Climate Influences Range and Phenology of Northwest Shrub Species

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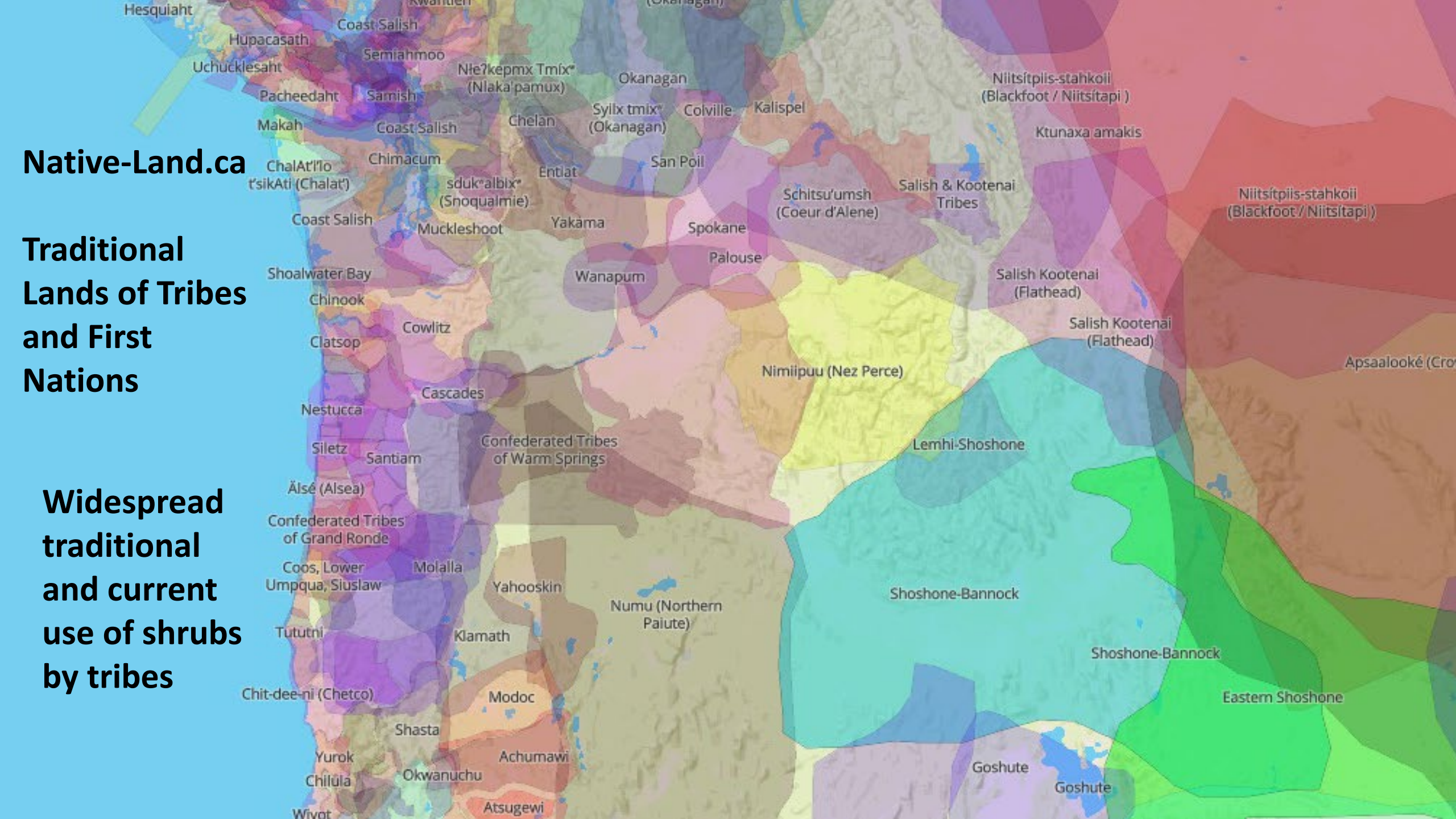
Why Study Shrubs?

Shrubs are critical ecosystem components and culturally valuable but little studied

Very few have range maps

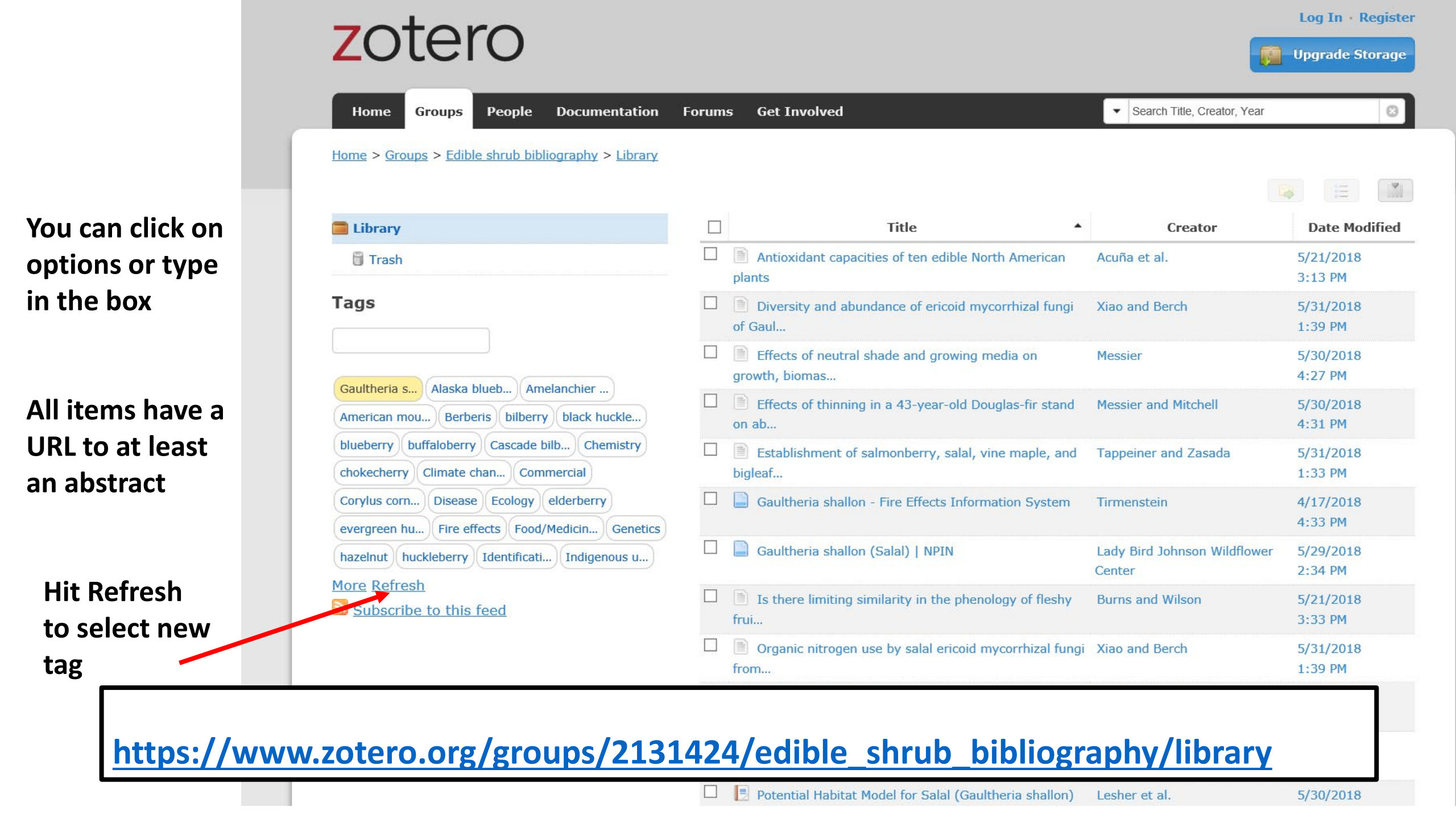
Mostly general descriptions of habitat

Most information piecemeal (small scale, limited topics)


Native-Land.ca
Traditional Lands of Tribes and First Nations
Widespread traditional and current use of shrubs by tribes
Hesquiaht
Coast Salish
Hupacasath
Semiahmoo
Uchucklesaht
Pacheedaht
Samish
Makah
Coast Salish
Chimacum
ChalAt'l'lo
t'sikAti (Chalat')
Coast Salish
Muckleshoot
Shoalwater Bay
Chinook
Cowlitz
Clatsop
Cascades
Nestucca
Siletz
Santiam
Confederated Tribes of Warm Springs
Älsé (Alsea)
Confederated Tribes of Grand Ronde
Coos, Lower Umpqua, Siuslaw
Molalla
Yahooskin
Tututni
Klamath
Numu (Northern Paiute)
Chit-dee-ni (Chetco)
Modoc
Shasta
Yurok
Achumawi
Chilula
Okwanuchu
Wiyot
Atsugewi
Nłe?kepmx Tmíx*
(Nlaka'pamux)
Okanagan
Syilx tmix*
(Okanagan)
Chelan
Colville
Kalispel
Entiat
San Poil
sduk*albix*
(Snoqualmie)
Yakama
Spokane
Palouse
Wanapum
Schitsu'umsh
(Coeur d'Alene)
Salish & Kootenai Tribes
Niitsítpiis-stahkoii
(Blackfoot / Niitsítapi)
Ktunaxa amakis
Salish Kootenai
(Flathead)
Nimiipuu (Nez Perce)
Lemhi-Shoshone
Shoshone-Bannock
Goshute
Eastern Shoshone
Apsaalooké (Cro

Several recent projects on shrubs

1. Bibliography
2. Current occurrences (78 native species)
3. Habitat suitability models (4 species)
   for 2000 and 2085
4. Phenology of flowering and fruiting
   Based on recent observations & predicted climate
5. Story Map (wraps it all together with pictures, interactive maps, links etc.)
6. Yakama Nation Vulnerability Assessment



You can click on options or type in the box

All items have a URL to at least an abstract

Hit Refresh to select new tag

https://www.zotero.org/groups/2131424/edible_shrub_bibliography/library

Current Occurrences

Very few species have detailed range maps (Little 1976, a few large shrubs; UDSA Plants database – yes/no by county)

Mostly general descriptions of habitat (e.g., moist sites west of Cascade Crest)

How can we document current occurrences?

- **USFS FIA (Forest Inventory and Analysis)**
- **PNW Herbaria (consortium of 60 herbaria)**
- **[Other databases & Citizen Science sources some species]**

Developed maps of occurrences for 78 native shrub species

(Little 1976 – V3 Minor western hardwoods)

[USDA Plants database]

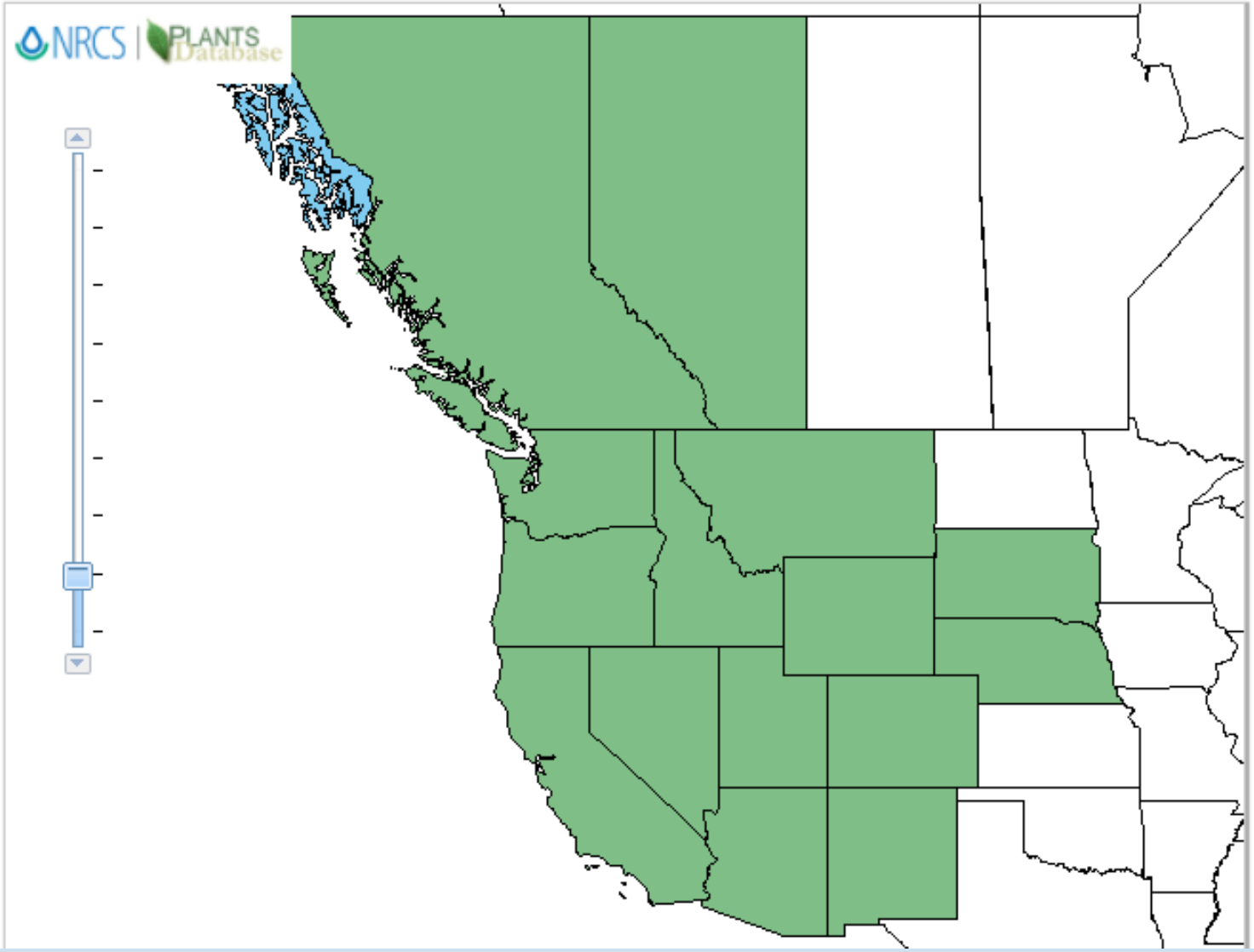
Species info and links

GENERAL | IMAGES | CLASSIFICATION | SUBORDINATE TAXA | WETLAND | RELATED LINKS | WILDLIFE

Acer glabrum Torr.
Rocky Mountain maple

Show All

About our new maps



General Information	
Symbol:	ACGL
Group:	Dicot
Family:	Aceraceae
Duration:	Perennial
Growth Habit:	Shrub Tree
Native Status:	AK I? CAN N L48 N
Characteristics	
Plant Guide (pdf) (doc)	

County level is closest zoom

GENERAL | IMAGES | CLASSIFICATION | SUBORDINATE TAXA | WETLAND | RELATED LINKS | WILDLIFE

Acer glabrum Torr.
Rocky Mountain maple

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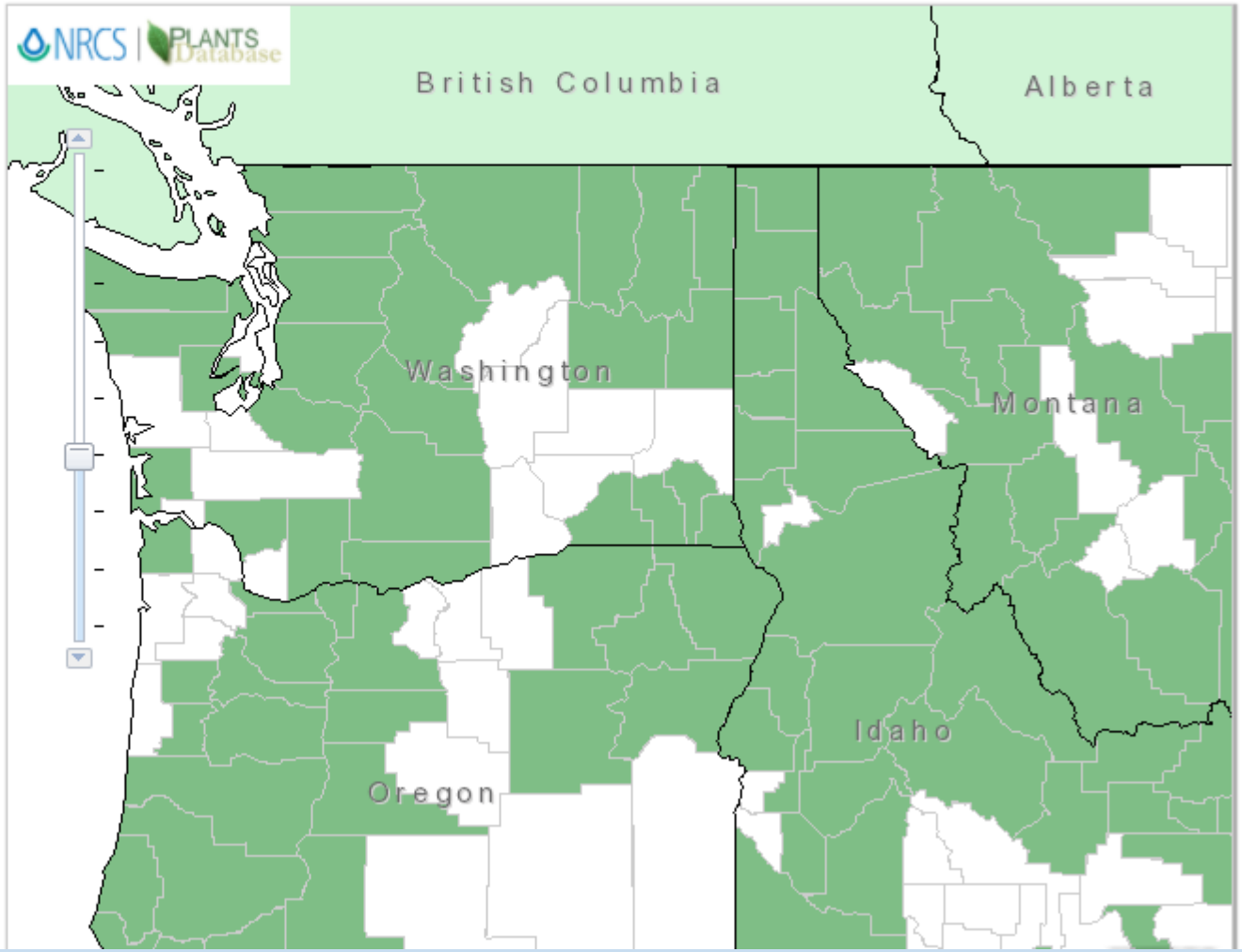

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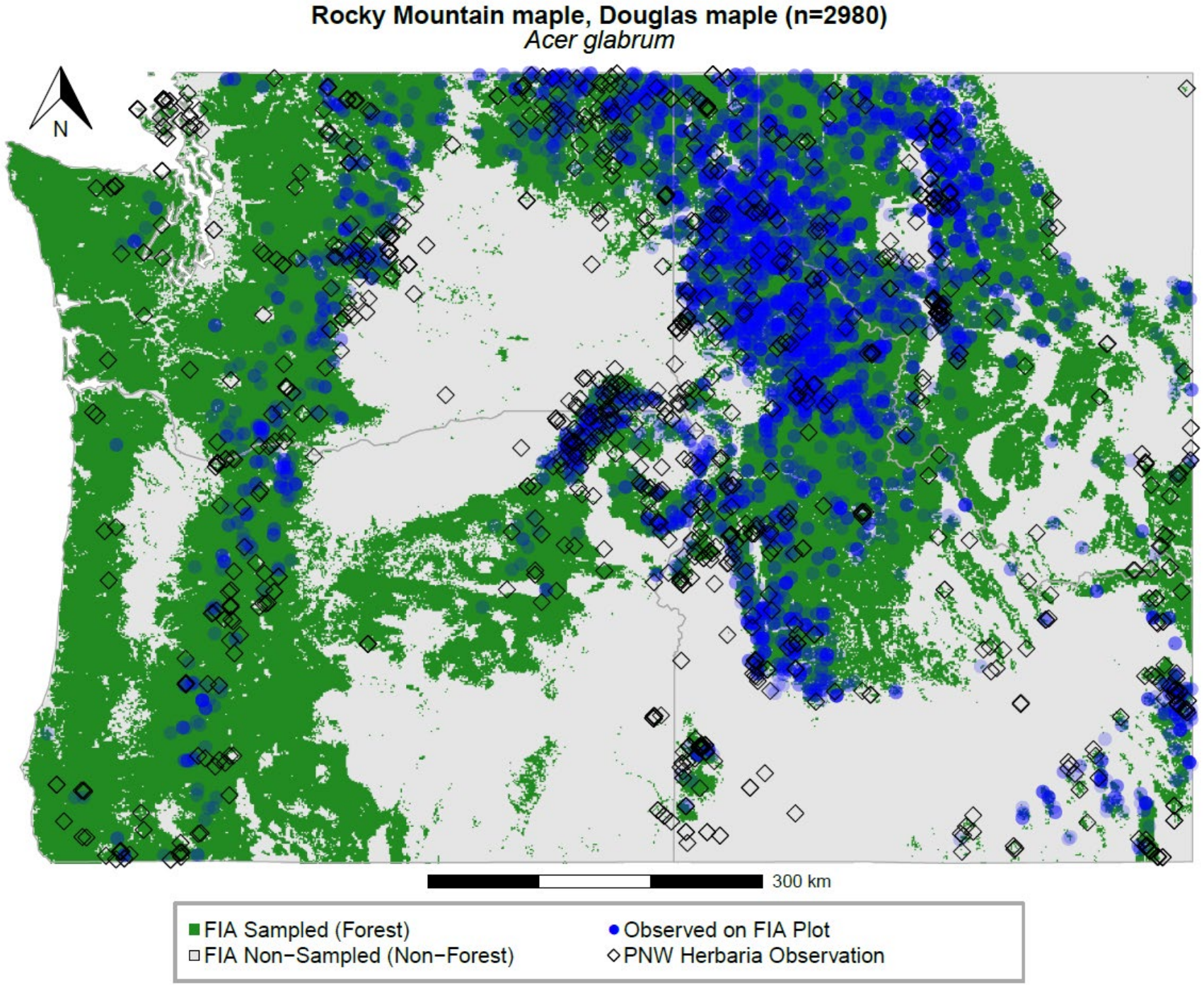
Characteristics	
Plant Guide (pdf) (doc)	
Data Source and Documentation	

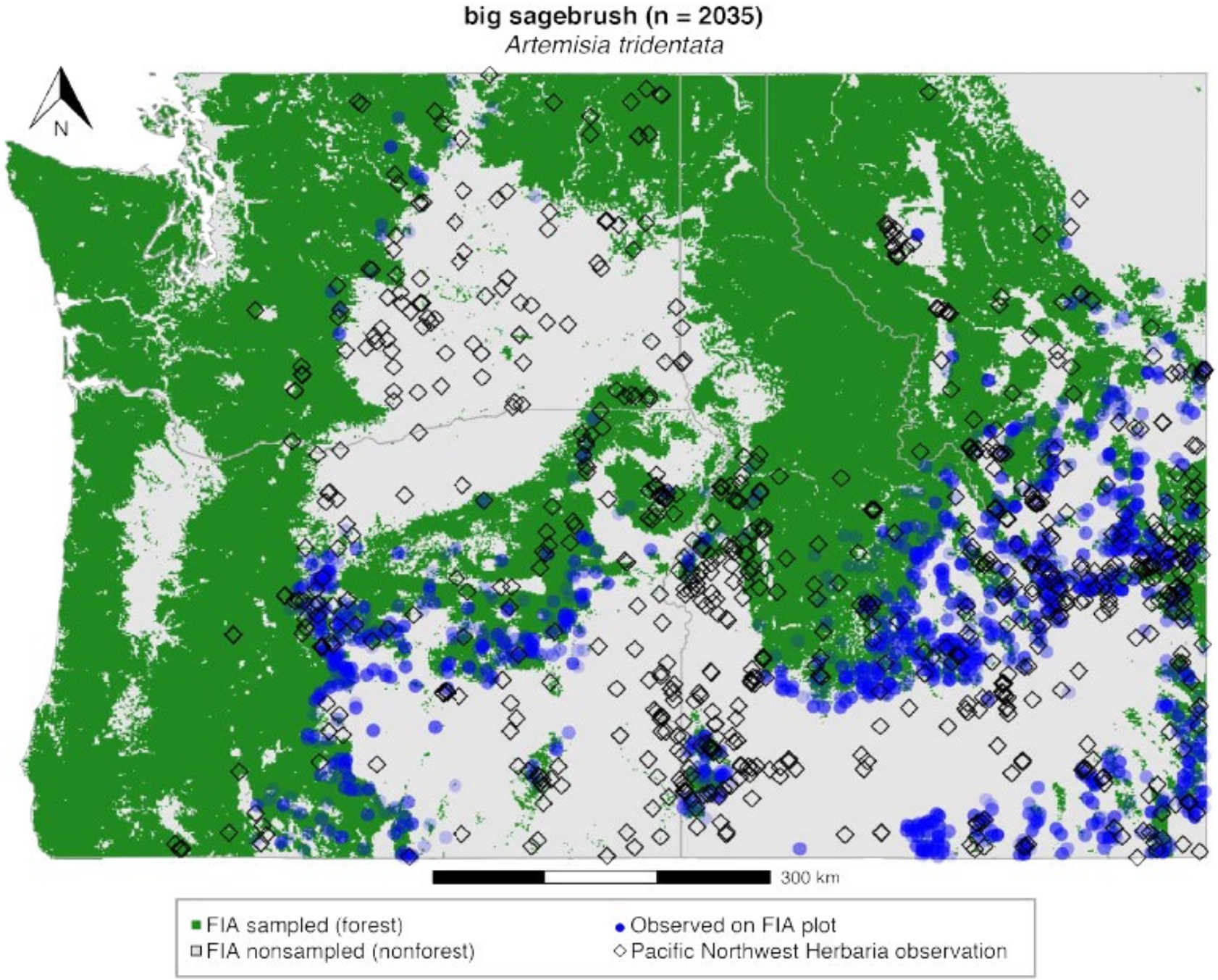
Gen. Tech. Rep. PNW-GTR-980. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 87 p.

Covers 78 species

https://doi.org/10.2737/PNW-GTR-980



Some species mostly associated w/forests so are well sampled in FIA (Forest Inventory and Analysis) plots



Other species are primarily found in areas other than forest land so many samples come from PNW Herbaria

Developed current and future habitat suitability maps for culturally important species – Patterns of occurrence allow us to speculate how ranges might shift as climate changes

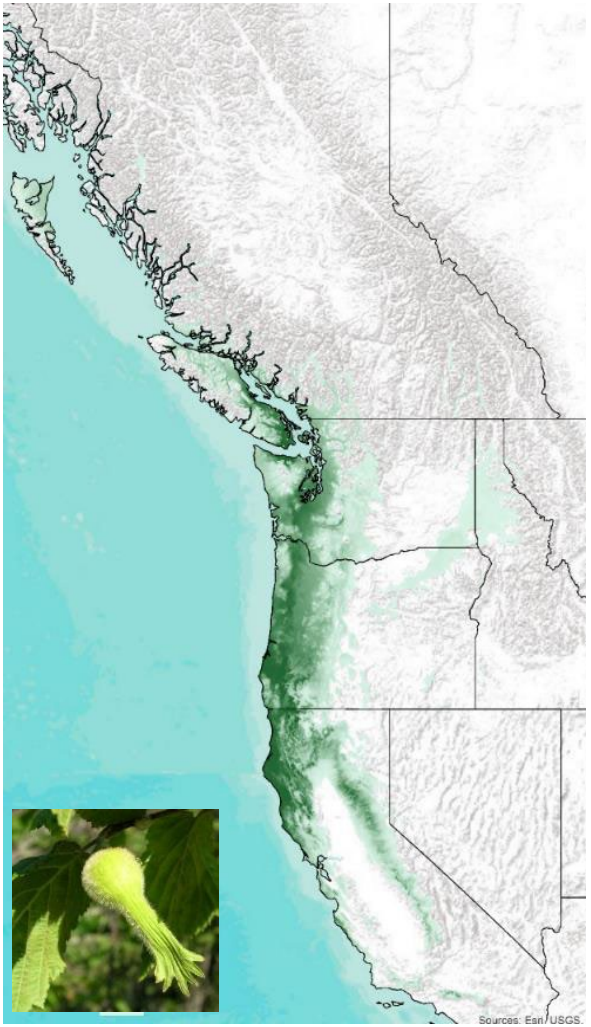
Why??

There is a strong interest in preserving and restoring culturally-important plant species across the Pacific Northwest

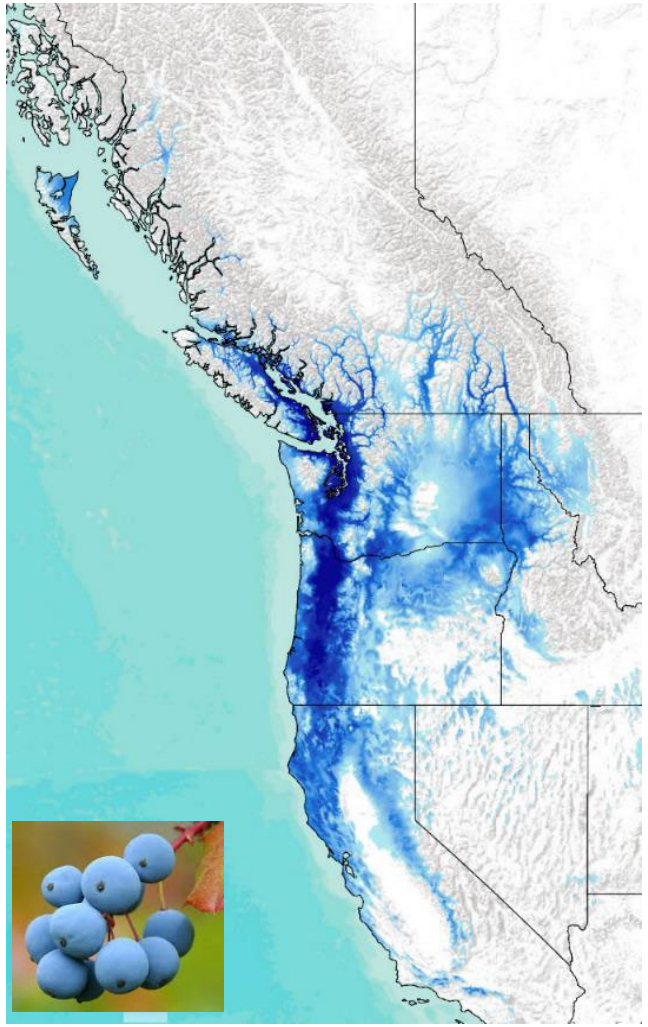
Warmer temperatures are changing habitat suitability

Current ranges: Habitat suitability models in MaxEnt (based just on climate variables)

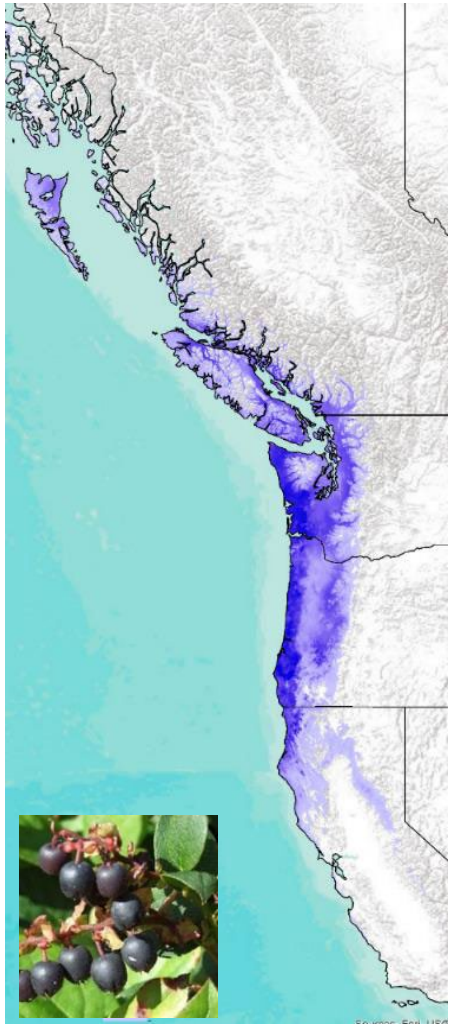
Hazelnut



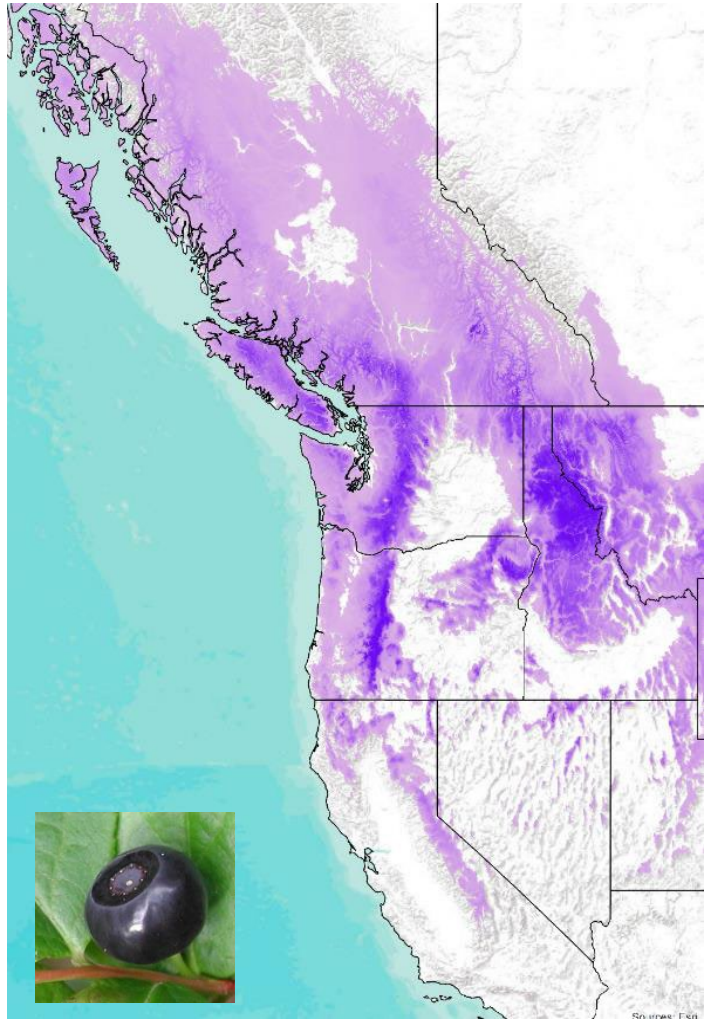
Oregon grape



Salal



Black huckleberry



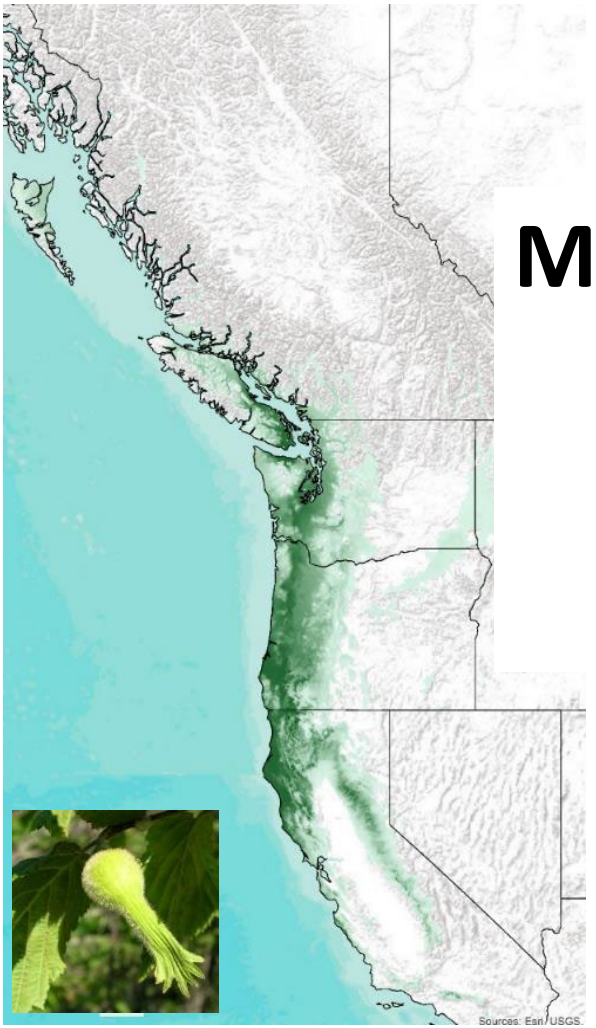
Current ranges: Habitat suitability models in MaxEnt

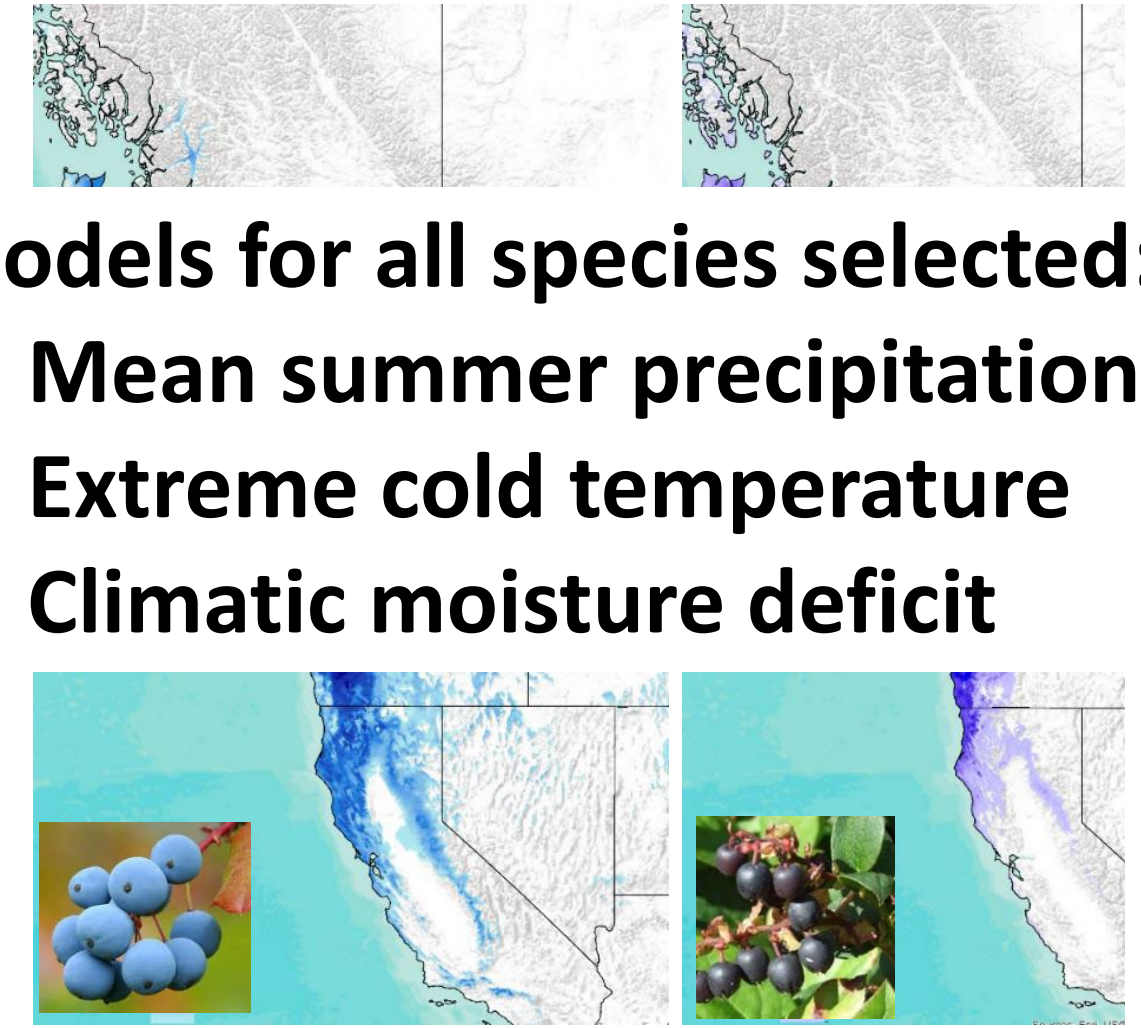
Hazelnut

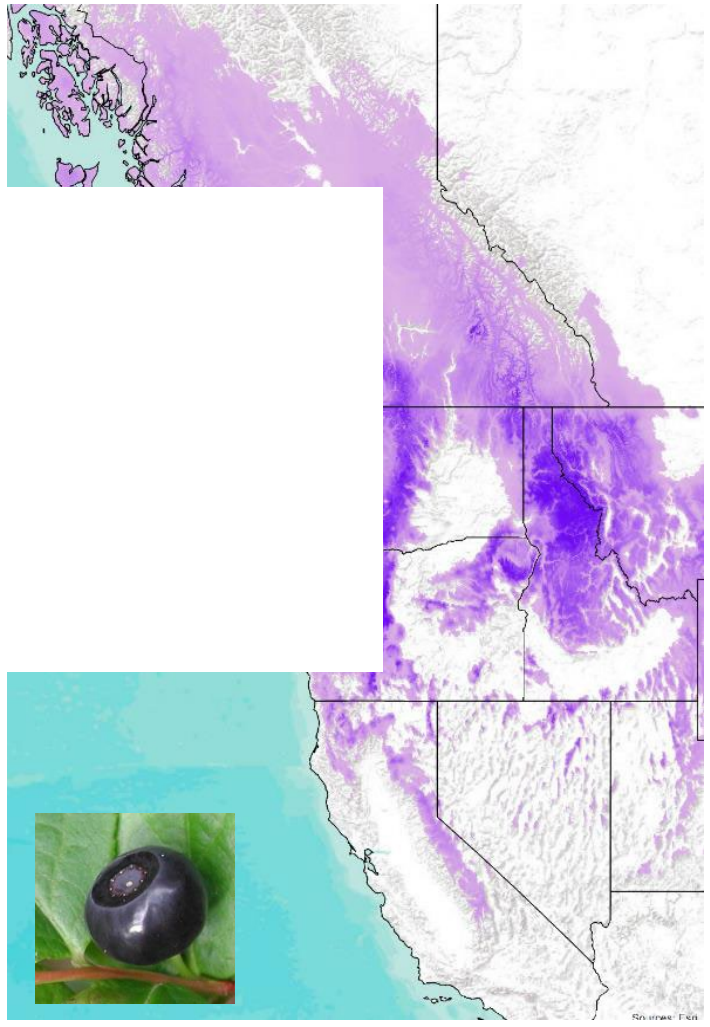
Oregon grape

Salal

Black huckleberry



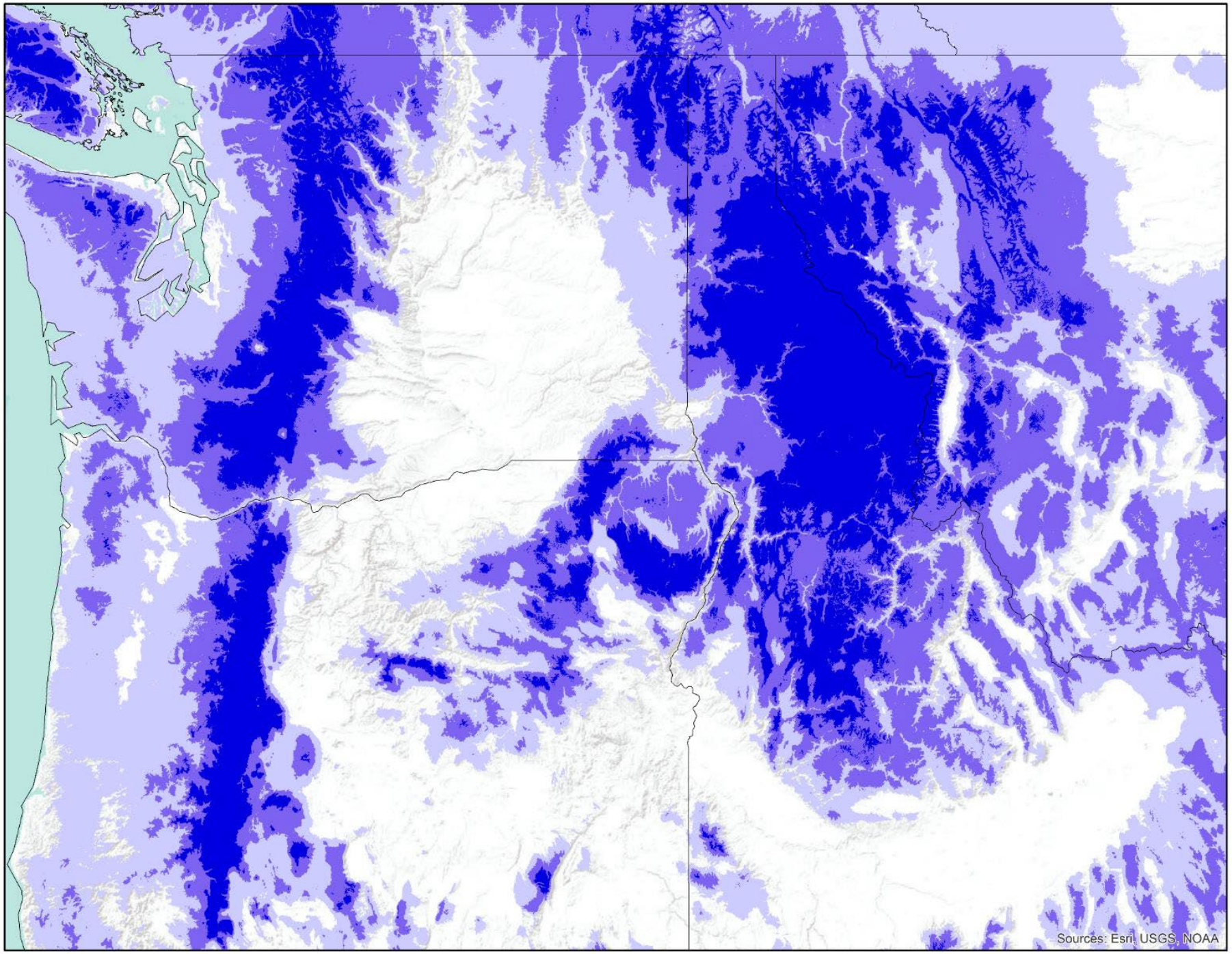




Models for all species selected:

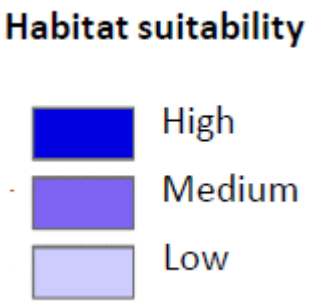
- **Mean summer precipitation**
- **Extreme cold temperature**
- **Climatic moisture deficit**

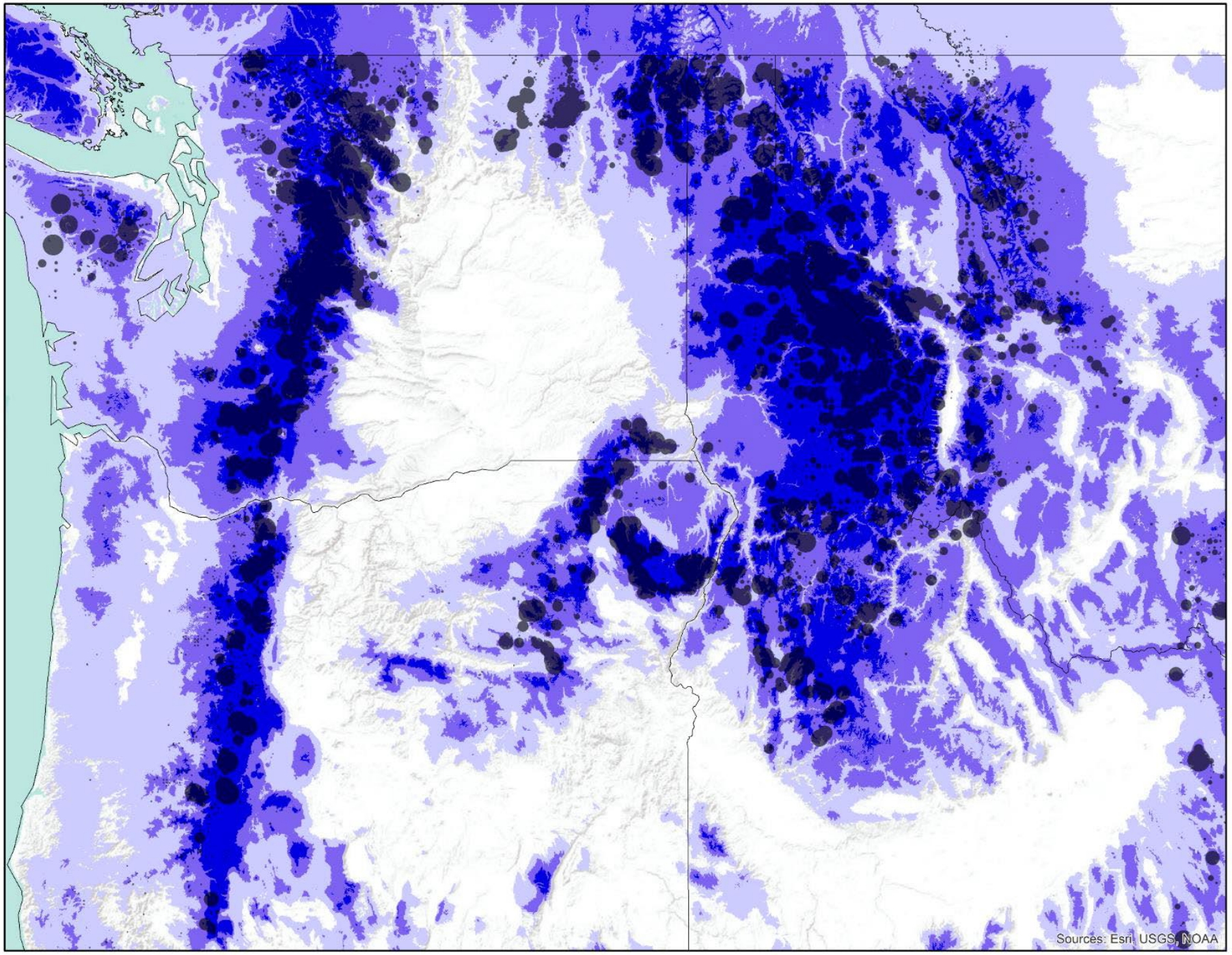
Predicted Current Habitat Suitability for huckleberry (VAME)



Current Habitat Suitability for huckleberry (VAME)

FIA plots with high abundance of black huckleberry



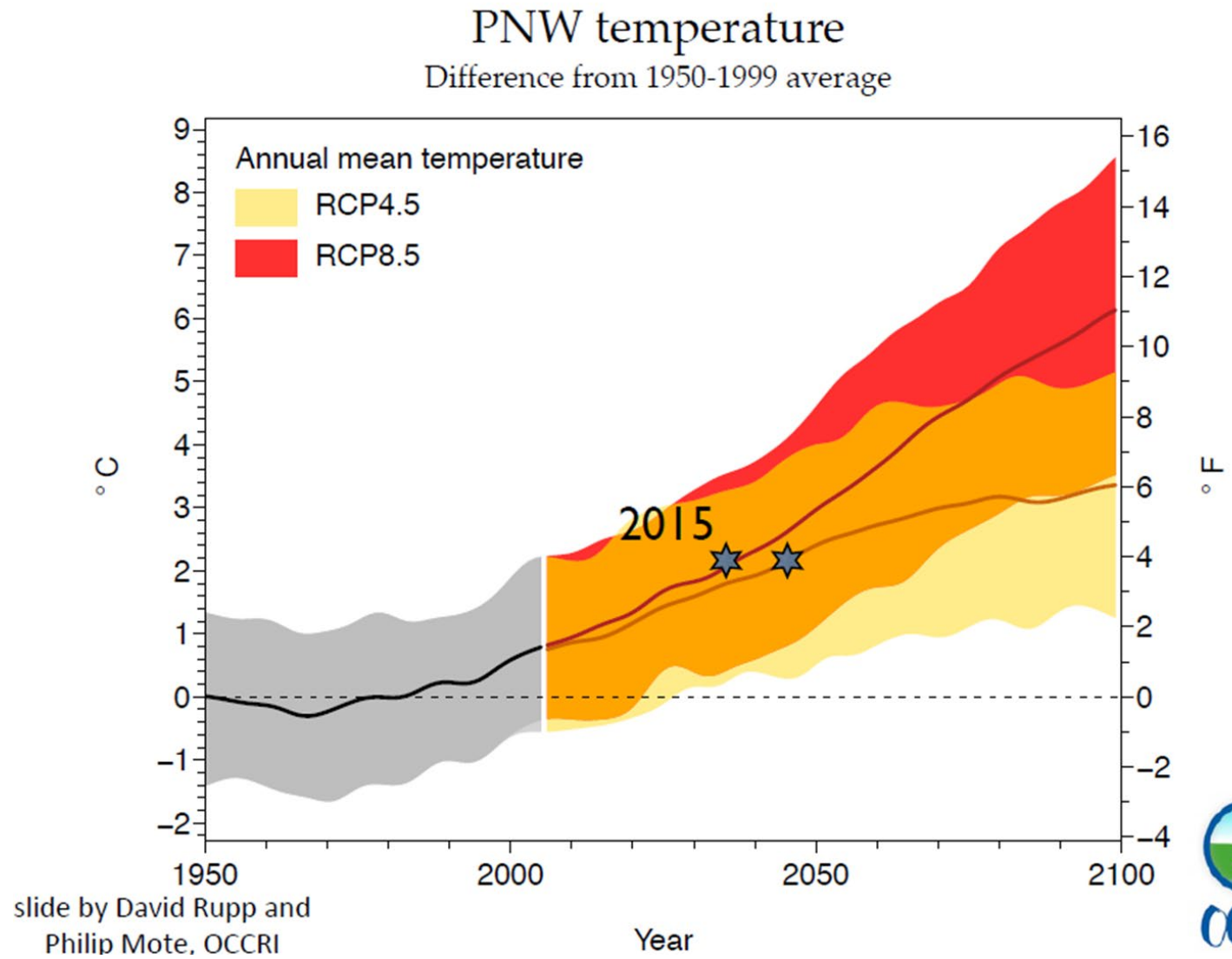


How will climate change impact species distribution?

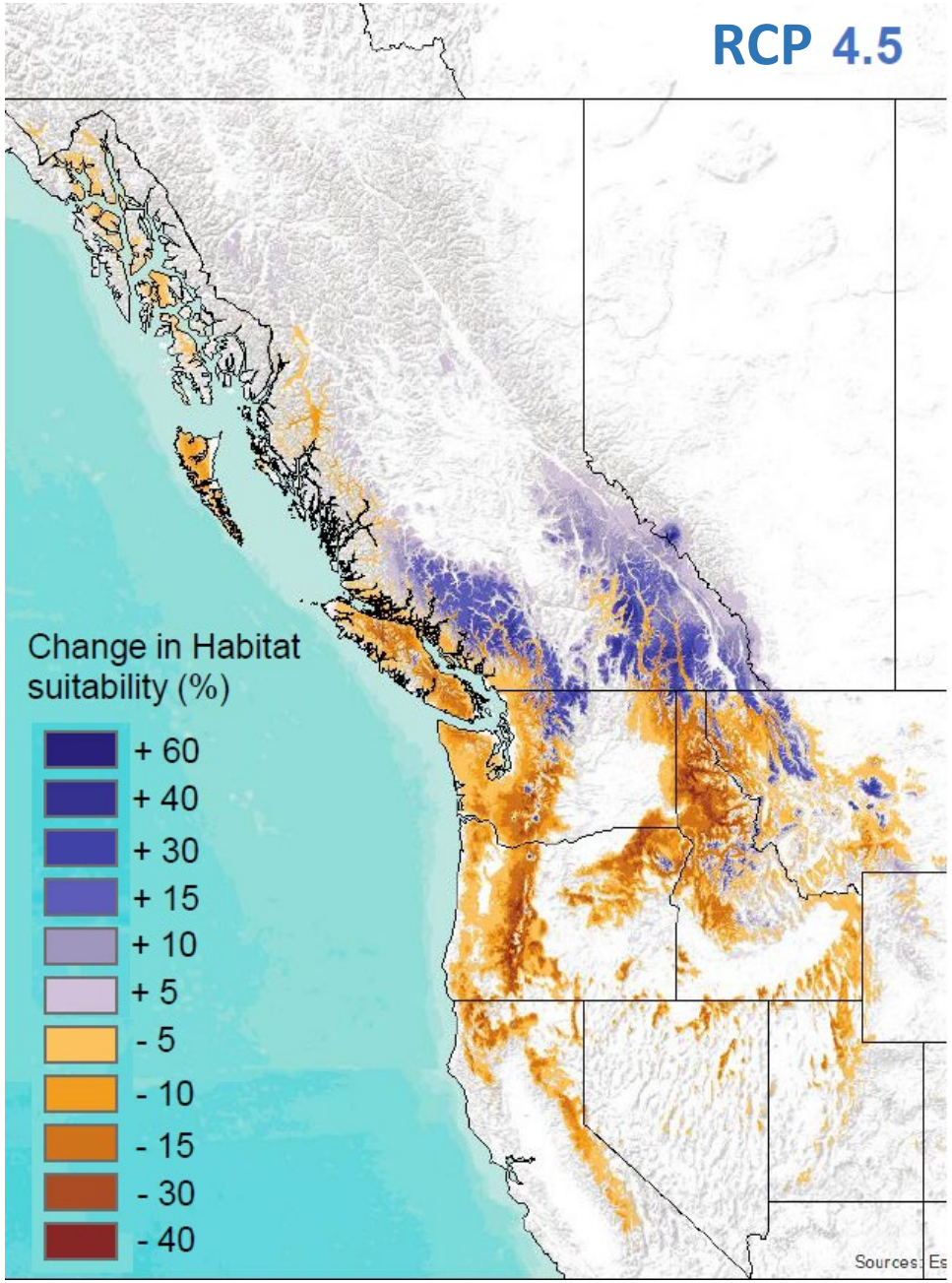
Used 15 CMIP5 model means to predict climate in the future (2085) for 2 emissions scenarios: RCP 4.5 and RCP 8.5

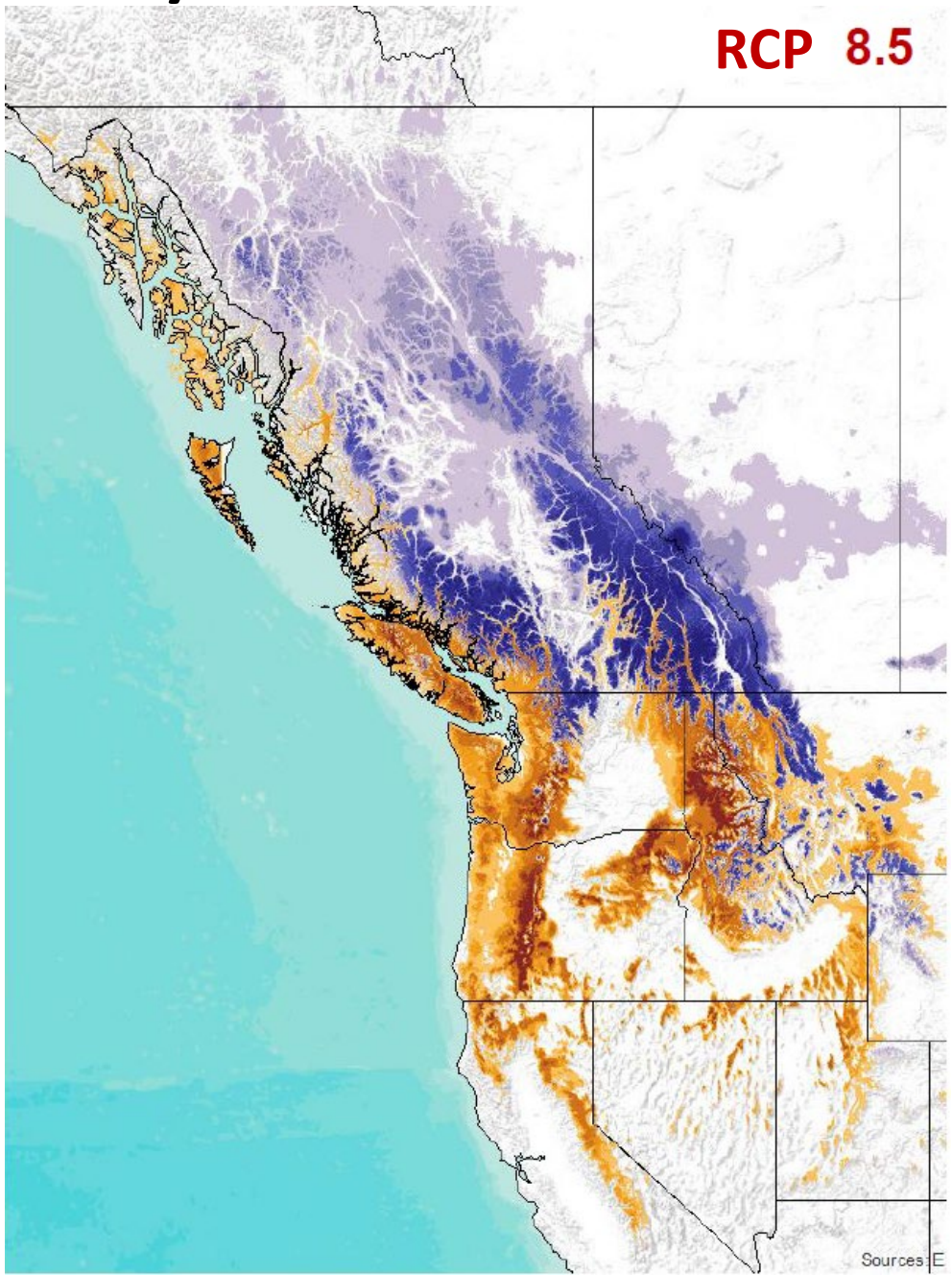
MaxEnt (Maximum Entropy) species distribution models to estimate how changes in important climate variables would impact the climatic niche of shrub species in the future

RCP = Representative concentration pathway is a greenhouse gas concentration trajectory IPCC 2014

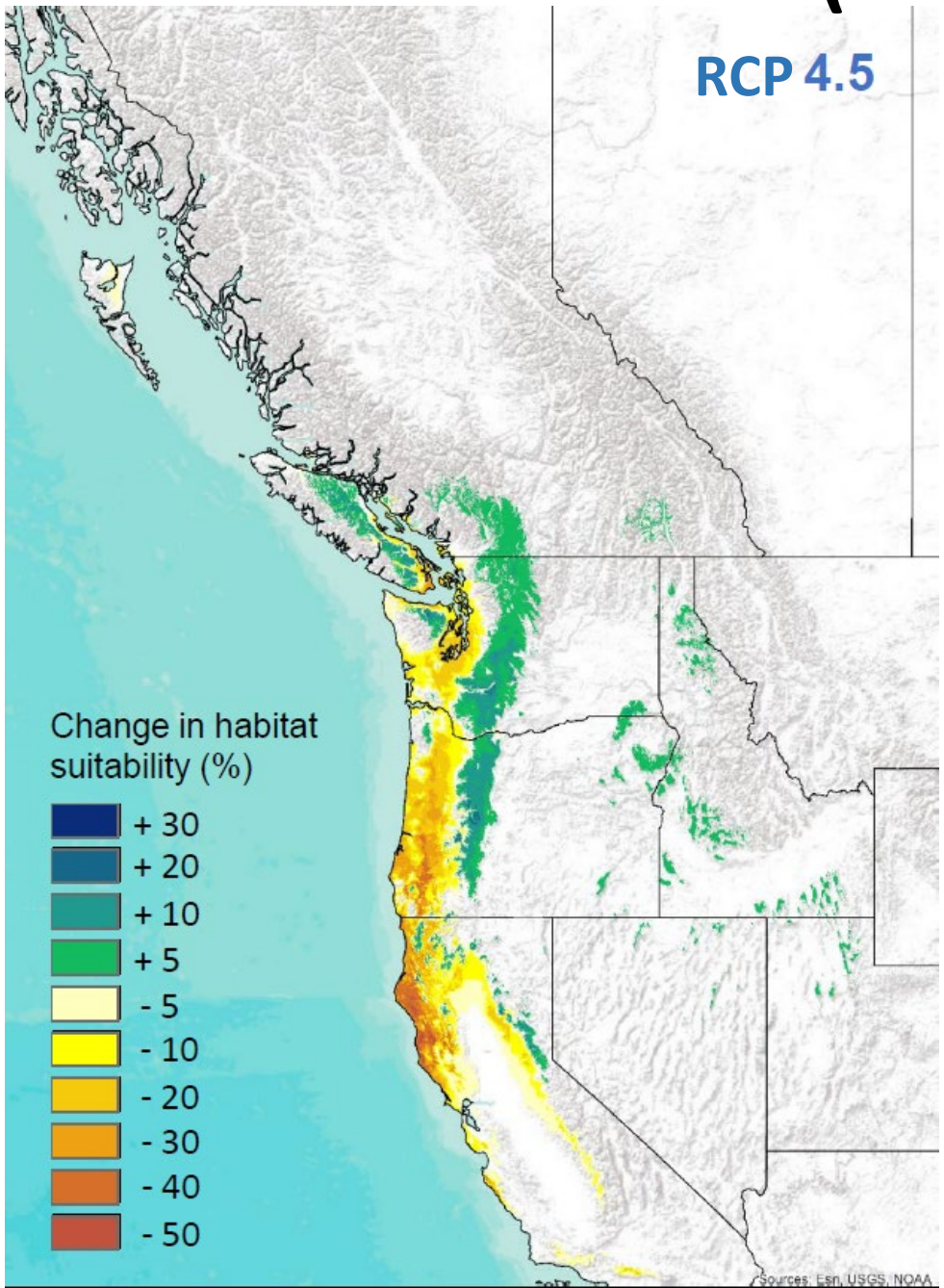


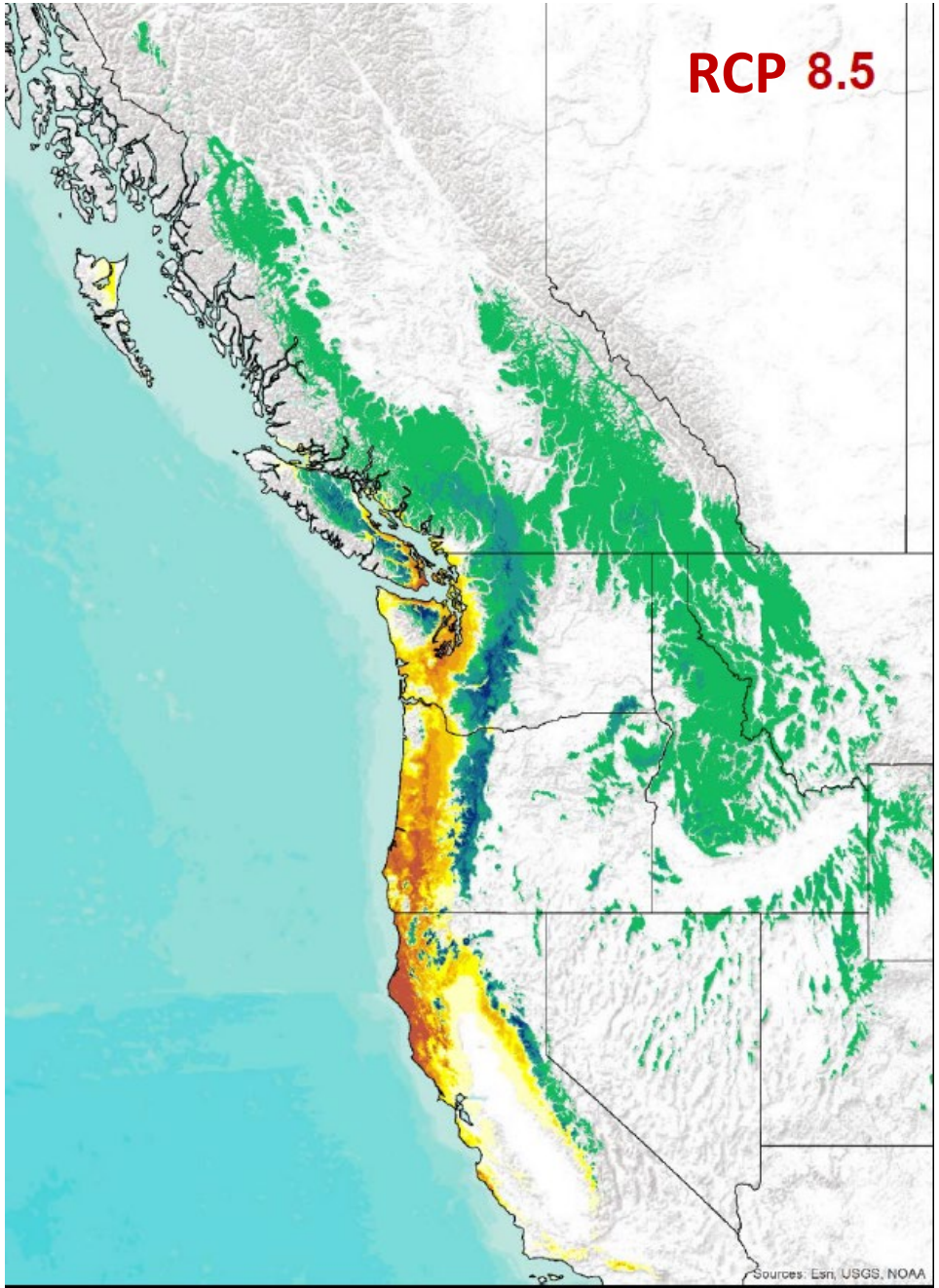
Huckleberry (VAME) in 2085



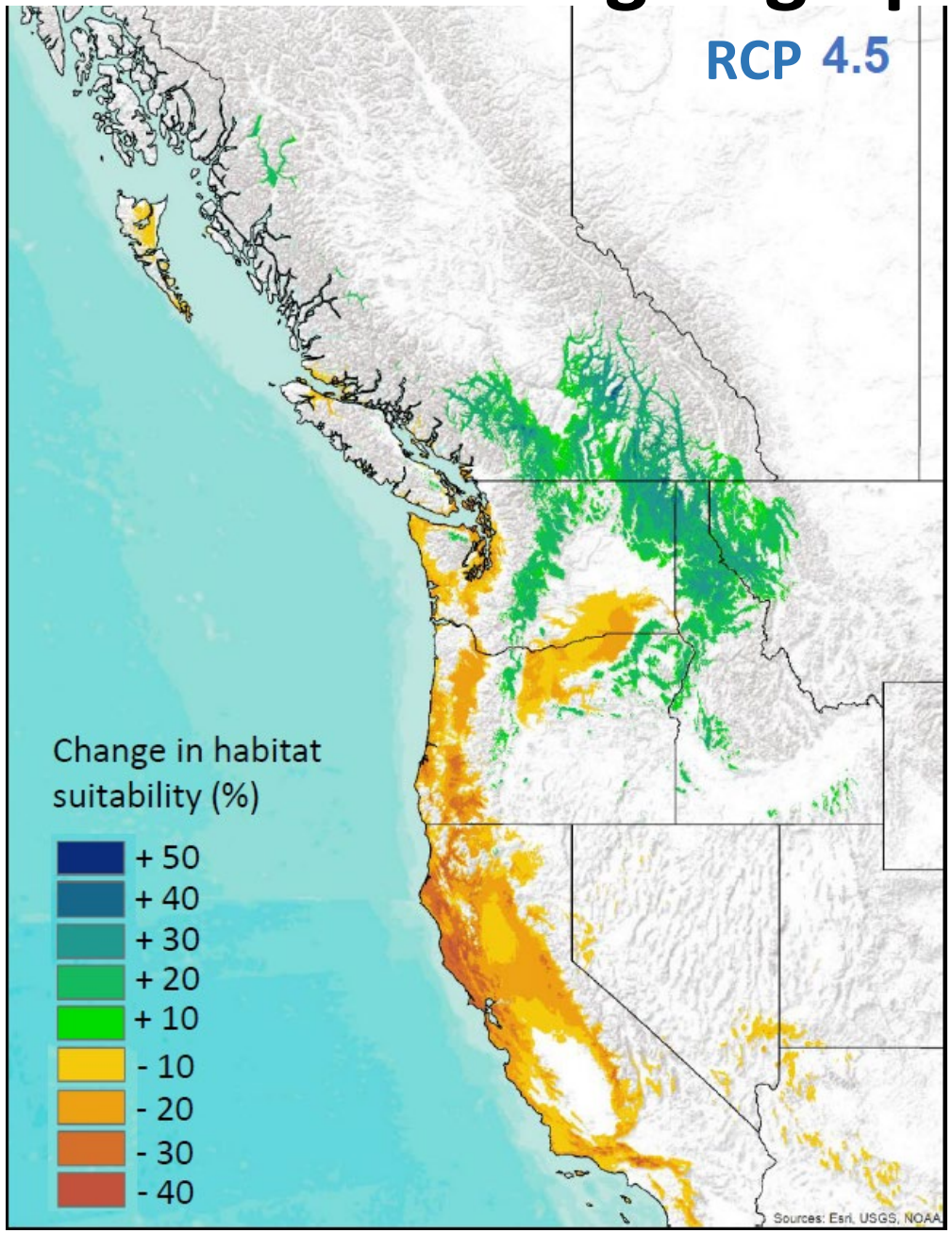


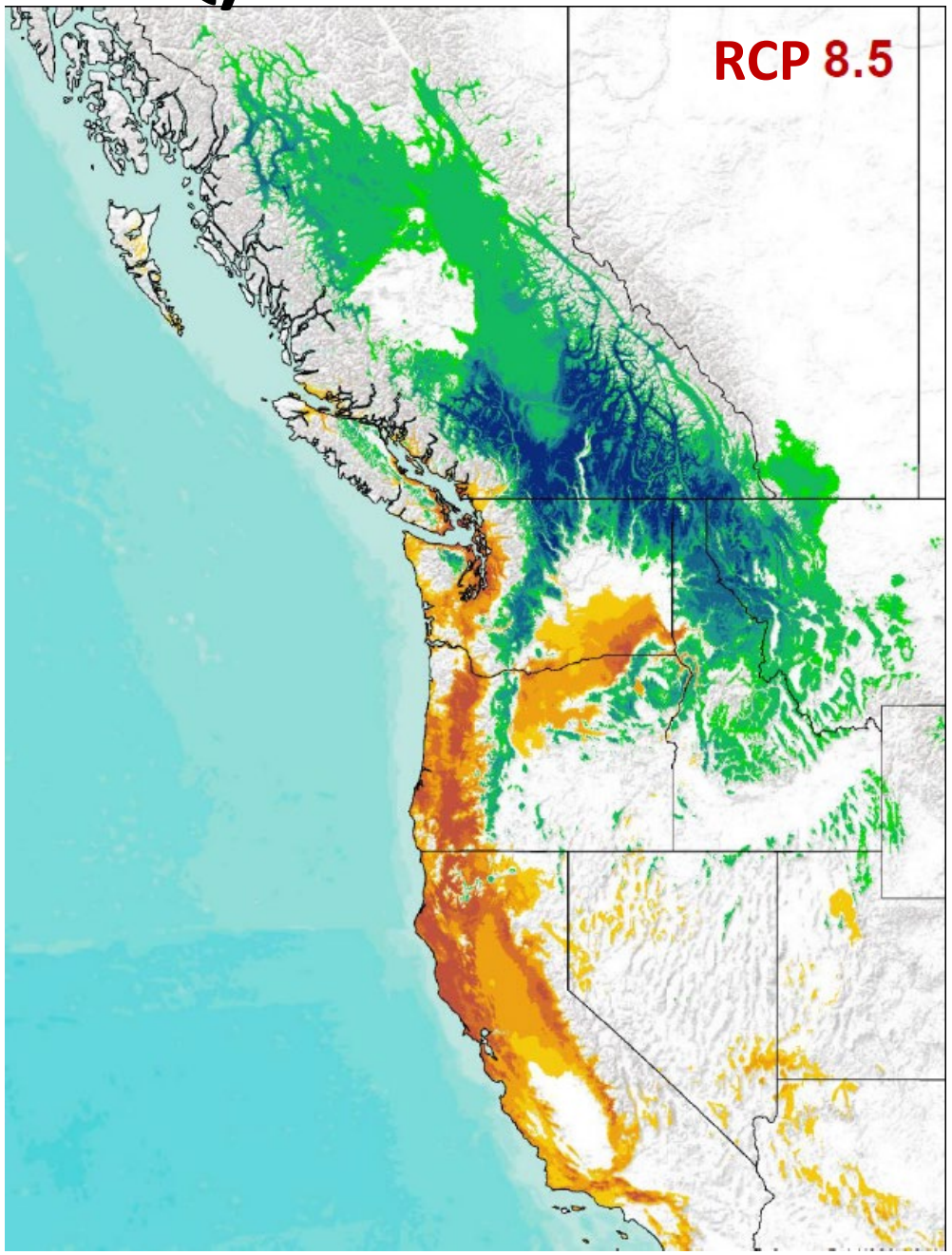
Hazelnut (COCO) in 2085



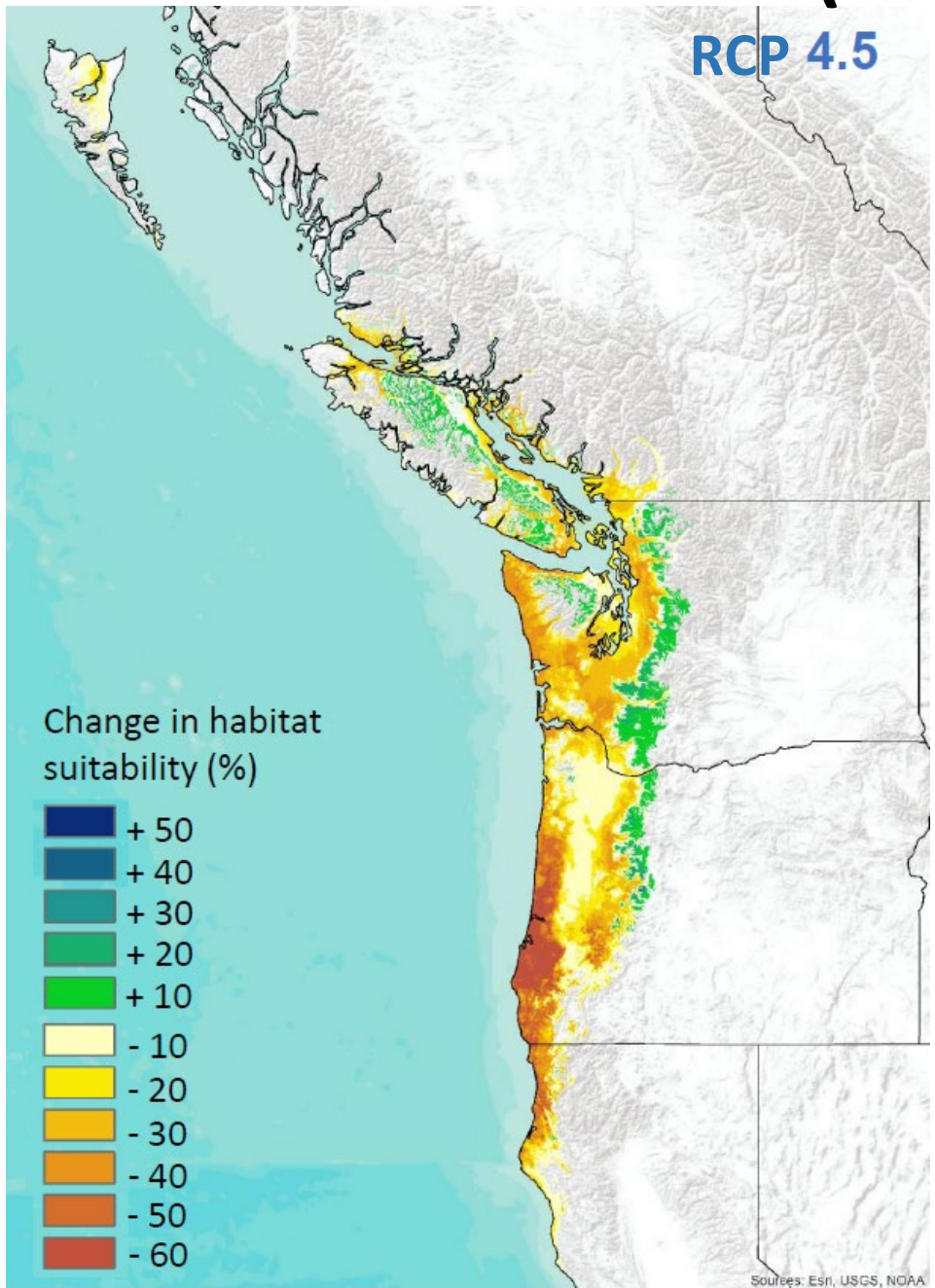


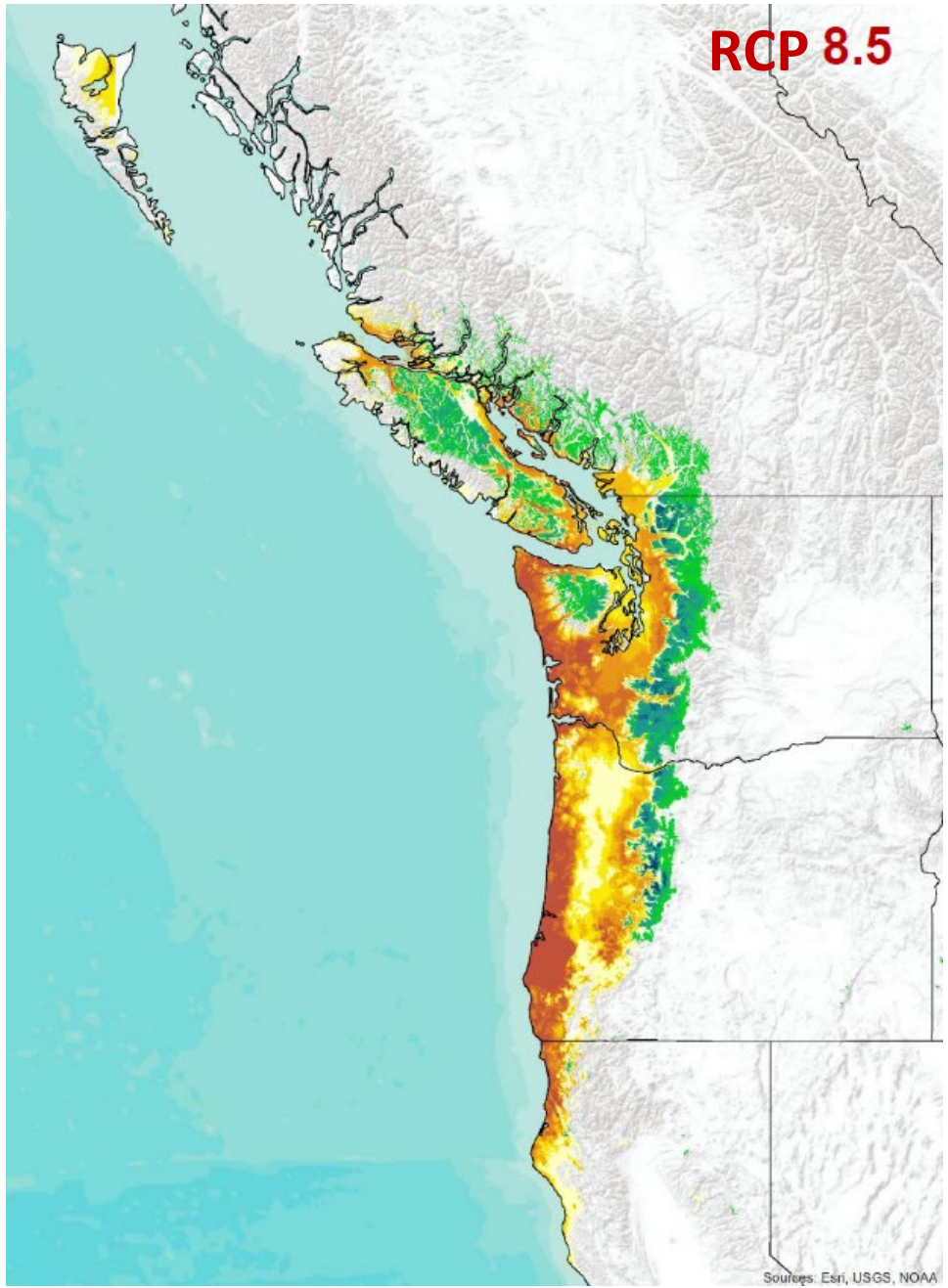
Oregon grape (MAAQ) in 2085



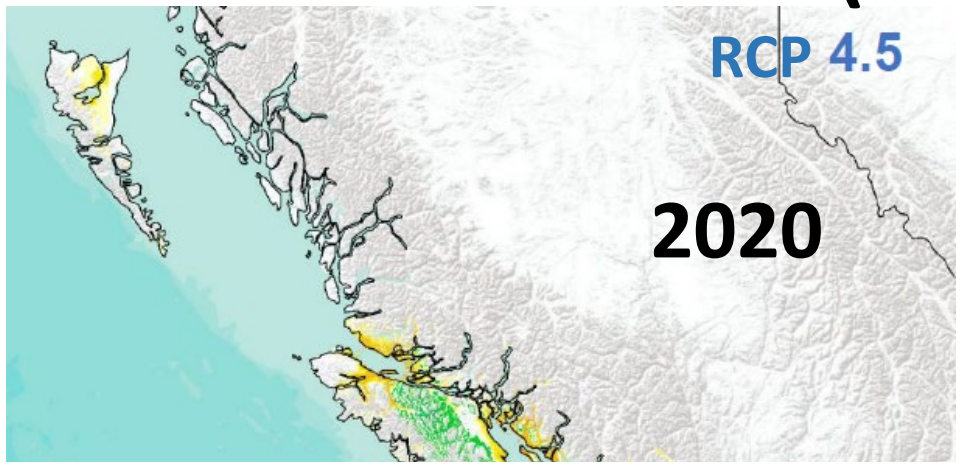


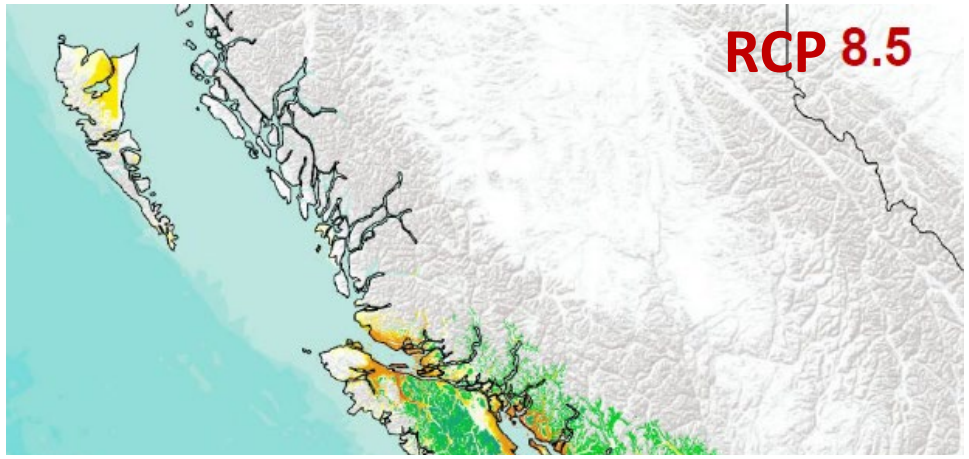
Salal (GASH) in 2085

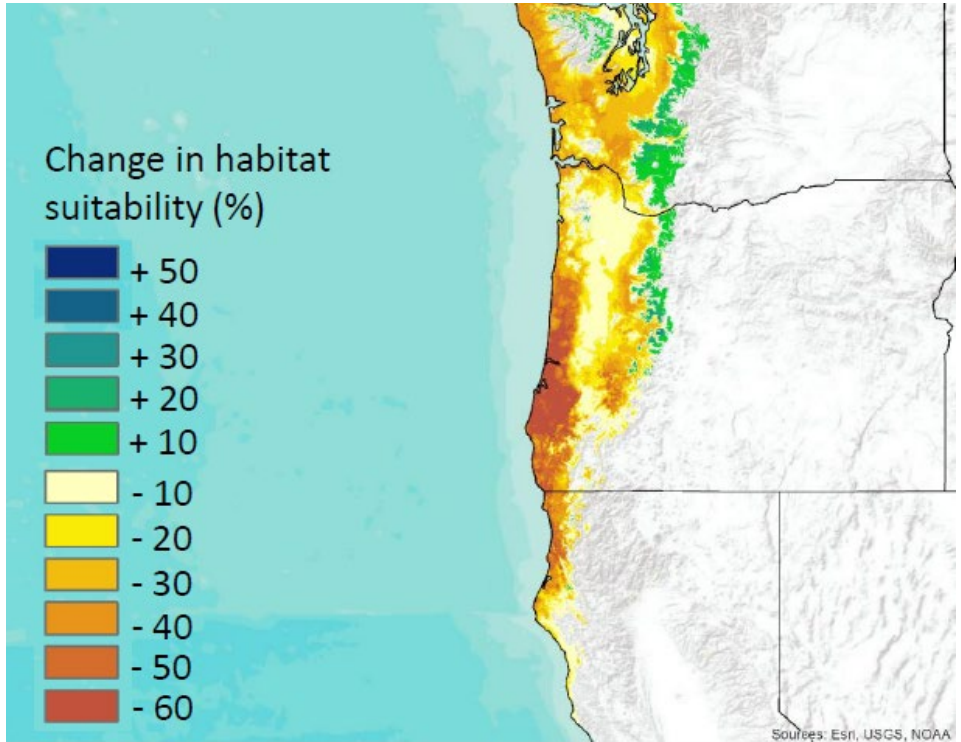


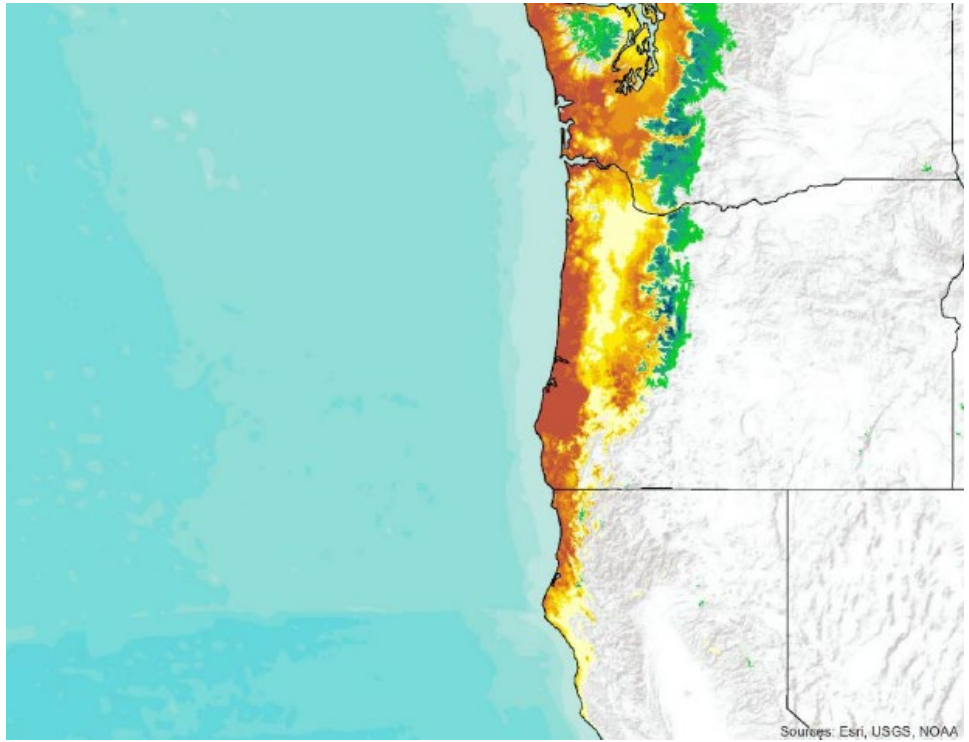


Salal (GASH) in 2085

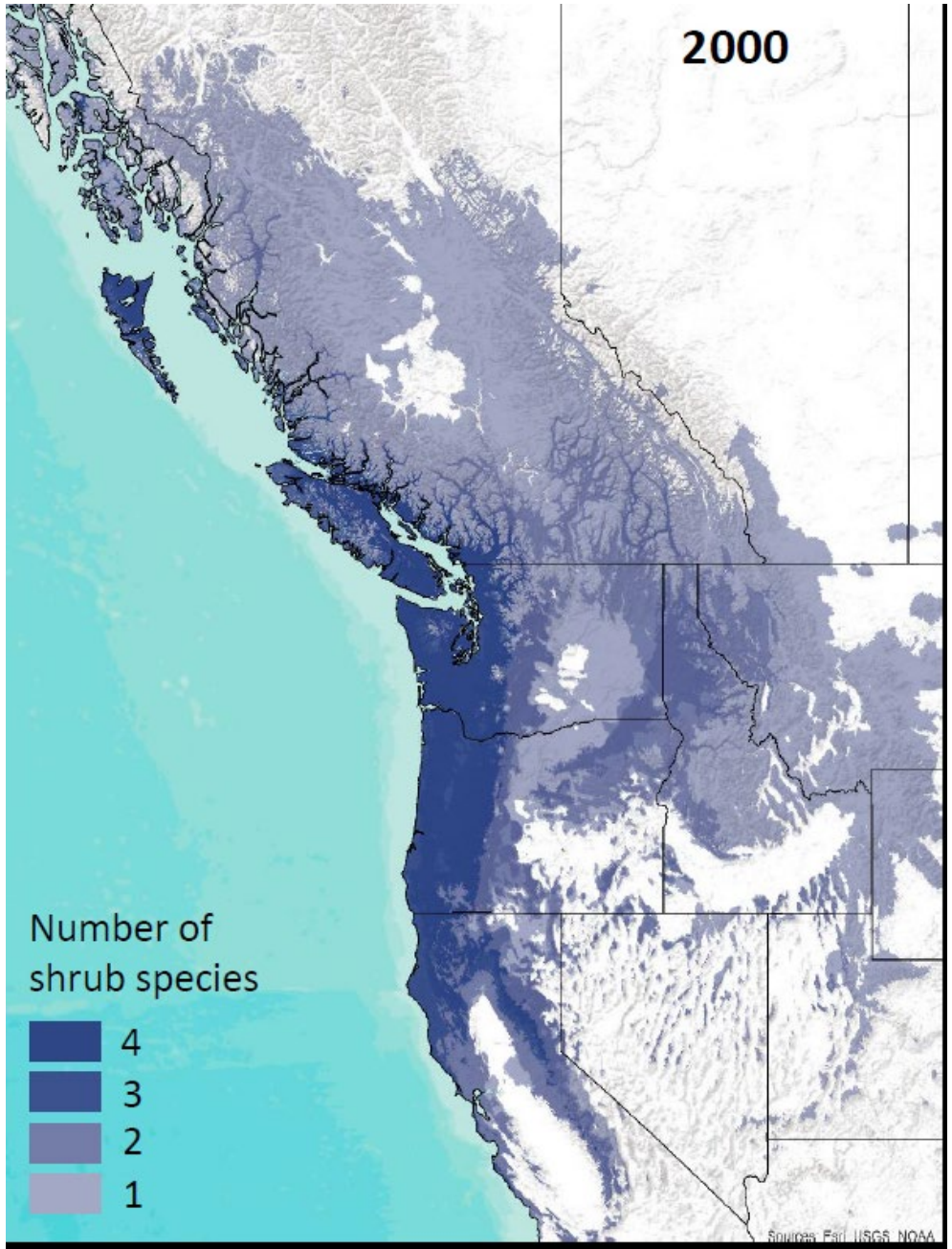


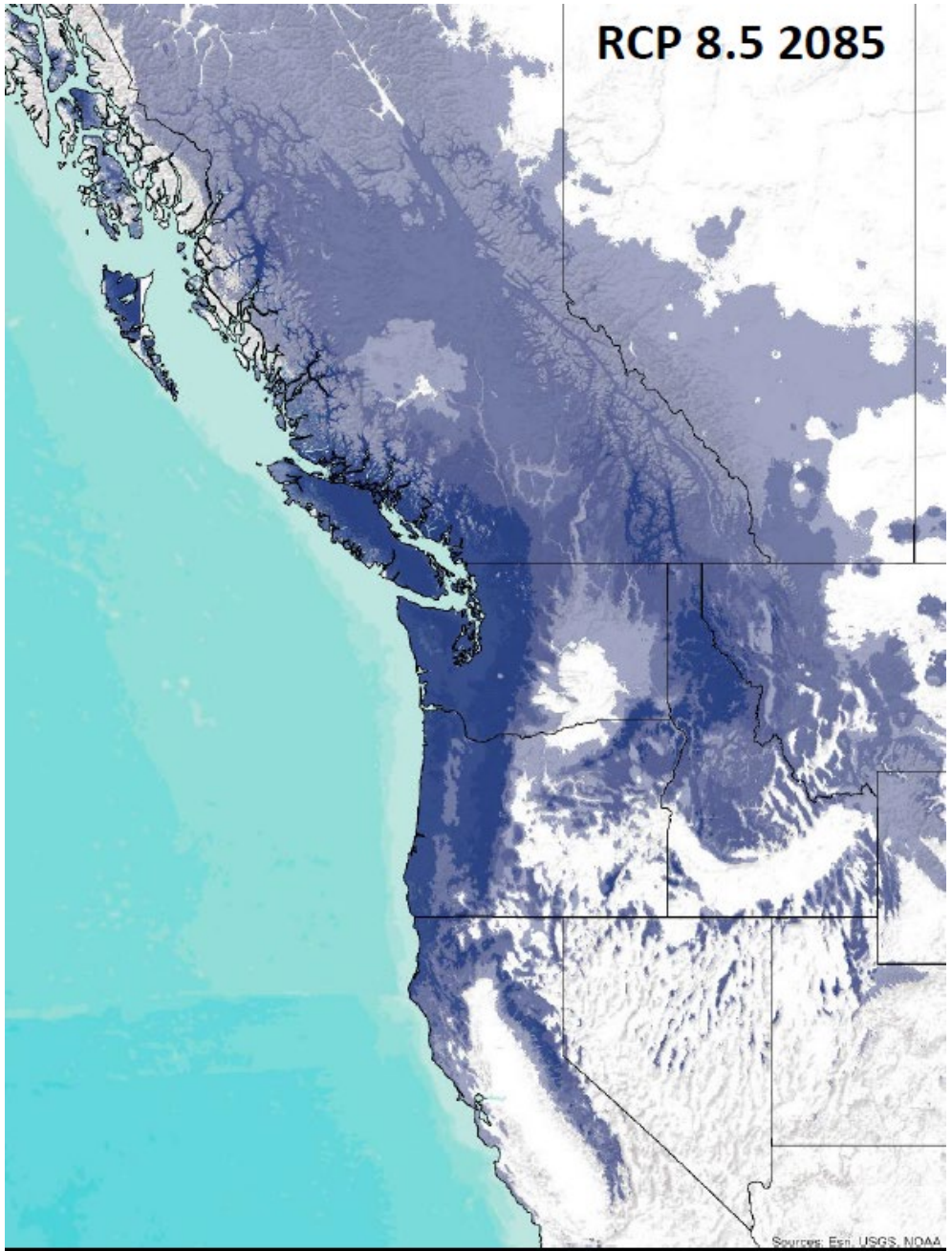






Predicted range shift for all 4 shrub species by 2085





USGS data release with all shrub habitat suitability model rasters

ScienceBase Catalog → USGS Data Release Products → Habitat suitability models for …

Habitat suitability models for understory shrubs of western North America

View

Dates

Publication Date : 2022-12-01
Start Date : 1981
End Date : 2100

Citation

Prevey, J.S., Parker, L.E., Brodie, L.C., and Harrington, C.A., 2022, Habitat suitability models for understory shrubs of western North America: U.S. Geological Survey data release, https://doi.org/10.5066/P9Z2TVGA.

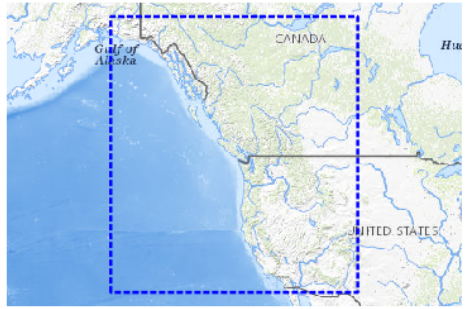
Summary

These data provide current and future projected habitat distribution models for four shrub species: beaked hazelnut (*Corylus cornuta*), Oregon grape (*Mahonia aquifolium*), salal (*Gaultheria shallon*), and black huckleberry, (*Vaccinium membranaceum*), as well as a current projected habitat distribution model for evergreen huckleberry (*Vaccinium ovatum*). Each raster file represents the projected habitat suitability for each shrub species, climate scenario, and time period. Files are named according to the species (coco = *Corylus cornuta*, maaq = *Mahonia aquifolium*, gash = *Gaultheria shallon*, vame = *Vaccinium membranaceum*, and vaov2 = *Vaccinium ovatum*), then the RCP pathway (none for current, 'low' for RCP 4.5, and 'high' for RCP 8.5), and lastly, the time period (current = 1981-2010, mid = 2041-2071, and end = 2071-2100). For example, 'maaq_low_mid.tif' is a raster file showing projected habitat suitability for *Mahonia aquifolium* for mid-century (2041-2070) under RCP 4.5.

Contacts

Point of Contact : Janet S Prevey
Originator : Constance A. Harrington, Leslie C. Brodie, Lauren E. Parker, Janet S Prevey
Metadata Contact : FORT Metadata Specialist
Publisher : U.S. Geological Survey
Distributor : U.S. Geological Survey - ScienceBase
SDC Data Owner : Fort Collins Science Center

Map »



Communities

- Fort Collins Science Center (FORT)
- USGS Data Release Products

Tags

Harvest Set : USGS Science Data Catalog (SDC)
Theme : biota, environment, non-timber forest products, shrub, understory
Place : British Columbia, California, Canada, Colorado, Idaho, Montana, Northwest Territories, Oregon, Pacific Northwest, Saskatchewan, United States, Washington, Wyoming, western North America
USGS Scientific Topic Keyword : Ecology

https://doi.org/10.5066/P9Z2TVGA

Attached Files

Click on title to download individual files attached to this item.

shrub_sdms_metadata.xml *Original FGDC Metadata*	View	34.69 KB	application/fgdc+xml
coco_high_mid.tif		274.38 MB	image/tiff

... show more ...

Related External Resources

Type: Related Primary Publication

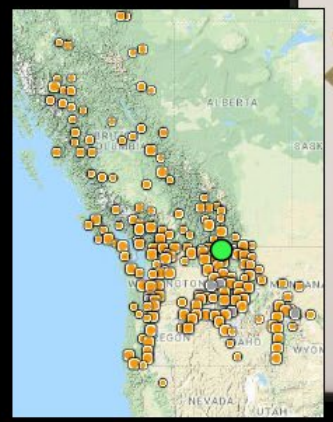
Moriarty KM, Thompson J, Delheimer M, Barry BR, Linnell M, Levi T, Hamm K, Early D, Gamblin H, Szykman Gunther M, Ellison J, Prevéy JS, Hartman J, Davis R. 2021. Predicted distribution of a rare and understudied forest carnivore: Humboldt marten (Martes caurina humboldtensis) PeerJ 9:e11670 https://doi.org/10.7717/peerj.11670	https://doi.org/10.7717/peerj.11670
Prevéy JS, Parker LE, Harrington CA. Projected impacts of climate change on the range and phenology of three culturally-important shrub species. PloS one. 2020 May 8;15(5):e0232537.	https://doi.org/10.1371/journal.pone.0232537
Prevéy, Janet S.; Parker, Lauren E.; Harrington, Constance A.; Lamb, Clayton T.; Proctor, Michael F. 2020. Climate change shifts in habitat suitability and phenology of huckleberry (Vaccinium membranaceum). Agricultural and Forest Meteorology. 280: 107803-. https://doi.org/10.1016/j.agrformet.2019.107803	https://doi.org/10.1016/j.agrformet.2019.107803

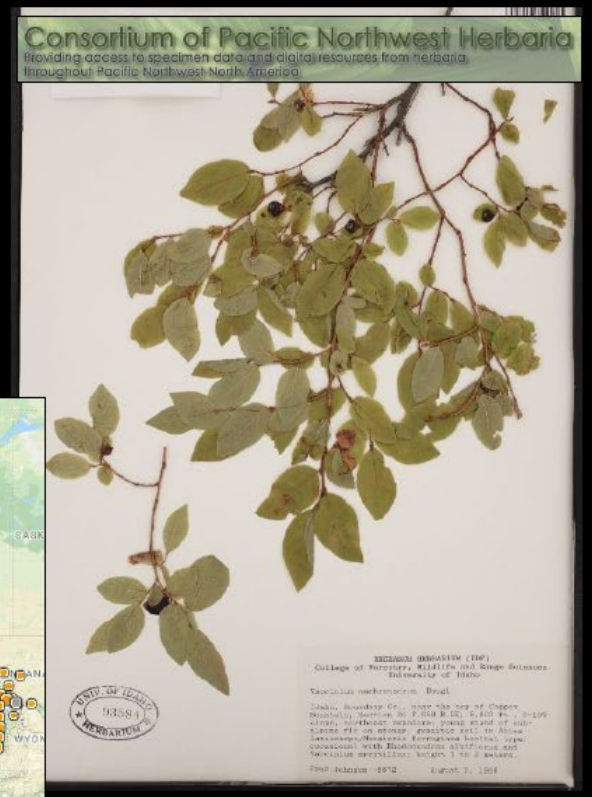
Type: Related Data Release

Prevéy, J.S., 2020, Location and phenology observations for beaked hazelnut (Corylus cornuta), Oregon grape (Mahonia aquifolium), and salal (Gaultheria shallon) in western North America: U.S. Geological Survey data release, https://doi.org/10.5066/P9G0UTKF.	https://doi.org/10.5066/P9G0UTKF

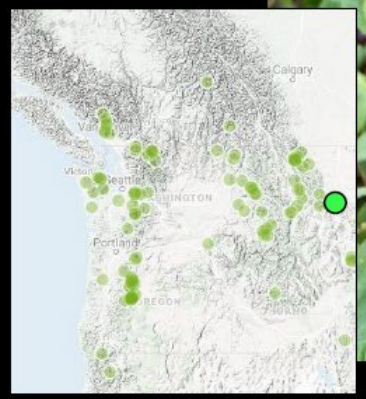
Changing phenology:
Flowering and fruiting observations

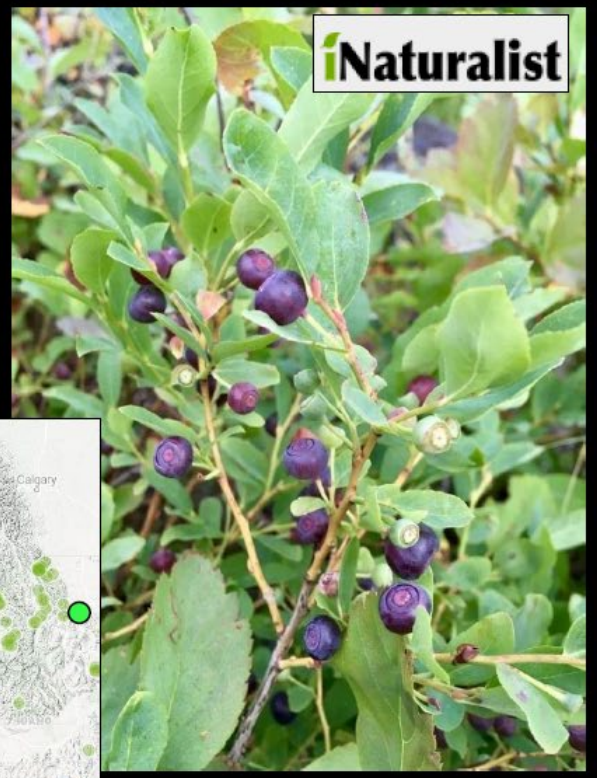
- Repeated measurements of shrub phenology data are **rare**, so we estimated dates of flowering and fruiting from diverse data sources to examine how shrub phenology relates to seasonal temperatures.





Black huckleberry in fruit, 8/3/1986
University of Idaho, collection by Fred Johnson





Black huckleberry in fruit, 7/29/2018
iNaturalist observation by Mitch Hurt

We used data from many sources

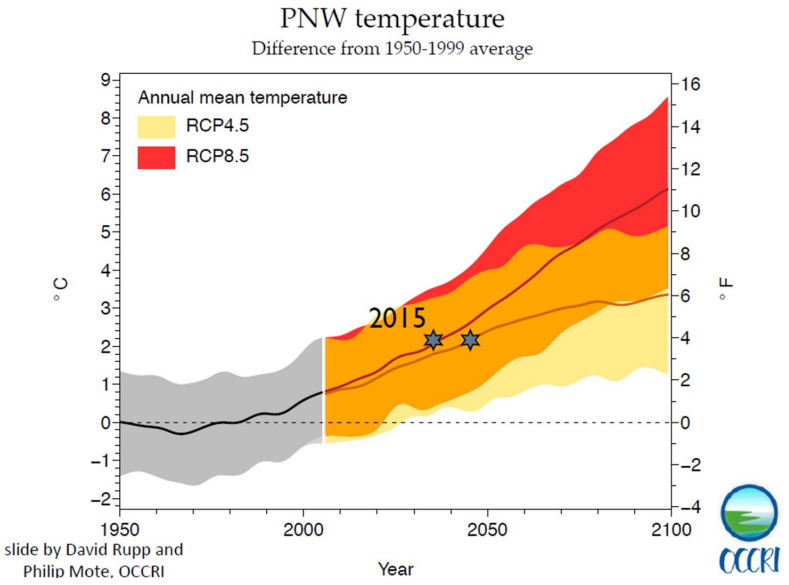
Phenology data hard to come by – especially flowering data at high elevation sites

Changing Phenology: Climate Data

Matched locations of phenology observations to interpolated temperature data from Daymet from all observations between 1980-2017

Cumulated daily temperature sums (growing degree days) for mean flowering and fruiting dates

Used GDD models and climate predictions to model future changes in phenology



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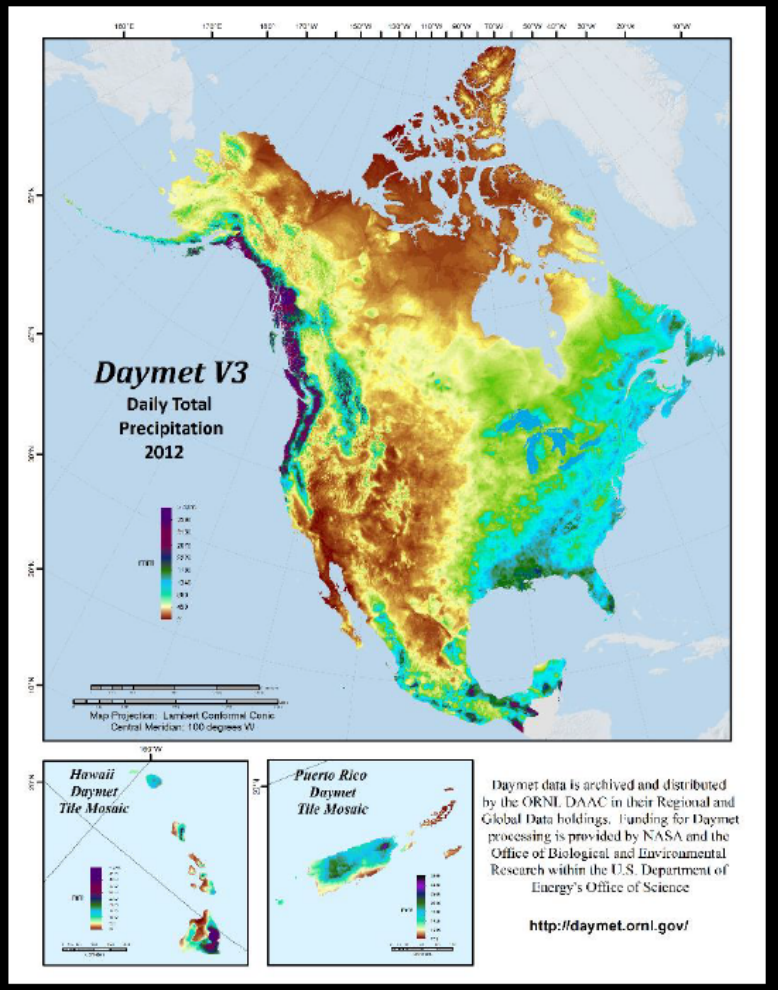

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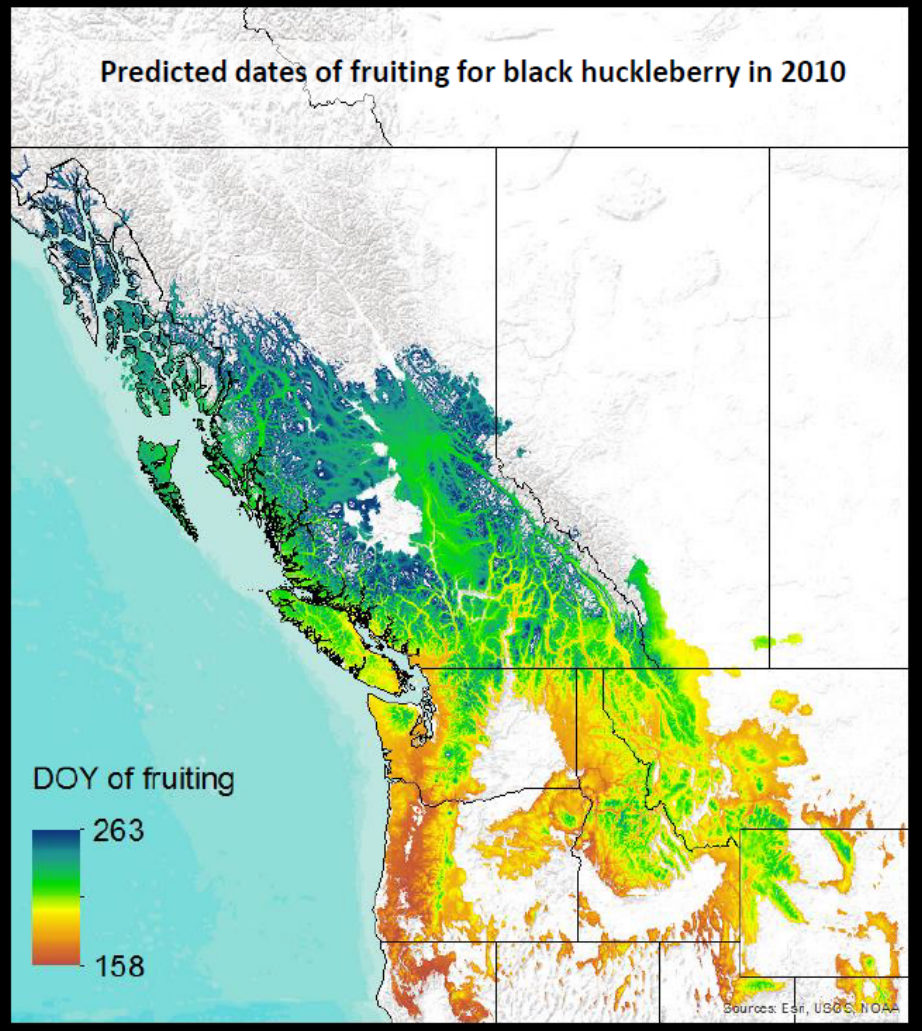
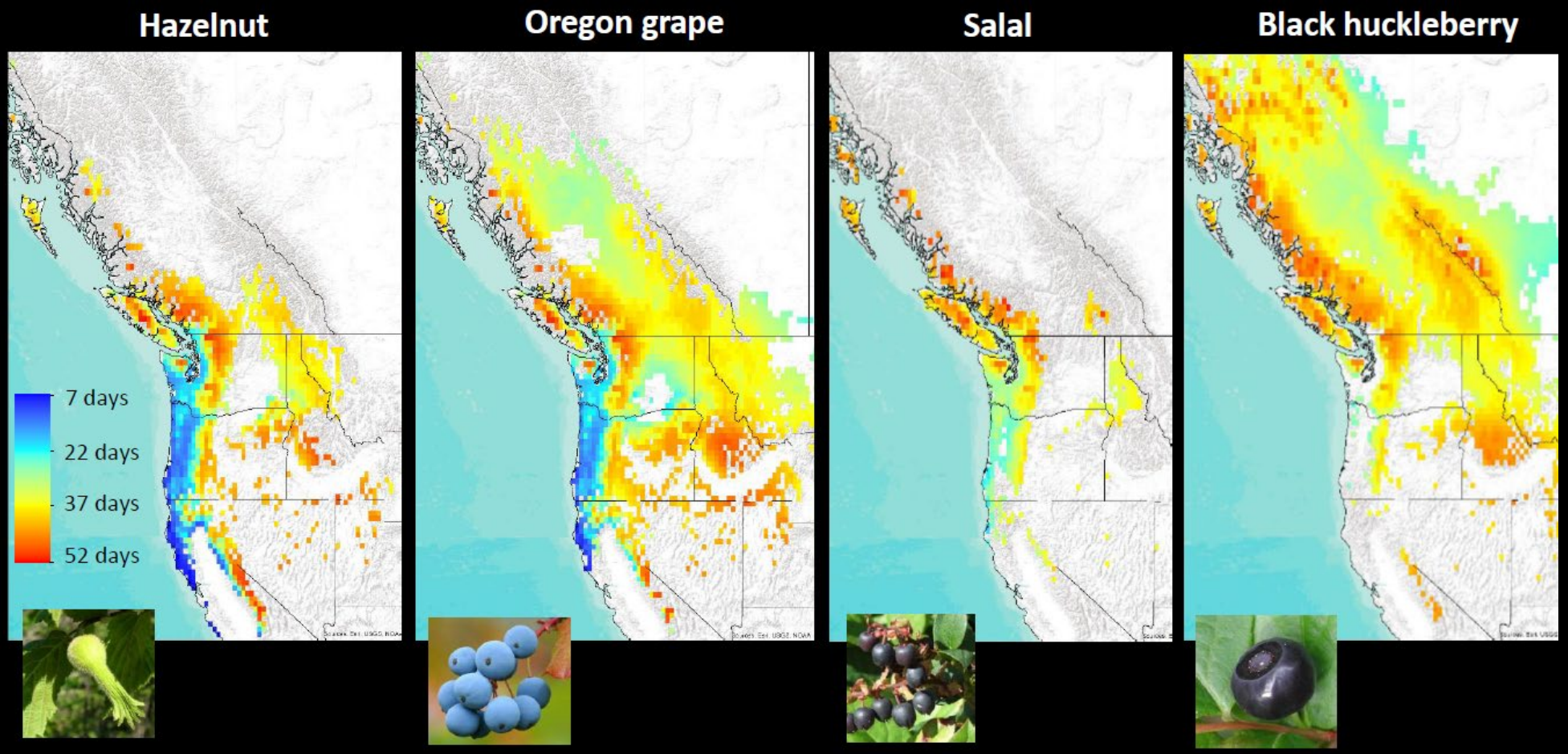
Climate data

- Matched locations of phenology observations to interpolated temperature data from Daymet from all observations between 1980-2017

- Cumulated daily temperature sums (growing degree days) for mean flowering and fruiting dates

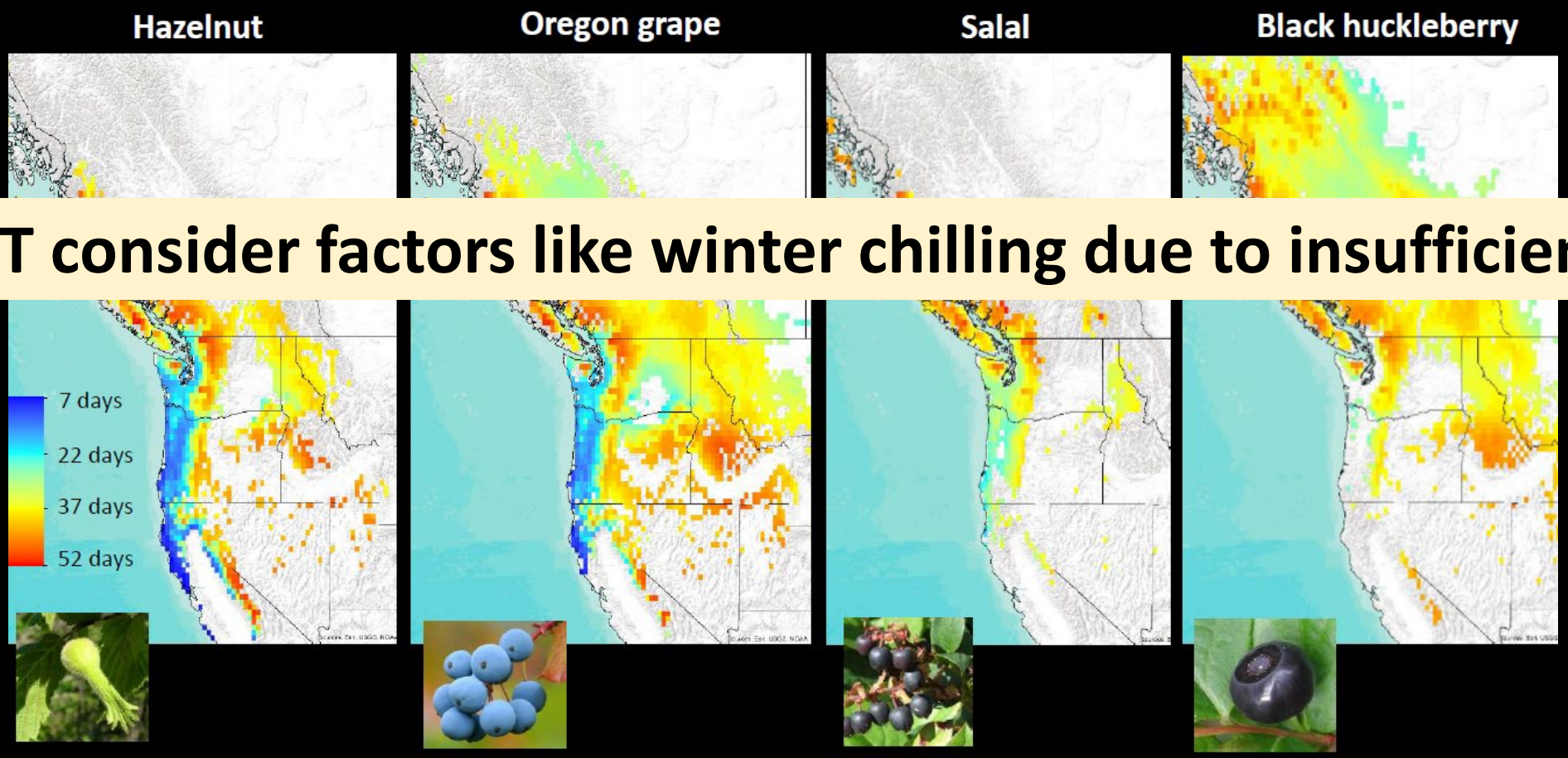


Changing phenology:
Shifts in flowering by 2085 - RCP 8.5



Flowering may advance 7 - 50 days by 2085

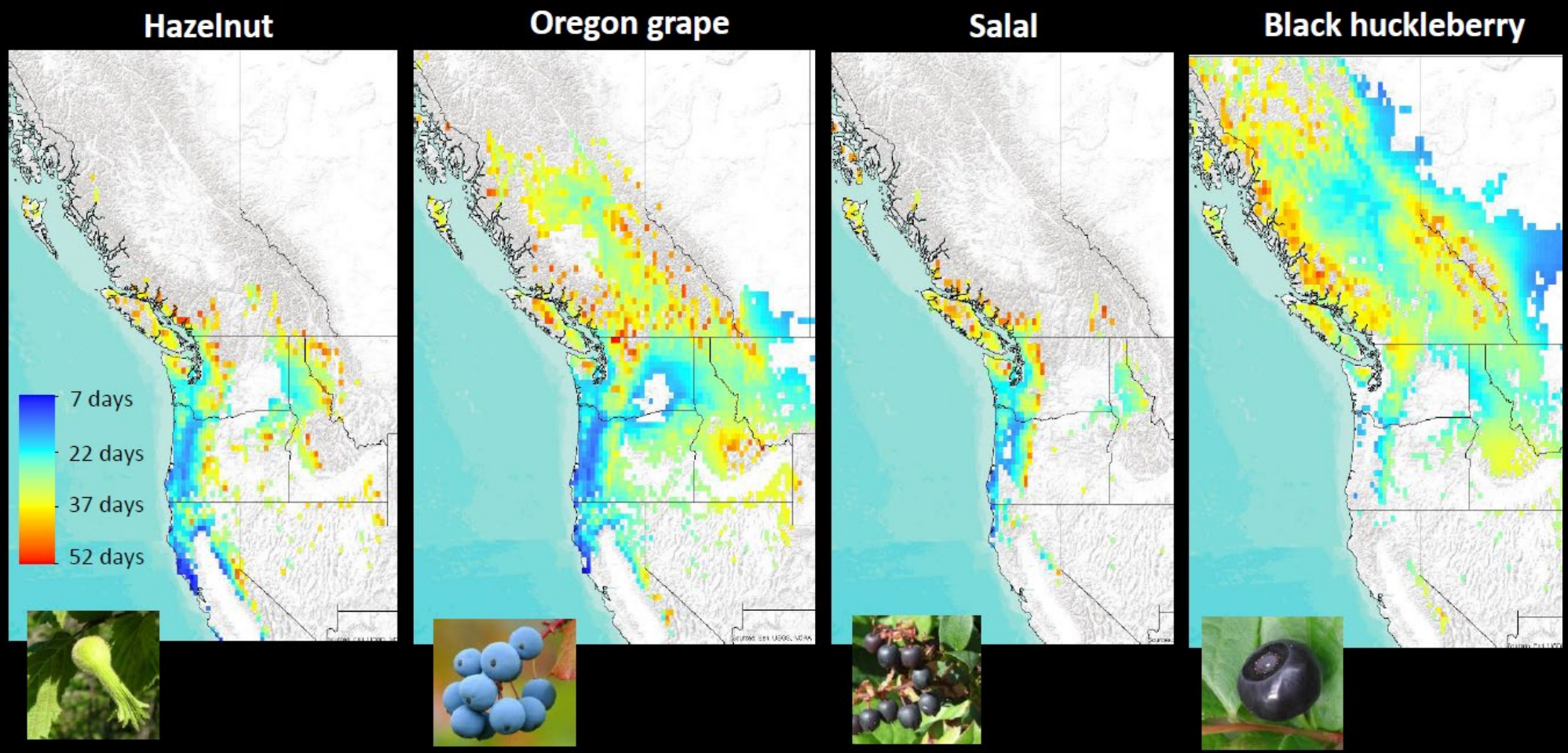
Changing phenology:
Shifts in flowering by 2085 - RCP 8.5



Did NOT consider factors like winter chilling due to insufficient data

Flowering may advance 7 - 50 days by the 2085….

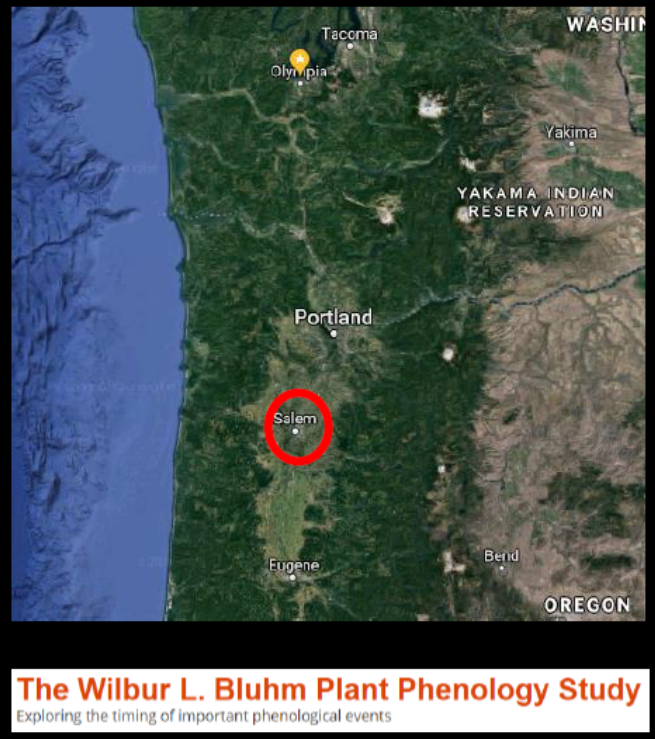
Changing phenology:
Shifts in fruiting by 2085 - RCP 8.5

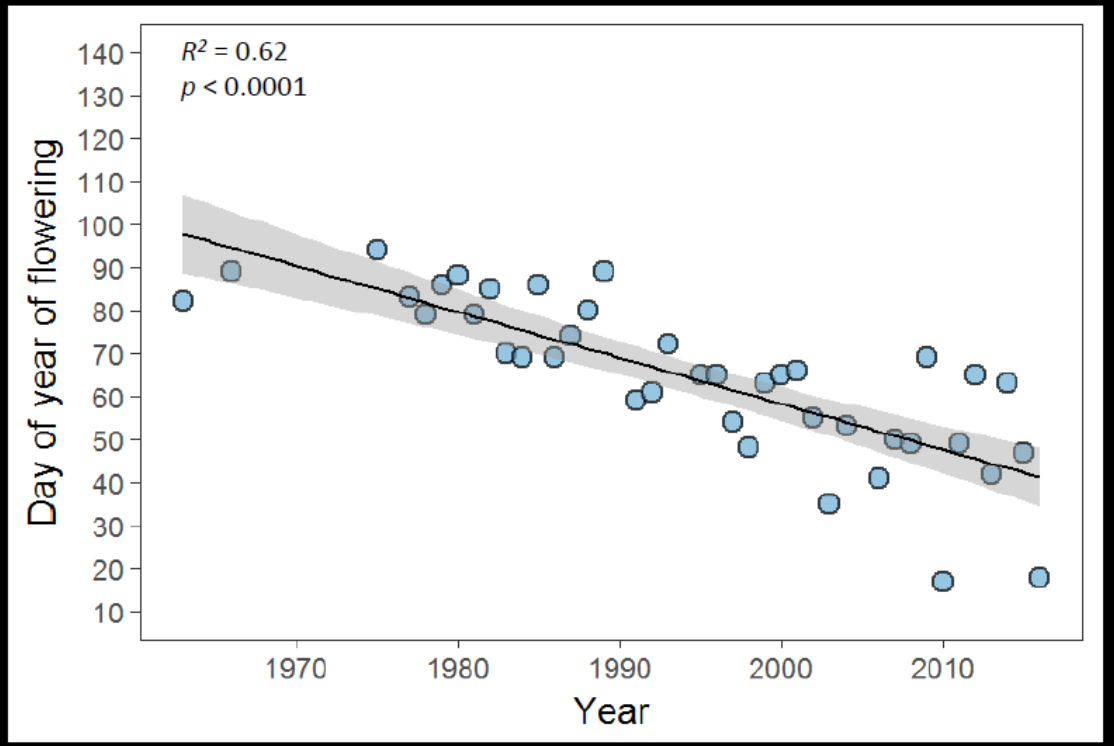


Fruiting may advance 10 - 55 days by 2085

Have there been large shifts in phenology over the recent past as temperatures have warmed?

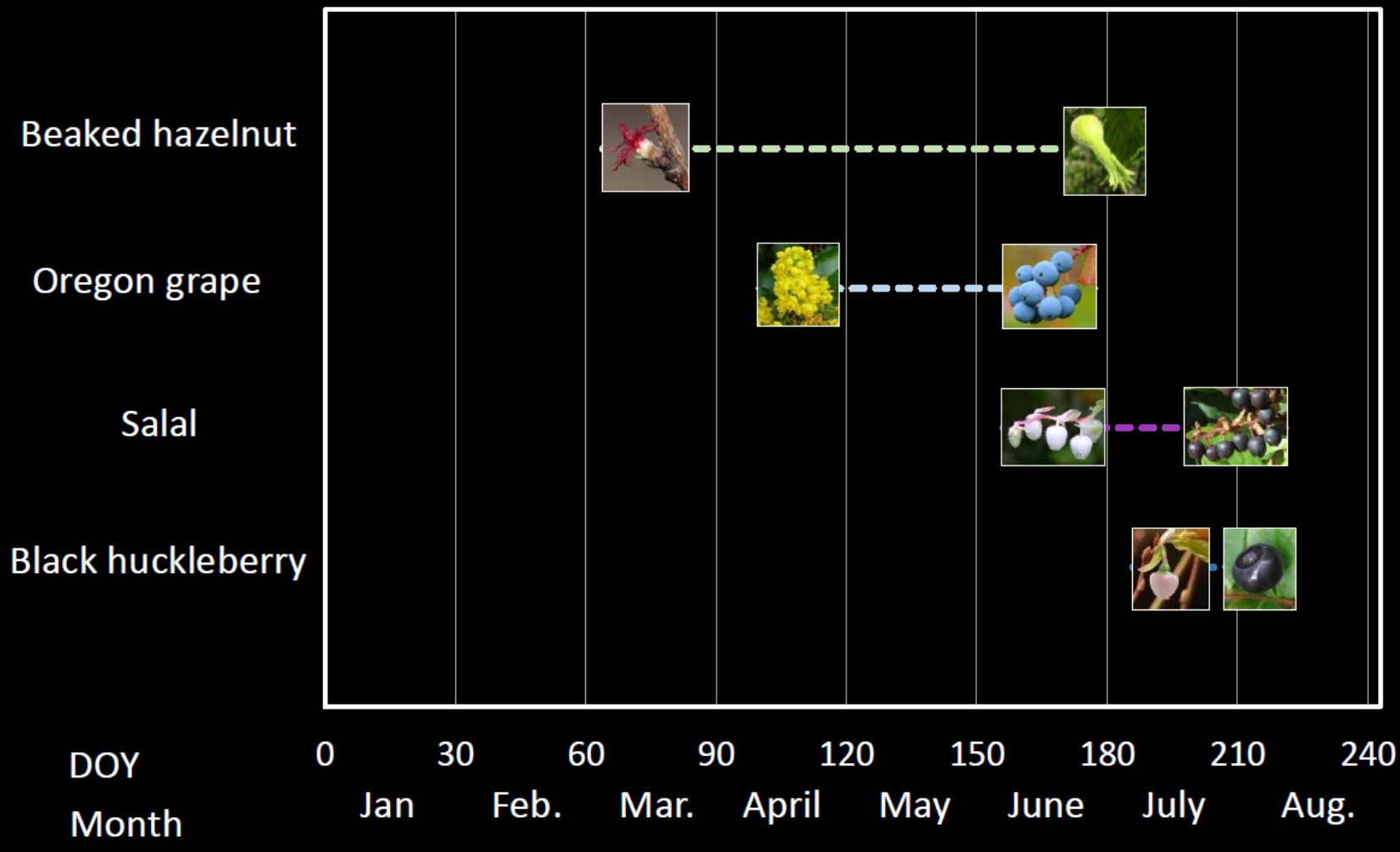
- Wilbur Bluhm recorded phenology data around Salem, Oregon for over 50 years: http://agsci-labs.oregonstate.edu/plantphenology/
  - He recorded dates of Oregon grape flowering from 1960 – 2016



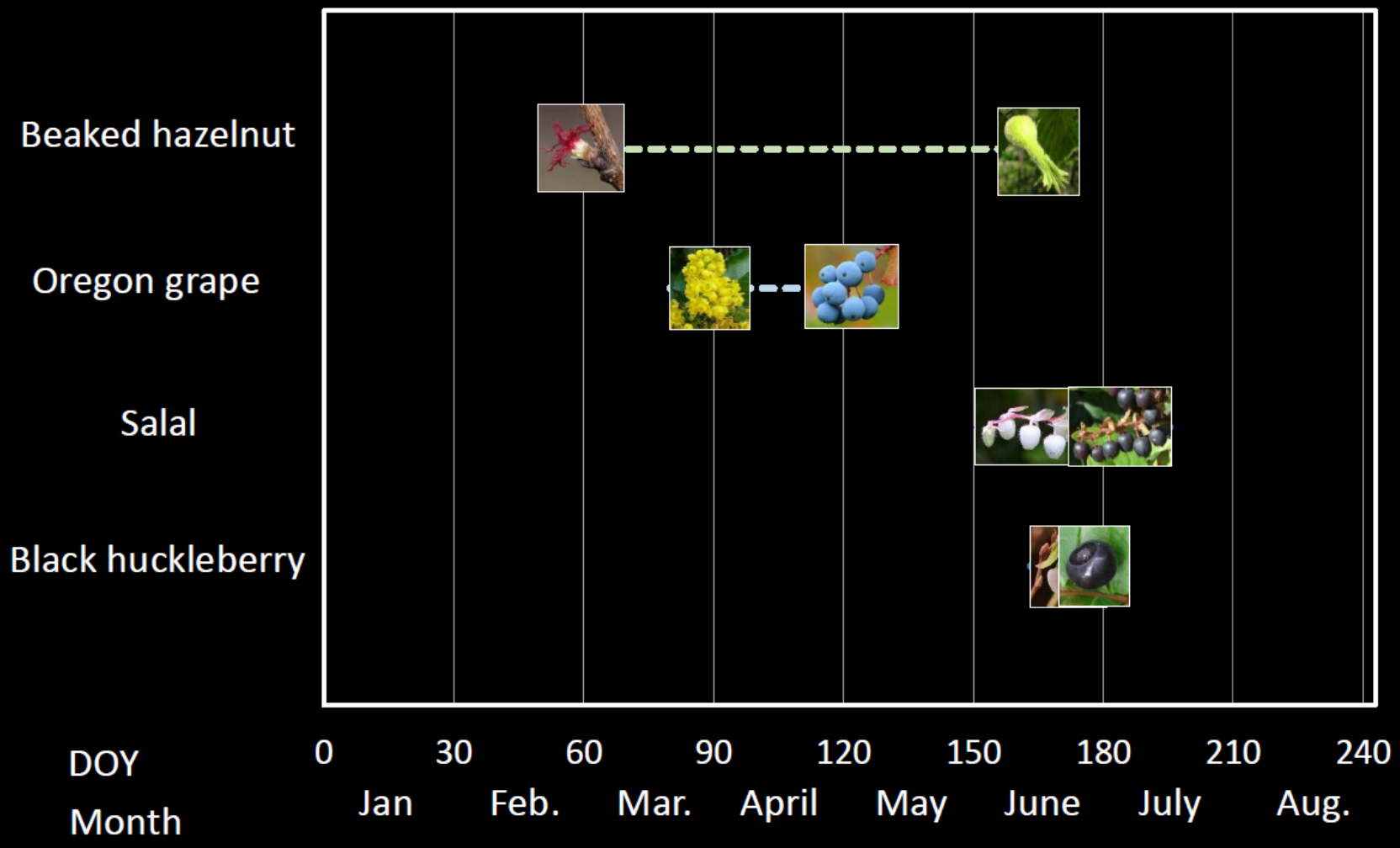


Flowering of Oregon grape has advanced an average of 50 days since 1960.....

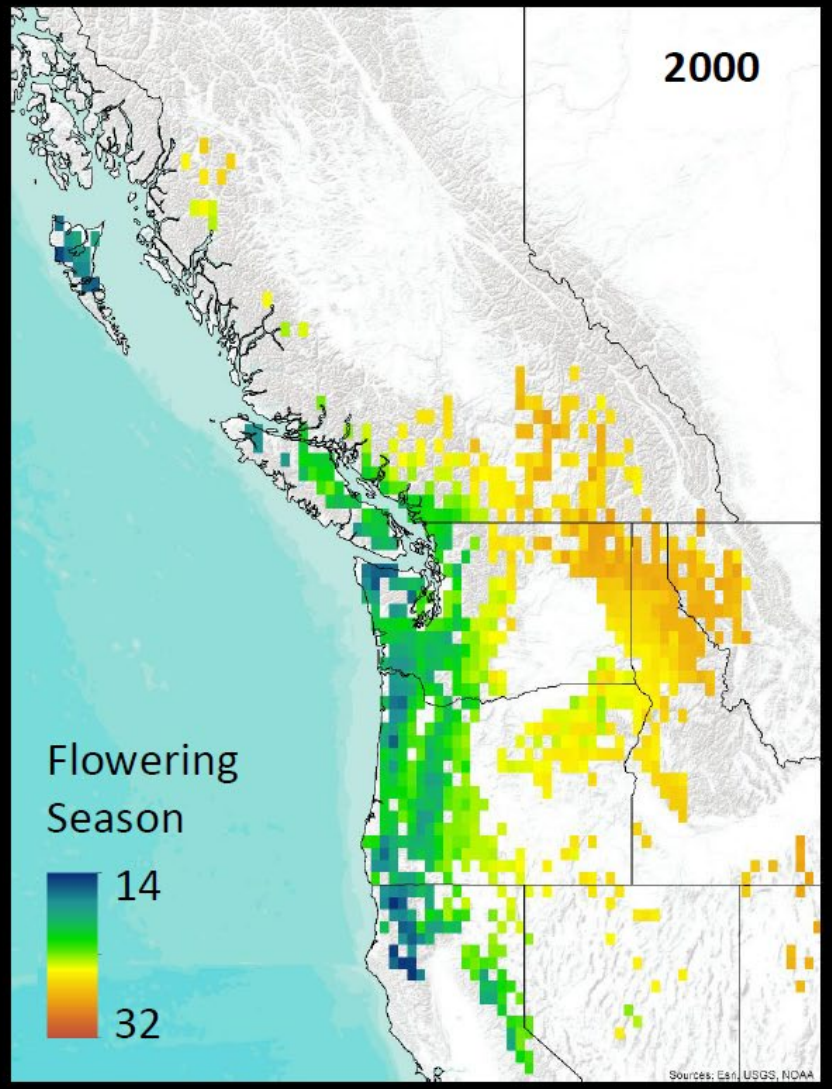
Mean flowering and fruiting dates: 1980-2016

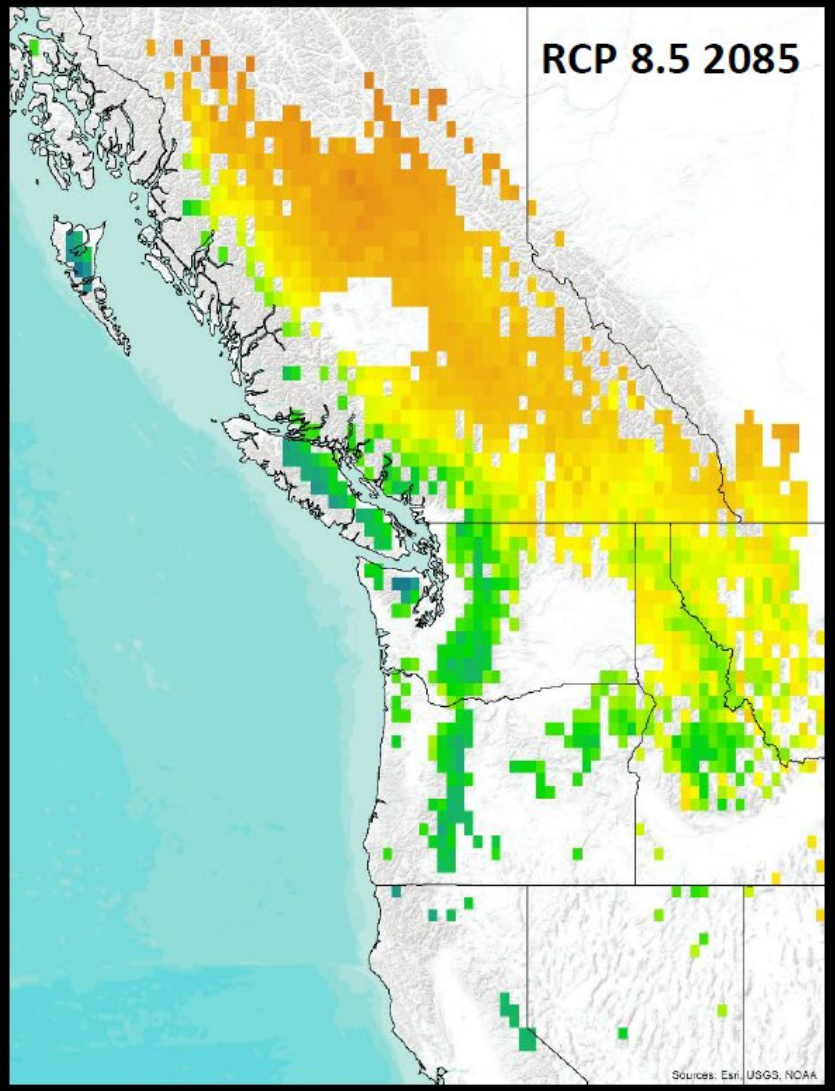


Predicted flowering and fruiting dates: 2085, RCP 8.5

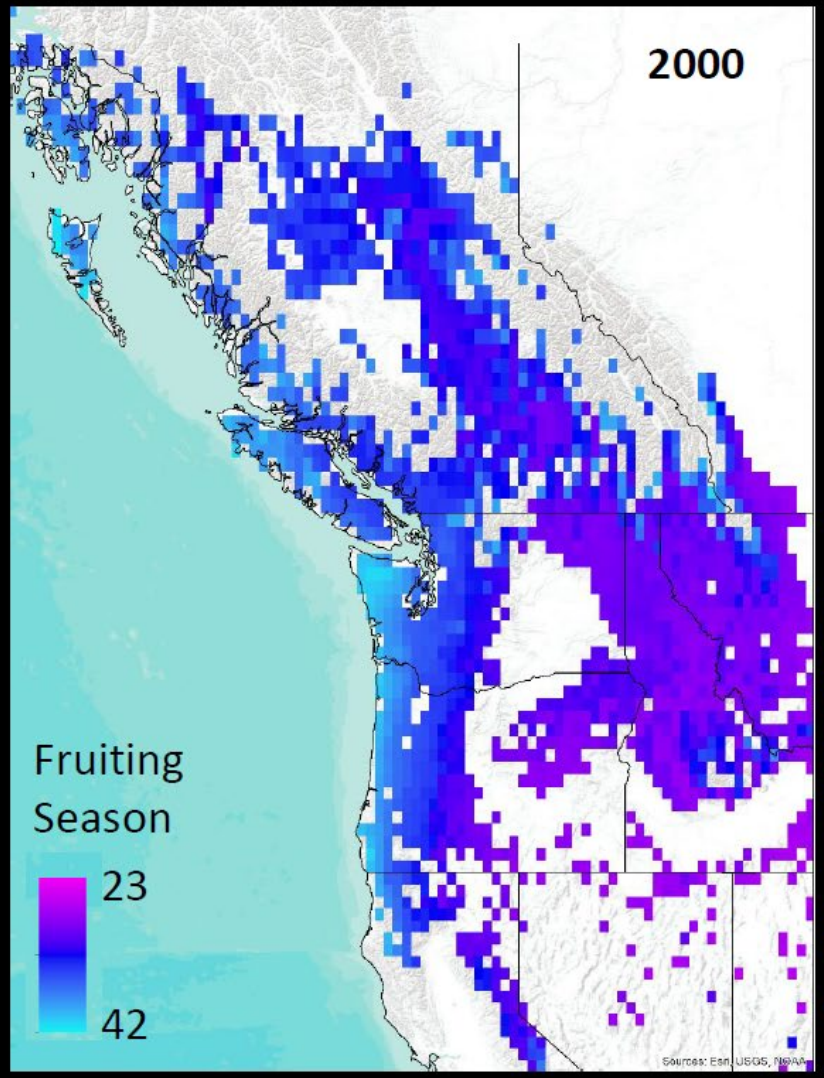


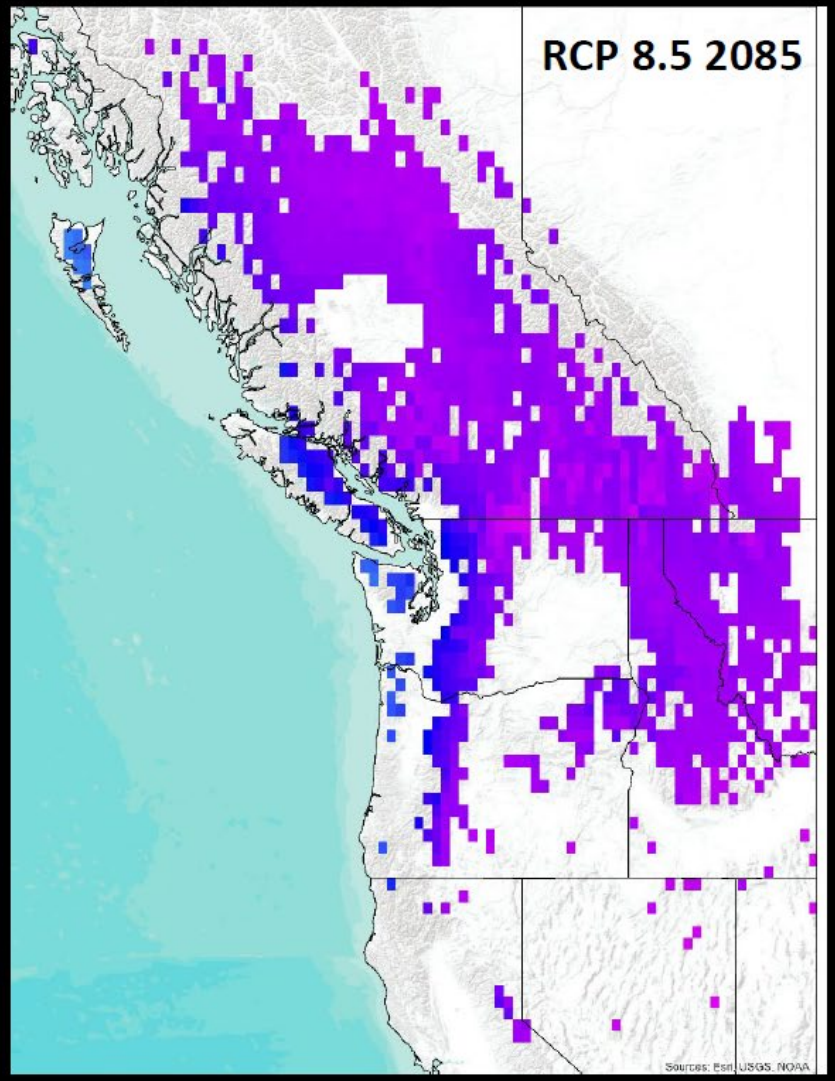
Flowering season length: Black huckleberry and Oregon grape





Fruiting season length: Black huckleberry and Oregon grape





Warmer temperatures may lead to a contraction in the flowering and fruiting seasons of co-occurring species……

Conclusions

- The ranges of culturally-important shrubs may **contract** at lower altitudes and drier sites across the Pacific Northwest

- The timing of flowering and fruiting could **advance** by 7- 55 days by 2080

- Large shifts in range and phenology of shrubs have the potential to greatly alter trophic relationships, plant-pollinator interactions, and the timing of traditional harvests in the future.

Photo: 2008 Ed Book

Photo: OSU Special Collections

Conclusions

“All models are wrong, but some are useful.” -George Box

Perhaps results could:
Inform climate vulnerability assessments for target species

Serve as a basis for targeted monitoring efforts

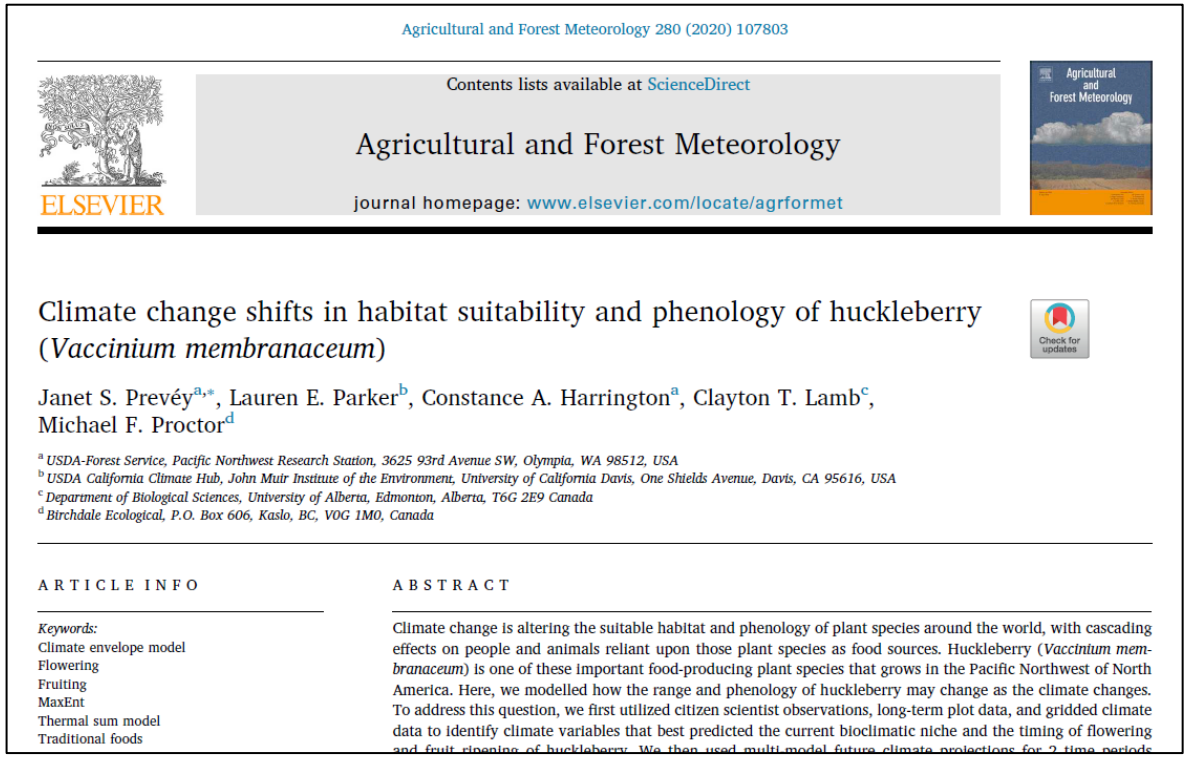
Identify areas where climate change might impact flowering and fruiting of important shrubs

Help managers determine suitable locations for restoration projects

Encourage more observations of flowering and fruiting (National Phenology Network)

Encourage more research on mechanisms of flowering and fruiting

Publications



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Climate change shifts in habitat suitability and phenology of huckleberry (*Vaccinium membranaceum*)

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ARTICLE INFO

Keywords:
Climate envelope model
Flowering
Fruiting
MaxEnt
Thermal sum model
Traditional foods

ABSTRACT

Climate change is altering the suitable habitat and phenology of plant species around the world, with cascading effects on people and animals reliant upon those plant species as food sources. Huckleberry (*Vaccinium membranaceum*) is one of these important food-producing plant species that grows in the Pacific Northwest of North America. Here, we modelled how the range and phenology of huckleberry may change as the climate changes. To address this question, we first utilized citizen scientist observations, long-term plot data, and gridded climate data to identify climate variables that best predicted the current bioclimatic niche and the timing of flowering and fruit ripening of huckleberry. We then used multi-model future climate projections for 2 time periods

https://doi.org/10.1016/j.agrformet.2019.107803

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RESEARCH ARTICLE

Projected impacts of climate change on the range and phenology of three culturally-important shrub species

Janet S. Prevéy, Lauren E. Parker, Constance A. Harrington

Published: May 8, 2020 • https://doi.org/10.1371/journal.pone.0232537

Article Authors Metrics Comments Media Coverage Peer Review

Abstract

Introduction

Materials and methods

Abstract

Climate change is shifting both the habitat suitability and the timing of critical biological events, such as flowering and fruiting, for plant species across the globe. Here, we ask how both the

https://doi.org/10.1371/journal.pone.0232537

“Story Map” Interactive website

The Northwest Huckleberry and Other Nuts and Berries of the Region

Pacific Northwest Research Station

Introduction | Modeling Shifts in Range | Phenological Changes | Thinleaf Huckleberry | Salal | Oregon Grape | Beaked Hazelnut | Other Species | Bibliography | Contact

An Important Part of the Northwest Landscape and Culture

Fruit-producing shrubs such as huckleberries, salal, Oregon grape, and beaked hazelnut are an important component of social history and traditional tribal diets in the Pacific Northwest. The fruits of these shrubs are also an important food source for foraging wildlife and pollinators, and serve as the basis for both non-tribal harvesting and small-scale commercial operations. Among land managers there is a strong interest in preserving and restoring these culturally important plant species across the Pacific Northwest. Information about ecology and management of Northwest berries is scattered in many different locations and formats. We have created this website as a guide to several types of information. This webpage is a work in progress, as we become aware of additional resources we will add them to the webpage. Please send us publications or links to add additional information (huckleberry@fs.fed.us).

Photos: OSU Special Collections and USFWS - Pacific Region

Main photo: USFWS - Pacific Region

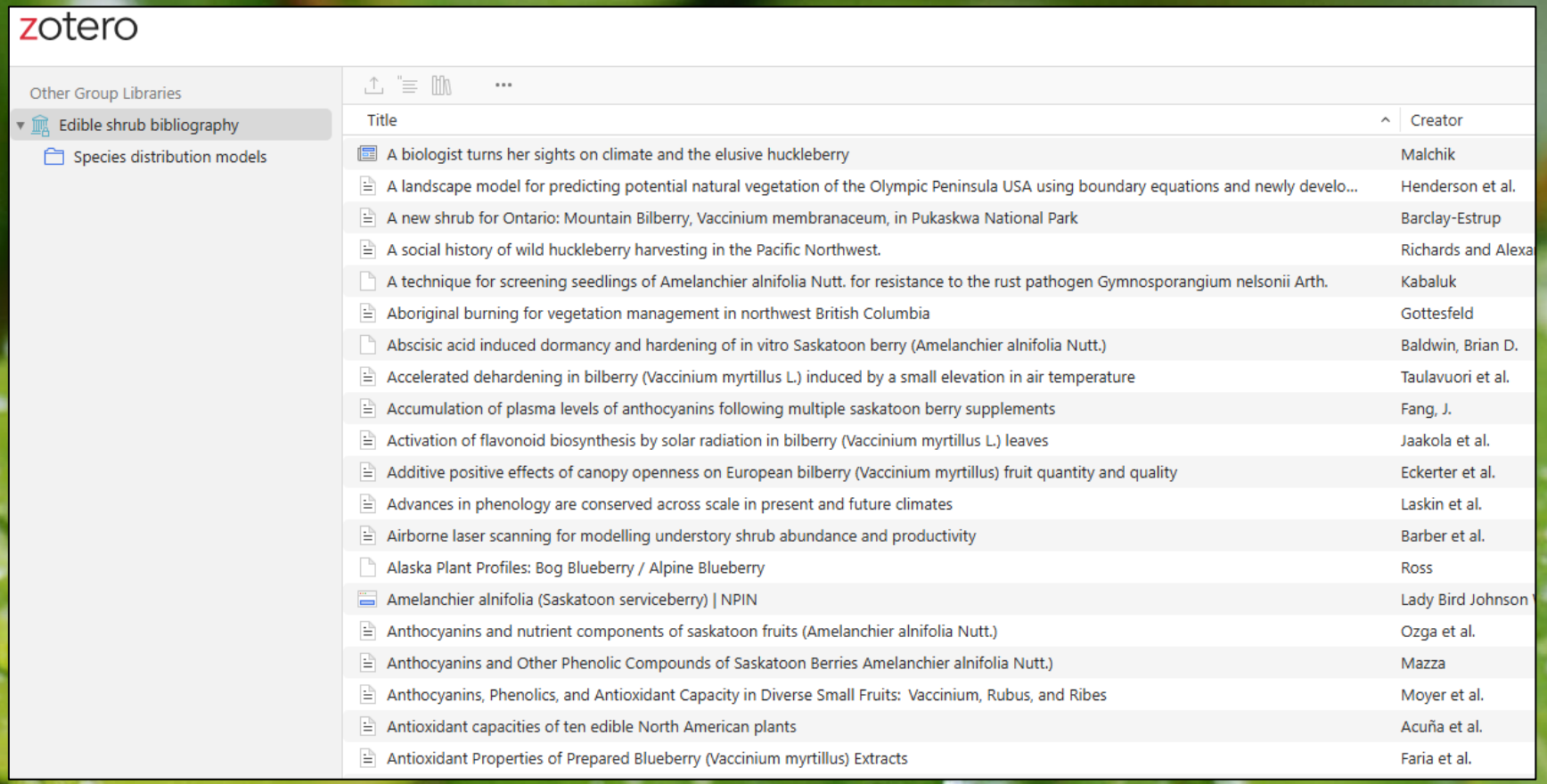
https://storymaps.arcgis.com/stories/14e2c14aac6a48d4baab2b1ae2f75ec5

Visit our Bibliography

A full description of the methodologies and discussions of the findings presented in this StoryMap can be found in these publications:

Prevéy, Janet S.; Parker, Lauren E.; Harrington, Constance A.; Lamb, Clayton T.; Proctor, Michael F. 2020. Climate change shifts in habitat suitability and phenology of huckleberry (*Vaccinium membranaceum*). Agricultural and Forest Meteorology. 280: 107803.

Prevéy, Janet S.; Parker, Lauren E.; Harrington, Constance A. 2020. Projected impacts of climate change on the range and phenology of three culturally-important shrub species . PLOS ONE. 15:e0232537.



www.zotero.org/groups/2131424/edible_shrub_bibliography/items

The Northwest Huckleberry and Other Nuts and Berries of the Region

Pacific Northwest Research Station

Shifts in Range for Tall Oregon Grape (*Mahonia aquifolium*)

Choose the combination of range maps you wish to see. Maps will open in separate windows. Note: RCP 4.5 models a more moderate change in future climate than RCP 8.5. Read more about it: What is a representative concentration pathway (RCP)?

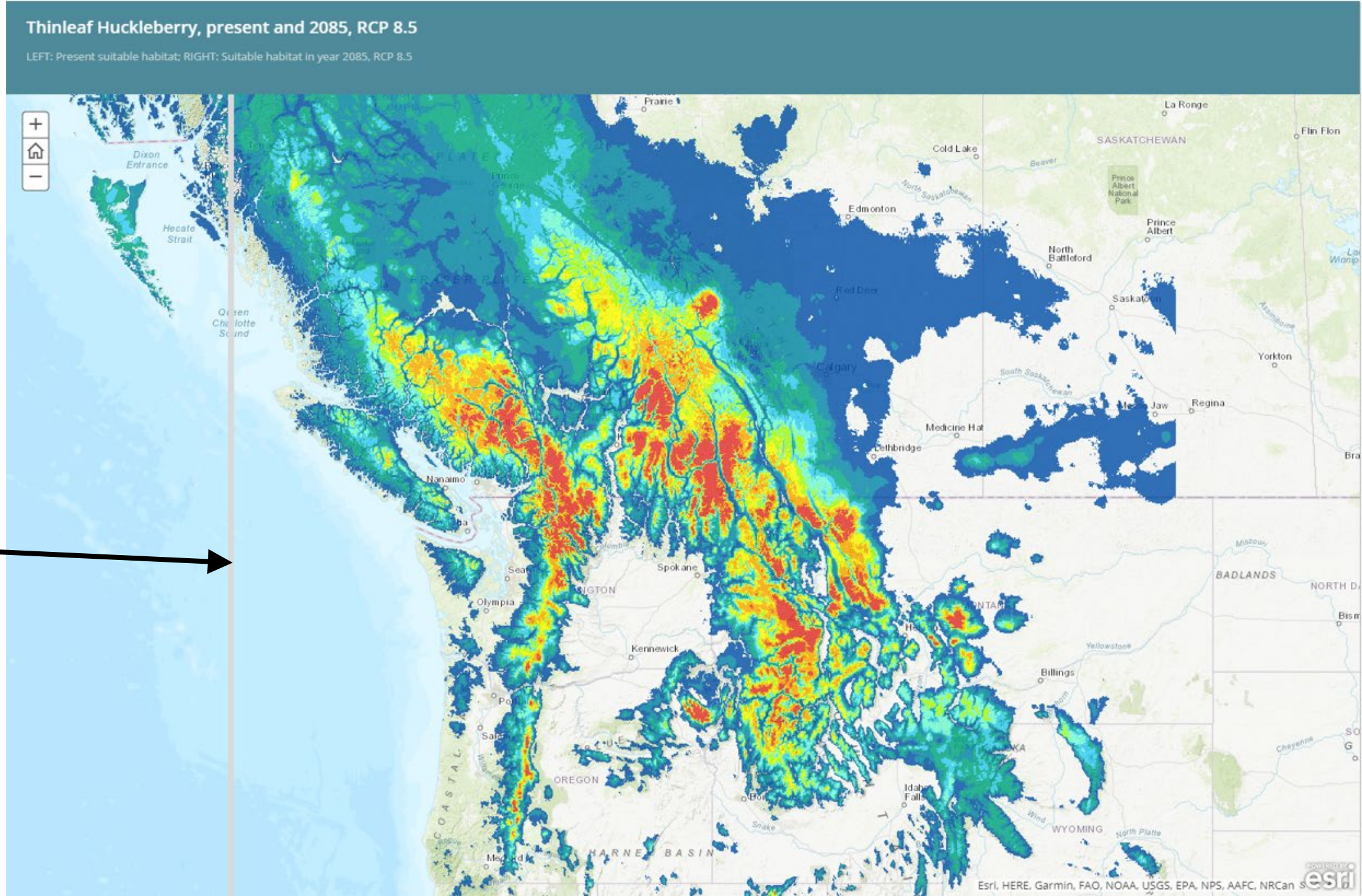
The high resolution of these maps requires some time to load. Please wait until the red color appears before using the slider. Your patience is appreciated.

- Present suitable habitat and RCP 4.5, year 2055
- Present suitable habitat and RCP 4.5, year 2085
- Present suitable habitat and RCP 8.5, year 2055
- Present suitable habitat and RCP 8.5, year 2085

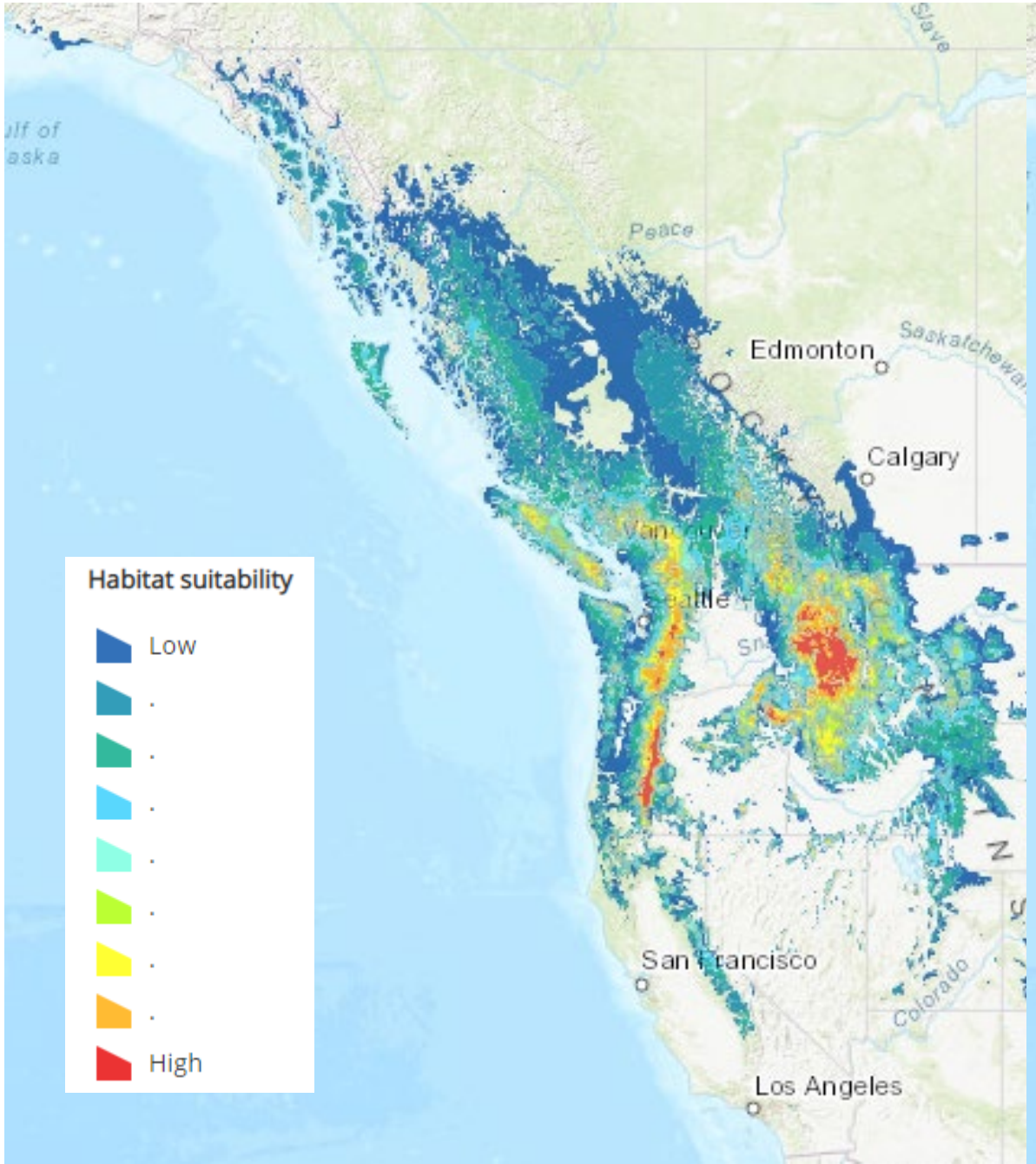
Phenological Changes

Climate projections were used to predict how the timing of flowering and fruiting would change in the future. **Click on the map below to enlarge.**

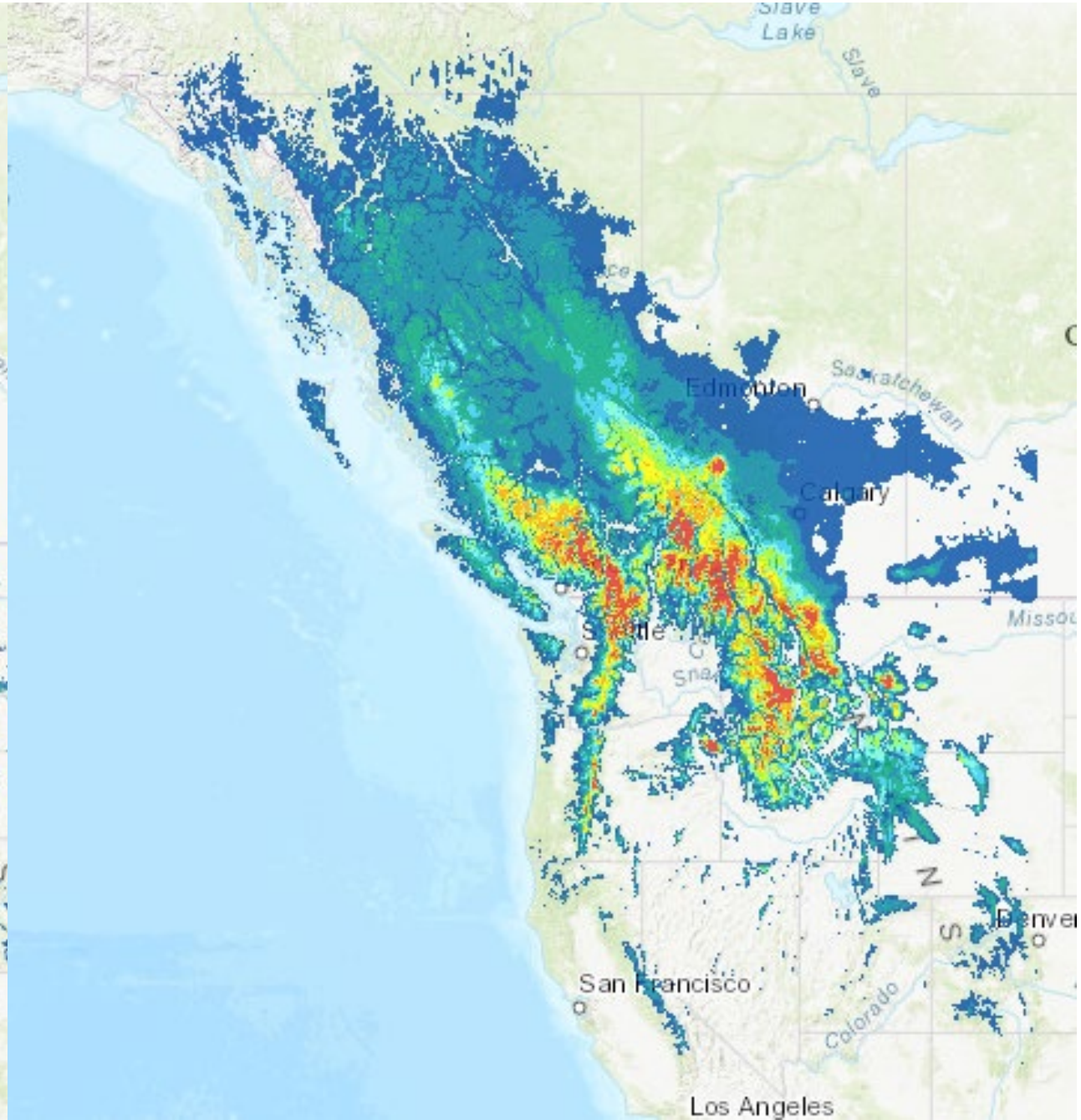
Slider bar to see changes in suitable habitat between now and future



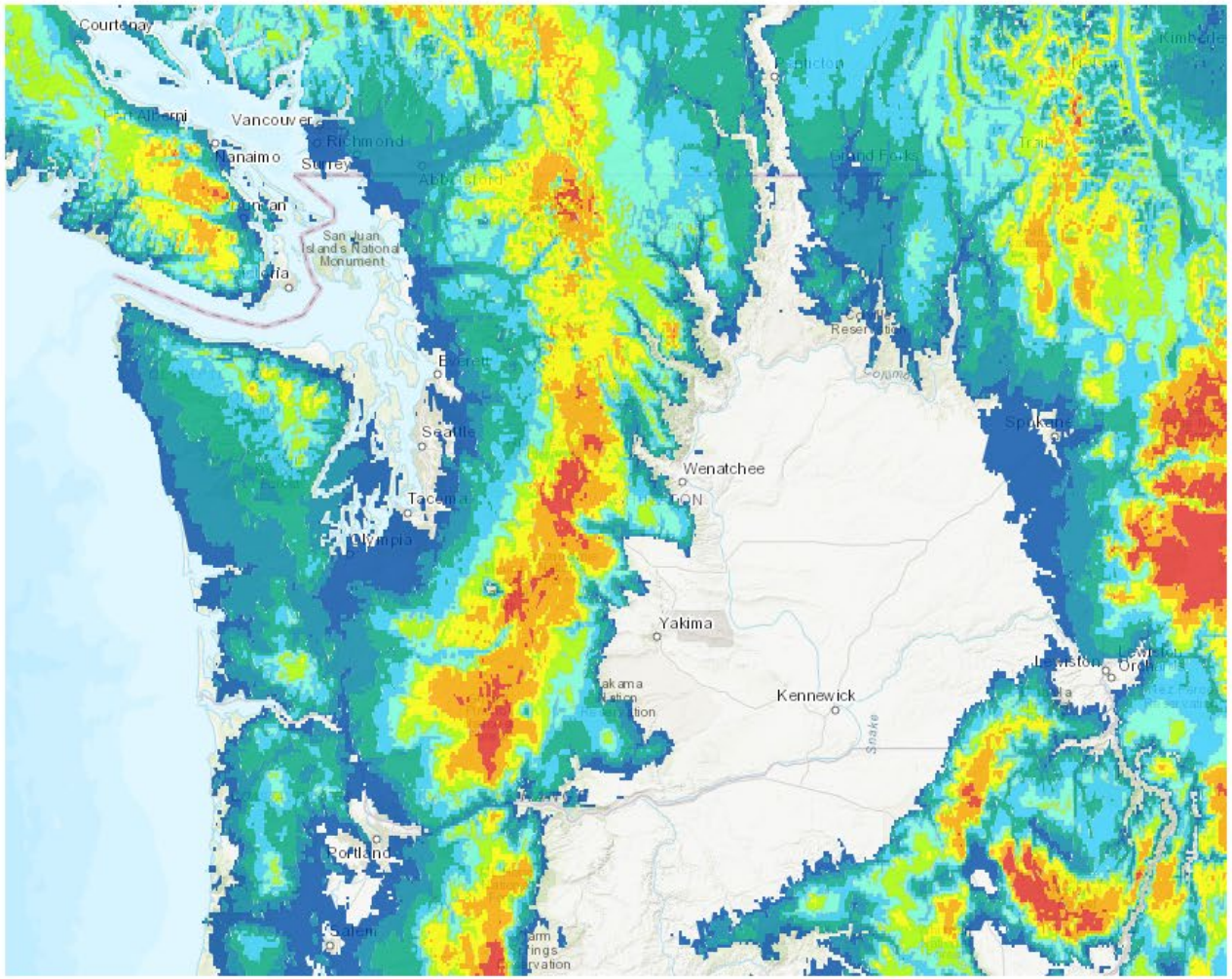
VAME Present Time



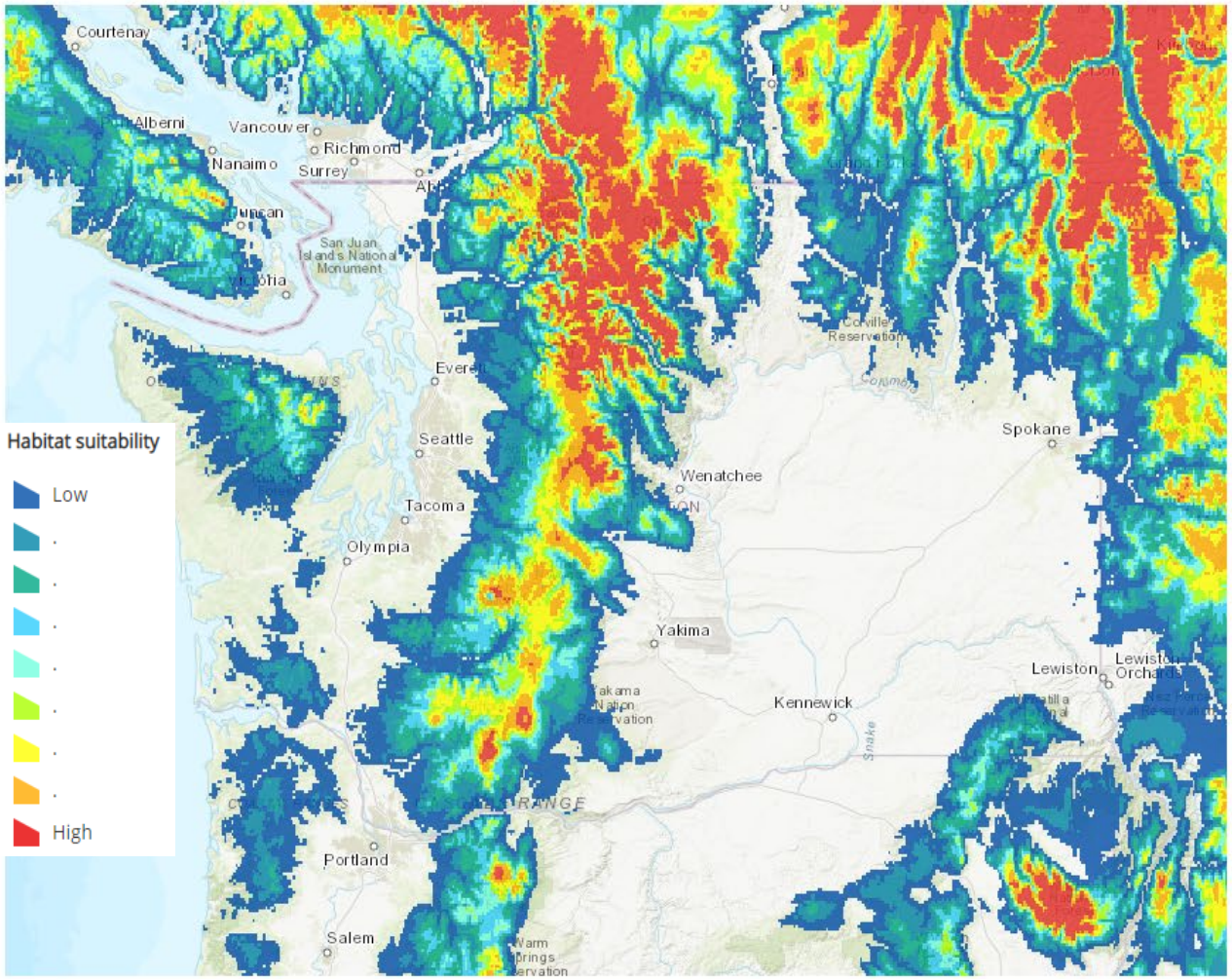
VAME 2085 RCP 8.5



VAME Present Time



VAME 2085 RCP 8.5



Climate Vulnerability Assessments for Plants

Guide to Assessing Climate Change Impacts
on Tribally Important Plants
Using Traditional and Expert-Based Knowledge

May 2019

Integrated Approach to assessing tribally important plant species using the *Three-Step Decision Support Framework* [1], *System for Assessing Vulnerability of Species to Climate Change* [2], and *Climate Adaptation Library* [3] to rapidly develop climate-informed Species Management Proposals

Developed draft process to assess vulnerability (habitat, physiology, phenology, biotic interactions)
Used huckleberry as example species
Included monitoring and management recommendations

Yakama Nation, USFS, SAH Ecologia, UW Climate Impacts Group, Consulting Research Ecology, CTUR

Potential Monitoring or Management Options

Monitor productivity on selected traditional picking sites for areas predicted to both increase and decrease in suitability (3-5 years)

Test of models

Monitor selected picking areas for insects such as spotted wing Drosophila (2/year)

Plant in areas predicted to have good habitat suitability in future

Reduce above and below ground competition for huckleberry plants by thinning trees and by reducing cover of other shrub species

https://www.usanpn.org

We are undertaking a major revision of our *Nature's Notebook* data collection app to make it easier and more fun to track plant and animal seasonal activity!

Learn More

USA National Phenology Network

Observe with Nature's Notebook | Explore Phenology Data | Community | What's Happening | About

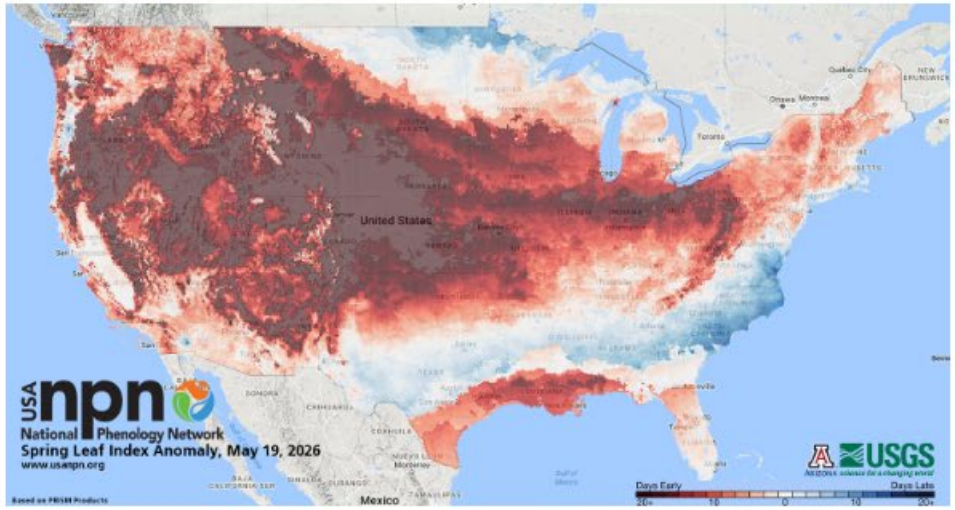
Search

USA National Phenology Network is a national-scale monitoring and research initiative focused on collecting, organizing and delivering phenological data, information, and forecasts to support natural resource management and decision-making, to advance the scientific field of phenology, and to promote understanding of phenology by a wide range of audiences.

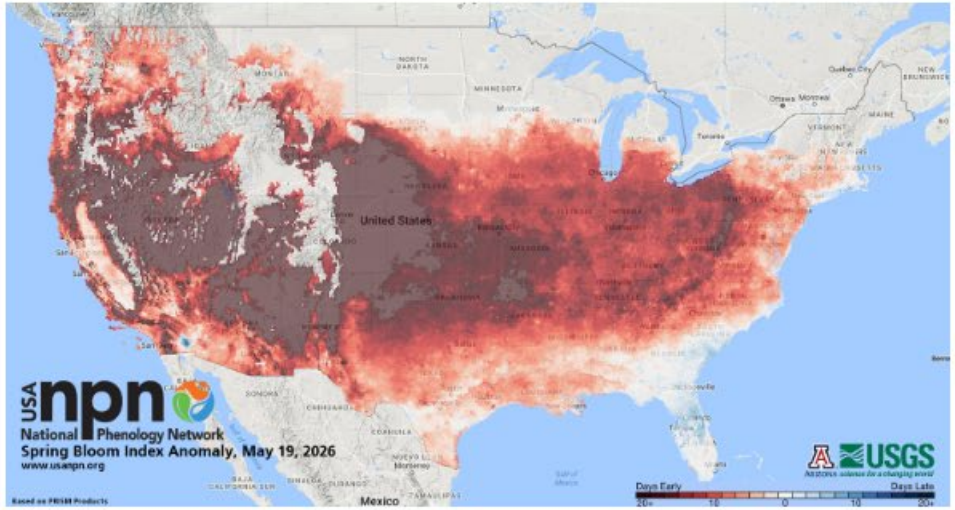
WATCH VIDEO ▸

Interactive Maps from National Phenology Network

SPRING FIRST LEAF INDEX



SPRING FIRST BLOOM INDEX



Thank you!

Funding: Northwest Climate Science Adaptation Center
Yakama Nation

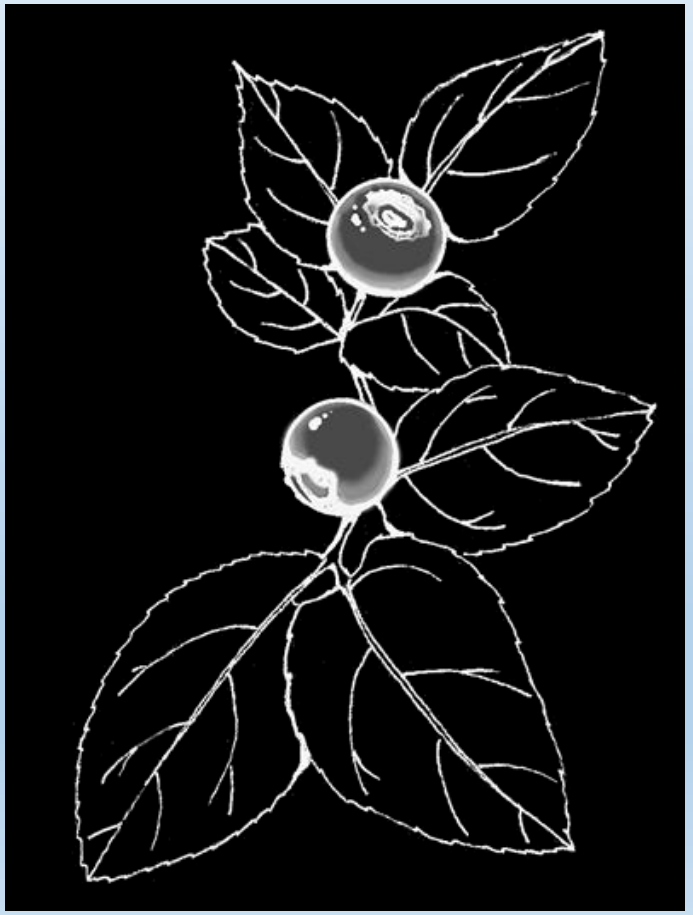
People: Leslie Brodie, Yianna Bekris, Jacob Strunk, Bev Luke, Tabitha Graves
Clayton Lamb, Michael Proctor, and the many citizen scientist data collectors

Plant Data sources:

- USFS Forest Inventory and Analysis
- USFS R-6 Ecology Program
- National Park Service
- USDI Bureau of Land Management
- i-Natualist
- Project Budburst
- USA National Phenology Network
- PNW Herbaria
- Oregon Flora

Climate data sources:

- Daymet
- Worldclim
- ClimateNA



Questions?

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JanetPrevey@gmail.com