Soil Moisture Patterns in Sierra Nevada Mixed Conifer Forest

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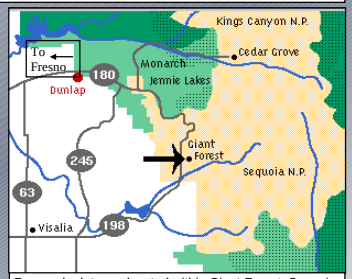
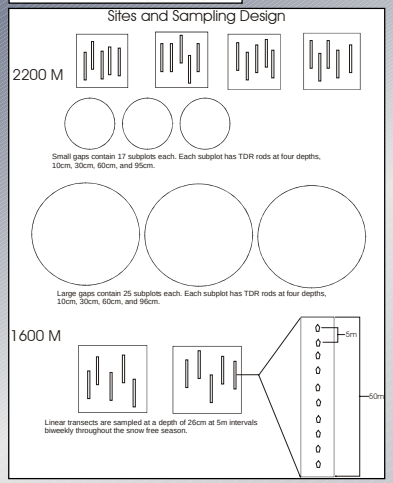
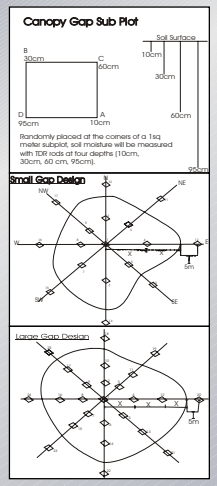
Abstract

The goal of this project is to quantitatively describe temporal (seasonal) and spatial (horizontal and vertical) variation in volumetric percent soil moisture of forest soils in Sequoia – mixed conifer forests within Sequoia National Park, California. Soil moisture is an important factor in determining overstory and understory species richness, density and pattern within these forests. Soil moisture will be measured in both canopy gaps and along linear transects located within the range of canopy covers found in these forests (closed canopy to open gap). A gap is an opening, or patch, in the forest canopy created by the removal of the canopy stratum formed by the death of a single tree, part of a tree, or a few trees in a group. Percent soil moisture will be sampled using permanently installed Time Domain Reflectometry (TDR) rods. Sampling sites are located at two elevations and are instrumented to determine soil moisture in (a) gaps and (b) a range of percent forest covers. Within forest gaps, rods are installed at four depths (10, 30, 60, 95 cm) in six canopy gaps (three < 0.3 ha and three > 0.5 ha) established at 2200 m elevation. Rods are placed as a radial array of transects (radial transects) crossing each gap (N-S, W-E, NW-SE, and NE-SW). Soil moisture under canopy cover was assessed as thirty 50-m long transects (linear transect) with TDR sample points at 5-m intervals established in six plots (five transects per plot) at 1600 (2 plots) and 2200 m (4 plots) elevation. Soil moisture will be measured in the transects and in the canopy gaps every two weeks throughout the snow-free season. In addition, hemispherical photos will be taken at all sample points in gaps and transects for characterization of canopy cover (percent canopy openness) and solar radiation (percent total transmittance). The experimental design allows testing of hypotheses concerning the patterns of soil moisture availability and use in forest gaps and understory and how these patterns relate to solar radiation and canopy cover. Project results will improve the understanding of forest dynamics in the middle and southern Sierra Nevada and will be useful to forest managers and research collaborators attempting to preserve this resource.



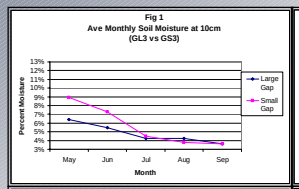
Research plots are located within Giant Forest, Sequoia National Park (Elevation 1600-2200 m) 100 miles east of Fresno, California in the southern Sierra Nevada.

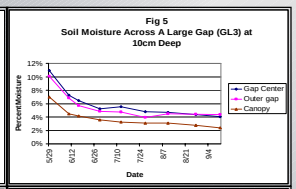


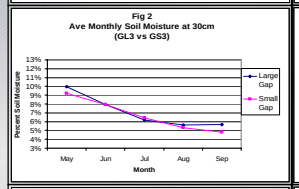


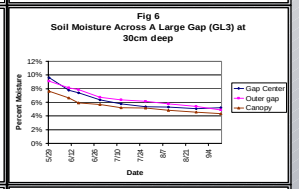
Hypotheses:

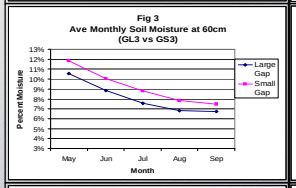
1. Overall soil moisture will be greater at upper versus lower elevations.
2. Soil moisture will be greater in large gaps than small gaps.
3. Early in the season soil moisture will be evenly distributed in the soil column, and as the season progresses, the moisture content will draw down quickly. This moisture draw down will be more prevalent in the upper layers of the soil and will occur earlier at lower elevation sites.
4. There will be a gradient of decreasing soil moisture at all depths from the gap center into the understory.
5. The surface soil moisture (0-20cm) under the canopy will be depleted earlier in the season than will soil in canopy gaps.
6. Light will be proportional to gap size and asymmetrically zoned from least light under the canopy along the southwest edge to the greatest light under the canopy along the northeast edge.
7. Species richness and density will be positively related to soil moisture.

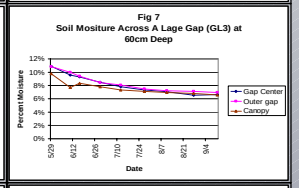


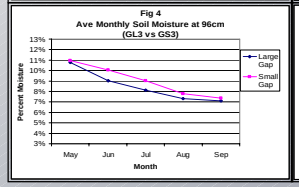


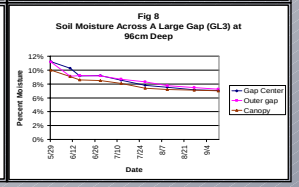












This research is Supported by a grant to Dr. Ruth Ann Kern from the California State University Agricultural Research Initiative (ARI), working in collaboration with the Sequoia-Kings Canyon Field Station of the USGS, Western Ecological Research Center, as well as the Environmental Protection Agency (EPA)

Background

In forests, canopy gaps are important sites for vegetation regeneration that might provide spatial gradients for resource or habitat differentiation. Gap partitioning occurs when species differentiate along gradients within gaps or among gaps of different sizes. Internal physical and biological environments vary with gap size, which affects not only contemporary species compositions, but also influence the next phase of the forest cycle.

Preliminary Results

Soil Depth and Gap Size

Figures 1-4 address hypotheses 2 and 3.

0-10cm – (fig 1) Relative to large gaps, small gaps have more soil moisture. This difference disappears as the seasonal soil moisture draw-down progresses.

10-30cm – (fig 2) No difference detected in soil moisture regardless of gap size.

30-60cm – (fig 3) The small gap had more moisture throughout the season than the large gap

60-95cm – (fig 4) The small gap had more moisture throughout the season than the large gap

These results contradict previous research which found that gap size is positively related to subsurface soil moisture.

Location Within Gap

Figures 5-8 address hypotheses 3,4,and 5.

Soil Moisture, light, and species composition change as you go from the gap center into the understory.

0-10cm – (fig 5) Distance from gap center inversely proportional to percent moisture. Largest difference between the gap and the understory. This difference is maintained through the growing season.

10-30cm - (fig 6) No detectable difference within the gap, but gap retained more soil moisture throughout the season relative to beneath the canopy.

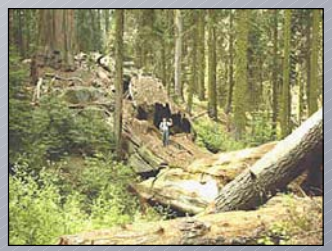
30-60cm – (fig 7) No detectable difference within the gap throughout the season. Under the canopy there is less soil moisture in the early season, but as the season progresses there is no difference.

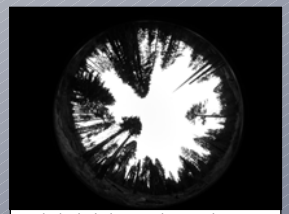
60-95cm – (fig 8) No difference in soil moisture detected between locations within and around gaps.

Soil Moisture differences between locations within and around gaps was detected less as soil depth increased.

Implications

This research will yield a greater understanding of soil moisture patterns at different elevations, depths, light levels, and locations both within and out of forest gaps; and will increase the understanding of variation in soil moisture and its effect on mixed conifer structure. These results indicate that species with high drought tolerance are more likely to establish in large gaps than small gaps, but the chance for other species to colonize increases as drought tolerant species get closer to the gap center where increased moisture levels might favor less drought tolerant species.





Hemispherical Photographs are taken at ground level with a fish eye lens attached to a Nikon Coolpix 4500.

Soil Moisture measurements are taken using a Time Domain Reflectometer (TDR machine), pictured here with the Hewlett Packard 200 palmtop.

TDR rods are installed to take volumetric percent soil moisture.

This Fellow is Sponsored by EPA's Greater Research Opportunity (GRO) Program.