Characteristics of whitebark pine (*Pinus albicaulis*) growth and defense in response to disturbance

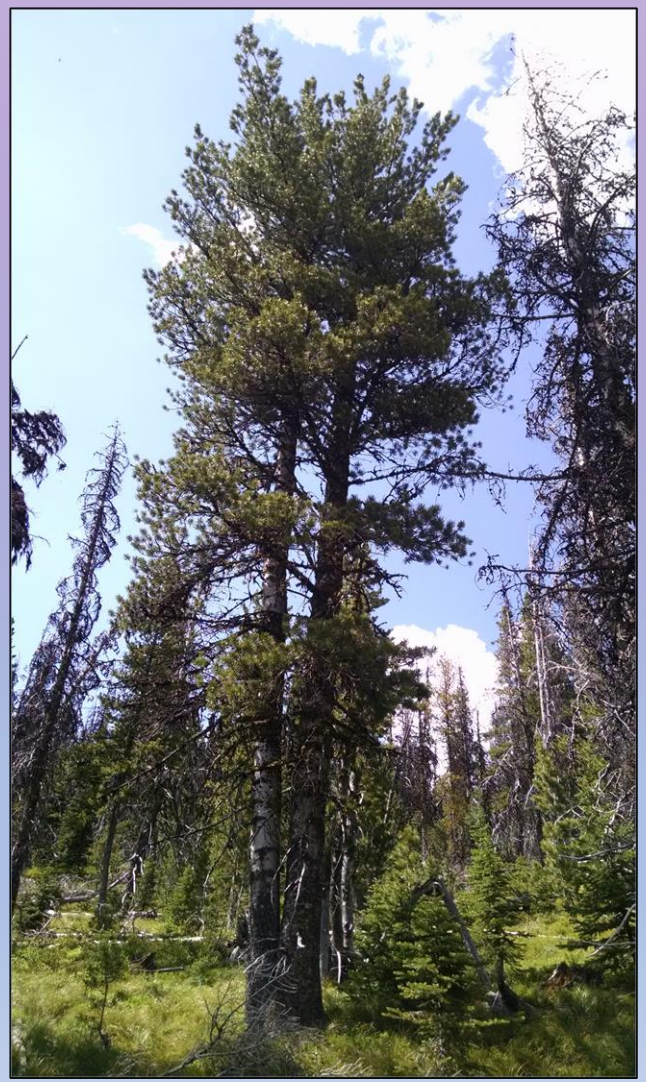
Nick Kichas – *Montana State University*

Sharon Hood – *U. S. Forest Service*

Greg Pederson – *U. S. Geological Survey*

Rick Everett – *Salish Kootenai College*

Dave McWethy – *Montana State University*



MONTANA STATE UNIVERSITY

USGS science for a changing world

In collaboration with:

Confederated Salish and Kootenai Tribes

Salish Kootenai College

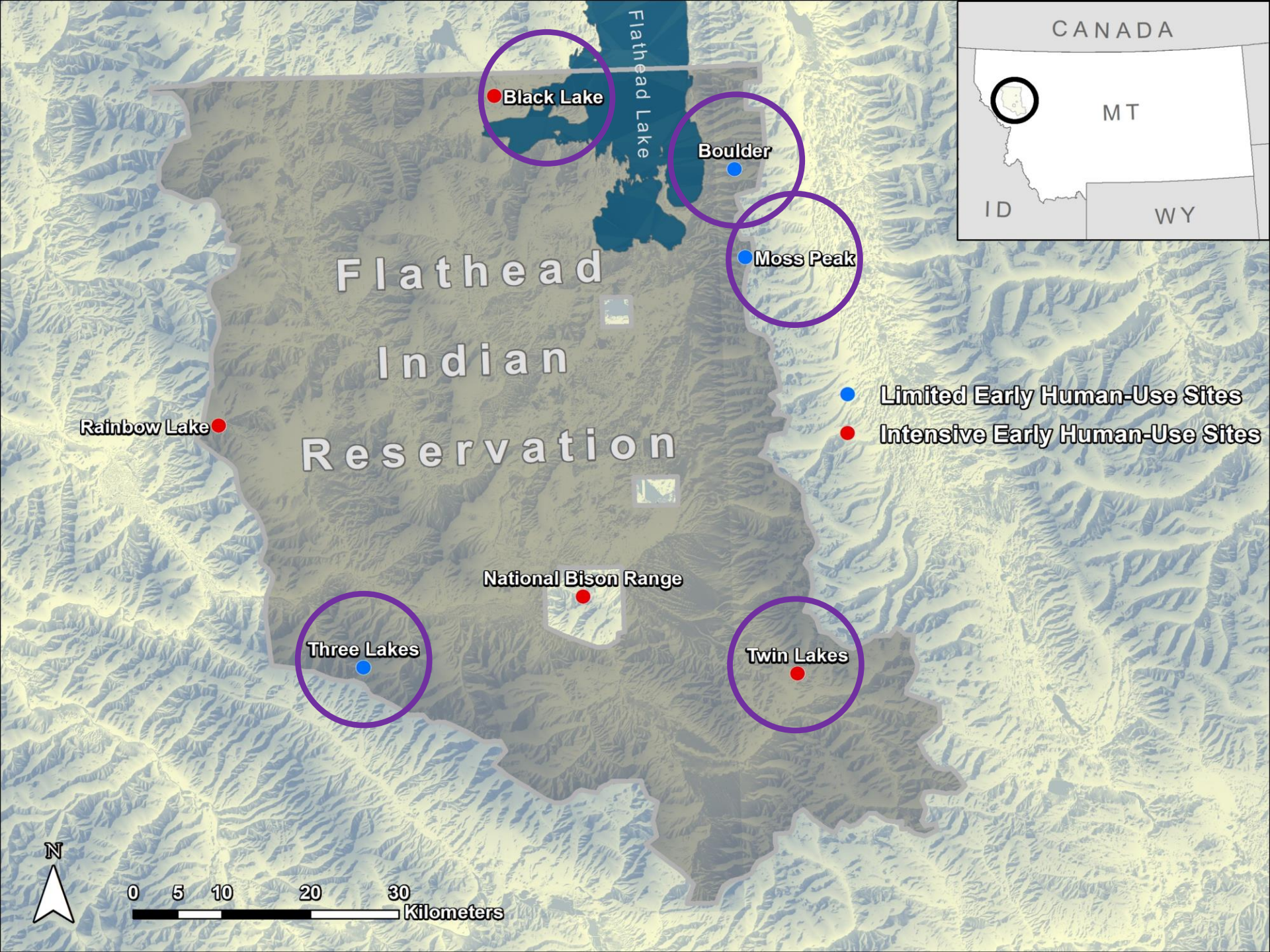
Salish & Kootenai Culture Committees

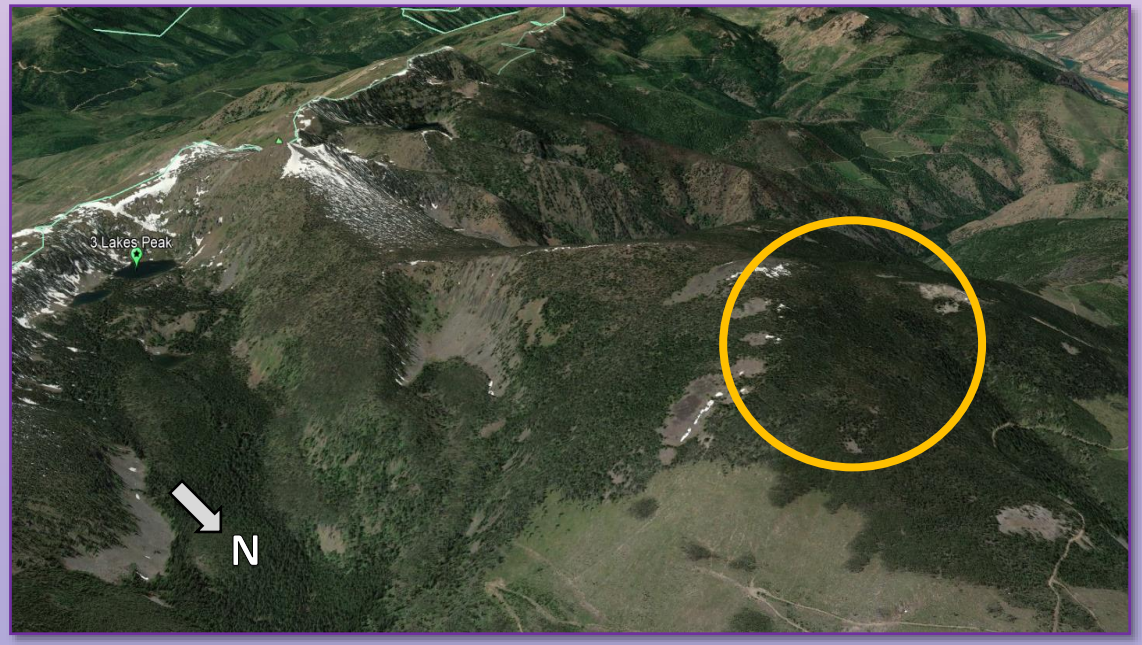
Rich Jannsen – CSKT Natural Resource Department

Tony Incashola, Jr. – CSKT Forestry

Jim Durglo – CSKT Forestry

Michael Durglo, Jr. – Tribal Preservation Department


Flathead Lake
Black Lake
Boulder
Moss Peak
Flathead
Indian
Reservation
Rainbow Lake
National Bison Range
Three Lakes
Twin Lakes
Limited Early Human-Use Sites
Intensive Early Human-Use Sites
CANADA
MT
ID
WY
N
0 5 10 20 30
Kilometers

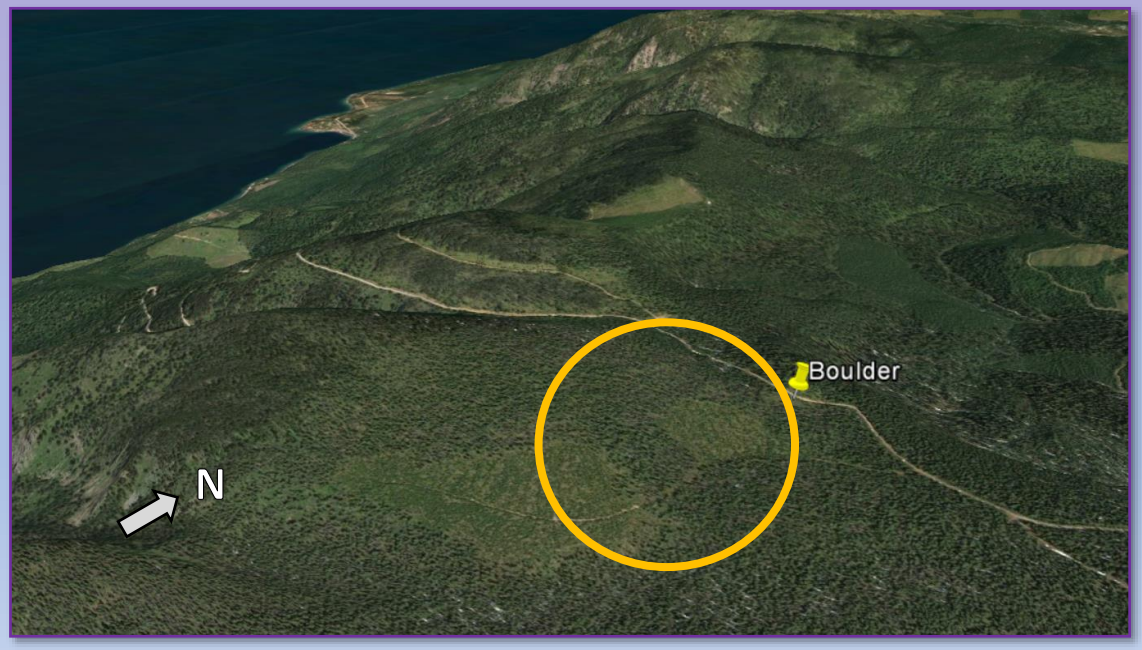


Three Lakes Peak

- 225 whitebark sampled
  - ~ 73% Mortality

For this study: 60 trees

(30 live / 30 dead)



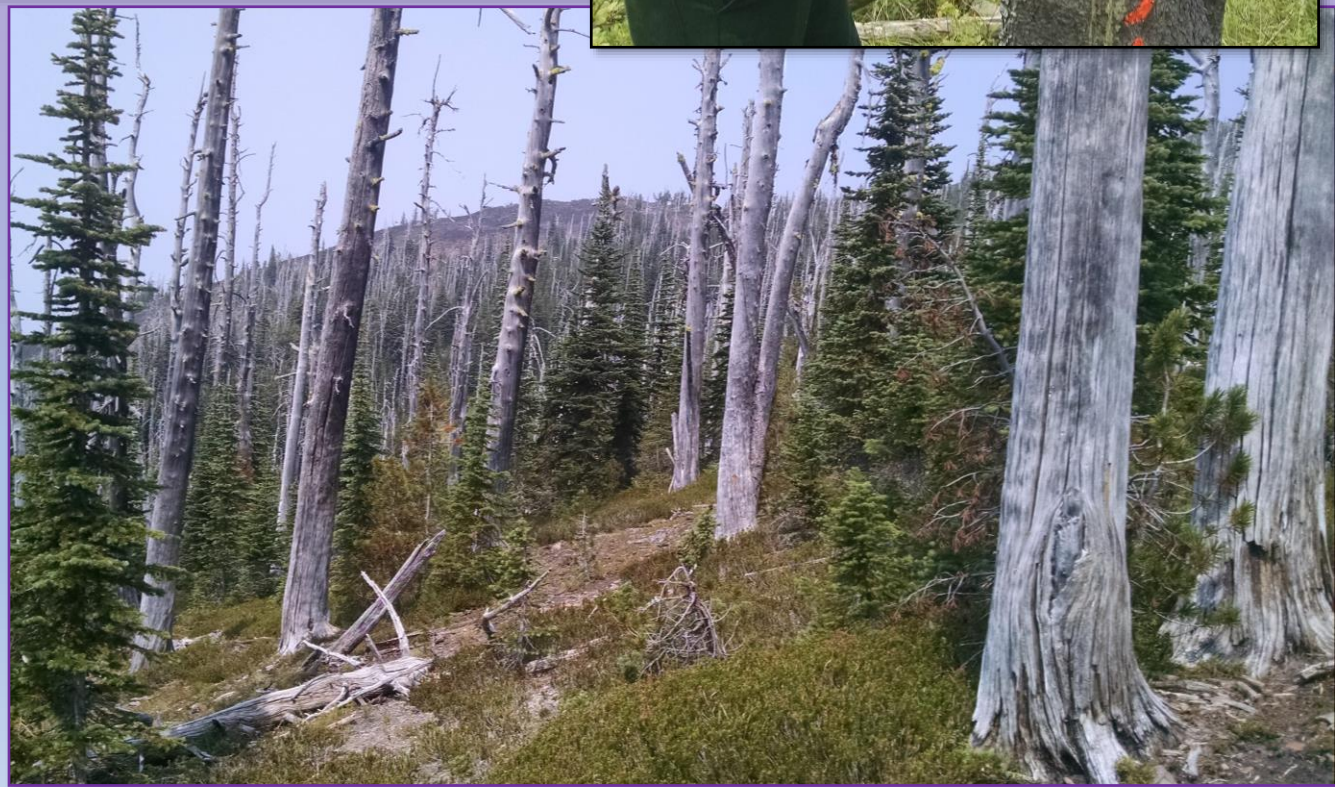
Boulder

- 476 whitebark sampled
  - ~ 86% Mortality

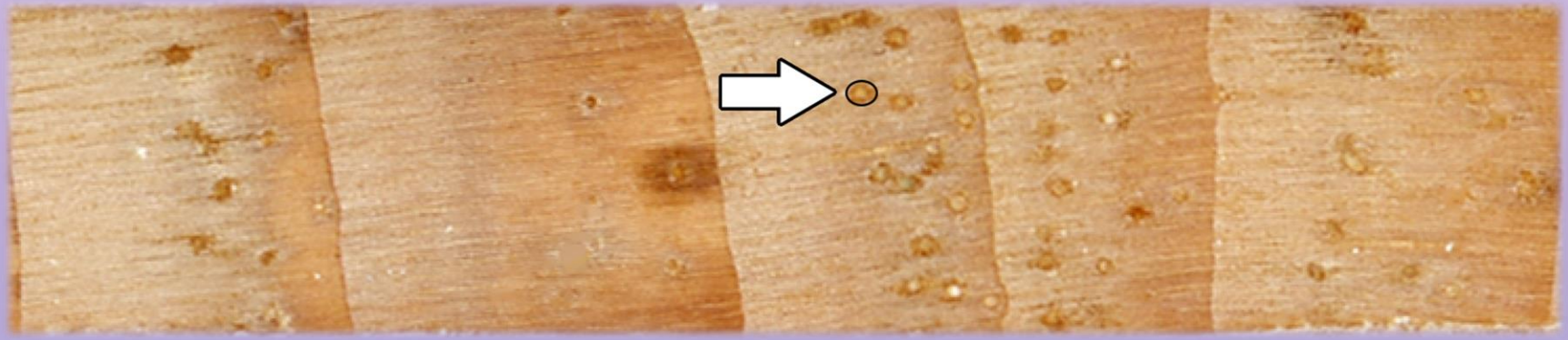
For this study: 84 trees

(42 live / 42 dead)

72 pairs (144 total trees)



Resin Ducts: Important for Defense



Oecologia (2010) 164:601–609
DOI 10.1007/s00442-010-1683-4

PHYSIOLOGICAL ECOLOGY - ORIGINAL PAPER

Importance of resin ducts in reducing ponderosa pine mortality from bark beetle attack

Jeffrey M. Kane · Thomas E. Kolb

Tree Physiology 35, 112–123
doi:10.1093/treephys/tpu106

Research paper

Differentiation of persistent anatomical defensive structures is costly and determined by nutrient availability and genetic growth-defence constraints

Xoaquín Moreira[1,4], Rafael Zas[2], Alejandro Solla[3] and Luis Sampedro[2]

Tree Physiology 35, 1223–1235
doi:10.1093/treephys/tpv098

Research paper

Ponderosa pine resin defenses and growth: metrics matter

Sharon Hood[1,2,3] and Anna Sala[1]

forests

MDPI

Article

Contrasting Impacts of Climate and Competition on Large Sugar Pine Growth and Defense in a Fire-Excluded Forest of the Central Sierra Nevada

Andrew W. Slack [1,2,*], Jeffrey M. Kane [1], Eric E. Knapp [3] and Rosemary L. Sherriff [1,4]

Oecologia (2014) 174:1283–1292
DOI 10.1007/s00442-013-2841-2

PLANT-MICROBE-ANIMAL INTERACTIONS - ORIGINAL RESEARCH

Resin duct characteristics associated with tree resistance to bark beetles across lodgepole and limber pines

Scott Ferrenberg · Jeffrey M. Kane · Jeffry B. Mitton

Ecological Applications, 0(0), 2016, pp. 1–17

Fortifying the forest: thinning and burning increase resistance to a bark beetle outbreak and promote forest resilience

Sharon M. Hood,[1,2,3] Stephen Baker,[1] and Anna Sala[2]

ORIGINAL ARTICLE

WILEY

Anatomical defences against bark beetles relate to degree of historical exposure between species and are allocated independently of chemical defences within trees

Charles J. Mason[1] | Ken Keefover-Ring[2] | Caterina Villari[3] | Jennifer G. Klutsch[4] | Stephen Cook[5] | Pierluigi Bonello[3] | Nadir Erbilgin[4] | Kenneth F. Raffa[6] | Philip A. Townsend[7]

Tree Physiology 35, 107–111
doi:10.1093/treephys/tpv015

Commentary

To grow or defend? Pine seedlings grow less but induce more defences when a key resource is limited

Scott Ferrenberg[1,4,5], Jeffrey M. Kane[2] and Joseph M. Langenhan[3]

Low-severity fire increases tree defense against bark beetle attacks

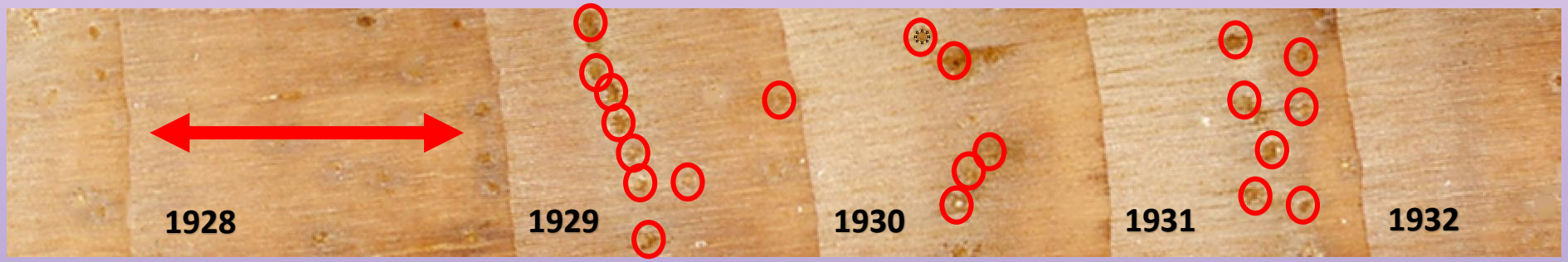
Sharon Hood,[1,4] Anna Sala,[1] Emily K. Heyerdahl,[2] and Marion Boutin[3]

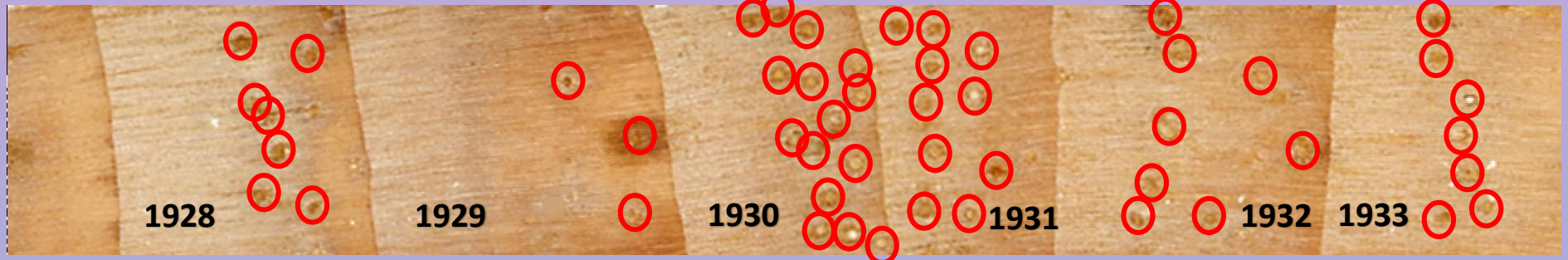
New Phytologist

Research

Drought predisposes piñon–juniper woodlands to insect attacks and mortality

Monica L. Gaylord[1], Thomas E. Kolb[1], William T. Pockman[2], Jennifer A. Plaut[2], Enrico A.Yepez[2,3], Alison K. Macalady[4], Robert E. Pangle[2] and Nate G. McDowell[5]





Live

1922 *1970*

Dead

1922 *1970*

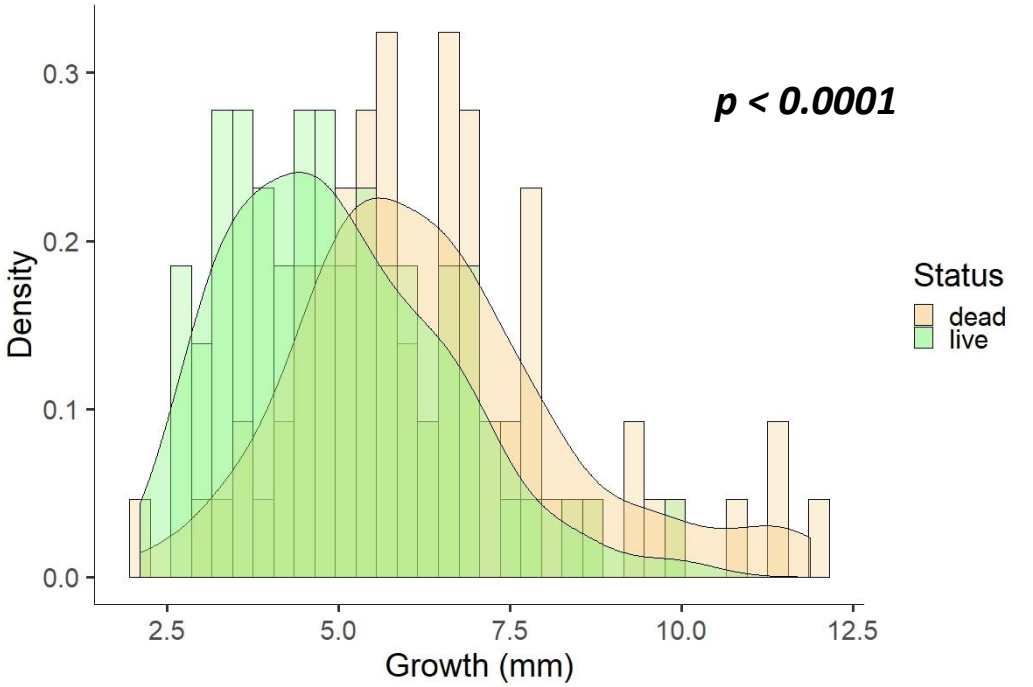
Research Questions

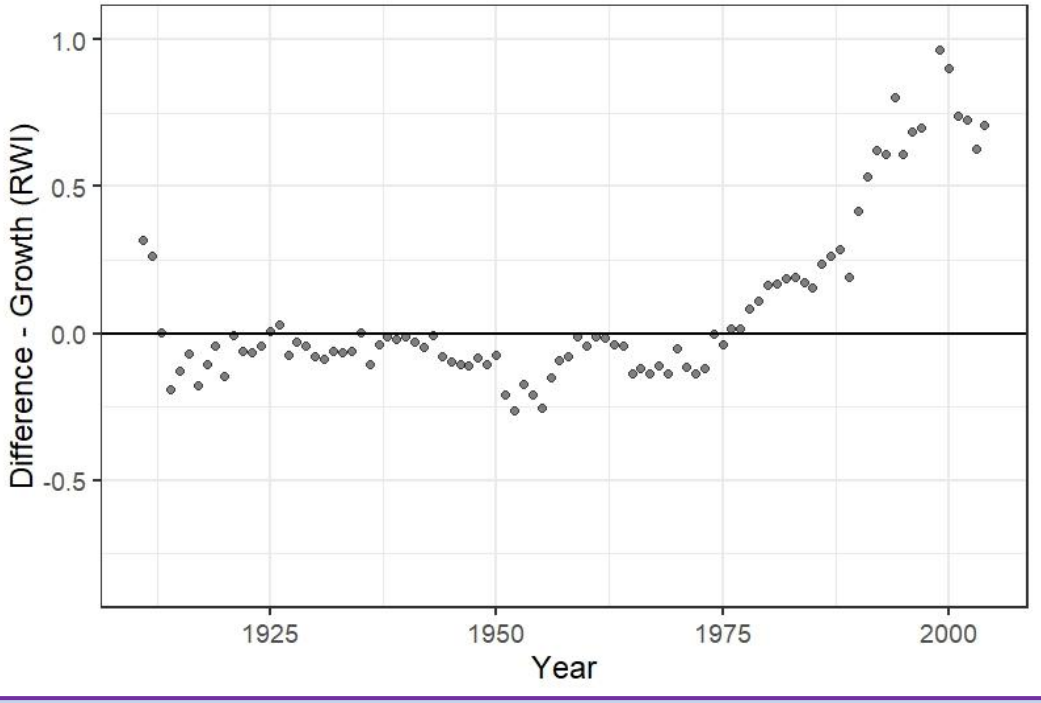
Differences in Physiology (radial growth / resin duct properties)?

What physiological properties inform survivorship?

H_1: live whitebark pines will exhibit more rapid and sustained growth than dead whitebark pines, during the overlap of their lifespan
(Ferrenberg *et al*. 2014, Hood & Sala 2015, Hood *et al*. 2016).

H_2: live whitebark pines will have more robust defensive features (increased resin duct size, density, and cumulative area) than dead whitebark pines, during the overlap of their lifespan.
(Kane & Kolb 2010, Ferrenberg *et al*. 2014, Hood *et al*. 2015)



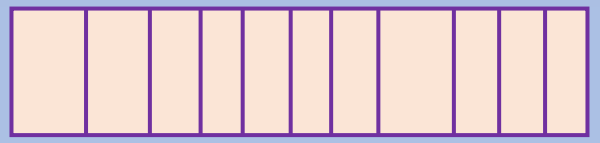


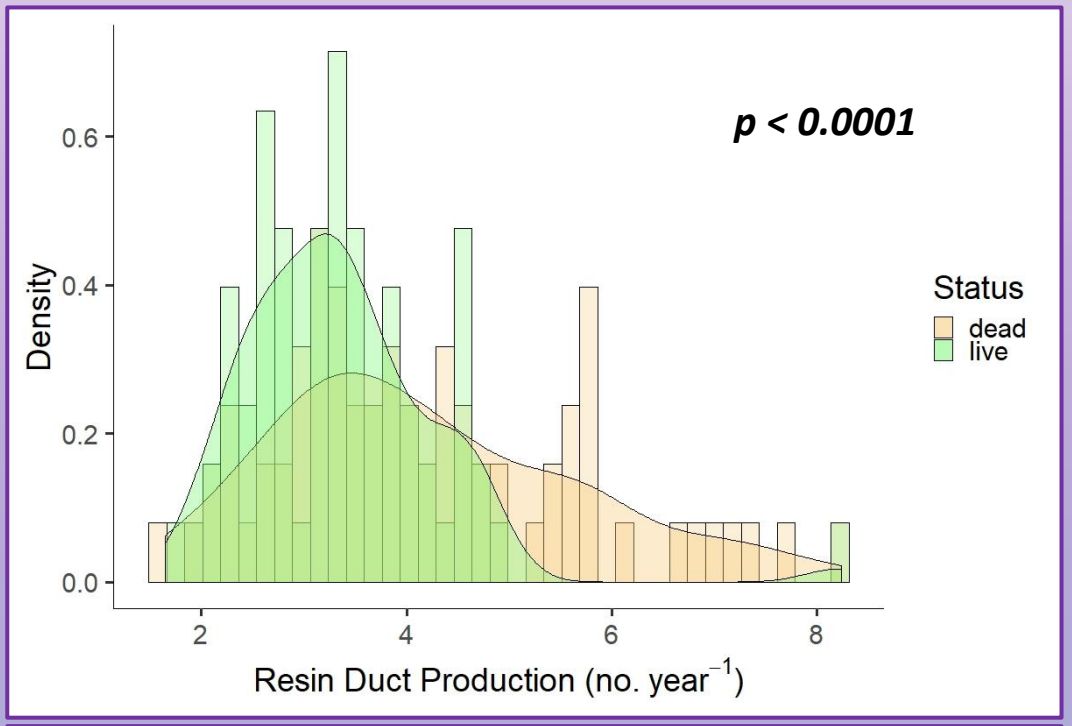
Growth

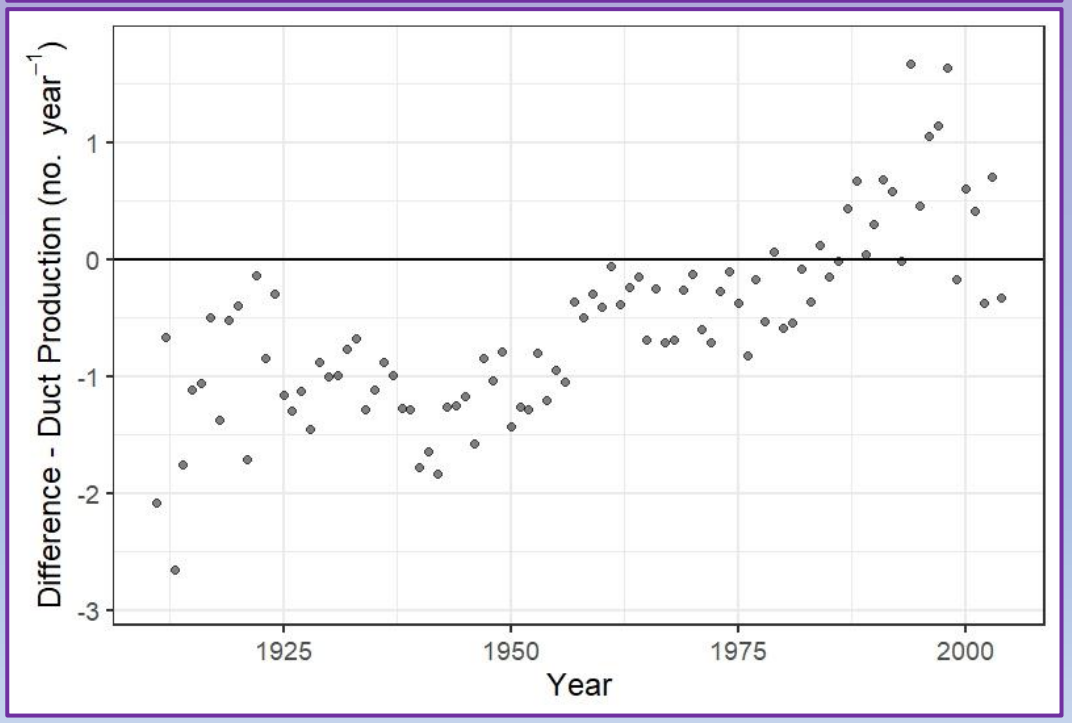
(Ring Width Index)

Live

Dead



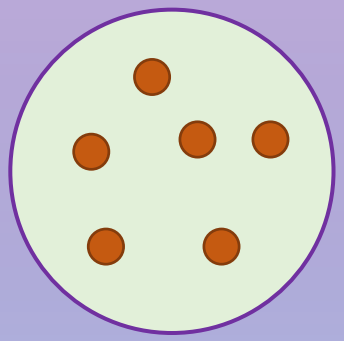




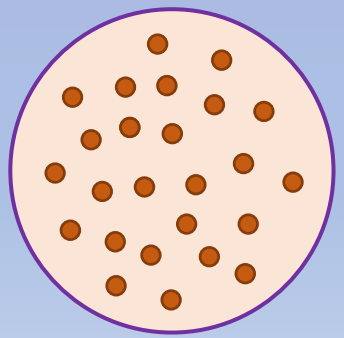
Duct Production

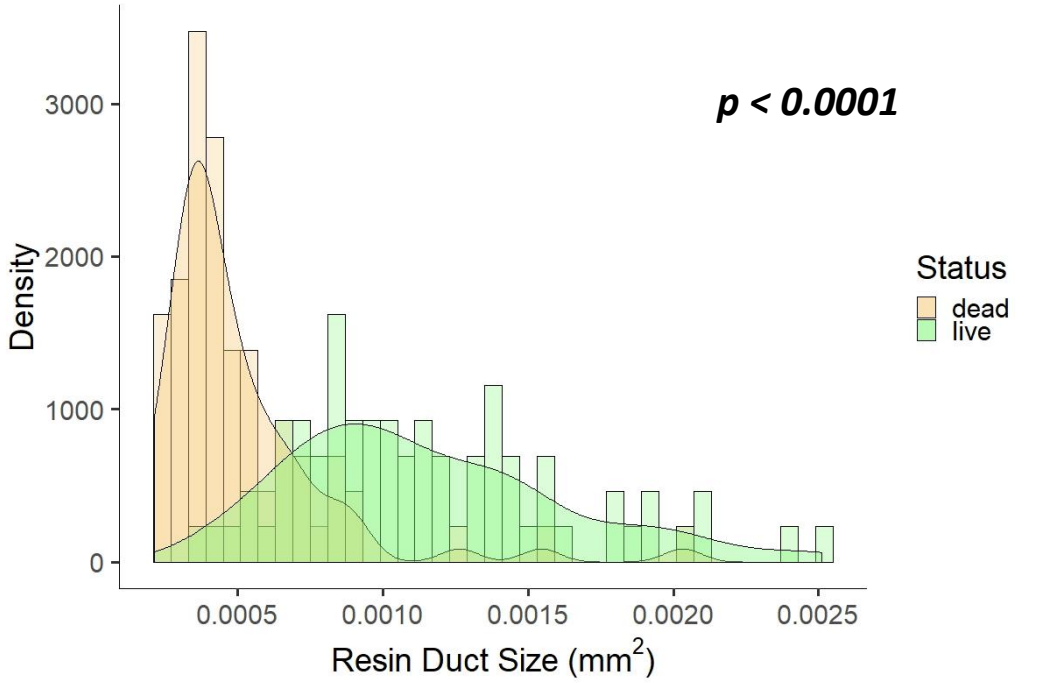
(total # of ducts per annual ring)

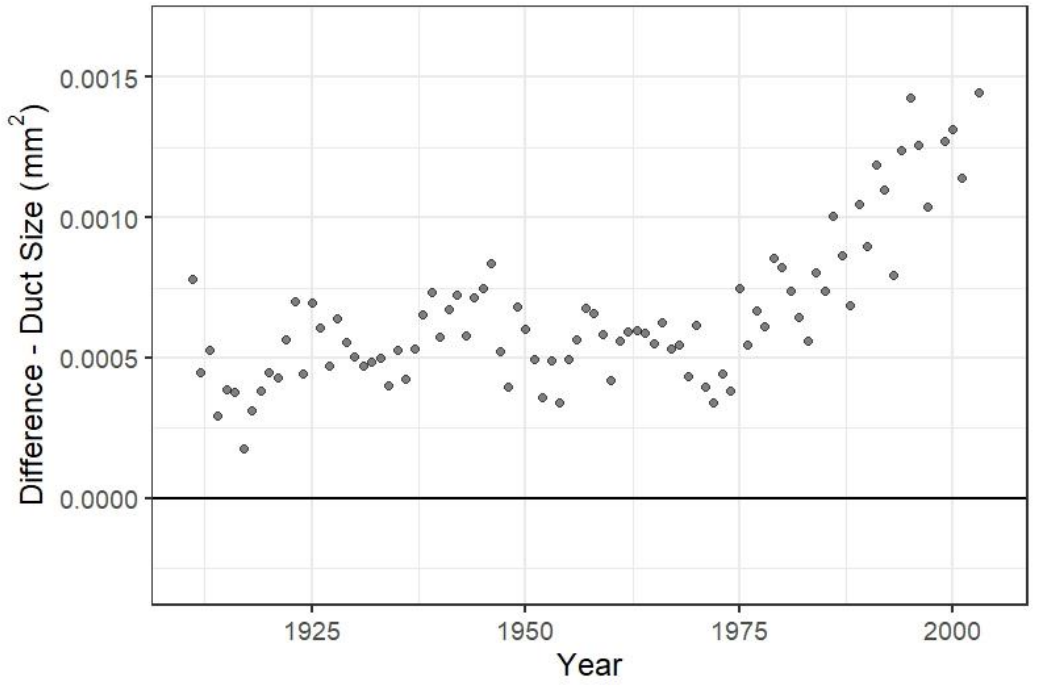
Live



Dead



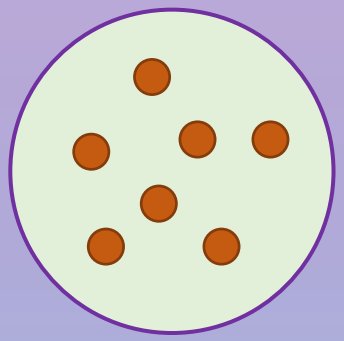




Duct Size

(mean size of all ducts per annual ring)

Live



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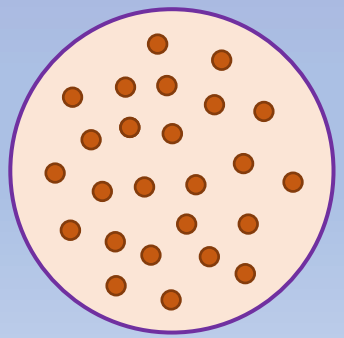
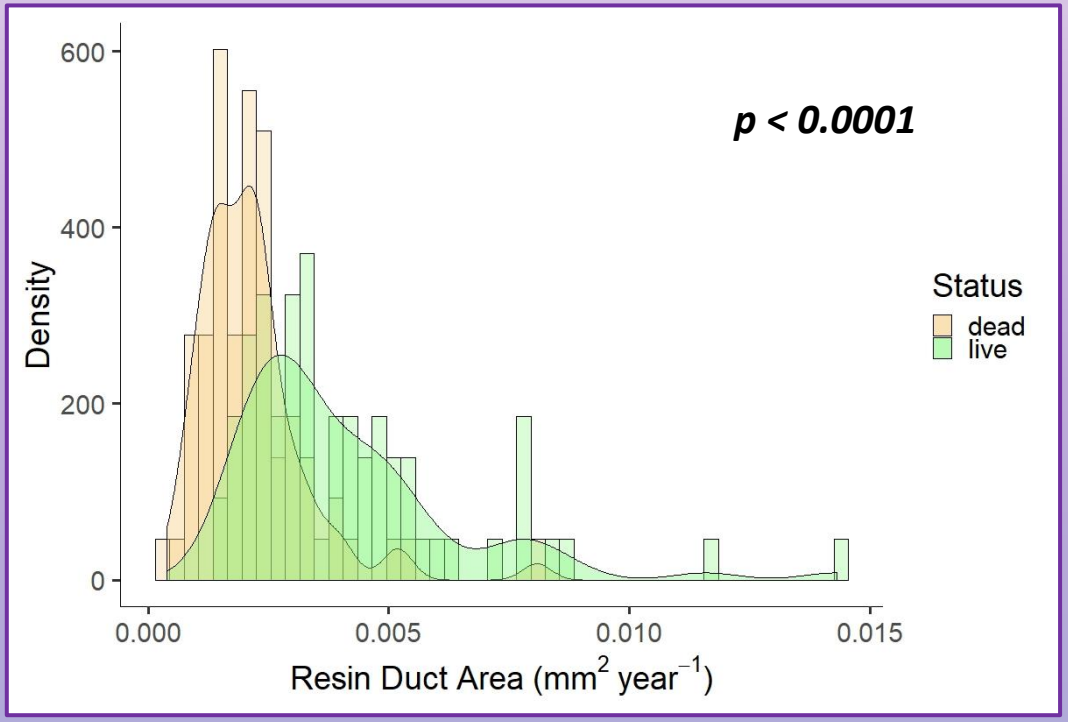
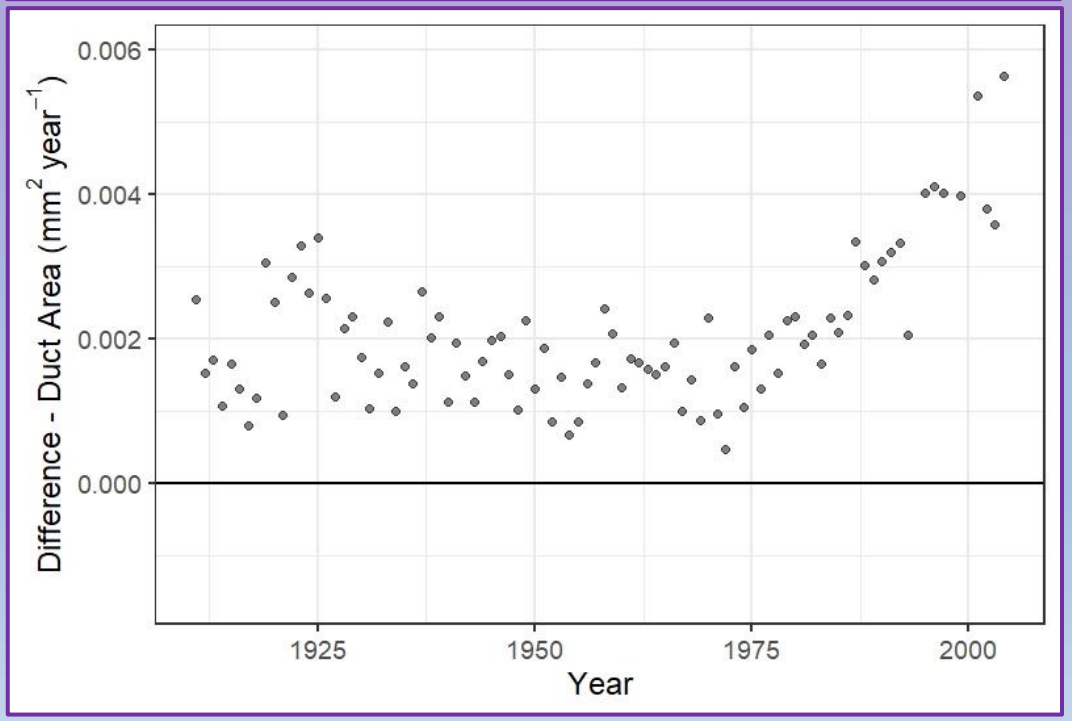


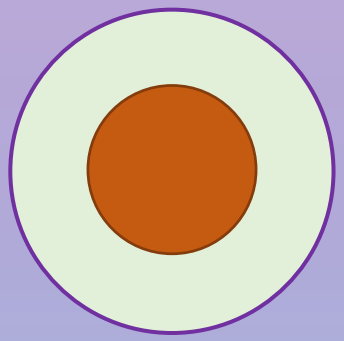




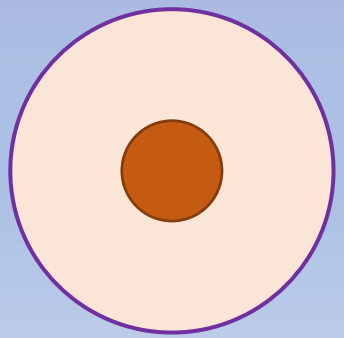
Duct Area

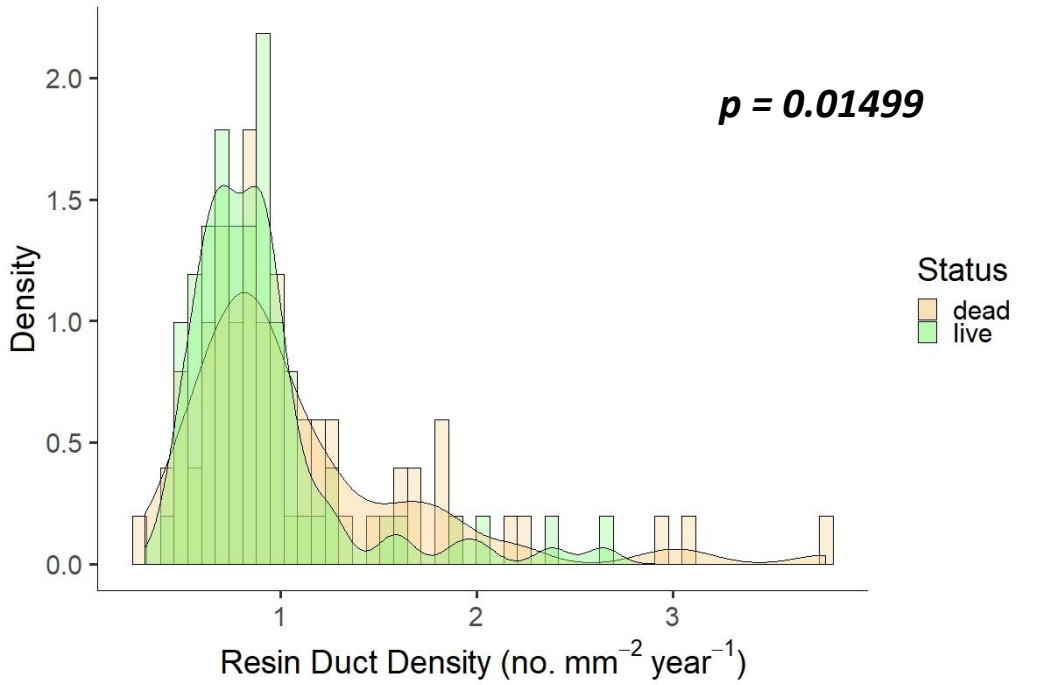
(Sum of duct area per annual ring)

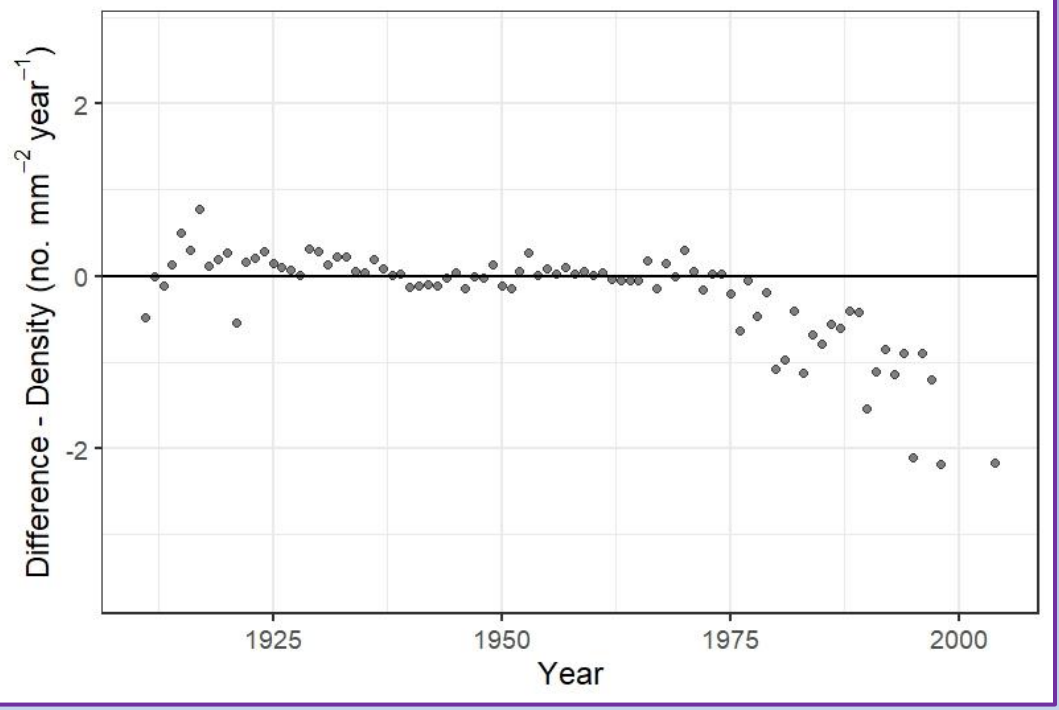
Live



Dead



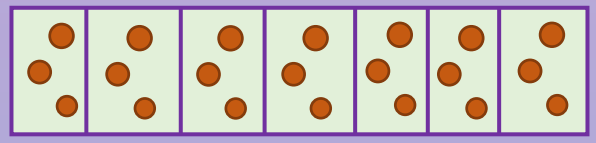




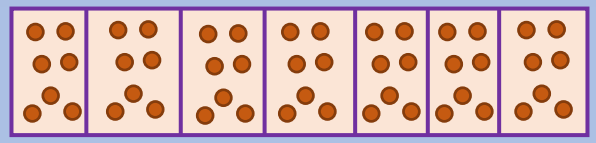
Duct Density

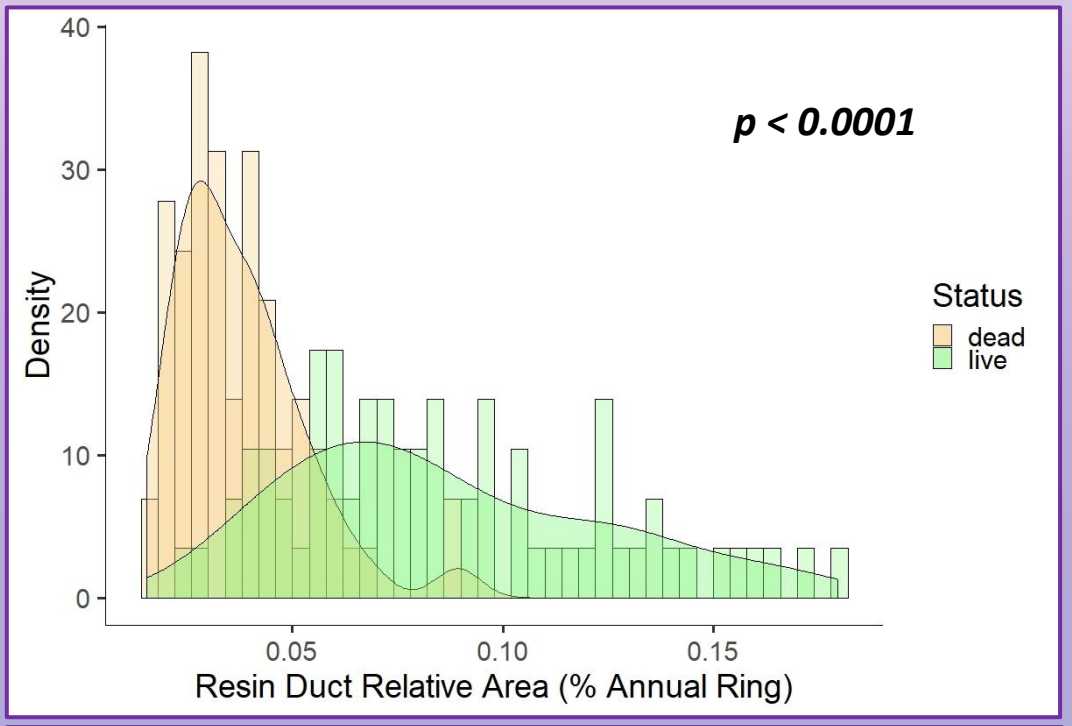
(Total # of ducts per annual ring divided by ring area)

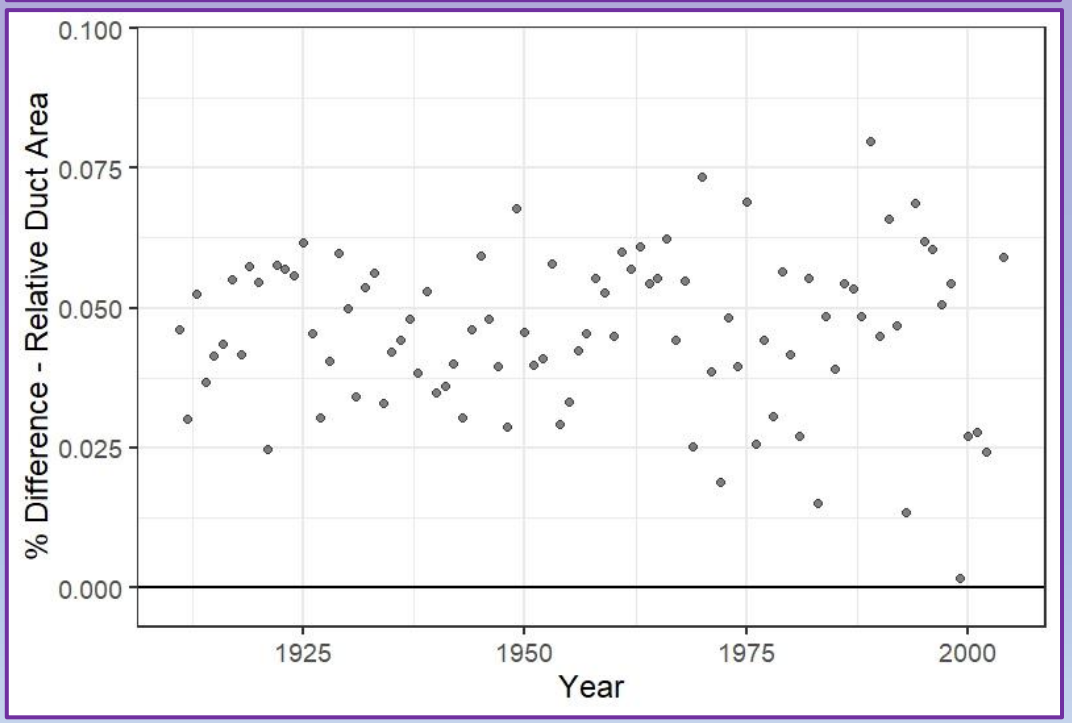
Live



Dead



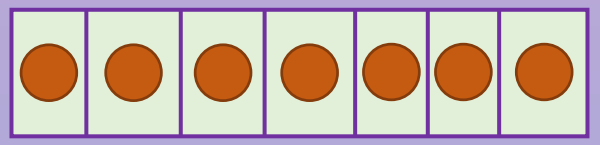




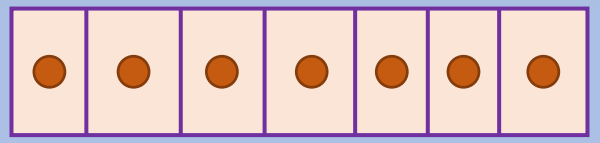
Relative Area (%)

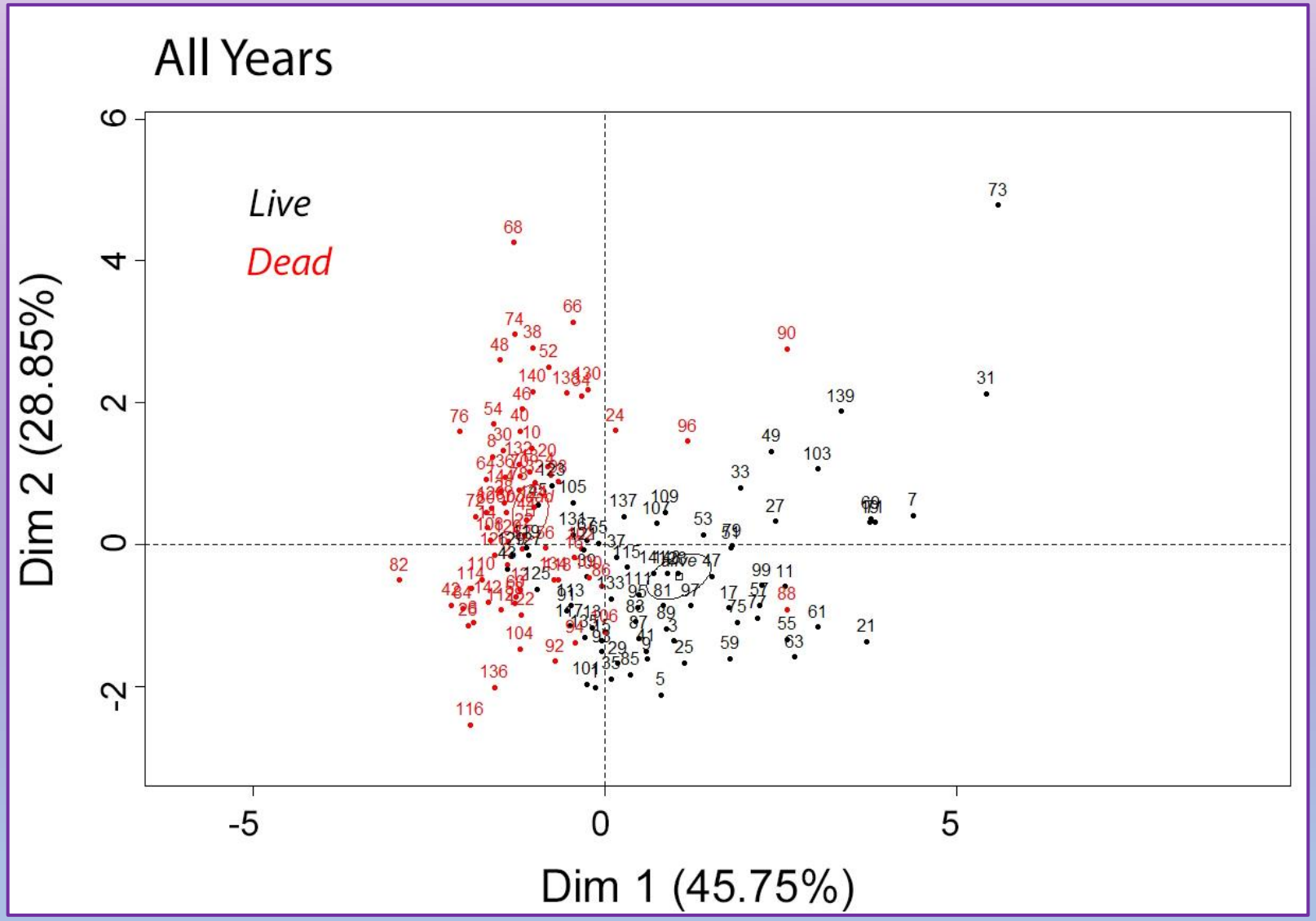
(Total duct area divided by ring area x 100)

Live



Dead



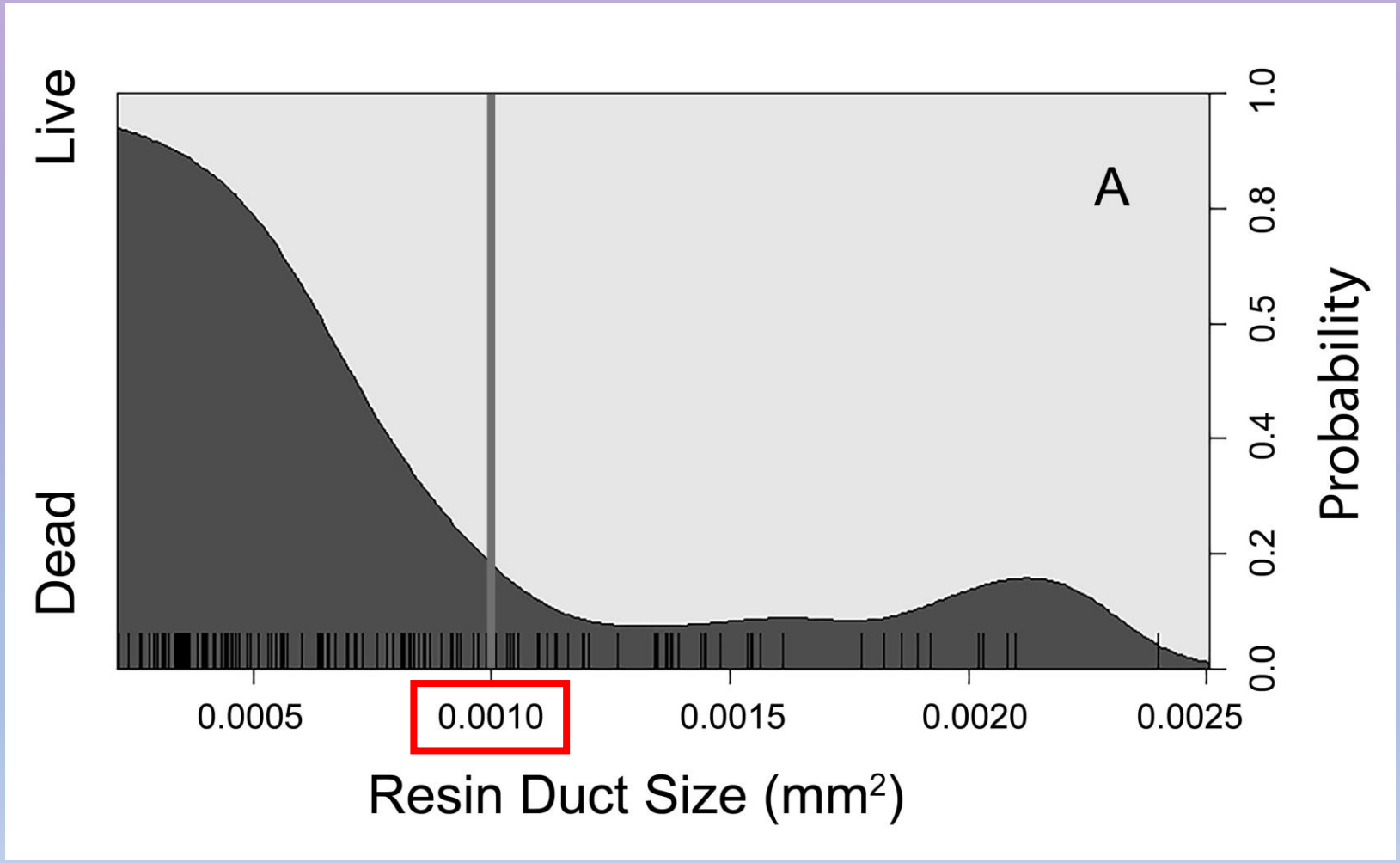


PC 1: resin duct size, resin duct area, resin duct relative area, duct density

PC 2: growth (RWI), resin duct production

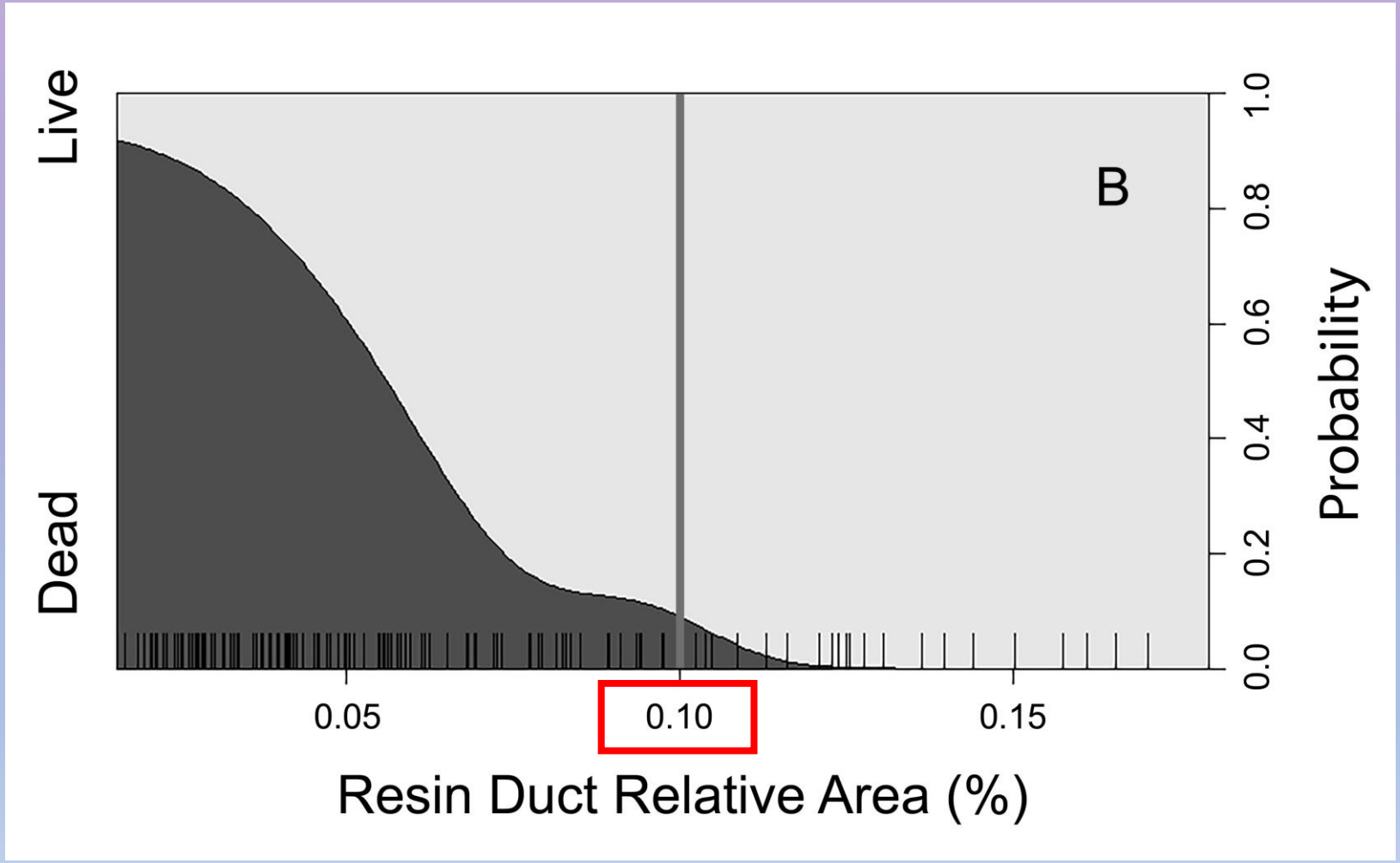
Conditional Density Plot

*describes how the conditional distribution of a categorical variable (**Y**) changes over a numerical variable (**X**)*



Conditional Density Plot

*describes how the conditional distribution of a categorical variable (**Y**) changes over a numerical variable (**X**)*



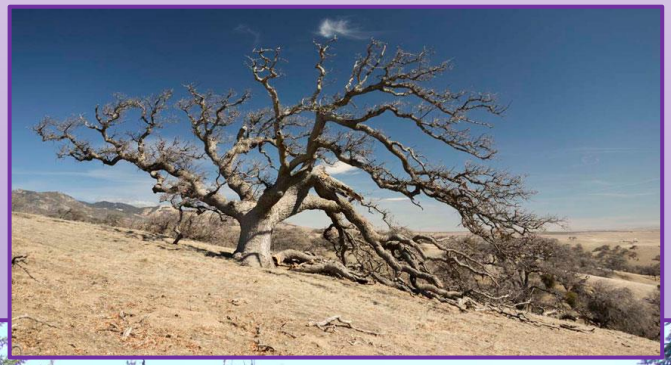
Summary

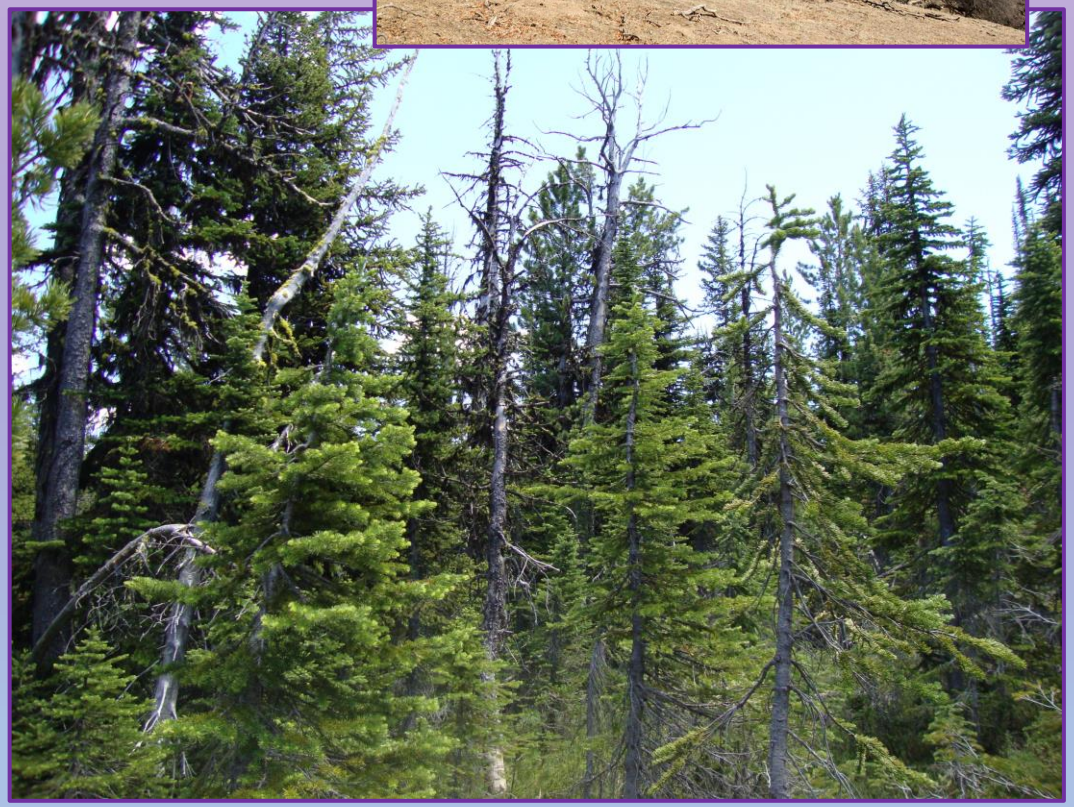
- ***Mean resin duct size and relative duct area were greater in trees that survived recent disturbances.***

- ***Resin duct size and relative duct area were the most important variables for predicting mortality.***

First evidence (*to our knowledge*) comparing growth and defense across pairs of live and dead whitebark pine.

Summary

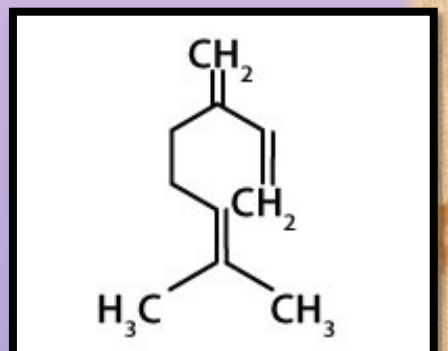




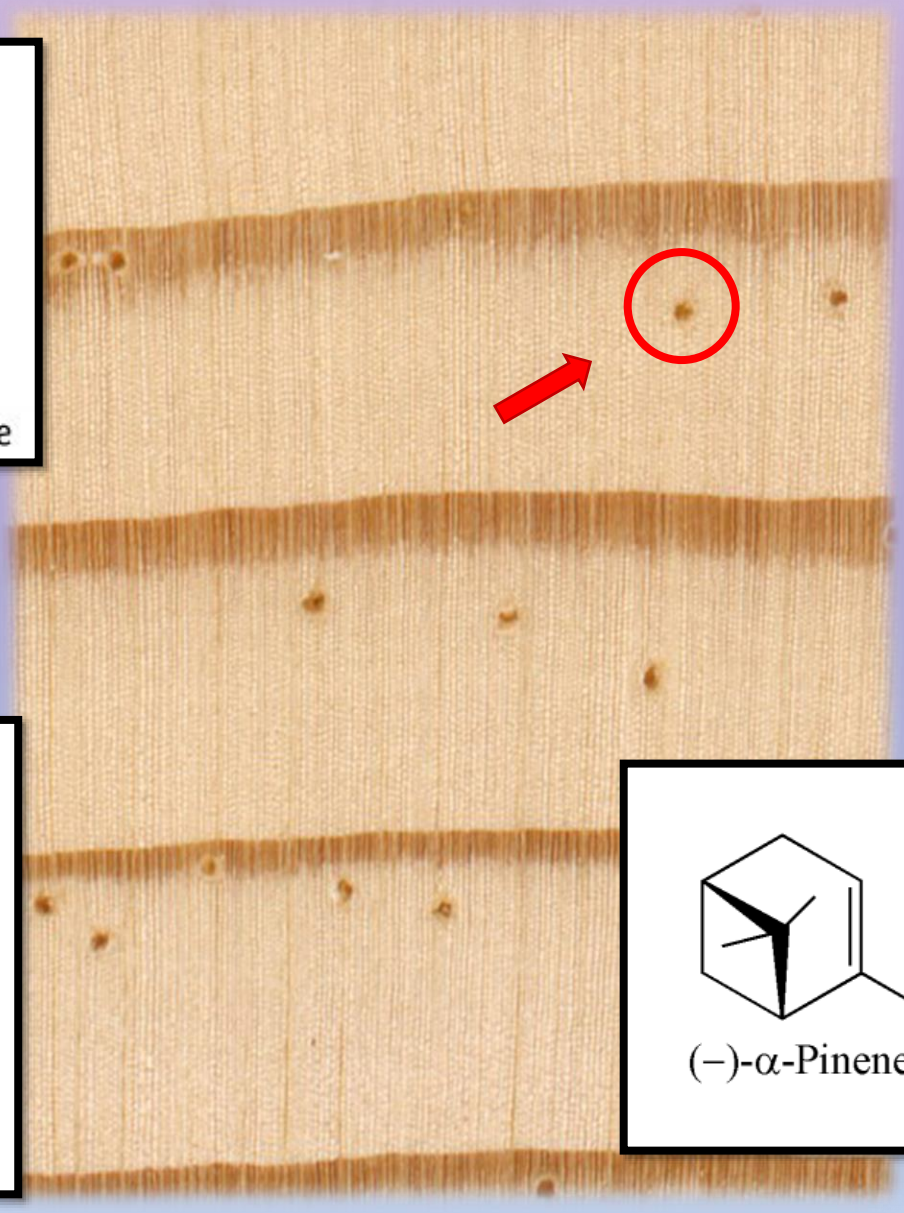
Multiple disturbances select for complex growth / defense strategies in whitebark pine.

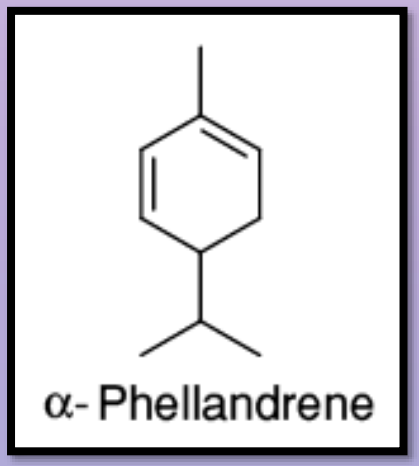
Important to maintain genetic diversity (buffers against future change).

Next Steps: Chemical Ecology of Whitebark Pine

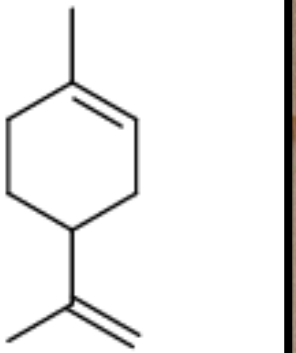


Monoterpene: Myrcene



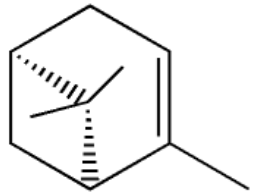


α- Phellandrene



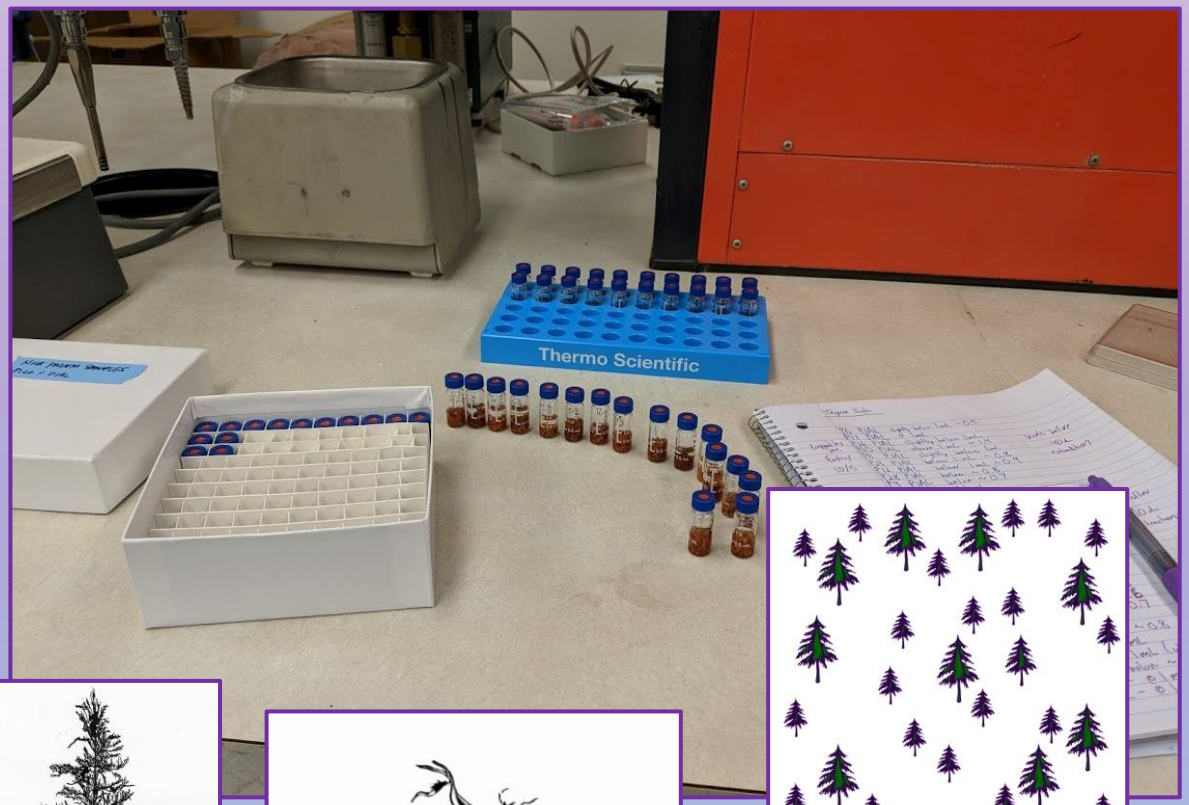
Limonene

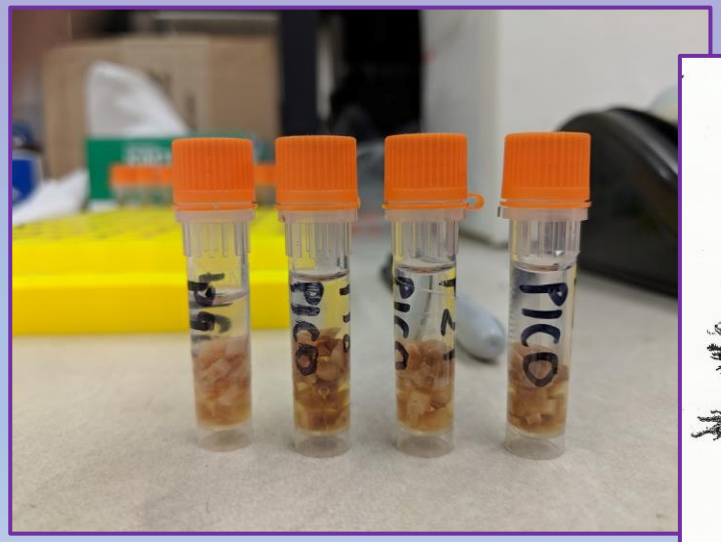
(−)-α-Pinene

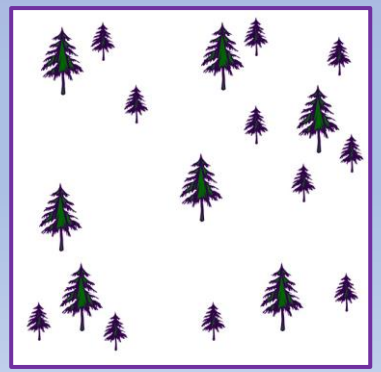


(+)-α-Pinene

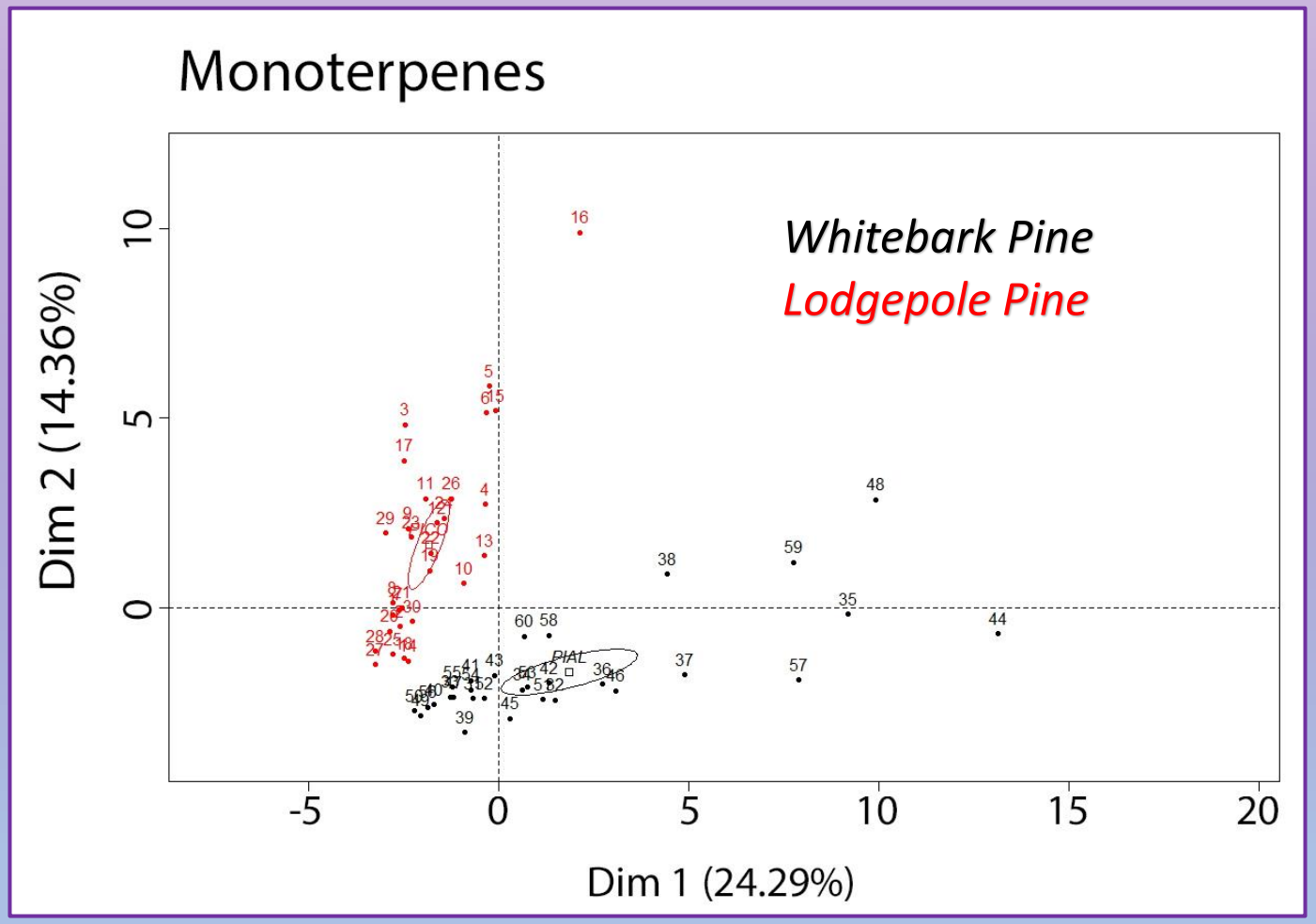
Next Steps: Chemical Ecology of Whitebark Pine







Next Steps: Chemical Ecology of Whitebark Pine



PC 1: α–pinene, β–myrcene, δ–limonene, sabinene

PC 2:, α–phellandrene, β–phellandrene, β–ocimene

Thank You!

Confederated Salish and Kootenai Tribes

Salish Kootenai College

Salish & Kootenai Culture Committees

Rich Jannsen ***Tony Incashola, Jr.*** ***Jim Durglo*** ***Michael Durglo, Jr.***

Advisory Committee
David McWethy
Gregory Pederson
Richard Everett
Sharon Hood

Collaborators
- Emily Heyerdahl
- Robert Keane
- Amy Trowbridge

Research Assistance
- Danny Stahle
- Cathy Whitlock
- MSU Paleoecology Lab:
  - Pico Alt
  - Peter Billman
  - Buzz Nanavati
  - Christopher Schiller
  - Shelby Sly
  - Barbara Ulrich
  - Matthew Weingart
  - John Wendt

Field Assistance
- Mckenzie Rides at the Door
- ShiNaasha Pete
- Tamara Birdsbill
- Joesef Andrews
- Derek Snyder
- Catherine Hopstad

Lab Assistance
- Zachary Gigone
- Aden Norris

Questions?