Plant community responses to climate change

Kavya Pradhan; Hille Ris Lambers Lab
Washington Botanical Symposium
3/4/2020
Climate change and consequences

Climate Impacts Group (UW): https://cig.uw.edu/
Climate change and consequences

Climate Impacts Group (UW): https://cig.uw.edu/
Climate change and consequences

Climate Impacts Group (UW): https://cig.uw.edu/
What is a community?
What is a community?
What is a community?
Why do we care about communities?
Why do we care about communities?

Oliver et al. 2015
How are communities responding to climate?
How are communities responding to climate?

Species richness
How are communities responding to climate?

Species richness

$\uparrow R$
How are communities responding to climate?

Species richness

↑R

↓R
How are communities responding to climate?

Species richness

Tree vs. Understory
Mount Rainier National Park
THE FOREST COMMUNITIES OF MOUNT RAINIER NATIONAL PARK

JERRY F. FRANKLIN
WILLIAM H. MOIR
SARAH E. GREENE
MILES A. HEMSTROM
BRADLEY G. SMITH
Species richness - Trees

Number of species

- 1970’s and 80’s
- 2010’s
Species richness - Trees

Number of species

Species gain

Number of sites

Species loss  Species gain

1970's and 80's  2010's
Species richness - Trees

- Number of species: 1970's and 80's vs. 2010's
- Species gain: -0.46
- Species loss: -0.46
Species richness - Understory

1970’s and 80’s
2010’s
Species richness - Understory

- Number of sites
- Species richness
- Number of species
- Species gain
- Species loss

1970's and 80's vs 2010's
Species richness - Understory

- Number of sites
- Species richness

- Number of species
  - 1970’s and 80’s
  - 2010’s

- Species gain
- Species loss

- 4.4

- -4.4
How are communities responding to climate?

Community turnover
How are communities responding to climate?

Increasing community turnover
How are communities responding to climate?

Increasing community turnover
How are communities responding to climate?

Increasing community turnover
How are communities responding to climate?

Increasing community turnover
How are communities responding to climate?

Increasing community turnover
How are communities responding to climate?

Increasing community turnover
Tree Understory

Community turnover

Turnover across time
Turnover across time

Community turnover

Tree

Understory
Turnover across time

Community turnover

Tree

Understory

Resurvey Community

Legacy Community

0.00
0.25
0.50
0.75
1.00
Turnover across time

![Box plot showing community turnover for Tree and Understory, with Resurvey and Legacy Communities illustrated nearby.](image)
Turnover across time

- Tree
- Understory
- Resurvey Community
- Legacy Community
Relationships with climate across space

![Image of mountain landscape](image1)

![Image of forest landscape](image2)

Time
Relationships with climate across space
Relationships with climate across space
Relationships with climate across space
Relationships with climate across space
Relationships with climate across space
Relationships with climate across space
What do we now know?

Species richness

\[
\begin{align*}
\uparrow R \\
\downarrow R
\end{align*}
\]
What do we now know?

Species richness

↑R

↓R

Community turnover

<
What do we now know?

Species richness

↑R

↓R

Community turnover

Community-climate relationships

<

≠
What do we now know?

Potential for community reorganization
Future work

Trait data collection
Thank you

Jerry Franklin and colleagues
Catherine Copass (NPS)
Michelle Spicer

Current HRL lab members:
Ruben Manzanedo Jordana Sevigny
Meera Sethi Samantha Brown
Stuart Graham Chelsea Brogan
Jiajia Su Ari Geary-Teeter
Aji John Ammara Touch
Haleh Mawson

Field crew members across the years

Janneke Hille Ris Lambers
Amy Angert

[Image of Janneke Hille Ris Lambers and Amy Angert]
Thank you
Extra slides
Communities across space
Communities across space
Communities across space

Western red cedar
Western hemlock
Pacific Yew
Communities across space

Western red cedar
Western hemlock
Pacific Yew

Western red cedar
Western hemlock
Douglas Fir
Communities across space

Western red cedar
Western hemlock
Pacific Yew

Western red cedar
Western hemlock
Douglas Fir

Douglas Fir
Sub Alpine Fir
Noble Fir
Future work

Trait environment relationships

\[ r^2 = 0.2, \quad P = 1.39 \times 10^{-15} \]

Snow cover days

Nitrogen content

Ecosystem
Community
Population
Organism
Productivity
Relationships with climate

- Snow covered days
- Mean annual temperature

Biological turnover
JSDM tree

Mean Annual Temperature

- Frequency observed vs. predicted
  - Current - Historic (Celsius)
  - Spearman's rank correlation: $r = 0.922$

Winter Precipitation (cm)

- Observed vs. predicted
  - Spearman's rank correlation: $r = 0.622$
Connecting community composition to productivity

Community Weighted Means

Functional Richness

Fit model with Sun-Induced Fluorescence data

Compare model fit

Predict trait at each location

Environment

Trait
How have plant communities changed in response to recent warming?

**HA1**: Communities have thermophilized due to similar responses of all species in a community.

**HA2**: Communities have reorganized due to species responding individualistically.
How have plant communities changed in response to recent warming?
How do communities respond to climate?

- Stay the same
- Change in a predictable manner
  - maintain community relationships with
- Communities reorganize

![Graph showing percent of current range maintained over different years (2020, 2050, 2080) for various categories: DF, ENG, GF, LPP, MH, NF, PP, PSF, SAF, SS, WH, WI, WP, WRC, YC.](image)
How are communities responding to climate?

Species richness

↑R

Community turnover

↓R

Tree vs. Understory