The future of Douglas-fir in southwest Oregon
Genetic and climate change considerations

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PNWTIRC

Climate change effects on forests

Altered tree reproduction, survival, and growth

Increased disturbances from fire, insects, pathogens

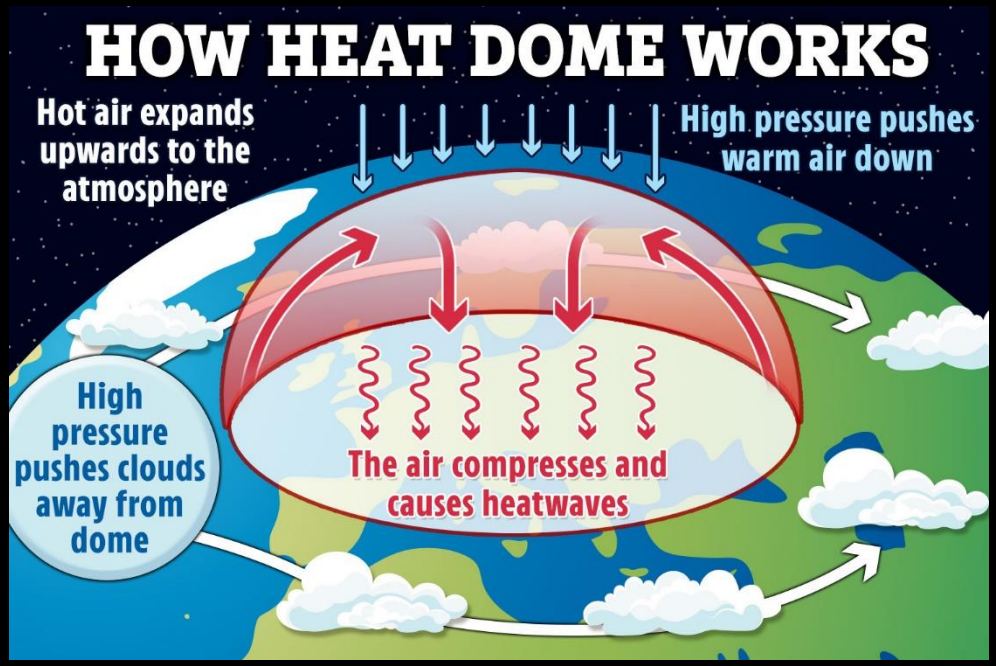
Changes in species habitats, distributions, and overall forest composition

PNW Heat Dome

June 2021

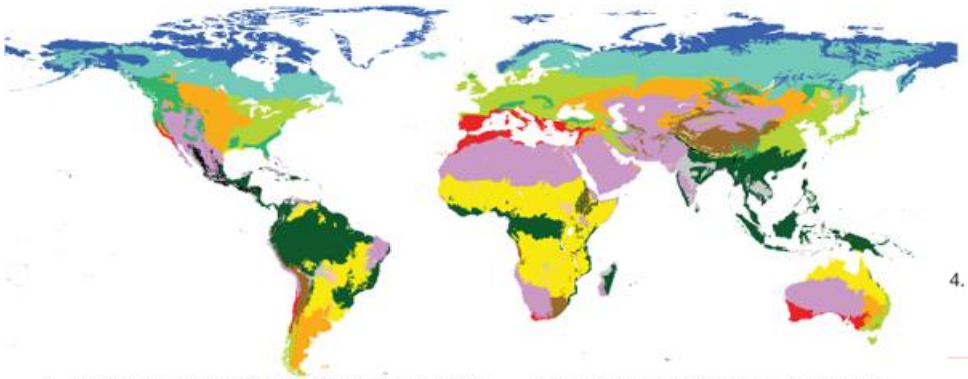
"Records were broken across the region in June of 2021, as temperatures soared as high as 118 degrees Fahrenheit. Portland saw a record high temperature of 116 degrees, while cities including Salem, Hillsboro and the Columbia River Gorge also broke their all-time records"

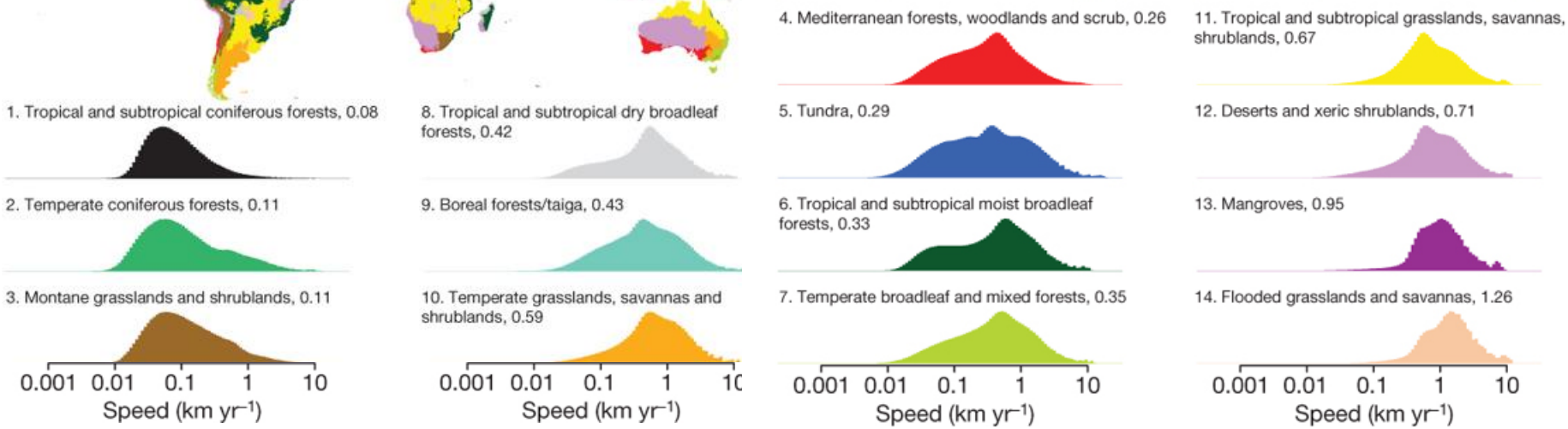
McKinnon and Simpson (2022) Geophysical Research Letters 49(18): 1-9



How fast will trees need to migrate?

Speed of temperature change within each biome. Histograms are ordered by increasing velocity according to their geometric means.





Forest examples

Temperate conifers	110 m/yr
Boreal and taiga	430 m/yr
Temperate broadleaf/mixed	350 m/yr

Loarie et al (2009) The velocity of climate change. Nature 462:1052-1055

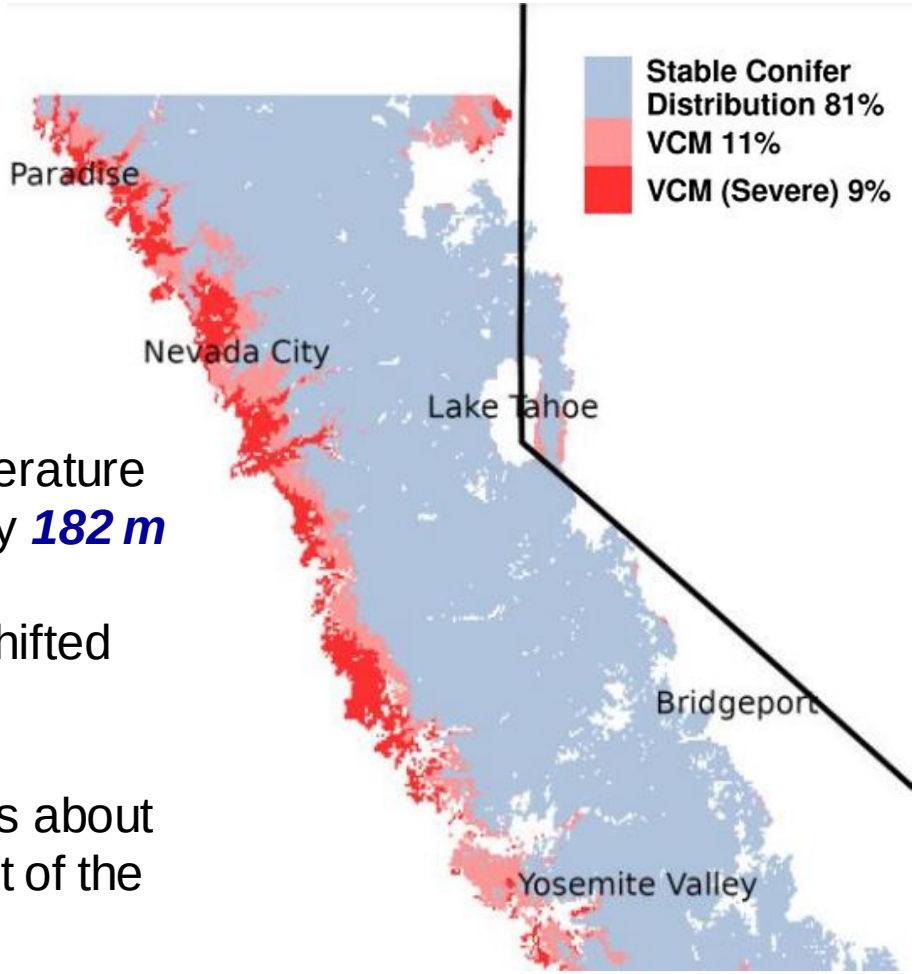
CA conifers not keeping pace with climate change

PNAS nexus

PNAS Nexus, 2023, 2, 1–9
https://doi.org/10.1093/pnasnexus/pgad004
Advance access publication 28 February 2023
Research Report

Low-elevation conifers in California's Sierra Nevada are out of equilibrium with climate

Avery P. Hill[a,*], Connor J. Nolan[b], Kyle S. Hemes[b], Trevor W. Cambron[c] and Christopher B. Field[a,b,c]



Since the 1930s, the characteristic temperature range for conifers has shifted up-slope by ***182 m***

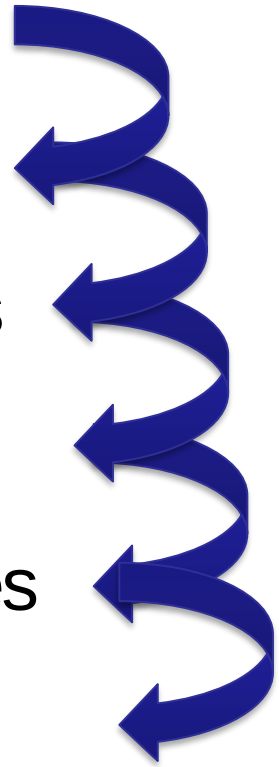
But the mean elevation of conifers has shifted up-slope by only ***34 m***

The magnitude of this temperature shift is about ***three to five times greater*** than the shift of the conifers

Result = vegetation-climate mismatch (VCM)

Uncertainty of forest responses

- Human behavior
- Greenhouse gases
- Global climate models
- Downscaling methods
- Direct forest responses
- Interacting stressors



Many levels of uncertainty!!

Modified from Dave Peterson, USFS PNWRS

Which factors influence habitat?

Animals

Vegetation

Micro-organisms

Temp

Moisture

Soils

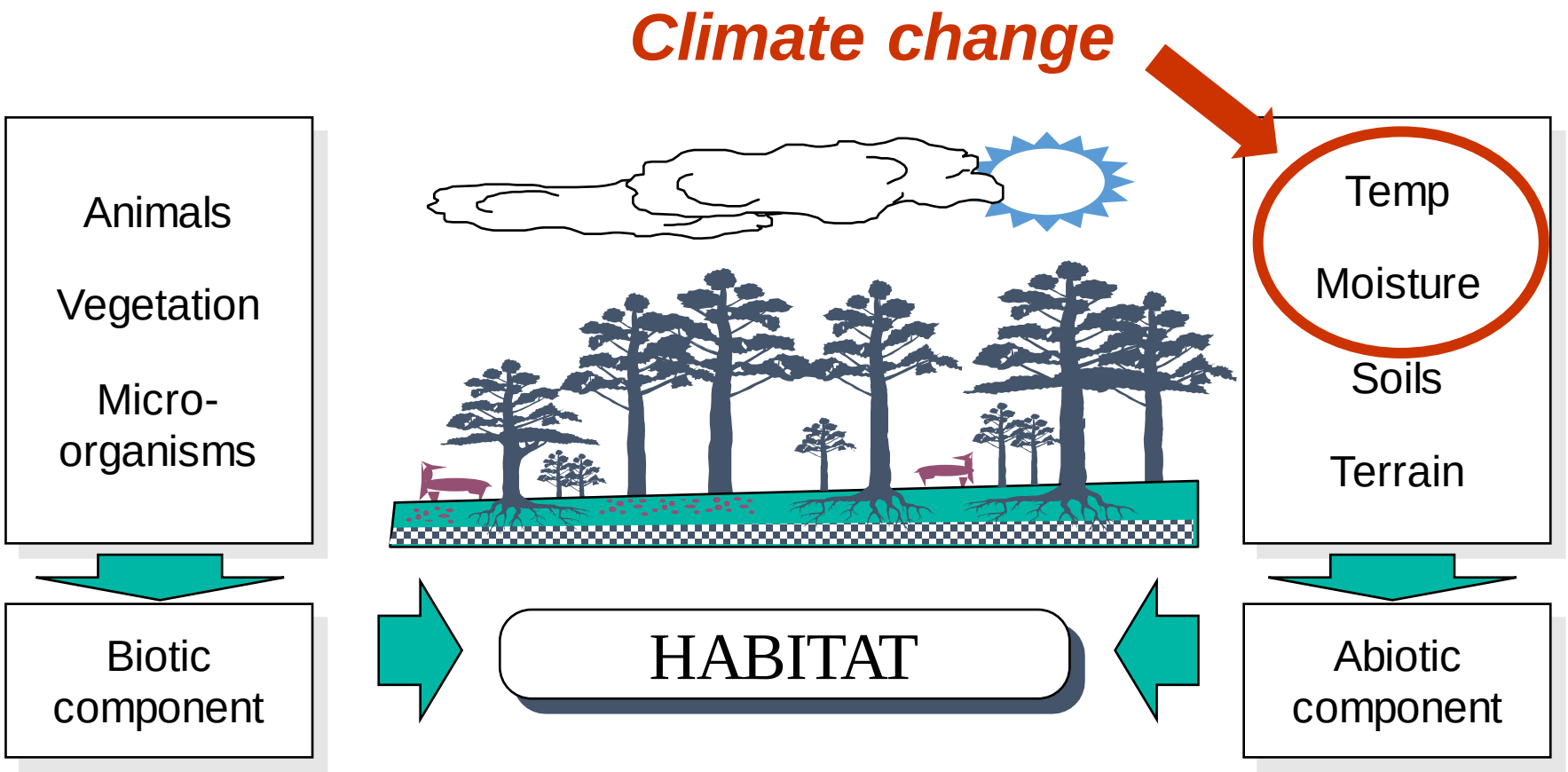
Terrain

Biotic component

HABITAT

Abiotic component

Which factors influence habitat?



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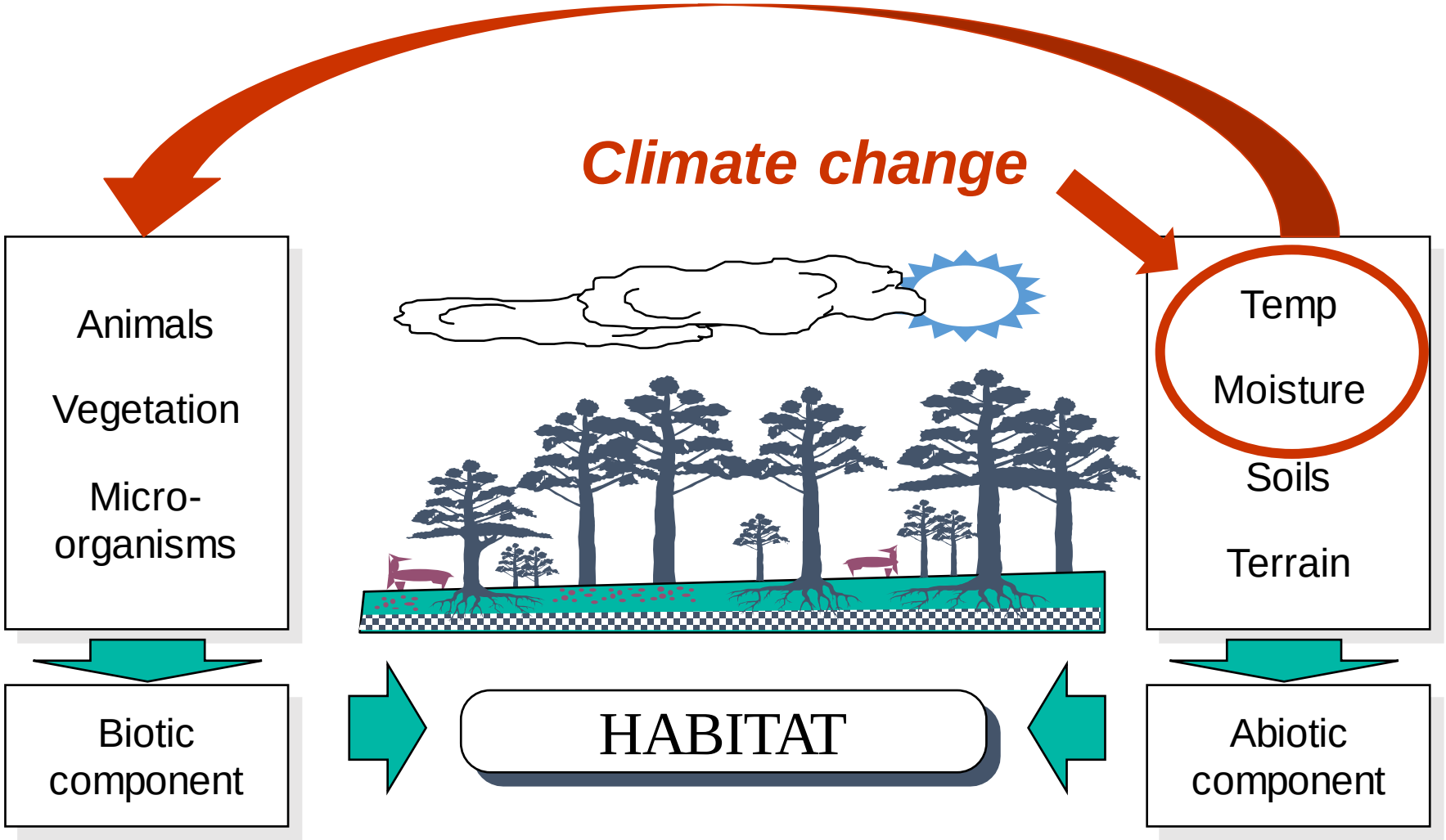
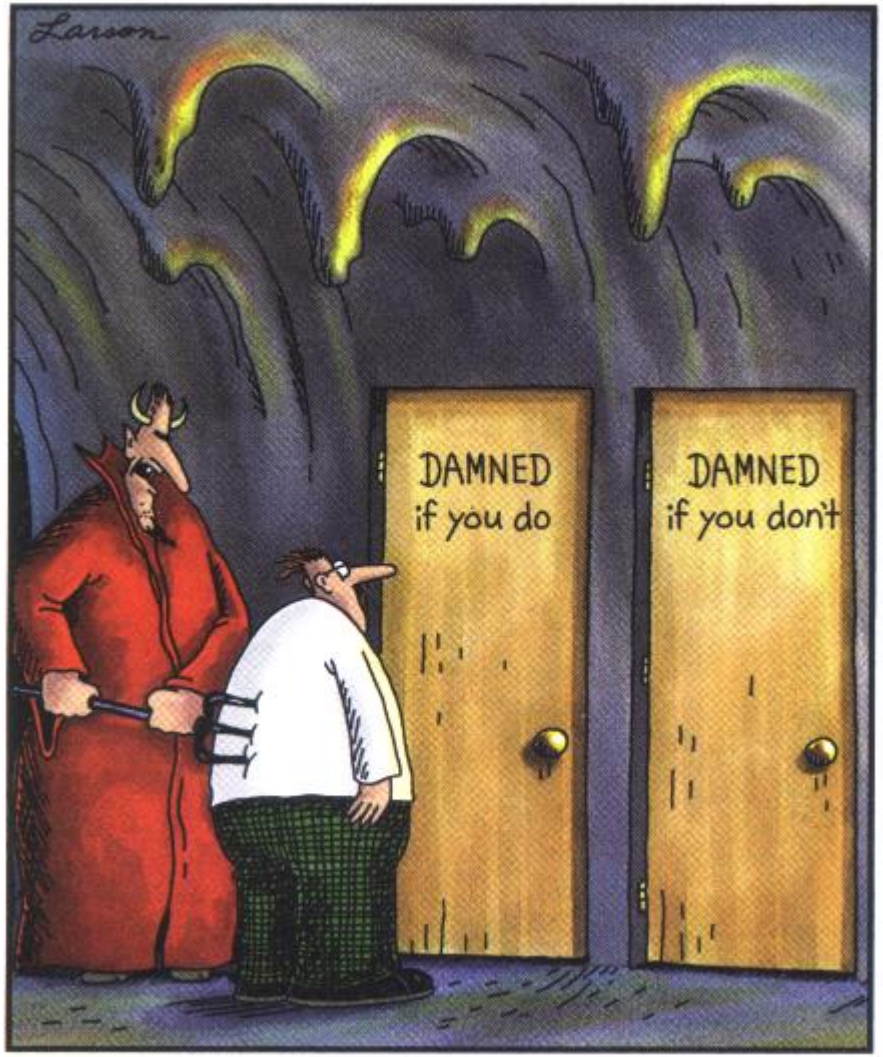


Avoid analysis paralysis

"Not to decide is to decide"



"C'mon, c'mon—it's either one or the other"

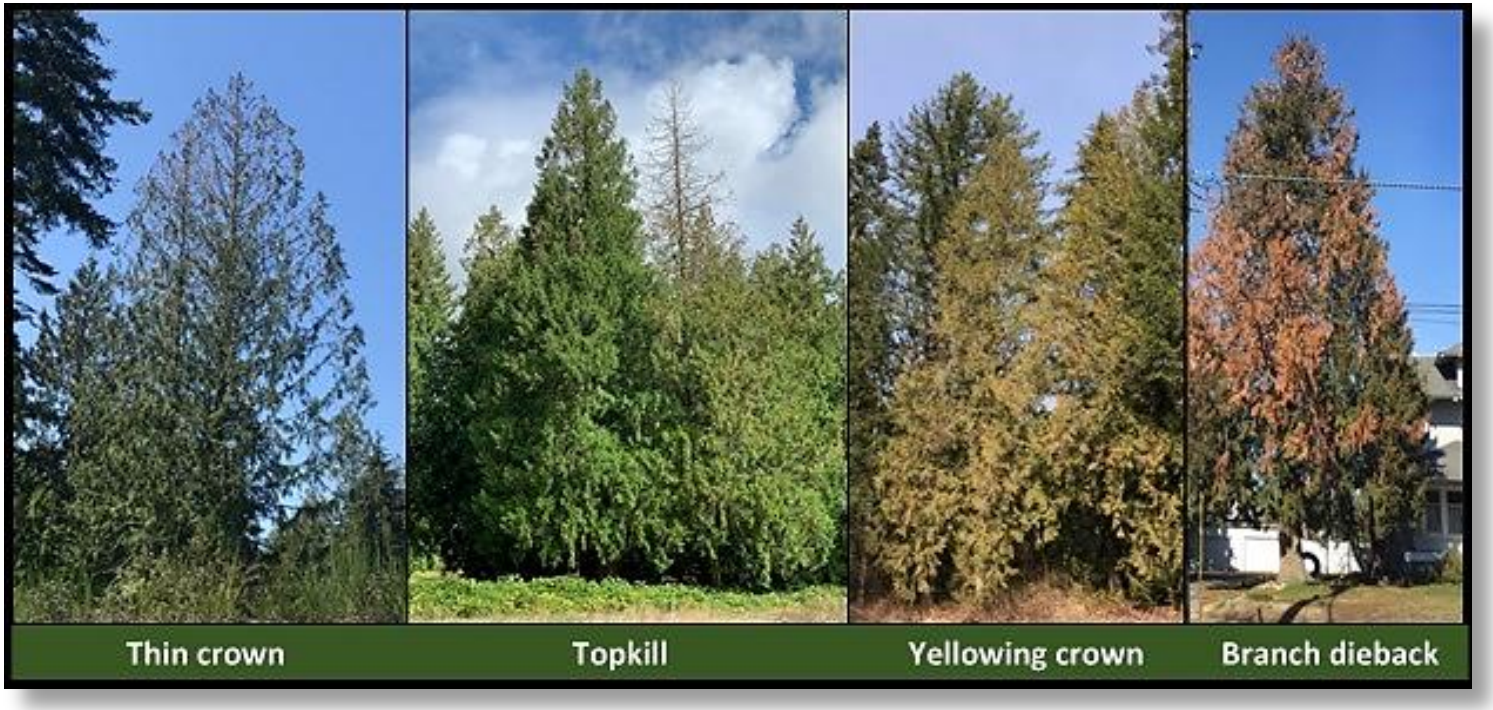
How to respond?

The view from 30,000 feet

Transition versus resistance/resilience

Local forest health problem?

Western redcedar dieback monitoring in the PNW – Help Wanted
Posted on April 20, 2021 by withrowb



https://blogs.oregonstate.edu/treetopics/2021/04/20/western-redcedar-dieback-monitoring-in-the-pacific-northwest-help-wanted/

Local forest health problem?

Oregon Capital Chronicle

POLITICS ENVIRONMENT EDUCATION ECONOMY HEALTH OREGON'S PEOPLE

ENVIRONMENT

Massive die-off hits fir trees across the Northwest

Labeled "Firmageddon," by researchers, the drought-driven "mortality event" is the largest ever recorded in the region

BY: NATHAN GILLES - FEBRUARY 14, 2023 9:30 AM

The Pacific Northwest Region Aerial Survey is cataloging tree decline (Daniel DeMuth/U.S. Forest Service)

This story was originally published by Columbia Insight.

Local forest health problem?

Journal of Forestry, 2023, **XX**, 1–16
https://doi.org/10.1093/jofore/fvad007
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Research Article - forest threats

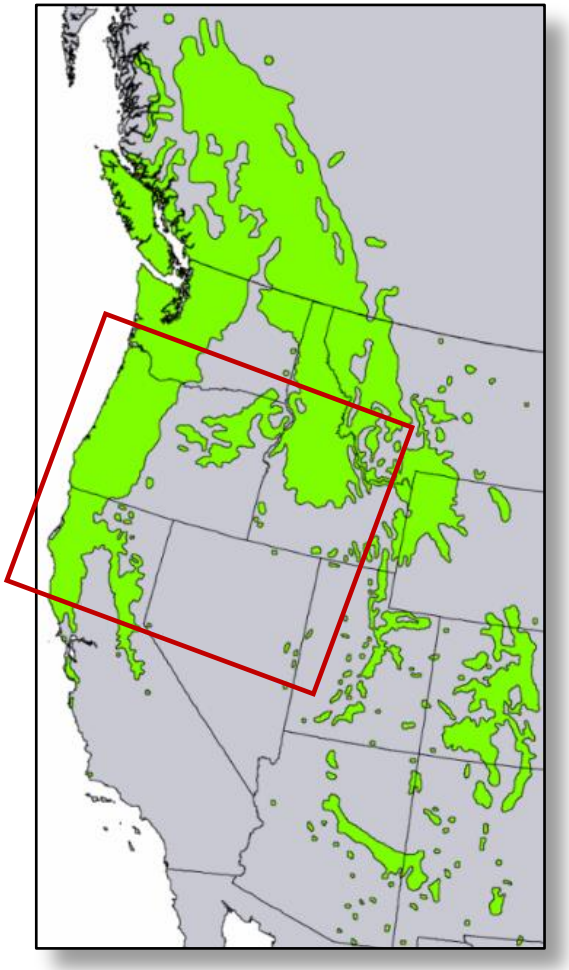
OXFORD

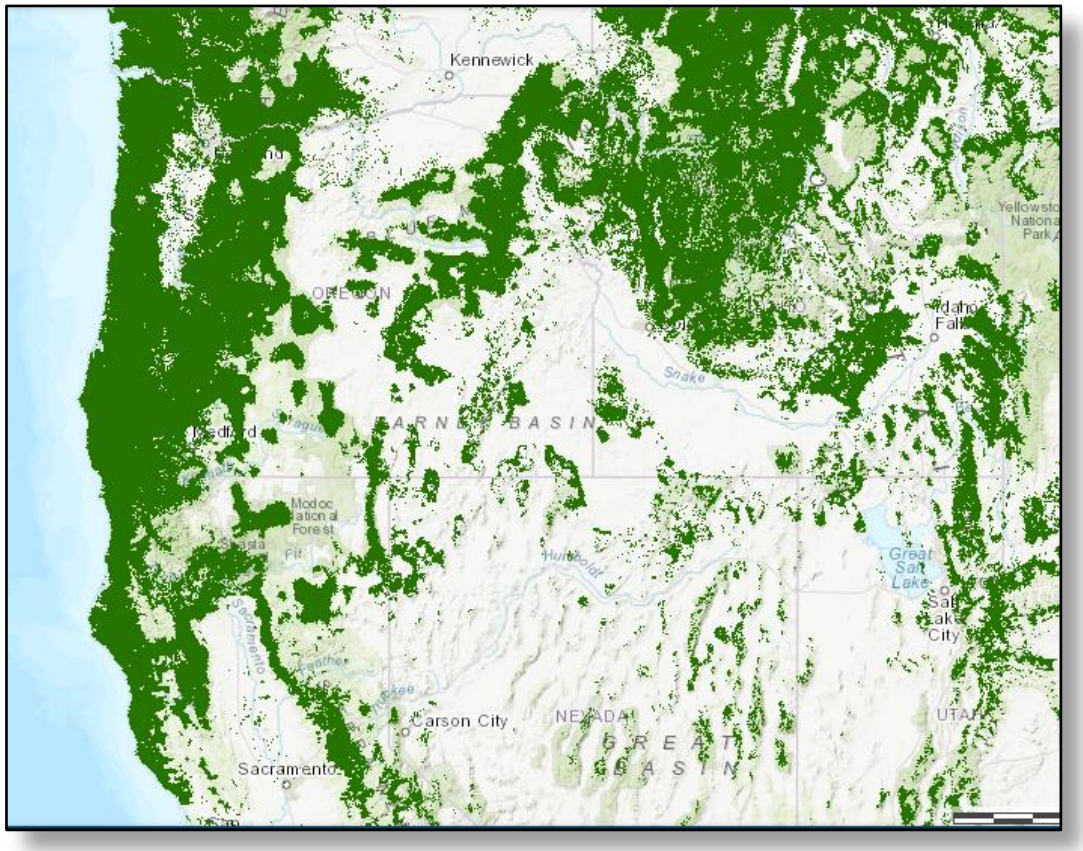
Recent Douglas-fir Mortality in the Klamath Mountains Ecoregion of Oregon: Evidence for a Decline Spiral

Max Bennett,[1,*] David C. Shaw,[2] and Laura Lowrey[3]


The view from 30,000 feet

Douglas-fir distribution





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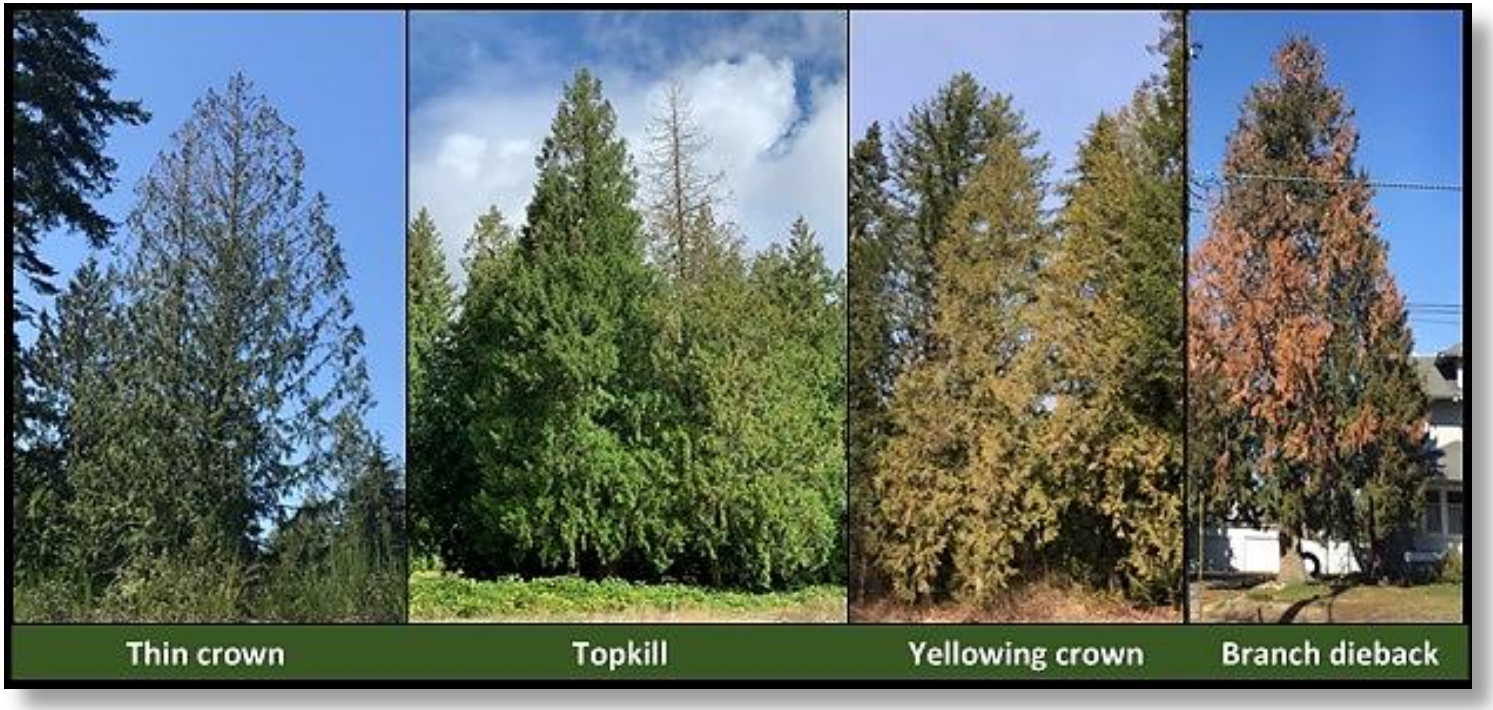

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Changes in species habitat?

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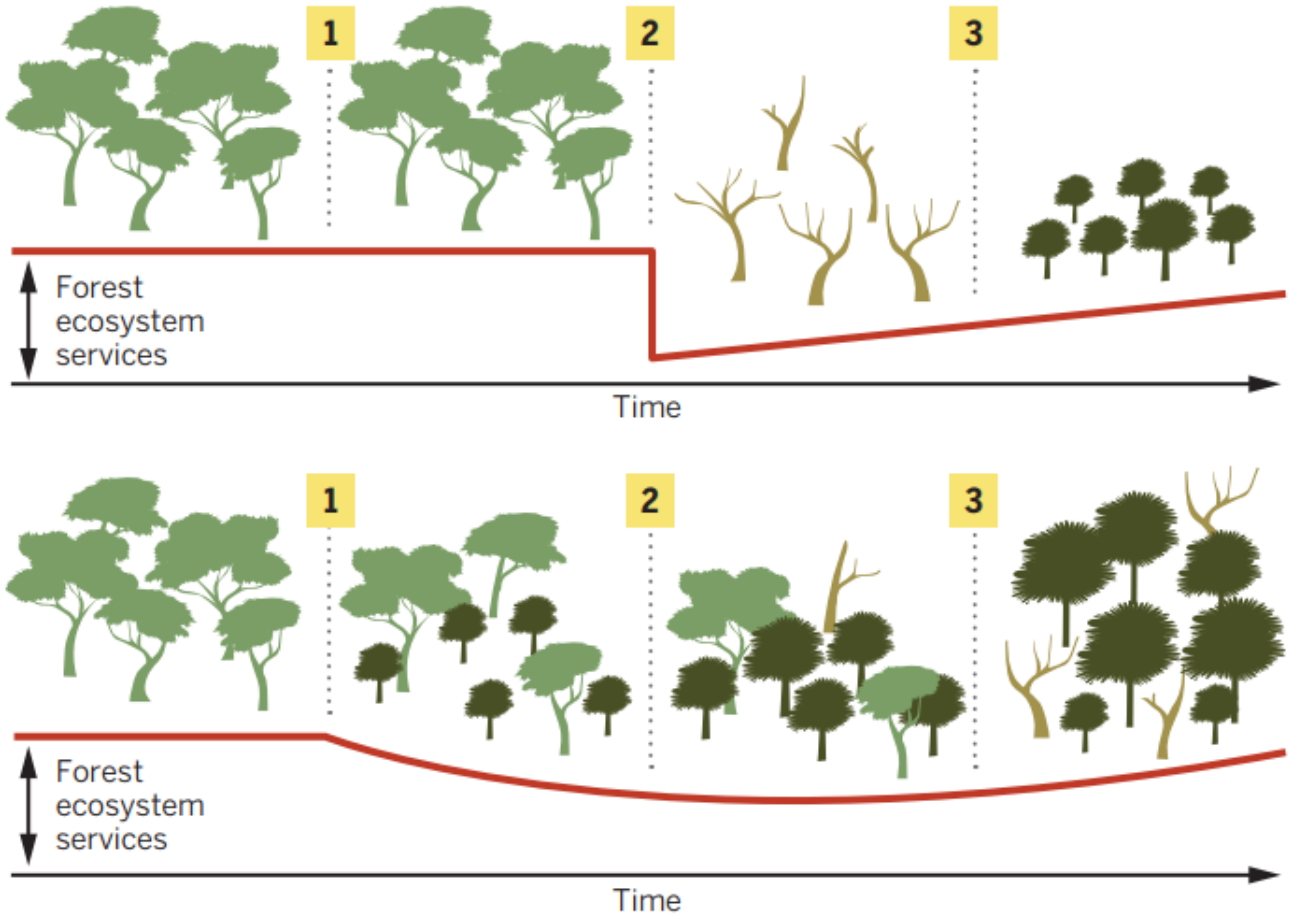


Millar, C.I. and Stephenson, N.L. (2015). Science 349(6250): 823-826

How can forest managers respond?

Choose appropriate species

Choose appropriate seedlots

How do we project where species can occur in the future?

Species distribution models

Bioclimatic models

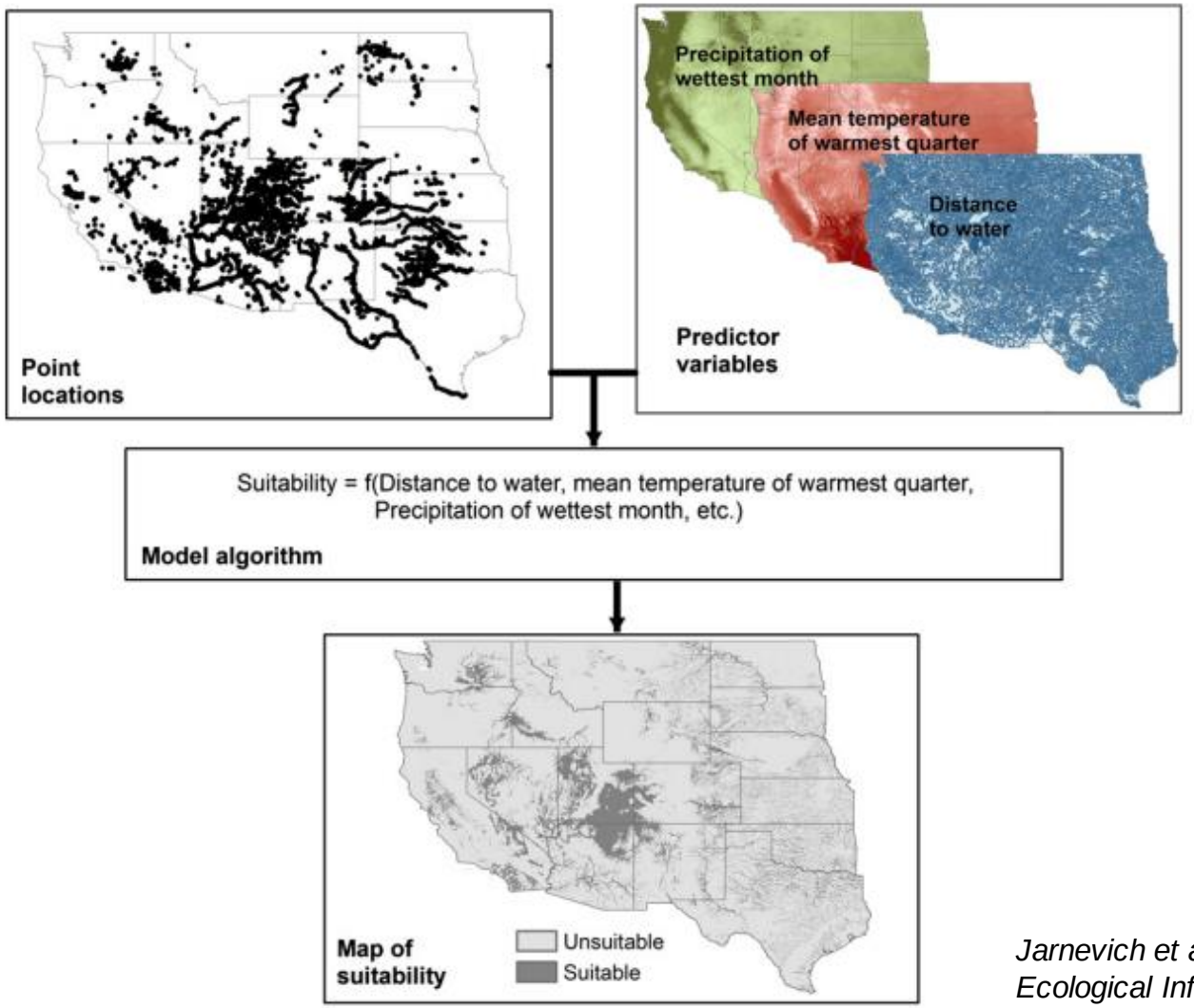
Climate envelope models

Ecological niche models

Resource selection functions

Habitat models

Habitat modeling – Approach



Jarnevich et al. (2015) Ecological Informatics 29:6-15

Issues?

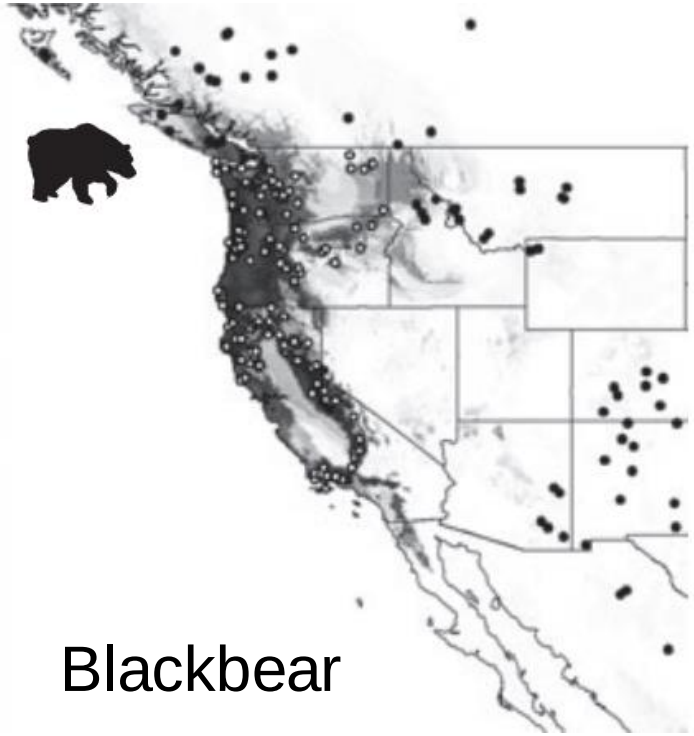
Journal of Biogeography (J. Biogeogr.) (2009)

GUEST EDITORIAL

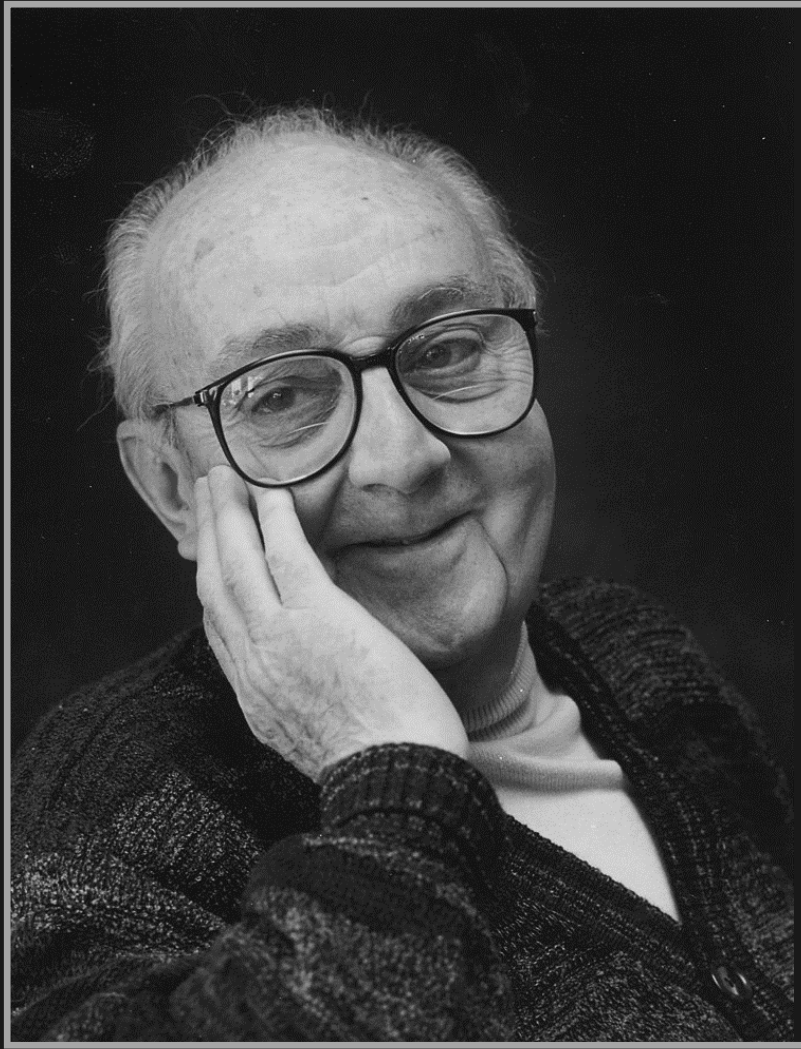
Predicting the distribution of Sasquatch in western North America: anything goes with ecological niche modelling

J. D. Lozier[1]*, P. Aniello[2] and M. J. Hickerson[3]

Sasquatch



Blackbear



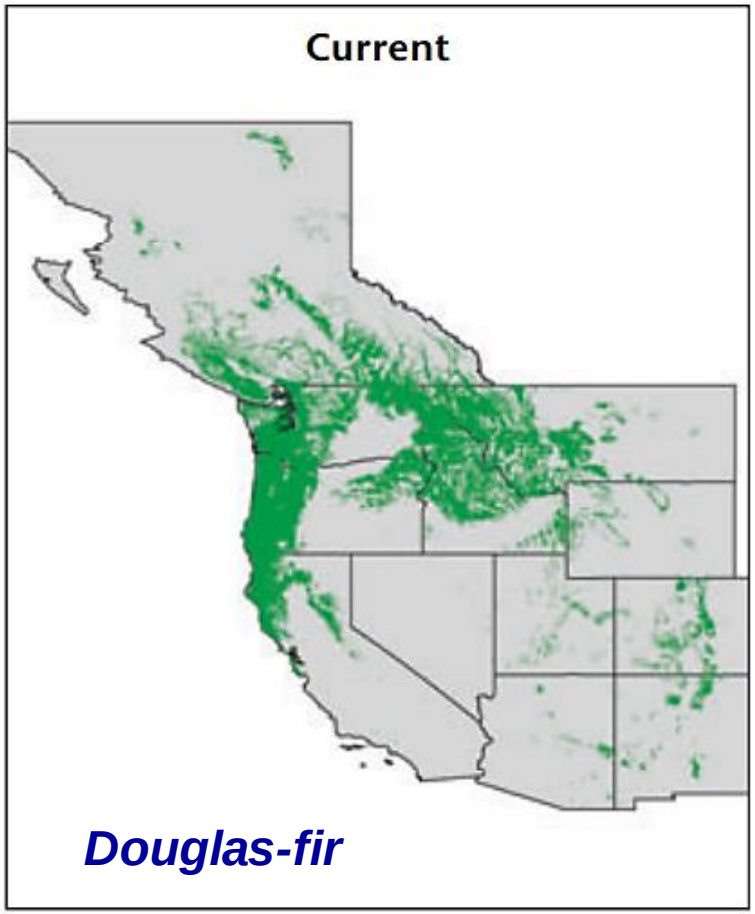
All models are wrong...

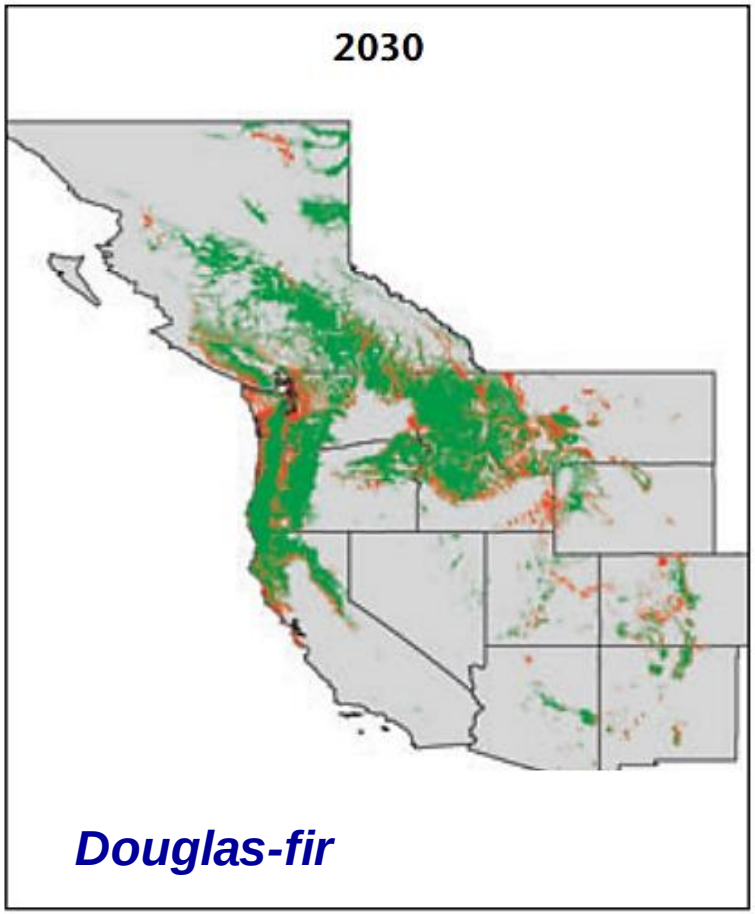
but some are useful

— *George E. P. Box* —

Choose appropriate species

Be careful about planting near the margins of a species distributions





Weiskittel et al. (2012) Weis Schweiz Z Forstwes 163 (3):70–78

Assisted migration

The intentional movement of species, populations, or genotypes outside of their known historical distributions in response to anticipated climate change

a.k.a. "managed relocation," "assisted colonization," "managed translocation"…

Assisted migration

Species-level

Population-level

Exotic species translocation

Range expansion

Seed transfer

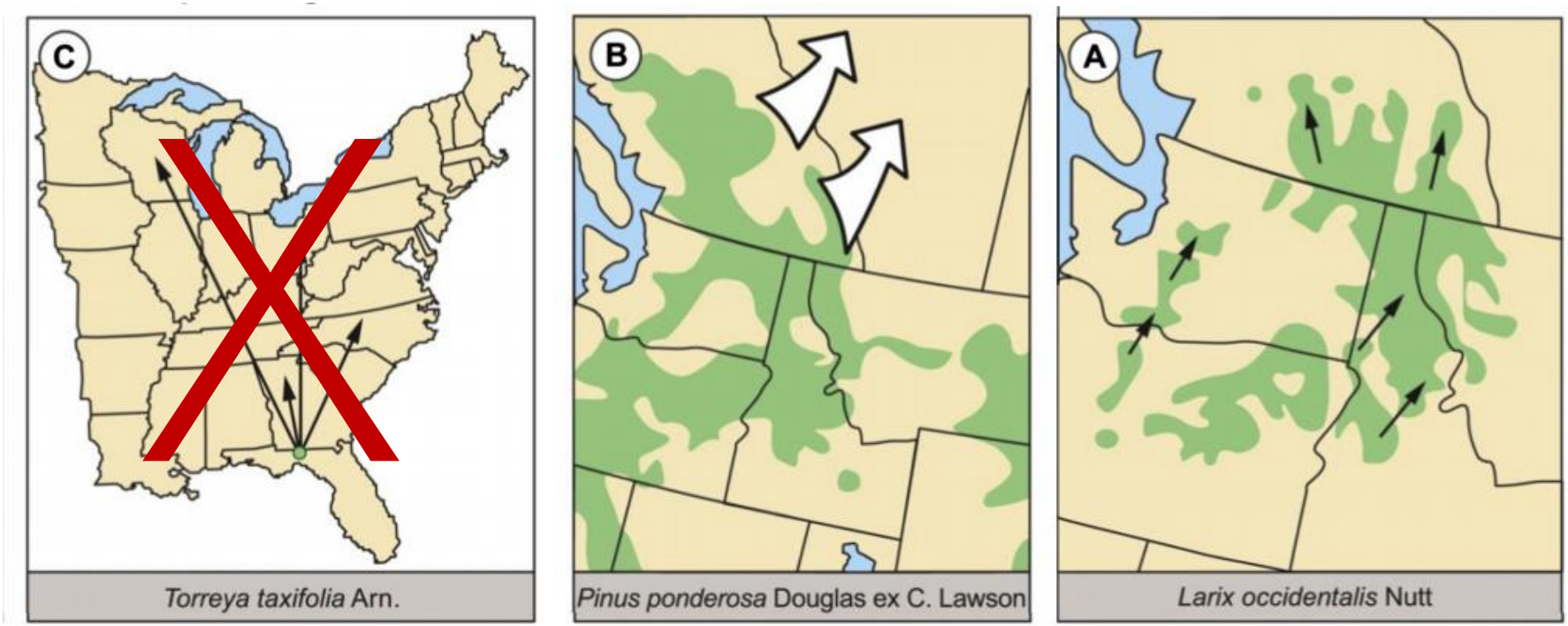


Figure modified from Williams and Dumroese (2014)Tree Planters' Notes 57(1):21-26

Species-level assisted migration

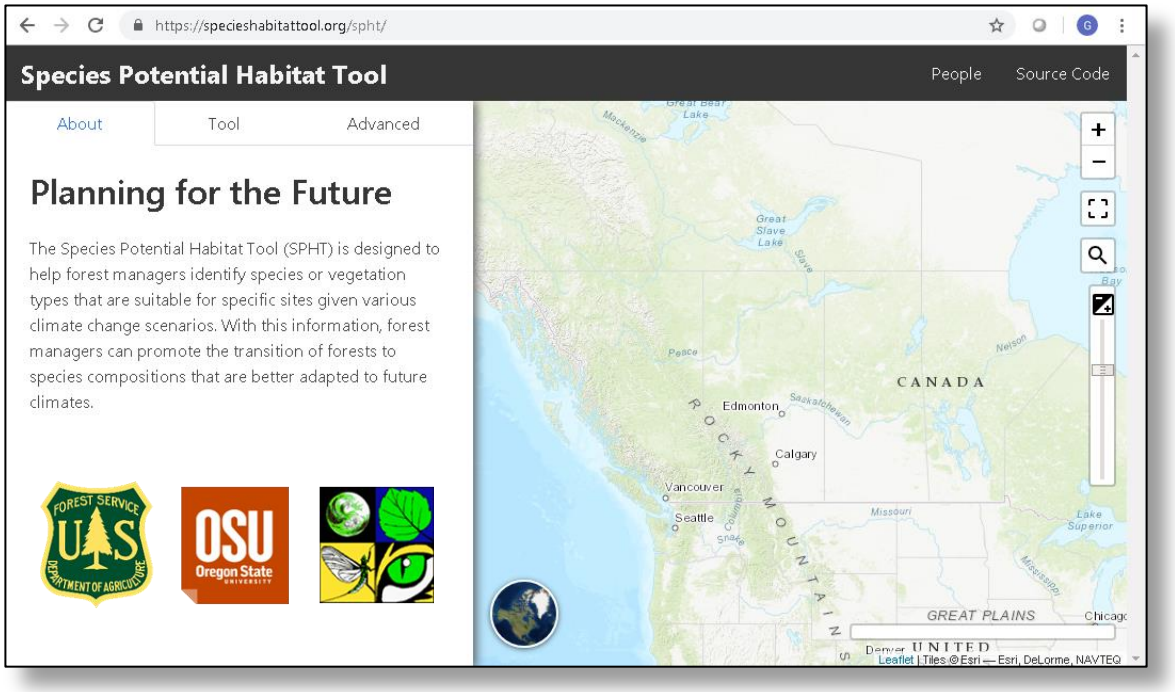
Species Potential Habitat Tool (SPHT)

https://specieshabitattool.org/spht/

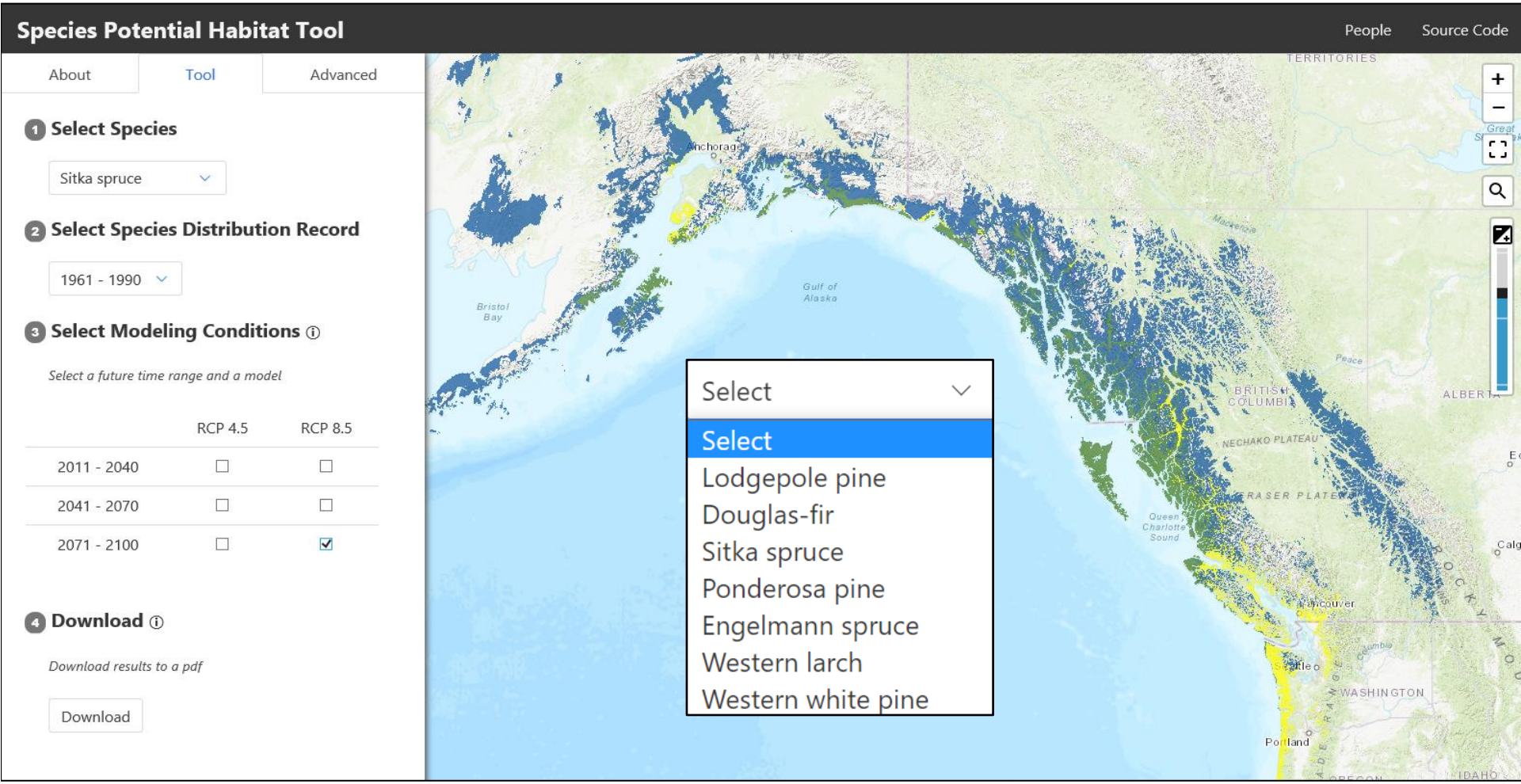
Species Potential Habitat Tool (SPHT)

A mapping tool to help forest managers match ***species*** with planting sites based on climate information

Check it out at: **https://specieshabitattool.org/spht/**



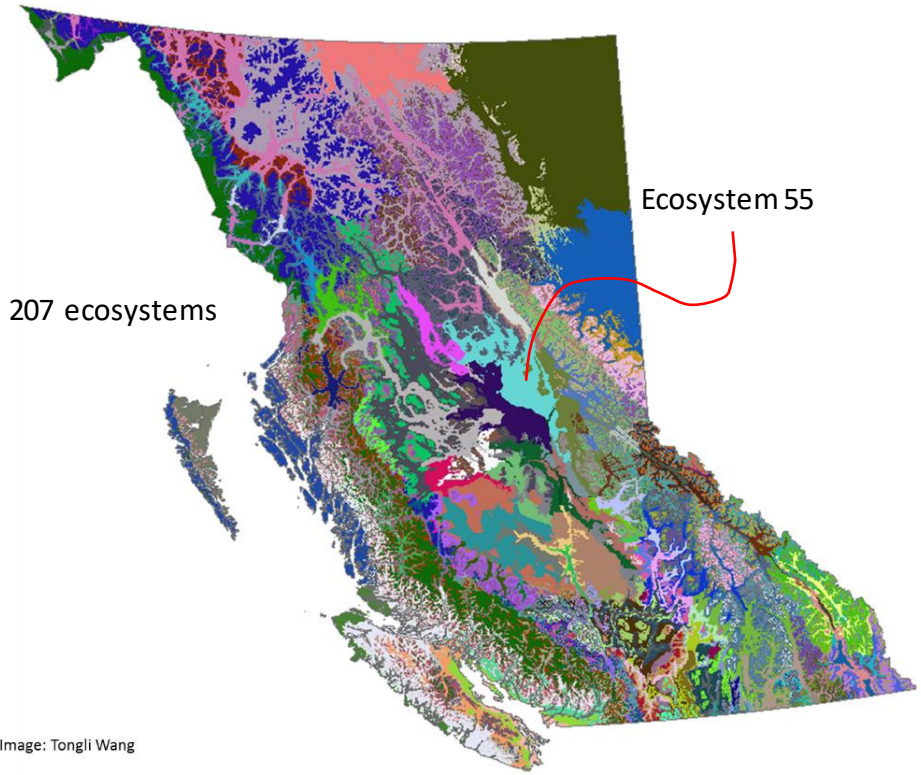
Species Potential Habitat Tool



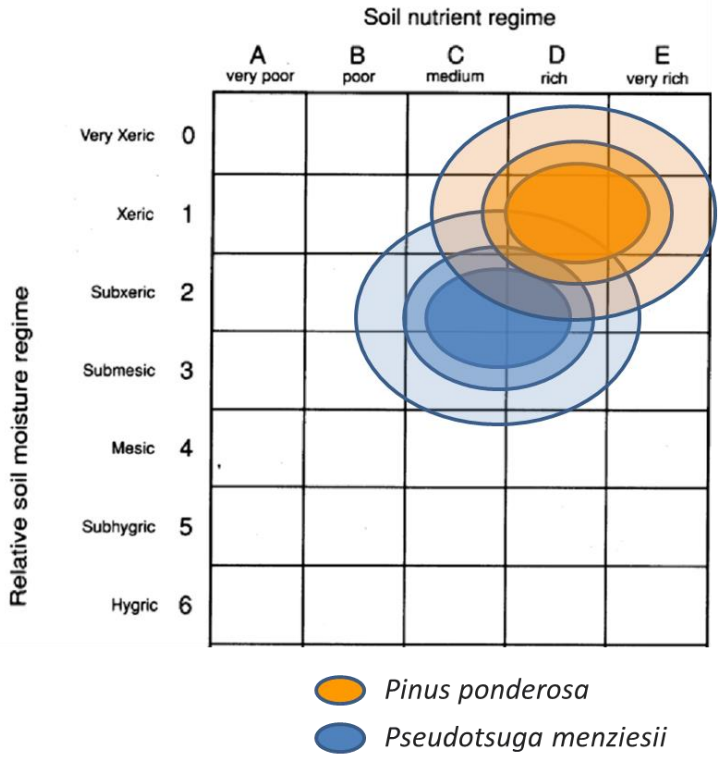
https://specieshabitattool.org/spht/

Habitats

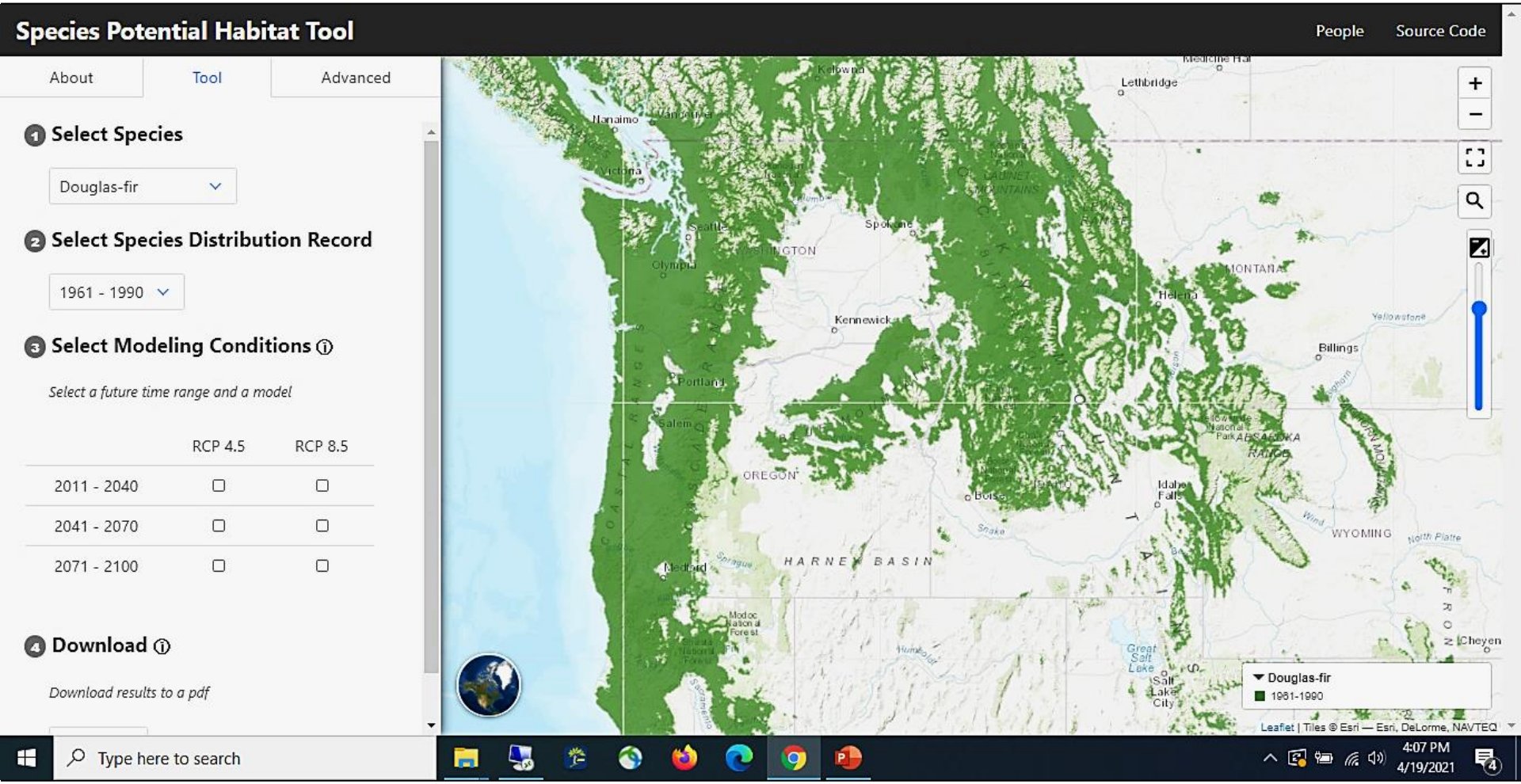
Ponderosa pine and Douglas-fir



Edatopic grid for ecosystem 55

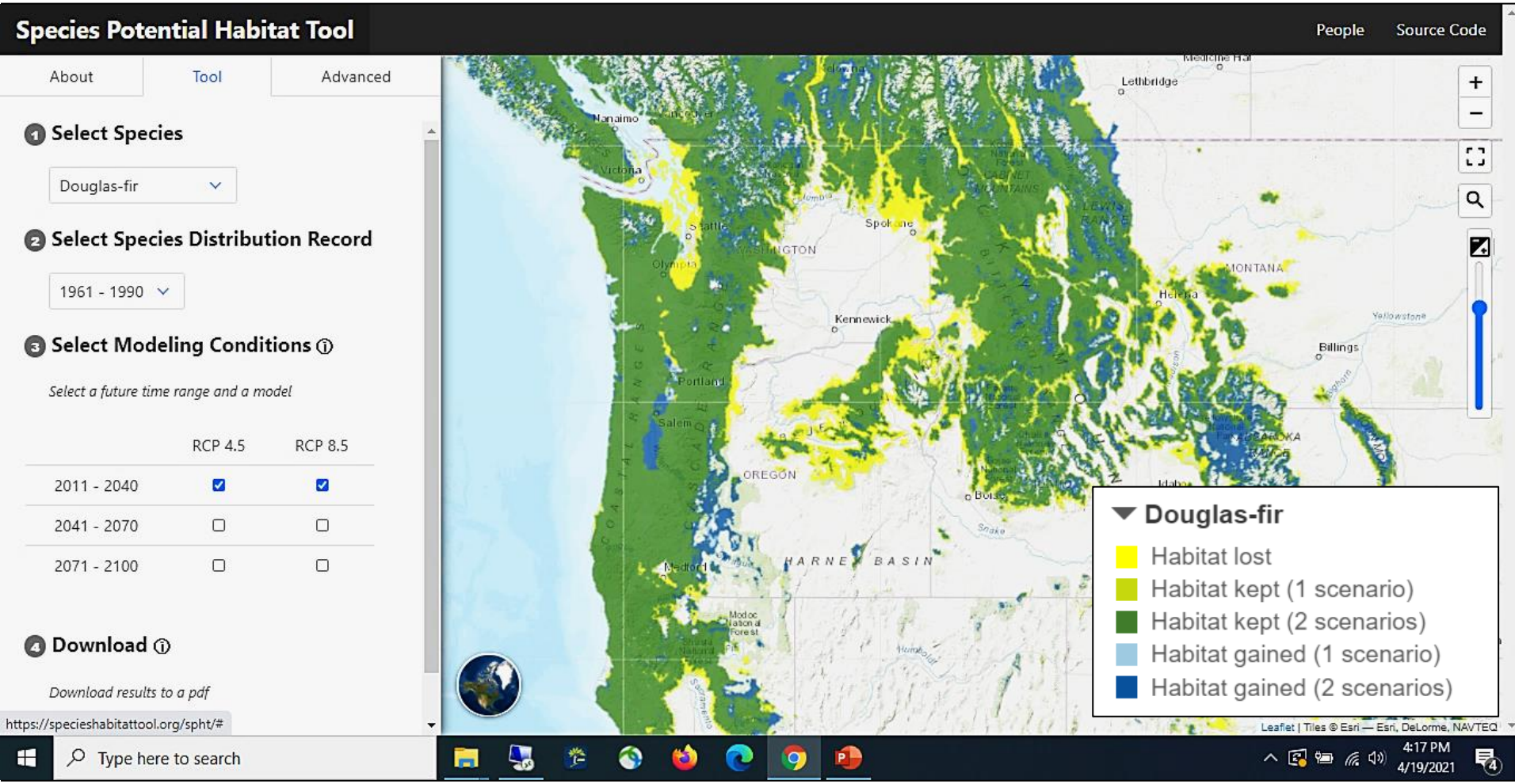


Douglas-fir | 1975



https://specieshabitattool.org/spht/

Douglas-fir | 2025



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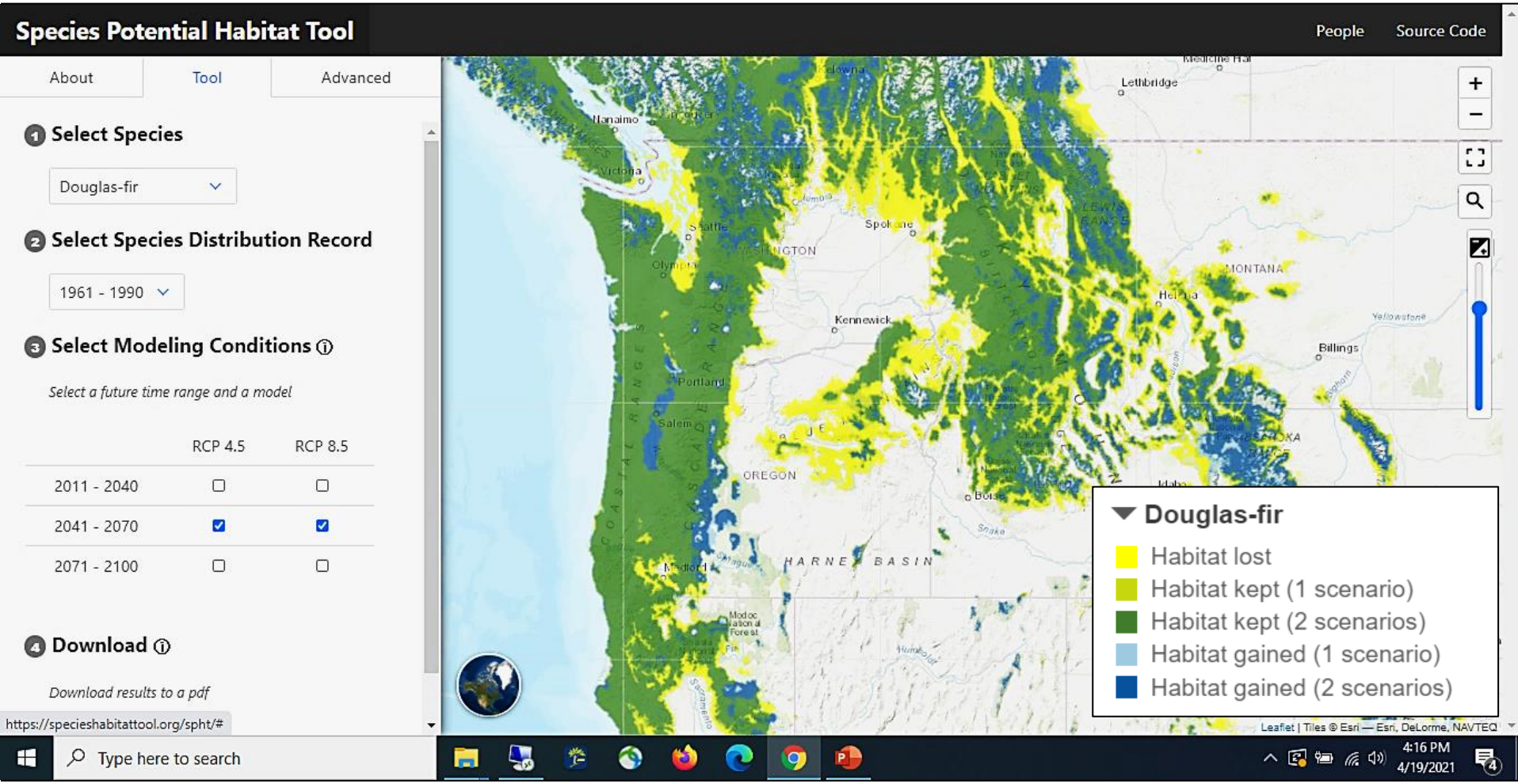
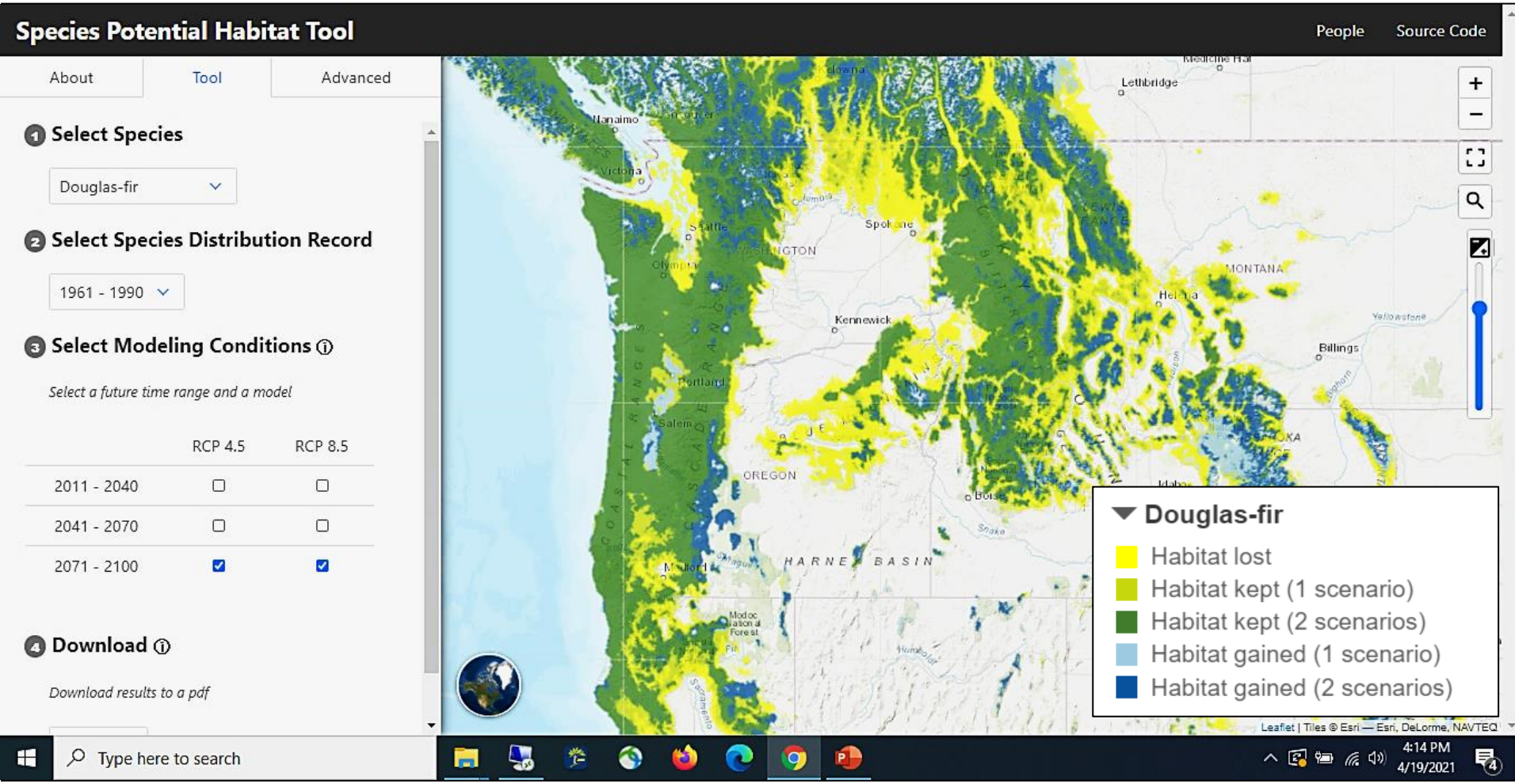
Douglas-fir | 2055



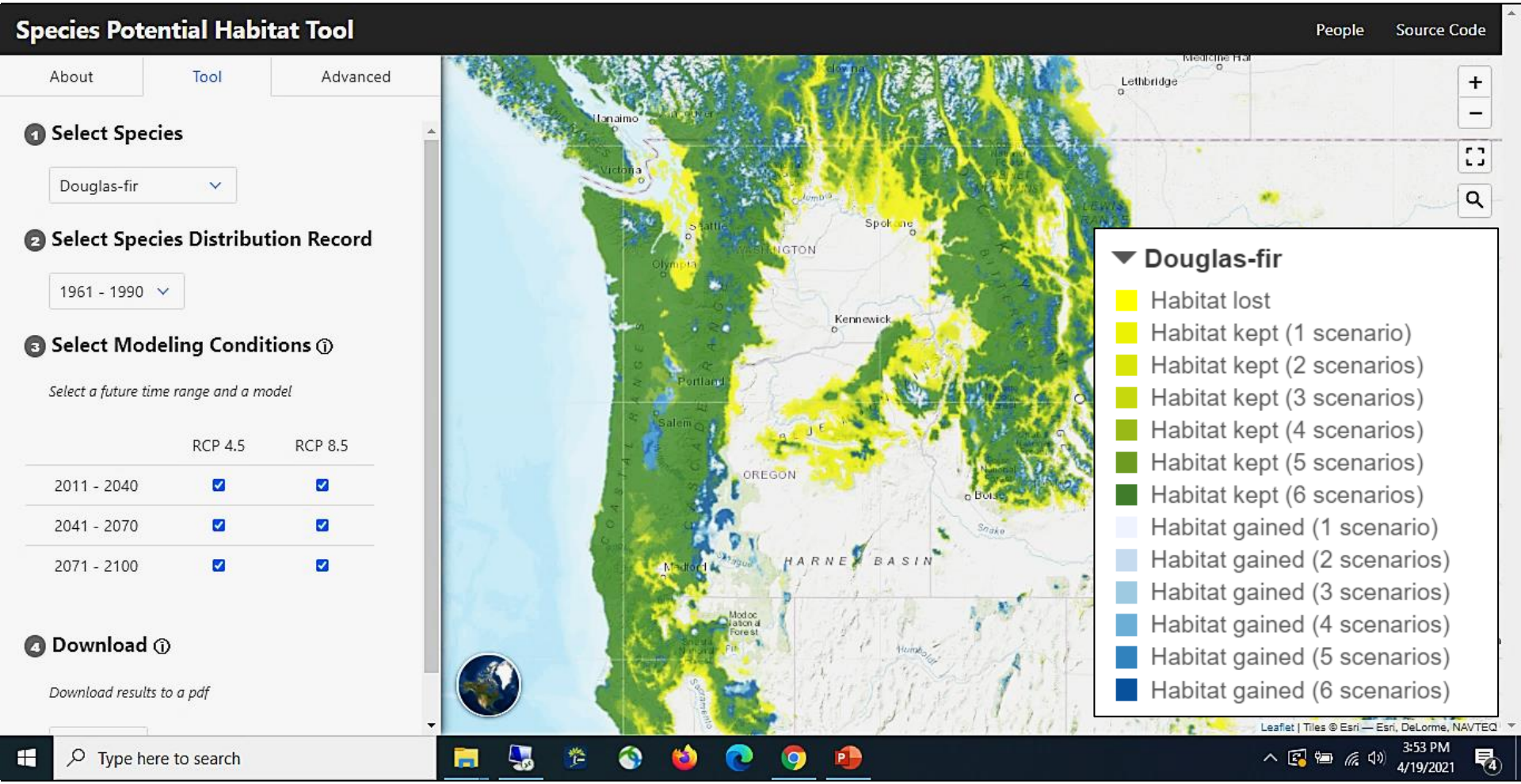
https://specieshabitattool.org/spht/

Douglas-fir | 2085



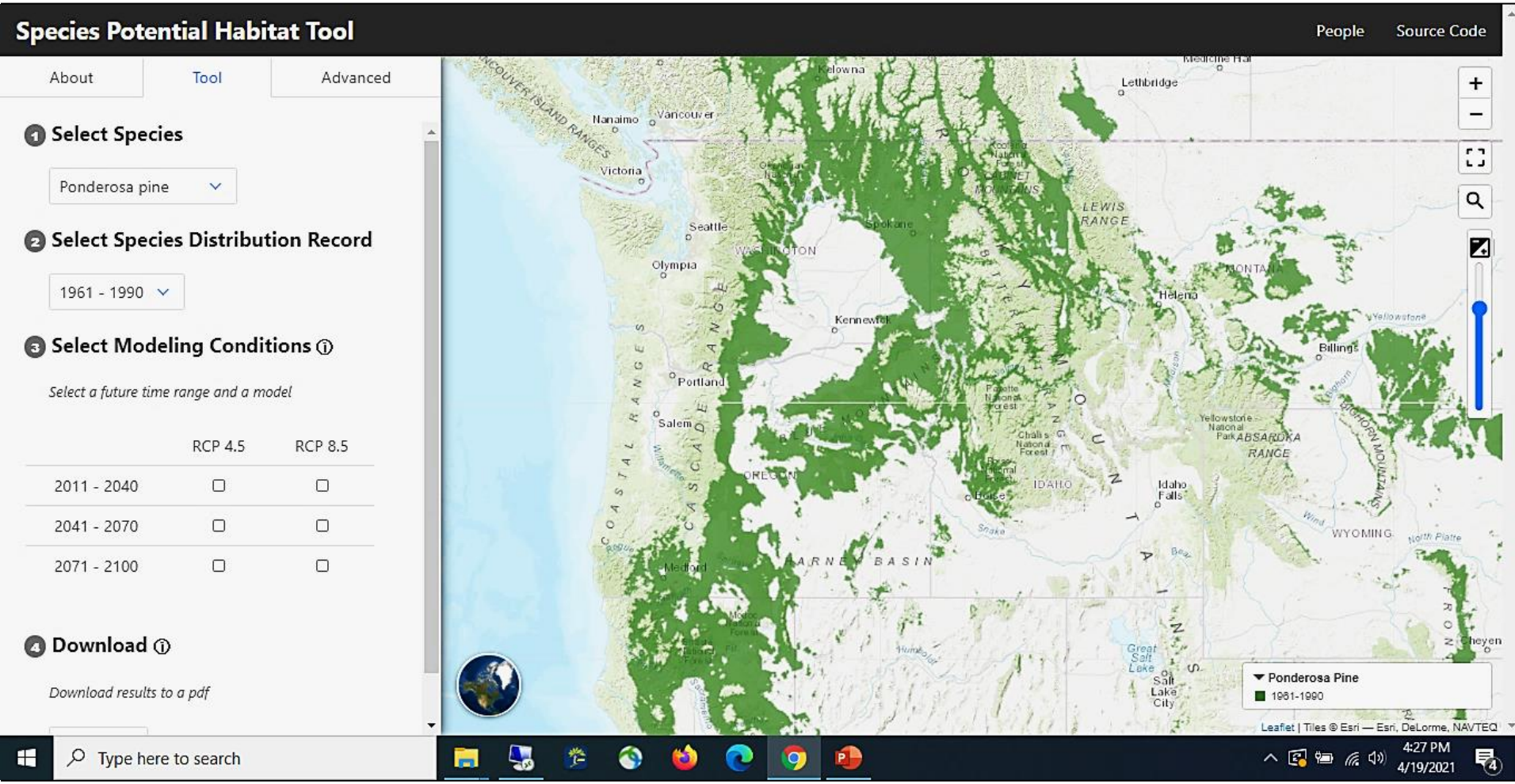
https://specieshabitattool.org/spht/

Douglas-fir consensus



https://specieshabitattool.org/spht/

Ponderosa pine | 1975



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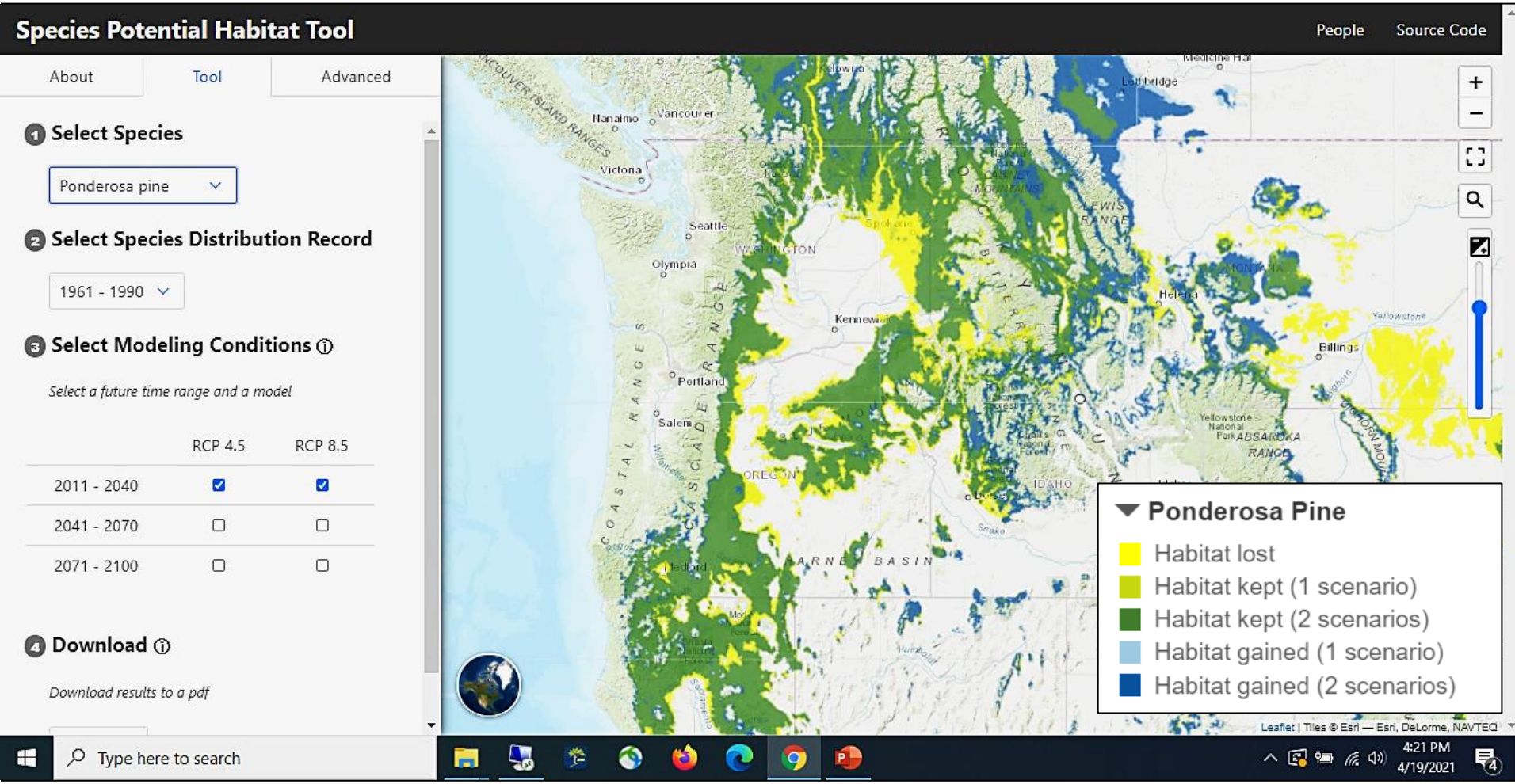
Ponderosa pine | 2025



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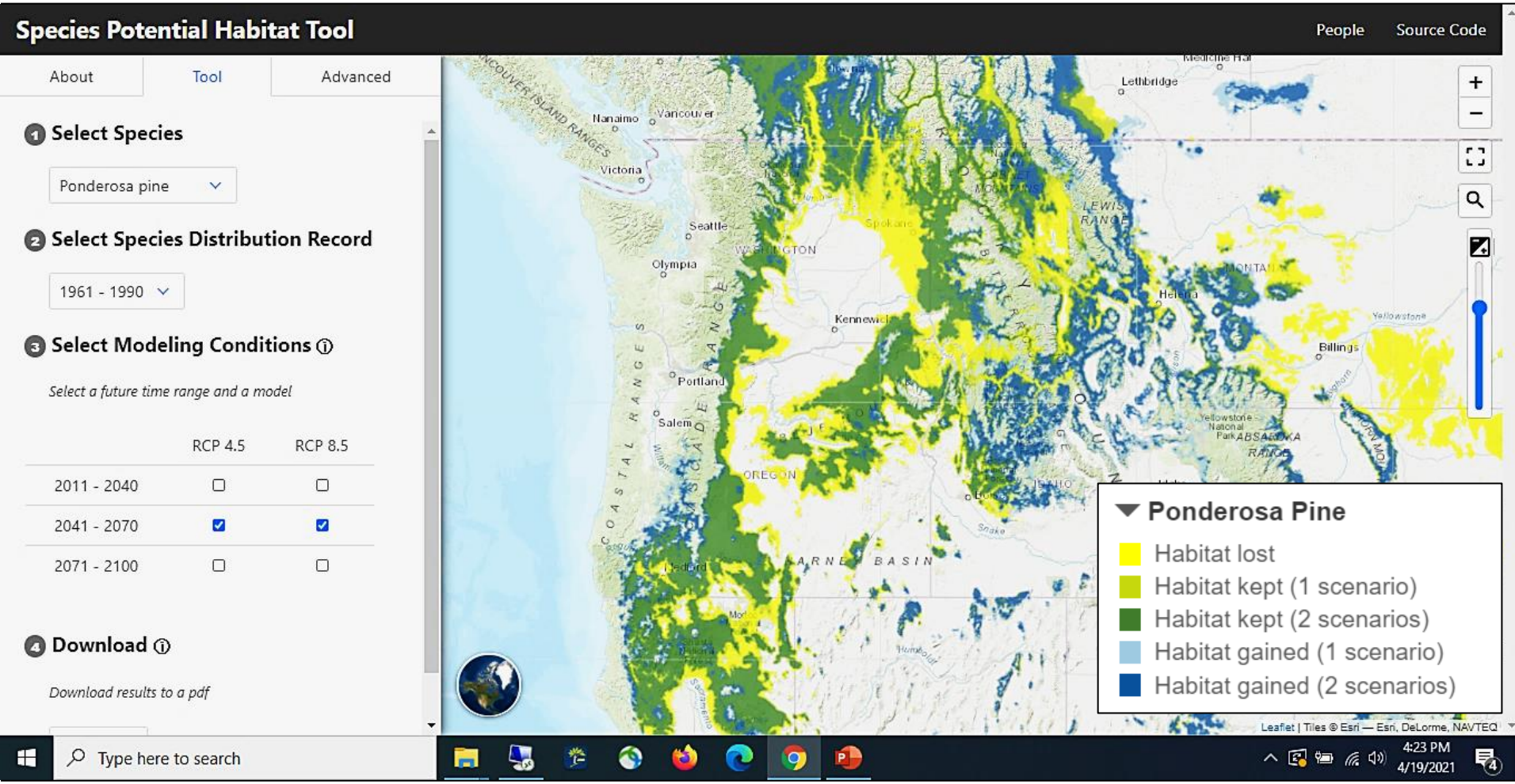

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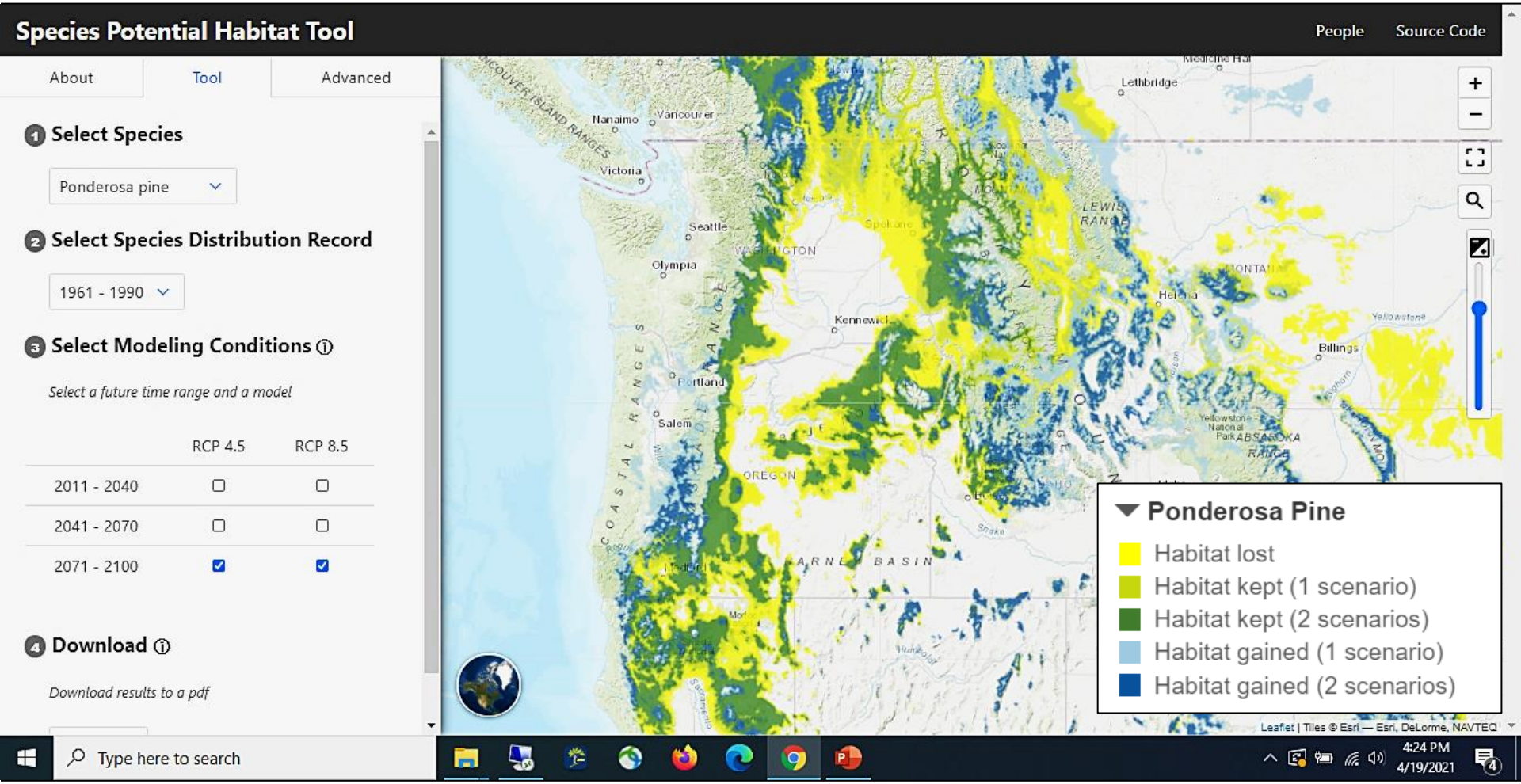

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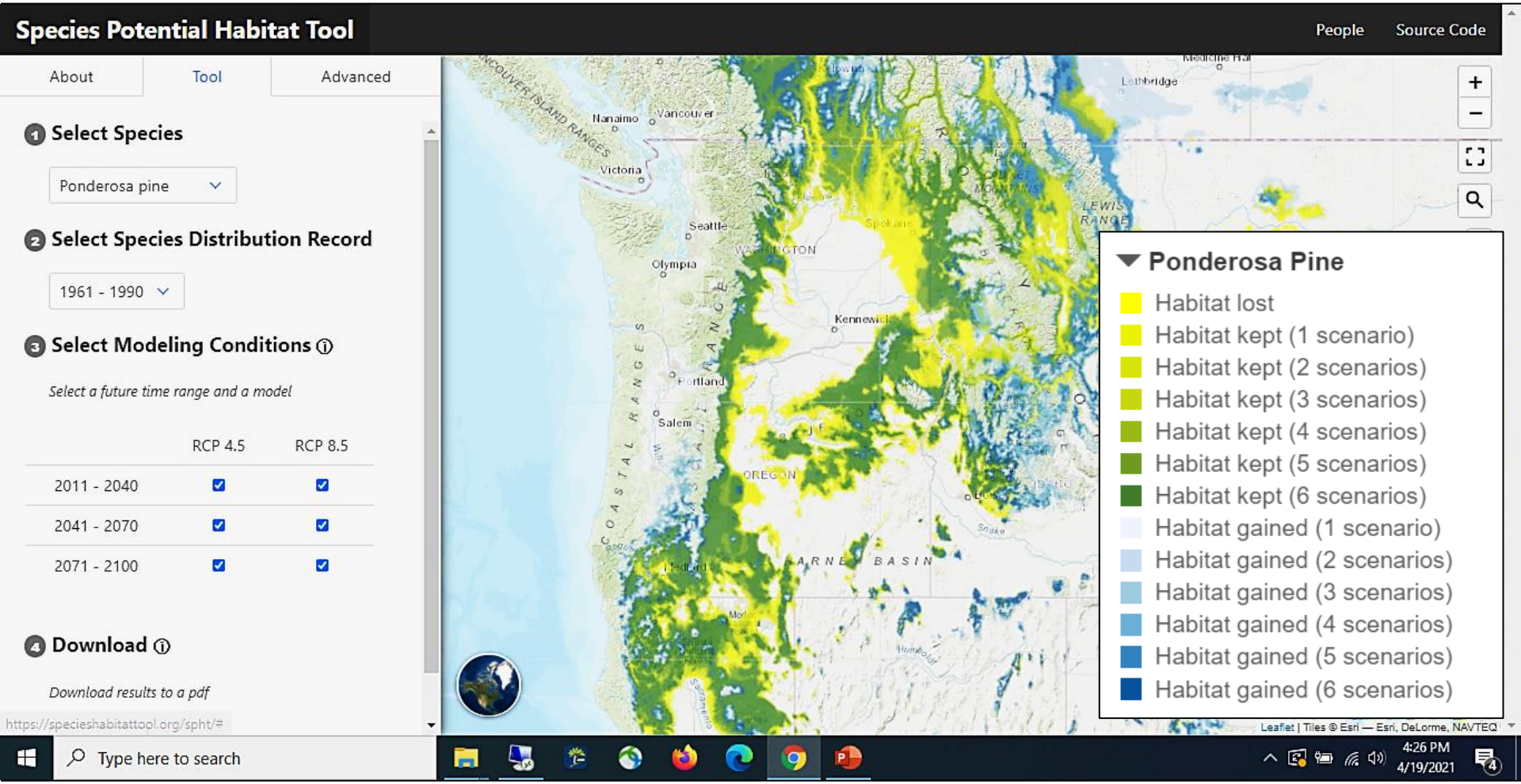

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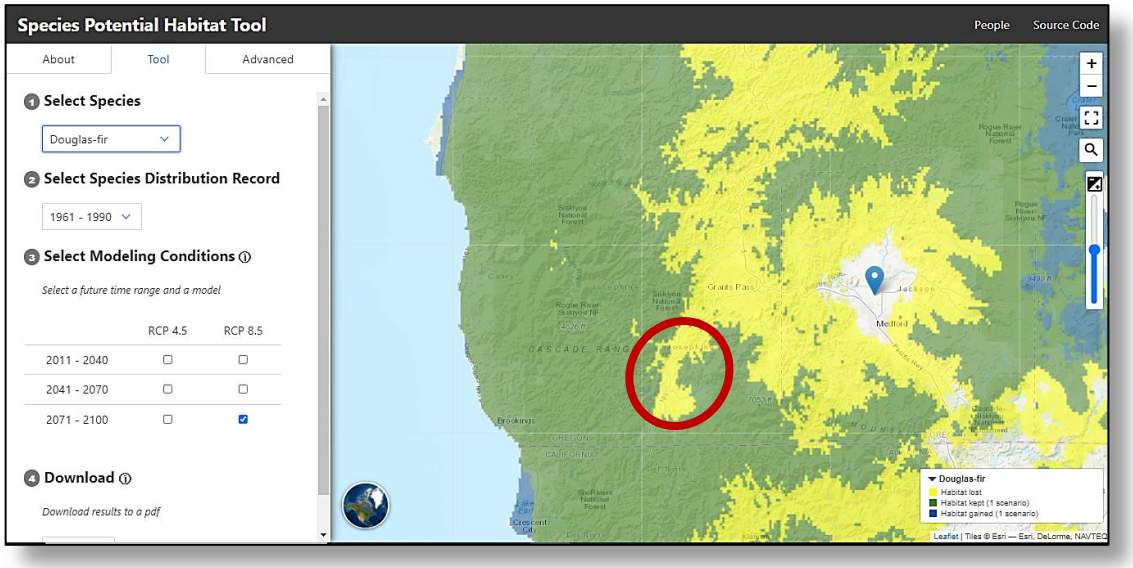
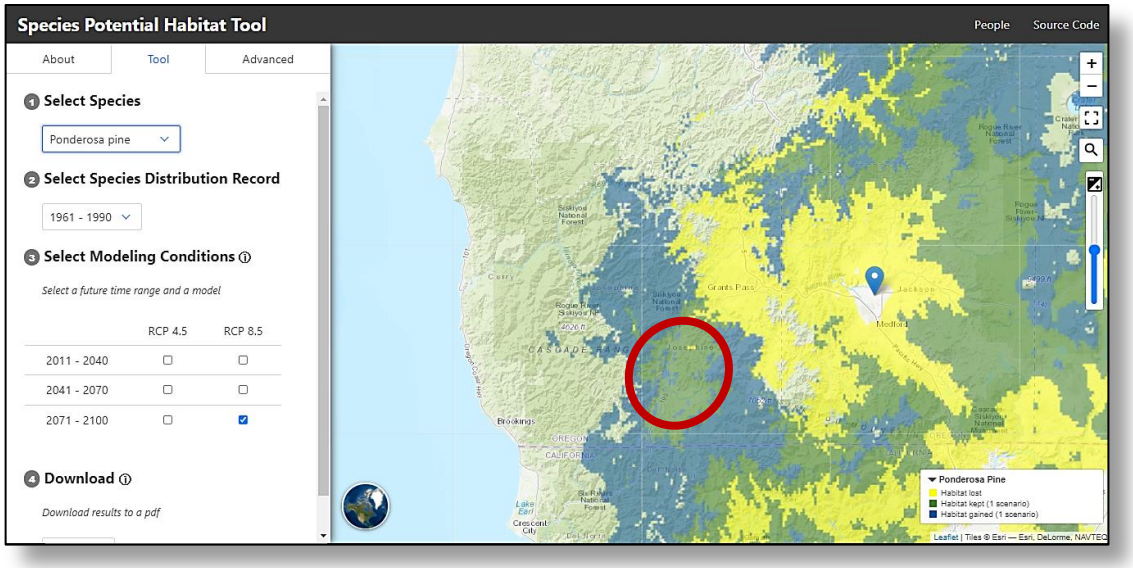
Douglas-fir vs ponderosa pine





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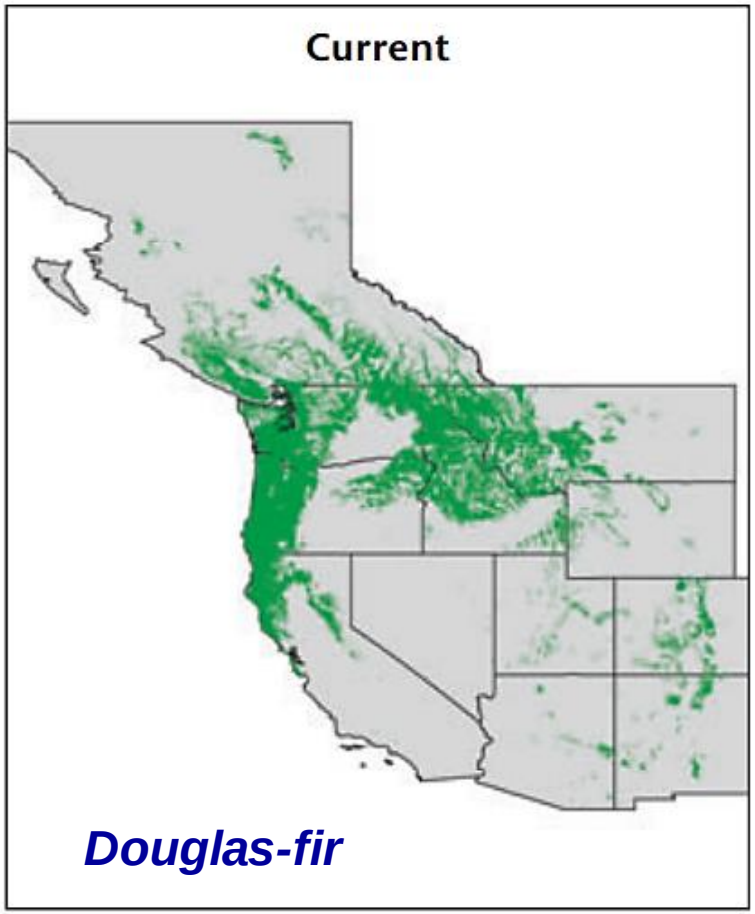

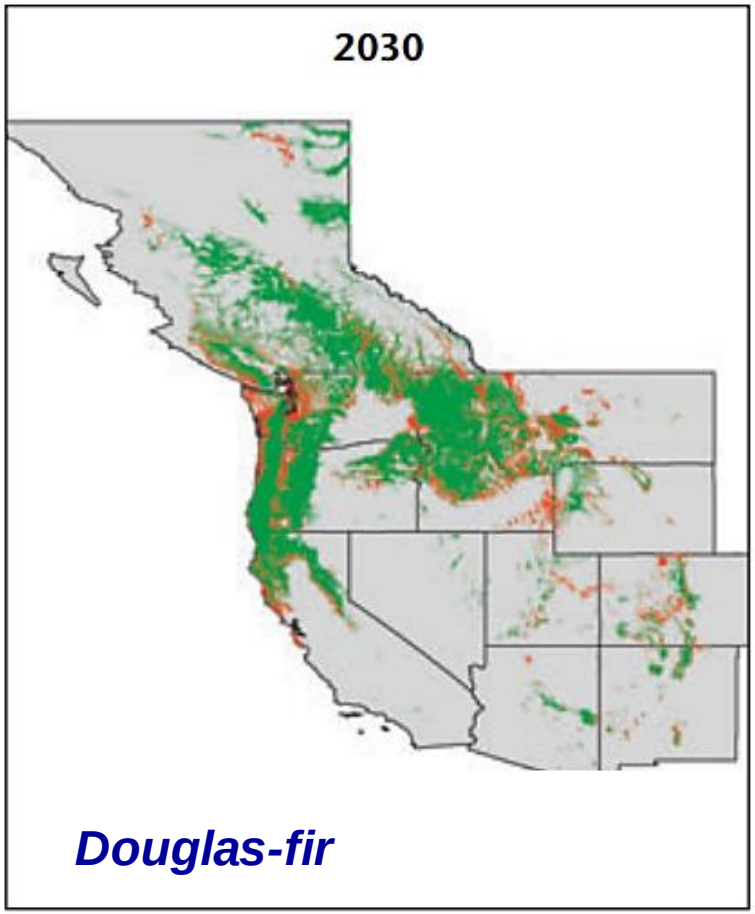

Weiskittel et al. (2012) Weis Schweiz Z Forstwes 163 (3):70–78

Where to get species information?

Natl. Individual Tree Species Atlas

USDA U.S. FOREST SERVICE
Caring for the land and serving people
United States Department of Agriculture

Enter Search Words | Search

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- Publications and Reports
- Contact Us

Mapping & Reporting

- Mapping & Reporting Home
- Detection Surveys
- Data and Application Development
- National Insect & Disease Risk Maps

Mapping & Reporting

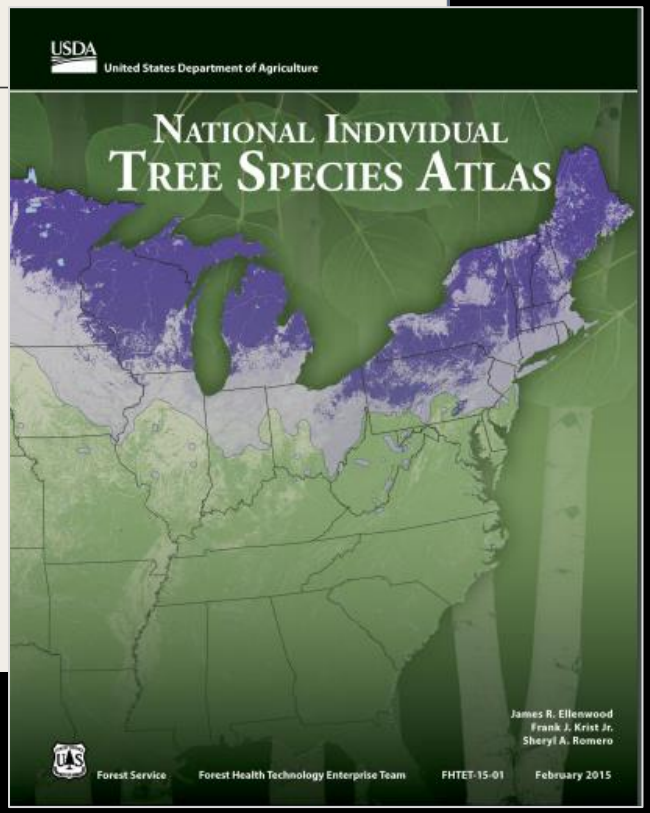
Individual Tree Species Parameter Maps

The Individual Tree Species Parameter Maps (ITSP) were developed to support the National Insect and Disease Risk Map (NIDRM) since insect and disease risk is often driven by the density of a given species. While similar to the Tree Atlas, the ITSP project mapped basal area and stand density index for each individual tree species. The parameter products are based on 30-meter Landsat satellite data, climate, terrain, and soil predictor layers and ground samples from the USFS Forest Inventory and Analysis plot data. Many other applications and analyses requiring tree-species density could benefit from this spatially refined dataset.

These data are available in View-Only mode from the ITSP web map viewer. The map services that drive the ITSB web map viewer are accessible from the Hosts folder at the ArcGIS Server connection https://apps.fs.usda.gov/fsgisx05/rest/services. Image services at a finer 30-meter pixel resolution area available in the 'RDW_FHP_TreeSpeciesMetrics' folder at the https://apps.fs.usda.gov/fsgisx01/rest/services Server connection.

The ITSP rasters used in NIDRM models are available for download from the following GIS Data Downloads.

National Individual Tree Species Atlas



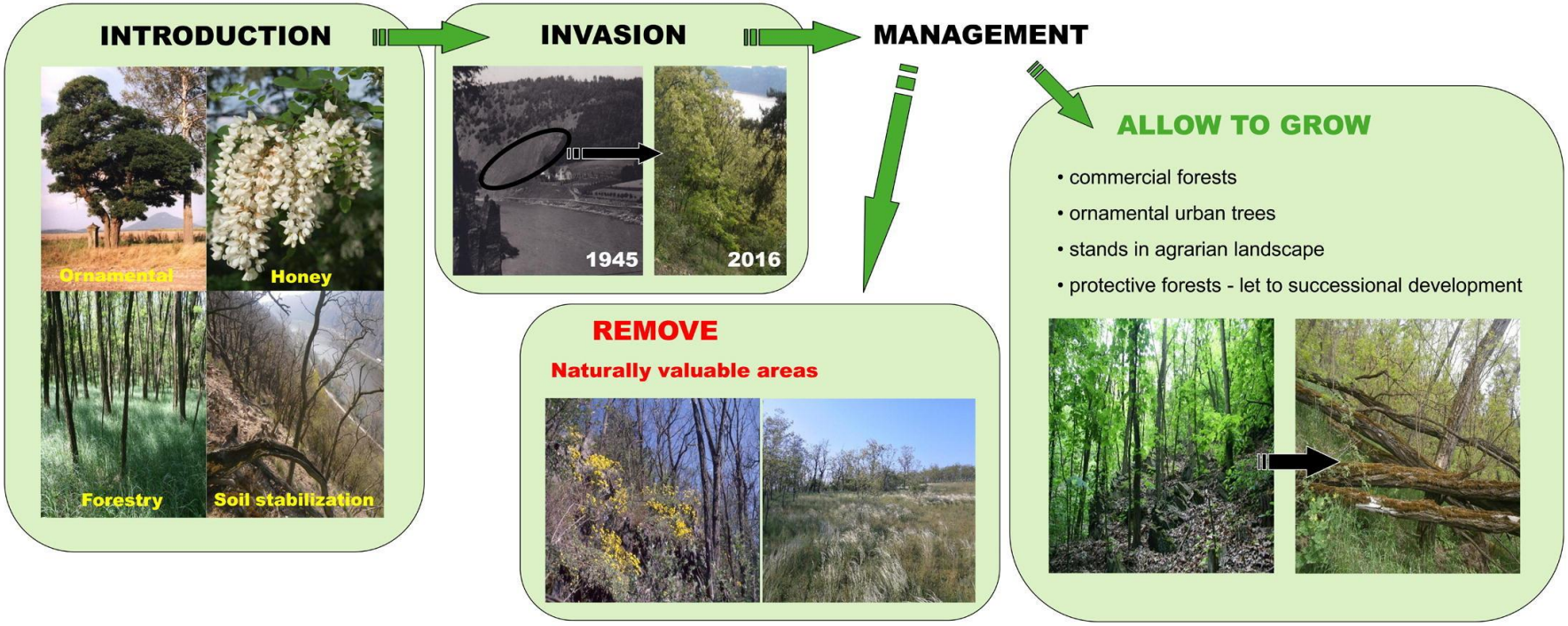
Natl. Individual Tree Species Atlas

Douglas-fir

Ponderosa pine

Species AM - Concerns

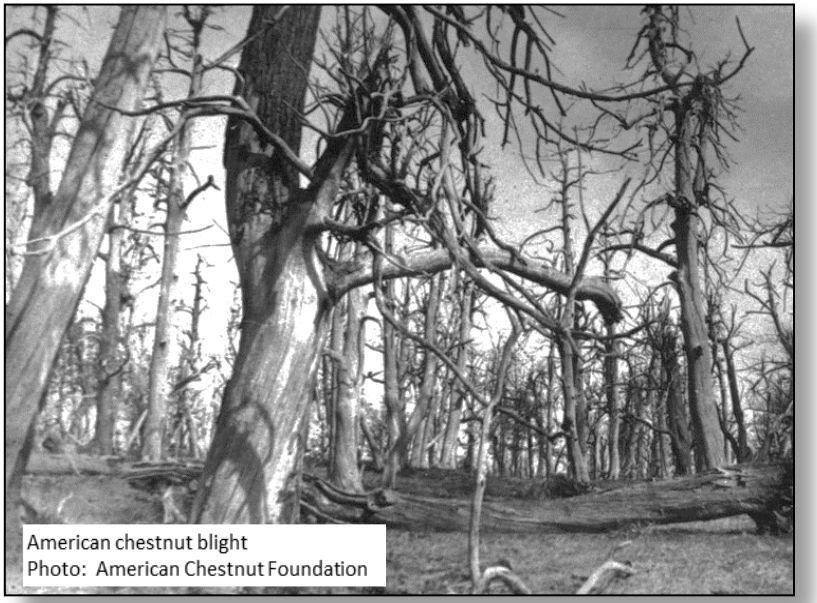
May lead to species invasions



Slide from Greg O'Neill

Species AM - Concerns

Insects and pathogens may hitchhike



American chestnut blight
Photo: American Chestnut Foundation

White pine blister rust
Photo: Natural Resources Canada, Canadian Forest Service

Slide from Greg O'Neill

I've chosen a suitable species… Which seedlot should I use?

Assisted migration

Species-level

Population-level

Exotic species translocation

Range expansion

Seed transfer

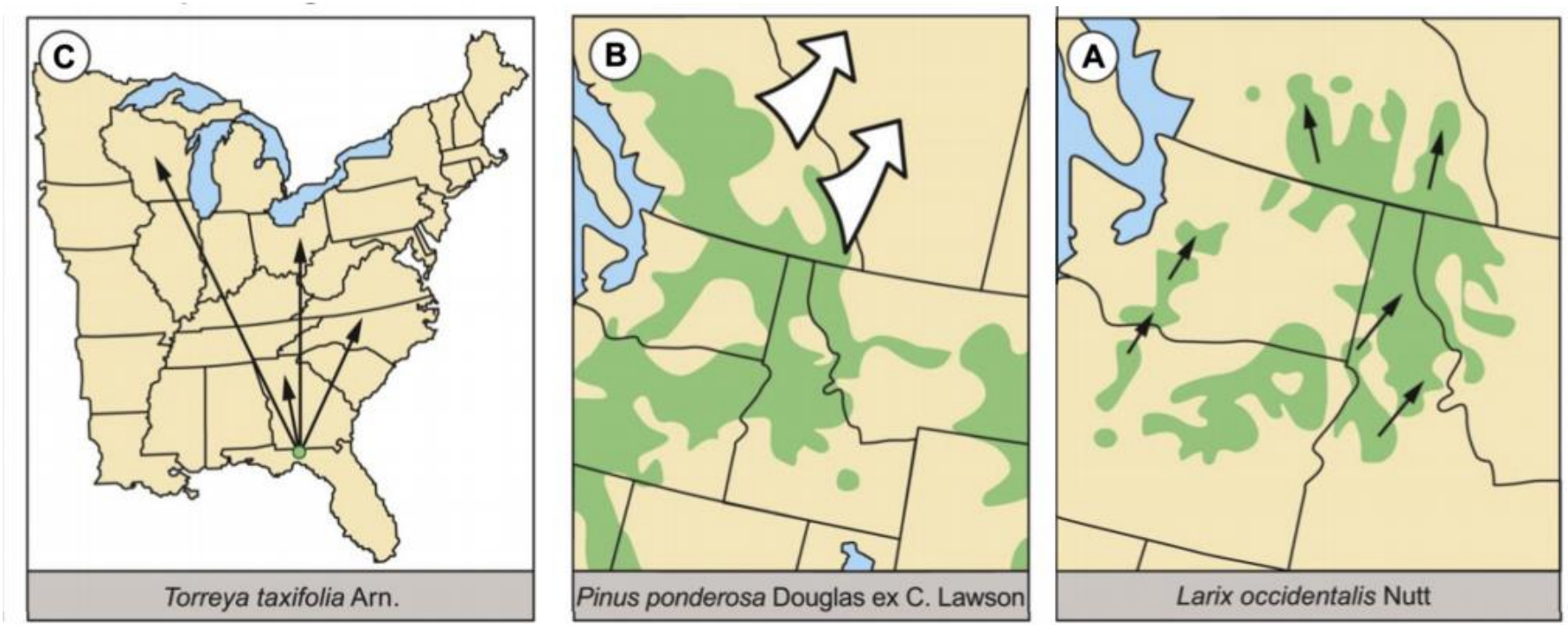


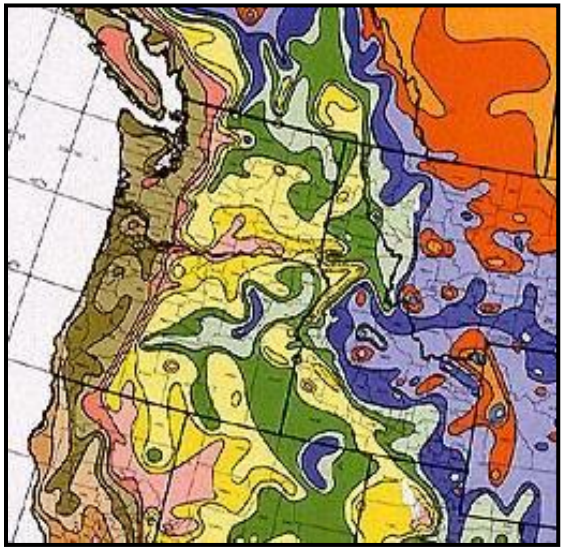
Figure modified from Williams and Dumroese (2014)Tree Planters' Notes 57(1):21-26

Population-level assisted migration

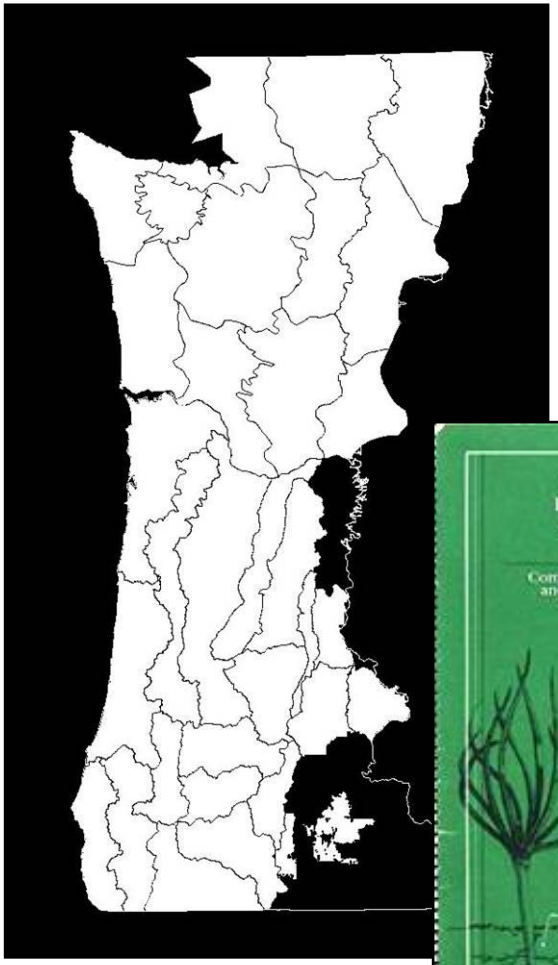
Zone Matcher

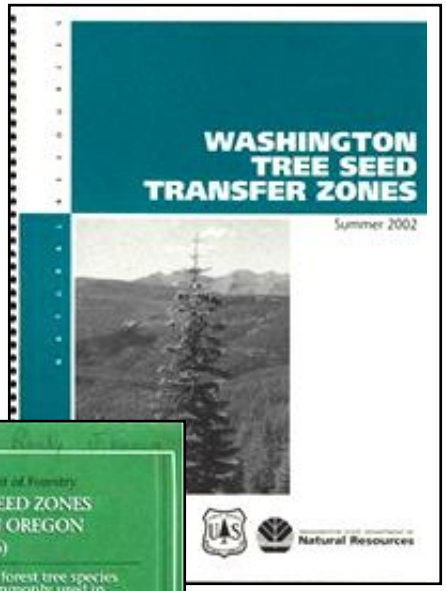
https://pnw-focal-zones.shinyapps.io/ZM_CMIP6_v5/

What to plant - Seed zones and breeding zones



Seed zones and breeding zones are largely delineated based on climate

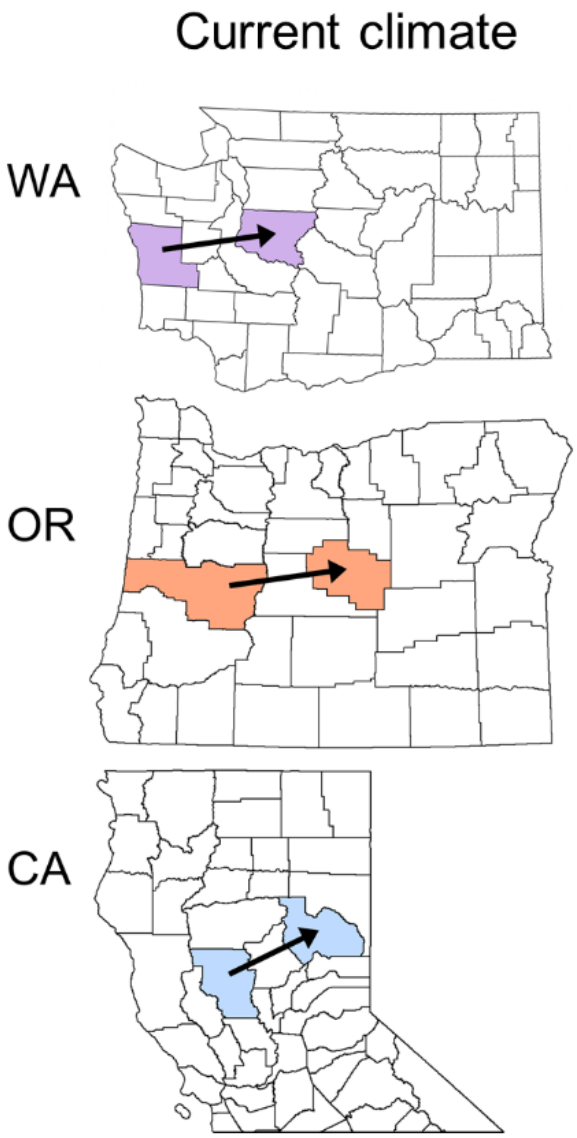




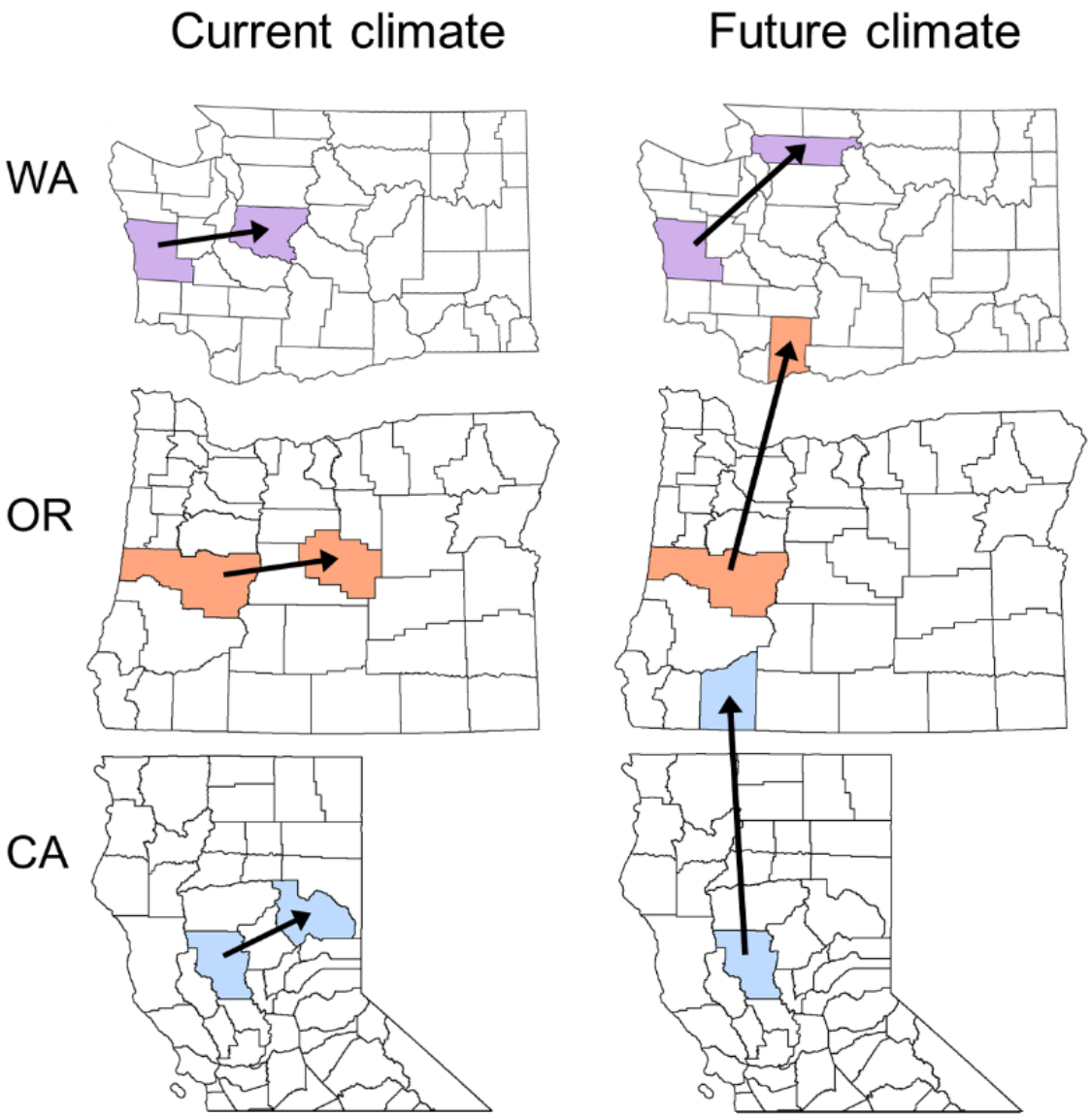
Randall and Berrang (2002) WA Dept Nat Resources

Randall (1996) OR Dept of Forestry

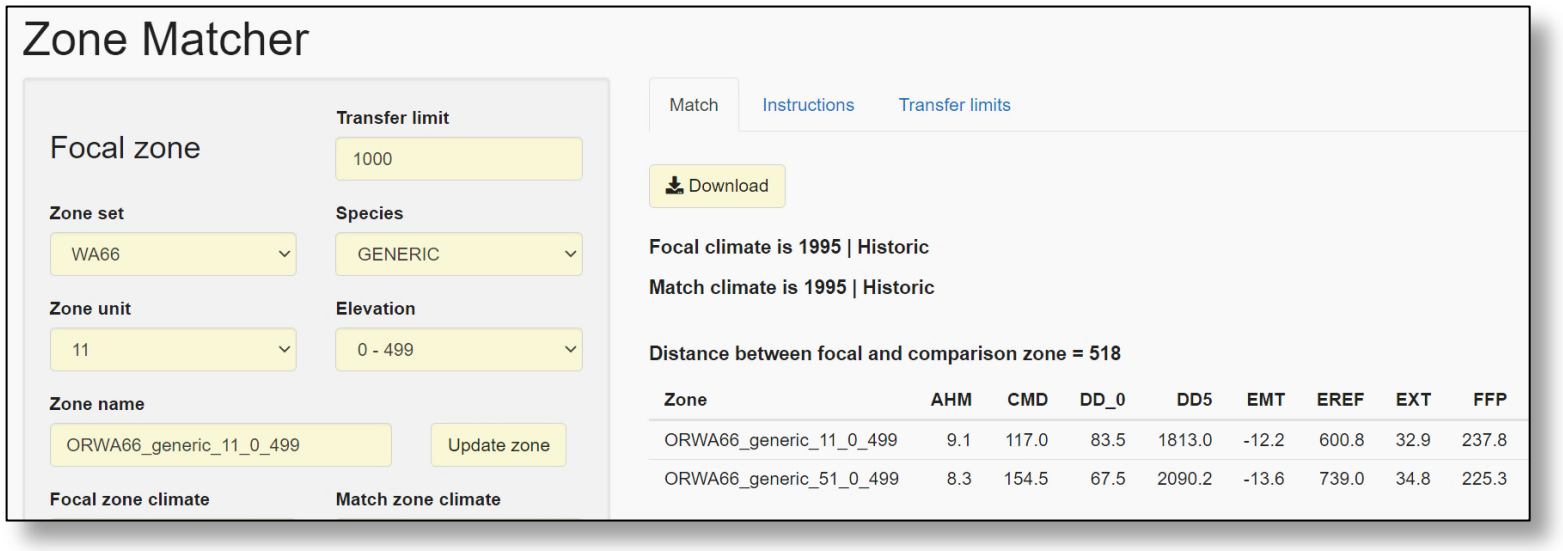
Zone matching – Current climates



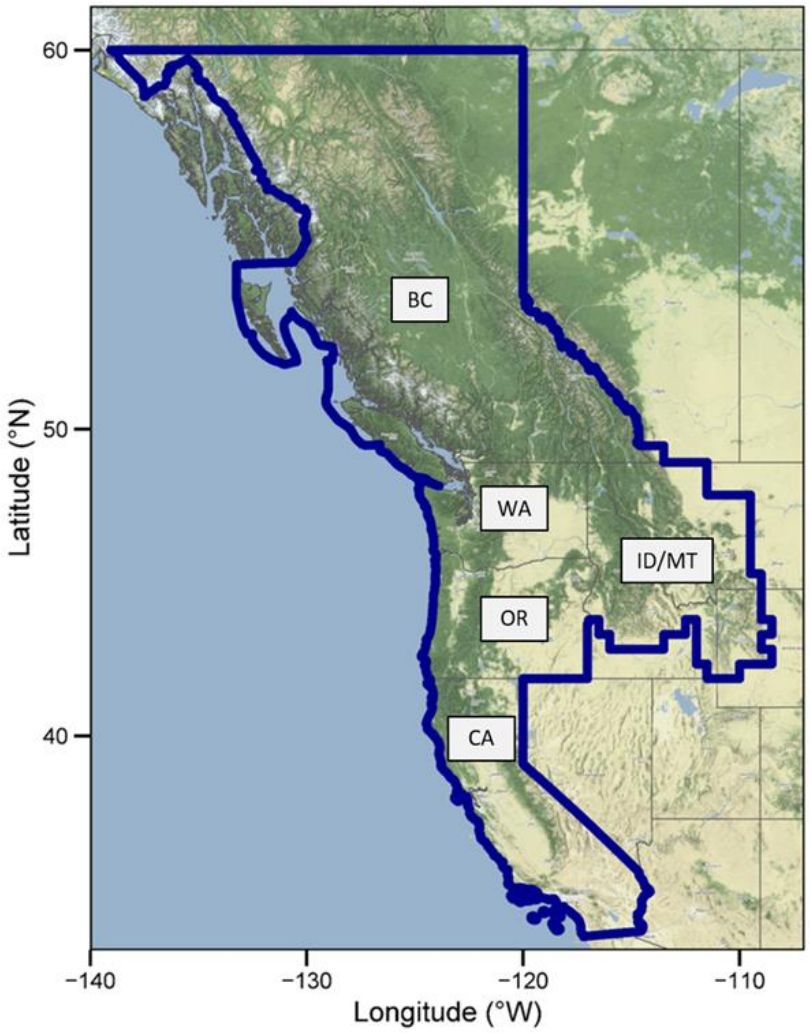
Zone matching – Future climates



Zone Matcher web application



Zone Matcher region

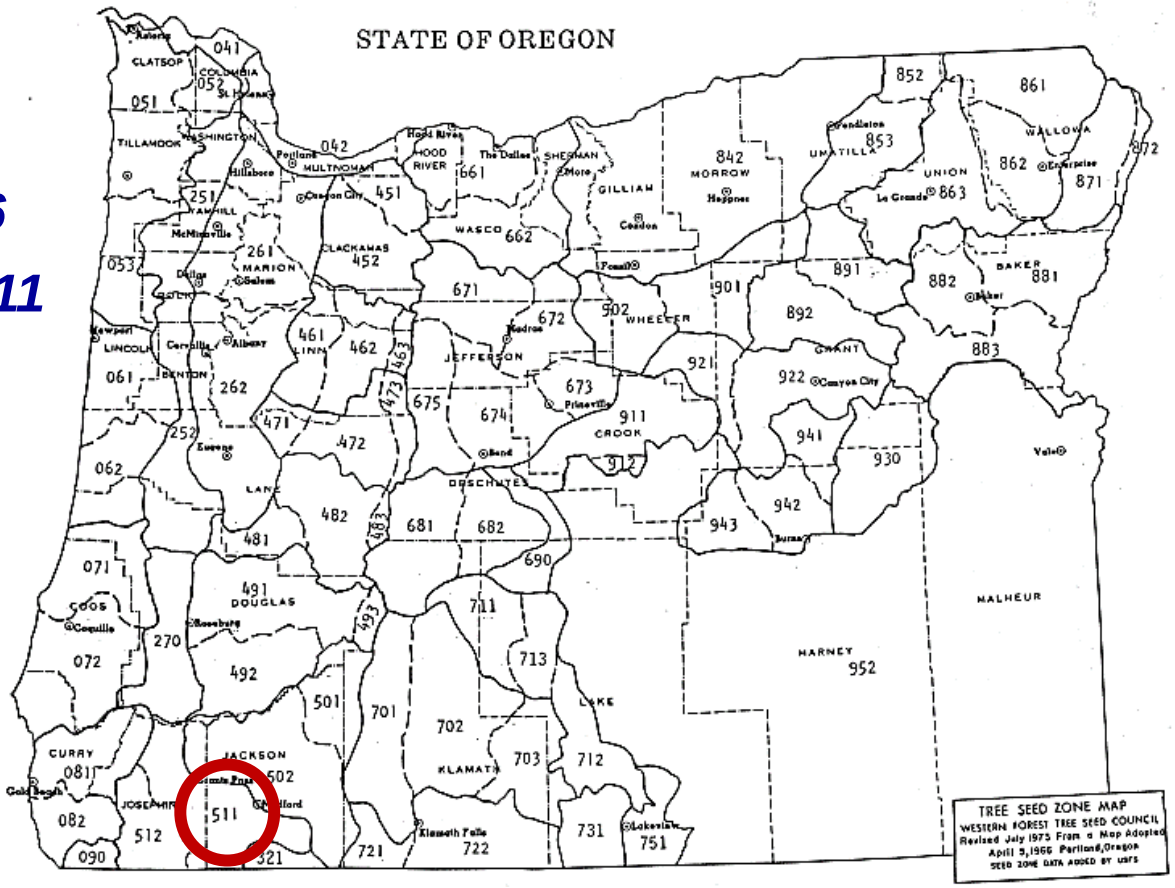


South of Grant's Pass, OR

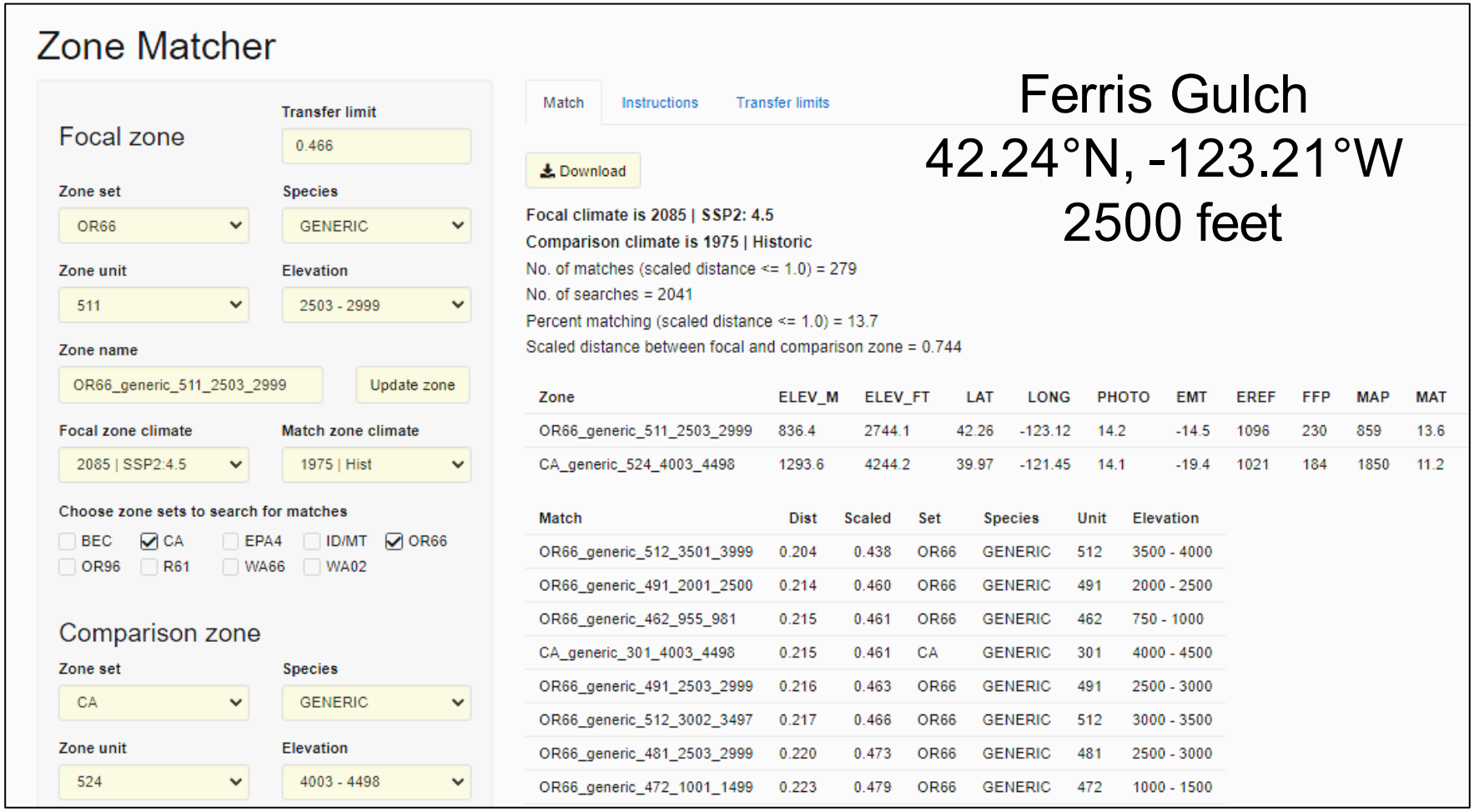
Ferris Gulch (42.24°N, -123.21°W, 2500 feet)

Oregon 1966

Seed Zone #511



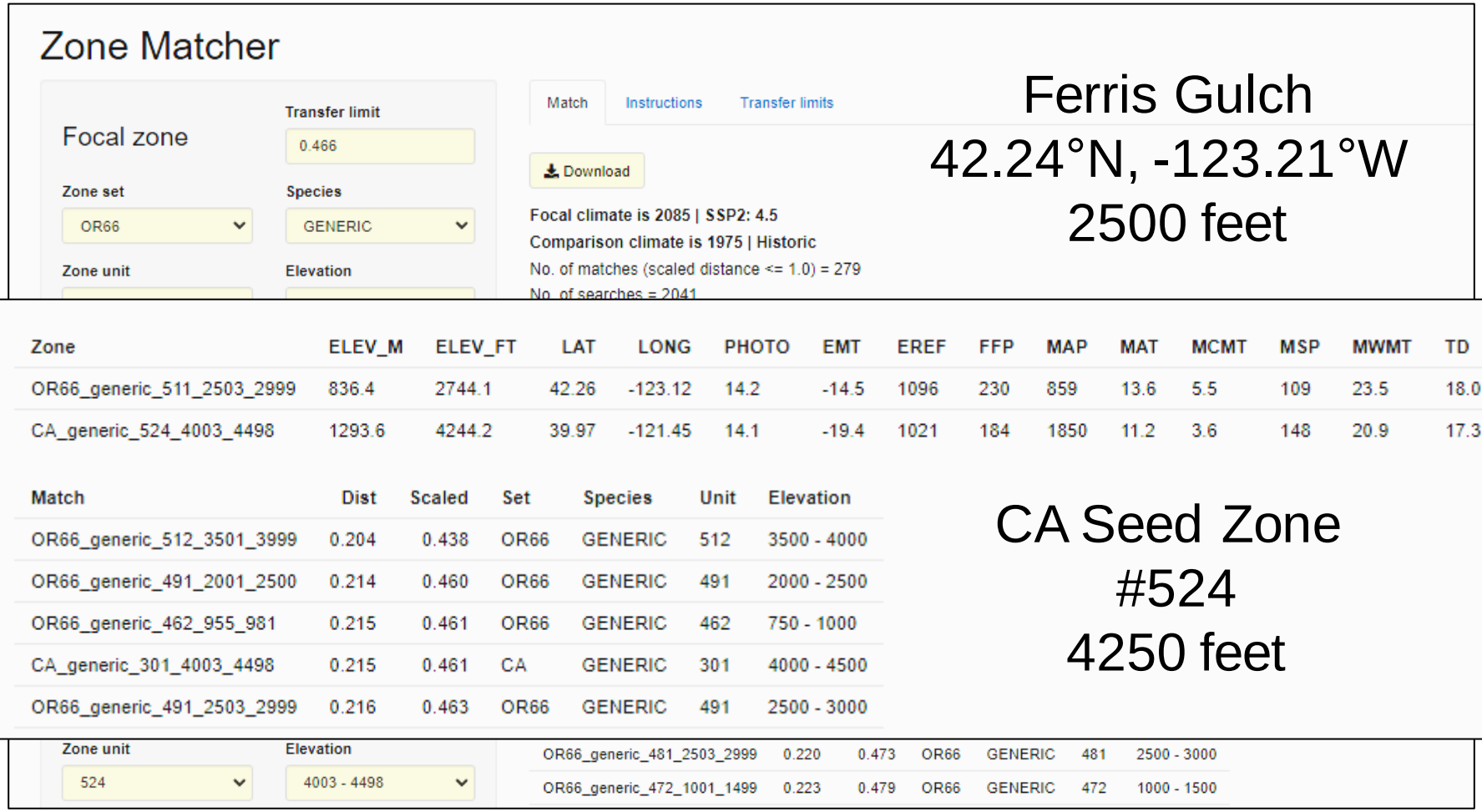
A reasonable climate match



Zone	ELEV_M	ELEV_FT	LAT	LONG	PHOTO	EMT	EREF	FFP	MAP	MAT
OR66_generic_511_2503_2999	836.4	2744.1	42.26	-123.12	14.2	-14.5	1096	230	859	13.6
CA_generic_524_4003_4498	1293.6	4244.2	39.97	-121.45	14.1	-19.4	1021	184	1850	11.2

Match	Dist	Scaled	Set	Species	Unit	Elevation
OR66_generic_512_3501_3999	0.204	0.438	OR66	GENERIC	512	3500 - 4000
OR66_generic_491_2001_2500	0.214	0.460	OR66	GENERIC	491	2000 - 2500
OR66_generic_462_955_981	0.215	0.461	OR66	GENERIC	462	750 - 1000
CA_generic_301_4003_4498	0.215	0.461	CA	GENERIC	301	4000 - 4500
OR66_generic_491_2503_2999	0.216	0.463	OR66	GENERIC	491	2500 - 3000
OR66_generic_512_3002_3497	0.217	0.466	OR66	GENERIC	512	3000 - 3500
OR66_generic_481_2503_2999	0.220	0.473	OR66	GENERIC	481	2500 - 3000
OR66_generic_472_1001_1499	0.223	0.479	OR66	GENERIC	472	1000 - 1500

A reasonable climate match

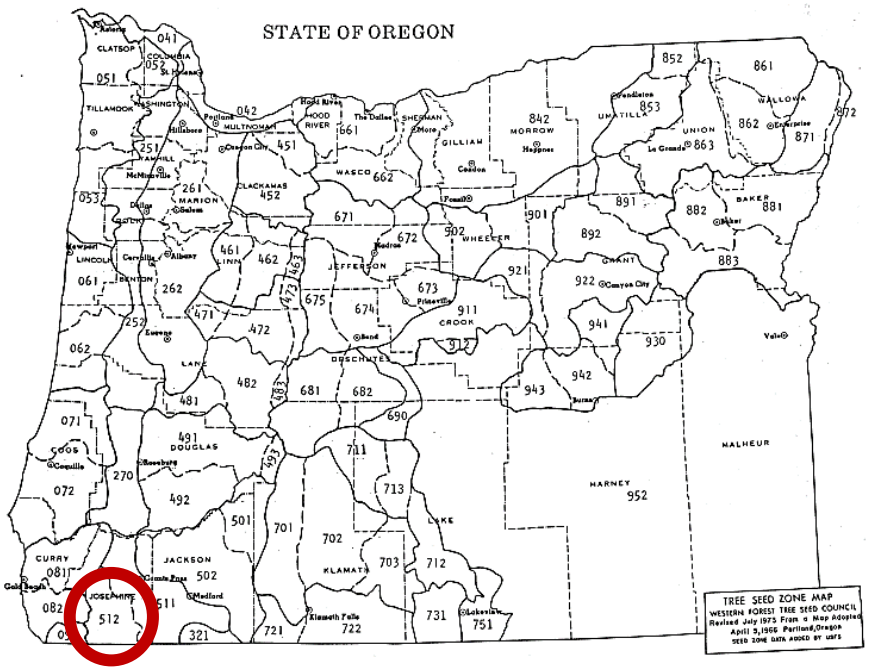


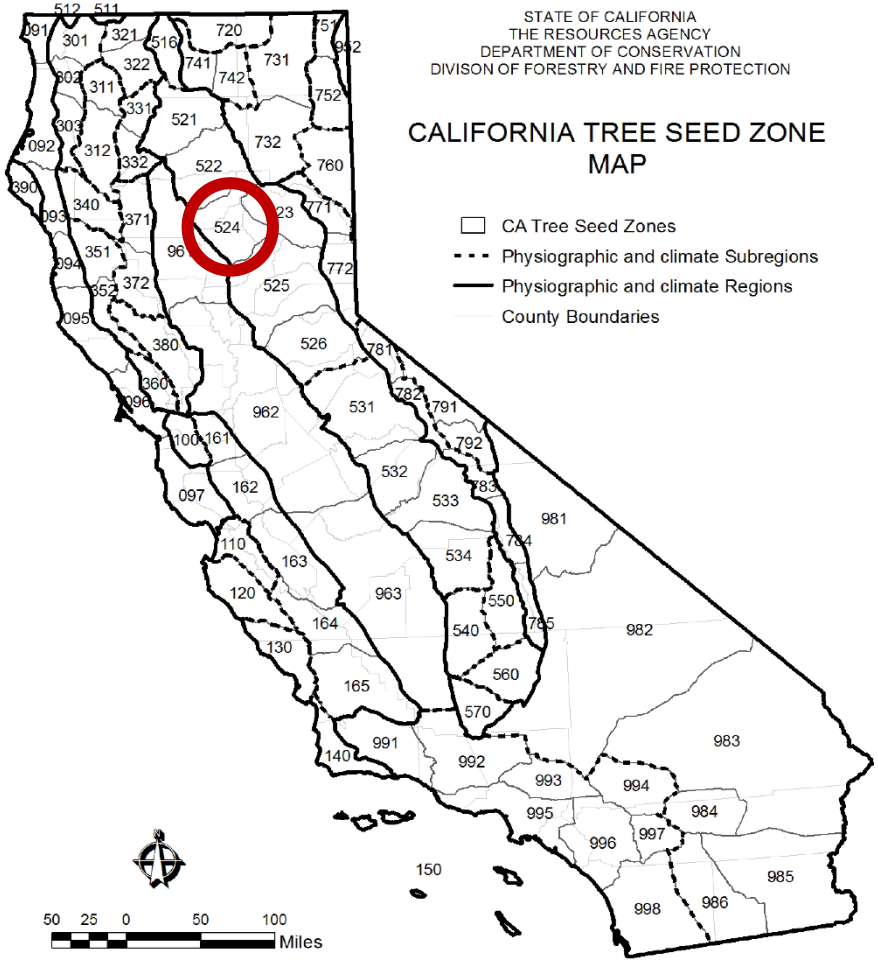
Zone	ELEV_M	ELEV_FT	LAT	LONG	PHOTO	EMT	EREF	FFP	MAP	MAT	MCMT	MSP	MWMT	TD
OR66_generic_511_2503_2999	836.4	2744.1	42.26	-123.12	14.2	-14.5	1096	230	859	13.6	5.5	109	23.5	18.0
CA_generic_524_4003_4498	1293.6	4244.2	39.97	-121.45	14.1	-19.4	1021	184	1850	11.2	3.6	148	20.9	17.3

Match	Dist	Scaled	Set	Species	Unit	Elevation
OR66_generic_512_3501_3999	0.204	0.438	OR66	GENERIC	512	3500 - 4000
OR66_generic_491_2001_2500	0.214	0.460	OR66	GENERIC	491	2000 - 2500
OR66_generic_462_955_981	0.215	0.461	OR66	GENERIC	462	750 - 1000
CA_generic_301_4003_4498	0.215	0.461	CA	GENERIC	301	4000 - 4500
OR66_generic_491_2503_2999	0.216	0.463	OR66	GENERIC	491	2500 - 3000
OR66_generic_481_2503_2999	0.220	0.473	OR66	GENERIC	481	2500 - 3000
OR66_generic_472_1001_1499	0.223	0.479	OR66	GENERIC	472	1000 - 1500

Redwood location in N. California

CA Seed Zone
#524
4250 feet





Questions?

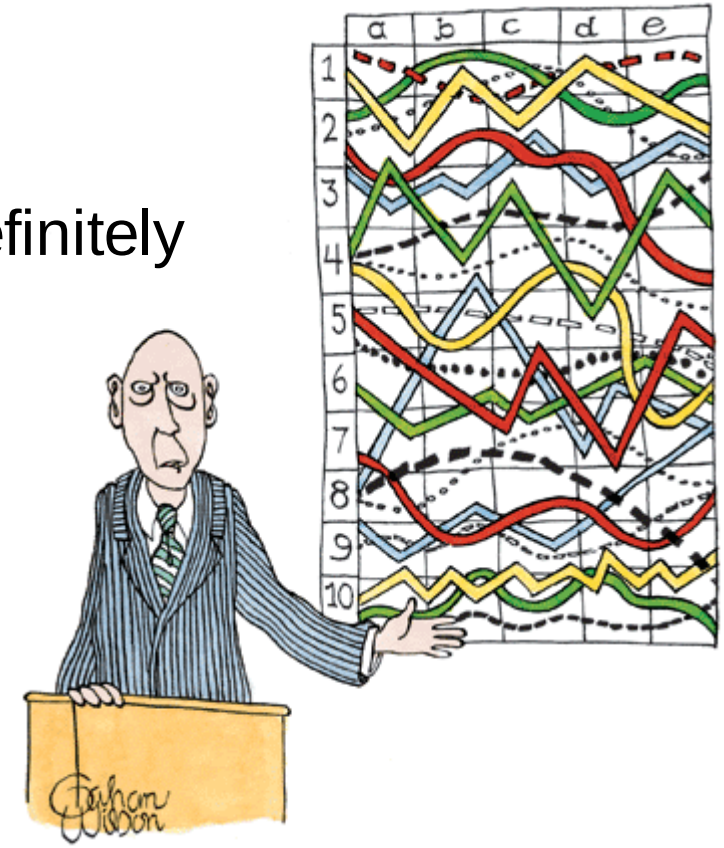
Climate change - think in terms of changing habitats

Use assisted migration (AM)

Species AM – Maybe

Population / seed source AM – Definitely

"I'll stop here so you can let this information sink in"



Questions?

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