



Hydrologic Response of Meadow Restoration Following the Removal of Encroached Conifers

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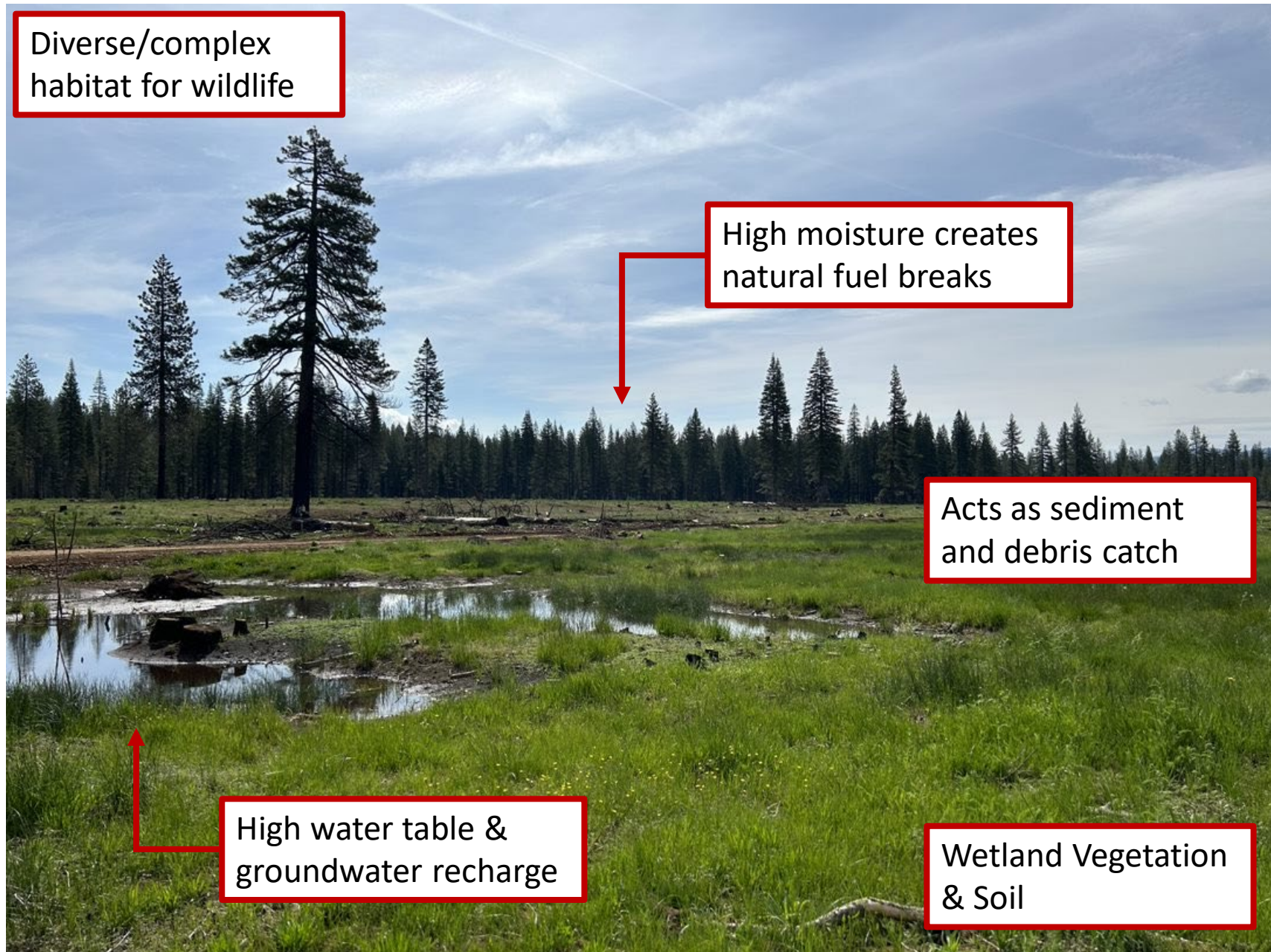
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CAL POLY

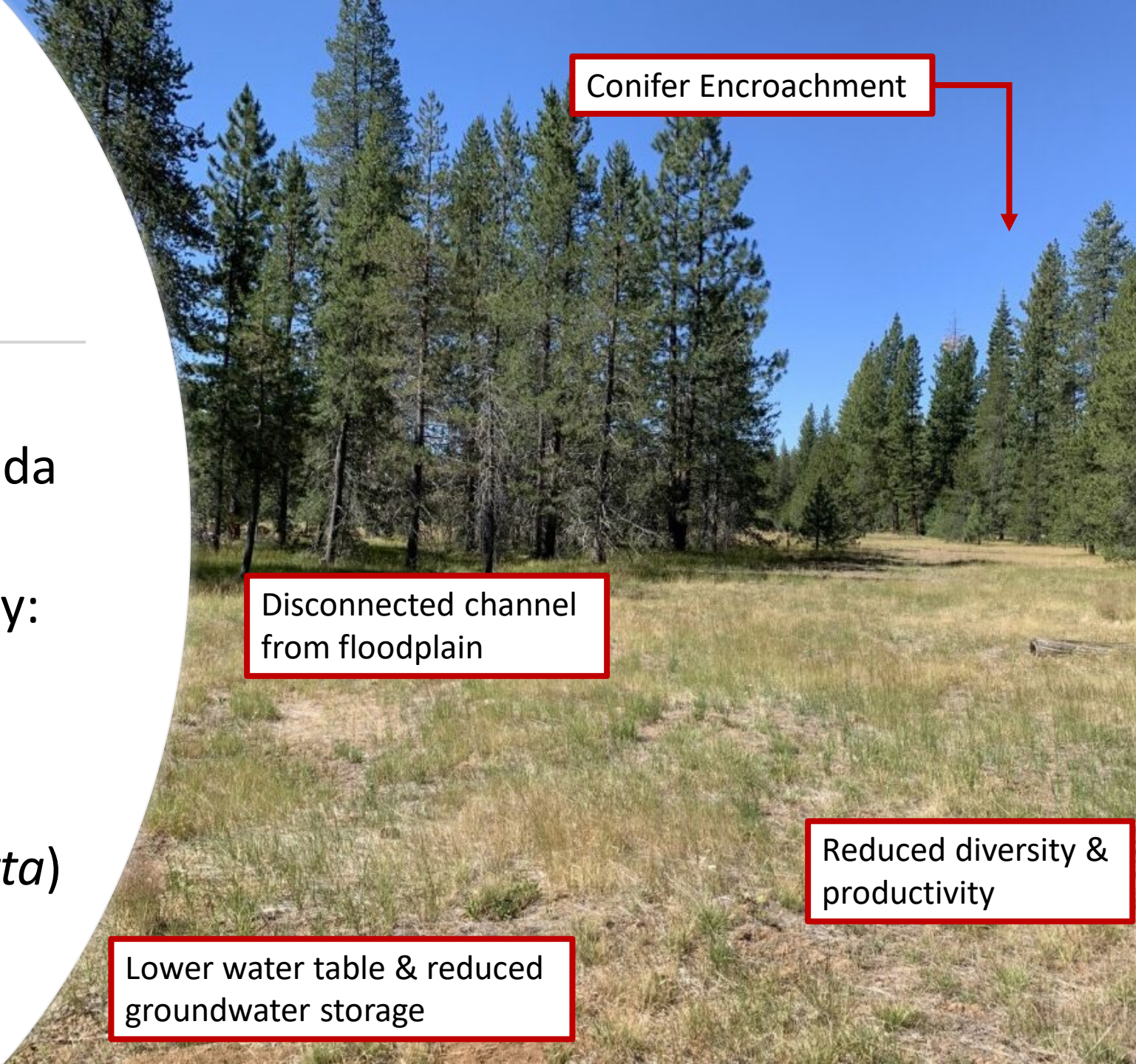
Healthy Montane Meadows

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



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.



Conifer Encroachment

Disconnected channel from floodplain

Lower water table & reduced groundwater storage

Reduced diversity & productivity

An aerial photograph of a dense conifer forest, showing a vast expanse of green trees from a high-angle perspective. The trees are packed closely together, creating a textured, green surface.

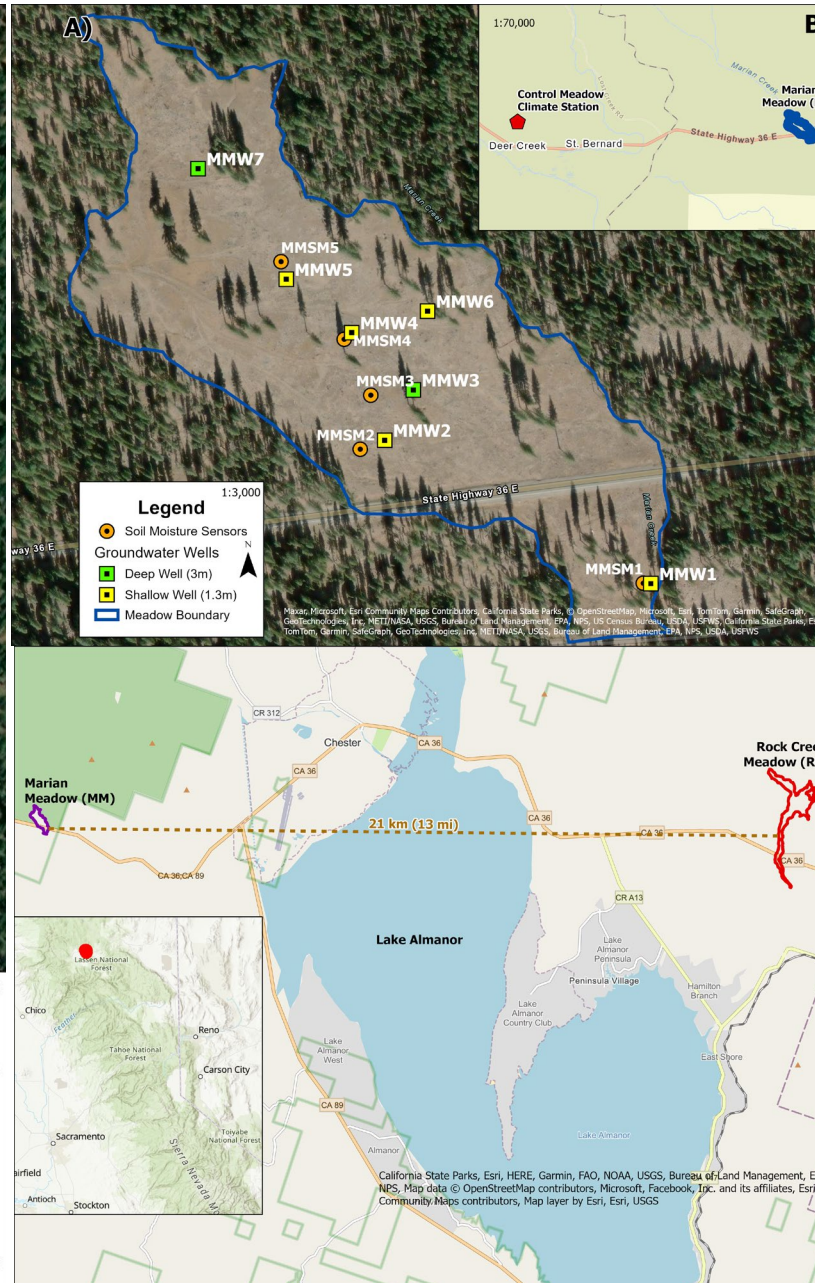
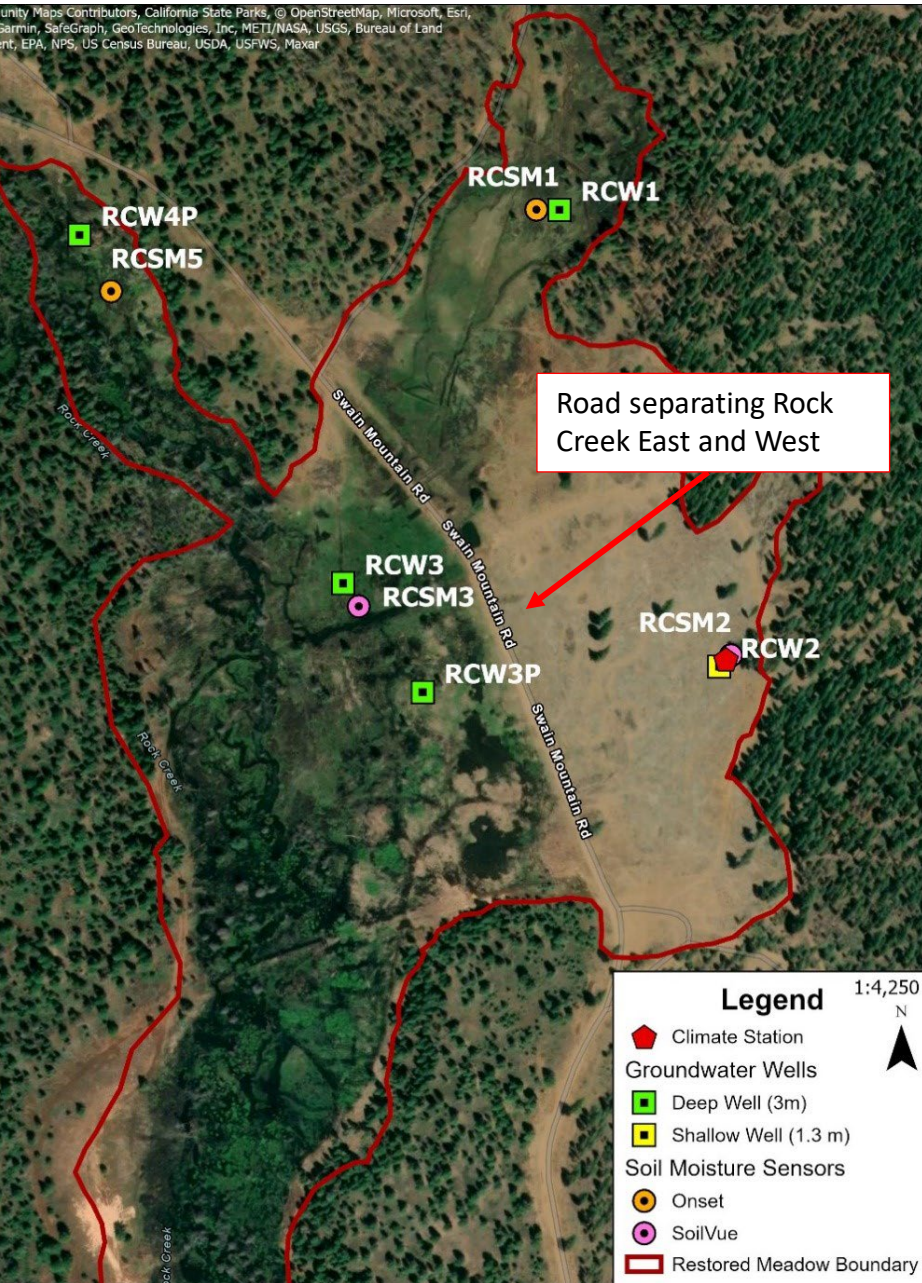
Research Overview

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



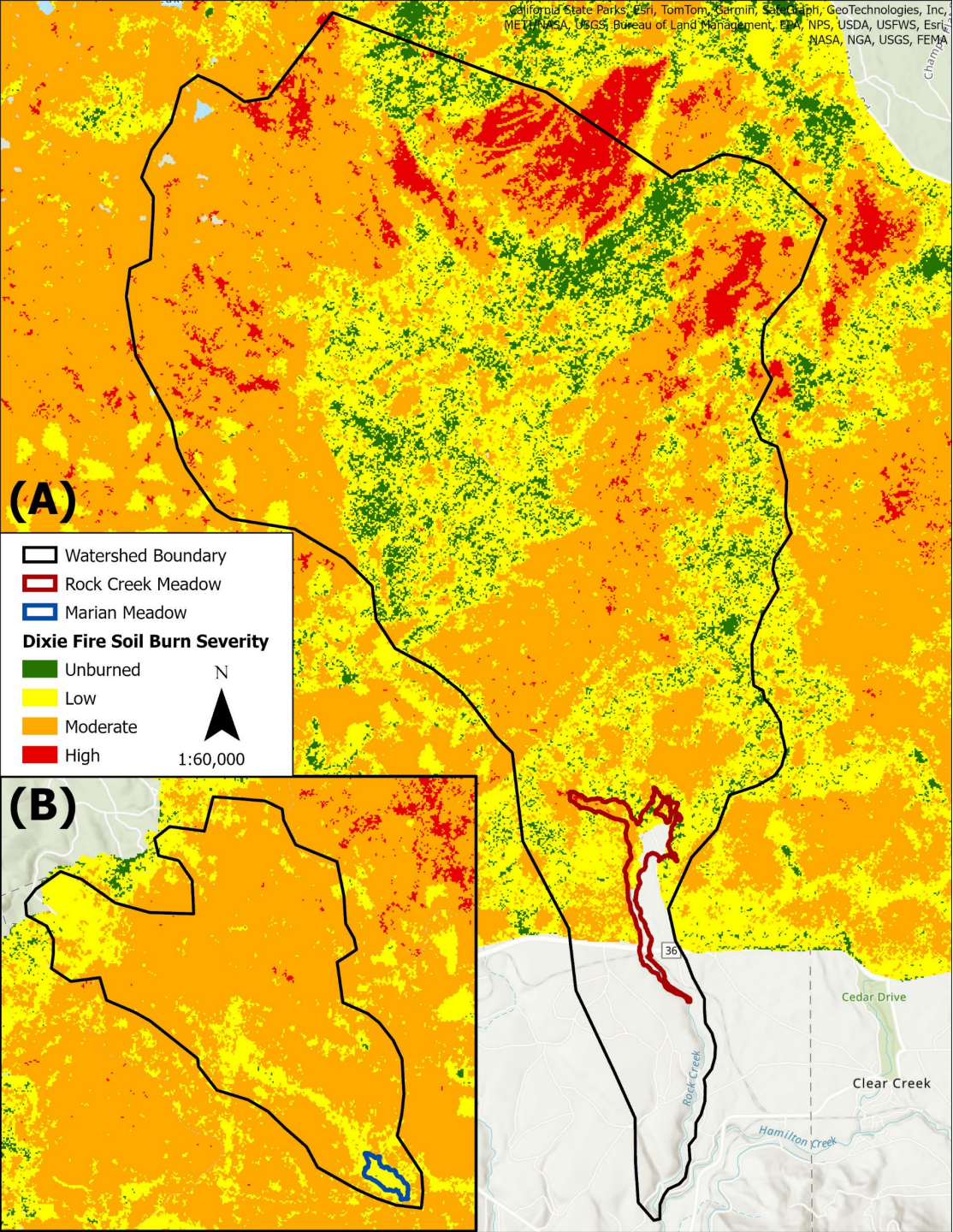
Well ID	Depth (m)	Riser Height (m)	Depth from Surface to Bottom of Well (m)
RCW1	2.90	0.15	2.75
RCW2	1.41	0.09	1.32
RCW3	2.63	0.42	2.21
RCW6	2.90	0.15	2.75
RCW3P	2.38	0.58	1.80
RCW4P	3.05	1.10	1.95

Timeline



2021 Dixie Fire

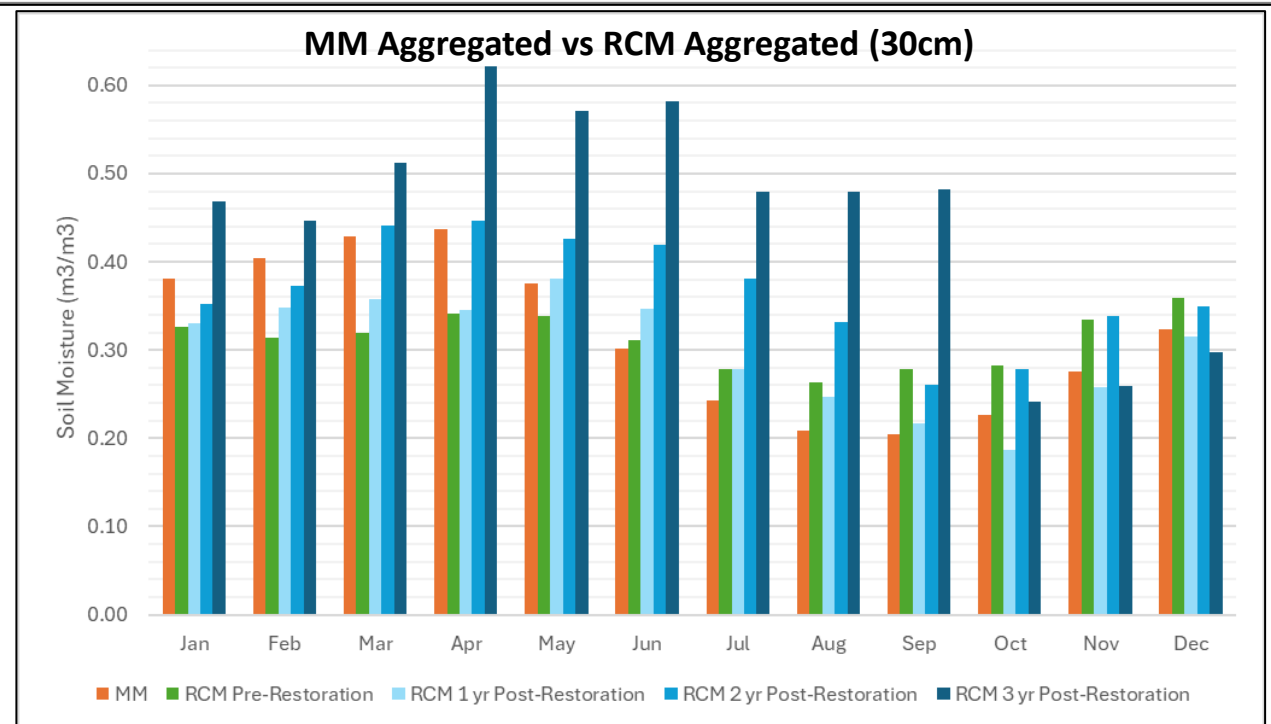
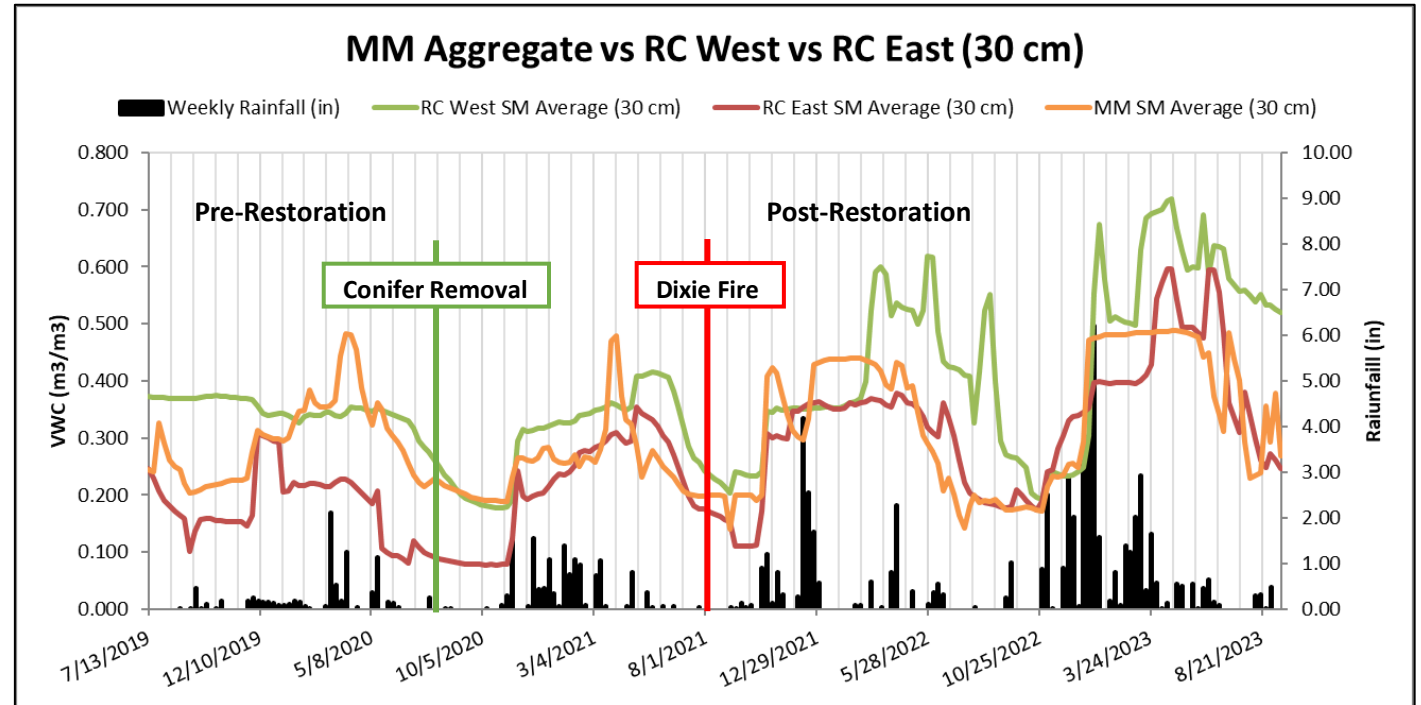
- Between July and September 2021, the Dixie Fire burned 963,309 acres in California's Butte, Plumas, Shasta, Lassen, and Tehama counties (Cal Fire, 2022).
- Consumption of herbaceous meadow vegetation and the surrounding forested area will influence the meadow hydrology.



Meadow	Watershed Contributing Area km ² (mile ²)	Percentage Moderate and High Burn Severity in Watershed	Meadow Vegetation Post Fire
Rock Creek Meadow (RCM)	70.3 (27.2)	57%	Patches of burned vegetation with varied burn severity.
Marian Meadow (MM)	13.5 (5.2)	78%	Moderate to high burn severity in the meadow.

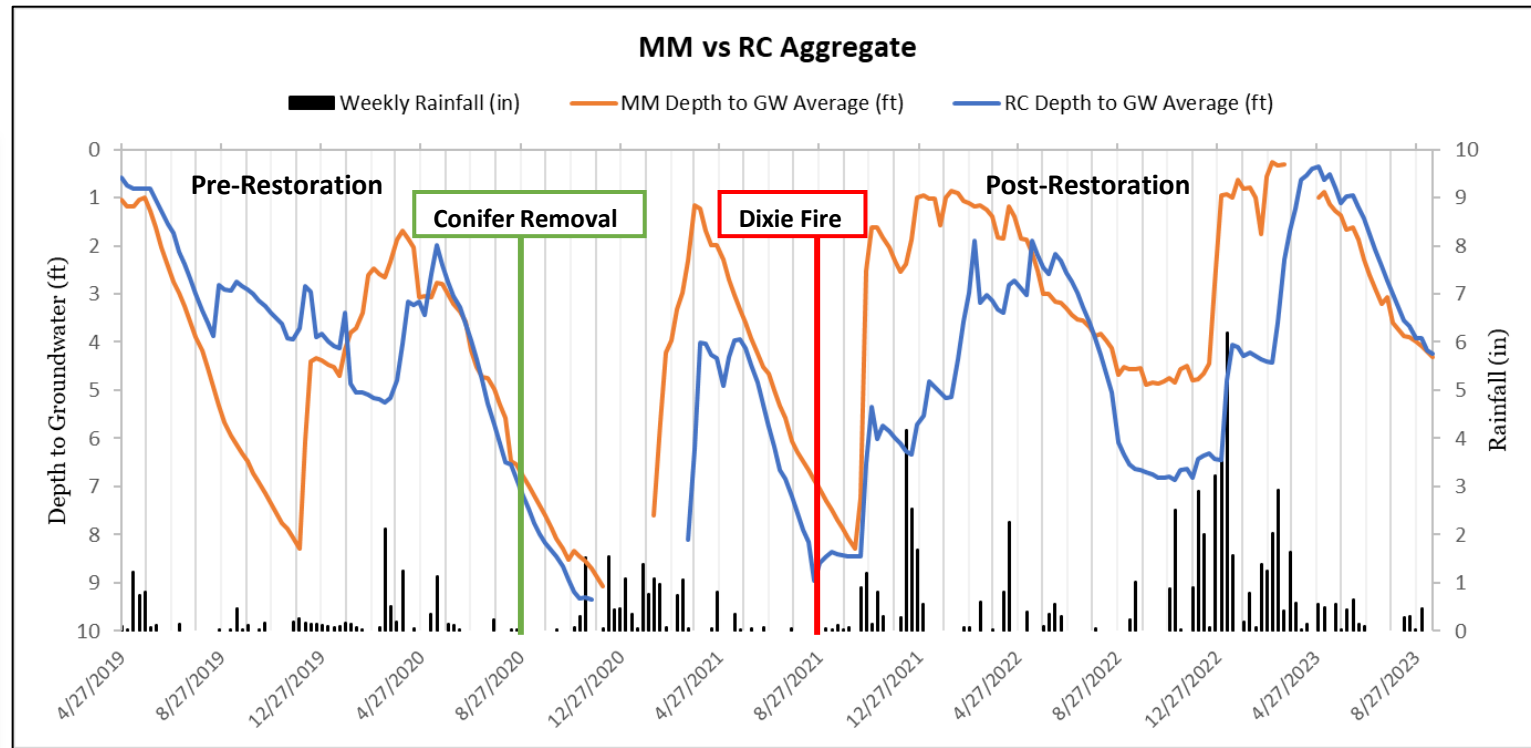
Percent Soil Moisture

- 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 1st year post-restoration. This was a drought year.
- Gaps in 3rd year data due to inability to service well probes during high winter snow levels.
- 3rd year post-restoration shows increased groundwater during the summer months.



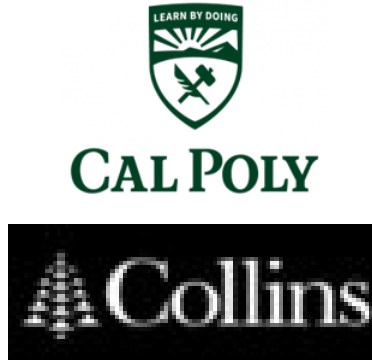
	Average Depth to Groundwater (m)				
Month	MM	RCM Pre-Restoration	RCM 1 yr Post-Restoration	RCM 2 yr Post-Restoration	RCM 3 yr Post-Restoration
Jan	0.63	0.56	Dry	0.92	0.69
Feb	0.82	0.72	Dry	0.41	0.50
Mar	0.51	1.04	1.67	0.35	0.40
Apr	0.52	0.34	0.75	0.40	-0.33
May	0.67	-0.11	0.63	0.06	-0.43
Jun	0.90	-0.21	0.65	-0.16	-0.55
Jul	1.25	-0.10	0.85	-0.25	-0.52
Aug	1.58	-0.07	0.97	-0.06	-0.49
Sep	1.85	-0.22	0.71	0.28	-0.40
Oct	1.94	-0.97	0.71	0.33	0.12
Nov	1.80	-0.66	1.04	-0.01	0.25
Dec	1.17	-0.14	Dry	0.69	0.78

**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.



Acknowledgements

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 - Tyler Petersen
 - Previous graduate and undergrad students





Questions? |

References & Associated Papers

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