FORESTRY

A Field Guide to Collecting Cones of British Columbia Conifers

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AUGUST 1996

Compiled by F.T. Portlock
for the British Columbia
Tree Seed Dealers' Association

Partnership Agreement on Forest Resource Development: FRDA II

Canada

BC

A FIELD GUIDE TO COLLECTING CONES OF BRITISH COLUMBIA CONIFERS

F.T. Portlock (compiler)
Canadian Forest Service
Victoria, B.C.

for the

BRITISH COLUMBIA TREE SEED
DEALERS' ASSOCIATION

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For additional copies and/or further information about the Canada-British Columbia Partnership Agreement on Forest Resource Development: FRDA II, contact:

Canadian Forest Service
Pacific Forestry Centre
506 West Burnside Road
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(604) 363-0600

or

B.C. Ministry of Forests
Research Branch
31 Bastion Square
Victoria, B.C. V8W 3E7
(604) 387-6721

or

B.C. Tree Seed Dealers Association
c/o Silva Enterprises Ltd.
P.O. Box 2888
Prince George, BC V2N 4T7
(604) 963-8617

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Code of Ethics

We vow to:

- Ensure that all seeds traded or sold are correctly identified as to species and origin.
- Make every effort to collect seeds with the lowest possible negative effect on the survival and well-being of the species collected, as well as minimize the impact on the environment in which the collection occurs.
- Expand and share knowledge concerning the collecting, processing, storing, and growing seeds of forest trees and other forest plants.

Preface

The need for a field guide to cone collecting has long been recognized by forestry staff involved in seed procurement. Several publications provide technical data on cone collection for individual species, including the Guide to Collecting Cones of British Columbia Conifers (1989) and the Seed and Vegetative Material Guidebook (1995) which forms part of the Forest Practices Code of British Columbia. However these publications do not describe in detail the actual procedures, that is "how to place cones in the bucket", required to plan and complete a successful cone collection operation. This need is further enhanced by the cyclic nature of cone crops and the turnover of forestry personnel which leads to loss of collection expertise from crop to crop.

The British Columbia Tree Seed Dealers Association (BCTSDA) is involved operationally in cone collecting. Its aim in preparing this field guide is to minimize, if not eradicate, many cone collection problems. The information in this field guide may also be applied to native plant seed collections. The chapters have been specifically designed to include information useful to field personnel and are based on personal experience and technical information. In preparing this field guide, the BCTSDA has recognized the need for further research into all aspects of forest tree seed collection. A glossary and a listing of references has been included in the appendix for additional information. In this endeavour, the BCTSDA worked in cooperation with the Pacific Forestry Centre (PFC) of the Canadian Forest Service (CFS) and the British Columbia Ministry of Forests (BCMOF).

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Contents

APPENDICES

TABLES

FIGURES

1. CONE CROP FORECASTING

Cone crop forecasting is an indispensable part of any cone collecting operation. The following procedures will enable the collector to predict the cone crop species (Appendix 2), location, size, and quality. This will enable the collector and the potential client to match seed requirements and availability at an early stage. It will also assist the collector to establish the appropriate collection plan in accordance with those seed requirements.

Many cone collectors monitor the different stages of bud and cone development before undertaking any formal forecasting procedures. Bud development is checked during the fall and winter for the frequency and ratio of male and female buds. During the spring, the occurrence and intensity of pollination, including male and female flower display and pollen distribution, is monitored also. During early summer, the first signs of cone development, which indicates the degree of pollination success, are looked for. With the appearance of recognizable cones, the more formal forecasting procedures begin.

1.1 Crop Monitoring and Sample Collection

1.1.1 Frequency

The frequency of monitoring cone development depends on staff experience and familiarity with the collection sites. The two goals of monitoring are:

- to find sites with high quality cones
- to evaluate cones and seed for maturity

At least two assessments should be made at a minimum of three weeks apart. For most species, the first can be carried out in late July and the second early to mid August. The goal of the earlier assessment is to find suitable sites, while the later assessment provides a preliminary estimate of crop

maturity. A follow-up evaluation a few days to one week later is advisable depending on how close the second assessment is to the expected date of picking.

1.1.2 Sample size

When cones appear to be close to maturity, a sample collection is made to evaluate the crop.

Recommended standards are:

- minimum of six trees with five cones per tree
- preferable sample size is 10 cones per tree and as many trees as can be sampled

Trees should be well distributed within the stand. If a compromise has to be made, it is better to collect fewer cones per tree than to decrease the number of trees sampled. When sampling interior lodgepole pine, ensure class I and II cones are included (see Appendix 4).

1.1.3 Sampling

The following are useful guidelines for sampling:

- sample as much as possible from the mid-canopy of the tree
- aerial sampling will be limited by local weather conditions and closeness of sample trees to other stand trees
- shooting branches from the ground will be limited by aim and patience

1.1.4 Shipping cones for evaluation

Keep cones cool at all times. Ideally, cones should be shipped in styrofoam boxes with freezer packs inside. Wrap the cones in plastic bags with absorbent towelling, but do not pack tightly. Cones shipped in paper bags tend to deteriorate if stored for any length of time.

1.2 Evaluating Cones

1.2.1 Tools

For most species a clean, sharp knife or cone cutter (Figure 1) is used to cut cones to evaluate maturity and quality. A traditional cone cutting knife consists of a machete or butcher knife attached to a board or pipe by a hinge at the blade tip. This device is simple enough to make. Circular cone cutters are particularly effective for very woody cones. (see Appendix 3 for supplier). To observe seed features in detail, a 10x magnifying glass or a portable dissecting microscope are extremely useful.

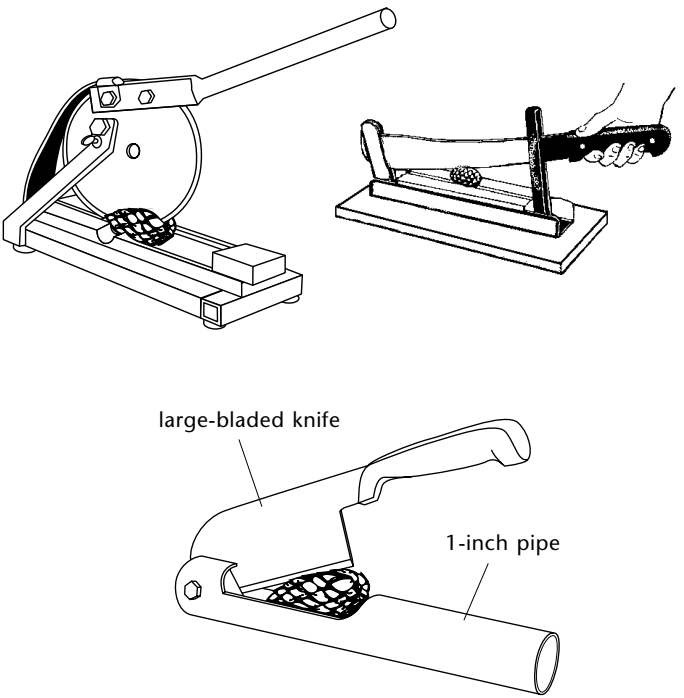

FIGURE 1. Cone cutters

The following guidelines should be used when examining cones.

- Douglas-fir, ponderosa pine, western white pine, spruces, true firs: cut each cone longitudinally through the centre of its axis using a cone cutter; the maturing cones are difficult to cut with an ordinary pocket knife
- Yellow-cedar, western redcedar: cones are cut transversely (cross- wise) half-way up the cone from the base; these cones are difficult to cut along their axis
- Lodgepole pine: cut cones transversely; alternatively dip them in hot, near-boiling water for one minute and dry in an oven at 50–60°C until open, or heat in a microwave for 4-5 minutes at full power. The seeds are then shaken out and evaluated. When sampling this species, ensure that all age classes of cones are sampled and evaluated (Appendix 4)

1.2.2 Maturity: What to look for

No single criterion can be used to determine if cones are ready to pick. Rather, a number of features of both the cones and seeds change as cones mature. By tracking these features, a very good indication of maturity is obtained. Tables 1 and 2 outline some of the most useful and easiest to apply criteria.

TABLE 1. Characteristics of mature cones by species

Species	Overall cone appearance	Scales/bracts	Seedwing	Seedcoat
Douglas-fir	yellow to golden brown	scales pale, bracts darker brown	golden, easily detached from scale	tan to golden brown one side often verigated light, the other dark, glassy
Grand fir	green with yellow tinge turning grey-brown	scales beginning to flex	light brown or purple with brown margins	creamy to light brown
Amabilis fir	grey to purple	scales beginning to flex	light brown or purple with brown margins	cream or tan

TABLE 1. *Continued*

Species	Overall cone appearance	Scales/bracts	Seedwing	Seedcoat
Subalpine fir	purple to grey	scales beginning to flex	light brown or purple with brown margins	creamy or tan
Western hemlock	purplish or yellow-brown	scales greenish with brown margins	light brown	brown to dark-brown, soft
Mountain hemlock	light purple to brownish purple	—	tan	golden to reddish-brown
Sitka spruce	yellow to brown	scales margins slightly flexed	golden brown	golden brown-dark brown-black
Interior spruce	light tan to golden brown	scales greenish or reddish with brown margins	light brown, dark stripe along one edge	glossy pale to dark brown or black
Western larch	brown	bracts flexed back, scales woody and appear open	tan	golden to reddish-brown
Western white pine	yellow-brown or beige to reddish	—	tan, and darker along straight edge	medium to dark-brown
Lodgepole pine	shiny, golden brown	—	light brown	dark brown to black
Ponderosa pine	lustrous yellow-brown	—	tan	pale brown-brown, often mottled; hard to cut
Western redcedar	golden to cinnamon brown	—	light brown	chestnut brown; soft
Yellow-cedar	yellow golden brown to reddish brown	scales slightly raised with brownish margins	light to medium-brown	dark brown; hard

TABLE 2. Criteria for evaluating seed maturity

Feature	Mature	Immature	Comments
Embryo length	> 90% of embryo cavity	< 90% of embryo cavity	at high elevations, or high latitudes, full embryo lengths may not be reached
Megagametophyte ("endosperm")	white or yellow depending on species; globular texture (like tapioca pudding or coconut meat)	translucent (glassy); no texture	
Cotyledons	distinct	indistinct	
Seed wing	woody coloured and stiff	may be purple or very light coloured and/or flexible	
Seed coat	either dark or tan; seed no longer attached to scale	cream coloured and thin; seed still attached to scale	

The cone maturation process includes drying of the cone, which ultimately leads to flexing of cone scales, cone opening and seed release.

1.2.3 Quality: What to look for

When evaluating crop quality, first assess the cone as a whole. Then use a cone cutter to cut a sample of cone as described in section 1.2.1. Assess each cut seed on one half of the cone face using the following criteria:

- number of seeds per cone (see Table 3)
- signs of insect damage or disease; curved cones generally indicate insect damage

Insect problem. Look for the following signs of insect damage:

- exit holes on the cone surface or on seeds
- signs of insects burrowing through the axis of the cone
- insects located in the seeds
- excess pitch which might indicate insect attack

Disease problems. Look for the following signs:

- mould on the surface of the cone
- spores (often orange coloured, associated with cone rusts)
- deterioration of the seeds, blotched or dark megagametophyte or embryos

TABLE 3. Recommended minimum number of filled seeds[1] exposed on one-half cone face

Species	Filled seeds per half cone face
Amabilis fir, Grand fir, Subalpine fir ("true firs")	8, 12, 5
Western redcedar	2 [2]
Yellow-cedar	2 [2]
Douglas-fir	5
Lodgepole pine	
interior	3-4 [3]
coastal	6-7
Ponderosa pine	7
Western white pine	10
Spruces (except black)	7
Black spruce	3
Western hemlock	3
Western larch	3

[1] Fewer numbers of filled seeds may be acceptable, depending on the seed requirements of forest companies.
[2] Cones cut transversely.
[3] If hot-water or microwave opened 15–20 seeds per cone.

Seed health. Look for the following signs:

- seeds drying out prematurely, embryos and megagametophytes shrivelling, which indicates the seeds are unable to develop completely, and that likely they will abort

1.3 Evaluating Seeds

1.3.1 Tools

The only equipment usually needed is a 5–10x hand lens or a portable dissecting microscope and a supply of single-edged razor blades. A pair of forceps (tweezers) may improve safety by helping to prevent inadvertent cuts to fingertips.

To examine the embryo and megagametophyte, cut each seed in half along its long axis. To do this, stand the seed on its narrow edge on a cutting surface and use forceps to hold it in place. Make a vertical, sliding cut with the razor blade downward through the seed between the forceps prongs (Figure 2). The seed may also be cut lying flat which is easier but does not show the seed details as well. An adequate evaluation would require examining up to 50 seeds from 10 cones. The sample should consist of one cone from 10 separate trees.

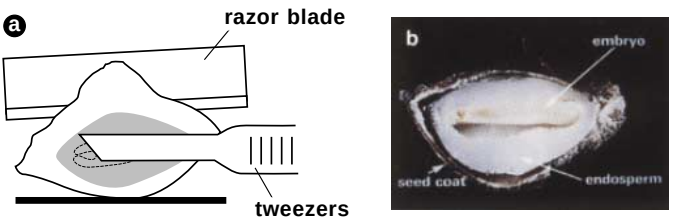

FIGURE 2. a) Seed cutting technique:
b) cut seed showing tissues

1.3.2 Maturity and quality

The criteria used for seed maturity and quality are similar to those used for cone evaluations. However, in this examination individual seeds are scored using the following system: count the number of visible, cut seeds on the cone face and classify them as filled, damaged, immature, or empty. For each cone calculate:

- percentage of seeds that are filled (i.e., embryo and megametophyte are fully developed, undamaged, not discoloured and appear alive and healthy) (Figure 3)
- percentage of seeds that are damaged (i.e., embryo or megametophyte are discoloured, deteriorating, and show signs of insect damage)
- percentage of seeds that are immature (i.e., embryo less than 75% of cavity length, cotyledons are small) (Figure 3)
- percentage of seeds that are empty (i.e., no embryo or megametophyte, or these tissues have shrivelled)

The percentage of damaged seeds will determine the potential quality of the collection (a low percent-damaged is desirable). The percentage of immature seeds will indicate if the time for collection is close (a low percent-immature indicates collection time may be close). The percentage of filled and empty seeds will indicate the potential yield of usable seeds (a high percent-filled is desirable).

For cone and seed evaluation services , contact the commercial seed dealers and the BCMOF Seed Centre. (see Appendix 5)

A form "*Cone and Seed Crop 19——*" (FS 727) is available from BCMOF Technical and Administrative Services Branch (see Appendix 6) and may be useful for the recording of cone and seed maturity data.

FIGURE 3. Mature (top) and immature (bottom) interior spruce seeds

1.4 Assessing Pest Damage

Insects and diseases attack conifer cones. Damage by these agents must be considered before cone collections begin (see Figure 4).

1.4.1 Factors affecting damage

Previous cone crops

- light crops following medium or heavy crops are often severely attacked by pests – heavy crops following light crops seldom sustain much pest damage

Weather

- a prolonged pollination period (e.g., because of cool weather) slows the development of cones and increases their availability to pest attack

Collection site

- pest complexes can vary between the coast and interior; for example, coastal Douglas-fir cones are attacked by the cone gall midge, while interior Douglas-fir cones are attacked by the cone moth
- pest complexes can vary with latitude; for example, the cone maggot is more common on spruce cones in southern latitudes, while the seed moth is more frequent on spruce cones in northern latitudes
- spruce cone rust will only become a problem when the alternate host, wintergreen (*Pyrola* spp.), is present

Tree species

- susceptibility of conifers to pests is variable; for example, spruces, Douglas-fir and true fir cones are often severely damaged, while western hemlock and lodgepole pine cones usually suffer less damage

These and other factors influence every cone crop. A knowledge of the potential pests will help in determining the best time to sample and what kinds of damage to look for. If sampling is neglected, resources can be wasted by collecting low-quality, insect-damaged cones.

FIGURE 4. Cone and seed pests:

a) Inland spruce cone rust *(Chrysomyxa pirolata).* Two healthy cones (one whole, one bisected) and one rusty cone (bisected to show yellow-orange aeciospore masses).

b) Budworm *(Choristneura* sp.*)* in western hemlock. Two damaged cones with budworm pupae, one healthy cone.

c) Ponderosa pine cone with overwintering seedworm caterpillar *(Cydia piperana)* in axis.

d) Fir coneworm *(Dioryctria abietivorella)* frass and damage in Douglas-fir cone.

e) Quartered coastal Douglas-fir cone with cone gall midge *(Contarinia oregonensis)* infested scale (small arrows), cone moth *(Barbara colfaxiana)* caterpillar frass and pupa (large arrows).

f) Coastal Douglas-fir cone heavily infested with cone gall midge *(Contarinia oregonensis).*

g) Spruce cone maggot *(Strobilomyia neanthracina)* larva and typical spiral tunnelling in young spruce cone.

h) Seed midge *(Kaltenbachiola* sp.*)* larvae and/or damage (short arrows), cone maggot *(Earomyia* sp.*)* larva and damage (long arrows) in subalpine fir cone.

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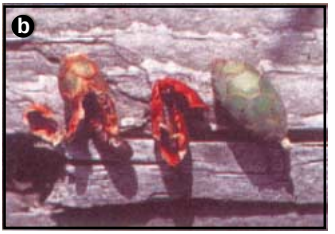
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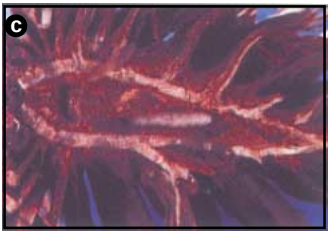
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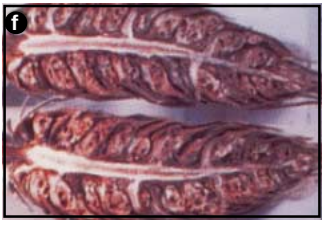
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1.4.2 Identifying pests

Pests can be identified by examining their features and by analyzing the timing of the pest attack, its location in the cone, and the damage sustained. See Table 4 for a listing of pests and the conifers they attack.

Identifying features of the pest

- a moth pupa has discernible wings, antennae, and abdomen
- a midge pupa is usually enclosed in an oval, featureless shell or puparium; it is difficult to see any of the adult form inside
- in Douglas-fir and spruce cones, frass (excrement) can be pellet-like, coarse, or fine depending on which insect produces it; for example, the coneworm (Dioryctria) generally leaves copious amounts of coarse, webbed, pellet-like frass on the cone surface, while the cone moth (Barbara) (on Douglas-fir) and the seedworm (Cydia) (on spruce) generally leave a finer frass

Timing of attack

- some insects are present in the cones from pollination through to harvest time or longer; for example, Douglas-fir cone moths feed in the cone from pollination through to July or August and then overwinter in the cone
- some insects are present in cones for a relatively short period; for example, spruce cone maggots leave the cone in June or July to overwinter in the soil

Pest location in the cone

- a pupa found in the axis of a spruce cone is generally the spruce seedworm (a moth) or the spruce cone axis midge (a fly)
- a seedworm caterpillar will feed from seed to seed and will leave frass near the seeds which it has eaten
- the spruce cone axis midge does most of its feeding in the axis of the cone; little direct damage to the seeds is evident

Cone damage

- may take the obvious form of tunnelling and/or seed consumption by seedworms and cone moths
- more subtle forms of damage can occur; for example, gall or resin midges cause galling or resin flow in the cone, hindering seed extraction.
- spruce cone rusts generally reduce seed production, as well as causing lower and/or abnormal germination

1.4.3 When to look for pest damage

Assessments made immediately before cone collection are the most reliable and can confirm predictions of pest losses made earlier in the season during crop forecasting. The majority of insects have completed their feeding by cone collection time. Coneworms may still be feeding, but subsequent damage usually will be minimal. Resources used to plan the collection will be wasted if early assessments are not carried out and pest damage is found to be extensive.

Assessing wild stands

Assessments carried out in late July or early August will indicate the probable pest population. Insects are generally large enough at this time to be noticable and their damage will be visible. Future damage can be predicted for the Douglas-fir cone moth and the spruce cone maggot as follows:

Douglas-fir cone moth

- if a cone sample contains one cone moth larvae per cone, up to 60% of the seeds may have been destroyed
- if the crop is sampled early in the summer (June) and each cone contains a young larva, then even if seed or cone counts are high, it is unlikely that enough seeds will be left to collect; by mid-July, the cone moth has done most of its damage and will be preparing to pupate; sampling at this time will provide a better estimate of the year's damage

TABLE 4. Pests and conifers attacked

Pest	Conifers affected: Douglas-fir (Fd)	Pines: Lodgepole (Pl)	Pines: Ponderosa (Py)	Pines: Western white (Pw)	Spruces: Black (Sb)	Spruces: Interior (Sx)	Spruces: Sitka (Ss)	True Firs: Grand (Bg)	True Firs: Amabilis (Ba)	True Firs: Subalpine (Bl)	Western hemlock (Hw)	Western larch (Lw)	Western redcedar (Cw)
Insects:													
Barbara spp. (cone moth)	C, S							C, S					
Camptomyia pseudotsuga (cone scale midge)	C												
Choristoneura occidentalis (western S budworm)	C, F				C,f	C,F	C,F				C,F		
Conophthorus monticolae (Pw cone beetle)				C, S									
Contarinia spp. (Fd cone gall & cone scale midges)	C, S												
Cydia spp. (seedworms)			C, S		C,S	C,S	C,S						
Kaltenbachiola spp. (cone and seed midges)					C	C	C	S	S	S			
Dioryctria abietivorella (coneworm)	C,S	C,S	C,S	C,S	C,S	C,S	C,S	C,S	C,S	C,S	C,S	C,S	

(Continued on next page)

Dioryctria auranticella (coneworm)			C,S										
Earomyia spp. (cone maggots)	C,S							C,S	C,S	C,S		C,S	
Ernobius punctulatus (Fd cone beetle)	C,S												
Eucosma recissoriana (Pl cone moth)		C,S		C,S									
Strobilomyia spp. (cone maggots)					C,S	C,S	C,S					C,S	
Leptoglossus occidentalis (cone bug)	S	S	S	S				S	S		S		
Mayetiola spp. (cone and seed midges)						S							C,S
Megastigmus spp. (seed chalcid)	S		C			S		S	S	S	S		
Pityophthorus orarius (Fd twig mining beetle)	T												
Resseliella sps. (cone scale midge)			C					C		C			
Diseases:													
Caloscypha fulgens (seed or cold fungus)	S					S	S	S					
Chrysomyxa monesis (coastal spruce cone rust)							C						
Chrysomyxa pirolata (inland spruce cone rust)						C	C						

Structure affected: C=cones, F=flowers and conelets, S=seeds, T=twigs

Note: no major pest damage has been identified in the cones and seeds of native tree species not included in this table.

Spruce cone maggot

- this insect leaves the cone in early summer (mid-June at lower elevations) and may not be present in July or August samples; a single larvae can destroy up to one-half of the seeds in a cone
- if sampling indicates one larvae in 50% of the cones, the expected seed yield may be only 75% of potential seed yield
- only one generation of cone maggot is produced per year; assuming no other insects are evident in the cone, the damage visible by mid-July will probably not increase

Assessing seed orchards

Douglas-fir, western redcedar, western larch, and spruce pest assessments should begin at pollination time in seed orchards. Egg densities of the major pests in orchard female flowers are determined and damage predicted before the conelets become pendant.

1.4.4 Summary

When determining pest damage, the following points should be considered:

- signs of the insects and their damage are usually observable and recognizable
- pest damage in wild stand cone crops is best assessed in mid-July or early August
- pest damage in seed orchard cone crops is assessed during the pollination period
- further damage in cone crops can be predicted before collection

- after assessments, stands can be screened; those with a high potential for damage should be eliminated from cone collection plans
- earlier predictions can be confirmed just prior to cone harvest when seed maturity checks are made
- leaving damage assessments to collection time may result in eliminating prospective stands at the last minute with no alternate collection sites

The Seed Pest Management group of the BCMOF provides assessment and diagnostic services and other cone and seed pest management advice. See Appendix 5 for a listing of contact names and addresses. See Hedlin (1974) and Sutherland et al. (1987) (Appendix 11) for more information about cone and seed insects and diseases.

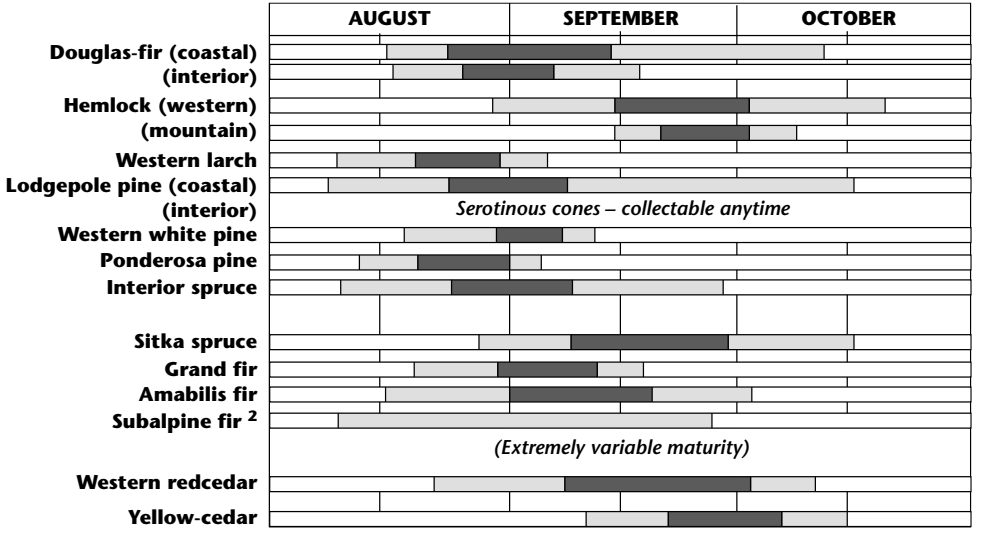
1.5 Cone Maturity

The forecasting of cone maturity and the eventual cone picking date is the result of careful crops monitoring. Monitoring will show variation between and within stands. This variation has many reasons including:

- aspect; cone crops generally mature faster on southern exposures
- elevation; cone maturity is generally delayed with increasing elevation
- latitude; cone mature may or may not be effected by increasing latitude

Table 5 may be useful to help determine one picking dates. This table should only be used as a guide and not a substitute for careful monitoring.

TABLE 5. Cone maturity periods by species[1]



1. This bar graph was derived from information on dates of collection which meet or exceeded current minimum BCMOF seed germination standards. Dark bar indicates period in which the majority of collections occurred.
2. Subalpine fir collection dates are extremely variable and graph data is based on a low number of previous collections.

2 PLANNING AND ORGANIZING CONE COLLECTIONS

2.1 Collection Plans

Before starting the actual cone collections, the collector must:

- obtain the required permits from the BCMOF (see Section 2.2.3)
- establish the seed requirements by species and volumes of cones (Appendix 7), Seed Planning Zones (SPZ) (Appendix 8), and Seed Transfer Limits (Appendix 9) and as indicated in the Seed and Vegetative Material Guidebook or by the user (e.g., forest company, seed dealer)
- define the specific area(s) where cones are to be collected, based on seed user's requirements, SPZs, means of access, cone crop rating and evaluation information which indicates a potential crop, as well as forecasts of cone maturity dates

The collector must also determine the most efficient and cost-effective collection method before starting the actual collection. Collection costs will vary greatly for each collection year.

Cone collection methods are listed below in order of decreasing skill level and/or equipment required:

1. helicopter
2. climbing trees
3. felling trees
4. squirrel cache

These methods are discussed in detail in Chapter 3.

2.2. Collection Details

2.2.1 Introduction

After the collection method has been selected, the collector develops a plan that covers the following procedural details:

- number of pickers required and where to find them
- time required to complete the collection within the collection window
- obtain and fill out the necessary forms related to cone collections
- number of cone sacks, ties, and labels required and where to obtain them; interim cone storage site, collection equipment and materials and where to obtain them
- provision for training and briefing of cone pickers including safety measures
- access to and from collection site; transportation of collection crew, equipment, and cones
- payment procedures for collection crew

2.2.2 Procedures

1. Number of pickers required and where to find them

The number of pickers required depends on the collection method chosen and the amount of cones to be picked (Table 6). The experience of the pickers, their physical condition, and whether they are paid per hour or at a piece rate, also play a role. Generally, piece-rate pickers work faster, although more supervision may be required to ensure quality and reduce waste.

TABLE 6. Approximate amounts[1] (in hl) of cones picked per worker day based on a medium to heavy cone crop (BCMOF standards)

Species	Helicopter	Climbing	Felling	Squirrel
Amabilis fir	5–10	—[2]	3–6	2–5
Douglas-fir	2–5	1–3	2–4	2-4
Grand fir	5–10	—	3–6	2–5
Lodgepole pine	0.5–1.5	—	0.5–2	—
Ponderosa pine	-	2–3	2–4	2-5
Spruce, interior	2–3	—	1–2	1–2
Sitka spruce	3–5	—	—	2–4
Subalpine fir	2–5	1–3	2–4	1–3
Western larch	—	0.5–1	1–2	0.5–1
Western hemlock	0.2–0.5	0.1–0.2	0.1–0.3	—
Western redcedar	0.5–1[3]	0.5–1.5	0.5–1.1	—
Western white pine	3–5	0.5–2	2–4	—
Yellow-cedar	0.03–0.05	0.03–0.05	0.05–0.1	—

1. These figures can vary greatly depending on the collector's skill level, crop conditions, equipment used, and weather conditions.
2. A dash (–) indicates no data.
3. May be higher (up to 5 hl per day) when using purity standards which are lower than current BCMOF standards.

Sources of cone pickers include:

- local silviculture and logging contractors
- BCMOF regional or district offices sometimes keep lists of individuals and organizations interested in silviculture work, including collecting cones
- service clubs, Boy Scouts, search and rescue organizations, and other groups looking for ways to raise funds
- students contacted through school, college bulletin boards, or school publications
- interested individuals contacted through advertisements in local newspapers
- first nation band offices
- employment agencies

2. Time required to complete the collection within the collection window

The collection "window" is the time available to complete the collection. This window occurs between the time when cones and seeds reach the required maturity level for collection (see Tables 1 and 2) and when seeds are released and dispersed naturally. The length of collection time required depends on many factors, including:

- the number of pickers involved, their experience and fitness level
- crop size, whether heavy or light
- collection method, and the type of equipment used
- weather conditions

Of these factors only labour and the collection method can be manipulated to any extent. The collection supervisor must have personnel and equipment ready at the proper time and be prepared to make the appropriate adjustments during collection.

3. Required forms and licenses related to cone collections (see Appendix 10 for examples)

A "*Seed and Vegetative Material Dealer's License*" (FS 786):

- is required for a company to operate as a seed dealer in British Columbia
- is available from regional BCMOF offices

A "*Cone and Vegetative Material Collection Permit*" (FS 504):

- is required to collect cones on Crown land
- is available from district BCMOF offices
- requires that written permission from the licensee be submitted to the district office with the application for a permit

A "*Natural Stand (and Plantation) Cone Collection Report*" (FS 721):

- must be completed and accompany shipments of cones from Crown lands to the extraction facility
- is available from BCMOF district and regional offices and the BCMOF Tree Seed Centre in Surrey
- includes printed instructions on the form regarding its completion

A "*Seed Orchard Cone Collection Report*" (FS 721A):

- is required for seed orchard cone collections shipped to the extraction facility
- is available from BCMOF seed production officers (Victoria, Vernon) and the Technical and Administrative Mail and Supply Warehouse in Victoria. See Appendix 5 for addresses

Written approval from private land owners should be obtained early in the cone collection planning stage.

Some cone collections are undertaken for seed export from Canada. The Organization for Economic Cooperation and Development (OECD) member countries require that imported seeds be accompanied by an OECD certificate which states the exact location of the collection, or seed origin. To obtain an OECD certificate, the collection site must be inspected by an OECD inspector authorized by the Canadian Forest Service. See Appendix 5 for address.

4. Cone sacks, ties, labels, interim cone storage, equipment and materials (Figure 5)

The number of sacks required is based on the amount of cones to be collected, species and size of cones, and the amount of cones placed in each sack. Optimum volumes per sack by species are typically:

- true firs, western white pine, ponderosa pine: 20–30 litres
- spruces, Douglas-fir: 25–30 litres

- western hemlock, yellow-cedar and western redcedar: 20 litres
- lodgepole pine, black spruce: 20-40 litres

Cone sacks for most species are normally made of $7^{1}/_{2}$ oz. jute. Some species (lodgepole pine) may be collected in 10 oz. jute. Sacks made of coarse-meshed nylon are available, but generally are more expensive than jute. The common volume for cone sacks is 40 litres to the base of the black line. To measure the amount of cones per sack, plastic pails may be used. Used pails are available from various sources (for example, logging sites/camps, food processing industry, restaurants, supermarkets, gas stations) in 10-25 litre sizes. All pails should be cleaned before use. Pails (and other measuring devices) must be checked with a standard measure to ensure proper volumes. Recommended dimensions for two, standard cone volume measures are shown in Figure 6.

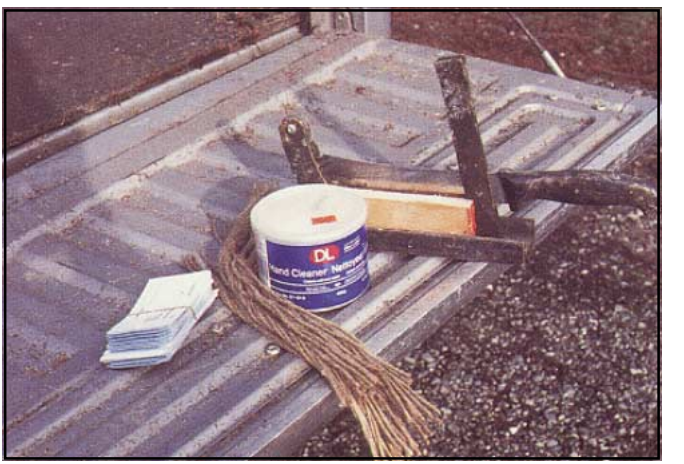
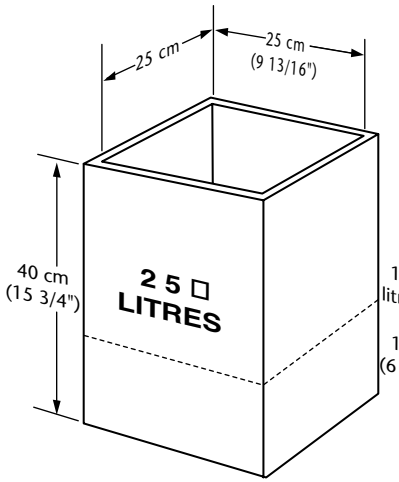


FIGURE 5. Some important cone collecting equipment

Cone Measurement Volume

When measuring cone volume, fill $^1/_2 - ^2/_3$ full, then shake or drop container to settle the cones, then fill to prescribed volume.

All dimensions are inside measurements.



Plywood box

20 litre oil containers are actually 22.5 litres when filled to the brim with cones. When filled as shown, they hold 25 litres, but it is advisable to check it with a standard measure (left).

These used oil containers are usually available free at most petroleum bulk plants. They must be cleaned with a solvent and water to remove oil residue before using.

FIGURE 6. Examples of standard measuring containers for cone volumes

Sacks must be tied near the mouth to provide the maximum space for possible cone expansion during interim storage (Figure 7). Jute or double-strand hemp twine (Figure 5) is preferred for ease of untying, but metal ties can be used. Some new cone sacks have ties stitched to the sack near the mouth. BCMOF tags for cone sacks are available from the Technical and Administrative Services Branch (see Appendix 3). Seed dealers, forest companies, and the BCMOF supply tags for private collections.

Tags consist of two parts; one part is tied to the outside of the sack, the other is placed inside the sack (Figure 8). Information recorded on tags includes:

- collection agency
- seedlot number
- collection site
- species code symbol (see Appendix 2)
- total number of sacks for each seedlot

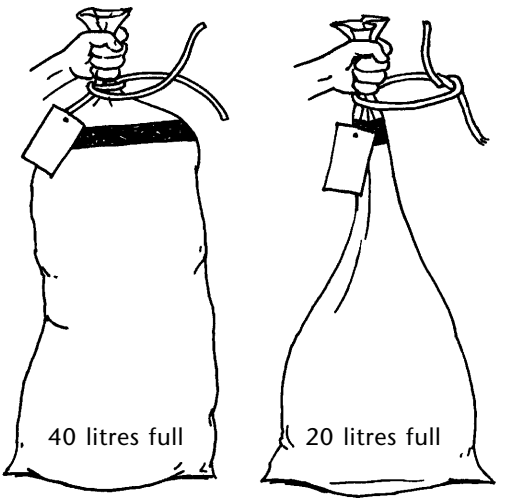


FIGURE 7. Tying of filled cone sacks

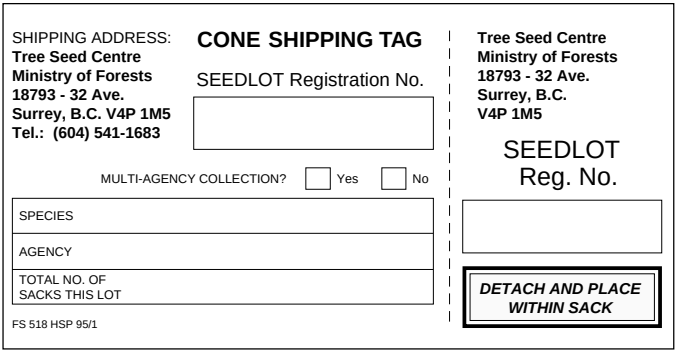


FIGURE 8. A BCMOF cone sack label

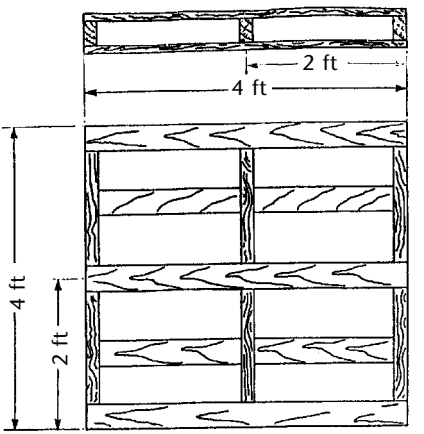
Different coloured tags, symbols, and flagging may be used to easily distinguish seedlots. Sometimes seedlot numbers are spray painted on sacks for easy recognition. However, this has some disadvantages including:

- extra work as cone tags must also be used
- paint may transfer to cones and seeds in sacks
- confusion if sacks are reused

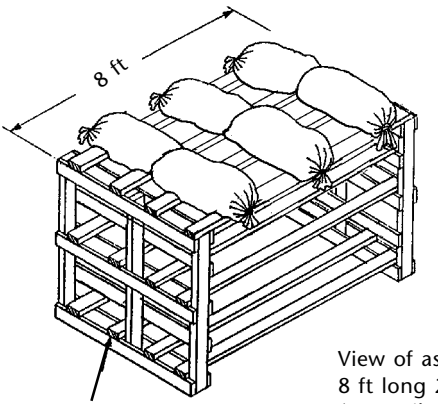
The reuse of cone sacks is not recommended by the BCMOF as it carries the risk of spreading disease from previous collections.

Interim cone storage may be required at the collection site, or nearby, before cones are moved to the extraction plant. Examples of designs for interim-storage facilities are shown in Figures 9, 10, 11, and 12.

For suppliers of tags and cone sacks, see Appendix 3. For a checklist of cone collection equipment, see Table 7.



Pallet construction:
2x4s and 1x4s



20 – 2" x 4"s x 8' - 0" (545)
per rack (not nailed).

View of assembled racks using
8 ft long 2x4s as stringers
(not nailed).

FIGURE 9. Example of a simple, inexpensive type of interim cone storage rack using standard pallets that can either be prefabricated and transported to the collection site, or be built at the collection site

Commercial scaffolding is available from most construction rental outlets. Cost is usually less than $15 for one 5x5x7 ft unit (per month). One unit can support 36 filled sacks if 2x4 studs are used to support the sacks. These units may be stacked two units high if necessary.

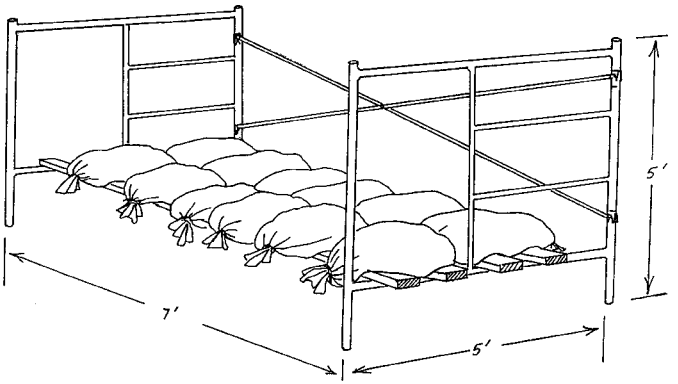


FIGURE 10. Interim cone storage rack using building scaffolding

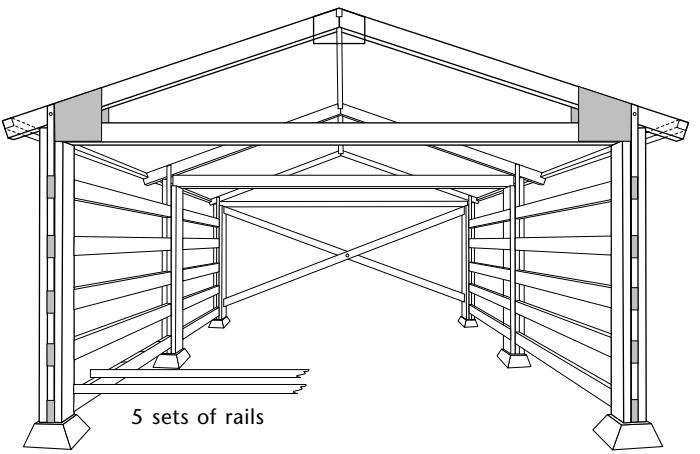


FIGURE 11. Portable knock-down cone storage shed using tarps for covering the roof

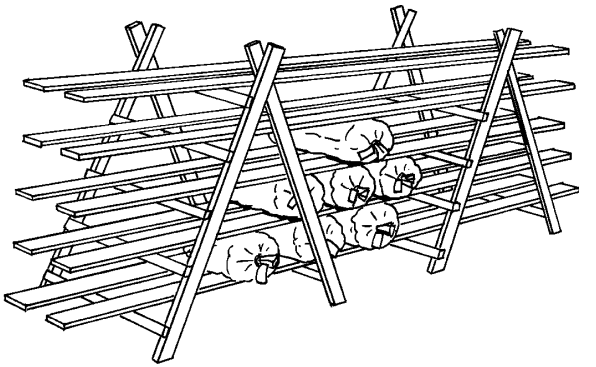


FIGURE 12. Another easily constructed and transported knock-down cone storage rack

TABLE 7. Cone collecting equipment checklist[1]

- altimeter
- axe, hand and/or chainsaw
- binoculars
- camera
- cargo net (helicopter)
- compass
- cone collection forms (or photo copies)
- cone collection field guide
- cone sacks, tags, ties
- cone cutting knife
- eye/ear protection
- file and/or hand grinder
- first aid kit (size depends on number in crew)
- fire-fighting equipment
- fuel for helicopter and associated equipment
- gloves
- hand cleaner (brands include DL, Lustresheen, Motocraft)
- hand lens
- hard hats
- high-visibility vests
- interim-storage building supplies
- maps
- marking pens
- marking tape
- note pad
- pens, pencils
- plastic pails
- pocket knife
- portable radio (2-way)
- rain gear
- spray paint
- sunglasses, sunscreen
- twine and/or wire
- tarp/poly sheet
- towels, paper or cloth
- water container, water, cups

[1.] Most of this equipment is available from local hardware stores.

5. Training and briefing of cone pickers, including safety measures

Cone collection workshops are held periodically by the BCMOF and the BCTSDA. Individuals interested in collecting cones, especially first-time collectors, should contact BCMOF and/or BCTSDA to find out when such workshops will be scheduled. Experienced cone pickers are encouraged to attend a workshop occasionally so that they become aware of changes in technology, of revised safety precautions, and government or other requirements. Also, experienced personnel may be able to pass on advice to newcomers.

Before starting the actual collection the collector must meet with:

- cone pickers, to give instructions on the collection methods and safety procedures to be followed; to make pickers aware of the quantity of cones that can be picked per day given the prevailing conditions and cone quality
- ground crew supervisor(s), to outline cone dumping procedures, cone quality control, monitoring of cone pickers, sack filling and labelling, records to be kept such as the interim cone collection report (Appendix 11), safety procedures, and use of equipment
- helicopter pilot(s), to outline cone quality requirements and tree selection, to cover collection procedures in the air and on the ground; to conduct pre-collection flight(s) at the collection location(s), selection of cone-dumping sites and refueling site(s); and to define safety procedures

Pickers who collect cones by climbing trees may be required to attend a climbing course (instruction sessions) organized by the BCTSDA, BCMOF or landscape tree maintenance organizations. These courses (sessions) are held infrequently.

Safety must be made an important part of all cone collection operations. It must be included in all levels of training and briefing sessions for cone-collecting personnel. Instruction should include the following:

- supervisors are responsible for the use of proper clothing, gear, and safety equipment
- collecting cones by felling trees requires proper chainsaw protective equipment including gloves, eye and hearing protection, and hard hats
- collecting cones by climbing requires climbing belts, gloves, and hard hats
- collecting cones by helicopter requires goggles, gloves, hearing protection preferably attached to hard hats, and high-visibility vests
- a well stocked first aid kit must always be on the site

The proper equipment and its use are described in Chapter 3 under collection methods and practices.

Currently, Workers' Compensation Board (WCB) regulations do not cover cone collections specifically, but collection sites are subject to WCB regulations and inspections. General WCB regulations that require working in a safe manner do apply. This may include ensuring that at least one crew member holds an industrial or survival first-aid ticket. If unsafe practices are found by WCB, the collection supervisor may be held accountable and the collection operation could be shut down.

Cone collection supervisory personnel must be knowledgeable about cone and seed maturity, quality standards, filling sacks, tagging, and interim cone storage. It must be emphasized with supervisors that they strive to achieve the highest seed quality by:

- carrying out regular cone and seed cutting tests throughout the collection to determine seed counts, maturity, and if certain trees or areas should be picked or avoided

- inspecting cones and seeds for possible damage by insects, fungi, moulds, rusts, or other pests, and rejecting cones from affected trees
- ensuring that limits for acceptable amounts of debris in the cone sacks are not exceeded, as stipulated below

The BCMOF standards for debris are:

- no more than 5% debris and unacceptable cones for all species except western hemlock, western redcedar, and yellow-cedar for which the limit is no more than 10% debris
- lodgepole pine collections permit no more than 25% Class III and IV cones (see Appendix 4)

Private seed dealers may allow different standards for debris depending on the species. They should be contacted directly to establish their tolerances.

6. Access to collection areas

Access is particularly important when crews must be moved in and out of the collection sites. The collector should ensure that:

- access agreements are drawn up with the landowner, licensees and BCMOF district offices early in the planning stage
- road access for gates, hours of work, and vehicle accessibility is checked; gate keys should be obtained from the licensee or BCMOF offices
- cone dumping sites for helicopter collections are prepared in advance
- other collection sites (climbing, felling sites) are prepared as necessary to provide a suitable work area

For information on helicopter cone collections see Chapter 3. See Chapter 4 for information on cone transport.

7. Payment procedures for cone collection personnel
Cone pickers generally are paid by the hour or at a piece rate. The pay level depends on a number of factors such as crop species, crop rating, collection method, available equipment, and tools required.

Advantages of hourly pay:

- easier to ensure quality work
- pickers can be assigned different tasks during the collection
- possibly less supervisor time is required

Disadvantages of hourly pay:

- low productivity because of lack of incentive
- work may not be finished within collection window
- higher cost

Advantages of piece-rate pay:

- increased productivity
- potentially better moral
- reduced cost

Disadvantages of piece rate pay:

- cone and seeds quality may suffer
- increased need for supervision
- increased cone waste

Other costs to be considered include whether:

- transportation of picking crew to collection site is provided and paid for by collection contractor or by cone pickers
- travel time is paid or not
- lodging/camp facilities are provided and paid for by contractor or by cone pickers
- clothing, gloves, safety equipment are supplied by contractor or by cone pickers

3. COLLECTION METHODS

3.1 Helicopter Collections

3.1.1 Introduction

Planning is the key ingredient to any aerial cone collection. Before deciding whether helicopters should be used for cone collections, the pre-collection cone crop and seed evaluation should be completed. If they have not, time, effort, and money may be wasted collecting cones from low-yielding trees with high insect or rust infestations in areas that are difficult and time consuming to gain access to by helicopter. During moderate crop years these evaluations may be the difference between success and failure. During good crop years, it may be the difference between average and great results.

A comprehensive description of collecting cones by helicopter can be found in the BCMOF publication *A Guide to Aerial Cone Collection Equipment and Techniques in British Columbia* (1990).

3.1.2 Helicopter company selection

A helicopter company should be selected when cone crops need to be evaluated.

Well before the projected collection date, the requirements for pilots and equipment should be specified in writing to the company. As cone collections must compete with other time-sensitive activities such as slash-burning and forest fire-fighting, the proper equipment and pilot combinations may not always be available.

Request pilots that are experienced with the type of cone collection apparatus to be used. It is immensely helpful if at least one of the pilots on the collection team is also a pilot for the crop evaluation sampling flights. Some helicopter

companies may send their experienced pilots for the cone evaluation flights, but then use less-experienced pilots during the collection flights when production time ratios are at a premium. Experienced pilots may collect twice the volume from the same stand as inexperienced pilots. If the helicopter company cannot assure your choice of pilots, negotiate a price per hectolitre of cones with them.

3.1.3 Helicopter fuel

Clear and concise arrangements for fuel provision, its transport and price should be made with the helicopter company.

Helicopter fuel considerations include:

- for large collection operations, helicopter fuel should be delivered by flatbed truck; empty fuel barrels can be returned using pickup trucks provided the barrels are well secured
- for short duration (1–2 days), a three-quarter ton pickup truck can provide enough barrels of fuel in one trip per day
- for large helicopters (Bell 204B or 205) fuel consumption may triple over a smaller machine (e.g., Bell 206B) (Table 8). For example, in a twelve-hour day, a Bell 205 may require over 23 barrels of fuel, a volume that cannot be safely or efficiently handled by pickup truck

3.1.4 Helicopter cone collection equipment

The choice of collection equipment depends on the cone species to be collected and the helicopters available. During heavy cone-crop years, this equipment should be reserved and secured as soon as possible. When a choice has to be made, suitability and efficiency must be known. This includes choosing between complete dependency on the helicopter when using rakes and shears, or less dependency on the pilot when using clippers, since the latter requires an experienced collector/clipper-operator in the helicopter also.

Aerial Rakes (Figures 13 and 14)

- Bicone Rake: although efficient, this rake is large and heavy (250 kg), and difficult to transport and handle; it requires the equivalent of a Bell 204B or 205 to operate
- Chilson or modified Chilson Rake: at 180 kg, this rake also requires a powerful helicopter such as the Turbo Hiller, Bell 206L or Hughes 500D
- Fandrich Rake: although lighter (136 kg), this rake still requires large payload helicopters because the helicopter lift power is necessary to cut branches; the Bell 206L, Hughes 500D and the Turbo Hiller are suitable
- Fandrich Power Rake (1993): this rake experienced some difficulties when first introduced; rake fingers often broke and the dump mechanism was inefficient and weak, consuming extra repair time; but in 1995, it underwent numerous modifications to make it more efficient; because of its light weight (136 kg), lower payload weight, and powered cone-stripping features, smaller helicopters can be employed; the Bell 206B or equivalent is suitable

Aerial shears (Figure 15)

- Fandrich Shear (manual-dumping): this shear weighs 167 kg, but as the apparatus includes a shearing device to cut the top from the tree, helicopter lift is required only for the loaded apparatus; Bell 206B, Hughes 500D and the Turbo Hiller helicopters are suitable with this equipment
- Fandrich Shear (self-dumping): this is currently the most commonly-used aerial shear; while slightly heavier than the manual-dumping model (which sacrifices some payload), its efficiency often makes it the preferred model; its self-dumping mechanism is somewhat prone to failure and personnel must be prepared to manually close the dump gates; collection trips/cycles may abort because in flight dumping can occur when the gate is not securely latched; Bell 206B, Hughes 500D and Turbo Hiller helicopters are suitable for this equipment

- Fandrich shear (self-dumping model 1994): this shear is heavier than previous models; because of its increased volume capacity it may be useful in transporting large volumes of tops, making remote collections more economical; may require the Bell 204B or 205 helicopters

FIGURE 13. Helicopter dumping cones on to the picking site from an aerial rake

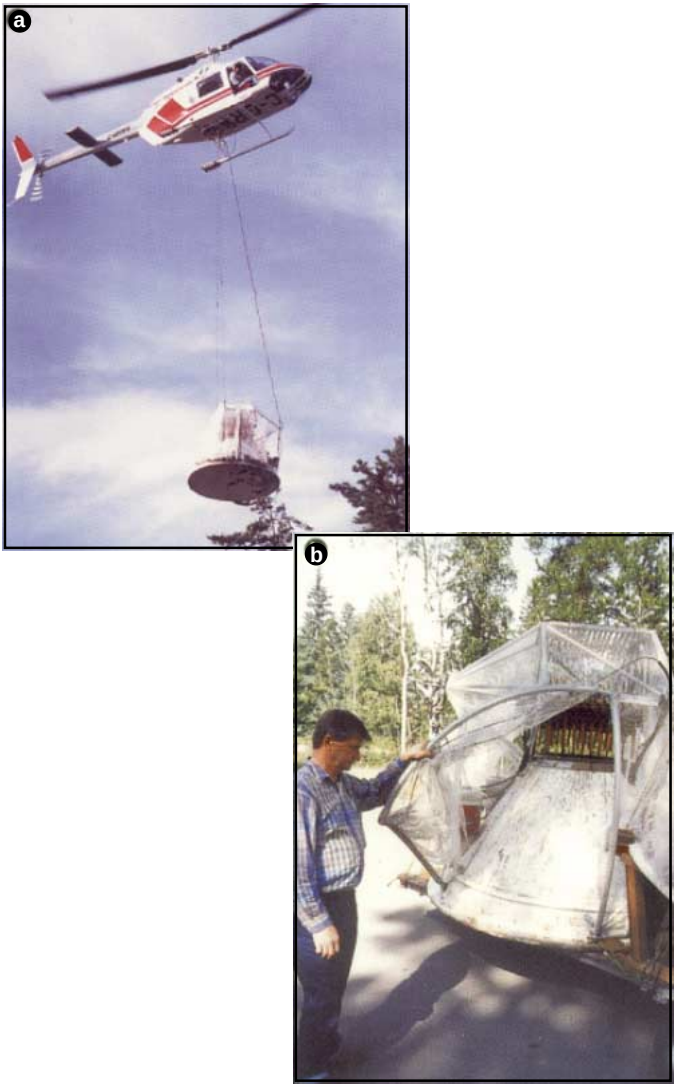


FIGURE 14. a) aerial power rake in action b) Improved version of the aerial power rake (1995)

FIGURE 15. Helicopter dumping cones from aerial shear into a transport truck

TABLE 8. Payload and fuel consumption for common helicopter models

Model	Payload (kg)	Fuel consumption (litres per hour)
A Star 350B	578	159
Bell 204B	1365	360
Bell 205	1635	386
Bell 206L	545	136
Bell 206B	385	113
Hughes 500D	545	127
Hiller Turbo	450	113

The use of aerial shears, as opposed to aerial rakes, provides an opportunity to sample and, if necessary, remove tops before the picking of cones begins by the collection crew. This is not practical with rakes as they only produce branches. This difference becomes more important if pollination has been sporadic, or insect/cone-rust infestations are high. In addition, when using shears, collecting tops may produce higher picking-crew efficiency. However, when collecting with rakes, the stem weight of the top is not transported by the helicopter and may produce higher cone payloads per flight/cycle.

Aerial clipping

Aerial clipping, or sawing, requires a second person in the helicopter. A well-trained clipper operator can be used to select crop trees, rather than depending on the pilot. This reduces or eliminates the volume of cull tops transported to the dumping site. The Bell 206B helicopter is appropriate with this equipment. However, aerial clipping is not used extensively.

3.1.5 Dumping site

The dumping site for tops and branches should be selected using the following criteria:

- it must be as close as possible to the crop to decrease flight/cycle times; along a roadway is often best (Figure 13)
- it should have at least two easy access routes for the helicopter
- it should be separate from the helicopter refueling site
- it should be lower in elevation than the collection area and should be easily accessible by vehicle

For larger collections, at least two dumping sites should be provided so that picking crews are in no danger when the helicopter dumps a load. This is not required if tops are dumped into transport vehicles and removed to a separate picking spot (Figure 15).

3.1.6 The first day of cone collection

The cone collection supervisor should arrive early and ensure that all the proper procedures have been followed in preparation of the collection site:

- in hot weather, picking crews should be prepared to work during the cool times of the day; this benefits personnel, machines, and seeds
- a supply of ground tarps should be provided for each dumping site to help keep sticky cones free of dirt and pathogens; for safety reasons, the tarps must be very well secured to the ground by stakes driven flush with the ground to reduce tripping hazards
- an adequate supply of cone sacks (jute is preferable, see Section 2) and identification tags must be provided; the supervisor should ensure that all tags (one part inside, one part outside each filled sack) are initialled by the picker

- notepads for recording flight times and number of tops returned on each helicopter cycle must be used
- racks and shelters for interim storage of bagged cones should be close to the picking site; filled sacks should always be carried, not dragged
- helicopter fuel must be readily available, but away from the cone dumping sites
- fuel and oil for the shearing device should be stored safely inside a vehicle or trailer to avoid fire hazards
- when an aerial shearing device or power rake is to be used, a replacement spark plug for the hydraulic pump motor should be kept handy, together with plenty of grease for the shear slides; periodically it may be necessary to chisel accumulated pitch from the shear slides
- all control wiring on the helicopter must be tested before the first day of cone collection
- cables that will be connected to the helicopter should be laid out beforehand so that they can be attached to and lifted by the helicopter without snagging or kinking; kinked cable may fray and need replacing
- the ground crew should be dressed appropriately with high-visibility vests, long sleeve shirts, pants, work boots, hard hats with hearing and eye protection attached, and gloves; the emphasis should be on comfort to ensure this essential equipment is worn
- a comfortable place for the off-duty pilot to rest should be provided
- although the off-duty pilot will probably have radio contact with the working pilot, it is often convenient to have a prearranged contact frequency for the supervisor's own radio

The third or fourth load of tops should be put to one side, picked and measured. Based on an assessment of this material, a decision must be made whether to continue or to end the collection. There are many reasons for low cone yields, including:

- pilot inexperience
- poor flight conditions which cause the pilot to take less than full weight per flight/cycle
- an earlier overestimate of the cone crop, with fewer than expected cones per top and or crop trees per area
- insect and/or rust infestation causing above-average culling

The supervisor should assign pickers to individual tops and inspect picked tops before assigning additional tops; piles of branches should be checked to ensure that all collectable cones have been removed.

Filled sacks must be laid horizontally with air spaces between them, and sheltered from sun and rain. If filled sacks are stood on end and close together (for even short periods of time), the cones become compressed in the bottom half of the sack leading to serious problems of overheating and mould. This condition may go unnoticed until the sack is emptied because the cones on the top half of the bag will appear healthy. Remedial action must be taken by the supervisor and crew members if sacked cones begin to smell mouldy.

Each day's collection should be removed from the picking site to an interim storage site during the cool of each evening. If the helicopter delivers more cones than can be picked in an hour or two after the helicopter has finished for the day, then more pickers should be added to the crew for the next day.

3.2 Tree Climbing

Tree climbing is one of the oldest methods of collecting cones. It is generally non-destructive to the trees, except

when tops or limbs are cut. Using this method the collector can select the best-looking trees (phenotypes) from which to collect cones. Climbing is suitable for most species and can be employed on almost any size tree. It is generally most efficient to collect from stands with trees under 15 m tall and with live branches to the ground. On larger trees, ladders or spurs are used to reach the live crown. However, this is only practical when the trees have an exceptionally good cone crop and the climber is highly skilled.

Climbing is a suitable collection method:

- for small-to-medium sized collections (less than 200 hl)
- where terrain and access are reasonably gentle
- where the distances from crop trees to roads are short (under 400m)

For species that have very small cones such as western redcedar or western hemlock, it is usually more efficient to detach branches using clippers or a pruning saw, drop the branches to the ground, then either pick the cones at the base of the trees, or transport the branches to a central location for cone removal. Caution should be used when transporting cones on branches because they can heat up if piled for too long causing serious damage to the seeds. (See Chapter 4)

When picking in the tree, the climber should start at the top and work down. The climber should go no higher than the point at which the tree is 8 cm (3 in) in diameter at eye level. Except when moving, the climber must attach the safety harness to the main stem of the tree. When a sack is filled (and tied), it should not be dropped more than 10m (30 ft) to prevent seed damage. Where possible, the sack of cones should be dropped on to soft ground or into bushes to help soften the impact. The use of ropes to lower the filled sack is recommended.

3.2.1 Tree climbing equipment

Tree climbing requires specialized equipment including:

- climbing belt (including safety harness) (Figure 16): belts range in price from $40 and up depending on the style and quality; the least expensive are adequate for occasional use, but when a great deal of climbing is involved, the more expensive belts are usually more comfortable; all belts should be WCB approved (See Appendix 2 for suppliers)
- cone hook (Figure 17): a pole, 1.2 m (4 ft) long, with a hook at one end, and a lanyard at the other end to attach to the climbing belt; is used to pull branches toward the picker that would otherwise be out of reach; in some cases the hook can be used to knock cones off
- S-hooks (Figure 17): bent pieces of metal rod used to suspend cone sacks from branches and hold the sack open; are easily made from welding rods or similar material; spares should be carried as they are easily lost, and picking is more difficult without them
- cone sacks (with twine for typing them closed): these should be carried inside vests or large pockets, but must never be carried in the ring to which the safety belt clasp is attached (Figure 17)

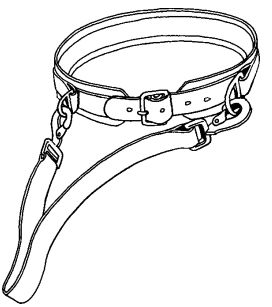


FIGURE 16. A typical climbing belt

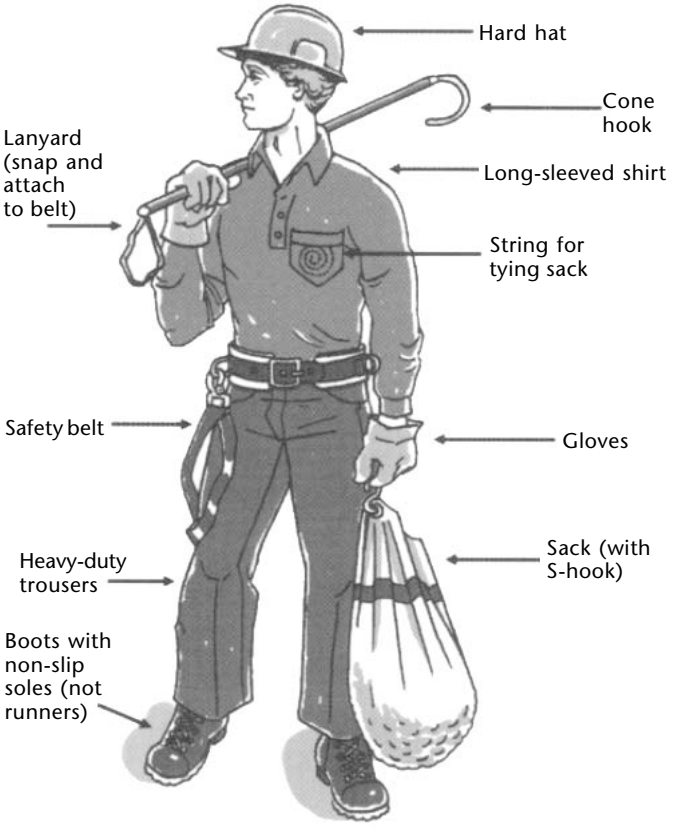


FIGURE 17. Recommended clothing and equipment for collecting cones by tree climbing

3.2.2 Climbing safety

The following safety guidelines should be followed:

- cone pickers must never climb alone
- regular contact with other crew members should be maintained
- appropriate protective clothing includes good boots, long-sleeve shirt, pants, and hat
- all equipment must be checked carefully for wear or damage before climbing
- cone pickers should not climb trees with which they are not comfortable (because of height or defects) or when weather conditions (wind, heavy rain) are unsafe
- the safety harness must be attached to the main tree stem while picking
- a well-stocked first aid kit must always be available at the collection site

For additional information on techniques and safety in tree climbing see Yeatman 1978 (Appendix 11).

3.3 Felling

Coordinating cone collection with logging is one of the most commonly used methods of obtaining seeds. Active logging operations offer opportunities to harvest cones from felled trees at a reasonable cost (Figure 18). Provided proper advance authorization is obtained, from the BCMOF and/or the land-owner, under certain circumstances trees maybe selectively felled for cone collection.

When good cone crops occur in areas scheduled for logging during the time of cone maturity, every attempt should be made to coordinate both of these activities and capitalize on the situation. For species in which critical seed shortages occur, it may be possible to arrange for logging plans to be altered to accommodate cone collection.

FIGURE 18. Collecting cones from logging slash

These guidelines should be followed:

- felling should be done by experienced fallers who are able to align the tree crowns for ease of picking and in a manner that maintains most of the cones on the tree
- falling towards roads and openings is the best practice; trees that hit the ground very hard often scatter the cones over a large area, or in brushy areas where the cones can be hard to find
- the use of feller-bunchers machines enables the trees to be laid out relatively gently and systematically for cone picking
- tops and branches should be bucked off, and moved away from the main tree stem before picking, to minimize the possibility of log roll-overs
- picking efficiency is increased if all the picked-over debris is systematically deposited in a pile, thereby avoiding covering the same branches twice

- trees that are far from roads, at the bottom of steep grades, or in areas with difficult access should be avoided; removing the cones manually by carrying them out can be time consuming and expensive
- keep cone pickers well away from active falling areas to avoid injuries

3.4 Squirrel Caches

Squirrels commonly cache cones of Douglas-fir, lodgepole pine, western white pine, ponderosa pine, Sitka spruce, white spruce, Engelmann spruce, amabilis fir, subalpine fir, and western larch.

Before 1976, collecting cones from squirrel caches was considered an acceptable collection method. However, due to concerns about seed-borne fungi associated with cached cones, and questions about the quality of the trees from which the squirrels had harvested the cones, the practice was discouraged by the BCMOF.

As well, concerns have been raised about removing the squirrels' food supply. While coniferous seeds are their preferred food, their diet is wide and varied and includes seeds of other plants, mushrooms, roots, grasses, insects, tree buds and bark, berries, cankers on trees, and even small birds. However, because human cone collectors are less than 100% efficient and squirrels harvest more cones than they can eat, there is little basis for these concerns.

Collecting cones from squirrel caches can be a very effective collection method:

- it is relatively inexpensive as no special equipment is required
- the collection period is much greater than with other methods
- success, however, depends on the phenotypic quality of the surrounding stand, and that reasonable care of the cones is taken during and after collection

3.4.1 Locating squirrel caches

Squirrels often start cutting cones prior to seed maturity and they usually eat the seeds from these cones immediately. They do not store significant quantities of cones until the seeds are mature.

Locating squirrel caches is not difficult. Use the following guidelines to recognize the signs of squirrel activity:

- squirrels are noisy animals and are readily located by their "chattering"
- look for evidence of chewed cone scales on logs, small pieces of branches (with or without cones) on the ground, and scattered freshly-cut cones on the ground throughout the stand
- after dropping cones from the trees, squirrels begin to gather them up and place them in piles (caches)
- these caches are usually located in cool, shady areas, including the edges of creeks and moist areas, depressions, around windfalls and old stumps, and brush piles; under these conditions cones are less likely to open and shed their seeds
- collection areas are often used by the squirrels for several years; look for evidence of mounds of old cone scales with new cones piled on top or stuffed into holes (Figure 19)

3.4.2 Collection techniques

When removing cones from squirrel caches, the following practices improve seed extractability and help reduce the risk of losses due to seed-borne pathogens:

- remove cones only from the upper part of the cache
- buried, very wet or dirty cones should be left in the cache; these are more likely to contain seed-borne fungi such as *Caloscypha fulgens*; this also leaves some cones for the squirrel for food

FIGURE 19. Squirrel cone cache

- squirrel-cached cones tend to be dirtier than cones collected by other methods; they must undergo some form of preliminary cleaning before being stored
- squirrel-cached cones must be dried properly in interim storage as they tend to be much wetter than cones collected by other means

3.5 Other Collection Methods

For small collections, other methods such as shooting, ground clipping, or the use of tarps may be practical.

3.5.1 Shooting

Shooting is used primarily for tree improvement collections. It is also practical for smaller, operational collections of species such as the true firs, which have abundant quantities of cones in the upper part of the crown. Stems up to 15 cm (6 in) in diameter can be sheared off with several well-placed

shots from a rifle of 30-30 caliber (or greater), using soft-nose shells. Collections up to 5 hl per day are not unusual for one person. Three keys to success are:

- ensure a good clear view of the target
- secure a steady rest for the rifle (Figure 20)
- patience

Extreme caution must be used to ensure that people and livestock are not placed at risk. Shooting in or near populated areas, or near active logging areas must be avoided. It is also advisable to post warning signs in the area where shooting is to take place. Hearing protectors should also be worn.

FIGURE 20. Collecting by shooting cone-bearing branches from a tree

3.5.2 Clipping from the ground

Trees along the edges of roads and openings often have better cone crops than those in the interior of the stand and the cones are easily accessible from the ground. Younger stands with shorter trees may also have cone crops. Cones in these stands can be collected using pole pruners or pole saws to cut or prune the branches to collect the cones. This method works particularly well for species such as western hemlock and western redcedar that often have cones on the lower branches. Useful equipment includes:

- conventional pole pruners with extensions to reach 10 m (30 ft) or more
- cutting-clippers or saws can be mounted on pole ends
- long extension poles are available from window washing, janitorial and swimming pool supply stores

Cones can be picked from the branches on site or the branches may be moved to a more convenient picking location. It is advisable not to strip the trees of all their foliage. All debris must be disposed of according to the land owners instructions. Operators of pole pruners or pole saws must be aware of the danger from power lines at all times.

3.5.3 Tarps

Tarps can be used to collect seeds that are in the process of being released from mature, opening cones of western redcedar, and samara (winged seeds) of some maples. The tarps are laid out under the trees, and the tree is shaken either from the ground or by climbing into the tree and shaking the branches. Often a substantial amount of debris is collected with the seeds, which may create additional work in the seed cleaning process.

4. CONE HANDLING

4.1 Introduction

The way cones are handled and stored after picking can have dramatic effects on the final seed quality. If cones are not properly cared for during this stage, then all of sampling, selecting, and picking costs will be wasted. The cone collection supervisor must accept and be aware of this responsibility. Freshly picked cones are very moist, and this moisture must be gradually removed to prevent damage to the seeds. If the cones are picked during wet weather, additional moisture problems may arise. At northern latitudes, extremely low, freezing temperatures may damage wet cones. Once filled with cones, individual sacks need to be exposed to freely circulating air. Heating by direct sunlight must be avoided. Cone sacks that became wet during the picking process may need to be changed, and the picked cones emptied into dry sacks. Sacked cones should be stored in the shade at the collection site and moved at the end of each day to interim storage facilities.

As much debris as possible should be removed from the cones before they are bagged. This can be done by providing individual pickers with a screen-bottomed box (Figure 21) or bucket in which to shake the cones before bagging. A large powered shaker over which all cones can be screened could also be used. Acceptable levels of debris are discussed in Chapter 2.

4.2 Field Handling By Species

After cone sacks are filled, the degree of care they require will differ according to species. The following descriptions begin with the most stable species and proceed through the most difficult species.

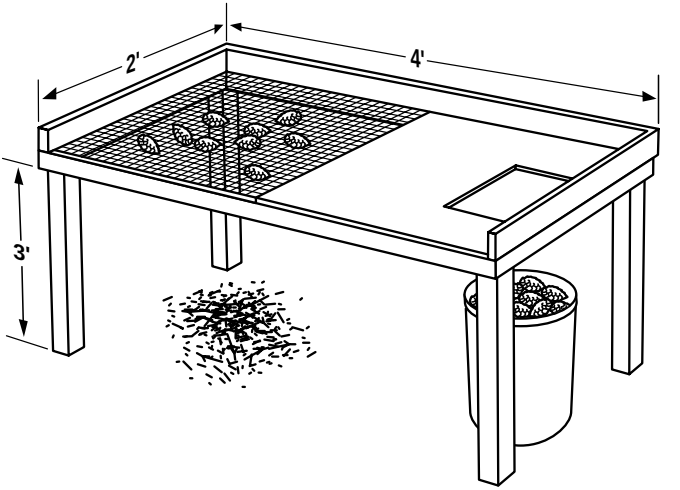


FIGURE 21. Portable cone cleaning table

General, for all species:

- filled sacks must be tied at top of bag to allow for cone expansion
- wet sacks should be changed if soaked during picking
- filled sacks should be stored in the shade during picking and moved to interim storage daily

4.2.1 Lodgepole pine

- sacks may be filled to the fill line (40 litres)
- filled sacks may be stacked on top of each other

Lodgepole pine cones may be stored for some weeks to several months without causing seed damage. It is important to keep the sacks dry and cool to prevent moulds from developing. Filled sacks should not be left out in direct sunshine, as this may break the resin bond which holds the cones scales closed. Broken resin bonds create entry points

for hot water if the cones are dipped in hot water at the seed extraction plant, causing seed damage. For this species, filled cone sacks can be loaded onto transport trucks as tightly as possible and left there for a week or more if necessary, with no seed damage (Figure 22).

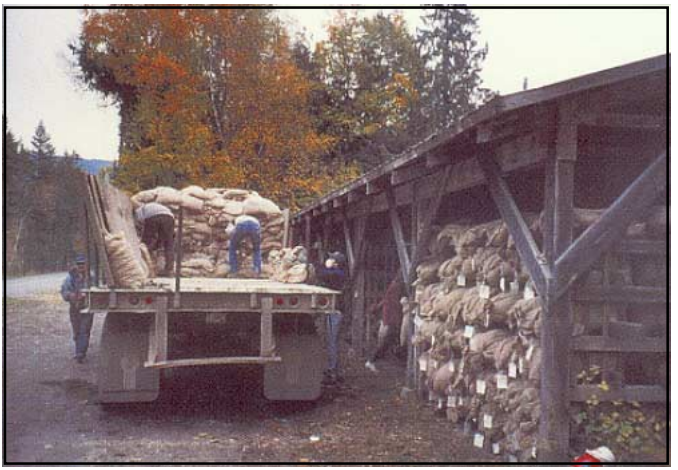


FIGURE 22. Transport of lodgepole pine cones by transport truck

4.2.2 Black spruce, ponderosa pine, western white pine

- sacks should be filled no more than half full (20–30 litres)
- interim storage should be on racks in a shaded area with good air circulation around the sacks

Sacks should only be half filled and tied near the top to give adequate room for cone expansion. The cone sacks may be tightly packed together for some hours (e.g., during transport) without damage, but as soon as possible they should be stored on racks in a dry place with space between the sacks. If the sacks are exposed to sunlight temporarily while in storage, it is unlikely that seed damage will occur.

4.2.3 Douglas-fir, Engelmann spruce, Sitka spruce, white spruce, western larch

- sacks should be filled no more than half full (25–30 litres)
- heat build-up within the filled sacks must be avoided at all times
- interim storage should be on racks in a shaded area with good air circulation around the sacks

These species will heat up in a few hours if stacked tightly together, causing mould development and seed damage. This is particularly true if the cones are picked early in the collection season when quite green (embryo length just reaching 90%) and some weeks from natural seed-fall. All possible precautions must be taken. The sacks must be kept separated from each other at the picking site to allow for air circulation, and they must be stored in a shaded area. If transportation to interim storage takes more than one or two hours, spaces between each layer of sacks must be provided in the truck using pallets, rails, or other means. Interim storage facilities should consist of an open shed where the sacks can be placed on rails with spaces between them and access provided for turning the sacks (Figure 23). For this group of species, each sack should be turned over daily for one week.

FIGURE 23. Interim storage of Douglas-fir cones

4.2.4 Yellow-cedar

- sacks should be filled with no more than 20–25 litres of cones
- heat build-up within the sacks must be avoided at all times
- interim storage should be on racks in a shaded area with good air circulation around the sacks
- turn the sacks on a daily basis

The chance of premature germination is remote in this species, but the cones should be treated with all the precautions noted for western hemlock and redcedar. Yellow-cedar cones are extremely difficult to collect which makes the cost of the seeds high, so the use of proper handling techniques is very important.

4.2.5 True firs

- sacks should be filled no more than half full (20–30 litres)
- heat build-up within the filled sacks must be avoided at all times
- interim storage should be on racks in a shaded area with good air circulation around the sacks

Cones of true firs are unique because they disintegrate when ripe. They must therefore be collected slightly ahead of full maturation. However, when the sacked cones are placed on racks and turned regularly for a minimum of four weeks (longer if practical), the cones will disintegrate in the sacks. The scales will separate from the cone axis and the seeds will detach from the scales. Thus, sacks must only be partially filled to allow the cones room to expand and break apart. During interim storage the sacks should be carefully turned at least once a week to ensure even drying.

4.2.6 Western hemlock, western redcedar

- sacks should be filled no more than half full (20-25 litres)
- heat build-up within the filled sacks must be avoided at all times
- interim storage should be on racks in a shaded area with good air circulation around the sacks

Western hemlock and western redcedar seeds are probably the most collection-sensitive of all British Columbia conifers, because of their ability to germinate at the time of harvesting. If sacks of freshly picked cones are tightly stacked for even an hour, some heating occurs from the energy of respiration. The rise in temperature, combined with the high cone moisture content, may permit the germination process to start while the seeds are still in the cones. All of the precautions suggested for other species must be carried out with even greater care in these species to prevent any seed damage or losses to premature germination. When the sacks are deposited in interim storage, they should be turned daily (if possible), to ensure thorough drying.

4.3 Interim Storage

For many collections, sacked cones may be maintained in semipermanent, interim storage facilities (Figure 24) for several weeks before they are shipped to the extraction plant. After collection, cones undergo changes that are variously referred to as “curing” or “after-ripening”. For collections made early in the season, proper interim storage is vital to ensure good seed quality. Interim storage ensures that the cones arrive in the best possible condition for processing,

particularly if they are scheduled for processing shortly after arrival, as well as helping to minimize congestion at the extraction plant. Therefore, interim facilities should be planned for and may include the following:

- open sheds, carports, barns, or any structure that provides cover and adequate ventilation
- avoid reefers (refrigerated trucks) and cold storage units without adequate ventilation
- circulating fans for supplemental ventilation are useful

Table 9 provides a quick reference guide to handling and interim storage conditions.

FIGURE 24. Semipermanent interim storage of Douglas-fir cones

TABLE 9. Handling and interim storage of cones of BC conifers

Species	Sack volume	% debris (less than)	Interim storage type		Turn	Potential[1] storage risk
			Stack	Store on rack		
True firs	20-30	5	no	yes	weekly	5
Western redcedar	20-25	10	no	yes	3x/week	5
Douglas-fir	25-30	5	no	yes	daily	3
Western hemlock	20-25	10	no	yes	daily	5
Western larch	25-30	5	no	yes	daily	3
Lodgepole pine	40	5	yes	n/r[2]	n/r	1
Ponderosa pine	20-30	5	no	yes	weekly	2
Western white pine	20-30	5	no	yes	weekly	2
Black spruce	20-30	5	no	yes	2x/month	2
Engelmann spruce	25-30	5	no	yes	daily	3
Sitka spruce	25-30	5	no	yes	daily	3
White spruce	25-30	5	no	yes	daily	3
Yellow-cedar	20-25	5	no	yes	3x/weekly	4

[1.] 1 = easiest, 5 = most difficult
[2.] n/r: not required.

4.4 Transport To Extraction Plant

After the cones have spent the required time in interim storage to after-ripen or cure, they can be transported to the extraction plant for processing.

It is vital that cone heating is minimized during transportation by:

- loading cones as close to truck departure time as possible
- loading cone sacks properly inside the transport
- avoiding parking of loaded, closed or open transports in the sun
- using transportation routes that take the shortest possible time to reach the extraction plant
- making sure that the extraction plant is expecting the cones

Cones are usually transported by open flat deck trailer or closed van. In both cases cone sacks should have pallets between every second layer to ensure good ventilation. Cones shipped by flat deck can be secured using cargo nets, or if reasonable well-cured, by tarps. Cones in closed vans should be well-cured and in addition to pallets between layers of cones have adequate ventilation along the front and sides of the van as well (Figure 25).

Ensure that the driver understands the importance of delivering the cones in a timely fashion, and that the processing facility is ready to receive the shipment.

FIGURE 25.
Loading of cones onto transport truck using pallets for spacing

All sacks must be properly marked as to seed lot number, and some form of separation between seedlots should also be evident.

When shipping lodgepole pine and very dry, already opening cones of other species care must be taken to ensure that cones are not crushed by piling to high.

Refrigerated ("Reefer") trucks may be used to transport freshly picked cones, but this method is necessary only if it is absolutely impossible to provide suitable interim storage, or if a long haul is required. Refrigerated transport is expensive, but it may be justified if it produces the highest-quality seeds.

Appendices

Appendix 1. Glossary

Cone
- the reproductive structure of conifers. The cone can be pollen bearing (male) or seed bearing (female)

Embryo
- the rudimentary plant within a seed; the product of fertilization

Empty seed
- a seed that does not contain all tissues essential for germination

Endosperm
- a commonly used, but incorrect, term applied to the nutrient tissue surrounding the embryo in a coniferous seed. The correct term is megagametophyte. It serves the same function as the endosperm in angiosperms (broadleaved) tree seeds, but fertilization is not required (in conifers) for this tissue to form

Germination
- growth of an embryo resulting in its emergence from the seed

Megagametophyte
- nutrient storage tissue in coniferous seeds. This tissue is often mistakenly called the "endosperm"

Pollen cone
- the male reproductive structure of conifers that produces pollen grains

Pollination
- the transfer of the pollen from the pollen cone to the receptive part of the seed cone

Provenance

- the geographical area (latitude, longitude, and elevation) and environment to which the parent trees are native, and within which their genetic constitution has evolved through natural selection

Seed

- a matured ovule containing an embryo and nutritive tissue enclosed by a protective seedcoat, that is capable of developing into a plant under suitable conditions

Seed cone

- the female reproductive structure of conifers that produces seeds

Seedlot

- a indefinite quantity of seeds of the same species, provenance, date of collection and handling history, and which is identified by a single number or name

Seed orchard

- a specially selected collection of trees, planted in a orchard fashion, established to produce seeds, usually of improved genetic quality

Seed planning zone

- in accordance with transfer rules, an area throughout which seeds of a given provenance may be transferred and in which the resulting seedlings can be expected to perform adequately

Seed source

- the place (latitude, longitude, and elevation) at which seeds are collected. The source of a seed collection may not be identical with its provenance

Serotinous

- a term applied to cones that remain on the parent tree, without opening, for a year or more after the seeds inside have matured. Examples are lodgepole pine and black spruce

Appendix 2. Species names and symbols

Scientific name	Common names used in BC	Symbol
Abies amabilis	amabilis fir, Pacific silver fir, balsam	Ba
Abies grandis	grand fir, balsam	Bg
Abies lasiocarpa	alpine fir, subalpine fir, balsam	Bl
Chamaecyparis nootkatensis	yellow-cedar, yellow cypress	Cy
Larix laricina	tamarack, larch	Lt
Larix lyallii	alpine larch	Ll
Larix occidentalis	western larch	Lw
Picea engelmannii	Engelmann spruce, interior spruce	Sx[1]
Picea glauca	white spruce, interior spruce	Sx[1]
Picea mariana	black spruce	Sb
Picea sitchensis	Sitka spruce	Ss
Pinus albicaulis	whitebark pine	Pa
Pinus contorta var. *contorta*	lodgepole pine, shore pine	Plc
Pinus contorta var. *latifolia*	lodgepole pine	Pli[2]
Pinus flexilis	limber pine	Pf
Pinus monticola	western white pine	Pw
Pinus ponderosa	ponderosa pine, yellow pine	Py
Pseudotsuga menziesii		
var. *menziesii*	Douglas-fir, fir (coast)	Fdc
var. *glauca*	Douglas-fir, fir (interior)	Fdi
Thuja plicata	western redcedar	Cw
Tsuga heterophylla	western hemlock	Hw
Tsuga mertensiana	mountain hemlock	Hm

[1.] Engelmann and white spruce are often referred to collectively as "interior spruce".

[2.] Interior lodgepole pine cones are serotinous.

Appendix 3. Equipment suppliers

Equipment Item	Supplier
1. CONE SACKS	
American Fabricators 1421 East Pender St. Vancouver, BC V5L 1V7 Ph: (604) 253-8277 Fax: (604) 253-4715	Burnaby Bag and Burlap Ltd. 5291 Imperial St. Burnaby, BC V5J 1E5 Ph: (604) 434-4725
Interwrap Industries Ltd. #104-1650 Broadway St. Port Coquitlam, BC V3C 2M8 Ph: (604) 941-4666 Fax: (604) 942-7599	Sandheat Holding Ltd. 32085 Holiday Ave. Mission, BC V2V 2M9 Ph: (604) 826-4210
2. TAGS	
Crown Land Collections: B.C. Ministry of Forests Technical and Administrative Services Branch 637 Bay Street Victoria, BC V8W 3E7 Ph: (604) 387-8688 Fax: (604) 387-8687	*Other collections:* Wayside Press Ltd. 3304-33rd. Street. P.O. Box 446 Vernon, BC V1T 6M3 Ph: (604) 545-2341 Fax: (604) 545-4530
3. CLIMBING EQUIPMENT	
Acklands Ltd. 8651 Eastlake Dr. Burnaby, BC V5A 3X4 Ph: (604) 421-9026	Fleck Bros. Distribution 4084 Mcconnell Burnaby, BC V5A 3N7 Ph: (604) 420-3535
Levitt Safety Ltd. Unit 10, 13511 Crestwood Pl. Richmond, BC V5T 1Z6 Ph: (604) 278-3328	Safety Supply Canada 240 East 10th Ave. Vancouver, BC V6V 2G1 Ph: (604) 879-5234
4. CONE CUTTING KNIVES	
Western Tree Seeds Ltd. P.O. Box 144 Blind Bay, BC V0E 1HO Ph: (604) 675-2463 Fax: (604) 675-2202	

Appendix 4. Lodgepole pine age classes

For the interior variety, in which the cones are mainly serotious, the following classes have been defined:

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 matured

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

Cones not to be collected

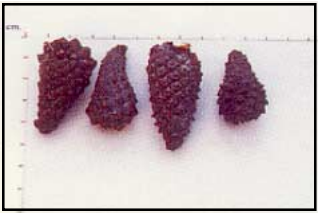
Class III
- fully weathered, closed cones
- generally grey in colour and most faces of the cones appear weathered
- cones tightly closed
- non-serotinous cones usually open at maturity at normal temperature in undisturbed stands

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

Class V
- obvious bore holes with or without frass
- exterior damage, cone eaten away
- no obvious damage, but parts of the cone crumble when pressed with thumbnail
- cone is abnormally curled

Class I

Class II



Class III

Class IV

Class V

Appendix 5. Contact names and addresses

B.C. Ministry of Forests
Technical and Administrative
Services Branch
637 Bay Street
Victoria, BC V4P 1M5
Ph: (250) 387-8688
Fax: (250) 387-8687

B.C. Ministry of Forests[1, 3]
Tree Seed Centre
18793-32nd. Avenue
Surrey, BC V8W 3E7
Ph: (604) 541-1683
Fax: (604) 541-1685

B.C. Ministry of Forests[1]
Seed Pest Management Officer
7380 Puckle Rd.
Saanichton, BC V8W 1M4
Ph: (250) 652-6593
Fax: (250) 652-4204

B.C. Ministry of Forests[1]
Seed Pest Management Officer
Kalamalka Forestry Centre
3401 Resevoir Road
Vernon, BC V1B 2C7
Ph: (250) 549-5696
Fax: (250) 542-2230

B.C. Tree Seed Dealers Association
c/o Yellow Point Propagation Ltd.
Long Lake Rd.
R.R. No. 3
Ladysmith, BC V0R 2E0
Ph: (250) 245-4635
Fax: (250) 245-4635

Canadian Forest Service
Pacific Forestry Centre
506 West Burnside Rd.
Victoria, BC V8Z 1M5
Ph: (250) 363-0600
Fax: (250) 363-0775

Quality Seed Collection Ltd.[1,2]
P.O. Box 1531
Kamloops, BC V2C 6L8
Ph: (250) 374-9689
Fax: (250) 374-9654

Reid, Collins Nurseries Ltd.[1,2]
P.O. Box 430
Aldergrove, BC V4W 2T9
Ph: (604) 856-6408
Fax: (604) 856-4218

Scientificals Consulting[1]
309-7297 Moffat Road
Richmond, BC V6Y 3E4
Ph: (604) 278-4904
Fax: (604) 278-4904

Silva Enterprises Ltd.[1,2]
P.O. Box 2888
Prince George, BC V2N 4T7
Ph: (250) 963-8617
Fax: (250) 963-3490

Western Tree Seeds Ltd.[1,2]
P.O. Box 144
Blind Bay, BC V0E 1H0
Ph: (250) 675-2463
Fax: (250) 675-2202

Yellow Point Propagation Ltd.[1,2]
Long Lake Rd.
R.R. No. 3
Ladysmith, BC V0R 2E0
Ph: (250) 245-4635
Fax: (250) 245-4635

[1.] Contacts for cone and seed evaluation
[2.] Commercial seed collecting and processing companies
[3.] Seed processing

Appendix 6. Cone and seed crop maturity form

Province of British Columbia Ministry of Forests

CONE AND SEED CROP 19___

VCL (Lot)	REGION	DISTRICT	SPECIES (one)

TENURE	CP	BLOCK	SEED ZONE

LICENSEE	PSYU / TSA	ELEVATION (m)

PRIVATE (owner)	NAT. TOPO. / UTM GRID	STAND AGE

OTHER	LOCATION	ASSOCIATED SPECIES

BIOGEOCLIMATIC SUBZONE	FOREST ECOSYSTEM TYPE

NUMERICAL CONE CROP RATING (one species)

(RATE ONLY DOMINANT AND CO-DOMINANT TREES OF CONE-BEARING AGE)

DESCRIPTION OF CONES OBSERVED	CROP IS	CIRCLE RATING
No cones on any trees	Nil	1
Few cones on < 25% of trees	Very light	2
Few cones on > 25% of trees	Light	3
Many cones on < 25% of trees	Light	4
Many cones on 25 - 50% of trees	Medium	5
Many cones on > 50% of trees	Heavy	6
Many cones on almost all trees	Very heavy	7

Average volume of cones / tree _____ (hl) x est. number of collectible trees / ha _____

x Area of stand _____ (ha) = a potential crop of _____ hectolitres.

DATE Y M D	RATED BY	POSITION

When numerical rating has been completed, detach this sheet only and forward it to the Regional Manager, attention: Silviculture, to arrive not later than July 30.

A REMINDER: Cone Crop Ratings provide information for:
1) making cone collecting plans (short-term);
2) history of cone crop periodicity (long-term).

Reports on "Nil" crops are, therefore, just as significant as reports on "Heavy" crops in any year.

FS 727 HSP 92/11 **DISTRIBUTION: WHITE & CANARY -** REGIONAL MANAGER, SILVICULTURE; **PINK -** ORIGINATOR

Appendix 7. Seed yields of British Columbia conifers

Seed yields can vary significantly depending how accurately cone volumes are measured. Using burlap sacks with lines indicating volume for example, can be misleading as the sacks may stretch. Debris will also exaggerate actual volumes.

As well seed processing sometimes influences seed yields. Removing all empty seed in the final cleaning stage to improve germination may reduce seed volume.

The table on the following page, is intended to be used only as a rough guide in the determination of one's cone collection requirement. The BCMOF Tree Seed Centre has provided much of the data, which has been supplemented and modified by the BCTSDA.

The seeds/cavity column and oversow factors column are modifications of the BCMOF sowing rules. It is important to note that these two factors often vary from nursery to nursery, depending upon the philosophy of the manager. Many managers prefer to single sow any seed lots over 90% to reduce seed and thinning costs. Others however, do not want to risk having empty cavities, particularly when using larger, more space costly containers.

The figures shown are a merging of both sets of rules for wild and orchard seed currently recommended by the BCMOF. This "merging" is based on consultation with numerous nurseries in B.C., although, there are differences in opinions.

The last column, "Average No. of Plantables per Hectolitre" is based on a simple formula which can be changed by the user by modifying the number of seeds per cavity planned. It should also be noted that this figure does not take into account any seed losses due to lack of sowing precision. For planning purposes suggest adding 10% to cover any losses.

Formula

Average number kg clean seed per hl cones	X 1000 X	Average number seeds/gram	÷ Seed/Cavity ÷ Oversow Factor =	**Average plantable trees per hl**

Example:

Coastal Douglas Fir

0.670 X 1000 X 100 ÷ 1 ÷ 1.45 = 46,207

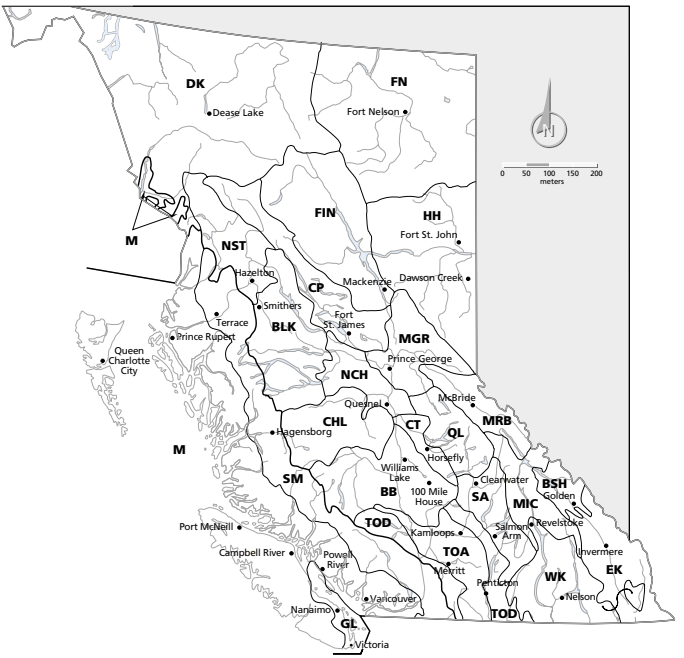
Note that, in this case, by doubling the seeds per cavity, you will reduce the number of plantable trees per hectolitre by half.

Seed costs rarely exceed 2% of the total cost of reforestation. For this reason, it is much more prudent to collect more seed than is required when a good crop occurs, than not having enough seed when it is unavailable.

Species		Avg. % germ	Seeds/gram low	Seeds/gram high	Seeds/gram avg	Kg clean seeds/hl of cones low	Kg clean seeds/hl of cones high	Kg clean seeds/hl of cones avg	Seeds/cavity based on avg germ	Oversow factor	Avg # of plantable trees/hl
Douglas-fir:	coastal (Fdc)	92	76	160	100	0.019	1.610	0.670	1	1.45	46,206
	interior (Fdi)	94	80	462	103	0.115	2.007	0.800	1	1.45	56,827
Hemlock:	western (Hw)	84	357	909	487	0.006	3.540	0.800	3	1.30	99,897
	mountain (Hm)	90	294	532	424	0.067	1.623	0.816	1	1.50	230,656
Western larch (Lw)		70	173	357	272	0.251	1.722	0.600	3	1.40	38,857
Pine:	lodgepole										
	– coastal (Plc)	94	286	510	340	0.133	1.456	1.000	1	1.45	234,482
	– interior (Pli)	94	247	470	367	0.060	0.500	0.274	1	1.45	69,350
	western white (Pw)	74	46	87	61	0.100	0.997	0.440	3	1.40	6,390
	ponderosa (Py)	86	18	29	21	1.000	3.040	1.632	2	1.40	12,240
Spruce:	interior (Sx)	92	198	789	442	0.018	1.500	0.895	1	1.50	263,727
	Sitka (Ss)	89	328	729	435	0.024	2.000	0.750	2	1.40	116,517
True fir:	grand fir (Bg)	62	19	79	46	0.050	3.802	2.200	4	1.50	16,867
	amabilis fir (Ba)	54	17	64	32	0.091	3.500	2.200	4	1.60	11,000
	subalpine fir (Bl)	51	53	132	100	0.132	2.500	1.630	4	1.60	25,469
Western redcedar (Cw)		79	597	1634	837	0.026	2.330	1.200	3	1.35	248,000
Yellow-cedar (Cy)		46	176	282	209	0.010	2.300	1.446	4	1.65	45,790

1 Interior Douglas-fir yields may vary significantly. Dry belt Douglas-fir cone yields are usually higher that wet belt cones.
2 Sitka spruce cones from the Queen Charlotte Islands often have higher yields (up to 1.2 kg/hl).
3 Western redcedar yields are based upon collections with less than 10% debris. Where collections with more debris are accepted, yields will be lower.

Appendix 8. Seed planning zones



COAST

GL – Georgia Lowland
M – Maritime
SM – Submaritime

INTERIOR

BB – Big Bar
BLK – Bulkley
BSH – Bush
CHL – Chilcotin
CP – Central Plateau
CT – Cariboo Transition
DK – Dease Klappan
EK – East Kootenay

INTERIOR (continued)

FIN – Finlay
FN – Fort Nelson
HH – Hudson Hope
MGR – McGregor
MIC – Mica
MRB – Mt. Robson
NCH – Nechako
NST – Nass Skeena Transition
QL – Quesnel Lakes
SA – Shuswap Adams
TOA – Thompson Okanagan Arid
TOD – Thompson Okanagan Dry
WK – West Kootenay

Appendix 9. Seed transfer limits

Coastal seed planning zones

1. Seed or vegetative material from coastal natural stand or plantation provenances may only be used within their native seed planning zones unless otherwise noted in Table 9.1 or subsections 3 and 4 below.
2. Subject to section 1 above, the transfer limits in Table 9.1 apply to the geographic origin of each coastal species' seed or vegetative lot.
3. Seed or vegetative material of natural stands or plantations may be moved outside its native seed planning zone in the following cases.
    - Douglas-fir from sources below 50° may be transferred from M to GL
    - grand fir provenances may be transferred from GL to M within the limits of 2°N and no limit S, and 2°E and no limit W. Or from M to GL within the limits of 2°N and 2°S, and no limit E and 2°W
    - western white pine from M to GL
    - submaritime provenances may be transferred to interior seed planning zones, if within the same biogeoclimatic zone, and the transfer limits for the species, as listed for the interior in Table 9.2 apply. Also, note the caution in subsection 5

4. Transferring seed or vegetative material of the following coastal species is NOT permitted between the specified geographic areas, for the noted species, unless made within the same biogeoclimatic variant:
    - amabilis fir from VI to ML or vice versa
    - western hemlock from QCI to ML or vice versa
    - other minor species from QCI and VI to ML or vice versa

(QCI = Queen Charlotte Islands, VI = Vancouver Island, ML = Mainland)

5. Exercise caution when moving seed from areas along the eastern edge of the SM (submaritime) to areas with more direct maritime influence, and vice versa. Caution is also to be exercised when moving suspected or known coastal/interior hybrid species.

TABLE 9.1 Transfer limits for coastal natural stand

Species		Seed planning zones				
Name	Code	Georgia Lowlands (GL)	Maritime (M)		Submaritime (SM)	
Amabilis fir	Ba	N/A	2°N 2°S	–300 m +300 m	2°N 2°S	–300 m +300 m
Douglas-fir	Fdc	no limit	3°N 2°S	–350 m +350 m	2°N 1°S	–350 m +350 m
Interior spruce	Sx	N/A	See *Exotic provenances,* subsection 2		2°N 1°S	–200 m +400 m
Lodgepole pine	Plc, Pli	no limit	2°N 2°S	–200 m +200 m	2°N 1°S	–100 m +200 m
Grand fir	Bg	no limit; upward transfer recommended	2°N 2°S	–200 m +300 m	2°N 2°S	–200 m +200 m
Sitka spruce	Ss	no limit	4°N 1°S	–200 m +300 m	2°N 1°S	–200 m +200 m
Sitka x interior spruce hybrid	Sxs	N/A	N/A		2°N 1°S	–200 m +200 m
Subalpine fir	Bl	N/A	2°N 2°S	–200 m +200 m	2°N 2°S	–200 m +300 m
Western hemlock	Hw	no limit	3°N 3°S	–300 m +300 m	2°N 2°S	–200 m +200 m
Western redcedar	Cw	no limit	3°N 3°S	–400 m +400 m	2°N 2°S	–300 m +300 m
Western white pine	Pw	no limit	no limit		no limit	
Yellow-cedar	Yc	N/A	4°N 3°S	no limit +400 m	2°N 2°S	–300 m +300 m
Other species		no limit	3°N 2°S	–200 m +300 m	1.5°N 1.5°S	–200 m +200 m

Interior seed planning zones

1. Seed or vegetative material from interior natural stands or plantations must not be transferred outside their native seed planning zones in the interior unless used within the same biogeoclimatic zone, and the transfer adheres to the latitudinal, longitudinal and elevational transfer limits listed in Table 9.2, unless otherwise noted below in subsection 3.
2. Subject to subsection 1 above, the transfer limits shown in Table 9.2 below apply to the geographical origin of each interior species' seed or vegetative lot.
3. Transfer of Douglas-fir between SA and TOD, or between CT and QL, and transfer of western larch between EK and WK, is not permitted.

TABLE 9.2 Transfer limits for interior natural stand

Species		Longitudinal and latitudinal transfer		Elevational transfer	
				Upwards	Downwards
Name	Code	N/S	W/E	(m)	(m)
Amabilis fir	Ba	2°/1°	3°/2°	300	200
Douglas-fir a	Fdi	2°/1°	3°/2°	200	100
Douglas-fir b	Fdi	2°/1°	3°/2°	300	200
Interior spruce	Sx	2°/1°	5°/2°	400	200
Lodgepole pine c	Pli	2°/1°	3°/2°	150	100
Lodgepole pine d	Pli	2°/1°	3°/2°	300	100
Ponderosa pine	Py	2°/1°	3°/2°	300	200
Western larch	Lw	2°/1°	3°/2°	300	200
Western white pine	Pw	2°/1°	3°/2°	700	700
Western redcedar	Cw	2°/1°	3°/2°	300	200
Subalpine fir	Bl	2°/1°	3°/2°	300	200
Other species		2°/1°	3°/2°	300	200

[a] Applies to all seed planning zones north of 52° latitude, plus EK.
[b] Applies to all seed planning zones south of 52° latitude, except EK.
[c] Applies to latitudes 56° to 60°.
[d] Applies to latitudes 49° to 56°.

Appendix 10. Cone collection permits

Seed and Vegetative Material Dealer's License (FS 786)

Province of British Columbia Ministry of Forests

SEED AND VEGETATIVE MATERIAL DEALER'S LICENCE

NAME	
CONTACT PERSON	
ADDRESS	
PHONE NO.	FAX NO.

IS HEREBY LICENSED TO BUY, SELL OR TRADE IN TREE CONES, SEEDS AND VEGETATIVE MATERIAL AND/OR PROCESS CONES AND SEEDS COLLECTED FROM CROWN LAND, OF ANY COMMERCIAL FOREST TREE. THIS LICENCE IS SUBJECT TO THE PROVISIONS OF THE TREE CONE, SEED AND VEGETATIVE MATERIAL REGULATION AND THE FOLLOWING CONDITIONS:

1. This Licence may not be sold or transferred.
2. This Licence is valid from the date of issue until the date of expiry, both shown below. This period shall not be greater than five years.
3. This Licence is subject to cancellation where the dealer:
   a) fails to comply with the conditions of this Licence;
   b) fails to comply with Sections 4 and 5 of the Tree Cone, Seed and Vegetative Material Regulation; or
   c) obstructs or impedes the Chief Forester or the Chief Forester's agent in carrying out that official's duties in Section 5(3) of the Tree Cone, Seed and Vegetative Material Regulation.

DATE OF ISSUE Y M D	SIGNATURE OF CHIEF FORESTER OR AUTHORIZED PERSON	
DATE OF EXPIRY Y M D	PRINTED NAME	TITLE

FS 786 HSI 95/6 **DISTRIBUTION: WHITE** - DEALER; **CANARY** - ISSUING OFFICE; **PINK** - SILVICULTURE PRACTICES BRANCH

THIS LICENCE IS ISSUED FREE OF CHARGE

Cone and Vegetative Material Collection Permit (FS 504)

Province of British Columbia Ministry of Forests

CONE AND VEGETATIVE MATERIAL COLLECTION PERMIT

NO.

1. AUTHORITY TO COLLECT CONES AND SEEDS UNDER THE TREE CONE, SEED AND VEGETATIVE MATERIAL REGULATION IS HEREBY GRANTED TO *(PRINT FULL NAME AND ADDRESS)* :

THIS PERMIT IS EFFECTIVE FROM DATE OF ISSUE TO EXPIRY DATE

Y M D

ISSUE DATE

EXPIRY DATE

SUPERVISOR'S NAME | PHONE NO.

2. CONES, SEEDS AND VEGETATIVE MATERIALS SHALL BE COLLECTED ***ONLY*** FROM THE CROWN LANDS DESCRIBED AS FOLLOWS *(LEGAL DESCRIPTION, IF POSSIBLE, OR LICENCE DETAILS)* WITHIN THE FOREST DISTRICT ISSUING THIS PERMIT:

SEED PLANNING ZONE(S)	LATITUDE BAND(S)	LONGITUDE BAND(S)	ELEVATION BAND(S)

LICENCE / LEASE NO.	CUTTING PERMIT	BLOCK / UNIT NO.	LOCATION

3. COLLECTIONS DESCRIBED TO BE CONDUCTED ON BEHALF OF OR IN AGREEMENT WITH:

4. SPECIES OF TREES PERMITTED	MEANS OF COLLECTION	ESTIMATED HI OF CONES	ESTIMATED VOLUME OF VEG. MATERIAL	ESTIMATED COLLECTION DATE(S)	HI of CONES HARVESTED	VOLUME OF VEG. MATERIAL HARVESTED	ACTUAL COLLECTION DATE(S)

4. MEANS OF COLLECTION PERMITTED

1. HELICOPTER
2. CLIMBING TREES
3. FELLING TREES OF THE SPECIES PERMITTED
4. OTHER *(specify)* _____

5. BRANCHES OR FOLIAGE MAY BE CUT FROM STANDING TREES FOR THE PURPOSE OF COLLECTING CONES OR SEEDS UNDER THIS PERMIT ☐ Yes ☐ No

IF 'YES', SPECIFY CONDITIONS

6. ALL CONES, SEEDS AND/OR VEGETATIVE MATERIALS COLLECTED UNDER THIS PERMIT HAVE BEEN OR WILL BE DELIVERED TO:

COMMENTS

7. DISPOSAL OF SLASH, DEBRIS AND LOGS RESULTING FROM COLLECTIONS SHALL BE AT THE PERMITTEE'S EXPENSE, AS FOLLOWS:

☐ MERCHANTABLE LOGS
- ☐ DECKING AT ROADSIDE
- ☐ REMOVE UNDER TIMBER MARK NO. _____
- ☐ OTHER _____

☐ NON-MERCHANTABLE MATERIAL
- ☐ LOP AND SCATTER
- ☐ PILE AT ROADSIDE / LANDING
- ☐ PILE AND BURN (subject to issuing of a Burning Permit)
- ☐ OTHER _____

CONDITIONS

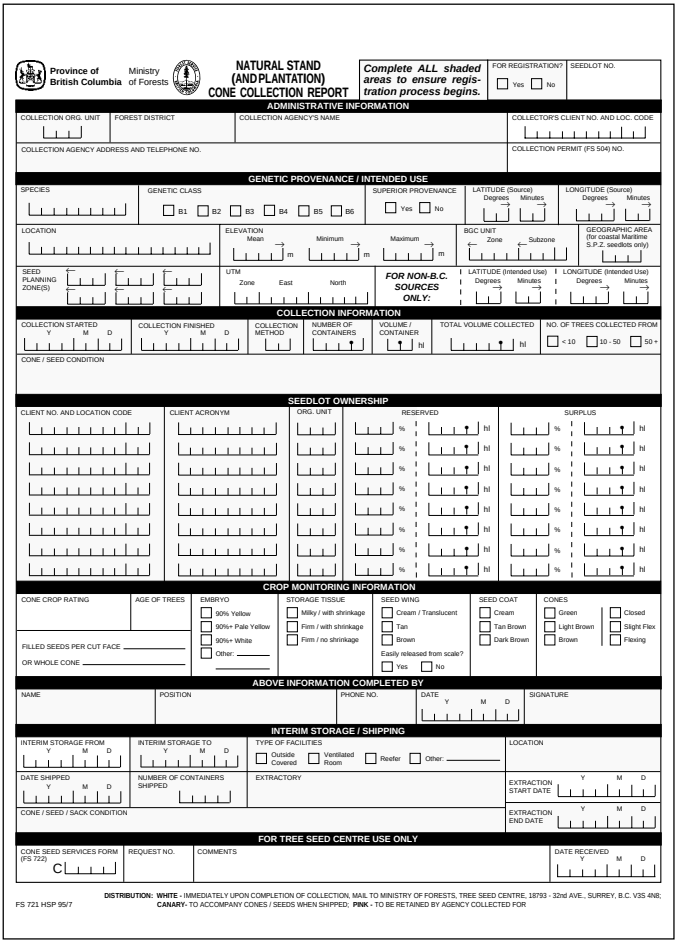
- In the case of Crown land held under licence or lease, the written permission of the Licensee or Lessee or his/her agent must first be obtained by the applicant, and a copy provided for Ministry of Forests records.
- The Permittee, not later than 30 days after the expiry date of the Permit, shall return the Canary copy of this Permit to the Forest District office with Sections 4 and 7 completed.
- The Permit may be suspended during any forest travel restriction covering the Permit area.
- The Permit is subject to immediate cancellation for contravention of any of the above conditions, or for unwarranted damage to the forest.
- The Ministry of Forests does not guarantee adequate supply of cones, seeds or vegetative material for the amount(s) permitted in Section 4. The Permittee does not have exclusive rights on land described in Section 2.

I have read and understood the terms and conditions of this Permit and the Regulations governing the collection of cones and seeds printed on reverse.	FOREST REGION	SIGNATURE OF DISTRICT MANAGER OR AUTHORIZED PERSON
PERMITTEE'S SIGNATURE	FOREST DISTRICT	PRINTED NAME
PRINTED NAME		TITLE

FS 504 HSP 95/6 **DISTRIBUTION: WHITE** - PERMITTEE; **CANARY** - PERMITTEE TO ISSUING OFFICE; **PINK** - ISSUING OFFICE

PERMIT ISSUED FREE OF CHARGE

Natural Stand (and Plantation) Cone Collection Report **(FS 721)**



Province of British Columbia — Ministry of Forests

NATURAL STAND (AND PLANTATION) CONE COLLECTION REPORT

Complete ALL shaded areas to ensure registration process begins.

FOR REGISTRATION? ☐ Yes ☐ No

SEEDLOT NO.

ADMINISTRATIVE INFORMATION

COLLECTION ORG. UNIT | FOREST DISTRICT | COLLECTION AGENCY'S NAME | COLLECTOR'S CLIENT NO. AND LOC. CODE

COLLECTION AGENCY ADDRESS AND TELEPHONE NO. | COLLECTION PERMIT (FS 504) NO.

GENETIC PROVENANCE / INTENDED USE

SPECIES | GENETIC CLASS ☐ B1 ☐ B2 ☐ B3 ☐ B4 ☐ B5 ☐ B6 | SUPERIOR PROVENANCE ☐ Yes ☐ No | LATITUDE (Source) Degrees → Minutes → | LONGITUDE (Source) Degrees → Minutes →

LOCATION | ELEVATION Mean → m Minimum → m Maximum → m | BGC UNIT Zone ← Subzone ← | GEOGRAPHIC AREA (for coastal Maritime S.P.Z. seedlots only)

SEED PLANNING ZONE(S) ← ← ← | UTM Zone East North | ***FOR NON-B.C. SOURCES ONLY:*** LATITUDE (Intended Use) Degrees → Minutes → | LONGITUDE (Intended Use) Degrees → Minutes →

COLLECTION INFORMATION

COLLECTION STARTED Y M D | COLLECTION FINISHED Y M D | COLLECTION METHOD | NUMBER OF CONTAINERS | VOLUME / CONTAINER hl | TOTAL VOLUME COLLECTED hl | NO. OF TREES COLLECTED FROM ☐ < 10 ☐ 10 - 50 ☐ 50 +

CONE / SEED CONDITION

SEEDLOT OWNERSHIP

CLIENT NO. AND LOCATION CODE	CLIENT ACRONYM	ORG. UNIT	RESERVED %	RESERVED hl	SURPLUS %	SURPLUS hl
			%	hl	%	hl
			%	hl	%	hl
			%	hl	%	hl
			%	hl	%	hl
			%	hl	%	hl
			%	hl	%	hl
			%	hl	%	hl
			%	hl	%	hl
			%	hl	%	hl

CROP MONITORING INFORMATION

CONE CROP RATING | AGE OF TREES

FILLED SEEDS PER CUT FACE _____

OR WHOLE CONE _____

EMBRYO ☐ 90% Yellow ☐ 90%+ Pale Yellow ☐ 90%+ White ☐ Other: _____

STORAGE TISSUE ☐ Milky / with shrinkage ☐ Firm / with shrinkage ☐ Firm / no shrinkage

SEED WING ☐ Cream / Translucent ☐ Tan ☐ Brown

Easily released from scale? ☐ Yes ☐ No

SEED COAT ☐ Cream ☐ Tan Brown ☐ Dark Brown

CONES ☐ Green ☐ Light Brown ☐ Brown ☐ Closed ☐ Slight Flex ☐ Flexing

ABOVE INFORMATION COMPLETED BY

NAME | POSITION | PHONE NO. | DATE Y M D | SIGNATURE

INTERIM STORAGE / SHIPPING

INTERIM STORAGE FROM Y M D | INTERIM STORAGE TO Y M D | TYPE OF FACILITIES ☐ Outside Covered ☐ Ventilated Room ☐ Reefer ☐ Other: _____ | LOCATION

DATE SHIPPED Y M D | NUMBER OF CONTAINERS SHIPPED | EXTRACTORY | EXTRACTION START DATE Y M D

CONE / SEED / SACK CONDITION | EXTRACTION END DATE Y M D

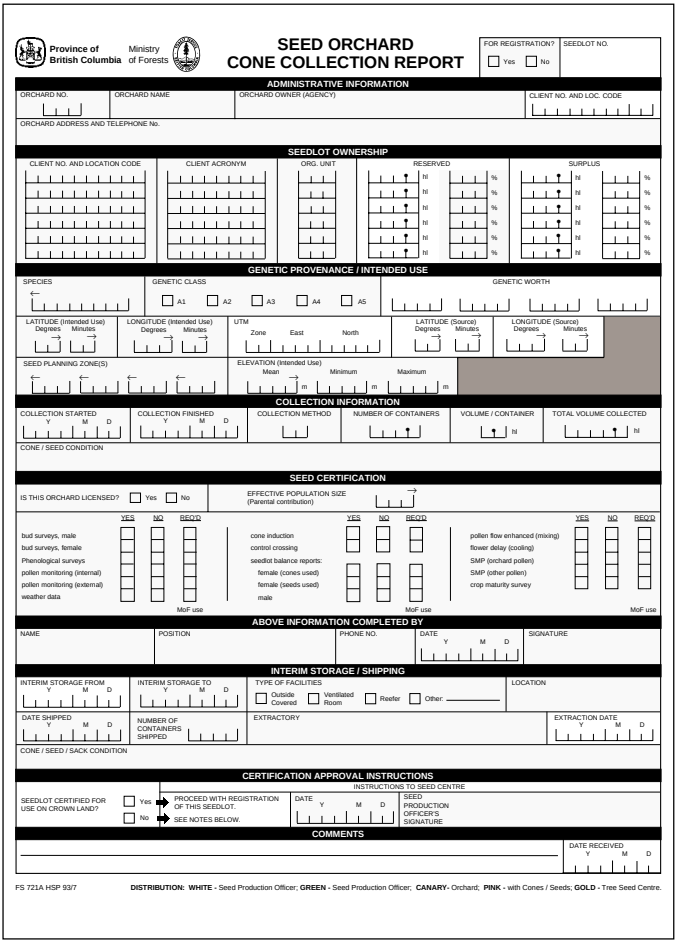
FOR TREE SEED CENTRE USE ONLY

CONE SEED SERVICES FORM (FS 722) C | REQUEST NO. | COMMENTS | DATE RECEIVED Y M D

DISTRIBUTION: WHITE - IMMEDIATELY UPON COMPLETION OF COLLECTION, MAIL TO MINISTRY OF FORESTS, TREE SEED CENTRE, 18793 - 32nd AVE., SURREY, B.C. V3S 4N8; **CANARY**- TO ACCOMPANY CONES / SEEDS WHEN SHIPPED; **PINK** - TO BE RETAINED BY AGENCY COLLECTED FOR

FS 721 HSP 95/7

Seed Orchard Cone Collection Report (FS 721A)



Province of British Columbia — Ministry of Forests

SEED ORCHARD CONE COLLECTION REPORT

FOR REGISTRATION? ☐ Yes ☐ No — SEEDLOT NO.

ADMINISTRATIVE INFORMATION

ORCHARD NO. | ORCHARD NAME | ORCHARD OWNER (AGENCY) | CLIENT NO. AND LOC. CODE

ORCHARD ADDRESS AND TELEPHONE No.

SEEDLOT OWNERSHIP

CLIENT NO. AND LOCATION CODE | CLIENT ACRONYM | ORG. UNIT | RESERVED (hl, %) | SURPLUS (hl, %)

GENETIC PROVENANCE / INTENDED USE

SPECIES | GENETIC CLASS ☐ A1 ☐ A2 ☐ A3 ☐ A4 ☐ A5 | GENETIC WORTH

LATITUDE (Intended Use) Degrees Minutes → → | LONGITUDE (Intended Use) Degrees Minutes → → | UTM Zone East North | LATITUDE (Source) Degrees Minutes → → | LONGITUDE (Source) Degrees Minutes → →

SEED PLANNING ZONE(S) ← ← ← ← | ELEVATION (Intended Use) Mean → m, Minimum m, Maximum m

COLLECTION INFORMATION

COLLECTION STARTED Y M D | COLLECTION FINISHED Y M D | COLLECTION METHOD | NUMBER OF CONTAINERS | VOLUME / CONTAINER hl | TOTAL VOLUME COLLECTED hl

CONE / SEED CONDITION

SEED CERTIFICATION

IS THIS ORCHARD LICENSED? ☐ Yes ☐ No

EFFECTIVE POPULATION SIZE (Parental contribution) →

	YES	NO	REQ'D
bud surveys, male			
bud surveys, female			
Phenological surveys			
pollen monitoring (internal)			
pollen monitoring (external)			
weather data			
MoF use			

	YES	NO	REQ'D
cone induction			
control crossing			
seedlot balance reports:			
female (cones used)			
female (seeds used)			
male			
MoF use			

	YES	NO	REQ'D
pollen flow enhanced (mixing)			
flower delay (cooling)			
SMP (orchard pollen)			
SMP (other pollen)			
crop maturity survey			
MoF use			

ABOVE INFORMATION COMPLETED BY

NAME | POSITION | PHONE NO. | DATE Y M D | SIGNATURE

INTERIM STORAGE / SHIPPING

INTERIM STORAGE FROM Y M D | INTERIM STORAGE TO Y M D | TYPE OF FACILITIES ☐ Outside Covered ☐ Ventilated Room ☐ Reefer ☐ Other: _____ | LOCATION

DATE SHIPPED Y M D | NUMBER OF CONTAINERS SHIPPED | EXTRACTORY | EXTRACTION DATE Y M D

CONE / SEED / SACK CONDITION

CERTIFICATION APPROVAL INSTRUCTIONS

SEEDLOT CERTIFIED FOR USE ON CROWN LAND? ☐ Yes → PROCEED WITH REGISTRATION OF THIS SEEDLOT. ☐ No → SEE NOTES BELOW.

INSTRUCTIONS TO SEED CENTRE

DATE Y M D | SEED PRODUCTION OFFICER'S SIGNATURE

COMMENTS

DATE RECEIVED Y M D

FS 721A HSP 93/7

DISTRIBUTION: WHITE - Seed Production Officer; **GREEN** - Seed Production Officer; **CANARY**- Orchard; **PINK** - with Cones / Seeds; **GOLD** - Tree Seed Centre.

Appendix 11. Recommended references

B.C. Ministry of Forests. 1995. Forest practices code of British Columbia: Seed and vegetative material guidebook. B.C. Min. For. Victoria, B.C. 57pp.

Camenzind, W.G. 1990. A guide to aerial cone collection equipment and techniques in British Columbia. B.C Min. For. Victoria, B.C. 30pp.

Eremko, R.D., D.G.W. Edwards and D. Wallinger. 1989. A guide to collecting conifers. Joint For. Can. B.C. Min. For. FRDA Report 055. Victoria, B.C. 90pp. & App.

Hedlin, A.F. 1974. Cone and seed insects of British Columbia. Environment Canada, Forestry Service, BC-X-90.

Sutherland, et al. 1987. Cone and seed diseases of North American conifers. North American Forestry Commission Publication Number 1. Victoria B.C.

Yeatman, C.W. and T.C. Nieman. 1978. Safe tree climbing in forest management. Can. For. Serv. Tech. Rpt. 24. Ottawa, Ont. 34pp.

Appendix 12. Interim field collection report

INTERIM SEEDLOT NO.	REGISTRATION NO.

PROVENANCE INFORMATION

SPECIES	GENETIC CLASS (see back) __B1 __B2 __B3 __B4 __B5 __B6	LATITUDE	LONGITUDE
LOCATION	ELEVATION Mean _____ Minimum _____ Maximum _____		
SEED PLANNING ZONE	COLLECTION DISTRICT	BIOGEOCLIMATIC ZONE	
MAP NO.	GENERAL LOCATION INFORMATION		
	Aspect	Land Form	Age of Stand	Species Composition

COLLECTION INFORMATION

COLLECTION STARTED Y/M/D	COLLECTION FINISHED Y/M/D	# OF PACKER DAYS
WEATHER CONDITIONS	COLLECTION METHOD	# OF SACKS
VOLUME/SACK	TOTAL VOLUME	NO. OF TREES COLLECTED FROM ____ <10 ____ 10–50 ___ >50

CROP MONITORING INFORMATION

EMBRYO	STORAGE TISSUE	SEED WING	SEED COAT
__ 90% Yellow __ 90% Pale Yellow __ 90% White __ Other _____	__ Milky/Shrinkage __ Firm/Shrinkage __ Firm/No Shrinkage	__ Cream/Translucent __ Tan __ Brown, Easily Removed From Scale	__ Cream __ Tan Brown __ Dark Brown

CONES		CONE CROP RATING	FILLED SEEDS/CUT
__ Green __ Light Brown __ Brown	__ Closed __ Slight Flex __ Flexing		

INTERIM STORAGE/HANDLING

INTERIM STORAGE FROM Y/M/D	INTERIM STORAGE TO Y/M/D	DATE SHIPPED Y/M/D
TYPE OF STORAGE		
_____ Outside/Covered	_____Ventilated Room	_____ Reefer	_____ Other
NO. OF CONTAINERS SHIPPED	SHIPPED BY	EXTRACTORY
LOCATION	CONDITION OF CONES	

SEEDLOT OWNERSHIP

AGENCIES COLLECTED FOR	PHONE	VOLUME
_____	_____	_____
_____	_____	_____
_____	_____	_____

COLLECTION SUPERVISOR	AGENCY	PHONE	DATE

COMMENTS: _____

COMPLETION NOTES

PROVENANCE INFORMATION

Genetic Class

B1 – Seed Production Area, a natural stand with the undesirable phenotype removed prior to pollination of the current crop:

B2 – Pre-selected natural stands and/or selected trees within a natural stand;

B3 – Normal stands with no effort made to select trees within stand;

B4 – Natural stand on which there is no information;

B5 – Squirrel caches and/or cuttings;

B6 – Plantations.

Biogeoclimatic Zone

Enter the appropriate ecological classification code as recorded in the Ministry of Forests Standard Symbols and Codes policy.

COLLECTION INFORMATION

Collection Method *(choose the single most appropriate method)*

01 – Aerial raking;

02 – Aerial clipping / topping;

03 – Felled trees;

04 – Climbing;

05 – Squirrel cache;

06 – Ground, ladder and/ or hydraulic lift

Appendix 13. Sources of photos

B.C. Ministry of Forests
Figures 2b; 3; 4b–h; 18 and 24.

Canadian Forestry Service
Figures 13 and 19.

Silva Enterprises Ltd.
Figures 4a; 14a–b; 15 and Appendix 4.

Western Tree Seeds Ltd.
Figure 22.

Yellow Point Propagation Ltd.
Figures 5; 20; 23 and 25.