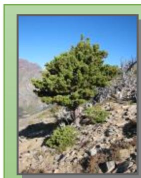

CROWN OF THE CONTINENT ECOYSTEM
WHITEBARK PINE RESTORATION STRATEGY
2019 PILOT
Project Summary

Crown of the Continent High Five Working Group Tech Team

BACKGROUND

Whitebark pine (*Pinus albicaulis*; WBP) is dramatically declining in the Crown of the Continent Ecosystem (CCE) due to a combination of mountain pine beetle (MPB, *Dendroctonus ponderosae*), effects of fire suppression, and the nonnative pathogen *Cronartium ribicola*, which causes white pine blister rust (WPBR), all of which have the potential to be exacerbated by climate change. Whitebark pine losses within the CCE are the greatest of anywhere in the species' range with >90% mortality in some locations[1]. The same stressors that challenge WBP are also impacting limber pine (*P. flexilis*) within the CCE. In Waterton Lakes National Park (Alberta) WPBR infection levels within limber pine stands range from 76 to 100% with the disease continuing to intensify through the province[2]. The large, high intensity Kenow wildfire (2017) burned approximately 47% and 70% of whitebark and limber pine habitat, respectively, within Waterton Lakes National Park and an unknown amount of WBP habitat in Akamina-Kishinena Provincial Park of southeast British Columbia. Within Waterton Lakes National Park, this wildfire resulted in the loss of 80% of limber and whitebark seedlings planted for restoration over the past 10 years and 58% of identified plus trees for both species including three limber pine with high levels of tested resistance. With this extent and intensity of burn, it is uncertain if the surviving limber and whitebark seed sources are sufficient to support natural reestablishment. Numerous wildfires in Glacier National Park in recent years and 2018 wildfires that spanned the boundary between Glacier and Waterton Lakes National Parks, highlights the likelihood of future large scale, high intensity wildfires occurring within the Crown.

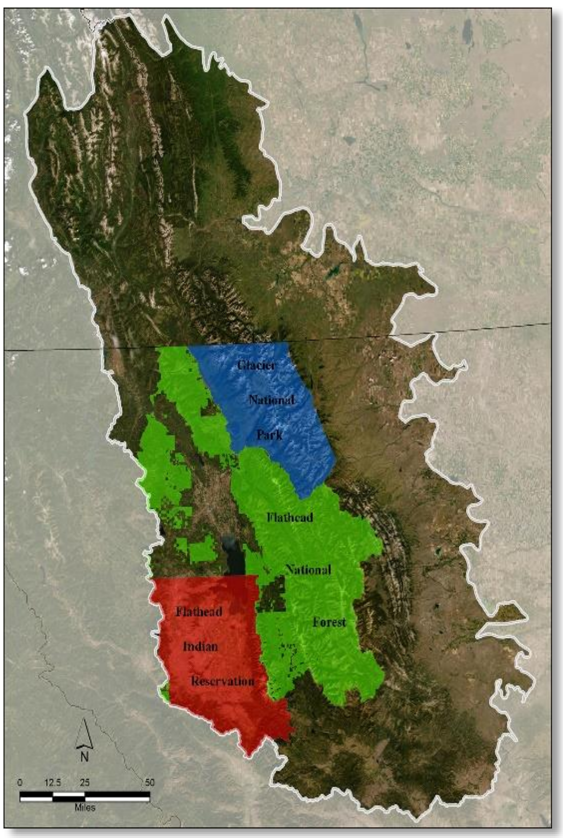

Figure 1. The Pilot area was composed of three Units in the Crown of the Continent Ecosystem: Flathead NF, Flathead Indian Reservation, and Glacier National Park.

Whitebark pine is a keystone species in that it maintains ecosystem structure and function. It defines the alpine tree-line; grows on exposed sites too harsh for other tree species; and often becomes established on a upper subalpine sites soon after disturbance; facilitates establishment and growth of other tree, forb, and shrub species; aids in soil stabilization; protects snowpack and delays snowmelt; and produces seeds that are a food source for many birds, small mammals, and bears. In the CCE, limber pine can co-occur with

1 Shepherd, B.; Jones, B.; Sissons, R.; Cochrane, J.; Park, J.; Smith, C.M.; Stafl, N. Ten Years of Monitoring Illustrates a Cascade of Effects of White Pine Blister Rust and Focuses Whitebark Pine Restoration in the Canadian Rocky and Columbia Mountains. Forests 2018, 9, 138.

2 Smith, C.M.; Langor, D.W.; Myrholm, C.; Weber, J.; Gillies, C.; Stuart-Smith, J. Changes in white pine blister rust infection and mortality in limber pine over time. Can. J. For. Res. 2013, 43, 919–928.

WBP in some high elevation habitats and also occurs at lower elevations demonstrating its broad ecological amplitude. Like WBP, limber pine also establishes on and stabilizes harsh habitats, is early successional on more productive sites, and its seeds provide food for wildlife.

In 2016, the CCE High Five Working Group (Hi5 WG) was formed under the umbrella of the Crown Manager's Partnership to help overcome the obstacles created by jurisdictional complexity in the CCE. The Hi5 WG is a multi-stakeholder, cross-boundary, formal working group whose mission is to protect and restore whitebark and limber pine ecosystems in the CCE. The Hi5 WG identified the development of a CCE-wide whitebark and limber pine restoration strategy as a one of its highest priorities. In 2019, the Hi5 WG piloted a process to develop a strategic approach for conserving and restoring WBP on a five-million acre subset of the CCE that includes the Confederated Salish and Kootenai (CSKT) tribal lands, Glacier National Park (GNP), and the Flathead National Forest (FNF) (Figure 1). The lessons learned and methodology established in this pilot will be used to complete a strategy for WBP, as well as limber pine, for all lands within the CCE.

The CCE spans almost 18-million acres along the shared Rocky Mountain Region of Montana, British Columbia and Alberta. Internationally recognized for its biodiversity, the CCE is one of North America's most ecologically intact and jurisdictionally fragmented landscapes. At its core is the first International Peace Park, Waterton-Glacier International Peace Park, and the third largest wilderness area in the lower 48 states, the Bob Marshall Wilderness Complex. The CCE includes many borders and jurisdictions: Tribes and First Nations; two countries; two provinces and one state; federal, provincial, state, and private lands. Because it is a mountain-based ecosystem, nearly every public lands agency and tribal government has WBP in their jurisdiction, as do many privately-held lands.

Each of these jurisdictions, while sharing the fate of these important Hi5 species, has their own missions, mandates, and capacities that vary widely. For example, Canada has listed WBP as endangered[3], and has recommended limber pine likewise[4], under their Species At Risk Act, while the U.S. has determined listing WBP as endangered under the Endangered Species Act is warranted, but precluded due to funding limitations (further review and designation of the listing status of whitebark in the US is pending)[5]. The province of Alberta has listed both limber and WBP as endangered under its Wildlife Act[6], but British Columbia and Montana do not have equivalent legislation. In Canada, ongoing development on public lands poses a threat, while in the United States, approximately 50% of the WBP is located in designated wilderness, which can limit both the regulatory and logistical feasibility to carry out restoration.

ABBREVIATIONS

Table 1. Abbreviations and Definitions Used Herein

Capability/ WBP Range	A model output ranking of areas conducive to WBP survival and growth (using potential current cone production as a proxy)
Core Areas	A model output of areas where restoration actions would benefit the persistence and function of the WBP within each administrative unit. Target area is 20-30% of potential WBP range[7] where restoration and conservation efforts will be focused over the next 10-20 years.
CC	Condition Classes
CCE	Crown of the Continent Ecosystem
CSKT	Confederate Salish and Kootenai Tribes
CV	Conservation Value - model output ranking areas biologically capable of providing WBP ecosystem services (e.g. wildlife food source, scenic/recreation value) now and in the future
FNF	Flathead National Forest, USDA Forest Service

[3] Government of Canada. 2019. Species at Risk Public Registry – Whitebark Pine. https://species-registry.canada.ca/index-en.html#/species/1086-748

[4] Government of Canada. 2019. Species at Risk Public Registry – Limber Pine. https://species-registry.canada.ca/index-en.html#/species/1275-933

[5] Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to List *Pinus albicaulis* as Endangered or Threatened With Critical Habitat. Federal Register Volume 76, Issue 138 (July 19, 2011). 76 FR 42631.

[6] Government of Alberta (2014) Species assessed by Alberta's endangered species conservation committee. https://www.alberta.ca/species-at-risk.aspx

[7] Whitebark Pine Ecosystem Foundation, National Whitebark Pine Restoration Plan, "Nominated core areas for each administrative unit, based on a subset of criteria and given priority designations. All nominated core areas combined will represent a target proportion (e.g., 20% to 30%) of whitebark pine's distribution in any administrative unit." See - https://whitebarkfound.org/national-whitebark-pine-restoration-plan/

GIS	Geographic Information Systems
GNP	Glacier National Park, USDI National Park Service
MPB	mountain pine beetle (*Dendroctonus ponderosae*)
NPS	United States Department of the Interior, National Park Service
Pilot unit	CSKT, FNF and GNP
Potential WBP Range	A model output of areas where WBP could grow under current conditions – whether they are currently known to occur or not.
Predicted WBP Range	A model output of areas where WBP is assumed to occur
Rx	Prescribed (as in “Rx fire” or “Rx burning”)
Stressors	Stressors affecting the sustainability of WBP, e.g. MPB, WPBR, climate change, fire and fire suppression
Tech Team	CCE High-Five Technical Team (a subset of the CCE High-Five Working Group)
USFS	USDA Forest Service
WBP	Whitebark Pine (*Pinus albicaulis*)
White pines	Five-needle pines within Pinus subgenus Strobus; in CCE this includes whitebark and limber pine
WPBR	white pine blister rust (disease caused by *Cronartium ribicola*)

METHODS

The Hi5 WG recognized that developing a strategy for two tree species on a jurisdictionally complex, 18-million acre area would be a herculean task given time and funding restraints. A decision was made to first develop a methodology for a pilot study. The pilot established a proof of concept approach to assess the relative conservation value of WBP stands (both extant and suitable habitat) within a subset of the CCE and prioritize conservation and restoration actions needed to ensure the persistence of functional populations of this species across the pilot landscape. The area includes the US portion of the CCE on CSKT, FNF, and GNP lands (Figure 1). Future work will cover the full CCE including both whitebark and limber pine. Mapmonsters GIS, Inc. (Victoria BC, Canada) conducted the spatial analysis for the pilot restoration strategy. The completed strategy integrates existing data sources, expert opinion, and modeling within a GIS platform utilizing 30m pixels as the base resolution. Mapmonsters and a team of managers and scientists from the Hi5 WG Technical Team (Tech Team) collaborated closely to complete the analysis. GIS data were selected based on quality and applicability (scale, accuracy, reliability, relevancy, and extent) of understanding WBP distribution and stressors under current and future conditions.

The Hi5 WG used the following approach to guide the identification of areas where restoration actions would benefit the persistence and function of the WBP (core areas) using selected datasets (Table 2; Figure 2).

Figure 2 and Table 2 illustrate an approach to guide the application of the selected datasets to identify where restoration actions would most benefit the persistence and function of the WBP (core areas). The process first delineated where WBP is capable of growing (Step 1). In the next step, areas currently providing ecosystem services or capable of providing ecosystem services, within Step 1 results, were identified (Step 2, Conservation Value). In Step 3 (Stressors), areas were identified, where existing and future stressors reduced or likely would reduce the conservation values. In Step 4 (Condition Classes) a matrix of landscape condition classes was created by combining Step 2 and 3 ranking values (Figure 3). And finally, in Step 6, condition classes 1 and 2 (see Figures 2 and 3) were identified as core WBP areas (or those that represent the highest likelihood for treatments to benefit the persistence and function of the species within each of the pilot units).

A different approach to filter core areas was developed (Step 5) that assigned values based on the likelihood of success of treatment in consideration of conservation values (Step 2) and stressors (Step 3). Although this pilot only used Step 4 condition classes 1 and 2 to identify core areas, in future application of this approach, Step 5 (Treatment Option Logic Model[8]) could be used in substitution of Step 4 (Condition Classes) (*see Recommendations below*).

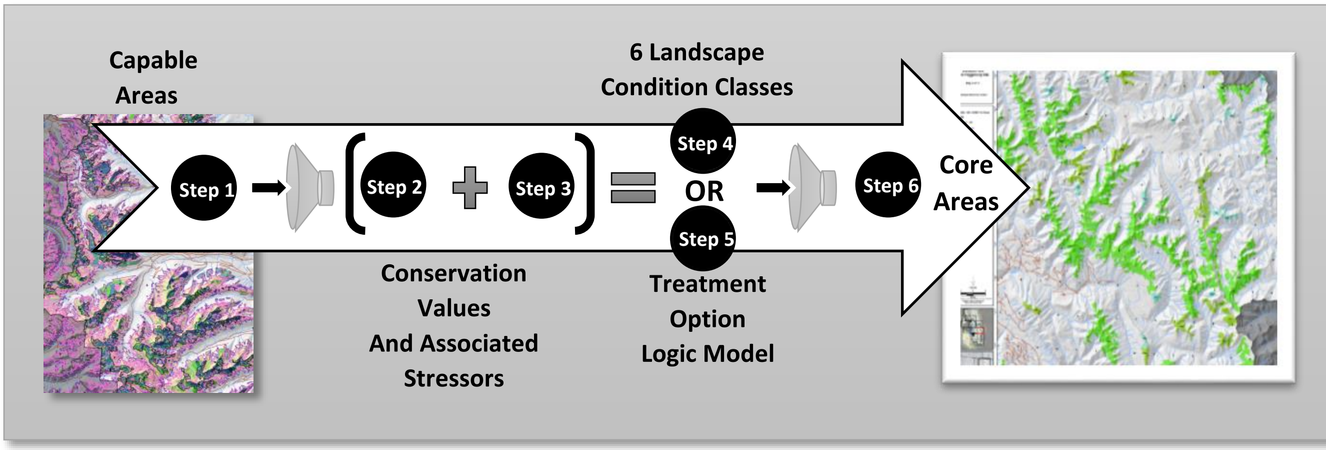

Figure 2. Pilot Approach to assess conservation and restoration actions needed to ensure the persistence of functional populations of WBP in the CCE. Step 1-Identify areas capable of supporting WBP; Step 2-Identify areas currently providing ecosystem services and biologically capable of providing ecosystem services (within the Step 1 capability range); Step 3-Identify areas where existing and future stressors reduced or are likely to reduce conservation values; Step 4-Create matrix of landscape conditions classes based on Step 2 and 3; Step 5-Idendify likelihood of success of restoration actions based on Step 2 and 3; Step 6-Identify core areas for restoration actions based on Step 4 OR Step 5 outcomes.

Table 2. Pilot Approach to assess conservation and restoration actions needed to ensure the persistence of functional populations of WBP in the CCE. Unique considerations to this pilot are designated by an *.

Steps		Indicator	Data
1	CAPABILITY	Areas where the species is capable of existing on the landscape under current climate conditions	• Existing information sources were used (e.g. previous modeling efforts, elevation ranges, biophysical conditions conducive to whitebark survival and growth, existing plot data) to model capability of the land.
2	CONSERVATION VALUE (CV)	Areas currently providing ecosystem services **AND** areas biologically capable of providing ecosystem services (within the Step 1 capability range).	• 2 Conservation Values classes (high, low) *created based on the contribution of* a) social values (municipal watershed, scenic/recreation, grizzly bear occupancy) of the ecosystem services provided by WBP ecosystems and b) biological factors (cone production, rust resistance, regeneration potential) • Weights were assigned to each CV; pilot units assigned unit-specific weights based on their varying mission/policy. Scenic/recreation value was the only CV weight varying among units (weighted higher for GNP).
3	STRESSORS	Areas where existing and future stressors reduced or are likely to reduce conservation values	• Stressors included mountain pine beetle, succession, fire, climate change, and WPBR. • Existing stressors and future stressors were evaluated separately, each ranked in six classes derived from natural data breaks. • 3 stressor classes (High, Medium, Low) created based on combining existing and future stressor ratings • Stressors were weighted to help determine the relative need for restoration and reflected the level of accuracy of the data that went into the rating; although permitted to provide differing weights, the three units weighted all stressors the same. • The influence of climate was weighted as a stressor for this step. The pilot used existing models to weight the influence of climate change to WBP.* *(Because of the uncertainty inherent in climate*

Steps		Indicator	Data
			model predictions five to ten decades into the future, this stressor was given a lower weight.)
4	LANDSCAPE CONDITIONS CLASSES (CC)	Matrix of landscape conditions classes	• 6 conditions classes created based on conservation value (Step 2) and stressor (Step 3) ratings. (Figure 3)
5	TREATMENT OPTIONS LOGIC MODEL[8]	Likelihood of success of restoration actions	• Restoration actions (cone collections, daylighting, mechanical, pheromone applications, planting, Rx burn hand crews, Rx Burn broadcast, seeding, and thinning) were evaluated and assigned values based on the likelihood of success of treatment to benefit the persistence and function of WBP within the condition of the land (i.e. Step 3 stressors).* • E.g., planting/seeding assigned a high value in high severity fire areas. • E.g., where stressors negatively impacted the potential success of the treatments (e.g. high rust hazard negatively impacts the success of planting), a negative value was assigned. • Treatment options logic model was not used to determine core areas (Step 6) in this initial pilot. However, the Tech Team recommends that aspects of this logic model replace Step 4 in future applications.
6	CORE AREAS[9]	Focus areas for restoration actions (20-30%, of Step 1 capable range Step)	• CC 1 and 2 from Step 4 (see Figures 2 and 3) were identified as representing the highest likelihood for treatments to benefit the persistence and function of the species within each of the pilot units. • In addition, patch sizes > 250 acres were considered more likely to provide the effective population size required to maintain adequate evolutionary fitness. • For each pilot unit, CC1 and CC2 polygons were merged together to form three complex classes (100-250 acres, 250-1,000 acres, 1,000+ acres). • CC1 polygons that intersected complexes (>100 acres) were selected for core area inclusion. • Then CC2 polygons that intersected the above CC1 core area polygons were selected and added to the CC1 polygons until the core areas approached 25-30% of the capable areas within each pilot unit. • Although polygons <100 acres were not included in the core areas for this pilot exercise, future application of this process could consider these <100 acre patches if they also have high CVs. • High mortality rates resulting in low wbp densities, made consideration of connectivity challenging. Connectivity was addressed in the application of core areas by emphasizing patches >250 acres and will also be considered when determining restoration actions in 10-20 year restoration plans (Future Step 7). • Logistical limitations such as access and land use designation (e.g. wilderness) were not incorporated until the end of the process so that areas with the highest CV, and areas where restoration actions can have the most benefit, would not be arbitrarily excluded from consideration. Logistical limitations are considered as the individual units develop their 10-20 year action plans to determine which restoration actions to pursue

[8] Building on frameworks developed in Schoettle AW, Jacobi WR, Waring KM, Burns KS. 2019. Regeneration for Resilience framework to support regeneration decisions for species with populations at risk of extirpation by white pine blister rust. New Forests 50: 89–114. https://doi.org/10.1007/s11056-018-9679-8

[9] Whitebark Pine Ecosystem Foundation, National Whitebark Pine Restoration Plan, "*Nominated core areas for each administrative unit, based on a subset of criteria and given priority designations. All nominated core areas combined will represent a target proportion (e.g., 20% to 30%) of whitebark pine's distribution in any administrative unit*." See - https://whitebarkfound.org/national-whitebark-pine-restoration-plan/

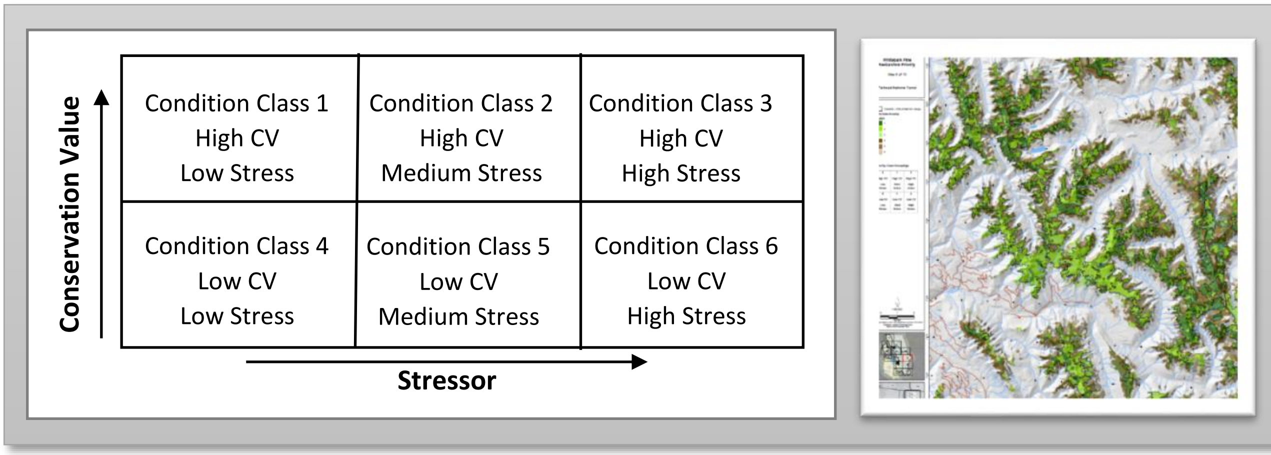

Figure 3. Step 4 – Landscape Condition Classes (CV-conservation Value from Step 2 rankings (high or low) and Stress values from Step 3 rankings (high, medium, or low)

RESULTS AND PRODUCTS

The pilot produced the following products:

1) **Conservation Strategy Development Approach** A collaboratively developed method that used priority landscape condition classes to identify areas that would benefit from restoration actions. The process can be adopted and modified across other jurisdictions to similarly prioritize WBP restoration actions or adopted/modified to develop conservation strategies for other resources.

2) **Treatment Option Success Logic Model** – Likelihood of restoration action success was evaluated based on expert opinion of the action coupled with individual stressor and high conservation values within (CC1 and CC2 and CC3). For each pilot unit (CSKT, FNF, GNP) restoration action maps were created for nine treatment options (cone collection, daylighting, mechanical, pheromone applications, planting, Rx burn hand crews, Rx Burn broadcast, seeding, and thinning).

3) **Condition Class (CC) Summaries** – Data layers for the CV-Stressor combinations (CC1-6). These composite condition classes were used to help prioritize core areas but they may be more useful for providing general descriptive statistics of the condition of the landscape by CV and Stressor classes.

4) **Core Areas for CSKT, FNF, and GNP** – Maps identifying where restoration would benefit the persistence and function of the species for each of the pilot units within core areas (Table 3, total acres identified).

Table 3. Core area for Confederated Salish Kootenai Tribes, Flathead National Forest, and Glacier National Park.

Unit	Potential Range *(acres)*	Core Area* *(acres)*	Percent of Potential Range
CSKT	101,621	29,119	28.7%
FNF	941,472	268,810	28.6%
GNP	348,042	97,428	28.0 %

**65% of total core areas is within various protected area designations (e.g. wilderness, roadless, national park)*

LESSONS LEARNED AND RECOMMENDATIONS

Producing a complex approach, across multiple jurisdictions, over a short period of time created both challenges and lessons learned. A few are highlighted here for consideration in future approaches to single or multi-jurisdictional conservation strategies.

Leadership and Team commitment/expertise: A strong leader, with coordination skills to work remotely with the team and organize information, as well as technical knowledge of the resource, was critical. Timely decisions occurred through weekly Tech Team meetings with the contractor to keep momentum and decrease loss of what was previously learned and decided upon. Also essential to success was a diverse team of managers and scientists.

Predefined Methodology would have been helpful, but not necessary: The Tech Team began contractor work with limited understanding of a defined process and logical flow to produce the products. Because the approach was created and refined as data sources were compiled and evaluated, there were many iterative discussions in the refinement of the logical steps described above. The team accepted that a working draft of "how-to steps" would be improved as they learned more from each other and more from the quality of the data and evaluation of draft outputs.

Fire, love it or hate: Fire effects were a topic of much deliberation in the Hi5 WG because of both the positive and negative contributions of fire to whitebark pine. The Tech Team included fire as a conservation value in Step 2 (as regeneration opportunities) and a stressor in Step 3 (past fire mortality and future fire hazard). In addition, recent fire burn severity was assigned a high stressor weight in Step 3 due to the high level of WBP mortality it created. Weighting fire burn severity as a high stressor in Step 3 resulted in the inclusion of some areas in condition class 3 (Step 4) that was not included in the initial pilot core areas (Step 6). However, high severity burn areas are generally preferred sites for seedling establishment because of their low fire hazard and good site conditions for survival and growth. The utility of fire burn severity as a stressor should be considered in future applications of this pilot approach. However, the Step 5 Treatment Option Logic Model resolved this issue by rating the burned areas as high likelihood of treatment success for planting.

Inability to compare among units due to differing data resolutions: Because the data inputs to classify conservation values (Step 2) and stressors (Step 3) were not the same resolution across the three pilot units, the numerical outcomes cannot be compared among them. The relative classifications and prioritizations are consistent within a pilot unit, but the absolute scores from which those classifications and prioritizations were made are not directly comparable among units. As a result, areas in each unit were identified in each conservation values/stressor combination (CV-S), consequently, seamless classification and prioritizations across the entire pilot unit were not possible. This may be an even greater challenge when trying to unify Canadian and US data sources. For the expansion of the pilot to CCE-wide, the Tech Team will need to consider tradeoffs between the desire for greater detail and accuracy of outputs at the unit level vs the desire to compare priorities across the entire CCE.

Evaluate Outputs throughout the process: Step 4 condition class 3 (CC3 - High Conservation Value, High Stress) was not initially included in the selection of core areas (see Step 6), as the team presumed that the high stress values for this CC3 might have lower success for restoration actions. While this assumption may be true for some stressors (e.g. WPBR) it does not hold true for others (e.g. recent fire) and therefore does not hold true for all lands within the composite CC3 condition. Upon evaluation of outputs, CC3 was represented by the fewest acres of all the CCs so the impact of excluding it was relatively small. Regardless, future refinement of core areas will likely consider CC3. As with the fire issue above, use of the Step 5 treatment Option Logic Model to identify core areas could resolve this concern as many of the CC3 acres included those areas with high burn severities.

Integration of Conservation Values with Vulnerabilities (Stressors) for Priority Restoration: The most difficult process question the Tech Team addressed was how to integrate conservation values (Step 2 - CV) and current and future stressors (Step 3) to establish condition classes for restoration priorities (Step 4 conditions classes). The Tech Team also deliberated over how stressors that can be mitigated with restoration actions (bark beetle hazard, succession, fire hazard) could be weighted differently than those that cannot be mitigated (blister rust hazard, future climate hazard). In addition, the inclusion of Step 4 - CC3 - High Conservation Value, High Stress into Step 6 core areas did not have team consensus. Some regarded areas with high-stress as potentially requiring too much investment of limited resources to make a difference and concentrating on areas with low and moderate stress classes would result in greater investment success. However, as stated above, outputs depicted limited acres in CC3. Future application of this pilot process will need to closely evaluate areas exhibiting high stress (high vulnerability) to consider quantity and distribution of these high stress areas relative to other lower stressed conditions, to determine if investments in the high-stress conditions are warranted. It is recommended that Step 4 be used in future applications only when an integrated assessment of the landscape conditions (such as Step 5) is not completed.

IMPLEMENTATION AND POSSIBLE NEXT STEPS

1) **Out-year plan** – Develop landscape strategy.
   a. Determine where best to resist, accept, and/or direct impacts of stressors when considering other ways to identify Step 6 core areas.
   b. For each pilot unit: Use Step 5 (likelihood of treatment success) to help create a diversified portfolio of actions when identifying Step 6 core areas.

2) **Additional Considerations** - Consider tradeoffs not modeled in the above steps, e.g., distribution and abundance of treatment action types, distribution of stands, connectivity, access, partner/agency priorities for other impacted resources, piggy-backing on existing opportunities, land management use emphasis (protected areas, or other land designations), etc.

3) **CCE-wide strategy** - Integrate lessons learned into pilot expansion to CCE-wide strategy for whitebark and limber pines.

4) **Whitebark Pine Ecosystem Foundation, National Whitebark Pine Restoration Plan (NWPRP)**
   a. Incorporate pilot core areas and CCE-wide strategy core areas into the NWPRP to represent the target. (https://whitebarkfound.org/national-whitebark-pine-restoration-plan)
   b. Adapt the pilot approach to assist other land bases outside of the CCE to identify core restoration areas.

5) **Common Data Collection Method** - A set of data collection protocols has been developed that will allow managers in the CCE to more easily share and compare data. The goal is to eventually have one central location for data storage. The data collected will have many purposes including ground-truthing the pilot and providing data for the CCE-wide effort.

CONCLUSION

This pilot produced products that can be used to strategically plan restoration actions in the pilot units (CSKT, FNF, GNP). The approach allowed units to individualize weighting schemes based on jurisdictional missions. The use of pilot outputs will increase funding/grant proposal success, ensuring that investments will target priority areas that were rigorously evaluated to have the greatest impact and likelihood of success, by experienced WBP managers and scientists.

The Hi5 WG would like to encourage all landowners and land managers within the CCE whose lands contain whitebark or limber pine to take advantage of the progress that has been made through the pilot and the potential benefits to participants by joining us in the CCE-Wide Whitebark and Limber Pine Restoration Strategy. This approach can also be adapted for application in other parts of the WBP range and to distributions of the other high elevation five-needle pines.

CCE Hi-5 Working Group Technical Team

- Melissa Jenkins (Lead), USDA Forest Service, Flathead National Forest
- Tony Incashola Jr., Confederated Salish Kootenai Tribes
- Dawn LaFleur, USDI Park Service, Glacier National Park
- Linh Hoang, USDA Forest Service, Region 1
- Katie Renwick, USDA Forest Service, Region 1
- Anna Schoettle, USDA Forest Service, Rocky Mountain Research Station
- Sabine Mellman-Brown, USDA Forest Service, Region 1
- James Lozeau, Confederated Salish Kootenai Tribes
- Kelly Rose O'Bennick, Confederated Salish Kootenai Tribes
- Elliott Meyer, USDA Forest Service, Flathead National Forest
- Karl Anderson, USDA Forest Service, Flathead National Forest
- Rob Sissons, Parks Canada, Waterton Lakes National Park
- Bob Keane, USDA Forest Service, Rocky Mountain Research Station, Fire Sciences
- Brad Jones, Alberta Environment and Parks

A Mapmonsters report to the Tech Team (*Crown of the Continent Whitebark Pine Restoration Strategy Pilot, June 2019*) documenting the details of their analysis, including map products and data layers is available upon request. Contact Linh Hoang, linh.hoang@usda.gov.