



The diversity-stability debate as related to plant-pollinator networks in the HJ Andrews Experimental Forest

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Background

- Many studies have examined the relationship between diversity and stability with varying conclusions
- Complexity is negatively related to stability
 - May, 1972
 - Used theoretical randomly assembled food-web networks
- Species diversity increases stability
 - Tilman, 2005
 - Ten year study of grasslands

Research Questions

1. How does (pollinator) species composition vary over time?
2. What is the relationship between a network's species composition and its structure?
3. How does the complexity of a meadow relate to its stability?

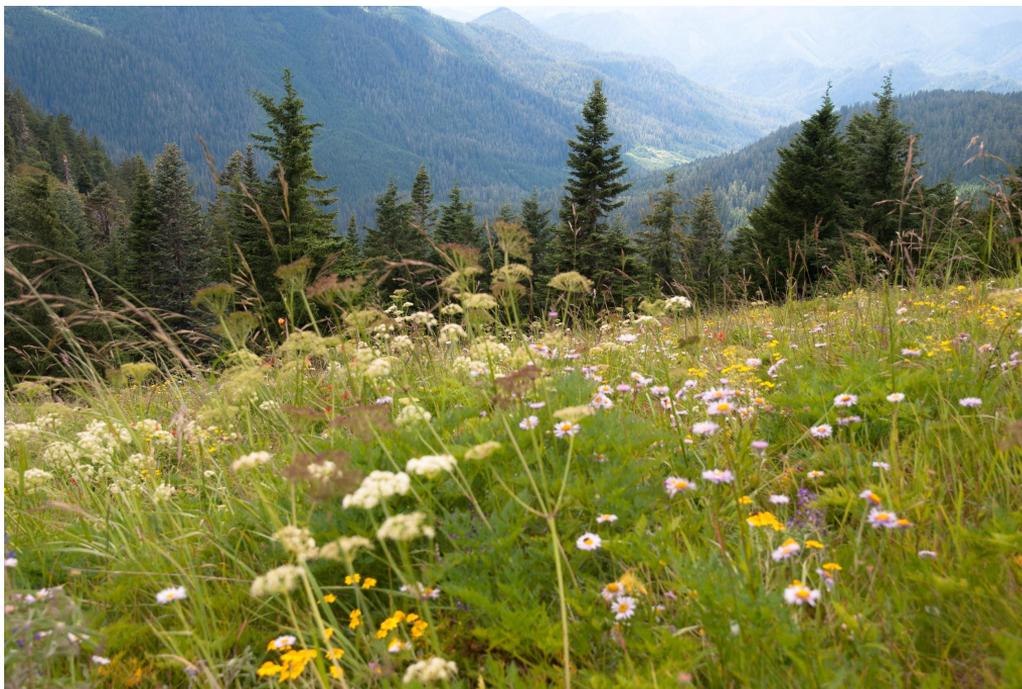


Photo: Carolyn Silverman

Definitions

- **Diversity:** number of rows or columns
- **Connectance:** number of 1's/total cells 0.33
- **Complexity:**
 $\sqrt{\text{diversity} \times \text{connectance}}$
- **Stability:** changes in the species in the columns or rows between years

Example interaction network

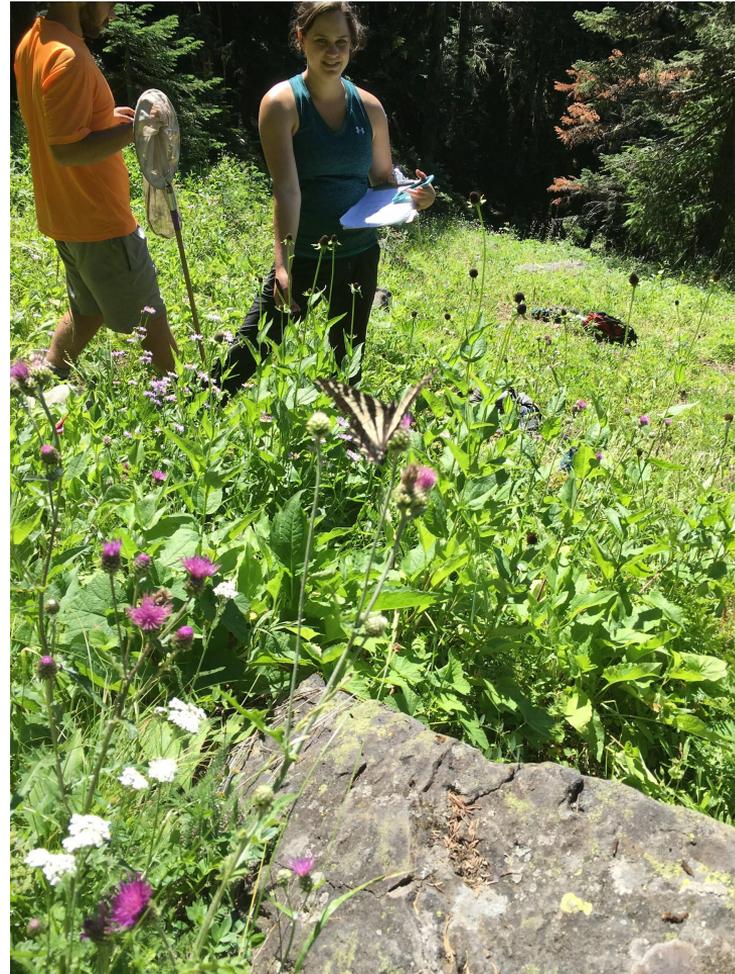
pl = plant species

po = pollinator species

	pl1	pl2	pl3	pl4	pl5	pl6
po1	1	1		1		1
po2			1		1	
po3		1				
po4		1				
po5	1			1		

Field Sampling

- Interaction survey data
- Record which pollinators interact with which plants in a 15 minute watch



1. Species Composition-Methods and Hypotheses

How does the composition of pollinator species change over time?

Plot number of pollinator species over time.

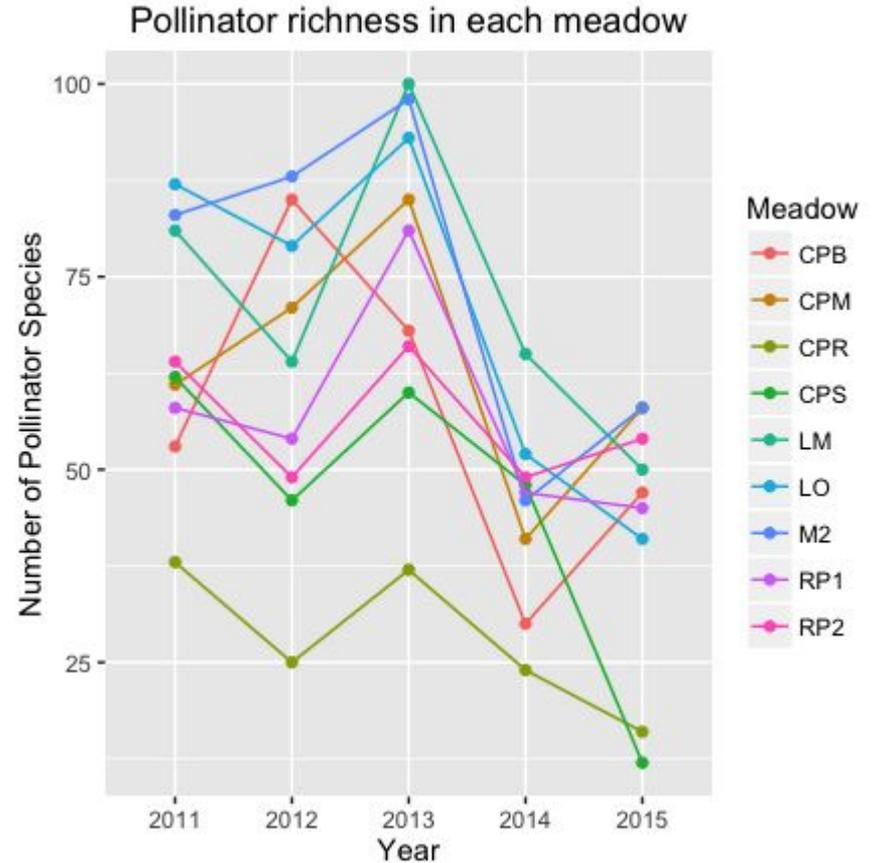
Expect to see some variation. Will there be a decrease for 2015, a drought year?



Change between years of species composition of Pollinators

We can see that the richness of pollinators varies throughout the years of the study

Do these meadows have characteristics that influence these changes?



2. Diversity and Connectance Relationship -Methods and Hypotheses

Examine relationship between size of the network and network structure.

Plot plant + pollinator species vs connectance to examine the relationship

Expect to see some sort of relationship

May theorized networks are stable if complexity = $\sqrt{N * C} < 1/b$



Photo: Carolyn Silverman

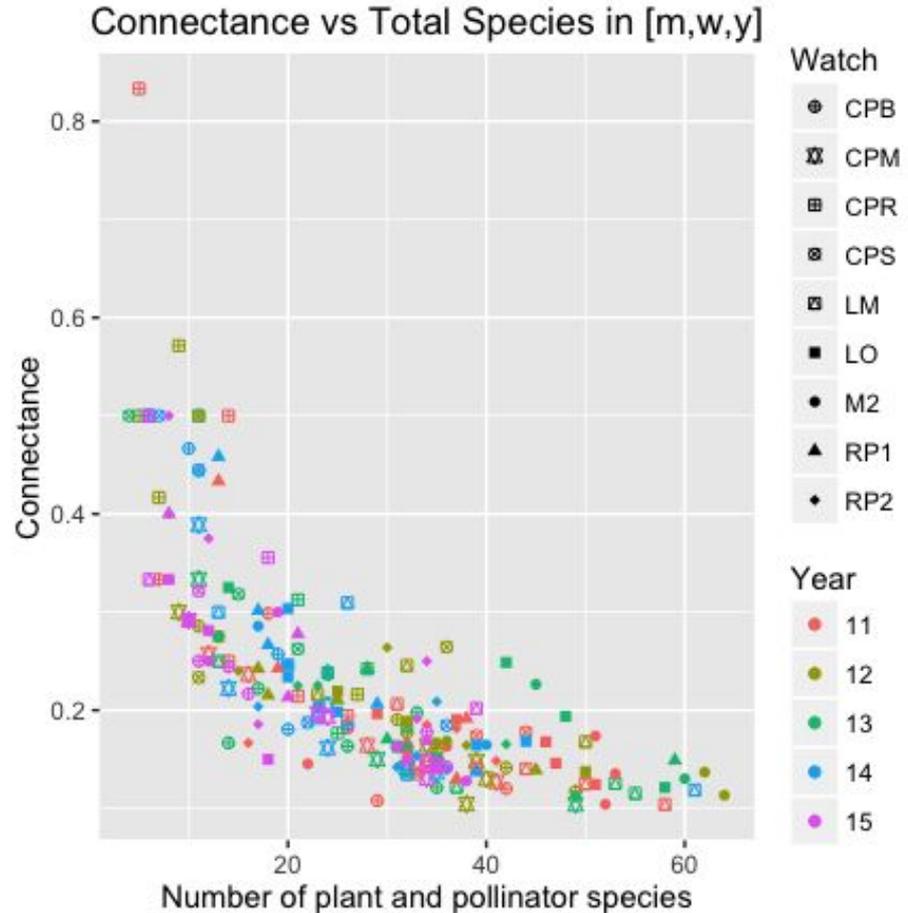
Relationship between diversity and connectance

Reciprocal relationship

Does not vary much throughout the years

Networks with higher complexity would be those closer to the upper right of the graph.

Which networks are more stable?



3. Stability and Complexity- Methods and Hypotheses

Test the relationship between stability and complexity of pollinator species by using two similarity indices.

Two stability indices: Jaccard Index and Sorensen-Dice Index. Both are used for presence absence data. A higher value would mean that the makeup of pollinator species is more similar across years.

Jaccard Index:
$$J = \frac{|A \cup B|}{|A \cap B|}$$

Sorensen-Dice Index:
$$S = \frac{2|A \cap B|}{|A| + |B|}$$

May's complexity index: $\sqrt{N \cdot C}$.

Hypothesize that since the relationship between diversity and connectance agreed with May, we could see a negative relationship between stability and complexity.

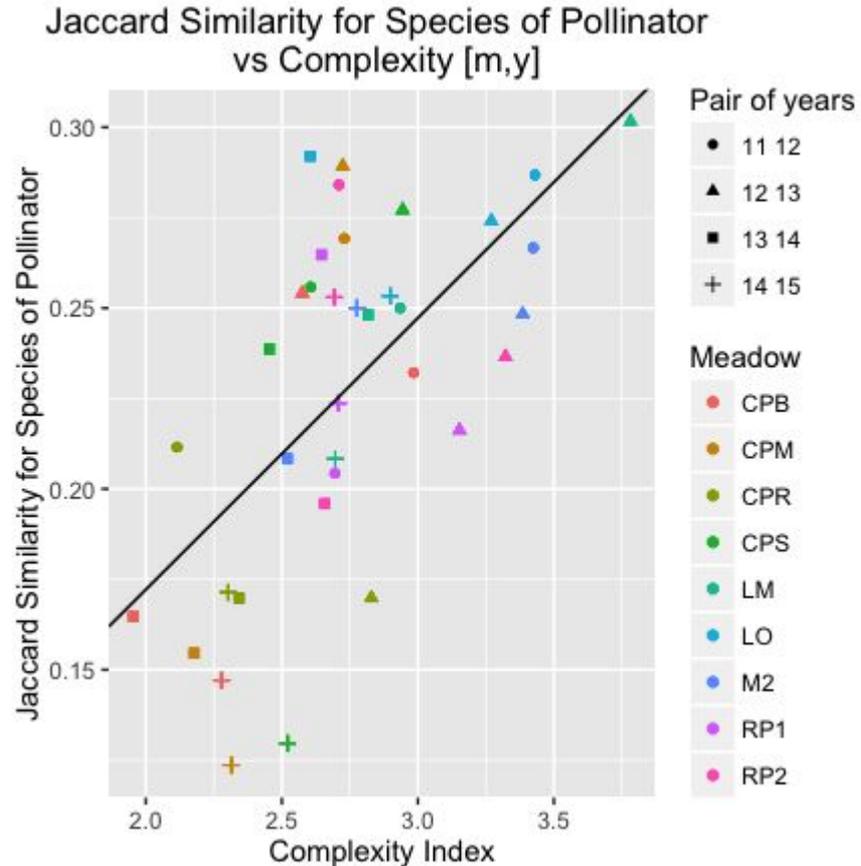
Complexity positively related to stability

- Jaccard Index

$$J = \frac{|A \cup B|}{|A \cap B|}$$

Significant positive relationship between complexity (\sqrt{NC}) and stability

The more complex a network, the less the species composition of pollinators changes



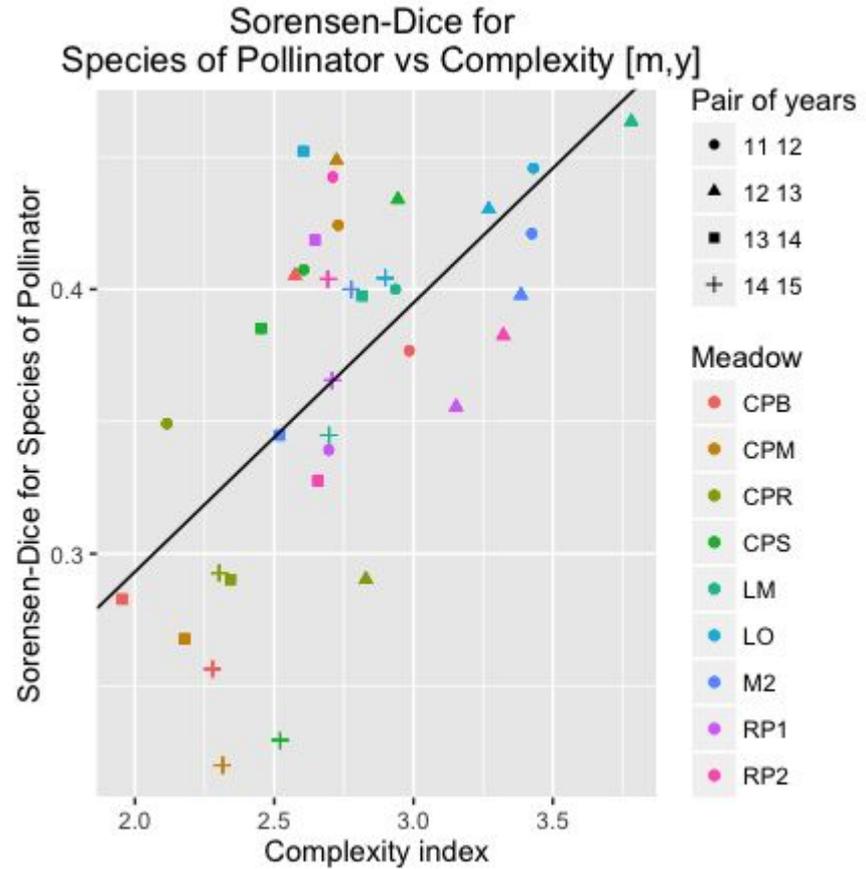
Complexity positively related to stability

- Sørensen-Dice coefficient

$$S = \frac{2|A \cup B|}{|A| + |B|}$$

Also shows significant positive relationship between complexity and stability.

Slightly steeper slope



Conclusions & Future Research

- Pollinator species composition has shown changes
- Relationship between number of species in a network and its connectance
- Why? Perhaps due to generalist/specialist aspect of plant-pollinator networks
- Plant-pollinator networks with increased complexity have more stability
- Include plant-plant and pollinator-pollinator interactions



Thank you!