Hydrologic Response of Meadow Restoration Following the Removal of Encroached Conifers

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Healthy Montane Meadows

- Facilitate water cycling
- Help with sediment capture
- Create natural fire breaks in forested regions
- Diverse vegetation and wildlife habitat
- Carbon sequestration

Diverse/complex habitat for wildlife

High moisture creates natural fuel breaks

Acts as sediment and debris catch

High water table & groundwater recharge

Wetland Vegetation & Soil
Problem

- Meadow habitat has been decreasing in the Sierra Nevada and Cascades.
- Forest densification caused by:
  - Fire suppression
  - Poor grazing practices
  - Climate change
- Lodgepole Pine (*Pinus contorta*) prefers areas with higher soil moisture.
Research Overview

**Research Goal:** To quantify changes to meadow hydrologic conditions once conifers have been cleared from the meadow and identify if there is an environmental benefit.

**Research Question:** Does the removal of conifers on historical meadows, create a hydrologic response to restore montane meadow habitat?

**Hypothesis:** The water availability of a montane meadow will improve in the long-term after conifer removal.

**Location:** The southern Cascades/northern Sierra Nevada mountain range, near Chester, CA.
Study Area

- Rock Creek Meadow (RCM)
- Before-After Control-Impact (BACI) study design
  - Marian Meadow (MM) as the control
  - 1 year of pre-restoration data (2019 WY)
  - 3 years of post-restoration data (2020 – 2023 WY)
Methods

- Groundwater Wells
  - 1.3 to 3 m deep
- Soil Moisture Probes
  - 10 to 100 cm deep
- Climate Stations

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Depth (m)</th>
<th>Riser Height (m)</th>
<th>Depth from Surface to Bottom of Well (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCW1</td>
<td>2.90</td>
<td>0.15</td>
<td>2.75</td>
</tr>
<tr>
<td>RCW2</td>
<td>1.41</td>
<td>0.09</td>
<td>1.32</td>
</tr>
<tr>
<td>RCW3</td>
<td>2.63</td>
<td>0.42</td>
<td>2.21</td>
</tr>
<tr>
<td>RCW6</td>
<td>2.90</td>
<td>0.15</td>
<td>2.75</td>
</tr>
<tr>
<td>RCW3P</td>
<td>2.38</td>
<td>0.58</td>
<td>1.80</td>
</tr>
<tr>
<td>RCW4P</td>
<td>3.05</td>
<td>1.10</td>
<td>1.95</td>
</tr>
</tbody>
</table>
Timeline

- August 2020 Pre-Harvest
- October 2020 Mid-Harvest
- November 2020 Post Dixie Fire
- June 2022
- January 2023
2021 Dixie Fire

- Between July and September 2021, the Dixie Fire burned 963,309 acres in California’s Butte, Plumas, Shasta, Lassen, and Tehama counties (Cal Fire, 2022).
- Consumption of herbaceous meadow vegetation and the surrounding forested area will influence the meadow hydrology.

<table>
<thead>
<tr>
<th>Meadow</th>
<th>Watershed Contributing Area km² (mile²)</th>
<th>Percentage Moderate and High Burn Severity in Watershed</th>
<th>Meadow Vegetation Post Fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock Creek Meadow (RCM)</td>
<td>70.3 (27.2)</td>
<td>57%</td>
<td>Patches of burned vegetation with varied burn severity.</td>
</tr>
<tr>
<td>Marian Meadow (MM)</td>
<td>13.5 (5.2)</td>
<td>78%</td>
<td>Moderate to high burn severity in the meadow.</td>
</tr>
</tbody>
</table>
Percent Soil Moisture

- Increased soil moisture in RCM following *Pinus Contorta* removal.

- RCM west maintains a higher soil moisture content than RCM east almost year-round.

- By Year 2 Post-Restoration RCM soil moisture was greater than or equal to monthly MM and RCM pre-restoration levels.
Depth to Groundwater

- Decrease in groundwater 1\textsuperscript{st} year post-restoration. This was a drought year.

- Gaps in 3\textsuperscript{rd} year data due to inability to service well probes during high winter snow levels.

- 3\textsuperscript{rd} year post-restoration shows increased groundwater during the summer months.

**Monthly difference between average MM depth to groundwater from pre-restoration RCM and RCM for each year post-restoration (WY 2021-2023) depth to groundwater values.**
Conclusions

• RCM shows increased soil moisture 2 to 3 years post-restoration.

• Depth to groundwater has had a mixed response to restoration, with an increase to summer groundwater levels 3 years post-restoration.

• Unclear what effects the Dixie Fire may have had on the study.

• More statistical analysis needs to be conducted.
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Questions?
References & Associated Papers

