Lake Tahoe Basin Management Unit
Whitebark Pine Pilot Fieldwork Report

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Photo on cover page: *Pinus albicaulis* near Freel Peak. Photo by Daniel Hastings.

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Background

Whitebark pine (*Pinus albicaulis*) is a long-lived and slow-growing tree found in upper montane to subalpine forests of southwestern Canada and the western United States. It regularly defines upper treeline and co-occurs with other conifers. Of the approximately 250,000 acres where whitebark pine forms pure stands in California, >95% is on public land, often in remote wilderness settings on National Forest and Park lands per CNPS calculations using the area mapped by CALVEG and the National Park Service as whitebark pine dominant vegetation types. However, the acreage of the pine's occurrences in the state is much greater (see Figure 1).

Across the state, the species is found from 1,830 m – 4,240 m (6,000 ft-13,899 ft) in the Sierra Nevada, Cascade, Warner, and Klamath mountains where it is an outlier of a much broader range (Arno et al. 1989, Murray 2005) from the more contiguous Rocky Mountains and Cascades in western North America. Within this range, the species prefers cold, windy, snowy, and generally moist zones. In the moist areas of the Klamath and Cascades, it is most abundant on the warmer and drier sites. In the more arid Warner Mountains and in the Sierra Nevada, the species prefers the cooler north-face slopes and more mesic regions.

Western coniferous forests are currently undergoing large-scale changes in composition and distribution. These changes are due to shifts in the following: climate regimes, insect and fungal pathogen distributions, fire return intervals, fire severity/intensity, and logging practices— among others. High elevation five-needle pines have been harbingers for climate change for millions of years, and because high-elevation ecosystems are likely to be the first to register the impacts of global climate change (Bunn et al. 2005), surveying high elevation five-needle pine is a way to catalog trends in vegetation and climatic shifts.

Whitebark pine (WBP) is currently the most susceptible of the five-needle pines to mortality due to the combined effects of climate change-induced disturbance. Mortality data collected in multiple studies throughout its range strongly suggest that whitebark pine is in range-wide decline (Keane et al. 2012; US Fish and Wildlife Service 2011b). The primary threat to whitebark pine across its range is a synergistic combination of climate change, white pine blister rust (WPBR), periodic mountain pine beetle (MPB) outbreaks and fire exclusion (Keane et al. 2012; Millar et al. 2004; US Fish and Wildlife Service 2011b). WPBR is an invasive pathogen (*Cronartium ribicola*) (Tomback and Achuff 2010). MBP is a native insect having co-evolved with western pine forests in fluctuations of periodic disturbance, while more recently, mass beetle infestations have been correlated with increased climatic warming (Logan and Powell 2001, Logan et al. 2010, Mock 2007). When compared to other parts of the range, such as the

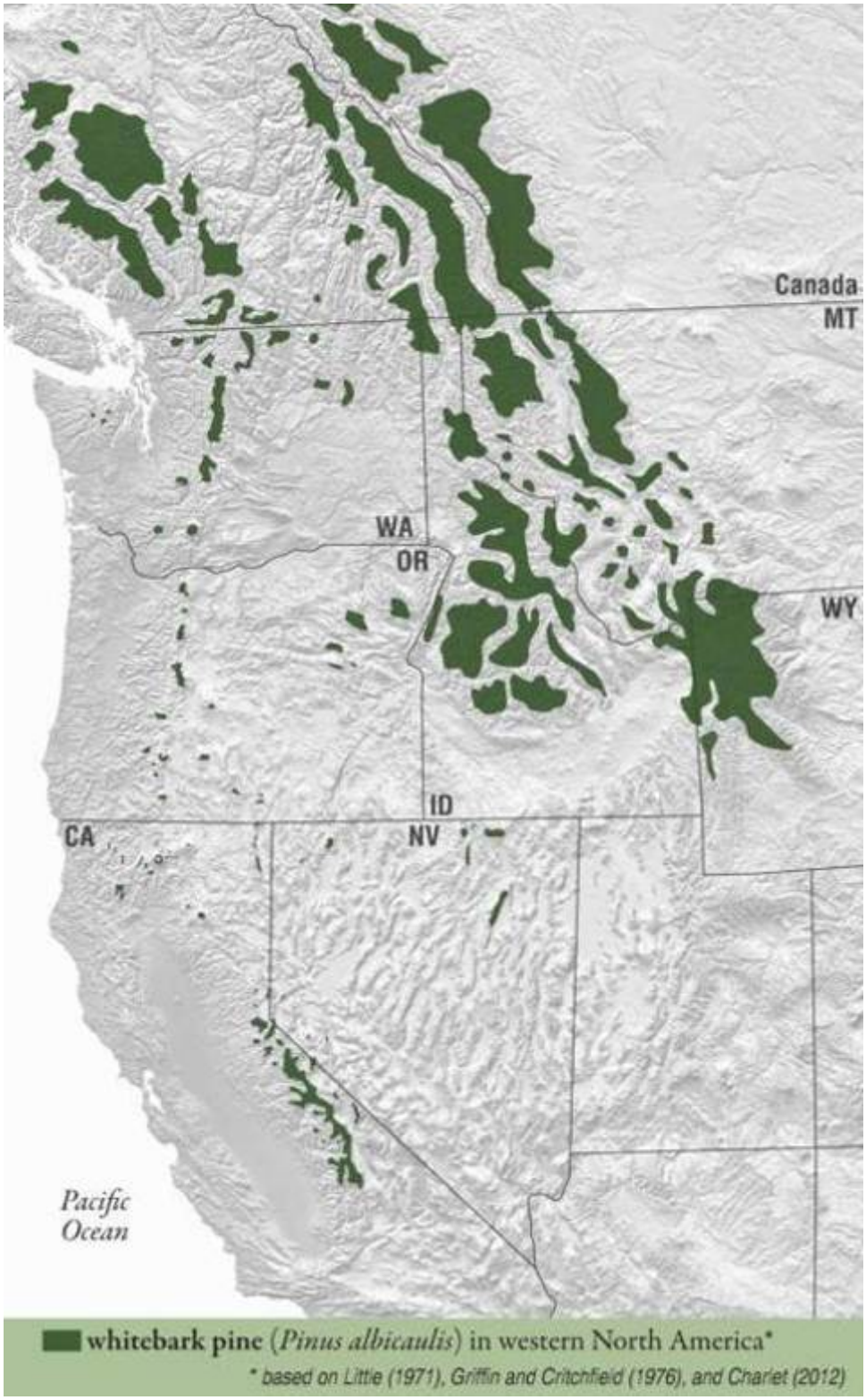

Figure 1. Whitebark pine distribution in western North America. Map created by Michael Kauffmann.

Rockies, California has experienced relatively low mortality of whitebark pine, potentially due to the lower incidence of WPBR (Dunlap 2010; Millar et al. 2012); however, recent monitoring and research results suggest that this may be changing (Forest Health Protection 2012; Gibson et al. 2008). Nonetheless, the current and potential loss of this keystone species in the high mountains of California poses serious threats to biodiversity and losses of ecosystem services, since whitebark pine is one of only a few tree species in these settings.

Unlike other five-needle pines, whitebark pine is set apart in that its cone does not open at maturity and its seed is "wingless"; consequently, they are solely dependent on Clark's nutcrackers (*Nucifraga columbiana*) for seed distribution and future seedling recruitment. These birds open cones, collect the seeds, and cache them. Inevitably, around 20% of the seeds are forgotten or moved by other animals (Lanner 1996) and, in the years following, clumps of whitebark pine saplings grow from these forgotten caches. These two species are both keystone mutualists, where the loss of one species would have a profound impact upon the ecosystem as a whole.

The range-wide threats to whitebark pine led to its consideration for federal listing under the Endangered Species Act (ESA) in 2011; it is now considered a candidate species by US Fish and Wildlife Service (US Fish and Wildlife Service 2011b). Candidate species receive no statutory protection under ESA (US Fish and Wildlife Service 2011a); however, US Fish and Wildlife Service encourages land owners to undertake active management of candidate species. In 2013, whitebark pine was added to the Regional Forester's Sensitive Species List (USDA Forest Service 2013). As such, the Forest Service must analyze the effects of its management activities on WBP and ensure that viability of the species is maintained (USDA Forest Service 2005).

Introduction

Information on the abundance of whitebark pine is very limited. Stands occur at high elevations, are often inaccessible, and occur within habitats that fall outside of the productive timber land base. Because of these factors, whitebark pine communities have historically received less management attention than more common lower elevation forested habitats. While there are many stands of whitebark pine known on the Lake Tahoe Basin Management Unit (LTBMU), extending from Mt. Rose in the north to Red Lake Peak in the south and some west shore peaks, there is a high level of uncertainty regarding the abundance and distribution of these stands.

Currently, the best available spatial data for estimating LTBMU's whitebark pine abundance and distribution is the USFS Pacific Southwest Region - Remote Sensing Lab's CALVEG (Classification and Assessment with Landsat of Visible Ecological Groupings) dataset. CALVEG classifies existing vegetation following national and regional guidance, and the vegetation mapping is primarily through automated processing of satellite imagery (USDA Forest Service 2009). This dataset uses a minimum of 2.5 acres based on cover type, vegetation type, tree cover, and tree diameter. For LTBMU, CALVEG was last updated in 2005, except for the Angora Fire portion which was updated in 2009 after the fire (USDA Forest Service 2009). Regardless of recent field verification, many stands have not been ground truthed to confirm the accuracy of CALVEG vegetation types. Additionally, little field assessment has been done to identify the presence of whitebark pine, its abundance, and stand health.

The California Native Plant Society (CNPS), working in collaboration with the US Forest Service, initiated field surveys in the summer of 2013 to assess the extent and status of whitebark pine in areas lacking ground surveys in California. Three national forests in the Sierra Nevada and four national forests in the Cascades and Klamath Mountains were selected for field surveys in 2013. LTBMU in the Sierra Nevada area was added in 2014.

The goals of the field assessments were to verify distribution and health of whitebark pine, ground-truth polygons designated by CALVEG as Whitebark Pine Regional Dominance Type, conduct modified rapid assessments and reconnaissance surveys (recons) on whitebark pine and related stands, and check the USDA Forest Service (USFS) Forest Health Protection Margins dataset (Bokach 2013) points and other datasets for changes in mortality of whitebark pine due to Mountain Pine Beetle and White Pine Blister Rust, if time allowed. Locations were targeted for the assessment based on potential occurrence of healthy stands in high elevations. Post field assessment, photo interpretation and delineation of whitebark pine extent beyond field surveyed areas were also conducted. This information is being used, along with other reputable sources, to develop a distribution map of whitebark pine in California.

Methods and Materials

The California Native Plant Society (CNPS) obtained existing GIS data from various sources including the USFS Pacific Southwest - Region Remote Sensing Lab's CALVEG maps (USFS 2013c), USFS Forest Health Technology Enterprise Team's National Insect and Disease Risk Model (USFS 2013a) Host species layers, USFS Pacific Southwest Regional Forest Health and Monitoring Aerial Detection Survey Data (USFS 2013b), USFS Forest Health Protection Margins dataset (Bokach 2013), USFS Forest and Inventory Analysis database (USFS 2013d), USFS

Terrestrial Ecological Unit Inventory (TEUI) Potential Natural Vegetation dataset (AMSET 2005), Consortium of California Herbaria (UC Berkeley 2013), USFS Central Sierra Province Ecologist Becky Estes, USFS Southern Sierra Nevada Province Ecologist Marc Meyer, USFS Lake Tahoe Basin Management Unit Ecologist Shana Gross, USFS Northern California Shared Service Center Entomologists Cynthia Snyder and Danny Cluck, National Park Service (NPS) Sierra Nevada Network Inventory and Monitoring Program Ecologist Jonathan Nesmith, US Geological Survey (USGS) Western Ecological Research Center Ecologist Nathan Stephenson, California Department of Fish and Wildlife (CDFW) Wildlife Biologist Pete Figura, University of California Davis Ecologist Pat Maloney, USFS Stanislaus National Forest Botanist Quinn Young, and USFS Lassen National Forest Assistant Forest Botanist Tim Kellison. In addition, we used older sources of whitebark pine distribution in the state for context (Griffin and Critchfield 1972) and for lone populations or individuals not delineated or attributed by CALVEG (UC Berkeley 2013).

Upon evaluating existing datasets and obtaining input from local National Forest staff, we identified areas to further ground-truth to better determine the distribution, status and health of whitebark pine on the National Forest lands. Priorities included sampling within wilderness lands, having accessibility, and identifying areas with low-levels of insect or disease impact. See Appendix 1 for a list of contacts made overall for this assessment.

Three areas were selected for sampling in the Lake Tahoe Basin Management Unit: Freel, Red Lake, and Relay peaks. Relay Peak was the only area accessed within wilderness (Mt. Rose). During the field visits, staff visited areas where CALVEG polygons were designated as Whitebark Pine for the Regional Dominance Type, to determine if whitebark pine was present. We also visited other areas that were identified through aerial photo interpretation and through recommendations of USFS staff as having high likelihood of whitebark pine occurring in the area.

Prior to data collection, CNPS reviewed existing protocols that evaluate whitebark pine vegetation and insect/disease impacts. These protocols included the NPS Standard Operation Procedures for monitoring White Pine (USDOI 2012), Whitebark Pine Ecosystem Foundation (Tomback, et al. 2005), Whitebark Pine Inventory and Monitoring Plot protocol (USFS 2013e) and several government research and staff reports (i.e., Millar et al. 2012, Simons and Cluck 2010, Figura 1997, McKinney et al. 2011, and Maloney et al. 2012). We also discussed the existing protocols for assessing whitebark pine vegetation with USFS staff, including Marc Meyer and Shana Gross.

The CNPS/CDFW Vegetation Rapid Assessment protocol (see Appendix 2) was selected to gather information on occurrence, habitat, and impacts of stands with whitebark pine. We modified this protocol to include signs of Mountain Pine Beetle (MPB) and White Pine Blister

Rust (WPBR), and overall whitebark pine status and health. The modified rapid assessment aimed to gather pertinent information on whitebark pine health without spending a significant amount of time establishing plots or collecting data on individual trees. Therefore, the survey technique was stand based to assess the extent of whitebark pine vegetation across broad areas in a short amount of time (approximately 30 minutes). Sampling included pure stands, mixed conifer stands, and high elevation krummholz, as long as whitebark pine was a component (see Appendix 2 for the CNPS definition of a stand).

The modifications to the rapid assessment included the collection of additional information from the Pacific Southwest Research Station (PSW) Ecology Program's Whitebark Pine Protocol such as whitebark pine impacts from MPB and WPBR, MPB level of attack, and percentage (%) of WBP cones (female). Other items added to the collection protocol included the number of individual clumps or stems per area, phenology of WBP (% vegetative, % male flowers and % fruiting), and overall site or occurrence quality and viability as cited by the California Natural Diversity Database (CNDDB). Since MPB attack and WPBR infestation were the main disturbance of interest to be recorded, USFS Pathologists and Entomologists were contacted for visual aids for accurate whitebark pine health assessment. Subsequently, comprehensive field guides were made for recognizing symptoms and signs of MPB and WPBR attack (Kauffmann 2014).

The reconnaissance (recon) form used for the assessment takes pertinent information from the CNPS/CDFW Vegetation Rapid Assessment protocol to gather basic information about a stand (see Appendix 2). While the overall goal of the assessment was to gather information on healthy stands of WBP over a large area, the recon form was used to collect data on 1) WBP stands that were diseased or infested, 2) stands attributed as WBP by CALVEG that were deemed incorrect, or 3) WBP stands that were close to stands sampled by a Rapid Assessment.

After field assessment, *Pinus albicaulis* stands were delineated and attributed by CNPS staff in GIS using topographical information, whitebark pine field points and aerial imagery, including that of Google Earth. These delineations were then added to the statewide draft map of whitebark pine occurrence in California (see Figure 2). The map represents what we have compiled to date and is a work in progress.

Delineation and attribution followed the *Manual of California Vegetation* membership rules for the *Pinus albicaulis* Forest Alliance and mapping rules and floristic keys for tree-overstory (woodland/forest vegetation) per statewide classification and mapping projects (Sawyer et al. 2009). Membership rules state that *Pinus albicaulis* must have > 50% relative cover or be a conspicuous species in the tree canopy. *Tsuga mertensiana* may co-dominate, and while *Pinus*

contorta ssp. *murrayana* is not co-dominant (Sawyer et al. 2009, Keeler-Wolf et al. 2003). Additionally, the mapping rule we used for tree vegetation is when trees were evenly distributed and conspicuous throughout the stand. Shrub or herbaceous species may have higher total cover than trees, and the tree canopy may have as low as 8–10% absolute cover when shrubs and herbs are not significant (Sawyer et al. 2009). The minimum mapping unit (mmu) that we used for delineating and attributing tree stands was 1 acre.

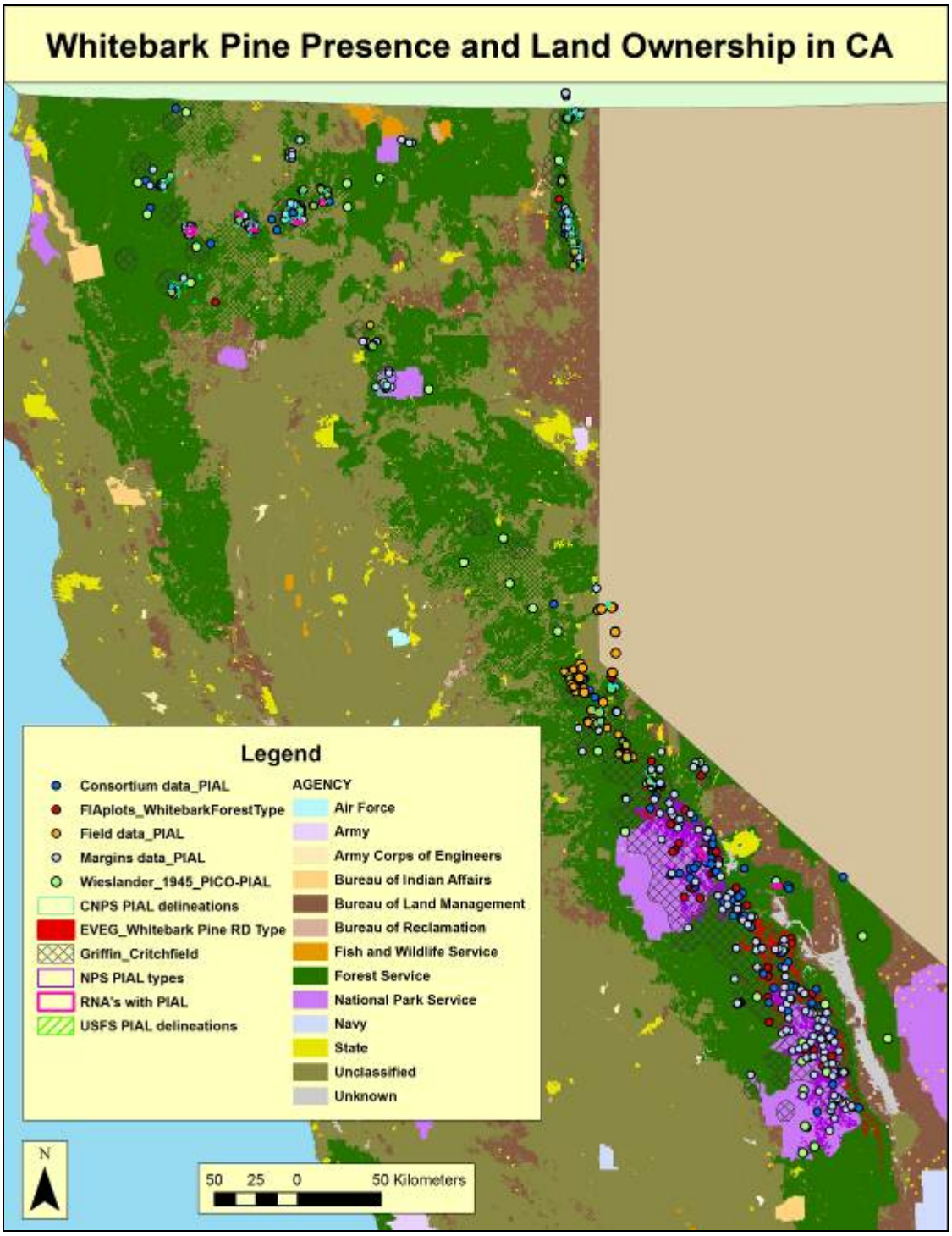

Figure 2. Draft map of whitebark pine presence and land ownership in California. Field data_PIAL includes all PIAL data points collected from CNPS in 2013 and 2014, USFS botanist survey/research points and academic research points in various years, etc. Land ownership layer is from the Bureau of Land Management (BLM 2014), http://www.blm.gov/ca/gis/. Note: Private property is classified mostly as Unclassified in this map.

Results

In October of 2014, two CNPS staff field-assessed whitebark pine in three areas within the LTBMU. Two areas were completely outside wilderness boundaries (Red Lake and Freel peaks) and one area assessed was both outside and inside the Mt. Rose Wilderness (Relay Peak). See Figure 3 and Appendix 3, Figures 4-6, for overview maps of these areas. This assessment included 3 field days of time with 11 whitebark pine-specific rapid assessments and 10 reconnaissance surveys collected, and the estimated cost for these survey types were approximately $350 and $115 per survey type, respectively. For more detailed summary information from this field work see Appendix 4. Photographs of field sites are provided in Appendix 5, Figures 7-13, and detailed maps of the field sites and updated delineations of whitebark pine are in Appendix 6.

In the Red Lake Peak area, stands of *Pinus albicaulis* mixed with other conifers such as *Pinus monticola*, *Pinus contorta* ssp. *murrayana*, and *Abies concolor* were found at 2,700 m (8,800 ft), and individuals were found as low as 2,652 m (8,700 ft). In these lower elevations, some symptoms of WPBR were detected, like flagging, but there were no obvious signs of the rust. Very little *Pinus albicaulis* mortality was detected and was presumed to be from natural causes; this was seen only west of the Pacific Crest Trail on the flanks of the ridgelines dividing the LTBMU from the Eldorado NF at lower elevations. Pure, upright *Pinus albicaulis* stands were found above 2,800 m (9,200 ft) along the base of the Red Lake Peak ridgeline. Some branch mortality was detected but was presumed to be from wind damage. Female cone production ranged from very low to moderate, from lower to higher elevations, respectively, and seedlings/saplings of *Pinus albicaulis* were seen in each stand assessed. No obvious symptoms or signs of WPBR or MPB were detected, mortality was very low (on average, estimated at <0.5% of stems/stand), and therefore, site conditions/occurrence quality and viability were rated as excellent. Overall in this area, 2 rapid assessments and 4 recons were conducted. Both of the rapid assessments were for *Pinus albicaulis* Alliance that were mapped as CALVEG Whitebark Pine Regional Dominant. Three of the recons were for *Pinus albicaulis* Alliance, which were mapped in CALVEG as one Whitebark Pine Regional Dominant, one Low Sagebrush Regional Dominant, and one not defined. The fourth recon was for a *Pinus contorta* ssp. *murrayana* Alliance that was mapped as CALVEG not defined with *Pinus albicaulis* present.

In the Freel Peak area, *Pinus albicaulis* was primarily in pure stands at 2,942 m (9,600 ft) or mixed with *Tsuga mertensiana* at 2,856 m to 2,918 m (9,370 to 9,570 ft). *Pinus albicaulis* stands in lower elevations were mixed with *Pinus monticola* and *Pinus jeffreyi*. Symptoms of an

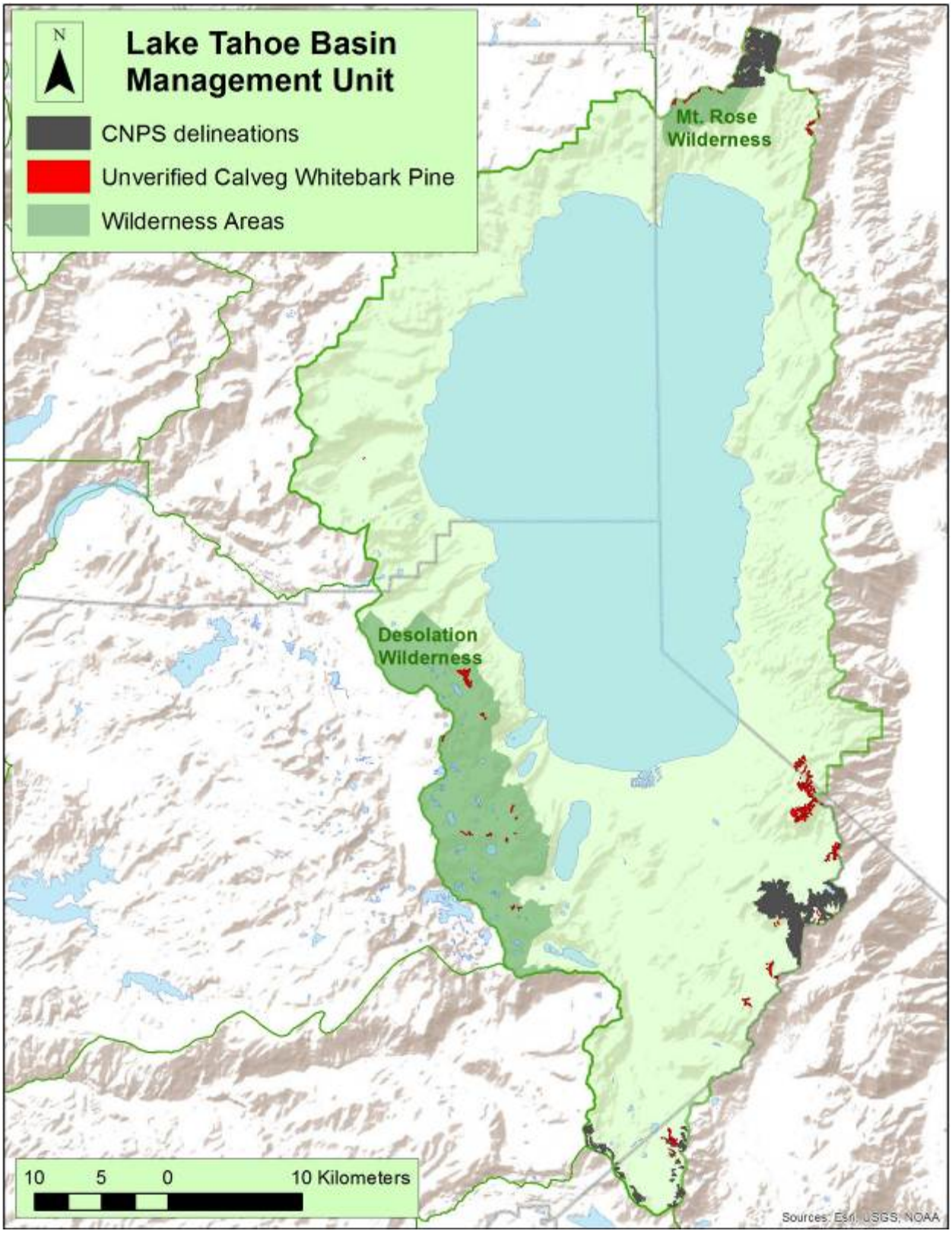

Figure 3. Locations within LTBMU of the three areas that CNPS field assessed and mapped with whitebark pine.

unknown pathogen and signs of MPB were detected; specifically in lower elevation stands around 2,708 m (8,880 ft). In one day, 6 rapid assessments were conducted for *Pinus albicaulis* Alliance (3 mapped as CALVEG Subalpine Conifers Regional Dominant, 2 as CALVEG Whitebark Pine Regional Dominant and 1 as CALVEG Western White Pine Regional Dominant), and 3 recons were conducted for *Pinus albicaulis* Alliance (and mapped as CALVEG Whitebark Pine Regional Dominant). One recon was conducted in a long term monitoring (LTM) plot established by Pat Maloney in the summer of 2009. At that time, relatively low whitebark pine mortality was detected in this region but WPBR and MPB impacts were observed. In the LTM plot we took several photos of tagged trees that had questionable evidence of WPBR impacts. After showing these photos to Martin McKenzie, Forest Pathologist for the USDA Forest Service South Sierra Service Area, the symptoms/signs could not be confirmed as WPBR (see Figure 12-13). On several different aspects of Freel and Trimmer Peak (adjacent to Freel Peak) questionable symptoms/signs of WPBR were found in many whitebark pine trees. At lower altitudes (2,680 m or 8,800 ft), some whitebark pine mortality was detected from MPB attack and was confirmed by beetle galleries in the standing snags. Even though whitebark pine impacts were detected in this area, we found little overall mortality in the places assessed (on average, estimated at 2% of stems/stand). Whitebark pine stands were relatively healthy with reproducing stems per stand ranging from 6 to 70% (relative to the total number of stems within a defined area) with 1 to 10 cones per stem, and in many places whitebark pines were large and mature with recruits of seedlings and saplings. Site conditions/occurrence quality and viability ratings were therefore determined as good to excellent.

In the Relay Peak area, mature, upright *Pinus albicaulis* stands dominated the upper portions of the Radio Tower Access Road from 2,680 m to 3050 m (8,800 to 10,000 ft) and along the Tahoe Rim Trail to Gray Peak Trail at varying elevations. In some sections along the Tahoe Rim Trail, on the east to southeast facing slopes at 2,872 m (9,400 ft), *Pinus monticola* and *Tsuga mertensiana* co-dominate with *Pinus albicaulis*. Little to no reproduction was seen in the stands assessed, and evidence of MPB mortality and symptoms of unknown pathogens were seen throughout. Overall stem mortality was higher in this area than Red Lake or Freel Peaks (on average, estimated at 7% of stems/stand); however, it was difficult to decipher the specific contributor(s) of tree death. It is possible that a portion of the mortality was due to MPB since we observed evidence of MPB killed stems (snags) in this area, but due to fire many snags were darkened and galleries were faded and indistinguishable. Overall, higher incidence of an unknown pathogen attack was seen on whitebark pine stems, from lower to higher elevations (see Figure 10), and site conditions/occurrence quality and viability ratings were therefore determined as fair. In one day, 3 rapid assessments were conducted for *Pinus albicaulis* Alliance(1 mapped as CALVEG Western White Pine Regional Dominant, 1 as CALVEG Supalpine Conifers Regional Dominant, and 1 as Whitebark Pine Regional Dominant) and 3 recons were

conducted for *Pinus albicaulis* Alliance (1 mapped as CALVEG Whitebark Pine Regional Dominant and 2 as undefined CALVEG). One recon survey was conducted in Toiyabe National Forest because high cover of *Ribes cereum* was seen in the understory. A small sample of *Ribes cereum* leaves were collected and submitted to the California Department of Food and Agriculture and confirmed negative for WPBR.

In the Lake Tahoe Basin Management Unit, the total area attributed by CALVEG as Whitebark Pine (WBP) for the Regional Dominance Type is 614 hectares (1,518 acres); see Table 1. The three areas that were field and map assessed comprised about 60% of the total attributed by CALVEG, or approximately 365 hectares (902 acres). In comparing these field sites with updated delineations of whitebark pine, if vegetation was mapped by Calveg as whitebark pine but not mapped by CNPS as whitebark pine, these are denoted as negative delineations. If the vegetation was mapped by Calveg as other types but mapped by CNPS as whitebark pine, these are denoted as updated (and positive) delineations. A majority of this assessed area was not ground-truthed by rapid assessment or recon but by a combination of visual assessment in the field using binoculars, topo maps, field points and whitebark pine signature recognition of Google Earth aerial imagery. Additionally, the CALVEG methods include a minimum mapping unit (mmu) of 2.5 acres when mapping contrasting vegetation conditions (such as regional dominance cover type, tree cover, and tree diameter classes), whereas CNPS uses a 1 acre mmu for the tree alliances (and 3 acres mmu for contrasting tree cover classes).

At Freel Peak, over 5% (11 ha ÷ 240 ha) of the CALVEG polygons attributed as WBP were assessed by CNPS as incorrect (Table 1). In addition, about 73% (643 ha ÷ 873 ha) of the CALVEG delineation that are in the updated CNPS delineation of *Pinus albicaulis* Alliance were attributed inaccurately (see Table 2), with Subalpine conifers Regional Dominance Type being the type having the highest error of omission.

In the Red Lake Peak area, approximately 38% (28 ha ÷ 73 ha) of the CALVEG polygons attributed as WBP were assessed by CNPS as incorrect (Table 1). In addition, about 76% (146 ha ÷ 191 ha) of the CALVEG delineation that are in the updated CNPS delineation of the *Pinus albicaulis* Alliance were attributed inaccurately (see Table 3) with Subalpine conifers Regional Dominance Type being the type having the highest error of omission. In the Relay Peak area, approximately 13% (7 ha ÷ 52 ha) of the CALVEG polygons attributed as WBP were assessed by CNPS as incorrect (Table 1). In addition, about 91% (486 ha ÷ 532 ha) of the CALVEG delineation that are in the updated CNPS delineation of the *Pinus albicaulis* Alliance were attributed inaccurately (see Table 4) with Lodgepole pine Regional Dominance Type being the type having the highest error of omission.

Table 1. Delineation in hectares (acres in parentheses) of CALVEG Whitebark Pine Regional Dominance Type and of CNPS *Pinus albicaulis* Alliance for the portions of LTBMU with field and map assessment.

	CALVEG WBP delineation	CALVEG negative and altered delineation	CNPS updated delineation not originally in CALVEG	CNPS updated WBP delineation in LTBMU	Total Area Assessed
Freel Peak area	**240** (594)	**11** (27)	**643** (1,589)	**873** (2,156)	**883** (2,183)
Red Lake Peak area	**73** (180)	**28** (68)	**146** (360)	**191** (472)	**218** (540)
Relay Peak area	**52** (129)	**7** (17)	**486** (1,202)	**532** (1,314)	**539** (1,331)
Totals in LTBMU	**614** (1,518)	**45** (112)	**1,275** (3,150)	**1,595** (3,942)	**1,641** (4,054)
Portion of CALVEG not assessed	**249** (614)				

Overall, Regional Dominance types with the highest errors of omission in LTBMU were Subalpine conifers and Barren, 33% and 15% of the total area assessed respectively. More specifically, at Freel Peak, out of the 873 hectares that CNPS has mapped as *Pinus albicaulis* Alliance, 45% was mapped by CALVEG as Regional Dominant type Subalpine conifers, 26% as Whitebark pine, 19% as Barren, and 2% as Lodgepole pine. At Red Lake Peak, out of the 191 hectares mapped as *Pinus albicaulis* Alliance, 27% was mapped by CALVEG as Regional Dominant type Subalpine conifers, 24% as Whitebark pine, 13% as Perennial grasses and forbs, and 13% as Barren. At Relay Peak, out of 532 hectares mapped as *Pinus albicaulis* Alliance, 33% was mapped by CALVEG as Regional Dominant type Lodgepole pine, 15% as Subalpine conifers, 9% as Alpine mixed scrub and 9% as Whitebark pine (see Tables 2, 3 and 4 for Regional Dominant types with less area in the regions assessed).

The increase in the vegetation type delineation of *Pinus albicaulis* Alliance was approximately 280% in Freel Peak, 324% in Red Lake and 1,080% in the Relay Peak areas. With a little over half of the CALVEG distribution assessed, the delineated area in LTBMU increased by 533%. The CALVEG delineation for WBP throughout the entire LTBMU ranged from 1,975 m to 3,244 m, with a mean value of 2,875 m. The CNPS updated delineations of WBP similarly ranged from 2,677 to 3,126 m with a mean value of 2,828 m. Therefore, from our assessment, whitebark pine stands are slightly lower in elevation than what has been mapped by CALVEG.

The updated delineations show areas previously mapped as Whitebark Pine for Regional Dominance Type that were found not to be *Pinus albicaulis* Alliance in the field, as well as areas not previously mapped that were assessed to be dominant or co-dominant whitebark pine. See Appendix 6, Figures 14-16, for close-up spatial representation of the mapping of positive and negative delineations for the *Pinus albicaulis* Alliance in the three areas visited in LTBMU, following the membership and mapping rules stated.

Table 2. Comparison of the CALVEG delineation of Regional Dominance Types and updated CNPS delineation for *Pinus albicaulis* Alliance in the Freel Peak area (provided in both hectares and acres).

Regional Dominant Vegetation types	CALVEG		CNPS (total area mapped)		CNPS (additional area mapped)	
	hectares	acres	hectares	acres	hectares	acres
Subalpine conifers	**397**	980				
Whitebark pine	**229**	565	**873**	2,156	**643**	1,589
Barren	**173**	426				
Lodgepole pine	**25**	63				
Alpine mixed scrub	**12**	29				
Pinemat manzanita	**8**	21				
Western white pine	**7**	18				
Alpine grasses and forbs	**6**	16				
Red fir	**3**	7				
Upper montane mixed shrub	**3**	7				
Huckleberry oak	**2**	6				
Upper montane mixed chaparral	**2**	6				
Great Basin–Mixed chaparral transition	**2**	4				
Perennial grasses and forbs	**2**	4				
Aspen (shrub)	**0.1**	0.4				
Total	**873**	2,156	**873**	2,156	**643**	1,589

* Note: Subalpine conifers may include whitebark pine trees, but the whitebark pine would have less relative cover.

Table 3. Comparison of the CALVEG delineation of Regional Dominance Types and updated CNPS delineation for *Pinus albicaulis* Alliance in the Red Lake Peak area (provided in both hectares and acres).

Regional Dominant Vegetation types	CALVEG		CNPS (total area mapped)		CNPS (additional area mapped)	
	hectares	acres	hectares	acres	hectares	acres
Subalpine conifers	**52**	128				
Whitebark pine	**45**	112	**191**	472	**146**	360
Perennial grasses and forbs	**25**	61				
Barren	**25**	61				
Low sagebrush	**13**	32				
Alpine mixed scrub	**8**	20				
Mountain sagebrush	**5**	11				
Alpine grasses and forbs	**4**	11				
Upper montane mixed shrub	**4**	10				
Great Basin mixed scrub	**4**	9				
Red fir	**3**	8				
Wet grasses and forbs	**1**	3				
Willow (riparian scrub)	**1**	2				
Snowberry	**0.4**	1.0				
Huckleberry oak	**0.2**	0.5				
Total	**191**	472	**191**	472	**146**	360

* Note: Subalpine conifers may include whitebark pine trees, but the whitebark pine would have less relative cover.

Table 4. Comparison of the CALVEG delineation of Regional Dominance Types and updated CNPS delineations for *Pinus albicaulis* Alliance in the Relay Peak area (provided in both hectares and acres).

Regional Dominant Vegetation types	CALVEG		CNPS (total area mapped)		CNPS (additional area mapped)	
	hectares	acres	hectares	acres	hectares	acres
Lodgepole pine	**178**	439				
Subalpine conifers	**78**	193				
Alpine mixed scrub	**49**	122				
Whitebark pine	**46**	113	**532**	1,314	**486**	1,201
Western white pine	**38**	94				
Alpine grasses and forbs	**34**	85				
Barren	**34**	84				
Perennial grasses and forbs	**27**	67				
Low sagebrush	**17**	43				
Mountain sagebrush	**11**	28				
Wet grasses and forbs	**8**	20				
Great Basin mixed scrub	**5**	12				
Willow (riparian scrub)	**4**	9				
Urban-related bare soil	**2**	4				
Upper montane mixed chaparral	**1**	1				
Total	**532**	1,314	**532**	1,314	**486**	1,201

* Note: Subalpine conifers may include whitebark pine trees, but the whitebark pine would have less relative cover.

Conclusions and Discussion

The whitebark pine field work in Lake Tahoe Basin Management Unit was important in assessing the overall distribution of this vegetation, including significant increases in mapped areas of whitebark pine compared to previous delineations from remote sensing. The total amount of *Pinus albicaulis* Alliance delineated through photo-interpretation after the field assessment was approximately 1,275 hectares (3,150 acres); this includes CALVEG polygons confirmed as Whitebark Pine for the Regional Dominance Type and stands assessed on the ground during the survey. The CALVEG Regional Dominance type that had the highest error of omission for whitebark pine was the Subalpine conifers (33% of the total area mapped as *Pinus albicaulis* Alliance). The Subalpine conifers type is defined by CALVEG as a mixture of high elevation conifer species where no single conifer species is dominant; whereas, the CNPS *Pinus albicaulis* Alliance is defined by *Pinus albicaulis* having > 50% relative cover or being a conspicuous species in the tree canopy. *Tsuga mertensiana* may co-dominate and *Pinus contorta* ssp. *murrayana* is not co-dominant. Differences in vegetation descriptions and mapping rules may be leading to the under mapping of *Pinus albicaulis* by CALVEG. The increase in mapped area for the Relay Peak area was substantial, with a 1,080% change. Updated delineations of the *Pinus albicaulis* Alliance have been imported into a new state draft map from the 8 forests that were visited in the summer and fall of 2013 and 2014 (See Figure 2).

Using the California Natural Diversity Database (CNDDB) protocol for documenting overall quality and viability of whitebark pine stands observed in the Lake Tahoe Basin Management Unit, we conclude that stands overall had fair to excellent viability (probability of persistence) over the next 20 years. Due to size of stands, amount of threat or impacts, abiotic and biotic conditions, and signs of reproductive health, whitebark pine in these areas of the LTBMU (representing about 60% of the estimated area dominated by the species according to CALVEG) are relatively healthy. Additionally, in the areas we assessed, no evidence of increased WPBR infection or mortality over that of the Maloney survey of 2009 was detected. We recommend future surveys in the area to include a long-term monitoring protocol, such as provided in Appendix 7, since this area is easily accessible for monitoring.

Areas of concern in the LTBMU are whitebark pine stands at Relay Peak and other areas of the Forest under 2,700 m (9,000 ft). Fortunately, long-term monitoring plots have been established in a range of elevations throughout the forest by USDA Forest Ecologist Shana Gross and UCD professor Pat Maloney, to detect the impacts on WBP due to MPB and WPBR, both currently and over time. Overall quality and viability of these stands may differ substantially from the areas assessed for this project, since our focus for assessment was collecting data at higher elevations where lesser impacts from beetles and pathogens are to be expected. For an

understanding of the overall health of whitebark pine, the recent LTBMU plot monitoring data (Gross 2014 and Maloney 2012) are important quantitative additions.

Data Gaps and Recommendations for Future Work

Priority areas recommended for additional field assessment in the Lake Tahoe Basin Management Unit include polygons mapped by CALVEG as Whitebark Pine Regional Dominant in the following locations:

- near Mount Tallac and Rubicon Peak in the Desolation Wilderness
- within the Heavenly Resort Ski Area and Monument Peak
- north of Star Lake and southeast of Incline Lake along the Tahoe Rim Trail
- south of Freel Peak and near Armstrong Pass.

Other CALVEG Regional Dominance Types to target would be Subalpine conifers and Lodgepole pine stands that are above 2,590 m (8,500 ft) throughout the LTBMU.

Priority areas for long term monitoring include the Red Lake Peak area, where healthy, upright stands of whitebark pine can be accessed in a half hour or less hike off the Pacific Crest Trail. In several regions of the Forest, long term monitoring plots have already been established. At the same time, some of the recommended areas for additional field assessment may be appropriate for the establishment of monitoring plots if the stands have low MPB and WPBR impacts.

Areas of priority for future field assessment in other National Forests are as follows: 1) southern Sierra NF in the Monarch Wilderness and CALVEG polygons near Florence and Edison Lakes 2) southern Inyo NF CALVEG polygons in the Golden Trout Wilderness 3) northern Inyo NF Research Natural Areas, Sentinel Meadow and Harvey Monroe Hall, based on ecological surveys (Keeler-Wolf 1990) 4) northern Sequoia NF in the Monarch and Jennie Lakes Wilderness areas near 3,000 m (10,000 ft); and 5) Stanislaus and Eldorado NF peaks above 2,700 m (9,000 ft) in Carson-Iceberg, Emigrant, Desolation and Mokelumne Wilderness areas.

Lastly, this report is not comprehensive; it was based upon the available funding and resources for pilot fieldwork and the USDA Forest Service staff schedules in 2013 and 2014. The draft map of whitebark pine distribution (Figure 2) is, therefore, not complete but provides an updated version of the distribution from field surveys and aerial interpretation including limited modeled data. The modeled data presented from CALVEG in Figure 2 should be used to

prioritize additional areas for field assessments, since, according to our calculation, CALVEG is less than 20% accurate for the Whitebark Pine Regional Dominance Type.

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Appendix 1: Key Individuals/Contacts

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Appendix 2: Inventory and Monitoring Protocols / Field Forms

CALIFORNIA NATIVE PLANT SOCIETY / DEPARTMENT OF FISH AND WILDLIFE
PROTOCOL FOR COMBINED VEGETATION RAPID ASSESSMENT
AND RELEVÉ SAMPLING FIELD FORM
(Modified for WBP)
July 8, 2013

Introduction

This protocol describes the methodology for both the relevé and rapid assessment vegetation sampling techniques as recorded in the combined relevé and rapid assessment field survey form dated June 28, 2013. The same environmental data are collected for both techniques. However, the relevé sample is plot-based, with each species in the plot and its cover being recorded. The rapid assessment sample is based not on a plot but on the entire stand, with 12-20 of the dominant or characteristic species and their cover values recorded. For more background on the relevé and rapid assessment sampling methods, see the relevé and rapid assessment protocols at www.cnps.org.

Selecting stands to sample:

To start either the relevé or rapid assessment method, a stand of vegetation needs to be defined.
A stand is the basic physical unit of vegetation in a landscape. It has no set size. Some vegetation stands are very small, such as alpine meadow or tundra types, and some may be several square kilometers in size, such as desert or forest types. A stand is defined by two main unifying characteristics:

1) It has compositional integrity. Throughout the site, the combination of species is similar. The stand is differentiated from adjacent stands by a discernable boundary that may be abrupt or indistinct.
2) It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest originally dominated by the same species that burned on the upper part of the slopes, but not the lower, would be divided into two stands. Likewise, sparse woodland occupying a slope with very shallow rocky soils would be considered a different stand from an adjacent slope with deeper, moister soil and a denser woodland or forest of the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. For an area of vegetated ground to meet the requirements of a stand, it must be homogeneous (uniform in structure and composition throughout).

Stands to be sampled may be selected by evaluation prior to a site visit (*e.g.,* delineated from aerial photos or satellite images), or they may be selected on site during reconnaissance (to determine extent and boundaries, location of other similar stands, etc.).

Depending on the project goals, you may want to select just one or a few representative stands of each homogeneous vegetation type for sampling (*e.g.,* for developing a classification for a

vegetation mapping project), or you may want to sample all of them (*e.g.,* to define a rare vegetation type and/or compare site quality between the few remaining stands).

For the rapid assessment method, you will collect data based on the entire stand.

Selecting a plot to sample within in a stand (for relevés only):
Because many stands are large, it may be difficult to summarize the species composition, cover, and structure of an entire stand. We are also usually trying to capture the most information as efficiently as possible. Thus, we are typically forced to select a representative portion to sample.

When sampling a vegetation stand, the main point to remember is to select a sample that, in as many ways possible, is representative of that stand. This means that you are not randomly selecting a plot; on the contrary, you are actively using your own best judgment to find a representative example of the stand.

Selecting a plot requires that you see enough of the stand you are sampling to feel comfortable in choosing a representative plot location. Take a brief walk through the stand and look for variations in species composition and in stand structure. In many cases in hilly or mountainous terrain look for a vantage point from which you can get a representative view of the whole stand. Variations in vegetation that are repeated throughout the stand should be included in your plot. Once you assess the variation within the stand, attempt to find an area that captures the stand's common species composition and structural condition to sample.

Plot Size
All relevés of the same type of vegetation to be analyzed in a study need to be the same size. Plot shape and size are somewhat dependent on the type of vegetation under study. Therefore, general guidelines for plot sizes of tree-, shrub-, and herbaceous communities have been established. Sufficient work has been done in temperate vegetation to be confident the following conventions will capture species richness:

Herbaceous communities: 100 sq. m plot
Special herbaceous communities, such as vernal pools, fens: 10 sq m plot
Shrublands and Riparian forest/woodlands: 400 sq. m plot
Open desert and other shrublands with widely dispersed but regularly occurring woody species: 1000 sq. m plot
Upland Forest and woodland communities: 1000 sq. m plot

Plot Shape
A relevé has no fixed shape, though plot shape should reflect the character of the stand. If the stand is about the same size as a relevé, the plot boundaries may be similar to that of the entire stand. If we are sampling streamside riparian or other linear communities, our plot dimensions should not go beyond the community's natural ecological boundaries. Thus, a relatively long, narrow plot capturing the vegetation within the stand, but not outside it would be appropriate. Species present along the edges of the plot that are clearly part of the adjacent stand should be excluded.

If we are sampling broad homogeneous stands, we would most likely choose a shape such as a circle (which has the advantage of the edges being equidistant to the center point) or a square (which can be quickly laid out using perpendicular tapes).

Definitions of fields in the protocol

Relevé or Rapid Assessment: Circle the method that you are using.

I. LOCATIONAL/ENVIRONMENTAL DESCRIPTION

Polygon/Stand #: Number assigned either in the field or in the office prior to sampling. It is usually denoted with a four-letter abbreviation of the sampling location and then a four-number sequential number of that locale (*e.g.* CARR0001 for Carrizo sample #1). The maximum number of letters/numbers is eight.

Air photo #: The number given to the aerial photo in a vegetation-mapping project, for which photo interpreters have already done photo interpretation and delineations of polygons. If the sample site has not been photo-interpreted, leave blank.

Date: Date of the sampling.

Name(s) of surveyors: The full names of each person assisting should be provided for the first field form for the day. On successive forms, initials of each person assisting can be recorded. Please note: The person recording the data on the form should circle their name/initials.

GPS waypoint #: The waypoint number assigned by a Global Positioning System (GPS) unit when marking and storing a waypoint for the sample location. Stored points should be downloaded in the office to serve as a check on the written points and to enter into a GIS.

For relevé plots, take the waypoint in the southwest corner of the plot or in the center of a circular plot.

GPS name: The name/number assigned to each GPS unit. This can be the serial number if another number is not assigned.

Datum: (NAD 83) The standard GPS datum used is NAD 83. If you are using a different datum, note it here.

Bearing, left axis at SW pt (note in degrees) of Long or Short side: For square or rectangular plots: from the SW corner (= the GPS point location), looking towards the plot, record the bearing of the axis to your left. If the plot is a rectangle, indicate whether the left side of the plot is the long or short side of the rectangle by circling "long" or "short" side (no need to circle anything for circular or square plots). If there are no stand constraints, you would choose a circular or square plot and straight-sided plots should be set up with boundaries running in the cardinal directions. If you choose a rectangular plot that is not constrained by the stand dimensions, the short side should run from east to west, while the long side should run from north to south.

UTM coordinates: Easting (UTME) and northing (UTMN) location coordinates using the Universal Transverse Mercator (UTM) grid. Record in writing the information from a GPS unit or a USGS topographic map.

UTM zone: Universal Transverse Mercator zone. Zone 10 is for California west of the 120th longitude, zone 11 is for California east of 120th longitude, which is the same as the straight portion of California's eastern boundary.

Error: ± The accuracy of the GPS location, when taking the UTM field reading. Please record the error units by circling feet (ft), meters (m), or positional dilution of precision (pdop). If your GPS does not determine error, insert N/A in this field.

Is GPS within stand? Yes / No Circle"Yes" to denote that the GPS waypoint was taken directly within or at the edge of the stand being assessed for a rapid assessment, or circle "No" if the waypoint was taken at a distance from the stand (such as with a binocular view of the stand).

If No, cite from waypoint to stand, distance (note in meters) & bearing (note in degrees): An estimate of the number of meters and the compass bearing from the GPS waypoint to the stand.

Elevation: Recorded from the GPS unit or USGS topographic map. Please circle feet (ft) or meters (m).

Photograph #s: Write the name or initials of the camera owner, JPG/frame number, and direction of photos (note the roll number if using film). *Take four photos in the main cardinal directions (N, E, S, W) clockwise from the north, from the GPS location.* If additional photos are taken in other directions, please note this information on the form. Also include overview photos of Whitebark pine.

Stand Size: Estimate the size of the entire stand in which the sample is taken. As a measure, one acre is about 4000 square meters (approximately 64 x 64 m), or 208 feet by 208 feet. One acre is similar in size to a football field.

Plot Size: If this is a relevé, circle the size of the plot.

Plot Shape: Record the length and width of the plot and circle measurement units (i.e., ft or m). If it is a circular plot, enter radius (or just put a check mark in the space).

Exposure: (Enter actual º and circle general category): With your back to the general uphill direction of the slope (i.e., by facing downhill of the slope), read degrees of the compass for the aspect or the direction you are standing, using degrees from north, adjusted for declination. Average the reading over the entire stand, even if you are sampling a relevé plot, since your plot is representative of the stand. If estimating the exposure, write "N/A" for the actual degrees, and circle the general category chosen. "Variable" may be selected if the same, homogenous stand of vegetation occurs across a varied range of slope exposures. Select "all" if stand is on top of a knoll that slopes in all directions or if the same, homogenous stand of vegetation occurs across all ranges of slope.

Steepness: (Enter actual º and circle general category): Read degree slope from a compass or clinometer. If estimating, write "N/A" for the actual degrees, and circle the general category chosen.. Make sure to average the reading across the entire stand even if you are sampling in a relevé plot.

Topography: First assess the broad (**Macro**) topographic feature or general position of the stand in the surrounding watershed, that is, the stand is at the top, upper (1/3 of slope), middle (1/3 of slope), lower (1/3 of slope), or bottom. **Circle *all* of the positions that apply for macrotopography.**

Then assess the local (**Micro**) topographic features or the lay of the area (*e.g.,* surface is flat or concave). **Circle only *one* of the microtopographic descriptors**.

Geology: Geological parent material of site. If exact type is unknown, use a more general category (*e.g.,* igneous, metamorphic, sedimentary). *See code list for types.*

Soil Texture: Record soil texture that is characteristic of the site (*e.g.,* coarse loamy sand, sandy clay loam). *See soil texture key and code list for types.*

Upland or Wetland/Riparian (circle one): Indicate if the stand is in an upland or a wetland. There are only two options. Wetland and riparian are one category. Note that a site need not be officially delineated as a wetland to qualify as such in this context (*e.g.,* seasonally wet meadow).

% Surface cover (abiotic substrates). It is helpful to imagine "mowing off" all of the live vegetation at the base of the plants and removing it – you will be estimating what is left covering the surface. **The total should sum to 100%.** Note that non-vascular cover (lichens, mosses, cryptobiotic crusts) is not estimated in this section.

% Water: Estimate the percent surface cover of running or standing water, ignoring the substrate below the water.

% BA Stems: Percent surface cover of the plant basal area, *i.e.*, the basal area of stems at the ground surface. Note that for most vegetation types BA is 1-3% cover. Estimate for a set area (e.g., 400 m2) of BA to help calibrate on this % (on average % is between 1.5-4.5% for conifers)

% Litter: Percent surface cover of litter, duff, or wood on the ground.

% Bedrock: Percent surface cover of bedrock.

% Boulders: Percent surface cover of rocks > 60 cm in diameter.

% Stone: Percent surface cover of rocks 25-60 cm in diameter.

% Cobble: Percent surface cover of rocks 7.5 to 25 cm in diameter.

% Gravel: Percent surface cover of rocks 2 mm to 7.5 cm in diameter.

% Fines: Percent surface cover of bare ground and fine sediment (e.g. dirt) < 2 mm in diameter.

% Current year bioturbation: Estimate the percent of the sample or stand exhibiting soil disturbance by fossorial organisms (any organism that lives underground). Do not include disturbance by ungulates. Note that this is a separate estimation from surface cover.

Past bioturbation present? Circle Yes if there is evidence of bioturbation from previous years.

% Hoof punch: Note the percent of the sample or stand surface that has been punched down by hooves (cattle or native grazers) in wet soil.

Fire Evidence: Circle Yes if there is visible evidence of fire, and note the type of evidence in the "Site history, stand age and comments section," for example, "charred dead stems of *Quercus berberidifolia* extending 2 feet above resprouting shrubs." If you are certain of the year of the fire, put this in the Site history section.

Site history, stand age, and comments: Briefly describe the stand age/seral stage, disturbance history, nature and extent of land use, and other site environmental and vegetation factors. Examples of disturbance history: fire, landslides, avalanching, drought, flood, animal

burrowing, or pest outbreak. Also, try to estimate year or frequency of disturbance. Examples of land use: grazing, timber harvest, or mining. Examples of other site factors: exposed rocks, soil with fine-textured sediments, high litter/duff build-up, multi-storied vegetation structure, or other stand dynamics.

Disturbance code / Intensity (L,M,H): List codes for potential or existing impacts on the stability of the plant community. Characterize each impact each as **L** (=Light), **M** (=Moderate), or **H** (=Heavy). For invasive exotics, divide the total exotic cover (e.g. 25% Bromus diandrus + 8% Bromus madritensis + 5% Centaurea melitensis = 38% total exotics) by the total % cover of all the layers when added up (e.g. 15% tree + 5% low tree + 25% shrub + 40% herbs = 85% total) and multiply by 100 to get the % relative cover of exotics (e.g. 38% total exotics/85% total cover = 45% relative exotic cover). L = 0-33% *relative* cover of exotics; M =34-66% relative cover, and H = > 66% relative cover. *See code list for impacts.*

List percent of WBP impacted by Mountain Pine Beetle (39-MPB/L/approx. % impacted) and White Pine Blister Rust (40-WPBR/H/approx. % impacted) within the stand. For Mountain Pine Beetle, search the bole for entry holes (reddish colored pitch) or frass. For WPBR, search for 'signs' of an active canker (i.e., a canker with visible aecia, or fruiting bodies containing spores), or 'symptoms' of any of the following five indicators: rodent chewing, flagging, swelling, roughened bark, and oozing sap. Explain signs and symptoms in the notes and take photos when necessary.

II. HABITAT AND VEGETATION DESCRIPTION

California Wildlife-Habitat Relationships (CWHR)

For CWHR, identify the size/height class of the stand using the following tree, shrub, and/or herbaceous categories. These categories are based on functional life forms.

Tree DBH: Circle one of the tree size classes provided when the tree canopy closure exceeds 10 percent of the total cover, or if young tree density indicates imminent tree dominance. Size class is based on the average diameter at breast height (dbh) of each trunk (standard breast height is 4.5ft or 137cm). When marking the main size class, make sure to estimate the mean diameter of all trees over the entire stand, and weight the mean if there are some larger tree dbh's. The "**T6 multi-layered**" dbh size class contains a multi-layered tree canopy (with a size class T3 and/or T4 layer growing under a T5 layer and a distinct height separation between the classes) exceeding 60% total cover. Stands in the T6 class need also to contain at least 10% cover of size class 5 (>24" dbh) trees growing over a distinct layer with at least 10% combined cover of trees in size classes 3 or 4 (>11-24" dbh). This is weighted: In your representative area add number of trees for each category and record above (T1,T2,T3, etc). Can square root later to get the weighted average for this category (if there are many sizes).

Shrub: Circle one of the shrub size classes provided when shrub canopy closure exceeds 10 percent (except in desert types) by recording which class is predominant in the survey. Shrub size class is based on the average amount of crown decadence (dead standing vegetation on live shrubs when looking across the crowns of the shrubs).

Herb: Circle one of the herb height classes when herbaceous cover exceeds 2 percent by recording the predominant class in the survey. Note: *This height class is based on the average plant height at maturity, not necessarily at the time of observation.*

Desert Palm/Joshua Tree: Circle one of the palm or Joshua tree size classes by averaging all the stem-base diameters (*i.e.* mean diameter of all stem-base sizes). Diameter is measured at the plant's base above the bulge near the ground.

Desert Riparian Tree/Shrub: Circle one of the size classes by measuring mean stem height (whether tree and/or shrub stand).

Overall Cover of Vegetation

Provide an estimate of cover for the following categories below (based on functional life forms). Record a specific number for the total aerial cover or "bird's-eye view" looking from above for each category, estimating cover for the living plants only. Litter/duff should not be included in these estimates. The porosity of the vegetation should be taken into consideration when estimating percent cover (how much of the sky can you see when you are standing under the canopy of a tree, or how much light passes through the canopy of the shrub layer?).

To come up with a specific number estimate for percent cover, first use generalized cover classes as reference aids such as the CWHR cover classes (<2%, 2-9%, 10-24%, 25-39%, 40-59%, 60-100%) or the modified Braun-Blanquet cover-abundance scale (<1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, >75%). While keeping these intervals in mind, you can then refine your estimate to a specific percentage for each category below.

% Total NonVasc cover: The total cover of all lichens, bryophytes (mosses, liverworts, hornworts), and cryptogrammic crust on substrate surfaces including downed logs, rocks and soil, but not on standing or inclined trees or vertical rock surfaces.

% Total Vasc Veg cover: The total cover of all vascular vegetation taking into consideration the porosity, or the holes, in the vegetation. This is an estimate of the absolute vegetation cover, disregarding overlap of the various tree, shrub, and/or herbaceous layers and species. Could use densitometer to calibrate, but sometimes this provides an over-estimate.

% Cover by Layer

% Conifer Tree /Hardwood Tree: The total foliar cover (considering porosity) of all live tree species, disregarding overlap of individual trees. Estimate conifer and hardwood covers separately.
Please note: These cover values should not include the coverage of regenerating tree species (i.e., tree seedlings and saplings).

% Regenerating Tree: The total foliar cover of seedlings and saplings, disregarding overlap of individual recruits. See seedling and sapling definitions below.

%Shrub: The total foliar cover (considering porosity) of all live shrub species disregarding overlap of individual shrubs.

%Herbaceous: The total cover (considering porosity) of all herbaceous species, disregarding overlap of individual herbs.

Height Class by Layer

Modal height for conifer tree /hardwood tree, shrub, and herbaceous categories: Provide an estimate of height for each category listed. Record an average height value per each category by estimating the mean height for each group. Please use the following height intervals to record a height class: 01 =< 1/2m, 02=1/2-1m, 03 = 1-2 m, 04 = 2-5 m, 05 = 5-10 m, 06 = 10-15 m, 07 = 15-20 m, 08 = 20-35 m, 09 = 35-50 m, 10 => 50m.

Species List and Coverage

- If mistletoe present add in what species it is living on
- Record absolute percent cover of dead tree species (can include saplings and seedlings)

For rapid assessments, list the 10-20 species that are dominant or that are characteristically consistent throughout the stand. These species may or may not be abundant, but they should be constant representatives in the survey. When different layers of vegetation occur in the stand, make sure to list species from each stratum. As a general guide, make sure to list at least 1-2 of the most abundant species per stratum.

For relevés, list all species present in the plot, using the second species list page if necessary.

For both sample types, provide the stratum:
T = Tree. A woody perennial plant that has a single trunk.
S = Shrub. A perennial, woody plant, that is multi-branched and doesn't die back to the ground every year.
H = Herb. An annual or perennial that dies down to ground level every year.
E = SEedling. A tree species clearly of a very young age that is < 1" dbh.
A = SApling. 1" - <6" dbh and young in age, OR small trees that are < 1"diameter at breast height, are clearly of appreciable age, and kept short by repeated browsing, burning, or other disturbance.
N = Non-vascular. Includes moss, lichen, liverworts, hornworts, cryptogammic crust, and algae.

Be consistent and don't break up a single species into two separate strata. The only time it would be appropriate to do so is when one or more tree species are regenerating, in which case the Seedling and/or Sapling strata should be recorded for that species. These may be noted on the same line, e.g.:

Strata	**Species**	**%Cover**	C
T/E/A	Quercus douglasii	40/<1/<1	

If a species collection is made, it should be indicated in the collection column with a "C" (for collected). If the species is later keyed out, cross out the species name or description and write the keyed species name in pen on the data sheet. Do not erase what was written in the field, because this information can be used if specimens get mixed up later. If the specimen is then thrown out, the "C" in the collection column should crossed out. If the specimen is kept but is still not confidently identified, add a "U" to the "C" in the collection column (CU = collected and unconfirmed). In this case the unconfirmed species epithet should be put in parentheses [e.g

Hordeum (murinum)]. If the specimen is kept and is confidently identified, add a "C" to the existing "C" in the collection column (CC = Collected and confirmed).

Use Jepson Manual nomenclature. Write out the genus and species of the plant. Do not abbreviate. When uncertain of an identification (which you intend to confirm later) use parentheses to indicate what part of the determination needs to be confirmed. For example, you could write out *Brassica* (*nigra*) if you are sure it is a *Brassica* but you need further clarification on the specific epithet.

Provide the % absolute aerial cover for each species listed. When estimating, it is often helpful to think of coverage in terms of the following cover intervals at first:

<1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, >75%.

Keeping these classes in mind, then refine your estimate to a specific percentage. All species percent covers may total over 100% because of overlap.

Include the percent cover of snags (standing dead) of trees and shrubs. Note their species, if known, in the "Stand history, stand age and comments" section.

For rapid assessments, make sure that the major non-native species occurring in the stand also are listed in the space provided in the species list with their strata and % cover. For relevés, all non-native species should be included in the species list.

Also for relevés, you can record the <1% cover in two categories: r = trace (i.e., rare in plot, or solitary individuals) and + = <1% (few individuals at < 1% cover, but common in the plot).

Unusual species: List species that are locally or regionally rare, endangered, or atypical (*e.g.,* range extension or range limit) within the stand. This field will be useful to the Program for obtaining data on regionally or locally significant populations of plants.

INTERPRETATION OF STAND

Field-assessed vegetation Alliance name: Name of Alliance or habitat following the most recent CNPS classification system or the Manual of California Vegetation (Sawyer J.O., Keeler-Wolf T., and Evens, J. 2009). Please use scientific nomenclature, *e.g., Quercus agrifolia* forest. An Alliance is based on the dominant or diagnostic species of the stand, and is usually of the uppermost and/or dominant height stratum. A dominant species covers the greatest area. A diagnostic species is consistently found in some vegetation types but not others.

Please note: The field-assessed Alliance name may not exist in the present classification, in which case you can provide a new Alliance name in this field. If this is the case, also make sure to state that it is not in the MCV under the explanation for "Confidence in Alliance identification."

Field-assessed association name (optional): Name of the species in the Alliance and additional dominant/diagnostic species from any strata, as according to CNPS classification. In following naming conventions, species in differing strata are separated with a slash, and species in the uppermost stratum are listed first (*e.g., Quercus douglasii/Toxicodendron diversilobum*). Species in the same stratum are separated with a dash (*e.g., Quercus lobata-Quercus douglasii)*.

Please note: The field-assessed association name may not exist in the present classification, in which you can provide a new association name in this field.

Adjacent Alliances/direction: Identify other vegetation types that are directly adjacent to the stand being assessed by noting the dominant species (or known type). Also note the distance away in meters from the GPS waypoint and the direction in degrees aspect that the adjacent Alliance is found
(e.g., *Amsinckia tessellata* / 50m, 360° N *Eriogonum fasciculatum* /100m, 110°).

Confidence in Identification: (L, M, H) With respect to the "field-assessed Alliance name", note whether you have L (=Low), M (=Moderate), or H (=High) confidence in the interpretation of this Alliance name.

Explain: Please elaborate if your "Confidence in Identification" is low or moderate. Low confidence can occur from such things as a poor view of the stand, an unusual mix of species that does not meet the criteria of any described Alliance, or a low confidence in your ability to identify species that are significant members of the stand.

Phenology: Indicate early (E), peak (P) or late (L) phenology for each of the strata.

Other identification problems or mapping issues: Discuss any further problems with the identification of the assessment or issues that may be of interest to mappers. Note if this sample represents a type that is likely too small to map. If it does, how much of the likely mapping unit would be comprised of this type. For example: "this sample represents the top of kangaroo rat precincts in this general area, which are surrounded by vegetation represented by CARR000x; this type makes up 10% of the mapping unit." Depending on who mapped polygon (Calveg, etc); we should denote that information here.

Is polygon >1 type: Yes / No (circle one): In areas that have been delineated as polygons on aerial photographs/imagery for a vegetation-mapping project, assess if the polygon is mapped as a single stand. "Yes" is noted when the polygon delineated contains the field-assessed Alliance and other vegetation type(s), as based on species composition and structure. "No" is noted when the polygon is primarily representative of the field-assessed Alliance.

If yes, explain: If "Yes" above, explain the other vegetation Alliances that are included within the polygon, and explain the amount and location that they cover in the polygon.

Other CNDDB/Whitebark Pine (WBP) monitoring Data:
Trees/stems are assessed within a representative portion of the stand (using a specific radius or area for averaging).

Mountain Pine Beetle (MPB) Level: Should equal 100%.

Note the level of mountain pine beetle attack using the following:

0 = No evidence of attack or beetle pitch tubes or unknown
1 = less than 5 observable beetle pitch tubes ('hits')

2 = less than 50% of the bole is attacked; sporadic pitch tubes spread on most parts of the bole or several localized areas with a high density (>10) pitch tubes
3 = greater than 50% of the bole is attacked; numerous pitch tubes spread on many parts of the bole

% of WBP Cones (female only): Should equal 100%.

Record the number of cones in the tree/stem using the following numeric system:

0 = no cones
1 = 1 to 10 cones
2 = 11 to 100 cones
3 = greater than 100 cones

Total # WBP individuals/stems or clumps and size (CNDDB):

The number of individuals observed/detected during assessment. This should be recorded as # of stems within # of clumps per defined area (square meters, hectares, acres, etc.).

Phenology of WBP (CNDDB): Should equal 100%.
The average percent of WBP that is vegetative, flowering (nascent female cones) and/or fruiting (mature female cones).

% WBP mortality:
These percentages are for mortality of trees/stems from mountain pine beetle (MPB) or white pine blister rust (WPBR); 'Other' can be % mortality from both MPB and WPBR; including WPBR mortality on other species E.g. WPBR-PIMO/PIBA 5% (white pine blister rust on *Pinus monticola* or *Pinus balfouriana* at 5% cover) or unknown causes.

Overall site/occurrence quality/viability (site + population) (CNDDB):
Is the likely persistence of the occurrence into the future Excellent, Good, Fair, or Poor? This is an assessment of the overall viability of this occurrence. Both the quality & condition of the site and of the occurrence must be considered when scoring. Take into account population size, demography, viability over time, site condition, and any disturbances. And also see additional characteristics at: http://www.natureserve.org/explorer/eorankguide.htm

Determination of WBP: Please indicate how the species identification was determined.

CNPS and CDFG Combined Vegetation Rapid Assessment and Relevé Field Form (modified for WBP project)

Relevé or Rapid Assessment (circle one) (Revised June 28, 2013)

For Office Use:	**Final database #:**	**Final vegetation type name:**	**Alliance_____ Association**

I. LOCATIONAL/ENVIRONMENTAL DESCRIPTION

Polygon/Stand #:	**Air photo:**	**Date:**	**Name(s) of surveyors (circle recorder):**

GPS wypt #: _____ GPS name: _____ Datum: _____ or NAD83. Bearing, left axis at SW pt_____ (degrees) of Long / Short side

UTME ___ ___ ___ ___ ___ ___ **UTMN** ___ ___ ___ ___ ___ ___ ___ **Zone: 10 / 11** (circle one) **Error: ±_____ ft / m / pdop**

GPS within stand? Yes / No If No, cite from waypoint to stand, distance _____(meters) & bearing _____(degrees)

Elevation: **ft / m Camera Name/Photograph #'s**:

Stand Size (ac/ha): <1, 1-5, >5 ac| _____ ha Plot Size (m2): 10 / 100 / 400 | Plot Shape ___ x___ m or Circle Radius____ m

Exposure, Actual °: _____ NE NW SE SW Flat Variable All | Steepness, Actual °: _____ 0° 1-5° 5-25° > 25

Topography: Macro: top upper mid lower bottom | Micro: convex flat concave undulating

Geology code: _____ Soil Texture code: _____ | Upland *or* **Wetland/Riparian** (circle one)

% Surface cover: (Incl. outcrops) (>60cm diam) (25-60cm) (7.5-25cm) (2mm-7.5cm) (Incl sand, mud)

H20:____ BA Stems:____ Litter: ____ Bedrock:____ Boulder:____ Stone:____ Cobble:____ Gravel:____ Fines:____ =100%

% Current year bioturbation _____ Past bioturbation present? Yes / No | Fire evidence: Yes / No (if yes, explain below)

Habitat description, surrounding land use, comments (CNDDB):

Disturbance / Intensity (L,M,H) ____/____ ____/____ ____/____ ____/____ WBP Impact__39___/____/____ __40__/____/____

II. HABITAT AND VEGETATION DESCRIPTION

Tree DBH : T1 (<1" dbh), **T2** (1-6" dbh), **T3** (6-11" dbh), **T4** (11-24" dbh), **T5** (>24" dbh), **T6** multi-layered (T3 or T4 layer under T5, >60% cover)

Shrub: S1 seedling (<3 yr. old), **S2** young (<1% dead), **S3** mature (1-25% dead), **S4** decadent (>25% dead)

Herbaceous: H1 (<12" plant ht.), **H2** (>12" ht.) **% NonVasc cover:____ % Vasc Veg cover:_____**

% Cover - Conifer tree / Hardwood tree: _____/_____ Regenerating Tree: _____ Shrub: _____ Herbaceous: _____

Height Class - Conifer tree / Hardwood tree: _____/_____ Regenerating Tree: _____ Shrub: _____ Herbaceous: _____

Height classes: 01=<1/2m 02=1/2-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m

Species, Stratum, and % cover. Stratum categories: T=Tree, S = Shrub, H= Herb, E = SEedling, A = SApling, N= Non-vascular.
% cover intervals for reference: <1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, 75%.

Strata	Species	% dead	% cover	C	Strata	Species	% dead	% cover	C

Other rare taxa in stand (CNDDB)_____

III. INTERPRETATION OF STAND

Field-assessed vegetation alliance name: _____

Field-assessed association name (optional): _____

Adjacent alliances/direction: _____/_____, _____/_____	☐
Confidence in alliance identification: L M H Explain: _____	☐
Other identification or mapping information: Phenology (E,P,L): Herb___ Shrub___ Tree___	
Is poly >1 type: Yes / No If yes, explain:	

CNPS and CDFG Combined Vegetation Rapid Assessment and Relevé Field Form (modified for WBP project)
Other CNDDB/Whitebark Pine Monitoring Data:

Polygon/Stand #:	
MBP Level: 0=no attack_____% 1=>5 hits _____% 2=<50% of bole attacked_____% 3=>50% of bole attacked_____%	
Avg % of WBP Cones: No cones_____% 1-10 cones_____% 11-100_____% >100 _____%	
Total # individuals/stems, clumps (WBP) and size (CNDDB)_____ #, _____# per_____ hectares (or radius in meters)	
Phenology of WBP (CNDDB): Vegetative_____% Flowering (cones)_____% Fruiting (cones)_____%	☐
%WBP mortality: MPB_____% WPBR_____% Other:_____ _____% _____ _____%	
Overall site/occurrence quality/viability (site + population) (CNDDB): ☐Excellent ☐Good ☐Fair ☐Poor	
Determination of WBP: Keyed ____ By another person (name) ____ Compared with photo/drawing ____ Other ____	

Field Reconnaissance Form

Surveyors: ____ **Date:** ____________

Polygon #: ________ **GPS waypoint #:** ________ **GPS in stand?** Y / N **If No, distance/bearing:** ______/______

Correct Y / N **UTME** __ __ __ __ __ __ __ **UTMN** __ __ __ __ __ __ __ __ **Error:** +/-______ **GPS name:**________

Aspect: ______ **Elevation**: _________ **ft/m** **Size of stand:** _____ **acre** **Photograph #'s**: ____________________________________

Field Alliance name: ____ **Site Impacts:**_________________________________

Comments: ____

____

Tree cover/ht /dbh: ______/______/_____ **Shrub cover/ht:** _____/_____ **Herbaceous cover/ht:** ______/______ **% Density**_______

Strata	Species	% cover		Strata	Species	% cover		Strata	Species	% cover

Polygon #: ________ **GPS waypoint #:** ________ **GPS in stand?** Y / N **If No, distance/bearing:** ______/______

Correct Y / N **UTME** __ __ __ __ __ __ __ **UTMN** __ __ __ __ __ __ __ __ **Error:** +/-______ **GPS name:**________

Aspect: ______ **Elevation**: _________ **ft/m** **Size of stand:** _____ **acre** **Photograph #'s**: ____________________________________

Field Alliance name: ____ **Site Impacts:**_________________________________

Comments: ____

____

Tree cover/ht /dbh: ______/______/_____ **Shrub cover/ht:** _____/_____ **Herbaceous cover/ht:** ______/______ **% Density**_______

Strata	Species	% cover		Strata	Species	% cover		Strata	Species	% cover

Polygon #: ________ **GPS waypoint #:** ________ **GPS in stand?** Y / N **If No, distance/bearing:** ______/______

Correct Y / N **UTME** __ __ __ __ __ __ __ **UTMN** __ __ __ __ __ __ __ __ **Error:** +/-______ **GPS name:**________

Aspect: ______ **Elevation**: _________ **ft/m** **Size of stand:** _____ **acre** **Photograph #'s**: ____________________________________

Field Alliance name: ____ **Site Impacts:**_________________________________

Comments: ____

____

Tree cover/ht /dbh: ______/______/_____ **Shrub cover/ht:** _____/_____ **Herbaceous cover/ht:** ______/______ **% Density**_______

Strata	Species	% cover		Strata	Species	% cover		Strata	Species	% cover

CNPS and CDFG Combined Vegetation Rapid Assessment and Relevé Field Form (modified for WBP project)

Relevé or Rapid Assessment (circle one) (Revised June 28, 2013)

DB 11/4/14

For Office Use:	Final database #: WBP0153	Final vegetation type name:	Alliance / Association

I. LOCATIONAL/ENVIRONMENTAL DESCRIPTION

Polygon/Stand #:	Air photo:	Date:	Name(s) of surveyors (circle recorder):
LTBM0003	—	10/29/2014	Smith, Dah, SrM

GPS wypt #: ____ GPS name: 4 Datum: ____ or NAD83. Bearing, left axis at SW pt____ (degrees) of Long / Short side

UTME 246997 UTMN 4315239 Zone: 10 / 11 (circle one) Error: ± 21 ft / m / pdop

GPS within stand? Yes / No If No, cite from waypoint to stand, distance ____(meters) & bearing ____(degrees)

Elevation: 2,708 ft / m Camera Name/Photograph #'s: Cam 10 (N) 748-751 Flat stand 752

Stand Size (ac/ha): <1, 1-5, >5 ac/ ____ ha Plot Size (m2): 10 / 100 / 400 | Plot Shape ___ x ___ m or Circle Radius 22 m

Exposure, Actual °: ____ NE NW SE SW Flat Variable All | Steepness, Actual °: ____ 0° 1-5° 5-25° >25

Topography: Macro: top upper mid lower bottom | Micro: convex flat concave undulating

Geology code: GRAN Soil Texture code: — | Upland or Wetland/Riparian (circle one)

% Surface cover: (Incl. outcrops) (>60cm diam) (25-60cm) (7.5-25cm) (2mm-7.5cm) (Incl sand, mud)

H20: 0 BA Stems: 1 Litter: 13 Bedrock: 0 Boulder: 10 Stone: 6 Cobble: + Gravel: 39 Fines: 30 =100%

% Current year bioturbation 0 Past bioturbation present? Yes / No | Fire evidence: Yes / No (if yes, explain below)

Habitat description, surrounding land use, comments (CNDDB): Stand on variable slope, sapling seedling of WBP throughout, dead snags burned cause of mortality. MPB mortality in snags w/in stand. No seedling if beetle holes/ fall in living trees nearby dead trees, 754-761 (MPB attack in dead WBP). Western White mixed in w/ WBP & dwarfs in stone (many old snags)

Disturbance / Intensity (L,M,H) 20 / L / / / WBP Impact 39 / L 3 40 / +

II. HABITAT AND VEGETATION DESCRIPTION

Tree DBH : T1 (<1" dbh), T2 (1-6" dbh), T3 (6-11" dbh), T4 (11-24" dbh), T5 (>24" dbh), T6 multi-layered (T3 or T4 layer under T5, >60% cover)

Shrub: S1 seedling (<3 yr. old), S2 young (<1% dead), S3 mature (1-25% dead), S4 decadent (>25% dead)

Herbaceous: H1 (<12" plant ht.), H2 (>12" ht.) % NonVasc cover: 1 % Vasc Veg cover: 21

% Cover - Conifer tree / Hardwood tree: 12 / 0 Regenerating Tree: 1 Shrub: 8 Herbaceous: +

Height Class - Conifer tree / Hardwood tree: 05 / 0 Regenerating Tree: 03 Shrub: 02 Herbaceous: 01

Height classes: 01=<1/2m 02=1/2-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m

Species, Stratum, and % cover. Stratum categories: T=Tree, S = Shrub, H= Herb, E = SEedling, A = SApling, N= Non-vascular.

% cover intervals for reference: <1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, 75%.

Strata	Species	% dead	% cover	C	Strata	Species	% dead	% cover	C
T/A/S	Pinus albicaulis	1	12/1/+		S2	Pinus monophylla		+	
S/A	Pinus jeffreyi	+	4		H	Achnatherum occidentalis		+	✓
T	Pinus monticola		1		H	Leptodactylon Dyeri		+	
S	ARTr Tridentata		4		S	Eriogonum (marifolium		+	c
S	Holodiscus discolor		2		H	Montiella aforthis		+	
S	Arctostaphylos nevadensis		1		N	Lichen		+	
S	Ribes cereum		+	C	N	Moss		+	
S	Chrysothamnus nauseosus		+						

Other rare taxa in stand (CNDDB)____

III. INTERPRETATION OF STAND

Field-assessed vegetation alliance name: Pinus albicaulis

Field-assessed association name (optional): Artemisia tridentata / Holodiscus discolor

Adjacent alliances/direction: ____ / ____ / ____ / ____

Confidence in alliance identification: L M H Explain: ____

Other identification or mapping information: MAP 10291052 - Pinus pine point Phenology (E,P,L): Herb L Shrub L Tree P

Is poly >1 type: Yes / No If yes, explain:

CNPS and CDFG Combined Vegetation Rapid Assessment and Relevé Field Form (modified for WBP project)
Other CNDDB/Whitebark Pine Monitoring Data:

Polygon/Stand #: LTBU0003
MBP Level: 0=no attack 100 **% 1=>5 hits** — **% 2=<50% of bole attacked** — **% 3=>50% of bole attacked** — **%**
Avg % of WBP Cones: No cones 30 **% 1-10 cones** 70 **% 11-100** ____ **% >100** ____ **%**
Total # individuals/stems, clumps (WBP) and size (CNDDB) 25 **#,** — **# per** 22 **hectares (or radius(m) above)**
Phenology of WBP (CNDDB): Vegetative 30 **% Flowering (cones)** — **% Fruiting (cones)** 70 **%**
%WBP mortality: MPB — **% WPBR** ____ **% Other:** fire — **%** ____ ____ **%**
Overall site/occurrence quality/viability (site + population) (CNDDB): ☐Excellent ☒Good ☐Fair ☐Poor
Determination of WBP: Keyed Smk **By another person (name)** ____ **Compared with photo/drawing** ____ **Other** ____

Field Recon

DH 46

Surveyors: Smt SCM | Date: 10/29/2014

WBP0170
Polygon #: — | GPS waypoint #: WBP10291226 | GPS in stand? Y / N | If No, distance/bearing: /
Correct Y / N | UTME 247393 | UTMN 4305342 | Error: +/- 3.3 | GPS name: 4

Aspect: SW | Elevation: 2873 ft/m | Size of stand: ≈5 acre | Photograph #'s: Cam10 (N) 764-767

Field alliance name: Pinus albicaulis | Site Impacts: MPB / L / 1%

Comments: few stems are attacked w/ bus orange w/ stems dying; overall mortality ≈ 4% (768-769 MPB attack) few in area some from fire

stand overall healthy

Tree cover/ht /dbh: / / | Shrub cover/ht: / | Herbaceous cover/ht: / | % Density 20

Strata	Species	% cover	Strata	Species	% cover	Strata	Species	% cover
T/A/E	Pinus alb	20/+/+						

WBP0172
224
Polygon #: — | GPS waypoint #: WBP10291 1606 | GPS in stand? Y / N | If No, distance/bearing: /
Correct Y / N | UTME 249724 | UTMN 4305801 | Error: +/- 3.2 | GPS name: 4

Aspect: SW | Elevation: 2900 ft/m | Size of stand: 3+ acre | Photograph #'s: Juno 4 (NY) 54-57, 58

Field alliance name: Pinus albicaulis | Site Impacts: WPBR? photos 59-62 Juno 4

Comments: Healthy stand of Pinus alb, Tsuga mertensiana scattered here & there. No stem mortality in WB - Evey polygon. WPBR is scaly bark, similar to RA nearby

Tree cover/ht /dbh: / / | Shrub cover/ht: / | Herbaceous cover/ht: / | % Density 24

Strata	Species	% cover	Strata	Species	% cover	Strata	Species	% cover
T	Pinus alb	23/+/+		~~Photos 57 to 62~~				
T	Tsuga mertensiana	+						

10/31/2014
WBP0174
Polygon #: — | GPS waypoint #: WBP10301546 | GPS in stand? Y / N | If No, distance/bearing: 2 dg /
Correct Y / N | UTME 245732 | UTMN 4354397 | Error: +/- 3.2 | GPS name: 4

Aspect: 109 | Elevation: 2872 ft/m | Size of stand: 5+ acre | Photograph #'s: Cam10 957-960

slope 20

Field alliance name: Whitebark Pine (med confidence) | Site Impacts: no obvious impacts

Comments: mixed Western white pine, WBP, Tsuga mertensiana, Lodgepole pine; WBP is more sapling / seedling than tree

Tree cover/ht /dbh: 14 / 10 / 15 | Shrub cover/ht: + / 01 | Herbaceous cover/ht: + / 01 | % Density 15

Strata	Species	% cover	Strata	Species	% cover	Strata	Species	% cover
T/A	Pinus monticola	4	T/E	Tsuga mertensiana	3/+			
T/A/E	Pinus albicaulis	6/1/+	E	Pinus jeffreyi	+			

10/30/2014
WBP0175
Polygon #: | GPS waypoint #: WBP10301715 | GPS in stand? Y / N | If No, distance/bearing: /
Correct Y / N | UTME 246361 | UTMN 4356199 | Error: +/- 2.4 | GPS name:

Aspect: Variable slope 7 | Elevation: 2972 ft/m | Size of stand: 5+ acre | Photograph #'s: Cam 10 (N) 871-874 MBB/L

Field alliance name: Pinus albicaulis | Site Impacts: possibly old MPB attack by WPBR/L

Comments: Patchy WBP along convexities of hillslope, in concavities WBP is more sapling / seedling stage. Some old dead snags, no recent mortality

Tree cover/ht /dbh: 25 / 05 / 14 | Shrub cover/ht: 0 / 0 | Herbaceous cover/ht: 2 / 01 | % Density 26

Strata	Species	% cover	Strata	Species	% cover	Strata	Species	% cover
T/A/E	Pinus albicaulis	24/+/+						
H	Lupinus (breweri)	2						

875-876 WPBR?

Appendix 3: Overview Maps of 2014 Locations Visited on the National Forest

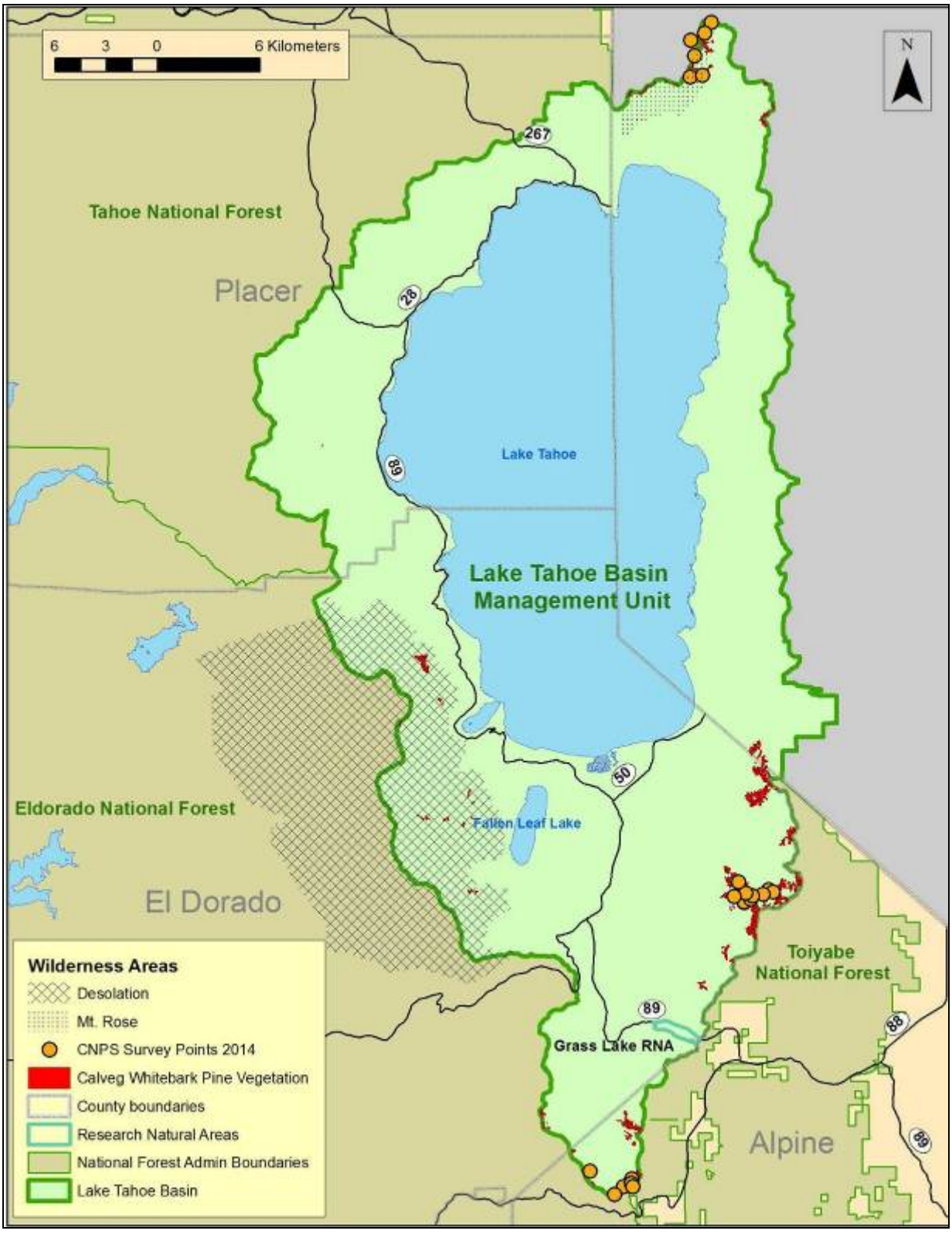

Figure 4. Overview map of LTBMU with forest areas and vegetation data.

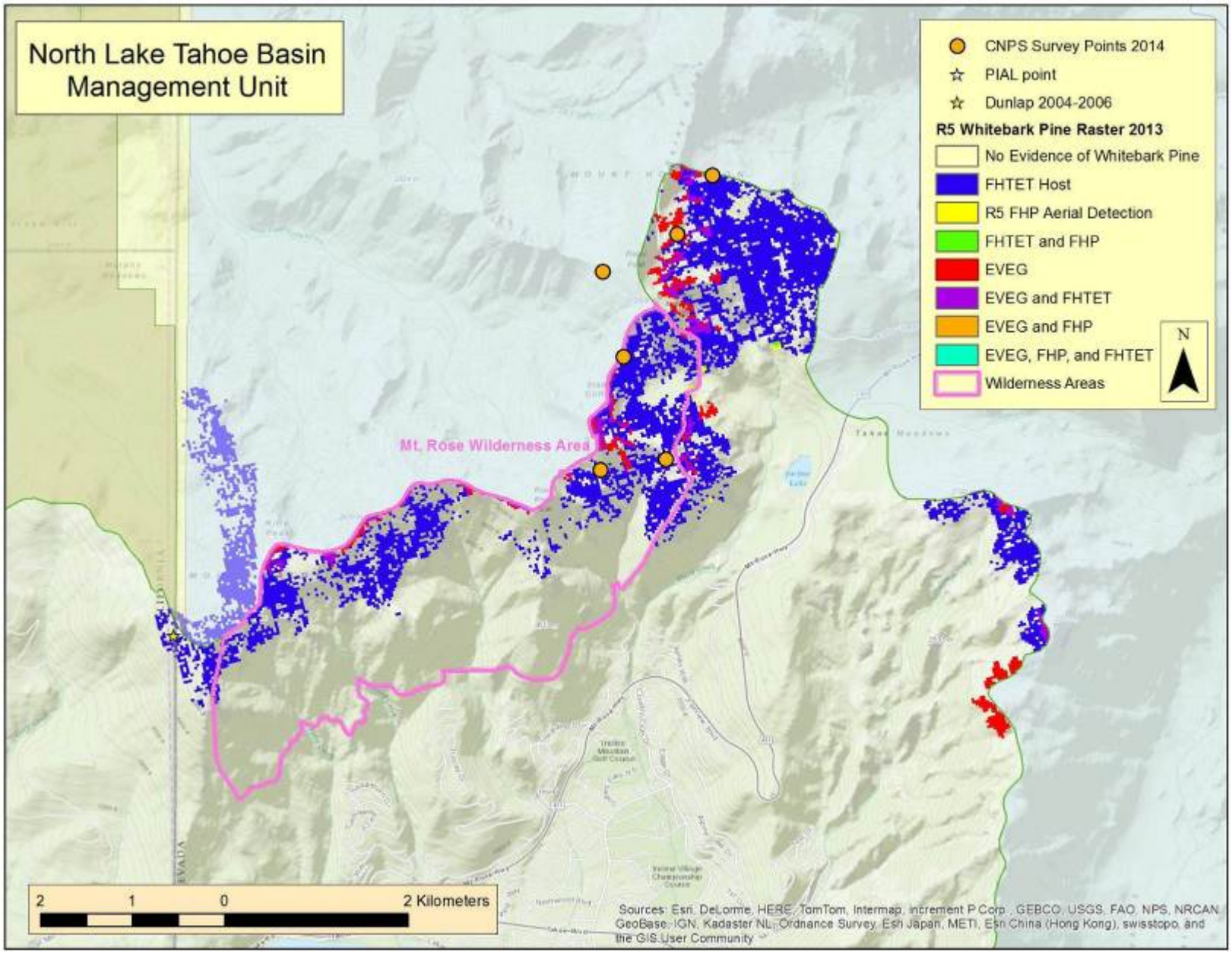

Figure 5. Overview map of Northern LTBMU with whitebark pine vegetation data.

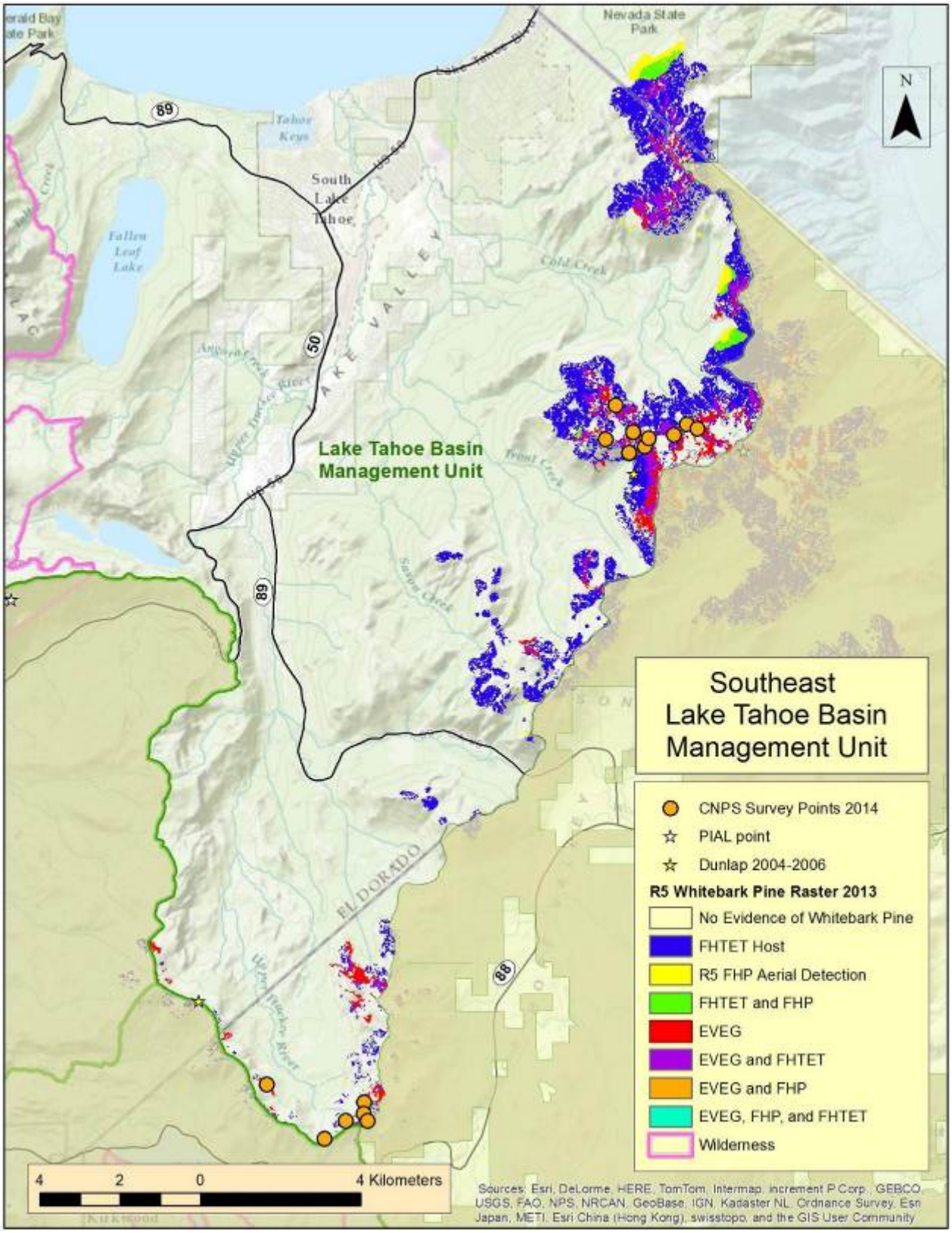

Figure 6. Overview map of Southern LTBMU with whitebark pine vegetation data.

Appendix 4: Summary Tables from the CNDDB Rare Plant Occurrence Forms and the CNPS Vegetation Rapid Assessment/Relevé Form

Table 5. Rapid Assessment summary, LTBMU

DbaseID	County	Wilderness	Site name	Alliance	Estimated Pct Cover PIAL	PIAL Seedlings Present	PIAL Saplings Present	Altitude (m)	Impacts
WBP0151	Alpine		Red Lake Peak	*Pinus albicaulis*	25	yes	yes	2795	
WBP0152	Alpine		Red Lake Peak	*Pinus albicaulis*	15			2695	Rust (2%)
WBP0153	El Dorado		Freel Peak	*Pinus albicaulis*	25	yes	yes	2708	Foot traffic/trampling (low), MPB (3%)
WBP0154	El Dorado		Freel Peak	*Pinus albicaulis*	52	yes	yes	2857	Development (low), MPB (trace), Rust (70%)
WBP0155	El Dorado		Freel Peak	*Pinus albicaulis*	49	yes	yes	2896	Rust (25%)
WBP0160	El Dorado		Freel Peak	*Pinus albicaulis*	13			2942	
WBP0161	El Dorado		Freel Peak	*Pinus albicaulis*	15		yes	2915	
WBP0162	El Dorado		Freel Peak	*Pinus albicaulis*	12	yes	yes	2856	
WBP0156	Washoe	Mt. Rose	Relay Peak	*Pinus albicaulis*	13	yes	yes	2851	
WBP0163	Washoe		Relay Peak	*Pinus albicaulis*	25	yes	yes	2917	MPB (3%), Rust (75%)
WBP0164	Washoe	Mt. Rose	Relay Peak	*Pinus albicaulis*	11	yes	yes	2811	

Table 6. Additional Rapid Assessment Attributes for *Pinus albicaulis* in LTBMU

DbaseID	Site name	Stand Size	Stems per hectare	Percent Vegetative	Percent Fruiting	Mortality by MPB	Mortality by Rust	Total Mortality	Quality
WBP0151	Red Lake Peak	1-5 acres	177	70	30	0	0	0	Excellent
WBP0152	Red Lake Peak	1-5 acres	478	100	0	0	0	trace	Good
WBP0153	Freel Peak	1-5 acres	165	30	70	1%	2%	4%	Good
WBP0154	Freel Peak	> 5 acres	279	70	30	trace	0	8%	Excellent
WBP0155	Freel Peak	> 5 acres	796	100	0	0	0	2%	Fair
WBP0160	Freel Peak	> 5 acres	239	93	7	0	0	0	Excellent
WBP0161	Freel Peak	> 5 acres	553	50	50	0	0	0	Excellent
WBP0162	Freel Peak	> 5 acres	320	94	6	0	0	0	Good
WBP0156	Relay Peak	> 5 acres	239	93	7	0	0	trace	Excellent
WBP0163	Relay Peak	> 5 acres	649	100	0	0	0	27%	Fair
WBP0164	Relay Peak	1-5 acres	510	100	0	0	0	15%	Fair

Table 7. Reconnaissance summary, LTBMU

DbaseID	County	Wilderness	Site name	Alliance	Stand size	Estimated Pct Cover PIAL	PIAL Seedlings Present	PIAL Saplings Present	Altitude (m)	Impacts
WBP0165	Alpine		Red Lake Peak	*Pinus albicaulis*	> 5 acres	12			2863	
WBP0166	Alpine		Red Lake Peak	*Pinus albicaulis*	> 5 acres	7			2852	
WBP0167	Alpine		Red Lake Peak	*Pinus albicaulis*	> 5 acres	9			2883	
WBP0168	Alpine		Red Lake Peak	*Pinus contorta* subsp. *murrayana*	1-5 acres	trace			2652	
WBP0170	El Dorado		Freel Peak	*Pinus albicaulis*	> 5 acres	20	yes	yes	2873	
WBP0171	El Dorado		Freel Peak	*Pinus albicaulis*	> 5 acres	7			2947	
WBP0172	El Dorado		Freel Peak	*Pinus albicaulis*	> 5 acres	23	yes	yes	2900	
WBP0173	Washoe	Mt. Rose	Relay Peak	*Pinus albicaulis*	> 5 acres	14			2990	Rust (low)
WBP0174	Washoe	Mt. Rose	Relay Peak	*Pinus albicaulis*	> 5 acres	7	yes	yes	2872	
WBP0175	Washoe		Relay Peak	*Pinus albicaulis*	> 5 acres	24	yes	yes	2972	MPB (low), Rust (low)

Appendix 5: Photos from 2014 Field Work

Figure 7. Stand of *Pinus albicaulis* east of the Pacific Crest Trail near Red Lake Peak. Photo by CNPS.

Figure 8. Stand of *Pinus albicaulis* near Freel Peak at 2,708 meters with some Mountain Pine Beetle mortality. Photo by CNPS.

Figure 9. Stand of *Pinus albicaulis* with *Wyethia mollis* understory near Rose Knob Peak, Mount Rose Wilderness. Photo by CNPS.

Figure 10. Unidentified pathogen attack on live *Pinus albicaulis* stem near Rose Knob Peak, Mount Rose Wilderness. Photo by CNPS.

Figure 11. Mountain Pine Beetle attack on live *Pinus albicaulis* stem near Freel Peak. Photo by CNPS.

Figure 12. Unconfirmed White Pine Blister Rust on live *Pinus albicaulis* stem near Freel Peak. Photo by CNPS.

Figure 13. Unconfirmed pathogen attack on live *Pinus albicaulis* stem at Maloney 2012 LTM plot, near Freel Peak. Photo by CNPS.

Appendix 6: Detailed Vegetation Maps of Positive and Negative Data for Whitebark Pine

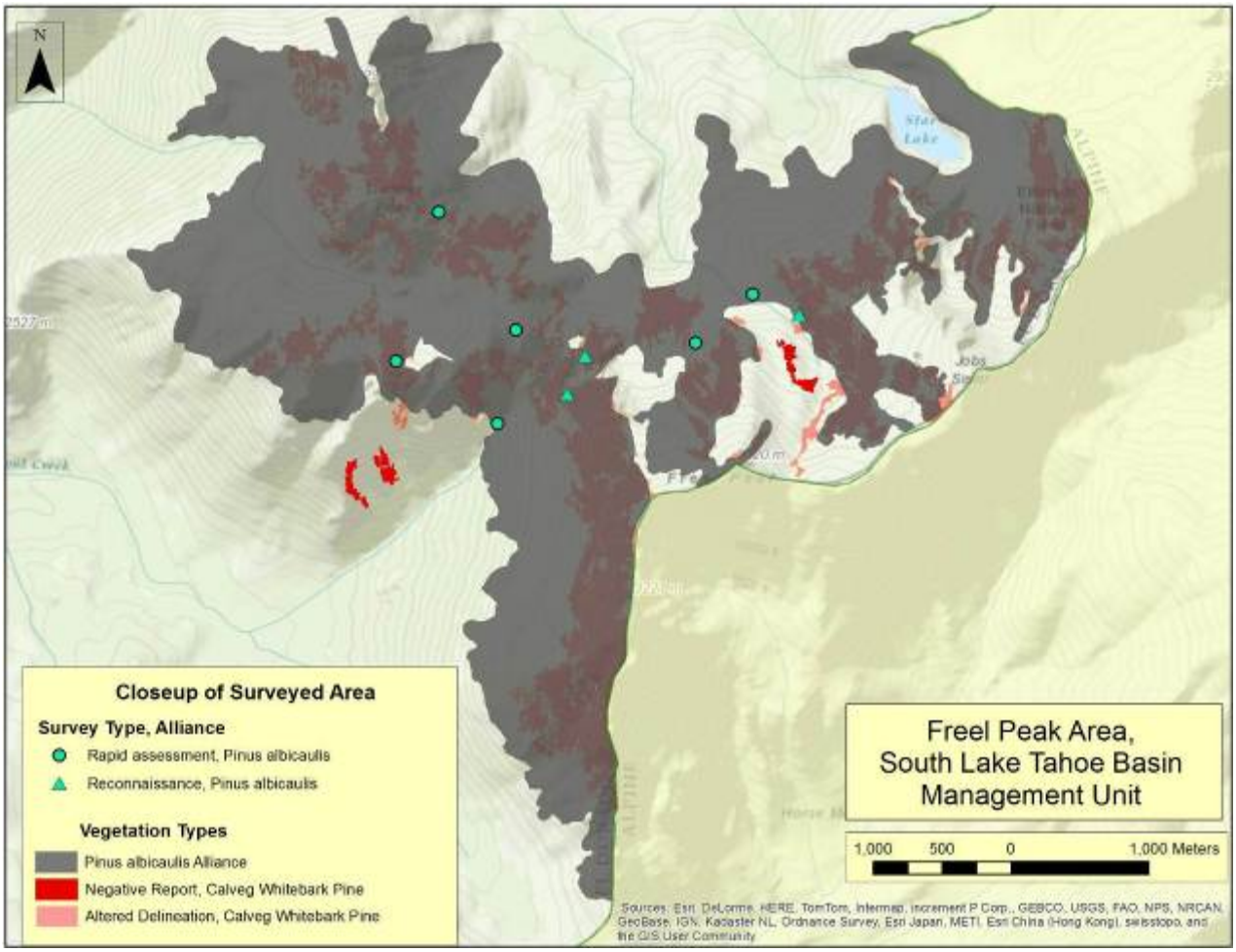

Figure 14. Map of positive and negative vegetation data for Freel Peak.

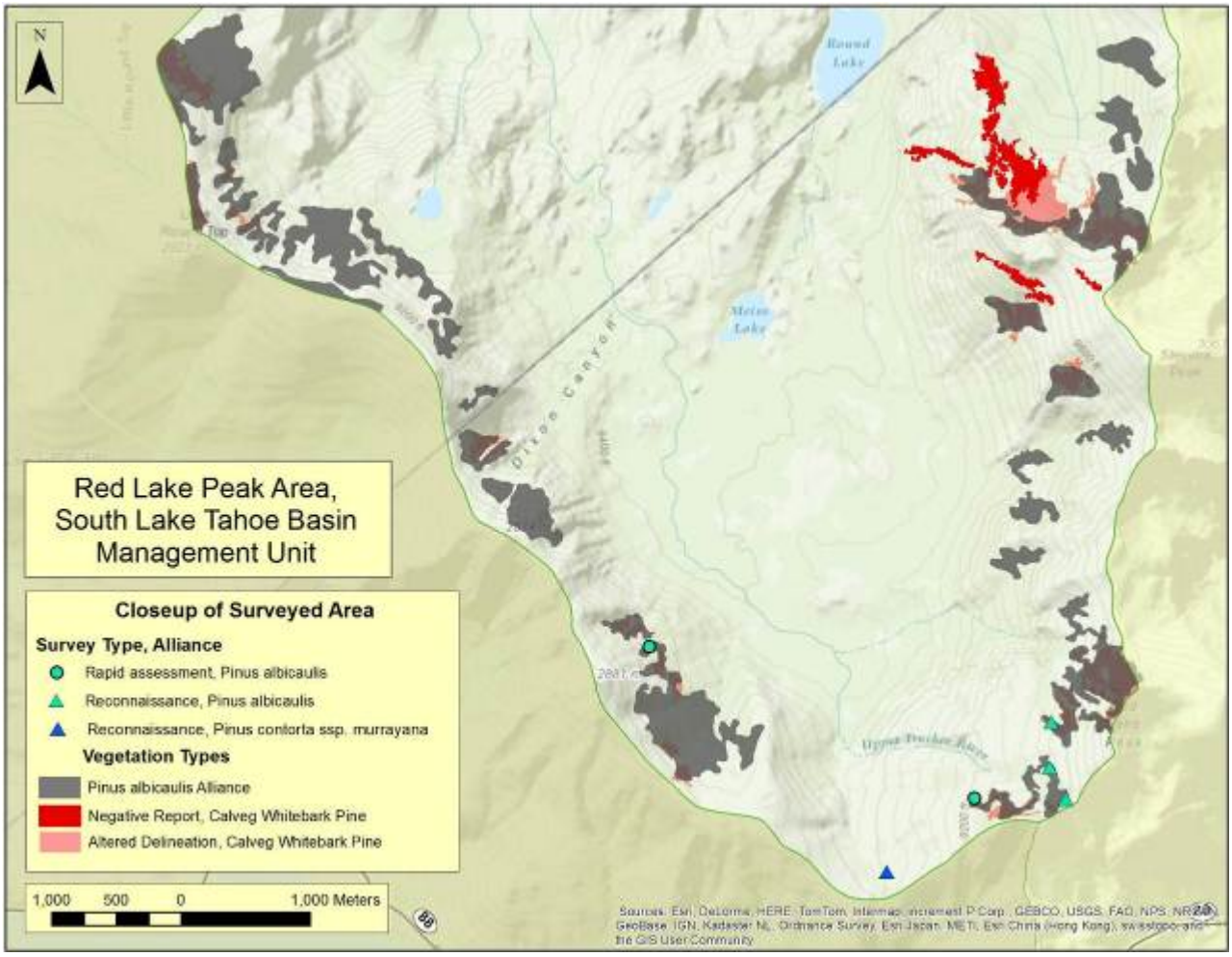

Figure 15. Map of positive and negative vegetation data for Red Lake Peak.

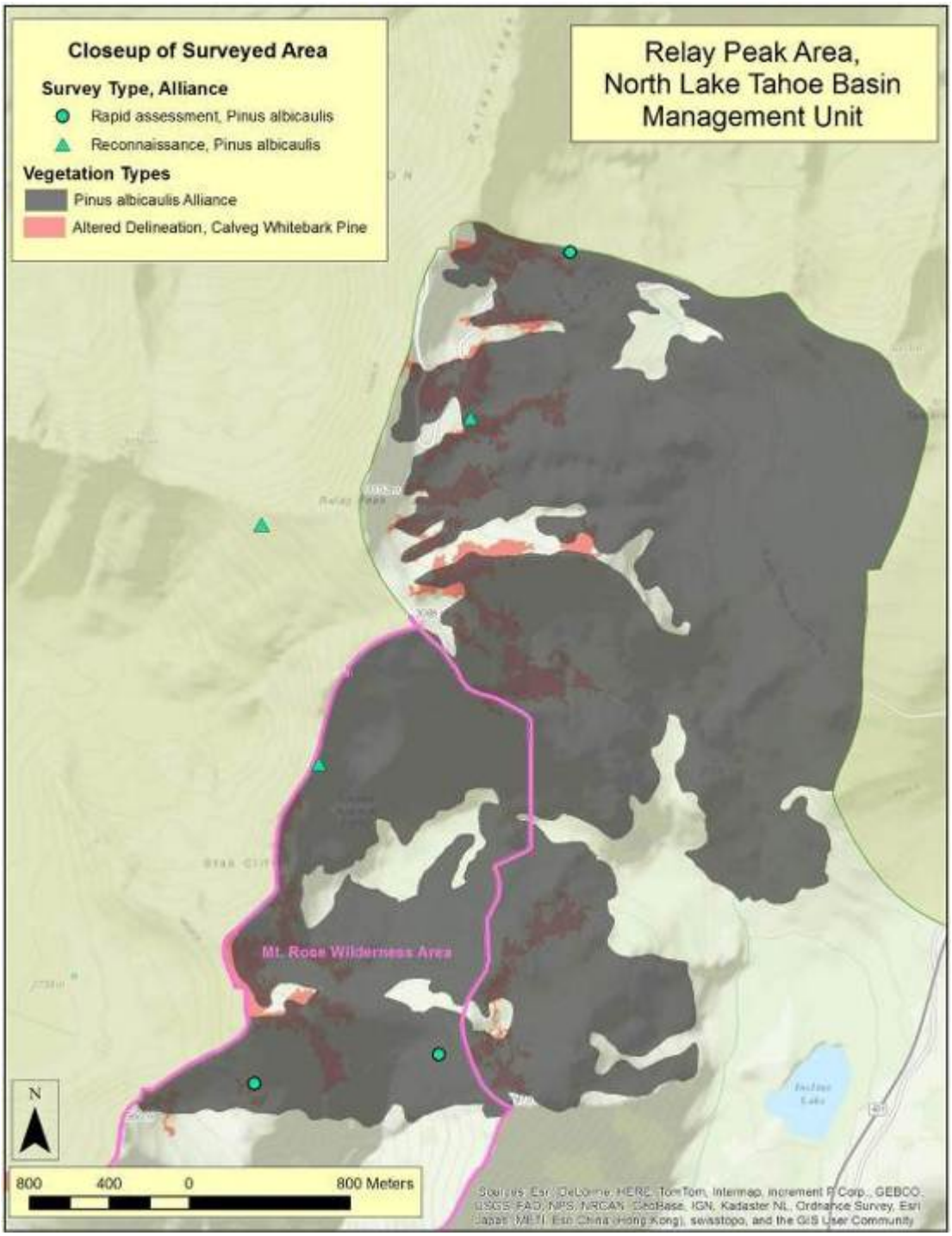

Figure 16. Map of positive and negative vegetation data for Relay Peak. (Note: The far west reconnaissance *Pinus albicaulis* point is in the Toiyabe National Forest and therefore was not included in the *Pinus albicaulis* Alliance delineation. This point was taken because unknown pathogen attack was seen throughout the whitebark pine stands and *Ribes cereum* leaves were collected for WPBR verification).

Appendix 7: Recommended Protocols for Future Work

Whitebark Pine Inventory and Monitoring Plot Protocol
Revised: May 16, 2013

Introduction:
This protocol was developed collaboratively by the USFS Region 5 Ecology Program and Forest Health Protection Program to provide inventory and status-and-trend monitoring data in stands dominated by whitebark pine (*Pinus albicaulis*) or lodgepole pine (*P. contorta*) with whitebark pine as a codominant species. It also focuses on stands that have experienced recent tree mortality related to insects (mountain pine beetle) or diseases (white pine blister rust). This protocol was developed using elements of the Regional Ecology Program post-fire regeneration monitoring protocol and the Forest Health Protection Whitebark Pine Monitoring Plot Protocol for the Warner Mountains, Modoc National Forest (the FHP protocol is based on *Greater Yellowstone Whitebark Pine Monitoring Working Group* [GYWPMWG] *Interagency Whitebark Pine Monitoring Protocol for the Greater Yellowstone Ecosystem 2007*).

I. Site attributes:

- Record the location (geographic or watershed scale), site (topographic scale), and plot number (micro-scale).
- Use a GPS device to locate plot center - take care to avoid biasing the location.
- Monument permanent plots (established for monitoring rather than inventory) with 2-foot long rebar driven approximately 1.5 ft into the ground at plot center. Label with plot number and mount safety cap. Include brief notes of plot location using distinctive landscape features, if any.
- Record the date that data were collected.
- Record the crew names of the people collecting the data.
- Establish a plot with a radius of 12.6 m, which is approximately 0.05 ha (0.124 acres). Flag four places around the perimeter for reference.
- Record the dominant tree species present.
- Take one photograph from a point 12.6 m south of the plot center, looking north. Make sure you have something (pin flag) at plot center so it can be relocated. using the photo. Take another photograph from a point 12.6 m north of the plot center, looking south (toward pin flag). Record both photo numbers.
- Record the average slope of the plot in percent (use clinometer).
- Record the average aspect of the plot in degrees (use compass [make sure you have the right declination])

II. Vegetation and ground cover attributes

- Estimate the cover (%) of: *basal vegetation* (i.e. the area covered by the bases of tree boles, shrub stems, herbs), *litter*, *bare ground*, *rock* (>2 mm diameter), and *woody debris* (>3 inches [7.5 cm] diameter), summing to 100% (imagine chopping off all vegetation at ground level, what do you have left?; it is rare for basal vegetation to be more than 5%, unless there are trees or many large shrubs in the plot). Record cover vales to nearest 5%, using 0.5% as trace cover
- Estimate vegetation cover to nearest 1% (1-10% cover), 5% (10-30%) or 10% (30-100%):

- % Overstory veg cover = cover of plants >2 m in height (trees and tall shrubs; this is a snapshot of total canopy cover taken from above, i.e. it is the % of the plot that has trees/tall shrubs covering it. Tree/tall shrubs growing completely beneath other trees/tall shrubs are not counted as they cannot be seen from above) (see Figure 1)
    - Estimate cover of live trees and tall shrubs
    - Also estimate % dead cover (trace circles around the remnants of dead trees >2 m in height). When this value is added to the live cover it should give us an estimate of the total pre-beetle mortality live cover.
- % Shrub and Herbaceous plant cover = cover of understory vegetation <2 m in height (this is a snapshot of total understory cover taken from above, i.e. it is the % of the plot that has understory vegetation covering it. Understory plants growing completely beneath other plants are not counted, as they cannot be seen from above) (see Figure 1).
- Record separately the cover of aspen <3 m in height. Aspen >3 m height should be recorded as overstory cover.

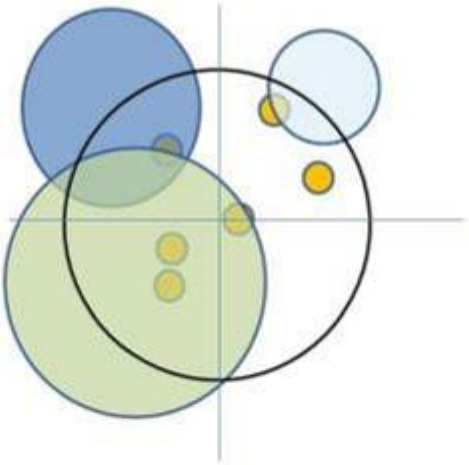

Fig. 1. Circular plot, with four species of understory plants (colored). The blue crosshairs are added to aid in estimating cover. The understory vegetation cover is about 64% (the total plot area minus the area that is not covered by live vegetation. The gray species (shrub) has 49% cover, the dark blue species (shrub) has 17% cover, the light blue species (grass) has 4%, and the orange species (forb) has 6% (each orange circle is 1% in this case). Due to plant overlap, summing the different species' cover values gives a value that is larger than the total understory vegetation cover (76% vs. 64%). Overall shrub cover in this plot is 58% (two shrub species, subtracting overlap; summed up [i.e., ignoring overlap], the two species have 66% cover between them). Herb cover is 9.5%, forb cover is 6%, grass cover is 4%. Each shrub species will have its own cover entered in the species-cover section of the datasheet. Cover is measured by drawing a line around the outside of the plant canopy, ignoring gaps that may be found within the perimeter. For plots of this size (500 m^2), your clipboard is about 0.015% of the plot area.

III. Basal area, snags, and litter depth

- Use the basal area gauge (20 factor) to record the basal area of live and dead whitebark pine and other tree species (e.g., lodgepole pine) in the stand
  - Swinging the gauge around the plot center, tally the number of trees that are larger than the 20 factor aperture. Count live and dead trees separately for each species.
- Record the species and dbh of any older snags (>7 years; **prior to 2005**) in the plot. Only record snags that are >1.37 m tall.
- Measure litter depth at 3 locations midpoint between plot center and plot perimeter in 3 directions (0°, 120°, and 240°).

IV. Tree regeneration attributes

- Tally the number of seedlings and saplings (trees less than 7.6 cm dbh of each tree species for each age class)
  - Use a separate row for each species and basal cluster (see below).
  - Count the number of live and dead stems arising from each seedling or sapling cluster. Clusters are defined using the following two criteria:
    - Stems are less than 10 cm at the base from the cluster of other stems
    - Diameter of stem (saplings only) must not exceed 25% of next largest stem in the cluster
  - Determine minimum age by counting the bud scars, subtracting the current year
  - Record dbh for saplings (>1.37 m height) only
  - In the Health Code column, note the number of seedlings or saplings in each cluster that exhibit health issues and include the appropriate health codes for these numbers (e.g., 2-a). Health codes include:
    - C = cankers or stem swelling
    - SC = stalactiform canker (*P. contorta* only) as spindle-like in middle of bole
    - P = pitching
    - F = branch flagging
    - S = needle spots
    - T = twig beetle sign (e.g. terminal branch flagging and pitch tubes)
    - 2 = secondary beetle
    - M = dwarf mistletoe
    - R = native rusts – take photo and collect sample when available
    - H = sapsucker/woodpecker holes
    - A = aecia (i.e., rust fruiting body) or aeciospores
      - Take closeup photos of any branches displaying aecia and consider collecting samples for laboratory identification
      - Aecia could be a sign on WPBR or a native rust
  - Record the height for the tallest individual seedling of each species

V. Understory vegetation attributes

- Measure the modal height and overall cover for the four most common (by % cover) shrub and herbaceous plant species in the plot. Additional understory species may be noted in the Notes section . Especially note the presence of species in the genera *Ribes*, *Castilleja*, and *Pedicularis* (WPBR secondary hosts)
  - Measure cover to nearest 5%, 0.5% = trace cover
  - Modal height is the most common height

VI. Notes section

Items of interest to record in the notes section:

- If fire scars or other evidence of fire are in the plot
- If plot is located on a unique (non-granitic) substrate (e.g., pumice soils)
- If plot has been treated in some way - specify
- If non-native species are on plot or adjacent to plot - specify
- If other mortality agents (insects, diseases) are present - specify
- If WPBR, mountain pine beetle, twig beetle, or other potential mortality agents are observed adjacent to plot but not recorded within the plot
- If conifer stumps are present from trees that may have parented seedlings before they were cut
- Additional understory species if more than four shrubs or herbaceous plants
- Other notes?

VII. Tree attributes

For all trees (>7.6 cm dbh) record the following information

- Species ID, and number live and dead stems in each cluster. Tree clusters are defined by stems that are less than 1 m at the base from the cluster of other stems of similar size (diameter and height).
- Individual stems growing in close proximity will be defined as individual tree stems or branches using the following GYWPMWG (2007) criteria:
  1) There must be a discernible growth groove that separates that stem from other stems of the tree.
  2) The diameter of a given stem must be more than 25% of the diameter of the largest stem.
  3) The stem must be less than one foot from the "mother" tree to which it is associated. Otherwise it is to be considered as a separate seedling, sapling, or tree.
  4) The angle of the stem in question must be no less than a 45° angle from the main stem.
- For each cluster, provide a consecutively-numbered cluster ID number. For each stem within a cluster, provide a stem ID value.
- Record the dbh of all live and dead stems in each cluster.

- For monumented monitoring plots, nail aluminum tags to all live trees that are counted with the basal area gauge (20 factor) sweep. Begin consecutively-numbered tags at the northernmost tree proceeding clockwise. Nail tags at dbh so that each tag faces plot center, leaving approximately one inch of space between the nail head and the tree bole in order to avoid damage during tree growth. Enter tag numbers in the Notes column.
- Note with a checkmark whether live basal sprouts are present for a given tree cluster. These basal sprouts are defined as smaller-diameter (typically <7.6 cm dbh) live stems located at the base and often surrounding clusters of larger live and dead tree clusters (typically with stems exceeding 20 cm dbh).
- Note the % of live crown in the stem (largest live is the default) in increments of 10% using the following coding system: 1 = 10%, 2 = 20%, 3 = 30%, etc.
- Note the level of mountain pine beetle attack using the following:
  - 0 = No evidence of attack or beetle pitch tubes or unknown
  - 1 = less than 5 observable beetle pitch tubes ('hits')
  - 2 = less than 50% of the bole is attacked; sporadic pitch tubes spread on most parts of the bole or several localized areas with a high density (>10) pitch tubes
  - 3 = greater than 50% of the bole is attacked; numerous pitch tubes spread on many parts of the bole
- Estimate the time since mountain pine beetle attack based on the following system:
  - 0 = less than one year since attack (occurred during current season); typically little sign of crown discoloration or dead needles but evidence of beetle attack
  - 1 = approximately one year since attack (last season); crown shows significant density of dead or dying needles (substantial portion of crown contains brown/orange colored needles)
  - 2 = two years since attack; entire crown consists of dead (brown/orange colored) needles that are mostly intact
  - 3 = three years since attack; most but not all of dead needles have fallen from crown, with few clusters of dead needles retained
  - 4 = four to seven years since attack; no dead needles retained in crown; smaller branches may have broken off and fallen, with most larger to medium branches retained
- Record the number of cones in the tree using the following numeric system:
  - 0 = no cones
  - 1 = 1 to 10 cones
  - 2 = 11 to 100 cones
  - 3 = greater than 100 cones
- Record the health code for each tree using the codes listed under the tree regeneration attributes section (see above)
- In Notes column record any remarkable observations pertaining to a tree or tree cluster, including:
  - lightning or fire scars

- evidence of other damage caused by wildlife, humans, or unknown causes
- Other notable features or observations

VIII. Seed-Caching Wildlife Point Counts (optional, if time permits)

- At end of vegetation sampling period, return to each plot and spend 5 minutes noting any visual or auditory sign of Clark's Nutcracker (*Nucifraga columbiana*), Douglas' squirrel (*Tamiasciurus douglasii*), lodgepole chipmunk (*Neotamias speciosus*), golden-mantled ground squirrel (*Callospermophilus lateralis*), or any other seed-eating species within 50 m of each side of transect. Record plot number, observer, time and date of survey, and number of each species observed at each sample point (i.e., plot).
- Note any observations of seed caching, seed dispersal, or seed predation during survey period.
- Record data on separate field notebook