TICtalk

FGC Forest Genetics Council of British Columbia

Information for and from the tree improvement community of British Columbia

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Tenth Edition

Congratulations on the 10th edition of TIC*talk*! I reviewed our first edition from 1996, and smiled that then-editor Roger Painter called it "A Timely Publication". Diane Douglas, present editor, carries on this tradition. Editions come out "periodically"; are packed with news, information, and new knowledge; and recognize people who have made a difference in the Tree Improvement Community.

TIC*talk* extends new knowledge in the areas of genetic conservation, genetic deployment, and genetic enhancement in support of the mandate of the Forest Genetics Council. As well, knowledge gaps are identified.

We have made significant progress in enhancement since 1996. The investments in establishing, maintaining, and evaluating provenance and progeny tests are being applied to the broader landscape through regeneration programs. I've tracked average genetic worth of WFP planting programs: the average volume gain being deployed to our plantations began to creep up about a decade ago. With the addition of high-gain western redcedar, the lead species in our planting program, things are certainly looking up! Thanks to the work of the past and present delivery team – breeders, orchard managers, nursery growers, technicians, researchers, policy makers, and administrators – we are seeing significant up-take of the tree improvement product.

A few Seed Planning Units (SPU) are not realizing full results of their breeding programs. For some, we do not have the orchard seed supply to meet current regeneration levels. We do not have a complete knowledge of the reproductive biology of tree species and populations and their pests; a better understanding may allow us to modify our cultural practices to improve orchard crops. For others, natural regeneration is resulting in suboptimal performance and lost opportunity. Regeneration demand is variable; dramatic changes in seed use are evident. Right-sizing and right-timing orchard supply is a continuing challenge.

We are seeing timely changes in deployment strategies. With the changes to western larch transfer limits, policy now supports assisted migration. This change is among the first of the interim measures that lead to climate-based seed transfer limits. As information is gleaned from the adaptation trials together with progeny and provenance trials, more assisted migration recommendations are anticipated. At present we are expanding deployment ranges; the more challenging piece will be the contraction of deployment from current ranges. Timeliness will again be critical or economic opportunity will be lost through suboptimal performance of regeneration.

Our knowledge of the status of forest genetic diversity for conservation and utilization purposes is improving. The report for BC indicates that we have maintained good levels of genetic diversity to date, but the effects of climate change are evident and we know we have vulnerabilities that require additional knowledge to address.

From an industry perspective, we are cautiously optimistic that we have passed through the financial crucible; the economy is improving. Government is now passing through its financial crucible with staff adjustments. These are challenging times for those who go and those who remain. Sincere thanks to all of you for your continued dedication to your work to advance our knowledge and delivery of genetic resource management.

Timely knowledge management is critical to the continued success of our efforts in tree improvement and genetic resource management. We need adequate resources, trained and inquisitive personnel, and timely policies to support knowledge management and implementation. This will result in proactive practice changes that sustain – for the long term – our forests' ability to meet society's economic, environmental, and social expectations.

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Chair, Coastal Technical Advisory Committee (CTAC), FGC

INSIDE

Lodgepole Pine Cone Size and Scale Number are Shaped by Location

submitted by Patrick von Aderkas and Elizabeth Kruithof

Do smaller cones have fewer fertile scales and less ovules?

For some time, orchard managers have been aware that seed shortfalls occur in lodgepole pine (Pli) orchards planted in the North Okanagan. This shortfall is location-specific, as ramets of the same genotypes planted in Prince George produce substantially more seed than in the North Okanagan. Depending on weather, insects and other factors annual seed production can vary in both locations. On occasion, yield in some North Okanagan orchards has ranged from 2-10 filled seeds/cone while the identical genotypes in Prince George were producing approximately 25 seeds/cone. Since the number of potential seed is a function of the number of ovules that have developed, it is natural to ask whether there may be some underlying difference in ovule number with North Okanagan cones having fewer ovules than cones in Prince George. The basis for this question lies in the observation that cone size varies according to location: ramets planted in the North Okanagan produce smaller cones than those planted in Prince George (Figure 1). Do smaller cones have fewer fertile scales and consequently fewer ovules?

Figure 1. Mature Year 2 cones that have released their seed. Three genotypes are illustrated with ramets in both Prince George (PG) – top row – and the North Okanagan (NO) – lower row.

Cone formation in lodgepole pine is a long and drawn out affair, taking three years from initiation to maturity. Cones are given stage-specific names. When they are initiated in mid-summer of Year 0 they are called cone buds. In the following spring, in Year 1, they form receptive ovules, and become pollinated; at this stage they are known as conelets. In spring of Year 2, eggs differentiate and are fertilized by pollen held over in the cone from the previous year. The resulting embryo and its surrounding ovule tissue matures into a seed. The cone and its seed are ready for collection by late summer or early autumn of the same year.

To test whether final cone size differences in Year 2 were the consequence of differences in Year 1, we collected conelets, counted the number and types of scales, and measured weight, height and width of five conelets taken in autumn 2008 from ramets of eight genotypes (1737,1792, 2028, 2062, 2071, 2082, 2100, 2222) planted at Red Rock Research Station near Prince George and at Vernon Seed Orchard Company in the North Okanagan. Two genotypes (2028, 2100) in Prince George had fewer cones because of significant pine beetle damage to ramets in the orchard. We analyzed the data using two-way ANOVA of paired comparisons of averages. Significance was set at $p<0.05$.

We also pulled conelets apart under a dissecting microscope and placed each scale (i.e. bract - ovuliferous scale complex) on two-sided tape in approximate order. Conelet scales were brown and lignified in their distal regions. We measured width and height of the brown lignified apophysis and umbo (Figure 2).

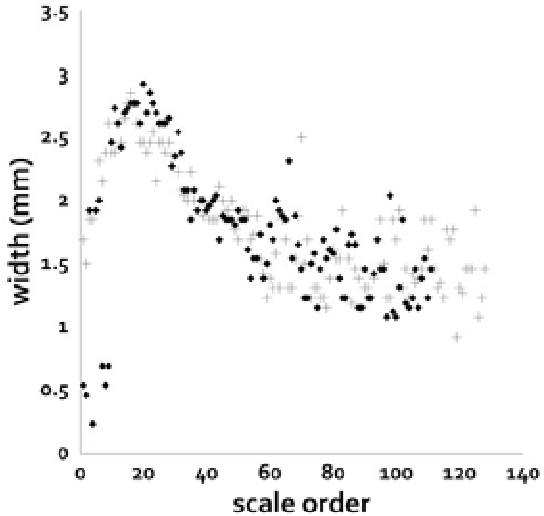

Figure 2. Plot of width of scales of two Year 1 cones (+ and diamond) by approximate order within cone, with 1 being the apex.

Fertility and scale size were related. Scales were initially small and sterile. They increased in size over the upper middle portion of the conelet. The fertile scales were restricted to a narrow zone in this part of the conelet (Figures 3 and 4).

Fertile scales are restricted to a narrow zone in a conelet.

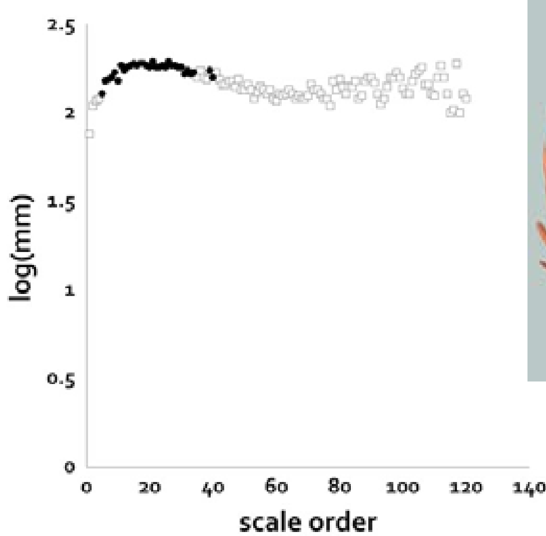

Figure 3. Plot of log width of scales of a Year 1 cone by approximate order within cone, with 1 being the apex. Fertile scales are shown in solid circles, sterile in empty squares.

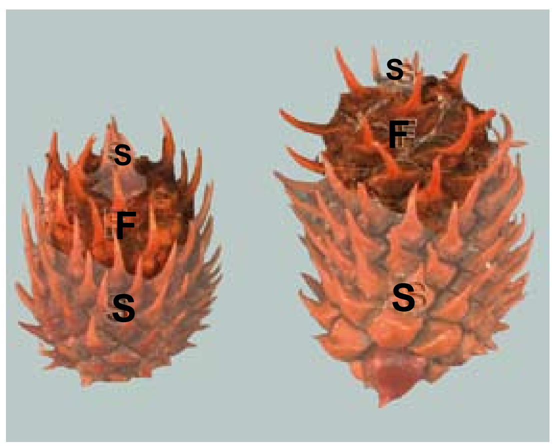

Figure 4. Year 1 cones of 2071 from Prince George (l) and North Okanagan (r) with fertile scales (F) located between two zones of sterile scales (S).

Lodgepole pine cone development responds in a location-specific manner.

Fertile scales were defined initially as those having at least one obvious ovule (Fig. 5).

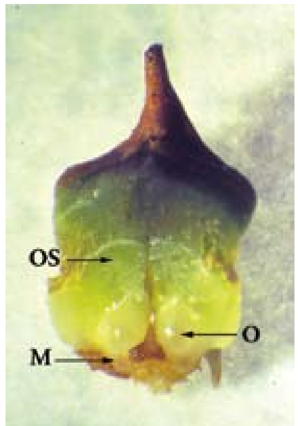

Figure 5. Fertile scale of Year 1 cone. Ovule (O) and micropyle (M) are located on an ovuliferous scale (OS), with two OSs per fertile scale.

However, our experience after counting hundreds of these was that fertile scales had pairs of healthy ovules, which is to say they never had an ovule missing or prematurely aborted. All remaining scales proximal or distal to this zone were sterile. These progressively declined in size until the base, where the smallest scales were found.

The number of fertile scales/cone did not differ between the two places. Conelets in the North Okanagan had a greater number of total scales/cone than those from Prince George and that this increase was solely due to an increase in sterile scales/cone.

Conelet width and height was the same between the North Okanagan and Prince George sites, which means that differences in mature cones between the sites (Prince George > North Okanagan) occurred after the conelet stage.

The major discovery of our study is that conelets at the two different sites did not differ in mass or size but in the number of total scales. The increase in North Okanagan conelet scales must have occurred during cone bud initiation in Year 0; this increase may be due to a longer growing season compared to Prince George, but this requires further study as it is unclear what phenotypic adaptation arises from addition of sterile parts.

The main point is that lodgepole pine cone development does respond in a location-specific manner. As far as orchard management is concerned, there are no obvious practices unique to the North Okanagan orchards that could account for cone size differences. It is hard to find any universal treatment of the trees that could account for the shortfall in seed, other than local climatic factors that have particular affects on lodgepole pine.

In the end, bigger is better. The larger Prince George cones produce more seed. The increase in size occurs in early Year 2 conelets, as the conelets at the end of Year 1 did not differ in the two sites. Larger cones produce more seed, but generally the reason given is that larger cones have more fertile scales and more ovules (e.g. *Picea* - Caron and Powell. 1989). Our results are somewhat in contrast to this, as Prince George cones are bigger not because they have more parts: they just have a greater investment of mass by the mother plant in fewer scales.

Since conelets from trees in both Prince George and North Okanagan do not differ in the number of fertile scales, lower seed production of North Okanagan ramets cannot be due to a shortage of fertile scales and ovules. This implies that seed losses are due to a possible combination of reductions in pollination, fertilization or embryogenesis.

Reference

Caron, G.E. and G.R. Powell. 1989. Cone size and seed yield in young *Picea mariana* trees. Canadian Journal of Forest Research 25: 351-358.

How Can Seed Tests Help Valuate Seeds?

submitted by Dave Kolotelo

This article will provide an overview on how the results of seed tests can help in the valuation of tree seeds. (This article also appeared in the Tree Seed Working Group News Bulletin No. 50 found at http://www.for.gov.bc.ca/hti/publications/tswg/TSWGNewsbulletin50.pdf).

It is intended to provide both the seed owner and the seed buyer with a better understanding of their product. The discussion provided will be general in nature, but examples will be provided in reference to the current BC Ministry of Forests and Range seed prices: http://www.for.gov.bc.ca/HTI/treeseedcentre/tsc/fees.htm#surplus and in the context of our seed use standards in BC (*Chief Forester's Standards for Seed Use*): http://www.for.gov.bc.ca/code/cfstandards/html/.

The most common and simplest valuation system is to sell seeds on a standard price per kilogram (kg) and the various adjustments to this based on seed testing results will be discussed.

The importance of seedlot moisture content for longevity of orthodox seed[1] is rarely questioned and even though most people recognize that seed weight is influenced by moisture content, this variable seems absent from seed valuations. The *Chief Forester's Standards for Seed Use* (*CFS*) states that for registration the moisture content (MC) must be between 4 and 9.9%, yet if we sell by seed weight the difference in moisture content is not accounted for. Does this really matter? Let's use Sitka spruce ($4000/kg) as an example. If a kilogram of seed was at 4% MC then the dry weight equivalent is 960 grams *vs.* 901 grams at 9.9 % MC. So, one kg can vary by as much as 59 grams of dry mass and for Sitka spruce this difference is equivalent to about $236/kg. The difference reaches its peak with western redcedar where the acceptable moisture content range can result in a $384/kg difference.

It is generally accepted that reduced moisture content will increase seed longevity, so the intent is certainly not to advocate moisture loading to increase the cost recovery of seed sales. It is simply one of the seedlot characteristics that varies and can easily be incorporated into pricing. Moisture content also contributes to differences in seed yield when presented as kg of seed per hectolitre (hl) of cones and a similar correction factor to those discussed can also be employed to standardize yield reporting.

The results of seed weight and purity tests will be discussed together as they both influence the number of seeds per gram which is a variable we use in British Columbia (BC) to calculate potential seedlings. The purity of a seedlot is simply the average proportion of a seedlot deemed to consist of pure seed. A purity of 99.0% implies that 990 grams out of one kg of seed will be pure seed and the remaining ten grams will consist of debris (inclusion of seeds of other species is quite rare, but also considered an impurity if applicable). The seed weight test is the average weight of 100 seeds (derived as the average of eight replicates) and is a method of quantifying seed mass.

To provide a more meaningful seed mass variable, seeds per gram (SPG) is used and calculated as the seedlot purity (%) divided by the average weight of 100 seeds. The higher SPG values represent the lightest seeds and vice versa. This is probably the largest and most important source of variation unaccounted for in seed valuation. I'll supply a few examples: for seed orchard produced coastal Douglas-fir, the SPG ranges from 106 to 68 indicating that there is a difference of 38 seeds available per gram or 38 000 seeds per kilogram. For natural stand lodgepole pine, the range is much greater (504 to 253) resulting in a difference of 251 000 seeds per kilogram! These examples illustrate the extremes for effect, but clearly show that attention to SPG can result in a much lower (or higher), but more realistic cost per seed compared to a standard price per kg. Certainly one consideration is whether there is a practical advantage in the use of larger seeds. I am not convinced that an advantage exists in terms of plantation success, but there are contradictory results in the literature. A good review is provided by Sorenson and Campbell (1985) and some additional comments are provided by Kolotelo (2000). An alternate view, along with different references, is provided by Castro et al (2008).

Seeds per gram, moisture content and germination capacity all influence the number of germinable seed.

[1] Seed that can be dried to low moisture content and stored at sub-freezing temperatures.

Instead of a basic seed price per kg a more encompassing variable would have seed price as a function of germinable seed.

If you believe that seed size is an important attribute to meet your objectives then you may be content paying more per seed based on a simple, unadjusted per kilogram cost.

Germination Capacity (GC) is the variable that has been used in seed valuation in BC. Currently, if a seedlot is below the species average then a price adjustment is applied using the specific seedlot germination as a proportion of the species average germination (seedlot GC/species GC). No cost adjustment is applied to above average germinating seedlots. The GC is the other variable along with SPG that is used in the calculation of potential seedlings and that may be a variable used to valuate seed. A simpler solution may be to use the GC and SPG variables independent of the relationship to potential seedlings. This could take the form of quantifying the **germinable seeds** represented as **(amount of seed [g]) X (SPG) X (GC/100)**. Instead of a basic seed price per kg of seed, this more encompassing variable would have seed pricing as a function of germinable seeds. A further refinement could be to account for the seedlot moisture content (as a decimal value in the equation) in terms of germinable seeds on an oven-dry (0%) or other standardized (i.e. 7%) moisture content. For oven-dry weight assessment the equation would expand to:

Germinable seeds based on dry weight = (amount of seed [g]) X (1-MC) X (SPG) X (GC/100)

This variable is intended to account for variability in seed attributes between seedlots. I believe the greatest benefit would be derived by integrating GC and SPG as these are the most variable results between seedlots. There is also variability within a seedlot and this has been quantified as the precision of germination tests and can be surprisingly high in some cases. Variability in SPG tests within a seedlot has not been similarly quantified, but as is common with our relatively wild tree species – variability should be the expectation.

In addition to the standard tests of seed characteristics, other variables may also aid in seed valuation. Fungal assay testing is one example, but valuation is complicated because the link between fungal occurrence (% contamination or infection) does not readily correspond to disease or loss of seedlings, but a quantification of potential risk. A seedlot with 10% *Fusarium* contamination has greater risk than a 2% seedlot, but the relationship may not equate to five times the risk. These relationships have not been well documented and unique nursery conditions could play the largest role in the risk of seedling loss.

Other variables such as Genetic Worth for growth or disease resistance may play an important role in seed valuation, but these values are not the product of a seed testing lab. There are several seed testing results that may improve the quantification of seed value to more closely reflect the number of germinable seeds and adjust for differences in moisture content. Hopefully, this will promote further discussion on seed valuation and a better appreciation of how seed test results practically impact the commodity value of each unique seedlot.

References

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Kolotelo, D. 2000. Differences in seed and seedling attributes between select (orchard produced) and standard (wild stand) seedlots. In Proc. 20th Forest Nursery Association of BC Annual Meeting. Tech. Co-ord. N. Wilder, P. Byman and C. Hawkins. Sept. 18-21, 2000. Prince George BC.

Sorenson, F.C. and R.K. Campbell. 1985. Effect of seed weight on height growth of Douglas-fir (*Pseudotsuga menziesii*) seedlings in a nursery. Can. J. For. Res. 28:418-426.

Interim Red Alder Seed Production Notes

submitted by Don Pigott

The demand for red alder seed used for reforestation has been relatively small compared to other species in British Columbia and the Pacific Northwest. More seed is used in restoration projects where it is often broadcast sown with various grass seed mixtures.

Recently however, there has been more interest in establishing red alder plantations, primarily due to industry demand for red alder logs and wood products. Planting in BC has increased in recent years to over 400,000 seedlings and could exceed 1,000,000 seedlings in the next few years. From 2008 to 2010 the sowing requests ranged from 133,000 to 208,000 seedlings.

Red alder seed has been historically collected from felled trees, climbing and clipping branches, and pruning from the ground with pole pruners. Trees as young as three years old can produce male and female strobili. Often, the best sources of cones, with the highest seed yield, are young stands (8-15 years old) of open grown trees adjacent to more mature stands which provide a larger pollen cloud.

In British Columbia, the Ministry of Forest and Range has recently made forward selections in one of the two alder provenance-progeny trials. Eighty-six parents were selected, cuttings taken and grafted at Cowichan Lake Research Station. The purpose is for preservation and establishment of a seed orchard. At present, as there are currently no seed orchards for red alder, little information is available on potential seed production. However, scion material has been collected from the top 19 parents in the Cook Creek provenance trial, and propagation is in progress to establish a small seed orchard for a private forest company. Gains as high as 29% could be expected.

2004 Collection at McKay Lake

In 2004, although it was generally a poor crop year for red alder coast-wide, it was necessary for us to make a few small collections to satisfy our client's needs.

One of these collections was at McKay Lake near Cassidy. The cones were collected from young roadside trees between 8 and 12 years old. The trees were 4-9 meters tall, and had a dbh range of 7-15 cm. Most of the trees were along the edge of an 8 year-old Douglas-fir plantation. As there were no major stands of red alder nearby, the young alder collected from probably originated from scattered parents within the harvested block. Less than 20% of the trees had any cones, less than 10% were considered to have collectable crops. Cones were collected from 42 trees using a 9-meter pole pruner, and one tree was cut down.

From these 42 trees, a total of 2.75 hectolitres of cones were harvested, yielding 1.765 kg of seed or 0.64 kg of seed per hectolitre of cones. Of the five collections we made in 2004 this was the lowest yield, the range being from 0.64 to 1.0 kg/hl, and an overall average of 0.68.

The average number of cones per tree was 6.5 litres, although the one tree that was cut down had 8.0 litres or 1934 cones. This nine-year old, open grown tree was 5.18 meters tall, and 11 cm in diameter at stump height. There were 1535 seeds per gram for this seedlot and the germination was 83%.

Pre 2004 Collections

Table 1 shows some species average data to illustrate relative yield and quality expectations. The McKay collection is in bold.

Recently there has been interest in establishing red alder plantations, primarily due to industry demand for red alder logs and wood products.

SOURCE	YEAR(S)	No. of Collections	% GERM	SEEDS/ GRAM	KG/HL
McKay Lk. (YPP)	**2004**	**1**	**83**	**1535**	**0.64**
British Columbia	1994 -2004	10	80	1540 (1320-1903)	1.06 (0.34 - 1.74)
YPP	2004	5	73	1523	0.68 (0.25 - 1.00)
YPP	2001	9	71		1.53 (1.00 -2.04)
Seeds of Woody Plants	1974	unknown	56	(844 –2300)	(0.12 – 1.39)

Table 1. Average data to illustrate relative yield and quality expectations of red alder seed. The McKay collection is in bold.

Sowing Factors and Nursery Practices

In 2006 there are approximately 421,000 seedlings being sown through the sowing request system (SPAR). Of these, 413,000 are being grown as 0.5+0 –0.5+0 (half/half's) in 310 containers. The seeds are usually sown in March in these small containers, and the seedlings subsequently transplanted to the field in early July, where they are grown until they are lifted for planting. The advantages are, that you are able to produce a larger stock type in one year, and the opportunity for inoculation with *Frankia* are much greater in the field.

The other 8000 seedlings are being grown in 410 containers. Nurseries that grow red alder seedlings, sow the seed at the following rates;

- greater than 80% germination: 3 seeds per cavity, and a 30% oversow.
- greater than 70% germination: 4 seeds per cavity, and a 30% oversow.

Seed Production Requirements & Estimates

Determining the size for a red alder orchard will be difficult.

Determining the size of an orchard, or the number of ramets required, to produce enough seed to supply any reforestation program, for any species is difficult enough, but even more so with a species such as red alder for which no one has any experience. In the early 1970's, I remember discussing with Joe Wheat of the I.F.A the detailed methodology he used to use to determine the size of their Douglas-fir orchards. He concluded with, "and when we finally arrived at the size of the area we felt we needed, we doubled it".

To err on the conservative side, I will use the data from the McKay Lake collection for demonstration purposes. In the following table there are four different scenarios.

Table 2 shows that even in the worst case, it will require a relatively small number of ramets to produce one million seedlings in any given year. If we were to use the Joe Wheat "rule of thumb," and doubled the number of ramets, assuming there will be smaller crops in the early years, and perhaps reasonable crops every other year, the size of an orchard will not need to be very large.

Summary

The demand for red alder lumber has increased significantly in the past 20 years. As there are concerns about the wood supply, there is considerable interest in the establishment of managed plantations to produce high quality logs primarily for furniture manufacture. If we can overcome the reluctance to accept red alder as a preferred species on some sites, the demand for seed would increase. High gain genetic material is available now, and because red alder produces abundant seed at an early age, only small orchards are needed to meet projected seed requirements.

A	B	C	D	E	F	G	H	I	J	K
SEEDS/ GRAM	% GERM	SEEDS/ CAVITY	OVER -SOW	NURSERY FACTOR	KG/HL	SEEDLINGS PER KG	SEEDLINGS PER HL	LITRES OF CONES/ RAMET	SEEDLINGS PER RAMET	RAMETS REQ'D FOR 1,000,000
1 535	80	3	1.30	1.08	0.640	364 435	233 238	6.5	15 160	66
"	"	"	"	"	"	"	"	5	11 661	86
"	"	"	"	"	0.500	"	182 217	5	9 110	91
"	"	"	"	"	"	"	"	3	5 466	183

Table 2. Four different scenarios for red alder seed production.

Figure 1. Red alder along the edge of 8 year old Douglas-fir plantation.

Figure 2. .Young red alder stand at McKay Lake. Note pruned trees.

Conserving Native Tree and Shrub Species *In Situ*: Testing the Predictions

submitted by Jodie Krakowski

Grand fir and cascara can be used as model species to draw inferences about species distributions with similar habitats and/or life history traits, as non-commercial species have very limited inventory data..

Update on genetic conservation reports

In the December 2008 edition of TIC*talk*, two related projects were reported that summarized the genetic conservation status of British Columbia's forest genetics resources (Krakowski and Chourmouzis 2008). We are pleased to note that Technical Report 053 on *in situ* conservation in protected areas is available for download at: http://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr053.htm, and the companion Technical Report 054 on the status of commercial species is available at: http://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr054.htm.

Pilot study to verify predictions of TR053

Background

In the 2009 field season, a pilot study was initiated to develop methods to test the predictions behind Chourmouzis et al. (2009) for selected species with conservation gaps. Two species were chosen for this pilot: grand fir (*Abies grandis*) and cascara (*Rhamnus* syn. *Frangula purshiana*). Both occurred in two coastal and two interior BEC zones (CDF, CWH, IDF and ICH), and conveniently, often together or in similar habitats. This allowed me to test the prediction accuracy for one large, wind-pollinated and dispersed, continuously distributed conifer and one insect-pollinated, patchily distributed deciduous shrub. These can be used as model species to draw inferences about species distributions with similar habitats and/or life history traits, as non-commercial species have very limited inventory data.

Methods

The temptation for extensive wandering throughout BC's spectacular protected areas network was hard to resist. But being diligent and scientific, the investigations were limited to the two species, four BEC zones, and parks where they were predicted to occur. Parks were surveyed slightly beyond the mapped species' distributions, since predictions were based on BEC 4, and considerable adjustments have since been made with current mapping, especially in the coast-interior transition and the west Kootenays. Maps provided by Tree Improvement Branch helped guide sampling.

Permits were obtained and nearly 120 national, provincial, regional, and municipal protected areas were sampled. Populations of mature grand fir or cascara were large enough to collect data from in 88 parks across 18 BEC variants. Transects with defined areas were established, targeting locations where the species were most abundant. This provided an upper bound for population estimates, allowing habitat to be stratified into suitability categories.

Since efficiency is the order of the day, other minor species were noted in each park to guide future sampling. To support the Range Division of Ministry of Forests and Range (MFR), data on invasive species was collected, helping fill a critical data gap in the provincial Invasive Alien Plant Program database. Range Division, Ministry of Environment (MOE) Environmental Stewardship Division, local and regional governments, and the Coastal Invasive Plant Council were all pleased to get free data, as their crews were cut drastically this year. This data will be used to manage alien species and maintain the ecological integrity of our parks.

Densities and expected population sizes (Ne) were calculated by BEC unit for each protected area. The threshold of Ne>1000 corresponds roughly to a population of 5000 mature trees for typical conifers, the minimum for conserving the genetic resources of a population *in situ* over the long term. Predicted and observed population sizes were compared for each park.

Results

Grand fir was far less abundant than predicted in the CDF, CWH, and IDF, and more common than predicted in the ICH. Many parks in the interior, particularly the IDF, had no grand fir where it was predicted; with BEC 7 those parks are predicted to have none. Some inventory records turned out to be amabilis fir. Only a small proportion of protected areas had populations >5000. Whether 5000 mature trees are really needed to capture this range of diversity is difficult to say as no genetic markers have been studied for grand fir populations. Ne of 1000 could be captured by fewer trees, depending on the mating system; amabilis fir has population substructuring caused by mating among relatives, but not selfing (El-Kassaby et al. 2003). Grand fir grows in a restricted area on a narrow range of site types with gentle topography, fresh to very moist soils, and well to imperfectly drained, mesic to richer sites. Including these features in the model would improve the prediction accuracy substantially.

Predictions of cascara had little relationship to where or how abundant it actually was. Its distribution has distinct boundaries and there were almost no areas that supported a population >5000. No genetic data exists for this species, but related species and those with comparable life history traits have been studied, implying that more genetic diversity is partitioned across populations than for conifers due to high pollen and seed gene flow. Cascara's life history traits affect population differentiation patterns that may support adequate genetic diversity at a lower threshold. Cascara is restricted mostly to wetland margins, sites with fluctuating water tables, and disturbed mesic to richer sites. Adding these features to the model should improve the prediction for this and associated species with similar habitats.

Figure 1. Grand fir stand at Champion Lakes Provincial Park in the ICH. Some subalpine fir was also present.

Figure 2. A dense thicket of cascara at Westwood Lake Park in a disturbed lakeside site in the CWH.

Grand fir was far less abundant than predicted in the CDF, CWH, and IDF, and more common than predicted in the ICH. Predictions of cascara had little relationship to where or how abundant it actually was.

Follow-up plans

When funding is available next year, sampling throughout the CDF would confirm the conservation status of many species with predicted gaps. The southern Okanagan BG/IDF/PP zones would be the next candidate area to sample several species simultaneously and cost-effectively. Detailed mapping projects from forested zones in these areas are being added to the geodatabase to improve the accuracy of species range maps and field sampling.

Cataloguing *in situ* resources: the next generation

With the support of the Integrated Land Management Bureau and Tree Improvement Branch, a geodatabase combining layers such as ecological project data, tenure, protected areas, topography, land inventory and classification, and age class structure is being assembled. This data set will support the next iteration of this project. The current analysis is based on data up to 2001 and changes in the status of protected areas, tens of thousands of new georeferenced ecosystem plots, and refinements in BEC 7 support improved accuracy of predictions and make field verification far more efficient. Results from common widespread commercial species will likely be similar, but those for minor species and those with restricted ecological niches will likely change, and may affect their conservation status. Revising this analysis approximately every 10 years allows us to gauge changes based on the current benchmark for population representation in protected areas.

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Online Decision Tool to Assist with Deploying Weevil-resistant Sitka Spruce on Vancouver Island

submitted by Jodie Krakowski

Background

Weevil-resistant Sitka spruce seed production has now grown to meet projected demand of around 3 million plantables per year. Planting remains below half a million, in part because the default stocking standards emphasize weevil damage as a problem when spruce is selected for planting. Spruce has been downgraded in some site series from preferred to acceptable and in others from acceptable to not acceptable. Under *FRPA*, licensees have the flexibility to develop their own stocking standards to meet Forest Stewardship Plan objectives. Departures from the default may be justified using empirical studies supporting the decision.

Open-pollinated resistant seed from superior provenances is 50-70% more resistant (i.e., lower mean annual weevil attack rates: King and Alfaro 2009). Available F1 seed is up to 90% more resistant than wild stand seed. By the time trees outgrow weevil susceptibility, they will have suffered far fewer attacks and hence have much better form and height growth than unselected material.

While foresters may be hesitant to assume the risk to their plantations associated with planting spruce, much of this risk can be mitigated by not only planting resistant material, but by planting it in sites that have lower hazard for weevil attacks. This was quantified in 55 plantations and naturally regenerated stands of Sitka spruce around Vancouver Island. Ecological and stand factors were assessed and factors associated with weevil attack severity were quantified. Attack severity categories were chosen because they were closely correlated with cumulative attack rates, and better expressed the actual impact on growth and form, since some trees may be attacked but recover without much damage.

Tool development

The currently accepted model of McMullen (1976) was tested by comparing degree days above 7.2°C with attack severity. Degree days above 7.2°C for the range of Sitka spruce were calculated by interpolating climate station data and correlating degree days with output from ClimateBC. The misclassification rate was quite high based on this model, suggesting: 1) other factors also contribute to hazard, 2) 888 might not be the best threshold to distinguish categories, or 3) this model might be overly simplistic in terms of only distinguishing 2 hazard levels.

Degree days was a significant influence on attack severity, but only explained 9% of the effect – 11% after adjusting for the fog belt. Several hazard categories were delineated, with intermediate levels (i.e., low to medium and medium to high). A number of other site factors were significant, including soil nutrient regime, slope, substrate cover, and stand or regeneration density, explaining over 50% of weevil hazard at a site. The most important were incorporated into an online decision tool to provide guidance for foresters to support deployment of Sitka spruce: http://www.for.gov.bc.ca/hre/forgen/projects/SpruceWeevil/.

Using the web tool

The tool is simple to use, and starts with a degree days calculator based on the site coordinates. The degree days value for the site provides the baseline hazard. Next, the baseline hazard category is adjusted up or down based on the various site factors associated with higher or lower hazard. The influence of each factor is explained in more detail by clicking on each hyperlink.

Under *FRPA*, licensees have the flexibility to develop their own stocking standards to meet Forest Stewardship Plan objectives. Departures from the default may be justified using empirical studies supporting the decision.

Available F1 seed is up to 90% more resistant than wild stand seed. By the time trees outgrow weevil susceptibility, they will have suffered far fewer attacks and hence have much better form and height growth than unselected material.

Silvicultural guidance for Sitka spruce is provided for low, medium, and high hazard categories. For sites with high (or medium-high) hazard, consider alternative species if timber production is the primary objective. Even with 70% reduction in attack rates from superior provenances, trees will still be attacked frequently enough to impair their form. For other sites, plant resistant Sitka spruce following the guidance.

Other applications

Foresters on the north coast have expressed strong interest in evaluating site hazard to support with deploying Sitka and hybrid Sitka spruce over a wider range of sites. Currently stocking standards list very few preferred or acceptable species in the region, and stands are being converted from mature spruce to immature pine. Delineating suitable sites would provide more silvicultural flexibility and resilience across the region. Conducting a project similar to this one on the north coast would support this objective.

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State of British Columbia Forest 2010 Report: Assessing the Genetic Diversity of the Province's Managed Forests

submitted by Leslie McAuley and Michael Stoehr

The State of British Columbia's Forests is a provincial, sustainable forestry report that provides information periodically about BC's forests in three categories: environmental, economic and social, and governance and support. It contains objective, statistical information in each of these areas, along with the ministry's assessment of what that information tells us about sustainability. The report is produced by the Ministry of Forests and Range, which has a long history of reporting to the public on the condition and management of its forest and range lands. The State of British Columbia's Forests continues this tradition as it monitors, assesses, and reports on the main components of sustainable forest management in British Columbia.

Assessing the Genetic Diversity of BC's managed forests is one of the criteria.

Scorecard
Indicator: Genetic Diversity

State: Good
Maintaining genetic diversity is critical to the health, productivity, and adaptation of forest tree populations and ecosystems. The current state of BC's forest tree genetic resources is 'Good' with provisions in place to encourage sound genetic resource management across British Columbia.

Trend: Mixed
Although forest tree species are well represented in British Columbia's network of protected areas, there is increasing uncertainty due to climate change and associated ecosystem stress. The current trend is 'Mixed', however, the Genetic Resource Management (GRM) Community of Practice's early response to observed and anticipated climate change impacts has been less encouraging.

Information: Partial
Information is rated as 'Partial' given the need for new indicator measures to assess the vulnerability of the province's forest tree genetic resources due to climate change impacts. GIS based forest genetic analyses are being undertaken to support the development of interim policies, climate change adaptation strategies, and a climate-based GRM decision support framework.

Changes since 2006

Changes to assessment scores (since those previously reported in 2006) were made to the Information category (revised from 'Adequate' to 'Partial'). This change reflects the need for new information to address climate change. No revisions were made to State or Trend.

Key Questions[1]

Four **key questions** were posed for each indicator measure:

Genetic Conservation

How well conserved are the genetic resources of trees?

Genetic Resilience (Variation)

What is the level of genetic diversity in regenerated forests?

Genetic Resilience (Diversity)

What is the proportion of forest regeneration by genetic source?

Genetic Resilience (Adaptation)

What is the extent and source of genetic variation in forest regeneration across the province?

Data and Methods

Updates were based on a **GIS-based analysis and data summaries** of seed selection, use and deployment based on forest (silviculture) opening data reported in the Reporting Silviculture Updates and Land Status Tracking System (RESULTS) from 1970 to 2007. Regeneration data is also tracked spatially at the forest (silviculture) opening level using RESULTS and the Vegetation Resources Inventory system (VRI).

Reporting

Four key indicator measures were updated in the 2010 edition of the BC State of the Forest Report. Two of the key indicator measures (6-3 Genetic Resilience (Diversity) and 6-4 Genetic Resilience (Adaptation)) were updated through FGC Genetic Resource Decision Support subprogram support and funding from the Forest Investment Account (FIA).

Genetic diversity, a fundamental component of biological diversity, is required for adaptation and evolution.

1 Genetic Value is assessed in the SOF 2010 Report - Silviculture indicator; see Timber Volume Gain (select seed use).

Tracking the extent and source of genetic variation is important for conservation purposes and understanding the adaptability, resilience and productivity of forests in a changing climate.

Indicator 6-1 Level of conservation of forest tree genetic resources.

Cataloguing of the province's forest tree genetic resources continues to be a priority as part of an overarching forest tree genetic conservation strategy for the province. Field verification of tree species and ecosystems in protected areas is currently underway to support catalogue updates. In 2008, whitebark pine was added as a provincial blue-listed species as it is considered at risk due to high mortality from blister rust, the mountain pine beetle, climatic warming and successional replacement.

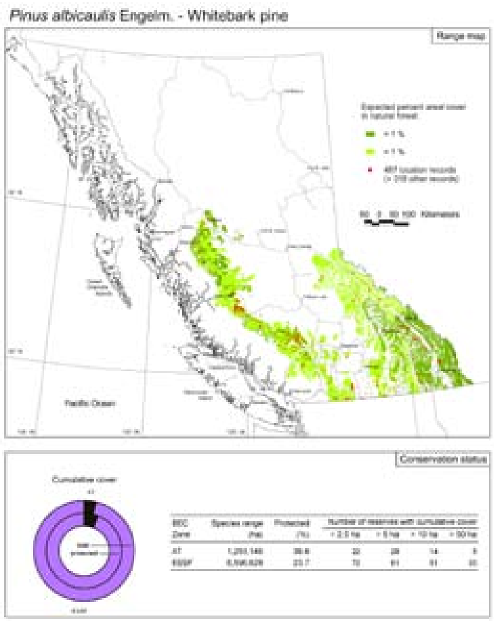

Figure 1. Example of genetic resource conservation information, whitebark pine.

Indicator 6-2 Level of genetic variation in regenerated forests.

Genetic diversity is genetic variation within individual organisms, within populations and among populations and species. Planted forests, where trees are grown from seed obtained from seed orchards, have similar or higher genetic diversity to naturally regenerated forests. Between 2004 and 2008, the genetic diversity estimated for orchard seedlots, expressed as a percentage of the total genetic diversity found in natural populations, ranged from 98.26 to 98.68 percent.

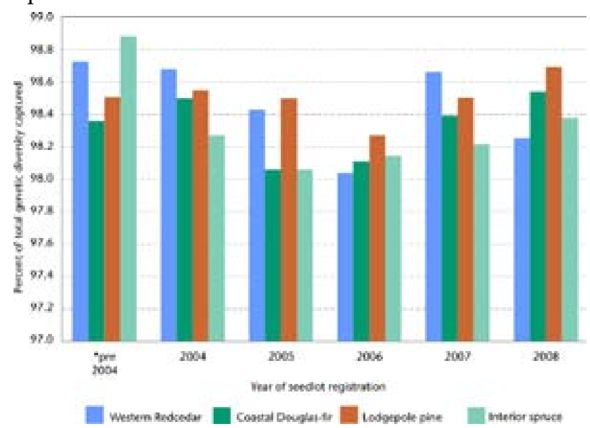

Figure 2. Genetic diversity in orchard seedlots of four tree species over six time periods

Indicator 6-3 Proportion of regenerated forests by genetic source (1970 – 2007).

Seed use trends continue to see a range of genetic sources used in forest regeneration. Legislation requiring the use of the best genetic material increased the use of select seed from 12% (27,004 hectares) of the total area reforested in 1995 to 46% (82,511 hectares) in 2007.

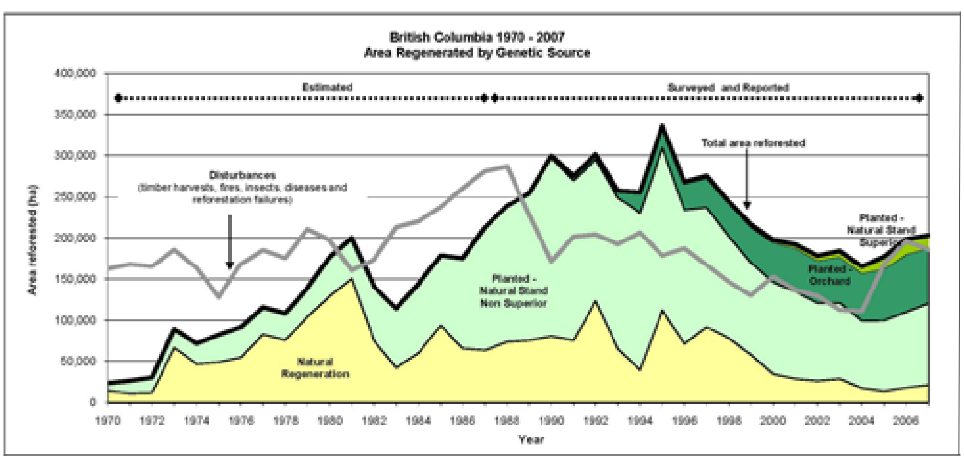

Figure 3. Area disturbed, naturally regenerated, planted with natural stand non-superior seed, planted with natural stand superior seed, and planted with orchard seed, 1970-2007.

Indicator 6-4 Extent and source of genetic variation in forest regeneration across the province: 1970 – 1987 and 1988 to 2007.

Seed deployment trends indicate an increase in genetic sources used through planting, including natural stand superior provenance and orchard seed sources. The percentage of forest (silviculture) opening spatial data is also increasing as we move forward in time (approximately 70% of the total forest and silviculture openings are spatial).

Contact Information

To view and download the State of the Forest Report, see http://www.for.gov.bc.ca/hfp/sof/. Online publication of the 2010 State of the Forest Report is planned for summer 2010.

For more information on indicator development and assessment contact: Leslie McAuley, (Leslie.Mcauley@gov.bc.ca) or Michael Stoehr (Michael.Stoehr@gov.bc.ca). For information on report publication, contact: Pat Martin, State of the Forest 2010 Report, project lead (Pat.Martin@gov.bc.ca).

Note: Geodatabase development and GIS analysis was provided by Dave S. Coster, RPF, Senior Resource Analysis Manager, TECO Natural Resource Group Limited (formerly Timberline Natural Resource Group Ltd.) RESULTS data extracts were provided by Mei-Ching Tsoi, contractor; and, natural regeneration SQL queries were provided by Rocky Yee, Programmer Analyst, Information Management Branch, MFR.

Genetic adaptation is increased through applying appropriate regeneration choices and seed transfer standards across the landscape.

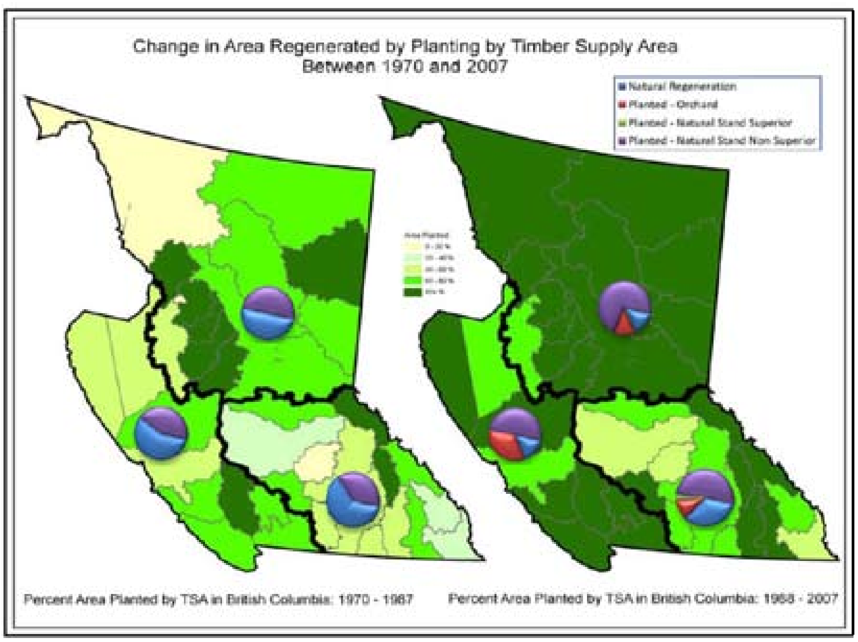

Figure 4. By Timber Supply Area, the percent of harvested area that was planted in 1970-1987 and 1988-2007. Pie charts depict the proportion of area reforested by forest region by natural regeneration, planting with seed orchard seed, planting with superior natural stand seed, and planting with non-superior natural stand seed.

Western Larch Policy Amendments, June 2010

submitted by Lee Charleson

Expand the seed transfer limits of western larch (*Larix occidentalis*).

On June 3, 2010, in accordance with requirements and authorities provided under section 169 of the *Forest and Range Practices Act* (*FRPA*), section 43 of the *Forest Planning and Practices Regulation* and section 32 of the *Woodlot Licence Planning and Practices Regulation*, Jim Snetsinger, Chief Forester, amended the *Chief Forester's Standards for Seed Use.*

The purpose of these amendments are to expand the seed transfer limits of western larch (*Larix occidentalis*) to increase species diversity, and address the potential forest health and productivity impacts associated with a changing climate. Specifically, they provide for the range and population expansion of western larch beyond its contemporary range (historical and current climate envelopes) in areas projected to be climatically suitable in the year 2030.

The amendments make provisions for agreement holders to plant up to 10% western larch seedlings (or, up to 5,000 western larch seedlings for small operators), of the combined total number of seedlings planted each year. They apply to western larch orchard seedlots only and those seedlots suitable for use in new western larch tested parent tree seed planning zones, LW1, LW2 and LW3, will be identified on the Seed Planning and Registry (SPAR) system. Tree Improvement Branch will provide training regarding the changes in various forums including two on-line sessions on September 21 and September 29, 2010. For registration and additional information on those sessions, please see the main page of the Tree Improvement Branch website at http://www.for.gov.bc.ca/hti

The western larch seed transfer changes are based on recent scientific research and analysis conducted by Dr. Gerald E. Rehfeldt (USDA Forest Service, retired) and Barry Jaquish (MFR, Research, Innovation and Knowledge Management Branch), as reported in their publication, "Ecological impacts and management strategies for western larch in the face of climate change" (March, 2010, Mitigation and Adaptation Strategies for Global Change; ISSN 1381-2386, Volume 15, Number 3); feedback solicited through stakeholder consultation; and analysis undertaken by ministry staff.

These amendments align with the BC Climate Action Secretariat's vision to "make adaptation a part of the BC Government's business, ensuring that climate change impacts are considered in planning and decision-making across government". They also will serve as "interim measures" prior to the development of the climate-based tree species selection and seed transfer decision support system over the next two to five years.

These western larch seed transfer amendments come into effect on October 3, 2010, four months after notice was published in the Provincial Gazette on June 3, 2010. This four month notification period is required under section 169 of *FRPA*. However, persons may waive this notification period in accordance with section 169(4)(b and c(ii)) if they so choose.

To view and download the "Range and Population Expansion of Western Larch (2030) Climate Change" maps (Version 1.0) see: http://www.for.gov.bc.ca/ftp/HTI/external/!publish/Western_Larch_Interim_Measures_2010/LW1_LW2_LW3_overview_pdfs/. Spatial data (i.e. shape files), for the purposes of operational seed use, is available upon request by contacting Matt LeRoy (email: Matthew.LeRoy@gov.bc.ca or phone: (250) 387-4836).

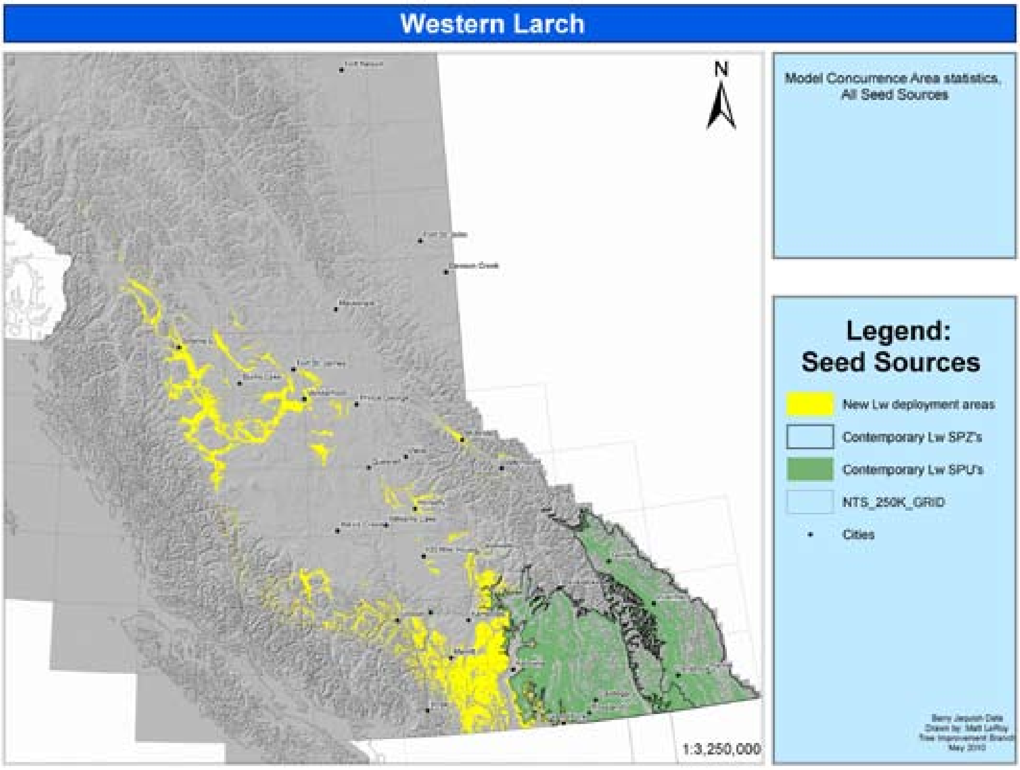

Figure 1. Seed planning zones LW1, LW2 and LW3 are combined to show the overall extended footprint for western larch areas of use.

Tree Improvement Branch will provide training.

Speculation about the 'Dioryctria Disaster' that Occured in North Okanagan Seed Orchards in 2004 - Are We Ready for a Future Invasion?

submitted by Jim Corrigan

...the total value of the 2004 crops losses was figured to be roughly one million dollars across all North Okanagan locations.

In this episode of 'Tales from the Seed Orchard Crypt,' I speculate about the devastating crop losses that took place at a number of North Okanagan locations during the 2004 growing season. These events occurred two years before I moved to British Columbia, and my musings are based on observations made twenty years ago in the conifer forests of eastern Newfoundland. Despite the ephemeral nature of the 'data' discussed in this report, I hope my retrospective interpretation can help prepare us for the next time that the fir coneworm, *Dioryctria abietivorella* [Lepidoptera: Pyralidae], invades BC's Interior seed orchards in force.

Although they commonly are called fir coneworms, populations of *D. abietivorella* attack most conifer species. The larvae are extremely destructive, burrowing inside cones, eating and/or damaging most of their seed contents (Figure 1). Often a larva will attack more than one cone; individuals readily move from a damaged cone to its neighbours to complete their immature development.

Figure 1. Frass build-up on a spruce cone in Kalamalka Seed Orchard 305, late July 2009. This is a characteristic indication of attack by the fir coneworm, *Dioryctria abietivorella* [Lepidoptera: Pyralidae].

During the 2004 growing season, very large populations of the fir coneworm suddenly appeared in many seed orchards located around the North Okanagan. The Vernon Seed Orchard Company (VSOC) estimated that they lost 80-90% of their Douglas-fir production to the coneworms, and also experienced Dioryctria-based damage to 55-60% of the cones in several of their spruce orchards. Pacific Regeneration Technologies (PRT) lost 60-65% of their Douglas-fir crop to these insects. Although the spruce crop at Eagle Rock was too small to be harvested in 2004, Greg Pieper felt that over half of these cones had been hit by fir coneworm. At Kalamalka, Dioryctria larvae were responsible for 40% losses to their spruce seed harvest, and destroyed about 23% of their larch crop. Chris Walsh estimated that $70,000 worth of seed was destroyed in a single Kalamalka spruce orchard (306), and the total value of the 2004 crop losses was figured to be roughly one million dollars across all North Okanagan locations.

When shipments of infested cones were sent for processing at the Tree Seed Centre (TSC), huge numbers of fir coneworm larvae were evident in cones, cone sacks and in the seed processed from these lots. The Dioryctria larvae greatly complicated the separation process; batches of infested seed had to be placed at -20ºC for several days to kill the larvae, after which additional cleaning was needed to remove dead larvae and damaged seed from the batches.

Figure 2. Two (of many) late-instar Dioryctria larvae found wandering over the cone sacks in the Kalamalka cone storage sheds in late August of 2004. Photograph by Chris Walsh.

There was no advance warning of these invasions. Coneworm damage was mentioned only twice in Seed Orchard Pest Survey Reports from 2000-2004. Both citations (2001, 2004) concerned small amounts of damage seen in the white pine orchard at Bailey Road. The Douglas-fir orchards at VSOC and PRT were just coming into commercial-level production, so no crop history was available for them at the time of the coneworm invasions. However, there was no historical record of significant losses to Dioryctria in spruce, although spruce crops had been harvested at Kalamalka for over fifteen years and at VSOC for a decade prior to 2004. The devastation of 2004 seemingly had come out of nowhere, and the magnitude of the seed losses was unprecedented in the history of any interior seed orchard operation.

I have been haunted by stories of the 2004 crop disaster since I started working in BC's interior seed orchards, hearing many tales of hordes of *D. abietivorella* larvae leaving the cone sacks and marching across the parking lots at Kalamalka and the TSC (Figure 2). From a management perspective, I wondered where these huge populations had come from and whether pest managers would be any better prepared to deal with them if (or when) they re-appear en-masse in a future growing season.

Last summer, Caroline Whitehouse, a graduate student working on *D. abietivorella* in Ward Strong's lab, gave me a paper describing a fir coneworm epizootic[1] that took place in Newfoundland in the late 1980's (Mosseler et al. 1992). The paper focused on cone damage occurring in populations of red pine, *Pinus resinosa*. This species is described as occurring in "small isolated stands" in Newfoundland's forests. Such a description could be used to characterize BC's conifer seed orchards in relation to our natural forest ecosystems, so I read the paper with great interest. Below, I quote sections of the abstract and conclusions from this article.

From the Abstract:

"During 1989 and 1990, the fir coneworm, Dioryctria abietivorella (Grote), infested the entire cone crop in two of six natural red pine stands in eastern Newfoundland while the average incidence of coneworm in the remaining four stands was 89% in 1989 and 83% in 1990."

"Following a bumper cone crop in all conifers in 1988, high numbers of fir coneworm became concentrated in red pine which had produced consistently good cone crops for 3 consecutive years, while cone production has been sporadic in other conifers."

[1]An epizootic is a disease that appears as new cases in a given animal population, during a given period, at a rate that substantially exceeds what is "expected" based on recent experience (i.e. a sharp elevation in the incidence rate). Epidemic is the analogous term applied to human populations.

...there was no historical record of significant losses to Dioryctria in spruce, although spruce crops had been harvested at Kalamalka for over fifteen years and at VSOC for a decade prior to 2004.

The losses seen in red pine in eastern Newfoundland (80-100%) were similar in magnitude to those experienced in our interior Douglas-fir orchards in 2004.

From the Conclusions:

"The outbreak of fir coneworm in red pine may be related to the bumper cone crop that occurred in other conifers in 1988. With the exception of red pine, this bumper crop was followed by poor cone crops in the other native conifers in 1989 and 1990."

What similarities do I see between a pest situation that took place in the natural forests of eastern Newfoundland and the severe attacks recorded in 2004 in some North Okanagan seed orchards? Although there are some unresolved taxonomic issues, the same or a closely related pest species was responsible for the damage in both cases. The losses seen on red pine in eastern Newfoundland (80-100%) were similar in magnitude to those experienced in our interior Douglas-fir orchards in 2004. There was a sudden, unpredicted onset of heavy cone damage in both situations. Most significantly, the authors felt that the damage observed in red pine was the result of fluctuations in cone production of other conifer species located around the stands under study.

While most North Okanagan seed orchards are immediately surrounded by grassland ecosystems, the hills that enclose the northern end of the valley are densely forested with conifers. These stands host substantial populations of Douglas-fir, a species whose cones are readily attacked by *D. abietivorella*. I speculate that a bumper cone crop was produced in the hills surrounding the North Okanagan in 2003 and that these cones were heavily attacked by fir coneworms. Robb Bennett has provided some observational support for these speculations. In his travels around the interior, he felt that Dioryctria populations were building up in interior forests for several years before the 2004 invasions of our seed orchards.

As had occurred in Newfoundland in 1989, a collapse of cone production in the natural forests in 2004 would have caused large numbers of Dioryctria adults to disperse to the nearest trees that were bearing good cone crops. In the grasslands of the North Okanagan, the majority of these cone-bearing trees would have been located inside seed orchards.

If my speculations have any merit, they might explain the sudden and dramatic appearance of a pest species that only had been detected in trace amounts in our seed orchards in every year before 2004, including the season that immediately preceded it. These insect populations had to come from somewhere. It seems unlikely to me that such large, damaging populations could have remained undetected in our seed orchards in earlier years, or that the explosion of insects seen in 2004 could have sprung out of the relatively small numbers that were thought to reside in our orchards. The sudden, unprecedented occurrence of huge populations of *D. abietivorella* in our seed orchards in 2004 is the basis for my speculative comparison of the BC situation to what was observed in Newfoundland in the late 1980's.

It is one thing to know that a pest species only occasionally reaches damaging population levels, another to detect an infrequent 'bad year' before significant crop losses can take place. What measures do we now have in place to prevent substantial seed losses in the event of another mass invasion of the fir coneworm into BC's interior seed orchards?

For several years, pest management personnel at all interior locations have been encouraged to conduct regular in-season monitoring surveys to enumerate the amount of pest damage occurring to their cone crops. Detecting Dioryctria damage is easily done through non-destructive visual observations of the cones (Figures 1, 3). In the spruce and larch orchards at Kalamalka, Dioryctria infestation rates have not risen above 5% since 2004. The same cannot be said for the Douglas-fir orchard at Bailey Road. In 2009, Judy Murphy found a Dioryctria attack rate of 25% in several rows that were left as unsprayed controls. In discussions with Hilary Graham of PRT, Dan Gaudet and Tia Wagner of VSOC, everybody asserted that fir coneworms were an annual management issue in their Douglas-fir orchards. The current control regime is to apply one or two sprays of the systemic insecticide Dimethoate (trade name Cygon) to these ramets in every growing season.

Figure 3. The small amount of frass seen towards the base of this Douglas-fir cone is indicative of early attack by the fir coneworm. The photo was taken on June 1, 2007.

So, examination of Douglas-fir seed orchards might not give us an indication of an upcoming bad year for Dioryctria, as one would find damaging populations of fir coneworm in these orchards in most growing seasons. In contrast, similar surveys done in spruce and larch orchards should indicate when we are about to enter a 'Dioryctria nightmare' year. Obviously, infestation rates would be well above 5% during such a season. Our pest monitoring experts are able to detect coneworm attacks on cones virtually as soon as the larvae start to feed on them (Figure 3). In a season when attack rates in spruce or larch were observed to be well above 5%, we would get early warnings of a potential 'nightmare' year for fir coneworm. By timing monitoring efforts to coincide with early larval feeding, pest managers still would have plenty of time to get systemic insecticide sprays on potentially affected orchards in order to preclude major crop losses.

This is the 'insurance' aspect of annual pest monitoring programs. In many years, these efforts might appear to be wasted, as no significant pest problems are detected. However, it is critical to do regular pest monitoring in our seed orchards, and to keep these records in a format where year-to-year comparisons are easily made. Such records provide the best way to detect a 'blip' that would indicate that an usually minor pest species was going through a destructive population surge. As seen from 2004, the losses incurred in a single bad year can far exceed the costs of decades of pest monitoring efforts.

In the case of *D. abietivorella*, early detection of unusually large coneworm larval populations in spruce or larch seed orchards should be taken as very strong indications that 'this could be the year,' and provide a rationale for quick and decisive action to protect seed crops. With routine annual pest monitoring systems in place, I feel that we are better prepared to detect the 'next one' in a timely manner, and should be able to avoid the kinds of dramatic crop losses caused by fir coneworm in 2004.

Acknowledgements

I would like to thank Chris Walsh, Gary Giampa, Ward Strong, Robb Bennett, Hilary Graham, Tia Wagner, Dan Gaudet, Greg Pieper, Debbie Picard, Dawn Stubley and Dave Kolotelo for sharing their recollections of the 2004 Dioryctria disaster with me. Chris Walsh reviewed and improved early drafts of this article. Thanks to Caroline Whitehouse for showing me the Newfoundland paper, and to all of the pest management workers in the Interior seed orchards whom, through their diligent work, help to keep us safe from the 'next one.'

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By timing monitoring efforts to coincide with early larval feeding, pest managers still would have plenty of time to get systemic insectide sprays on potentially affected orchards in order to preclude major crop losses.

Land Purchased to Expand Skimikin Seed Orchard

submitted by David Reid

This new orchard should start to produce seed within five years and eventually will produce enough seed for 7.5 million seedlings per year.

Tree Improvement Branch (TIB) is pleased to announce the acquisition of almost 15 hectares of unmanaged farm land to the Skimikin Seed Orchard (SSO) site. The formerly private farm land adjacent to Skimikin Seed Orchard was purchased to support the need for additional lodgepole pine (Pli) orchards, as identified in the Forest Genetics Council of BC business plan. This new land will be the future home of the new western gall rust naturally resistant lodgepole pine seed orchard for the Prince George low Seed Planning Unit.

This acquisition represented one of the most significant and complex land acquisitions the BC Forest Service has undertaken in the past two decades. The acquisition process was started in December 2007 and was anticipated to be completed by March 2009, but various regulatory group inspections, approvals, and other extenuating circumstances extended the completion to August 2009. Fortunately, in these difficult economic times, funds used to purchase this land were accrued from last fiscal year's (2008-09) MFR budget.

Some of the many benefits this new land brings include significant cost and time savings over traditional land clearing for new orchards which means faster orchard establishment with improved disease resistant seed being provided years sooner. Also, by not clearing forest land for the new orchard, carbon emissions were significantly less as the new land is cleared, unmanaged grassland.

Skimikin Seed Orchard staff, upon transfer of the ownership in August, immediately began preparing the site and the new orchard was fully planted with 5,000 young lodgepole pine grafted seedlings (that were being grown in a nearby holding bed) by the end of October. This new orchard should start to produce seed within five years and eventually will produce enough seed for 7.5 million seedlings per year.

Many thanks go to Skimikin staff Keith Cox and Karen Turner for initiating this project, former TIB Business Operations Manager Keith Thomas, and in particular to Cheryl Wirsz, Real Estate Project Manager, with the Ministry of Forests and Range Resource Tenures Branch Real Estate Operations Group, whose involvement was instrumental to the success of this project.

Figure 1. Tree Improvement Branch Director Brian Barber and Skimikin Seed Orchard Manager Keith Cox cut the ceremonial ribbon giving access to start managing the new seed orchard site land behind them . Skimikin staff observing the ceremony are: (l to r) Cindy Anderson, Karen Turner, Laurie Farrell (hidden behind Brian) Steven Farrell, Margaret Lazar, and Alle Palmer.

Figure 2. Ceremonial sod turning to start the planting of the new orchard site from left to right: TIB Branch Director Brian Barber, Skimikin Machine Operator Vaughn McArthur, Seed Orchard Supervisor Karen Turner, Auxiliary staff Steven Farrell, Cindy Anderson, Margaret Lazar, Laurie Farrell, Skimikin Seed Orchard Manager Keith Cox, and Auxiliary staff Alle Palmer.

Ceremonial sod turning and planting of the new lodgepole pine seed orchard at Skimikin, October, 2009.

Figure 3. Tree Improvement Branch Director Brian Barber planting a seed orchard lodgepole pine tree in the new orchard site (October 2009).

Figure 4. 2 Skimikin auxiliary staff Jane McLean and Shirley Ladner planting out the last of the new lodgepole pine trees into the new site in October.

Photos by David Reid

Bumper Crop Brings MFR Minister Pat Bell to Kalamalka Seed Orchards

submitted by Chris Walsh

The Ministry of Forests and Range's Kalamalka Seed Orchard produced a record volume of cones in 2010. The completion of the Kalamalka harvest coincided with the start of National Forest Week and Minister Pat Bell visited the site to assist in collecting the final cones. Various media were in attendance to document the event.

The cone crop from the two Kalamalka Seed Orchard sites totaled 872 hectolitres, or about five million cones of interior spruce, lodgepole pine, western larch, interior Douglas-fir and western white pine. We predict that after extraction and processing at the Ministry's Tree Seed Centre, the resulting seed will be about 644 kg, or 192 million seeds, equivalent to over 90 million seedlings, with an average genetic worth of 19.

Minister Bell has great timing. Our weather had been showery for days but moments after he arrived, the clouds scattered and the sun came out. After some introductions, seed orchard technician Karen Meggait trained Minister Bell on the operation of an orchard lift and set him to work collecting spruce cones. The raised bucket of the orchard lift provided a platform from which the Minister spoke about the harvest, BC's commitment to the tree improvement program, and the resulting benefits which accrue to the forest industry and the people of British Columbia – all this while filling a pail with cones. A second orchard lift was made available for the media camera operators to shoot from, which made for some impressive video.

The Minister, assisted by seed orchard technician Nancy van der Laan and accompanied by local MLA Eric Foster, then added his cones to a sack and placed the full sack in our cone shed with the other 4,300-odd sacks. The politicians took questions from the media. Meanwhile, seed orchard technician Judy Murphy brought out a beautiful cake she had made for the occasion, complete with a Forest Service Oval rendered in icing. After the media left, Minister Bell joined the orchard staff in our lunchroom for coffee and cake, with the Minister making the first cut in the appropriate place: right through the base of the oval's tree.

A good time was enjoyed by all!

Press release: http://www2.news.gov.bc.ca/news_releases_2009-2013/2010FOR0156-001098.pdf

Peak-to-Valley Whitebark Pine Transect under the Peak-to-Peak Gondola

submitted by Sierra McLane and Jack Woods

Whitebark pine (*Pinus albicaulis*) got a modest boost this fall, thanks to a joint research and restoration initiative in which seven hundred seedlings were planted along a dramatic elevation transect under the massive new Peak-to-Peak gondola in Whistler, BC. The experiment establishes a new cohort of whitebark pine on the mountain, where many of the mature stands are dying from white pine blister rust. Simultaneously, the project enables researchers to assess the response of whitebark pine to climate change, by using lower elevations as a proxy for future climatic conditions. Seedlings were planted on six sites spanning from the middle of the species' current niche near Blackcomb's Rendezvous Lodge, to locations nearly 1,000 m lower – and with a mean annual temperature of over 3°C warmer – near the valley bottom. Seedlings representing multiple provenances were used to track genetic differentiation among populations under warmer temperatures. Previous studies suggest that vegetative competition, rather than warmer temperatures, limits the growth and survival of the whitebark pine seedlings at lower elevations. The cut line under the gondola lends an ideal setting (cleared of trees, consistent in aspect, and easy to access) for testing this hypothesis.

The project was designed and executed by Sierra McLane, Sally Aitken and Lisa Erdle of the University of British Columbia's Centre for Forest Conservation Genetics, with support from Arthur DeJong of Whistler-Blackcomb Resort, Bob Brett of Snowline Ecological Research, Jack Woods of the Forest Genetics Council of BC, Jodie Krakowski of the Ministry of Forests and Range, and Alban de Grully from France who kindly donated his time and enthusiasm. The project used trees left over from other projects that were funded, in part, by the Forest Investment Account through the BC Forest Genetics Council to the Centre for Forest Conservation Genetics (S. Aitken), and was implemented largely with volunteer labour. We give our sincere thanks to the Whistler Blackcomb resort for permission to use the site and for providing access.

Figure1. Overhead photo - volunteer planters as viewed from the Peak-to-Peak gondola at Whistler Blackcomb.

Figure 2. Dr. Sally Aitken planting the lowest elevation site with assistance from Molly.

Figure 3. Crew planting the second lowest of six sites under the Peak-to-Peak gondola.

FGC Award - John Elmslie

submitted by Jack Woods

John Elmslie retired from Winton Global as Chief Operating Officer in 2008 after a career that spanned a broad range of responsibilities in forestry and management. John served as president and Chairman of the Board for Vernon Seed Orchard Company from 1996 to 2008, and as industry Co-Chair of the Forest Genetics Council from 2005 until 2008. A strong advocate for tree improvement in forest management and for cooperative, multi-stakeholder approaches, John provided strong industry leadership to Council.

Figure 1. John Elmslie receives an award from Chief Forester, Jim Snetsinger and FGC Co-Chair Brian Barber for his service as Industry Co-Chair of the FGC from 2005 to 2008.

Dan Rudolph - In Memorium

Daniel Steven Rudolph was born August 17, 1952 in Vancouver, BC. Dan graduated from Lord Byng high school in Vancouver and attended UBC (sciences) and BCIT in Forestry.

Dan was first employed by the BC Forest Service as a summer student in 1971. On June 1, 1973 Dan was hired as a Forest Assistant at Cowichan Lake Experimental Station, Research Division. In November, 1974, he was identified as a Tree Breeding Technician.

Dan was transferred from Research Division to Reforestation Division in September, 1975. His job designation was Seed Orchard Technician, Duncan Nursery HQ, Reforestation Division, BC Forest Service. At this time he reported to Mike Meagher, Forester I/C Seed Production Program of Reforestation Division.

Dan's job description in November, 1978 read: general administration, orchard stock management, pollen management, cone harvest, orchard site development, and other (Parent Tree selection, scion collection, training and propagation). His designation was Seed Orchard Technician, Koksilah (Duncan) Seed Orchard and Pollen Bank, Division Reforestation Branch, Silviculture, Coastal Seed Orchards and Dan's supervisor was Mike Crown.

In November, 1979, his duties involved supervision of Koksilah Seed Orchard, development of the new Cobble Hill Seed Orchard, the Pollen Bank/Clone Bank, Parent Tree registration of all coastal species and providing assistance in training for parent tree selection.

In 1990 as 'Seed Orchard Operations Supervisor', Dan was given the additional responsibilities of supervising Surrey and Saanich Seed Orchards.

With the phasing out of Koksilah Seed Orchards in 1991, the Duncan seed orchard operations and Coastal Seed Orchard administration staff were relocated to Saanich Seed Orchard, Saanichton in August, 1992. Dan's title became 'South Island Seed Orchard Supervisor' and remained responsible for Cobble Hill, Saanich and Surrey Seed Orchards. Surrey Seed Orchard was phased out in 1998.

In April 2002, due to Gord Morrow's retirement, supervision of Bowser and Campbell River Seed Orchards also became Dan's responsibilty as 'Vancouver Island Seed Orchards Operations Supervisor'.

On May 13, 2003, Dan was relocated to the Bowser Seed Orchard to manage the 2nd generation Douglas-fir seed production program. This relocation was due to closures of Cobble Hil (March 31, 2003) and Campbell River Seed Orchards (2002) and cut down of the Dewdney Sub-Maritime orchard at Saanich.

Dan received his BC Forest Service long service award for 35 years in October, 2006. Dan retired September 1, 2007.

Dan and his wife Sue lived in Duncan with their two daughters, Amanda and Karen. Dan passed away March 28, 2010.

Dan and his family enjoyed life together and travelled extensively.

Dan's contribution to coastal tree improvement was extensive and he saw many changes and developments during his career.

Figure 1. Dan and Sue Rudolph.

Dan's Gone to Seed

submitted by Mike Meagher at Dan Rudolph's retirement
September 27, 2007

To day we meet to honour Dan
Our "Free love 'mongst the trees" man
From sites near and far flung
He'd confine them among
Each other to fulfill his plan.

To replant BC was his aim
With native trees – but not the same
By means foul and fair
He'd excite them where
Each tree played a role in his game.

To ensure his mothers ranked high
Dan consulted the tree breeders wise
By statistics pured
Their advice ensured
That all moms could function as guys.

Not content to perform inferior
And by using methods mysterior
Dan collected pollen
For uses appallin'
To generate seedlots superior.

If some trees were feeling just virginal
He used tricks to make them go "urginal"
With a flood like Niagara
Of arboreal Viagra
Trees transformed to wonders "materginal".

If clones attained a high rating
Dan would invoke forced mating
With cold showers and girdling
All barriers hurdling
To prevent miscegenating.

So farewell to our buddy Dan
To tree love he's given a span
From free love to incest
Our Dan takes a rest
From boosting our tree-planting plan.

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