Interacting effects of water input, nitrogen deposition, and fire on Coastal Sage Scrub

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(1) How vulnerable (resilient, resistant, etc) are Southern California’s ecosystems to stress (fire, climate change, N deposition, etc)?

(2) What stress or combination of stresses poses greatest risk (where’s the Achilles heel)?
Experimental approach

Transect Surveys
Manipulations
Eddy Flux

Santa Ana Mtns
San Jacinto Mtns
Palm Springs
• Loma Ridge section of historic Irvine Ranch (~75 km southeast of here)
• Currently managed by Irvine Ranch Conservancy
• Mosaic of exotic annual grassland coastal sage evergreen oaks
• Experiment site
• What did this area look like 80 years ago?
• VTM (Vegetation Type Map) survey in ~1930
• Hand drawn – working off ~1895 topographic maps – lots of uncertainty
• Mosaic of exotic annual grassland coastal sage evergreen oaks
• Similar to what we see today
• Experiment site - dominated by California sagebrush, black sage and buckwheat
California sagebrush, black sage and buckwheat

California sagebrush, black sage and buckwheat still dominate; Rhus/Malosma have increased
Why so stable?

- Differences in soil? Nope – same texture across border – same texture to 2-m depth

- Constant environment? Nope – at least 4 wildfires (1948, 67, 98, 07), an order of magnitude interannual precip variation

- Lots of ecological resiliency (at least to normal fire and precip patterns of management since 1930)
Resiliency to wildfire – an unfortunate dataset
Eddy covariance – measures whole ecosystem exchanges, such as photosynthesis

- Two sites ~300 m apart on similar soil
- Both burned in Oct 2007 Santiago wildfire
- Fire had no (or positive) effect on grass production
- CSS production recovered rapidly – rates of exchange 3-4 years after fire appear higher than before fire
• Loma Ridge

• Manipulate water (+-50%) and Nitrogen (+) input for last 5 years
Simulate effects of climate change on experimental plots using roofs that close/open to remove/add water -

Roofs open ~97% of the time
Roofs closed 3% of the time (for big storms)
Water input for the various treatments

1/3 of the plots get extra water
1/3 of the plots get normal water
1/3 of the plots get reduced water
Grassland - Very rapid shifts in species composition
• Rapid changes in relative abundance – Species reordering
• Species coexist at climatological precipitation (median 236 mm /yr)
• Species reordering tied to traits
• Favored with drought - Forbs and shorter time to flowering
• Favored in wet treatments - Grasses and N fixers
CSS’ Achilles heel? The combination of:
• Fire (knocks shrubs back 2-3 years; no or positive effect on grasses)
• Several dry years (soil below 0.5-1 m remains dry; hurts shrubs, not grasses)
• Added N (accelerates grasses; only small effect on shrubs)

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<tr>
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<th>Normal Nitrogen</th>
<th>Added Nitrogen</th>
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<tr>
<td>Reduced precipitation</td>
<td>Moderate risk of change to red brome grassland</td>
<td>Large risk of change to red brome grassland</td>
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<tr>
<td>Normal precipitation</td>
<td>Stable</td>
<td>Moderate risk of change to brome grassland</td>
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