Climate Influences Range and Phenology of Northwest Shrub Species

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NW CSC
Northwest Climate Science Center

Shrubs are important ecosystem components (structure, cover, food) and culturally valuable but little studied

Very few have range maps

Mostly general descriptions of habitat

Most information piecemeal

Several recent projects on shrubs

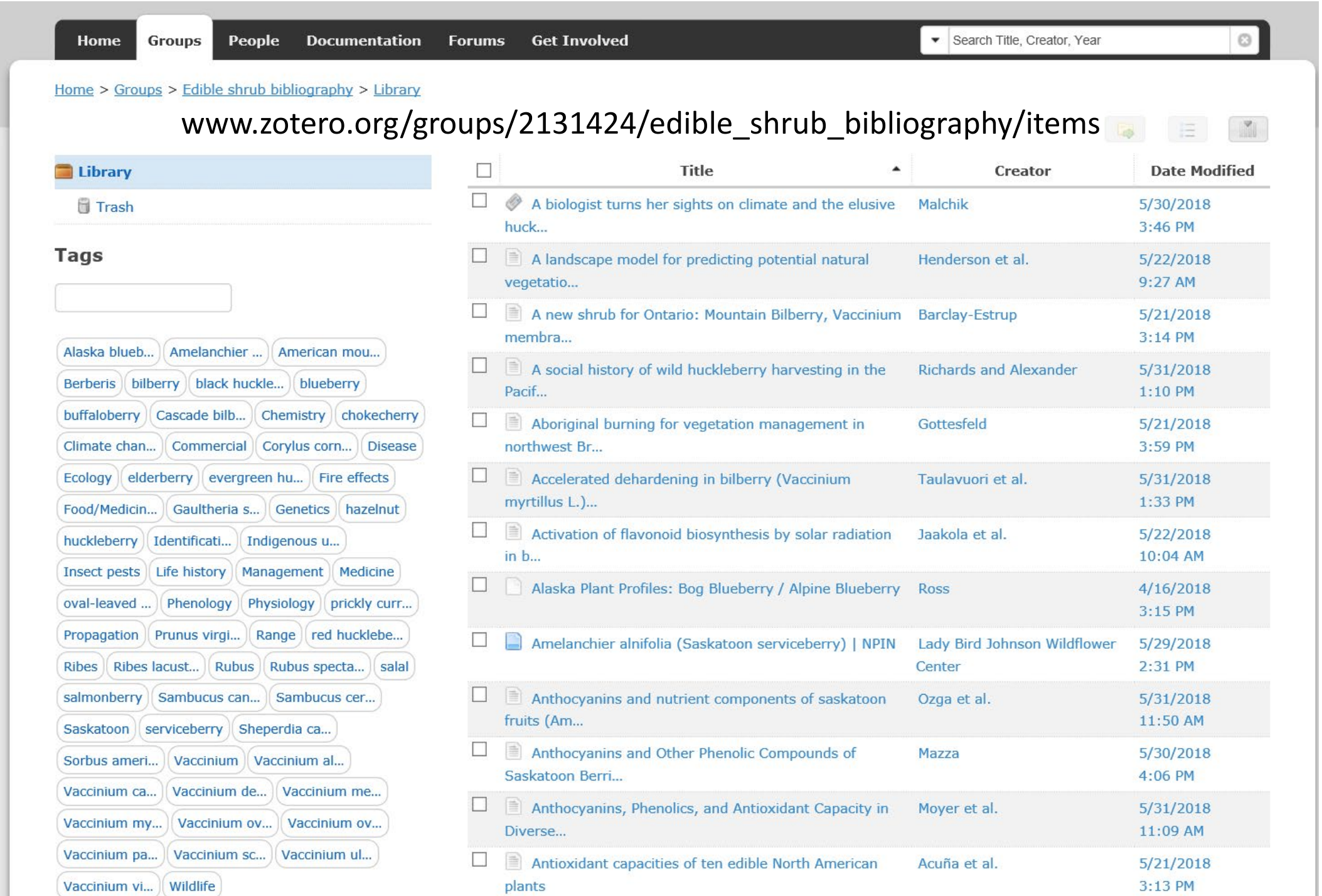
1. Bibliography
2. Current occurrences (78 native species)
3. Habitat suitability models (4 species)
   for 2000 and 2085
4. Phenology of flowering and fruiting
   Based on recent observations & predicted climate
5. Story Map (wrap it all together with pretty pictures!)

Several recent projects on shrubs

1. Bibliography
2. Current occurrences (78 native species)

Various projects differ in geographic extent, species included, and spatial resolution

5. Story Map (wrap it all together with pretty pictures!)



ZOTERO On-Line Bibliography

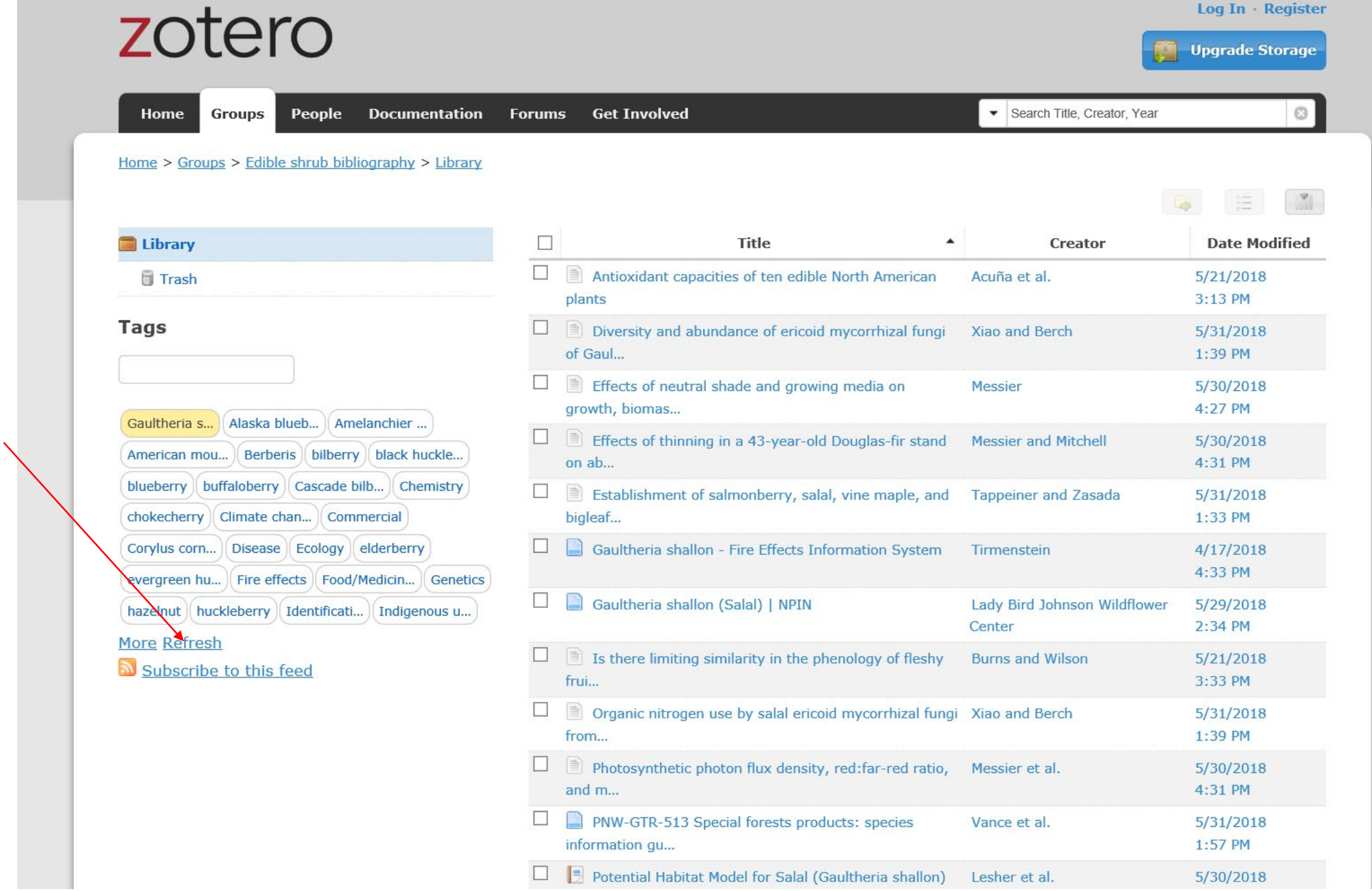
Publically available

Salal selected for example –

You can click on options or type them in the box

Note, hit **Refresh** to search a new species

All items have a URL to at least an abstract



Current Occurrences

Very few species have range maps (Little 1976; some large species)

Mostly general descriptions of habitat

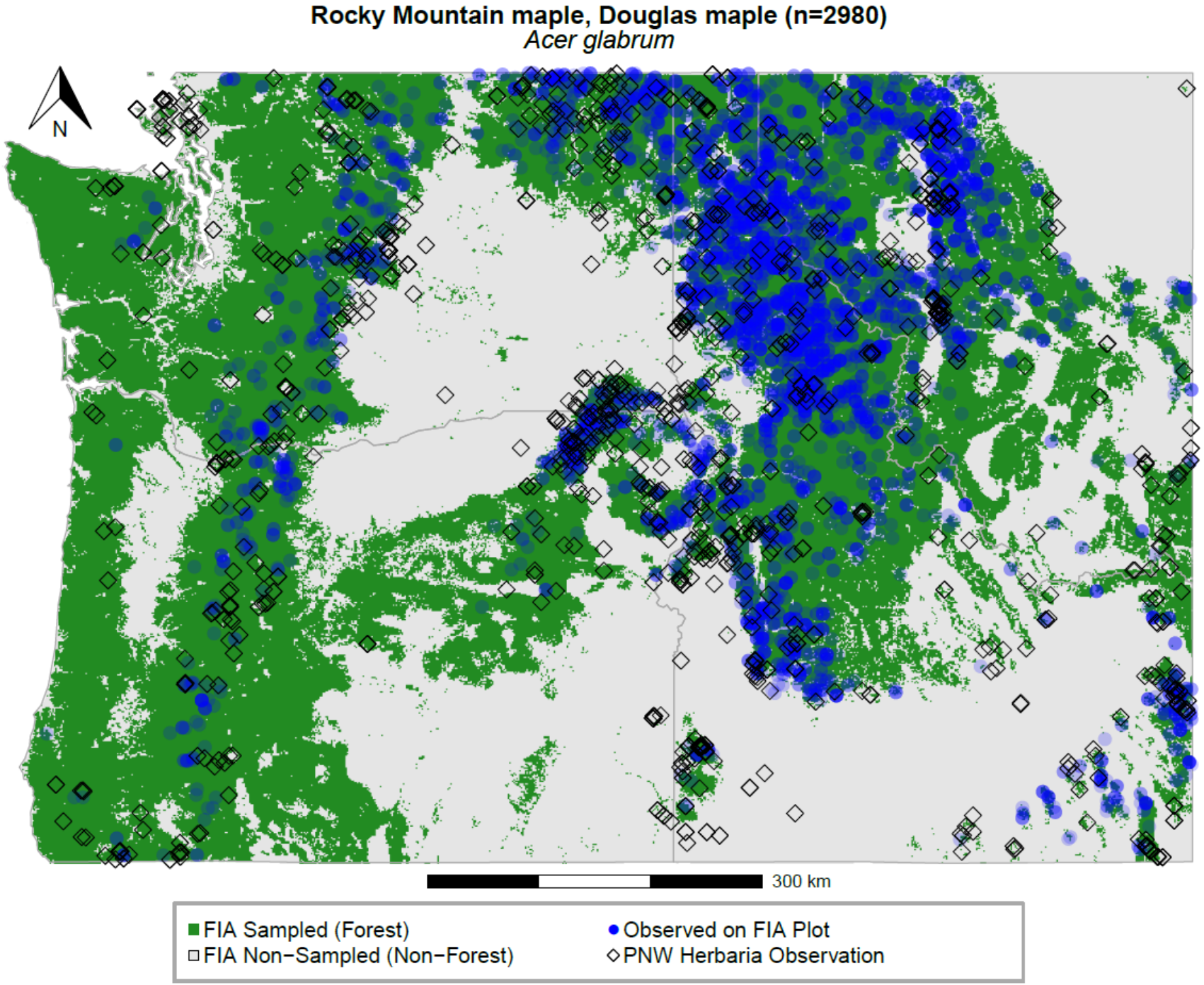
Needed to start with current occurrences

USFS FIA (Forest Inventory and Analysis)

PNW Herbaria

[Used other databases for some species]

Developed maps of occurrences for 78 native shrub species



Should be available by Dec 1 on PNW and TreeSearch websites

Developed current and future habitat suitability maps for 4 culturally important species – Patterns of occurrence /w current climate allow us to speculate how ranges might shift in the future

Why??

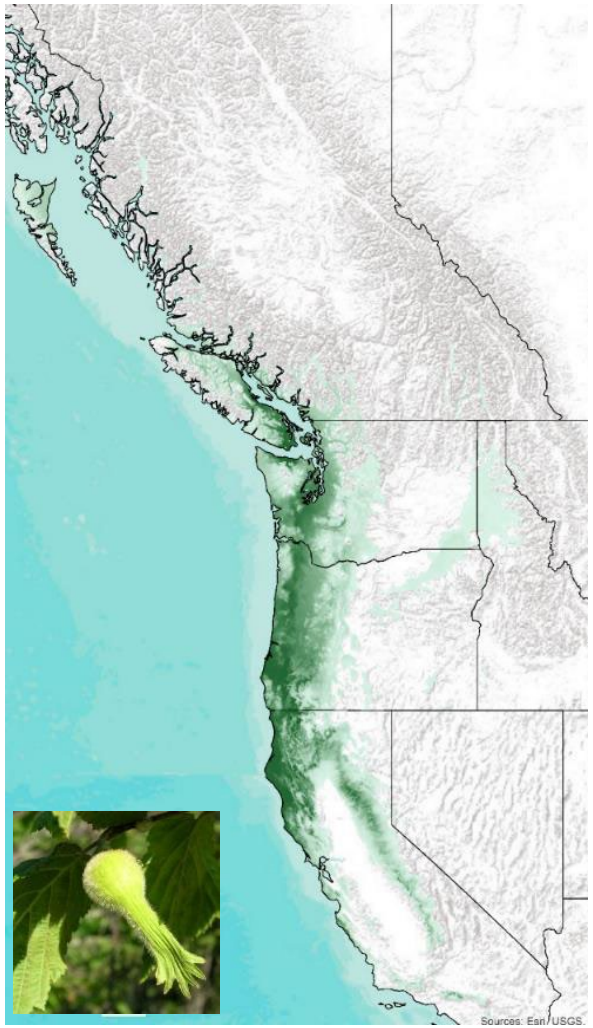
There is a strong interest in preserving and restoring culturally-important plant species across the Pacific Northwest

Warmer temperatures are changing habitat suitability

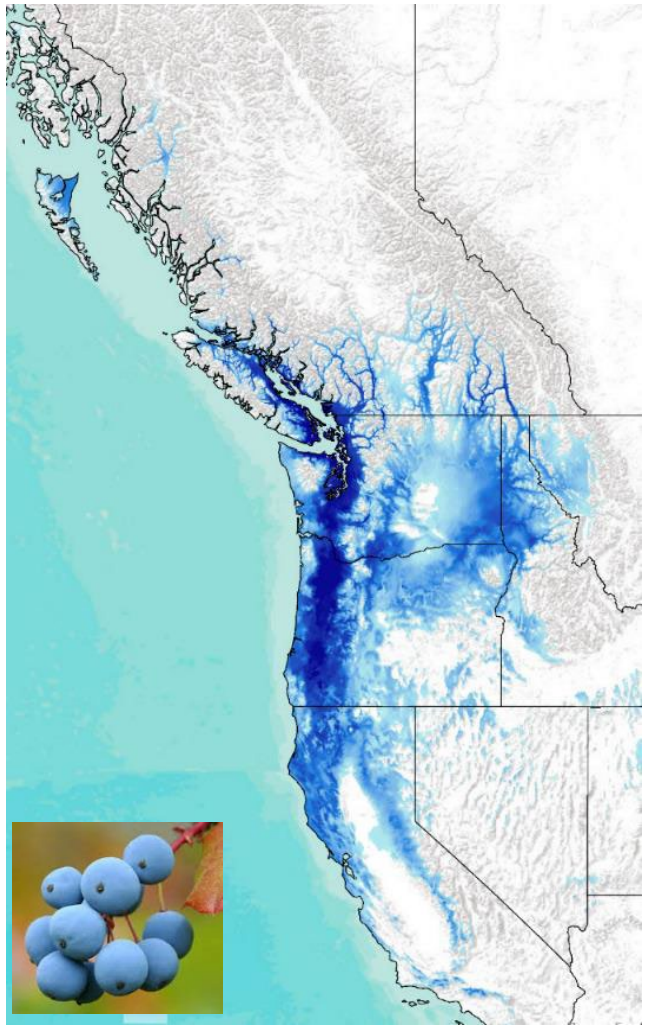
Current ranges: Habitat suitability models in MaxEnt

MaxEnt (Maximum Entropy) = species distribution model in R

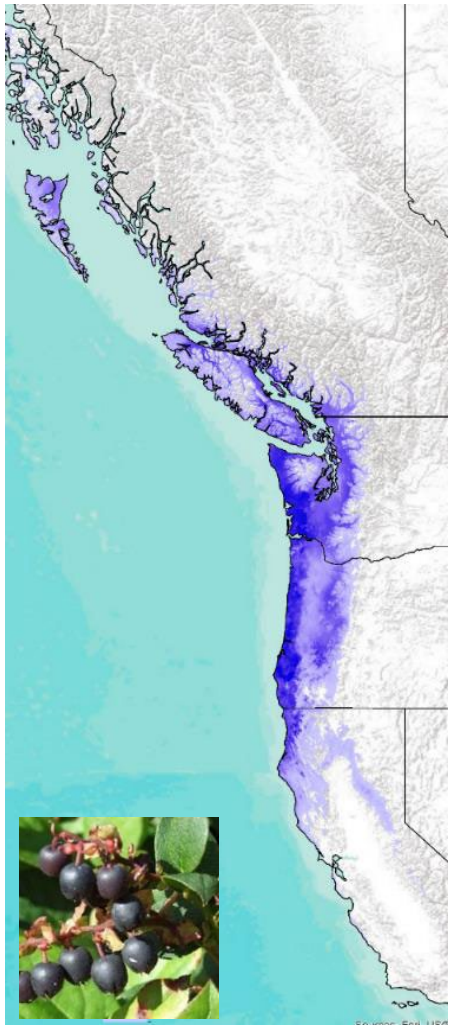
Hazelnut



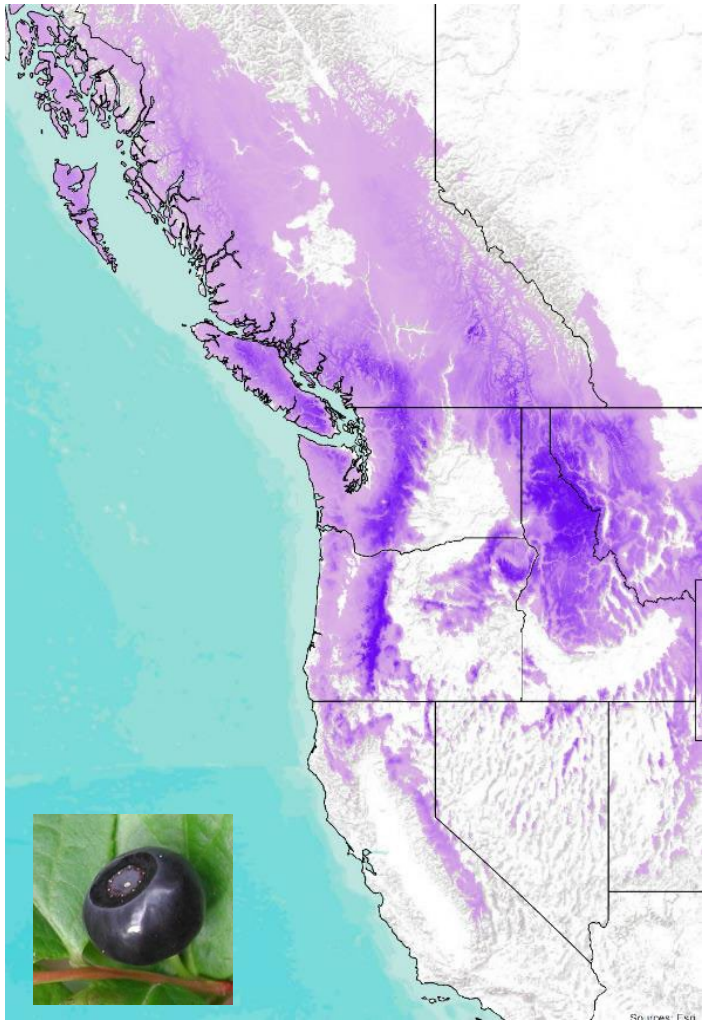
Oregon grape



Salal



Black huckleberry



Current ranges: Habitat suitability models in MaxEnt

Hazelnut

Oregon grape

Salal

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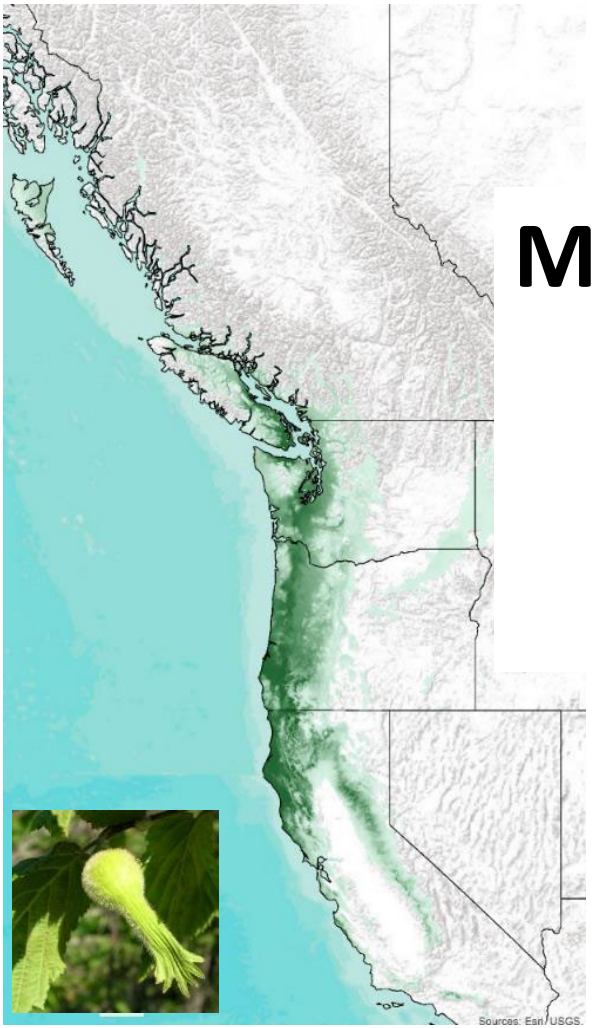
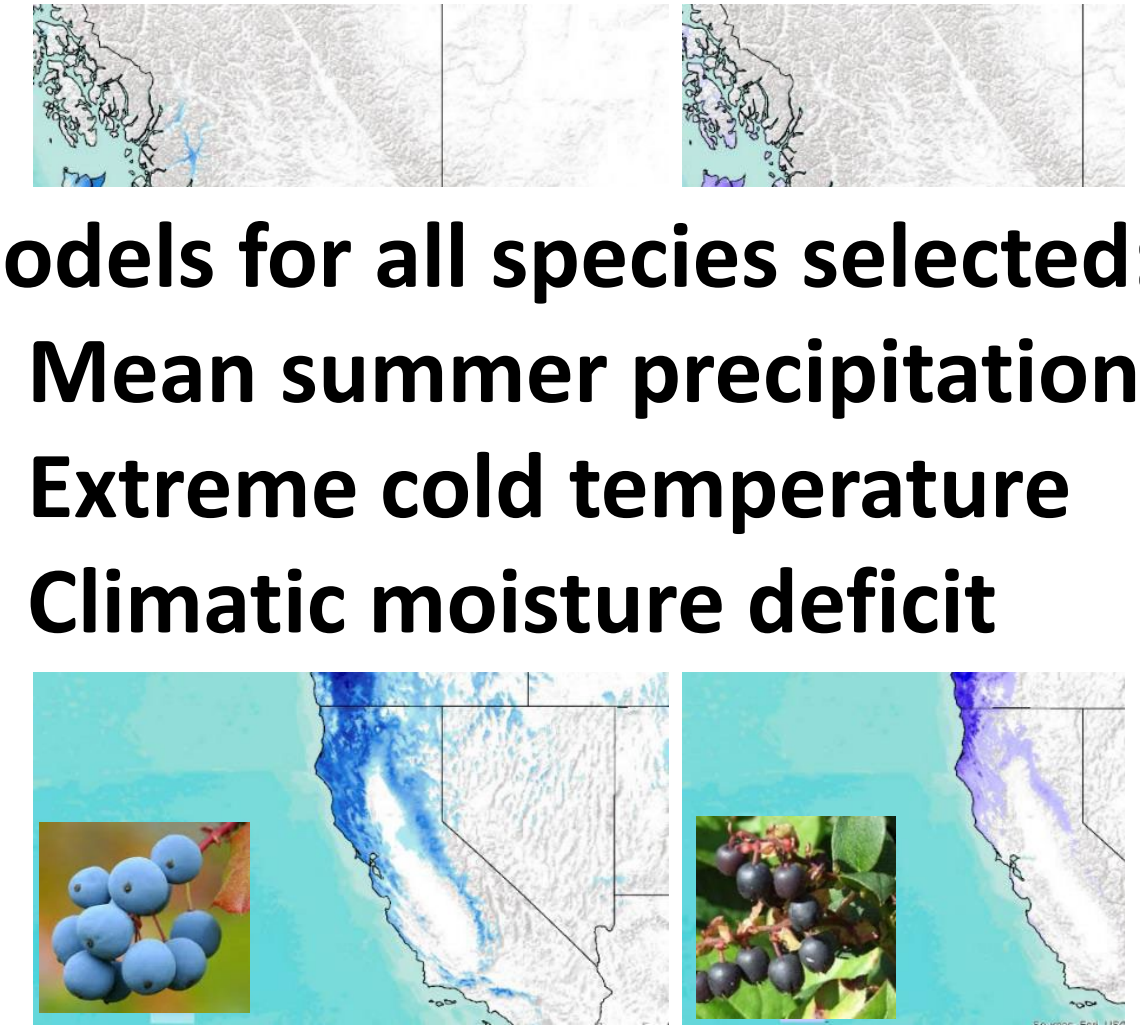
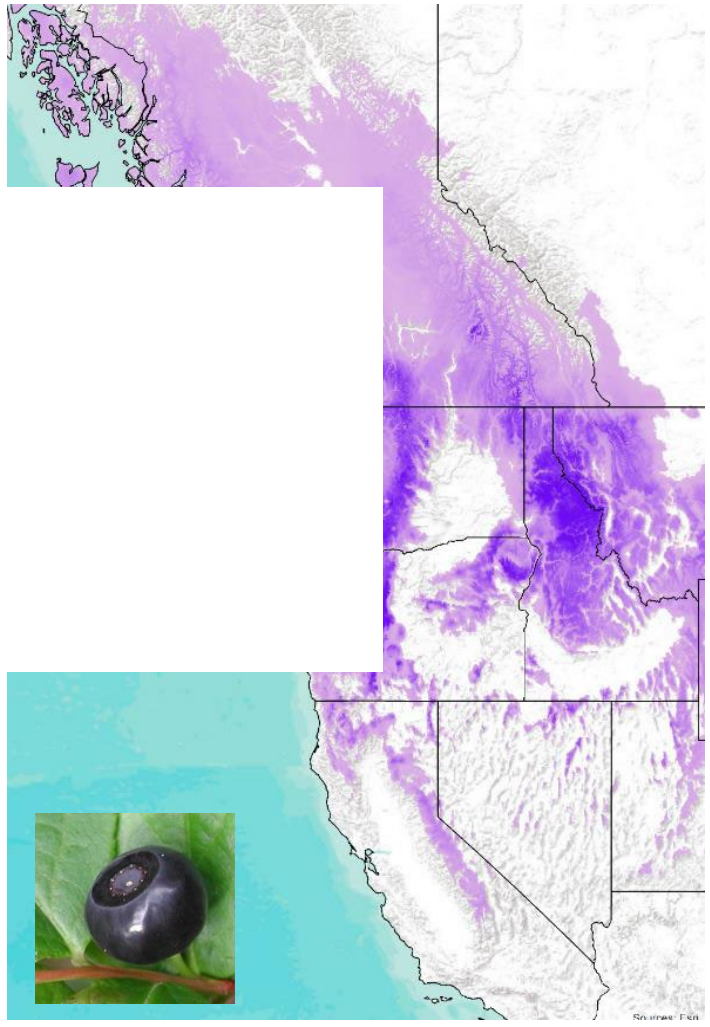






Models for all species selected:

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

Bioclimatic variables (**Bold = used in VAME model**)

Annual Heat Moisture Index (AHM)

Hargreave's Climatic Moisture Deficit (CMD) *

Degree-days below 0 °C (DD0)

Degree-days below 5 °C (DD5)

30-year extreme minimum temperature, °C (EMT) *

30-year extreme maximum temperature, °C (EXT)

Frost-free period (FFP)

Mean annual precipitation, mm (MAP)

Mean annual temperature, °C (MAT)

Mean temperature of the coldest month, °C (MCMT)

Mean temperature of the warmest month, °C (MWMT)

Precipitation as snow, mm (PAS)

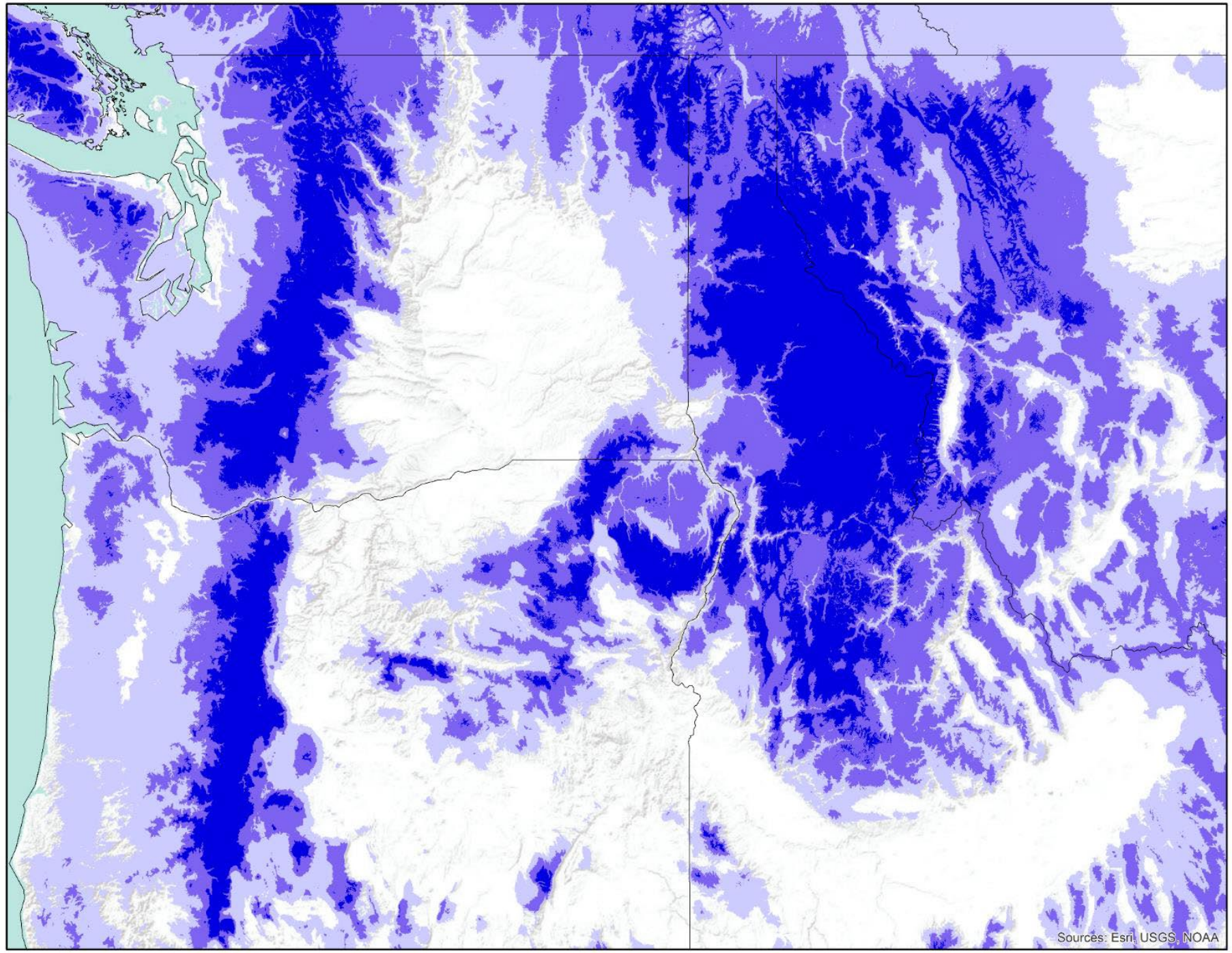
Summer heat moisture index (SHM)

MCMT – MWMT, °C, provides a measure of continentality (TD) Hargreave's reference evapotranspiration (EREF)

Mean summer (May – September) precipitation, mm (MSP) *

*** = climate variables selected in all 4 shrub models**

Current Habitat Suitability for huckleberry (VAME)

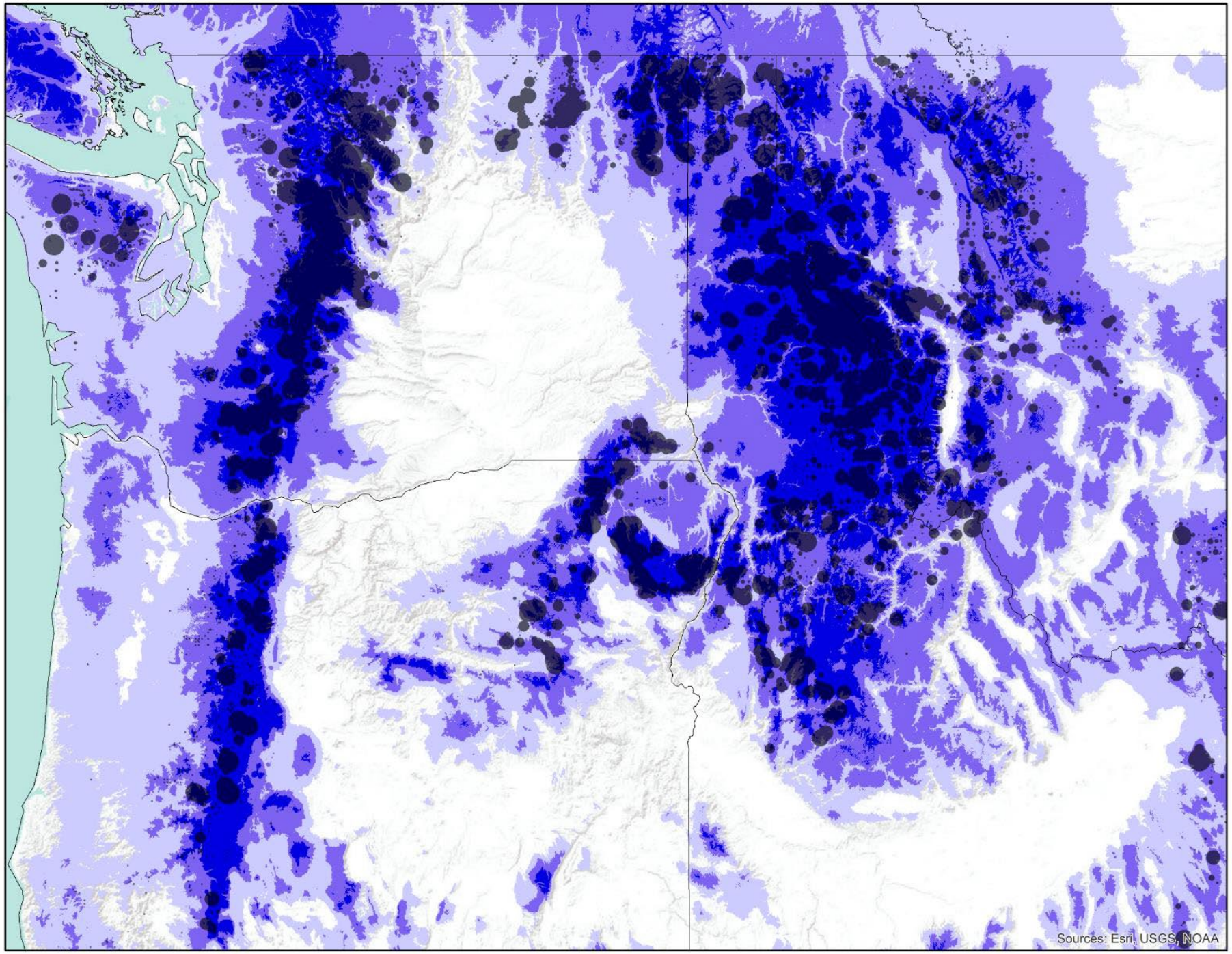


Current Habitat Suitability for huckleberry (VAME)

FIA plots with high abundance of black huckleberry ●

Habitat suitability

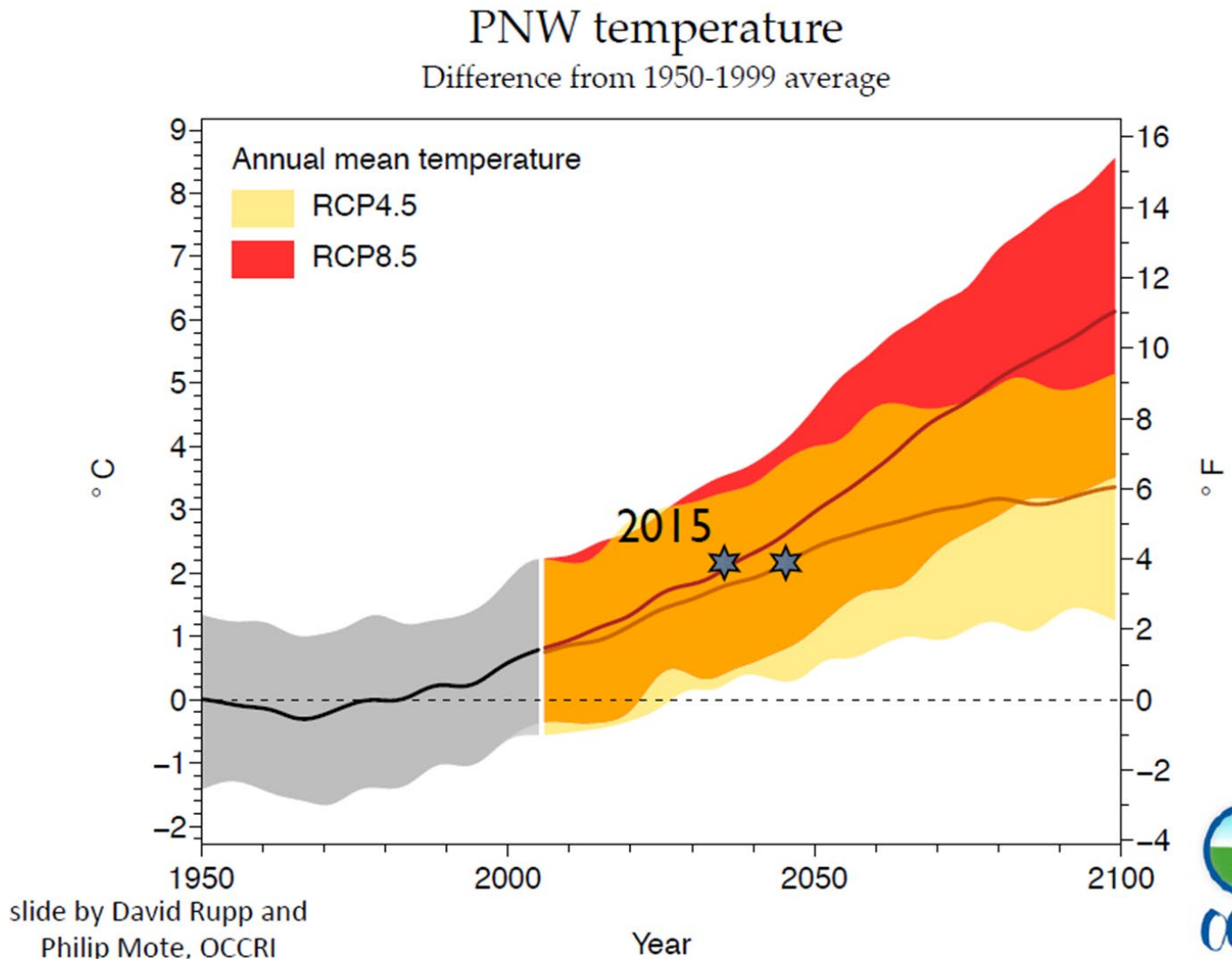
- High
- Medium
- Low



How will climate change impact species distribution?

Used 15 CMIP5 model means to predict climate in the future (2040-2069 and 2070-2099) for 2 emissions scenarios: RCP 4.5 and RCP 8.5

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



slide by David Rupp and Philip Mote, OCCRI

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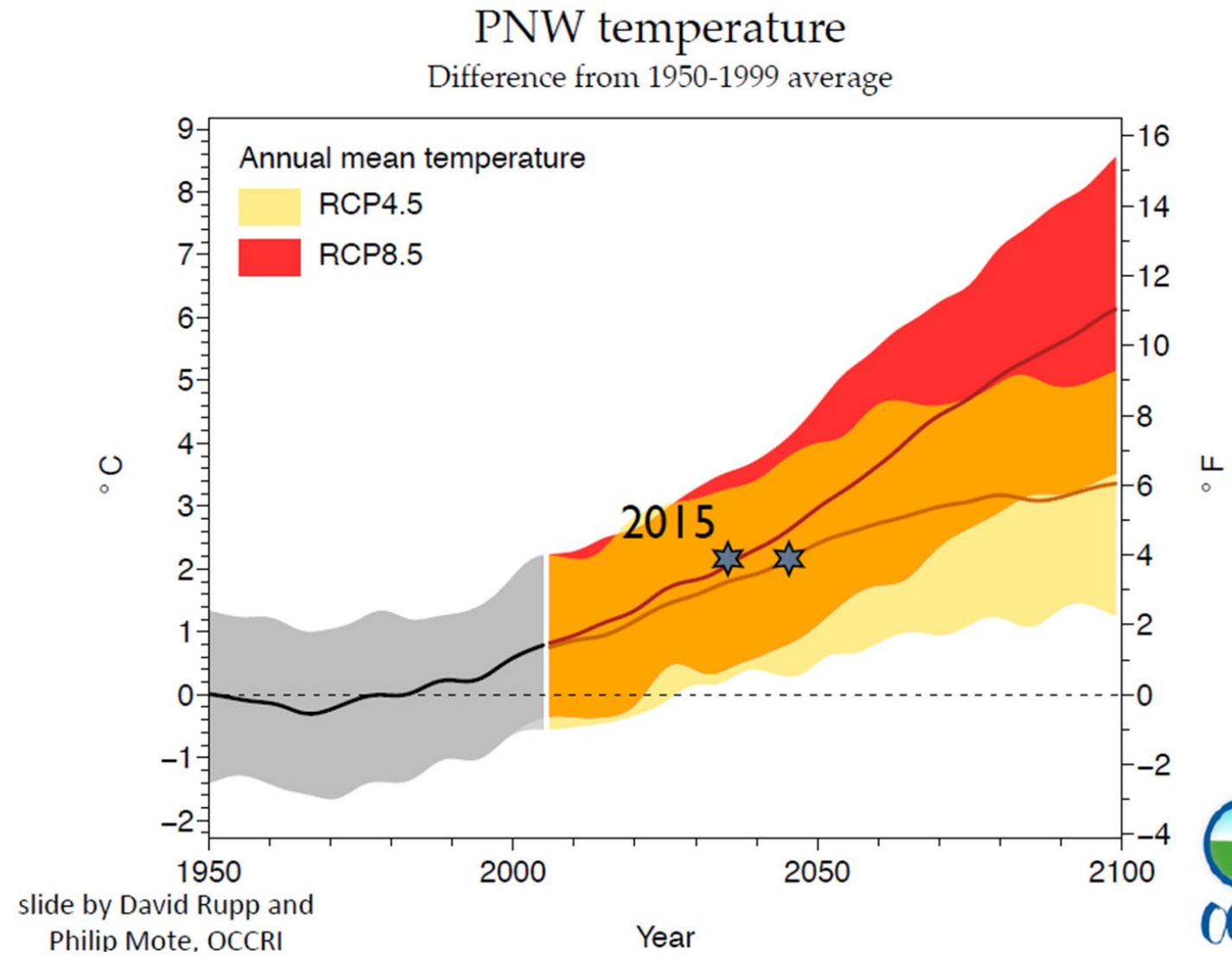
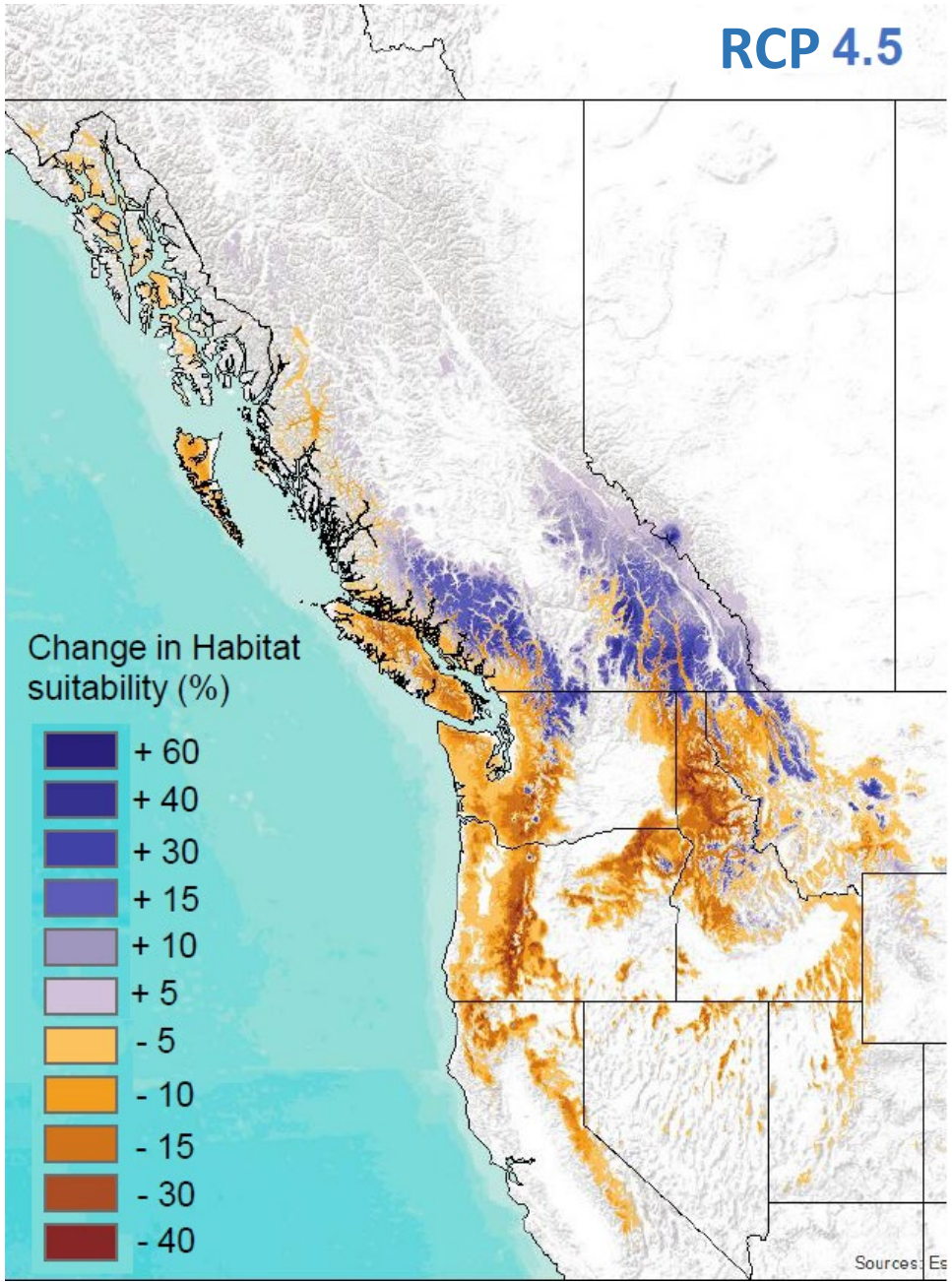
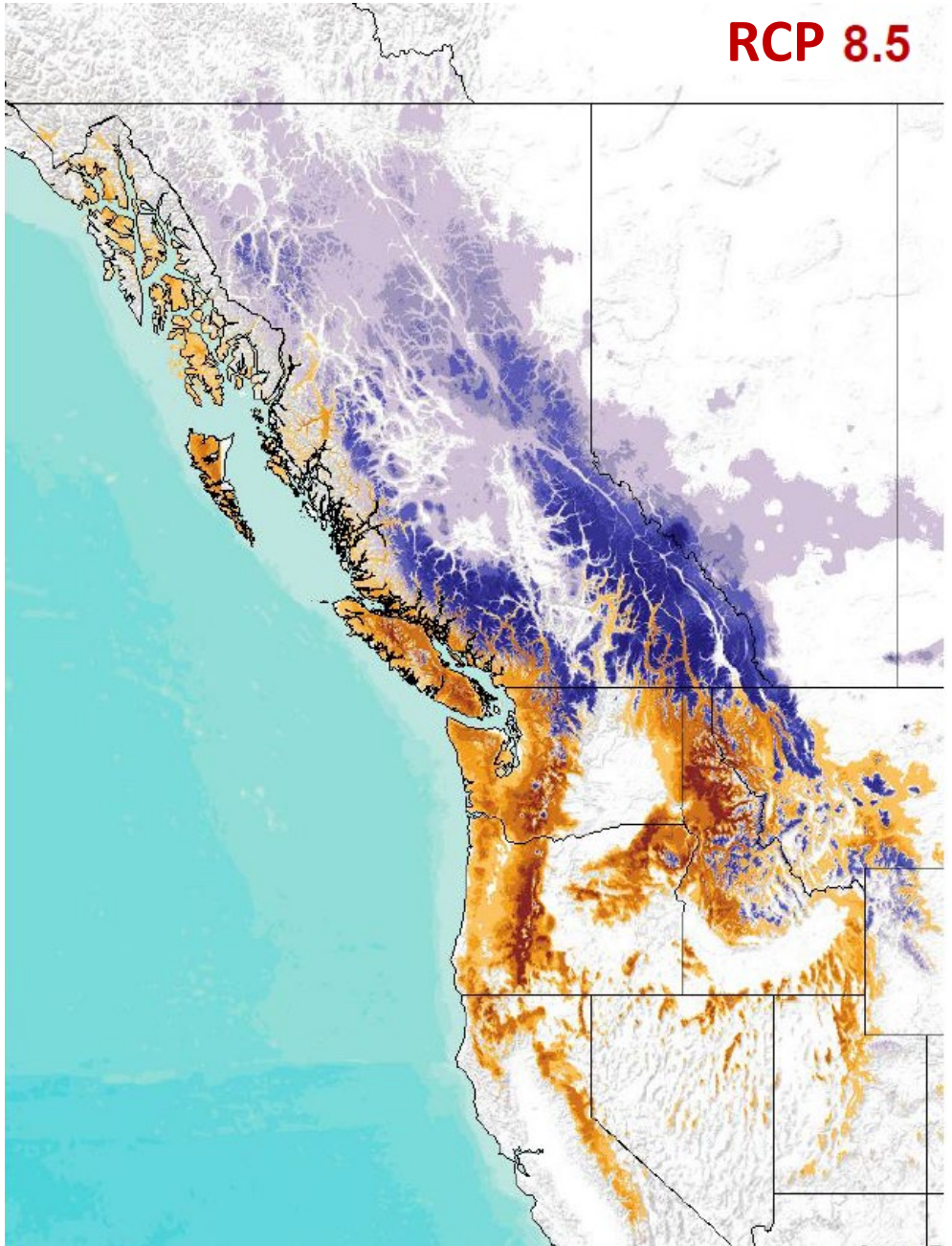
MaxEnt (Maximum Entropy) species distribution models to estimate how changes in important climate variables would impact the climatic niche of shrub species in the future



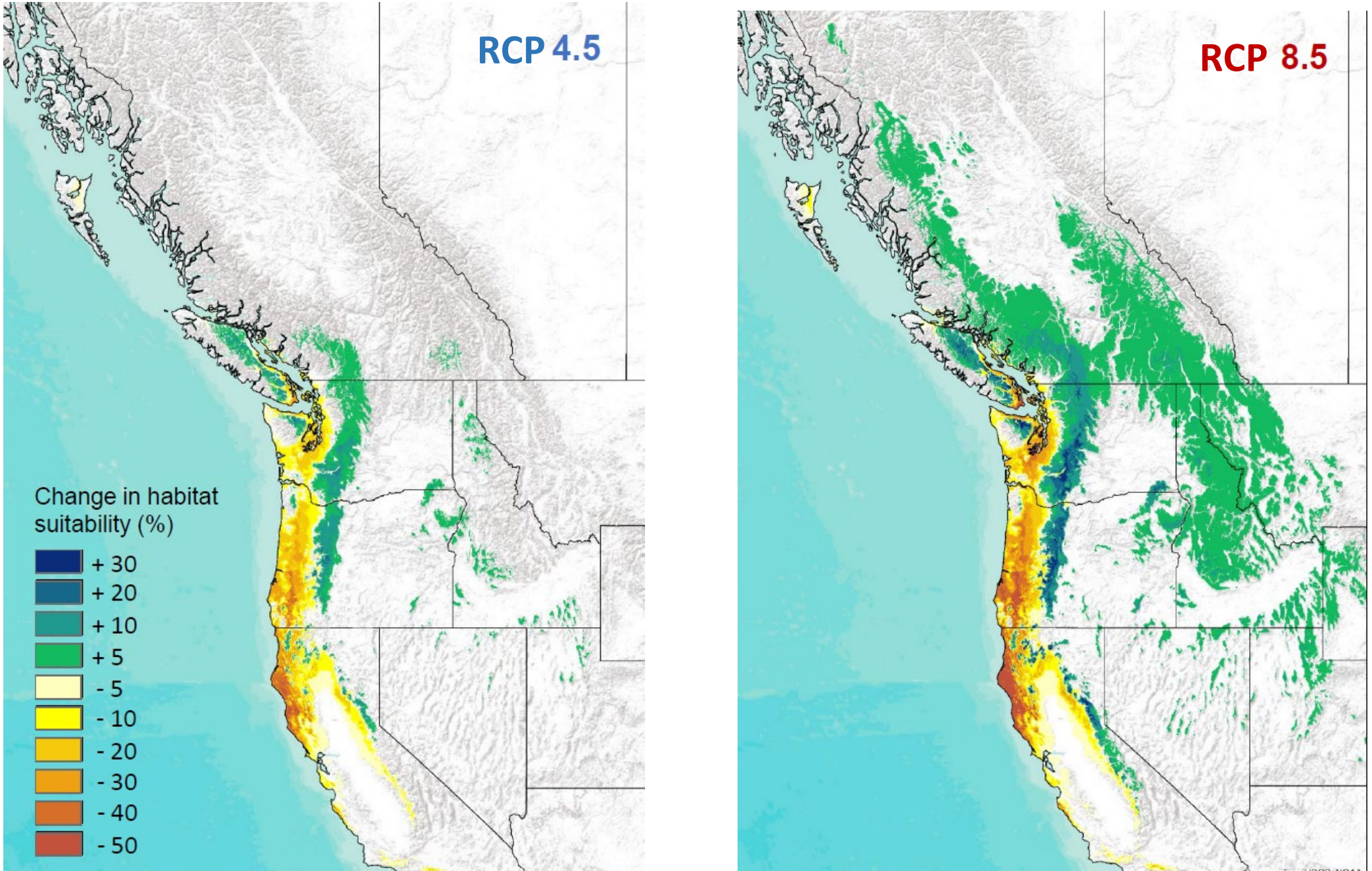
slide by David Rupp and Philip Mote, OCCRI

Huckleberry (VAME) in 2085

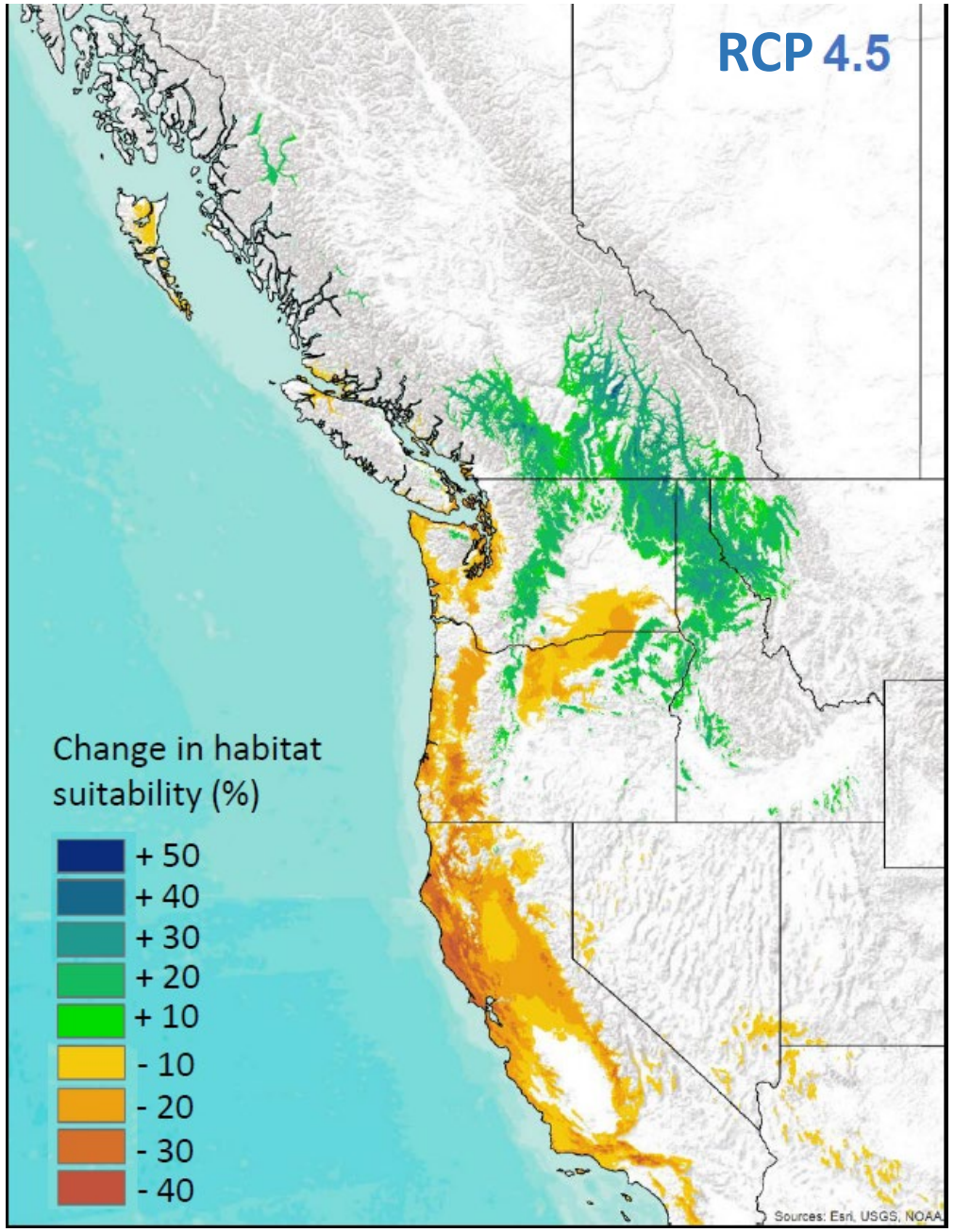


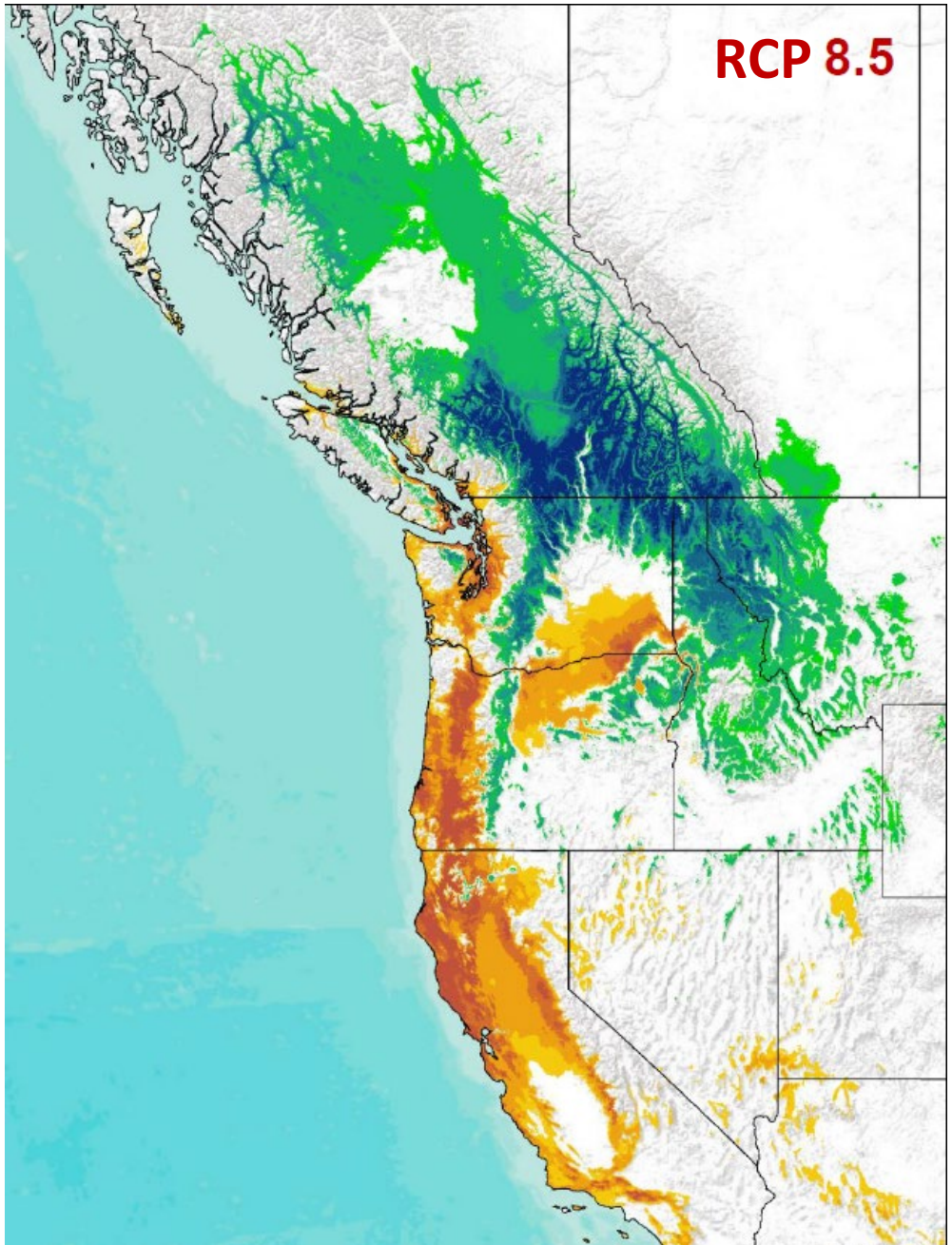


Hazelnut (COCO) in 2085

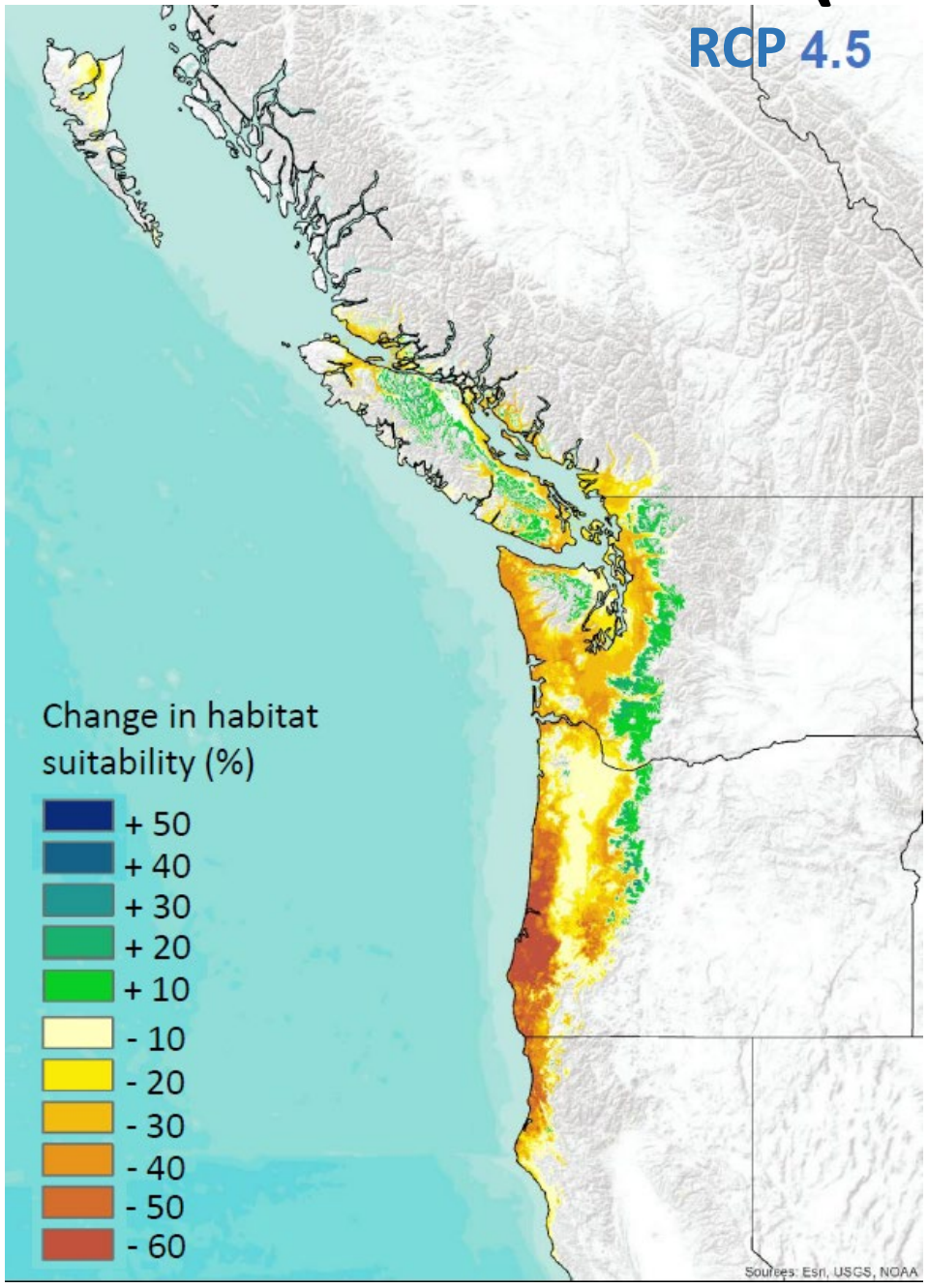


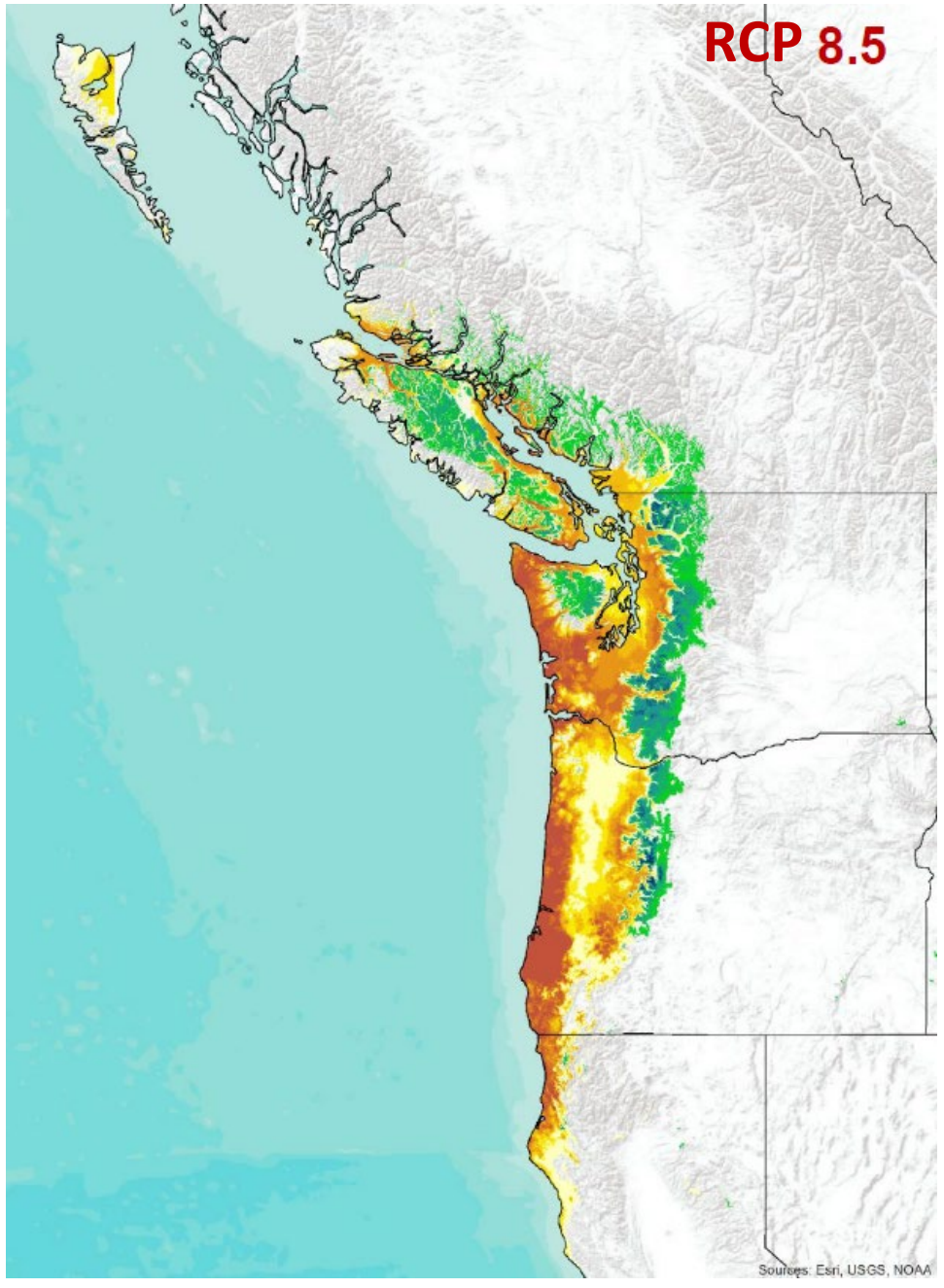
Oregon grape (MAAQ) in 2085



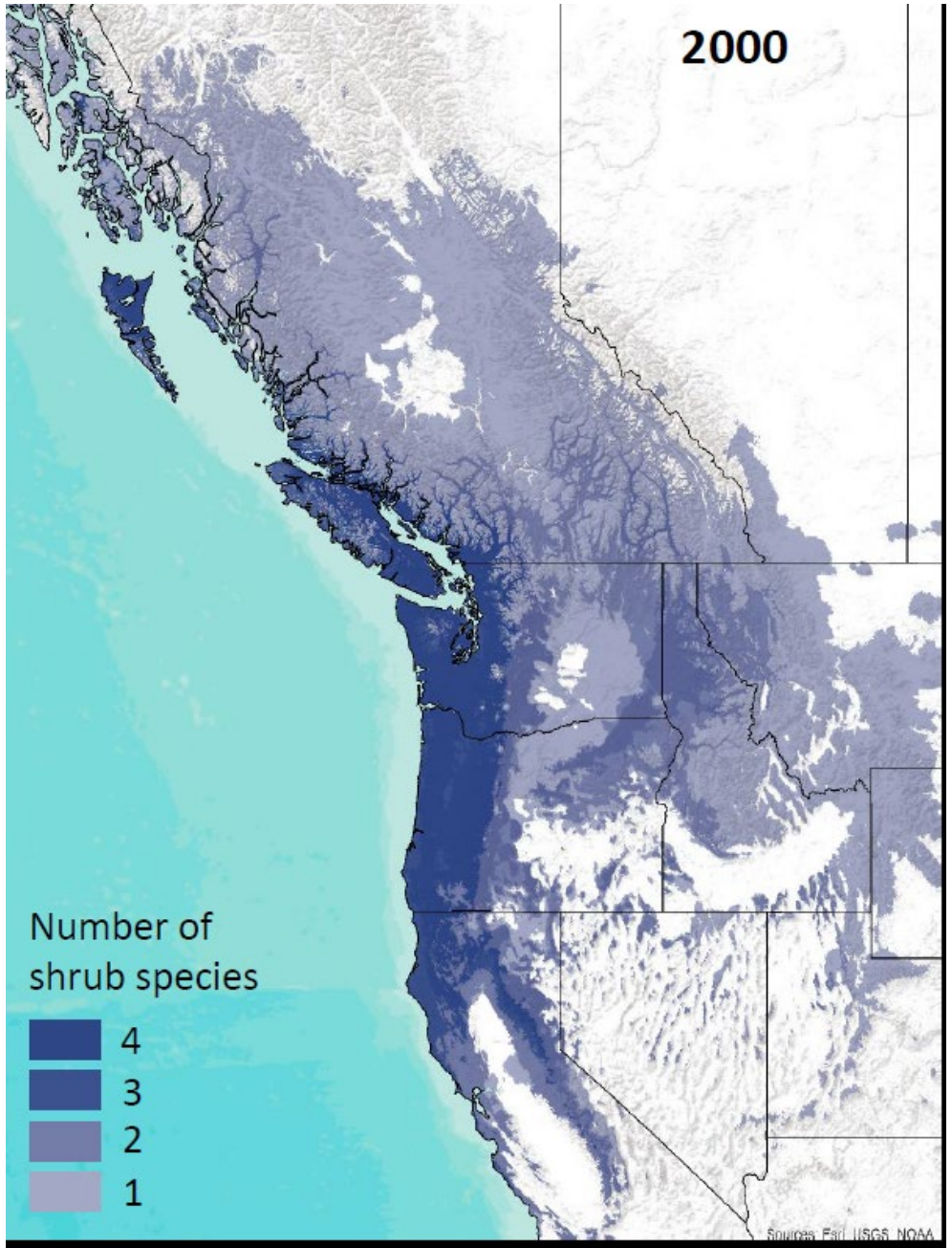


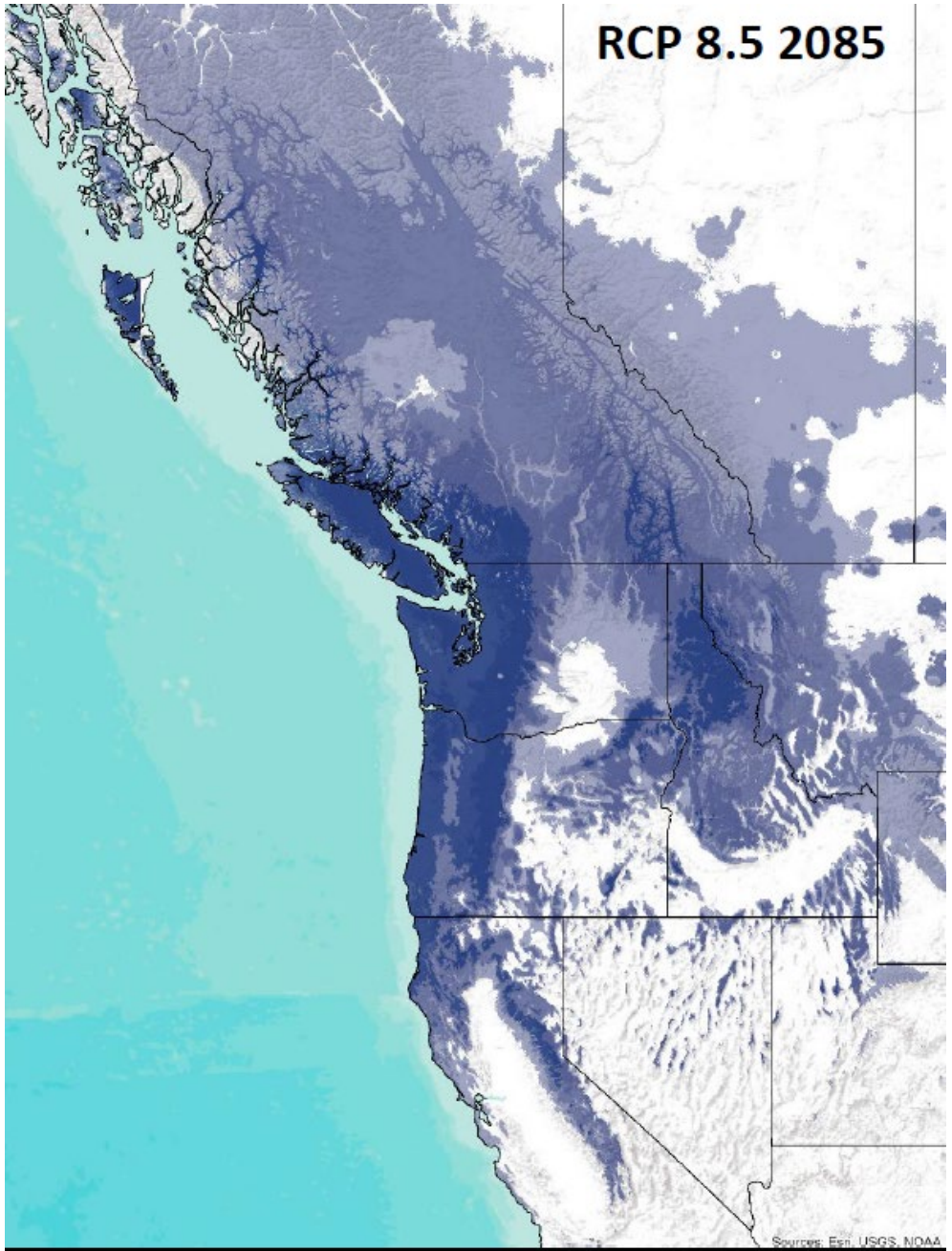
Salal (GASH) in 2085





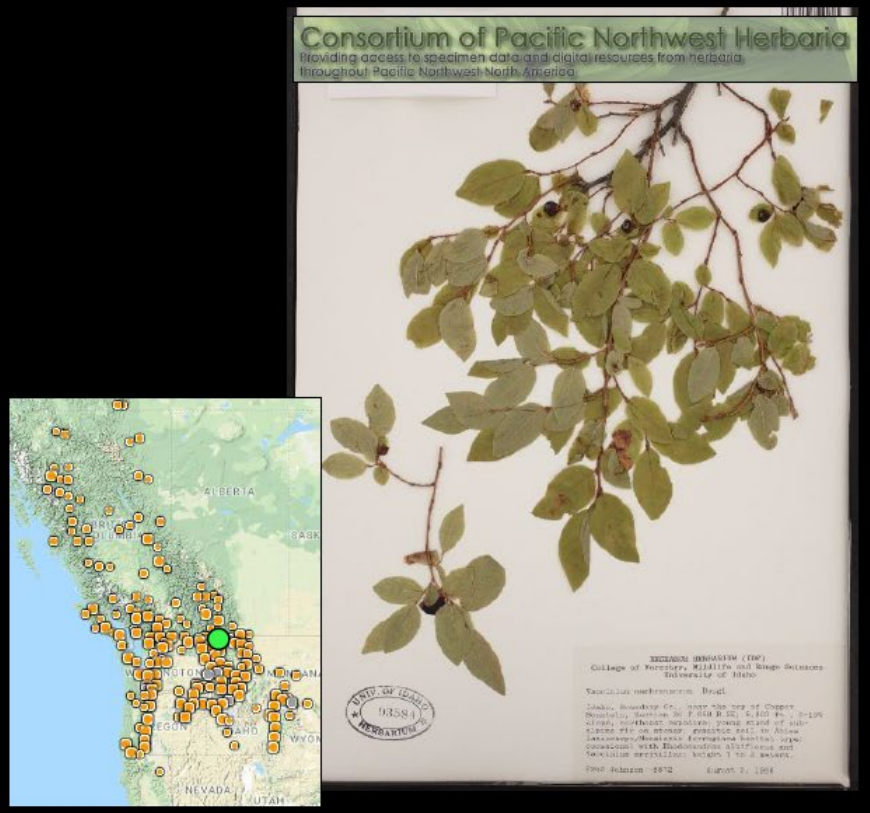
Predicted range shift for all 4 shrub species by 2085



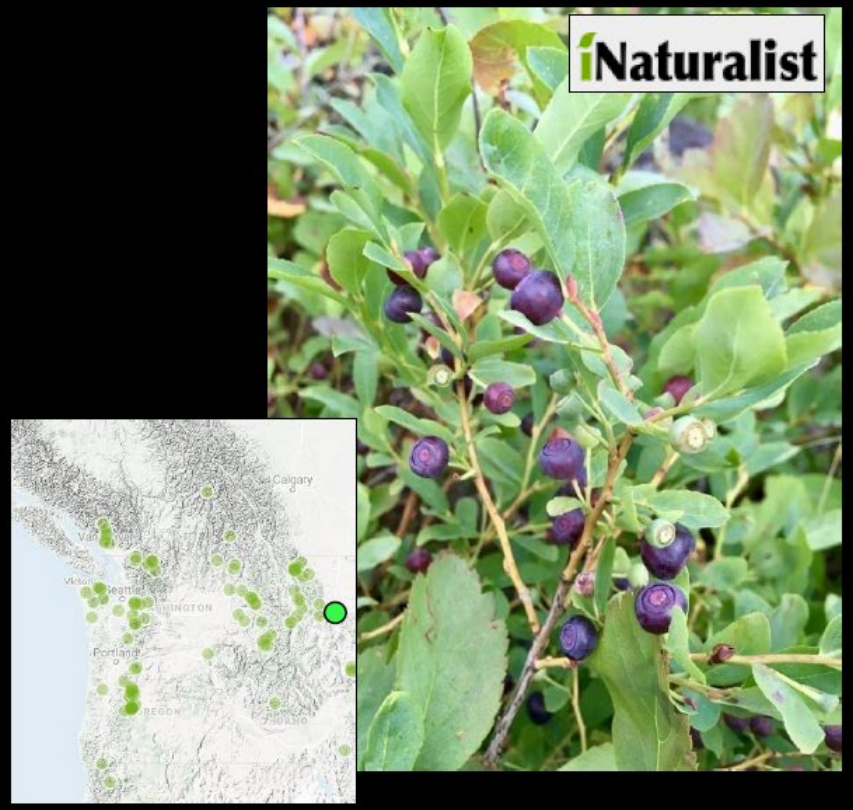


Changing phenology:
Flowering and fruiting observations

- 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

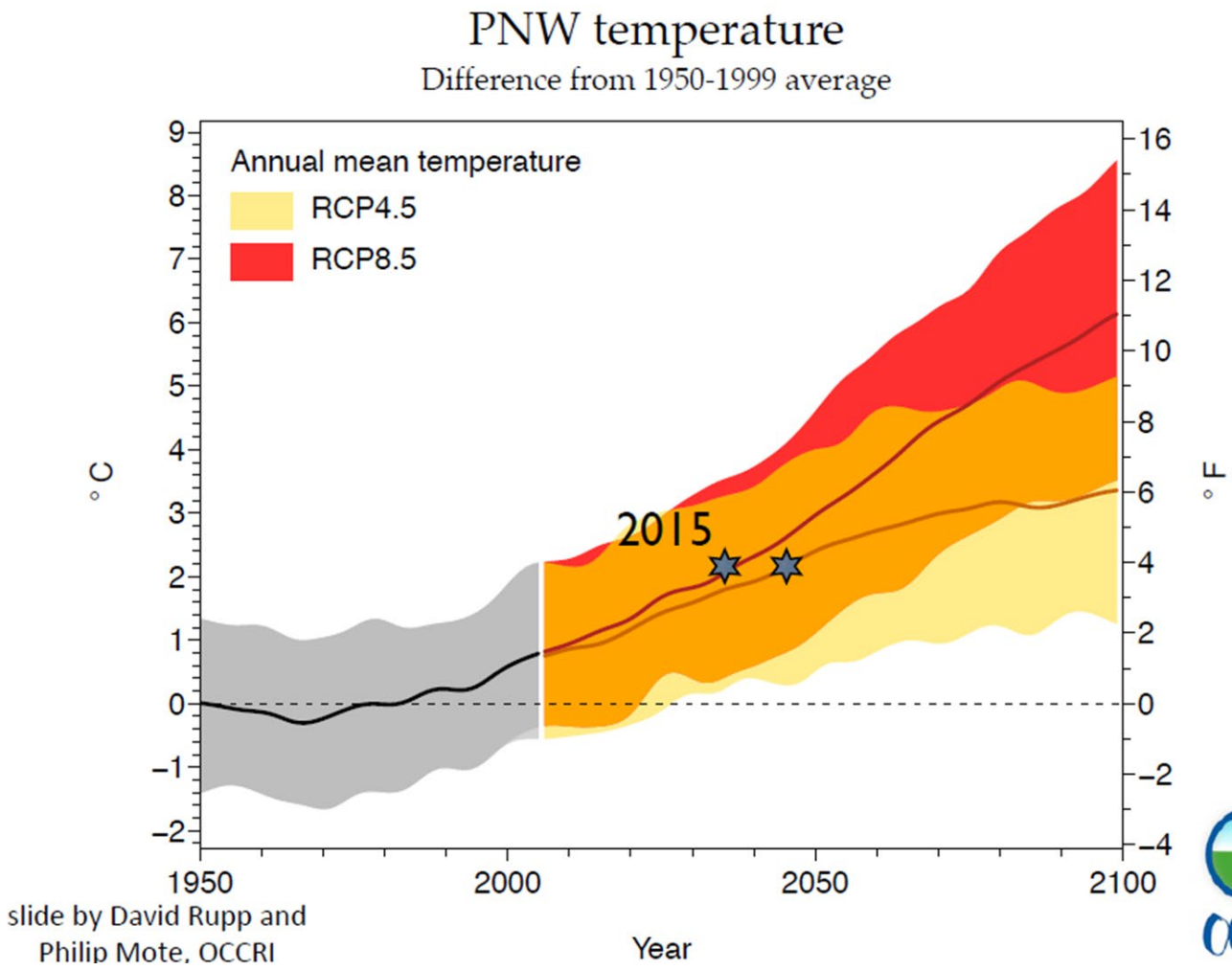
Phenology data hard to come by – especially flowering data at high elevation sites

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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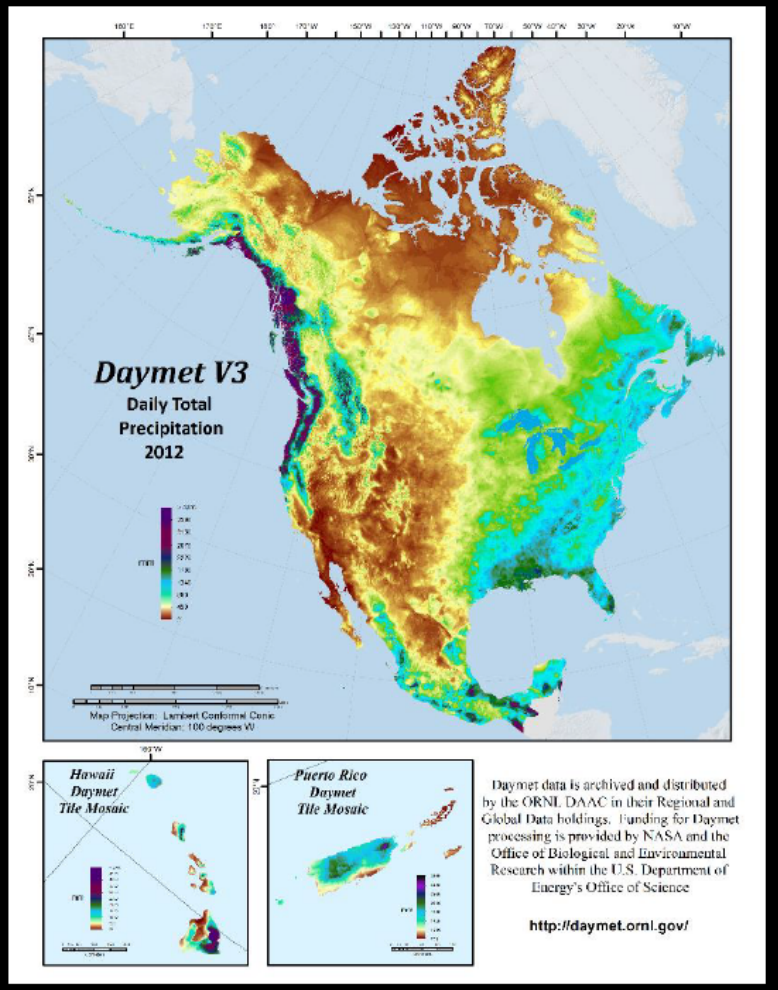

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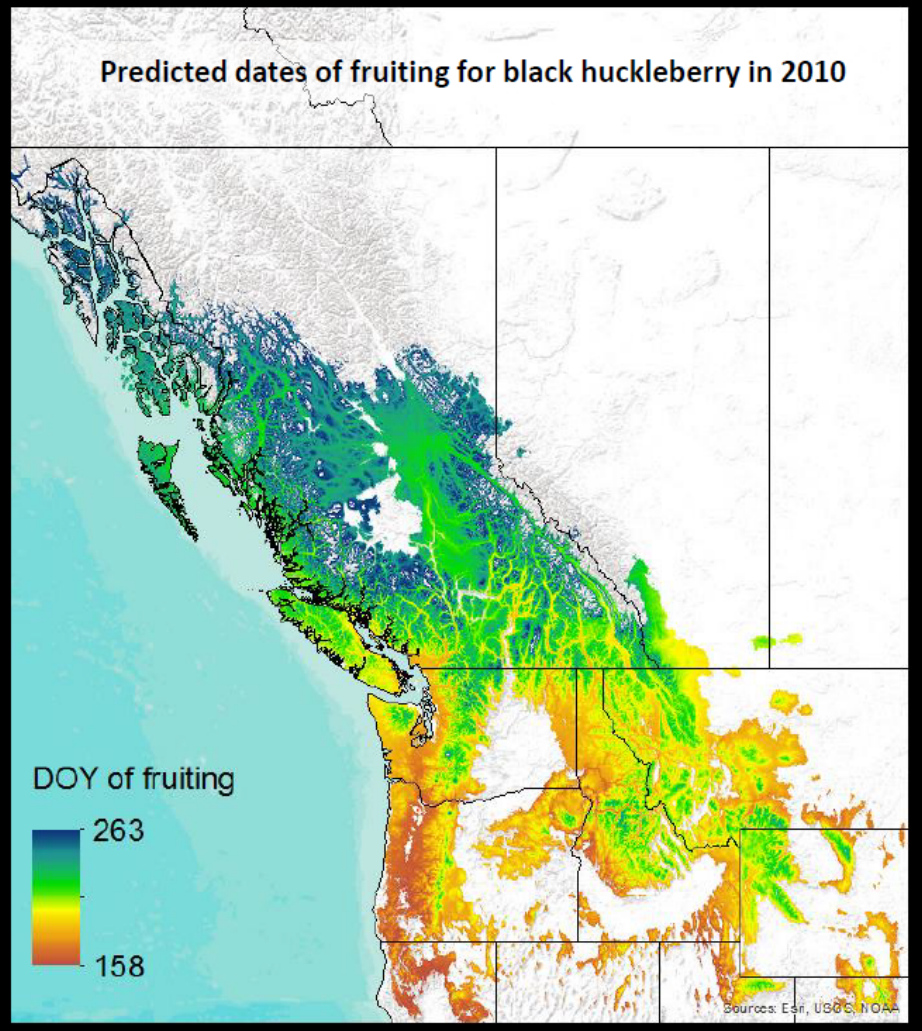
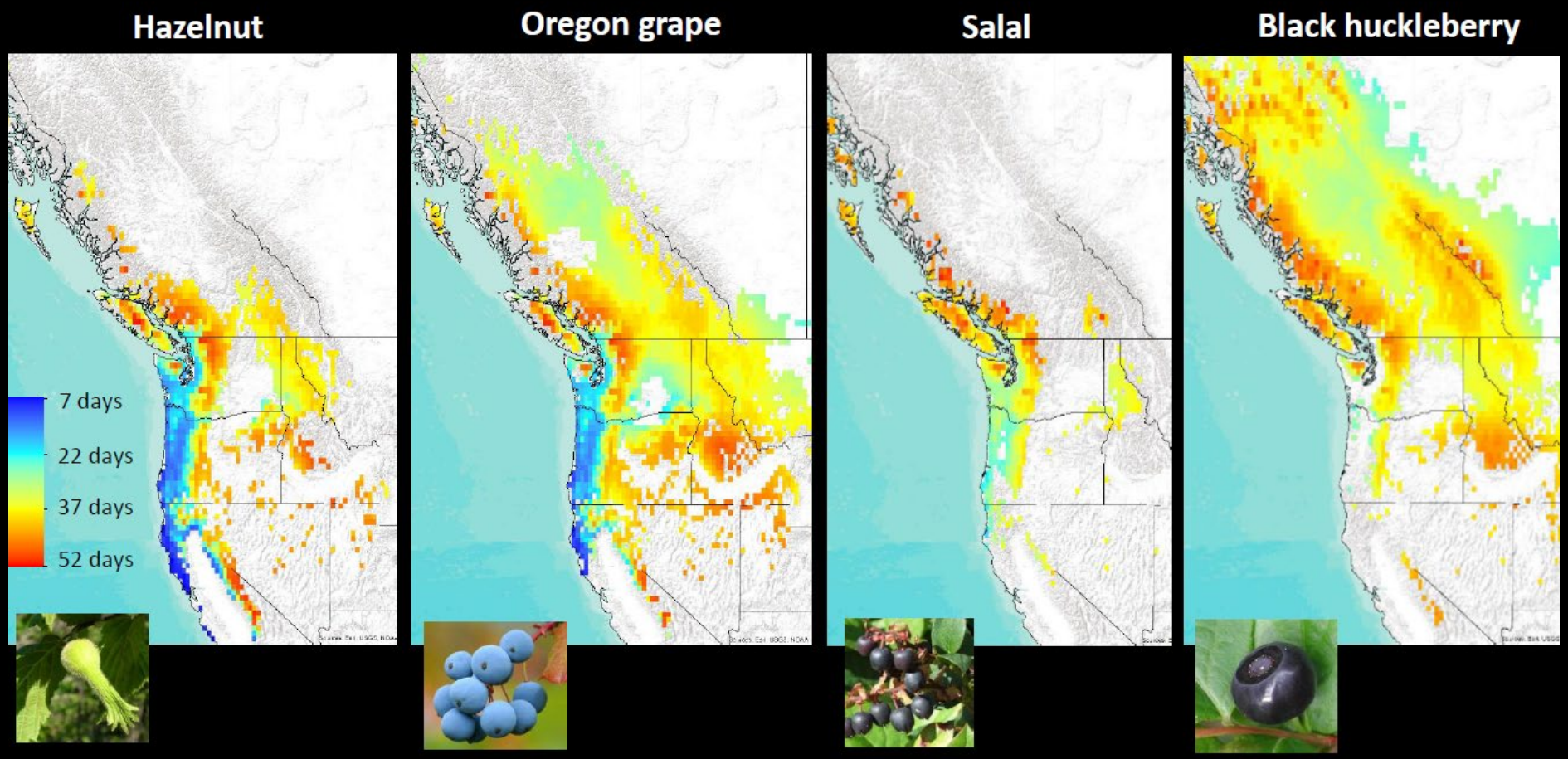
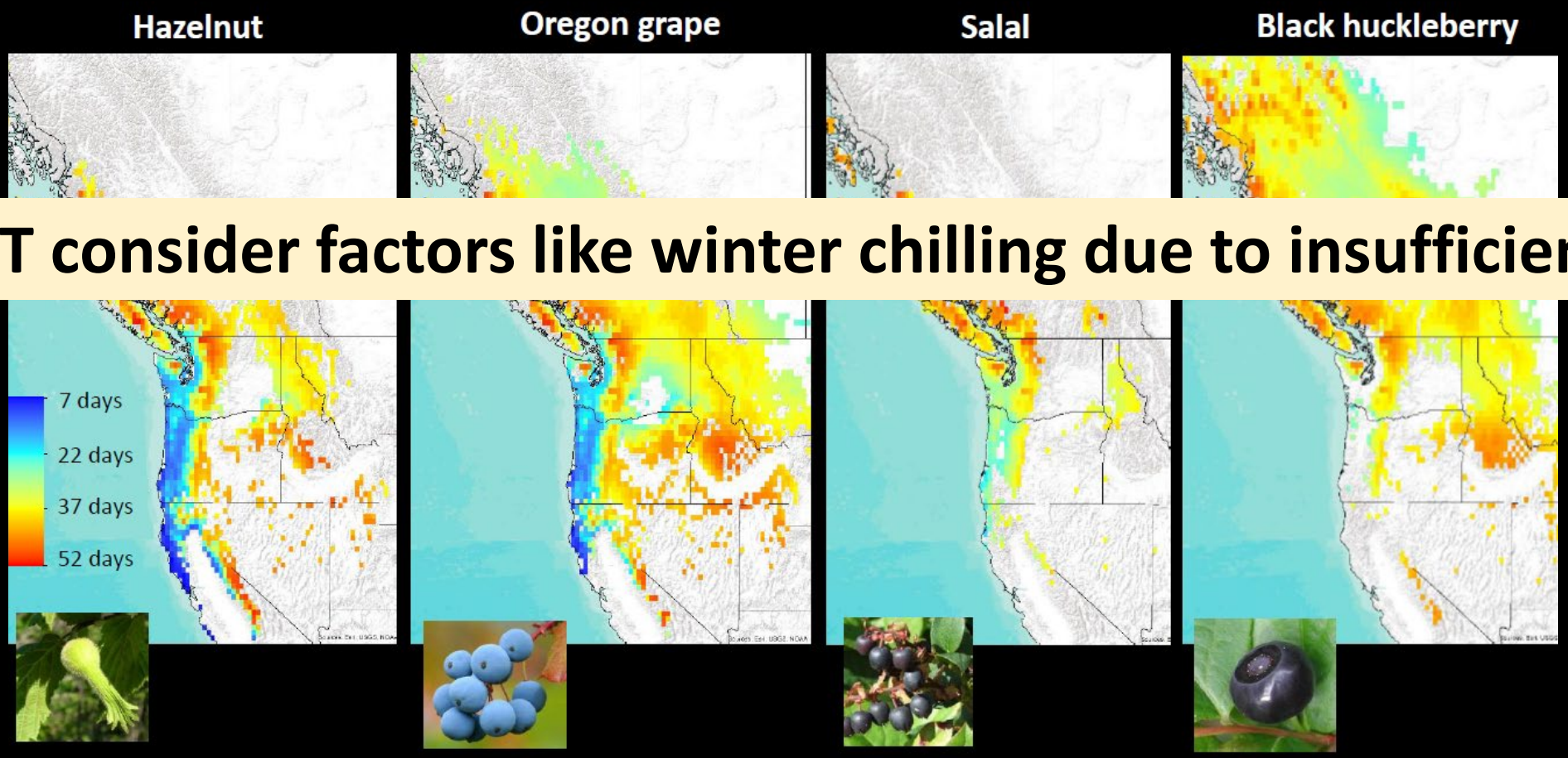


Changing phenology:
Shifts in flowering by 2085 - RCP 8.5



Flowering may advance 7 - 50 days by 2085

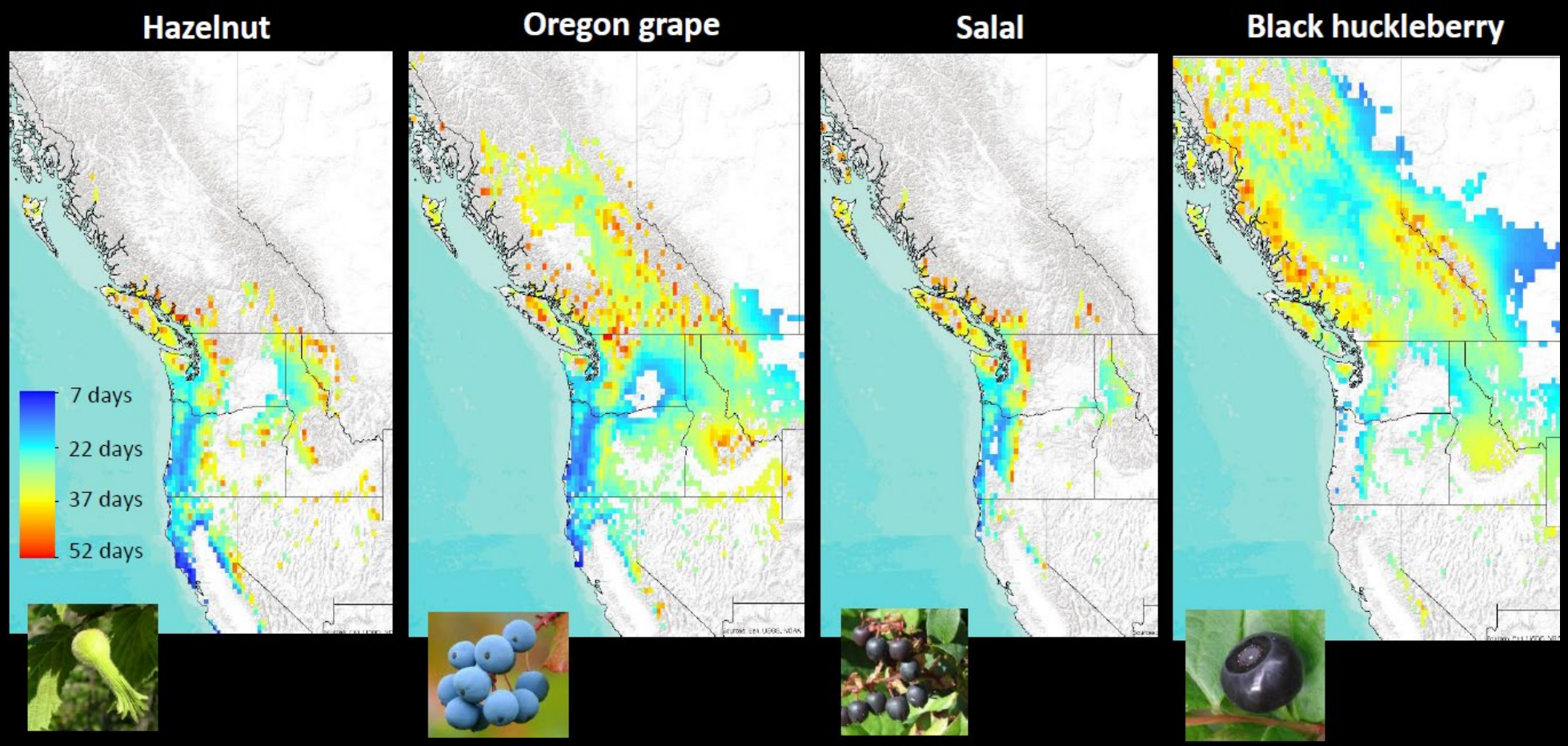
Changing phenology:
Shifts in flowering by 2085 - RCP 8.5



Did NOT consider factors like winter chilling due to insufficient data

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

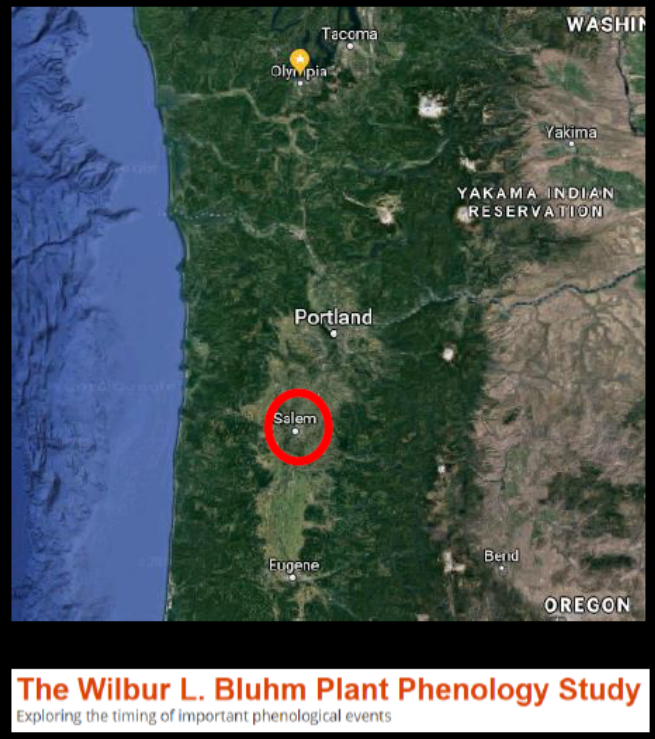
Changing phenology:
Shifts in fruiting by 2085 - RCP 8.5

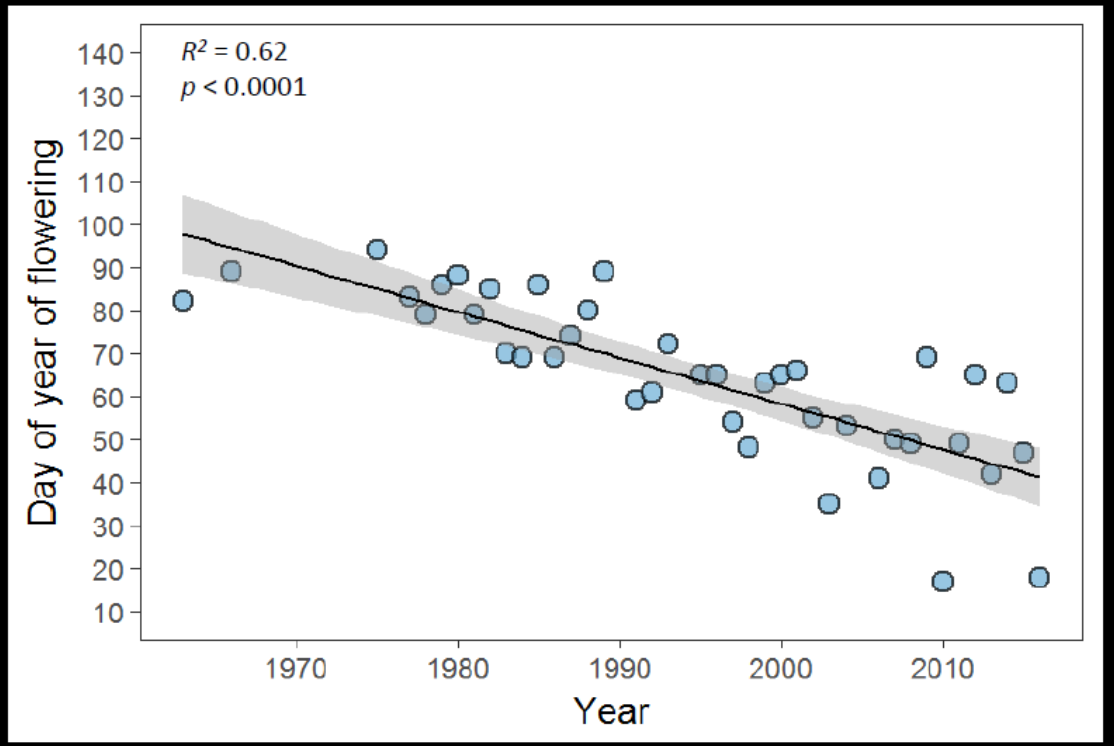


Fruiting may advance 10 - 55 days by 2085

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

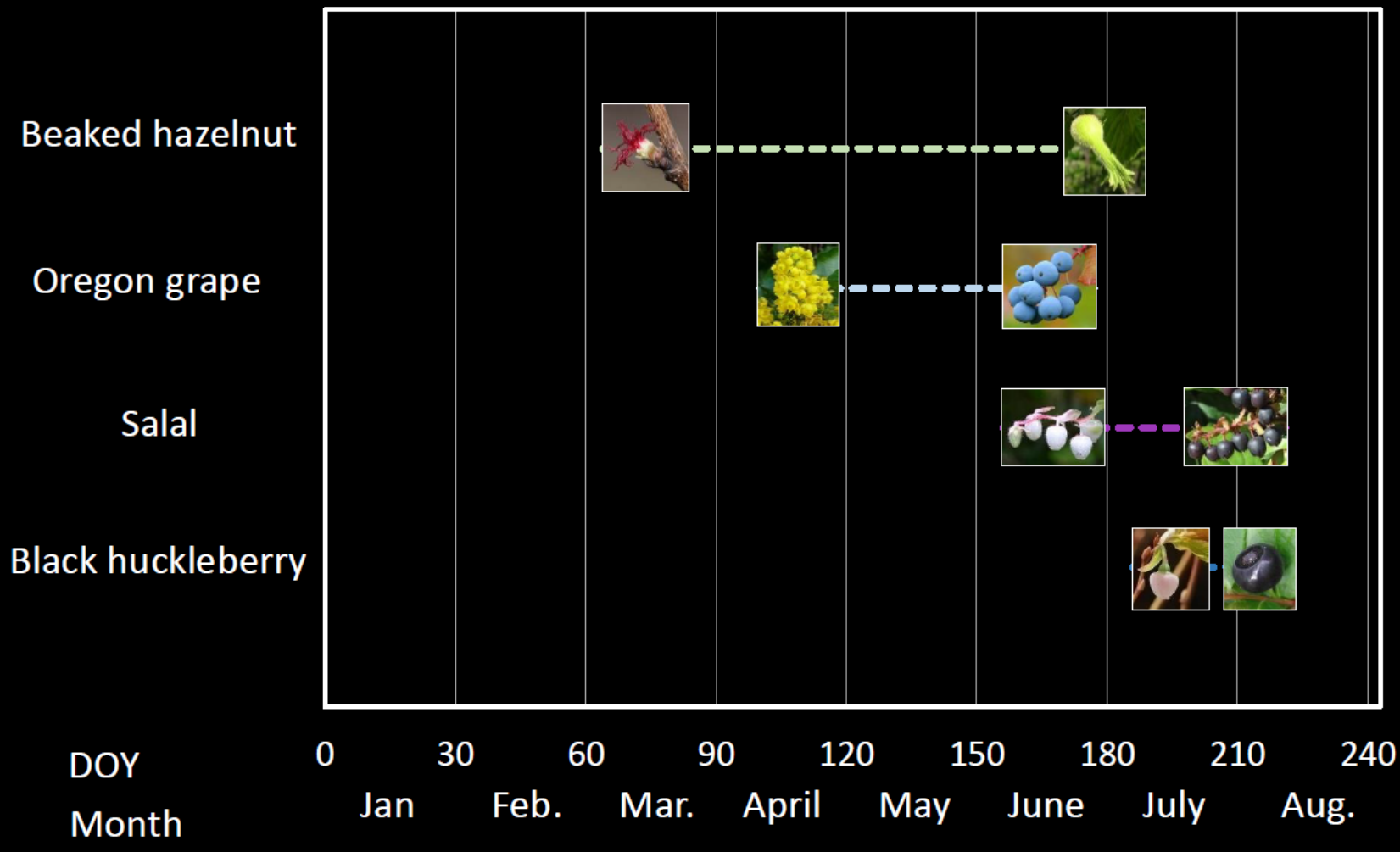
- Wilbur Bluhm recorded phenology data around Salem, Oregon for over 50 years: http://agsci-labs.oregonstate.edu/plantphenology/
  - He recorded dates of Oregon grape flowering from 1960 – 2016



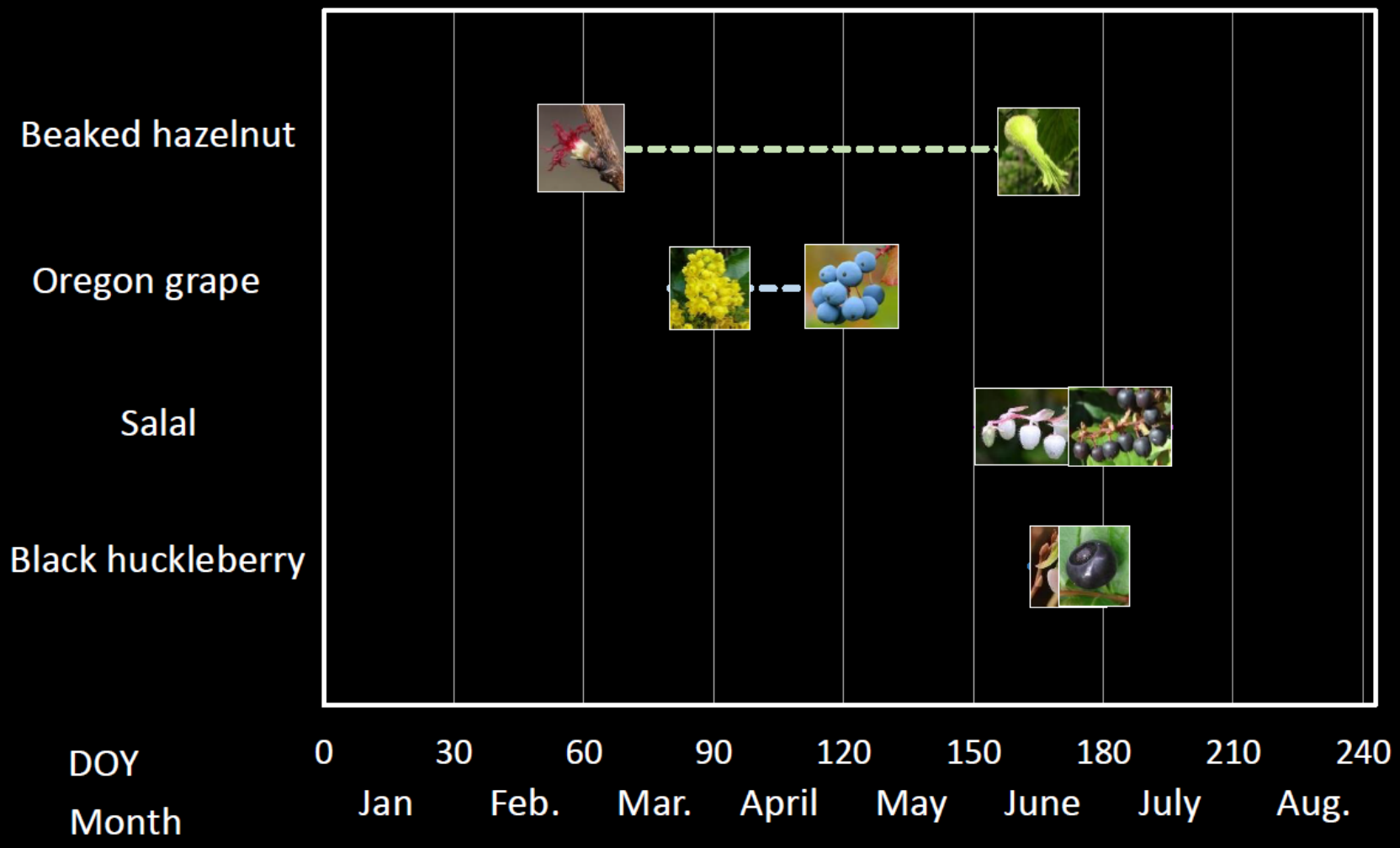


Flowering of Oregon grape has advanced an average of 50 days since 1960.....

Mean flowering and fruiting dates: 1980-2016



Predicted flowering and fruiting dates: 2085, RCP 8.5



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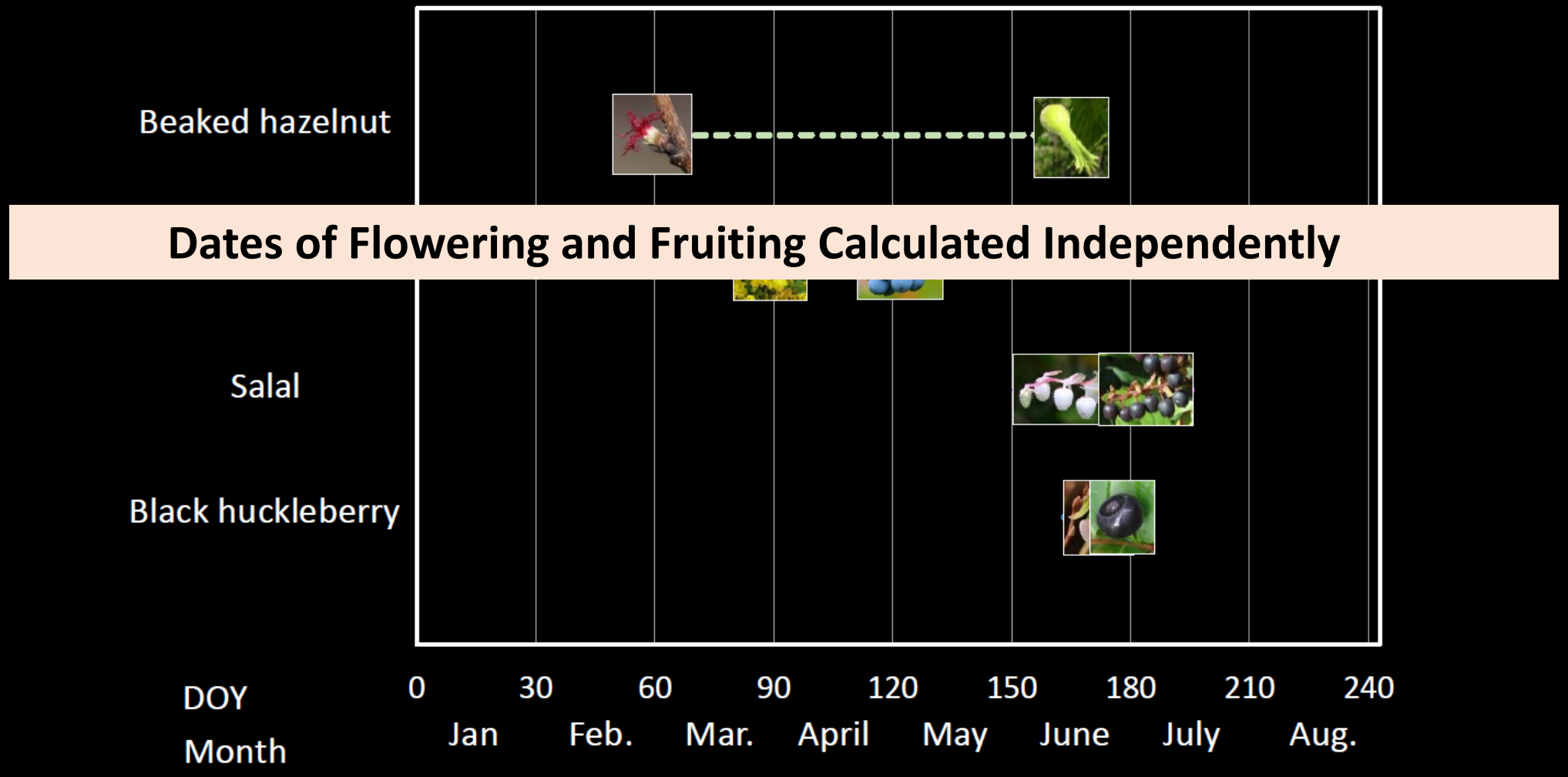
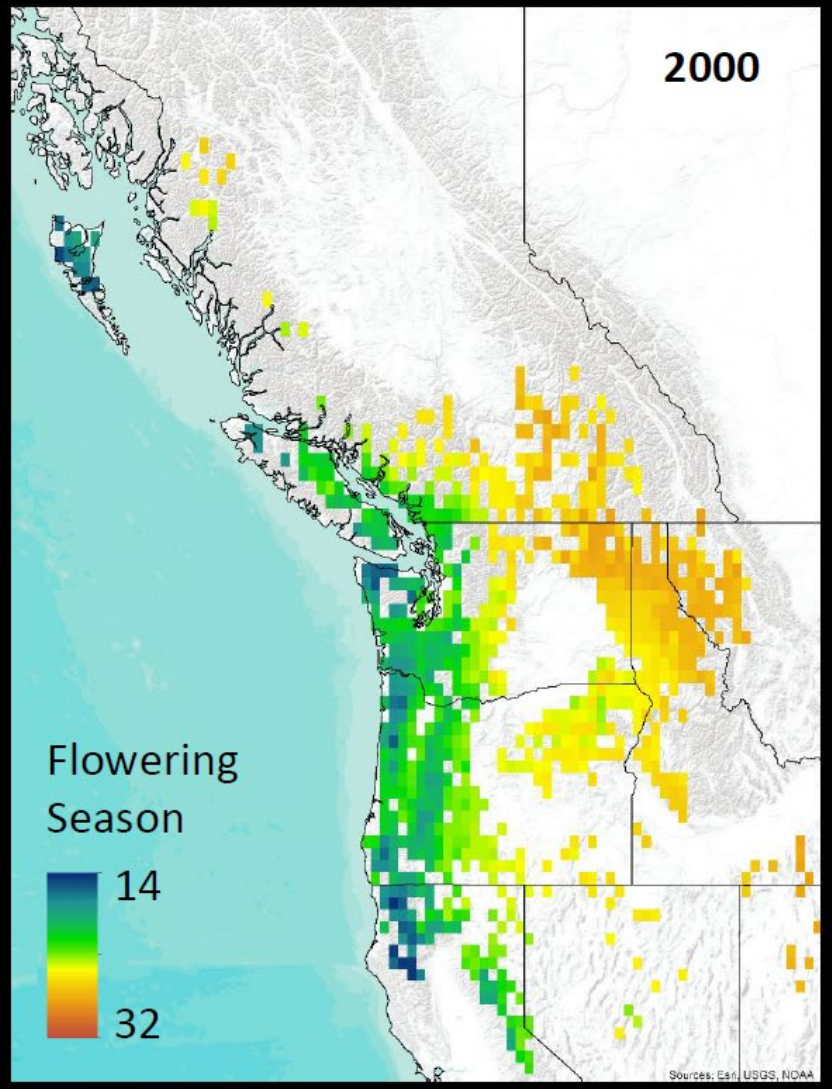
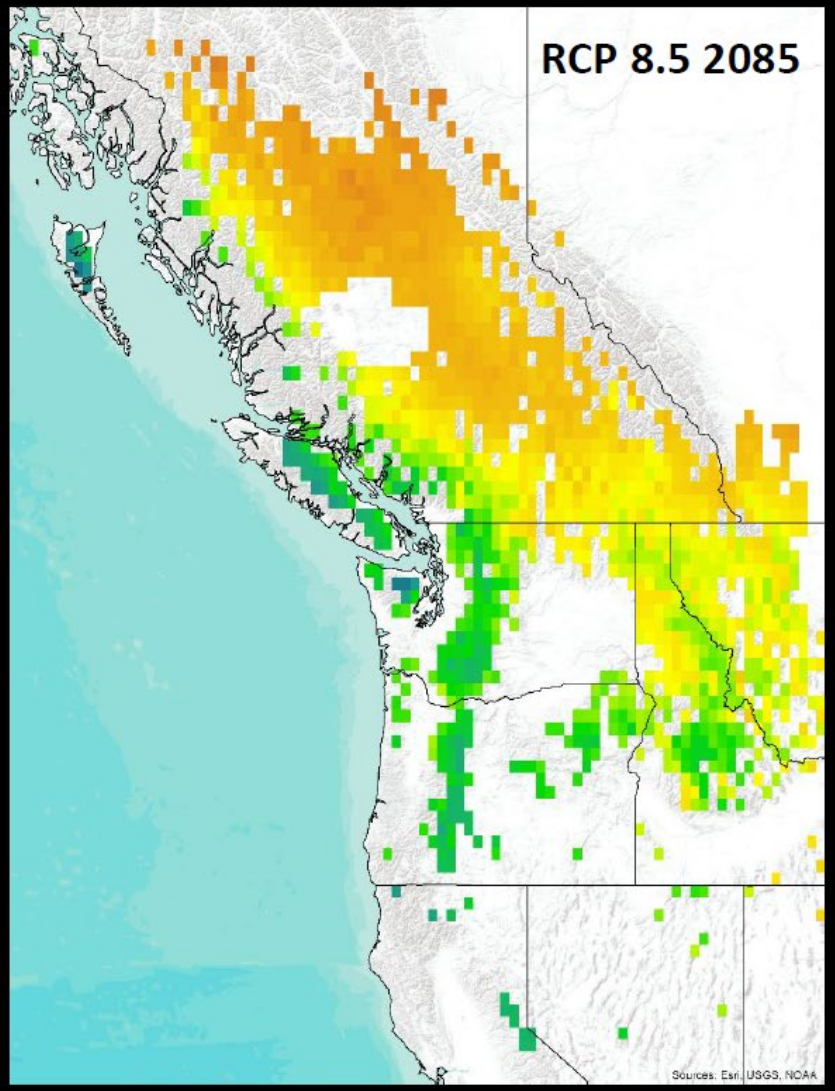
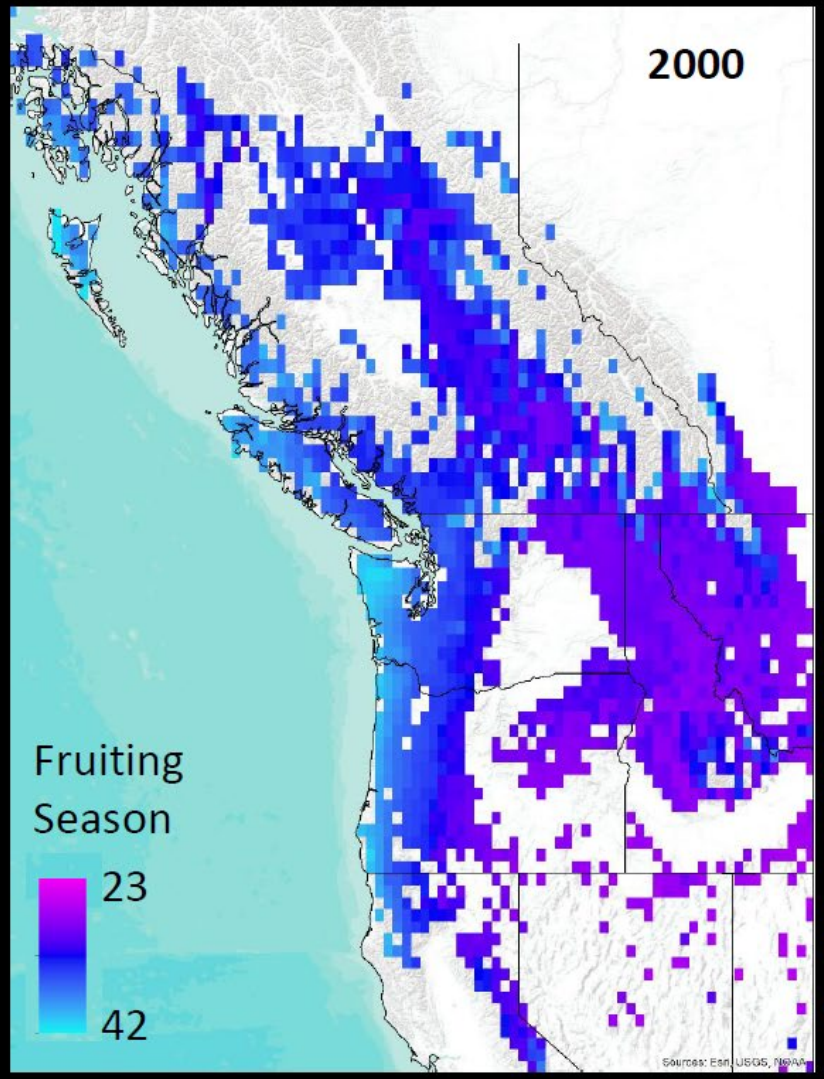


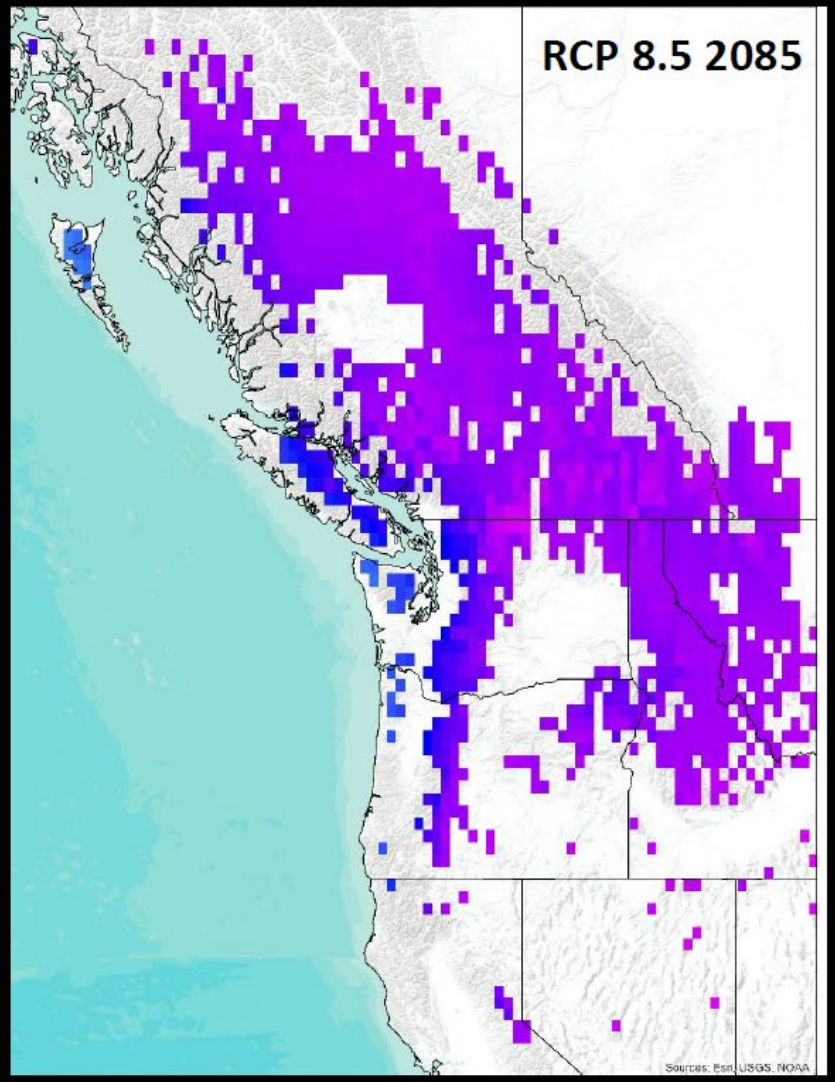
Flowering season length: Black huckleberry and Oregon grape





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

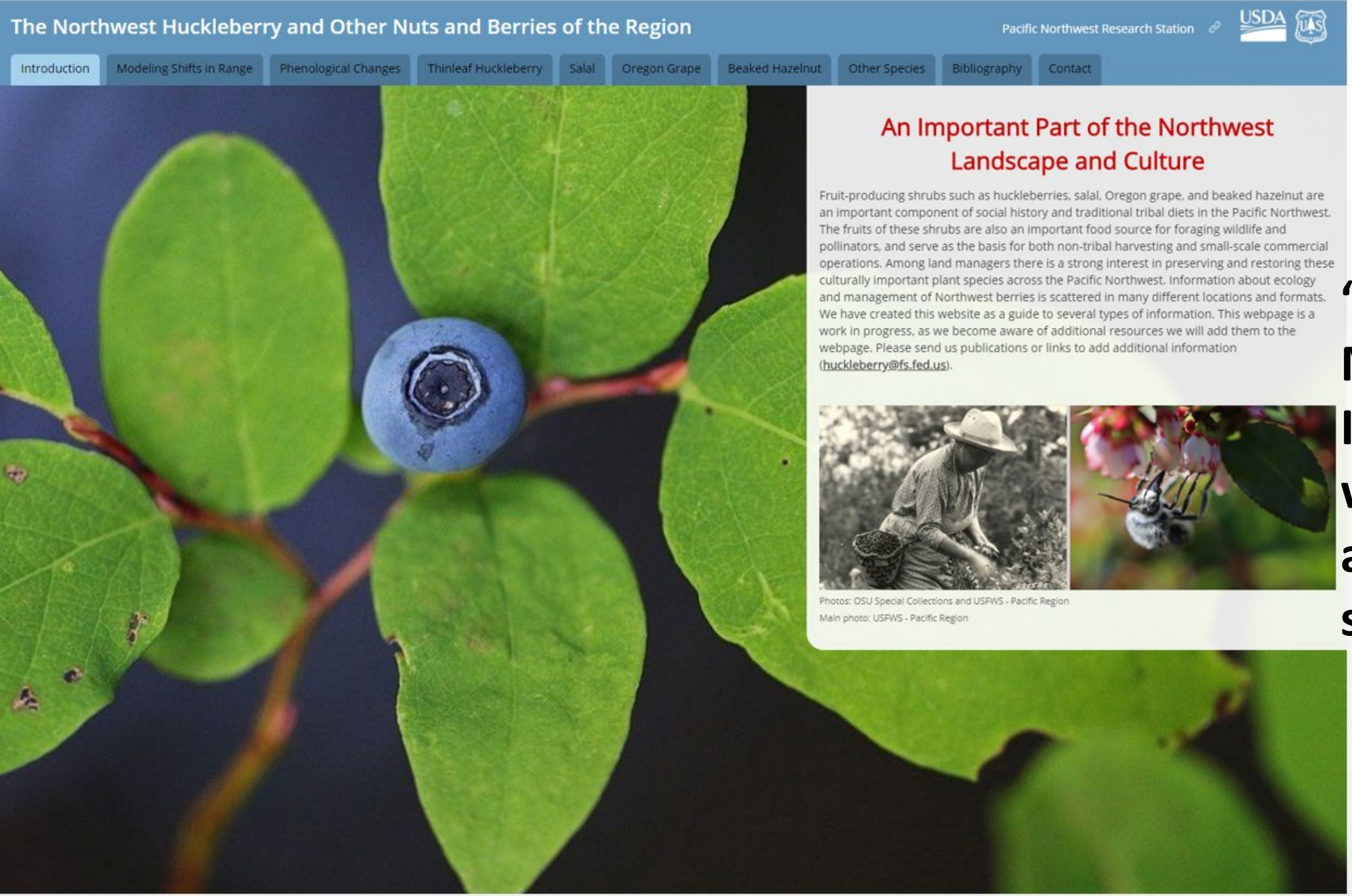
Perhaps results could:
Inform climate vulnerability assessments for target species

Serve as a basis for targeted monitoring efforts

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

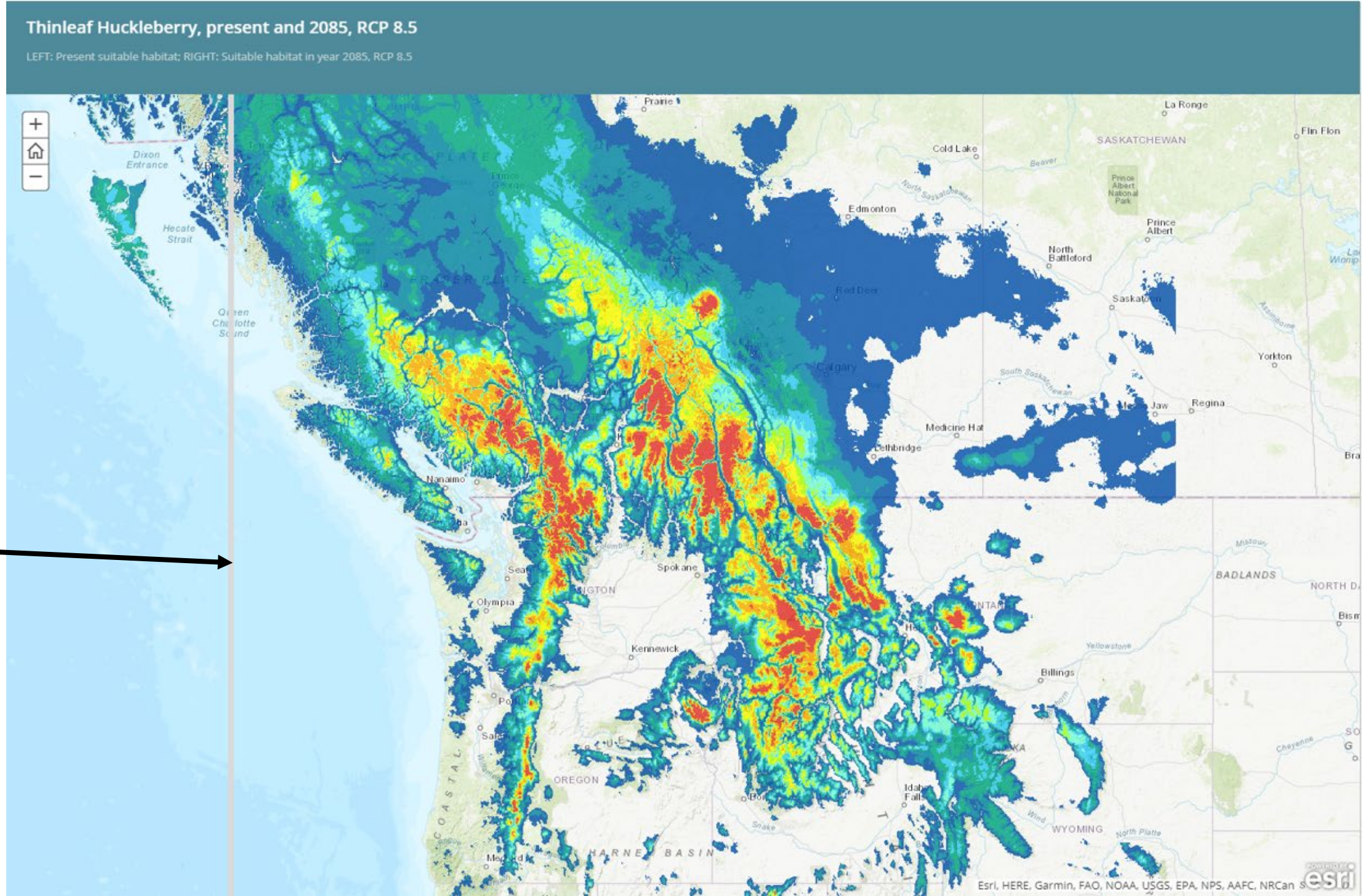
Help managers prioritize locations for restoration projects

Encourage more observations of flowering and fruiting!



“Story Map” Interactive website – available soon!!!

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



Thank you!

Funding: Northwest Climate Science Adaptation Center
Yakama Nation

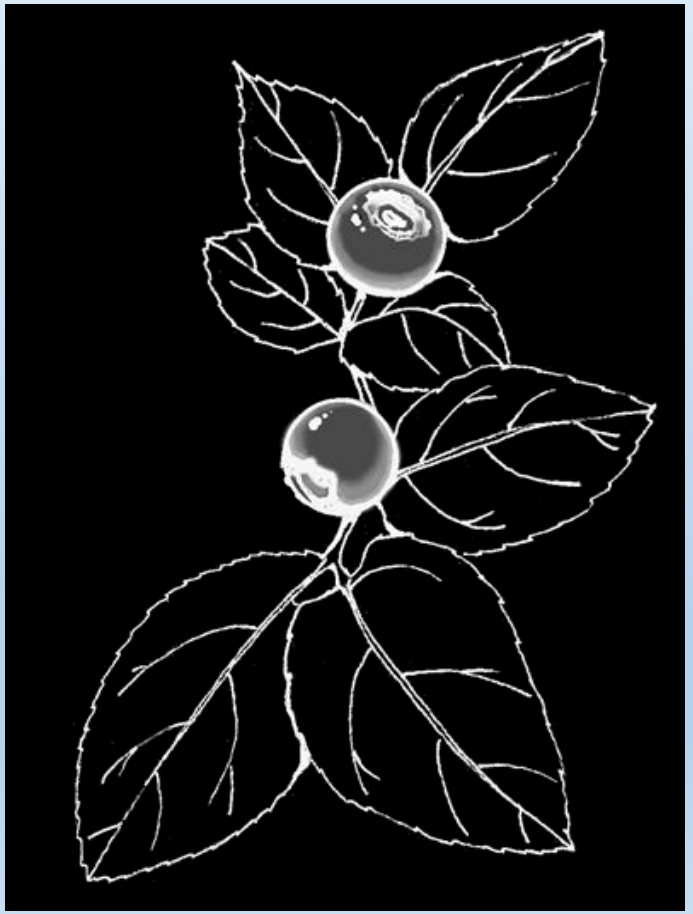
People: Leslie Brodie, Yianna Bekris, Jacob Strunk, Bev Luke, Tabitha Graves
Clayton Lamb, and the many citizen scientist data collectors!

Plant Data sources:

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

Climate data sources:

- Daymet
- Worldclim
- ClimateNA



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 plant vulnerability (based on habitat, physiology, phenology, biotic interactions)
Example for huckleberry in this document
Included monitoring and management recommendations

Questions?

Connie.Harrington@usda.gov

GDD averages

	GGD Flower	GGD Fruit	DOY Flower	DOY Fruit
Beaked Hazelnut	142.39	859	64	188
Oregon grape	145.62	735.39	100	177
Salal	459.17	1006.66	156	221
Black huckleberry	369.98	622.03	186	214