2010/2011

Forest Genetics Council of BC

Tree Improvement Program

Project Report

Front Cover: Tree Seed Centre staff at work.

Back Cover: Seed Handling System.

http://www.for.gov.bc.ca/hti/treeseedcentre/index.htm

2010/2011

Forest Genetics Council of BC

Tree Improvement Program Project Report

Editors
Darrell Wood and Diane Douglas

Acknowledgements

Now in its fourteenth year, the Forest Genetics Conservation and Management Program, continues to meet provincial strategic objectives related to select seed production, genetic gains, genetic conservation, and reporting. Through the hard work and dedication of everyone involved this program is successful, and this year is no exception.

The broad program continues to focus on structuring for a changing climate and for the implications this has on forest management. One of the primary means by which we can respond is the matching of seedlots (genotypes) with future climates to ensure forests are well adapted to the climate in which they grow. This will result in better health, greater productivity and ultimately a more secure forest-based economy.

In response to this need, the Seed Transfer Technical Advisory Committee (STTAC) is identifying priorities for climate-based seed transfer research, structuring a program for delivery of this research, and providing oversight for new climate-based seed transfer standards. This work is directly aligned with priorities in the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) and receives the support of the Land Based Investment Strategy (LBIS).

As well, a Genetic Resource Decision Support Technical Advisory Committee was established to assist the Forest Genetics Council (FGC) in providing decision support to clients, particularly seed users. With government embracing "transformation and technology"; and in response to new technologies and methods of communication; this committee will provide a critical link in responding and developing the FGC approach to technology planning and innovation.

This Tree Improvement Program Project Report, in conjunction with the FGC Business Plan and FGC Annual Report, meets the reporting obligations of Council and the Forest Genetic Conservation and Management Program. It provides a project-level overview of our efforts and highlights our successes.

Sincere thanks to the Project Leaders for submitting their contributions. A very special thanks to the reviewers, Michael Stoehr, Annette van Niejenhuis and Gary Giampa, and acknowledgments to all those who provided images for the report.

Again, thanks to all those who have worked on this program in the past year and over the past fourteen years; including Council members, review committees, species committees, various Technical Advisory Committees (TACs) and all the Project Leaders.

Darrell Wood
Manager, Business Operations
Tree Improvement Branch

The Forest Genetics Council Co-chairs invite you to review the programs and projects described in this report and return any questions or comments to:

Tree Improvement Coordinator
Ministry of Forests, Lands and Natural Resource Operations (MFLNRO)
Tree Improvement Branch
PO Box 9518 Stn. Prov. Govt.
Victoria, BC V8W 9C2

Further Tree Improvement information can be found at our web sites:

Forest Genetics Council	http://www.fgcouncil.bc.ca
MFLNRO, Tree Improvement Branch	http://www.for.gov.bc.ca/hti
	http://www.for.gov.bc.ca/hre/forgen/

FGC Forest Genetics Council of British Columbia

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Tree Improvement in British Columbia

The Forest Genetics Council of British Columbia (FGC) is a multi-stakeholder group reporting to the provincial Chief Forester and representing the forest industry, Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), the Canadian Forest Service, and universities. Council's mandate is to champion forest genetic resource management (GRM) in British Columbia, to oversee strategic and business planning for the provincial Land Based Investment Strategy (LBIS) Tree Improvement Program, and to advise the province's Chief Forester on forest genetic resource management policies. FGC Technical Advisory Committees (TACs) provide technical and policy information to Council and contribute to the development of FGC plans and associated budgets.

Council's vision is that BC's forest genetic resources are diverse, resilient, and managed to provide multiple values for the benefit of present and future generations. This vision is supported by six objectives that are set out in Council's Strategic Plan for the period 2009 to 2014 and reported upon annually. http://www.fgcouncil.bc.ca/StratPlan0914-Layout-Web-22Dec09.pdf

Annual business planning processes are designed to support achievement of the objectives, and the FGC Business Plan defines the annual set of activities and budgets needed to achieve objectives and realize the overall vision.

Forest genetic resource management is a co-operative effort in BC. In broad terms, the MFLNRO leads tree breeding activities and private companies contribute with test-sites. Orchard seed production is a collaborative effort between MFLNRO and the private sector. The MFLNRO, universities and consultants carry out research supporting operational GRM programs. Various cooperative advisory committees reporting to the FGC facilitate collaboration on a variety of support issues, including genetic conservation, climate-based seed transfer, orchard pest management, extension, and records management and decision support.

LBIS – FGC Tree Improvement Subprograms

The Land Based Investment Strategy, Tree Improvement Program (LBIS-TIP) is structured to deliver the provincial strategy for forest genetic resource management developed by the Forest Genetics Council. There are eight subprograms:

- Genetic Conservation
- Tree Breeding
- Operational Tree Improvement Program (OTIP)
- Orchard Seed Supply (SelectSeed Co. Ltd.)
- Extension and Communication
- Genecology and Seed Transfer
- Genetic Resource Decision Support
- Seed Orchard Pest Management

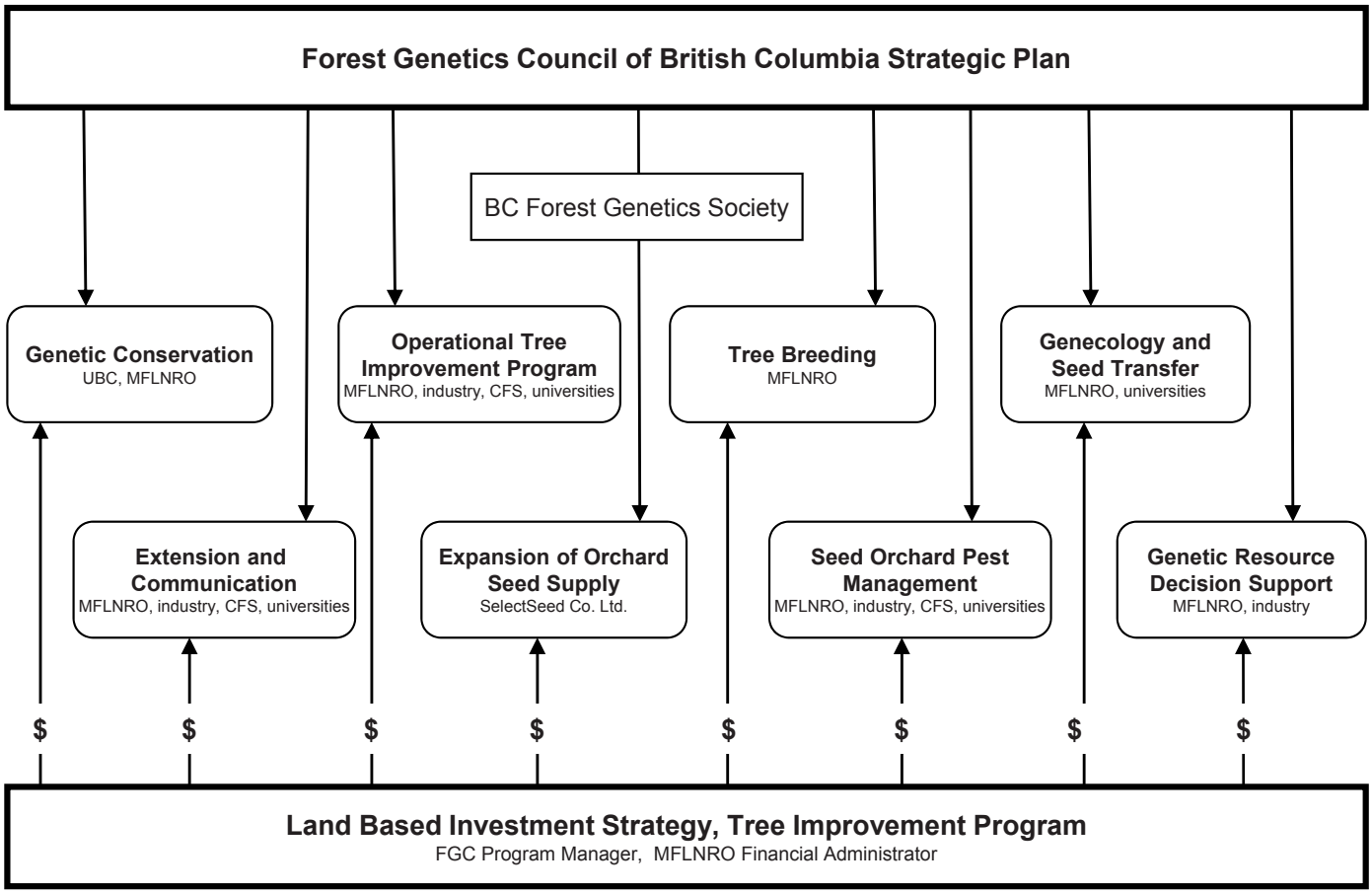

Figure 1. Relationship between FGC Strategic Plan, LBIS-TIP, and participants in various forest genetic resource management areas.

1.0 Expansion of Orchard Seed Supply Subprogram (SelectSeed Co. Ltd.)

Jack Woods

Overview

SelectSeed Company Ltd. is wholly owned by the Forest Genetics Council of BC (FGC), and operated under the leadership of a Board of Directors. SelectSeed's mandate from the FGC is to establish and manage seed orchards needed to meet FGC objectives for seed supply and to provide program management services to Council.

SelectSeed derives revenue through seed sales and Land Based Investment Strategy (LBIS) contributions. As seed production and seed sales increase, LBIS contributions are diminishing. We expect that all revenues will be derived from seed sales by about the 2014 fiscal year. SelectSeed operations are guided by an annual business planning process that is reviewed and approved by the SelectSeed Board of Directors and the FGC. All SelectSeed orchard investments are through long-term contracts with the private sector.

SelectSeed also provides program management services to the FGC, including business plan and annual report preparation, support for policy development, meeting organization, oversight of structural and planning issues, and legal and accounting matters.

Seed Orchard Operations

During the fiscal year ending March 31, 2011, SelectSeed orchards produced the largest crops to date, with harvest from all 14 orchards. Nine lodgepole pine orchards produced a total of 334 hectoliters of cones, yielding 88 kg of seed. SelectSeed's share of this crop was 56 kg with the remainder of the seed going to the partner company operating the orchard. Average seed set was 254 grams per hectolitre, down from 294 grams per hectolitre in 2010, but still within the range needed to meet seed production and financial objectives. Three Douglas-fir orchards produced 41 hectoliters of cones, yielding 26 kg of seed (SelectSeed share 16 kg), and two interior spruce orchards produced 92 hectolitres of cones, yielding 94 kg of seed (SelectSeed share 61 kg).

The total value of seed added to SelectSeed's inventory was approximately $682,000. Seed sales totaled $580,000, up from $484,542 in the previous year and well above a forecast of $350,000. Seed inventory of about $182,000 (all spruce) remains in storage and will be marketed in 2011 and beyond. With a larger inventory of seed to sell, the SelectSeed customer base increased to over 71 companies and agencies, including major licensees, BC Timber Sales, the MFLNRO, woodlot owners, first nations, smaller licensees and community forests.

Plate 1. A large 2010 spruce cone crop developing in the Thompson Okanagan high elevation spruce orchard operated by Tolko Ltd. in partnership with SelectSeed Company Ltd. (photo J. Woods)

FGC program management

FGC program management activities included the coordination of Business Plan development and reporting on progress indicators, as well as governance and organizational matters pertaining to Council meetings and the BC Forest Genetics Society. The FGC was represented on issues related to seed, genetics, and policy matters. During the year, contributions were made to forestry carbon-offset protocol development by the Ministry of Forests, Lands and Natural Resource Operations and the Climate Action Secretariat.

Reports and plans completed during the year on behalf of the FGC include:

- FGC 2009/10 Annual Report
http://www.fgcouncil.bc.ca/FGC-AnnReport-0910-Web.pdf
- FGC 2010/11 Business Plan
http://www.fgcouncil.bc.ca/FGC-BusinessPlan-2010-11.pdf

Support was provided to Council's Technical Advisory Committees and species committees, and species plans were maintained, updated, and made available for 50 provincial seed planning units. A website was also maintained on behalf of the FGC. A number of communication activities were completed, including formal and informal talks to various forest industry staff, presentations at conferences, and numerous presentations to committees.

SelectSeed management and administration

All SelectSeed financial and governance needs were completed. These include financial and legal matters on long-term seed orchard agreements, maintenance and audit of books of account, Company Act reporting requirements, Board of Director support, financial reporting on the SelectSeed Multi-Year Agreement, and reporting to the FGC.

2.0 Genetic Conservation Technical Advisory Committee (GCTAC)

Dave Kolotelo, Tree Seed Centre

The Genetic Conservation Technical Advisory Committee (GCTAC) has oversight for genetic conservation within the FGC and has three main budget line items: UBC Centre for Forest Conservation Genetics (CFCG), MFLNRO, and *ex situ* seed collections.

2.1 Centre for Forest Conservation Genetics (CFCG) University of BC

Sally Aitken

Research projects within the Centre for Forest Conservation Genetics (CFCG) have proceeded largely according to plan and to budgets in 2010-11. We continue to leverage FGC funds from the Genetic Conservation subprogram with funding from other sources including a Natural Sciences and Engineering Research Council Discovery grant (NSERC) and $100K Genome BC funding to S. Aitken and K. Ritland (Genome BC). We have also funded genecology-related projects through the Forest Genetics Council Seed Transfer Technical Advisory Committee's Genecology call for proposals (STTAC). Here we report in more detail on those projects funded largely or entirely through the FGC GCTAC and STTAC, although other sources of funding for these projects are involved and indicated in some cases. We also provide a complete listing of products of the CFCG's research, regardless of funding source.

Testing climate change predictions for whitebark and lodgepole pine (Sierra McLane)

Sierra McLane spent the majority of the last year finishing her dissertation. Two of her chapters are in press, one is under review, and the fourth will be submitted this spring. Sierra was an invited speaker at the Whitebark Pine Ecosystem Foundation annual conference that took place in July 2010 in Missoula, Montana. Along with her dissertation work, Sierra organized the planting of 700 whitebark pine seedlings on Blackcomb Mountain in Whistler, BC, as part of a joint restoration and research initiative that will be monitored by the CFCG and others over the coming decades. Sierra McLane, Tongli Wang and Elizabeth Campbell (CFS) are co-authoring a new paper predicting the species range for whitebark pine under climate change using Random Forest modeling techniques.

Development of a climate-based seed transfer system for changing climates (Tongli Wang)

The main objectives for the current fiscal year (2010-2011) include: 1) the construction of the climate-based seed transfer units (CSTUs), 2) migration of the current Seed Planning Units (SPUs) to new climate based seed transfer system, and 3) some Global Circulation Model (GCM) runs to demonstrate the shifts in the new SPUs in future climates. To construct the CSTUs from predicted bioclimate envelopes for the BEC variants, over 600 digital maps showing both the mapped and predicted BEC variants have been generated and examined. The BEC variants to be modified; have been identified and modified.

A GIS layer for the CSTUs has been generated and modeled with Random Forest using 44 climate variables as predictors for the reference period 1961-1990. Their shifts in current (2001-2009) and future periods (2020s, 2050s and 2080s) have been predicted for one GCM scenario. To migrate the current SPUs to the new CSTUs, we first modeled the SPUs' bioclimate envelopes to identify similar climatic conditions beyond the current SPUs and to correct errors in the current SPUs. The bioclimate envelopes of SPUs have been migrated to the CSTUs. The range shifts of SPUs in the climate based seed transfer system have been predicted for one GCM scenario.

Potential impacts of climate change on the distribution of ecosystems and tree species in British Columbia (Tongli Wang)

For predictions of BC ecosystems, we have been working on the manuscript for several rounds for internal review. The process has been slow and consequently the initial results have been outdated because of the small number of climate change scenarios used. We have started to run more scenarios to keep the work updated. For the species range predictions, we have developed a procedure to stratify absent data point based climate variable to improve the prediction precision.

Maintenance of ClimateBC/WNA (Tongli Wang)

The continual updating and improvement of climatic models continues to keep Tongli Wang busy. Models have been updated with new version of GCMs from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessments. A manuscript entitled "ClimateWNA -- High-Resolution Spatial Climate Data for Western North America" has been submitted to the Journal of Applied Meteorology and Climatology.

Climatic response of western larch and western redcedar populations evaluated in controlled climate chambers (Pia Smets)

This experiment measures the response of twenty well-chosen seed lots of each of western larch and western redcedar to five temperature regimes and two drought levels. From these data, we derive the response curves which help us predict response to future climates. Previous projects have included lodgepole pine, interior spruce, and whitebark pine. Methods developed by Pia Smets to simulate a range of climatic conditions using growth chambers continues to improve, and to produce interesting results. The first replication was sown in February 2010 and the second in September 2010. Treatments were applied throughout the year and height measurements were made at regular intervals. Fluorescence measurements were carried out to evaluate drought stress. We are in the process of making the final measurements on the plants of the second replication. The experiment was successful, with clear treatment and population differences. Significant mortality in the second year was a desired outcome and reflects the impact of extreme temperature, drought and competition. Cold hardiness testing will take place in April and will complete the adaptation picture. These highly phenotypically plastic species have shown very strong environmental responses to these temperature regimes, but have also shown genetic variation in those responses. As previous work has been with largely determinant, less plastic species, these results will be of note both for these species in particular and for our understanding of conifer responses to climate in general.

Conservation genetics of non-commercial broadleaf species (Jordan Bemmels and Lisa Erdle)

The CFCG's research on the population genetics and genecology of Pacific dogwood has wrapped up with the completion of a scientific manuscript based on the MSc research of Karolyn Keir and the BSc (Hon) research of Jordan Bemmels (funded by the FGC GCTAC and NSERC). The Garry oak genecology trial at UBC was assessed for stem form in 2010 by undergraduate research assistant Lisa Erdle. We anticipate distributing results in the form of a scientific manuscript in 2011 based largely on Colin Huebert's MSc research with the addition of these new measurements.

Genetic structure and conservation genetics of interior spruce (Amanda De La Torre)

Interior spruce comprises *Picea glauca* (white spruce), *Picea engelmanni* (Engelmann spruce), and their hybrids. We genotyped 750 progeny in the interior spruce breeding program from the East Kootenays, West Kootenays, Mt. Robson and Quesnel Lakes breeding populations for 384 single nucleotide polymorphisms, and genotyped another 800 parent trees in the breeding program and putative 'pure' white spruce (Fort Nelson) and Engelmann spruce (U.S. populations) for 10 microsatellite loci. Phenotypic data were provided for the progeny by Barry Jaquish.

The majority of genetic resources show an elevational cline in admixture corresponding to climatic gradients in temperature and precipitation. The high number of advanced generation hybrids indicates that introgression is extensive and that the zone is possibly of ancient origin. Preliminary analyses suggest that introgression is asymmetric towards Engelmann spruce, with apparently pure Engelmann spruce over 1800 m in all four breeding zones, and many individuals that are 50-100% Engelmann (e.g., backcrosses of hybrid individuals to Engelmann spruce), but relatively few trees that are more than 50% white spruce (e.g., backcrosses to white spruce) and almost no 'white spruce' throughout these four zones. This asymmetry towards Engelmann spruce may be a result of differences in phenology or other incompatibilities. If a bias towards hybrid reproduction exists, it may present a challenge to tree breeders and seed orchard managers as Engelmann spruce is slower growing than white spruce and with climate change will become less adapted to many reforestation environments.

Meta-analysis of adaptation to climate across western North American species (Jordan Bemmels)

Given the wealth of past genecological projects conducted in BC and elsewhere in western North America, we have initiated a new meta-analysis of provenance trial results for all species to quantify and compare the climatic

clines of these species for quantitative traits including growth, timing of bud break, timing of bud set, and cold hardiness. For species with published or available population source location details and mean quantitative trait values, Research Assistant/Technician Jordan Bemmels has converted geographic location data to climatic source data using Climate WNA, and estimated clines for standardized traits using regression analyses. Our hope is that this will provide us with information on the extent to which genotype-climate relationships vary among species, and whether generalizations can be drawn about adaptive generalists versus specialists (partially funded through NSERC Discovery Grant).

2.2 Research Branch Conservation Activities

Jodie Krakowski

During the past year, the MFLNRO conducted a range of activities in support of genetic conservation, ranging from a field-oriented large study to delivering extension.

Field verification of *in situ* conservation of BC tree species

As a follow-up to the pilot study of 2009-2010, a comprehensive field survey was conducted to ground truth estimates provided in Chourmouzis et al. (2009)[1] to determine the accuracy of the modelling method used to predict population abundance in different parts of the province. A publication is planned summarizing the key findings.

Methods: To most efficiently test areas with conservation concerns, areas of the province with the highest concentration of species that were predicted to be potentially underprotected were systematically surveyed using a stratified sampling design with fixed-area transects. A total of 149 park-biogeoclimatic zone combinations were sampled encompassing the CDF, dry CWH variants, and the BG, PP, and IDF zones, for a total of 29 parks in the interior and 89 on the coast. Twenty-two species were sampled on the coast and 22 in the interior, focusing primarily on non-commercial species.

1 Chourmouzis, C., A. D. Yanchuk, A. Hamann, P. Smets, and S. N. Aitken. 2009. Forest tree genetic conservation status report 1: *In situ* conservation status of all indigenous British Columbia species. Centre for Forest Conservation Genetics, Forest Genetics Council of B.C., and B.C. Min. For. Range, For. Sci. Prog. Victoria, B.C. Tech. Rep. 053. www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr053.htm

Results: Findings determined that many "minor" or non-commercial species were relatively abundant and models tended to under-predict their occurrence. Species with ecologically restricted or scattered distributions tended to be dramatically over-predicted. However, depending on the habitat niche and land use patterns of each species, being less common than predicted did not necessarily correspond with conservation risk – often species that are restricted to narrow ecological niches are abundant within a small area, and species that naturally have a sparse distribution may never be abundant and this distribution pattern does not translate into being at risk.

Predictions of abundance for many minor species especially for a given park, were not borne out by observations. On the coast, 0 to 43% of coastal species were predicted to be present when they were actually present, and in the interior the accuracy of prediction for presence was 0 to 55%. Predictions of species absence were more reliable, but highly variable among species. There were also discrepancies on which parks were predicted to have large population sizes. On the coast, the species that were most overpredicted in terms of the number of parks with adequate protection levels were Garry oak, grand fir, and Sitka spruce, and the most underpredicted species were arbutus and crabapple. In the interior, the most overpredicted species were ponderosa pine, paper birch, and aspen, while the most underpredicted was pin cherry. There were very few cases where actual abundance of any species was within 50 to 200% of the predicted abundance for a given park.

Commercial species, although not included in the analysis, tended to be far more abundant than predicted, primarily for generalist species such as lodgepole pine, Douglas-fir, and western hemlock; species with more restricted habitat requirements were often absent or less common than predicted.

Follow-up: The predictive accuracy based solely on ecological inventory plots, in combination with underlying model assumptions, is too inaccurate to base conservation decisions upon. Genetic conservation objectives may be better met by obtaining baseline genetic data on population differentiation to assess whether population variability is adequately conserved based on genotypic traits, potentially in combination with adaptive differentiation.

Ex situ conservation collections

2010 was an excellent year for *ex situ* conservation, with both whitebark and limber pine yielding good crops in areas not previously represented in provincial inventory. In collaboration with graduate students, non-profits,

consulting firms, ski hill operators, and First Nations, access was secured for a very broad range of difficult to access sites. Seed for conservation as well as other activities for these partners who were able to collect seed for their own needs including producing seedlings for restoration was collected.

Highlights included collections throughout the Yalakom Valley north of Lillooet, several whitebark pine habitats in the Fraser Canyon, remote areas in the East Kootenays, and ski hills including Kicking Horse at Golden and a massive collection at Mount Baldy near Rock Creek.

Yellow Point Propagation coordinated and/or conducted seed collections for 2010-11. Other species that were collected were Rocky Mountain juniper, Pacific flowering dogwood, and cascara. In 2010-11, GCTAC priorities will continue to guide seed collections with the multi-year objective of broad representation of populations of most minor species securely conserved in the Tree Seed Centre, with seed surplus to conservation criteria potentially available for research projects and restoration.

Whitebark pine support activities

The primary activities related to whitebark pine genetic conservation in 2010-11 were focused on *ex situ* seed collection (see above). GCTAC continues to play an important role as a resource and liaison for information, finding partners, tracking seed availability, and supporting extension and volunteer work in whitebark pine. Priorities for GCTAC support will be guided by the Whitebark Pine Genetic Conservation Strategy, which is available at:

http://www.fgcouncil.bc.ca/GCTAC-WhitebarkPine-GenConsStrat-BC-2009.pdf

While not formally affiliated with GCTAC, the Whitebark Pine Ecosystem Foundation (WPEF) of Canada was formally established as a nonprofit society in 2010 to support restoration, education and research projects. WPEF-Canada will be hosting a field workshop in Lillooet in July 2011 showcasing recent studies and conservation efforts in a spectacular setting offset by the devastation of recent large wildfires. For more information see: www.whitebarkpine.ca.

Extension

A poster series was published highlighting the role and importance of genetic conservation in British Columbia forests. Five posters make up the series, providing information on: 1)the MFLNRO genetic conservation program, 2) genetic conservation as an element of forest management, and genetic resource management issues associated with, 3) western white pine, 4) western redcedar, and 5) western larch.

The posters can be downloaded from the Production Resources website
http://www.for.gov.bc.ca/hfd/pubs/Docs/P/P085.htm

and hard copies can be ordered from Crown Printing
http://www.for.gov.bc.ca/hfd/pubs/orderinfo.htm

toll free 1-800-663-6105, Victoria (250)387-6409, fax (250)387-1120.

3.0 Tree Breeding

3.1 Coastal Douglas-fir Program

Michael Stoehr, Keith Bird, Lisa Hayton

This year the program focused on final establishment and ID tagging of our Series 4 (EP 708.24) and additional Series 3 (EP 708.23.1) progeny trials for SPU1. Excellent survival on all newly planted sites has been noted to date. Extensive ID checks and tagging were performed on earlier established trials, Series 2 (EP 708.22), prior to measurements and data collection. After data analysis, selections and collections from Series 2 (EP 708.22) have now been grafted for future distribution to SPU 1 orchards. Breeding values (based on age 9 years) of the forward selections ranged from 16 to 23 (% volume gain at rotation of 60 years).

Selections continued to be distributed to client seed orchards in fall and spring lift orders for SPU 1 and SPU 19 (SM zone of Fdc). Further collection and grafting of Series 1 continued and will be distributed when ready along with clone banking of all high breeding value (BV) material available. Again good survival has been noted. Fall 2011 measurements and data collection has been set for Series 3 (EP 708.23).

Maintenance, measurements and data collection was completed on all sites in our EP 1200 (SM zone of Fdc) and now has analysis in progress.

Thirty-five year measurements were completed on three EP 708 sites (#23 Adam, #28 Fleet, #33 Lost) to check against earlier measurements to validate the selection criteria and to evaluate possible competition effects on height superiority of previous selections.

Rooted cuttings trials were initiated to study the efficacy of producing large quantities of improved Fdc material for future seed orchard distribution. The goal is the possible elimination of the grafting phase to allow for quicker "bulking up" of requested material and avoidance of potential graft incompatibility. Three successive monthly collections were set using two hormone and two zone stratifications of the selected donor trees. Analysis is continuing.

Seedlings from previous full-sib crosses are being grown this year at Cowichan Lake Research Station (CLRS) to be used on future studies including possible Swiss Needle Cast and bud worm pest issues.

Our realized gain study was measured at age 12 and the estimated genetic height gains appear to be realized at this stage (Figure 2) with top-cross (tc) material performing best on four of the five test sites and mid-gain (mg) seedlings being intermediate to top-cross and wildstand controls.

However, in volume per tree, the additional gain in diameter growth caused larger than expected gains (Figure 3) in both mid-gain and top-cross seedlings. No spacing by genetic entry interactions were observed, indicating that spacing does not cause any rank changes in performance.

List of Publications

El-Kassaby, Y.A., S. Mansfield, F. Isik, and M. Stoehr. 2011. *In situ* wood quality assessment in Douglas-fir. Tree Genet. Genomes 7:553-561.

Stoehr, M., K. Bird, G. Nigh, J. Woods, and A. Yanchuk. 2010. Realized genetic gains in coastal Douglas-fir in British Columbia: Implications for growth and yield projections. SilvaeGenetica 59(5): 223-233.

Stoehr, M., J. Woods, K. Bird and L. Hayton. 2011. Verifying genetic gain estimates in coastal Douglas-fir in British Columbia. Min. of Forests and Range, For. Sci. Prg. Ext. Note 104.

Stoehr, M., J. Woods, and A. Yanchuk. 2011. Selection Approaches in High-Elevation Coastal Douglas-fir in The Presence of GxE Interactions. Silvae Genetica 60(2): 79-84.

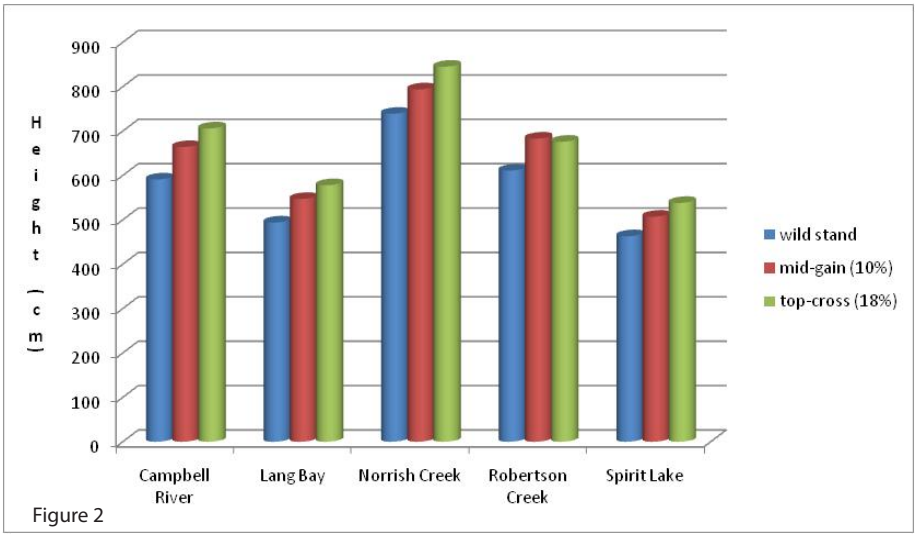

Figure 2. Observed average 12-year heights (cm) of trees of three genetic classes in coastal Douglas-fir at five test locations across four spacings.

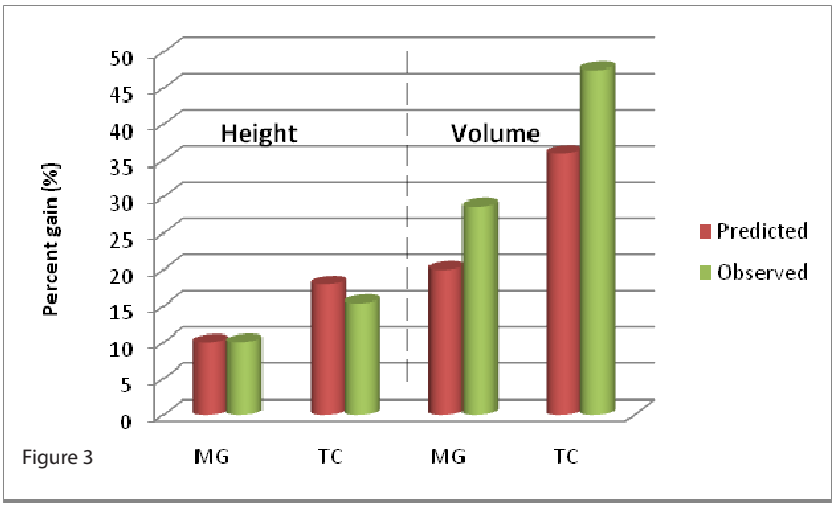

Figure 3 . Observed vs. expected gains in heights and individual tree volume for mid-gain and top-cross old coastal Douglas-fir trees across five test sites and four spacings at age 12 years.

3.2 Western Hemlock Forest Genetics Program

Charlie Cartwright

An internal review of this program was undertaken in the fall of 2010 and new goals were developed. Since planting of hemlock is no longer the usual practice on the BC Coast, the focus of the program will be to remain on maintenance of installations already established to secure investment in them. An exception to this was that the review committee recommended measurement of one advanced generation trial in order to meet obligations to the Hemlock Tree Improvement Co-operative (HEMTIC). Ties to HEMTIC may prove a benefit in the long term as the co-op advances to a third breeding generation buoyed by annual plantings of roughly 8 million seedlings per annum in the United States. Since material from BC is included in the forward development of that program, as well as parent trees from Washington State shown to be well adapted to our climate, suitable third generation seed may eventually be available to us from American members of the co-operative.

For the high elevation program (SPU 24) trials a similar approach was supported by the program review. High elevations tests will be maintained, but other activities will not be undertaken. Consequences of delaying measurements for the installations at higher elevations are less substantial due to the slower growth rates they exhibit. Whether planting numbers increase or not over the next few years, a synopsis of program developments since the last all encompassing document of 1997 will be issued.

3.3 True Fir Forest Genetics Program

Charlie Cartwright

Interest in subalpine fir is increasing in the province's Interior due to decimation of lodgepole pine stocks and the need to supply mills with green logs. More emphasis on harvesting of higher elevation stands has not translated into a much greater use of subalpine fir seed, but planning should anticipate somewhat increased seed requests. Scheduled maintenance of 8 recently established provenance trials and measurements of 3 older farm field test sites was completed. As well 2 new field sites were added, one near Williams Lake and another in the Rocky Mountain Trench. Replacement stock was sown for sites with poorer survival resulting from unavoidably late planting dates.

For the Pacific silver fir program 7 sites were maintained and 7 were measured as planned. Analysis of data from 4 ten year old low elevation provenance trials will allow for the identification of superior provenances and possible sourcing of B+ seedlots. Although low elevation transfer guidelines could now be revised, it is wiser to wait for data from the later series of tests which were planted more broadly and particularly at higher elevations and in the Coast/Interior transition.

With noble fir, the old provenances trials have been visited where possible, access notes updated, and signage and tags checked. Scions from range-wide provenances have been collected from the trials to serve genetic conservation aims and represent good form, best adapted provenances.

For grand fir similar activities have taken place. Four older trials have been maintained (all but one with water table problems) and feature impressive growth. (Plate 2) Signs and tags were checked and access notes updated.

Plate 2. Thirty year old grand fir provenance trial.

3.4 Western Redcedar Breeding Program

John Russell and Craig Ferguson

The western redcedar breeding program is moving towards developing durable populations for resistance to current, and future known and unknown, biotic threats as well as maintaining adaptability and growth. Current known biotic threats include ungulates, heartwood fungi and cedar leaf blight. Understanding resistance mechanisms for these organisms has been ongoing and a key component is secondary extractives, both in the foliage and heartwood.

We are also beginning to explore cross resistance and genetic correlations among the different biotic threats, and with growth. Figure 4 illustrates that monoterpenes in the foliage exhibit a slight positive correlation with heartwood tropolones. The blue box in Figure 4 depicts selections that can be made for both deer resistant clones (positive values for foliage monoterpenes) and heartwood rot resistant clones (positive values for tropolones).

A deer resistance population has been developed by selecting individuals with high needle monoterpene concentrations. A resistant seedlot and vegetative lot (veglot) are currently being developed for operational deployment trials (Plate 3).

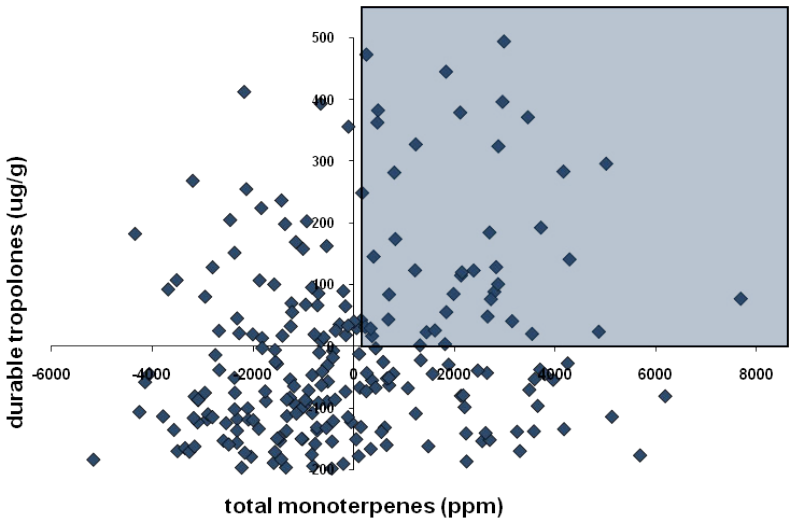

Figure 4. Relationship between foliage monoterpenes and heartwood tropolones clonal values.

Plate 3a. Breeding for deer resistance seed; Plate 3b. Donor stock for propagating deer resistant clones.

3.5 Yellow Cypress Breeding Program

John Russell and Craig Ferguson

This program is currently focussing on maintenance and measurements of the clonal full-sib field trials. A select clonal population with a genetic gain of 20% volume has been established with serial propagated donors in greenhouses at CLRS (Plate 4). This elite veglot has the potential to be 35% greater in early height as compared to wildstand seedlots across a wide range of ecosystems within the yellow cypress maritime SPU.

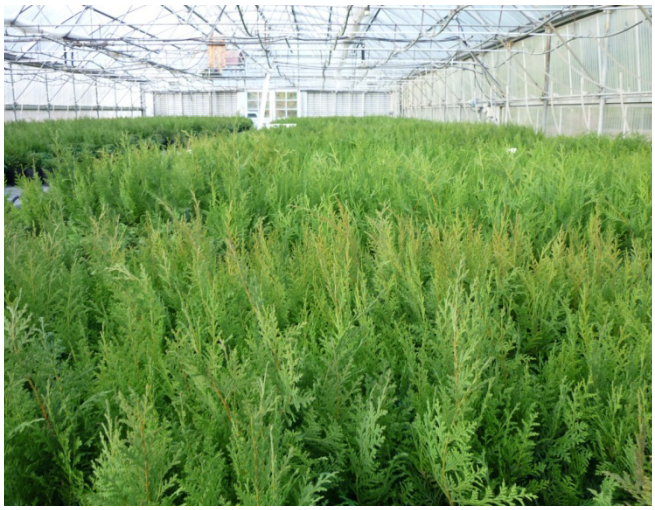

Plate 4. Yellow cypress clonal donor stock at Cowichan Lake Research Station.

3.6 Coastal Broadleaf Species Genetics Program

Chang-Yi Xie, Doug Ashbee, Lisa Hayton and Keith Bird

Commercial planting of red alder is expanding, seed orchard establishment is in the planning stage, and a breeding program is under consideration. To assist seed orchard management and tree breeding, a red alder reproductive biology study has been initiated to provide information on male and female flower production, and timing of pollen shed and female receptivity for each clone in the clone bank.

Pollen collection, processing, storage, and viability testing methodologies will be developed. Polycrossing of high breeding value clones will be completed in 2012 and second-generation progeny tests will be established in 2013/2014.

A manuscript reporting the 3-year test results of black cottonwood at Terrace has been accepted for publication by the Canadian Journal of Forest Research. The 5-year assessments have been accomplished at Terrace and Red Rock and 3-year assessment has been completed at the Harrison site. Data will be analysed and the results will be used for clonal selection this fall. Brushing and re-tagging at Terrace and tilling, spraying and tag-removing at the Harrison site were done. A new beaver fence at the Harrison site was also established.

All 4 big-leaf maple test sites (Skutz Falls, Sayward, Powell River and Carey Island) were well maintained and permanent tags were installed. Three year assessments at all 4 sites were accomplished this spring. Data will be analysed this fall.

3.7 Interior Douglas-fir Tree Breeding Program

Barry Jaquish, Val Ashley, Gisele Phillips and Bonnie Hooge

The BC Interior Douglas-fir tree breeding program began in 1982 and focuses largely on productive forest lands in the central and southern Interior. Within this wide-ranging land base, six seed planning units (SPUs) have been delineated for tree improvement. The first cycle of breeding in each SPU is based on: 1) phenotypic selection in wild stands, 2) establishment of grafted breeding orchards and clone banks, 3) progeny testing using open-pollinated (OP) seed from wild stand trees, 4) delayed clonal seed orchards established with backward selected parents based on early progeny test results, and 5) controlled mating to produce pedigree material for second-generation selection. Tree height, diameter and volume are the major traits for improvement, while wood relative density is an important secondary trait. The recent discovery of resistance to *Armillaria* root disease in Interior Douglas-fir suggests that resistance to *Armillaria* could become an important trait of interest. Plans are currently in place to expand the screening of Nelson SPU parents for resistance to *Armillaria*. The first-generation progeny testing program includes 1,466 OP families from the six SPUs. Seed orchards were established in the north Okanagan in the early 1990's and are coming into production. In 2010, selected parent trees from southern zones were identified to establish new 1.5 generation seed orchards for the Thompson Okanagan high and low elevation SPUs. The Thompson Okanagan region was avoided in the program's early stages because of low productivity; however, recent increases in planting numbers combined with severe seed shortages for the area necessitate the establishment of orchards for these lands. Nearly 1.3 million class "A" Interior Douglas-fir seedlings were planted in BC in 2010, which represents about 11 percent of the year's total planting of Interior Douglas-fir.

The second-generation crossing program focuses on the Nelson SPU and includes selected parents from the West Kootenay, Shuswap Adams and Mica regions. Since inter-varietal (coastal x interior Douglas-fir) hybrids have proven to be hardy and fast growing in the Nelson low elevation zone (Plate 5 a and b), the Nelson second-generation breeding population has been augmented with 16 high breeding value parents from the BC coastal breeding program and 16 forward selections from superior Submaritime provenances in the Trinity Valley range-wide Interior Douglas-fir provenance test (Plate 6).

Ministry restructuring and restraint had a significantly negative effect on 2010 crossing activities. In total, 76 controlled crosses were completed in six Douglas-fir SPUs and 37 pollen lots were collected, processed and stored for future breeding. Controlled crossing for the Nelson SPU remains about 80 percent complete. In fall 2010, 10 progeny tests in three SPUs were maintained and measured, and the 35-year-old Trinity Valley range-wide provenance test was measured. At Trinity Valley, seed sources from the Coast-Interior transition zone continue to outperform local Interior seed sources.

Publications

Xiao-Xin Wei, J. Beaulieu, D. P. Khasa, J. Vargas-Hernández, J. López-Upton, B. Jaquish, and J. Bousquet. 2011. Range-wide chloroplast and mitochondrial DNA imprints reveal multiple lineages and complex biogeographic history for Douglas-fir. Tree Genetics and Genomes. Accepted.

Plates 5 a and 5 b. Fifteen-year old Douglas-fir progeny test at Skimikin Seed Orchard. Genetic entries include submaritime and interior open pollinated families, Fdc x Fdi inter-varietal hybrids and coastal Douglas-fir full-sib families.

Plate 6. Young grafts of high breeding value coastal Douglas-fir parents in Kalamalka. Trees will be used in controlled-crossing with interior parents from the Nelson seed planning unit.

3.8 Interior Spruce Tree Breeding Program

Barry Jaquish, Val Ashley, Gisele Phillips and Bonnie Hooge

Interior spruce is the oldest tree improvement program in the BC Interior. Parent tree selection and genetic testing began in the mid-1960s and expanded rapidly through the 1970s. The first phase of the program focussed on three ecologically and geographically unique regions: Prince George, Bulkley Valley and East Kootenay. Phase two began in the mid-1970s and centred on the remaining geographic regions where Interior spruce was commercially and ecologically important. The program has progressed to the point where much of the current planting stock (50 - 90 million seedlings per year) comes from improved first-generation seed orchards. Full-sib 2nd-generation progeny tests are in place for Prince George, East Kootenay and Smithers SPUs. In the Prince George Series 1 program, 65 2nd-generation forward selections have been grafted and established in clone banks and breeding orchards. In 2009, 75 2nd-generation forward selections were made based on ten-year measurements in the East Kootenay SPU (Plate 7). Scion material was collected from each selection and grafting was completed in early spring 2010. Breeding for 2nd-generation selection is now focussing on the Nelson low and mid-elevation SPUs. Unfortunately, no crosses were completed in 2010. Sixteen-year measurements were completed on three West Kootenay (Nelson SPU) sites.

Publications

Ukrainetz, N., G. A. O'Neill and B. Jaquish. 2011. Comparison of fixed and focal point seed transfer systems for reforestation and assisted migration: a case study for interior spruce in British Columbia. Can. Journal of Forest Research. Accepted.

Verne, S., B. Jaquish, R. White, C. Ritland and K. Ritland. 2011. Global transcriptome analysis of constitutive resistance to the white pine weevil in spruce. Genome Biology and Evolution. Accepted.

Plate 7. East Kootenay SPU second-generation full-sib progeny test.

3.9 Western Larch Tree Breeding Program

Barry Jaquish, Val Ashley, Gisele Phillips and Bonnie Hooge

In 2010, approximately five million western larch seedlings were planted in BC, 76 percent of which originated from seed orchards. In the second-generation crossing program, 34 crosses were completed and 38 pollen lots were collected and stored for future crossing. Second-generation crossing in the East Kootenay and Nelson SPUs is now about 80 percent complete and should be completed within three years. Two six-year-old East Kootenay SPU realized gain genetic tests were maintained and measured. Overall mean height of the elite, seed orchard high genetic worth, seed orchard low genetic worth, and the composite wild stand control seedlots were 211.1 cm, 187.7 cm, 188.5 cm, and 170.6 cm, respectively. Ten western larch progeny tests in the East Kootenay and Nelson SPUs were maintained and measured. Analyses of these data are on-going. The 20-year-old Lamb Creek range-wide provenance test was also maintained and measured. Preliminary results suggest that the tallest provenances came from the moist valleys in the northern portion of the range and the shortest provenances came from Oregon and the Cascade Mountain region of western Washington. Clines between 20-year growth traits and geographic variables are relatively flat.

3.10 Lodgepole Pine, Western White Pine and Interior Paper Birch

Michael Carlson, Vicky Berger, Nicholas Ukrainetz

Lodgepole Pine

The lodgepole pine breeding program has advanced to the second generation of progeny testing in five seed planning zones (Bulkley Valley, Central Plateau, Prince George, Thompson Okanagan and Nelson). Within each seed planning zone (SPZ), 50 parents were selected for superior growth, and 50 parents were selected for superior wood density. Breeding was conducted among the parents within each of these groups to create 65 controlled cross families per group. These families were deployed on 3 test sites within each SPZ along with several local control and seed orchard (A-class) seedlots. These tests will become a supply of high gain material to be incorporated into seed orchards. The first generation, open pollinated progeny tests continue to provide information for updating seed orchard parent tree breeding values and opportunities to assess pest and disease resistance, while the provenance tests remain a wealth of information for modelling impacts of climate change and seed transfer regulations.

The new parent tree clone bank and breeding arboretum at Skimikin was expanded this year to include all of the parent trees which were used in the second generation breeding program. Material was collected from the Kalamalka Forestry Centre clone bank and several seed orchards in the Okanagan. The Skimikin clone bank will become an archive of genetic material from around the province which has become important to the lodgepole pine breeding program.

Nine second generation progeny test sites from the Nelson (NE), Thompson Okanagan (TO) and Central Plateau (CP) seed planning zones were measured for height growth and assessed quickly for signs of disease. Concurrently these sites underwent significant maintenance to remove all brush and competing vegetation and re-tagging. This early growth data will help us to develop a strategy for data analysis and future forward selections and disease information will aid in prioritization of future disease surveys.

The mountain pine beetle (MPB) epidemic has swept through most of central British Columbia and has led to the demise of several mature lodgepole pine genetics research plantations which has resulted in an ideal situation

for investigating the possibility of genetic variation for MPB resistance and tolerance. Early results from work done by Alvin Yanchuk and John Murphy in collaboration with Kimberly Wallin (bark beetle expert from the University of Vermont) and Dan Ott (MSc candidate) strongly suggested that bark beetles prefer certain families and that this variation in attack was heritable. To follow up on this great work we surveyed two mature, open pollinated progeny tests in the Thompson Okanagan seed planning zone for MPB attack and diameter to determine if the variation in attack among different open pollinated families were similar across seed planning zones, to test its repeatability across sites within a seed planning zone and to determine the level of resistance and tolerance in the Thompson Okanagan. Similar patterns of genetic variation for MPB resistance and tolerance were found in the Thompson Okanagan and this variation was consistent across sites within the SPZ. Attack rates among families within a site varied by as much as 70% (21% to 92%; Figure 5). Although MPB attack seemed to be strongly associated with tree size, there is a strong genetic component which allows individual trees within families with the lowest attack rates to survive beetle attacks more often (Plate 8 a and b).

Many of the mature Illingworth provenance test sites have been attacked by MPB. We surveyed 25 sites and each tree was assessed for MPB attack, severity of attack and the presence of a hypersensitive reaction on live trees with attack (Plate 9). This information will help us to investigate patterns of genetic variation for MPB resistance and tolerance across the landscape. We found that there is significant variation for attack rate among different populations and that this is strongly related to tree size.

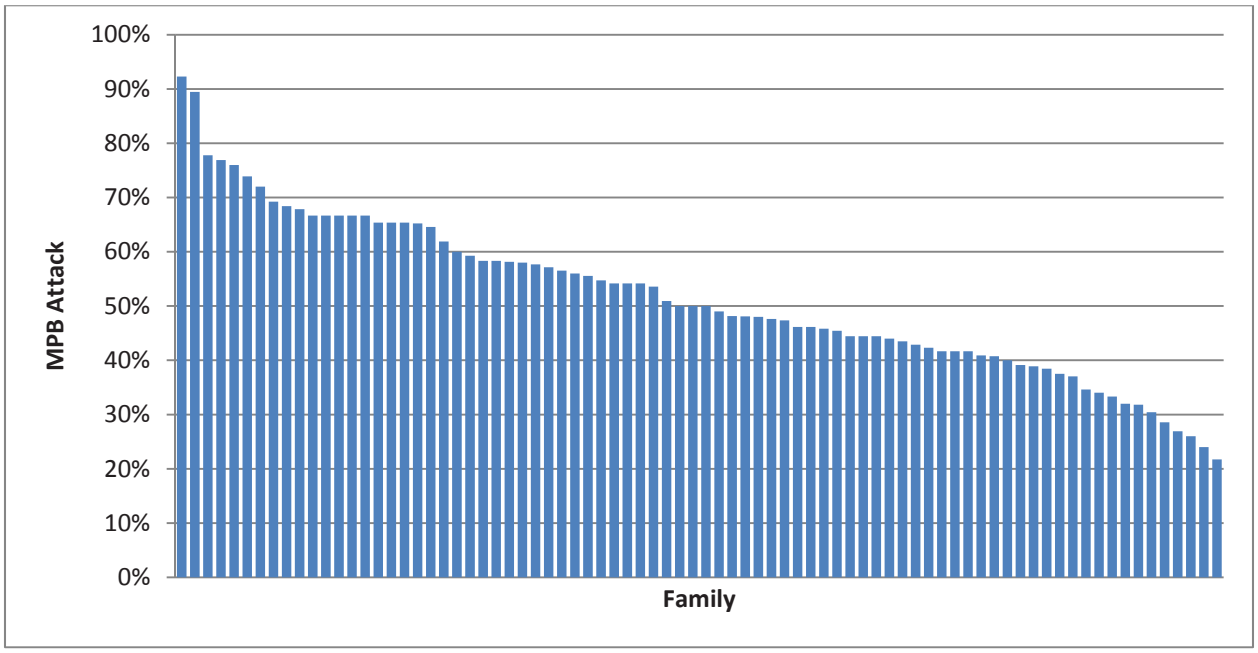

Figure 5. Variation in MPB attack rate among families at the Pennask open pollinated progeny test site planted in 1984. Family attack rates ranged from 21% to over 90% of trees attacked within a family.

Plates 8 a and 8 b. This tree survived attack by mountain pine beetle (MPB). After 3 years of growth post-attack the beetle gallery is easily visible on the outside of the bark as the tree heals over the wound with new bark. The bark can be removed around these failed galleries to reveal a typical hypersensitive lesion which is characteristic of MPB tolerant trees.

Plate 9. Future Forest Services Ltd. contracting crew assessing trees in a provenance test site for mountain pine beetle attack. Back: Kenton Fretz and Ben Woods. Front: Lynette Ryrie and Mary Fraser.

Western White Pine

The supply of blister rust resistant western white pine seed in the interior of BC is produced at the Bailey Seed Orchard (orchard 335) in Vernon. The seed orchard is composed of a combination of parent trees imported from Moscow, Idaho, and local seedlings from BC. The parent trees from Idaho were selected from a 17 year old, full-sib family screening trial growing at the Priest River Experimental Station. The full-sib families were created by inter-crossing tested and selected first generation parents. Seed from BC parent trees was screened for rust resistance at Cowichan Lake Research Station. Surviving trees were selected for having good resistance reactions to white pine blister rust. Scions were eventually collected from selected trees, grafted and planted in the seed orchard. The genetic material now located in the Bailey Seed Orchard will form the breeding population for future breeding activities.

The western white pine breeding program has undergone a program review and the recommendation was to continue to focus on producing rust-resistant material for seed orchards. The future of the breeding program in the interior will focus on conducting control crossing amongst various sources and establishing a series of progeny tests which will be used as a source of material for future orchards. These tests will allow us to select trees which are superior for blister rust resistance and growth while monitoring other biotic and abiotic hazards. We are collecting scions from the Bailey Seed Orchard for a long-term clone bank and breeding arboretum at the Kalamalka Forestry Centre in Vernon which will aid in breeding activities and we are planning to begin breeding activities in 2011-2012. We are also continuing to explore the concept of ontogenic resistance (age related resistance) and are growing the final age class for the Age Related Resistance Trial (ARRT) and *Ribes* plants for inoculations in 2012.

Interior Paper Birch

The interior paper birch program consists of three test series which assess several provenances and families across a wide range of test sites. EP 1069.11 tests 18 provenances collected across the range of interior paper birch on 6 test sites from Kispiox to Creston. EP 1069.12 is located at Skimikin Nursery and contains open pollinated families collected from 19 stands in the Kootenay Region. EP 1069.13 is an elaborate genecology study planted on three test sites (Prince George, Skimikin and northern Idaho) and contains several latitudinal, longitudinal and elevational transects.

EP 1069.12 located at Skimikin Nursery was retired and removed after collecting scion material from forward selections for the paper birch seed orchards located at the Kalamalka Seed Orchard and Skimikin Seed Orchard. Four sites from EP 1069.11 and two sites from EP 1069.13 were measured for height and diameter growth and were brushed to remove competing vegetation. The data will be used to generate seed transfer guidelines for a future climate based seed transfer system.

3.11 Assisted Migration Adaptation Trial (AMAT)

Greg O'Neill, Michael Carlson, Vicky Berger, Nick Ukrainetz

The AMAT is a long-term field trial of orchard seedlots that will help refine seed source selection to ensure that plantations are adapted, productive and healthy well into the future. Despite several significant administrative and financial hurdles arising from the recent recession, the Assisted Migration Adaptation Trial (AMAT) is still on track. During fiscal 2010/11, the second series of 12 sites were established; seedlings for the third series were sown, grown and lifted; and sites for the third series were identified and prepared. Formal agreements with several American collaborators as well as environmental impact assessments with Yukon government and USDA Forest Service were completed, paving the way for establishment of the third series of test sites which will range from Sacramento, California to Whitehorse, Yukon. Seedling import permits were arranged by Michael Carlson, who also coordinated 11th hour negotiations with the USA consulate to allow our planting contractors to work in the USA.

Considerable effort was devoted toward extension activities in fiscal 2010/11. The project was presented or discussed at the following meetings, tours or publications:

- Southern Interior Silviculture Committee (SISCO), Naramata, BC (April 2010)
- Canadian Forest Service – Laval, QC (June 2010)
- Janet M. Poor Research Symposium, Chicago Botanical Gardens (June 2010)
- MLA Eric Foster, Vernon (July 2010)
- Chief Forester, MFLNRO, Vernon (July 2010)
- Northern Silviculture Committee (NSC), Vanderhoof (Aug 2010)
- ADM, Competitiveness and Innovation Division, MFLNRO, Victoria (Aug 2010)
- UBC Okanagan, Kelowna (Sept 2010)
- Science Illustrated (Sept/Oct 2010)
- Coastal Forest Genetics Extension Symposium field tour, Jordan River – (Dec 2010)
- Business Week (Dec 2010)
- BC FGC Interior Technical Advisory Committee - Vernon (Jan 2011)
- FoResTTraC – European Union climate change workshop – Flagstaff, Arizona (Feb 2011)
- FORREX, teleconference (Feb 2011)
- Canadian Forest Service - Victoria (March 2011)

The AMAT team is collaborating with researchers at UNBC, UBC and Oregon State University, providing seed or seedlings for 5 projects. The AMAT team thanks its many collaborators who have kindly provided advice, seed and test sites, and looks forward to developing further collaborations.

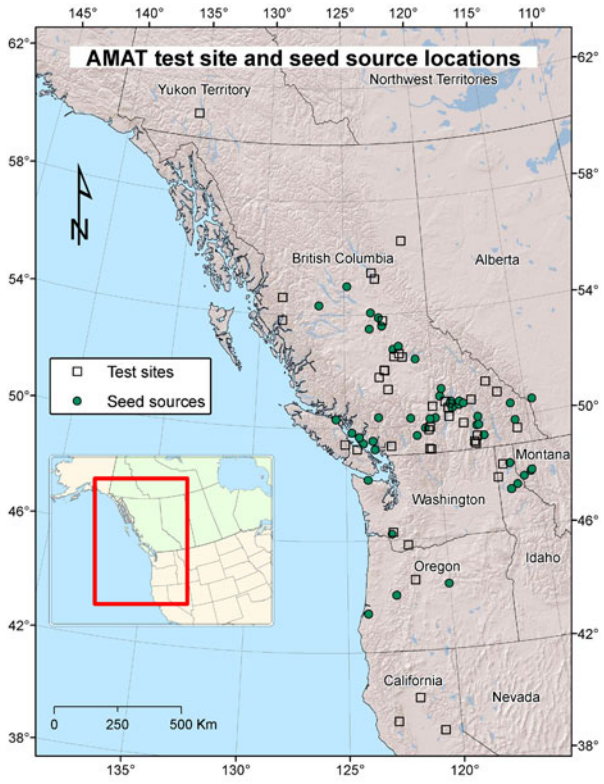

Plate 10. Map of AMAT test sites identified to-date (March 2010) and seed source locations. (Map credit – Matt LeRoy)

Plate 11. Species tested in AMAT. (Photo credit – Ward Strong/Michael Carlson)

4.0 Seed Transfer Technical Advisory Committee

Lee Charleson

The Seed Transfer Technical Advisory Committee (STTAC) continues its work developing priorities in genecology research, vetting project proposals and providing budget recommendations to FGC for genecology and seed transfer research. Additionally, the STTAC raises genecology and seed transfer issues to CTAC and ITAC for their information and consultation.

The identification of priorities has changed from the previous year. As the bulk of genecology projects are conducted by ministry forest genetics research staff, STTAC agreed to have priorities and funding needs identified and documented directly by the ministry forest genetics research team with the work led by John Russell. In fall 2010, a rough draft was prepared of a three year genecology research plan which was submitted to STTAC in the fall. Qualifications for funding ministry work will be determined by ministry forest genetics research staff and manager in accordance with the research plan. One condition requested by STTAC is that a short lay summary be prepared and submitted annually for each project that will receive FGC funds in genecology.

The TAC retains an open call for proposals which will be a small, low budget call for other innovative ideas to be tried and tested beyond the ministry. The priorities for acceptable tree species and projects are based upon the 2009-2010 priorities table and the uniqueness and innovation of the proposed project.

Five projects were submitted to the call for proposals in winter 2010-2011. A review committee, smaller than last year, was convened to assess the proposals. Based upon the review committee's work, STTAC recommended to FGC that three proposals be fully funded, one proposal be partially funded and one proposal not meeting criteria in the call for proposals not be funded.

For a complete list of genecology projects in 2010-2011, see Table 1, the same information is posted on the STTAC webpage at http://www.fgcouncil.bc.ca/sttac-area.html. One final report, from the project lead by Phil LePage, was generated. To view the report, *Assessment of Off-Site Tree Plantations in the Northwest Interior of British Columbia -Project Summary*, see:

http://www.fgcouncil.bc.ca/Off-Site_Species_Assessment_Final_Report_Opt.pdf

Species	Project Leader	Project Title
At	Chris Hawkins	Genecology of Aspen in British Columbia
Ba	Charlie Cartwright	EP0824 - Provenance Studies of Pacific Silver Fir
Bl	Charlie Cartwright	EP0824 - Provenance Studies of Subalpine Fir
Bl and Ba	Sylvia L'Hirondelle	Patterns in frost, heat, and drought response of *Abies lasiocarpa* and *Abies amabilis* populations from a range of climates
Cw	John Russell	Western redcedar interior climate change and seed transfer study
Cw and Lw	Sally Aitken	Climatic response of western redcedar and western larch seed source using controlled climate chambers
Ep	Nicholas Ukrainetz	Provenance test variation for paper birch in the interior of British Columbia for the development of transfer functions for a Climate Based Seed transfer system
Fdc	Marty Kranabetter	Coevolution of ectomycorrhizal fungal communities with local provenances of coastal Douglas-fir and the implications for assisted migration
Fdc	Michael Stoehr	Seed transfer study in the coastal Douglas-fir sub-maritime zone: final measurements
Fdi	Barry Jaquish	Trinity Valley range-wide Douglas-fir provenance test: 35 year maintenance and measurement
Hw	Jodie Krakowski	Refining western hemlock seed transfer to optimize productivity for seed sources based on genecology trial results
Lw and Fdi	Barry Jaquish	Lamb Creek range-wide western larch fir provenance test: 20 year maintenance and measurement
Multi species	Greg O'Neill	Assisted Migration Adaptation Trials (AMAT)
Multi species	Jodie Krakowski	Quantifying impacts of climate change on forest health of BC indigenous tree species
Multi species	Phil LePage	Assessment of offsite tree plantations in the Northern Interior Forest Region
Pli	Nicholas Ukrainetz	Assessment of lodgepole pine provenance variation for Mountain Pine Beetle and secondary bark beetle attacks
Sx	Greg O'Neill	Interior spruce seed transfer and assisted migration
System	Sally Aitken	Development of a climate based seed transfer system for changing climates

Table 1. Genecology projects, 2010-2011.

5.0 Genetic Resource Decision Support Technical Advisory Commitee

Lee Charleson

The year 2010-2011 was a year of rebuilding the Decision Support Technical Advisory Committee (DSTAC). No projects were directly undertaken by DSTAC. In related work, the Decision Support staff with the Tree Improvement Branch conceptualized and undertook development of spatially-enabled decision support tools to support seed planning activities such as cone collection and seed inventory management in mountain pine beetle impacted areas. GIS analyses were conducted to integrate seed planning spatial data with the Mountain Pine Beetle Impact Mapping project and geodatabase. The resultant geodatabase includes the following seed planning spatial data sets: orchard and natural stand seed planning zones (SPZ), new western larch climate change seed planning zones, orchard seed planning units, and natural stand seedlots. A series of interactive pdf maps have been developed in 22 priority management units (Timber Supply Areas - TSAs). In addition, opportunity maps were developed to identify potential opportunities related to cone collection within two of the management units (Williams Lake TSA and Quesnel TSA).

The aim of this work is to allow forest managers, stewards and practitioners to conduct Genetic Resource Management (GRM) impact and risk assessments, map current and future tree improvement and seed use opportunities, and determine where forests are vulnerable with regards to genetic adaptation, diversity, and resilience to climate change. The impact of the mountain pine beetle (*Dendroctonus ponderosae*) is equally important when gauging forest health and assessing the implications for seed planning. The results of this decision support project are meant to support both strategic and operational level planning activities; however, these maps are not intended to replace on-the-ground verification; or negate the need to look at current or forecast seed inventories.

A new DSTAC committee was formed in 2010-2011 and a new terms of reference was developed by the committee and approved by FGC.

6.0 Operational Tree Improvement Program

Darrell Wood

The objective of the Operational Tree Improvement Program (OTIP) is to increase the quality and quantity of select seed produced from existing private and Ministry of Forests, Lands and Natural Resource Operations seed orchards.

To meet this objective, a Call for Proposal process is administered each year based on species plan priorities. FGC committees review and rank these proposals based on technical merit, impact, value and costs.

As a result of this work, the Forest Genetics Conservation and Management Program has the ability to meet future seed demands because of key investments in:

- testing
- seed orchard pest management
- seed orchard quality and quantity boosts
- orchard development

OTIP uses a performance measurement system to monitor progress and set reasonable targets for project success. This year, as in past years, orchardists and researchers have responded to this approach and have achieved and exceeded planned targets.

For additional information regarding the budget and key performance indicators, please refer to the FGC Annual Report 2010/11 at: http://www.fgcouncil.bc.ca/FGC-BusinessPlan-2010-11.pdf

6.1 Orchard Projects

6.1.1 Saanich Forestry Centre (WFP)

Annette van Niejenhuis

Western Forest Products (WFP) manages tree seed orchards for forest regeneration programs in the Maritime zone of coastal British Columbia at the Saanich Forestry Centre. Low and high elevation Douglas-fir, low elevation western redcedar, low and high elevation western hemlock, and low elevation Sitka spruce seed orchards as well as yellow cypress hedge orchards are established. As a co-operator in the Forest Genetics Council programs, WFP receives OTIP funds to implement incremental orchard management techniques to deliver quality seed in quantity to the coastal forest regeneration programs.

Low Elevation Coastal Douglas-fir Crop and Orchard Enhancement

Ramet replacement for upgrading and production continued with the establishment of 129 trees in orchards 166 and 405. Current inventory in these orchards is 1,569 ramets with an average breeding value of 18. Grafts for the vacant orchard locations and replacement of poor ramets were maintained. Nutrient management with fertilization of replacement stock for good crown development continued. Plans are in place to address deer management in these orchards.

The 2010 cone crop was small and heavily infested with insects. A very small supplemental pollen management program was implemented. Crop yields were disappointingly low.

High Elevation Douglas-fir Replacement Orchard

Wet weather prevented the establishment of replacement stock in orchard 406. Current orchard inventory is 231 ramets and 16 vacancies; orchard breeding value is 13. Nutrient management for the promotion of good crown development continued. Plans are in place to control deer access to this orchard.

Western Redcedar Orchard and Crop Enhancement

Wet weather in the third and fourth quarters prevented planting of replacement ramets in orchard 198. Current inventory is 308 ramets with a breeding value of 18. Nutrient management of the replacement stock continued.

The 2010 cone crop showed high midge infestation and an average of only 0.5 filled seed on the cone cut, resulting in low yields. Initial observation of the 2011 crop indicated good numbers of females but few male cones.

Low Elevation Western Hemlock Orchard Enhancement

Seed of high genetic worth in storage for western hemlock far exceeds current coastal seed needs, thus we did not manage or harvest the 2010 crop. Orchard maintenance continued; the orchard will be upgraded with roguing and ramet replacement before additional crops will be managed.

High Elevation Western Hemlock Orchard and Future Crop Enhancement

Wet weather precluded planting of replacement ramets in orchard 187. The current orchard inventory is 206 ramets with a breeding value of 11. Nutrient management for early development of the crowns continued. Rabbit damage was detected; vexar tubing was installed on 43 small trees. Plans to control deer access will be implemented next year.

Pollen management was implemented in the small crop in orchard 187. Supplemental mass pollination of breeding value 14 was applied in the first quarter.

Sitka Spruce Orchard and Crop Enhancement

Orchard management in Sitka spruce orchard 172 continued with nutrient management of young stock. Green spruce aphid treatment was applied in the first quarter, and monitoring continued through all quarters. Present orchard inventory is 551 ramets with a resistance breeding value of 86%.

A good cone crop was realized in orchard 172 in 2010, yielding seed for more than 3.5 million plantables. Pollen management was not implemented, but reproductive surveys were conducted.

Yellow Cypress Production Hedges Enhancement

Work continued in the new donor orchard with the establishment of an additional of 1,113 ramets. Current inventory in this hedge orchard is 3,446 donors with a clonal value of 20. These donors represent the top field performers for growth and form that also showed good rootability in cuttings trials. Pests were monitored, nutrients were managed, and crowns were developed for production of cuttings.

6.1.2 Mt. Newton Seed Orchard (TimberWest Forest Company)

Tim Crowder

Douglas-fir

SPU 0106 covers activities in five Fdc M Low orchards: 134, 154, 183, 197 and 404. The management objective is to increase the genetic worth of these orchards from the current 12% to approximately 18% by 2015, and maintain an average annual production of 5 million trees.

These orchards contain a total of 4978 ramets, about half of which are not yet in production. 800 more trees were grafted this year, and 650 trees were established in the fall. An additional 200 were purchased from CLRS as we continue to convert to high density plantings. 328 trees which were too small to plant out were maintained in holding beds.

SMP was required to augment the insufficient pollen cloud on 70 trees of the early and late clones. Both fresh and stored, high breeding value pollen was used and all stored pollen was tested before use.

5 litres of pollen was collected, dried and stored for future use. Internal and external pollen flights were monitored and a contamination rate for foreign pollen was calculated.

Insect pests were monitored and due to high numbers of damaging insects, a spray program of insecticide was carried out.

$GA_{4/7}$ and double overlapping girdles were used to induce a 2011 crop on 750 ramets.

305 large ramets with GW<7 were rogued from the orchards during the winter and the stumps removed to create new planting positions.

Western red cedar

SPU 0205 covers activities in two Cw M Low orchards: 140 and 152. These two orchards are similar in composition and are typically induced in alternating years to provide a steady seed supply.

264 orchard trees were maintained and managed. Monitoring the crop trees for insect pests indicated the need to apply insecticide, so the crop was sprayed.

58 trees were sprayed with GA_3 in July to induce a crop for 2011.

515 grafts from series 3 to 6 were maintained in holding beds awaiting field test results.

25 young high gain trees were planted in positions created by last year's roguing.

Plate 12. Roguing 25 year old Fdc trees with low genetic values.

6.1.3 Saanich Seed Orchards

Lisa Meyer

Orchard Management Operations to Maintain Productivity and Increase Gain in Seed Orchard 181 SM Fdc (SPU 1902)

The objectives of this project are to enhance the seed yield and genetic worth of seedlots produced in orchard 181 by roguing according to progeny test results, utilizing orchard management techniques to optimize growing stock vigour and crop health, and monitor for and apply pest control if necessary.

The project consisted of identifying and roguing 378 backward selection ramets as a result of the Fdc breeder's progeny test analysis. 150 new grafts were planted out in the orchard and holding bed.

A total of 717 trees in the orchard including both forward and backward selections were managed through appropriate cultural practices. Graft and ID maintenance were conducted. Foliar nutrient samples were taken and analysed, nutrient prescriptions prepared and fertilizer applied. Soil moisture was monitored and irrigation applied as needed. Top pruning and crown management was conducted on all ramets to initiate potential cone producing sites. Graft unions were surveyed.

Crop management included phenological and bud surveys. Pollen was collected clonally. Due to transplant related stress, the orchard was not managed for cone production and no supplemental mass pollination applied. Production for 2010 was 0.25 l of pollen collected for future use. Pest surveys were conducted. *Contarinia* levels were low in 2010 requiring no treatment. Orchard #181, after the additional roguing of the backward selections and addition of the initial forward selections is predicted to produce seedlots at GW 18. The increase in gain from this orchard meets one of the main objectives of the FGC.

Plate 13. Orchard 181.

Plate 14. Backward selection ramet transplanted.

Upgrade Orchard 175 - Rust Resistance Western White Pine (SPU 0804)

The objective of this project was to upgrade the existing putatively rust resistant white pine ramets at the MFLNRO Saanich Orchard site with the Pw Breeding Program slow canker growth (SCG) and Difficult to Infect (DI) white pine ramets. A total of 487 ramets were in the orchard and holding beds over the growing season. These were managed using appropriate cultural practices. No new grafts were acquired. Graft and ID maintenance were conducted, foliar nutrient samples taken and analysed, nutrient prescriptions prepared and fertilizer applied. Soil moisture was monitored and irrigation applied as needed. Crown management was conducted on all appropriate ramets to initiate potential cone producing sites. Pest surveys were conducted and no control measures were required.

Deliverables from this project are established vigorous orchard stock with slow canker growth (SCG) and Difficult to Infect (DI) rust resistant mechanisms that will produce future seedlots of rust resistant seedlings.

Plate 15. Orchard 175.

Plate 16. Orchard 175 close-up.

Orchard Management Operations to Maintain Productivity in High –elevation Western Hemlock Orchard 196 (SPU 2403)

Orchard 196 consists of 26 clones of 210 ramets producing a seedlot of GW 10. Pollen management, pest monitoring and control, and orchard management techniques optimized the growing stock vigour and crop health. Graft and ID maintenance were conducted. Foliar nutrient samples were taken and analysed, nutrient prescriptions prepared and fertilizer applied. Soil moisture was monitored and irrigation applied as needed. Top pruning and crown management was conducted on all ramets to initiate potential cone producing sites. Graft unions were surveyed. Mortalities were removed. Pollen buds were collected from ramets BV 8 and higher resulting in 0.25 litres of stored pollen to be used for future pollen application. Deliverables from this project consist of vigorous orchard stock with a production of 5.3 hl of cones resulting in 5.5 kg of seed.

Plate 17. Orchard 196.

Plate 18. Orchard 196 cone crop.

Genetic Enhancement and Production of Seed Crops from Second Generation Douglas-fir Seed Orchard 199 (SPU 0114)

The purpose of this project was to improve the genetic quality and the quantity of seed crops produced from second generation Douglas-fir Seed Orchard #199 at the MFLNRO Saanich orchard site through management activities in several project categories.

A total of 1143 ramets in Orchard 199, and 383 high gain replacement ramets in holding beds were managed using appropriate cultural practices over the growing season. Scion collected in 2009 from orchard stock provided 497 grafts that were planted out in the orchard.

Graft and ID maintenance were conducted. Foliar nutrient samples were taken and analysed, nutrient prescriptions prepared and fertilizer applied. Soil moisture was monitored and irrigation applied as needed. Top pruning and crown management was conducted on all ramets to initiate potential cone producing sites. Graft unions were surveyed. Mortalities were removed.

Pollen buds were collected from ramets with BV 20 and higher resulting in 2 litres of stored pollen to be used for future pollen application. This pollen has potential to offset the effects of contaminant pollen, provide increased GW of crops produced and increased seed production in early and late clones. Due to transplant related stress, the orchard was not managed for cone production and no supplemental mass pollination applied. Pest surveys were conducted but no control measures were required.

Deliverables from this project consist of vigorous orchard stock established with potential to maximize production of future crops as well as a moving front orchard with ramets capable of producing crops with genetic worth of 20 or higher by 2011, and 2 litres of stored pollen for future application.

Plate 19. Orchard 199.

Plate 20. Orchard 199 cone crop.

6.1.4 Bowser Seed Orchards

David Reid

This project was originally designed to upgrade the genetic composition of Douglas-fir seed through various management activities and to increase the seed yield of the seedlots produced here.

Clones with breeding values of 12 were rogued from orchards 149 and 162. A total of 187 ramets were removed resulting in a change in the current average BV to 16.5. A total of 10 l of pollen was collected from clones with a BV of 18 or higher and a mix of the fresh and stored pollen was applied to boost the gain in the early and late clones.

Seedlot #63265 yielded a collection of 18.46 hl of GW 14 seed, and a seed yield of 1.375 kg. Seedlot #63266 yielded a collection of 37.75 hectolitres of GW 16 seed and seed yield of 2.833 kg. All orchard trees were maintained through appropriate cultural practices. Foliar nutrient samples were taken; fertilizer was applied for both growing stock and crop maintenance; crown management and top pruning completed to increase potential cone sites; and graft union surveys completed.

Surveys were conducted for *Contarinia*, *Dioryctria* and *Leptoglossus*, and the surveys determined that the orchard had a *Dioryctria* infestation but it could not be treated due to pesticide application restrictions. This resulted in lower than expected seed yields.

Future crop management and cone collection of the Bowser Seed Orchard shifts to Saanich Seed Orchard as Ray Cardy and Phyllis Taylor are enjoying their retirement. (see page 56).

Plate 21. Bowser - picking the crop.

Plate 22. Phyllis Taylor and Ray Cardy wave goodbye.

Plate 23. Bowser Seed Orchard rests.

6.1.5 Kalamalka Seed Orchards

Chris Walsh

In 2010/2011, Kalamalka Seed Orchards received OTIP approval for 11 projects under the operational production subprogram. The funding allowed for a significant enhancement of the effectiveness of our orchards in delivering improved seed. Activities included:

- Improving orchard composition through grafting higher-breeding-value ramets, maintaining recently grafted high-value ramets destined for orchards, transplanting the older higher-value ramets to the orchards, and roguing lower-value ramets from the orchards;
- Improving orchard seed quantity and quality through cone induction and pollen management, including collecting high-breeding-value pollen from clone banks and applying Supplemental Mass Pollination; and
- Improving orchard productivity through pest management and other management activities.

Orchard Composition Activities by Project

Project	Species	SPZ	Orchard	Roguing	Grafts Made	Maintained	Transplants	Induction
SPU0401	Sx	NE	305			49	4	*
SPU0502	Sx	NE	306			30	5	*
SPU0701	Pli	NE	347			508	27	
SPU1501	Pw	KQ	335		129	100	70	
SPU1708	Pli	BV	230	364	500			
SPU2201	Fdi	NE	324					475
SPU3501	Sx	BV	620			21	2	*
Totals				364	629	708	108	475

* due to a very large Sx crop in 2010, we did not induce and awarded funds were returned.

Table 2. Orchard Composition Activities by Project.

Pollen Management Activities by Project

Project	Species	SPZ	Orchard	Pollen Collected (litres, dry)	Trees Pollinated
SPU0401	Sx	NE	305	2.0	792
SPU0502	Sx	NE	306	2.0	663
SPU0701	Pli	NE	307	3.0	1,525
SPU1501	Pw	KQ	335		1,858
SPU1708	Pli	BV	230	1.0	900
SPU2201	Fdi	NE	324	2.0	1,425
SPU3201	Pli	EK	340	3.0	1,279
SPU3501	Sx	BV	620	2.5	465
SPU3901	Fdi	EK	336	1.0	
SPU4401	Sx	NE	341	2.0	541
Totals				18.5	9,448

Table 3. Pollen Management Activities by Project.

Plate 24. After a large crop is a good time to top Sx ramets. OTIP funds crown management activities that boost productivity.

Plate 25. Kalamalka's terrific tree trimmer Karen Meggait.

Operational Pest management activities at Kalamalka Seed Orchard

- monitoring pest levels to make informed decisions regarding control,
- using Safer's Soap sprays to control adelgids in Sx and Fdi,
- removing weevil-infested spruce leaders to reduce weevil populations,
- removing pine pitch moths damaging orchard tree stems,
- baiting for control of rodents feeding on tree roots,
- sanitation picking of cones in orchards with non-collectible crops to reduce pest populations,
- spraying to control *Dioryctria* in Pw and Fdi cones,
- spraying to control mites in Fdi and Sx,
- applying dormant oil to control larch adelgids, and
- spraying to control *Leptoglossus* in Pw, Fdi and Pli.

Other funded management activities to boost productivity and gain included foliar analysis to determine the nutrient status of orchard trees and crown management of orchard trees.

The OTIP funding was instrumental in increasing both the quantity and quality of seed produced. At Kalamalka in 2010 we produced approximately 730 kg of western larch, lodgepole pine, interior spruce, interior Douglas fir, and western white pine seed equivalent to over 100 million seedlings with an average GW of +19. Large areas of the interior of the province are using Kalamalka seed.

Protecting Orchard Trees from Mountain Pine Beetle (MPB) Attack at Kalamalka

Gary Giampa

Objective

The purpose of this project is to protect 4827 pine trees in four seed orchards from MPB attack and preserve seed production capacity. We also protected 151 Pli pollen donors located in the Kalamalka Forestry Centre Research blocks.

Activities

In consultation with the Interior Seed Orchard Pest Management Biologist, we applied insecticide to selected tree stems in seed orchards 230, 340, 307 and 335 prior to the 2010 MPB flight. An Integrated Pest Management monitoring program was initiated to continuously evaluate the efficacy of the pre-flight spray through the growing season. The monitoring program consisted of twice-weekly checks of pheromone traps to detect new flights of beetles dispersing into the orchards and regular orchard tours to detect new attacks on orchard trees.

Results

Monitoring data indicated that all mature Interior pine seed orchards were exposed to potentially harmful population levels of MPB in the summer of 2010. The prophylactic spray provided total protection. We did not lose any of the 4978 susceptible trees to MPB in 2010.

Output and Deliverables

Results from the 2010 MPB protection program give us a very strong indication that seed orchard pine trees can be protected from MPB attack. While protection programs in Interior seed orchards probably will need to be carried out at most locations for the next 3-10 years, we are confident that the sources of seed needed to replant the pine forests of the province can be preserved until the ultimate collapse of the MPB populations around BC.

Plate 26. Bark beetle entrance wounds on a ramet in lodgepole pine orchard 307 at the Kalamalka Forestry Centre.

Protecting Kalamalka Seed Orchard Pine Trees from Red Turpentine Beetle (RTB) Attack

Gary Giampa

Objective

During the spring of 2010 it had become apparent that incidence of RTB activity in North Okanagan pine orchards had increased to alarming levels. Lodgepole pine, white pine and yellow pine seed orchard trees are all vulnerable to RTB attack. It was imperative that we monitor for these pests and protect valuable seed orchard trees in five orchards as necessary.

Activities

We developed an RTB control program consisting of a five stage approach.

1. Duff, needles and weeds needed to be removed from the bases of 10,309 trees to allow for efficient monitoring and pesticide application.
2. The trees were monitored for evidence of RTB attack.
3. Where practical beetles were manually removed from attacked ramets before the tree was girdled.
4. We treated 2397 Pli ramets in Bailey orchard 340 with a Sevin XLR bole spray. Orchards 230, 307 and 335 were treated in the middle of June for Mountain Pine Beetle. It was assumed that these orchards would be adequately protected. Orchards 346 and 347 were monitored but a bole spray was deemed unnecessary.
5. For the remainder of the season we continued to survey all 10,309 ramets to assess the efficacy of our control program and to monitor for further attack.

Results

108 orchard trees were attacked by RTB. 11 trees died. We feel that our monitoring and control programs are providing adequate protection from RTB. We will continue to use the knowledge we gained in 2010 to prevent damage to valuable orchard trees.

Output and Deliverables

Our five pine orchards are providing seed for 5 interior SPUs. Seedling demand for these areas totals 26.8 million units annually. Our RTB protection program helped to minimize ramet mortality allowing us to work towards meeting these high demands.

6.1.6 Vernon Seed Orchard Company (VSOC)

Dan Gaudet

Operational Tree Improvement Program (OTIP), has once again provided funding for seed orchard production companies to successfully produce improved seed for Industry and the Province of BC. With OTIP monies, orchards are able to collect scion and graft, control pest, collect pollen for breeding, as well as a multitude of other vital daily tasks which are required to produce the best seed available.

We consistently achieve the Forest Genetics Council (FGC) objectives and we continue to increase the gain, health, production levels and standards of the tree improvement programs of British Columbia.

Vernon Seed Orchard has been diligent in fulfilling contract obligations through required reporting mechanisms. This has been very successful in assuring continued growth and accountability for this vital provincial program.

SPU 1202 Enhancing the Effectiveness of Prince George Orchard 222

Lodgepole Pine is a crucial species for Northern BC and seed production needs to increase through ramet development and increased future production levels. VSOC has begun to replace and increase production trees to reach target level demands set out by the FGC and will continue to develop and pursue silviculture demands through grafting strategies of forward selection parent trees.

1000 ramets were grafted with 2000 ramets held over winter for planting in 2011/12 and insect control was carried out for existing orchard trees.

SPU 1208 Pollination and Pest Management in Prince George Orchard 236

5 litres of pollen from high gain parent trees were collected for SMP. This pollen will maximize gain in potential seedlots.

Insect control, monitoring and spraying for 4500 trees was completed

SPU 1403 Enhancing Production in Prince George Weevil Tolerant Orchard 211 - White Spruce

Disease monitoring and pest control strategies were used for maximizing our largest crop to date in this orchard. A few families that were identified by the breeder were rogued.

SPU 1706 Pollination and Pest Management for Bulkley Valley Orchard 234

Pollen from high gain parent trees was collected for SMP 2500 ramets. This pollen will help achieve and maximize gain in potential seedlots.

Insect control, monitoring and spraying for 2930 trees was completed.

SPU 1801 Enhancing the Effectiveness of Central Plateau Orchard 218

Dioryctria has begun to infest orchard cones. Timing and spray strategies are now in place to effectively prevent further seed loss. Monitoring for this and other pests is ongoing.

SPU 3702, 3703, 4102, 4103, 4301 Increasing Seed Production in Interior Douglas Fir Orchards 231, 232, 233, 225, 226

Douglas-fir orchard seed production has started to flourish in the Interior. Warm seasons have been instrumental in larger than anticipated seed yields. Pollen strategies, pest monitoring and inducing crops through $GA_{4/7}$ are part of the success. Control and good orchard management strategies are a must to be successful.

SPU 4202 Pest Management in Prince George High Elevation Orchard 239

Spider mites, adelgids and other pests can seriously affect crop potential. Funding allows orchards to control potential losses efficiently through sprays and monitoring. VSOC had their first harvest of this seed which is in high demand.

SPU 4057E32 Mountain Pine Beetle Control in Lodgepole Pine Orchards

Spraying for control of the Mountain Pine Beetle has reduced drastically potential tree losses in the interior of BC. Standardized spray schedule applications and trap counts have eliminated virtually all losses. Spray costs are excessive and funding has allowed control measures.

Some key strategies and cost indicators were established in the fall of 2010 by a committee of Industry and Ministry staff. Fixed costs of incremental project items were established in order to make the proposal application, review and approval process more efficient and fair.

Plate 27. Top cross seedlings going to Quesnel.

Plate 28. 2nd gen Sx grafts that are going to VSOC for a new 2nd gen orchard.

Plate 29. Pli grafts. June 10, 2010.

Plate 30. Pli seedlings, June 10, 2010.

6.1.7 Grandview Seed Orchards (PRT Armstrong)

Hilary Graham

Projects 0702, 0721, 1001, 1002, 1007, 210, 4057E35, 0722A and Red Turpentine Beetle

PRT Grandview manages five lodgepole pine orchards and one Douglas-fir orchard, producing seed for the Thompson Okanagan (TO) low elevation and the Nelson (NE) low elevation seed planning units. Three of the Pli orchards are mature (308, 311, and 313), and two are younger orchards (337 and 338) established in cooperation with SelectSeed Company in 2002. The Fdi orchard was also established in 2002 with older grafts and is nearing maturity.

In 2010/11, projects in each of the orchards received OTIP funding for activities to increase the yield and genetic gain of seed produced. These activities included grafting, holding bed maintenance, planting of grafts, roguing, insect and disease monitoring and control, rodent control, crown management, foliar analyses, pollen distribution, pollen collection, flower induction (Fdi only), and supplemental mass pollination (SMP). In addition to the individual orchard projects, two incremental projects were funded for the management of Mountain Pine Beetle, and the Red Turpentine Beetle.

The activities conducted in 2010/11 with the assistance of OTIP funding continue to support our goal of increasing the amount and quality of A-class seed for the Pli NE low, Pli TO low, and Fdi NE low seed planning units. Increasing seed production in these orchards and protecting them from MPB and RTB attack directly supports the FGC's goals by making more genetically improved seed available for use in BC's forests.

Pli orchards

In the spring of 2010, 260 grafts were made to improve the quality of the older Pli orchards 308, 311, and 313. These grafts were maintained in pots in a holding area until September when they were planted out into a field bed for overwintering. Because of a recurring problem with June beetle larvae feeding on the roots of newly planted grafts in the orchards, we decided to delay planting in 2010. While dealing with the June beetle problem, we also delayed roguing for the season.

Pollen management activities began in early May with pollen collection and the distribution of natural pollen using an orchard air-blast sprayer. The SelectSeed Pli orchards 337 and 338 received four SMP applications to supplement their smaller natural pollen clouds. Pollen was collected from the mature orchards 311 and 313 which have an abundant pollen supply. Shedding pollen was collected with backpack vacuums by clone. We collected 3 litres of pollen for the TO low and 1 ½ litres of pollen for the NE low for use in future years.

Foliar tissue samples were taken to determine the appropriate fertilizer mix for spring and fall applications. Throughout the season, we monitored all Pli orchards for insect, rodent, and disease problems. This ensured that measures were taken to protect ramet health and developing cones. A single insecticide spray was applied to control *Leptoglossus* seed bug in orchard 338 but no sprays were required in the other Pli orchards due to low populations of *Leptoglossus*. Poison baits were used to control rodents feeding on tree roots, and Sequoia pitch moth larvae were removed manually. In the fall of 2010, pruning was done in the larger orchards to open up the crowns, restrict ramet height, and maintain tractor access down the rows. Approximately 1/3rd of each orchard (Pli 308, 311, and 313) is pruned each year to maintain a more consistent cone supply from year to year.

All projects were completed as planned in 2010/11. The 2010 cone harvest yielded seed volumes far in excess of expectations. In the Pli Thompson Okanagan Low, we collected 55 kg of seed with the potential to produce 10.1 million seedlings. In the Pli Nelson Low, we collected 19.1 kg of seed with the potential to produce 3.52 million seedlings.

Crop Statistics (0722A)

As part of a collaborative project headed by Michael Carlson at the Kalamalka Forestry Centre, data was collected from orchards 311, 313, and 338 to assess seed orchard seed set and productivity. This data, collected at all interior Pli orchards using a standardized method, will contribute to our understanding of seed-set in the different Okanagan Seed Orchards. This will ultimately lead to recommendations for orchard management practices that will improve seed production.

Fdi orchard

Because of the limited supply of natural pollen, we applied stored pollen to receptive flowers four times (SMP). At the same time, pollen for future use was collected from ramets within orchard 321 that had a heavier pollen load. With only a moderate amount of pollen available in 2010, only one litre of pollen was collected, processed, and put into freezer storage.

Throughout the season, we monitored the Fdi orchard for insect damage to the developing cone crop. An insecticide spray was applied early in the season to protect the crop from *Dioryctria* (fir coneworm), which has caused substantial damage to previous cone crops. Prior to cone harvest, fresh *Dioryctria* attacks were showing up in the crop and a second insecticide spray was required. With two well-timed insecticide sprays there was very little damage evident at the time of cone harvest.

For crop induction, we applied gibberellic acid (GA) to 600 ramets by stem injection. Also, all larger ramets were drought stressed during bud initiation to promote the formation of reproductive buds for the 2011 season.

The 2010 Fdi crop met the expected target with 18.05 kg of seed extracted (892,000 plantables).

Grandview Seed Orchards Incremental Projects

Mountain Pine Beetle - Pli Ramet Protection

In 2010 we continued with a proactive approach to MPB control, applying a prophylactic insecticidal bole spray applied to approximately 5500 susceptible ramets in the five Pli orchards in advance of any beetle flight. In addition, MPB pheromone traps were set up around the PRT Armstrong site to monitor the presence and abundance of beetles in the area. Trap monitoring indicated that the orchards were exposed to moderate populations of beetles during the summer of 2010. However, monitoring of orchard ramets throughout the season showed no MPB attacks on any of the treated orchard ramets. However, a number of windbreak and landscape Pli and Py trees on the PRT site which were unprotected by the spray were attacked and killed during this same period. The presence of beetles and absence of damage in the orchards indicates that the single prophylactic spray was again very effective in protecting our orchards.

Red Turpentine Beetle (RTB)

In 2009 the Pli orchards at PRT suffered numerous RTB attacks (over 350 ramets affected and over 30 ramets killed by the beetle). Ramets with a bole diameter of as little as 3 cm were being attacked and killed. As a result, in 2010, a project was funded to monitor and remove any beetles, and to treat smaller diameter ramets with an insecticidal bole spray. The RTB spray treatment targeted those smaller diameter ramets not already protected by the MPB bole spray. In addition, RTB pheromone traps were set out on the site to determine the population levels around the orchards. Trap catches revealed a peak flight period in early May, which coincided with the bole spray application. Duff and grass was removed from around the base of the boles to facilitate monitoring as the beetles tend to attack at soil level and signs of damage can be difficult to see. Throughout the season all ramets were monitored for beetle damage on a weekly basis. Where evidence was found, beetles were physically removed. In 2010, over 200 ramets were attacked by RTB and 40 ramets died as a result of damage suffered in 2009 and 2010. Constant monitoring and the removal of beetles soon after attack prevented more extensive mortality. The dead ramets were removed from the orchards.

Plate 31. Digging for red turpentine beetle.

Plate 32. Collecting cones for Crop Statistics (Project 0722).

Plate 33. PRT cone harvest crew 2010.

6.1.8 Eagle Rock Seed Orchards (Tolko Industries)

Greg Pieper

Five orchards are managed by Tolko Industries for the Thompson Okanagan seed planning zone. Three of these orchards, two interior spruce and one lodgepole pine, are SelectSeed funded orchards. The four projects funded by the Operational Tree Improvement Program aid in improving the quality and quantity of seed produced for the forest community. In 2010, Eagle Rock produced seed for 4.3 million lodgepole pine seedlings and 30 million interior spruce seedlings for reforestation in the Thompson Okanagan region.

SPU 16 Thompson Okanagan Pli High, Orchards 310 (Tolko) and 339 (SelectSeed), Project 1601

- Male bud and phenology surveys were completed to determine clonal contribution, timing of pollen shed and female receptivity for each clone.
- When surveys indicated optimal receptivity, supplemental mass pollination was completed with the aid of a mist blower and helicopter.
- Pocket gophers were controlled using bait.
- Weekly pest monitoring was completed for *Leptoglossus* and five sprays were required for control.
- *Synanthedon* and *Dioryctria* were manually removed.
- Lateral branches were pruned in orchard 310 to increase access for orchard equipment.
- Foliar samples were collected and sent to Pacific Soils Lab for analysis. Lab results aid in determining fertilization requirements for the following season.
- Phenology and cone collection was completed for OTIP0722. Information and samples were sent to Kalamalka Seed Orchard for processing.

SPU 28 and 30 Thompson Okanagan Sx Low, Orchard 342 and Sx High, Orchard 343, Project 2801

- Due to the sizable cone crop in spruce, induction was only completed on a select number of trees that were healthy and had no cone load.
- Routine monitoring for pests such as *Dioryctria*, Adelgids, *Pissodes strobi*, and *Oligonychus ununguis* was completed. Control for *Dioryctria* was required after pollination and leaders containing *Pissodes* spp. were removed to decrease the population.
- To optimize seed set, SMP was completed with the aid of a mist blower to stir the pollen throughout the orchard.

Incremental Projects
Mitigate the Effects of the Red Turpentine Beetle

- The duff was removed from around each tree to monitor for attacks and make subsequent monitoring more efficient.
- Weekly monitoring of all ramets for attack symptoms, dying trees or feeding at soil line, was completed.
- Treatment with a 2% Sevin spray on the bole of each tree was done to prevent new attacks.

Mountain Pine Beetle Management

- All ramets in orchard 339 were administered one application of 2% Sevin to the boles of the tree in mid June to prevent attacks.
- Routine visual monitoring for evidence of mountain pine beetle attacks on the boles of orchard ramets was completed. No attacks were observed in 2010.
- Pheromone traps were placed in four locations (2 traps per location) around the orchard perimeter. Trap catches were monitored weekly throughout the growing season. Populations have declined from previous years.

Plate 34. Eagle Rock Seed Orchards Overview.

Plate 35. Stirring pollen with the aid of a helicopter.

6.1.9 Prince George Tree Improvement Station (PGTIS)

Rita Wagner

SPU 1203, 1802, 1702

Activities are aimed at increasing the quantity and quality of lodgepole pine seed from Orchard 220 (Prince George low planning zone), Orchard 223 (Central Plateau low planning zone) and Orchard 228 (Bulkley Valley low planning zone).

Five Operational Tree Improvement Projects were conducted at the Prince George Tree Improvement Station in 2010-2011.

Phenology surveys were completed to keep track of receptivity periods which can vary considerably from year to year. Pollen flights were monitored. Outside pine pollen flight is basically non-existent due to the devastation caused by the mountain pine beetle.

October foliar samples were taken for nutrient analyses. Fertilizer applications were increased ensuring maximum ramet health.

Branch damage caused by hydraulic lifts, heavy & wet snow loads and strong winds required tree maintenance. Surveys for western gall rust, *Elytroderma* needle cast, *Lophodermella* pine needle cast, *Zelleria* pine needle-sheath miner, *Cecidomyia* pitch midge, and various other insects were completed. *Cecidomyia* and *Zelleria* caused considerable flower abortion, and spot surveys were conducted to keep track of severity of outbreak. Topping of 30% of orchard trees was completed.

Lindgren traps were set up throughout the site to monitor secondary bark beetle flights (mainly *Ips*). As in 2009, mountain pine beetle activity in the Prince George area continued to drop in 2010.

Despite some roguing and three consecutive excellent crop years, our three lodgepole pine orchards produced the second largest crop in 2010. The three provenance orchards yielded 63.388 kg of seed, the equivalent of approximately 13.28 million potential seedlings with a genetic worth of 6%.

Some squirrel trapping was required to avoid seed loss and loss of potential cone sites.

SPU 1412 & 40U0023

Management of interior spruce clone banks at the Prince George Tree Improvement Station is designed to ensure the availability of scions to replace existing orchard ramets or develop new orchards to boost productivity and gain. The Interior Spruce Clone Banks at the Prince George Tree Improvement Station provide vital support to the orchard and tree breeding programs in BC. The clone banks are a centralized source of scion material for the grafting of new and improved seed orchards. They contain the only copy of many of the interior spruce parent tree selections found in seed orchards and breed arboreta.

The following activities were carried out:

- Maintenance of 250 grafts planted in 2008.
- Tagged 100 small ramets.
- Replaced unreadable tags on 120 ramets and moved 400 tags to prevent girdling.
- Planted 100 grafts into various clonebanks.
- Updated clonebank data base and created 1-page field maps for each clonebank.
- Topped 520 trees to a height of 3.5 to 4.0 m.
- Pruned bottom branches up to 0.5 to 1.0 m in the Ft. Nelson and Quesnel Lakes Expansion clonebanks, including moving of tags.

To ensure good ramet health the following management activities were carried out in the 12,000-tree clone banks: inventories, irrigation maintenance, fertilization, mowing and weeding/brushing, label replacement and foliar sampling. Extensive headland mowing was necessary to control weeds and prevent brush from moving in. Insect (root collar weevil and spruce leader weevil) and disease monitoring was carried out to keep abreast of potential pest problems.

Plate 36. Crew celebrating 2nd biggest crop from three provenance orchards.

Plate 37. Planting Quesnel Lake Spruce CB.

Plate 38. Joe Toth CPF 223 roguing.

Plate 39. Bulkley 228 finishing mower.

Plate 40. Ian Wayland rock picking in Bulkley 228.

6.1.10 Skimikin Seed Orchards

Keith Cox and Karen Turner

Summary for Projects 404, 411, 501, 1503, 3502, 4002, and 4057E13.

Work was funded in ten of the seed orchards, the research plantations, and to help monitor and control the Mountain Pine Beetle infestation at Skimikin in 2010.

Nelson Mid and High Sx (SPUs 404 & 501)

The West Kootenay (Nelson Mid and High elevation) spruce orchards had 145 replacement grafts maintained in the holding area. The orchards were surveyed for insects and disease; three rust brooms (*Chrysomyxa arctostaphyli*), and thirteen weevil (*Pissodes strobi*) attacked tops were removed, rodents were baited, and the orchards were sprayed for spider mites and *Dioryctri*a.

Orchard 301 (Nelson mid) had a crop of 79.8 hl yielding 111.23 kg and orchard 302 (Nelson high) had a crop of 100.0 hl yielding 147.50 kg.

Prince George Low Pli (SPU 1211)

Orchard 352, comprised of parents selected in two progeny tests for Western Gall Rust Resistance, was planted in the fall of 2009. The 4134 ramets were monitored for insects and disease and baited for rodents. About 10 to 15 trees died from rodents chewing the root systems, mostly throughout the first winter and early spring. The field had previously been an unused hay field and no rodent control had been done so the initial population was quite high when the orchard was planted.

Kamloops-Quesnel Pw (SPU 1503)

The white pine orchard (#609) was monitored extensively because of the mountain pine beetle, the pine cone moth, and *Dioryctria* resulting in 42 trap counts being done over the season, plus many visual surveys. The orchard was sprayed with Sevin XLR in late May for the mountain pine beetle using two orchard lifts fitted with spray units. No trees were attacked. The crop was 38.0 hl and yielded 29.2 kg.

Bulkley Valley Low Sx (SPU 3502)

The three spruce orchards for the Bulkley Valley Low were sprayed for spruce cone rust, spruce budworm, and *Dioryctria*. Twelve weevil attacked tops and two rust brooms were removed. The 398 replacement grafts were maintained in the holding area.

The crop was 303.8 hl and yielded 412.56 kg of seed.

Peace River Low and Mid Sx (SPU 4002)

In the spruce orchards for the Peace River low and mid elevation zones (#212 & #213) the 3776 trees were monitored for insects, disease, and rodents. Orchard 212 was sprayed for spruce budworm, spider mites, cone rust, and *Dioryctria*. Orchard 213 was sprayed with Btk for spruce budworm. A total of 44 weevil damaged tops were removed and the orchards were baited extensively for rodents. The 168 replacement grafts were maintained for orchard 213.

The crop in orchard 212 was 121.2 hl and yielded 107.6 kg.

Research Plantations (SPU 411)

The on-site research plantations were also monitored for insects and disease and baited for rodents. The youngest spruce plantation was sprayed for spruce budworm. The *Ribes* garden was maintained and white pine seedlings were inoculated in September. The white pine Age Related Resistance Trial (ARRT) was planted at its final spacing and was treated for cutworms in June. The sites where plantations were removed in 2009 were cultivated and reseeded. A lodgepole pine plantation was removed in the summer, to reduce the red turpentine beetle population, and a lodgepole pine demonstration, a hybrid aspen plantation, and two birch plantations were removed in the fall.

Mountain Pine Beetle (4057E13)

Extensive monitoring was done for the mountain pine beetle and orchards 345 (Py) and 609 (Pw) were sprayed with Sevin XLR in late May. The beetle traps were checked once a week and the trap counts peaked the third week in July, with a few counts being over 100. This was down considerably from 2007 when many of the trap counts were in the 1000s when the traps were being checked twice a week.

Plate 41. Cone collection in Sx orchard 301 SPU 404.

Plate 42. Cone collection in Pw orchard 609 SPU 1503.

Plate 43. Cone collection in Sx orchard 302 SPU 501.

Plate 44. Cone collection in Sx orchard 212 SPU 4002.

Plate 45. Cone collection in Sx orchard 207 SPU 3502.

6.1.11 Kettle River Seed Orchard Company (KRSO)

Rick Hansinger

Pollination And Pest Management in Central Plateau Orchard 238 – Lodgepole Pine (SPU 18)

Objectives

• Collect and store 3.0 litres of pollen for SMP in young Pli Orchard 238 to increase the production of Class A seed to 500,000 plantables by summer 2011.
• Minimize filled seed losses from predation by *Leptoglossus* through pesticide applications.

Results

• 4.9 litres of pollen was vacuum collected in the Pli CP low orchard; then cleaned, dried and stored for application spring 2011. (Genetic Worth G+21 class A). Approximately 3600 ml of pollen was applied to 2,200 ramets during the receptivity period from May 20 to June 10. The Central Plateau pine orchard is now producing sufficient pollen to meet SMP needs. Three SMP passes were completed in order to ensure early and late receptive clones received sufficient pollen to fertilize female conelets. Remaining late pollen was air blasted with a turbo fan sprayer.
• Developing cones were inspected for the presence of *Leptoglossus* and the risk to the seed crop was deemed negligible; pesticides were not applied.

Output and Deliverables

• 28.6 hl of cones were collected. The final seed crop is 4.337 kg of seed with a future potential of yielding 984,499 seedlings.

Pollination and Pest Management in Prince George Orchard 237 – Lodgepole Pine (SPU 12)

Objectives

• Collect and store 4.0 litres of pollen for SMP in young Pli Orchard 237 to increase the production of Class A seed to 500,000 plantables by summer 2011.
• Minimize filled seed losses from predation by *Leptoglossus* through pesticide applications.

Results

• 4.7 litres of pollen was vacuum collected in the Pli PG low orchard; then cleaned, dried and stored for application spring 2011. (Genetic Worth G+16.7 Class A). Approximately 4.9 l of pollen was applied to 2,500 ramets during the receptivity period from May 20 to June 10. The Prince George Pli orchard is now producing sufficient pollen to meet SMP needs. Three SMP applications were completed in order to ensure early and late receptive clones received sufficient pollen to fertilize female conelets. Remaining late pollen was air blasted with the turbo fan sprayer.
• Developing cones were inspected for the presence of *Leptoglossus* and the risk to the seed crop was deemed negligible; pesticides were not applied.

Output and Deliverables

• 26.7 hl of cones were collected yielding a total of 3.972 kg of seed with a future potential of yielding 901,644 seedlings.

Plate 46. Gina Hansinger collecting pollen with Tail Vac in Pli CP low.

Plate 47. Pollen collection crew using Tail Vac in Pli CP low. 13.5 litres of pollen collected in 4 working days, from May 30 to June 5, 2010.

Plate 48. 90 horsepower tractor and 36" Turbo Mist Turbo Fan sprayer ready to commence moving pollen in the orchard.

Plate 49. Sprayer in action creating ideal air flow conditions to assist fertilization of receptive female conelets.

Plate 50. Clone 2082 in KRSO Pli CP low orchard showing prolific tendency to produce female conelets. Approximately 100 receptive females on four branches. All 2082 ramets in the orchard are good producers although this particular ramet went above and beyond the call of duty.

6.1.12 Sorrento Seed Orchards

Hilary Graham

OTIP 1707, 1803 and 4057E37, 4057E37 and Red Turpentine Beetle

Sorrento Seed Orchards manages two large lodgepole pine orchards established in 2003 in partnership with SelectSeed Company. These orchards supply seed for the Central Plateau (CP) low elevation and the Bulkley Valley (BV) low elevation seed planning units. The first cone crops were harvested in 2007.

In 2010/11 OTIP funding was approved to maximize potential seed yield through pollen application (SMP), pollen collection, and protecting the crops from insect damage. With the orchard ramets increasing in size and susceptibility to attack from the Mountain Pine Beetle (MPB), an incremental project for MPB monitoring and protective spraying was approved. Also, given the potential risk from the Red Turpentine Beetle (RTB), a project was approved to monitor and remove any beetles, and to treat smaller diameter ramets not already protected by the MPB bole spray.

While the orchards at Sorrento are growing rapidly and approaching maturity, they continue to produce very little pollen and SMP is required for adequate fertilization. For the CP orchard, pollen was purchased from the Vernon Seed Orchard Company (VSOC) where a mature CP orchard is established. Pollen was collected for the Bulkley Valley orchard using backpack vacuums from a mature orchard at VSOC. This pollen was applied four times to all receptive flowers during the pollination period. Thanks to the staff at VSOC for providing access to the pollen required.

Monitoring for cone and seed pests was done weekly from mid-May to September to determine the need and timing for control measures. *Leptoglossus* seed bug was not observed until the time of cone harvest, and spraying was therefore not necessary.

Plate 51. Pli Central Plateau low orchard at Sorrento.

Mountain Pine Beetle (MPB)

In late May a protective insecticidal bole spray was applied to approximately 700 susceptible ramets in the two Pli orchards. MPB pheromone traps were set up and monitored for the season, indicating a small population of beetles in the area around the orchards. Orchard ramets were monitored throughout the season for any sign of MPB attack, and no ramets were affected.

Red Turpentine Beetle (RTB)

In 2009, the Pli orchards at PRT in Armstrong experienced significant attack, damage, and mortality by the RTB. As a result, preventative measures were taken by all other Pli orchards in the Okanagan/Shuswap to avoid losing orchard ramets to this destructive bark beetle. At Sorrento, approximately 3200 ramets in the two orchards were bole sprayed with Sevin insecticide to protect from beetle attack. The RTB bole spray targeted those smaller diameter ramets not already sprayed for protection from MPB.

Duff and grass was removed from around the base of the boles to facilitate monitoring as the beetles tend to attack right at soil level. Also, throughout the season all ramets were monitored for beetle damage. Where evidence was found, beetles were physically removed from the ramets. In 2010, 16 ramets were attacked by RTB and 9 of those died as a result. The dead ramets were removed from the orchards.

Early seed production in these young orchards, and their protection from MPB and RTB attack directly supports the FGC's goals by making more genetically improved seed available for use in BC's forests. Cones harvested in the Bulkley Valley orchard yielded 614,000 plantables in 2010. In the Central Plateau orchard, the 2010 harvest yielded approximately 415,000 plantables. These yields meet the targets in the FGC 2010/2011 business plan.

Plate 52. Monitoring for red turpentine beetle in the Bulkley Valley orchard at Sorrento.

6.2 Technical Support Programs

6.2.1 Increasing Quality, Genetic Gain, and Quantity of Yellow Cypress Cuttings

Mark Griffin, John Ogg, Craig Ferguson and John Russell

SPU 1113

Introduction

This project involves increasing the quantity and quality of high-value yellow cypress cuttings for the coastal program. Objectives include:

1. provide the cultural treatments required to improve hedge production.
2. enhance hedge composition by replacing lower-genetic-value families and clones with newly tested, improved clones.

20010/2011 Highlights

Pruning of hedges occurred in June 2010.The media for the greenhouse-grown container-planted donor plants contained APEX 16-5-11, augmented bi-weekly with applications of hi-sol.

In the autumn of 2010 there were 9400 donor plants in the operational hedge. The estimated number of cuttings available from this hedge is currently estimated at 173000 plants. Roguing has been deferred until 2011. 2800 cuttings from series 2 were transplanted from 160's into 615 blocks and 2800 cuttings from series 1 were potted in an effort to maximize increased growth rate while maintaining genetic variability.

In an effort to increase the rooting success of the clones in the hedge, some 2800 cuttings were set to test hedge root ability. A sampling of every clone from series 1&2&3 in the greenhouse was set to test each clone's propensity to root. Clones will be evaluated and poor performing clones may be removed from production. Clones are being evaluated annually on an ongoing basis

In late 2010, some 20,000 cuttings from the operational hedge were supplied for production to reforestation nurseries.

6.2.2 Estimating Pollen Contamination in Coastal Seed Orchards

Joe Webber

SPU 0113

Contamination levels in two coastal Douglas-fir orchards (2010) were 46.1% and 19.9% for Western Forest Products (WFP - 166) and TimberWest (TW - 183), respectively. These values are higher than expected; 2009 was the highest recorded for the last six years. Orchard receptivity period in both orchards was the same this year (April 01-21). Orchard pollen loads for the receptivity period were considerably different for the two orchards. Table 4 shows the pollen load for the receptivity period of the orchard (ORCH PL) and regional monitors (REG PL). The biggest difference between 2009 and 2010 is the orchard pollen load for WFP which in 2010 was about 67% less than in 2009. Regional pollen loads were the same for both orchards in 2010 (same receptivity periods) but differed substantially in 2009 (different receptivity periods).

Table 4 also shows contamination values determined from DNA paternity analysis (2005-2007) which agree well with pollen monitoring data based on a simple ratio of pollen load from regional to orchard values summed over the receptivity period of the orchard. Because 2009 values were the highest recorded for both WFP and TW, Dr. Yousry El-Kassaby is currently determining contamination values from DNA analysis.

The other important feature in 2010 was the protracted receptivity period. This allowed the calculation of the orchard adjustment factor (OAF) according to the green book protocol (Woods et al. 1996). Table 5 shows the range of the OAF for both the mean of three Regional (-R) monitors and one orchard OUT (-O) monitor (used by the orchards for their regional pollen load calculations). Table 5 also shows the adjusted Regional and Out pollen load values with their corresponding contamination values. Although not an objective for OTIP 0113 (2010), corresponding pollen load and contamination values for the MFLNRO orchard 199 are also included.

The OAF values shown in the above table were all greater than 1 for Regional monitoring and only WFP OUT monitor data produced an OAF value less than 1. In my opinion, the OAF factor is not useful since it is very dependent on which dates are used and has not improved our estimates of contamination when both pollen monitoring and paternity data are compared.

Table 4

	WFP						TW		
	2005	2006	2007	2008	2009	2010	2008	2009	2010
REG PL	4.6	6.7	24.6	7.3	39.1	12.7	3.2	23.0	12.7
ORCH PL	96.3	54.6	114.6	48.9	85.4	27.5	28.6	67.8	63.7
% Contamination									
PM	4.8	12.5	21.5	14.9	45.8	46.1	11.2	34.0	19.9
DNA (Stoehr)	9.7	11.7	19.3	na	na	na	na	na	na
DNA (El-Kassaby)	10.5								

Table 4. Coastal Douglas-fir orchard pollen contamination values based on the ratio of regional pollen load (REG PL) to orchard pollen load (ORCH PL) in Western Forest Products (WFP orchard166) and TimberWest (TW orchard 183) for the years 2005 to 2010 (WFP) and 2008-2010 (TW). Contamination values based on paternity analysis by Stoehr and El-Kassaby are shown where available.

Table 5

	Pollen Load		no OAF		OAF	
Orchard (Orch)	6-Weeks	Recep	%Contam-R	%Contam-O	%Contam-R	%Contam-O
WFP	31.9	27.5	46.2	37.8	79.6	18.5
TW	75.3	63.7	19.9	22.0	95.7	33.9
MFLNRO	33.4	12.0	38.3	45.0	61.3	61.3
Regional (R)	6-Weeks	Recep	OAF per Protocol		Adjusted-REG	Adjusted-O
WFP	20.3	12.7	2.0	0.4	25.4	5.1
TW	20.3	12.7	4.8	1.7	61.0	21.6
MFLNRO	20.3	4.6	1.6	1.6	7.4	7.4
Orchard-OUT (O)	6-Weeks	Recep				
WFP	20.8	10.4				
TW	22.3	14.0				
MFLNRO	14.3	5.4				

Table 5. Calculation of Douglas-fir contamination from orchard (ORCH) and regional (REG) data with and without the Orchard Adjustment Factor (OAF). Contamination was also calculated using each of the three orchards OUT data.

6.2.3 Collection of Crop Statistics for Interior Lodgepole Pine Orchards

Final Report OTIP 0722 - 2010 Summary

Prepared for Michael Carlson by Joe Webber

The full report is available at this url.

http://www.fgcouncil.bc.ca/2010_OTIP_0722_final_summary.pdf

Executive Summary

Seed yields (filled seeds per cone) from north Okanagan (NO) orchards have not met expectations compared with seed yields routinely realized at Prince George (PG). This report summarizes the 2010 data collected for eight of the original 12 NO orchards, six new expansion NO orchards and two PG lodgepole pine seed orchards. It also provides a summary of annual statistics for cone and seed yields from eight of the original 12 orchards over the period of 2006 to 2010.

In previous years, higher seed yields per cone but fewer cones were observed at PG. However, in 2010, PG orchards produced similar number of cones per tree compared to the eight NO orchards and six expansion orchards. The PG orchards produced more seed per cone (20.6) than the eight older orchards (11.5) and six new orchards (8.3). Similar values were observed for the total number of seed per cone. The number of cones per tree from KAL 230 has consistently been the highest over the five year period with seed yields similar to those observed in PG.

The number of seed per ramet between NO and PG was 3217 and 5902, respectively. If NO orchard 230 were excluded, the difference between NO and PG would be even greater. The mean number of seed per tree from the eight old and six new orchards was 4120 and 2186, respectively. Both PRT 338 and Tolko 339 produced over 3000s seed per tree which was similar to the mean number for all NO orchards (excluding KAL 230).

Bagging effects were also monitored in 2010. On average, bagged cones produced about 5 seed per cone more than unbagged cones (15.9 versus 11.0 filled seed per cone). Over the five years observation, the loss of seed from unbagged cones ranged from about 2 to 5 filled seed per cone. The greatest loss of seed occurred at Kalamalka. There was no seed loss from unpegging cones at PG.

In 2010, an attempt to determine when seed losses from bagging occurred was repeated. In this trial, cones were exposed for a two week period beginning late April and continuing through late August. Seed yields for each of the 9 exposure periods were then compared to seed yields from cones always protected (bags always on) and cones never protected (bags always off).

Substantial seed losses occurred late in the season. Seed losses were largest at KAL, less so at PRT and least at VSOC. Debate continues about the cause of this seed loss. One side of the argument suggest the losses are too large to be caused by insects alone. However, it is difficult to suggest a mechanism by which a fully formed embryo in July disappears in August. Since inferences on timing of seed losses can not be made from one year data, this experiment is intended to be repeated in 2011.

We continue to see about 10-15 fewer seed per cone from NO orchards compared to PG orchards. If bagging effect accounts for about 3-5 seed per cone, we still can not account for about 5-10 fewer seed per cone from NO orchards. The only way we can understand how embryos from post-dormant first year cones are lost in the second year cone is to complete comprehensive developmental studies.

7.0 Extension Technical Advisory Committee (ETAC)

Diane Douglas

This past year was a year of cooperative projects and funding participation!

Workshops

ETAC members participated in the development and delivery of the following workshops.

International Cedar Symposium "A Tale of Two Cedars Symposium" May 25-28, 2010
The organizing committee included Barb Hawkins (UVic), Jodie Kradowski, John Russell and Diane Douglas (MFLNRO), Paul Hennon, USFS, Alaska and Connie Harrington, USFS, Washington state. More than 60 people attended the full workshop with 9 additional people attending the silviculture session.
On-line conference proceedings are at:
http://treesearch.fs.fed.us/pubs/36731
Hard copies are available at: http://www.fs.fed.us/pnw/publications/gtrs.shtml

Deer Browse Resistant Cedar Workshop (John Russell) – June 2, 2010 CLRS. 50 people attended

Coastal White Pine and Sitka Spruce Deployment Workshop October 19, 2010 This was managed through the Coast Region Implementation Team (CRIT) and Campbell River Forest District with 30 people in attendance.
http://www.for.gov.bc.ca/rco/stewardship/CRIT/index.htm http://www.for.gov.bc.ca/rco/stewardship/CRIT/docs/PwSsCoastannounceOct.pdf

UBC/Coastal Technical Advisory Committee Extension meeting held at UBC - November 23, 2010 – student presentations. (organized by Sally Aitken and Annette van Niejenhuis)

Coastal Breeders Biennial Extension Meeting & Field Trip, Victoria – November 30 & December 1, 2010.

On-line presentation by Laura Gray's, December 20, 2010
"An Update on Matching Planting Stock with Environments for Reforestation Under Climate Change"
http://www.for.gov.bc.ca/ftp/HTI/external/!publish/Laura_Gray/

Publications

A number of extension publications and posters were completed.

- PMTAC - Pest Leaflets http://www.fgcouncil.bc.ca/doc-pestmaninfo.html
- Verifying genetic gain estimates in coastal Douglas-fir in British Columbia, Extension Note 104 – Michael Stoehr et al. https://www.for.gov.bc.ca/hfd/pubs/Docs/En/En104.htm
- Seedlot Genetic Worth Values Verified for Coastal Douglas-fir at age 12, FGC Fact Sheet 2 – Jack Woods et al. http://www.fgcouncil.bc.ca/Factsheet2-DFir-13Apr11-Web.pdf
- Forest Genetic Conservation Posters – 5 posters prepared - Jodie Krakowski http://www.for.gov.bc.ca/hfd/pubs/Docs/P/P085.htm
- Whitebark Pine Background Paper - Don Pigott http://www.fgcouncil.bc.ca/Factsheet1-WhitebarkPine-27May10-Web.pdf
- Fungal Assay Poster - Dave Kolotelo http://www.for.gov.bc.ca/hti/publications/tsc/Fungal_Assay_Poster_sm.pdf
- TICtalk http://www.fgcouncil.bc.ca/TICtalk_September_2010.pdf

DEER BROWSE RESISTANT WESTERN REDCEDAR WORKSHOP

Wednesday, June 2, 2010
Cowichan Lake Research Station (map attached)

Accommodation available at Cowichan Lake Research Station. http://www.for.gov.bc.ca/hre/forgen/cclrs_oc.htm

Field tests of deer browse-resistant seedlots have produced encouraging results. Trees have been selected that are "not-preferred" (putatively resistant) by blacktail deer based primarily on needle monoterpene content, which is highly heritable in western redcedar. However, deploying only "resis material may alter deer behaviour if there is no alternative food source available. Preliminary deployment trials involving mixtures of needle monoterpene levels through genetic selection and stocktype have been encouraging. The next step is to test this material in larger-scale operational settings to determine optimal mixtures of preferred and not-preferred seedlings across different site types and silvicultural treatments. To achieve this goal a co-operative approach is necessary involv growers, field foresters and researchers.

Agenda:

0800	**Breeding for browse resistant populations** John Russell, RB, MFR **Issues surrounding deployment of mammal resistant planting stock** Bruce Kimball, USDA/MONELL Sensing Lab, Philadelphia, PA Opportunity to phone in for these presentations. (call info TBA)
1030	**Tour of deer resistance research at CLRS**
1200	Lunch at the historic cookhouse
1300	**Deployment research with browse resistant *Eucalyptus*** Julianne Wapstra-O'Reilly & Brad Potts, U. of Tasmania, AU(presented by J Ru **Deployment research with browse resistant western redcedar** John Russell and Bruce Kimball **Discussion on developing a co-operative to support operational deployment trials.** (Opportunity to phone in for presentation and participate in the discussion.TBA
1530	Depart for tour of deer preferred and not-preferred seedlings at Holt Creek field site.
1700	Conclusion

There is no charge. Please register at:
http://www.fs.fed.us/pnw/olympia/silv/CedarSymposium.html or contact:
John Russell, John.Russell@gov.bc.ca, 250.749.6811 ext. 26 or
Diane Douglas, Diane.L.Douglas@gov.bc.ca, 250.356.6721

Plate 53. A Tale of Two Cedars and Deer Browse Resistant activities.

ENCOURAGING DEPLOYMENT OF WESTERN WHITE PINE AND SITKA SPRUCE IN THE COAST FOREST REGION. A LOOK AT RECENT ADVANCES IN PEST RESISTANCE

Campbell River
0800 - 1630 October 19 2010

Location: Campbell River Area (District office and local area field sites)

Purpose: Provide operational foresters with the latest information regarding operational performance of rust-resistant western white pine and weevil resistance Sitka spruce on the British Columbia coast.

Target Audience: Operational Foresters and silviculturalists with an interest in managing for western white pine and Sitka spruce on the BC Coast.

Objectives:

- Review rust-resistance mechanisms and breeding program for rust resistant white pine
- Review weevil-resistance mechanisms and breeding program for weevil resistant Sitka spruce
- Review identification, history and impact of both white pine blister rust and spruce weevil
- Present and discuss data on the performance of both rust-resistant white pine and weevil resistant Sitka spruce
- Review weevil risk hazard rating methods and their application
- Review blister rust hazard rating methods and possible application
- Discuss opportunities for increased use of western white pine and Sitka spruce on the BC coast
- Discuss management recommendations for the use of rust-resistant white pine and weevil –resistant Sitka spruce

Registration:
There is no registration fee for the workshop Please bring a bag lunch.

Respond to: Craig Wickland Craig.Wickland@gov.bc.ca or
Scott Dunn Scott.Dunn@gov.bc.ca with your name and contact information if you would like to attend the one day workshop.

Registration will be confirmed and an agenda sent by e-mail to participants approximately 1 week prior to workshop.

Ministry of Forests and Range

Plate 54. White pine and Sitka spruce field day.

8.0 Seed Orchard Pest Management

Jim Corrigan

The Seed Orchard Pest Management Subprogram supports research, extension activities, and orchard-level pest management to increase orchard yields of high quality seed. Research and extension are handled by the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), Tree Improvement Branch.

Dr. Ward Strong leads the research component. Jim Corrigan delivers extension services. Seed orchard personnel handle pest management activities in the seed orchards. The Pest Management Technical Advisory Committee (PMTAC) guides investments and activities, and is comprised of members from MFLNRO Tree Improvement Branch, the Canadian Forest Service, private seed orchards, universities, and the Forest Genetics Council. Research plans and budgets are established through an annual process of proposal development and discussions by the PMTAC. This fiscal, the PMTAC administered projects on conifer seed bug, fir coneworm, novel pesticides, a cone and seed insect field guide, lab and technical research support, as well as interior cone and seed pest management extension operations (previously administered through the OTIP subprogram). Projects are summarized in Table 6.

Project	Species primarily impacted	Progress
Contarinia oregonensis Host-finding mechanisms	Fd	Due to late delivery of funding, this project was restricted to purchase of equipment required for future studies.
Fir coneworm (*Dioryctria abietivorella*) Reproductive biology	Fd, Sx, Lw, Pw	This project, in collaboration with University of Alberta, was wrapped up with funding to finish data analysis, writing, and graduate student thesis submission.
Conifer seed bug (*Leptoglossus occidentalis*) Seed bug dispersal, host selection, and abundance study.	All Pinaceae	Seed bug dispersal, host selection, and abundance study. (University of Northern BC (UNBC); UBC – Okanagan). Data collection for this project, in collaboration with UNBC, was wrapped up. Data analysis as well as writing of reports and M.Sc. thesis continues.
Cone and seed insects: Host-finding mechanisms	All Pinaceae	Continuing studies in collaboration with Simon Fraser University investigated the interaction of visible light, infrared radiation, and host shape in host finding by *Leptoglossus occidentalis*, *Dioryctria abietivorella,* and *Contarinia oregonensis*.
Cone & seed insect control: Trials of novel pesticides	All species	Continuing studies of foliar sprays from 2009, this project selected the most promising pesticides for further testing in 2010.
Cone and seed insect field guide	All species	The field guide has been completed with 14 Pest Management Leaflets produced. These are available at http://www.fgcouncil.bc.ca/doc-pestmaninfo.html
Research lab and technical support	All species	Funding was provided for on-going lab operations and technical assistance in support of research activities.
Interior pest management extension operations	All interior species	Funding provided on-going extension support to Interior seed orchards and natural stand seed production personnel.

Table 6. Pest Management TAC projects..

Plate 55. Pesticide trial - Mario Lanthier's employee applying pesticides for the pesticide trial. (photo Mario Lanthier)

Plate 56. Bug dorms - colonies of conifer seed bugs for the UNBC dispersal and host selection study. (photo Ward Strong)

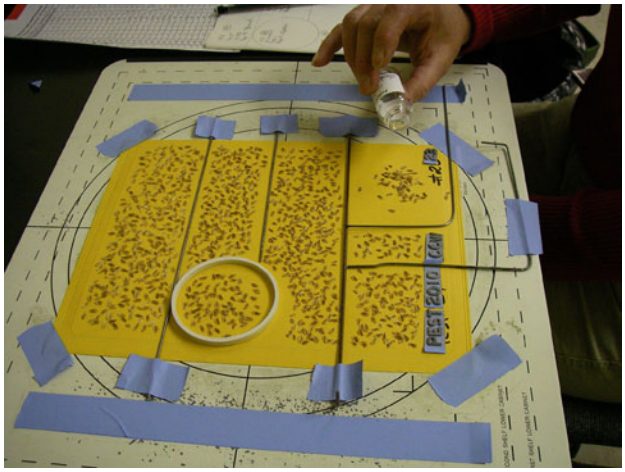

Plate 57. Seed X-rays - setting up seeds for X-raying to determine insect damage. (photo Ward Strong)

Plate 58. Douglas-fir cones damaged by fir coneworm, *Dioryctria abietivorella*. (photo Jim Corrigan)

Plate 59. *Eucosma recissoriana* adult on white pine needles. (photo Jim Corrigan)

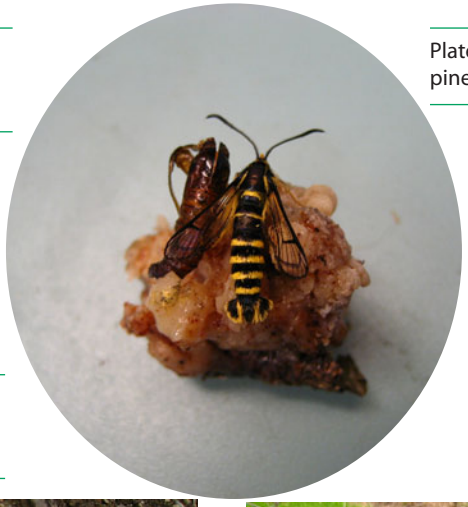

Plate 60. (Centre) Adult pitch moth, *Synanathedon sequoia*, just after emerging from pitch mass. (photo Jim Corrigan)

Plate 61. Larvae of the black cutworm, *Agrotis ipsilon*, found under a cocomat after attacking a white pine seedling. (photo Jim Corrigan)

Plate 62. Faye Klassen applies fabric wrap to a lodgepole pine ramet to protect it from boring damage caused by the pitch moth, *Synanathedon sequoiae*. (photo Jim Corrigan)

9.0 Retired Friends and Colleagues

Helga Mehl

Helga Mehl retired in October 2010. She started with the Ministry in May 1982 working in seedling physiology lab at the Glyn Road Research Station (nowadays known as Research Branch Laboratory or RBL). Later she moved to the container seed orchard program, where she was involved in controlled pollination, herbicide, and pruning studies, as well as stock maintenance. Helga then worked with Sylvia L'Hirondelle on seedling frost hardiness and UV b tolerance, until another Ministry re-org, after which she ran the Molecular Genetics lab at RBL. Her ability to quickly learn the complicated molecular DNA techniques and her attention to details during any trouble shooting allowed her to efficiently gather large amounts of DNA data for fingerprinting and genotyping of seed orchard clones. This work resulted in data that formed the basis of several peer-reviewed articles, which is a direct reflection of her high quality of work. Most recently, Helga worked in the Analytical lab with Clive Dawson's group.

Helga moved with her husband Ron, dog Luke and cat Lucy to Pender Harbour (near Sechelt) where she enjoys hiking, cycling, paddling and honing her wine expertise. (Helga passed the third level to be a professional sommelier in 2009). So, when you visit her and Ron make sure you don't bring the cheapest wine ...

Helga's many contributions to Forest Genetics Research and Tree Improvement are much appreciated.

Plate 63. Helga Mehl.

Keith Cox

After 33 years with the Forest Service, Keith retired from the Skimikin Seed Orchard as the Seed Orchard Supervisor on February 28, 2011.

After Keith graduated from BCIT in 1977, he worked for the BCFS Engineering Division, establishing the high water mark for the Revelstoke Dam reservoir, then up to Houston surveying the Morice River Forest Road, along with a winter stint in the Victoria office. In May 1978, Keith was offered a job at the newly established Skimikin Seed Orchard. In June 1978, this involved selecting spruce parent trees for the rest of the summer and fall and then switching to scion collection in mid November. In mid March 1979 he parked the snowmobile and put away the rifle and began helping organize for spring planting. At this time there were five seed orchard staff at Skimikin: Maarten Albricht, Gary Clarke, Keith Cox, Madelaine Dunleavy, and Arne Ericson.

In 1976, Keith married Noelle, his wife of 35 years and counting. Keith and Noelle have two children, Jennifer born in October 1980 and Graham in November 1983.

1981 saw some shifting from field selections and scion collection to orchard management and Keith was promoted to the Supervisor of the Skimikin orchard site. Reasonable crops were produced in 1987 and 1990 and then came the giant crop of 1993.

Over Keith's tenure, since 1978, the Skimikin Seed Orchard has grown to be the second largest Ministry seed orchard with over 20,000 seed producing trees of spruce, white pine, lodgepole pine, yellow pine and paper birch. Keith has left the Skimikin Seed Orchard in great shape to produce the next generation of improved seed for the interior of British Columbia.

Plate 64. Keith Cox.

Carolyn Lohr

Carolyn began her Forest Service career January 2, 1992 at Saanich Seed Orchard and worked there until her retirement in January 2011.

Coming from an agricultural background in Alberta, Carolyn quickly adapted her Bachelor of Science in Agriculture plant science and horticulture expertise towards forest trees and seed production. Under Carolyn's steady guidance, the Saanich Seed Orchard transformed from being a single species, single orchard site to having five species of almost 5,000 trees including the new 3rd generation coastal Douglas-fir. Due to this site transformation, Carolyn became an expert in drainage systems, irrigation systems, septic systems, heating systems, alarm systems, greenhouse management, fence and road construction, tree reproduction biology, tree nutrition and fertilization analysis and application, along with a myriad of other details that are required in running a modern day seed orchard site.

When not working at the orchard, Carolyn, husband Wayne, and children Ami and Krystal were heavily involved in the local 4-H Horse Club, as well as breeding, raising and showing Quarter horses.

In 2004, Wayne's employment required the family move to Olds, Alberta. Carolyn remained with the seed orchard and became a WestJet commuter until her retirement when she returned to married life, joining Wayne on the farm in Olds. Her daughters live nearby and Carolyn is enjoying spending time with Wayne and the girls and extended family all living in Alberta. She has taken over many of the farm maintenance projects and spends much of her time training and riding their many quarter horses, being entertained by and caring for their two boxer dogs, Julie and Stella, and generally enjoying being on the farm with views of the Rocky Mountains from the pasture.

Plate 65. Carolyn Lohr, tree planting at Saanich Seed Orchard.

Gladys Baird

After 29 years with the Forest Service, Gladys retired on February 7, 2011 from the Saanich Seed Orchard as a Forest Technician.

Gladys began her career as an auxiliary Orchard Technician at the Koksilah Seed Orchard in Duncan. During this period of time, the Cobble Hill Seed Orchard was being developed and Gladys soon found herself working between the two sites. Upon privatization of the Koksilah Seed Orchard in 1989, Gladys was transferred to the Cobble Hill Seed Orchard. When necessary, she also assisted with field duties at the Saanich Seed Orchard and upon closure of the Cobble Hill Seed Orchard on April 1, 2003, Gladys was transferred to the Saanich Seed Orchard. Thus, Gladys has worked at most of the ministry coastal seed orchard sites over time and has always shown her adaptability and versatility in working at new locations and with new species, quietly and competently going about her duties. One thing we know Gladys won't miss is the daily commute from Cobble Hill to Saanich.

We will miss Gladys but are happy to know that she is now enjoying her well earned retirement by spending more time with her husband, George, their children and grandchildren. She can now spend more time working in her garden, enjoying her horse and assisting with the family beef farming business. Gladys has a new puppy, Emma, and she is enjoying the training regime.

Plate 66 a

Plate 66 b

Plates 66 a and b. Gladys Baird at work and enjoying her new puppy Emma, in retirement.

Ray Cardy

Ray Cardy retired on May 2, 2011 after 36 years with the Forest Service.

Ray began his career with the Forest Service on March 6, 1975 as a labourer at the Koksilah Nursery in Duncan. Duties included all aspects of container and bareroot operations, seed and cone processing, irrigation, storage and shipping stock.

In 1979 Ray was promoted to a Junior Technician where he provided assistance to the Quality Control Technician which included stock inventories, cultural regimes, audits, and growth monitoring. In 1981 he was promoted to Quality Control Technician. In 1988 Ray's position was reclassified to Operations Supervisor. Ray left the Forest Service in 1989 due to the privatization of the Koksilah Nursery. However, after the privatized nursery closed in 1992, Ray returned to the Forest Service as a Forest Technician at the Bowser Seed Orchard.

During Ray's tenure at the Bowser Seed Orchard, he especially recalls significant accomplishments such as the establishment of the second generation Douglas-fir orchard #162, and the 2001 record Fdc orchard 149 crop that produced 165.602 kg of select seed. Ray is proud of the effort and contributions he and his co-workers made supporting BC's reforestation with select seed. To date, Ray and staff at the Bowser Seed Orchard have produced, during Bowser's 20 year existence, over 1,164 kilograms of improved seed – enough for 50 million seedlings.

During a visit with his father at the Cowichan Hospital in 2000, Ray met his partner Sue and stepson Angus. Sue was Ray's father's favourite nurse and Ray shares with us that it was a blessing that something good came out of the sad situation. As for post retirement, Ray looks forward to pursuing his passions which include fishing, spending time with his dogs and touring Canada in his motorhome.

Plate 67. Ray Cardy.

Phyllis Taylor

Phyllis Taylor retired on March 31, 2011. Phyllis has contributed 20 years to the Forest Service and has been working at the Bowser Seed Orchard as a Forest Technician since September 23, 1991.

Prior to Phyllis' start with the Forest Service, she held a very exciting position of Travelling Companion to Chief Dan George. From 1970 to 1973, she was responsible for overseeing logistics when Dan George was on speaking tours, or making movie or television programs. Movies included Marcus Welby MD, Kung Fu, Dan Candy's Law with Donald Sutherland, Ecstasy of Rita Joe in Washington DC and speaking tours throughout the United States including Hawaii.

In 1974 Phyllis met her husband, Wayne and worked as an Accounts Receivable Clerk for Superior Repro in Vancouver BC until 1984. In 1984, while living in Vancouver, BC, Phyllis and Wayne's daughter Jessica was born. The following year, Phyllis and Wayne relocated to Deep Bay, just outside of Bowser. Today, Wayne is a fish buyer and works out of Prince Rupert.

Phyllis settled into the role of a full-time home maker from 1984 to 1991 and became involved with community activities, providing programs including tennis lessons, floor hockey, and Halloween parties. She was also the treasurer for the Lighthouse Recreation Commission.

Phyllis returned to work on September 21, 1991 and was hired by Gordon Morrow, for the position of Forest Technician at the Bowser Seed Orchard. Phyllis carried out a variety of seed orchard activities.

During Phyllis' retirement years, she hopes to make a fortune selling books on eBay and to finally travel to Port Edward to see where her husband, Wayne, has been working for the last 18 years.

Plate 68. Phyllis Taylor's retirement.

Patti Brown

As an Air Force brat, Patti grew up in many different parts of Canada. She received her forestry degree from the University of Alberta and began her career with the Ministry of Forests at the Red Rock Research Station in Prince George. She soon transferred to the Silviculture Section in the Prince Rupert Region where she spent two years mainly dealing with seed issues.

In 1983, she started with Canadian Forest Products as an assistant forester at their North Island operations in Woss, BC. From 1992 until 2009, Patti was Manager Seed Orchard, Tree Improvement Forester with Canadian Forest Products Ltd. in Sechelt BC. In this capacity, Patti converted the seed production facility serving a public relations role into an operation producing some of the highest quality seed in the province. She also managed Canfor's coastal forestry operations seed procurement and nursery sowing requirements.

Patti's leadership at the Sechelt Seed Orchard resulted in improved genetic quality and quantity of seed for coastal regeneration programs. Future forests will deliver 14% additional value. She also developed innovative operating procedures to realize the genetic gain in western hemlock, upgrading the seed quality from 2% to 16% through orchard management with no increase to costs.

Patti was a member of tree improvement and seed related committees including Chair of White Pine Species Committee.

Annette van Niejenhuis, WFP stated "Patti's success in promoting and advancing the white pine program can certainly be seen on the ground in our Nimpkish Tree Farm Licence."

Patti is enjoying kayaking in Sechelt and other activities at home and still keeps a hand in with her forestry pursuits.

Plate 69. Patti Brown at Mt. Hynne.

Douglas Ashbee

Doug Ashbee gave 33 years of dedicated service to BC's provenance research program (1978 to 2011). Doug graduated from University of Victoria in 1975 with a Bachelor of Science in geography. He joined the Protection Branch of BC Forest Service as a forest fire fighter in 1976. In 1978, Keith Illingworth, then the provincial provenance forester, hired Doug and charged him with the responsibility of looking after the Illingworth lodgepole pine provenance tests. The trial involved 150 range-wide provenance collections and was planted at over 70 test sites from the US border to Yukon Territory in both interior and coastal regions of British Columbia. It may be the largest single-species provenance trial in the world.

Doug became the only technical staff responsible for the provenance tests of all species including coastal Douglas-fir, Sitka spruce and interior spruce, and true firs after Don St. Pierre and Ralph White left the program in the mid-1980s. His responsibility further extended to include provenance tests of coastal hardwood species provenance trials in the mid-1990s.

Doug is known for his attention to detail and being involved in all aspects of the task including record-keeping, data collection, test site maintenance, test layout mapping and more. Doug's access notes to the test sites were known for their detail at every turn and landmark. In those days, without GPS, Doug's access notes helped a great deal in finding these test sites throughout every corner of the Province.

BC's provenance research program owes Doug for its high quality data, its well-maintained experimental plots, and its record-keeping for long-term continuity in access, protection and maintenance.

Doug and his wife Randi are interested in exotic culture and travelling. Both are still at their energy-rich 50-something. We wish them well in their earned retirement.

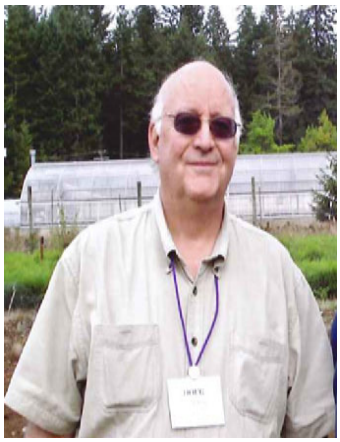

Plate 70. Doug Ashbee at Cowichan Lake Research Station.

Robb Bennett

Dr. Robb Bennett, Tree Improvement Branches' Cone and Seed Pest Management Officer, was impacted by the provincial government's Workforce Adjustment Process and left his position in August 2010 after 17 years in that job.

Robb came to us from Ontario where he had earlier obtained a PhD in Entomology from the University of Guelph. Following an initial auxiliary term, Robb started out in Silviculture Branch headquarters at Bastion Square on July 23, 1993 as the Cone and Seed Pest Management Officer. He subsequently moved out to the Saanich Seed Orchard on Puckle Road where a shared lab facility was set up to help Robb in his tasks. Robb had Bev McEntire working for him until her departure in 1996 and Michelle Hall until she left in 2004. Robb was also instrumental in getting two other entomologists hired for interior orchard work - Dr. Ward Strong in January, 1996 and Jim Corrigan in May, 2006.

On the coast, Robb very diligently set to work declaring war on the major insect pests that impact our seed orchard crops. He and his staff catalogued the major pests in an impressive collection, sent out month by month life cycle charts of what insect to look for and eventually developed the web based pest management site (below) that resides on the Tree Improvement Branch website to this day http://www.for.gov.bc.ca/HTI/IIG/index.htm

Robb was passionate about extension work, teaching and training, and research. Robb and his team conducted many extension training programs for orchard staff throughout the province. When pest losses were threatening Forest Genetic Council production goals, a Pest Management Technical Advisory Committee was established and first met on January 9, 2003, under Dr. Bennett's chairmanship. Through this forum, much research was done at the major universities around the province and many grad students owe their degree to the funding arranged by Robb. In addition, Robb and the PMTAC developed a series of leaflets that have proved useful for conifer seed pest management throughout the Pacific Northwest. http://www.fgcouncil.bc.ca/doc-pestmaninfo.html

Robb's passion for entomology also led him to volunteer his time back in Ottawa for many summers at the Ottawa-based Canadian National Collection of Insects and Arachnids. His expertise helped improve the collections of cone and seed insects there, especially cone midges and parasitoid insects that attack them. Robb also was heavily involved in the Entomological Society of BC, and the Entomological Society of Canada (ESC) serving on the ESC governing board as an ESC Director, chair or member of various committees and Editor-in-Chief of *The Canadian Entomologist.*

On February 5, 2001, Robb took a Temporary Appointment as the province's "Endangered Invertebrate Specialist" with the Wildlife Branch, Research and Conservation Section of the Ministry of Environment, Lands and Parks. Unfortunately, funding cuts ended this TA four months later and Robb returned to Puckle Road in July 2001. However, with the contacts Robb made while on his TA, he continued to volunteer his time not only with this program, but with Parks Canada, the Royal BC Museum and the Committee on the Status of Endangered Wildlife in Canada.

And last but not least, no story about Robb would be complete without mentioning his true passion – SPIDERS. Only the brave ventured into his lab, among all the jars of preserved and some not preserved collections of spiders including his pet Black Widows. Robb became known as Spiderman around Victoria, not only because he always wore a brass spider belt buckle, but due to the many presentations he made on spiders and as a result, he was frequently interviewed by the media.

Robb, your quick wit, your sometimes "sick" sense of humour, and your dedication to improving seed yields in BC seed orchards through integrated pest management and constantly seeking new control methods will be sorely missed.

Plate 71. Jenny Terpenning and Robb Bennett on Chatham Island.

John King

In September, 2010, Dr. John King joined the growing ranks of retirees from the genetics and tree improvement program in BC. John had a long and interesting career in genetics research.

After receiving his forestry degree from the University of Alberta in 1978, he moved away from learning about large woody plants and forests, and headed off to Scotland to obtain a Master of Philosophy degree from the University of Edinburgh, on brown trout genetics of all things!

He returned back to the University of Alberta in 1982 and started his PhD there, returning back to trees by using Chris Heaman's EP 707 Douglas-fir study as his experimental population. Immediately after completing his doctoral studies in 1986, he literally 'jumped on to the plane' and headed to the Forestry Research Institute (FRI) in New Zealand as a post-doctoral fellow, and quickly obtained a scientist position there. John worked at FRI on radiata pine and Eucalyptus tree improvement for approximately four years, before we were lucky enough to coax him and his family back here to BC.

John took on the task of re-starting the western hemlock tree breeding program for us, and in only a few years he and Charlie Cartwright assembled a large number of high genetic value parents by starting up the Hemlock Tree Improvement Cooperative. With that, he quickly reformed the hemlock breeding program and had it on par, in terms of genetic gain, with many of our other programs.

John then took over the somewhat stalled western white pine blister rust resistance program and the Sitka spruce weevil resistance program, and similarly, in a few short years had those programs running to world-class levels as well. John will continue to stay involved and support the tree improvement programs in BC, working in the emeritus program in the Forest Service, and shortly will be moving to the lucrative world of a consultant. Thanks John, and all the best!

Plate 72. Dr. John King.

Plate 73. Dr. John King and Dr. Diana Tomback (University of Colorado, Denver) at a 5-needle IUFRO conference in Siberia, 2011.

Plate 74. Dr. John King and Dr. Cheng Ying.

Appendix 1 FGC Seed Planning Unit

Seed planning unit (SPU)					Program category
#	Species	Common Name	SPZ	Elev. band (m)	
1	Fdc	Douglas-fir	M	1-900	1
2	Cw	Western redcedar	M	1-700	1
3	Hw	Western hemlock	M	1-600	2
4	Sx	Interior spruce	NE	1000-1700	1
5	Sx	Interior spruce	NE	1700-2100	2
6	Ss	Sitka spruce	M	1-500	2
7	Pli	Lodgepole pine	NE	700-1600	1
8	Pw	Western white pine	M/SM	1-1000	1
9	Ba	Amabilis fir	M	1-1000	3
10	Pli	Lodgepole pine	TO	700-1400	1
11	Yc	Yellow cypress	M	1-1100	2
12	Pli	Lodgepole pine	PG	700-1400	1
13	Lw	Western larch	NE	700-1600	1
14	Sx	Interior spruce	PG	600-1400	1
15	Pw	Western white pine	KQ	500-1400	1
16	Pli	Lodgepole pine	TO	1400-1600	2
17	Pli	Lodgepole pine	BV	700-1400	1
18	Pli	Lodgepole pine	CP	700-1300	1
19	Fdc	Douglas-fir	SM	200-1000	2
20	Pli	Lodgepole pine	NE	1600-2000	2
21	Fdi	Douglas-fir	NE	400-1200	1
22	Fdi	Douglas-fir	NE	1000-1800	2
23	Sx/Ss	Spruce	SM/NST	all	2
24	Hw	Western hemlock	M	600-1100	2
25	Sx	Interior spruce	EK	750-1900	2
26	Pli	Lodgepole pine	PG	1400-2000	3
27	Cw	Western redcedar	SM	200-1000	2
28	Sx	Interior spruce	TO	1300-2100	2
29	Pli	Lodgepole pine	EK	1500-2000	2
30	Sx	Interior spruce	TO	700-1500	1
31	Fdc	Douglas-fir	M	900-1200	2
32	Pli	Lodgepole pine	EK	800-1500	2
33	Cw	Western redcedar	M	700-1500	2
34	Lw	Western larch	EK	800-1700	1
35	Sx	Interior spruce	BV	500-1400	2
36	Bg	Grand fir	M	1-700	3
37	Fdi	Douglas-fir	QL	700-1400	2
38	Hw	Western hemlock	M north	1-600 (part of SPU 3)	
39	Fdi	Douglas-fir	EK	700-1400	2
40	Sx	Interior spruce	PR	<650 & 650-1200	2
41	Fdi	Douglas-fir	PG	700-1200	2
42	Sx	Interior spruce	PG	1200-1550	2
43	Fdi	Douglas-fir	CT	600-1400	2
44	Sx	Interior spruce	NE	1-1000	1
45	Pli	Lodgepole pine	BB/CHL	All	3
46	Bl	Sub-alpine fir	all int.	all	3
47	Bn	Noble fir	M	all	3
48	Aspen/birch/poplar		Interior	-	3
49	Alder/poplar/maple		Coast	-	3
50	Lw	Western larch	NE	1200-1800	2
51	Py	Ponderosa pine	S. Interior	300-1200	2

Appendix 2 Tree Species

CONIFERS	LATIN NAME	TREE SPECIES CODES
western redcedar	*Thuja plicata*	Cw
yellow cypress	*Callitropsis nootkatensis*	Yc
Douglas-fir	*Pseudotsuga menziesii*	Fdc
interior Douglas-fir	*Pseudotsuga menziesii* var. *glauca*	Fdi
amabilis fir	*Abies amabilis*	Ba
grand fir	*Abies grandis*	Bg
noble fir	*Abies procera*	Bp
subalpine fir	*Abies lasiocarpa*	Bl
mountain hemlock	*Tsuga mertensiana*	Hm
western hemlock	*Tsuga heterophylla*	Hw
Rocky Mountain juniper	*Juniperus scopulorum*	Jr
alpine (subalpine) larch	*Larix lyallii*	La
western larch	*Larix occidentalis*	Lw
limber pine	*Pinus flexilis*	Pf
lodgepole pine	*Pinus contorta*	Pl
interior lodgepole pine	*Pinus contorta* var. *latifolia*	Pli
ponderosa pine	*Pinus ponderosa*	Py
shore pine	*Pinus contorta* var. *contorta*	Plc
western white pine	*Pinus monticola*	Pw
whitebark pine	*Pinus albicaulis*	Pa
Engelmann spruce	*Picea engelmannii*	Se
Sitka spruce	*Picea sitchensis*	Ss
white spruce	*Picea glauca*	Sw
spruce hybrid (interior spruce)	*Picea* cross (Se and Sw mixtures)	Sx
Sitka x unknown hybrid	*Picea sitchensis x*	Sxs
western (Pacific) yew	*Taxus brevifolia*	Tw
HARDWOODS		
red alder	*Alnus rubra*	Dr
black cottonwood	*Populus balsamifera* ssp. *trichocarpa*	Act
hybrid poplars	*Populus* spp.	Ax
trembling aspen	*Populus tremuloides*	At
paper birch	*Betula papyrifera*	Ep
Garry oak	*Quercus garryana*	Qg

Appendix 3 Author Contact List

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Carlson, Michael	MFLNRO	250-260-4767
Cartwright, Charlie	MFLNRO	250-387-6477
Charleson, Lee	MFLNRO	250-387-4839
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Douglas, Diane	MFLNRO	250-356-6721
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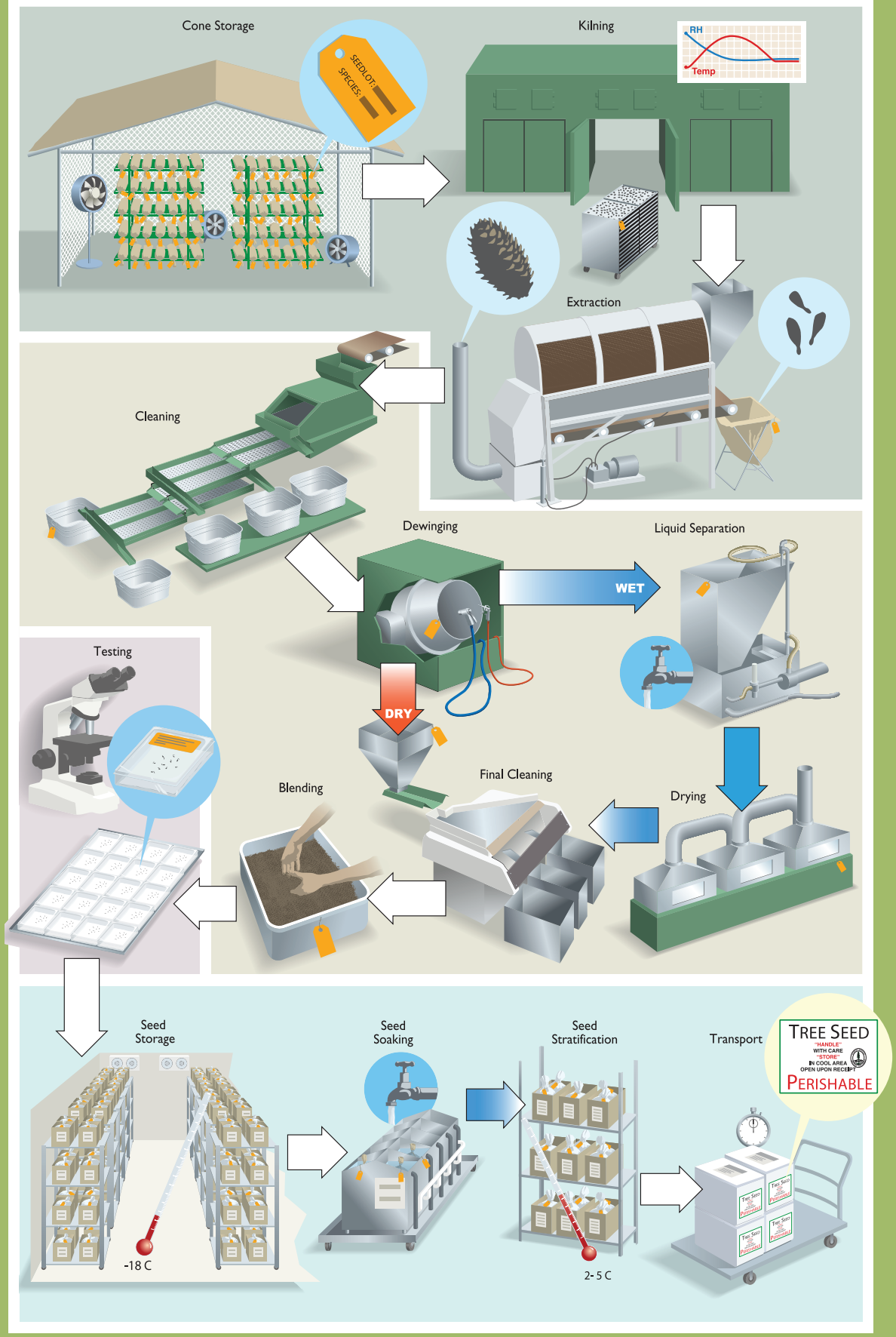
Webber, Joe	ProSeed Consulting	250-537-8871
Wood, Darrell	MFLNRO	250-356-1127
Woods, Jack	SelectSeed	604-734-5778
Xie, Chang-Yi	MFLNRO	250-387-8911

Cone Processing
Cone storage, conditioning and extraction to separate seeds from cones

Seed Processing
Removal of debris, dewinging, drying, removal of non-viable seeds and blending

Testing
Quantify cone and seed quality for decision-making, storage and use

Inventory Management
Seedlot registration, storage, pretreatment and distribution of seed



BRITISH COLUMBIA
Ministry of Forests, Lands and Natural Resource Operations

FOREST SERVICE BRITISH COLUMBIA

FGC Forest Genetics Council of British Columbia