



Vegetation Community Monitoring

2017 Results From Lava Beds National Monument and Redwood National and State Parks

Natural Resource Data Series NPS/KLMN/NRDS—2019/1214



ON THE COVER

Photo of vegetation monitoring crew working in an old-growth redwood site.

Photo by NPS

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and are summarized and presented accordingly.

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Abstract

During the 2017 field season, the Klamath Inventory and Monitoring Network implemented the seventh season of its vegetation monitoring protocol (Odion et al. 2011) at Lava Beds National Monument (Lava Beds) and Redwood National and State Parks (Redwood). The vegetation monitoring plots are 20 x 50 m (0.1 ha) and are partitioned into one of three sampling frames: matrix (upland), riparian (within 10 m 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 revisited those sites in 2016.

This report summarizes the data collected in 2017 from Lava Beds and Redwood. At Lava Beds we revisited 30 matrix sites. At Redwood we revisited all 26 matrix and 20 of 21 riparian sites established in 2011. One riparian site, originally established in 2011 has become overgrown by blackberry and is inaccessible; this site was replaced by another riparian site established this season. The total number of riparian sites at Redwood remains at 21. 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.

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 National Park Service (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 we 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), and we revisited those sites in 2015 (Smith 2016). In 2013, we established sites at Oregon Caves National Monument and Crater Lake National Park (Smith and Sarr 2014a), and we revisited those sites in 2016 (Smith 2018). 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 2017 field season was to collect data from the 30 matrix plots at Lava Beds and 26 matrix and 21 riparian sites at Redwood.

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 on a periodic basis, with topics generally 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 overview to provide context for this report.

Site Selection

For safety and logistical reasons, monitoring sampling frames 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 Whiskeytown National Recreation Area: due to safety issues regarding illegal cannabis cultivation in the park, all sites (except high elevation) were <150 m 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).

Lava Beds only has the matrix sampling frame. Redwood has the matrix and riparian sample frames. Where possible, we aimed to co-locate our plots with landbird monitoring sites (Stephens et al. 2010) and stream monitoring sites (Dinger et al. 2013).

Training and Logistics

Two NPS crew leads (GS-7) began work on May 15, 2017 (A. Rachkowski and M. Nicolli), as well as one GS-5 crew member (C. Kieffer). Two more GS-5 crew members began on May 29, 2017 (A. Peretz, and R. Chrisco).

Initial training for the early hired crew occurred during the week of May 15th, with the two later GS-5 hires beginning May 29. The initial in-office training included a review of the 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 Lava Beds for species familiarization and hands-on instruction about protocol procedures. After training as a group for two weeks, the crew began site sampling at Lava Beds. After finishing at Lava Beds, we conducted two days of training at Redwood for species familiarization, and site specific safety training. 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.

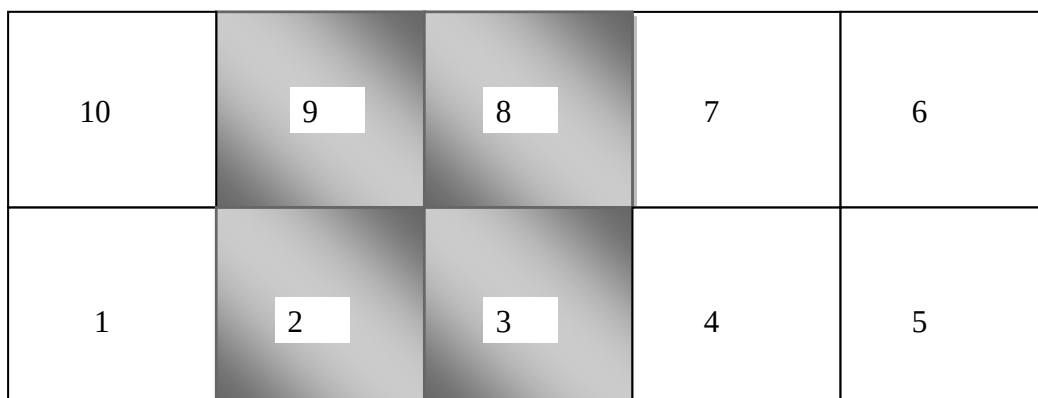


Figure 1. The 20 × 50 m matrix and high elevation site plot layout. Each numbered square is 10 × 10 m. Shaded squares are the four intensive modules.

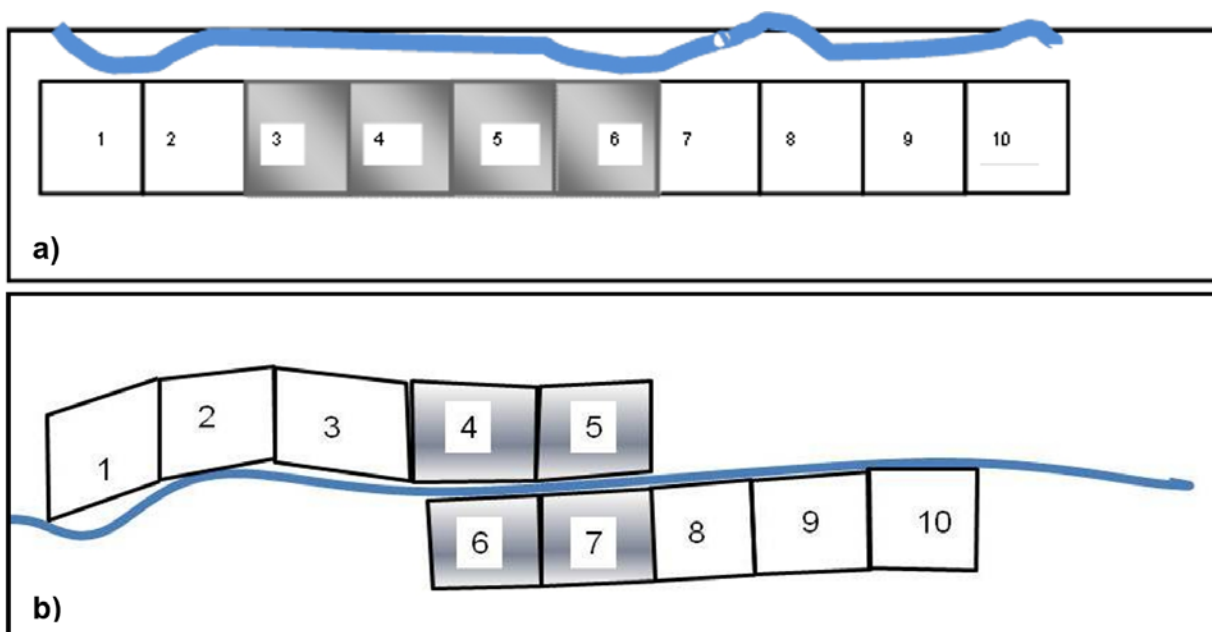


Figure 2. Riparian site plots in (a) one 10 × 100 m layout or (b) two 10 × 50 m layouts. Each numbered square is 10 × 10 m and shaded squares are the four intensive modules.

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), defined by time lag classes: how many hours would it would take for 2/3 of the dead fuel to respond to atmospheric moisture. In other words, how long for it to dry out. (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), also defined by lag classes (1000-hr sound; 1000-hr rotten)
15. Litter and duff (depth/thickness)

Data Management, Analysis, and Presentation

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. 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 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.

Multiple floras were used for species identification: The California Flora *Jepson Manuals 1 and 2* (Hickman et al. 1993, Baldwin et al. 2012), *Flora of the Pacific Northwest* (Hitchcock and Cronquist 1973), *Flora of North America* (V 24 and 25: 1993), and *Field Guide to Sedges of the Pacific Northwest* (Wilson et al. 2008). To correct differences in the taxonomic conventions of these various floristic references, we matched all identified species to the US Department of Agriculture, Natural Resources Conservation Service PLANTS database (2016). When an identified species did not have a direct match in PLANTS we carefully evaluated synonymy to match the field name to the accepted PLANTS name. The vascular plant taxonomy used in this report follows the United States Department of Agriculture (USDA) Plants Database (USDA, NRCS 2016).

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

Results

Sampling began at Lava Beds on May 23rd and ended on June 18th, 2017. Sampling occurred at Redwood from June 27th to Aug 28th, 2017. Our 2017 sampling went smoothly with the crew finishing well ahead of schedule. This allowed us to offer the crew's assistance on the Crater Lake Vegetation Mapping Project.

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

Lava Beds

At Lava Beds, we resampled 30 matrix sites (Figure 3).

Redwood

At Redwood, we resampled all 26 matrix sites, and 20 riparian sites. One riparian site, established in 2011, was not sampled and a replacement site was fully monumented and sampled (Figure 4 a,b).

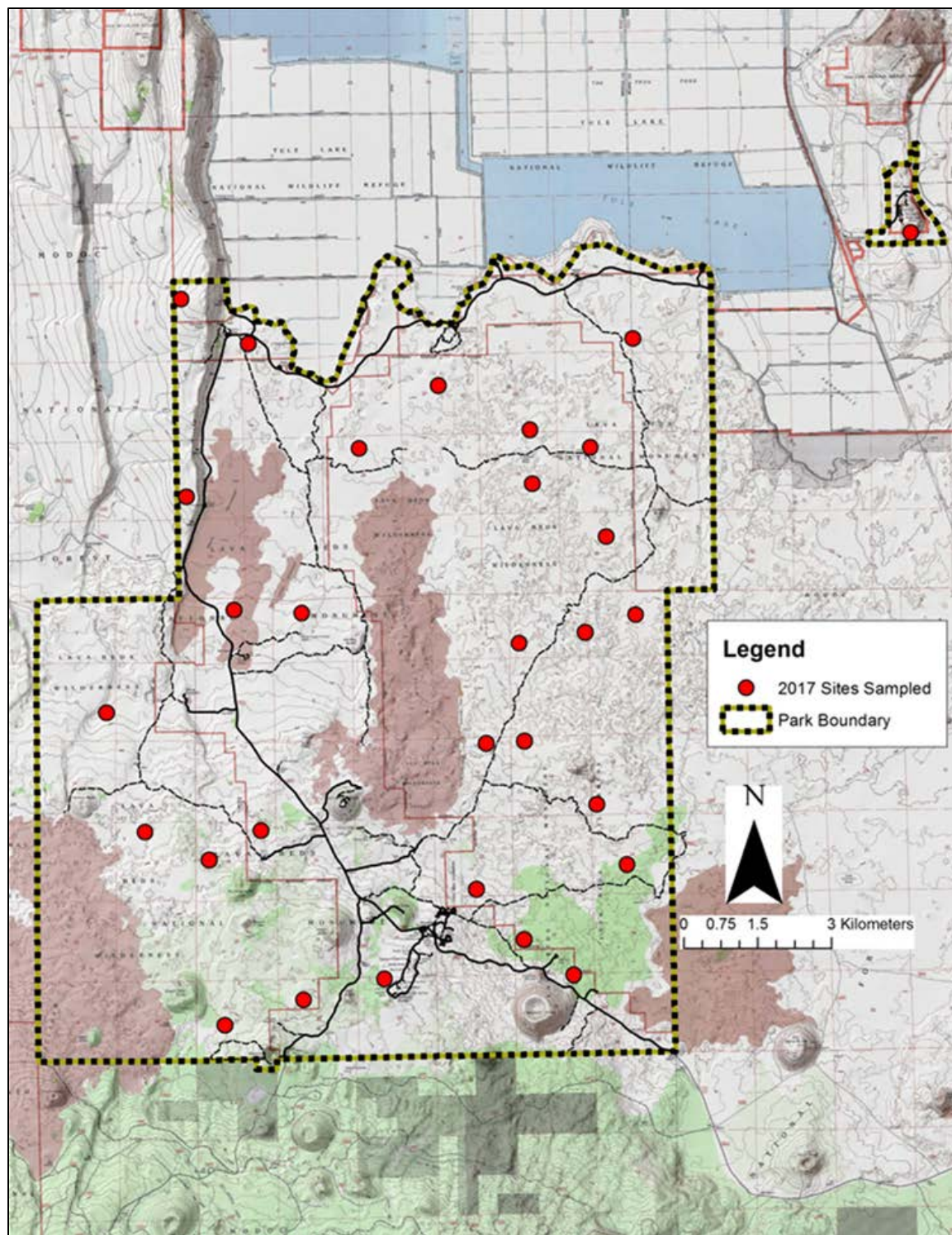


Figure 3. Location of vegetation monitoring sites at Lava Beds National Monument in 2017.

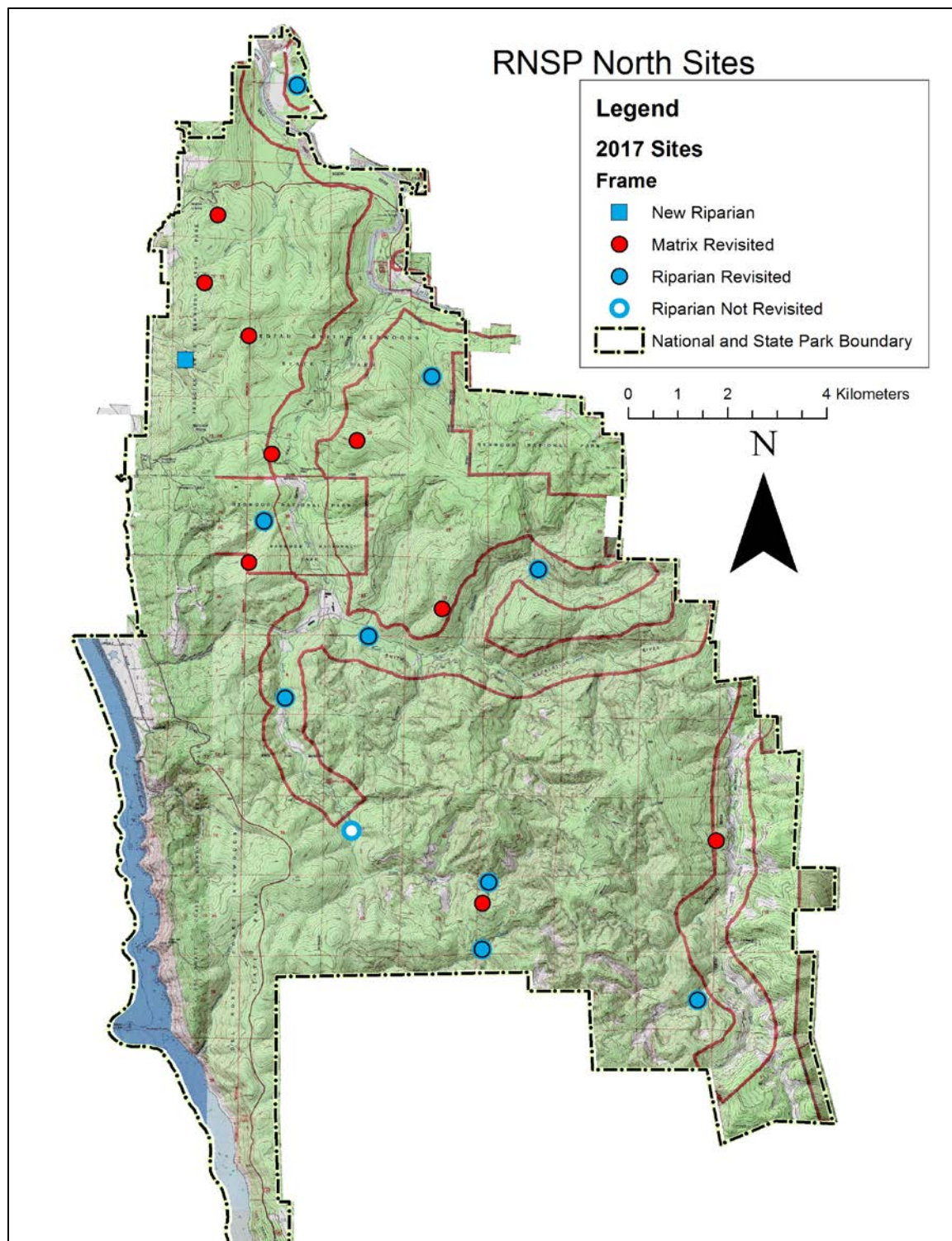


Figure 4a. Location of vegetation monitoring sites at Redwood (North sites) in 2017.

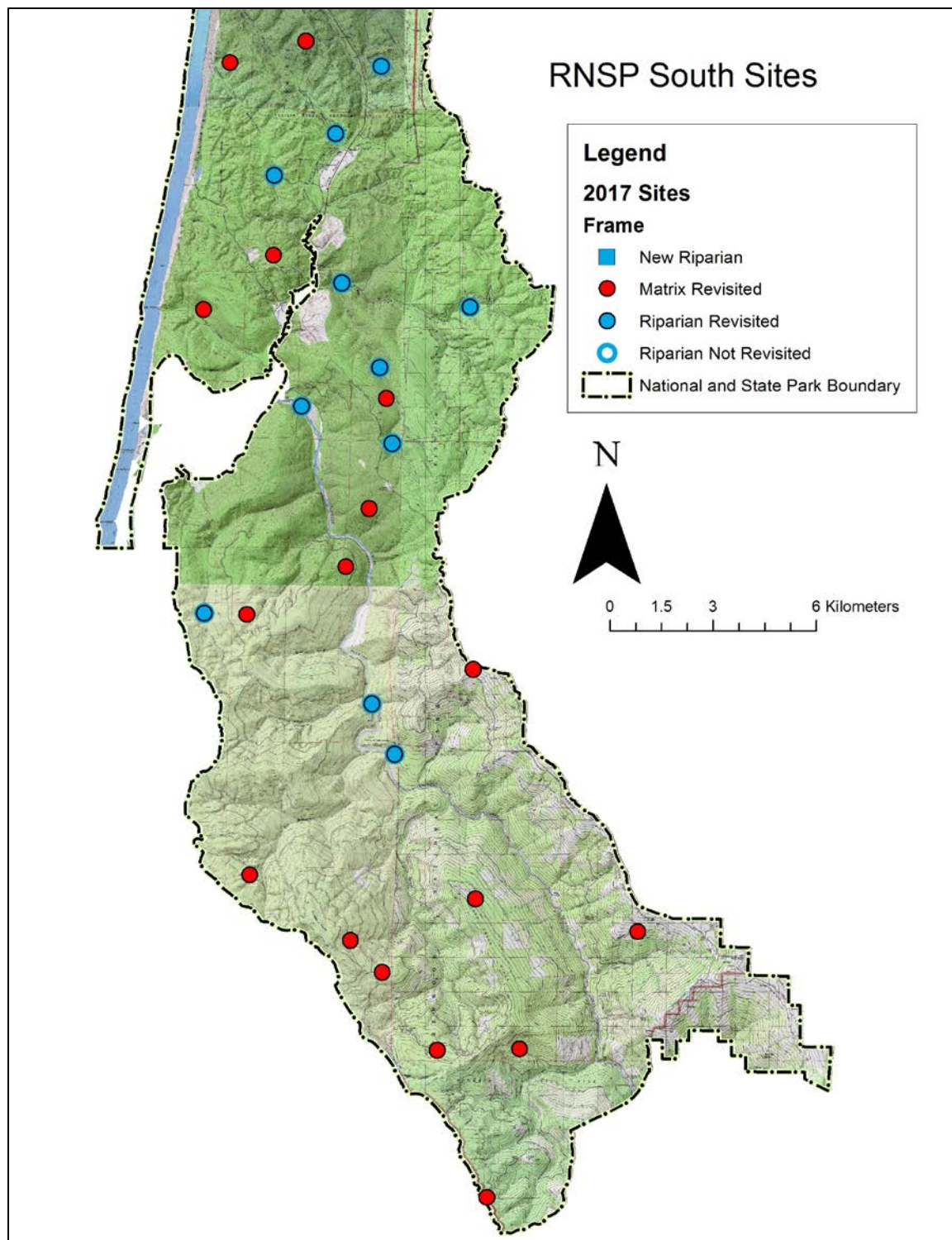


Figure 4b. Location of vegetation monitoring sites at Redwood (South sites) in 2017.

Vegetation Composition

Lava Beds

Vascular plant species richness for matrix plots at Lava Beds ranged from 12 to 45 species (Table 1, Figure 5), with an average species richness of 34. For all matrix plots, 121 species were recorded, although the total was 131 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 Table 2. Figure 6 shows the composition of tree basal area by tree species at each site.

Ten non-native species were observed in the matrix sample frame. Non-native species by site ranged from 3 to 42% of total site species richness (Figure 5).

Table 1. Vascular plant species richness (SR) range, mean (standard deviation in parenthesis), and sample frame total from the 2017 vegetation monitoring plots at Lava Beds.

Sample Frame	SR Range	SR Mean	Species Total
Matrix	12 - 45	33.8 (7.4)	131

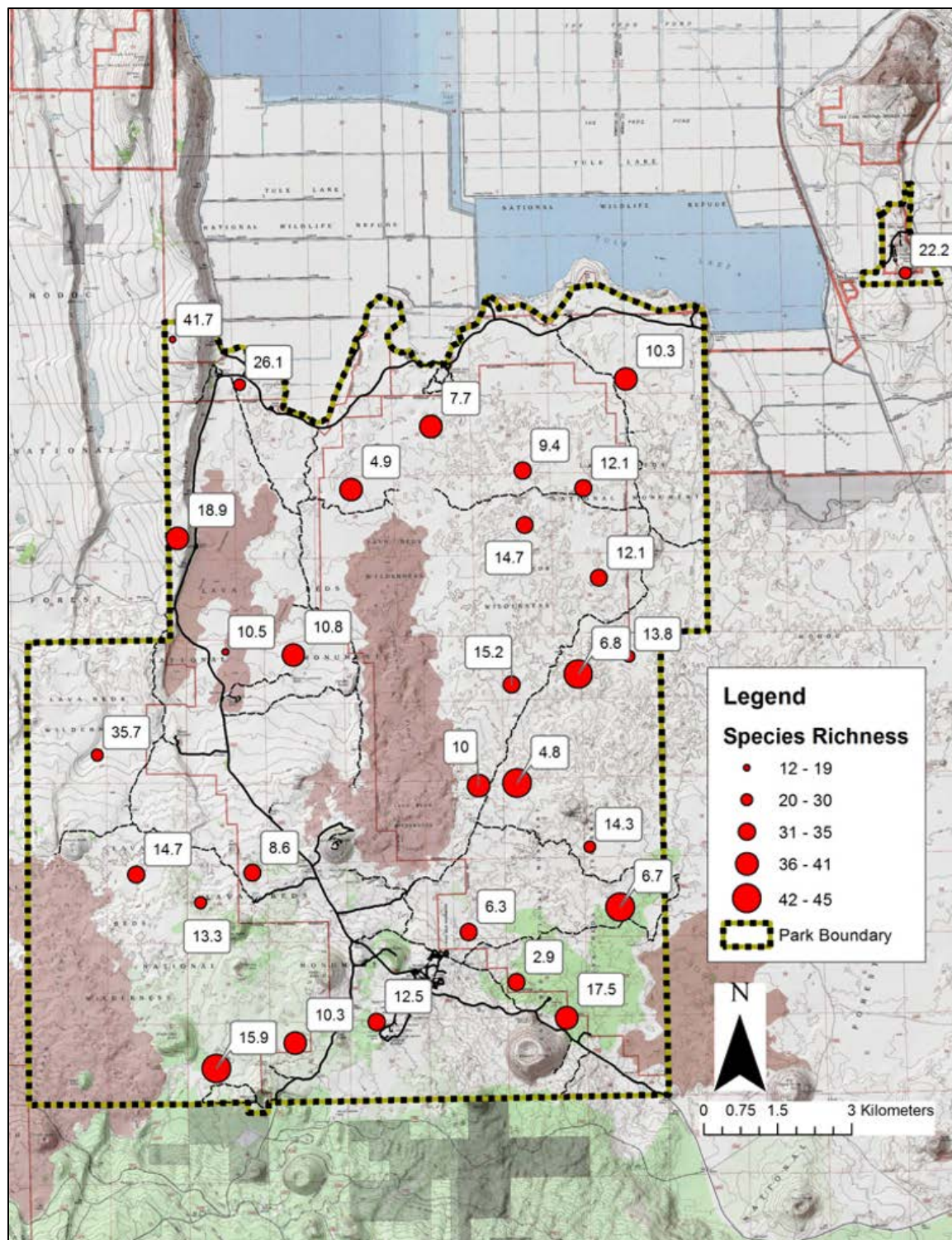


Figure 5. Vascular plant species richness for sites at Lava Beds in 2017. Numbers next to sites indicate the percentage of non-native species present. Sites without non-native species are not labeled.

Table 2. Most frequently occurring understory vascular plant species at Lava Beds matrix sites. Number indicates frequency (% of plots where species occurred).

Veg Type	Species	% Plots
Herb	<i>Poa secunda</i>	100
	<i>Bromus tectorum</i>	100
	<i>Elymus elymoides</i>	93
	<i>Achnatherum thurberianum</i>	87
	<i>Pseudoroegneria spicata</i> ssp. <i>spicata</i>	77
	<i>Crepis acuminata</i>	77
	<i>Arabis sparsiflora</i>	77
	<i>Draba verna</i>	73
	<i>Lactuca serriola</i>	70
	<i>Phacelia linearis</i>	63
Shrub	<i>Artemisia tridentata</i>	90
	<i>Ericameria nauseosa</i> ssp. <i>consimilis</i> var. <i>oreophila</i>	80
	<i>Purshia tridentata</i>	73
	<i>Ribes velutinum</i>	70

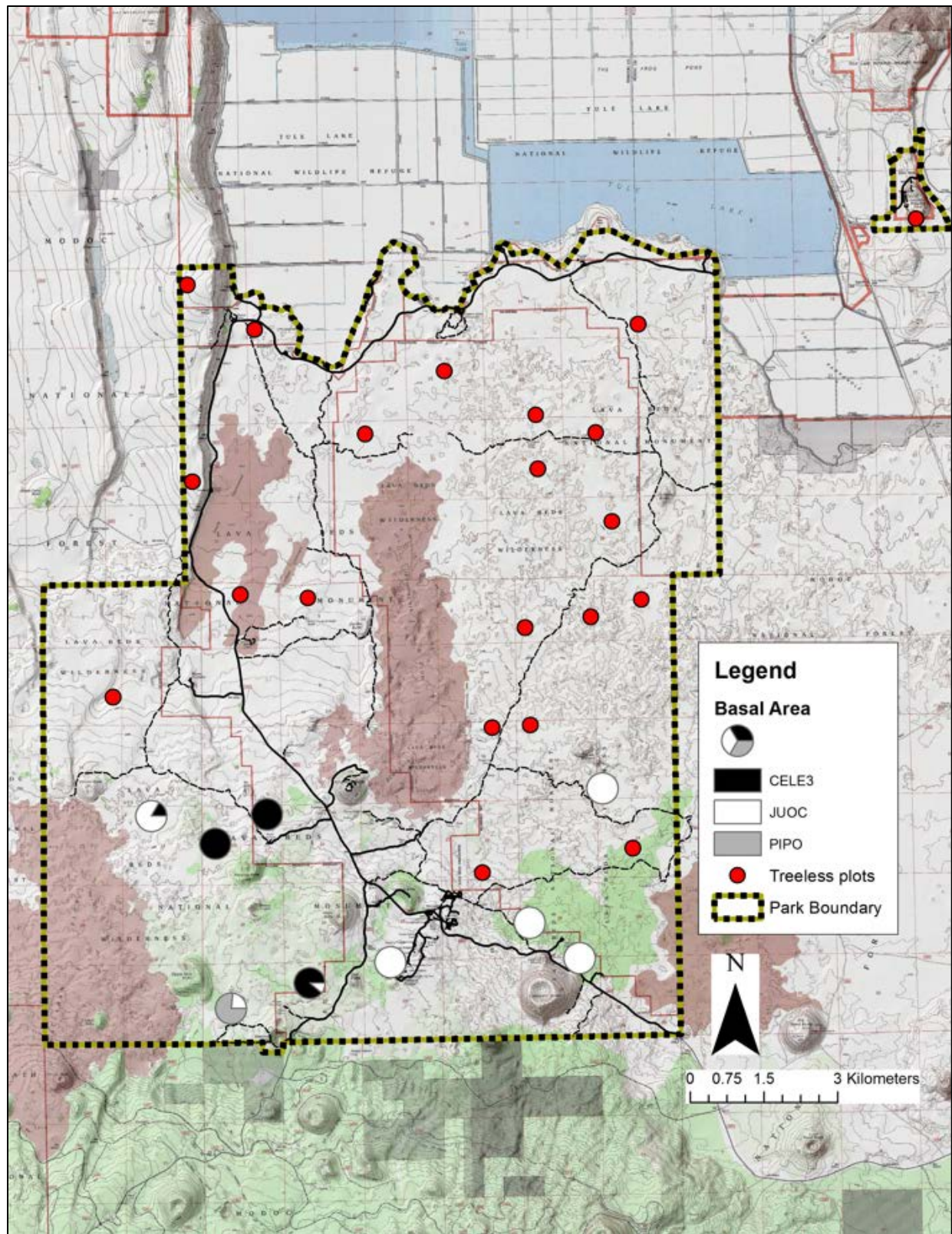


Figure 6. Individual tree species (>15 cm dbh) basal area composition at Lava Beds sites in 2017. CELE3- *Cercocarpus ledifolius*; JUOC- *Juniperus occidentalis*; PIPO- *Pinus ponderosa*.

Redwood

Vascular plant species richness in the Redwood matrix sampling frame ranged from 14 to 66 species per 0.1 ha sampling plot (Table 3, Figure 7a,b). Across all matrix plots sampled, we observed 139 species, although the total was 152 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 26 to 81 species, with 173 species observed (193 including unknowns). The most common herbaceous and shrub species by sample frame are shown in Tables 4, 5, and 6. Tree basal area composition by site is shown in Figure 8.

Non-native species composition ranged from 0 to 59% in matrix sites, and 0 to 60% in riparian sites (Figure 7). We observed sixty non-native species.

Table 3. Vascular plant species richness (SR) range, mean (standard deviation in parenthesis), and sample frame total from the 2017 vegetation monitoring plots at Redwood.

Sample Frame	SR Range	SR Mean	Species Total
Matrix	14 - 66	25 (12)	152
Riparian	26 - 81	45 (15)	193

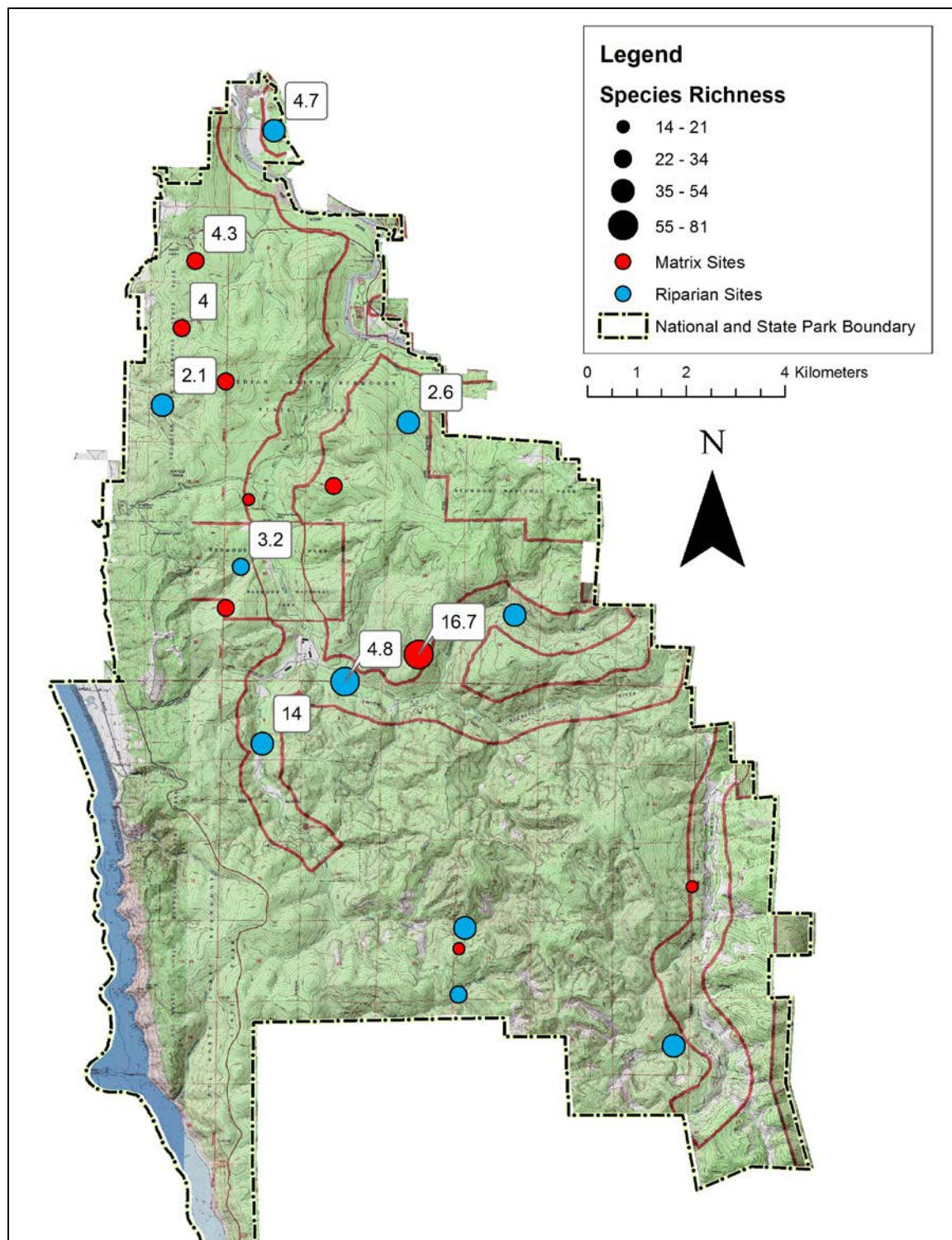


Figure 7a. Vascular plant species richness for sites at Redwood (north) from each sampling frame in 2017. Numbers next to sites indicate the percentage of non-native species present. Sites without non-native species are not labeled.

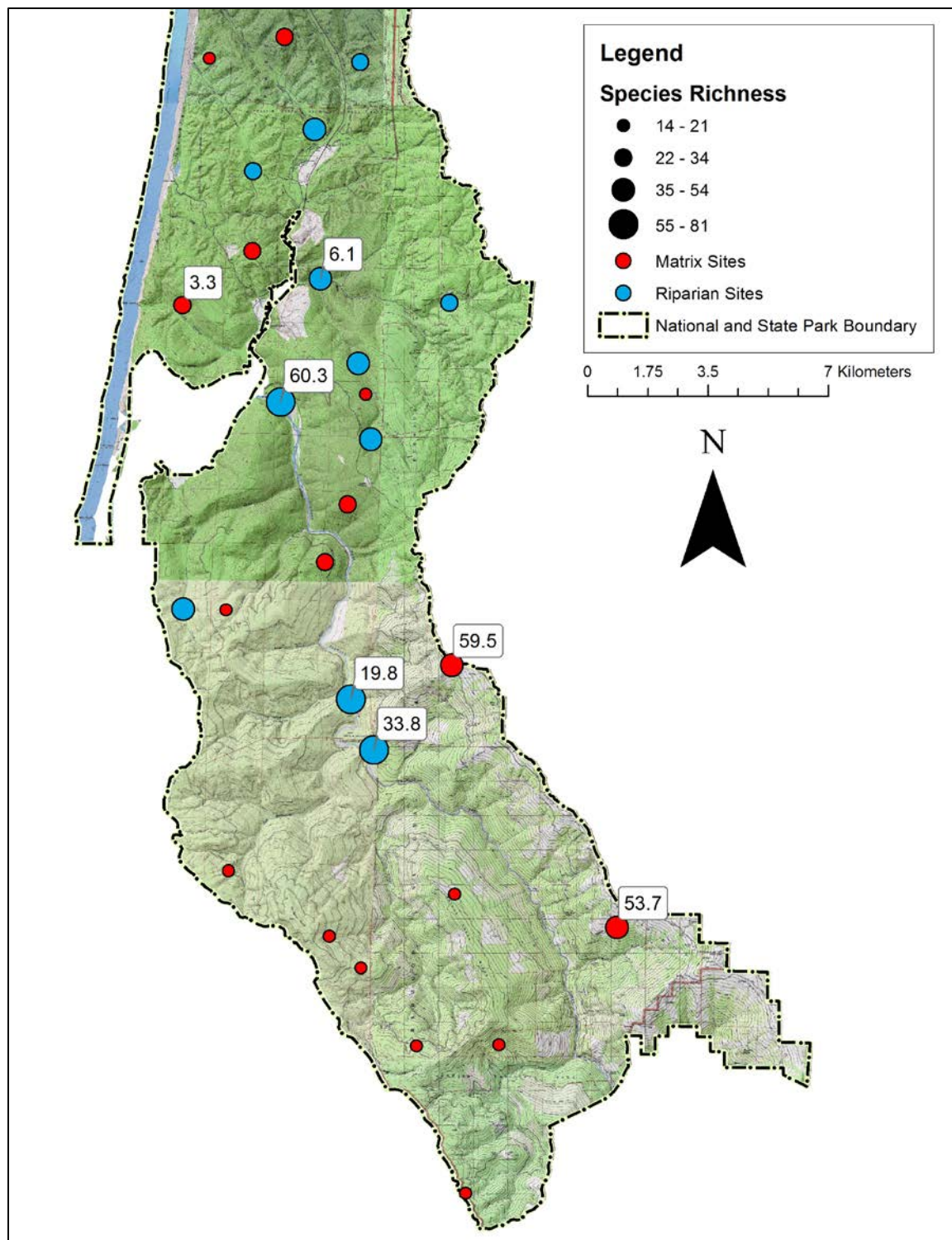


Figure 7b. Vascular plant species richness for sites at Redwood (south) from each sampling frame in 2017. Numbers next to sites indicate the percentage of non-native species present. Sites without non-native species are not labeled.

Table 4. Most frequently occurring understory vascular plant species at Redwood matrix sites. Number indicates frequency (% of plots where species occurred).

Vegetation Type	Species	% Plots
Herb	<i>Polystichum munitum</i>	92
	<i>Trillium ovatum</i>	85
	<i>Viola sempervirens</i>	85
	<i>Galium triflorum</i>	58
	<i>Blechnum spicant</i>	58
	<i>Oxalis oregana</i>	50
	<i>Trientalis borealis</i> ssp. <i>latifolia</i>	46
	<i>Goodyera oblongifolia</i>	46
	<i>Prosartes hookeri</i>	42
	<i>Pteridium aquilinum</i> var. <i>pubescens</i>	38
Shrub	<i>Vaccinium ovatum</i>	92
	<i>Gaultheria shallon</i>	88
	<i>Vaccinium parvifolium</i>	88
	<i>Rhododendron macrophyllum</i>	65

Table 5. Most frequently occurring understory vascular plant species at Redwood riparian sites. Number indicates frequency (% of plots where species occurred).

Vegetation Type	Species	% Plots
Herb	<i>Tolmiea menziesii</i>	95
	<i>Polystichum munitum</i>	95
	<i>Oxalis oregana</i>	95
	<i>Athyrium filix-femina</i>	90
	<i>Vaccinium parvifolium</i>	90
	<i>Ribes bracteosum</i>	81
	<i>Mimulus dentatus</i>	81
	<i>Galium triflorum</i>	81
	<i>Blechnum spicant</i>	76
	<i>Stachys rigida</i> var. <i>rigida</i>	76
	<i>Dryopteris expansa</i>	76
	<i>Carex leptopoda</i>	67
	<i>Prosartes smithii</i>	67
Shrub	<i>Rubus spectabilis</i>	90
	<i>Vaccinium ovatum</i>	81

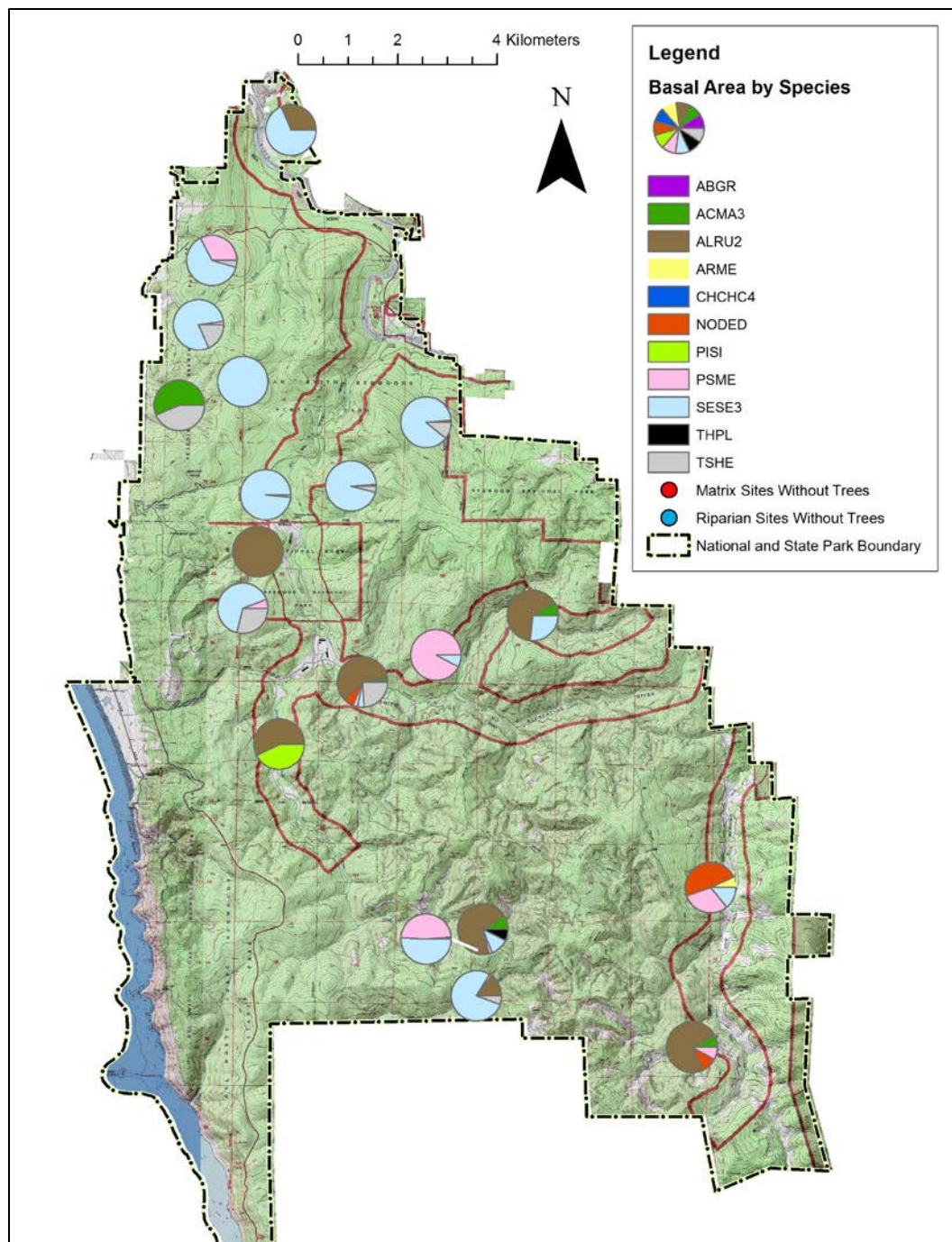


Figure 8a. Individual tree (>15 cm dbh) species basal area composition of Redwood (north) in 2017. White line indicated actual plot location, as basal area pie charts are offset to avoid overlap; treeless plots are not offset to avoid overlap. ABGR- *Abies grandis*; ACMA3- *Acer macrophyllum*; ALRU2- *Alnus rubra*; ARME- *Arbutus menziesii*; *Chrysolepis chrysophylla* var. *chrysophylla*; NODED-*Notholithocarpus densiflorus* var. *densiflorus*; PISI- *Picea sitchensis*; PSME- *Pseudotsuga menziesii*; SESE3- *Sequoia sempervirens*; THPL- *Thuja plicata*; TSHE-*Tsuga heterophylla*. Not shown: *Frangula purshiana* (5 sites); *Prunus emarginata* (1 site); *Salix scouleri* (1 site), all are less than 1 m²/ha when present at sites.

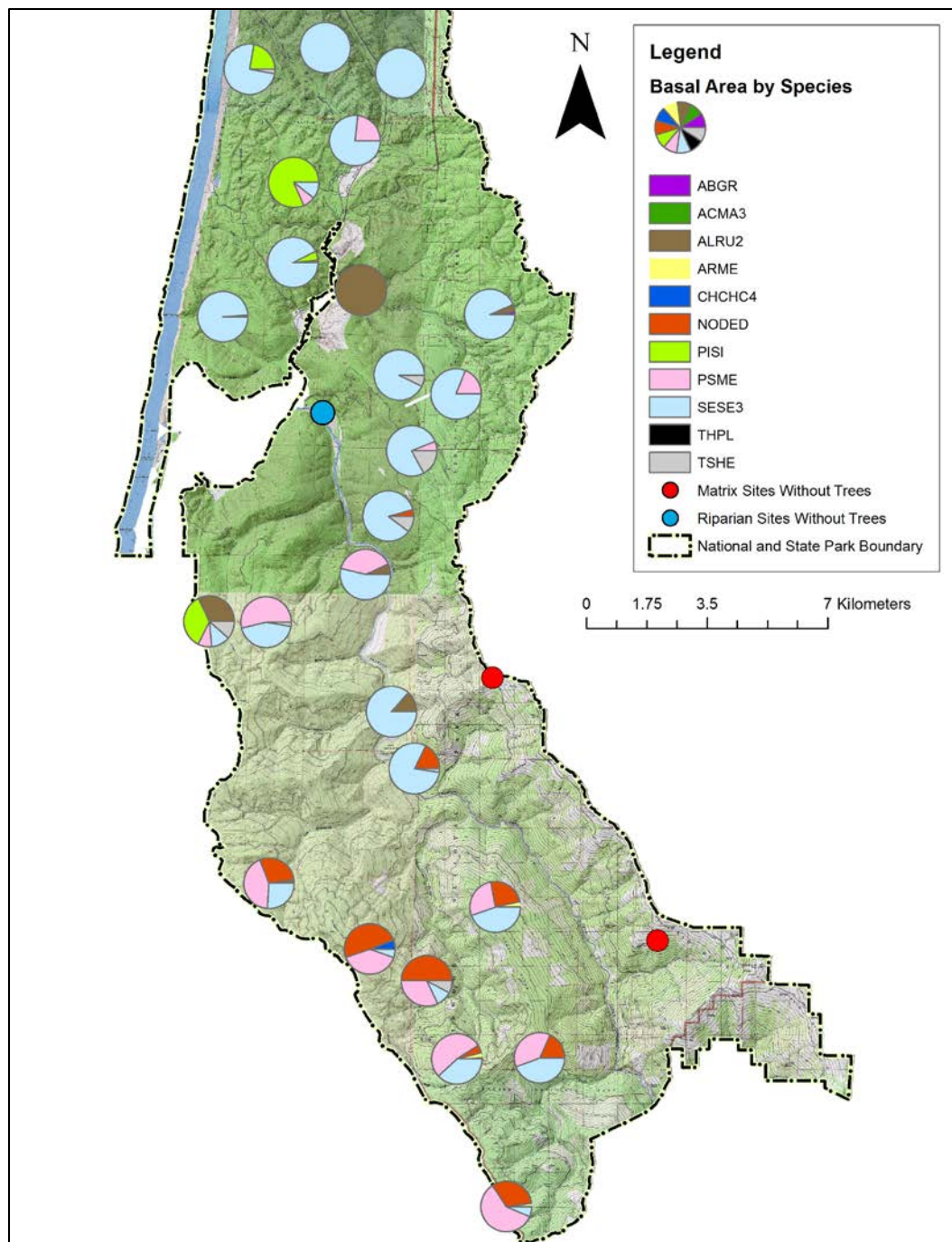


Figure 8b. Individual tree (>15 cm dbh) species basal area composition of Redwood (south) in 2017. White line indicated actual plot location, as basal area pie charts are offset to avoid overlap; treeless plots are not offset to avoid overlap. ABGR- *Abies grandis*; ACMA3- *Acer macrophyllum*; ALRU2- *Alnus rubra*; ARME- *Arbutus menziesii*; *Chrysolepis chrysophylla* var. *chrysophylla*; NODED- *Notholithocarpus densiflorus* var. *densiflorus*; PISI- *Picea sitchensis*; PSME- *Pseudotsuga menziesii*; SESE3- *Sequoia sempervirens*; THPL- *Thuja plicata*; TSHE- *Tsuga heterophylla*. Not shown: *Frangula purshiana* (5 sites); *Prunus emarginata* (1 site); *Salix scouleri* (1 site), all are less than 1 m²/ha when present.

Vegetation Structure

Lava Beds

The highest mean vegetation cover in the Lava Beds matrix sampling frame occurred in height stratum 1 (<0.75 m) (Table 6).

Table 6. Vegetation cover (%) by height stratum in the matrix sampling frame at Lava Beds. SD = standard deviation.

Height Stratum	Min.	Max.	Mean	SD
<0.75 m	5.1	90.2	43	25.8
0.75-2.5 m	0.5	43.25	19.90	13.10
2.6-5 m	0.00	18.00	2.36	4.33
>5 m	0.00	20.58	1.55	4.23

Mean plot basal area for the matrix sampling frame was 1.2 m²/ha for live trees and 0.02 m²/ha for snags (Table 7). Only nine of thirty matrix plots had trees >15cm dbh. Mean tree density was 15 trees/ha (Table 8). Table 8 also shows tree height, height to crown, and maximum height. Snag density and mean heights are shown in Table 9. Woody debris lag class values are presented in Table 10. Tables 12 and 13 summarize ground substrate cover and litter depth.

Table 7. Live tree and snag basal area (BA) minimum, maximum, mean, and standard deviation (SD) at Lava Beds. Units are m²/ha.

Frame	Min. Live Tree BA	Max. Live Tree BA	Mean Live Tree BA	Live Tree BA SD	Min. Snag BA	Max. Snag BA	Mean Snag BA	Snag BA SD
Matrix	0	10.6	1.22	2.7	0	0.4	0.02	0.01

Table 8. Mean live tree density (stems/ha), height (m), height to crown (m), and maximum tree height (m) at Lava Beds. Standard deviations are shown in parentheses.

Frame	Mean Tree Density	Mean Tree Height	Mean Height to Crown	Max. Tree Height
Matrix	15 (30.7)	6 (2)	1 (1)	12

Table 9. Mean snag density (stems/ha) and height (m) at Lava Beds. Standard deviations are shown in parentheses.

Frame	Mean Snag Density	Mean Snag Height
Matrix	0.7 (2.5)	5 (0)

Table 10. Mean woody debris time lag classes (tons per acre) at Lava Beds. Standard deviations are shown in parentheses (see page 4, #13 and #14 for lag class size criteria).

Frame	1-hr	10-hr	100-hr	10000-hr Rotten	1000-hr Sound
Matrix	0.09 (0.1)	0.3 (0.4)	0.3 (0.6)	0 (–)	0.7 (2.1)

Table 11. Ground/substrate mean percent cover at Lava Beds. Standard deviations are shown in parentheses.

Frame	Bare Soil	Bryophytes	Coarse Wood	Fine Wood / Litter	Rock	Water
Matrix	21.4 (20.1)	1.7 (1.8)	1.2 (2.1)	39.3 (22.8)	36.5 (27.4)	0.0

Table 12. Litter and duff minimum, maximum, and mean depth at Lava Beds. 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
Matrix	0.6 (0.5)	0.8	2.5	0.1 (0.2)	0	0.7

Redwood

Mean percent vegetation values are shown in Table 13. The highest mean values for vegetation cover, 88.8 and 89.7 %, were found in matrix and riparian (respectively) height stratum 4 (>5 m) (Table 13).

Table 13. Vegetation cover (%) by height stratum in matrix and riparian sampling frames at Redwood. SD = standard deviation.

Height Stratum	Frame	Min.	Max.	Mean	SD
<0.75 m	Matrix	2.3	129.4	19.1	26.9
	Riparian	6.6	76.0	26.2	21.2
0.75-2.5 m	Matrix	13.9	78.8	39.	17.2
	Riparian	17.2	144.1	60.9	28.1
2.6-5 m	Matrix	0.0	70.5	24.2	18.0
	Riparian	0.0	37.5	5.4	8.0
>5 m	Matrix	0.0	159.8	88.8	39.9
	Riparian	0.0	132.3	89.7	32.5

Mean live tree basal area at Redwood was highest in the matrix sampling frame (122 m²/ha) (Table 14). Mean snag basal area (31.2 m²/ha) was also highest in the matrix sample frame (Table 14). Two matrix plots lacked live trees >15cm dbh. Matrix site mean tree density was 413 trees/ha (Table 15), and mean snag density was 51 trees/ha (Table 16). Riparian mean basal area was 77.7 m²/ha, while snag basal area was 6.8 m²/ha (Table 14). Only one riparian site lacked trees >15 cm dbh. Mean tree density in the riparian frame was 342 tree/ha, and snags were the highest density of all three sample frames at 25 trees/ha. Dead and down woody debris data are shown in Table 17. Substrate cover and litter and duff are shown in Tables 19 and 20.

Table 14. Live tree and snag basal area (BA) minimum, maximum, mean, and standard deviation (SD) for sampling frames at Redwood. Units are m²/ha.

Frame	Min. Live Tree BA	Max. Live Tree BA	Mean Live Tree BA	Live Tree BA SD	Min. Snag MA	Max. Snag BA	Mean Snag BA	Snag BA SD
Matrix	0.0	287.3	122.0	90.8	0.0	294.7	31.2	68.8
Riparian	0.0	215.8	77.7	54.6	0.0	74	6.8	16.6

Table 15. Mean live tree density (stems/ha), height (m), height to crown (m), and maximum tree height (m) at Redwood. Standard deviations are shown in parentheses.

Frame	Mean Tree Density	Mean Tree Height	Mean Height to Crown	Max. Tree Height
Matrix	413 (330)	25 (13)	14 (7)	95
Riparian	342 (229)	26 (12)	12 (6)	110

Table 16. Mean snag density (stems/ha) and height (m) at Redwood. Standard deviations are shown in parentheses.

Frame	Mean Snag Density	Mean Snag Height
Matrix	51 (41)	12 (9)
Riparian	25 (39)	8 (7)

Table 17. Summary of mean woody debris time lag classes (tons per acre) at Redwood. Standard deviations are shown in parentheses (see page 4, #13 and #14 for lag class size criteria).

Frame	1-hr	10-hr	100-hr	10000-hr Rotten	1000-hr Sound
Matrix	0.33 (0.20)	1.78 (0.89)	2.74 (2.01)	58.6 (56.7)	91.024 (335.23)
Riparian	0.22 (0.23)	1.29 (0.97)	1.62 (1.48)	118.54 (219.74)	28.32 (48.36)

Table 18. Ground/substrate mean percent cover at Redwood. Standard deviations are shown in parentheses.

Frame	Bare Soil	Bryophytes	Coarse Wood	Fine Wood / Litter	Rock	Water
Matrix	0.7 (1.1)	1.7 (2.2)	11.2 (7.8)	80.2 (10.0)	0.5 (0.5)	0
Riparian	7.1 (13.7)	4.2 (6.9)	9.5 (6.3)	63.3 (14.4)	7.4 (10.9)	3.3 (3.3)

Table 19. Litter and duff minimum, maximum, and mean at Redwood. 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
Matrix	2.6 (1.1)	0	4.3	2.7 (2.4)	0	8.1
Riparian	3.2 (1.6)	0.1	6.2	2.1 (2.5)	0	10.2

Vegetation Function (Regeneration)

Lava Beds

In the matrix sampling frame at Lava Beds mountain mahogany (*Cercocarpus ledifolius*) was the most abundant regenerating tree species in all classes. Mean regeneration counts for all tree size classes are shown in Table 20.

Table 20. Regeneration by size class for all live tree species in the matrix sampling frame at Lava Beds. Units are trees/ha, and standard deviations are shown in parentheses.

Frame	≤15 cm Tall	<2.54 cm dbh*	2.54 to 5 cm dbh*	>5 to 10 cm dbh*	>10 to <15 cm dbh*
Matrix	158 (391)	950 (2919)	70 (209)	68 (165)	17 (41)

* Trees >15 cm tall.

Redwood

At Redwood, the most abundant regenerating tree species in the matrix sampling frame, tan oak (*Notholithocarpus densiflorus* var. *densiflorus*) had the highest density in three size classes except where redwood (*Sequoia sempervirens*) dominated at 2.54-5 cm dbh, and in the >10 to <15 cm dbh category, where Douglas-fir (*Pseudotsuga menziesii*) dominated. For the riparian sample frame, three trees comprised the dominants over the five classes: cascara (*Frangula purshiana*), ≤15 cm Tall, 2.54 to 5 cm dbh, and >5 to 10 cm dbh; redwood <2.54 cm dbh; red alder (*Alnus rubra*) >10 to <15 cm dbh. Mean regeneration counts for all trees by size class are shown in Table 21.

Table 21. Regeneration by size class for all live tree species in each sampling frame at Redwood. Units are trees/ha, and standard deviations are shown in parentheses.

Frame	≤15 cm Tall*	<2.54 cm dbh*	2.54 to 5 cm dbh*	>5 to 10 cm dbh*	>10 to <15 cm dbh*
Matrix	548 (781)	769 (1000)	152 (220)	156 (178)	85 (112)
Riparian	536 (1225)	286 (672)	71 (78)	85 (107)	71 (107)

* Trees >15 cm tall.

Summary

Overall the season was a success. We revisited all sites at Lava Beds. At Redwood we replaced a site overgrown with blackberry and revisited all other sites. We had no injuries.

Non-native Species

We will continue to monitor the abundance of non-native species. Locations of non-native species are available to parks upon request.

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