Thirty-year trends in postfire conifer regeneration in California and western Oregon

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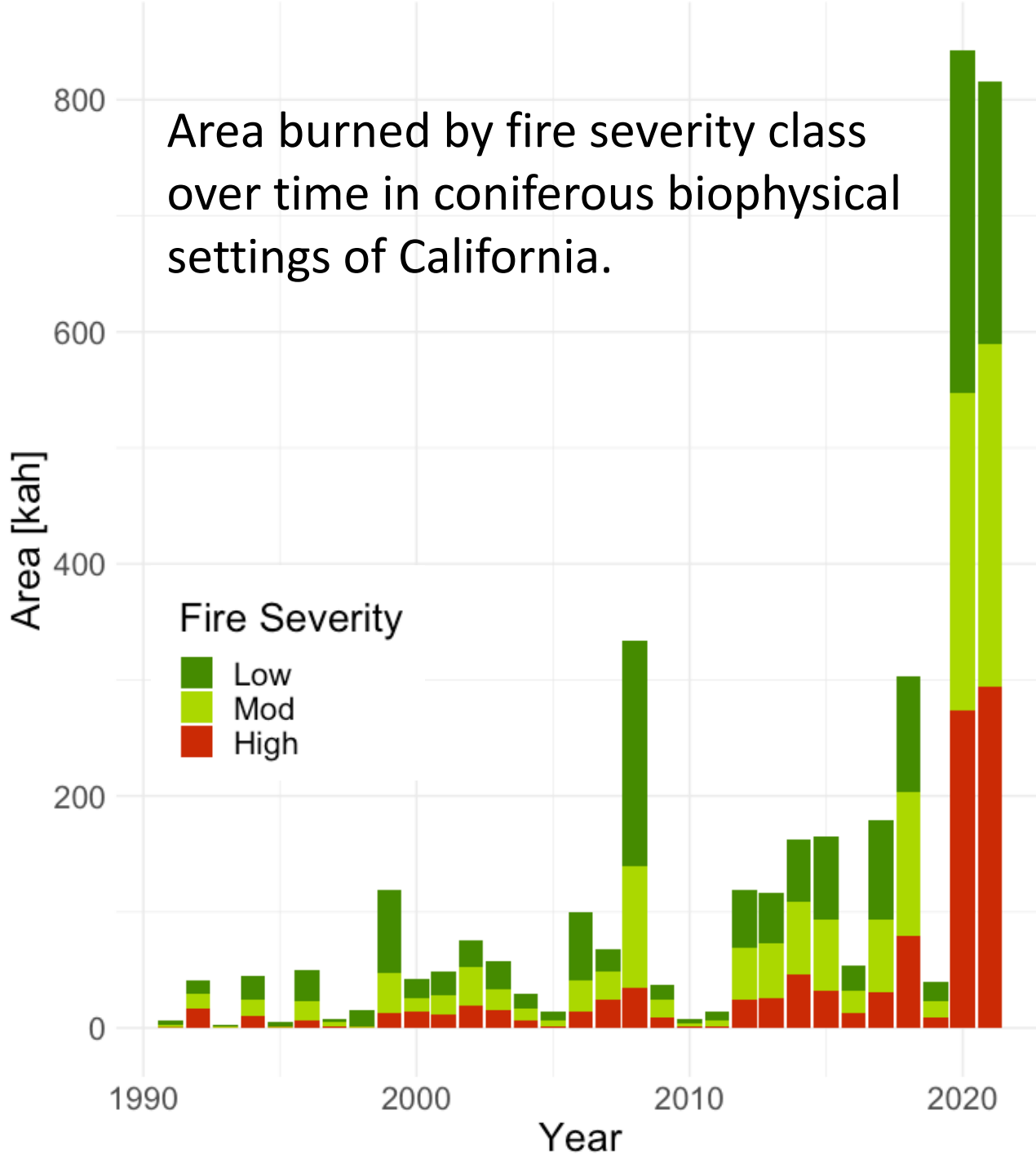
Photo credit: Carrie Vernon, NPS

Challenges for Conifers:

- Increasing proportion of high-severity fires (Miller *et al.* 2009, Miller & Safford 2012, Williams *et al.* 2023).
- Increasing high severity patch size and distance to seed source (Stevens et al. 2017).
- Postfire weather and climate change (Young et al. 2019, Davis et al. 2019).
- Limited reforestation resources (Fargione et al. 2021).



Postfire Conifer Reforestation Planning Tool (PostCRPT)

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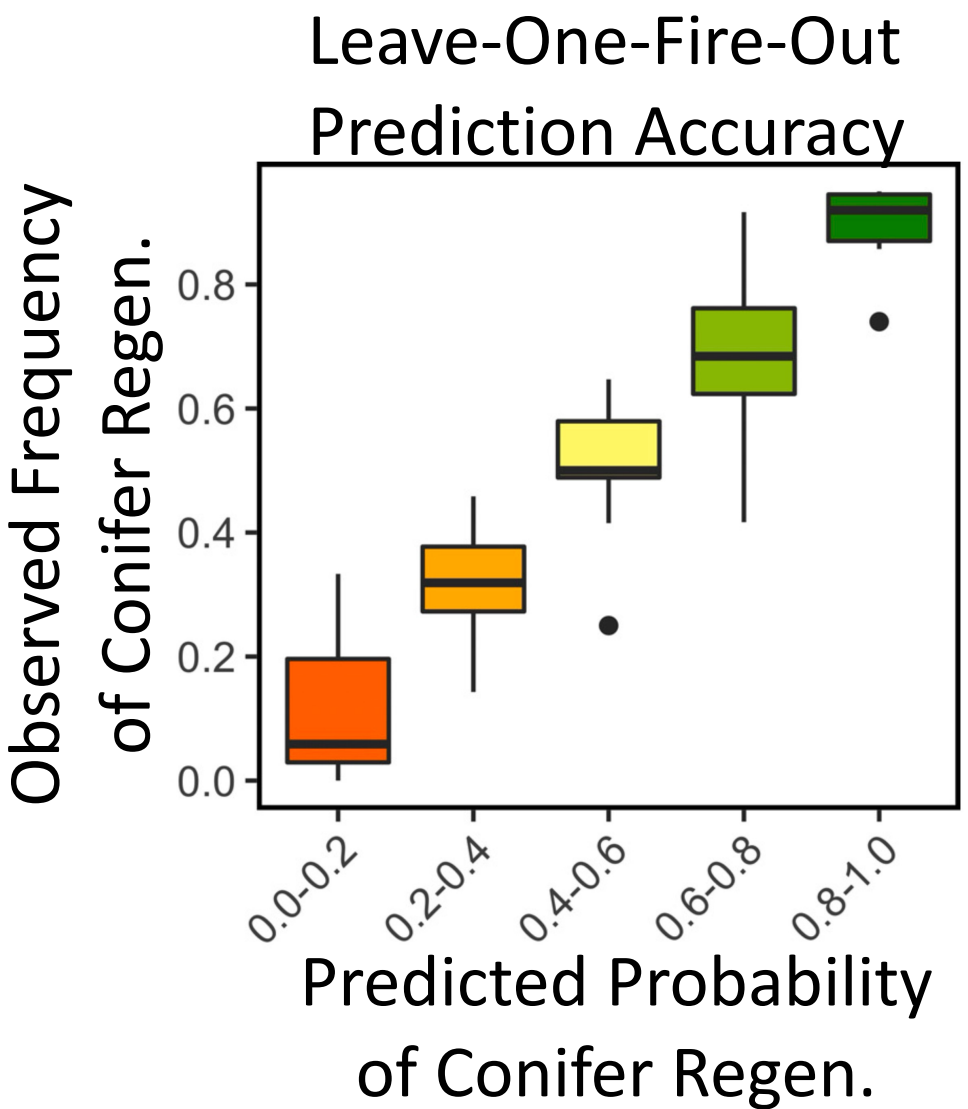
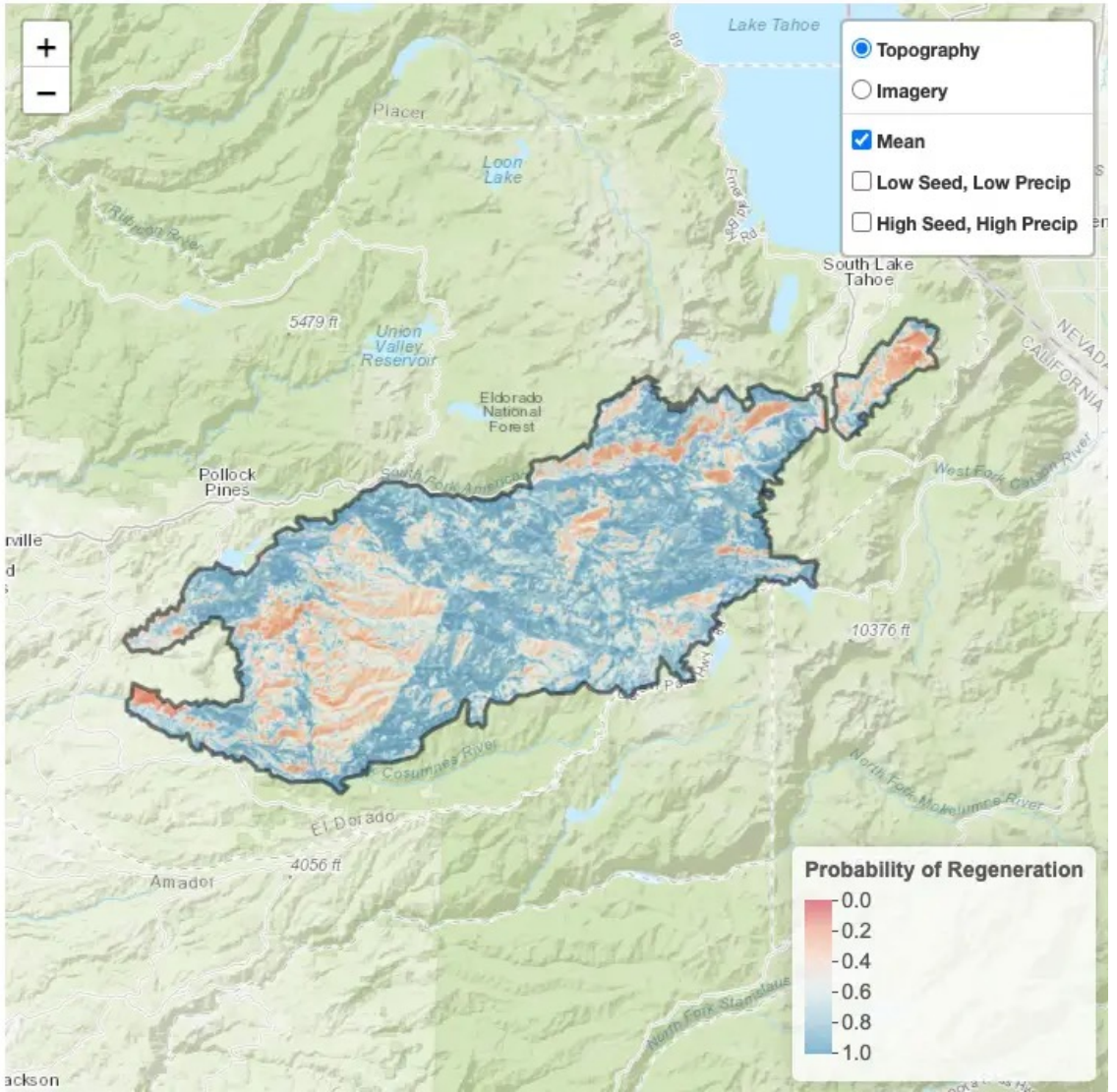




Ecological Applications, 31(3), 2021, e02280

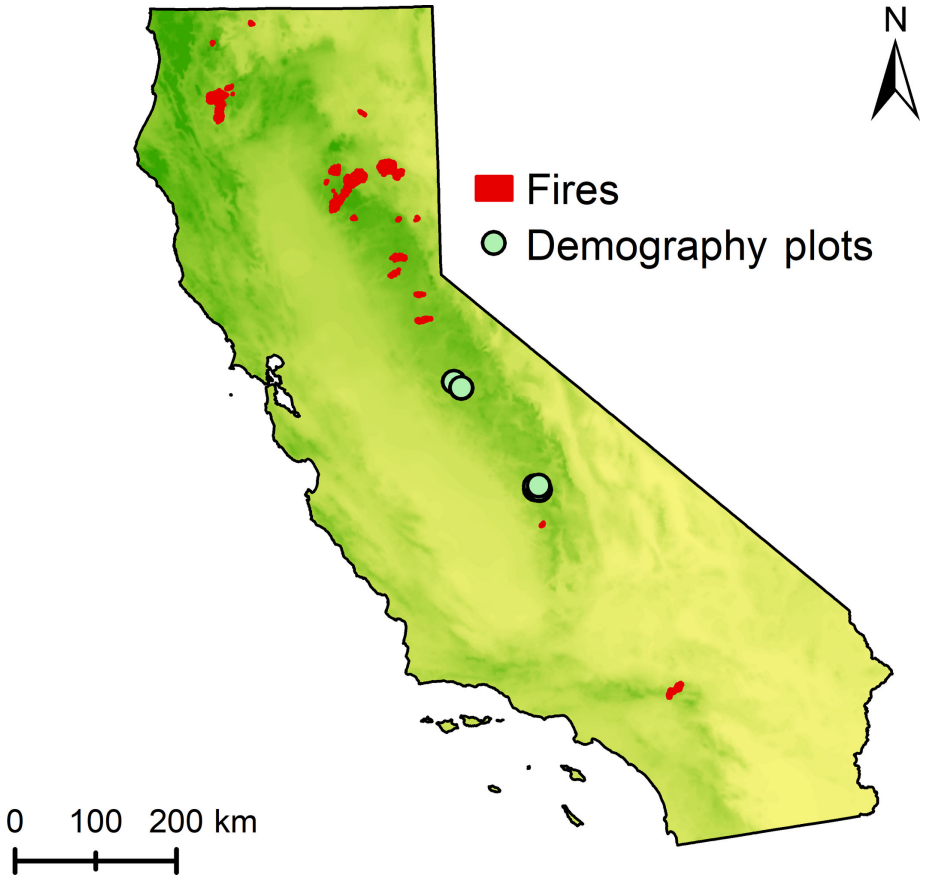
Effects of postfire climate and seed availability on postfire conifer regeneration

Joseph A. E. Stewart [1,2,8] Phillip J. van Mantgem,[1] Derek J. N. Young [3] Kristen L. Shive [1] Haiganoush K. Preisler,[4] Adrian J. Das,[5] Nathan L. Stephenson,[5] Jon E. Keeley,[5] Hugh D. Safford,[2,6] Micah C. Wright,[1] Kevin R. Welch,[7] and James H. Thorne [2]

Goals:

- Synthesize spatial and temporal predictors of postfire conifer regeneration into a **broadly applicable model**
- Taxon-specific predictions
- User-friendly tool to prioritize areas for postfire plantings

Data
(Stewart et al. 2021)



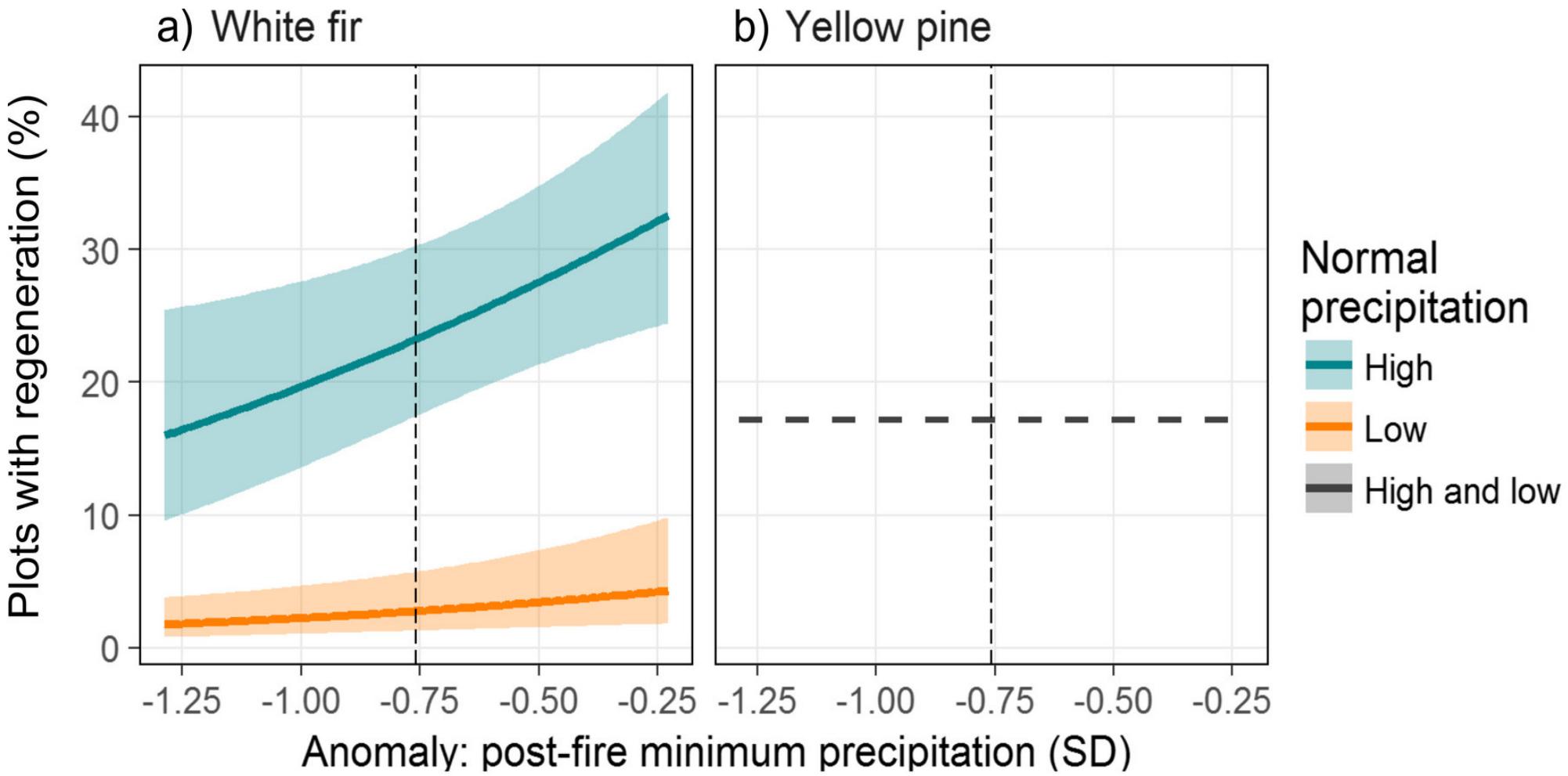
1,234 postfire plots

- 19 fires that burned 2004 - 2012
- 60 m^2 (4.4 m radius)
- 5-yrs postfire

12 Demography plots

- 216 seed fall traps (.25-m^2)
- 1999 - 2017

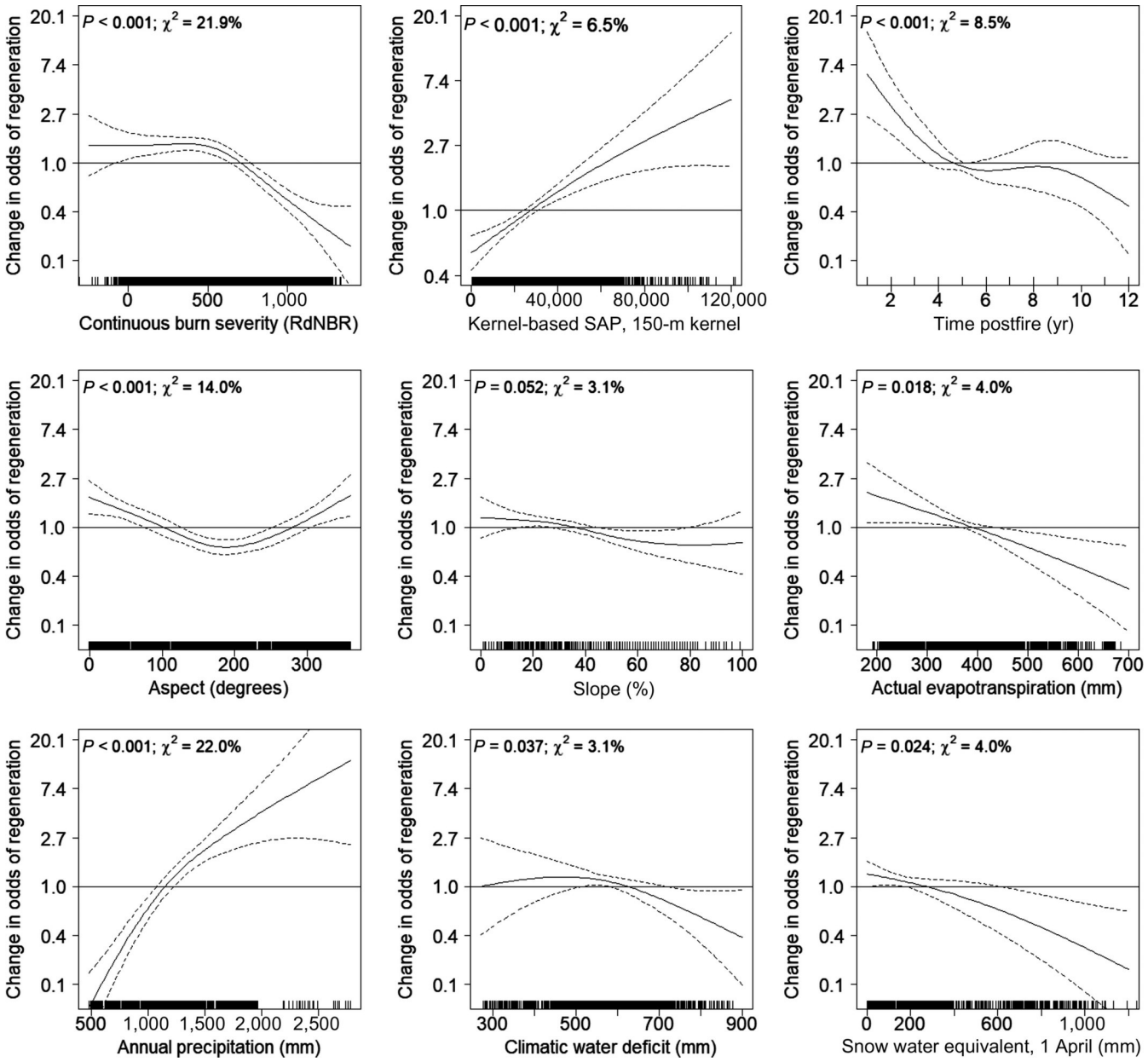
Young et al. 2019

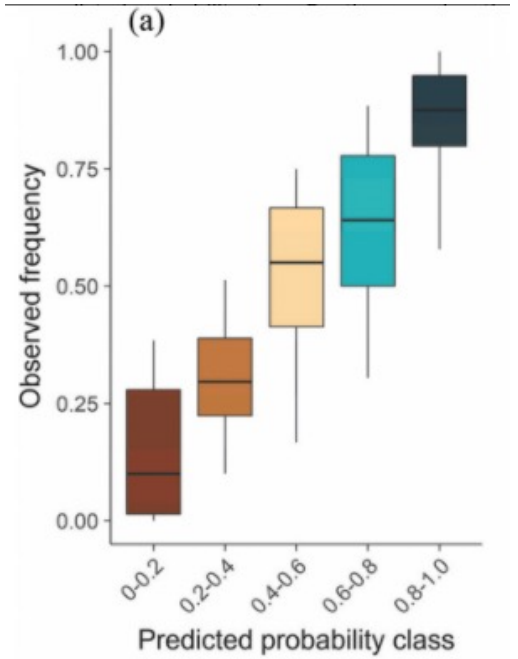


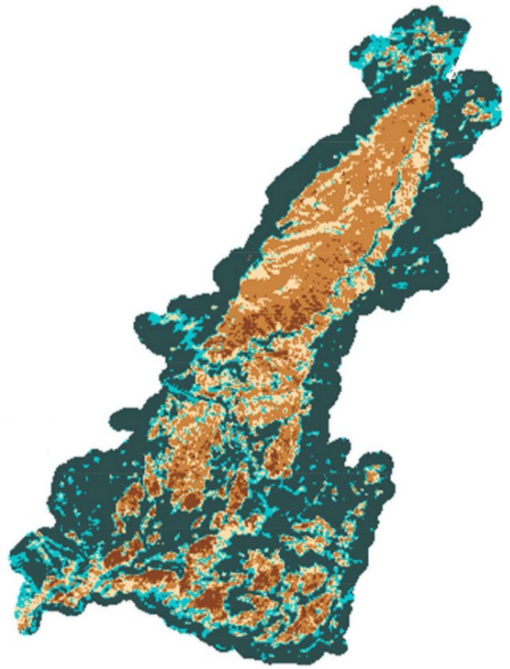
- N = 531
- 4-5 yrs post fire
- High-severity
- < 75 m away from seed source

- < 30% slope
- USFS land
- No management

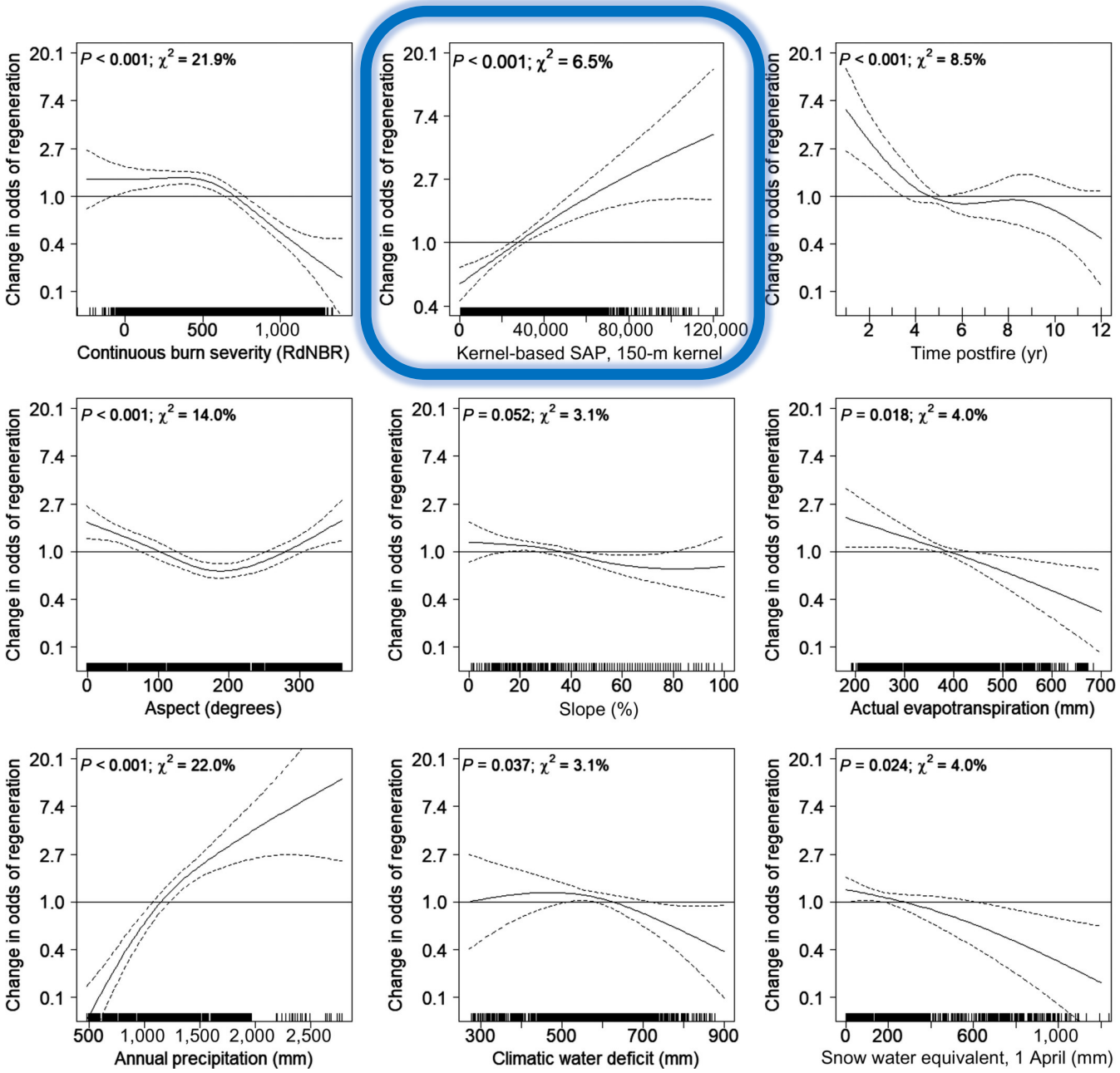
Shive et al. 2018

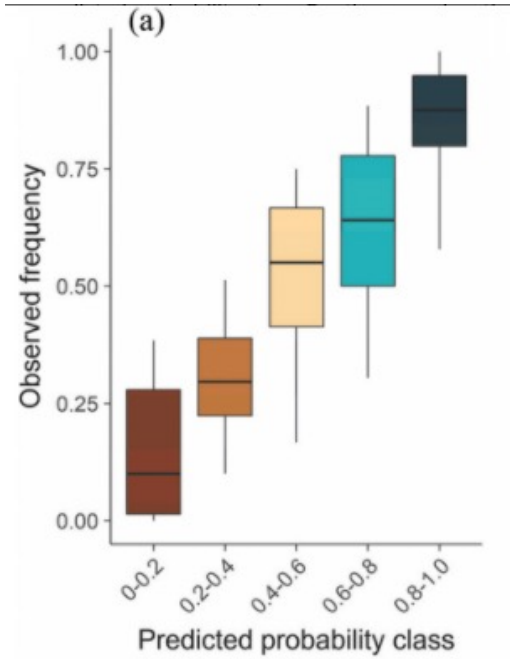


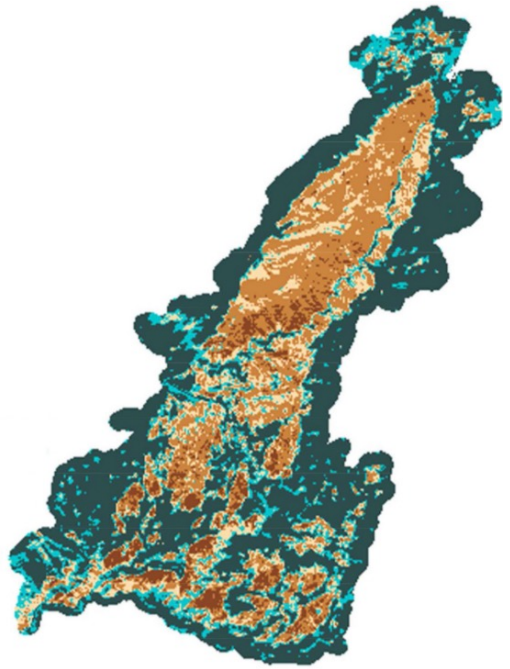




Shive et al. 2018

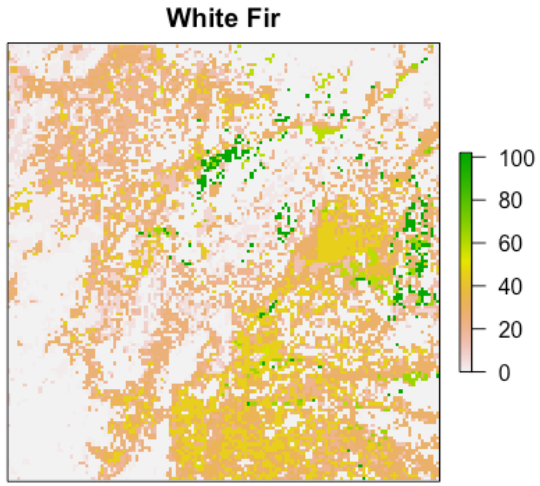




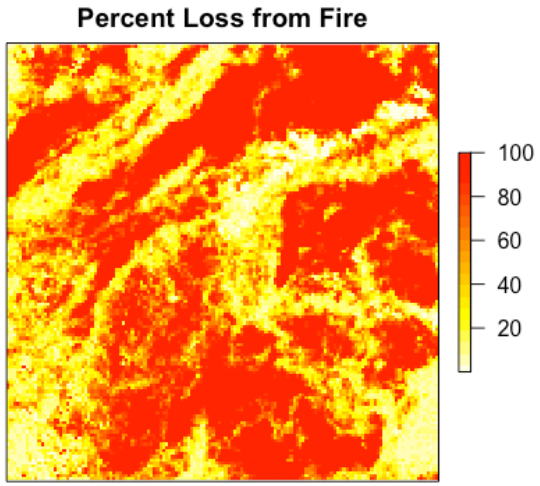


Seed Availability

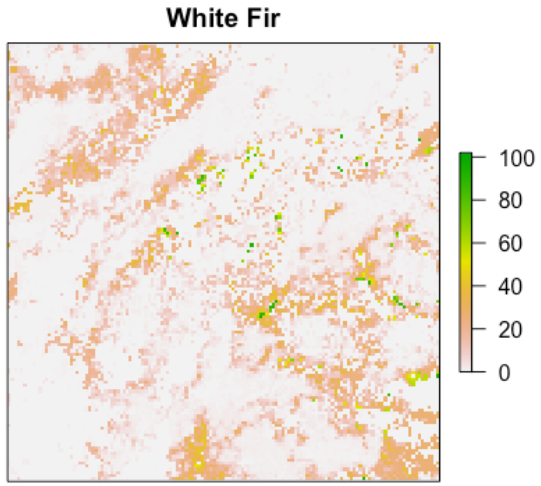
1. Prefire Basal Area



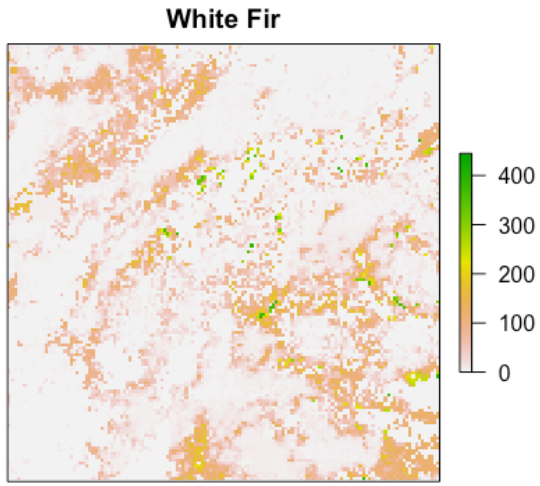
2. Loss from Fire



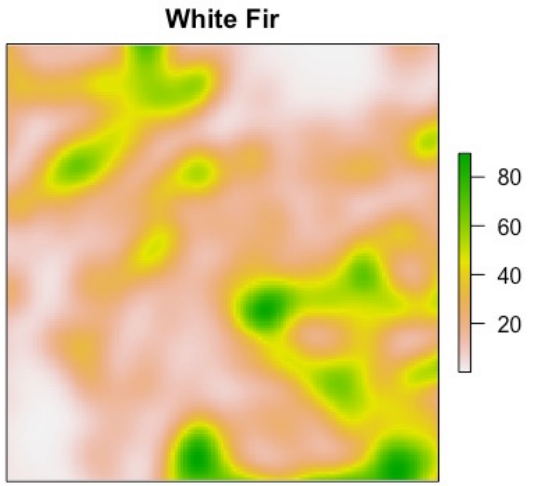
3. Postfire Basal Area



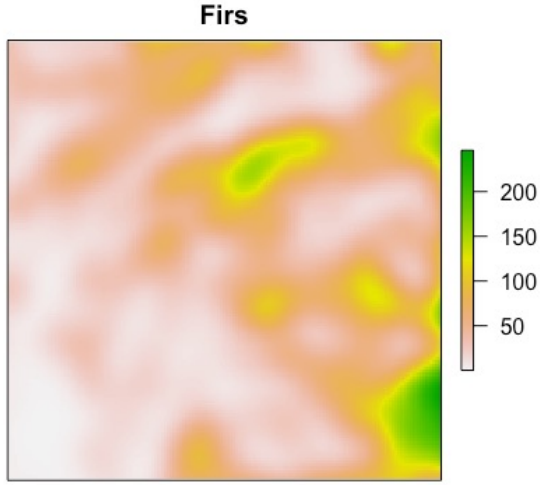
4. Seed Production



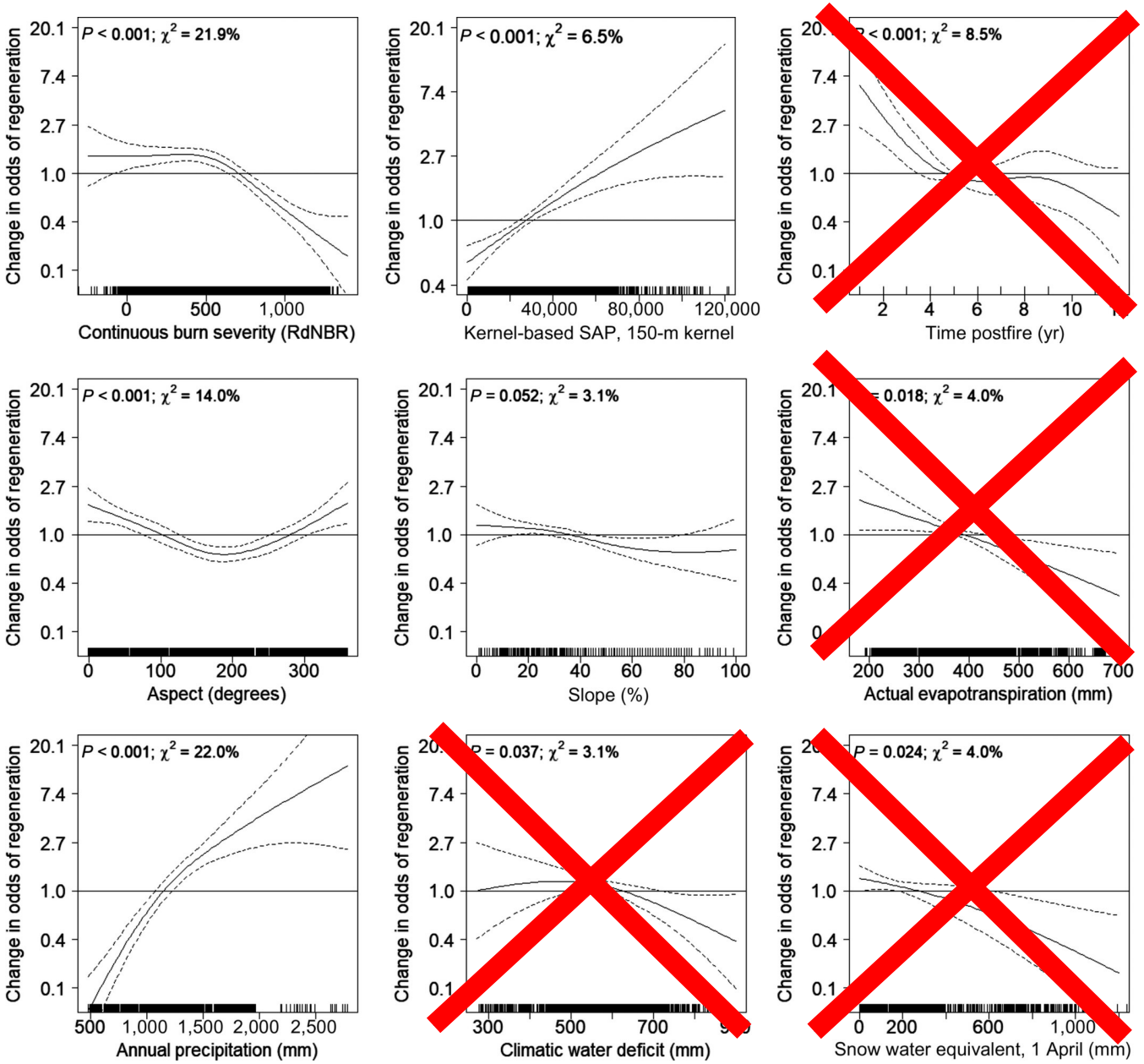
5. Seed Dispersal



6. Iterate over Taxa



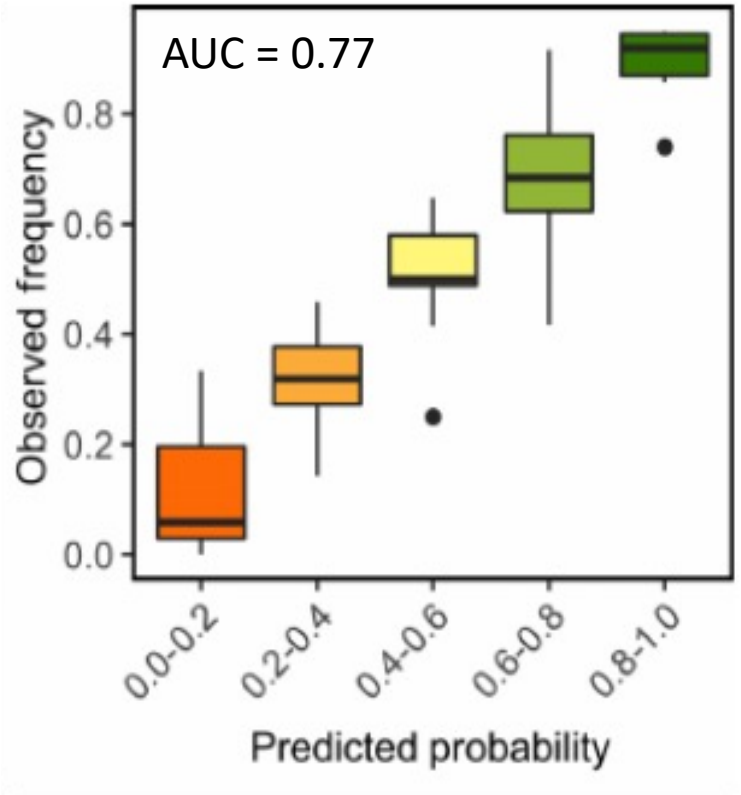
Rethinking Conifer Regen Model



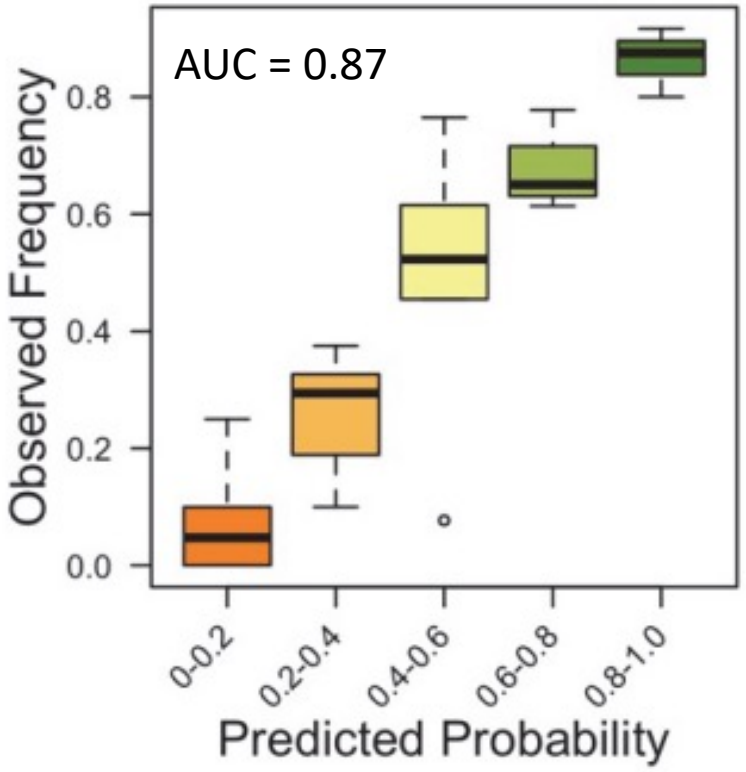
- Eliminated apparently overfit relationships
  - Used only 5-yr postfire data
  - Shape-constrained additive models
- Revised seed availability models
  - Tree loss from fire
  - Seed production
- Postfire climate
- Taxon-specific models

Leave-One-Fire-Out Cross Validated Predictive Performance

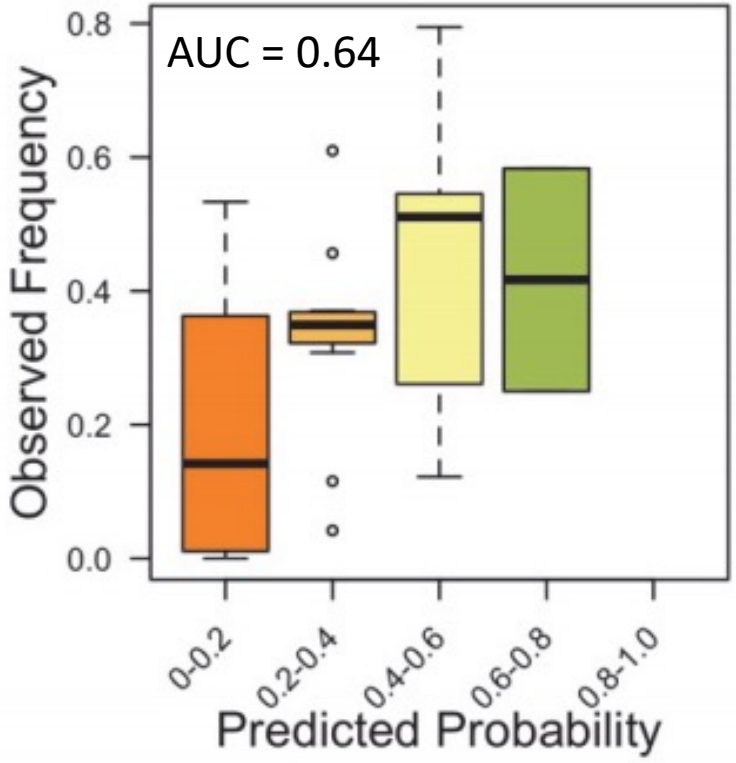
All Conifer



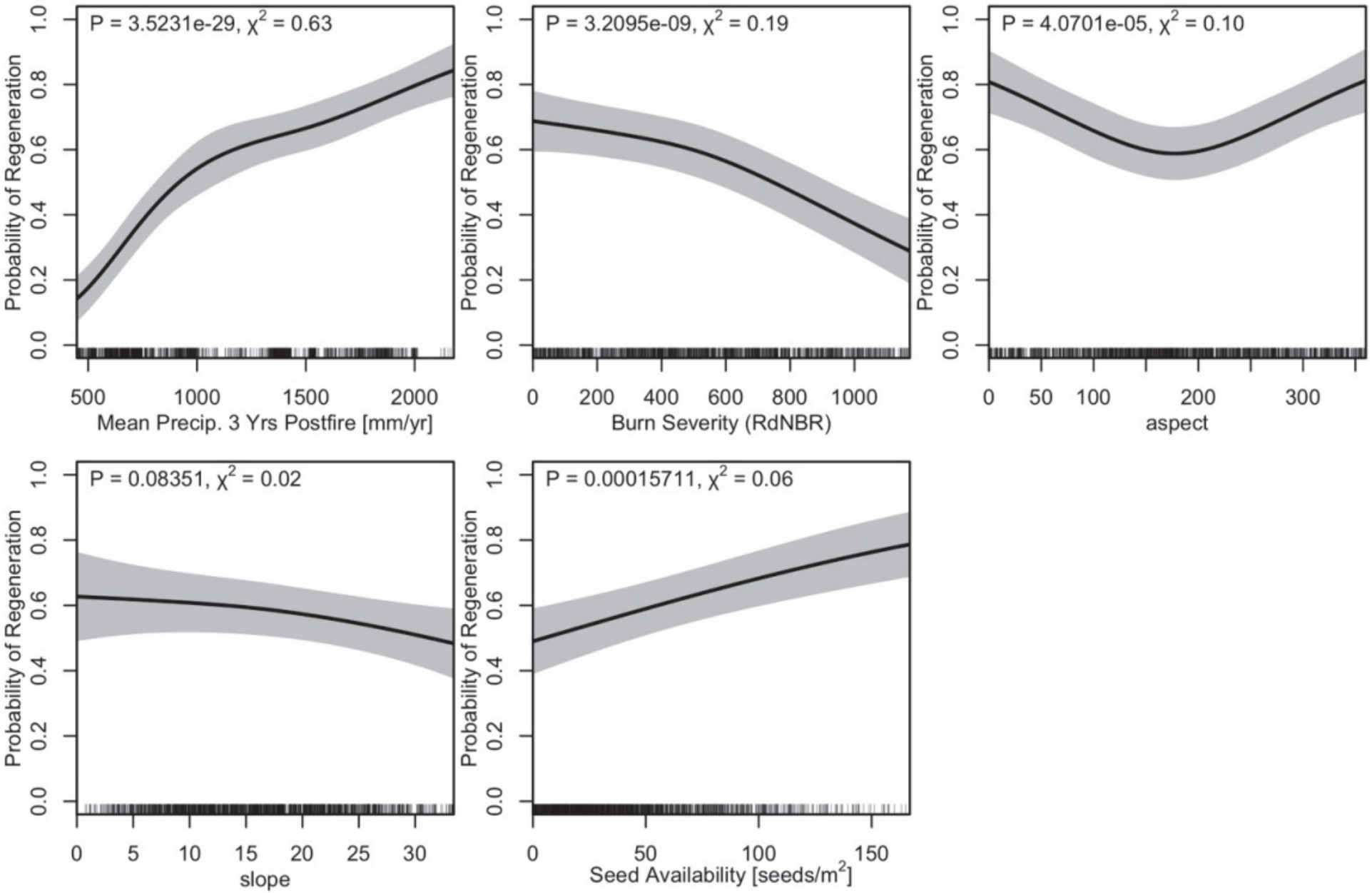
Abies



Pinus



Marginal Response Curves – All Conifer Model



Conifer Regeneration Predictions

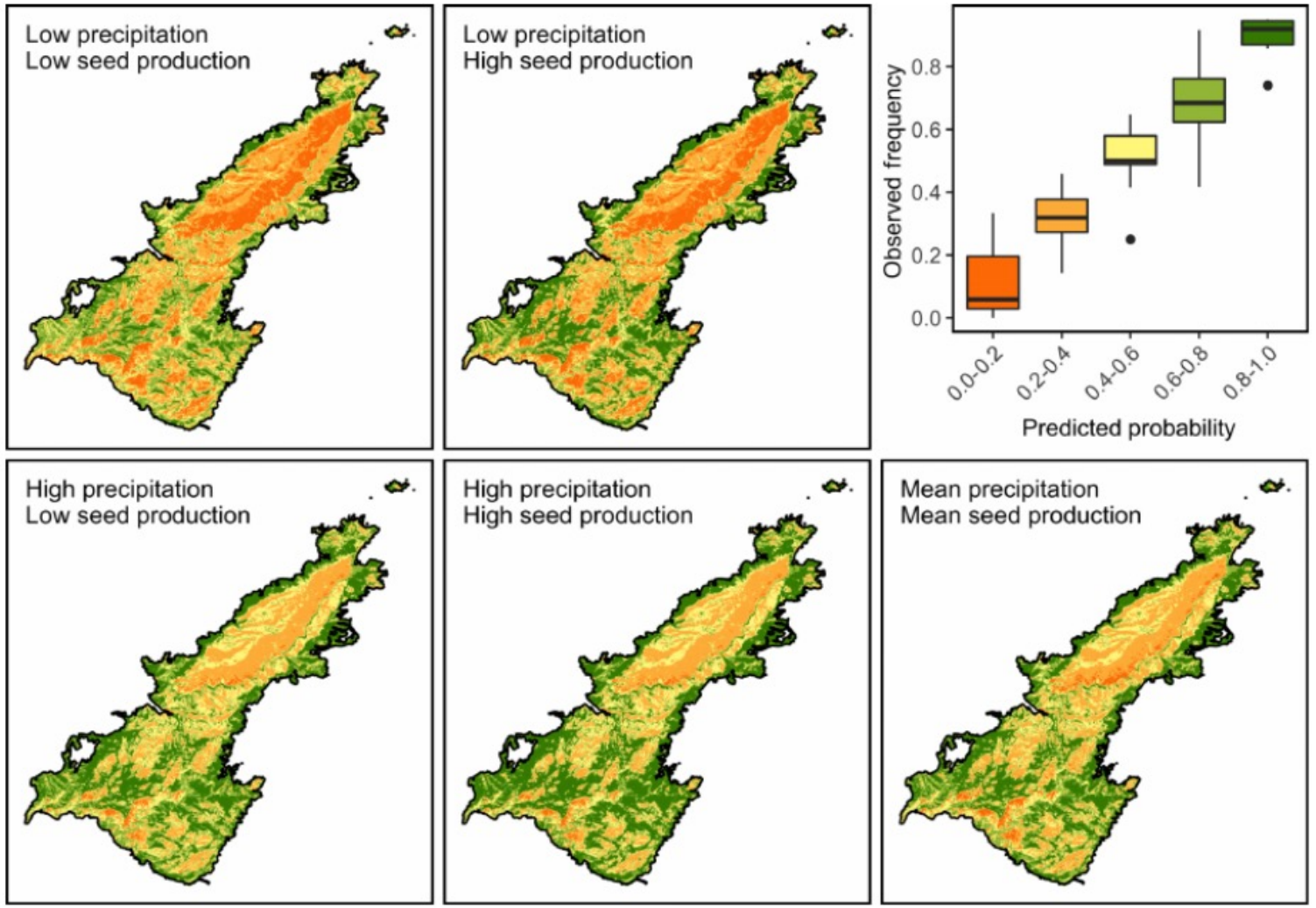
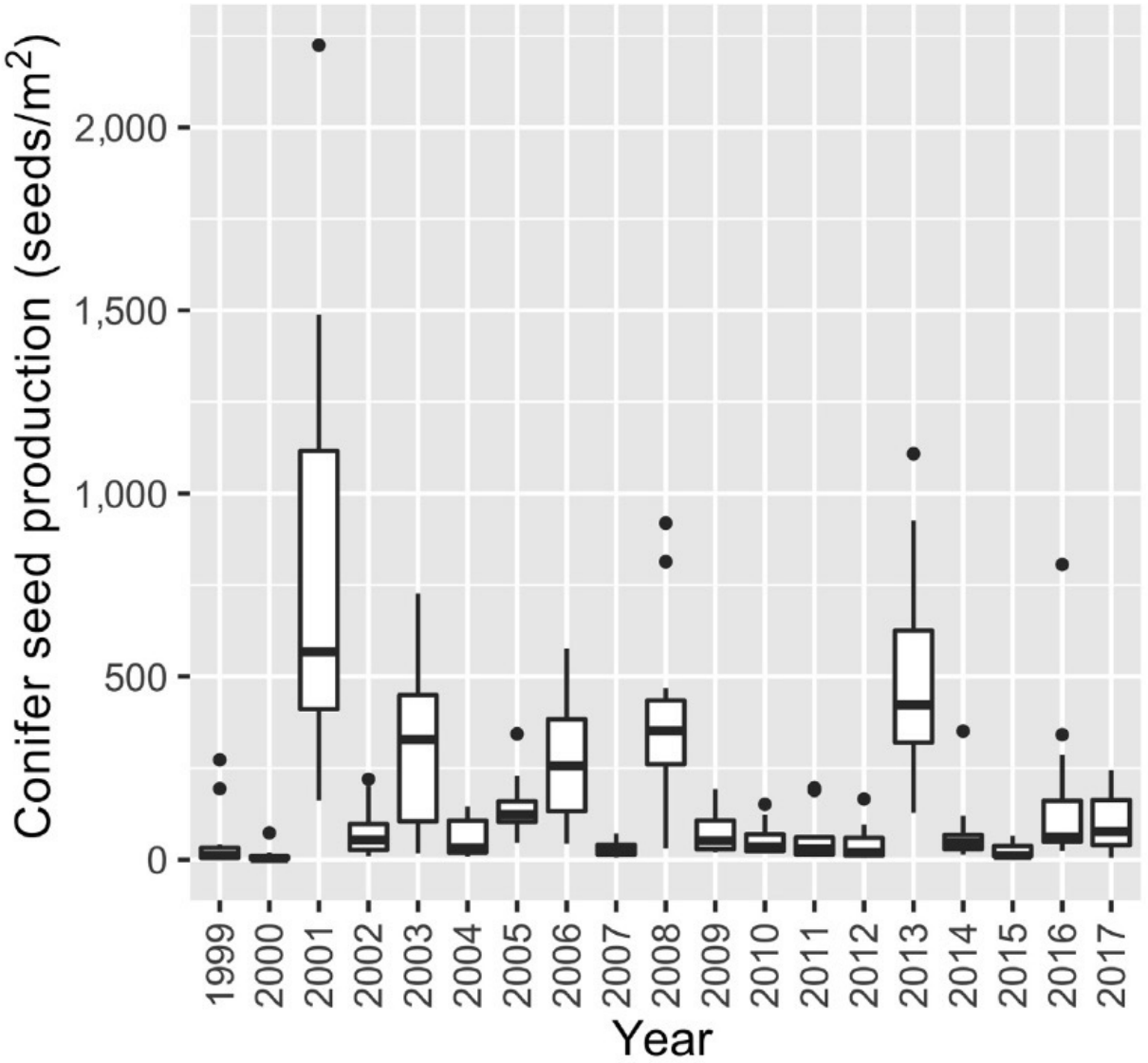
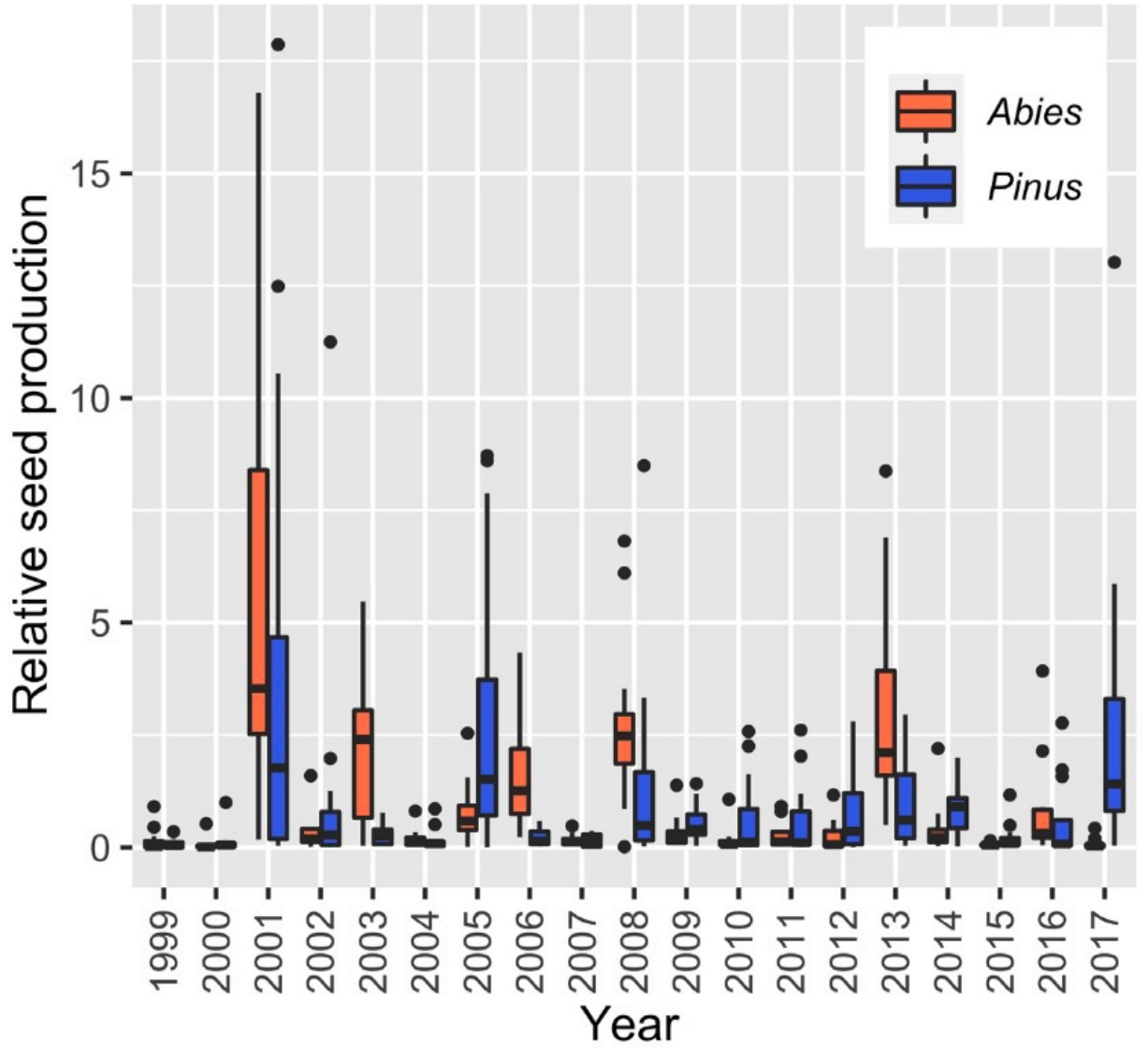


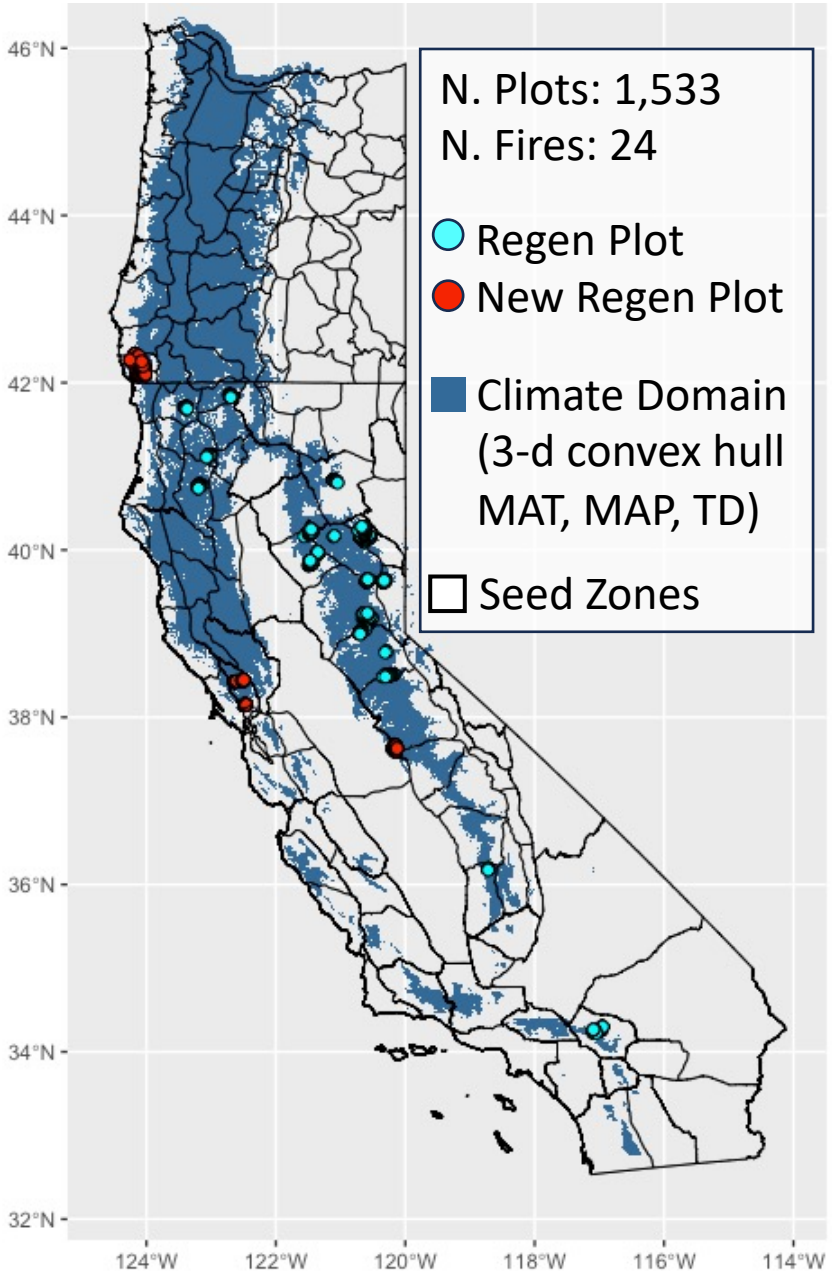
FIG. 5. Postfire conifer recruitment scenarios for the 2014 King Fire, under scenarios of variable postfire precipitation and seed production (Table 1, model C1). Reliability diagram in upper right is based on leave-one-fire-out cross-validation. High and low postfire precipitation conditions depicted here correspond to mean annual precipitation for mid-century (2040–2069) under the CNRM-CSM5 and MIROC-ESM scenarios, respectively. Mean precipitation was based on the period 1981–2010. Relative postfire seed production scenarios correspond to the 0.1 and 0.9 quantiles of the 5-yr moving average of seed production measured in seed traps (Fig. 2, Appendix S1: Fig. S2).

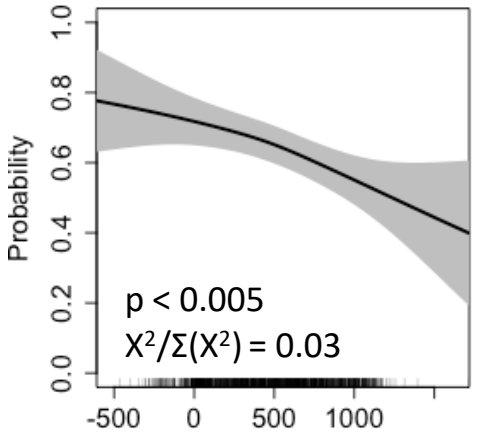

Conifer seed production (seeds/m^2)
2,000
1,500
1,000
500
0
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year

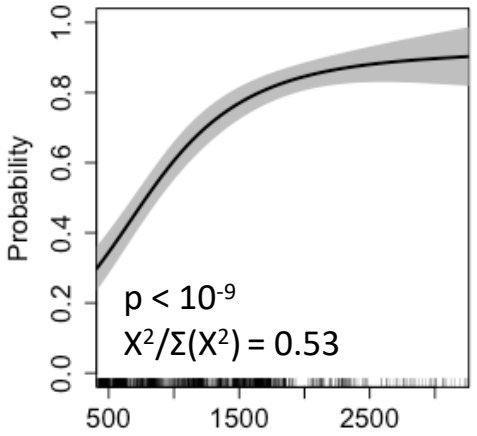

Relative seed production
15
10
5
0
Abies
Pinus
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year

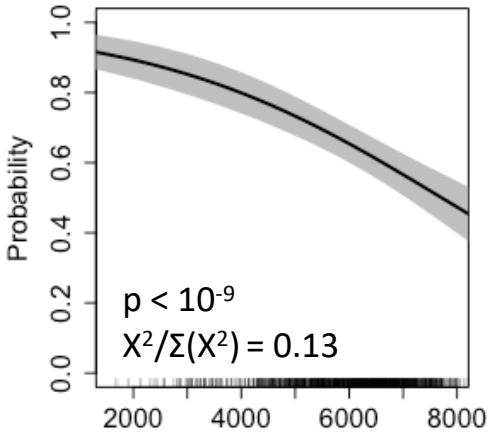
Model Updates In Progress

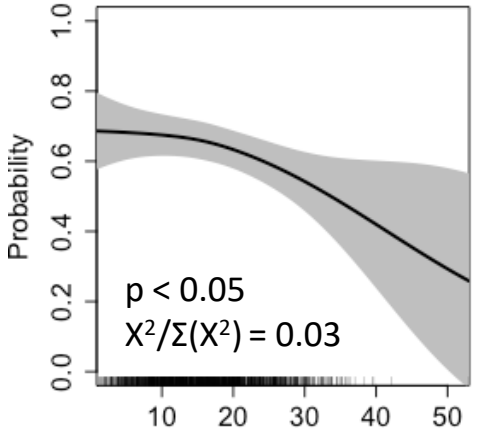
- Postfire regen data from five additional fires.
- Improvements to underlying predictor variables.
- Improved OOS predictive performance.
- Batch processed all fires

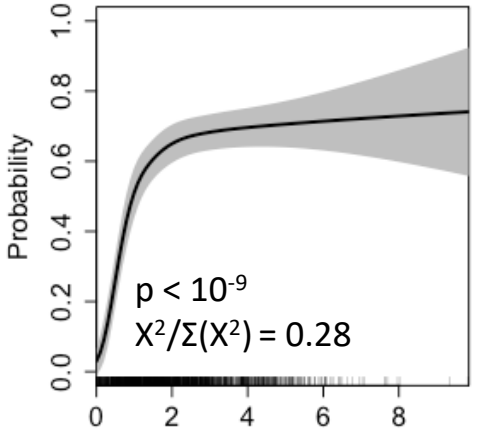




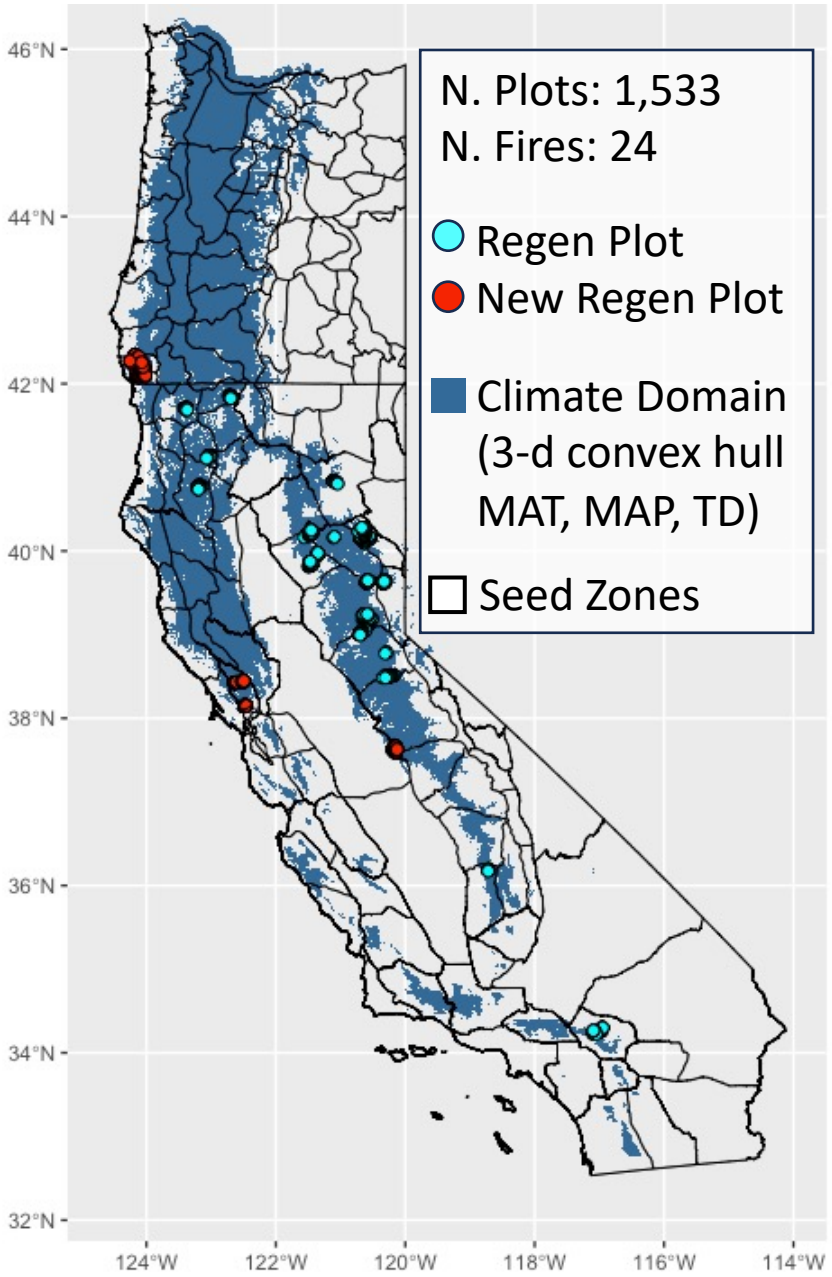


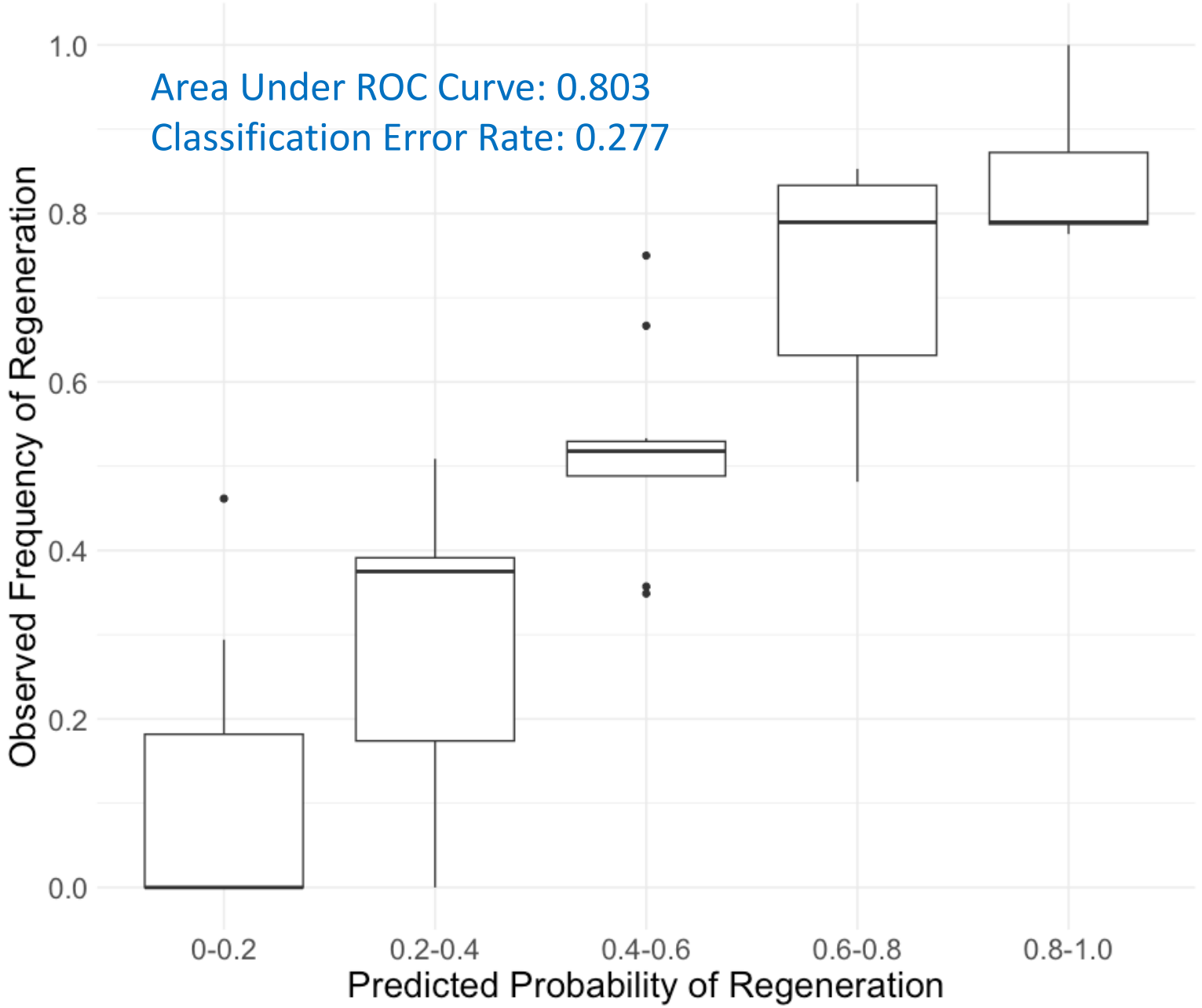






Out of Sample (Leave One Fire Out) Prediction Accuracy





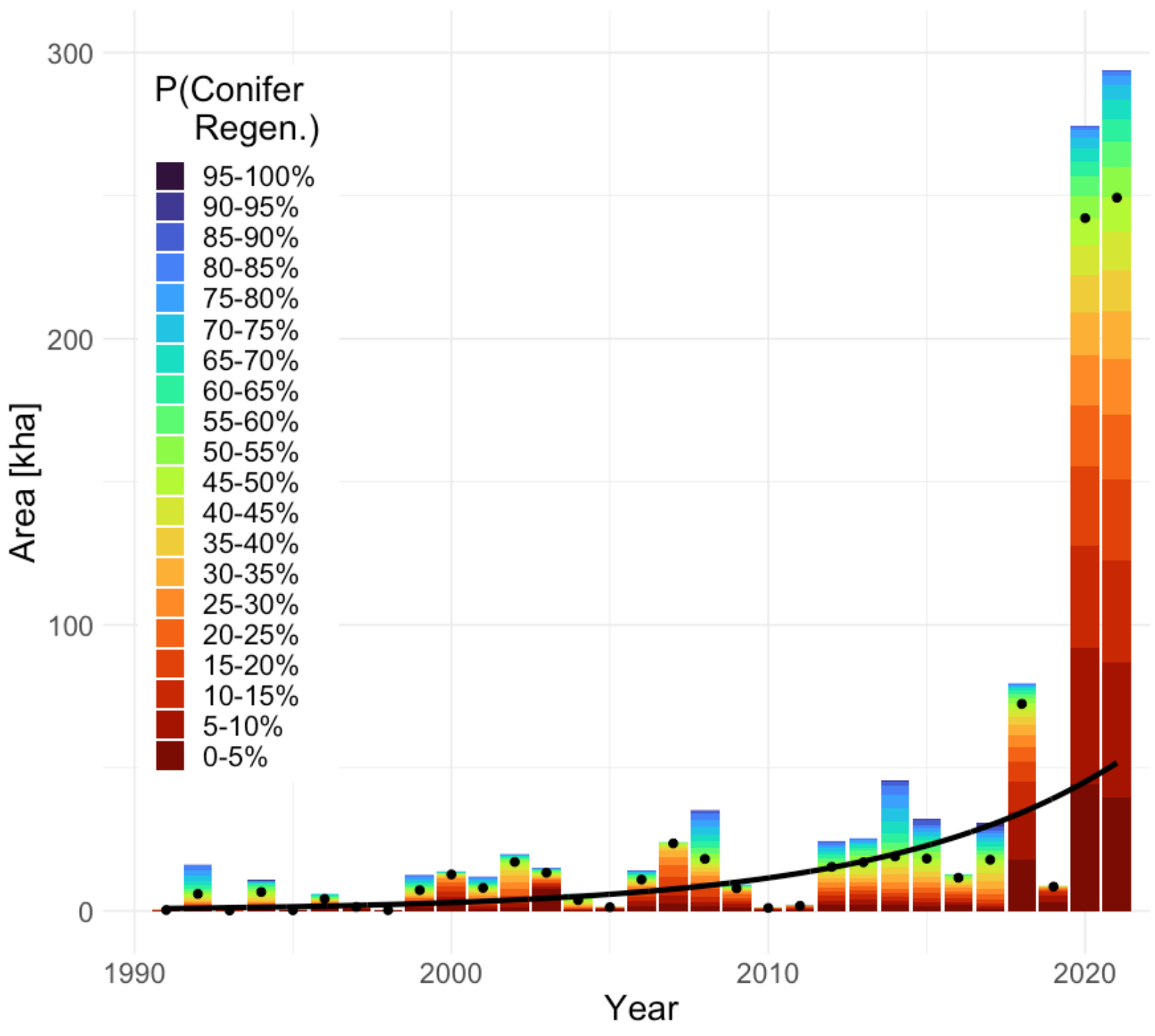
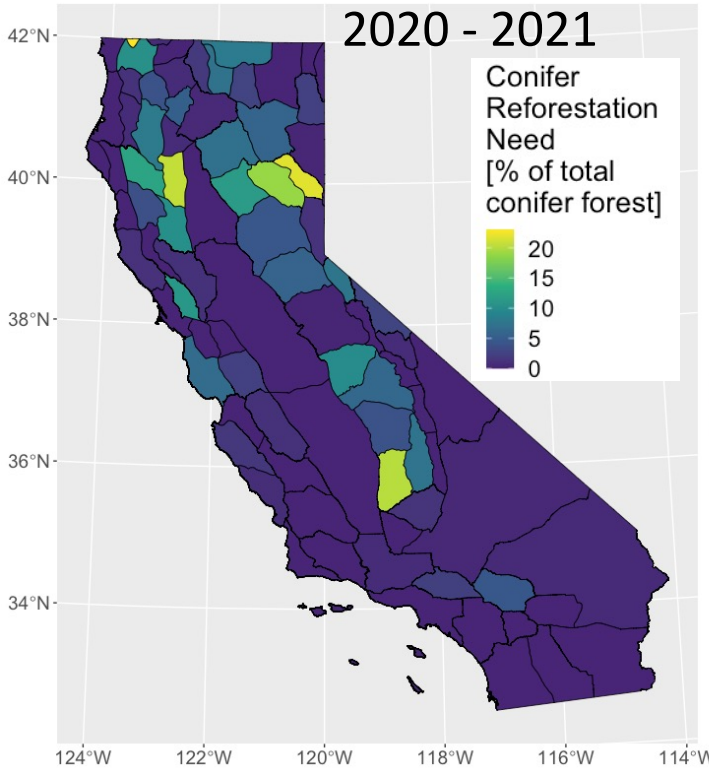


Fig. Conifer reforestation need in California over time (black dots).

- High Severity
- Coniferous Forest (BpS)
- < 50% probability of natural conifer regeneration within plot.



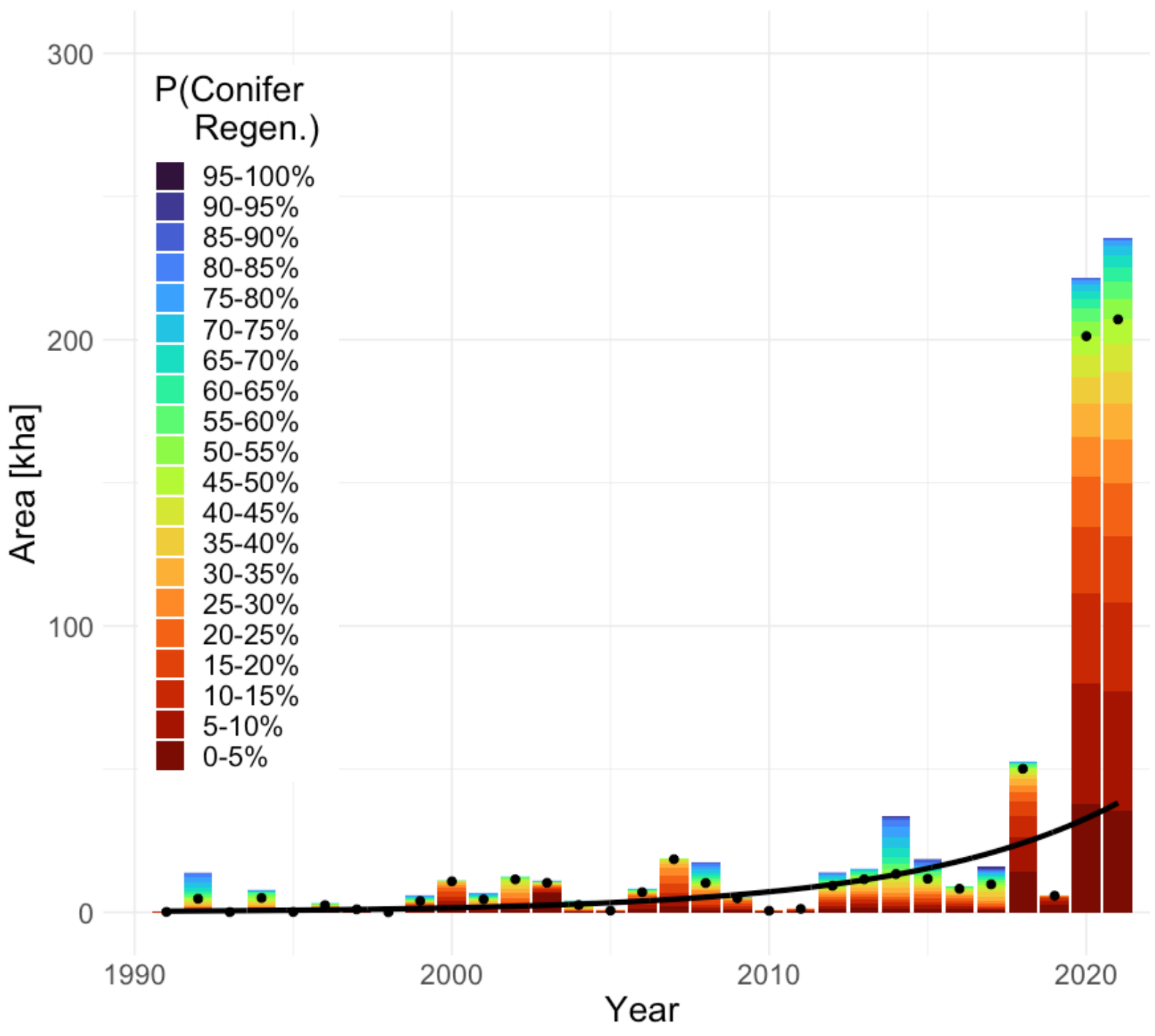
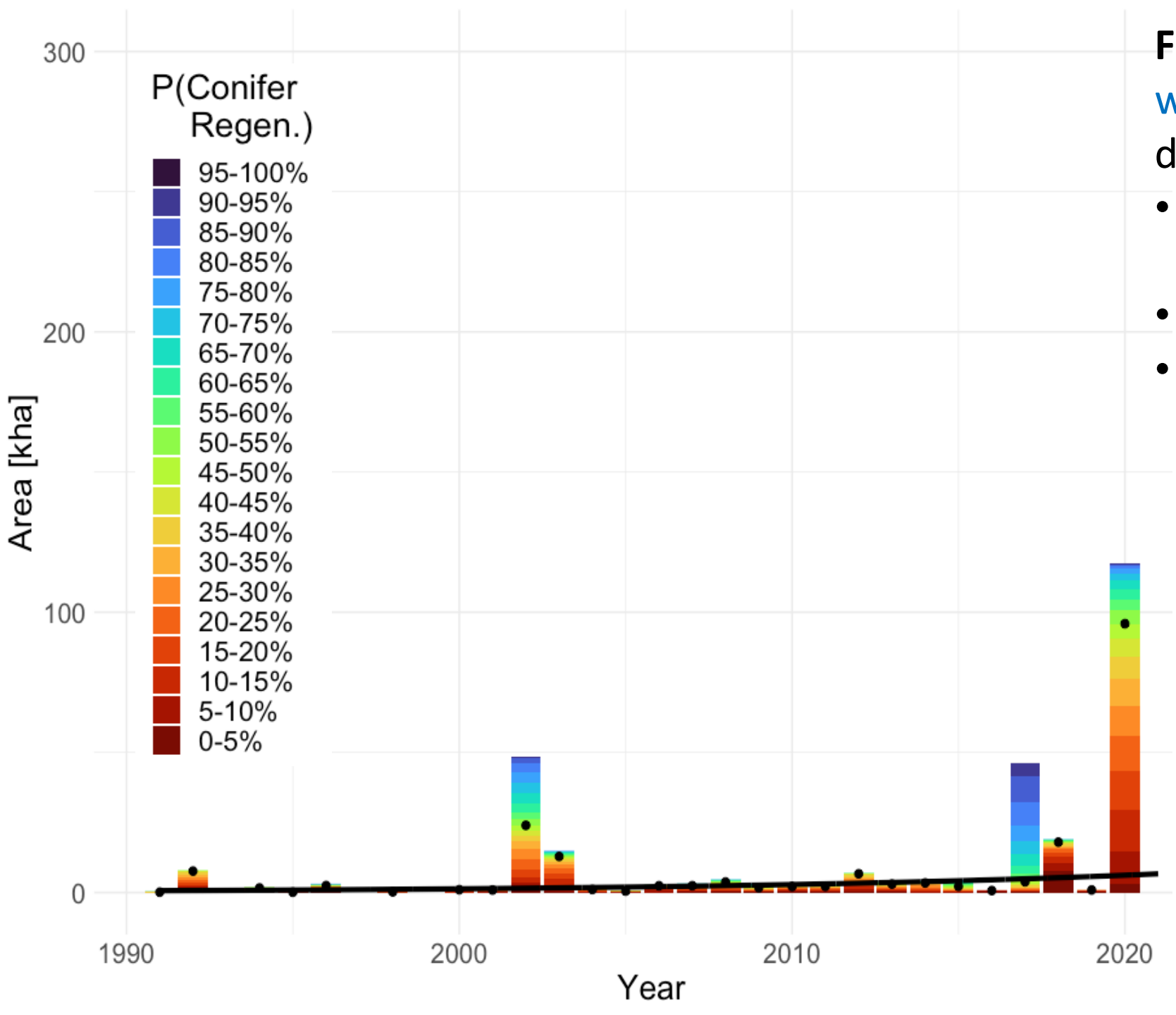


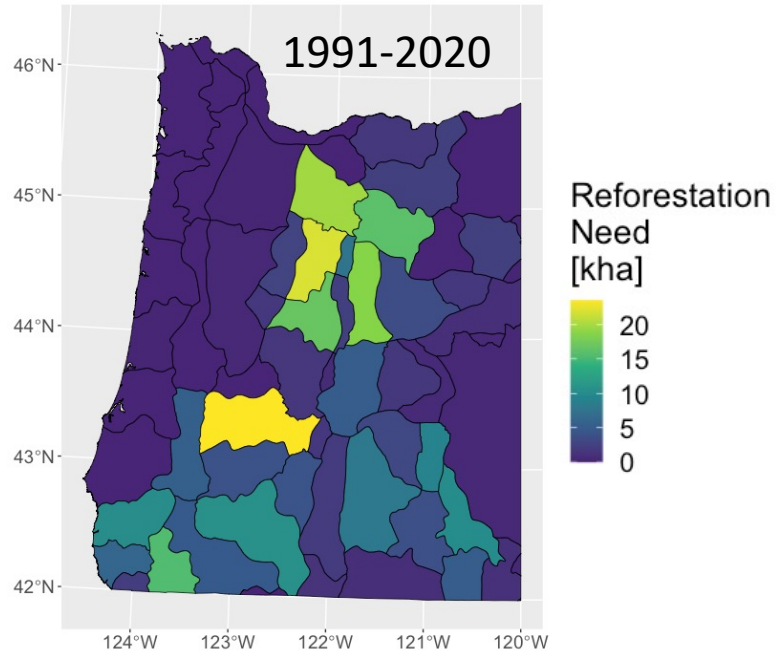
Fig. Conifer reforestation need in California over time (black dots).

- High Severity
  - HS Patch Size > 250 acres
- Coniferous Forest (BpS)
- < 50% probability of natural conifer regeneration within plot.

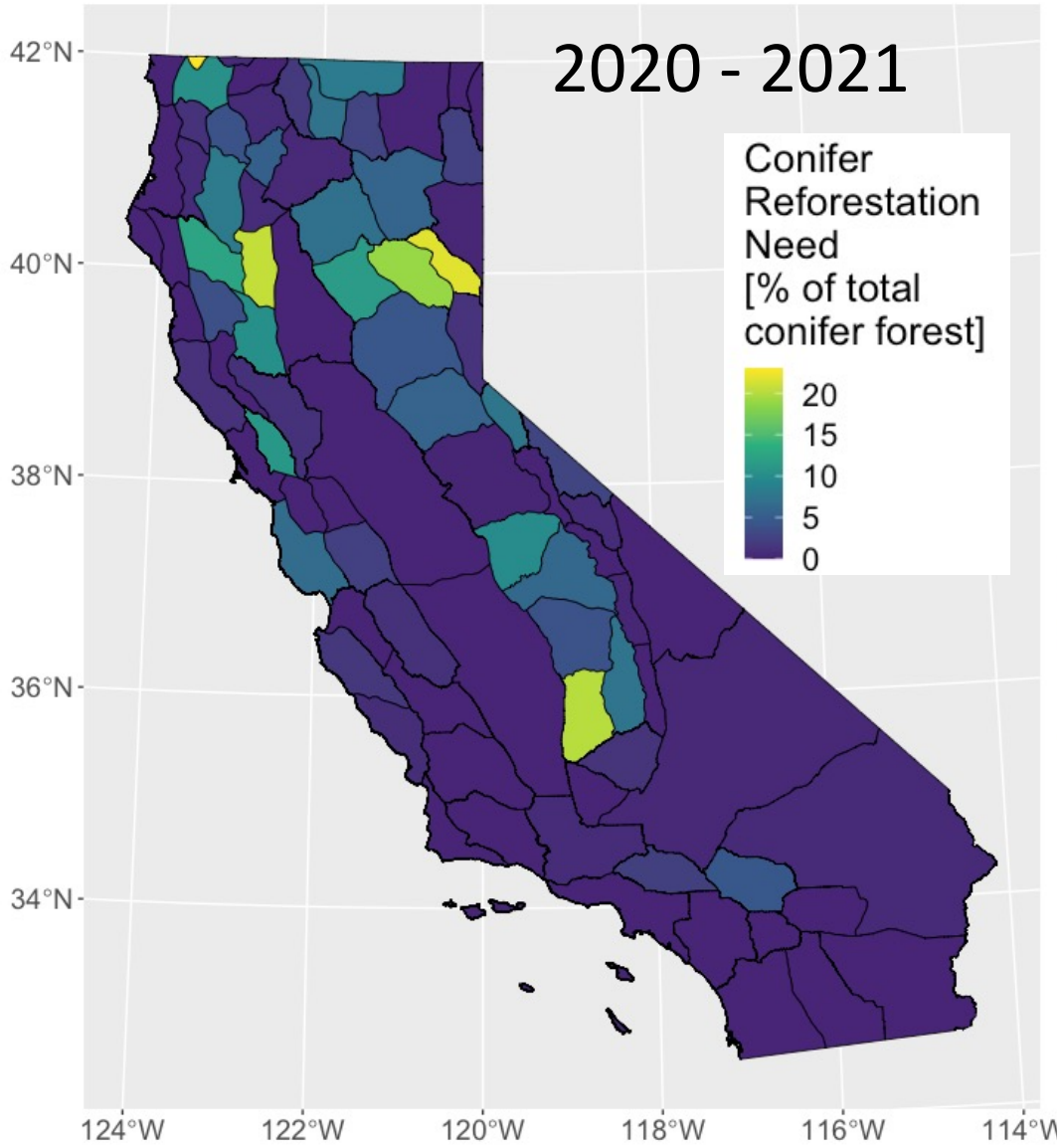
Fig. Conifer reforestation need in western Oregon over time (black dots).

- High Severity
  - HS Patch Size > 250 acres
- Coniferous Forest (BpS)
- < 50% probability of natural conifer regeneration within plot.





Not Enough Local Seed in Seedbanks to Meet Reforestation Needs



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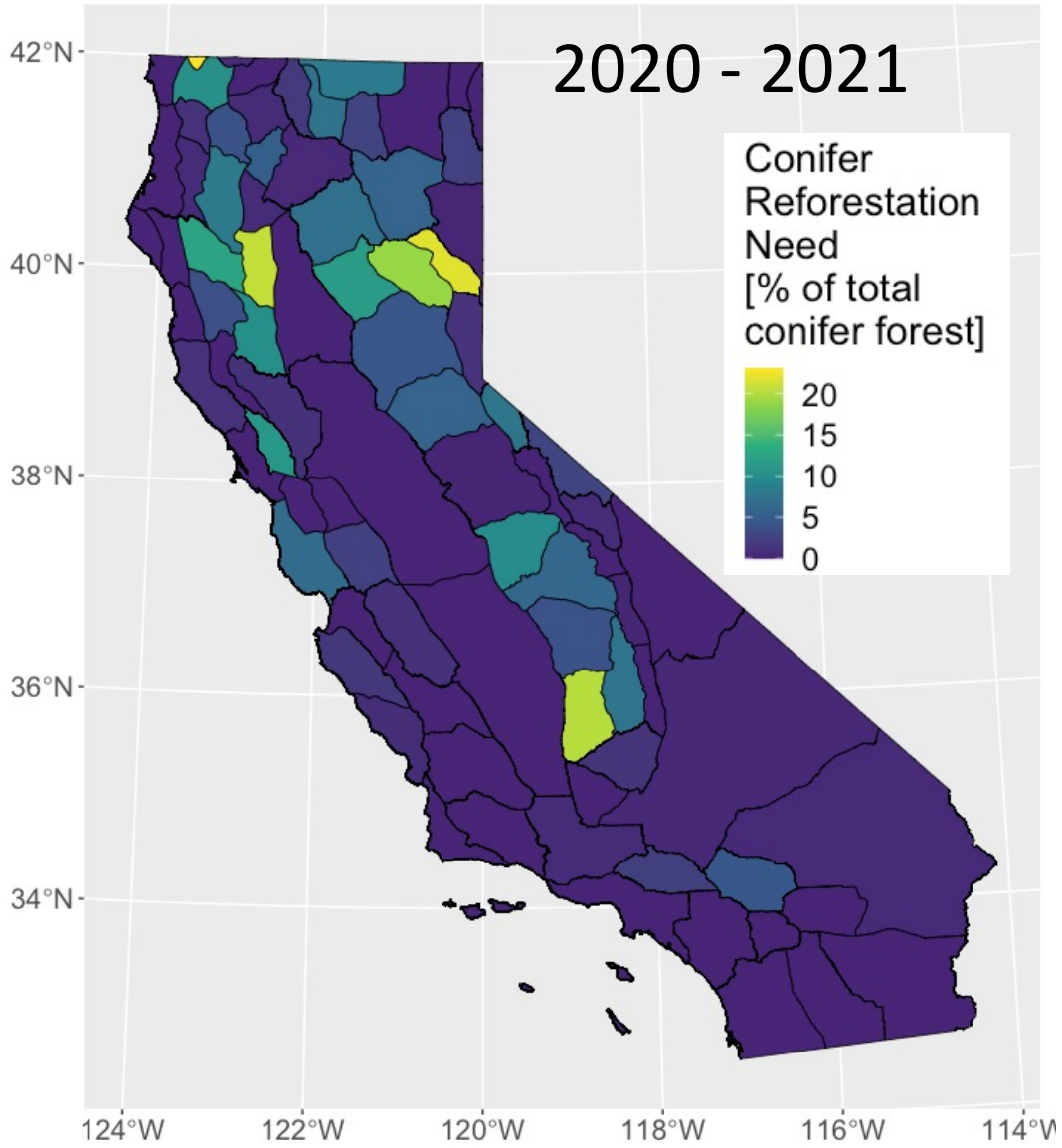
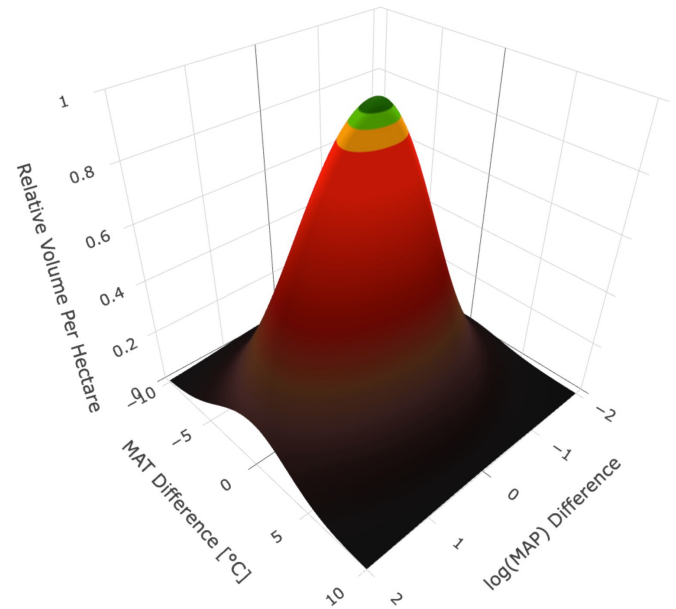
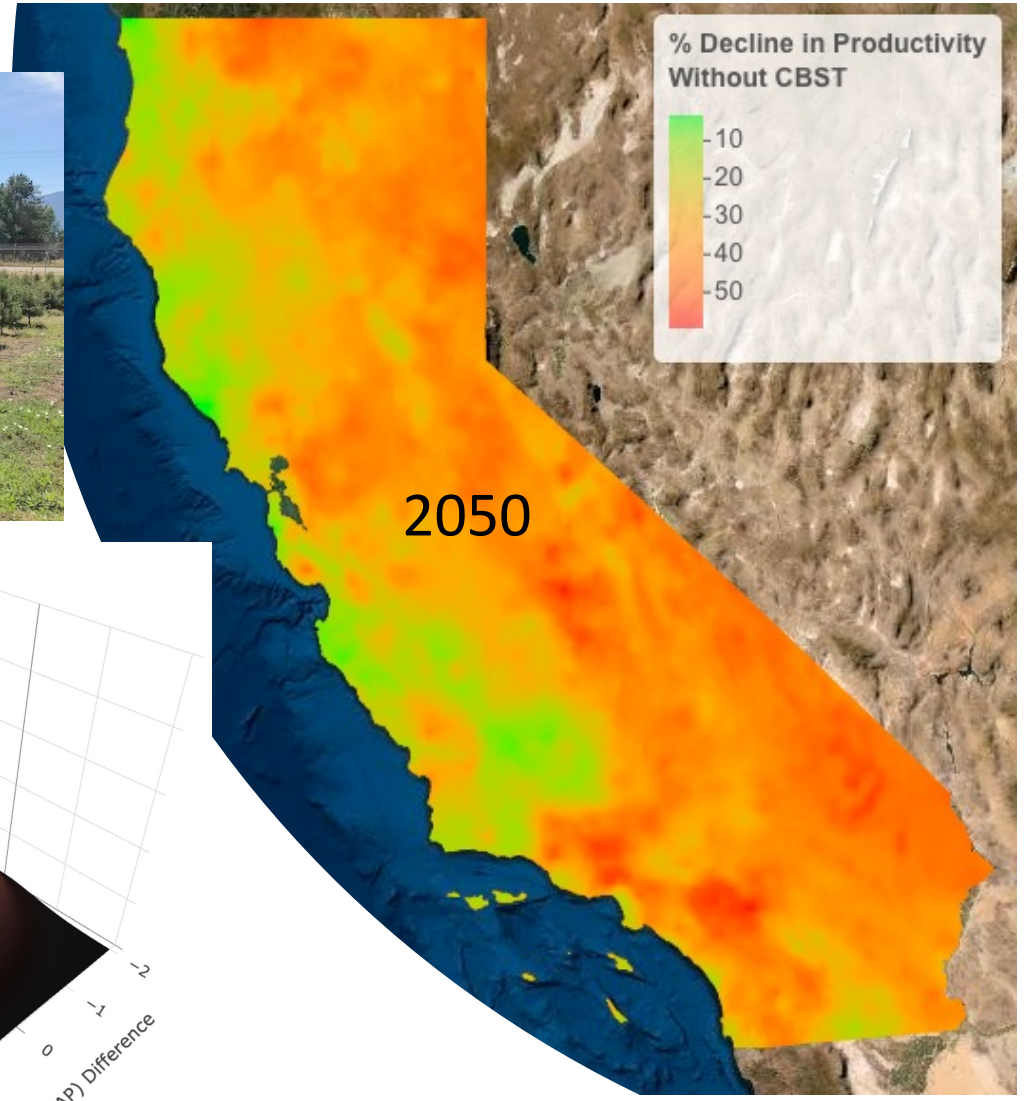
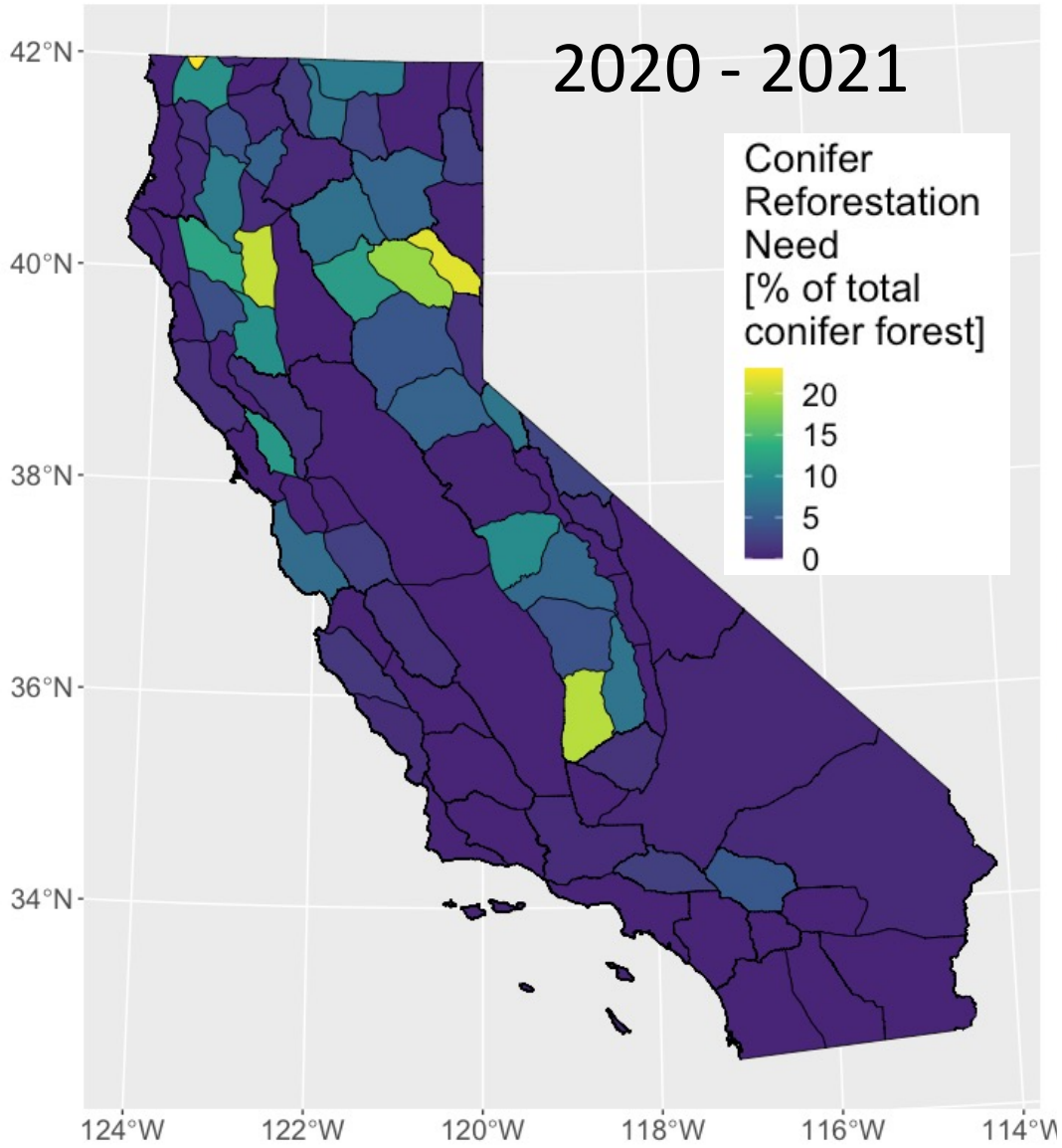


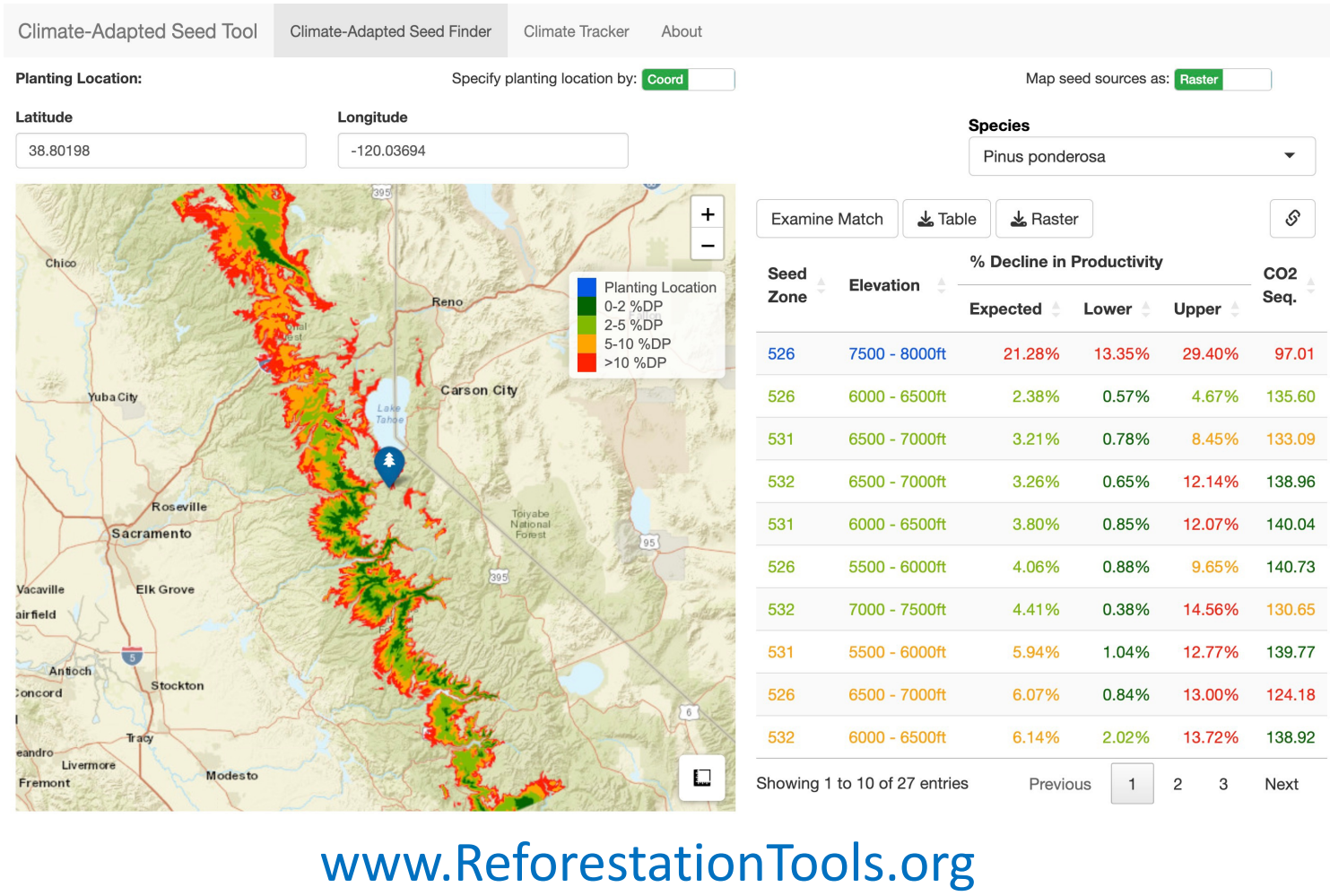
… and local seeds are no longer well adapted to the climate.





Not Enough Local Seed in Seedbanks to Meet Reforestation Needs





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Thank you!

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Bill Kuhn
Marcel Safford
Nicole Molinari

Michelle Coppoletta
Alison Paulson
Gabrielle Bohlman

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