Interactions of Major Insects and Diseases with Climate Change in Westside Douglas-fir

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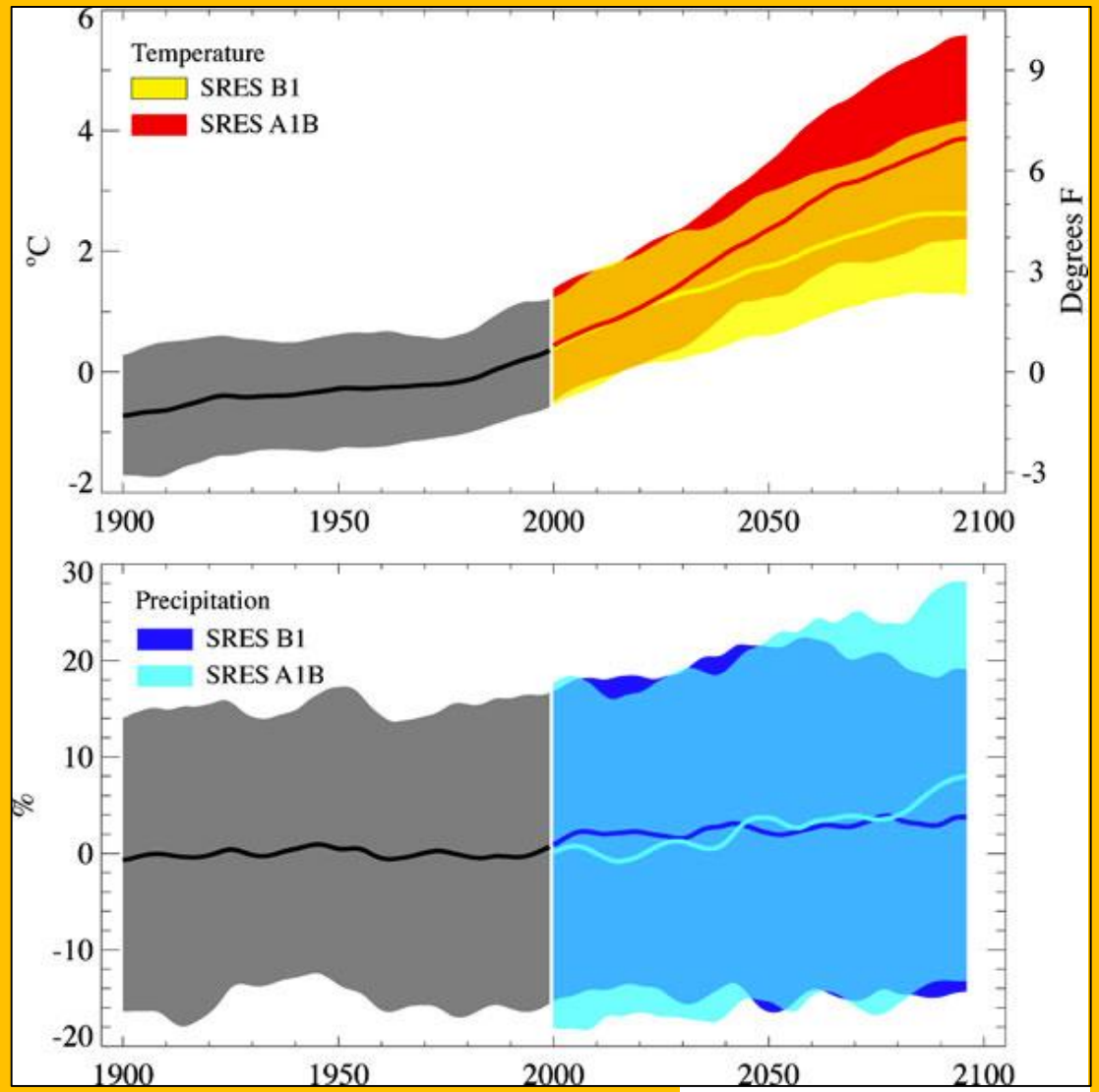
PNW

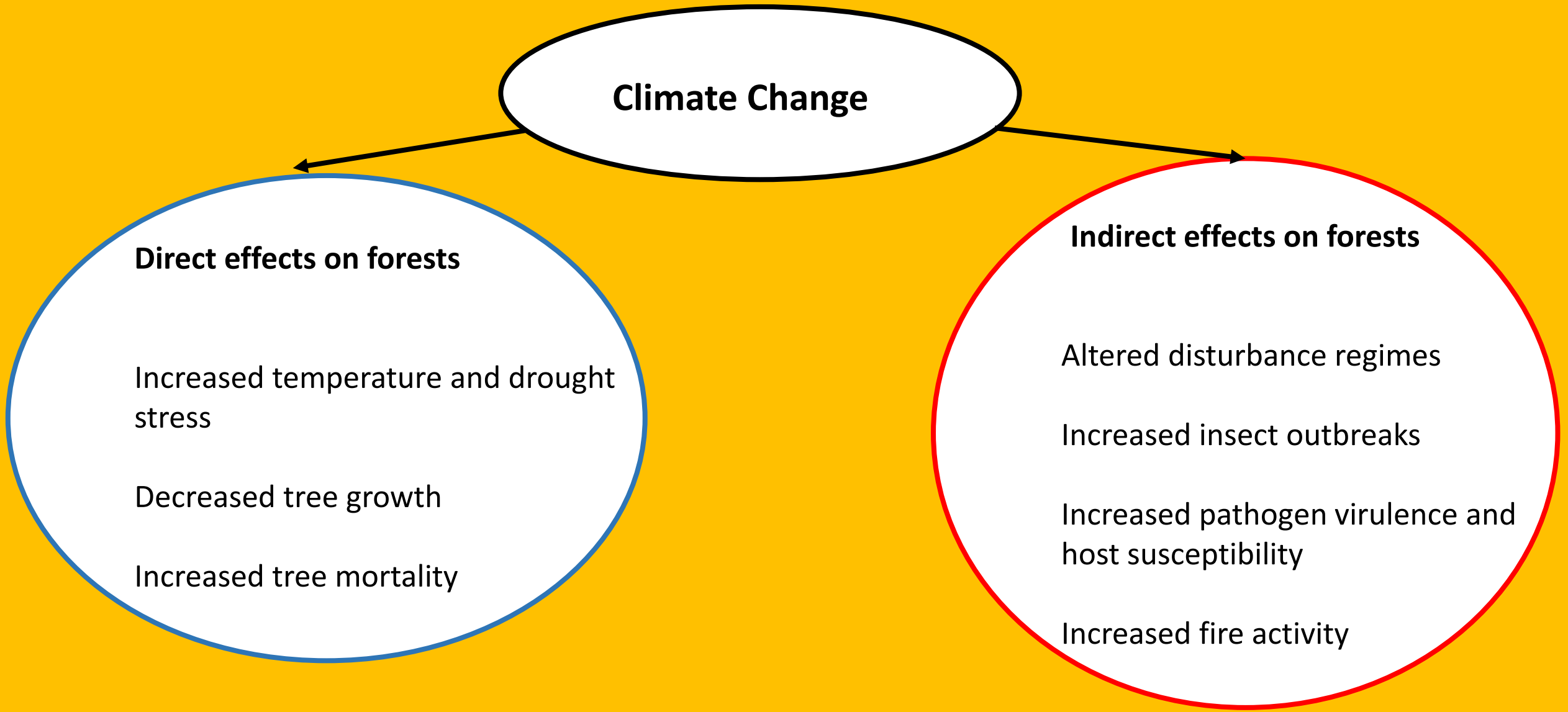
Climate Change in the Pacific Northwest

- Warmer-wetter winters
  - Increased winter temp
  - Reduced winter snowpack
- Hotter-drier summers
  - Increased summer temp
  - Decreased growing season precipitation
- Increased CO_2
  - Benefits limited by N, drought



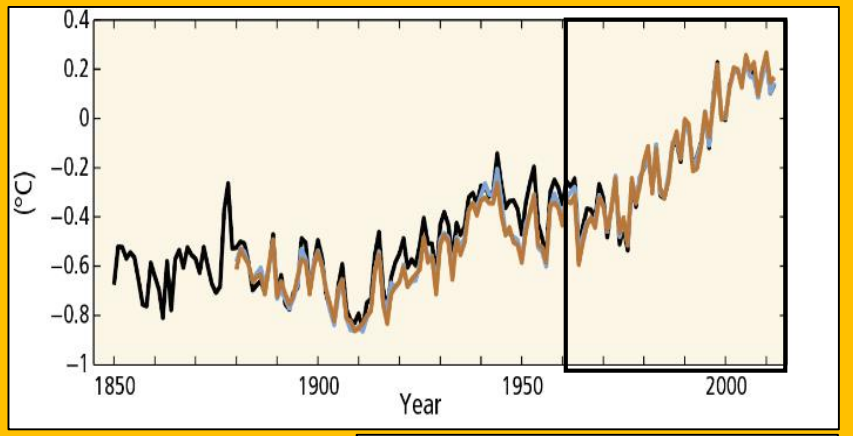
Mote and Salathe 2010

Climate Change Effects on Forests

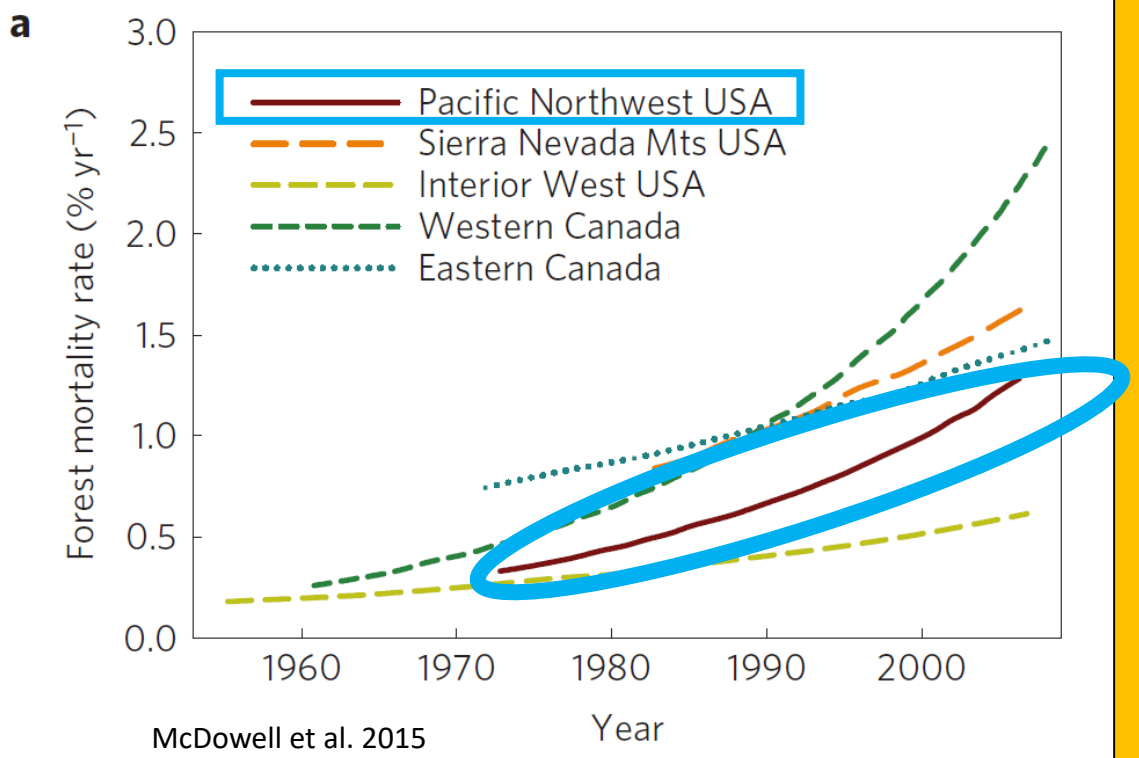


Direct Effects of Climate Change

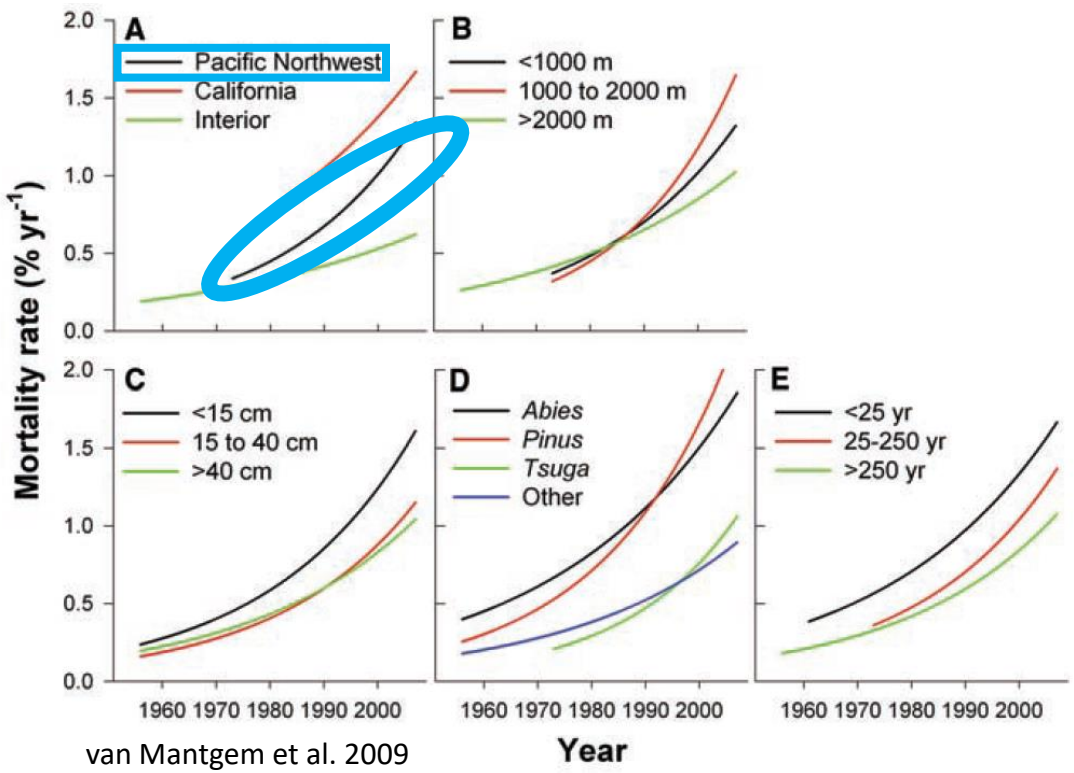
Forest mortality rates are increasing as average temperature rises



IPCC 2014, 5th Assessment Report



McDowell et al. 2015



van Mantgem et al. 2009

Douglas-fir in the PNW

- Douglas-fir (*Pseudotsuga menziesii*)
- Economically and ecologically important tree
- Particularly important in western Oregon and Washington

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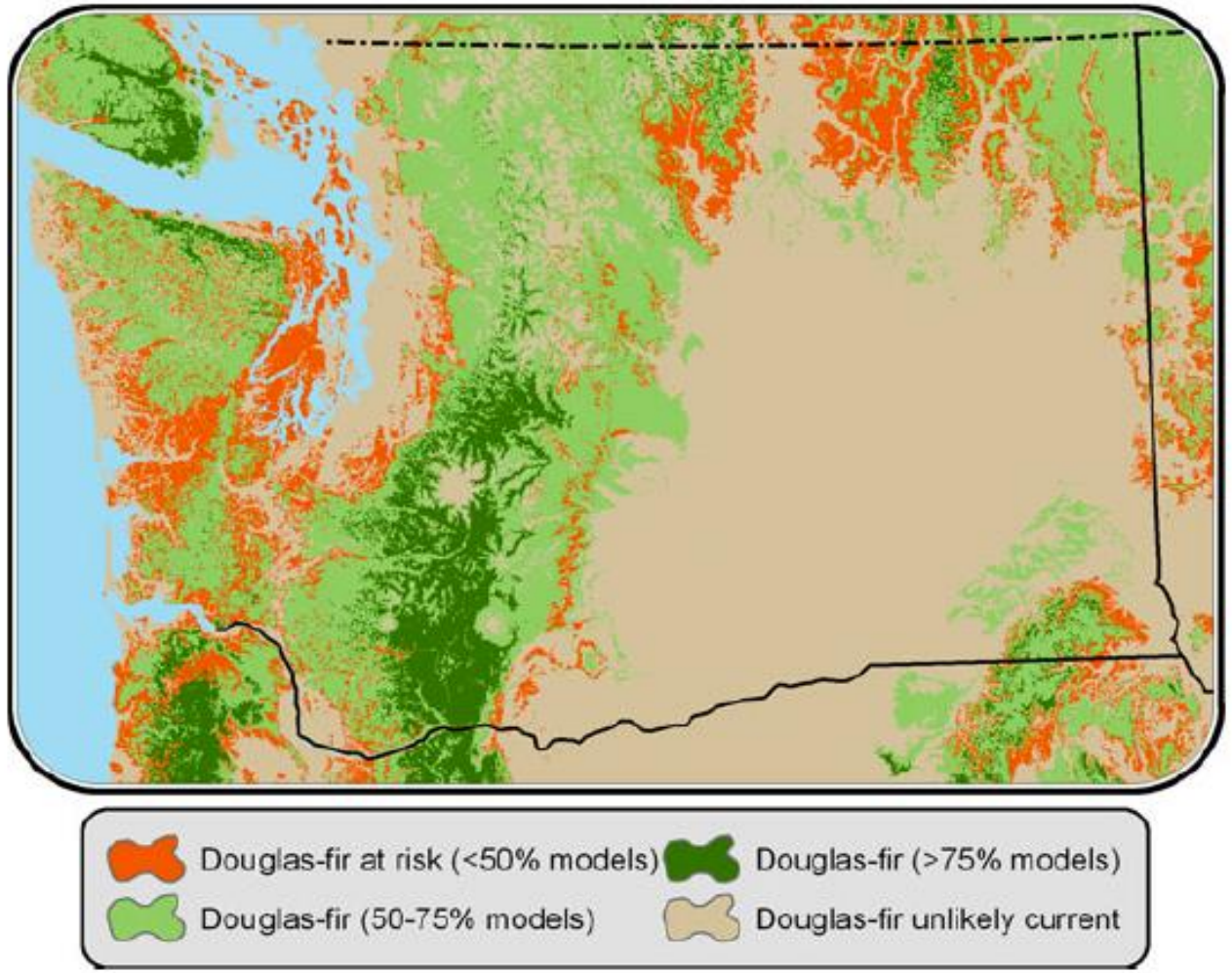
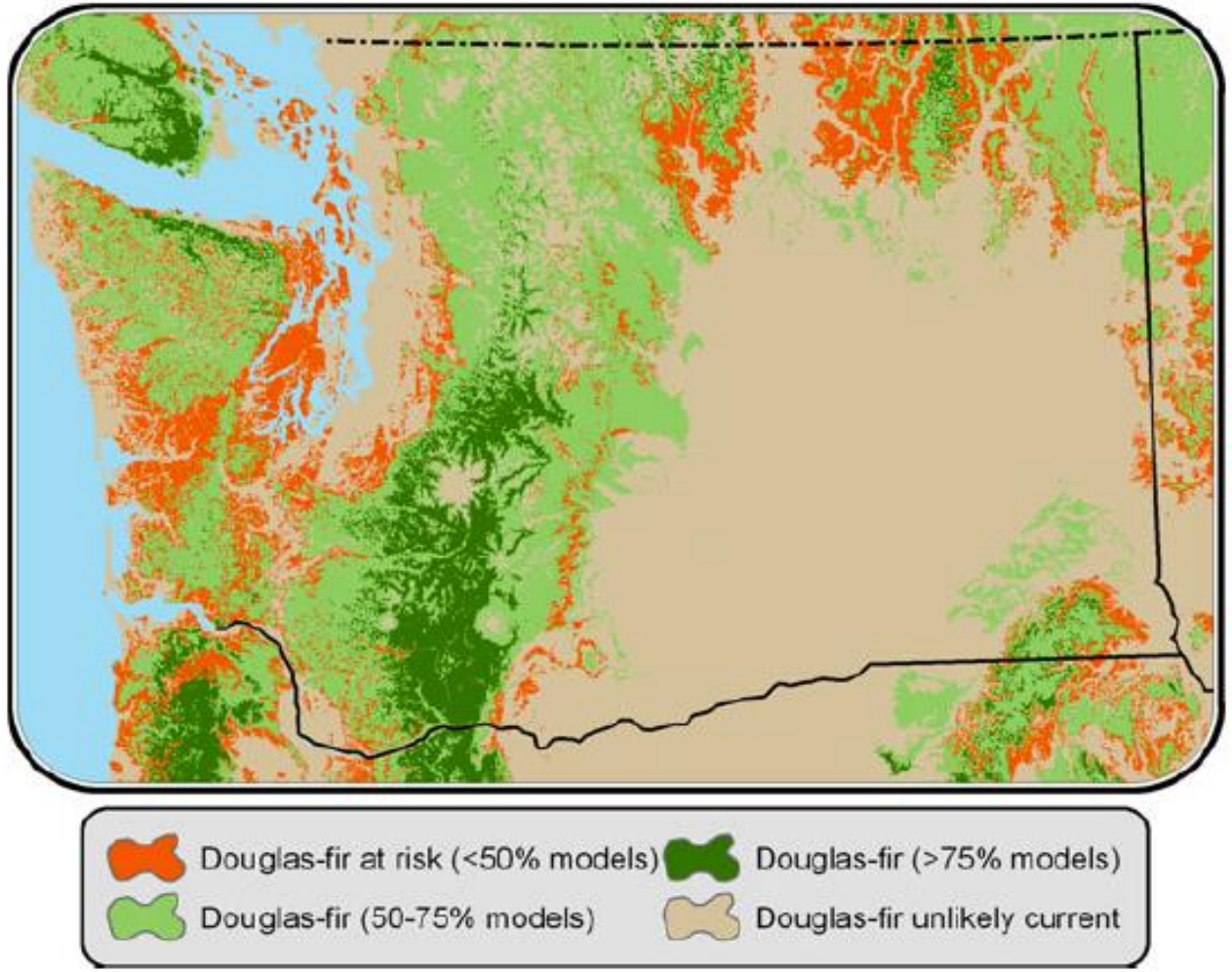


Littell et al. 2010

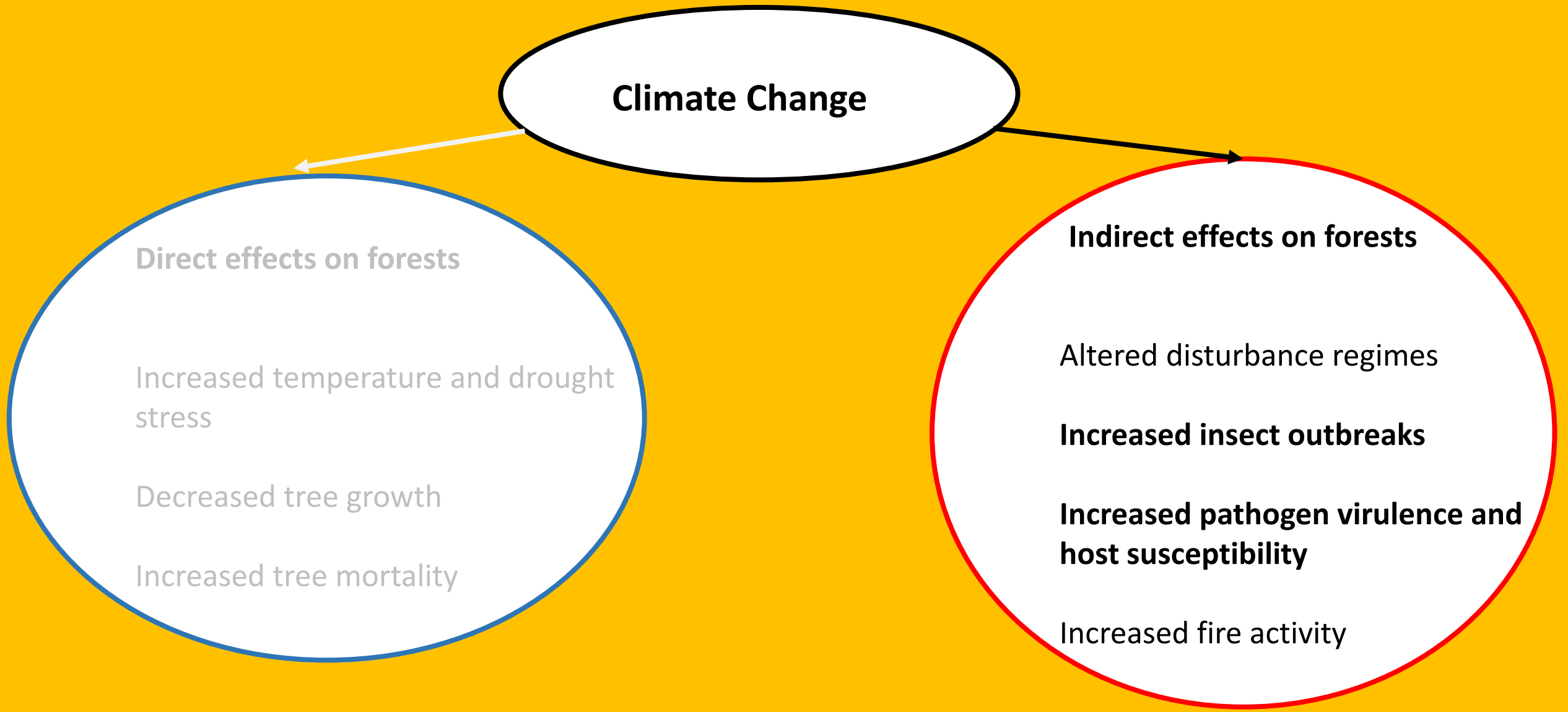
Direct Effects of Climate Change

- Range of Douglas-fir projected to be reduced substantially by the 2060s
- Based upon climate change projections and climate suitability alone



Littell et al. 2010

Climate Change Effects on Forests



Predominant insects and diseases of Douglas-fir

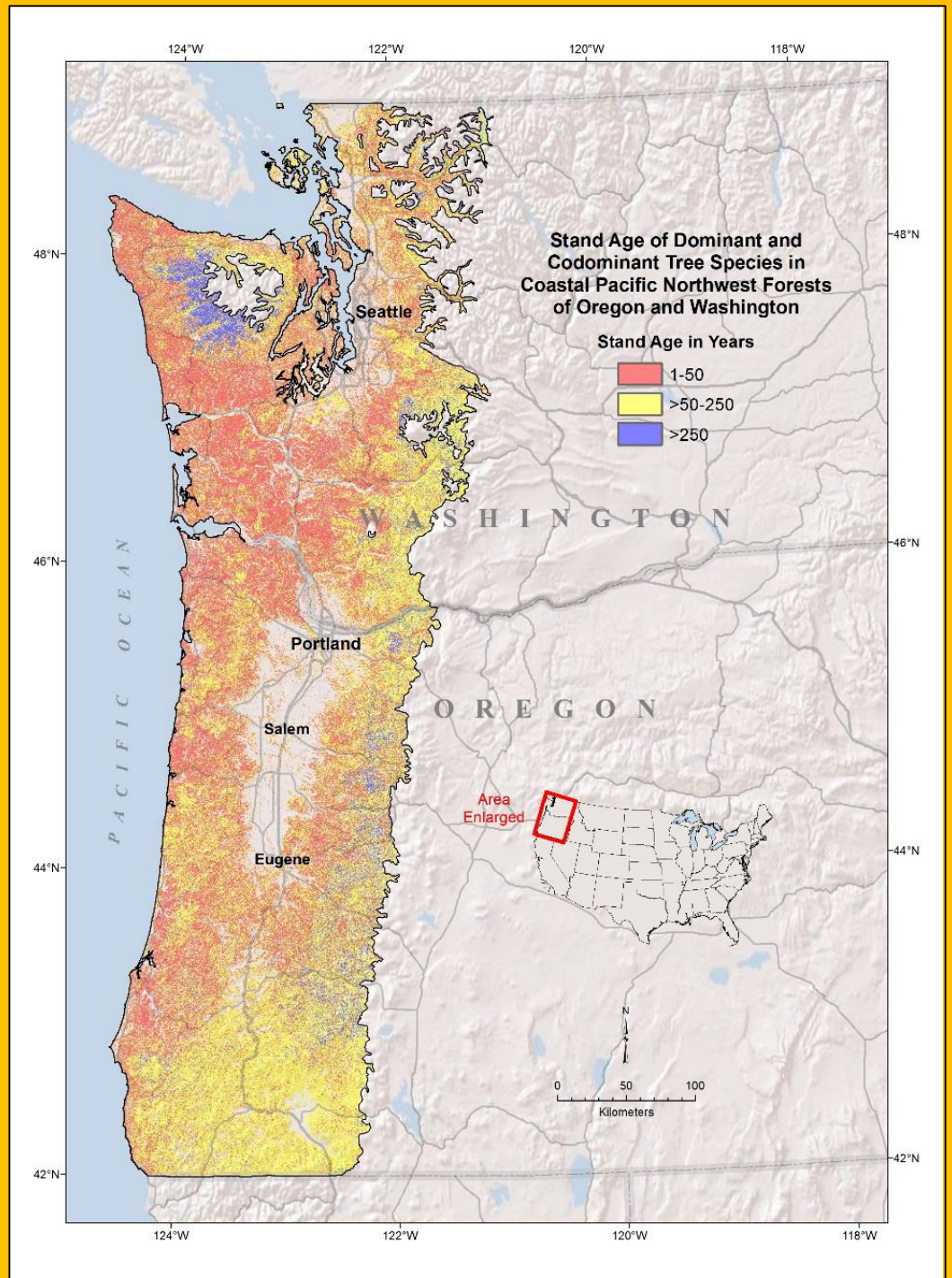
- Individual agents well understood, but interactions are not
- Need an understanding of all to anticipate indirect effects of climate change

Photo credit: Rob Flowers

- **Laminated Root Rot**
  - *Phellinus sulphurascens* (*weirii*)
- **Black Stain Root Disease**
  - *Leptographium wageneri* var *pseudotsugae*
  - Vectored by:
    - Weevils: *Steremnius carinatus, Pissodes fasciatus*
    - Root bark beetle: *Hylastes nigrinus*
- **Swiss Needle Cast**
  - *Phaeocryptopus gaeumannii*
- **Douglas-fir Beetle**
  - *Dendroctonus pseudotsugae*

Age-class distribution of Douglas-fir in Coastal PNW

- 1–50 years (red): 41%
- 50–250 years (yellow): 53%
- > 250 years (blue): 7%
- Insects and diseases of younger forests are now predominant on the landscape



Laminated Root Rot

- The most important root disease of Douglas-fir in western Oregon and Washington
- A disease of the site; grows clonally and causes mortality
- Mortality **not** related to tree vigor
- Occupies ~ 5 – 15 % of the land area

Laminated Root Rot and Climate Change

Root disease centers provide declining trees and windthrown trees that support Douglas-fir beetle populations

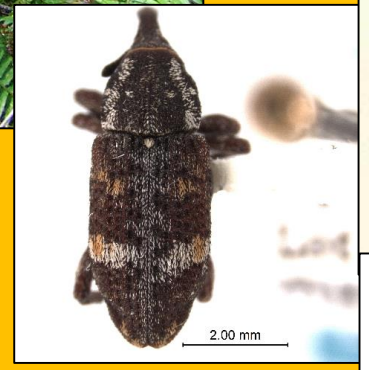
Climate change influence on pathogen thought to be minimal

May exacerbate drought impacts in affected hosts

Figures from: Thies and Sturrock 1995

Black Stain Root Disease

- Fungal vascular wilt disease
- Spreads by insects and locally by root grafting
- Insects target stressed trees, wounded roots, and thinned stumps
- Most common in young (thinned) plantations of Douglas-fir



Weevils CNC/BIO
Photography Group, Biodiversity Institute of Ontario

Black Stain Root Disease and Climate Change

- Insect vectors respond to ethanol production—disease linked with drought stress and wounding
- Pathogen and insect responses to changing climatic conditions unknown
- Disease response likely to be complex

Black stain root disease mortality in west side Douglas-fir

Swiss Needle Cast

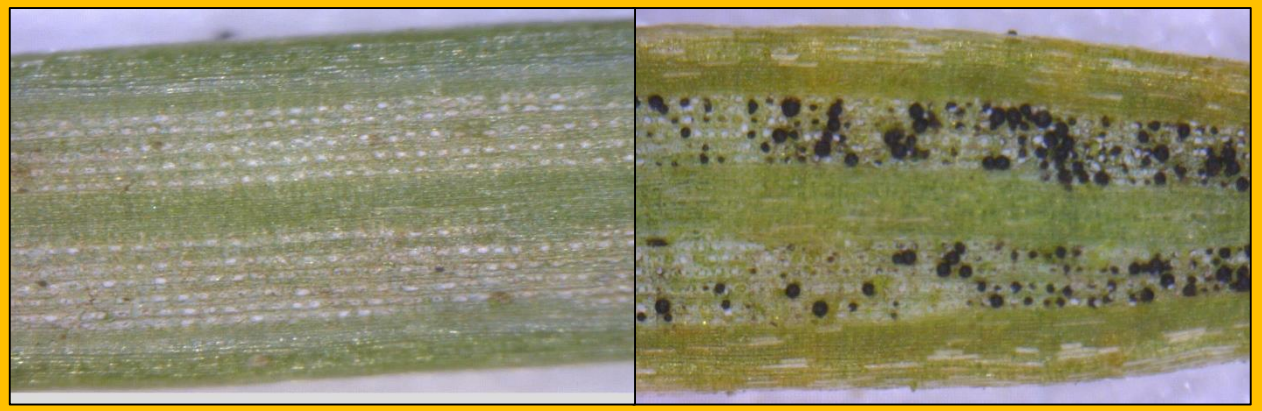


Photo credit: Rob Flowers

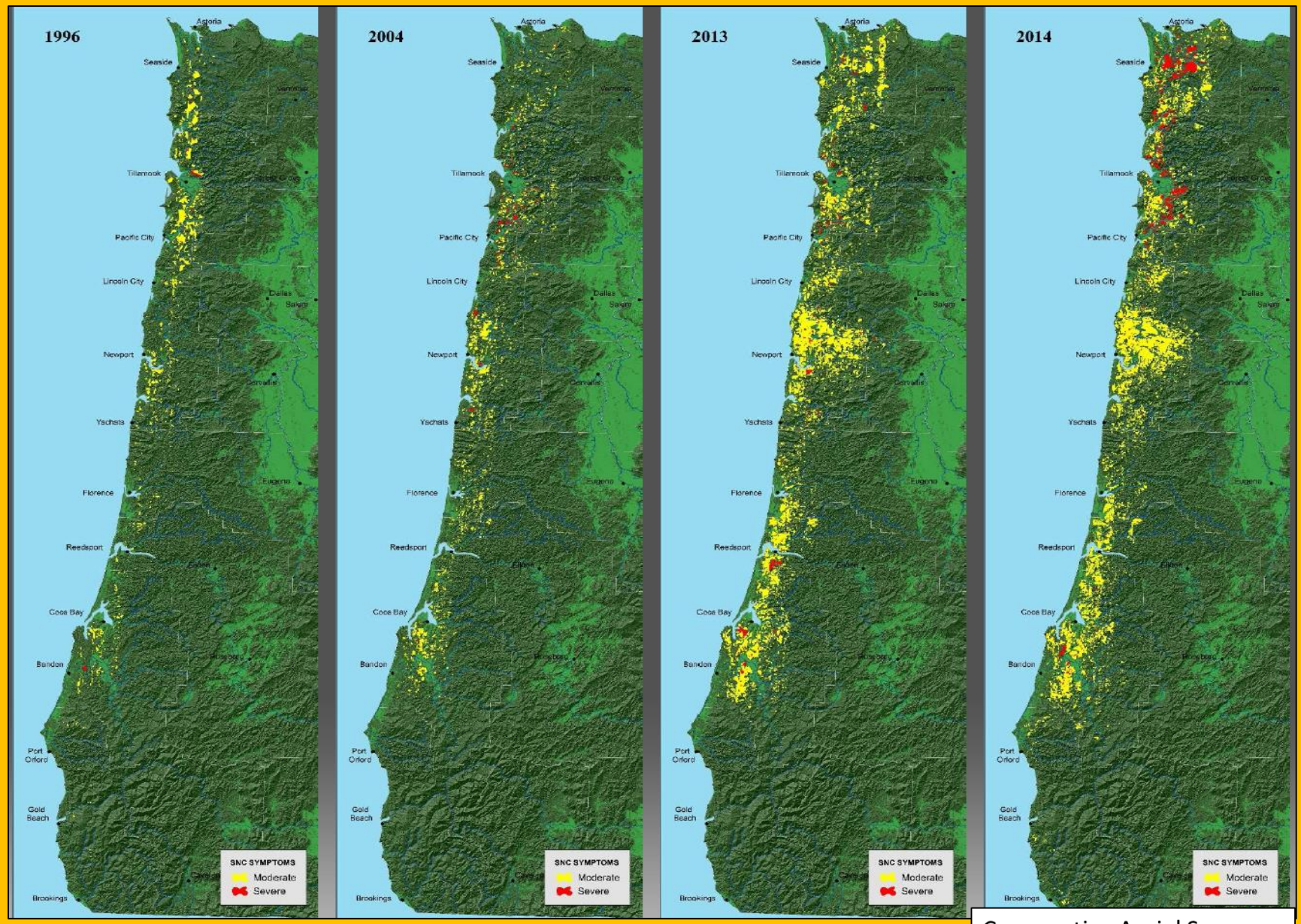
Swiss Needle Cast

~53,000 ha in 1996

~230,000 ha in 2014

Has been intensifying within ~50 km of the coast

Severe impacts in intensively managed stands



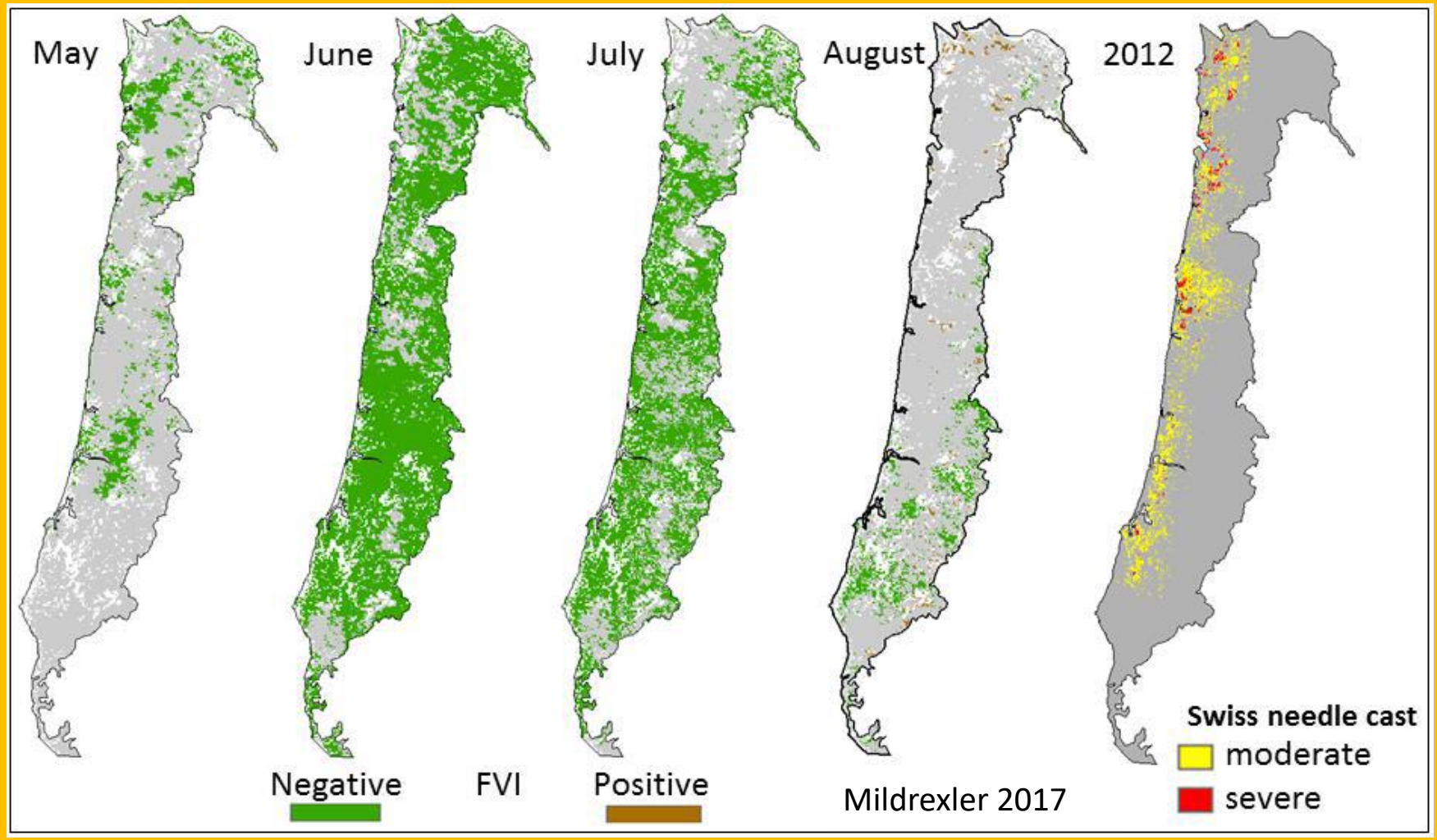
Cooperative Aerial Survey
ODF/USFS FHP 1996-2016

Swiss Needle Cast and Climate Change

Increased disease severity associated with **warm winter temperatures**, high spring to **early summer precipitation** and leaf wetness

Effect of increased summer temperatures unknown

Likely to intensify in many areas



Increased water balance in the Swiss needle cast zone in June and July from 2003 to 2012

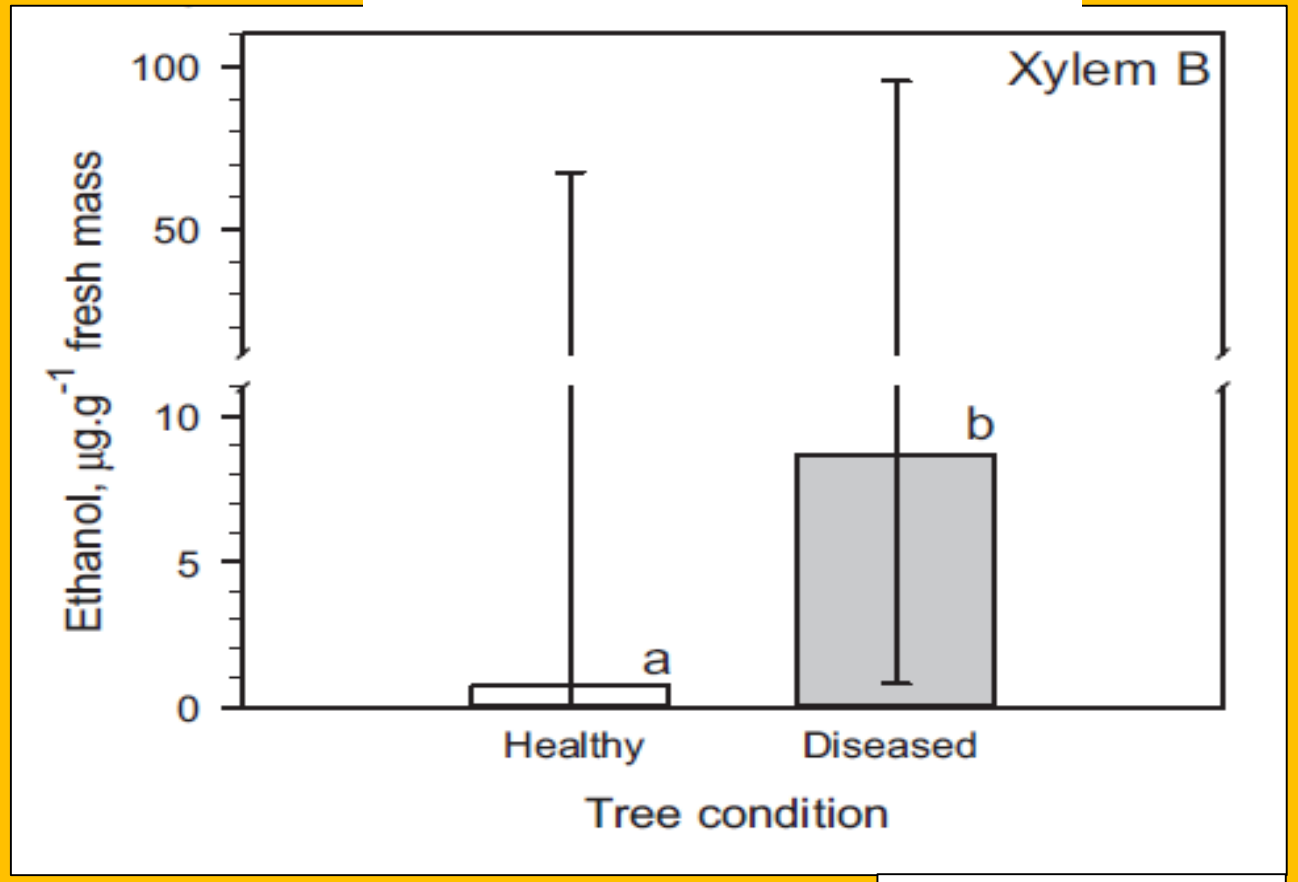
Douglas-fir Beetle

- Attacks occur in stressed, weakened, and recently wind-thrown (down) trees >25 cm DBH
- Outbreaks can occur after major wind-throw events
- Behaves differently in dry inland forests and wet west-side forests
  - Less aggressive on west side
  - Outbreaks subside more quickly

Douglas-fir Beetle Biotic Interactions

- Root disease-stressed trees have increased ethanol concentration
- Proposed mechanism for strong association between Douglas-fir beetle activity and laminated root rot centers

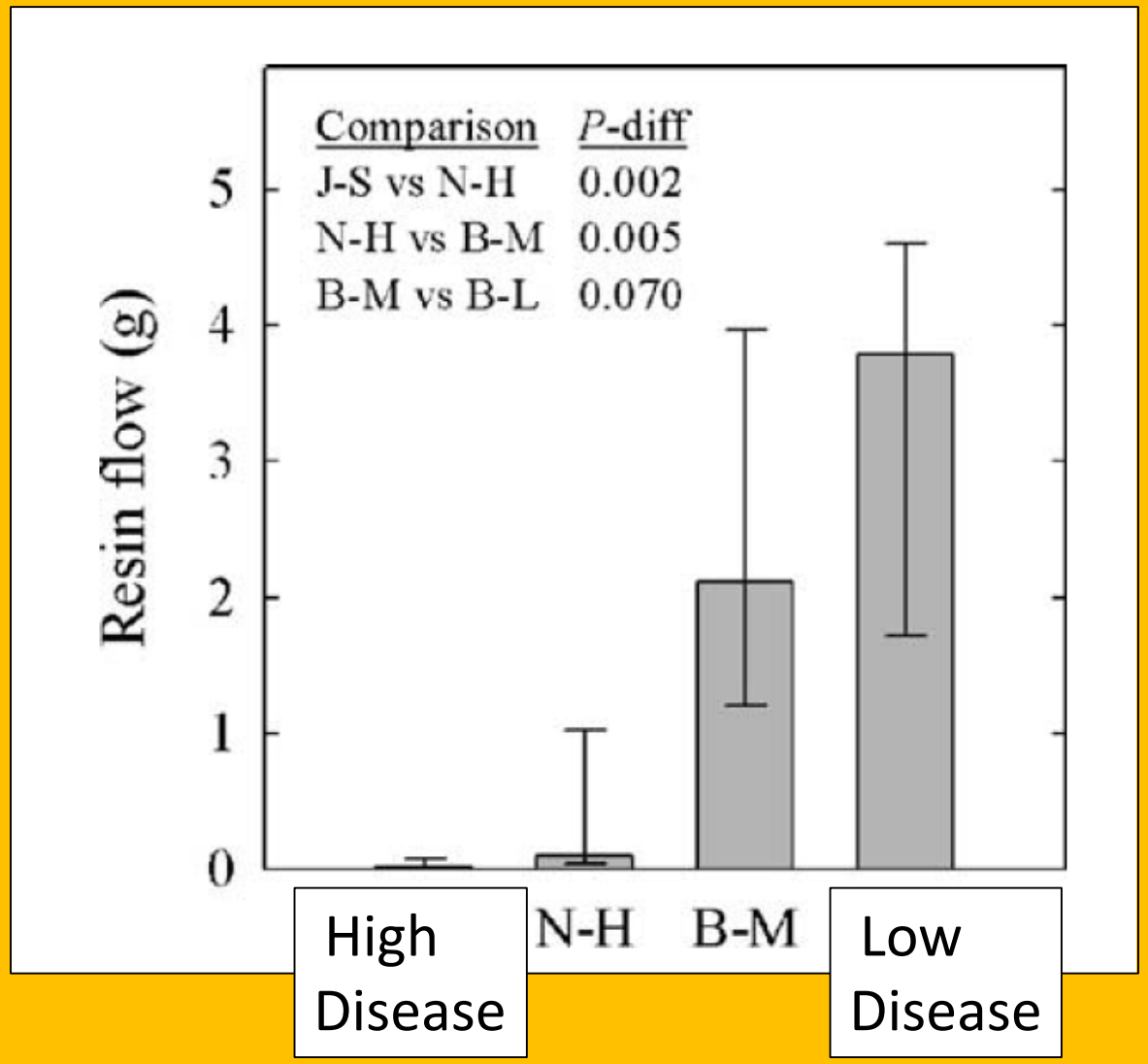
Laminated root rot infected trees – high ethanol concentrations



Kelsey et al. 2016

Douglas-fir Beetle Biotic Interactions

- Ethanol, monoterpene content and wound induced resin flow were all reduced in SNC trees
- Although defenses are reduced, SNC infected trees may not be attractive to Douglas-fir beetle due to carbon starvation



Kelsey and Manter 2004

Indirect Effects of Climate Change in West Side Douglas-fir

Agent	Warmer wetter winters
Laminated root rot	0
Black stain root disease	~+
Swiss needle cast	+
Douglas-fir beetle	~+

0 = no change
- = projected decrease
+ = projected increase
~- = possible decrease
~+ = possible increase

Indirect Effects of Climate Change in West Side Douglas-fir

Agent	Warmer wetter winters	Hotter drier summers
Laminated root rot	0	~+
Black stain root disease	~+	+
Swiss needle cast	+	~-
Douglas-fir beetle	~+	~+

0 = no change
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Indirect Effects of Climate Change in West Side Douglas-fir

Agent	Warmer wetter winters	Hotter drier summers	Increased CO_2
Laminated root rot	0	~+	?
Black stain root disease	~+	+	?
Swiss needle cast	+	~-	?
Douglas-fir beetle	~+	~+	?

0 = no change
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Net effects of climate change on biotic agents poorly understood

Climate change effects on biotic interactions difficult to predict

Armillaria root disease

- Currently has minor impacts on west side
- May increase in importance with hotter-drier summers
- Known to build up in maladapted tree populations

Flatheaded fir borer (*Phaenops drummondi*)

Classic flatheaded fir borer mortality pattern in Douglas-fir

Mortality on stand edges and among oaks

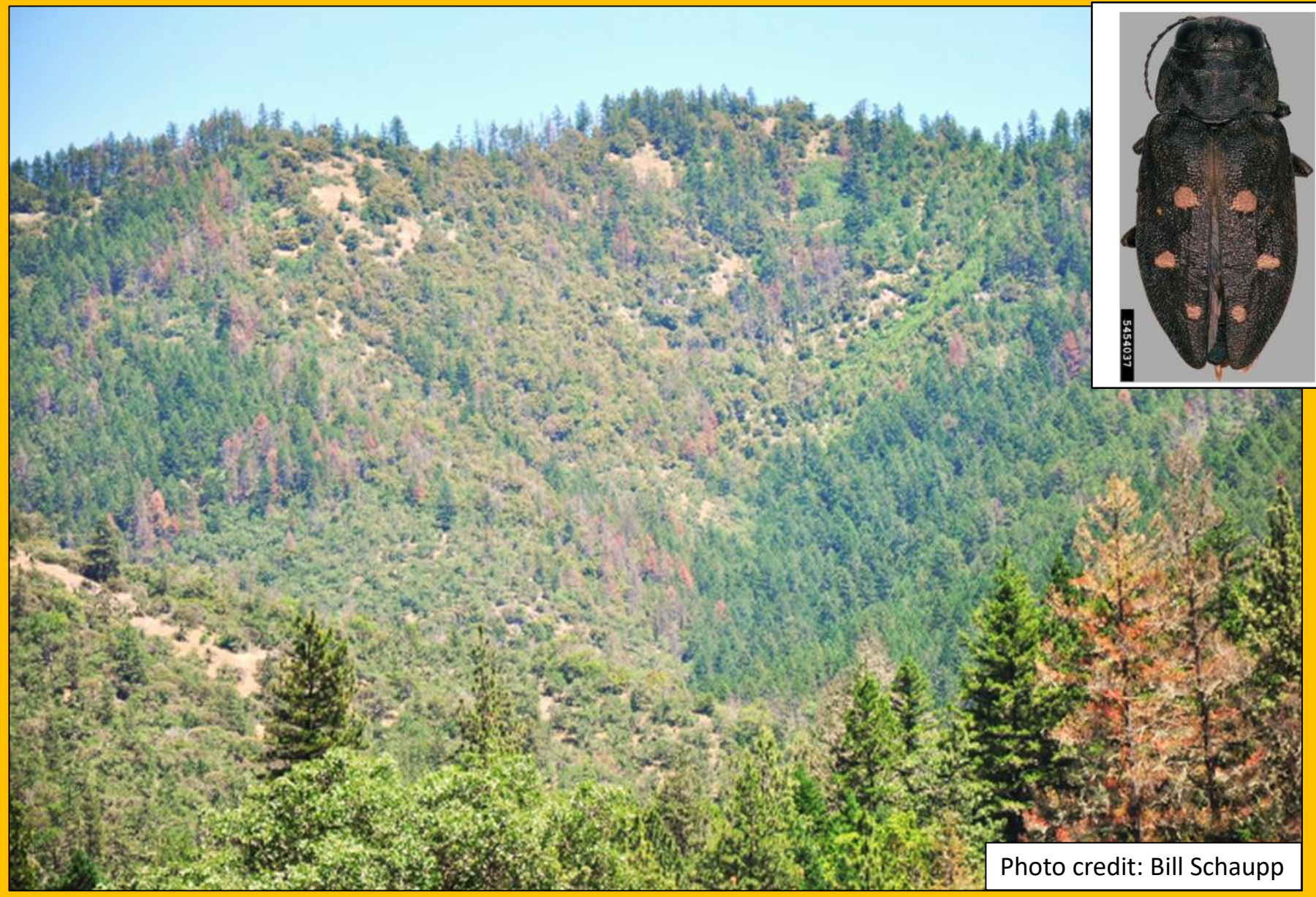

Photo credit: Bill Schaupp

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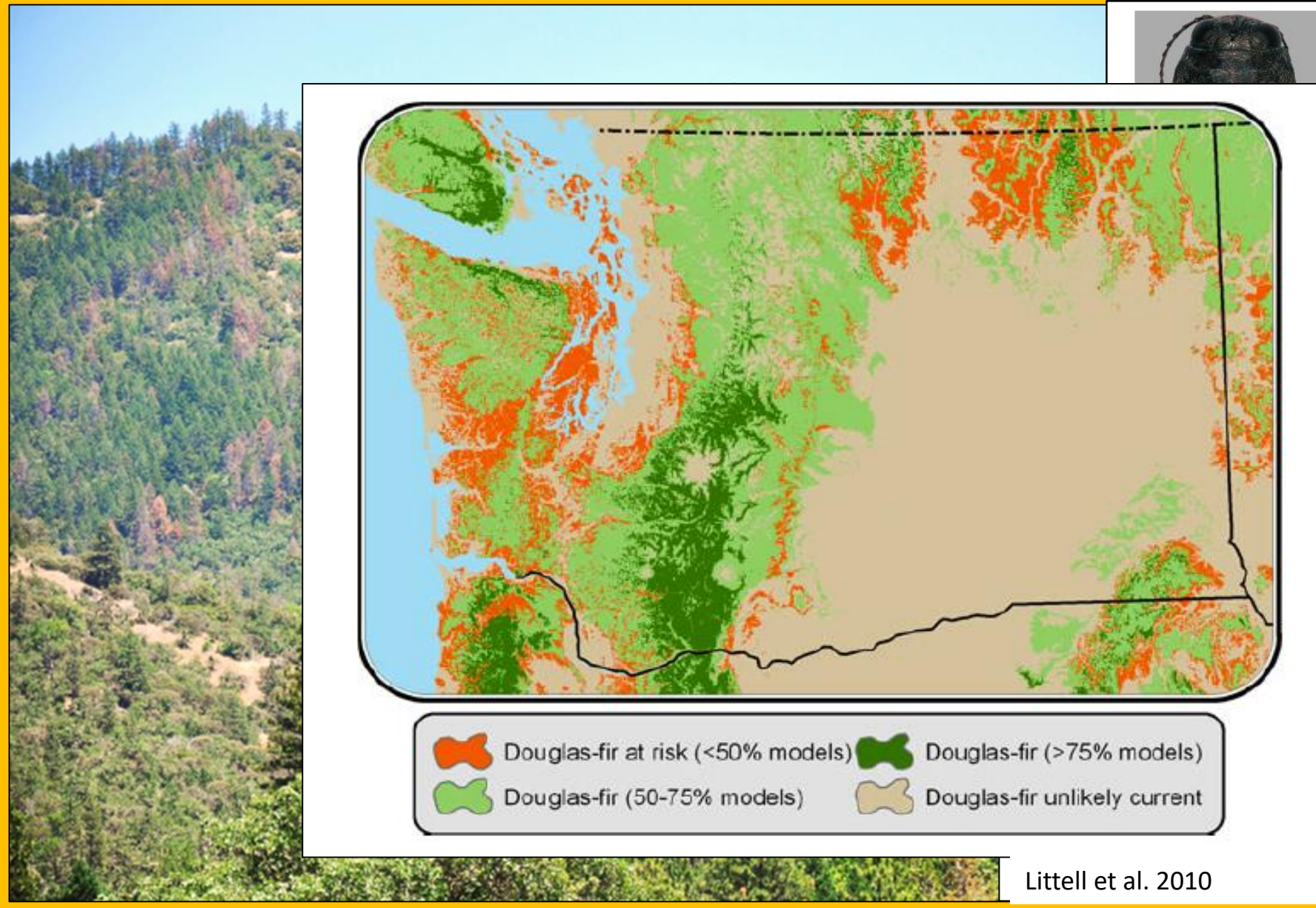


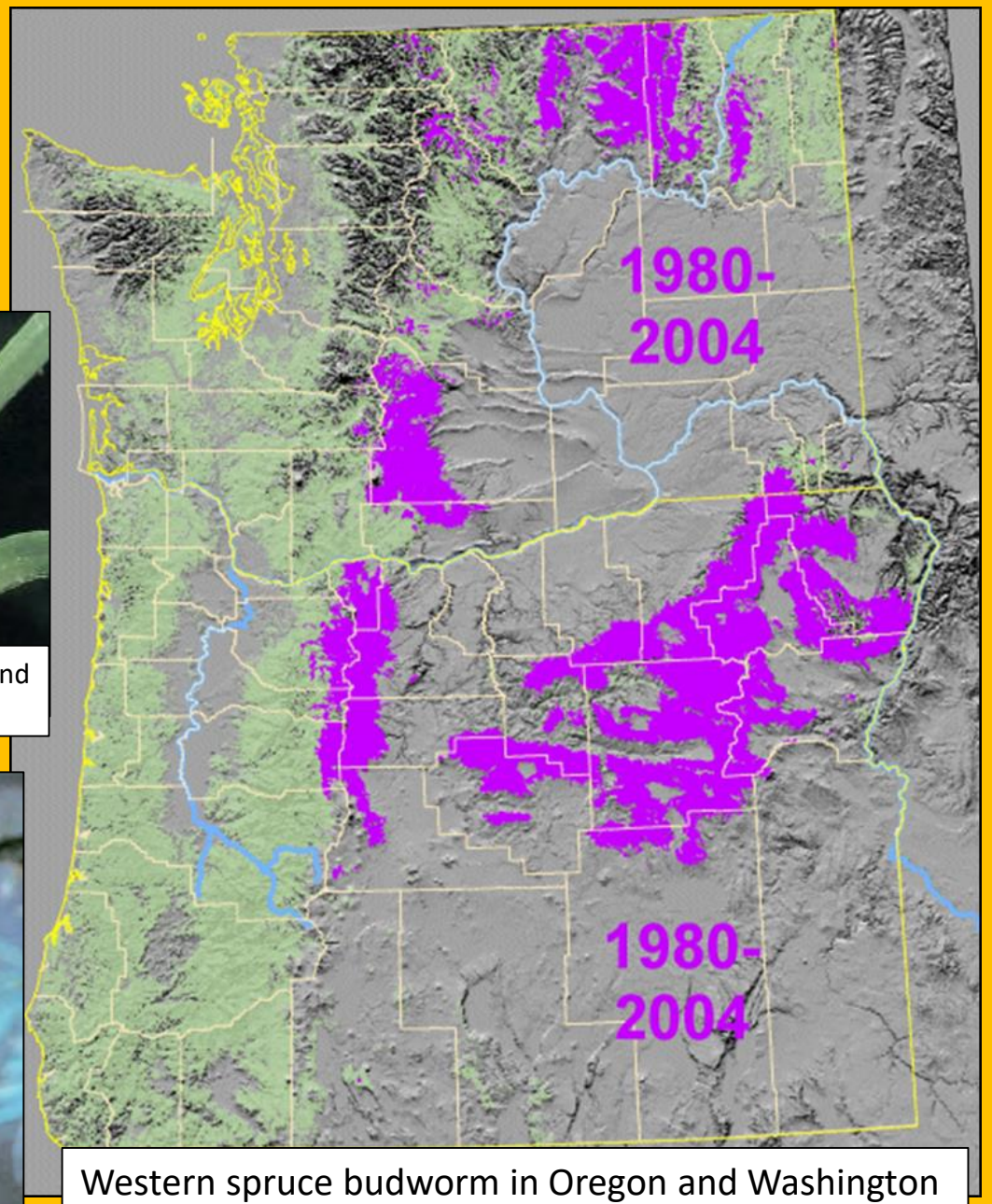
Littell et al. 2010

Could major east-side defoliators come west?

- Western spruce budworm
  - *Choristoneura freeman*
- Douglas-fir tussock moth
  - *Orgyia pseudotsugata*
- Warmer-wetter winters, hotter-drier summers = increased potential?

Photo from Fellin and Dewey 1986

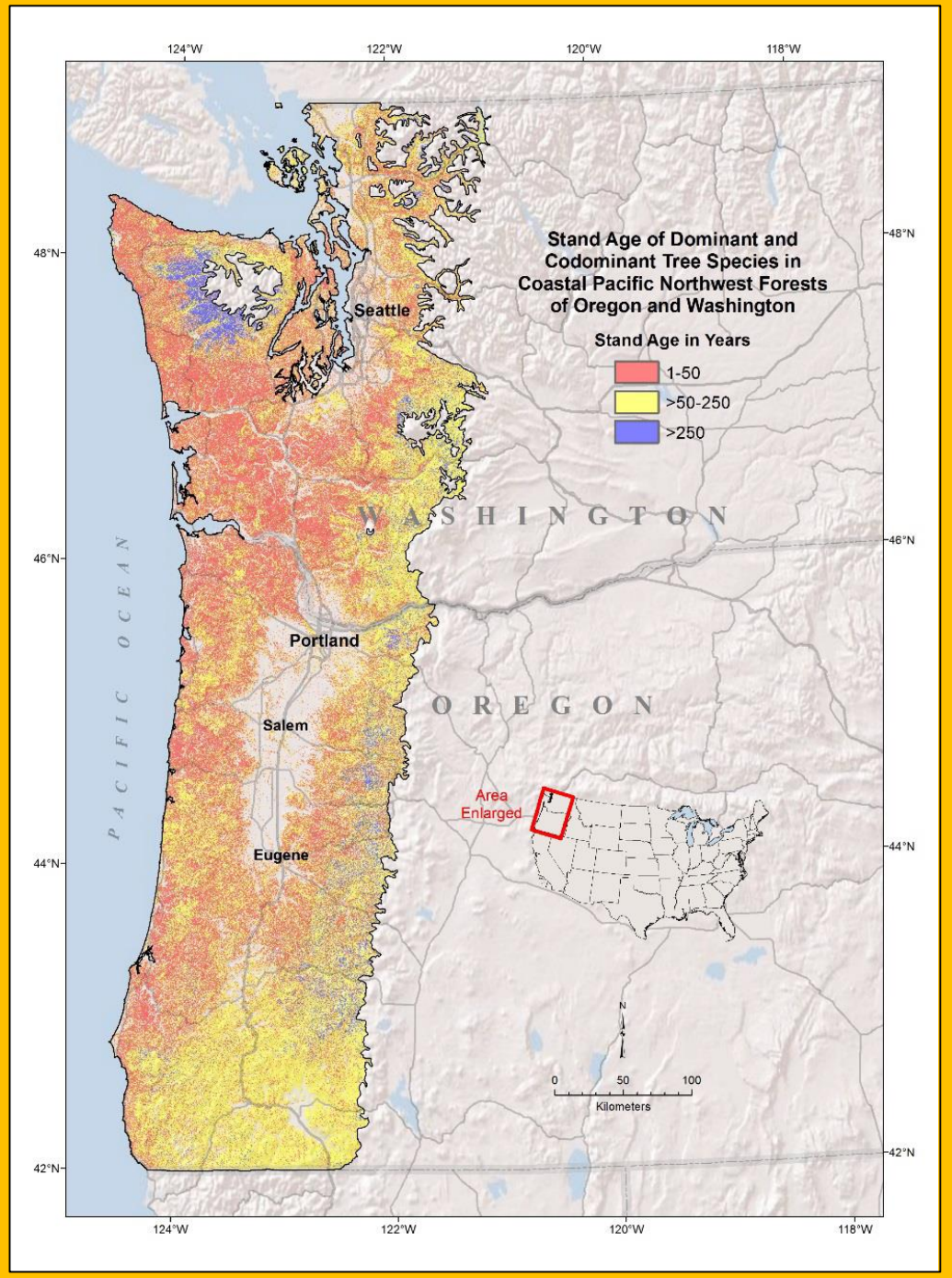
Photo from Wickman et al. 1981



Western spruce budworm in Oregon and Washington 1980-2004; Aerial Detection Survey, USFS FHP R6

Summary

- Climate conditions are changing and will influence current insects and diseases



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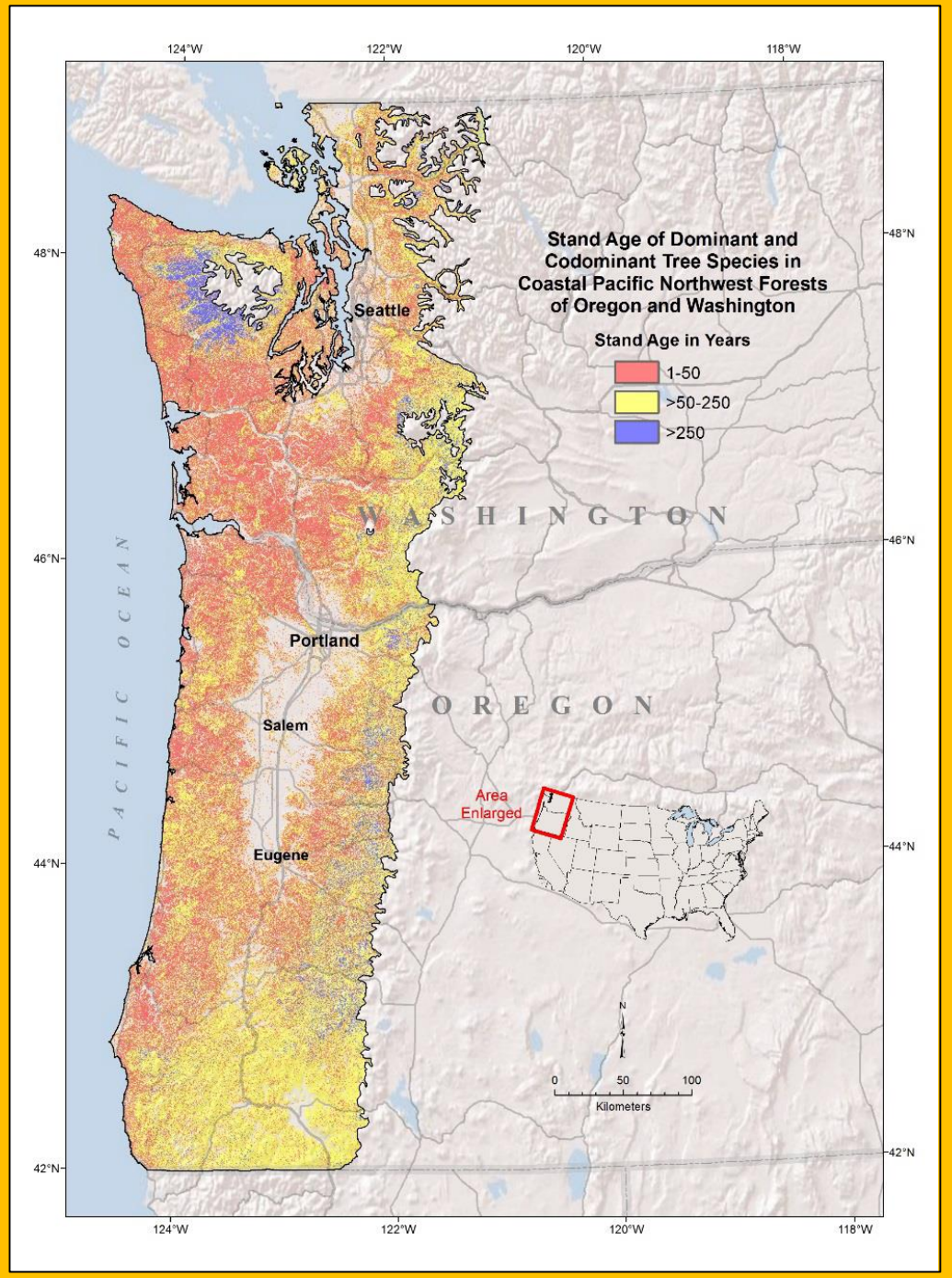

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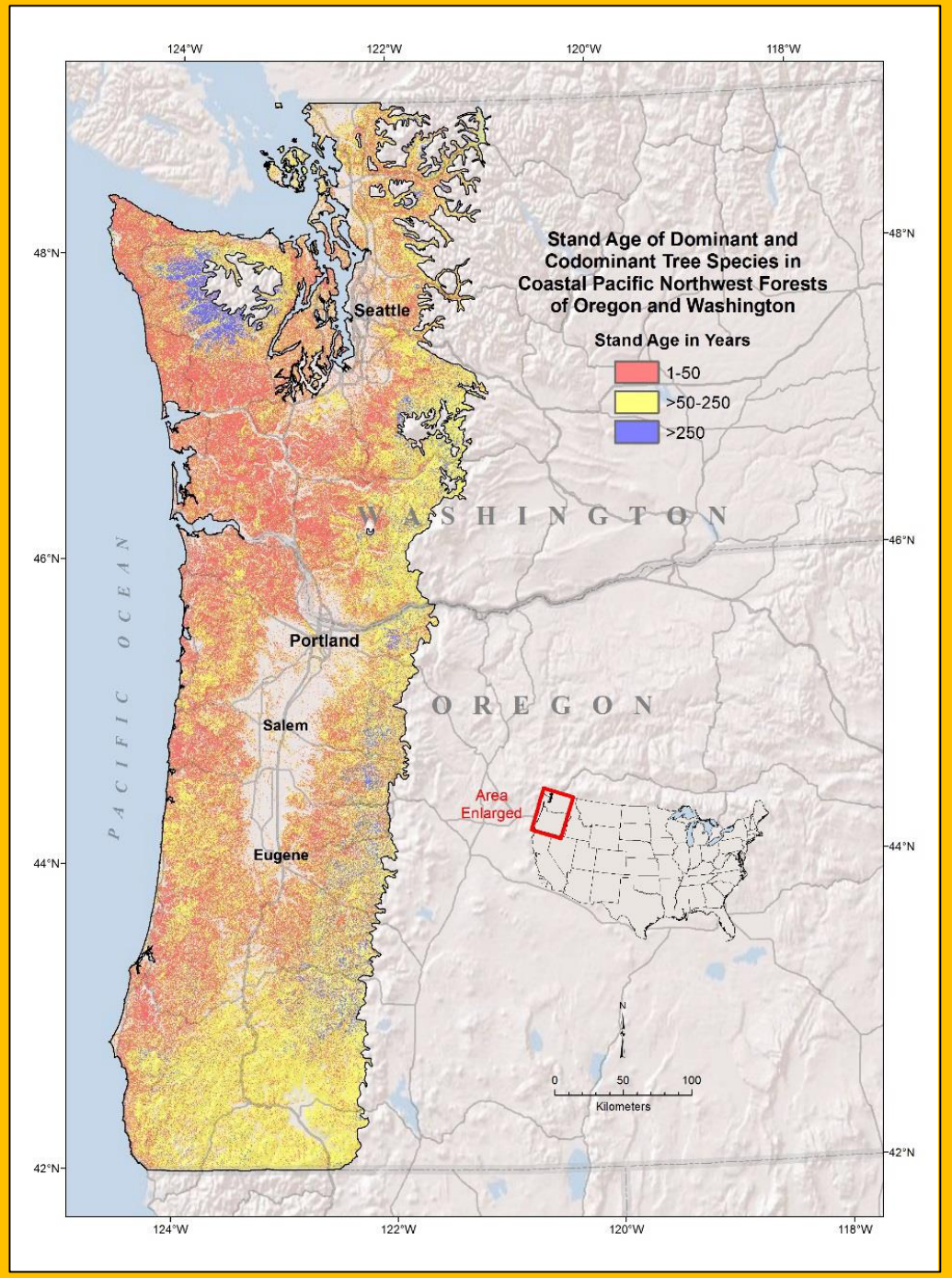

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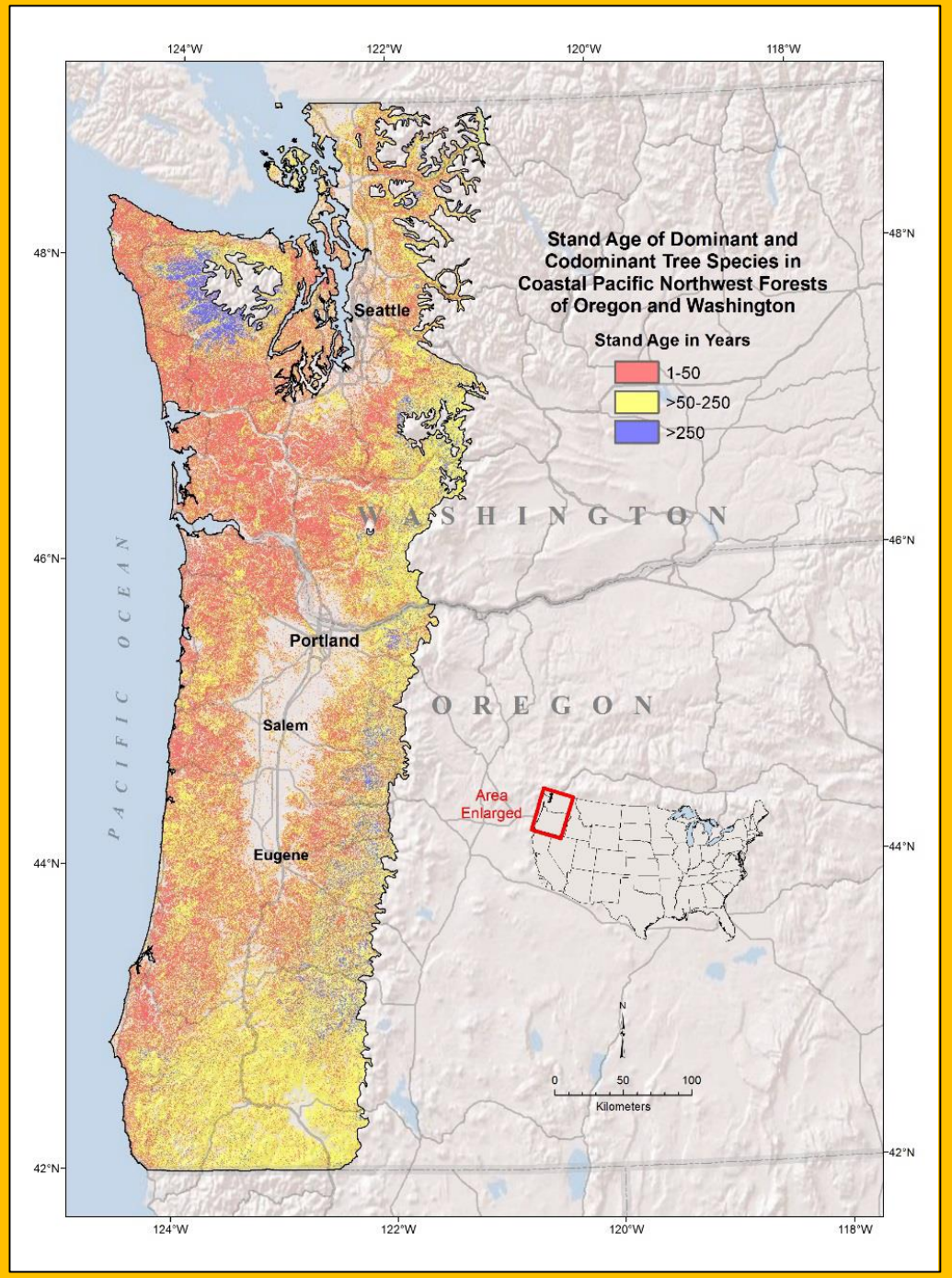

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- Interactions of dominant insects and pathogens under changing climate need more investigation
- Management in the context of climate change requires awareness of insects and diseases