Monitoring Mountain Pine Beetle Life Cycle Timing at Multiple Elevations and Latitudes in California

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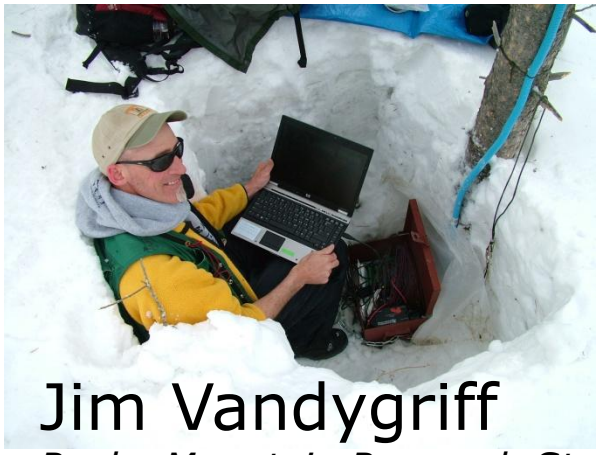

Jim Vandygriff

Rocky Mountain Research Station
Logan, UT

Dendroctonus ponderosae

Cooperators

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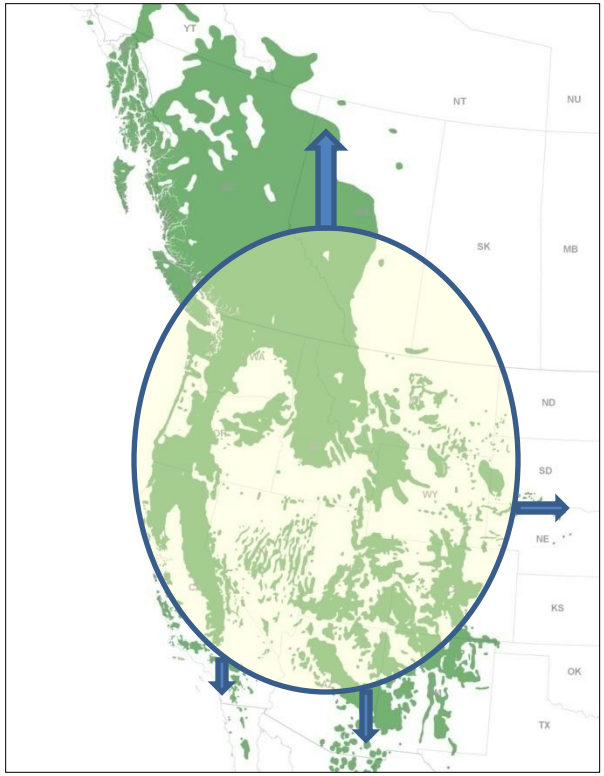
FOREST HEALTH PROTECTION

Dendroctonus ponderosae
Mountain pine beetle (MPB)



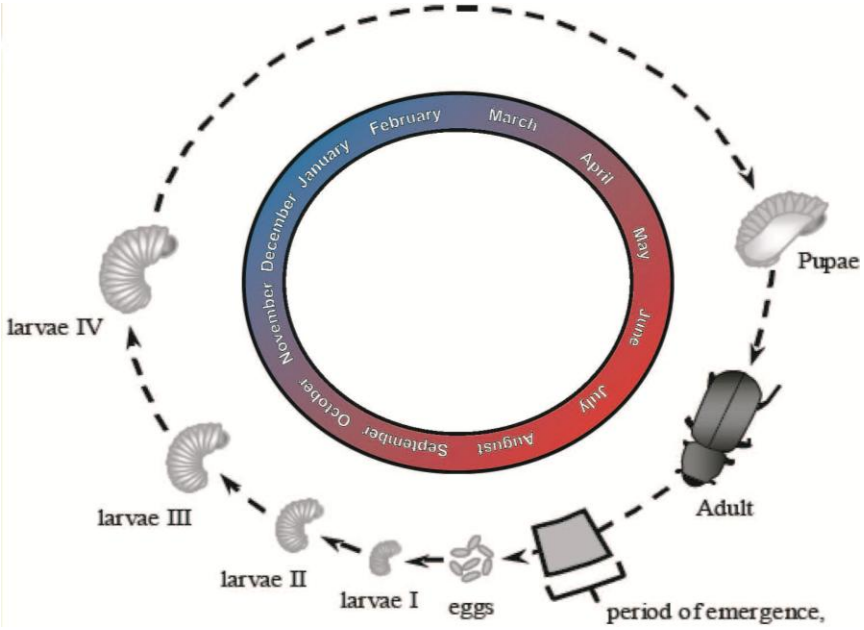
Current MPB host tree associations:

Pinus contorta
P. monticola
P. ponderosa
P. lambertiana
P. monophylla
P. albicaulis
P. flexilis
P. balfouriana
P. aristata
P. longaeva
P. strobiformis
P. banksiana

Mountain pine beetle (MPB) distribution is limited by climate not host trees.
MPB distribution is expanding.

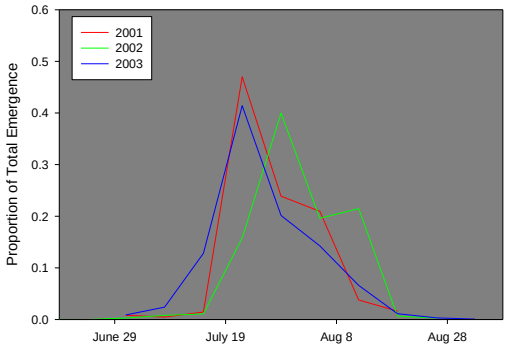
~41m acres affected in western US (1999 – 2011)

Temperature can directly influence MPB success



Seasonality –

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

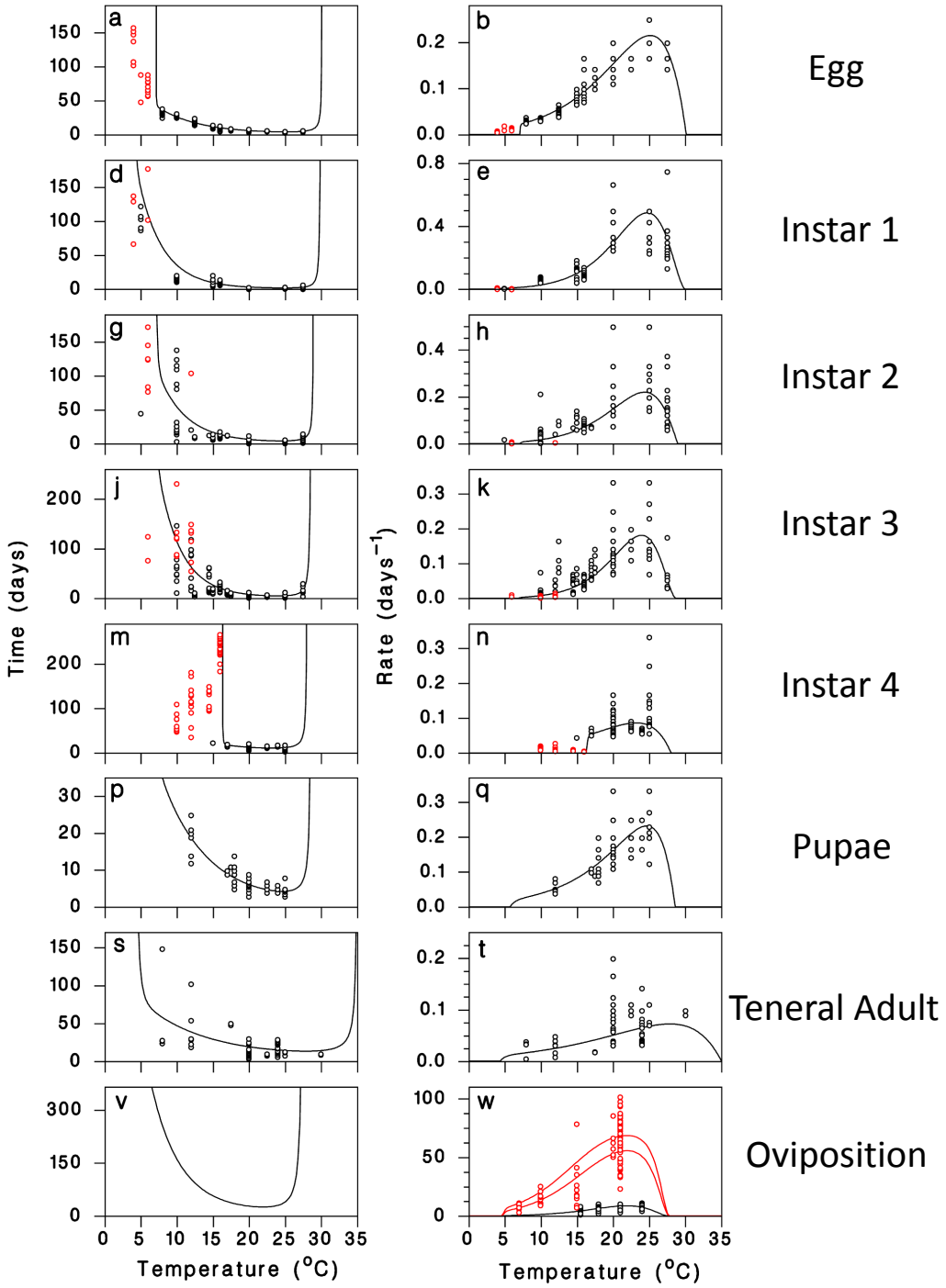


Beetle wins

Beetle loses

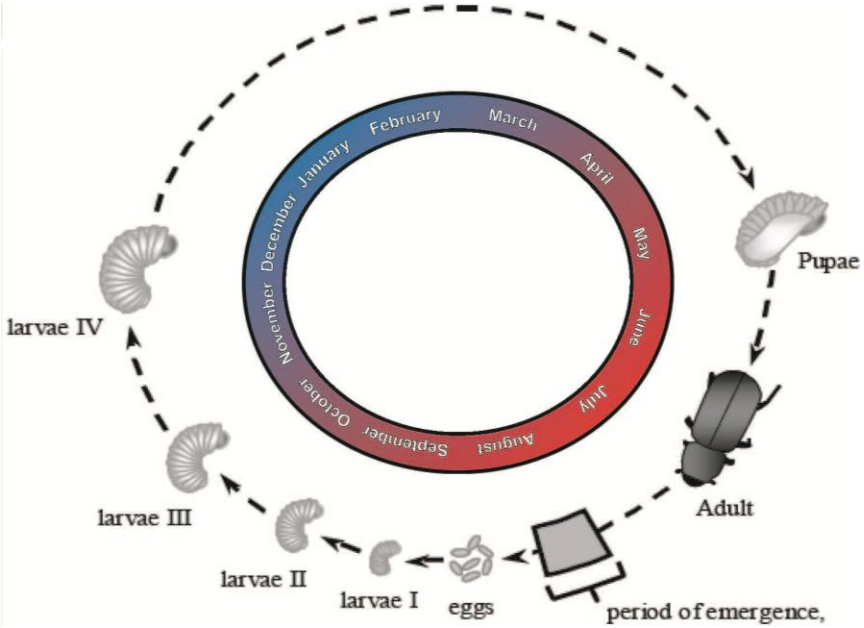
MPB Phenology

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



From Bentz et al. 1991, Powell and Bentz 2009, Regniere, Powell, Bentz and Nealis 2012

Temperature can directly influence MPB success



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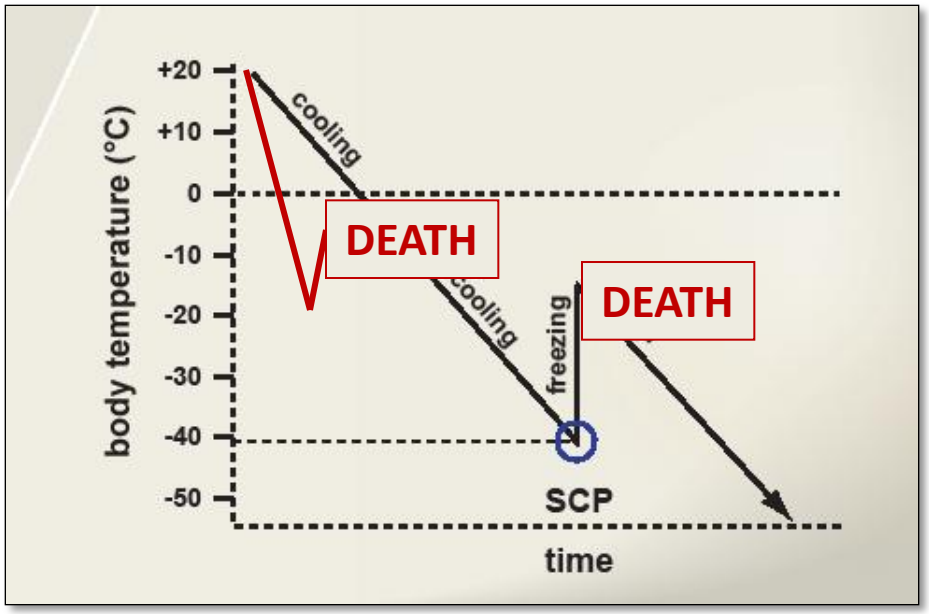
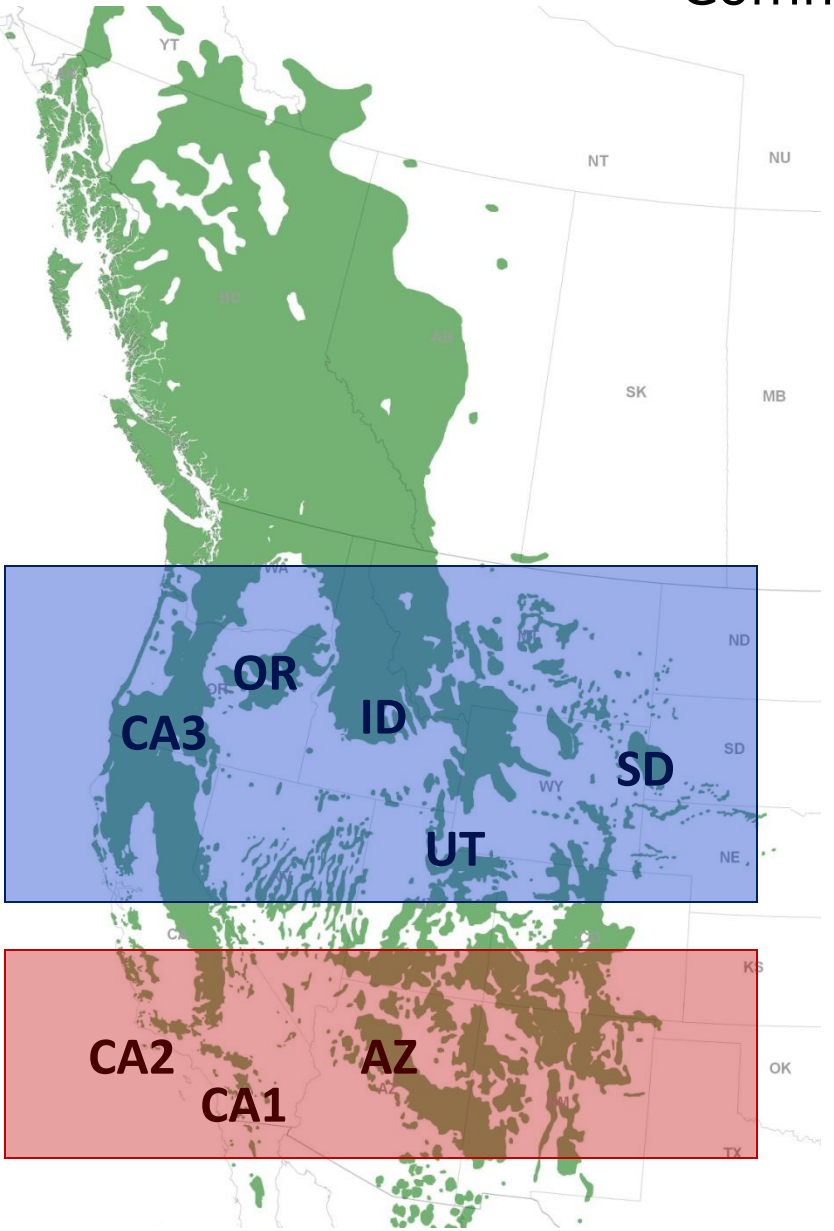
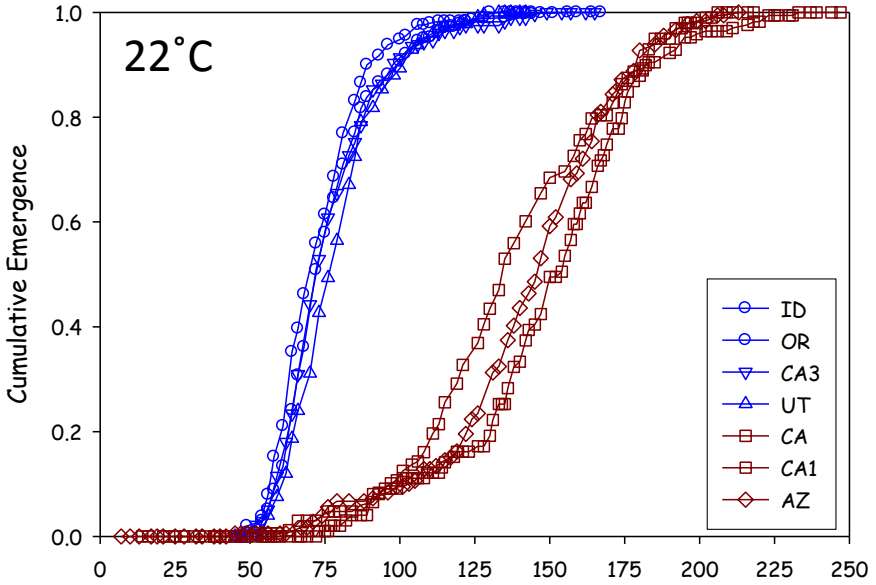


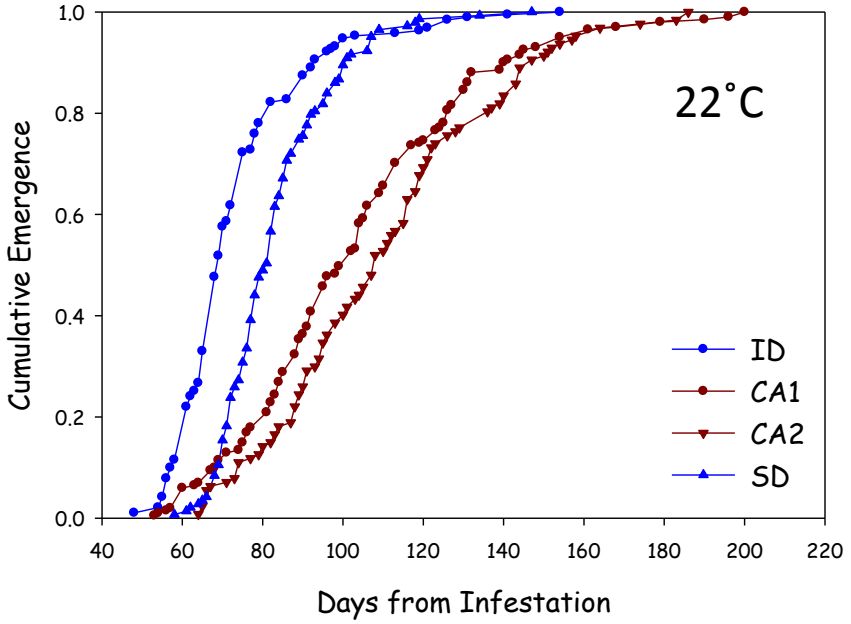
Mortality due to cold temperatures

Bentz and Mullins 1999,
Regniere and Bentz 2007

Common Garden Rearing Experiments

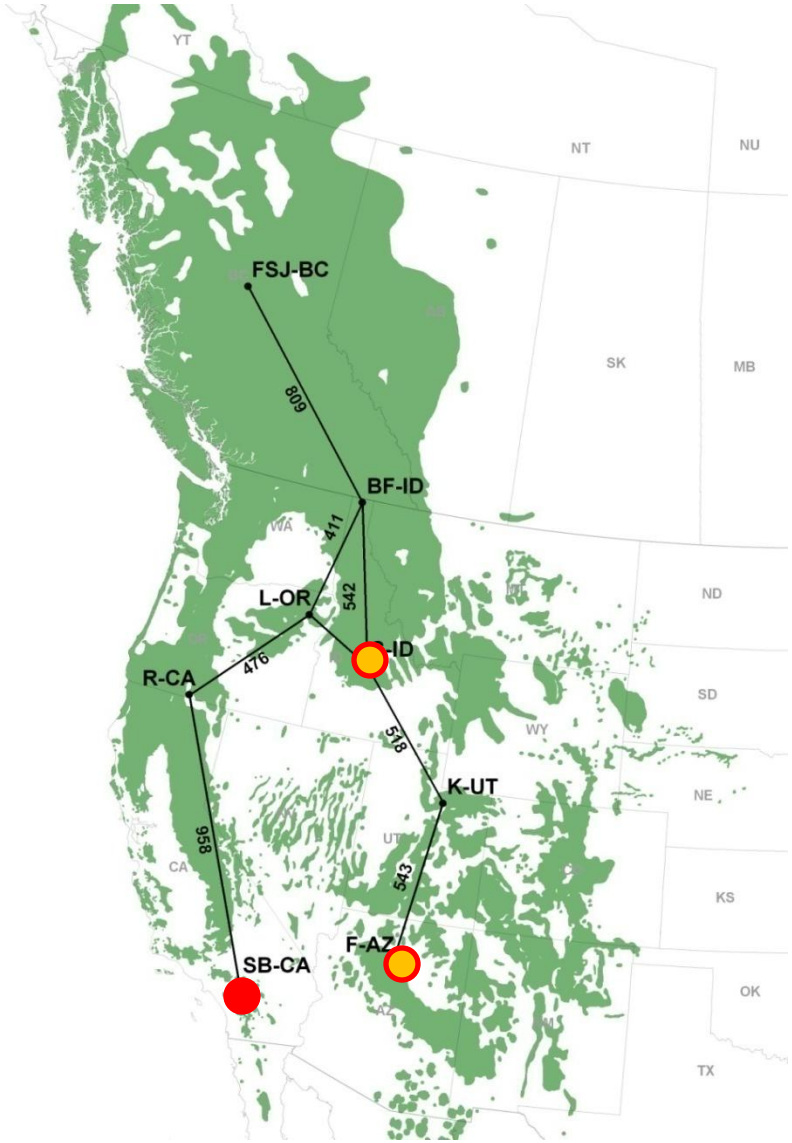




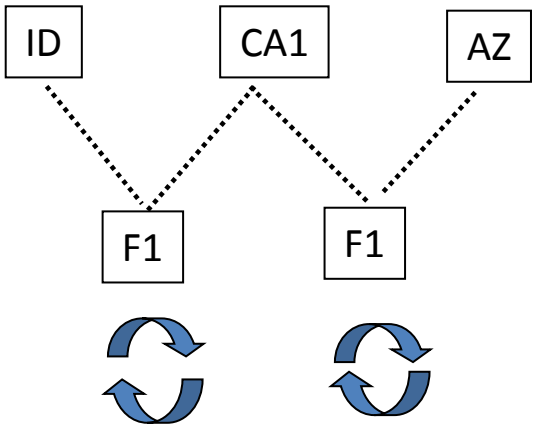


Bracewell et al. 2010; Bentz et al. 2001, 2011

Phylogeography of mountain pine beetle



- Based on AFLP data, gene flow occurs in a horseshoe-shaped distribution around the Great Basin and Mojave deserts.
- CA and AZ populations are the most divergent.
- Mating studies show a reproductive incompatibility between populations on the eastern and western sides of the Great Basin.



From Mock et al. 2007; Bentz et al. 2011; Bracewell et al. 2010

No offspring due to sterile males !!

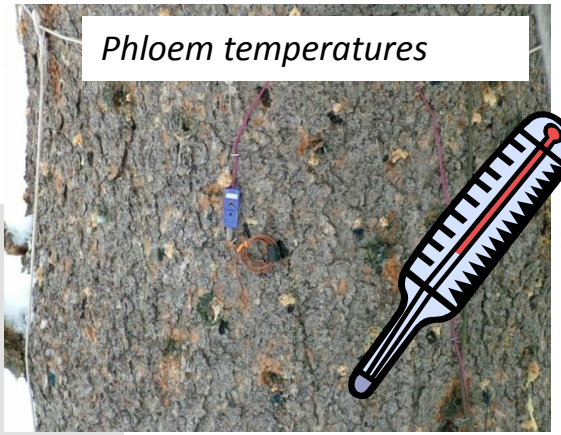
Objectives

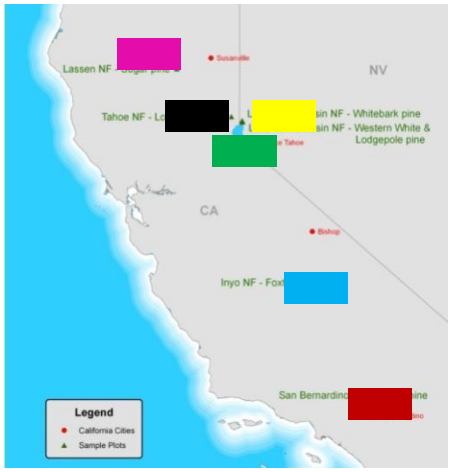
- Develop baseline information on mountain pine beetle lifecycle timing across multiple latitudes and elevations in California.

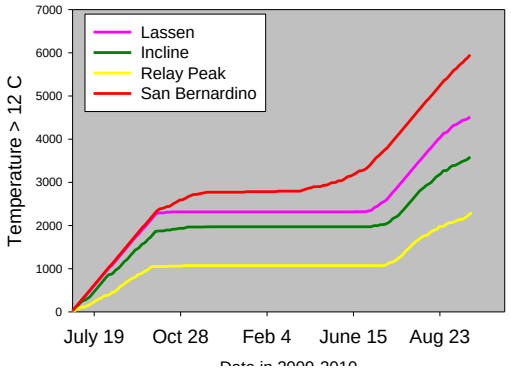
- Evaluate the potential for bivoltine (2 generations per year) populations in California.

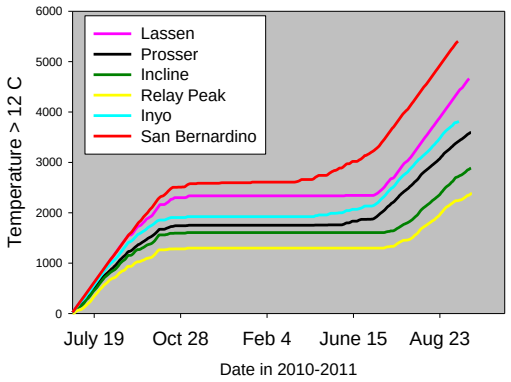
- Evaluate how well our mountain pine beetle phenology model predicts developmental timing in California.

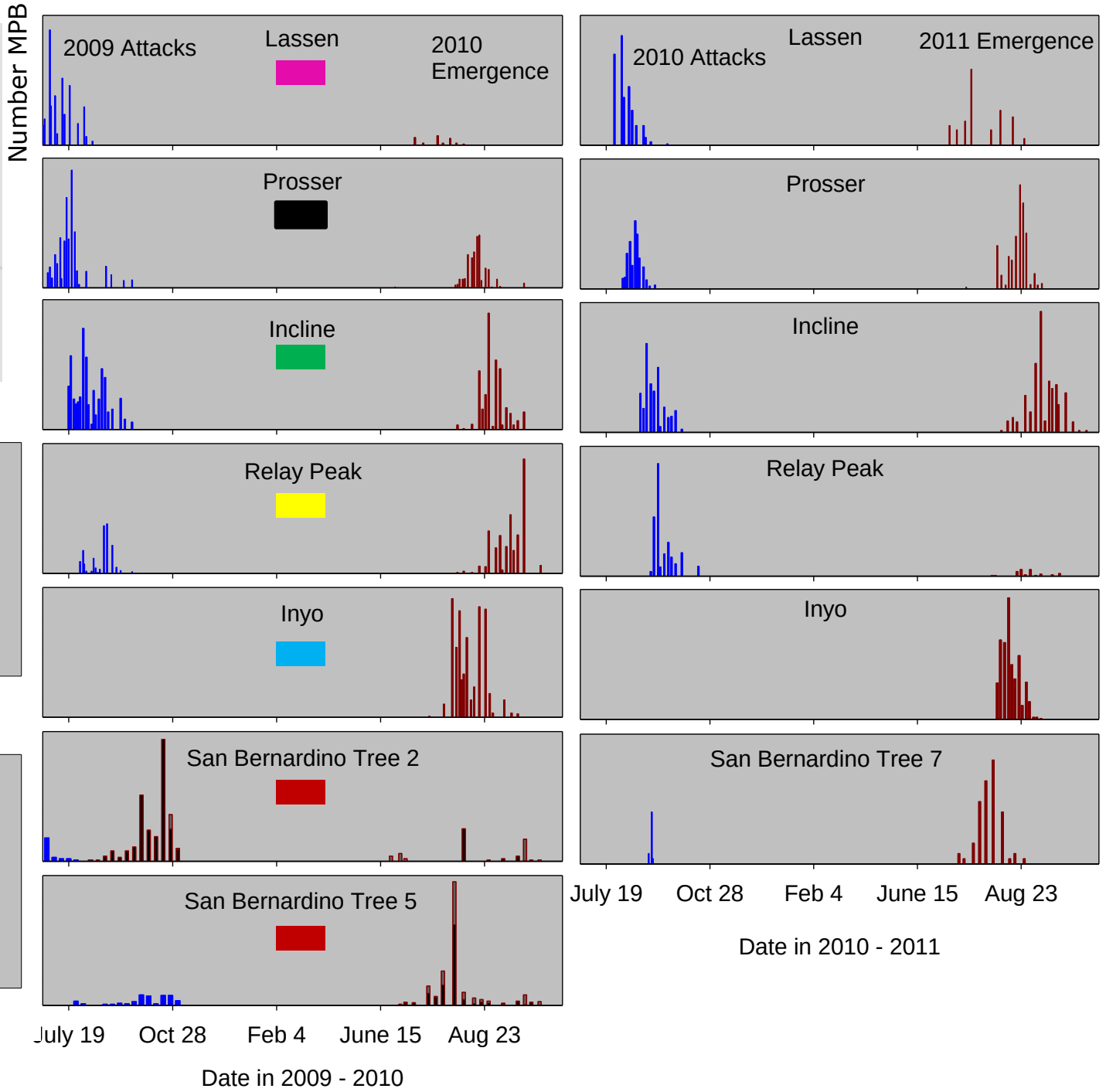
Mountain pine beetle lifecycle monitoring in California, 2009 - 2012




NV
CA
Legend
California Cities
Sample Plots

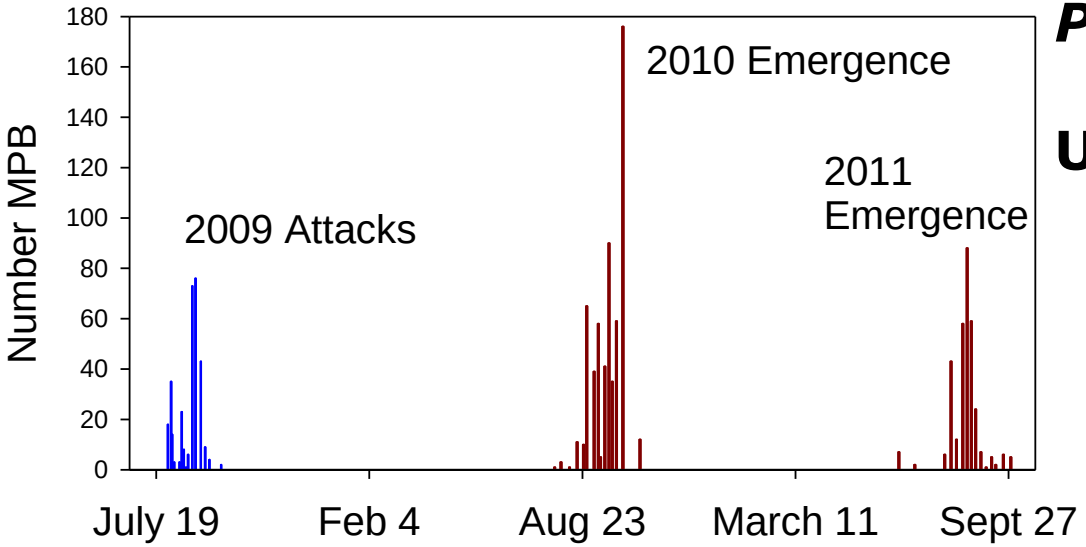

Lassen
Incline
Relay Peak
San Bernardino
Temperature > 12 C
July 19
Oct 28
Feb 4
June 15
Aug 23

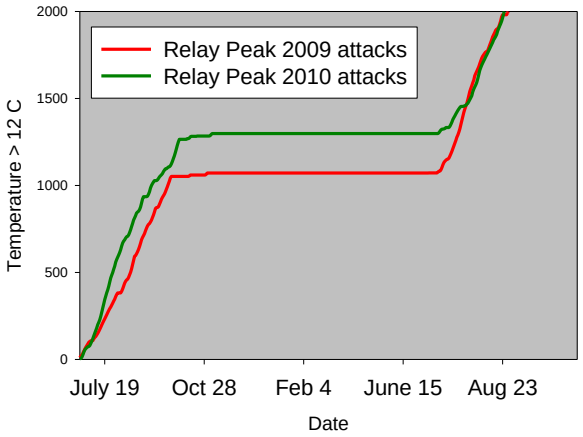

Lassen
Prosser
Incline
Relay Peak
Inyo
San Bernardino
Temperature > 12 C
July 19
Oct 28
Feb 4
June 15
Aug 23
Date in 2010-2011

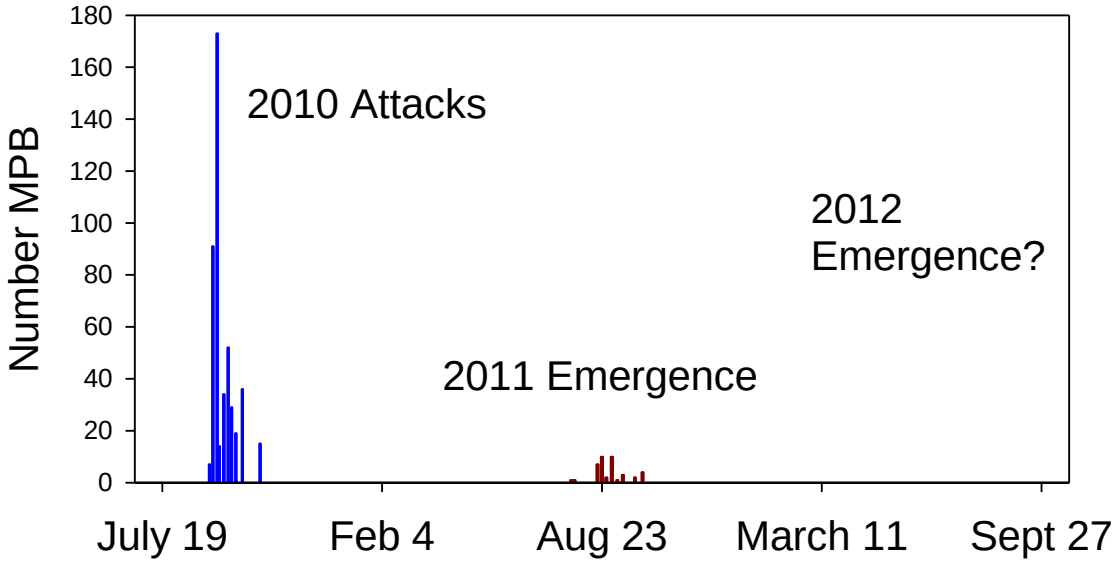

Number MPB
2009 Attacks
Lassen
2010 Emergence
2010 Attacks
2011 Emergence
Prosser
Incline
Relay Peak
Inyo
San Bernardino Tree 2
San Bernardino Tree 7
San Bernardino Tree 5
July 19
Oct 28
Feb 4
June 15
Aug 23
Date in 2009 - 2010
Date in 2010 - 2011

Relay Peak, Tahoe Basin MU
Pinus albicaulis 2907 m

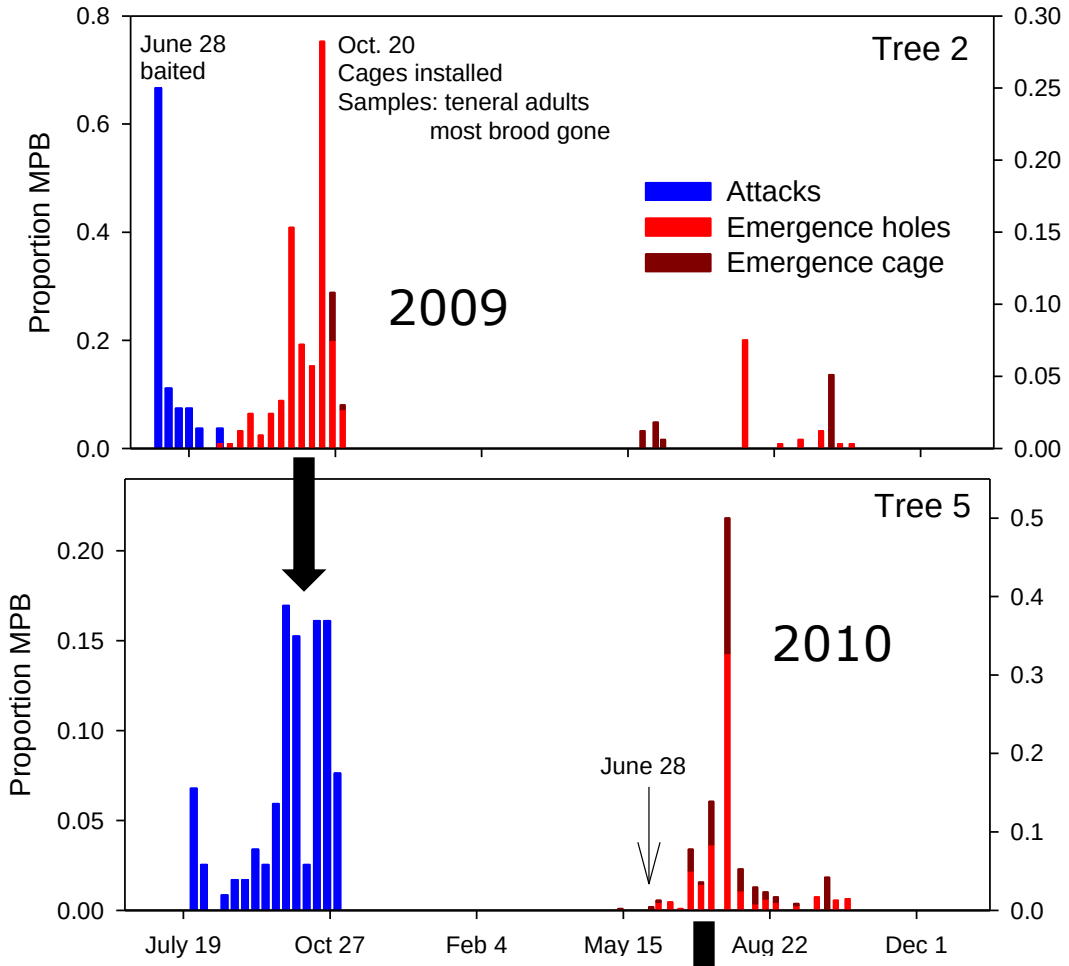
Univoltine – Semivoltine Mix





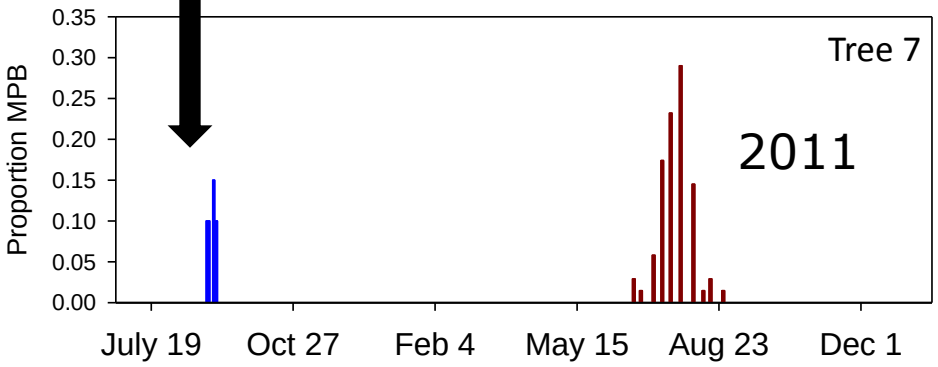


San Bernardino NF, CA
Pinus monophylla, 2079 m



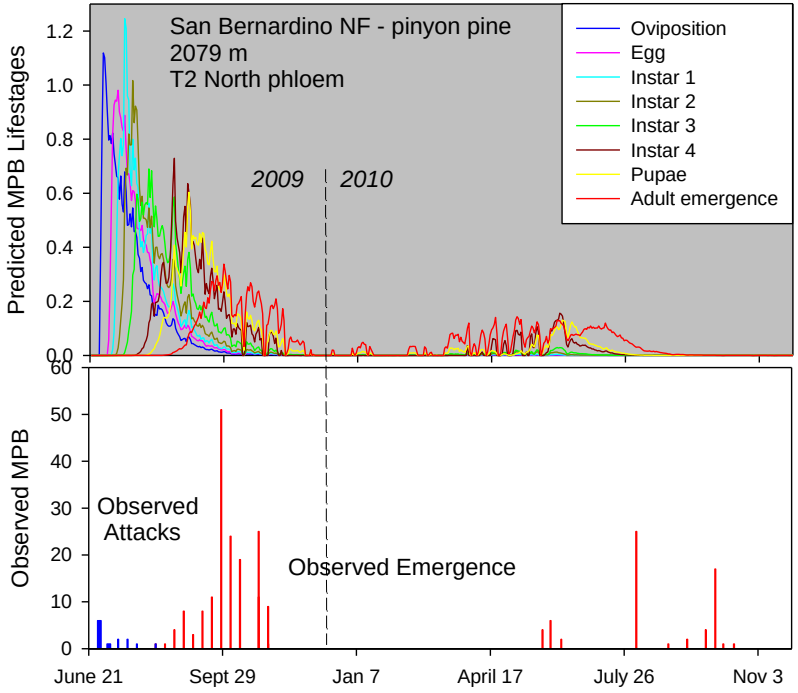
3 generations in ~2½ years.

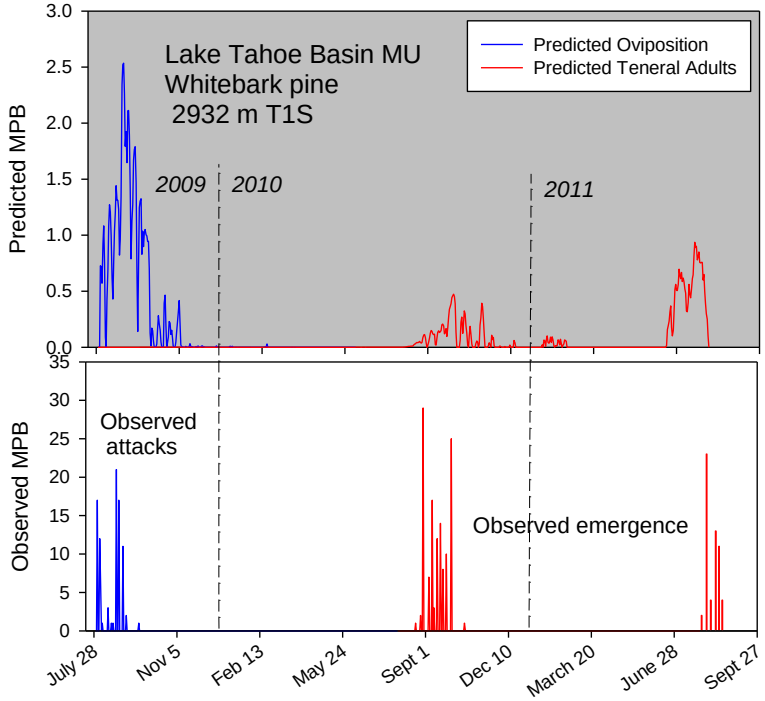
NOT Bivoltine

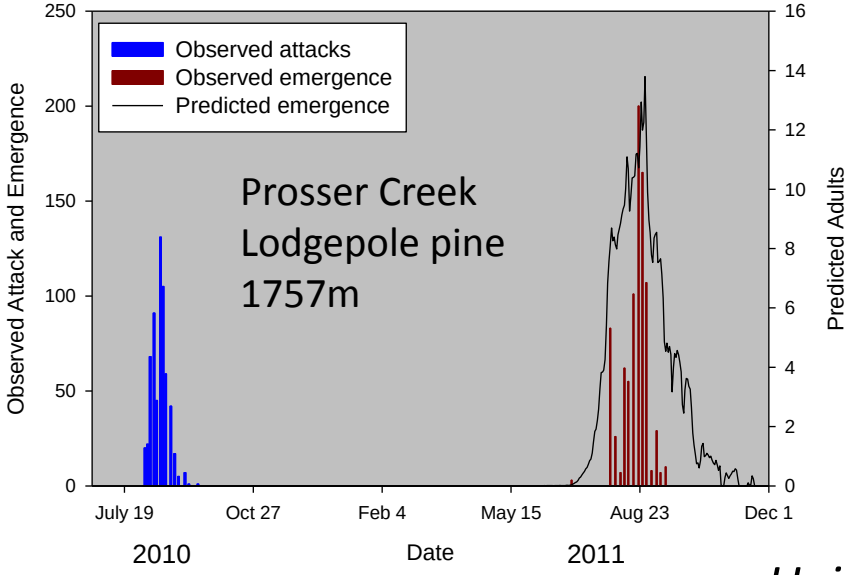


MPB Phenology Model Validation

< Univoltine Mix

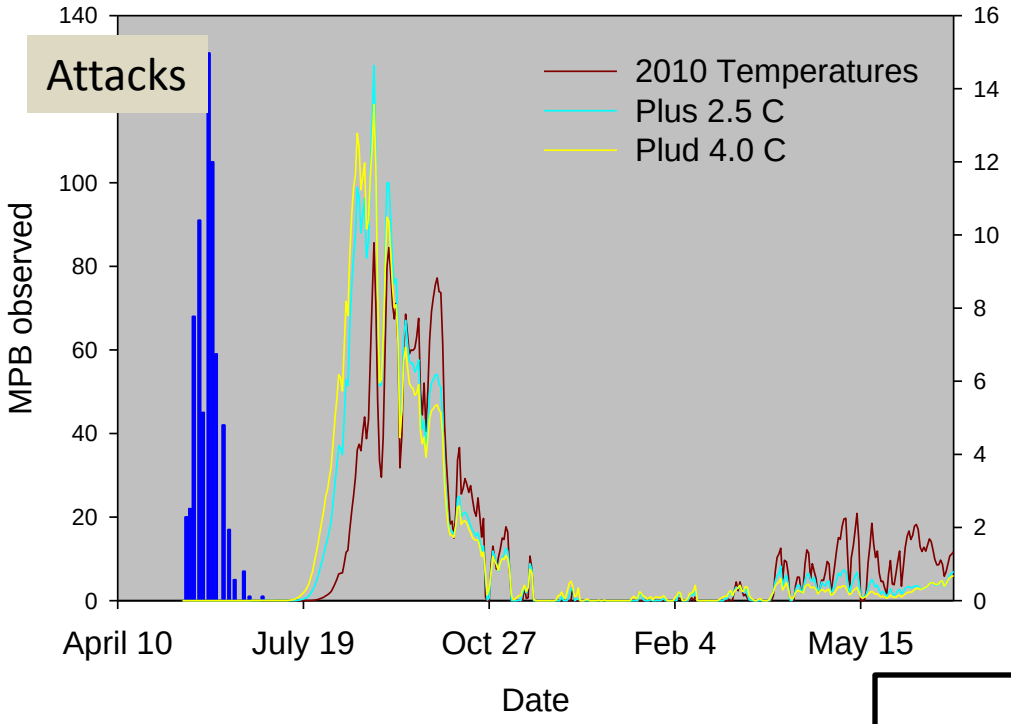






Univoltine

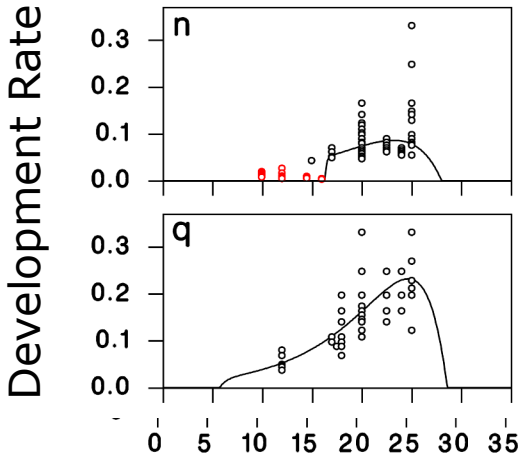
Univoltine –Semivoltine Mix



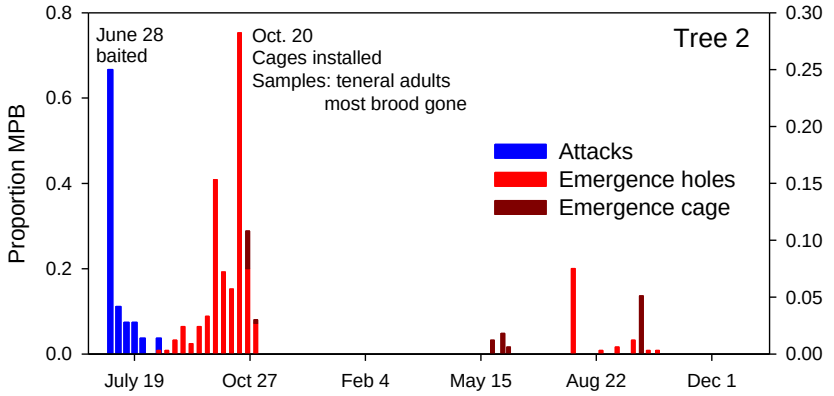
Can climate change and increasing temperature result in a bivoltine lifecycle at Prosser Creek?

Temperature increase up to 4.0°C results in NO BIVOLTINISM

WHY?
15 – 17°C threshold for development to pupal lifestage

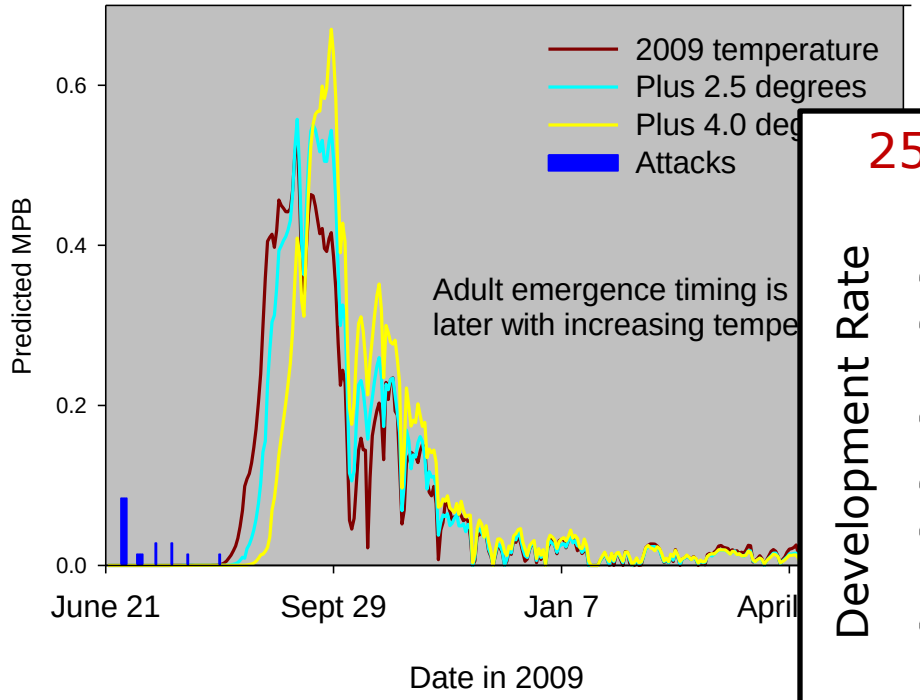


San Bernardino, CA – Mixed Univoltine

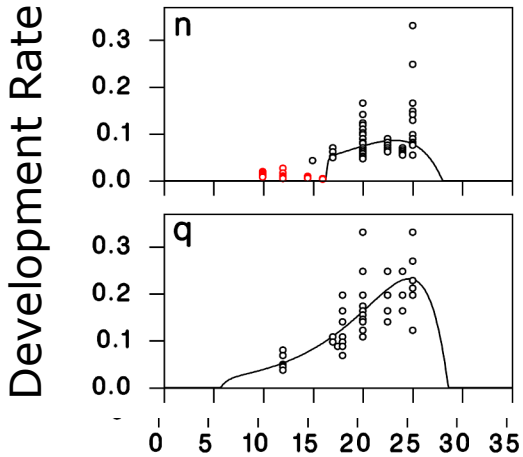


When temperatures at a site are at optimal or above for development (~25°C) then -

Development rate will decrease with increasing temperature causing later emergence timing.



25°C is optimal development rate



Instar 4/pre-pupae

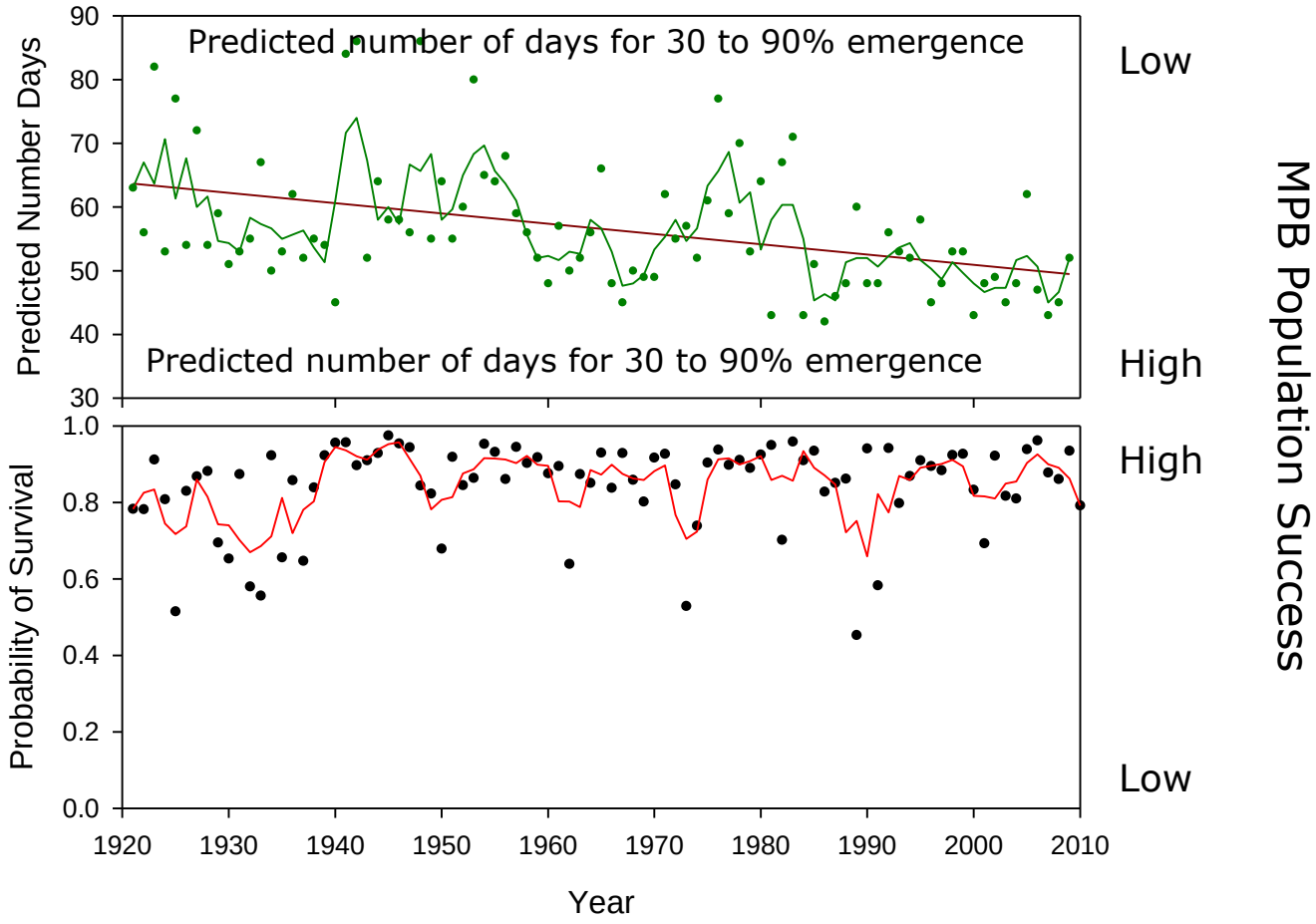
Pupae

Lake Tahoe NF, CA
Prosser creek
Lodgepole pine, 1757 m

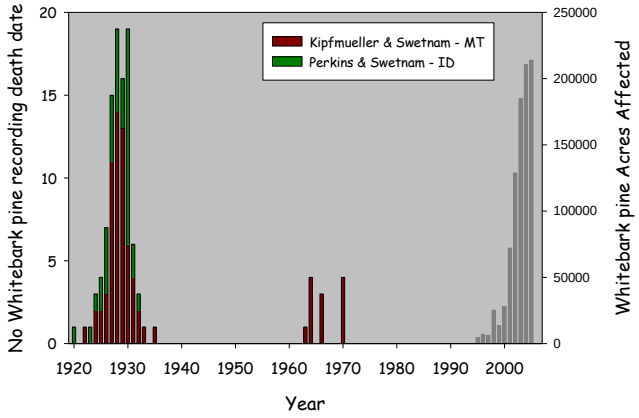
We can use these data and models to analyze trends in MPB population success

Development and emergence timing

Cold temperature survival

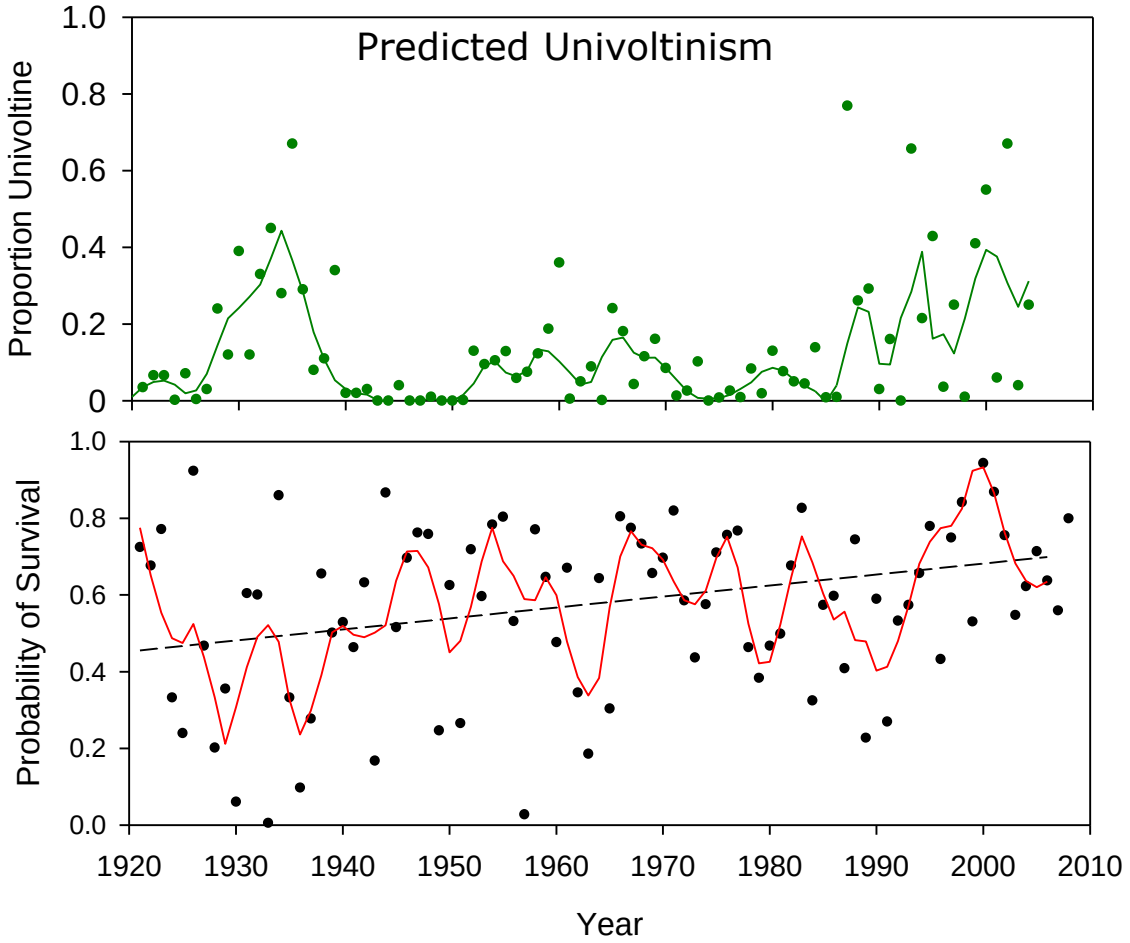


Shoshone NF, WY
Togwotee Pass
Whitebark pine, ~2900 m



Development and emergence timing

Cold temperature survival



Conclusions

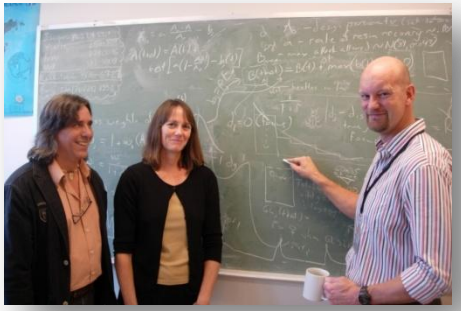
- Field-observed mountain pine beetle lifecycle timing confirm the role of temperature and phenotypic plasticity in population success at multiple sites across CA.

- We did not observe bivoltine lifecycle timing at any site, despite warm temperatures.

- Based on our knowledge of mountain pine beetle physiology, bivoltinism is not possible without adaptation that would result in new developmental thresholds.

- Projections with our temperature-driven mechanistic models can provide important information on population success in a changing climate.

Collaborators and Funding Acknowledgements



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