NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Native Seeds—Research, Development, Demand, and Application

February 13, 2024

11:00 AM – 12:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

ENGINEERING
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AICP Credit Information

1.5 American Institute of Certified Planners Certification Maintenance Credits

You must attend the entire webinar

Log into the American Planning Association website to claim your credits

Contact AICP, not TRB, with questions

Purpose Statement

This webinar will highlight the importance of locally adapted native seeds and the climate impacts of invasive species. Presenters will discuss native seed and plant research and production. Presenters will also discuss the increasing demand and state and national strategic applications.

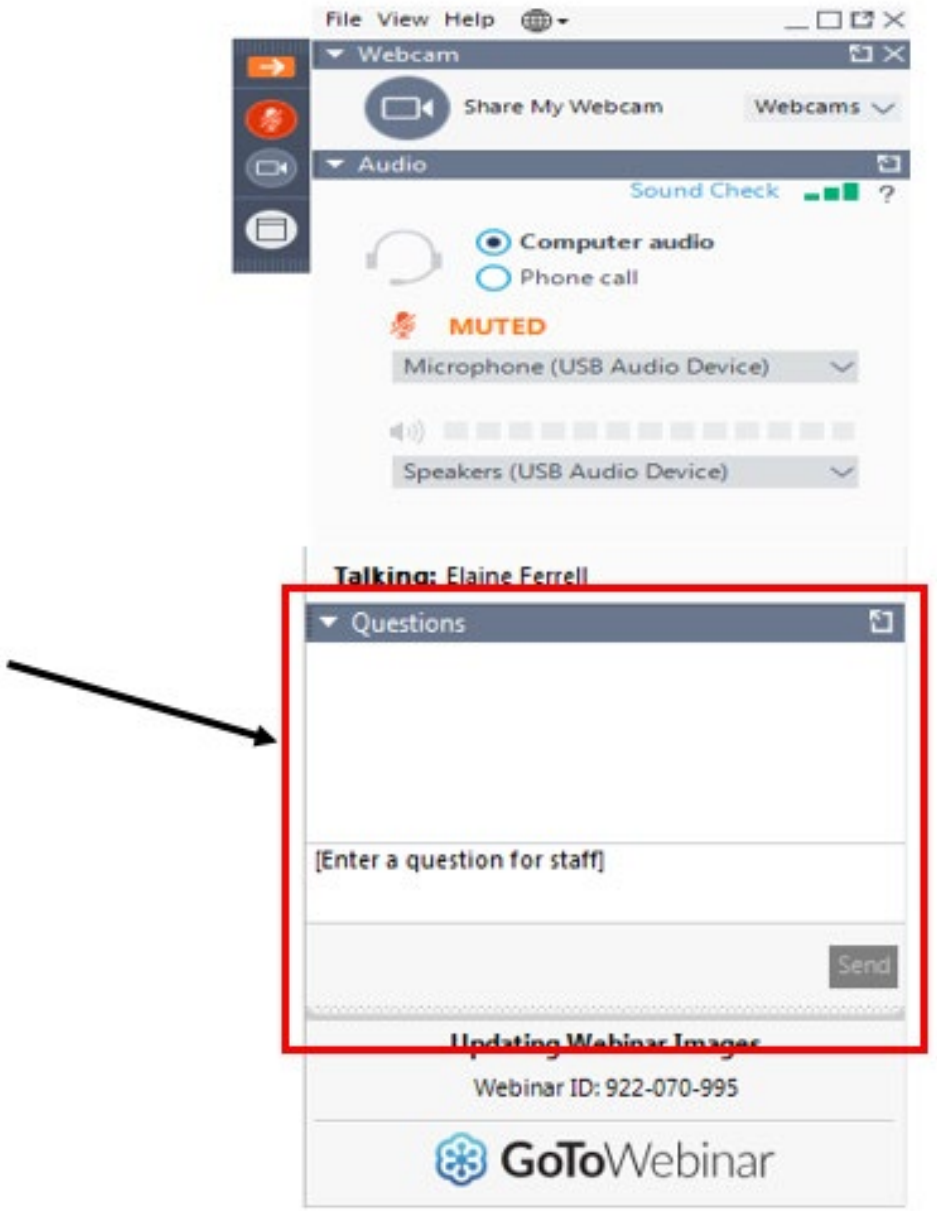
Learning Objectives

At the end of this webinar, you will be able to:

- Identify the importance of locally adapted native seeds
- Utilize strategies for native seed and plant development
- Meet restoration and conservation goals and future seed needs with strategies, applications, and collaborations

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's presenters

Brian Smith
bsmith@dot.gov
Federal Highway Administration

Dr. Tony Falk
anthony.falk@tamuk.edu
Texas Native Plant Program

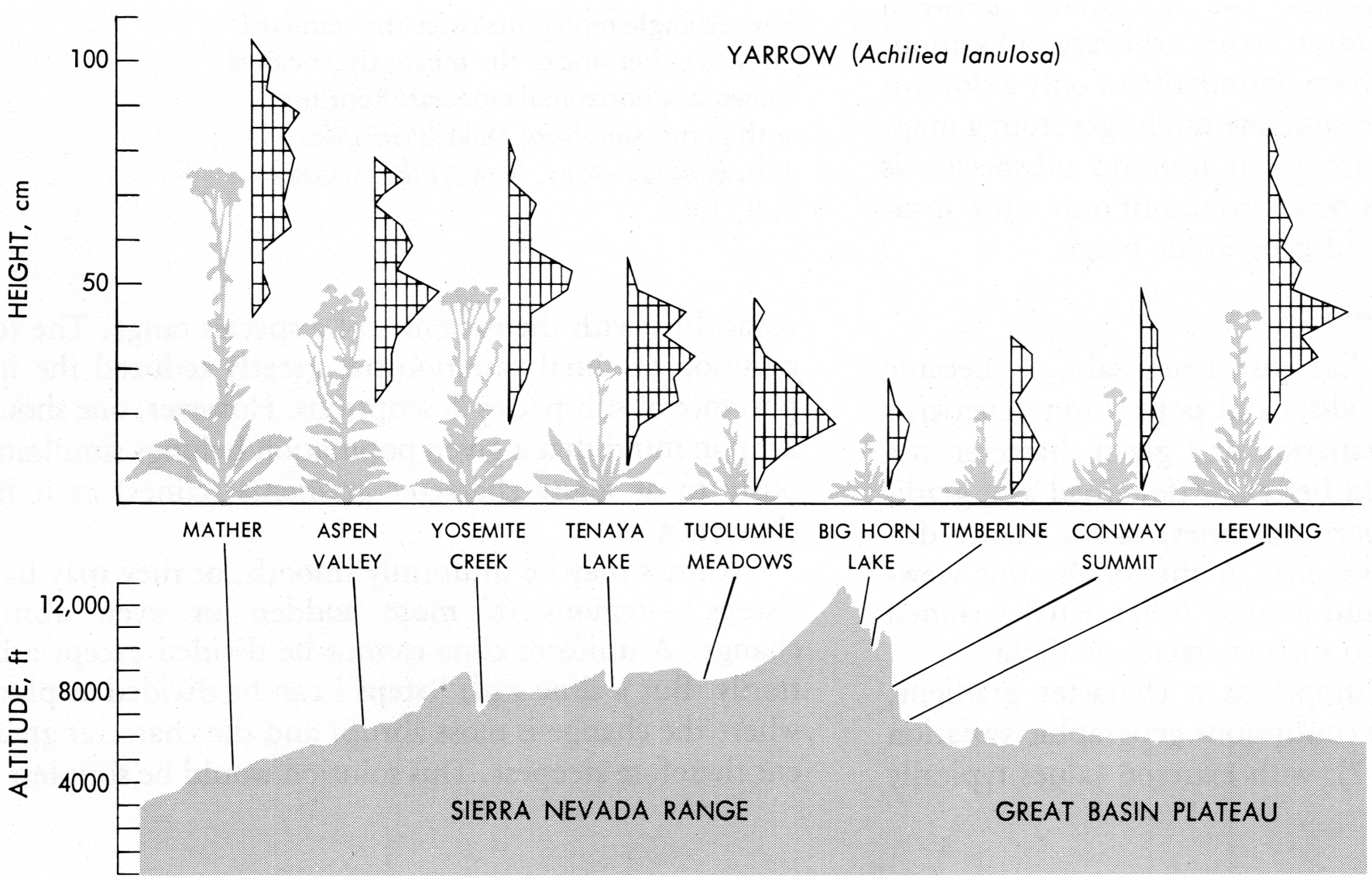
Dr. Francis Kilkenny
francis.f.kilkenny@usda.gov
U.S. Forest Service, Rocky Mountain Research Station

Ken Murray
email@email.com
California Department of Transportation

What are seed transfer zones and how are they used?

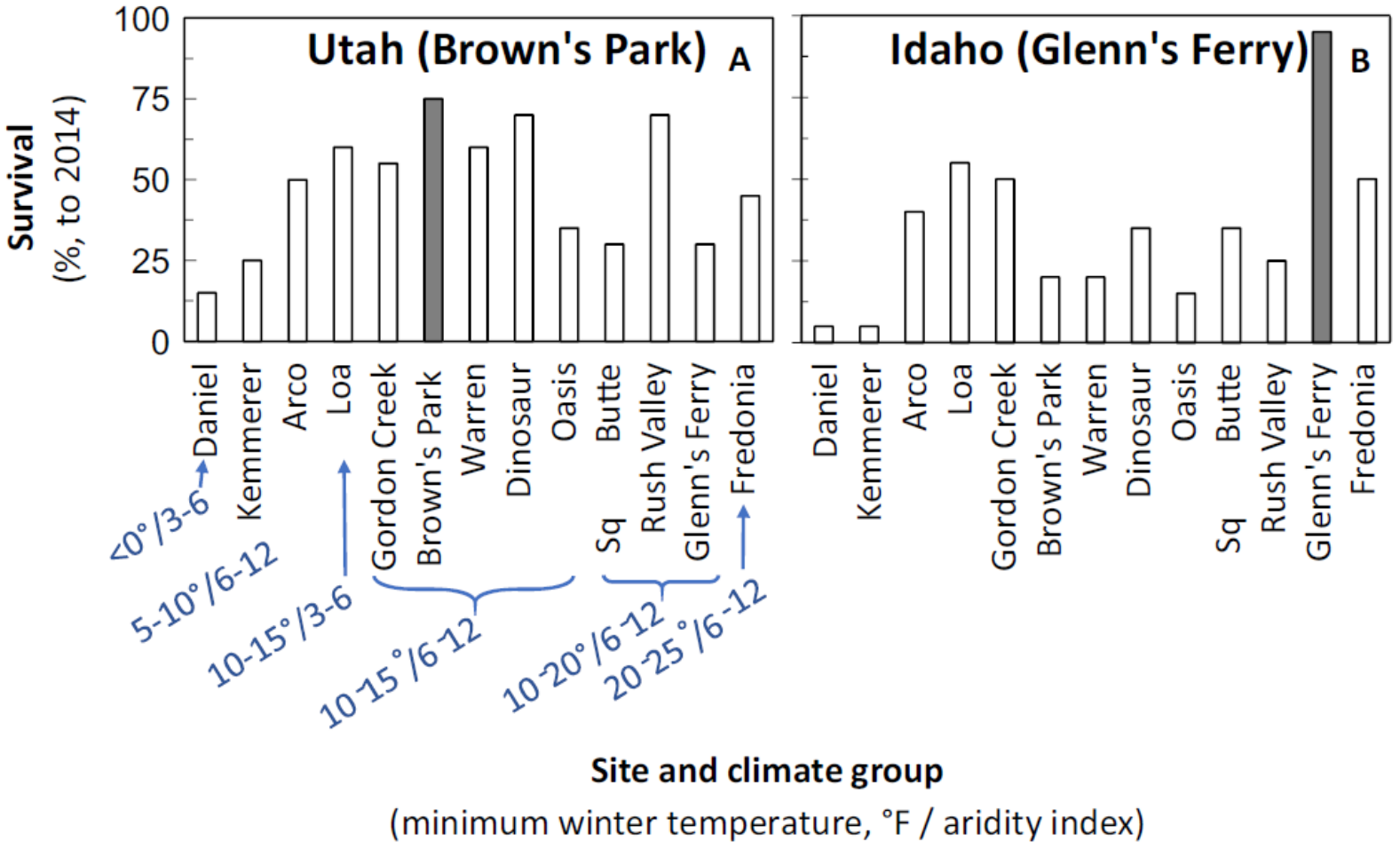
Francis Kilkenny
United States Department of Agriculture, Forest Service, Rocky Mountain Research Station, Boise, United States

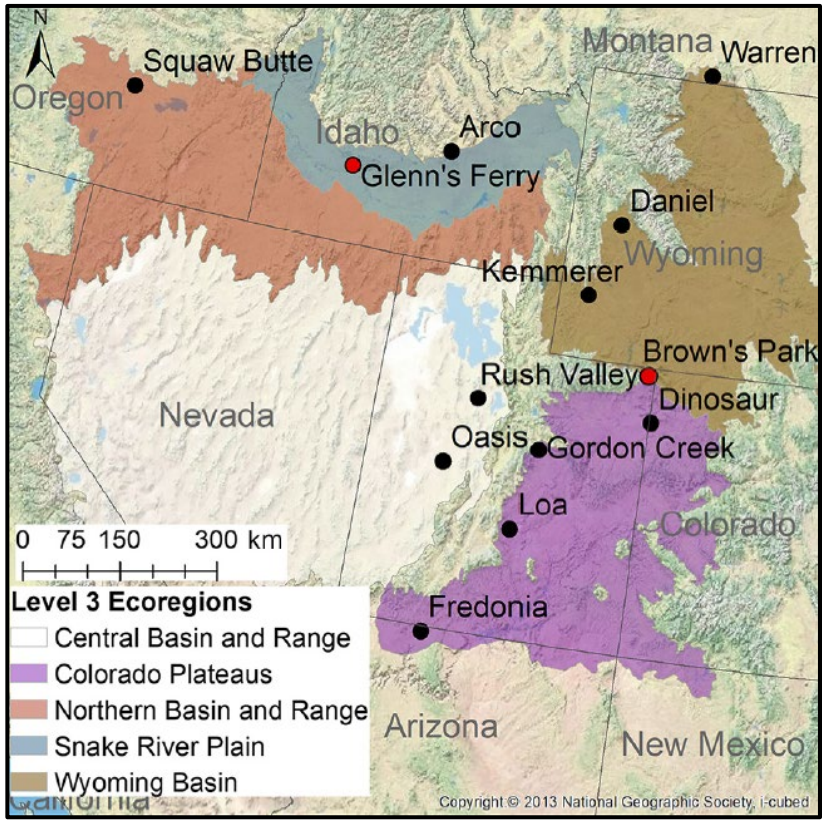
What is local adaptation? – A classic example



Clausen et al. 1948. Carnegie Institution of Washington Publication 581

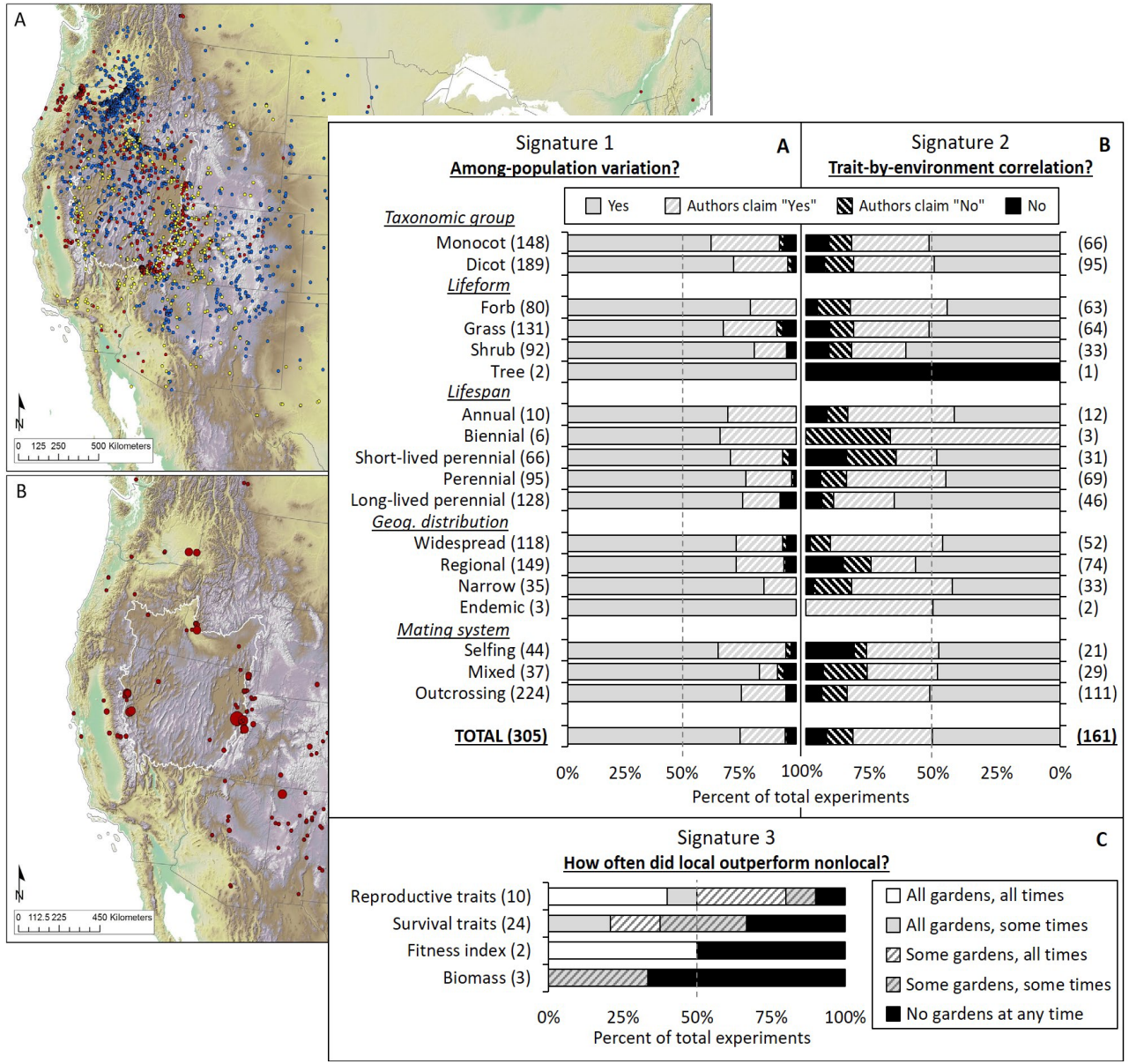
What is local adaptation? – A modern example





Germino et al. 2019. *Ecological Applications* 29: e01842

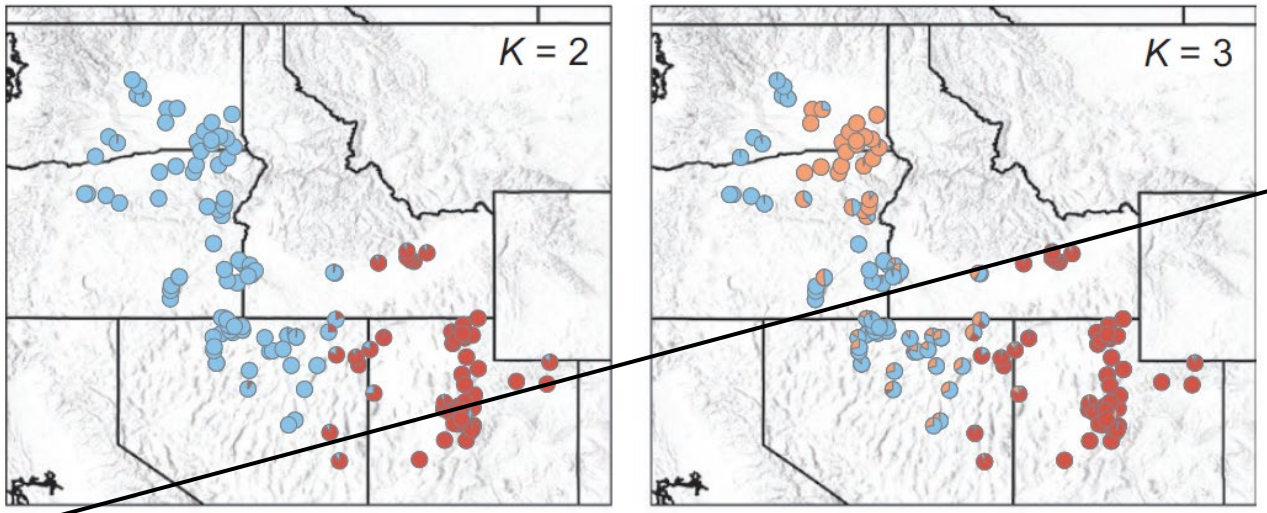
How prevalent is local adaptation? - Great Basin

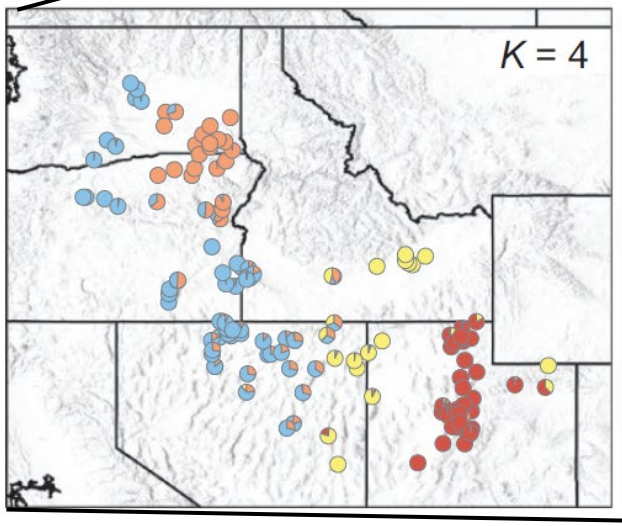


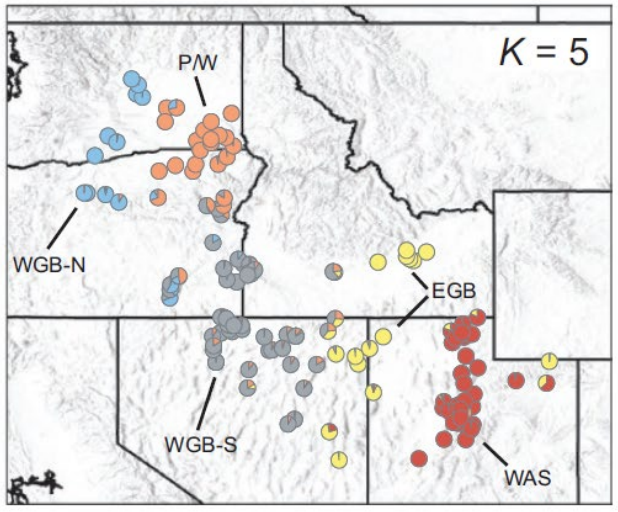
Study	Freq. of LA (^ bounds)
Leimu and Fischer 2008	71%
Hereford 2009	71%
Oduor et al. 2016 - Native	55%
Oduor et al. 2016 - Invasive	45%
Baughman et al. 2019 - GB Surv.	67%
Baughman et al. 2019 - GB Rep.	90%

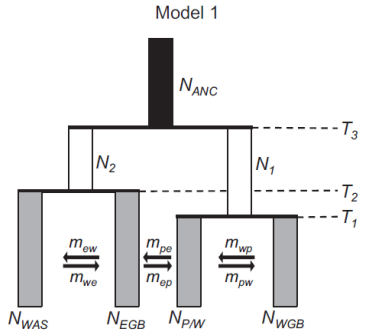
Baughman et al. 2019, *Ecology and Evolution* 9: 6259-6275

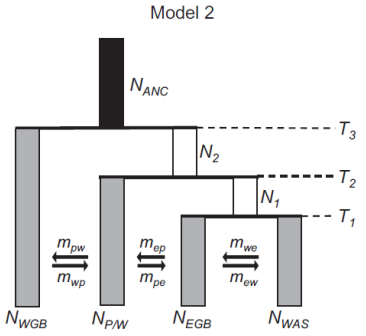
Evolutionary history – Bluebunch wheatgrass

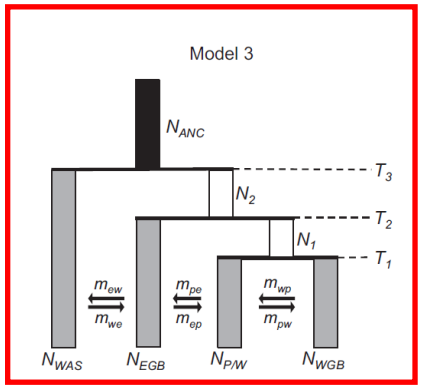


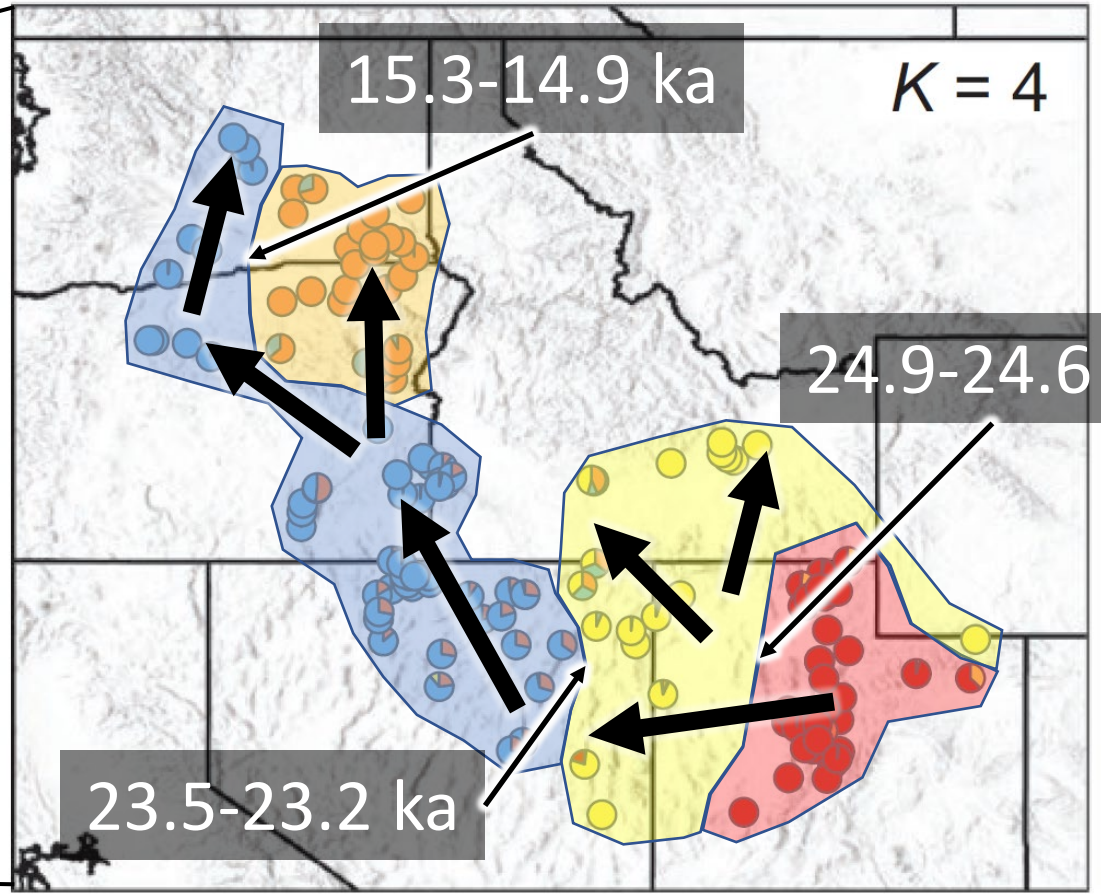




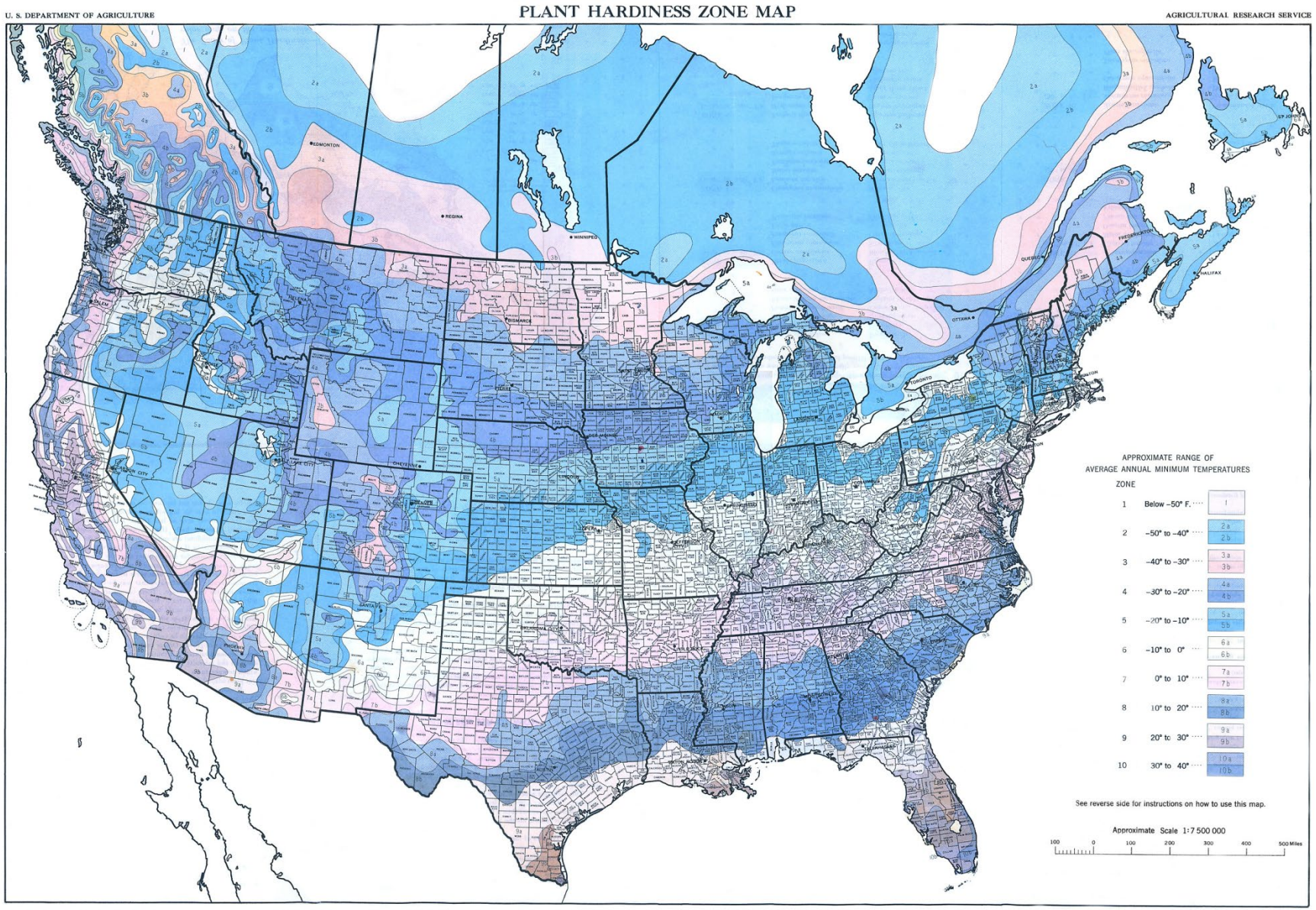




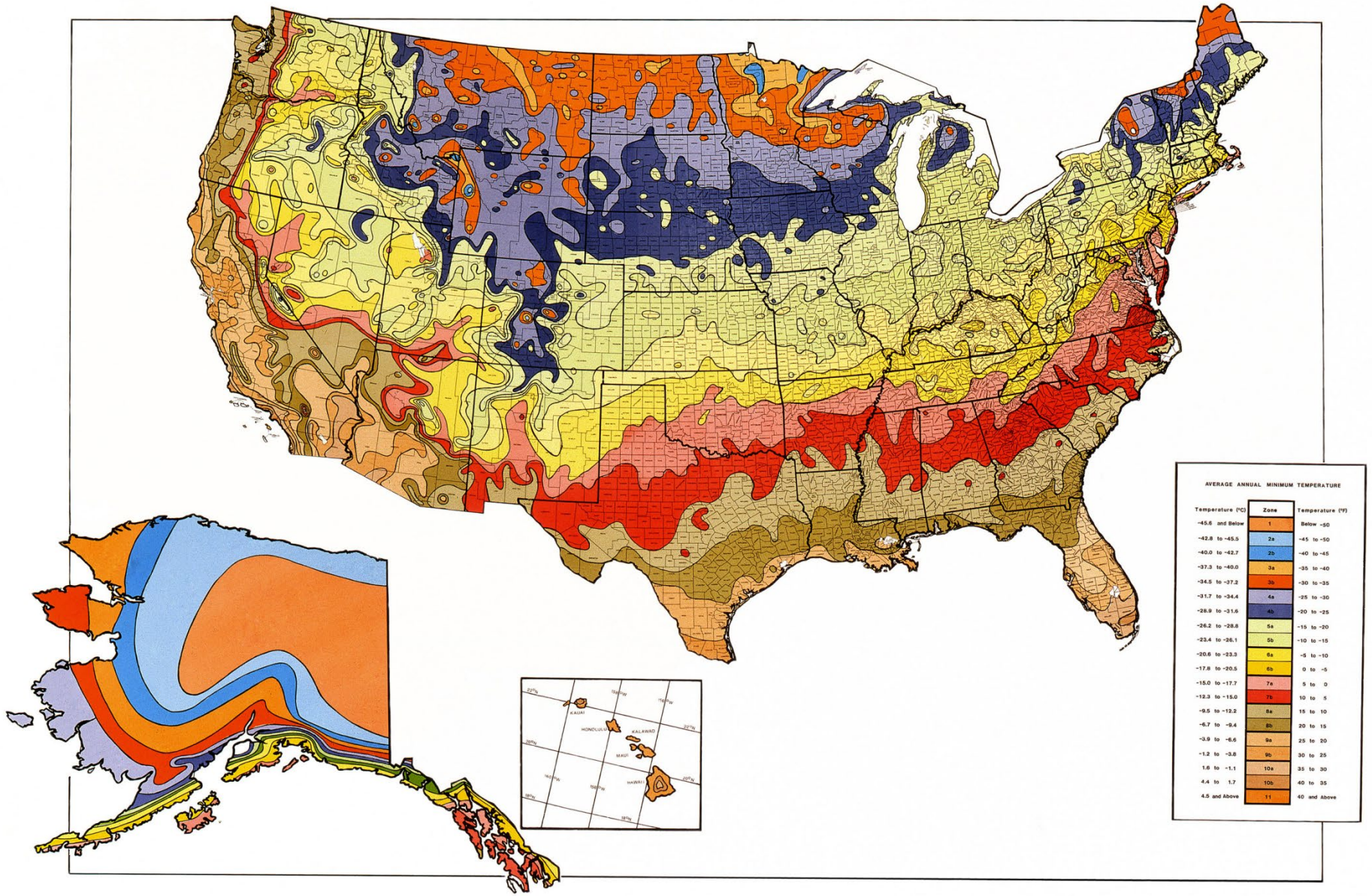




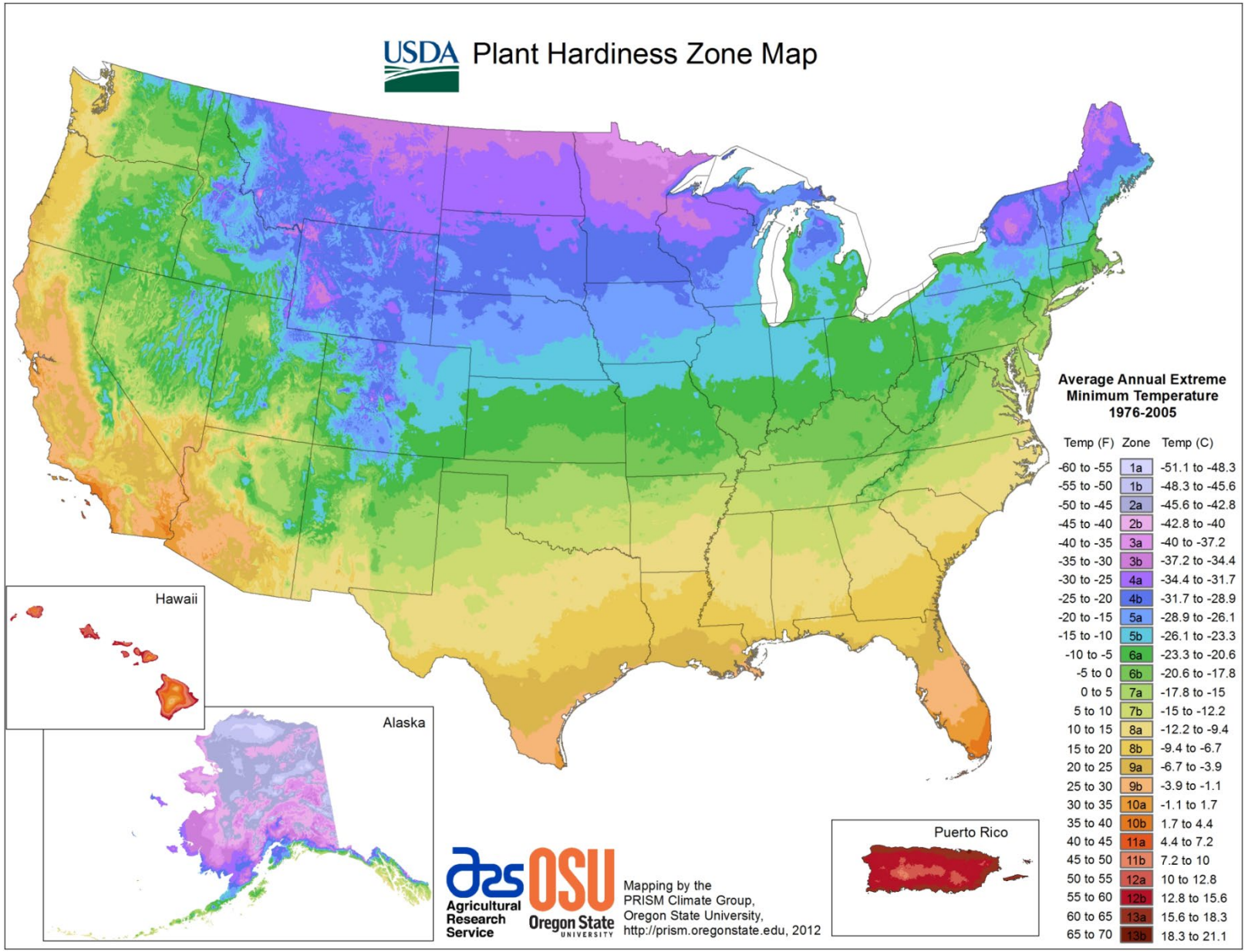
USDA Plant Hardiness Zones - 1960



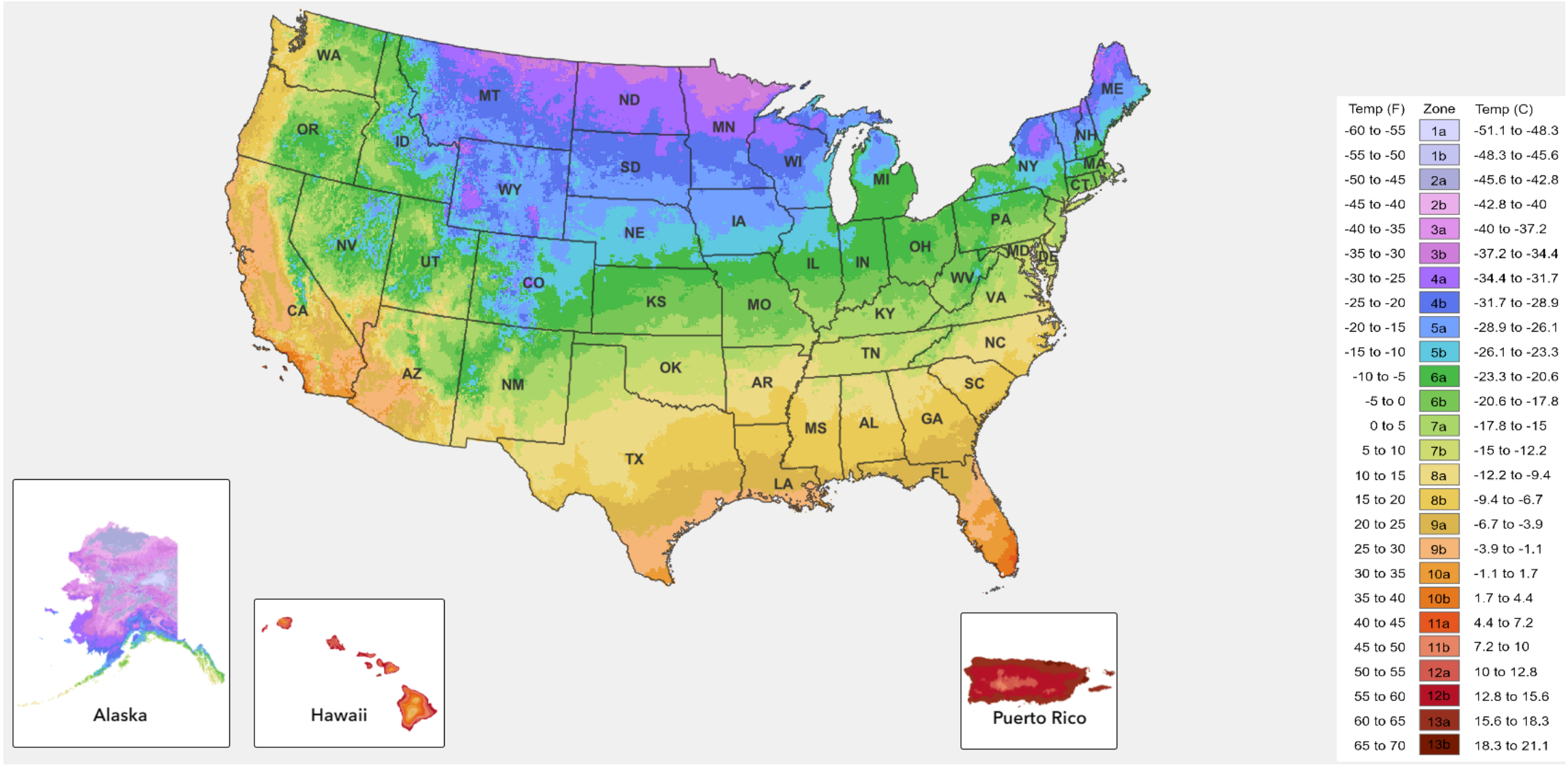
USDA Plant Hardiness Zones - 1990



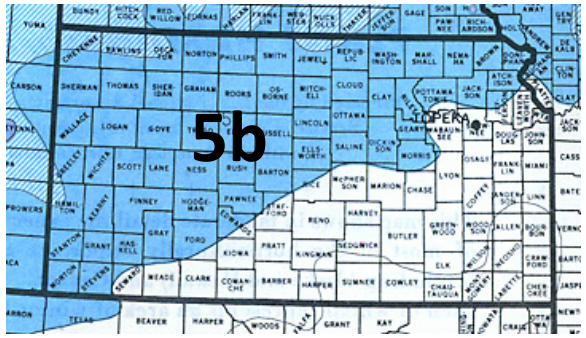
USDA Plant Hardiness Zones - 2012



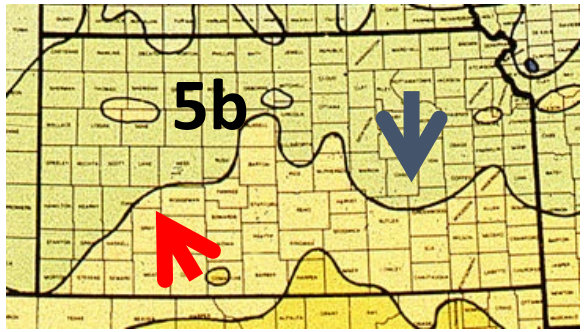
USDA Plant Hardiness Zones - 2023



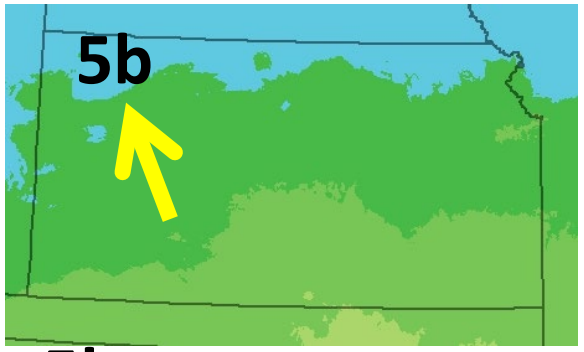
Temp (F)	Zone	Temp (C)
-60 to -55	1a	-51.1 to -48.3
-55 to -50	1b	-48.3 to -45.6
-50 to -45	2a	-45.6 to -42.8
-45 to -40	2b	-42.8 to -40
-40 to -35	3a	-40 to -37.2
-35 to -30	3b	-37.2 to -34.4
-30 to -25	4a	-34.4 to -31.7
-25 to -20	4b	-31.7 to -28.9
-20 to -15	5a	-28.9 to -26.1
-15 to -10	5b	-26.1 to -23.3
-10 to -5	6a	-23.3 to -20.6
-5 to 0	6b	-20.6 to -17.8
0 to 5	7a	-17.8 to -15
5 to 10	7b	-15 to -12.2
10 to 15	8a	-12.2 to -9.4
15 to 20	8b	-9.4 to -6.7
20 to 25	9a	-6.7 to -3.9
25 to 30	9b	-3.9 to -1.1
30 to 35	10a	-1.1 to 1.7
35 to 40	10b	1.7 to 4.4
40 to 45	11a	4.4 to 7.2
45 to 50	11b	7.2 to 10
50 to 55	12a	10 to 12.8
55 to 60	12b	12.8 to 15.6
60 to 65	13a	15.6 to 18.3
65 to 70	13b	18.3 to 21.1



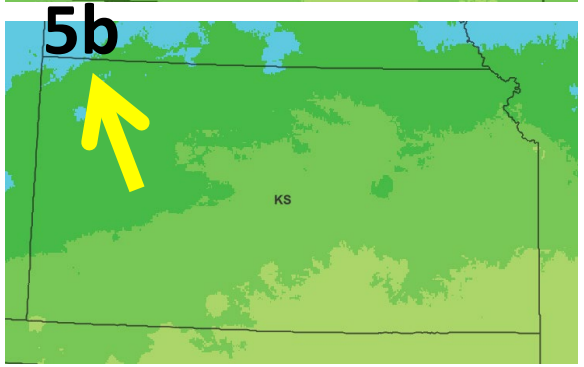
1960 – Relatively stable



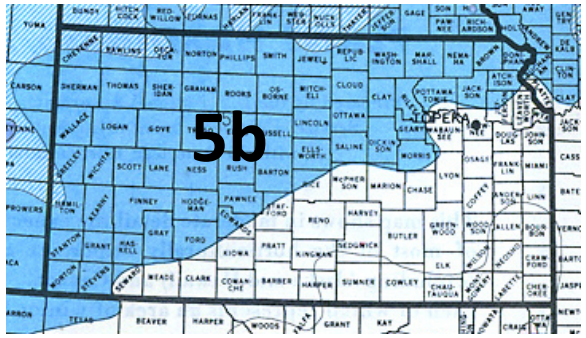
1990 – Minor shifts, both warmer and cooler

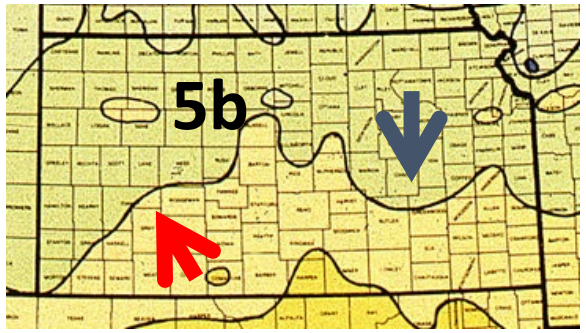


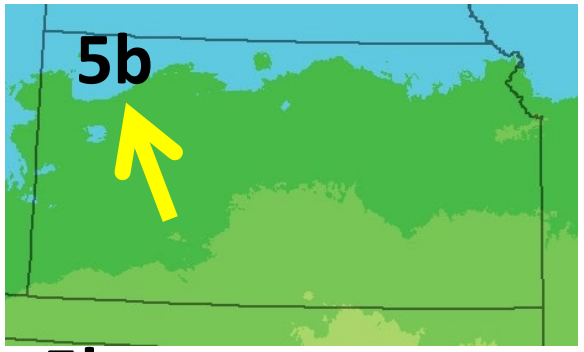
2012 – Major shifts, all warmer

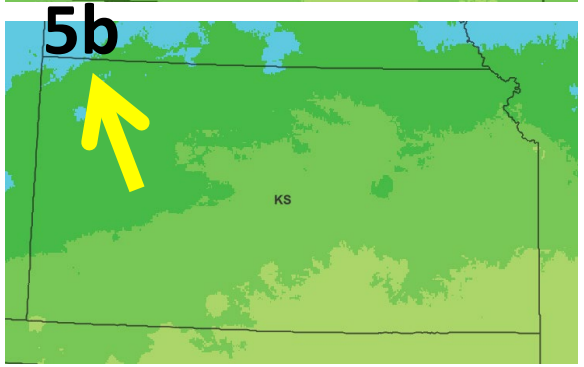


2023 – Continued major shifts, all warmer









"Toto, I've a feeling ~~we're~~ not in Kansas anymore."

5b is

Seed transfer zones – A taxonomy

Species-specific

Provisional

Generalized

Ecological niche models

Empirical

Adaptive variation

Neutral variation

Adaptive loci

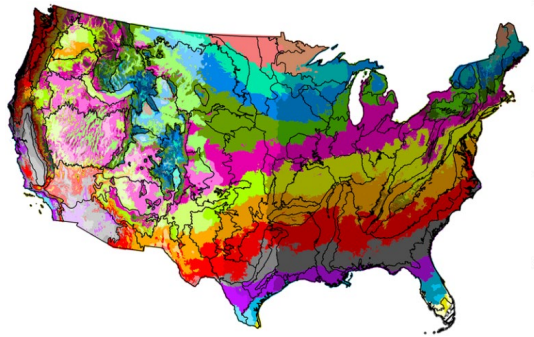
DNA markers

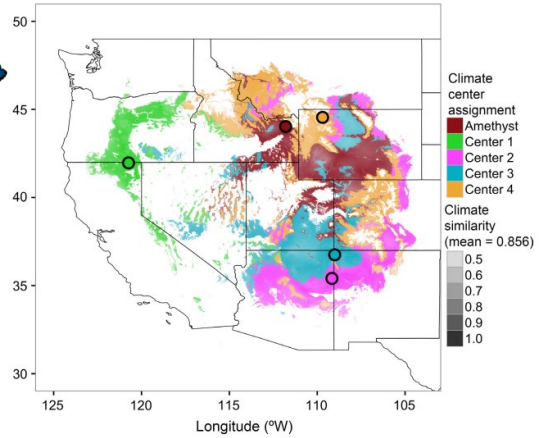
Genecological common garden

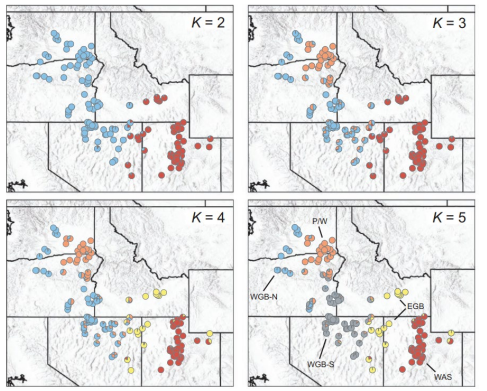
Common garden array

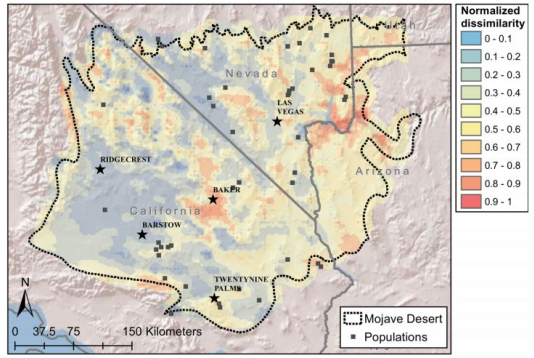
Reciprocal transplant

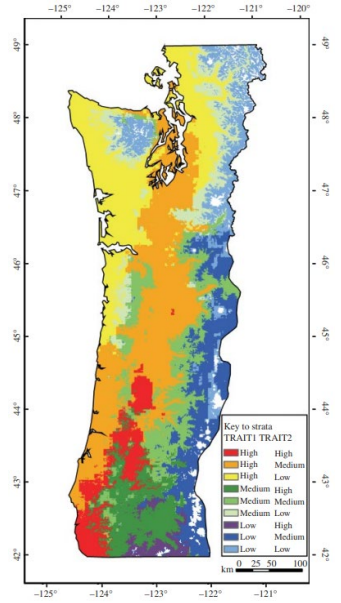
Common gardens

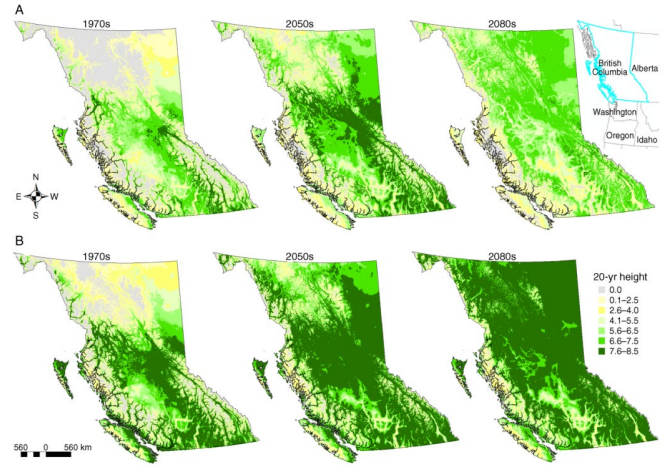












Seed transfer zones – Provisional vs. empirical

Species-specific

Provisional

Generalized

Ecological niche models

Empirical

Adaptive variation

Neutral variation

Adaptive loci

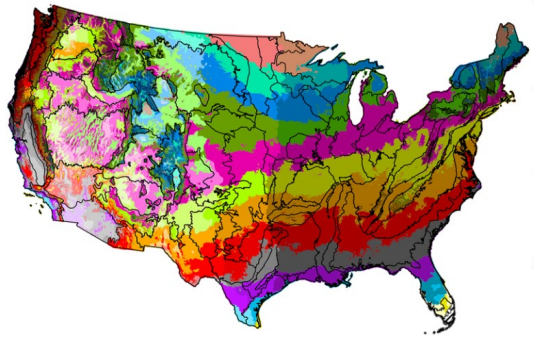
DNA markers

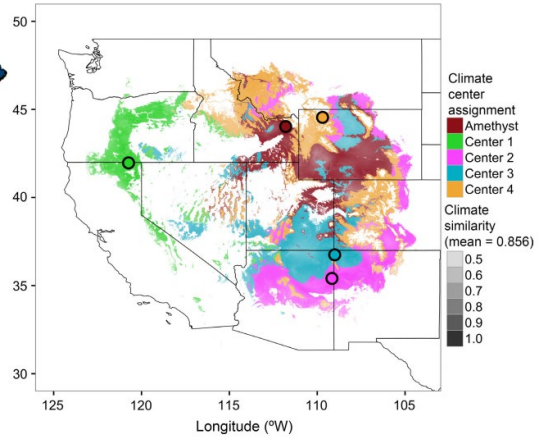
Genecological common garden

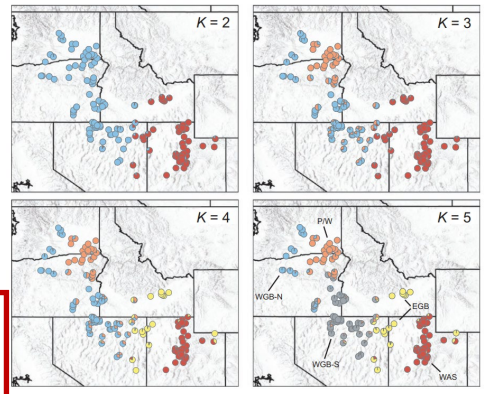
Common garden array

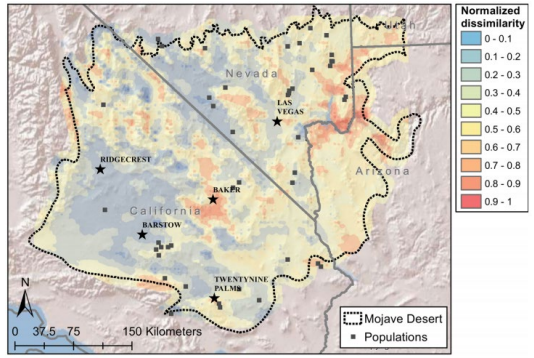
Reciprocal transplant

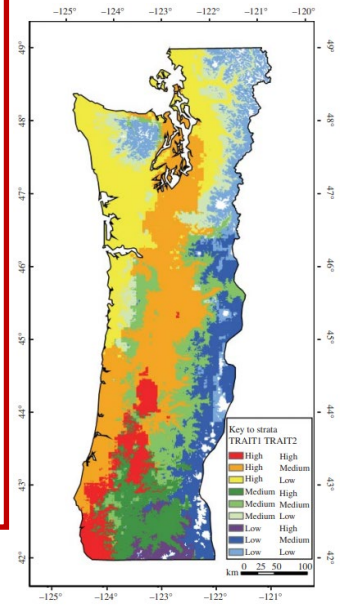
Common gardens

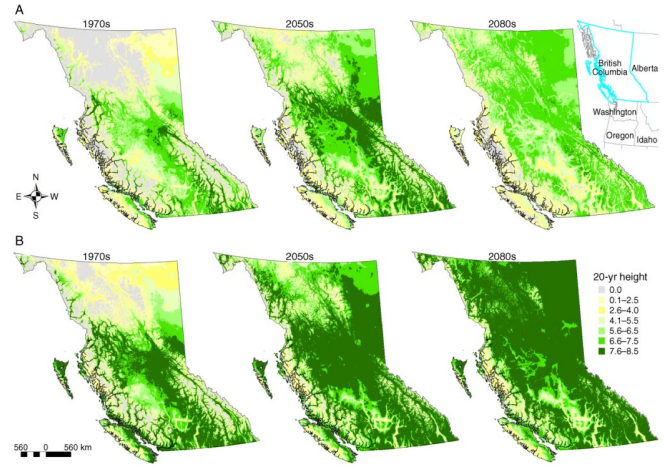












Seed transfer zones – Generalized vs. species-specific

Species-specific

Provisional

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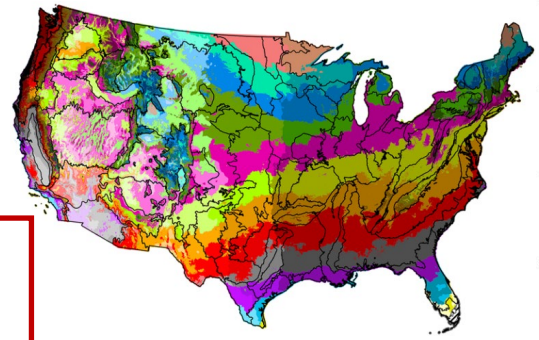

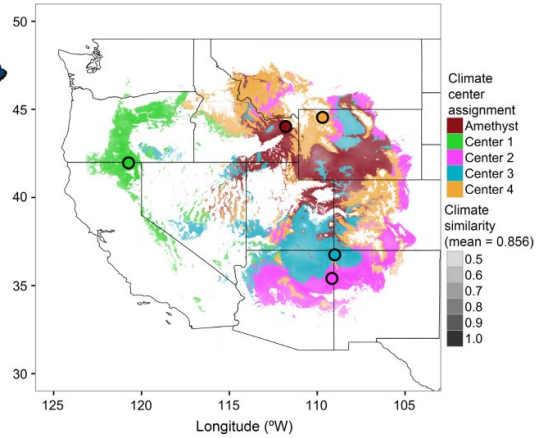

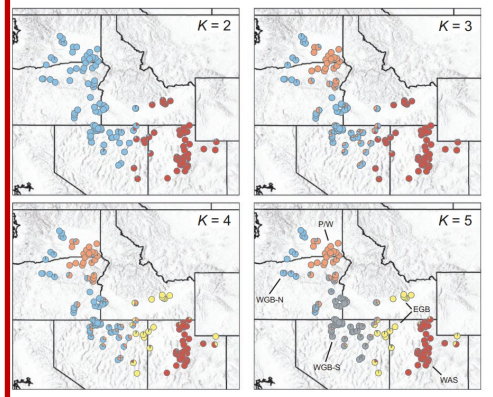

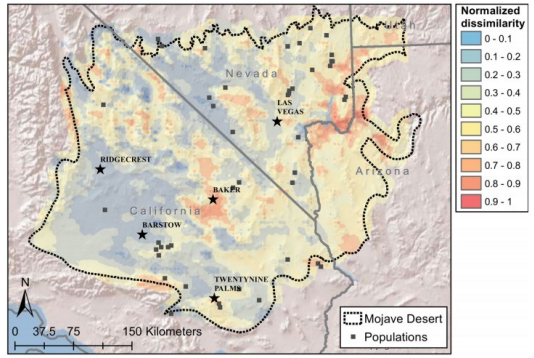

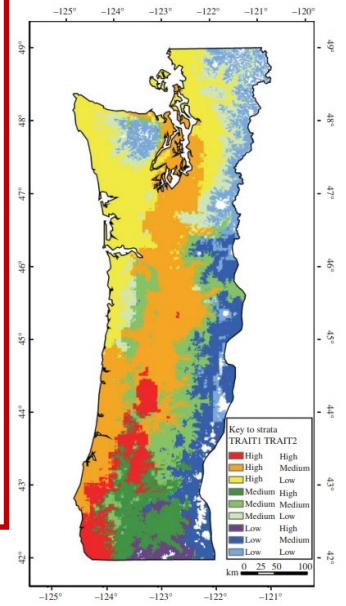

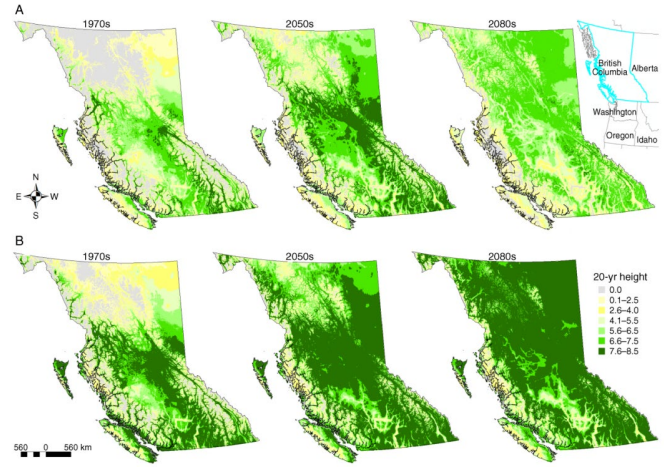

Seed transfer zones – Adaptive phenotypes vs. DNA markers

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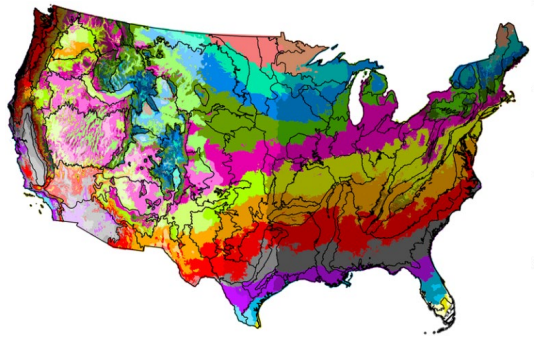
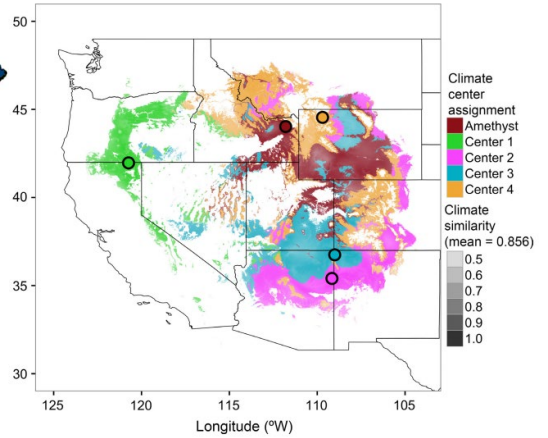
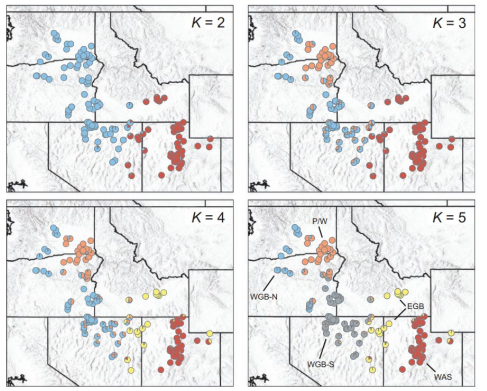
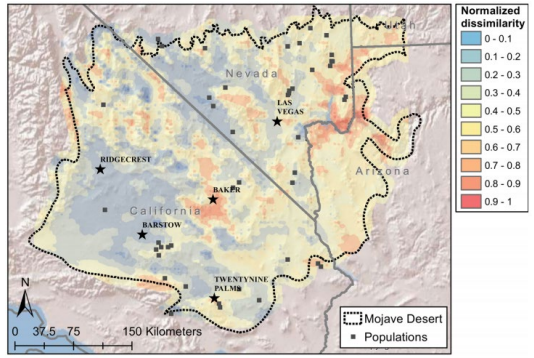
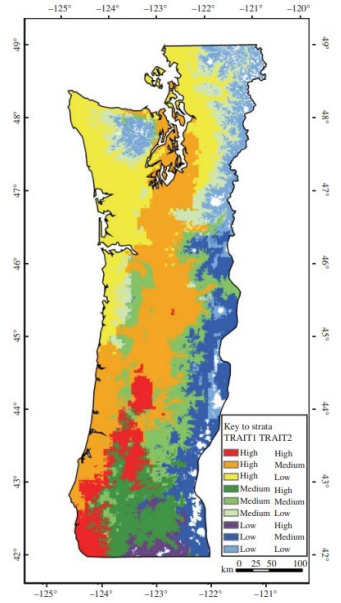
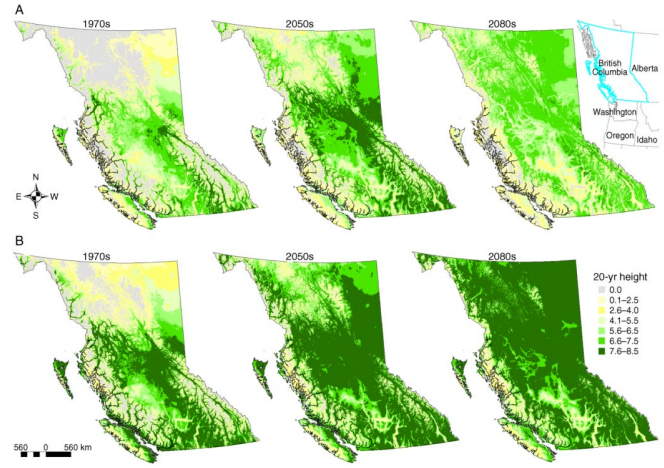






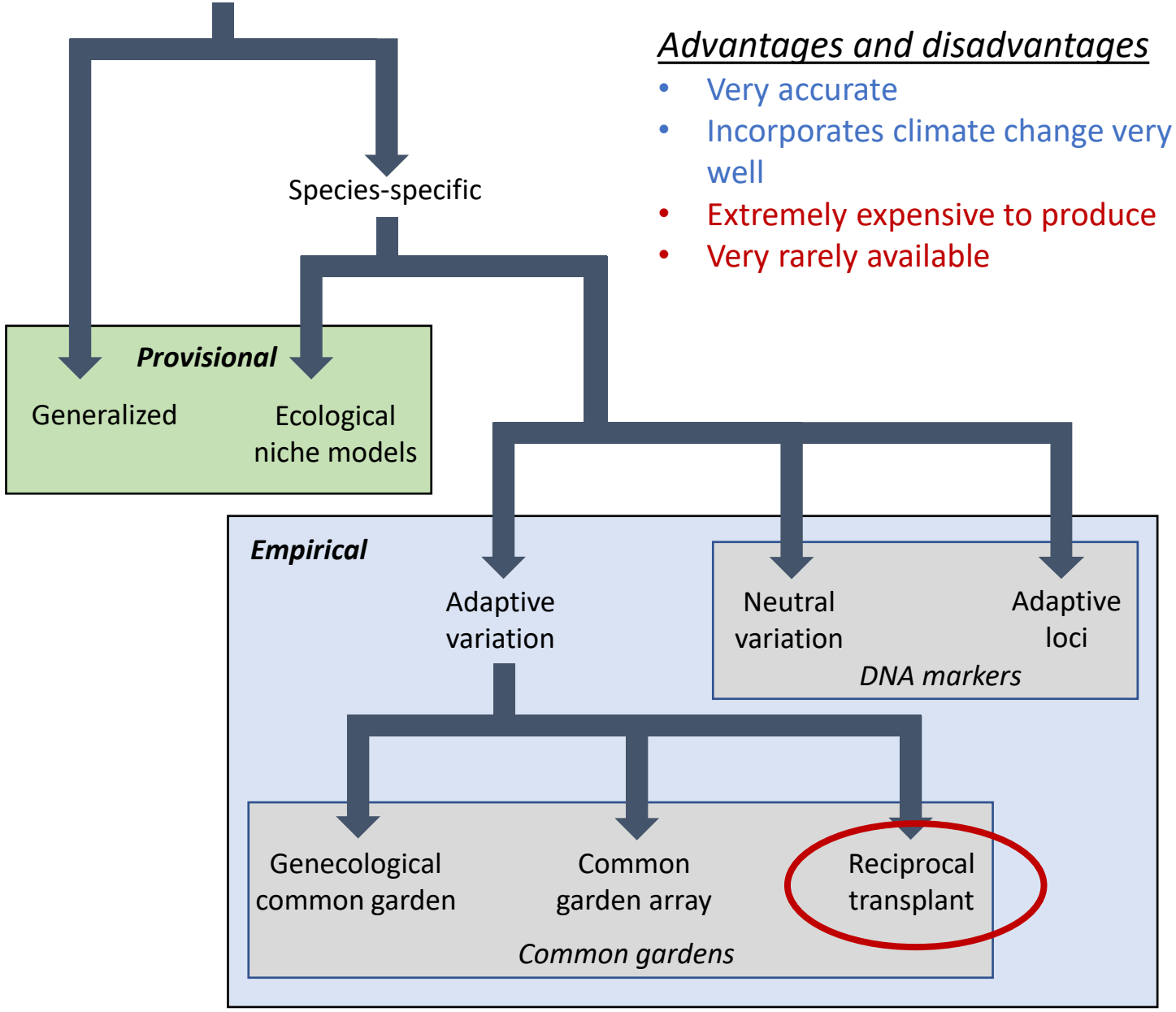






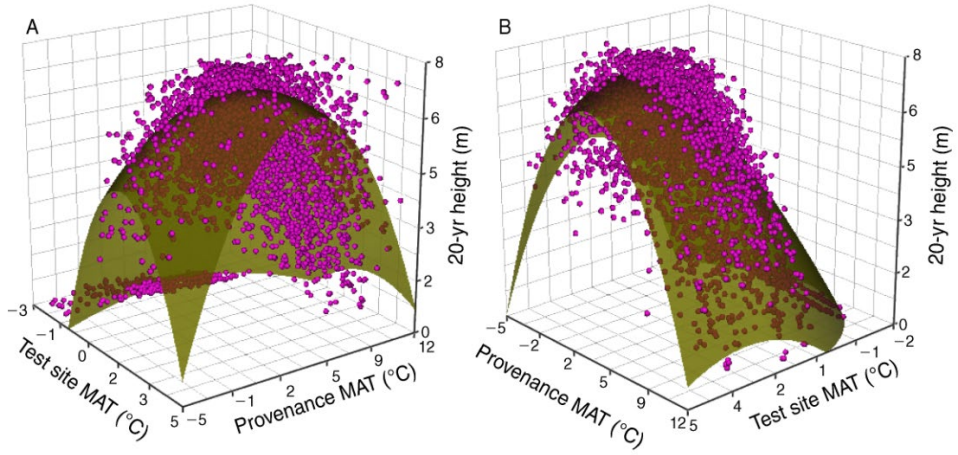
Traditional seed transfer methods

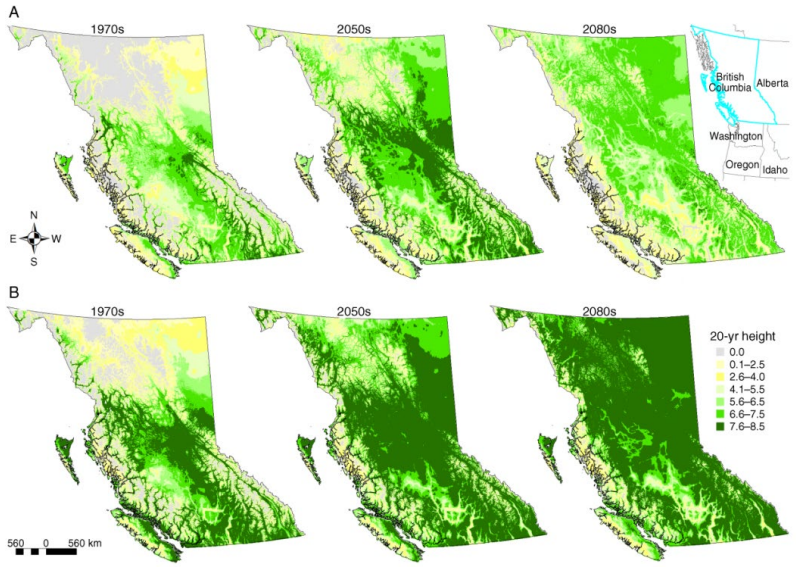
Seed transfer zones – Reciprocal transplant studies



Advantages and disadvantages

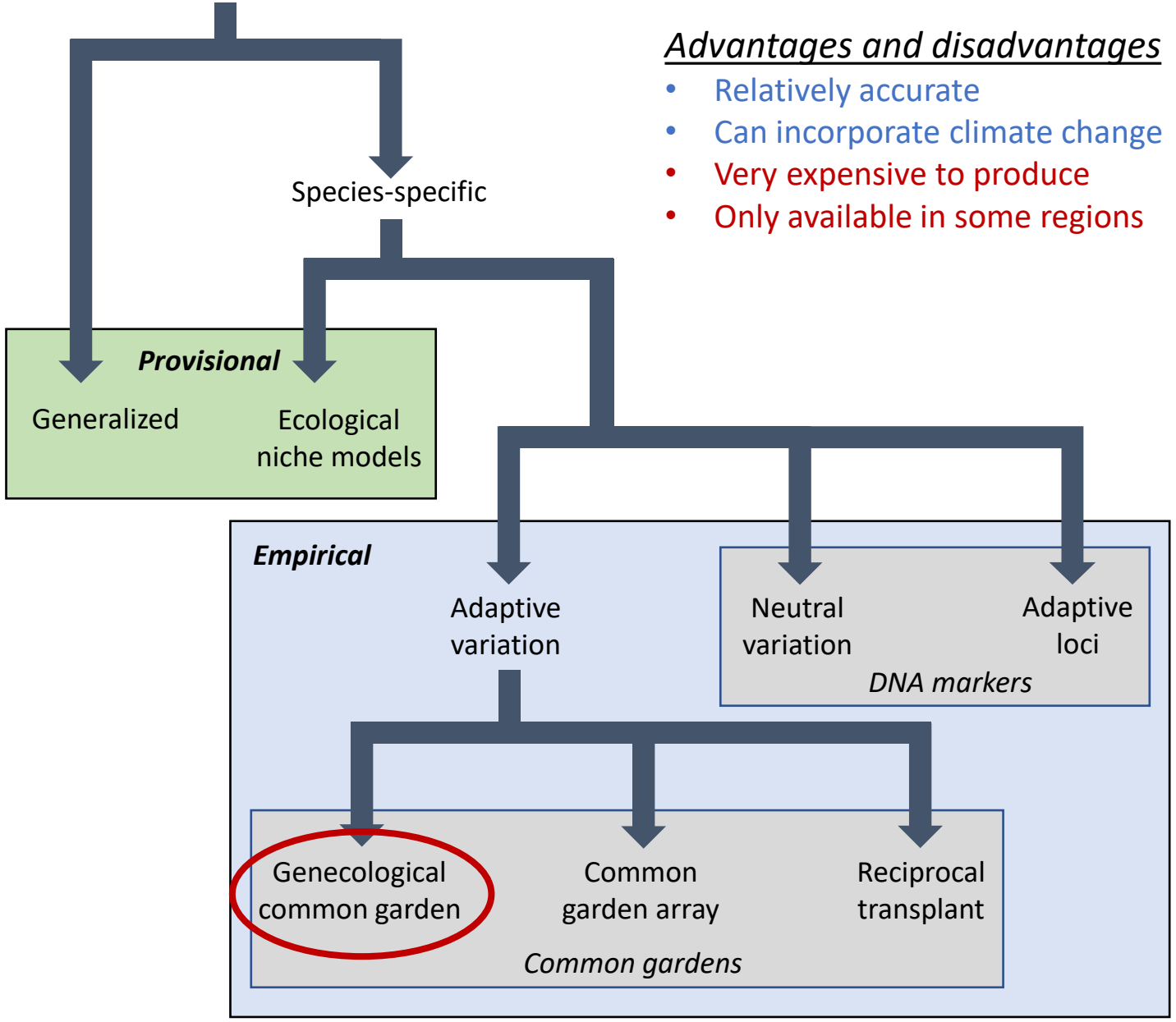
- Very accurate
- Incorporates climate change very well
- Extremely expensive to produce
- Very rarely available





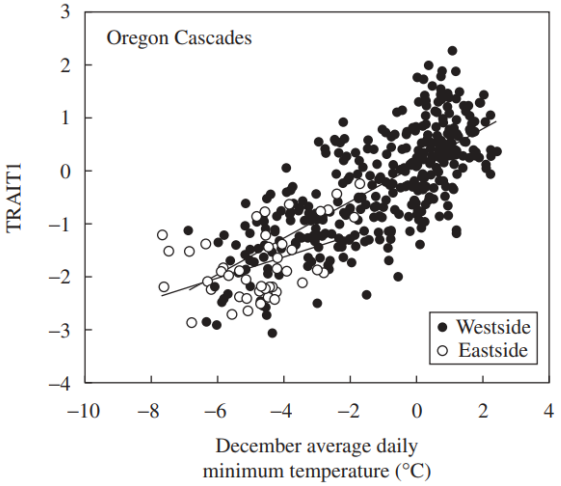
Wang et al. 2010. *Ecological Applications*, 20: 153–163

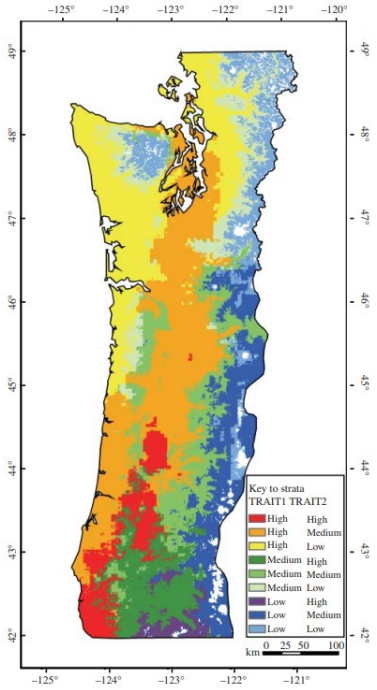
Seed transfer zones – Genecological common gardens



Advantages and disadvantages

- Relatively accurate
- Can incorporate climate change
- Very expensive to produce
- Only available in some regions



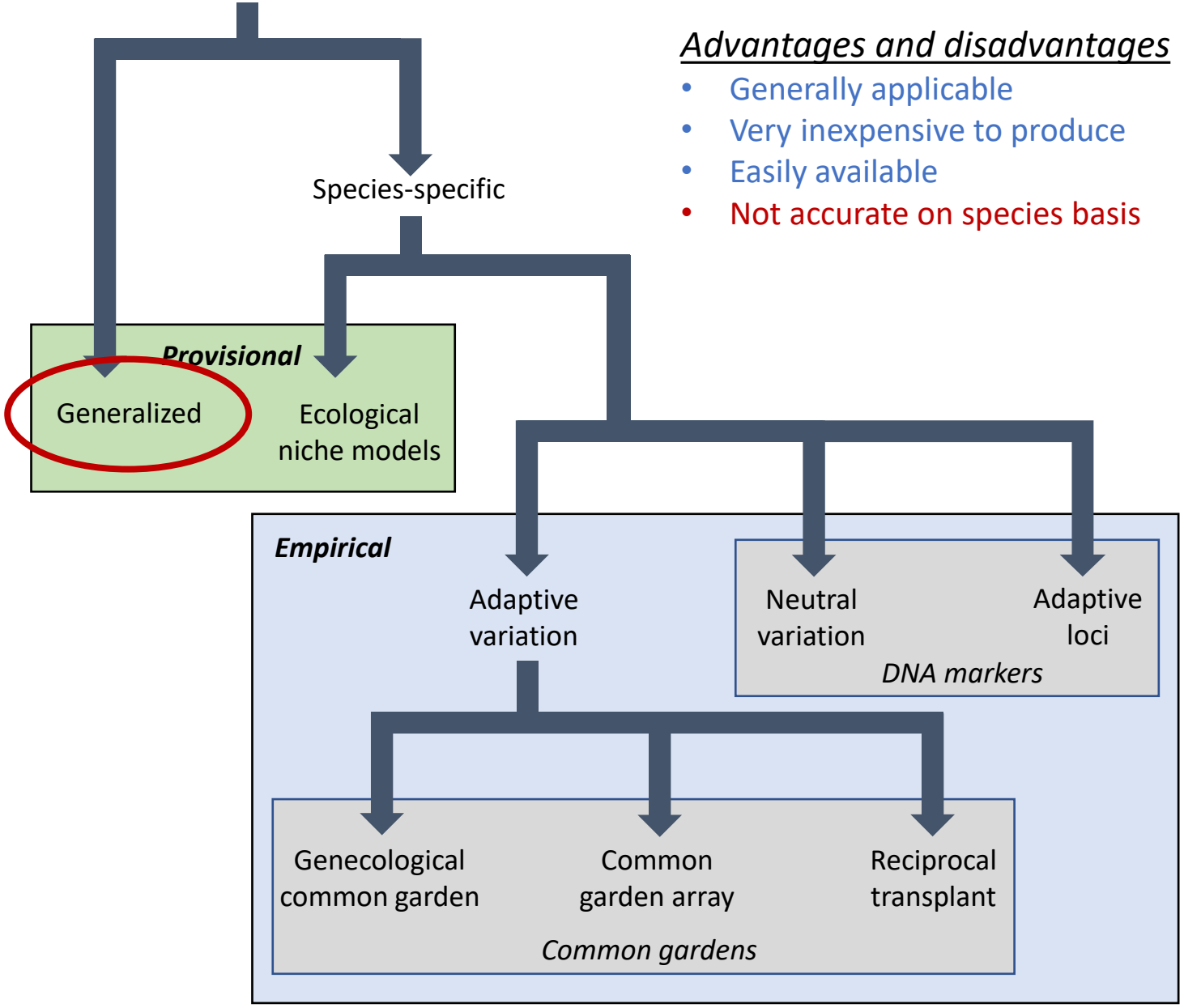


St. Clair et al. 2005, *Annals of Botany* 96: 1199-1214

Alternative seed transfer zone methods

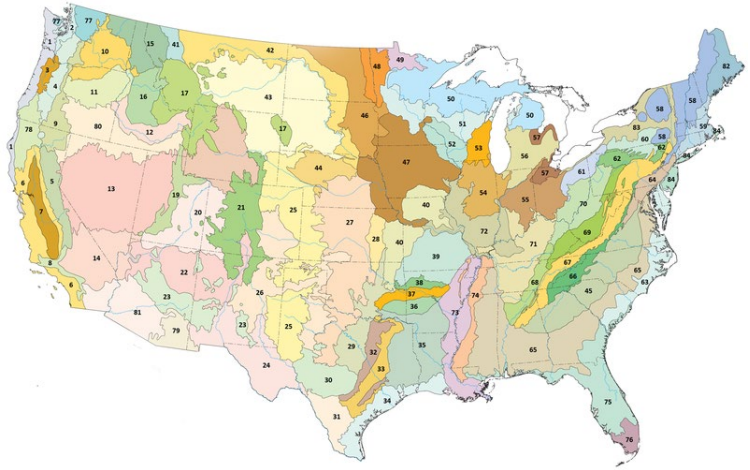
More cost-effective methods?

Seed transfer zones – Generalized seed zones

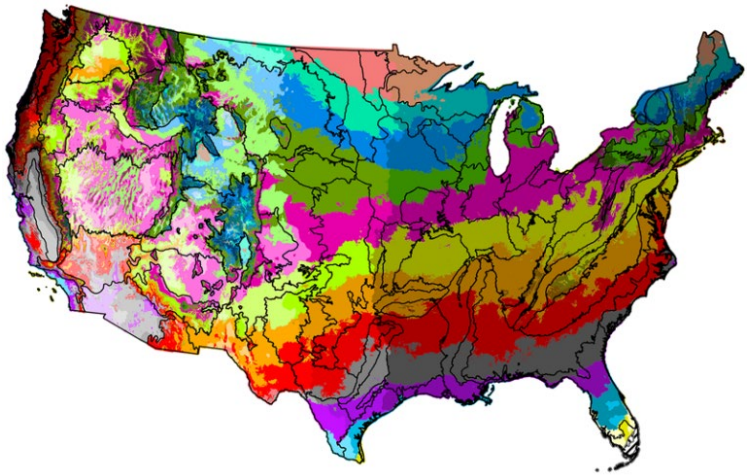


Advantages and disadvantages

- Generally applicable
- Very inexpensive to produce
- Easily available
- Not accurate on species basis

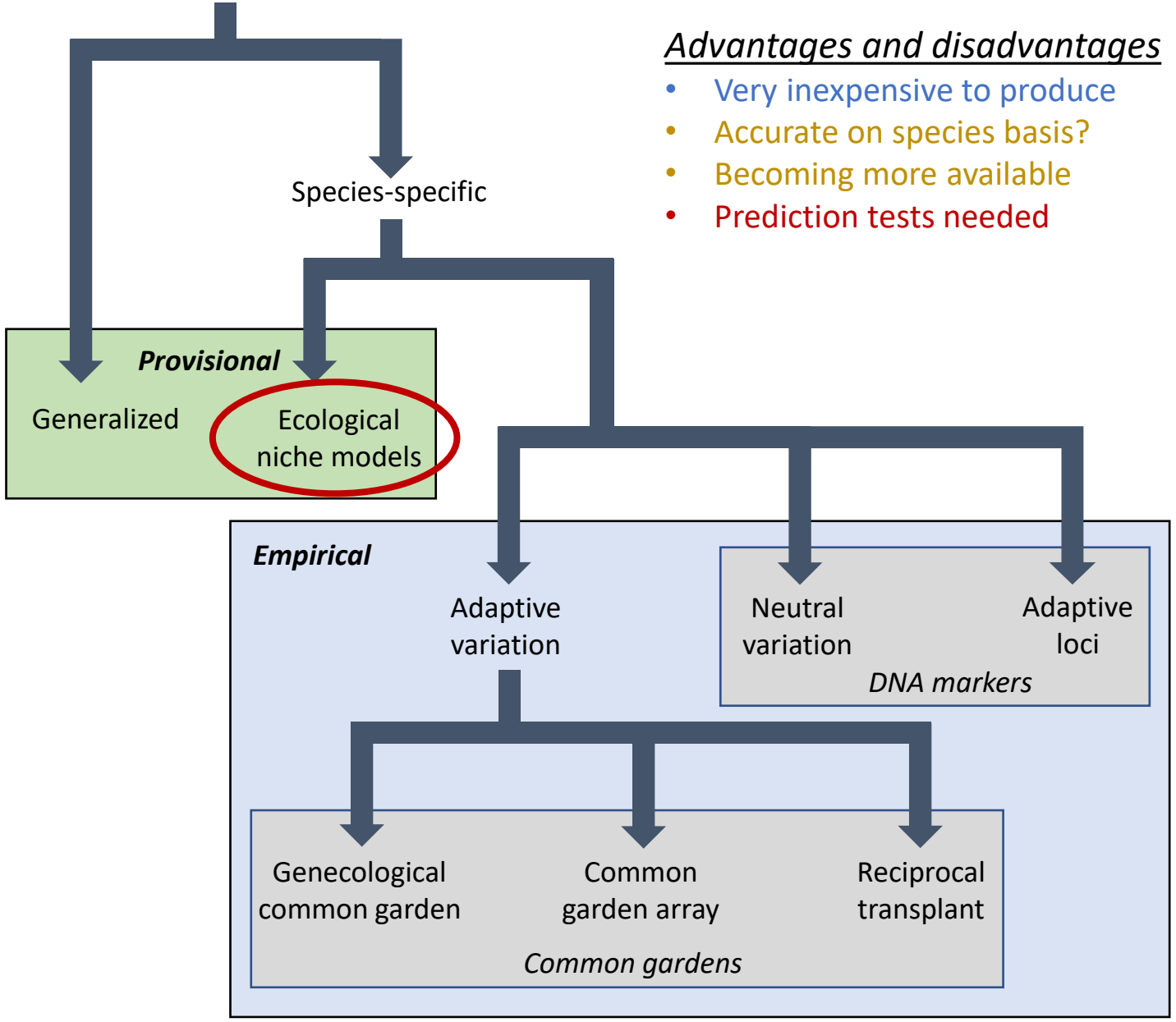


Omernik. 1987. *AAAG*, 77: 118–125



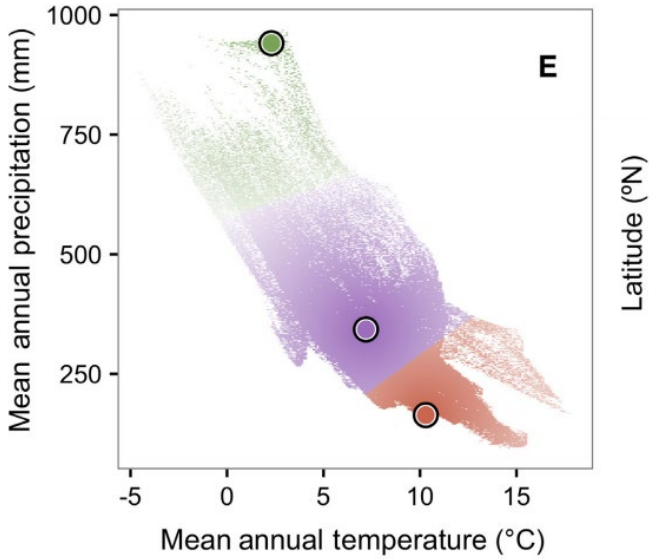
Bower et al. 2014. *Ecological Applications*, 24: 913–919

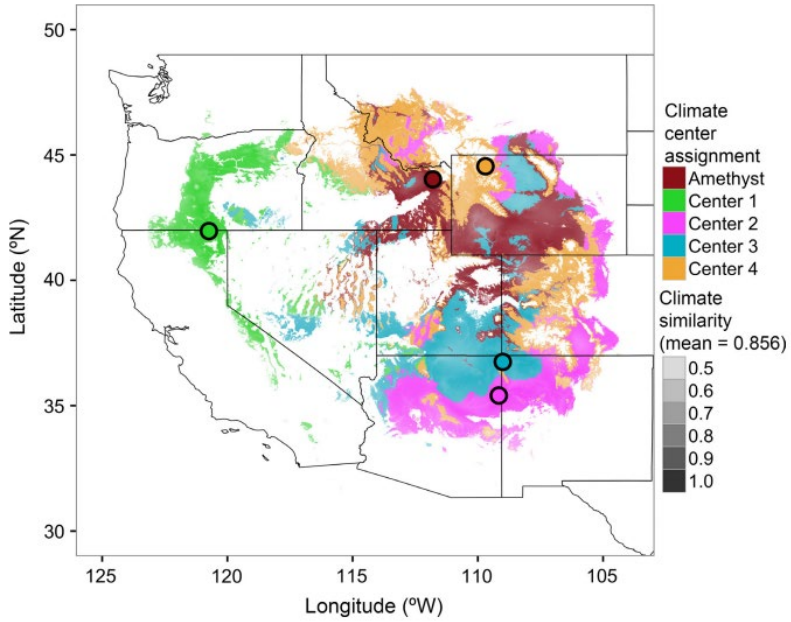
Seed transfer zones – Ecological niche models



Advantages and disadvantages

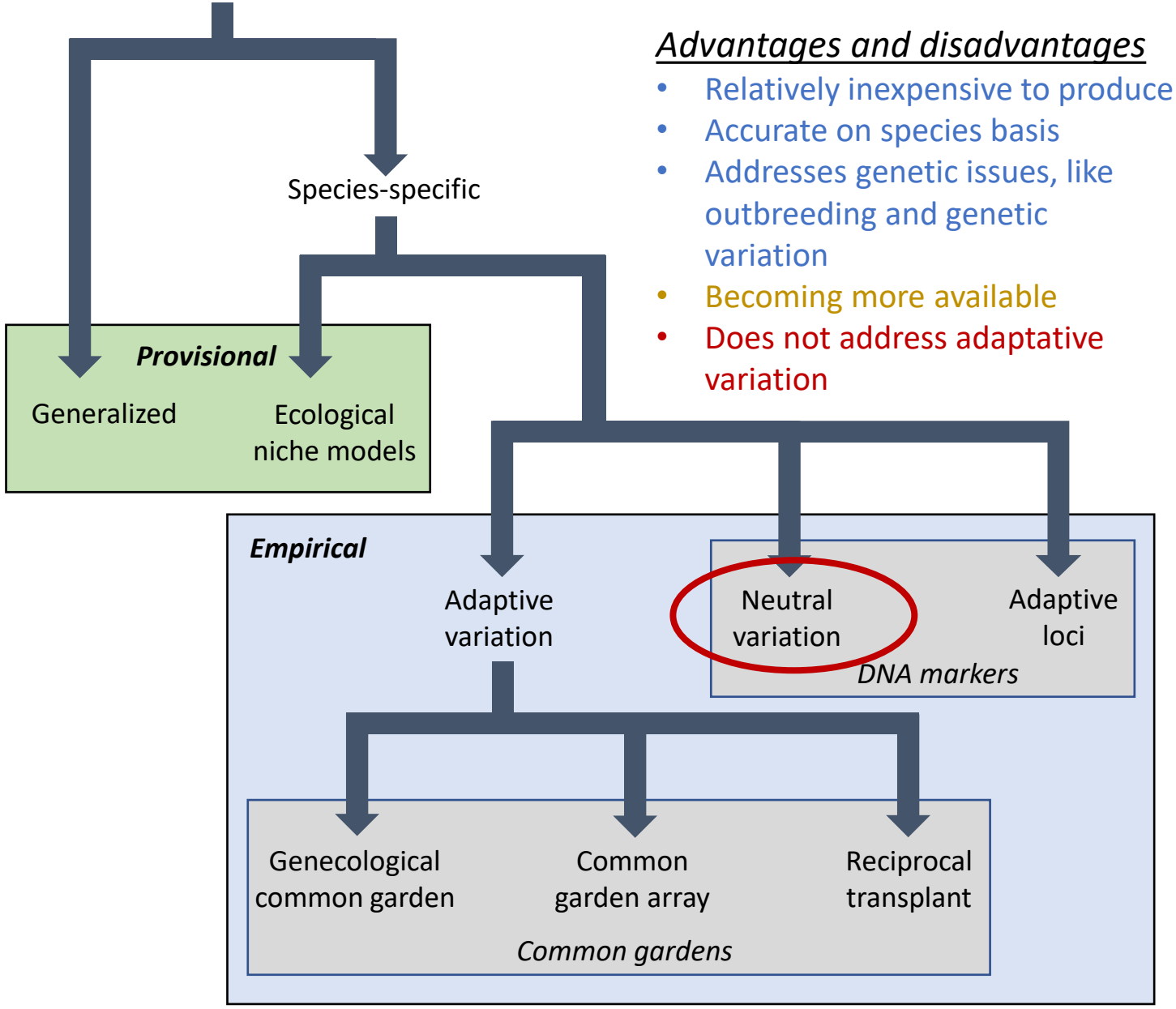
- Very inexpensive to produce
- Accurate on species basis?
- Becoming more available
- Prediction tests needed





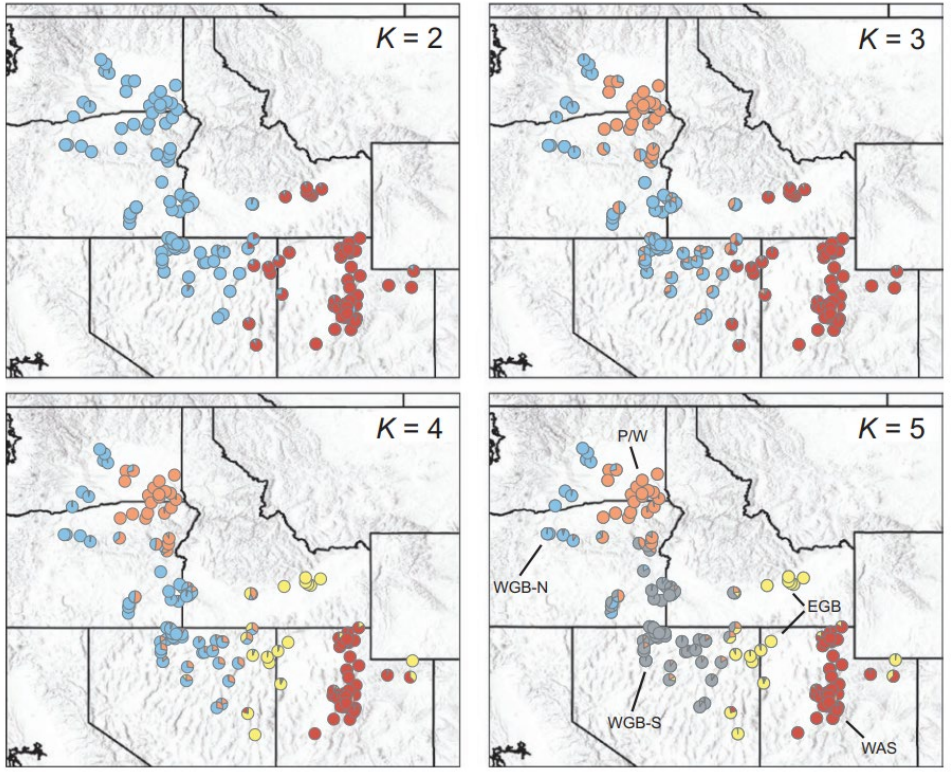
Doherty et al. 2017. *Ecological Applications*, 27: 1010–1023

Seed transfer zones – Neutral genetic variation



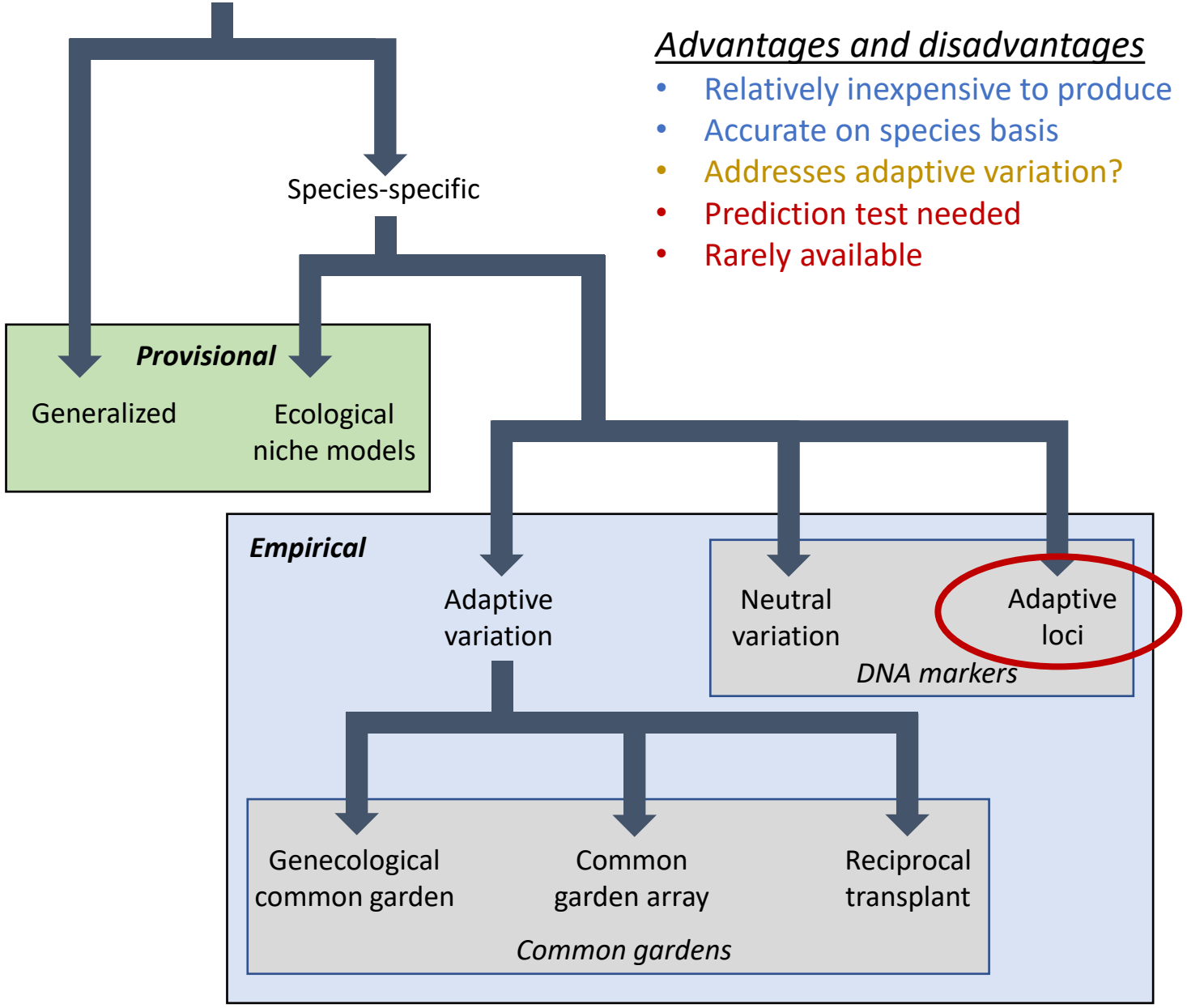
Advantages and disadvantages

- Relatively inexpensive to produce
- Accurate on species basis
- Addresses genetic issues, like outbreeding and genetic variation
- Becoming more available
- Does not address adaptative variation



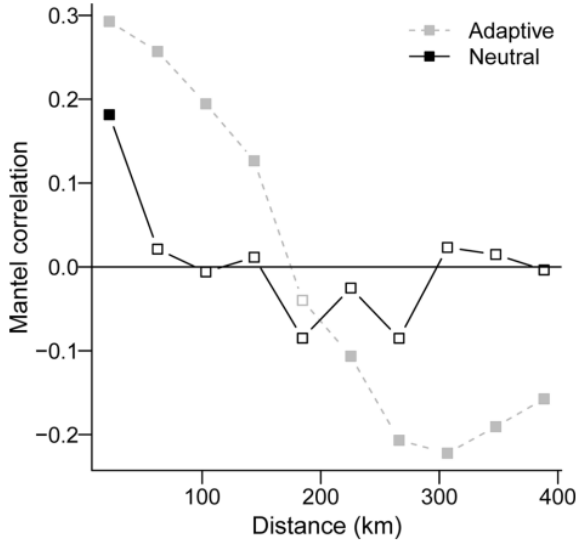
Massatti et al. 2018, *Evolutionary Applications* 11: 2025-2039

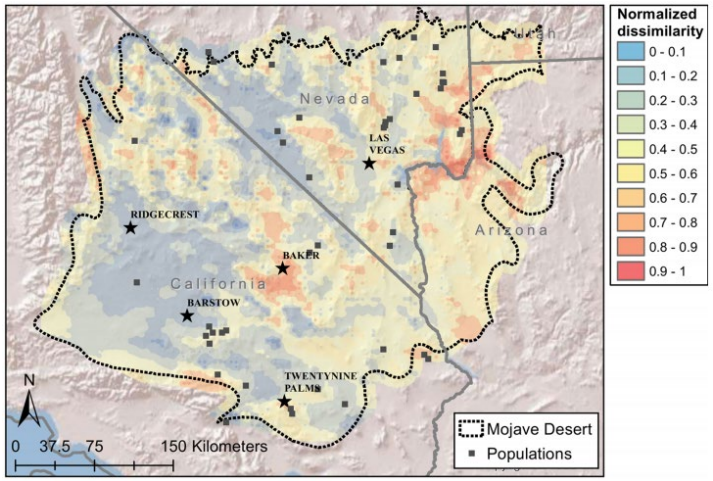
Seed transfer zones – Adaptive loci DNA markers



Advantages and disadvantages

- Relatively inexpensive to produce
- Accurate on species basis
- Addresses adaptive variation?
- Prediction test needed
- Rarely available

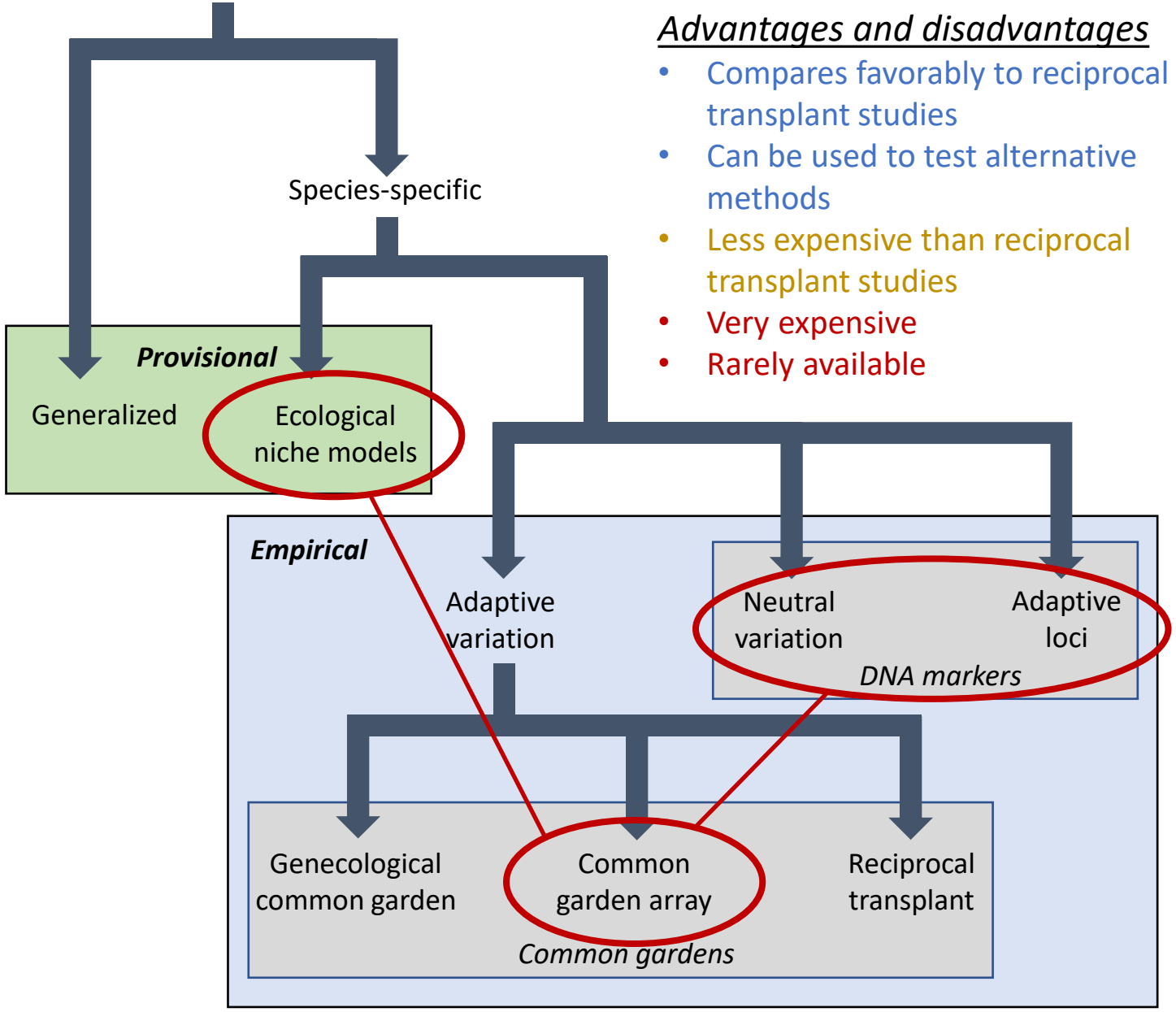




Shryock et al. 2015. *Conservation Genetics*, 16: 1303–1317

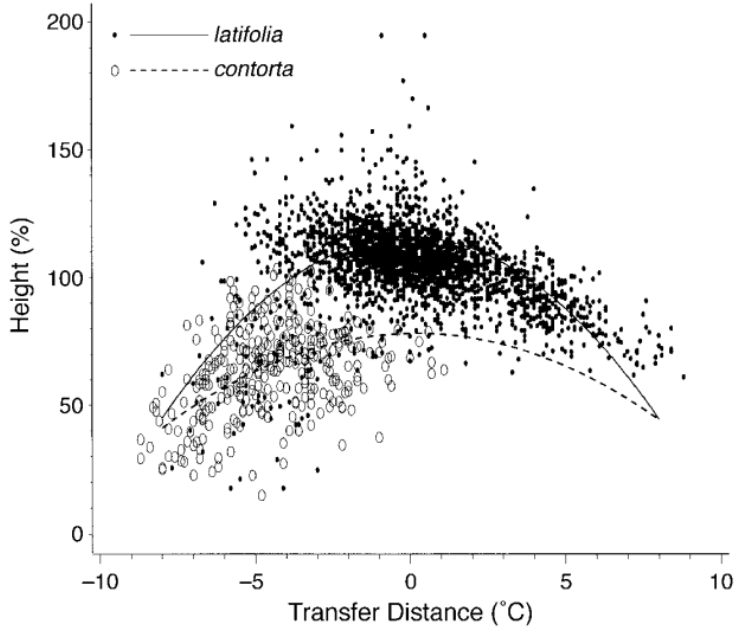
How can we test alternative methods?

Seed transfer zones – Common garden array

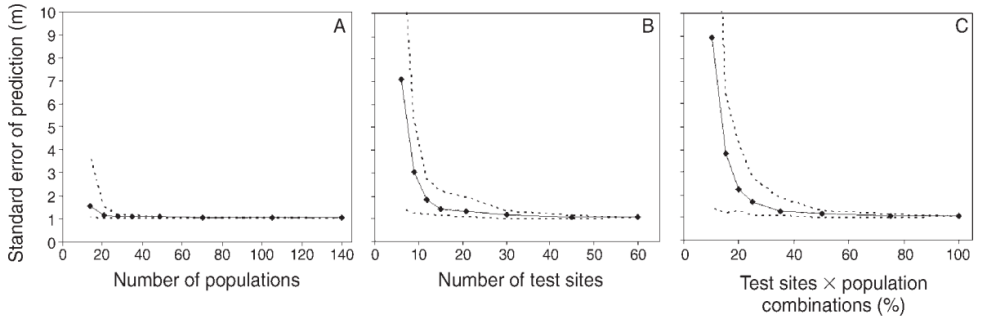


Advantages and disadvantages

- Compares favorably to reciprocal transplant studies
- Can be used to test alternative methods
- Less expensive than reciprocal transplant studies
- Very expensive
- Rarely available

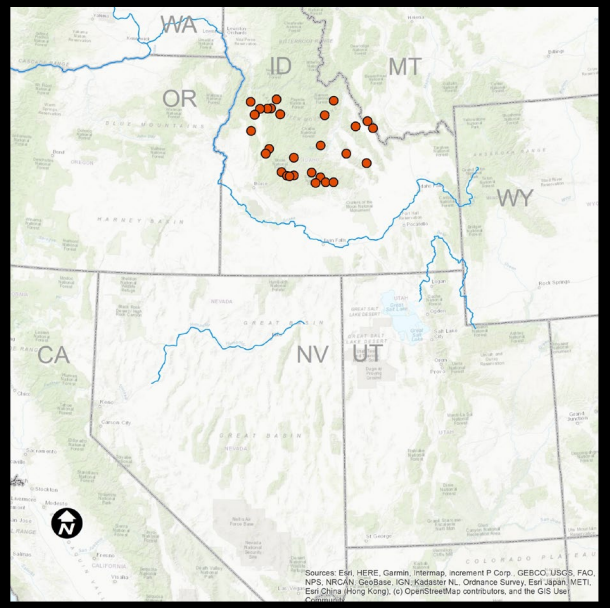


Rehfeldt et al. 1999, *Ecological Monographs* 69: 375-407

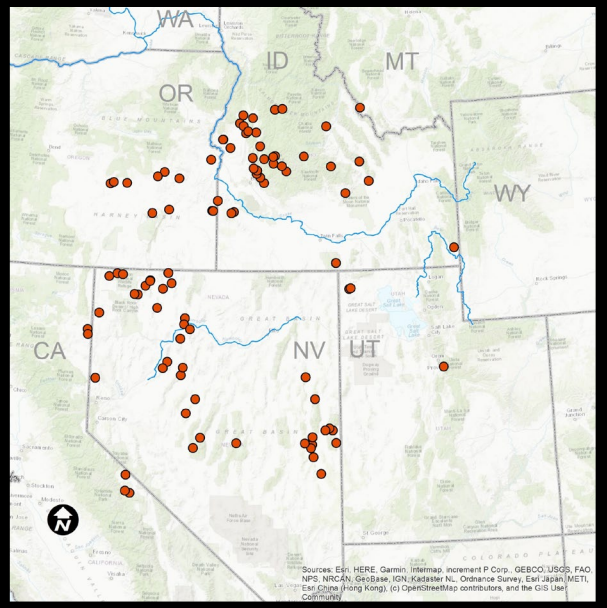


Wang et al. 2010. *Ecological Applications*, 20: 153–163

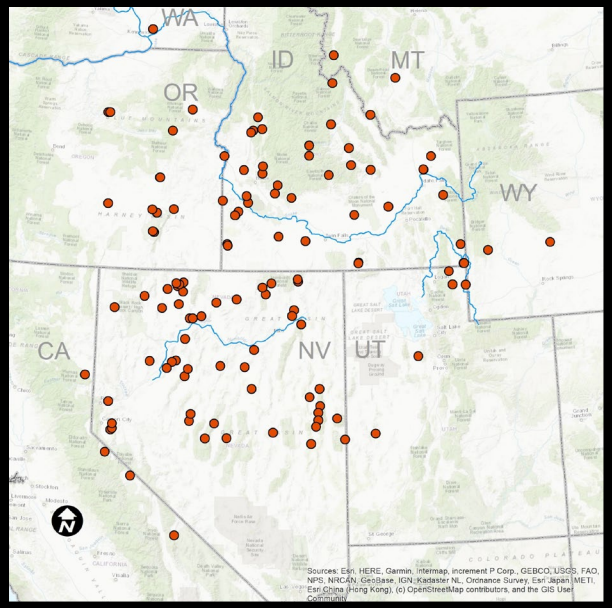
Erigeron speciosus



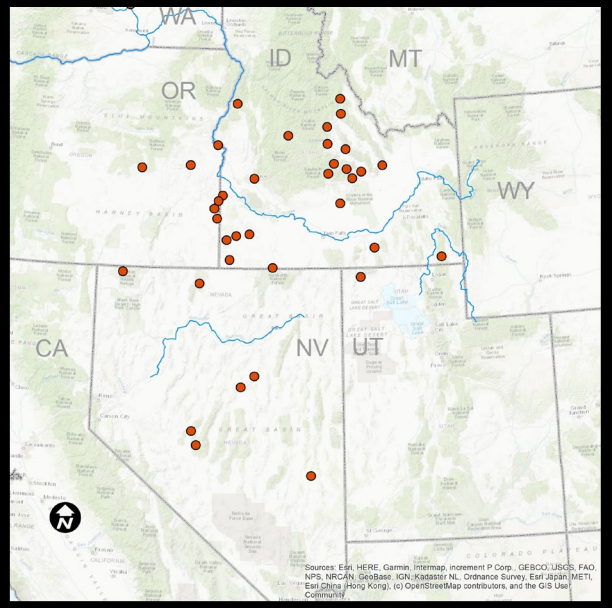
Chaenactis douglasii



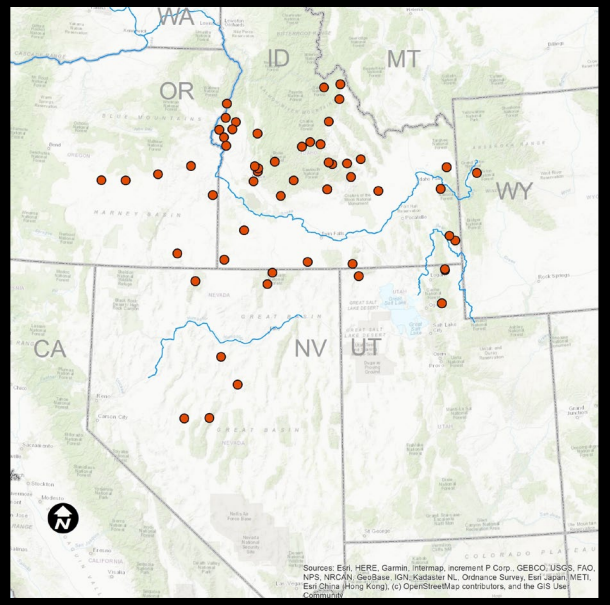
Machaeranthera canescens



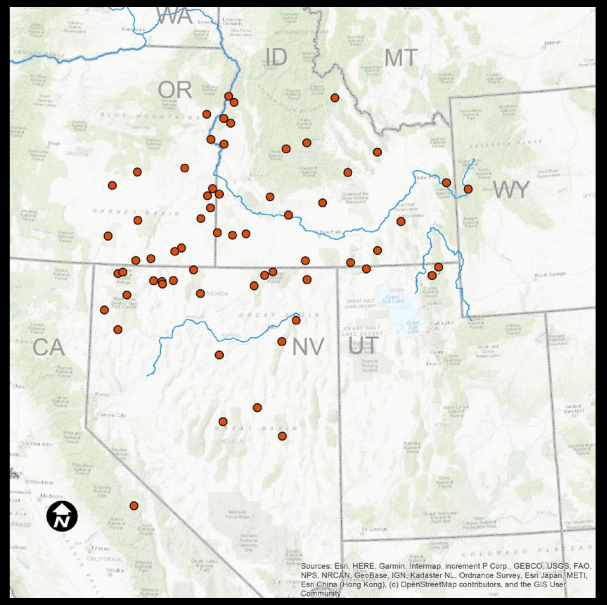
Erigeron pumilus



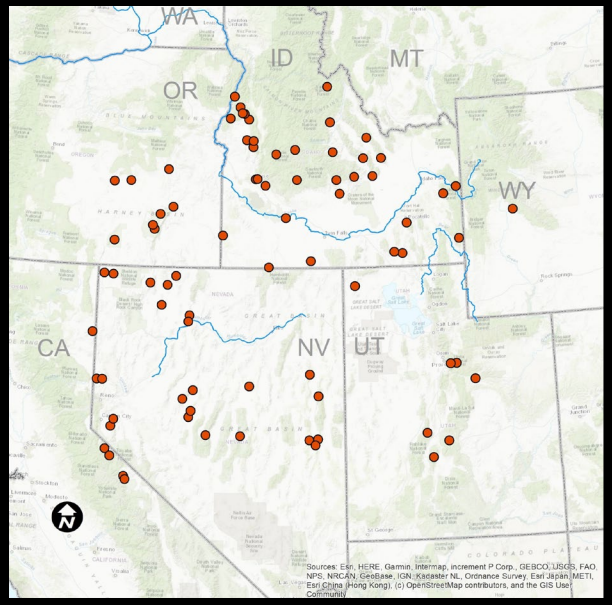
Phacelia hastata



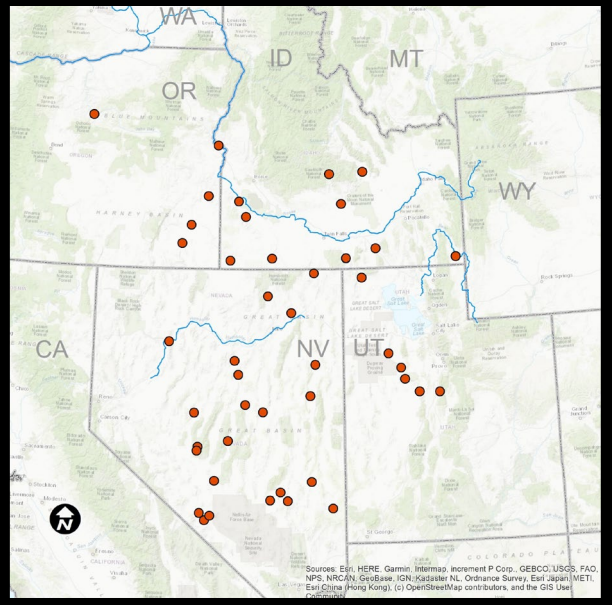
Balsamorhiza sagitata

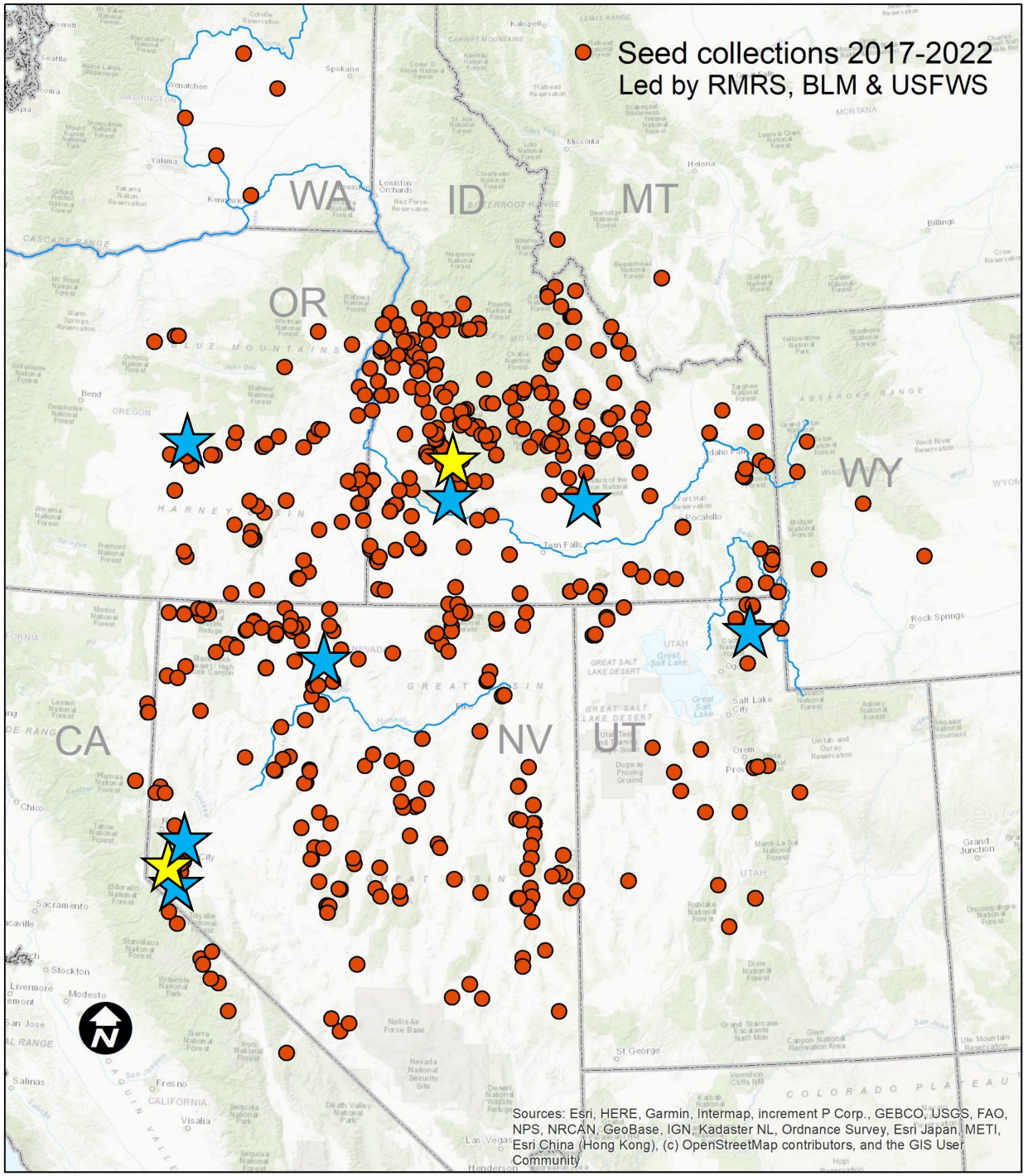


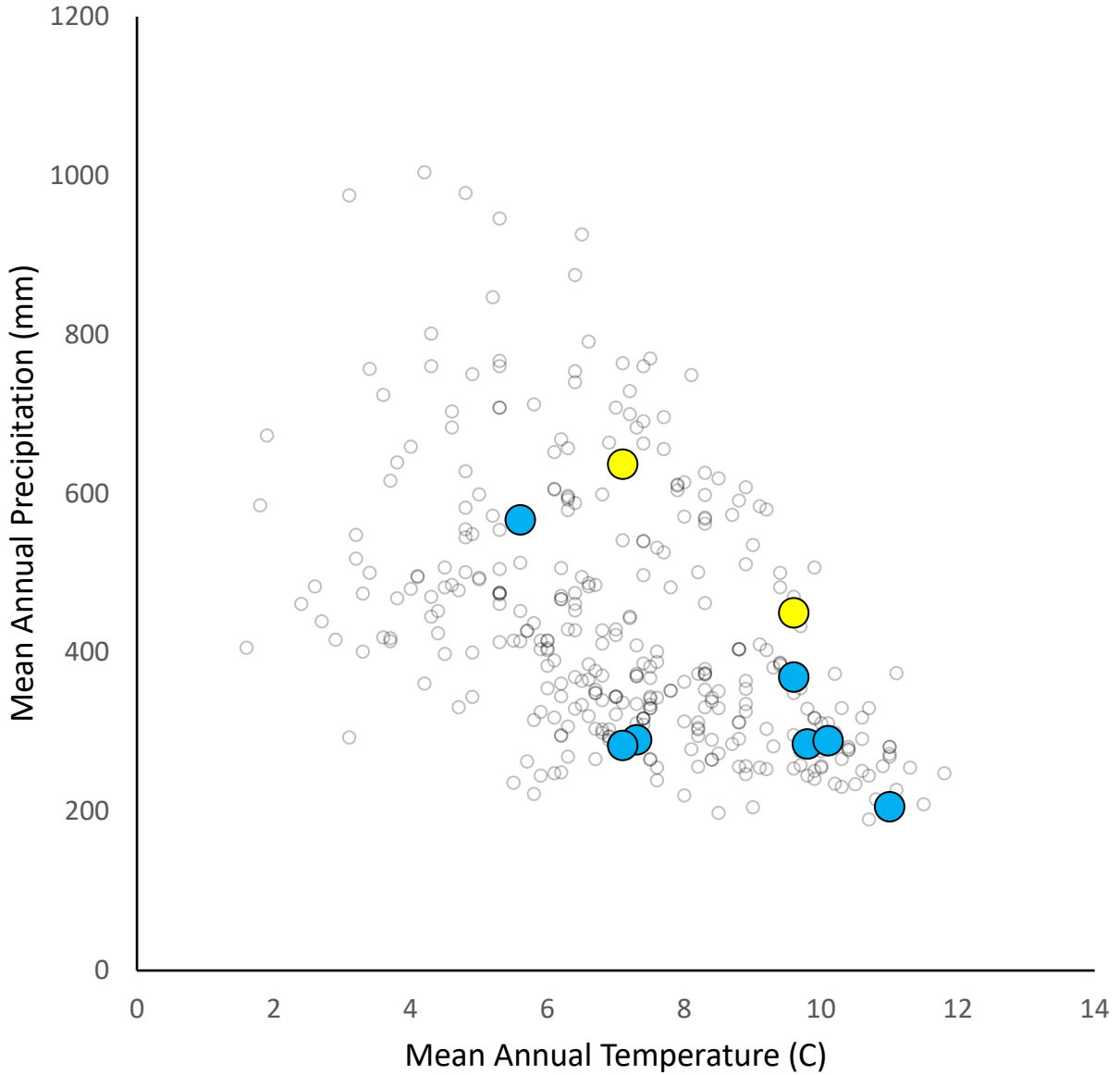
Crepis acuminata

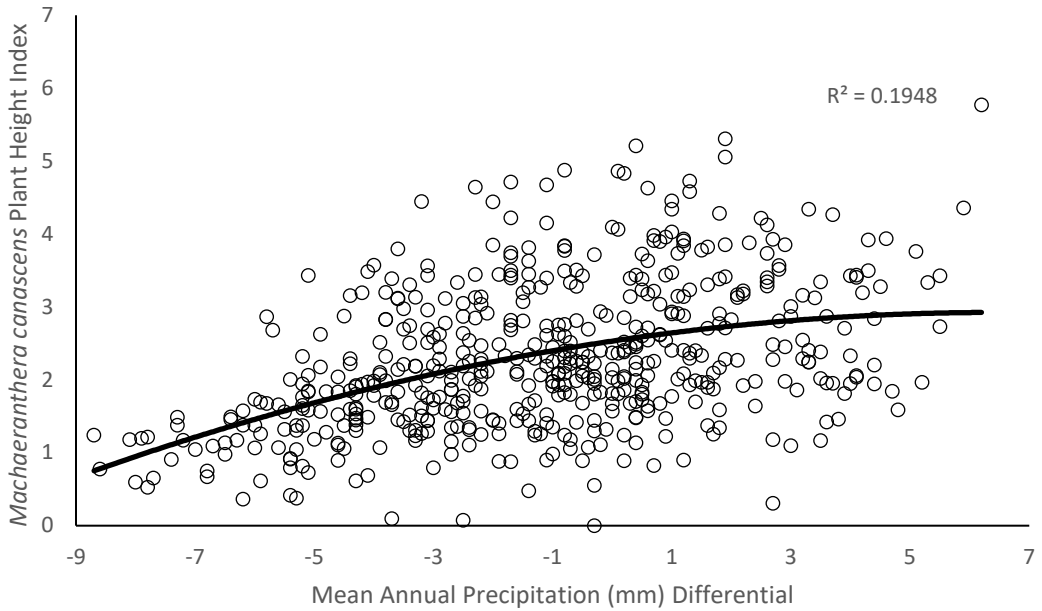


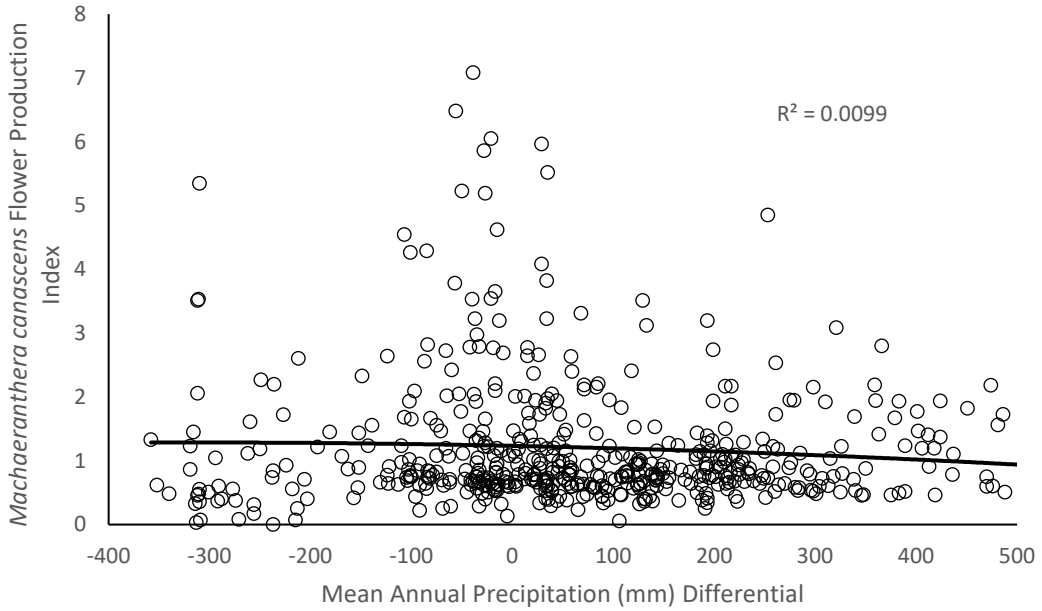
Sphaeralcea sp.

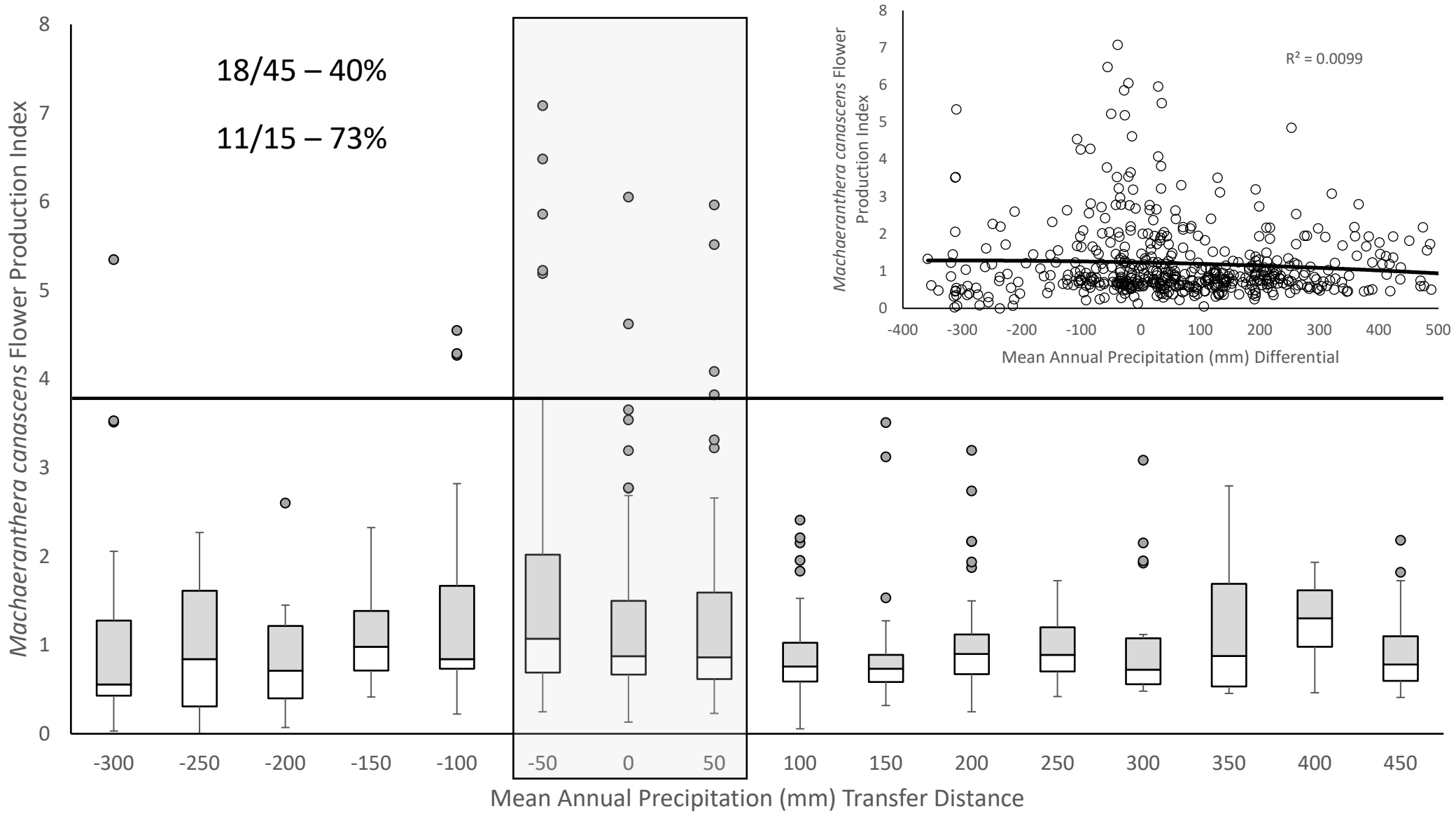



Seed collections 2017-2022
Led by RMRS, BLM & USFWS
WA
ID
MT
OR
WY
CA
NV
UT
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

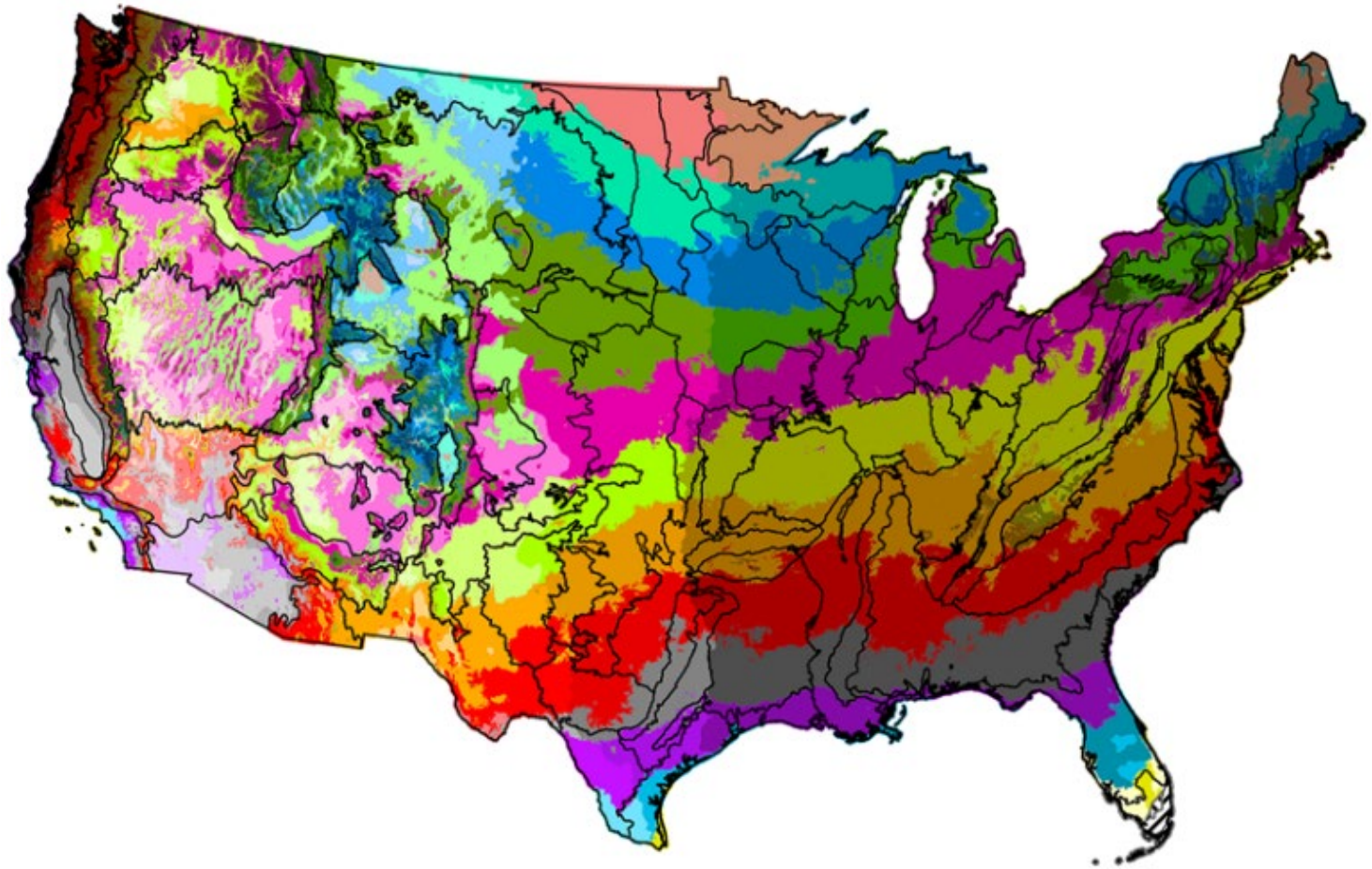

Mean Annual Precipitation (mm)
0
200
400
600
800
1000
1200
0
2
4
6
8
10
12
14
Mean Annual Temperature (C)


Machaeranthera canascens Plant Height Index
R² = 0.1948
Mean Annual Precipitation (mm) Differential


Machaeranthera canascens Flower Production Index
R² = 0.0099
Mean Annual Precipitation (mm) Differential


18/45 – 40%
11/15 – 73%
Machaeranthera canascens Flower Production Index
0
1
2
3
4
5
6
7
8
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
450
Mean Annual Precipitation (mm) Transfer Distance
R² = 0.0099
Machaeranthera canascens Flower Production Index
-400
-300
-200
-100
0
100
200
300
400
500
Mean Annual Precipitation (mm) Differential

Seed and seed zone availability – US Zones



https://www.fs.usda.gov/wwetac/threat-map/TRMSeedZoneMapper.php

ARTICLE

Methods, Tools, and Technologies

ECOSPHERE
AN ESA OPEN ACCESS JOURNAL

Seedlot Selection Tool and Climate-Smart Restoration Tool: Web-based tools for sourcing seed adapted to future climates

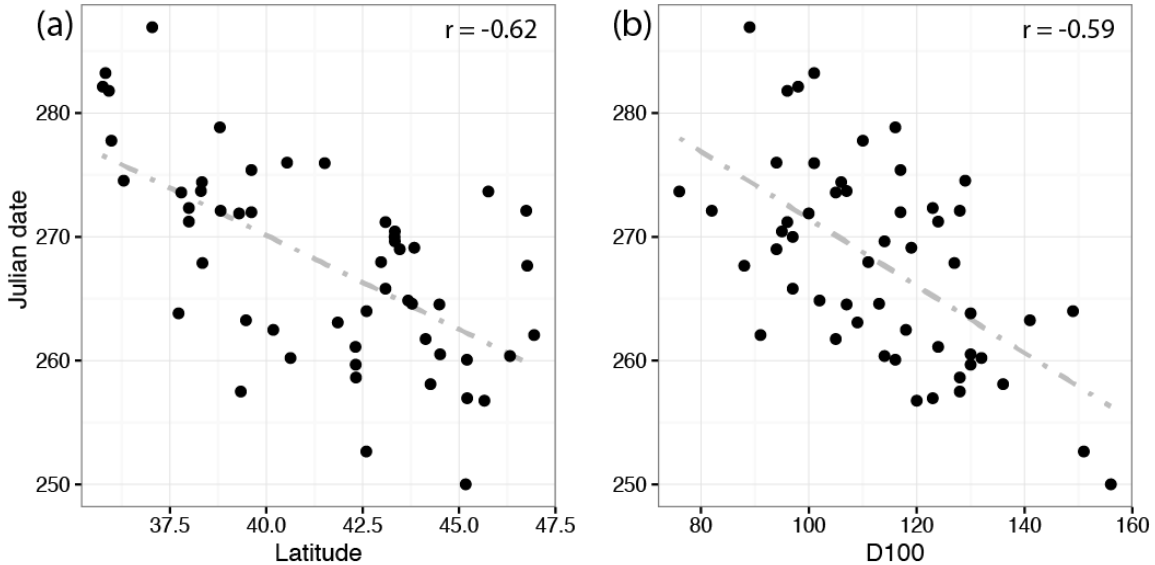
John Bradley St.Clair[1] | Bryce A. Richardson[2] | Nikolas Stevenson-Molnar[3] | Glenn T. Howe[4] | Andrew D. Bower[5] | Vicky J. Erickson[6] | Brendan Ward[3] | Dominique Bachelet[3] | Francis F. Kilkenny[7] | Tongli Wang[8]

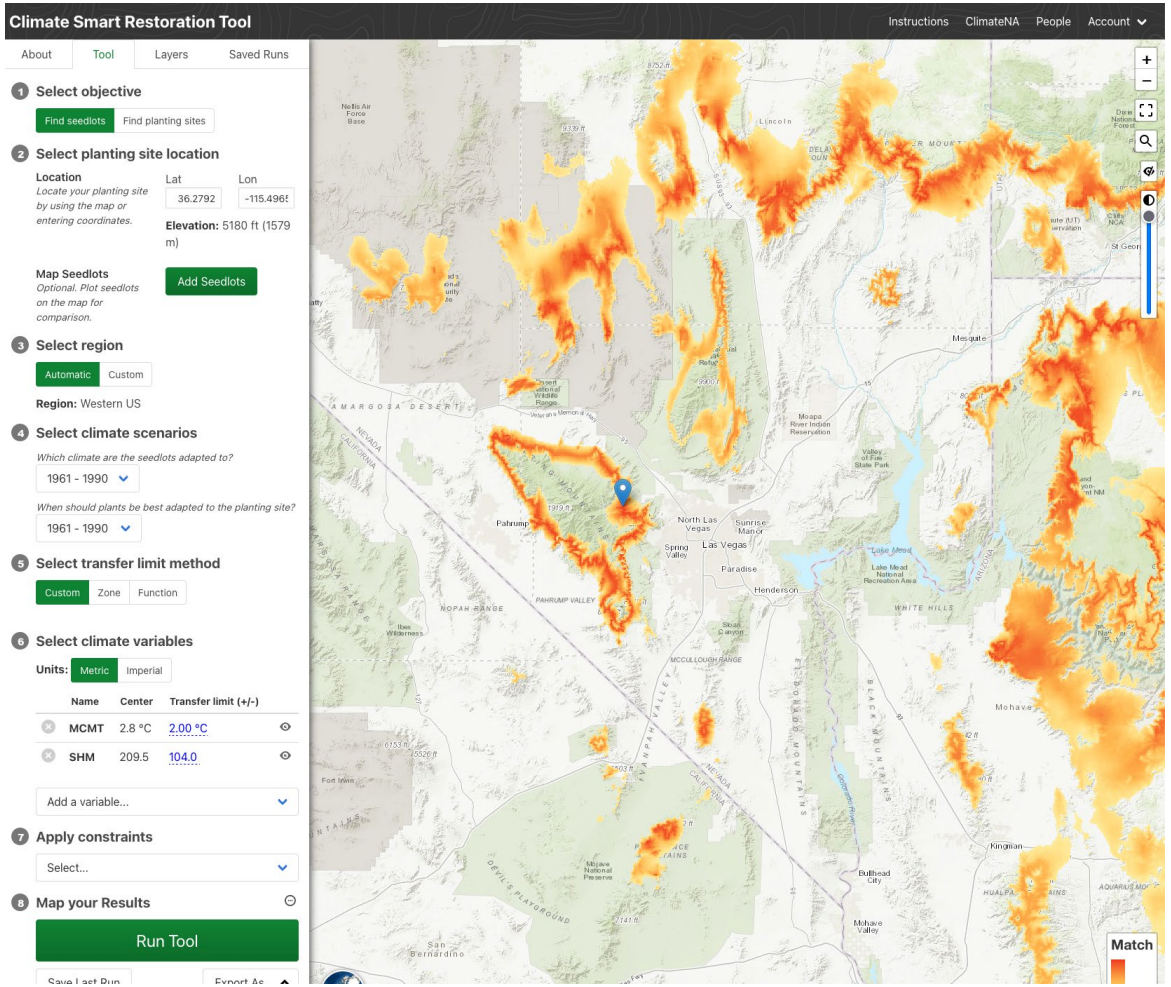
DOI: 10.1002/ecs2.4089

https://climaterestorationtool.org/csrt/

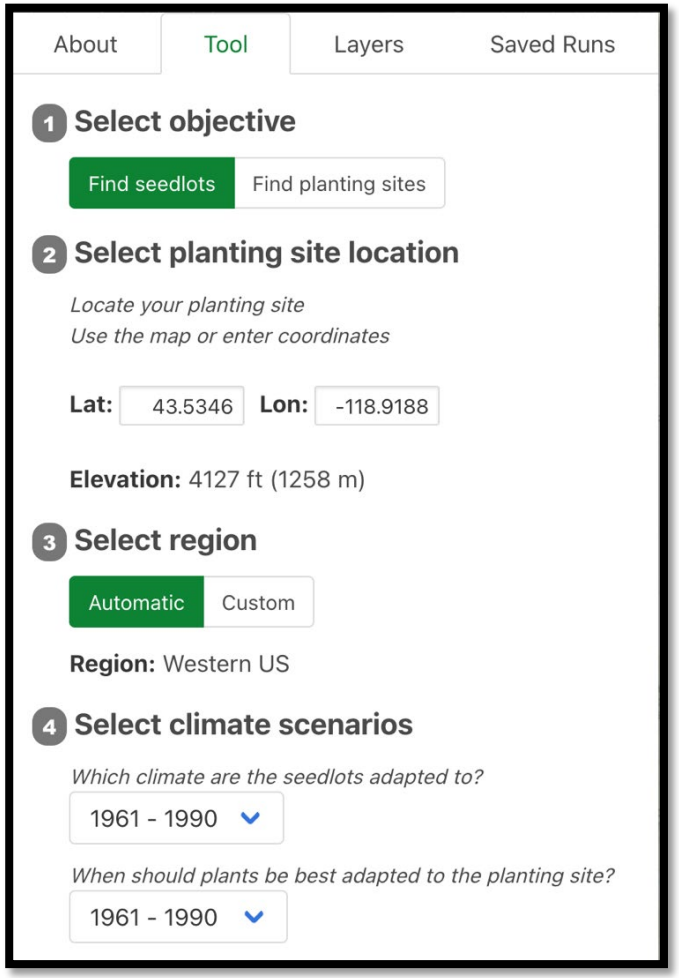
Climate Smart Restoration Tool (CSRT)

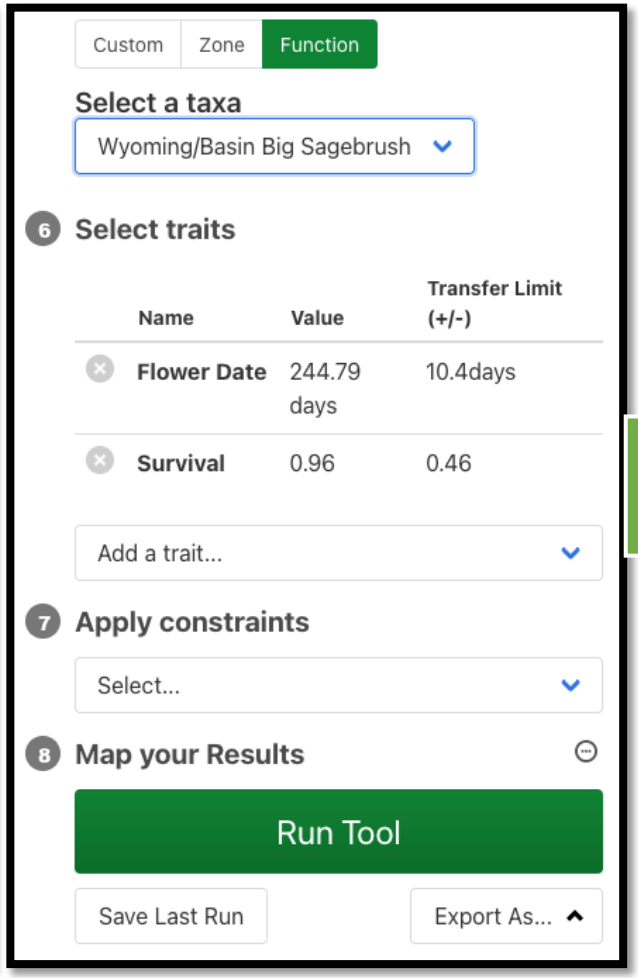
- Climate-based: use climatic limits that are common to many plant species
- Function-based: statistical model where suitability is predicted by empirical climate × phenotype relationship.

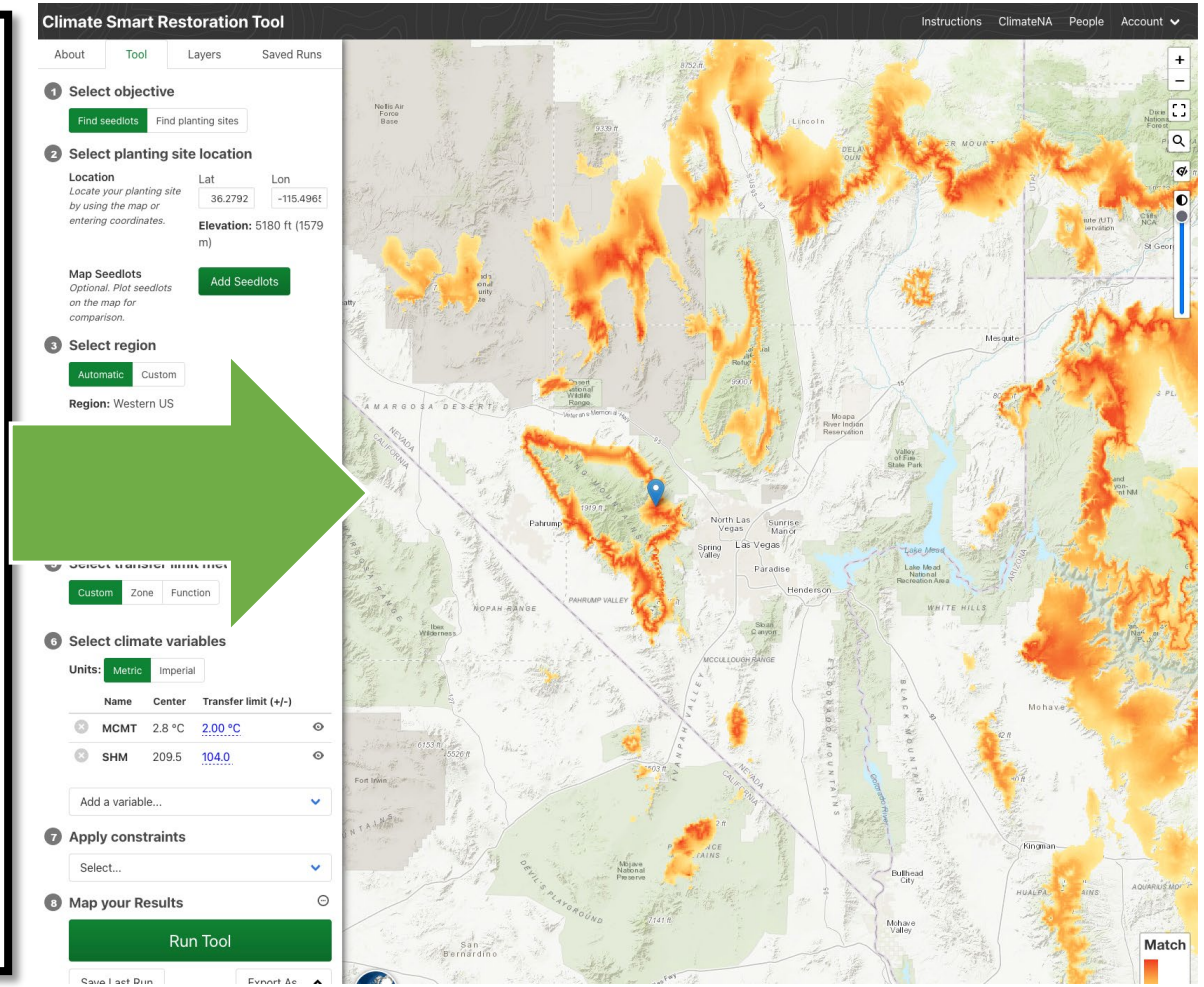




Climate Smart Restoration Tool (CSRT)







THANK YOU!

CHICAGO BOTANIC GARDEN

SEEDS OF SUCCESS

The Nature Conservancy

Great Basin Institute

University of Nevada, Reno

UTAH STATE UNIVERSITY 1888

USGS

ARS

Developing and Commercializing Locally Adapted Native Species: The Texas Native Seeds Model

Anthony Falk

Collaberation

How do we get from a lunch bag of seed to a 250 acre production field

Deciding what species to work with

- Regional Technical Committees
  - State wildlife personal
  - Commercial seed dealers
  - Private land managers
  - State highway department
  - Federal land managers
- Meat and potato species
  - Mainly grasses
  - Species with wide distribution

Types of seed sources

Wild Harvest/Native/VNS

- For some species only Seed source
- single source
  - Limited genetics
  - Limited area of use
  - In theory best possible material for some sites
- May/may not have seed test
- Closest seed source

Types of seed sources

Germplasm

- Made up of multiple source populations
  - Broad areas of adaptation
  - Lots of genetic material
- Tested for 3-5 years
- Commercially produced
- Seed tested for quality and cleanliness
- Not all species suitable

Types of seed sources

Cultivar

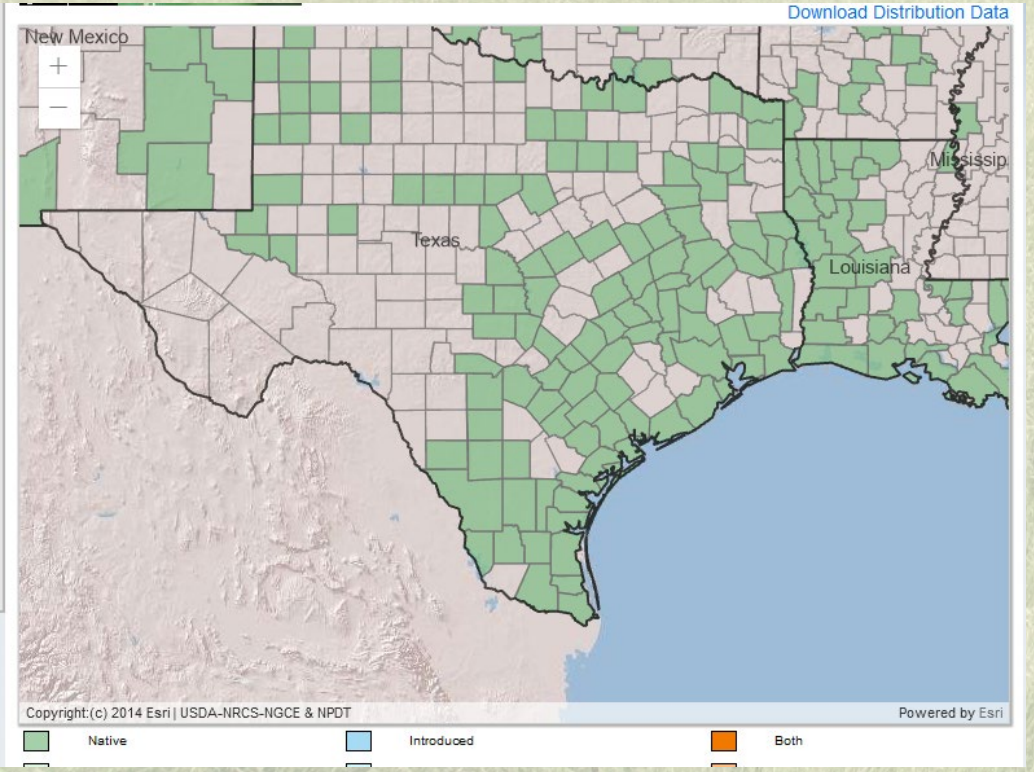
- Single source could be individual plant
  - Repeatable genetics
  - Can have limited area of adaptation
  - Super plants
- Tested for 7-10 years
- Developed for specific use
- Commercially produced
- Seed tested for quality and cleanliness

Evaluation criteria

- Number of plants
- Vigor/plant health*
- Leaf density*
- Uniformity*
- Phenology
- Forage production*
- Seed production*
- Stand height
- Canopy cover
- Germination

* Evaluation criteria scored with a visual ranking

Duval Germplasm red lovegrass (*Eragrostis secundiflora*)



Accession	Origin
9064457	Zavala
9064476	Erath
9064479	Freestone
9064480	Cottle
9064481	Cottle
9064485	Washington
9064489	Jones
9076877	Montague
9076878	Parker
9076879	Young
9076880	Brown
9076883	Calhoun
9076884	Calhoun
9076887	Walker
9076891	Guadalupe
9076893	Kenedy
9090369	Willacy
9093480	Jim Hogg
9093481	Webb

L-2123
December 1984

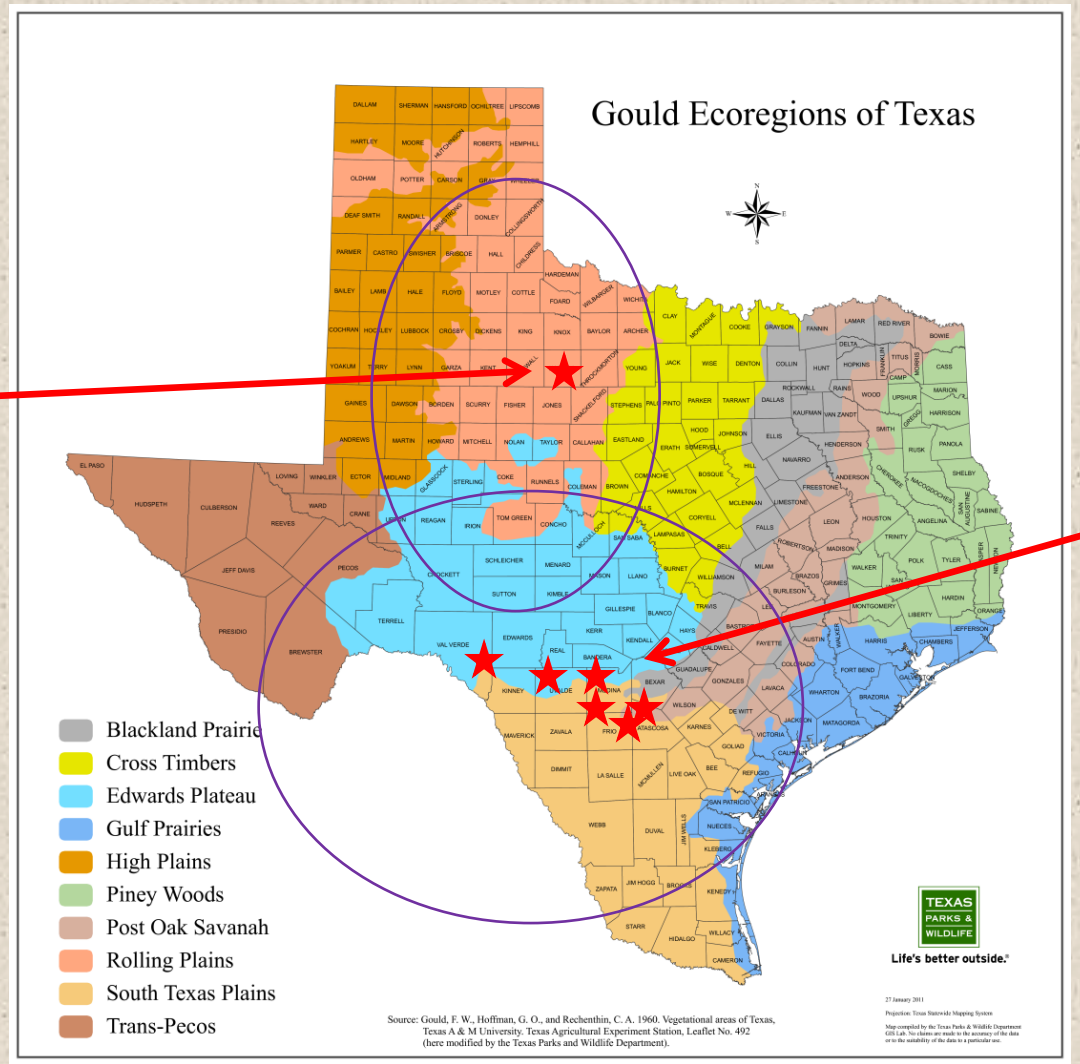
Haskell
Sideoats Grama

A long-season native, rhizomatous sideoats selection

- *High-quality grass for range or pasture uses*
- *Adapted to Centraland South Texas*
- *Helps control erosion on surface-mined areas*

The Texas Agricultural Experiment Station
Neville P. Clarke, Director
The Texas A&M University System
College Station, Texas

In cooperation with the U.S. Department of Agriculture-Soil Conservation Service and USDA-Agricultural Research Service



Source: Gould, F. W., Hoffman, G. O., and Rechenthin, C. A. 1960. Vegetational areas of Texas, Texas A & M University. Texas Agricultural Experiment Station, Leaflet No. 492 (here modified by the Texas Parks and Wildlife Department).

27 January 2011

Projection: Texas Statewide Mapping System

Map compiled by the Texas Parks & Wildlife Department GIS Lab. No claims are made to the accuracy of the data or to the suitability of the data to a particular use.

South Texas Germplasm
Sideoats Grama

Bouteloua curtipendula **(Michx.) Torr. var. *caespitosa* Gould & Kapadia**

South Texas Natives

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

AgriLIFE RESEARCH
Texas A&M System

All of the effort doesn’t matter if the product doesn’t sell


M346

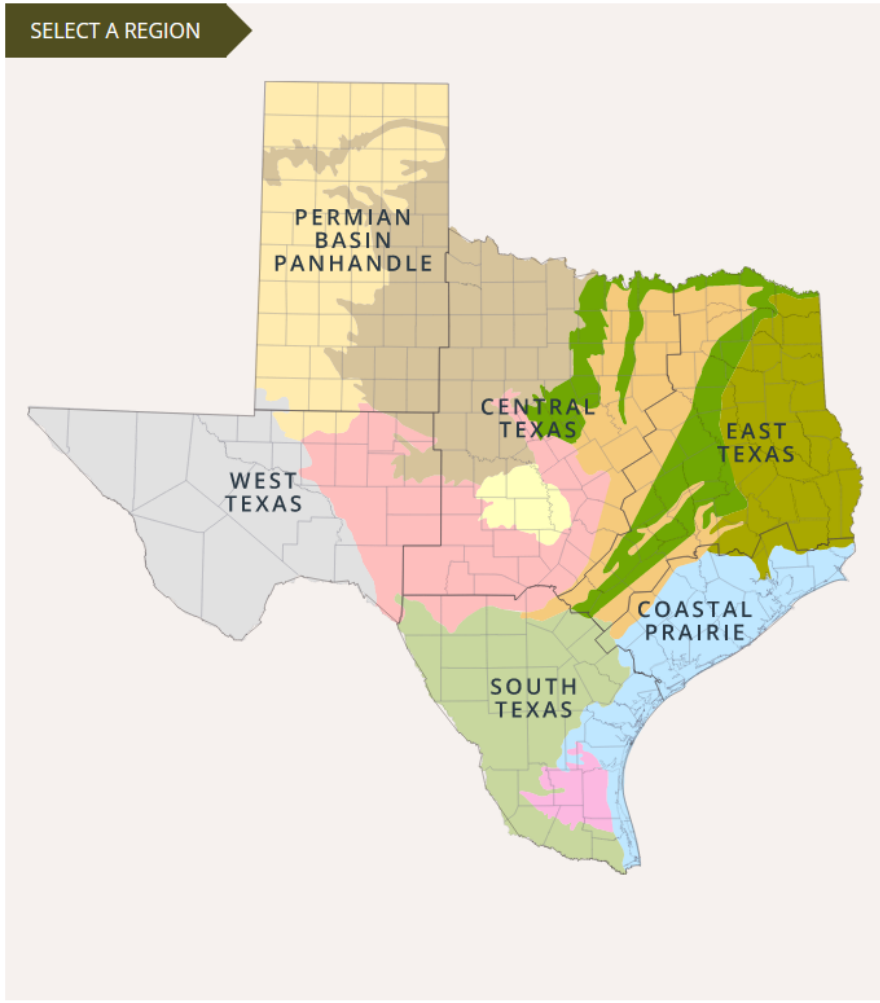
- Provide free seed mix recommendation

Native Seed Selection Tool

SEED MIX MAP

To view a custom seed mix for your area, first select the region that your property is located in. Within the zoomed region select your county. Once you click on your county a box will generate which will list the soil types within each ecoregion in that county. Select the soil type that applies to your area and a pdf will generate once selected.

The pdf will list the recommended varieties with % of planting rate and a Pure Live Seed rate. Also included are licensed seed vendors along with contact information for local technical guidance.



Today's presenters

Brian Smith
bsmith@dot.gov
Federal Highway Administration

Dr. Tony Falk
anthony.falk@tamuk.edu
Texas Native Plant Program

Dr. Francis Kilkenny
francis.f.kilkenny@usda.gov
U.S. Forest Service, Rocky Mountain Research Station

Ken Murray
email@email.com
California Department of Transportation

Upcoming events for you

February 26, 2024

TRB Webinar: Disruptive Technologies and the Future of the Transportation Agency

June 23-26, 2024

2nd International Roadside Safety Conference

https://www.nationalacademies.org/trb/events

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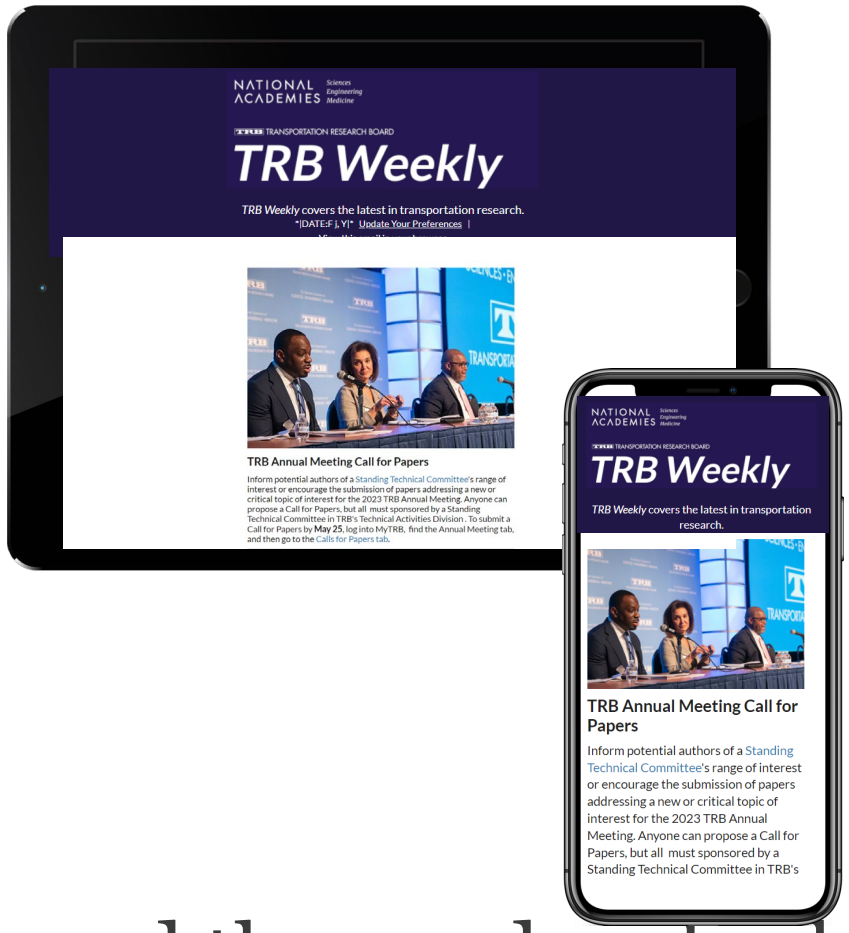

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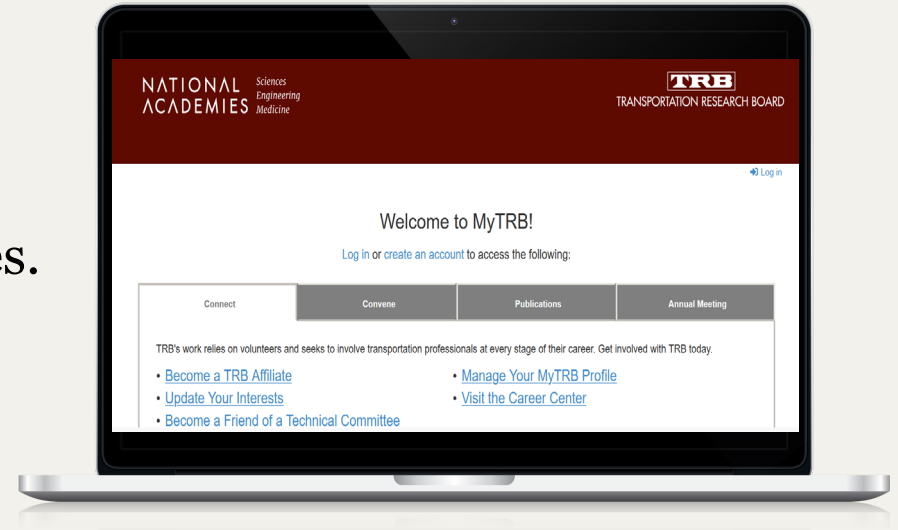

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