not for publication

Guideline to Collecting Cones of B.C. Conifers

(interim)

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Prepared jointly by the British Columbia Forest Service and the Pacific Forest Research Centre (Canadian Forestry Service)

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FOREWORD

The B.C. Forest Service is rapidly expanding its seedling production program to meet growing reforestation needs throughout the province. Such expansion can only be sustained, however, if adequate amounts of good quality seed of the required species can be obtained. As requirements for seed grow, so too will the numerous biological and logistic problems which hamper a tree seed supply operation increase in importance. There is a clear need to minimize problems on all fronts.

Training of field and laboratory personnel in the required procedures and techniques is of major importance. Toward this end, the B.C. Forest Service and the Pacific Forest Research Centre (Canadian Forestry Service) have formed a joint committee to bring together up-to-date information and prepare a series of guidelines relating to various aspects of the production, procurement and processing of tree seed, specifically addressed to operational personnel. These cone and seed guidelines are intended as references and as training aids but they will not negate the need for clinics and workshops. Neither will they lessen the need for liberal applications of "common sense" by the many persons upon whom a successful seed supply operation must depend.

This interim cone collection guideline is intended for use in advance of the 1974 collection season. It is also the forerunner of a finished publication which should be ready prior to the 1975 season and, as such, it provides an opportunity for extensive review by the field personnel to whom it is principally addressed. The value of the "final" guideline will depend considerably on feedback received from readers who have "on the ground" experience in cone collection operations. Your comments are needed. To further encourage users' to forward their comments, a feedback sheet has been provided as the last page of this interim guideline. Comments should be sent to:

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B.C. Forest Service,
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INTRODUCTION

The problem of providing good quality seed for reforestation purposes has many similarities to that of managing several chequing accounts. As with most chequing accounts, withdrawals from a tree seed bank are made frequently and quite regularly while deposits are generally infrequent, often irregular and sometimes uncertain -- and overdrafts are not allowed. The analogy is to "several chequing accounts" because a seed bank contains many *seed lots** carefully identified as to species, the zone and elevation from which the seed was collected as well as several other factors. If Douglas-fir seed is needed for reforestation in the Sayward Forest, the fact that we have an abundance of lodgepole pine seed from the Burns Lake area is of no help. The analogy to chequing accounts serves one further purpose. It focuses attention on the overriding importance of making timely deposits. Most of us earn a paycheque before we can add money to our accounts. Similarly, deposits to a seed bank depend first on getting the seed, or more specifically, on collecting the cones which bear the seed.

This guideline is concerned with the cone collection operation from the determination of seed requirements to the delivery of cones to a seed extraction plant. Much of the information is general; some of it is specific to one or more species. For this reason, we have organized the guideline in two parts. Part I is a general survey of the cone collection operation; major sections concern planning, pre-organization, and collection and handling of cones. Part II provides specific information and recommendations for collecting cones of important conifers. While the guideline is particularly addressed to B.C. Forest Service personnel, we expect it to be useful to forest company personnel and other private parties interested in collecting tree seed. For this reason, we have reproduced in Appendix II the provincial regulations relating to the "Picking of Tree Cones and Tree Seeds". Also included are samples of a Cone Pickers Permit and a License to Purchase Cones and Seeds (Appendix III).

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* Italicized terms in text appear in glossary (Appendix I).

I. SURVEY OF THE CONE COLLECTION OPERATION

A. PLANNING

The planner has a never-ending job in that he must ensure an adequate and continuous supply of seed of appropriate species and *provenances* to sustain the reforestation program.

Planning for seed procurement is complicated by a number of factors, but two of these are especially important in setting limitations on the planner and in determining the procedures he must follow:

1. Uncertainty as to whether there will be a crop worth collecting.

2. A short period between the time when cones are ready to pick and they open to scatter their seeds.

Uncertainty as to whether there will be a collectable crop in any given year forces the forest manager to delay mobilizing a collecting operation, to monitor developing cone crops and, when a crop is available, to collect enough seed to meet requirements for several years. Uncertainty also prevents him from smoothly integrating the collecting operation with other seasonal routines. The short collection period often necessitates a large-scale, well-organized cone collecting operation lasting only a few weeks. Because of the infrequency of collectable crops, when one does occur it should receive first priority, taking precedence over all other activities.

Stages in cone and seed development. The problems encountered when planning a cone collection operation may be better appreciated by considering the four principal stages in the development of conifer seed. The following is sufficiently generalized to apply to all commercially-important B.C. conifers. (Specific data relating to these stages is presented in part II).

I. Formation and development of male and female reproductive buds. This stage extends through the spring, summer and fall of the year previous to the cone crop year. At some point, usually by mid-summer, the male and female buds can be distinguished from each other and from the vegetative buds which are also developing during this period.

II. Bud opening and development of pollen cones and seed cones. This stage occurs through the spring of the cone crop year. Upon opening, the male buds develop into pollen cones and the female buds develop into seed cones. Within the pollen cones, pollen grains are developing and within the seed cones, ovules, the structures which are destined to become seeds, are also developing.

III. Pollination and fertilization. This stage usually occurs in May to June of the cone crop year. When the pollen cones are fully developed and the seed cones have developed enough to be receptive, pollen is released from the pollen cones and transported by air

currents to the seed cones. This process is called *pollination* Upon reaching a receptive seed cone, the pollen grain produces a long tube which enters an ovule and introduces genetic material from the male structure. This process is termed *fertilization*.

IV. Final development of seed cones and seed. This final stage extends through the summer of the cone crop year and ends with cone opening and seed dissemination (see exceptions below).

Exceptions: 1) The pines require an additional season to produce mature cones. Stage I (development of reproductive buds) occurs two years before the cone crop year. Stages II and III (opening of reproductive buds and pollination and fertilization) and partial development of seed cones occur the year before the cone crop year. Final development of pine cones and seeds occurs during the spring and summer of the cone crop year.

2) Usually, interior lodgepole pine cones remain closed on the tree for several years after seed are fully mature. Such cones are termed *serotinous*. (This feature is a significant help to the forest manager because it removes both the uncertainty as to whether cones will be available for collecting and it eliminates the need for "panic" collecting during a short time period).

Impediments to cone and seed development. Each spring, buds are laid down on the growing branches and twigs of conifers. Most of these buds in turn are destined to open the following spring to produce more twigs or branch segements -- or perhaps to produce pollen cones or seed cones. When these buds are first laid down, they are undetermined -- that is, they may develop into vegetative buds or reproductive buds. By mid-summer, however, conditions have determined whether they will become vegetative buds or male or female reproductive buds. The factors which determine the type of bud to develop are not well understood but weather patterns and tree nutrition are thought to be involved. Thus, adverse weather during the period of bud determination may be regarded as potentially the first impediment to cone and seed development. Should conditions favor the formation of reproductive buds, adverse weather conditions such as drought, frosts or extensive rain during the pollination period may yet impede the development of a good cone crop.

Insects may also destroy or damage developing cone crops. Some insects lay their eggs within the reproductive buds while others attack the seed cones and still others lay eggs in the fertilized ovules. Those insects attacking reproductive buds and seed cones may cause cone abortion while insects attacking the developing seeds are more insidious in that they destroy the seed while allowing cones to develop normally.

Other impediments to cone and seed development are diseases such as cone rusts. Squirrels may harvest large quantities of cones before seeds are sufficiently mature for a collecting operation to be launched.

Periodicity. We see then, that trees do not produce bountiful cone crops every year and in some years they produce no cones at all. Moreover, the trees of a particular species tend to be in phase with each other over a broad region with the result that annual cone crops may vary from nil to abundant. This year to year variation in cone crops is termed *periodicity*. Cone crop periodicity results from a combination of interacting factors, including weather conditions, damaging agents and internal mechanisms. Most species exhibit this phenomenon although its extent and "period" may vary considerably from one to another. For example, abundant Douglas-fir cone crops may be separated by 2 to 11 years with an average of 5 years between them. Abundant spruce crops occur about once every 6 years in the Interior. With increasing latitude or elevation the period between good crops is increased. Periodicity imposes a major constraint on the planner and requires him to devote considerable effort in determining whether a cone crop is developing and in monitoring the potential crop.

Determination of seed requirements. Since tree seed must be collected to provide the seedlings for planting (or seed for direct seeding), it follows that reforestation projections are the first step in determining seed requirements. The planner must have reliable projections of the area to be planted or seeded annually to each species. And he must have this information for each *seed zone* and elevational band. (See seed zone map on next page). He may then determine his annual seed requirements by species and provenance. Consider the following computations for a single provenance of, say, white spruce:

1) Area to be planted annually — 1000 acres

The area to be planted derives from reforestation projections which take account of backlog N.S.R. (Not Sufficiently Restocked) and area cut annually. In planting this area, the silvicultural prescription may call for 8 ft spacing, which requires 680 trees per acre. Thus,

2) Trees per acre — 680

3) Annual seedling requirement (1000 x 680) = — 680,000 seedlings

Nursery experience has indicated that, on the average, 2 seeds are required to produce a plantable seedling. So,

4) No. of seeds required annually (2 x 680,000) = — 1,360,000 seeds

Conifer seeds vary greatly in size according to species. White spruce seeds averages 241,000 to the pound. Therefore,

5) Wt. of seed required annually (1,360,000 ÷ 241,000) = — 5.6 lbs. (2.5 kg.)

Thus, given our previous assumptions, we have determined that 5.6 pounds of seed of our particular provenance will be required annually. However, since

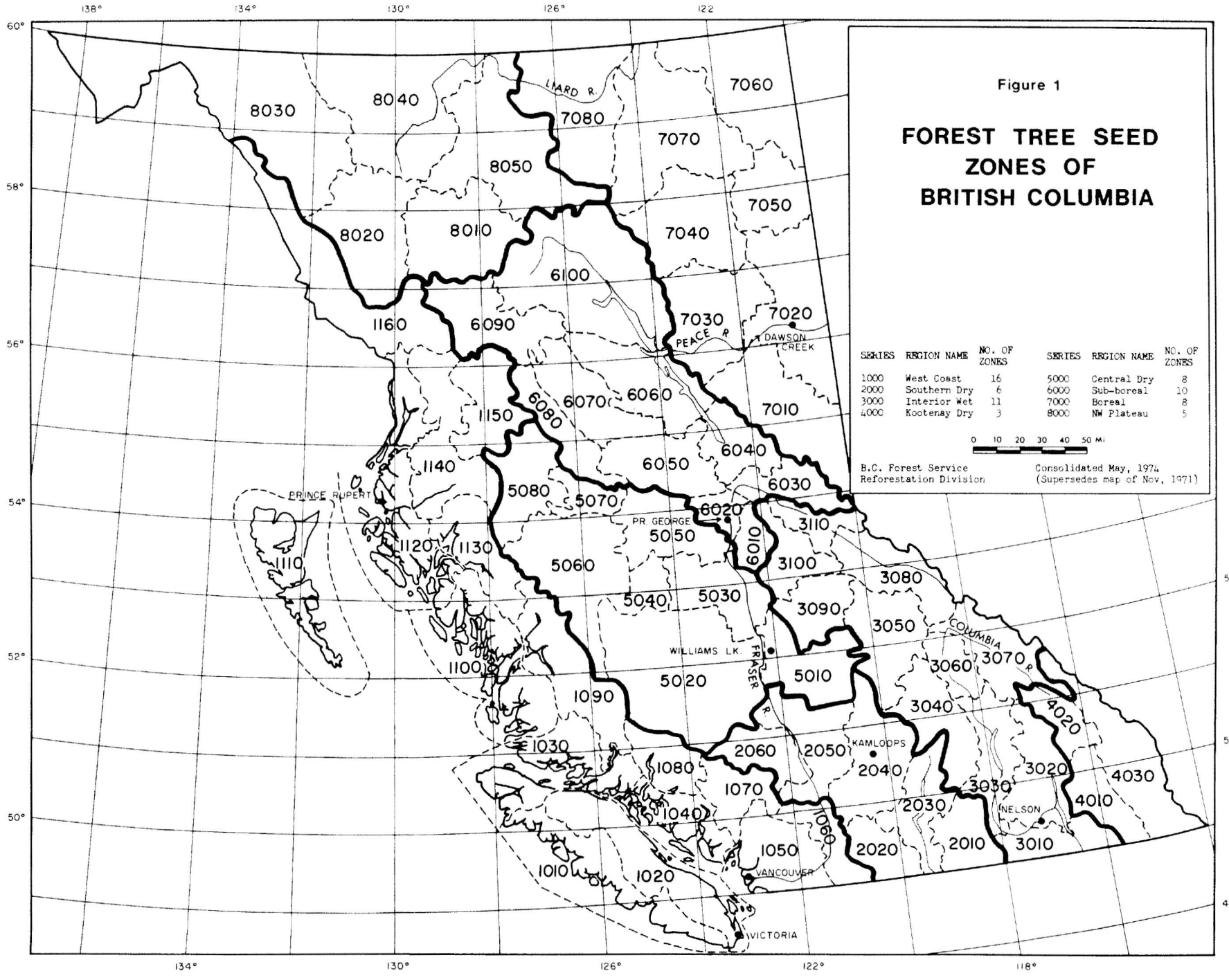
Figure 1
FOREST TREE SEED ZONES OF BRITISH COLUMBIA
SERIES REGION NAME NO. OF ZONES
1000 West Coast 16
2000 Southern Dry 6
3000 Interior Wet 11
4000 Kootenay Dry 3
5000 Central Dry 8
6000 Sub-boreal 10
7000 Boreal 8
8000 NW Plateau 5
0 10 20 30 40 50 Mi
B.C. Forest Service
Reforestation Division
Consolidated May, 1974
(Supersedes map of Nov, 1971)
LIARD R.
PEACE R.
DAWSON CREEK
PRINCE RUPERT
PR GEORGE
WILLIAMS LK.
FRASER R.
COLUMBIA R.
KAMLOOPS
NELSON
VANCOUVER
VICTORIA
8030
8040
7060
7080
7070
8050
7050
8020
8010
7040
6100
1160
6090
7030
7020
1150
6080
6070
6060
7010
1140
6050
6040
5080
5070
6030
6020
3110
1120
1130
1110
5050
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3100
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3090
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3070
1100
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2060
2050
2040
3020
4030
1080
1070
3030
4010
2030
1040
1060
1050
2020
2010
3010
1010
1020
118°
122°
126°
130°
134°
138°
48°
50°
52°
54°
56°
58°
60°

he cannot expect to collect the seed year by year as it is needed, the planner must expect to collect and store enough seeds when they are available to meet his needs until another collectable crop materializes. The number of years supply to be acquired in the anticipated collection will depend on such factors as the periodicity of the species, the seed storage life and seed stocks on hand. If we suppose that a 15-year supply of seeds is required of our hypothetical collection, we can carry our computations one further step:

6) Total wt. of seeds required
(15 x 5.6) = 84 lbs. (38 kgs.)

Determination of cone requirements. Once seed requirements are estimated, it is necessary to translate to cone requirements. This is based on average yield of good quality seeds per cone, or bushel of cones, which in turn depends on such things as growing conditions, effectiveness of pollination and presence of insects or disease. Average seed yields are presented in Appendix IV . More precise estimates can be made by cutting sample cones and counting apparently sound seed. Generally, cones are cut in half longitudinally and exposed filled seeds are counted. Examination of sectioned cones provides an indication of insect damage and seed maturity. (Further detail on cutting tests is presented on page 8).

Cone crop forecasting. When reproductive buds have formed, the forest manager may, by appropriate sampling, determine whether a potential crop is developing. The word potential is stressed because the many impediments to cone and seed development may at any stage cause the reproductive structures to abort or may destroy the maturing seed. As a result, we may conclude at an early stage that a crop will not develop or that one may develop. That a crop will develop cannot be determined until shortly before collection. Nevertheless, early crop forecasting and periodic evaluation of a developing crop are of great value to the forest manager in planning his cone collection operation.

Early forecasting is based on sampling to determine the relative numbers of female reproductive buds. Depending on species and time of year, female buds may be recognized externally; sometimes it may be necessary to section the bud. A method being used increasingly involves "forcing" the buds on collected twigs by placing them in water in a favorable environment. This "forces" the buds or causes them to break dormancy and open, at which time they can be readily identified as male, female or vegetative. However the buds are identified, the greater the ratio of female buds to vegetative buds, the better the potential cone crop provided that sampling has been properly conducted.

Cone crop rating. There is no point in forecasting or assessing cone crops unless a reliable method exists to express the "size" of the crop. The system used for rating crops is a numerical classification developed in California; it is based on visual observations of tree crowns and subjective assessments of the relative amount of cones in the crowns. This system is now used commonly throughout the Pacific Northwest. The person carrying out the examination merely walks through the stand observing the volume of

current year's cones on a number of well-distributed, representative dominant and co-dominant trees. His findings should then be noted according to the table below:

Crop rating		Criteria
None	1	No cones on seed trees*
Very light	2	Few cones on less than 25%
Light	3	Few cones on more than 25%
Medium	4	Many cones on 25-50%
Heavy	5	Many cones on more than 50%

Generally, medium and heavy crops are collectable. Obviously, the more trees observed, the greater will be the reliability of the rating. Two common errors which result in over-rating cone crops are 1) taking account of old cones which have either shed their seeds or which contain seeds of lower quality and 2) evaluating roadside trees which, because of their increased exposure to sunshine, often bear more cones than their neighbors within the stand.

Crop rating is done early in the summer (July) when cones are readily visible on tree branches. The Forest Service provides a form for this purpose (Appendix V). All areas in which good female flower crops were previously reported should be re-visited with the objective of determining the extent of the cone crop and the anticipated yield in bushels. By doing so, primary and alternate collection areas can be selected on the basis of stand quality, quotas to be met, location with regard to future needs and other factors.

Rating will, of course, refer to only one species; separate ratings should be made for additional species. Green cones may be examined if this is convenient but the main objective at this time is to rate the size of the crop and compare potential collecting areas.

In addition to a report on the intensity of the cone crop, the observer may wish to make an estimate of the bushel-yield which could be expected in order to determine if a collecting quota can be met. Those interested in trying this out can use a technique devised in Great Britain for true firs, Douglas-fir, spruce and pine.

> From the base of the tree, pace out a distance on the ground, roughly equal to the height of the tree. Use 6x (or 8x) binoculars to count visible cones, then multiply by 4 to estimate number of cones on the tree.

Or, for Douglas-fir, a system developed by Winjum and Johnson (1962, Weyerhaeuser Co., Forestry Res. Note 46) may be used:

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* Seed trees are upper story (dominant and co-dominant) trees.

Stand on the south side of the tree in a position affording a clear view of the crown. Using binoculars, count the cones on one branch in each whorl, then determine estimated number of cones using the following equation:

$$y = 7.76\,x - 253$$

where y = total number of cones/tree ($\pm$ 300)
and x = sum of branch counts

Knowing the number of cones per tree and the number of cone-bearing trees per acre, the observer can estimate cone yield per acre. In applying these methods, results should be averaged for at least 20 trees.

For the crop-rating procedure, the only needs are a map of the area, a compass, an altimeter, binoculars, note paper and pencil.

The Cone Crop Survey and Evaluation Form (F.S. 727) used by the Forest Service provides a good record of this rating examination and of the follow-up evaluation which is done in more detail (see following sub-section). An example of a completed form is shown in Appendix V . At the time of crop rating, however, only the headings and the right-hand table are completed.

Once cone crop ratings have been applied to possible collection areas for the desired species, the planner will be able to assign collecting priorities subject, of course, to the following evaluation of seed content (i.e. yield) from the cone crop.

Cone crop evaluation. While the rating of the crop tells us how many cones we can expect to get from one area as compared to another, the evaluation of the crop is meant to tell us how many seeds the cones contain, how good the seeds will be and their progress toward maturity. We are now more interested in the seeds than in the cones.

The evaluation generally takes place between the end of July and mid-August after collecting priorities have been established. It involves the sampling of cones from a minimum of six seed trees well distributed throughout the stand and a detailed examination of nine cones from each tree (three cones from each of the upper, middle and lower crown sections).

Each cone is sliced in half longitudinally along the cone axis with a sharp knife, axe, or cone cutting tool and a count made of the exposed filled seeds in one half-section. The average of the 54 half-cone seed counts indicates the potential seed yield from the stand and determines whether or not the cones are worth collecting. The following table shows average seed-count levels (for medium and heavy cone crop ratings) below which collections are generally not undertaken:

Recommended Minimum Collectable Levels

Species	Average of 54 half-cone counts of exposed filled seed	
	Medium crop	Heavy crop
Douglas-fir	5	7
Spruces	7	10
W. Hemlock	3	4
Pines	5	7
Larches	6	8

A different procedure is recommended for lodgepole pine cones. As these cones are very hard and difficult to section, it may be better to open them and extract the seed. This may be done by dipping cones in boiling water for 10 seconds, then placing them in an oven at 150°F for 3-4 hours. A minimum of 15-20 filled seeds per cone (full count) indicates a collectable crop. Filled seeds may be identified by crushing with the fingernail to reveal a white *endosperm*.

In most cases this will be the last crop assessment before collections begin. Therefore, it is also important that some idea of the degree of seed maturity is acquired in order that a possible date may be set for collections to begin. A cutting test should therefore be carried out on a sample of the seeds--between 20 and 30 taken from several cones. Each seed should be sliced (as nearly perfect as possible) exactly in half longitudinally. The contents of the seed (if full) are then examined with a 10x hand lens. (A tally should be kept of the number of empty seeds). Generally speaking, as the seeds mature, their *embryos* elongate and become yellow in color while the endosperm material gradually changes from a viscous milky condition to a firm doughy state similar to the meat of a coconut. Collection of cones can begin for most species when the embryo occupies 75% of the total length of the seed cavity and the endosperm is firm. Although some "after-ripening" of seeds occurs after the cones have been picked, 75% is considered to be the minimum embryo length to assure seed viability and germinative energy. A section of a fully mature Douglas-fir seed is illustrated in Figure 2.

Thus, examination of the seed itself will aid the observer in determining:

a) what percentage of the seeds are filled

b) what stage of maturity has been reached, and

c) a probable starting date for collecting.

It is also important at this time to note any evidence of insect

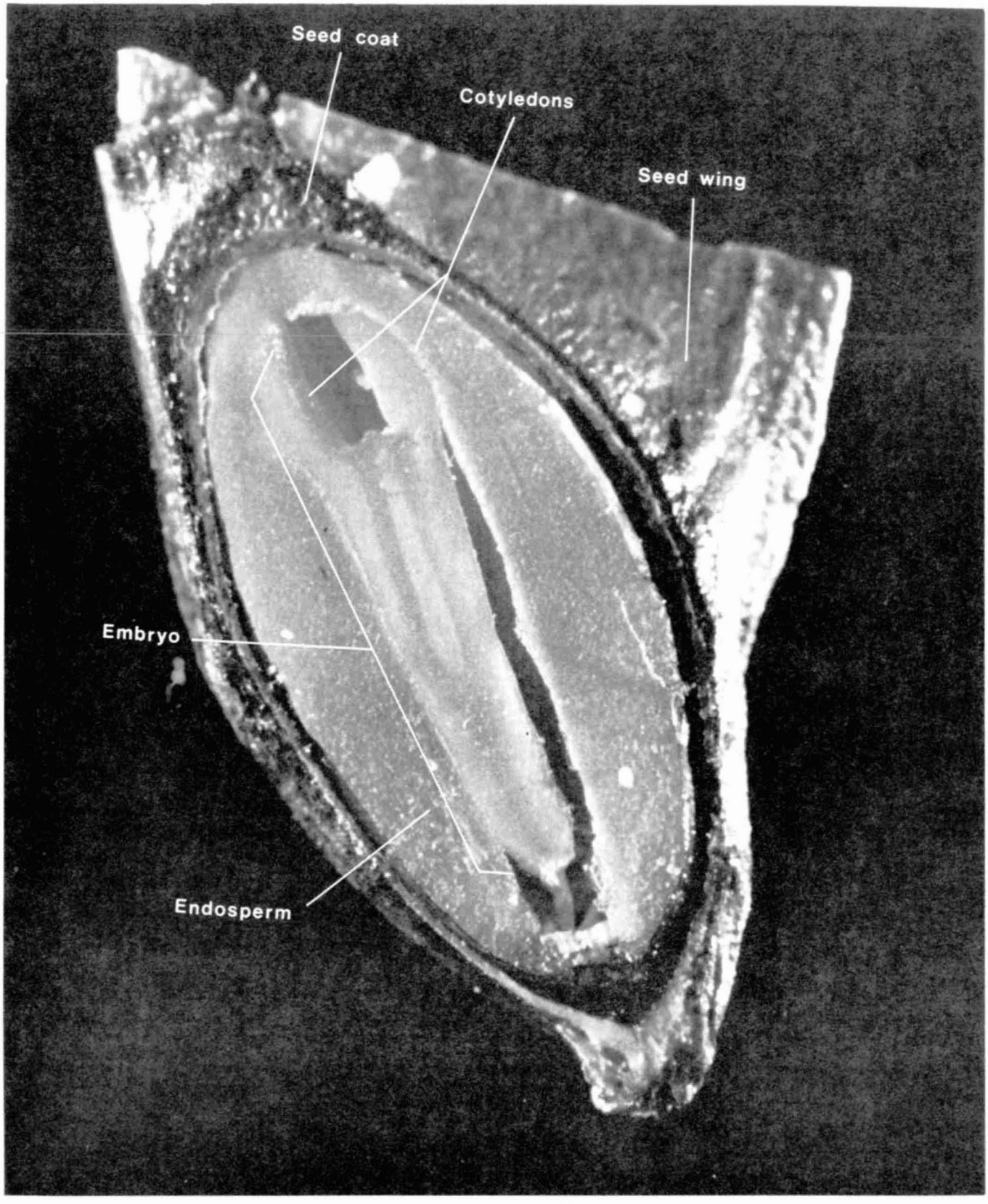


FIGURE 2 - Cut section of mature Douglas-fir seed (x40) from Owens, J.N., 1973, The Reproductive Cycle of Douglas-fir. Canadian Forestry Service, Publication BC-P-8.

It is also important at this time to note any evidence of insect damage to cones or seeds as well as the presence of any cone disease (mainly rust). Since these organisms affect the ability of the cone to produce good seeds, they affect the yield and therefore become a factor in deciding which area to collect from. If over 50% of seeds are damaged, collecting them may not be worthwhile.

The presence of insects in cones is often (but not necessarily) signalled by external features such as:

a) premature browning of cone in whole or in patches

b) small boring holes on cone scales

c) accumulation of boring dust (frass)

d) exudations of pitch-like material

e) disfigurement of cone's shape.

Interior evidence of insects in the cone will be generally boring holes, frass, damaged seeds and perhaps insect larvae. The extent of insect or disease damage to cones or seeds should be taken into consideration in the overall evaluation of the crop. For further detail regarding the identification and significance of insects, the reader is referred to "Cone and Seed Insects of British Columbia" by A.F. Hedlin (1974. Canadian Forestry Service, Report BC-X-90). Should cone and seed insects or disease show up during crop assessment, the damaging agent and its significance should be determined. This is best carried out by the Canadian Forestry Service (506 West Burnside Road, Victoria, B.C., V8Z 1M5).

The information collected during the evaluation can be used to judge whether or not an area is suitable for collection and to compare probable collection efficiency and set priorities among a number of similar areas. The Forest Service Form F.S. 727 (Appendix V) illustrates how the information from the evaluation should be recorded. A procedure has been established whereby this form is used to build basic data on which to establish crop periodicity patterns.

In short, the evaluation permits decisions to be made which lead to logical pre-organization, rather than confusion, when the collecting date arrives.

Summary. Planning involves that series of decisions and activities which ensures an adequate and continuous supply of tree seed of the species and provenances required for a reforestation program. It is long-term in nature but also has a short-term phase superimposed each year as seed procurement planners try to determine where collectable crops may be developing.

The planner is responsible for determining current and projected seed requirements, for determining whether and where potential cone crops are developing and, when a crop is anticipated, for setting cone collection quotas.

B. PRE-ORGANIZATION

The distinction between planning and pre-organization is not clear-cut. Both are preliminary to the cone collecting operation itself. However, planning is an on-going activity carried out on a broad scale while pre-organization tasks get underway after the prospect of a collectable crop is confirmed. Pre-organization is preliminary preparation for collecting the anticipated crop. The words prospect and anticipated should be emphasized, however, because even as pre-organization gets underway the crop may yet fail or be severely damaged. Further field work in assessing the development of the seed crop in terms of potential yield, insect or disease damage and the anticipated ripening date will either confirm or deny an actual collection operation.

Because of the necessity of carrying out collections efficiently in the short time that will be available, preparations for collecting must begin as soon as possible. Every conceivable detail must be considered and the necessary arrangements completed in advance so that the fullest possible energy and time can be devoted to actually collecting cones once the seeds are sufficiently mature. Pre-organization thus becomes a sort of "game plan" whereby the "team" is given the objective and then equipped and informed how to achieve it.

No pre-organization activities can be undertaken without first having the following information in relative detail:

1. Total anticipated collection.

2. Quotas to be collected according to
   a) seed zone
   b) species
   c) elevation
   d) intended use of seeds.

3. Location of collection areas and alternate areas.

In all probability, the total collection and details as to quotas will have been considered earlier by those responsible for planning the collection. The exact location of the areas where the collections will be made may or may not have been decided. If not, the field staff will have to undertake a search for suitable stands within the zone(s) and elevations prescribed.

The following sections deal with the aspects of collection to which the supervisor must give his attention now.

Examination and preparation of collection areas. Pre-organization essentially begins with an examination of proposed collection areas. Many subsequent decisions and activities will depend on the species and type of

stand in which collections are to be made. The following may be pertinent to initial examination and preparation of collection areas, depending on the collection method to be used (see following sub-section):

a) estimating the stand area necessary to yield the prescribed quota -
   - is the stand extensive enough?
   - how many trees need to be collected from?
   - how many bushels (litres) can be expected per picker-day?

b) pre-marking selected trees for climbing or felling.

c) location of possible squirrel caches.

d) improvement of roads, skid trails, etc., for better access to and within the area.

e) cleaning out windfalls and poor phenotypes, to facilitate mechanical shaker operation.

f) necessity for felling arrangements
   - will collecting conflict with logging operations?
   - can a cutting permit or small sale be arranged?
   - can felled material be utilized?
   - N.B. Faller should be approved by logging foreman.

At this time, alternate areas in the same zone and elevation should be considered in case circumstances change or events render collection impossible or inadvisable (e.g. losses to fire or insect outbreak, loss of access, etc.).

When areas have been decided upon and approved, collection permits may be obtained and arrangements made for preparatory work to go ahead.

Determination of collecting method. Efficiency, safety and the requirement of collecting high quality seed are the criteria which must be considered in choosing a collection method. Essentially, there are four methods available: 1) climbing, 2) picking from felled trees, 3) collecting from squirrel caches and 4) mechanical shaking. These methods are described in detail in section C; here we are concerned only with determining which method is most suitable under given circumstances.

Climbing is generally the method used for collection in Douglas-fir and ponderosa pine and occasionally in larch if the experienced climbers are available. The stand should be fairly open, trees full-crowned almost to ground level and not over 50 feet in height.

Collecting from felled trees is generally the method employed for the species which are more difficult to pick from or when trees cannot be climbed

readily (e.g. lodgepole pine, spruce). Trees are never to be felled solely for the purpose of obtaining cones. It is often possible to co-ordinate cone collecting with logging or land or road right-of-way clearing operations.

Squirrel cache collections are acceptable when taken in a stand of good form, vigor and site.

Mechanical shaking is not usually an available option in that tree shakers are still in the developmental stage and are not usually available for operational collections in wild stands.

The collection plan. Having decided on the method to be used, the supervisor can begin to put a collection plan together. With an estimate of the bushel (litre) yield per tree and the expected quantity per picker-day, the time required to achieve the quota can be calculated in relation to various crew sizes. Relating the crew size to the field supervision and transport available, the supervisor can then decide on the likely number of days of collecting on each area. When two or more areas are scheduled for collection, priorities should be assigned with regard to species, elevation, location, and available labor.

Bushels (litres) collected per picker-day will depend on a number of factors:

a) Species - some cones are harder to break off than others (e.g. lodgepole pine) and in some species old cones will still be on the branches and tend to confuse pickers (e.g. larch). (In lodgepole pine, cone coloration signifies age of cone and therefore seed quality).

b) Size of cones - obviously cone size varies by species. However, there are such things as "area effect" whereby cones of the same species vary in size from one geographical area to another, and "elevation effect" whereby cones become generally smaller in size as elevation increases.

c) Method of collection - it is generally more efficient to collect cones from the tops of felled trees rather than by climbing (especially in spruce).

d) Heaviness of crop - more cones on each tree and more trees with cones on them mean that pickers will not have to move as often.

e) Motivation of pickers - cone pickers are motivated and produce according to the nature of the job, the rate of pay, their age and how well the job is pre-organized and supervised.

f) Weather, insects, travelling time, etc.

g) Training - a vital prerequisite to efficient cone collecting.

The following table, although based on limited information, will serve as a rough guide in anticipating picker productivity. It assumes that a reasonable rate is being paid for cones and that pickers are fairly industrious.

Method of Collection	Estimated bushels per picker-day from a medium-heavy crop							
	Douglas-Fir	Interior Spruce	Lodgepole Pine	Ponderosa Pine	White Pine	Larch	Cedar (W.R.)	Hemlock
Climbing	6-8	-	-	12-14	-	1-2	1	1
Felled trees	6-8	3-4	3-4	-	10-12	2-3	1	1
Squirrel caches or cuttings	-	-	6-8	12-14	10-12	-	-	-

Equipment. The necessary equipment should be accumulated and made ready well in advance as things can get quite hectic as collection time draws near. Following is a list of basic equipment:

Binoculars - 7 x 50

Aneroid barometer

Map of area - 20 ch/in (with contours if possible)

Bushel (or litre) measure - container 10"x12"x18½" inside= 1 bu. (36½ litres)

10"x12"x37" inside= 2 bu. (73 litres)

Plastic pails

Cone cutter - (or strong knife and board)

Hand lens (10x) and razor blades

Illustration of cones - (green, ripe, diseased, insect infested, etc.)

Flagging tape and tarpaulin

Tally book

Axe and/or chain saw (fuel, file)

Collection Report Forms (F.S. 721 or 721A)

Hard hats for crew

First aid kit and stretcher

Hand cleaner and supply of clean rags

"Forestry Crew at Work" signs

Supply of burlap sacks - (2 bushel size)

Cone collection shipping tags, stencils and paint for sacks

Strong twine or wire fasteners for sacks

Safety belts for climbing

Sticks (6-8 ft. long with hook in one end)

Small "S"-shaped hooks

Large (8-10 inch dia.) open-ended cans (for keeping sack mouths open)

Water bags

Portable inspection bins and cleaning tables

Long-handled rakes - (spacing of teeth relative to cone size)

Some means of signalling all pickers - (whistle, horn, etc.)

Insect repellent.

The experienced supervisor will pre-organize interim storage facilities (at the Ranger Station, for example). This will involve the fabrication of an adequate system of temporary shelving, racking, etc., which should be in a shaded, covered and cool location. Cone caches may also have to be protected from the activities of local squirrel and chipmunk populations. Necessary materials should be obtained and structures erected before the collections begin. It should be remembered that these are temporary measures and in the interests of economy, use of materials at hand plus some degree of ingenuity are called for.

Transport. Adequate and suitable transport whether by land or water for getting the crew(s) to and from the collection area will be required and should be arranged in advance.

Units should be checked over for proper licencing, insurance and safety features and should be properly inspected for operating condition and serviced before use. The collection supervisor cannot afford to have vehicles broken down. He should ensure that the assigned operator has the proper certificate and is qualified to operate the unit. Seating and shelter should be fairly comfortable.

Transport of each day's sacked cones from the field to the interim storage facility is recommended.

Cone picking labor. In most cases, prospective cone pickers, having seen the crop, will come around asking about collections. However, if this is not the case, advertisements placed in the local newspapers will usually get the desired results. Advertisements should outline the basic requirements such as:

a) expected starting date

b) age limitation for pickers (15 years-old for Forest Service)

c) place where further information can be obtained.

In addition, it is a good idea to have ready a printed handout or posted notice regarding details and conditions of work: viz.,

a) starting date and duration of collection

b) species to be collected

c) marshalling point and time to meet

d) location of site, travel time and time of return to marshalling point

e) equipment to be supplied by agency

f) what the picker should provide (e.g. clothing, gloves, boots, lunch, etc.)

g) Workmen's Compensation Board coverage

h) basic rate of pay (hourly, per bushel, etc.)

i) method and frequency of payments.

A list should be made up of those persons interested together with their phone numbers. An immediate means of contact is most important for time cannot be wasted locating pickers. In some localities, organized groups such as Junior Forest Wardens, Boy Scouts and sports groups may be interested in collecting as a unit, but in general picking crews will be made up of individuals or groups of friends picking for themselves.

Crews should be organized according to quotas, anticipated duration of the collection and supervision available. Each crew must be supervised. The prime thought should be that once the cones are ready, collection of the quota should be completed as quickly as possible.

In some cases, experienced and trustworthy pickers from previous seasons may be employed as collection foremen. A one-day training session should be given to collection supervisors and foremen, a day or two before collection starts. This session should cover:

a) determination of cone and seed insects and diseases and the types of damage they cause, symptoms, etc.

b) cone and seed maturity, embryo development, cutting cones, slicing seeds, etc.

c) selection of good phenotypes in stands

d) measuring and tallying, cone types, inspection and cleaning

e) tagging and tying, transport, field storage

f) crew safety, collection methods

g) provenance and elevation control

h) use and care of equipment

i) crop assessment (bushels per tree, roadside effect, etc.)

j) cone picker "dodges" (such as adding foreign material to sacks, etc.)

Much of this information will have to be transmitted to the crew once they get out on the site.

Cooperation and coordination with other agencies. Cooperation with other agencies, notably licensees, is beneficial to the collection program and should be developed during assessment of the crop. Phases of the program in which cooperation can be promoted are:

a) location of collectable crops and assessment

b) coordination of collection planning

c) coordination of felling on active cutting areas and approved rights-of-way, etc.

d) cooperative training sessions

e) cooperation on subsequent collections

f) knowledge of picking activity through issuance of permits.

Licensees who are undertaking collections for reforesting Crown lands should deliver cones to the Forest Service for extraction. Those collecting cones for Crown-granted lands should notify the extraction plant to which they intend to ship their cones and advise them of the expected amounts, species, and likely delivery date. This will assist the extractory in preparing for the shipment and planning plant time and staff.

Right-of-way and other cuttings by Hydro, Highways, Parks and other agencies, as well as cutting activities on private lands should be checked out as possible collection areas. Advance notice of collections may be given to the local press; this may aid in the recruitment of pickers and may result in a feature story which would promote local interest and good relations with the public.

Cone prices. Normally basic prices to be paid per bushel of cones by species will have been fixed by District Headquarters. However, an allowance may be added to compensate for local factors which may contribute to lower than average production - e.g., excessive travel time, small cones, poor picking conditions, etc. The general intent is to set prices at a level so that an industrious picker will earn approximately the amount he would make as a laborer. Adjustments to the basic price should be carefully considered and should be approved by District Office. In special cases (e.g. Seed Production Areas) special prices or hourly rates may be necessary where experimental collections and techniques are being tried out.

Weather information. If they can be arranged, spot weather forecasts (e.g. 5-day outlooks) are helpful in determining the length of the collection period and the feasibility of collections on a day-to-day basis. It may be possible to set these up through the District Office. Basic information of value would be:

a) max/min temperatures - by elevation zones

b) relative humidity - by elevation zones

c) winds - direction and force

d) % chance of rain

e) duration of existing conditions

f) occurrence of inversions

Summary. Pre-organization concerns those activities which are carried out in preparation for collecting an anticipated cone crop. These activities include planning the particular operation, monitoring the crop, and arranging in advance for alternate collection areas, equipment, labor, transport and cooperation and coordination with other agencies.

C. CONE COLLECTION

The cone crop evaluation provides the information upon which the final decision to mount a collection operation is based. If expectations of a collectable crop have been upheld, preparations have moved into a final and hectic stage. Cone pickers must be hired, pre-oriented and placed on standby for each collection area. (Pre-orientation includes information on general conditions of employment -- duration of job, hours of work, transportation, payment procedures and safety precautions.) And, very important, everything must be in readiness for handling the cones -- for bagging, tagging, storing and transporting.

Supervision of pickers. On the first day of collection the supervisor should review working conditions, collection objectives and safety matters. The picking crew must be instructed in the use of equipment, in what constitutes acceptable cones and in proper filling, tying and tagging of cone sacks.

Once the picking is underway the supervisor should ensure that the pickers are collecting from the right trees and that they are conforming to safety precautions. A record is maintained of each picker's collection and an inspection made to ensure that the contents of each sack is acceptable. Sacks containing unacceptable cones or excessive debris must be cleaned by the picker prior to acceptance. (Debris such as needles, cones scales, twigs and dirt is difficult to remove in the seed extraction process and causes unnecessary handling of seeds which can reduce seed quality.) A bushel measuring unit must be available to check the amounts of cones collected by pickers as a basis for pay (see details of unit on page 15).

Picking cones from standing trees. Climbing is hazardous, thus this method should be confined to stands less than 50 feet tall. Climbing trees to pick cones is practical in immature stands in species with medium to large cones - e.g. Douglas-fir, white pine and spruce. Trees with desirable characteristics bearing cones can be pre-selected. The picker then climbs the tree and, when in position, fastens himself to the main stem with his safety belt. He should climb as high as safely practical (the main stem should be no smaller than 3 inches at face level) and pick cones as he works his way down the trees. Using a short hooked stick, the picker pulls the branches upwards and in towards him, gathers the cones and drops them into a sack which is suspended from a branch by means of a "S"-shaped hook. The mouth of the sack may be kept open by tying it around a large open-ended tin can. Cones on uppermost branches may be knocked off with the stick. Another method is to set a tarpaulin beneath the tree, then rake the cones off the branches. The cones can then be gathered from the tarpaulin and placed in sacks.

Collecting cones from felled trees. Cone collections may be made in conjunction with active logging operations or from cone collection stands reserved (from cutting) for provision of seed. Where collections are made on active cutting-permit areas, prior agreements must be made with the licensee. Collections should be made in areas apart from the active logging

to ensure safety of the picking crew. As recovery of small cones from slash and brush-covered ground is difficult, it is suggested that areas where trees are to be felled be windrowed to provide clean ground for gathering cones. Trees should be felled by competent fallers, approved by the logging foreman, in advance of the picking crew. Collections should be made from trees having a suitable *phenotype* after examination for seed count and ripeness.

Where collections are made from cone collection stands, all trees felled for this purpose must be subsequently utilized. A District Forester sale or direct sale could be prepared to ensure that this is done.

Collecting cones from squirrel caches. Collecting from squirrel caches is an acceptable method provided the stand source is of good quality. This method may be useful when quotas cannot be met through other collection methods or seed has disseminated.

It is best to have a two-man crew reconnoiter areas and mark locations of caches for the pickers to gather later. Squirrels usually locate their caches year after year in the same places. Typically they are found in damp areas near springs, small creeks or marshes; on northern exposures; and in decayed wood or duff or around old dead and down logs or windfallen trees. Fresh cones on the ground are a sign of squirrel activity; piles of cone scales and cores mark where they have been sampling cones and may indicate a nearby cache.

The concern that removal of cones from caches condemns the squirrel to starvation is probably unfounded. Squirrels have a varied diet and usually collect far more cones than they can eat. Also, they survive over periods of several years when no cone crops occur.

Mechanical cone collection. Cone harvesting to date has been primarily a manual task. Future intensive forest management will require larger amounts of high quality seeds. Consequently, dependence upon collections from seed production areas and seed orchards will increase. Stands tended primarily for seed production are best suited to partial or complete mechanical cone collection.

Partial mechanization of cone harvesting has been accomplished by use of tree shakers. Trials conducted in other countries indicate variable degrees of cone removal. It appears shakers will be most effective on species with cones which are easily detached -- e.g. spruces, Douglas-fir, ponderosa pine and true firs (provided the latter can be collected prior to disintegration).

Cone handling procedures. Freshly picked cones (except interior lodgepole pine) contain considerable moisture. As the cones lose this moisture, they expand and generate heat which may directly damage the seeds or which may encourage damaging molds. For this reasons, proper ventilation of sacked cones is very important. In large piles, ventilation must be allowed around each sack. Buildings with open walls or large doors provide

suitable temporary storage. If available, a portable fan can facilitate air movement. Temporary storage racks can be constructed with a minimum of labor and material and are especially justified where large collections are planned. Storage facilities must be protected against theft of cones, and against losses from animals predators.

Seedlot identification -- Recording and tagging. A provisional seedlot number is assigned (by the collection coordinator) for each collection by species, area and collection year. This provides a means of identification during collection, interim-storage and transport to the extraction plant. Each sack of cones must be identified by agency and/or owner and by provisional seedlot number. The Reforestation Division provides a tag for this purpose (see Figure 3). This tag should be filled out on both sides and attached to the tie-string; the tear-off copy should be placed inside the sack.

Cone sacks should be securely tied well above the fill-line to allow for cone expansion. The only cones which will not expand as cones dry during storage are those of interior lodgepole pine. Cone expansion must be allowed during interim storage or cone scales may "case harden" or set and cause subsequent extraction problems. A secure tie is essential as much handling time is lost and cone wastage occurs when ties become loose and cones are spilled. As an additional aid in maintaining seedlot identity during storage and transit, the provisional seedlot number may be printed on the sack (in large enough numerals to be discernible from a distance of 20 ft.-see Fig.4.

Cone Collector's Report form. A Cone Collector's Report form (F.S. 727) should be promptly filled-out by the supervisor after collection of each seedlot is completed. It is important that the instructions on completing this form be followed carefully to ensure smooth processing of seed and seed registration. A cost report form (F.S. 736) should also be completed and attached to the collector's report form. (Examples of these completed forms and instructions are illustrated in Appendix V). The completion of these forms and delivery of the cones to the extractory finalizes the collection job.

Shipment of the cones to extractory. Good communication between the collection supervisor and extraction plant is essential. All cones must be delivered in the shortest possible time to the extraction plant as even short stop-overs add to the heat build-up in cone sacks during transit.

Closed vans should only be used for hauling interior lodgepole pine cones. For other species, trucks and trailers with open flat decks should be used and cones should be stacked to prevent displacement during transit. A net must be used to stabilize the load as a safety precaution. The truck driver should be informed of the nature of his load and the need for proper care and prompt delivery.

Information on the estimated time of arrival of a shipment of cones must be conveyed in advance to the extraction plant. This enables the receiving station to provide staffing for prompt unloading of cones. Each shipment should be accompanied by a shipping invoice indicating number of sacks by seedlot number.

FIGURE 3 - Label for tagging cone sacks

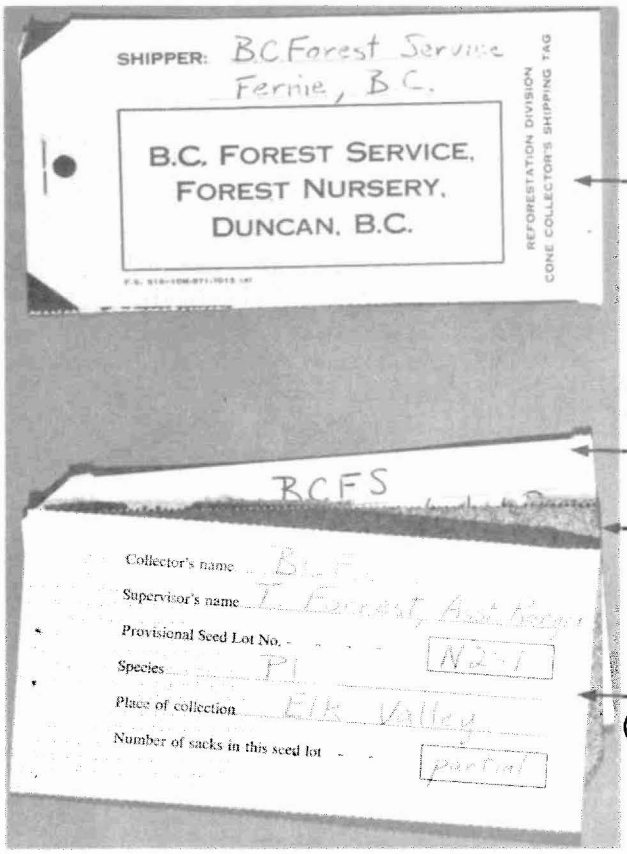
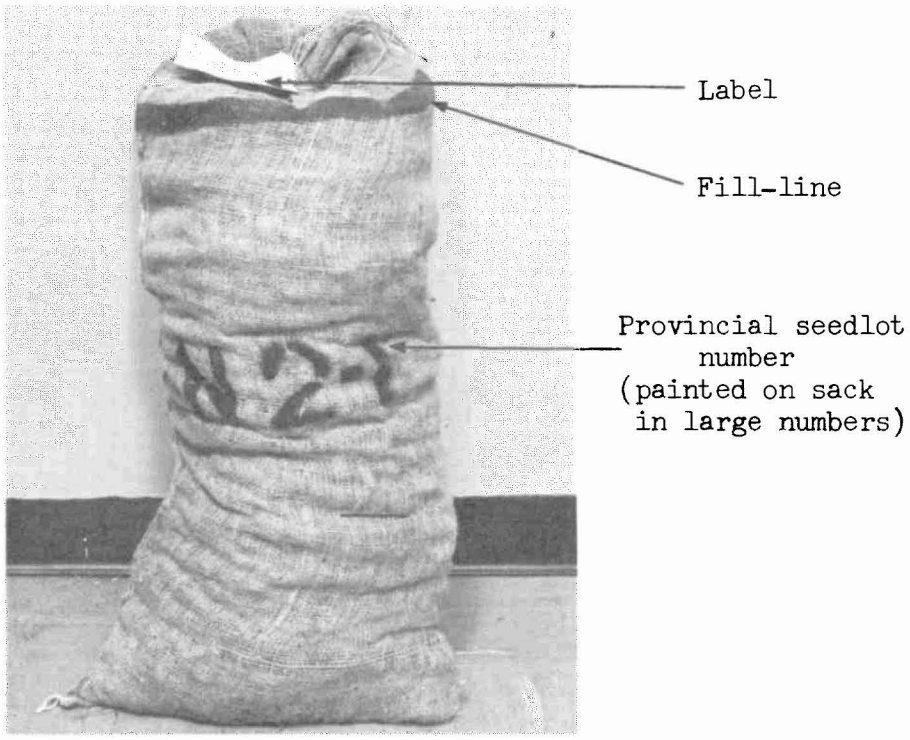


FIGURE 4 - Properly marked sack of cones



Summary. Cone collection, whether from standing or felled trees or from squirrel caches is the goal of the entire operation. The results of favorable climatic and botanical developments and, of course, of inspired planning and pre-organization are turned into real dividends when cone collection quotas are met. This phase of the tree seed procurement program involves picking, bagging and labelling the cones; it involves storing them temporarily and transporting them; and, inevitably, it requires careful record keeping.

II. INFORMATION AND DATA FOR IMPORTANT B.C. CONIFERS

A. INTRODUCTORY NOTES

Information and data is presented in the following section for 20 B.C. conifers judged to have present or prospective importance in the provincial reforestation program. Of these, only 5 are prominent reforestation species at present: Douglas-fir, Interior spruce (white and Engelmann combined), lodgepole pine, Sitka spruce and western hemlock. Importance in reforestation and importance in current harvesting are two quite different matters as can be seen from the following table.

Species	% of 1973 harvest	% of 1974 nursery sowing
Douglas fir-coastal	14	38
Douglas fir-interior		9
Interior spruce	22	29
Sitka spruce		5
Lodgepole pine	13	14
Western hemlock	21.5	4
True fir (Abies spp.)	14	1
Western red cedar	12.5	
Others	3	

There are several reasons for species having a different order of importance in reforestation from that implied by their representation in current harvesting data. Among these are differences in economic value, rates of growth, ease of reforestation, potential management problems and, of course, availability of quality seed of the required provenances. There are also reasons why species which are not currently important in reforestation may become so in the future. For example, western white pine, while having several superior characteristics, is so readily killed by white pine blister rust that it cannot be considered a species for reforestation at this time. However, recent progress in developing resistant strains of white pine and in controlling the disease makes it likely that this species will figure importantly in future reforestation programs. Many high-elevation species will become important in reforestation as more sub-alpine areas are harvested. Yet another reason for the prospective importance of currently unimportant species is that the growing emphasis on recreational and amenity requirements may bring about gradual changes in reforestation emphases.

The information and data in the following section has been presented by species or groups of species according to a standard format. The format devotes 4 pages to each species (or group of species) as follows: The first page is the title page and contains an illustration (approximately life-sized) of the cone (in most cases) and a brief general statement. The second page indicates the distribution of the species within B.C. with the aid of a map. Distribution maps are based on "Native trees of Canada" (7th edition. Hosie, R.C. 1969. Canadian Forestry Service, Ottawa). The third page gives

information and data relating to cone production characteristics and cone collection recommendations; it includes tabular data extracted from a master table appearing in Appendix IV. These data are derived from various sources and cannot be guaranteed to be accurate in all cases; they are intended for guidance only. Wherever tabular data are missing, sufficiently reliable data were unavailable. The fourth page is headed "Personal Notes" and is left blank for that purpose.

In preparing this guideline, we decided to omit information relating to cone and seed insects because another planned guideline will be partly devoted to this subject. In the meantime, the reader is referred to A.F. Hedlin's recent publication entitled "Cone and seed insects of British Columbia" (Canadian Forestry Service, Pacific Forest Research Centre, Publ. BC-X-90).

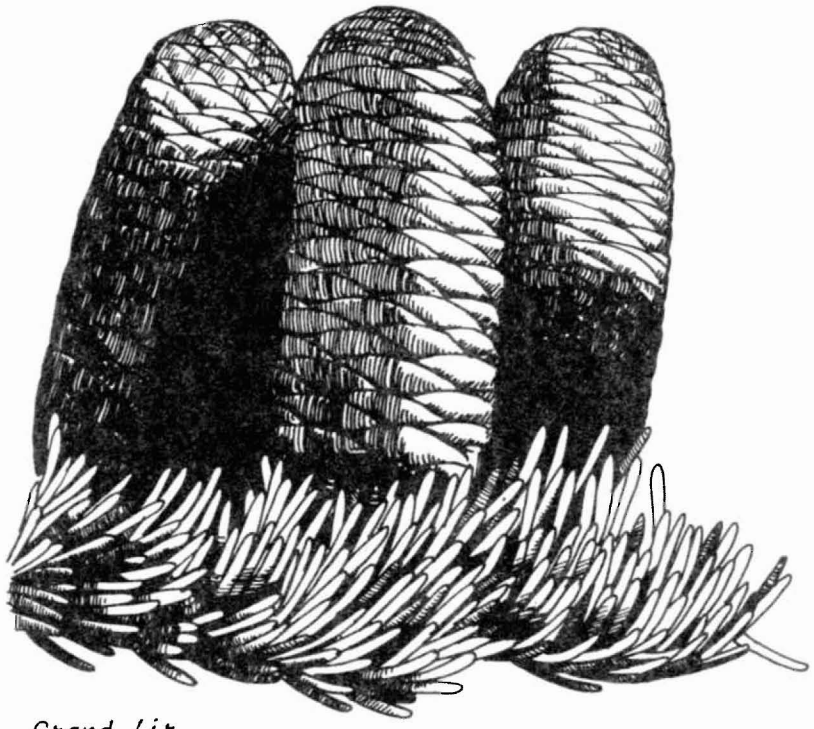
Page

B. INFORMATION AND DATA

AMABILIS (PACIFIC SILVER) FIR (Abies amabilis)

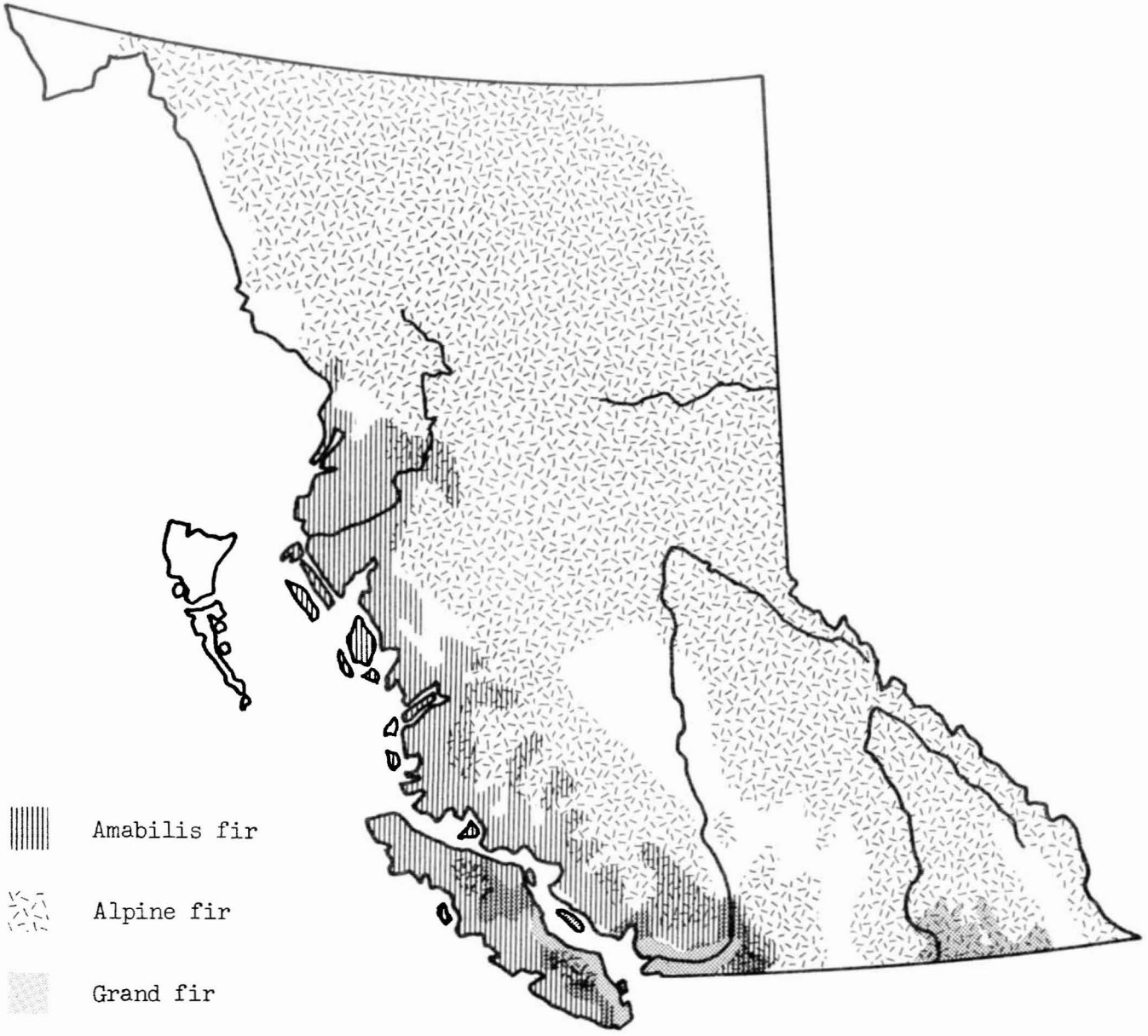
GRAND FIR (Abies grandis)

ALPINE FIR (Abies lasiocarpa)



Grand fir

Of the 9 species of Abies indigenous to North America, only 3 grow in B.C. Because of infestations with balsam woolly aphid, no attempts have been made to artificially regenerate true fir forests since 1966. Both alpine and amabilis firs have been identified as important components of high (and some lower) elevational sites. As soon as the ban on moving Abies seedling stock is lifted, all three species will gain an important place in the provincial reforestation program.



Distribution:

Amabilis fir grows from sea level to 5000 feet on Vancouver Island, but is not usually found this high on the adjacent mainland. Grand fir, the largest of the Canadian true firs, is found between sea level and 1500 feet on the coast, but up to 3000 feet in the Interior. Alpine fir grows abundantly between 2000 and 7000 feet in the Interior.

Amabilis fir/Grand fir/Alpine fir

Cone Production Characteristics: In amabilis fir, pollination occurs from mid-April to mid-May or even later at higher elevations. In grand fir, pollination is usually completed in early May but in alpine fir pollination occurs between mid-May and mid-June. In all species, cones ripen the same year in which pollination occurs. Cones are usually ripe when the scales begin to separate; collections should then be made immediately since the scales are not fused to the cone spike and the cones will quickly disintegrate. Insect damage may cause the scales to separate prematurely. Ideally, cone collections should be made 2 to 3 weeks before scale separation begins; cone color is not a very reliable index of ripeness but when the cones have become brownish and the seed endosperm is firm, the cones may be considered collectable. B.C. true firs will probably ripen artificially if picked before fully mature, provided they are stored in cool, well-ventilated areas. Since mature cones disintegrate on the tree, there is no danger of collecting old cones.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection	Approx. picking dates
			Avg.	Range			½sect. per cone	
Abies amabilis	20	3½-5	2-3			250		late Aug. to mid-Sept.
Abies grandis	20	2-4½	5-6	3-8		250		late Aug. to mid-Sept.
Abies lasiocarpa	20	2½-4½	3	2-5		300		mid-Sept. to mid-Oct.

Cone Collection:

1. Stand and Tree Selection -- cones should not be collected from trees with crooked or deformed stems and branches or from stands in which the balsam woolly aphid has been observed.

2. Cone Picking Methods -- cones may be collected from standing trees but since the wood of most Abies species is brittle, considerable caution should be exercised. The uppermost cones should be regarded as inaccessible. Felled trees or fresh slash are usually the best sources of cones. Squirrel caches can sometimes be used but care should be taken to see that the seeds are ripe (firm endosperm).

3. Post-collection Handling -- cones should be stored in cool, well-ventilated and shaded areas prior to transportation. This is especially important if artificial ripening of early collected cones is to be ensured. Precautions against heating and molding in the sacks must be taken. Care should be taken to prevent loss from rodents.

Personal Notes:

Amabilis fir/Grand fir/Alpine fir

YELLOW CEDAR (Chamaecyparis nootkatensis)

The genus Chamaecyparis includes three species native to North America only one of which, C. nootkatensis, grows in western Canada. To date, yellow cedar has not played a role in the reforestation program in B.C. but it has been identified as a valuable component of high-elevation stands in the southern part of the province. Future reforestation plans for high elevation sites may well include this species.

Distribution:

In southern B.C., yellow cedar is seldom found below 2000 feet while north of Vancouver Island the elevational range extends from sea level to the tree line.

Yellow cedar

Cone Production Characteristics: Pollination occurs from April, in the southern part of the range, to late May in the northern part. Cones mature in the fall of the year following that in which pollination occurs. Both 1- and 2-year cones can be found on the same branch. One-year cones are 1/8"-1/4" in diameter, generally uniformly green and are found near the tips of the branchlets. Two-year cones may show purple or golden-brown coloration, particularly along the margins of the scales, are larger - up to 1/2" -- and are found further down the branch. After the seeds have been shed, the opened cones may persist for a third year or longer.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection		Approx. picking dates
			Avg.	Range			$\frac{1}{2}$sect.	per cone	
Chamaecyparis nootkatensis		$\frac{1}{4}$-$\frac{1}{2}$	2-4					2	Aug. to Oct.

Cone Collection:

1. Stand and Tree Selection -- cones should be collected only from trees of good form.

2. Cone Picking Methods -- cones should be collected by hand from standing or felled trees in the fall before seed dispersal. Cone rakes help in removing cones from branches. Sufficient instruction should be provided to pickers to ensure that only mature cones are picked.

3. Post-collection Handling -- cones should be temporarily stored in cool, well-ventialted and shaded areas prior to transportation. Precautions against heating and molding in the sacks must be taken. Since it is impossible to avoid collecting some unripe, 1-year cones in any collection, placing the cones into a kiln or heated room (not above 110°F; 43°C) soon after collection, i.e. before they have had time to dry out naturally, will cause ripe, 2-year cones to open quickly. Prolonged heating over several days will also open one-year cones. This method will help in separating 1- and 2-year cones. Seeds must be removed from the kiln as soon as the mature cones have opened.

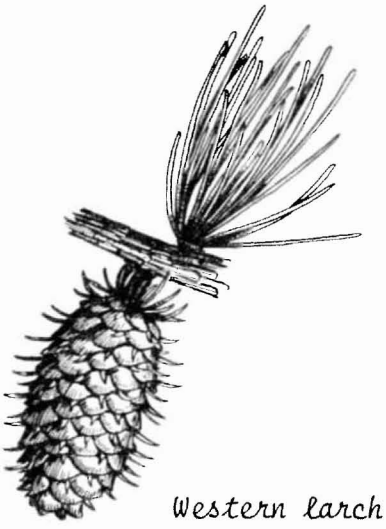
Personal Notes:

Yellow cedar

WESTERN LARCH (Larix occidentalis)

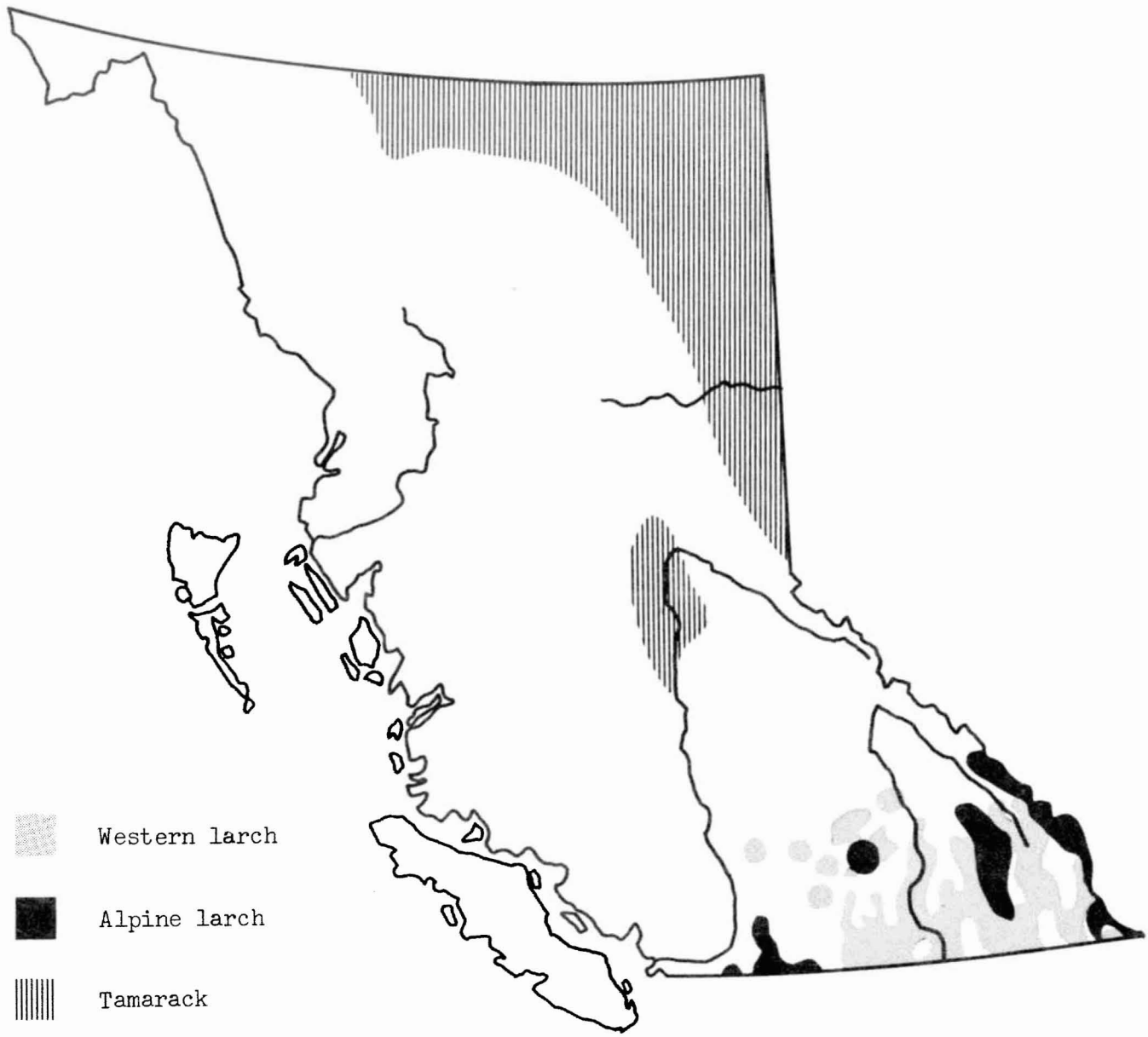
ALPINE LARCH (Larix lyalli)

TAMARACK (Larix laricina)



Western larch

All 3 of the Larix species native to North America occur in B.C. Two of these, western larch and tamarack currently have no commercial value but the third, alpine larch, may become important in the reforestation of high elevation sites.



Distribution:

Western larch is a characteristic tree of the southeastern part of B.C., growing between 1500 and 5500 feet. Alpine larch, found within approximately the same geographical area, grows between 6000 and 7000 feet. Tamarack has the widest range of all North American conifers. In B.C., its best growth is on favorable sites between 600 and 1700 feet.

Western larch/Alpine larch/Tamarack

Cone Production Characteristics: Pollination generally occurs from late May to early June in western larch and tamarack, but may be delayed until late June in alpine larch. Cones mature in the late summer-early fall of the same year. Cones should be collected as soon as they are ripe. Ripe cones are brown; the seed coats are hard and the endosperm firm. Cones may be found for some distance along the branch, being most common on 2- to 4-year old branchlets but also found on branchlets 5 to 10 or more years old. Old cones may persist indefinitely on the tree, therefore it is generally not practical to attempt to rake cones from the branches.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection		Approx. picking dates
			Avg.	Range			½ sect.	per cone	
Larix occidentalis	40-50	1-1½	5-6			4000	5	40	Aug. to Sept.
Larix lyalli		1½-2							Aug. to Sept.
Larix laricina	40	½	5-6						Aug. to Sept.

Cone Collection:

1. Stand and Tree Selection -- cones should be collected only from vigorous, well-formed trees free from infestation by dwarf mistletoe.

2. Cone Picking Methods -- cones may be picked from standing or recently felled trees, from fresh slash or from squirrel caches.

3. Post-collection Handling -- cones should be stored in cool, well-ventilated and shaded areas prior to transportation. Precautions against heating and molding in the sacks, and from loss from rodents, must be taken.

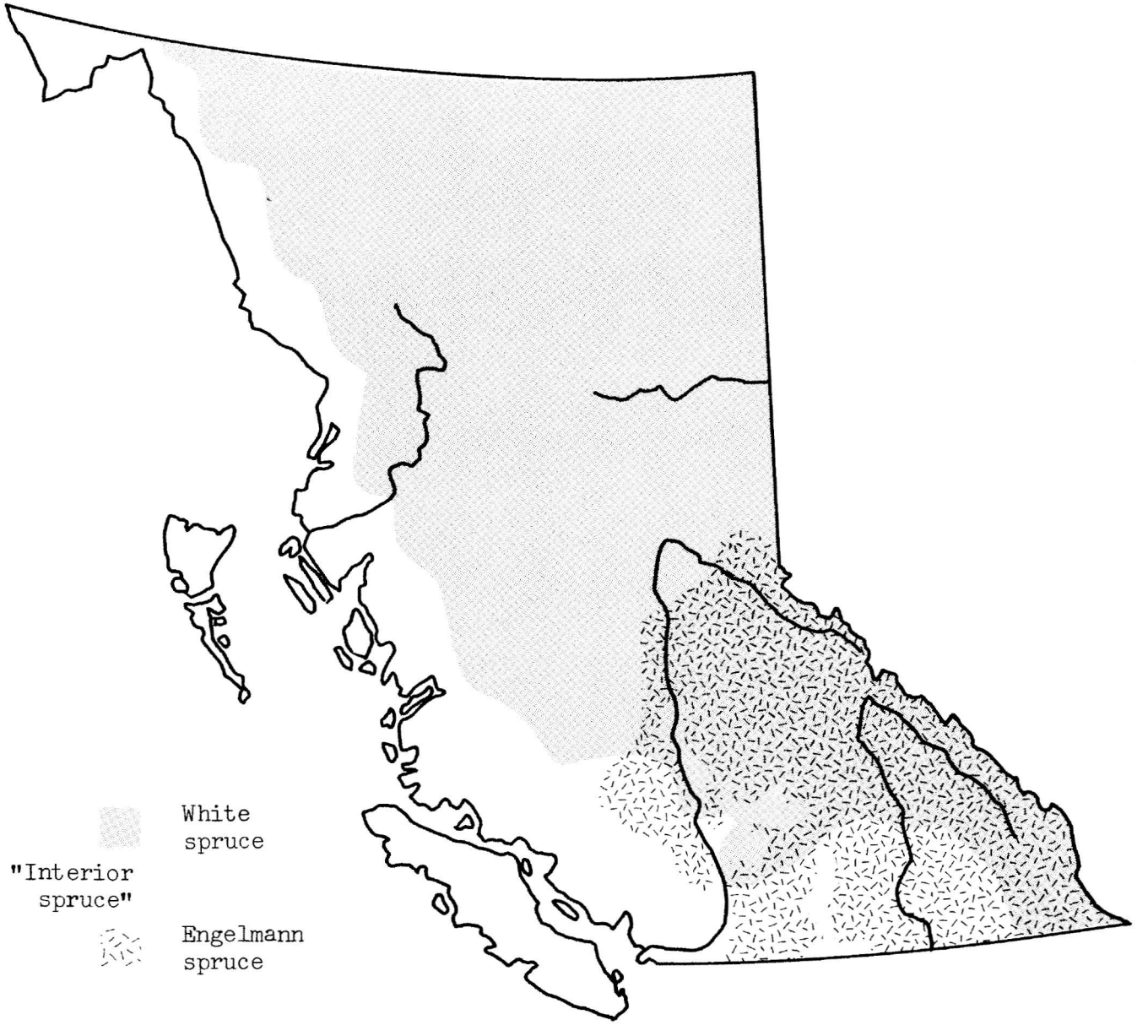
Personal Notes: Western larch/Alpine larch/Tamarack

WHITE SPRUCE (Picea glauca)

ENGELMANN SPRUCE (Picea engelmannii)

Engelmann spruce

Of the 40 or more species of Picea, 8 are native to North America and 4 grow in B.C. White and Engelmann spruce are very similar species, especially in cone production characteristics, and are known to hybridize over a considerable portion of their range. For this reason they are often described collectively as "Interior spruce". Problems in achieving prompt natural regeneration have been encountered. In view of this difficulty, and the broad distribution of the species, seedling production has recently increased and Interior spruce now represents a major component of the reforestation program.



Distribution:

In the southern part of B.C., Interior spruce is a minor forest component between 1500 and 3500 feet but becomes a major component above 3500 feet. In the central interior, it is a major component between 2000 and 5000 feet while in the northern part of the province it is a major component as low as 1000 feet.

Interior spruce (white/Engelmann)

Cone Production Characteristics: Pollination occurs in mid-May to early June; cones are ripe from mid-August to early September of the same year. Cones are ready for collection when the seed coat and wing have become a golden-brown color, the endosperm is firm and the yellow-green embryo has elongated to 75% of the seed length. Collection period from standing trees is about 14 days.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection	Approx. picking dates
			Avg.	Range			½sect. per cone	
Picea glauca	20	1½-2	6	2-12		4000	7-10	mid-Aug. to Sept.
Picea engelmannii	16	1-3	5	2-10		3000	7-10	mid-Aug. to Sept.

Cone Collection:

1. Stand and Tree Selection -- cones should be collected only from dominant or codominant trees with straight stems, uniform and slightly pendant branching habit.

2. Cone Picking Methods -- cones can be picked by climbing (ladders may be used), from freshly felled trees or squirrel caches. Climbing is usually difficult since tree limbs are small and cones are predominantly in the uppermost parts of the crown (in natural stands). Climbing is feasible in seed production areas where controlled spacing has been practiced. When collecting from fellings, care should be taken that tops fall onto skid-roads or cleared areas for efficient collection. Cones are usually quite pitchy.

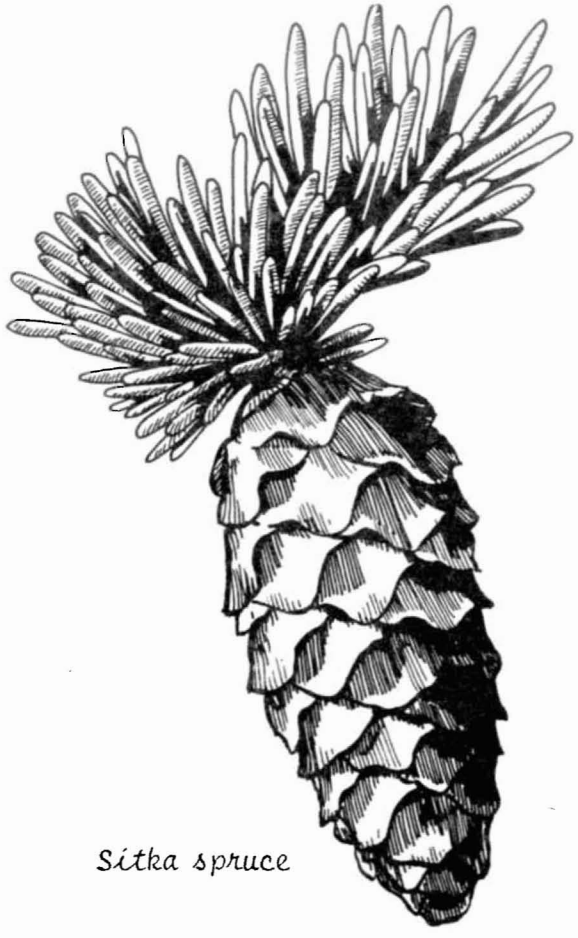
3. Post-collection Handling -- cones should be stored in cool, shaded and well-ventilated areas prior to transportation. Precautions gainst heating and molding in the sacks, and against loss from rodents, must be taken.

Personal Notes:

White spruce/Engelmann spruce

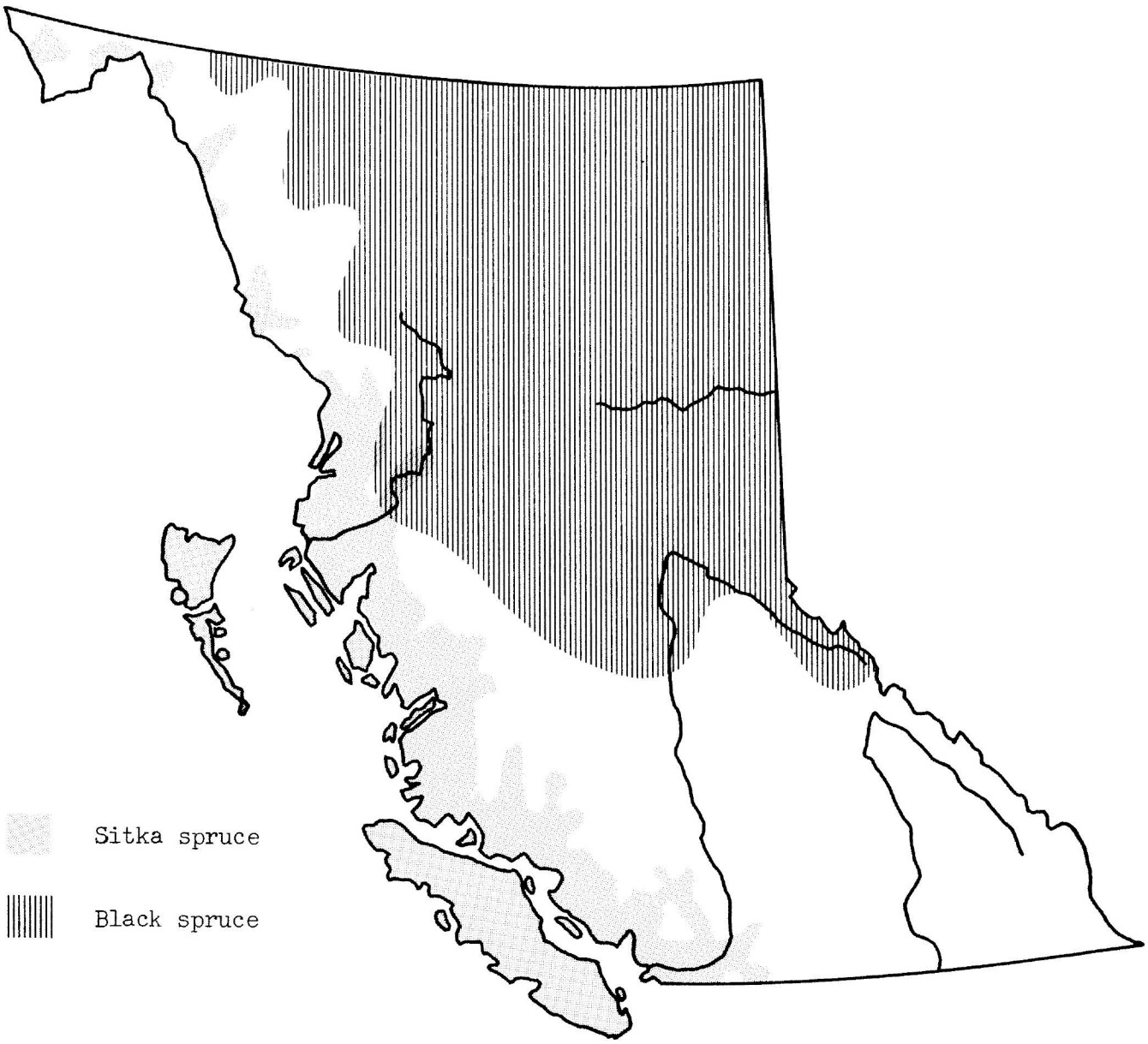
SITKA SPRUCE (Picea sitchensis)

BLACK SPRUCE (Picea mariana)



Sitka spruce

Sitka spruce represents only a minor component of the provincial reforestation program. This species is attacked by the Sitka spruce weevil, which has restricted planting in the south coastal area. Black spruce has not been included in reforestation efforts to date, but this species could become important as close-utilization is extended.



Distribution:

Sitka spruce grows best below 1000 feet but may be found up to 2500 feet; it occupies the most humid and productive forest land along river valleys. Black spruce occurs mostly between 1000 and 3000 feet.

Sitka spruce/Black spruce

Cone Production Characteristics: In Sitka spruce, pollination occurs in late-April to early May; cones ripen in mid-September of the same year. Cones are collectable when the seed coat and wing have turned a golden-brown color, the endosperm is firm and the yellowish-green embryo has elongated beyond 75% of seed length.

In black spruce, pollination occurs in mid-June and cones mature in early September of the same year. Cones are persistent and semi-serotinous; viable seeds are shed slowly over a period of about 4 years. This semi-serotinous habit ensures an almost constant seed supply. However, it is best to collect shortly after the cones mature. Mature cones are purple, the seed endosperm is firm and the yellowish-green embryo has elongated beyond 75% of seed length.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection	Approx. picking dates
			Avg.	Range			½sect. per cone	
Picea sitchensis	20	2½-4	3-4	2-5	1-3	1700	7-10	Sept.
Picea mariana	10	½-1½	4-5	2-6				Sept.

Cone Collection:

1. Stand and Tree Selection -- cones should be collected only from stands and trees of good form.

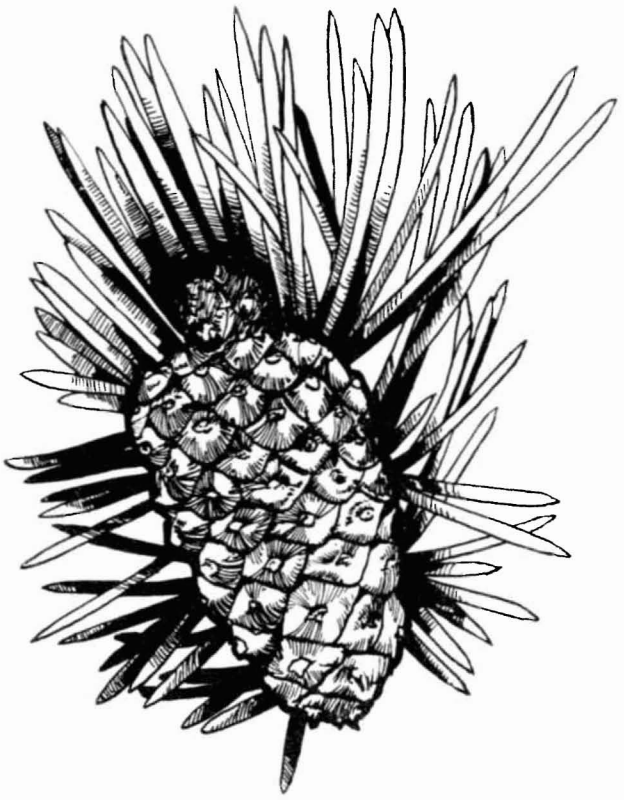
2. Cone Picking Methods -- in Sitka spruce, cone collections are usually made from felled trees or squirrel caches. Since mature trees can be 200 feet tall and surrounded by heavy underbrush, it is especially important to fell trees into areas which have been cleared of brush and debris. When collecting black spruce cones, care must be exercised to collect freshly ripened cones to optimize yield and viability.

3. Post-collection Handling -- cones should be stored in cool, shaded and well-ventilated areas prior to transportation. Care should be taken to avoid heating and molding in the sacks, as well as loss from rodents.

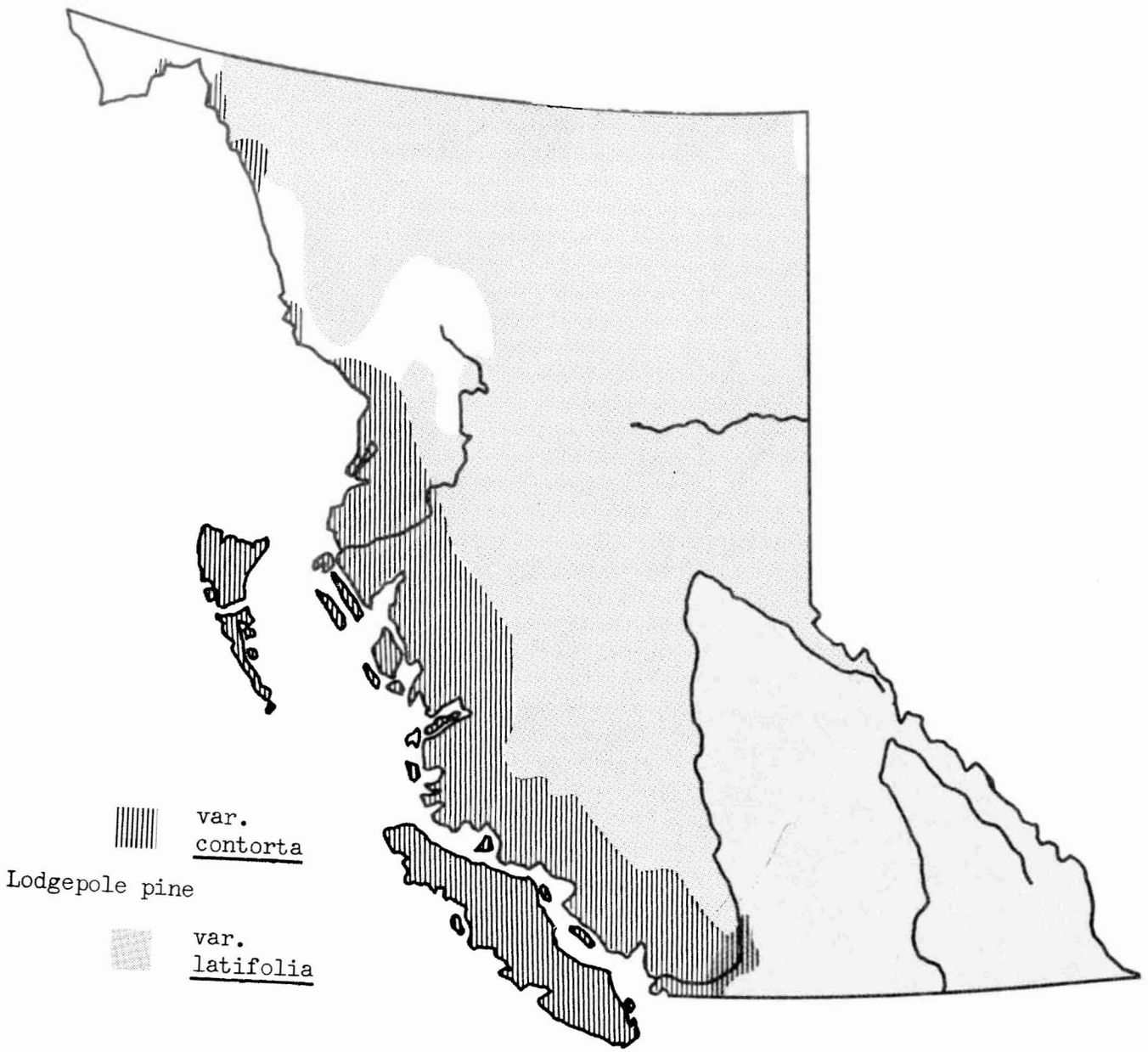
Personal Notes:

Sitka spruce/Black spruce

LODGEPOLE PINE (Pinus contorta)



Of the 80 or 90 species of Pinus, some 35 of which are native to North America, only 5 are found in B.C. Two varieties of lodgepole pine occur in the province: coastal, var. contorta and interior, var. latifolia. Both varieties have similar leaves, flowers and cones. The coastal variety is, however, generally scrubby, of poor form and of only minor reforestation importance, whereas the interior variety is of good form and is rapidly becoming a major component of the reforestation program.



Distribution:

Lodgepole pine is the most widespread of the conifer species in B.C. and may be found on a wide variety of sites from sea level to timberline.

Lodgepole pine

Cone Production Characteristics: Pollination usually occurs from mid-May to late June. The cones mature in late September of the year following pollination (2 year cycle). In the coastal variety cones are mainly non-serotinous, whereas the interior variety usually bears serotinous cones. Cone serotiny is silviculturally important in that large quantities of viable seed are available for release following a wild fire or cutting. In both varieties, cones persist on the trees for many years but only freshly ripened cones have the highest numbers of viable seeds. This makes cone selection an important feature of lodgepole pine cone collections. Immature cones are dark green in August and early September. The seeds are ripe when the cones have turned a shiny golden-brown (late September-October).

In the coastal variety only freshly ripened cones, found near the branch tips, should be collected. Cones further along the branch are older, have a weathered appearance and contain negligible amounts of useable seeds; they should be avoided. The collection period from standing trees is variable, depending upon the degree of cone serotiny, and the period between cone ripening and seed dispersal may be four weeks or longer.

For the interior variety, the cones of which are mainly serotinous, four cone classes have been defined:

i) freshly ripened,
ii) partially weathered, closed cones,
iii) completely weathered, closed cones,
iv) partially-opened or opened, old or new, cones

Only freshly ripened and partially weathered, closed cones should be collected. The period of cone collection is much longer than in the coastal variety; collections can be made anytime after ripening since few cones open while on the tree unless exposed to the high temperatures produced by forest fires. Fall collections (both varieties) are preferable to allowing the seed to remain on the tree overwinter which may reduce seed viability; best cone opening in the kiln, and thus seed recovery, is also obtained from fall collections.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection		Approx. picking dates
			Avg.	Range			½sect.	per cone	
Pinus contorta	10-15	1-2	3	2-4	1-2	3000		15-20	Oct.

Cone Collection:

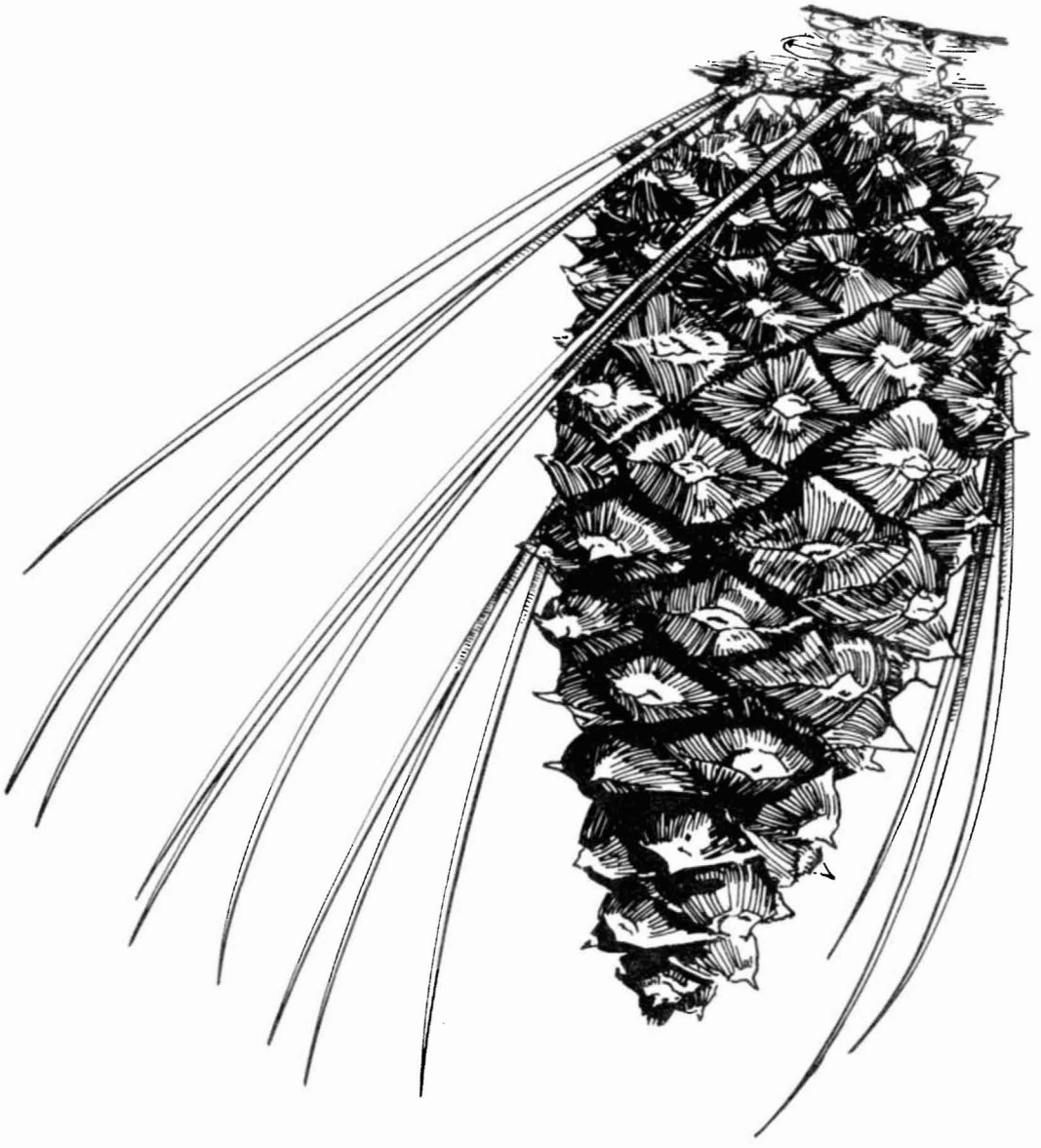
1. Stand and Tree Selection -- cones should only be collected from stands and trees with good form. Particularly in interior lodgepole pine, cones should not be collected from trees heavily infested with dwarf mistletoe.

2. Cone Picking Methods -- the spiney cones are usually picked from felled trees or squirrel caches. Cones are persistent and picking is easier when temperatures of 0°F (-18°C) are reached since the cone stalks are then brittle.

3. Post-collection Handling -- since cone moisture levels are usually low, well-ventilated interim storage, while desirable, is not essential. Prolonged storage should be avoided as there appears to be tension loss in the cone scale release mechanism, leading to subsequent extraction problems.

Personal Notes:

PONDEROSA PINE (Pinus ponderosa)



Ponderosa pine frequently occurs in pure, but open, park-like stands on dry and generally unproductive forest sites. It will grow on a wide variety of soils, making its best growth on well-drained deep, moist soils. This species represents a very minor component of the provincial reforestation program.

Distribution:

Ponderosa pine is found only in the south-central and south-eastern parts of the province from 800 feet in the Fraser Canyon area, to 3500 feet further east.

Ponderosa pine

Cone Production Characteristics: Pollination occurs between mid-May and mid-June. At this time, the female conelets are about one inch long; they continue growing through the first growing season and reach full size about mid-August of the second growing season. Cones are ripe in late August to early September and are collectable when they have turned from a green-yellow to a yellowish-brown. Cone collection period from standing trees is about 14-20 days.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection		Approx. picking dates
			Avg.	Range			½ sect.	per cone	
Pinus ponderosa	16-20	3-6	3	2-5	3-4	250	12-15	75	late Aug. to early Sept.

Cone Collection:

1. Stand and Tree Selection -- collect cones only from stands and trees of good form.

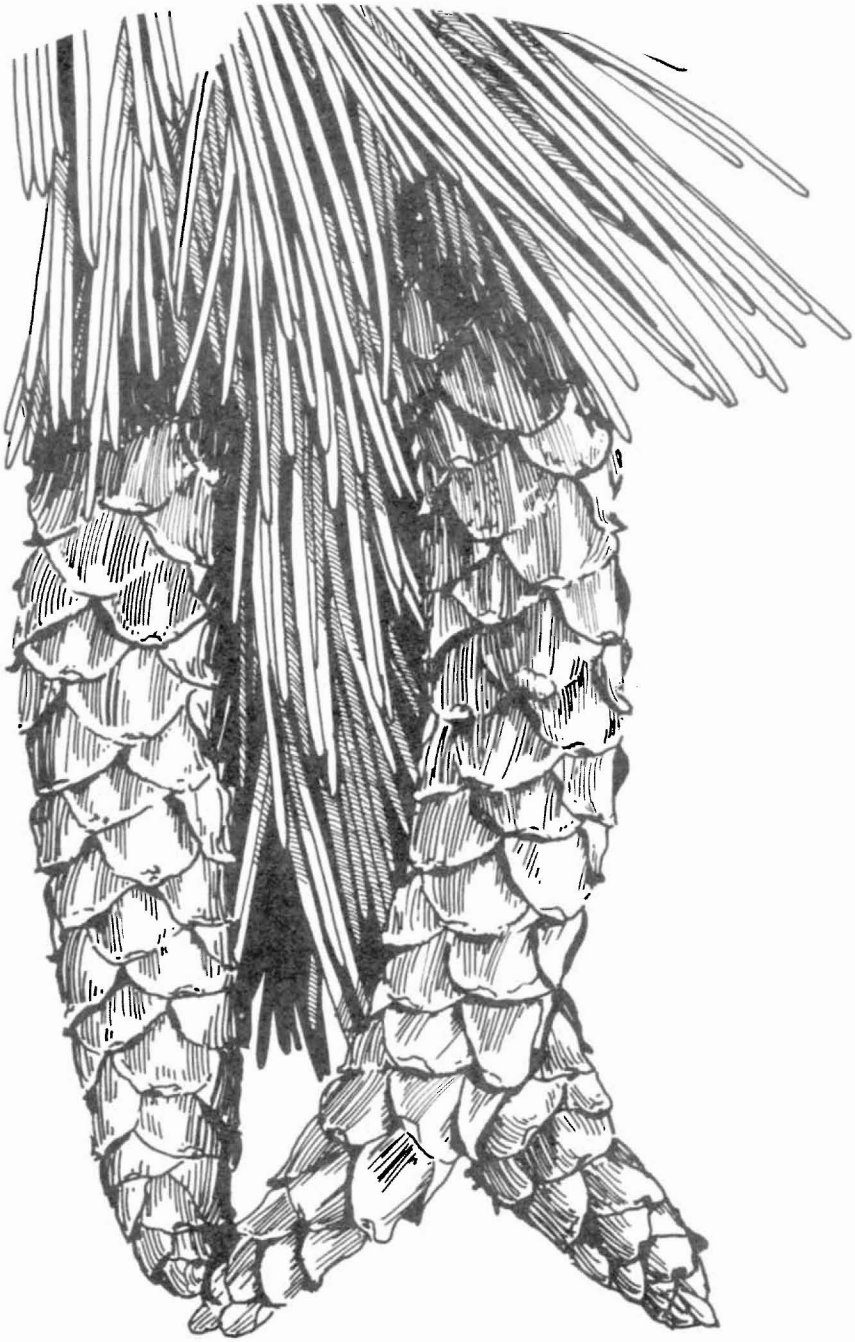
2. Cone Picking Methods -- cones can be picked by climbing, from felled trees, or from squirrel caches. The branches are brittle, so extra care must be taken when climbing. Cones should be bent towards end of branch to break the stalk; they can also be knocked or shaken off and gathered from the ground later. (Heavy cones and wind-firmness make this species a candidate for mechanical tree shaking as a collection method). As cones have sharp prickles protruding from the scales, gloves are essential.

3. Post-collection Handling -- cones should be stored in cool, well-ventilated and shaded areas prior to transportation. Precautions against heating and molding in the sacks, and from loss from rodents, must be taken.

Personal Notes:

Ponderosa pine

WESTERN WHITE PINE (Pinus monticola)



Throughout its range in B.C., western white pine grows in a wide variety of soils and sites. It is a very fast growing tree, generally overtoppping its competitors on most sites. The species is attacked by white pine blister rust and many trees fail to reach merchantable size. Due to the severity and extent of this disease, reforestation of western white pine has been negligible. However, efforts in breeding blister rust-resistant strains are promising and this species could obtain a prominent role in the reforestation program.

Distribution:

Western white pine occurs in the southern part of the coastal mountains from sea level to timberline. In the wet belt of the Interior, it is found between 1000 and 5500 feet.

Western white pine

Cone Production Characteristics: Pollination occurs in mid-June to mid-July. The conelets are $\frac{1}{2}$ to $1\frac{1}{2}$ inches long at pollination. They develop through two growing seasons and, when mature, may exceed 10 inches in length. Cones are collectable when they turn from green to a yellowish or red-brown. The cone collection period from standing trees is about 14 days.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection		Approx. picking dates
			Avg.	Range			$\frac{1}{2}$ sect.	per cone	
Pinus monticola	10-15	4-10	4	3-7	$\frac{1}{2}$-1	25-30	6-8	90	late Aug. to early Sept.

Cone Collection:

1. Stand and Tree Selection -- cones should be collected only from stands and trees of good form. As the white pine blister rust has restricted reforestation of this species to date, cone collections will be for experimental purposes only. Cones should normally be gathered from rust resistant trees in a generally heavily infested area.

2. Cone Picking Methods -- cones should be picked by climbing or from felled trees. They are very resinous and gloves are essential.

3. Post-collection Handling -- cones should be stored in cool, well-ventilated and shaded areas prior to transportation. Precautions against heating and molding in the sacks, and loss from rodents, should be taken.

Personal Notes:

Western white pine

LIMBER PINE (Pinus flexilis)

WHITEBARK PINE (Pinus albicaulis)

Whitebark pine

Both limber and whitebark pines are timberline trees of similar general appearance. The cones are readily distinguishable, however. Neither species is important in B.C., either for timber or reforestation purposes, at the present, but they are important components of the alpine forest. Limber pine, especially, grows to considerable size and has good form on some sites; it could become useful in high elevation reforestation.

Distribution:

Limber pine is found only in the headwaters of the Columbia river, between 3000 and 6000 feet. Whitebark pine occurs in both the southern parts of the Rocky Mountains and the Coastal Range, between 3000 and 6000 feet.

Limber pine/Whitebark pine

Cone Production Characteristics: Both species are similar in cone production habits. Pollination occurs in late June to July. Cones develop through two growing seasons before they reach maturity. In whitebark pine, cones are considered collectable when they turn from a purplish color to brown. They remain closed after ripening, fall from the tree, and must decay on the ground before the wingless seeds are released. Because of this, the collection period is a prolonged one. Limber pine cones are usually collectable when they turn from green to a light brown color. They open after ripening and the cone collection period from standing trees is limited to about 3 weeks; the seed is almost wingless.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection		Approx. picking dates
			Avg.	Range			½ sect.	per cone	
Pinus albicaulis	20-30	1½-3		3-5					Aug. to Sept.
Pinus flexilis	20-40	3-8	3	2-4					late July, Aug. to Sept.

Cone Collection:

1. Stand and Tree Selection -- there are few limitations in selecting trees of either species from which cones may be collected. Severely deformed, or diseased trees should be avoided.

2. Cone Picking Methods -- the usual method of collecting cones is by climbing. Collections from mature whitebark pine trees in a closed stand would be from felled trees; provided snow conditions permitted, fallen, but still intact, cones might be collected from the ground.

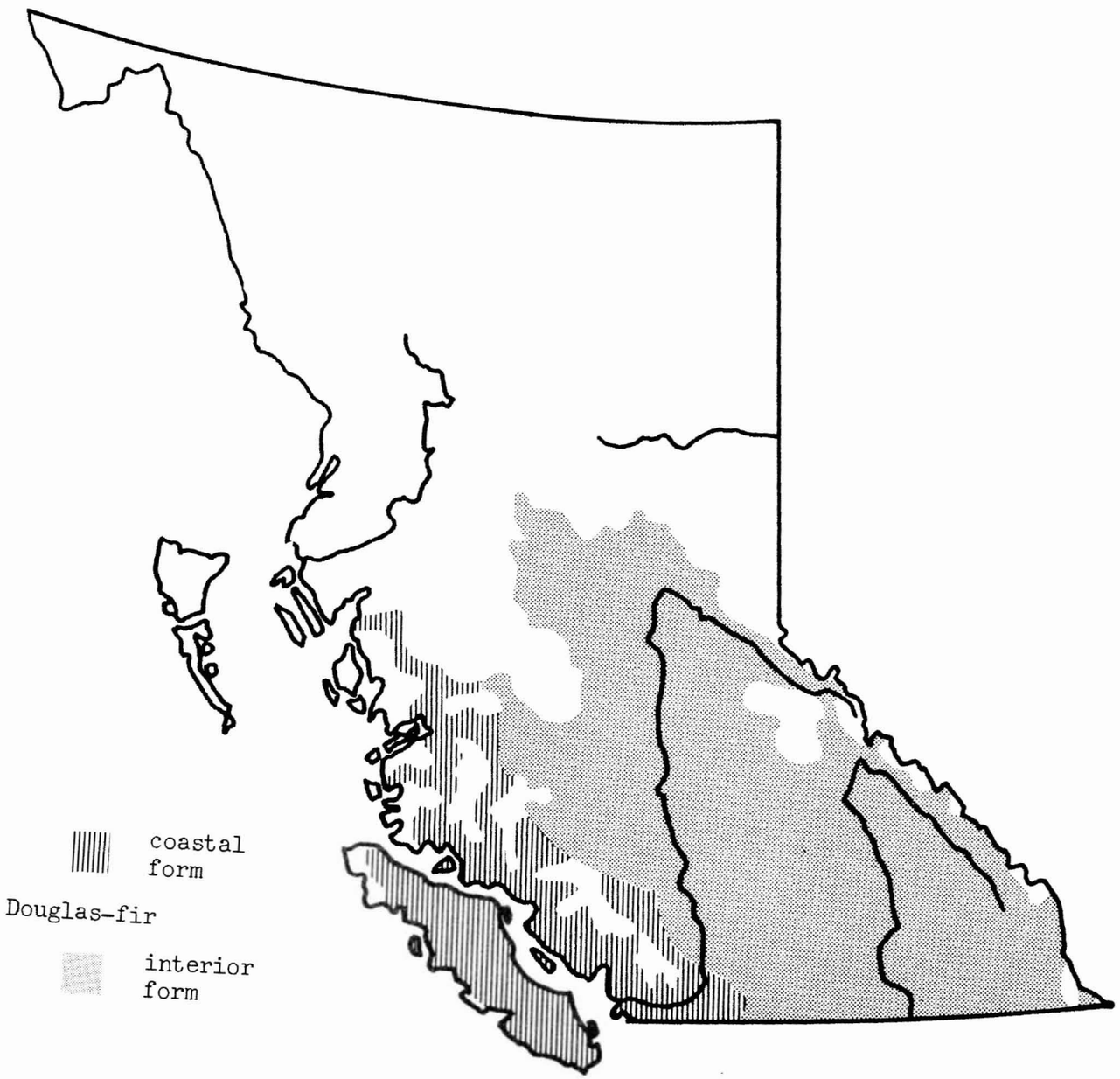
3. Post-collection Handling -- cones should be stored in cool, well-ventilated and shaded areas prior to transportation. Precautions against heating and molding in the sacks, and against loss from rodents, must be taken.

Personal Notes:

Limber pine/Whitebark pine

DOUGLAS-FIR (Pseudotsuga menziesii)

Two of the 6 species of Pseudotsuga are native to western North America. Only one grows in B.C. but two forms, coast and interior, are generally recognized. Douglas-fir has been, and still is, the major species used for reforestation in the province. It is a fast growing tree throughout most of its range and is a popular reforestation species in other countries.



Distribution:

The coastal form of Douglas-fir occurs from sea level to 4000 feet while the interior form is found as high as 5000 feet.

Douglas-fir

Cone Production Characteristics: Pollination occurs from mid-April through the first week of May. Cones ripen in late summer or early fall of the same year. Cones may be picked up to 4 weeks before seed dissemination begins and, if stored in sacks in cool, well-ventilated and shaded areas, they will continue to ripen artificially and good quality seeds will be obtained. Cones are usually considered collectable when they have turned predominantly brown or purplish; the seed coats and wings of ripe seeds are golden brown, the seeds will detach readily from their scales and their endosperm has become firm. Old cones, recognizable by their grey-brown weathered appearance and stiffly open scales, should be avoided.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection		Approx. picking dates
			Avg.	Range			$\frac{1}{2}$sect.	per cone	
Pseudotsuga menziesii	12-16	2-4	5	2-10	1-3	1000	4-6		mid-Aug. to early Sept.

Cone Collection:

1. Stand and Tree Selection -- cones must not be collected from trees with crooked or deformed stems and branches or, for the Interior form, from trees heavily infested with dwarf mistletoe. Since a host of insects attack Douglas-fir cones and seeds, infested cones should be avoided where possible. Damage from insect attack is usually inversely proportional to the abundance of cones.

2. Cone Picking Methods -- cones may be picked from standing trees, felled trees or squirrel caches. Young trees that are relatively open grown are easily climbed.

3. Post-collection Handling -- cones should be stored in cool, well ventilated and shaded areas prior to transportation. This is especially important if cones have been picked early and are expected to ripen in the sack. All precautions against heating and molding in the sacks must be taken; this is again very important for early collected cones which are much more sensitive to degradation factors than mature cones. Precautions against loss from rodents must also be taken.

Personal Notes:

WESTERN RED CEDAR (Thuja plicata)

Of the 2 species of Thuja native to North America, only T. plicata grows in B.C. Because this species regenerates well naturally, only minimal numbers of seedlings have been planted to date. It is expected that its reforestation important will increase in the future as decadent, overmature western red cedar stands are rehabilitated.

Distribution:

Western red cedar is confined almost entirely to regions with abundant precipitation and atmospheric humidity. It may be found above 4500 feet but its growth becomes very stunted.

Western red cedar

Cone Production Characteristics: Pollination may occur as early as mid-April on warmer sites, but at higher elevations flowering may be delayed until late May or early June. Cones mature in late summer or early fall of the same year. They should be picked as soon as they turn brown and the seed has become firm. Current cones are borne very near branchlet tips; old cones, distinguishable by their weathered, grey-brown color and open scales, are found further along the branch, and should be avoided. It is suspected that cedar seeds have a shorter storage life than many other conifers; this is offset by frequent seed crops. Therefore, it is unnecessary to maintain more than a five-year seed inventory.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection	Approx. picking dates
			Avg.	Range			$\frac{1}{2}$sect. per cone	
Thuja plicata	16	$\frac{1}{2}$-$\frac{3}{4}$	2-3	1-4				Aug. to Sept.

Cone Collection:

1. Stand and Tree Selection -- there are few limitations in selecting cedar trees from which cones may be collected. Severely deformed trees should be avoided.

2. Cone Picking Methods -- cones should be picked from standing trees or from fresh slash. Cone rakes may be used to collect cones from felled trees.

3. Post-collection Handling -- cones should be stored in cool, well-ventilated and shaded areas prior to transportation. Precautions against heating and molding in the sacks, and from loss from rodents, must be taken.

Personal Notes:

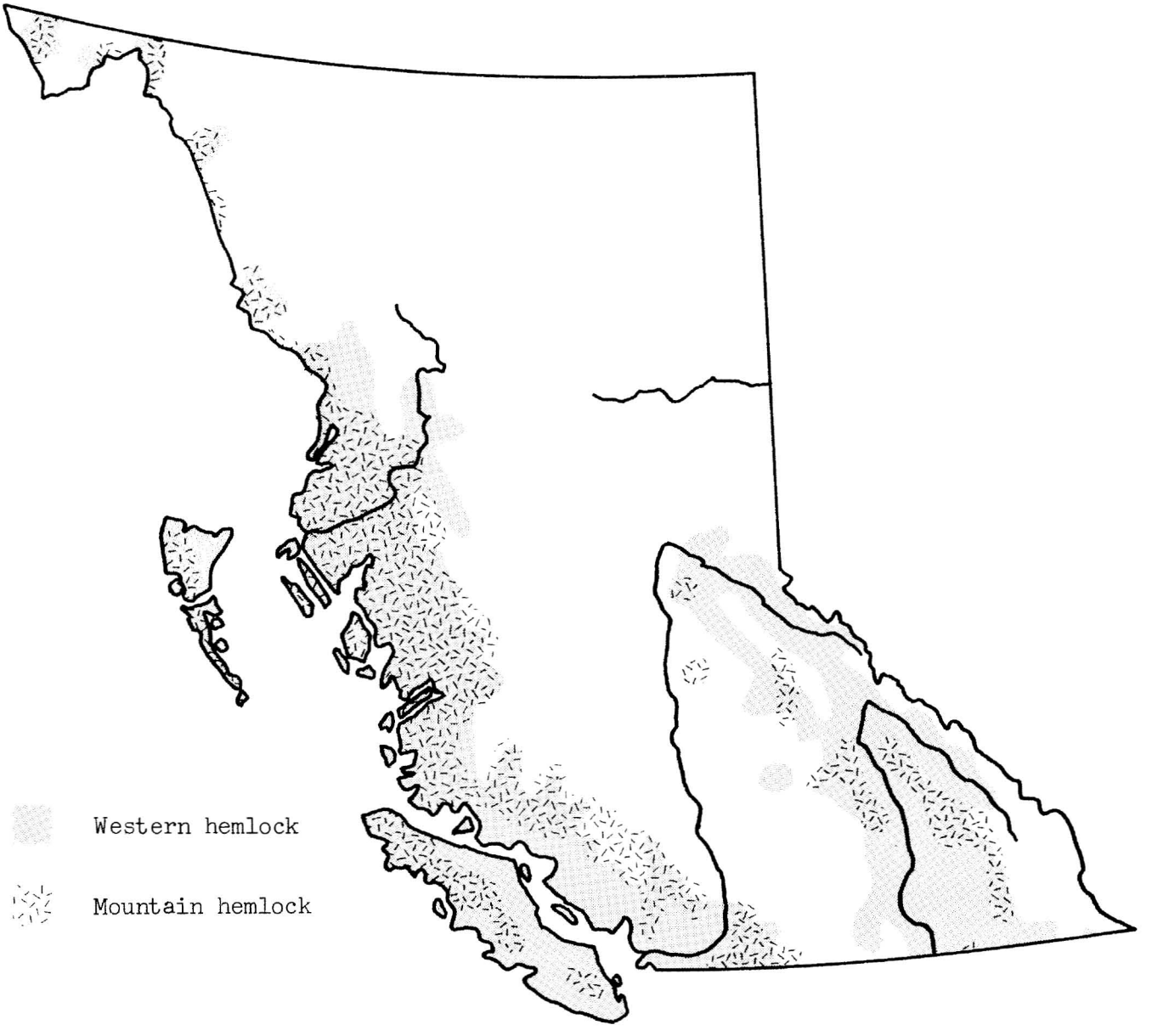
Western red cedar

WESTERN HEMLOCK (Tsuga heterophylla)

MOUNTAIN HEMLOCK (Tsuga mertensiana)

Western hemlock

Of the 4 species of Tsuga native to North America, 2 grow in B.C. Western hemlock is one of the commercially most important tree species in the province. It has come into increasing demand in the reforestation program and this trend is expected to accelerate. Mountain hemlock has comprised only a very small component of the provincial reforestation program but this species is likely to increase in importance as more attention is given to the regeneration of high elevation sites.



Distribution:

Western hemlock develops best between sea level and 2000 feet, ranging up to 5000 feet in the Selkirk Mountains. Mountain hemlock is a timberline species commonly occurring between 3000 and 5000 feet.

Western hemlock/Mountain hemlock

Cone Production Characteristics: In western hemlock, pollination occurs from April, in the southern part of the range, to May in the northern part. In mountain hemlock, pollination takes place in June or July. In both species, cones ripen in the autumn of the same year in which pollination occurs. Cones should be picked as soon as they ripen, i.e. when they have changed from green to purplish or brown. Old cones of western hemlock should be avoided; these are recognized by their dark brown/greyish color and their open scales. In mountain hemlock, cones usually fall off the tree in spring or early summer of the second year.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection		Approx. picking dates
			Avg.	Range			$\frac{1}{2}$ sect.	per cone	
Tsuga heterophylla	25-30	$\frac{3}{4}$-$1\frac{1}{4}$	3-4	2-8		30000	3-4		Sept.
Tsuga mertensiana	20	$\frac{3}{4}$-3		1-5					Sept. to Oct.

Cone Collection:

1. Stand and Tree Selection -- cones should not be collected from trees with crooked or deformed stems and branches or from trees heavily infested with dwarf mistletoe.

2. Cone Picking Methods -- cones should be picked by hand from standing trees or fresh slash. Cone rakes may be used when picking from felled trees.

3. Post-collection Handling -- cones should be stored in cool, well-ventilated and shaded areas prior to transportation. Precautions against heating and molding in the sacks, and from loss from rodents, must be taken. Since western hemlock seeds can germinate in cool, moist conditions, cones should be extracted promptly after picking. Do not store longer than one month.

Personal Notes:

Western hemlock/Mountain hemlock

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APPENDICES

APPENDIX I - Glossary of terms

Embryo - the rudimentary "seedling" contained within the seed.

Endosperm - the nutritive tissue within the seed which provides food for the embryo during germination and early development (Note: Strictly speaking, the term endosperm cannot be applied to conifer seeds, but it is commonly used, anyway).

Fertilization - The union of nucleii affected by the transfer of genetic material from pollen grain to ovule after which the latter structure may develop into a seed.

Phenotype - An organism as observed - i.e. as judged by its visually perceptible characteristics.

Pollination - The transfer of pollen from the male flower to the receptive part of the female flower.

Provenance - 1) The geographical area and environment to which the parent trees are native 2) The geographical source, i.e. place of origin, of a given lot of seed or pollen.

Seed lot - Those seeds having in common species, provenance, time of collection and handling history and which are identified by a common number for reforestation purposes.

Seed zone - A partially-arbitrary zone designated on the basis of biogeoclimate and forest management units. Seed zones serve as a means of ensuring that reforestation stock is planted within the general area from which its seeds were collected.

Serotinous - A term applied to cones which remain on the tree without opening for a year or more after they mature.

APPENDIX II - Forest regulations pertaining to the picking of tree cones and seeds.

B.C. Reg. 197/71

FOREST ACT

REGULATION MADE BY ORDER IN COUNCIL 3061, APPROVED AUGUST 24, 1971

REGULATION ON THE PICKING OF TREE CONES AND TREE SEEDS

Division (1)—Application of Regulation

1.01 For the purpose of this regulation, tree cones and tree seeds include any cones from trees or tree seeds of forest-tree species of British Columbia, or those tree species grown in tree-seed orchards or specificially for the purpose of producing tree seeds for reforestation or afforestation.

Division (2)—Permits

2.01 No person shall take tree cones or tree seeds from trees on lands the title to which is in the Crown without having first obtained a permit so to do, as further provided in this regulation.

2.02 The Chief Forester may grant or refuse to grant a permit to any person for the purpose of collecting tree cones or tree seeds from trees on Crown lands not held under licence or lease, subject to this regulation and to such further and other terms and conditions as the Chief Forester deems advisable.

2.03 The Chief Forester may grant or refuse to grant a permit to any person for the purpose of collecting tree cones or tree seeds from trees on lands held under licence or lease from the Crown on the consent of such licensee or lessee, subject to this regulation and to such further and other terms and conditions as the Chief Forester deems advisable.

Division (3)—Damage to Trees

3.01 No person shall cut down or top or cause to be felled any tree, or cut or break off branches of any tree, or otherwise damage any tree on Crown lands for the purpose of collecting the tree cones or tree seeds from such tree.

3.02 Section 3.01 shall not apply to tree cones and tree seeds collected from lands designated for the continuous production of tree cones and tree seeds, and lands maintained as seed orchards, provided that the management of all of the said lands is under the supervision of a professional forester registered under the laws of the Province of British Columbia.

3.03 Notwithstanding section 3.01, the Chief Forester may authorize the felling of trees on Crown lands not otherwise alienated for the purpose of harvesting tree cones or tree seeds therefrom or the cutting of branches or parts of the tree as may be necessary for the propagation of seed orchards.

Division (4)—Licences to Purchase Tree Cones or Tree Seeds

4.01 Every purchaser, including agents of purchasers, of tree cones or tree seeds shall

(*a*) secure and be in possession of a licence to purchase tree cones and tree seeds granted by the Minister of Lands, Forests, and Water Resources;

(*b*) not purchase tree cones or tree seeds from any person who does not possess a valid permit issued by the Chief Forester to harvest tree cones or tree seeds from lands the title to which is in the Crown;

(*c*) not purchase tree cones or tree seeds from any person who does not hold a written consent from the owner of private lands or the lessee or licensee of lands;

(*d*) keep a register in which shall be entered every purchase of tree cones or tree seeds showing

(1) name and address of vendor;

(2) date of purchase;

(3) number of bushels of tree cones or weight of tree seeds purchased;

(4) area from which tree cones and (or) tree seeds were obtained and the legal description thereof;

(5) name and address of the person issuing the permit or consent;

(6) number of permit, if any;

(*e*) keep every register, as required under 4.01 (*d*) above, within the Province of British Columbia, which may be inspected and notations made therefrom by any person authorized by the Chief Forester at any reasonable hour.

Division (5)—Manufacture Within the Province

5.01 All tree cones collected from Crown lands pursuant to this regulation shall be processed for the seeds from them within the Province; provided, however, the Chief Forester may grant permission relieving a person of the requirement of this regulation.

Division (6)—Penalty

6.01 Every person who violates or fails to comply with any of the provisions of this regulation or any term or condition of any permit or licence or consent issued or given thereunder is guilty of an offence and liable, on summary conviction, to the penalties provided under the general provisions of the *Forest Act*.

Reprinted from *The British Columbia Gazette*—Part II, September 9, 1971.

APPENDIX III - Permits and Licences

PROVINCE OF BRITISH COLUMBIA	FOREST SERVICE	DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES

Permit to Harvest Tree-seed and Cones on Crown Lands or Lands Held under Licence or Lease from the Crown

No. 28027

J. Dee, of Vanderhoof

is hereby authorized to harvest tree-seed and cones from the following Crown lands:

Lots 110 & 111

Cariboo Land District

or, having duly secured the consent of the respective Licensee or Lessee or their authorized representatives as indicated by the signature herewith, is hereby authorized to harvest tree-seed and cones from the following lands held under licence or lease from the Crown:

Land District,

from the date of this permit until 30th September, 1973

subject to the following conditions:—

(1) No tree shall be cut down, felled, or topped, or the branches cut or broken off, or the tree otherwise damaged in any way for the purpose of collecting the cones or tree-seed from such tree.
(2) The Permittee named herein is authorized to collect cones or tree-seed only in the area described in this permit.
(3) This permit shall be automatically suspended during any forest closure covering the area described in this permit.
(4) No person shall transport any cones during a general forest closure.

August 15, 1973
(Date of issue)

J. White, *Forest Officer,*
Common Place *Ranger District,*
Prince George *Forest District.*

I have read and understand the terms and conditions of this permit and the regulations governing the collection and sale of cones and tree-seed under which it was issued and solemnly declare that I will comply therewith in every respect.

..... *Permittee.*

F.S. 504—250 bks. (50)-570-4499 (4)

PERMIT ISSUED FREE OF CHARGE.

FOREST SERVICE

VICTORIA, B.C.

No. _____

LICENCE to PURCHASE TREE CONES and TREE SEED

(Issued pursuant to the Forest Act and Regulations)

Pursuant to the provisions of B.C. Reg. 197/71, being a regulation on the picking of tree cones,

_____

(Name)

_____

(Address)

is hereby licensed to buy, sell and deal in tree cones and tree seeds subject to the provisions of the said B.C. Reg. 197/71: and subject to the following conditions:

1. The licensee shall comply with all the requirements set forth in Division 4 of the said regulation on back hereof;

2. This licence shall expire on the 1st day of July following date of issue;

3. Date of issue _____, 19____.

_____

Minister of Lands, Forests,
and Water Resources.

Division 4 of the said regulation B.C. Reg. 197/71 provides as follows:

4.01 Every purchaser, including agents of purchasers, of tree cones or tree seeds shall

(a) secure and be in possession of a licence to purchase tree cones and tree seeds granted by the Minister of Lands, Forests, and Water Resources;

(b) not purchase tree cones or tree seeds from any person who does not possess a valid permit issued by the Chief Forester to harvest tree cones or tree seeds from lands the title to which is in the Crown;

(c) not purchase tree cones or tree seeds from any person who does not hold a written consent from the owner of private lands or the lessee or licensee of lands;

(d) keep a register of every purchase of cones or tree seed showing

(1) name and address of vendor;
(2) date of purchase;
(3) number of bushels of tree cones or weight of tree seeds purchased;.
(4) area from which tree cones and (or) tree seeds were obtained and the legal description thereof;
(5) name and address of the person issuing the permit or consent;
(6) number of permit, if any;

(e) keep every register, as required under 4.01 (d) above, within the Province of British Columbia, which may be inspected and notations made therefrom by any person authorized by the Chief Forester at any reasonable hour.

Note: The British Columbia Forest Service will only store and handle tree seed that has a ninety-five percent purity analysis; that is between six to nine percent moisture content; and that is properly identified as to origin as certified on the Cone Collector's Report Form (F.S. 721).

Original - Licensee
Copy - District Forester
Copy - Reforestation Division

TABLE 1. Cone production characteristics of B.C. conifers.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection		Approx. picking dates
			Avg.	Range			½sect.	per cone	
Abies amabilis	20	3½-5	2-3			250			late Aug. to mid-Sept.
Abies grandis	20	2-4½	5-6	3-8		250			late Aug. to mid-Sept.
Abies lasiocarpa	20	2½-4½	3	2-5		300			mid-Sept. to mid-Oct.
Chamaecyparis nootkatensis		¼-½	2-4					2	Aug. to Oct.
Larix occidentalis	40-50	1-1½	5-6			4000	5	40	Aug. to Sept.
Larix lyalli		1½-2							Aug. to Sept.
Larix laricina	40	½	5-6						Aug. to Sept.
Picea glauca	20	1½-2	6	2-12		4000	7-10		mid-Aug. to Sept.
Picea engelmannii	16	1-3	5	2-10		3000	7-10		mid-Aug. to Sept.
Picea sitchensis	20	2½-4	3-4	2-5	1-3	1700	7-10		Sept.
Picea mariana	10	½-1½	4-5	2-6					Sept.

TABLE 1. Cone production characteristics of B.C. conifers.

Species	Cone bearing age begins (years)	Cone size (in.)	Years between collectable crops		Yield per mature tree (bushels)	Cones per bushel	Min. filled seed count for collection		Approx. picking dates
			Avg.	Range			$\frac{1}{2}$sect.	per cone	
Pinus contorta	10-15	1-2	3	2-4	1-2	3000		20-25	Oct.
Pinus monticola	10-15	4-10	4	3-7	$\frac{1}{2}$-1	25-30	6-8	90	late Aug. to early Sept.
Pinus ponderosa	16-20	3-6	3	2-5	3-4	250	12-15	75	late Aug. to early Sept.
Pinus albicaulis	20-30	$1\frac{1}{2}$-3		3-5					Aug. to Sept.
Pinus flexilis	20-40	3-8	3	2-4					late July, Aug. to Sept.
Pseudotsuga menziesii	12-16	2-4	5	2-10	1-3	1000	4-6		mid-Aug. to early Sept.
Thuja plicata	16	$\frac{1}{2}$-$\frac{3}{4}$	2-3	1-4					Aug. to Sept.
Tsuga heterophylla	25-30	$\frac{3}{4}$-$1\frac{1}{4}$	3-4	2-8		30000	3-4		Sept.
Tsuga mertensiana	20	$\frac{3}{4}$-3		1-5					Sept. to Oct.

TABLE 2. Seed yields for B.C. conifers. Data are based on B.C. Forest Service cone collections from 1962 through 1971; values for the last 6 species are based on limited data.

	Average Seed Yields							
	Lbs. of seed per bushel of cones	Kgs. of seed per bushel of cones	No. of seeds per lb.	Range	No. of seeds per kg.	Range	Ave. no. of viable seeds per bushel	Range
Douglas-fir								
Coast (0-1500 ft.)	.515	.234	49,150	38-63M	108,130	83-139M	19,280	4-34M
Coast (above 1500 ft.)	.510	.232	50,010	36-72M	110,030	80-160M	19,440	5-28M
Interior (Wet Belt)	.662	.301	48,700	36-67M	107,150	78-148M	23,880	3-45M
Interior (Dry Belt)	.504	.229	48,800	37-61M	107,370	82-133M	17,050	6-38M
Western hemlock	.717	.326	242,920	169-413M	534,440	371-909M	93,860	9-264M
Western red cedar	.961	.437	367,210	256-482M	807,870	563-1060M	352,800	82-370M
Sitka spruce	.451	.205	209,270	159-316M	460,400	349-696M	59,840	11-178M
White spruce	.539	.245	238,700	188-399M	525,140	414-878M	66,500	7-211M
Engelmann spruce	.530	.241	224,830	121-310M	494,630	268-681M	57,380	5-162M
Lodgepole pine (Interior)	.183	.083	155,845	124-209M	342,860	273-460M	12,690	4-61M
Ponderosa pine	1.654	.752	9,740	8-11M	21,420	18-23M	13,100	7-17M
Western white pine	.475	.216	29,260	24-40M	64,370	53-87M	3,460	2-32M
Western larch	.508	.231	168,230	81-434M	370,100	178-954M	44,820	7-161M
Grand fir	1.811	.823	22,270	20-25M	49,000	43-55M	23,530	9-63M
Alpine fir	1.111	.504	53,090	45-66M	116,800	100-146M	10,280	4-35M
Amabilis fir	2.022	.919	17,000	15-22M	37,400	33-49M	8,230	3-23M

APPENDIX V - Forms

FORM 1. Cone Crop Survey and Evaluation Form (F.S. 727).
Report number 1 illustrates the rating, in mid-July, of a Douglas-fir cone crop.

BRITISH COLUMBIA FOREST SERVICE

CONE-CROP SURVEY AND EVALUATION, 19 74

REFORESTATION DIVISION

Species D FIR Forest District N Ranger District 3 GOLDEN Location WAITABIT CRK.

Ownership (if known) VCL Nat. Topog. Grid Ref. B2N11 Aspect SE

Elevation range 3,500 - 4,000 Slope < 10% Approx. acreage 120? Age-class: -40. ☐ 40-100. ☑ 100+ ☐

Lot, TS, etc. Accessibility GOOD 2WD Stand description DF - S - (PL)

Collection methods: Squirrel cuttings. ☐ Climbing. ☑ F.&B. ☐ Cone condition

Insects Seed condition: Milky. ☐ Doughy or firm. ☐

Embryo development Wing and seed colour: White. ☐ Pale brown. ☐ Brown. ☐

CUTTING TEST

Filled Seeds per Cone Section (Sample trees must be well distributed throughout stand.)

Tree No.	Cone Position in Crown: Top 1	2	3	Middle 4	5	6	Lower 7	8	9	Totals	Average
1											
2											
3											
4											
5											
6											
Totals											

NUMERICAL RATING OF CONE CROP
(Circle numerical rating which applies.)

None.	1. No cones on any seed trees.
Very light.	2. Few cones on less than 25 per cent of the seed trees.
Light.	3. Few cones on more than 25 per cent of the seed trees.
Medium.	4. Many cones on 25 to 50 per cent of the seed trees.
(Heavy.)	5. Many cones on more than 50 per cent of the seed trees. *A seed tree is any dominant and codominant tree of seed-bearing age.*

Date JULY 13/74 Initials T.F.O.

I have examined this stand and recommend/do not recommend it for cone-collecting

to commence about and estimate possible yield at approximately bushels.

Please forward along with the Summary Form F.S. 719a in duplicate to the District office by July 31st of each year.

District Reforestation Officer to submit summary copy of F.S. 719a's to Victoria as soon as possible.

(Date) Reforestation Officer

F.S. 727—5M bks. (25)-771-5985 (2)

REPORT #1

Report number 2 shows how the form used for the July rating is completed in the follow-up evaluation, carried out in late August, of the same Douglas-fir crop.

BRITISH COLUMBIA FOREST SERVICE

CONE-CROP SURVEY AND EVALUATION, 19 74

REFORESTATION DIVISION

Species D. FIR Forest District N Ranger District 3 GOLDEN Location WAITABIT CRK.

Ownership (if known) VCL Nat. Topog. Grid Ref. B2N11 Aspect SE

Elevation range 3500 - 4000 Slope < 10% Approx. acreage 120? Age-class: -40. ☐ 40-100 ☑ 100+ ☐

Lot, TS, etc. Accessibility GOOD 2WD Stand description DF - S - (PL)

Collection methods: Squirrel cuttings. ☐ Climbing. ☑ F.&B. ☐ Cone condition GOOD - BROWN COLOR

Insects Very few Seed condition: Milky. ☐ Doughy or firm. ☑

Embryo development 60-70% Wing and seed colour: White. ☐ Pale brown. ☐ Brown. ☑

CUTTING TEST

Filled Seeds per Cone Section (Sample trees must be well distributed throughout stand.)

Tree No.	Cone Position in Crown: Top 1	2	3	Middle 4	5	6	Lower 7	8	9	Totals	Average
1	8	7	5	7	6	6	6	5	5	55	6.1
2	6	7	7	6	5	8	7	5	8	59	6.6
3	8	8	6	5	7	8	6	6	7	61	6.8
4	5	7	7	8	7	7	7	7	7	62	6.9
5	6	8	9	6	5	8	8	5	4	59	6.6
6	7	7	6	7	5	7	7	6	6	58	6.4
Totals	40	44	40	39	35	44	41	34	37	354	6.6

NUMERICAL RATING OF CONE CROP
(Circle numerical rating which applies.)

None.	1. No cones on any seed trees.
Very light.	2. Few cones on less than 25 per cent of the seed trees.
Light.	3. Few cones on more than 25 per cent of the seed trees.
Medium.	4. Many cones on 25 to 50 per cent of the seed trees.
(Heavy.)	5. Many cones on more than 50 per cent of the seed trees. *A seed tree is any dominant and codominant tree of seed-bearing age.*

Date JULY 13/74 Initials T.F.O.

I have examined this stand and recommend/~~do not recommend~~ it for cone-collecting

to commence about AUGUST 26/74 and estimate possible yield at approximately 12,000 bushels.

Please forward along with the Summary Form F.S. 719a in duplicate to the District office by July 31st of each year.

District Reforestation Officer to submit summary copy of F.S. 719a's to Victoria as soon as possible.

(Date) August 19/74 Reforestation Officer J. Doe

F.S. 727—5M bks. (25)-771-5985 (2)

REPORT #2 - SAME STAND

FORM 2.

BRITISH COLUMBIA FOREST SERVICE

Reforestation Division

FOREST SERVICE CONE COLLECTOR'S REPORT

(see inside cover for instructions)

1060	V2-5	
Seed Zone Number (see instructions)	**Collector's Provisional Number** (see instructions)	**Official Registration Number** (leave blank)

1. Forest District Vancouver 2. Ranger District #2, Hope 3. Forest (PSYU) Dewdney
4. Owner's Name B.C.F.S. 5. Owner's Address
6. Collected by " 7. Supervisor A.J. Dickson
8. Number of Permit to Harvest Tree Seed and Cones (F.S. 504)
9. Species Douglas fir 10. Seed Class B3 11. Associated Species in Stand Lodgepole pine
12. Aspect of Stand South-West 13. Elevation Limits 2600 - 2800 feet
14. Location (River, Creek, Mountain, etc.) Shawatum Creek, Skagit River
15. National Topographical Grid Reference 92H3 16. Latitude 49° 06' 17. Longitude 121° 05'
18. Age of Trees collected from: Under 40 yrs [x] 40-100 yrs. [ ] over 100 yrs. [ ]
19. Number of Trees collected from 200 22. Number of Sacks of Cones Shipped 142
20. Date of Collection Aug. 30 - Sept. 3, 1973 23. Number of Bushels of Cones Shipped 213
21. Method of Collection Climbing 24. Condition of Cones when Shipped Dry & Cool
25. Purpose of Collection: Research only [ ]; General stock [x] Owner's Use [ ]
Reforestation special [ ]; Special request [ ] Other [ ] –
26. Collector's remarks (description of special trees, shipping instructions, etc.) Cones were stored in a sheltered location at the Ranger Station until transported by Engineering Division vehicle on September 10, 1973.

Date: September 14 1973 Supervisor's Signature A. J. Dickson
for G.D. Bertram,
Forest Ranger

Extractor's Report (see instructions)

Date Cones received 19 Number of sacks received
Number of bushels received
Condition of Cones when received
Date Extracted 19
Yield of Seed Kgm. (or) lbs. Purity %
Number of Containers of Seed Shipped to
Date Shipped 19 Shipped by
Moisture Content of Seed when Shipped %
Extractor's Remarks:

Extractor's Signature

F.S. 721

ORIGINAL – DUNCAN SEED CENTRE, Box 816, Duncan, B.C., V9L 3Y2

INSTRUCTIONS FOR COMPLETING CONE COLLECTOR'S REPORT FORM (F.S. 721 and 721A)

All forest tree seed handled by the British Columbia Forest Service must be registered. A central registry at the Duncan Seed Centre records and registers each seed lot. The completion of this form (F.S. 721 or 721A) is required for registration.

While most items to be completed are straightforward, special note should be made of the following items when completing this form:

Provisional Seed Zone Number — to be completed by the Forest District office or Duncan Centre. This number will relate to the Seed Zone map issued in November 1971 and subsequent revisions.

Collector's Provisional Seed Lot Number — This is the number by which the cones are identified when they are received at Duncan and given an official registration number. Each individual collector, if working alone on a small collection, or the person in charge of a crew collecting together from a single stand or location, will allot a collector's provisional seed lot number to each cone lot. These will run consecutively for each collector for each season. Normally all the cones from one species in one stand should be included in one seed lot unless the elevation range is more than about 500 feet.

Forest Service collections will be given provisional numbers based on Forest District, Ranger District and collection number (e.g. G15-1, G15-2, etc.).

Company collections should NOT use the Forest Service system of provisional number as this creates confusion. Company collections should be numbered according to Licence; e.g. TFL 18-1; TSHL A01445-3, etc. or should designate seed lots by company name or initial; e.g. Kaiser-1; C.F.I.-3.
All provisional numbers will begin at 1 on July 1st of each year.

Official Seed Registration Number — to be completed by the Duncan Seed Centre.

Item 6—This refers to the agency making the collection for the owner and not to the individual collector.

Item 7—This is the name of the person supervising the actual collection.

Item 8—Order-in-Council 3061 approved August 24, 1971, requires that a permit be secured to collect cones on Crown Land and written consent of the owner of private land or the tenant of Crown Land held under licence or lease.

Item 10—Seed Class — Production tree seed collections are classified as follows:

A. Classes — A5 — "Type" trees or individual tree collections.	
B. Classes	is seed from—
B1	Cleaned and registered plus stands.
B2	Plus stands or normal stands collected under supervision.
B3	Normal stands.
B4	Minus stand or no information.
B5	Plantations.

At the present time most cone collections will be from normal stands and will accordingly be classed B3. If cones are collected only from the better trees in a normal stand, the seed may be classed B2. Seed from cleaned seed production areas where only the better trees remain will be classed B2. Where insufficient information is provided, collections will be classed as B4. Seed from plantations will be classed separately, as the type of parent tree is often unknown. The ultimate objective, of course, is to have cones collected only in Classes B1 and B2.

Item 13—Normally single lots of cones will be limited to a 500-foot elevation range, more or less. If the range is considerably more than this, the stand should be broken into two or more lots.

Item 14—Location should be pin-pointed as closely as possible, giving name of district or nearest geographical feature (lake, river mountain, etc.) and distance and direction from nearest post office if possible.

Additional Instructions

1. Forest Service Collections

The original of the Cone Collector's Report Form for each separate seedlot should be mailed directly to the Seed Centre, B.C. Forest Service, Box 816, Duncan, as soon as the collection is finished. The duplicate copy should be sent to the District office and the third copy retained for Ranger District files. Every item on the form should be filled in except the extractor's report.

Tagging—All Forest Service collectors will normally receive a supply of Cone Collector's Shipping Tags (F.S. 518) addressed to B.C. Forest Service, Forest Nursery, Duncan, B.C. On the face of this tag is a space for shipper's name and address. On the reverse side are spaces for collector's name, the seed lot number he gives to this particular lot as explained above, species, place of collection, and number of sacks. When the back of the tag is completed, the perforated paper portion should be torn off and inserted inside the sack with the cones. It will be seen that this sheet has been duplicated on the back of the heavier outside shipping tag.

Standard two-bushel sacks will normally be supplied for collecting. When filling, do not place more than 1½ bushels in a sack. After inserting the perforated sheet removed from the back of the tag, sacks should be sown or tied and the tag attached. Every sack must have a tag on the outside and the corresponding duplicate sheet on the inside. As an additional aid to identification, the provisional seed lot number should be spray-painted in large print on the sacks.

Color of Cone Collector's Shipping Tags (F.S. 518) indicates the Forest District from which the cones originated: Vancouver Forest District, yellow; Prince Rupert Forest District, green; Prince George Forest District, blue; Nelson Forest District, white: Kamloops Forest District, red; Cariboo Forest District, brown.

2. Company and Private Collections

Company collections intended for reforesting Crown forest lands and private lands within Tree Farm Licenses will be delivered to the Forest Service for extraction at the Forest Service extraction plant. Private collections intended for reforesting Crown-granted forest lands will be processed at commercial extractories. Plain tags showing the agency or owner's name, company provisional seedlot number, species, location of collection and number of sacks in the lot should be placed both inside and outside the sack when shipping to the extractory. The date and method of shipping should be shown under Item 26 of the report form.

Cone Collector's Report Forms (F.S. 721A) are available from Reforestation Division, Victoria, from the District Forester's office or from Ranger District offices. When completed, the company should retain the second copy and forward the original and triplicate to the extractory along with the cones. The extractor will then complete his report and forward the original to the Duncan Seed Centre with the seed, keeping the third copy for his records.

At the Duncan Centre, seed will be tested and placed in storage, and a complete report showing the official registration number will be forwarded to the owner.

Extractor's Report

This section is designed to aid the private owner, the extractor and the Forest Service in following the movement and treatment of this valuable product. It is not necessary to enter extraction details such as kiln time, temperature, etc. but this may be shown under remarks if desired. Extracted seed should be forwarded with the original of the report form as soon as convenient to Duncan Seed Centre, Box 816, Duncan, B. V9L 3Y2

FORM 3. Cost Report Form

CONE COLLECTING COSTS

N.B.: One ~~sheet required~~ for each Provisional Seedlot Number
(i.e. one for each species collected)

Provisional Seedlot No. P.G. 19-01 Species Pl

Forest District Prince George No. of Bushels 68.25

1. Indirect Costs (F.S. Personnel Wages)

Pre Collecting Reconnaissance $20.00

Supervision $280.00

F.S. Transportation $70.00

TOTAL $370.00

2. Direct Costs (Non F.S. Personnel wages and all invoices)

Wages, Foremen -

Fallers -

Pickers $682.50

Hired Transportation -

Supplies -

Misc. Expenses -

TOTAL $682.50

3. Total Cost $1,052.50

4. Cost per Bushel (fob Ranger Station) $15.42/bushel

R Wood
Supervisor

5. Added Shipping Costs

From _____ to _____ $_____

From _____ to _____ $_____

_____ _____
Date Reforestation Officer

NOTES:

APPENDIX VI - Feedback sheet

This interim guideline is to be succeeded by a revised "final" guideline which should be published within a year. As the value of the "final" guideline will depend considerably on feedback from users of this interim guideline, we ask that you forward your comments and suggestions to:

Forester i/c, Reforestation Division,
B.C. Forest Service,
Legislative Buildings,
Victoria, B.C.
V8V 1X5

This sheet may be cut out for this purpose or other sheets may be used.