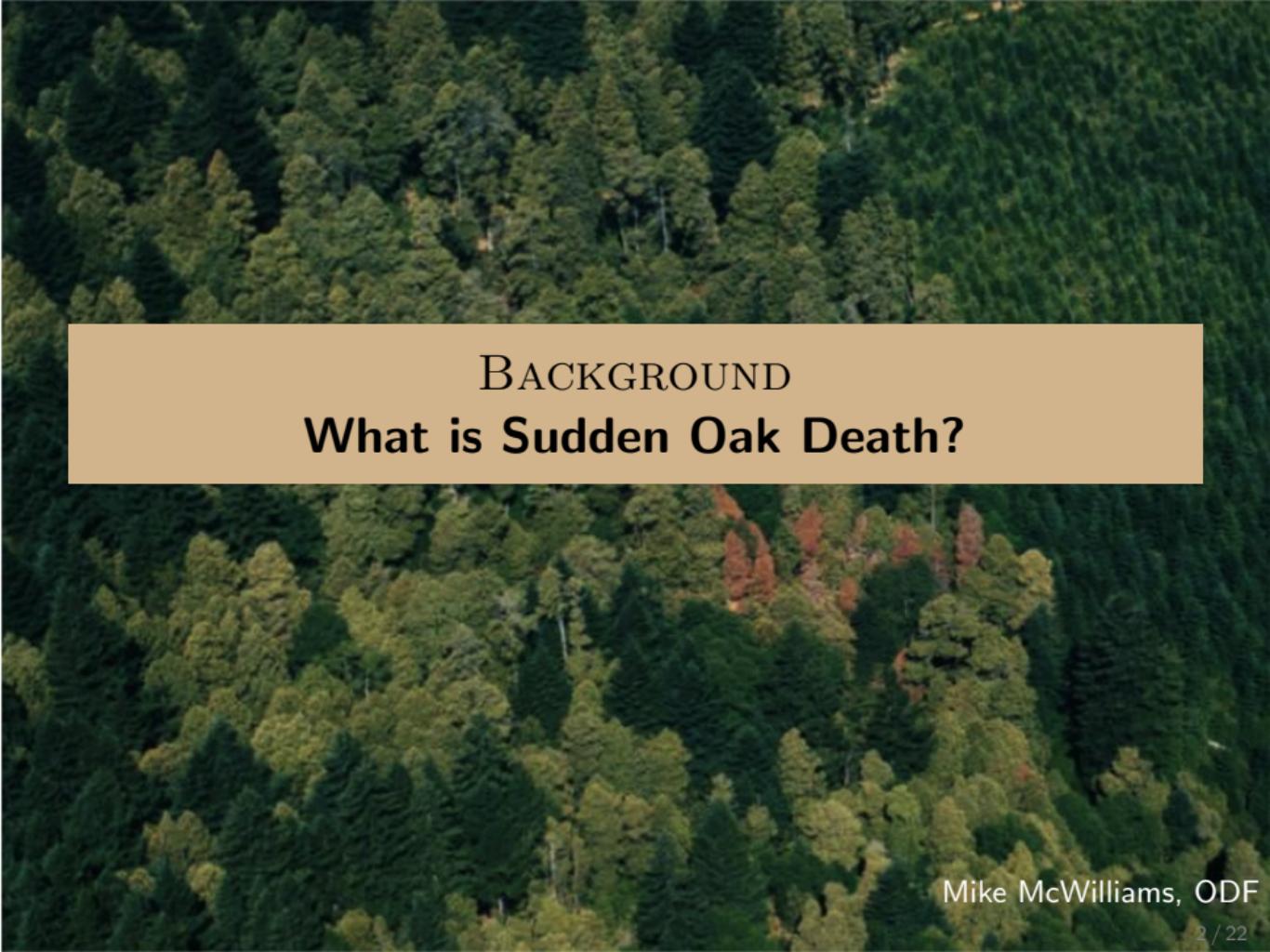


Evidence for at least two introductions of the sudden oak death pathogen into Oregon forests

**ZN Kamvar, MM Larsen, AM Kanaskie,
EM Hansen, and NJ Grünwald**

APS Annual Meeting, Pasadena, CA
August 02, 2015



BACKGROUND

What is Sudden Oak Death?

Mike McWilliams, ODF

Phytophthora ramorum

- ▶ Non-native
- ▶ > 100 hosts
- ▶ Introduced into CA Bay Area circa mid 1990s
- ▶ 4 Clonal lineages
 - ▶ NA1, NA2
 - ▶ EU1, EU2
- ▶ **Spread to Oregon before 2001**
(Hansen et al., 2008)



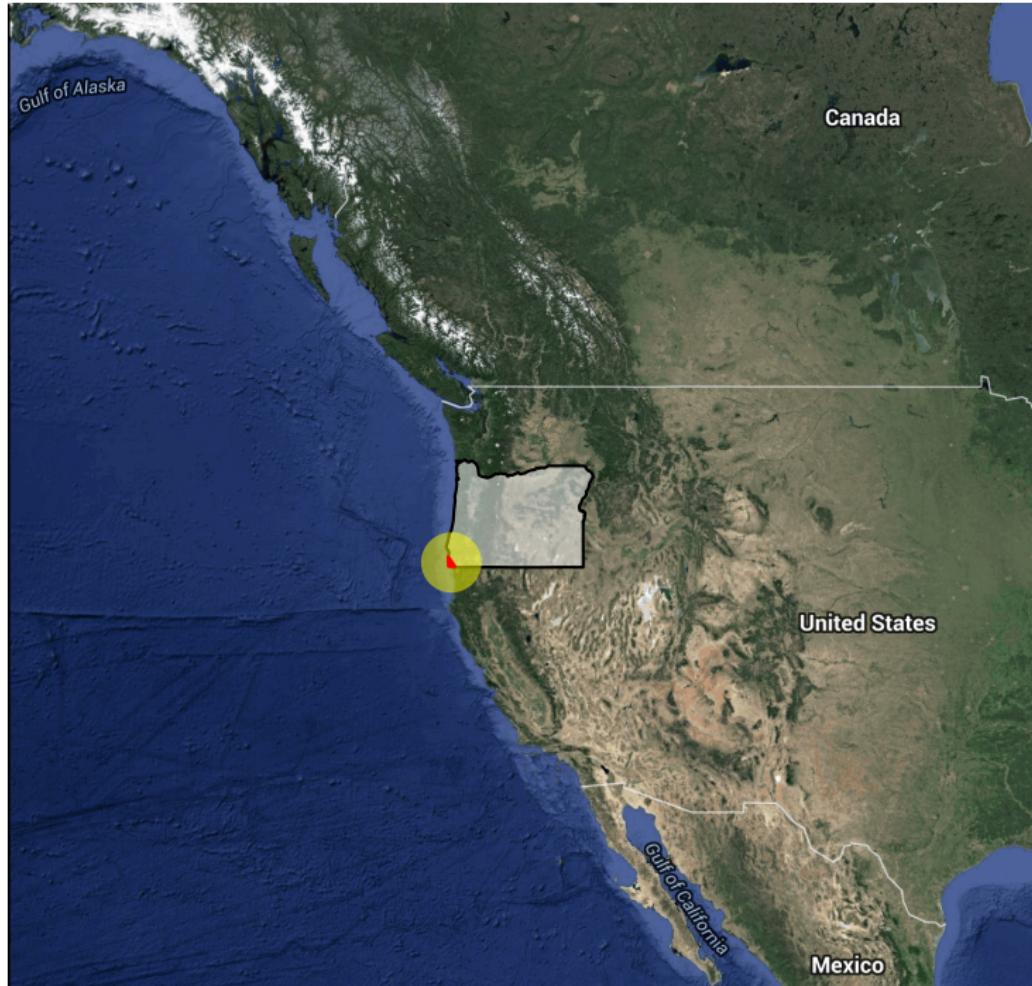
Photo: Jennifer Parke, OSU

Curry County Epidemic

2001 – Present



Mike McWilliams, ODF

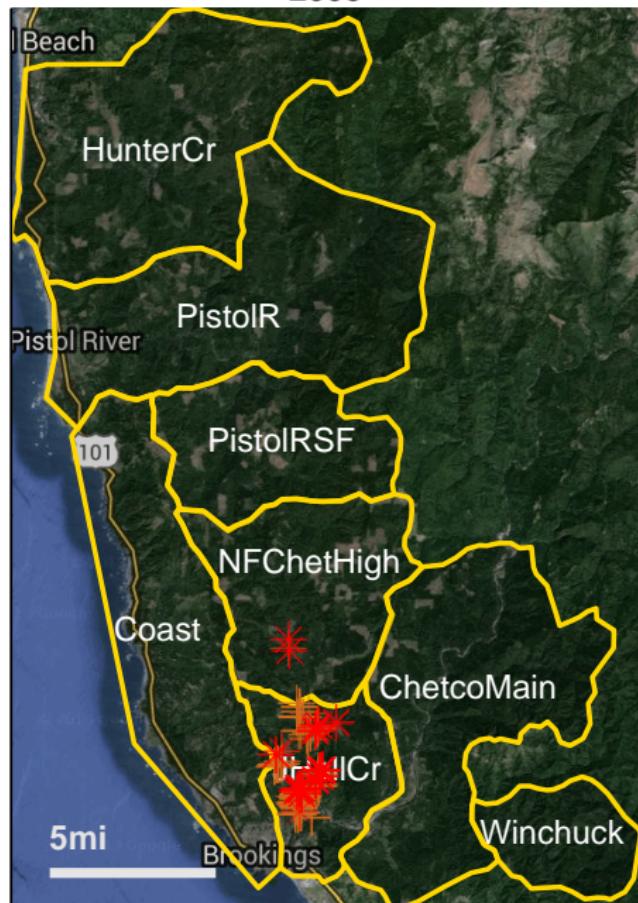




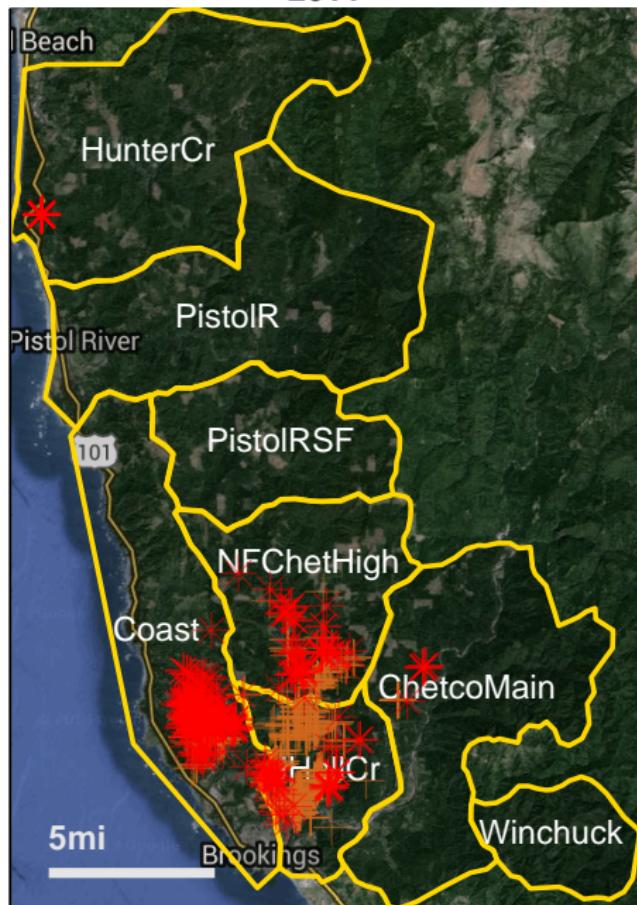
2001



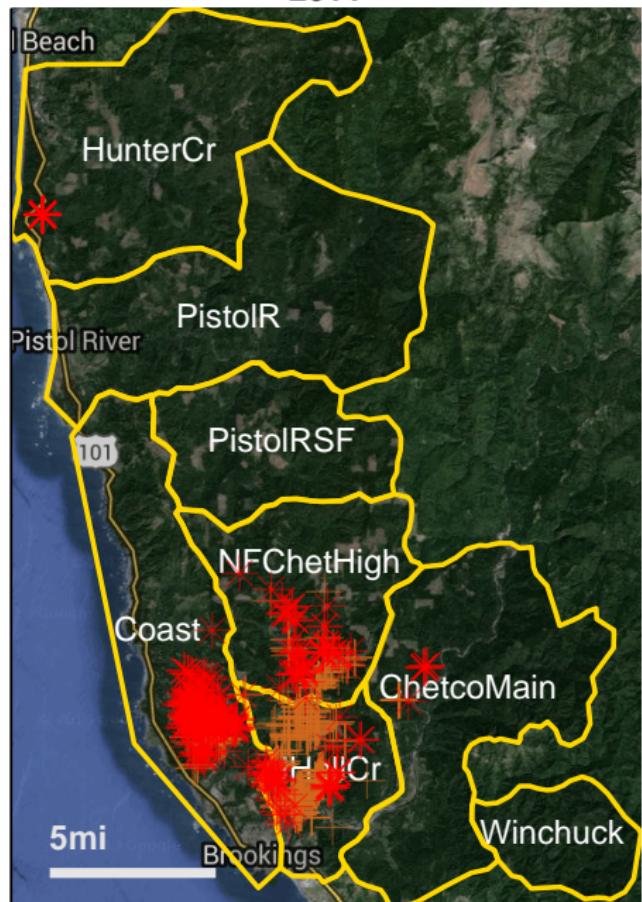
2005



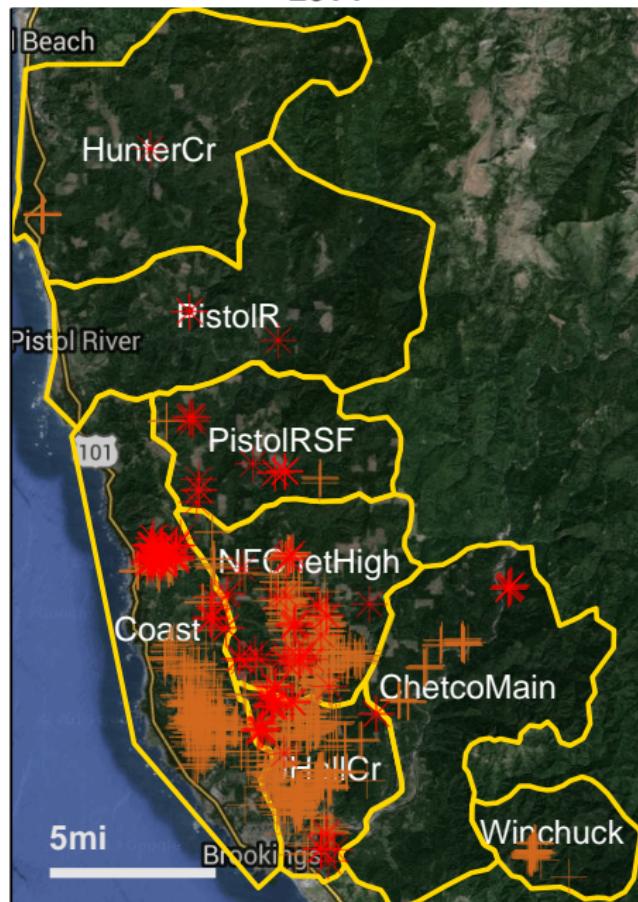
2011



2011



2014



Curry County epidemic

- ▶ 2001 – present
- ▶ Aerial survey detection
- ▶ **Aggressive Management**
(Hansen et al., 2008)
- ▶ **NA1** clonal lineage



Curry County epidemic

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Questions



Curry County epidemic

- ▶ 2001 – present
- ▶ Aerial survey detection
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Questions

1. New lineages introduced?



Curry County epidemic

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Questions

1. New lineages introduced?
2. Multiple introductions?



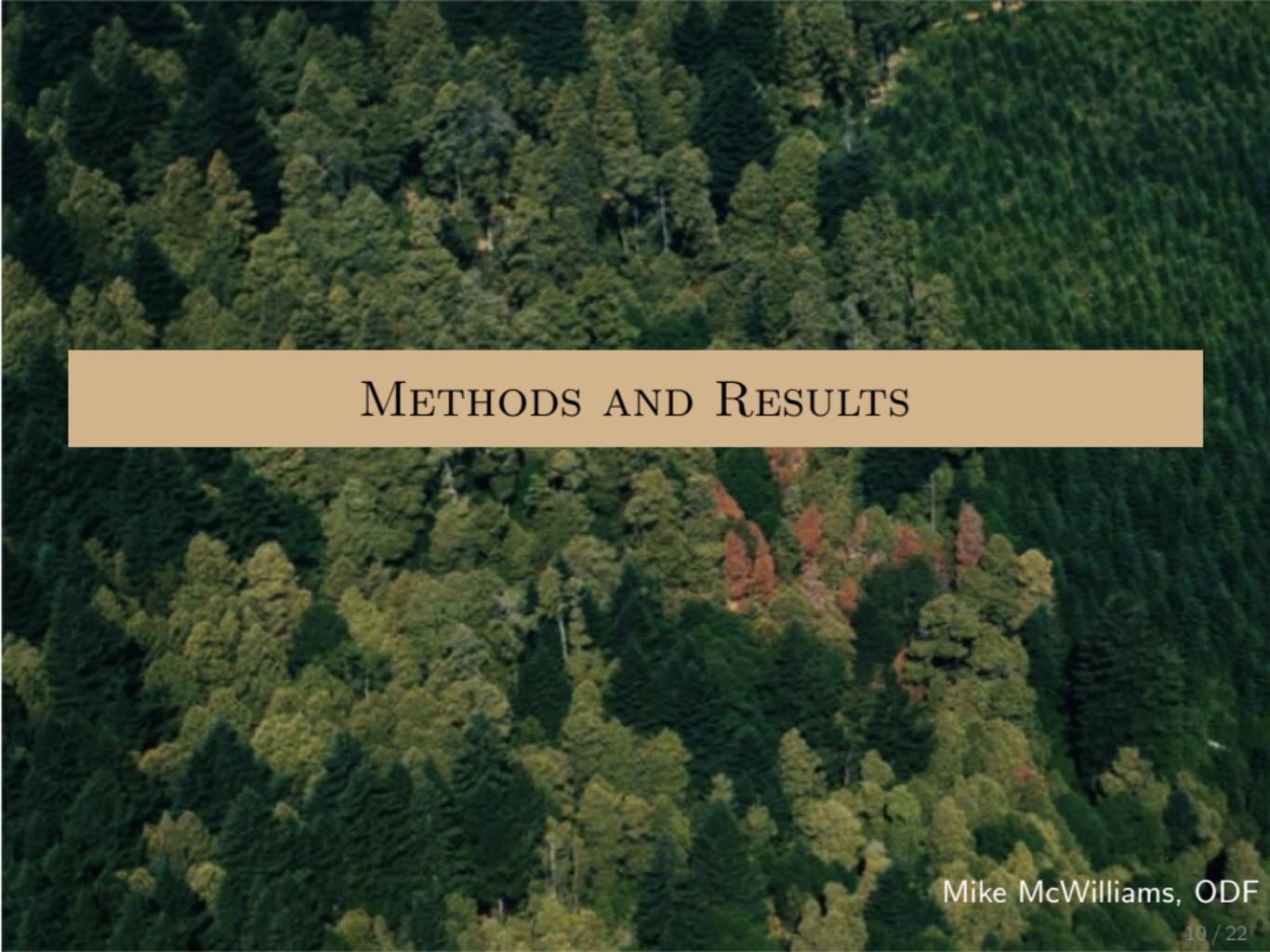
Curry County epidemic

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- ▶ Aerial survey detection
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- ▶ **NA1** clonal lineage

Questions

1. New lineages introduced?
2. Multiple introductions?
3. Nursery = source?

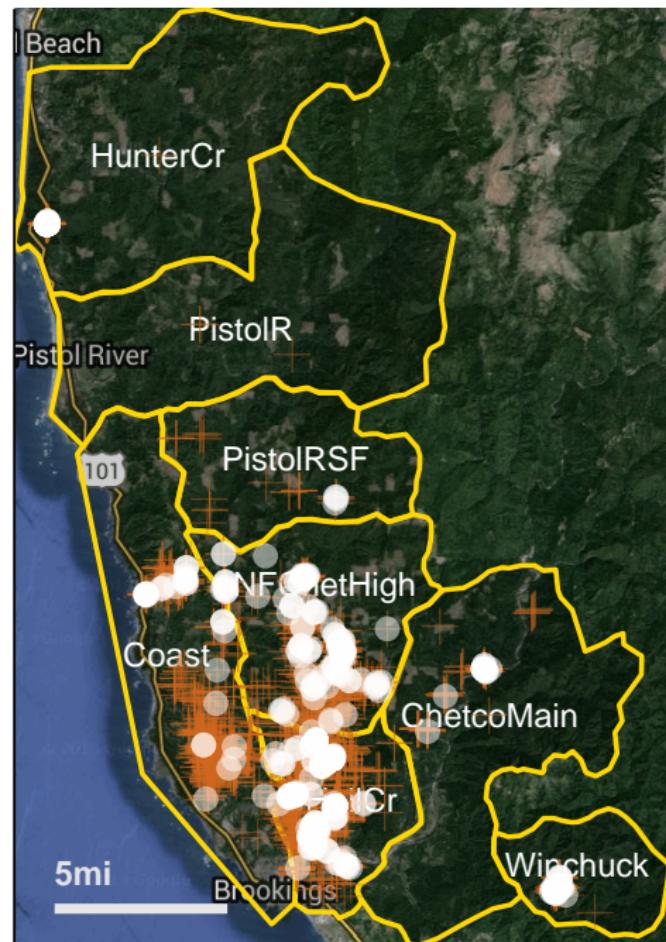


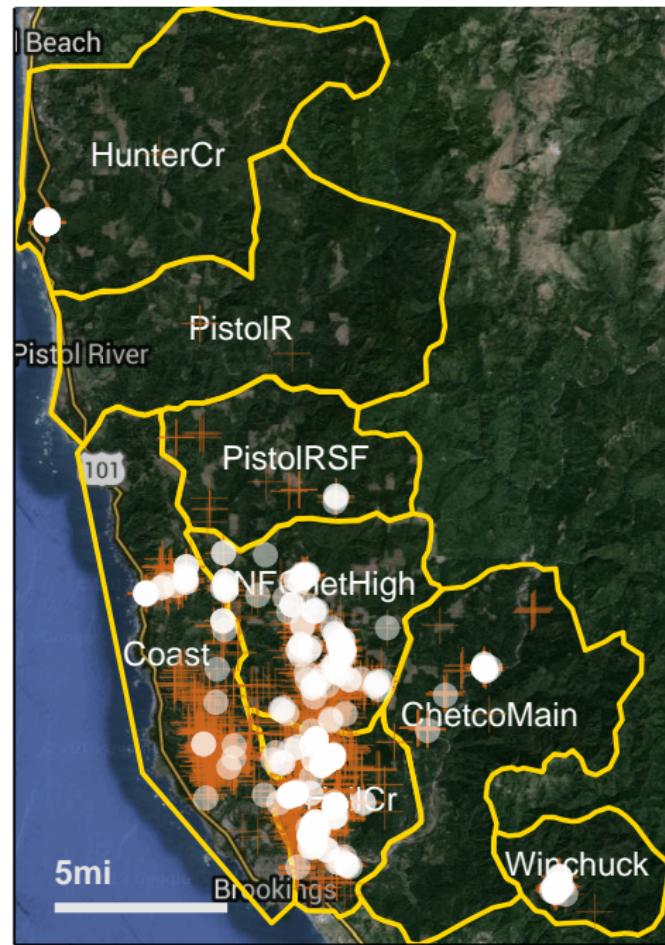


METHODS AND RESULTS

Mike McWilliams, ODF

Data



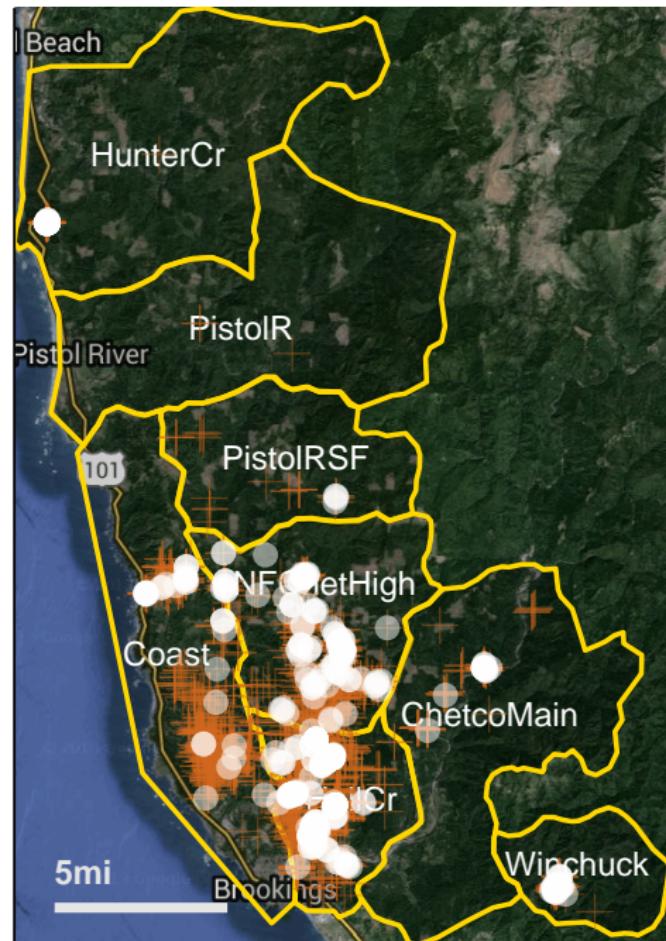


Data

- ▶ 512 forest samples
 - ▶ 70 MLG

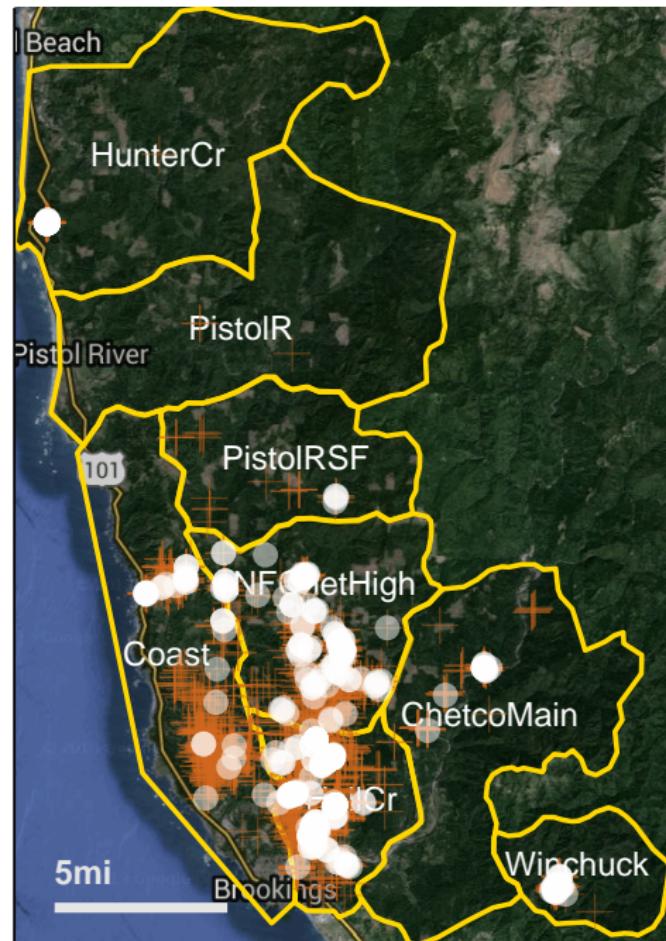
Data

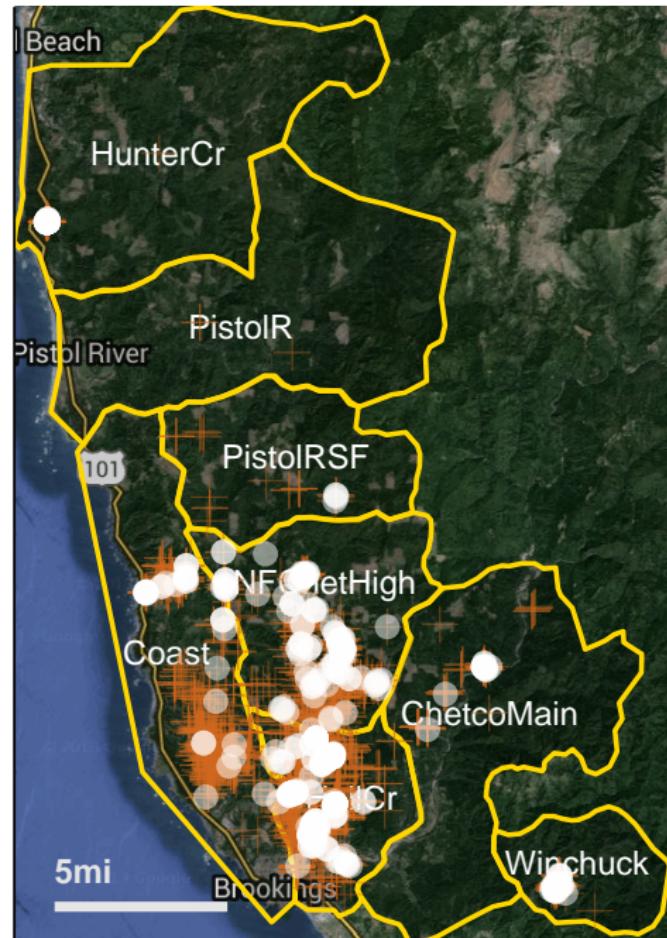
- ▶ 512 forest samples
 - ▶ 70 MLG
- ▶ 5 SSR loci



Data

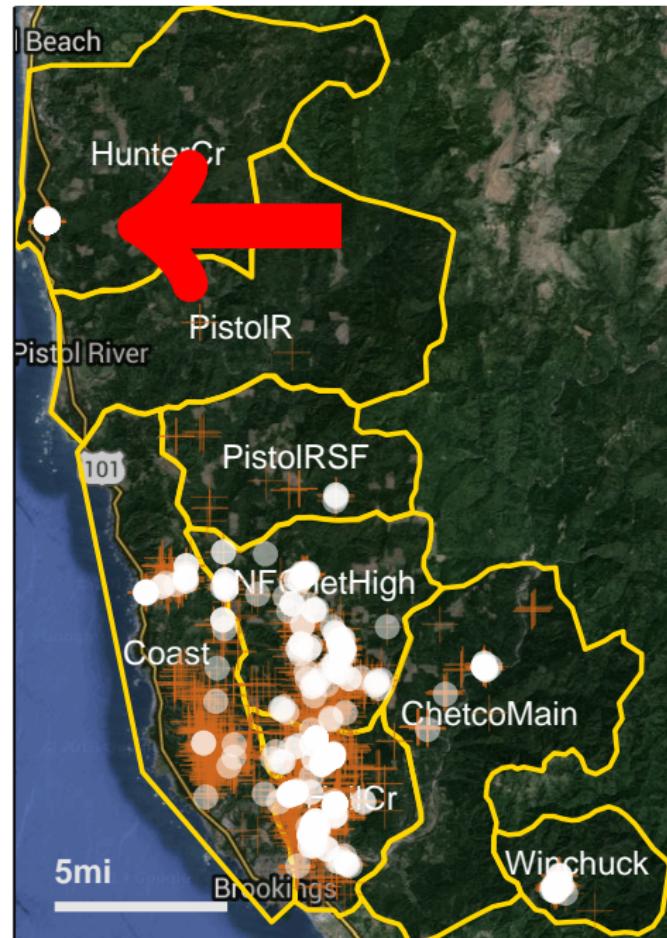
- ▶ 512 forest samples
 - ▶ 70 MLG
- ▶ 5 SSR loci
- ▶ 216 nursery samples
 - (Goss et al., 2009)
 - ▶ 40 MLG
 - ▶ 12 shared w/ forest





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- ▶ 512 forest samples
 - ▶ 70 MLG
 - ▶ 5 SSR loci
 - ▶ 216 nursery samples
 - (Goss et al., 2009)
 - ▶ 40 MLG
 - ▶ 12 shared w/ forest
 - ▶ Missing years
(2005–2010) ^a

^aPeterson, Hansen, and Kanaskie, 2015



Data

- ▶ 512 forest samples
 - ▶ 70 MLG
- ▶ 5 SSR loci
- ▶ 216 nursery samples
 - (Goss et al., 2009)
 - ▶ 40 MLG
 - ▶ 12 shared w/ forest
- ▶ Missing years (2005–2010)^a
- ▶ 2011 Anomaly

^aPeterson, Hansen, and Kanaskie, 2015

Methods

- ▶ **New Lineage Detection**
 - ▶ 14 diagnostic microsatellites

Methods

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- ▶ **Multiple Introductions & Nursery Contribution**

Methods

- ▶ **New Lineage Detection**
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- ▶ **Multiple Introductions & Nursery Contribution**
 - ▶ Discriminant Analysis of Principal Components (DAPC)
(Jombart, Devillard, and Balloux, 2010)

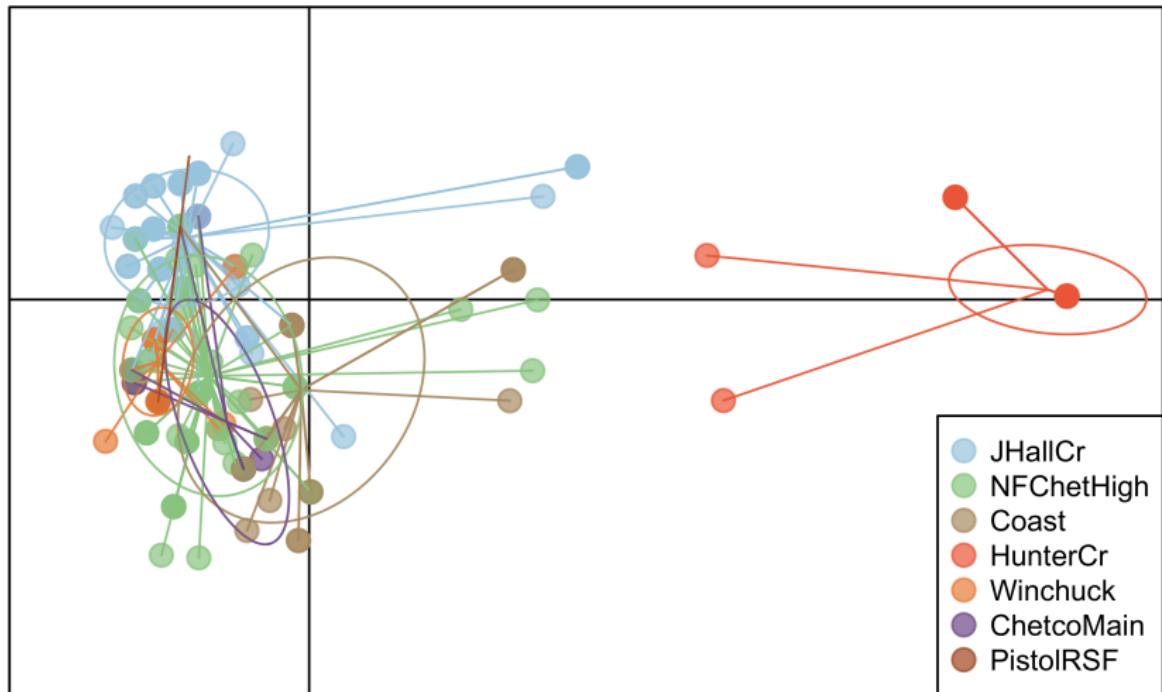
Methods

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 - ▶ Bootstrap Analysis
 - ▶ Nei's distance (Nei, 1973)

Methods

- ▶ **New Lineage Detection**
 - ▶ 14 diagnostic microsatellites
- ▶ **Multiple Introductions & Nursery Contribution**
 - ▶ Discriminant Analysis of Principal Components (DAPC)
(Jombart, Devillard, and Balloux, 2010)
 - ▶ Bootstrap Analysis
 - ▶ Nei's distance (Nei, 1973)
 - ▶ Minimum Spanning Networks (MSNs)
 - ▶ Bruvo's distance (Bruvo et al., 2004)

DAPC of forest populations



MSN of forest populations

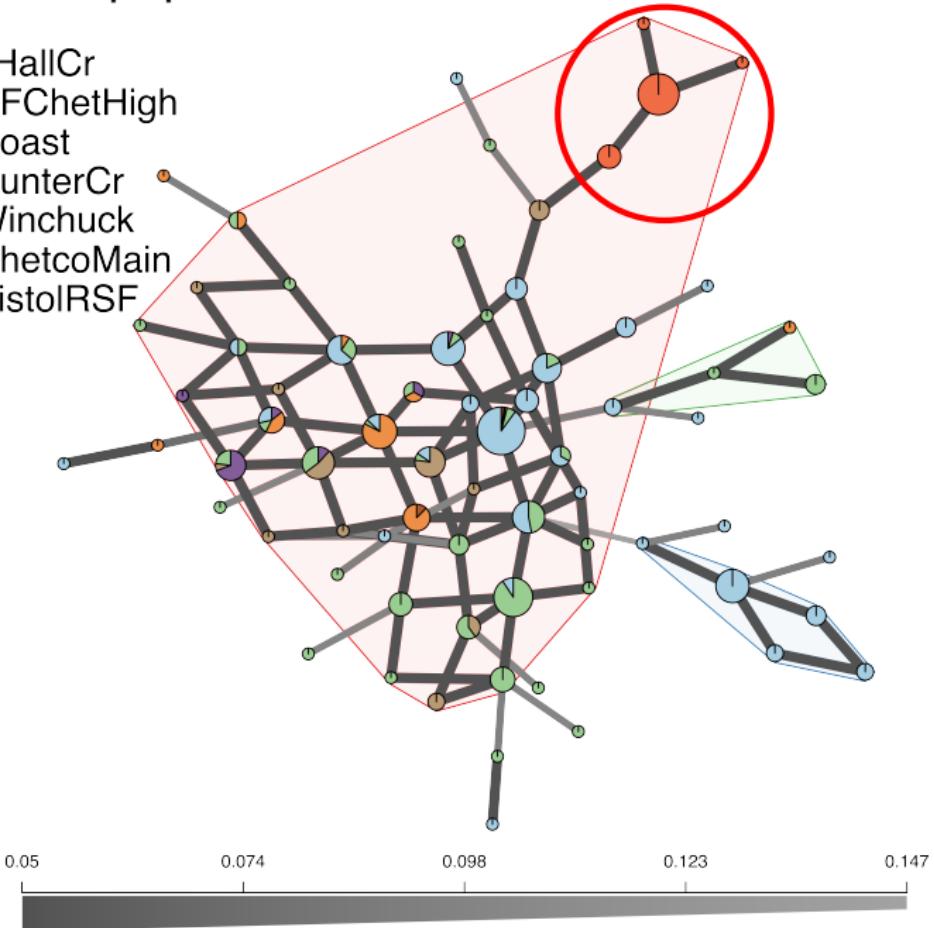
- JHallCr
- NFChetHigh
- Coast
- HunterCr
- Winchuck
- ChetcoMain
- PistolRSF

0.05 0.074 0.098 0.123 0.147



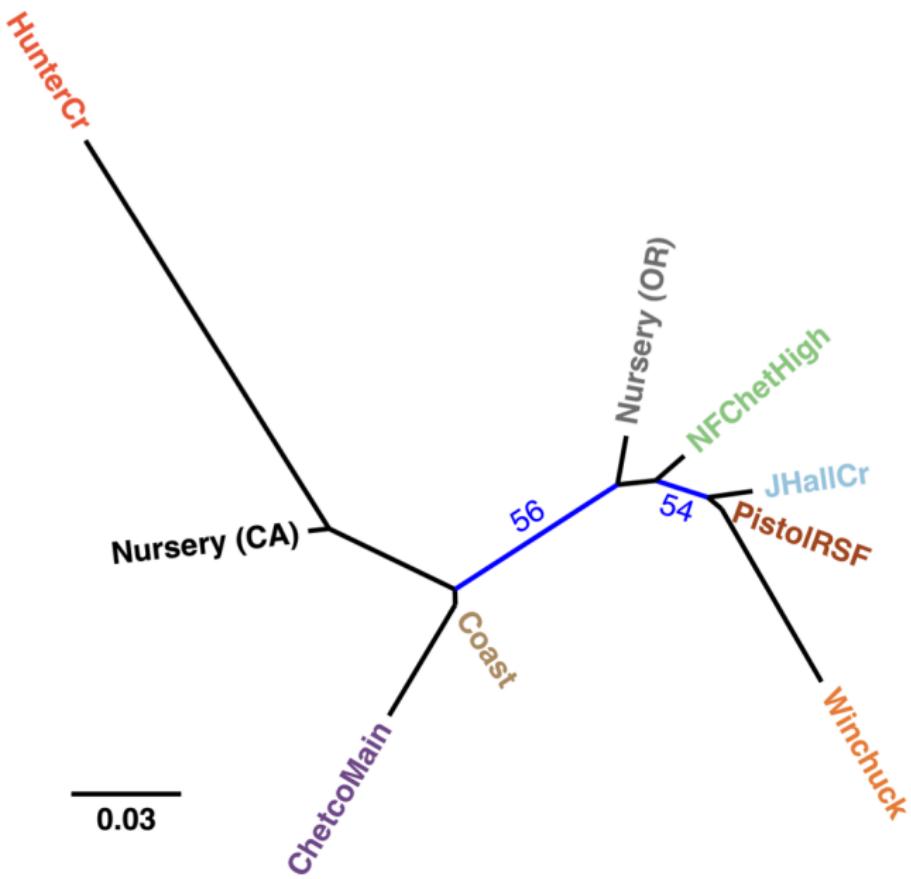
MSN of forest populations

- JHallCr
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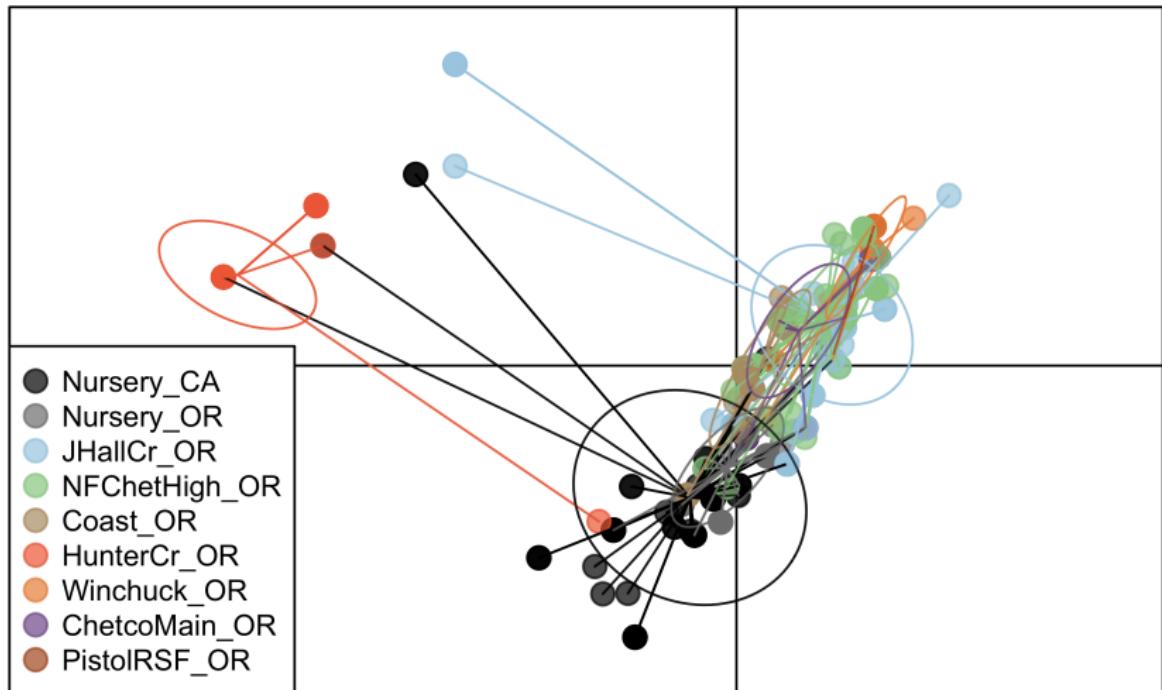


WHAT HAPPENS WHEN WE ADD NURSERY DATA?

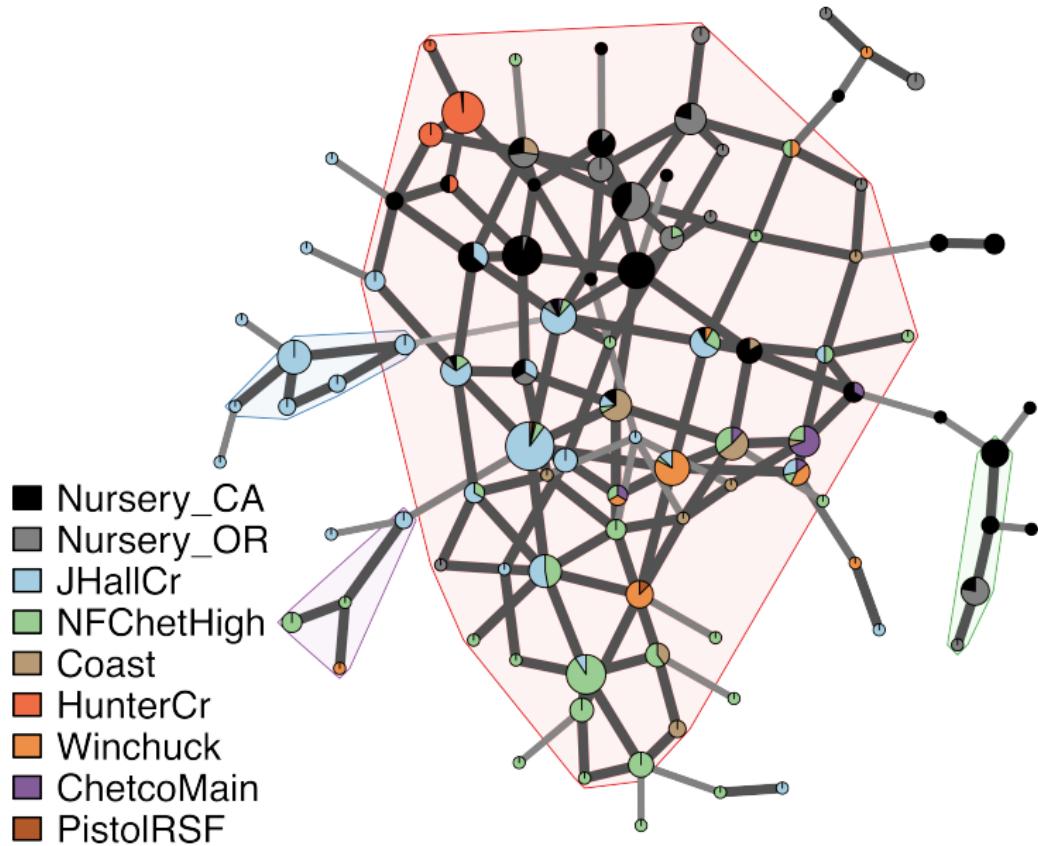
Nei's genetic distance



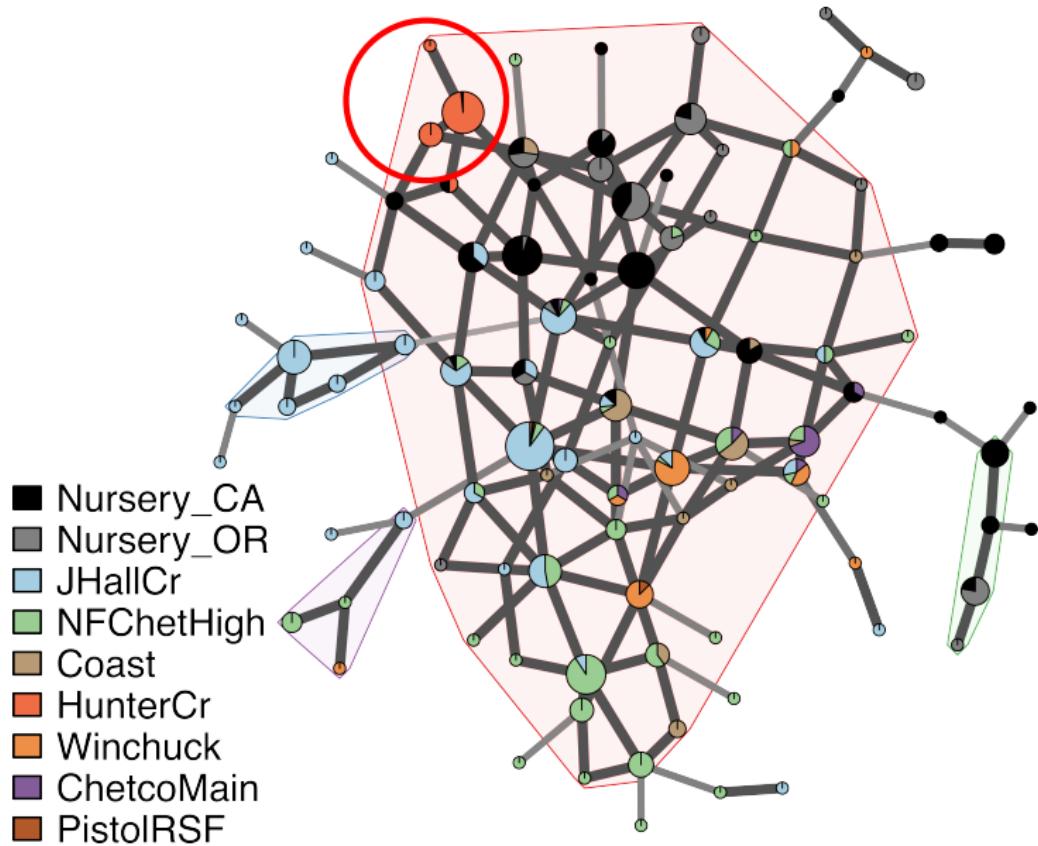
DAPC of forest & nursery populations

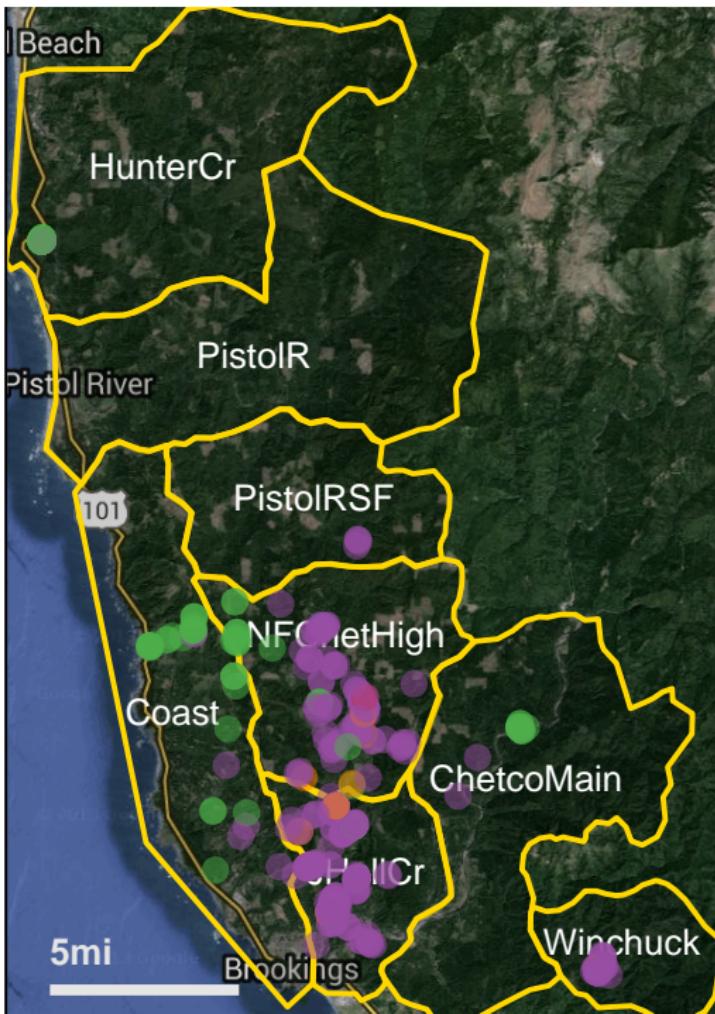


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MSN of forest & nursery populations



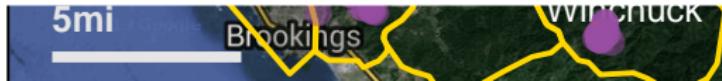
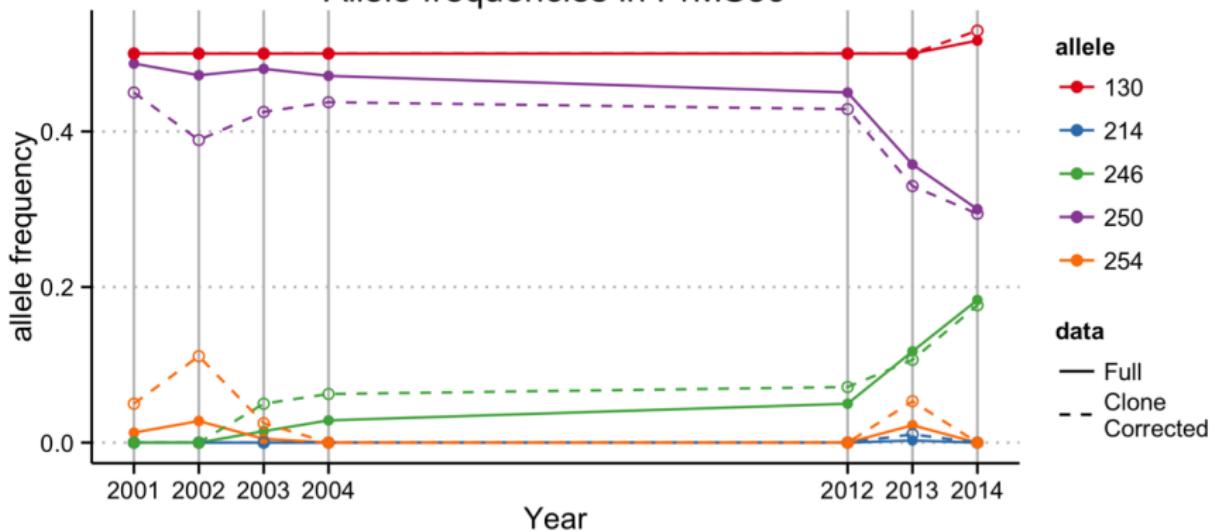


PrMS39

- 130/130
- 130/214
- 130/246
- 130/250
- 130/254



Allele frequencies in PrMS39





CONCLUSIONS

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What did we find?

- ▶ No new lineages

What did we find?

- ▶ No new lineages
- ▶ Evidence for at least 2 introductions
 - ▶ First in Joe Hall Creek
 - ▶ Second in Hunter Creek

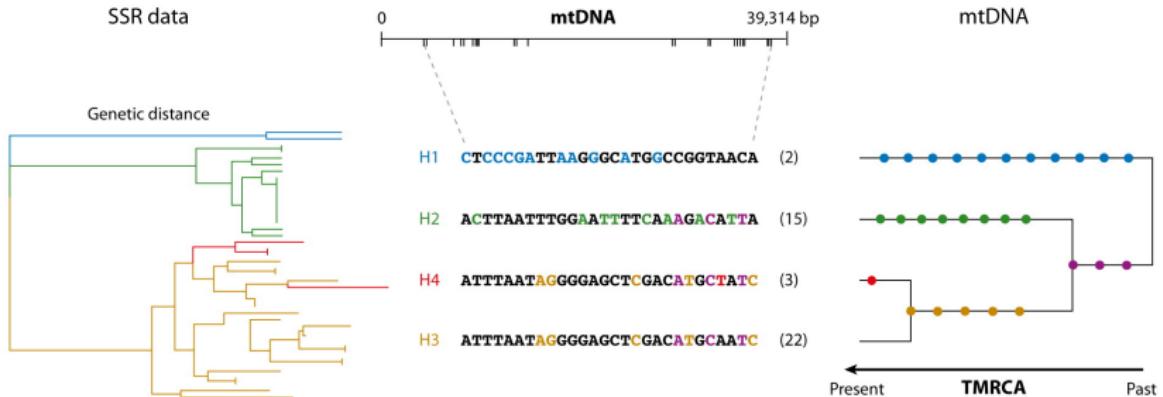
What did we find?

- ▶ No new lineages
- ▶ Evidence for at least 2 introductions
 - ▶ First in Joe Hall Creek
 - ▶ Second in Hunter Creek
- ▶ These are closely related to nursery genotypes

Acknowledgments

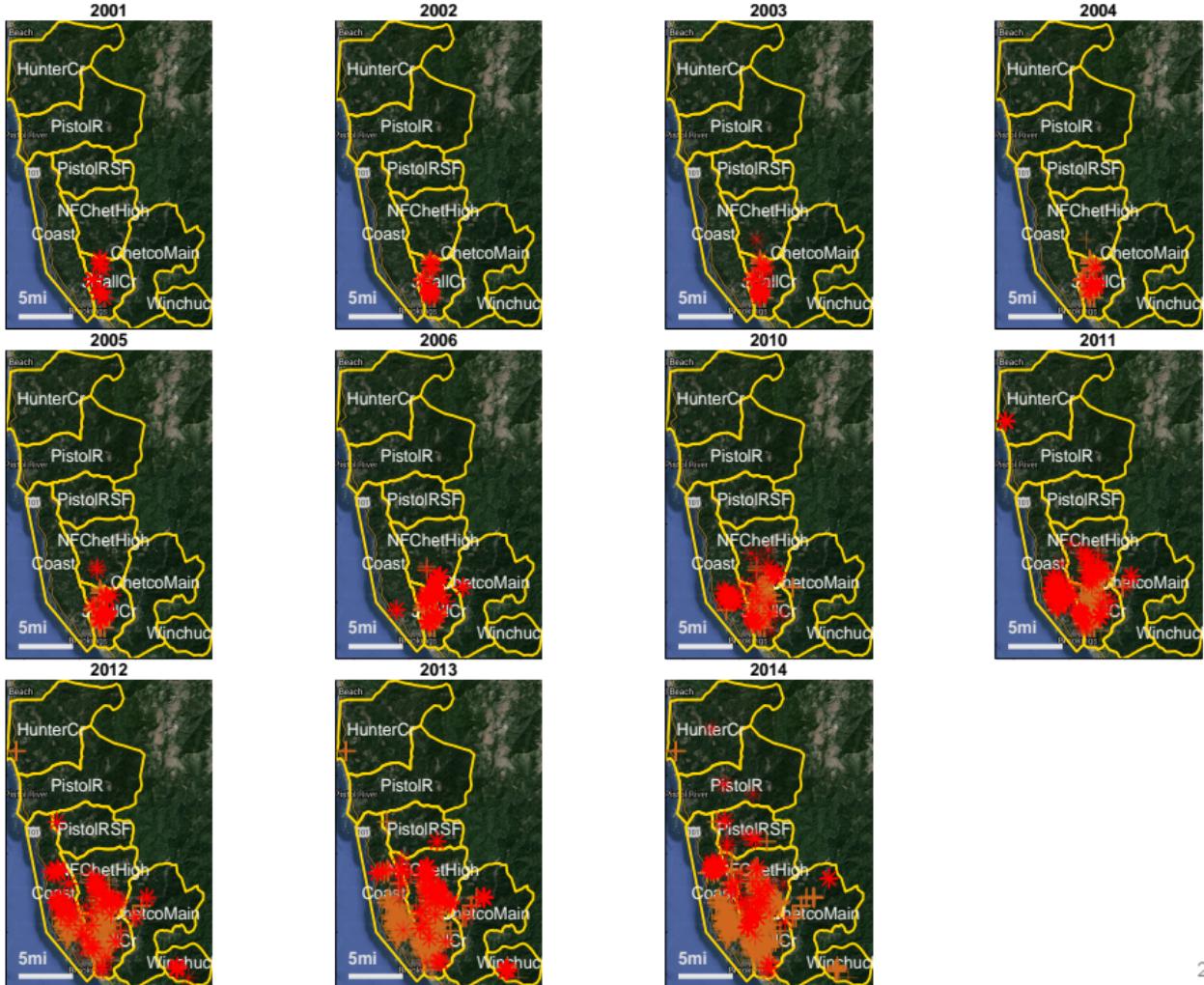
- ▶ **Mike McWilliams** – Aerial Surveys
- ▶ **Alan M. Kanaskie** – GIS work, field surveys, data collection
- ▶ **Brookings ground crew** – data collection, geotagging
- ▶ **Hansen Lab** – Culturing and identification
- ▶ **Jen Britt** – Early genotyping
- ▶ **Meredith M. Larsen** – Genotyping and data harmonization between labs
- ▶ **Erica M. Goss** – Nursery genotypes
- ▶ USDA-ARS grant 5358-22000-039-00D
- ▶ USDA-APHIS
- ▶ USDA-ARS Floriculture Nursery Initiative
- ▶ ODA/OAN
- ▶ USDA Forest Service Health Monitoring Program
- ▶ APS Pacific Division Student Travel Award

Clonal Lineages



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(Grünwald and Goss, 2011)



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