Assessing Shrubland Biomass in Southern California: New data, New Tools

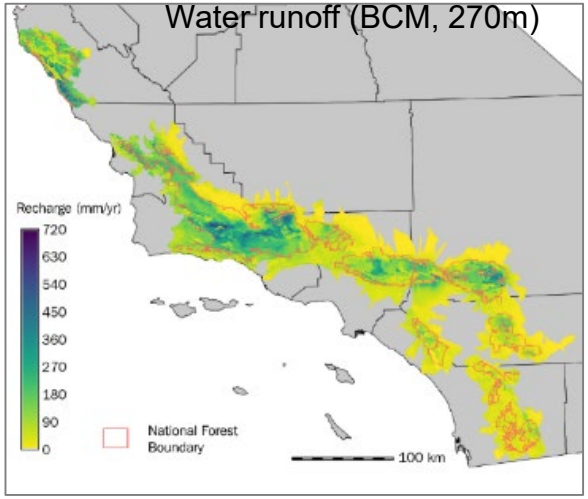
Emma Underwood
University of California, Davis
eunderwoodrussell@ucdavis.edu

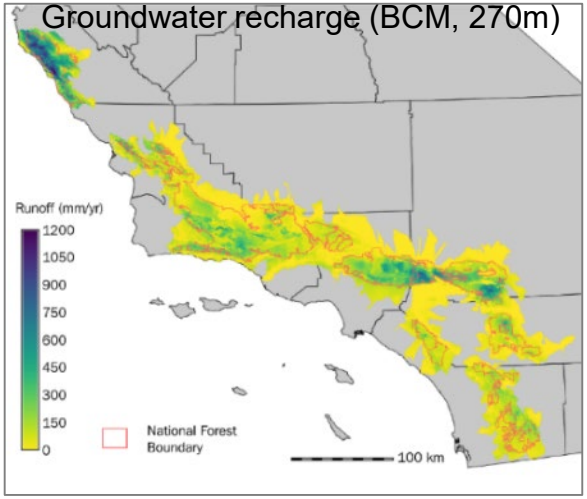
Charlie Schrader-Patton
USDA Forest Service, Western Wildlands Environmental Threat Assessment Center
Charlie.Schrader-patton@usda.gov

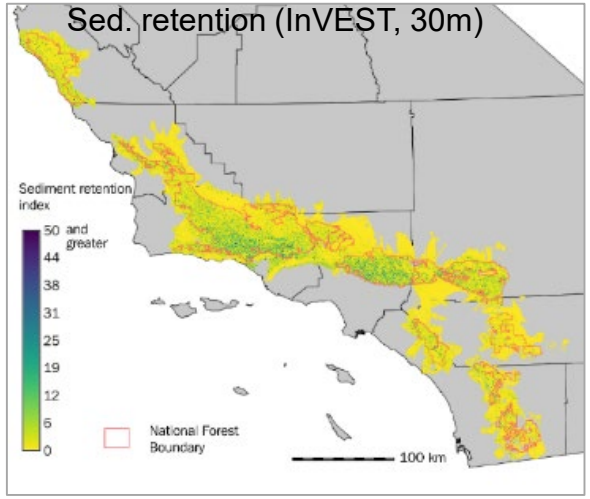
Overview

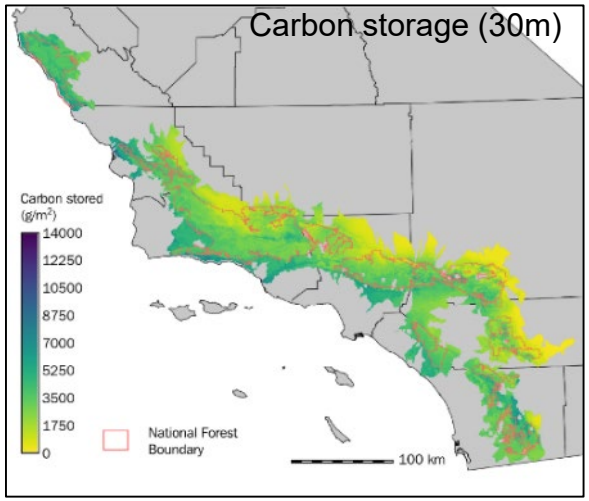
- Describe aboveground live biomass data 2000-2022
- Estimates of other shrub biomass pools
- Identify drivers of shrubland biomass
- Estimate recovery of biomass post-fire
- Demonstrate SoCal EcoServe Tool

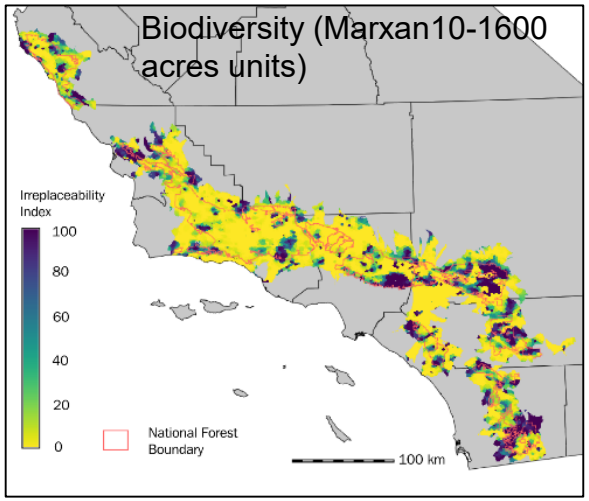
Ecosystem services in southern California











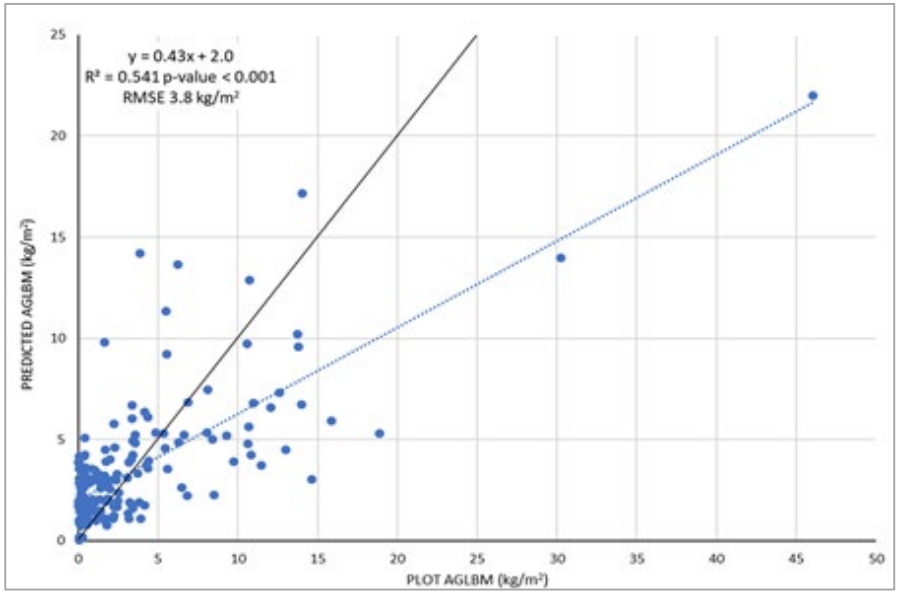
Recreation – Rec Demand Models

Underwood et al. Mapping the value of national forest landscapes for ecosystem service provision. In Valuing Chaparral. Springer.

Aboveground live biomass

Random Forest AGLBM model

- Dependent variable – 766 field plots (FIA, LFRDB, & research plots)
- Covariates – NDVI, precipitation, climatic water deficit, solar radiation, aspect, elevation

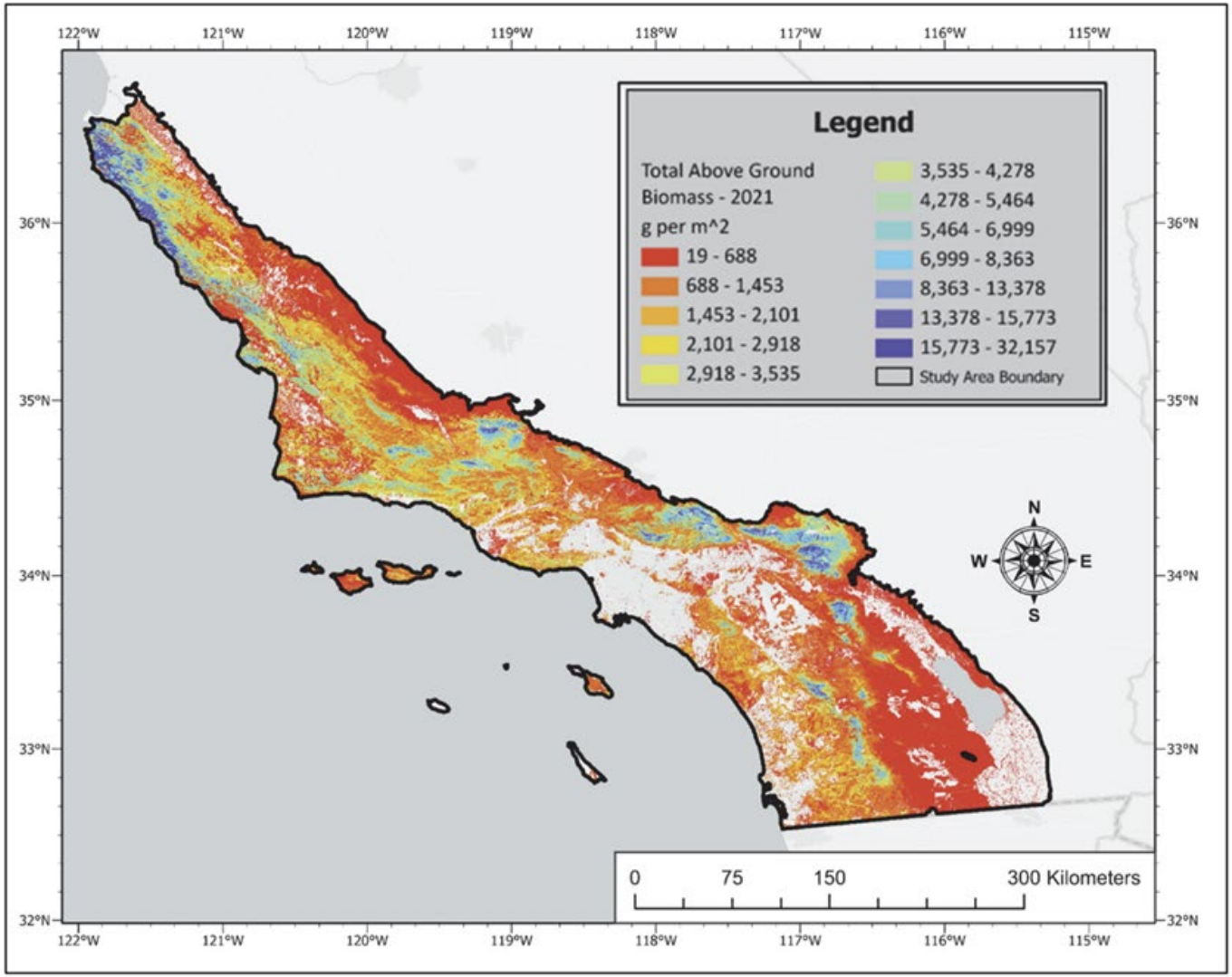


Field validation (Uyeda et al 2016, San Dimas)

Mean biomass (kg/m^2) of 15 plots:

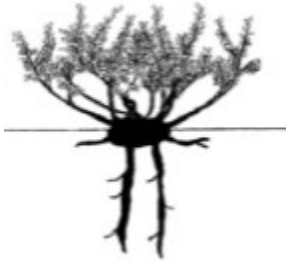
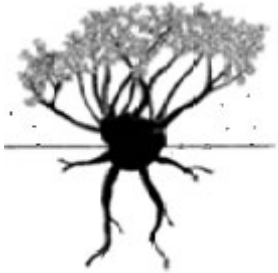
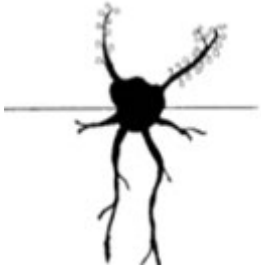
Field estimates	3.14
CA-ARB	1.23
NAWFD	1.12
This model	1.88

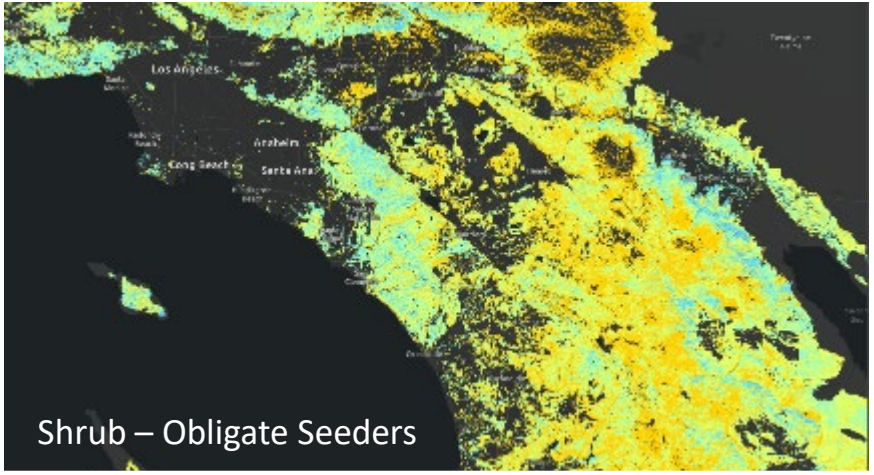
- Schrader-Patton et al. 2021. Remote Sensing https://doi.org/10.3390/rs13081581.
- Schrader-Patton et al. 2023. Ecology e4031
- Schrader-Patton et al. 2022. Dryad, Dataset https://doi.org/10.5061/dryad.qz612jmjt


Legend
Total Above Ground
Biomass - 2021
g per m^2
19 - 688
688 - 1,453
1,453 - 2,101
2,101 - 2,918
2,918 - 3,535
3,535 - 4,278
4,278 - 5,464
5,464 - 6,999
6,999 - 8,363
8,363 - 13,378
13,378 - 15,773
15,773 - 32,157
Study Area Boundary
N
W
E
S
0
75
150
300 Kilometers
122°W
121°W
120°W
119°W
118°W
117°W
116°W
115°W
36°N
35°N
34°N
33°N
32°N

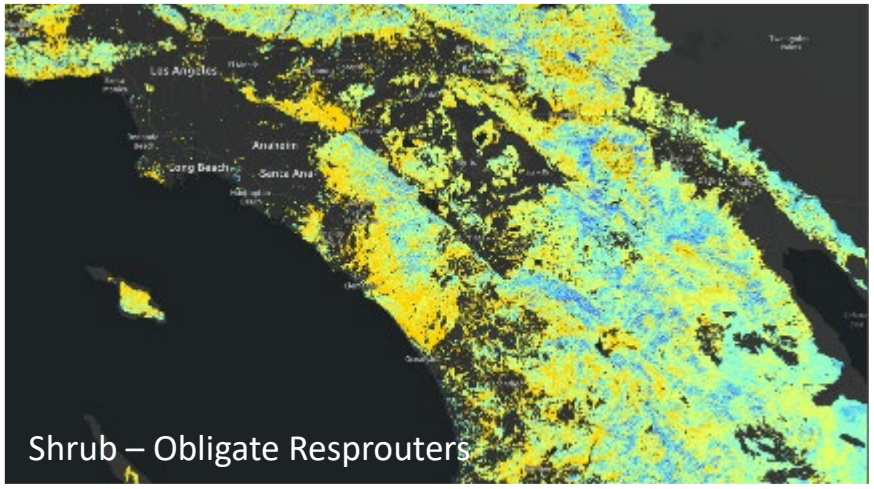
Estimates of other shrubland biomass pools

- Limited estimates of standing dead, litter, belowground esp at regional scale
- Relate estimates in literature to AGLBM
- Shrub biomass pools differ based on post-fire regeneration type

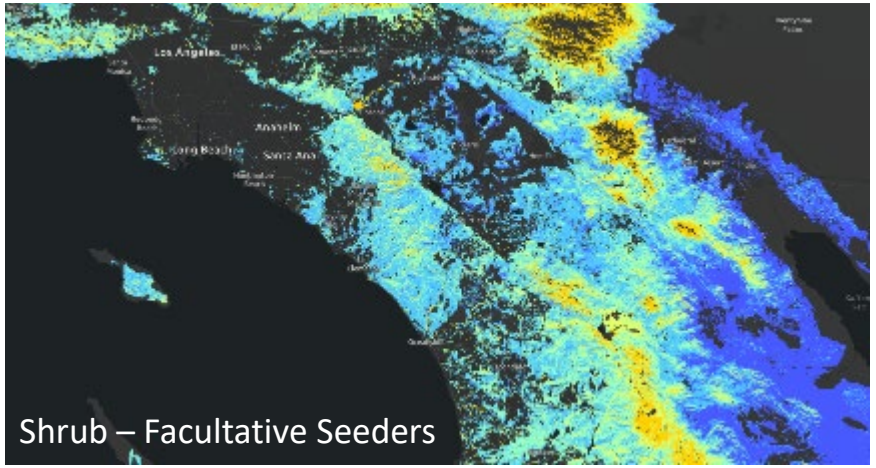
	Obligate Seeders	Obligate Resprouters	Facultative seeders
Pre-fire			
Post-fire			
			
	Germinate from fire-cued seeds, e.g., bigpod Ceanothus (*Ceanothus megacarpus)*	Produce new shoots from dormant buds, e.g., toyon *(Heteromeles arbutifolia)*	Use both mechanisms, e.g., chamise (*Adenostoma fasciculatum)*



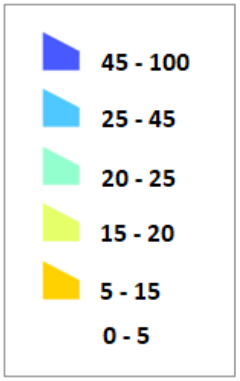
Shrub – Obligate Seeders



Shrub – Obligate Resprouters



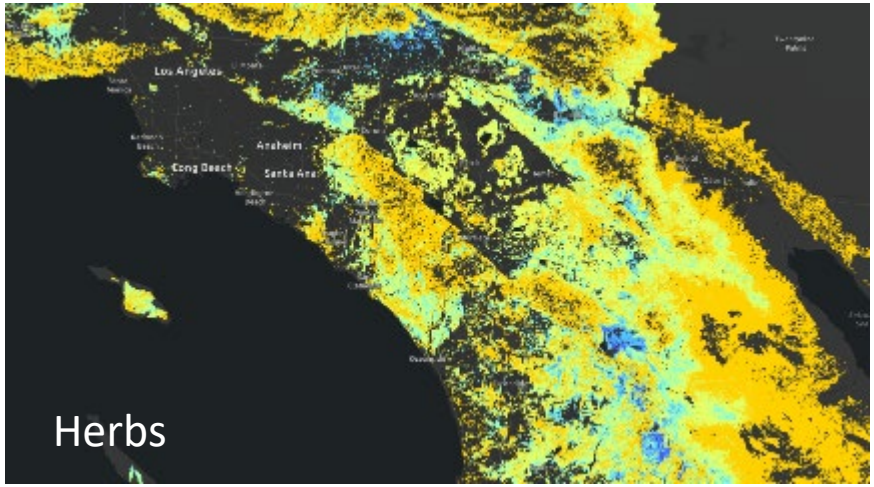
Shrub – Facultative Seeders

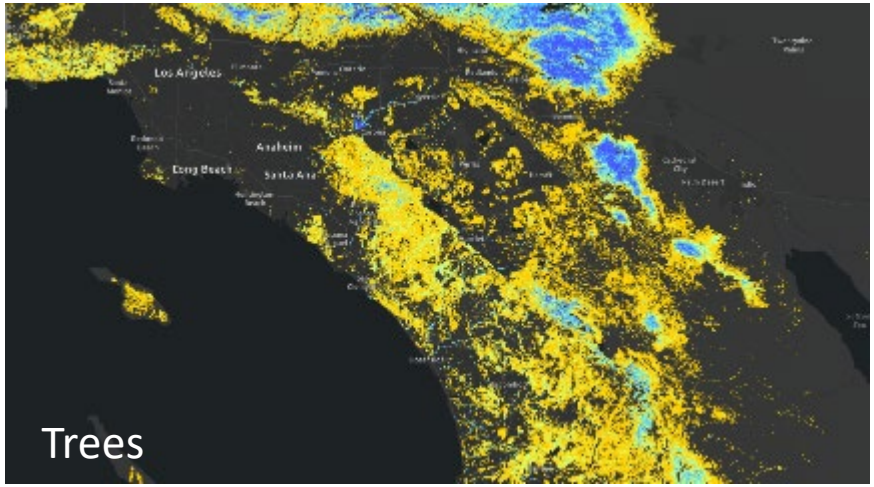


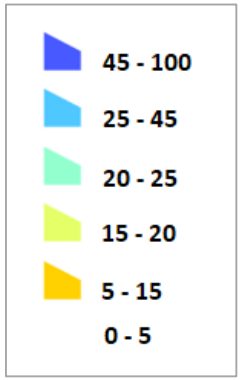
Built a multinomial model using FIA & LFRDB plots to predict proportion of pixel biomass from: 3 life history types, plus trees and herbs

For shrub dominated pixels in ecoregion:

- Obligate Seeders dominate 5%
- Obligate Resprouters dominate 5%
- Facultative Seeders dominate 71%





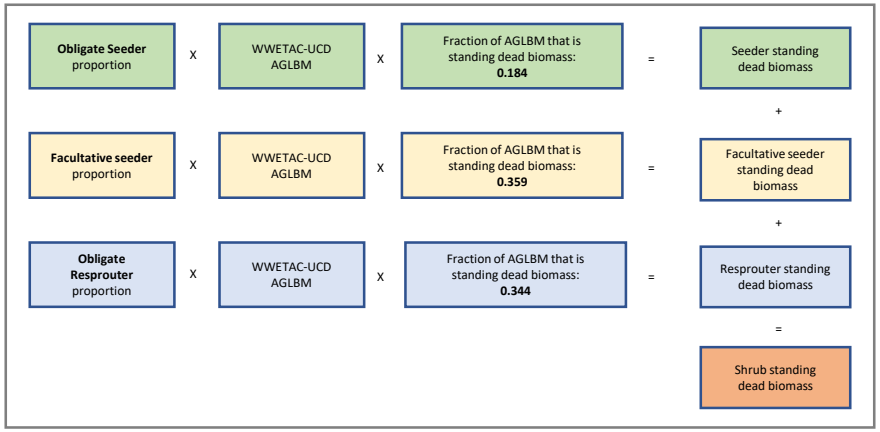


Biomass estimates can be used for both forest and non-forest landscapes

Underwood, E.C., et al. 2023. Frontiers in Ecology and Evolution (In press).

Importance of mapping post-fire regeneration types

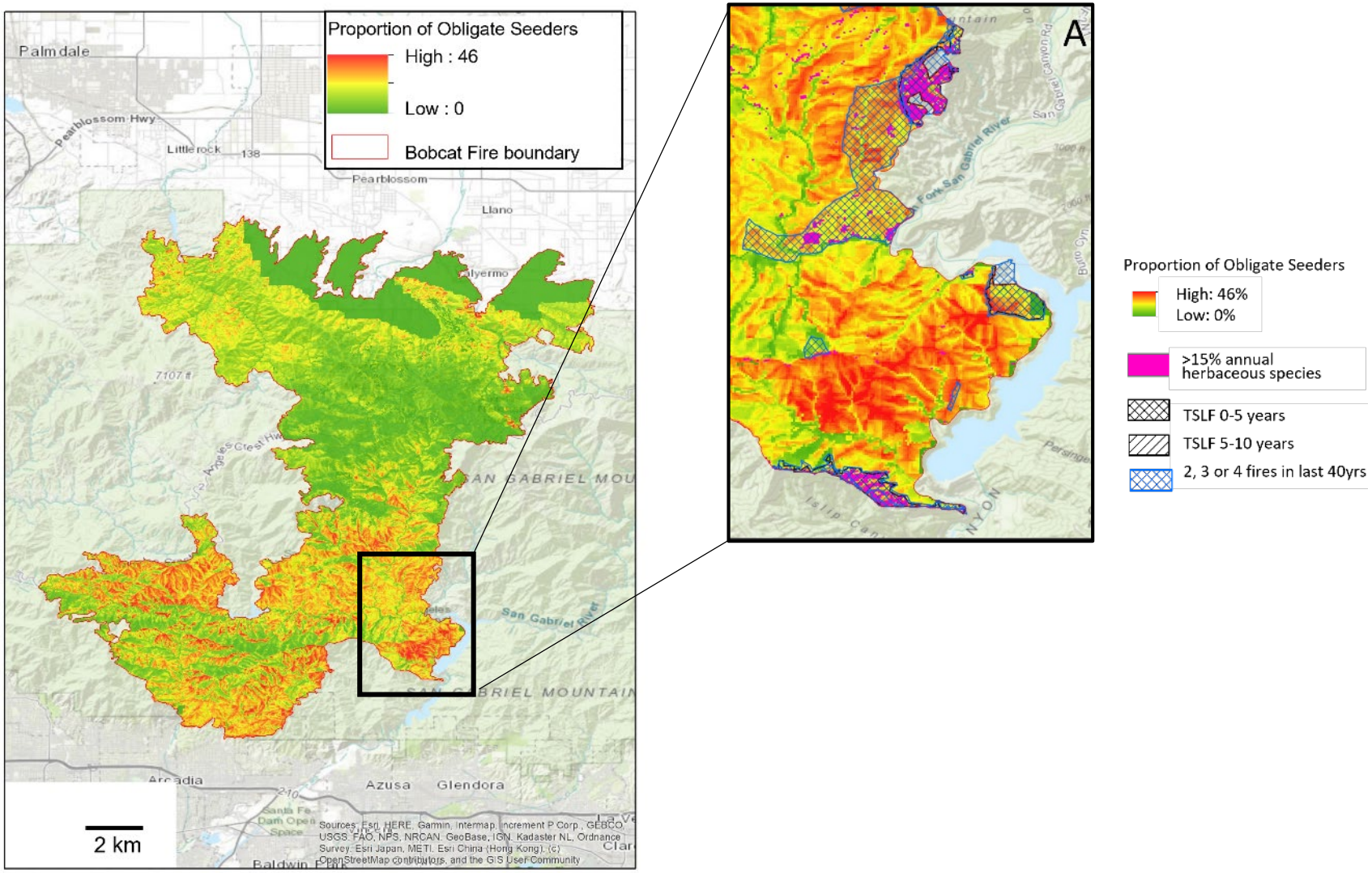
- More complete estimate of shrub biomass



- Quantify impacts of wildfire or track carbon storage over time

- Help prioritize areas for restoration e.g., obligate seeding areas

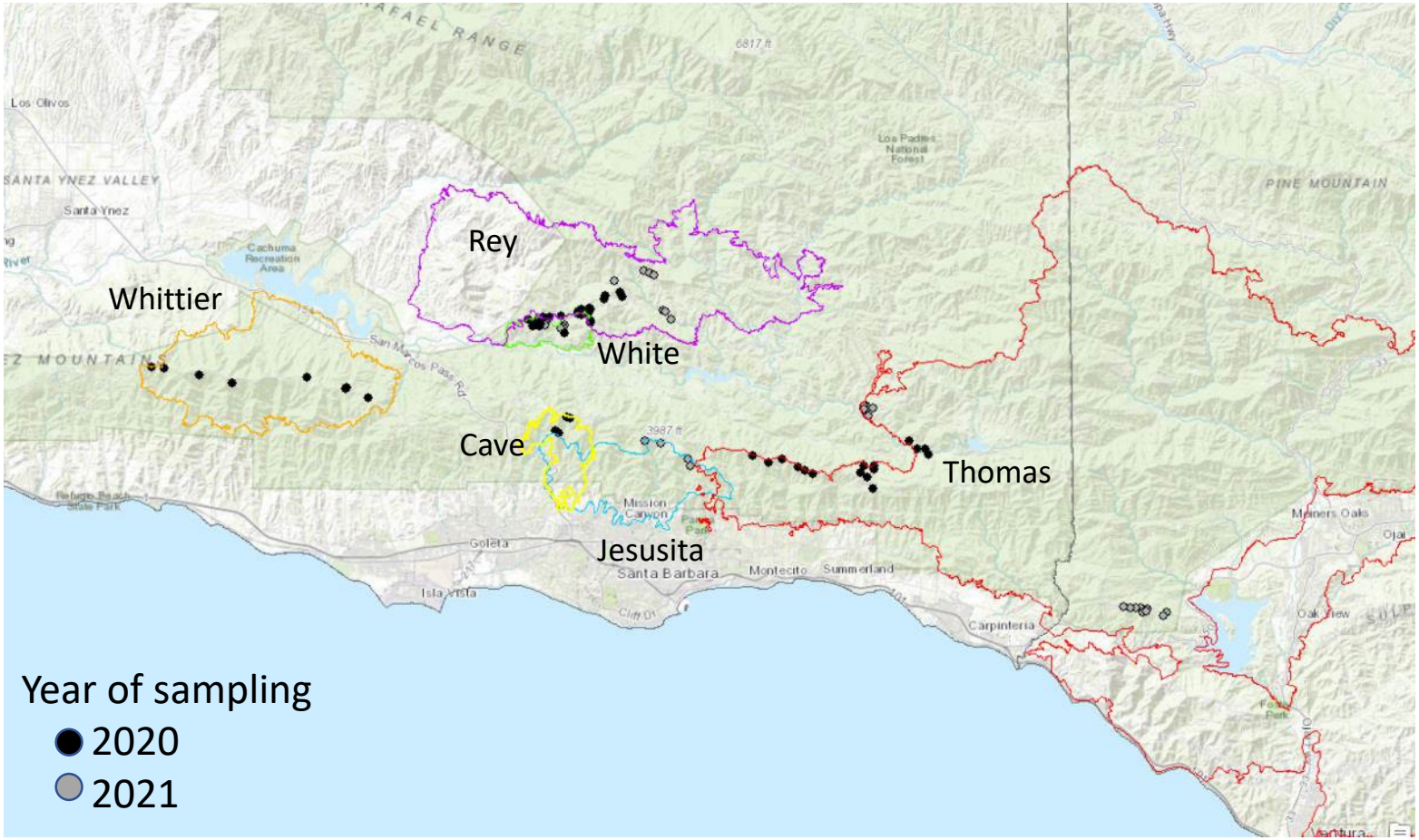
Obligate seeding species in Bobcat Fire (2020)



Underwood, E.C., et al. 2023. Frontiers in Ecology and Evolution (In press).

Drivers of shrubland biomass

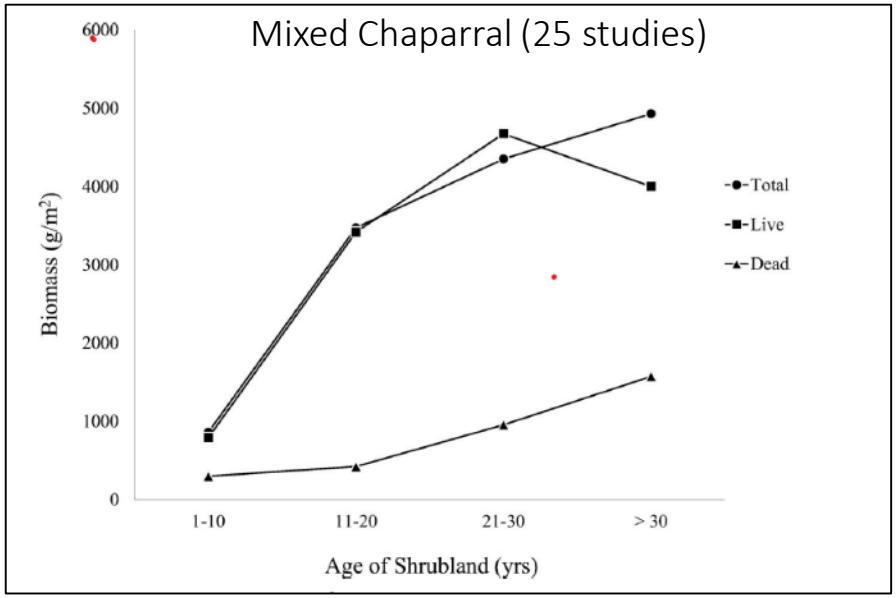
- 155 field plots sampled in 2020/21 across mixed chaparral
- Time since fire ranged from 1 to 12 years
- Applied allometric equations to estimate biomass
- Linear Mixed Model to assess temporal and environmental variables to explain biomass

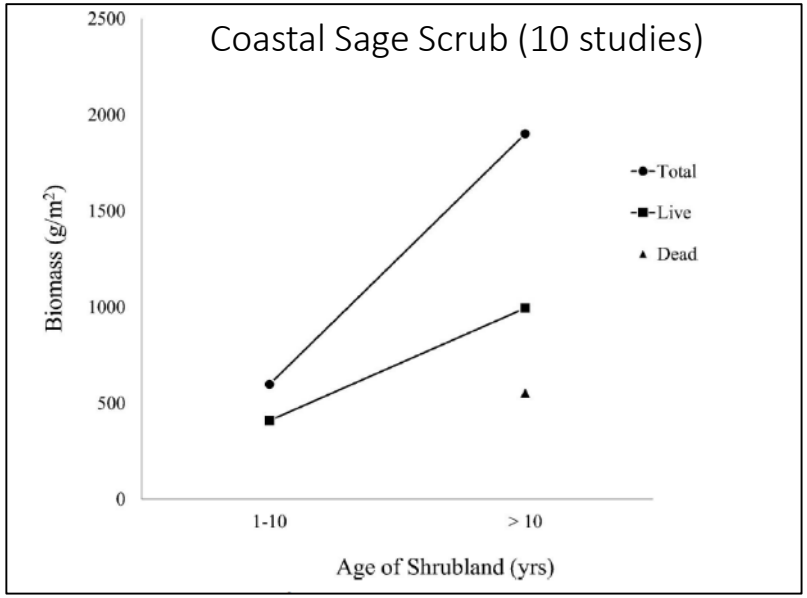


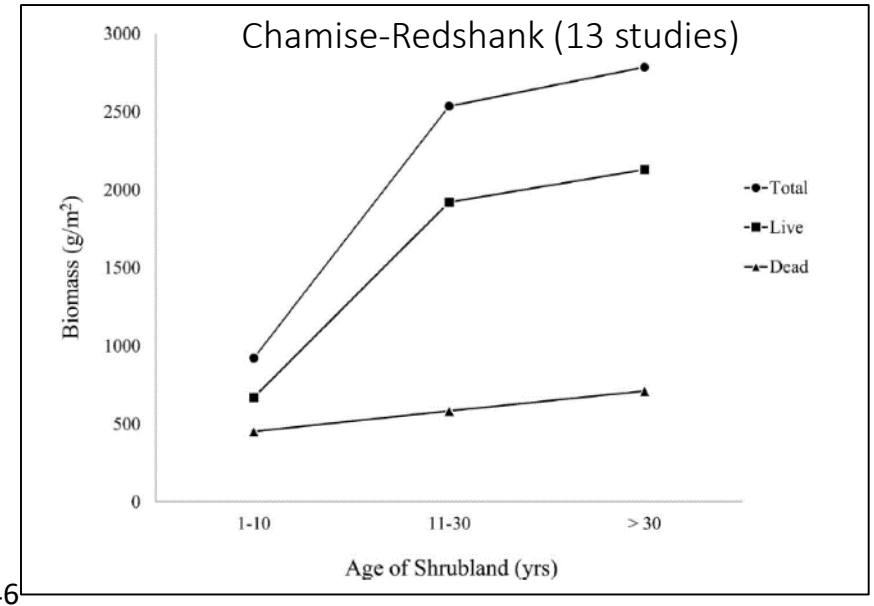
Drivers explaining shrubland biomass

- Time since last fire: older fires more biomass
- Solar radiation: lower solar radiation more biomass
- Prop of species with ability to resprout: more OR species, more biomass
- Distance to coast: coastal sites more biomass

Recovery of shrubland biomass post-fire



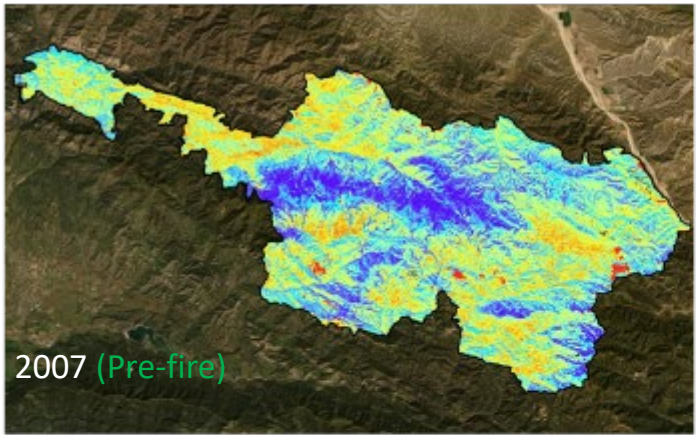


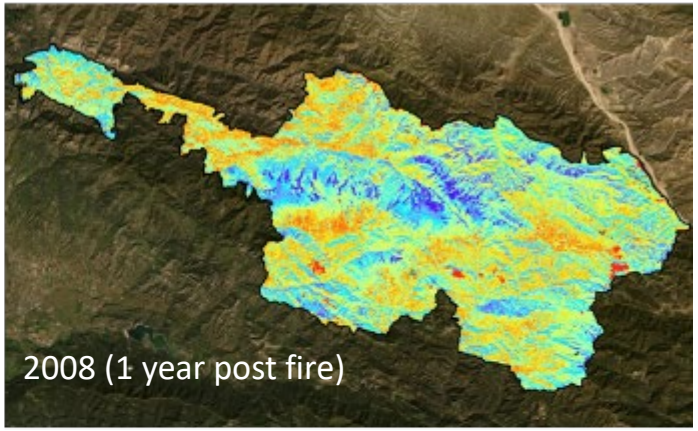


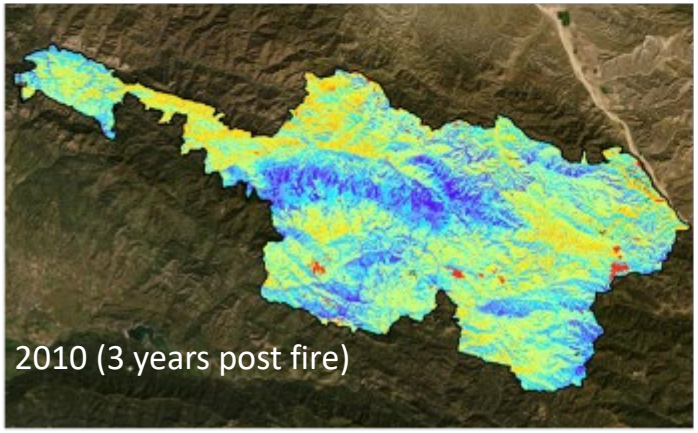
Bohlman et al. 2018. Madrono. 65(1): 28-46

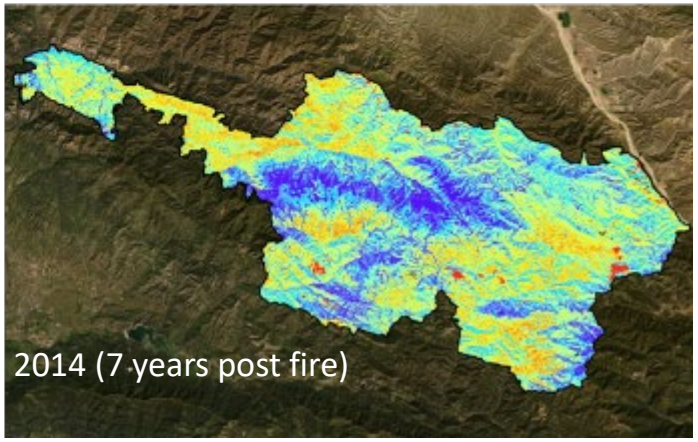
Annual aboveground live biomass 2000-2022

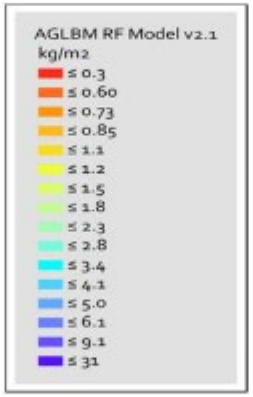
Zaca fire – Burned July-August 2007





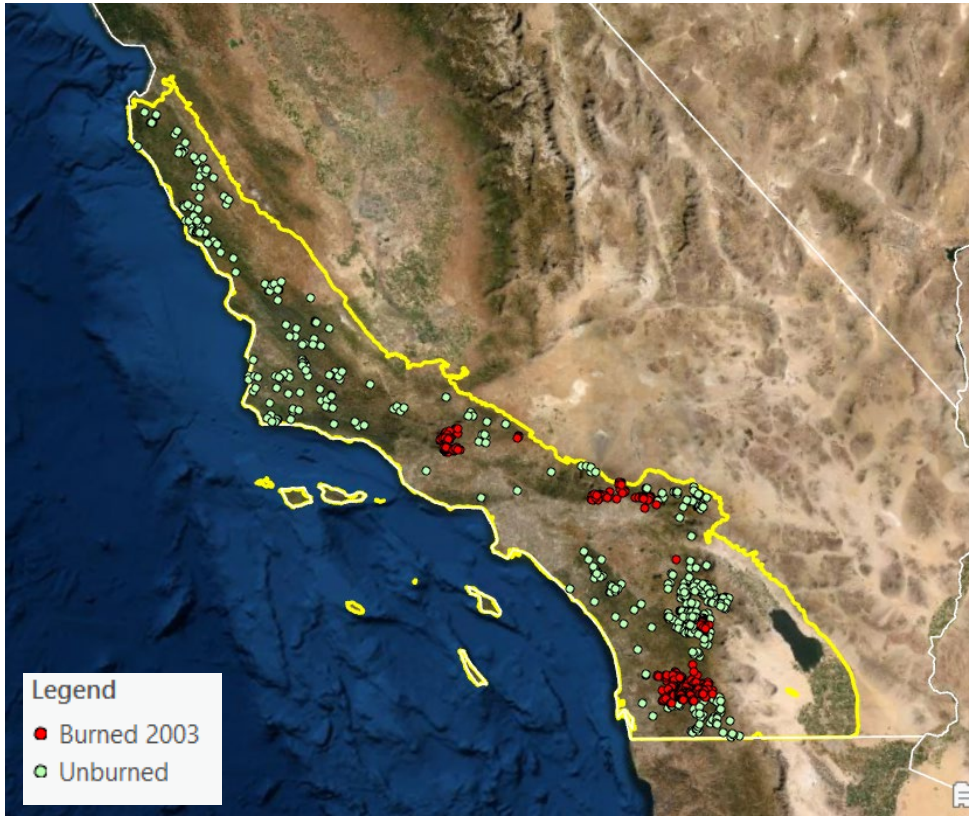




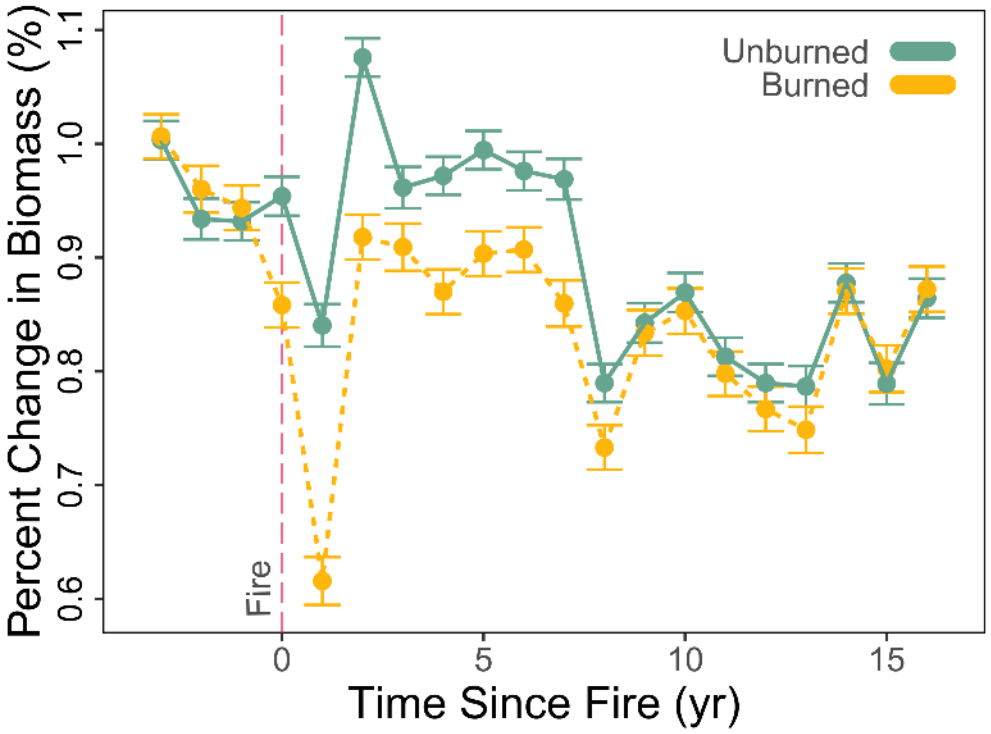


Sample points for recovery analysis

Shrub community	Burned plots	Unburned plots
Mixed chaparral	125	100
Chamise redshank	300	300
Coastal scrub	106	106



Recovery post-fire – mixed chaparral



Future developments

- Extend pre-fire biomass estimates further in time
- Develop for chamise redshank and coastal sagescrub communities

Next steps for shrubland biomass work

- Expand shrubland biomass mapping statewide
- Conduct a comprehensive comparison of biomass datasets with field plots
- Integrate lidar imagery to improve estimates of shrub height and cover
- Expand post-fire recovery for different shrub community types

Powerhouse Fire, 2013. Credit: Ramon Vallejo

Funding and partners

Funding

- California Department of Forestry and Fire Protection (CalFire)
- USDA Forest Service Western Wildland Environmental Threat Assessment Center
- USDA Forest Service Pacific Southwest Region
- National Fish and Wildlife Foundation
- California Landscape Conservation Cooperative

Partners

- University of California, Davis: Hugh Safford. Quinn Sorenson, Allan Hollander,
- US Forest Service: Nicole Molinari

SoCal EcoServe Tool

For resource managers to view and download pre- and post-fire ecosystem services data

- Quantify change in biomass/carbon storage and track recovery post-fire;
- Assist the USFS in reporting carbon storage over time;
- Detect and monitor changes in vegetation state;
- Support decision making, e.g., prioritizing restoration activities post-fire