

BENEFICIAL MANAGEMENT PRACTICES FOR LIMBER PINE AND WHITEBARK PINE IN ALBERTA

Value and status of whitebark pine and limber pine

Whitebark pine and limber pine are keystone species of foothills and mountain ecosystems: their loss impairs unique ecological functions including wildlife habitat, erosion control, and headwater stream flow timing. Both species are Endangered in Alberta ([Wildlife Act](#)). Whitebark pine is listed, and limber pine is being assessed for federal Endangered status listing ([Species At Risk Act](#)).

An introduced fungus is the main threat to both species in Alberta, infecting 95% of trees in southwest Alberta, and killing 75% of mature trees. Rare, high-value trees with disease resistance are the key to recovery through their seedlings that will survive and reproduce. Slow growth means each mature cone bearing tree can take a century to replace if killed, a serious blow to recovery. Mountain pine beetle, fire suppression, and climate change are also major [threats](#).

Mitigation: first avoid, then minimize, compensate as last resort

The [Mitigation Hierarchy](#) is a widely accepted, scientifically credible [restoration policy used in Alberta](#). Avoidance is preferred; if deemed impossible, minimize impacts; if not possible, only then consider compensation for impacts to achieve no net loss of individuals and their habitat quantity and quality. It is difficult or impossible after disturbance to restore functions and capacities of key ecosystem components in a timeframe that can be monitored for success. When proponents become aware of the potential to impact whitebark or limber pine trees or their habitat on provincial Crown land of in a project area, they must contact the Provincial Whitebark and Limber Pine Recovery Team co-chairs (GOA.EndangeredPine@gov.ab.ca) to develop a rationale describing how proposed measures are consistent with the Mitigation Hierarchy.

Beneficial management practices

- ***Avoid:*** Priority is to prevent impacting endangered species by careful planning and design. Recovery team can confirm if a monitoring plot, resistant tree, or restoration project is nearby. Check [Open Data](#) for habitat models indicating these species may be in the project area.
- ***Baseline data:*** Collect data on extent and health of stands and trees in the project area. Retain a professional with experience identifying white pine blister rust to identify rare resistant trees. Contact the [Whitebark Pine Ecosystem Foundation of Canada](#) to find regional experts.
- ***Mountain pine beetle:*** Apply Verbenone and green leaf volatiles to mature and resistant trees early to mid-June if MPB is a local threat; these are only effective at low to moderate beetle population sizes and not during a severe outbreak. Contact [regional Forest Health staff](#).
- ***Disease resistant trees:*** Submit data on resistant trees to the Recovery Team, contact them for requirements. Collect seed for testing and restoration, and scions for grafting.
- ***Collect seed:*** Protect high value tree seeds from wildlife by installing wire 1/8" mesh cages from May to August, secured well around cone-bearing branches. Collect cones starting third week September in burlap sacks. Collect, label, and store seed from each tree separately in well

ventilated area. Send seed to Alberta Tree Improvement and Seed Centre, contact [Provincial Seed Specialist](#) for documentation and handling instructions.

- *Disease resistance testing:* Send seed from each resistant tree to Dorena Genetic Resource Center Oregon, or Coeur D'Alene Forest Nursery, Idaho for blister rust resistance testing. Proponent will cover costs for phytosanitary inspection, shipping, testing, and follow instructions for seed numbers, packaging, shipping, documentation, and timing. Confirm with [Recovery Team](#) first, and submit all data to them.
- *Planting:* Grow 2- or 3-year plug seedlings from selected or tested resistant trees in the same seed zone. Spatially delineate the planting site. Send data and seedling numbers to the [Recovery Team](#), who can provide information on seedlot registration, species-specific seed zones, and seed transfer for whitebark and limber pine.
- *Planting:* Transplanting trees or saplings, and planting seedlings grown from parent trees that are not selected for disease resistance, are **not best practices. Plant seedlings from selected or tested resistant trees only.** Replace each disease resistant tree impacted with 200 seedlings. Replace each other mature tree (10+ cm DBH) impacted with 100 seedlings. Replace each immature tree (1.3 cm+ DBH, <10 cm DBH) impacted with 50 seedlings. Replace each seedling impacted with 5 seedlings. Microsite [planting and seasonal timing](#) are essential for survival.
- *Grafting:* if a selected or tested resistant tree will be impacted, collect 20 grafts, ideally in winter when dormant or if not possible then during cone collection, and have a nursery graft them onto compatible rootstock to add to the provincial recovery program. Submit data and materials to [Recovery Team](#); contact them in advance for information on graft collection and to confirm rootstock and grafters are available.
- *Interpretive signs:* All-weather signs describing whitebark and limber pine importance and conservation measures on site or a nearby trailhead. Recovery Team has templates available.
- *Recovery team direct project funding:* If avoidance and mitigation options have been thoroughly explored and are not feasible, proponent may financially contribute to priority recovery plan actions including:
 - operational nursery seedling production (takes 3 years, \$1.25 to \$1.75 per seedling);
 - covering the cost of disease resistance testing (~\$1350-1700 CAD per tree, takes 7 years);
 - supporting seedling planting for restoration in areas identified by the recovery team – may require horse packing or helicopter transport of seedlings;
 - covering cost of helicopter access to remote sites for seed collection (2 visits) and monitoring (1 visit);
 - retaining experienced contractors to collect data and cones of putatively disease resistant trees following recovery team protocols.

Contact information

- Provincial Whitebark and Limber Pine Recovery Team co-chairs GOA.EndangeredPine@gov.ab.ca
- Provincial Forest Health Officers Fh.Info@gov.ab.ca
- Alberta Tree Improvement and Seed Centre atisc@gov.ab.ca
- Provincial Seed Specialist Lindsay.Robb@gov.ab.ca
- Whitebark Pine Ecosystem Foundation of Canada <http://www.whitebarkpine.ca/>
- [Alberta whitebark pine recovery plan](#)
- [Alberta limber pine recovery plan](#)
- [Federal whitebark pine draft recovery strategy](#)
- [Restoring whitebark pine ecosystems in the face of climate change](#)

Whitebark and Limber Pine Fact Sheet 1

Alberta regulatory requirements relevant to 5NP

Seed and vegetative material collection, transport, and planting on all Alberta Crown land is governed by [Alberta Forest Genetics Resource Management and Conservation Standards \(FGRMS\)](#), enabled under Alberta's [Timber Management Regulation and Forests Act](#). These are enforced by Forest Officers.

In FGRMS, wild materials are "Stream 1" and materials collected from a production facility such as a seed orchard are "Stream 2". Whitebark and limber pine collections from Alberta are all Stream 1.

Fillable FGRMS forms are available at <https://www.alberta.ca/forestry-forms.aspx>

To **collect wild seed or cuttings from Crown land**, you must contact the local [Forest Area office](#) and request authorization first. Carry the authorization letter in case of compliance inspection.

[Appendix 10A Authorization to Collect Plant Material Request Form for Stream 1 Material](#)

To **collect in a provincial protected area**, apply online through [Alberta Environment and Parks OPAC system and receive a Research and Collection Permit](#). Reporting is required. Your application must be clear about proposed use and ownership of material. Take care to follow all permit conditions. Annual applications or amendments are required for multi-year projects. Keep this permit with you for inspection.

To **collect in a National Park**, apply online for a Parks Canada [Research and Collection Permit](#). Reporting is required. Your application must be clear about proposed use and ownership of material. Take care to follow all permit conditions. Annual applications or amendments are required for multi-year projects. Keep this permit with you for inspection. Alberta legislation does not apply on Federal land.

All seed used for planting on Crown land must be **registered** with the Alberta Tree Improvement and Seed Centre (ATISC) in Smoky Lake. [Registration requirements for whitebark and limber pine](#) are at least 10 unrelated, healthy selected parents from the same species-specific seed zone or within the approved transfer distance (latitude, longitude, and elevation). FGRMS specifies that all seeds collected from, and registered for use on provincial Crown **land must be stored and documented at ATISC**. [Lindsay Robb](#) is the provincial seed specialist. [Appendix 2 Registration Request for Stream 1 Material](#)

To **select new plus trees** fill in the Parent Tree selection form based on health comparisons, using accepted methodology, which is [a monitoring transect following WPEFC methods](#) or a 100-tree survey and submit the form to ATISC. Submit detailed tree and stand data to the provincial recovery team at GOA.EndangeredPines@gov.ab.ca. Fact Sheet 3 has more information on Plus Trees.

[Appendix 11A Parent Tree Selection Form - Wild Stand or Plantation Comparison Tree Method](#)

You must have a form documenting **transport of seed, cones, or seedlings from the collection site** to ATISC. This is subject to inspection.

[Appendix 16 Transportation of Research, Conservation, and Controlled Parentage Program Plant Material Form](#)

You must have a form **requesting withdrawal of seeds from the provincial seed bank** and transporting them to the planting site. This is subject to inspection.

[Appendix 17 Seed and Vegetative Materials Withdrawal and Transportation Form](#)

For operations under AER, follow the [Master Schedule of Standards and Conditions](#) for these species.

Whitebark and Limber Pine Fact Sheet 2

Infected trees - what to do?

Infected trees are not useless and should not be removed. Cutting off cankered branches is not advised as infected trees are likely to be re-infected, and there may well be other infections you did not notice so canker removal will not make much difference.

The **value of infected trees**:

While the long-term recovery value of a healthy tree in a healthy stand is very high, and the value of a healthy tree in a heavily infected stand is paramount and the key to recovery (=a plus tree, and after testing indicates genetic resistance, an elite tree), infected trees are not without significant value too. If you search the literature you can find supporting information for the below.

- The infected tree or trees you are looking at may be less infected than the stand average, and may have some degree of heritable resistance they are passing to their offspring and therefore increasing the resistance level of the population.
- Many infected trees are still producing seeds and that is the primary and unique ecological value of the species.
- Many infected trees are still producing pollen and contributing to stand seed production.
- Some infected trees may be exhibiting signs of tolerance to blister rust and these are extremely valuable and rare individuals that we want to include in the recovery population.
- Removing infected trees from a stand reduces the effective population size, genetic diversity, and can decrease the viability and ecological function of the stand overall by reducing the capacity of the stand to fertilize ovules and produce diverse and viable seed.
- The slope anchoring function of these trees is also important; even if trees are infected - they often grow where no other tree species can persist so these ecological roles may go unfilled.
- Removing slow-growing, shade-intolerant limber or whitebark pine may irreversibly change the stand composition to favour other species through succession. Denser stands of more shade-tolerant competitors will not support whitebark or limber pine regeneration. Habitat for their many associate species, and the ecological values and functions of the site may be lost permanently.
- These trees also provide shade and microsites that are key to successful regeneration. Shade can delay snowmelt for 2-3 weeks, providing a very important moisture source for germinants and seedlings that can make the difference to survival. Cumulatively, this also contributes key hydrological functionality for headwater streams in these montane and subalpine habitats by reducing stream temperatures, increasing flow volumes later in the season, and reducing the "flashiness" of peak flows, which can be important to endangered fish species like bull trout and westslope cutthroat trout.
- Cutting off a branch with a canker, or excising the canker with a pruning knife may prolong the life of the tree or limb. But, given that most trees have multiple infections, it may not end up making much difference – the tree is still likely susceptible to rust and will get re-infected next year or in several years. It may also have other cankers you did not notice.

Whitebark and Limber Pine Fact Sheet 3

Plus trees: criteria, methods, data collection and sharing

Plus trees are trees selected in the field based on physical indications that they are **likely to be disease resistant**. They have not been tested yet and confirmed to have heritable resistance (those are “**elite trees**”). Given their rarity, focusing exclusively on plus trees for seed collection will still increase the frequency of disease-resistant regeneration on the landscape.

Whitebark and limber pine mature very slowly, only producing cones after age 50 to 80 years. Trees must survive until beyond that age to effectively sustain the population.

Un-selected trees are assumed to have zero resistance. **Do not plant seedlings grown from un-selected trees** in areas with moderate or higher rust hazard because they are very likely to die before maturity, wasting the effort and cost to collect seeds, register and store them, grow seedlings, and plant them. Do not select plus trees in stands with low rust infection levels. There is no way to reliably identify a disease resistant tree without a stringent comparison to a heavily infected stand.

GOA has a recovery program with **many plus trees already selected** that are undergoing rust resistance testing, with permanent unique ID tags. The identities of these trees have been compiled in a database.

To select new plus trees, they must conform to GOA standards of selection and data collection. **Field training is required**. Submit to the recovery team to add to the program database by emailing GOA.EndangeredPine@gov.ab.ca. Permanent unique ID tags conforming to the GOA numbering system must be installed on each selection. Only select in heavily infected stands (>80%), otherwise selections are considered unreliable. The chance of confirming heritable resistance is much higher if nearly all trees in a stand are infected and you select a healthy tree.

Data on plus trees must include Tree ID tag, detailed GPS location, measurement, age, and a detailed health assessment of the tree using high-powered binoculars, following GOA data standards. A health assessment of the stand, using standardized methods of the [WPEFC](#) or a 100-tree survey, is required. Data must be submitted to the recovery team to add to the program database to ensure it meets GOA criteria for selection.

Plus trees, plus a 30-m buffer around the roots, should be **protected** – these are **irreplaceable** and rare genetic resources fundamental to recovery of the species. New selections are added annually to GOA spatial data sets as high-value resources for incorporation in wildfire management and land use planning.

Plus trees should **be screened for heritable rust resistance to confirm suspected status**. This is costly and takes 7 years from submission of seed to final results. Interim results may be available. Facilities accepting seeds for testing are: 1) USDA Forest Service nursery in at Coeur D’Alene, 2) USDA Dorena Genetic Resource Centre in Oregon, and 3) BC forest ministry Kalamalka Forestry Centre in Vernon. [A CFIA phytosanitary certificate](#) is required to ship seeds to the USA, but not an export permit. Inoculation protocols are fairly consistent between facilities, but sample size and mechanisms assessed vary. USDA facilities provide very detailed interpretations of different resistance mechanisms; the BC facility focuses on survival. Costs range currently from \$1000 CAD per tree in BC to around \$1700 CAD per tree in the USA, varying with exchange rate and inflation. It may or may not be possible to get resistant tested “winners” back from the USA - it has been done before, but no guarantee.

Where plus trees have poor test performance, do not remove the tags in the field. That way we know they were already considered and evaluated and can look up the results.

Whitebark and Limber Pine Fact Sheet 4

Seed Collection

In Alberta, you need a **permit or authorization letter** to [collect](#) and [transport](#) cones and seeds. [Provincial Standards](#) require 10% of un-tested seed collected from Crown land to be provided to Alberta.

Alberta stores seeds in **the Alberta Tree Improvement and Seed Centre in Smoky Lake**, properly archived and stored under optimal conditions.

Proper collection and handling methods have huge effects on seedling vigour, yields, and longevity in storage. This [Seed Matters report](#) has best practices. Exceptionally high fat and protein cause these seeds to start losing viability after 7 to 10 years, but can keep longer if treated right. They are very costly to collect so make sure you get the most from every cone.

To **collect seeds**, protect cones from predation before cones start getting pecked by Clark's nutcrackers (limber pine start May, whitebark pine start June or early July) by installing [wire mesh cages](#), secured around branches with zip ties. Whitebark pine cones do not open so mesh can be 1/4", but limber pine cones open and seeds will fall out if mesh is larger than 1/8". Caging requires climbing to tree tops. Without caging, no seeds may remain to collect. Avoid injuring branches, damaging next year's developing cones, or cramming too many cones in the cage. Collect no earlier than mid-September, **as late as possible** so seeds mature properly – another climb. Remove each cage without damaging the branch, insert the cones, fold the cage closed. Do not leave cages over winter: snow may break branches, and seeds become rancid in sunlight (e.g., late spring before cages are accessible).

Avoid caging cones damaged by birds, infections or pests, and broken branches. Avoid caging trees that are not plus trees as their seedlings will be unlikely to reproduce. Blister rust is ubiquitous so your restoration will be ineffective. A tarp on the ground reduces potential contact with pathogens on the forest floor if dropping cages to the ground crew during collection. Clean cages after use.

Methods and equipment must follow [provincial health and safety regulations and standards](#). ArborCanada and Parks Canada have developed whitebark pine-specific safe climbing and access methods to resolve unique challenges of working with these species, including how to manage sap accumulation without injuring the tree. Contact [ArborCanada](#) for a specialized training session.

Keep cones separate by tree to grow seedlings, track field performance, and add to provincial archives.

Keep cones in **well-aerated burlap sacks**, separate sacks for each tree. No pillowcases. Leave plenty of air space below the tie-off: heat from respiring seeds can kill seed embryos and promote fungal and bacterial growth. Each sack needs a matching **tag inside AND outside** with Tree ID, date, GPS location and number of cones. Keep sacks in a single layer on mesh racks with fans in shade. **Protect from mice and squirrels** – rodents love these seeds above all else.

Cones must be air-dried and processed manually to extract seeds; a tumbler can extract some limber pine seed, but need to be manually pried out of the cone scales. Whitebark pine cones must be crumbled apart into pieces and the seeds separated from the cone bits. Seed processing facilities can process your cones, or do it yourself, but the seed will only be accepted for registration and storage if it meets provincial standards for quality. ATISC will only accept extracted seed, not cones. [Seed Matters](#) has advice on seed handling.

[This link has good resources on whitebark pine seed biology](#). Embryo immaturity is common in these species. If properly handled and stored, seeds can still germinate even if the embryo only fills 30% of the cavity, and if the megagametophyte is translucent. So keep all seed except those with air-separated or x-rayed empty seed coats with no embryos.

Whitebark and Limber Pine Fact Sheet 5

Planning to grow and plant seedlings

You cannot purchase whitebark or limber pine seedlings in Alberta. **You need to secure seeds for your area** that meet provincial registration criteria (see Fact Sheet 1), have the seedlot registered to allow for planting on Crown land, and arrange to have the seedlings grown in a nursery. In Alberta, the provincial recovery program never has a surplus of seedlings compared to the restoration needs. Plan **to collect your own seed** (Fact Sheet 4). From beginning seed stratification treatment to receiving a plantable seedling, expect a bare minimum of 2 years. You will not likely be able to collecone cones in 1 year and extract the seeds and send them to the nursery the so plan for a year delay.

Here is a suggested timeline, assuming you have a seed supply. **Year 1**, secure a restoration area to plant. **Field check** it to ensure it is suitable for long-term survival. Calculate planting density and how many seedlings you will need. **Year 1 August-September**: order your seeds from the seed bank, adjusting for germination and seed viability estimates. Secure your seedling order with the nursery. Have seeds ship to the nursery. **Register the seedlot** with Alberta for planting on Crown land (Fact Sheet 1). **Year 1 fall**, seed is stratified at nursery. **Year 2 spring**, seeds sown at nursery. **Year 3 fall**, seedlings ready to ship and plant.

To **germinate**, a long stratification period is needed: 5-6 months, at specific temperatures. This cannot be skipped, or germination may only be 1-10% and you have wasted a huge amount of seed. See [Seed Matters report](#) for details. Follow the instructions carefully to avoid mixing up tree identities, avoiding fungal and bacterial contamination that can kill seeds, and to get the most and best seedlings from your expensive seed. You will never get 100% germination from these seeds – some are not viable. **Cut testing** can indicate seed viability but read Fact Sheet 4 about embryo immaturity. Viability varies a lot from year to year, tree to tree, and with handling. Expect roughly **35 to 80%** germination, for planning estimate based on 50% if you have no other information.

There are a couple of **nurseries** that have experience growing limber and whitebark pine in Alberta: Bonnyville Forest Nursery and Grumpy's Greenhouse. Contact them directly for pricing and options. Several BC nurseries have also had success. [The recovery team](#) may have more information.

Because in Alberta the habitat of these species tends to suffer **severe drought during the growing season**, survival and growth have been best using bigger seedlings with more robust roots than stock typically used for reforestation, which emphasizes larger shoots. A 2-year limber or whitebark pine seedling survives and grows much better than a 1-year seedling, and planted seedlings have much success than just planting seeds, which also get eaten by wildlife. We have had good growing and planting **2+0 plugs grown in styroblocks**, or even larger (3-year-old) seedlings. Various stock types have been tried, and 415 or 512 size stock is working well, with 60-77 cavities per styroblock.

Before shipping, the nursery will **wrap the seedlings in bundles** of 5, 10, or 15 depending on the size. These are packed in waxed cardboard boxes that must be kept cool and dark to avoid stressing the seedlings. Seedlings are living breathing organisms. They need air, so do not leave them in closed boxes for long, and keep them out of the hot sun. Silvicool tarps are special forestry tarps designed to reflect sunlight and keep seedlings cool in the field, order from a forestry supplier.

In the Rocky Mountain region, **planting in the later half of September or into October** has worked fairly well, before snow blocks access but ideally just before fall rain and snow starts to provide moisture for establishment. By that time, seedlings have set bud but are not fully cold hardy or dormant.

Whitebark and Limber Pine Fact Sheet 6

Planting seedlings in Alberta

Review the other Fact Sheets first) You have a registered seedlot of seedlings that a nursery has grown for you. They are ready to be planted in a site that you have field checked that is suitable for long term restoration, and that is in the right species-specific seed zone for the seedlot. Planters with tree planting equipment are available and it is late September or after. You have already estimated the density and number of seedlings for your planting area.

Timing: In the Rocky Mountain region, **planting in the later half of September or into October** has worked fairly well, before snow blocks access but ideally just before fall rain and snow starts to provide moisture for establishment. Seedlings have set bud but are not fully cold hardy or dormant.

Delivery of seedlings: All suitable planting sites are fairly remote. There may be no cell signal. Shipping companies may have difficulty finding and accessing out-of-the-way sites without a regular address. You may need to meet a shipper and transfer the seedlings, escort the driver to the delivery site, or pick up the seedlings yourself and deliver them to the site. The [recovery team](#) also may have some additional information.

Planting density: Ecosystems containing 5NP have highly variable density. Consider **250 mature stems/ha** as a minimum target, with **400 mature stems/ha** a median target, and 500 stems/ha as an upper target, but denser stands are not common and most sites should support between 250-400 stems/ha as a target. Because these sites are harsh, up to 50% mortality may be expected before seedlings reach reproductive maturity in 50 to 80 years. So plant at double this target. One hectare is 100m x 100m, or 10,000 m². For 250 stems/ha, plant 500 stems/ha, average 4.5 x 4.5 m spacing. For a target of 400 stems/ha, plant 800 stems/ha or 3.5 x 3.5 m spacing. For 500 stems/ha, plant 1000 stems/ha, 3.2 x 3.2 m spacing. Spacing does not need to be exact, but average – picking a good microsite is much more critical than having exact spacing (see below).

Planting technique: These sites are rocky and tough, there is not a lot of soil. If the shovel won't go deep enough in the ground to get the full root plug in straight, find a new site. Jump on the shovel and wiggle to get it in the ground. Crack the soil open, reach in your planting bag for a seedling, guide the plug in along the shovel blade, remove the shovel, and stomp the gap shut. Tug a bit to ensure it is snug. The entire root plug, up to, and even over the root collar, must **be fully in the ground**. There should be no air between the roots and the soil so make sure the crack is firmly tamped down after the tree is inserted. There is no need to dig a hole. Roots must be straight all the way in – **no "J" roots**. If roots are not fully in the ground up to the root collar, frost heaving will pop them out and kill them through desiccation, or deer and elk can easily pull them out.

Planting microsite: For survival of properly planted seedlings for these species, nothing is more critical than picking the right microsite. Within 50 cm of the planting spot, there should be some **protection** from sunscald and this should be provided by an object that will not easily move when kicked. E.g. a hummock, stump, boulder, or depression. A rock or piece of wood is no good, and will move. The microsite should provide some **shade**. This also protects from drought for up to 2-3 weeks in spring as snowpack melts later in the shade.

Competition: These species are too slow-growing to compete with other species like lodgepole pine or subalpine fir. Do not plant them close to another tree species, except a mature whitebark or limber pine. Otherwise they will become too shaded and die. Leave 3-5 m spacing from another tree or sapling, or even remove the other sapling.