Scientific Name: *Abies lasiocarpa*

Common Names: Subalpine fir, Balsam Fir, Rocky Mountain Fir, Western Balsa

Above: *Abies lasiocarpa*. arken, some rights reserved, CC-BY-NC. Cropped from original. https://www.inaturalist.org/observations/7679480

Life Form: Tree

Site Preferences: Cold mountain forests from 600-3500 metres elevation (Hunt, 1993)

Tolerances: Tolerant of low temperatures, deep snow cover. Low tolerance to high temperatures and drought (Alexander et al., 1990).

Distribution: Alaska, Yukon and Northwest Territories, British Columbia, Alberta and as far south as New Mexico in the US. (Alexander et al., 1990)

Plant Identification: *A. lasiocarpa* is a coniferous tree growing up to 20m with a spire-like crown. The trunk will have a diameter up to 0.8m with whorled branches. Thin grey bark begins to split at 2 years to reveal a red-brown layer. Leaves are green and 1.8 - 3.1cm long. The leaves are spiraled and turned upward with a flat cross section. Pollen cones range from purple to purplish-green. Seed cones are dark purple to grey when ripe, cylindrical and range from 6 – 12cm long. Seed cones stand upright from the branch and are concentrated at the crown of the tree (Edwards, 1982). Seeds of *A. lasiocarpa* are brown and 5 – 7mm long with a light brown wing approximately 1.5 times as long as the nut (Hunt, 1993). .

Harvesting Considerations:

Abies lasiocarpa may begin to produce cones at approximately 20 years of age and when about 1.2 – 1.5 m tall (Alexander et al., 1990). Dominant trees between 150 – 200 years old produce the most seeds. Good seed crops occur every 3 – 5 years with light crops or failure in between (Alexander et al., 1990). Cones are collected in early to mid September in Glacier National Park in Montana (Luna et al., 2008). However, collection dates of this species are variable therefore Yukon harvest dates should be determined by forecasting earlier in the season (Banerjee et al., 2001, Portlock, 1996). Cones should be harvested once they have turned purple and begun to dehisce (Luna et al., 2008). Cones disintegrate when ripe and seeds will be carried away by the wind. This occurs from September through the end of October in the Rocky Mountains (Alexander et al., 1990). Large quantities of cones must be collected, as seed fill are low in the *Abies* genus (Luna et al., 2008). To evaluate seed content of cones, cones can be cut longitudinally with a circular cone cutter or knife. A good quality cone should have a minimum of 5 seeds per half cone face and not show signs of insect damage or disease (Portlock, 1996)

Collection of conifer cones should be completed in dry weather as moist cones may heat up and become moldy (Fennessy, 2002). Wet cones can be damaged by freezing temperatures at high latitudes (Portlock, 1996).

If a population is small, sample as randomly as possible. If the population is large and has little phenotypic variation, establish grids or transects to sample individuals. Germination characteristics of *A. lasiocarpa* vary with the latitude, longitude and elevation of seed collection (Baskin & Baskin, 2014). Therefore, seeds collected from areas that differ in respect to these geographic variations should be kept separate. The number of individuals sampled from the separate areas should be in proportion to the individuals in the subpopulation relative to the total population size (Way, 2003). Ensure that sampling methods do not remove more than 20% of available seeds (Way & Gold, 2014).

Above left: Smooth, grey bark of *Abies lasiocarpa*. David McCorquodale, some rights reserved (CC BY-NC). https://www.inaturalist.org/observations/7017198
Above right: *Abies lasiocarpa*. Note the concentration of cones at the crown. Lena Zappia, some rights reserved (CC BY-NC) https://www.inaturalist.org/observations/9909573

Seed Collection:

Assess ripeness of cones before collecting. Ripe cones that have been dropped to the ground can be collected by hand. Collect cones into 20-30 litre sacks, do not fill sacks over half full (Portlock, 1996). A ladder can be used to access cones remaining higher on the tree. Safety information and procedures for climbing crop trees can be found in “A Field Guide to Collecting Cones of British Columbia” compiled by F.T. Portlock (1996). Cones should be lowered to the ground rather than dropped to minimize damage to the seeds (Edwards, 1982).

Pole pruners and pole saws that extend 10m or more can be used to cut cones and branches from the tree (Portlock, 1996). When using this technique, place a tarp on the ground below the tree where the branches may fall to prevent exposure to seed borne fungi. Ensure that collections are not influenced by accessibility to shorter or younger trees whose cones may be easier to reach.

Above: *A. lasiocarpa* seeds. Steve Hurst, hosted by the USDA-NRCS PLANTS Database. Cropped from original.
Left: *A. lasiocarpa* cone. cporter, some rights reserved (CC BY-NC). Cropped from original

If seed collection is coordinated with logging efforts, cones may be collected from felled trees with the appropriate authorization (Portlock, 1996). Additionally, individual trees with high concentrations of good quality cones may be felled with appropriate authorization (Portlock, 1996).

Squirrel caches are an inexpensive source of cone collection although these cones may be subject to

seed-borne fungi and the practice is generally discouraged (Kolotelo et al., 2001, Portlock, 1996).

Helicopter collection can be a useful tool to efficiently harvest cones from *A. lasiocarpa* when stands are remote or when crop trees are scattered over a large distance or rugged terrain. More information can be found in “A Guide to Aerial Cone Collection Equipment and Techniques in British Columbia” by William G. Camenzind for the B.C. Ministry of Forests (1990).

Post-Harvest Handling:

Cones that are collected with branches should be removed from the branch before storage. Even short-term storage with branches may damage the seeds (Portlock, 1996). Large debris should be removed from collections before storage. Additionally, any sacks that have become wet should be emptied and the cones transferred to dry sacks.

Moist cones should be dried immediately as wet cones are subject to damage from both hot and cold conditions.

During interim storage, sacks should not be stacked as to allow exposure to freely circulating air and be sheltered from direct heating by the sun (Portlock, 1996). Sacks should be turned at least once a week for a minimum of four weeks to ensure even drying of cones.

Seed Processing:

Cones should be spread out on trays in well-ventilated areas maintained at 10-15°C to allow the seeds to mature and cones to disintegrate. Once seeds have separated from cones, remove debris such as cone scales, resin, needles and rocks. Next, remove smaller debris particles and non-viable seeds. This can be completed using an aspirator or gravity table (Kolotelo et al., 2001). However, some sources suggest these techniques to be damaging to the seeds of *Abies* species (Edwards,1982, Huber, 1981). Brushing seeds over a screen can be a low impact alternative (Kolotelo et al., 2001).

Dewinging must be done carefully to avoid damaging viable seeds (Huber, 1981). Dewinging can be completed by brushing seeds over a screen of unknown specifications that allow the seeds to pass through while the wings remain above the screen. Ensure there is minimal damage to the outer seed coat during processing as this may reduce germination (Kolotelo et al., 2001). Alternatively, wings may be removed by hand in small batches.

Seeds of *A. lasiocarpa* may be tested for seed borne fungi and viability. Common fungi found in *A. lasiocarpa* are *Fusarium* species and *Caloscypha fulgens* (Kolotelo et al., 2001). Methods and procedures for testing tree seeds in Canada can be found in Edwards (1987).

Seed Storage:

Seeds may be viable after up to 5 years in storage at 0°C in sealed containers (Luna et al., 2008). *A. lasiocarpa* exhibits orthodox seed behavior and longevity may be improved by storing seeds frozen (Royal Botanic Gardens Kew, 2018). Longevity of orthodox seeds increases with low moisture content and low temperatures (Rao et al., 2006). The Forest Ministry of BC recommends storage at -18°C at 4.9 – 9% moisture content for long-term storage (Kolotelo et al., 2001).

Germination Pre-Treatment

Soak seeds in running water for 24-48 hours before stratification. At 45% moisture content, stratify seeds at 25°C for eight hours with light followed by 16 hours at 15°C without light. After four weeks at 45% MC, surface dry the seeds to 30-35% MC and continue stratification for an additional 8 weeks (Kolotelo et al., 2001).

However, the US Forest Service recommends a 28 day moist cold stratification with 30°C during the day and 20°C at night with no specified day length offered. (Baskin & Baskin, 2002, 2014).

The Forest Ministry of BC suggests a 1-16 hour soak in a 3% hydrogen peroxide solution post stratification to reduce fungal levels. However, *Abies* species respond inconsistently to this treatment and variable influences in germination have been reported (Kolotelo et al., 2001).

Seed Germination:

For germination testing, label germination containers with collection number, species, germination conditions, start date, and number of seeds. Place germination paper into petri dishes. Wet paper just enough so that paper is moist but there is no standing water. Place a representative sample of seeds into Petri dish and space in an even grid. Multiple dishes may be required depending on sample size. Place lids on Petri dishes and place in germination chamber (or area with stable temperature) at 30°C (Baskin & Baskin, 2002). (Davies et al., 2015). If appropriate humidity cannot be maintained in the germination chamber, seal dishes in a Ziploc bag. Seeds should not be in direct sunlight but exposed to daylight. Monitor seeds daily and record proportion of seeds having germinated. Moisten filter paper as necessary.

The Field Guide to Collecting Cones of British Columbia Conifers compiled by Portlock (1996) identified transfer limits for interior natural stands of *A. lasiocarpa.* Seeds should not be transferred more than 2°-1° north or south or more than 3°-2° west or east. Seeds should not be transferred higher than 300m in elevation or lower than 200m from where they were sourced.

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