

Drought Happens. . . So make the most of it.

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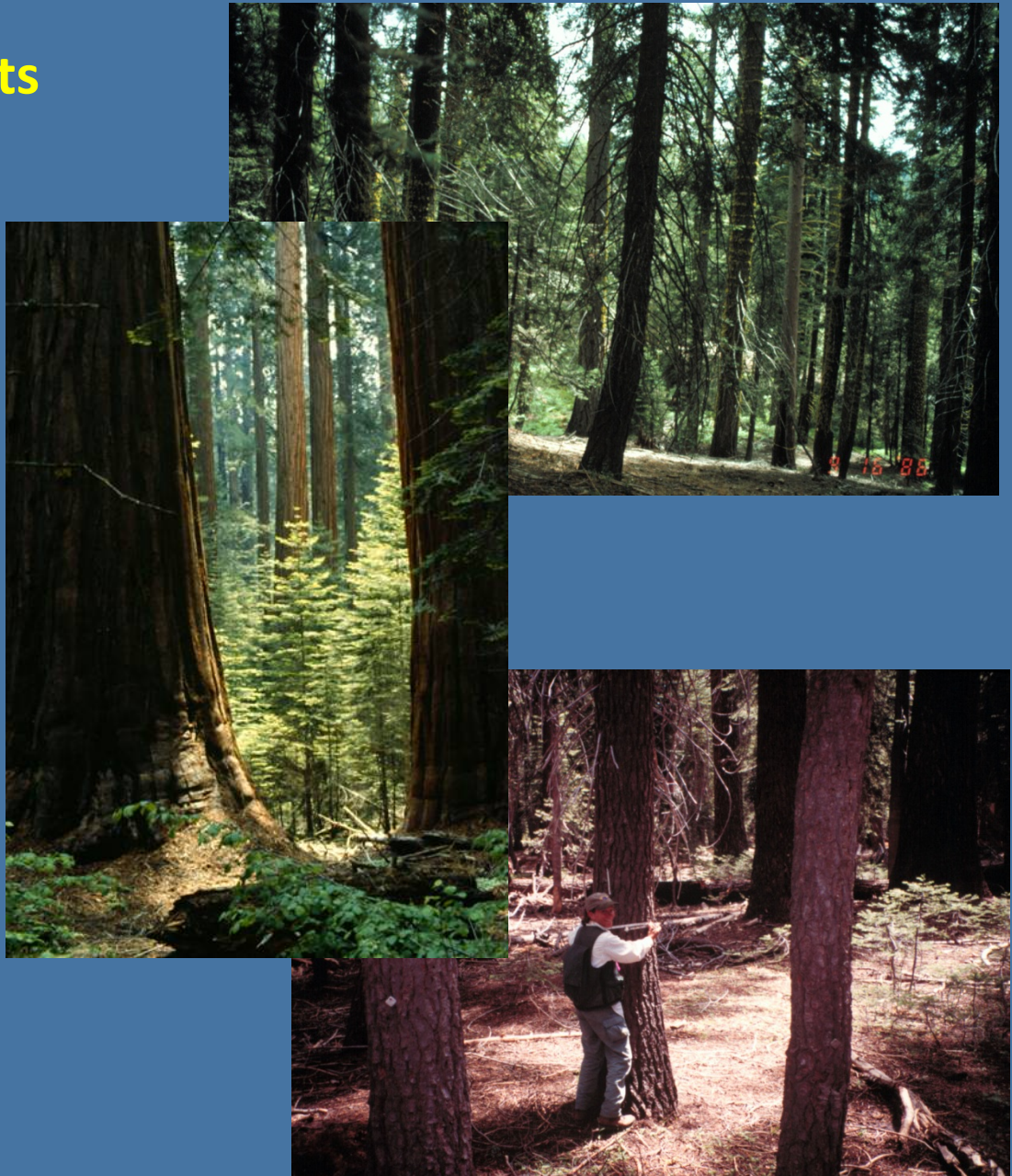
U.S. Department of the Interior
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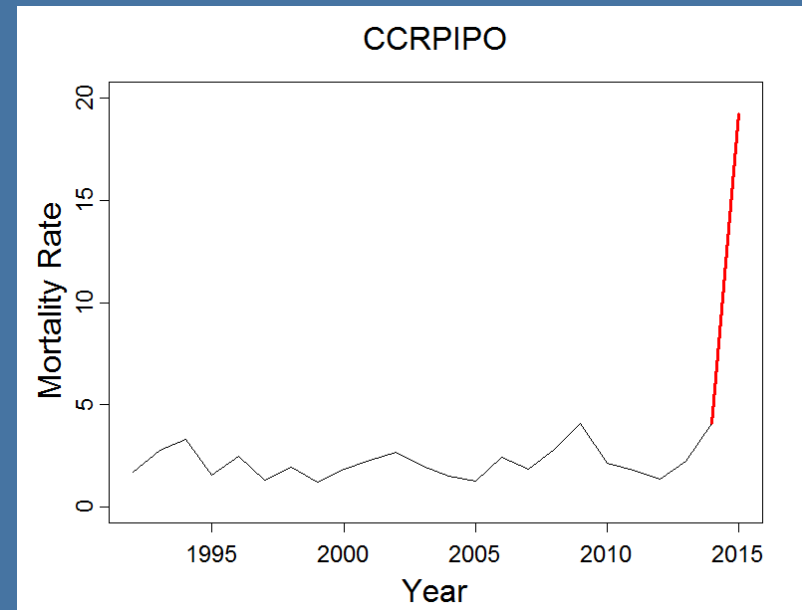
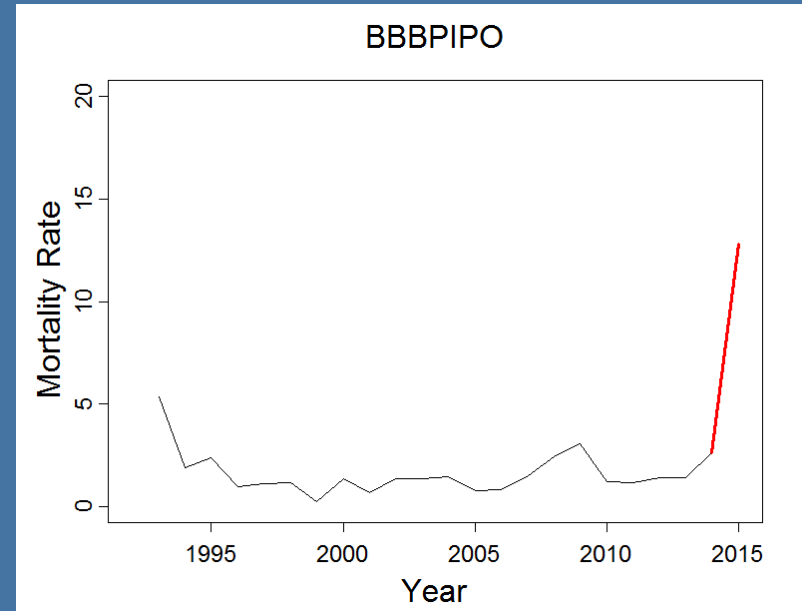
Long-term Monitoring Plots

Thirty Permanent Plots (0.9 to 2.5 ha)

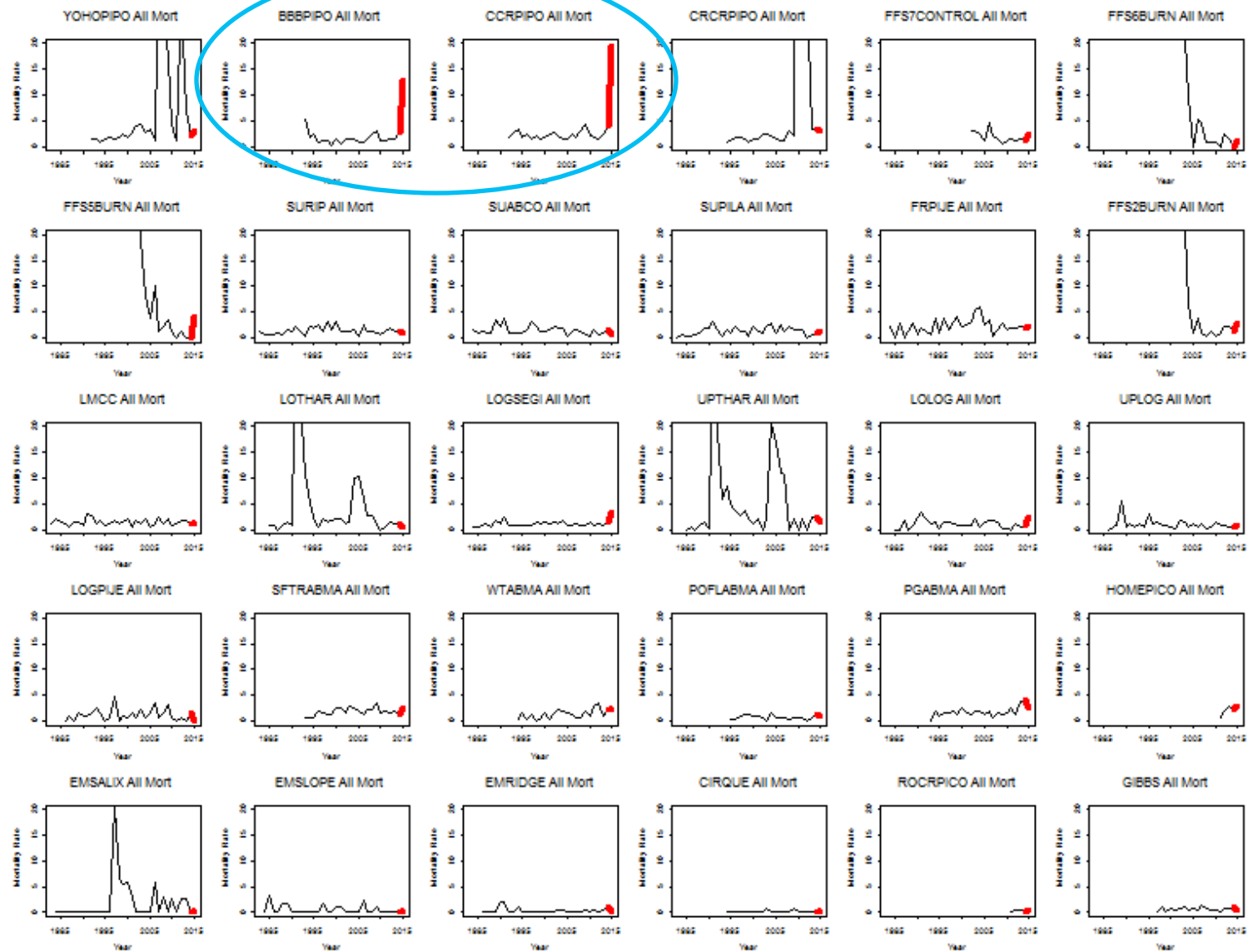
- Established between 1982 and 2010
- Elevation: 1500m to 3300m
- Including ponderosa pine-mixed conifer, white fir, mixed conifer, red fir, lodgepole pine, Jeffrey pine and subalpine forests
- Annual Mortality Rate Data



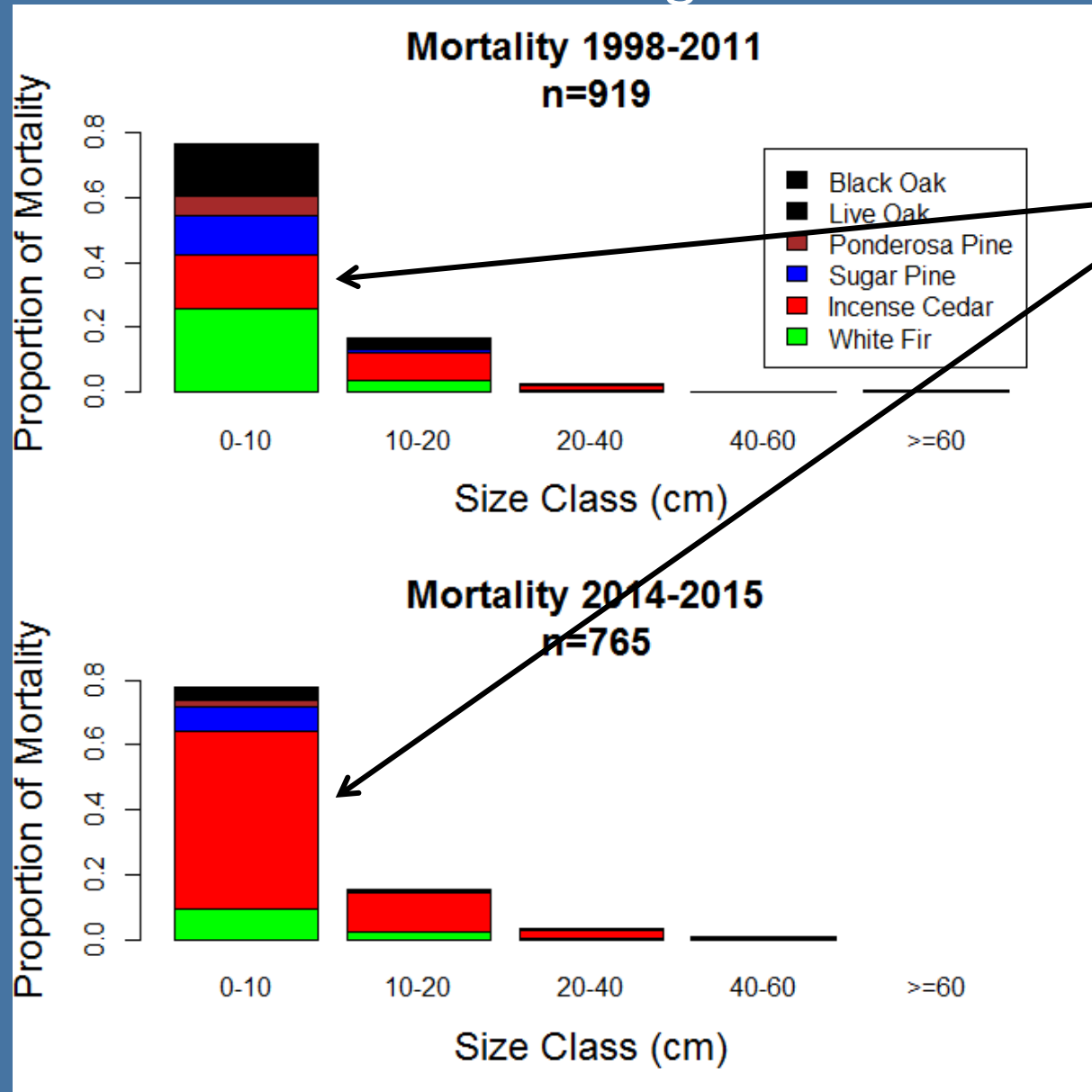
Fourth year of a severe drought: Massive Mortality?



Yes, but it varies in space . . .

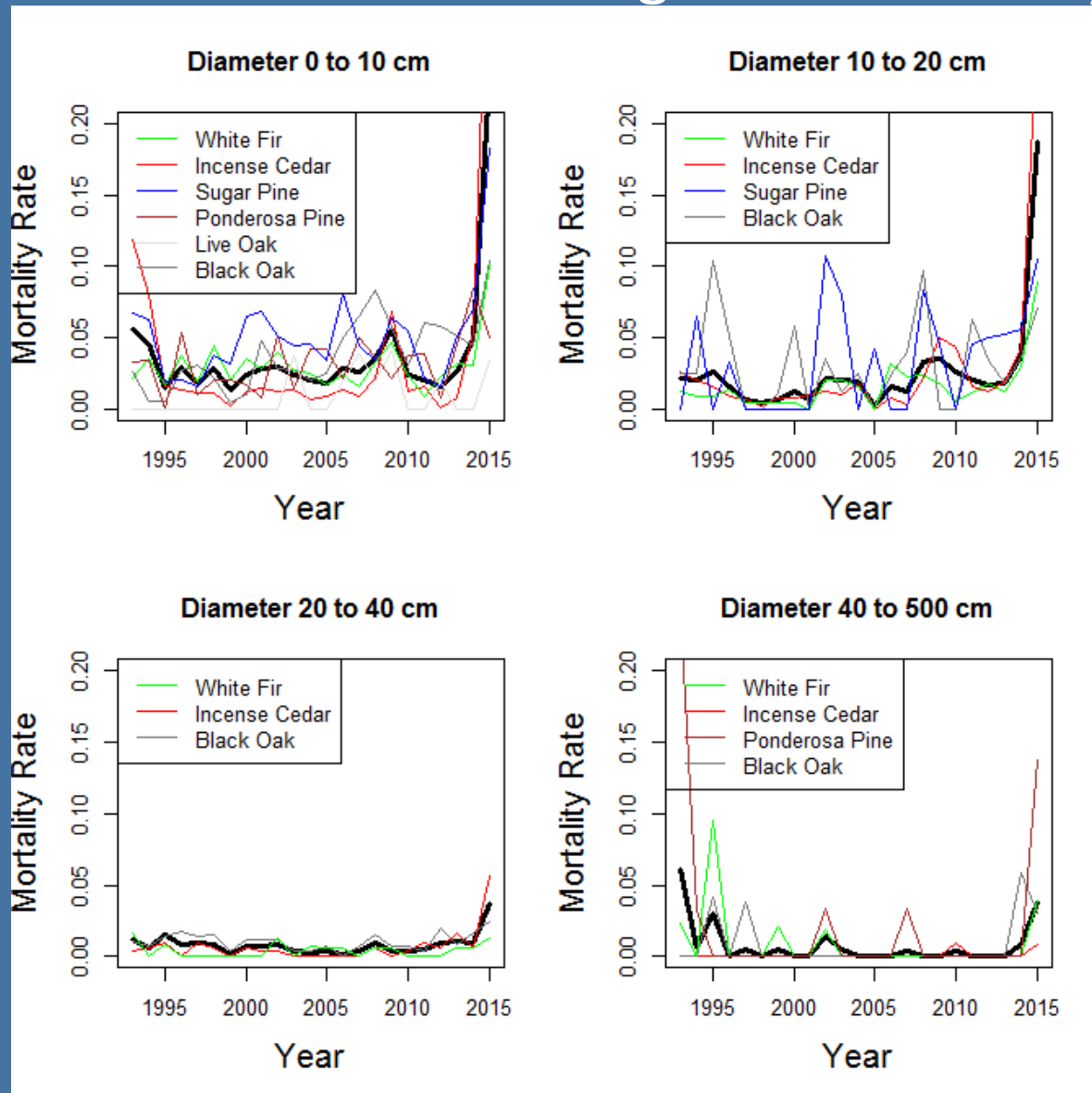


Does elevated drought mortality differ from typical background mortality?



- Size structure similar
- Species composition quite different

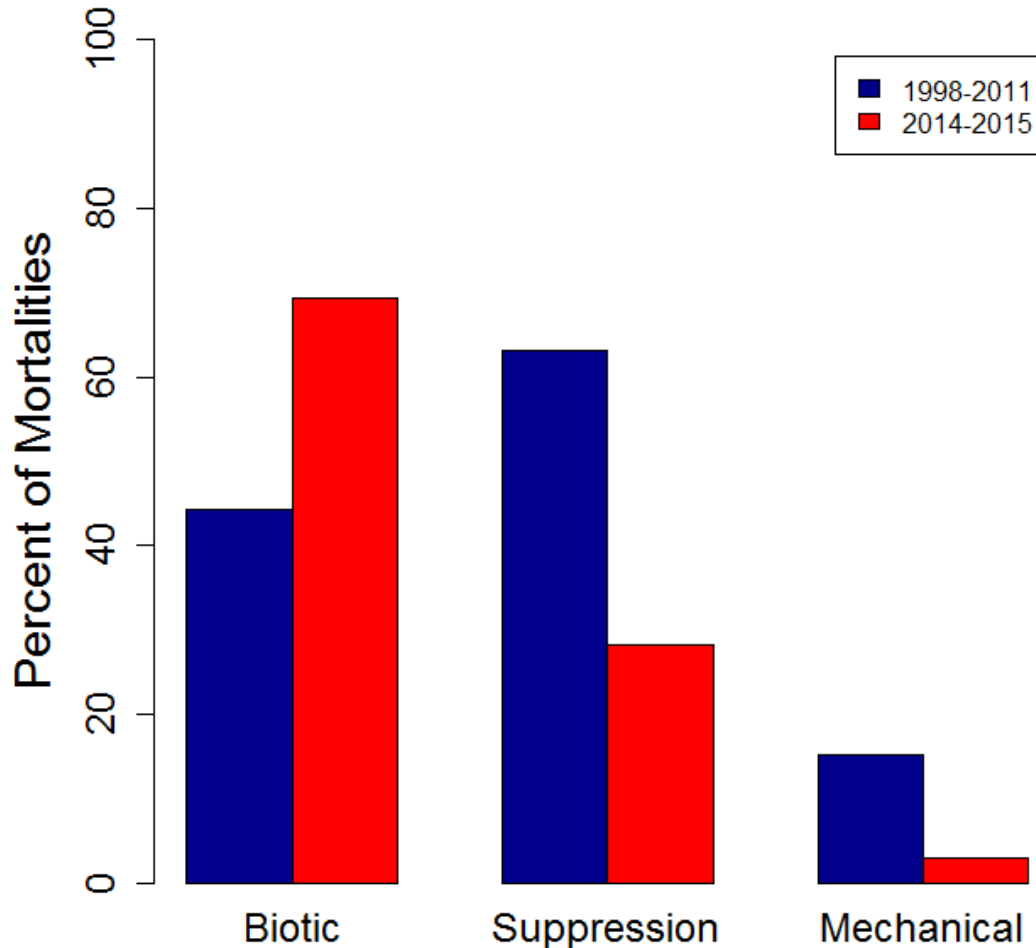
Does elevated drought mortality differ from typical background mortality?



- Larger increases in Incense cedar (CADE) mortality across smaller size classes
- Larger increase in pine mortality in largest size class

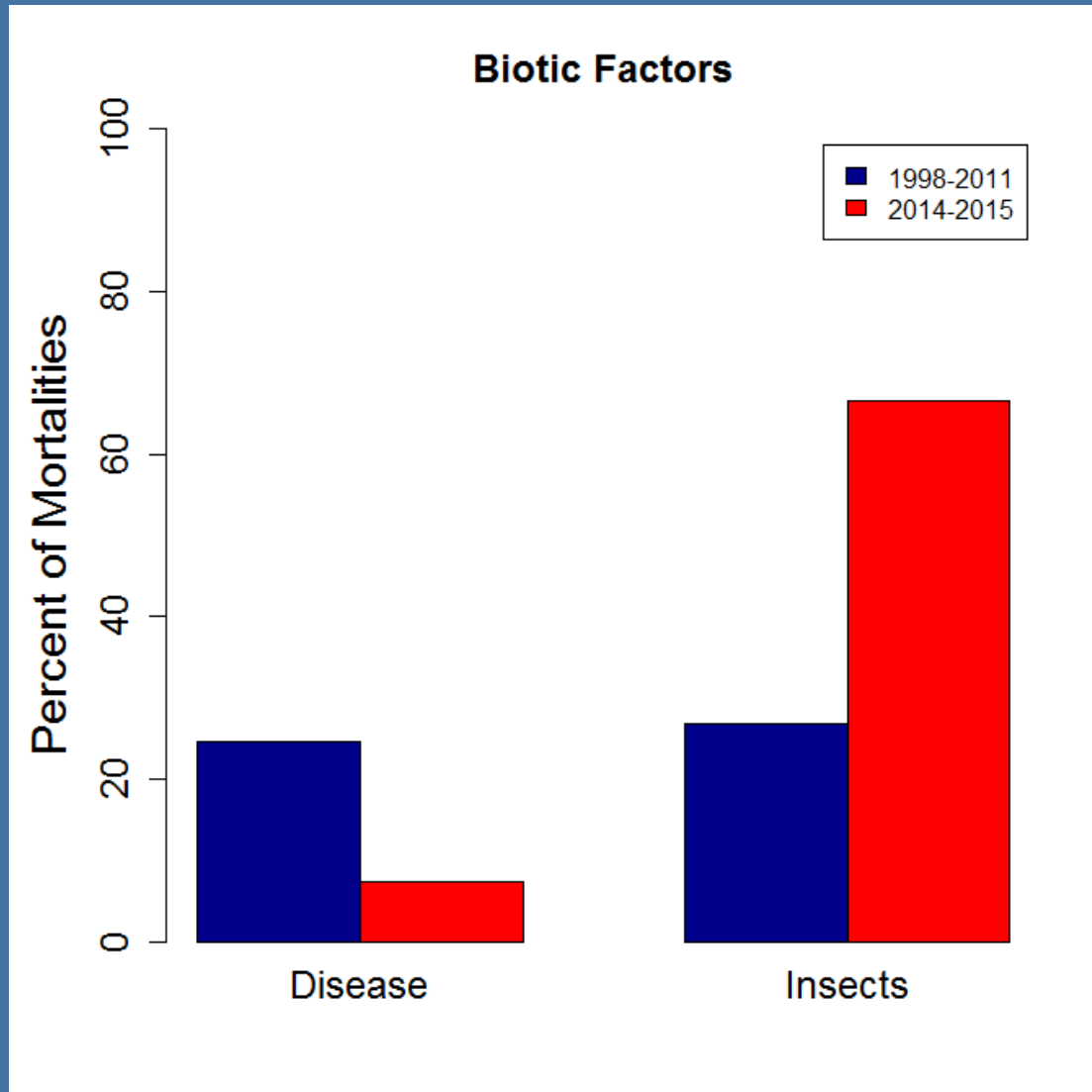
What's killing the trees? Is it different in a drought?

Breakdown of Mortality Factors



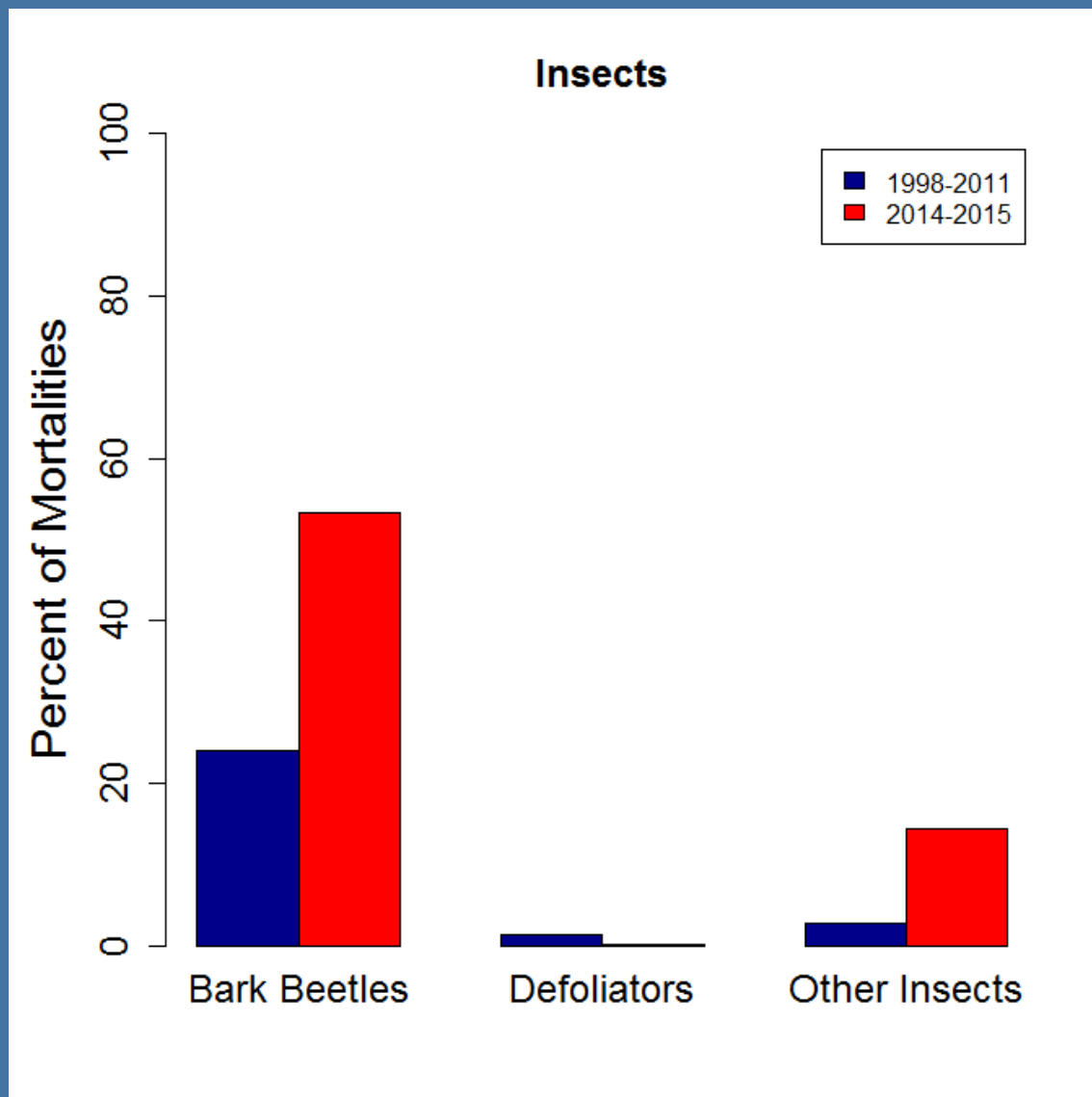
Biotic factors are more prevalent during the drought

What's killing the trees? Is it different in a drought?



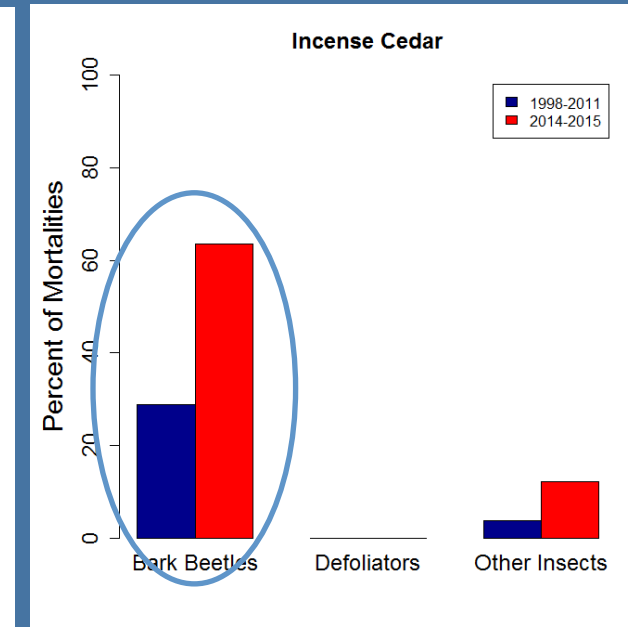
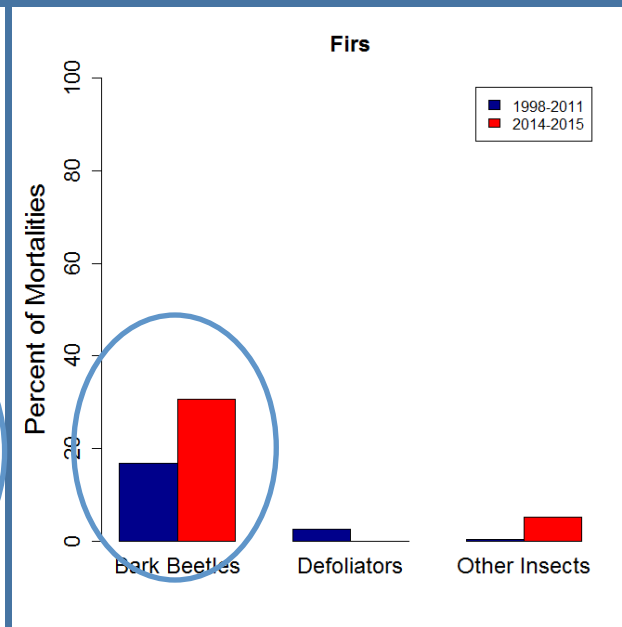
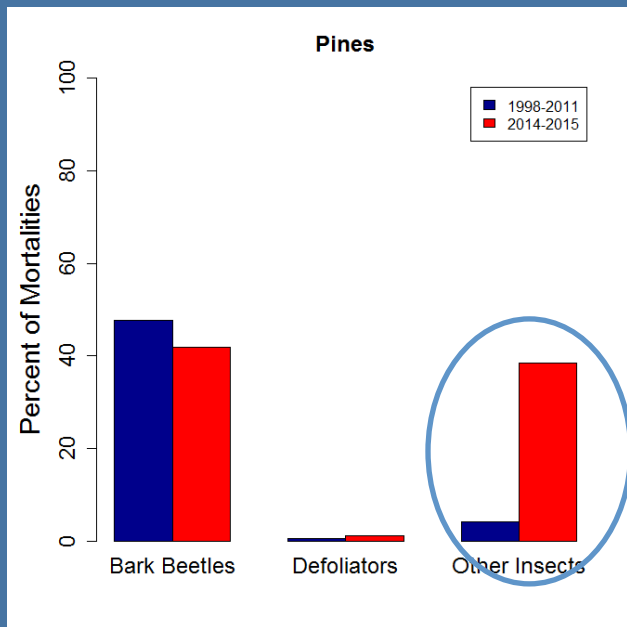
The biotic increase is driven by increases in insects.

What's killing the trees? Is it different in a drought?



Bark beetles and other insects drive the increases rather than defoliators

The Beetle is in the details.



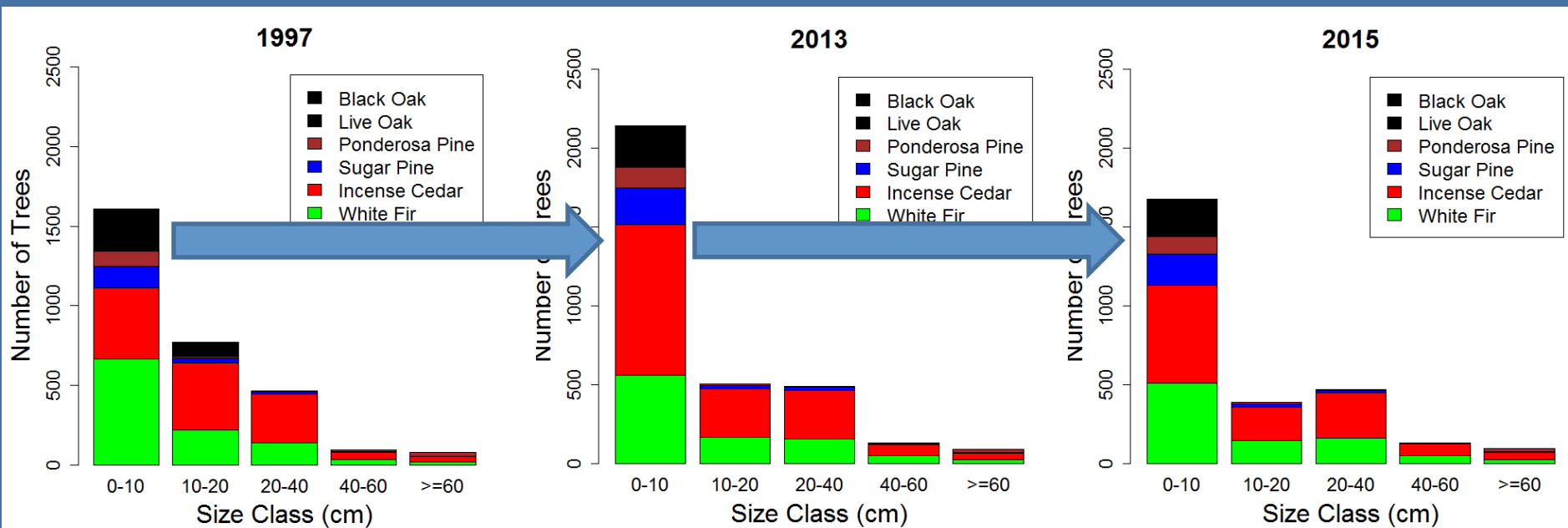
Surprisingly, for pines, the increase in biotic factors is NOT due to bark beetles. It's a weevil!

For firs, the increase is associated with *Scolytus* bark beetles.

For incense cedars—normally without a strong bark beetle attacker—the increase is apparently driven by a rise in *Phloeosinus* attacks

** Mortality increases during drought are apparently, in part, driven by organisms that are considered minor players in typical conditions.

What does this mean for structure and composition?



- In the non-drought period, small trees were increasing, particularly incense cedar.

- After four years of drought, the small size class looks much like it did 20 years ago, though middle classes still low.

Summary

- Even in extreme drought, mortality is spatially variable
- In our plots, the size structure of mortality did not change substantially. But the species composition did.
- Increases in mortality were associated with strong increases in biotic attack.
- There is evidence that there were substantial increases in the activity of insects normally considered minor players.

Where to next?

- Tying plot data to remote sensing to get an understanding at the landscape scale
- Causes of spatial variation in mortality
- Lagged effects of drought
- Temporal trends in causes of mortality through summer