MOUNTAIN PINE BEETLE PRODUCTIVITY IN WHITEBARK PINE

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Whitebark Pine Ecosystem Foundation Annual Science Meeting

Whitebark Pine: Keystone and Foundation Species

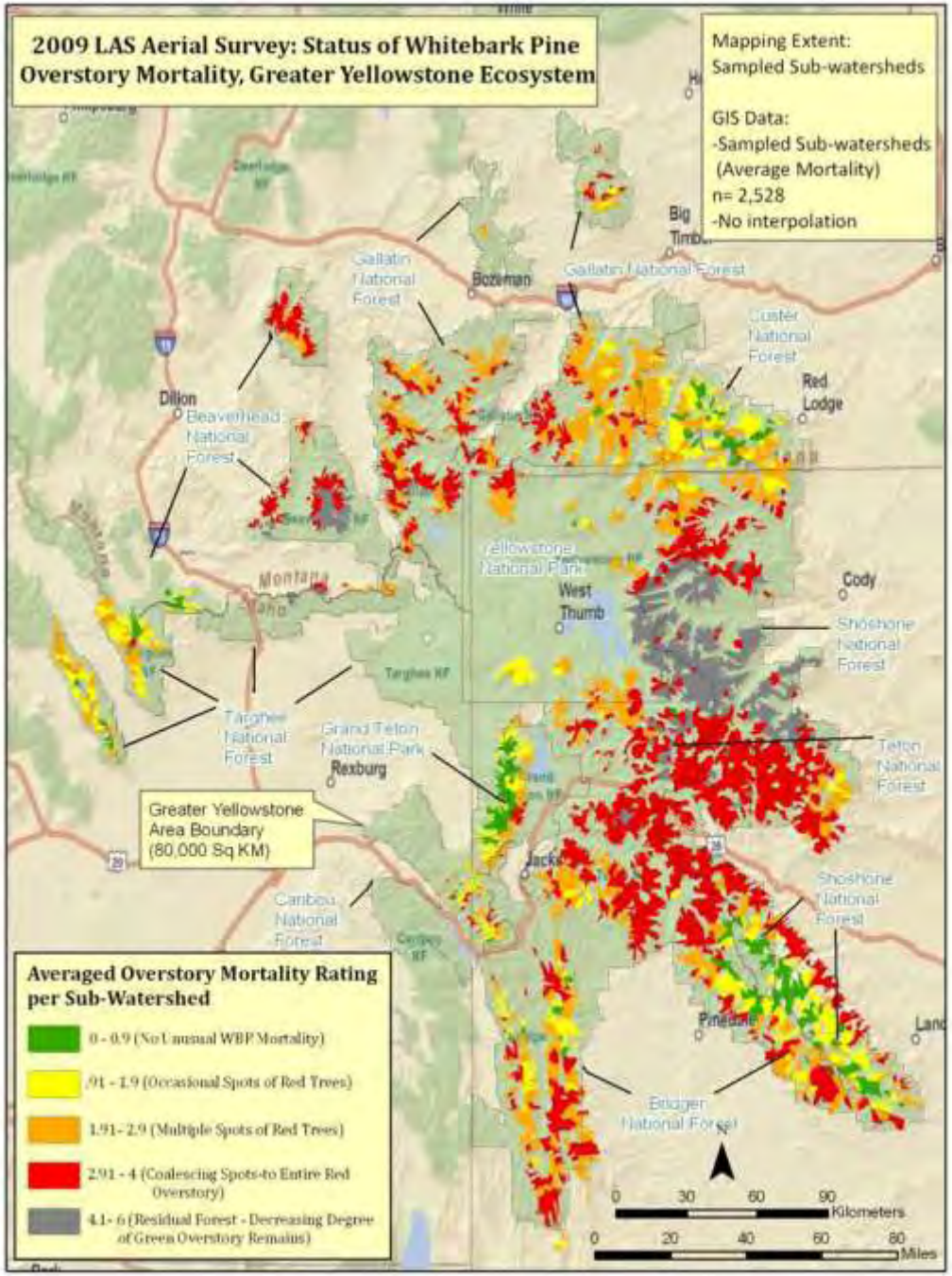
Threats: Mountain Pine Beetle (MPB)(*Dendroctonus ponderosae*)

Whitebark Decline in the Greater Yellowstone Ecosystem

MPB caused whitebark mortality

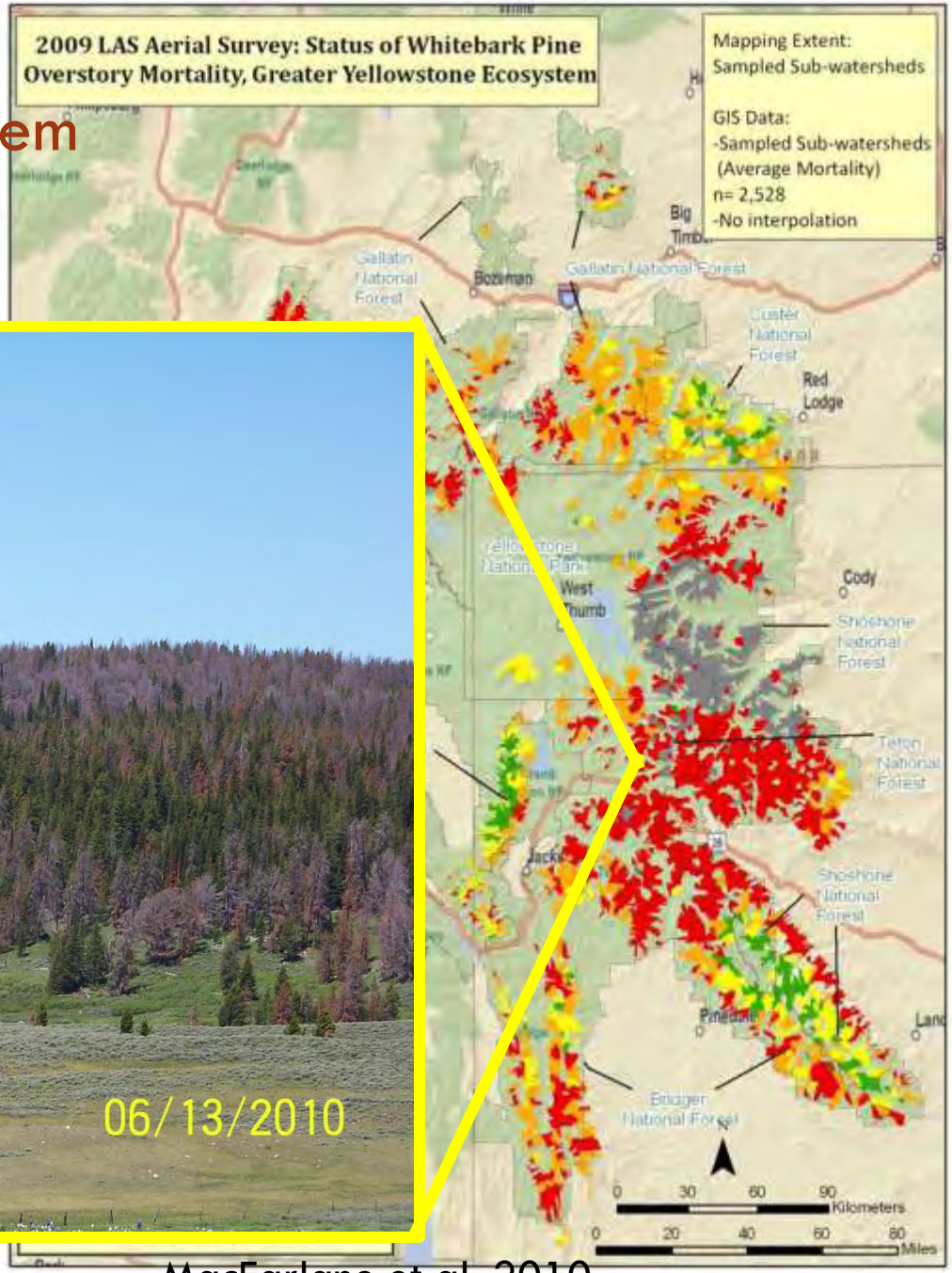
- ❑46% - high mortality
- ❑36% - medium mortality
- ❑13% - low mortality
- ❑5% -no mortality

- ❑>80% significant mortality



MacFarlane et al. 2010

Whitebark Decline in the Greater Yellowstone Ecosystem



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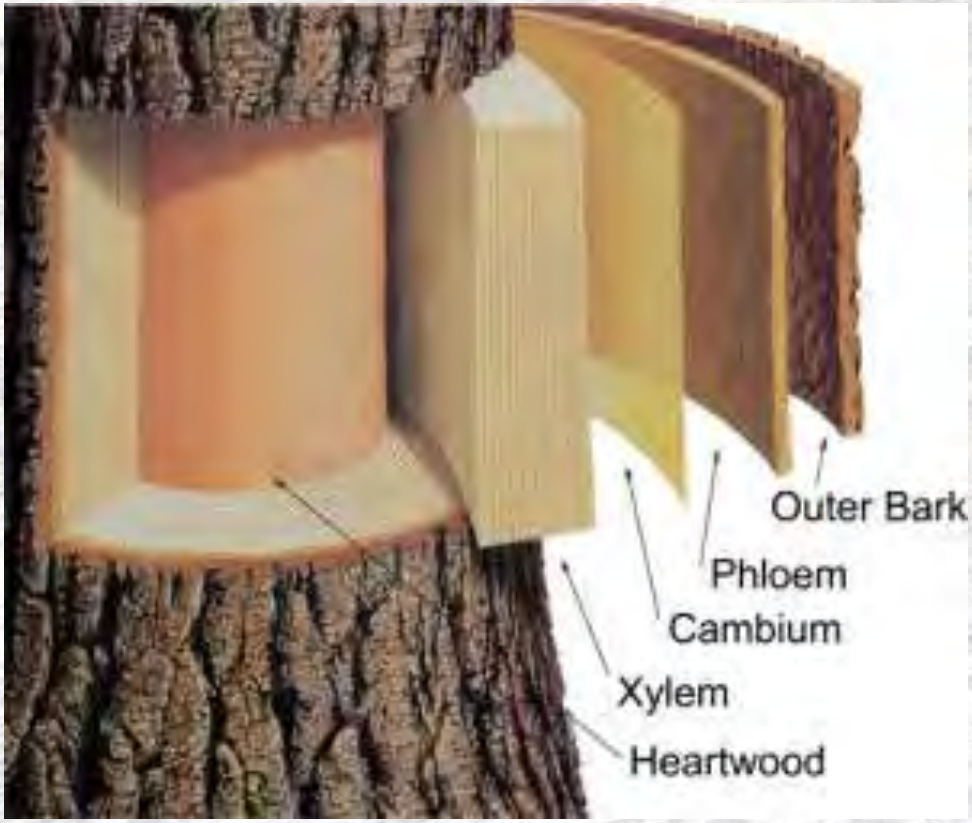
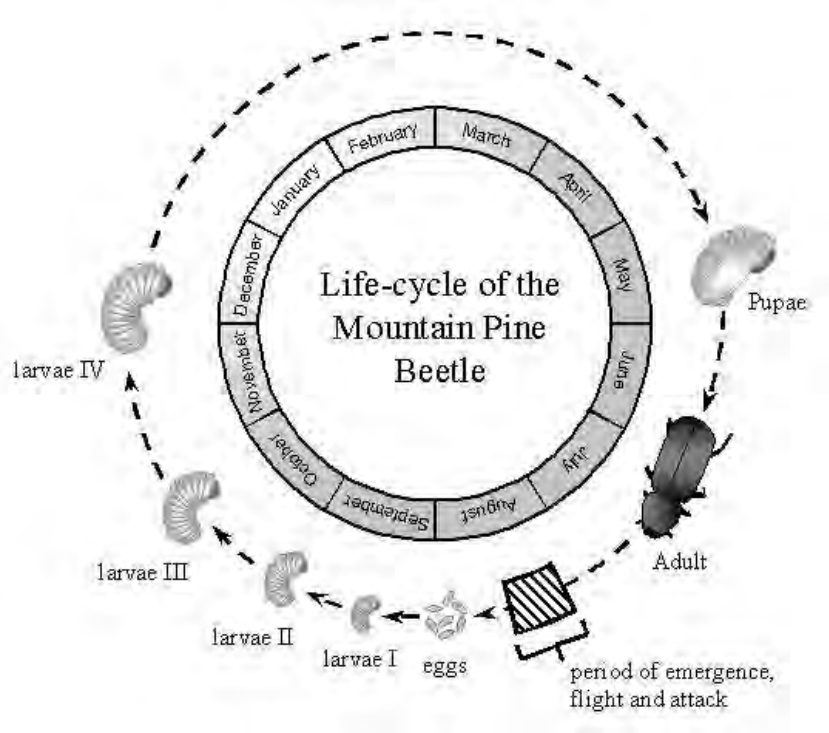
MPB Biology

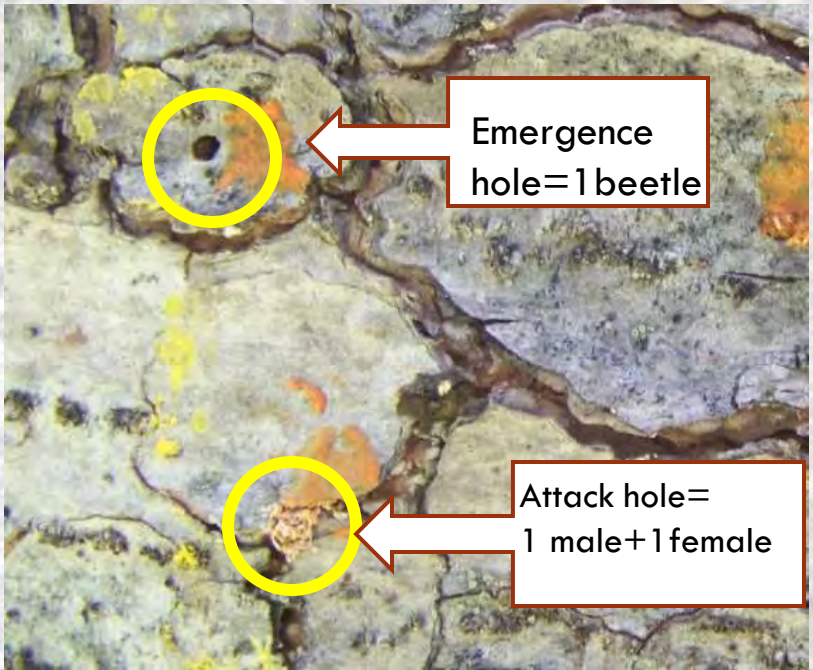


http://essmextension.tamu.edu/treecarekit

Photo: Ryan Bracewell

MPB Biology


Life-cycle of the Mountain Pine Beetle
January
February
March
April
May
June
July
August
September
October
November
December
Pupae
Adult
period of emergence, flight and attack
eggs
larvae I
larvae II
larvae III
larvae IV


Emergence hole=1 beetle
Attack hole= 1 male+1 female

Why are MPB outbreaks so extensive in whitebark pine?

Climate?

- High elevations were previously too cold for MPB development
  (Amman 1973, Safranyik 1978)
- ~2°C warming of average annual temperature was predicted a shift MPB from 2 to 1 year life cycle in high elevations
  (Logan and Powell 2001)

Superior Host?

- MPB prefer to attack whitebark pine over lodgepole pine
  (Six and Adams 2006, Bokino 2008)

06/13/2010

Host Question

Is there a difference in beetle attack rate, body size or emergence rate between whitebark and lodgepole pine?

Previous Work:

MPB fitness was lowest when emerging from lodgepole pine compared with ponderosa pine, western white pine and whitebark pine (Amman 1982).

MPB fecundity was higher from lodgepole than whitebark pine, but MPB emerging from whitebark pine were larger (Gross 2008).

Hypothesis

- Whitebark pine is a better host for mountain pine beetles than lodgepole pine.

Predictions

- More beetles will attack & emerge from whitebark than lodgepole pine.
- Attack density & emergence rate are positively related to tree DBH regardless of species.
- MPB emerging from whitebark pine will be larger than those emerging from lodgepole pine.

MPB measures

- Both body size and numbers emerging

Bigger beetles

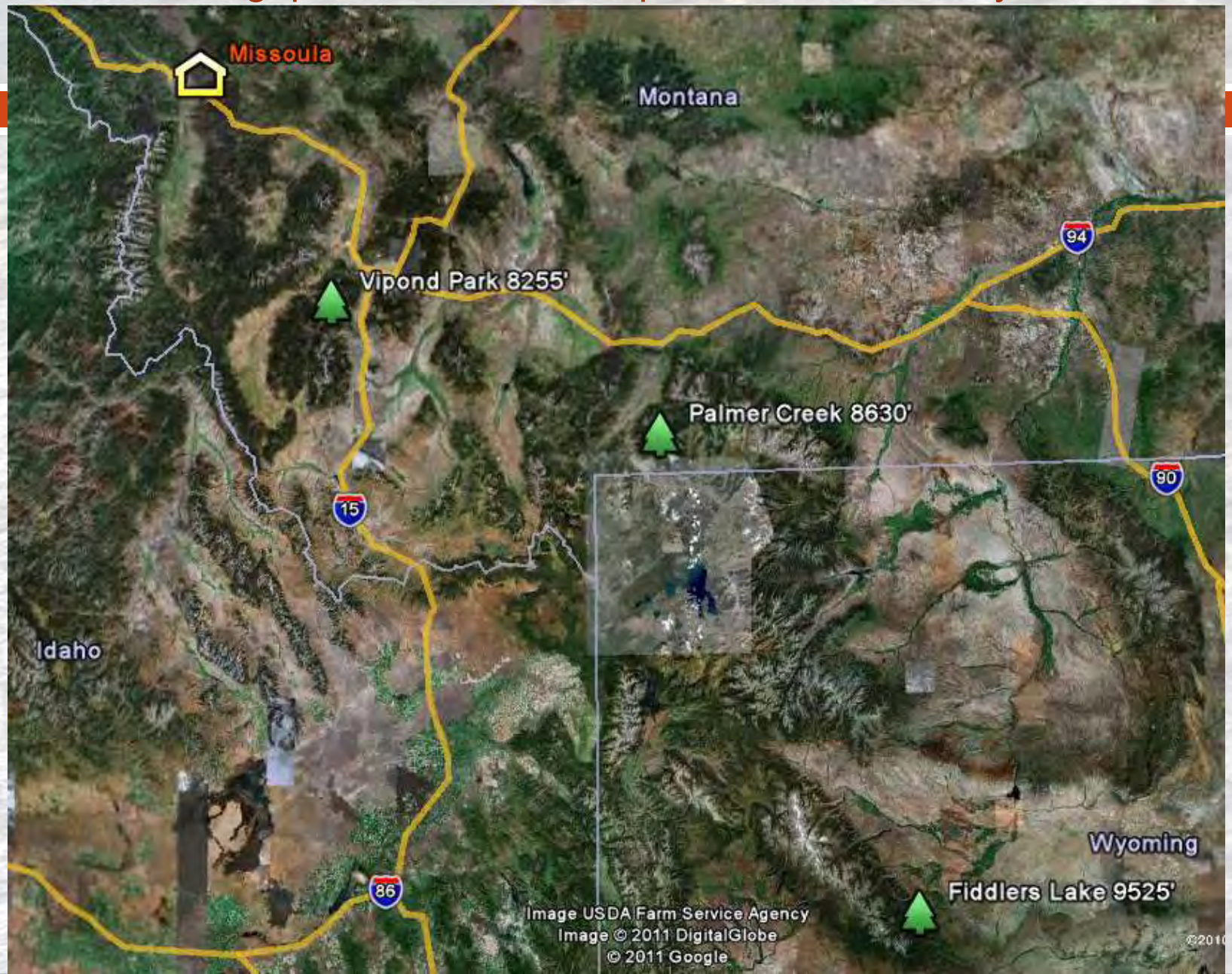
- produce more, and larger eggs
- fly further
- are more cold hardy
- produce more pheromones

More beetles

- can kill more trees!

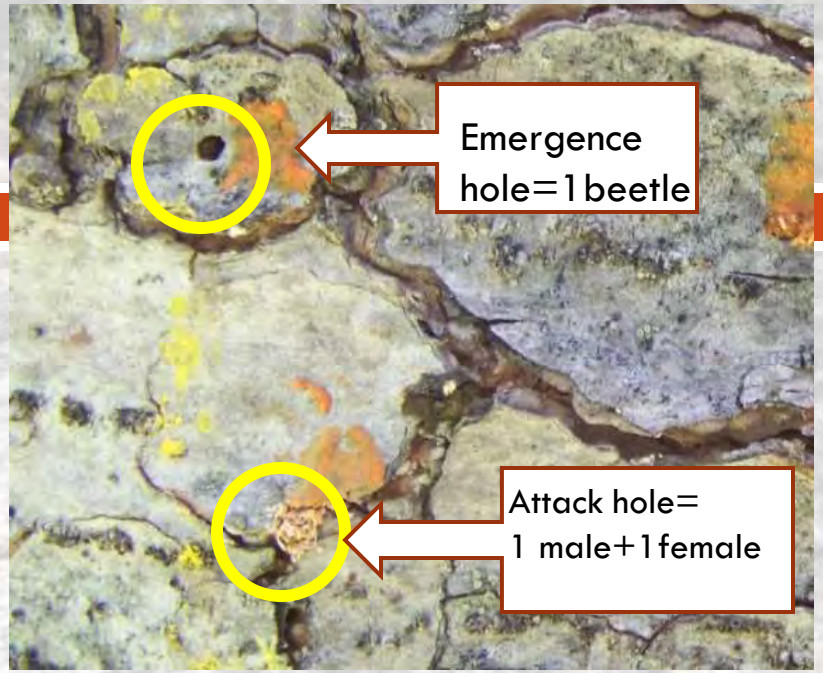
Photo: Ryan Bracewell

3 Sites-mixed lodgepole and whitebark pine stands with very low blister rust



Methods

emergence cage



pronotum width

MPB Attack Dynamics

- within tree species, each 1 cm increase in tree DBH related to 2.9% (±0.8) more attacks (t=3.83, df=174, p<0.001
- 12.5% (±7.8) more MPB attacks on whitebark pine than on lodgepole pine (t=1.94, df=174, p=0.054)

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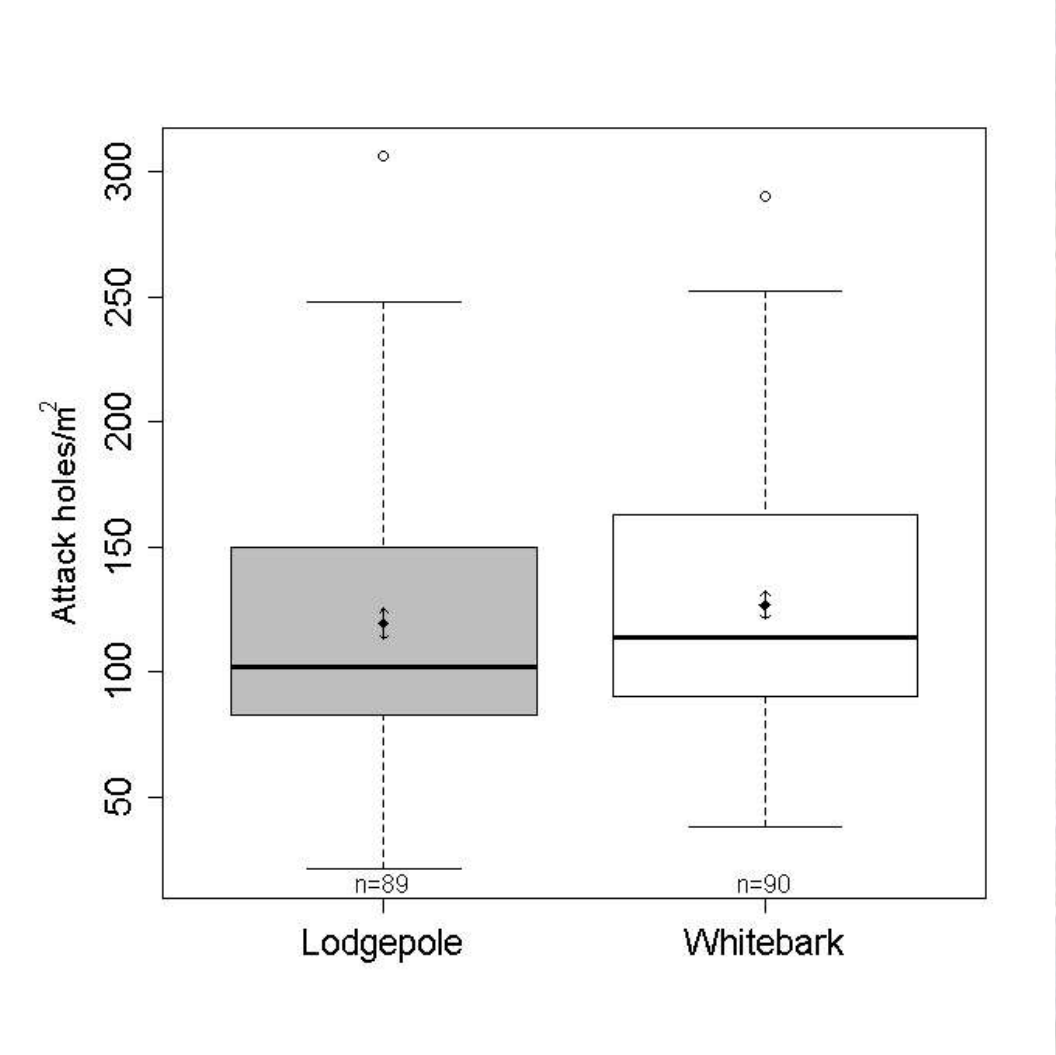


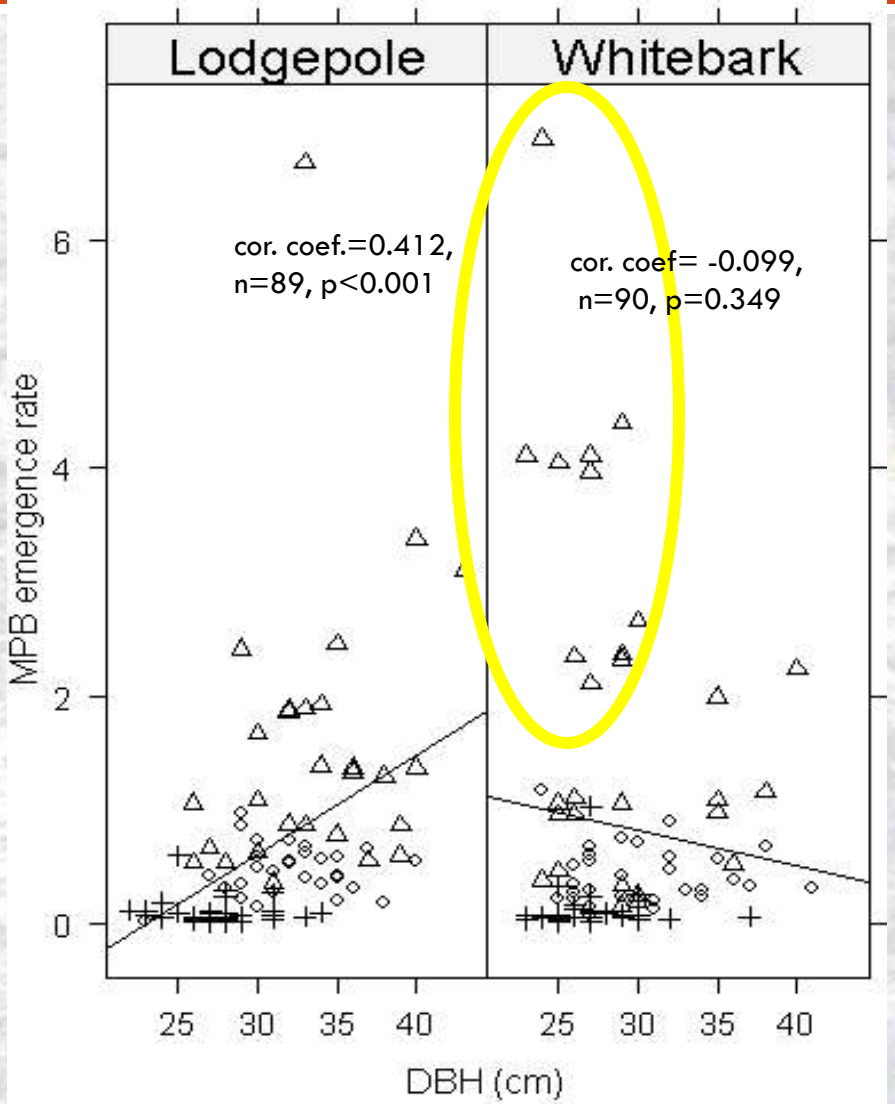
Emergence Rate Between Species

Emergence rate=# emergence holes/ # entrance holes

- MPB emergence rate increased by 5.6% (±1.7) for each one centimeter increase in DBH
- emergence rate declined exponentially as entrance hole density increased
- 8 (±5.5) times more MPB emerging out of whitebark pine than lodgepole pine (holding entrance hole density and DBH constant)

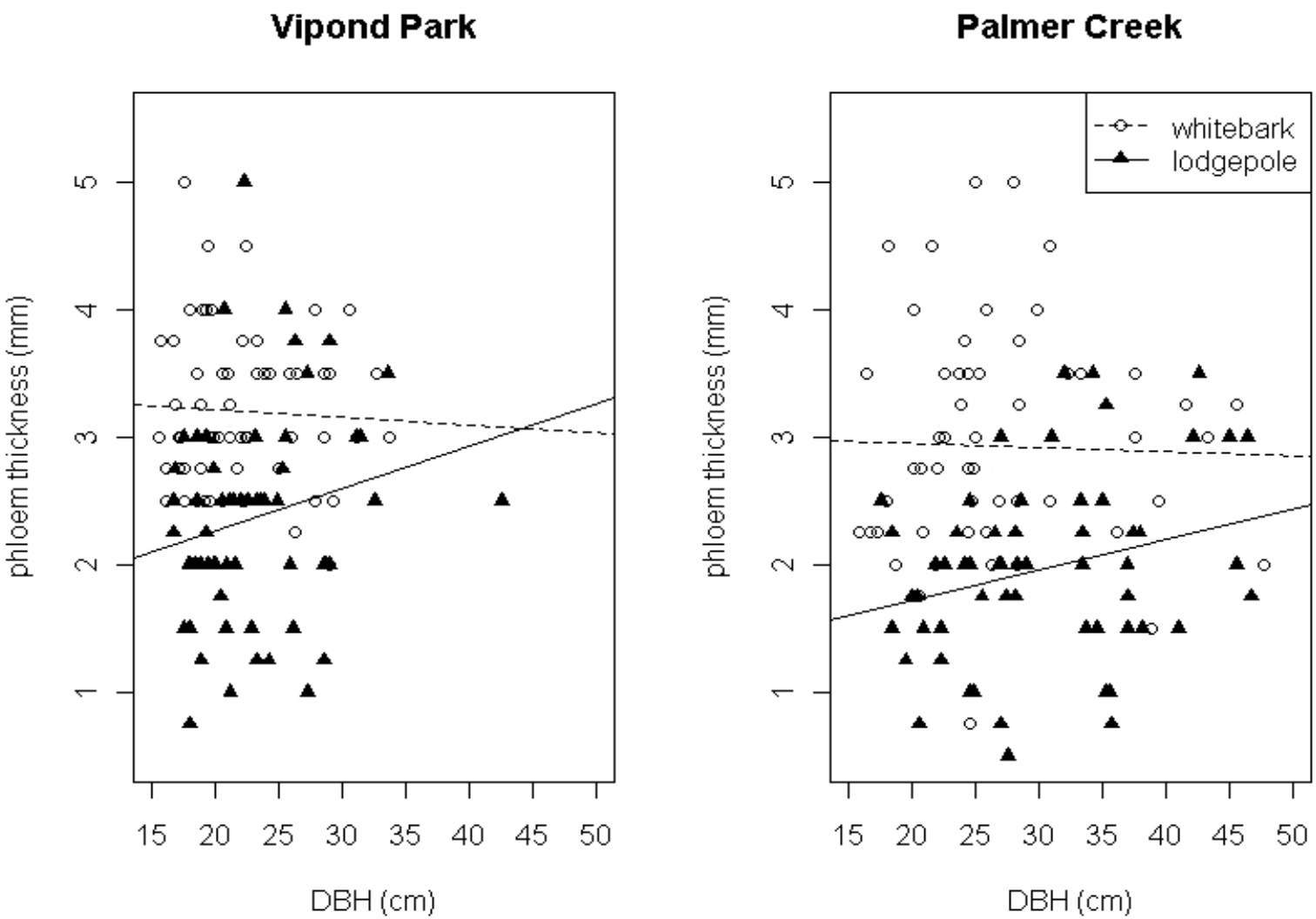
A Complicated Story

- the relationship between MPB emergence and tree DBH is different between tree species



What's going on with these highly productive, small trees?

Small whitebarks have thicker phloem than small lodgepole at 2 of my study sites

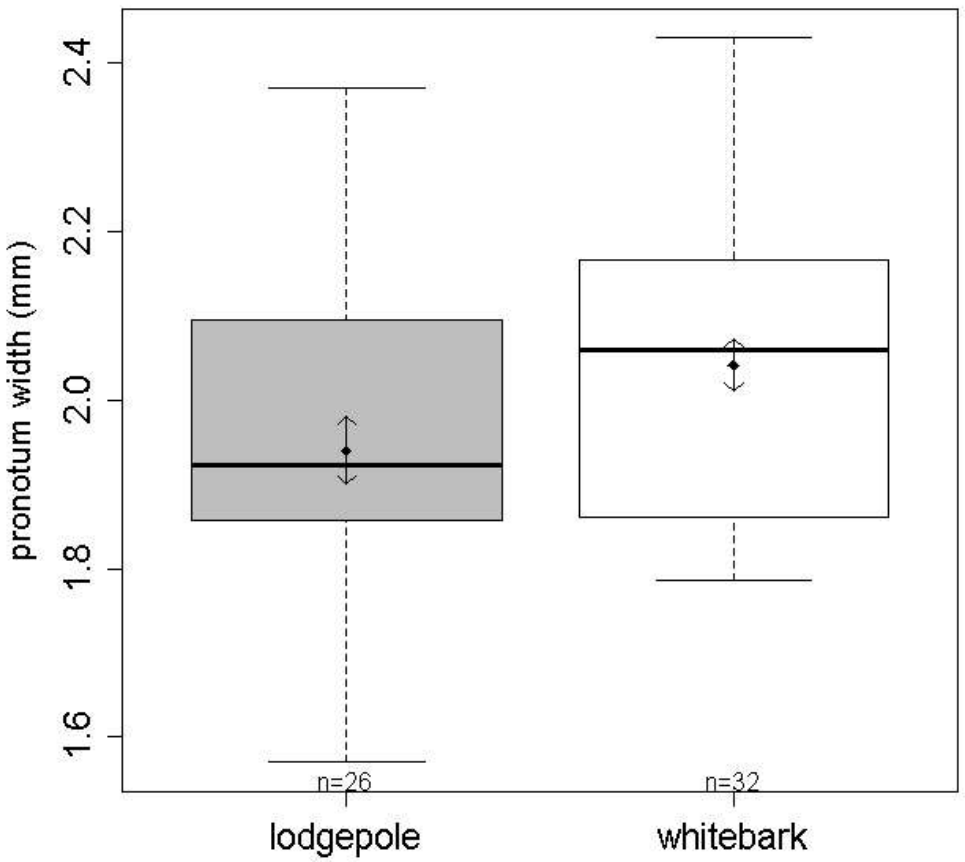


Beetle size did not differ between species

- sex of beetle was a significant predictor of beetle size (t=-2.69, df=43, p=0.010).

- there was no difference in beetle size between tree species

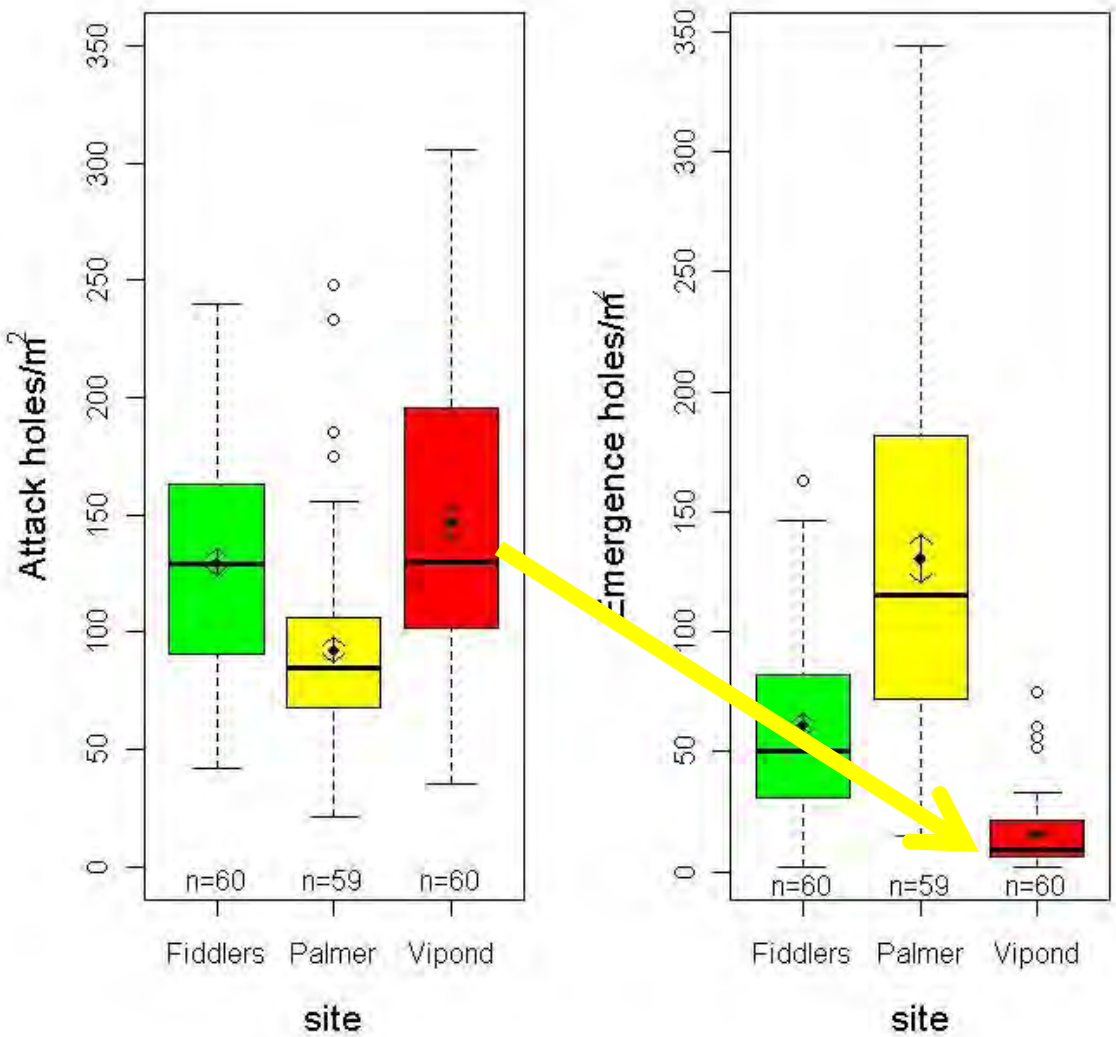
  (t=0.70, df=12, p=0.500)



Populations at each site

- no significant differences in MPB population decline *between species* at any site

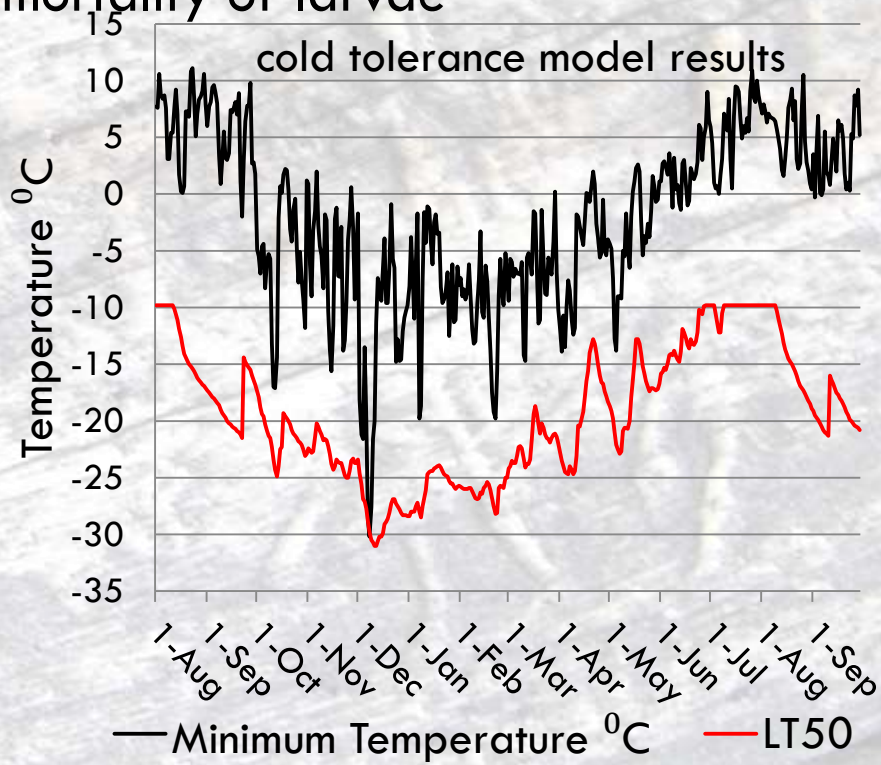
(Vipond Park: t=1.687, df=58, p=0.097, Palmer Creek: t=-1.410, df=57, p=0.164, Fiddler's Lake: t=0.671, df=58, t=0.505).



Investigating Population Crash

Synchronous termination of larval galleries

- integrated phenological and cold tolerance model predicted only 27% survival of larvae
- mid October -15° C cold snap caused 98% mortality of larvae



Host Tree Question Conclusions

- Beetle size does not differ between whitebark and lodgepole pine.
- Beetle emergence rate is higher out of whitebark pine
- relationship between DBH & emergence rates is different between whitebark and lodgepole pine
  - may be due to thicker phloem in small whitebark
- An October cold snap likely killed developing larvae
- The conclusive power of these results was likely affected by the low emergence rate and sample size.

Questions?