiveness of incorporating the G12 stratification regime into Tree Seed Centre seed testing and seedling request preparation practices.

Materials and Methods

The same materials and methods were used as in the previous study (Lei, 2021). A random, representative sample was taken from each seedlot and counted out into four replicates of 100 seeds per test. Replicates were soaked in standing water for 24 hours, spread manually into germination dishes (Fig. 1a, Hoffman Manufacturing Inc.) and then put into a 2–5°C cooler for three or six weeks of cold stratification. Dishes were placed in germinators (30°C with light for 8 hours, 20°C dark for 16 hours) and examined by technicians three times a week for 21 days. Germinants with total hypocotyl and radicle growth reaching four times the length of the seed were recorded as "normal" (Fig. 1b). The number of normal germinants in each of the four replicates was averaged to calculate the germination capacity (GC, expressed as a percentage) of the seedlot for that test type. Abnormal germinants were recorded but not included in GC results. Peak value (PV) is a measure of when the germination rate was the highest and determined as the maximal value of the cumulative germination divided by the days in the test. The higher the PV, the faster the germination of a seedlot.

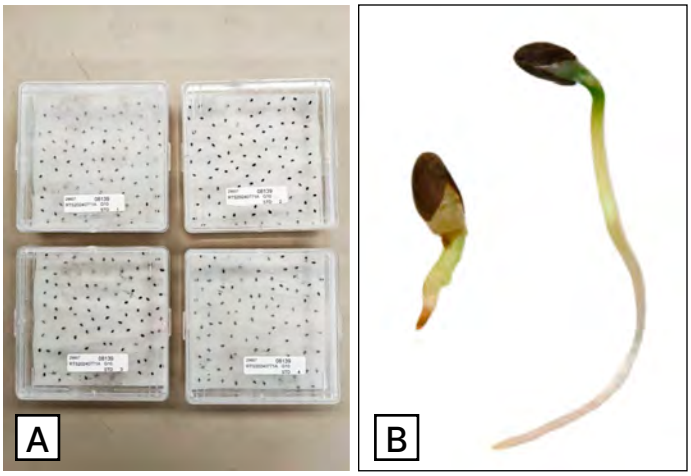

Figure 1a. Germination test setup for one seedlot consisting of four replicates of 100 seeds per dish. 1b. An abnormal SX germinant (left) compared to a normal SX germinant (right).

A total of 172 SX seedlots have had both G10 and G12 GC results uploaded to the Seed Planning and Registry Application (SPAR). SPAR uses GC and seeds per gram (SPG) results to calculate grams required when seedlings are ordered and facilitate seed sales. Conversely, grams in storage can be presented as potential trees. For each seedlot, GC of the most recent G10 and G12 tests were compared, and the higher result was "A-ranked" and became the default test type. If the G10 result was A-ranked, any seedling requests for that seedlot would receive three weeks stratification. If the G12 result was A-ranked, seedling requests would receive six weeks stratification.

Thirty-one tests were out-of-tolerance (where one or more replicate results was too different from the other replicates) or highly irregular (e.g. much moldier than expected or having a high number of abnormal germinants). Those results have been excluded since most of those tests were repeated.

1 Correction: Table 1 (Lei, 2021) should have shown a Total Average GC% increase of 0.8 and PV increase of 0.2.

Results and Discussion

This study has had a significant impact on the Tree Seed Centre SX inventory, which consists of 1,002 seedlots (Table 1). There are many more B-class (wild stand) than A-class (orchard) seedlots, but most seedling requests are for A-class seed. If only considering the 159 A-class SX seedlots, the G12 test is the A-ranked test for 79% of the grams and 82% of the potential trees (highlighted cells).

So far, only 172 SX seedlots have been tested with extended stratification and their results uploaded to SPAR (Table 2). Some seedlots have been used up and expired since the study began, resulting in fewer total A-class seedlots and A-class seedlots with a G12 A-ranked test in Table 1 than in Table 2. Also, a number of A-class seedlots were not tested because their balances were too small, resulting in more A-class seedlots with a G10 A-ranked test in Table 1 than in Table 2. Thus, any A or B-class seedlots which weren't included in this study have G10 as the A-ranked test type, resulting in the possible misconception that many more seedlots do better with the G10 test type than the G12 when looking at the whole inventory.

When considering the tested A-class seedlots only, the G12 test did better and was A-ranked for 98 out of 152 or 64% of the seedlots tested (Table 2). There was an average increase of 2.2% in GC and 0.5 in PV (highlighted A-class cells). That is a slight decrease from the 3.2% GC and 0.6 PV improvement for 57% of the seedlots tested in the previous study (Lei, 2021), though there were only 124 seedlots in that study. For the other 36% of A-class seedlots tested, the average gain from the G12 test type was negative, meaning that the G10 tests did better (2.4% higher in GC and 0.3 in PV).

Though a lesser priority due to lower seedlot usage, 20 of the most-used B-class seedlots were also tested. The G12 test was A-ranked for 55% of seedlots tested, with an average increase of 2.9% in GC and 0.4 in PV (highlighted B-class cells). The G10 test was A-ranked for the other 45% of seedlots tested, with a 2.7% higher GC and 0.2 higher PV.

Table 1. BC Tree Seed Centre interior spruce (SX) inventory by A-ranked test type and genetic class.

	Total SX Inventory			A-class Seedlots			B-class Seedlots		
A-ranked Test Type	Number of Seedlots	% of Grams	% of Potential Trees	Number of Seedlots	% of Grams	% of Potential Trees	Number of Seedlots	% of Grams	% of Potential Trees
G10	908	84%	83%	77	21%	18%	831	98%	98%
G12	93	16%	17%	82	79%	82%	11	2%	2%
Total	1,001[1]			159			842		

[1]One SX seedlot was omitted because it has a D1 test type (no soak or stratification) as its A-ranked test.

Table 2. Average germination capacity (GC) and peak value (PV) results of all tested interior spruce seedlots by A-ranked test type. Gain was calculated by subtracting the G10 result from the G12 result. Slight discrepancies are due to rounding.

	Number of Seedlots	Average Seeds per Gram	Average GC (%)			Average PV		
A-ranked Test Type			G10	G12	Gain	G10	G12	Gain
A-class seedlots								
G10	54	410	87.8	85.4	-2.4	6.9	6.6	-0.3
G12	98	406	86.5	88.6	2.2	6.8	7.3	0.5
Total / Average	152	408	86.9	87.5	0.5	6.8	7.1	0.2
B-class seedlots								
G10	9	514	77.2	74.6	-2.7	5.6	5.4	-0.2
G12	11	508	80.5	83.5	2.9	6.0	6.5	0.4
Total / Average	20	511	79.1	79.5	0.4	5.8	6.0	0.1
All Seedlots Total / Average	**172**	**420**	**86.0**	**86.5**	**0.5**	**6.7**	**6.9**	**0.2**

Complications arise when the G10 and G12 results are very close to each other or inconsistent. For instance, the G10 result may be A-ranked after initial tests, but the G12 result may come out higher after retests and become the new A-ranked test. The stratification regime could change after each set of retests if the A-ranked test type keeps flipping. This may require that both test types get tested in each round of retests, doubling the amount of work and seed required. After a few rounds, we may stop double-testing and only retest the test type that gets A-ranked more often to conserve resources.

It was initially thought that the food reserves in smaller seeds might be used up more quickly during extended stratification and result in lower germination. However, when the G12 results for A-class seedlots were compared to the number of seeds per gram, there was no strong relationship between seed size and G12 GC (Fig. 2). Average seed size was fairly similar between A-class seedlots with G10 A-ranked tests (SPG=410) and G12 A-ranked tests (SPG=406) (Table 2). Overall, B-class seedlots had smaller seeds (G10 A-ranked tests: SPG=514, G12 A-ranked tests: SPG=508).

The G12 result tended to be higher than the G10 result for newer seedlots (Table 3). The older the seedlots, the smaller the proportion of seedlots with a G12 A-ranked test. Days in freezer storage were used to approximate seedlot age. Twenty-one seedlots were removed from Table 3 because they were created from returned seed (due to canceled or unused seedling requests) and thus potentially much older than the recorded days of freezer storage. Though previously stratified and dried back, 12 out of 21 returned seedlots showed a 2.75% gain in GC and 0.7 in PV with the G12 test type so their results have been included in all other relevant tables and figures.

Some seedlots experienced significant gains or losses when comparing the G12 and G10 results (Fig. 3). For example, seedlot 63421 had an 11% gain in GC (G12: 90%, G10: 79%), while seedlot 31310 had a G12 result 10% lower than the G10 result (G12: 79%, G10: 89%). Large potential gains or losses justify the testing of both test types against current and future SX seedlots. By utilizing 800 seeds (usually 2–3 grams), you can determine the stratification regime which gives a higher germination result. Higher germination means less seed is needed to fulfill a requested number of seedlings, translating to potentially large seed savings.

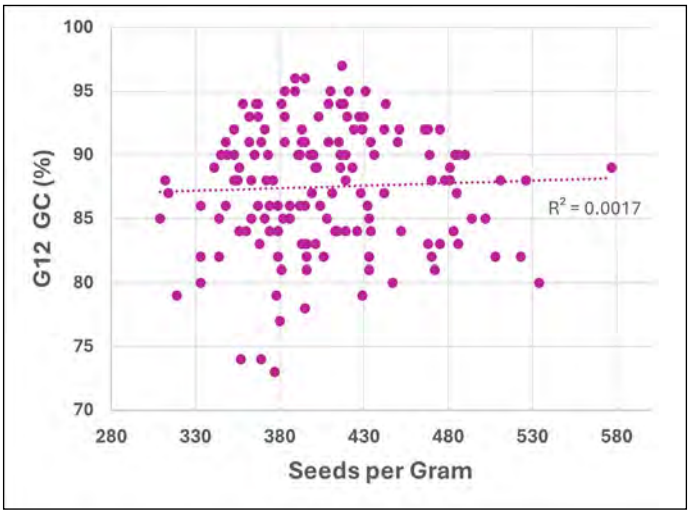

Figure 2. The G12 germination capacity (GC (%)) compared to seed size (seeds per gram) for A-class SX seedlots.

Table 3. The percentage of seedlots with a G10 or G12 A-ranked test by seedlot age, not including seeds created from returned seed.

Seedlot Age (Years)	Number of Seedlots	% of Seedlots with a G10 A-ranked Test	% of Seedlots with a G12 A-ranked Test
0–2	12	17%	83%
3–5	29	21%	79%
6–9	24	38%	63%
10+	86	43%	57%
All Seedlots	151	36%	64%

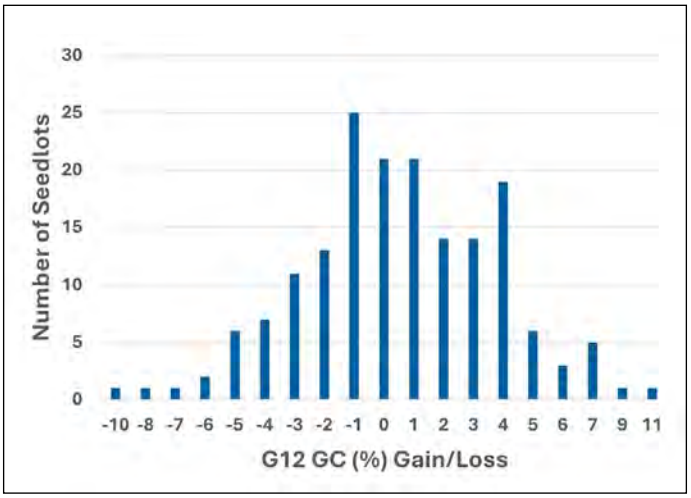

Figure 3. All SX seedlots tested categorized by the difference between the G12 and G10 results (G12 GC (%) minus G10 GC (%)).

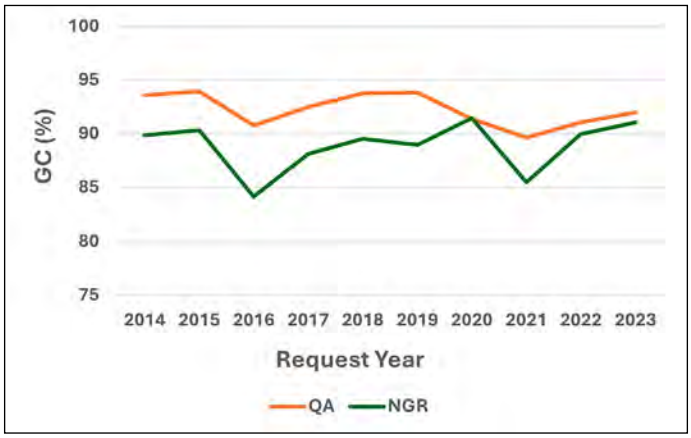

Figure 4. Quality Assurance (QA) and Nursery Germination Results (NGR) for all interior spruce seedling requests for the past 10 years. The G12 stratification regime was introduced in the 2020 request year.

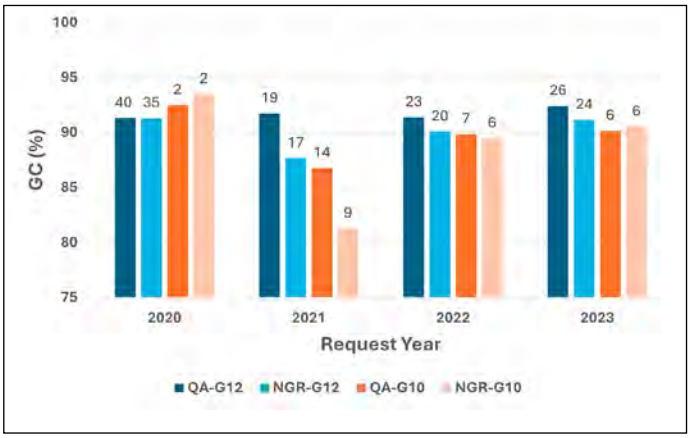

Figure 5. Quality assurance (QA) and Nursery Germination Results (NGR) by test type since the G12 stratification regime was introduced.

In addition to standard lab germination tests, quality assurance (QA) tests were conducted to monitor how seedlots performed operationally. Differing from lab germination tests, QA germination tests were sampled from seedling requests which received operational stratification practices (e.g. running water soak, cold stratification of larger seed volume in bags) and used 4×50 seed replicates to increase the number of seedling requests sampled. The operational cold stratification durations were the same as in lab germination tests (G10=three weeks, G12=six weeks). At least 30 SX seedling requests per year were sampled at shipping. We also solicited nurseries for feedback to obtain nursery germination results (NGR) for those same seedling requests.

A 10-year review all SX seedling requests tested showed that NGR results were on average 4.6% lower than QA results before 2020 (Fig. 4). A possible explanation for this could be because nursery seedlings are usually evaluated at a later stage of development (e.g. after they have emerged from the growing media and are about to shed their seed coats), and some seedlings may germinate successfully but succumb to disease or other issues. After the G12 stratification regime was introduced in the 2020 request year, the gap decreased to within 1.1% except for in 2021, suggesting that extended stratification had a beneficial impact on nursery germination. The seedlots requested each year were not necessarily the same, so the variation in germination capacity could be due to different seedlots and not because seedlots were improving or deteriorating.

If broken down by stratification regime, the lower results in 2021 were partly due to more seedling requests receiving the G10 regime (Fig. 5) and a corresponding falldown at the nursery level. Other years showed no major detrimental effects to seedling requests which received the G12 extended stratification.

Conclusion

Since G12 extended stratification has been shown to improve lab germination for 64% of seedlots tested and there have been no major detrimental effects in operational seedling requests, we will continue conducting G12 tests. Incremental, small increases in germination can translate to large amounts of seed saved. During this ongoing season, we have received nursery feedback that a few SX seedlots are outperforming lab germination results. We welcome any additional feedback nurseries may have on growing SX seedling requests which have received extended stratification.

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Sweden desires OECD Certified Seed from BC and USA

Colleagues, Sweden needs you. Last issue, I wrote an article titled "The View from Sweden". I ended that text with this note: *"For us in the Swedish seed orchard business, climate change is one of the biggest challenges that we are facing in our daily work. Finding new methods and learning from others is essential."*

This year I have a request to all of you reading the TSWG Bulletin. I represent Sveaskog Förvaltnings AB, which is the Swedish state-owned forest company and largest forest owner in Sweden, and we are looking for a seed trade business partner. We are hoping to find someone we can buy OECD certified BC interior Douglas fir seedlots from and also develop a good relationship where knowledge exchange in all sorts of seed-related topics can be made. During the first couple of years, we are interested in purchasing around 10 kilograms, with good possibilities to increase that amount long term. Historically, seed material from the Kamloops area, BC and Bond Creek, Idaho, USA, have been exported to Sweden and have good growing results in the nursery.

If you are the collaborating partner we are looking for, please contact me by email.

Johanna Gårdebrink
Head of Seed Production, Sveaskog Förvaltnings AB
Email: johanna.gardebrink@skogsplantor.se

Above: A Douglas fir seedling crop growing at our northern-most nursery Kilåmon, latitude 63.5 and longitude 16.6, during the season of 2024. Photo by Malin Olofsson.

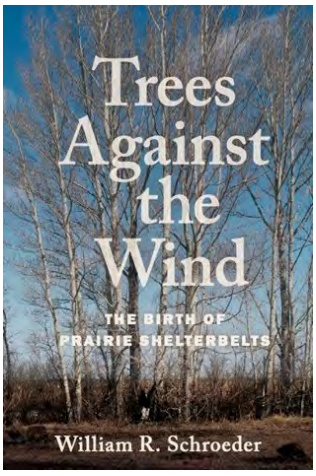
New Book: Trees Against the Wind

Author William R. Schroeder relates how a government initiative begun in 1901 transformed Canada's open prairie into a tapestry of treed farmyards and planted shelterbelts.

Curious about the origins of the government tree planting program he had worked for, retired research scientist William R. Schroeder was driven to learn more about the people who had the foresight and belief that tree planting could succeed on the Canadian prairies. Scouring archives in Indian Head, Regina and Ottawa, he gathered information and images that would help him trace their story.

In *Trees Against the Wind*, Schroeder brings to life the inspiration, the people, the science, the business and the politics behind prairie shelterbelts. This enlightening history is a tribute the thousands of innovative prairie farmers who planted trees to shelter their homes and land, and to Norman M. Ross, Chief of the Tree Planters, who, from 1901 to 1941, shaped, promoted and fought for the program that ultimately distributed over 600 million trees to western Canadian farmers. Complemented by over 130 archival photos and maps, this 288-page publication provides an important and captivating perspective on prairie history and a heightened appreciation for prairie trees. A sample of photos are provided for TSWG interest.

Trees Against the Wind: The Birth of Prairie Shelterbelts
by William R. Schroeder, foreword by Trevor Herriot.



ISBN 9780921104377 (soft cover, $29.95 CAD + GST).

Available at https://www.naturesask.ca/publications/special-publications and the author's website (www.agroforestrysolution.com).

Above: Scots pine and spruce were grown on transplant beds at a wider spacing than in seedbeds (AAFC Indian Head, Saskatchewan BA5 116, photo taken in 1919).

Above: A shelterbelt planted by J. Lowe at Ardkenneth, Saskatchewan, in 2016; photo taken in 1920.

Above: A nicely trimmed caragana hedge borders the farmyard driveway of J.A. Bavel near Craigmyle, Alberta, 1926 (AAFC Indian Head, Saskatchewan CB1-B P20)

Free Distribution of Trees

BY THE

Government of Canada

ANY FARMER living in Manitoba, Saskatchewan or Alberta can procure **FREE OF CHARGE**, enough seedlings and cuttings of hardy forest trees to establish a good shelter belt round his farm buildings and garden.

Thousands of successful plantations have been established as a result of this distribution.

Already over 27,000,00 trees have been given away **FREE**

Over 4,000,000 will go out this spring

Make Your **FARM** a **Real HOME**
BY PLANTING TREES

Superintendent's residence Nursery Station at Indian Head, 1904

Same Place in 1914

ALL APPLICATIONS for trees to plant in 1917 must be received **BEFORE** March 1 1916.

A limited number of **EVERGREEENS** is available for delivery this coming spring under special conditions

All applications and inquiries should be addressed to

Norman M. Ross
NURSERY STATION
INDIAN HEAD **SASKATCHEWAN**

Write for Bulletins on Tree Planting

Above: A Forest Nursery Station advertisement placed in prairie farm papers and magazines in 1916 (AAFC Indian Head, Saskatchewan).

Review: MSc in Seed Technology and Business Management

There are limited options for someone looking to study seed science at a graduate level in the United States. As someone getting started in the tree seed industry, I wanted to learn more and within a more structured environment than what attending conferences and reading texts such as the Woody Plant Seed Manual has to offer. I also wanted to continue to work full-time in the industry so that my studies could complement my hands-on experience and contextualize the work.

After some research I applied for and enrolled in the Master of Science degree in Seed Technology and Business Management program through Iowa State University: https://iowastateonline.iastate.edu/programs-and-courses/agriculture/seed-technology-and-business-master-of-science-in-seed-technology-and-business/.

While the program is entirely online, they do offer some optional in-person visits to the university. I've chosen to split the program into two segments where I'm first pursuing a Graduate Certificate in Seed Science before going on to complete the full M.S. The lectures are all prerecorded so I'm able to navigate course deadlines as my work schedule allows. I've found that taking two courses per semester provides a manageable workload between school and the demands of growing seedlings and working at an extractory.

I'm sure it won't be a surprise that the case studies presented in the course do not focus on tree seed, but are predominantly about commodities such as corn and soybeans. However, the professors recognize that the cohort work in many different sectors of the seed industry. Thus, the majority of the assignments are flexible in terms of subject and I have been able to tailor them to learn more about tree seed.

I have been enrolled since January 2023 and am so far really happy with the program; I have been able to incorporate the tools, resources, and learning from every course into either something tangible for work, or at the least appreciable knowledge for future professional development.

Specific courses of interest so far have been:

- **Data Science for Agricultural Professionals:** In this course we learned to use R to do analysis on seed and crop-related data using both spreadsheets and geographic information.
- **Seed Conditioning and Storage:** This course focused on designing seed processing facilities, the various types and operating principles of the major seed cleaning machinery, as well as the tools and techniques used for seed testing and storage
- **Seed Physiology:** This course provided both broad strokes and granular information on seed development and maturation, though there was almost no material presented about gymnosperms. The depth of focus on seed dormancy and desiccation tolerance was a highlight.

I'm happy to answer questions about my experience in the program up to this point, so feel free to reach out.

Ben Alexandrowicz
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Roy, Oregon, USA
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Training & Meetings

British Columbia Forest Genetics Council Interior Technical Advisory Council Meeting (January 17–28, 2024) presentations posted:
https://forestgeneticsbc.ca/meetings/interior-tac/

Southwestern USA Conifer Seed Collection, Processing, and Storage Workshop Summary: Millions of acres within the Southwestern United States are in need of reforestation. Seed collection, processing, and storage are the first set of critical steps in the reforestation process. Seed collection is critical because our seed inventory is low across all land management agencies at a time when we have had increased high severity fires across the Western US; additionally, new federal policies are funding and supporting reforestation, but we need more seed to achieve the goals outlined in policies such as the REPLANT Act. Staff from the Colorado Forest Restoration Institute at Colorado State University, American Forests, The Nature Conservancy Colorado Chapter, New Mexico Highlands University, New Mexico State University, and New Mexico Energy, Mineral and

Above: Group shot of field tour participants at the 2023 Northeast and Southern Nursery Conference, held July 17–20, 2023 in State College Pennsylvania. This image was submitted but did not fit in the last issue; see article in TSWG No. 74 by Carolyn Pike.

Natural Resouces Department gathered professionals from more than 70 organizations across nine states on February 23, 2023 to discuss challenges and opportunities relating to native conifer seed collection, processing, and storage. The goals of this workshop were to:

- Connect land managers and other interested and affected parties to discuss questions and concerns around seed collection, processing, and storage in Southwestern states;
- Identify existing resources, information, datasets, funding, and policies that may support native conifer seed collection, processing, and storage;
- Assess the needs of current and future cone collectors in the Southwest to determine knowledge gaps, appropriate resources, future policy, and a tentative regional strategy.

To obtain workshop resources, contact: marin.chambers@colostate.edu; reference project CFRI-2403.
Website: cfri.colostate.edu

Botanic Garden Conservation International Tree Conservation and Propagation Protocol Courses:
Open-access: https://training.bgci.org/course/index.php?categoryid=7
Free Templates and Protocol Manual (2024): https://www.bgci.org/resources/bgci-tools-and-resources/propagation-protocol-manual/

2024 RNGR-US Forest Service Eastern Region Tree Improvement 101 Series and Resources
On-demand webinars (recorded in April): https://forestrywebinars.net/sponsor-pages/trees-101
Programs and References shared in the Series: https://forestrywebinars.net/webinars/tree-improvement-101-module-4/Tree_Improvement_101_References_Videos.pdf/at_download/file

2024 Joint Annual Meeting: Southern & Northeast Forest and Conservation Nursery Associations
July 22–25, 2024
Little Rock, Arizona, USA
This event will cover nursery infrastructure, carbon markets, forest health, labor issues, agroforestry, etc.
https://westernforestry.org/upcoming-conferences/2024-joint-annual-meeting-southern-and-northeastern-forest-and-conservation-nursery-associations

2024 Joint Annual Meeting of the Western Forest and Conservation Nursery Association and Intermountain Container Seedling Grower's Association
September 4–5, 2024
Wenatchee, WA, USA
https://westernforestry.org/upcoming-conferences/icsga-wfcna-western-nursery-meeting

2024 Intertribal Nursery Council Conference
September 10–12, 2024
Grande Ronde, OR, USA
https://westernforestry.org/upcoming-conferences/2024-intertribal-nursery-council-conference

Forest Nursery Association of British Columbia: 42nd Conference and Annual General Meeting
September 11–13, 2024
Vernon, BC, Canada
More information to come: https://www.fnabc.com/copy-of-2022-fnabc-agm

ISTA Workshop on Germination and Tetrazolium Seed Testing
October 4–8, 2024
Application Deadline: September 1, 2024
Registration Deadline: September 30, 2024
Kimihia Research Centre Laboratory, Lincoln, New Zealand (agronomic species will be used)
https://www.seedtest.org/en/workshops-and-webinars/ista-workshop-on-germination-and-tetrazolium-seed-testing-product-10058.html

International Oak Symposium
October 7–10, 2024
Knoxville, Tennessee, USA
https://naturalresources.tennessee.edu/oak-symposium/

IUFRO 2.09.02: ARBUTUS 2024, the International Symposium on *Arbutus unedo* (Strawberry Tree) and related species.
October 28–30, 2024
Coimbra, Portugal
https://ucpages.uc.pt/en/plant-biotechnology-lab/arbutus-2024/

Recent Publications

Proceedings, Reports and Newsletters

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