

Conserving Genetic Resources of Forests in the Pacific and Yukon Region: An Introduction to Project PC-71-50

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Forests of the Pacific and Yukon Region are highly diversified and harbour some of the world's most prized genetic resources in woody species. For example, with 16 species, south-central British Columbia features the highest concentration of conifers in Canada. The entire Region has long served as a major genetic resource for less-endowed parts of the world.

Many agencies—regional, national, and international—have commented on the Region's biological heritage, and have expressed concern over the possibility of irreversible losses resulting from a combination of lack of appreciation of their value, limited knowledge on the dimensions of genetic diversity in the Region, and a dearth of institutional and technical instruments for their conservation.

Two approaches may be taken to conserve genetic resources. In the first, locally evolved, adapted populations are maintained *in situ*, through a variety of measures ranging from seed stands to ecological areas with strong jurisdictional protection. However, effective strategies must be based on an adequate knowledge of such populations; while tree improvement programs have spurred research into important commercial species, some significant gaps remain in the Region's tree flora. A distinct problem lies in the incomplete representation of forest types in protected areas, and in the limited understanding of what is currently protected. The second approach to conservation is through *ex situ* measures, notably seed storage and plantations. Here, too, lie several problems, resulting from inadequate knowledge of the behaviour of genetic materials *ex situ*.

In 1991, the Forestry Minister announced the program, "Partners in Sustainable Development of Forests," as one of Forestry Canada's contributions to the Green Plan. The program commits Forestry Canada to two important conservation initiatives. In the first, a new National Forest Genetic Resource Centre is aimed at conserving plant and other forest resource materials. In the second, Ecological Reserves, Forestry Canada will help the forest sector in completing the representation of Canada's diversity of forests in the national network of protected areas.

The Forest Ecosystem Dynamics Program is contributing to the conservation of plant and other forest resource materials, the first initiative, with several studies aimed at addressing several *in situ* and *ex situ* issues. Specifically these deal with: population structure of mountain hemlock, a species that has gained prominence in high elevation forestry in coastal parts of the province; appropriate technology for preservation of gene resources of western forests; and the effects of long-term storage on the genetic integrity of stored seeds. One of the arguments for *in situ* conservation is that it maintains the most options for the future, because as yet unrealized resources are protected, as well as those with current utility. This project recognizes the special place of Native people's knowledge of natural products, in particular pharmaceuticals, and will pursue opportunities to safeguard this information. We are responding to the emergence of Pacific yew as the world's most important source of taxol, recently approved for the treatment of ovarian cancer. The quest for yew bark has raised questions regarding the security of the species and the ability of the Region to meet escalating demands for raw material. The taxol issue is extremely volatile, as pharmaceutical testing continues in light of intense public interest. Our initiative is designed to encourage the sustainable development of this new resource.

For the second initiative, Ecological Reserves, the Forest Ecosystem Dynamics Program has been asked to provide national leadership for the enhancement of Canada's network of forested ecological reserves. Cooperatively, by fostering partnerships at regional and national levels, Forestry Canada will help the forest sector in completing the representation of Canada's diversity of forests in a national network of protected areas.

The conservation of genetic resources is an important aspect of biodiversity, today a highly topical issue on scientific, public, and political agendas. The Forest Ecosystems Dynamics Program will maintain a flexible position to respond to emerging needs and opportunities in the Region, particularly where they coincide with priorities in the federal government's Green Plan.

These goals are pursued within the following strategies:

- Develop protocols for conserving genetic resources of forests in the Pacific and Yukon Region.
- Prepare guidelines for the sustainable use of Pacific yew for taxol.
- Evaluate diversity of minor crop species to foster their continued maintenance in the biodiversity of the Region.
- Provide national leadership and regional management of the Green Plan Ecological Reserves project.
- Improve institutional and technical arrangements for incorporating the conservation of genetic resources into management objectives.

***Ex situ* Conservation of Forest Biodiversity in British Columbia**

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Introduction

Biological diversity of our forests, which has become a preeminent concern of forest practitioners, users, and the public, has three major components: species diversity, ecosystem diversity, and genetic diversity. This project focuses on the conservation of genetic diversity because no similar studies were being conducted; work on species and ecosystem diversity is under way elsewhere. Since little information is available on the impact of *ex situ* conservation on the genetic diversity of tree seeds, this project was initiated.

Ex situ conservation in crop plants relies on frequent rejuvenation (i.e., production of new plants, conducting of controlled crosses, and harvesting of fresh seeds for further storage). *Ex situ* conservation in forestry, specifically conifers, cannot accommodate this rejuvenation component because of the well-known long duration required by seedlings to reach sexual maturity. Thus, the genetic integrity of stored seedlots has to be assumed to remain constant, unchanging over time. This project is designed to test the efficacy of this assumption through simulated (accelerated), long-term ageing.

Before any testing is begun, two fundamental questions must be addressed: 1) what genetic differences exist in germination parameters; and 2) what genetic differences exist in dormancy levels. These questions are essential for establishing benchmarks against which deterioration during simulated ageing can be evaluated, and for testing the hypothesis that genotype-specific differences in dormancy are related to rate of deterioration.

Germination/dormancy-breaking is a by-product of enzymatic activity. Most of the proteins involved in this are stored in the nutritive (megagametophyte) tissue. It is expected, therefore, that rate of deterioration in stored seeds will be associated with changes in the protein matrix. The protein matrix will be monitored through the simulated ageing process to determine the presence or absence of associated changes.

Objectives

The objectives of the project are:

- to determine if commonly used forest tree seed storage practices result in a reduction of genetic diversity;
- to relate any reductions to specific genotypes;
- to identify specific changes (gene markers) in the protein matrix with deterioration during storage; and
- to propose alternative approaches to current seed storage procedures to circumvent any changes in the genetic composition of stored seedlots.

Materials and Methods

The species to be studied will include all coniferous species under domestication programs (coastal: Douglas-fir, Sitka spruce, western hemlock, western redcedar; and interior: lodgepole pine, "interior" spruce), minor species (mountain hemlock), and a representative broadleaved species (red alder) (Table 1).

TABLE 1. *Ex situ* Conservation Work Plan 1992–1997

Species	Genetic differences	Accelerated aging	Biochemical analysis
Douglas-fir	Inheritance of germination - published 1992 Germination speed - publication 1992 Manipulation of dormancy - data analysis - publication 1993	Completed - data analysis ongoing - reporting in progress	In progress
Sitka spruce	Inheritance and germination differences - completed - publication 1992	Completed - publication 1993 (in press)	1994/95
western hemlock	Inheritance, germination differences and dormancy - in progress	1993/94	1994/95
western redcedar	Germination differences - completed Preliminary data presented	1994/95	1994/95
mountain hemlock	Germination differences - completed	1993/94	1994/95
lodgepole pine	Inheritance, germination differences and dormancy manipulation - in progress	1993/94	In progress
interior spruce	1993/94	1994/95	1994/95
red alder	1993/94	1994/95	1994/95

The methods to be used include: 1) traditional seed pretreatments; 2) modified seed pretreatments; 3) simulated (accelerated) ageing techniques; and 4) biochemical analyses (2-D electrophoresis).

The standard method developed for simulating ageing in crop plants will be modified by means of pilot tests, to suit individual tree species. (Work already carried out on Douglas-fir, Sitka spruce, and mountain hemlock has indicated that custom-made ageing treatments are required for every species.) The modified method will then be used to determine whether differences in resilience to simulated long-term storage exist, and whether these differences are genotype specific.

Standard germination tests will be employed to establish benchmarks for germinability/dormancy and to establish the presence of genetic differences among genotypes.

Biochemical analyses (2-D electrophoresis) are being used to determine changes in the protein matrix and whether such changes (losses/additions) are genotype specific.

Results

1. Genetic differences in germination parameters and dormancy have been found in Douglas-fir (El-Kassaby *et al.* 1992), Sitka spruce (Chaisurisri *et al.* 1993b), and western redcedar (El-Kassaby *et al.* 1993). Evidence of strong genetic (maternal) control ($h_b^2 > 0.5$) has been found for Douglas-fir, Sitka spruce, western redcedar (El-Kassaby *et al.* 1993a) (Table 2), and mountain hemlock. The unique structure of coniferous seeds dictates this strong maternal effect (4:1 maternal:paternal) (El-Kassaby *et al.* 1992). A novel interpretation of germination parameters has also been reported (Thompson and El-Kassaby 1993).