Sierra Nevada tree die-off; lessons learned & future challenges

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MODIS image
Drought stress?
Field measurements

E-W transect of flux towers

San Joaquin Experimental Range 400 m
Soaproot Saddle 1100 m
CZO Providence 2000 m
Shorthair Creek 2700 m

Ground measurements of precipitation, evapotranspiration, discharge, soil-moisture storage, snowpack storage

(Shorthair not available)
Flux tower data

Comparing 2011 (wet) & 2014 (3rd drought yr)

Providence, mixed-conifer forest, 2000 m, 2152 vs 634 mm precip, 20% drop in ET

Soaproot Saddle, pine-oak forest, 1100 m, 1320 vs 390 mm precip, 47% drop in ET

Cumulative water-year evapotranspiration

Cumulative water-year gross CO₂ uptake
Matric potential

At 2-m depth at Providence (2000 m) shows recharge during drought, but not at Soaproot (1100 m)
Field measurements

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**Approach to scaling**

Annual ET measured by flux towers, correlated with MODIS NDVI

ET calculated across the Southern Sierra using this calibration

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**Conceptual**

High LAI $\leftrightarrow$ High ET & NPP

High LAI $\rightarrow$ High NDVI

NDVI indicates ET needed to support the current LAI
Southern Sierra averages

Precipitation (P) from PRISM

Evapotranspiration (ET) from NDVI: “canopy-acclimated ET”

P – ET is difference
Forest – interpretation

Tree dieoff greatest where recharge to deeper root zone was limited. Regolith storage buffers drought if mean annual precipitation exceeds annual ET.

Southern Sierra CZO, Jun 2015

Low precip., high LAI & higher ET demand in rain zone → one-yr subsurface water-storage buffer at 1100 m

Higher precip., slightly lower LAI & ET demand in snow zone → multi-year subsurface water-storage buffer at 2000 m
What is a sustainable forest density for the Sierra Nevada?

Restore (thin) forest → reduce ET
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