

Tree planting outcomes after severe wildfire depend on climate, competition, and priority

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Inyo National Forest



Lake Tahoe Basin



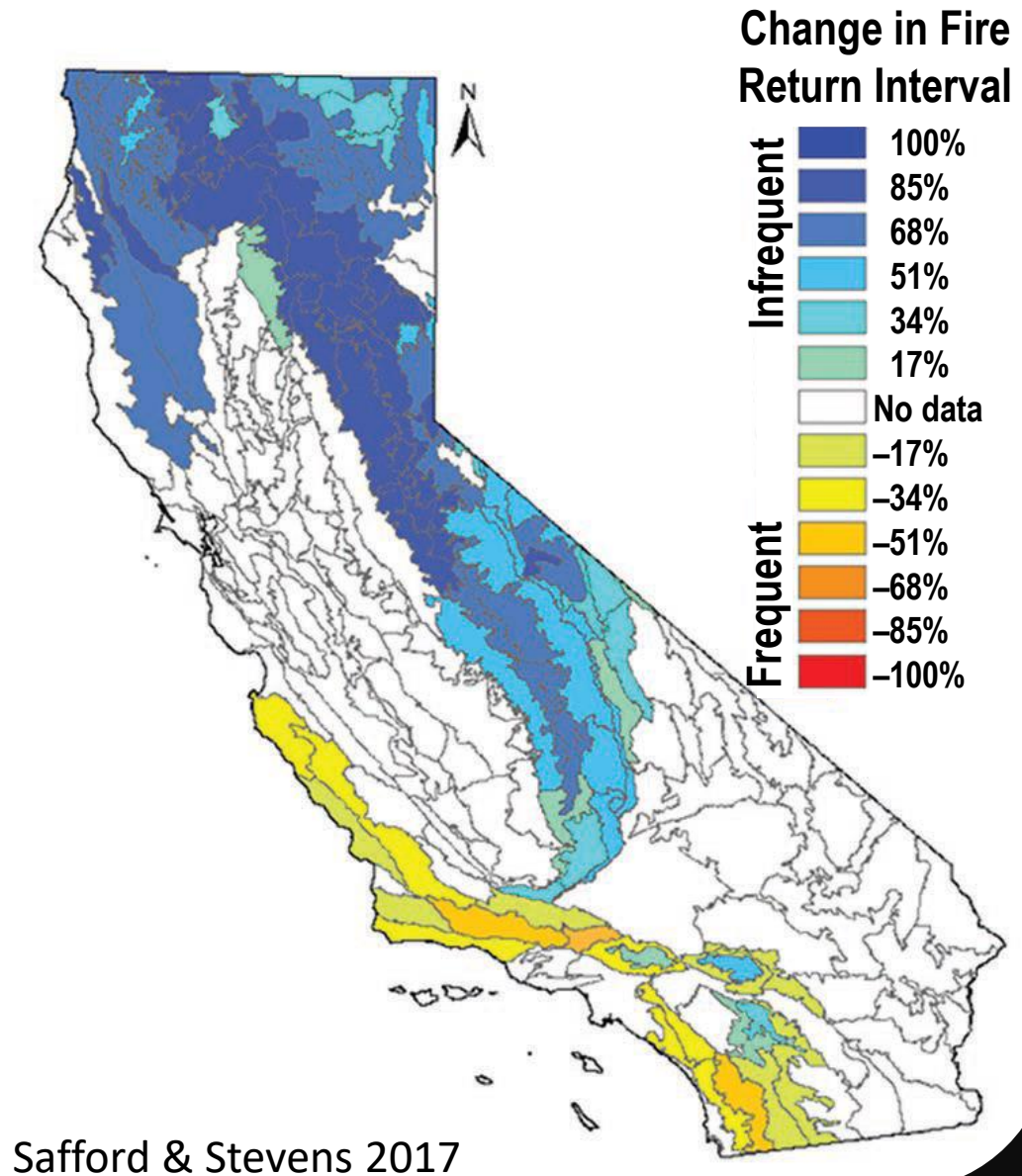
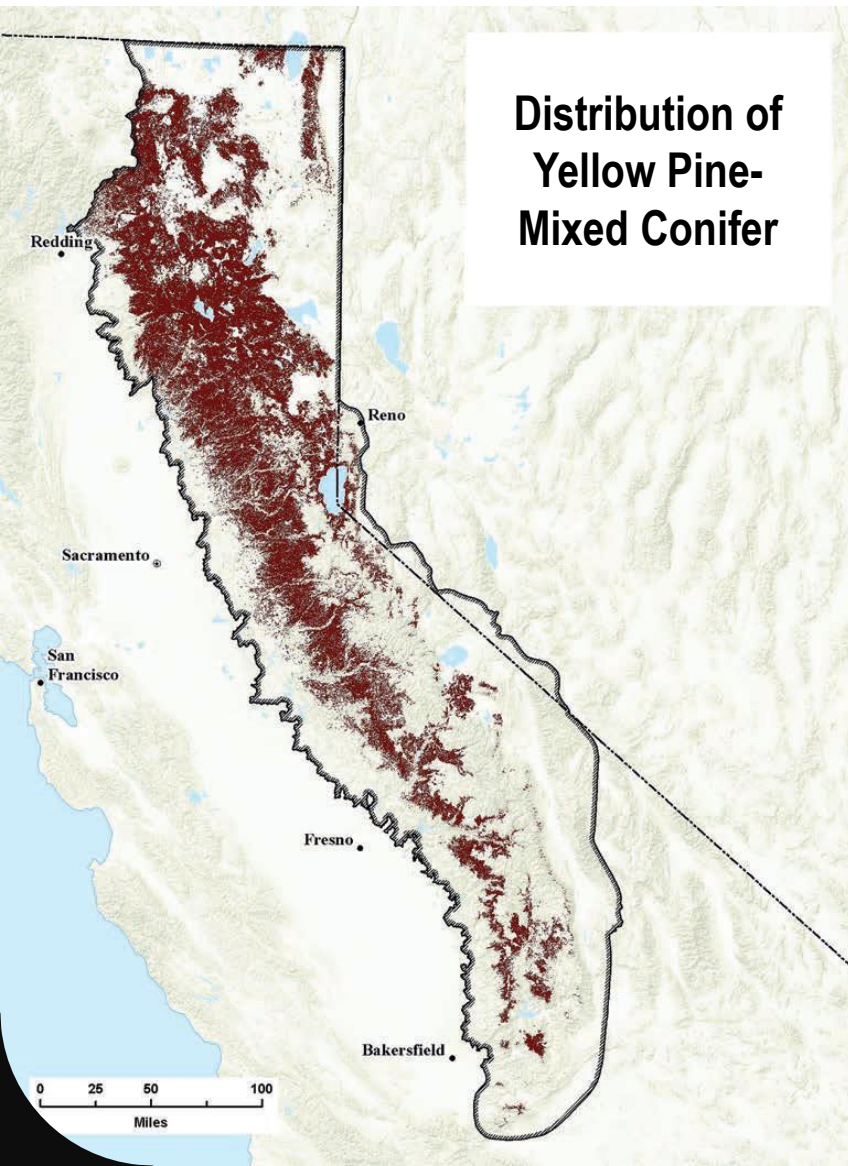
Sierra de San Pedro Mártir



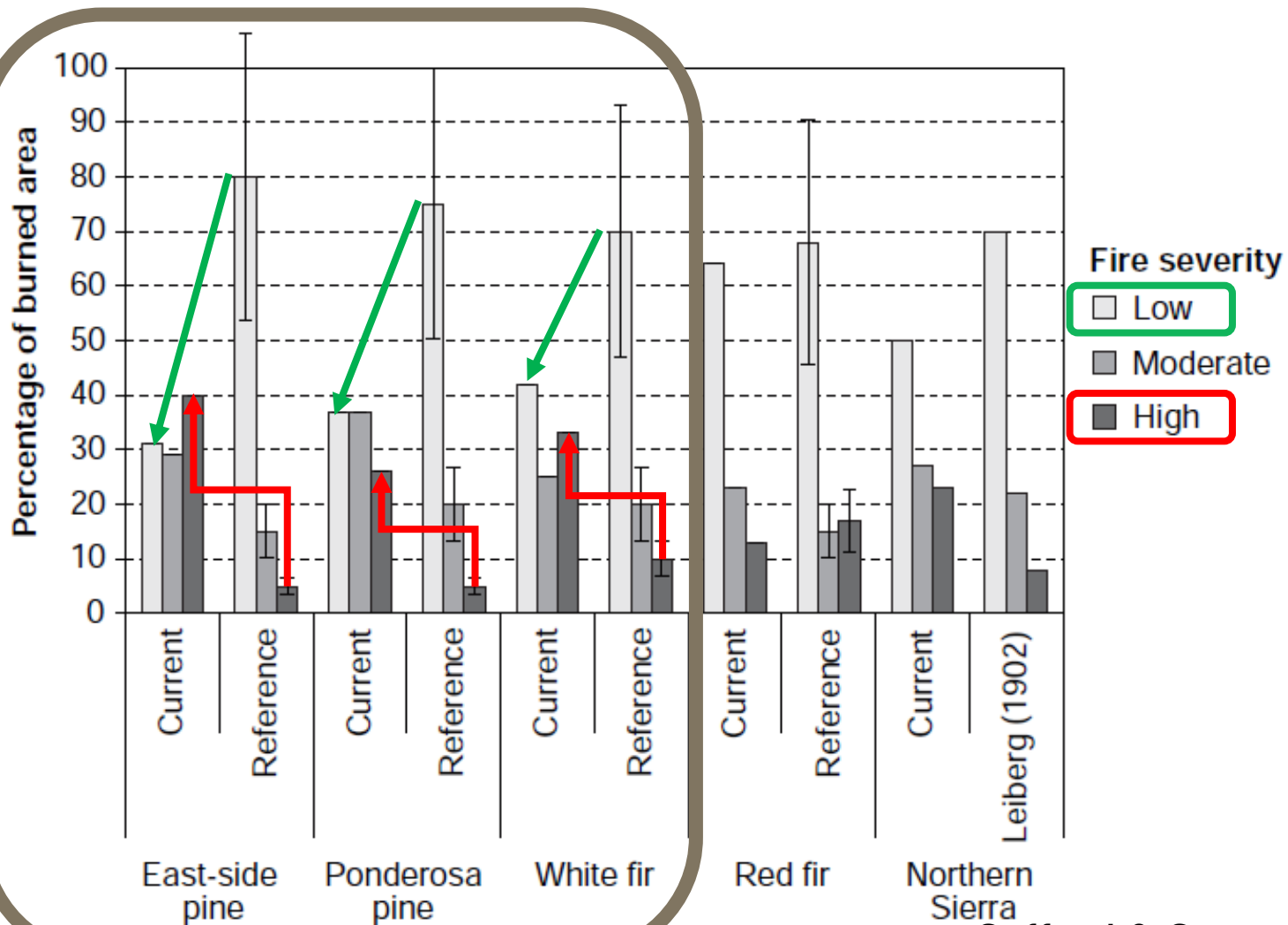
Tahoe National Forest

Dunbar-Irwin & Safford 2016

Yellow pine-mixed conifer



High severity fire increases



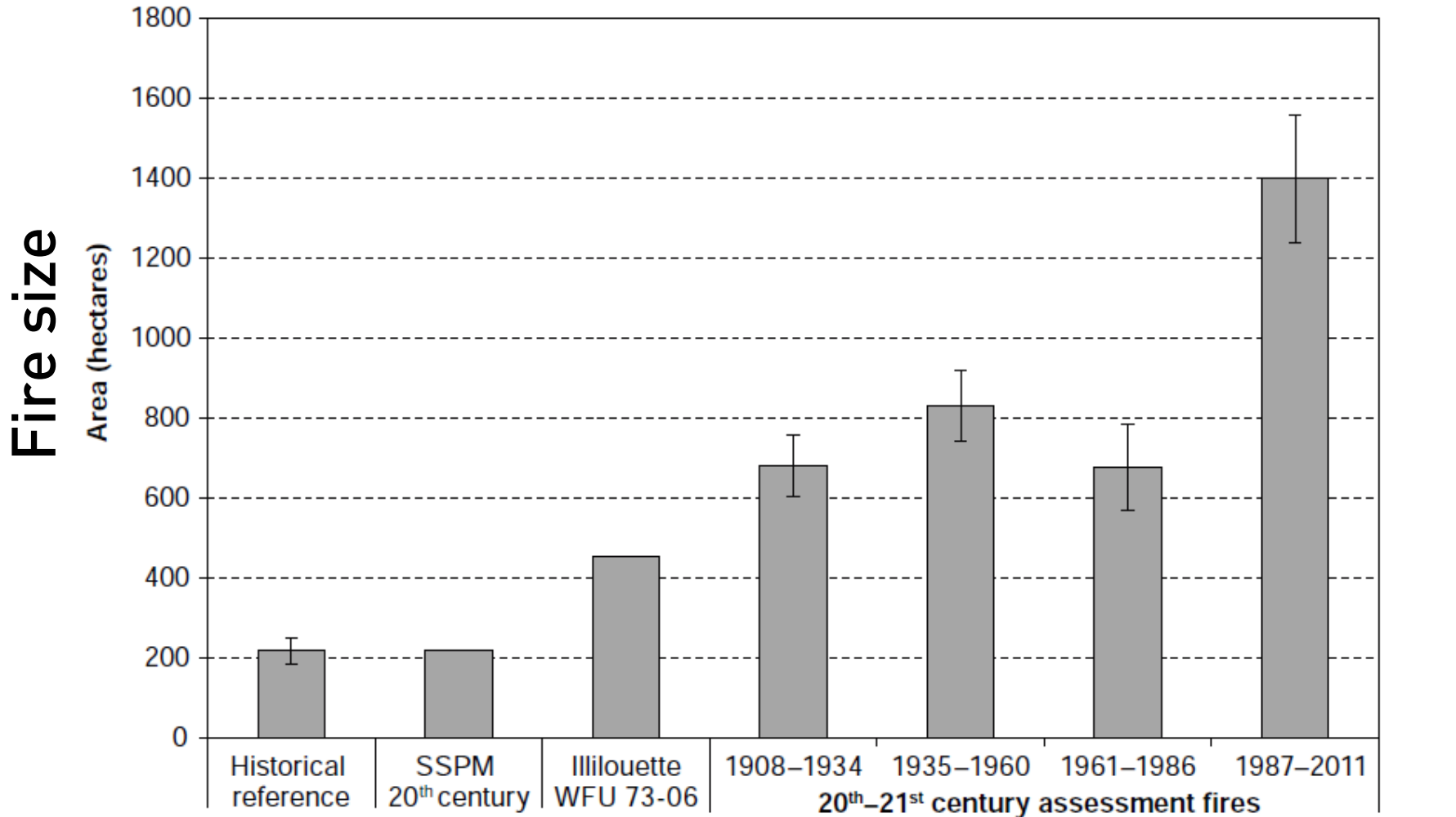
Fire suppression







Fire size has increased dramatically









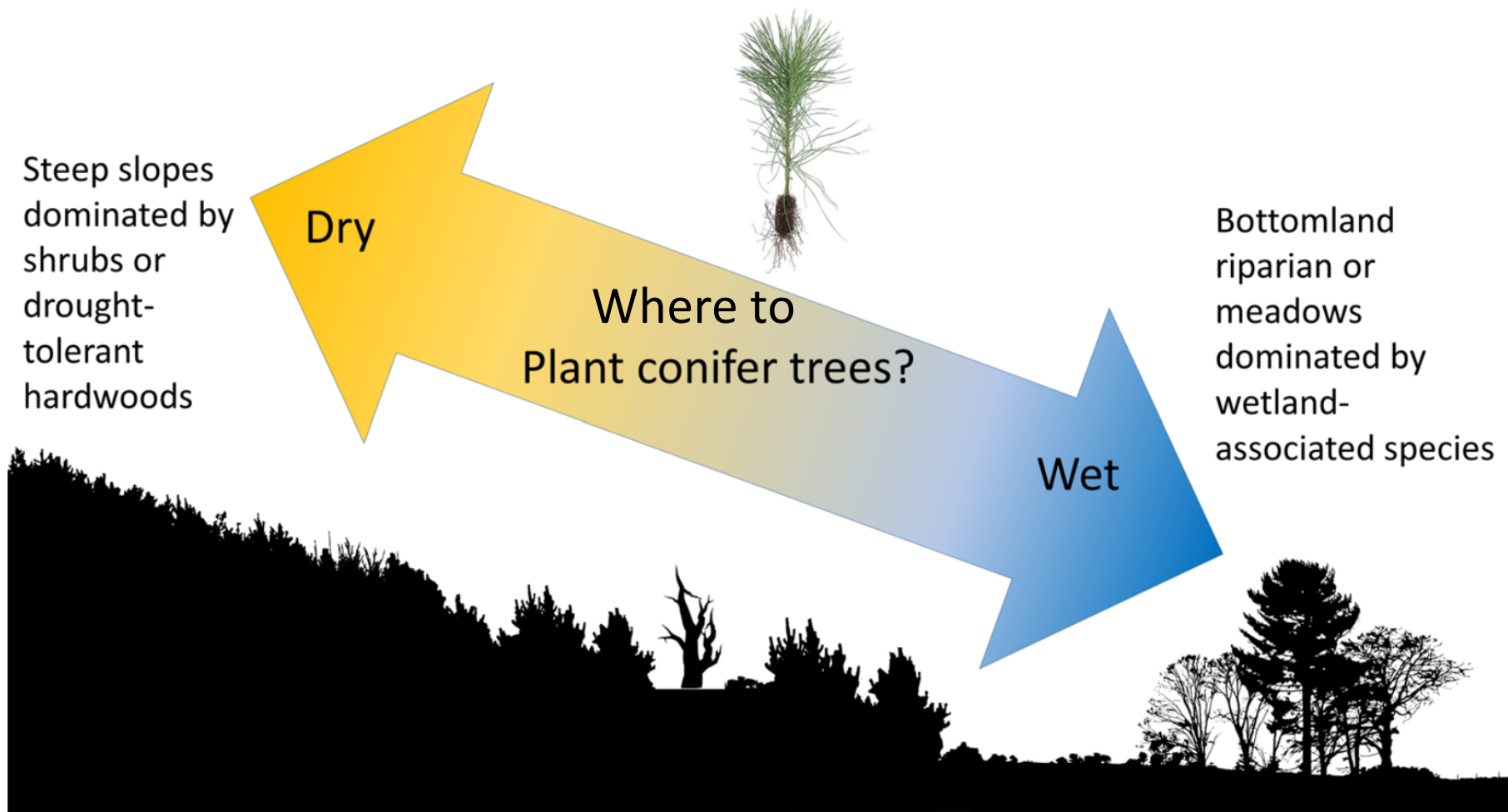
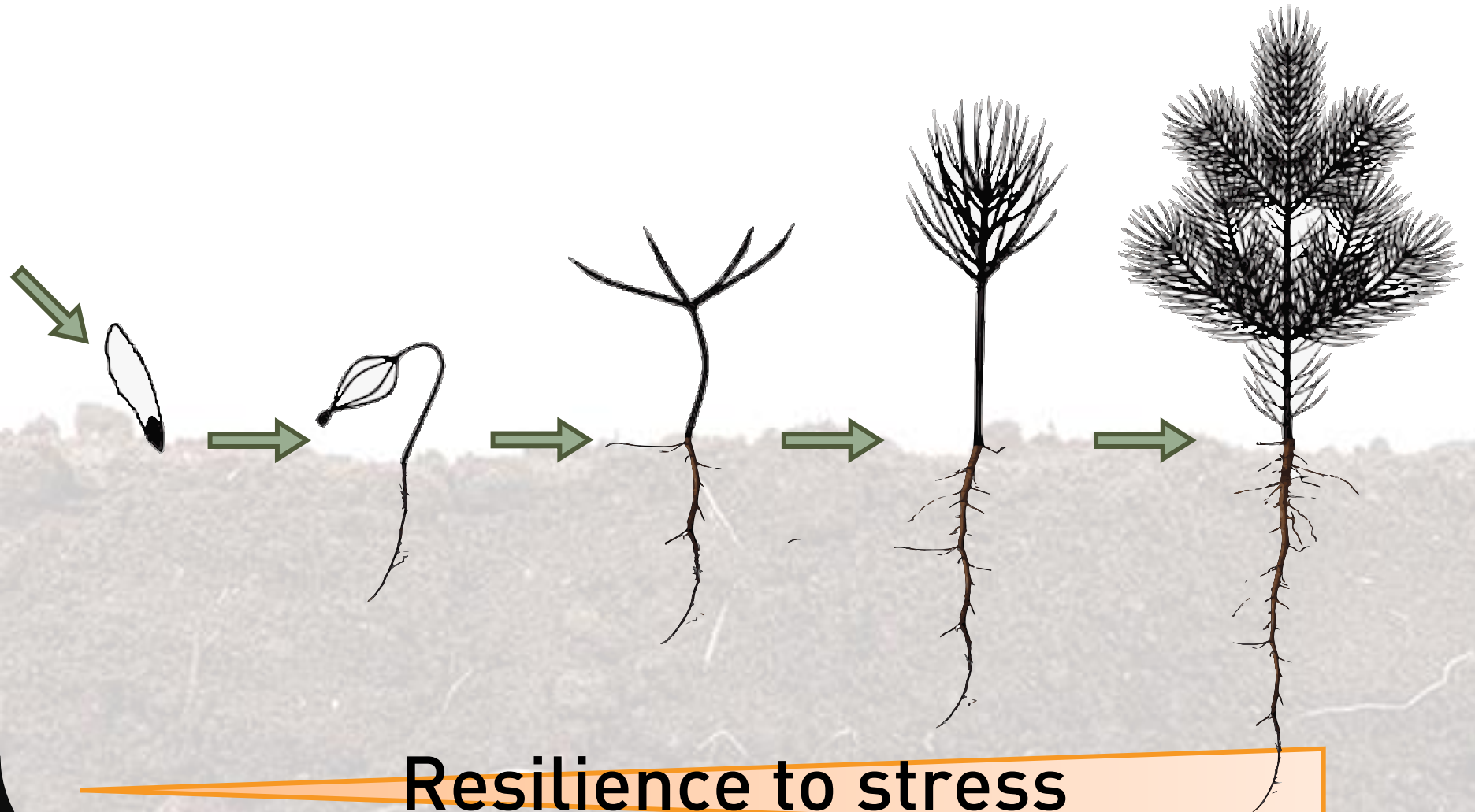


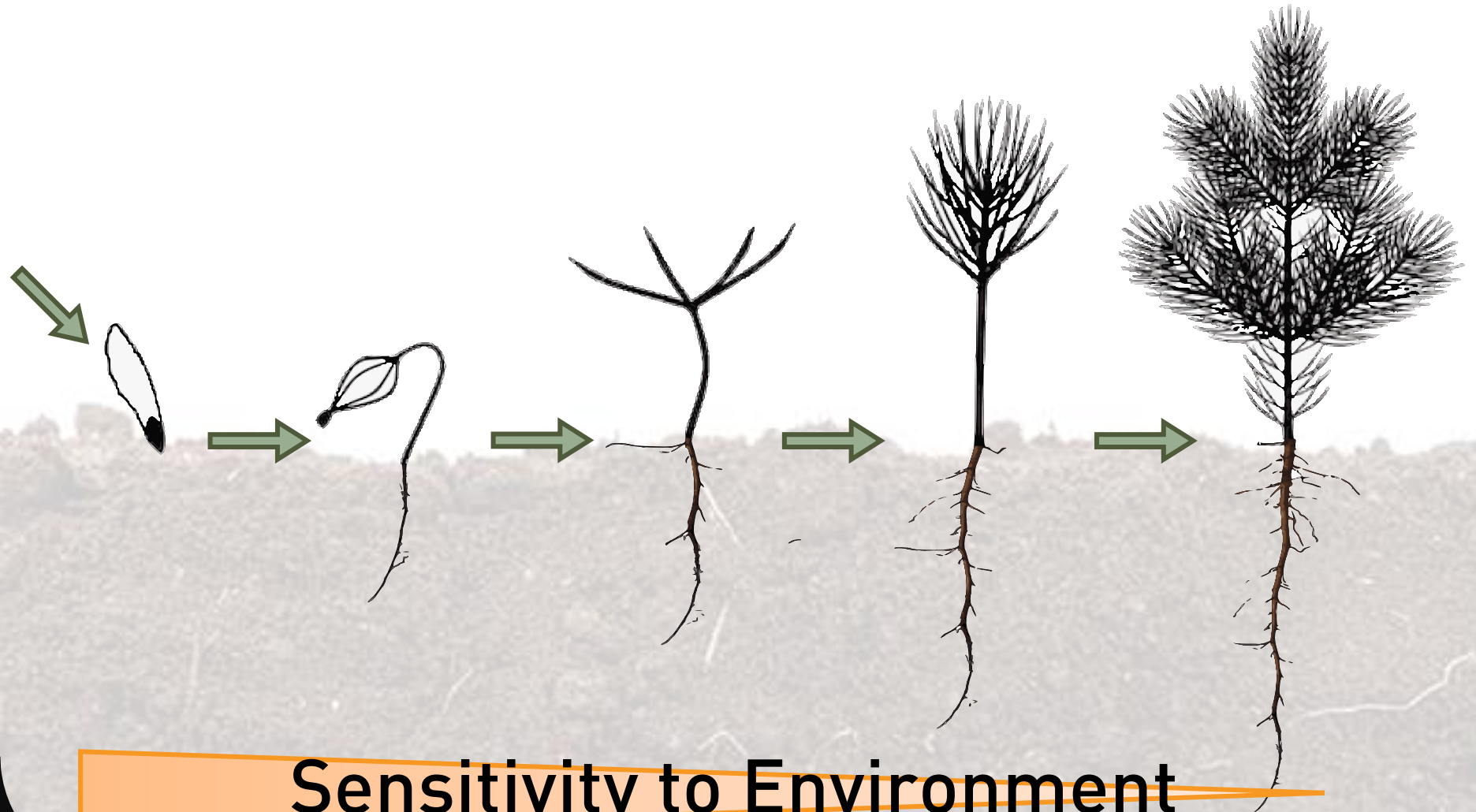
Fig. 3 Conceptual representation of how landscape moisture relationships may influence post-fire reforestation decisions. Conifer planting is more likely to be avoided on steeper, dry slopes where tree survival is likely to be poor, but planting may also be avoided in moist bottomlands where natural regeneration, particularly by desirable non-conifer species, is expected

Early seedling establishment



Resilience to stress

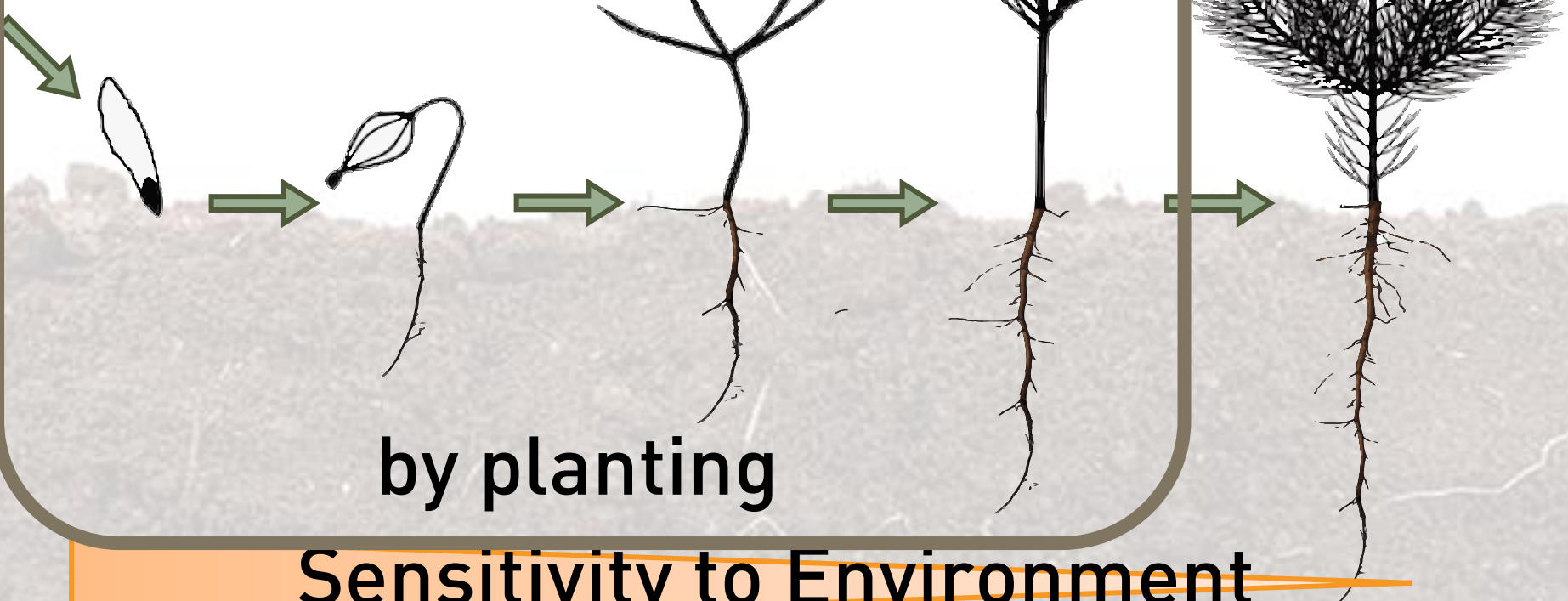
Early seedling establishment



Sensitivity to Environment

Early seedling establishment

Bypassed



by planting

Sensitivity to Environment

Objective

Predict where tree planting is most beneficial

Limited resources

Variation in transplant survival

Variation in natural regeneration

Practical Objective:

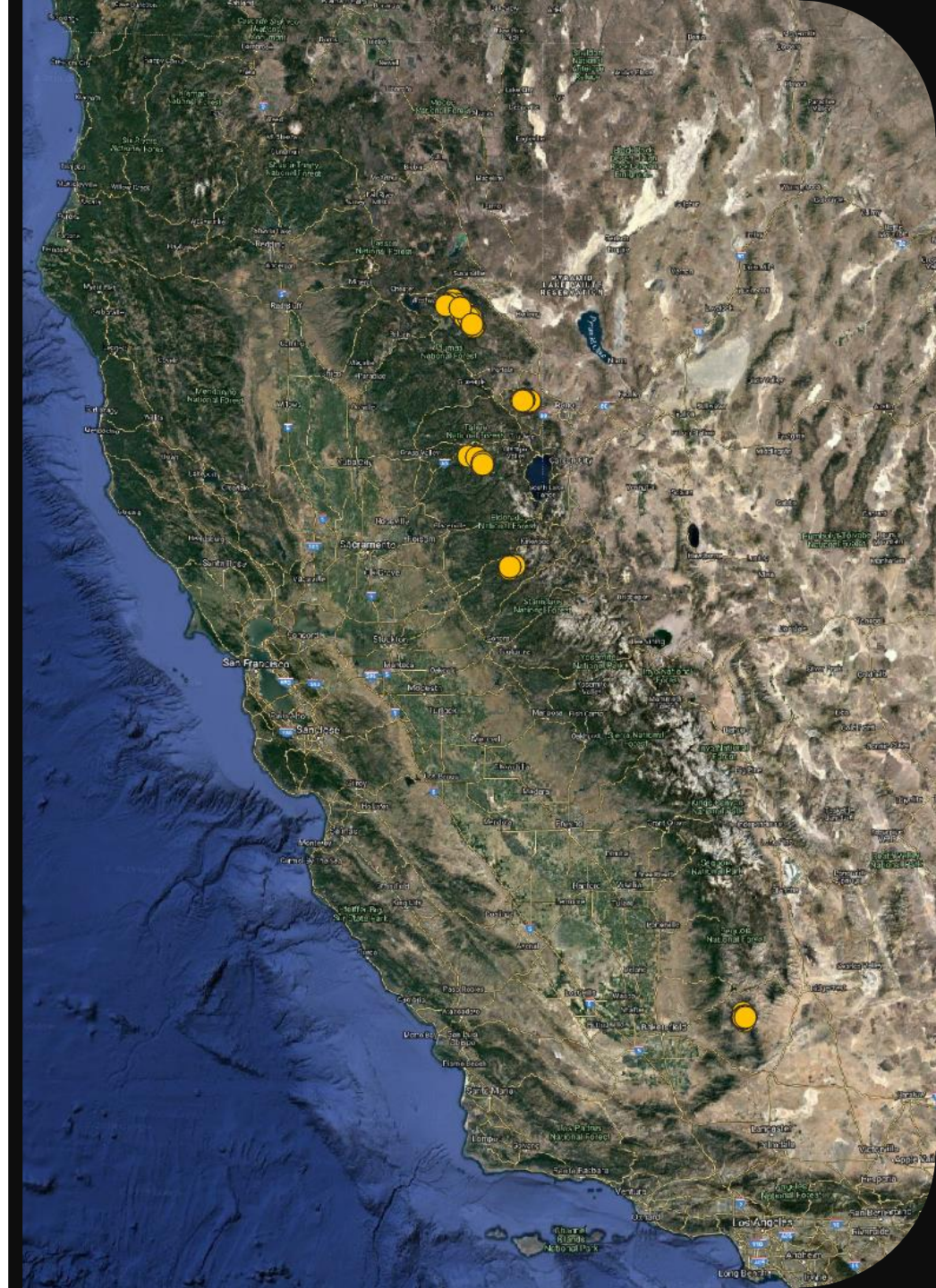
Create planting prioritization tool

Question

Can we use environmental variation to predict where tree planting is needed and will increase tree density the most?

5 Fires in Yellow Pine-Mixed Conifer

1. Cottonwood
2. American River
3. Moonlight/
Antelope
4. Piute
5. Power

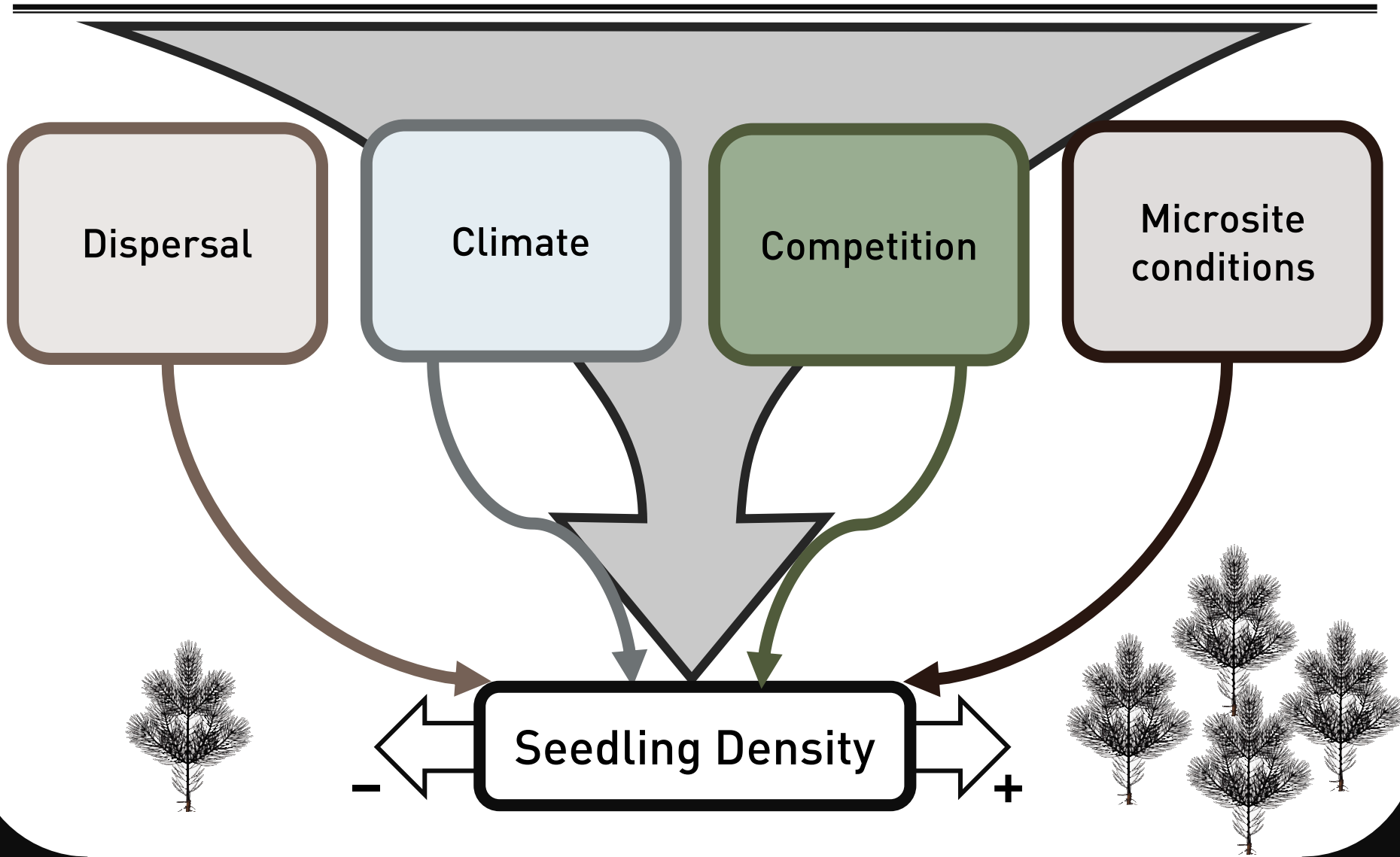




- Only high-severity patches
- Paired plots
- 11m diameter plots
- Spanning environmental variation
- 15–25 pairs/site
- Sampled 7–20 yrs after planting
- Planted 1–3 yrs after fire
- Average management

Analysis

Environmental Variation



Dispersal

Climate

Competition

Microsite
conditions

Seedling Density

-

+

Analysis

Environmental Variation

Dispersal

- Distance to nearest seed source

Climate

- Normal Annual Precipitation
- Temperature
- Solar Radiation

Competition

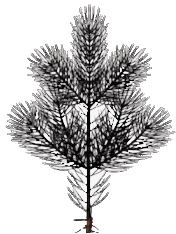
- Shrub cover
- Timing of planting

Microsite conditions

- Litter and Duff depth
- Topographic Position Index
- Elevation
- Slope

Planting

Seedling Density

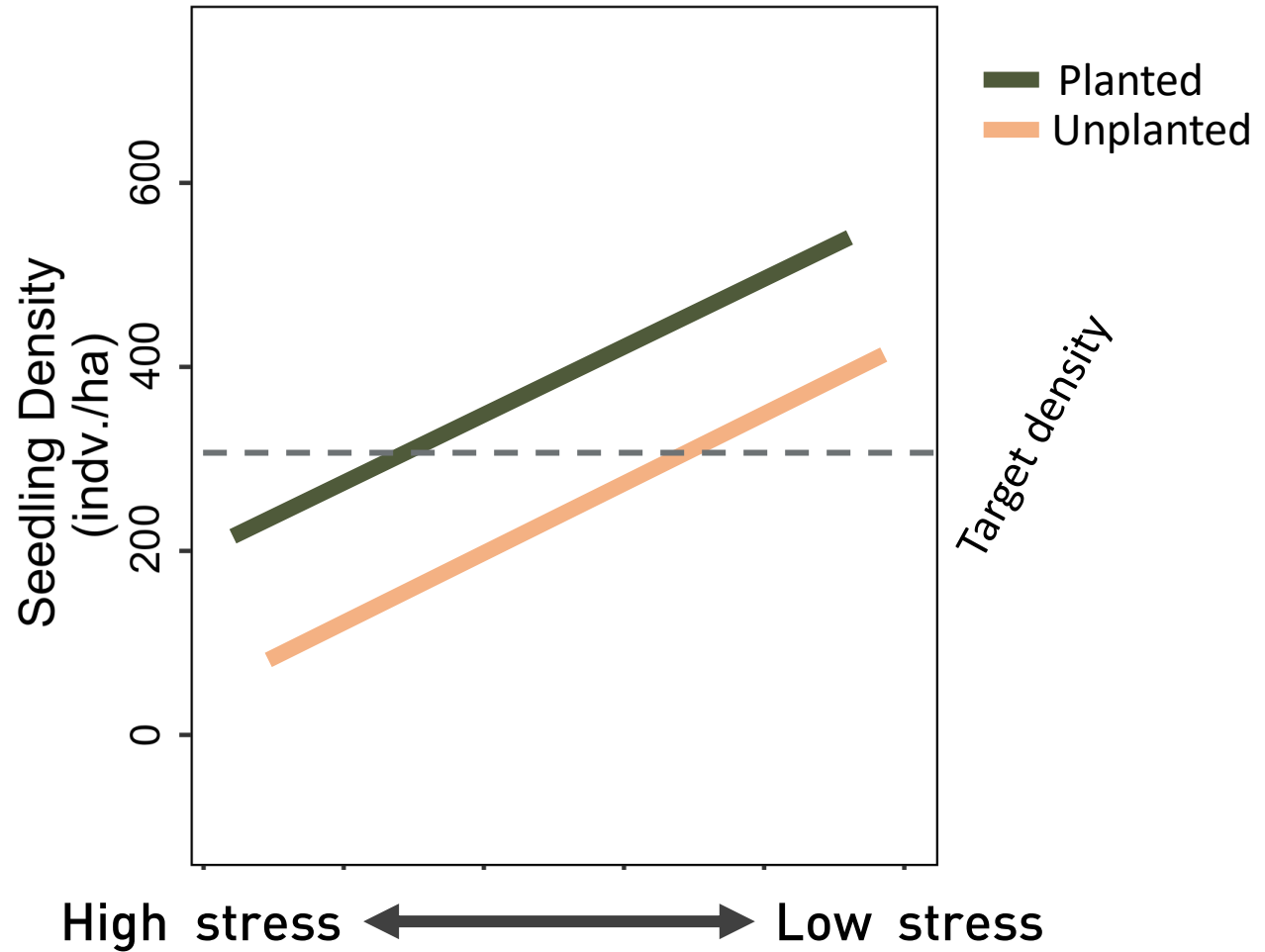


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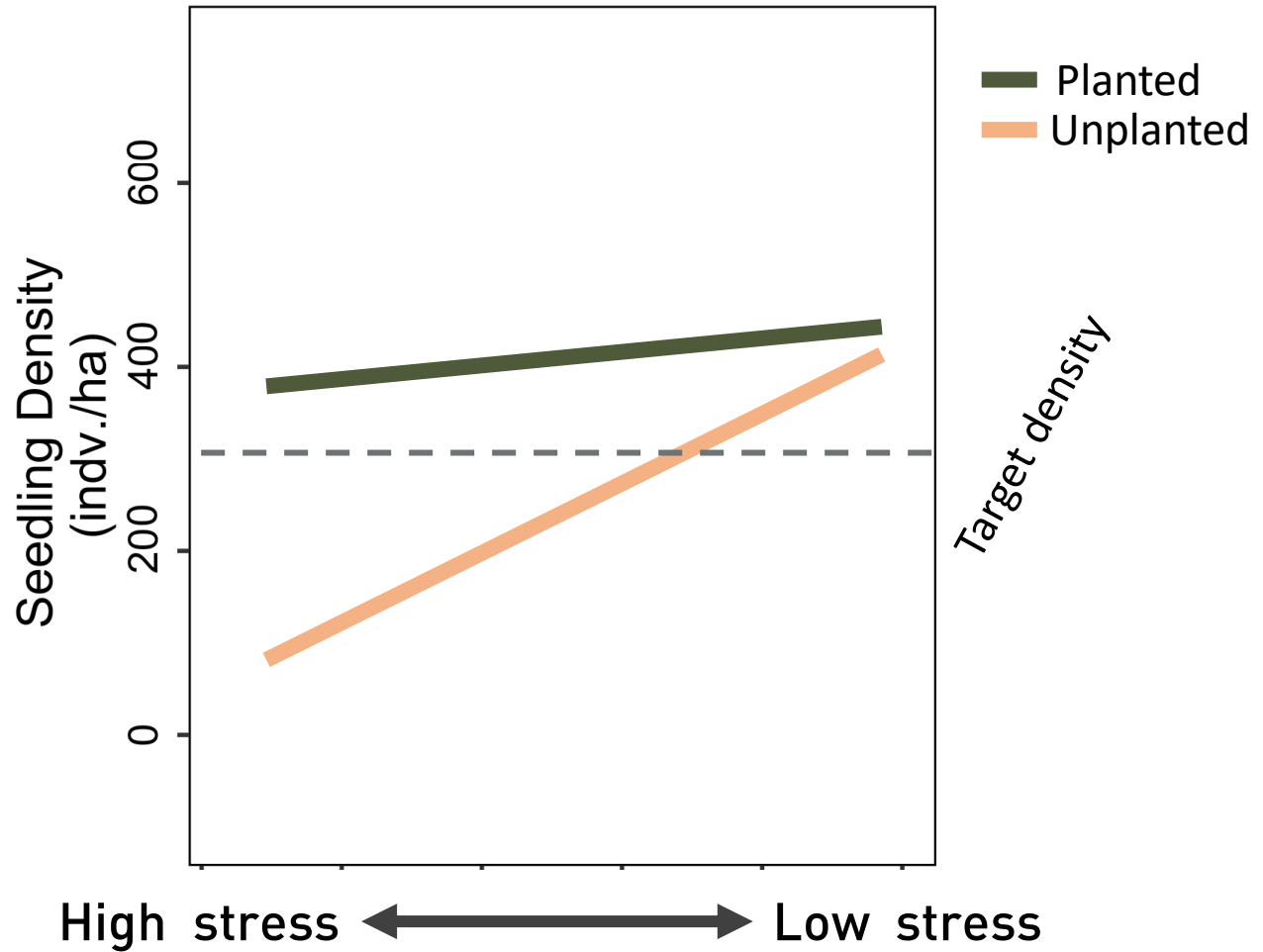
+



Interaction with Planting



Interaction with Planting



Interaction with Planting



Best Model

Climate

Annual average minimum temperature *
Normal annual precipitation +

Competition

Shrub cover * Planted *
Years planted after fire +

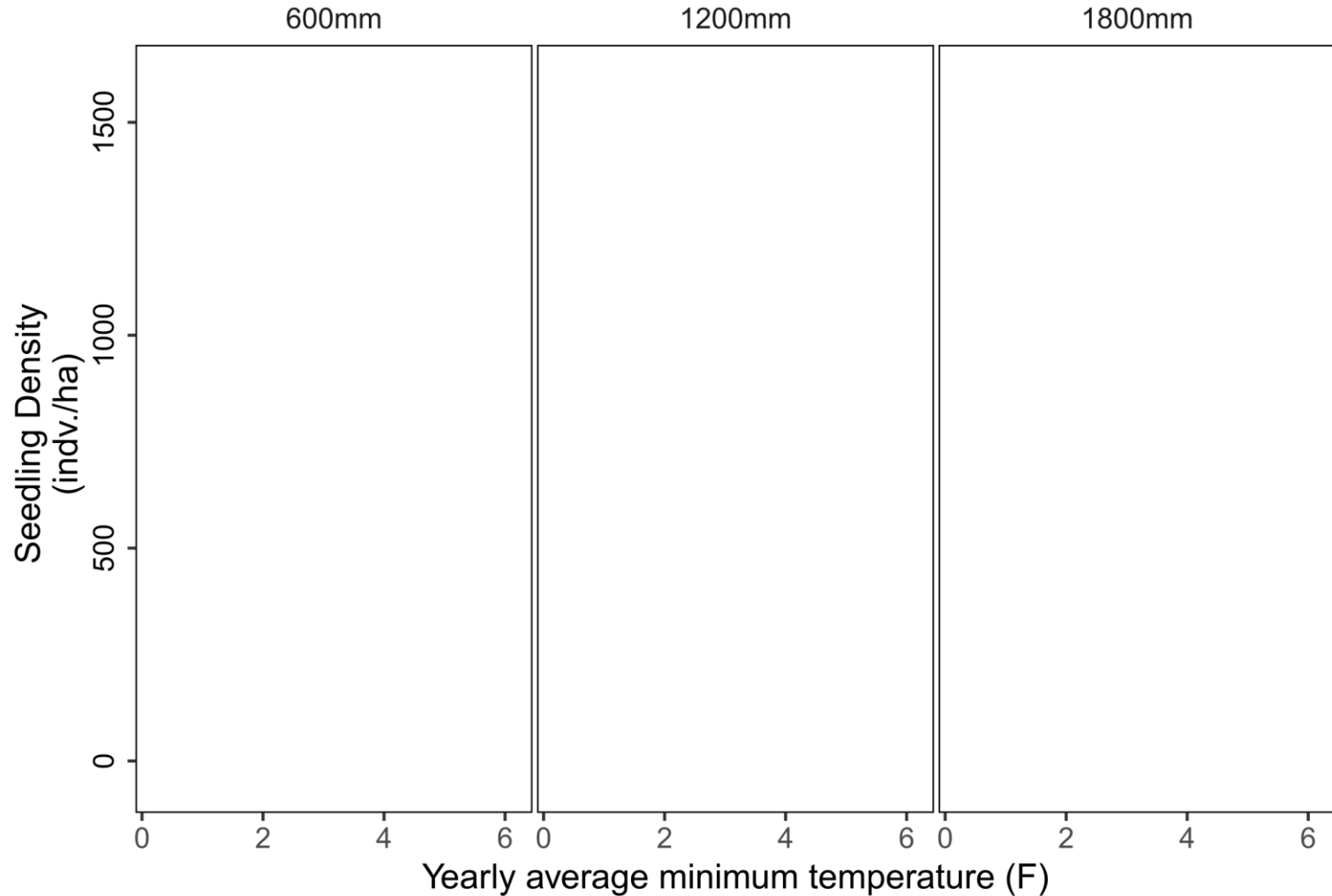
Dispersal

Distance from seed source +

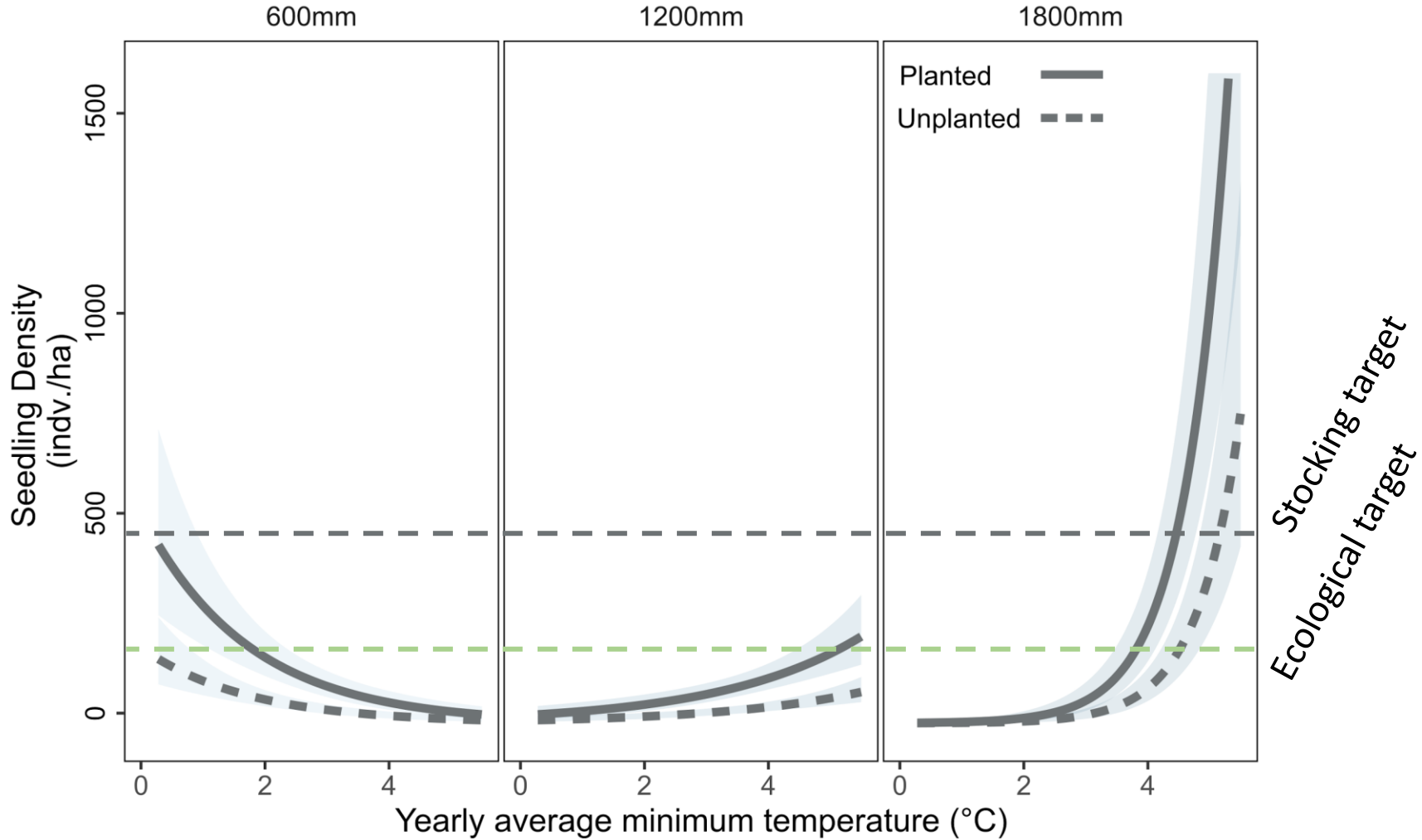
Microsite

Litter&Duff +
Elevation * Topographic position index

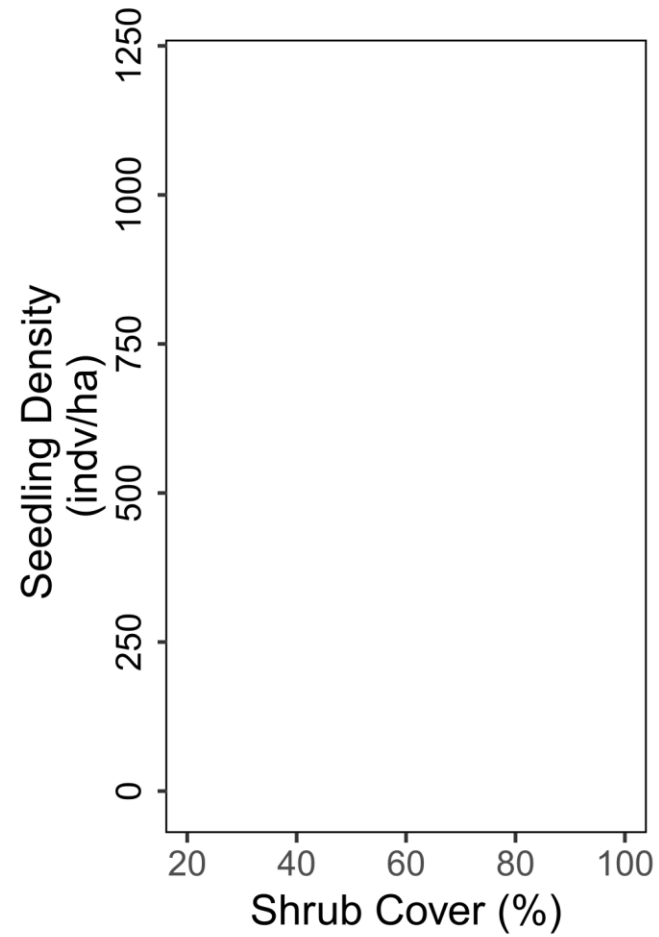
Temperature and Precipitation



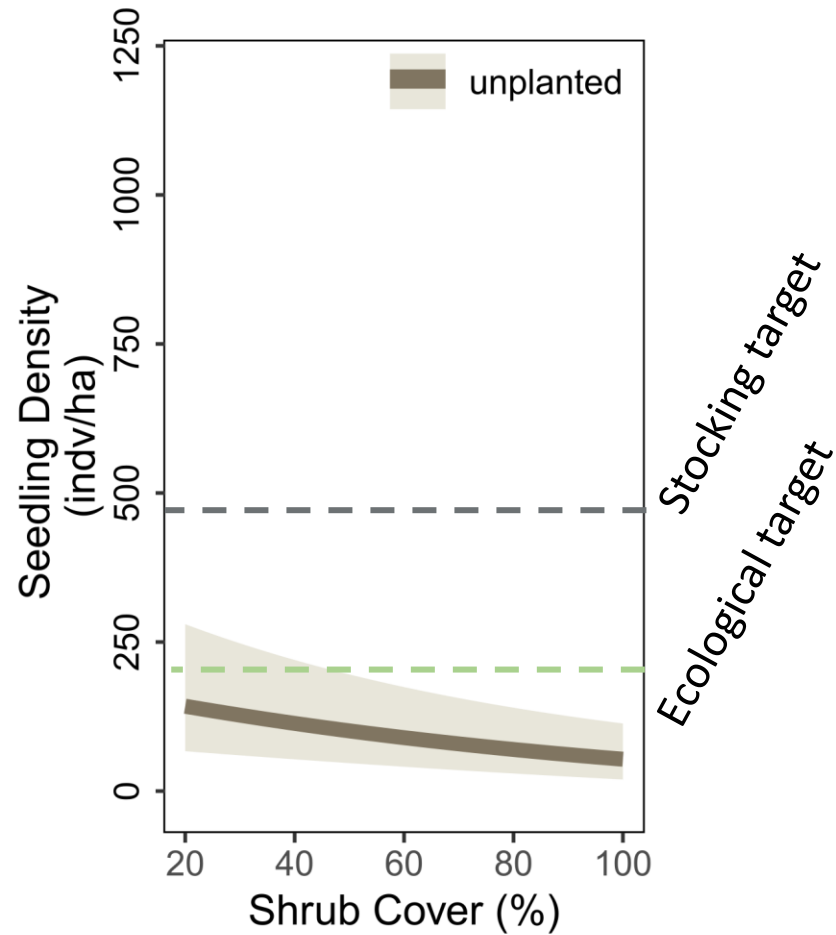
Temperature and Precipitation



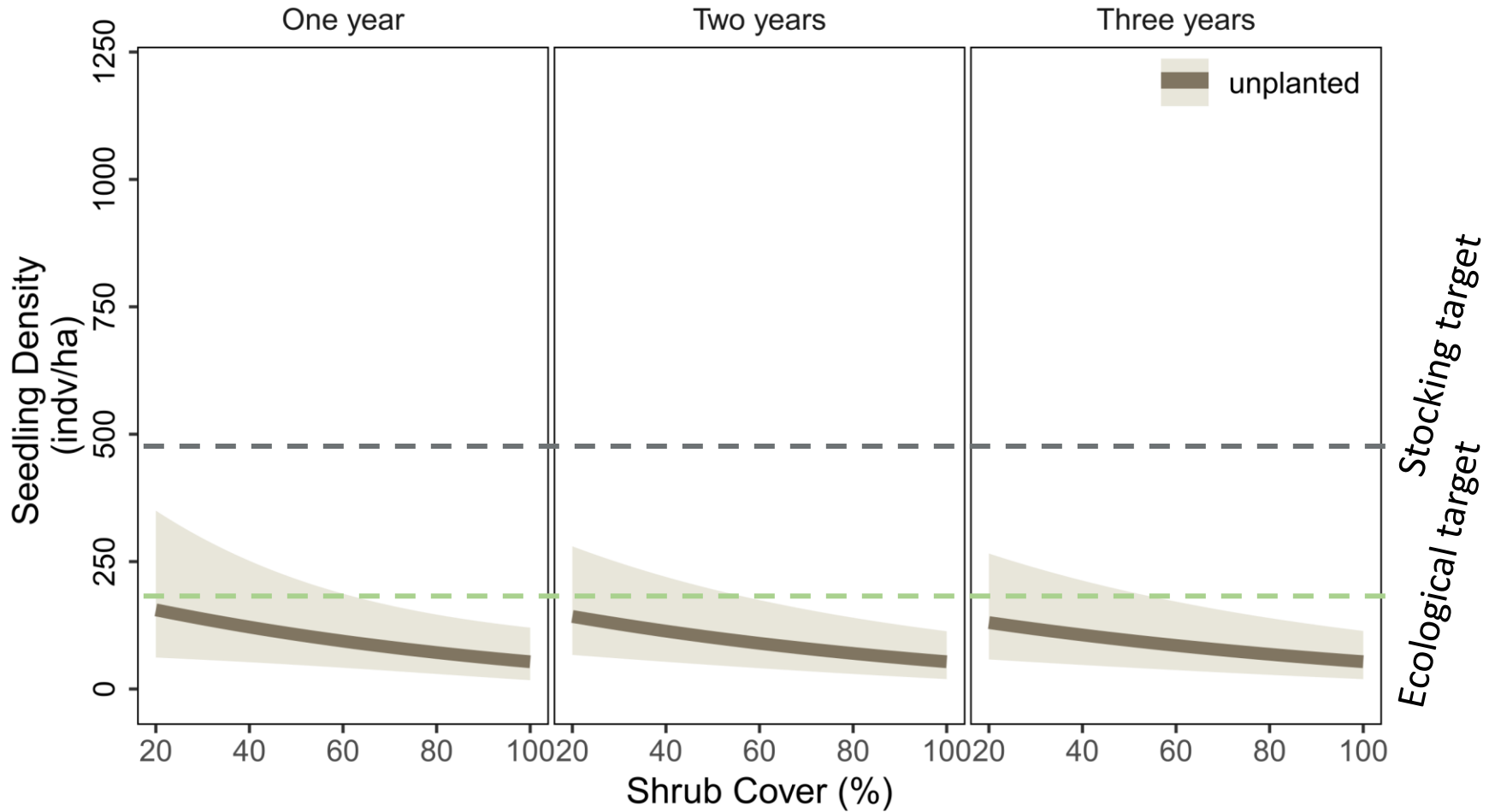
Shrub Cover



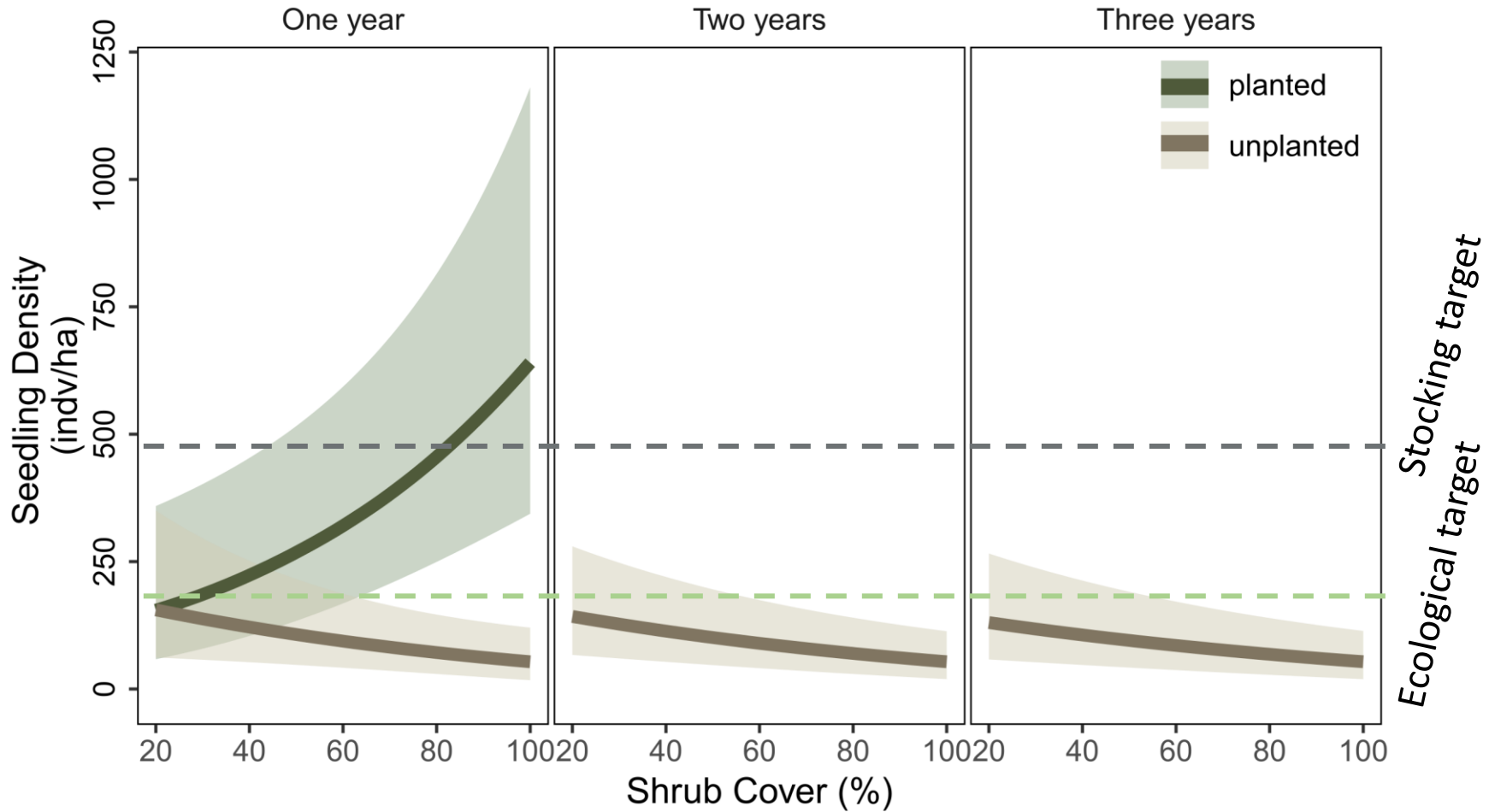
Shrub Cover



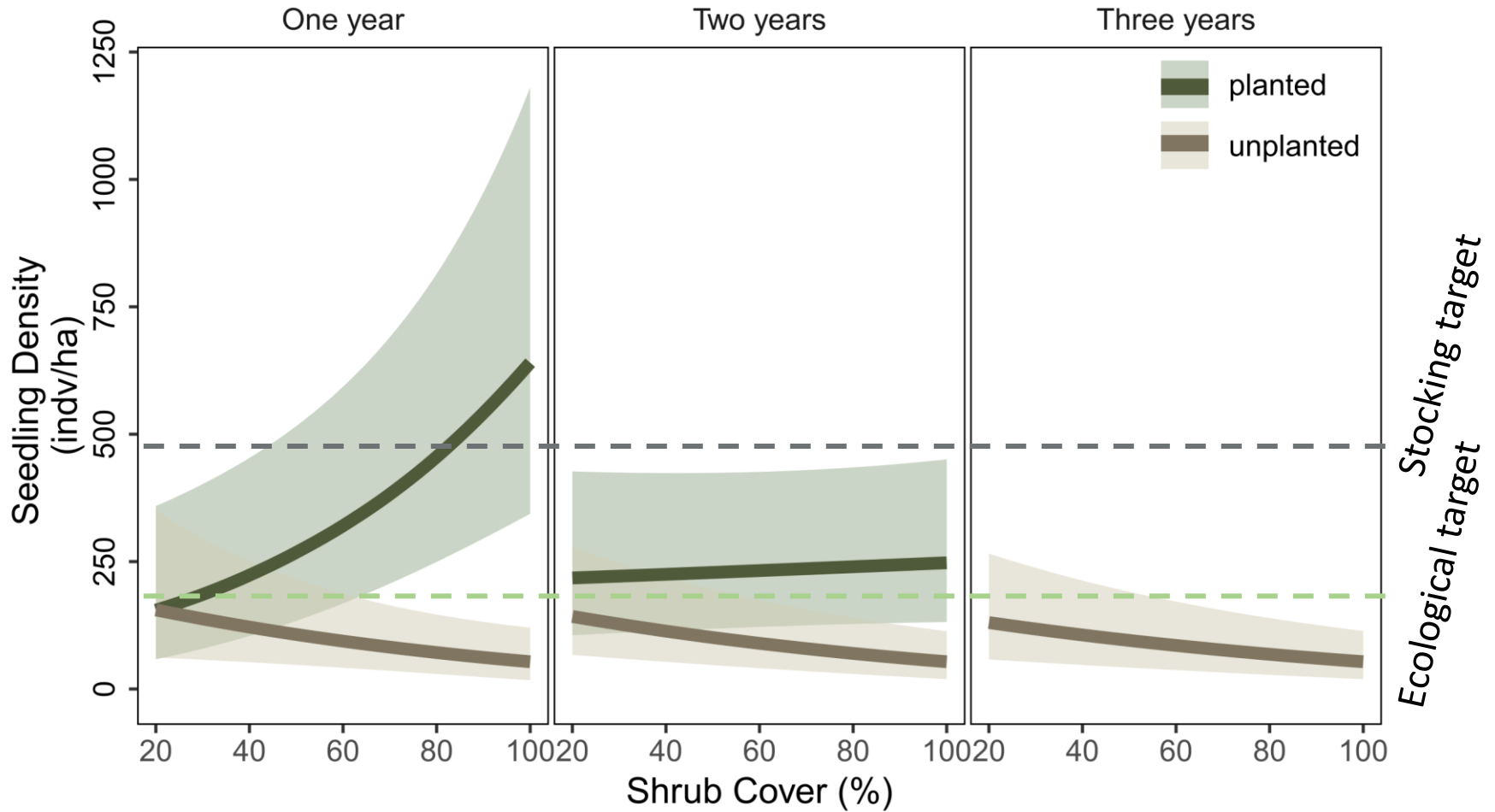
Shrub Cover



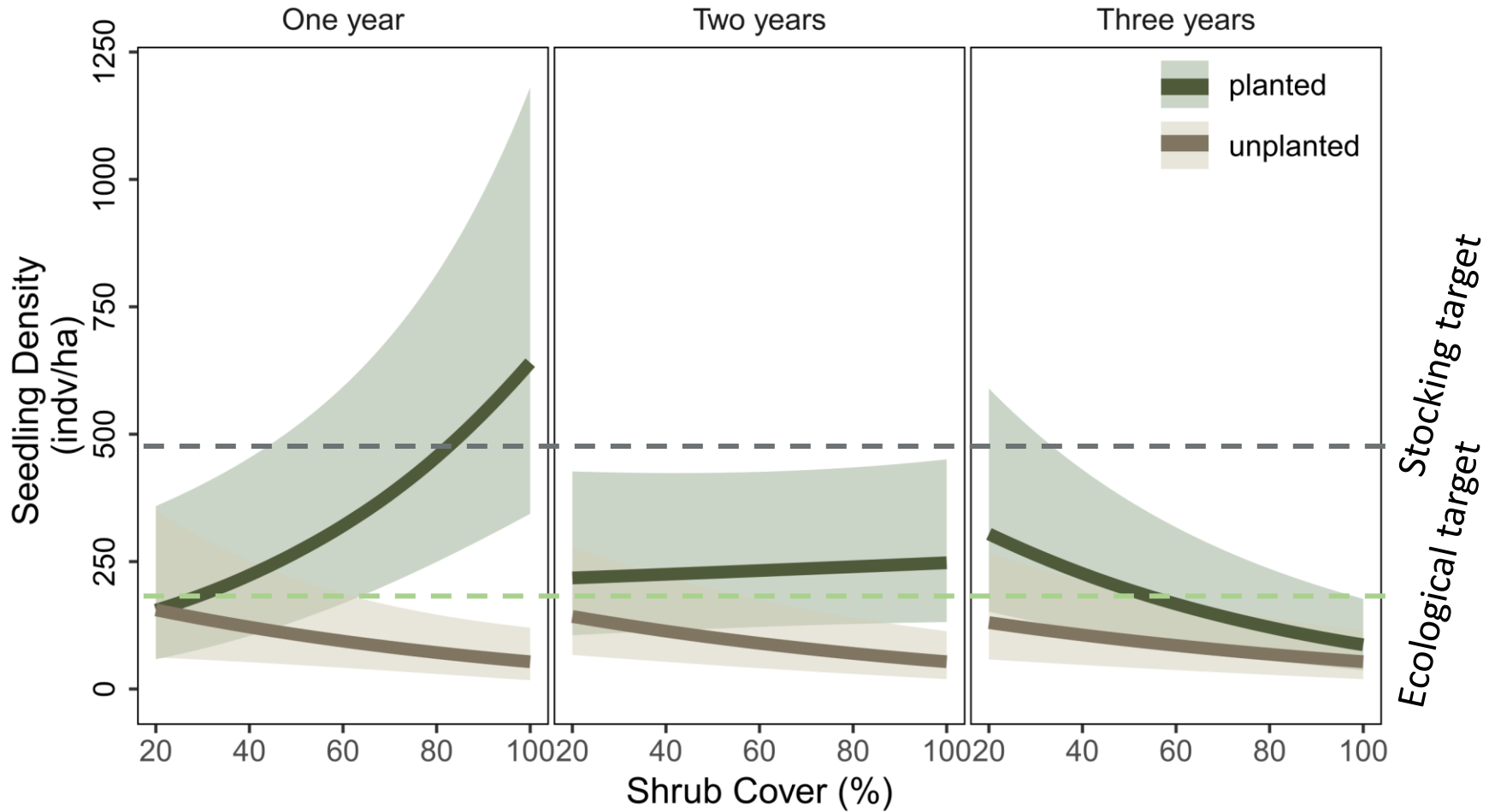
Shrub Cover and Timing



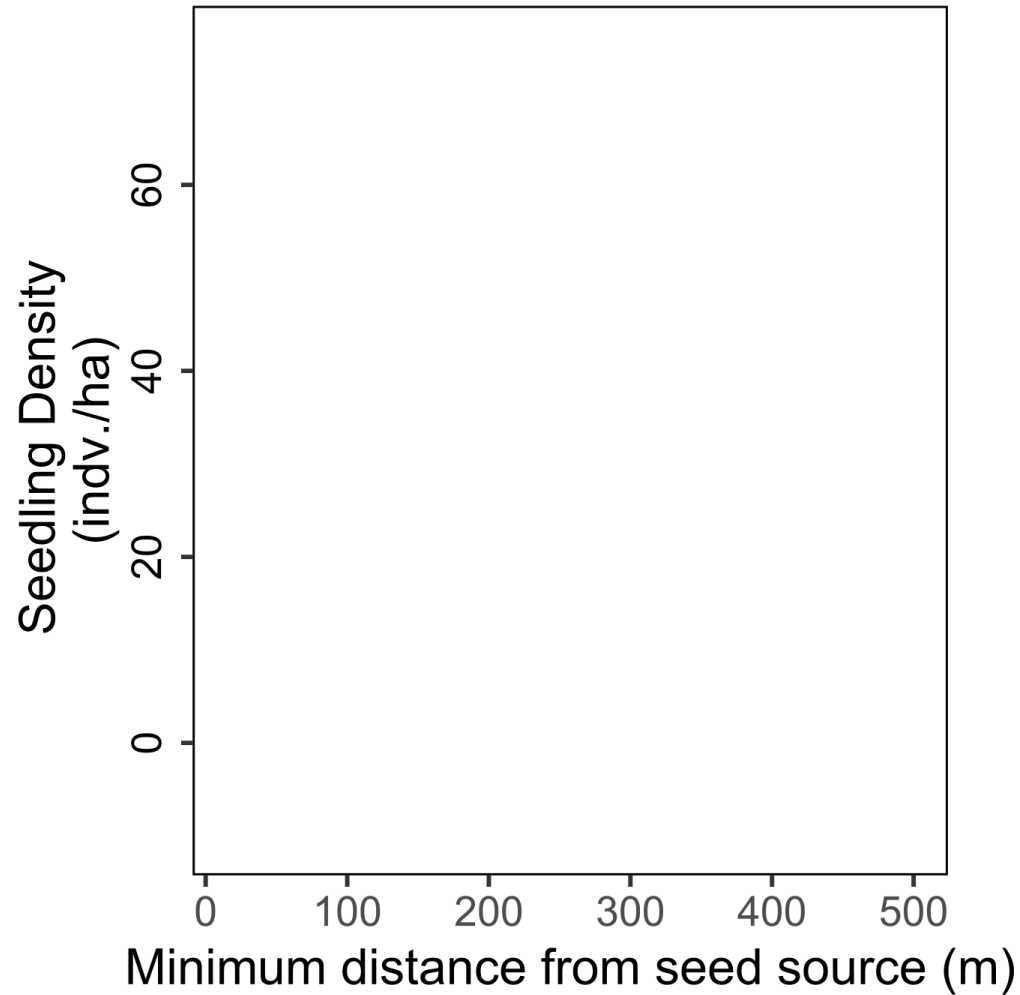
Shrub Cover and Timing



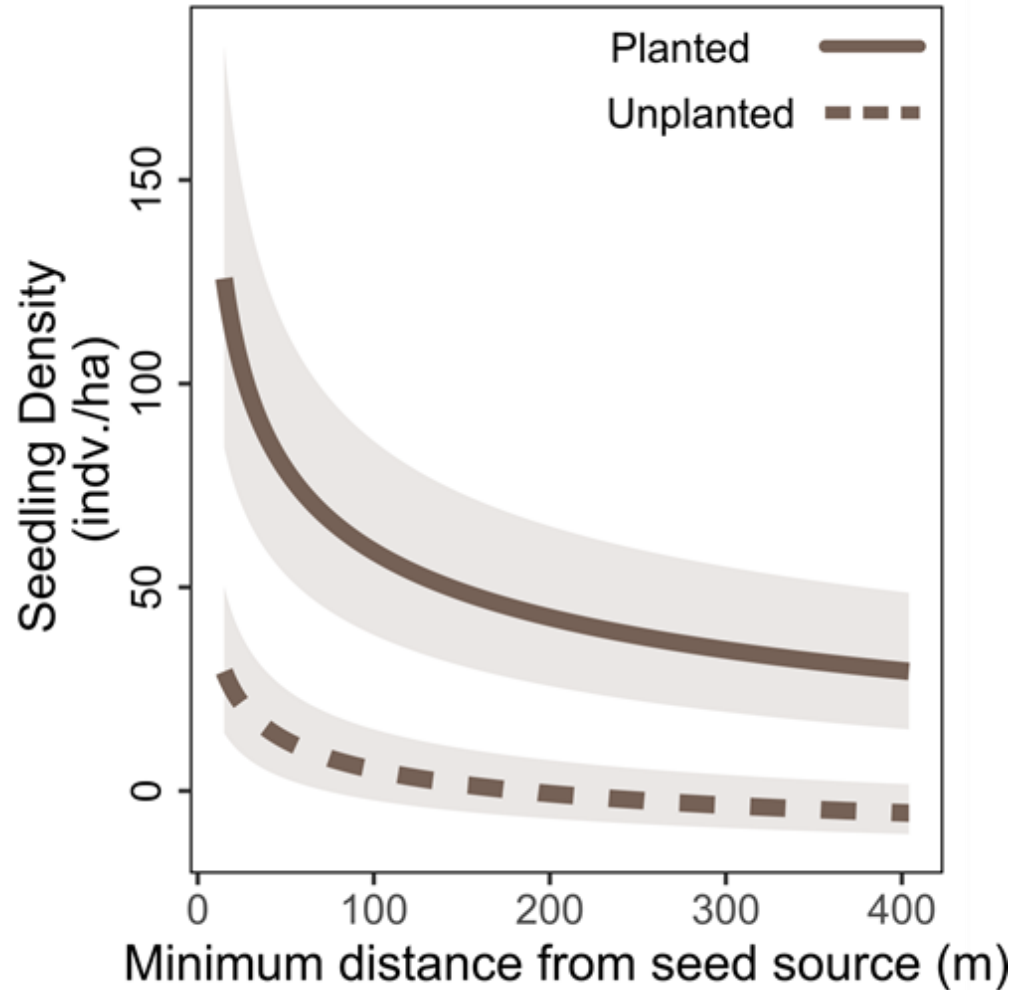
Shrub Cover and Timing



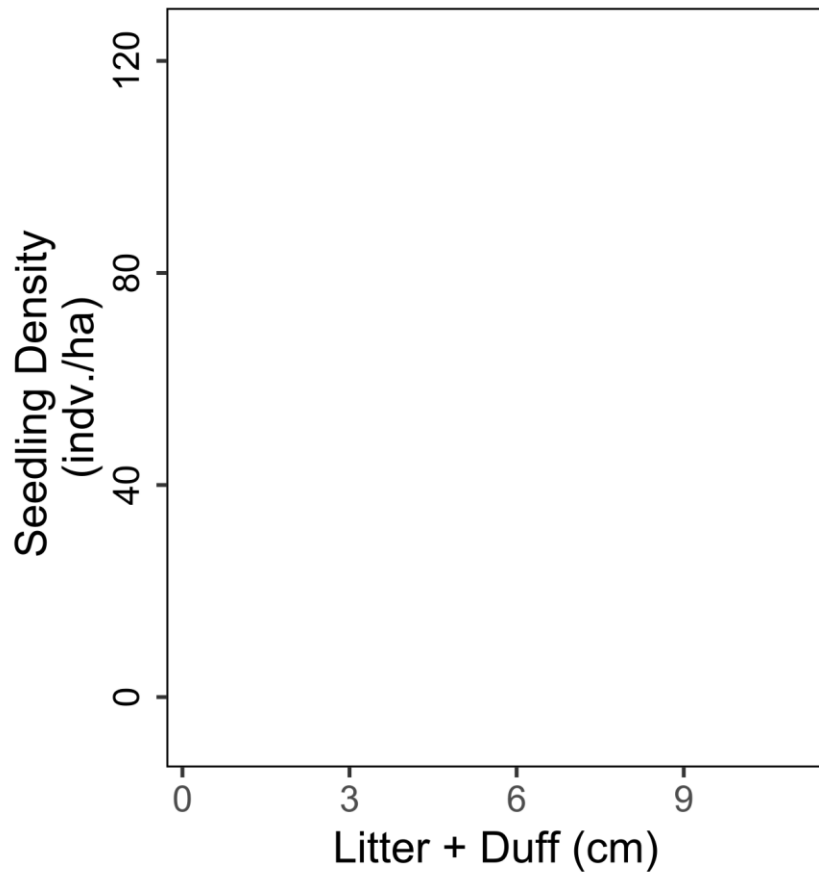
Distance from Seed Source



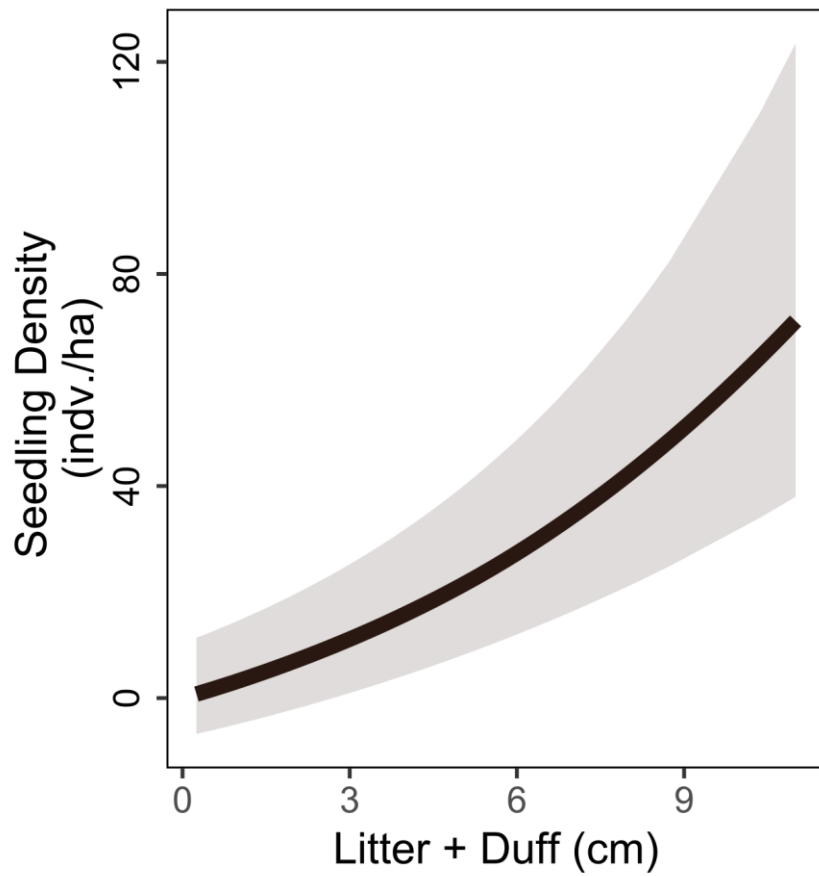
Distance from Seed Source



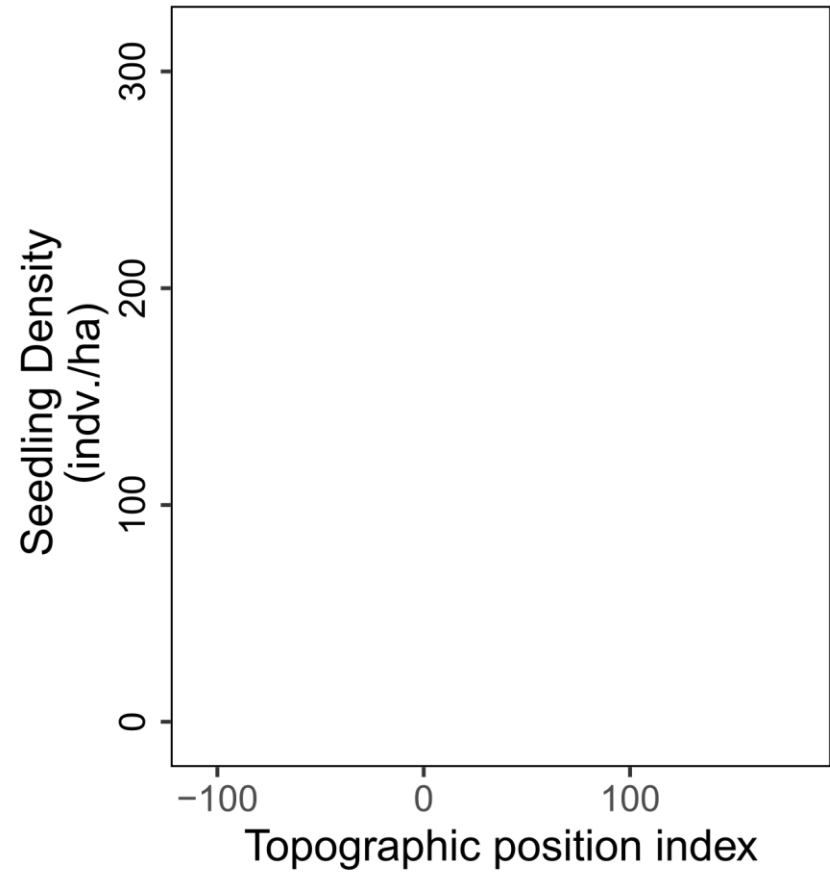
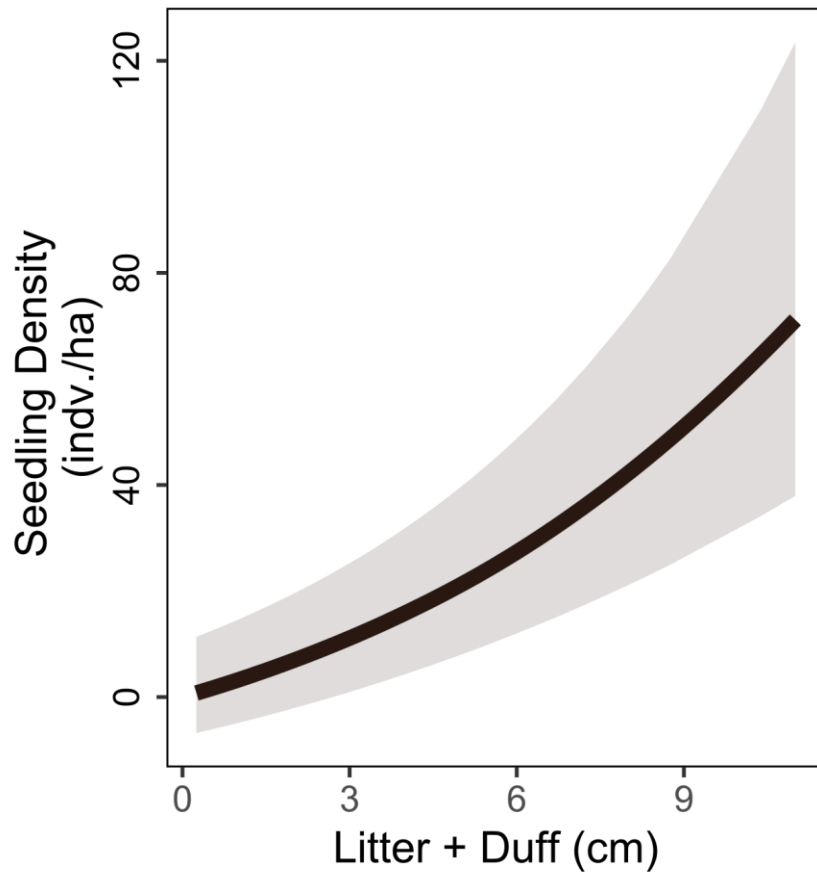
Litter and Duff



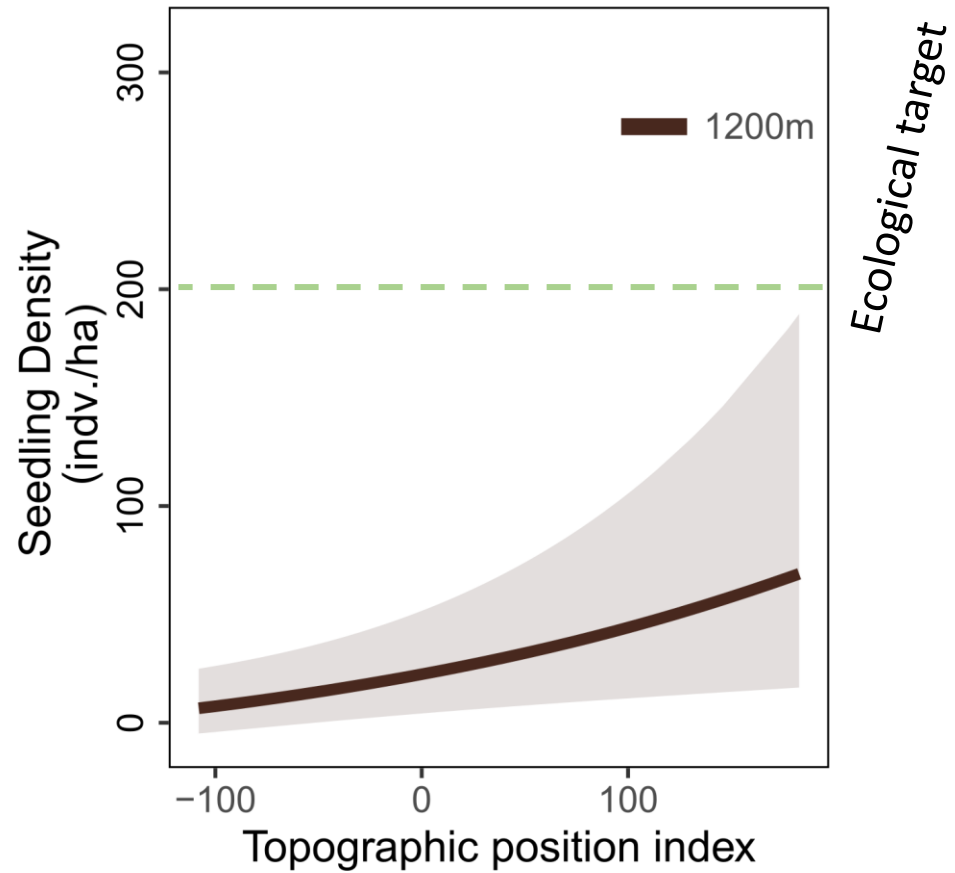
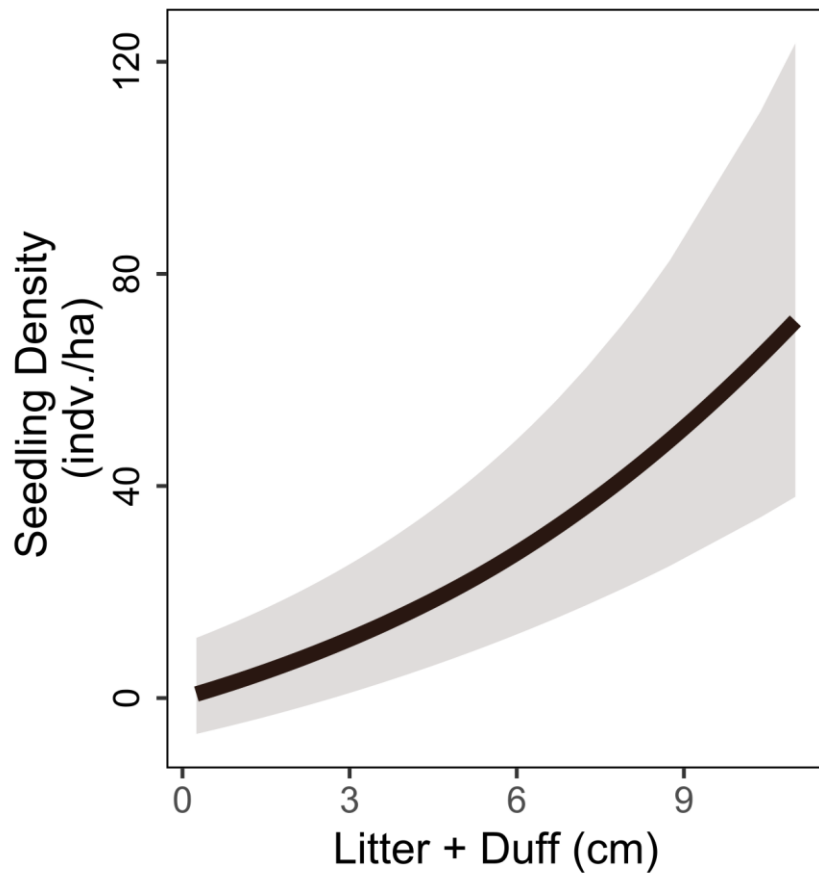
Litter and Duff



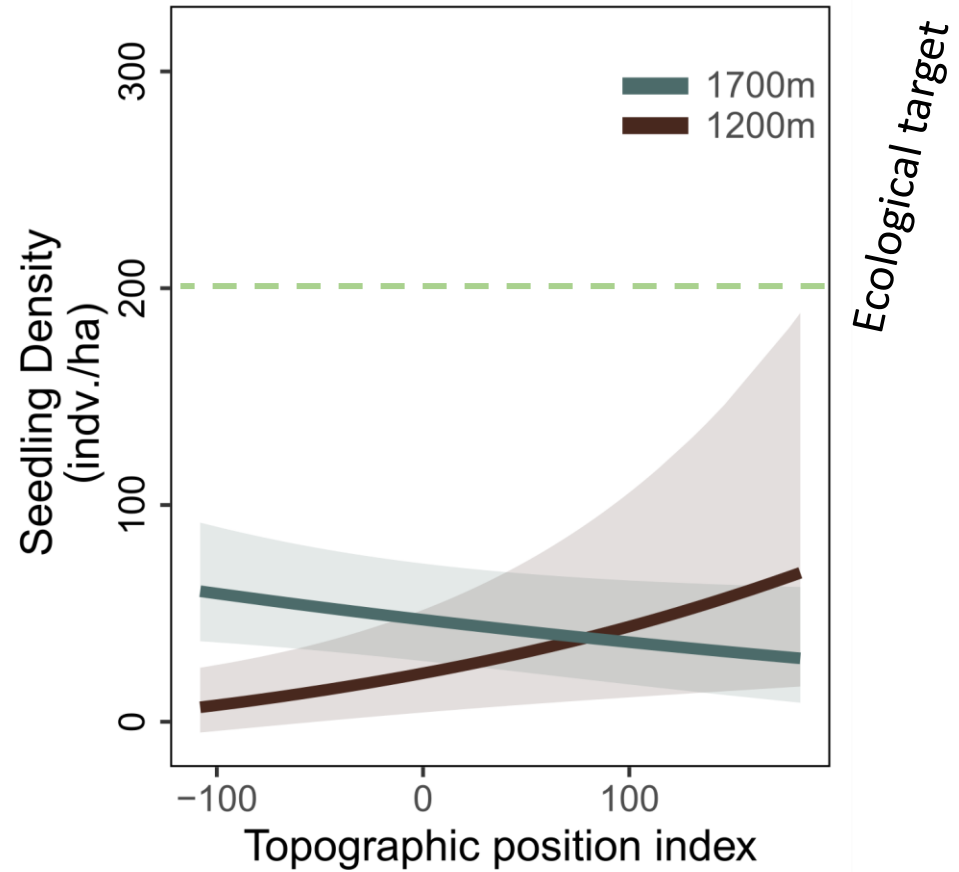
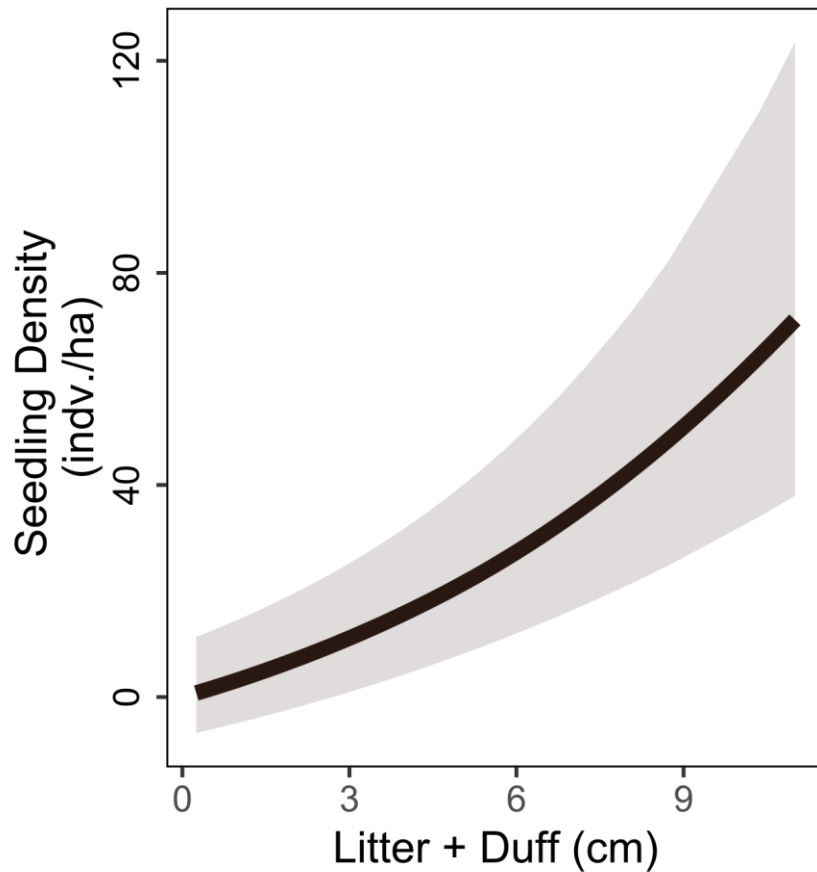
Topographic position and elevation



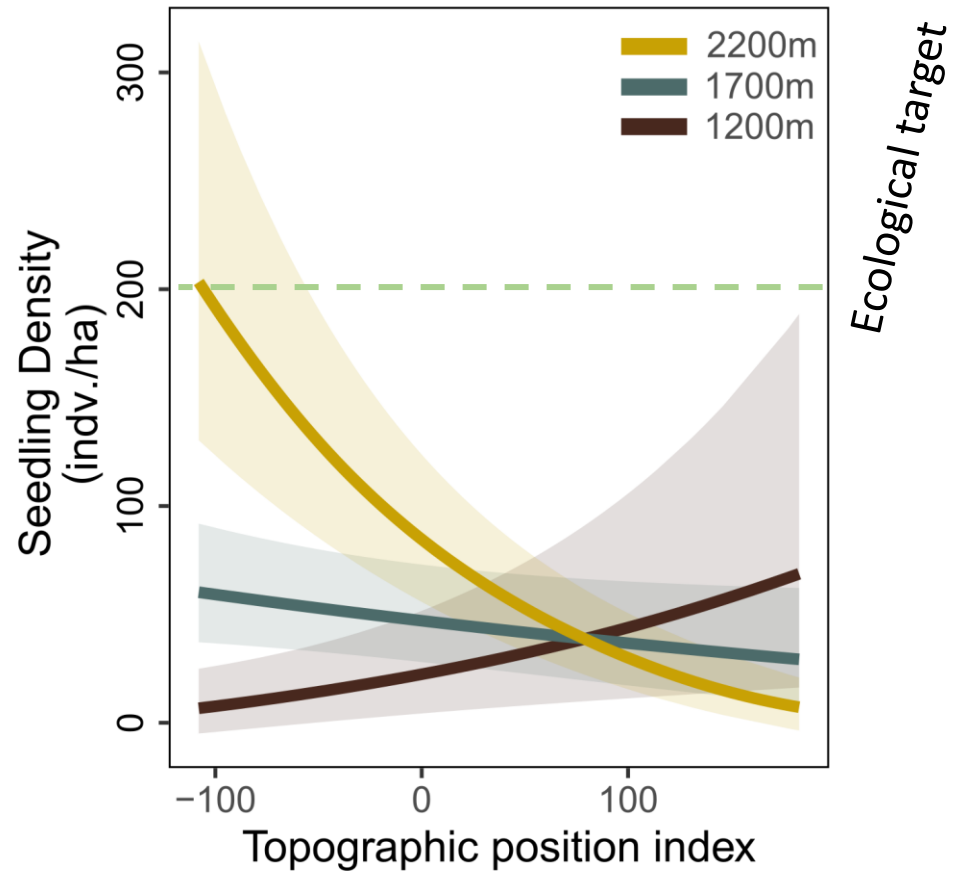
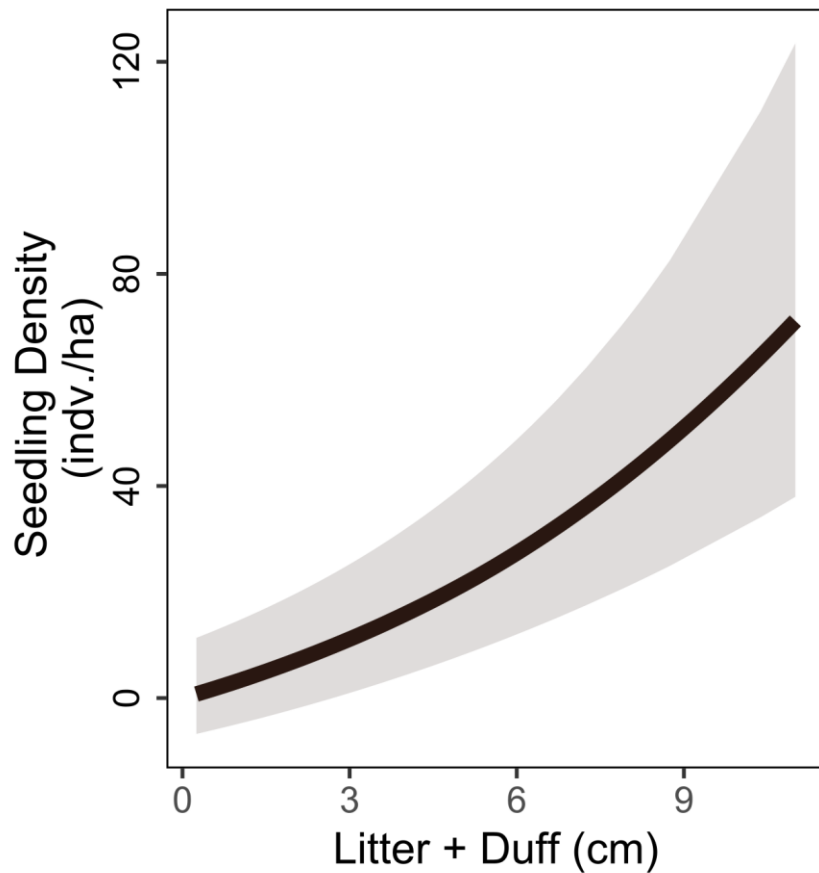
Topographic position and elevation



Topographic position and elevation

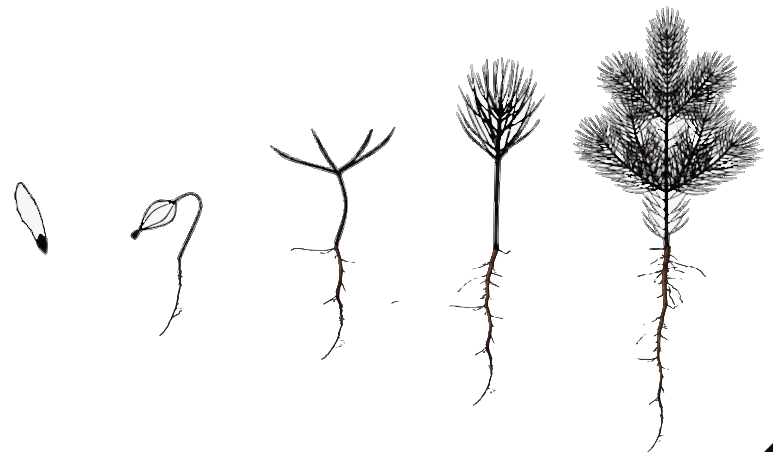


Topographic position and elevation



Conclusions

- Seedling density is controlled by many environmental factors, which can interact.
- Often these interactions seem to underlay water availability, stress, and competition.
- Trees can successfully compete with shrubs but depends on the pace of establishment.



Recommendations

- Planting should occur during the first year after a fire in high productivity sites.
- Planting in stressful sites is likely less urgent and can be saved for later years.
- Natural regeneration is often adequate with low water stress, but planting can help under more arid conditions.
- Predicting planting success will benefit from strategic monitoring across more fires.

PReSET

The screenshot shows a web browser window with the URL `reforestation.shinyapps.io/preset/`. The page has a dark blue navigation bar with the following menu items: **PReSET**, **Reforestation Tool**, **User Guide**, **Technical Details**, and **About**. The main content area is split into two columns. The left column contains a settings panel with the following sections and options:

- Planting year:**
 - 1 year post-fire
 - 2 years post-fire
 - 3 years post-fire
- Expected shrub cover:**
 - Predicted (varies across space)
 - Low (30%) everywhere
 - Moderate (60%) everywhere
 - High (90%) everywhere
- Map filtering:**
 - Show high-severity area only
 - Show yellow pine & mixed-conifer only
 - Hide low model confidence areas (slow)
- Layers to display:**
 - Planting benefit
 - Shrub cover
 - Annual temperature (1981-2010 mean)
 - Annual precipitation (1981-2010 mean)
 - Topographic position index

The right column is titled **Predicted planting benefit** and features a map of a region with a color-coded overlay. A legend below the map shows a vertical color gradient from yellow (low) to purple (high).

TOOL



TIME

PReSET

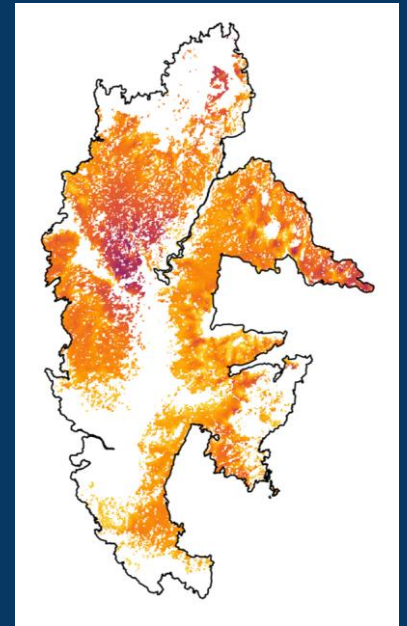
the Post-fire Reforestation
Success Estimation Tool

reforestation.shinyapps.io/preset

Developed by: Derek Young, Quinn Sorenson, Andrew Latimer
UC Davis

Why not predict absolute seedling density (seedlings/acre)?

- Depends on natural regeneration
 - Seed source density
- Depends on post-fire weather
- Depends on management methods
- Depends on other local nuances



Complementary tools:

- POSCRPT (Kristen Shive et al. 2018)
- poscrptR (forthcoming: Micah Wright, Joseph Stewart, et al.)

Considerations

- Absolute density predictions are in beta
 - Relative predictions are more appropriate
- Use PReSET in conjunction with complementary tools
 - POSCRPT, poscriptR
- Interpret predictions critically
 - Reforestation not appropriate everywhere

Future directions

- Expand beyond Sierra Nevada
- Incorporate management variation
- Implement user requests

Thank you!

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