Climate Influences Range and Phenology of Northwest Shrub Species

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

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

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

Needed to start with current occurrences

USFS FIA (Forest Inventory and Analysis)
PNW Herbaria
[Other databases & Citizen Science sources some species]

Developed maps of occurrences for 78 native shrub species
Some species are primarily associated with forests so are well sampled in FIA (Forest Inventory and Analysis) plots.
Some 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 – Current 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)
Current ranges: Habitat suitability models in MaxEnt

Models for all species selected:
Mean summer precipitation
Extreme cold temperature
Climatic moisture deficit
Predicted and 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 (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

Change in Habitat suitability (%)

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

Sources: [Map details]
Huckleberry (VAME) in 2085

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

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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 modeled 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 gridcell climate data to identify climate variables that best predicted the current bioclimatic niche and the timing of flowering and fruiting across huckleberry. We then used multi-model future climate projections for 2 time periods.
Hazelnut (COCO) in 2085

RCP 4.5

RCP 8.5
Oregon grape (MAAQ) in 2085

RCP 4.5

RCP 8.5

Change in habitat suitability (%)

$\begin{align*}
+50 \\
+40 \\
+30 \\
+20 \\
+10 \\
-10 \\
-20 \\
-30 \\
-40
\end{align*}$
Salal (GASH) in 2085

Change in habitat suitability (%)
- Dark blue: +50
- Blue: +40
- Light blue: +30
- Dark green: +20
- Green: +10
- Light yellow: -10
- Yellow: -20
- Orange: -30
- Dark orange: -40
- Red: -50
- Dark red: -60
Salal (GASH) in 2085

Research results for COCO, MAAQ and GASH submitted for publication and are “in review”
Predicted range shift for all 4 shrub species by 2085
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
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 fruiting 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 flowering by 2085 - RCP 8.5

Flowering may advance 7 - 50 days by the 2085.
Changing phenology:
Shifts in fruiting by 2085 - RCP 8.5

Hazelnut

Oregon grape

Salal

Black huckleberry

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

DOY (Day of Year) vs. Month:

- January
- February
- March
- April
- May
- June
- July
- August
Predicted flowering and fruiting dates: 2085, RCP 8.5

- Beaked hazelnut
- Oregon grape
- Salal
- Black huckleberry

DOY (Date of Year) vs. Month

0  30  60  90  120  150  180  210  240

Flowering season length: Black huckleberry and Oregon grape

Models for flowering and fruiting added to phenology.naturecast.org forecasts for our 4 key species
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 important shrubs

Help managers determine suitable 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).

Photo: OSU Special Collections and USDA – Pacific Region
Main photo: USDA – Pacific Region.

“Story Map” Interactive website – available
Slider bar to see changes in suitable habitat between now and future
Thank you!

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**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
Questions?
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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)
Example for huckleberry in this document
Included monitoring and management recommendations

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