



Vegetation Composition, Structure, and Function

Crater Lake National Park, 2013

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 Crater Lake National Park and Oregon Caves National Monument in 2013.

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



Plot CRLA29 showed recent fire activity. Two invasive species were observed at this site, bull thistle (*Cirsium vulgare*) and woodland ragwort (*Senecio sylvaticus*).

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).

At Crater Lake, field crews established 26 matrix sites, 15 co-located with bird monitoring sites; 20 riparian sites, 17 co-located with stream monitoring sites; and 20 high elevation sites, 10 co-located with whitebark pine monitoring sites. A 20 x 50 m plot was used for sampling matrix 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

We had one confirmed new species, Starweed (*Cerastium fontanum*) (Figure 2). We also observed four species that if confirmed, would be new additions to the park: Northwestern moonwort (*Botrichium pinnatum*), Smooth-beak sedge (*Carex integra*) and still to be identified species of *Carex* and *Erigeron*.

Species richness in the Crater Lake matrix sampling frame ranged from 7-36 species per 0.1 ha sampling plot (Figure 3). Across all matrix plots sampled, 81 species (87 when counting unknowns) were observed. The riparian sampling frame proved to be very diverse; species richness at the plot level ranged from 52-89 species, with 250 species observed (293 when counting unknowns). Species richness in the high elevation frame ranged from 5-28, with 60 species observed (72 when counting unknowns).

Non-native species composition ranged from 0-11.1 % in matrix sites, 0-3.8 % in riparian sites, and 0 % for all sites in the high elevation frame (Figure 3). We observed three non-native species in the matrix sampling frame and three in the riparian. Of the six non-natives observed (*Chenopodium album*, *Gallium aparine*, *Cerastium fontanum*, *Taraxacum officinale*, *Cirsium vulgare*, and *Senecio sylvaticus*) the latter three are on the KLMN Invasive Species Early Detection prioritization list (Odion et al 2010). Only dandelion (*Taraxacum officinale*) and bedstraw (*Gallium aparine*) were observed with notable frequency in the riparian sampling frame (each at six sites).

Twelve tree species were observed; nine occurred in the matrix sampling frame, eight in the riparian frame, and four in the high elevation frame. See Figure 4 for the basal area composition at each site by species.



Figure 2. *Cerastium fontanum*, a newly confirmed species for Crater Lake National Park.

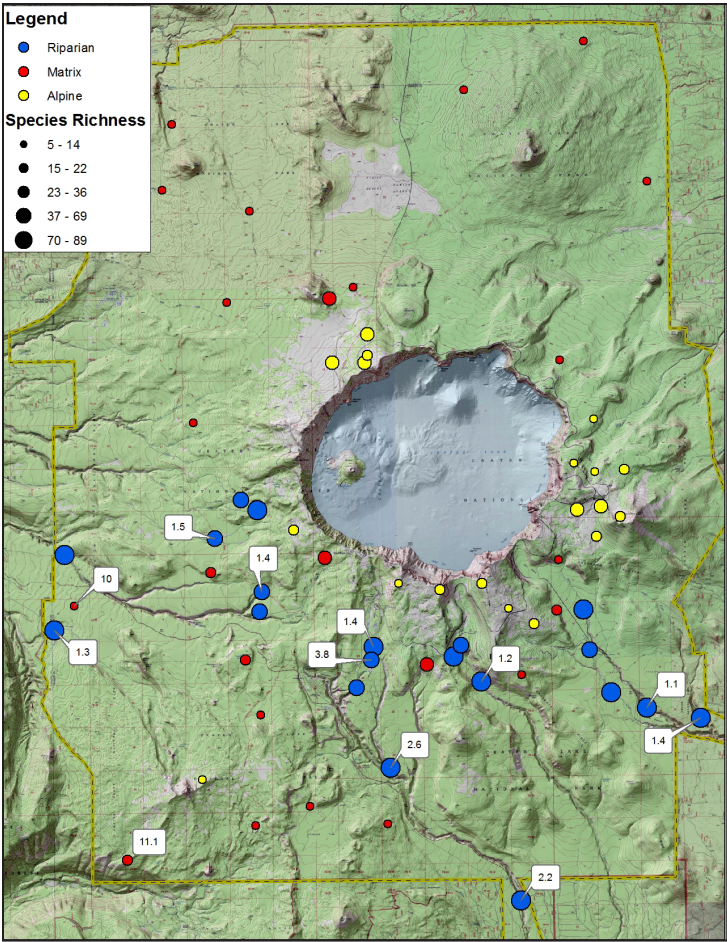


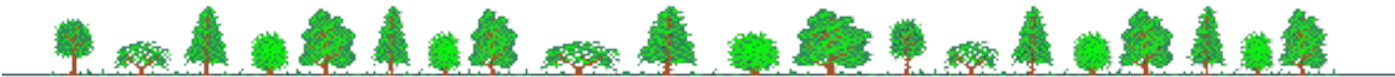
Figure 3. Crater Lake site species richness from each sampling frame. White labels show percentage of species that are non-native. Sites with no non-native species are not labeled.

Vegetation Function (Regeneration)

The most abundant regenerating tree species in the matrix sampling frame for all classes except >10cm - <15cm dbh was mountain hemlock (*Tsuga mertensiana*). Lodgepole pine (*Pinus contorta* var *muryana*) was the most abundant species in the >10cm - <15cm dbh class. In the riparian sampling frame *Tsuga mertensiana* was most abundant in the >15cm tall class, while subalpine fir (*Abies lasiocarpa*) was dominant in all other classes. High elevation sites had whitebark pine (*Pinus albicaulis*) as the dominant species in the <15cm tall and >10cm - <15cm dbh classes, while *Tsuga mertensiana* was dominant in the middle three size classes. Mean regeneration counts for all tree species shown in Table 1.

Table 1. Crater Lake regeneration by size class for all live tree species by sampling frame. Units are trees/ha, standard deviations shown in parentheses.

Frame	<15cm Tall	>15cm Tall- <2.54cm dbh	>15cm Tall >2.54 - <5cm dbh	>15cm Tall >5 - <10cm dbh	>15cm Tall >10 - <15cm dbh
High Elevation	917 (1697)	667 (800)	143 (241)	82 (119)	20(33)
Matrix	4029 (4551)	3865 (4945)	376 (419)	268 (238)	135 (110)
Riparian	2950 (3058)	5413 (4281)	266 (249)	199 (150)	68 (67)



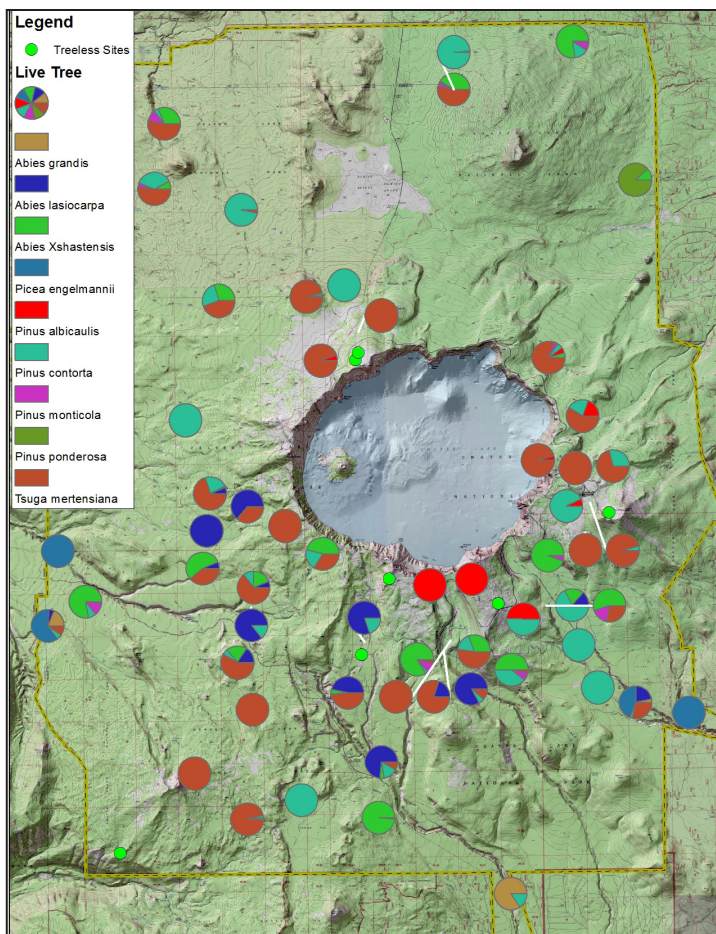


Figure 4. Individual tree (>15cm dbh) species basal area composition of Crater Lake sites. Three tree species are not shown in the map because they are not visible, due to small percentages of basal area: Pacific silver fir (*Abies amabilis*), Douglas-fir (*Pseudotsuga menziesii*), and western hemlock (*Tsuga heterophylla*).

Vegetation Structure

Highest overall mean value for vegetation cover was found in riparian stratum 1 (<0.75m height) --38.2%. Mean vegetation percent cover in both the high elevation (20.9%) and matrix (27.8%) sampling frames was highest in stratum 4 (>5m in height).

Mean live tree basal area at Crater Lake was highest in the matrix (42.07 m²/ha), second highest in the riparian (28.8 m²/ha), and lowest in the high elevation (21.1 m²/ha) sampling frames. Snag basal area was much lower than live tree basal area. One matrix, one riparian, and five high elevation plots lacked live trees >15cm dbh. Matrix site mean tree density (339 trees/ha) was higher than for both high elevation (123 trees/ha) and riparian (181 trees/ha) sites. Matrix site mean snag density (96 trees/ha) was highest, followed by riparian (84 trees/ha), and lastly, high elevation (23 trees/ha) sites.

Mean shrub heights were .5m for riparian sites, with a maximum of 2.8m. Both matrix and riparian sites had a mean shrub height of <0.05m.

Fine wood/litter was the dominant ground cover in both the matrix (83.2%) and riparian (75.8%) frames. In the high elevation sampling frame, while bare soil was highest (46.3%), fine wood/litter (42.2%) was also a substantial component. Additional vegetation structural summaries are available in Smith and Sarr (In review).

Comparisons with Other KLMN Parks

Between Crater Lake and Oregon Caves, there was an overlap of 41 species in 2013 (Smith and Sarr, in review). Species overlap during the 2012 season (Whiskeytown and Lassen) was 71 species (Smith and Sarr 2014). During the 2011 field season, at Redwood and Lava Beds, only four species were present at both parks (Smith and Sarr 2013). Only one species was consistently observed among all six parks: Common yarrow (*Achillea millefolium*).

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.

References Cited

- Odion, D. C., D. A. Sarr, S. R. Mohren, and S. B. Smith. 2011. [Monitoring vegetation composition, structure and function in the parks of the Klamath Network Parks](#). Natural Resource Report NPS/KLMN/NRR—2011/401. National Park Service, Fort Collins, Colorado.
- Odion, D. C., D. A. Sarr, S. R. Mohren, and R. C. Klinger. 2010. [Invasive species early detection monitoring protocol for Klamath Network parks](#). Natural Resource Report NPS/KLMN/NRR—2010/227. National Park Service, Fort Collins, Colorado.
- Smith, S.B., and D. Sarr. 2013. [Monitoring vegetation composition, structure, and function in Lava Beds National Monument and Redwood National and State Parks: Fiscal year 2011 annual report](#). Natural Resource Data Series NPS/KLMN/NRDS—2013/447. National Park Service, Fort Collins, Colorado.
- Smith, S. B., and D. Sarr. 2014. [Monitoring vegetation composition, structure, and function in Whiskeytown National Recreation Area and Lassen Volcanic National Park: Fiscal year 2012 annual report](#). Natural Resource Data Series NPS/KLMN/NRDS—2014/628. National Park Service, Fort Collins, Colorado.
- Smith, S. B. and D. Sarr. In review. Monitoring vegetation composition, structure, and function in Oregon Caves National Monument and Crater Lake National Park: Fiscal year 2013 annual report. Natural Resource Data Series NPS/KLMN/NRDS—2017/XXX. National Park Service, Fort Collins, Colorado.

More Information

Sean Smith, Botanist
National Park Service, Klamath Network
Email: sean_b_smith@nps.gov
Phone: 541-552-8570

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