are subject to WCB Amended Accident Prevention Regulation 33.00 (Appendix 4). Flight safety is the responsibility of the pilot, whose instructions on air operations and procedures must be followed. Collections must be suspended the moment safety is in question. Safety at the dump site is the responsibility of the collection supervisor. During aerial collections, all loose objects at the fueling and drop sites must be secured. If possible, separate dump sites should be arranged so that pickers can work well away from the helicopter’s rotor wash, noise, and dust. Ground personnel must remain clear of all aircraft, and only those persons designated by the collection supervisor should attend to the harvesting device. In clipping operations, only certified clipper operators can be employed.

Emergency procedures must be well understood by all personnel before the start of operations. All helicopter and designated ground personnel are to be equipped and qualified to take appropriate emergency action in the event of an accident. First aid is to be administered immediately to injured personnel, on site, until transport to the nearest hospital can be provided. In the event of a downed aircraft, all personnel will remain at the crash site until rescue is complete. All injuries are to be reported to the collection supervisor immediately. Aircraft will be considered overdue if no communication has been received for 30 minutes, at which time the nearest Air Traffic Control Centre, the helicopter company’s office, and the appropriate B.C. Forest Service and/or forest company office are to be notified. Detailed discussions of safety in aerial collections are described in the sources cited at the end of this section.

The efficiency and cost of aerial cone harvesting will depend on:

- the size of the crop being collected
- the frequency of cone-bearing trees
- cone size
- seed yields (filled seed counts)
- the efficiency of the equipment being used
- the size and maneuverability of the helicopter
- turn-around time
- ground organization
- the experience and ability of the pilot(s)

Aerial collections should be co-ordinated among agencies to minimize ferry times to and from the dump site(s), and to consolidate mutual collection quotas.

**Climbing**

The collection of cones by climbing may be practical in young, open-grown stands of species such as ponderosa pine, white pine, Douglas-fir, and occasionally larch. Trees selected for climbing should be full crowned and less than 15 m tall. Branches should be well spaced, begin near ground level, and large enough to safely support the picker. The majority of cones on trees to be climbed should be within the picker’s reach, while the picker remains belted to the main stem.

Safety precautions must be rigorously maintained during any climbing collection. Safety belts and straps must be checked at least twice each day. Except for
brief periods when the picker is moving from one level to another, the safety belt must be attached around the main stem of the tree. Tools such as pruning poles and cone rakes should not be carried while the tree is being climbed. They should be hoisted up later by a light haul line, and returned to the ground in a similar manner.

The climber should begin picking at the top of the tree and work down and around the crown. Cones may be placed in sacks, or dropped to the ground and sacked later. Dropping cones is not suitable for all species, (e.g., true fir cones usually shatter on impact), and it is best done only when there is ground vegetation to soften the impact. Cones should not be collected from the lower branches of the tree, since cones on these branches are often self-pollinated. Pickers should also ensure that the area beneath the tree in which they are working is clear before dropping cones or lowering equipment or filled sacks. Readers contemplating climbing collections should consult the references cited at the end of this chapter.

**Felling**

Cones may be collected from trees felled either especially for collection purposes or as part of a logging or clearing operation. Cones should only be collected from trees of good phenotype and, ideally, only these trees should be felled before cones are collected. The remaining trees can be removed later, if it is appropriate to do so. Felling must be delayed until seeds are sufficiently mature, after which cones should be collected as soon as possible, generally within 1 to 4 days of felling. When trees are felled too far in advance of picking, some cones may be taken away by squirrels. Other cones exposed to the sun often show signs of overheating and desiccation, and may become caschardened. During seed extraction, such cones tend to remain partially unopened, even after prolonged kilning.

Trees should be felled in a manner that facilitates the maximum recovery of cones. This involves good directional falling so that crowns are placed on or across unused roads, landings, or other areas cleared of brush. To ensure crew safety, pickers must remain at least three tree lengths from the site of felling.

Where collections are made on active cutting permits, agreement must be obtained in advance from the licensee. It is important that trees are felled in accordance with cutting permit specifications and by competent fallers approved by the logging foreman. Fallers must be briefed on any specific requirements for the cone collecting operation.

**Squirrel caches**

Cones may be collected from squirrel caches when quotas cannot be met through other collection methods, provided that the source stand is of good quality. Collections from squirrel caches are otherwise discouraged since parent-tree phenotype is uncertain and cached cones may be infected with the disease *Calscypha fulgens* (seed fungus, or cold fungus). When attacked by this disease, seeds appear to be normal, but may be mummified and incapable of germinating. This disease has been found in stored seeds of Douglas-fir, grand fir, interior spruces and Sitka spruce (Appendix 2).

Squirrels usually put their caches in the same places year after year. Typically,
these are in damp areas, on northern exposures, and in decayed wood or duff, or around old dead and downed hollow logs or windfallen trees. Fresh cones on the ground in August are a sign of squirrel activity and may indicate a nearby cache but are not necessarily a sign that cones are mature. If cones are collected from squirrel caches, total depletion of the cache should be avoided to ensure that a sufficient supply of winter food remains.

**Collection Quality**

To ensure that seed quality is maintained throughout all stages of seed handling, the crop should be monitored regularly during collection and while it is in temporary storage. Monitoring is the responsibility of the collection supervisor. Filled-seed content, embryo and storage tissue condition, insects or disease damage, and cone condition should be assessed and recorded during each day’s collection. These assessments are useful when completing the cone collector’s report form, and they ensure that continued collection is worthwhile. In aerial collections, cones from each load should be monitored to guide the pilot to the best portions of the stands and, because of the large area covered, to ensure that seed quality is comparable throughout the collection area. The collection supervisor must ensure that cones are collected only from trees exhibiting good phenotypic characteristics, and that cones and seeds meet all maturity standards.

All collections should meet established quality standards. Because of the periodicity of cone crops, there is no guarantee that additional collections of the same species and provenance will be possible within the planning period. Consequently, care must be taken to minimize reductions in seed quality and seed yields as a result of immaturity and/or damage during collection and post-harvest handling.

Cones of most species may open and reclose several times before seedfall, depending on climatic conditions. In some species, such as spruce, almost complete reflexing of the cone scales is required before seeds begin to be shed; consequently, there is no need to collect until cones first show some scale reflexing. Readers are cautioned, however, that some species, such as western redcedar and white pine, shed their seeds quickly after minimal reflexing of the cone scales (see Section 5 for species-specific information). Also, not all the cones on a single tree, or within a stand, mature at exactly the same time. Thus, provided losses of seeds due to initial natural shedding are minimized, it is better to delay collections to ensure maturation in the bulk of the crop, than to begin too early.

In addition to ensuring that seeds are mature and of good quality, it is also the collection supervisor’s responsibility to ensure that post-collection handling procedures do not result in the deterioration of seed quality. Recommended standards for collections of British Columbia conifers are summarized in Table 9.

**Cone Handling**

Cones must be carefully handled after they are removed from the tree. Seeds are very perishable and can be irreparably damaged if cones are not properly handled after harvest, even if the cones are collected at the peak of maturity. Damage incurred in the field cannot be remedied during extraction and processing.

Cones should be picked from the branches, cleaned, and sacked as quickly as
<table>
<thead>
<tr>
<th>Crop characteristic</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONE CROP RATING</strong></td>
<td>5 or more</td>
</tr>
<tr>
<td><strong>FILLED SEED CONTENT</strong></td>
<td>minimum average number acceptable as defined in Table 7</td>
</tr>
<tr>
<td><strong>MATURITY</strong></td>
<td>present and filling at least 90% of the embryonic cavity</td>
</tr>
<tr>
<td>Embryo</td>
<td>creamy yellow to pale green</td>
</tr>
<tr>
<td></td>
<td>cotyledons visible with 10x hand lens</td>
</tr>
<tr>
<td>Storage tissue</td>
<td>white</td>
</tr>
<tr>
<td></td>
<td>not translucent</td>
</tr>
<tr>
<td></td>
<td>nut-like in texture</td>
</tr>
<tr>
<td></td>
<td>little or no shrinkage after drying</td>
</tr>
<tr>
<td>Seedwing</td>
<td>tan to golden brown</td>
</tr>
<tr>
<td></td>
<td>brittle after drying</td>
</tr>
<tr>
<td></td>
<td>easily detached from cone scale</td>
</tr>
<tr>
<td>Cones</td>
<td>slight flexing of scale margins</td>
</tr>
<tr>
<td></td>
<td>golden to medium brown</td>
</tr>
<tr>
<td></td>
<td><em>Abies</em> may be purplish or greenish grey</td>
</tr>
<tr>
<td><strong>CLEANLINESS</strong></td>
<td>less than 5% debris and unacceptable cones in collections of all species except Sw, Hw and Cy</td>
</tr>
<tr>
<td></td>
<td>less than 10% debris in collections of Sw, Hw, and Cy</td>
</tr>
<tr>
<td></td>
<td>less than 25% class III and IV of PI cones</td>
</tr>
<tr>
<td><strong>SACKS</strong></td>
<td>must be made of a material woven in a manner which allows good air circulation and moisture exchange</td>
</tr>
<tr>
<td></td>
<td>clean, dry and undamaged</td>
</tr>
<tr>
<td></td>
<td>must contain no more than 0.4 hl of cones</td>
</tr>
<tr>
<td></td>
<td>must be securely tied near top</td>
</tr>
<tr>
<td></td>
<td>must display seedlot number clearly and have attached a completed shipping tag with duplicate copy inside</td>
</tr>
<tr>
<td><strong>STORAGE</strong></td>
<td>sacked cones must be shaded, dry and well-ventilated</td>
</tr>
<tr>
<td></td>
<td>sacks must be racked lying flat</td>
</tr>
<tr>
<td></td>
<td>temperatures inside cone sacks should not exceed 25°C</td>
</tr>
<tr>
<td></td>
<td>should provide protection against vandalism and predation</td>
</tr>
<tr>
<td><strong>SHIPPING</strong></td>
<td>sacks of cones must be protected, kept well-ventilated and dry</td>
</tr>
<tr>
<td></td>
<td>pallets must separate layers of cone sacks</td>
</tr>
<tr>
<td></td>
<td>reefer temperature must be maintained at 5-10°C during transport</td>
</tr>
<tr>
<td></td>
<td>processing facility must be informed and prepared to accept shipments</td>
</tr>
<tr>
<td></td>
<td>all shipments must be accompanied by the collection reports and a list of seedlots</td>
</tr>
<tr>
<td></td>
<td>should involve the least time possible</td>
</tr>
</tbody>
</table>
possible. Cones should be free of debris such as needles, twigs, bark, litter, stones, and dirt. Unacceptable cones (those that show signs of heavy insect or disease damage, are unusually small, or have opened prematurely) should be removed.

Debris causes damage by the abrasion and bruising of seed tissue during extraction, and results in decreased seed viability. Debris and unacceptable cones also add moisture to the collection, promoting development of mould and inhibiting drying. Unacceptable material should be removed at the collection site or, if this is not possible, at the temporary storage facility. Clean collections will reduce the risk of seed damage during storage and in transit to the processing facility, as well as improve extraction efficiency. Extra care should be taken if seeds are being released from the cones at the time of collection. Released seeds are no longer protected by the cone and are much more susceptible to damage.

Mould is encouraged by overheating, which results from wet, improperly sacked, and poorly ventilated collections. Heat is naturally produced as cones dry and expand, but excessive heat can result in direct damage to the seeds. Moisture, overheating, and mould problems are particularly prevalent in immature collections. Collections of cedars, hemlocks, and true firs, which have characteristically high cone and seed moisture contents at maturity, are especially prone to such damage.

When cones are moist at the time of collection, they should be spread out and air-dried for several days at the temporary storage facility, then re-sacked in clean, dry sacks. Sacks should be made of a material such as burlap, which is durable and allows good air and moisture exchange. Tightly woven fabric and solid or woven plastic bags inhibit circulation and promote mould and overheating. (For specifications when purchasing cone sacks, contact the Forest Service Seed Centre.)

When filled to the “fill-line,” cone sacks used in British Columbia will contain 40 litres (0.4 hl) of cones (Figure 19). Half-filling sacks may be appropriate when collections are made during inclement weather, and for collections of cedars, hemlock, true firs, and, in some cases, spruce. When cone sacks are not filled completely, a cone volume measure (Figure 20) should be used to correctly tally the volume collected by each picker. This measured volume is the basis of payment, and will be used to settle any payment disputes arising over cone volumes contained in “filled” sacks. Payment is always based on the volume of clean cones.

Sacks should be securely tied well above the fill-line, allowing ample room for expansion and good air circulation. Cone sacks should never be overfilled, since cones expand as they dry. If this expansion is restricted, the cone scales may set in a partially opened position, a condition that impairs seed extraction. Similar guidelines must be observed when re-sacking cones dried at the temporary storage facility.

At the collection site and during temporary storage, sacks of cones should be stored on racks that are shaded and protected from the rain. Each sack should be surrounded by air space and turned regularly, at least once a week, to further reduce the risk of overheating and mould. Temperatures exceeding 25°C inside the sacks will cause damage to the seeds. In addition, collections may need to be protected
from squirrels and rodents.

The seedlot number must be spray-painted on each cone sack and recorded on the shipping tag. Shipping tags should be durable (i.e., weatherproof and tearproof). Each tag should have two copies. One is placed inside the sack to identify the cones in case the tag secured to the outside of the sack is lost. The tags indicate the collection agency, species, collection location, and number of sacks in the same seedlot (Figure 21).

Sacks should not be loaded into vehicles until shortly before transport. Filled cone sacks should be transported daily from the field to a central temporary storage facility. Cones must be kept dry, cool and well ventilated during transport, and at regional storage facilities. Cone sacks should be separated on pallets during transport and sacks should be kept away from the walls of the truck, to allow for adequate air circulation. Similar conditions must prevail during transport to the processing facility.

In general, cones should not be transported to the processing facility until requested by the plant manager. Good communication is required between the collection agency and the processing facility to ensure prompt transfer of cones on arrival at the plant. Travel time to the processing facility should be as short as possible, and refrigerated trucks kept at 5°-10° C should be used. For most species, cones should be kept in interim storage for at least 4 weeks, or until air-dried. Species such as western hemlock and western redcedar, however, require prompt transport to the processing facility. Seeds of these species sometimes germinate while still in the cones, particularly if cone temperatures rise to about 15°C (which can occur when these species are harvested in mild conditions, combined with the natural heat generated as the cones dry and expand). The risk of such premature germination can be reduced by providing cool, well-ventilated conditions during temporary cone storage and transport, and by prompt extraction of the seeds.

Each collection must be accompanied by a completed cone collector's report (FS 721) (Figure 22). It is the collection supervisor's responsibility to ensure that the appropriate documentation for the collection is completed, and that all cone sacks are properly marked with the seedlot number and tagged before cones leave the collection area. Completion of the cone collector's report form is essential for seedlot registration.

Accurately completing both the collection report and shipping tags, as well as painting the seedlot number on each cone sack, is necessary to ensure that all sacks in one seedlot can be identified before extraction. Accurate identification is particularly important because processing facilities may receive collections from many sites simultaneously. Unidentified cones will not be processed. The cone collector's report form also provides information for the provincial Tree Seed Register, which tabulates seed availability and suitability, by seedlot, for subsequent reforestation use. The seedlot number is the means by which seed testing results are organized. All seedlots sent to the Forest Service Seed Centre, for which an invoice for services is to be levied, must be accompanied by a cone-seed services form (FS 722) (Figure 23).
**CONE COLLECTOR'S REPORT**

(From natural stands and/or plantations)

**LOCATION OF COLLECTION**
Mamit L.

**TSA**
Merritt

**PSYU**
Nicola

**BIOGEOCLIMATIC ZONE (AND SUBZONE)**
10Fa

**VCL LOT**
2248, 3640, 4430

**PRIVATE OWNER**

**AGENCY COLLECTED FOR**
Ministry of Forests, SBFEP

**ADDRESS**
2196 Quilichena Ave., Bag 4400, Merritt, B.C. V0K 250

**COLLECTED BY**
D.K. Helicopter International Ltd.

**COLLECTION SUPERVISOR**
J. Smith

**COLLECTED FOR:**
- [ ] GENERAL STOCK
- [ ] RESEARCH
- [ ] OWNER'S USE
- [ ] SPECIAL REQUEST

**COLLECTION STARTED:** 88/9/07
**FINISHED:** 88/9/12

**AGE OF TREE COLLECTED FROM**
- [ ] < 40
- [x] 40 - 100
- [ ] > 100 YRS.

**OTHER SPECIES IN STAND**

**ASPECT**

**COLLECTION METHOD:**
- [ ] CLIMBING
- [ ] FELLING
- [ ] RAKING
- [ ] OTHER (GROUND)

- [x] HELICOPTER RAKING
- [ ] HELICOPTER CLIPPING
- [ ] HELICOPTER TOPPING

**NO. TREES COLLECTED FROM**
100+

**VOLUME OF CONES COLLECTED**
63.75

**HECTOLITRES**

**ENDOSPERM CONDITION:**
- [ ] CLEAR
- [ ] MILKY
- [ ] WHITE
- [x] FIRM
- [ ] OTHER

**EMBRYO CONDITION:**
- [ ] WHITE
- [ ] PALE YELLOW
- [ ] YELLOW
- [x] 100% OF EMBRYO CAVITY FILLED

**CONE CROP RATING**

**AVERAGE SEED COUNT / HALF CONE**
56

**OR NO. FILLED SEEDS/CONE**

**CONES CLEANED BY:**
- [x] HAND
- [ ] SHAKING TABLE
- [ ] ROLLER
- [ ] OTHER
- [ ] NOT CLEANED

**CONDITION OF CONES WHEN SHIPPED**
- [x] CLEAN, DRY, PITCHY
- [ ] CONDITION OF CONTAINERS
- [ ] DRY

**SHIPPED BY:**
- [ ] OPEN TRUCK / TRAILER
- [ ] VENTILATED VAN
- [ ] OTHER

**SHIPPED TO INTERM STORAGE AT**
Merritt District Warehouse

**DATE**
Sep. 9, 10, 11, 12

**INTERM STORAGE:**
- [ ] OUTSIDE COVERED
- [ ] VENTILATED ROOM
- [ ] OTHER

**SHIPPED TO**
255 CONTAINERS TO EXTRACTORY AT
Surrey Seed Centre

**DATE**
Sept. 28

**SUPERVISOR'S COMMENTS:**
Cones were showing some fine white mould at time of shipping to Seed Centre, due to wet weather in the week prior to shipment. Sacks turned on a weekly basis during interim storage and sacked at 0.25 hl. per sack.

**DISTRICT COMMENTS:**

**SIGNED**
J. Smith

**POSITION**
District Silviculturist

**DATE**
Sept. 27

---

**SECTION 88 NUMBER**

**PART 1 – IMMEDIATELY UPON COMPLETION OF FORM MAIL THIS COPY TO:**
MINISTRY OF FORESTS SEED CENTRE, BOX 816, DUNCAN, B.C. V9L 3Y2

---

42
FIGURE 23. A sample cone-seed services form (FS 722)

<table>
<thead>
<tr>
<th>SEEDLOT NUMBER</th>
<th>SPECIES</th>
<th>CONES</th>
<th>SEEDS</th>
<th>CONES/SEEDS NOW LOCATED AT</th>
</tr>
</thead>
<tbody>
<tr>
<td>6378</td>
<td>Interior Douglas-fir</td>
<td>255</td>
<td>63.75</td>
<td></td>
</tr>
</tbody>
</table>

SERVICES REQUESTED (described on reverse)

CHECK

- EXTRACTION
- AND PROCESSING
- TRUE FIRE (ABIES) HL @ $__________
- LODGEPOLE PINE HL @ $__________
- OTHER SPECIES HL @ $__________
- PLUS: BASIC CHARGE OF $__________ PER SEEDLOT X ________ SEEDLOTS = $__________
- TESTING: @ $__________ PER SEEDLOT X ________ SEEDLOTS = $__________
- SEED STORAGE: ________ kg @ ________ PER YEAR = ________
- OTHER TREATMENT OR SERVICE: ____________________________

TOTAL FEE FOR SERVICES: $__________

FORM OF PAYMENT:

☐ INVOICE TO CLIENT MINISTRY ACCOUNT # 04891
☐ INVOICE TO CLIENT AT ABOVE ADDRESS


J. Smith
District Silviculturist

COPY 1 (WHITE) Seed Centre - Invoice  COPY 2 (CANARY) Seed Centre - Records  COPY 3 (PHO) Clerk
Tests are performed on all seedlots arriving at the provincial processing facility to access maturity, insect and disease damage, and debris content, before the cones are processed. After extraction and processing, further testing takes place to determine seed yield, purity, moisture content, seed weight, and germination. Testing results are recorded in processing reports (Figure 24) which are sent to all collectors. The results of seed tests and other data are used to determine sowing requirements and to estimate future seed needs, as well as to inform potential users of seedlot quality.

The attention given to collection quality, beginning with the selection of collection sites through to post-harvest handling, influences and the quality of seeds available in storage and the costs of obtaining them. Processing and testing results provide an excellent means of reviewing field procedures and improving the quality of future collections.

**Sources of Cone Collection Information**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerial</td>
<td>B.C. Min. For. and Lands 1985; 1987b; Fandrich 1986; Hedin 1984; Wallinger 1986; Workers’ Comp. Board 1980</td>
</tr>
<tr>
<td>Climbing</td>
<td>B.C. Min. For. and Lands 1987b; Yeatman and Nieman 1978</td>
</tr>
<tr>
<td>Felling</td>
<td>B.C. Min. For. and Lands 1987b</td>
</tr>
<tr>
<td>Seed registration</td>
<td>B.C. Min. For. 1988</td>
</tr>
<tr>
<td>REGISTRATION #</td>
<td>#SACKS</td>
</tr>
<tr>
<td>---------------</td>
<td>--------</td>
</tr>
<tr>
<td>8102</td>
<td>101</td>
</tr>
<tr>
<td>REMARKS:</td>
<td>Collection received in good condition. The occurrence of debris, Class III and IV cones, insect damage/losses rated as nil to light. The weighted (by hectolitres collected) average yield per hectolitre and germination for the 1988 Interior Lodgepole pine crop have been calculated at 0.299 Kg/H and 95%.</td>
</tr>
<tr>
<td>8103</td>
<td>128</td>
</tr>
<tr>
<td>REMARKS:</td>
<td>Collection received in good condition. The occurrence of debris, Class III and IV cones, insect damage/losses rated as light. Weighted crop averages indicated in the remarks for seedlot 8102.</td>
</tr>
<tr>
<td>8268</td>
<td>158</td>
</tr>
<tr>
<td>REMARKS:</td>
<td>Remarks for seedlot 8102 generally apply. The only problem experienced was most tags showed seedlot 8266. Cone and seed quality reflected in the yield and germination results.</td>
</tr>
<tr>
<td>8269</td>
<td>162</td>
</tr>
<tr>
<td>REMARKS:</td>
<td>Remarks for seedlot 8268 apply.</td>
</tr>
<tr>
<td>25581</td>
<td>38</td>
</tr>
<tr>
<td>REMARKS:</td>
<td>Collection received in good condition. The occurrence of debris, Class III and IV cones, insect damage/losses rated as nil to light. The weighted (by hectolitres collected) average yield per hectolitre and germination for the 1988 Interior Lodgepole pine crop have been calculated at 0.299 Kg/H and 95%.</td>
</tr>
<tr>
<td>26153</td>
<td>94</td>
</tr>
<tr>
<td>REMARKS:</td>
<td>Collection received in satisfactory condition. The occurrence of debris and insect damage/losses rated as nil to light; greater volume, although still acceptable of Class III and IV cones in this collection compared to other 1988 seedlots; and grey external mold noted on cones.</td>
</tr>
</tbody>
</table>

September 1988  page 1 of 1
5  SPECIFIC SEED PRODUCTION AND COLLECTION
CHARACTERISTICS OF BRITISH COLUMBIA CONIFERS

Completing the cone collector's report

Light interior spruce crop

Maturing interior spruce cones

Heavy interior spruce crop

The coneworm in Douglas-fir cones

The spiral spruce cone borer in an interior spruce cone
5 Specific Seed Production and Collection Characteristics of British Columbia Conifers

The organization of any cone collection program depends on many interrelated factors, including the reproductive characteristics of individual species, the environmental and biological conditions that affect crop development and maturation, and the demand for seeds from species bearing crops. The success of the collection program, in terms of seed yield, cost effectiveness, and most importantly – seed quality, depends on proper monitoring, harvest timing, collection, and handling.

This section contains seed production and cone collection information for 18 major coniferous species found in British Columbia. Species are presented alphabetically by scientific name. The range maps are those of Krajina et al. 1982. The other information has been abstracted from many sources, as cited below. Readers are encouraged to refer to the original sources for detailed descriptions of these cone and seed production characteristics. Descriptions of pests affecting cone and seed production are provided in Appendix 2. This section is intended as a guide and should be used in conjunction with local experience. The information provided should be updated as new findings become available. “Notes” sections have been provided for readers’ use. Seed transfer rules are not included in this guide since they are under review. B.C. Forest Service staff should be consulted for the latest seed transfer information.

Sources of Information for British Columbia Conifers

<table>
<thead>
<tr>
<th>Topic</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection notes</td>
<td>Ont. Min. Natural Resources. 1983; H. Rooke, pers. comm., 1988, B.C. Min. For. Seed Centre, Surrey, B.C.</td>
</tr>
<tr>
<td>Collection productivity</td>
<td>H. Rooke, pers. comm., 1988, B.C. Min. For. Seed Centre, Surrey, B.C.</td>
</tr>
<tr>
<td>Collection standards</td>
<td>B.C. Min. For. and Lands 1987b; Dorena Tree Improvement Centre, pers. comm., 1988, United States For. Serv., Cottage Grove, Oreg.; Eis and Craigdallie 1983; Ont. Min. Natural Resources 1983; Owens 1975; Schopmeyer 1974; H. Rooke, pers. comm., 1988, B.C. Min. For. Seed Centre, Surrey, B.C.</td>
</tr>
<tr>
<td>Cone bearing age</td>
<td>Eis and Craigdallie 1983; Schopmeyer 1974</td>
</tr>
<tr>
<td>Cone length</td>
<td>Eis and Craigdallie 1983; Hedin 1983</td>
</tr>
<tr>
<td>Cones/hectolitre</td>
<td>Eis and Craigdallie 1983</td>
</tr>
<tr>
<td>Ease of detachment</td>
<td>Apt et al. 1979; Hedin 1983</td>
</tr>
<tr>
<td>Periodicity</td>
<td>Eis and Craigdallie 1983; Ont. Min. Natural Resources 1983; Schopmeyer 1974</td>
</tr>
<tr>
<td>Pests affecting cone and seed production</td>
<td>Hedlin 1974; Hedlin et al. 1980; Sutherland et al. 1987</td>
</tr>
<tr>
<td>Plantable trees/hectolitre of cones</td>
<td>C. Bartram, pers. comm., 1988, B.C. Min. For., Victoria, B.C.</td>
</tr>
<tr>
<td>Position of cones in crown</td>
<td>Eis and Craigdallie 1983; Hedin 1983; Hosie 1979</td>
</tr>
<tr>
<td>Recommended collection techniques</td>
<td>Edwards 1986; Wallinger 1986</td>
</tr>
<tr>
<td>Reproductive cycle</td>
<td>Eis and Craigdallie 1983; Owens and Blake 1985</td>
</tr>
<tr>
<td>Species description and nomenclature</td>
<td>Krajina et al. 1982</td>
</tr>
<tr>
<td>Viable seeds/hectolitre of cones</td>
<td>C. Bartram, pers. comm., 1988, B.C. Min. For., Victoria, B.C.</td>
</tr>
</tbody>
</table>
**Abies amabilis** (Dougl. ex Loud.) Forbes - Pacific Silver Fir (Ba)

Ba grows in the moist coastal region of British Columbia, in the CWH and MH biogeoclimatic zones, from sea level to 1500 m, on Vancouver Island and at somewhat lower elevations on the mainland. This species has low frost resistance and requires heavy accumulations of snow to protect its roots. It is narrow-crowned and highly shade-tolerant. Ba has a very large water requirement and is generally found on moist sites.

**Cone and Seed Production Characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reproductive cycle</td>
<td>2 years</td>
</tr>
<tr>
<td>Cone length (cm)</td>
<td>9-13</td>
</tr>
<tr>
<td>Cone bearing age (collectable quantities)</td>
<td>20 years</td>
</tr>
<tr>
<td>Cones/hectolitre</td>
<td>700</td>
</tr>
<tr>
<td>Periodicity</td>
<td>2-3 years</td>
</tr>
<tr>
<td>Viable seeds/hectolitre of cones</td>
<td>30 389</td>
</tr>
<tr>
<td>Position of cones in crown</td>
<td>Top 1/4</td>
</tr>
<tr>
<td>Ease of cone detachment</td>
<td>Difficult</td>
</tr>
<tr>
<td>Plantable trees/hectolitre of cones</td>
<td></td>
</tr>
<tr>
<td>Bareroot</td>
<td>7 000</td>
</tr>
<tr>
<td>Container</td>
<td>18 000</td>
</tr>
</tbody>
</table>

**Recommended Collection Standards**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filled seeds/half-cone</td>
<td>8-12</td>
</tr>
<tr>
<td>Cone colour</td>
<td>Greenish with a yellow tinge and turning grey or purplish in colour</td>
</tr>
<tr>
<td>Storage tissue</td>
<td>Opaque and firm</td>
</tr>
<tr>
<td>Seedcoat</td>
<td>Creamy or tan</td>
</tr>
<tr>
<td>Embryo</td>
<td>Should occupy 90% of the cavity; yellowish; radicle end may be pale green; with 10X lens, cotyledons appear well developed</td>
</tr>
<tr>
<td>Seedwing</td>
<td>Light brown or purplish with brown margins</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>Less than 5% debris and unacceptable cones</td>
</tr>
</tbody>
</table>

**Pests Affecting Cone and Seed Production**

Insects

- Alpine-fir seed chalcid (*Megastigmus lasiocarpae*)
- Fir cone maggot (*Eaomyia abietum*)

**Collection Productivity**

<table>
<thead>
<tr>
<th>Collection technique</th>
<th>Hectolitres collected/man-day Average (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerial</td>
<td>5 (1.7 - 10.5)</td>
</tr>
<tr>
<td>Felling</td>
<td>1.4 (0.5 - 3.3)</td>
</tr>
</tbody>
</table>

**Collection Notes**

1) Under the provisions of the British Columbia Plant Protection Act, Balsam Woolly Aphid Regulation (Appendix 4), the movement of *Abies* twigs is restricted. Consequently, all *Abies* cones must be completely removed from twig or branch material before they leave the collection area.

2) Ba cones disintegrate quickly following maturation and must be collected somewhat prematurely. These moist cones must be loosely sacked (20-25 litres/sack), and be kept cool, dry, and well ventilated during collection, transport, and in storage.

3) Filled seed counts should include only embryos that are more than 50% exposed.

4) Insect attack tends to be high in all *Abies* species.
**Abies grandis** (Dougl. ex Don) Lindl. - Grand Fir (Bg)

The range of Bg is not extensive in British Columbia. This species is found on the southern coast and in the southern portion of the Kootenays. It grows in the IDF, IWH (drier subzones), and CDF biogeoclimatic zones, from sea level to 450 m at the coast and 1360 m in the Interior. This species is found on a wide variety of sites and soils. Bg prefers drier growing conditions than Ba and requires a long growing season. It also has high nutritional requirements. Bg is known to have low frost resistance on the coast. Trees growing in the Interior probably have a greater degree of resistance.

### Cone and Seed Production Characteristics

- Reproductive cycle: 2 years
- Cone length (cm): 5-12
- Cone bearing age (collectable quantities): 50 years
- Cones/hectolitre: 700
- Periodicity: 2-3 years
- Viable seeds/hectolitre of cones: 50,776
- Position of cones in crown: Top 1/4
- Ease of cone detachment: Difficult
- Plantable trees/hectolitre of cones
  - Bareroot: 12,000
  - Container: 1,000

### Recommended Collection Standards

- Filled seeds/half-cone: 12-14
- Cone colour: Greenish with a yellow tinge and turning grey or purplish in colour
- Storage tissue: Opaque and firm
- Seedcoat: Creamy or tan
- Seedwing: Light brown or purplish with brown margins
- Embryo: Should occupy 90% of the cavity; yellowish; radicle end may be pale green; with 10X lens, cotyledons appear well developed
- Cleanliness: Less than 5% debris and unacceptable cones

### Pests Affecting Cone and Seed Production

**Insects**

- Cone scale midge (*Resseliella* spp.)
- Fir cone maggot (*Euromyia abietum*)
- Fir cone moth (*Barbara* spp.)
- Fir seed moth (*Dasineura abiesemia*)

**Diseases**

- Seed fungus or cold fungus (*Caloscypha fulgens*)

### Collection Productivity

<table>
<thead>
<tr>
<th>Collection technique</th>
<th>Hectolitres collected/man-day Average (ranges)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerial</td>
<td>3.2 (1 - 12.8)</td>
</tr>
<tr>
<td>Felling</td>
<td>2 (0.4 - 3)</td>
</tr>
</tbody>
</table>

### Collection Notes

1) Under the provisions of the British Columbia Plant Protection Act, Balsam Woolly Aphid Regulation (Appendix 4), the movement of *Abies* twigs is restricted. Consequently, all *Abies* cones must be completely removed from twig or branch material before they leave the collection area.

2) As in other *Abies* species, Bg cones disintegrate quickly following maturation, so they must be collected somewhat prematurely. These moist cones must be loosely sacked (20-25 litres/sack), and be kept cool, dry, and well ventilated during collection, transport, and in storage.

3) Filled seed counts should include embryos that are more than 50% exposed.

4) Insect attack tends to be high in all *Abies* species.
Many Cones

Mature Cones

Notes:

---

Range
Abies lasiocarpa (Hook.) Nutt. - Subalpine Fir (BI)

BI can be found in subalpine environments through much of British Columbia, at elevations ranging from 600 to 2100 m. It occurs on a wide variety of soils and sites in the ESSF, SWS and SBS biogeoclimatic zones. This species is very resistant to frost and flooding, and is shade-tolerant, although less so than Ba. It prefers humid climates with short growing seasons.

Cone and Seed Production Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reproductive cycle</td>
<td>2 years</td>
</tr>
<tr>
<td>Cone length (cm)</td>
<td>6-12</td>
</tr>
<tr>
<td>Cone bearing age (collectable quantities)</td>
<td>20 years</td>
</tr>
<tr>
<td>Cones/hectolitre</td>
<td>850</td>
</tr>
<tr>
<td>Periodicity</td>
<td>2-4 years</td>
</tr>
<tr>
<td>Viable seeds/hectolitre of cones</td>
<td>40 582</td>
</tr>
<tr>
<td>Position of cones in crown</td>
<td>Top 1/4</td>
</tr>
<tr>
<td>Ease of cone detachment</td>
<td>Difficult</td>
</tr>
<tr>
<td>Plantable trees/hectolitre of cones</td>
<td></td>
</tr>
<tr>
<td>Barefoot</td>
<td>17 000</td>
</tr>
<tr>
<td>Container</td>
<td>32 000</td>
</tr>
</tbody>
</table>

Recommended Collection Standards

- Filled seeds/half-cone: 4-6
- Cone colour: Greenish with a yellow tinge and turning grey or purplish in colour
- Storage tissue: Opaque and firm
- Seedcoat: Creamy or tan
- Seedwing: Light brown or purplish with brown margins
- Embryo: Should occupy 90% of the cavity; yellowish; radicle end may be pale green; with 10X lens, cotyledons appear well developed
- Cleanliness: Less than 5% debris and unacceptable cones

Pests Affecting Cone and Seed Production

Insects

- Alpine-fir seed chalcid (Megastigmus lasiocarpace)
- Fir cone maggot (Earomyia aquilonia)

Collection Productivity

<table>
<thead>
<tr>
<th>Collection technique</th>
<th>Hectolitres collected/man-day Average (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerial</td>
<td>1 (0.9 - 1.2)</td>
</tr>
<tr>
<td>Felling</td>
<td>1.6 (0.2 - 4.3)</td>
</tr>
</tbody>
</table>

Collection Notes

1) Under the provisions of the British Columbia Plant Protection Act, Balsam Woolly Aphid Regulation (Appendix 4), the movement of Abies twigs is restricted. Consequently, all Abies cones must be completely removed from twig or branch material before they leave the collection area.
2) BI cones disintegrate quickly following maturation so they must be collected somewhat prematurely. These moist cones must be loosely sacked (20 litres/sack), and kept cool, dry, and well ventilated during collection, transport, and in storage.
3) Filled seed counts should include only embryos that are more than 50% exposed.
4) Insect attack tends to be high in all Abies species.
**Chamaecyparis nootkatensis (D.Donn) Spach. - Yellow-Cedar (Cy)**

Cy is found in the MH and CWH biogeoclimatic zones of coastal British Columbia. In southern British Columbia, this species is seldom found below 600 m. However, north of Vancouver Island and where it occurs in the West Kootenays, Cy can be found at all elevations below timberline. It prefers wetter sites and is shade tolerant, but it has low frost resistance unless the soil is heavily covered with snow.

### Cone and Seed Production Characteristics

- Reproductive cycle: 3 years
- Cone length (cm): 0.5 - 1.5
- Cone bearing age (collectable quantities): Unknown
- Cones/hectolitre: 130 000
- Periodicity: 4 or more years
- Viable seeds/hectolitre of cones: 93 965
- Position of cones in crown: Throughout
- Ease of cone detachment: Easy
- Plantable trees/hectolitre of cones:
  - Bare-root: 32 000
  - Container: 39 000

### Recommended Collection Standards

- Filled seeds/half-cone*: 2
- Cone colour: Yellow to reddish brown
- Storage tissue: Opaque and firm
- Seedcoat: Dark brown and hard
- Embryo: Should occupy 90% of the cavity; yellowish
- Seedwing: Light brown
- Cleanliness: Less than 10% debris and unacceptable cones

*Cut transversely at 1/2 cone length.

### Pests Affecting Cone and Seed Production

Cy has no major cone and seed pests.

### Collection Productivity

<table>
<thead>
<tr>
<th>Collection technique</th>
<th>Hectolitres collected/man-day Average (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felling</td>
<td>0.1 (0.04 - 0.4)</td>
</tr>
</tbody>
</table>

### Collection Notes

1. Both immature (1st year), and mature (2nd year) cones can be found on the same tree and/or branch. However, seeds from immature cones will not germinate. Consequently, care must be taken to identify mature cones properly before collection. Immature cones are green, purple or a combination of these two colours. Immature seeds are white or very light green and soft.

2. Mature, 2nd-year cones are hard and not easily opened with fingernails. The margins of cone scales frequently turn brown and become raised in the 2nd year. These features are often hard to distinguish. Mature cones are formed on the previous year’s shoots, that is, farther in from the branch ends, than 1st year cones. The most reliable external indicator of maturity is seed colour, which changes from a creamy yellow colour in the 1st year to brown in the 2nd. However, the embryo must be examined for an accurate assessment of maturity.

3. Hand rakes help to remove cones from branches.
First-year cones

Second-year cones

Notes:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

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________________________________________________________________________

________________________________________________________________________

Range
Larix laricina (Du Roi) K. Koch - Tamarack (Lt)

Three Larix species occur in British Columbia; Larix laricina (Du Roi) K. Koch (tamarack); Larix lyallii Parl. (subalpine larch); and Larix occidentalis Nutt. (western larch). Of these, only L. laricina is presently used for reforestation. L. occidentalis is found in northeastern British Columbia, in the BWBS and SBS biogeoclimatic zones, at elevations between 180 and 520 m. This species is highly frost and flood resistant but has low shade tolerance. It has high nutritional requirements and grows best on moist, nutrient-rich sites.

Cone and Seed Production Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reproductive cycle</td>
<td>2 years</td>
</tr>
<tr>
<td>Cone length (cm)</td>
<td>1.5</td>
</tr>
<tr>
<td>Cone bearing age (collectable quantities)</td>
<td>40 years</td>
</tr>
<tr>
<td>Cones/hectolitre</td>
<td>25 000</td>
</tr>
<tr>
<td>Periodicity</td>
<td>3-6 years</td>
</tr>
<tr>
<td>Viable seeds/hectolitre of cones</td>
<td>32 000</td>
</tr>
<tr>
<td>Position of cones in crown</td>
<td>Throughout non-shaded portion of crown</td>
</tr>
<tr>
<td>Ease of cone detachment</td>
<td>Moderate</td>
</tr>
<tr>
<td>Plantable trees/hectolitre of cones</td>
<td></td>
</tr>
<tr>
<td>Bareroot</td>
<td>16 000</td>
</tr>
<tr>
<td>Container</td>
<td>13 000</td>
</tr>
</tbody>
</table>

Recommended Collection Standards

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filled seeds/half-cone</td>
<td>Unavailable (26 per whole cone)</td>
</tr>
<tr>
<td>Cone colour</td>
<td>Brown</td>
</tr>
<tr>
<td>Storage tissue</td>
<td>Opaque and firm</td>
</tr>
<tr>
<td>Seedcoat</td>
<td>Golden to reddish-brown</td>
</tr>
<tr>
<td>Embryo</td>
<td>Should occupy 90% of the cavity; white to yellow</td>
</tr>
<tr>
<td>Seedwing</td>
<td>Tan</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>Less than 5% debris and unacceptable cones</td>
</tr>
</tbody>
</table>

Pests Affecting Cone and Seed Production

Lt has no major cone and seed pests

Collection Notes

1) Previous years’ cones may remain on the tree and should not be collected.
2) Local collection productivity information is not available.
3) Recommended collection techniques: climbing, felling.
**Larix occidentalis** Nutt. - Western Larch (Lw)

Lw is found in southeastern British Columbia in the PPBG, IDF, and drier IWH biogeoclimatic zones at elevations ranging from 450 to 1800 m. It prefers moist, nutrient-rich sites, and has high frost resistance and low shade tolerance.

### Cone and Seed Production Characteristics

- **Reproductive cycle**: 2 years
- **Cone length (cm)**: 2-3
- **Cone bearing age (collectable quantities)**: 25 years
- **Cones/hectolitre**: 10 000-15 000
- **Periodicity**: 1-10 years
- **Viable seeds/hectolitre of cones**: 119 312
- **Position of cones in crown**: Throughout non-shaded portion of crown
- **Ease of detachment**: Moderate

**Plantable trees/hectolitre of cones**
- Bareroot: 34 000
- Container: 33 000

### Recommended Collection Standards

- **Filled seeds/half-cone**: 6
- **Cone colour**: Brown
- **Storage tissue**: Opaque and firm
- **Seedcoat**: Golden to reddish-brown
- **Embryo**: Should occupy 90% of the cavity; pale yellow
- **Seedwing**: Tan
- **Cleanliness**: Less than 5% debris and unacceptable cones

### Pests Affecting Cone and Seed Production

Lw has no major cone and seed pests

### Collection Productivity

<table>
<thead>
<tr>
<th>Collection technique</th>
<th>Hectolitres collected/man-day</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Felling</strong></td>
<td>0.7 (0.4 - 1.2)</td>
</tr>
</tbody>
</table>

### Collection Notes

1) Lw cones are persistent, remaining on the tree for an indefinite period, so care must be taken not to include old cones in collections. This persistence also makes it impractical to attempt to rake cones from branches.

2) The cone scales of Lw open and reclose several times before reflexing completely and releasing seeds. Therefore, the collection period is somewhat extended in comparison to other species.

3) Larch stems and branches are very brittle, so pickers must use extreme caution when climbing. Branches break off when bent toward the climber.
Many Cones

Mature Cones

Range
**Picea glauca x engelmannii** Perry ex Engelm. - Interior Spruce (Sx)

Two species of spruce, white (*Picea glauca*) and Engelmann (*Picea engelmannii*), occur throughout much of central British Columbia. These species hybridize freely wherever their ranges overlap. Consequently, they are often referred to collectively as interior spruce. Sx grows on moist sites in the ESSF, SBS, SWB, BWBS, SBS and northern CALP biogeoclimatic zones. It generally occurs between 600 m and tree line, and has high frost resistance, low shade tolerance, and high flood resistance. It is most productive on nutrient-rich sites.

### Cone and Seed Production Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reproductive cycle</td>
<td>2 years</td>
</tr>
<tr>
<td>Cone length (cm)</td>
<td>3-6</td>
</tr>
<tr>
<td>Cone bearing age (collectable quantities)</td>
<td>40 years</td>
</tr>
<tr>
<td>Cones/hectolitre</td>
<td>10 000</td>
</tr>
<tr>
<td>Periodicity</td>
<td>6 years</td>
</tr>
<tr>
<td>Viable seeds/hectolitre of cones</td>
<td>347 163</td>
</tr>
<tr>
<td>Position of cones in crown</td>
<td>Top 1/3</td>
</tr>
<tr>
<td>Ease of cone detachment</td>
<td>Moderate</td>
</tr>
<tr>
<td>Plantable trees/hectolitre of cones</td>
<td></td>
</tr>
<tr>
<td>Barefoot</td>
<td>84 000</td>
</tr>
<tr>
<td>Container</td>
<td>73 000</td>
</tr>
</tbody>
</table>

### Recommended Collection Standards

- **Filled seeds/half-cone**: 7
- **Cone colour**: Lustrous light brown
- **Storage tissue**: Opaque, firm and resembling coconut meat
- **Seedcoat**: Glossy, pale to dark brown
- **Seedwing**: Light brown, with a dark stripe along one edge
- **Embryo**: Should occupy 90% of the cavity; yellowish; firm
- **Cleanliness**: Less than 5% debris and unacceptable cones

### Pests Affecting Cone and Seed Production

#### Insects

- Coneworm (*Dioryctria abietivorella*)
- Seed chalcid (*Megastigmus piceae*)
- Spiral spruce cone borer (*Lasionoma anthracina*)
- Spruce cone axis midge (*Dasineura rachiphaga*)
- Spruce seed midge (*Mayetiola carphophaga*)
- Spruce seedworm (*Cydia strobiella*)

#### Diseases

- Inland spruce cone rust (*Chrysomyxa pirolata*)
- Seed fungus or cold fungus (*Caloscypha fulgens*)

### Collection Productivity

<table>
<thead>
<tr>
<th>Collection technique</th>
<th>Hectolitres collected/man-day Average (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerial</td>
<td>1 (0.2 - 3.4)</td>
</tr>
<tr>
<td>Felling</td>
<td>1 (0.2 - 5.8)</td>
</tr>
</tbody>
</table>

### Collection Notes

1) The embryo in an Sx seed will fill its cavity well before the seed is mature. Consequently, cones should not be collected until all maturity criteria have been met. It is generally recommended that Sx collections should begin only after some of the cones in the stand have begun to open.

2) The cone scales of Sx reflex almost completely before seeds begin to fall, so the collection period is somewhat extended in comparison to other species.

3) The embryos of Sx are extremely small and should be excised for evaluation.

4) Since Sx cones are usually quite pitchy, gloves are recommended when picking.
Many Cones

Mature Cones

Notes:

Range
**Picea mariana** (Mill.) B.S.P. - Black Spruce (Sb)

Sb occurs on sites in the BWBS and SWB biogeoclimatic zones where moisture is abundant. It is generally found at elevations ranging from 300 to 1000m. It is extremely resistant to frost and has high shade tolerance.

### Cone and Seed Production Characteristics

- Reproductive cycle ........................................... 2 years
- Cone length (cm) .................................................. 2.5
- Cone bearing age (collectable quantities) .......... 10 years
- Cones/hectolitre .............................................. 19 000-45 000
- Periodicity ..................................................... 4 or more years
- Viable seeds/hectolitre of cones ..................... 108 000
- Position of cones in crown ................................. Top 1/4
- Ease of cone detachment .................................. Difficult
- Plantable trees/hectolitre of cones
  - Bareroot ........................................................ 41 000
  - Container ..................................................... 36 000

### Recommended Collection Standards

- Filled seeds/half-cone ............ 7
- Cone colour ...................... Purple to black
- Storage tissue ..................... Opaque and firm
- Seedcoat .......................... Black and firm
- Embryo .............................. Should occupy 90% of the cavity; white to yellow
- Seedwing ......................... Unavailable
- Cleanliness ...................... Less than 5% debris and unacceptable cones

### Pests Affecting Cone and Seed Production

**Insects**

- Coneworm (**Dioctria abietivorella**)
- Spruce cone axis midge (**Dasineura rachiphaga**)
- Spiral spruce cone borer (**Lasionna anthracina**)

**Diseases**

- Inland spruce cone rust (**Chrysomyxa pirolata**)

### Collection Notes

1) Sb cones are persistent and semi-serotinous. Viable seeds are shed slowly over a period of about 4 years.

2) Local collection productivity information is not available.

3) Recommended collection technique: felling.
**Picea sitchensis** (Bong.) Carr. - Sitka Spruce (Ss)

Ss occupies the most humid and productive forest land along river valleys in the CWH biogeoclimatic zone. It is usually found between sea level and 800 m, and has low shade tolerance, low frost resistance, high flood resistance, and high nutritional requirements. Ss hybridizes freely with Sc and Sw where their ranges overlap. The use of Ss in the province’s reforestation program has been limited as a result of its susceptibility to the Sitka spruce weevil.

**Cone and Seed Production Characteristics**

- Reproductive cycle ................................................. 2 years
- Cone length (cm) ..................................................... 5-10
- Cone bearing age (collectable quantities) ................. 25-40 years
- Cones/hectolitre ................................................... 4 000-6 000
- Periodicity .............................................................. 3-4 years
- Viable seeds/hectolitre of cones ................................. 194 270
- Position of cones in crown ....................................... Top 1/3
- Ease of cone detachment .......................................... Moderate
- Plantable trees/hectolitre of cones
  - Bareroot ............................................................. 83 000
  - Container .......................................................... 67 000

**Recommended Collection Standards**

- Filled seeds/half-cone ........ 7
- Cone colour .................. Yellowish-brown
- Storage tissue ................ Opaque and firm
- Seedcoat .................. Golden brown to dark brown
- Embryo .................. Should occupy 90% of the cavity
- Seedwing .................. Golden brown with darker strip along one edge
- Cleanliness .................. Less than 5% debris and unacceptable cones

**Pests Affecting Cone and Seed Production**

Insects

- Spiral spruce cone borer (*Lasionyx anthracina*)
- Spruce seedworm (*Cydia strobilella*)
- Spruce cone axis midge (*Dasineura rachipaga*)

Diseases

- Coastal spruce cone rust (*Chrysomyxa monensis*)
- Seed fungus or cold fungus (*Caloscypha fulgens*)

**Collection Notes**

1) Local collection information for this species is unavailable.
Pinus albicaulis Engelm. - Whitebark Pine (Pa)

Pa grows on moist, nutrient-rich sites in the upper subcontinental MH and the ESSF biogeoclimatic zones. It occurs at elevations ranging from 1000 to 2000 m, and is highly frost resistant and generally shade tolerant except on very dry sites.

Cone and Seed Production Characteristics

Reproductive cycle .......................................................... 3 years
Cone length (cm) ................................................................. 3-8
Cone bearing age (collectable quantities) .............. 20-30 years
Cones/hectolitre ............................................................. Unavailable
Periodicity ................................................................. 3-5 years
Viable seeds/hectolitre of cones ...................................... 515
Position of cones in crown .............................................. Throughout
Ease of cone detachment ................................................ Difficult
Plantable trees/hectolitre of cones
Bareroot ........................................................................... 100

Recommended Collection Standards

Filled seeds/half-cone ........ Unavailable
Cone colour ......................... Purple to brown
Storage tissue ...................... Opaque and firm
Seedcoat ................................. Unavailable
Embryo ................................. Should occupy 90% of the cavity
Seedwing ......................... Generally wingless
Cleanliness .......................... Less than 5% debris and unacceptable cones

Pests Affecting Cone and Seed Production

Pa has no major cone or seed pests.

Collection Notes

1) Pa cones remain closed after ripening, fall from the tree, and must decay on the ground before the wingless seeds are released. Because of this, the collection period is prolonged. However, the seeds are a favourite food of ravens and jays, and seed losses may occur if collections are delayed.

2) Local collection productivity information is not available.

3) Recommended collection techniques: climbing, pruning shears.
Notes:


Range
**Pinus contorta** Doug. ex Loud. - Lodgepole Pine (PL)

Two varieties of PL occur in British Columbia: coastal (var. contorta) and interior (var. latifolia). Both varieties have similar foliage, flowers, and cones. The coastal variety is, however, generally scrubby and of poor form and currently of only minor reforestation importance. The interior variety is of good form and is a major component of the reforestation program.

PL grows on a wide variety of sites in the ESSF, SBS, CALP, BWBS, IDF, JWH, wetter CDF, and CWH biogeoclimatic zones. It can be found at all elevations from sea level to timberline, has moderate to high frost resistant and low shade tolerance. Cones of the coastal variety are mainly non-serotinous, whereas the interior variety usually bears serotinous cones. Cone serotiny is silviculturally important, in that large quantities of viable seeds are available for release following a wild fire or cutting. In both varieties, cones persist on the trees for many years, but only freshly-ripened cones have the highest numbers of viable seeds. This makes cone selection an important feature of lodgepole pine collections.

### Cone and Seed Production Characteristics

<table>
<thead>
<tr>
<th>Reproductive cycle</th>
<th>3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cone length (cm)</td>
<td>3-6</td>
</tr>
<tr>
<td>Cone bearing age (collectable quantities)</td>
<td>15-20 years</td>
</tr>
<tr>
<td>Cones/hectolitre</td>
<td>8 300</td>
</tr>
<tr>
<td>Periodicity</td>
<td>2-4 years</td>
</tr>
<tr>
<td>Viable seeds/hectolitre of cones</td>
<td></td>
</tr>
<tr>
<td>Coast</td>
<td>176 660</td>
</tr>
<tr>
<td>Interior</td>
<td>70 546</td>
</tr>
<tr>
<td>Position of cones in crown</td>
<td>Throughout</td>
</tr>
<tr>
<td>Ease of cone detachment</td>
<td>Difficult except when frozen</td>
</tr>
<tr>
<td>Plantable trees/hectolitre of cones</td>
<td></td>
</tr>
<tr>
<td>Coast Bareroot</td>
<td>43 000</td>
</tr>
<tr>
<td>Container</td>
<td>25 000</td>
</tr>
<tr>
<td>Interior Bareroot</td>
<td>29 000</td>
</tr>
<tr>
<td>Container</td>
<td>21 000</td>
</tr>
</tbody>
</table>

### Recommended Collection Standards

| Filled seeds/half-cone | 5 |
| Filled seeds/whole cone | 20 |
| Cone colour | Shiny, golden brown |
| Storage tissue | Opaque and firm |
| Seedcoat | Dark brown to black; may be mottled |
| Embryo | Should occupy 90% of cavity; white |
| Seedwing | Light brown |
| Cleanliness | Less than 5% debris and less than 25% Class II and IV cones |

* Cut transversely at 1/2 cone length.

### Collection Productivity

<table>
<thead>
<tr>
<th>Collection technique</th>
<th>Hectolitres collected/man-day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerial</td>
<td>1 (0.4 - 1.2)</td>
</tr>
<tr>
<td>Felling</td>
<td>0.7 (0.2 - 3.5)</td>
</tr>
</tbody>
</table>

### Pests Affecting Cone and Seed Production

Insects:

Pine cone moth (*Eucosma recissoriana*)

### Collection Notes

1) In interior PL, filled seeds are generally found in only the top 1/3 to 1/2 of the cone, whereas in the coastal variety, filled seeds occur throughout the cone.

2) As a result of the lack of colour contrast between the embryo and endosperm in PL, embryos must be excised to assess maturity accurately. This is very important, because in some situations, embryos may be missing.

3) PL seeds can be extracted from closed cones for evaluation by dipping the cones in near-boiling water for about 1 minute, or until the cracking sound stops, and then heating them in a microwave oven at full power for 1-1.5 minutes. Care should be taken not to overheat, and hence damage, the seeds. Damage will be indicated by a fatty smell.

4) Insect damage in PL tends to be minimal and is generally in the form of boring at the base of the cones.

5) Cones are usually picked from felled trees. Cones are persistent and picking is easier when temperatures are below -15°C, since the cone stalks are then brittle.
6) For the interior variety, in which the cones are mainly serotinous, the following classes have been defined:

(illustrations are provided on page 72.)

**Cones to be collected**

Class I
- freshly-ripened, current year’s cones
- usually brown, bronze or gold colour on all faces, and tightly closed
- cone age, 2 years
- do not collect when cones are olive in colour, as the seeds are not fully mature

Class II
- partially-weathered, closed cones
- usually bronze, brown, or gold on one face and grey (weathered) on other faces
- cones tightly closed
- cone age, approximately 3-5 years

In undisturbed stands, only a few cones open after ripening at normal temperatures. A fire or logging disturbance is usually required to open and disperse seeds from serotinous cones.

**Cones NOT to be collected**

Class III
- fully weathered, closed cones
- generally grey in colour and most faces of the cones appear weathered
- cones tightly closed
- cone age definitely greater than Class II cones
- non-serotinous cones usually open at maturity at normal temperature in undisturbed stands

Class IV
- partially-opened or opened, old or new cones
- cones variable in colour, but have opened or partially opened and some or all seeds have been dispersed