

Coastal Cutthroat Trout resilience to wildfire in the western Cascade Mountains



Dana Warren – Oregon State University
Allison Swartz – Oregon State University
Jansen Ivie – Oregon State University
David Roon – Oregon State University



Resistance and Resilience of an ecosystem

DISTURBANCE
EVENT

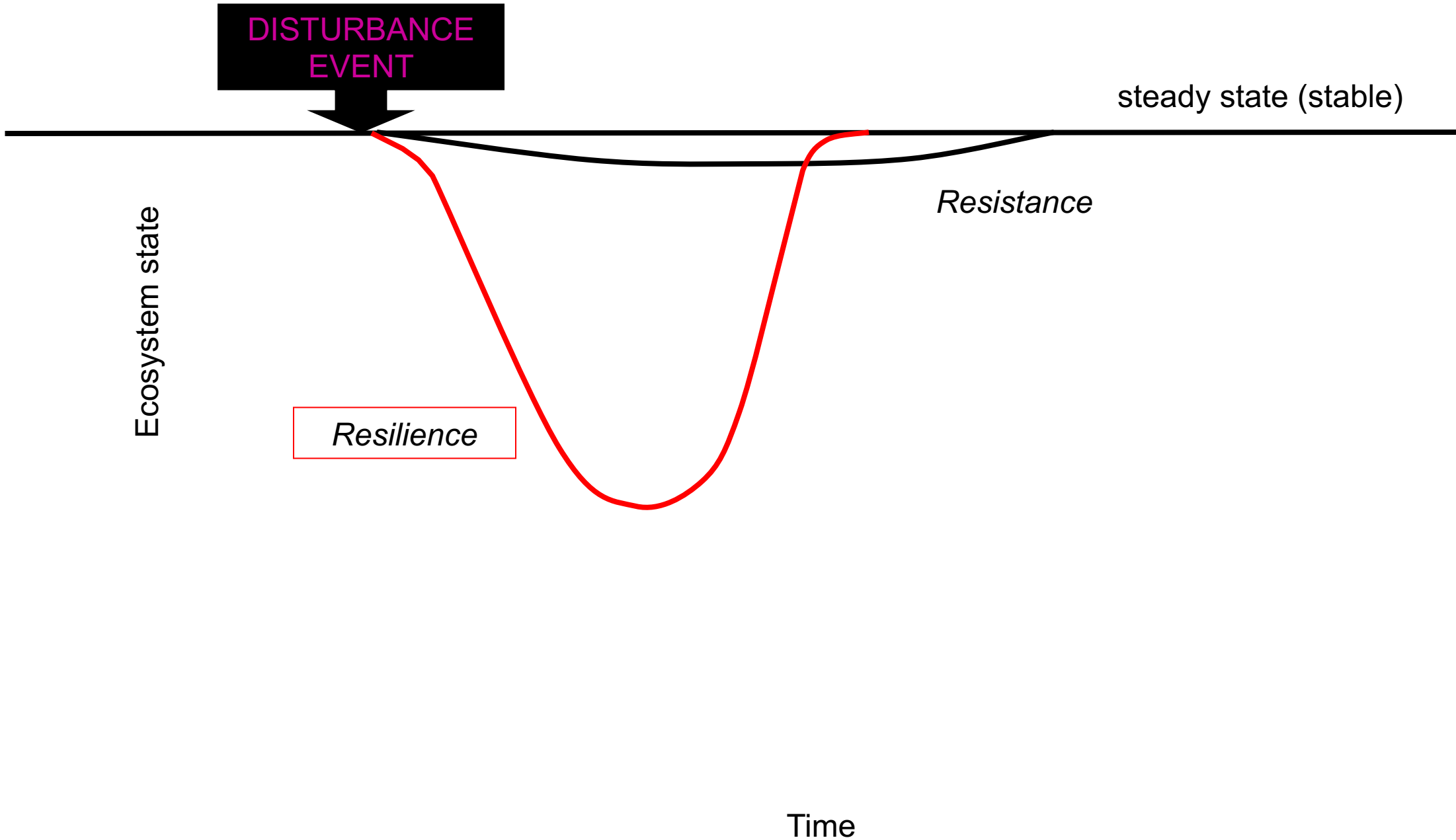
steady state (stable)

Ecosystem state

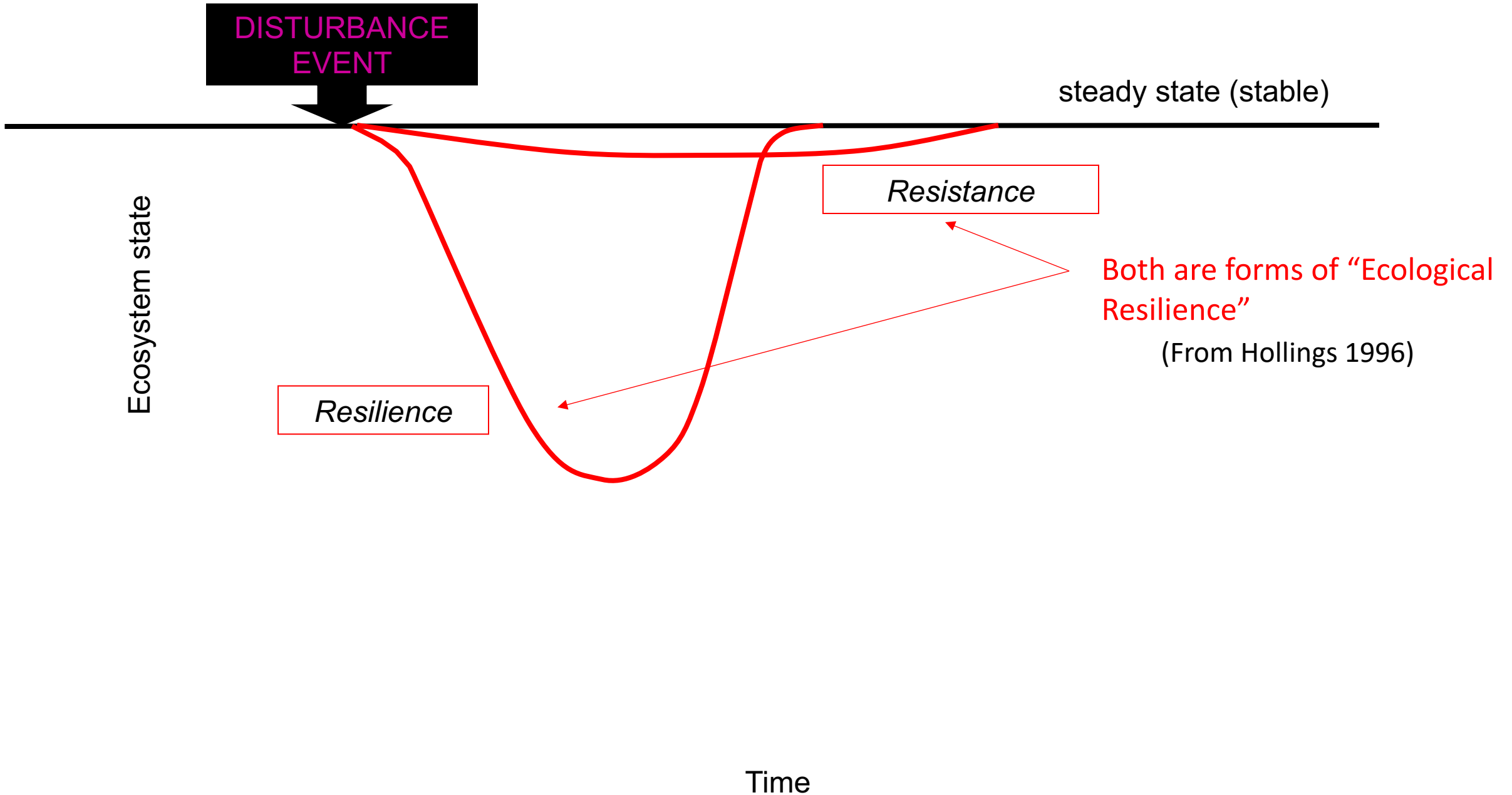
Time



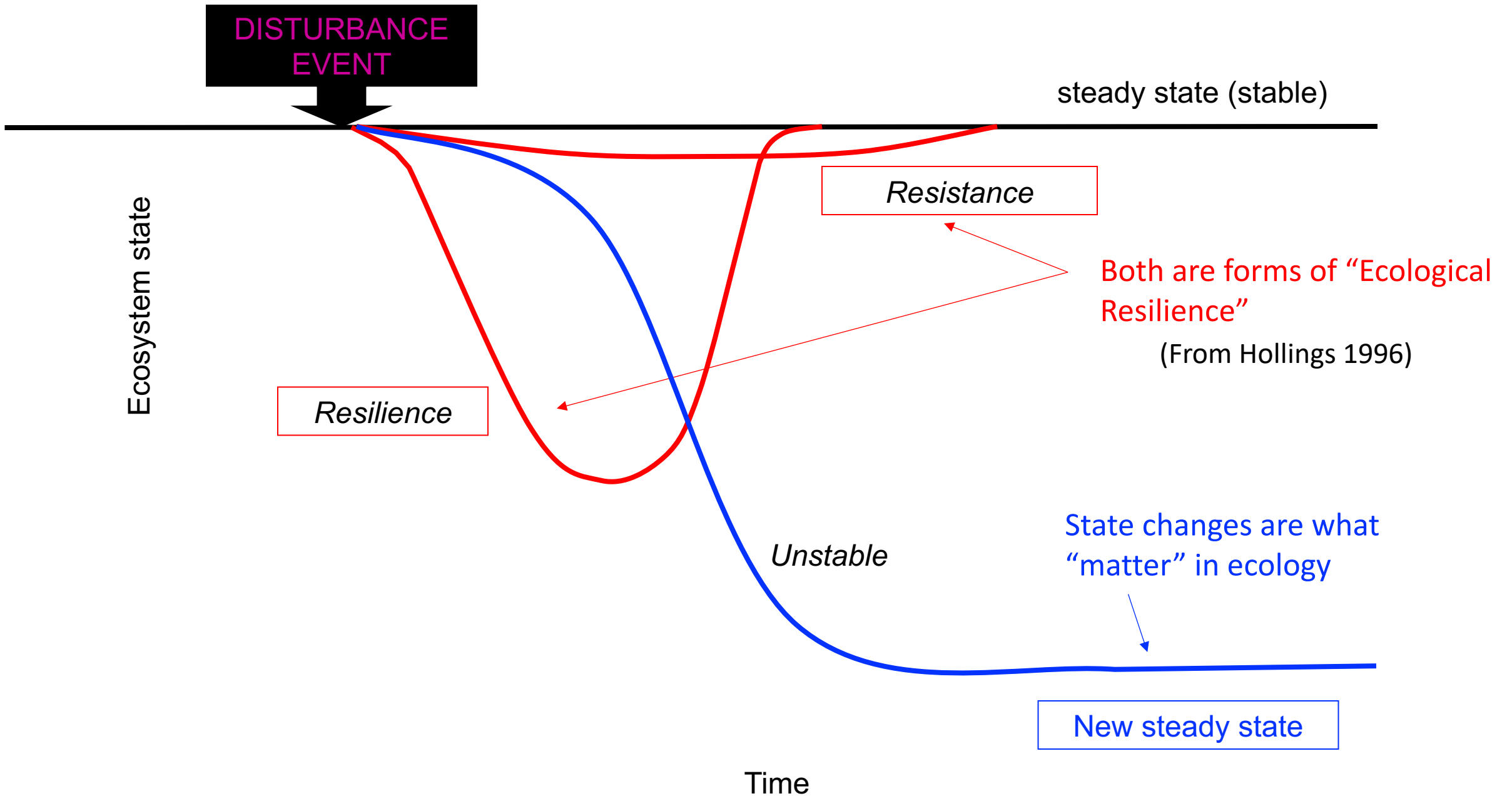
Resistance and Resilience of an ecosystem



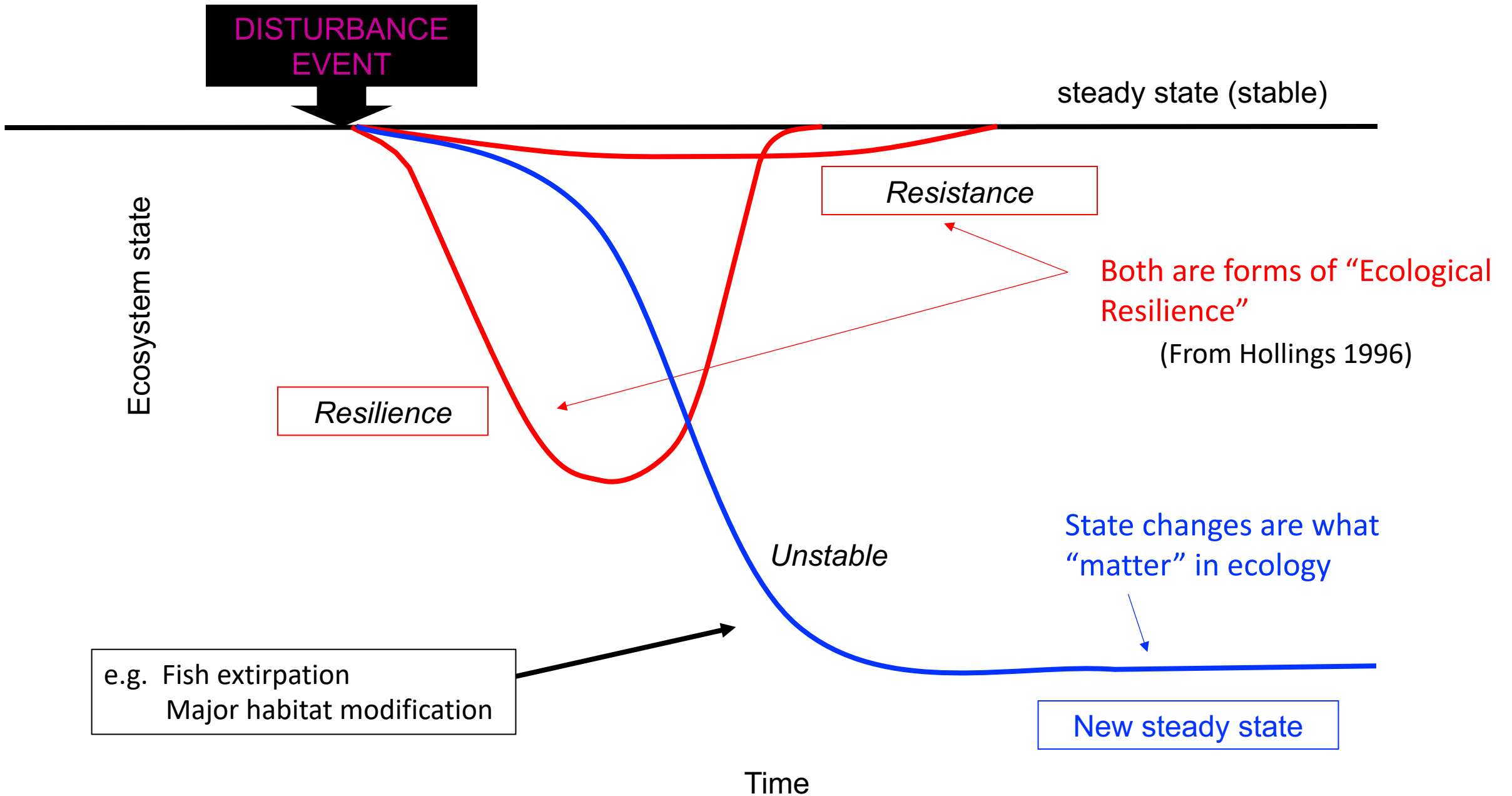
Resistance and Resilience of an ecosystem



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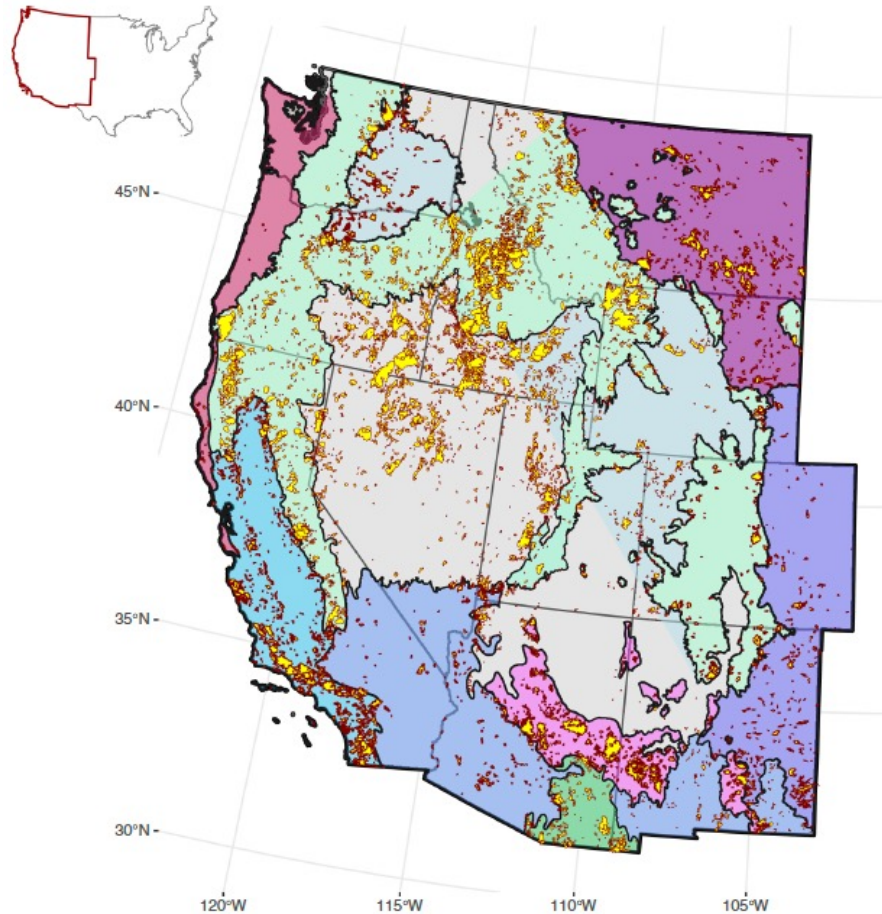
Increasing wildfire in the western United States

<https://doi.org/10.1038/s41467-021-22747-3>

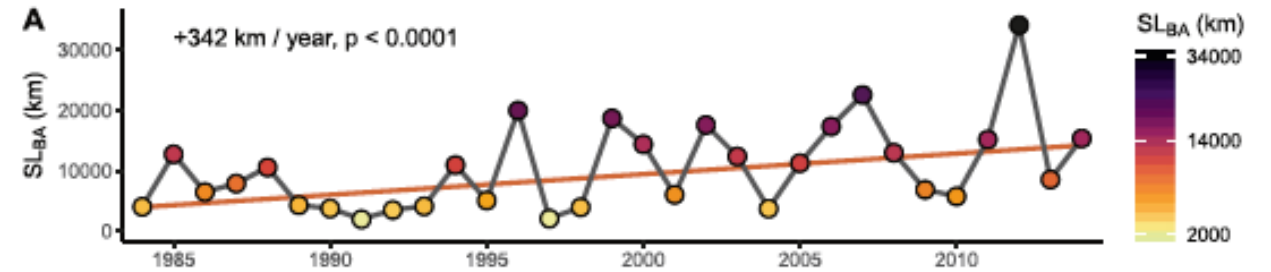
OPEN

Wildfires increasingly impact western US fluvial networks

Grady Ball^{1,6}, Peter Regier^{2,5,6}, Ricardo González-Pinzón^{2,6}, Justin Reale³ & David Van Horn^{4,6}



1984 - 2014



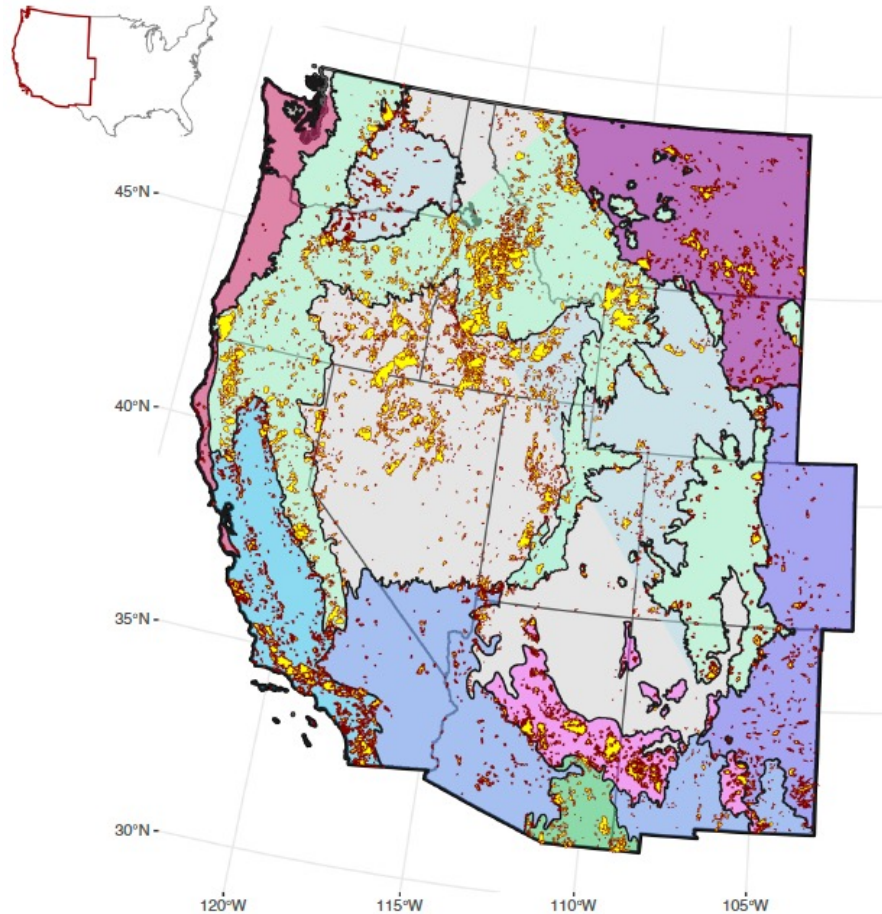
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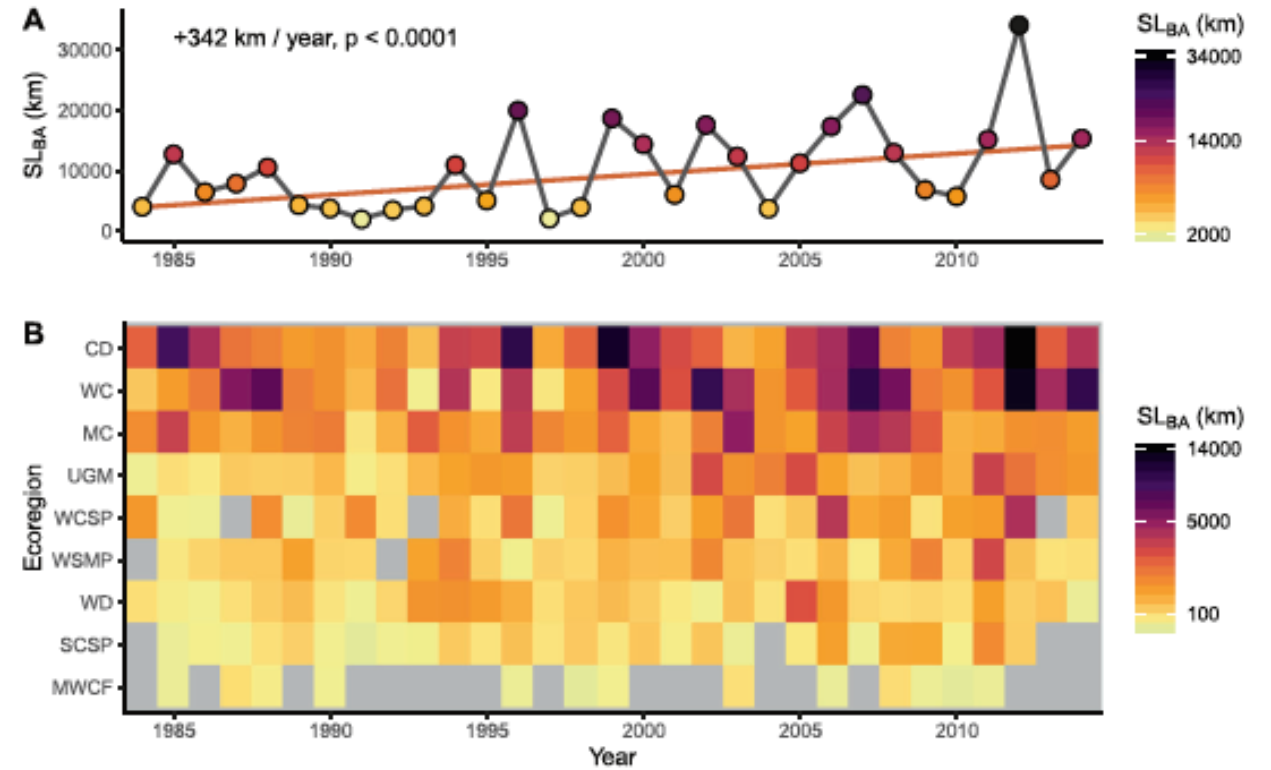
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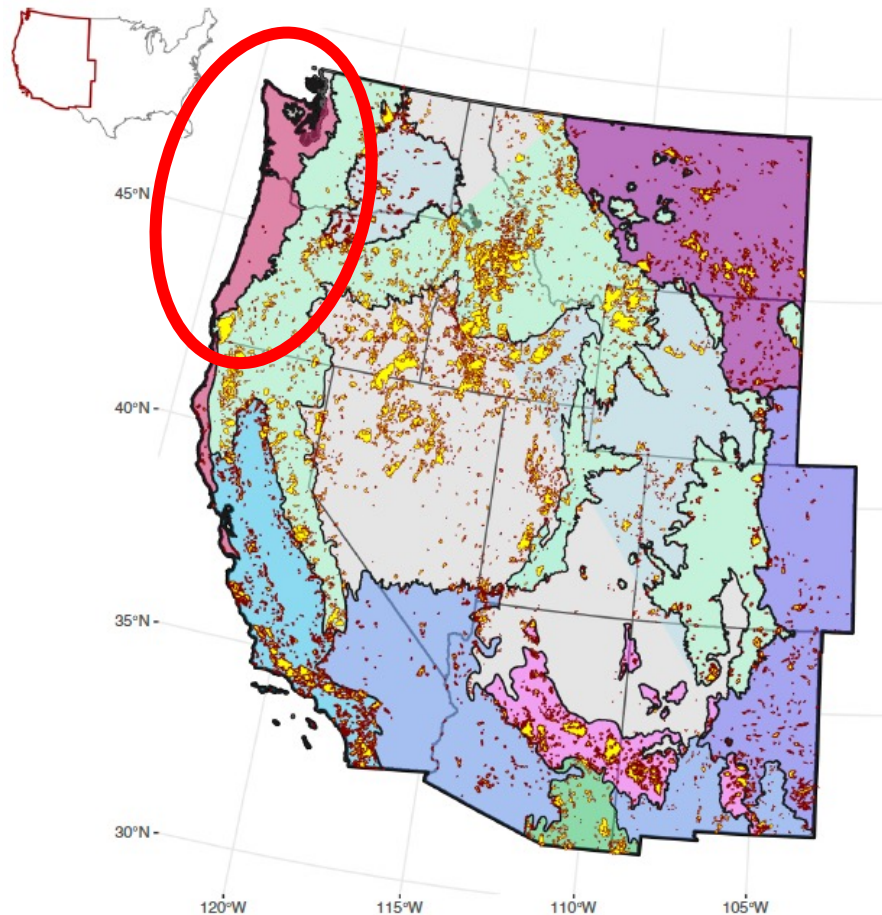
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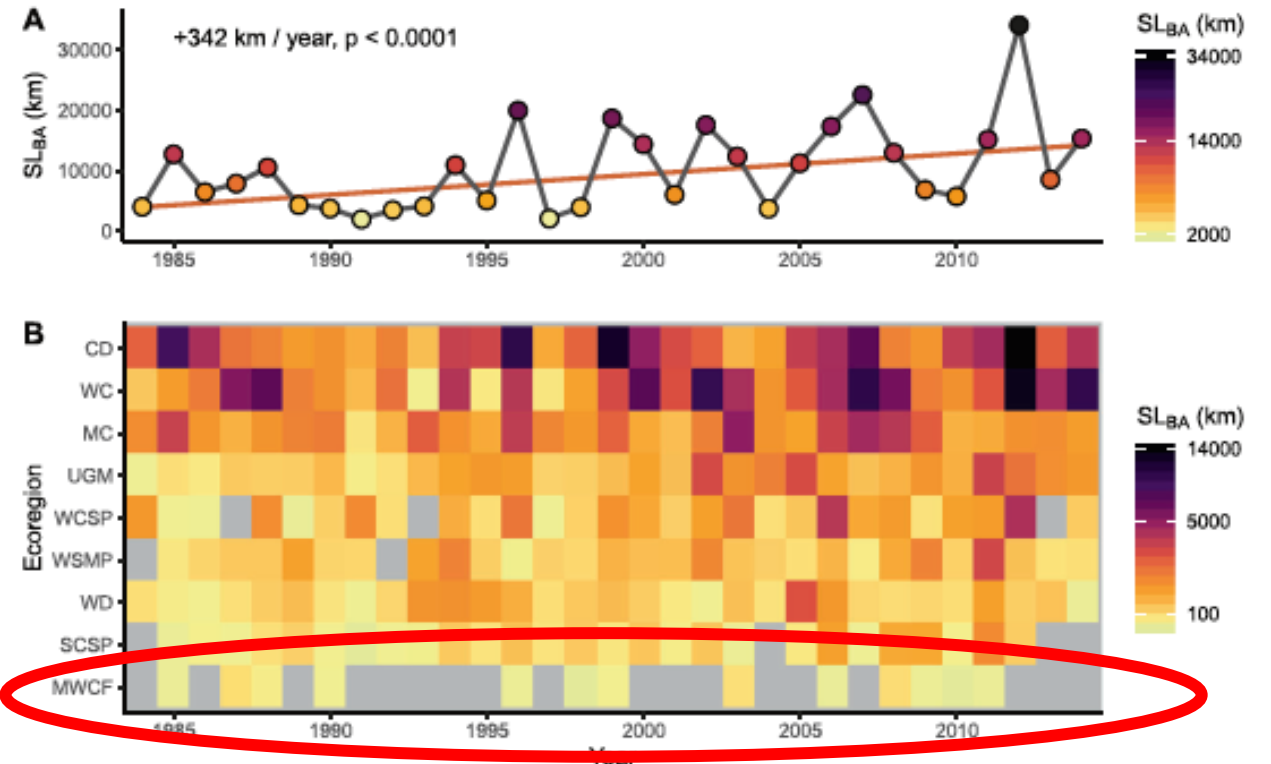
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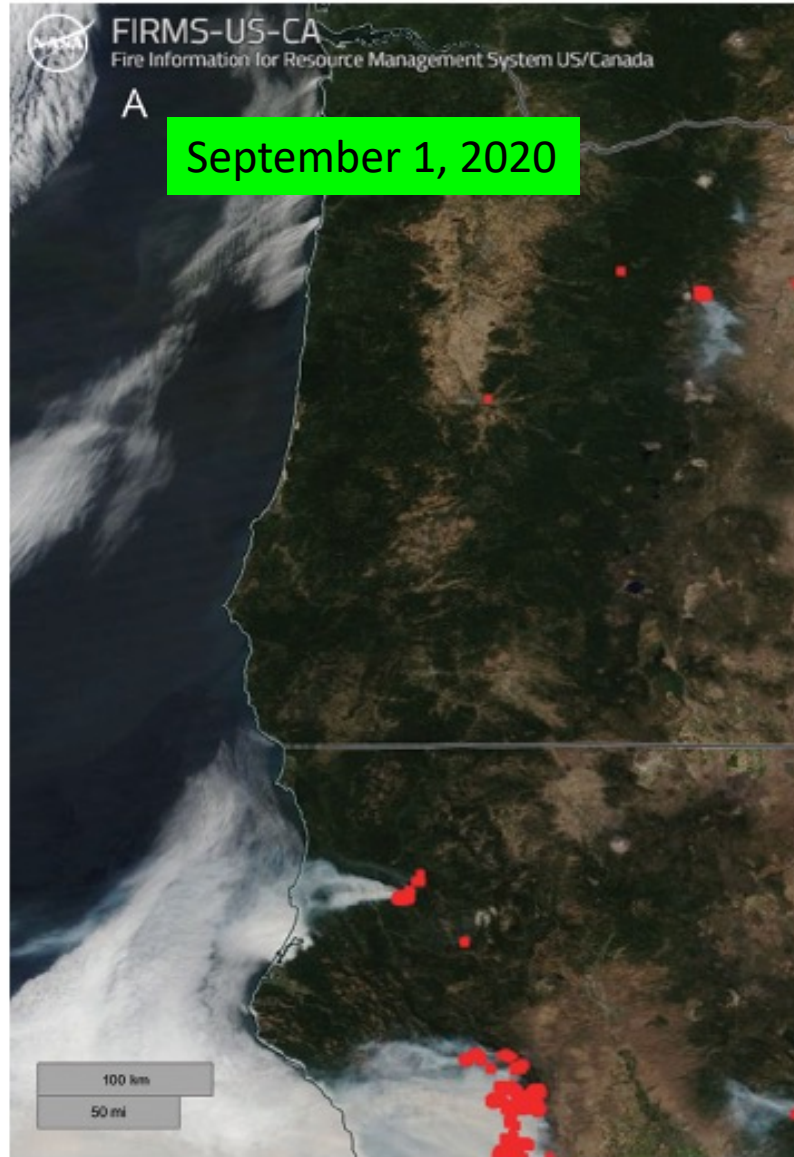
1984 - 2014



“Marine West Coastal Forest” – not showing same trend. . .

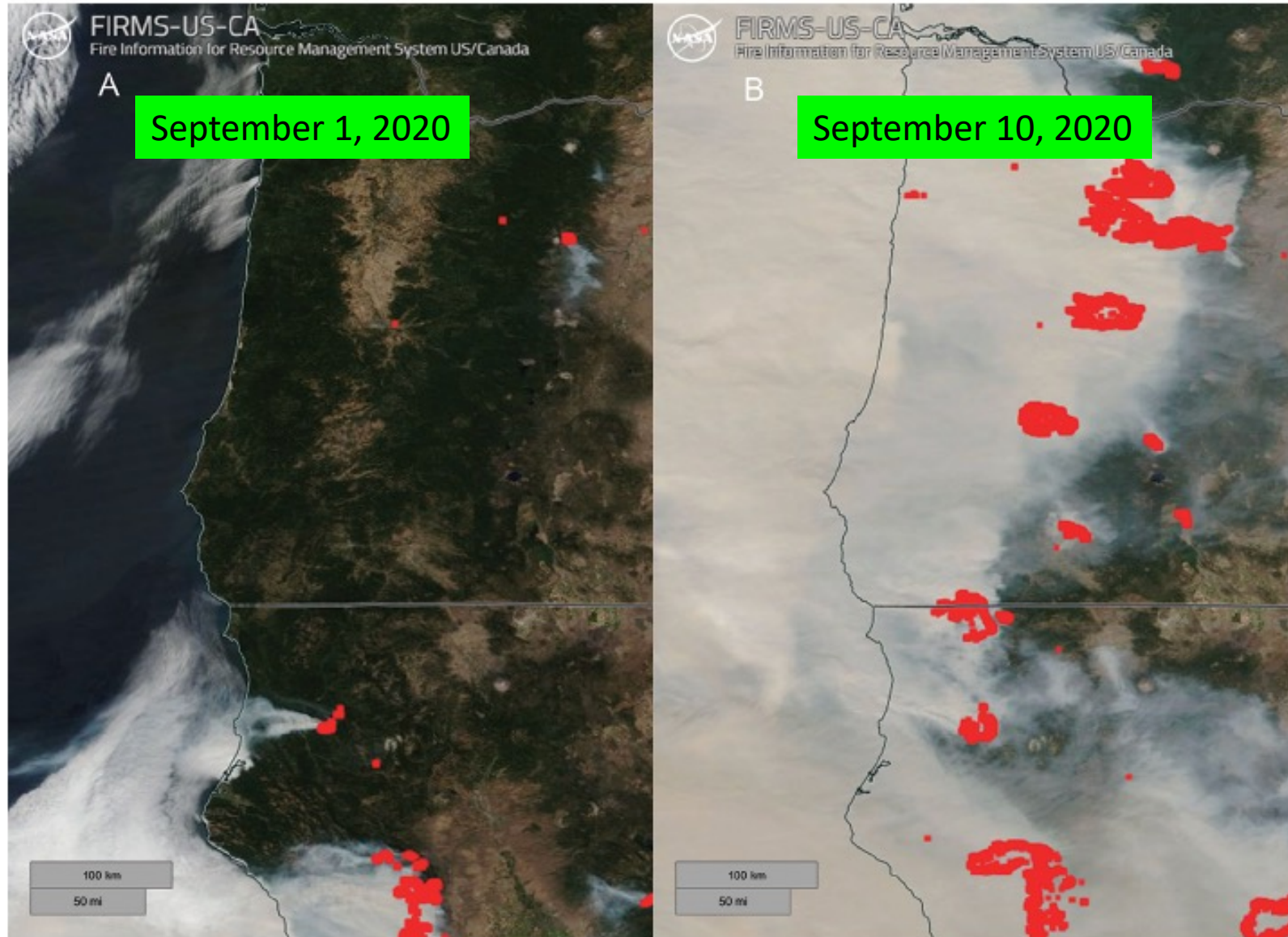
Increasing wildfire in the western United States

"Labor Day Fires" 2020



Increasing wildfire in the western United States

"Labor Day Fires" 2020

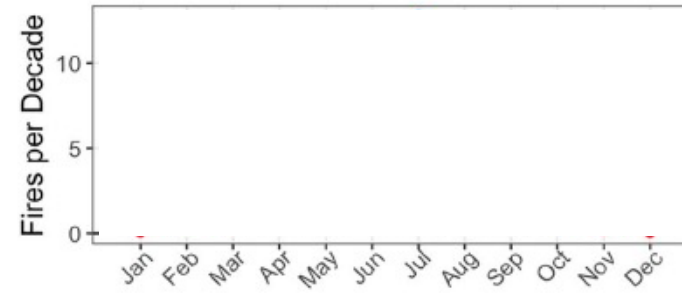


Increasing wildfire in the western United States

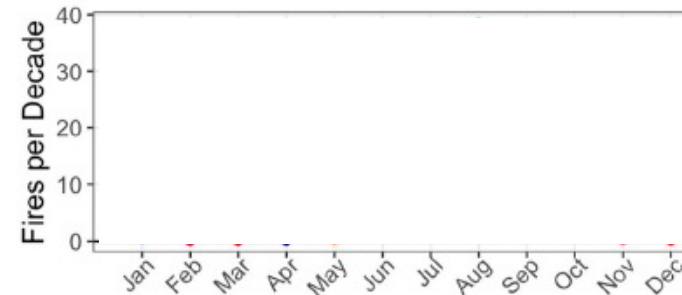
Simulated Future Shifts in Wildfire Regimes in Moist Forests of Pacific Northwest, USA

Alex W. Dye¹, Matt J. Reilly², Andy McEvoy¹, Rebecca Lemons¹, Karin L. Riley³, John B. Kim², and Becky K. Kerns⁴

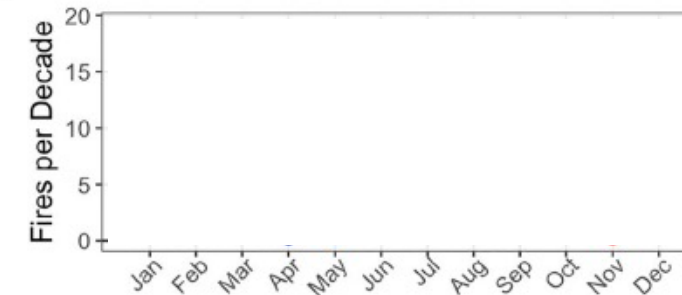
a) Olympics & Puget Lowlands



d) OR West Cascades



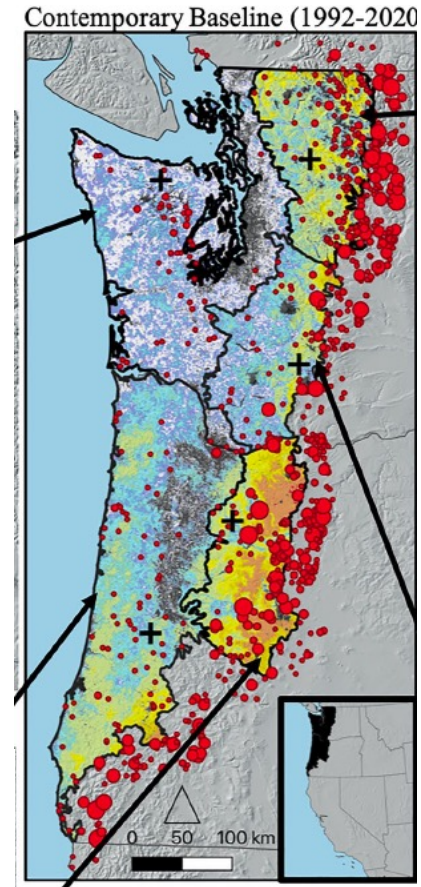
d) OR Coast Range



Fire Occurrence
Observations
(1992-2020)

Contemporary
Baseline
(1992-2020)

Mid-21st Century
(2035-2064)
12-GCM Median

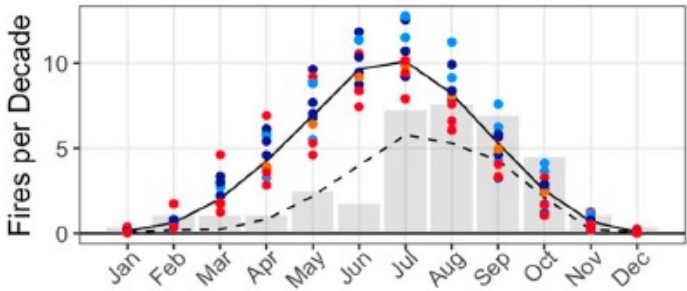


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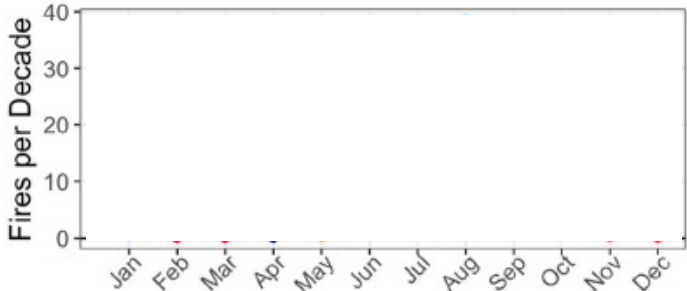
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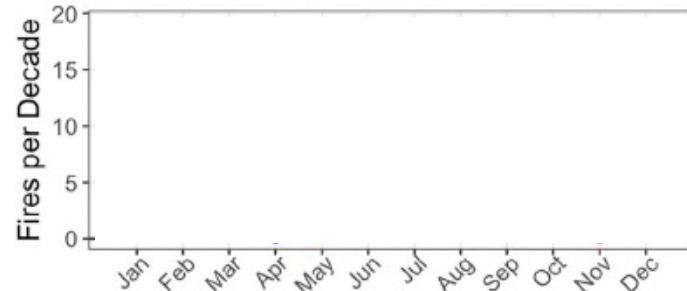
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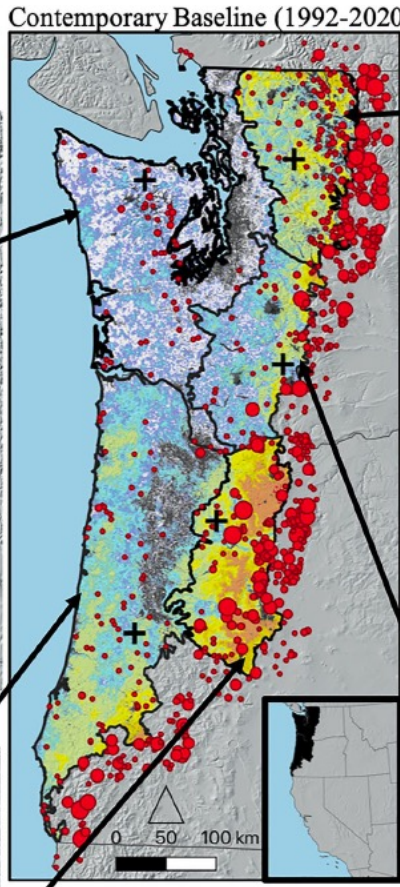
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Contemporary Baseline (1992-2020)

Mid-21st Century (2035-2064) 12-GCM Median

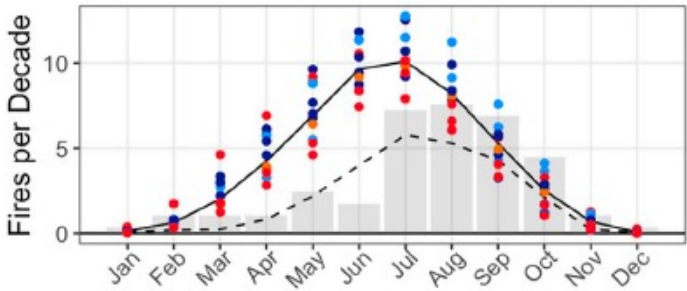


Increasing wildfire in the western United States

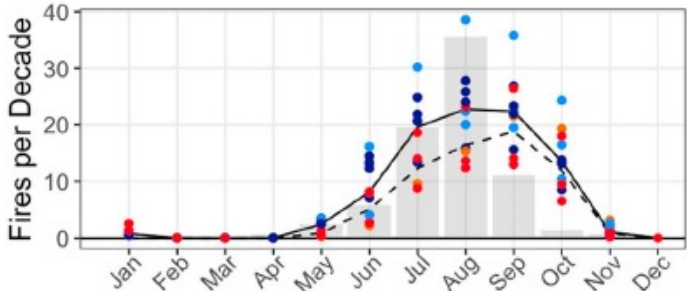
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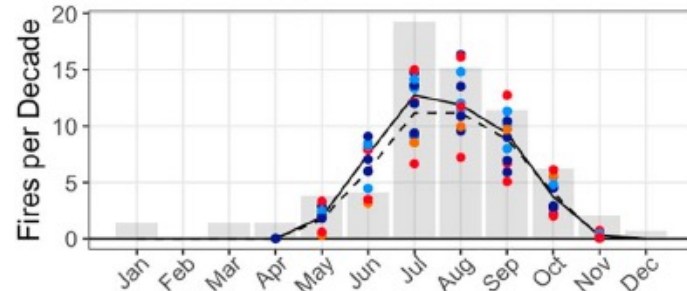
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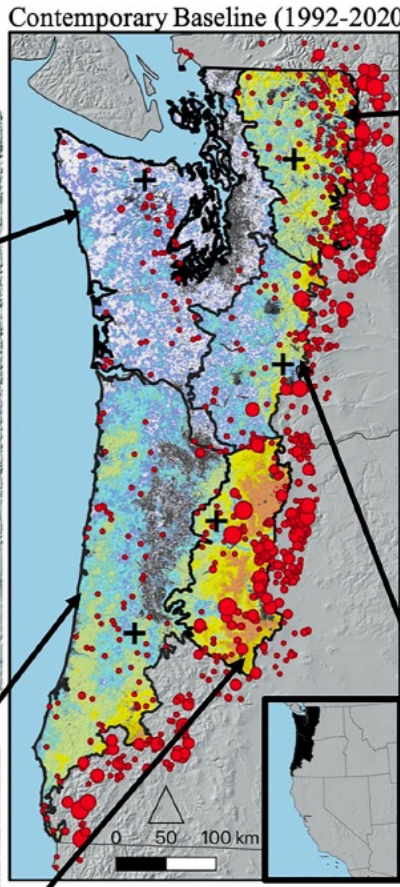
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Fire Occurrence Observations (1992-2020)

Contemporary Baseline (1992-2020)

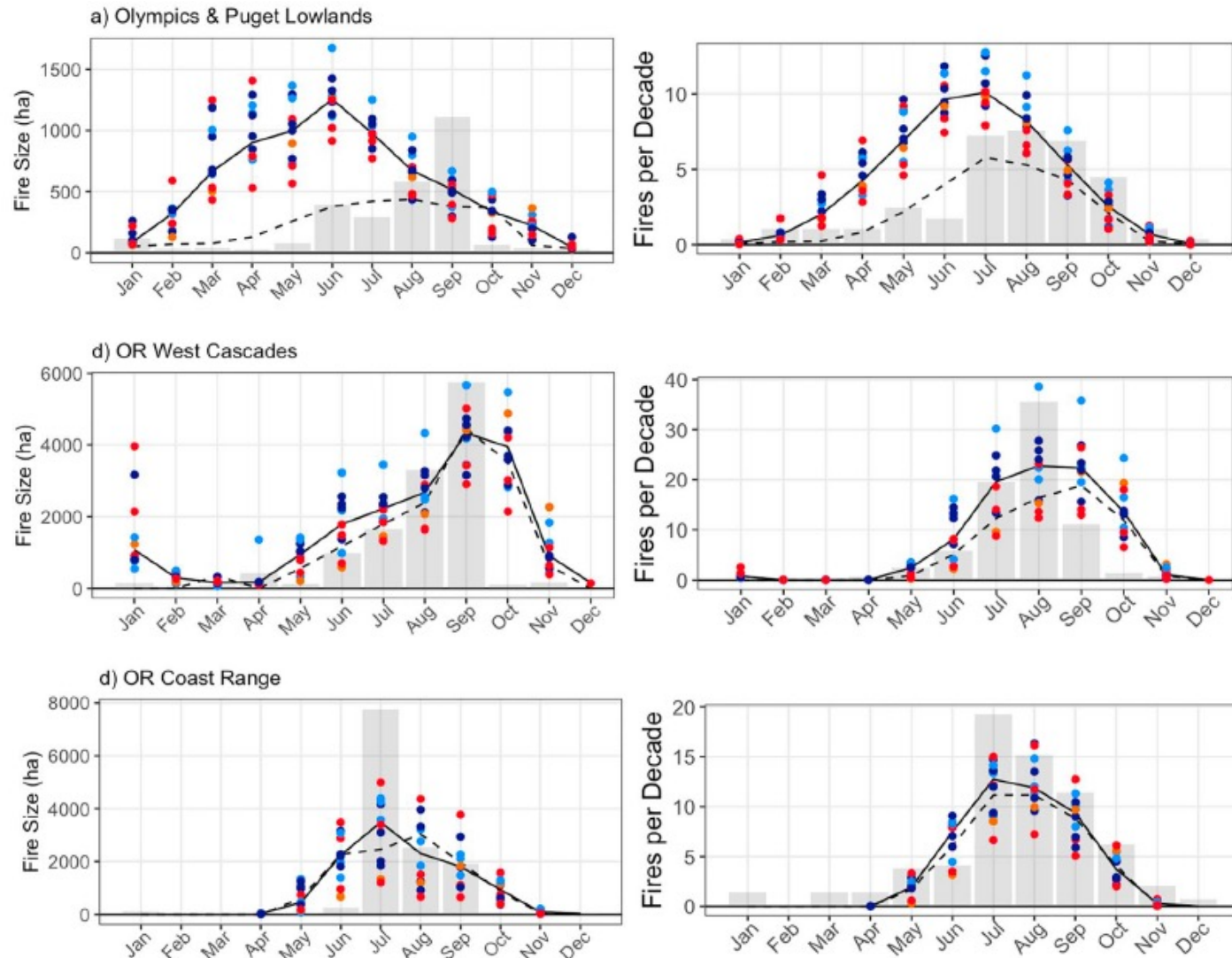
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Increasing wildfire in the western United States

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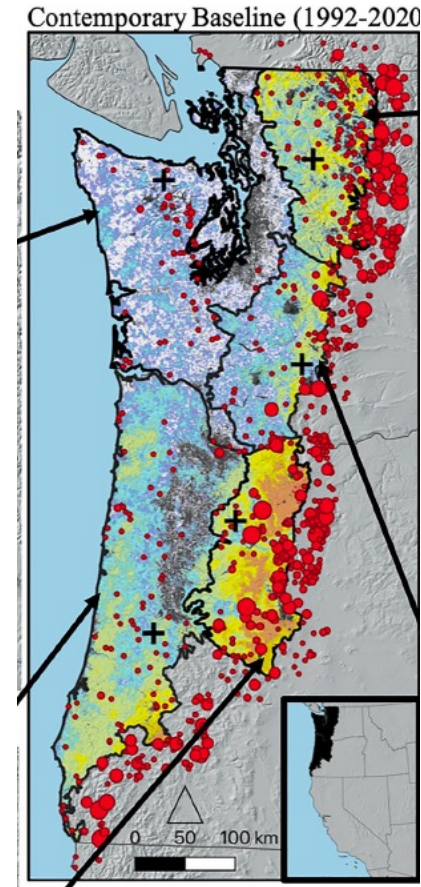
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Take home Message:

Wildfires likely to increase across much (but not all) of Western Cascades and Coastal systems in Washington and Oregon (*where Coastal Cutthroat Trout dominate headwater stream fish communities*)

Increasing wildfire in the western United States

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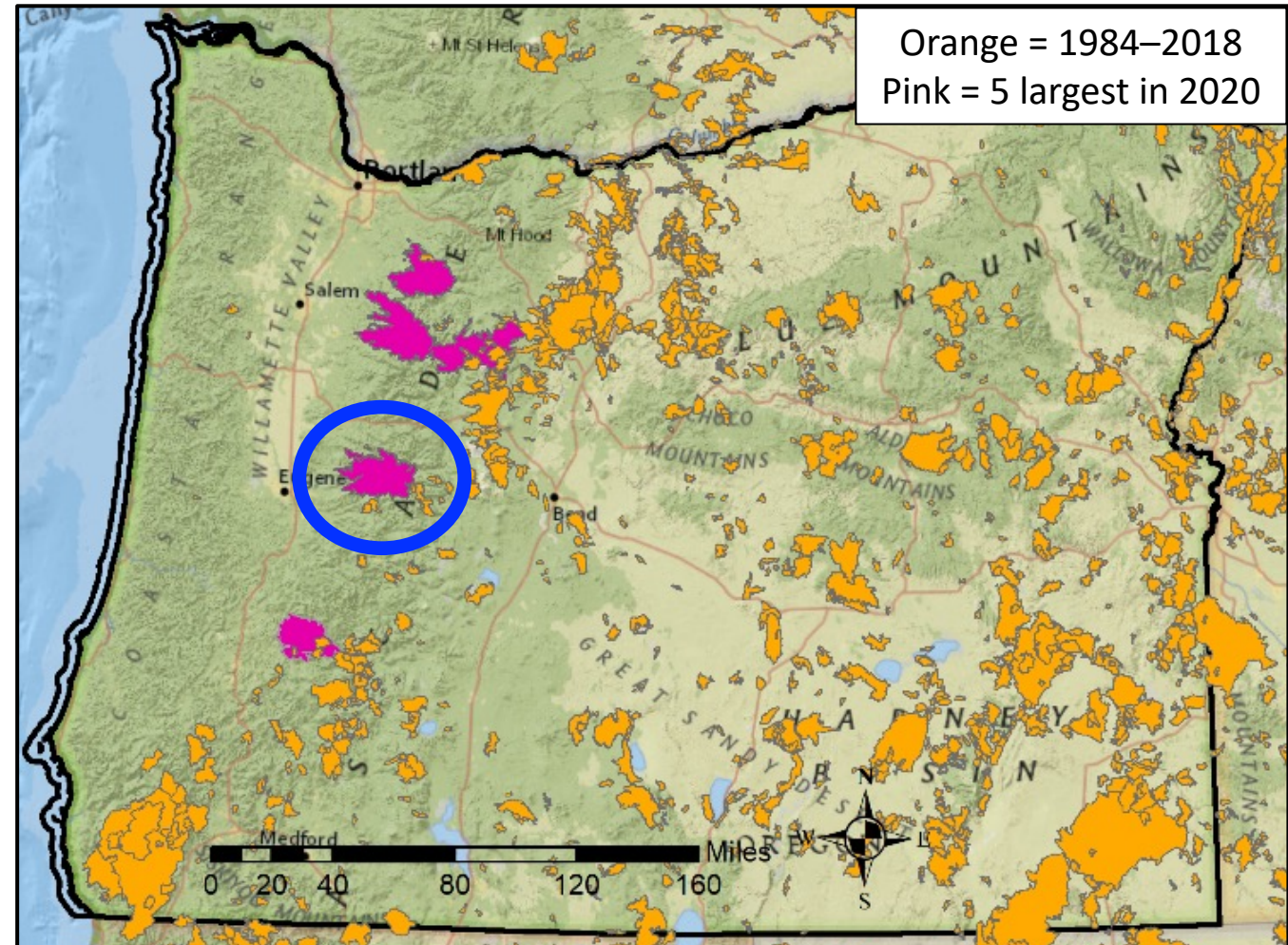
Study Question

What are the implications of this increase for Coastal Cutthroat Trout (*Oncorhynchus clarkii clarkii*)?

How resilient are coastal cutthroat trout in headwater streams to wildfire?

2020 fires in western Oregon a unique research opportunity

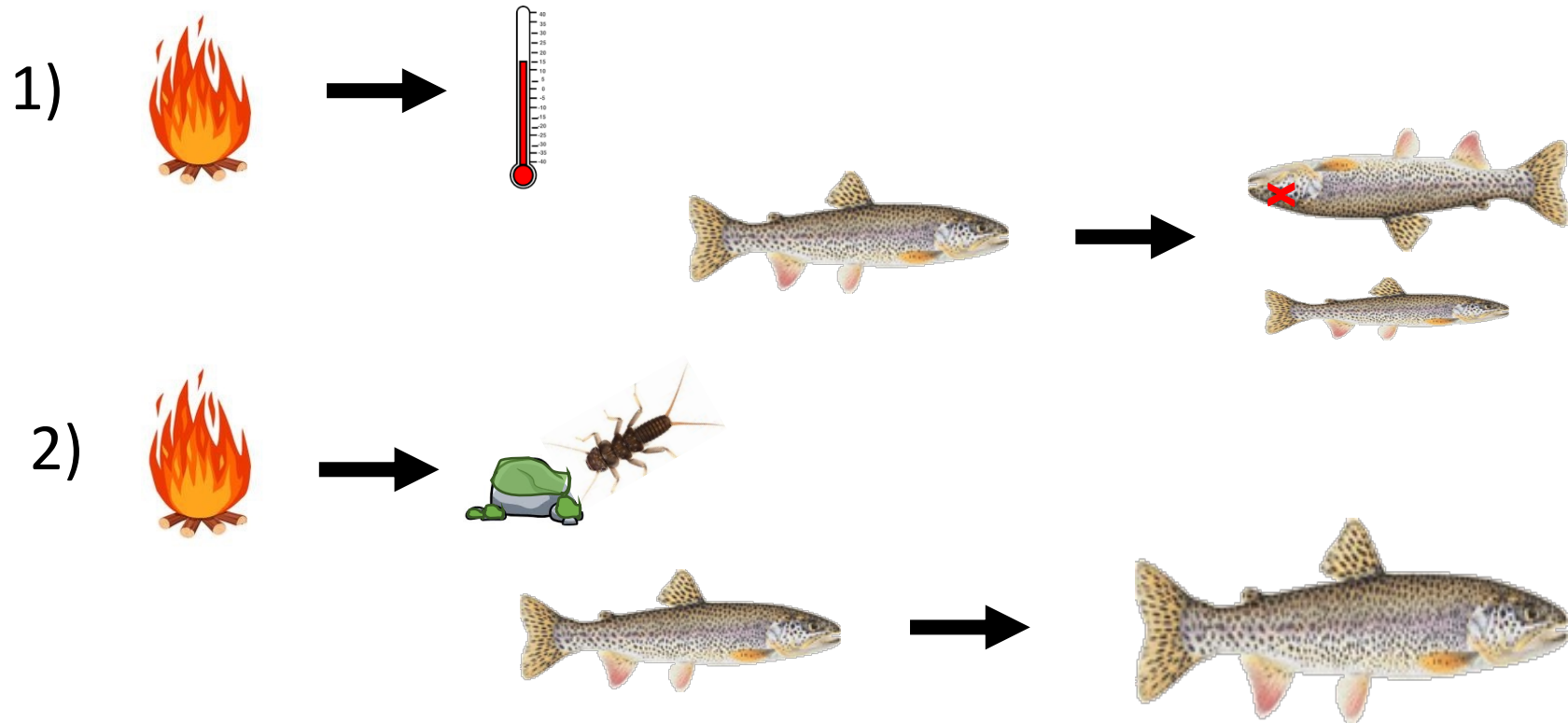
- 2020 Oregon wildfires burned more than ~1.19M acres (4,815 km²)
- **Holiday Farm Fire**
 - Study 1: Pre-treatment data from 2018 in burned and nearby unburned streams



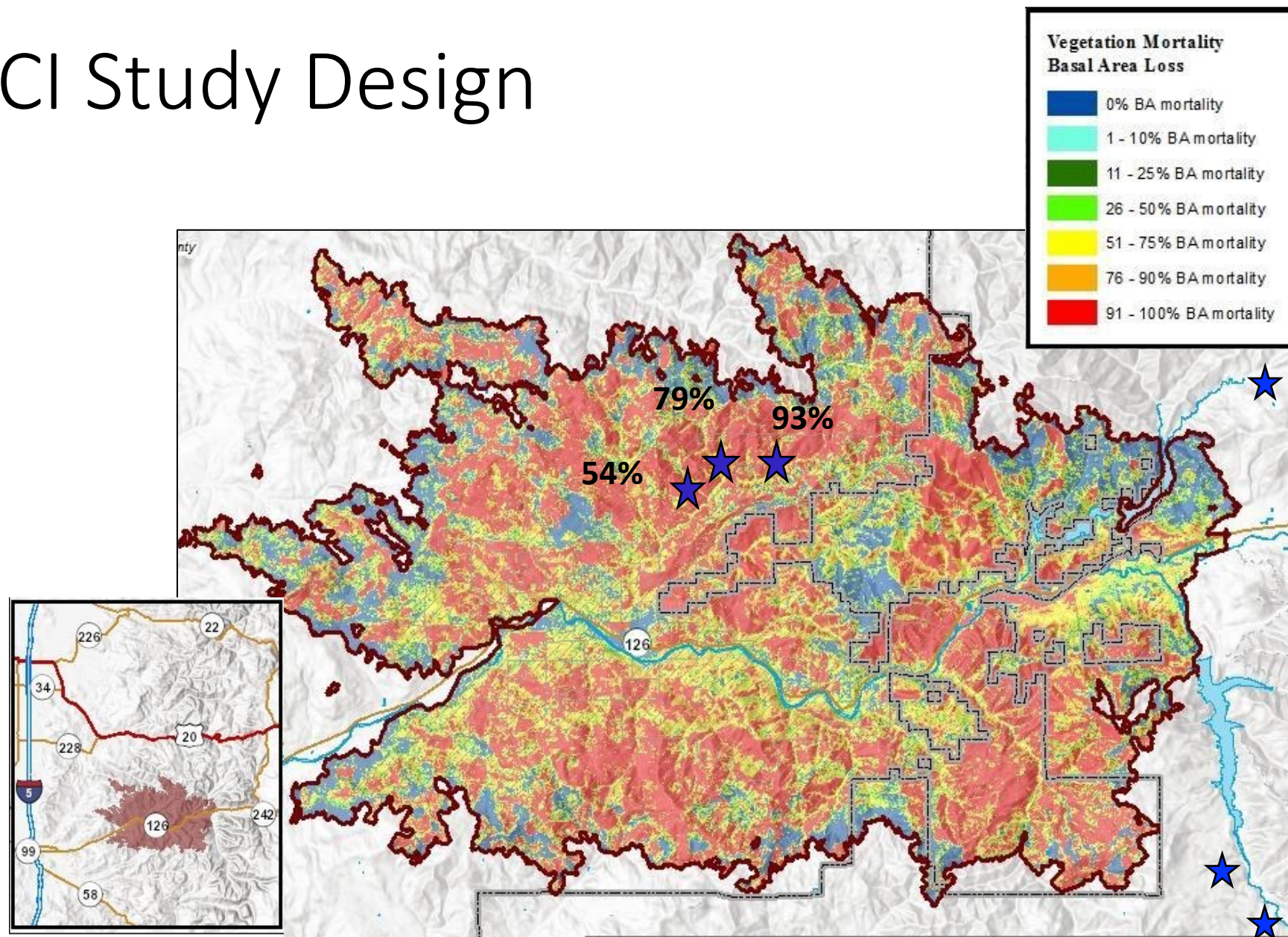
Fire response hypotheses:



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BACI Study Design



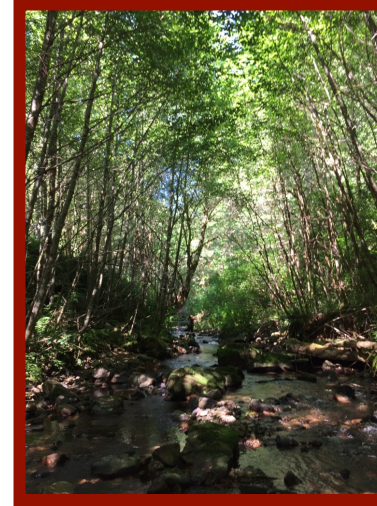
W-113



W-100



W-122



Loon



McTE



Chucksney

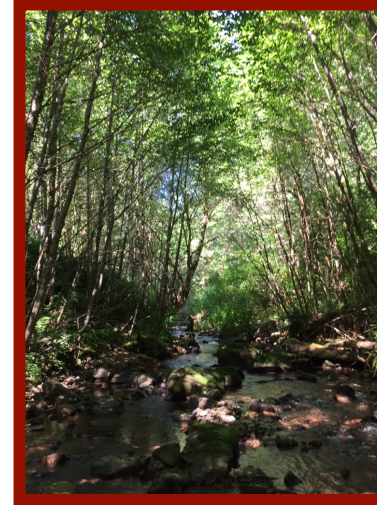




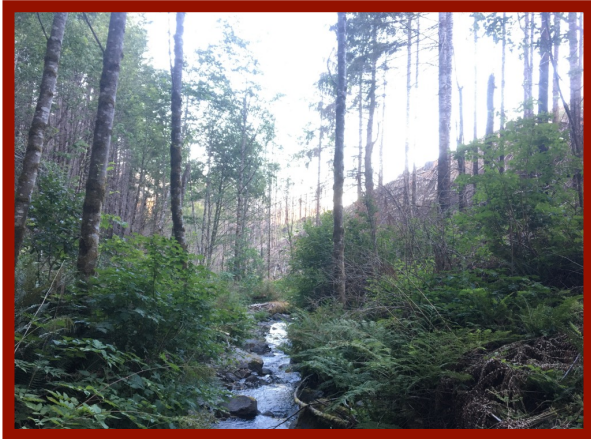
W-113 – 54%



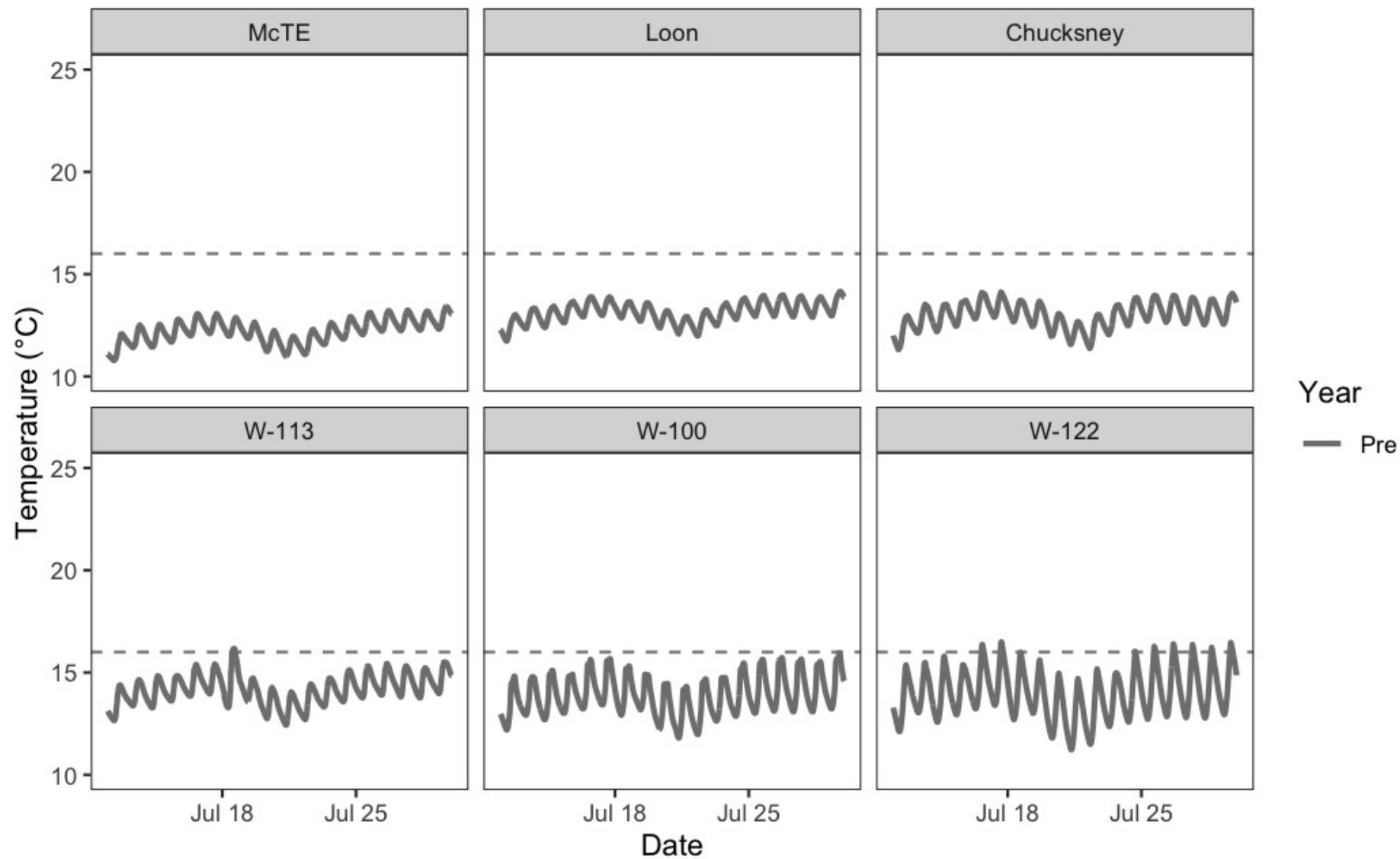
W-100 – 79 %



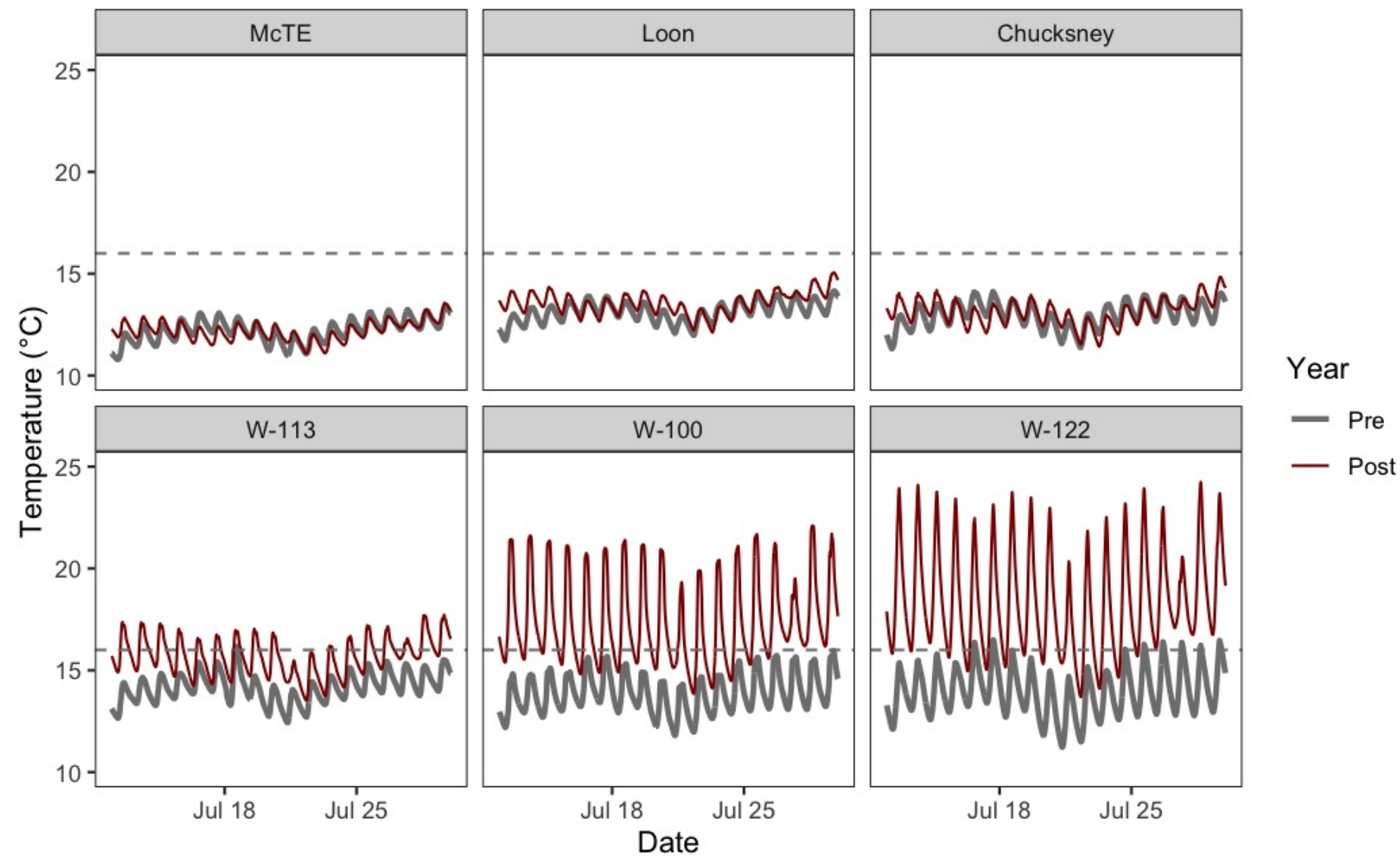
W-122 – 93%



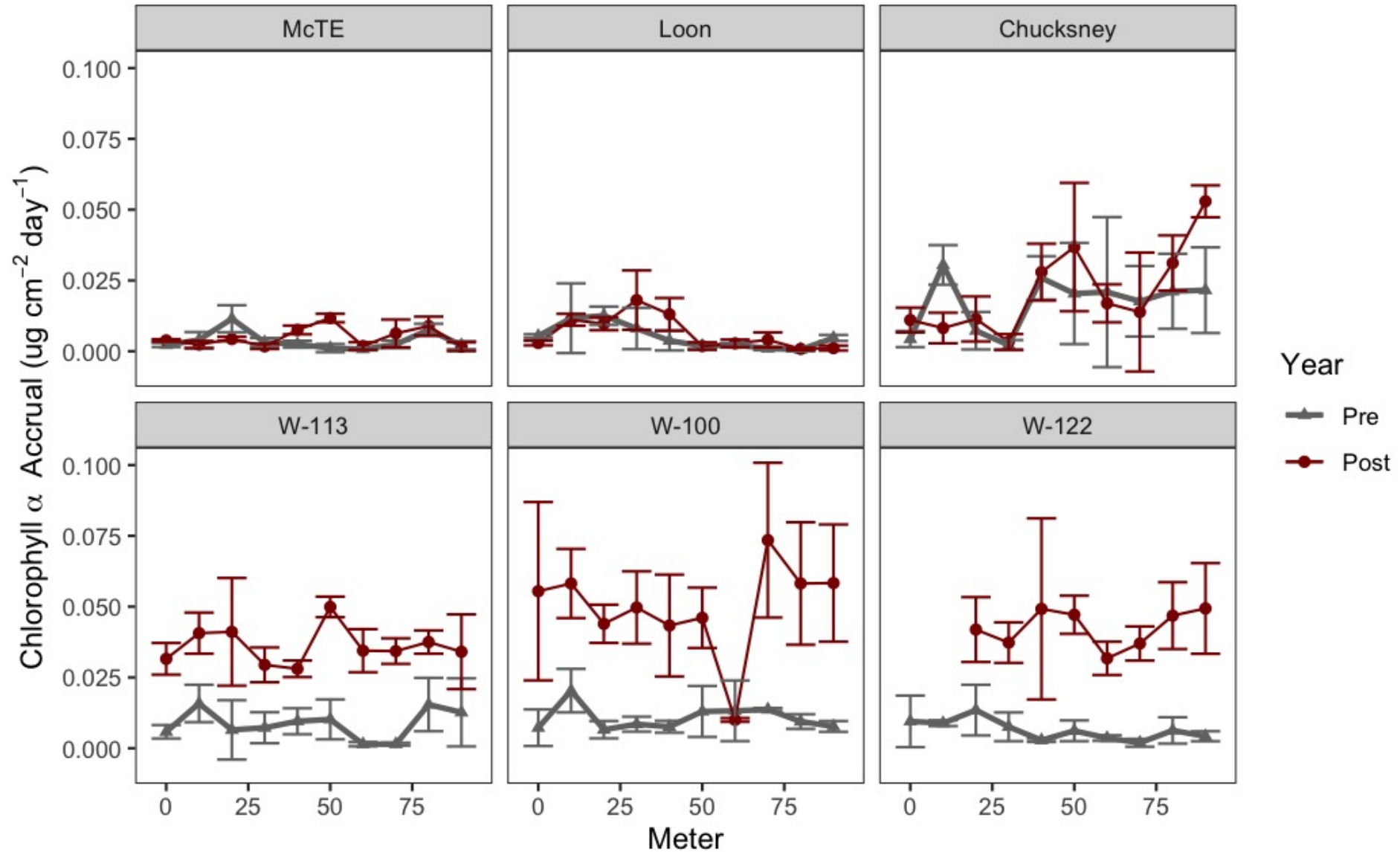
Results- *Stream Temperature*



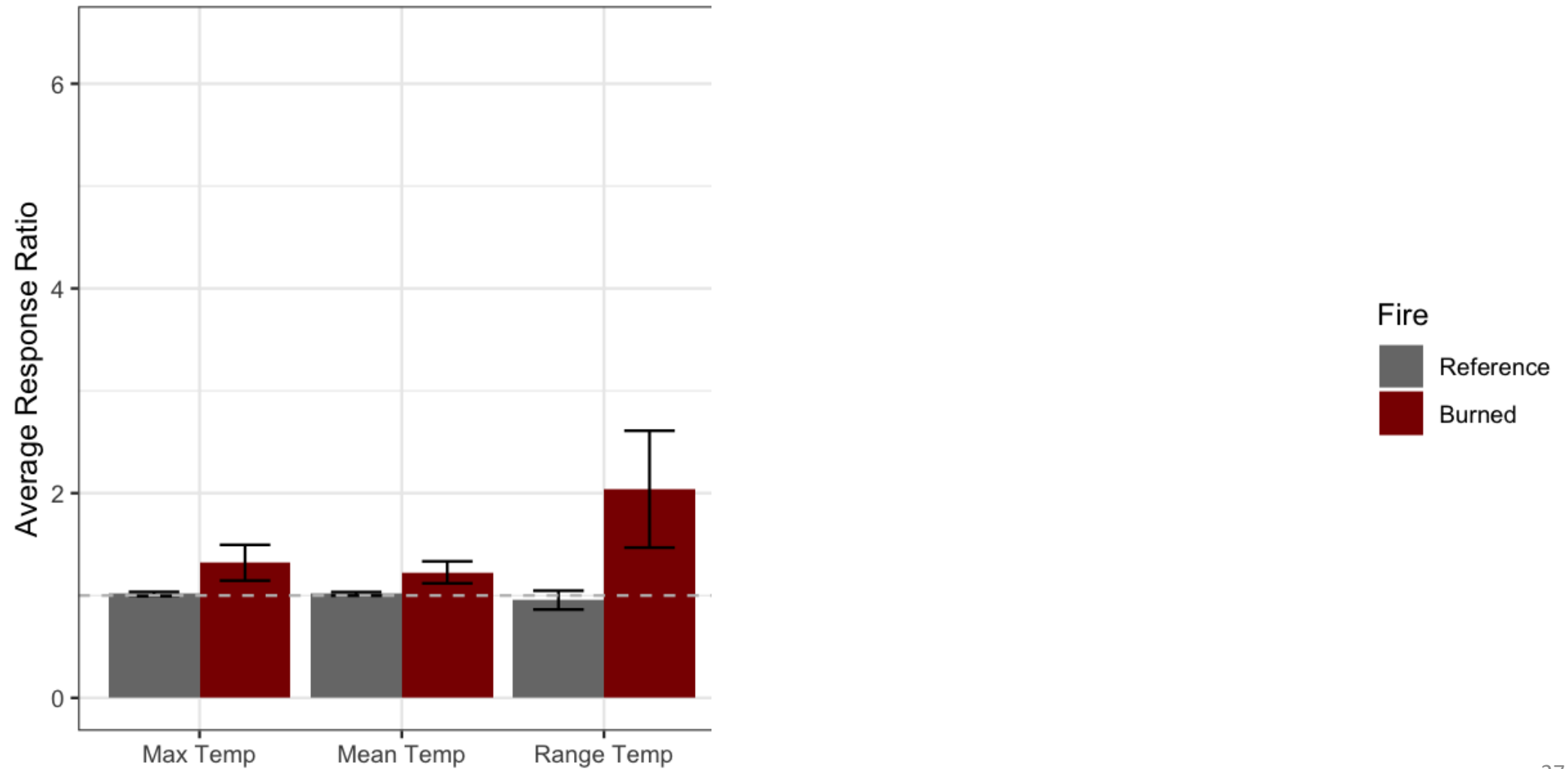
Results- *Stream Temperature*



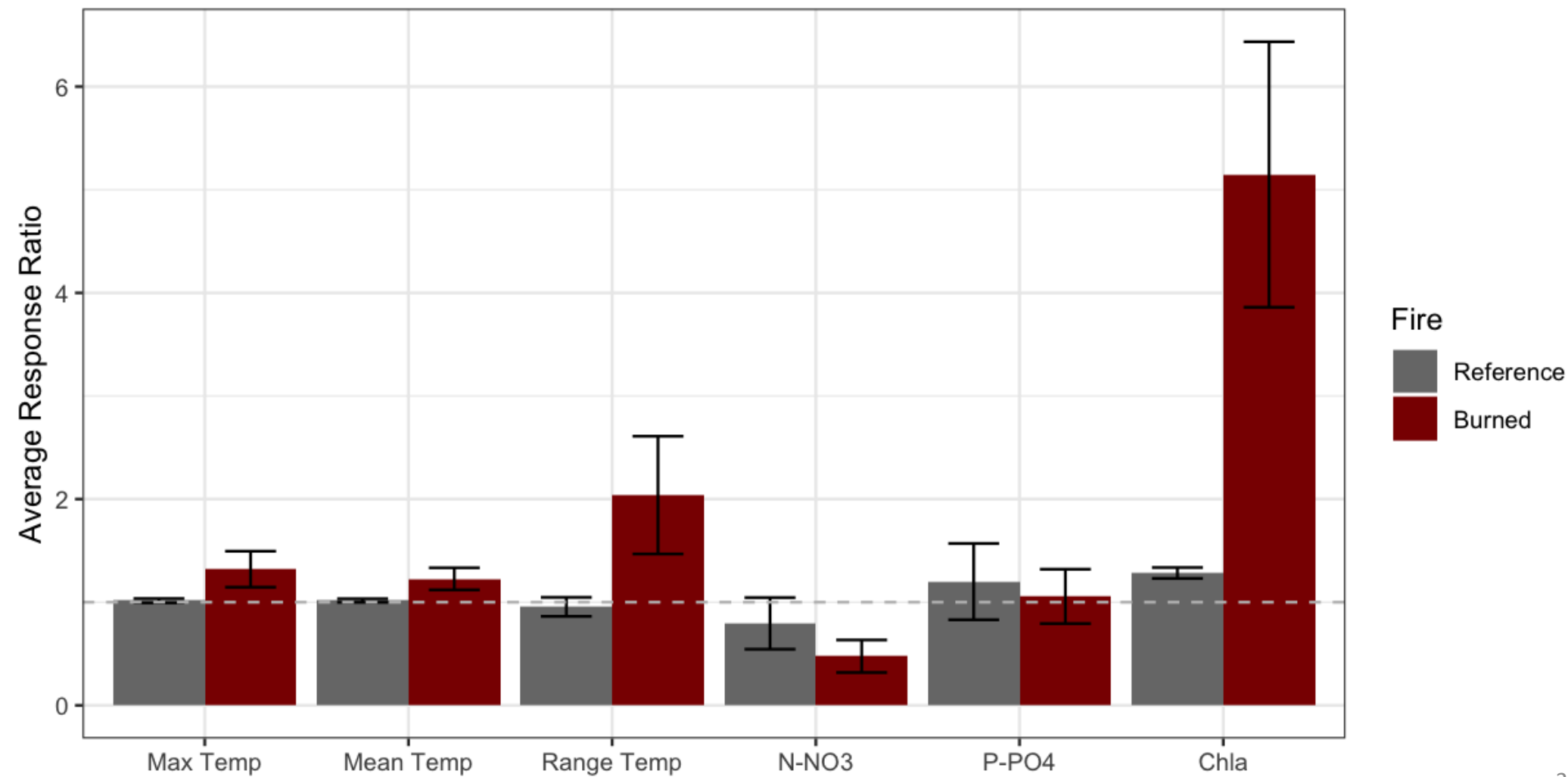
Results- *Chlorophyll a*



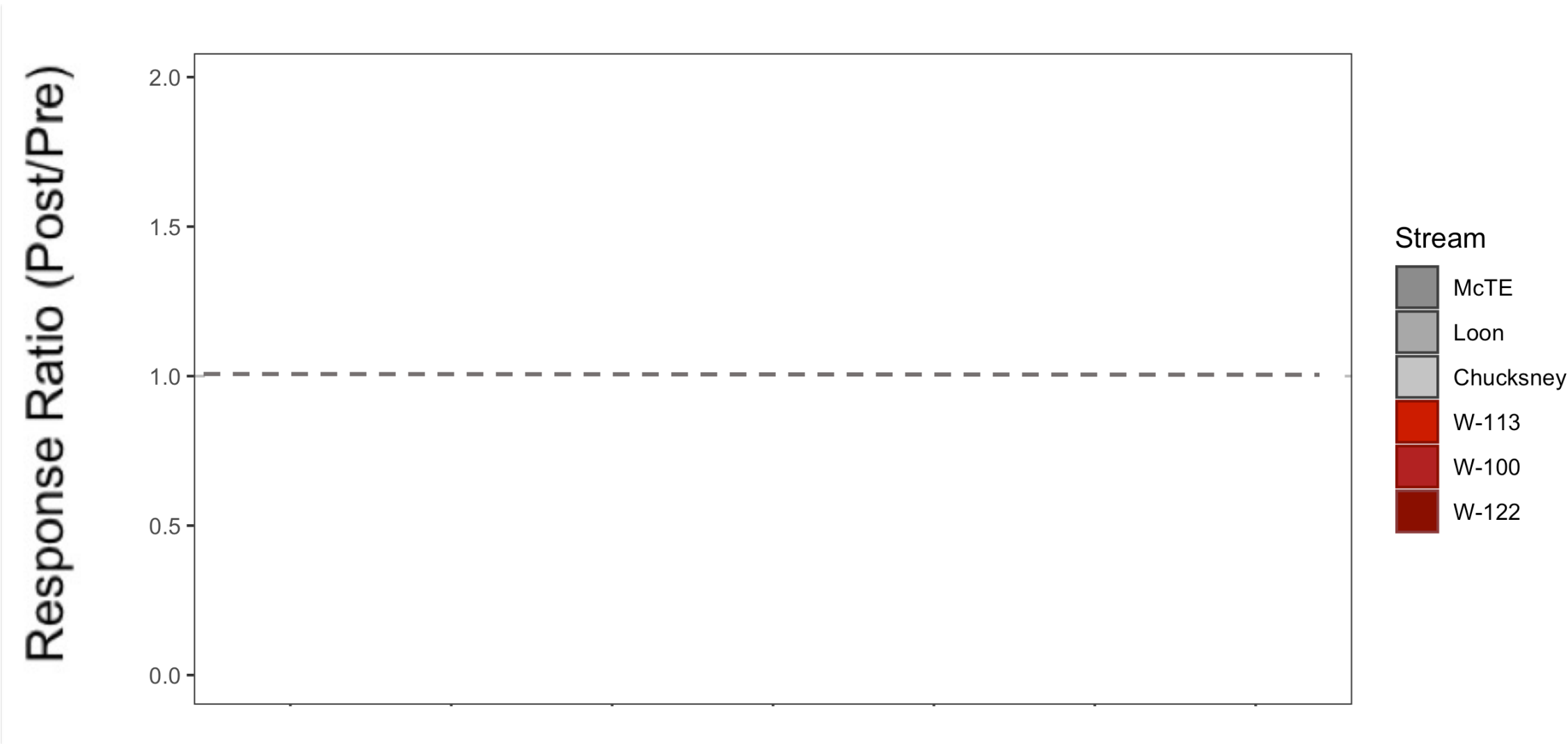
Results- *Overall fire responses relative to unburned sites*



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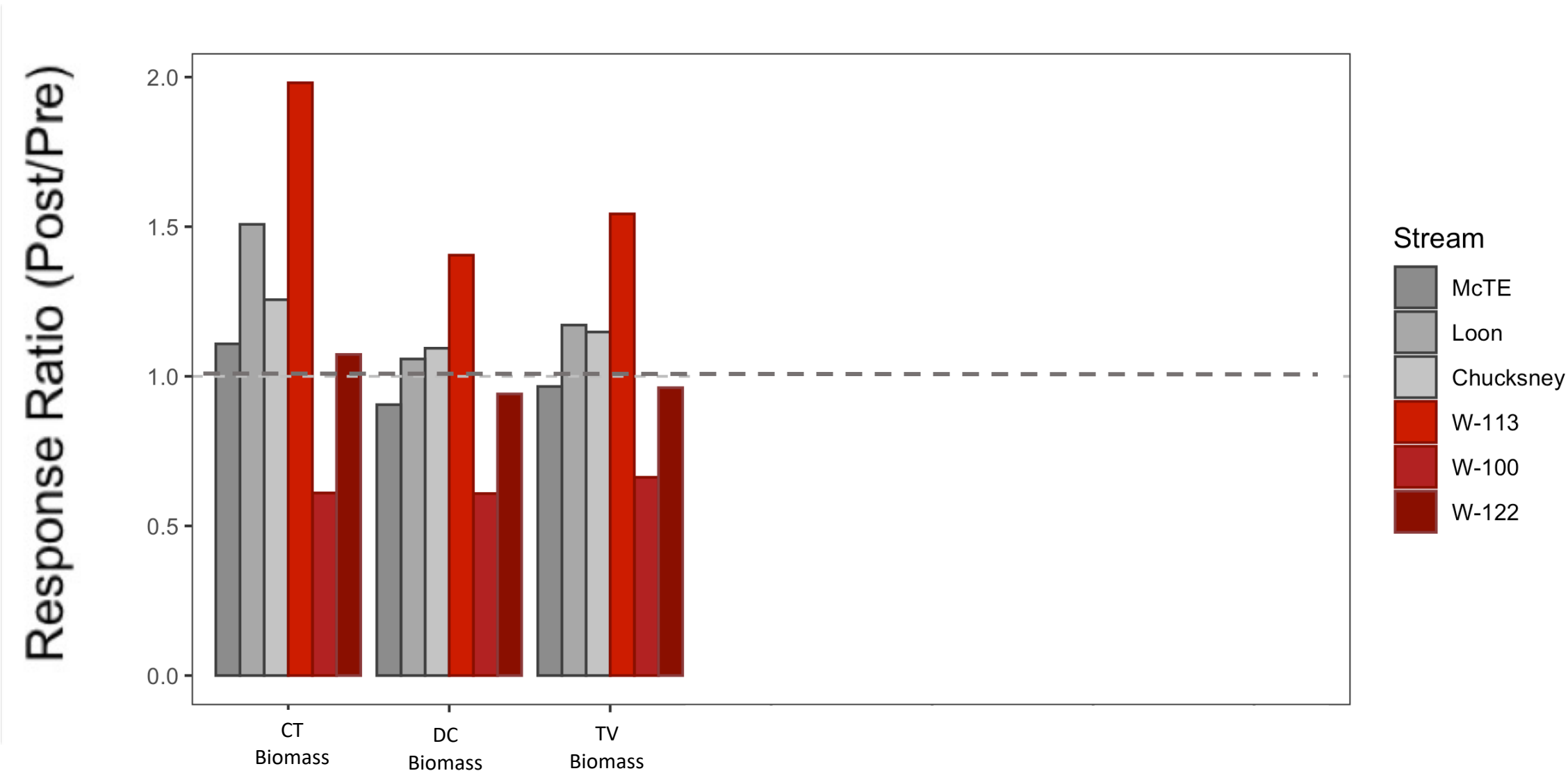
Results- *Stream Vertebrate ratios post/pre for burned and reference sites*



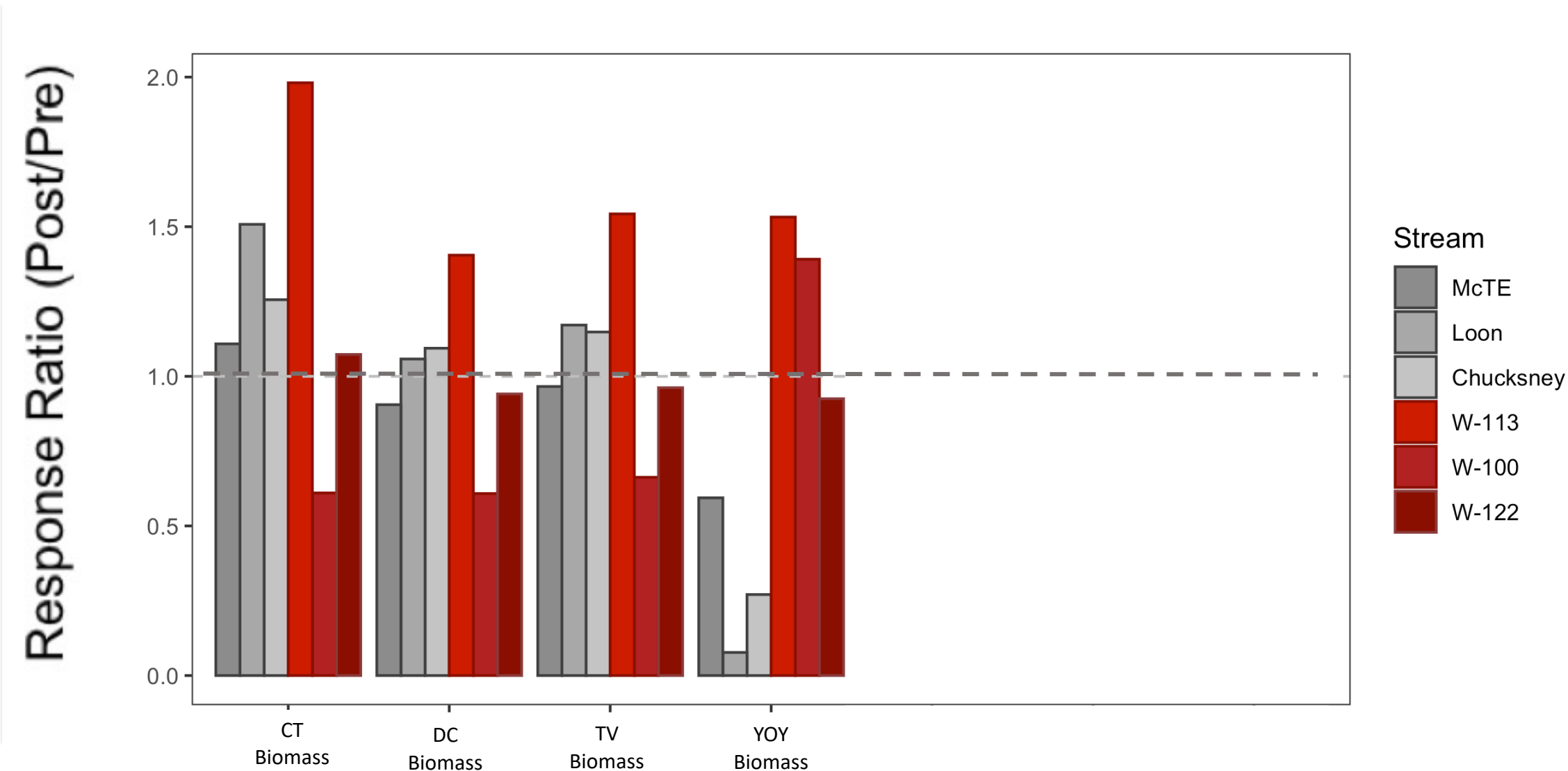
Results- *Stream Vertebrate ratios post/pre for burned and reference sites*



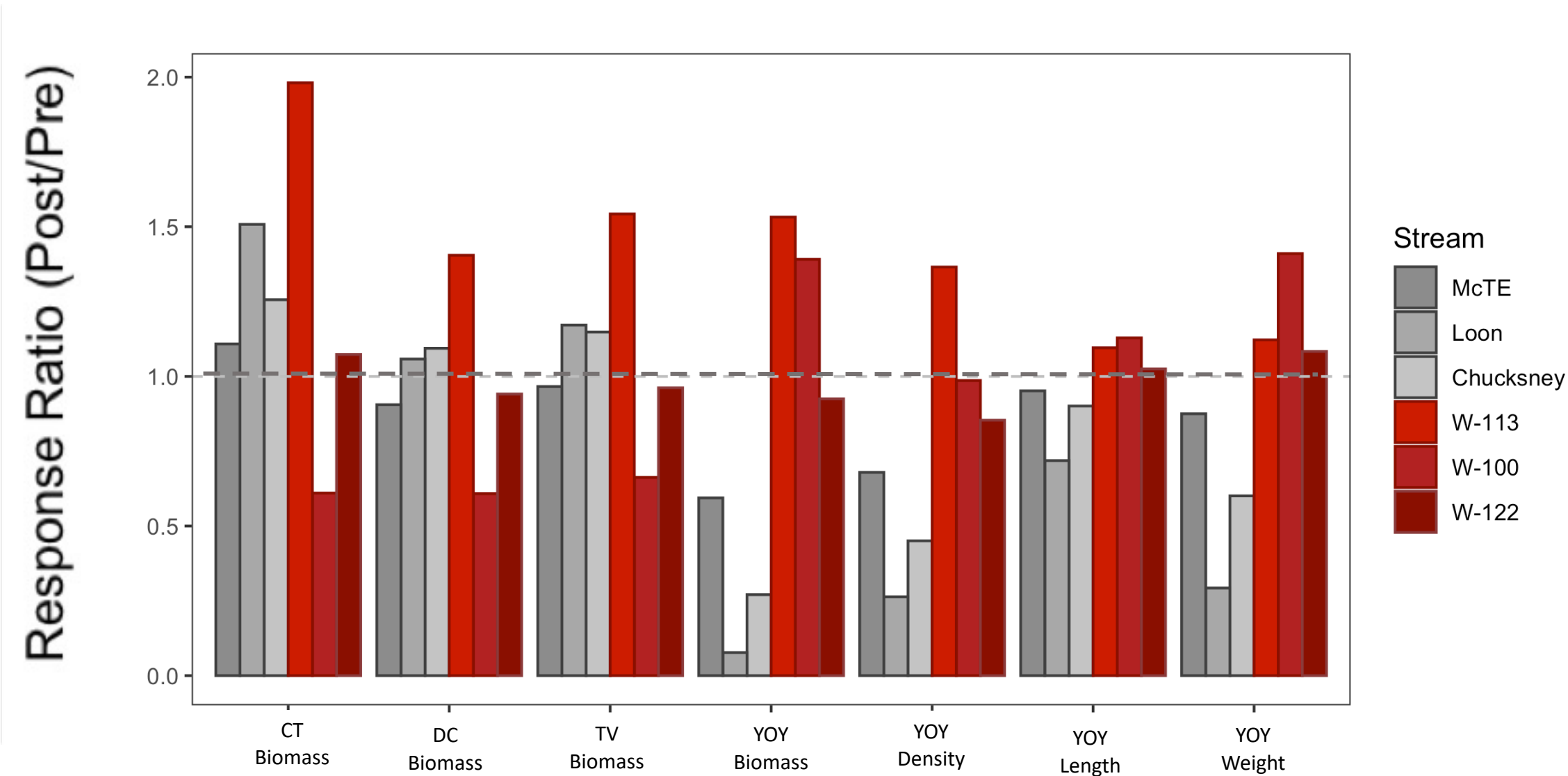
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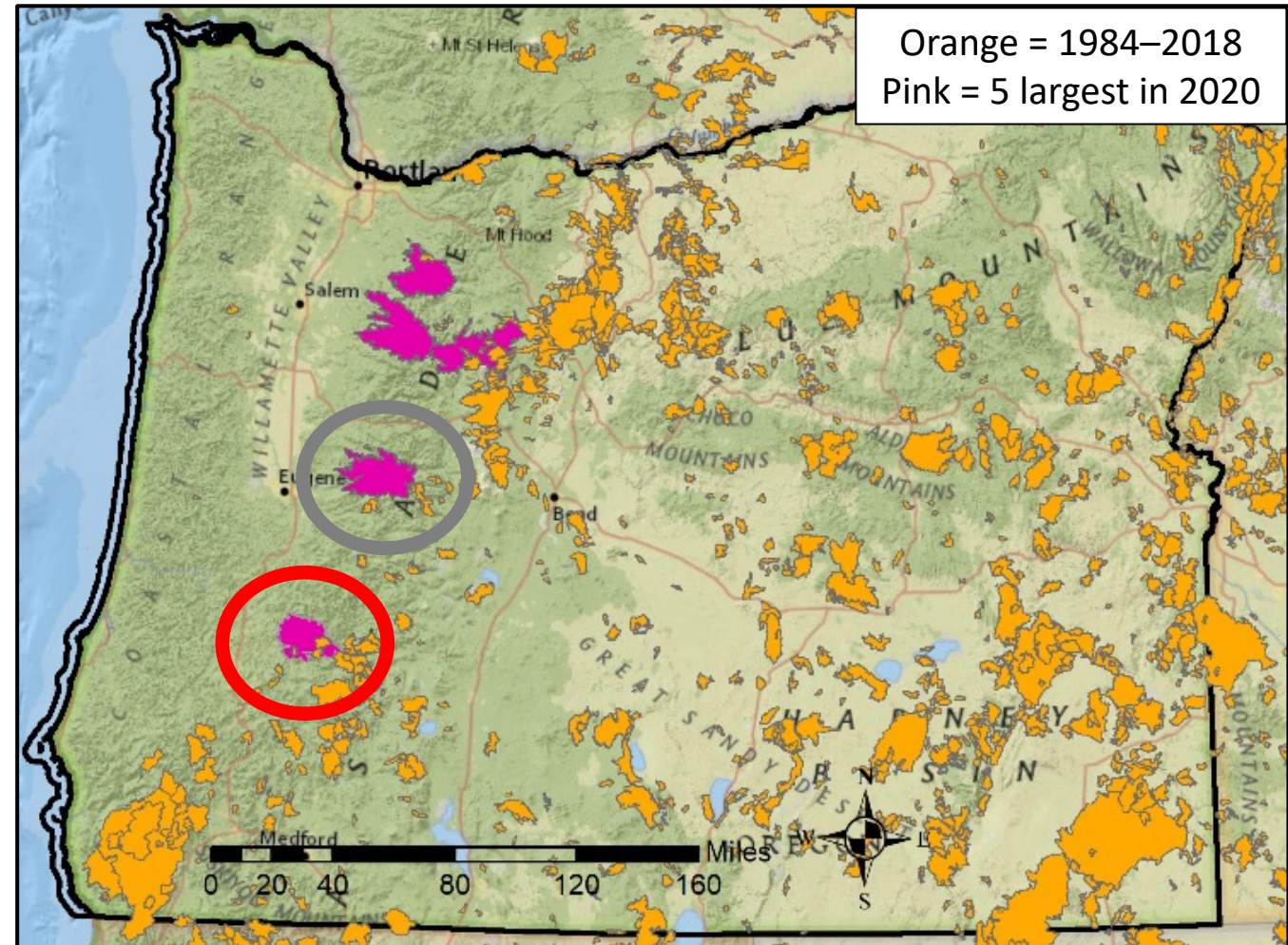
Conclusions

One-year after severe wildfire:

- ↑ temperature
- ↑ autotrophs
- Adult fish and vertebrates responses differed with burn severity
 - Some increase, some decrease, but no extirpation
- YOY cutthroat trout increased in size and density relative to ref sites in all burned sites

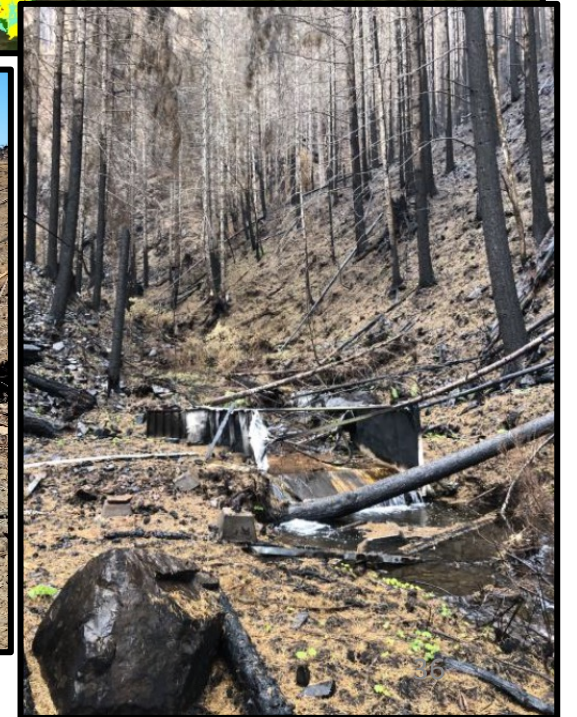
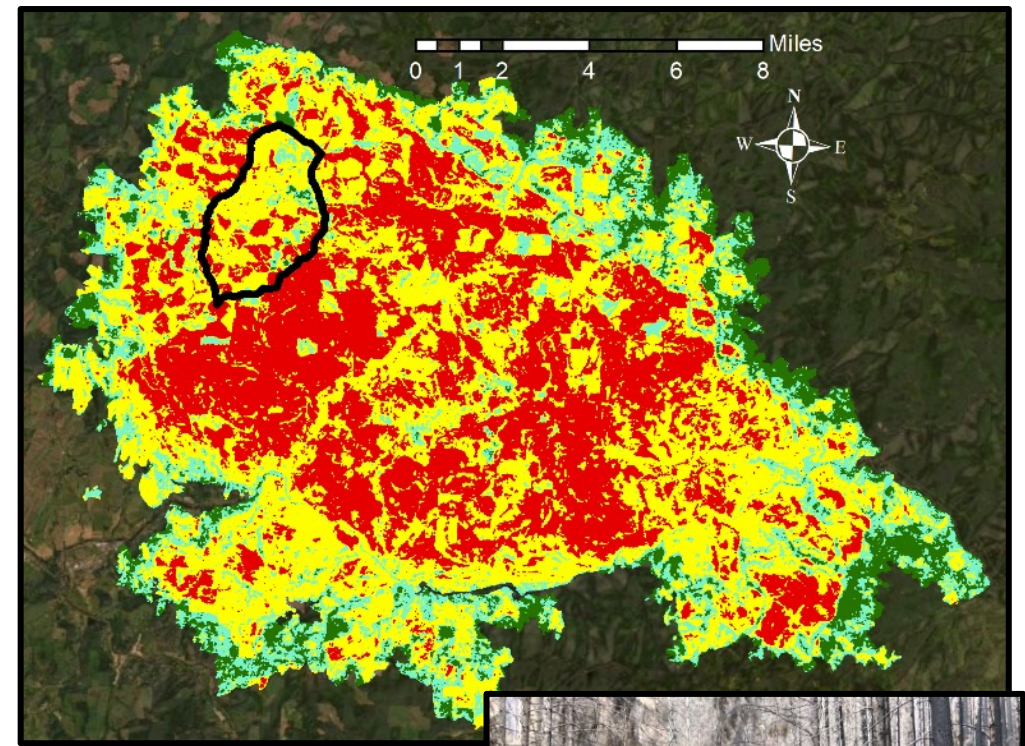
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- **Holiday Farm Fire**
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- **Archie Creek Fire**
 - Study 2: Pre-treatment data from 2001-2011 Hinkle Creek study

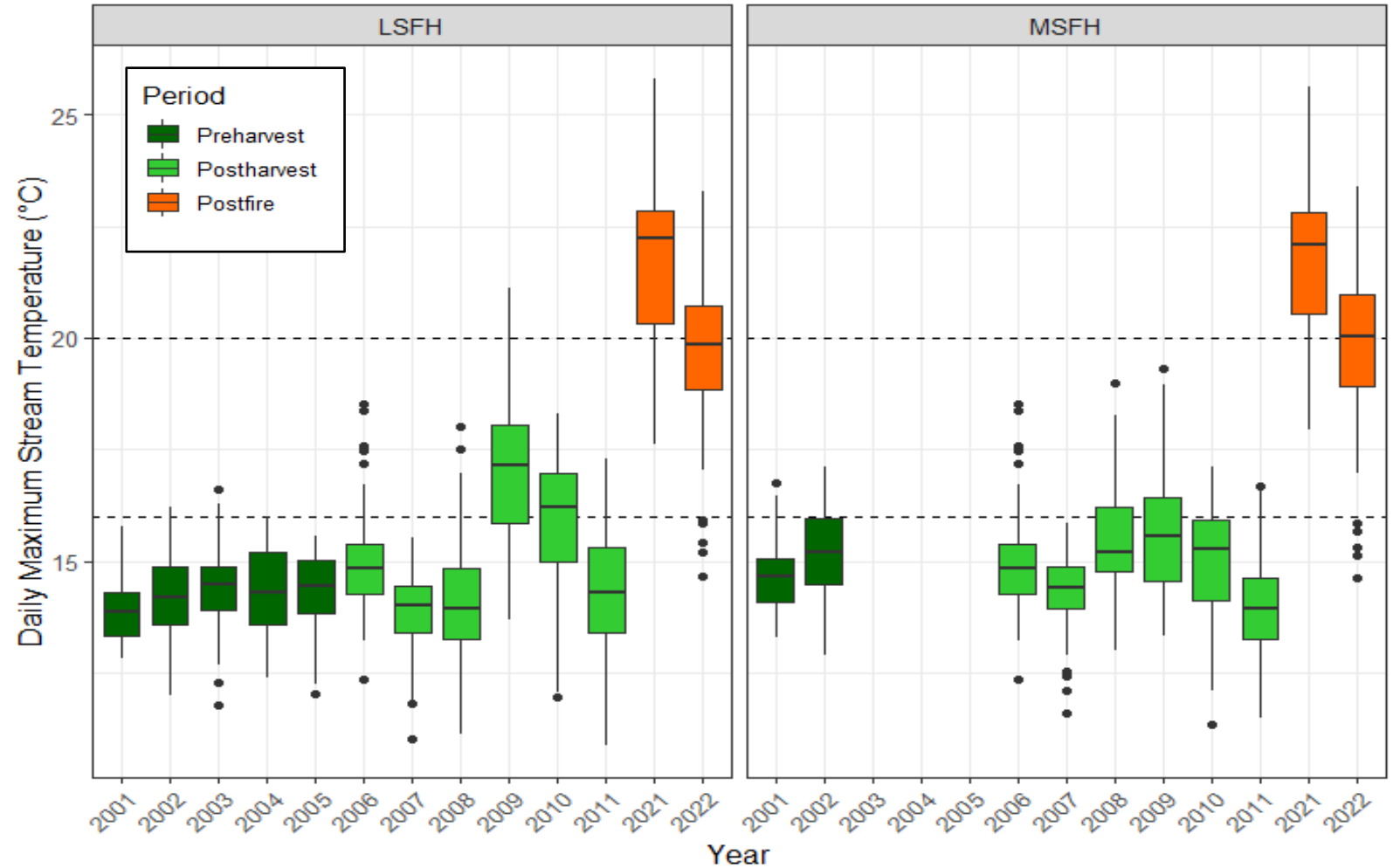
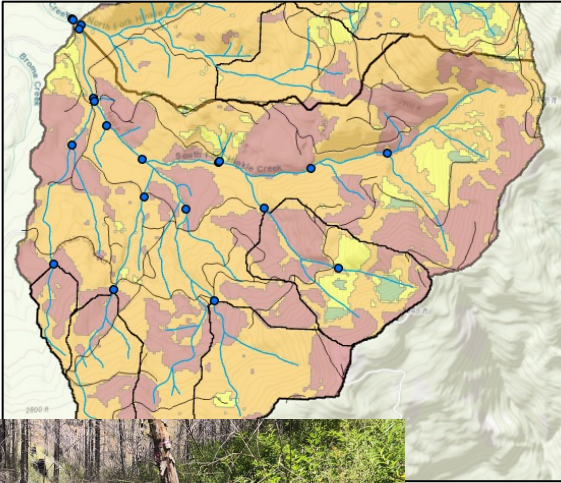


Hinkle Creek watershed

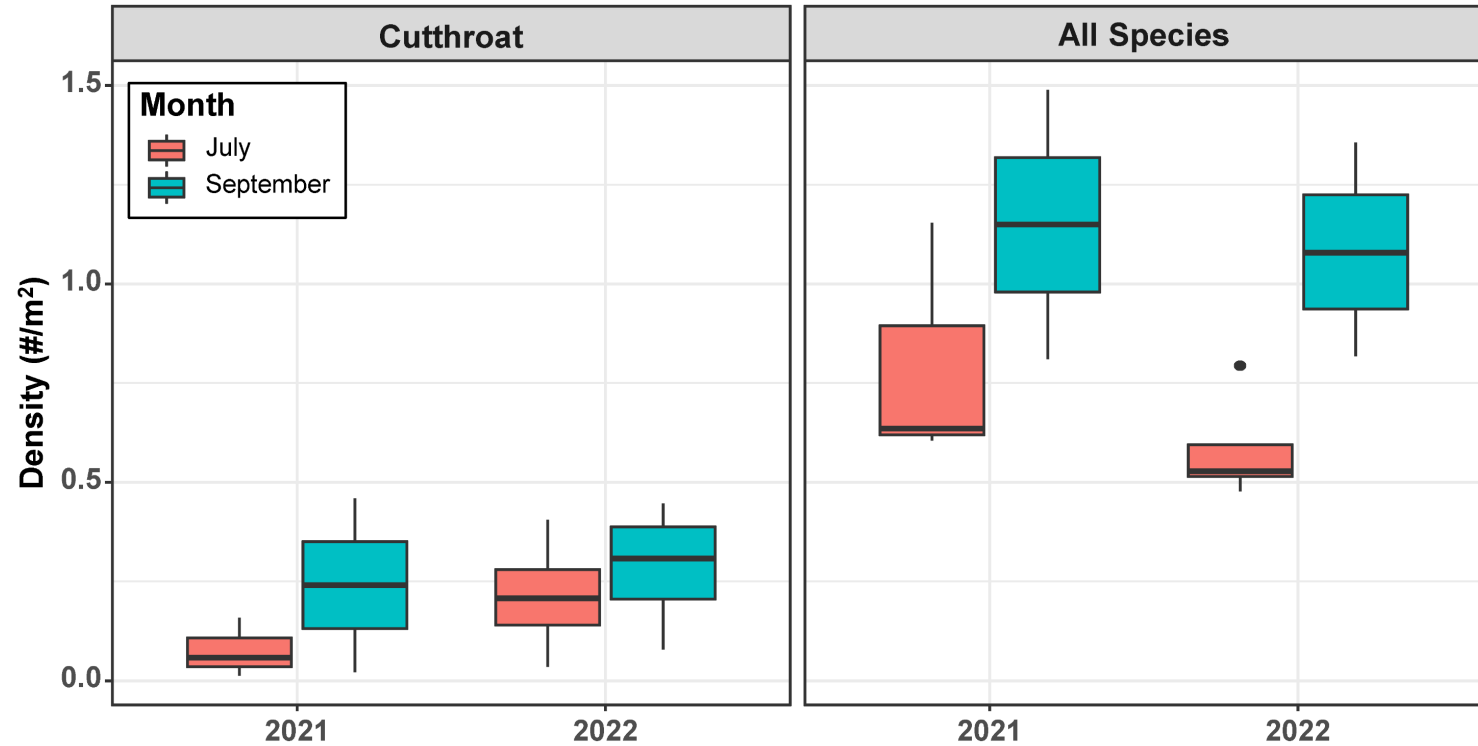
- Archie Creek Fire in Umpqua River Basin burned 131,542 acres (531 km²)
- Burn severity
 - High: 32.9 %
 - Moderate: 44.0 %
 - Low: 14.2 %
 - Unburned: 8.9 %
- Burned area included sub-watersheds from the original Hinkle Creek Watershed Study



Major post-fire increases in summer stream temperature



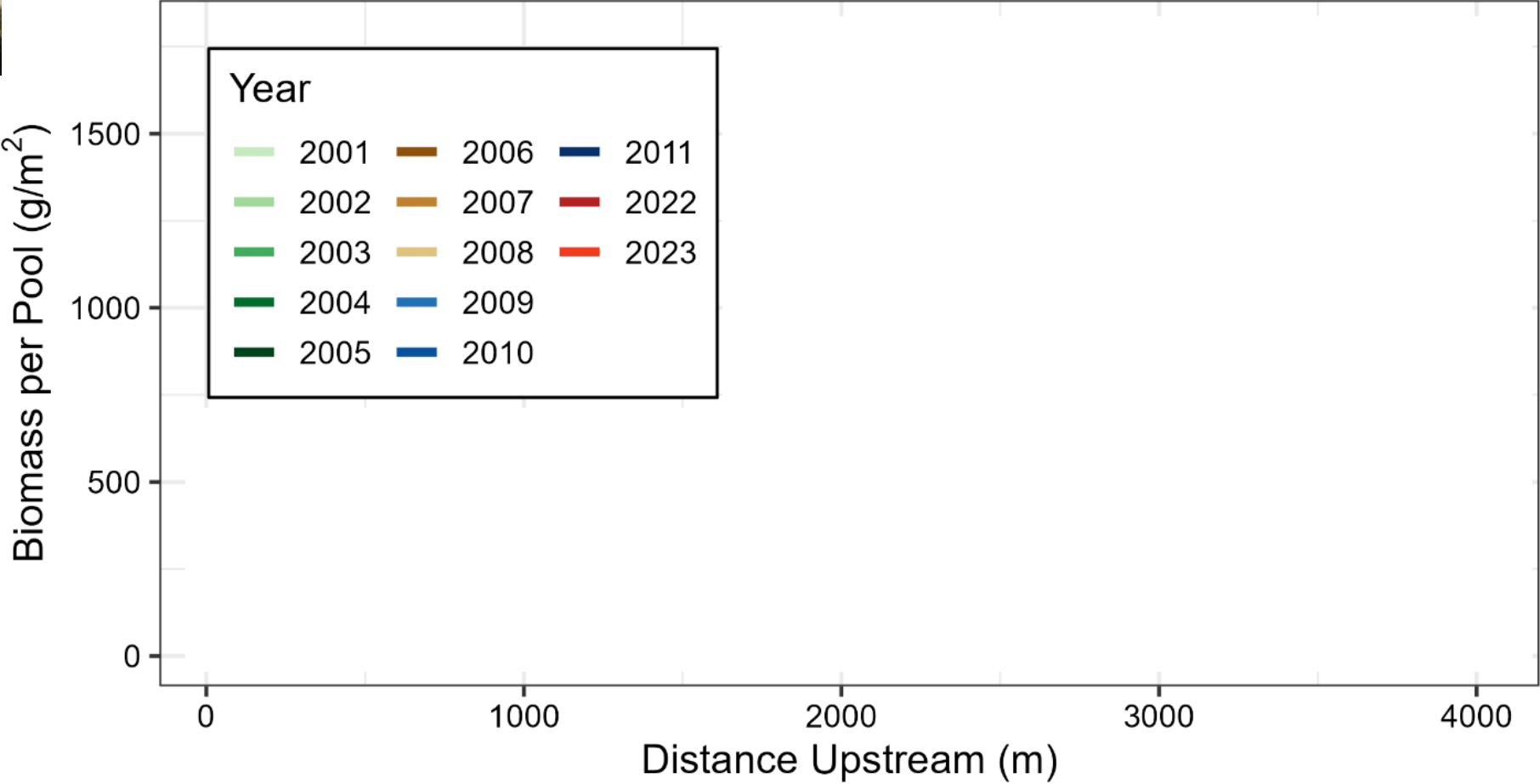
Post-fire persistence of cutthroat trout in the first two summers after wildfire



Post-fire **adult cutthroat trout** biomass along SF Hinkle Creek post-fire relative to Hinkle surveys 2001-2011



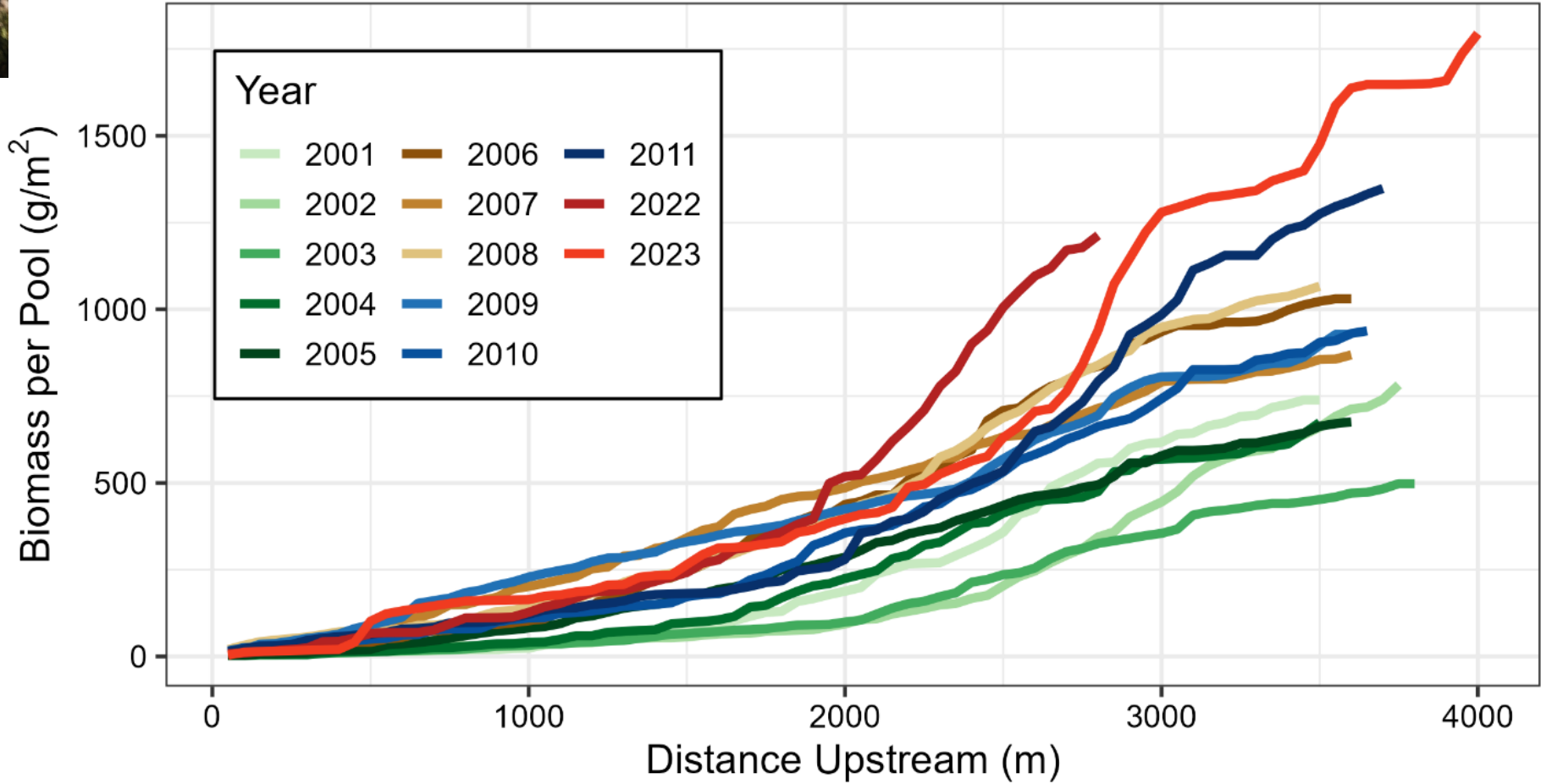
Cumulative Cutthroat Biomass



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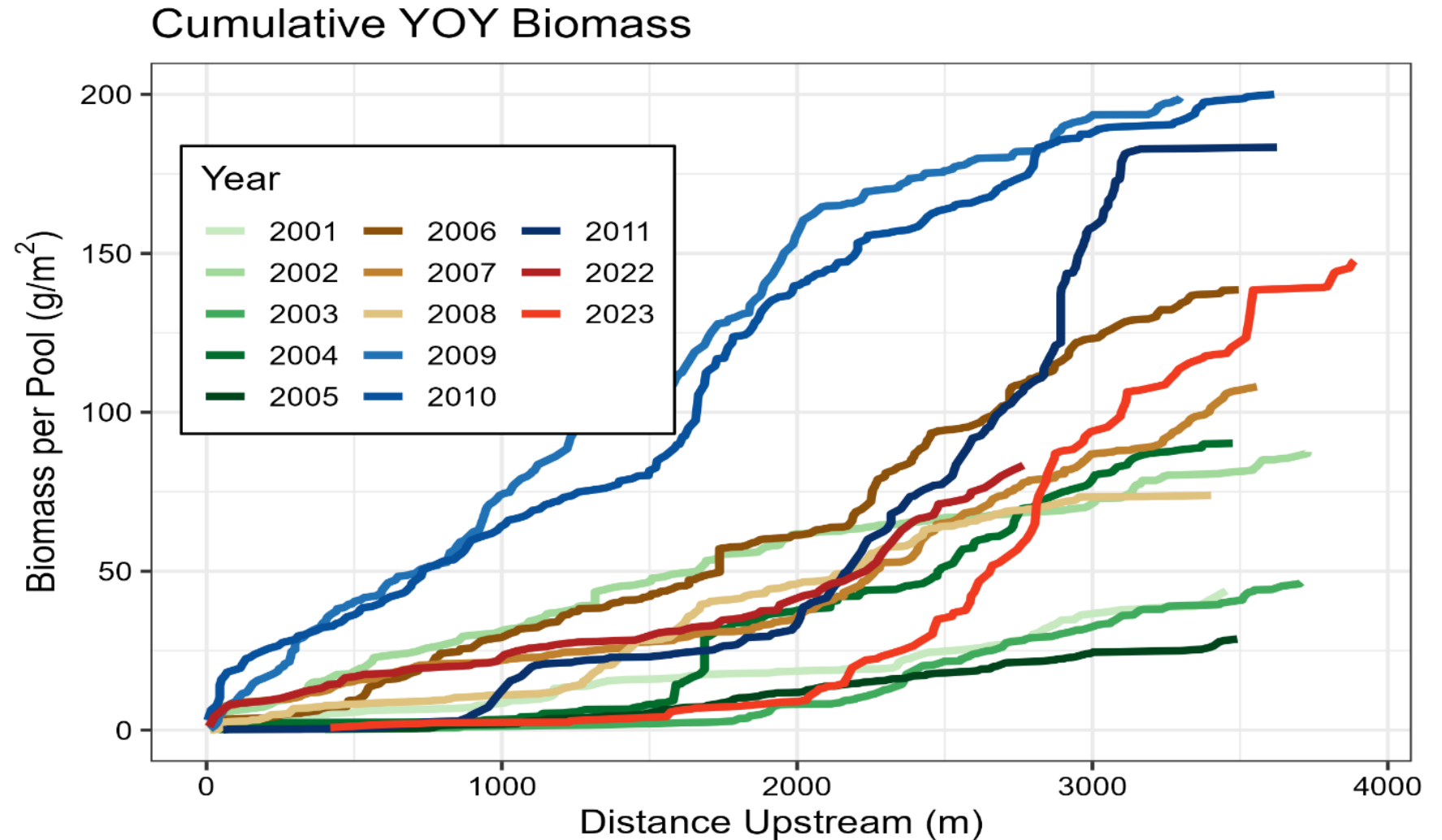
Cumulative Cutthroat Biomass



Post-fire YOY salmonid biomass along SF Hinkle Creek post-fire relative to Hinkle surveys 2001-2011



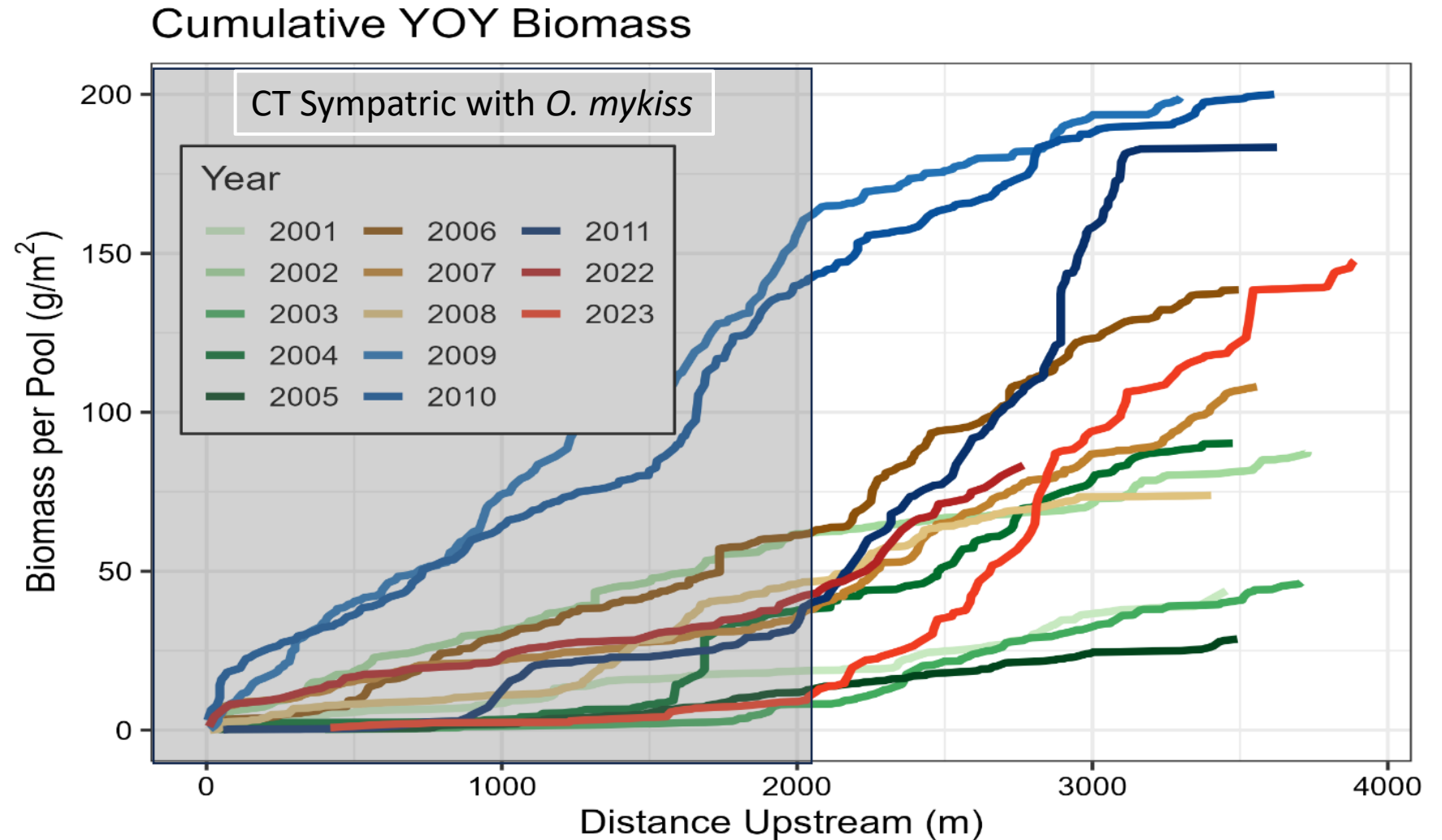
(*O. mykiss* &
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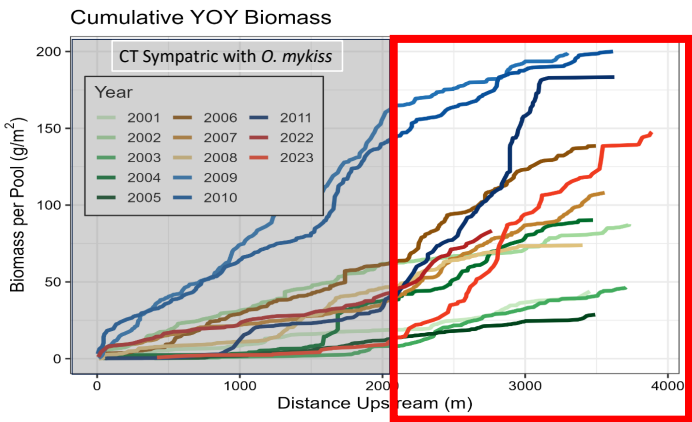
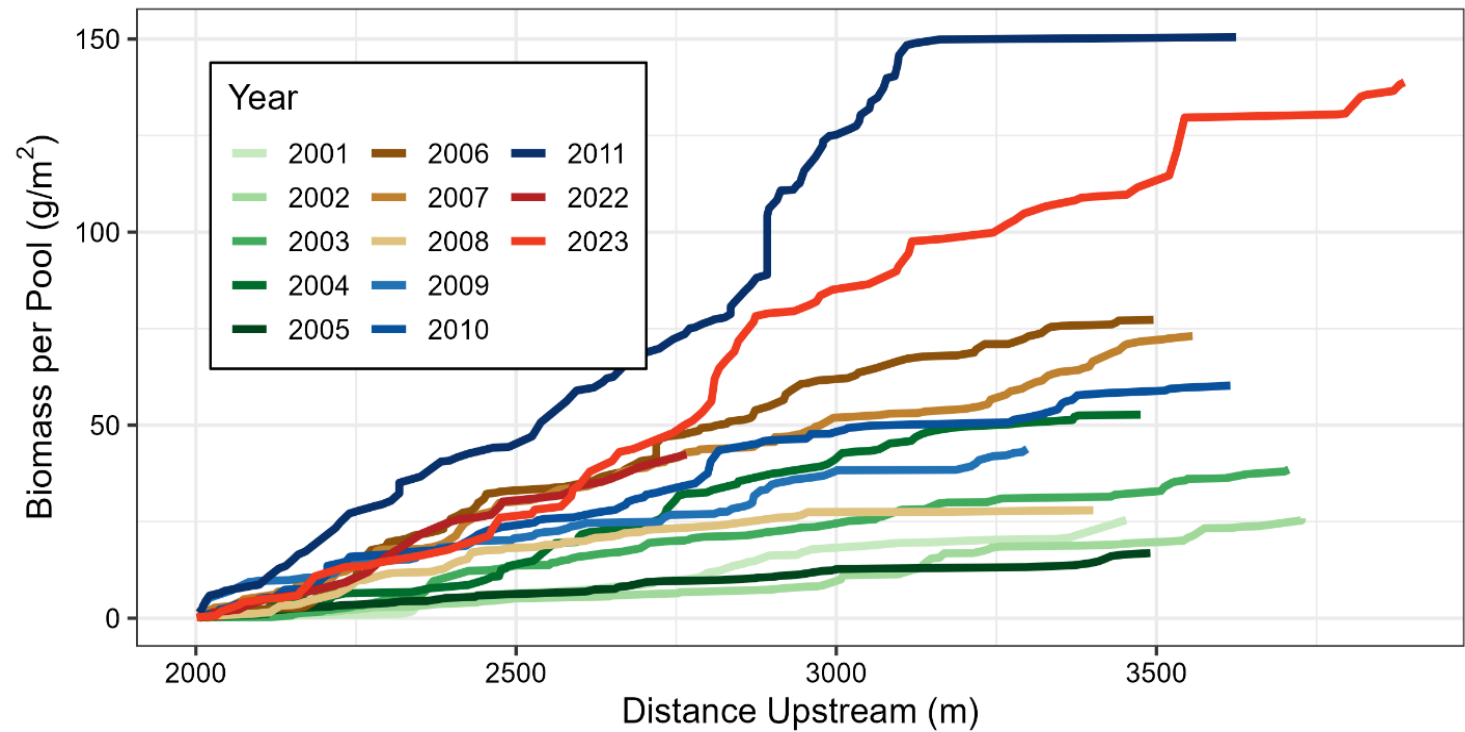
(*O. mykiss* &
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Post-fire **YOY CT** biomass along SF Hinkle Creek upstream of meter 2000 post-fire relative to Hinkle surveys 2001-2011



Cumulative YOY Biomass above 2000m



Overall Conclusion

Coastal Cutthroat trout in headwater streams had strong ecological resilience to 2020 wildfires in years 1-3 post-fire

- No cases of population loss
- Few substantial adult abundance declines
- Some adult abundance increases
- YOY generally responded positively

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Hypothesized Mechanisms (not mutually exclusive)

- Increased food allows for persistence in warmer temperatures
- Thermal refugia prevalent in these systems
- Strong YOY year classes after allow for population recovery even if adult fish decline
- Fish move. . .

Acknowledgements

- Funding
 - NCASI, OFIC, OSU, NSF
- Landowners
 - Roseburg Forest Products
 - Weyerhaeuser, Inc.
- Field crews
- HJ Andrews LTER program
- Willamette National Forest
- Original Hinkle Watershed Study



HJ Andrews Experimental Forest
LONG-TERM ECOLOGICAL RESEARCH



Oregon State
University



Weyerhaeuser