Whitebark Pine Pilot Fieldwork Report
Lassen National Forest

By Michael Kauffmann[1], Sara Taylor[2], Kendra Sikes[3], and Julie Evens[4]

In collaboration with:
Allison Sanger, Forest Botanist, Lassen National Forest
Diane Ikeda, Regional Botanist, Pacific Southwest Region, USDA Forest Service
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1. Kauffmann, Michael E., Humboldt State University, Redwood Science Project, 1 Harpst Street, Arcata, CA 95521, mek31@humboldt.edu | http://www.conifercountry.com/
2. Taylor, Sara M., California Native Plant Society, 2707 K Street, Suite 1, Sacramento, CA 95816, staylor@cnps.org
3. Sikes, Kendra., California Native Plant Society, 2707 K Street, Suite 1, Sacramento, CA 95816, ksikes@cnps.org
4. Evens, Julie., California Native Plant Society, 2707 K Street, Suite 1, Sacramento, CA 95816, jevens@cnps.org

California Native Plant Society

Photo on cover page: *Pinus albicaulis* seen from the
Thousand Lakes Wilderness area, Lassen National Forest

All photos by Michael Kauffmann unless otherwise noted
All figures by Kendra Sikes unless otherwise noted

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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; however, the acreage of the pine's presence in the state is much greater (see Figure 1).

Across the state, the species is found from 1,830 – 4,240 m (6,000'-13,899') 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. But some of these phytogeographic patterns are shifting.

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.

Unlike other five-needle pines, whitebark pine is set apart in that its seed does not open at maturity and is "wingless"; consequently, they are solely dependent on Clark's nutcrackers (*Nucifraga columbiana*) for seed distribution and future seedling recruitment. The birds open the cone, 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 keystone mutualist, where the loss of one species would have a profound impact upon the ecosystem as a whole.

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 across much of its range is attributed to white pine blister rust (WPBR) outbreaks caused by the non-native invasive pathogen (*Cronartium ribicola*) (Tomback and Achuff 2010) and native mountain pine beetle (*Dendroctonus ponderosae*) attacks (Logan and Powell 2001, Logan et al. 2010). Decimation to populations in the northern Rocky Mountains has led Canada to list the species as endangered in 2010 (http://www.cosewic.gc.ca/eng/sct1/searchdetail_e.cfm). 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.

Mountain pine beetles (MPB) are of concern with respect to high elevation conifers and a warming climate. The beetle is a native insect, having co-evolved with western pine forests in fluctuations of periodic disturbance often followed by cleansing fire regime events. More recently, mass beetle infestations have been correlated with increased climatic warming (Mock 2007). Mountain pine beetles require sufficient thermal input to complete the life cycle in one season. Historically, high elevation ecosystems did not meet these conditions. However, due to recent warming trends, there is adequate thermal input at high elevations for the beetle's lifecycle and infestations of whitebark pine are now increasingly common (Logan and Powell 2001). The preponderance of mass infestations at high elevations has been witnessed throughout California—especially in the arid Warner and eastern Sierra Nevada mountains.

In addition to native insects, a non-native fungal pathogen is affecting high elevation forests. In 1910 white pine blister rust (*Cronartium ribicola*) arrived in a British Columbia port and by 1930 had spread to southern Oregon, infecting western white pine (*Pinus monticola*) and sugar pine (*Pinus lambertiana*) (Murray 2005) along the way. The lifecycle completion requires WPBR to utilize Ribes spp. as alternate hosts. In late summer, spores from *Cronartium ribicola* are blown from the Ribes host and then enter 5-needle pines through stomata. Upon successful entry, hyphae grow, spread through the phloem, then ultimately swell and kill tissue above the site of infection. Infected trees can survive for over 10 years, but the infection inhibits reproduction (Murray 2005). For species like WBP, which live in fringe habitat and therefore delay reproductive events until conditions are optimal, having an infection that further inhibits cone production is a dangerous proposition. The fungus is found on foxtail and whitebark pines in northwest California (Maloy 2001) where variability in microsite infestation occur (Ettl 2007). On Mount Ashland in the Siskiyou Mountains, blister rust has infected 4 of the 9 WBP trees in the population (Murray 2005). All five-needle native western pines have shown some heritable resistance in the past 100 years (Schoettle et al. 2007), but enduring an infection works against a long-lived pine's survival strategy. Populations of whitebark pine did not evolve to withstand fungal infections.

Seedling establishment for organisms that are on the ecological edge, like WBP, is also jeopardized because of the effects of climate change. Causes of unsuccessful seedling recruitment are many but at high elevation include the effects of fire suppression over the past 100 years. While fire has never been a common phenomenon in high-elevation forests, a shift in fire regime occurred in WBP populations during the Holocene, around 4500 years ago. Before that time fire was not a significant factor in WBP ecology but since has become significant (Murray 2005). The introduction of fire regime suppression in the 1930s is another factor in maintaining whitebark populations. The lack of fire, when coupled with effects of climate change, could also lead to population decline. Whitebark pines need open space for seedling establishment and historically some of this open space has been created by fire events. Fire suppression has also led to increased fire severity and intensity which could be compounded by pathogens. If blister rust and mountain pine beetles continue to move into the high elevations of California, they will potentially generate more dead and downed wood. While considering the potential for the risk of stand replacing fire, this would not mimic historical fire regimes—which have been of low intensity and often focused on individual trees by lightning strikes (Murray 2007).

For more images and discussion of whitebark pine forest health in California see supplementary document (Kauffmann 2014).

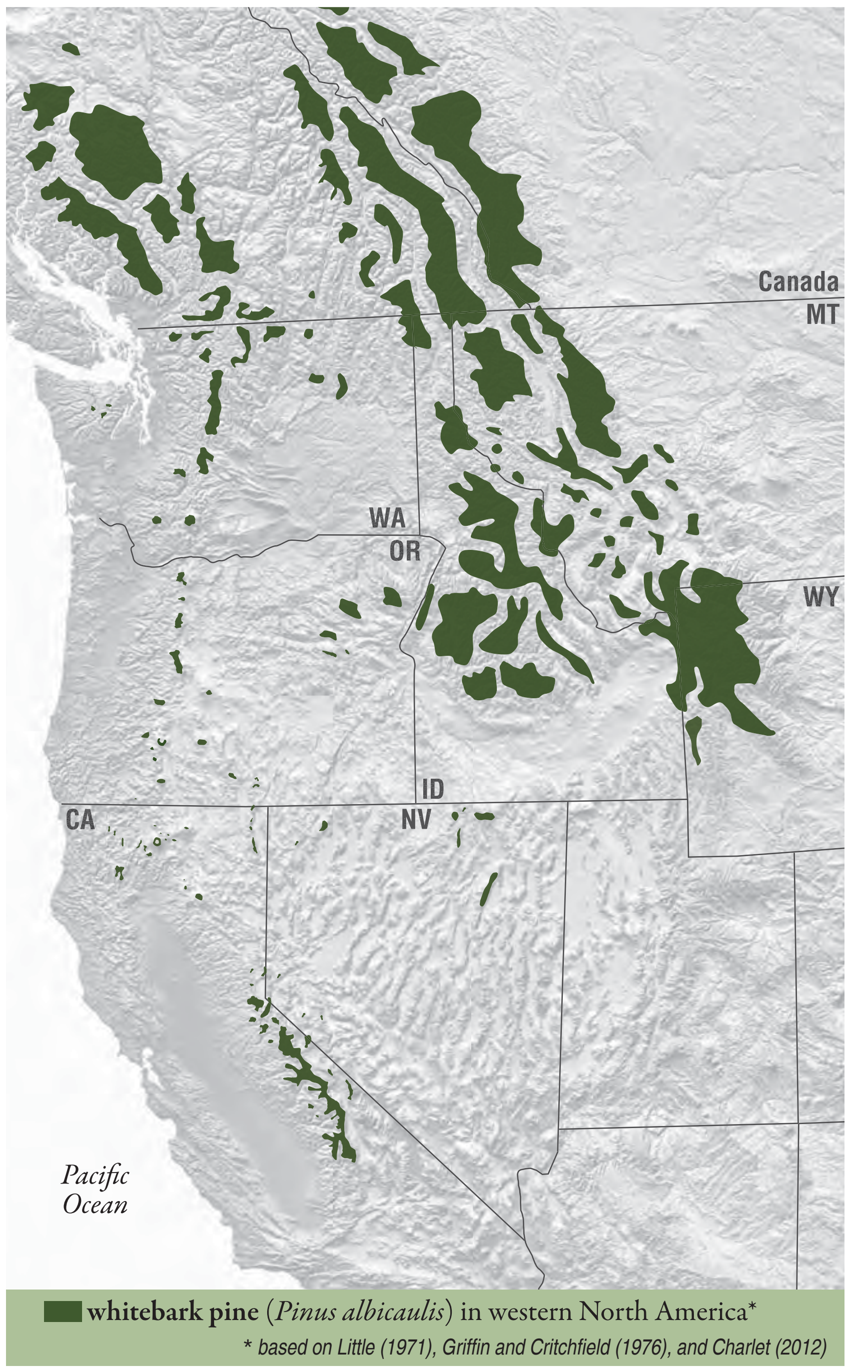


Figure 1: Range of whitebark Pine (by Michael Kauffmann)

Introduction

Mapping of whitebark pine occurrence and status/threat has been done primarily using aerial imagery in the National Forests of California by the US Forest Service, including the Pacific Southwest Region - Remote Sensing Lab's CALVEG classification system and maps. The existing USFS vegetation tiles are a result of a 2004-2005 Classification and Assessment with LANDSAT of Visible Ecological Groupings (CALVEG) map product, source imagery ranging from 2002-2009 (USFS 2013c). Even though tile data is continually updated, many stands have not been visited in the field to confirm the accuracy of CALVEG vegetation types. Additionally, little field assessment has been done in the state to identify the presence of whitebark pine, its abundance and status.

The California Native Plant Society (CNPS), working in collaboration with the US Forest Service, initiated field surveys in the summer/fall 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.

The goals of the field assessments were to verify distribution and status 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) Margins' dataset points for changes in mortality of whitebark pine due to mountain pine beetle and white pine blister rust, if time allowed. Locations within national forests were targeted for the assessment based on potential occurrence of healthy stands in high elevations within the western-most range for the species. Post field assessment, photo interpretation and delineation of whitebark pine extent beyond field surveyed areas were also conducted.

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), The Consortium of California Herbaria (UC Berkeley 2013), USFS Central Sierra Province Ecologist-Becky Estes, USFS Southern Sierra Nevada Province Ecologist - Marc Meyer, 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 and USFS Northern California Shared Service Center Entomologist - Cynthia Snyder. 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 (Consortium of California Herbaria, 2014).

CNPS also reviewed existing protocols for evaluating 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.

Upon evaluating existing datasets and obtaining input from local National Forest staff, we identified areas to further ground-truth to better determine the distribution and health/status of whitebark pine on the National Forest lands. Priorities included sampling within wilderness lands and identifying areas with low-levels of insect/disease impact.

We selected the CNPS/CDFW Vegetation Rapid Assessment protocol (see Appendix 2) 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/health. The modified rapid assessment aimed to gather as much 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. Sampling included pure stands, mixed conifer stands, and high elevation krummholz, as long as whitebark pine was deemed a component.

The modifications to the rapid assessment included additional information from Marc Meyer's 'Whitebark Pine Inventory and Monitoring Plot Protocol' such as; whitebark pine impacts from MPB and WPBR, MPB level of attack and % of WBP cones (female). Other protocol information added included; # of individual clumps/stems per area, phenology of WBP (% vegetative, % male flowers and % fruiting) and overall site/ occurrence quality/viability (site + population) from 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 proper 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 simplified, general information about a stand (see Appendix 2). Since the goal of the assessment was to gather information on healthy stands of WBP over a large area, the three purposes of the recon form were to collect data either on 1) WBP stands that were largely diseased or infested, 2) stands attributed as WBP by CALVEG but were incorrect, or 3) WBP stands that were close to stands sampled by a Rapid Assessment.

Areas that were selected for sampling in the Lassen National Forest were based on several approaches including identifying and locating populations that were not yet verified, stand accessibility by road, and wilderness settings that were predicted to have been affected by beetles or rust. These assessment areas were also based on locations that Michael Kauffmann had already identified as whitebark pine habitat/population centers (Kauffmann 2013). Thanks to Jeff Bisbee to identifying the population at the summit of Burney Mountain in email communications.

Results

In the region under discussion there are three separate populations of whitebark pine, isolated on the highest peaks and subalpine landscapes where they range from approximately 2,121-3,030 m (7,000-10,000 ft). One of these populations is located around the Lassen Peak highlands within Lassen National Park, managed by the National Park Service. The other two populations occur in the Lassen National Forest. One is within the Thousand Lakes Wilderness around Magee and Crater peaks and the other is a scattered stand of approximately 40 trees across 15 acres on the summit of Burney Mountain. While white pine blister rust was present at varying degrees across the three population centers, mortality by mountain pine beetles was generally absent. Reasons for lack in MPB infestations could include the lower percentage of lodgepole pine within the populations of whitebark compared to more arid regions of the West (which could mitigate the vectoring of beetles into the area), WBP often inhabited xeric ridgelines on south slopes rather than the north slopes, MPB have not yet "found" these trees in large numbers, or, as suggested in a new study, the physiological construction of the tree's resin ducts (Kane et al. 2013). Within the Lassen National Forest, whitebark pines associate with white fir (*Abies concolor*), red fir (*Abies magnifica*), mountain hemlock (*Tsuga mertensiana*), Lodgepole pine (*Pinus contorta*), western white pine (*Pinus monticola*), and Jeffrey pine (*Pinus jeffreyi*).

- **<u>Lassen National Park</u>**

Field work was not a major focus in the park here because several entities are already conducting research including the Jules Lab from Humboldt State University as well as park service botanists. Based on conversations with Erik Jules as well as map study of higher elevation summits outside of the Lassen Peak highlands, we targeted Prospect Peak (2524 m • 8,330 ft) near Butte Lake to ground-truth for whitebark pine's occurrence. While there was an isolated vegetation type of mountain hemlock, western white and lodgepole pine at the summit, but there were no whitebark pine found. See negative report map for more on peak's location.

• <u>**Hat Creek Ranger District**</u>

Thousand Lakes Wilderness

We spent the better part of a day walking through the crater and along the ridgelines formed by the eruption of the ancient Thousand Lakes Volcano. While we did find evidence of white pine blister rust, there was only one tree across several miles of walking that had been killed by mountain pine beetles. Beetle kill was, however, quite common in lodgepole pine forests around the Twin Lakes basin, about 800' below the elevational limit of whitebark pine in this region. Overall, whitebark pine health was excellent though trees themselves were relatively small. The largest stands of the trees occurred on the south slopes of the caldera's rim. Within the caldera itself, the concentration of whitebark pines is less dense but the largest individual specimens grow on ridges (moraines from ancient glaciers) above the swales (which were often inhabited by mountain hemlock). In many cases the hemlocks are expanding their range significantly (see pictures below) in the swales and often up onto the north facing slopes of the caldera.

Burney Mountain

At the summit near the lookout and just below into the west and north facing slopes of Burney Mountain's caldera exists an isolated population of whitebark pine. I counted 38 individual trees of varying age classes scattered across 15 acres of volcanic rock. None of the trees are very large and, if they are over 3 feet tall, are windswept in the easterly directions. Mountain pine beetles were not present but white pine blister rust occurred on 70% of trees with a DBH greater than 6'', which is approximately 20 trees. We were chased into the lowlands by an ensuing thunderstorm or I would have explored further from the road, down into the lower reaches of the caldera where I believe more WBP grow. Thanks to Jeff Bisbee for telling me about this populations so it could be documented.

Conclusions/Discussion/Recommendation

The whitebark pine field work in the Lassen National Forest was important in assessing the overall distribution of this vegetation, including significant increases and re-shaping of existing mapped areas of whitebark pine compared to previous delineations from remotely sensing plus the documentation of whitebark pine occurrence at the summit of Burney Mountain. The increase in mapped area for the Thousand Lakes Wilderness was substantial and previously identified population size was expanded significantly.

Using the California Natural Diversity Database (CNDDB) protocol for documenting overall quality and viability of whitebark pine stands observed in the surrounding National Forest areas, we conclude that, overall, populations had good to excellent viability (probability of persistence) over the next 20 years.

Lassen National Park

1. During working group and into the future, develop a protocol to assimilate research within the park with National Forest data.
2. Explore the impacts of mountain hemlock encroachment upon whitebark pine stands.
3. Create and finalize a collaborative range map for the species within the park.
4. Ground truth Raker Peak (7,483'), Saddle Mountain (7,620'), and Reading Peak (8,741') ridgeline to confirm or deny WBP occurrence at these sites.

Thousand Lakes Wilderness

1. Monitor the spread of mountain pine beetles in lodgepole pine within the Twin Lake Basin. Are the infestation centers moving upslope? Are they affecting whitebark pines above Everett Lake?
2. What is the overall impact of white pine blister rust in the Thousand Lakes caldera region?
3. Explore the impacts of mountain hemlock encroachment upon whitebark pine stands.

Burney Mountain

1. Set up a long term monitoring plot for the estimated 15 acres, 40 tree (probably more) region on the west and northwest facing slopes into the caldera below the lookout.
2. Create a better map for the extent of WBP on the mountain. We got chased down by a thunderstorm but there are probably more trees, especially on the north slops or over the west ridge. It is recommended that every tree gets mapped since there are so few.

Lastly, this report is not comprehensive; it was based upon the available funding, resources and USDA Forest Service staff schedules in 2013. The draft map of whitebark pine distribution is therefore not complete but hopefully provides an updated version of whitebark pine distribution from field surveys and aerial interpretation with limited modeled data. The modeled data that is presented from CALVEG is used to provide areas of data gaps where future field assessments are needed.

More resources for whitebark pine in northern California:

Keeler-Wolf, Todd. 1990. Ecological surveys of FS research natural areas in California.
http://www.fs.fed.us/psw/publications/documents/psw_gtr125/

- o Crater Creek RNA, Klamath
- o Mt. Eddy RNA, Shasta Trinity
- o Sugar Creek RNA, Klamath
- o Antelope Creek Lakes, Klamath

Table 1. Area of whitebark pine populations by national forest region in northern California

Forest	Region	Acres	Hectares
Klamath National Forest	South Goosenest (5 polygons with a small amount in the Shasta-Trinity NF)	2,631	1,065
	North Goosenest (3 polygons)	152	62
	Marble Mountain Wilderness	4,721	1,911
	Russian Wilderness	630	255
	China Mountain Region (some in Shasta-Trinity)	609	246
	total	**9,198**	**3,722**
Shasta-Trinity National Forest	Mount Eddy Region	6,048	2,448
	Mount Shasta	11,595	4,692
	Trinity Alps Wilderness	5,671	2,295
	Also see China Mountain and South Goosenest above		
	total	**22,039**	**8,919**
Lassen National Forest (including Lassen N.P.)	Within Lassen National Park	11,435	4,628
	Thousand Lakes Wilderness	645	261
	Burney Mountain	15	6
	total	**12,095**	**4,895**
Modoc National Forest	Buck Mountain Region	2,401	826
	South Warner Wilderness	20,125	8,548
	Middle Warners	448	181
	North Warners	3,884	1572
	total	**26,858**	**11,127**
Total acreage in the four forest regions of Northern California		**70,906**	**28,633**

Table 2. Rapid Assessment summary, Lassen NF

DbaseID	County	Ranger District	Wilderness	Site name	Alliance	Estimated Pct Cover PIAL	Altitude (m)	Impacts
WBP0035	Shasta	Hat Creek		Burney Mtn	Chrysolepis sempervirens	2	2339	Rust (70%)
WBP0061	Shasta	Hat Creek	Thousand Lakes	Thousand Lakes	Pinus albicaulis	30	2582	
WBP0062	Shasta	Hat Creek	Thousand Lakes	Thousand Lakes	Pinus albicaulis	19	2530	
WBP0063	Shasta	Hat Creek	Thousand Lakes	Thousand Lakes	Pinus albicaulis	20	2422	Rust (13%)
WBP0064	Shasta	Hat Creek	Thousand Lakes	Thousand Lakes	Western North American Montane Sclerophyll Scrub Group	2	2358	MPB (7%), Rust (14%)

Table 3. *Pinus albicaulis* attributes from Rapid Assessments in Lassen NF

DbaseID	Site name	Stand Size	Individuals per hectare	Percent Vegetative	Percent Flowering	Percent Fruiting	Mortality by MPB	Total Mortality	Quality
WBP0035	Burney Mtn		10.0	90	10		0	0	Good
WBP0061	Thousand Lakes	> 5 acres	40.0	80	15	5	0	5%	Excellent
WBP0062	Thousand Lakes	> 5 acres	30.0	20	40	40	0	0	Excellent
WBP0063	Thousand Lakes		30.0	80		20	0	5%	Good
WBP0064	Thousand Lakes		25.0	7	93		7%	8%	Fair

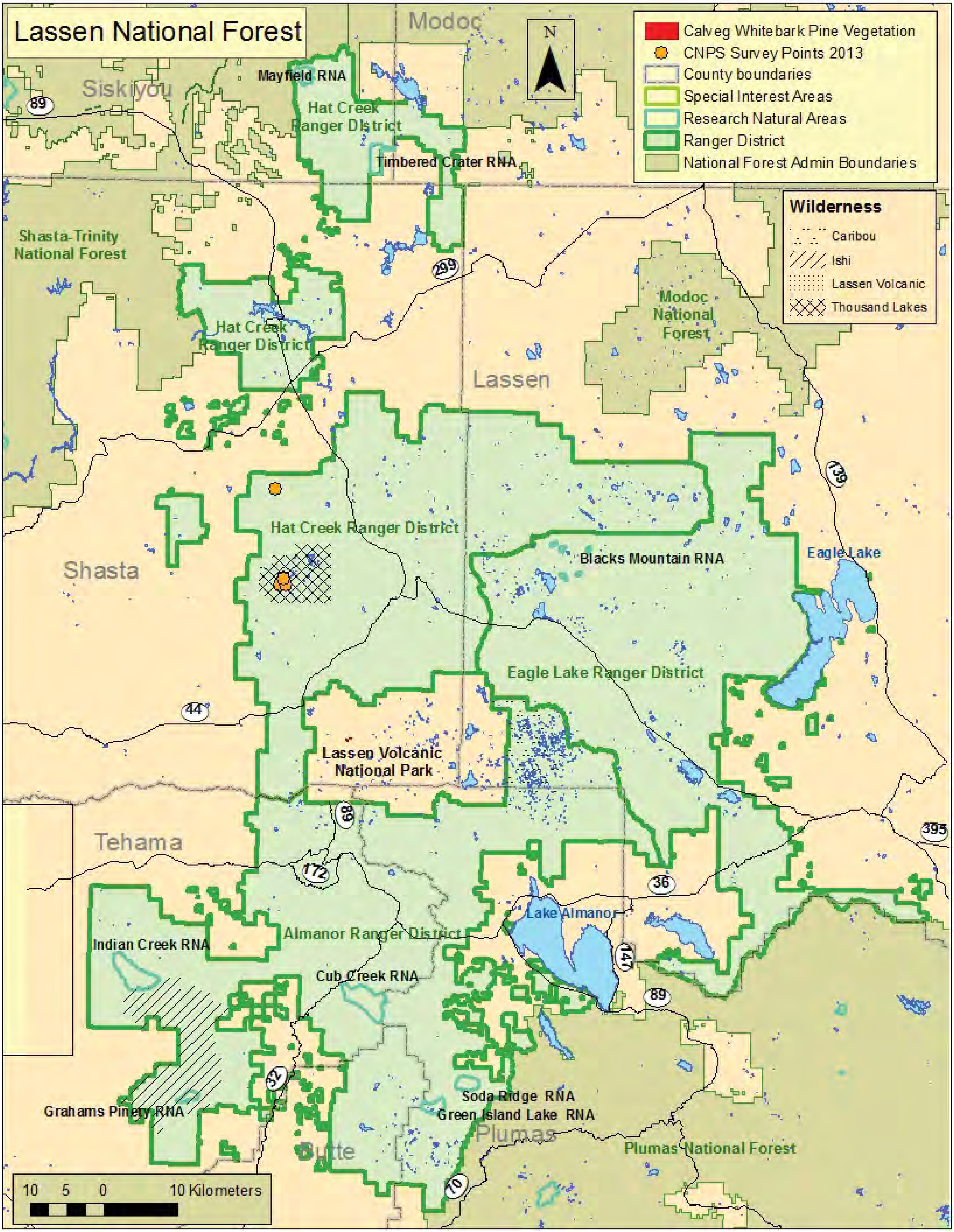


Figure 2: Overview Maps of 2013 Locations Visited on the Lassen NF

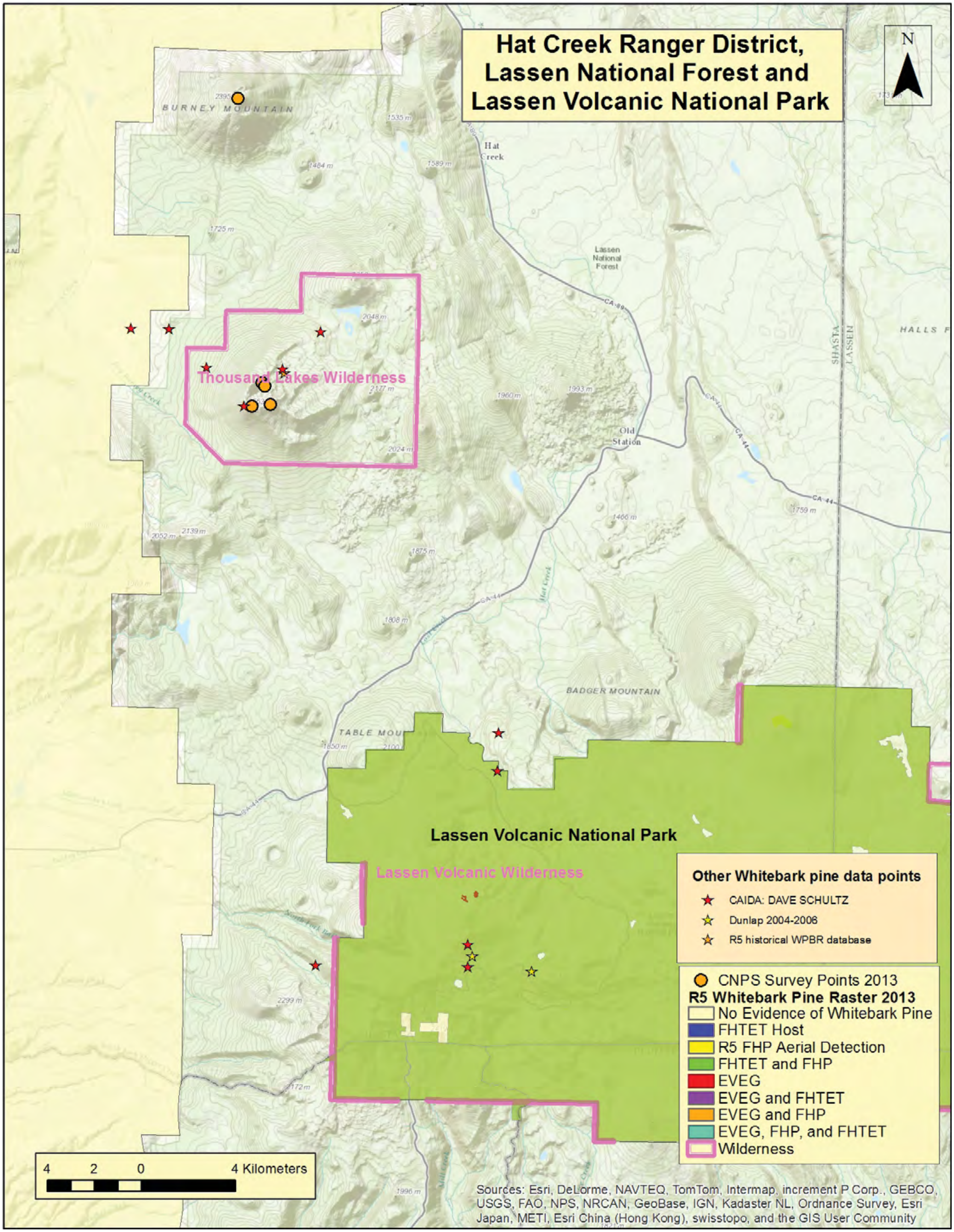
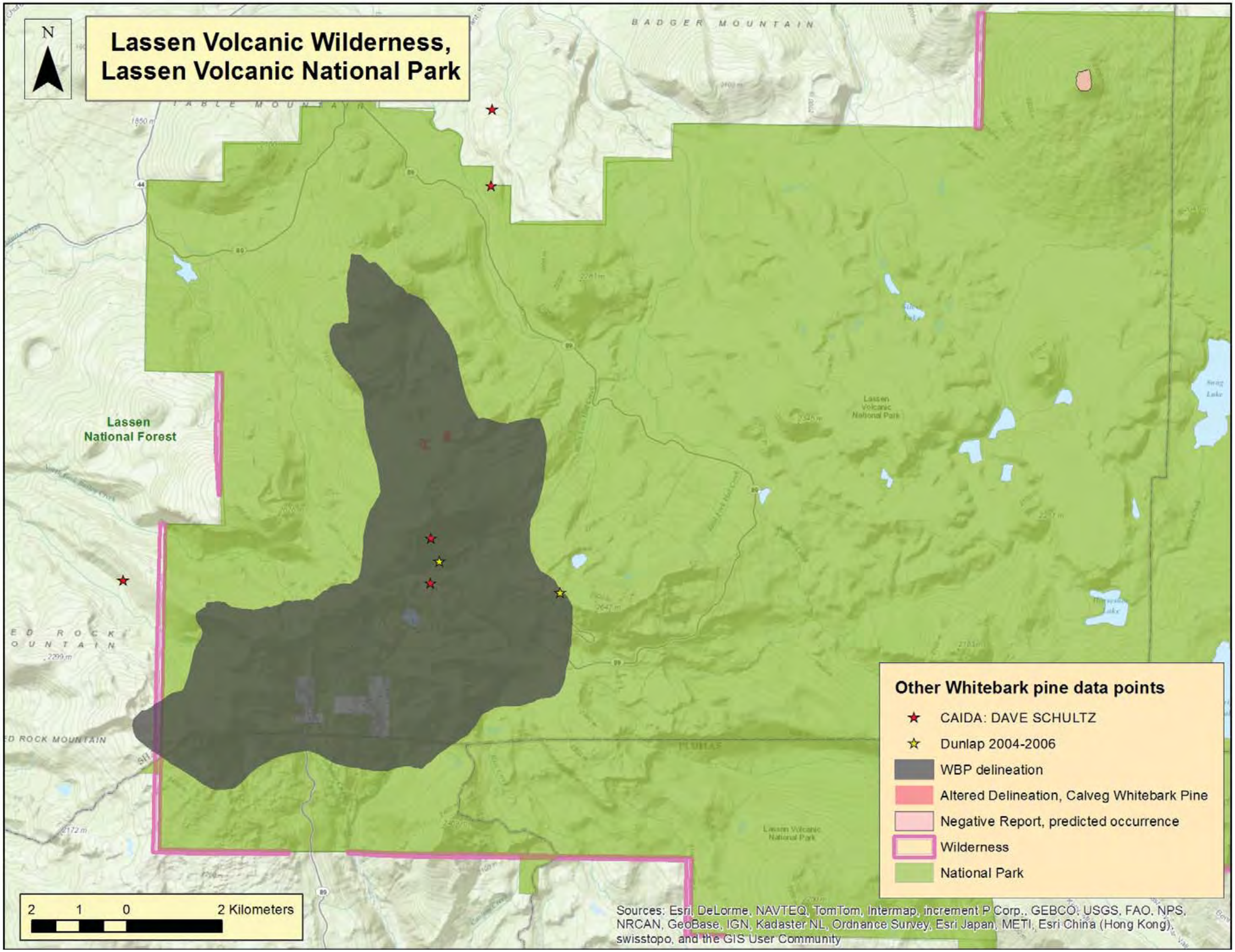


Figure 3: Hat Creek Ranger District and Lassen NP Assessment Plots

Figure 4: Lassen National Park



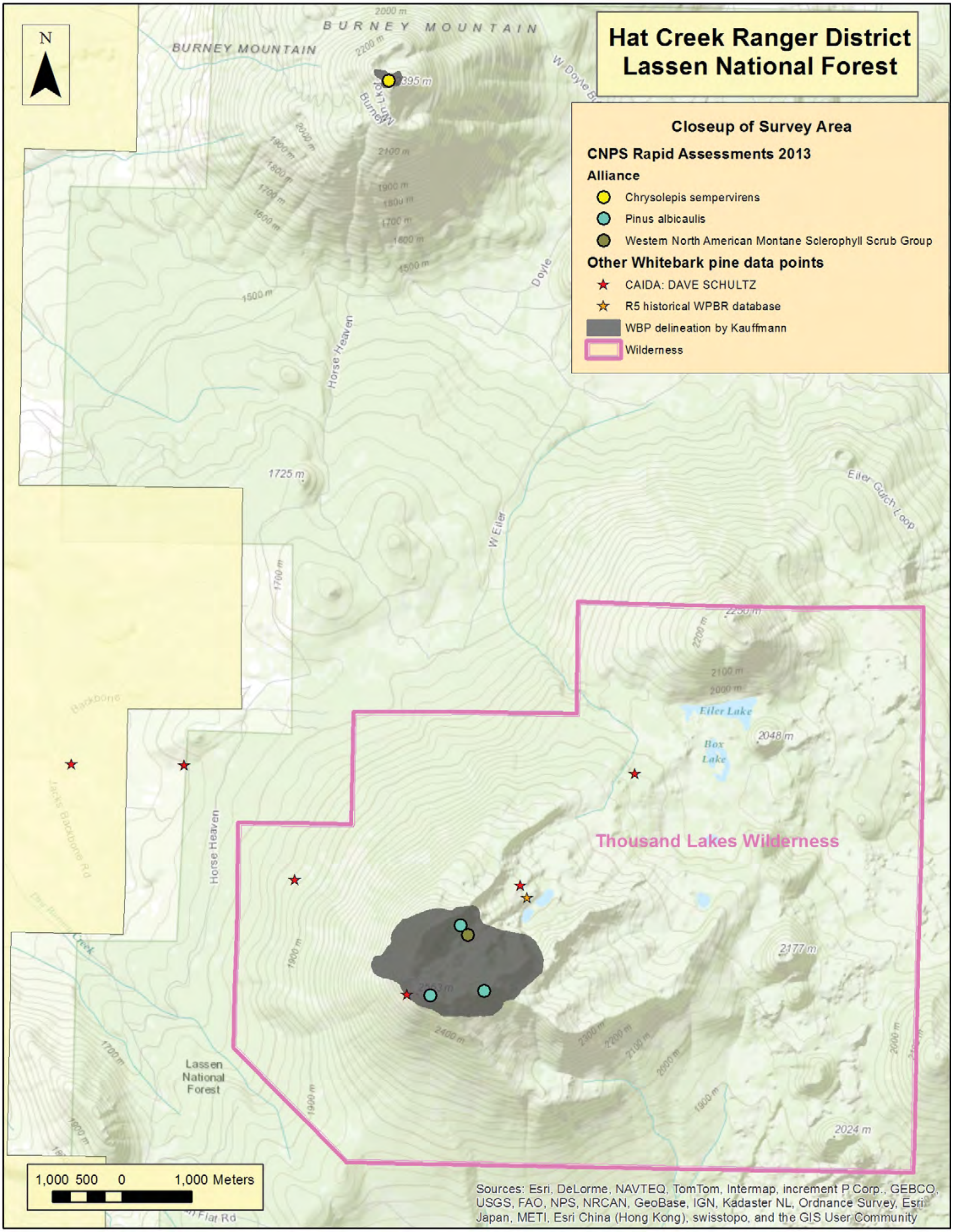


Figure 5: Whitebark pine range within the Hat Creek Ranger District

Lassen National Park

Figure 6: Whitebark pine survives adjacent to a fumarole in Bumpass Hell, Lassen National Park.

Figure 7: Whitebark pine with mountain hemlock in Lassen National Park.

Lassen National Park

Figure 8: Whitebark pine habitat on Lassen Peak

Figure 9: Whitebark pine habitat on Brokeoff Mountain

Hat Creek Ranger District - Thousand Lakes Wilderness

Figure 10: South-facing ridgelines are blanketed in low-growing whitebark pine, here looking west toward Magee Peak. Overall , the subalpine forest here is quite healthy

Figure 11: Windswept whitebark pine

Hat Creek Ranger District - Thousand Lakes Wilderness

Figure 12: Volcanic redrock country decorated with large, old whitebark pine on the ridges above the swales.

Figure 13: While mountain pine beetles had not yet begun to infect whitebark pine, 1,000' feet below at Lower Twin Lake, lodgepole pine mortality from MPB was much more common.

Hat Creek Ranger District - Thousand Lakes Wilderness

Figure 14: Within the caldera, on the north slopes of Magee Peak, new recruitment of mountain hemlock and whitebark pine was common due to decreased snowpack and increased growing season.

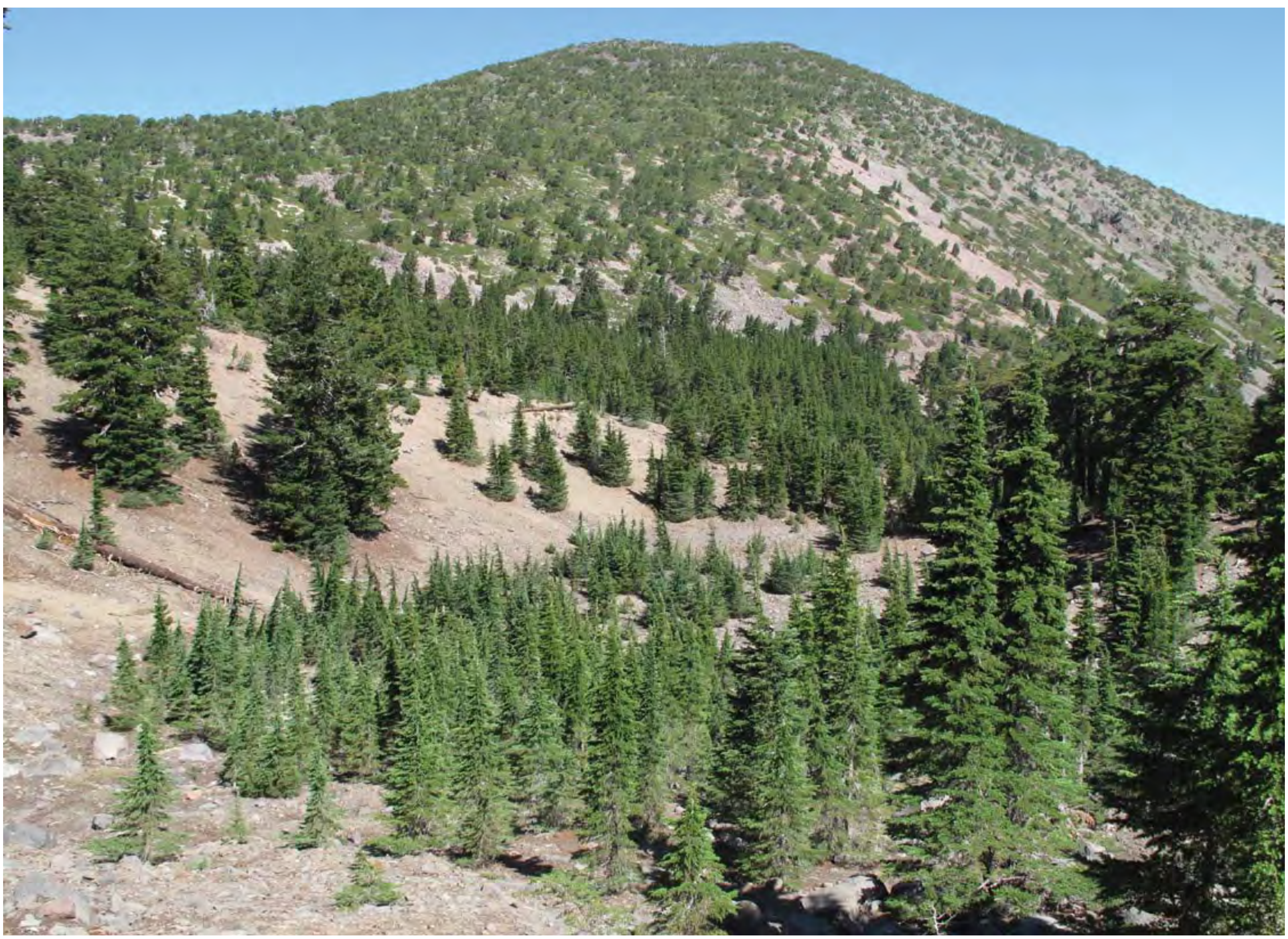


Figure 15: More extensive recruitment from mountain hemlock in the swales of the north-facing slopes of Magee Peak. Crater Peak is pictured.

Hat Creek Ranger District - Burney Mountain

Figure 16: Montane chaparral carpeted in Arctostapylus nevadensis, Holodiscus discolor, and Chrysolepis sempervirens and speckled with whitebark pine.

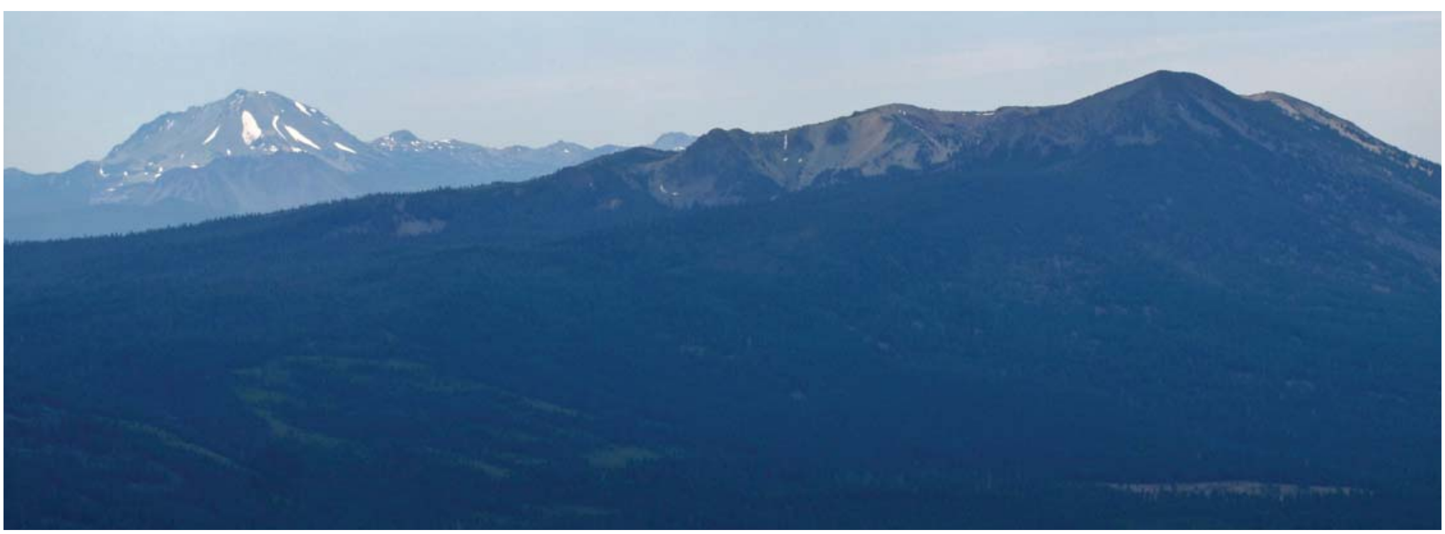


Figure 17: The view looking south from Burney Mountain toward the two main population centers for whitebark pine in the Lassen National Forest – Crater Peak in the Thousand Lakes Wilderness (front right) and Lassen Peak (back left)

Hat Creek Ranger District - Burney Mountain

Figure 18: A windswept whitebark pine along a west facing ridge on Burney Mountain, looking toward the town of Burney.

Figure 19: A young whitebark pine near the summit of Burney Mountain.

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Appendix 1: Inventory and Monitoring Protocols and Field Forms from 2013

CALIFORNIA NATIVE PLANT SOCIETY / DEPARTMENT OF FISH AND GAME 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 ° 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 ° 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 or clumps and size (CNDDB):
The number of individuals observed/detected during assessment. This should be recorded as clumps (or # 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___**

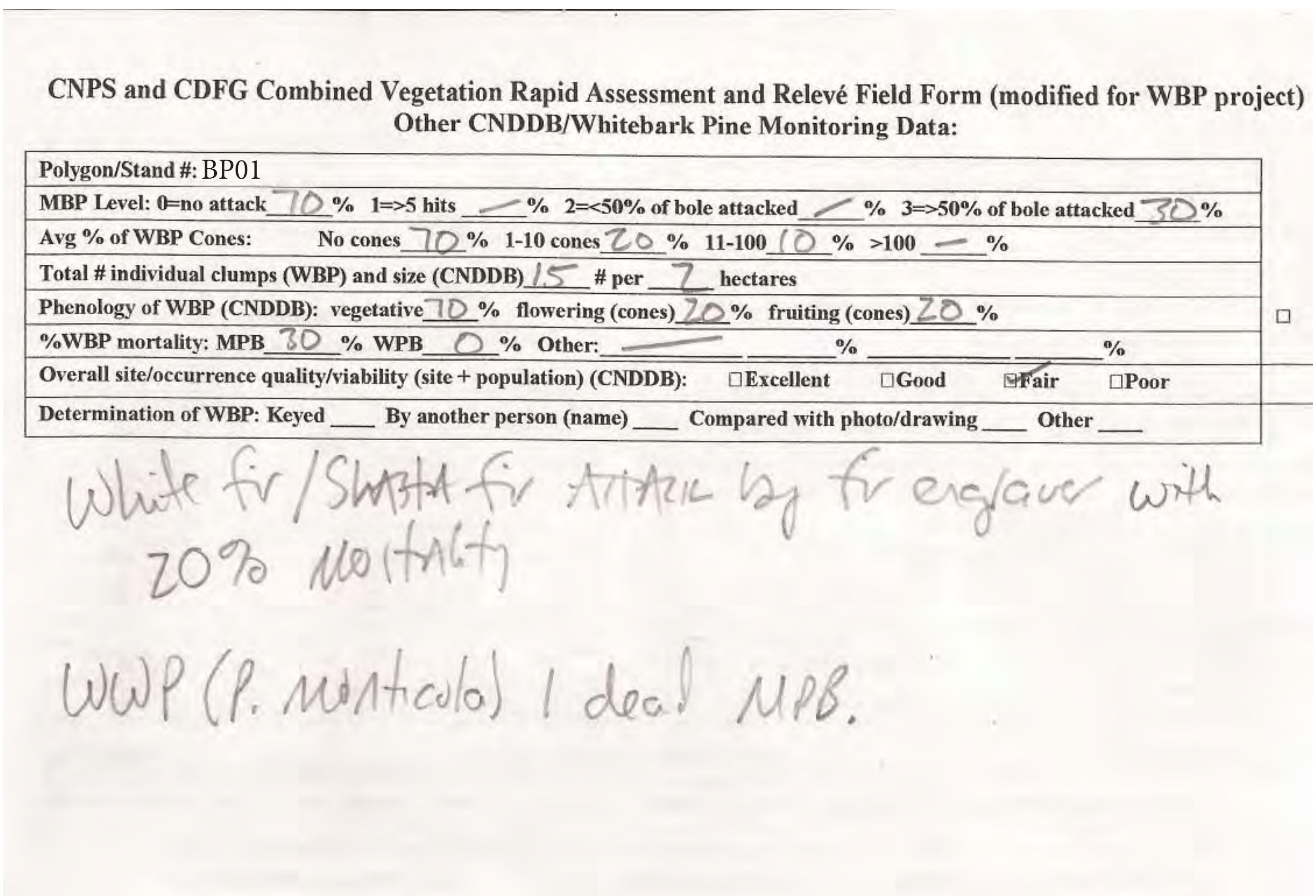
Is poly >1 type: Yes / No If yes, explain:

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 or clumps (WBP) and size (CNDDB)______ # per ______ hectares
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 ____

☐

Sample Rapid Assessment from the Boulder Peak Region - Marble Mountain Wilderness



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

Polygon/Stand #: BP01
MBP Level: 0=no attack 70 **% 1=>5 hits** — **% 2=<50% of bole attacked** — **% 3=>50% of bole attacked** 30 **%**
Avg % of WBP Cones: No cones 70 **% 1-10 cones** 20 **% 11-100** 10 **% >100** — **%**
Total # individual clumps (WBP) and size (CNDDB) 15 **# per** 7 **hectares**
Phenology of WBP (CNDDB): vegetative 70 **% flowering (cones)** 20 **% fruiting (cones)** 20 **%**
%WBP mortality: MPB 30 **% WPB** 0 **% 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 ____

☐

White fir/Shasta fir Attack by fir engraver with 20% mortality

WWP (P. monticola) 1 dead MPB.

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):
BP01		9/20/13	Kaufmann

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

UTME 492814 **UTMN** 4604449 **Zone: (10) / 11** (circle one) **Error: ±**2.3 **ft / m / (pdop)**

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

Elevation: 1985 **ft / (m) Camera Name/Photograph #'s:**

Stand Size (ac/ha): <1, 1-5, >5 ac| ____ ha **Plot Size (m2):** 10 / 100 / (500) | **Plot Shape** ___ x ___ m or (**Circle Radius**) 12 m

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

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

Geology code: Gabbro **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: 5 **BA Stems:** 30 **Litter:** 57 **Bedrock:** — **Boulder:** 10 **Stone:** 5 **Cobble:** 5 **Gravel:** 5 **Fines:** 10 **=100%**

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

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

On edge of creek, 1/2 mile below lower Wright Lake (on trail) meadow edge riparian. Fire evidence from 50+ years ago now with white fir encroaching.

Disturbance / Intensity (L,M,H) Grazing / L / / **WBP Impact** 39 / M / 50% 40 / L / 30%

II. HABITAT AND VEGETATION DESCRIPTION

Tree DBH : T1 (<1" dbh) 2, **T2** (1-6" dbh) 3, **T3** (6-11" dbh) 2, **T4** (11-24" dbh) 2, **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:** 35 **% Vasc Veg cover:** 65

% Cover - **Conifer tree / Hardwood tree:** 15 / — **Regenerating Tree:** 5 **Shrub:** 25 **Herbaceous:** 20

Height Class - **Conifer tree / Hardwood tree:** 05 / — **Regenerating Tree:** 02 **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	Whitebark	30%	5%		S	Serviceberry		3%	
T	White fir	10	10%		S	Ribes sp.		4%	
T	Shasta fir		3%		H	Grass sp.		10%	
T	Western white pine (1)	dead	1 new		H	Lupine sp		5%	
S	Salix sp.		5%		H	elderberry		5%	
S	Snowberry		5%		T	Foxtail pine - 4 new regen trees		3%	
S	Vaccinium sp.		5%						
S	Sorbus sp.		3%						

Other rare taxa in stand (CNDDB)

III. INTERPRETATION OF STAND

Field-assessed vegetation alliance name: White fir - WBP

Field-assessed association name (optional): Meadow to

Adjacent alliances/direction: East / , /

Confidence in alliance identification: L (M) H **Explain:**

Other identification or mapping information: Along trail **Phenology (E,P,L): Herb** ___ **Shrub** ___ **Tree** ___

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

Appendix 2: 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.

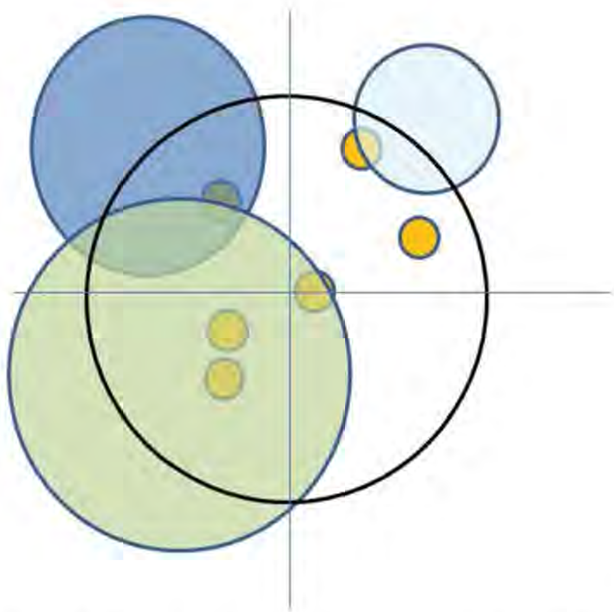


Fig. 1. Circular plot, with four species of understory plants (colored). The blue crosshairs are added to aid in estimating cover. The understory vegetation cover is about 64% (the total plot area minus the area that is not covered by live vegetation. The gray species (shrub) has 49% cover, the dark 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