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Unprecedented Douglas-fir mortality from drought and Swiss needle cast at Tillamook, Oregon

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Office of Research and Development
Pacific Ecological Services Division

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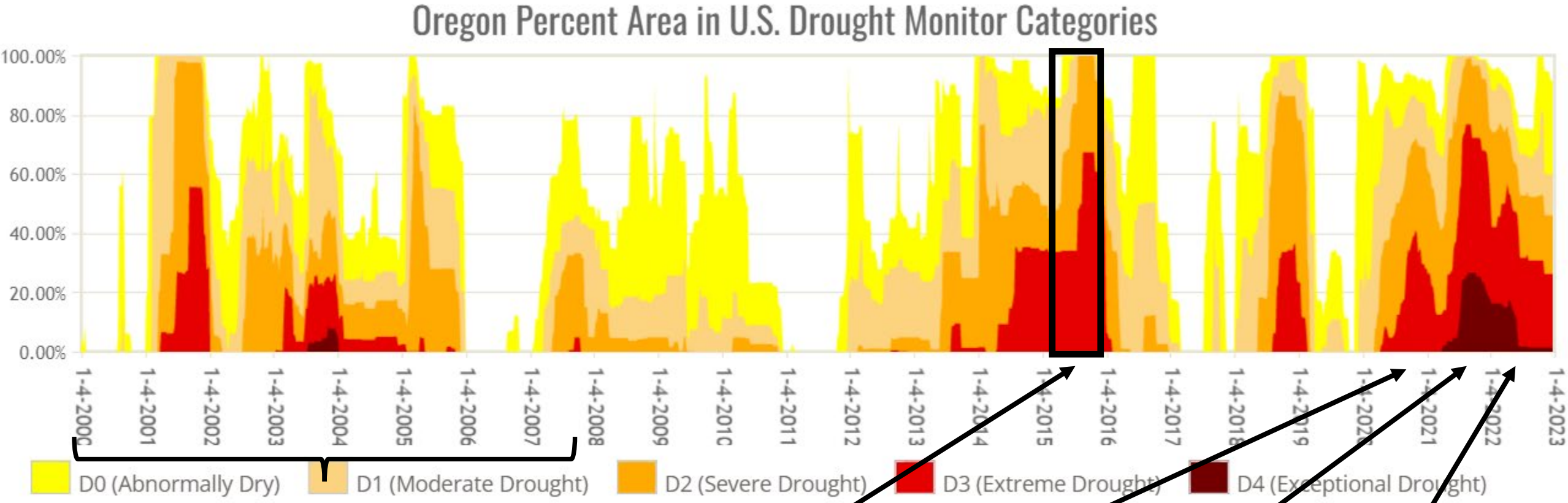
Douglas-fir mortality at Tillamook

Drought in Oregon 2000-2022 (US Drought Monitor)



1999-2007 Whitebark pine mortality from MPB Three Sisters

2015 DF mortality at Tillamook

2020 Labor Day fires in W OR

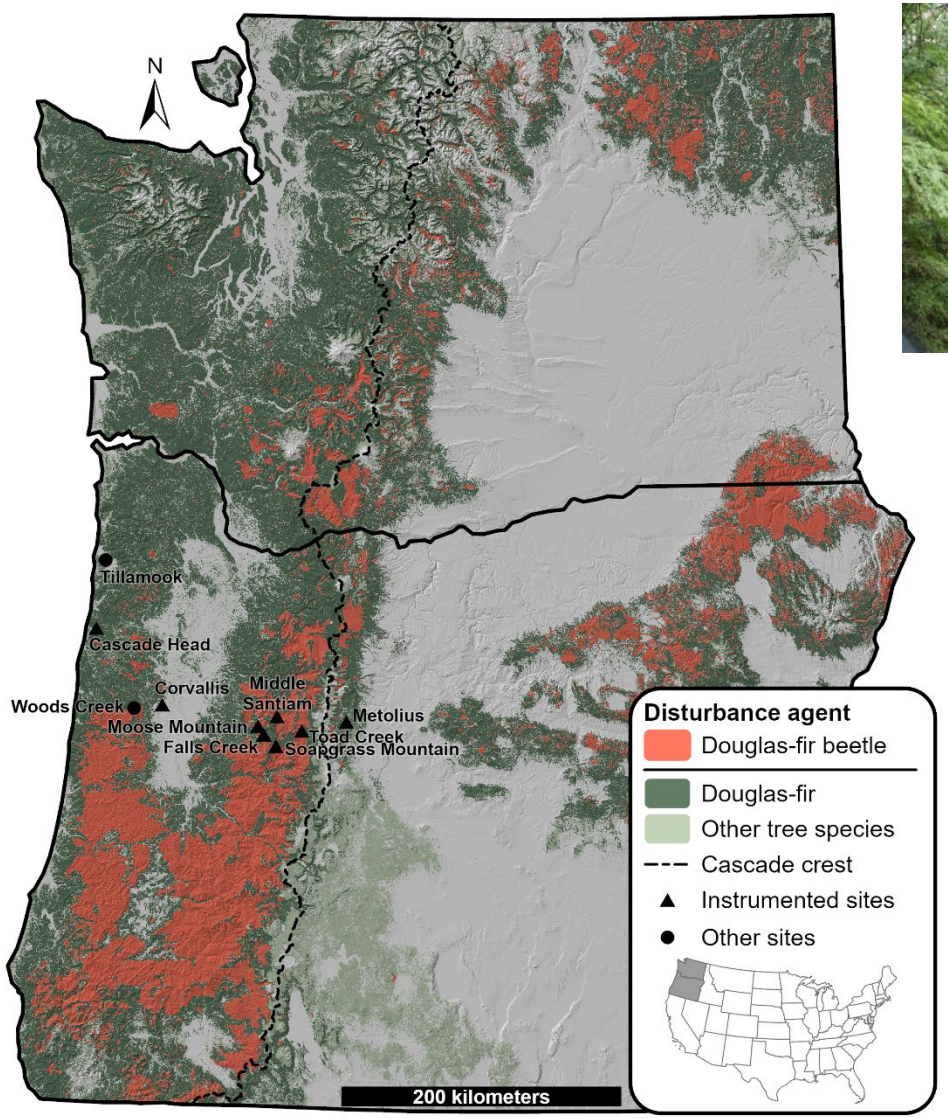
2021 DF mortality from borers & DFB

2022 true fir mortality from FE

EPA Monitoring Network in Oregon

Q: What is the role of drought on tree growth and mortality in western Oregon?

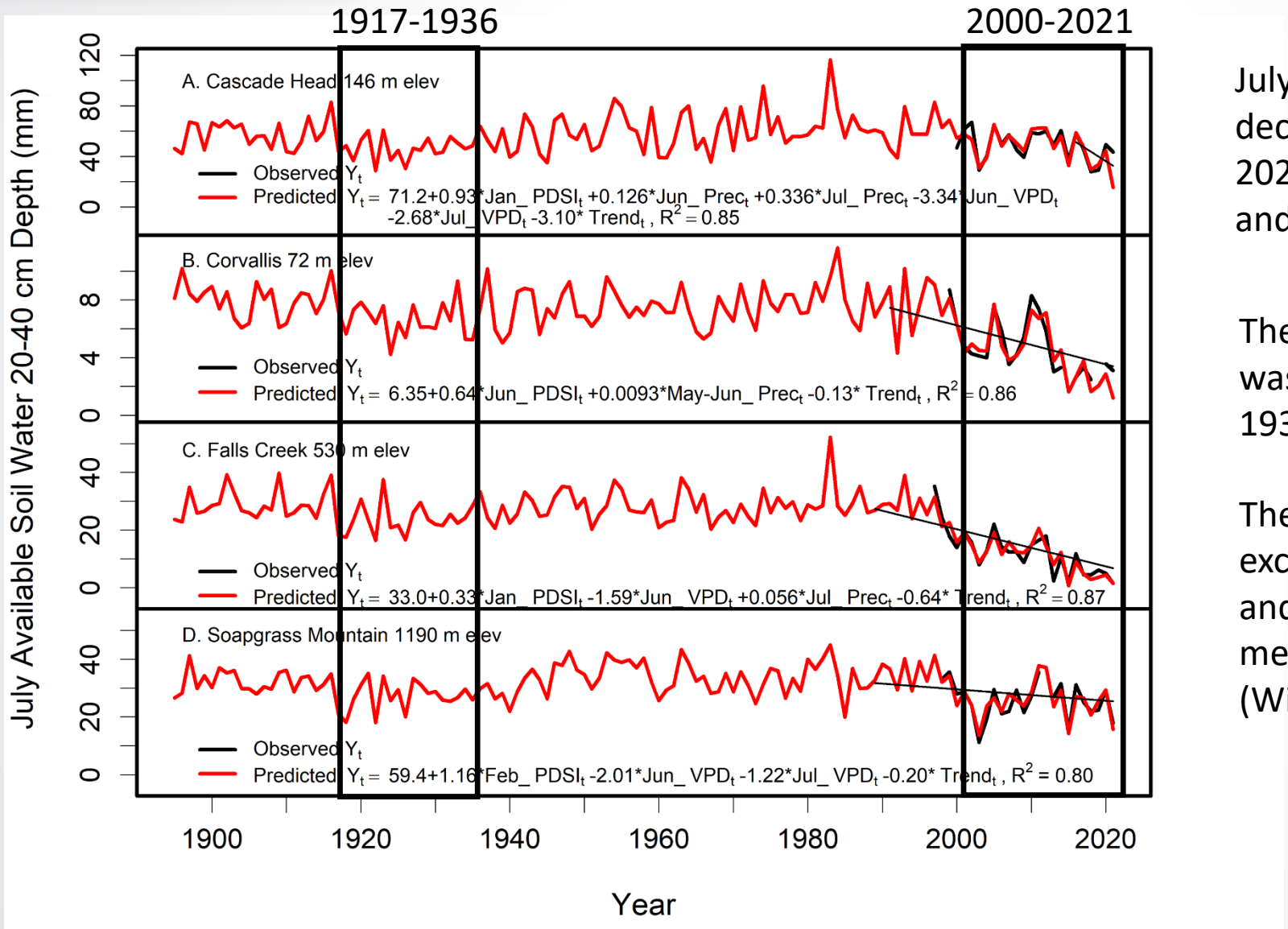
Growth-climate and mortality-climate relationships based on available soil water measurements recorded continuously since 1998, annual mortality surveys, and dendrochronological records at permanent field sites



Map generated by Colin Welk, ORISE student contractor

EPA met stations at Coast-to-Crest field sites

2000-2021 Worst Drought in 700 Years

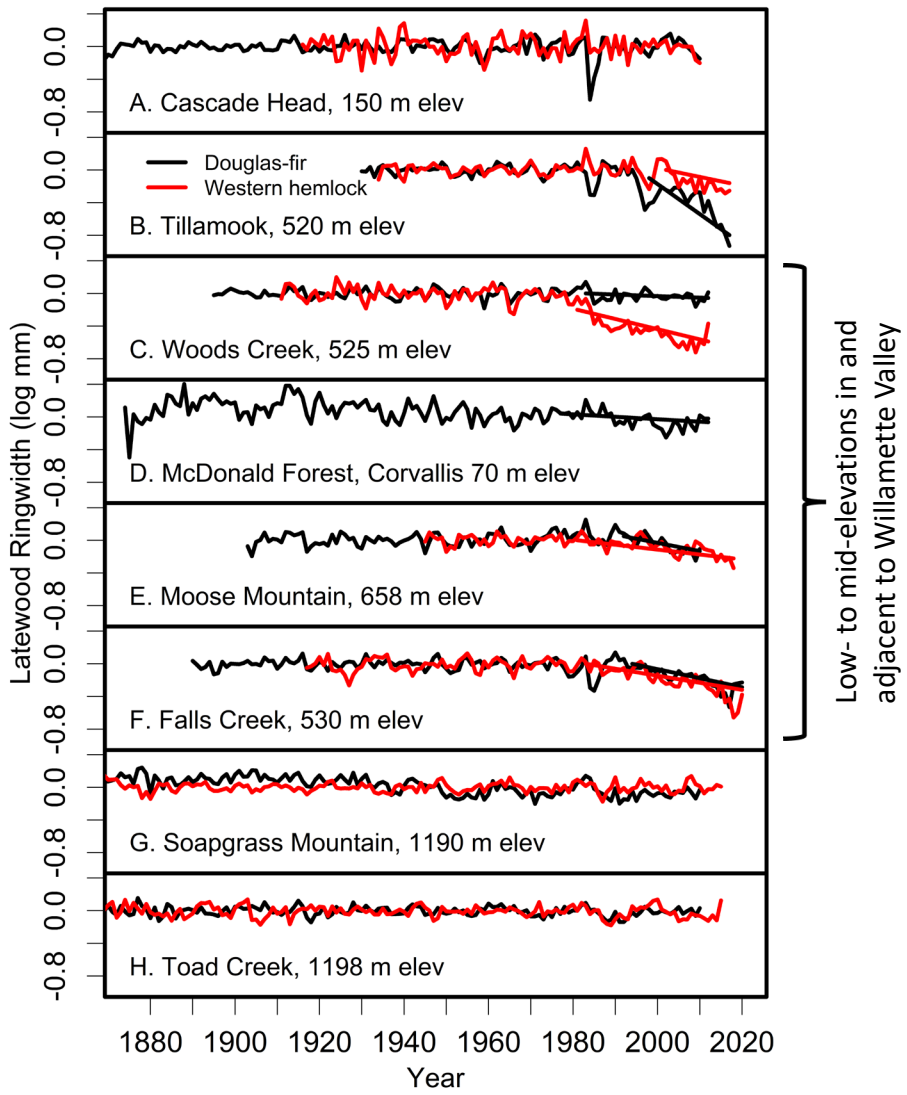


July available soil water decreased ~80% from 1998 to 2020 at low- to mid-elevations in and around Willamette Valley.

The 1917-1936 Dust Bowl drought was worst drought in 620 years (Keen 1937).

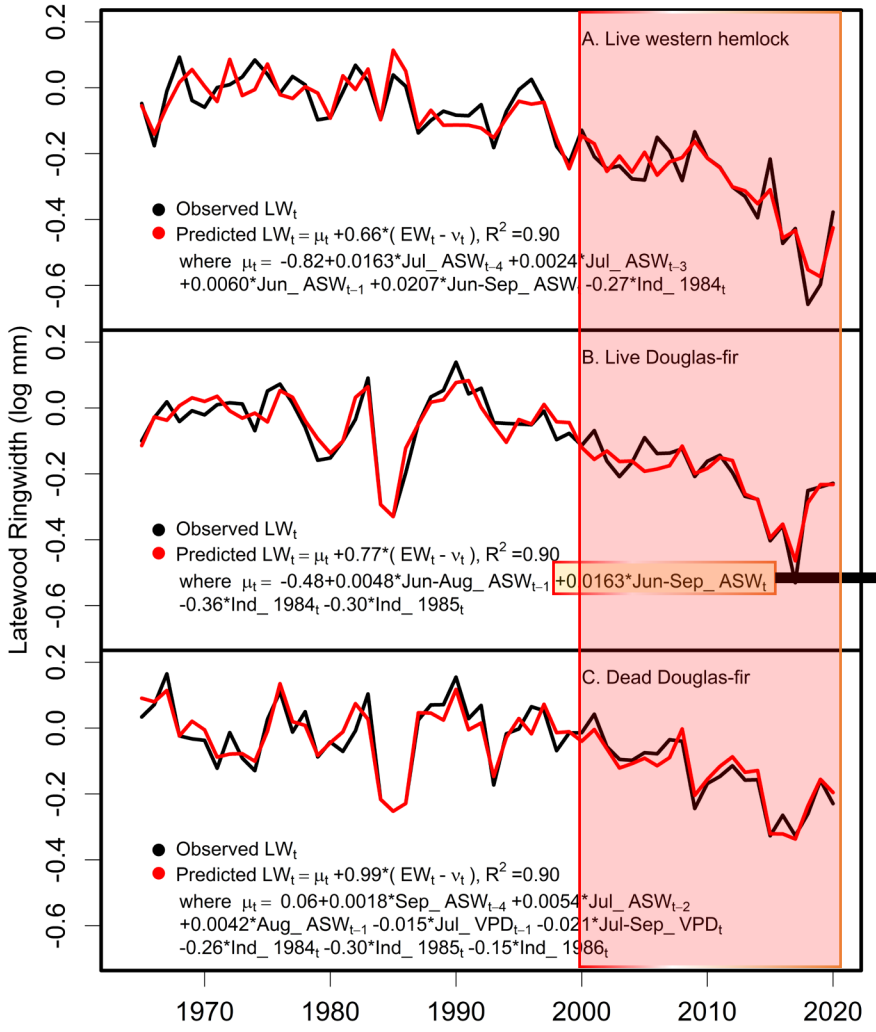
The 2000-2021 drought in Oregon exceeded the 1917-1936 drought and was an extension of 2000-2021 megadrought in the southwest (Williams et al 2022).

Risk of tree mortality from drought and BDAs is higher in areas with declining tree growth

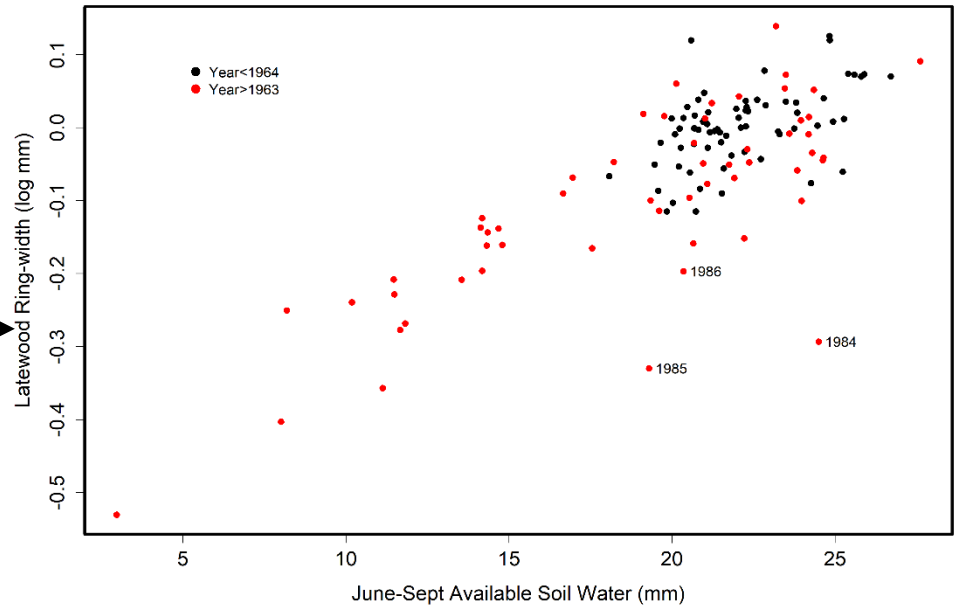


Latewood growth decline is most strongly associated with available soil water (ASW +) in current and previous years

2000-2021 Drought



Latewood growth has become more water-limited as available soil water has decreased below a threshold (<40%) in recent decades

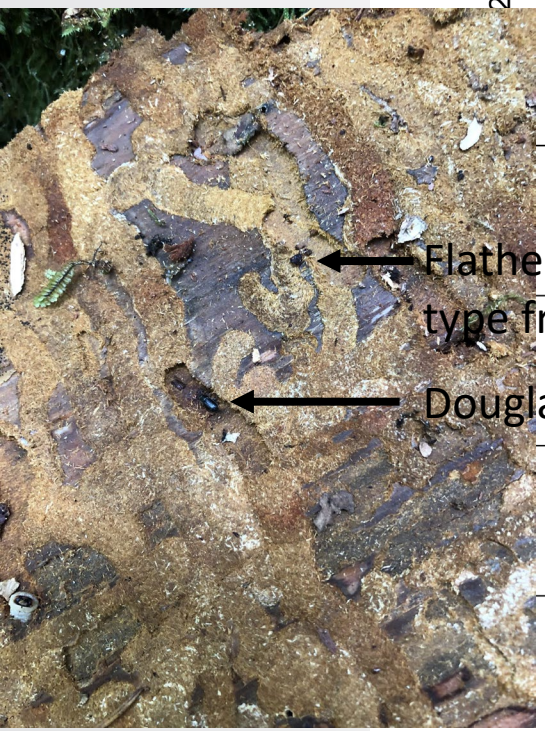


Dendrochronological records for Falls Creek (530 m elev)

Annual mortality survey data at Falls Creek (0.49 ha)

Total dead western hemlock = 148 suppressed

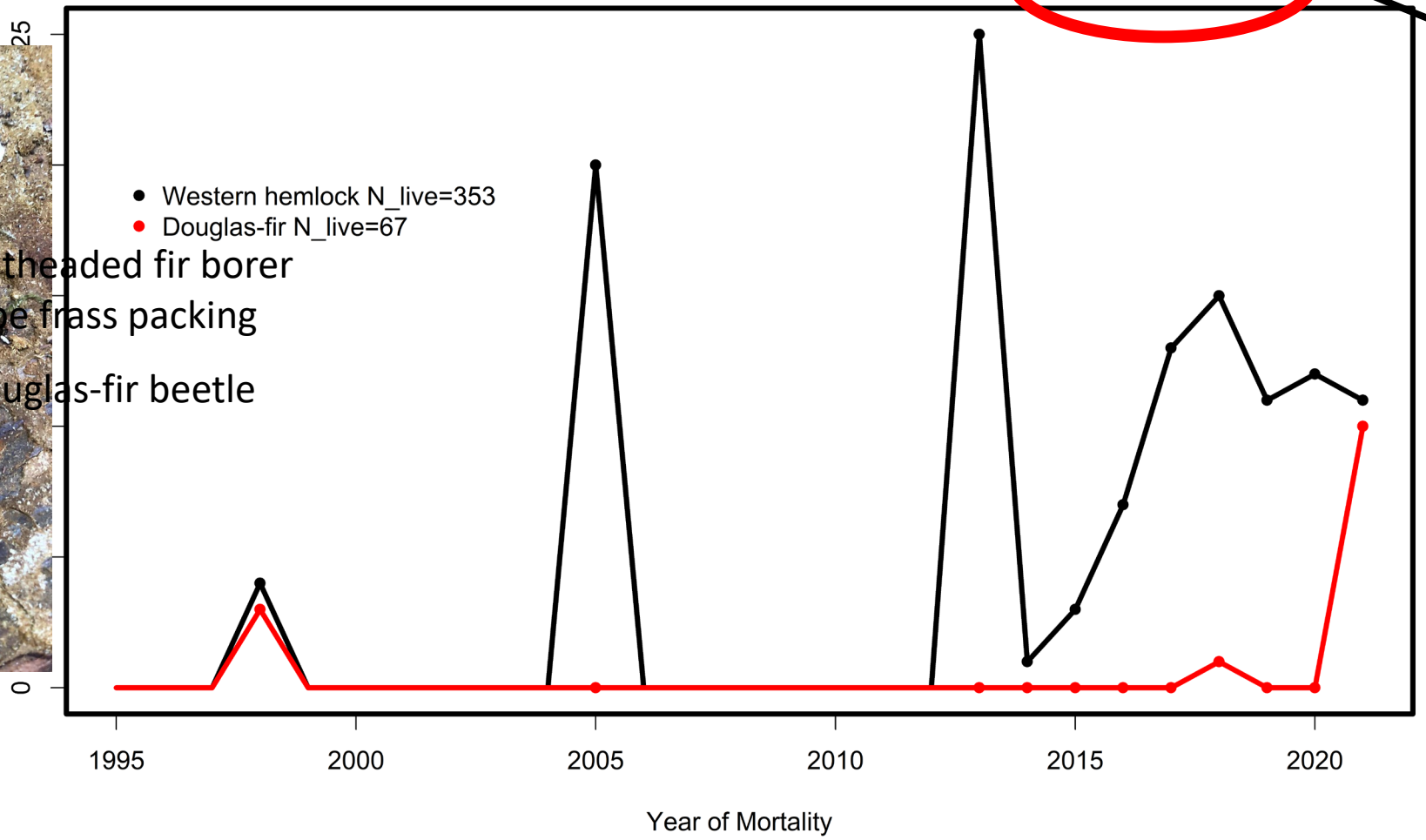
Total dead Douglas-fir = 3 suppressed, 2 intermediate, 9 co-dominant



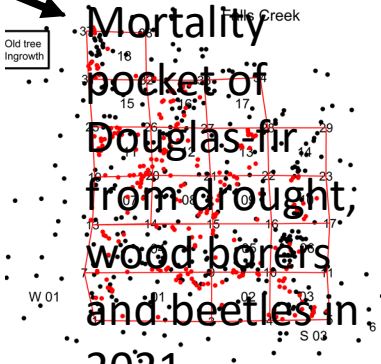
Flatheaded fir borer type frass packing

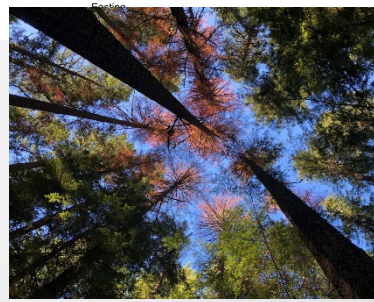
Douglas-fir beetle

Photos by Dave Shaw taken Oct 30, 2021

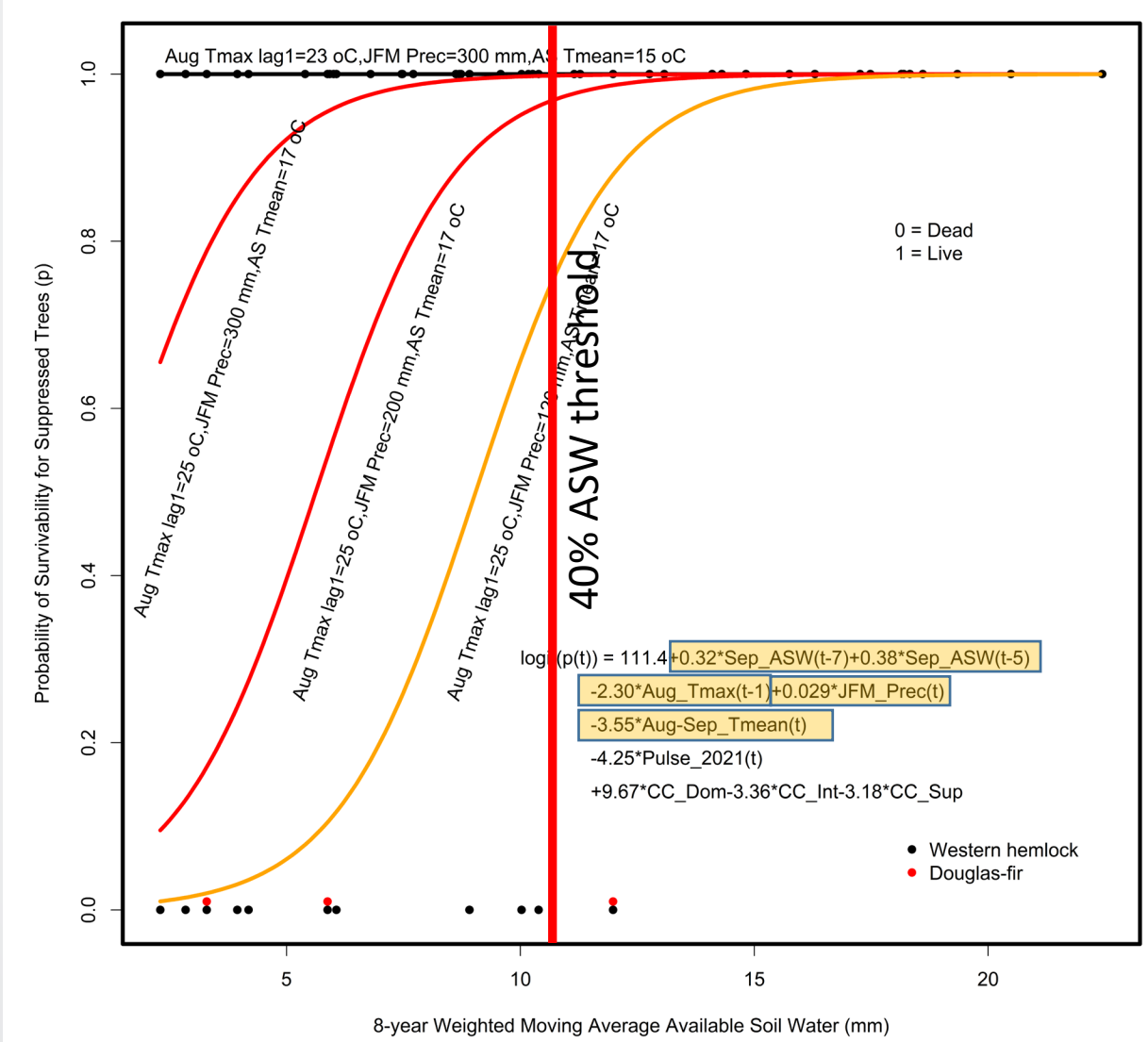


Mortality pocket of Douglas-fir from drought, wood borers and beetles in 2021

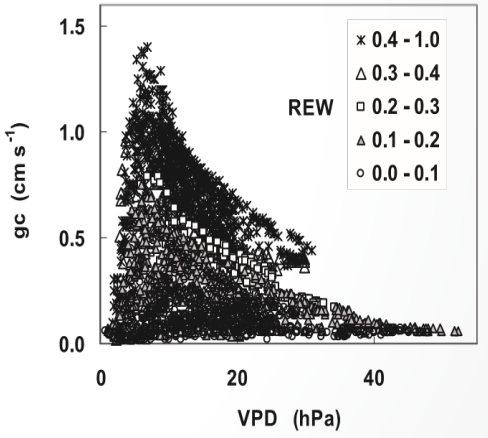


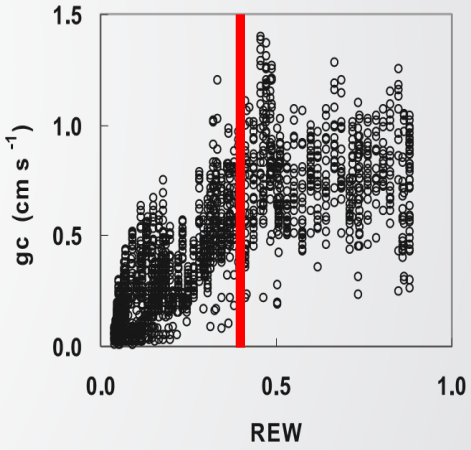


Tree mortality increases with decreasing available soil water (ASW) and increasing summer temperature at Falls Creek



Tree mortality occurs earlier when heatwave follows the onset of drought rather than simultaneous drought and heatwave (Cochard et al. 2020).

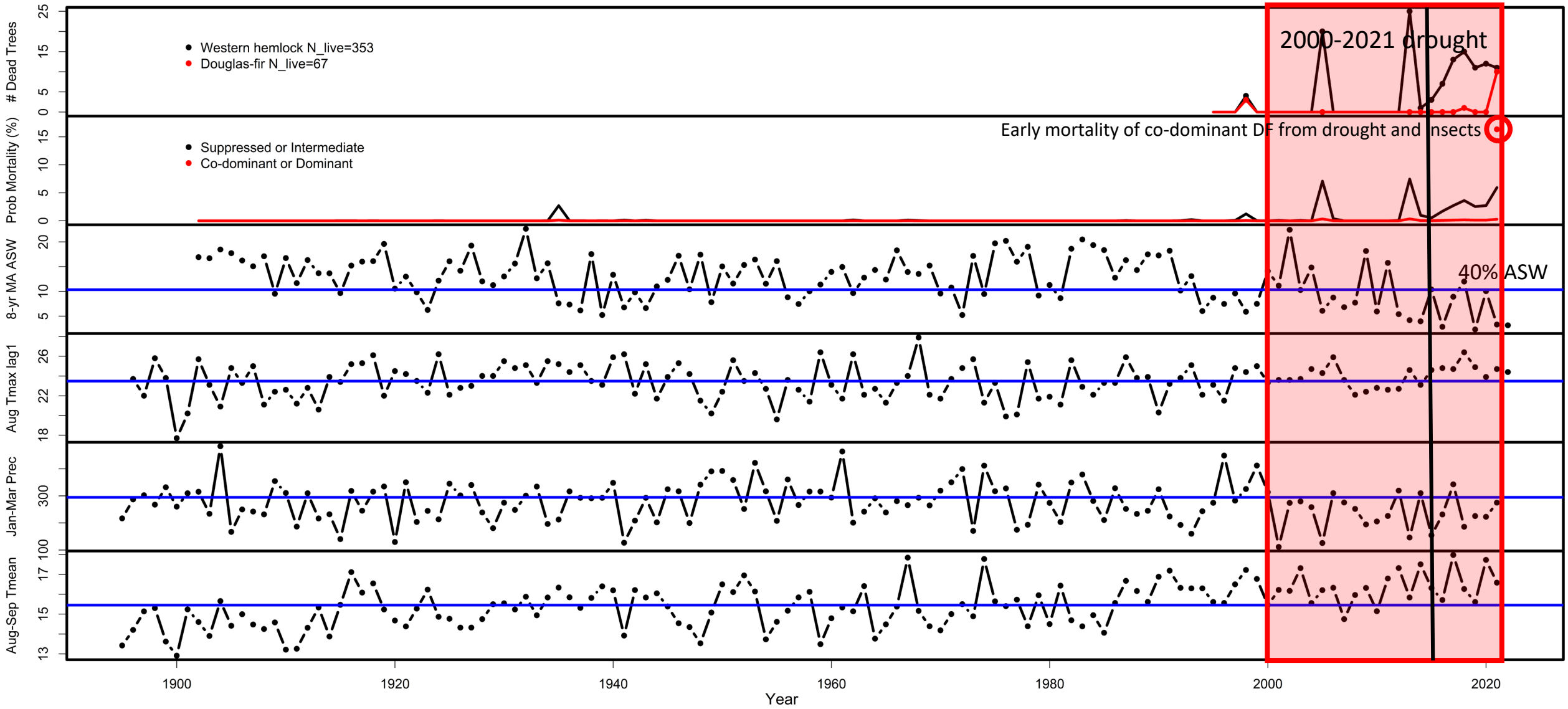




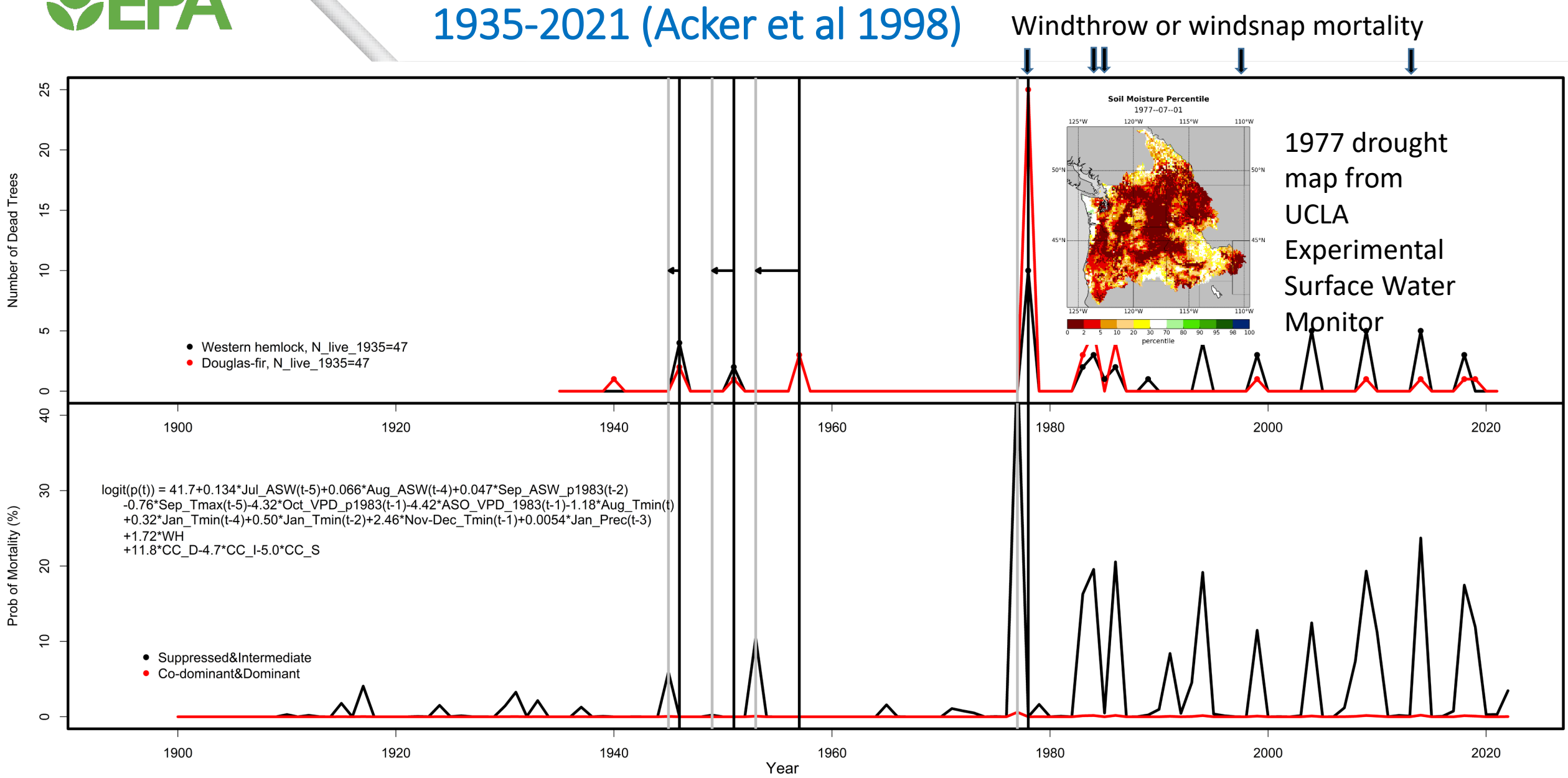
Canopy conductance decreases once relative extractable soil water (REW) drops below a threshold of 40% (Bréda et al 2006)

Mortality from drought and BDAs at Falls Creek

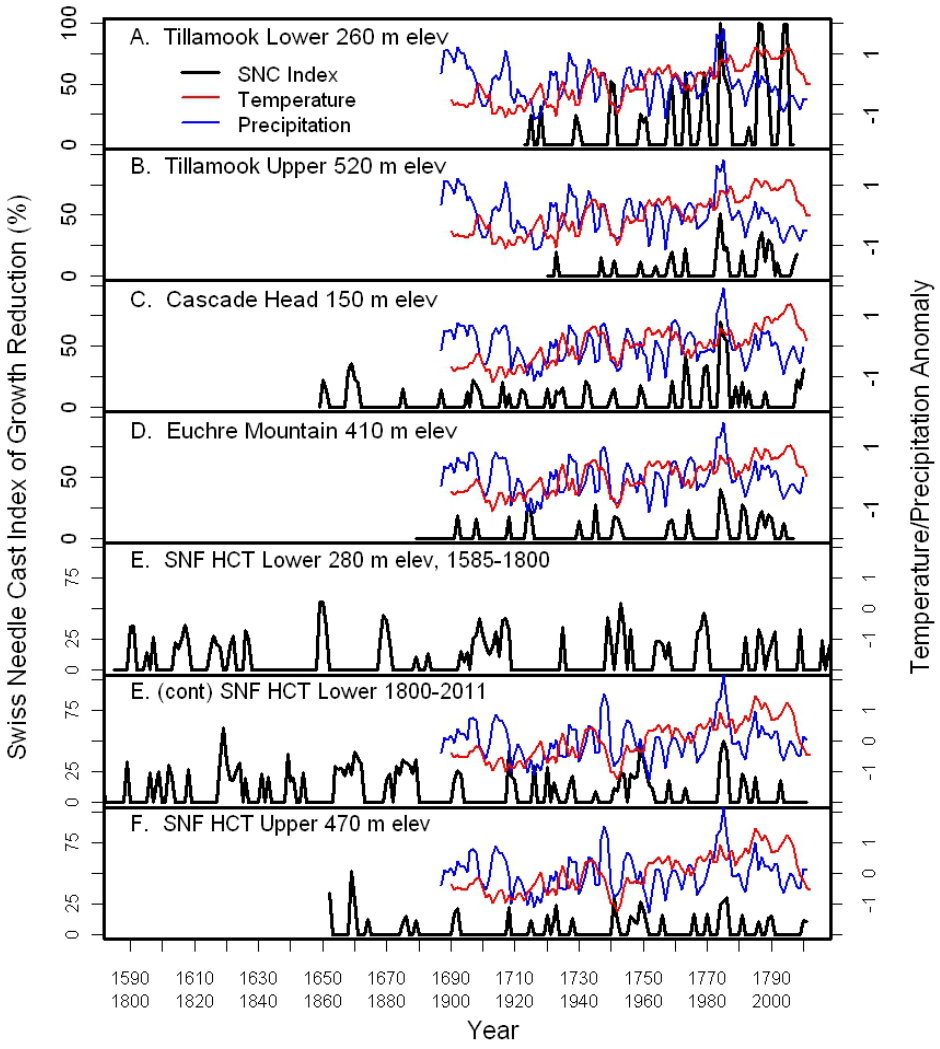
Early mortality of co-dominant DF at Tillamook in 2015



Tree Mortality Surveys at Cascade Head Experimental Forest 1935-2021 (Acker et al 1998)



Swiss needle cast severity increasing in recent decades (Lee et al. 2013, 2017, 2021)



- Growth declines of w hemlock at Tillamook are explained by decreasing soil moisture, indicating drought impacts on growth.
- SNC impacts on DF growth has been increasing in recent decades due to warmer winters and is most severe at Tillamook (Lee et al., 2013).
- Mortality agent is specific to Douglas-fir (e.g., SNC) and impacts dominant and co-dominants.

Douglas-fir mortality is likely due to carbon starvation associated with SNC, drought and warmer temperatures at Tillamook.

Conclusions

- 2000-2021 drought is the driest 22-year period in past 700 years in PNW.
- Regional tree growth decline and mortality in PNW are most strongly associated with decreasing soil moisture followed by heatwaves.
- Rate of mortality from drought is increasing for suppressed and intermediate canopy classes in recent decades.
- Rate of Douglas-fir mortality from drought and BDAs is increasing for dominant and co-dominant canopy classes in recent decades in western Oregon.
- Douglas-fir mortality at Tillamook, starting in 2015, was unprecedented in North America and was largely influenced by increasing SNC severity and decreasing soil moisture associated with warming temperatures in recent decades.

Thank you!