



Vegetation Composition, Structure, and Function *Redwood National and State Parks, 2011*

Background and Importance

Vegetation defines habitat for most other forms of life, makes up most of the biomass on the landscape, and plays an important role in energy pathways. Changes in vegetation composition, structure, and function will therefore have a profound effect on ecosystems. The vegetation of the Klamath parks contributes to the renowned biodiversity of the region. Climate and fire are major drivers of vegetation change. Fire suppression, climate change, local land-use changes, and non-native species invasions can result in significant changes in vegetation communities. Monitoring vegetation is critical to detecting and understanding status and trends in vegetation as well as other park vital signs.

The Klamath Network (KLMN) Inventory & Monitoring Program measures vegetation composition, structure, and function on selected sampling frames in each of six parks of the network every three years (Odion et al. 2011). Parks are paired to enable sampling to be timed well with plant development and flowering. Monitoring began at Lava Beds National Monument (LBE) and Redwood National and State Parks (RNSP) in 2011.

Monitoring Objectives

Following are the vegetation monitoring objectives:

1. Describe the composition, structure, and function of vegetation communities in Klamath Network parks by installing and sampling a network of permanent plots established with a probabilistic sample design in safe, relatively accessible areas.
2. Quantify temporal and spatial change in these factors through the re-measurement of permanent plots.
3. Sample communities of special concern (alpine and riparian) at greater intensities to allow improved statistical sensitivity to ecological change and better identification of emerging threats.
4. Co-locate some vegetation plots with bird and stream sampling locations to provide more comprehensive status and trend data and evaluate interrelationships among biota.

Monitoring Approach

The monitoring sampling frame used was constrained for safety and logistical reasons to exclude areas with slopes greater than 30 degrees, and locations less than 100 meters (m) or more than 1 kilometer (km) from a road or trail. Across all parks, three types of sampling



An example of vegetation structure at a monitoring plot in Redwood National and State Parks. NPS photo.

frames are recognized: 1) Riparian (areas within 20 m horizontally of a perennial stream), 2) High Elevation (elevations above a specific elevation limit in each park), and 3) Matrix (remaining areas).

Between June 6 - September 27, 2011, the field crew established 26 matrix sites and 21 riparian sites at Redwood. All of the matrix sites were co-located with bird monitoring sites. A 20 x 50 m plot was used for sampling all of the sites. A wide range of data is collected from each plot. On each forested plot, vegetation is assessed in four strata, from tree canopy to ground layers. Each plot consisted of ten 10 x 10 m modules, four of which are sampled intensively for species, ground cover, and seedling and sapling data (Figure 1). Other components of vegetation examined include down wood, litter, and duff.

10	9	8	7	6
1	2	3	4	5

Figure 1. The 20 x 50 meter matrix site layout. Each numbered square is 10 x 10 meters. Shaded squares are the four modules where more intensive sampling occurs.

Results

Vegetation Composition

Vascular plant species richness at Redwood ranged from 13-58 species per 0.1 ha sampling plot (Figure 2). Across all matrix plots sampled, 148 (169 when counting unknowns) species were observed. The riparian sampling frame proved to be very diverse: Species richness at the plot level ranged from 23-84 species, with 182 species observed (212 when counting unknowns). Overall 264 species were observed (275 when counting unknowns).

The most frequent understory species in both sampling frames was sword fern (*Polystichum munitum*). The most frequently occurring shrub in the matrix and riparian sampling frames were salal (*Gaultheria shallon*) and salmon berry (*Rubus spectabilis*), respectively. Non-native species composition ranged from 0-70 percent in matrix sites, and 0-59 percent in riparian sites. We observed 38 non-native species in the matrix sampling frame, and 45 in the riparian. None of these species occurred with notable frequency. Fourteen tree species were observed; 11 occurred in the matrix sampling frame and all 14 in the riparian frame. Tree composition by site is shown in Figure 3.

Three forbs were observed that, if confirmed, would be new additions to the RNSP flora: 1) Oregon bent grass (*Agrostis oregonensis*)—was observed at one plot; 2) Broad-leaved lotus (*Lotus crassifolius*)—was

observed at one plot; 3) Sweet briar (*Rosa eglanteria*)—was observed at one plot. Additional specimens would need to be collected of the first two species to confirm identification, but the third, *Rosa eglanteria*, is a non-native species that is distinctive and was identified with confidence on-site.

Vegetation Function (Regeneration)

In the matrix sampling frame tan-bark oak (*Lithocarpus densiflorus*) was the most abundant regenerating tree in all size classes except >2.54 - <5 cm DBH, where coast redwood (*Sequoia sempervirens*) was the most abundant. In the riparian sampling frame coffee berry (*Frangula purshiana*) was the most abundant regenerating tree in the smallest two classes; red alder (*Alnus rubra*) was the most abundant regenerating tree in the largest three size classes. Mean regeneration counts for all tree species combined by size class are provided in Smith and Sarr (2013).



Tan-bark oak acorns. Photo: www.forestfarm.com.

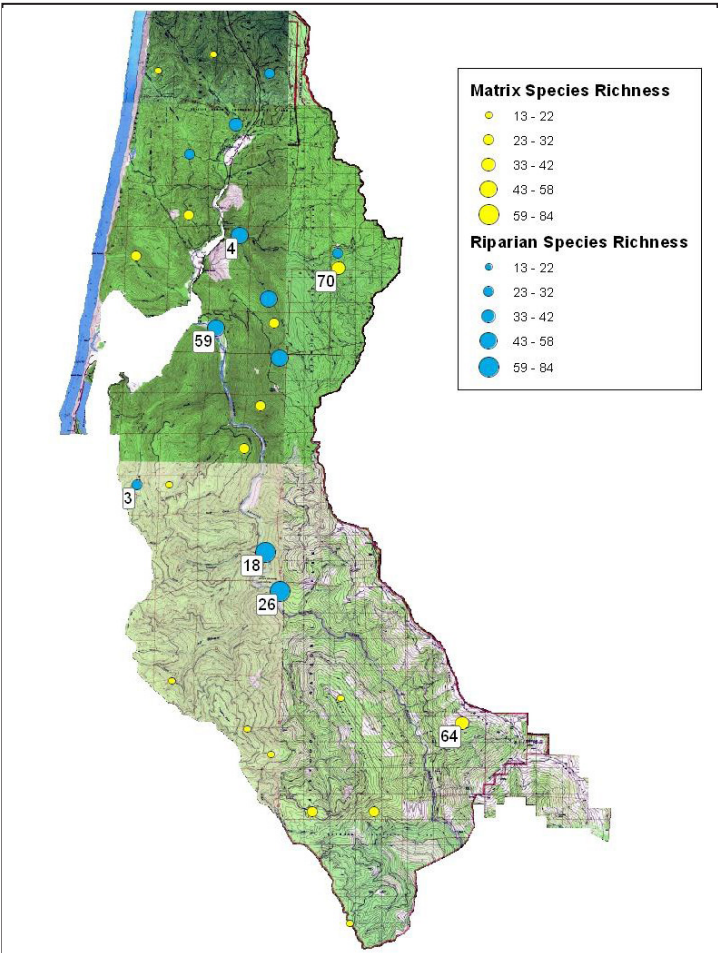
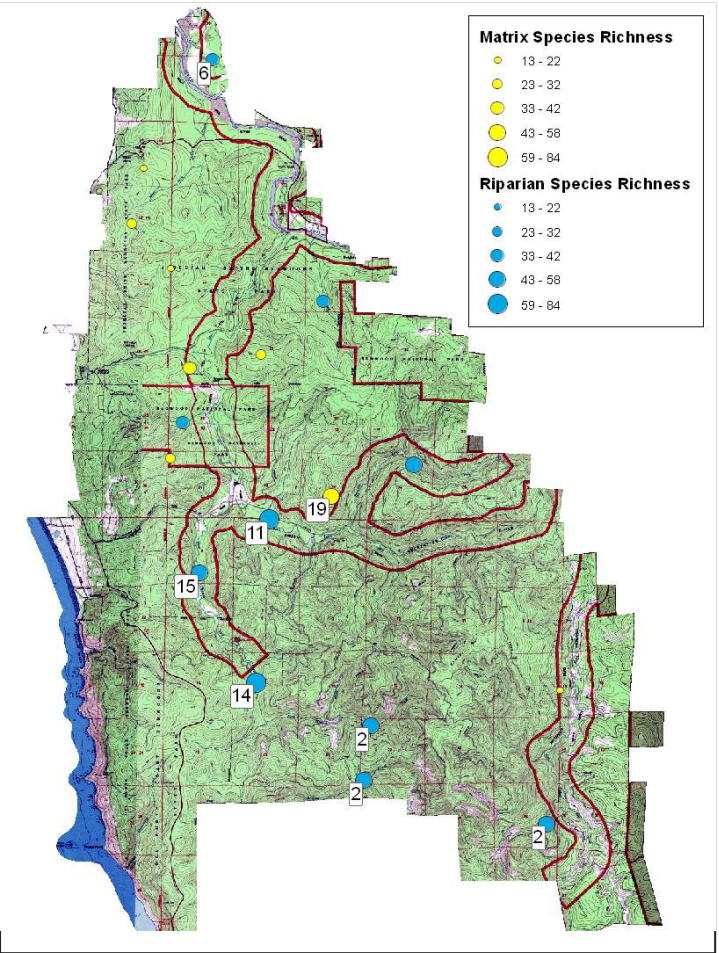


Figure 2. Site species richness from each sampling frame displayed by yellow or blue bubble sizes. White labels show percentage of species that are nonnative. Sites without a label do not have any nonnative species. The northern half of the park is shown on the left and the southern half on the right. (The central portion of the park has been excluded, as KLMN did not have any plots there). Red lines delineate Smith River tributaries.

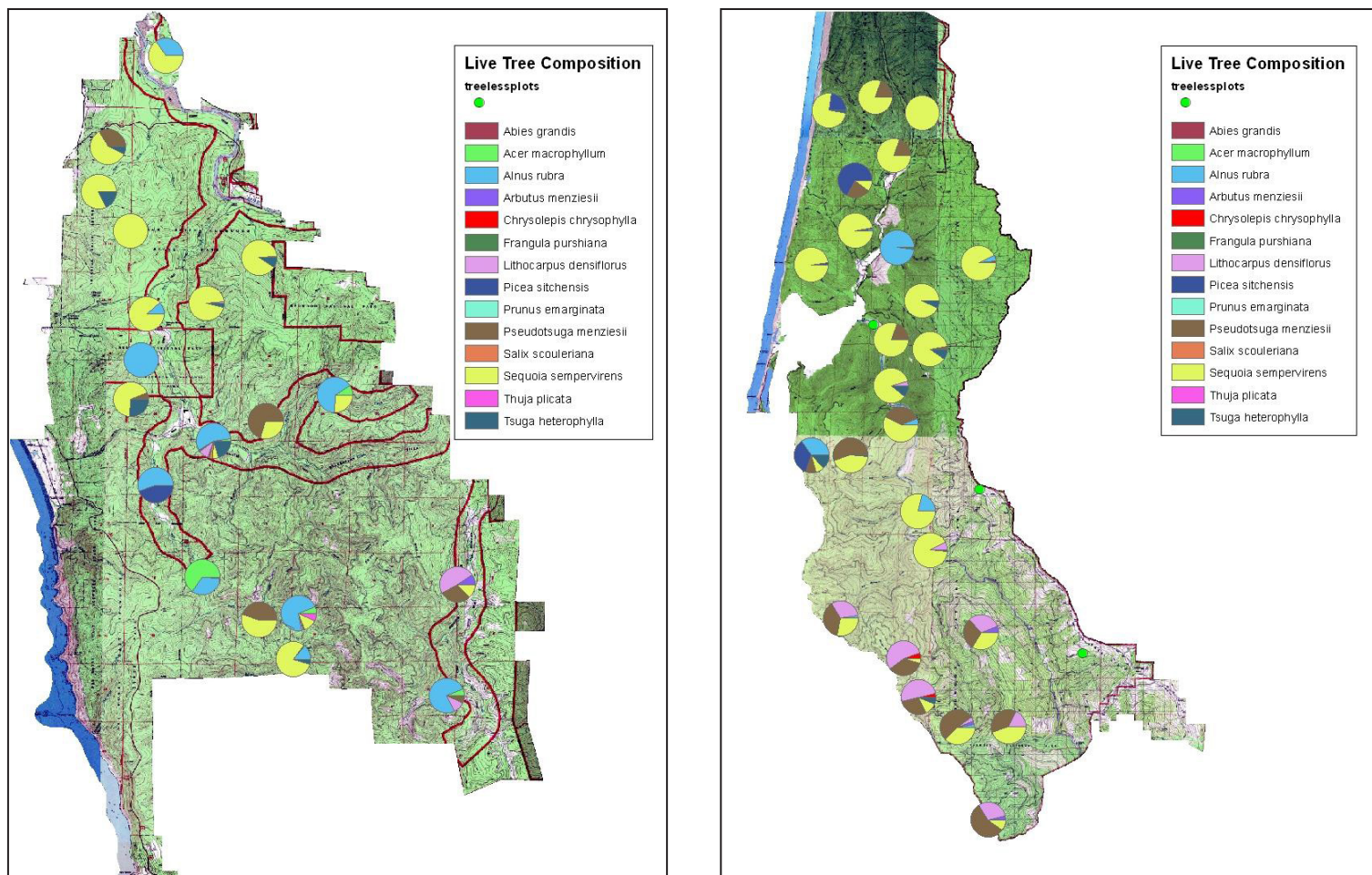


Figure 3. Tree species composition for all RNSP sites sampled in 2011. The northern half of the park is shown on the left and the southern half on the right.

Vegetation Structure

At RNSP average vegetation cover percent was highest in stratum 4 (>5m height), with an average of 80.1 percent (S.D. 29.5) and 74.9 percent (S.D. 27), for the matrix and riparian, respectively; both sampling frames had a maximum of 131.5% cover. The photo on page 1 shows an example of vegetation structure at RNSP.

Mean live tree basal area at RNSP was high, with the matrix (301 m²/ha) and riparian (250.9 m²/ha) being comparable. Snag basal area was much lower than live tree basal area. Two matrix and one riparian plot lacked trees. Matrix site tree density mean (458 trees/ha) was higher than the riparian (325 trees/ha), and snags followed a similar pattern, but with the totals being a whole order of magnitude less (Table 1).

Mean shrub heights were comparable between the matrix 1.97 m (S.D. 1.01 m) and riparian 1.83 (S.D. 0.89 m). The matrix minimum was 0.0 m and the maximum 3.84 m, two plots lacked shrubs. The riparian minimum was 0.56 m and the maximum 4.47 m, all plots contained shrubs.

Fine wood and litter was the dominant ground cover in both the matrix and riparian sampling frame. Coarse wood was the second most prevalent ground cover in the matrix, while bryophytes had second highest cover for the riparian frame. Mean litter and duff depths were greater for the matrix sampling frame. See Smith and Sarr (2103) for more information about vegetation structure.

Table 1. Basal Area (BA) minimum, maximum, average, and standard deviation for sampling frames. Units are m²/ha.

Sampling Frame	Minimum Basal Area	Maximum Basal Area	Mean Basal Area	Standard Deviation
Matrix - Live Trees	0.00	301.02	113.74	90.89
Riparian - Live Trees	0.00	250.94	81.31	71.74
Matrix - Snags	0.00	26.46	2.81	6.65
Riparian - Snags	0.00	7.26	0.91	1.77



Comparisons with Other KLMN Parks

As this is the first season implementing our Vegetation Monitoring Protocol (Odion et al. 2011) we can only present data on status. Data collected in 2011 were for the most part what we expected: Lava Beds and Redwoods, located at opposite ends of the coast to interior climate gradient, have very different vegetation composition. Species overlap between the two parks was limited to four species: *Achillea millefolium*, *Galium aparine*, *Sambucus mexicana*, and *Taraxacum officinale*.

Differences in structure are obvious to anyone who has driven through these parks, and are reaffirmed by our data. Overall generalities are that Lava Beds has moderate understory cover and very sparse overstory cover, low basal area and tree density, and the trees that are present aren't very tall; correspondingly, litter, duff and woody debris are also low. At Redwood, the generalities are opposite on all accounts, with RNSP even boasting some of the tallest trees in the world. Subsequent monitoring years in the other KLMN parks revealed that only one species was consistently observed among all six parks: Common yarrow (*Achillea millefolium*) (Smith and Sarr, in review).

Logistics

The 2011 sampling effort at RNSP resulted in meeting 65% (26/40) of our sample size goal for the matrix sites and 80% (21/26) for riparian sites. Sampling logistics were challenging due to conditions such as high tree density, high species diversity, high cover percentages, tall understory vegetation (shrubs mostly), difficult off-trail hiking (bush whacking), long drive time to plots, and large and dense down woody debris.

Sampling at RNSP could have been made more efficient if we had camped closer to some of the sites requiring more drive time. We will aim to work with RNSP to allow crews to camp on park lands where drive times are high. Reducing drive time would likely liberate 3-5 person days for additional sampling. However, even with this time gained, we anticipate needing to reduce our sample number goals for future years.

At RNSP, two sites along Redwood Creek had very dry vegetation when we sampled them in mid September; these sites should be sampled in mid August at the latest. Sampling of all other plots seemed to capture most species before they senesced.

Management Relevance

Annual reports from this project provide parks information about the status of vegetation community composition, function, and structure. This includes documentation of non-native species locations, plant species newly discovered for the park, and vegetation responses to disturbances such as extreme weather events or fire. Over time, trend data will provide valuable information on spatial and temporal patterns of vegetation change, providing a foundation for resource stewardship activities and research projects that can be directed at better understanding the causes of observed changes.



Vegetation monitoring crew member laying out a transect in Redwood National Park. NPS photo.

References Cited

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More Information

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<http://science.nature.nps.gov/im/units/klmn/monitor/vegetation.cfm>