Novel climate change adaptation strategies for conserving drought-adapted blue oak genotypes in California

Alissa Fogg, Blair McLaughlin, and Alicia Herrera

Point Blue Conservation Science

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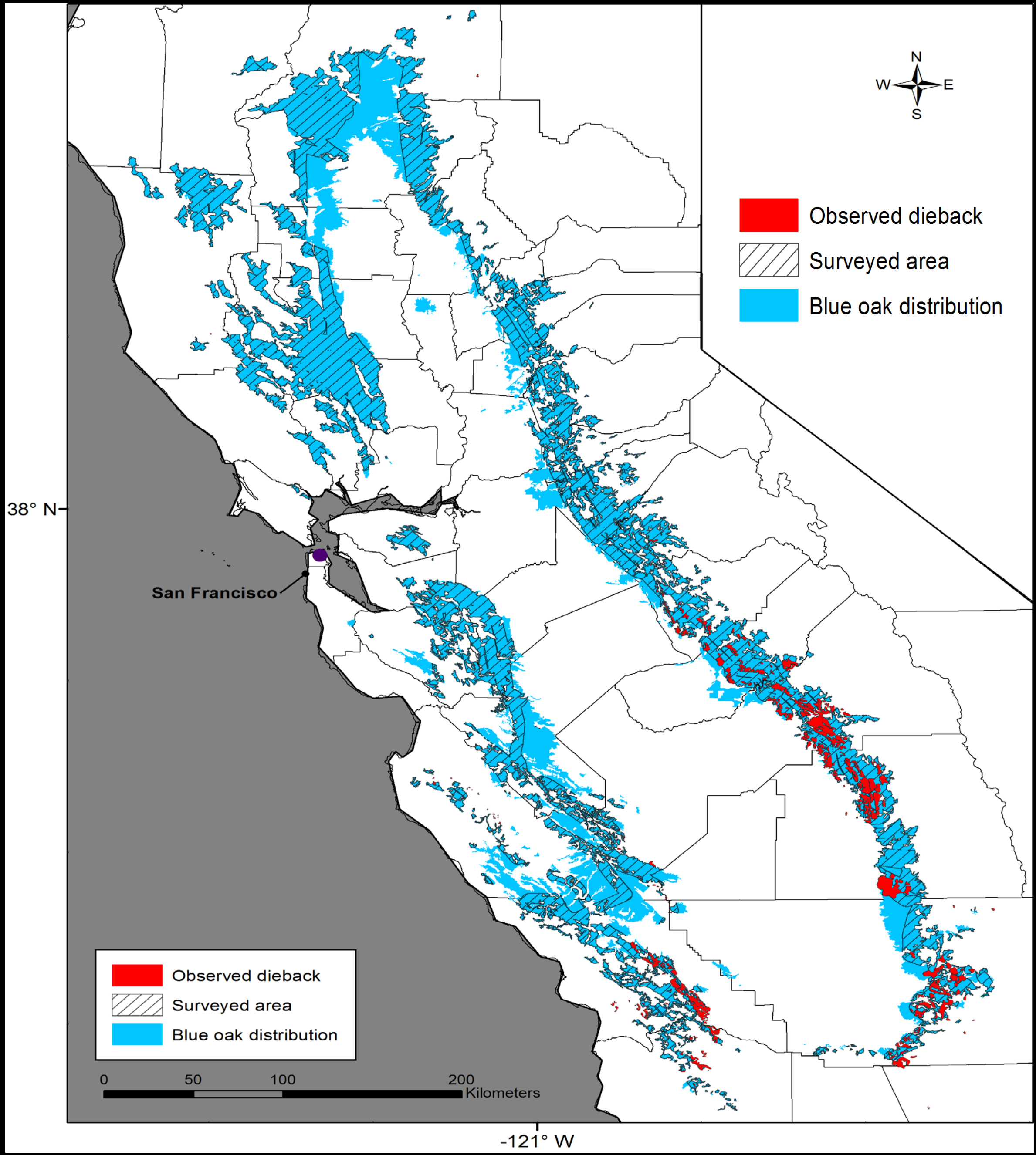
Blue Oak mortality, Griswold Canyon, San Benito County, summer 2015
Photo credit: Ryan O’Dell, BLM

We are losing 'trailing edge' blue oaks (*Quercus douglasii*) from the southern and drier (xeric) extent of their range

Photo credit: Ryan DiGaudio



Brown and McLaughlin et al. 2017

Blue oak genetic exposure

1. Direct loss of individual trees where the climate shifts outside of their tolerance
2. Early loss of the part of the genome most adapted to extreme climate conditions

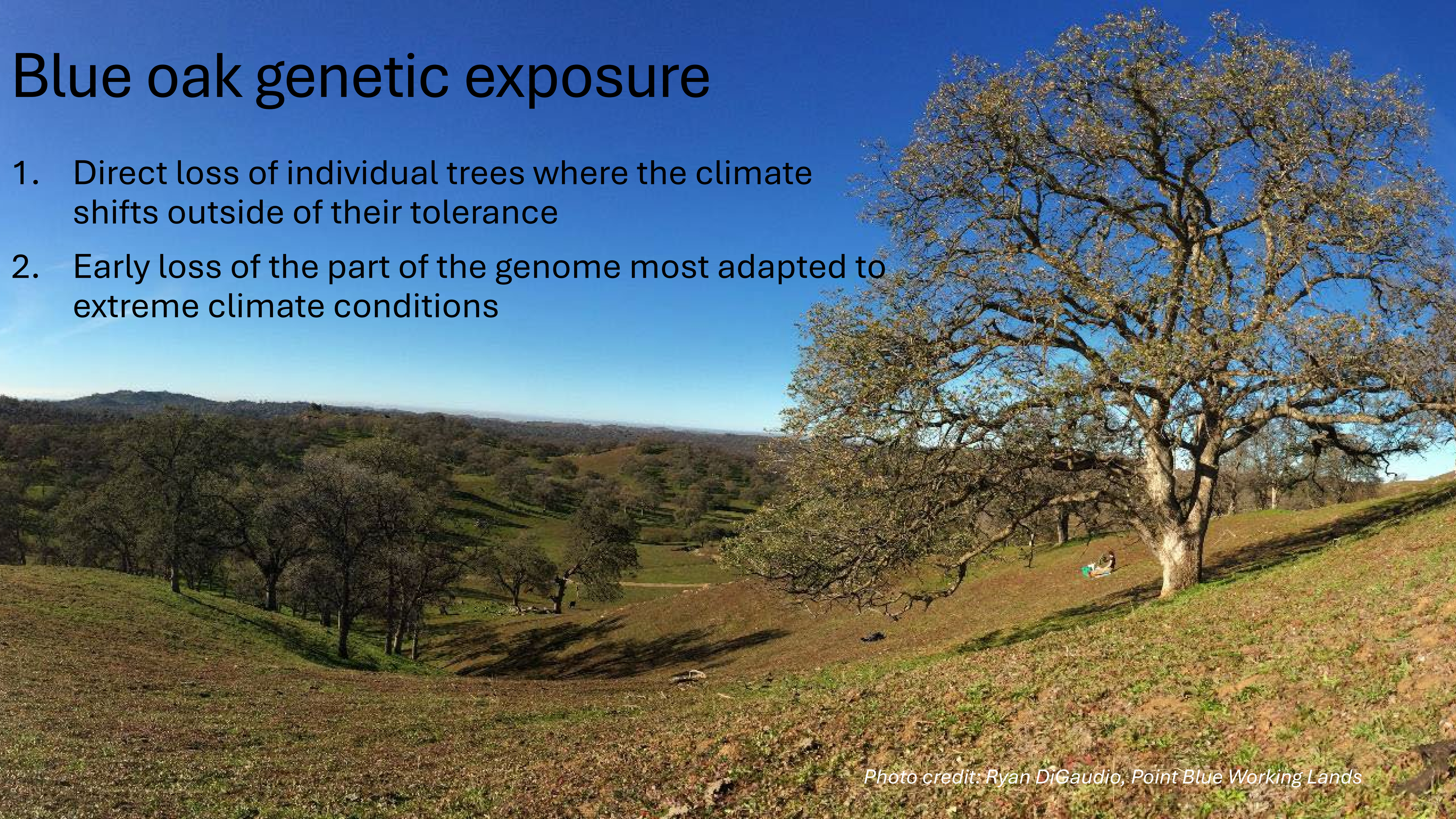
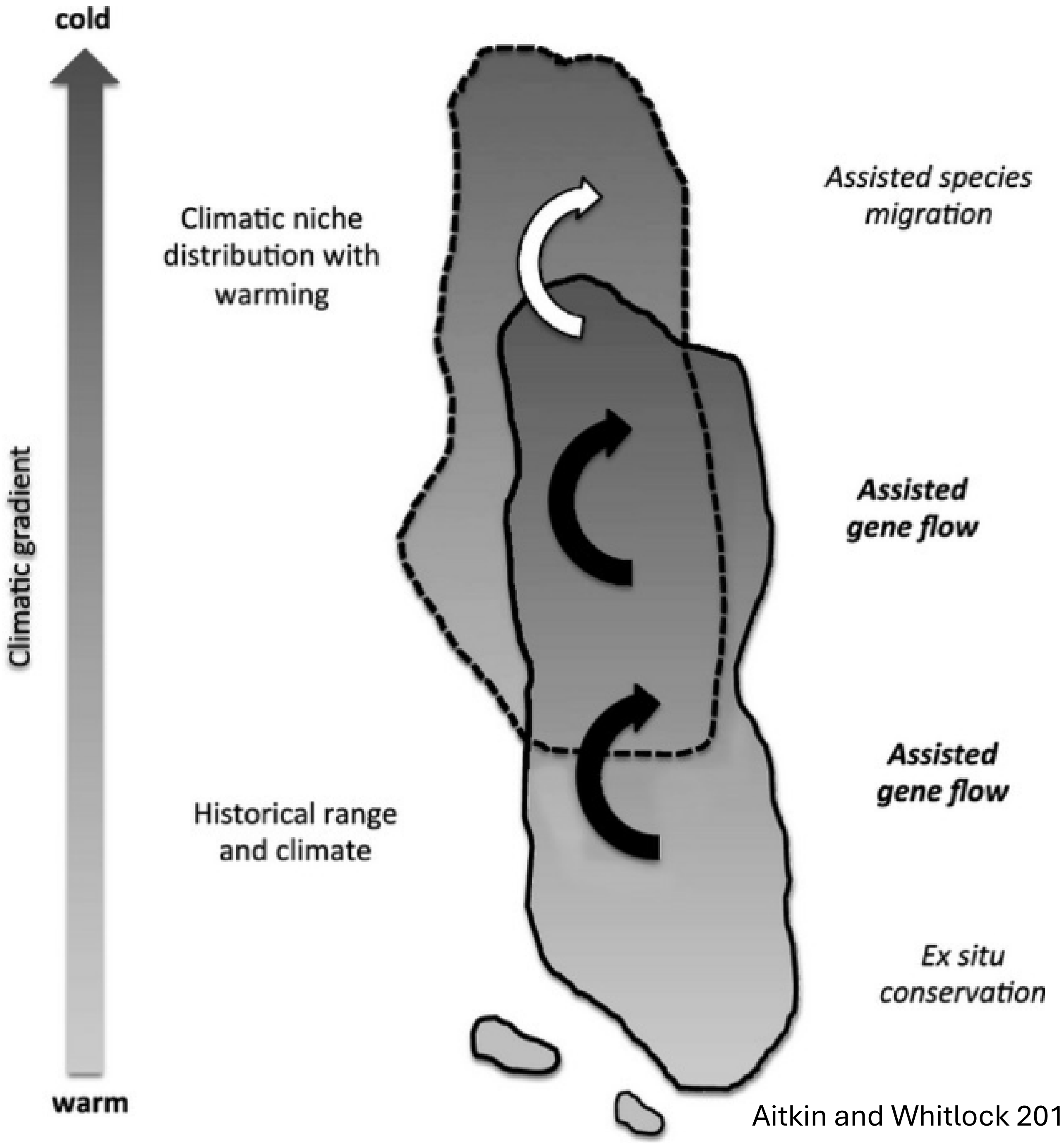


Photo credit: Ryan DiGaudio, Point Blue Working Lands

Assisted gene flow: The intentional movement of organisms or gametes between populations *within* species' current distributions (Aitkin and Whitlock 2013)



Aitkin and Whitlock 2013

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Likely candidates…

Long generation times

Reproductively isolated populations

Short dispersal distances

Sessile species

Concerns

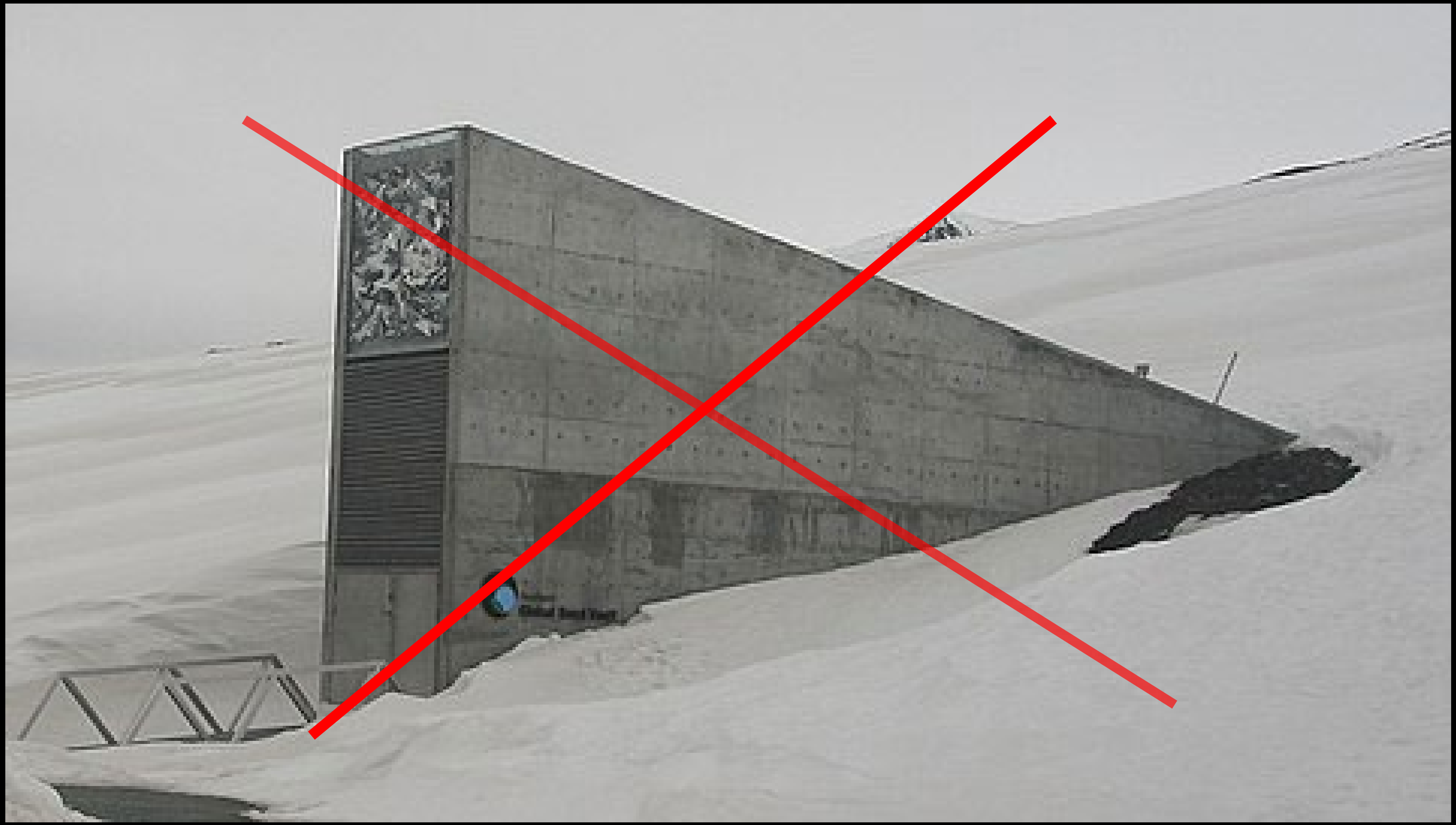
Introduction of maladaptive traits

Outbreeding depression

Uncertain climate futures

Loss of purity of genetic lineages and *relationships* a plant has with its environment and community

Acorns cannot tolerate conventional seed storage




Climate-adaptive,
participatory field
gene banking

Paired plantings of trailing edge (xeric) and locally gathered acorns

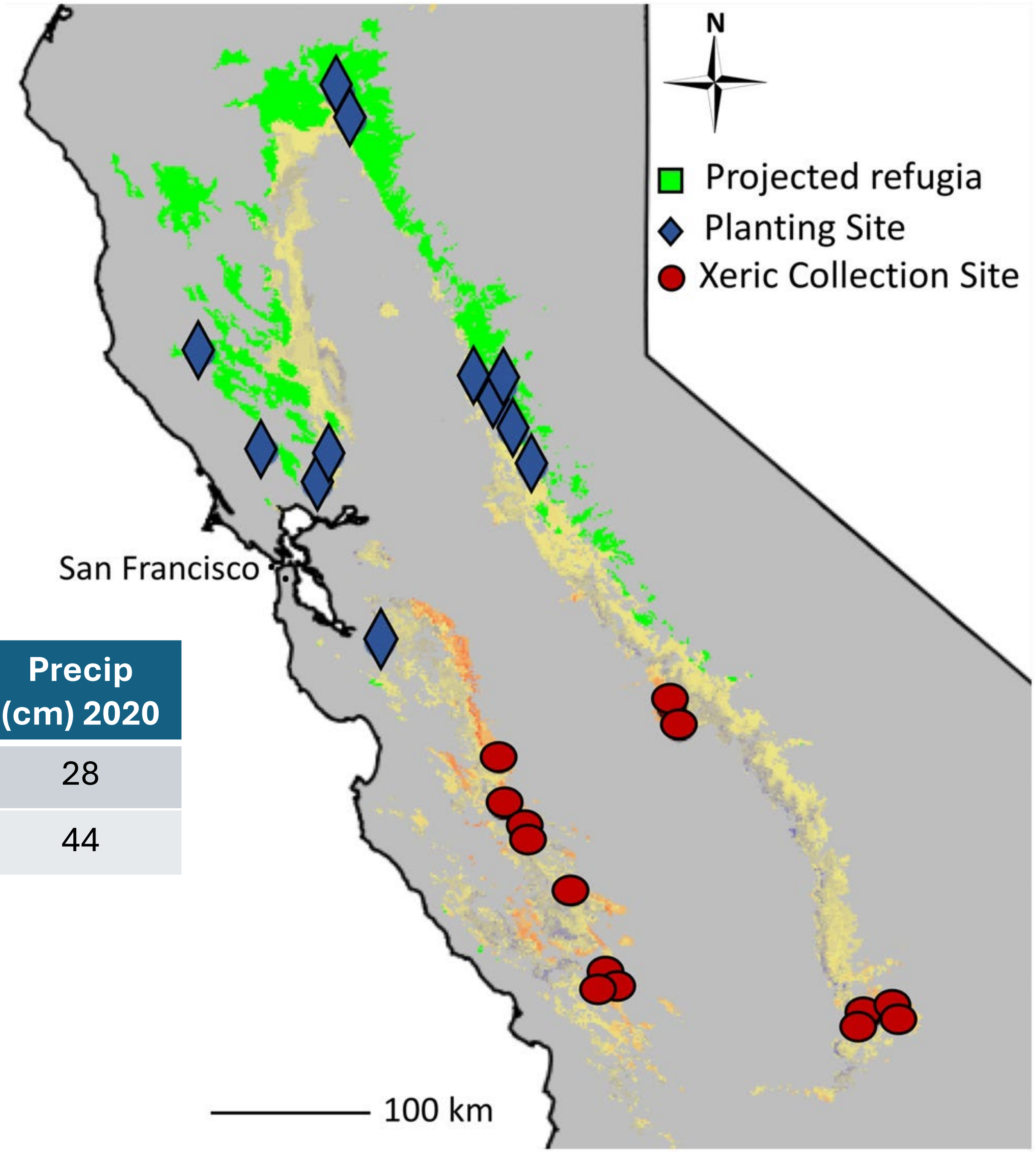
Field Gene Bank Sites

Planting occurred winter 2018-19 and 2019-20
Two new sites planted winter 2024-25

Counties	Ranches	Planting Areas	Acorns Planted
8	15	39	296

Site type	AAP (cm) 1981-2010	Min temp (°C)	Max temp (°C)	Precip (cm) 2019	Precip (cm) 2020
Xeric edge	38	1.8	34	46	28
Planting	84	1.7	32	112	44

AAP = Average annual precipitation
Climate measures represent water year (*Flint et al. 2021*)

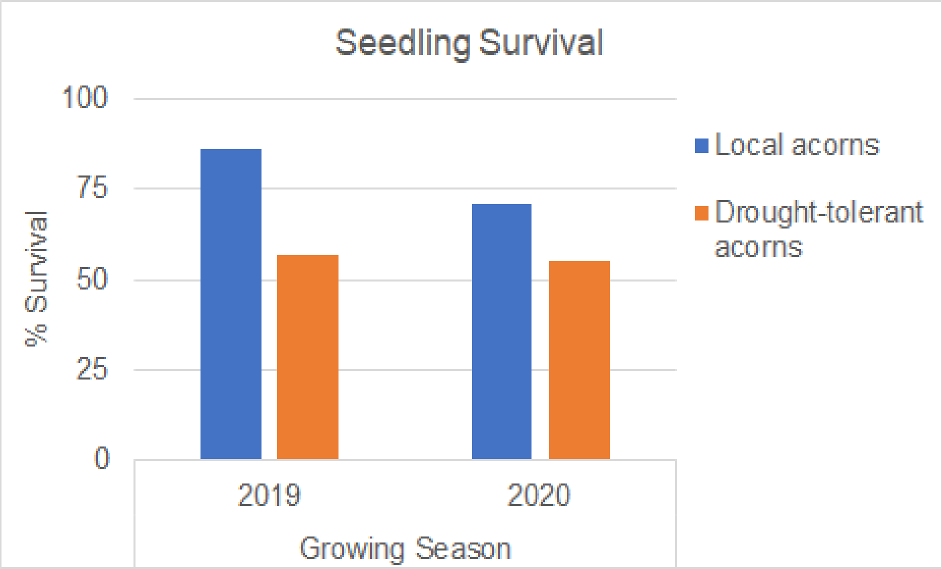


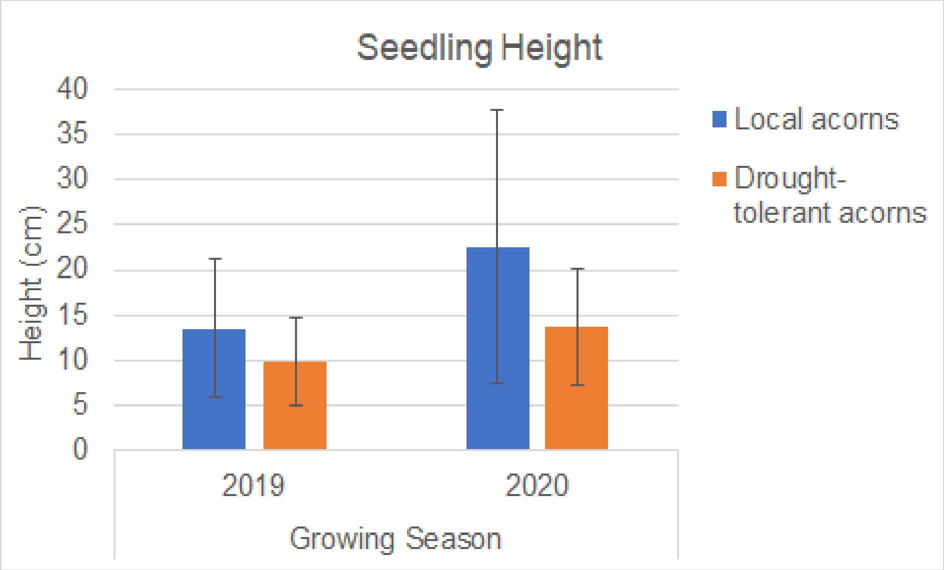
McLaughlin et al. 2021 *Restoration Ecology*

Local seedlings had higher survival in wetter growing season and grew taller than drought-tolerant seedlings

A living seed bank is a viable strategy for preserving genetic diversity

Further study is warranted to understand how genetic diversity can be used for habitat restoration





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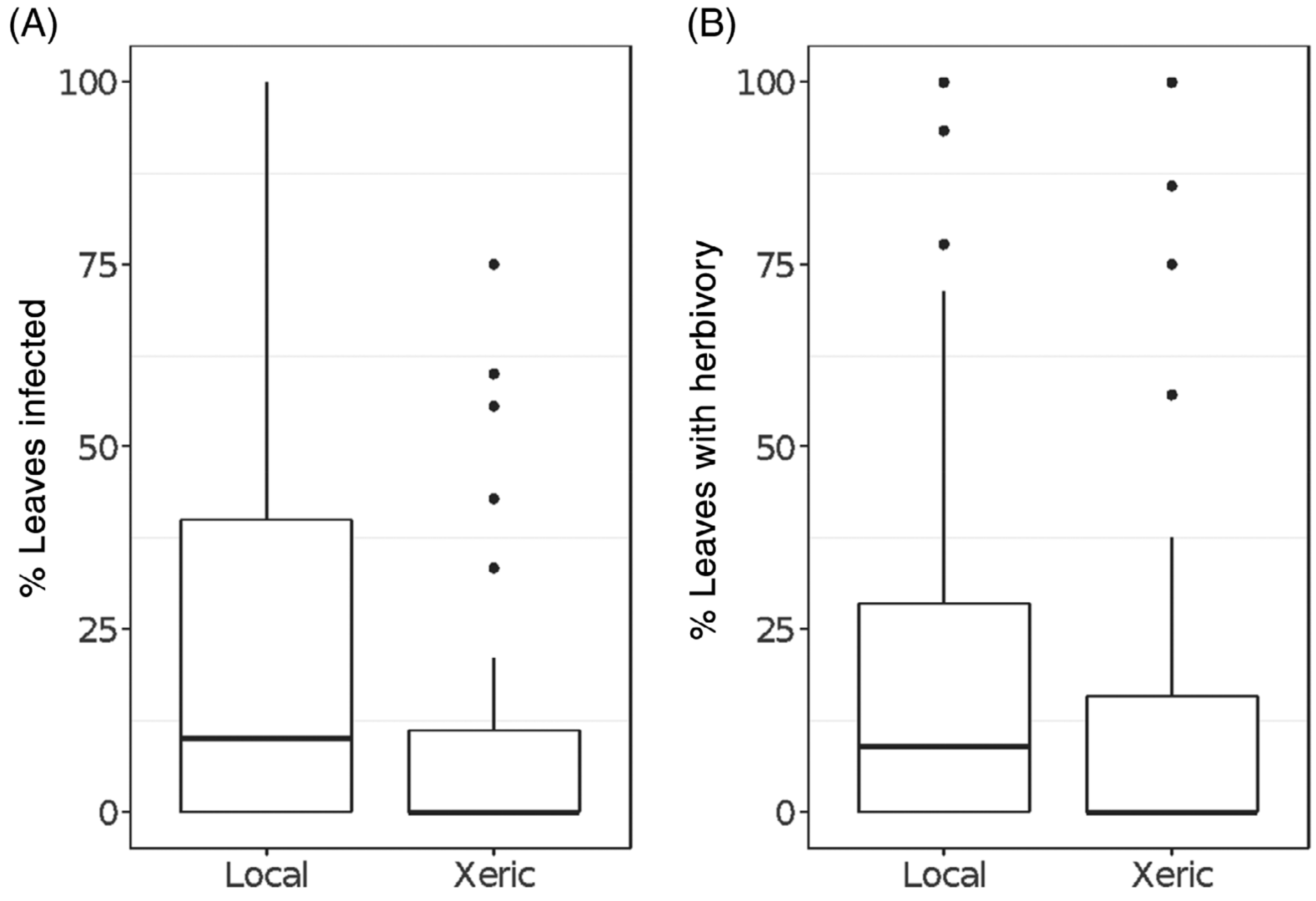
Disease and herbivory

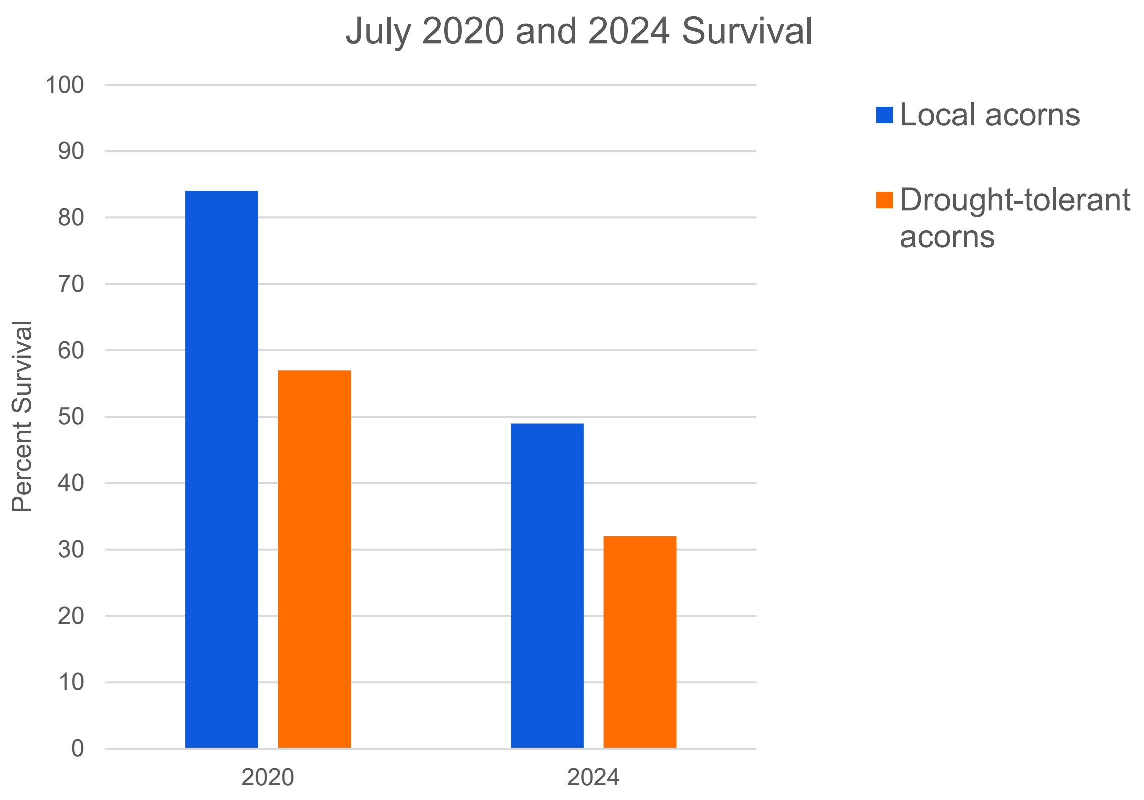
Figure 3. Boxplots showing percent of seedling leaves (A) infected with disease, and (B) with signs of herbivory, by local and xeric edge acorn origin.



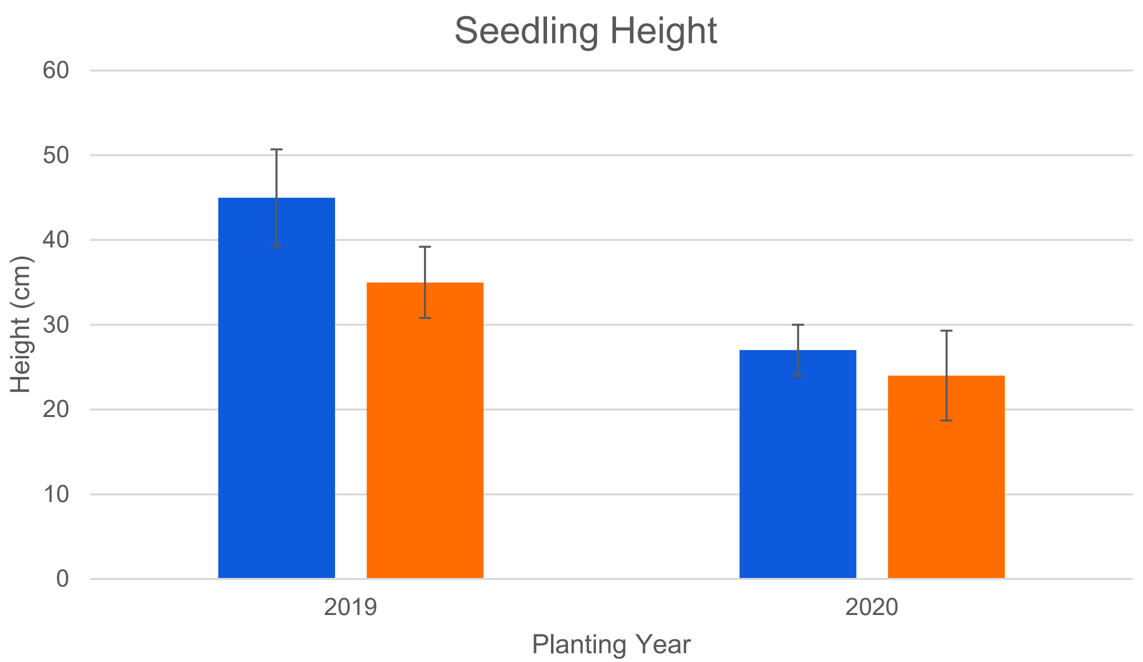
Follow-up to our 2021 manuscript

- Outreach events (planting workshop, UC Climate Stewards)
- UC Santa Cruz Conservation Science & Stewardship lab awarded $700,000 USDA NIFA grant to investigate the genetic component of drought adaptation
- Completed monitoring at 13 ranches summer 2022 and 2024
- Expanded the basic field gene bank to 2 more sites

2024 survival and height (5 and 6 year old seedlings)



2020-2024 Survival decreased for local acorns by 35% compared to 25% for drought-tolerant acorns. We currently have 33 local seedlings and 22 drought-tolerant.

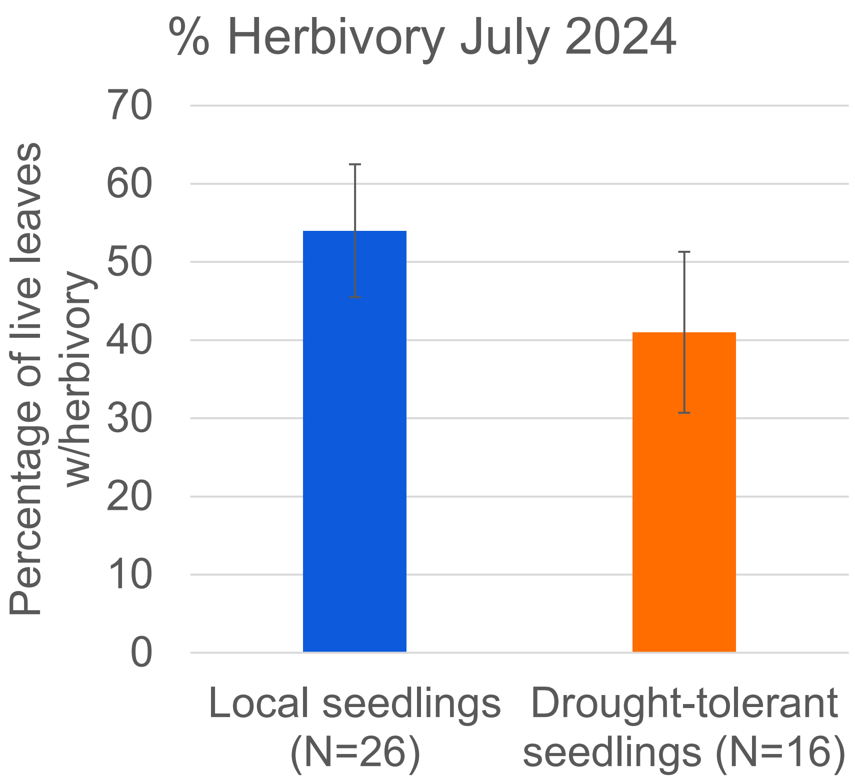


Height for the acorns planted with a drier initial winter (2019-20) stayed similar for both local and drought-tolerant acorns. With a wetter initial winter, (2018-19), the local acorns grew, on average, 10 cm taller than drought-tolerant acorns.

Disease and herbivory (July 2024 data)

Disease:
No powdery mildew and very few disease brown spots compared to July 2019 and 2020 surveys

Herbivory:
Local seedlings continued to have a higher percentage of leaves with herbivory compared to drought-tolerant seedlings.



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Next steps

- Genetic analysis and identifying traits that could be used to increase population resilience in future, drier climates
- Identify blue oak populations with drought-adapted traits
- Creating best practices for assisted gene flow translocations
- Extend the field gene bank to more sites using acorns with known genetic adaptations
- Continued monitoring and outreach to a diversity of land stewards

Thank you!

Ranchers, land trusts and land stewards who generously let us collect and plant acorns on their land.

Erika Zavaleta lab at UC Santa Cruz for helping us understand the mechanisms behind drought adaptation.

Point Blue Partner Biologists for monitoring and stewardship.

Wildlife Conservation Society and USDA NIFA program for funding and support.

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USDA NIFA
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National Institute of Food and Agriculture

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Questions?

afogg@pointblue.org

Photo credit: Tom Grey