



Vegetation Community Monitoring: 2015 Results From Whiskeytown National Recreation Area and Lassen Volcanic National Park

Natural Resource Data Series NPS/KLMN/NRDS—2016/1051



ON THE COVER

View from Lassen Volcanic NP site LV26
Photo by Matt Gregory, GeoCorps Intern

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Sean B. Smith

National Park Service
Klamath Network I&M Program
1250 Siskiyou Blvd.
Ashland, OR 97520

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Abstract

During the 2015 field season, the Klamath Inventory and Monitoring Network implemented the fifth season of its vegetation monitoring protocol (Odion et al. 2011) at Whiskeytown National Recreation Area (Whiskeytown) and Lassen Volcanic National Park (Lassen). The vegetation monitoring plots are 20 x 50m (0.1ha) and are partitioned into one of three sampling frames: matrix (upland), riparian (within 10m of a perennial stream), and high elevation (above a predetermined elevation, generally near tree line). Once every three years we measure vegetation composition, structure, and function at two of the six network parks (all parks are visited once every three years). The protocol was initiated in 2011 when we established sites at Lava Beds National Monument, and Redwood National and State Parks (Smith and Sarr 2013), those sites were revisited and remeasured in 2014 (Smith 2015). In 2012 we established sites at Whiskeytown National Recreation Area and Lassen Volcanic National Park (Smith and Sarr 2014b), and revisited those sites in 2015. In 2013 we established sites at Oregon Caves National Monument and Crater Lake National Park (Smith and Sarr 2014a), we will revisit those sites in 2016.

This report summarizes the data collected in 2015 from Whiskeytown and Lassen. At Whiskeytown we revisited 21 matrix, 13 riparian, and 10 high elevation sites. Two riparian sites could not be revisited, due to safety concerns (in 2012 we established 15 riparian sites). At Lassen we revisited all sites established in 2012 and added five sites to both the matrix and riparian sample frames. The total number of sites at Lassen is now 23 matrix, 19 riparian, and 10 high elevation. For vegetation composition we report on species richness and non-native species presence. Structural data metrics include: live and dead trees/ha, live and dead tree basal area, tree height and height to crown, woody debris, substrate cover percentages, litter and duff depths, and vegetation cover by height strata. For vegetation function we report on tree species regeneration: most abundant tree by size class and trees/ha by size class.

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Introduction

The development of the Klamath Inventory and Monitoring Network (Klamath Network) vital signs monitoring has emphasized the importance of documenting status and trends in the composition, structure, and function of ecosystems. Vegetation is a foundation for terrestrial ecosystem composition, structure, and function. Vegetation also ranked among the highest potential vital signs for monitoring in the Network's vital signs selection process. The reasons are simply that vegetation dominates biomass and energy pathways and defines the habitat for most other forms of life. Changes in vegetation composition, structure, and function will therefore have a profound effect on ecosystems. Monitoring vegetation change is thus imperative to detecting and understanding status and trends in park ecosystem vital signs, the overriding goal of NPS Inventory and Monitoring. Natural processes that have shaped vegetation inside and outside parks have been directly affected by a variety of land use activities, fire suppression/management, plus climate/atmospheric changes and many other anthropogenic factors. Vegetation sampling can help document changes in species composition, structure, and function that occur as a result of these processes.

In 2011, we began monitoring vegetation following the Klamath Network vegetation monitoring protocol (Odion et al. 2011), and established sites at Lava Beds National Monument, and Redwood National and State Parks (Smith and Sarr 2013), and revisited those sites in 2014 (Smith 2015). In 2012, we established sites at Whiskeytown National Recreation Area and Lassen Volcanic National Park (Smith and Sarr 2014b). In 2013, we established sites at Oregon Caves National Monument and Crater Lake National Park (Smith and Sarr 2014a). Once every three years we measure vegetation composition, structure, and function on selected sampling frames in six network parks.

The main objective for the Fiscal Year 2015 field season was to collect data from the 21 matrix, 15 riparian, and 10 high elevation plots at Whiskeytown and 18 matrix and 14 riparian, and 10 high elevation sites at Lassen. Should time allow, we aim to establish sites not accessible in 2012 due to the Reading Fire at Lassen.

Annual reports such as this one are intended for park staff and partners and summarize the data collected that season on the status of vegetation composition, structure, and function. The analyses and data summaries are selected to convey basic descriptive information in an easily interpreted format. More complex analyses and syntheses will be conducted every third year (beginning in 2014 for all six parks sampled from 2011 to 2013) as outlined in the vegetation monitoring protocol (Odion et al. 2011).

Methods

Complete methods for site selection, data collection, data management, and analysis are described in Odion et al. (2011), which provides detailed guidance for sampling in each park. This summary of methods is an abbreviated overview to provide context for this report.

Site Selection

For safety and logistical reasons, we constrained the monitoring sampling frames to exclude areas with slopes greater than 30 degrees and locations less than 100 m, or more than 1 km, from a road or trail. An exception occurred at WHIS: due to safety issues regarding illegal cannabis cultivation in the park, all sites (except high elevation) were < 150m from a road or trail. Across all parks, three types of sampling frames were recognized: 1) riparian (areas within 10 m horizontally of a perennial stream), 2) high elevation (elevations above a specific elevation threshold in each park), and 3) matrix (remaining upland areas).

Both Whiskeytown and Lassen have all three sample frames. Where possible, we aimed to co-locate our plots with land bird monitoring sites (Stephens et al. 2010) and stream monitoring sites (Dinger et al. 2013).

Training and Logistics

Four National Park Service (NPS) crew members began work on May 11: two GS-7 Crew Leaders (G.J. Johnson and C. Rinas) and two GS-5 Biological Science Technicians (S. Violet and M. Jesus). We also had one GeoCorp intern start on May 11 (V. Ngyuen). A second GeoCorps intern (M. Gregory) began work on June 15.

Initial training occurred during the first work week. The initial in office training included a review of protocol and standard operating procedures, as well as safety and job hazard analysis discussions. Field procedure training occurred at a nearby green space. During the second work week, we made a site visit to Whiskeytown for species familiarization and hands-on instruction about protocol procedures. After training as a group for two work weeks, we split into two crews for site sampling at WHIS. After finishing Lava Beds, we conducted two days of training at Lassen for species familiarization. The Project Lead (Sean Smith) assisted with site sampling periodically at Whiskeytown, but the crew did not need assistance at Lassen. Crews worked a field schedule of eight 10-hour days; an eight-day work week is referred to hereafter as a hitch.

Field Sampling

A 20 × 50 m (0.1 ha) plot was used for sampling matrix sites (Figure 1); a 10 × 100 m or two 10 × 50 m plots were used for riparian sites, and riparian plot shape depended on the sinuosity of the stream channel (Figure 2). The 10 m wide riparian plots were used to avoid going too far into the upland habitat type, and the varying plot angles allowed us to capture more of the streamside vegetation. Site reference diagrams were drawn in the field for all riparian sites.

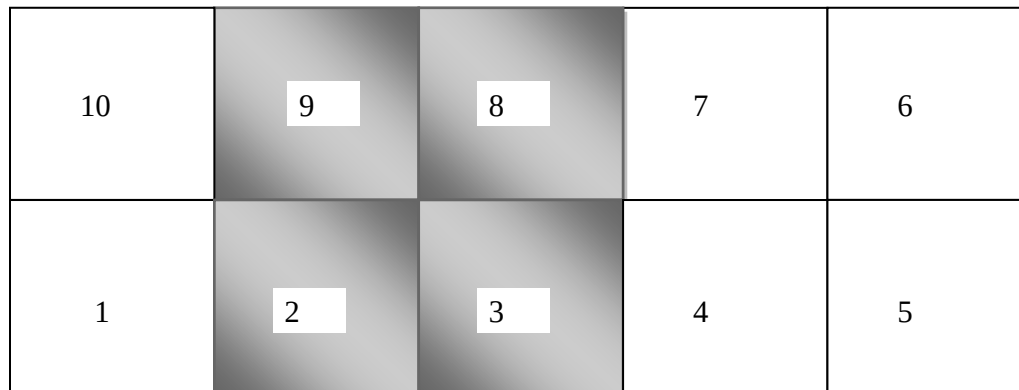


Figure 1. The 20 × 50 m matrix and high elevation site plot layout. Each numbered square is 10 × 10 m. Shaded squares are the four intensive modules.

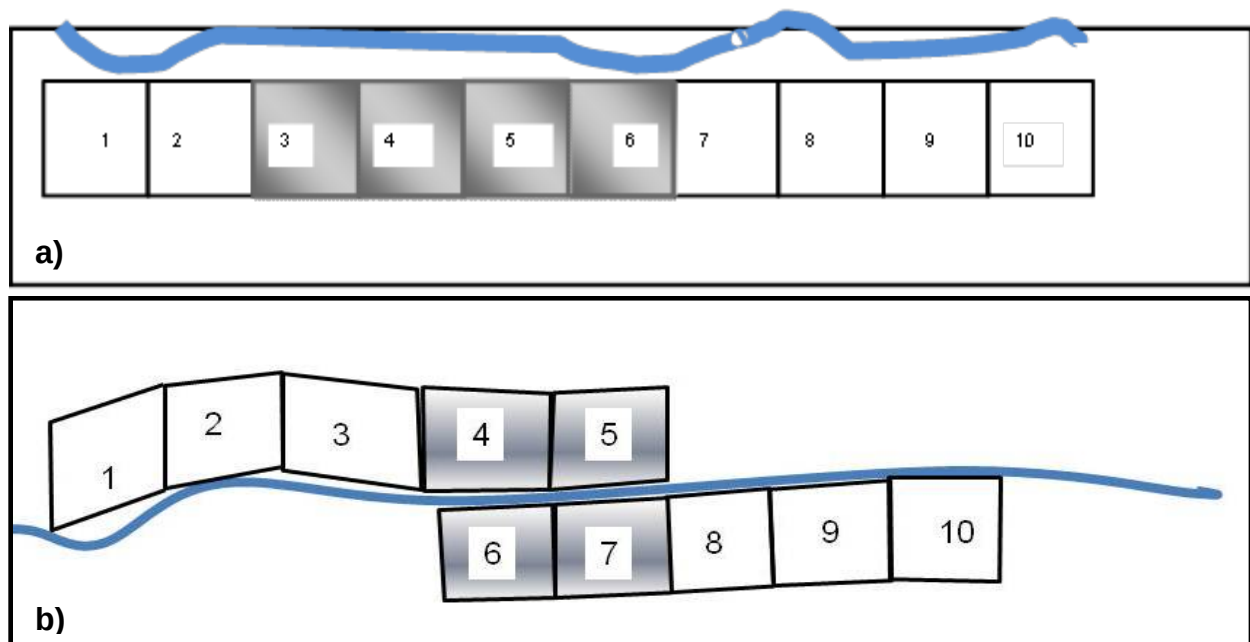


Figure 2. Riparian site plots in one 10 × 100 m layout (a) or two 10 × 50 m layouts (b). Each numbered square is 10 × 10 m and shaded squares are the four intensive modules.

Each plot (total area 0.1 ha), regardless of sampling frame, consisted of ten 10 × 10 m modules, four of which were sampled intensively for species and substrate percent cover, and seedling and sapling counts. Standard Operating Procedures 6–9 of the vegetation monitoring protocol (Odion et al. 2011) provide details on the measurements of the following parameters sampled in each plot:

1. Slope
2. Aspect
3. Elevation
4. Micro topography
5. Macro topography

6. Vascular plant cover by species and height strata (Stratum 1 = (<0.75 m), Stratum 2 = (0.75–2.5 m), Stratum 3 = (2.6–5 m), and Stratum 4 = (>5 m)
7. Ground cover
8. Tree seedlings
9. Tree saplings by size class
10. Small trees by size class
11. Live trees (diameter at breast height [dbh], canopy position, and condition)
12. Dead trees (dbh, decay class)
13. Fine wood (<7.6 cm diameter) (1-hr = 0–0.62 cm; 10-hr = 0.63–2.54 cm; 100-hr = 2.55–7.6 cm)
14. Coarse wood (>7.6 cm in diameter, size, and decay class) (1000-hr sound; 1000-hr rotten)
15. Litter and duff (depth/thickness)

Data Management, Analysis, and Presentation

All data management followed the procedures outlined in Standard Operating Procedure 12 of the vegetation monitoring protocol (Odion et al. 2011). We collected field data on tablet computers, with nightly and weekly downloads to a secure thumb drive or computer, respectively. Verification of specimens and validation of data occurred throughout the field season and were finalized at the end of the field season by the Project Lead.

We performed general data summaries to provide descriptive statistics of the park vegetation. These included measures of central tendency (mean, median) and variance (range, standard deviation) for selected parameters. Data are presented in tabular form, and where suitable, in a user-friendly graphical format to aid in the visualization of data distribution or geographic variation across the sampling frame. Depending on data collected during future monitoring of the parks, annual reports may show different statistics, but will use the same general families of analysis and similar tables and illustrations.

Due to database constraints, the vascular plant taxonomy used in the study is a combination of The Jepson Manual, 1st edition (Hickman 1993), The Jepson Manual, 2nd edition (Baldwin et al. 2012), and the United States Department of Agriculture (USDA) Plants Database (USDA, NRCS 2014).

Woody debris (tons/acre) was calculated using FFI (FEAT/FIREMON Integrated Database; Lutes et al. 2009) fuel constants.

Results

Sampling began at Whiskeytown on May 19 and ended on July 18, 2015. Sampling occurred at Lassen from July 15 to August 31, 2015. Our 2015 sampling, for the most part, went smoothly. One GeoCorps intern suffered an injury very early in the season, and could not participate in field sampling for the remainder of the season. This injury resulted in only a minor loss of productivity.

Here we summarize selected data most relevant to our monitoring objectives.

Whiskeytown

At Whiskeytown, we resampled 21 matrix, 13 riparian, and 10 high elevation sites (Figure 3). We did not sample two riparian sites (WT126, WT155) due to proximity to illegal *Cannabis* gardens. We will revisit these riparian sites not sampled this year in 2017.

Lassen

At Lassen, we resampled 18 matrix, 14 riparian, and 10 high elevation sites (Figure 4). We were able to add 5 sites to both the matrix and riparian sample frame. We were not able to access and monument these sites in 2012 due to the Reading Fire. The total number of monumented sites at Lassen is 23 matrix, 19 riparian, and 10 high elevation sites.

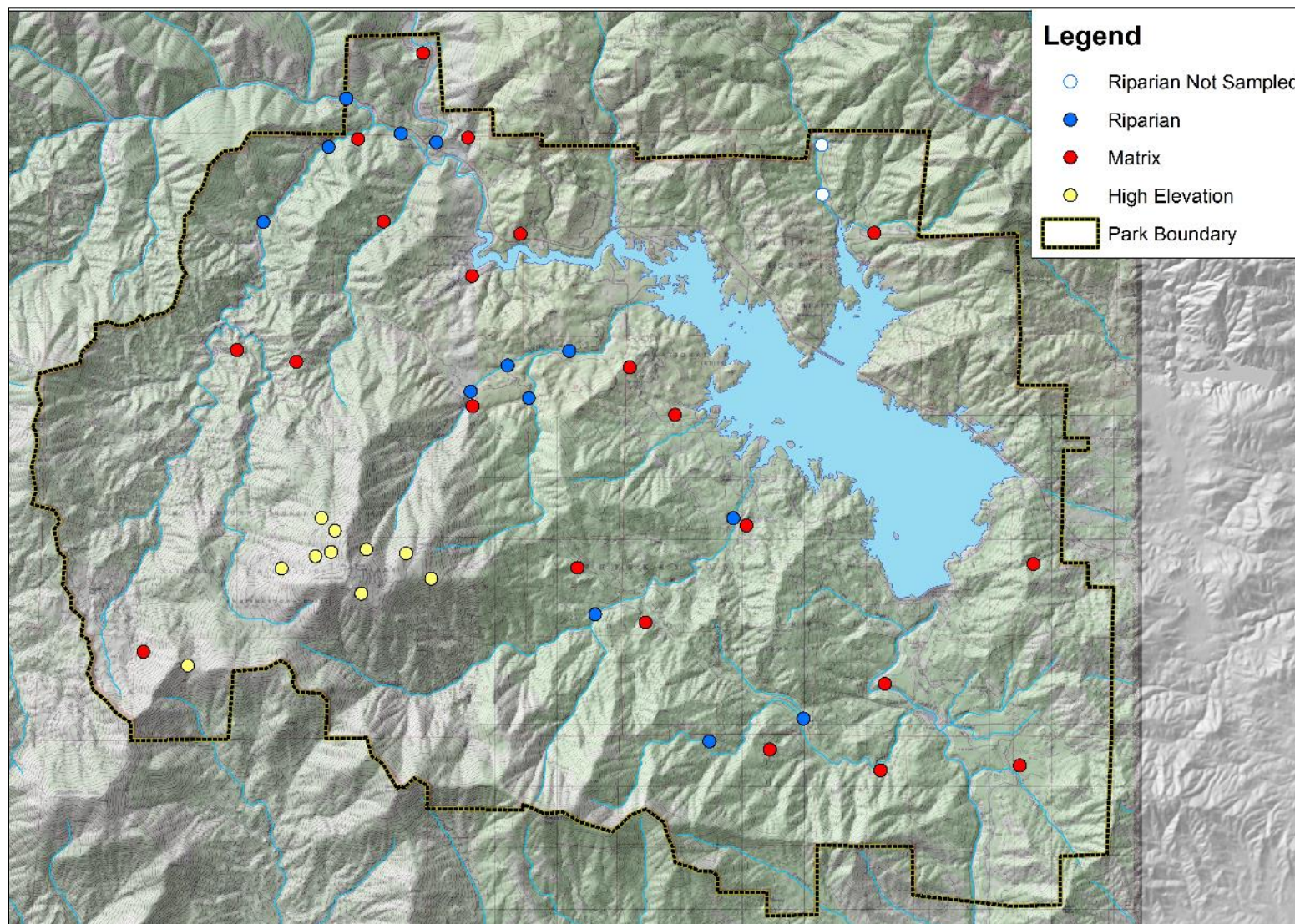


Figure 3. Location of vegetation monitoring sites at Whiskeytown National Recreation Area in 2015.

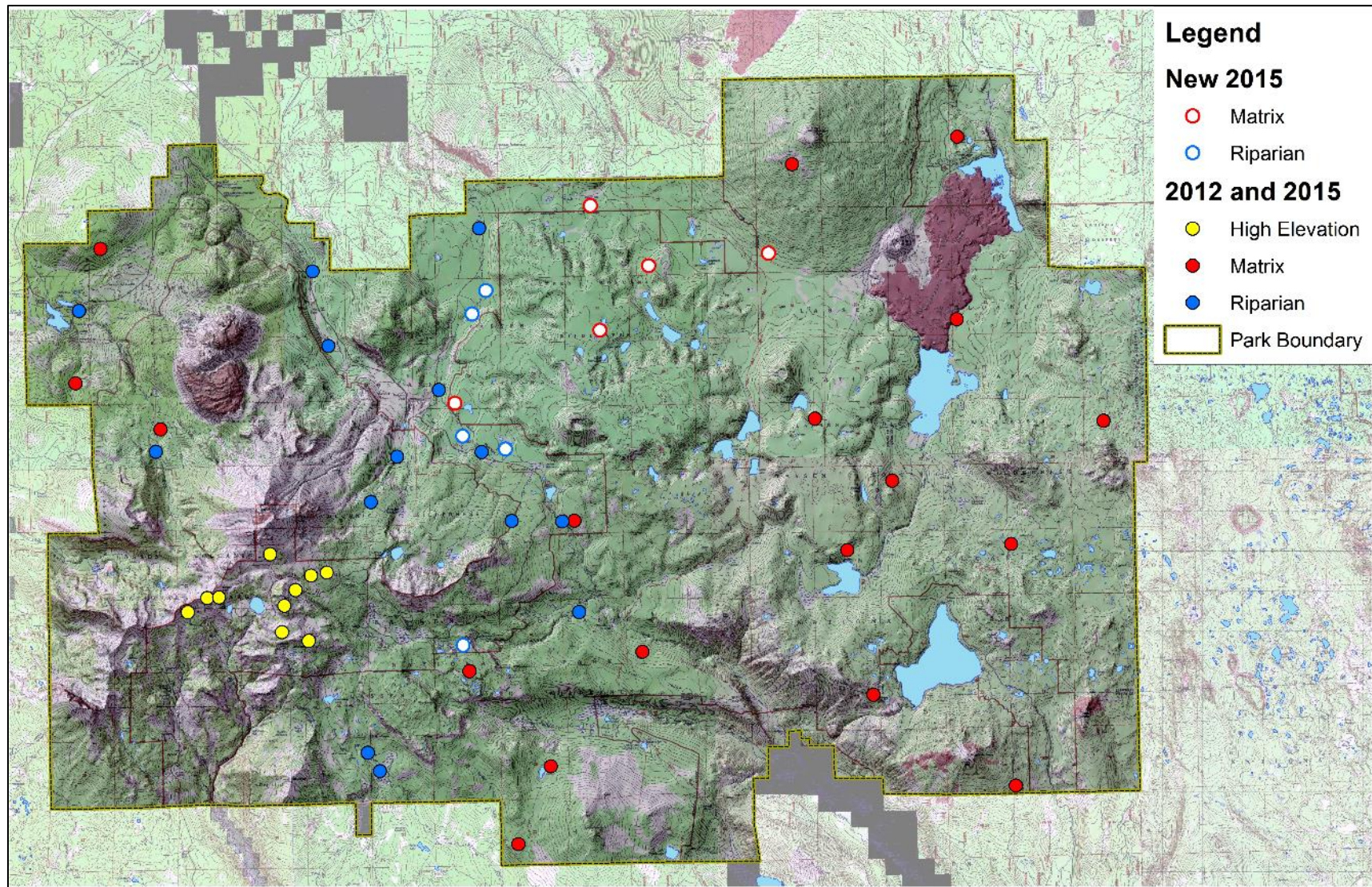


Figure 4. Location of vegetation monitoring sites at Lassen Volcanic National Park in 2015.

Vegetation Composition

Whiskeytown

Vascular plant species richness for matrix plots at Whiskeytown ranged from 7 to 87 species (Figure 5, Table 1), with an average species richness of 40. For all matrix plots, 189 species were recorded, although the total was 224 when including unknowns. Riparian sites proved to be the most diverse, species richness ranged from 31-83 species per plot. For all riparian plots, 198 species were recorded, although the total was 228 when including unknowns. High elevation site species richness ranged from 8-43 species per plot. For all high elevation plots, 66 species were recorded, although the total was 73 when including unknowns. We define unknowns as any plant encountered in a sampling plot that cannot be identified to the species level; names are recorded to the finest taxonomic resolution possible: genus, family, lifeform, etc. The most frequently occurring herbaceous and shrub species by sample frame are shown in Tables 2, 3, and 4. Figure 6 shows the composition of basal area by tree species at each site. We observed one native species previously undocumented for the park: *Ranunculus hebecarpus*. This is an annual species found in grasslands and open woodlands.

Twenty two non-native species were observed in the matrix, 40 in the riparian, and none in the high elevation sample frame. Nonnative species by site ranged from 0 to 24% (Figure 5) for matrix, and 0-34% for riparian sites. Among all sample frames, the most frequently occurring nonnative species was *Torilis arvensis*. We observed two non-native species previously undocumented for the park: 1) *Festuca arundinacea*, this species was believed to be present in the park, but had not been confirmed. We observed this species at one riparian site. 2) *Lychnis coronaria*, this is a new observation for the park. We found this species at one riparian site.

Table 1. Vascular plant species richness (SR) range, mean (standard deviation in parenthesis), and sample frame total from the 2015 vegetation monitoring plots at Whiskeytown (WHIS).

Park	Sample Frame	SR Range	SR Mean	Species Total
WHIS	Alpine	8 - 43	17 (9.9)	73
WHIS	Matrix	7 - 87	40 (19.3)	224
WHIS	Riparian	31 - 83	57 (16.3)	228

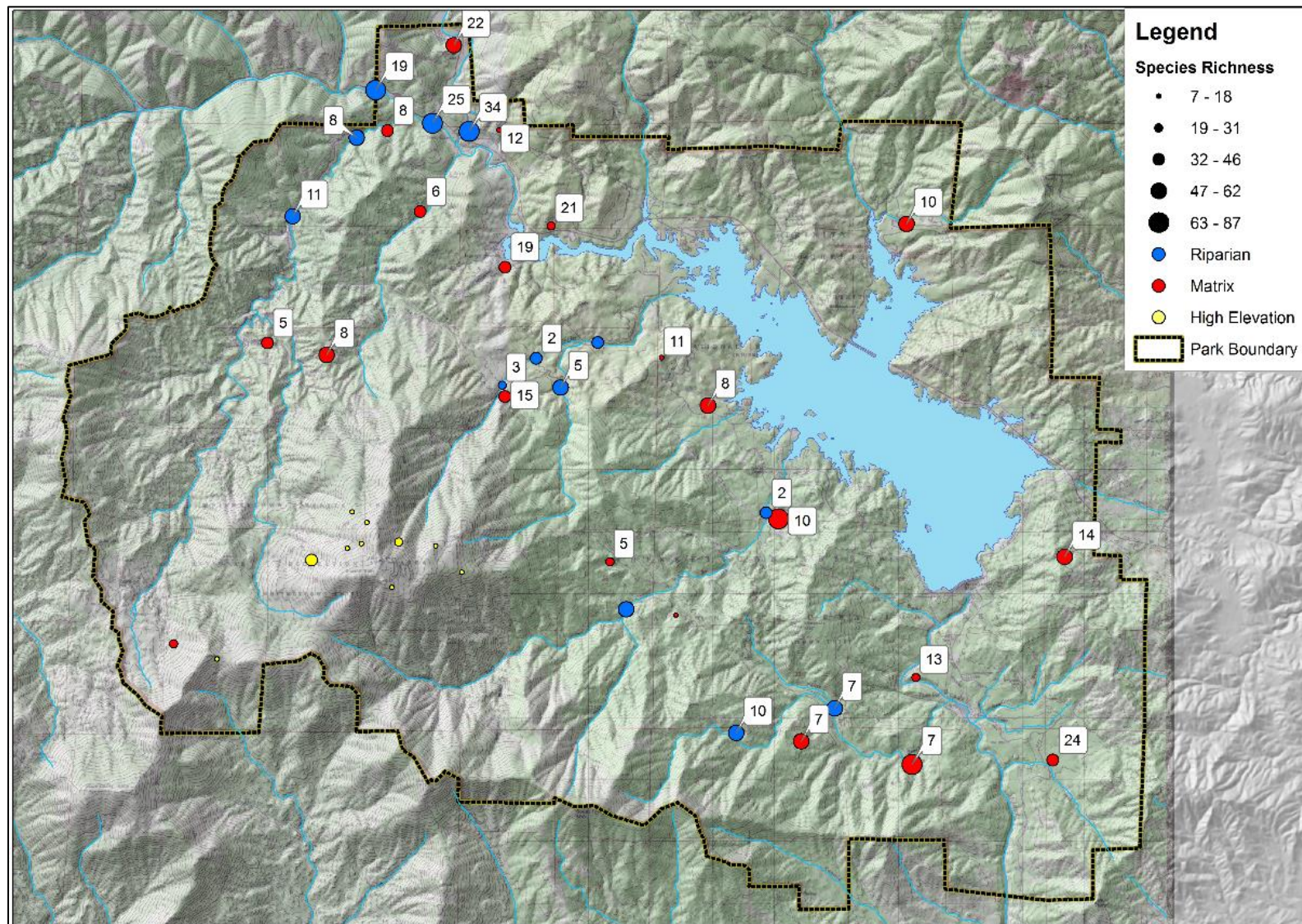


Figure 5. Vascular plant species richness for sites at Whiskeytown in 2015. Numbers next to sites indicate the percentage of non-native species present, no number shown for sites with no non-native species present.

Table 2. Most frequently occurring understory vascular plant species at Whiskeytown matrix sites. Number indicates frequency (% of plots where species occurred). Note that * indicates a non-native species.

Vegetation type	Species	% plots
Herb	<i>Galium porrigens</i> var. <i>tenue</i>	81
	<i>Vulpia myuros</i> *	76
	<i>Collomia heterophylla</i>	71
	<i>Melica harfordii</i>	67
	<i>Polygala cornuta</i>	67
	<i>Aira caryophyllea</i> *	67
	<i>Torilis arvensis</i> *	62
	<i>Carex multicaulis</i>	57
	<i>Hypericum concinnum</i>	48
	<i>Luzula comosa</i>	48
	<i>Comandra umbellata</i> ssp. <i>californica</i>	48
	<i>Vulpia microstachys</i>	48
Shrub	<i>Toxicodendron diversilobum</i>	95
	<i>Heteromeles arbutifolia</i>	71
	<i>Arctostaphylos viscida</i>	67
	<i>Lonicera interrupta</i>	57
	<i>Ceanothus lemmonii</i>	48

Table 3. Most frequently occurring understory vascular plant species at Whiskeytown riparian sites. Number indicates frequency (% of plots where species occurred). Note that * indicates a non-native species.

Vegetation type	Species	% plots
Herb	<i>Pteridium aquilinum</i> var. <i>pubescens</i>	92
	<i>Melica harfordii</i>	92
	<i>Galium triflorum</i>	85
	<i>Trientalis borealis</i> ssp. <i>latifolia</i>	85
	<i>Darmera peltata</i>	85
	<i>Rubus ursinus</i>	85
	<i>Woodwardia fimbriata</i>	85
	<i>Collomia heterophylla</i>	77
	<i>Claytonia parviflora</i> ssp. <i>parviflora</i>	77
	<i>Aralia californica</i>	77
	<i>Elymus glaucus</i>	77
	<i>Polystichum imbricans</i>	77
Shrub	<i>Vitis californica</i>	92
	<i>Toxicodendron diversilobum</i>	85
	<i>Philadelphus lewisii</i>	85

Table 4. Most frequently occurring understory vascular plant species at Whiskeytown high elevation sites. Number indicates frequency (% of plots where species occurred). Note that * indicates a nonnative species.

Vegetation type	Species	% plots
Herb	<i>Carex rossii</i>	90
	<i>Apocynum androsaemifolium</i>	60
	<i>Achnatherum occidentale</i>	50
	<i>Lotus crassifolius</i>	50
	<i>Chimaphila menziesii</i>	40
Shrub	<i>Lithocarpus densiflorus</i> var. <i>echinoides</i>	80
	<i>Arctostaphylos patula</i>	70
	<i>Arctostaphylos nevadensis</i>	70
	<i>Chrysolepis sempervirens</i>	60
	<i>Ceanothus prostratus</i>	40
	<i>Quercus vacciniifolia</i>	40
	<i>Symphoricarpos mollis</i>	40

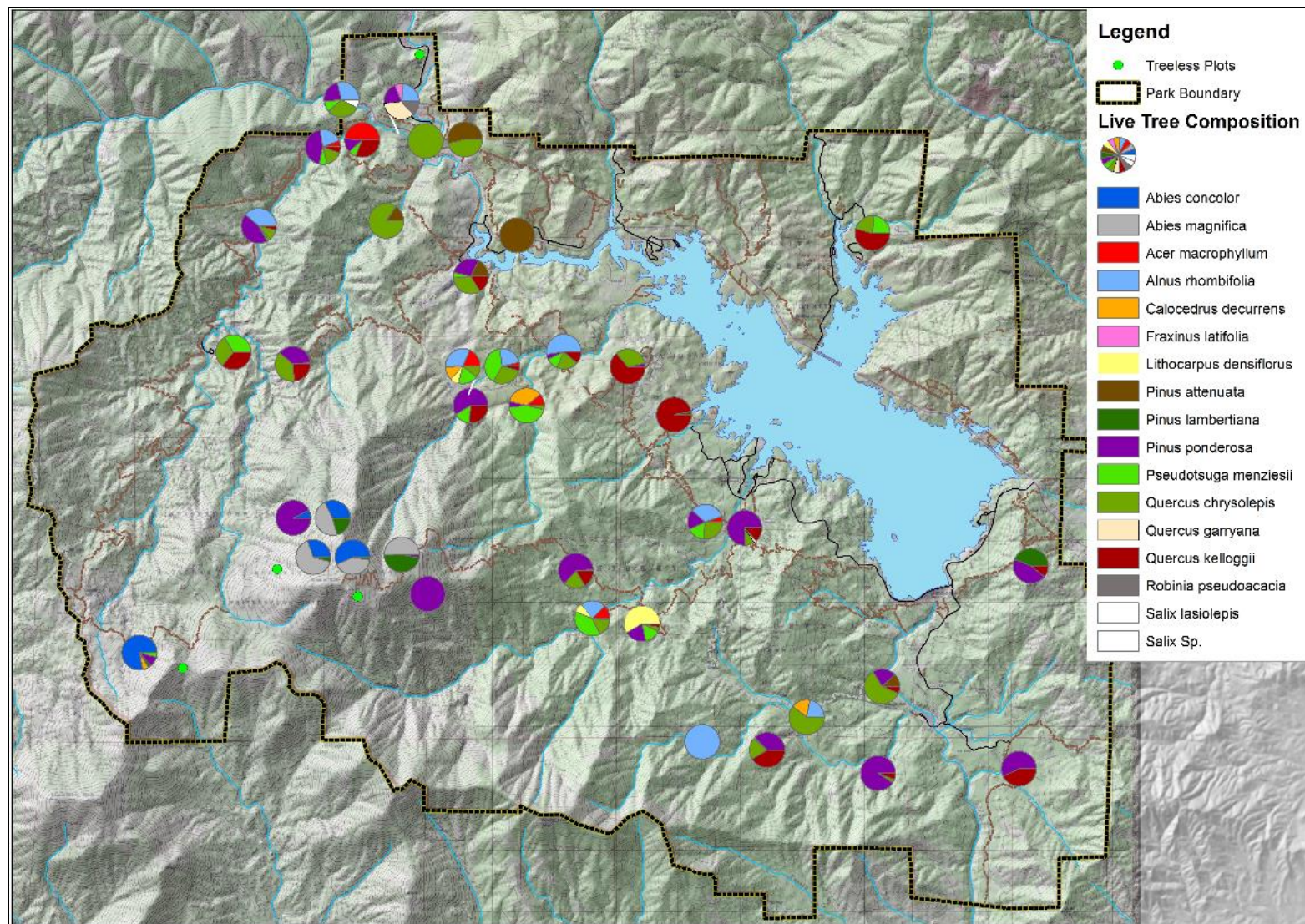


Figure 6. Individual tree species (>15 cm dbh) basal area composition at Whiskeytown sites in 2015. *Cornus nutallii* present with low basal area at one site, not visible in pie chart and not shown. Sites not sampled not shown.

Lassen

Vascular plant species richness in the Lassen matrix sampling frame ranged from 4 to 35 species per 0.1 ha sampling plot (Figures 7; Table 5). Across all matrix plots sampled, we observed 113 species, although the total was 119 when including unknowns. We define unknowns as any plant encountered in a sampling plot that cannot be identified to the species level; names are recorded to the finest taxonomic resolution possible: genus, family, lifeform, etc. In the riparian sampling frame, species richness at the plot level ranged from 50 to 97 species, with 277 species observed (310 when including unknowns). High elevation sites had the lowest species richness, with a range of 7-26 species per plot, and 42 species observed and no unknowns. The most common herbaceous and shrub species by sample frame are shown in Tables 6, 7, and 8. Tree basal area composition by site is shown in Figures 8.

Nonnative species composition ranged from 0 to 6% in matrix sites, 0 to 6% in riparian sites, no nonnative species were observed in the high elevation sites (Figure 7). We observed 6 nonnative species overall. From all sample frames, the most frequently occurring nonnative species were *Cirsium vulgare* and *Taraxacum officinale*, both present at 13 sites. We collected vouchers (one specimen one photo) of *Senecio sylvaticus* from two riparian sites. These sites were not measured in 2012 and were burned during the Reading Fire.

Table 5. Vascular plant species richness (SR) range, mean (standard deviation in parenthesis), and sample frame total from the 2015 vegetation monitoring plots at Lassen (LAVO).

Park	Sample Frame	SR Range	SR Mean	Species Total
LAVO	Alpine	7 - 26	13 (5.7)	42
LAVO	Matrix	4 - 35	17 (8.0)	119
LAVO	Riparian	50 - 97	71 (13.3)	310

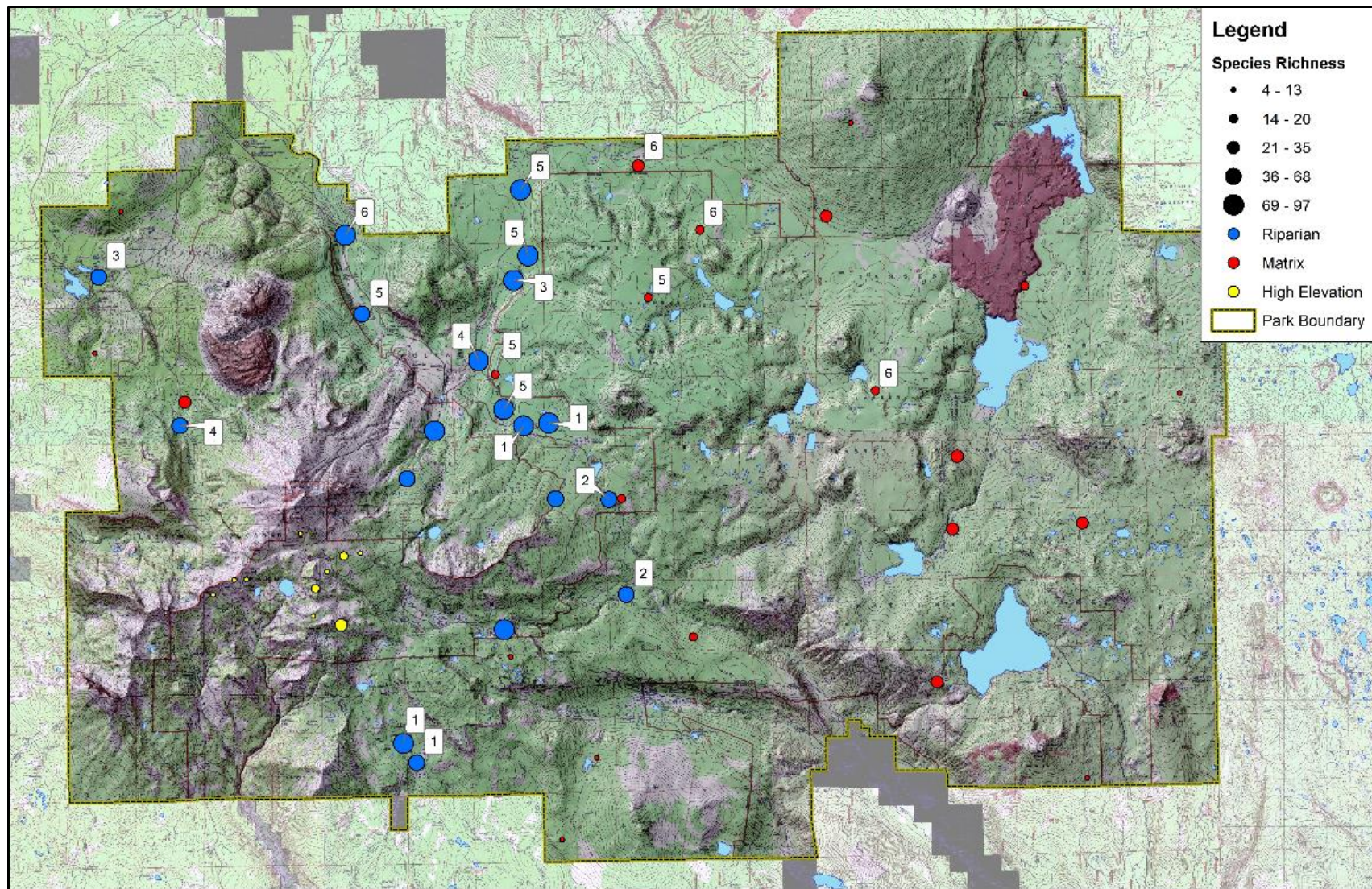


Figure 7. Lassen site vascular plant species richness from each sampling frame in 2015. White labels show percentage of species that are nonnative. Sites without non-native species are not labeled.

Table 6. Most frequently occurring understory species at Lassen matrix sites. Number indicates frequency (% of plots where species occurred).

Vegetation type	Species	% plots
Herb	<i>Carex rossii</i>	70
	<i>Achnatherum occidentale</i>	70
	<i>Elymus elymoides</i> ssp. <i>californicus</i>	65
	<i>Gayophytum diffusum</i>	61
	<i>Monardella odoratissima</i> ssp. <i>pallida</i>	52
	<i>Arabis platysperma</i>	52
	<i>Penstemon gracilentus</i>	35
	<i>Carex brainerdii</i>	35
	<i>Elymus glaucus</i> ssp. <i>glaucus</i>	30
	<i>Pyrola picta</i>	30
	<i>Stephanomeria lactucina</i>	26
	<i>Bromus suksdorfii</i>	22
	<i>Pedicularis semibarbata</i>	22
	<i>Viola purpurea</i>	22
	<i>Achnatherum lemmonii</i>	22
Shrub	<i>Arctostaphylos nevadensis</i>	61
	<i>Chrysolepis sempervirens</i>	39
	<i>Ceanothus velutinus</i> var. <i>velutinus</i>	39
	<i>Arctostaphylos patula</i>	35
	<i>Ericameria bloomeri</i>	26

Table 7. Most frequently occurring understory species at Lassen riparian sites. Number indicates frequency (% of plots where species occurred).

Herbs	% plots	Herbs	% plots
<i>Elymus glaucus</i> ssp. <i>glaucus</i>	79	<i>Luzula comosa</i>	74
<i>Galium triflorum</i>	79	<i>Galium trifidum</i>	68
<i>Mimulus guttatus</i>	79	<i>Hordeum brachyantherum</i> ssp. <i>brachyantherum</i>	68
<i>Lupinus polyphyllus</i> var. <i>burkei</i>	79	<i>Taraxacum officinale</i> *	68
<i>Cinna latifolia</i>	74	<i>Trifolium longipes</i> var. <i>nevadense</i>	63
<i>Juncus howellii</i>	74	<i>Glyceria elata</i>	63
<i>Achillea millefolium</i>	74	<i>Equisetum arvense</i>	63
<i>Carex rossii</i>	74	<i>Mimulus primuloides</i> var. <i>primuloides</i>	63
<i>Ligusticum grayi</i>	74	<i>Osmorhiza chilensis</i>	63
<i>Gayophytum diffusum</i>	74	<i>Perideridia parishii</i> ssp. <i>latifolia</i>	63
<i>Calamagrostis canadensis</i>	74	<i>Viola glabella</i>	63

Table 8. Most frequently occurring understory species at Lassen high elevation sites. Number indicates frequency (% of plots where species occurred).

Herbs	% plots
<i>Lupinus obtusilobus</i>	100
<i>Eriogonum marifolium</i>	90
<i>Polygonum davisiae</i>	70
<i>Calyptridium umbellatum</i>	70
<i>Arabis platysperma</i>	50
<i>Carex breweri</i> var. <i>breweri</i>	50
<i>Elymus elymoides</i> ssp. <i>californicus</i>	50
<i>Carex rossii</i>	50
<i>Eriogonum pyrolifolium</i>	40
<i>Juncus parryi</i>	40
<i>Carex stramineiformis</i>	40
<i>Achnatherum occidentale</i>	40

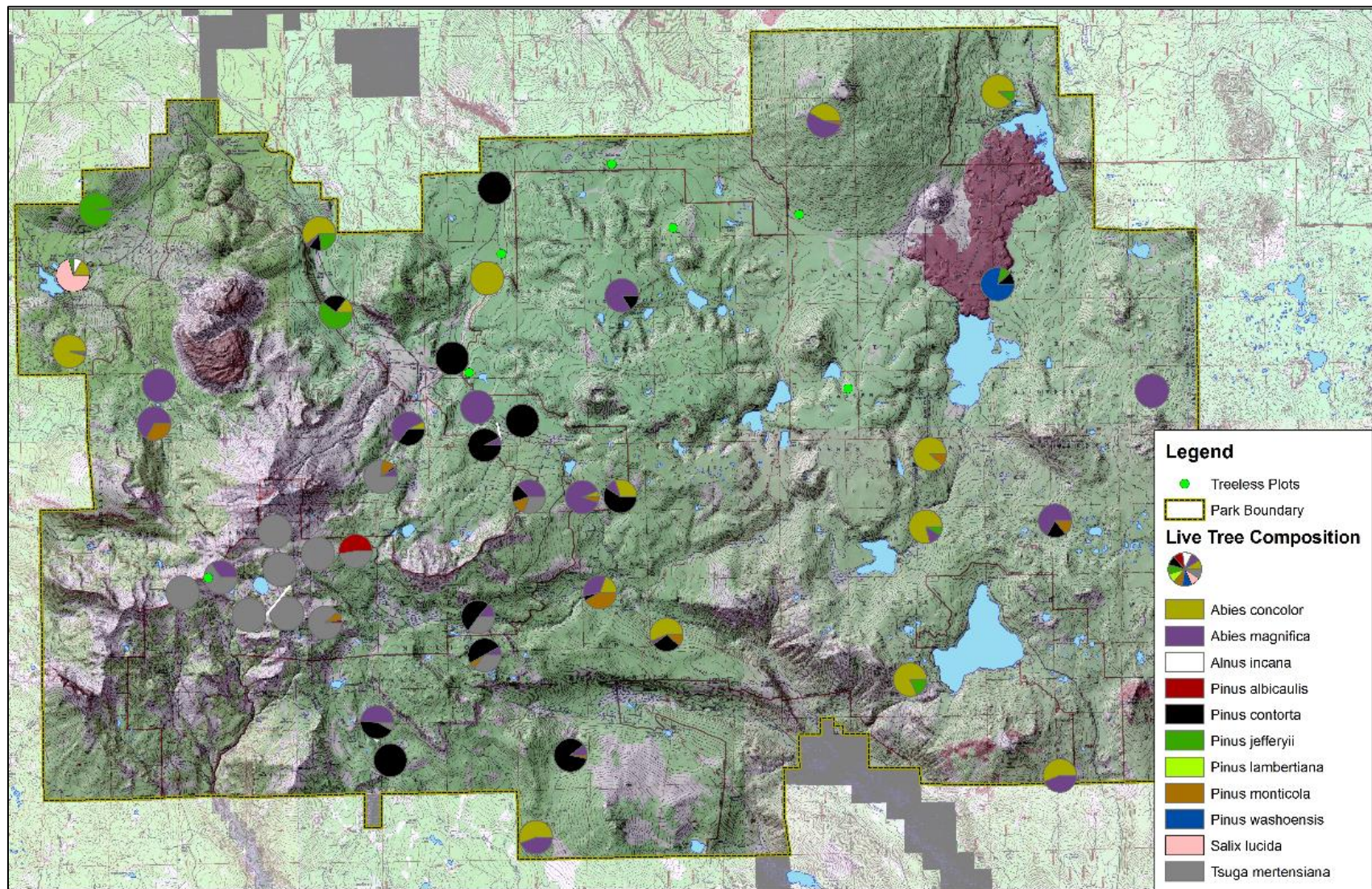


Figure 8. Individual tree (>15 cm dbh) species basal area composition of Lassen in 2015.

Vegetation Structure

Whiskeytown

The highest mean vegetation cover in the matrix and riparian sampling frame occurred in height stratum 4 (>5 m) (Table 9). High Elevation sites had the highest mean cover in stratum 2 (0.75-2.5 m) (Table 9).

Table 9. Vegetation cover (%) by height stratum in the matrix sampling frame at Whiskeytown. SD = standard deviation.

Height Stratum	Frame	Min	Max	Mean	SD
<0.75 m	High Elevation	1.3	67.3	23.6	24.9
	Matrix	1.6	61.5	11.5	14.0
	Riparian	3.6	25.6	14.9	7.1
0.75-2.5 m	High Elevation	8.5	75.3	30.7	21.3
	Matrix	0.1	105.8	23.9	24.9
	Riparian	4.8	69.2	29.8	16.3
2.6-5 m	High Elevation	0.0	8.5	1.8	3.1
	Matrix	0.0	48.8	10.6	13.4
	Riparian	6.3	49.3	24.1	12.8
>5 m	High Elevation	0.0	42.8	16.5	15.9
	Matrix	0.0	183.0	65.2	42.8
	Riparian	10.8	118.8	77.1	29.5

Mean plot basal area for the matrix sampling frame was 22.7 m²/ha for live trees and 2.0 m²/ha for snags (Table 10). One of the matrix plots did not have trees >15cm dbh. Mean tree density was 273 trees/ha (Table 11). Within the riparian sample frame mean plot basal area was 34.7 m²/ha and 2.5 m²/ha for snags. All riparian plots had trees > 15cm dbh. Riparian mean tree density was 305 trees/ha. High elevation site had mean plot basal area of 19 m²/ha and 1.8 m²/ha for snags; mean tree density was 169 trees/ha. Four high elevation plots lacked trees >15 cm dbh. Table 11 also shows tree height, height to crown, and maximum height. Snag density and mean heights are presented in Table 12. Woody debris lag class values are presented in Table 13. Tables 14 and 15 summarize ground substrate cover and litter depth.

Table 10. Live tree and snag basal area (BA) minimum, maximum, mean, and standard deviation for all sampling frames at Whiskeytown. Units are m²/ha.

Frame	Min Live Tree BA	Max Live Tree BA	Mean Live Tree BA	SD	Min Snag BA	Max Snag BA	Mean Snag BA	SD
High Elevation	0.0	65.5	19.0	22.1	0.0	9.5	1.8	3.0
Matrix	0.0	71.8	22.7	17.6	0.0	8.7	2.0	2.5
Riparian	2.0	81.5	34.7	21.6	0.0	11.6	2.5	3.2

Table 11. Mean live tree density (stems/ha), height (m), height to crown (m), and maximum tree height (m) at Whiskeytown. Standard deviations are shown in parentheses.

Frame	Mean Tree Density	Mean Tree Height	Mean Height to Crown	Max Tree Height
High Elevation	169 (196)	14 (6)	6 (4)	34
Matrix	273 (175)	16 (8)	7 (5)	48
Riparian	305 (119)	18 (9)	8 (5)	56

Table 12. Mean snag density (stems/ha) and height (m) at Whiskeytown. Standard deviations are shown in parentheses.

Frame	Mean Snag Density	Avg Snag Height
High Elevation	16 (22)	10 (6)
Matrix	32 (42)	9 (6)
Riparian	26 (30)	10 (8)

Table 13. Mean woody debris time lag classes (tons per acre) at Whiskeytown. Standard deviations are shown in parentheses (see page 5 #13 and #14 for lag class size criteria).

Frame	1-hr	10-hr	100-hr	10000-hr Rotten	1000-hr Sound
High Elevation	0.15(0.12)	1.64(1.38)	1.50(1.02)	4.76(13.11)	6.42(16.57)
Matrix	0.22(0.19)	1.39(1.39)	2.80(2.23)	1.37(3.77)	5.7(11.19)
Riparian	0.22(0.15)	1.6(1.62)	1.58(1.08)	0.61(1.40)	7.97(10.59)

Table 14. Ground/substrate mean percent cover at Whiskeytown. Standard deviations are shown in parentheses.

Frame	Bare Soil	Bryophytes	Coarse Wood	Fine Wood / Litter	Rock	Water
Alpine	3.4(5.9)	0.1(0.1)	4.2(6.2)	81.7(14.1)	9.8(10.6)	0.0
Matrix	3.4(6.8)	0.5(0.4)	3.3(3.1)	87.9(11.8)	2.7(5.5)	0.0
Riparian	1.9(1.2)	4.9(3.8)	2.1(1.2)	73.6(8.6)	12.0(7.1)	1.8(1.1)

Table 15. Litter and duff minimum, maximum, and mean depth at Whiskeytown. Units are cm, and standard deviations are shown in parentheses.

Frame	Mean Litter Depth	Min Litter Depth	Max Litter Depth	Mean Duff Depth	Min Duff Depth	Max Duff Depth
High Elevation	2.0(1.2)	0.03	4.1	2.0(1.9)	0.2	6
Matrix	2.2(1.2)	0.5	5.6	0.7(0.8)	0	2.6
Riparian	3.3(1.5)	0.4	5.5	0.6(0.8)	0	2.5

Lassen

The highest overall mean value for vegetation cover was found in riparian height stratum 1 (<0.75 m), at 35.2% (Table 16). High elevation sites also had the highest cover in stratum 1. Mean stratum cover was greatest in the matrix frame in stratum 4 (> 5m). Mean percent vegetation values are shown in Table 16.

Table 16. Vegetation cover (%) by height stratum in matrix and riparian sampling frames at Lassen.

Height Stratum	Frame	Min	Max	Mean	SD
<0.75 m	High Elevation	4.6	75.9	20.7	21.5
	Matrix	0.3	85.9	20.6	27.2
	Riparian	9.3	69.8	35.2	16.6
0.75-2.5 m	High Elevation	0.0	13.0	3.0	3.9
	Matrix	0.0	7.6	2.0	2.5
	Riparian	1.3	45.2	11.2	10.3
2.6-5 m	High Elevation	0.0	19.0	4.7	5.6
	Matrix	0.0	9.0	2.1	2.7
	Riparian	0.0	104.3	12.5	25.0
>5 m	High Elevation	0.0	38.0	9.1	12.0
	Matrix	0.0	72.5	30.1	25.0
	Riparian	0.0	73.8	20.2	18.7

Mean live tree basal area at Lassen was highest in the matrix sampling frame (35.0 m²/ha) (Table 17), and mean snag basal area was 15 m²/ha. Five matrix plots lacked live trees >15cm dbh. Matrix site mean tree density was 266 trees/ha (Table 18), and mean snag density was (121 trees/ha) (Table 19). Riparian mean basal area was 25.5 m²/ha, while snag basal area was 10.2 m²/ha (Table 17). Only one riparian site lacked trees >15 cm dbh. Mean tree density in the riparian frame was 206 tree/ha, and snags were the highest density of all three sample frames at 136 trees/ha. The high elevation sample frame had the lowest live tree basal area (18.2 m²/ha), and snag basal area (3.0 m²/ha). High elevation tree density was 239 trees/ha for live and 27 trees/ha for snags. One high elevation site lacked trees > 15 cm dbh. Dead and down woody debris data are shown in Table 20. Substrate cover and Fine wood/litter are shown in Tables 21 and 22.

Table 17. Live tree and snag basal area (BA) minimum, maximum, mean, and standard deviation (SD) for sampling frames at Lassen. Units are m²/ha.

Frame	Min BA	Max BA	Mean BA	SD	Min Snag MA	Max Snag BA	Mean Snag BA	SD
High Elevation	0	54.1	18.2	22.3	0	21.9	3.0	6.9
Matrix	0	110.7	35.0	29.3	0	45.2	15.0	11.3
Riparian	0	71.2	25.5	23.2	0	35.2	10.2	12.6

Table 18. Mean live tree density (stems/ha), height (m), height to crown (m), and maximum tree height (m) at Lassen. Standard deviations are shown in parentheses.

Frame	Mean Tree Density	Mean tree Height	Mean Height to Crown	Max tree Height
High Elevation	239 (232)	8 (3)	2 (2)	18
Matrix	266 (257)	17 (8)	7 (5)	49
Riparian	206 (181)	16 (9)	5 (4)	46

Table 19. Mean snag density (stems/ha) and height (m) at Lassen. Standard deviations are shown in parentheses.

Frame	Mean Snag Density	Mean Snag Height
High Elevation	27 (51)	6 (3)
Matrix	121 (116)	13 (8)
Riparian	136 (202)	15 (7)

Table 20. Summary of mean woody debris time-lag classes (tons per acre) at Lassen. Standard deviations are shown in parentheses. (See the descriptions for parameters #13 and #14 on page 5 for lag class size criteria.).

Frame	1-hr	10-hr	100-hr	10000-hr Rotten	1000-hr Sound
High Elevation	0.15 (0.15)	0.36 (0.37)	0.55 (1.05)	0.03 (0.08)	2.79 (5.41)
Matrix	0.33 (0.28)	1.96 (1.48)	1.95 (1.27)	3.17 (4.62)	17.59 (21.15)
Riparian	0.26 (0.17)	1.05 (0.79)	1.86 (1.85)	15.01 (24.76)	12.04 (13.18)

Table 21. Ground/substrate mean percent cover at Lassen. Standard deviations are shown in parentheses.

Frame	Bare Soil	Bryophytes	Coarse Wood	Fine Wood / Litter	Rock	Water
High Elevation	17.5 (18.9)	0.05 (--)	3.0 (3.5)	32.8 (26.4)	47.4 (29.0)	0.00 (--)
Matrix	5.5 (7.4)	0.1 (0.2)	6.7 (4.7)	80.2 (13.7)	6.6 (8.8)	0.00 (--)
Riparian	4.2 (5.0)	1.1 (1.0)	4.6 (3.8)	80.7 (9.9)	6.5 (8.1)	0.9 (0.7)

Table 22. Litter and duff minimum, maximum, and mean at Lassen. Units are cm, and standard deviations are shown in parentheses.

Frame	Mean Litter Depth	Min Litter Depth	Max Litter Depth	Mean Duff Depth	Min Duff Depth	Max Duff Depth
High Elevation	0.9 (1.0)	0	2.6	0.1 (0.3)	0	0.7
Matrix	2.1 (1.4)	0.02	5.1	0.9 (0.9)	0	3.9
Riparian	2.4 (2.2)	0.05	8.9	0.7 (0.7)	0.03	2.2

Vegetation Function (Regeneration)

Whiskeytown

In the matrix sampling frame at Whiskeytown, *Quercus chrysolepis* was the most abundant regenerating tree in all size classes. *Quercus chrysolepis* was also the most abundant regenerating species in the riparian sampling frame for the two smallest size classes, and *Alnus rhombifolia* dominated the largest three size classes. The high elevation sampling frame had both *Abies magnifica* and *Abies concolor* with equal densities in the smallest size class, but *Abies concolor* was most abundant in all other size classes. Mean regeneration counts for all tree size classes are shown in Table 23.

Table 23. Regeneration by size class for all live tree species in the matrix sampling frame at Whiskeytown. Units are trees/ha, and standard deviations are shown in parentheses.

Frame	≤15 cm Tall	>15 cm Tall			
		<2.54 cm dbh	2.54 to 5 cm dbh	>5 to 10 cm dbh	>10 to <15 cm dbh
High Elevation	225 (362)	275 (381)	48 (95)	120 (160)	25 (71)
Matrix	3036 (2984)	4393 (5865)	149 (153)	175 (189)	75 (87)
Riparian	3096 (3560)	5019 (4818)	229 (183)	183 (247)	92 (158)

Lassen

At Lassen, the most abundant regenerating tree species in the high elevation sampling frame for all classes was *Tsuga mertensiana*. Within the matrix sampling frame *Abies concolor* had the highest density in all size classes except in the > 15 cm tall and < 2.54 cm dbh category, where *Abies magnifica* has the highest density. For the riparian sample frame, *Abies magnifica* had the highest density in the two smallest classes, while *Pinus contorta* var. *murrayana* had the highest density in the three largest classes. Mean regeneration counts for all trees by size class are shown in Table 24.

Table 24. Regeneration by size class for all live tree species in each sampling frame at Lassen. Units are trees/ha, and standard deviations are shown in parentheses.

Frame	≤15 cm Tall	>15 cm Tall			
		<2.54 cm dbh	2.54 to 5 cm dbh	>5 to 10 cm dbh	>10 to <15 cm dbh
High Elevation	25 (79)	875 (1113)	165 (204)	213 (242)	80 (84)
Matrix	435 (766)	870 (1155)	105 (168)	108 (141)	48 (75)
Riparian	1855 (2322)	2605 (3461)	205 (214)	158 (198)	61 (64)

Summary

Overall the season was a success. Missing only two sites at WHIS due to safety concerns regarding illegal *Cannabis* cultivation. If safety clearance is assured, we will revisit these sites in 2018. At LAVO, we were able to establish both riparian and matrix sites we could not access in 2012 due to the Reading Fire; we are now at full implementation at LAVO, and have no plans to add new sites.

Nonnative Species

We found two non-native species previously undocumented at WHIS: *Festuca arundinaceae* and *Lychnis coronaria*. Neither of these species are outside of their expected range. *Festuca arundinacea* is a species of concern for the Klamath Network invasive species early detection protocol (ISED) (Odion et al. 2010), and listed as a Cal-IPC (Cal-IPC, 2016) species of moderate concern. *Lychnis coronaria* is not listed as a non-native species of concern, it is often cultivated and occasionally escapes.

In two sites burned during the Reading Fire we found *Senecio sylvaticus*, a species previously undocumented in the park. This species is very near its expected range, and listed as naturalized by Baldwin et al. (2012) and is not listed as a species of concern by Cal-IPC (Cal-IPC 2016) nor KLMN ISED (Odion et al. 2010).

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