Climate Influences Range and Phenology of Northwest Shrub Species

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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!)
### Library

<table>
<thead>
<tr>
<th>Title</th>
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<tr>
<td>A biologist turns her sights on climate and the elusive huckle...</td>
<td>Malchik</td>
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<td>A landscape model for predicting potential natural vegetation...</td>
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<td>Moyer et al.</td>
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<td>Antioxidant capacities of ten edible North American plants</td>
<td>Acufia et al.</td>
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</table>
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
Black huckleberry

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) **
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)
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.

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.
Huckleberry (VAME) in 2085

Change in Habitat suitability (%)

- 60
- 40
- 30
- 15
- 10
- 5
  5
  10
  15
  30
  40

RCP 4.5

RCP 8.5
Oregon grape (MAAQ) in 2085

Change in habitat suitability (%)

- + 50
- + 40
- + 30
- + 20
- + 10
- 10
- 20
- 30
- 40
Salal (GASH) in 2085

Change in habitat suitability (%)

- 60
- 50
- 40
- 30
- 20
- 10
+ 10
+ 20
+ 30
+ 40
+ 50
+ 60

RCP 4.5

RCP 8.5
Predicted range shift for all 4 shrub species by 2085

Number of shrub species:
- 4
- 3
- 2
- 1
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.

We used data from many sources

Phenology data hard to come by – especially flowering data at high elevation sites.
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.
Changing phenology:
Climate data

- Matched locations of phenology observations to interpolated temperature data from Daymet from all observations between 1980-2017
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 fruting dates
Changing phenology:
Shifts in flowering by 2085 - RCP 8.5

Flowering may advance 7 - 50 days by 2085
Did NOT consider factors like winter chilling due to insufficient data.
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/](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

- **Beaked hazelnut**
- **Oregon grape**
- **Salal**
- **Black huckleberry**

![Graph showing flowering and fruiting dates for various plants over different months from January to August.](image-url)
Predicted flowering and fruiting dates: 2085, RCP 8.5

Dates of Flowering and Fruiting Calculated Independently

- Beaked hazelnut
- Salal
- Black huckleberry

DOY
Month
0 30 60 90 120 150 180 210 240
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.
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!
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).

“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?

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## GDD averages

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<th>GGD Flower</th>
<th>GGD Fruit</th>
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<tbody>
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<td>Beaked Hazelnut</td>
<td>142.39</td>
<td>859</td>
<td>64</td>
<td>188</td>
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<tr>
<td>Oregon grape</td>
<td>145.62</td>
<td>735.39</td>
<td>100</td>
<td>177</td>
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<tr>
<td>Salal</td>
<td>459.17</td>
<td>1006.66</td>
<td>156</td>
<td>221</td>
</tr>
<tr>
<td>Black huckleberry</td>
<td>369.98</td>
<td>622.03</td>
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