

Climate Change and Bark Beetles in Oregon: What Might the Future Bring?

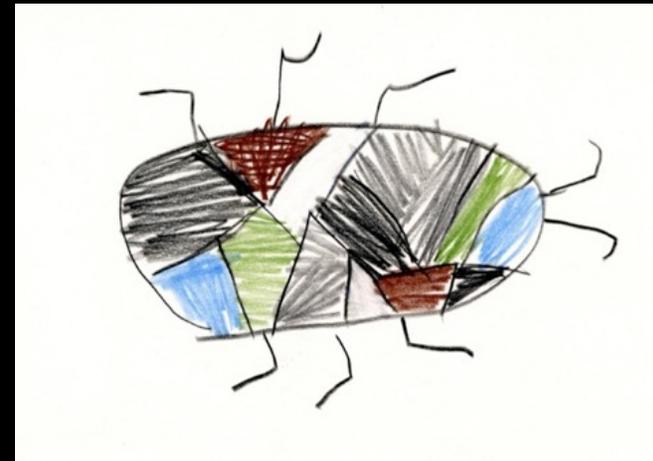
Jeffrey A. Hicke, U. Idaho
Jesse Logan, USFS, retired
Arjan Meddens, U. Idaho
Polly Buotte, Oregon State U.
Kenneth Raffa, U. Wisconsin
Haiganoush Preisler, USFS

and lots of other collaborators...

Mountain pine beetle, electron microscope
Leslie Manning, Canadian Forest Service



Mountain pine beetle, colored pencil
Ava H., Age 6



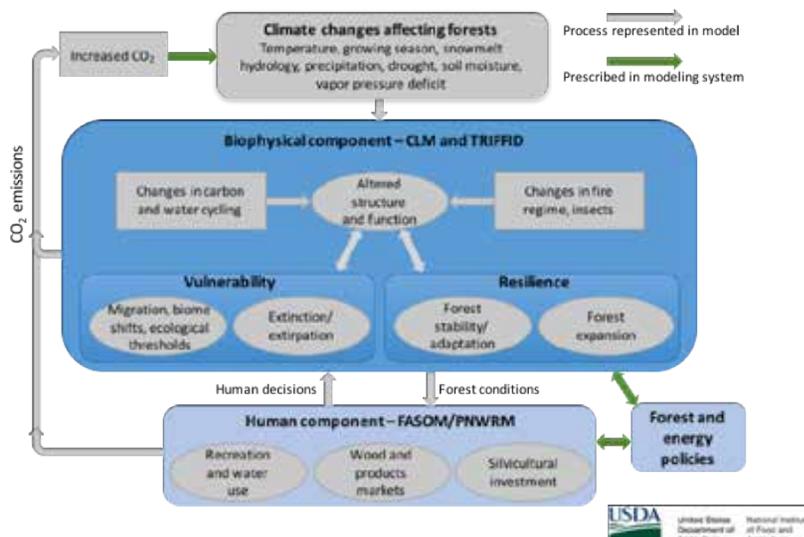
Funding sources (thanks!)



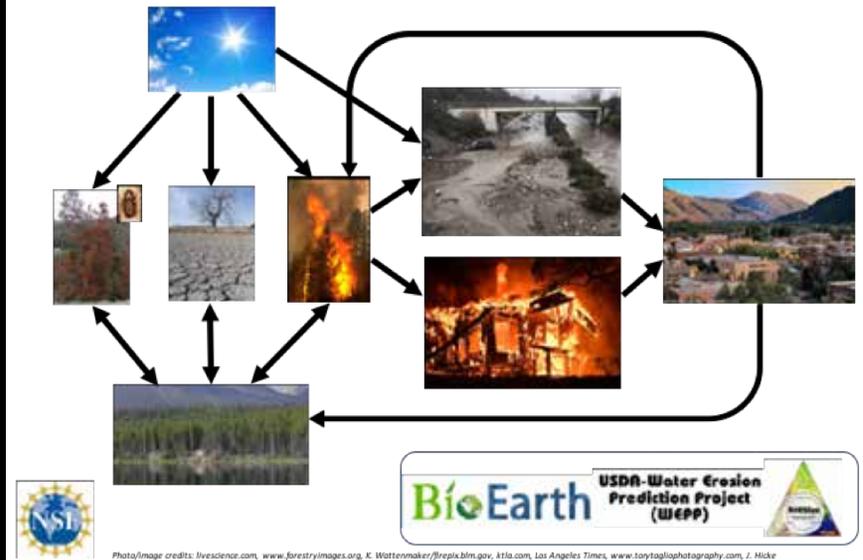
DOE National Institute for
Climate Change Research - *Western Region*



FMEC: Forest Mortality, Economics, and Climate



FireEarth: Advancing Resilience to Compounding Disasters: An Integrated Natural-Human Systems Assessment of Wildfire Vulnerability



Outline

- extent of bark beetle outbreaks
- role of climate
 - ecology
 - case studies of historical climate
 - future projections
- impacts of beetle-killed trees



Outline

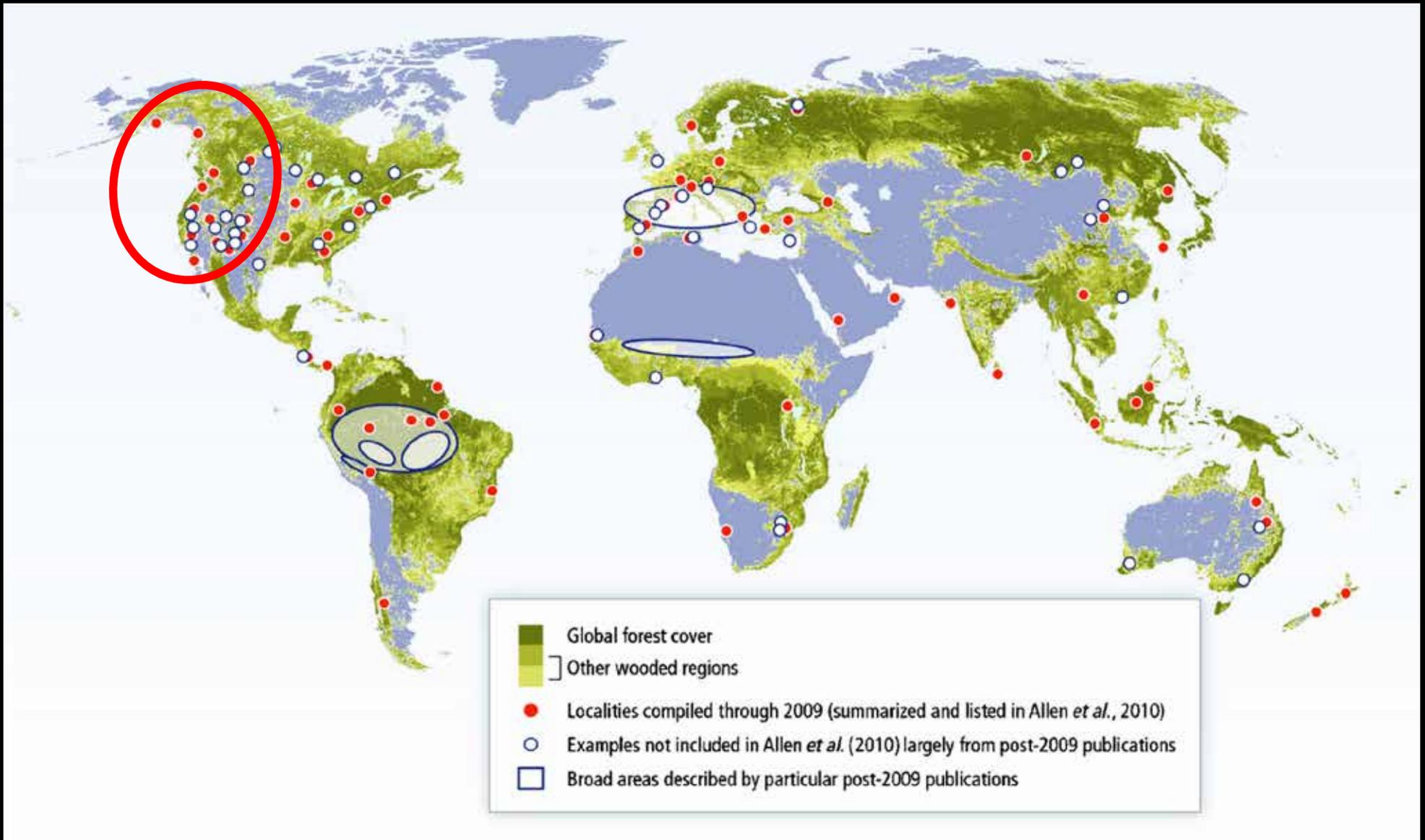


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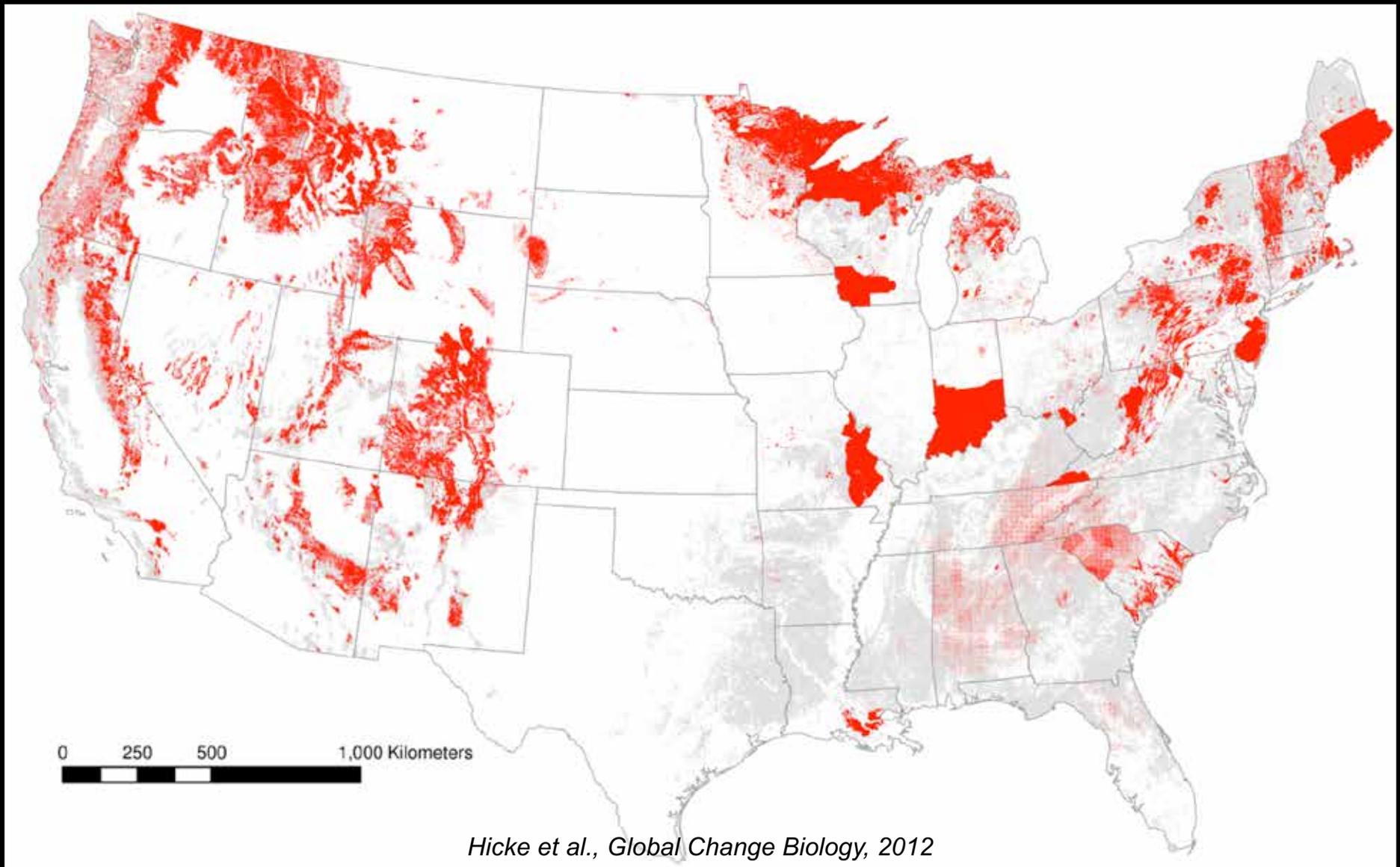
Forest dieoffs

1) widespread recently; 2) associated with heat, drought



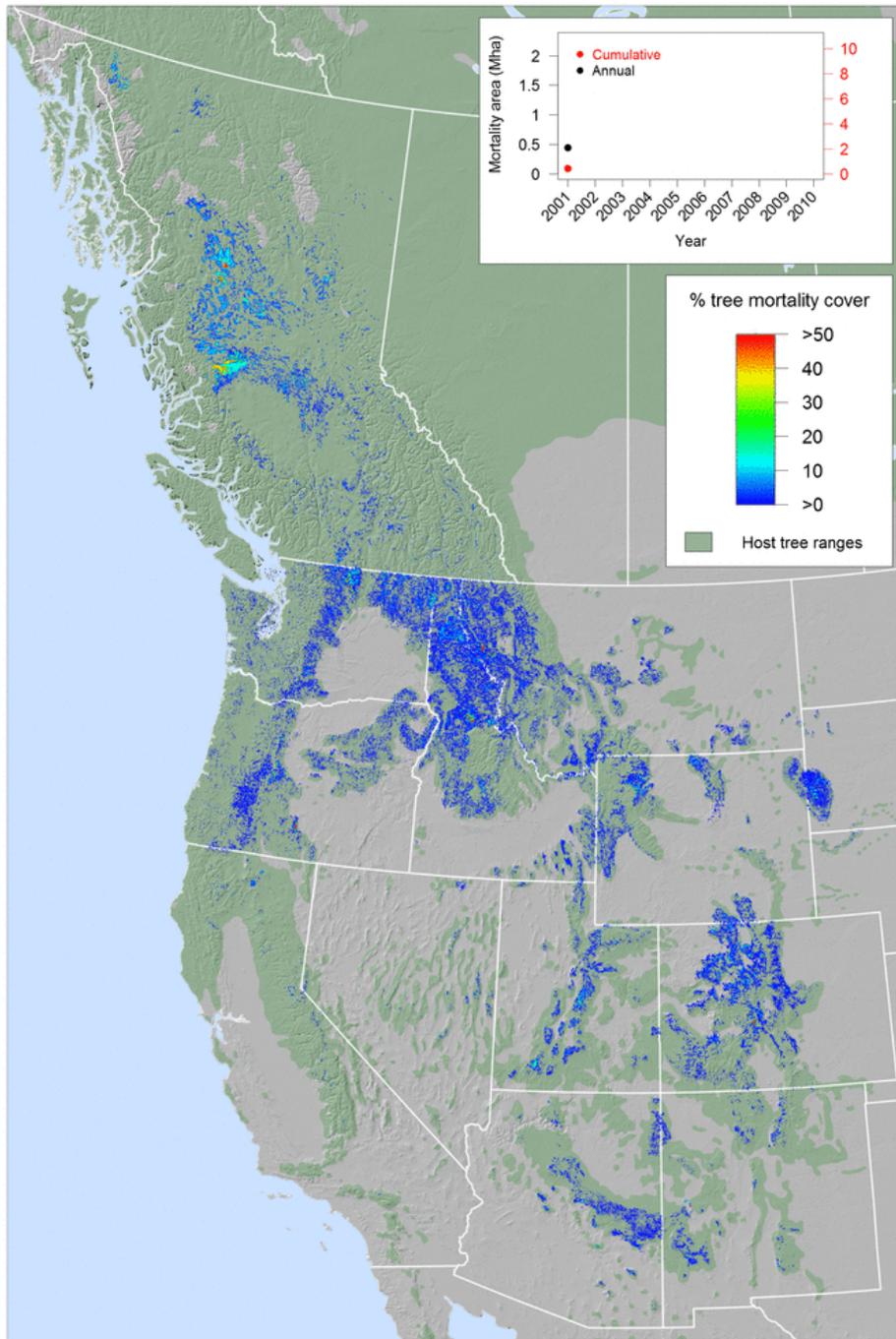
Insect and disease outbreaks are major forest disturbances in North America

affected area reported by aerial surveys, 1997-2010

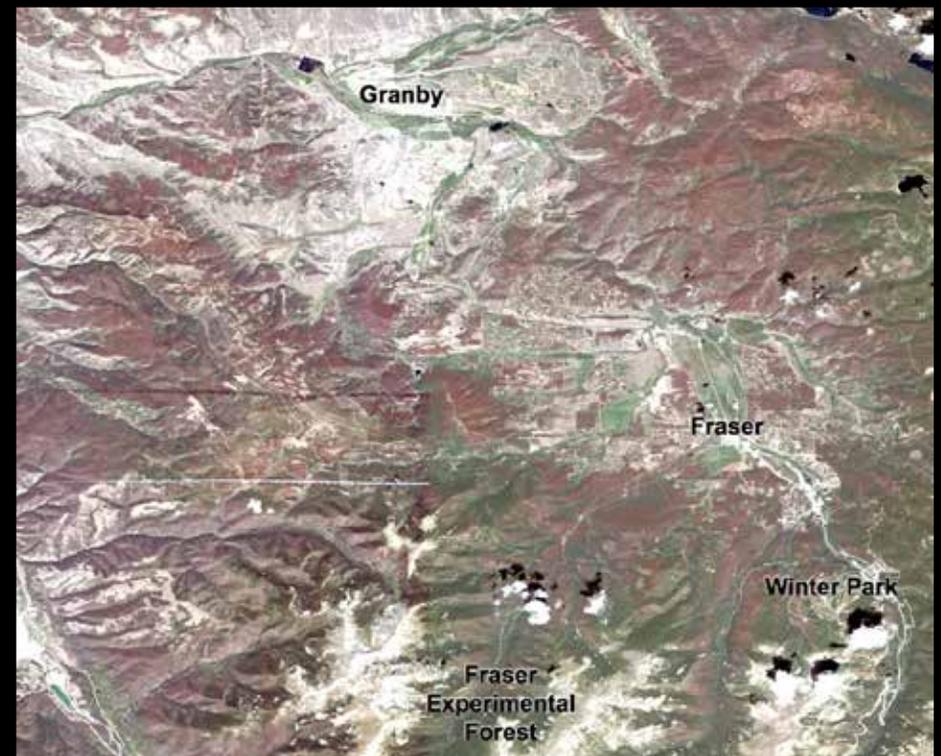


Hicke et al., Global Change Biology, 2012

Cumulative bark beetle-caused tree mortality (2001)

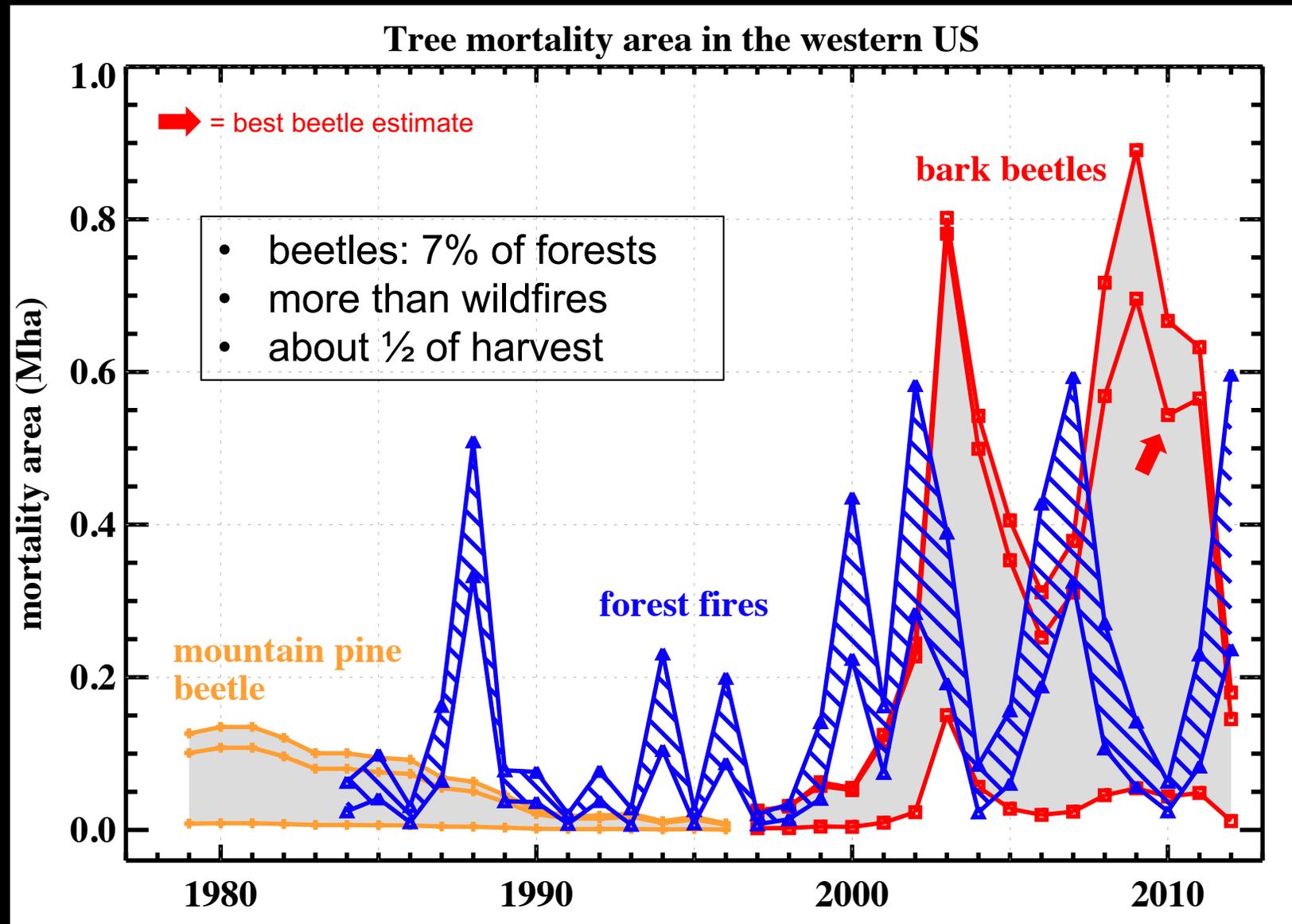


Bark beetle outbreaks are widespread and extensive in western North America



Meddens et al., 2012; Hicke et al., 2016

Mortality area from bark beetle outbreaks in the western US

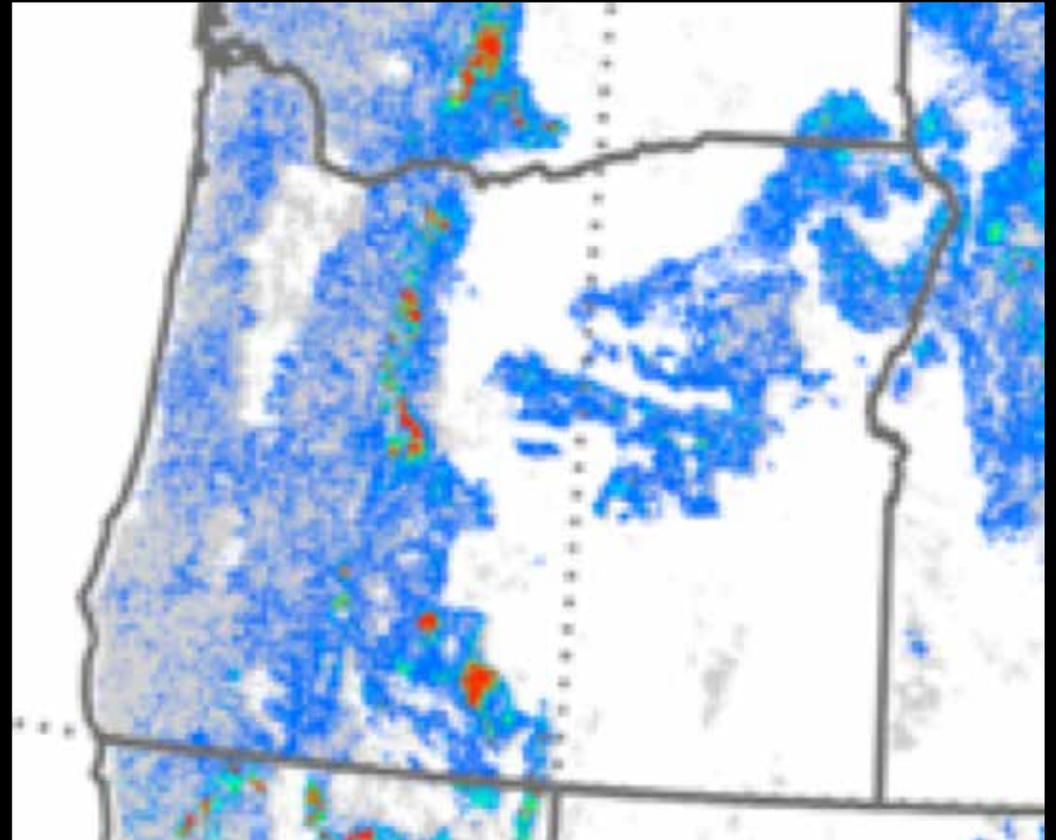
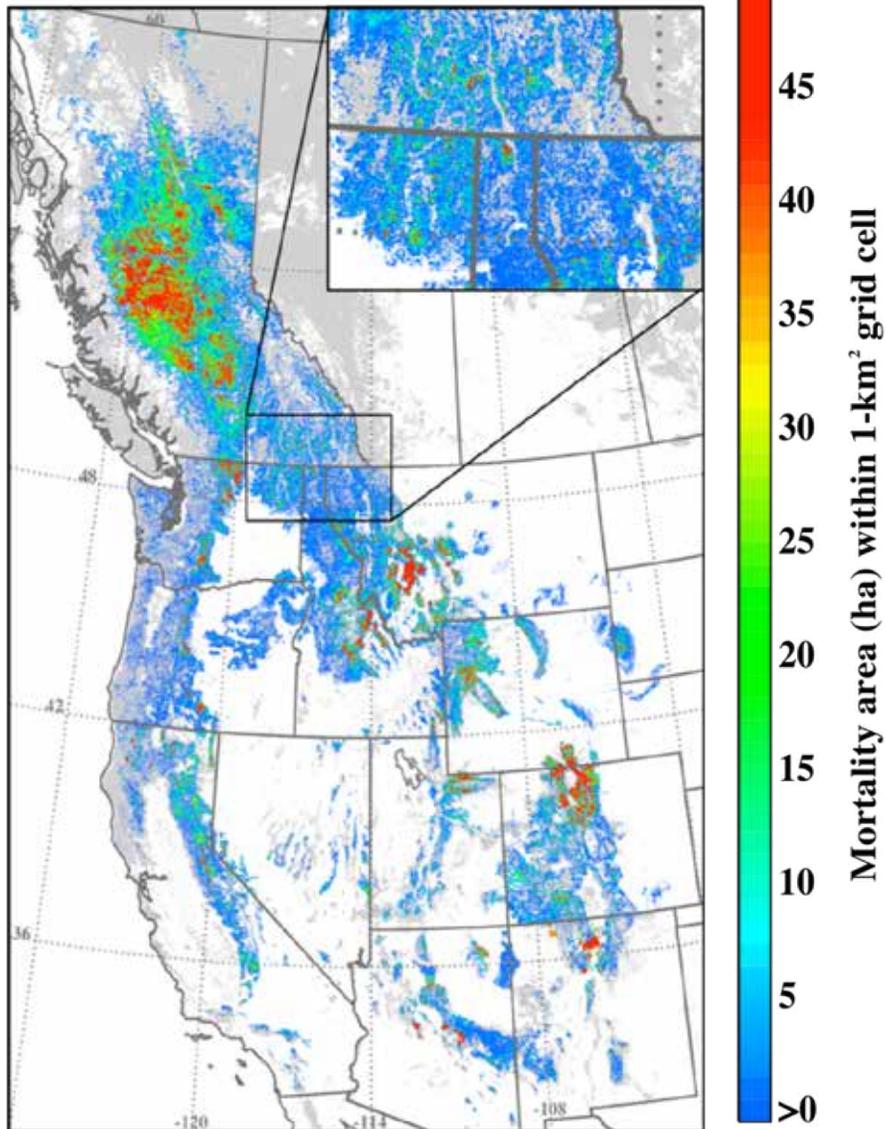


Bark beetle-caused tree mortality area

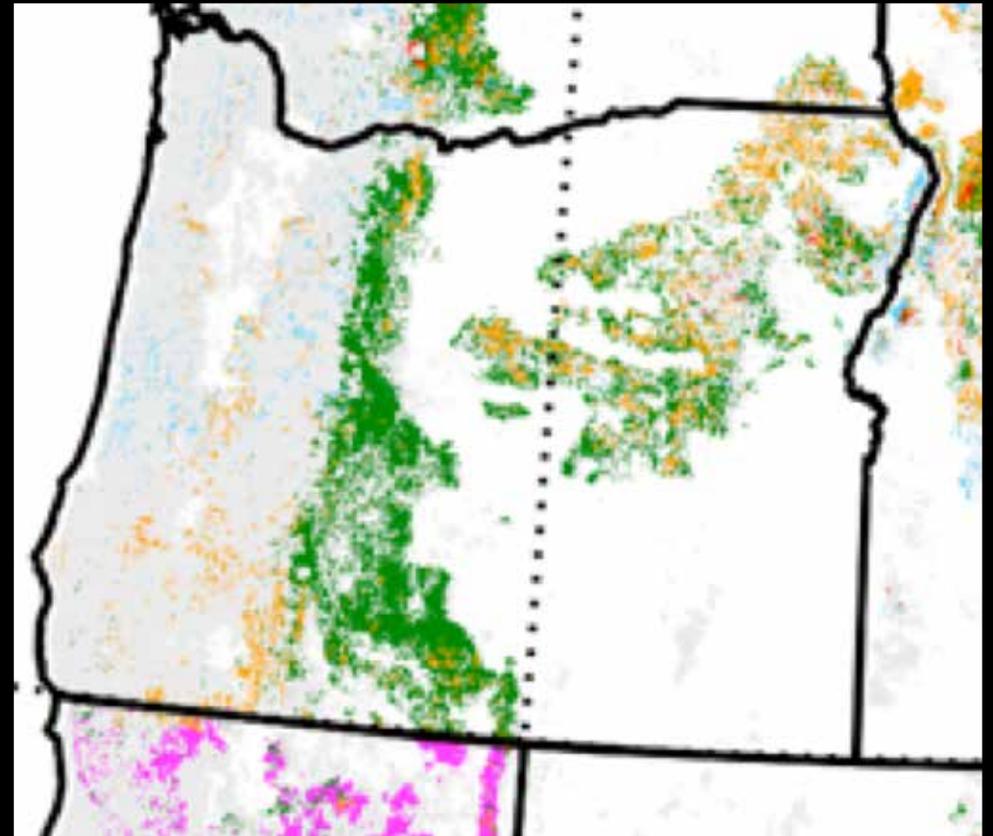
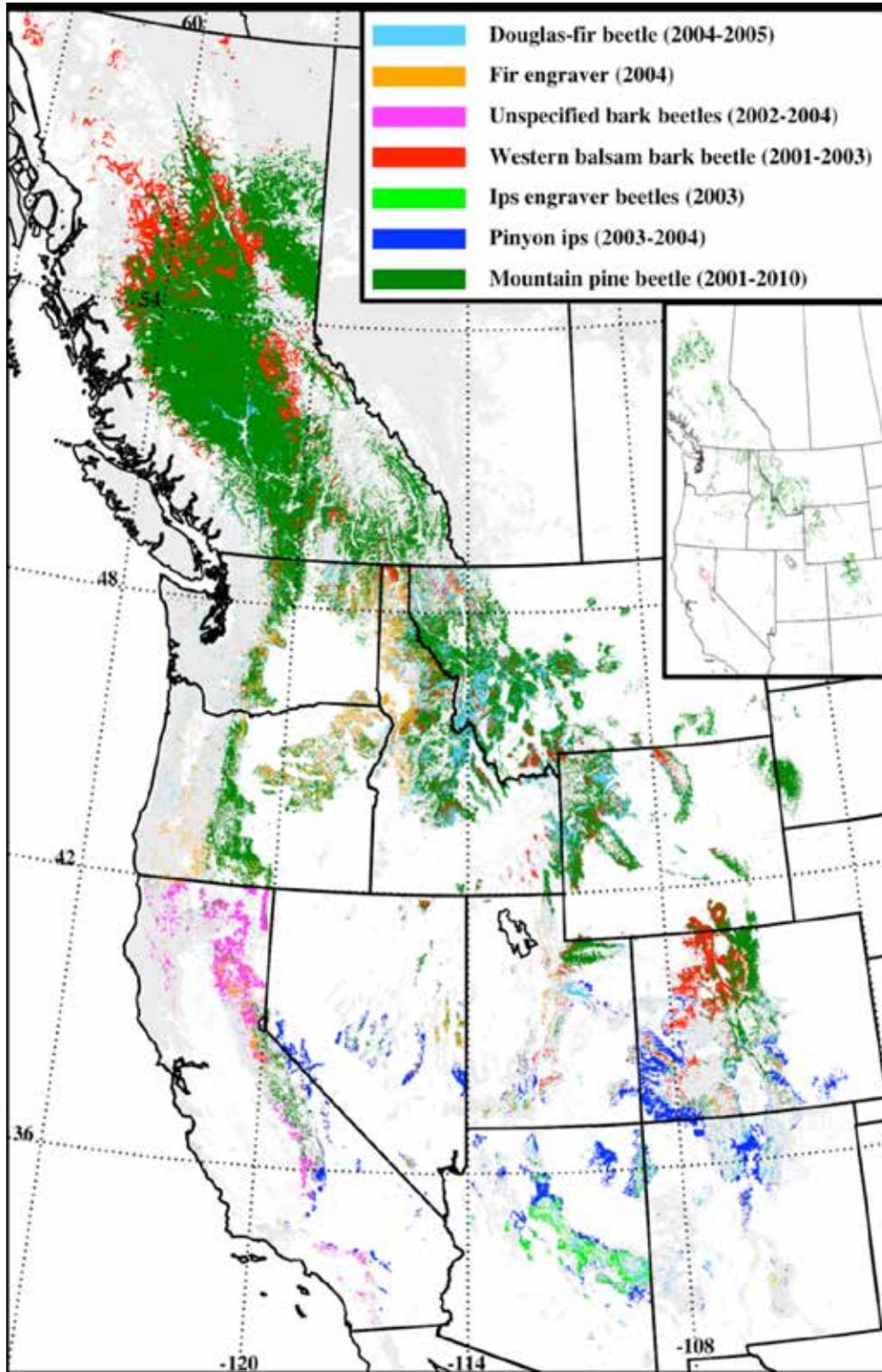
Cumulative mortality area, 1997-2010

Upper estimate

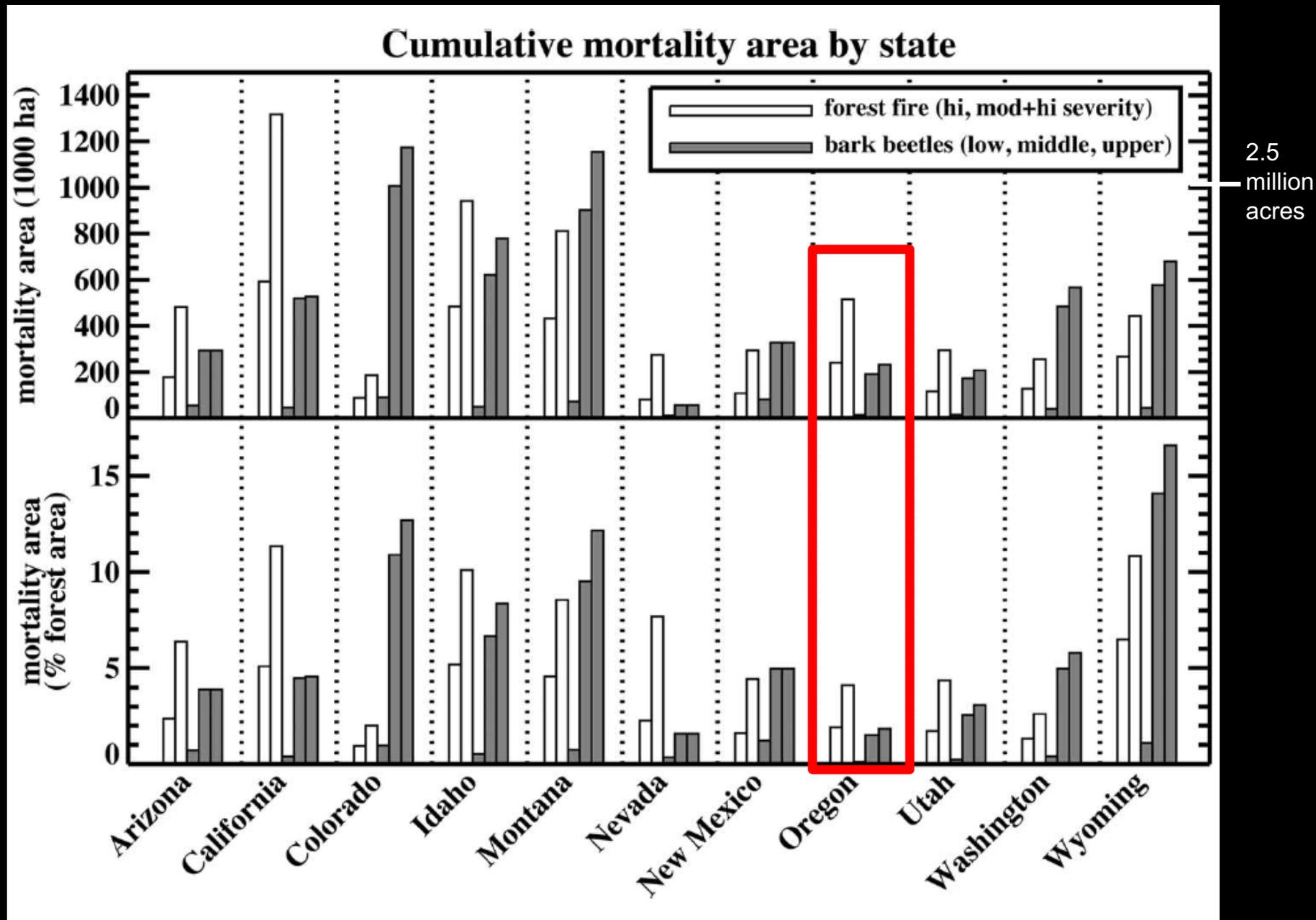
(B)



Multiple forest types affected



Mortality area from outbreaks and fire by state, 1997-2012



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Photos by J. Hicke



Factors influencing mountain pine beetle epidemics

Factors related to trees:

- presence of host tree species
- tree size/age
- stem density
- drought stress on trees

Factors related to beetles:

- beetle populations last year
- temperature effects on
 - winter beetle mortality
 - population synchronization/
one-year life cycles
("adaptive seasonality")

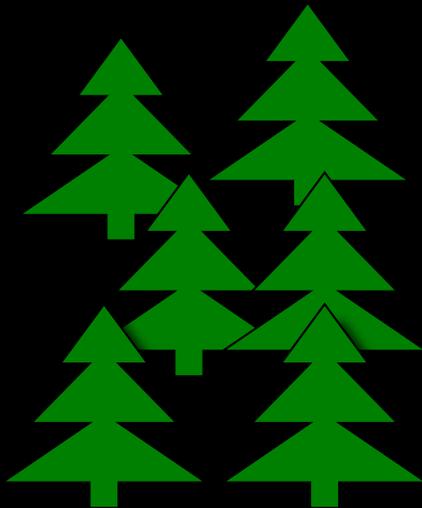


Photo courtesy USDA Forest Service, www.forestryimages.org

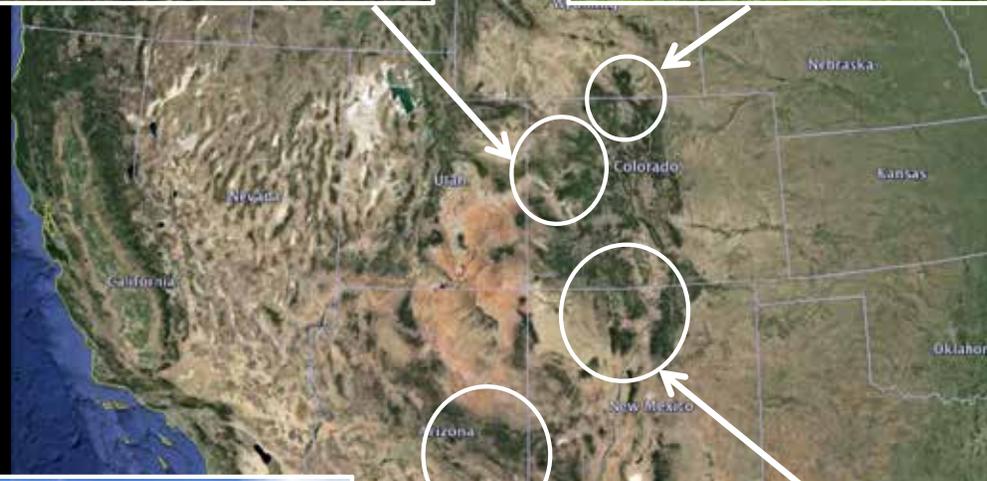
Safranyik et al. 1975; Shore and Safranyik 1992; Carroll et al. 2004; Logan and Powell 2001

For some forest dieoff types, drought more important

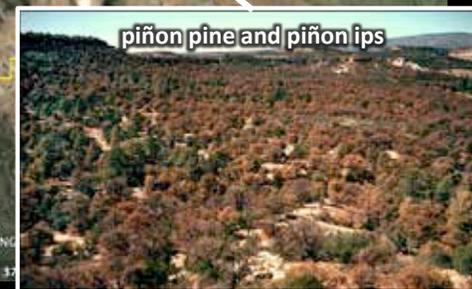
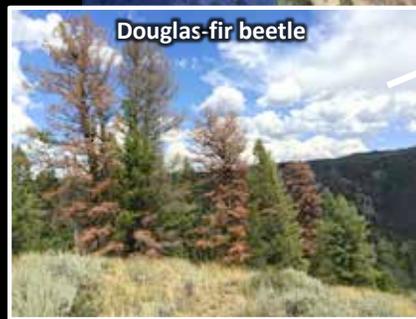
Type 1:
drought, no
biotic agents



Type 3: drought
triggers outbreaks



Type 4:
outbreaks
caused by
multiple factors



Type 2: drought,
with beetles
present

Outline

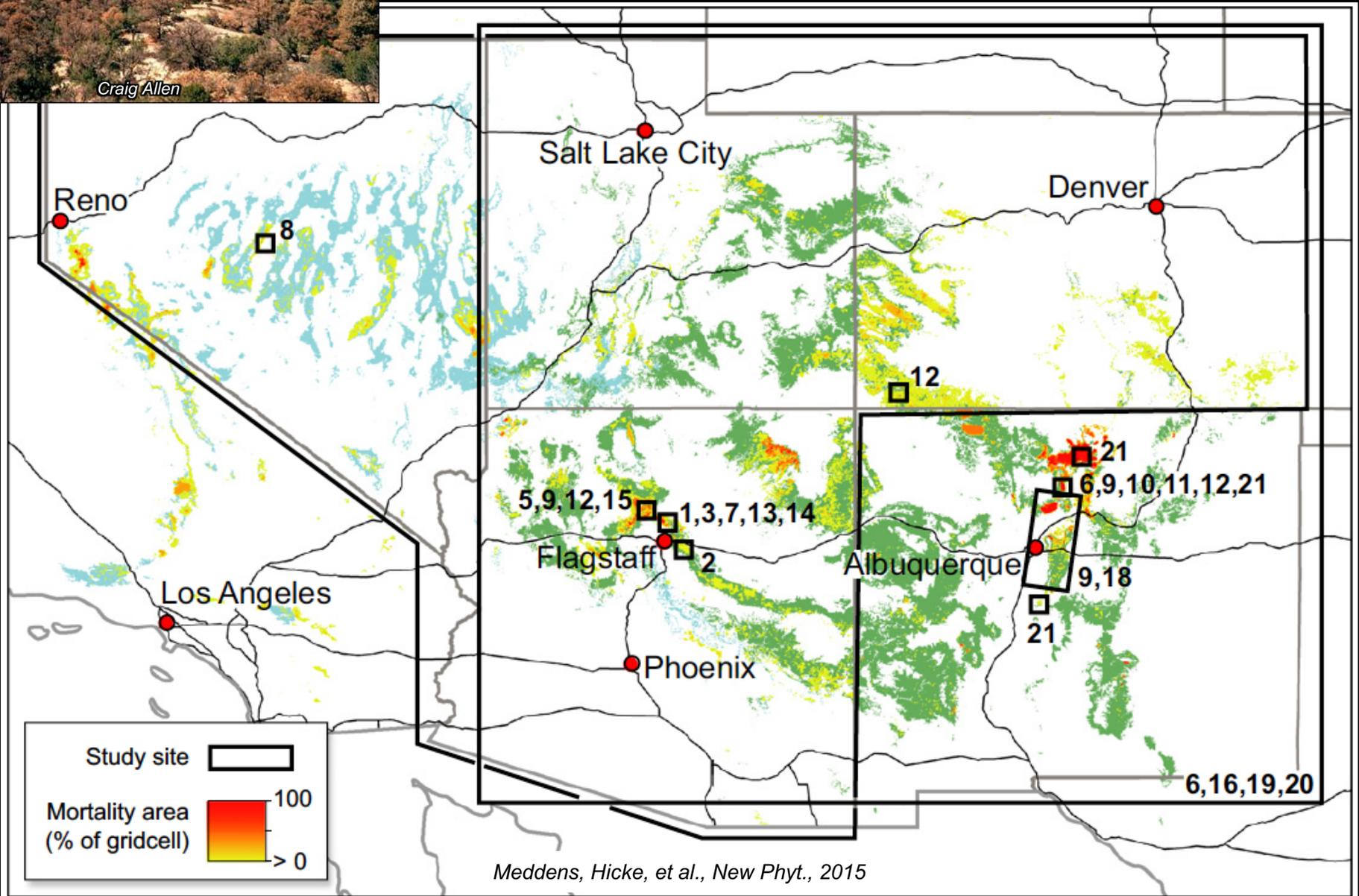
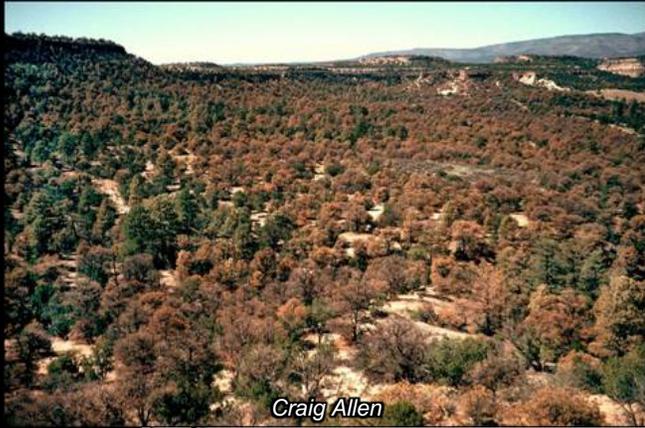
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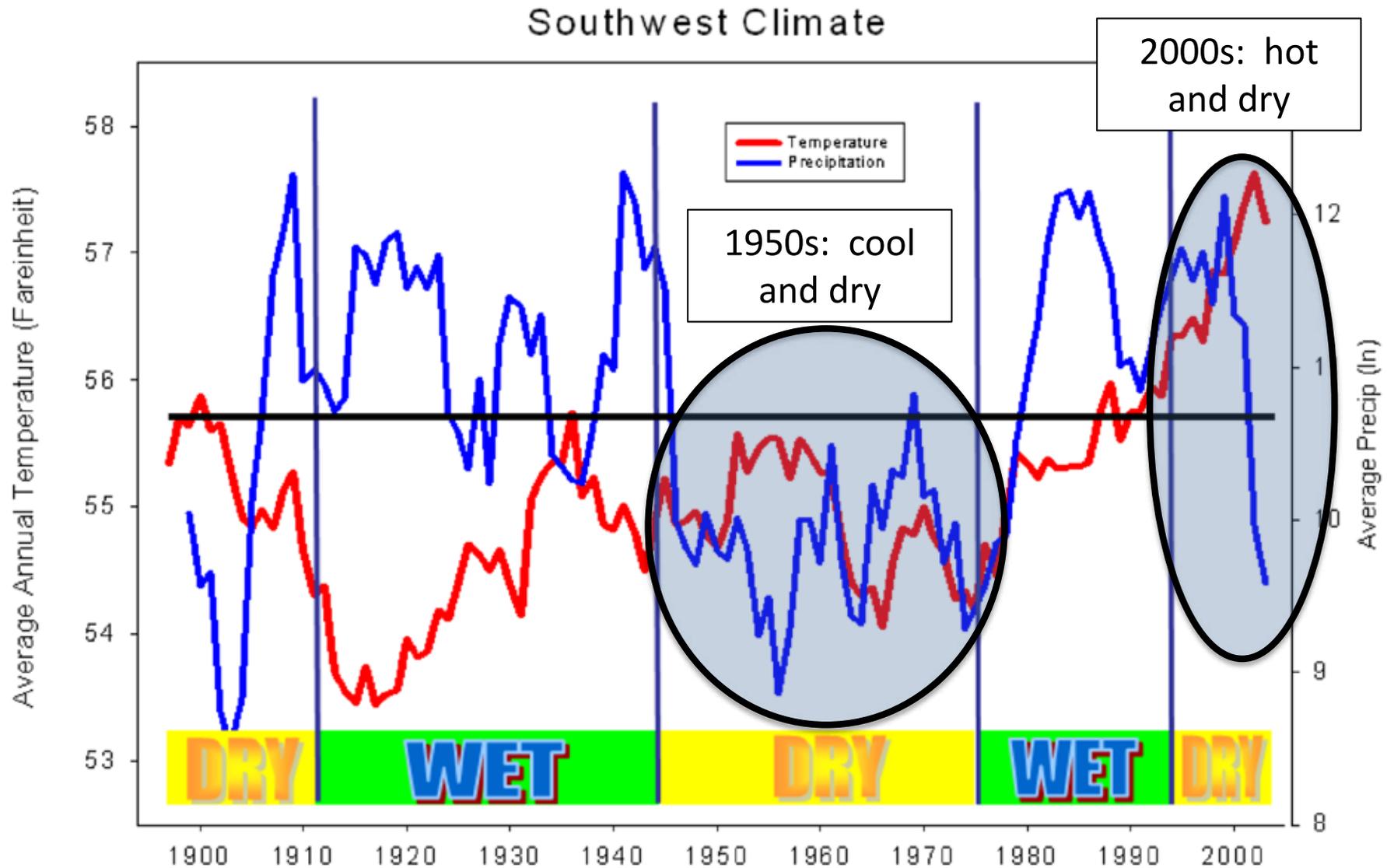
Photos by J. Hicke



Pinyon ips, drought, and pinyon pine dieoff in 2000s

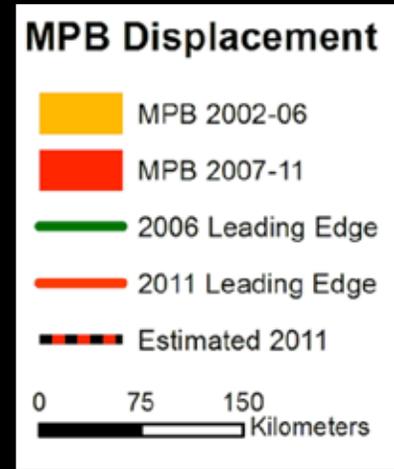
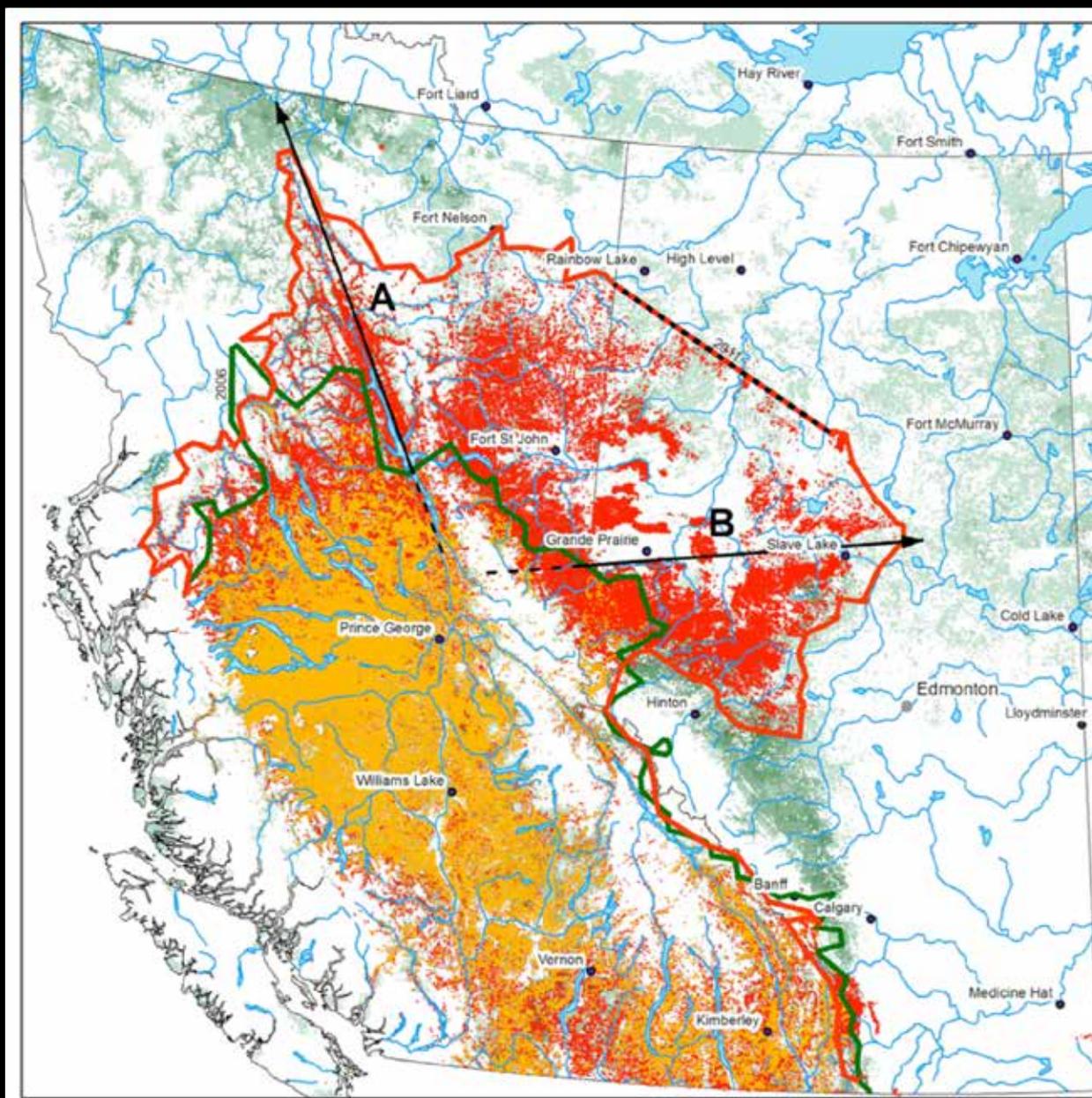


Hotter drought: Pinyon pine mortality in Southwestern US

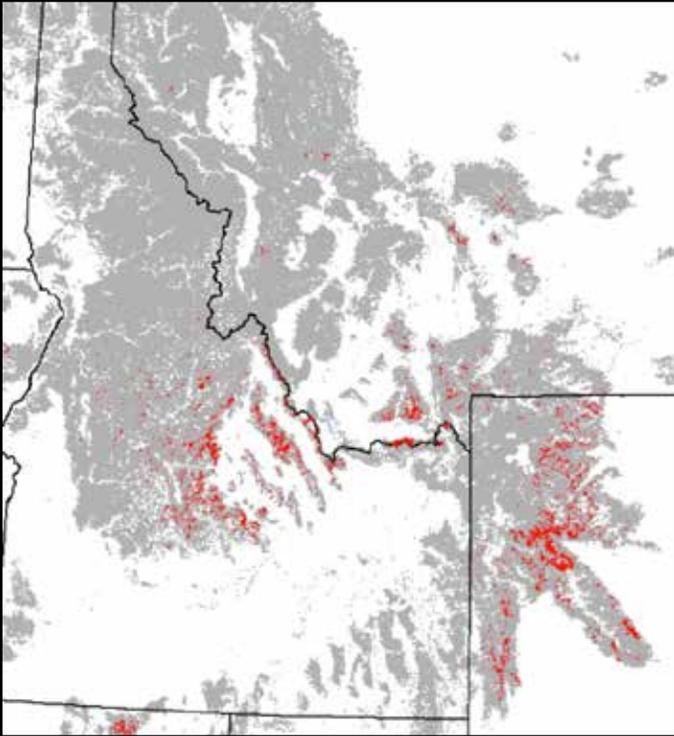


Breshears et al. PNAS, October 18, 2005, vol. 102, no. 42, 15144-15148, and graphic from Neil Cobb

Warming: northward range expansion of mountain pine beetle



Warming: upward expansion of mountain pine beetle



Weed, Ayres, and Hicke, *Ecol. Mono.*, 2013



J. Hicke



© Jane Pargiter, *EcoFlight* 2006

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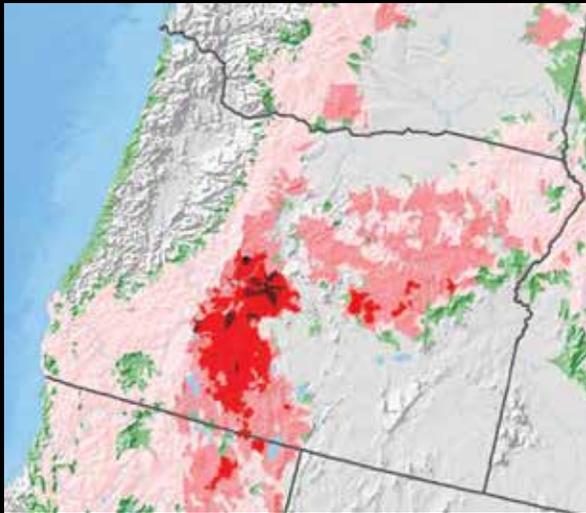


Photos by J. Hicke

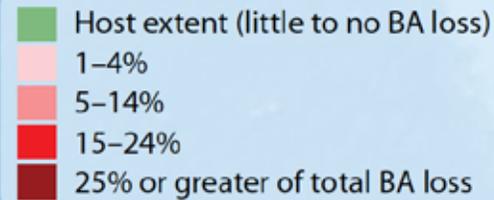
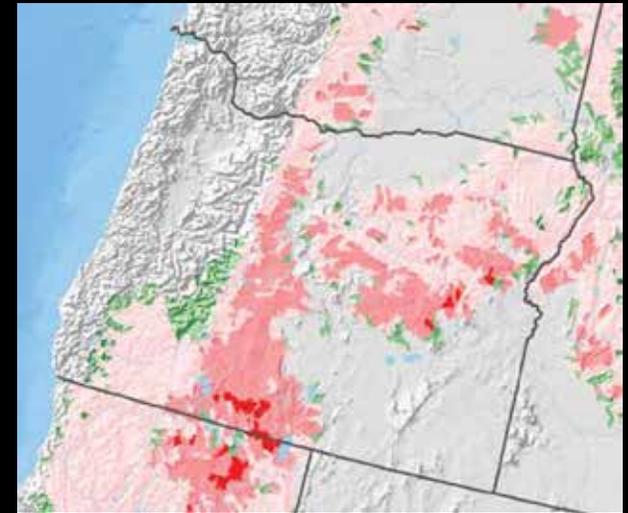


Many forests are currently susceptible to outbreaks based on stand structure

mountain pine beetle



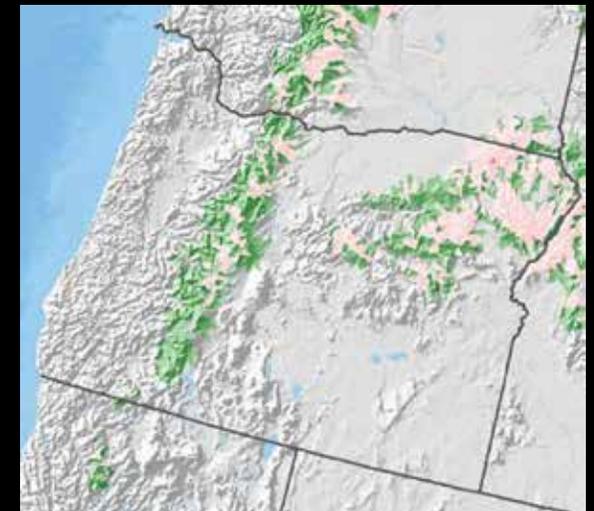
western pine beetle



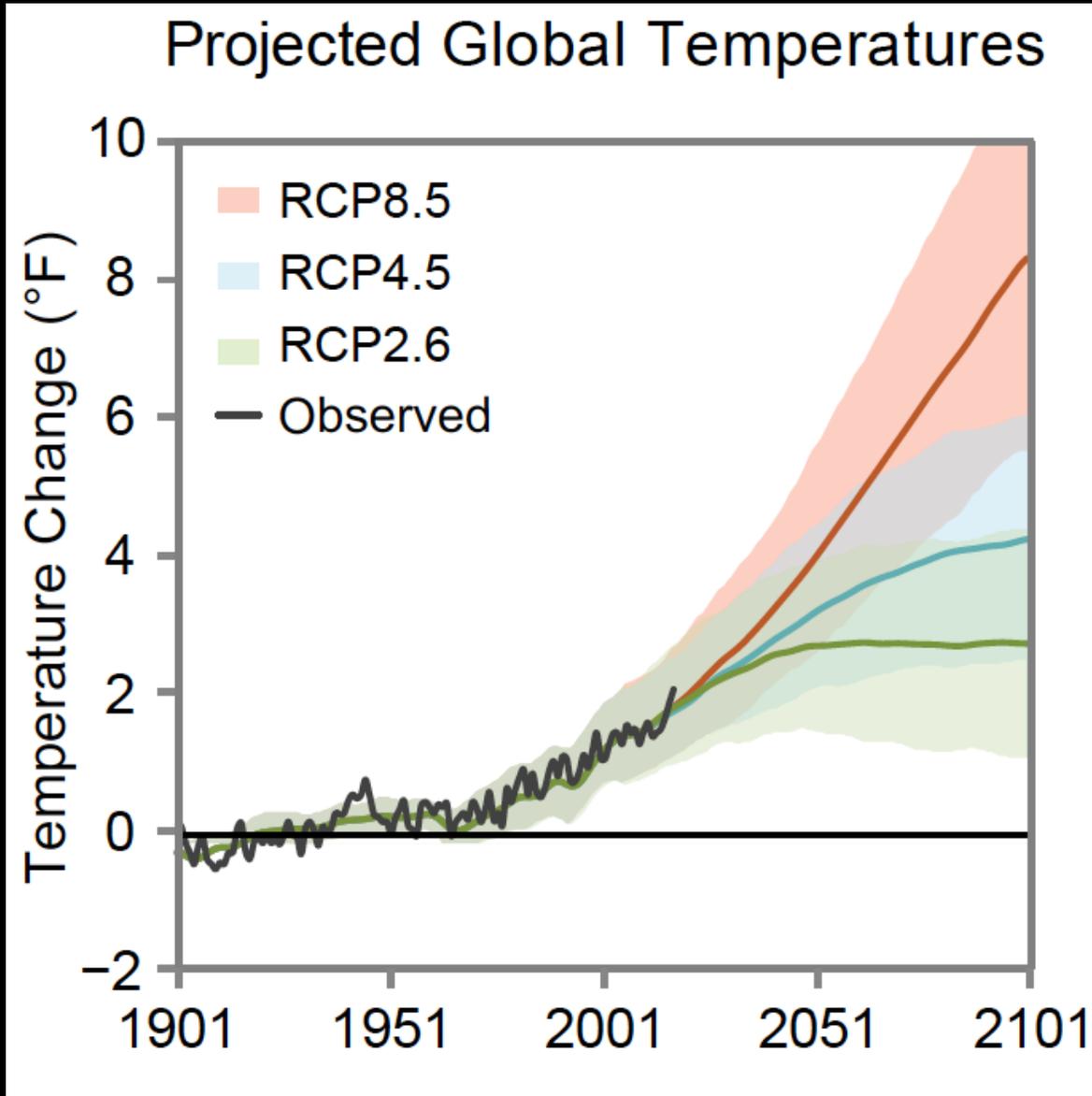
fir engraver



spruce beetle



Continued warming and climate change



- favorability for beetles
- increased host stress

Continued warming and climate change

warming

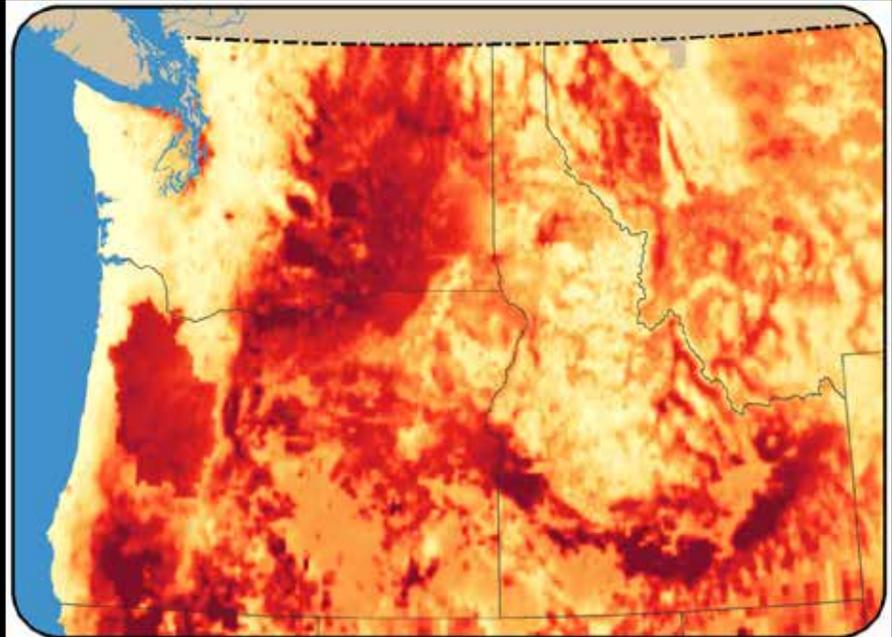


greater water deficit

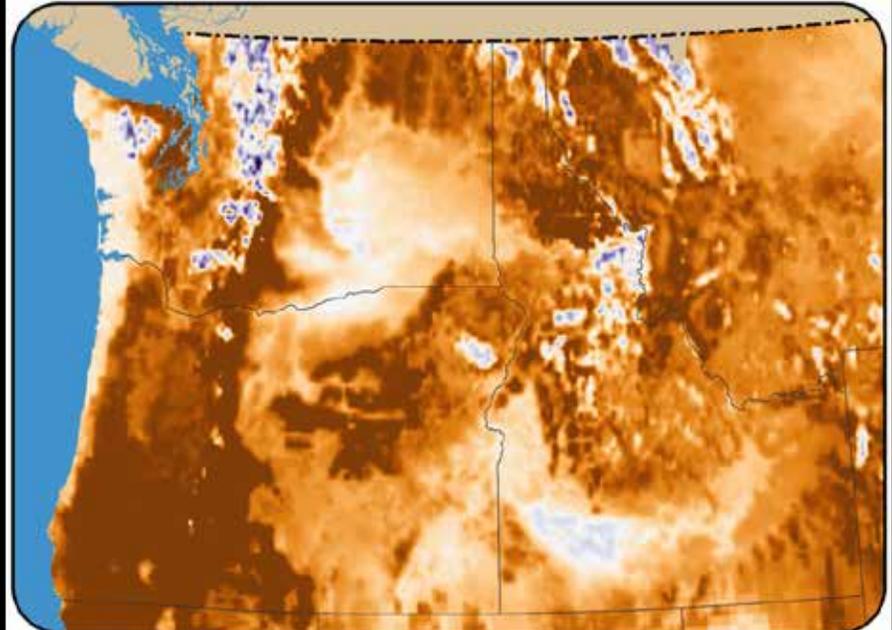


greater host stress

historical
(1916-2006)



change
(2040s)



Historical JJA Deficit

0" 8" 16"



0 mm 200 mm 400 mm

Change in Deficit, 2040s

-2" 0" 4"



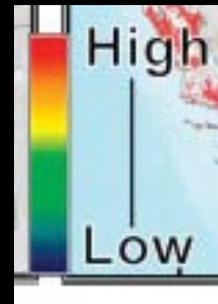
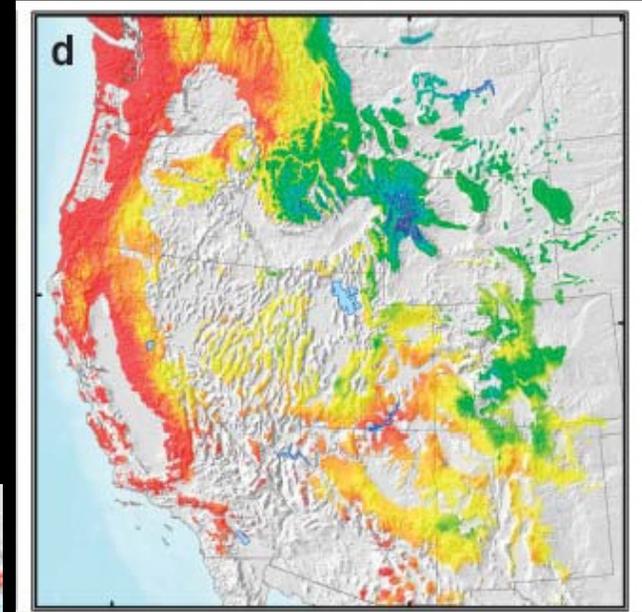
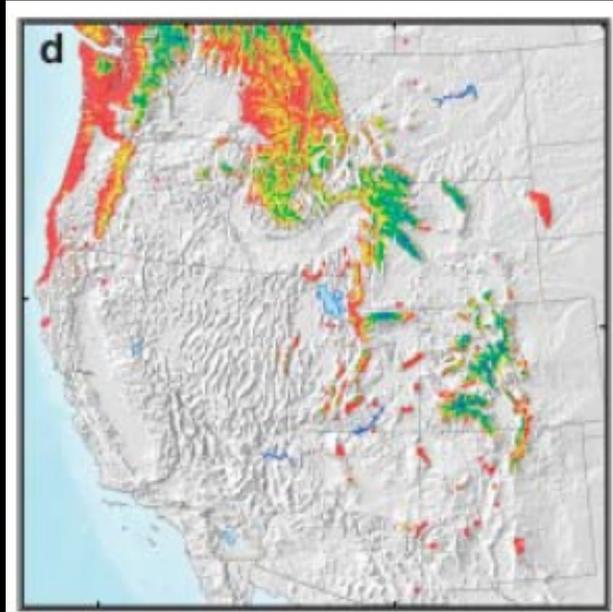
-50 mm 0 mm +100 mm

Warming: more favorable in some situations

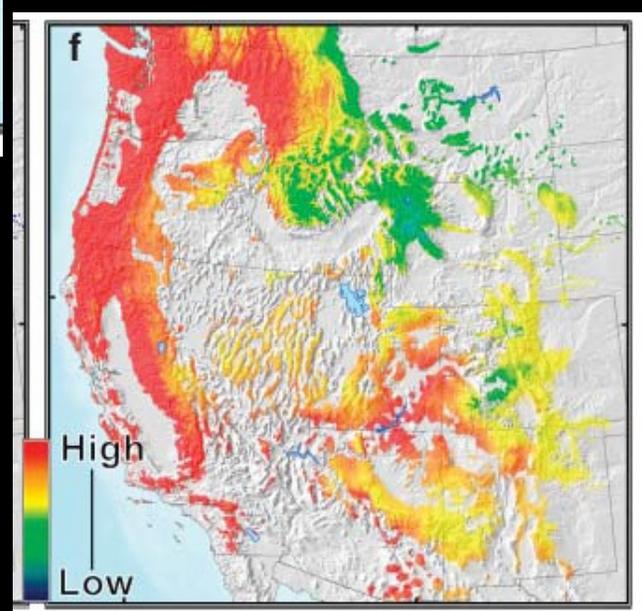
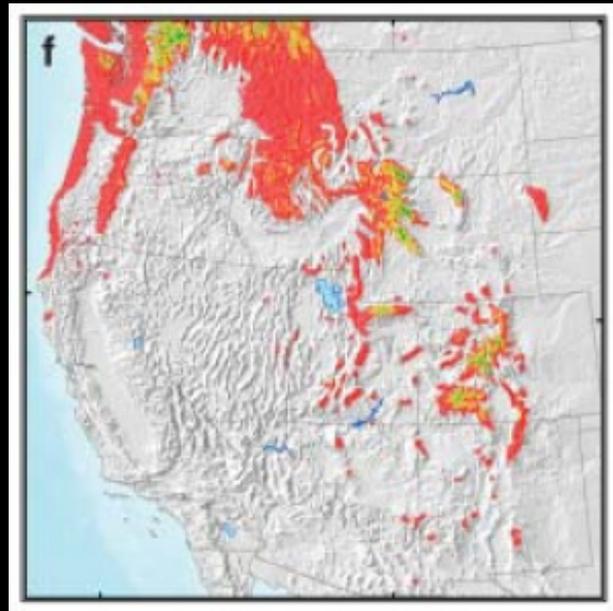
spruce beetle development rate

mountain pine beetle winter survival

1961-
1990



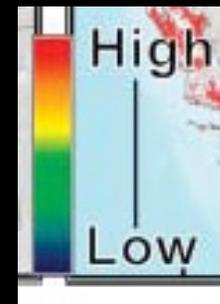
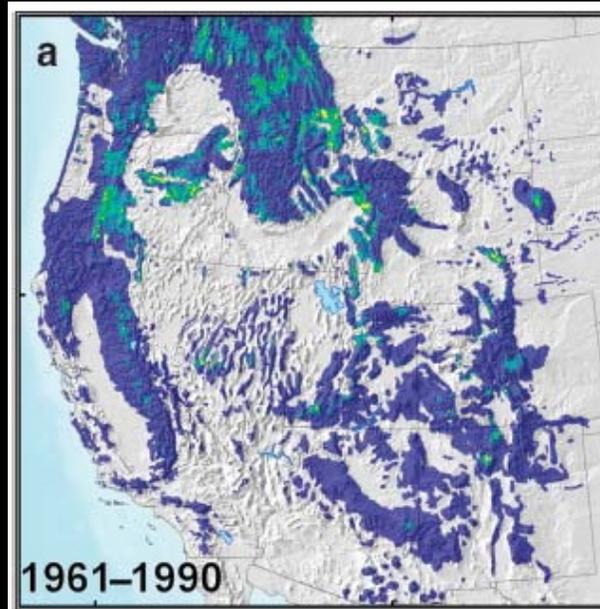
2071-
2100



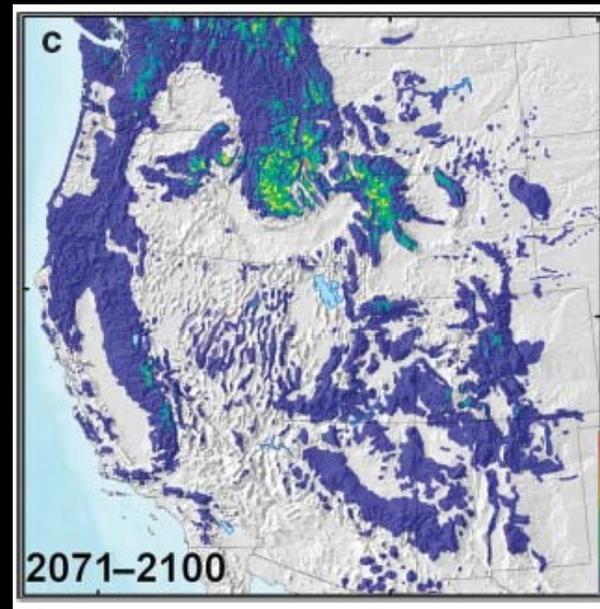
Warming: more favorable in some situations

mountain pine beetle development rate

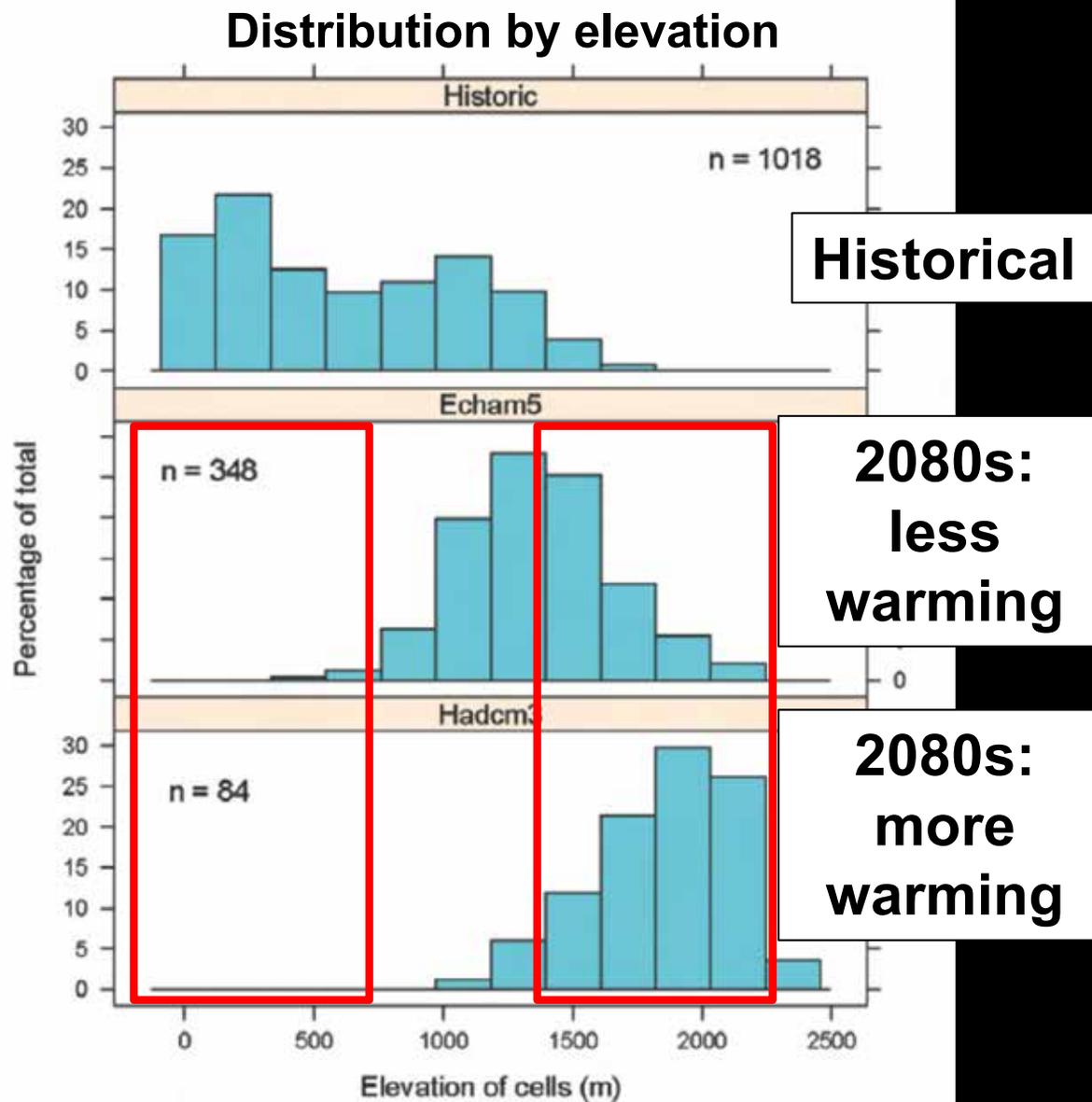
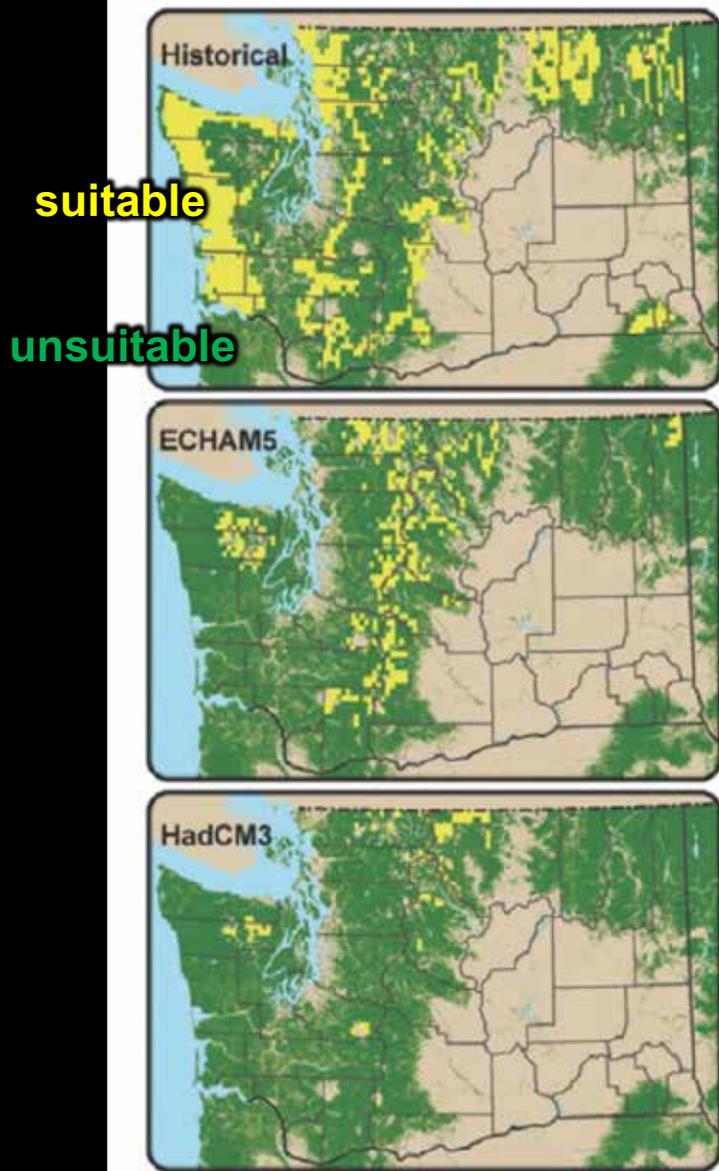
1961-
1990



2071-
2100



Warming: more favorable in some situations



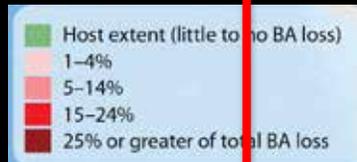
Eruptions of other native bark beetle species

Two to watch, because

- widespread host tree species
- influence of climate, but not much is known

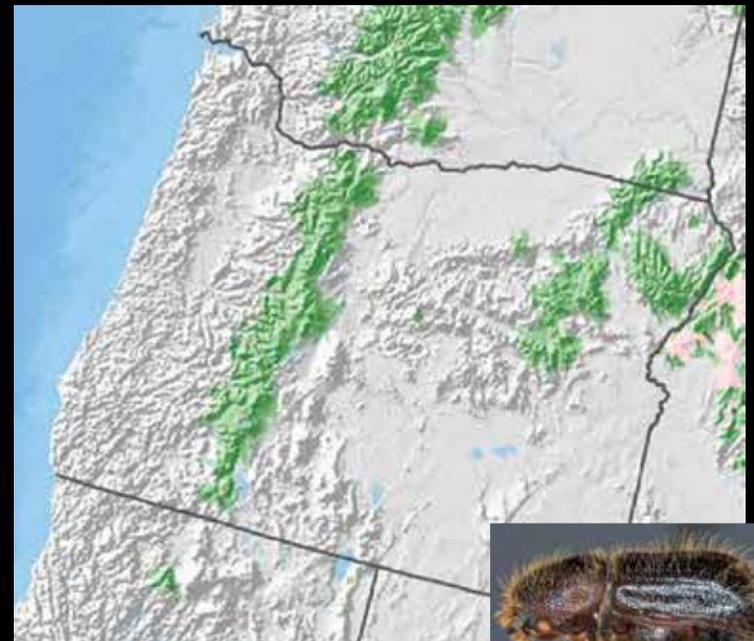
see talk by Michelle Agne this afternoon!

Douglas-fir beetle



USDA Forest Service FIDL 5

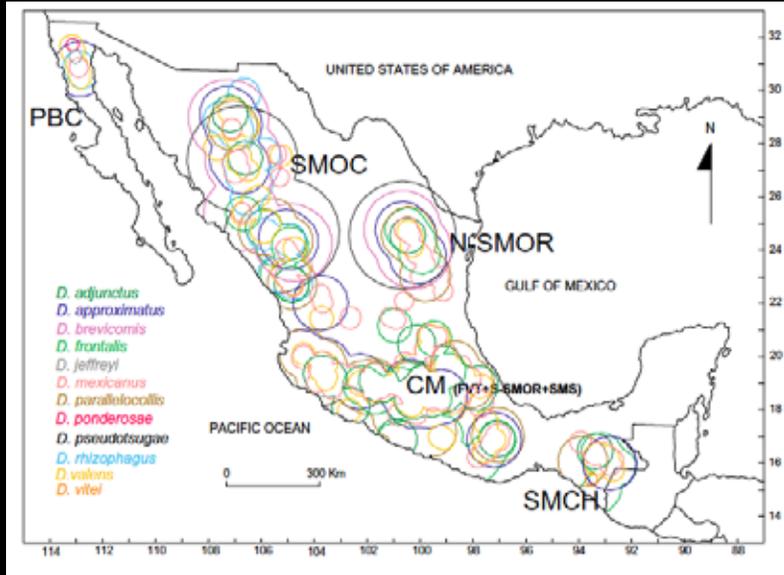
western balsam bark beetle



itp.lucidcentral.org

Surprises: Invasions, emergence

Mexican bark beetle species



Salinas-Moreno et al., *J. Biogeog.*, 2004

First record of Mexican pine beetle (*Dendroctonus mexicanus*) in US



Moser et al., *Entomological News*, 2005

California drought, 2015



Photo: J. Hicke

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Photos by J. Hicke



Do beetle-killed trees affect forest fires?

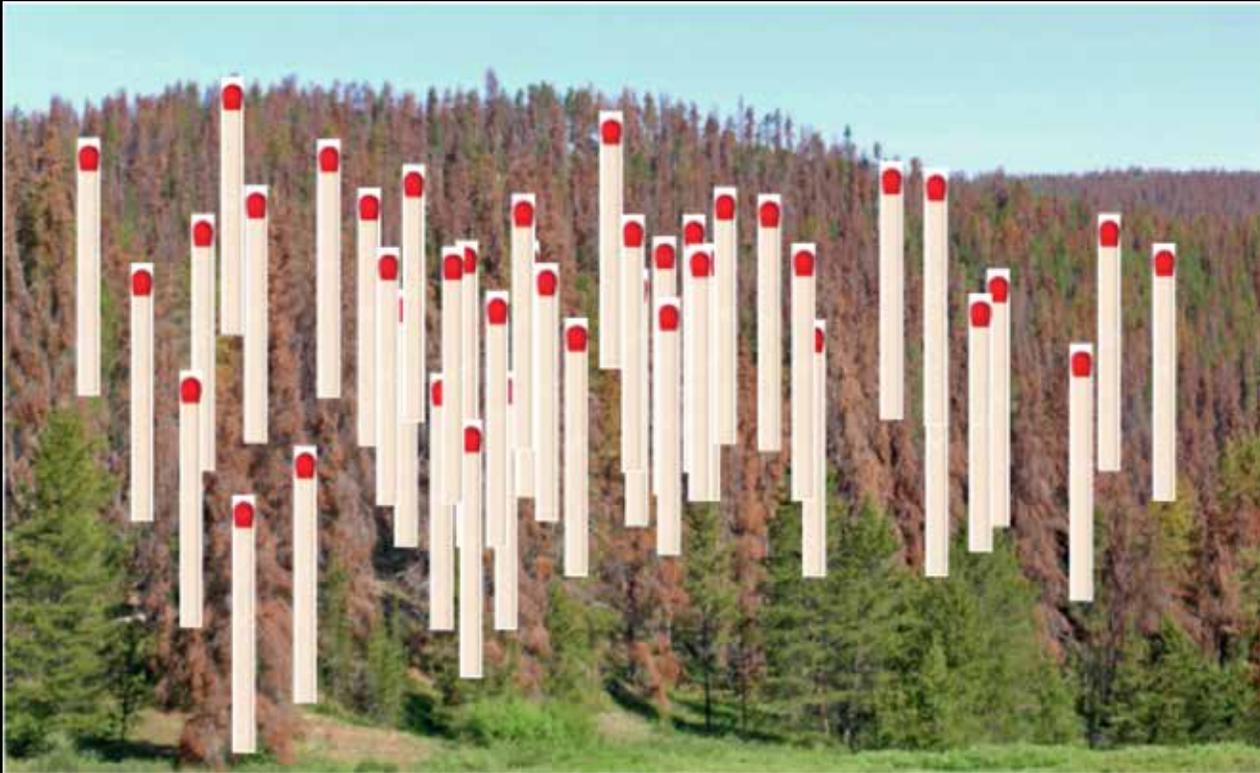


Photo by J. Hicke

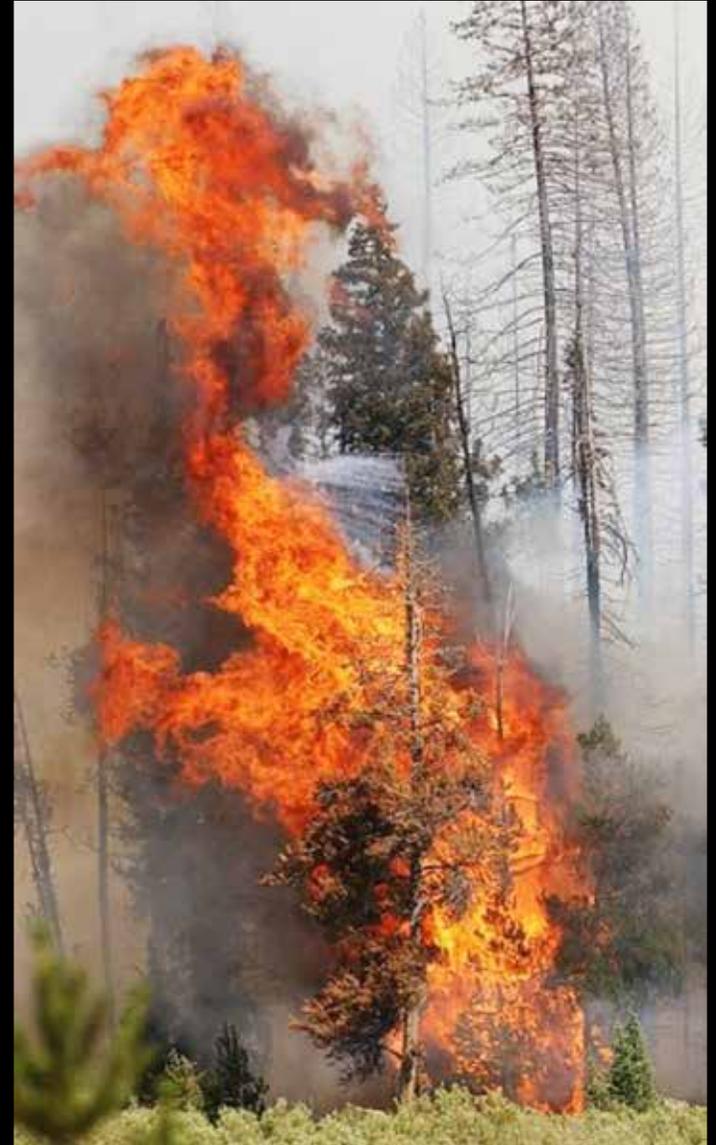


Photo by Matt Stensland

www.steamboatpilot.com/news/2008/aug/17/dying_forests_increase_wildfire_danger_across_west

Do beetle-killed trees affect forest fires?

depends on

- time since outbreak



Do beetle-killed trees affect forest fires?

depends on

- time since outbreak
- type of fire



www.dailycamera.com/cj_21025344/cu-researchers-pine-beetles-not-always-tied-increased



www.sierraforestlegacy.org/FC_FireForestEcology/FFE_FireScience.php

Hicke et al., FEM, 2012

Timber



J. Hicke



cascadiascorcard.typepad.com/blog/2004/08/introducing_den.html

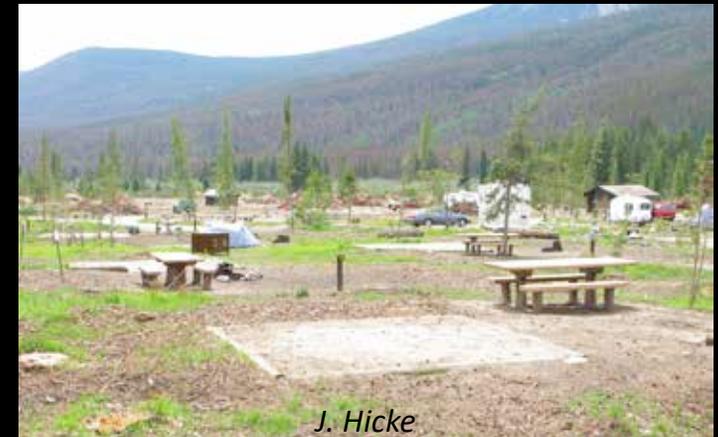


J. Hicke



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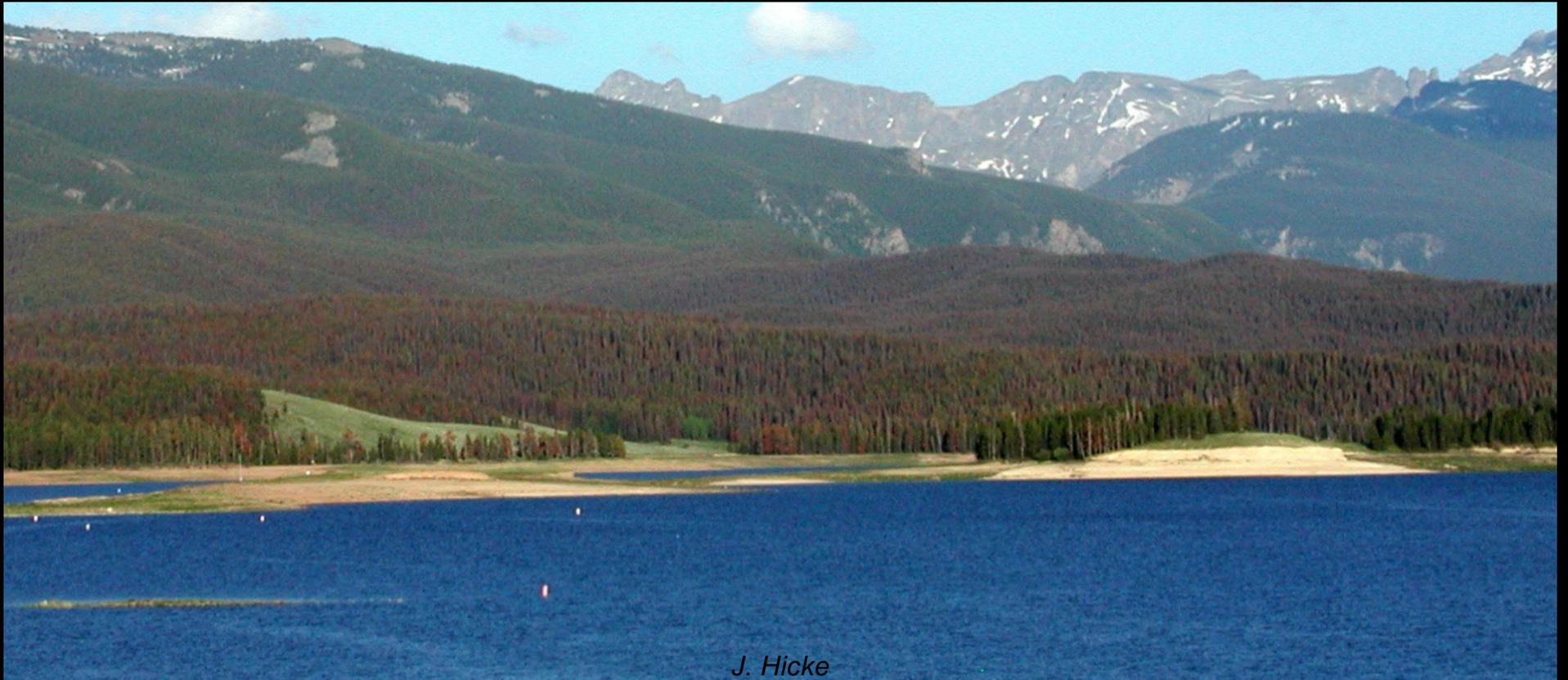
Infrastructure and recreation



“Every day across the West, an estimated 100,000 lodgepole pines fall in the forest...” USFS

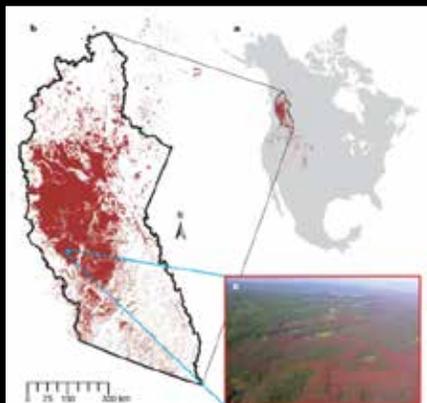
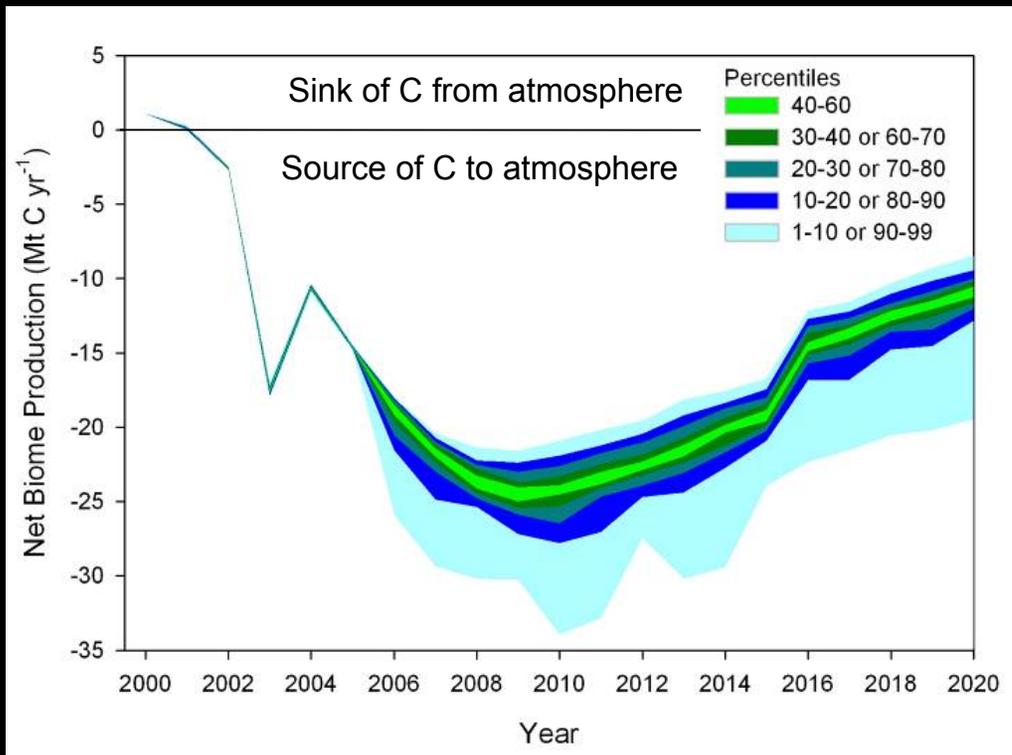
Water quantity and quality

- no change in water quantity
- decrease in water quality



J. Hicke

Carbon sequestration (or not)



Kurz et al., Nature, 2008

Oregon legislation: promote C sequestration

79th OREGON LEGISLATIVE ASSEMBLY—2018 Regular Session

House Bill 4109

Sponsored by Representative SMITH DB, Senator ROBLAN; Representatives BARRETO, NOBLE, OLSON, SPRENGER, STARK, WITT (Pre-session filed.)

SUMMARY

The following summary is not prepared by the sponsors of the measure and is not a part of the body thereof subject to consideration by the Legislative Assembly. It is an editor's brief statement of the essential features of the measure as introduced.

Directs Department of Environmental Quality and State Forestry Department to study opportunities for state actions to promote carbon sequestration and to include in study consideration of regional approaches for reducing greenhouse gas emissions through carbon sequestration.

Requires departments to report to interim committee of Legislative Assembly related to natural resources by September 15, 2019.
Sunssets January 2, 2020.

A BILL FOR AN ACT

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Relating to carbon sequestration.

Whereas Oregon produces 0.14 percent of global greenhouse gas emissions; and

Whereas over 60 percent of the greenhouse gas emissions from Oregon are sequestered in the form of carbon stored within our forests; and

Whereas over 30 percent of the carbon stored within our forests is released in the form of greenhouse gas emissions from wildfire and decay; and

Whereas industry is reducing greenhouse gas emissions through compliance with Oregon's renewable portfolio standards, through meeting the requirement for electric companies to eliminate, by January 1, 2030, coal-fired resources from their allocation of electricity and through improving carbon capture and sequestration efforts in accordance with the state's existing greenhouse gas reduction goals; and

Whereas wood from sustainably managed forests is renewable, recyclable and the primary element in thousands of products that are used every day; and

Whereas protecting Oregon's forests includes responsible forest management that not only decreases fire risks and increases forest health but that also provides a thriving forest sector economy, abundant recreational opportunities and healthy forest ecosystems; and

Whereas burning timber and brush from wildfires expel fine particles into the air at a rate three times as high as levels cited in emissions inventories by the United States Environmental Protection Agency; and

Whereas emissions from Oregon forest fires in the year 2007 produced enough greenhouse gases to equal to 11.1 million cars driven all year; and

Whereas comprehensive forestry treatment prescriptions designed to restore sustainable ecological conditions, including but not limited to logging, thinning and prescribed fire, can move 90 percent of treated acres into a low-hazard condition; and

Whereas the thinning of forests can reduce wildfire severity by up to 60 percent and remove up to 400 percent more carbon from the air than leaving forests alone; and

Whereas wood from Oregon forestland regulated by the state's forest protection laws can count

Summary

- beetle outbreaks kill lots of trees in western North America, including in Oregon
- clear examples exist of how historical climate has aided some outbreaks
- future outbreaks may be equally severe
- impacts to ecosystem services are significant



J. Hicke