Seed release after a mountain pine beetle outbreak

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Rocky Mountain lodgepole pine
(*Pinus contorta* var. *latifolia*)
Natural regeneration post MPB outbreak?

Natural regeneration under its own canopy?
Over 10 M ha killed, 46% in 2007 and ~ 76% in 2015
The resin bond
Seed banks post MPB
Research objectives

• The first objective was to determine if canopy seed release after a MPB outbreak in lodgepole pine forests occurs and how.

• The second objective was to model the temporal changes in the canopy and forest floor seed banks after a MPB outbreak.
Methods - Research sites
Methods – MPB-attacked stands
Methods – Surface cones
(recently fallen canopy cones)
Methods - Live residual trees
Methods - Cone openness

100% 75% 50% 25% 0%

Closed Open Partially open

Open Partially open Closed
Methods - Buried cones

Embedded in moss

Below moss
Results – Canopy-cone release

- Chart showing the number of cones (x10^2 ha^-1) for different colors:
  - Green
  - Red
  - Gray

- Diagram illustrating the process:
  - Canopy
  - Seed bank
  - Cone release
  - Surface cones
Results – Canopy-cone release

Cones are released onto the forest floor due to crown friction resulting in twig breakage.
Results – Canopy-cone opening
(Partial loss of serotiny)
Results – Canopy-cone opening (Partial loss of serotiny)

Canopy cones open due to increase sun exposure and weathering resulting in a partial loss of serotiny.
Results – Squirrel predation

Predation of surface cones

Predation adjusted for cone density

Relative predation (%)
Results – Squirrel predation

Squirrel predation persists in MPB-attacked stands resulting in a sustained reduction in the number of canopy cones.
Results – Forest floor-cone opening
Results – Forest floor-cone opening

Surface cones open and release seed due to soil-surface heating.
Results – Cone burial

**Embedded in moss**

**Below the moss**

![Diagram showing cone burial process]

- Forest floor
- Surface cones
- Cone burial
- Buried cone seed bank
Results – Cone burial

A forest floor-seed bank develops and maybe ecologically important if a secondary disturbance re-exposes these buried cones.
Results – Seed banks

After 6 years post MPB-outbreak, 45% of the canopy seed were released while 6% are still in cones buried in the forest floor.
Conclusions

• After six years, 45% canopy seed released
• Release via breakage, increased cone opening, and squirrel predation
• Forest floor-seed bank develops
• If normal levels of regeneration are to occur, either anthropogenic or fire disturbances must happen relatively soon after tree mortality.
What about fire post MPB?

Cone consumption by fire post MPB?
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