Considerations when mixing source populations for plants in restoration

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genetic diversity...yay!

- ✓faster recovery after climactic extremes
- ✓increased resistance to pests and pathogens
- ✓improved establishment success
- ✓more potential to respond to a changing climate

genetic theory...ugh.

A	a	A	A	A	B
A	B	A	a	A	A
a	a	A	A	b	b
A	b	A	a	A	b
A	b	A	a	A	b
B	B	b	b	A	b
B	b	b	b	A	A
a	a	A	a	A	A
A	A	b	b	B	b
a	a	B	b	A	a
A	A	A	b	A	b
A	a	a	a	B	b
a	b	A	b	A	a
A	b	A	A	B	b
b	b	B	b	A	A
a	a	a	B	A	A

Resources for genetic best practices

ELSEVIER

GfÖ
GfÖ Ecological Society of Germany, Austria and Switzerland

Basic and Applied Ecology 11 (2010) 300–311

Basic and Applied Ecology

www.elsevier.de/baae

A question of origin: Where and how to collect seed for ecological restoration

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RESEARCH ARTICLE

Seed Sourcing for Restoration in an Era of Climate Change

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ABSTRACT: Proper sourcing of seed for ecological restoration has never been straightforward, and it is becoming even more challenging and complex as the climate changes. For decades, restoration practitioners have subscribed to the "local is best" tenet, even if the definition of "local" was often widely divergent between projects. However, given our increasing ability to characterize habitats, and rapid climate change, we can no longer assume that locally sourced seeds are always the best or even an appropriate option. We discuss how plants are responding to changing climates through plasticity, adaptation, and migration, and how this may influence seed sourcing decisions. We recommend focusing on developing adequate supplies of "workhorse" species, undertaking more focused collections in both "bad" years and "bad" sites to maximize the potential to be able to adapt to extreme conditions as well as overall genetic diversity, and increasing seed storage capacity to ensure we have seed available as we continue to conduct research to determine how best to deploy it in a changing climate.

Index terms: assisted migration, climate change, provenance, restoration, seed sourcing

BACKGROUND

As anthropogenic disturbance and destruction of natural areas increase, so does the need for native plant seed for restoration and revegetation projects. From the pioneering work of Turesson (1922) and Clausen et al. (1940) on plant adaptation to the present, hundreds of studies have shown

the best adapted or most appropriate plant material (Leimu and Fischer 2008). Local adaptation is a function of the rate of change in environmental gradients for abiotic and biotic factors (temperature, precipitation, soil chemistry, pests and pathogens, pollinators, etc.) and the ability of populations to adapt to these changes, rather than simply distance (Hereford 2009;

REFEREED RESEARCH

Oregon ash (*Fraxinus latifolia* Benth. [Oleaceae]) seedling. Photo by Adrienne Basey

Producing native plant materials for restoration: 10 rules to collect and maintain genetic diversity

Adrienne C Basey, Jeremie B Fant, and Andrea T Kramer

ABSTRACT

Ecological restoration aims to assist the recovery of degraded, damaged, or destroyed ecosystems. Restoration practitioners increasingly recognize the value of using ecologically appropriate and genetically diverse native plant material to support ecosystem recovery and long-term persistence in the face of

We outline each step where genetic diversity can be lost or gained, and describe 10 rules that can be used to maintain high genetic variability in native plant material throughout the production process.

Basey AC, Fant JB, Kramer AT. 2015. Producing native plant materials for restoration: 10 rules to collect and maintain genetic diversity. Native Plants Journal 16(1):37–52.

When to mix sources

No sources match reintroduction site

Small and/or fragmented source populations

Low genetic diversity

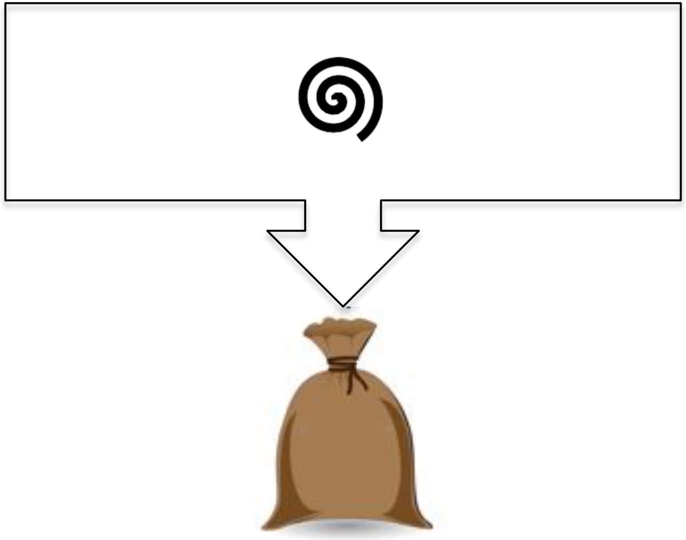
Inbreeding depression

BUT choose populations wisely:

avoid outbreeding depression

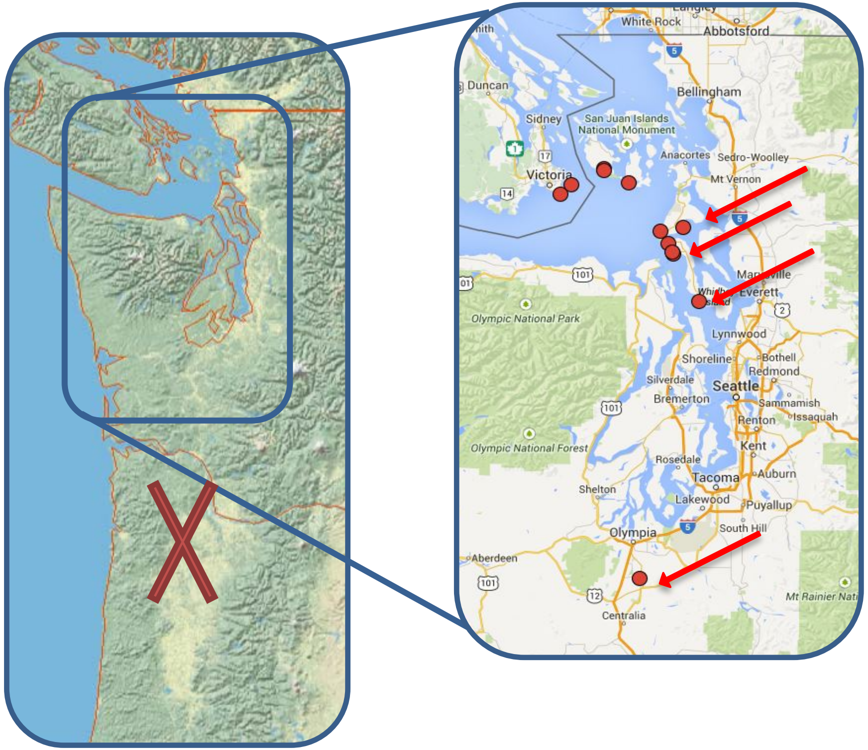
Regional Admixture Provenancing

One method for establishing genetically diverse yet ecologically appropriate populations. It refers to mixing of source material throughout a given ecological region.

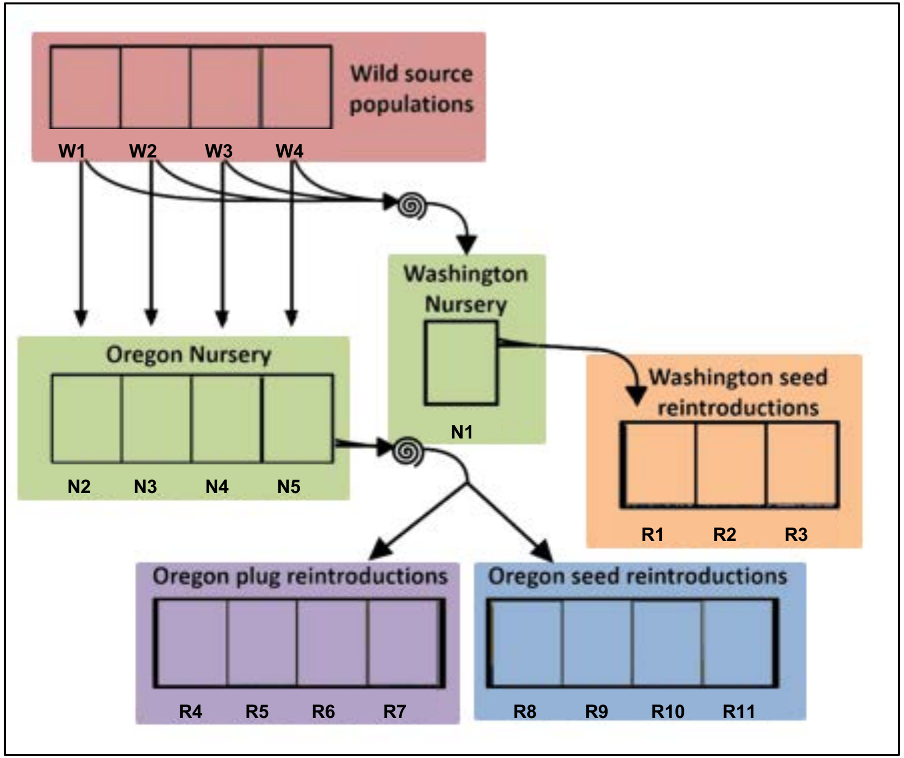


Map adapted from USFS TRM Seed Zone map found at https://usfs.maps.arcgis.com

Golden paintbrush – *Castilleja levisecta*



Golden paintbrush populations

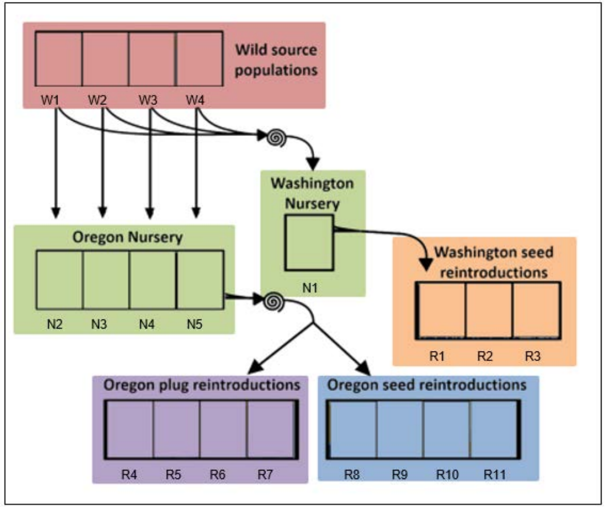


1) Do genetic diversity and inbreeding change?

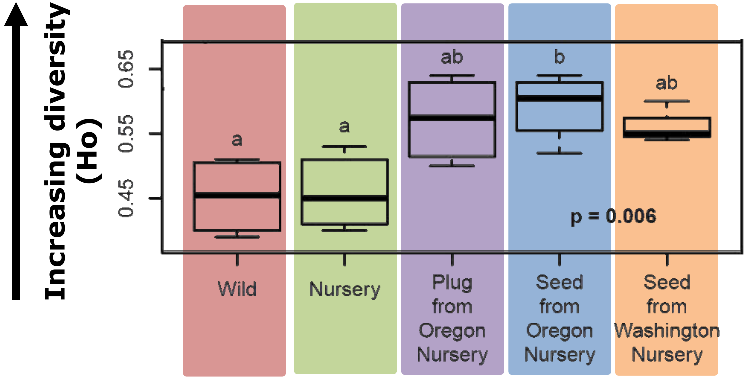
2) Does production approach impact our genetic results

3) Are all source populations represented?

Results!



1) Does genetic diversity change?

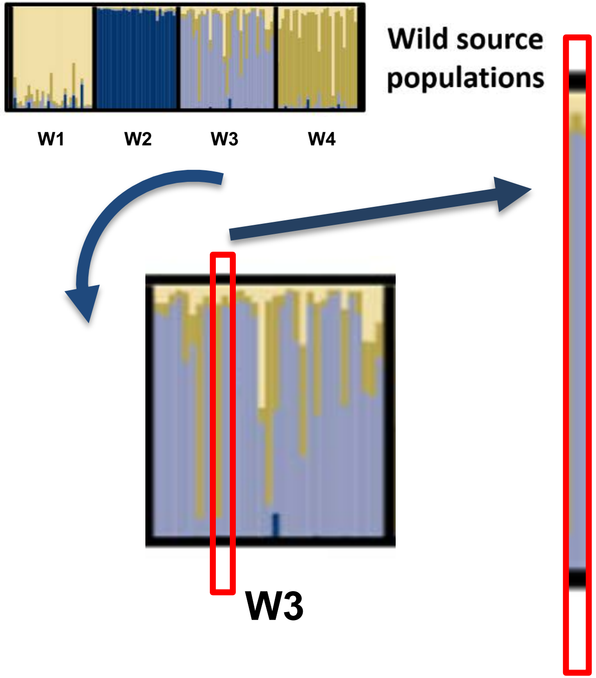


YES! Genetic diversity is greater in reintroductions than wild or nursery populations.

2) Does production approach or propagule type matter?

Maybe. Seed had less variability in its genetic diversity measures, but we didn’t see a consistent difference.

Results – how to read genetic structure diagrams

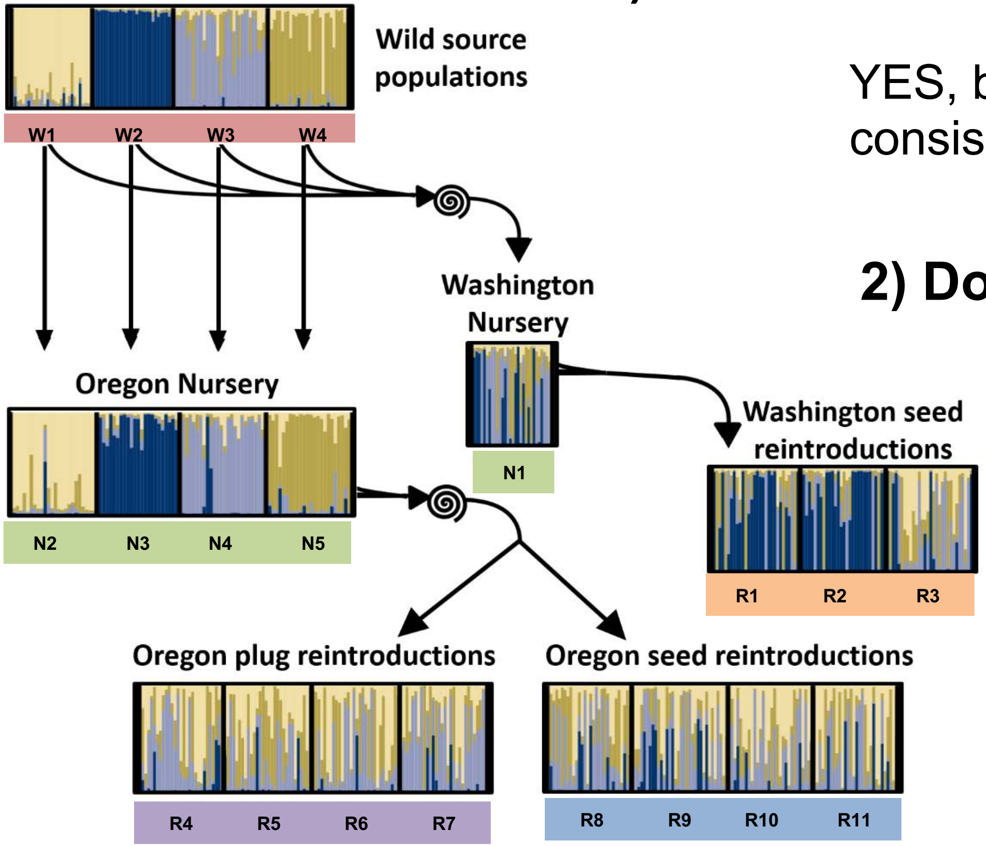


- each column = one individual
- each color = a group that is genetically similar
- colors in the column = which group that individual belongs to

The structure diagram for our four wild source populations show that individuals within each population are genetically similar to one another (because they are all roughly the same color) and that the four populations are genetically distinct from one another (because they are four different colors)

genetic structure diagrams are a visual representation of genetic diversity and relatedness.

Results



3) Are all source populations represented?

YES, but...not with consistency

2) Does production approach or propagule type matter?

YES! Mixing after nursery production and using plugs = most uniform representation.

Conclusions

- Mixing works
- The timing of mixing matters
- The propagules type may matter

Recommendations

- Consider your seed zone and buy within that zone
- Ask how your seed was collected and from how many populations
- Ask your suppliers how they manage for genetic diversity.

St. Clair, A.B., Dunwiddie, P.W., Fant, J.B., Kaye, T.N. and Kramer, A.T. (2020), Mixing source populations increases genetic diversity of restored rare plant populations. Restor Ecol, 28: 583-593. https://doi.org/10.1111/rec.13131

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