Introduction

Proper seed handling techniques are necessary for successful reforestation efforts. With the short supply of seeds from some sources, higher cost of seed orchard seeds, and the legislated use of seeds of the best genetic quality available in BC, there is good reason to be as efficient as possible with tree seeds. This guidebook is intended for use by individuals who handle cones or seeds (collectors, orchardists, processors, and nurseries) and by those who would benefit from an integrated view of seed handling—from cone collection to sowing seeds in nurseries (seed owners, reforestation foresters, certification agencies). The guidebook focuses on north temperate conifers, particularly from the Pacific Northwest, but the general principles are applicable to most conifer species. Discussion of procedures are based on those at the BC Ministry of Forests Tree Seed Centre and supporting facilities or functions. Exact procedures may differ by facility, but this guidebook will be focused more on principles than exact procedures. Most of us deal with only part of this seed handling system, but it is important to understand the full spectrum of seed handling activities. Poor handling by others at any previous or subsequent stage may negatively impact your product!

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This guidebook is intended to provide readers with information on seed handling with an emphasis on three topics:

- **Guidelines for proper seed handling**
- **The tools required to recognize seed problems**
- **Techniques for avoiding or correcting seed problems.**

The guidebook provides some background information on seed condition, seed insects, and seed fungi and then covers the 'seed handling system' that encompasses all seed handling activities from cone collection to sowing in the nursery (Figure 1). The system begins with the collection of cones from seed orchards, wild stands, or plantations. This guidebook does not discuss cone crop development or monitoring. For information on these topics readers are referred to *Forest Tree Seed Production* (Owens and Blake 1985), *A Guide to Collecting Cones of British Columbia Conifers* (Eremko et al. 1989); *A Field Guide to Collecting Cones of British Columbia Conifers* (Portlock 1996), or Chapter 15 in *Regenerating British Columbia's Forests* (Leadem et al. 1990).

Post-collection handling, including temporary storage, monitoring and transport of cones to a processing facility, is a key step in the production of high quality seeds. Unfortunately it is a stage that too often receives inadequate attention. It is generally recommended that the cones of most species should be field-stored (interim storage) for approximately four weeks prior to shipping to the extractory to reduce moisture content and risk of damage. However, exceptions to this rule include western hemlock[1] and western redcedar which have shallow seed dormancy and should be shipped to the seed processing facility immediately after picking. Cone storage or conditioning may continue at the cone and seed processing facility if moisture content is still too high or if cones are not scheduled for immediate processing.

Cones are generally opened through a kilning process and the seeds extracted by tumbling or screening. Cones of *Abies* spp. may not be kilned at some facilities as their cones naturally disintegrate with additional conditioning. The drying process and separation of seeds from cones, by either method, constitutes cone processing.

Seed processing involves the removal of debris, removal of non-viable seeds, and reduction of seed moisture content that prepares the seeds for long-term storage. Many different processes and pieces of equipment may be used in seed processing. For example, all **Pinaceae** species have their seed wing removed during processing. However, the seed wing is not removed in the **Cupressaceae** species since it would significantly damage the seeds.

Seed testing is an important step as it quantifies seedlot quality and allows one to estimate the number of seedlings that may be obtained (potential seedlings) from a quantity of seed. Legislated requirements to ensure seed quality for testing are in place and acceptable values for purity and moisture content must be met before registration can occur. Testing provides the basic seedlot information that will help manage the use of a seedlot.

[1] Scientific names, common names, and abbreviations of BC conifer species are presented in Appendix 1.

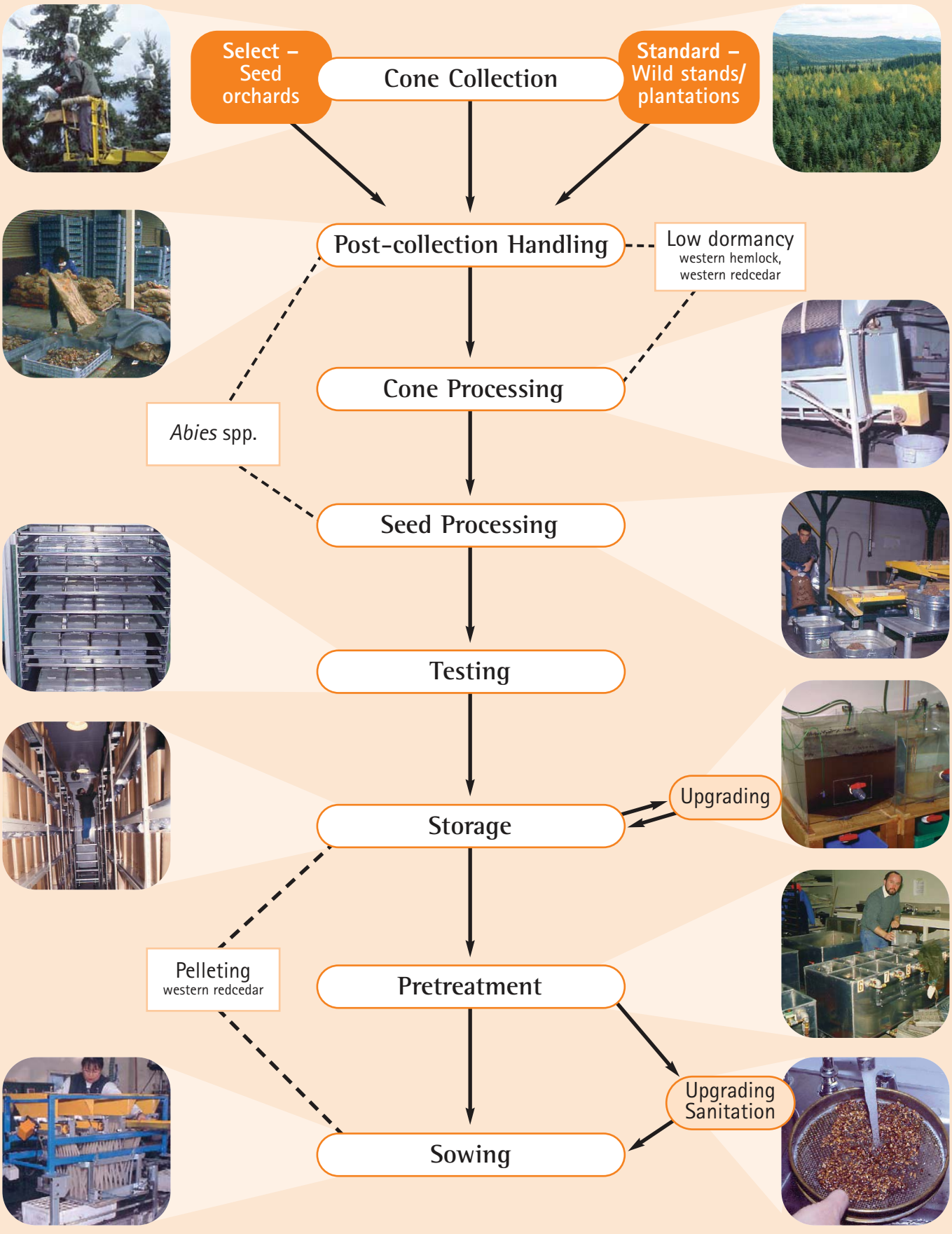

Figure 1
The seed handling system depicting seed handling from cone collection to nursery sowing.

Seeds remain in long-term storage (-18°C) until they are required for sowing. Fortunately, conifers exhibit good storability under appropriate conditions. During storage, seedlots will be retested for germination and may be upgraded for purity, moisture content, or germination and placed back into long-term storage.

Seeds are withdrawn for reforestation and pretreated with the appropriate techniques to maximize germination capacity and rate. All species, except western redcedar, are initially soaked in running water and given a period of cold stratification to remove dormancy, increase the speed and uniformity of germination, and improve their ability to germinate under sub-optimal conditions. Following partial or full stratification, it may be possible to upgrade seedlots through various procedures to eliminate poor seeds and thereby increase the overall quality of seeds sown in the nursery.

Western redcedar seeds are not dormant and do not require cold stratification. Because of their lightweight, irregularly shaped seeds and wings, which are not removed during seed processing, western redcedar seeds are pellet-coated to facilitate mechanical sowing in the nursery. Nursery sowing is generally performed mechanically and one or more seeds may be sown per cavity depending on seed quality and nursery policy. Seed sanitation procedures (e.g., hydrogen peroxide soaks) may also be implemented before, during, or after soaking, or at some point during stratification.

Chapters entitled "Germination Environment" and "Nursery Germination" are also included in this guidebook to complete the seed story and extend available information on these important topics. These sections are specific to the **container** system used throughout BC and most of Canada. The sowing aspect of the seed handling system is quite different in **bareroot** seedling production, which has been virtually eliminated as a method of growing seedlings for reforestation in BC.

The seed handling system illustrates the many facets of handling—showing how handling at each stage affects the next stage and ultimately the quality of the final seedlot. A key element to improving knowledge of seed handling is the sharing of hands-on experience and research on conifer tree seeds. While seed value has increased dramatically in most jurisdictions, the amount of seed research being performed and the pool of experienced seed technicians has decreased in North America (Smith 1998; Bonner 1996). By understanding the entire seed handling system, it is believed that efficiencies can be gained in seed use.

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The information that follows is presented in a practical fashion with the intention of bringing all readers to a common level of knowledge. Technical terms will be indicated in **bold** print for their first usage and are defined in the glossary (Appendix 2).