

Using assisted gene flow to establish climate-adapted forests

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UC DAVIS





Seed zones of California

Local adaptation and climate change



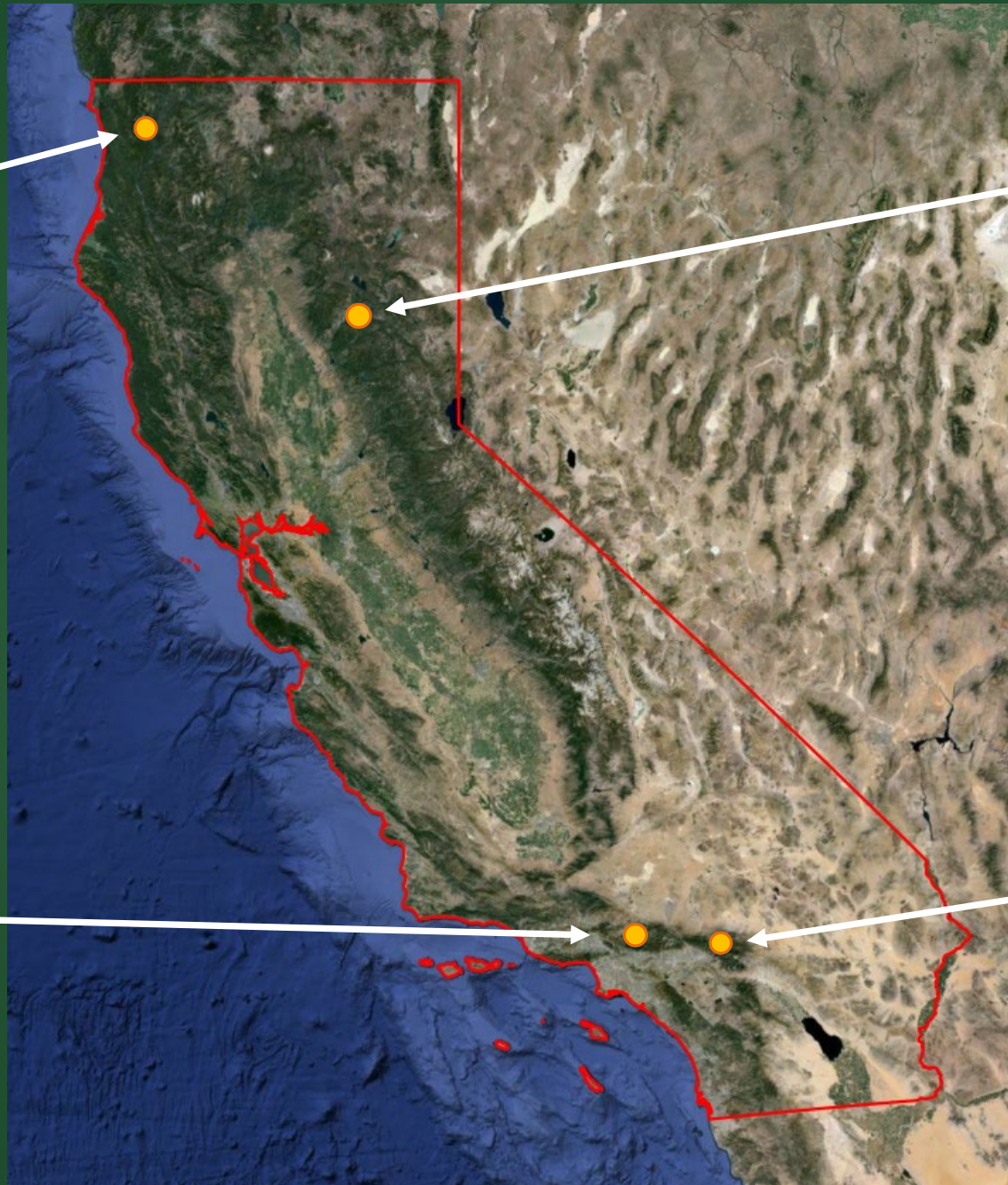
Warming and drying

Klamath NF
3 species
X
3 seed lots

Plumas NF
2 species
X
2 seed lots

Angeles NF
3 species
X
3 seed lots

San Bernardino NF
1 species
X
2 seed lots



Total of 3528 seedlings planted

Plumas NF: Rich Fire

Elevation: 6200 ft

Block 1

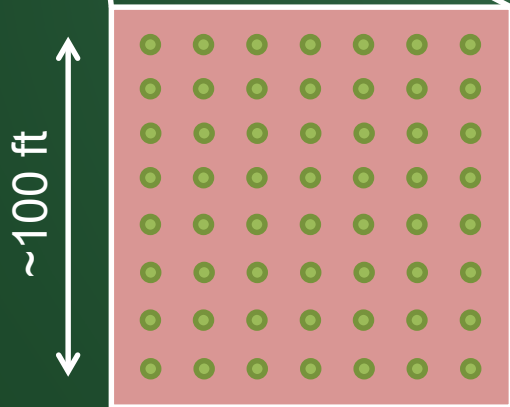
JP 5000- 5500 ft	SP 4500- 5000 ft
JP 6000- 6500 ft	SP 6000- 6500 ft

Block 2

JP 6000- 6500 ft	JP 5000- 5500 ft
SP 4500- 5000 ft	SP 6000- 6500 ft

Block 3

SP 4500- 5000 ft	JP 5000- 5500 ft
JP 6000- 6500 ft	SP 6000- 6500 ft



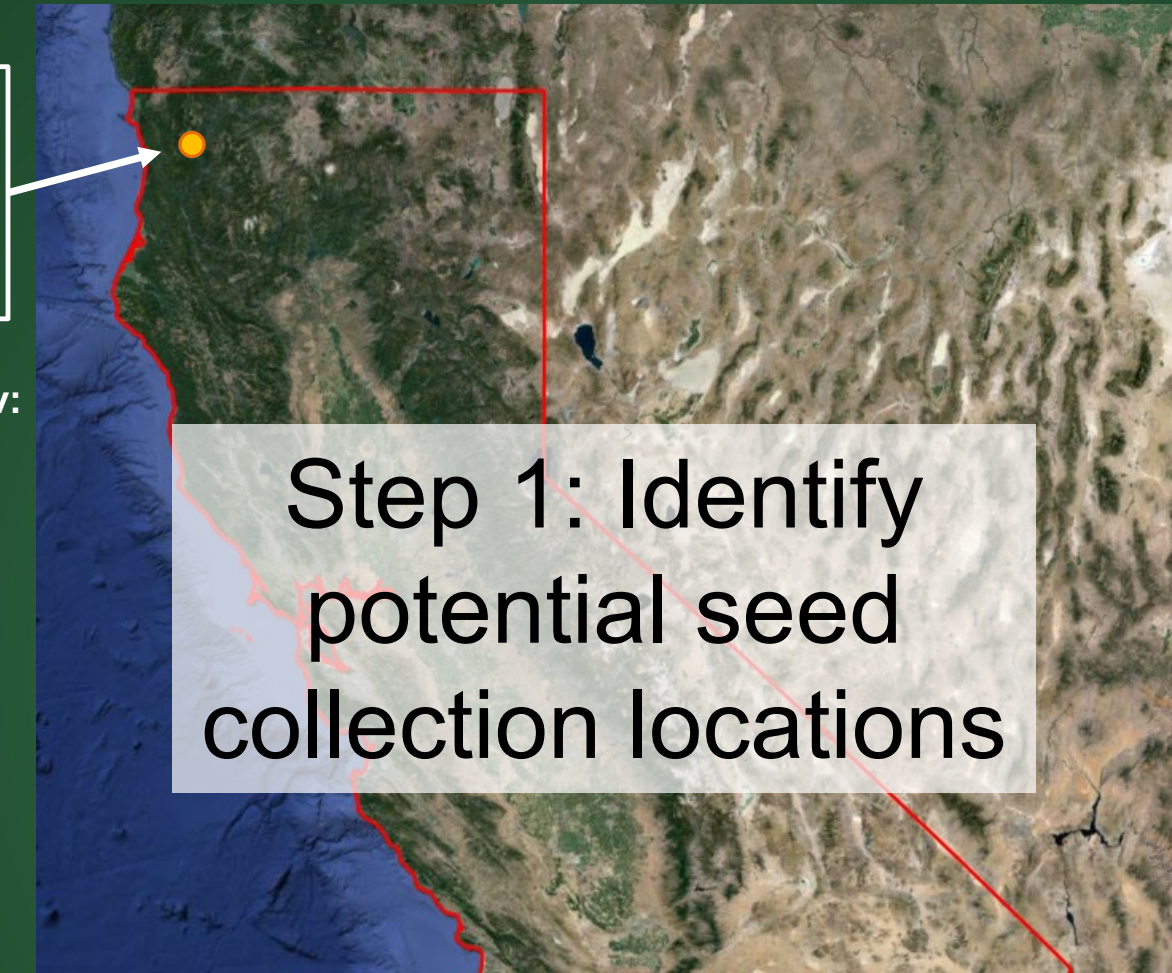
JP: Jeffrey pine
SP: sugar pine

Measured seedlings

1 year after planting

4 years after planting

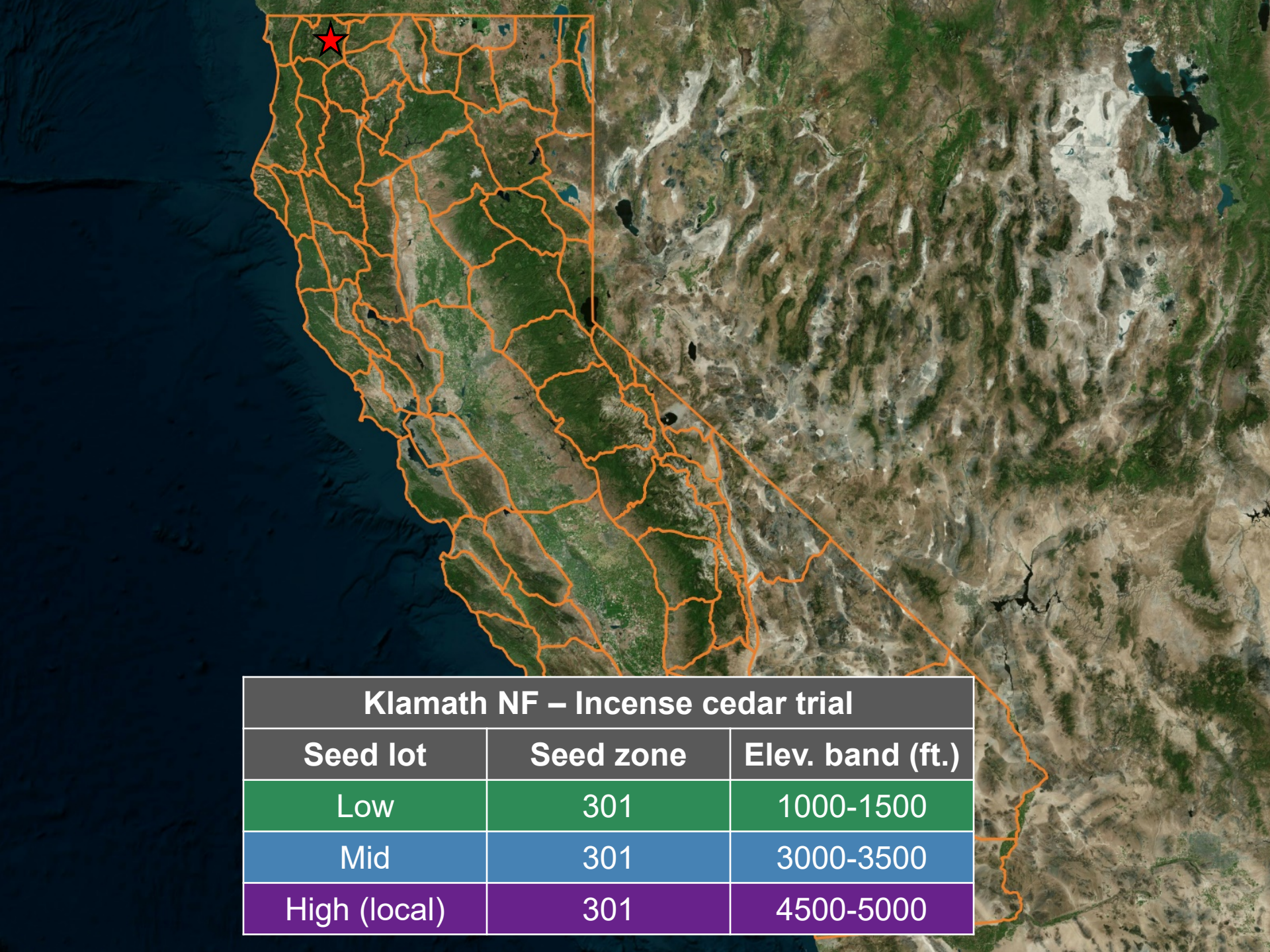
Klamath NF
3 species
X
3 seed lots



Step 1: Identify potential seed collection locations

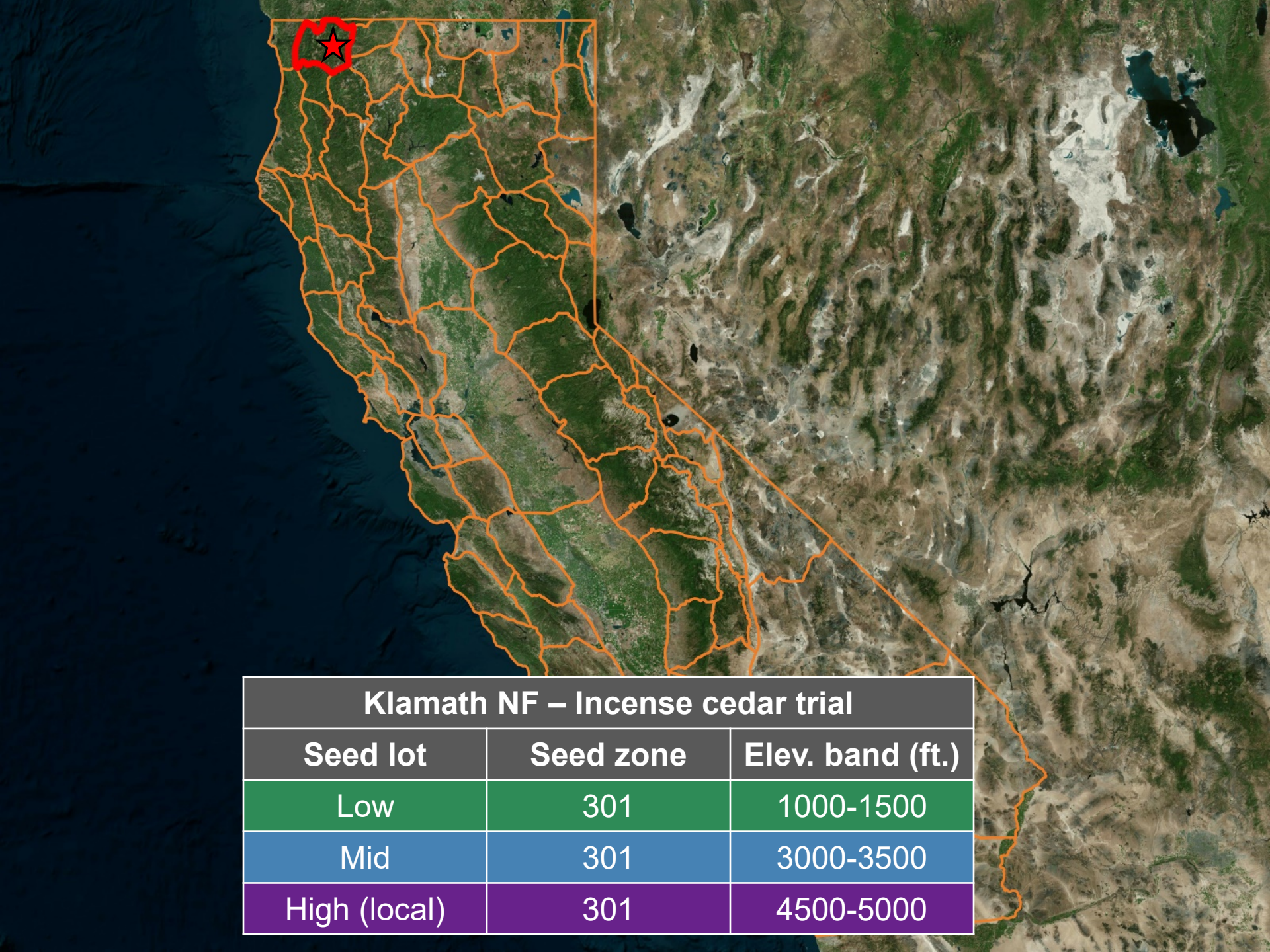
Planting site elev:
4650 ft

Klamath NF – Incense cedar trial		
Seed lot	Seed zone	Elev. band (ft.)
Low	301	1000-1500
Mid	301	3000-3500
High (local)	301	4500-5000



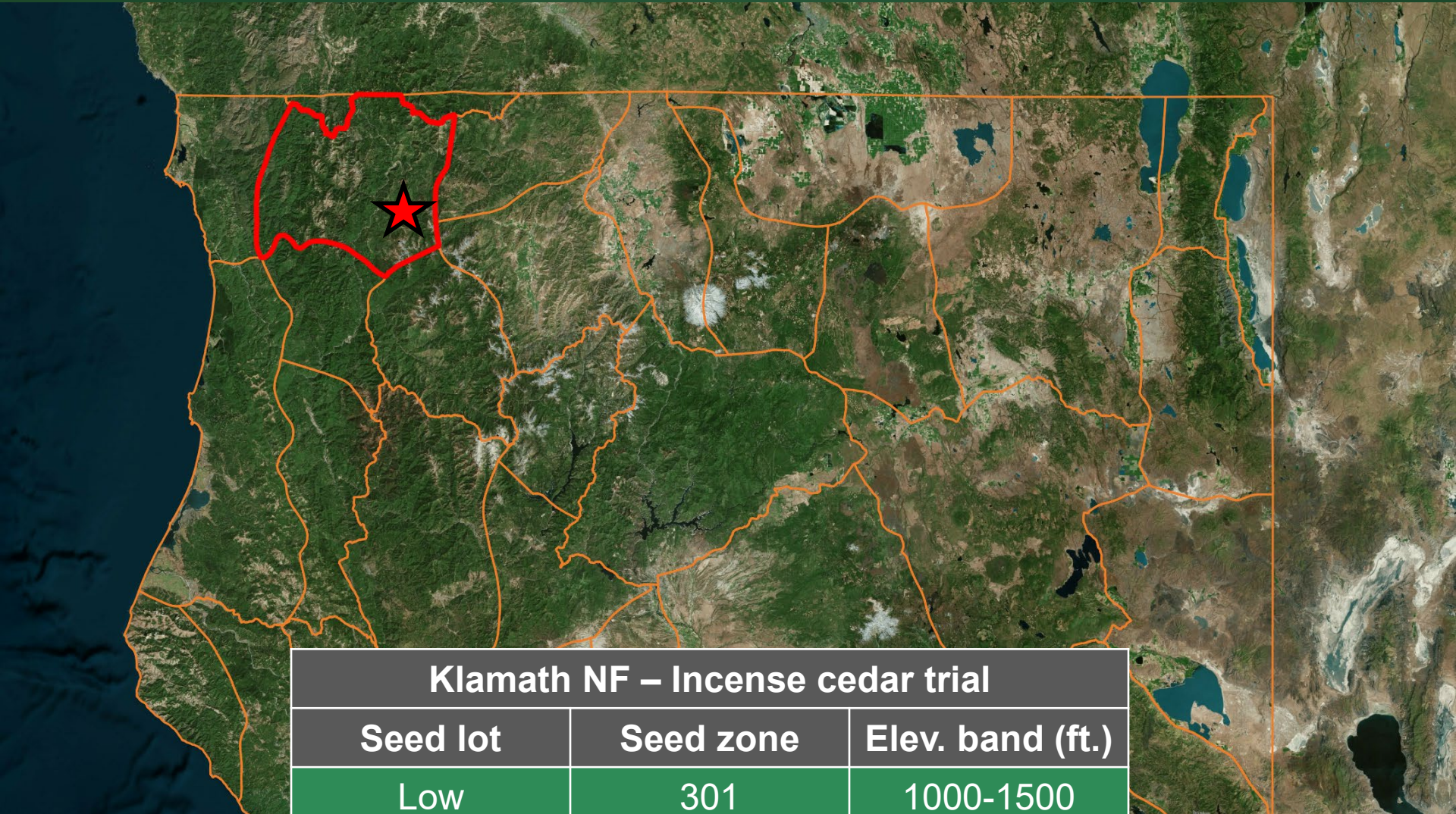
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Klamath NF – Incense cedar trial

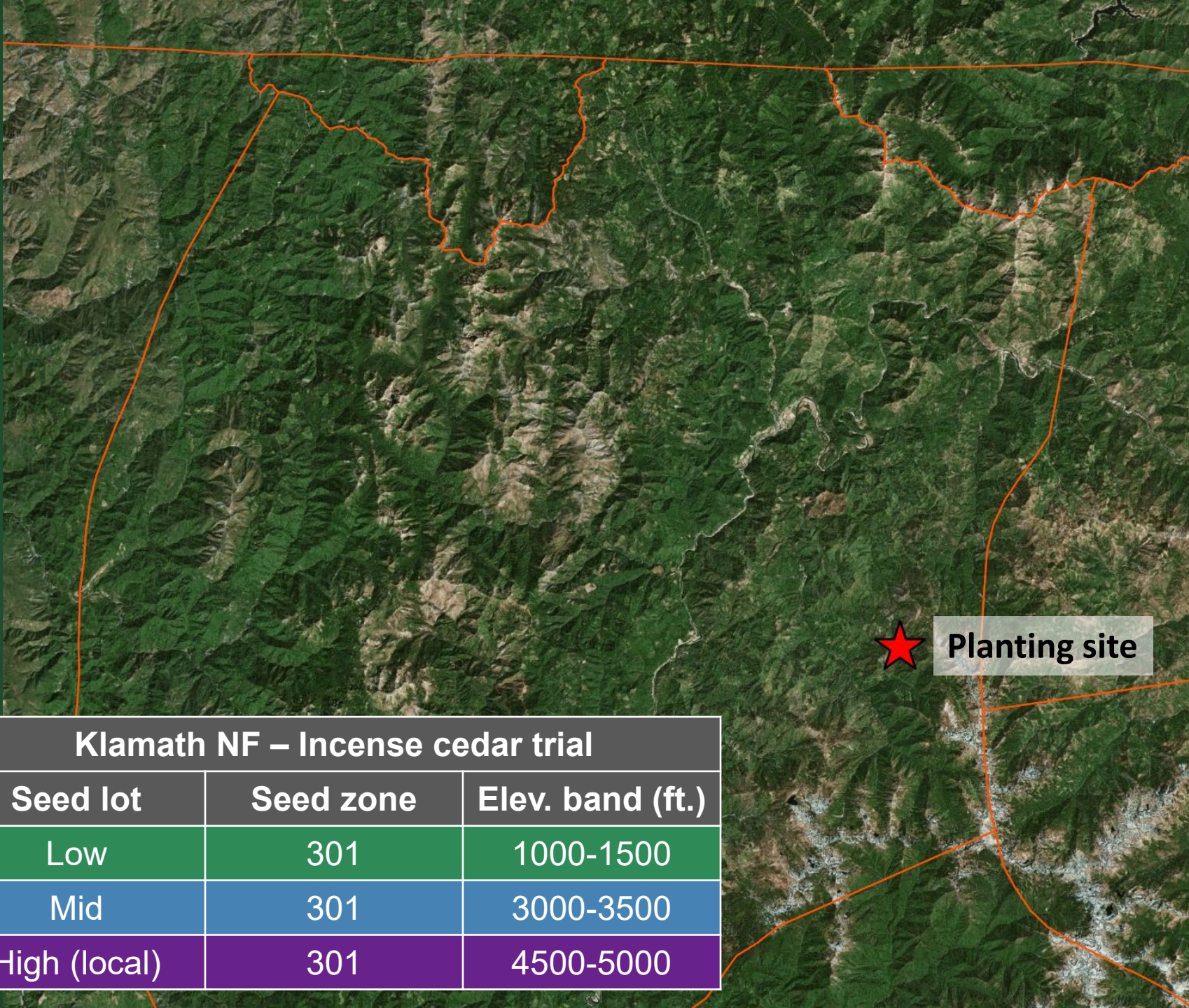
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Klamath NF – Incense cedar trial

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 = planting site



Planting site

Klamath NF – Incense cedar trial

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Shading reflects elevation



Planting site

Klamath NF – Incense cedar trial

Seed lot	Seed zone	Elev. band (ft.)
Low	301	1000-1500
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Possible seed source locations

Shading reflects elevation

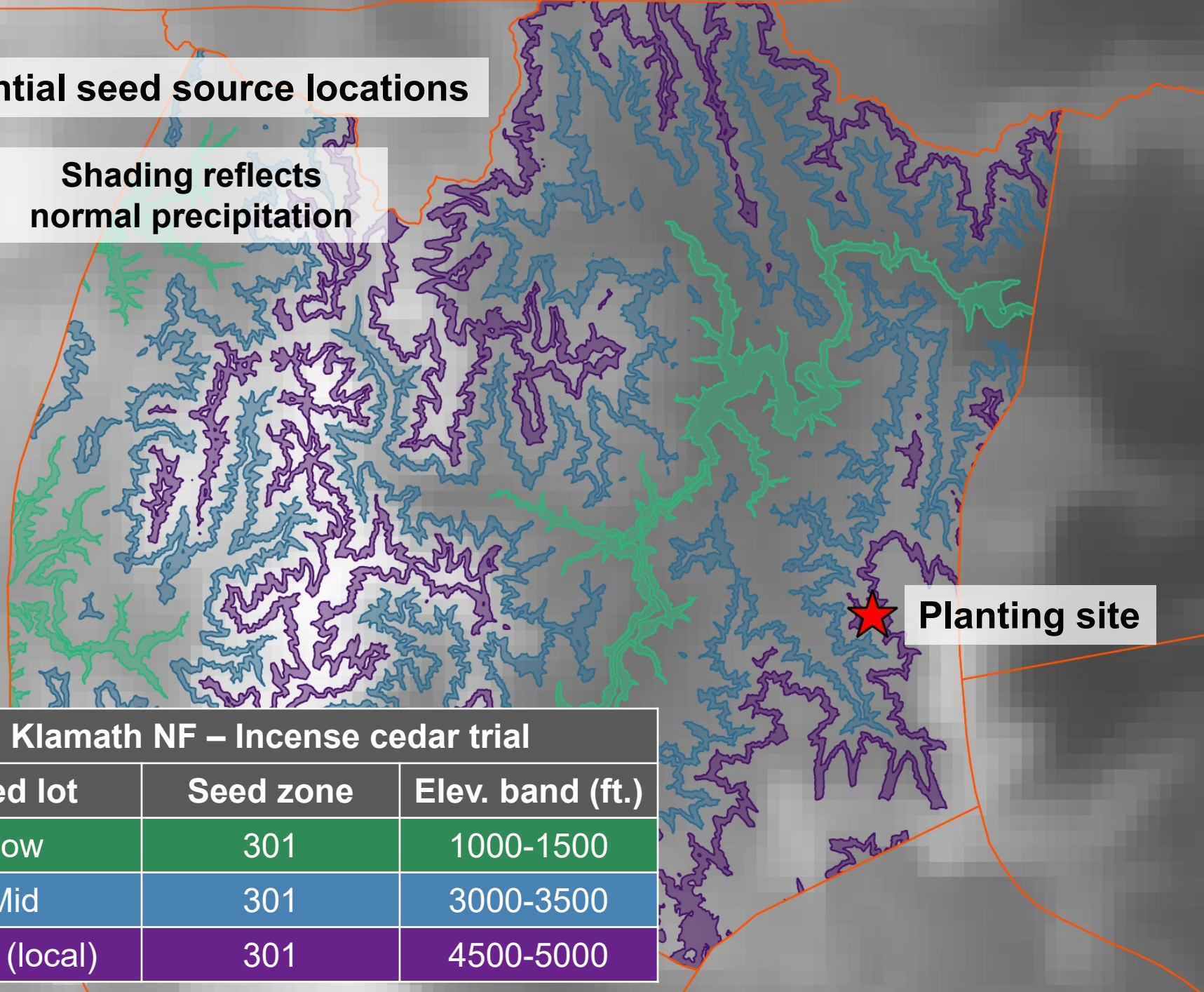
 **Planting site**

Klamath NF – Incense cedar trial

Seed lot	Seed zone	Elev. band (ft.)
Low	301	1000-1500
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High (local)	301	4500-5000

Potential seed source locations

Shading reflects
normal precipitation

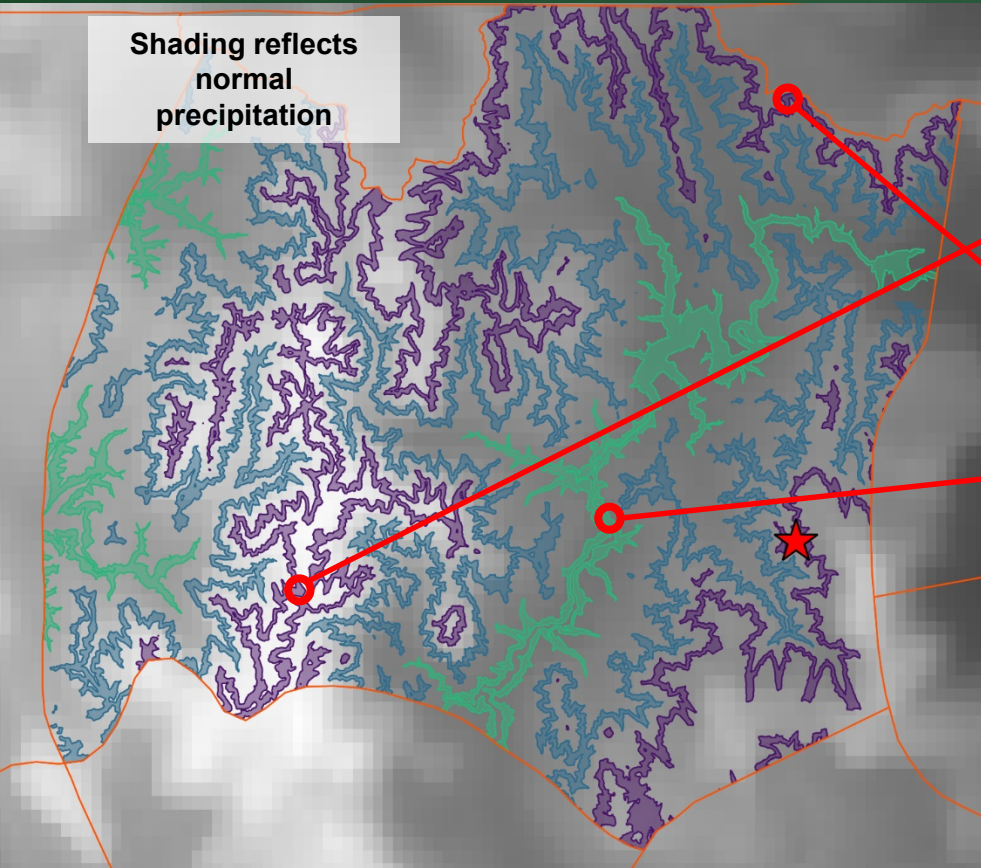


★ Planting site

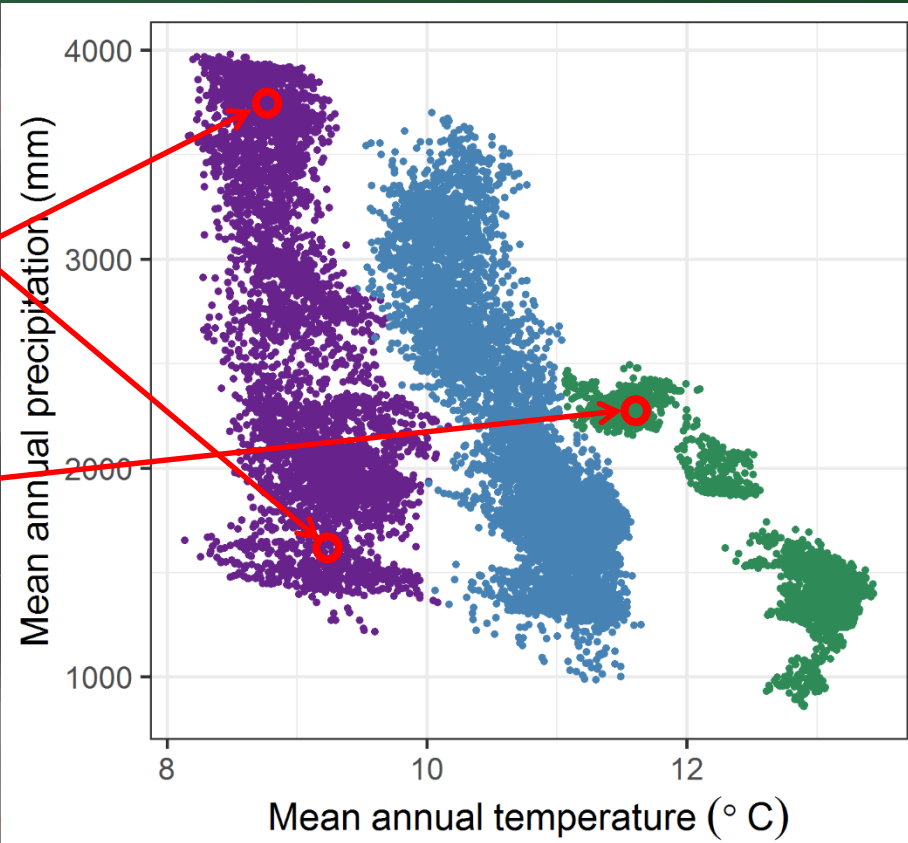
Klamath NF – Incense cedar trial

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Possible seed source locations



Possible seed lot source climates



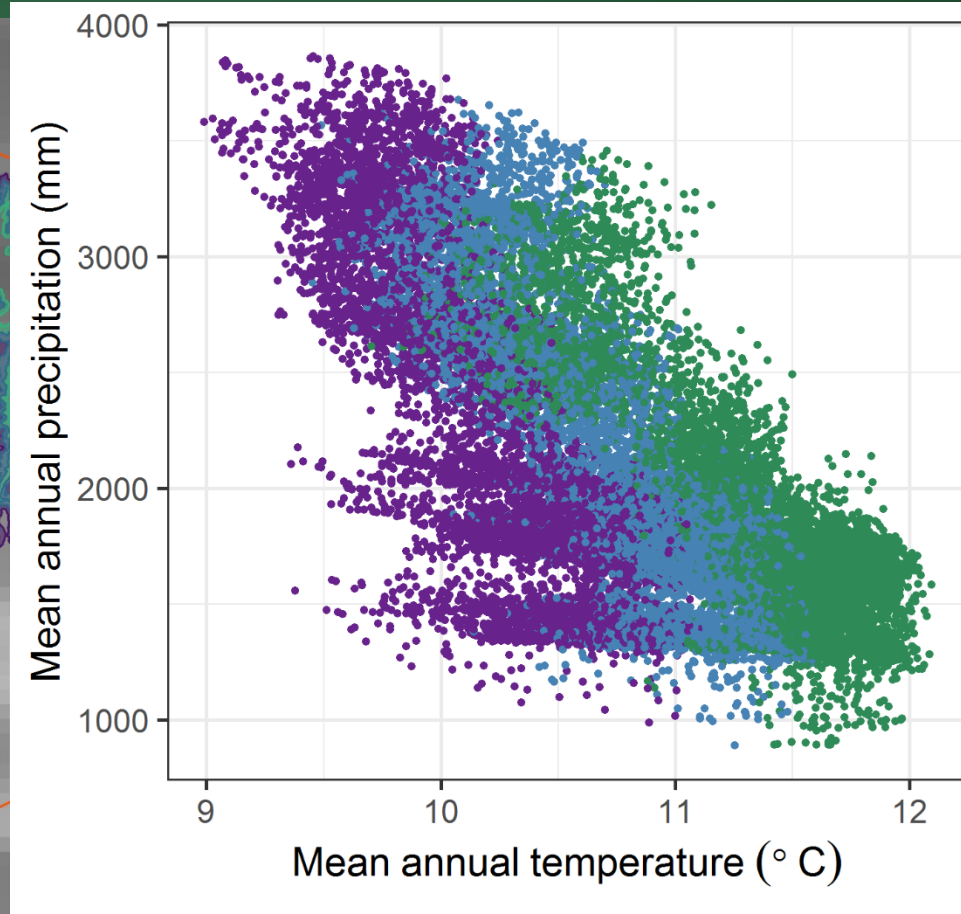
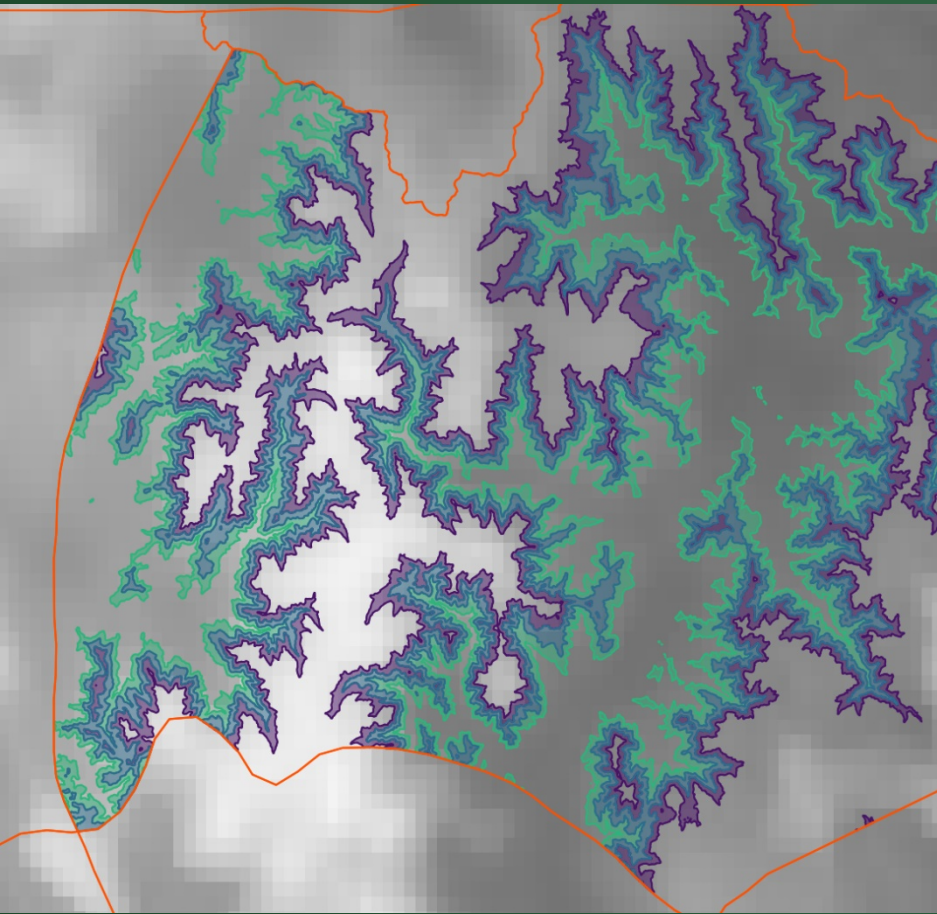
Klamath NF – Incense cedar trial

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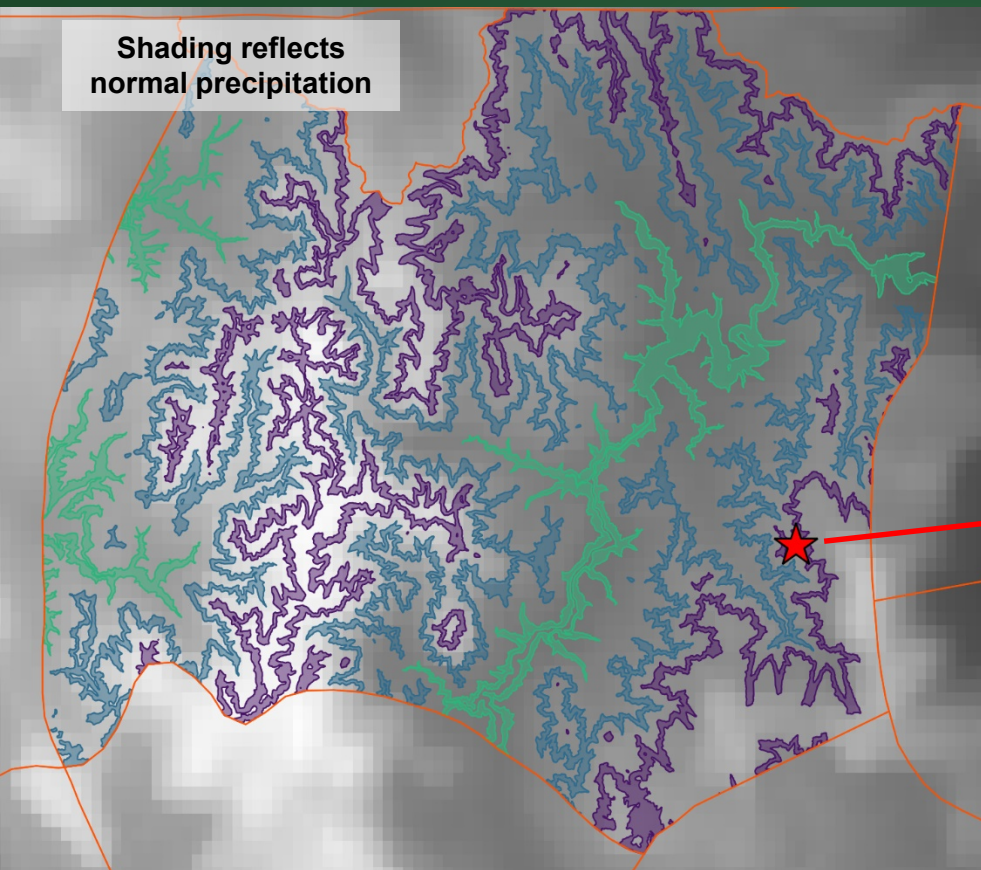
Hypothetical scenario: adjacent elevation bands

Substantial climate overlap

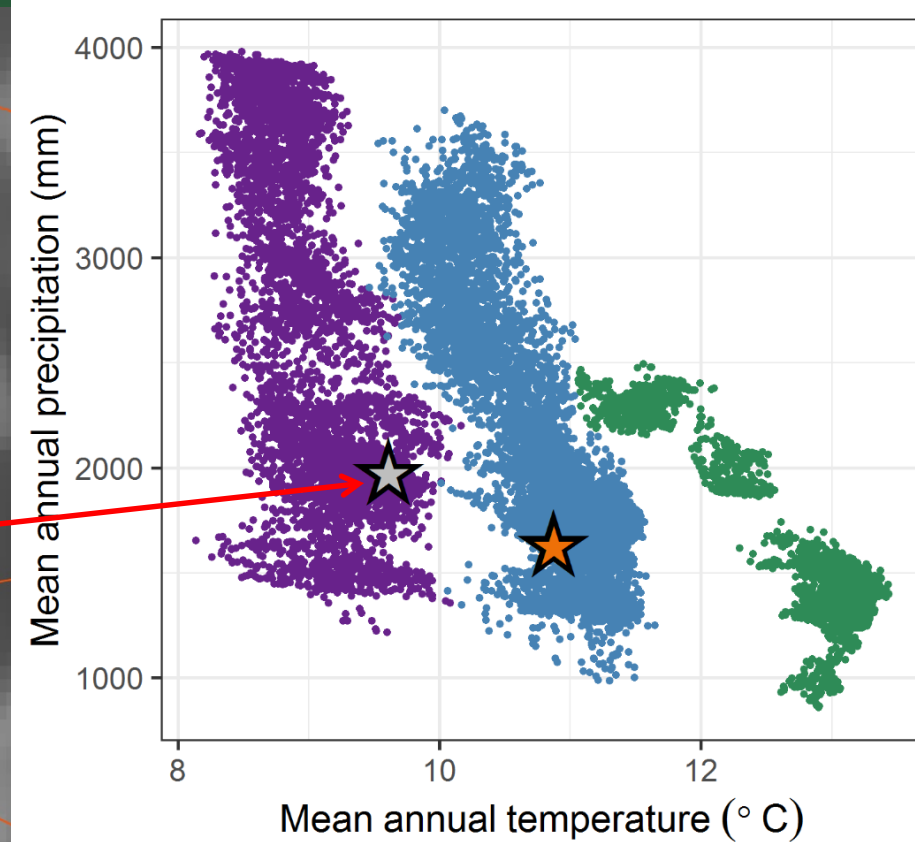
Possible seed lot source climates



Possible seed source locations



Possible seed lot source climates

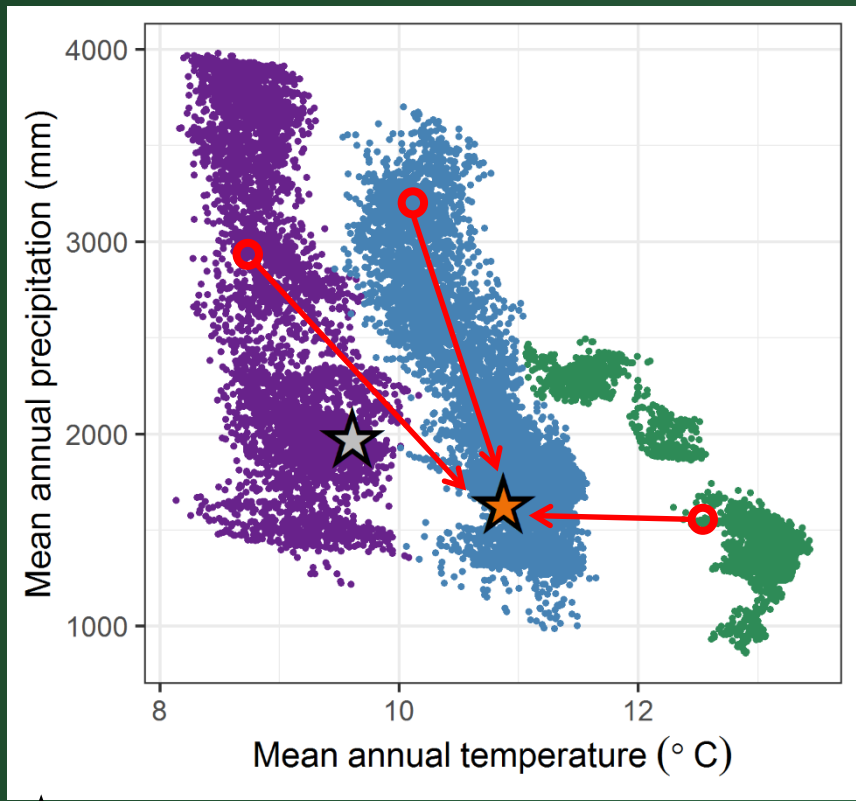




Klamath NF – Incense cedar trial

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- ★ planting site normal climate
- ★ planting site recent climate

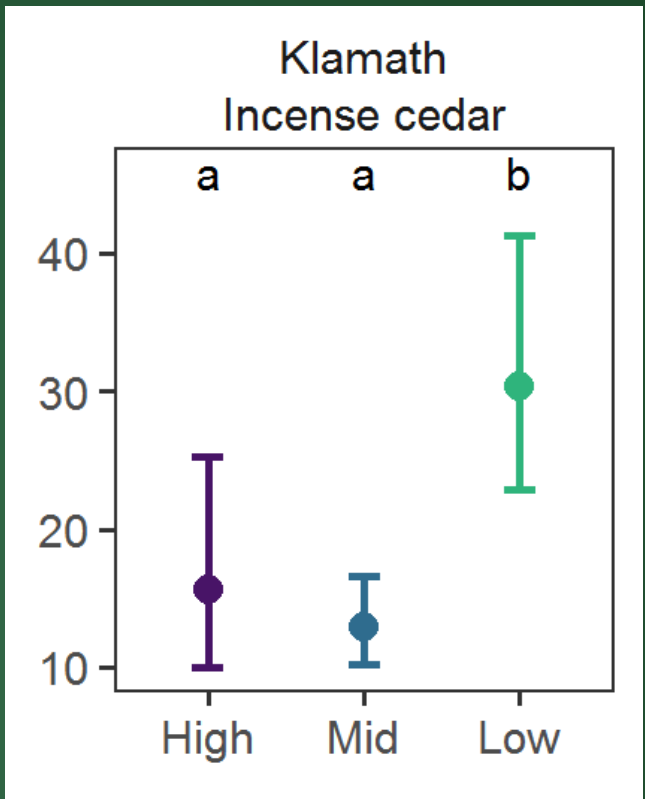
Possible seed lot source climates



-  planting site normal climate
-  planting site recent climate

Seed lot performance

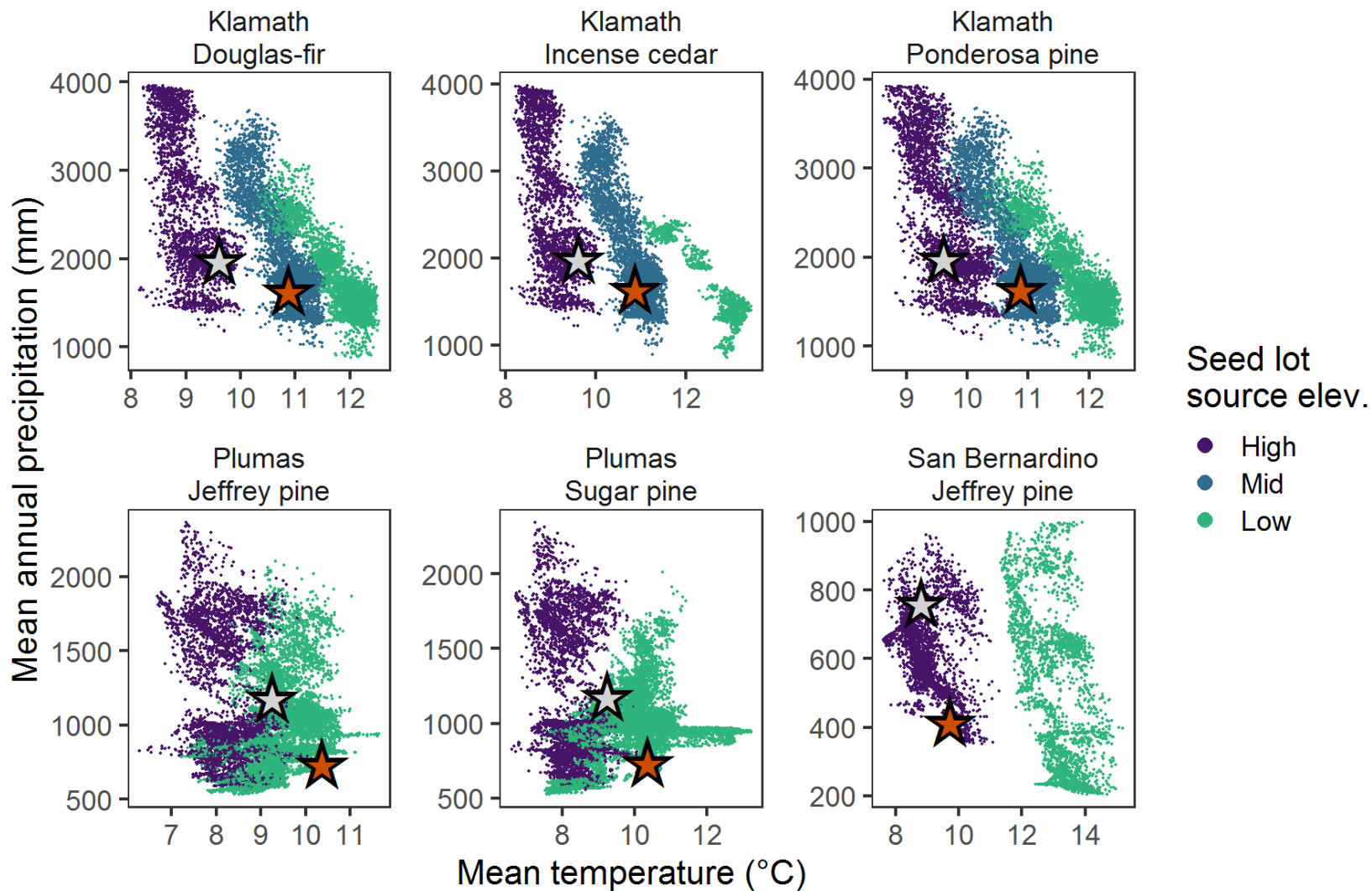
Volume growth (cm³)



Source elevation

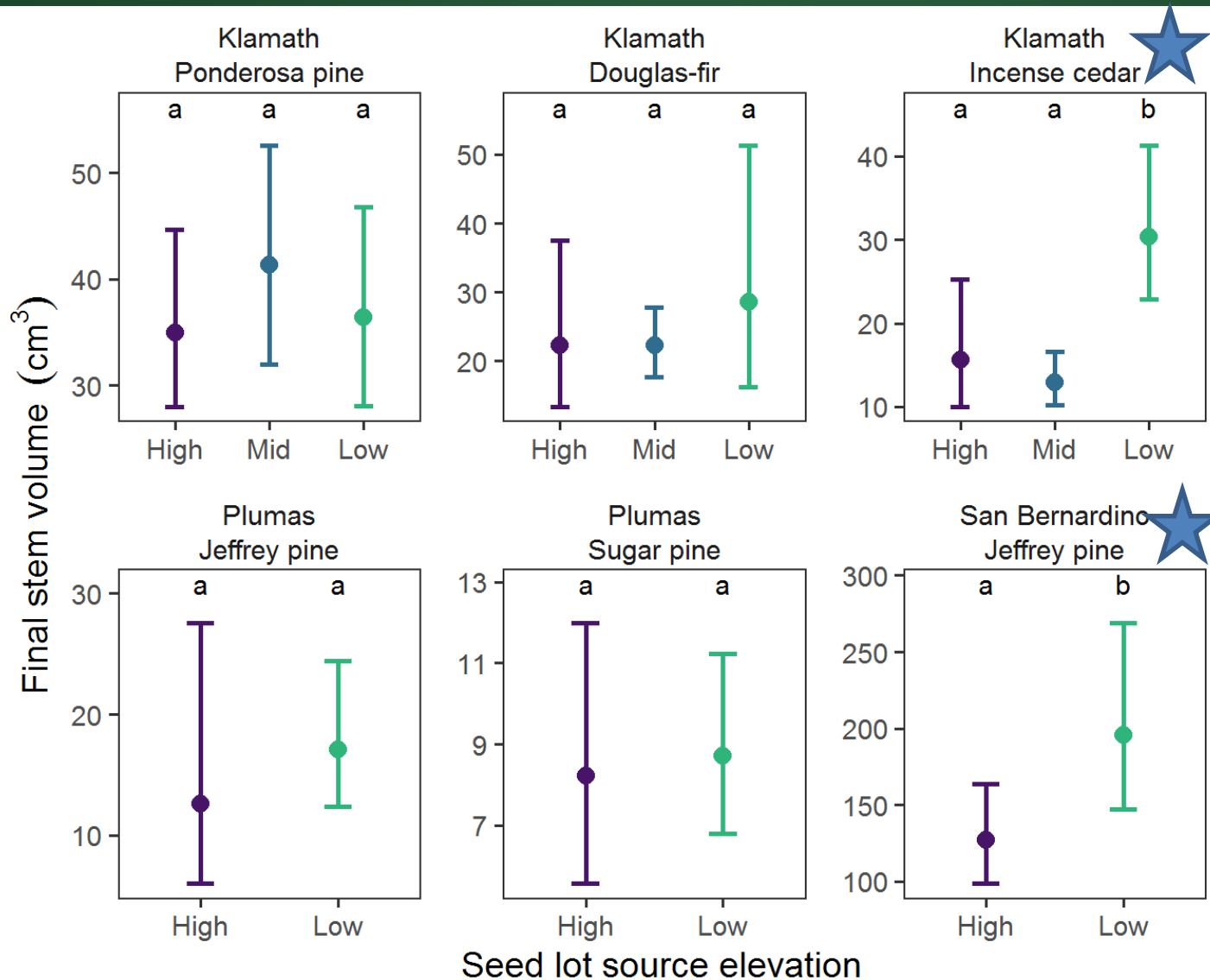
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Possible seed lot source climates: all trials



★ planting site normal climate
★ planting site recent climate

Seed lot performance



=

Significant
difference in
growth



Conclusions

- Moving seed to higher elevations generally had a **positive or neutral effect** on performance, *given the drought*, with exceptions and caveats
- Often detected little differentiation in performance among seed lots
 - Large range of source environment within some seed lots may weaken local adaptation signals
 - Variability in silvicultural conditions may overwhelm seed source effects

Recommendations

When selecting seed lots:

- Lower elevation does not always mean warmer and drier
- Consider potential negative or unexpected consequences of seed transfer

When collecting seed:

- Record more detail on seed collection sites
- Avoid pooling seed from multiple collection locations into a single seed lot

Thank you!

Young et al. (2020) Assisted gene flow in the context of large-scale Forest management in California, USA. *Ecosphere*.

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- Sara Wilson



Forest Service silviculture staff:

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- Linda Smith
- Todd Drake
- Chris Stith
- Jen Hooper



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