Whitebark Pine Recovery in the Bridge River Drainage

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Prepared for: Fish and Wildlife Compensation Program

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Executive Summary

Whitebark pine (*Pinus albicaulis*) is a keystone species of high elevation ecosystems whose ecological role is diminishing due to declining populations caused by white pine blister rust, mountain pine beetle, fire and fire suppression, and global climate change. This population decline is so dire that whitebark pine has been listed as endangered on Schedule 1 of the federal Species at Risk Act. This project most closely aligns with the Upland and Dryland Chapter of the Bridge-Seton Watershed Action Plan, namely with species-based actions with the priority action: BRG.UAD.SB.38.01 built upon previously funded Whitebark Pine work-P1. The secondary action type was also from the Bridge-Seton Watershed Action Plan; Research and Information Acquisition. With a Priority Action of BRG.ALL.RI.37.01 Inventory & restoration for at-risk and/or culturally important plant species-P3. To recover whitebark pine the Fish and Wildlife Compensation Program along with BC Parks, Two Billion Trees (2BT), and American Forests supported a multi-faceted program which consisted of seedling planting, competition removal, cone collections, and outreach. Planting consisted of utilizing putatively resistant seedlings, which may have resistance to white pine blister rust. At Yalakom Provincial Park we planted 1680 seedlings over 8.8 hectares; at Fred Antoine Provincial Park 3390 seedlings were planted over 15.1 hectares. Planting has the advantage of ensuring putatively resistant stock is being distributed, particularly in burned areas where recruitment can be a slow and protracted process. Surveys of 2021 planting found that stocking exceeded planted densities with a high level of natural recruitment in some plots with virtually no natural recruitment in adjacent plots. First year survival was 96% in sample plots. Competition was removed from whitebark pine over 2.6 ha in the Holbrook region, and in five sample plots in the area. The treatment moved whitebark from 18 to 28% composition of the stand and demonstrated that treatments to promote whitebark pine in a mixed species multiple objective stand may be feasible. To support future restoration work, we also collected cones at Mt Carson, Elizabeth Mine, and D'arcy Tower; given the exceptionally high rust levels at D'arcy, seeds from three trees were submitted to the provincial rust screening program. A field-based outreach event was attended by 19 individuals and addressed the range of recovery topics facing whitebark pine. Volunteers assisted with surveying a planted area and were instrumental in locating far more natural seedling than would have been located by an operational planting crew.

Key recommendations from 2022 work includes: continue planting as nurseries have developed capacity to produce high quality seedlings and we have enough seed in storage to plant 49,000 seedlings; continue monitoring planting to ascertain success levels over time; continue with competition removal, particularly in areas where permits have already been secured in the Holbrook and Mud Lakes area; continue with cone collections when cone crops are present and given the number of seeds in storage, target high rust populations and seek seeds from the plus trees in these populations; and continue with outreach and deliver in an appropriate manner aware that sharing of knowledge and building an empowered volunteer base are the objectives of the day.

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Introduction

Whitebark Pine (*Pinus albicaulis*) is a five-needled pine that plays keystone ecological roles in subalpine ecosystems. It is listed as endangered under the federal Species at Risk Act (SARA) due to the negative effects of white pine blister rust (*Cronartium ribicola*), mountain pine beetle (*Dendroctonus ponderosae)*, changing fire regimes, and global climate change (COSEWIC 2010, Environment and Climate Change Canada 2017). Whitebark pine occurs throughout southern BC with its northernmost limits at Mount Blanchet and Kakwa Provincial Parks.

As a keystone species, whitebark pine is an important food source for many wildlife species, namely the Clark's nutcracker (*Nucifraga columbiana*), red squirrel (*Tamiasciurus hudsonicus*) and grizzly bear (*Ursus arctos*) (Tomback and Kendall 2001). Whitebark pine and Clark's nutcracker maintain a mutualistic relationship whereby the pine offers seeds as an essential food source and the nutcracker hides uneaten seeds away from the parent tree, forgotten seeds may result in the colonization of new sites.

In the fall, red squirrels hoard whitebark pine cones into middens to feed on over winter. Middens are vulnerable to predation by opportunistic species such as grizzly bears. In many areas, grizzly bears regularly feed on whitebark pine cones during their pre-denning hyperphagic phase (Mattson et al., 1992; Mattson and Reinhart, 1997; Gunther et al. 2004). In the South Chilcotin region, grizzly bears have also been observed stripping branches from trees to access cones.

The decline of whitebark pine has resulted in disruptions to the important ecological processes it supports. These declines have resulted in whitebark pine being listed as Endangered by Environment and Climate Change Canada (ECCC) under SARA (Environment and Climate Change Canada, 2017; COSEWIC, 2010). To address the threats to whitebark pine, the federal Recovery Strategy [draft] describes pathways to recovery in the Recovery Planning Table. As described in the recovery planning table, this project addressed the threat of rust and fire through planting of putatively resistant seedlings and planting seedlings in post-burn environments.

Goals and Objectives

This is year-five of a five-year project. The objectives of this project were to:

a) Plant seedlings grown from seed collected from putatively resistant parents (parent trees displaying some level of resistance to rust in the field but not confirmed through testing);

b) Remove competition from around naturally occurring whitebark pine saplings to support the natural recruitment in areas of high natural density co-occurring with high densities of competing species;

c) Collect seed from populations with very high rust levels to select the healthy, likely genetically superior, parent trees; and

d) Conduct outreach with the public, government decision makers, and local licensees considering whitebark pine management in their operations.

In the first four-years of the project we achieved the following:

In year-one of this project we collected seed from over 350 trees (in conjunction with other programs). This seed is being grown into seedlings for deployment in years 3 – 5 of this project. This was originally a 3-year project with all seed and seedlings to be planted in year-three; however, the seed yield was so high that the project was expanded to five years.

In year-two of the project, Aboriginal Funds for Species at Risk (AFSAR) funded work to identify planting locations across the province, primarily in recent wildfire areas and this funding will also support some work until 2021.

In year-three we planted 3,500 seedlings; with just over 2,000 planted in Yalakom Provincial Park and 1,500 planted on Big Dog Mountain. Both areas burned about a decade ago and there is very little regeneration on site in whitebark pine habitat. In addition to planting, we also removed competition from around regenerating whitebark pine in Yalakom and South Chilcotin Provincial Parks.

In year-four we planted 18,750 seedlings over three sites including Porcupine Ridge, Big Dog Mountain, and Mount McLean. We collected approximately 2,000 cones from Porcupine Ridge and Seton Ridge. We conducted training with Splitrock Environmental to support outreach with local licensees, government officials, and the public at the Lillooet Farmers' market.

Linkages to Action Plans

This project most closely aligns with the Upland and Dryland Chapter of the Bridge-Seton Watershed Action Plan; within this chapter the project most aligns with species-based actions, namely the priority action: BRG.UAD.SB.38.01 Build upon previously funded Whitebark Pine work-P1.

The secondary action type was also from the Bridge-Seton Watershed Action Plan; Research and Information Acquisition. With a Priority Action of BRG.ALL.RI.37.01 Inventory & restoration for at-risk and/or culturally important plant species-P3.

Study Area

Recovery work for whitebark pine was conducted at numerous locations including:

- Mount Carson – Cone Collections
- Big Dog Mountain – Cone Collections
- Fred Antoine Provincial Park - Planting
- Yalakom Provincial Park - Planting
- Porcupine Ride – Outreach and Planting Surveys
- Holbrook – Competition Removal
- Mud Lakes – Competition Removal Planning

This work occurred with the Traditional Territory of the St’at’imc First Nations. Employees from Splitrock Environmental, a Sekw’el’was (St’at’imc member Band) owned company assisted with work in the region.

Methods

Four primary recovery activities were undertaken: 1) Planting, 2) Competition Removal 3) Cone Collection and 4) Outreach.

Planting

Seedling planting sites were identified in Yalakom Provincial Park in 2019 and a backup site in Fred Antoine Provincial Park was identified in early summer 2022. The Yalakom site burned in 2009 and the Fred Antoine site burned in 2021. During other work in the region we flew over the Fred Antoine site (Mckay Creek Fire) and noted ample planting opportunities and road access to the site.

To select planting sites, walkthroughs were completed to determine the level of whitebark pine regeneration and the suitability of the site for whitebark pine planting as indicated by fire killed whitebark pine remaining on site. Field surveys also ensured that high-density natural regeneration had not already been established on site. Each site was surveyed for hazards such as danger trees, steep slopes, and potential wildlife related issues such as bear sign. Planters were instructed to report and avoid any hazards encountered.

Planting was done using seedlings produced from seed locally collected in 2018. A total of 5,000 seedlings were ordered from the nursery for planting at the local sites. Planting was done at a density target density of 500 stems/ha. During planting, planters were instructed to plant seedlings as singles, and adhere to the following guidelines:

- Ensure soil closed well around the roots of the seedling, this was accomplished by avoiding organic soils and closing mineral soils around the roots using the shovel blade or by hand.
- Ensure seedlings were planted deep enough to eliminate the risk of frost heaving, this was accomplished by ensuring the root collar was planted just below the level of the native soils and the root collar never extended above this level; further seedlings were always planted deep enough that roots extended straight down.
- Select protected microsites; this included avoiding cool air drainage sites and protecting from snow creep and excessive insolation by planting in the shelter of rocks, stumps, or other protective features. On many sites this required protecting seedlings on both upslope and downslope sides.
- Plant a selection of seedlings in monitoring plots to facilitate planting success monitoring.

Competition Removal

Prior to removing competition from whitebark pine seedlings and saplings, pre-treatment surveys were conducted to confirm restoration need. Surveys were conducted by establishing five 11.28 m fixed radius plots and tallying all species and heights of each individual. In areas with a large whitebark pine population growing among competition, a restoration benefit was likely and treatment applied. Surveys were conducted near Holbrook and Mud Lakes to identify

treatment needs. Prior to competition removal a Section 52 Authorization was secured from the Cascades Forest District.

Once a treatment site was confirmed, competition removal was implemented. Competition removal occurred at two scales: from within plots and across the treatment polygon. Within plots, all competition removed was recorded to provide pre and post treatment stand composition; at the treatment polygon scale, similar methods were applied as in the plots but were not recorded as the plots were intended to be representative of the overall treatment area.

To implement competition removal whitebark pine seedlings or saplings were located and all competition within a 3-5 m radius were removed. The radius of competition removal was variable to account for tree sizes and likelihood of competition from adjacent trees; for example trees growing upslope on steep slopes or to the north of whitebark pine trees may be providing little competition for sunlight resources provided the trees aren't crowding. As competition was cut it was spread on site to ensure fire hazards or ips beetle hazards weren't increased.

Plot locations and treatment areas were mapped following treatment.

Cone collections

Whitebark pine cones were collected from three locations; D'arcy Tower, Elizabeth Mine, and Mount Carson. All sites required long drives but were ultimately accessible by vehicle. Collection trees were selected based on health as the healthiest trees in relatively diseased sites are most likely to contain blister rust resistant genes. Cones were collected in accordance with common and emerging techniques for cone collection described in the Whitebark Pine cone Collection Manual. Wire cages were put on the selected trees in August 2022 to protect the cones from predation by rodents and the Clark's nutcracker. Trees were also tagged and GPS marked at this time and recorded for easy return. The crew returned in October 2022 to collect the mature cones. Cones were kept separate by tree number and were stored in breathable bags for transportation and cones were dried until seed extraction was completed.

Outreach

An Outreach day was conducted in the form of a "field day" for individuals interested in whitebark pine conservation and recovery. For this field day, the local Naturalist Club and the St'at'imc Nation were contacted to seek participants; a poster was created and distributed to these groups (Figure 1). This workshop took place at Porcupine Ridge, a field day was selected as an appropriate means of outreach as numerous presentations have been delivered to the community over time. As a component of the outreach program, conservation activities were planned to provide first-hand experience to participants.

Figure 1. Poster distributed to Lillooet community to motivate volunteers to attend field day.

Results

Planting

Whitebark pine seedlings were planted using two crews in Yalakom and Fred Antoine Provincial Parks on October 5, 2022. Originally only Yalakom was going to be planted; however, access to the park was limited by an active forest fire which had been burning in the area that flared up the day prior to planting (Figure 2). This fire limited the ability of staging a crew near the park to be flown in, thus the decision was made to have a single crew fly in from Lillooet and another crew drive to Fred Antoine Park as it had vehicle access to whitebark pine habitat.

Figure 2. Forest fire flaring up near Yalakom Provincial Park, photo taken from Holbrook Region.

At Fred Antoine a total of 3390 seedlings were planted over 15 ha for a total of 226/ha; this low density was largely due to rocky soils resulting in large unplantable areas (Figure 3). At Yalakom Provincial Park 1680 seedlings were planted over 8.8 ha for a planted density of 191/ha (Figure 4). This low density was due to a rock outcrops, hot-dry openings that did not appear to support forest cover pre-fire disturbance thus were avoided, and natural whitebark pine regeneration that occurred in the shadier portions of the treatment unit. during this planting. These unsuitable areas formed a matrix within the planting area thus could not be pulled out of the treatment mapping.

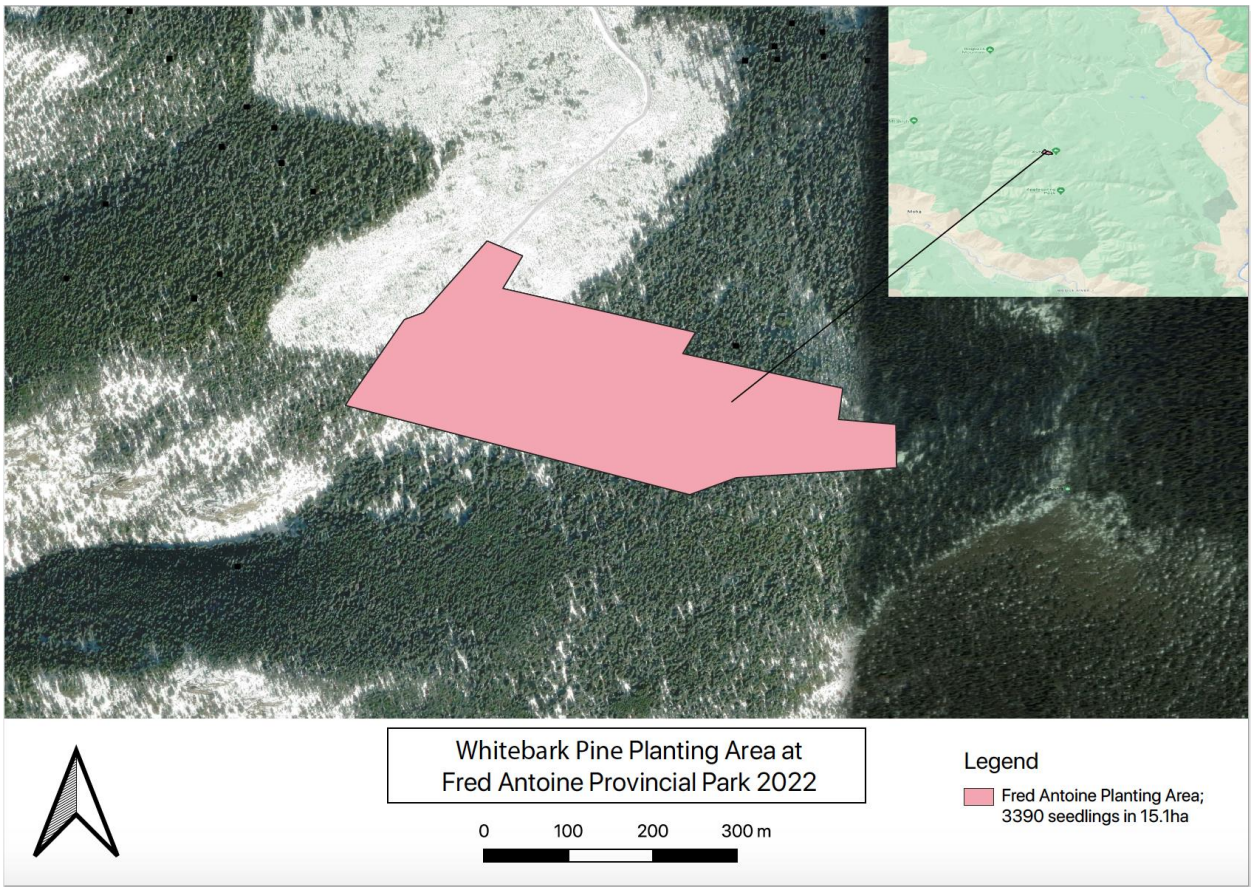

Figure 3. Planted area at Fred Antoine Provincial Park.

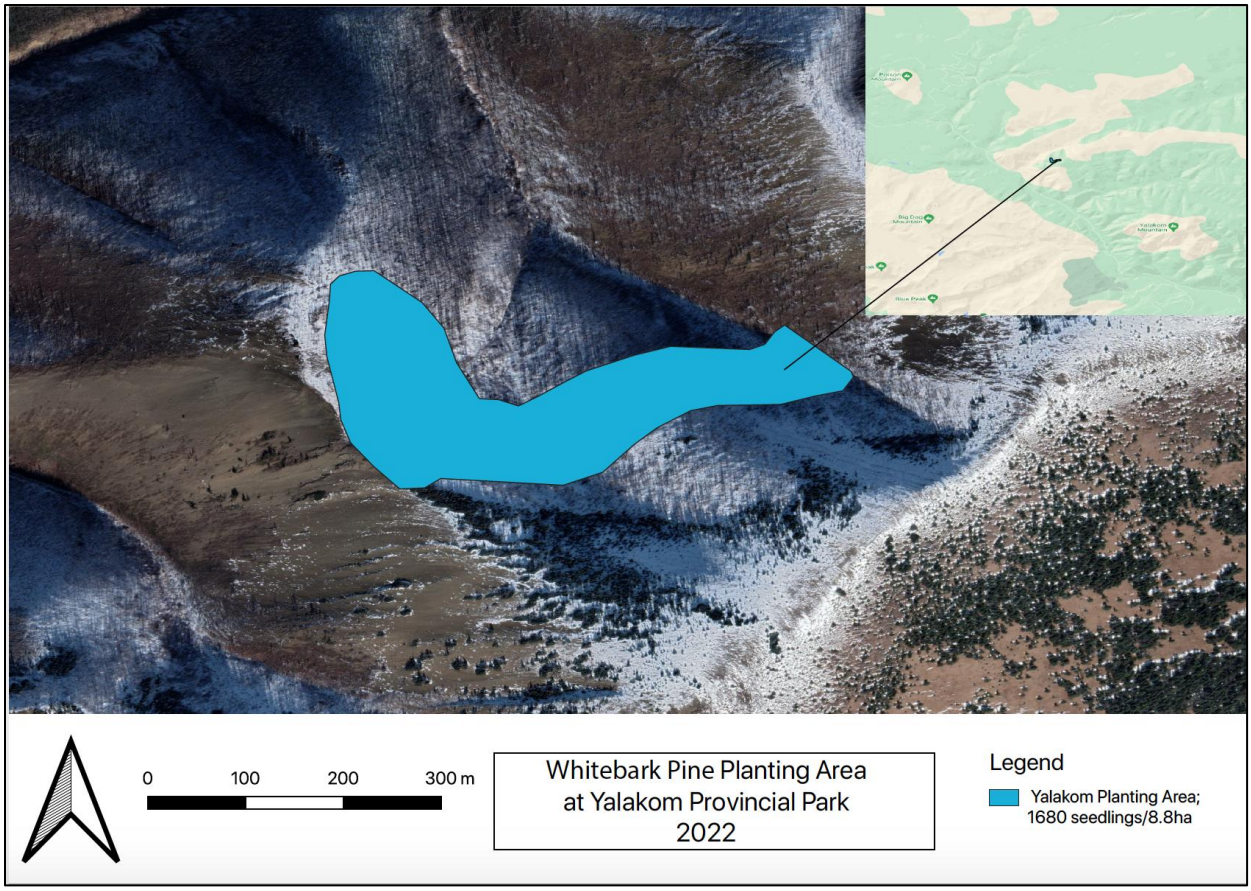

Figure 4. Planting area at Yalakom Provincial Park.

At both sites, permanent monitoring transects were established to aid in tracking the success of planted seedlings on site (Table 1). These transects are 30 m in length and have 30 seedlings planted every metre beginning at the 0.5 m mark.

Table 1. Summary of transect start-end coordinates for planting monitoring.

Site	Latitude	Longitude
Fred Antoine Transect A start	50.92314	-122.05740
Fred Antoine Transect A end	50.92304	-122.05777
Fred Antoine Transect B start	50.92197	-122.05322
Fred Antoine Transect B end	50.92163	-122.05337
Yalakom Transect A start	51.09640	-122.50006
Yalakom Transect A end	51.09657	-122.49974
Yalakom Transect B start	51.09706	-122.502105
Yalakom Transect B end	51.09722	-122.50231

Competition Removal

Competition was removed from around whitebark pine seedlings and sapling over 2.6 ha at the Holbrook Site (Figure 2); the Mud Lakes site was also surveyed and a permit secured but not thinned as the permit applies to multiple years and will be thinned in future programs. Thinning at Holbrook altered stem densities from a baseline of 4395 stems/ha to 2870 stems/ha for a mean change of -1525 stems/ha (Table 2). This was a 35% reduction in stems per hectare. No whitebark pine were cut during thinning; this activity changed whitebark pine's composition of the stand from 18.9% in pre-thinning conditions to 28.9% in post-thinning conditions, maintaining the mixed species nature of the stand but favouring whitebark pine.

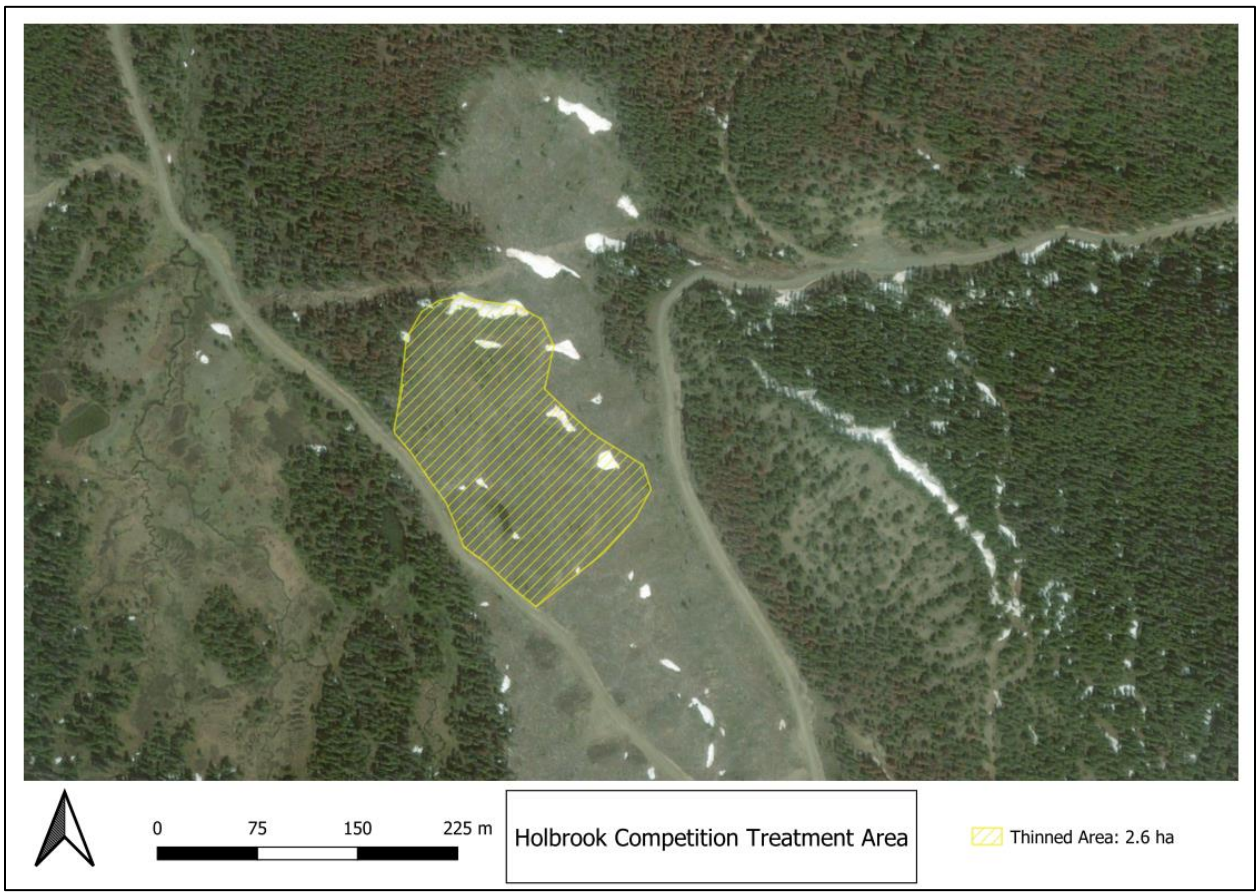

Figure 5. Map of competition removal area near Holbrook Lake.

Table 2. Summary of competition removal changes to plot composition.

	Engelmann Spruce			Subalpine fir			Lodegpole Pine			Whitebark Pine			Plot Total Means		
Plot #	Pre	Post	Net	Pre	Post	Net	Pre	Post	Net	Pre	Post	Net	Pre	Post	Net
Plot 1	125	50	-75	1250	275	-975	2400	1175	-1225	850	850	0	4625	2350	-2275
Plot 2	175	175	0	350	275	-75	3100	2575	-525	625	625	0	4250	3650	-600
Plot 3	75	75	0	1600	300	-1300	1475	625	-850	1075	1075	0	4225	2075	-2150
Plot 4	50	50	0	1900	775	-1125	2075	1075	-1000	1250	1250	0	5275	3150	-2125
Plot 5	50	0	-50	225	150	-75	2975	2625	-350	350	350	0	3600	3125	-475
												Mean	**4395**	**2870**	**-1525**

Cone Collection

Cones were collected at three sites; Elizabeth mine on Big Dog Moutain, D'arcy Tower, and Mount Carson.

Elizabeth Mine is an active gold mine containing a high density of whitebark pine around 2200 meters elevation. Once we checked in with attendants, we were able to drive directly up to where the whitebark pine begins. Ten trees were caged in this location in early August, and we returned for the mature cones in early October. We ultimately collected 379 cones from this site (Figure 4).

Whitebark pine at D'arcy Tower was accessible by a steep but well-used forestry road. However, once the trees were reached, poor weather limited the ability of crews to cage cones and only 4 trees received cages in August. When we returned in October, no uncaged cone crop remained, and the 52 caged cones were collected (Figure 5). Blister rust levels were great enough at D'arcy (~76%) that three of the collection trees were submitted to the provincial rust screening program.

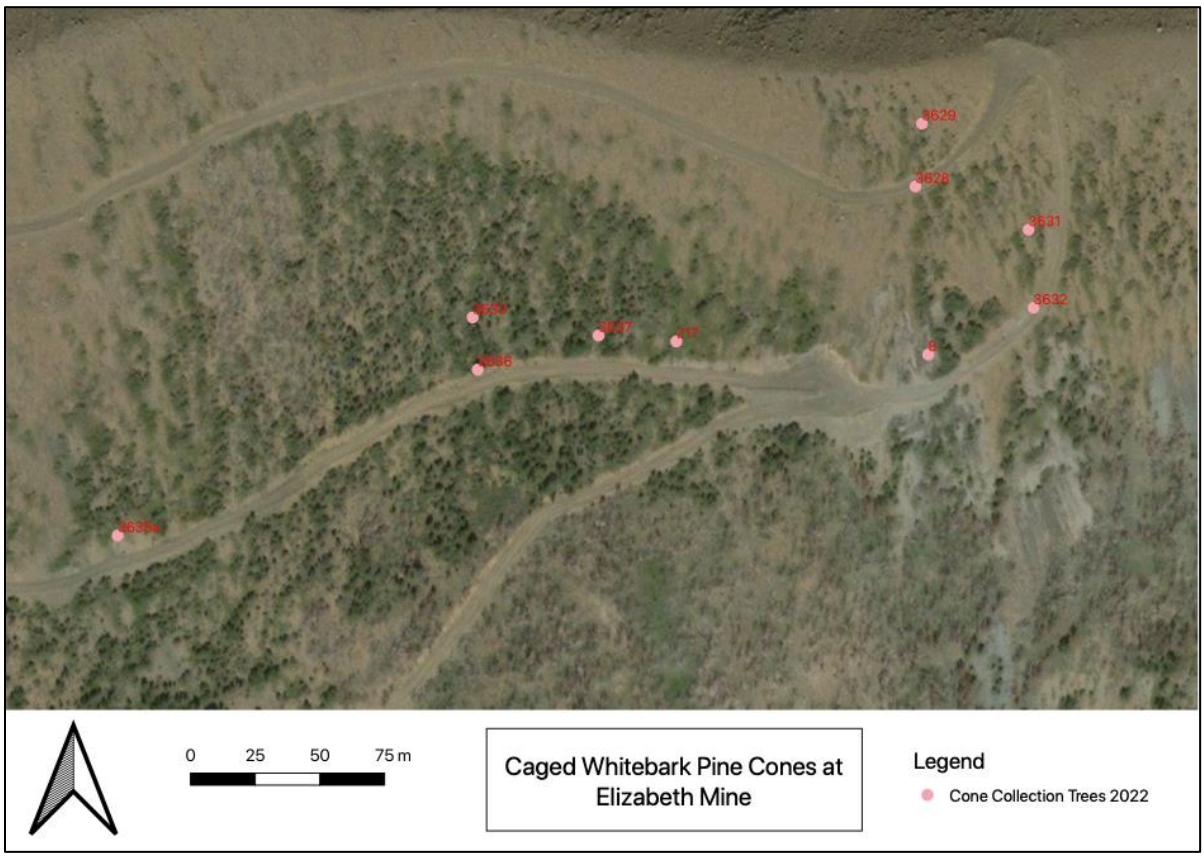

Figure 6. Cone Collection sites at Elizabeth Mine on Big Dog Mountain.

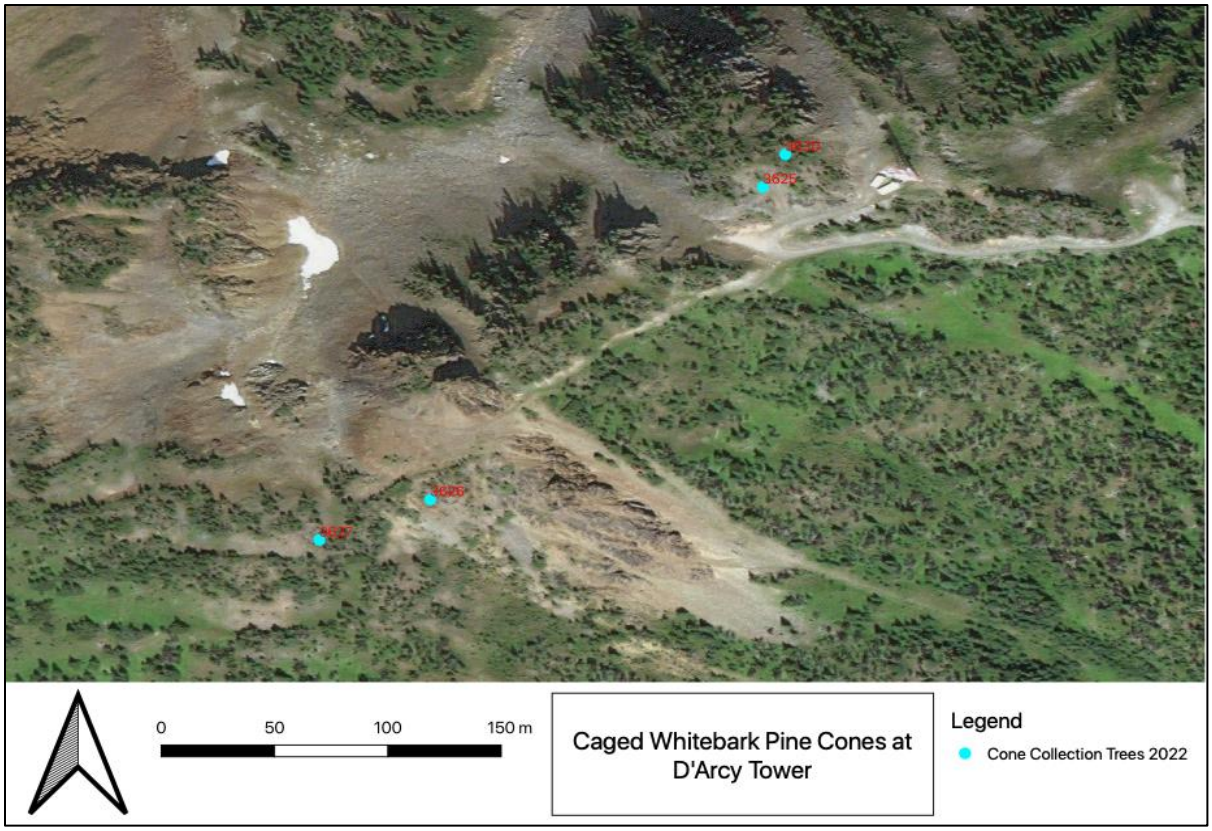

Figure 7. Cone collection sites at D'arcy Tower.

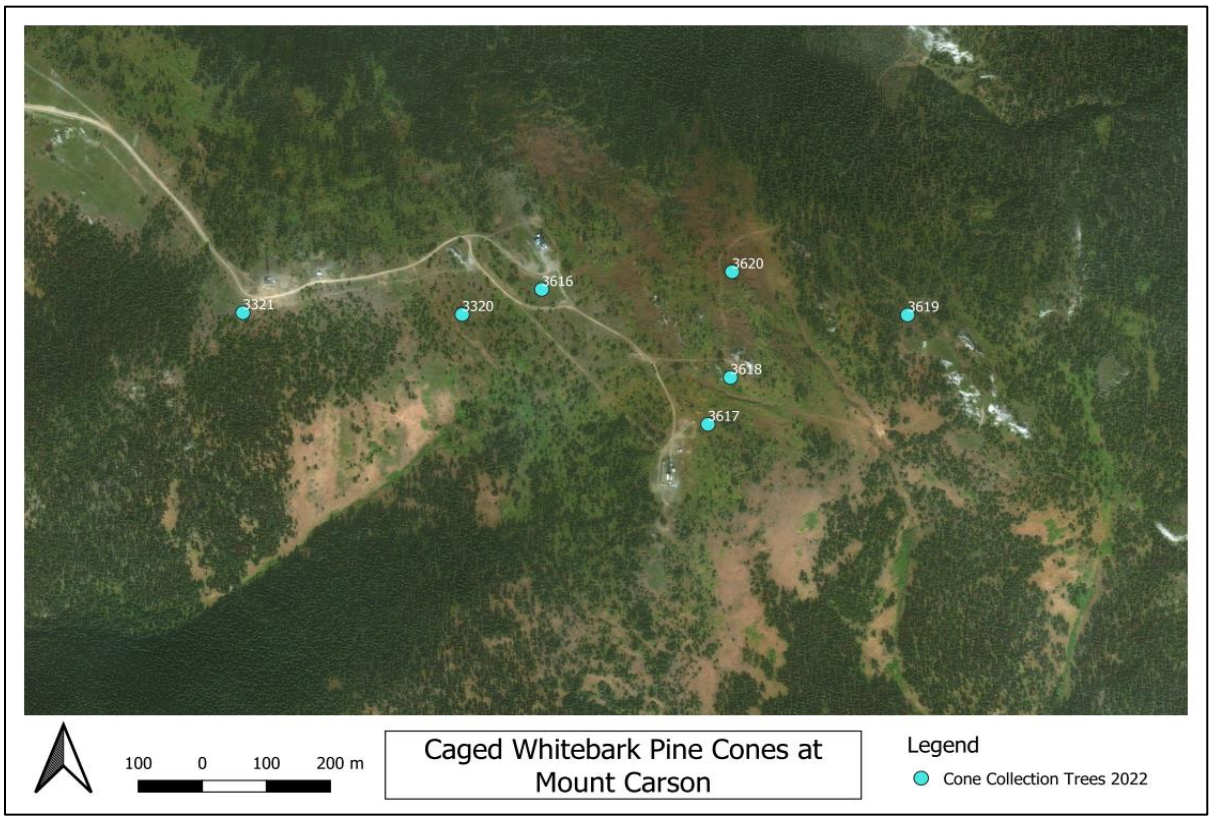

Figure 8. Cone collection sites at Mount Carson.

Outreach

The outreach day drew 19 participants to Porcupine Ridge (Figure 9). The site was accessed by vehicle convoy as the access can be difficult to determine in the maze of roads in the region. Participants included locals from the Naturalist Club and the St'at'imc First Nation. Once at the site, a presentation on tree and blister rust identification was conducted along with a tree climbing demonstration and a survey of restoration in the adjacent burn (Figure 9 and Figure 10).

Figure 9. Whitebark pine outreach day at Porcupine Ridge.

Figure 10. Whitebark pine outreach at Porcupine Ridge.

The outreach crew assisted in sampling regeneration and planting success from 2022. To conduct this, 11.28m fixed radius plots were established and divided into quadrants marked by flagging, each quadrant was scoured by the volunteers and whitebark pine seedlings recorded. The site was well stocked by a combination of planted and natural seedlings with a total per hectare stocking of 2385 stems/ha (+/-2415) (Table 3). This high standard deviation in the stocking density reflects the high variability in stocking due to plots 1 and 2 where natural recruitment was very high. Mortality of planted stock was very low with a total of 6 dead seedlings recorded over the 5 plots (5x400m^2). Both planted and natural seedling vigour appeared to be very good, particularly in light of the drought that occurred at the time of establishment (heat dome of 2022).

Table 3. Summary of whitebark pine stocking in area planted in 2022.

Plot	Planted (n)	Natural (n)	Total	Dead	% Survival*
Plot 1	825 (33)	5500 (220)	6325	1	97%
Plot 2	225 (9)	2875 (115)	3100	0	100%
Plot 3	1050 (42)	0 (0)	1050	1	98%
Plot 4	750 (30)	25 (1)	775	2	94%
Plot 5	575 (23)	100 (4)	675	2	92%
Mean (s.d)	685 (+/-309)	1700 (+/-2453)	2385 (+/-2415)	30	

*Planted/(Planted/Dead)

Figure 11. Natural seedlings on left on planted seedling on right; both examples showed good vigour.

Recommendations

Based on the outcomes of the four primary activities conducted this year, the following recommendations were developed:

Planting

Planting conducted in 2022 was a combination of good planning and adaptive management due to local fire conditions. The initial planning was to plant Yalakom Provincial Park and investigate opportunities in Fred Antoine; fortunately we surveyed Fred Antoine during our summer trip which allowed us to plant it when the access to Yalakom did not permit a two crew shuttle to occur. The survival levels observed in the field surveys were promising in that this planting occurred following the hottest period on record, thus it was unknown how that would impact survival. Based on the logistics and observed survival, the following recommendations were made:

- Based on the environment in the region it is advisable that alternate planting sites always be identified; over time work has been hampered by fires, landslides, and excessive heat, thus utilizing alternate sites is not unrealistic;
- Utilizing local seed collected in 2018-2022 sow and grow seedlings to support future planting. Whitebark pine seedlings are a two-year crop, thus this program requires some foresight to ensure planting support when seedlings are ready for planting.
- Select areas at ecological intervals to prioritize plantings. There isn't a need to restore everywhere but restoration should occur to ensure connectivity between restored populations; in other areas of BC managers are using a target of 500-5,000 trees at maturity to guide planting and restoration needs; this planning was science based and can apply to the Bridge River region as well;
- Work with the Mckay Creek Wildfire restoration group to ensure whitebark pine is captured in any restoration prescriptions. This fire burned a large portion of Fred Antoine Provincial Park, thus any plans should be collaborative where possible.
- Measure planting transects; given the extreme weather of past years (heat dome), planting success may be impacted thus it is crucial that survival is tracked. If survival is poor whitebark pine habitat may need to be shifted to more mesic sites with greater moisture availability. Most of the Yalakom seedlings were planted on cooler sites to test aspect effects.

Competition Removal

Competition removal has not been applied over broad areas as it can be more challenging to implement than planting due to permitting and equipment requirements, and does not have the advantage of allowing the restoration team to control the genetics as planting is done using seed from plus trees whereas we do not know if trees being selected for protection during thinning have had time to be infected as they are generally smaller and younger than seed trees. However, two of the threats to whitebark pine are seral replacement (generally due to fire suppression) and blister rust, one certainty in thinning scenarios is that the young

whitebark pine are experiencing seral replacement as they are going to be outcompeted by faster growing or more shade tolerant species on site. These areas serve as whitebark pine regeneration sinks – where large number of the young whitebark pine end up but are not going to recruit to the larger cohort due to high competition. Thus, it is worth reducing this competition level to potentially expose the trees to an uncertain rust environment by removing the certain high competition environment. Further, thinning seedlings/saplings that have been established for up to two decade, has the advantage that ensuring establishment as in seedling planting is not a concern, thus future survival due to site factors is not likely a concern during thinning. The following recommendations were made to support thinning success:

- Monitoring of thinned sites should be conducted to determine success, as it is possible that the newly opened area will allow for more rust spore interception and increased rust infection;
- Competition removal on accessible well-stocked sites is generally more cost effective than planting (~33-50% the cost); thus thinning may be preferred over planting where natural regeneration is common;
- Thinning crew can 'rogue out' infected whitebark pine to remove these highly susceptible individuals from the population;
- The competition removal we undertook resulted in an increase in the proportion of the stand composed of whitebark pine but still resulted in a mixed stand composed largely of lodgepole pine, this initial thinning demonstrated that thinning may be an option to meet multiple objectives;
- A Section 52 authorization was secured for multiple years, based on the likelihood of success and the bureaucracy of securing this permit, it is advisable that the areas permitted under this authorization be treated in the future.

Cone Collections

Cone collections conducted in 2022 were smaller than previous years but contributed to the total seed in storage to support broad scale replanting in the region. From all of the project years there are now 16.4 kg of seed at the Surrey Tree Seed Centre to support future programs, this seed translates to an estimated 49,000 seedlings, which would cover between 80 – 100 hectares. Based on the current seed resources, the following recommendations were made:

- Work with the St'at'imc Nation, BC Parks, and local Licensees to develop a seedling planting program to ensure this seed is utilized;
- Continue to make targeted collections as was done at D'arcy tower where this highly infected stand was collected from but very few acceptable trees (plus trees) were located due to high infection levels; and
- Work to identify plus trees in the region and monitor them for cone crops.

Outreach

This was the most extensive outreach conducted over the five years of the project. The site selected allowed for volunteers of all fitness levels to attend. In the past we conducted outreach at hike-in sites, very common for whitebark pine recovery, and much of the time was spent waiting or tending to less fit or prepared individuals. Based on the interest levels and participation of the volunteers, the following recommendations were made:

- Select easily accessible sites, the objective is to educate the public and gain allies in the recovery of whitebark pine not to complete a challenging hike;
- Select tasks easily accomplished by volunteers, the objective is to educate on this day not complete recovery or restoration goals on the site; we conducted surveys but have done cone collections and planting, with these two activities you must be cognisant of the volunteers' limitations;
- Provide tangible results, the volunteers were tasked with locating natural regeneration or planted seedlings, a task that resulted in far more being located than could be expected from an operational planted implementing work on site as the seedlings were small and often camouflaged, acknowledging the challenge and the success of locating these seedlings inspired the crew to keep working; and
- Provide relevant merchandise; we provided hats and t-shirts as a gesture of appreciation. We don't support blatant merchandise production and distribution but do acknowledge that this giveaway may spark further interest or conversation around whitebark pine recovery and acknowledge the efforts made by individuals to attend the field day.

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