Native Bark Beetles in the Rocky Mountains, US

Data from Forest Health Protection

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NATIVE Bark Beetle Species That Can Cause Landscape-Wide Tree Mortality in Northern Rocky Mountain Forests

**SPRUCE**
- Spruce beetle
  *Dendroctonus rufipennis*

**DOUGLAS-FIR**
- Douglas fir beetle
  *Dendroctonus pseudotsugae*

**PINES**
- Mountain pine beetle
  *Dendroctonus ponderosae*
- Roundheaded pine beetle
  *Dendroctonus adjunctus*
- Arizona fivespined ips
  *Ips lecontei*
- Pinyon ips
  *Ips confusus*
- Western balsam bark beetle
  *Droycoetes confusus*
- Western pine beetle
  *Dendroctonus brevicomis*

**TRUE FIRS**
- Fir engraver
  *Scolytus ventralis*
1925. Mountain pine beetle-killed lodgepole pine in Yosemite National Park, CA

Dendroecological reconstructions of spruce beetle outbreaks (Berg et al. 2007)
Native bark beetles have affected > 79 million acres in the western US over the past decade +

(USDA Forest Health Protection)
Bark Beetle-Caused Tree Mortality in 13 Western US States: 1999 to 2012

Data source: USDA Forest Service, Forest Health Protection, Aerial Detection Surveys
Susceptible landscape for bark beetle outbreaks -

• Large expanses of susceptible-aged and homogenous host trees
What makes a **susceptible landscape** for spruce beetle?

*Retrospective study of spruce beetle outbreaks in UT, AZ, CO (Hansen et al. 2009)*

- Study included stands treated between 1970 and 1990, and spruce beetle attacks occurred in the 1990’s.
- Stands with partial cutting treatments had reduced spruce mortality relative to untreated stands, but untreated stands had more residual spruce following outbreak.
- No differences in spruce regeneration between treated and untreated stands.
- Suggested refinement to Schmid and Frye (1976) ratings:
  - Use spruce SDI or spruce BA rather than total BA
  - Use density of spruce stems > 11 in DBH rather than average DBH of spruce > 10 in.
Susceptible landscape for bark beetle outbreaks -

• Large expanses of susceptible-aged and homogenous host trees

Assuming a susceptible landscape, multiple factors, associated with reduced tree defenses, can trigger bark beetle outbreaks -

• Temperature – *outbreaks often start on warm sites*
• Pathogens
• Windthrow, avalanches, logging residue (spruce beetle)
• Drought
Resin ducts

"Pitch out"

2002 drought provided trigger for MPB in CO (Chapman et al. 2012).

Drought is a potential trigger for spruce beetle populations as well (DeRose and Long 2012).

Susceptible landscape for bark beetle outbreaks -
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Assuming a susceptible landscape, multiple factors associated with tree defenses, can trigger bark beetle outbreaks -
- Drought
- Temperature
- Pathogens
- Windthrow, avalanches, logging residue (spruce beetle)

Once triggered, multiple factors influence beetle population growth -
- Concurrent suitable environmental factors (e.g., temperature) are required
- Susceptible landscape (stand) conditions become less correlated with tree mortality as outbreak progresses (DeRose and Long 2012, Aukema et al. 2008)
- Reduced tree defenses become less important as outbreak progresses (Boone et al. 2012)
Thresholds and positive feedback processes at multiple scales contribute to the eruptive, outbreak nature of bark beetle populations. Climate can have direct and indirect effects on population success at multiple scales.

Raffa et al. 2008, Bioscience
Temperature influences many feedback processes and can directly influence bark beetle success -

Seasonality – appropriately timed phenology that is synchronized among individuals to facilitate a mass attack on host trees.

Mortality due to cold temperatures

MPB - Bentz and Mullins 1999, Regniere and Bentz 2007
ESB - Miller and Werner 1987
Spruce beetle

Semivoltine

Univoltine

NO-larval diapause  YES-adult diapause

Proportion Univoltine brood =

\[ f \text{ (cumulative hours above } 17^\circ \text{C following peak flight biofix)} \]

(Hansen et al. Unpublished data)

June July Aug Sept WINTER  June July Aug Sept WINTER  June July Aug

1 year  2 years
Spruce beetle
Proportion univoltine brood = f (# hours > 17°C accumulated after Peak Flight Biofix)

Hansen et al. 2011
Reproductive Capacity of a

1 year (univoltine) beetle = 2 year (semivoltine) beetle

(Hansen & Bentz 2003)
Spruce beetle

Semivoltine

Diapause

Univoltine

NO-larval diapause

YES-adult diapause

Mountain pine beetle

Univoltine

Semivoltine

June July Aug Sept WINTER June July Aug Sept WINTER June July Aug

1 year

2 years
MPB Phenology

Instar-specific development rates and thresholds drive population synchrony and success.

From Bentz et al. 1991, Powell and Bentz 2009, Regniere, Powell, Bentz and Nealis 2012
Temperature can directly influence bark beetle success -

Seasonality – appropriately timed phenology that is synchronized among individuals to facilitate a mass attack on host trees.

Mortality due to cold temperatures

MPB - Bentz and Mullins 1999, Regniere and Bentz 2007
ESB - Miller and Werner 1987
Annual acres affected in Colorado-

Spruce beetle

Mountain pine beetle

http://csfs.colostate.edu/pages/common-insects.html
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