TICtalk

FGC Forest Genetics Council of British Columbia

Information for and from the tree improvement community of British Columbia

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Ninth Edition

It's been said that in times of change the learners inherit the earth, while the learned may find themselves equipped to deal with a world that no longer exists (Hoffer). Looking back at BC's relatively short 50-year history of tree seed management, tree improvement, and forest genetics activities, it is evident that the people involved have both learned and changed. From the modest early digs of the Provincial Tree Seed Centre (TSC) at the Chesterfield Nursery site in Duncan to the modern, efficient, and world-class facility in Surrey, the 50 years of exemplary service provided by the hard-working staff at the TSC epitomize the many people contributing to the successful broader program of forest genetics in BC, including the selection, production, conservation, handling, and use of tree seed.

This ninth edition of TIC*talk* comes at a transitional time. A time when a previously vibrant forest industry in BC faces unprecedented financial pressures from forces beyond its control. A time when the combined forces of economics, political history, climate change, and (MPB) biology are causing a shift in the spectrum of forest resource values and policies to ones that bear less and less resemblance to those of past decades. Collapsing government revenues will place increasing pressure on many components of the genetic resource management (GRM) program, and the retirement of skilled and experienced people will force those of us who remain to re-examine our priorities, to re-evaluate what we thought we knew, and to team up to provide meaningful value and service to changed present and future needs.

Our strengths are people and knowledge. This edition of TIC*talk* provides a healthy snapshot of the range of talent and activities that are the heart of the GRM program in BC, and that make it a world leader. Collaboration of stakeholders, setting objectives, reporting on results, and an operational on-the-ground focus keep this program on track. These same attributes must continue and strengthen in the coming years of budget pressure. We must enthusiastically take on the work that is needed, and cast aside that which could be done, but adds little value. Our role, our contribution, and ultimately our program security, will depend upon each of us working to a make a solid contribution to the jointly set and applied objectives of the FGC. As we adjust to change I'm confident that the competent people and relevant work of this program will allow us to continue to add value to sustainable forest management in BC.

Jack Woods
Program Manager, Forest Genetics Council of BC
CEO, SelectSeed Ltd.

INSIDE

A Challenge Dialogue Respecting Forest Tree Genetic Resource Conservation and Management in British Columbia

submitted by Brian Barber

A Challenge Dialogue is an iterative process whereby questions and draft statements are prepared for comment, and then, based on feedback, improved upon.

British Columbia's forest genetic resources are the foundation for maintaining healthy productive forest ecosystems and a globally competitive forest industry. BC is fortunate to have a strong, multi-sectoral community of practice involved in conserving and managing its forest genetic resources. However, a number of social, economic and environmental drivers, such as the Mountain Pine Beetle epidemic and climate change, challenged us to re-examine the assumptions, objectives, activities, and desired outcomes that guide Forest Tree Genetic Resource Conservation and Management (GRM) in BC.

In 2006–08, under the sponsorship of Jim Snetsinger, Chief Forester, and Craig Sutherland, Deputy Chief Forester, representatives from Tree Improvement Branch, Research Branch and the Forest Genetics Council of BC (FGC) undertook a Challenge Dialogue™ [1] with members of the GRM community of practice, stakeholders and interested members of the public to develop a collective vision and strategy for guiding GRM activities over the next decade.

A Challenge Dialogue is an iterative process whereby questions and draft statements are prepared for comment, and then, based on feedback, improved upon. This dialogue afforded persons the opportunity to participate, learn, share, and wrestle with ideas regarding GRM. As a result, the Dialogue process was just as, if not more, important than its final products.

A new vision, scope, sets of assumptions and guiding principles, and objectives for GRM in BC were compiled by the project champions and supporters in March 2008 based on the diverse and rich input received though various meetings, responses to two challenge papers, and a workshop. The final report can be downloaded at http://www.for.gov.bc.ca/hti/grm/grm_dialogue.htm.

This final report will serve to guide the development of business plans and the FGC's next five-year strategic plan (2009–2014). The latter will include performance measures necessary to achieve the desired objectives for the three core business areas of GRM: Conversation, Resilience, and Value; and their enablers: Research, Policy, Decision Support and Extension.

1 Challenge Dialogue is a trademark of Innovation Expedition Inc. http://www.innovationexpedition.com/CDS.html

Assisted Migration Adaptation Trial

submitted by Greg O'Neill, Michael Carlson, Vicky Berger and Nick Ukrainetz

Approximately 50% of all seed used in the province originates from seed orchards. By 2013, this amount is expected to be 75%. In an effort to better understand the climatic tolerances of these important populations, so that the populations best adapted to climates anticipated throughout the rotation can be selected for each reforestation site, Research Branch has initiated the *Assisted Migration Adaptation Trial* (AMAT) – a long-term field trial of orchard seedlots from each seed planning unit.

Forty-nine orchard (or candidate orchard) seedlots representing 13 conifer and three broadleaf tree species will be tested across 48 test sites from Fort Nelson to southern Oregon. Growth, form and pest resistance will be recorded every five years and related to the climate of the test site to help identify the best seedlots for any climate.

Several design features make this trial unique:

- all of BC's main commercial tree species will be tested together in a single experiment
- the number of test sites is greater and the climatic range of the sites is much wider than most genetic trials, allowing more accurate prediction of productivity of each population across a range of climates
- considering that most of BC's most productive land is expected to possess climates currently present in northwestern USA, a number of USA seedlots and climates have been included in the trial
- the exclusive focus on selected (orchard) populations is new in genecology trials and will allow much better understanding of the adaptation of BC's most important reforestation materials
- by testing local wild-stand (Class B) control seedlots alongside the orchard populations, and by using large (5 × 5 tree) square plots, the tests will allow calculation of realized genetic gain of BC and northwest USA's orchard populations.

Due to the large size of the experiment, 12 sites will be planted per year for four years, beginning in spring 2009. As of March 2009, the first 12 sites and most of the second set of a 12 sites have been identified. Sites that will be planted in spring 2009 have been prepared and fenced, where required, and all sites have been layed out. The 53 000 seedlings for the first planting series have been lifted and stratification is starting for the second planting series.

The 2008/09 fiscal year has seen considerable extension activity for the AMAT. The project was presented or discussed at the following meetings or tours:

- Canadian Tree Improvement Association (Canadian Forest Genetics Association) – Quebec (August 2008)
- Pest Vulnerability workshop hosted by Pacific Climate Impacts Consortium – Victoria (November 2008)
- Kamloops Future Forest Strategy workshop – Kamloops (June 2008)

…all of BC's main commercial tree species will be tested together in a single experiment

Figure 1. Seedling diversity.

Figure 2. AMAT tagging crew.

Forty-nine orchard (or candidate orchard) seedlots representing 13 conifer and three broadleaf tree species will be tested across 48 test sites from Fort Nelson to southern Oregon.

- Chief Forester – Victoria (May 2008)
- Okanagan TSA Public Advisory Group field tour – Summerland (September 2008)
- Cariboo TSA field foresters – Williams Lake (September 2008)
- Northern Silviculture Committee – Prince George (January 2009)
- Coastal Silviculture Committee – Nanaimo (February 2009)

The AMAT team is looking forward to sowing the seed for the second planting series in April 2008 and working closely with our many industrial collaborators who have generously provided seed and assisted us in finding test sites.

Start-up funding for the AMAT was provided by the BC Forest Genetics Council in fiscal years 2006/07 and 2007/08. Funding is currently provided by FIA–FSP.

Figure 3. AMAT seedling species for 2008/09.

Cataloguing British Columbia Forest Genetic Resources: Reports identify conservation status and gaps for indigenous and commercial tree species

submitted by Jodie Krakowski and Christine Chourmouzis

The UBC Centre for Forest Conservation Genetics (CFCG), with the support and collaboration of the Ministry of Forests and Range (MFR) and the Forest Genetics Council (FGC), has completed the *Forest Tree Genetic Conservation Status Report 1:* In Situ *Conservation Status of All Indigenous B.C. Species*, by Christine Chourmouzis, Andreas Hamann, Alvin Yanchuk, and Sally Aitken. This report will be published as a MFR Technical Report following completion of peer review, and will be freely available online. There will also be a limited number of printed copies. This study represents the synthesis of several years of analysis evaluating protection levels of commercial and non-commercial tree species throughout BC by biogeoclimatic unit.

The same group of partners has also produced an accompanying report, *Forest Tree Genetic Conservation Status Report 2: Gene Conservation Status of Operational Tree Species*, by Jodie Krakowski, Christine Chourmouzis, Alvin Yanchuk, Dave Kolotelo, Andreas Hamann, and Sally Aitken, which is also currently under review prior to publication as a MFR Technical Report. This study analyzes protection levels of commercially utilized tree species *in situ*, *inter situ*, and *ex situ* by seed planning unit (Figure 1). Both reports will be available for download via the FGC (http://www.fgcouncil.bc.ca/doc.html), MFR (http://www.for.gov.bc.ca/hfd/pubs/Tr.htm), and CFCG (http://genetics.forestry.ubc.ca/cfcg/publications.html) websites.

The analysis provides a critical linkage between conservation of biodiversity and genetic resources, and identifies gaps in conservation that can be used to prioritize future conservation efforts. Species distributions were mapped using data from Biogeoclimatic Ecosystem Classification (BEC) and forest inventory plots. Protection levels were calculated based on predicted population sizes and area of different ecological units and Seed Planning Units. For commercial species, the numbers of seed and genotypes originating from each area in trials and in long-term storage as seed collections were quantified. Based on population genetic analyses, threshold values of minimum population sizes needed to maintain current levels of genetic diversity to allow species to adapt to new conditions in the long term were calculated. Cumulative cover of each species in protected areas was then estimated, providing an index of the protection status of the species by biogeoclimatic zone and by seed planning unit. Summary tables of all data are included in the report, and supplementary material is available on the CFCG website. Where values for a species fell below the identified threshold, a gap was noted, and a summary of conservation priorities was compiled.

For the upcoming field season, ground truthing of several model species is planned to quantify accuracy levels based on the methods. Field sampling methods are being developed and may include stratifying habitats based on air photos, terrestrial or other informative mapping if available and the collection of census data along transects for species with differing distributions. For example, a species with a scattered distribution, such as western white pine, may not be accurately reflected in forest inventories, nor may a patchy species whose distribution is restricted to specific habitats, such as hawthorn. Ground truthing is an essential component of this project required to adjust model results to actual species distributions.

The work done to date represents an important baseline to gauge progress protecting the long-term sustainability of forest genetic resources of all indigenous species and focus resources to most effectively achieve this goal. Follow-up steps to build on this foundation include:

- filling identified gaps wherever possible for commercial species through seed collections and *inter situ* installations
- compiling an updated database of protected areas and revised species distribution maps based on updated inventories

The work done to date represents an important baseline to gauge progress protecting the long-term sustainability of forest genetic resources of all indigenous species and focus resources to most effectively achieve this goal.

- addressing new priorities for genetic conservation based on the results.

For additional information on Report 1, please contact:

Christine Chourmouzis or Sally Aitken
UBC Centre for Forest Conservation Genetics
Forest Sciences Department
3rd Floor, 2424 Main Mall
University of British Columbia
Vancouver, BC, V6T 1Z4
phone 604.822.1951
email chourmou@interchg.ubc.ca or sally.aitken@ubc.ca.

For additional information on Report 2, please contact:

Jodie Krakowski
Ministry of Forests and Range
Research Branch
Cowichan Lake Research Station
Box 335
Mesachie Lake, BC, V0R 2N0
phone 250.749.6811 ext. 43
email Jodie.krakowski@gov.bc.ca.

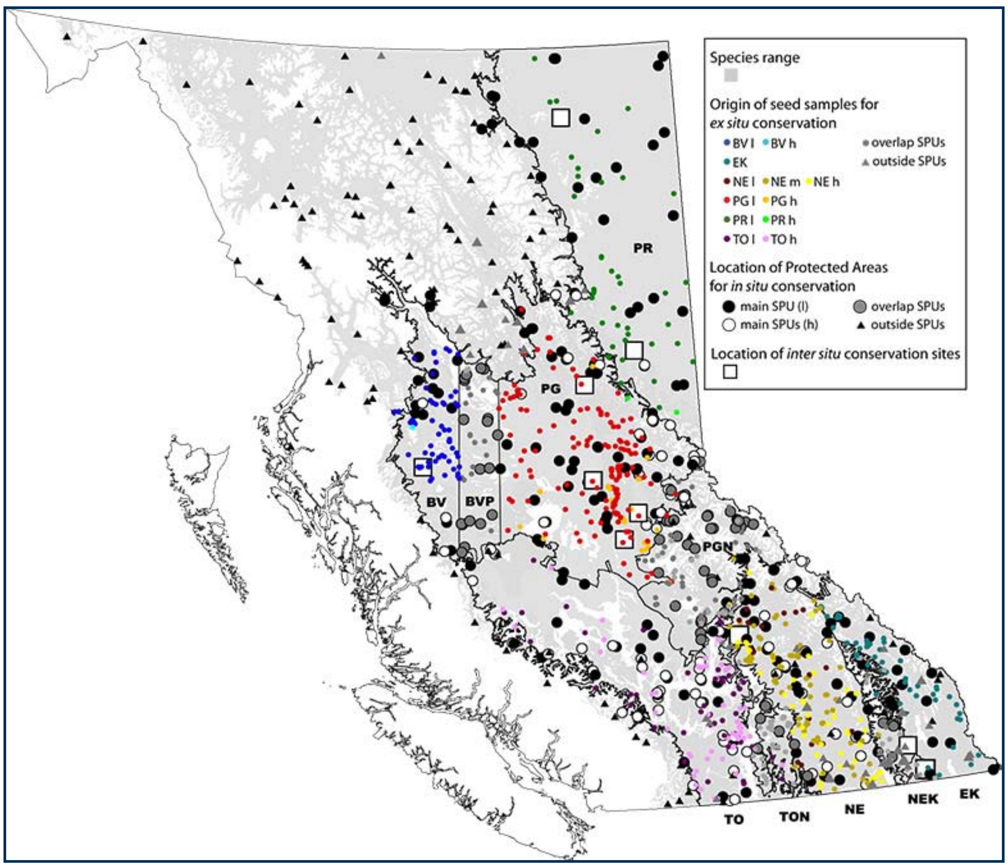

Figure 1. Protection status of Interior spruce. *Ex situ* samples with over 1000 seeds are represented by small dots with a different colour for each seed planning unit (SPU); grey dots indicate areas where SPUs overlap; triangles indicate collections outside current SPUs. *In situ* protection (>5000 trees) is indicated by large dots; grey dots indicate areas where SPUs overlap; triangles indicate parks outside current SPUs. Inter situ conservation sites (provenance trials including well-adapted local genotypes with effective population size >100) are indicated by squares.

Climate Change and Seed Transfer Policy Amendments

submitted by Lee Charleson

The *Chief Forester's Standards for Seed Use (CF Standards)* is a policy document that sets standards respecting the registration, storage, selection, use and transfer of seed and vegetative materials. The *CF Standards* has been in effect since April 1, 2005. It has undergone minor amendments since initiated; however, fall 2008 saw significant changes to seed transfer standards.

Amendments to seed transfer are required to address potential forest health and productivity impacts associated with climate change, and to guide the appropriate selection and deployment of seed. This is an interim step towards climate-based adaptation policy under the ministry's Future Forest Ecosystem Initiative and may be the first proactive response to reforestation practices in Canada in consideration of climate change.

Analysis and recommendations are reported by Dr. Greg O'Neill et al.[1]

The upper seed transfer limits of natural stand and orchard seed planning units (SPUs) were assessed under a climate lens. Recommendations of an increase to the upper limits of seed transfer of 100 m or 200 m to a number of species were subsequently approved by the Chief Forester in November 2008.

Seed Transfer Amendments

Following the announcement of the seed transfer amendments, the Tree Improvement Branch received questions seeking clarification to the announcement. Some of the more common questions are categorized general, natural stand, superior provenance, and orchard and untested parent trees, and are responded to in the following sections.

General

Why is there no increase to the lower elevation limits?

The intent of the current amendments is to improve the match between present and future climates of seed sources and seed deployment areas while increasing planting site options. Changes in seed transfer limits for lower elevations were not recommended. However, the deployment of orchard seed in the lowest 200 m of the Pw Maritime and Sx East Kootenay SPUs is discouraged, as is the transfer of natural stand seed of amabilis fir and western hemlock more than 200 m downward and western redcedar more than 300 m downward.

Do the amendments consider tree species selection decisions?

New transfer limits are based upon an assessment of potentially suitable climate in 2030. The expanded upward transfer limits do not imply that the additional areas are necessarily ecologically suitable for the tree species. The appropriate species selection guidelines must be applied.

Natural Stand

Why do some but not all of the species have elevation changes?

The upper elevation transfer limit is increased by 200 m for eight species, by 100 m for two species and unchanged for three species. Each species was examined separately and, when no change is recommended, it is because existing genecology data for the species suggests that a change is not warranted.

Why can Pli seed now be moved from the TOA and TOD SPZs to the BB SPZ?

Feedback to the project team heightened the need for broadening Pli seed transfer. Analysis showed that mid-elevation bands of the TOA and TOD SPZs can be transferred to the BB SPZ based upon climate-based assessment.

Superior Provenance

Is there a change to elevation for superior provenances of species other than Pli?

Superior provenances of Ss, Sx and Yc were not analyzed, thus no changes were made.

What is the elevation increase to Pli superior provenances?

This question is best responded to with an example using Pli seedlots from the China Valley provenance which have a SPZ of origin

Amendments to seed transfer are required to address potential forest health and productivity impacts associated with climate change, and to guide the appropriate selection and deployment of seed.

1 O'Neill, G. et al. 2008. Assisted migration to address climate change in British Columbia: recommendations for interim seed transfer standards B.C. Min. For. Range, Res. Br., Victoria, BC. Tech. Rep. 048.

Seedlot selection for 2009 seedling requests and planning for 2009 spring planting may take advantage of the amendments immediately, if seedlot owners so choose.

in the TOD. Seed from the China Valley provenance may be used within +500 and -200 m from the mean elevation of origin in the TOD and within +300 and -200 m from the mean elevation of origin in the SA and TOA (and, of course, TOD) SPZs.

Note that the Seed Planning and Registry (SPAR) can only provide one elevation range for a seedlot. If a seedlot owner is using Pli superior provenance seed within its SPZ of origin and expects to use it between +300 to +500 m above the mean elevation of origin, the seedlot that they own should be split to register an additional seedlot for use in the SPZ of origin and increased elevation limit.

Orchard and Untested Parent Trees

Is there a change to elevation for untested parent trees?

Lots from untested parent trees were not analyzed, thus no changes were made.

Why do some but not all of the SPUs receive an increase to the upper elevation limit?

Each SPU was assessed individually. The results indicate that, of the 30 SPUs examined, eight should retain their current upper elevation limits (no change), one upper elevation limit increased by 100 m, and the remainder increased the upper elevation limit by 200 m.

How can I find orchard deployment information?

The information is available in SPAR; conduct an Orchard Search in SPAR's Search menu. Parent tree area-of-use tables and SPUs are also available from SPAR's Reports menu.

Where are the parent tree area-of-use tables located?

The parent tree area-of-use – interior and coastal – tables are housed outside of the CF Standards, and are located in SPAR and on the Tree Improvement Branch website at http://www.for.gov.bc.ca/hti/seedplanning/parenttree-aou.htm.

What is the new orchard exceptions table (Table 3) that is posted on the TIB website (http://www.for.gov.bc.ca/hti/seedplanning/parenttree-aou.htm)?

Some orchard seedlots have elevation limits in SPAR that do not match a tested parent tree area-of-use. Table 3 was created to make the information posted in SPAR more transparent.

Seedlots, Spatial Data and Maps

Updates to SPAR seedlots, spatial data and maps are underway. Amendments to SPU digital data will be loaded into the Land Resource Data Warehouse with a target date of April 1, 2009.

Although the effective date of the amendments to the *CF Standards* is April 1, 2009, the four-month notification period, required under section 169 of *FRPA*, may be waived. Seedlot selection for 2009 seedling requests and planning for 2009 spring planting may take advantage of the amendments immediately, if seedlot owners so choose.

The amendments and additional information are posted at http://www.for.gov.bc.ca/code/cfstandards/. Questions or comments on the *CF Standards* are welcomed – please contact Lee Charleson at Lee.Charleson@gov.bc.ca.

Acknowledgements

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2008 Sowing Request Quality Assurance Results

submitted by Dave Kolotelo

This article provides an update on the Tree Seed Centre Quality Assurance (QA) program for sowing requests. The five-year (2004–08) average for moisture content and germination capacity (GC) representing over 1000 sowing requests is presented in Table 1. In general, operational germination results over this period were very good with seed preparation matching lab results (only a 0.2% difference) and the average nursery falldown being 2.5%. Under nursery conditions, subalpine fir (Bl) and western white pine (Pw), two deeply dormant species, showed large falldowns in addition to red alder (Dr), which is considered non-dormant. At the other extreme, yellow cedar performed better in the nursery and, although not a large sample size, the results indicate a need for improvements in lab testing protocols.

Table 1. Results of Quality Assurance sowing request monitoring for moisture content and germination presented as the seed preparation and nursery germination difference from lab test results. Numbers in brackets indicate sample sizes.

Species	Moisture Content %	Lab Germination %	Seed Prep Difference %	Nursery Difference %
Ba	33.0 [10]	73.9 [10]	+3.9 [10]	-2.9 [7]
Bg	33.8 [13]	71.9 [13]	+2.4 [13]	-4.7 [10]
Bl	37.4 [53]	64.2 [53]	-0.6 [53]	-10.1 [29]
Cw		82.7 [167]	-1.2 [160]	-4.9 [135]
Dr		69.7 [18]	-3.1 [18]	-9.5 [13]
Fdc	32.3 [92]	91.4 [111]	+1.2 [96]	-1.1 [78]
Fdi	33.4 [100]	89.3 [106]	+2.4 100]	-0.3 [87]
Hm	33.5 [21]	83.3 [21]	+4.9 [21]	-2.6 [20]
Hw	27.8 [72]	85.7 [79]	+1.5 [79]	+1.0 [70]
Lw	34.9 [85]	84.9 [87]	+1.7 [87]	-0.7 [74]
Plc	28.4 [21]	93.7 [21]	0.0 [21]	-1.9 [11]
Pli	29.8 [146]	94.6 [180]	0.0 [146]	-1.9 [138]
Pw	37.4 [95]	90.3 [94]	-5.4 [94]	-8.4 [80]
Py	27.4 [56]	90.5 [57]	-2.2 [57]	-1.9 [37]
Ss	25.5 [43]	92.6 [47]	-1.0 [47]	-3.3 [40]
Sx	28.6 [133]	89.3 [150]	+2.1 [136]	-0.5 [124]
Sxs	29.8 [24]	87.4 [25]	+1.8 [25]	-3.5 [19]
Yc	44.6 [9]	48.7 [9]	+3.7 [9]	+19.3 [6]
MEAN	31.6 [973]	87.0 [1248]	+0.2 [1172]	-2.5 [978]

An area actively discussed at the TSC is how nursery falldowns relate to actual stratification duration. This was examined for 2008 sowing requests by using the actual soak date and the actual sow date (supplied by the nursery) to calculate actual length of stratification for comparison with standard lab stratification durations. The graphical results are presented in Figure 1 and are colour-coded by quadrant – green indicates increased stratification resulted in increased GC; pink indicates reduced stratification resulted in reduced GC; yellow indicates increased stratification results in reduced GC; and the grey quadrant indicates reduced stratification results in increased GC, but no sowing requests fell into this category. This figure provides some insights into current sowing practices.

- Most sowing requests are sown after extended stratification (more stratification vs. lab testing) – most points right of the zero mark on the X-axis and some extensions are as long as five to six weeks.
- Reduced stratification results in reduced GC (pink quadrant) – no reductions in stratification resulted in increased GC (grey).
- For most sowing requests, increased stratification did not result in increased GC. It was a little surprising that most points fell into this quadrant (yellow), but the explanations for the nursery falldowns are basically the same ones that have been presented in the past – germination conditions used can be quite different (especially germination temperature), germination criteria, count duration, and any additional treatments (other than extended stratification) at the nursery may also be explanations for these falldowns. Most of the nursery falldowns occur within 5% of the lab test results and are probably not a large problem for growers to meet requested numbers of seedlings. This falldown level also generally falls within the inherent variation associated with lab germination test results.[1] Not all species had examples of reduced stratification, but western white pine (Pw),

1 Germination Tests: How Precise Are They? TSWG Newsbulletin #36, http://testwww.for.gov.bc.ca/hti/publications/misc/GCTSWG36.pdf

In general, operational germination results over this period were very good with seed preparation matching lab results (only a 0.2% difference) and the average nursery falldown being 2.5%.

subalpine fir (Bl) and coastal Douglas-fir (Fdc) sowing requests exhibited reduced germination when stratification was reduced by even one week.

In general, extending stratification is beneficial as it will increase the rate of germination (decreasing required heat inputs and window of opportunity for pests) and increase the ability of the seed to germinate under suboptimal conditions. Extended stratification has a metabolic cost associated with it and, at some point, embryo reserves will be depleted and may not sustain normal germination. The data does not suggest this is currently a problem, otherwise one would expect the greatest stratification extensions to show larger falldowns (i.e., clustering in the bottom right corner of the yellow quadrant in Figure 1).

Pelleting

Another aspect of the QA program is to evaluate the efficiency of the pelleting procedure with western redcedar (Cw) and red alder (Dr). A sample of 200 pellets (8 replicates of 25 pellets) are individually broken down and assessed for whether they contain: 1) a single seed (the desired outcome), 2) nothing = are empty, 3) debris (a function of seedlot purity), or 4) more than one seed. The pelleting efficiency is the proportion of pellets with only one seed per pellet. For Cw, the 2008 value, based on 34 sowing requests, was 97.8% and for Dr, based on only two sowing requests, was 92.8%. The difference in efficiency can primarily be tied to differences in seed size as Cw averages about 778 seeds per gram, but Dr has much smaller seeds at 1764 seeds per gram. Germination differences are also influenced by pelleting, as standard lab tests are performed on naked seeds while QA and nursery results are based on pelleted seeds. Part of the seed prep and nursery differences in Table 1 are explained by the pelleting process itself. Seedlot deterioration in Cw is also a factor with this species consistently showing higher than average deterioration rates.[2]

Returned Seed

There were about 22 seedlots sown from returned seed last year accounting for 1.7 million seedlings. These were primarily from lodgepole pine (14=64%) and interior spruce (6=27%) with coastal Douglas-fir (2=9%) accounting for the remainder. Average nursery falldown was only 0.8% confirming the good results with returned seed obtained over the last few years.[3] Part of the success with returned seed is attributed to the re-stratification process even though some evidence exists indicating that seed dried

2 Conifer Seed Longevity. TSWG Newsbulletin #45, http://www.for.gov.bc.ca/hti/publications/misc/ConStorTSWG45.pdf

3 Returned Seed Quality. TSWG Newsbulletin #45, http://www.for.gov.bc.ca/hti/publications/misc/RetSeedTSWG45.pdf

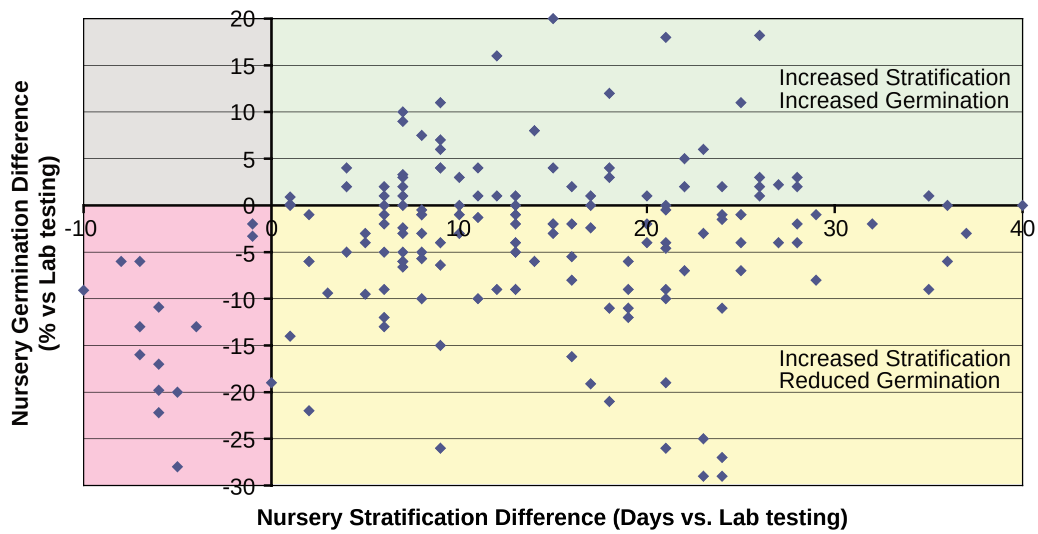

Figure 1. The relationship between the nursery stratification duration difference (days) versus the nursery germination % difference, compared to lab testing protocols and results.

back after stratification does not result in dormancy re-imposition (Adams, E.A. 1975; Allen 1962; Danielson and Tanaka 1978; Hall and Olson 1986; Muller et al. 1999). The second dose of stratification can be thought of as an extension of stratification with the respective benefits of increased speed and vigour of germination. The same cautions exist that if the extension is excessive, germination reserves can be depleted. Returned seedlots can be recognized by their seedlot numbers – all returned seedlots are in either the 52000 series (wild stand seedlots) or the 62000 series (orchard seedlots).

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Are We Realizing the Full Potential of Our A-class Seed?

submitted by Darius Bucher

British Columbia's forest geneticists have been working hard to improve the quality of the growing stock planted out on the landscape. From there it is widely assumed that, once a tree with improved genetics is planted, the benefits of enhanced growth will be realized. That's what our computer models are assuming. However, I would challenge not only forest geneticists, but foresters alike, to think about that for just a moment. Is that big assumption we are making indeed correct? Are we actually realizing the full potential of the seed being developed?

We must first take a step back and remember that a seed is nothing more than a potential tree wrapped in a protective coat. Although the seed may have great potential to grow into a mighty tree in a short period of time, and have superior qualities to fend off pests and overcome the harsh environment it is planted into, all that it really truly is, is potential. For the full potential of that seed to be realized, it must planted into the right environment. There is no escaping that reality and no shortcut to get around it. **For a seed to reach its full potential it must be planted into the right environment and given everything it needs to perform.** If we aren't willing to do that, then what is the point of developing the seed in the first place?

Realizing the full potential of the seed starts with producing the right seedling to get the tree off to the right start.

Realizing the full potential of the seed starts with producing the right seedling to get the tree off to the right start. Are we sowing the right stock for a particular site or are we producing what we hope we can get away with? Even more important is planting the seedling into the right site conditions. Are we planting the tree into a microsite where it can perform its best or where we are happy enough if it just survives and slowly plugs along in a manner that is "acceptable"? Once the tree is well established, are we content to cut it loose or are we willing to tend it and follow it through to maturity? These are the questions that must be considered before the seed ever hits the soil or is even developed.

After 15 years experience actively practicing silviculture forestry in the BC interior I have come to the conclusion that we are not even close to realizing the full potential of our genetically improved seed. The reasons for underachieving are many, but I feel that one of the biggest is that mediocre tree performance has become so common, we have come to think it is actually good. However, what disappoints me the most is the fact that we haven't really even tried. There is usually something hindering us from doing so. The reasons range from legislation that offers few incentives, to budgets, to even computer models, which are based on limited data and major assumptions, that tell us many times the extra investment just simply isn't worth it.

The trees in Figures 1 and 2 show that we can do much better.

Figure 1. **Left:** B class, no fert. & prep.
Right: A class, fert. & prep.

Figure 2. A class, fert. & no prep.

In Figure 1, both trees were extracted after four growing seasons and planted into the same site conditions on the same block.[1] Here the differences end. The tree on the right came from genetically selected A-class seed and was fertilized at the time of planting with Reforestation Technologies International (RTI) Continuem fertilizer blend containing sulphur in a form immediately available to the tree. The tree on the left was from a local B-class (natural stand) seed source and was not fertilized at the time of planting. It is typical of what we have become satisfied with. From this comparison, it is obvious to see the benefits of investing in the seedling. Look at the differences in foliage and root systems! How much of the gains came from the fertilizer and how much came from the improved genetics aren't known in this particular situation[2] but I would suggest that the sum of the parts is greater than the whole. The gains would not have been as great if the nutritional gap[3] had not been filled. It goes to show what the potential is if a good tree is placed into the right environment and given the nutrition it needs to get it off to a good start. Randomly measuring 50 trees of each treatment type showed average volume differences of over 350% after only four years! Not only that, it is anticipated the gap will continue to widen over the longer term. This fertilizer blend also provides the tree with the nutrition to produce the secondary compounds needed to defend itself against pests.

Now look at Figure 2. That tree is from the exact same A-class seedlot and planted in an adjacent area nearby to the other A-class tree at the same time. It was also fertilized at the time of planting and photographed after four growing seasons. Why is its size similar to the B-class tree? This is the result of failing to invest in the tree and stabbing it straight into the ground "as is" without preparing a proper microsite. In this poor microsite, with dense soils, fireweed, and little organic matter, the tree could neither take advantage of the fertilizer nor its genetics. And this is the best tree I could find! It is obvious to see that, in this particular situation, we are not realizing the full potential of the A-class seed. However, we tend to be satisfied with it because it's "coming along."

In the end, was the extra cost of the fertilizer and site prep worth it to get the most out of the genetically improved seed? I'll let you decide. But in my mind, the benefits shown above are why we must be relentless and focused on getting the most out of the seed. I know which tree I would want in my plantation and to pass along to my children despite the extra cost. Given the many challenges we are facing today, can we afford to continue to be satisfied with the status quo? Economic challenges will always be there. We must somehow find a way to invest in our future and get the most out of what we have. Otherwise all we will end up passing along to our children are excuses telling them why we failed to realize the full potential of the opportunities we had.

Darius Bucher is affiliated with Reforestation Technologies International and this article reflects his operational trials and field observations with the use of A-class seed and their fertilizer regimes.

Editor

1 The block is located in the McLure Fire (2003) near Kamloops and site preparation consisted of knocking down the existing burned timber with a bulldozer. There was significant mineral soil disturbance from the tracks of the bulldozer and the pulled up stumps. Seedlings were 410 1+0 spring planted. Work was completed by Integral Forest Management Ltd. under the Forests For Tomorrow program.

2 Five-year results from the Lemieux Creek fertilization at the time of planting trial showed volume differences in Pli B+ seed (same seedlot) planted into the same site-prepared ground to be 65% greater for the fertilized trees. In that fertilizer trial, RTI's BIO-paks, which contain no sulphur, were used. In that same trial, volume gains for Pli fertilized at the time of planting and planted into prepped ground were on average 134% greater than just planting the tree "as is" without fertilizer!

3 Because sulphur is one of the most limiting nutrients in BC, gains from fertilization at the time of planting have increased significantly once sulphur was added to the blend. That being said, it must be noted that not all forms of sulphur are equal. It must be in a format readily available to the tree and released slowly in a controlled manner so it is not lost and leached away before the tree can utilize it.

Estimating Pollen Contamination in Coastal Seed Orchards

submitted by Joe Webber and Michael Stoehr

…contamination will lower the value of the seedlot, reduce future wood production and possibly put plantations established at the limits of the seed zone at risk.

Levels of contamination are estimated by comparing the extent and magnitude of pollen flight from pollen monitoring stations located within the orchard (ORC) to pollen catch from regional stations (REG)…

Introduction

All BC coastal seed orchards are located in the warmer, drier climates of Vancouver Island which provide a natural inductive effect for improved flowering. Since all conifers are wind pollinated and the periods of reproductive development for indigenous stands and orchards overlap, non-orchard sources of pollen (contamination) can breed a significant number of female flowers (seed cones). Depending on the extent and magnitude of contamination, the genetic worth (GW) which an estimate of rotation-age volume gain as a percentage (Woods 2005) will be reduced. Ultimately, contamination will lower the value of the seedlot, reduce future wood production and possibly put plantations established at the limits of the seed zone at risk.

The Chief Foresters Standards (CFS) *For Seed Use* (2006) in British Columbia defines seed orchard contamination as “pollen, originating from a natural stand outside a seed orchard that contributes to the pollination of female cones on parent trees in the orchard.” Furthermore, the CFS requires seed orchard managers to determine if contamination is present (Appendix 4.2, Item 6) and if the answer is YES, the “the proportion of contaminant pollen and the methodology used to calculate percent contamination be reported” (Item 7).

While the CFS does not define a specific methodology to assess the annual level of contamination, the principle method used by orchards is pollen monitoring (Woods et al. 1996). Counts of daily pollen catch are expressed as grains/mm^2/24h and represent the pollen load used to calculate contamination which is the ratio of non-orchard pollen load (regional monitoring) to orchard pollen load (which includes regional pollen).

Douglas-fir, western redcedar, western hemlock and Sitka spruce are all coastal orchard species that could be at risk from contamination. Because of the extensive stands of Douglas-fir over the east coast of Vancouver Island, we have reported levels of contamination for Douglas-fir only. However, over the past four years, pollen monitoring data have been collected for all four coastal species. Table 1 shows the mean pollen load (grains/mm^2/24 hrs seven-day monitors) summed over a six-week monitoring period for 2005–08. Pollen load values for western hemlock (Hw) are lower than those of Douglas-fir (Df) but still high enough to suggest that orchard clones may be at risk from contamination. Western redcedar (Cw) pollen load values are about five times greater and Sitka spruce (Ss) values about five times less than Douglas-fir. It is reasonable to consider Sitka spruce orchards on the Saanich peninsula are not at risk from pollen contamination. However, western redcedar is certainly at risk from contamination and the actual effect of western hemlock contamination is debatable.

Table 1. Six-week pollen load (grains/mm^2) – Saanich Peninsula

	Mean 5 Regional 7-day Monitors			
	2005	2006	2007	2008
Df	18.3	15.0	30.7	14.6
Hw	9.2	1.9	4.0	2.9
Ss	1.6	0.8	dnm	dnm
Cw	118	33.3	107	64.3

Pollen Monitoring Technique

The current protocol for rating seed orchard crops is described by Woods et al. (1996) and Woods (2005). Levels of contamination are estimated by comparing the extent and magnitude of pollen flight from pollen monitoring stations located within the orchard (ORC) to pollen catch from regional stations (REG) located at about 1 to 2 km from the orchards. The extent of pollen contamination is measured over the duration of receptivity of each specific orchard and the magnitude is calculated as the sum of daily pollen catch over the same receptivity period.

The receptivity period of each orchard is determined by detailed phenological assessments. A crop tree is assessed as receptivity when 20% of the flowers are receptive to pollen (Webber and Painter 1996) and assessed as past receptivity when 80% of the flowers are no longer receptive to pollen (Woods et al. 1996). For calculating levels of contamination, the period between 20% of the orchard clones reaching seed-cone receptivity and 80% of the clones passing seed-cone receptivity is used.

The ministry standard for monitoring pollen load uses seven-day pollen recorders (Webber and Painter 1996) (Figure 1a) and expresses pollen load as grains/mm^2/24 hrs. Currently, only the ministry orchards (Puckle Road and Bowser) use seven-day monitors for both orchard and regional pollen catch. All industry orchards use a microscope slide attached to a platform and weather vane assembly (Figure 1b). Slides are changed daily and pollen catch is also expressed as grains/mm^2/24 hrs. The catch area of the two monitors are similar (the area of a microscope slide) but the biggest difference in potential catch efficiencies is protection from weather. Slide monitors are exposed to weather whereas the seven-day monitors have a cap covering the seven-day chart and chart-drive assemblies. A second important difference between the two monitoring procedures is the location of regional monitors. The ministry uses three to five stations (monitors) located within about 1- to 2-km radius of all Saanich peninsula orchards (both ministry and industry) whereas the industry orchards locate their regional monitors at the boundary of the orchard site which are typically 200 to 400 metres from any specific orchard.

Figure 1a. Seven-day monitor.

Figure 1b. Slide monitor.

Sampling

Monitoring contamination in coastal Douglas-fir orchards has been done for years. However, there has often been disagreement between slide and seven-day monitor data. This became the focus of a FIA–FSP project (Y05110 to Y073110). Between 2004 and 2006 regional data were compared to orchard slide data. It became clear that pollen identification and sampling procedures needed to improve. Orchard staff were attempting to identify and count conifer pollen grains (Figure 2) with a

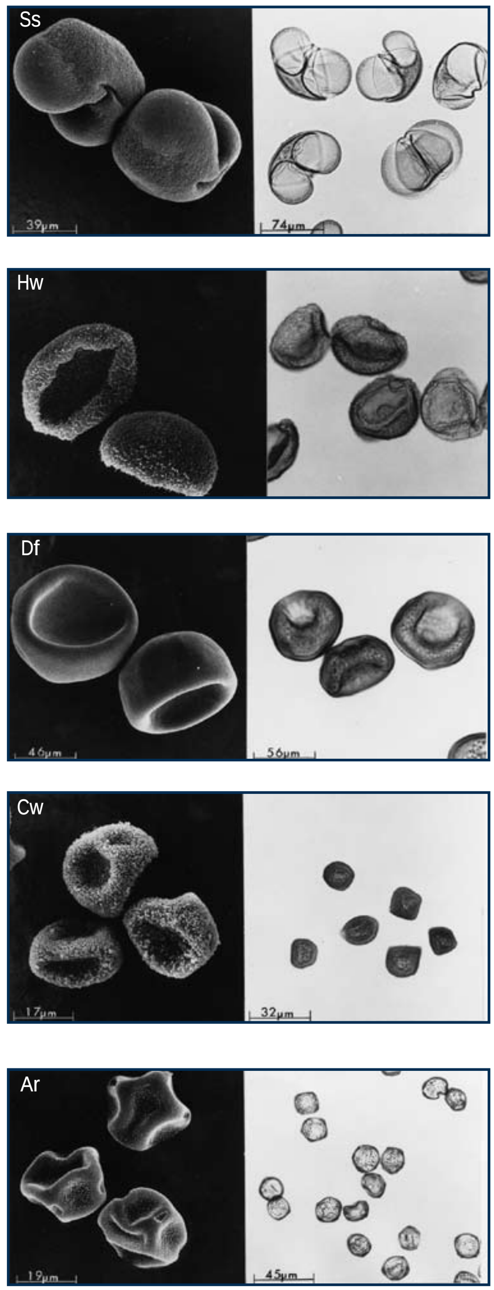

Figure 2. Conifer pollen grains of Ss, Hw, Df, Cw and Ar (red alder).

dissecting microscope at ×40 magnification. Neither the type of microscope nor the power of magnification (see Owens and Simpson 2006 for microscopic description of pollen from BC species) was sufficient to properly distinguish fine pollen grain detail. This was especially true for western redcedar pollen which is the smallest sized pollen (about 25μ) of all coastal species. Furthermore, western hemlock, Sitka spruce and grand fir shed pollen coincidentally with Douglas-fir. It becomes very difficult to distinguish between these species using ×40 magnification of a dissecting microscope. Consequently, the levels of Douglas-fir pollen load, especially regionally, were substantially inflated.

After training in the use of a compound microscope with magnification of ×100 and demonstration of the features distinguishing co-mingling conifer pollen, orchard staff could readily identify the pollen grains of all coastal species. For counting captured pollen grains, two reps of about 45 mm^2 are counted for the seven-day charts and three reps of about 1 mm^2 are counted on the slides. Overall, the improved counting procedures have reduced errors associated with estimates of pollen load, but we must still determine if the type of monitors used (i.e., slide monitors) are adequate for some species (western redcedar) when pollen flight occurs during wet, stormy weather. Figure 3 shows an example of grand fir (large dark), Douglas-fir (slightly smaller than grand fir) and western hemlock (smallest with rough excine).

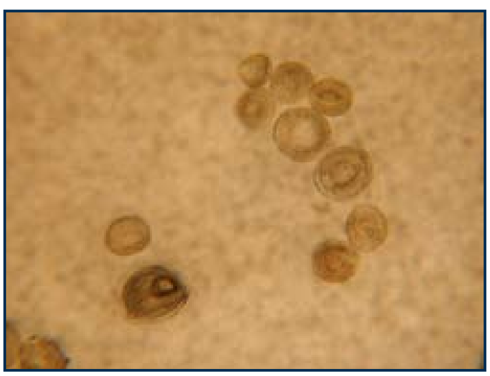

Figure 3. Microscopic view of grand fir, Douglas-fir and western hemlock pollen grains (×100).

Douglas-fir

We have monitored the level of Douglas-fir contamination on the Saanich peninsula for the last three years using our best capture and sampling procedures. These new sampling procedures have been in effect for the last three years and estimates of contamination from pollen monitoring (both seven-day and slide monitors) have been within 5% of those determined from the more robust DNA paternity analyses. The estimates of pollen contamination in Table 2 were calculated using Regional (REG) pollen monitoring data (seven-day recorders) and Western Forest Products (WFP) Orchard (ORC) pollen monitoring data from daily slide counts.

Table 2. Estimates of contamination for 2005–2007 at WFP using seven-day pollen monitoring and slide monitoring data

	Pollen Load (grains/mm^2) Sum Orchard Receptivity			% Contamination	
				7-day	WFP
	REG	ORC OUT	ORC IN	REG/ Slide	Slide/ Slide
Year	7-day	Slide	Slide	no OAF	no OAF
2005	4.6	6.5	96.3	4.8	6.7
2006	6.7	8.1	54.6	12.2	14.9
2007	24.6	28.8	114	21.5	25.2

In 2008, contamination at the WFP and Timberwest (TW) orchard sites was calculated using seven-day monitor data for both REG and ORC. Contamination was 15.0 and 10.1% at each site respectively.

Contamination values not only vary between orchards but also within orchards. For example, in 2006, we also compared contamination at WFP for selected clones by phenology. If we compared REG and ORC pollen load over the receptivity period of the orchard, contamination was 12.2% (Table 3). If we compared REG and ORC pollen load for the receptivity period of the clone, average contamination was 18.7%. Furthermore, if we compared average contamination by phenology period, contamination was 32.5% for early clones, 19.5% for mid-flowering clones and 6.6% for late flowering clones.

Table 3. Estimates of 2006 contamination at WFP

	% Contamination
% Orchard	12.2%
% Clone	18.7%
Clone × Phenology	
E	32.5%
M	19.5%
L	6.6%

Since coastal Douglas-fir is rated the most important species economically, the impact of contamination can be large. The mean breeding value of current, producing coastal

Douglas-fir seed orchards is about 15%. If pollen contamination runs about 13% (2005–2008 average), contamination would reduce the seed crops genetic worth (GW) by about 1%. As an exercise, we can calculate the estimated cost of a loss in growth of coastal Douglas-fir occurring from a 13% level of contamination.

For a seedlot rated with a genetic worth (GW) of 15% (7.5% female + 7.5% male), a 13% level of pollen contamination would result in an estimated loss of 1% wood volume at rotation. For a moderate site index (SI 33), the merchantable volume for a GW15 seedlot is about 862 m^3/ha at 60 years rotation. The merchantable volume of a GW14 seedlot (the loss of 1.3% growth due to contamination) is 853 m^3/ha at 60 years rotation. This is a direct loss of about 9 m^3/ha of wood at rotation.

Assuming a planting density of 1000 stems/ha and a planting of 10 million seedlings/year, the loss of annual merchantable volume at rotation on 10,000 ha would be about 90 000 m^3.

Western Hemlock

There are two western hemlock orchard sites on the Saanich peninsula (TW 182 and WFP 170) with a breeding value of about 15%. In 2008, we estimated the levels of contamination in each of these orchards using seven-day monitors to be 11.8 and 17.4%, respectively. While the values are similar to Douglas-fir, we do not expect the same impact on GW (orchards are young and pollen production will increase) or future loss of wood (lower value species). We do not have extensive data to determine risk but western hemlock natural stands on the Saanich peninsula are not large and we expect orchard pollen production to increase substantially in the next few years. This suggests that contamination in western hemlock orchards may not be as important as for Douglas-fir orchards. At the current level of orchard BV, we do not expect a sufficient decrease in orchard GW to warrant annual estimates of contamination. However, when orchard BV values increase to greater than 20%, monitoring pollen contamination may be warranted.

Western Redcedar

Based on regional pollen loads observed over the last four years, pollen contamination in coastal western redcedar orchards is potentially large. However, capturing pollen during the inclement weather of early spring (February/March) and the difficulties of counting pollen (its small size and co-shedding with red alder pollen) make errors associated with western redcedar pollen contamination higher than other species. Currently we do not have good data for orchard pollen loads and this will become a primary objective of future monitoring.

While contamination has a negative effect on orchard seed lots of other species, it may have less effect on western redcedar. Wang and Russell (2006) suggest that an approximate 1% increase in volume occurs for each 10% reduction in selfing. Since western redcedar is a good selfing species, contamination may actually have a positive effect on a seedlots genetic worth.

Again, the higher BV western redcedar orchards are younger so the higher estimates of pollen contamination will not be indicative of those values to expect when within orchard pollen production increase. However, Table 4 suggests that the potential for contamination can be as large as, or perhaps larger than, Douglas-fir.

Table 4. Western redcedar six-week pollen loads (Saanich Peninsula)

Monitoring Location	Pollen grains/mm^2			
	2005	2006	2007	2008
Puckle Road	148.1	54.8	118.0	59.1
Saanich Pen Hospital	113.3	18.9	107.6	59.3
Agriculture Canada	155.4	65.4	189.9	97.4
Stelly's X Road	99.2	15.4	70.9	55.6
Mount Newton	75.8	12.1	47.8	50.0
Mean All Stations	118.5	33.3	106.8	64.3

Since western redcedar is a high value wood species and the levels of contamination could be far greater than Douglas-fir, we will continue monitoring the annual western redcedar pollen loads. As orchard production increases, we will begin to relate within orchard pollen loads during receptivity to potential contamination pollen loads. At some future date, it will also be prudent to confirm the estimates of contamination from pollen monitoring to values determined for DNA paternity analysis.

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Sitka Spruce

For the years we counted Sitka spruce pollen on the Saanich peninsula (REG), pollen load values were so low that they pose no thread to orchards. Again, Sitka spruce orchards are young and orchard pollen production is expected to increase over the years. There is no compelling evidence to suggest that annual monitoring of Sitka spruce contaminant pollen levels is required.

Conclusions

Pollen monitoring gives good estimates of the annual production of contaminant pollen. Since there is a substantial loss in potential growth of Douglas-fir, orchard managers have options for reducing the effect of contamination. We expect contamination levels to be higher for clones that flower early (see Table 3). El-Kassaby and Davidson (1990) were able to reduce the levels of contamination in WFP's Saanichton orchard to 0% using a combination of bloom delay (Fashler and El-Kassaby 1987) and supplemental mass pollination. While this was only one year's estimate, and we know contamination levels will vary by year, bloom delay does provide a useful option to protect high breeding value clones from contamination.

Pollen monitoring gives good estimates of the annual production of contaminant pollen.

Based on these results, we will continue to recommend estimates of annual contamination in Douglas-fir and western redcedar orchards using pollen monitoring procedures. We do not feel the level of contamination in western hemlock orchards is sufficient to warrant annual monitoring for the short term. This conclusion is based on the current BV of orchards and expected increase in within-orchard pollen production. However, as higher BV orchards are established, monitoring western hemlock orchards will be prudent.

In all of the above discussion, we have assumed that the breeding value of contaminant pollen is zero for southern Vancouver Island contamination sources. This has replaced a previous BV value of -15% based on the performance of southern Vancouver Island sources in provenance trials. The adjustment of the contaminant pollen breeding value was based on a trial where Saanich peninsula sources of pollen (contamination) were crossed with parents from the sub-maritime (coastal/interior transition zone) and compared to progeny from orchard pollen sources (Stoehr et al. 2004). After nine years, the progeny from Saanich peninsula pollen (contamination) compared to orchard sources of pollen, showed no significant reduction in growth or effect on adaptive traits (frost damage) in a plantation near Pemberton and on a coastal site on the Saanich peninsula. The lack of any effect of contaminant pollen on growth of progeny from these orchard parents was not surprising since the BV of this orchard was near 0%. We do not expect the same response when contaminant pollen is crossed with high breeding value (20%) parents (clones).

Funding for the FIA–FSP project that assessed pollen monitoring procedures described above was extended (Y091070–Y0931070) to determine the actual effect of southern Vancouver Island contamination pollen on growth of orchard seed. In 2007, we created a series of progeny from high BV maritime Douglas-fir clones sired by:

1. southern Vancouver Island pollen sources (contamination), and
2. high BV pollen parents (within orchard) on the same high BV seed-cone parents.

Funding for the FIA–FSP project that assessed pollen monitoring procedures described above was extended (Y091070–Y0931070) to determine the actual effect of southern Vancouver Island contamination pollen on growth of orchard seed.

At the time of harvest, we will also collect open pollinated (OP) cones to determine the magnitude of pollen contamination for that year. Seedlings from these three treatments have now been grown and two low (<300 m) and two high (900 m) elevation sites have been planted. Growth will be measured periodically and the actual effect of contamination on growth (BV) will be determined.

Acknowledgement

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FGC Forest Genetics Council of British Columbia

BC's Mountain Pine Beetle Epidemic: Ecological spin-offs in Interior seed orchards

submitted by Jim Corrigan, Lisa Lielich, Penny Major, Judy Murphy and Robb Bennett

The unprecedented wave of destruction caused by the mountain pine beetle (MPB), *Dendroctonus ponderosae* (Coleoptera: Curculionidae: Scolytinae), has yet to run its course in British Columbia. This bark beetle will likely destroy about 80% of the mature pine trees in the province by 2015 (BC Ministry of Forests and Range, 2007). This degree of devastation has already occurred across much of the north and central Interior. The dramatic change in forest structure is creating 'spin-off' ecological phenomena in these conifer habitats. In this article, we report on indirect consequences of the MPB epidemic observed at several Interior seed orchard locations.

The Prince George Tree Improvement Station – 'Secondary' attacks after the MPB wave has passed

The destruction caused by MPB in the Prince George area appeared to have crested in 2006, when most of the mature pine trees in the region were already dead or under attack. Massive beetle populations attacked 'unsuitably' small pine trees and researchers documented the successful brood development of MPB on spruce (Huber et al.). At the Prince George Tree Improvement Station (PGTIS), most of the lodgepole pine research blocks and four lodgepole pine seed orchards were written off to MPB attack.

Annual protective pesticide sprays have been applied to the boles of lodgepole pine ramets in three other PGTIS seed orchards from 2006 to the present (Corrigan et al., 2007). This program has been successful in protecting the majority of these ramets through the past three growing seasons.

Since 2006, there have been strong indications that MPB populations are collapsing around the Prince George area. Beetle trap catches at PGTIS (in Lindgren traps baited with MPB-attractants) were among the lowest recorded at any Interior seed orchard location in both 2007 and 2008. So, we were surprised to find new bark beetle attacks in our 'protected' PGTIS pine seed orchards in 2007. This time, ramets were being mass attacked by species of *Ips*, *Pityogenes* and *Pityophthorus* bark beetles rather than by MPB (Figure 1). These bark beetles are considered to be 'secondary' pests; they usually do not overwhelm the defenses of healthy trees. However, 'secondary' bark beetles do attack healthy trees when their populations are sufficiently large.

The devastation caused by MPB in the Prince George region created ideal conditions for the buildup of 'secondary' species that target weakened pine trees. Table 1 shows the frequency of MPB and 'secondary' bark beetle attacks on PGTIS seed orchard lodgepole pine ramets from 2006 to 2008. During this period,

The devastation caused by MPB in the Prince George region created ideal conditions for the buildup of 'secondary' species that target weakened pine trees.

Figure 1. **Left:** Sawdust and dead *Ips* bark beetles seen at base of ramet treated against MPB in the previous year. **Top right:** Bole of ramet that was fatally attacked by *Pityogenes* bark beetles. **Bottom right:** *Pityophthorus* bark beetle adults under bark of twig. All damaged ramets from PGTIS lodgepole pine orchard 228 in 2007. (Photographs by Jim Corrigan.)

the total number of attacked ramets decreased dramatically and MPB virtually disappeared from the surviving PGTIS pine orchards. In 2007, large populations of 'secondary' bark beetles were responsible for most attacks, but by 2008, there were very few attacks by any bark beetle species (Table 1).

Table 1. Ramets attacked by bark beetles in the PGTIS 220-series pine seed orchards in the past three growing seasons

	Ramets attacked by:	
Year	MPB	*Ips*, *Pityogenes*, and/or *Pityophthorus*
2006	214	20
2007	1	53
2008	0	6 (all *Pityogenes* sp.)

The pattern of attack observed at PGTIS for species of *Ips*, *Pityogenes* and *Pityophthorus* could be expected in the aftermath of a wave of MPB-based pine mortality (Dr. Lorraine Maclauchlan, Regional Entomologist, BC Ministry of Forests & Range – Kamloops, personal communication). Local populations of these 'secondary' bark beetle species appear to be subsiding quickly as suitable host material (weakened, but not yet dead pine trees) disappears. Based on these trends, we are optimistic that PGTIS will be the first seed orchard site in the province to be managed under a 'post-MPB' paradigm. However, other pine seed orchards in the Interior may be at risk from 'secondary' bark beetle attacks for some years into the future.

Kalamalka Seed Orchards – MPB attacks reveal insights into the biology of a poorly known fly species

Populations of MPB may have reached their highest levels in the Interior of BC in 2006. Enormous clouds of adult beetles dispersed over great distances in high altitude air currents and large numbers were even carried over the Rocky Mountains into Alberta. Beetles landed in the upper Okanagan in early August of 2006 and attacked about 1000 lodgepole pine ramets at the Kalamalka Forestry Centre in Vernon in less than 48 hours (Corrigan et al., 2006). Fortunately, only three ramets were killed of the approximately 800 ramets hit in two orchards (Corrigan et al., 2007). Although many of the attacked ramets were 'shot full of holes' (adult entrance wounds), most attacked individuals successfully repelled the attacks as evidenced by 'pitched-out' adults and no development of larval brood under the bark (Corrigan et al., 2007).

During routine monitoring for new MPB attacks in 2007, we found fresh pitch flows at, or just above, some MPB entrance wounds created in the previous year (Figure 2). No associated MPB were detected but we did find larvae of the sequoia pitch moth, *Synanthedon sequoiae* (Lepidoptera: Sesiidae), a common clearwing moth in our pine orchards. As well, we collected numerous fly maggots that we were unable to identify (Figure 2). The copious pitch flows suggested that these fly larvae were utilizing living tissue in the tree wounds. Because these larvae were common in our pine orchards, we assumed that their identity

Based on these trends, we are optimistic that PGTIS will be the first seed orchard site in the province to be managed under a 'post-MPB' paradigm.

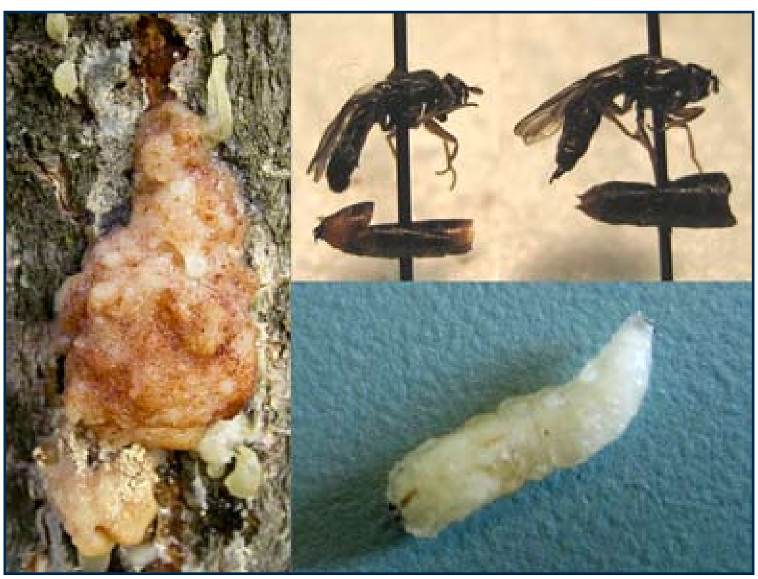

Figure 2.
Left: Fresh (2007) pitch mass over site of 2006 MPB entrance wound.
Bottom right: Fly larva extracted from old, failed MPB parental gallery.
Top right: *Chyliza scrobiculata* (Diptera: Psilidae) adult male (left) and female (right) pinned over the remnants of their puparia. (Photographs by Jim Corrigan.)

…specimens sent to the Canadian National Insect Collection in Ottawa were identified by Drs. Jeff Skevington and Brad Sinclair as *Chyliza scrobiculata*…

and biology would be well known, but no BC entomologists were familiar with this insect. We had to circulate pictures of the larvae to experts across Canada before someone was able to identify it; Dr. Steve Marshall, a world-renowned fly specialist at the University of Guelph, recognized them as a species of *Chyliza* (family Psilidae).

In early November of 2007, we collected about 100 pitch masses containing pupae of the *Chyliza* species and placed these in a freezer to overwinter at -2°C. The pupae were brought out of cold storage in early February 2008 and subsequently held at 20°C. Over 60 adult flies emerged, and specimens sent to the Canadian National Insect Collection in Ottawa were identified by Drs. Jeff Skevington and Brad Sinclair as *Chyliza scrobiculata* (Figure 2).

Virtually nothing is known about this species. Only a single specimen had been deposited in the Canadian National Collection prior to our contributions and nothing has been published about the biology of *C. scrobiculata*. Scanty biological information exists for other species of *Chyliza* and is consistent with our experience with *C. scrobiculata* at Kalamalka; larvae are found in association with wounds on deciduous and coniferous trees (Teskey 1976; Lyneborg 1987).

It appears that *C. scrobiculata* is phytophagous, entering and developing in existing wounds on pine. In the summer of 2008, two of these maggots were found in non-MPB-created wounds on lodgepole pine ramets at the Kettle River Seed Orchards. So, like the sequoia pitch moth, the flies appear to be attracted to any wounds made on living pine trees. At Kalamalka during the 2007 growing season, they were using the MPB entrance holes and failed parental galleries found on many ramets in one orchard to attack the boles in unprecedented numbers. It is unlikely that *C. scrobiculata* is a serious problem in our pine seed orchards; no mortality was associated with fly attacks and, like the wound-based sequoia pitch moth attacks, it is probable that mature pine ramets can tolerate *Chyliza* attacks without suffering mortality or significant reductions in cone yields.

Bailey Road Seed Orchards – A new white pine cone pest emerges?

The fir coneworm, *D. abietivorella* (Lepidoptera: Pyralidae), is one of the most destructive seed orchard pests in North America, attacking cones and other parts of most conifer species. In early June of 2008, we found larval feeding damage, characteristic of *Dioryctria* coneworms, in Kalamalka's Bailey Road white pine seed orchard (Figure 3). This seemed early for fir coneworm damage and we monitored the attacked cones closely. In mid-July, we collected about 80 of the damaged white pine cones and reared 22 adult moths from them by the end of the month. These moths were easily identified as adults of the ponderosa pine coneworm, *Dioryctria auranticella* (Figure 3).

Although this orchard has produced commercial volumes of cones for the past decade, this was the first observation of ponderosa pine coneworm there or elsewhere at the Bailey Road site. Ponderosa pine coneworm has been recorded from ponderosa,

These moths were easily identified as adults of the ponderosa pine coneworm, *Dioryctria auranticella*…

Figure 3.
Lower left: Frass buildup at entrance of *D. auranticella* larval feeding site on white pine cone. Note that the cone is dead and discoloured beyond the attack site.
Top left: *D. auranticella* larva entering cone.
Top right: Silk window over entrance site made just before individual pupates in cone.
Bottom right: Adult *D. auranticella* reared from white pine cone.
(Photographs by Jim Corrigan.)

knobcone, and other pines in North America (Furniss & Carolin, 1977) but apparently not from white pine in BC. There are no records of association of this moth with white pine in the Royal BC Museum, Pacific Forestry Centre, University of Alberta Strickland Museum of Entomology or Canadian National Insect Collection. To the best of our knowledge, these specimens of *D. auranticella* represent a new host record for BC.

The biology of *D. auranticella* differs from the extremely variable seasonal biology of the fir coneworm, *D. abietivorella*, in that life stages of the ponderosa pine coneworm are synchronized through the growing season. Adult *D. auranticella* emerge in mid-summer, mate and lay eggs on host trees. The eggs hatch in late summer and individuals overwinter as early-instar larvae. In late spring, the larvae chew into second-year cones. When they have finished feeding, each mature larva of *D. auranticella* seals off its entrance hole with silk (Figure 3), and pupates inside the damaged cone. It is difficult to distinguish larval feeding damage by the ponderosa pine coneworm from that caused by the fir coneworm. However, the larvae of the fir coneworm, *D. abietivorella*, do not seal off the entrance holes into cones at pupation and their larvae usually leave the cones to pupate. The damage caused to cones and their seed contents is similar, and severe, for both species of coneworm.

In the past several years, resident MPB populations have increased in the North Okanagan. The City of Kelowna reports that thousands of trees already have been killed in the area (http://www.kelowna.ca/CM/Page1077.aspx). The Bailey Road site is located several kilometers south of Vernon along the Highway 97 corridor to Kelowna. Substantial portions of the ponderosa pine populations along the inter-lake ridge between Vernon and Kelowna have been lost to MPB attack since 2006. We suspect that adult females of *D. auranticella* have failed to find sufficient numbers of healthy ponderosa pine trees on the ridge above Bailey Road and have moved into the white pine ramets at the site.

Although we believe this particular feeding damage will be a short-term problem, there clearly are no impediments to the successful development of ponderosa pine coneworms in white pine cones. Given the destructive nature of their larval feeding, there could be serious consequences to seed production if populations of *D. auranticella* become permanent additions to the pest complex in our pine seed orchards.

Conclusions

In this article, we have discussed three different insect-based issues that have occurred in Interior seed orchards over the past few years. What do these relatively unrelated phenomena have in common? We believe that each of them is an indirect result of the devastation caused by MPB in the province. In areas where the overwhelming majority of mature pine trees have been killed by beetle attack, other pine-attacking species are being pushed onto any pine trees remaining in the area. Blocks of seed orchard ramets often form the largest concentrations of pine remaining in these places, so it's not surprising that we have seen some of these 'spin-off' phenomena in our Interior seed orchards.

We encourage seed orchard pest management personnel to continue careful monitoring of pine ramets and to 'expect the unexpected' over the next few years. It is quite possible that we will see more examples of unprecedented or previously undocumented biological activity that stem from the current MPB crisis. We hope that any novel pest situations arising will be both trivial and temporary, but we need to remain alert for unusual pestiferous activities in our pine seed orchards until the end of the MPB crisis in the forests of British Columbia.

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The authors sincerely thank Drs. Steve Marshall, Jeff Skevington and Brad Sinclair for identifying our specimens of *C. scrobiculata* and to Drs. Rob Cannings, Lee Humble, Felix Sperling, Amanda Roe and Jean-Francois Landry for sharing information on *D. auranticella*. We are grateful to the Forest Genetics Council and the Pest Management Technical Advisory Committee of British Columbia for their ongoing support of our pest management efforts in the Interior Seed Orchards.

To the best of our knowledge, these specimens of *Dioryctria auranticella* represent a new host record for BC.

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Tree Seed Centre Celebrates

submitted by Heather Rooke

This past year, the Tree Seed Centre (TSC) celebrated "Over 50 Years of Excellence in Cone & Seed Services" and here are some of the highlights. In May, the Forest Stewardship Division management team toured the facilities and our newly renovated office space was officially re-opened by Jim Snetsinger, Chief Forester. In July, a two-day technical forum to bring together those with an interest in Seed Use Efficiencies took place in Langley followed by a tour and taste of southern bar-b-q at the TSC. In August, a luncheon and tour were held as a way to express thanks to those individuals and representatives of organizations for their significant contributions over the past 50 years and over a variety of disciplines, as follows: Leadership; Client Support; Communication & Extension Services; Cone & Seed Services; Engineering & Infrastructure; Information Management & Technology; and Seed Science & Technology. As part of the 2008 Forest Nursery Association of BC Annual General Meeting, a tour of the TSC was provided in September. An open house for Friends and Family followed on the first Saturday in October. Over the year, a number of tours were provided to include staff from Forestry Innovation Investment, university and post-secondary students, our ministry's Provincial Leadership Forum and a variety of clients. During this time, our former manager Rob Bowden-Green returned on a part-time basis to work on a report that outlines our first 50 years.

It's been quite a year, none of which would have been possible without the extra-ordinary efforts and support of the TSC's 50th Anniversary Organizing Committee comprised of Rob Bowden-Green, Diane Douglas, Laura Klade, Dave Kolotelo, Michael Postma, Anita Rebner, Spencer Reitenbach, Heather Rooke, Dawn Stubley and Chuck Woodward, TSC staff who continue to deliver well above average volumes of cone and seed services throughout the year, our director Brian Barber, Tree Improvement Branch and the Ministry's Forest Stewardship Division.

In 2008, the Tree Seed Centre celebrated "Over 50 years of Excellence in Cone & Seed Services."

Tree Seed Centre 50-year Celebration

submitted by Rob Bowden-Green

BC Forest Service celebrates 100 years in 2012.

What a privilege it has been to come back to the TSC to be part of the 50-year celebration after nine years of retirement. While researching the TSC history, it has been a bonus to relive the memories of our past successes and to learn more about the early history and the accomplishments of the TSC staff since I left.

It's wonderful to be able to continue to learn at this stage in life. I am amazed at how much more I have learned about the early nursery and seed extraction business in this province and have gained a new insight into the establishment of the extractory at the Duncan Nursery.

The Seed Use Efficiency Meeting, the Appreciation Event and the TSC Open House, along with the 'interviews' throughout this year, have provided great joy. To be able to renew old friendships and acquaintances and meet the new players that provide 'excellence in cone and seed services' in this province had never entered my thoughts.

This exercise of documenting the 50 years of TSC history points out to me that the upcoming celebration of 100 years of the BC Forest Service will be a worthwhile and fascinating process for a lot of people.

Thank you to Heather Rooke, Manager of the Tree Seed Centre, and all those involved for this most successful venture.

Forest Nursery Association of British Columbia Annual Meeting 2008

submitted by Spencer Reitenbach

The 28th Annual FNABC theme was "A Changing Climate – Economic, Political, Environmental and Labour." We looked at Planting Trees for Carbon Sequestration, Selling Carbon Credits, Forest Carbon and CO_2, Growing Willow as a Heat Source, making fuel from manure, Immigration Initiatives, 'Safe' Companies and a few technical sessions. We had about 60 delegates registered which included about 10 exhibitors. Of the 29 nurseries in BC, only eight had individual representation at the meeting, though there was some upper management representation from PRT. Even though the group was smaller than normal, there was still the opportunity for exchange between nurseries. Attendance was only about 50–60% of what is normally expected at the meeting; tough times in the nursery industry and personal reasons were some of explanations for poor attendance.

A lengthy business meeting was held to try to focus the future direction of the group and to work on updating the current constitution. The following BC Ministry of Forests and Range staff had presentations: Allan McDonald presented on Pli Seed Supply, Brian Raymer on Forest Carbon and CO_2, Shon Ostafew on BCTS Nursery Services – Coast & Interior, and Sylvia L'Hirondelle on Frost Hardiness Thresholds.

In the 2008 season, BC nurseries produced over 212.6 million seedlings at $0.11–$0.15+ each or $23–$31+ million (depending on species and stock size grown) but does not include all trees grown for private lands, stock overruns or for planting outside of BC.

In previous years, in excess of 273 million seedlings were produced by the industry, so there appears to be a current over-capacity in the province. However, nurseries do not provide their capacity and the number of trees would vary depending on stock type and species. The 10-year average for the industry is 235 million seedlings requested.

With the addition of the three new Seedling and Reforestation Specialist positions in BC Timber Sales, more extension services may be brought back to the MFR. Last season, over 79% (23/29) of BC nurseries grew seedlings for BCTS or some other ministry funding source.

The Chief Forester's Award for best seedlings grown from the same seedlot to predetermined specs were grown by various nurseries and submitted to a FNABC committee for adjudication. The first Chief Forester's Award was presented in 1983 to the Pacific Forestry Centre. Rob Bowden-Green, retired Manager of the Tree Seed Centre in Surrey, has the following recollection about the award:

"It was all about bragging rights for the next year on who could grow the best stock. As I remember, the incentive was to improve nursery stock with a little friendly competition at a time when industry and private nurseries had entered with the Forest Service in producing seedlings. I believe the Chief Forester presented the first award but I'm not sure how the rules were developed."

The Chief Forester's Award 2008 was awarded to K&C Silviculture, Oliver, BC.

Figure 1. Elizabeth Brown – 2008 FNABC President, PRT Pelton; Jorge Avila – K&C Silviculture, award recipient; and Laura Klade – MFR – Tree Seed Centre.

Figure 2. Jorge Avila – K&C Silviculture.

In the 2008 season, BC nurseries produced over 212.6 million seedlings at $0.11–$0.15+ each or $23–$31+ million (depending on species and stock size grown)

Updates

Canadian Forest Genetics Association has a new website at http://www.cfga-acgf.com/

Tree Seed Centre

In conjunction with our 50th anniversary as part of the BC Forest Service, the Tree Seed Centre hosted a Seed Use Efficiency meeting in Langley, BC (July 30 and 31, 2008). The meeting included 1.5 days of presentations followed by a tour of the Tree Seed Centre and a BBQ at our facility. The event attracted about 95 people from tree breeding and seed orchard programs, cone collectors and processors, nursery personnel and a host of forestry professionals looking for ways to increase seed use efficiency. Many more individuals expressed an interest, but due to our difficult economic times were unable to attend. The PowerPoint presentations and abstracts from most talks have been placed on a dedicated web page which can be found at http://www.for.gov.bc.ca/hti/treeseedcentre/tsc/workshops&presentations/seed-use-efficiency/index.htm.

The presentations from the 2007 Tree Seed Workshop have also been placed online and can be found at http://www.for.gov.bc.ca/hti/treeseedcentre/tsc/workshops&presentations/treeseedworkshop2007/index.htm.

Additional presentations will continue to be placed on similar pages. If there is something specific you are interested in, please Dave Kolotelo at Dave.Kolotelo@gov.bc.ca.

Canadian Forest Genetics Association

The joint conference of IUFRO Working Groups 2.04.01 (Population, ecological and conservation genetics) and 2.04.10 (Genomics), along with the Canadian Tree Improvement Association (CTIA) was held in Québec City, August 24–29, 2008. It was hosted by Université Laval and its partners.

The theme was Adaptation, Breeding and Conservation in the Era of Forest Tree Genomics and Environmental Change.

At that meeting, the name of the Canadian Tree Improvement Association was changed to the Canadian Forest Genetics Association. A newly launched website is now available at http://www.cfga-acgf.com/.

Interior Pest Reports

The Interior Pest Reports are brief communications produced to disseminate pest information to the 10 Interior seed orchard locations on an ‘as it happens’ basis during each growing season. The reports include:

- alerts about activity by specific pest species
- reminders to conduct routine monitoring or control operations
- requests for information about poorly understood or novel pest situations.

They consist of short written sections on each pest issue. These sections usually are accompanied by photographs of the damage or pests under discussion. There is no regular publishing schedule for these reports; they are circulated on an ‘as needed’ basis during each growing season. The files are distributed through an email distribution list to Orchard Managers and Pest Biologists around the Interior seed orchards, and to forest pest management experts in BC and other western jurisdictions.

If you are interested in being put on the mailing list to receive the Interior Pest Reports, please contact Jim Corrigan at Jim.Corrigan@gov.bc.ca.

Western White Pine Management Workshop

A Western White Pine Management Workshop was organized and held in Vernon June 17–18, 2008. Organizers Michelle Cleary, Michael Carlson, Stefan Zeglen, Diane Douglas and Vicky Berger put together a stimulating and informative two-day event with presentations by pathologists (from Idaho, California and BC), and ecologists, silviculturists, tree breeders, seed orchardists, wood products and technology industry representatives, all from BC. Highlighted was the long history of white pine blister rust (WPBR) breeding in the U.S. and our more recent efforts in BC, including a tour of our Ministry of Forests and Range Bailey seed orchard near Vernon. A three-stop field tour the second day concentrated on realized genetic gain trials and a long-term pruning trial. Approximately 90 field foresters and forest managers attended the workshop. The general consensus among participants was that we now have sources of white pine seed that can be trusted to deliver disease resistance/tolerance levels of approximately 65% at rotation (e.g., we can expect 65% of trees planted today to survive to rotation age, less other non-rust causes of mortality).

Canadian Silviculture magazine, November, 2008, has an article under Forest Health section entitled "Resistance Breeding and Screening Against Blister Rust: Return of the White Pine!" by Michelle Cleary and Michael Carlson (http://www.canadiansilviculture.com/nov08/foresthealth.html).

The Woody Plant Seed Manual

The Woody Plant Seed Manual is available in printed form and can be obtained through the National Seed Lab website at http://www.nsl.fs.fed.us/; a link to the Government Printing Office is provided. It is USDA Forest Service Agriculture Handbook number 727, July 2008 and is 1223 pages in length. The manual is an updated and expanded version of the classic 1974 Seeds of Woody Plants in the United States (Figure 1).

Figure 1. A comparison between the 1974 and 2008 USDA Agricultultural Handbooks dealing with Seeds of Woody Plants.

The cost of the publication is $144.20 CDN and, considering its length (full letter size pages), it is quite a good deal. We've just received our copy and it weighs in at just under 4.3 kg!

The introductory sections covering "Principles and general methods of producing and handling seeds" have been retained and updated with a slight adjustment to the titles. These chapters have been reduced from 163 to 145 pages in the latest edition. The section that was expanded upon is the genera – 236 genera are discussed compared to 188 in the 1974 version. Most of these new genera are tropical trees grown in Hawaii or one of the US territories (i.e., Puerto Rico) and a variety of shrubs that have increased in value for wildlife or restoration purposes.

The right margin has a letter index with specific genus indicated at the bottom of each page allowing you to quickly find the genera of interest. For those unable to purchase the manual or wanting to check on some seed details on the road, the online version produced in April 2008 can be found at http://www.nsl.fs.fed.us/nsl_wpsm.html. The intention is to use this site to set up a system to update and add to the 236 genera.

Specific to British Columbia, one of the nine pioneers to which the book is dedicated is George S. Allen, retired from the Canadian Forestry Service and the University of British Columbia. The other BC participant, George Edwards, provided the chapter on *Abies*, which is the first genera chapter coming in at 50 pages. Overall, this is a great resource and I highly recommend it to those dealing with seeds of woody plants.

***The Woody Plant Seed Manual* is available in printed form and can be obtained through the National Seed Lab website at http://www.nsl.fs.fed.us/**

Contributors

Brian Barber, RPF
Director
MFR Tree Improvement Branch
2nd Floor, 727 Fisgard Street
Victoria, BC V8W 1R8
Phone: 250.356.0888
Brian.Barber@gov.bc.ca

Robb Bennett
Seed and Pest Management Biologist
MFR Tree Improvement Branch
7380 Puckle Road
Saanichton, BC
Phone: 250.652-5600
Robb.Bennett@gov.bc.ca

Vicky Berger
Kalamalka Forestry Centre
MFR Research Branch
3401 Reservoir Road
Vernon, BC V1B 2C7
Phone: 250 260-4758
Vicky.Berger@.gov.bc.ca

Rob Bowden-Green
MFR Tree Seed Centre
Tree Improvement Branch
Surrey, BC V4P 1M5
Phone: 604.541.1683
Rob.BowdenGreen@gov.bc.ca

Darius Bucher, RPF
Integral Forest Management Ltd.
1127 Pleasant Street
Kamloops BC V2C 3C1
(Interior sales representative for
Reforestation Technologies International)
Phone: 250.374.9286 Cell: 250.318.8861
integrl1@telus.net

Mike Carlson, RPF
Forest Genetics and Tree Breeding
MFR Research Branch
Kalamalka Forestry Centre
3401 Reservoir Road
Vernon, BC V1B 2C7
Phone: 250.260.4767
Michael.Carlson@gov.bc.ca

Lee Charleson, RPF
Seed Policy Officer
MFR Tree Improvement Branch
2nd Floor, 727 Fisgard Street
Victoria BC V8W 1R8
Phone: 250.387.4839
Lee.Charleson@gov.bc.ca

Christine Chourmouzis
Forest Sciences Centre
UBC
2424 Main Mall
Vancouver BC V6T 1Z4
Phone: 604.822.1951
Christine.chourmouzis@ubc.ca

Jim Corrigan
Interior Seed & Cone Pest Management Biologist
Kalamalka Seed Orchards
MFR Tree Improvement Branch
3401 Reservoir Road
Vernon BC V1B 2C7
Phone: 250.549.5696
Jim.Corrigan@gov.bc.ca

Diane Douglas, P. Ag.
Extension and Communications
MFR Tree Improvement Branch
2nd Floor, 727 Fisgard Street
Victoria BC V8W 1R8
Phone: 250.356.6721
Diane.L.Douglas@gov.bc.ca

Dave Kolotelo, RPF
Cone and Seed Improvement Officer
MFR Tree Seed Centre
Tree Improvement Branch
Surrey BC V3S 0L5
Phone: 604.541.1683 extension 228
Dave.Kolotelo@.gov.bc.ca

Jodie Krakowski, RPF
CLRS
MFR Research Branch
7060 Forestry Road
Mesachie Lake BC V0N 2N0
Phone: 250.749.6811 extension 43
Jodie.Krakowski@gov.bc.ca

Lisa Lielich
PGTIS
MFR Tree Improvement Branch
17000 Domano Blvd
Prince George BC V2N 5M2
Phone: 250.963.8416

Penny Major
Kalamalka Seed Orchards
MFR Tree Improvement Branch
3401 Reservoir Road
Vernon BC V1B 2C7
Phone: 250.558.0932
Penny.Major@gov.bc.ca

Judy Murphy
Kalamalka Seed Orchards
MFR Tree Improvement Branch
3401 Reservoir Road
Vernon BC V1B 2C7
Phone: 250.260.4763
Judy.Murphy@gov.bc.ca

Greg O'Neill, RPF
Forest Genetics and Tree Breeding
MFR Research Branch
Kalamalka Forestry Centre
3401 Reservoir Road
Vernon, B.C. V1B 2C7
Phone: 250.260.4776
Greg.O-Neill@gov.bc.ca

Spencer Reitenbach
Inventory Management Supervisor
MFR Tree Seed Centre
Tree Improvement Branch
Surrey BC V3S 0L5
Phone: 604.541.1683 ext.229
Spencer.Reitenbach@gov.bc.ca

Heather Rooke
Manager
MFR Tree Seed Centre
Tree Improvement Branch
Surrey BC V3S 0L5
Phone: 604.541.1683 ext.224
Heather.Rooke@gov.bc.ca

Michael Stoehr, RPF
Forest Genetics and Tree Breeding
MFR Research Branch
PO Box 9519 Stn Prov Govt
Victoria BC V8W 1N1
Phone: 250.356.6269
michael.stoehr@gov.bc.ca

Nick Ukrainetz, RPF
Forest Genetics and Tree Breeding
MFR Research Branch
Kalamalka Forestry Centre
3401 Reservoir Road
Vernon, B.C. V1B 2C7
Phone: 250.260.4761
Nick.Ukrainetz@gov.bc.ca

Joe Webber
ProSeed Consulting
425 Stewart Road
Salt Spring BC V8K 1Y6
Phone: 250.537.8854
jewebber@telus.net

Jack Woods, RPF
Program Manager
Forest Genetics Council of BC
3370 Drinkwater Road
Duncan BC V9L 5Z2
Phone: 250.748.9579
jwoods.fgc@shaw.ca

TIC*talk* Availability

TIC*talk* is available in electronic format at http://www.fgcouncil.bc.ca/new-tict.html.

For more information, contact:

Diane Douglas, BCMFR Tree Improvement Branch
Tel: 250.356.6721 Fax: 250.356.8124
Email: Diane.L.Douglas@gov.bc.ca