

Forest Gene Conservation Programs in Alberta, Canada¹

Jodie Krakowski²

Summary

Provincial tree improvement programs in Alberta began in 1976. Early gene conservation focused on *ex situ* measures such as seed and clone banking, and research trials of commercial species with tree improvement programs. The gene conservation program now encompasses representative and unique populations of all native tree species *in situ*. The *ex situ* program aims to capture representative samples of each species by natural subregion combination in the provincial seed archive. Species whose seeds do not store well may be represented in clone banks, but resources limit those archives to threatened populations or those of special adaptive interest. Since most forested area in the province is public land, cooperators in tree improvement programs are legally obligated to share the responsibility for gene conservation for the benefit of all Albertans.

In Situ Conservation Status

The provincial *in situ* forest gene conservation strategy includes all 28 tree species native to Alberta. Priorities for species and populations were developed based on gap analysis interpolating species ranges, ecological regions, and expert knowledge. Ecological subregions (fig. 1) were used as surrogates for population adaptive differences as quantitative genetic data was lacking for many species. A spectrum of protection is afforded by different types of protected areas; all prohibit commercial forest harvest. National parks total 56.8 percent of Alberta's protected areas. Protection is ample in the Rocky Mountains Natural Region, but there are deficits in the Canadian Shield, Foothills, Grassland, and Parkland Natural Region (fig. 2). Climate change scenarios highlight vulnerabilities in long term genetic conservation as climates characteristic of natural subregions and species climatic envelopes are predicted to shift relatively rapidly beyond observed historic migration rates and protected area boundaries.

¹ A version of this paper was presented at the Gene Conservation of Tree Species – Banking on the Future Workshop, May 16-19, 2016, Chicago, IL.

² Alberta Agriculture and Forestry, Forest Management Branch, 8th Floor, 9920 108 St. NW, Edmonton, Alberta, Canada T5K 2M4.

Corresponding author: jodie.krakowski@gov.ab.ca.

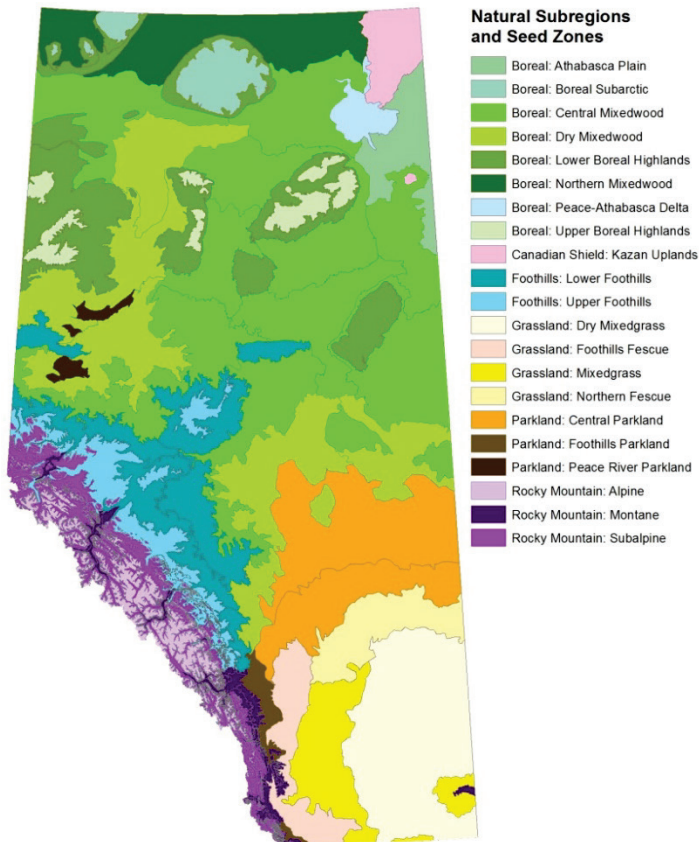


Figure 1—Natural regions and subregions of Alberta.

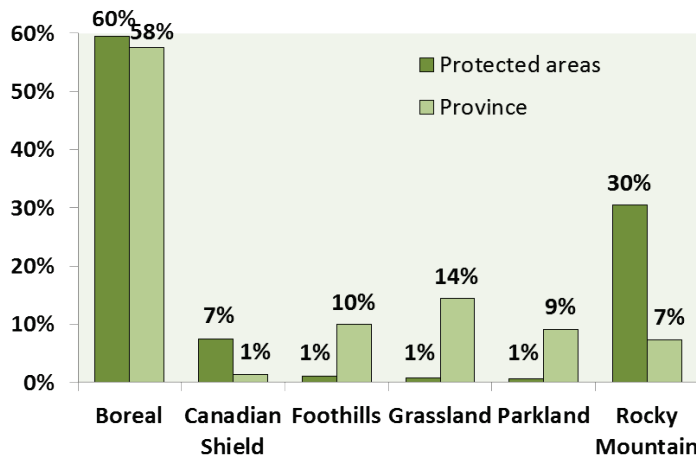


Figure 2—Distribution of natural regions by total area, and within protected areas in Alberta.

Ex Situ Conservation Status

Alberta has an *ex situ* conservation strategy for native species. Gaps and priorities were identified, emphasizing representative sampling of populations and targeted sampling of species at risk (table 1). The *ex situ* program complements provincial tree improvement programs through seed and clone bank archives. Built in 1978, a secure seed bunker stores seeds at -20 °C at the Alberta Tree Improvement and Seed Centre in Smoky Lake. Seed is stored in airtight containers, with a detailed inventory database, and

periodically re-tested for viability to identify seedlots that may need replacement. Following the recent addition of native shrubs to the provincial forest genetic standards, it is anticipated that those species will be added to the ex situ conservation program as we learn more about their seed biology.

Table 1—Ex situ collections in Alberta by natural region

Natural Region	Boreal		Canadian Shield		Foothills		Grassland		Parkland		Rocky Mountain	
Species	Bulk	Single Bulk	Single Bulk	Single Bulk	Single Bulk	Single Bulk	Single Bulk	Single Bulk	Single Bulk	Single Bulk	Single Bulk	Single
<i>Abies balsamea</i>	0 ^a	0	-	-	1	1	-	-	-	-	-	-
<i>Abies lasiocarpa</i>	0	0	-	-	0	0	-	-	-	-	2	<u>36</u>
<i>Betula papyrifera</i>	<u>4</u>	2	0	0	1	0	0	0	0	0	-	-
<i>Juniperus scopulorum</i>	-	-	-	-	-	-	-	-	-	-	1	19
<i>Larix laricina</i>	<u>25</u>	<u>89</u>	0	0	<u>8</u>	1	-	-	0	0		
<i>Larix lyallii</i>	-	-	-	-	-	-	-	-	-	-	2	<u>31</u>
<i>Picea engelmannii</i>	-	-	-	-	-	-	-	-	-	-	9	10
<i>Picea glauca</i>	<u>111</u>	<u>672</u>	0	0	<u>45</u>	<u>363</u>	-	-	3	1	11	<u>95</u>
<i>Picea glauca</i> x <i>engelmannii</i>	-	-	-	-	<u>3</u>	0	-	-	-	-	7	10
<i>Picea mariana</i>	<u>30</u>	<u>104</u>	0	0	<u>27</u>	<u>46</u>	-	-	0	0	1	1
<i>Pinus albicaulis</i>	-	-	-	-	-	-	-	-	-	-	10	<u>326</u>
<i>Pinus banksiana</i>	<u>35</u>	<u>114</u>	0	<u>15</u>	-	-	-	-	0	0	-	-
<i>Pinus flexilis</i>	-	-	-	-	0	0	-	-	-	-	<u>31</u>	<u>388</u>
<i>Pinus latifolia</i> var. <i>latifolia</i>	<u>68</u>	<u>113</u>	-	-	<u>168</u>	<u>576</u>	1	0	2	0	<u>95</u>	<u>216</u>
<i>Pinus latifolia</i> x <i>banksiana</i>	<u>57</u>	<u>70</u>	-	-	<u>133</u>	<u>658</u>	-	-	1	0		
<i>Populus balsamifera</i>	<u>4</u>	<u>30</u>	0	0	1	<u>17</u>	0	0	0	0	0	0
<i>Populus deltoides</i>	-	-	-	-	0	0	1	<u>49</u>	-	-	-	-
<i>Populus tremuloides</i>	<u>13</u>	<u>59</u>	0	0	<u>10</u>	<u>22</u>	0	0	1	0	0	9
<i>Pseudotsuga menziesii</i> var. <i>glauca</i>	-	1	-	-	-	-	0	0	1	0	10	<u>30</u>

^a Underlined cells have adequate representation, dashes indicate absence or very peripheral presence, and other cells have gaps.

A Shared Responsibility

Regulatory requirements for managing forest genetic resources on public land, with specific quantitative genetic targets, are established in the Alberta Forest Genetic Resource Management and Conservation Standards (2016 revision). Agencies with tree improvement programs for reforestation on public land must implement a forest gene conservation program for each species and region, with *in situ* and *ex situ* components that comply with the standards. Seedlots from seed orchards need an effective population size (Ne) of at least 18 to be eligible for deployment. Wild seedlots must contain at least 30 well-spaced

parents from a seed zone. Clonal collections are from 10 to 120 different clones, depending on the planned deployment on the landscape.

Case Study: Whitebark and Limber Pines

Special gene conservation measures are required by provincial recovery plans for whitebark (*Pinus albicaulis*) and limber (*Pinus flexilis*) pines, whose endangered status cannot be mitigated by *in situ* conservation alone. *Ex situ* collections include both legacy un-selected trees, and selected trees with putative genetic resistance to white pine blister rust (WPBR) caused by *Cronartium ribicola*. The current program focuses on selecting resistant trees for *ex situ* collections, identifying, and protecting high value *in situ* trees and stands. Candidate trees are being screened for WPBR resistance in British Columbia (Kalamalka Research Station), Oregon (Dorena Genetic Resource Center), and Idaho (Coeur D’Alene Forest Nursery). Scions of selected trees will be grafted in regional clonal archive that can be developed for seed production.

Conclusion

Forest genetic resource management in Alberta has been progressing for 40 years. Quantitative targets to regulate and maintain genetic diversity and adaptation of reforestation material on public lands are established in legal standards. Both *in situ* and *ex situ* conservation of native forest tree populations are ongoing, with priorities set by a provincial gene conservation strategy for native tree species.