Genetic Conservation Technical Advisory Committee (GCTAC) Strategic Plan 2015-2020

November 28, 2016

Prepared by the

Genetic Conservation Technical Advisory Committee

FGC Forest Genetics Council of British Columbia

Contents

EXECUTIVE SUMMARY

This plan was developed by the Genetic Conservation Technical Advisory Committee (GCTAC) at the request of the Forest Genetics Council (FGC). It updates a previous plan approved by Council in 2011. The following are key points and recommendations contained in the body of this plan.

1. Genetic conservation activities will focus on:

- **Measuring and reporting** conservation status,
- **Understanding** needs, developing scientifically sound approaches, and adjusting methodology to ensure efficiency and effectiveness,
- **Implementing** conservation actions, and
- **Collaborating with** other agencies.

2. The following GCTAC mandate is recommended:

- Provide **guidance and recommendations** to the FGC on genetic conservation issues for indigenous forest trees, including conservation issues associated with climate change and forest health.
- **Lead** the development of genetic conservation research, measurement, strategies, and programs.
- Provide **business planning** direction and recommend project budgets to the FGC for GCTAC funded activities.
- **Review** reports submitted for GCTAC funded activities.

3. The following working definition of genetic conservation is recommended:

The conservation of forest-tree genetic resources is the combination of policies and actions that maintain the genetic diversity of indigenous tree species to provide economic value, environmental services, and biodiversity for the present and future.

4. The following Performance Measure is in the FGC 5-year Strategic Plan (2015-2020)

"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"

5. Definition of tree species

Tree species are capable of developing a single woody stem and achieve heights of at least 10 meters. Forty-two species indigenous to BC are within the scope of this plan (see Section 5.1 and Appendix 1).

6. Subdivision of effort

Genetic conservation work will be carried out by staff within the Tree Improvement Branch of the MFLRNO, the UBC Center for Forest Conservation Genetics, and GCTAC members (Table 2 in Section 8), with additional collaborations to be developed with other agencies, institutions, and interested groups.

7. Resource needs

Human and financial resource needs are discussed in section 10. These include Land Base Investment Strategy funding through the FGC of approximately $250,000 per year for the next 5 years.

8. Significant new project recommended

Evaluate policy on the genetic diversity of reforestation materials from a conservation and species adaptation perspective, including consideration of climate change.

1. Introduction

The Forest Genetics Council of BC (FGC) Strategic Plan for 2015-2020 sets the following genetic-conservation outcome:

> *The genetic diversity of all indigenous tree species is adequately maintained to support their continued evolution while providing environmental services, and social and economic values.*

The following Performance Measure is also defined:

> *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.*

The Genetic Conservation Technical Advisory Committee of the FGC (GCTAC) prepared this document to set out the technical direction, activities, and resources required to meet this conservation objective.

This strategic plan is built on the 2007 GCTAC report *Indigenous-Tree Genetic Conservation in BC* and its sequel, the 2009-2014 Strategic Plan. It is considered a "living" document that will guide work and receive periodic updating and adjustment to ensure genetic conservation objectives are met and the most recent scientific procedures are followed. Activities will focus on:

- **Measuring** and reporting conservation status,
- **Understanding** needs, developing scientifically-sound approaches, and adjusting methodology to ensure efficiency and effectiveness,
- **Implementing** conservation actions, and
- **Collaborating** with other agencies

2. GCTAC Mandate

The GCTAC mandate was originally set out in the 2007 plan. This mandate was expanded in 2015 to include collaboration with other agencies. Presently, the mandate reads as follows:

1. Provide guidance and recommendations to the FGC on genetic conservation issues for indigenous forest trees, including conservation issues associated with climate change and forest health.
2. Lead the development of genetic conservation research, measurement, strategies, and programs.
3. Provide business planning direction and recommend project budgets to the FGC for GCTAC funded activities.
4. Review reports submitted for GCTAC-funded activities.

3. Definitions

3.1 Genetic Conservation

The conservation of forest-tree genetic resources is the combination of policies, plans and actions that maintains the genetic diversity of tree species to provide economic value, environmental services, and biodiversity for the present and future. Specifically, we are interested in conserving naturally occurring adaptive genetic variation.

3.2 Representative Populations

Representative populations should collectively represent the full range of naturally occurring adaptive genetic variation within British Columbia. Practically speaking, we use species x BEC zone combinations as a means to characterize and classify representative populations. These are logical groupings of individuals based on genetic adaptation to a similar climate. However, genetic variation and adaptation information can be drawn from all available sources, including common garden trials, population genetic or genomic studies, informed

judgment, or ecosystem–based climate envelope modelling (Hamann et al. 2005), and methods may be adjusted as new information suggests new efficiencies or new needs.

3.3 Adequately Conserve

Adequate conservation of the genetic diversity of a species is defined as conservation of representative populations of sufficient size and redundancy that existing levels of genetic variation can be maintained indefinitely. This can be achieved through *in situ*, *ex situ* or *inter situ* conservation. Redundancy across these three methods is desirable, as is redundancy within methods (multiple populations, seed collections or plantations).

In situ. For most wind-pollinated species occurring at high frequencies, an effective population size of Ne>1000 is considered adequate to balance the loss of variation due to genetic drift with the gain of variation due to mutation in an isolated population. In practise, for *in situ* conservation, a census population size of >5000 mature individuals is used as a threshold (Lester and Yanchuk 1996; Hamann et al. 2005; Allendorf et al. 2013 p. 291-292). Conserving at least three populations in separate locations (e.g. parks or other types of protected areas) within each representative population is considered sufficient redundancy for protection from change agents such as fire or harvest.

For rare, low frequency, and irregularly distributed (e.g., riparian) species, census numbers may be hard to determine reliably. Informed judgement will be used to determine when representative populations are adequately conserved. Information to be included in these assessments includes estimates of census population size from ground-truthing, genetic estimates of effective population size and genetic diversity, and geographic patterns of genetic diversity based on genecology studies or genomic markers.

Ex situ seed collections will be used to maintain genetic diversity in a seed bank maintained at the Provincial Tree Seed Center. This provides additional security of the genetic resource, and becomes especially important where *in situ* conservation is not feasible, reliable or sufficient. Current standards specify that adequate *ex situ* conservation requires at least three seed collections of 20 or more parent trees each, where individual parent trees are spaced 50 or more meters apart. These are, today, the guidelines for our conservation collections. Commercial seed collections (registered seedlots) have different requirements for numbers of parents and distances, but in general, there is a great deal of redundancy for *ex situ* conservation of commercial species at the level of representative populations.

Inter situ[1] conservation through the use of trials using seed with pedigree information can also be used to compliment *ex situ* and *in situ* conservation. *Inter situ* conservation will be used where other conservation measures are not feasible.

4. Context and Linkages

Genetic conservation activities undertaken through FGC-supported activities reside within the context of international, national, and provincial agreements and programs (Table 1). Specific provincial goals that are directly relevant to this plan and GCTAC-led activities are:

Goal 1: Effective action on climate change.

Goal 3: Healthy and diverse native species and ecosystems, and

Goal 5: Sustainable use of British Columbia's environmental resources.

Stewardship obligations of the Ministry of Forests, Lands and Natural Resource Operations will be considered and given priority by actions undertaken through this plan. These actions will be prioritized by the Forest Genetics Council of BC within the context of other needs and available resources.

[1] *Inter situ* reserves are plantations of trees of known pedigree such as open-pollinated unrelated families in a first generation progeny test. The trees are well adapted, have a broad genetic basis, and are exposed to natural selective pressures.

Table 1. Legislation, policies and actions that influence BC's tree genetic resources.

Acts and agreements	
International – Convention on Biological Diversity – Montreal process Federal – Species at Risk Act – Canadian Biodiversity Strategy – Convention on Biological Diversity: Aichi Target 11	Provincial – Park Act: protects natural resources – Ecological Reserves Act – Protected Areas of British Columbia Act: list ecological reserves, parks and conservancies – Forest and Range Practices Act: landscape and stand level biodiversity objectives required in forest stewardship planning – BC Conservation Framework – Oil and Gas legislation, Mining legislation – Cumulative Effects Framework
Actions	
International – Montreal Process Criteria 1: Conservation of biological diversity, 9 indicators Federal – Habitat Stewardship Program for Species at Risk – National Parks	Provincial – Protected areas – Other Conservation designations (i.e. Old Growth Management Areas) – BC Conservation Data Centre

5. Scope of Activities

5.1 Species

All tree species indigenous to BC that are generally able to grow to a height of 10 or more meters, typically with a single woody stem, are considered in-scope for this plan. This results in a list of 42 species (Appendix 1).

5.2 Geographic Area

All public and private lands in British Columbia, on which species listed in Appendix 1 naturally occur, are considered in this plan.

5.3 Supported Activities

The following types of activities are recommended for investments organized through the FGC and participating agencies or companies:

1. ***In situ conservation:***
   a) Collect and maintain information to evaluate and monitor the status of populations of tree species in existing reserves, and
   b) Work with other agencies to identify priorities for additional *in situ* conservation.
2. ***Ex situ conservation:*** Develop a comprehensive seed bank with adequate samples of geographically representative populations of species that can be stored successfully in the long term. Collect and maintain information on clone banks and arboreta established by the Forest Genetics section.
3. ***Inter situ conservation:*** Set conservation criteria for *inter situ* reserves; collect and maintain information on *inter situ* populations.

4. Research:

a) Develop conservation methods and strategies specific to the biology of each species,
b) Understand levels and patterns of genetic diversity for efficient conservation and restoration,
c) Predict and monitor the impacts of climate change on species and populations as it relates to genetic conservation, and
d) Evaluate the genetic diversity of reforestation materials to help develop seed-use policies that adequately consider genetic conservation needs and long-term species adaptation.

6. Current Efforts and Direction

6.1 Genetic Conservation Catalogue

Several inventories of genetic resources have been compiled in the past two decades, with each effort increasing the complexity of data and analysis. These reports include Lester and Yanchuk (1996), Hamann et al. (2004), Hamann et al. (2005), and Chourmouzis et al. (2009) for all indigenous species, and Krakowski et al. (2009) for species of economic importance that have genetic management and tree improvement programs.

Cataloguing work done to date has shown that the procedures used appear adequate for timber species, but are less effective for non-timber species. This difference is due largely to better inventory and genetic architecture information for timber species; in particular, species that are spatially well dispersed within a biogeoclimatic unit. In addition, assumptions of what constitutes an adequate population size (expressed in cumulative cover hectares, see Chourmouzis et al. 2009) for genetic conservation purposes are dependent upon genetic architecture, species density, and reproductive systems. These assumptions will continue to be refined through further research efforts and ground-truthing.

6.2 *In Situ* Conservation

The network of provincial and federal protected areas in British Columbia covers nearly 15% of the province, and is the backbone of the forest genetic conservation resource. Cataloguing work has evaluated the degree to which these areas capture representative populations of tree species and assure sufficient numbers of individuals to maintain rare alleles. While most tree species are protected at levels well above the thresholds required for adequate *in situ* conservation for maintenance of genetic variation, some gaps exist, particularly for species in the more highly populated areas of the province. Mechanisms need to be developed for addressing these gaps in conservation, and for integrating information on conservation on private lands and in new provincial and federal protected areas that are not included in these analyses. In addition, “working” forest areas within the timber harvest land base are contributing to the overall source of genetic diversity but are not considered in cataloguing efforts. This resource needs to be considered within the context of cataloguing efforts and methodology developed for doing so.

6.3 *Ex Situ* Conservation

Ex situ conservation is conducted primarily by the provincial tree seed bank, and by clone banks. As of April 2016, the seed bank has 10,007 seedlots, of which roughly 79% are operational (bulk) seedlots and roughly 21% (2146 individual tree collections) are conservation collections, specifically made for conservation purposes. Of the operational seedlots, the majority are wild stand collections but 957 are seed orchard lots. They, too, have some conservation value and especially research value for longitudinal studies, where changes in genetic composition over time are studied. A small sample of seed from timber species is also replicated at the National Tree Seed bank in Fredericton, NB.

Krakowski et al. (2009) showed that that nearly all Seed Planning Units (SPU) for commercial species met the criteria of having three or more seedlots with more than 1,000 viable seeds. For other indigenous tree species, many gaps exist, both at the species level and at population-within-species levels.

For the purpose of conserving all tree species, BEC units (Biogeoclimatic Ecosystem Classification zones) are more useful than seed planning units, because they place all species on a common basis. Genomic data has

recently become available which allows us to investigate whether conservation by BEC zone or by SPU makes a difference for two focal species, lodgepole pine and interior spruce.

Ex situ work will continue to focus primarily on obtaining seed samples from under-represented non-timber species. At the present time, about one third of these populations are in the conservation seed bank.

For most tree species, seed will stay viable in storage for a very long time (50+ years) if properly collected, processed and stored under suitable conditions. For some non-timber species, there are still gaps in knowledge regarding seed storage needs. Poplars and willows deteriorate more quickly in freezer storage, and require quick processing after harvest to maintain viability. Big leaf maple seed, investigated in 2010, was confirmed to be orthodox. New, non-destructive techniques (water activity) are being used for measuring seed moisture content, to confirm that seed is dry enough for freezer storage. However, Garry Oak, being recalcitrant, cannot be conserved using freezer storage. *In situ* and *inter situ* conservation efforts are more suitable for this species.

Clone banks and arboreta provide for *ex situ* conservation of 22 of our indigenous 42 tree species. There are considerably fewer individuals per population than with seed banks so that rare alleles cannot be considered secured, though there are sufficient numbers of trees to represent provenance level variation. Some of the species not amenable to seed storage, or yet collected, such as big leaf maple, Garry oak and western Yew, are protected in such reserves. These holdings were not catalogued in Krakowski et al. 2009, since inventories were on going at the time, but that document recognizes their value for rapid testing and propagation. Cataloguing these clone banks will be pursued in the next five years.

6.4 *Inter Situ* Conservation

Previous work has identified and documented key field installations that meet the intent for *inter situ* conservation populations (Krakowski et al. 2009). Approximately one third of the species by seed zone combinations (seed planning units) in BC (32 of about 90) have representative *inter situ* populations established. Most of these are first generation open-pollinated progeny trials, with some SPUs represented only by genecology trials. These 32, however, are the larger SPUs with respect to harvest and trees planted, representing over 85 percent of the total annual provincial planting. *Inter situ* populations are a significant resource for genetic conservation purposes and will continue to be integrated with cataloguing work. No new field plantations are proposed specifically for *inter situ* conservation purposes, but new installations developed for tree breeding and genecology research can serve a dual purpose. Climate change presents challenges for both *in situ* and *inter situ* genetic conservation resources as SPU and BEC zones shift over time and populations are exposed to new biotic and abiotic threats.

7. Needed Work

7.1 Catalogue

We will continue to use the catalogue to set priorities and objectives for genetic conservation; and measure progress toward the objectives. Catalogue updates will build on previous work, primarily Chourmouzis et al. (2009) and Krakowski et al. (2009). Ground-truthing work undertaken after the development of these documents has shown that poor inventory and genetic architecture information for many non-timber tree species will require modifications to the method used to estimate local population size. Development of revised cataloguing procedures remains a priority. Changes will incorporate a wider range of information on non-timber tree species genetic architecture and the need to recognize geographic zones that differ by species. We will, from **2015-2020:**

- Incorporate data from VRI (Vegetation Resources Inventory) database. Group species by reproductive system and dispersal ability, spatial distribution in their natural range, and set specific conservation objectives for species within each group

- Develop a measurable performance objective using catalogue information, collect data on and report on this objective
- Formally assess whether genetic architecture data are needed for the design of adequate conservation strategies using species with available population genetic data as test cases
- Continue to revise the catalogue with up-to-date conservation information
- Annually report on progress to the provincial conservation objective

7.2 *In Situ* Reserves

Collaborate with other agencies with responsibilities for the provincial network of conservation areas to support information needs on the genetic resources of tree species, to champion genetic conservation needs for tree species, and to help facilitate needed activities associated with genetic conservation or restoration of in-scope species.

7.3 *Ex Situ* Collections

During the period 2015 to 2020, *ex situ* seed collections will continue to emphasize non-timber species. A list of priorities will be maintained, and gaps identified in the conservation catalogue will be filled in accordance with these priorities. As seed crops are periodic for most species, annual work will be adjusted to take advantage of crops as they appear. Clone bank and arboreta inventories from research stations will be completed and catalogued.

7.4 *Inter Situ* Reserves

The primary focus for the period 2015 to 2020 is to update management plans for the provincial network of over 1,000 progeny and genecology field trials that form the *inter situ* reserve network. Plans will consider protection, rejuvenation in the face of climate change and forest health impacts, the integration of this network with *ex situ* and *in situ* conservation efforts in the conservation catalogue, and in setting priorities for actions.

7.5 Research

Genetic conservation of indigenous forest trees can be made more efficient by using the best scientific methods and knowledge to guide activities. Research efforts will be directed primarily at:

1. Assessing climate-change impacts on species distributions and genetic conservation needs
2. Developing conservation strategies for minor species which have been prioritized by GCTAC, including those with different reproductive systems, genetic architecture, geographic distributions, and vulnerability to climate change and forest health impacts. An example is the genetic conservation strategy for whitebark pine (GCTAC, 2009).
3. Developing *ex situ* seed storage techniques.
4. Determining genetic diversity needs for operational seedlots in the context of a comprehensive genetic conservation strategy.

7.6 Extension

Extension of genetic conservation knowledge, status, and pressing needs is an important component of the overall genetic conservation effort. This includes maintaining relevant and up-to-date information on the CFCG, FGC and Tree Improvement Branch websites, contributions to articles and interviews through the news media, and support for extension efforts undertaken by the FGC.

7.7 Conservation of species at risk

The conservation of species at risk may require additional actions. Specifically for whitebark pine, GCTAC supports the screening of seedlings for resistance; field trials to verify long-term resistance; development of climate based seed transfer guidelines; ex-situ seed collections; and seed swaps with other conservation organizations. In addition, conservation efforts are accelerated through collaborations with other agencies, as well as promoting and extending advancements in cone collecting, processing, testing and seedling production.

8. Program Delivery

Genetic conservation activities described in Section 7 will be delivered through a combination of work undertaken directly by FLNRO Tree Improvement Branch staff, contracted to the UBC Center for Forest Conservation Genetics, coordinated through collaborating agencies and companies, and carried out by GCTAC members. The following table outlines in broad terms who will undertake activities.

Table 2. Genetic conservation activities and responsibilities.

Group	Type of activity	Funding sources	Review and priority setting
FLNRO Tree Improvement Branch	• Ground truthing • Strategic planning • GCTAC support and participation • Maintenance of *ex situ* collections • Maintenance of *inter situ* trials • Setting planting diversity standards	• Land Base Investment Strategy (LBIS) • FLNRO salary and operating • Seed sale recoveries	• In collaboration with GCTAC and the FGC • Business plan approved annually by the FGC
UBC Center for Forest Conservation Genetics	• Catalogue updates • Research on catalogue methods, genetic architecture, genetic diversity needs, conservation strategies, forest health and climate-change impacts • Technical support for GCTAC • Maintenance of online technical resources and the BC Big Tree Registry	• LBIS • Leveraged grants from other funding agencies (NSERC, Genome BC, Genome Canada, etc.)	• GCTAC and FGC approved annual business plan
GCTAC members	• Strategic and business planning • Project review • Reporting to the FGC	NA	• In conjunction with the FGC
Others	• Collaboration on projects as needed	• Individual agency • LBIS	• Done by the GCTAC
All	• Collaboration with other agencies		

9. Business Planning and Reporting

9.1 Business Planning

The GCTAC will lead the development of annual business plans and prepare LBIS budget recommendations for the FGC. Priorities set through this planning process will be communicated to affiliated agencies to help guide their investments in genetic conservation.

9.2 Reporting and Performance Indicator

Conservation activities will be reported on by project, and include an outline of activities, outcomes, spending for the fiscal year, and performance to the provincial conservation objective of the FGC. Genetic conservation progress will be reported using the following performance indicator:

based on *in situ, inter situ,* and *ex situ* conservation information, each representative population (currently understood as a species x BEC zone combination) will be classified as:

- Adequately conserved
- Uncertain conservation status, or,

- Of conservation concern

The total number of "adequately conserved" populations, expressed as a percentage of the total number of populations in BC, for all species, will be the performance indicator at the provincial level. This single statistic will be compiled annually and presented in FGC Annual Reports in graphic form, along with previous years, to illustrate status and progress.

Individual genetic-conservation projects undertaken as part of annual plans approved by the FGC and supported with LBIS funds will provide financial updates to the Tree Improvement Program Administrator as required in funding agreements, and report annually to the GCTAC on performance indicators that are specific to the project and set out in approved plans.

9.3 Planning and Reporting Schedule

Planning and reporting will proceed on the following annual schedule:

November: Review of projects and needs, and priority setting

January: Submission of project plans, proposals, and budgets

February: Review of projects and budgets

March: Budget recommendation to the FGC

June: Reports on the previous year's activities

10. Resource Needs

This section considers only resources that will be applied directly to meeting the objectives set out in this plan, as well as associated human resources that support activities and provide expertise, but are not directly linked to this program.

10.1 Human Resources

Human resource needs must be balanced against available staff, budgets, and expertise. The following are considered reasonable within this context:

MFLNRO Tree Improvement Branch:

- Lead planning and interactions with other agencies, prioritize *ex situ* collections needs, carry out ground truthing and other activities supported by the GCTAC and FGC, coordinate research with the GCTAC, and lead some research projects.

UBC Centre for Forest Conservation Genetics

- Associate Director (½ FTE, cost of the other half proposed to be shifted to the Seed Transfer TAC for climate change work).
  Note: should Seed Transfer TAC funding of the other ½ FTE of the Associate Director be hampered, the CFCG risks losing its continuity.
- Graduate students and technical staff as required for specific research projects.
- Maintenance of extension materials, genetic conservation resources and website.

Others affiliated with genetic conservation

- MFLNRO Tree Improvement Branch: scientific staff participation in discussions and planning, and related support through breeding and genecology programs.
- SelectSeed Ltd: staff support for planning and review.
- MOE and other organizations: staff support for planning and review.

10.2 Funding

Only Land Base Investment Strategy (LBIS) funding directed by the FGC is considered here. Additional funding for staff is the responsibility of participating organizations. Table 3 outlines anticipated 5-year LBIS funding needs and MFLNRO Tree Improvement Branch staff needs. Annual budget requirements may vary as projects develop and information changes.

Table 3. Recommended five-year LBIS resourcing for genetic conservation program objectives ($ x 1000).

	Year				
Group and activity	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**
LBIS Tree Improvement program					
TIB program work	70	70	70	70	70
Ex situ seed collections	25	25	25	25	25
Seed bank management[2]	15	15	15	15	15
UBC Centre for Forest Conservation Genetics (projects assigned by GCTAC)	110	110	110	110	110
Other projects as needed	30	30	30	30	30
Total for LBIS TIP	250	250	250	250	250

Citations

Allendorf FW, Luikart G and SN Aitken. 2013. Conservation and the genetics of populations. Wiley-Blackwell, 602 pp.

Chourmouzis C, AD Yanchuk, A Hamann, P Smets, and SN 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. Ministry of Forest and Range. For. Sci. Prog. Victoria, B.C.Tech. Rep. 053

Gene Conservation Technical Advisory Committee. 2009. Genetic conservation strategy for whitebark pine in British Columbia. http://www.fgcouncil.bc.ca/GCTAC-WhitebarkPine-GenConsStrat-BC-2009.pdf

Hamann A, SN Aitken and AD Yanchuk. 2004. Cataloguing in situ protection of genetic resources for major commercial forest trees in British Columbia. For. Ecol. Manage. 197:295-305.

Hamann A, P Smets, AD Yanchuk and SN Aitken. 2005. An ecogeographic framework for in situ conservation of forest trees in British Columbia. Can. J. For. Res. 35: 2553-2561.

Krakowski J, Chourmouzis C, Yanchuk AD, Kolotelo D, Hamann A and SN Aitken. 2009. Forest Tree Genetic Conservation Status Report 2: Genetic Conservation of Operational Tree Species. B.C. Ministry of Forests and Range, Forest Science Program, Victoria, B.C. Technical Report No. 54.

Lester D and AD Yanchuk. 1996. A survey of the protected status of conifers in British Columbia: In situ gene conservation. B.C. Min. For., Res. Br. Victoria, B.C. Res. Rep. 04.

[2] Seed from *ex situ* conservation collections needs to be assessed for moisture levels, dried, inventoried and placed into long term storage.

Appendix 1: Indigenous Tree Species Considered In-Scope

Conifers

Code[3]	Species	Know-ledge
BA-ABIEAMA	Pacific silver fir	A
BG-ABIEGRA	Grand fir	A
BL-ABIELAS	Subalpine fir	A
YC-CALLNOO[4]	Yellow-cypress	A
JR-JUNISCO	Rocky Mtn. juniper	B
JM-JUNIMAR	Maritime juniper	B
LT-LARILAR	Tamarack	B
LA-LARILYA	Subalpine larch	B
LW-LARIOCC	Western larch	A
SE-PICEENG	Engelmann spruce	A
SW-PICEGLA	White spruce	A
SB-PICEMAR	Black spruce	A
SS-PICESIT	Sitka spruce	A
PA-PINUALB	Whitebark pine	B
PJ-PINUBAN	Jack pine	B
PL-PINUCON	Lodgepole pine	A
PF-PINUFLE	Limber pine	B
PW-PINUMON	Western white pine	A
PY-PINUPON	Ponderosa pine	A
FD-PSEUMEN	Douglas-fir	A
T-TAXUBREV	Pacific yew	B
CW-THUJPLI	Western redcedar	A
HW-TSUGHET	Western hemlock	A
HM-TSUGMER	Mountain hemlock	B

Broadleaves

Code	Species	Know-ledge
MV-ACERCIR	Vine maple	B
MR-ACERGLA	Douglas maple	B
MB-ACERMAC	Bigleaf maple	A
DR-ALNURUB	Red alder	A
R-ARBUMEN	Arbutus	B
EA-BETUNEO	Alaska paper birch	B
EW-BETUOCC	Water birch	B
EP-BETUPAP	Paper birch	B
G-CORNNUT	West. flowering dogwood	B
UP-MALUFUS	Pacific crab apple	B
ACB-POPUBAL	Balsam poplar	B
AT-POPUTRE	Trembling aspen	B
ACT-POPUTRI	Black cottonwood	A
VB-PRUNEMA	Bitter cherry	B
QG-QUERGAR	Garry oak	B
K-RHAMPUR	Cascara	B
WP-SALILUC	Pacific willow	B
WS- SALISCO	Scouler's willow	B

Knowledge level

A = considerable knowledge

B = incomplete knowledge

[3] There are two codes for each species – the first, in **bold** text for Ministry of Forests, Lands and Natural Resource Operations, and the second, with the first four letters of the genus and three letters of the species name, is used by the FLNRO Ecology Group for vegetation plot data as well as the Centre for Forest Conservation Genetics.

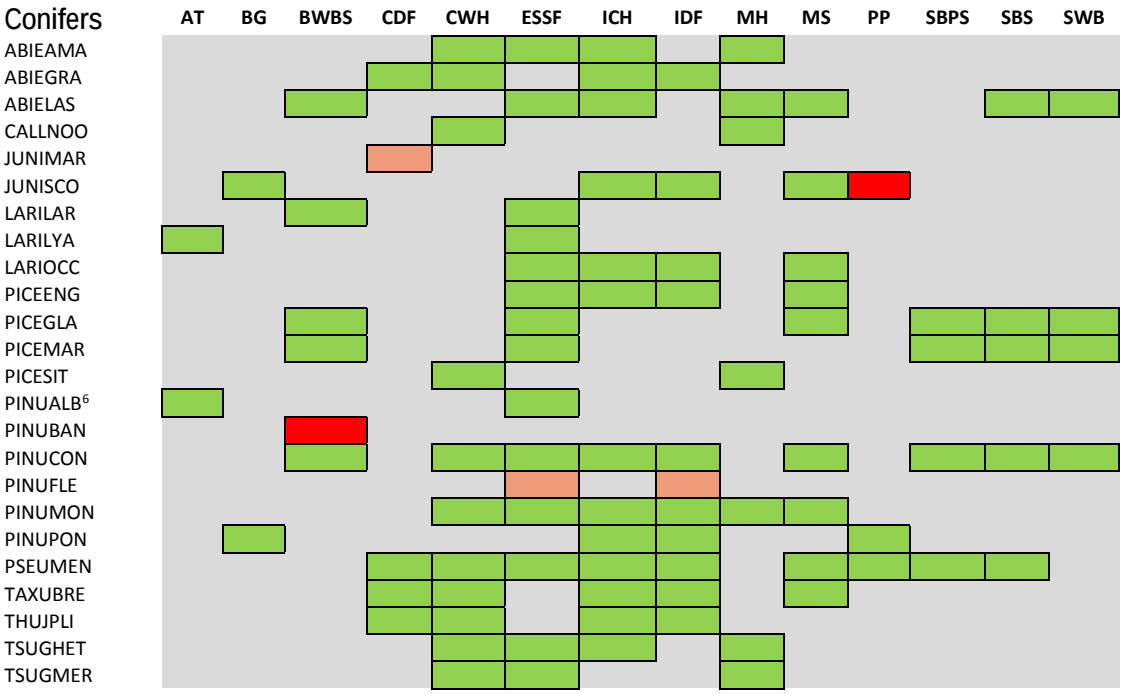
[4] Callitropsis nootkatensis or yellow cypress is the new name for Chamaecyparis nootkatensis or yellow-cedar. The abbreviation "chamnoo" Is still present in previous cataloguing documents, including the CFCG website. See:

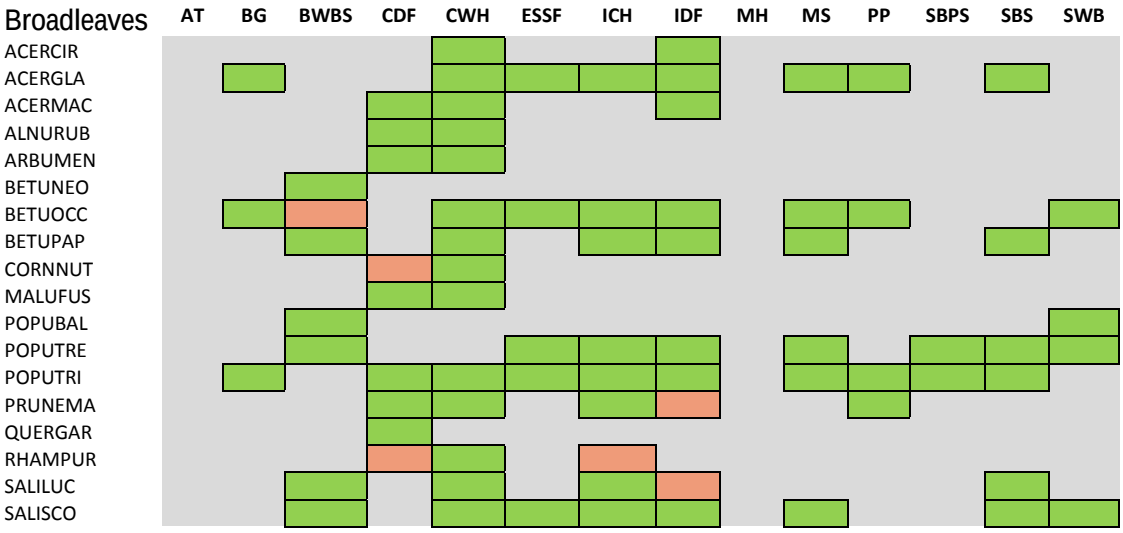
Little, D.P. 2006. Evolution and circumscription of the true cypresses (Cupressaceae: Cupresssus). Systematic Botany. 31:461-480.

Russell, John. 2012. A New Conifer Species Affects Taxonomic Classification in the Cupressaceae. TICTalk 11:3-4.

Appendix 2: Conservation Status in 2015

A. In Situ : Summary of the protection level in each BEC zone for species considered in-scope (176 cells). Updated[5] from Chourmouzis et al. (2009, table 1). Adequately conserved populations (*in situ*) are green. Orange indicates uncertain conservation status and red indicates "of conservation concern".





[5] Updated using ground truthing data from J. Krakowski (2011, unpublished)

[6] Although adequately protected according to *in situ* criteria, an *in situ* strategy alone is inadequate to conserve this species at risk.

B. Ex Situ

Total number of *ex situ* Conservation Collections (T#CC) collected to date, and total number of parent trees from which seed was collected (T#Par). Collections by BEC zone are put against the background colours of the *in situ* conservation status (previous page).

Conifers	T#CC	T#Par	AT	BG	BWBS	CDF	CWH	ESSF	ICH	IDF	MH	MS	PP	SBPS	SBS	SWB
ABIEAMA																
ABIEGRA	3	31							3							
ABIELAS	2	23									2					
CALLNOO																
JUNIMAR	3	18				2	1									
JUNISCO	12	130		2						8			1		1	
LARILAR	0	0														
LARILYA	2	44						2								
LARIOCC																
PICEENG																
PICEGLA																
PICEMAR																
PICESIT																
PINUALB	26	313	1					23			1				1	
PINUBAN	0															
PINUCON																
PINUFLE	5	99								4		1				
PINUMON																
PINUPON																
PSEUMEN																
TAXUBRE	11	113					2		6	3						
THUJPLI																
TSUGHET																
TSUGMER																

Broadleaves[7]	#CC	#Par	AT	BG	BWBS	CDF	CWH	ESSF	ICH	IDF	MH	MS	PP	SBPS	SBS	SWB
ACERCIR	3	62				1	2									
ACERGLA	8	132					1		1	3		1	2			
ACERMAC	5	104				2	1			1			1			
ALNURUB																
ARBUMEN	4	49				3	1									
BETUNEO	0	0														
BETUOCC	8	121		3						4			1			
BETUPAP	7	61				1	4		1	1						
CORNNUT	6	73				1	3			2						
MALUFUS	6	70				1	4			1						
POPUBAL	0	0														
POPUTRE	1	10			1											
POPUTRI	5	75		1		1	1			0.5		0.5	1			
PRUNEMA	5	54				1	2		1	1						
QUERGAR																
RHAMPUR	9	104				2	4		3							
SALILUC	0	0														
SALISCO	0	0														

[7] The following species are no longer considered in-scope, but are responsible for 15 conservation collections (165 parent trees): Fraxinus latifolia, Crataegus douglasii, Crataegus columbiana, Prunus virginiana, Betula glandulosa.

Appendix 3: Performance Indicator

A. In Situ: So far, our performance indicator has largely focused on *in situ* conservation, since this is deemed the most effective way of conserving genetic diversity for native species within the BC context. When evaluating the proportion of protected *in situ* populations in B.C. and its evolution over time, caution is needed because the baseline has changed over time. These changes concern the definition of representative populations, the number of species considered in-scope, the database used and the criterion used to determine protection. Due to such changes, the performance indicator does not reflect additional conservation efforts, achievements or shortfalls well. However, it still reflects our best knowledge about the *in situ* conservation status of tree species in BC.

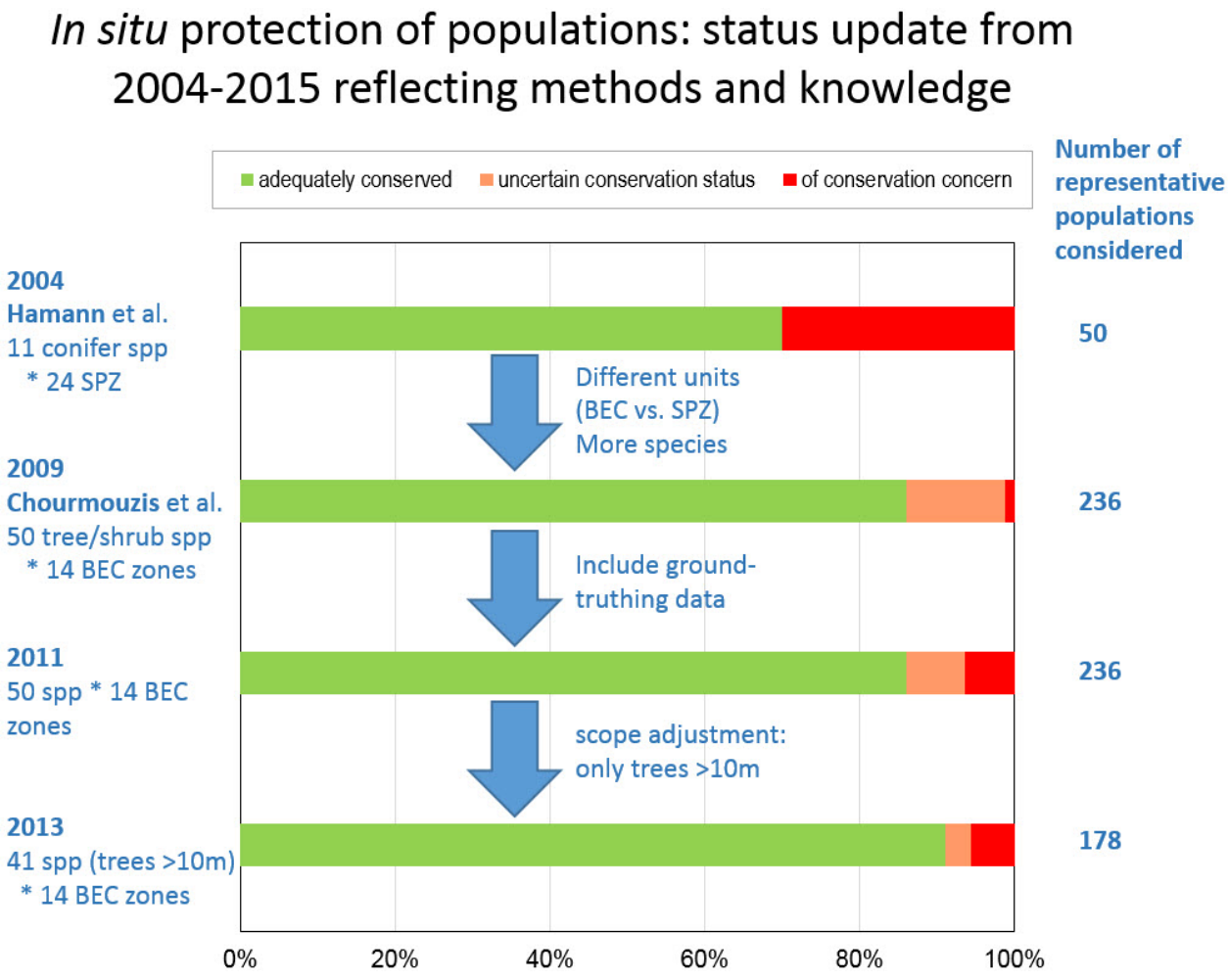


Figure 1: *In situ* protection of populations: status update from 2004-2015 reflecting methods and knowledge.

Future increases in the percentage of adequately conserved populations will result from increased knowledge (inventory, ground-truthing) and protection efforts (new protected areas), but in the end the catalogue needs to be combined with expert knowledge for a complete interpretation. Thus, changes in the indicator must also be expected due to new information about the effects of climate change and diseases.

B. Overall : in the end, we wish to decide whether populations are adequately protected through any combination of available methods. *In situ* conservation is the most sound and often the most easily achieved. *Ex situ* collections can fill the gaps and provide redundancy, and will be critical in cases where biological threats such as insects or diseases threated viability of in situ populations. *Inter situ* collections or clone banks may be the best option for species when their seeds cannot be stored long term.

Overall performance indicator table

Year	*In situ* A / U / I[8]	*Ex situ* A / I	*Inter situ* A / I	Total # of populations	Overall protection status A [9]	U	I [10]	Indicator
2015	163 / 9 / 4	84 / 92	17/159	**176**[11]	**165**	7	4	**93.8 %**
2016	.	.	.	.	.	.	.	.
2017	.	.	.	.	.	.	.	.
2018	.	.	.	.	.	.	.	.
2019	.	.	.	.	.	.	.	.
2020	.	.	.	.	.	.	.	.

Appendix 4: Priority listing

The top 10 species for conservation genetic research or operational conservation activities in 2002 and CFCG research projects for these species.

Scientific name	Common name	Abbreviation	CFCG project completed 2015	Future focus
Arbutus menziesii	Arbutus	ARBUMEN		x
Cornus nuttallii	Pacific dogwood	CORNNUT	√	
Pinus flexilis	limber pine	PINUFLE		
Salix scouleriana	Scouler's willow	SALISCO		
Quercus garryana	Garry oak	QUERGAR	√	
Crataegus douglasii	Douglas hawthorn	CRATDOU		- [12]
Juniperus scopulorum	Rocky Mountain juniper	JUNISCO		JUNIMAR[13]
Populus tremuloides	trembling aspen	POPUTRE		
Malus fusca	Pacific crab apple	MALUFUS		
Pinus albicaulis	whitebark pine	PINUALB	√	x

There is ongoing research on whitebark pine, focussing on *ex situ* seed collections and blister rust resistance testing. Genecology studies on Garry oak continue. Future high-priority minor species for CFCG include maritime juniper and Arbutus, and these will be pursued when funding, seeds, and appropriate personnel are available.

[8] Where A=adequate, U=uncertain, I=inadequate

[9] Using expert knowledge to decide which combination of *in situ*, *ex situ* and *inter situ* protection levels is adequate overall, in light of what is feasible for each particular species.

[10] A list of populations with inadequate or uncertain protection will be evaluated annually and used to set priorities.

[11] Not considering populations that contain less than one percent of the species' cumulative cover in B.C.

[12] No longer considered in-scope.

[13] Coastal sources are now recognized as a separate species and this is where the focus in the future will likely be.