Climate Change and Bark Beetles

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Outline

1. Introduction
2. Recent climate influences
3. Impacts
4. Future outbreaks
5. Management options

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Recent bark beetle outbreaks

Mountain pine beetle: Colorado lodgepole pine

June 2005, Gore Range, CO

September 2005, Fraser Valley, CO

Photos: J. Hicke

Recent bark beetle outbreaks

Mountain pine beetle: British Columbia lodgepole pine

2004, Yoho National Park

© Parks Canada/Ross MacDonald/KNP/2004

Recent bark beetle outbreaks

Mountain pine beetle: High-elevation whitebark pine

September 2005, Railroad Ridge, ID

October 2004, Sylvan Pass, Yellowstone NP

Photos: J. Hicke

Recent bark beetle outbreaks

Spruce beetle: Alaska spruce species

1990s, Kachemak Bay, Kenai Peninsula

USFS, 2000

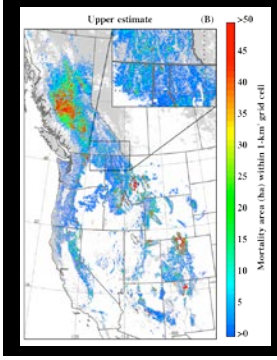
Recent bark beetle outbreaks

Ips species: Piñon pine in Southwest

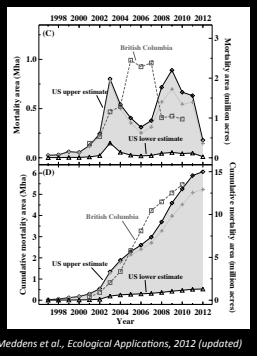
Photo by Craig Allen - USGS

Bark beetles are significant forest disturbances

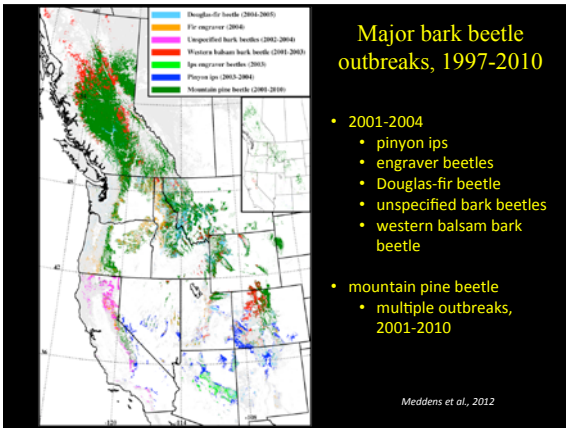
Cumulative mortality area, 1997-2010



Mortality area



Meddens et al., Ecological Applications, 2012 (updated)

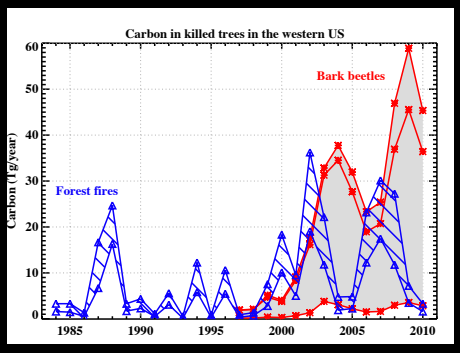


Major bark beetle outbreaks, 1997-2010

- 2001-2004
  - pinyon ips
  - engraver beetles
  - Douglas-fir beetle
  - unspecified bark beetles
  - western balsam bark beetle
- mountain pine beetle
  - multiple outbreaks, 2001-2010

Meddens et al., 2012

Bark beetles kill more trees than wildfires



Hicke et al., 2013

Factors influencing mountain pine beetle epidemics

Factors related to trees:

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

stand structure

climate

Photo courtesy USDA Forest Service, www.forestryimages.org

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

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Historical climate change and beetle outbreaks

1. intensified outbreaks within historical distribution

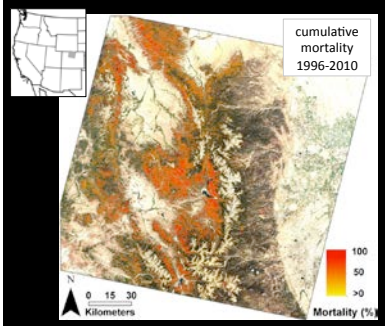
mountain pine beetle in areas historically too cold

Photo courtesy J. Logan

USGS, 2001

Historical climate change and beetle outbreaks

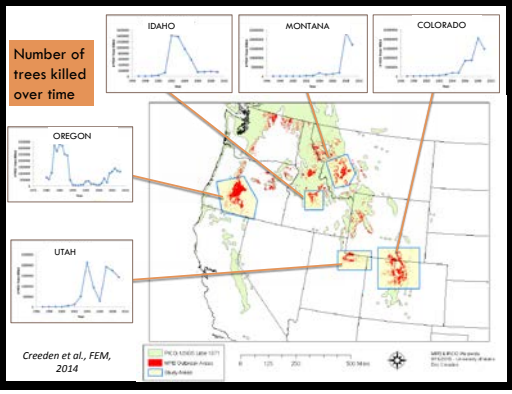
1. intensified outbreaks within historical distribution

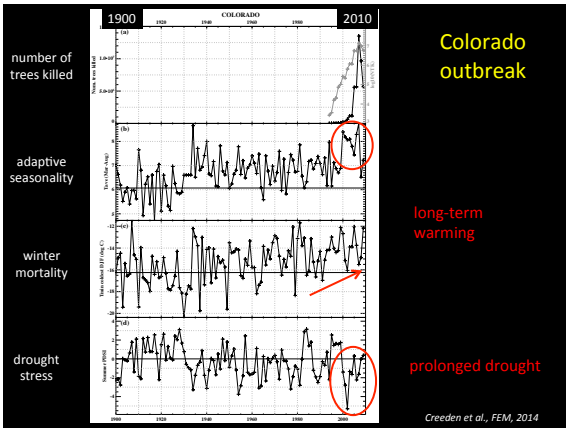


- 22% of forest area killed
- plot-level average:
  - 60% mortality within three years

Meddens et al., FEM, in press

Climate patterns during mountain pine beetle outbreaks



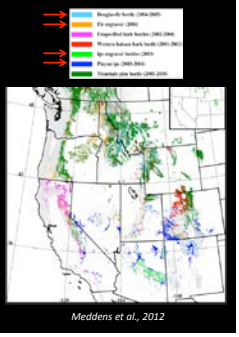


Historical climate change and beetle outbreaks

1. intensified outbreaks within historical distribution

warmer droughts in West

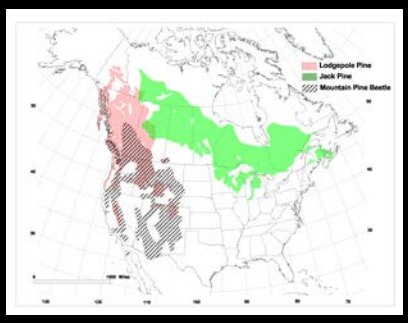
Photo courtesy C. Allen, USGS



Meddens et al., 2012

Historical climate change and beetle outbreaks

2. northward range expansion of mountain pine beetle



Logan and Powell, American Entomologist, 2001

Historical climate change and beetle outbreaks

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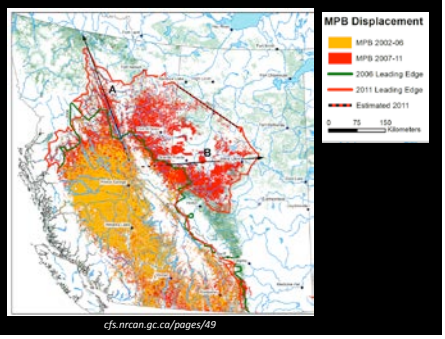


cfs.nrcan.gc.ca/pages/49

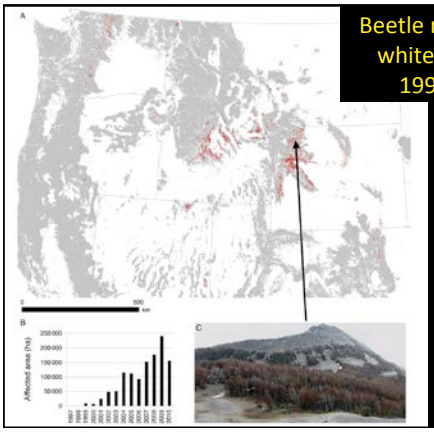
Historical climate change and beetle outbreaks

3. outbreaks in unusual habitats

extended outbreak in high-elevation whitebark pine

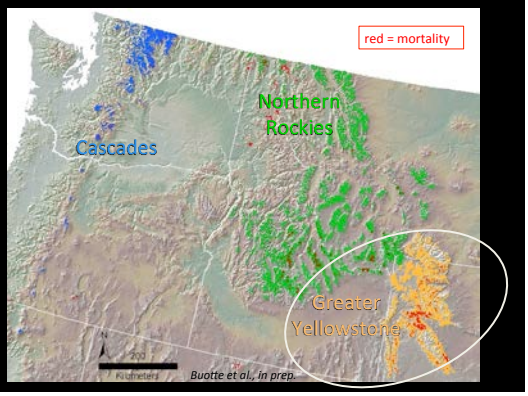
© Jane Pargiter, EcoFlight 2006

Beetle mortality in whitebark pine 1998-2009



Weed et al., Ecological Monographs, 2013

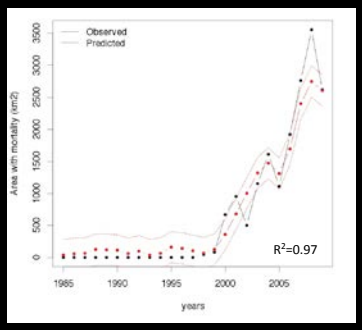
Study area: Whitebark pine range in western US (3 regions)



Buotte et al., in prep.

Statistical model of climate/beetle/whitebark pine

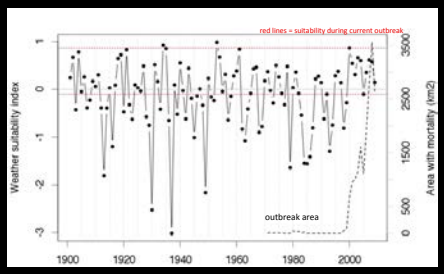
predictions similar to observations



Buotte et al., in prep.

Climate influences on current outbreak

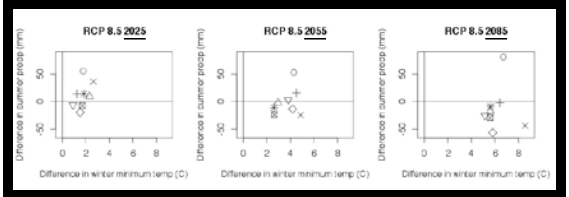
recent weather continuously suitable relative to last 100 years



Buotte et al., in prep.

Projected future climate change

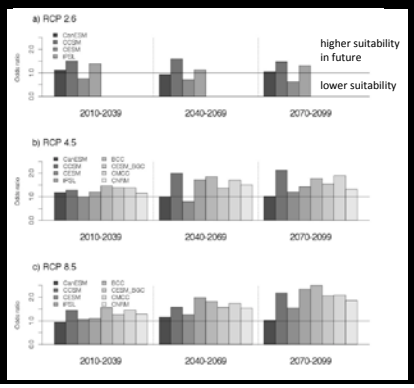
- consistent warming
- change in precipitation varies among models



symbols: 10 different climate models

Buotte et al., in prep.

Projected future change: more suitable conditions



ratio of future odds to historical odds

less emissions, less warming

moderate emissions, moderate warming

more emissions, more warming

Buotte et al., in prep.

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Severe impacts to forest ecosystems

effects on fires

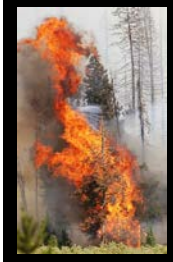


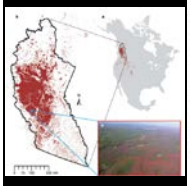
Photo by Matt Stensland
www.steamboatpilot.com/news/2008/aug/17/dying_forests_increase_wildfire_danger_across_west

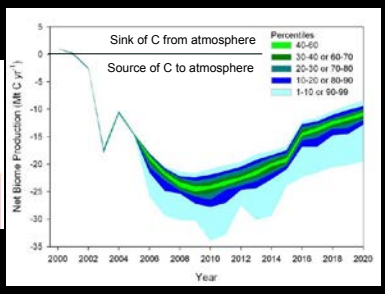
depends on time since outbreak

Photos: J. Hicke

Severe impacts to forest ecosystems

carbon management





Kurz et al., Nature, 2008

Severe impacts to forest ecosystems

impacts to wildlife

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Photo by Michael G. Shepherd

finearteamerica.com/featured/red-squirrel-with-pine-cone-gary-beeler.html

www.nrmsc.usgs.gov/node/398

Severe impacts to forest ecosystems

impacts to humans

www.woodbusiness.ca/industry-news/b-c-interior-lumber-to-peak-in-three-to-five-years

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

valeriefrieda.blogspot.com/2011/08/summertime-fun.html

Severe impacts to forest ecosystems

impacts to humans

www.realvail.com

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trib.com

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"Every day across the West, an estimated 100,000 lodgepole pines fall in the forest…" USFS

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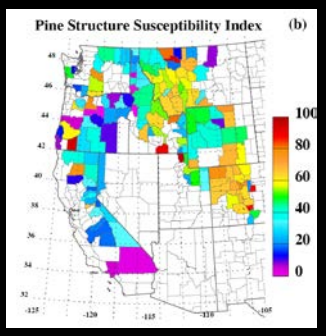
1. Forests are susceptible to outbreaks based on stand structure

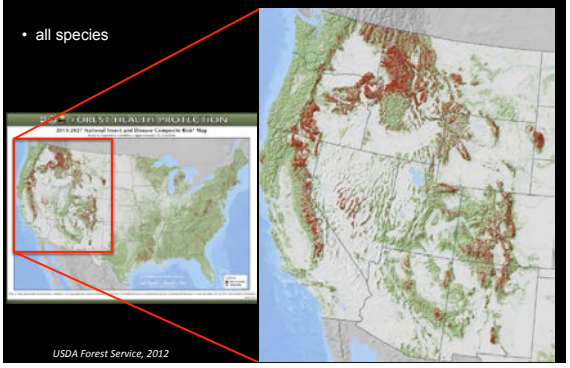
- mountain pine beetle in lodgepole pine
- USFS inventory data
- 47% of LPP is in a condition that would result in losses of 33% of basal area



Hicke and Jenkins, Forest Ecology and Management, 2008

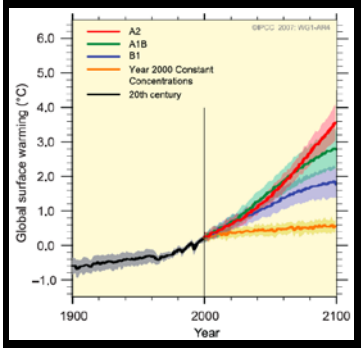
1. Forests are susceptible to outbreaks based on stand structure

- all species



USDA Forest Service, 2012

2. Continued climate change -> climate suitability

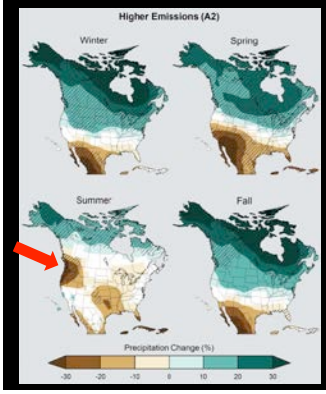


a. warming

- favorability for beetles
- increased host stress

Intergovernmental Panel on Climate Change, Fourth Assessment Report, 2007

2. Continued climate change -> climate suitability

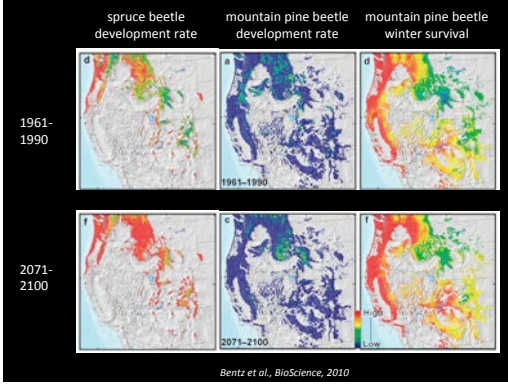


b. summer drying

- increased host stress

National Climate Assessment, 2014

Modeled warming effects



Bentz et al., BioScience, 2010

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Management options given future climate change

1. Help potential host trees

- increase diversity
  - species
  - age
- increase tree defensive capacity
  - thinning (stand level)
  - reduce future climate change

USFS


Photo: L. E. Maclauchlan

Management options given future climate change

2. Reduce beetle populations

- monitoring/rapid response after detection
- control (tree level)
  - spraying
  - chemical
- reduce future climate change

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www.monturecreek.com

Management options given future climate change

3. Other thoughts

- tree mortality is rarely complete
- early and landscape-scale management best
  - outbreaks are very difficult to stop
  - local management may have minimal effect
- promote acceptance while planning for impacts

Summary

- bark beetles are important forest disturbance agents
- recent climate change has facilitated extensive outbreaks
- extensive impacts to human and natural systems
- climate change will likely led to continued tree mortality
- management options exist, but are limited