



Sierra Nevada Network White Pine Monitoring

2017 Annual Report

Natural Resource Data Series NPS/SIEN/NRDS—2018/1194



ON THE COVER

Whitebark pine (*P. albicaulis*) near Tioga Pass, Yosemite National Park, California
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Sierra Nevada Network High Elevation White Pine Monitoring

2017 Annual Report

Natural Resource Data Series NPS/SIEN/NRDS—2018/1194

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Executive Summary

Five-needle white pines (Family Pinaceae, Genus *Pinus*, Subgenus *Strobus*), and in particular whitebark pine (*Pinus albicaulis*), limber pine (*P. flexilis*), and foxtail pine (*P. balfouriana*) are foundation species in upper subalpine and treeline forests of several National Park Service Pacific West Region parks, including Sequoia and Kings Canyon National Parks (SEKI) and Yosemite National Park (YOSE). The Sierra Nevada Network Inventory & Monitoring Program, in collaboration with the Klamath Network and the Upper Columbia Basin Network have implemented a joint long-term monitoring protocol to assess the current status and future trends in high elevation white pine communities. Key demographic parameters within white pine forest communities will be estimated by monitoring individual trees within permanent plots through time.

This report documents the results of the 2017 field season, which is the sixth year of monitoring in SEKI and YOSE. The 2017 goal was to complete installation of the third of three rotating panels (Panel 3) and perform the first re-read of previously installed plots in this panel for each species-park population: YOSE-whitebark pine, SEKI-whitebark pine, and SEKI-foxtail pine. Each panel consists of 12 permanent 50 x 50 m (2,500 m²) plots that were randomly selected for each of the three populations. Thus, there will be a total of 36 whitebark pine plots in YOSE, 36 whitebark pine plots in SEKI, and 36 foxtail pine plots in SEKI. Data from plot surveys will be used to characterize white pine forest community dynamics in SEKI and YOSE, including changes in tree species composition, forest structure, forest health, and demographics. This is the third year where previously installed plots have been re-measured to track changes in white pine populations through time. Parameters estimating rates of change are not reported in this report, however, as currently only a small subset of Panel 3 plots have been visited twice.

In addition, 2017 was the third and final year of data collection for a separate but related project to examine changes in white pine blister rust severity and distribution within SEKI. SIEN employed one additional employee to collect data on the remaining blister rust monitoring plots. The results of that project are not included in this report. Other work performed by the forest crew in 2017 included installation of a blue oak demography plot in SEKI, re-measure of sugar pine monitoring plots in YOSE, and outlet sampling of two SIEN lakes monitoring sites in SEKI (2017 was a reduced sampling year for the SIEN Lakes crew). The inclusion of this additional work was necessitated by the extremely high snowpack of 2017 that limited access to our high elevation monitoring plots well into the field season.

In total, the crew visited 36 sites during the 2017 field season and completed installation or re-reads of 27 of 36 Panel 3 plots. An additional two plots were partially installed. Within these completed plots, they measured 5,124 trees. Species composition, forest structure, and factors affecting tree health and reproduction including incidence and severity of white pine blister rust (*Cronartium ribicola*) infection, mountain pine beetle (*Dendroctonus ponderosae*) infestation, dwarf mistletoe (*Arceuthobium spp.*) infection, canopy kill, and female cone production were recorded. During the 2017 field season crews not only noted the presence or absence of female cones, but counted the total number of mature cones per tree for whitebark and foxtail pine. In addition, individual seedlings

were tagged instead of just being counted by size class and will be tracked through time, similar to trees taller than 1.37 m. A final addition to the protocol that was tested in 2017 was the use of crown condition codes to assess crown health. All three of these new procedures were conducted by each of the three participating networks and will be evaluated over the next few years to determine whether they should become permanent changes to the monitoring protocol.

In YOSE, five whitebark pine plots were re-measured and six plots were installed to complete sampling of 11 of the 12 Panel 3 plots. A total of 892 live whitebark pine trees and 1,715 other conifers were sampled. White pine blister rust (WPBR) was observed on 12 whitebark pine in one plot in the Merced Pass area of YOSE. This is the first time WPBR has been discovered in one of our monitoring plots in YOSE. Neither dwarf mistletoe nor mountain pine beetle activity were observed on any of the trees in 2017. The average number of live whitebark pine trees per plot was 81 (SD = 92). Twenty-two percent of live whitebark pine trees produced female cones. Cone-bearing trees averaged 15 (SD = 11) cones/tree. No cones were recorded in two of the 11 plots. Whitebark pine seedling regeneration averaged 718 (SD = 1446) seedlings per hectare. The largest number of whitebark pine seedlings found in a plot was 39 and only five of the eleven plots contained whitebark seedlings. Other species encountered included lodgepole pine (15 seedlings) and mountain hemlock (one seedling).

In SEKI, six Panel 3 whitebark pine plots were fully installed, two were partially installed, and one was re-measured to complete sampling of seven of 12 Panel 3 plots. Three additional sites were visited and rejected due to unsafe terrain and one site was scouted, but not installed. In the seven completed SEKI whitebark pine plots, 1,234 live whitebark pine, two foxtail pine, and 126 other conifers were sampled. Indicators of WPBR were found on whitebark pine in two plots in Kings Canyon. At least two trees were infected in Plot 51 near Kearsarge Lakes and a single tree in plot 59 in the Upper Basin area was infected. Mountain pine beetle activity was observed in one live lodgepole pine, three recently dead whitebark pine, and 14 dead whitebark pine within two plots in SEKI. Dwarf mistletoe was not encountered. The average number of live whitebark pine trees per plot was 176 (SD = 141). Thirty-five percent (SD = 11) of live whitebark pine trees produced female cones. Cone-bearing trees averaged 11 (SD = 6) cones/tree. Whitebark seedling regeneration averaged 353 (SD = 330) seedlings per hectare. The largest number of seedlings found in a plot was seven, and six of seven plots contained whitebark seedlings. Six lodgepole pine and one Jefferey pine seedling were also found within the regeneration plots.

In the Panel 3 foxtail pine plots, we installed two and re-measured seven to complete sampling of nine of 12 Panel 3 plots. Within these plots we measured 229 live foxtail pine, 302 whitebark pine, and 107 other conifers. Thirty-nine dead or recently dead trees were also measured. No signs of blister rust infection were observed on foxtail pine, but one whitebark pine (in plot 40 near Charlotte Dome) did have symptoms of WPBR. Neither mistletoe nor signs of beetle activity were observed in any of the plots. The average number of foxtail pine trees per plot was 21 (SD = 31). Sixty-six percent (SD = 33) of the foxtail pine trees produced female cones. Cone-bearing trees averaged 176 (SD = 149) cones/tree. Ten foxtail pine seedlings were recorded within the nine foxtail pine plots, resulting in an estimated 137 (SD = 168) seedlings per hectare. Four of the nine plots did not have

any foxtail seedlings within the regeneration plots. Six whitebark pine seedlings were also found in one of the plots.

Acknowledgments

Funding for this project was provided through the National Park Service Natural Resource Challenge and the Service-wide Inventory and Monitoring Program. Additional funding for the WPBR project was provided by the US Forest Service, Forest Health Monitoring program (IAA # 15IA11052021200). Park staff (Tony Caprio, SEKI; Garrett Dickman, YOSE) also provided valuable logistical support to field operations in 2017. The initial high-elevation white pine monitoring annual report (Stucki et al. 2012) on which this document is based was developed by Devin Stucki, Tom Rodhouse, and Shawn McKinney. This work would not have been possible without the amazing contributions of our dedicated field crew: Sean Auclair (lead), Tressa Gibbard, Hanna Mohr, Sam Zuckerman, and Jennifer Cribbs.

Background and Objectives

Many western North American coniferous forests are currently facing unprecedented health challenges, including upsurges of native pests and pathogens, invasive exotic species, and altered disturbance regimes. Increased atmospheric warming, carbon dioxide concentration, and nitrogen deposition, as well as changes in precipitation patterns (i.e., timing, magnitude, and type) portend additional short- and long-term changes in high elevation forest ecosystem processes. Each factor alone can alter forest structure, function, and species composition, and additive or synergistic effects are likely if multiple agents act jointly. How forest ecosystems will respond to modern perturbations is uncertain. However, the magnitude of change in structure, composition, and key ecological processes will likely be exceptional. Indeed, increased tree mortality rates over the last several decades have recently been documented across a broad range of latitude and forest types in western North America (van Mantgem et al. 2009), which may have important consequences for forest stand dynamics and ecosystem functions.

Five-needle white pines (Family Pinaceae, Genus *Pinus*, Subgenus *Strobus*), and in particular whitebark pine (*Pinus albicaulis*), limber pine (*P. flexilis*), and foxtail pine (*P. balfouriana*) are foundational species (Tomback and Achuff 2010) in upper subalpine and treeline forests of several National Park Service (NPS) Pacific West Region (PWR) parks, including Sequoia and Kings Canyon National Parks (SEKI) and Yosemite National Park (YOSE) (Figure 1). Ongoing declines of foundation tree species pose an especially compelling problem because these species provide fundamental structure to ecosystems and are therefore irreplaceable (Ellison et al. 2005). If a foundation tree species is lost from these systems, it will likely lead to a cascade of secondary losses, shifts in biological diversity, and ultimately affect the functioning and stability of the community (Ebenman and Jonsson 2005).

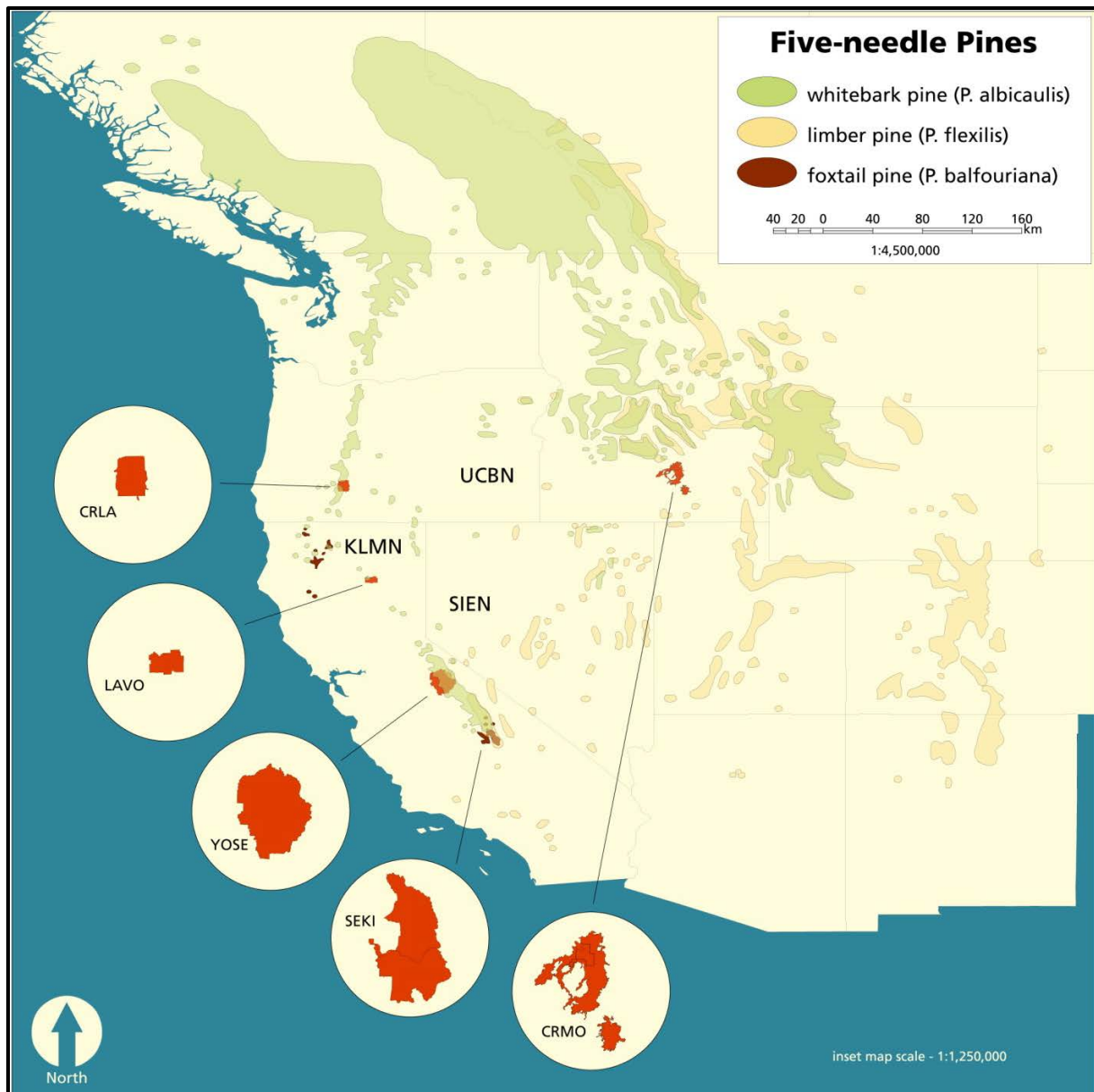


Figure 1. Distribution of whitebark pine, limber pine, and foxtail pine (from Little 1971) and locations of three Pacific West Region networks and associated parks.

Whitebark Pine

Whitebark pine occurs across a broad geographic range, occurring on both the west and the more arid east side of the Sierra Nevada crest and reaching its southern limit in central California in the Mount Whitney vicinity. Throughout its range, whitebark pine can occur in the montane, upper subalpine, and treeline zones (Arno and Hoff 1990). It often occurs as the only tree species on the coldest and driest sites near treeline (Figure 2) and as a seral species on protected, slightly lower sites more favorable to its shade-tolerant competitors (Arno and Weaver 1990).



Figure 2. Whitebark pine near Kuna Crest, Yosemite National Park (NPS/SIEN forest crew, 2017)

In the Pacific West Region (PWR), whitebark pine is scattered across tens of thousands of hectares in the high elevations of SEKI and YOSE (Figure 1). White pine blister rust (*Cronartium ribicola*) infections on whitebark pine decrease from north to south in the PWR, resembling the trend seen in the Rocky Mountains. White pine blister rust (WPBR) is relatively rare in high elevation forests of SEKI and YOSE when compared to northern portions of the PWR (e.g., North Cascades). Mountain pine beetles (*Dendroctonus ponderosae*) are currently abundant in the northern Cascades, but also decrease with latitude (Gibson et al. 2008) in the PWR.

Whitebark pine acts as a foundation species in high-elevation forest communities by regulating ecosystem processes, community composition and dynamics, and by influencing regional biodiversity (Ellison et al. 2005, Tomback and Kendall 2001). Whitebark pine plays a role in initiating community development after fire, influencing snowmelt and stream flow, and preventing soil erosion at high elevations (Tomback et al. 2001, Farnes 1990). The large, wingless seeds of whitebark pine are high in fats, carbohydrates, and lipids and provide an important food source for many granivorous birds and mammals (Tomback and Kendall 2001). Whitebark pine is a coevolved mutualist with Clark's nutcracker (*Nucifraga columbiana*), and is dependent upon nutcrackers for dispersal of its seeds (Tomback 1982, McKinney et al. 2009).

Foxtail Pine

Foxtail pine is endemic to two distinct areas in California, the Klamath Mountains in the northwest part of the state and the southern Sierra Nevada (Figure 1). Research on community and population dynamics is lacking for foxtail pine compared to whitebark pine. Foxtail pine occurs in four different forest types: 1) stands dominated by foxtail pine, 2) stands with foxtail pine and whitebark pine, 3) stands with foxtail pine and red fir (*Abies magnifica*), and 4) stands with foxtail pine, red fir, and western white pine (*P. monticola*) (Eckert and Sawyer 2002). Foxtail and whitebark pine overlap in some portions of their southern Sierra Nevada distribution, however, south of the Kings-Kern divide, foxtail pine is the major (sometimes exclusive) subalpine and treeline tree species (e.g., >3,000 m). Foxtail pine provides important habitat and food resources for birds and mammals, and influences snowmelt and soil erosion (Figure 3).



Figure 3. Foxtail pine near Rock Creek ranger station, Sequoia National Park (NPS/JENNY CRIBBS, 2017)

The southern population of foxtail, subspecies *austrina*, provides important data for dendrochronological research on paleoclimate (Lloyd 1997) as a consequence of its great longevity (> 2,000 years) and slow growth. In fact, five-needle pines, in general, have proven valuable in

enhancing our understanding of past climates through dendrochronological investigations (e.g., Kipfmüller and Salzer 2010, Woodhouse et al. 2011).

Objectives

At least three networks in the Pacific West Region identified white pine species as targets for long-term monitoring (Sarr et al. 2007, Mutch et al. 2008, Garrett et al. 2007). Ecologists in these networks (Klamath Network [KLMN], SIEN, and Upper Columbia Basin Network [UCBN]) collaborated to devise a common set of monitoring objectives and procedures which are documented in our multi-network white pine monitoring protocol (McKinney et al. 2012a, 2012b). The anticipated impacts from WPBR, dwarf mistletoe, mountain pine beetle, and climate change on high-elevation pines were primary factors considered in developing the monitoring objectives. Key demographic parameters within white pine forest communities will be estimated by monitoring individual trees within permanent plots. Specific objectives of white pine monitoring are to detect status and trend in:

1. Trees species composition and structure
2. Tree species birth, death, and growth rates
3. Incidence of white pine blister rust and level of crown kill
4. Incidence of bark beetles
5. Incidence of dwarf mistletoe
6. Cone production of white pine species

Information gathered from this white pine monitoring project will be integral to providing a more comprehensive understanding of the populations within SIEN parks as well as providing for comparisons across broader geographic areas. It will also allow early detection of important changes in populations that may trigger management intervention.

Methods

This section summarizes the methods used for white pine monitoring in SIEN in 2017. A full description of methods and standard operating procedures may be found in the multi-network white pine monitoring protocol (McKinney et al. 2012a, 2012b). Specific deviations from the published methods or clarifications on how the methods were interpreted in the field during the 2017 field season are documented in Appendix 1.

Sampling Frame

The sample frames for each species-park population (SEKI-whitebark pine, SEKI-foxtail pine, and YOSE-whitebark pine) were based on the distribution of whitebark and foxtail pine as identified in the YOSE and SEKI vegetation maps (Figures 4 – 6). An ordered list of plot locations was generated using a randomized, spatially-balanced sampling design via the Generalized Random Tessellation Stratified (GRTS) algorithm (Stevens and Olsen 2004). Plots in the ordered list were assigned to one of three panels and each panel will be sampled on a rotating basis every three years (Appendix 2). Extra plot locations were drawn in the event that plots from the original sample draw were rejected (the oversample). Common reasons for rejection included 1) plots were on slopes too steep to be safely sampled (slopes ≥ 35 degrees), 2) sites were not accessible in a safe manner, and 3) sampling frame errors (i.e., plot did not contain the target vegetation type). Based on this sampling design, our scope of inference extends broadly across mapped stands of whitebark and foxtail pine on < 35 -degree slopes within YOSE and SEKI.



Sequoia and Kings Canyon National Parks

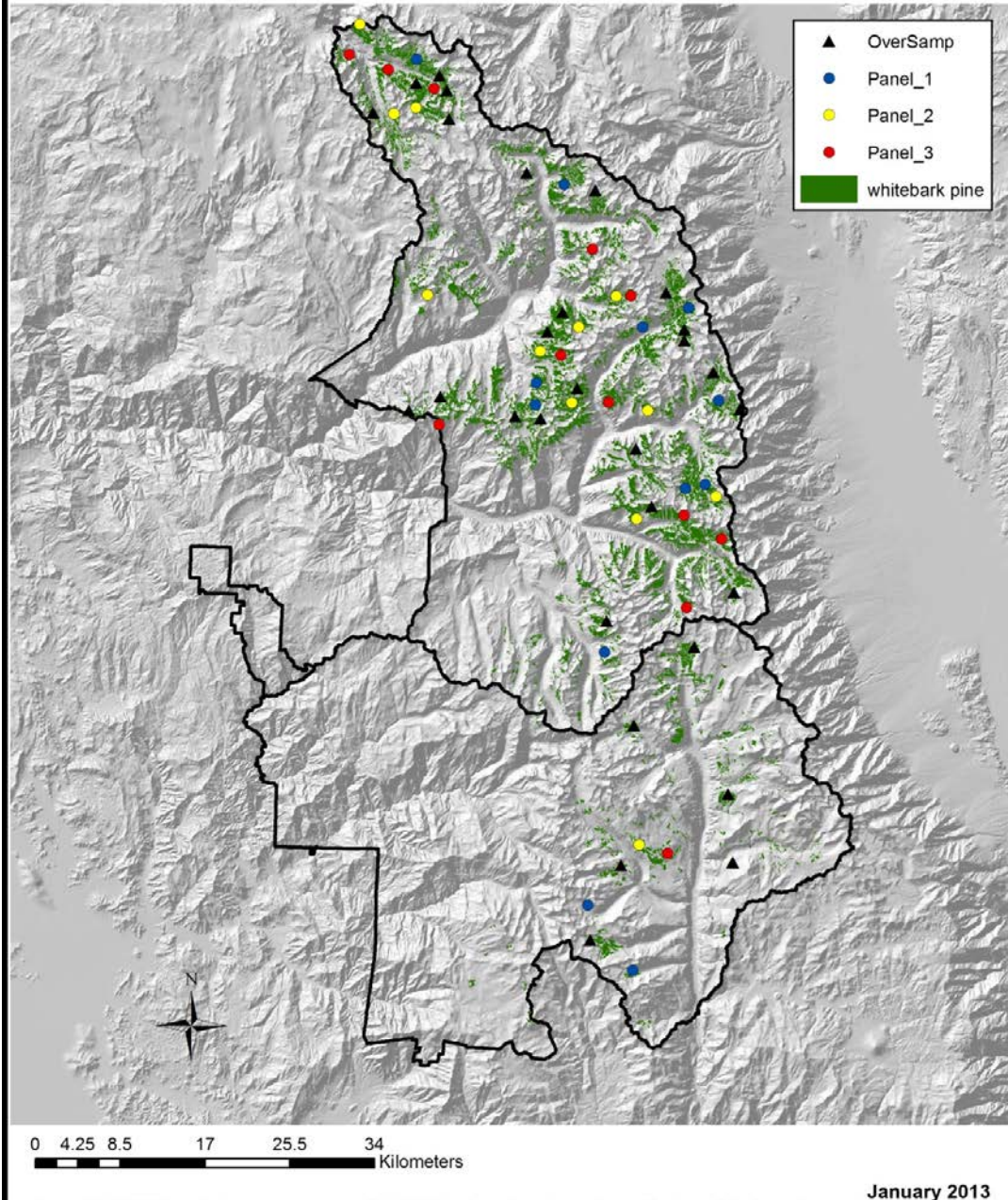


Figure 4. Whitebark pine sampling frame (green shading) and GRTS-based plot locations for Sequoia and Kings Canyon National Parks (colored dots). Plots are assigned to one of three panels (12 plots each), which are sampled every three years, or the oversample. An updated assessment of whitebark pine distribution within SEKI can be found in *Sequoia and Kings Canyon National Parks Wilderness Stewardship Plan/FEIS* pg. 340 (NPS 2015).



Sequoia and Kings Canyon National Parks

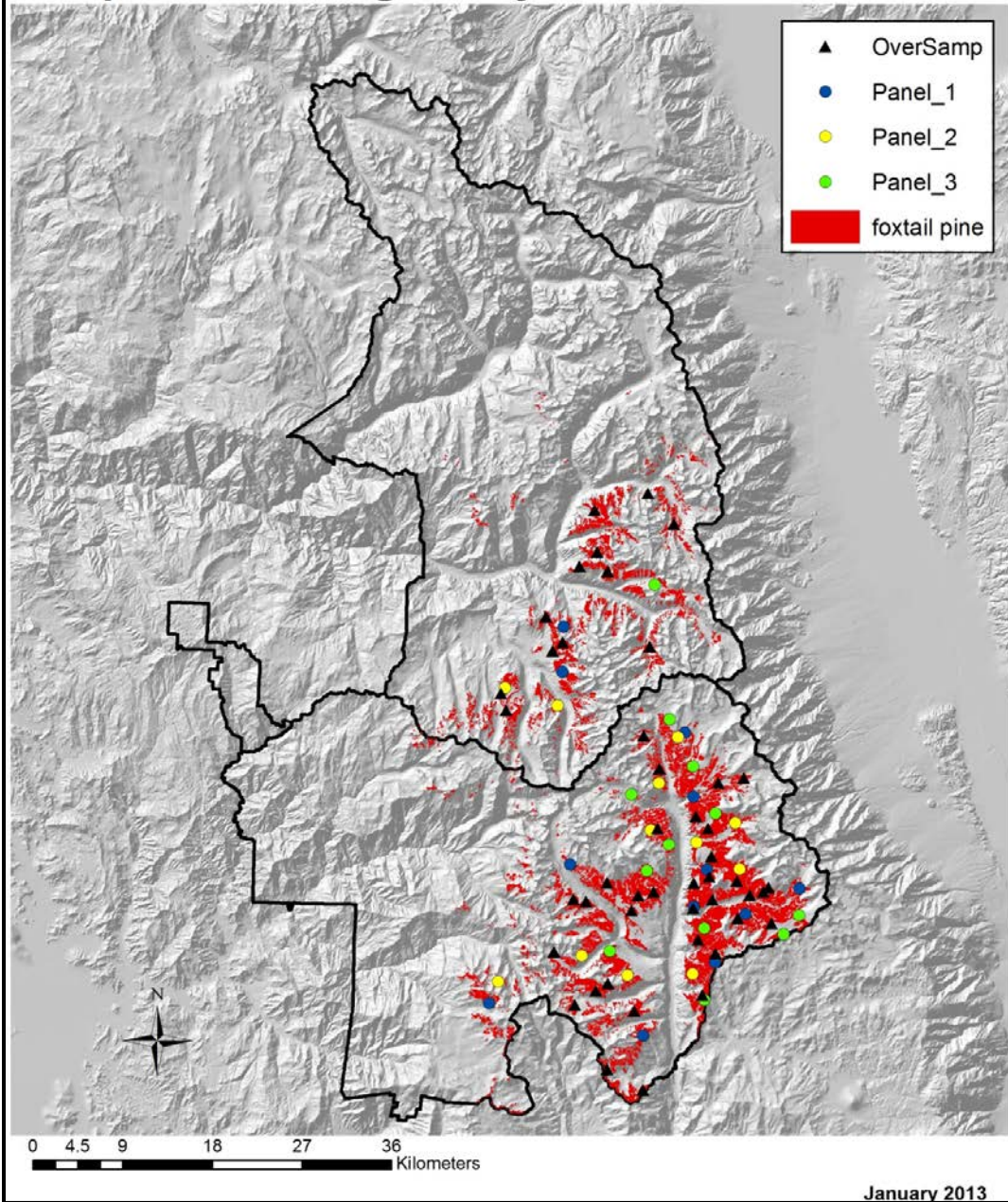


Figure 5. Foxtail pine sampling frame (red shading) and GRTS-based plot locations for Sequoia and Kings Canyon National Parks (colored dots). Plots are assigned to one of three panels (12 plots each), which are sampled every three years, or the oversample.



Yosemite National Park

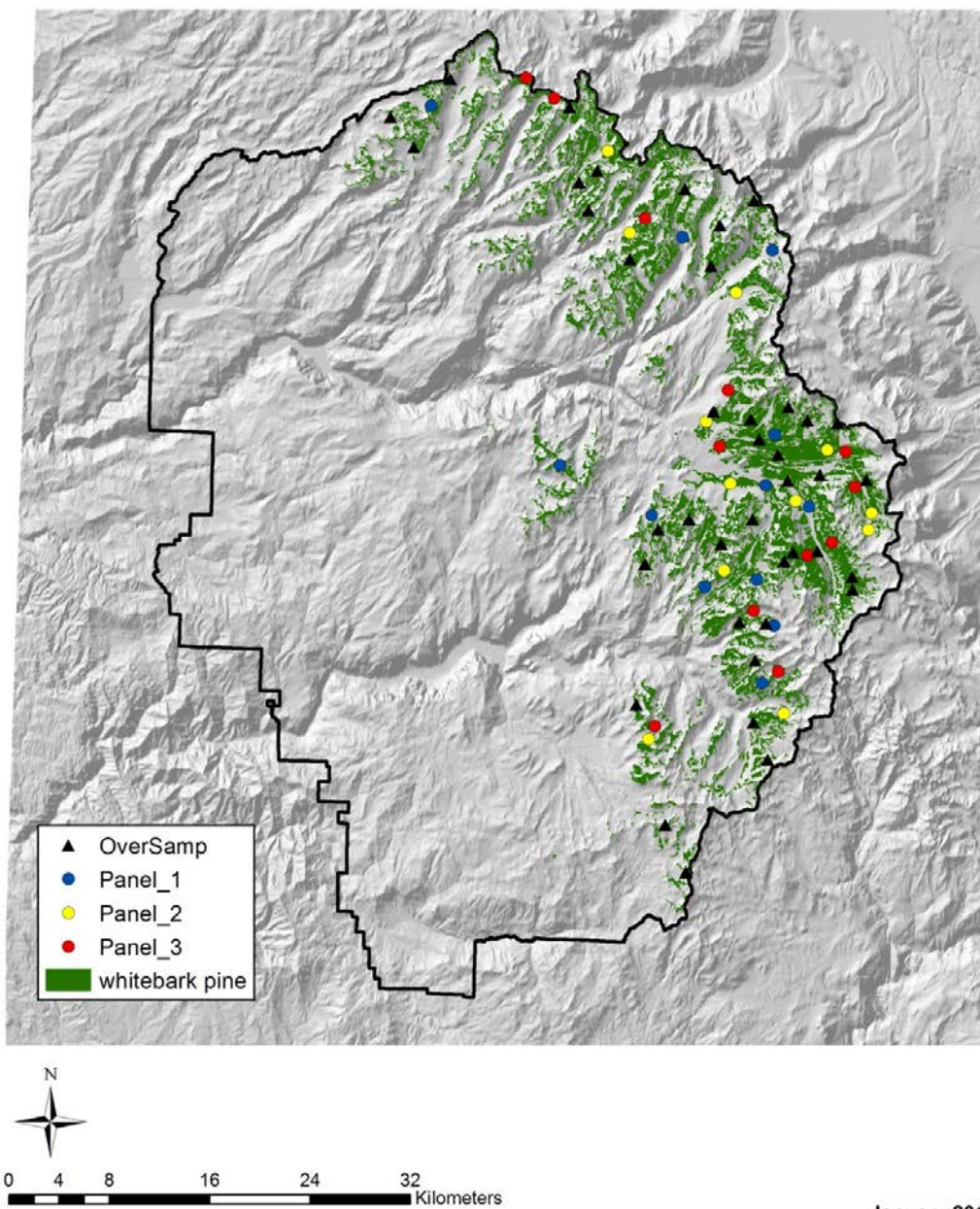


Figure 6. Whitebark pine sampling frame (green shading) and GRTS-based plot locations for Yosemite National Park (colored dots). Plots are assigned to one of three panels (12 plots each), which are sampled every three years, or the oversample.

Frequency and Timing of Sampling

We adopted a three-year rotating panel design for re-surveying permanent plots in SEKI and YOSE (McDonald 2003). Sampling occurs between June and October and each plot is surveyed once per three-year rotation (Table 1). A total of 36 plots will be monitored in each park (YOSE and SEKI) for each species, resulting in an overall total sampling effort of 72 plots in SEKI (36 whitebark and 36 foxtail) and 36 plots in YOSE (whitebark only).

Table 1. Revisit design for monitoring white pine species in the Sierra Nevada Network. This panel design is followed for each of the 3 species-park populations (YOSE-whitebark pine, SEKI-whitebark pine, and SEKI-foxtail pine) for a total SIEN $n = 108$ plots. An asterisk signifies that no sampling was conducted in 2012 and no sampling is planned for 2018 or 2022.

Panel	Year												
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1 (n = 12)	x	–	–	–	x	–	–	*	x	–	–	*	x
2 (n = 12)	–	*	x	–	–	x	–	–	–	x	–	–	–
3 (n = 12)	–	–	–	x	–	–	x	–	–	–	x	–	–

Plot Layout

Quarter-hectare (50 x 50 m) macroplots consisting of five subplots are used to measure and track forest demographic parameters, disease, and insect occurrence, and the magnitude of their impact (Figure 7). The response design for this protocol is compatible with the *Interagency Whitebark Pine Monitoring Protocol for the Greater Yellowstone Ecosystem* (GYWPMWG 2007) but differs in some respects, most notably, plot size. The 10 x 50 m plot size from the Yellowstone protocol has been increased to accommodate the often sparse or patchy distribution of white pines in our PWR parks and to adequately address forest demographic objectives. This design effectively represents five parallel 10 x 50 m subplots as used in the GYWPMWG and as proposed by the Whitebark Pine Ecosystem Foundation (Tomback et al. 2005).

A total of nine square regeneration plots (3 x 3 m) are established within each macroplot to measure seedling regeneration (Figure 7). Regeneration plots are located at each corner (4), at each midpoint between corners (4), and in the middle (1) of the macroplot. The current design was chosen because it provides a reasonable balance among sampling time constraints, observer accuracy and precision, and total area sampled.

Table 2 (continued). Relationship among measured variables, data, and objectives for long-term monitoring of white pine communities in the Pacific West Region. p/a indicates presence/absence.

Variable	Raw Data	Summarized Data	Objectives Addressed
Status	Tree (live or dead)	Proportion live and dead; all spp and by each sp. TPH and proportion by 5 cm diameter classes in each condition; all spp and by each sp.	2. birth and death rates
Crown kill	Each of three parts of a tree (%)	Mean (%); individual white pine trees.	3. level of crown kill
Active canker	Each of three parts of a tree (p/a)	Proportion and TPH with active cankers by each white pine sp.	3. rust infection incidence
Inactive canker	Each of three parts of a tree (p/a)	Proportion and TPH with inactive cankers by each white pine sp.	3. rust infection incidence
Rust infection	Tree (p/a of active <u>or</u> inactive canker)	Proportion and TPH infected and healthy by each white pine sp. TPH by 5 cm diameter classes in each condition by each white pine sp.	3. rust infection incidence
Bark beetle	Tree (p/a)	Proportion and TPH with beetle sign; all spp and each sp.	4. incidence of bark beetle
Dwarf mistletoe	Tree (p/a)	Proportion and TPH with mistletoe sign; all spp and each sp.	5. incidence of dwarf mistletoe
Female cones	Tree (p/a)	Proportion and TPH with cones by each white pine sp.	6. cone production
Seedlings	9 m ² plot; number of each of three size classes by species	Mean (number per m ²); all spp and each sp for each size class.	1. composition & structure 2. birth rates

Each live tree taller than 1.37 m is affixed with a uniquely numbered metal tag; its species is identified, and diameter at 1.37 m (breast height, DBH) and tree height are measured. Standing dead trees ≥ 5 cm DBH are also affixed with a metal tag and are recorded as either recently dead or dead. Recently dead trees have needles present (but no green needles) and dead trees have no needles present. For plots that are re-measured, recently dead trees are defined as those that were alive during the previous visit but are now dead and dead trees are those that were already dead. White pine blister rust infection is assessed for all living white pine trees. The bole and branches of white pine trees are each vertically divided into thirds (upper, middle, and bottom) and each third is assigned one of three rust condition classes: 1) absent—no sign of rust infection, 2) active cankers (aeciospores present), or 3) no active cankers, but with the presence of at least three of the following five indicators of infection: rodent chewing, flagging, swelling, roughened bark, and oozing sap. Mountain pine beetle occurrence is recorded for all pine trees using three indicators of beetle activity: pitch tubes, frass, and J-shaped galleries. The presence of galleries is only determined for recently dead and dead trees because bark has to be removed for this assessment (unless bark is already

missing and galleries can be observed on the live tree). Current dwarf mistletoe infection is recorded for all living white pine trees by noting presence or absence of mistletoe for each third of a tree using the Hawksworth (1977) rating system. The level of canopy kill in live trees is determined by dividing the tree's canopy (all the main branches, encompassing all foliage and supporting twigs and side branches) into thirds and obtaining an ocular estimate of the percentage of each third of the canopy that is dead. Cone production is recorded based on whether female cones are present or absent on each live whitebark or foxtail pine tree. In 2017 we also counted mature female cones on target species to assess cone abundance in addition to presence/absence. Live seedlings are counted by species and assigned to a height class in regeneration plots. Height classes are: 1) 20 to <50 cm, 2) 50 to <100 cm, and 3) 100 to <137 cm. Seedlings <20 cm are not measured. In 2017 all seedlings in the regeneration plots were tagged by using wire to attach a tag around the base of the stem. These seedlings will be individually tracked in the same way as the mature trees going forward.

2017 Sampling Logistics

Two three-person crews were hired to establish or re-measure up to 36 plots within YOSE and SEKI during the 2017 field season. Training occurred over several weeks in June at SEKI and included information on forest pathology by the SIEN Ecologist and USFS Region 5 Entomologist and Pathologist. Training on safety, backcountry communication, and project-specific sampling methods was provided by SIEN and SEKI RMS staff. In addition to the forest monitoring protocol, the crews also conducted the third year of field work for a separate project to re-visit permanent white pine blister rust plots that had been installed in SEKI in the 1990s. This project was a collaboration between the US Forest Service, US Geological Survey, and University of California, Berkeley. The goal in 2017 was to re-visit the remaining WPBR plots in SEKI conduct QA/QC on all the data from the project, and begin analysis. Forest monitoring fieldwork occurred at YOSE in July and August and at SEKI in August through October. Detailed notes for each trip and route descriptions were recorded by the crews and will be used in future years to help guide planning. These documents are stored in the forest project folder on the SIEN network drive. For a complete list of plot status and location see Appendix 2. In addition to the forest monitoring fieldwork, the crew spent several days in June installing a long-term blue oak woodland monitoring plot that will be overseen by SEKI and USGS staff. They also completed a re-measure and deconstruction of several sugar pine monitoring plots in the Crane Creek and Moss Creek areas that had been installed in YOSE in 2007 as part of J. Nesmith's dissertation work.

Results

Yosemite

From July 11 to September 12, 14 plots were visited throughout whitebark pine stands in YOSE (Figure 8). Six plots in Panel 3 were re-measured, five were installed, and three were rejected leaving just one additional plot in Panel 3 to be installed in YOSE.

Summary statistics for the YOSE whitebark pine plots are provided in Table 3. The 11 completed plots from Panel 3 contained a total of 2,680 trees: 892 live whitebark pine (1 recently dead, 12 dead), 1,581 live lodgepole pine (5 recently dead, 44 dead), and 134 live mountain hemlock (*Tsuga mertensiana*) (8 dead). For the live whitebark pine trees, 11% displayed a krummholz growth form and the average number of stems per clump was 2.5 (SD = 0.8). White pine blister rust was discovered on 12 whitebark pine in one plot in the Merced Pass area of YOSE. This is the first time WPBR has been discovered in one of our monitoring plots in YOSE. Neither dwarf mistletoe nor mountain pine beetle activity were observed in 2017. The average number of live whitebark pine trees per plot (2500 m²) was 81 (SD = 92) with a range of 4 to 251 trees. Approximately 22% (SD = 18) of live whitebark pine trees produced female cones and the proportion of cone bearing trees per plot ranged between 0 and 62%. The number of cones per tree for cone-bearing trees averaged 16 (SD = 11) cones/tree. Whitebark pine seedling regeneration averaged 718 (SD = 1,446) seedlings per hectare. Five of 11 Whitebark pine plots contained seedlings with a maximum count of 39. Lodgepole pine (15 seedlings) and mountain hemlock (1 seedling) were also encountered in the regeneration plots.

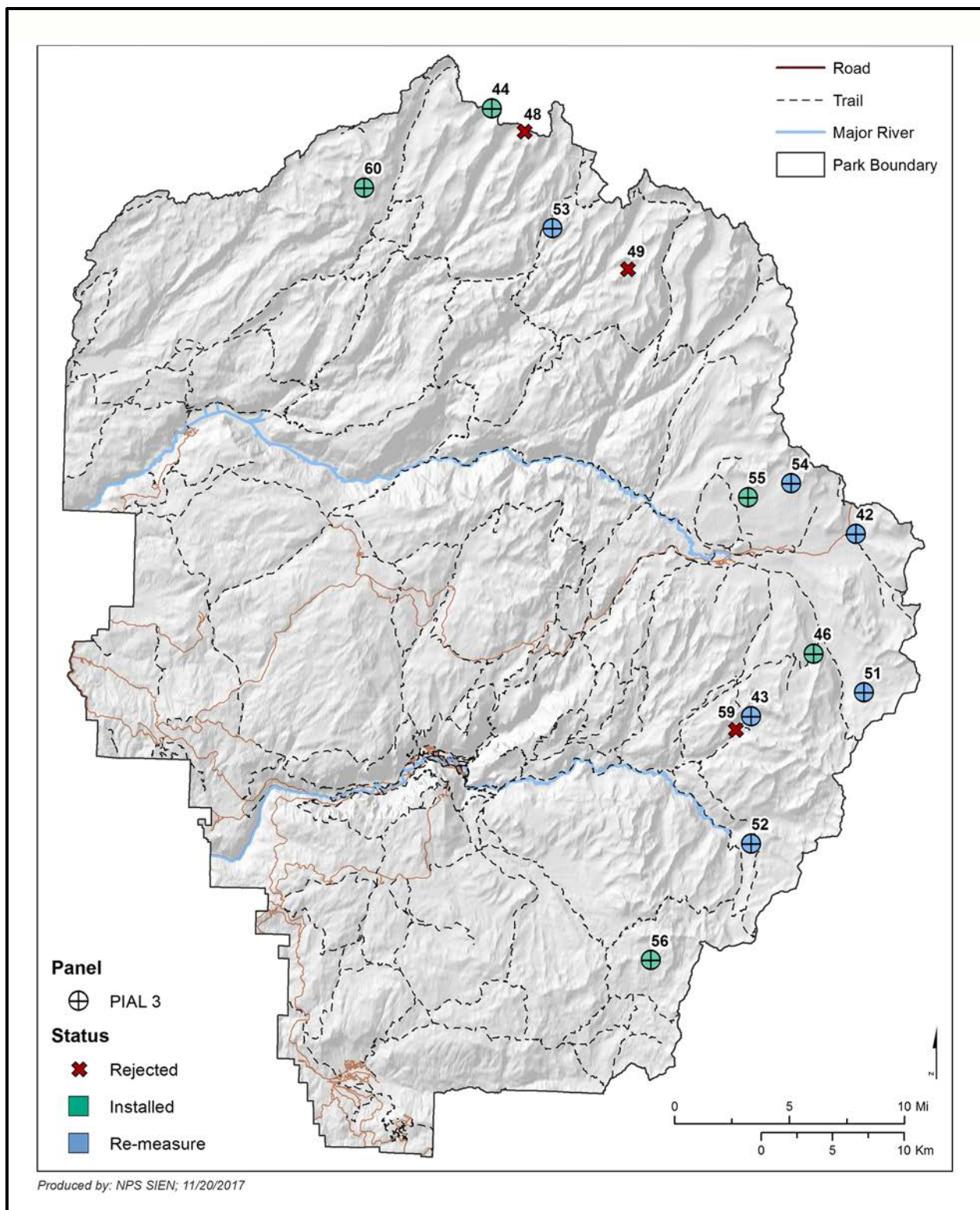


Figure 8. Location and status of 14 plots visited in Yosemite during the 2017 field season.

Table 3. Summary statistics of Panel 3 whitebark pine plots measured at YOSE in 2017 (n = 11). Snag DBH was only recorded in newly installed plots (n = 5) or for newly dead trees. Therefore, plot averages were not calculated for snag DBH or basal area.

Plot Metrics	Average (SD)	Range
<i>P. albicaulis</i> density (trees/ha)	324 (367)	16 – 1004
Other species density (trees/ha)	624 (556)	28 – 1776
Snag density (dead trees/ha)	27 (21)	0 – 72
<i>P. albicaulis</i> DBH (cm)	9.2 (7.4)	1.6 – 29.7
Other species DBH (cm)	18.1 (8.4)	3.2 – 34.6
Snag DBH (dead tree cm)	–	–
<i>P. albicaulis</i> Basal Area (m ² /ha)	1.2 (1.5)	<0.1 – 4.7
Other species Basal Area (m ² /ha)	7.9 (6.2)	<0.1 – 17.0
Snag Basal Area (dead tree m ² /ha)	–	–
<i>P. albicaulis</i> blister rust infection rate (# of infected trees/ha)	4.4 (14.5)	0 – 48
Dwarf mistletoe infection rate (# of infected trees/ha)	0	0
Mountain pine beetle infestation rate (# of infested trees/ha)	0	0
<i>P. albicaulis</i> seedling regeneration 20-136 cm (seedlings/ha)	718 (1446)	0 – 4815
Other species seedling regeneration 20-136 cm (seedlings/ha)	180 (294)	0 – 988
<i>P. albicaulis</i> female cone production (# of trees with cones/ha)	106 (185)	0 – 620
<i>P. albicaulis</i> # of cones/tree for cone-bearing trees	16.1 (10.6)	2.7 – 38.0

Sequoia and Kings Canyon

From July 24 to October 5, 2017, the forest crew visited 13 plots in the SEKI-whitebark pine population and nine plots in the SEKI-foxtail pine population (Figure 9).

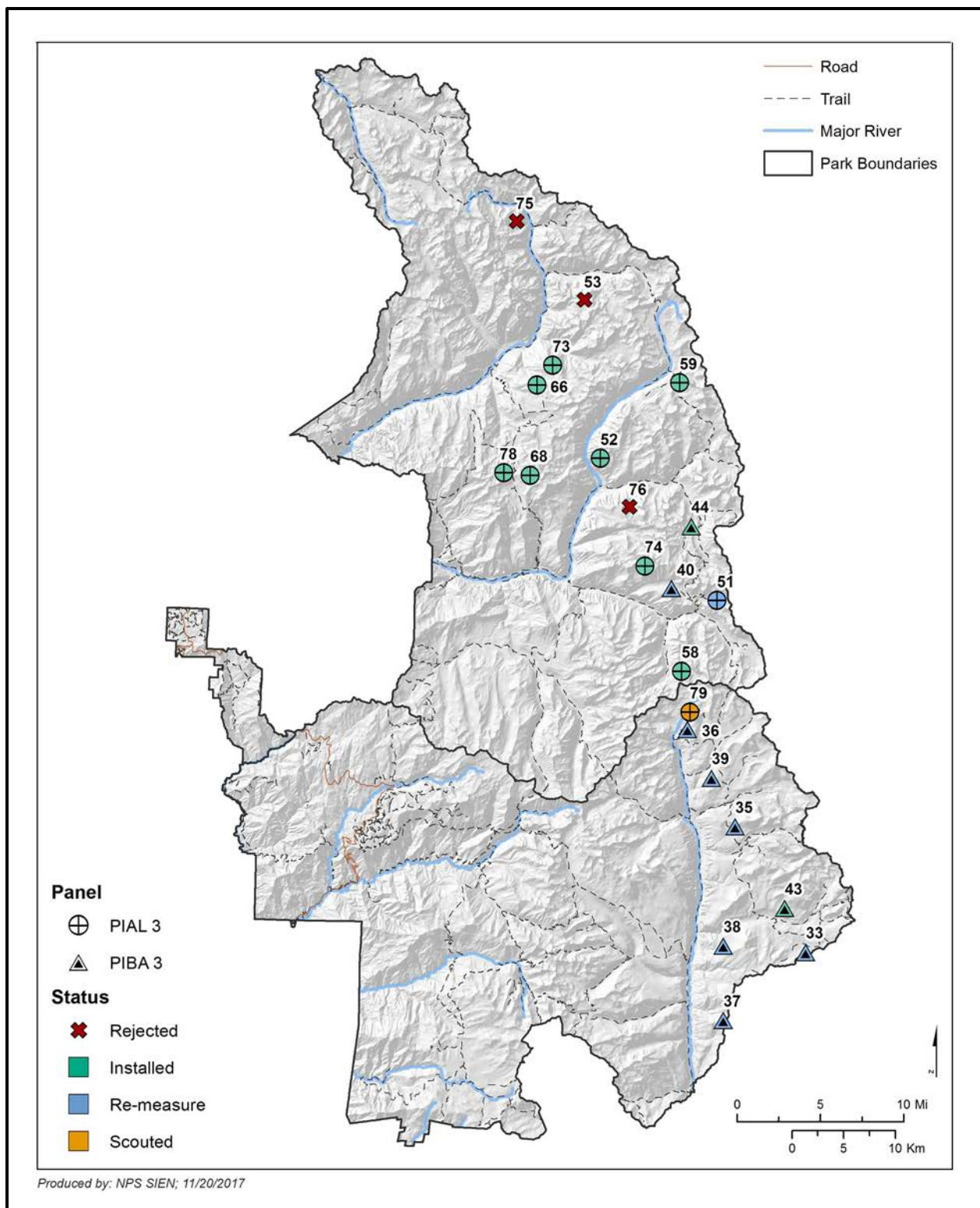


Figure 9. Location and status of 22 plots visited in Sequoia and Kings Canyon during the 2017 field season. PIAL_58 and PIAL_73 were only partially installed.

Whitebark Pine

Of the 13 whitebark plots that were visited, one Panel 3 plot was re-measured, eight were installed (installation of plots 58 and 73 were only partially completed), one was scouted, and three plots were visited and rejected due to lack of target species or unsafe terrain. Summary statistics are provided in Table 4. The seven Panel 3 whitebark plots that were fully measured contained a total of 1,408 trees: 1,234 live whitebark (36 dead, 3 recently dead), 126 live lodgepole (1 dead), 2 live foxtail pine, 1 dead western white pine, and 5 dead snags of unidentified species. Of the 1,234 live whitebark pine, an average of 2% per plot displayed a krummholz growth form. For trees that were multi-stemmed, the average number of trees per clump was 2.4 (SD = 0.3). Indications of white pine blister rust were found on two whitebark pine in a plot near Kearsarge Lakes in Kings Canyon National Park, though no spores were observed. An additional tree in a plot in Upper Basin also showed signs of infection. Mountain pine beetle activity was observed on one live lodgepole pine, three recently dead whitebark, and 14 dead whitebark pine from two different plots. Dwarf mistletoe was not encountered. The average number of live whitebark pines per plot was 176 (SD = 141) with a range of 16 to 392. Thirty-five percent (SD = 11) of whitebark pine trees produced female cones in 2017. Cone-bearing trees averaged 10.7 cones/tree (SD = 5.7) per plot. There were 20 whitebark pine seedlings recorded in the plots, resulting in an estimated 353 (SD = 330) seedlings per hectare. The largest number of seedlings found in a plot was seven, and six of the seven plots contained whitebark seedlings. Six lodgepole pine seedlings were also found.

Table 4. Summary statistics on whitebark pine plots installed at SEKI in 2017 (n = 7). Snag DBH was not recorded in plot 51 on were only observed in three of the installed plots.

Plot Metrics	Average (SD)	Range
<i>P. albicaulis</i> density (trees/ha)	705 (566)	64 – 1568
Other species density (trees/ha)	73 (111)	8 – 320
Snag density (dead trees/ha)	26 (41)	0 – 112
<i>P. albicaulis</i> average DBH (cm)	8.6 (2.9)	4.8 – 13.1
Other species average DBH (cm)	19.4 (15.2)	2.7 – 47.3
Snag average DBH (dead tree cm)	28.8 (16.3)	11.2 – 43.5
<i>P. albicaulis</i> Basal Area (m ² /ha)	2.8 (2.7)	0.2 – 6.8
Other species Basal Area (m ² /ha)	1.3 (2.1)	<0.1 – 5.9
Snag Basal Area (dead tree m ² /ha)	0.9 (1.9)	0 – 5.1
<i>P. albicaulis</i> blister rust infection rate (# of infected trees/ha)	1.7 (3.1)	0 – 8
Dwarf mistletoe infection rate (# of infected trees/ha)	0	0
Mountain pine beetle infestation rate (# of infested trees/ha)	10.3 (25.5)	0 – 68
<i>P. albicaulis</i> seedling regeneration 20-136 cm (seedlings/ha)	353 (330)	0 – 864

Table 4 (continued). Summary statistics on whitebark pine plots installed at SEKI in 2017 (n = 7). Snag DBH was not recorded in plot 51 on were only observed in three of the installed plots.

Plot Metrics	Average (SD)	Range
Other species seedling regeneration 20-136 cm (seedlings/ha)	106 (230)	0 – 617
<i>P. albicaulis</i> female cone production (# of trees with cones/ha)	221 (179)	36 – 524
<i>P. albicaulis</i> # of cones/tree for cone-bearing trees	10.7 (5.7)	4.7 – 19.9

Foxtail Pine

Nine foxtail plots were visited in 2017: One Panel 3 plot were fully installed and eight were re-measured. Summary statistics are provided in Table 5. The nine foxtail pine plots contained a total of 677 trees: 229 live foxtail pine (24 dead), 302 live whitebark pine (1 recently dead, 10 dead), 106 live lodgepole pine (4 dead), and 1 live Jeffrey pine. Symptoms of WPBR were not observed on any foxtail pine, but one whitebark pine in plot 40 near Charlotte Dome did have signs of infection. Neither mountain pine beetle activity nor mistletoe were observed in the foxtail pine plots. The average number of live foxtail pines per plot was 28 (SD = 32) with a range of 1 to 94. Sixty-six percent of foxtail pine trees produced female cones in 2017. Cone-bearing trees averaged 156 cones/tree (SD = 151) per plot. There were 10 foxtail pine seedlings recorded in the plots, resulting in an estimated 137 (SD = 168) seedlings per hectare. The largest number of seedlings found in a plot was four, and five of the nine plots contained foxtail pine seedlings. Six whitebark pine seedlings were also observed in plot 40.

Table 5. Summary statistics of Panel 3 foxtail pine plots visited at SEKI in 2017 (n = 9). DBH for all dead trees within the plot was only recorded in newly installed plots (n = 1) and are therefore not reported.

Plot Metrics	Average (SD)	Range
<i>P. balfouriana</i> density (trees/ha)	102 (118)	4 – 348
<i>P. albicaulis</i> density (trees/ha)	134 (191)	0 – 524
Other species density (trees/ha)	48 (116)	0 – 356
Snag density (dead trees/ha)	17 (18)	0 – 56
<i>P. balfouriana</i> DBH (cm)	51.6 (30.4)	3.6 – 110.5
<i>P. albicaulis</i> DBH (cm)	22.0 (32.4)	3.0 – 94.6
Other species DBH (cm)	18.5 (11.3)	7.2 – 38.8
Snag DBH (dead tree cm)	–	–
<i>P. balfouriana</i> Basal Area (m ² /ha)	6.0 (5.7)	<0.1 – 18.1
<i>P. albicaulis</i> Basal Area (m ² /ha)	0.7 (0.9)	0 – 6.2
Other species Basal Area (m ² /ha)	0.7 (1.8)	0 – 5.5

Table 5 (continued). Summary statistics of Panel 3 foxtail pine plots visited at SEKI in 2017 (n = 9). DBH for all dead trees within the plot was only recorded in newly installed plots (n = 1) and are therefore not reported.

Plot Metrics	Average (SD)	Range
Snag Basal Area (dead tree m ² /ha)	–	–
<i>P. balfouriana</i> blister rust infection rate (# of infected trees/ha)	0	0
<i>P. albicaulis</i> blister rust infection rate (# of infected trees/ha)	0.4 (1.3)	0 – 4
Dwarf mistletoe infection rate (# of infected trees/ha)	0	0
Mountain pine beetle infestation rate (# of infested trees/ha)	0	0
<i>P. balfouriana</i> seedling regeneration 20-136 cm (seedlings/ha)	137 (168)	0 – 494
<i>P. albicaulis</i> seedling regeneration 20-136 cm (seedlings/ha)	82 (247)	0 – 741
Other species seedling regeneration 20-136 cm (seedlings/ha)	0	0
<i>P. balfouriana</i> female cone production (# of trees with cones/ha)	66 (78)	0 – 196
<i>P. albicaulis</i> female cone production (# of trees with cones/ha)	27 (39)	0 – 92
<i>P. balfouriana</i> # of cones/tree for cone-bearing trees	176 (149)	25 – 500
<i>P. albicaulis</i> # of cones/tree for cone-bearing trees	123 (200)	5 – 500

Summary

Our data suggest that the whitebark pine and foxtail pine populations in areas sampled during the 2017 field season currently have extremely low incidence of white pine blister rust and mountain pine beetle. While other lower elevation forests within the parks have experienced substantial mortality due to the significant drought that has affected the southern Sierra Nevada since 2013, signs of significant mortality remained rare in the subalpine. Three whitebark pine trees were found within two plots in Kings Canyon that displayed symptoms of WPBR and 12 trees with symptoms of WPBR, as well as spores, were noted for the first time in a YOSE plot near the Merced Pass area. These results contrast sharply with whitebark pine health conditions in the Cascade and Rocky Mountain regions where infection rates of sampled trees have been recorded in excess of 80% (GYWPMWG 2010, Bockino and Tinker 2012). This was the first year that some of the long-term monitoring plots in Panel 3 were revisited. Tracking changes in forest composition, structure, and health through time will be particularly powerful in subsequent re-measures if incorporated into an adaptive management framework, where it can be used to inform sound, science-based management decisions at the park- or regional-level. Figure 10 shows the 2017 SIEN forest monitoring crew.



Figure 10. 2017 SIEN forest monitoring crew: Left to right, Sean Auclair (crew lead), Hanna Mohr, Tressa Gibbard, Sam Zuckerman (NPS)

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Appendix 1. Notes on Field Methods

From year to year there can be procedures in the protocol sampling methods that are interpreted differently or are ambiguous (i.e., plot and tree level measurements), and crews have to resolve them while conducting field sampling. This appendix attempts to document these known issues and interpretations for the 2017 field season.

In 2017 we added a few items to our data collection in the forest plots. We assessed the plot for alternate WPBR hosts this season and we noted the presence or absence of *Ribes*, *Castijella*, and *Pedicularis* in our plots.

We now also take photos at every corner of the plot showing the location of the rebar. The goal is to have the rebar in the photograph so it can be located for the next visit (make sure rebar is in the photo!). We took the corner photos as we were running the tapes so you get a sense of where the plot runs.

We also started to track individual seedlings and we tagged seedlings we encountered in our seedling plots.

Our other major change to the protocol this year was to assess the crown condition of the trees we surveyed this summer. We rated the trees from 1 (perfect health) to 5 (dead) following methods adapted from several studies including Nesmith et al. (2011). It takes a bit of getting used to and some trees seem to be on the border between two different ratings, but as we assessed more trees throughout the season we became more confident in this system, and it gives a nice straightforward way to assess the risk of mortality to the trees we were studying this season. If anything, we found that it seems to be simpler than trying to assess the percent crown kill in more exact numbers like we do on whitebark.

We started counting cones this season in the whitebark and foxtail pines. For other trees in our plots we simply noted presence or absence of cones, such as on lodgepole pine. The whitebark pines had a manageable amount of cones and collecting these data added a small amount of time in the field. The foxtail pines can have hundreds of cones, so we did the best we could to count, but ultimately we had to estimate as there are simply too many cones to accurately see and count PIBA cones in a timely manner.

We assessed two plots in Yosemite – **PIAL 49**, and **PIAL 53** that were installed by the 2011 crew that we found to be not safe to sample as part of a long term monitoring project. We could not safely re-create either original plot due to cliffy terrain. We were unable to find a safe location in the vicinity of **PIAL 49** so the plot was uninstalled and removed from Panel 3. **PIAL 53** was also in an area of unsafe cliffs, however, we were able to use the random number table to safely move the plot about 70 m to the SE, re-install the plot, and retain this location in the Panel 3 sampling rotation.

Due to a majority of the plots being fully installed at this point, beginning in 2019, snags should have their DBH measured to get a more complete record of stand structure, including snag density and size through time.

Appendix 2. Plot Status and Location

Table A-1. List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
YOSE-PIAL	01	272730	4211038	Panel_1x	Rejected	–	>35_Slope
YOSE-PIAL	02	288803	4213209	Panel_1x	Rejected	–	No trees
YOSE-PIAL	03	296088	4182250	Panel_1	2011	2015	–
YOSE-PIAL	04	290567	4185341	Panel_1	2011	2015	–
YOSE-PIAL	05	285267	4218542	Panel_1x	Rejected	–	No trees
YOSE-PIAL	06	279029	4195055	Panel_1	2015	2015	–
YOSE-PIAL	07	286332	4191015	Panel_1	2011	2015	Plot boundaries moved in 2015
YOSE-PIAL	08	295120	4177650	Panel_1	2011	2015	–
YOSE-PIAL	09	289361	4208460	Panel_1x	Rejected	–	>35_Slope
YOSE-PIAL	10	296034	4197576	Panel_1	2011	2015	–
YOSE-PIAL	11	295423	4193440	Panel_1x	Rejected	–	No trees
YOSE-PIAL	12	265845	4218338	Panel_1x	Rejected	–	No trees
YOSE-PIAL	13	290527	4215554	Panel_1x	Rejected	–	>35_Slope
YOSE-PIAL	14	298862	4191734	Panel_1	2011	2015	–
YOSE-PIAL	15	294711	4185917	Panel_1	2011	2015	–

Table A-1 (continued). List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
YOSE-PIAL	16	268730	4223684	Panel_1	2015	2015	–
YOSE-PIAL	17	272205	4217495	Panel_1x	Rejected	–	>35_Slope
YOSE-PIAL	18	295937	4212170	Panel_1	2013	2015	–
YOSE-PIAL	19	303605	4189886	Panel_1	2014	2015	–
YOSE-PIAL	20	286082	4173212	Panel_1	2013	2015	–
YOSE-PIAL	21	284547	4213602	Panel_2	2014	2016	–
YOSE-PIAL	22	303861	4191215	Panel_2	2013	2016	–
YOSE-PIAL	23	290671	4198498	Panel_2x	Rejected	–	No Trees
YOSE-PIAL	24	296891	4175231	Panel_2	2013	2016	–
YOSE-PIAL	25	293052	4208800	Panel_2	2013	2016	–
YOSE-PIAL	26	300265	4196210	Panel_2	2013	2016	–
YOSE-PIAL	27	292618	4193551	Panel_2x	Rejected	–	No Trees
YOSE-PIAL	28	287655	4220242	Panel_2x	Rejected	–	No Route
YOSE-PIAL	29	288002	4215672	Panel_2x	Rejected	–	>35_Slope
YOSE-PIAL	30	297811	4192202	Panel_2x	Rejected	–	No Trees
YOSE-PIAL	31	292132	4186649	Panel_2	2014	2016	–
YOSE-PIAL	32	282831	4220099	Panel_2	2014	2016	–

Table A-1 (continued). List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
YOSE-PIAL	33	281485	4206089	Panel_2x	Rejected	–	>35_Slope
YOSE-PIAL	34	295896	4203615	Panel_2x	Rejected	–	>35_Slope
YOSE-PIAL	35	300685	4188869	Panel_2	2014	2016	–
YOSE-PIAL	36	286581	4174238	Panel_2	2014	2016	–
YOSE-PIAL	37	282114	4211493	Panel_2x	Rejected	–	>35_Slope
YOSE-PIAL	38	302534	4193310	Panel_2	2014	2016	–
YOSE-PIAL	39	291731	4196540	Panel_2x	Rejected	–	No Trees
YOSE-PIAL	40	296396	4178608	Panel_2	2014	2016	–
YOSE-PIAL	41	292441	4201020	Panel_2	2016	2016	–
YOSE-PIAL	42	301791	4196147	Panel_3	2014	2017	–
YOSE-PIAL	43	294453	4183421	Panel_3	2014	2017	–
YOSE-PIAL	44	276329	4225930	Panel_3	Scouted	2017	–
YOSE-PIAL	45	294473	4210376	Panel_3x	Rejected	–	>35_Slope
YOSE-PIAL	46	298760	4187833	Panel_3	2017	2017	–
YOSE-PIAL	47	288739	4186425	Panel_3x	Rejected	–	–
YOSE-PIAL	48	278555	4224311	Panel_3	Rejected	–	Unsafe terrain

Table A-1 (continued). List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
YOSE-PIAL	49	285782	4214700	Panel_3	Rejected	–	Plot was installed in 2011 and rejected in 2017 due to unsafe terrain
YOSE-PIAL	50	279271	4196291	Panel_3x	Rejected	–	No Trees
YOSE-PIAL	51	302369	4185092	Panel_3	2015	2017	–
YOSE-PIAL	52	294465	4174505	Panel_3	2011	2017	–
YOSE-PIAL	53	280552	4217599	Panel_3	2011	2017	Plot boundaries moved in 2017 due to unsafe terrain. Original plot uninstalled.
YOSE-PIAL	54	297249	4199689	Panel_3	2011	2017	–
YOSE-PIAL	55	294244	4198696	Panel_3	2017	2017	–
YOSE-PIAL	56	287430	4166358	Panel_3	2017	2017	–
YOSE-PIAL	57	293520	4200811	Panel_3x	Rejected	–	>35_Slope
YOSE-PIAL	58	297189	4193810	Panel_3x	Rejected	–	No Trees
YOSE-PIAL	59	293338	4182489	Panel_3x	Rejected	–	Trail within plot boundaries
YOSE-PIAL	60	267368	4220379	Panel_3	2017	2017	
YOSE-PIAL	61	291778	4214161	Panel_3	Not established	–	
SEKI-PIAL	01	367290	4027141	Panel_1x	Rejected	–	No Trees
SEKI-PIAL	02	345651	4118343	Panel_1	2014	2015	–

Table A-1 (continued). List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
SEKI-PIAL	03	374530	4075808	Panel_1	2015	2015	–
SEKI-PIAL	04	375909	4084188	Panel_1	2015	2015	–
SEKI-PIAL	05	372907	4093446	Panel_1	2015	2015	–
SEKI-PIAL	06	343590	4112006	Panel_1x	Rejected	–	>35_Slope
SEKI-PIAL	07	368793	4067831	Panel_1x	Rejected	–	>35_Slope
SEKI-PIAL	08	357644	4085977	Panel_1	Scouted	2016	–
SEKI-PIAL	09	366236	4101569	Panel_1x	Rejected	–	>35_Slope
SEKI-PIAL	10	364469	4059015	Panel_1	Scouted	2016	–
SEKI-PIAL	11	372573	4075346	Panel_1	2015	2015	–
SEKI-PIAL	12	357557	4083750	Panel_1	2012	2014	Subplots 1 – 2 not completed in 2014
SEKI-PIAL	13	360381	4105785	Panel_1	2015	2015	–
SEKI-PIAL	14	376492	4057576	Panel_1x	Rejected	–	No Trees
SEKI-PIAL	15	368275	4091574	Panel_1	2015	2015	–
SEKI-PIAL	16	356989	4077572	Panel_1x	Rejected	–	>35_Slope
SEKI-PIAL	17	362761	4033663	Panel_1x	Rejected	–	No Trees
SEKI-PIAL	18	343283	4112827	Panel_1	Incomplete	2013	Subplots 4 – 5 not completed in 2013

Table A-1 (continued). List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
SEKI-PIAL	19	375619	4074608	Panel_1x	Rejected	–	>35_Slope
SEKI-PIAL	20	361155	4084009	Panel_1	2013	2013	–
SEKI-PIAL	21	371958	4097865	Panel_2x	Rejected	–	>35_Slope
SEKI-PIAL	22	351408	4095437	Panel_2x	Rejected	–	No Route
SEKI-PIAL	23	372112	4065836	Panel_2x	Rejected	–	>35_Slope
SEKI-PIAL	24	358026	4089119	Panel_2	2013	2016	–
SEKI-PIAL	25	365621	4094633	Panel_2	2013	2016	–
SEKI-PIAL	26	355753	4057139	Panel_2x	Rejected	–	No Trees
SEKI-PIAL	27	367661	4072341	Panel_2	2013	2016	–
SEKI-PIAL	28	361949	4091581	Panel_2	2013	2016	–
SEKI-PIAL	29	357722	4109427	Panel_2x	Rejected	–	>35_Slope
SEKI-PIAL	30	367938	4039738	Panel_2x	Rejected	–	No Trees
SEKI-PIAL	31	368793	4083219	Panel_2	2013	2016	–
SEKI-PIAL	32	365839	4066495	Panel_2x	Rejected	–	>35_Slope
SEKI-PIAL	33	339897	4121834	Panel_2	2014	2016	–
SEKI-PIAL	34	345544	4113490	Panel_2x	Rejected	–	>35_Slope
SEKI-PIAL	35	376672	4068290	Panel_2x	Rejected	–	>35_Slope

Table A-1 (continued). List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
SEKI-PIAL	36	362322	4084241	Panel_2x	Rejected	–	>35_Slope
SEKI-PIAL	37	361596	4104498	Panel_2x	Rejected	–	No Route
SEKI-PIAL	38	346720	4094780	Panel_2	2014	2016	–
SEKI-PIAL	39	372095	4070727	Panel_2x	Rejected	–	>35_Slope
SEKI-PIAL	40	354109	4085347	Panel_2x	Rejected	–	No Trees
SEKI-PIAL	41	363987	4095543	Panel_2x	Rejected	–	>35_Slope
SEKI-PIAL	42	361901	4057273	Panel_2x	Rejected	–	No Route
SEKI-PIAL	43	372447	4072712	Panel_2	2014	2016	Subplots 4 - 5 not completed in 2016
SEKI-PIAL	44	360112	4088754	Panel_2	2014	2016	–
SEKI-PIAL	45	347366	4115429	Panel_2	2014	2016	–
SEKI-PIAL	46	370788	4038875	Panel_2x	Rejected	–	No Trees
SEKI-PIAL	47	372218	4084481	Panel_2x	Rejected	–	>35_Slope
SEKI-PIAL	48	347886	4081797	Panel_2	2014	2016	–
SEKI-PIAL	49	367097	4094696	Panel_2	2014	2016	–
SEKI-PIAL	50	342764	4117298	Panel_3x	Rejected	–	>35_Slope
SEKI-PIAL	51	376111	4070297	Panel_3	2014	2017	–

Table A-1 (continued). List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
SEKI-PIAL	52	364852	4084028	Panel_3	2017	2017	–
SEKI-PIAL	53	363263	4099360	Panel_3	Rejected	–	No Route
SEKI-PIAL	54	338892	4118855	Panel_3	Rejected	–	Unsafe terrain
SEKI-PIAL	55	368946	4075659	Panel_3x	Rejected	–	>35_Slope
SEKI-PIAL	56	359700	4080686	Panel_3x	Rejected	–	>35_Slope
SEKI-PIAL	57	359051	4104460	Panel_3x	Rejected	–	No Route
SEKI-PIAL	58	372709	4063450	Panel_3	Incomplete	2017	Subplots 1-3 completed in 2017
SEKI-PIAL	59	372495	4091307	Panel_3	Scouted	2017	2017
SEKI-PIAL	60	361751	4085403	Panel_3	Scouted	2016	–
SEKI-PIAL	61	348673	4115246	Panel_3	Rejected	–	Unsafe terrain
SEKI-PIAL	62	376844	4044787	Panel_3	Rejected	–	No trees
SEKI-PIAL	63	371096	4080482	Panel_3x	Rejected	–	>35_Slope
SEKI-PIAL	64	349766	4082680	Panel_3x	Rejected	–	>35_Slope
SEKI-PIAL	65	348874	4112395	Panel_3	Rejected	–	Unsafe terrain
SEKI-PIAL	66	358734	4091091	Panel_3	2017	2017	
SEKI-PIAL	67	364688	4062127	Panel_3	Scouted	2016	Rebar installed
SEKI-PIAL	68	358068	4082392	Panel_3	2017	2017	–

Table A-1 (continued). List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
SEKI-PIAL	69	367417	4051647	Panel_3x	Rejected	–	No trees
SEKI-PIAL	70	363423	4076489	Panel_3x	Rejected	–	>35_Slope
SEKI-PIAL	71	359118	4093582	Panel_3x	Rejected	–	>35_Slope
SEKI-PIAL	72	372846	4069794	Panel_3x	Rejected	–	>35_Slope
SEKI-PIAL	73	360249	4093039	Panel_3	Incomplete	2017	Subplots 1-3 completed in 2017
SEKI-PIAL	74	369176	4073598	Panel_3	2017	2017	–
SEKI-PIAL	75	356689	4106954	Panel_3	Rejected	–	No route
SEKI-PIAL	76	367611	4079353	Panel_3x	Rejected	–	No Route
SEKI-PIAL	77	346084	4099017	Panel_3x	Rejected	–	>35_Slope
SEKI-PIAL	78	355533	4082622	Panel_3	2017	2017	
SEKI-PIAL	79	373490	4059513	Panel_3	Scouted	2017	
SEKI-PIBA	01	355122	4029380	Panel_1	2015	2015	–
SEKI-PIBA	02	375721	4039069	Panel_1	2011	2015	–
SEKI-PIBA	03	363289	4043329	Panel_1	2015	2015	–
SEKI-PIBA	04	362613	4067179	Panel_1	Rejected	–	No trees
SEKI-PIBA	05	370617	4026165	Panel_1	2015	2015	–
SEKI-PIBA	06	376988	4042810	Panel_1	2011	2015	–

Table A-1 (continued). List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
SEKI-PIBA	07	374789	4056572	Panel_1	2011	2015	–
SEKI-PIBA	08	362507	4062625	Panel_1	Scouted	2016	Rebar installed
SEKI-PIBA	09	377826	4033520	Panel_1	2011	2015	–
SEKI-PIBA	10	380915	4038349	Panel_1	2011	2015	–
SEKI-PIBA	11	375675	4050116	Panel_1	2011	2015	–
SEKI-PIBA	12	367913	4076907	Panel_1x	Rejected	–	No Trees
SEKI-PIBA	13	363692	4033498	Panel_1x	Rejected	–	>35_Slope
SEKI-PIBA	14	366283	4038676	Panel_1x	Rejected	–	>35_Slope
SEKI-PIBA	15	386345	4040899	Panel_1x	Rejected	–	Plot was installed in 2011 and rejected in 2015 due to unsafe terrain
SEKI-PIBA	16	356739	4061068	Panel_1	2013	2013	–
SEKI-PIBA	17	355948	4031543	Panel_2	2013	2016	–
SEKI-PIBA	18	375967	4045554	Panel_2	2013	2016	–
SEKI-PIBA	19	379846	4047488	Panel_2	2013	2016	–
SEKI-PIBA	20	367540	4067377	Panel_2x	Rejected	–	>35_Slope
SEKI-PIBA	21	375557	4032343	Panel_2	2013	2016	–
SEKI-PIBA	22	380284	4042853	Panel_2	2013	2016	–

Table A-1 (continued). List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
SEKI-PIBA	23	374094	4056105	Panel_2	2013	2016	–
SEKI-PIBA	24	361953	4059325	Panel_2	2016	2016	–
SEKI-PIBA	25	369054	4032210	Panel_2	2013	2016	–
SEKI-PIBA	26	371357	4046768	Panel_2	2016	2016	–
SEKI-PIBA	27	372176	4051432	Panel_2	2013	2016	–
SEKI-PIBA	28	373060	4084548	Panel_2x	Rejected	–	>35_Slope
SEKI-PIBA	29	364439	4034149	Panel_2	2013	2016	–
SEKI-PIBA	30	371006	4042667	Panel_2	2014	2016	–
SEKI-PIBA	31	386287	4038225	Panel_3	2014	2014	–
SEKI-PIBA	32	360362	4059458	Panel_3x	Rejected	–	>35_Slope
SEKI-PIBA	33	384714	4036309	Panel_3	2014	2017	–
SEKI-PIBA	34	373202	4045338	Panel_3	Scouted	2016	Rebar & tags installed
SEKI-PIBA	35	377887	4048446	Panel_3	2014	2017	–
SEKI-PIBA	36	373289	4057861	Panel_3	2014	2017	–
SEKI-PIBA	37	376739	4029729	Panel_3	2014	2017	–
SEKI-PIBA	38	376735	4036915	Panel_3	2014	2017	–
SEKI-PIBA	39	375604	4053148	Panel_3	2014	2017	–

Table A-1 (continued). List of sampling locations for white pine monitoring plots in the SIEN. The column EvalStatus indicates whether a site was established, dropped because it was non-target, or if it was not established (not visited) in the field. For sites that were visited, they are listed as either “Incomplete” indicating that not all subplots have been completed or “Scouted”, indicating that the plot has been visited and confirmed as target habitat, but not installed. If the plot was completed, the year it was fully installed is listed. Note that UTM X and UTM Y coordinates for established plots are the plot corner 1 (SW corner) coordinates as established in the field, and no longer match exactly the coordinates produced by the GRTS algorithm used to navigate to the plot during initial set-up.

Park-Species	Plot ID	UTM X	UTM Y	Panel	Installed	LastVisit	EvalNotes
SEKI-PIBA	40	371733	4071478	Panel_3	2014	2017	–
SEKI-PIBA	41	367280	4034622	Panel_3	2014	2014	–
SEKI-PIBA	42	369440	4050366	Panel_3	Rejected	–	No trees
SEKI-PIBA	43	382685	4040573	Panel_3	2017	2017	–
SEKI-PIBA	44	373659	4077444	Panel_3	2017	2017	–
SEKI-PIBA	45	363766	4029223	Panel_3	Not Established	–	–

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 102/149521, 104/149521, November 2018

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