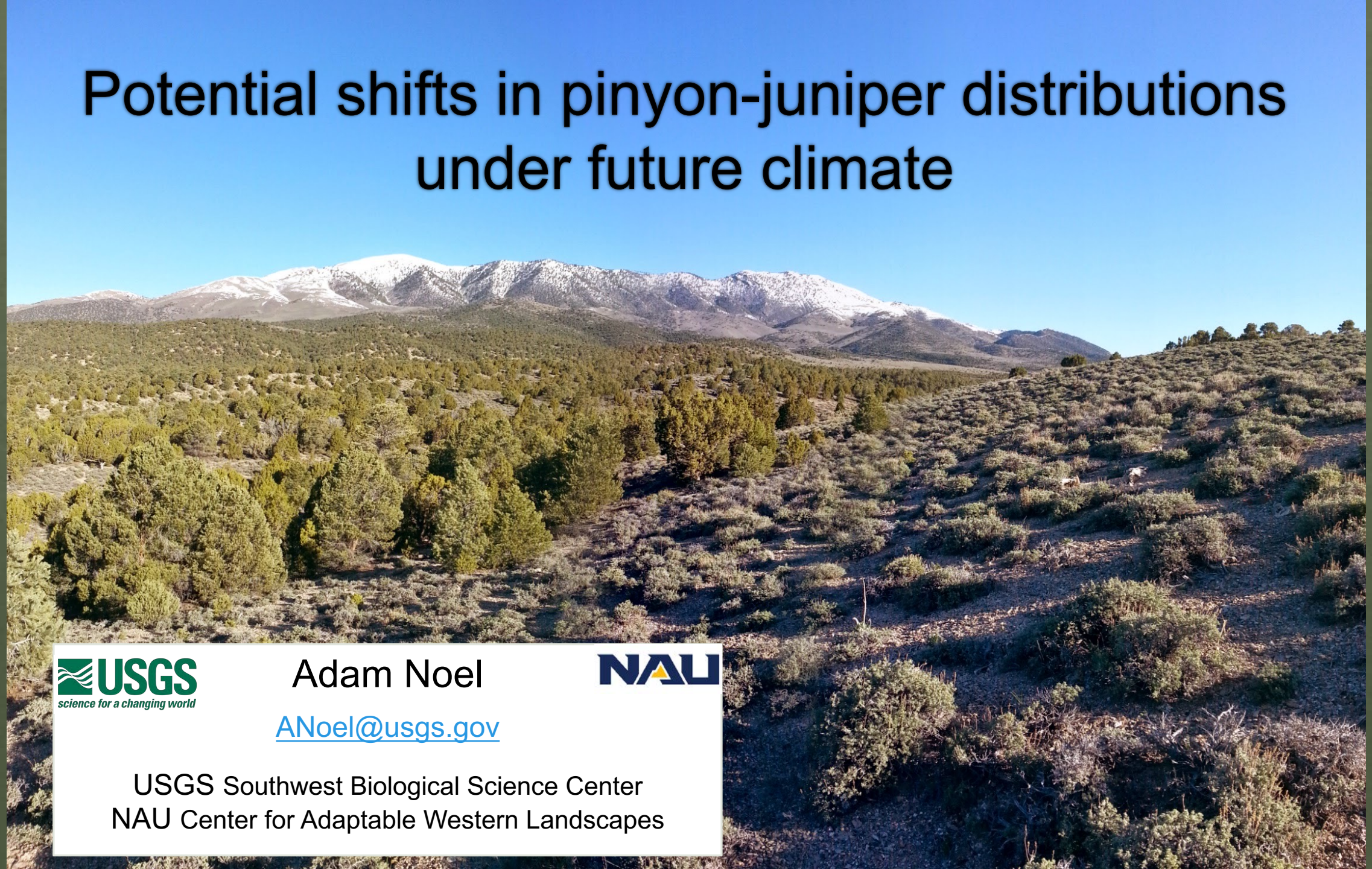
Potential shifts in pinyon-juniper distributions under future climate



Adam Noel

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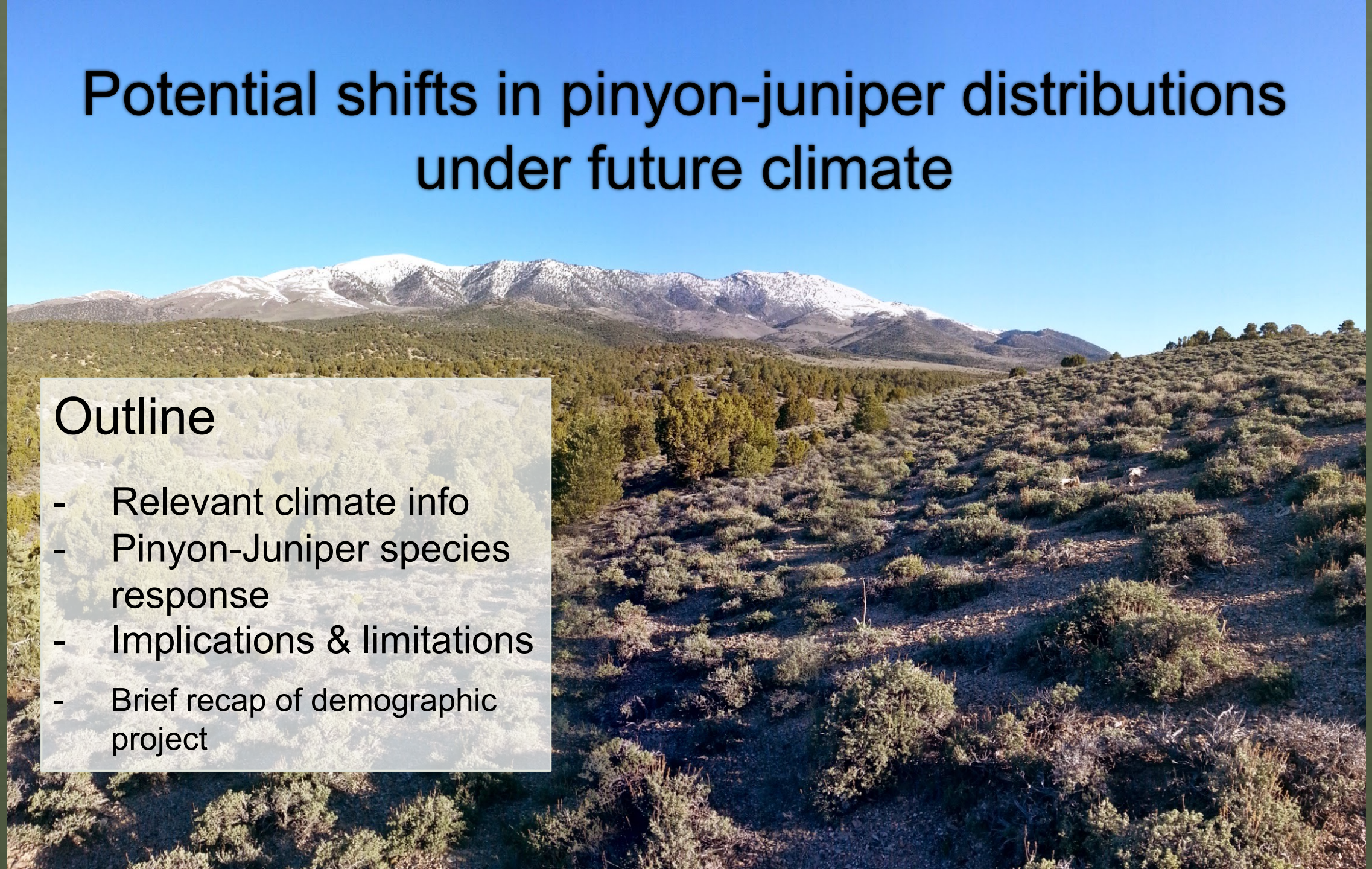
USGS Southwest Biological Science Center

NAU Center for Adaptable Western Landscapes

Potential shifts in pinyon-juniper distributions under future climate

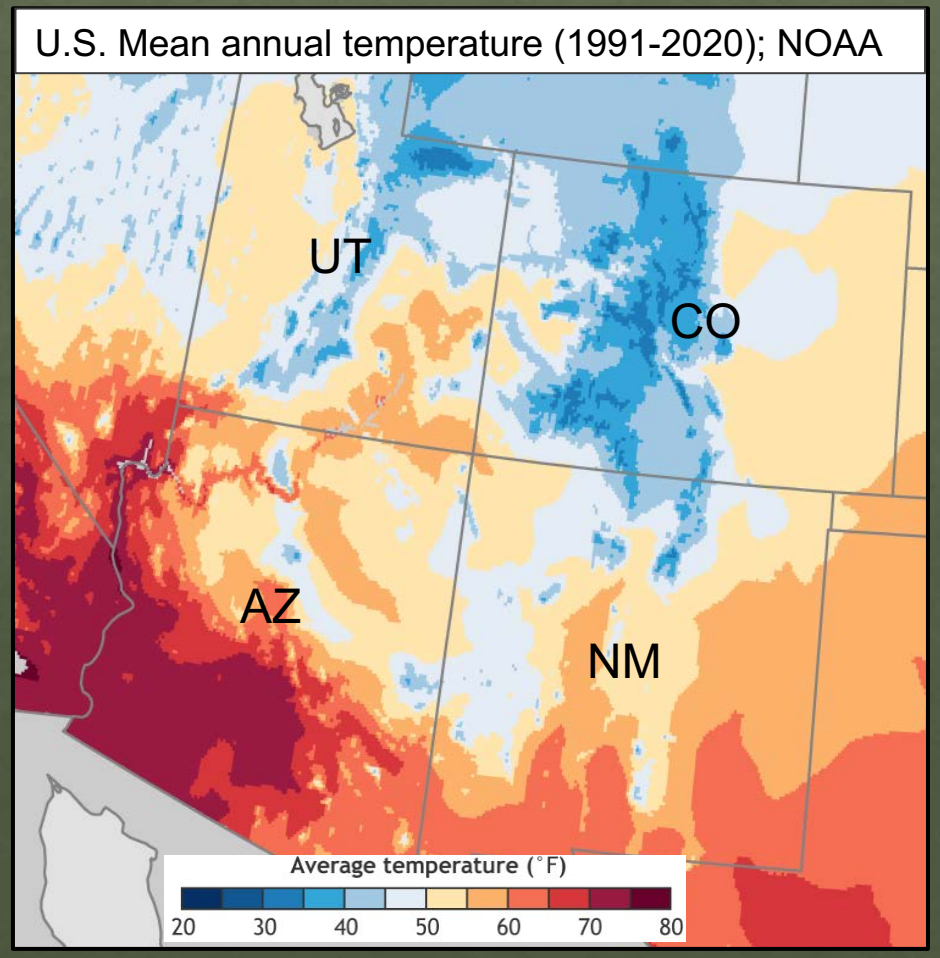


Outline

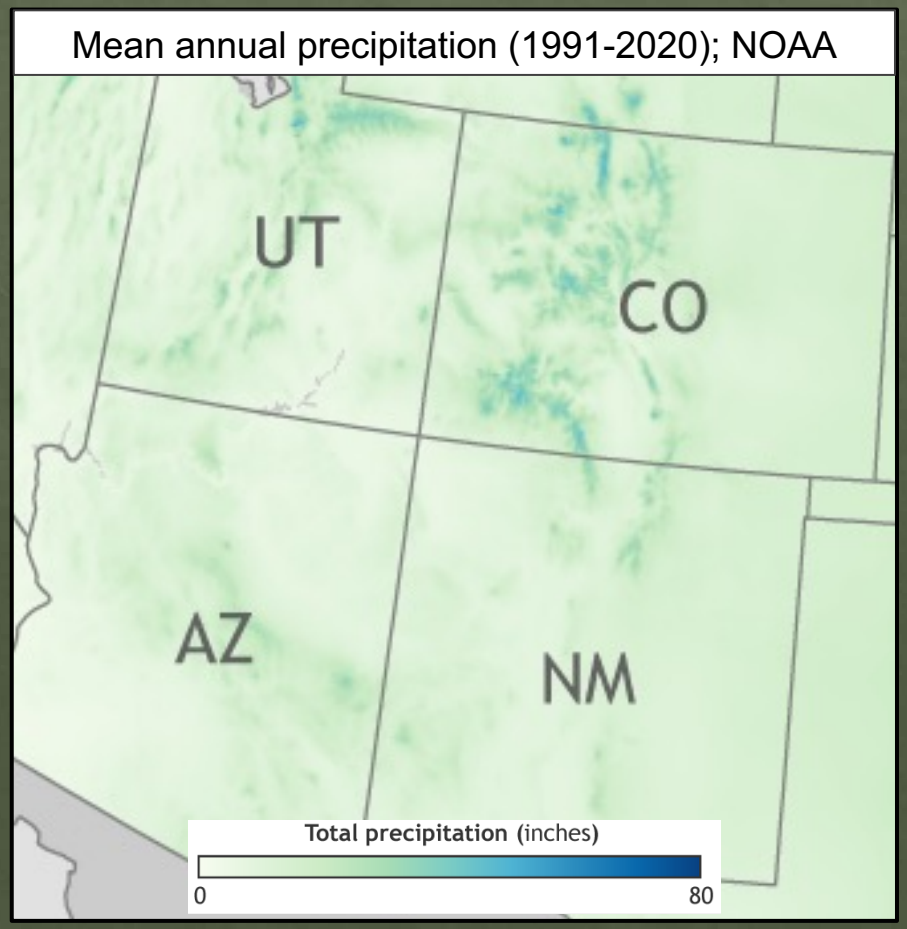
- Relevant climate info
- Pinyon-Juniper species response
- Implications & limitations
- Brief recap of demographic project

Pinyon-juniper distribution

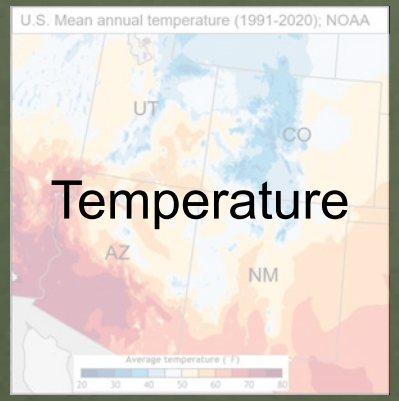
U.S. Mean annual temperature (1991-2020); NOAA



Mean annual precipitation (1991-2020); NOAA



Pinyon-juniper distribution



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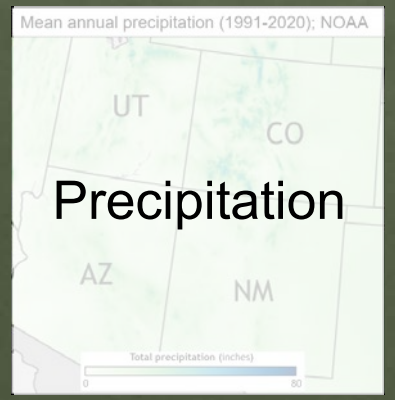
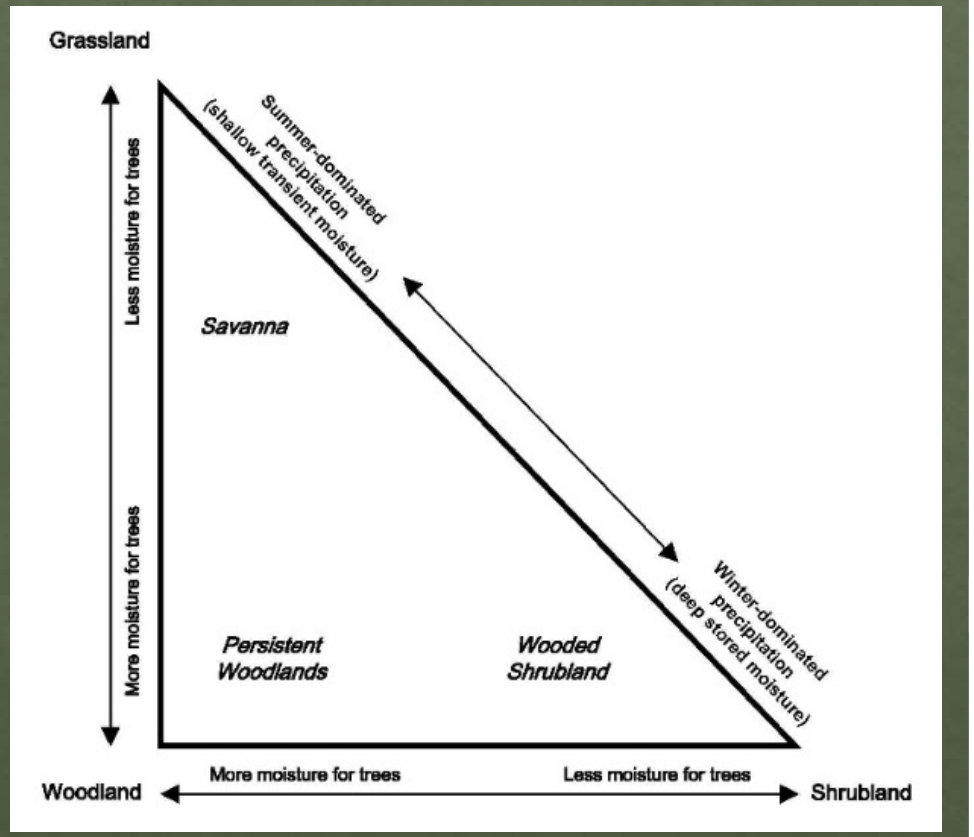


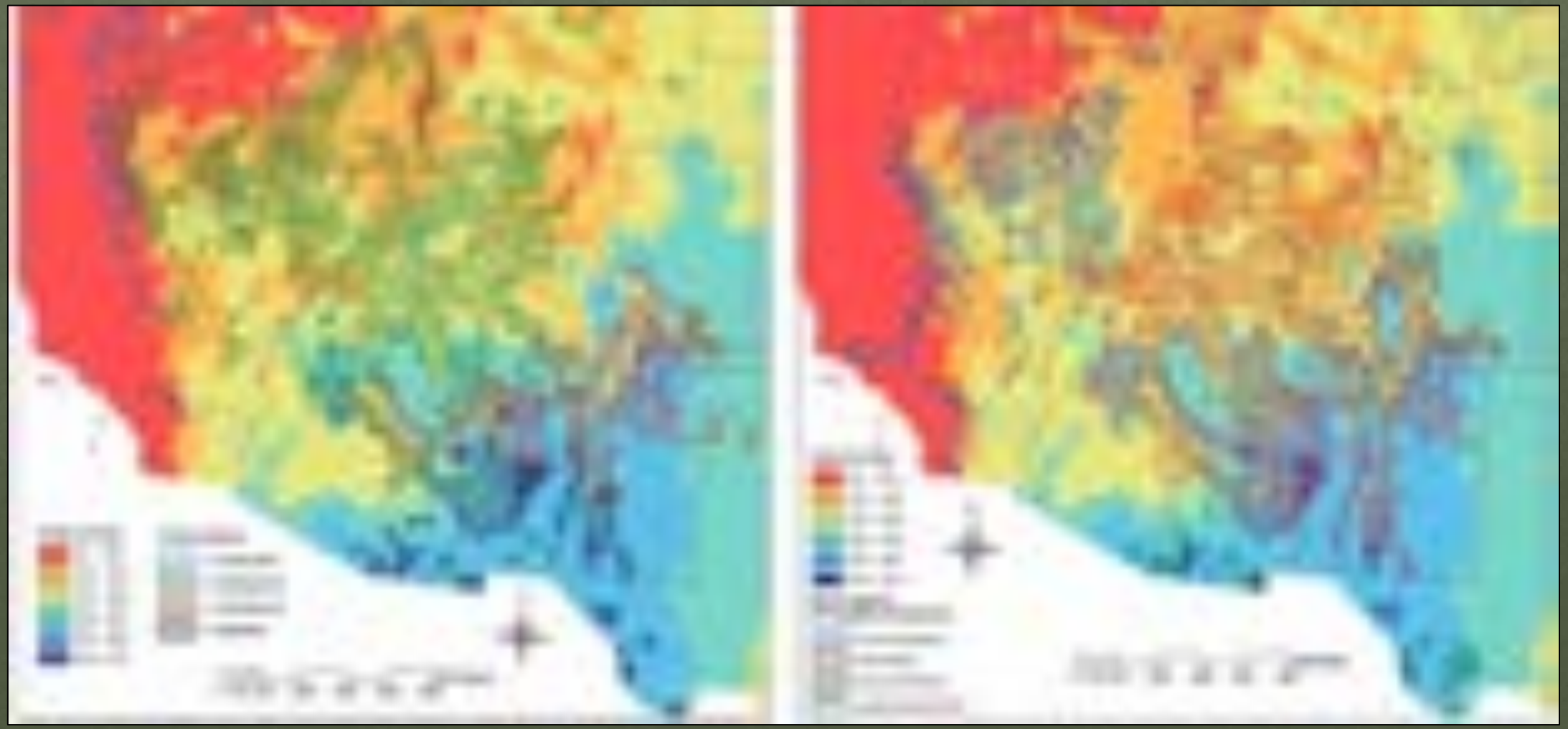


Romme et al. 2009

Pinyon-juniper distribution

Junipers

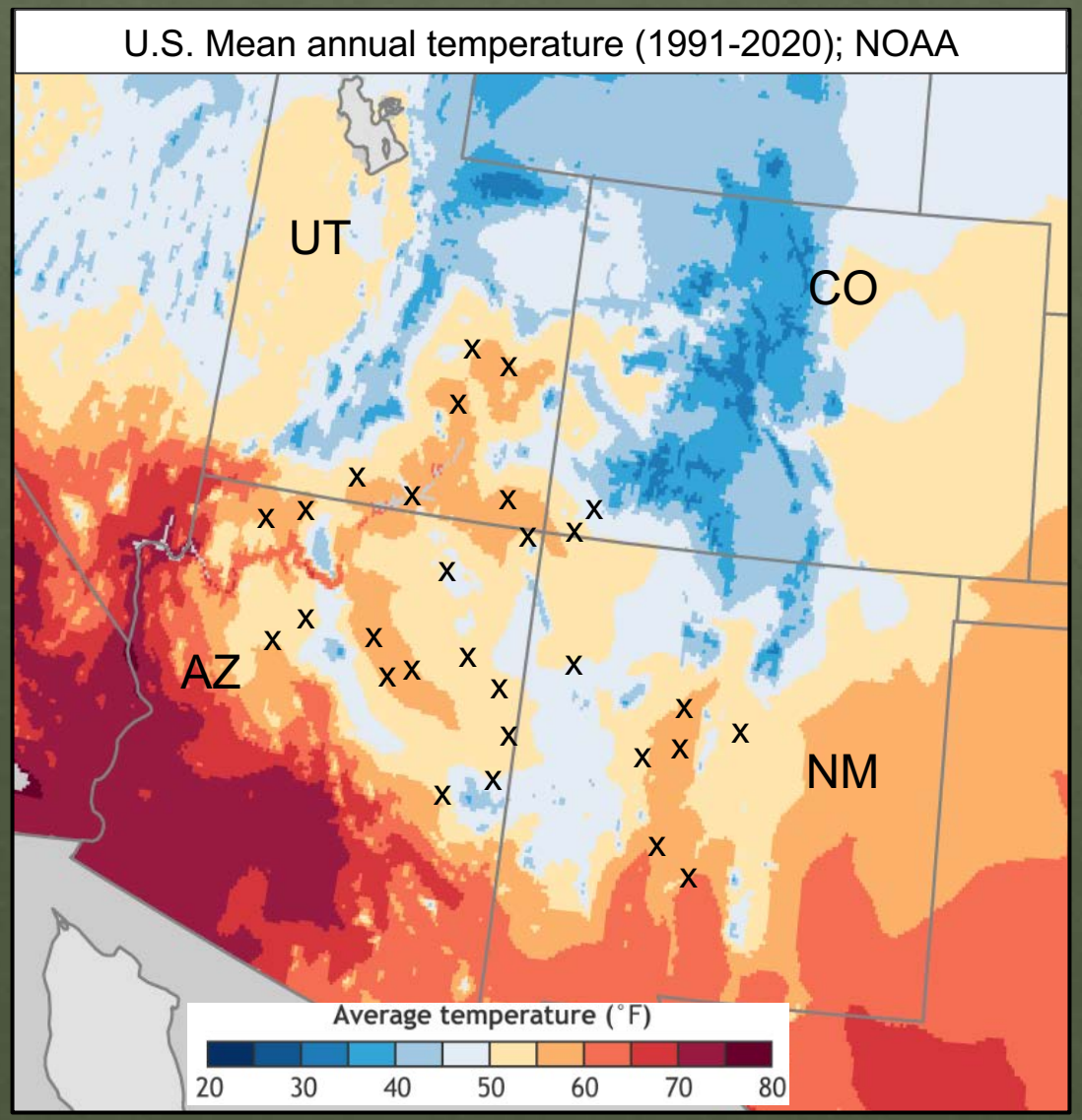
Pinyons (& J. scopulorum)

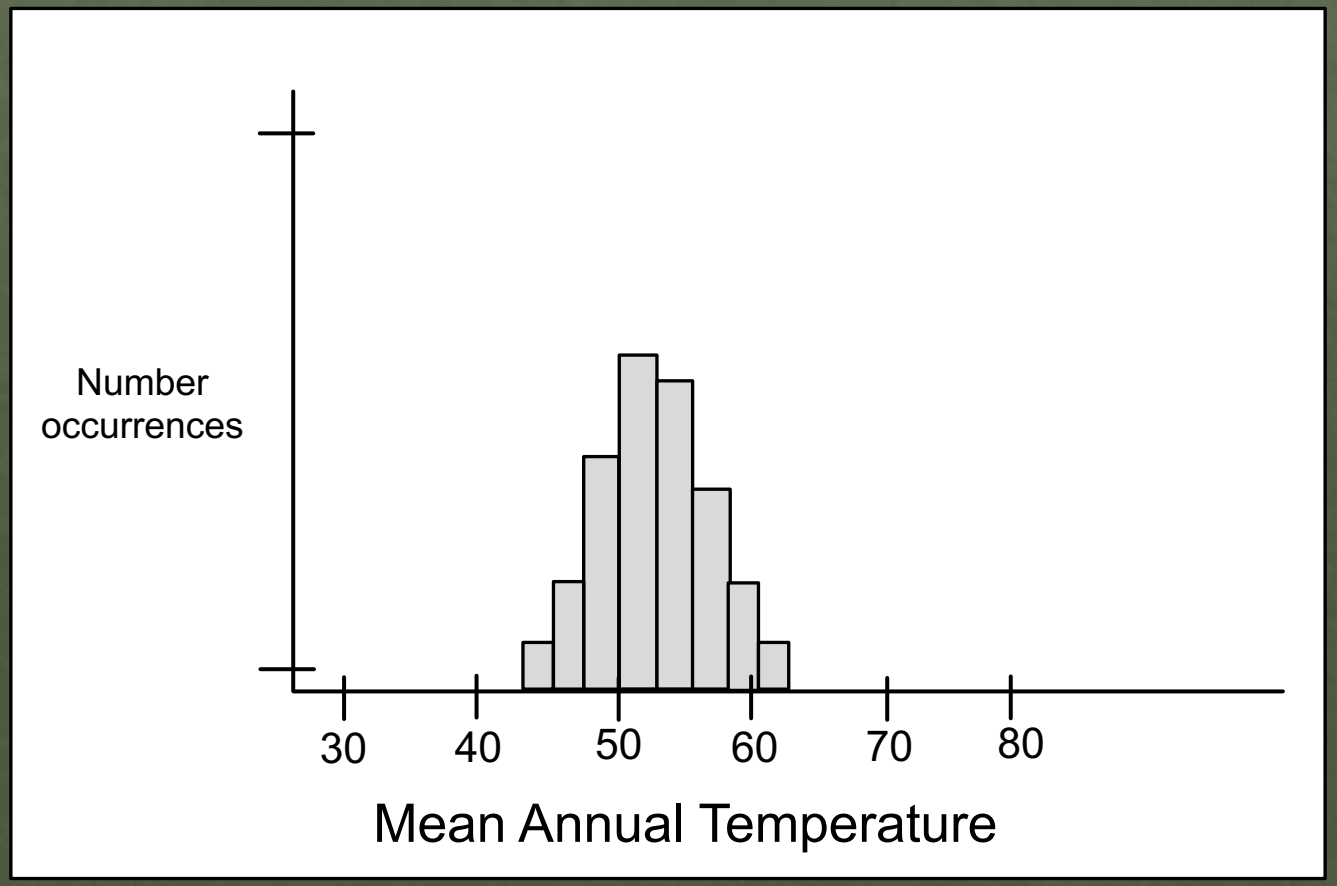


Romme et al. 2009

Pinyon-juniper distribution

Example: Tree occurrence data





Pinyon-juniper distribution

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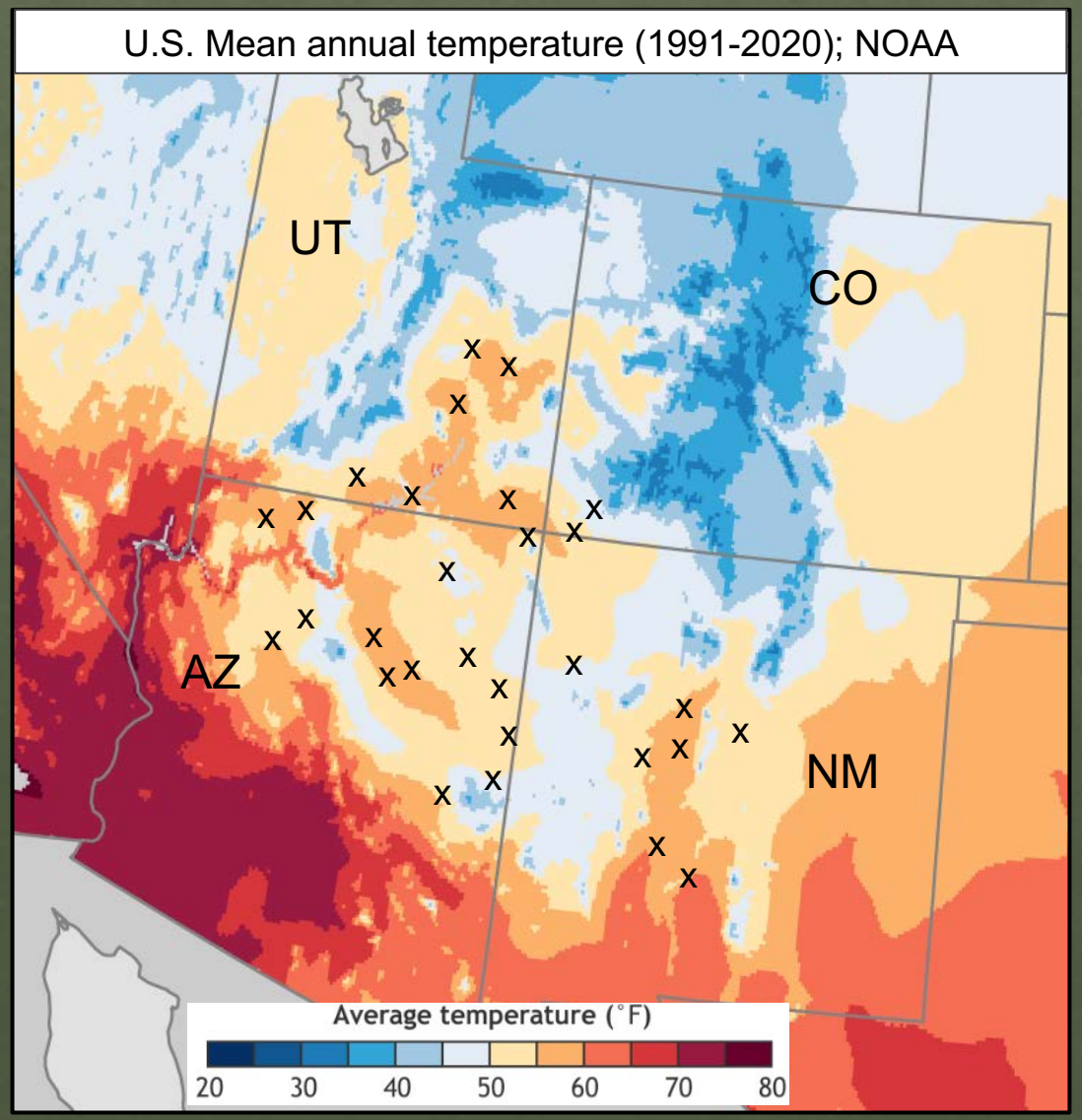

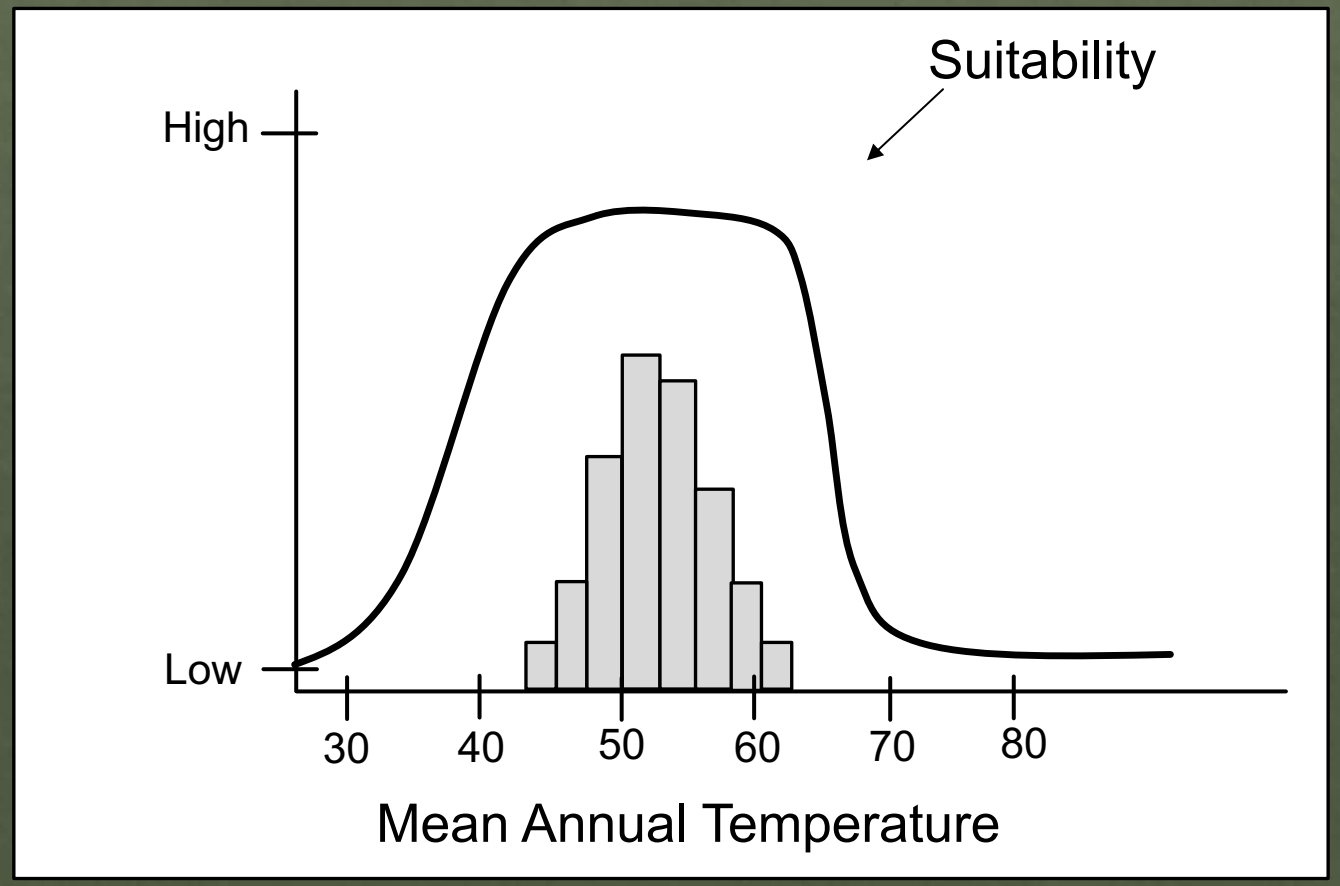

Pinyon-juniper distribution

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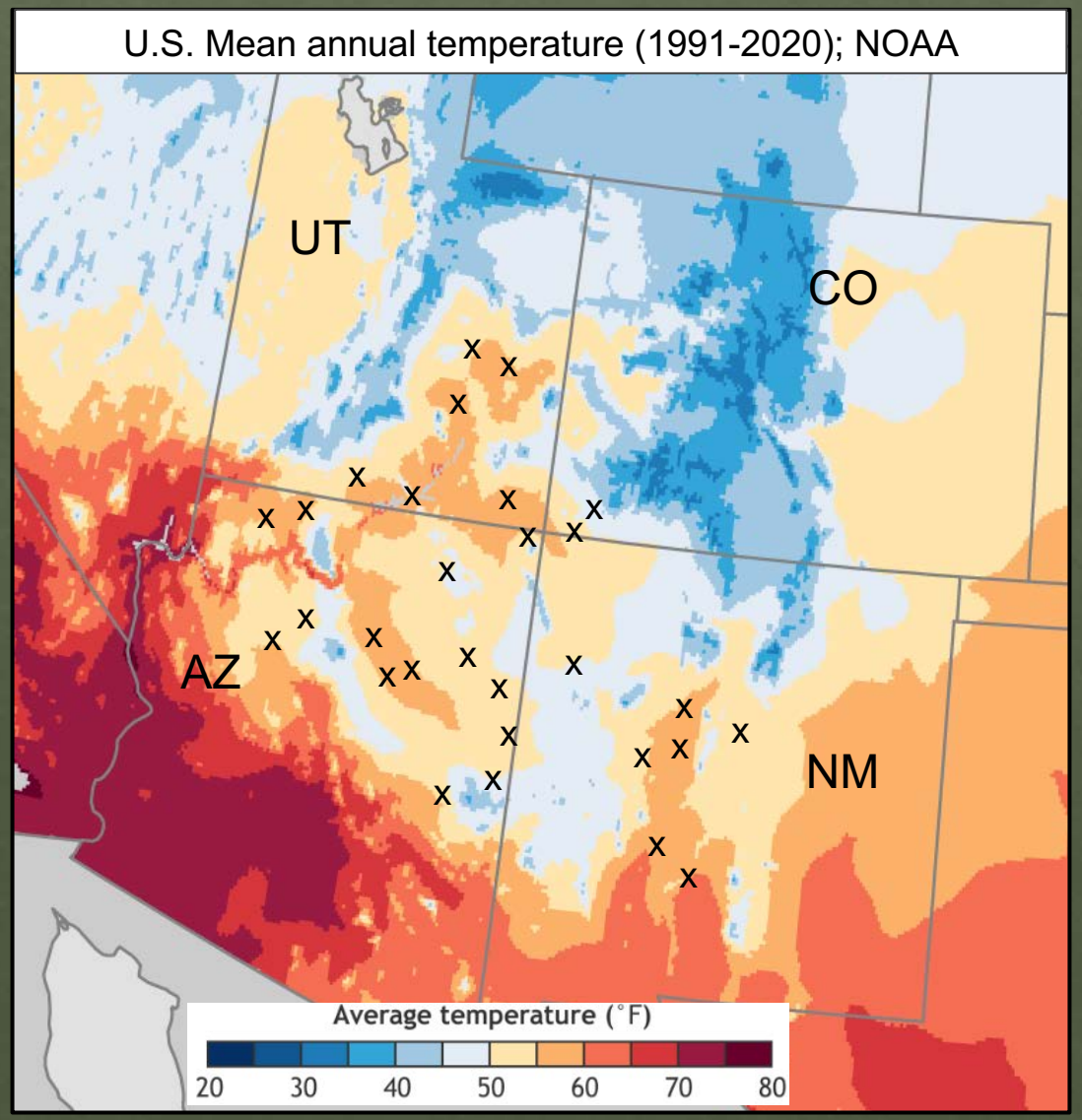

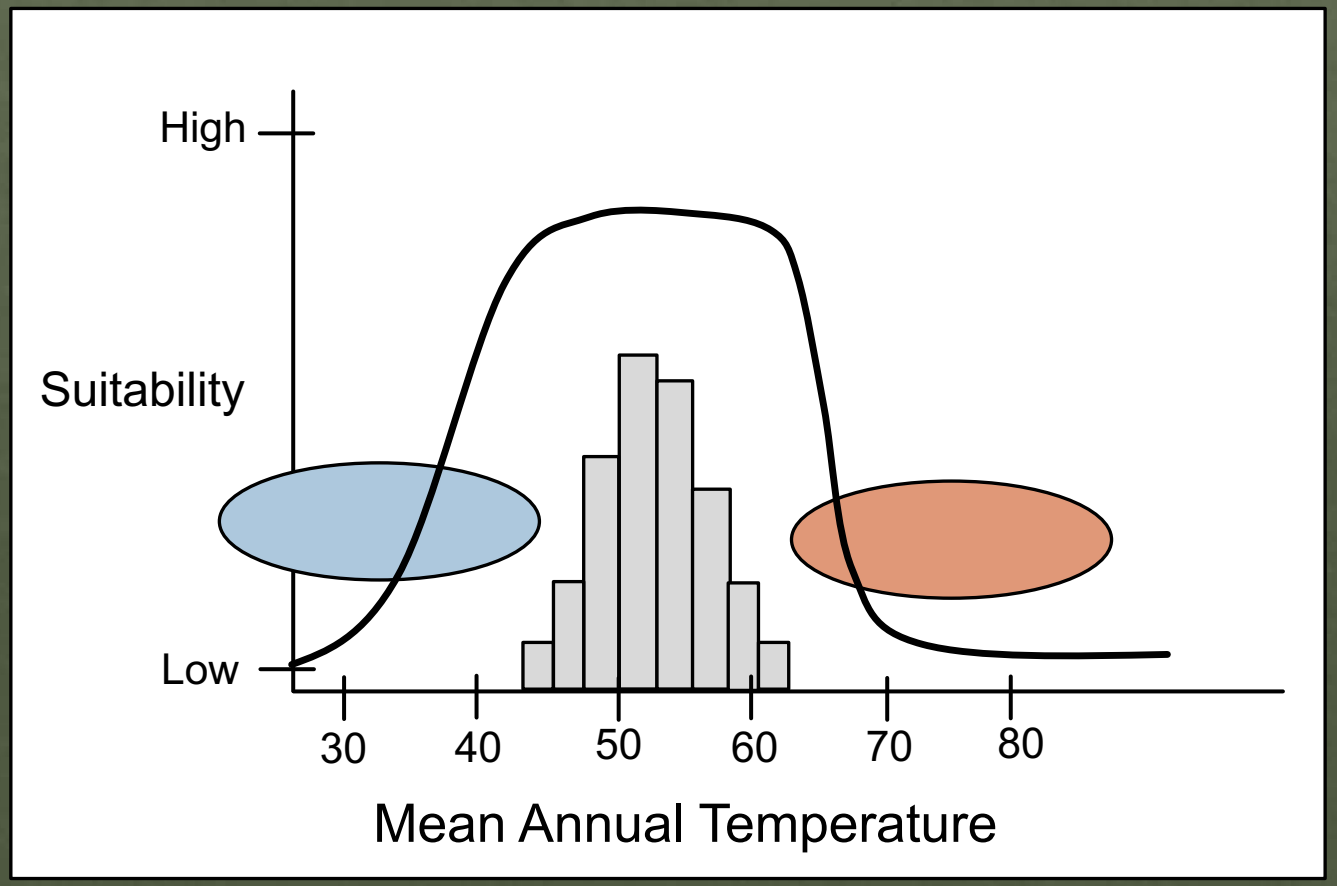

Pinyon-juniper distribution

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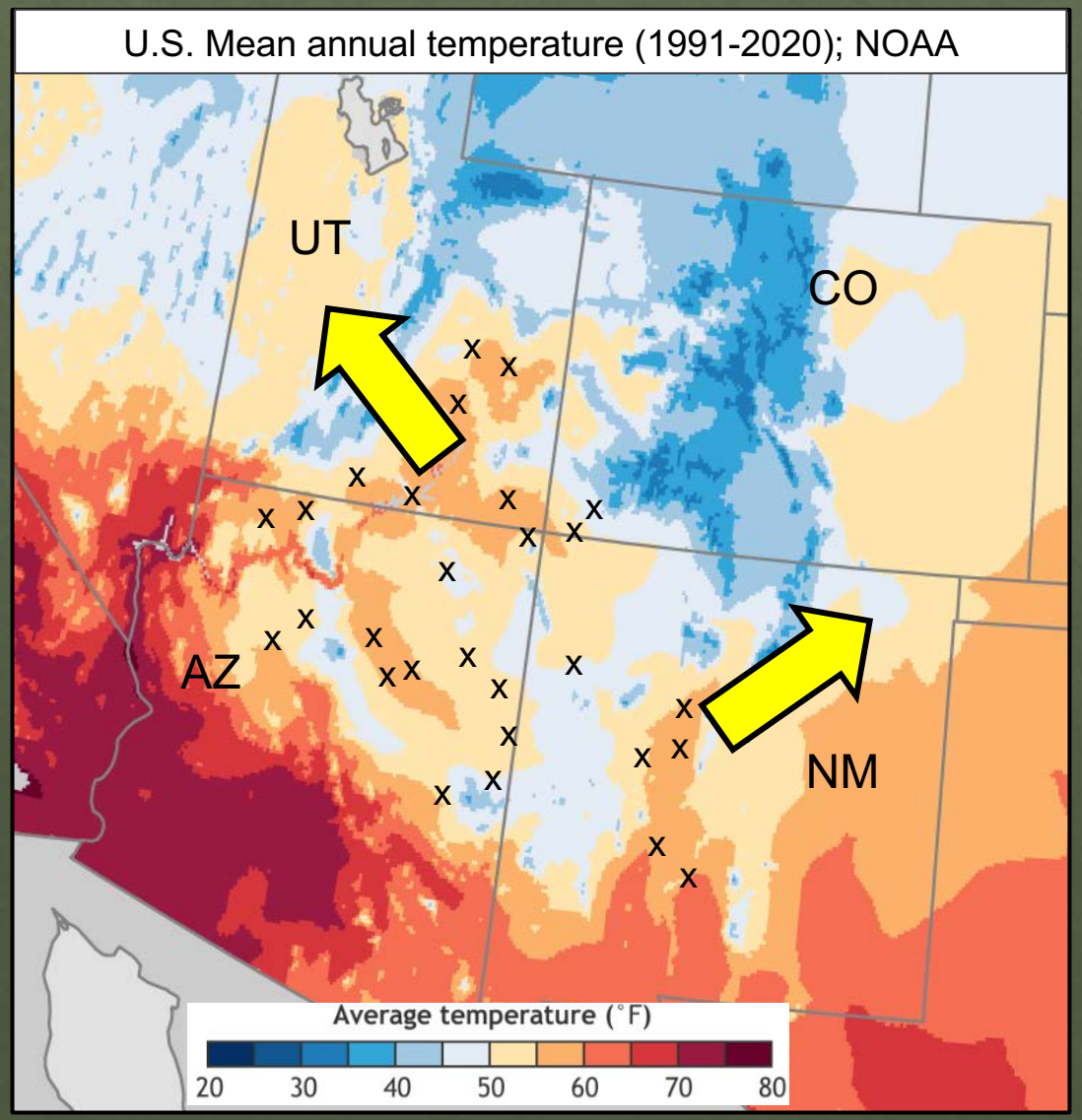

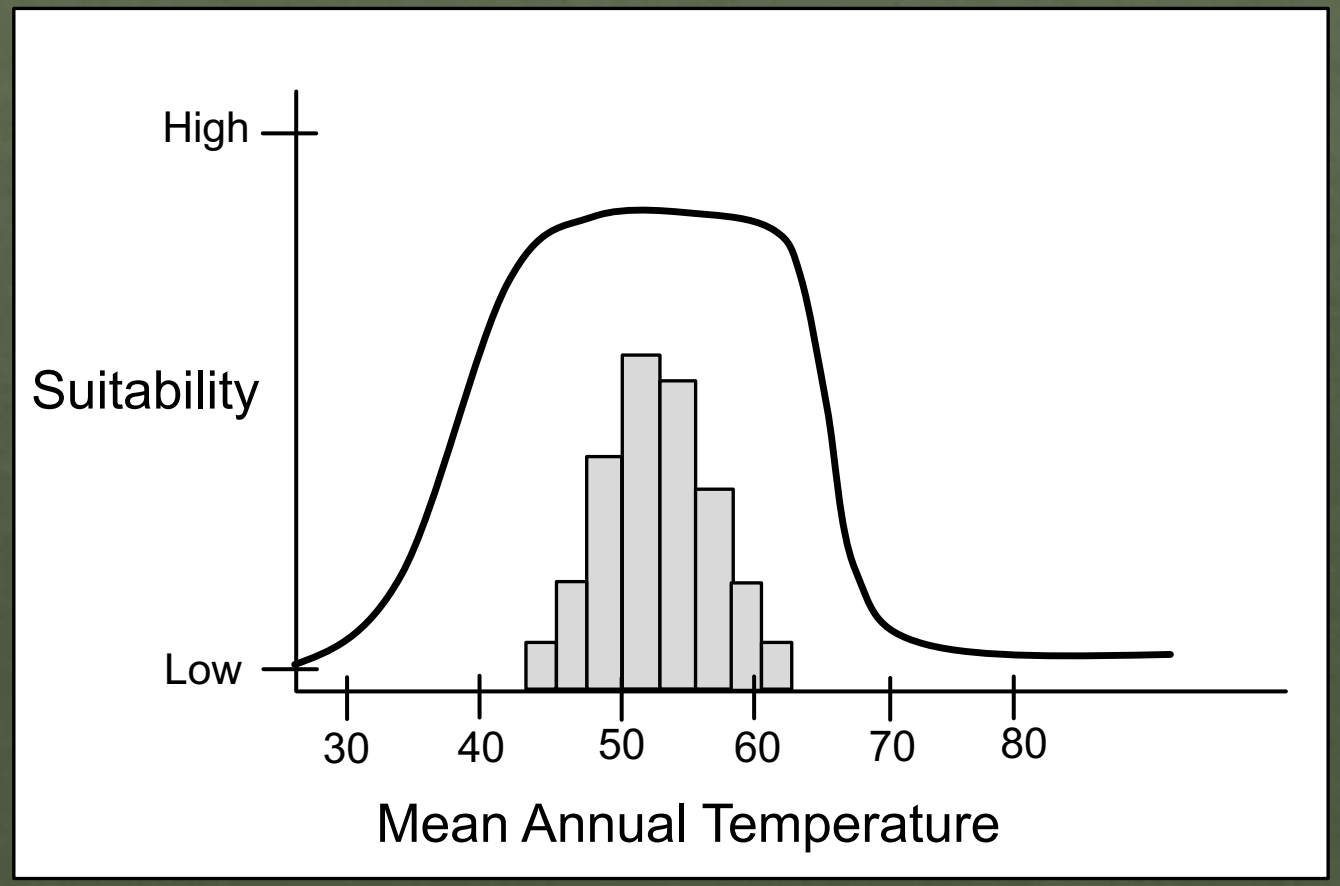

Pinyon-juniper distribution

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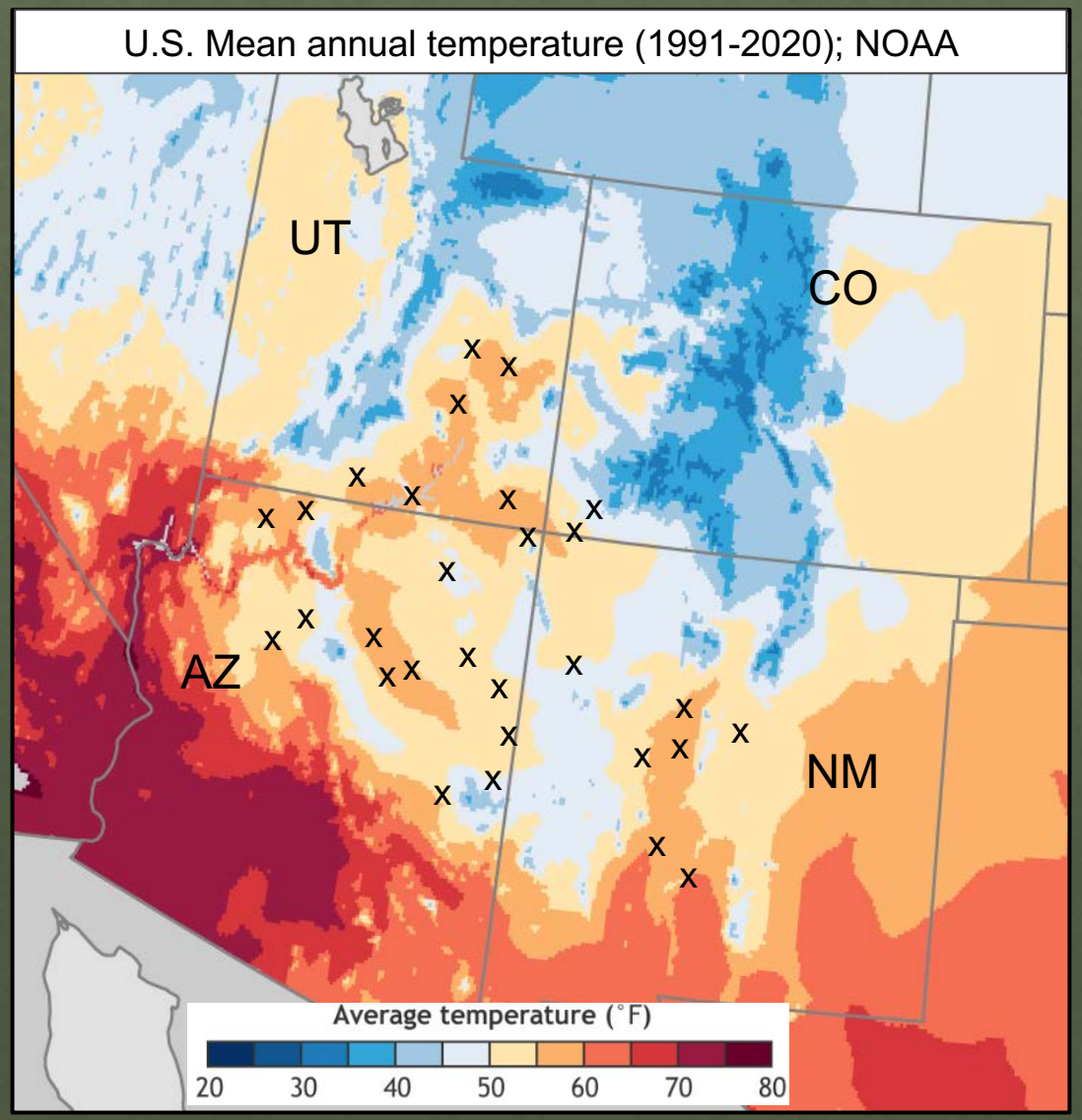

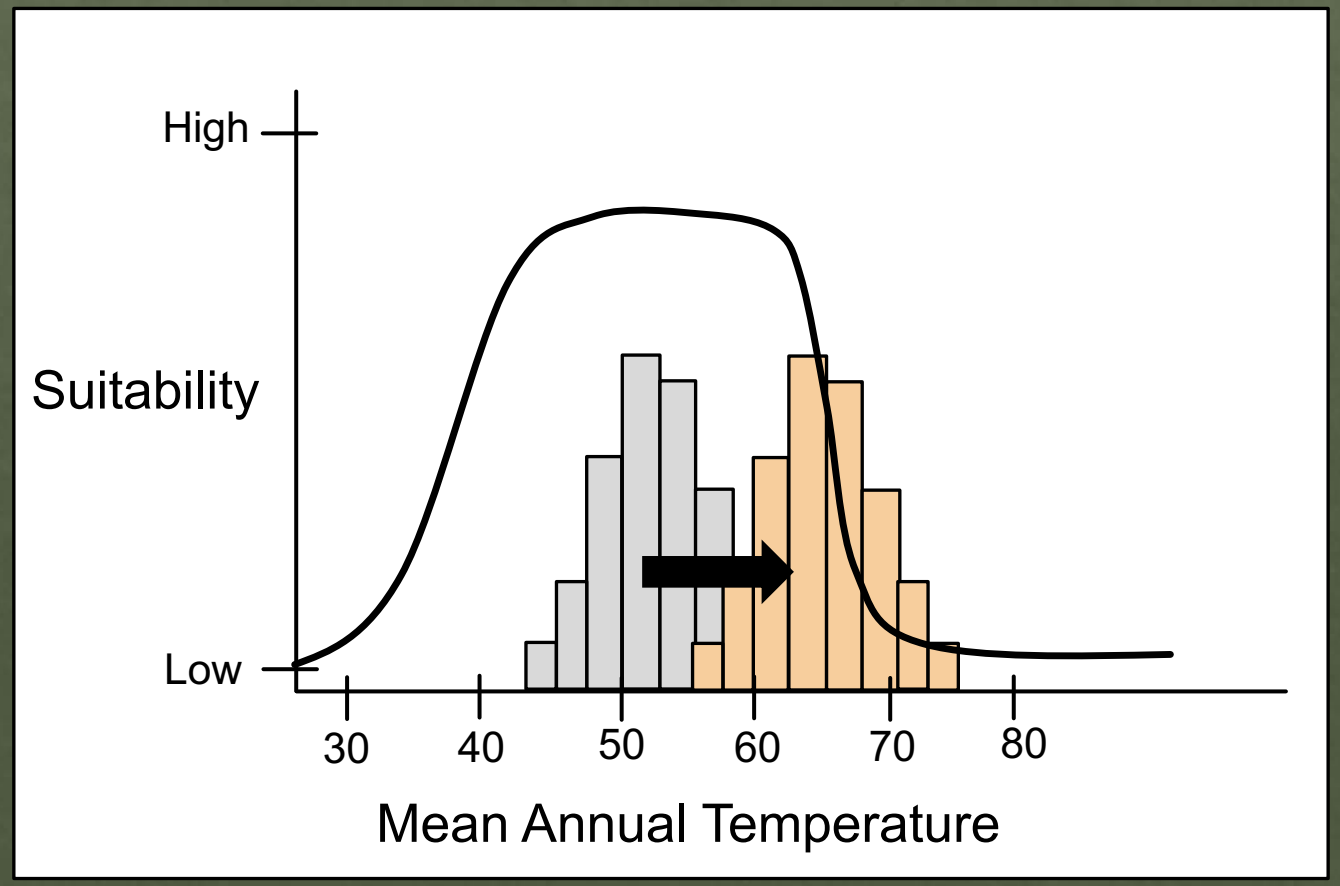

Pinyon-juniper distribution

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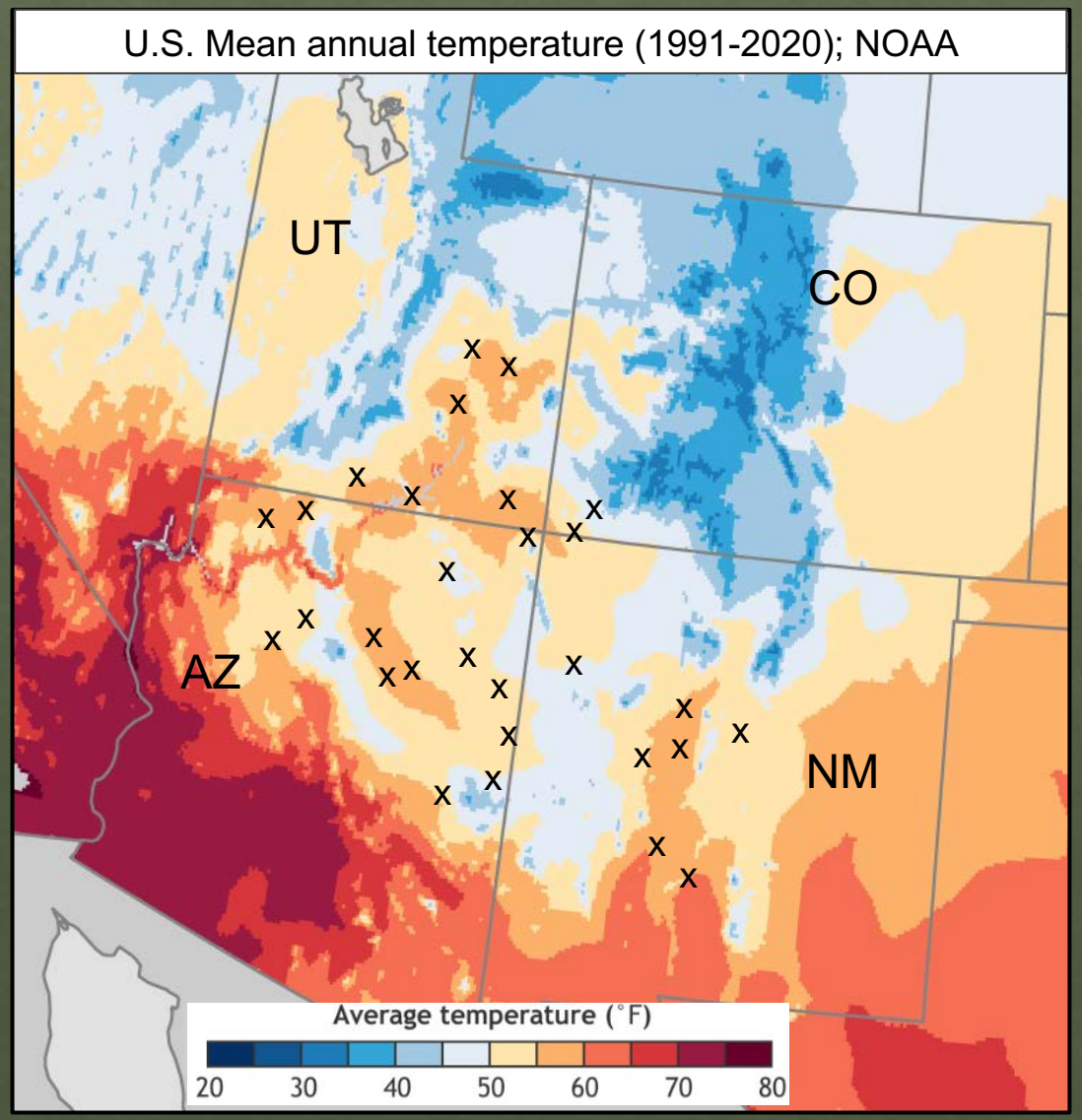
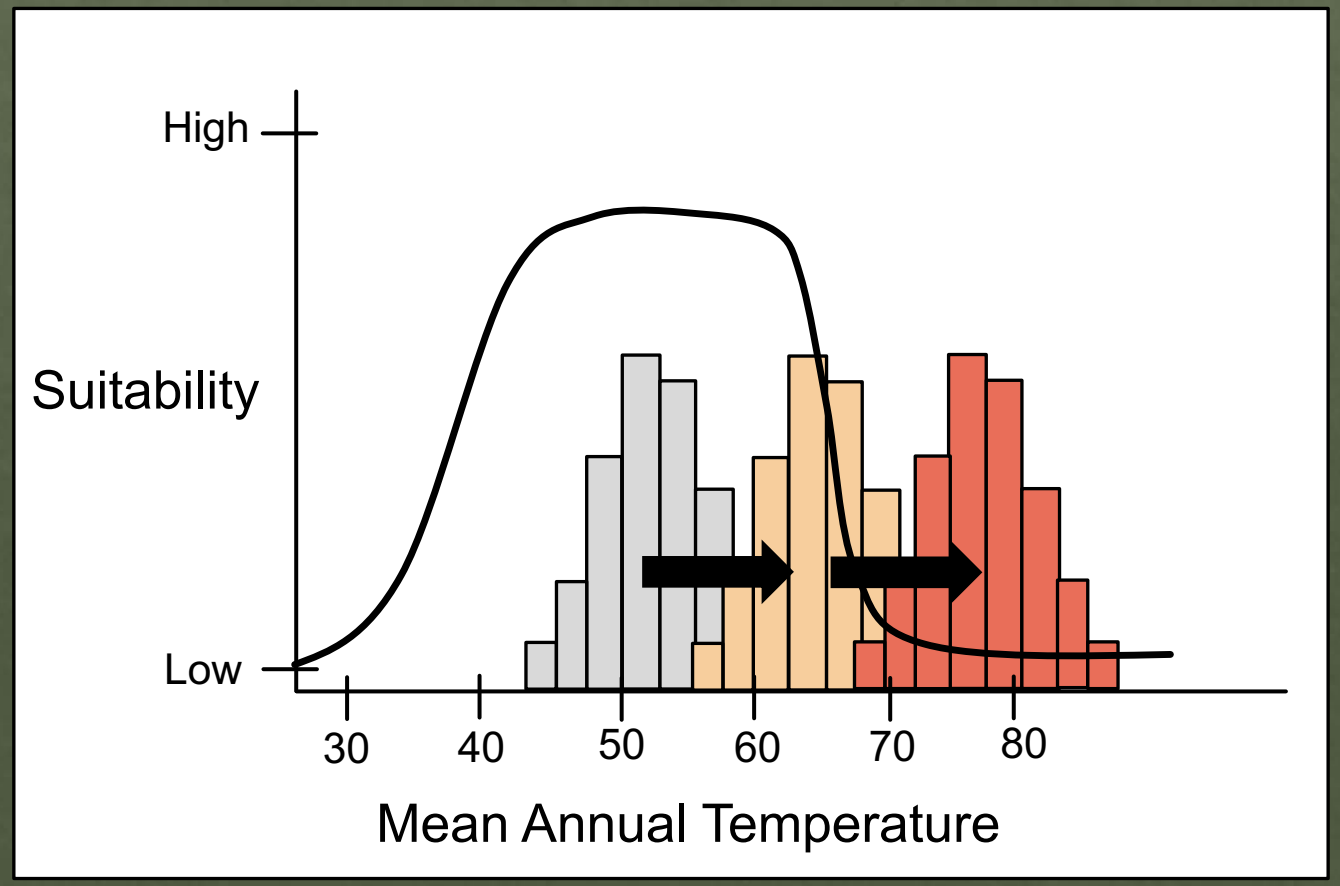




Species Distribution Models

- Combine known locations with environmental conditions to create model that predicts suitability

3 pinyons


P. edulis


P. monophylla


P. cembroides

6 junipers


J. osteosperma


J. monosperma


J. occidentalis


J. deppeana


J. scopulorum


J. californica

Species Distribution Models

- Combine known locations with environmental conditions to create model that predicts suitability


P. edulis


P. monophylla


P. cembroides


J. osteosperma


J. monosperma


J. occidentalis


J. deppeana


J. scopulorum


J. californica

Species Distribution Models

- Combine known locations with environmental conditions to create model that predicts suitability

Occurrence data

USFS – Forest Inventory & Analysis

BLM – Assessment, Inventory & Monitoring

Global Biodiversity Information Facility (GBIF)

SEINet – western herbarium network

Predictors

Mean annual temp. & precip.

Precip. seasonal timing

Vapor pressure deficit

Annual wet degree days

Soil hydraulic conductivity

Soil water holding capacity


P. edulis


P. monophylla


P. cembroides


J. osteosperma


J. monosperma


J. occidentalis

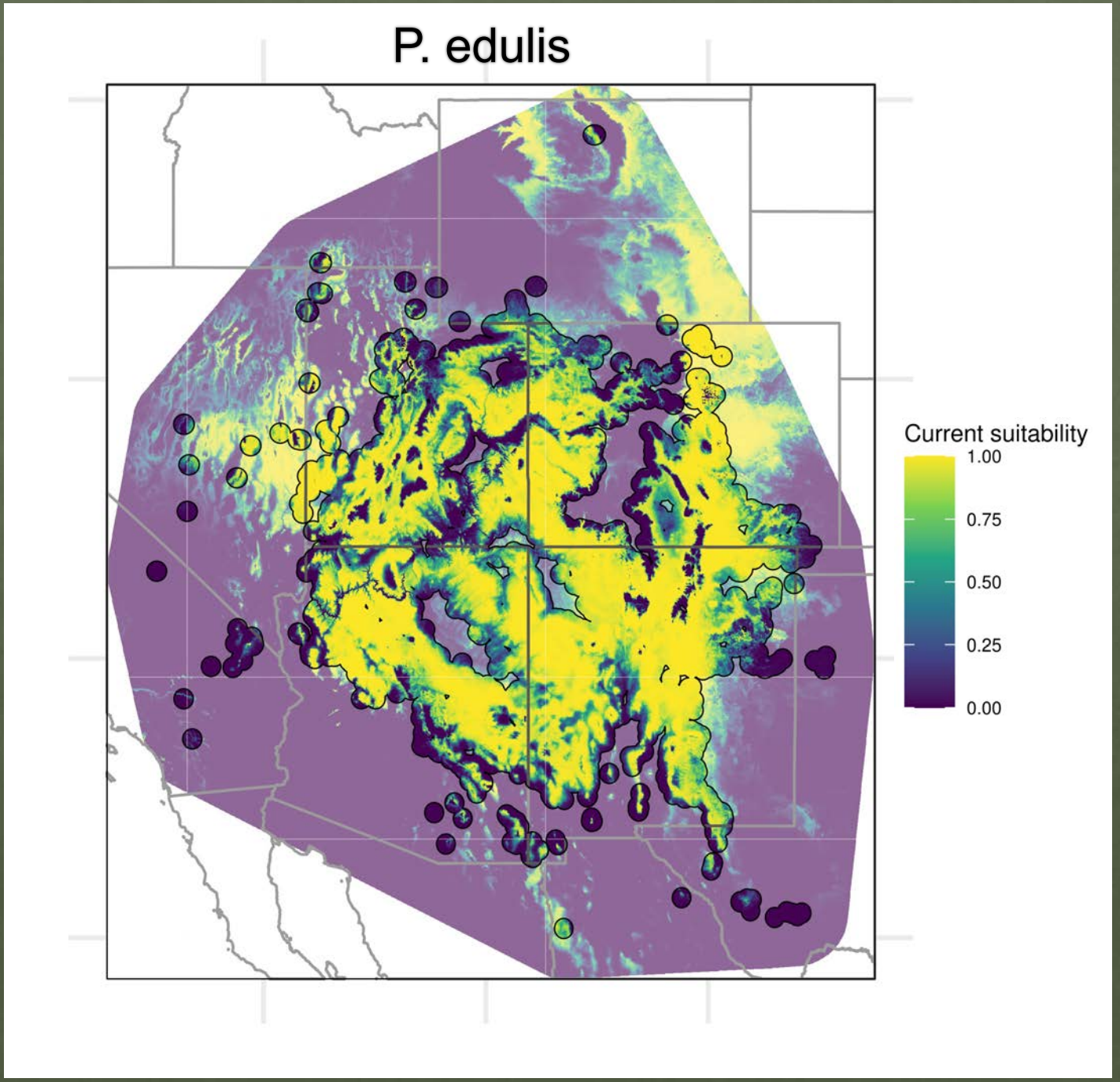

J. deppeana


J. scopulorum


J. californica

SDM output

Model + historic climate conditions = estimates of current suitability



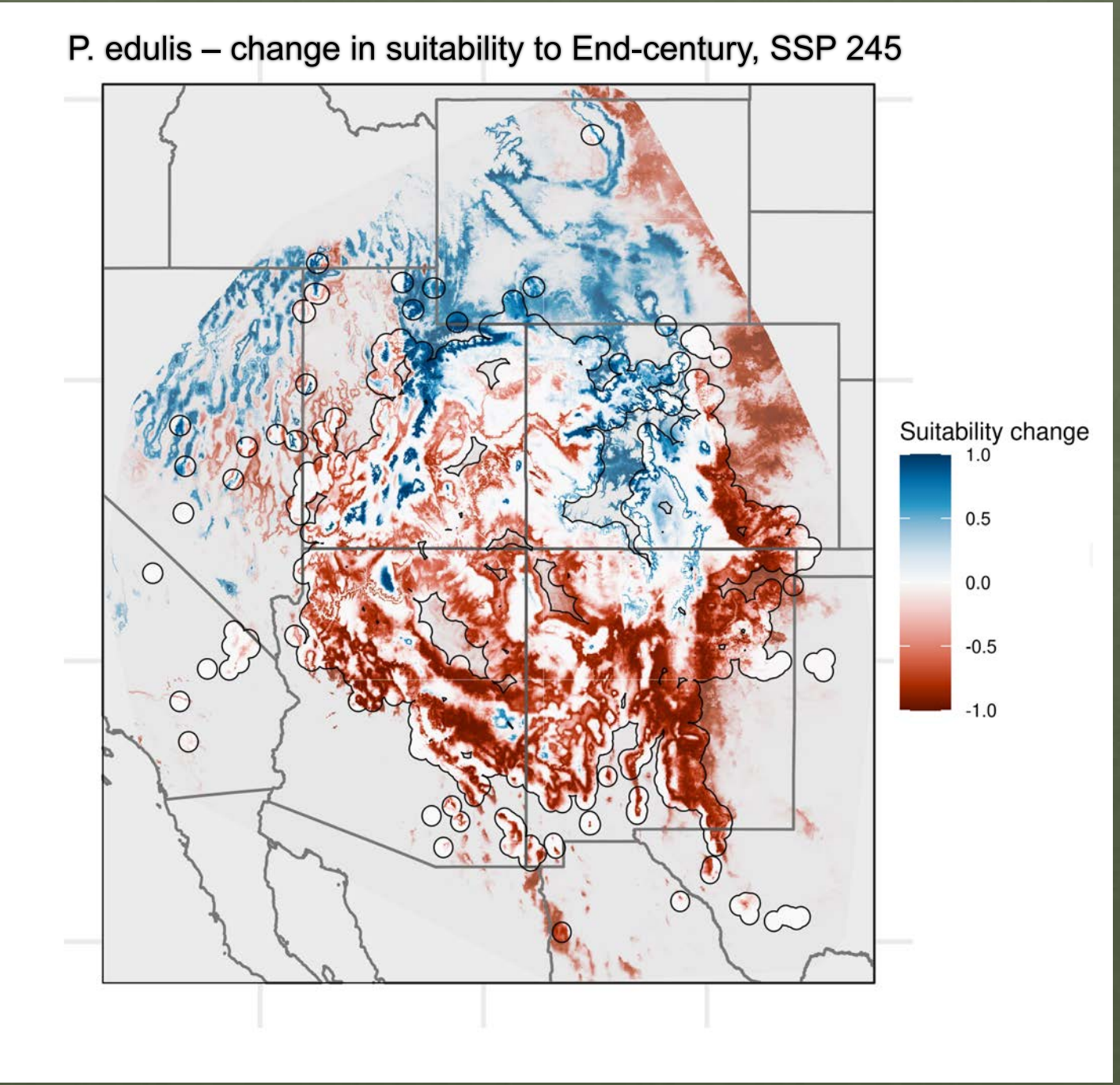
SDM output

Model + future climate conditions = calculate suitability change

1) Suitability change is highly variable

2) Many locations don't change suitability

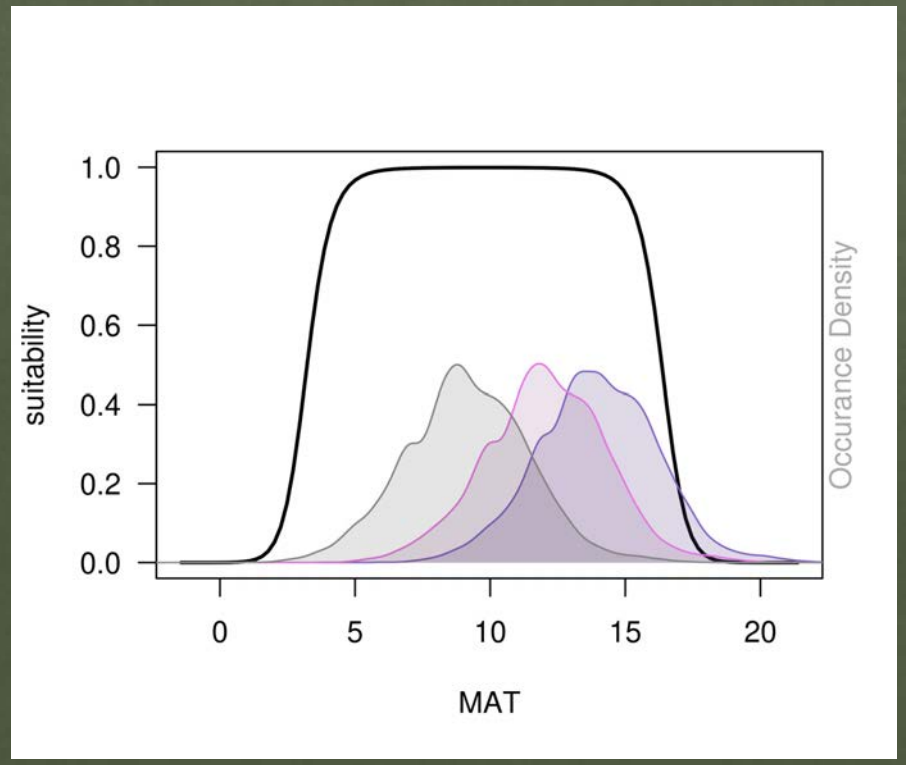
3) Suitability increases outside of current range

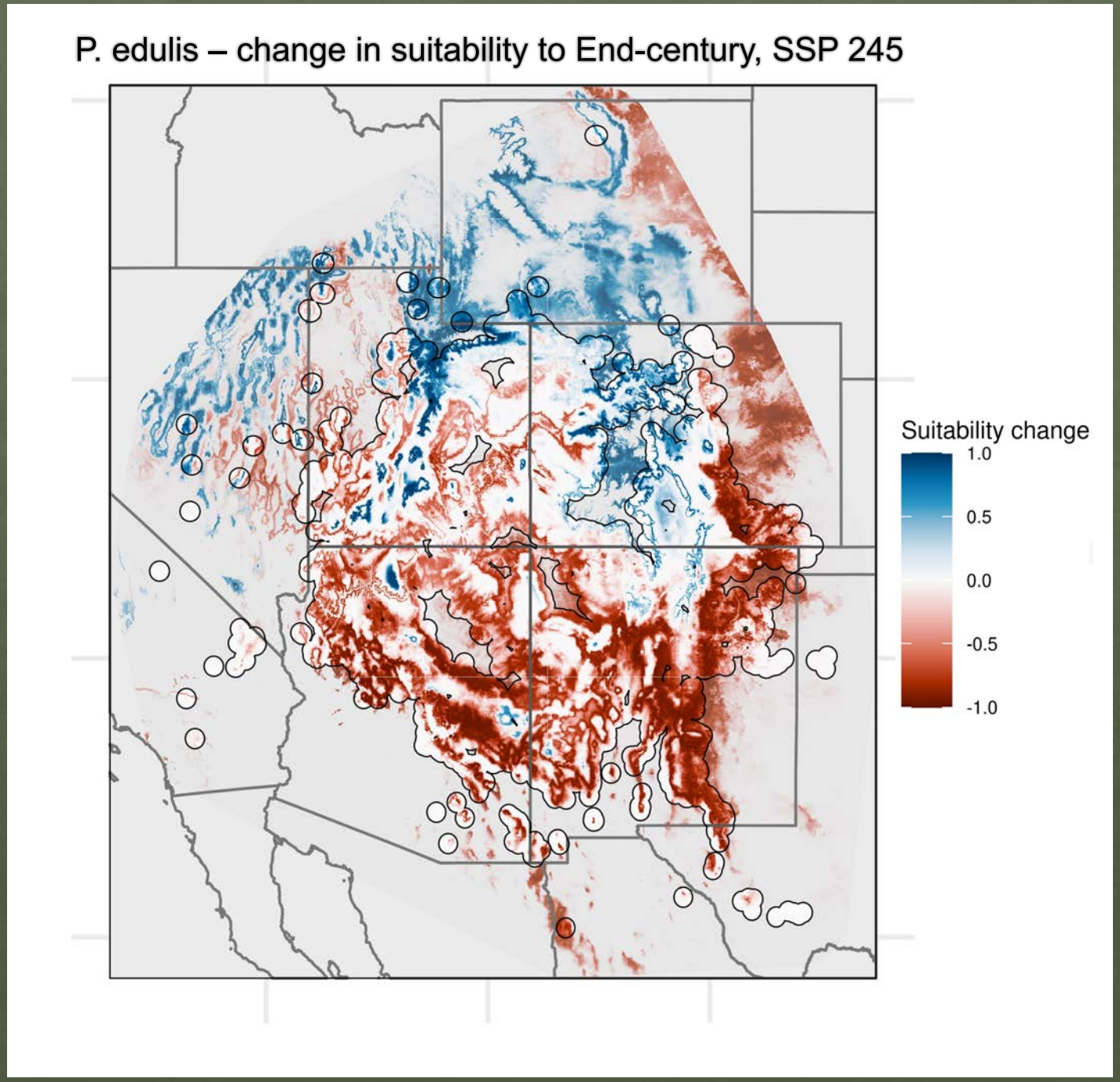


SDM output

What is driving declines in suitability?

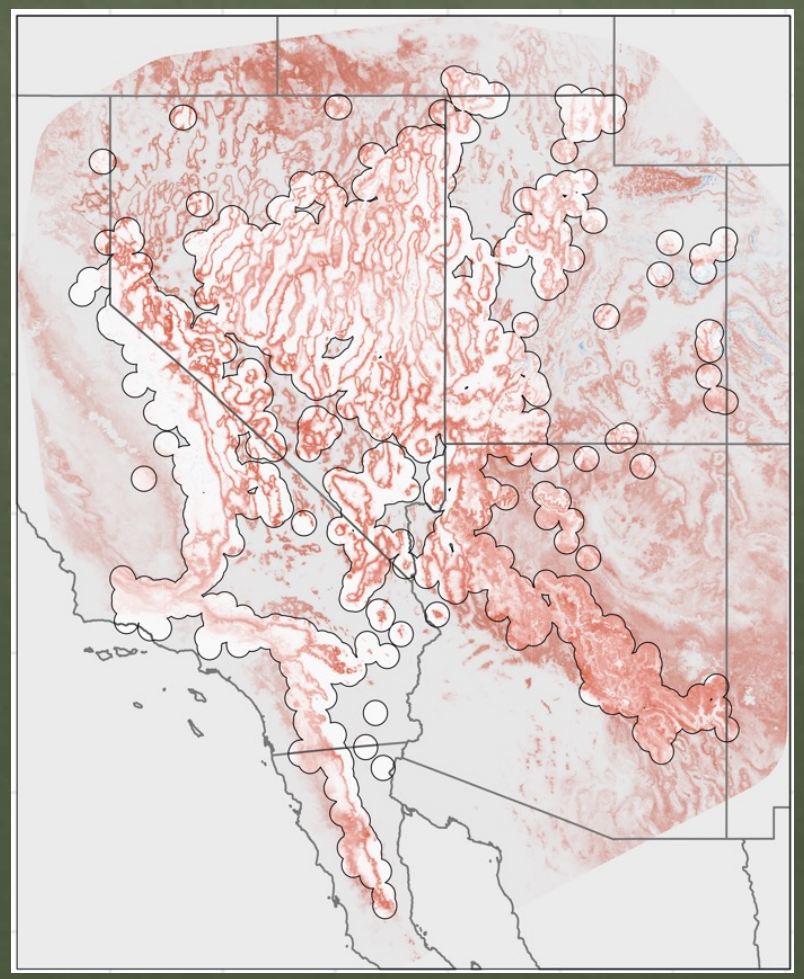
Partial dependence plot



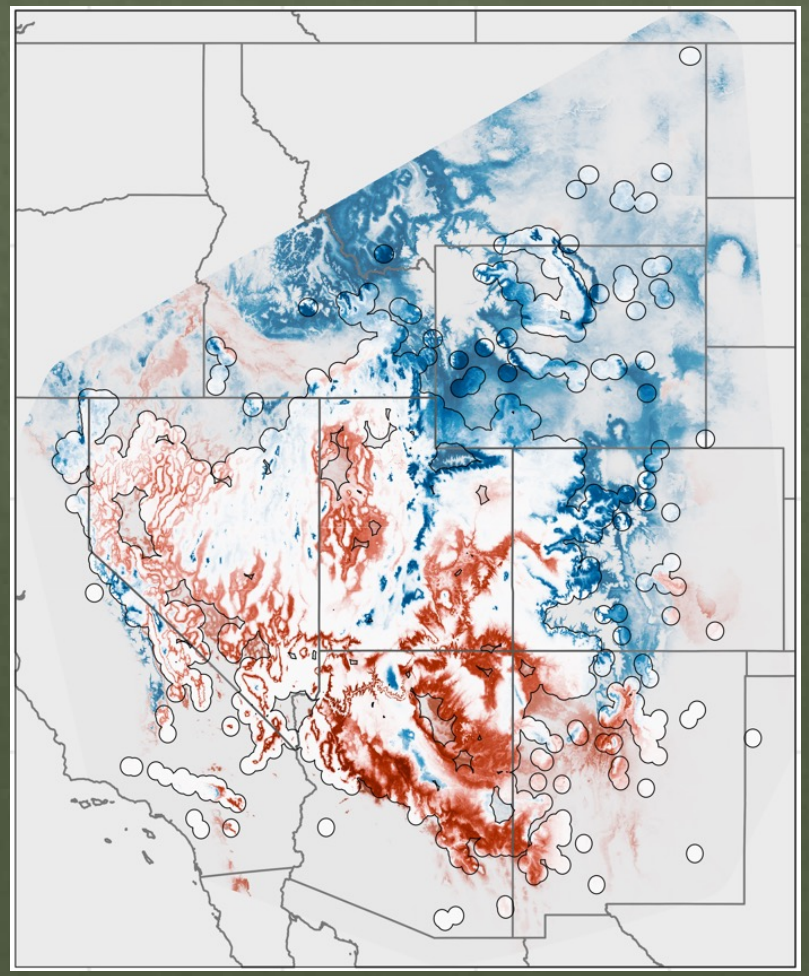


Suitability change: End-century, SSP 245

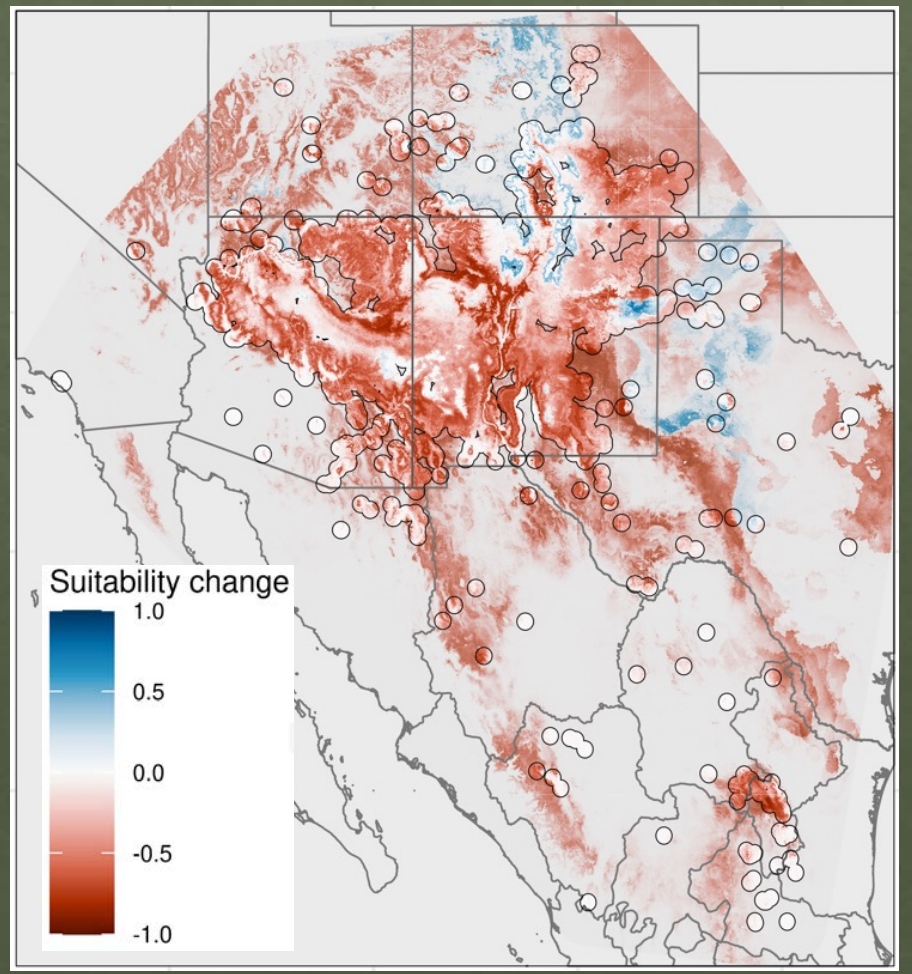
P. monophylla



J. osteosperma

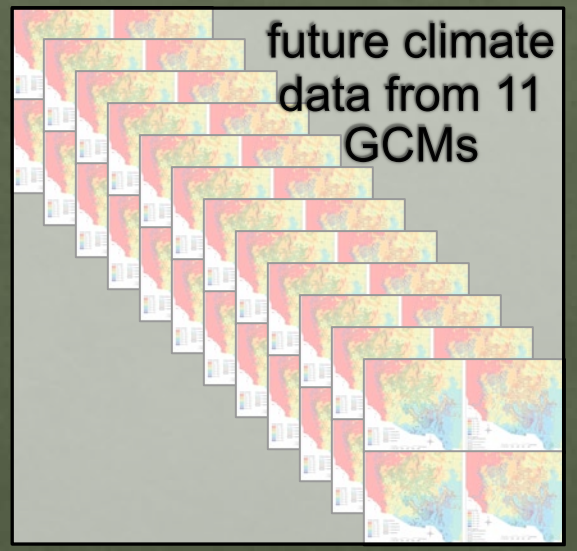


J. monosperma



Where do projections agree across climate uncertainty?

Model +



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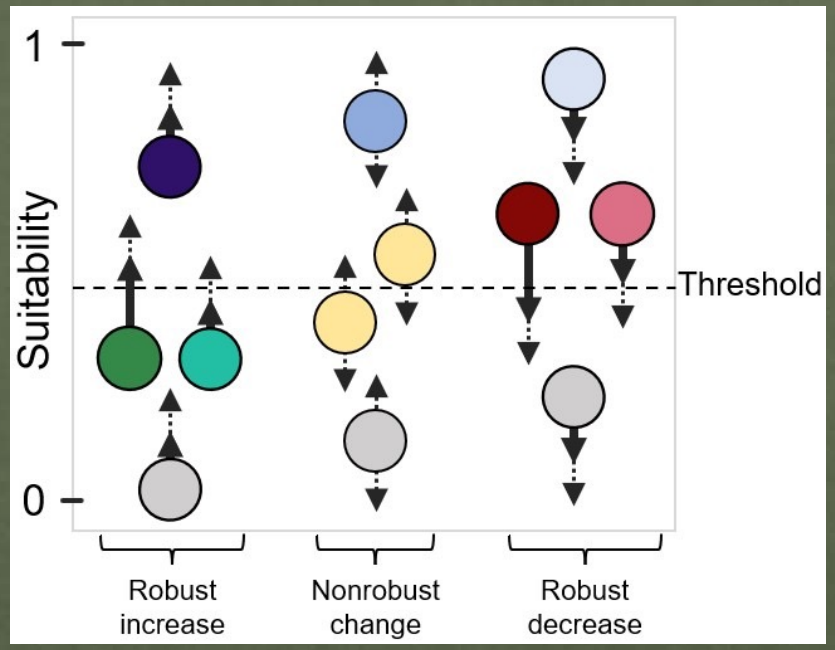
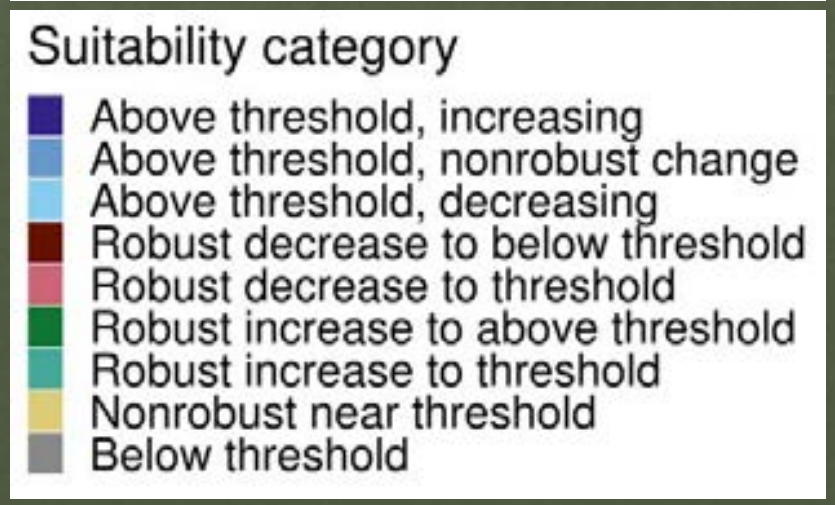
assess agreement of suitability change





P. edulis

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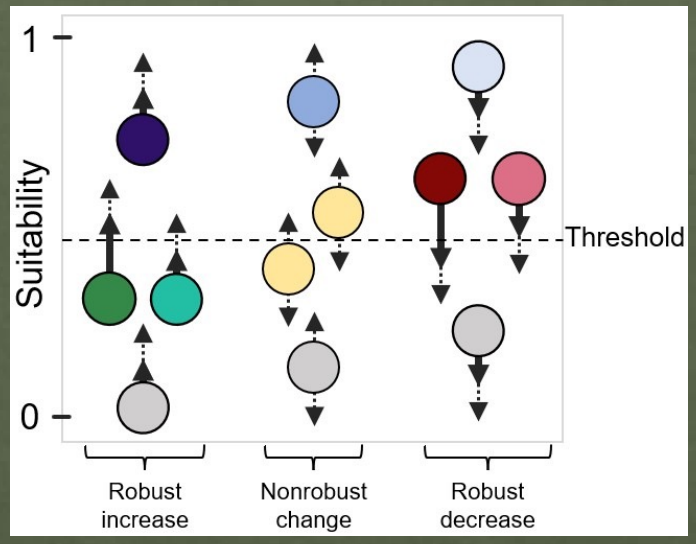

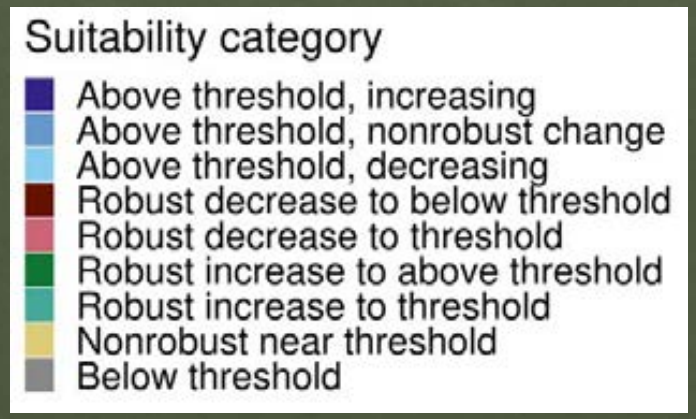

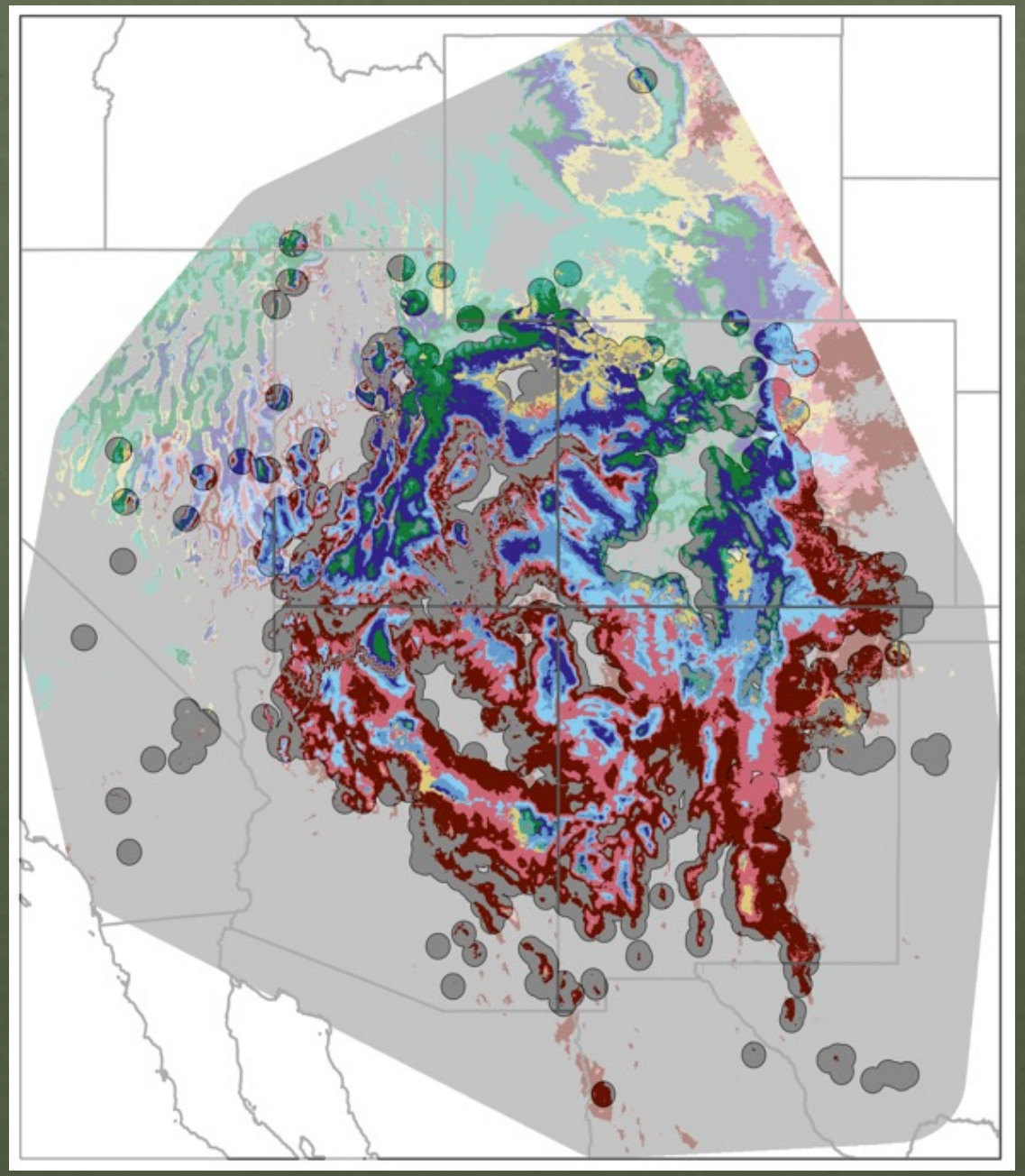

P. monophylla

J. osteosperma

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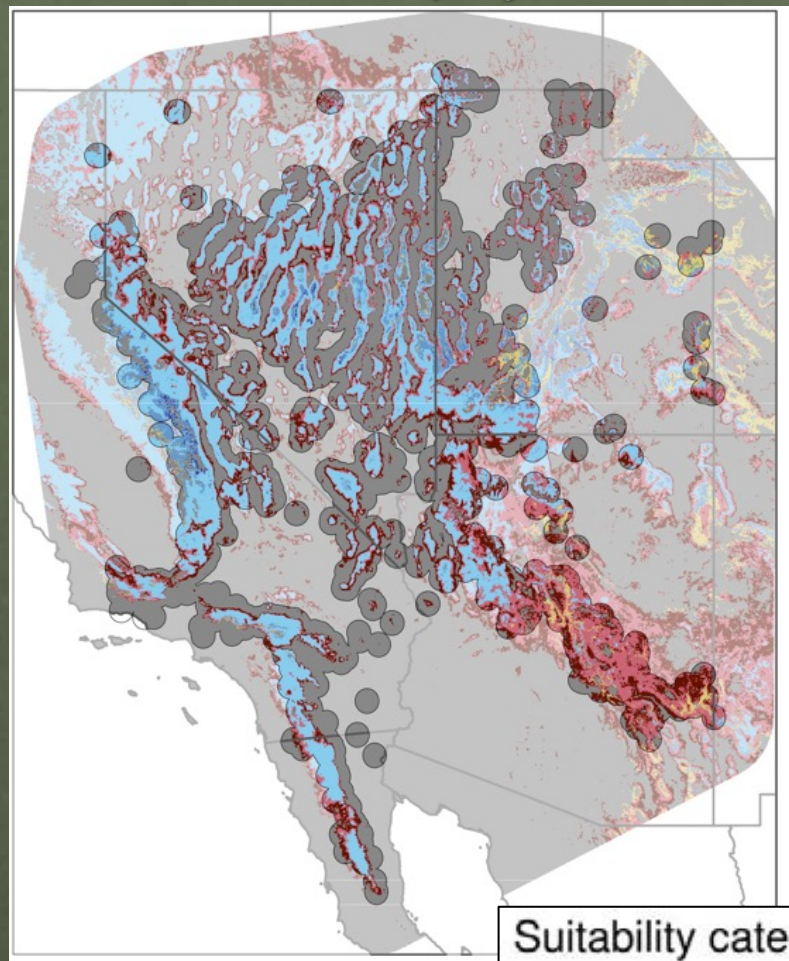
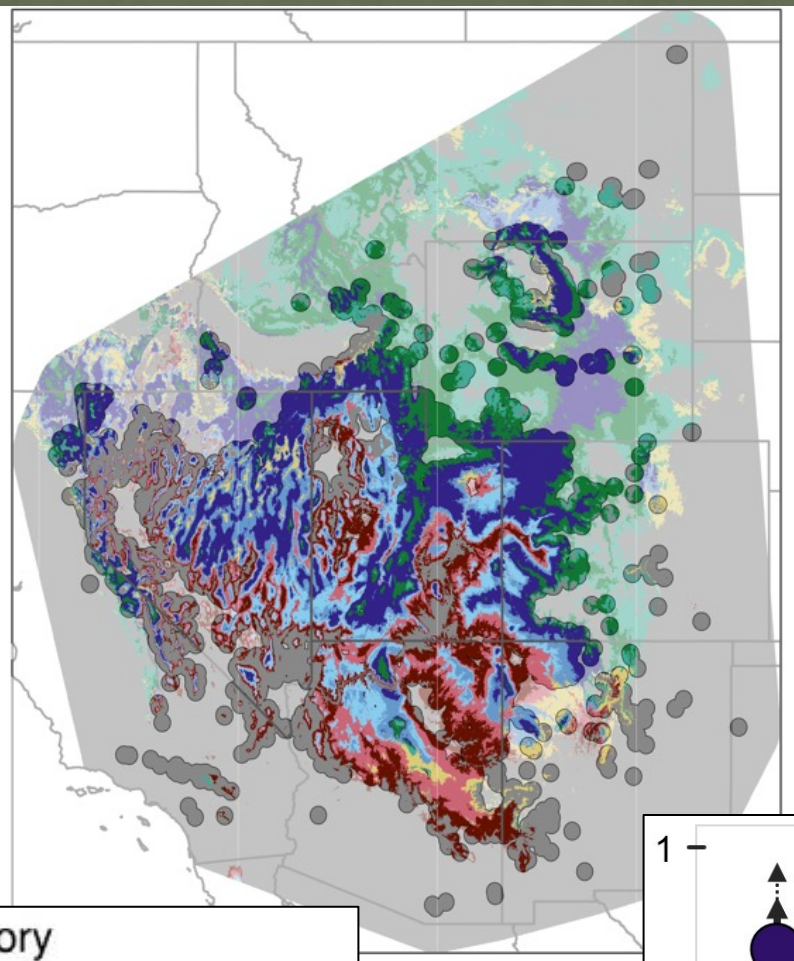
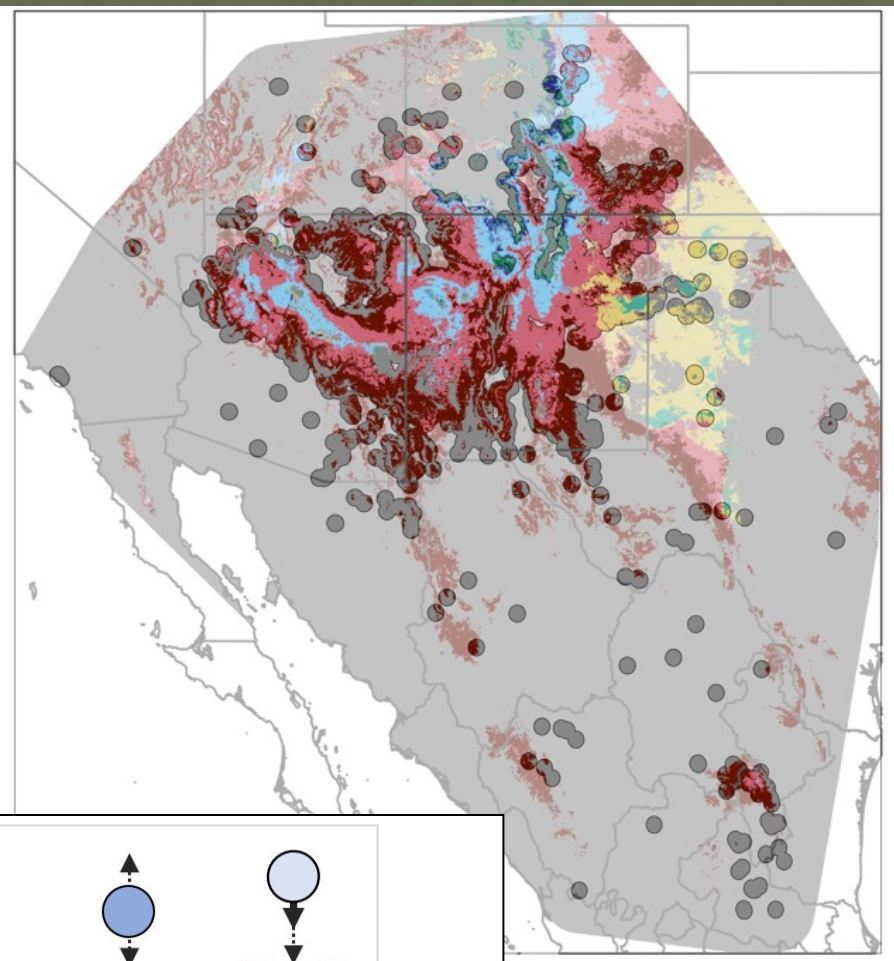
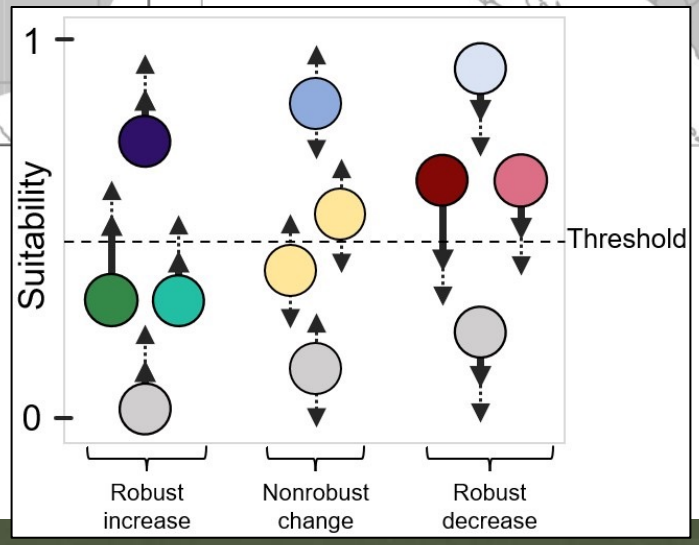






Suitability category

- Above threshold, increasing
- Above threshold, nonrobust change
- Above threshold, decreasing
- Robust decrease to below threshold
- Robust decrease to threshold
- Robust increase to above threshold
- Robust increase to threshold
- Nonrobust near threshold
- Below threshold



Strengths

- Combines multiple datasets for prediction
- Good at finding relationship between tree species and climate conditions
- Can predict to outside of species range & outside current climate

Limitations

- Cannot account for disturbance events
- Does not account for other species (tree / grass competition), or dispersal ability
- Climate-landscape perspective misses important steps for tree success

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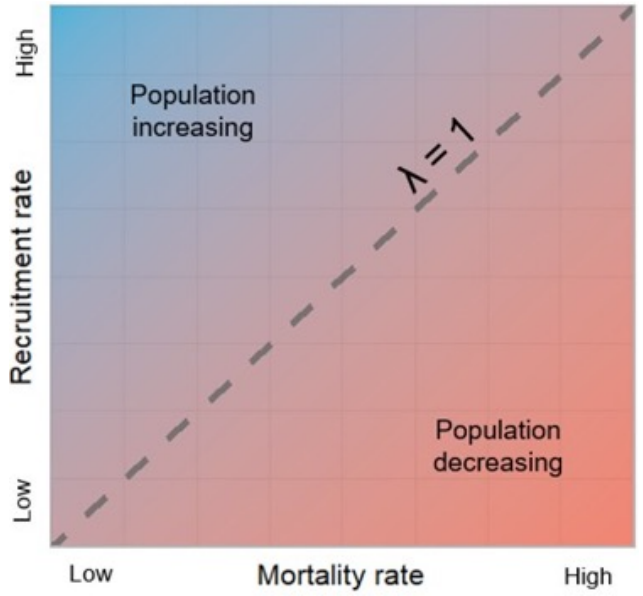
Where can managers effectively resist climate-driven ecological transformation in pinyon–juniper woodlands of the US Southwest?

Adam R. Noel, Robert K. Shriver, Shelley D. Crausbay, John B. Bradford

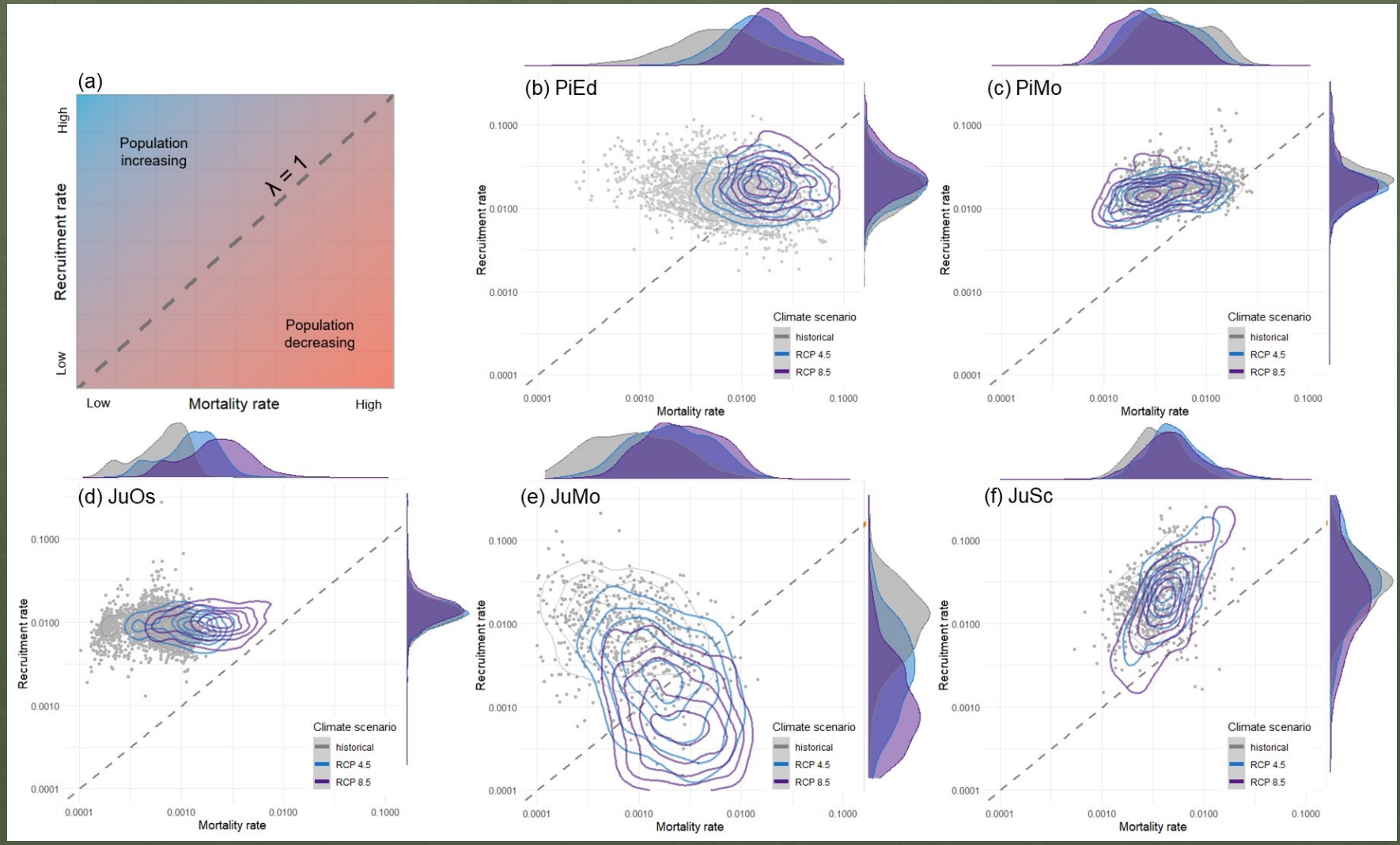
First published: 29 May 2023 | https://doi.org/10.1111/gcb.16756

Population stability depends on balance of recruitment & mortality



Pinyon-juniper populations

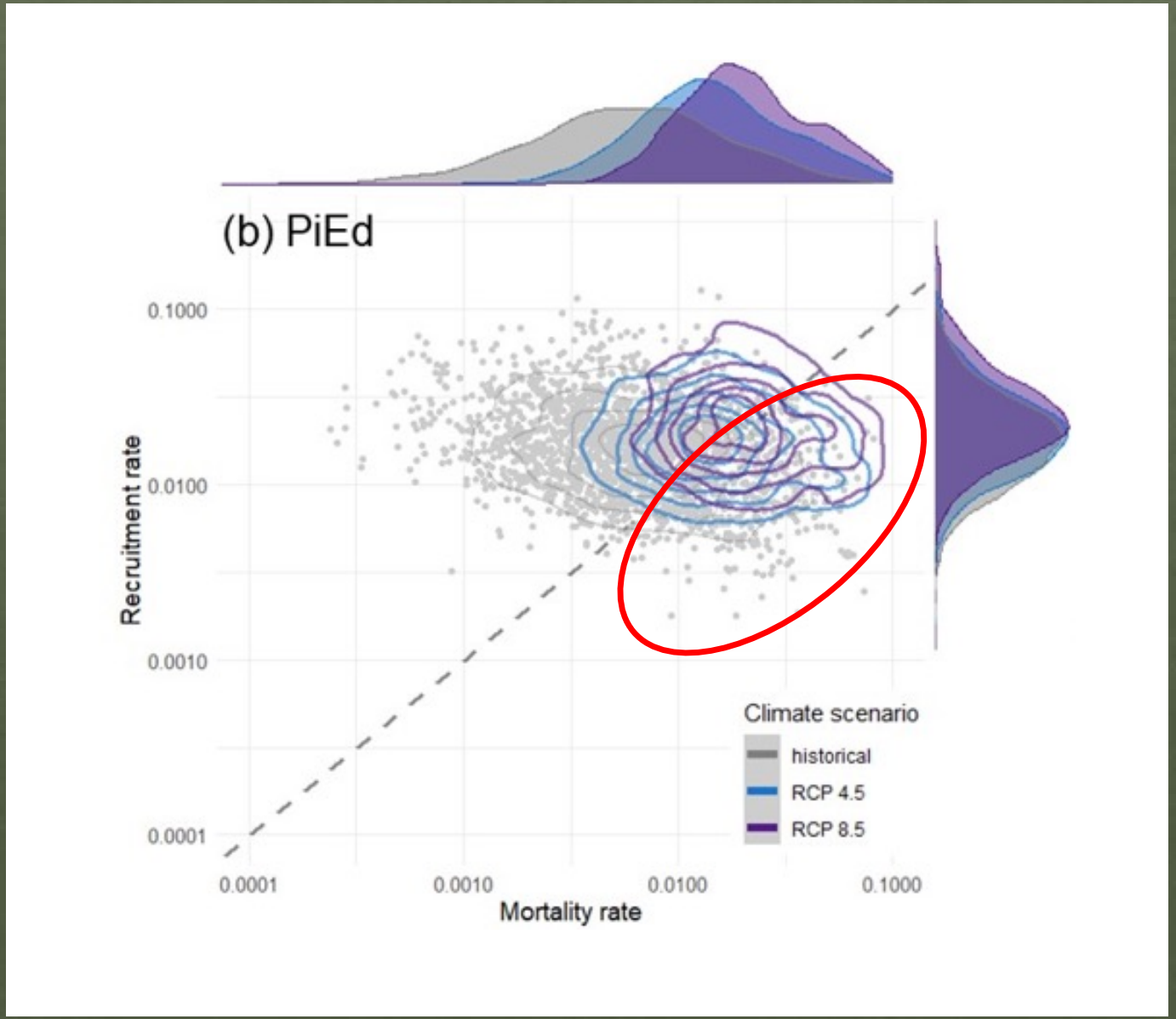
- Many shifts in species' demographic rates – some not enough to shift growth rate
- P. edulis & J. monosperma are vulnerable species under climate change



Pinyon-juniper populations

- Management to maintain positive growth rate?

Bradford and Bell (2017)



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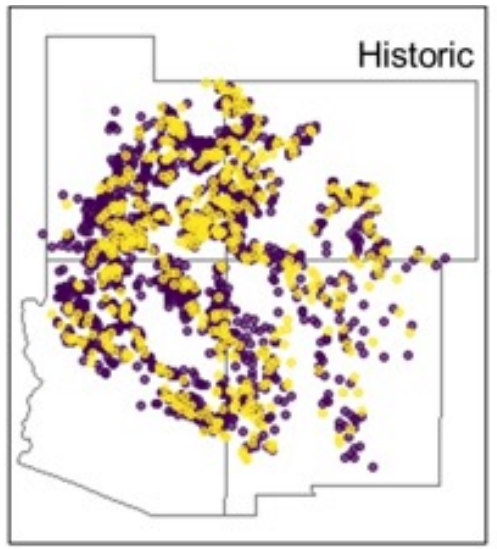
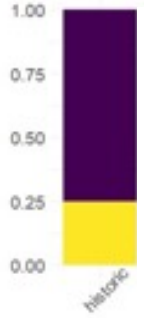


Lambda

- > 1 at current BA
- > 1 at half current BA
- < 1 at any BA



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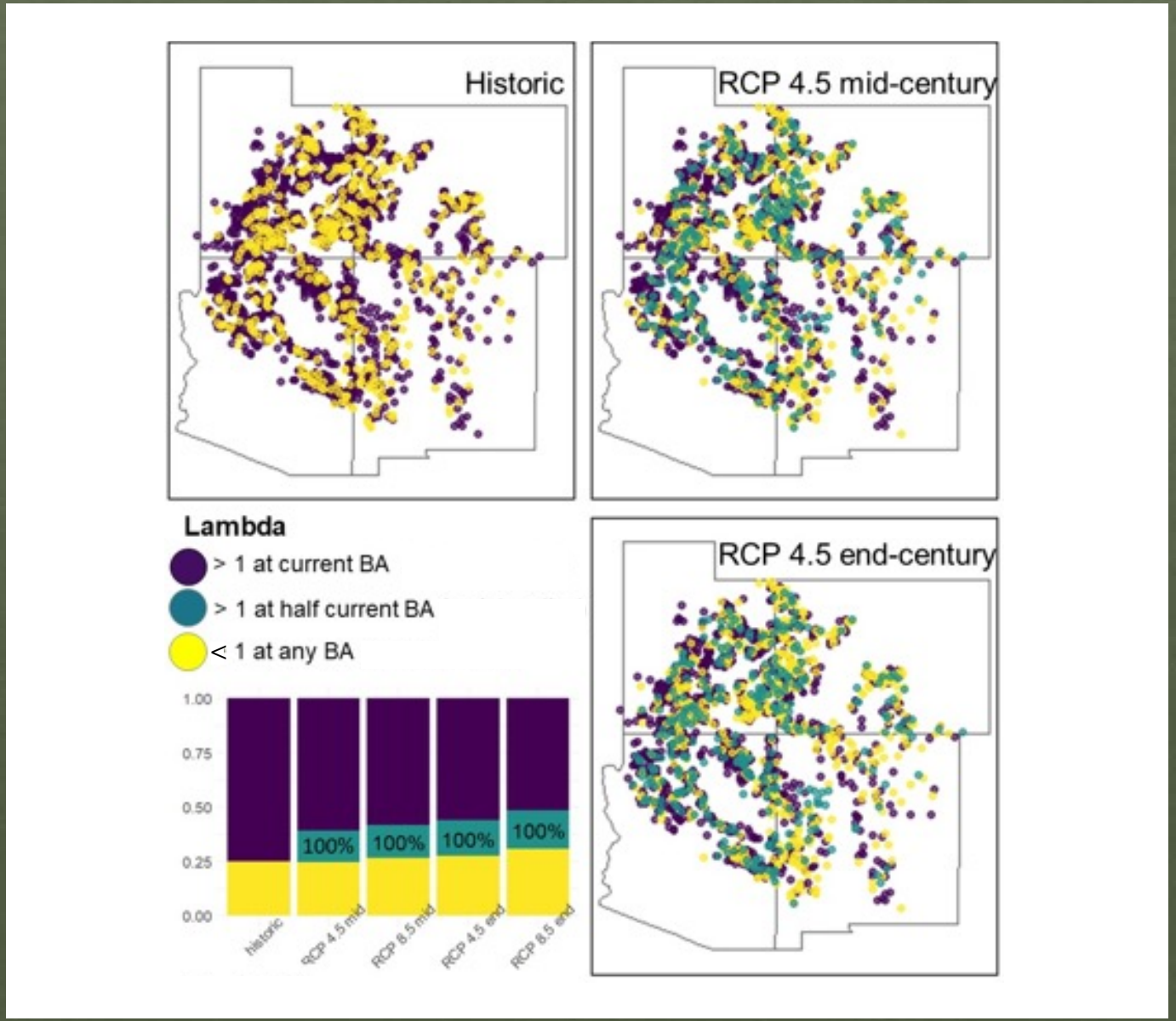

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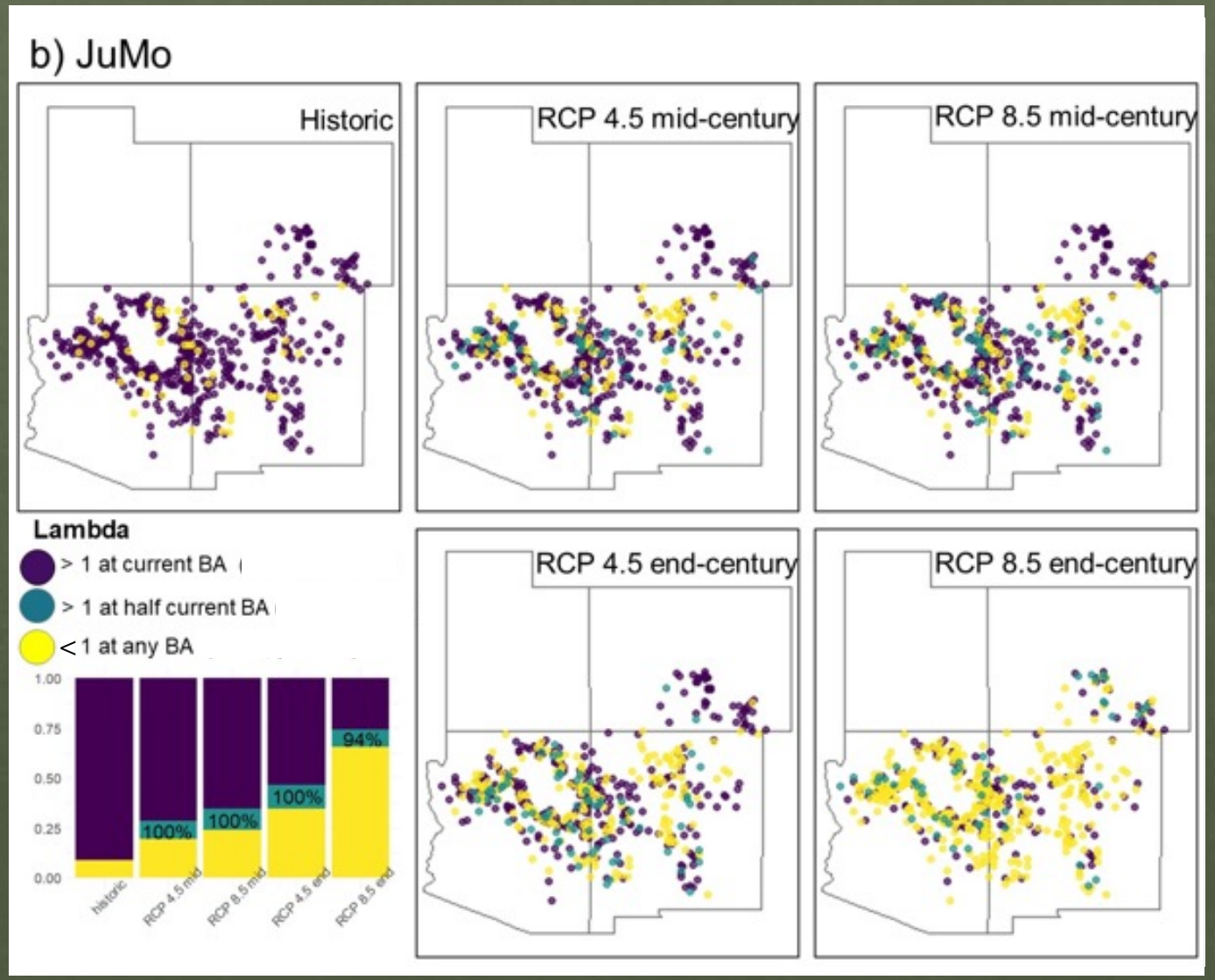
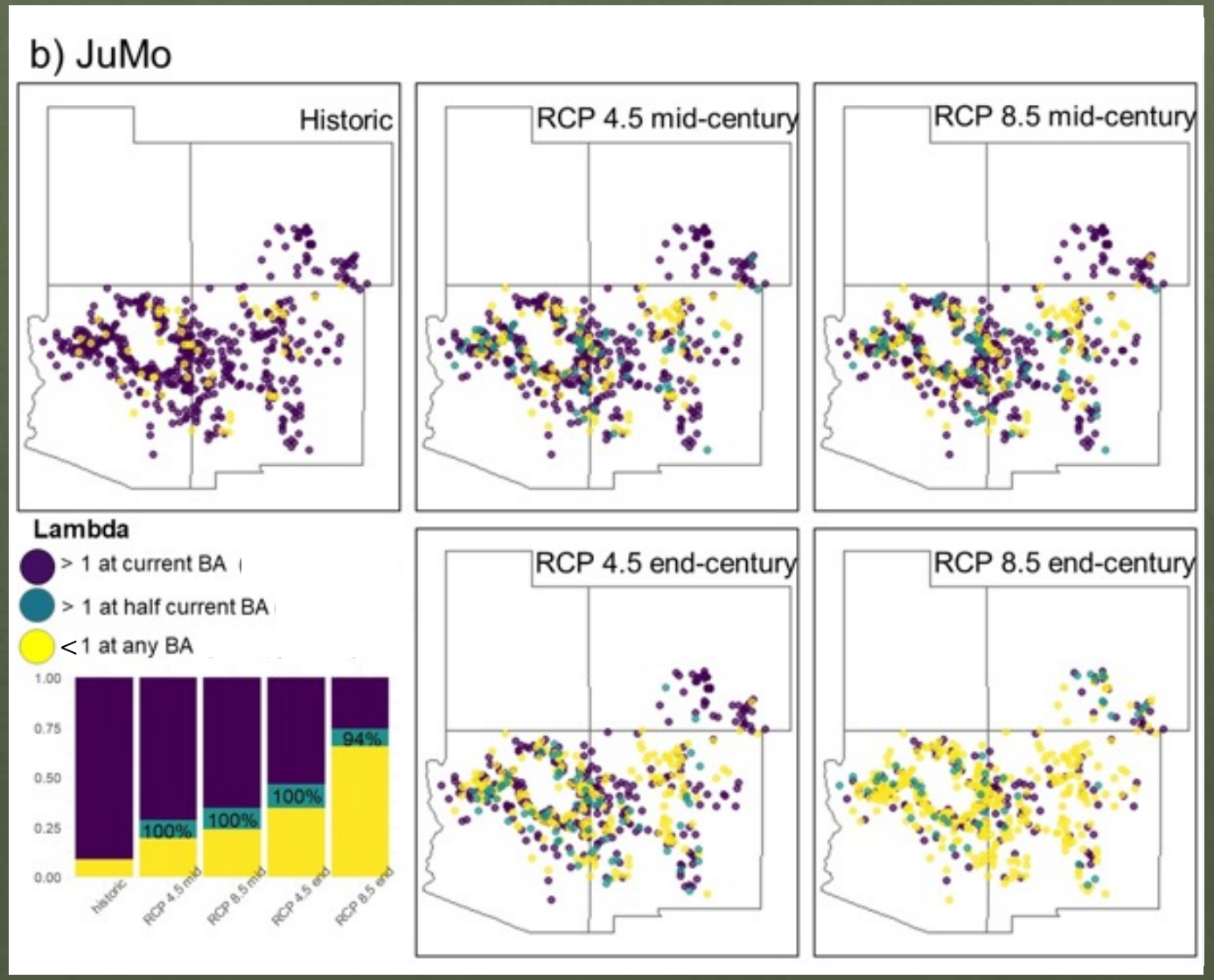


Pinyon-juniper populations

- Species' recruitment & mortality rates vary under future climate
- Thinning may reduce climate-driven declines in demographic rates

J. monosperma



Want more info or have questions?

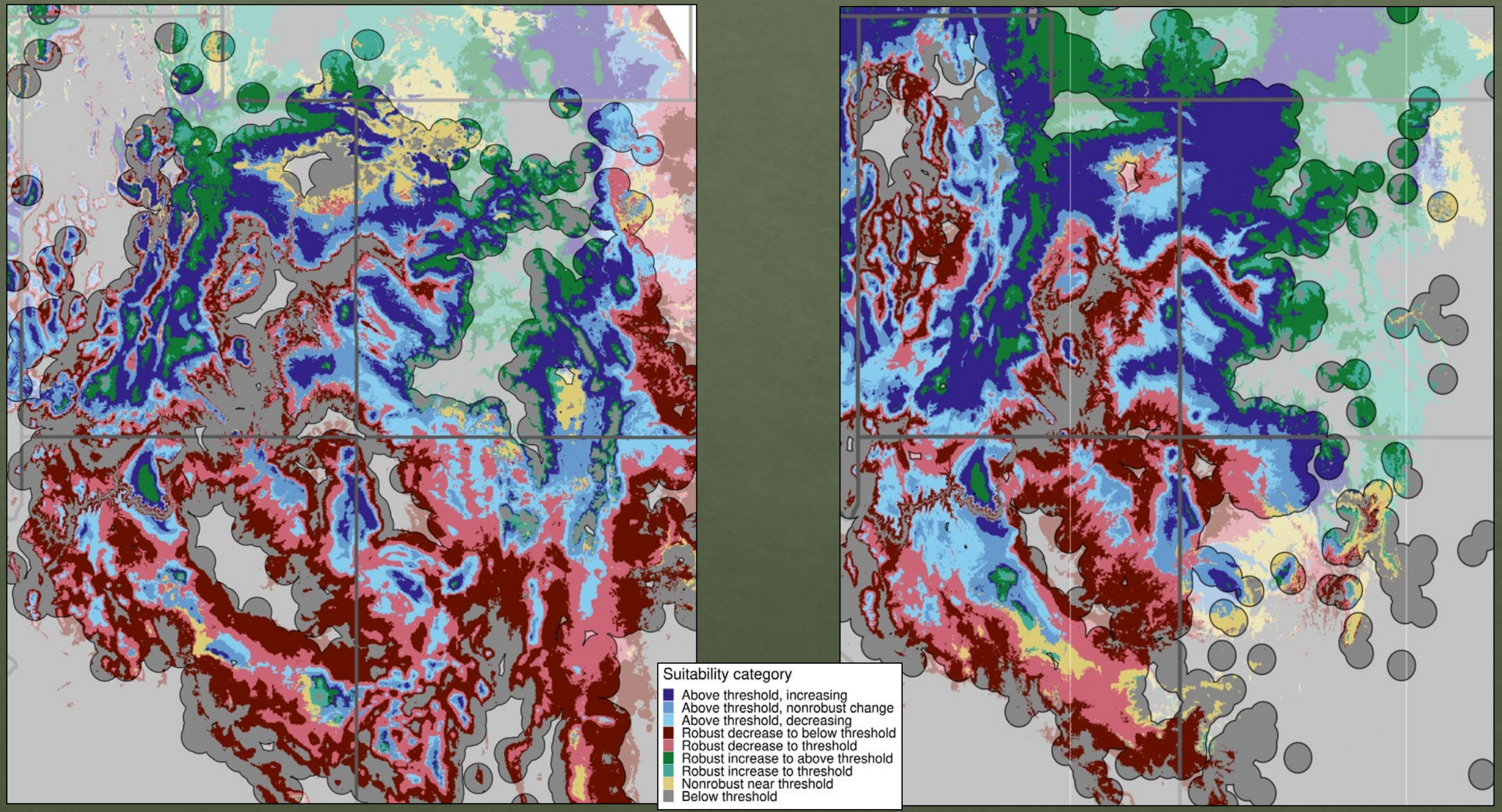
Adam Noel, USGS

Southwest Biological Science Center

ANoel@usgs.gov

P. edulis

J. osteosperma



Changes in climate on the CO plateau