Forest restoration treatments for sudden oak death: balancing carbon, fuels, and capacity

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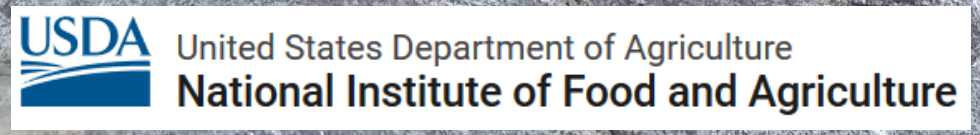
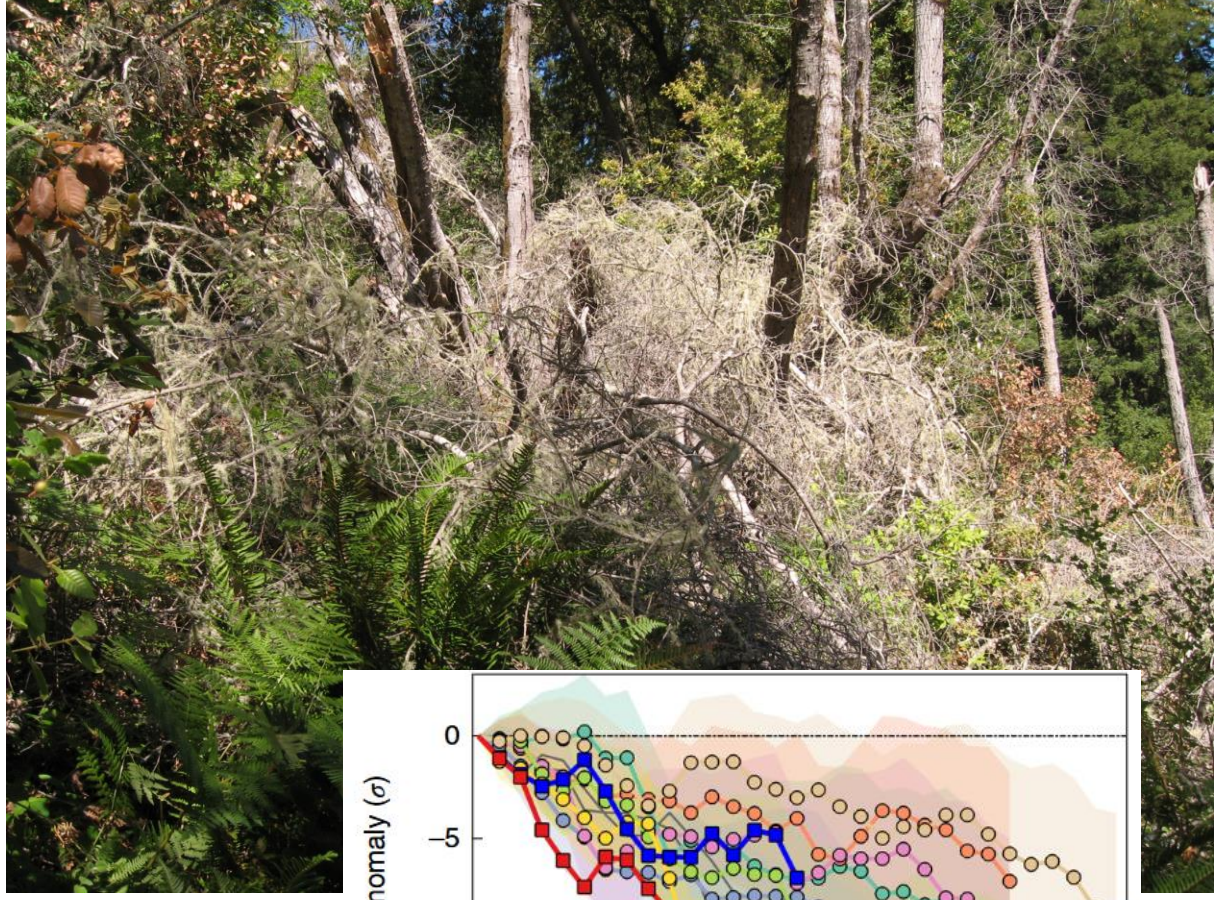
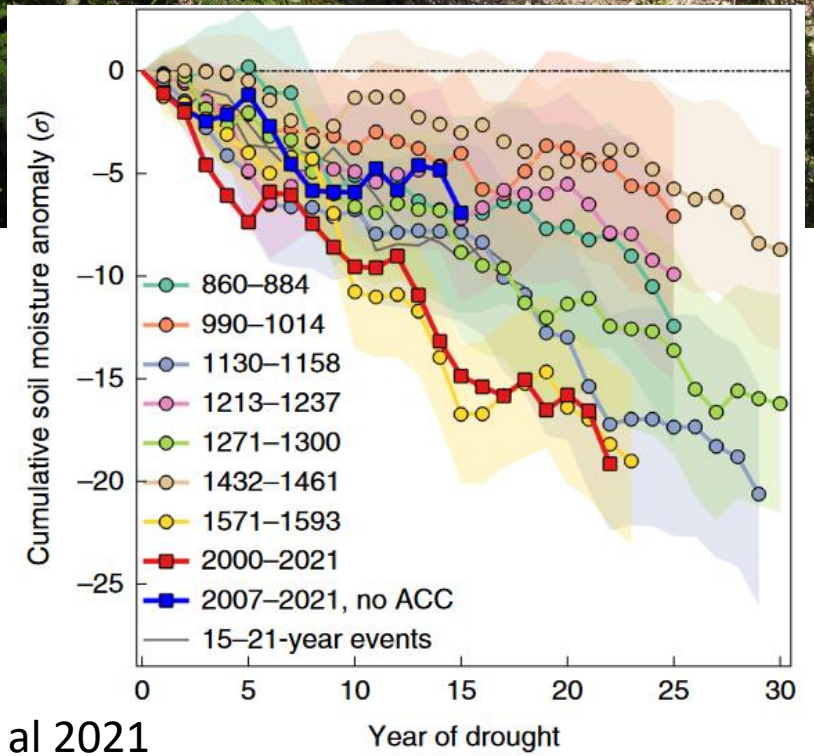
And thanks to Adrian Poloni and Ashley Hawkins



- California state and federal forest health investments…. (2-5 billion over ~5 yrs)
- Annual wildfire carbon emissions were about ~25% of CA total (~106 of 425 Tg yr^{-1})
- And (!!!) wildfire is super expensive!!!!

Fiscal Year	Expenditures
2014—2015	$402 million
2015—2016	$608 million
2016—2017	$534 million
2017—2018	$773 million
2018—2019	$890 million
2019—2020*	$691 million (EST)
2020—2021*	$1.76 billion (EST)
2021—2022*	$1.189 billion (EST)

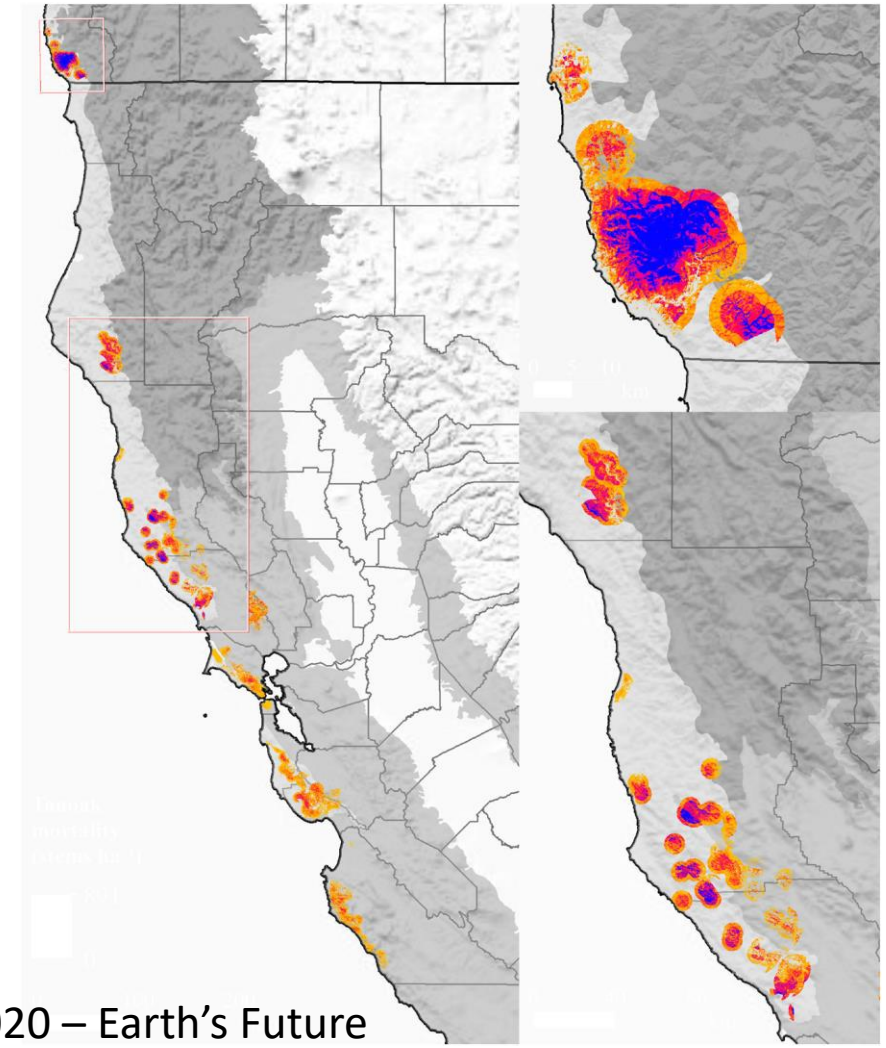




Williams et al 2021

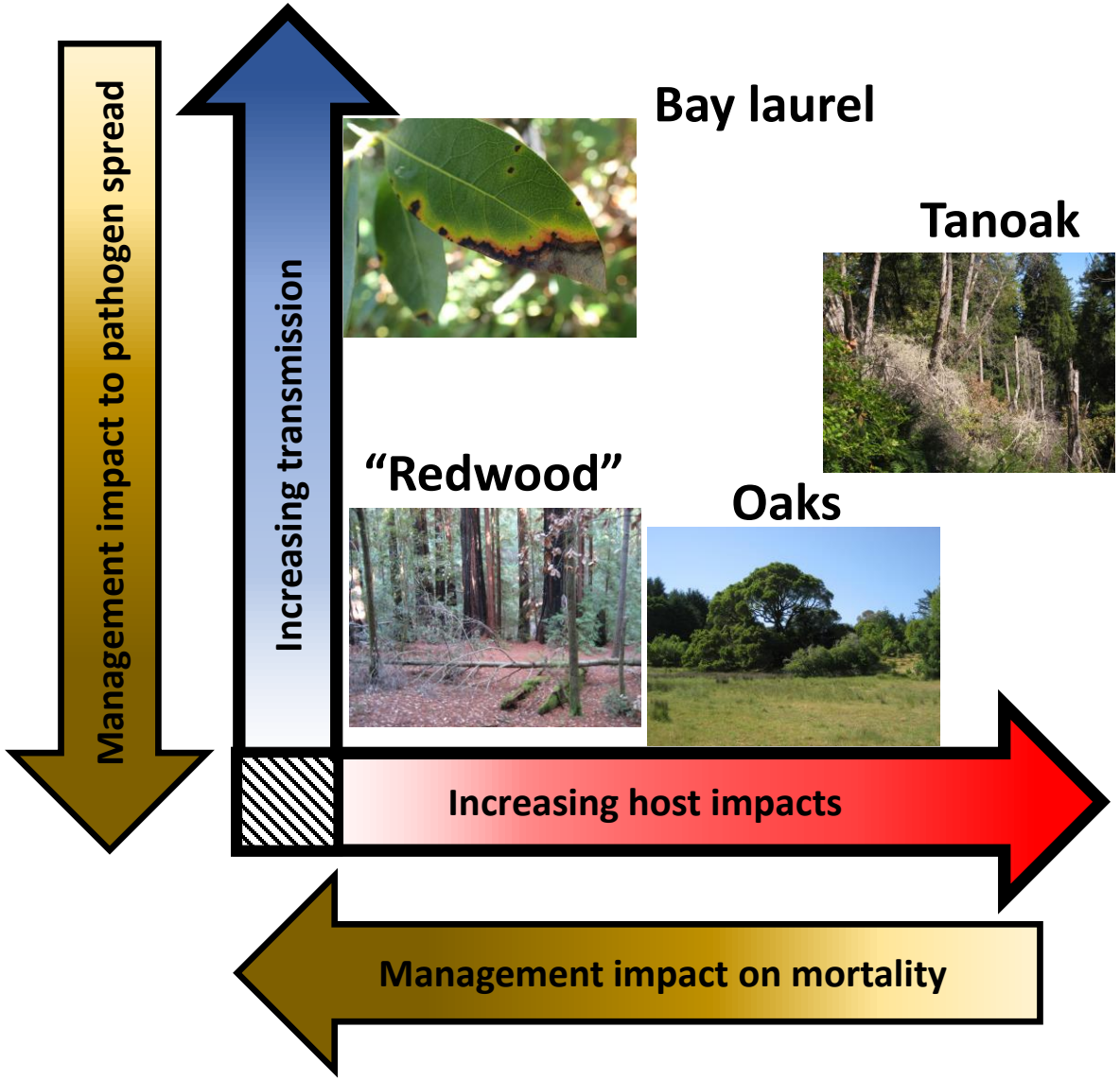
Tree mortality in California: lots of dead trees

- **The coast range:** *Phytophthora ramorum* (exotic) in coastal broad-leaved forests (~50 million trees killed with ~1.8 billion at risk)
- Also: Sierra Nevada; Bark beetles (native) (~300 million trees killed in 10 yrs)
- Both are landscape-level disturbances, effected by climate change, and overlap/interact with fire



Cobb et al 2020 – Earth's Future

Sudden oak death management at the stand scale: mitigate mortality or infection?



Phytophthora ramorum management in California: What treatments result in the greatest resource protection (fuels/fire, carbon, disease prevention)?

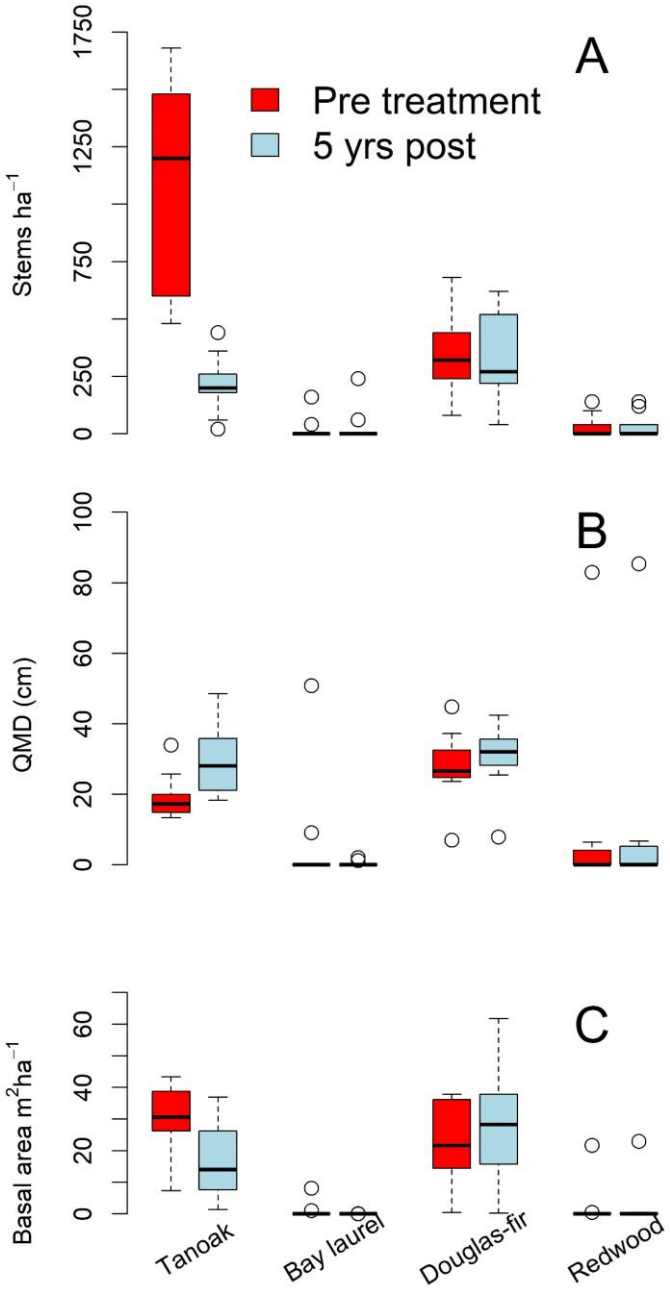
Field experiment:
Surveys: pre treatment, post treatment, 5 yr follow up (BACI design)
-- Pre invasion (Lacks Creek Humbolt County – 2013)
→ Hand crew thinning

-- Post invasion (Marin Municipal Water District – 2014)
→ mastication (distributed)
→ mastication (concentrated)
→ Hand crew piles
→ Hand crew piles with burning
Resprout removal on half of treatments

Pre disease (prevention)

- Tanoak thinning reduces tanoak basal area and density
- Resilient and timber species metrics are unchanged
- No evidence of increased timber growth
- Reduced ground fuels
- Increased quadratic mean diameter (QMD)

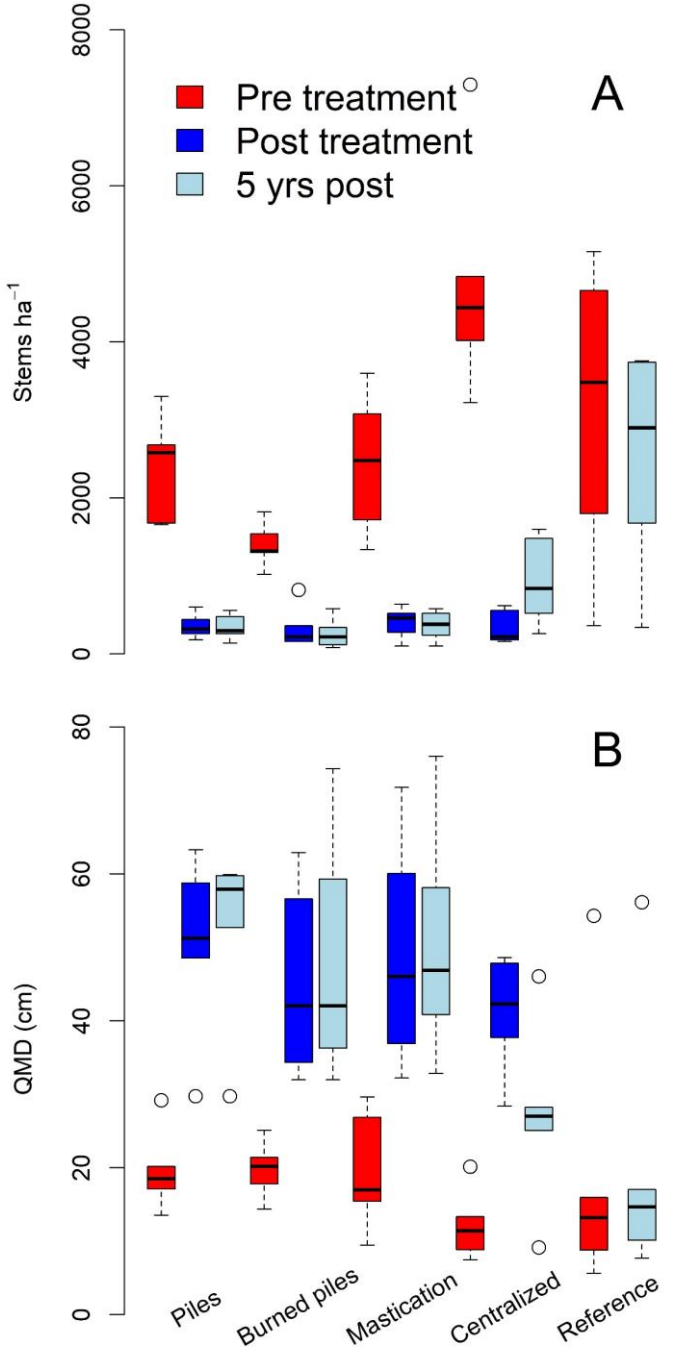
Quiroga et al. 2023 - CJFR



Post disease (restoration)

- All treatments decrease forest density and ground fuels
- After 5 yrs, no evidence of stimulated growth of redwood
- All treatments increase average tree size (QMD) without changing carbon stores
- Mastication treatments result in greater soil respiration, may translate to increased tree growth (unpublished)

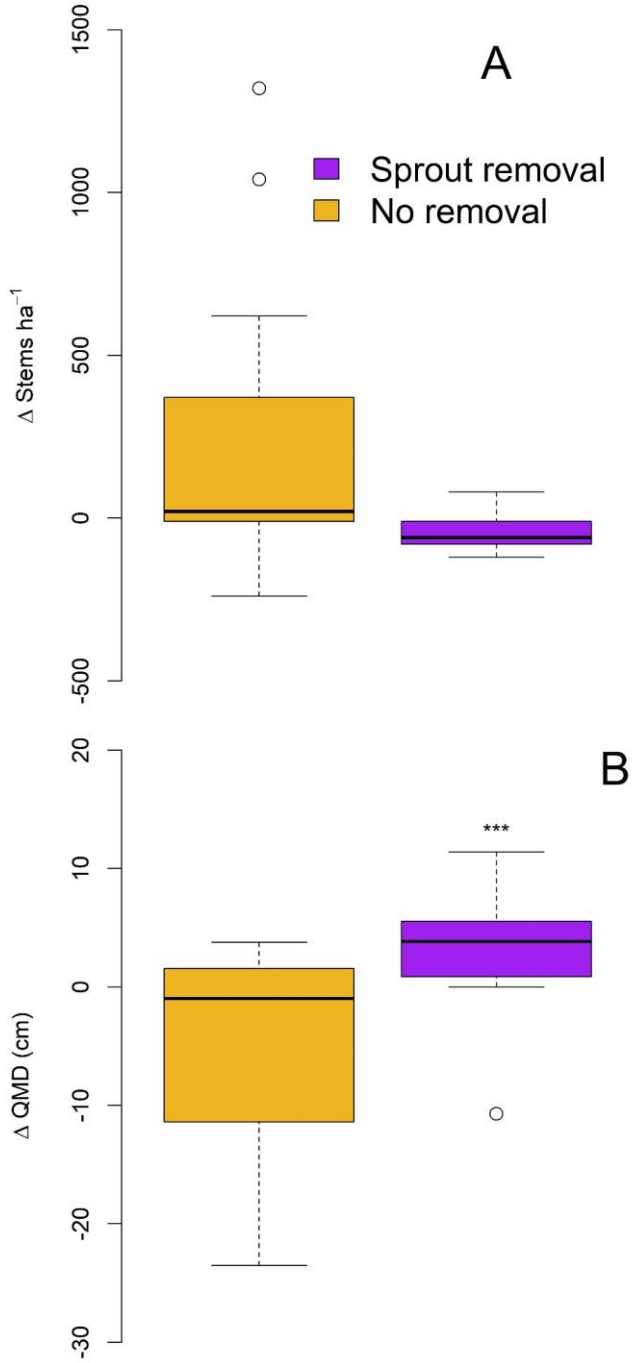
Quiroga et al. 2023 - CJFR



Post disease (restoration)

- Resprout removal maintains low density conditions
- Depending on goals, this may be a worthwhile investment

Quiroga et al. 2023 - CJFR



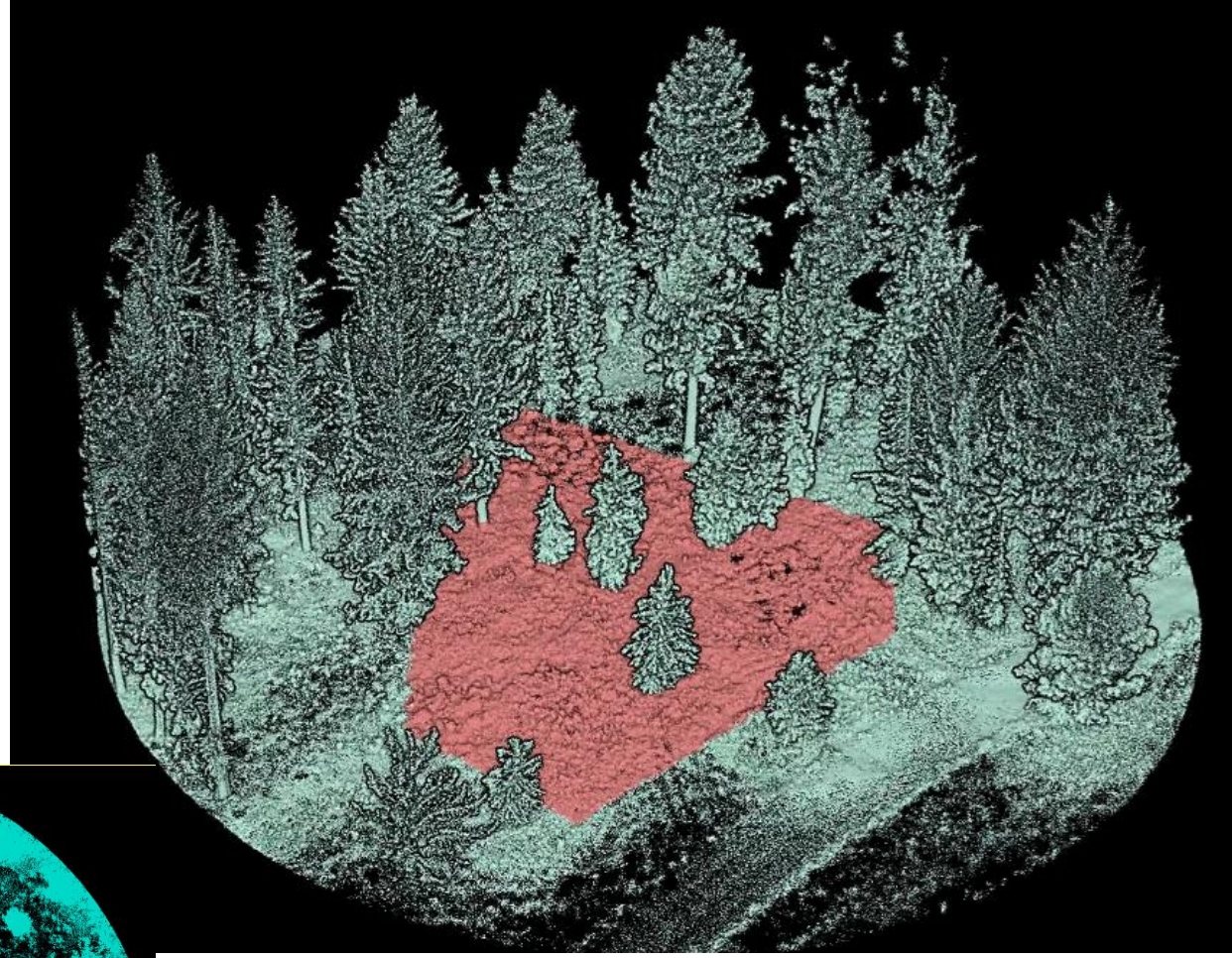
Do benefits hold up long term? How do we scale up?

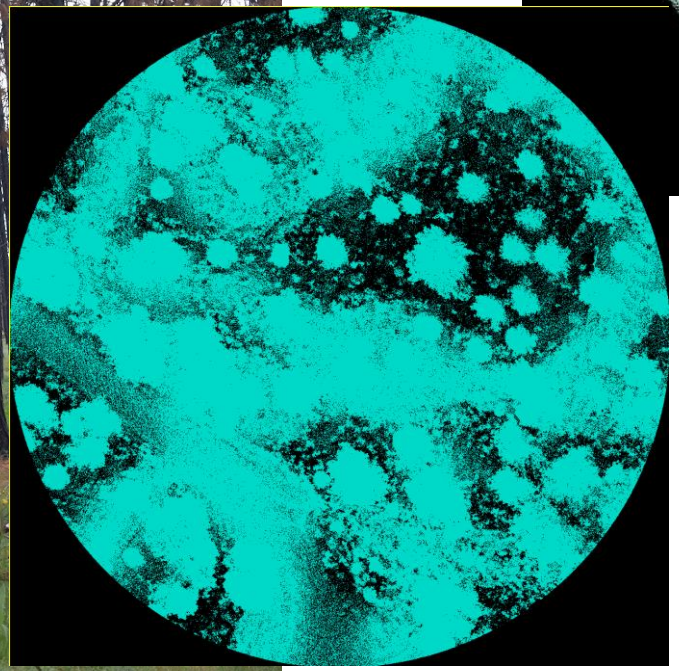
Challenges to scaling up

Outstanding problem	Actions
Scale mismatch – ecological heterogeneity	
Define treatment benefit in terms of goals	More stand-level experiments
Databases of forest condition	This will take a large effort, better sooner than later
Scale mismatch – social systems	
Map forest treatment capacity	More and better data
Partnership building	Recreate successful collaborative models
Policy-level challenges	
Liability protection for prescribed fire	Outreach and increased liability funds
Allocate resources in by subregion	People (capacity, workforce) and terrain (landform, forest condition)

Define treatment benefit in terms of goals

- Emerging technology to map fuels and treatment benefits (terrestrial laser scanning – TLS)

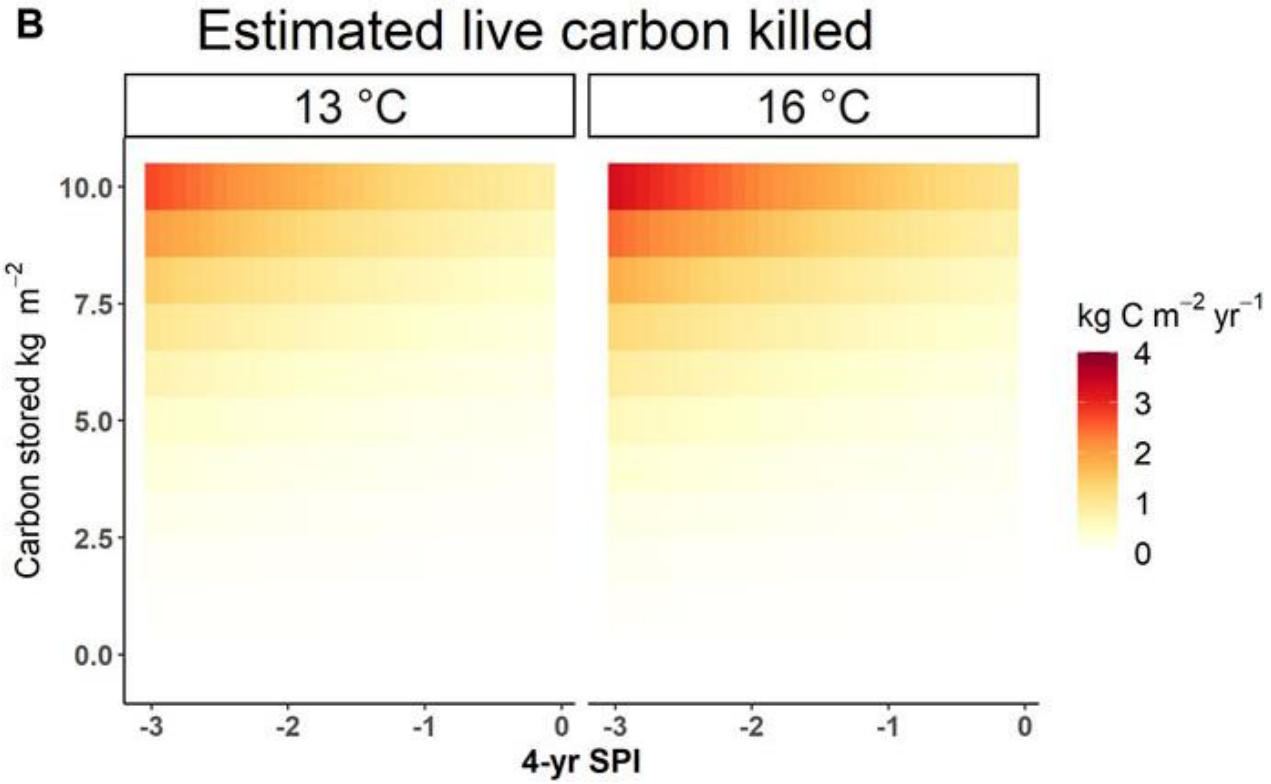




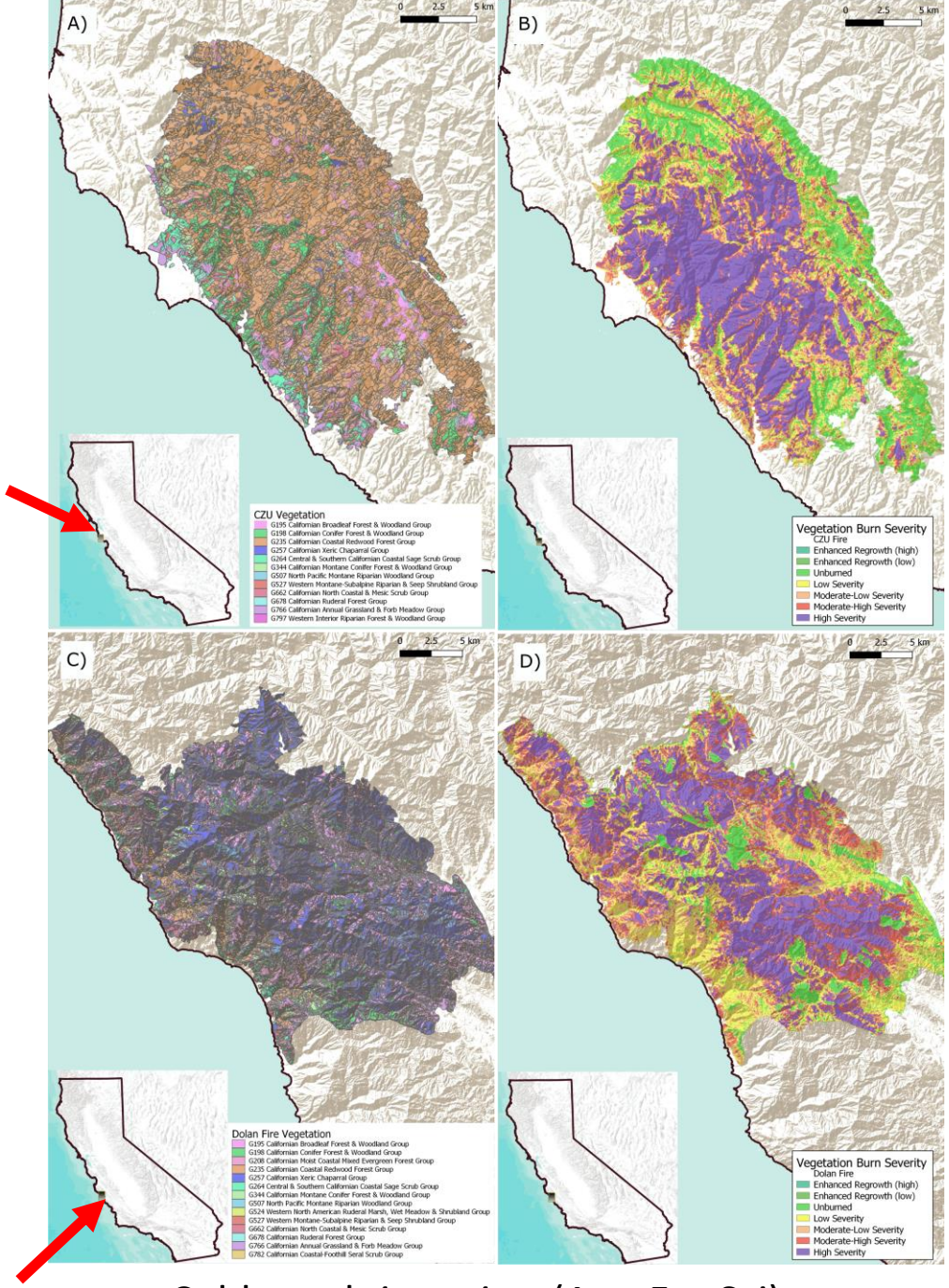
Define treatment benefit in terms of goals: an integrated pest management example (IPM)

	Mortality mitigation		**Fuels management**	
Forest type	Broadcast burn	Hand Crew	Broadcast burn	Hand Crew
CA black oak	(??)	(??)	(??)	(??)
Coast Redwood	(??)	+	(??)	+
Mixed evergreen	(??)	(??)	(??)	(??)
Oak savanna	(??)	(??)	(??)	(??)
Giant Sequoia	(??)	(??)	(??)	(??)
Jeffry pine	(??)	(??)	(??)	(??)
Pinyon Pine	(??)	(??)	(??)	(??)
Ponderosa pine	(??)	(??)	(??)	(??)
Sierra foothill	(??)	(??)	(??)	(??)
Sierra mixed (>2000m asl)	(??)	(??)	(??)	(??)
Sierra mixed (1000-2000m asl)	(??)	(??)	(??)	(??)

Databases (maps) of forest condition – hard to build but will help allocate resources



Robbins et al. 2023



Cobb et al. *in review* (Ann For Sci)

Partnership building: Soquel State Demonstration Forest Prescribed fire Fall 2022 – go small to go bigger

Partnership building: Soquel State Demonstration Forest Prescribed fire Fall 2023 – way hotter!!!

Liability protection for prescribed fire – regional allocation of response vs management (prevention)

Fire less relevant
Maximum disease importance

Gradients of interaction strength

Disease less relevant
Maximum fire importance