



Forest Genetics Council
of British Columbia



Progress Report
2018–2021

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Publication Information

Forest Genetics Council of British Columbia (www.forestgeneticsbc.ca)

Editor: Brian Barber, RPF, CEO, Select Seed Co. Ltd.

Design: Caorda Web Solutions, Victoria, BC

Title: Forest Genetics Council of BC – Progress Report – 2018–2021

Series: Forest Genetics Council of BC – Annual Reports – 2000/2001

ISSN 1499-125X = Annual report – Forest Genetics Council of British Columbia

Subjects: 1. Forest Genetics Council of British Columbia – Periodicals. 2. Forest Genetics – British Columbia –

Periodicals. 3. Forests and forestry – Research – British Columbia – Periodicals.

SD399.5.B74 34.9'8'09711'05 C2001-960195-6



Front Cover Photos

John Russell, Ph.D, RPF, examining western redcedar (*Thuja plicata*) seedling at the Cowichan Lake Research Station.

Photo: Chad Hipolito © Genome Canada, 2017.

Background photo: Western redcedar branch and cones.

Photo: Brian Barber, 2018.

CHIEF FORESTER'S MESSAGE

Over the past several decades, BC has developed a world class tree improvement program under the leadership of the Forest Genetics Council of BC (FGC). Through the FGC, a wide range of public, and private sector, organizations coordinate their activities to deliver a collaborative, provincial program.

This report describes activities and accomplishments during the last three years of FGC's 2015-2020 Strategic Plan. During this time, significant advances were made in the conservation of whitebark pine, the development of pest-resistant planting stock, and the adaptation of seedlings to climate change through the implementation of climate-based seed transfer standards. Additional species were added to the tree breeding program to diversify planting options, and BC's orchard stock was improved, including the establishment of three new lodgepole pine orchards. The reporting period also featured two bumper-crop years in BC's tree seed orchards and the milestone planting of over 200 million improved seedlings in a single year.

This progress report acknowledges many experienced staff that retired in the reporting period. Also, the report honours our friend and colleague, the late Dr. John Russell, an international expert in western redcedar and yellow cedar.

We thank the many individuals and organizations helping to achieve the FGC's goals and objectives. British Columbians greatly value their forests, and through the careful management of forest genetic resources, we are protecting and enhancing the health, value and diversity of BC's forests.

BC's tree
improvement
program adds
8 million
cubic meters
per year to future
timber supply



Diane Nicholls, RPF
Assistant Deputy Minister
and Chief Forester



Shane Berg, RPF
Deputy Chief Forester



Pat Martin, RPF
Ministry Co-Chair, and Director,
Forest Improvement and Research
Management Branch, Ministry of
Forests, Lands, Natural Resource
Operations and Rural Development



Domenico Iannidinardo, RPF
PEng, RPBio, Industry Co-Chair,
and Chief Forester, Mosaic Forest
Management

CO-CHAIRS' MESSAGE

FGC coordinates activities and provides advice to the Ministry regarding policies and funding for forest genetics research and operations. FGC is supported by three technical advisory committees (TACs) and Select Seed Company Ltd. (SelectSeed), which is owned by FGC through the BC Forest Genetics Society.

In the period covered by this report—April 1, 2018 to March 31, 2021—FGC and its TACs met several times a year. Fortunately, COVID-19 did not hamper operations nor deliberations significantly as we shifted to video conferences over the last two years.

During the term of this report, FGC undertook several important initiatives that will add to the legacy of this Province's commitment to continuously improving its renewable forest resources. This included a review of the Ministry's allocation for new second-generation lodgepole pine (Pli) seed orchards and approving SelectSeed's acquisition of a property to establish a new Pli seed orchard near Quesnel. FGC also undertook an analysis to estimate the number of seedlings required for reforestation by species, management unit and BEC variant to 2049. These forecasts will be used to determine priorities for tree breeding and seed orchards, including those under management agreements with SelectSeed.

The work of this program is protecting the genetic diversity of our forests and through tree breeding growing millions of additional cubic metres of timber each year on the public forests. As Co-Chairs, we celebrate the unique opportunity we have to help steer the dozens of organizations that ultimately make this all happen. BC is blessed to have a world-class program like this one, full of world-class workers with a passion for the betterment of the forests, and the families that rely on them for renewable jobs. We extend our thanks and appreciation to Brian Barber, CEO, SelectSeed for his services to the FGC and as lead author of this report, as well as to the many dedicated members who served on FGC, its TACs and everyone in the supply chain producing hundreds of millions of improved seedlings that will be ready for the world's climate and meeting the needs of society.

1. FUNDING AND ALLOCATIONS

FGC's objectives are achieved with financial and in-kind support from numerous agencies. The Ministry's Land Based Investment Strategy (LBIS) is the most important funding source for forest genetics conservation, climate change research, and tree breeding, the latter of which is the foundation of BC's tree improvement system.

LBIS funds are administered by the Ministry's Forest Improvement and Research Management Branch (FIRM) and allocated to programs and projects based on recommendations received from FGC and its TACs.

FGC Program	2018/19	2019/20	2020/21
Conservation	\$ 193,994	\$ 247,677	\$ 179,500
Health & Productivity (breeding)	\$ 1,521,006	\$ 1,669,068	\$ 1,456,094
Adaptation (climate change)	\$ 460,000	\$ 248,000	\$ 211,000
Operational Tree Improvement	\$ 325,000	\$ 335,255	\$ 153,406
Total	\$ 2,500,000	\$ 2,500,000	\$ 2,000,000

Table 1. LBIS funding allocations by FGC program and year

In 2020/21, LBIS funding was reduced from \$2.5M to \$2.0M. Several important projects and deliverables were deferred, support for incremental seed orchard operations was cancelled, and alternative funding sources were temporarily secured.

Public and private seed orchards, however, remained viable with revenues generated through seed sales. SelectSeed, in turn, continued its financial support for FGC and tree breeding under separate agreements with the Ministry.

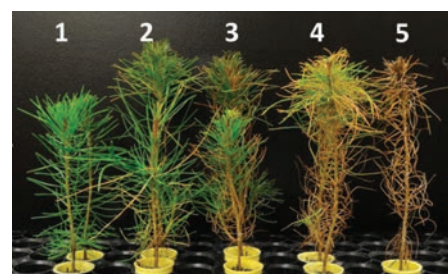
Forest companies continued to assist with the establishment and maintenance of Ministry field trials. Genomics research, supported by Natural Resources Canada, Genome BC and Genome Canada, also helped advance understanding of climate adaptation, forest health and wood quality.



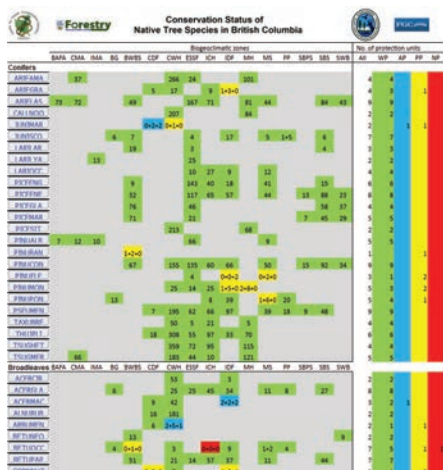
Interior spruce progeny test sort, 2018.
Photo: T. Doerksen



Colby Mahood picking Douglas-fir cones at Western Forest Products' Saanich Forestry Centre.
Photo: A. van Niejenhuis



Variation in tolerance to *Dothistroma* needle cast in lodgepole pine.
CoAdapTree Project, UBC Forestry.
Photo: N. Feau



Conservation Status Catalogue of
BC's Native Tree Species, Dr. Tongli
Wang, UBC Forestry
<http://climatebc.ca/cataloguing>

2. PERFORMANCE MEASURES

FGC's 2015–2020 Strategic Plan included five performance measures for enhancing the conservation, adaptation, and health and productivity of BC's forests.

2.1 Conservation

Performance Measure

Adequately conserve the genetic diversity of representative populations of all forest tree species native to BC by 2020, through a combination of *in situ*, *ex situ*, and *inter situ* conservation.

Progress

The conservation status of BC's 43 native tree species was reviewed and updated by biogeoclimatic zone. These zones serve as proxies for the species' adaptive genetic variation and conservation units.

The number of representative populations in parks and protected areas within each zone was used to identify *ex situ* conservation priorities. Since 2018, seed was collected from 530 trees representing 37 populations of 11 species and including bitter cherry, cascara, Pacific dogwood, Douglas maple, and big leaf maple. These *ex situ* collections are stored at the Provincial Tree Seed Centre, which contains over 3500 seed samples of non-commercial species. Combined with *in situ* reserves, 91% of the 200 zones are deemed to be "adequately" conserved. Seed collections continue to fill in the gaps.

Additional measures were taken to conserve Whitebark pine, threatened by an introduced blister rust and listed as endangered species under Canada's Species at Risk Act.



Don Pigott and Stan Wheat caging
whitebark pine cones. Photo: D. Pigott



Cowichan Lake Research Station established in 1929. Photo: J. King



Kalamalka Forestry Centre, Vernon, 2019. Photo: Ministry of Forests

2.2 Adaptation

Performance Measure

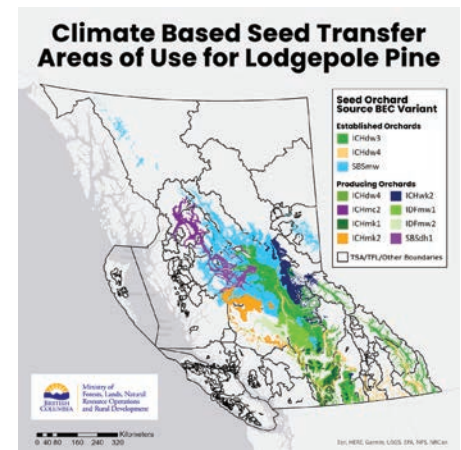
By 2020, the selection and transfer of all tree seed used to reforest Crown land in BC will be guided by a climate-based seed transfer (CBST) system.

Progress

In April 2018, the Chief Forester introduced new CBST Standards based on a comprehensive analysis to better match seedlots to the climate of their planting sites¹. The analysis included climate forecasts and data collected from extensive field trials, such as the Assisted Migration and Adaptation Trial.

FGC and its TACs assisted the Ministry with CBST assessment and implementation. The implementation period was extended to April 2022 due to its complexity. Consequently, only 57% of all seed sown in 2021 was selected using CBST. The system and tools are, however, now in place to achieve 100% within the next few years.

In recognition of this work, the Association of BC Forest Professionals (ABCFP) presented its 2018 Climate Change Innovator Award to the CBST project leaders.



CBST areas of use for Lodgepole Pine seed orchards

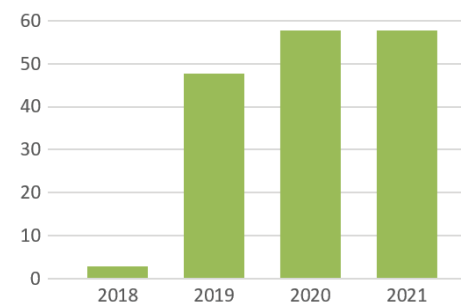


Figure 1. Percentage of seedling requests made using CBST by sowing year



ABCFP's 2018 Climate Change Innovator Award. Front: Leslie McAuley, Greg O'Neill, Susan Zedel. Back: Brian Barber, Margot Spence, Jack Woods. Missing: Diane Nicholls, Jim Snetsinger. Photo: ABCFP

¹ See <https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/tree-seed/seed-planning-use/climate-based-seed-transfer>



Petra Nielson grafting pine ramets, May 2019. Photo: B. Barber



Jimmie Hodgson, RPF with Class-A Douglas-fir seedling, Mosaic Forestland. Photo: B. Barber

2.3 Health and Productivity

2.3.1 INCREASE GENETIC GAIN FOR GROWTH

Genetic Gain

Increase the average volume gain of select seed² used for Crown land reforestation to 20% by the year 2020.

Progress

The genetic gain for volume (GVO) is the additional timber volume estimated to be available at harvest. For example, plantations established with GVO 25 seedlots are expected to yield 25% more cubic meters of wood in 60–80 years compared to those planted with wild stand seedlots.

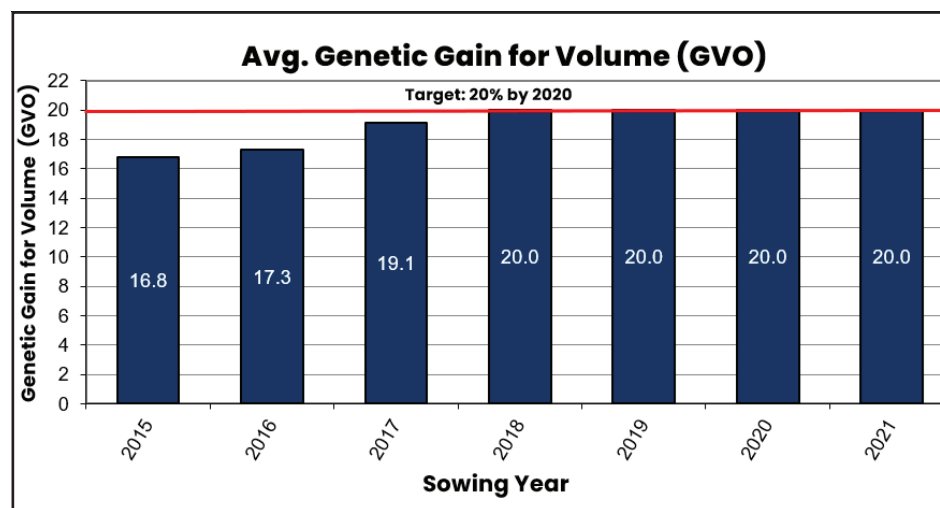


Figure 3: Average genetic gain for volume of all Class A seed used by year.

The target of increasing the average GVO of all Class A seed used to 20% was realized in all three years of this reporting period. This was achieved through progressive testing and selection by Ministry tree breeders and by incorporating higher gain parent trees in public and private seed orchards. Genetic diversity and wood quality are also maintained so BC's future forests remain resilient and valuable.

² Select seed includes seed collected in orchards (Class A) and superior provenance wild stands (Class B+). The genetic gain performance measure only includes Class A seed.

2.3.2 SELECT SEED USE

Performance Measure

Increase select seed use to 75% of the provincial total seed sown by 2020.

Progress

This performance measure was established in FGC’s first strategic plan (1998) with a target completion date of 2007. This goal was to be accomplished by increasing seed orchard capacity and forest policies that required the use of improved seed.

Although new seed orchards were established over the past two decades, lodgepole pine seed production fell short of forecasts. Seedlings requested also increased from 210M to over 300M per year during the same period. Consequently, the 75% select seed-use target was not realized by 2020.

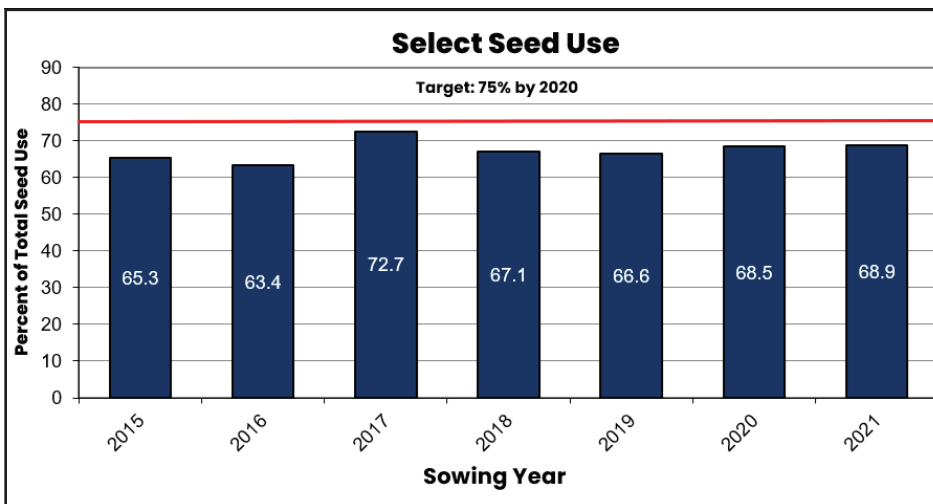


Figure 4: Select seed (Class A and B+) as percent of total seed used by year.

The total Class A seed used, however, increased from 79M seedlings in 2000 to over 200M seedlings in 2020 (Figure 4). Plantations established with the 200m seedlings, having an average GVO of 20%, will produce 8M additional cubic meters of wood at harvest. This incremental volume represents 13% of the current allowable annual cut of 63M cubic meters.



Douglas-fir seedlings grown from orchard seed, Sorrento Nursery.
Photo: B. Barber



Lodgepole pine cones.
Photo: B. Barber



Tyler Espen inspecting yellow cedar hedge orchard, Saanich Seed Orchards. Photo: C. Halldorson

Over 300M seedlings were sown in 2020 to reforest Crown and private forest land in BC. Of this total, over 200m seedlings were derived from Class A (seed orchard) seed.

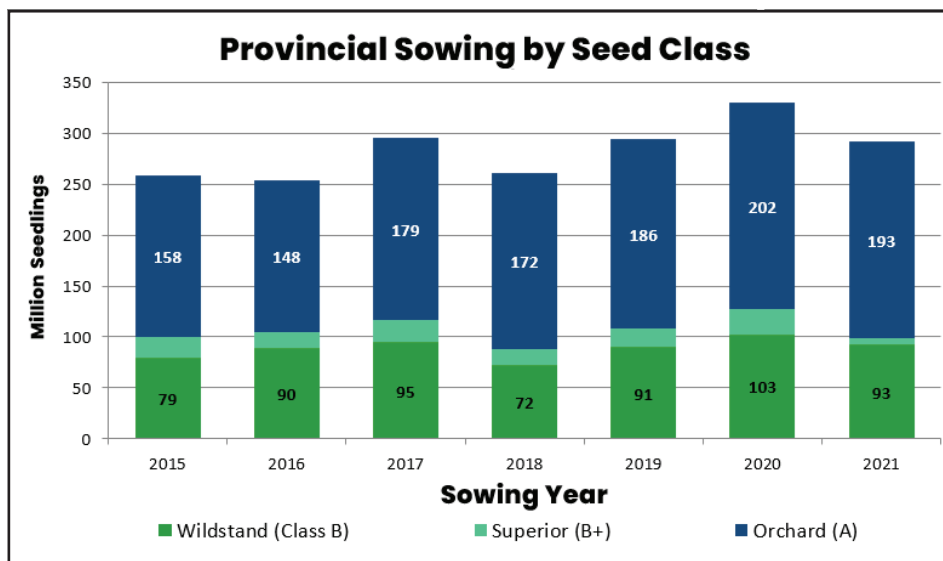


Figure 5: Seedling requested by seed class and year.



Mikayla Stirling and Lindsay Bellingham collecting Ponderosa pine drought trial data. Photo: M. Vance

In 2020, over 100m seedlings of Class A interior spruce (Sx) seed were sown, representing 96% of all Sx seed sown. Over 97% of coastal Douglas-fir (Fdc) seedling requests were also derived from Class A seed. In contrast, only 47% of all lodgepole pine (Pli) seed sown in 2020 was derived from Class A seed. New Pli seed orchards established in north-central BC are expected to help fill this gap.

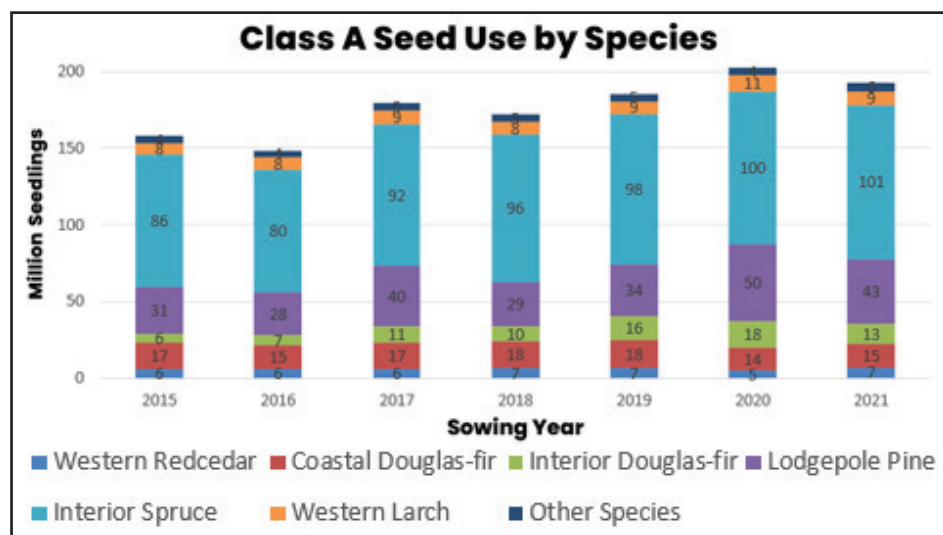


Figure 6: Class A seed use by species and year.

2.3.3 PEST-RESISTANT SEED USE

Select Performance Measure

Increase the use of seed with a genetic gain for pest resistance to 50% of select seed sown by 2035.

Progress

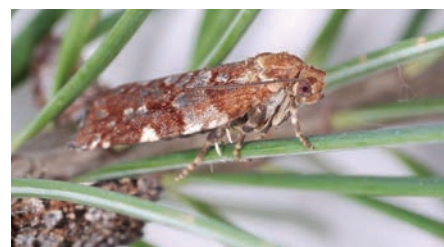
This performance measure was first introduced in 2015 to improve the survival and health of seedlings susceptible to native and introduced insects and diseases.

Ministry geneticists tested and selected parent trees resistant or tolerant to several pests. Orchards containing these parents produced seed with a higher level of genetic resistance compared to wild seed. This seed is used to reforest areas at higher risk to the pests.

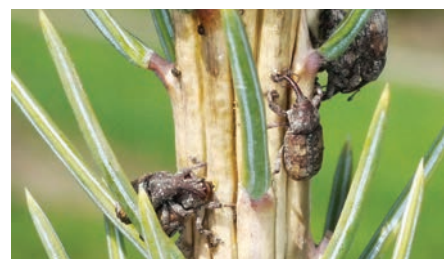
Over the past several years, the percentage of pest resistant seed, relative to the total select seed used, varied between 24% and 28%. This percent will increase over the next decade as new selections are made and new orchards are established.

Tree Species	Pest Resistance	Seedlings Requested (000s)			
		2018	2019	2020	2021
Sitka Spruce (Ss)	Terminal Weevil	356	276	256	256
Interior Spruce (Sx)	Terminal Weevil	35,244	38,844	42,325	35,472
Lodgepole Pine (Pli)	Western Gall Rust	3,251	1,485	9,440	4,044
Western White Pine (Pw)	Wht Pine Blister Rust	485	379	952	1,297
Western Redcedar (Cw)	Cedar Leaf Blight	6,227	6,474	5,151	6,788
Total Pest Resistant		45,563	47,458	58,124	47,856
Total Select Seed (A and B+)		189,811	210,768	208,027	202,175
Percent Pest Resistant		24%	23%	28%	24%

Table 2. Class A seedlings sown with genetic resistance to insects and disease.



Spruce budworm on Douglas fir.
Photo: W. Strong



Terminal leader weevil.
Photo: T. Doerksen



Western redcedar leaf blight.
Photo: L. van der Merwe



Comandra blister rust on lodgepole pine. Photo: B. Barber



Easton Jones and Jan Brewer collecting lodgepole pine cones at PRT Armstrong. Photo: B. Barber



Dan Gaudet showing VSOC's new lodgepole pine orchard in Quesnel. Photo: B. Barber

3. SEED ORCHARDS AND CROPS

In 2021, there were 92 active orchards representing a dozen species managed by the Ministry and private companies. These orchards contain over 102,000 trees which produce seed for specific biogeoclimatic-zone variants under CBST.

Orchard seed production varied from year to year. The 2018 and 2020 seed crops, measured in equivalent seedlings, were BC's two largest crops to date. The top-producing species are: interior spruce (Sx), lodgepole pine (Pli), interior and Coastal Douglas-fir (Fdi & Fdc), western larch (Lw) and western redcedar (Cw).

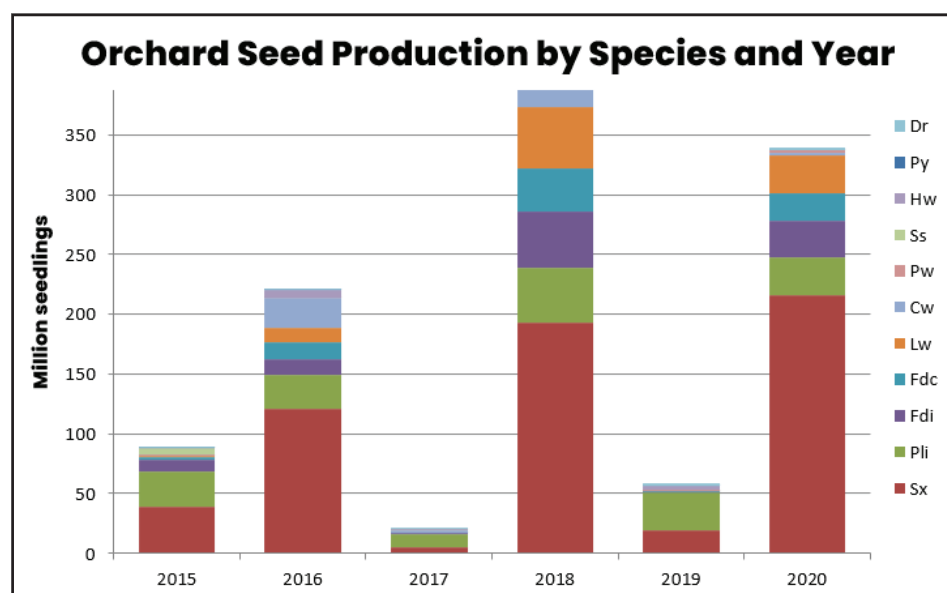
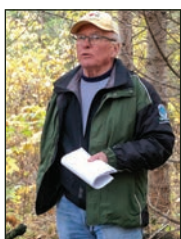


Figure 7: Seed orchard production by species and year

In 2019, with support from FGC, the Ministry approved the establishment of three new Pli orchards to produce seed for the Nechako-Bulkley Valley region. These 5000-ramet orchards will be managed by SelectSeed (Quesnel), Vernon Seed Orchard Company (Quesnel) and the Ministry (Prince George), respectively.

RETIREMENTS



Barry Jaquish, RPF, retired in Jun. 2019 after a 38-year career at the Kalamalka Forestry Centre, overseeing the interior Douglas-fir, Spruce and larch breeding programs. In 2016, he received ABCFP's Climate Change Innovator Award.



Dr. Ward Strong retired in Dec. 2020 after a 25-year career as a Research Scientist. Ward's research included tracking the western conifer seed bug, raising terminal weevils, and identifying rust-resistant whitebark pine.



Dr. Michael Stoehr, RPF, the Ministry's coastal Douglas-fir tree breeder, retired in Oct. 2020. During his 28-year career, he also served as section manager, adjunct professor, and received CIF's scientific achievement award.



Margot Spence, RPF, retired in May 2019 after successfully leading the CBST project team. Her public service career also included work with Aboriginal Affairs and Forest Policy and Planning.



Susan Zedel, PAG, retired in Apr. 2019, after a 35-year career with the Ministry. She was highly regarded by foresters, nursery managers and others for her client support for the Seed Planning and Registry System (SPAR).



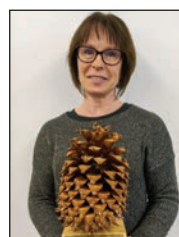
Leslie McAuley, RFT, retired Apr. 2021 after 32 years with the BC Public Service. She made significant contributions to tree seed policy and planning during this period. Leslie is pictured with FGC's appreciation 'tree' award.



Cathy Cooke retired in Dec. 2019 after 39 years at Western Forest Products' Saanich Forestry Centre. The seed she tended is planted all over Vancouver Island and Coastal Mainland.



Gary Giampa retired in Mar. 2020 after a 32-year career at the Ministry's Kalamalka and Bailey Road Seed Orchards, Vernon. Gary is known for his love of outdoor activities.



Kathy Theobald retired in Dec. 2019 after a 30+ year providing administrative support at the Cowichan Lake Research Station and Conference Centre.



Gernot Zemanek served on FGC as the Interior Seed User Rep from 2009 to 2019. He also operated Roserim Nursery near Canim Lake.



Glen Dunsworth, served on SelectSeed's Board of Directors from 1999 to 2018, and also as its President from 2002-2018.



Reid Carter, RPF, served on SelectSeed's Board of Directors as Secretary from 1999-2019. He also retired from Brookfield in 2019.

DR. JOHN HUBERT RUSSELL

September 11, 1955 – December 20, 2018

In Memoriam



Photo: Chad Hipolito © Genome BC

John, affectionately known as “JR”, was born in Oshawa, Ontario, and attended Beau Valley and O’Neill CVI schools. In 1980, he obtained a B.Sc. in Forestry from the University of Toronto. In 1984, John completed a master’s degree at the University of California with Dr. Bill Libby.

In 1985, John joined the B.C. Forest Service’s Research Branch working at the Cowichan Lake Research Station (CLRS). John was tasked with advancing clonal propagation as clonal forestry was expected to become more prevalent in breeding and reforestation. John became BC’s clonal forestry expert and pioneered rooted-cutting systems for spruce, yellow cypress and western redcedar. He also made substantial contributions to the development of BC’s forest genetics policies.

In the late 1980s, John noted redcedar cuttings exhibited remarkable genetic diversity, which others contended this species lacked. He subsequently initiated an intensive tree breeding program to enhance its growth and adaptation, and resistance to deer browse, leaf blight and heart rot. He also developed novel methods to stimulate early sexual maturation (3-years from seed) and reduce inbreeding.

In 2016, John initiated the CeDAR genomic selection project in collaboration with Drs. Bohlmann and Gamal of UBC, Genome BC and Genome Canada, to accelerate the process of identifying redcedar trees with superior wood durability traits. The results of this project will soon be applied to tree improvement operations in BC.

John also made tremendous gains in the yellow cypress breeding program producing vegetative propagules with timber volume gains exceeding 20%. His research in yellow cypress led to a PhD from University of British Columbia (UBC) with Dr. Don Lester in 1993.

In 2008, John became the principal scientist at the CLRS. John was proud of the station, its unique features, tree collections and dedicated staff. John also served as an adjunct professor at UBC and the University of Victoria, and he was an associate editor for the Canadian Journal of Forest Research for many years. John participated in research exchanges to New Zealand, Australia, and France. Everybody who knew John professionally was impressed by his knowledge and passion for forest genetics.

Sadly, at age 63, John passed away from kidney cancer, which he battled heroically for several years. John loved the Grateful Dead, growing garlic, his job, but most of all, his family. John is survived by his wife Valerie and their children Heather, Andrew and Christopher.



Photo by D. Kolotelo

On May 22, 2019, a tree was planted and a Cupressaceae arboretum was co-dedicated to John at a memorial service held at CLRS. Others continue to advance John’s research, which will benefit BC’s forests and people for generations.

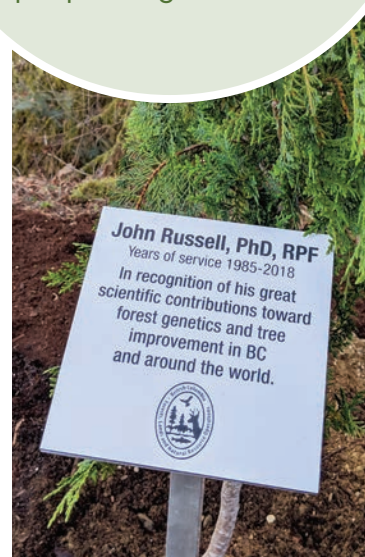


Photo by B. Barber

ACKNOWLEDGEMENTS

Persons and organizations contributing to FGC's goals 2018–2021



Forest Genetics Council of BC

Pat Martin, RPF, Co-Chair	Gernot Zemanek
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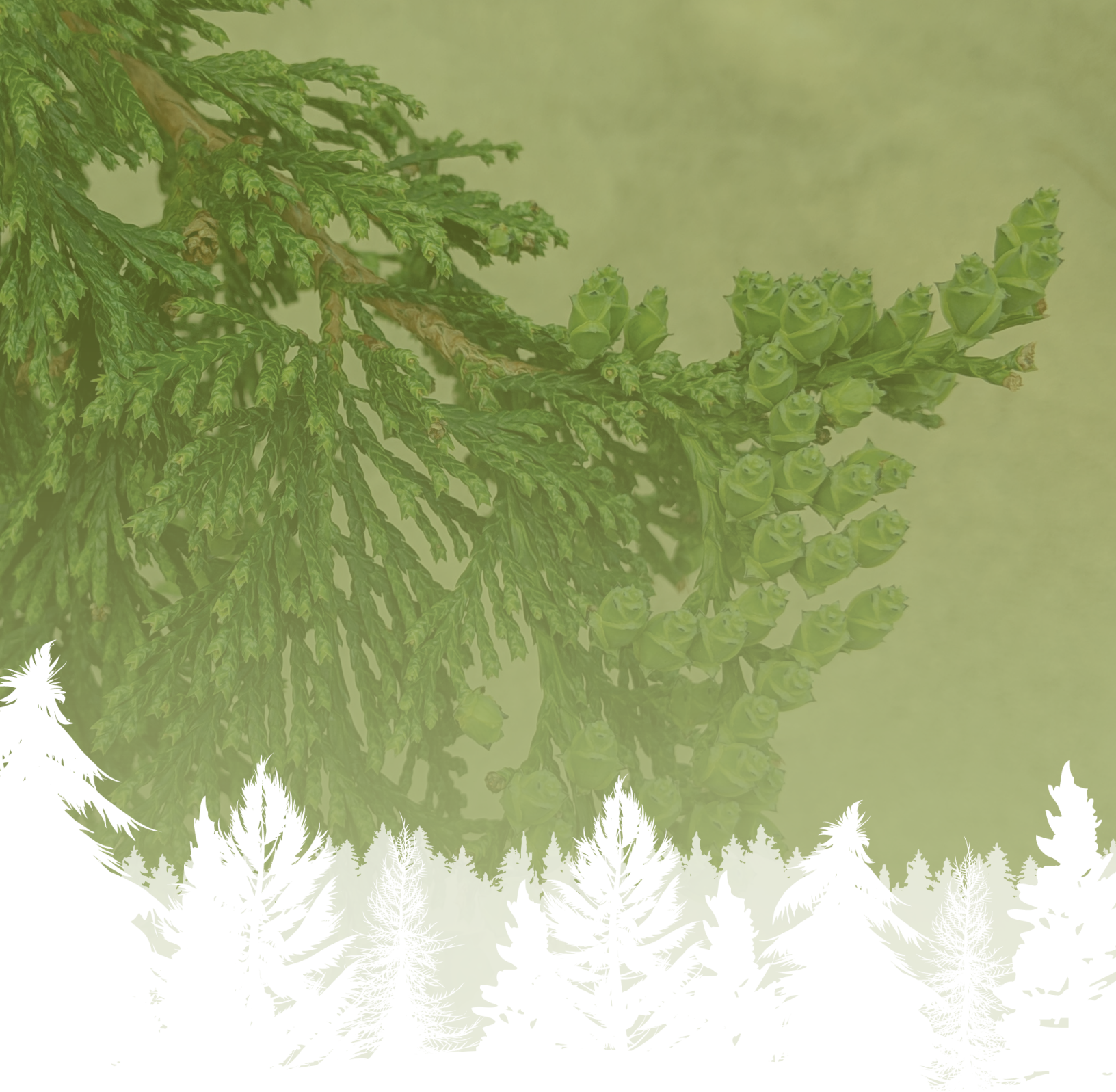
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Kerry McGourlick, Jack Woods, Henry Benskin, Jim Burbee, Rod Willis, and Brian Barber.



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