Diana Six , Clare Vergobbi, Polly Buotte,\
University of Montana, Missoula
University of Idaho, Moscow

Adaptation to climate change:

Embracing natural selection and genetics in whitebark pine conservation

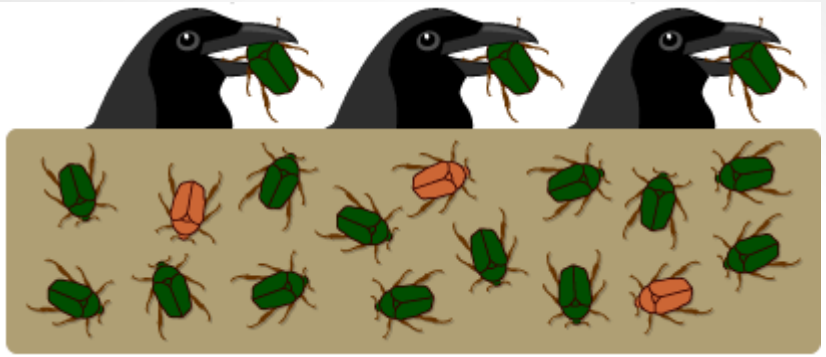
Mountain pine beetle

- Native
- Can colonize and reproduce in most pines
- Mainly develops outbreaks in lodgepole pine but also in ponderosa and whitebark pines
- Distribution and outbreak potential based on host distribution plus climatic factors

National Geographic 2015

In recent years…

- Developed a massive outbreak in western North America
- Expanded its range eastward, northward and upward in elevation
- Has devastated whitebark pine forests in parts of the tree's range



- **Approach: To use the outbreak as an opportunity to investigate potential for adaptation to climate change in WBP**
  - Has the outbreak resulted in a massive natural selection event?
  - In hard hit stands, some mature trees remain unscathed
  - What is different about these ‘survivor’ trees?
  - How might understanding ‘survivors’ help us maintain the tree on the landscape?

Hypotheses

- Trees chosen by beetles exhibit poorer growth and defenses in recent years than survivors
- Survivors have different chemical profiles than those that are attacked by beetles

Initial study – Vipond and Comet, MT

- **Outbreak stand - Vipond**
  - Determine size distribution of beetle-killed trees
  - Locate 100 survivors within diameter range killed by beetles
    - Measure diameters, take cores, collect needles and phloem, measure resin flow
  - Locate 100 beetle-killed trees
    - Measure diameters, take cores
  - Locate 100 trees ‘just below’ diameter used by beetles
    - Measure diameters, take cores, collect needles and phloem
- **Non-outbreak stand – Comet**
  - Locate 100 live trees within diameter range killed by beetles at Vipond
    - Measure diameters, take cores, collect needles and phloem, measure resin flow

Tree core – climate analysis

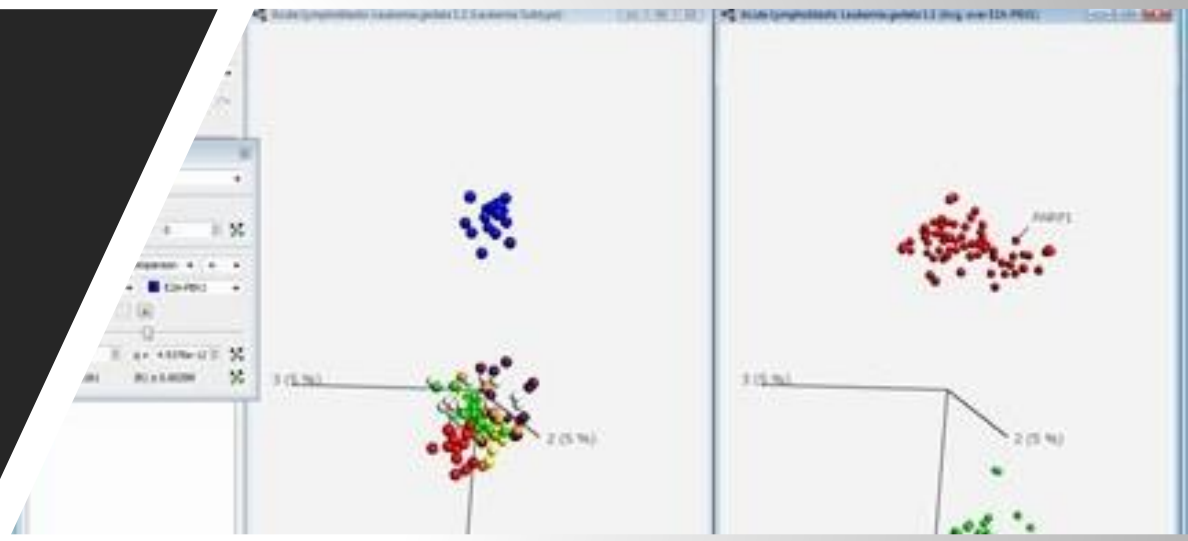
- Develop chronologies for the sites
- Develop predictive models of tree ring-width, late wood deposition, and wood density for survivors and trees killed by MPB
- Using PRISM and TOPOWX climate datasets, calculate annual and seasonal temperature and precipitation metrics previously shown to affect tree growth rates
- Conduct model development with data from live and dead trees and allow responses to vary by tree status.

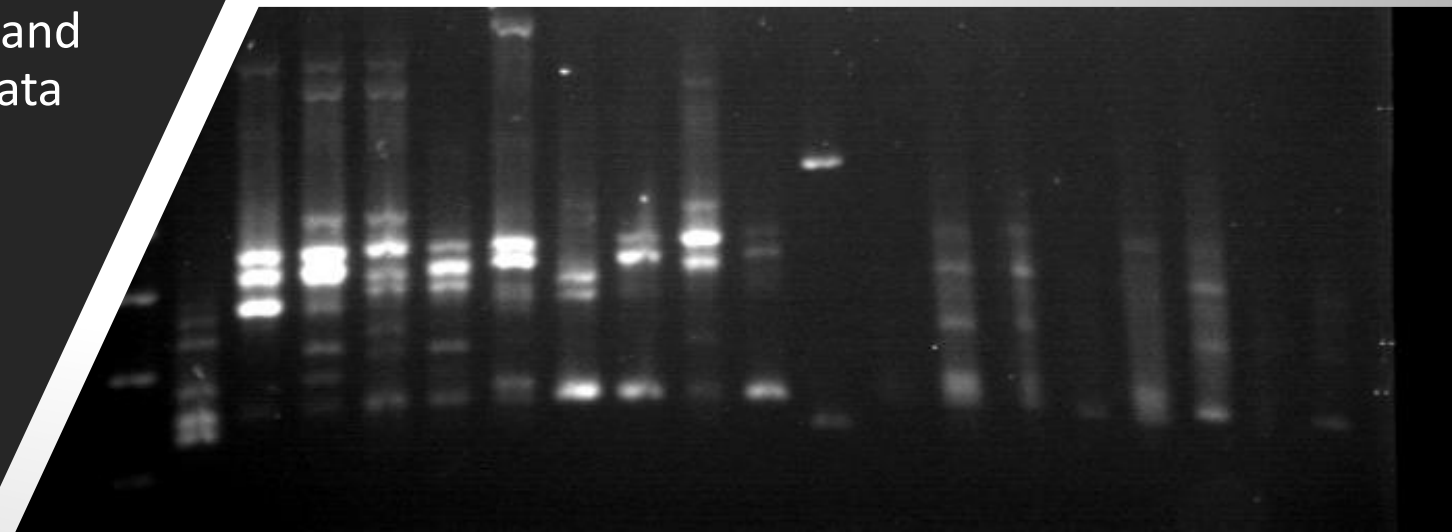
This will allow us to determine if trees that survived the recent outbreak responded differently to climate conditions than trees that were killed.

Inter Simple Sequence Repeat (ISSR) ANALYSIS

- Rapid, cheap, reproducible PCR-based method
- 8 PRIMERS
- ~60 polymorphic markers

- PCA/Correlation analysis with ISSR data and growth rate, chemistry, and resin flow data





UNIVERSITY OF MONTANA

University of Idaho

MONTANA INSTITUTE ON ECOSYSTEMS

Northwest Climate Science Center