# Influence of pollinator traits on algorithm-based module detection in an H. J. Andrews plant-pollinator network

Anne Thomas

Brigham Young University

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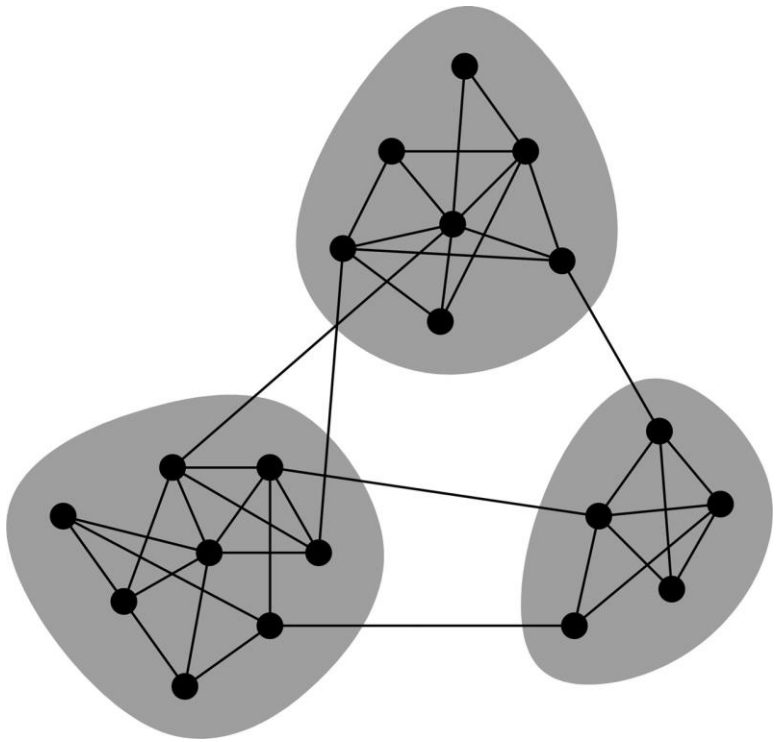
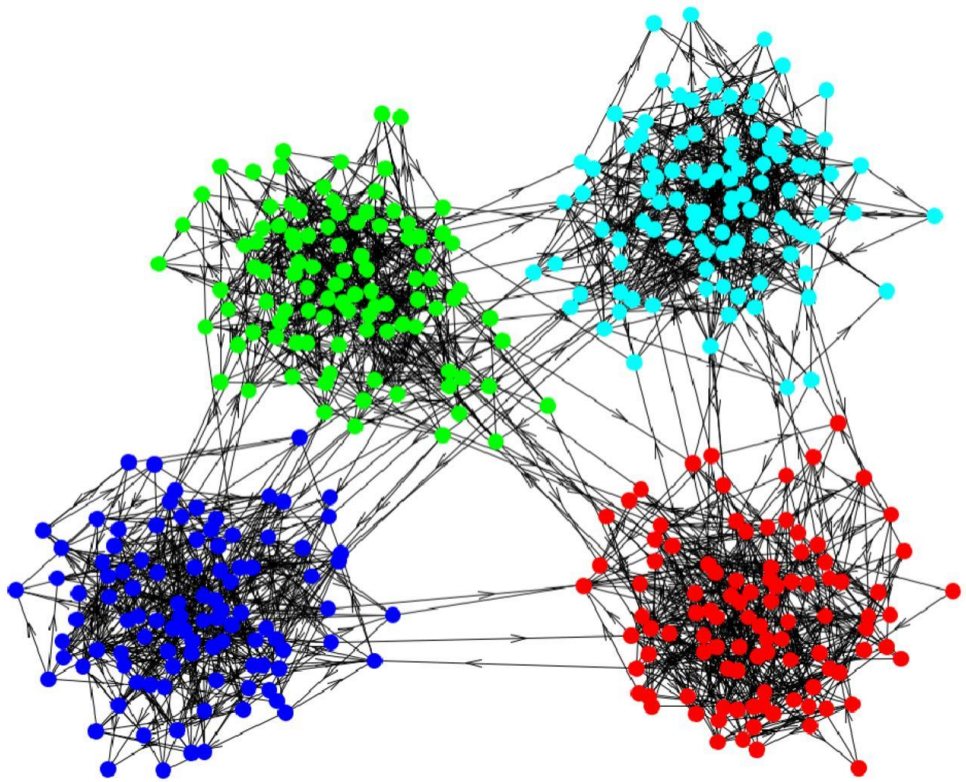
# Outline

- Network modules: what are they and what’s behind them?
- How do we detect modules?
- How can traits can inform detection?
- Our network: Frissell meadows 2013, 2014
- What can pollinator traits tell us about network modules?

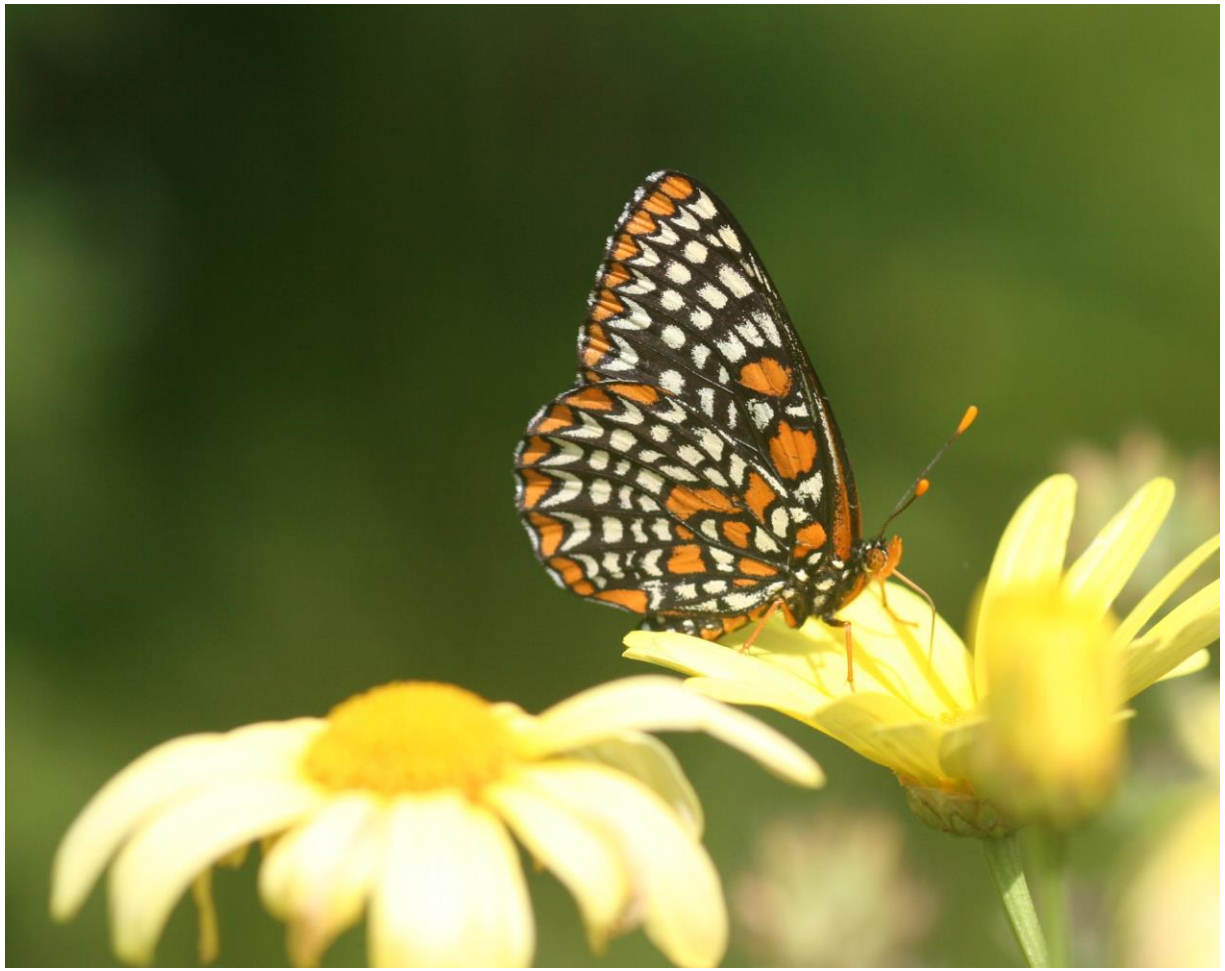
# What is a network module?





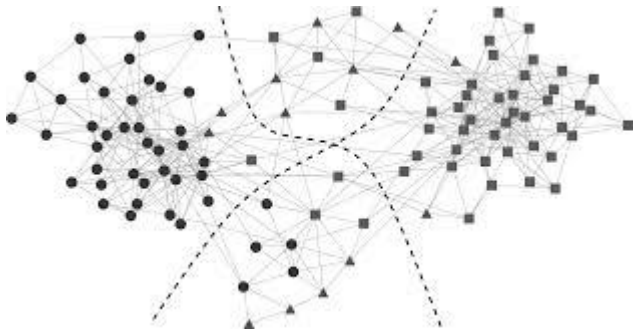
# Why study modules?

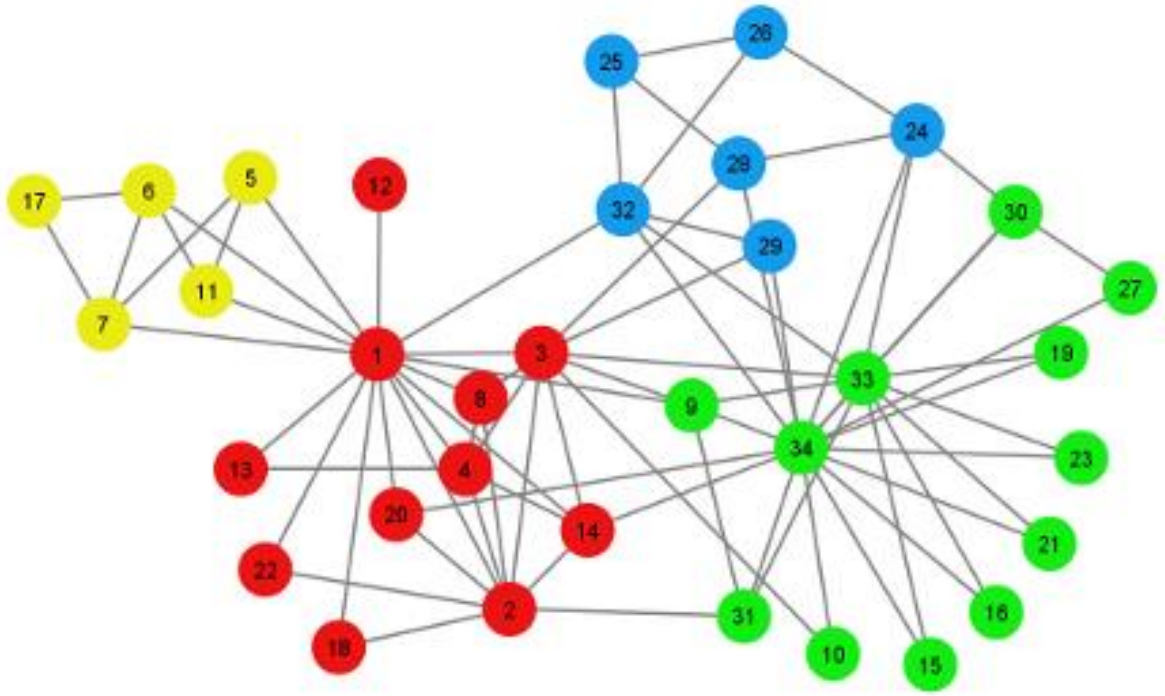
- Resilience
- Evolution
- Conservation



# How do we detect modules?

- Most algorithms: structure



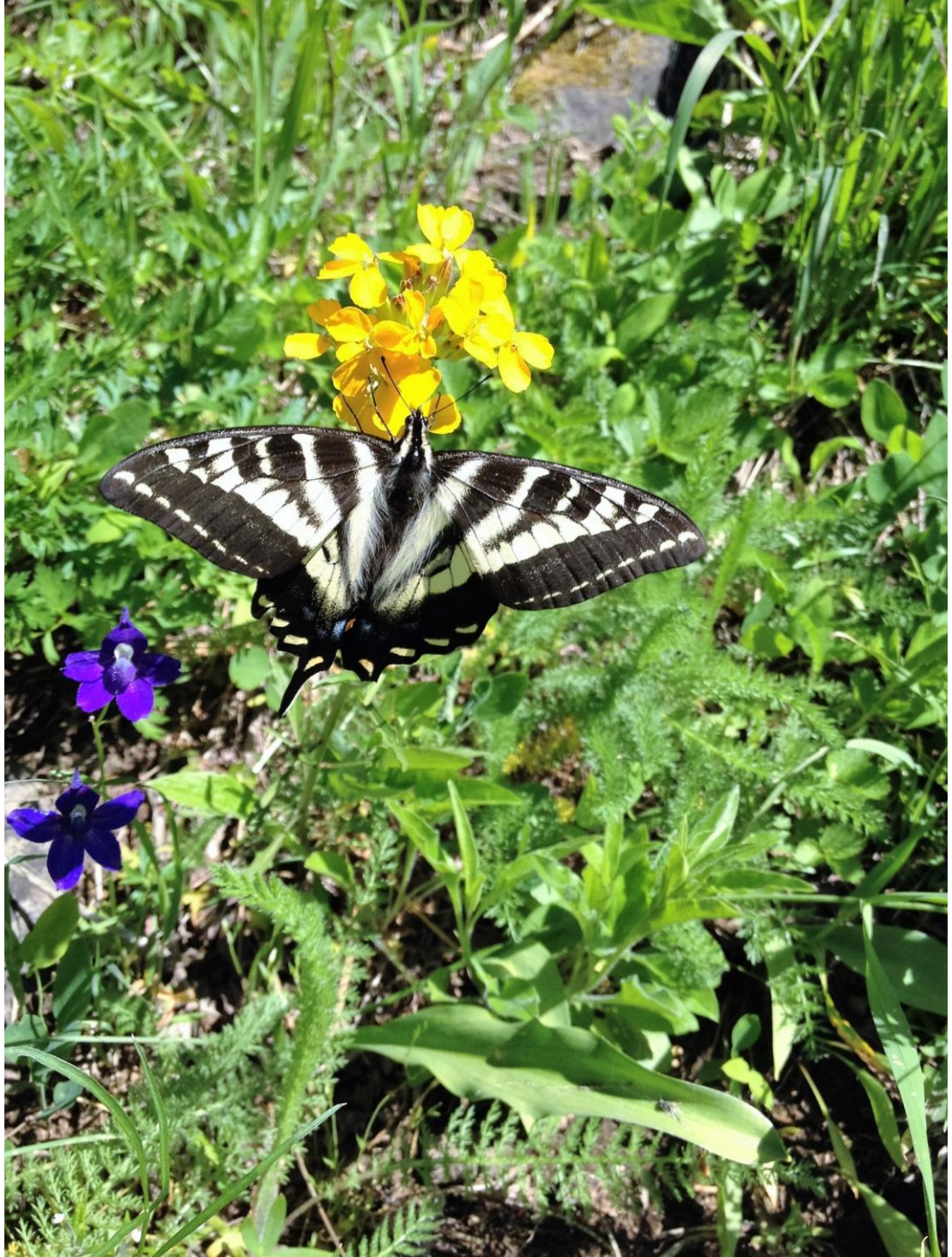


# What do traits have to do with modules?

- Tongue length
- Body size
- Flower color
- Etc.

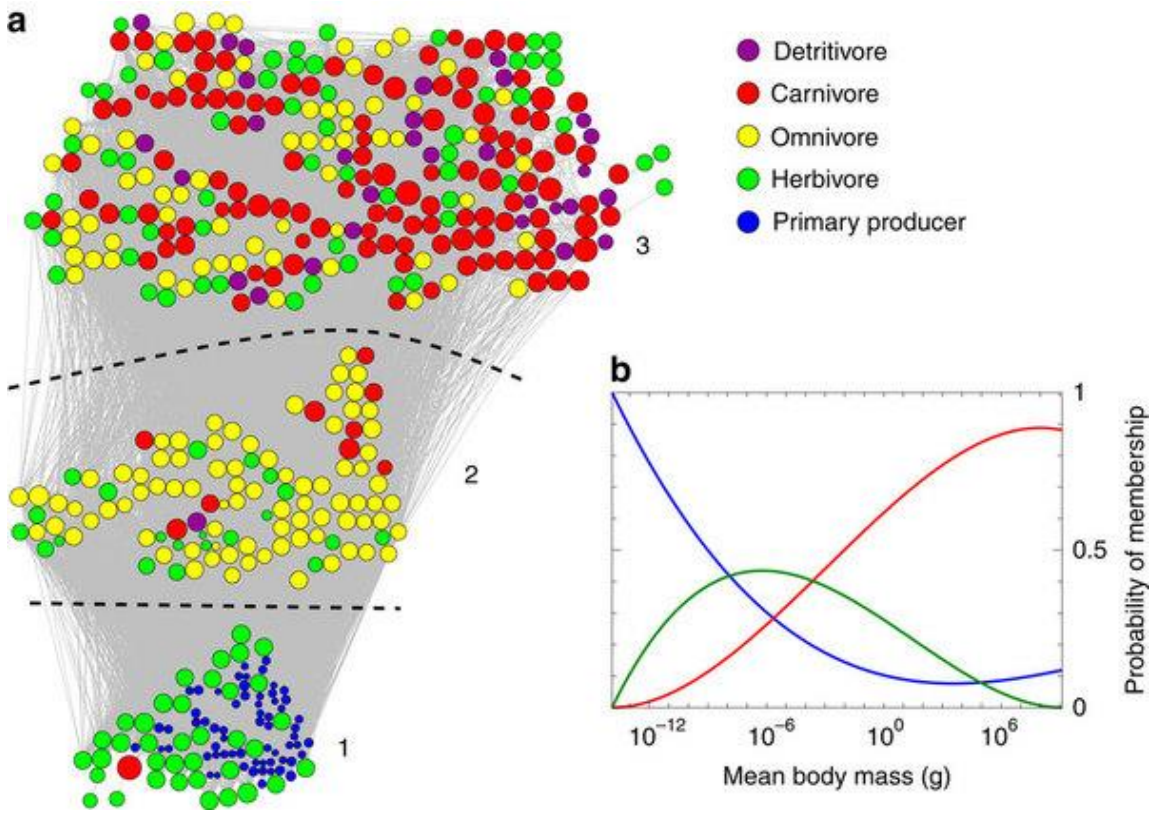
# Research Question

- How are network groupings in the Andrews influenced by pollinator traits?
  - Are network groupings correlated to traits?
  - Does this translate to a meaningful ecological group?



# The Newman-Clauset algorithm

- Annotated network input **(metadata)**
- Bayesian statistics and model fit
- Output: module assignments for each node
  - K: user-defined number of modules to be detected

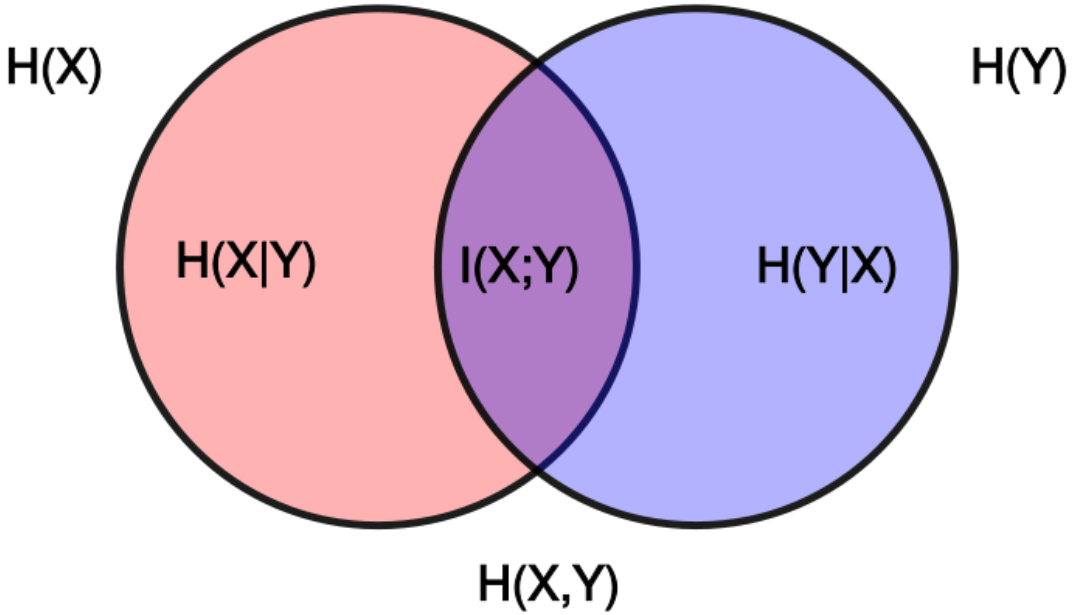



From Newman and Clauset 2016: a food network divided into three communities based on body mass

Newman, M. E. J. and Aaron Clauset, "Structure and Inference in Annotated Networks," Nat Commun 7 (June 16, 2016), http://dx.doi.org/10.1038/ncomms11863.

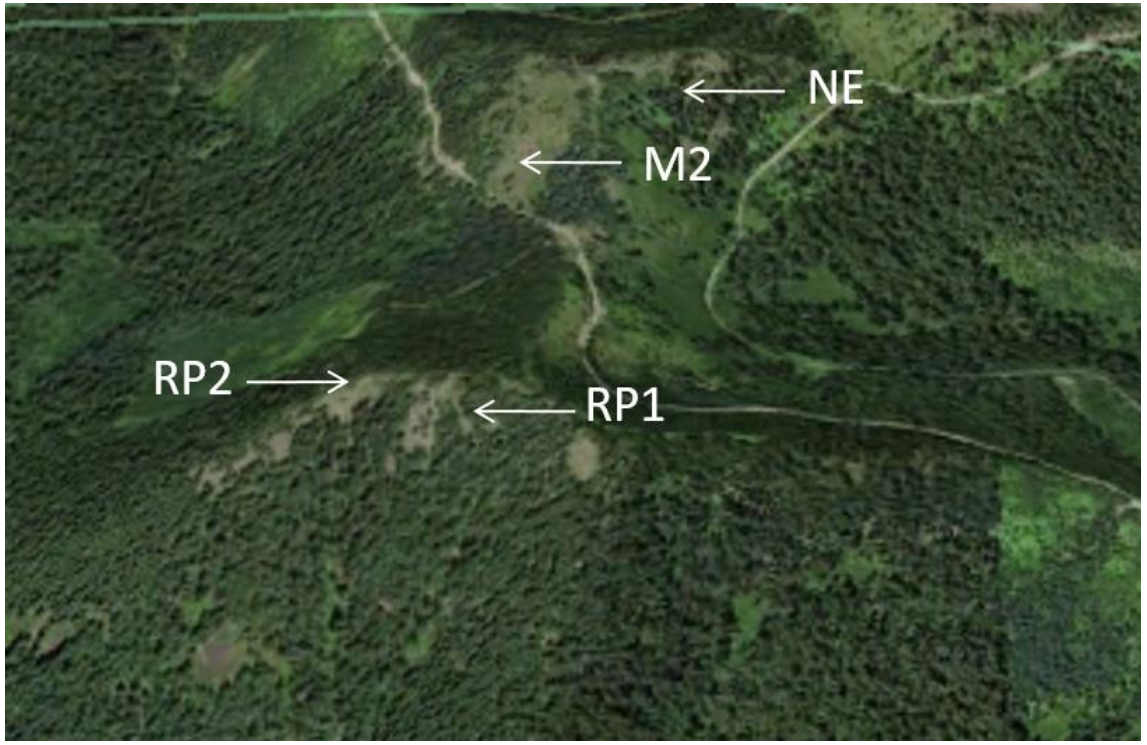
# NMI measures correlation between metadata and module assignments

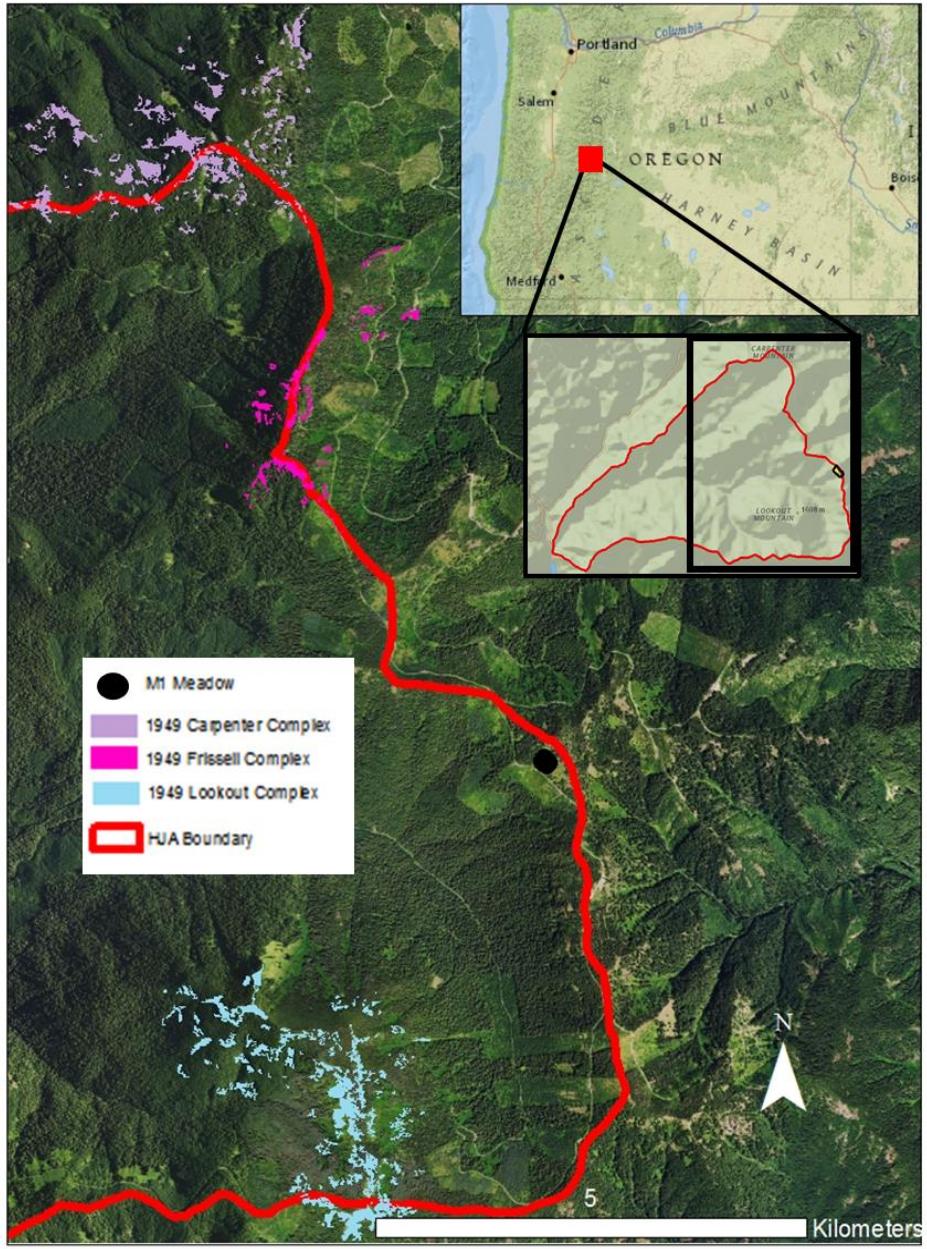
- **Normalized mutual information**
- 0 = metadata gives no information about community divisions
- 1 = metadata completely informs community divisions



# Our network

- Frissell complex
- 2013 and 2014



# Pollinators and Traits

- One-mode projection
- 2013: 168 pollinator species
- 2014: 96 pollinator species
  - 61 species shared between 2013 and 2014

- Tongue Length
- Body Size (decile)


https://jappliedecologyblog.wordpress.com/2015/09/25/making-the-most-of-pollinators-to-improve-and-predict-crop-yields/

# How tongue length and body size were related to modules

| Year | trait | k | NMI |
|---|---|---|---|
| 2013 | Tongue length | 3 | 0.1983129 |
| 2013 | Body Size | 3 | 0.07418211 |
| 2014 | Tongue length | 4 | 0.4487 |
| 2014 | Body Size | 3 | 0.4644127 |

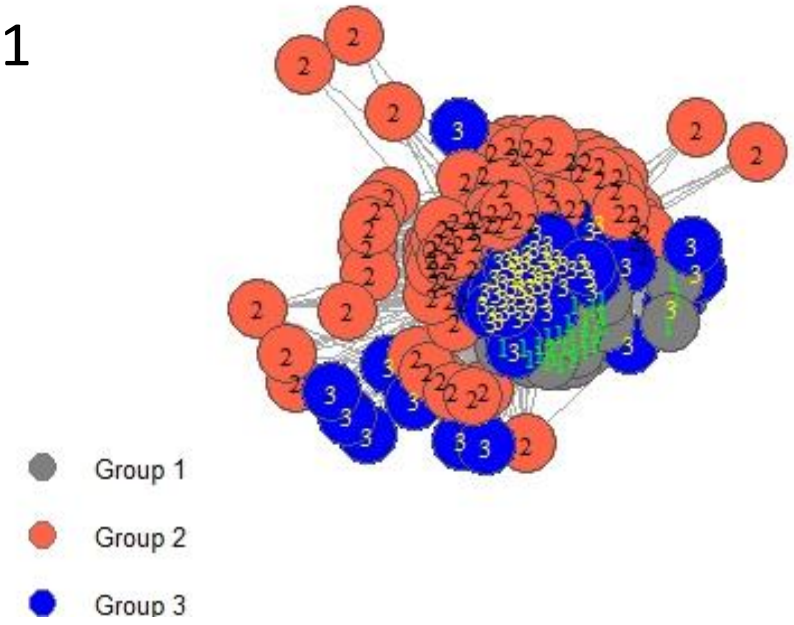
# Body size not correlated to modules detected in 2013

Frissell 2013

Metadata = Body Size

K = 3

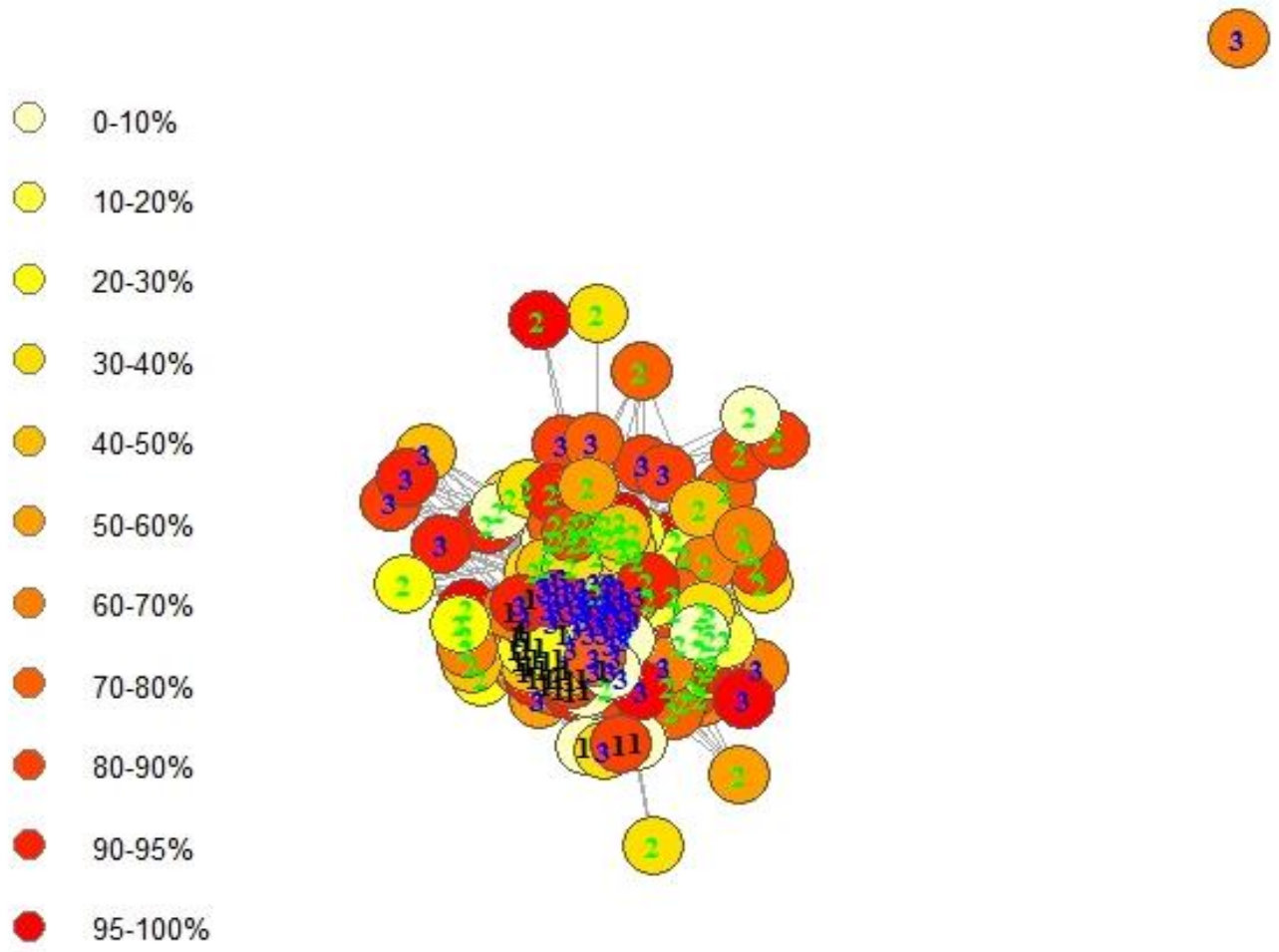
NMI = 0.07418211




2013 mean body size decile (1-11)

| group | mean |
|---|---|
| 1 | 5.60 |
| 2 | 5.75 |
| 3 | 6.37 |

# Body size values dispersed in 2013 modules



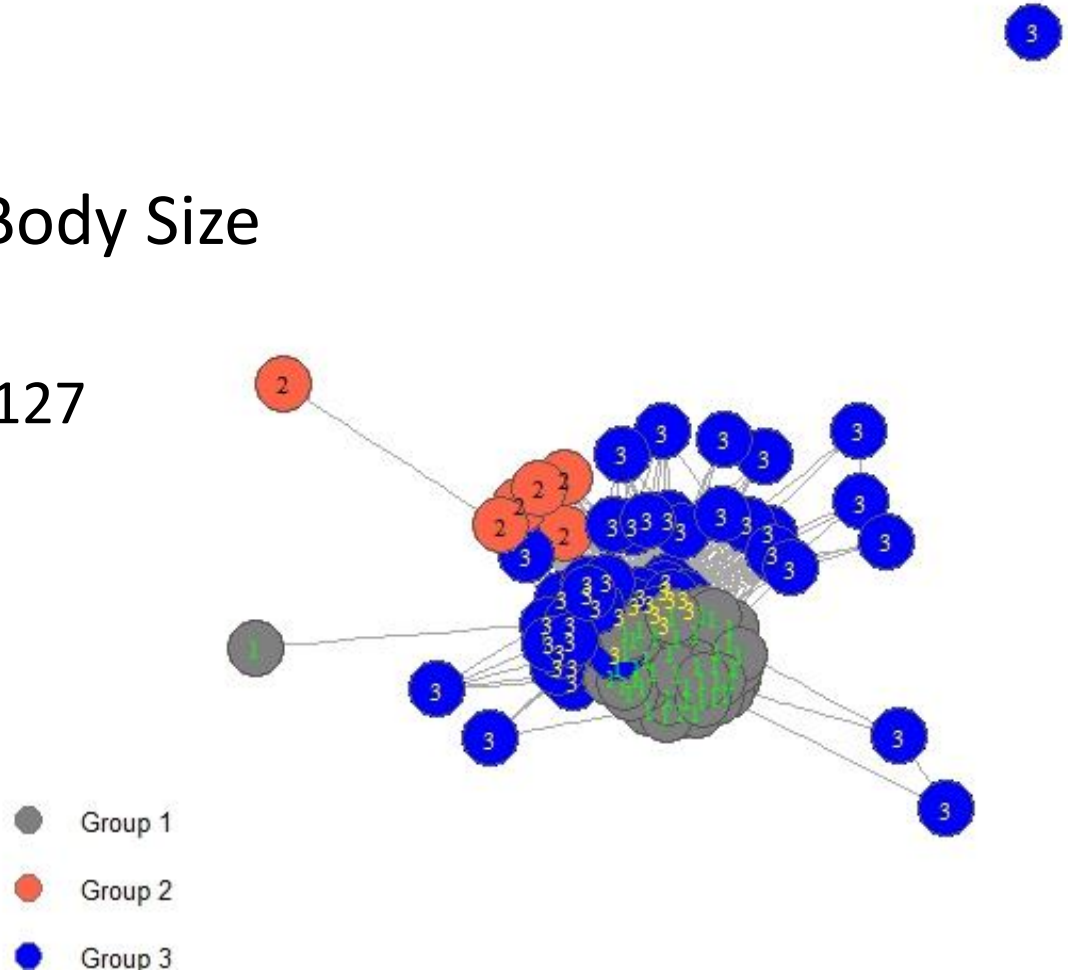
# Body size better correlated to modules detected in 2014

Frissell 2014

Metadata = Body Size

K = 3

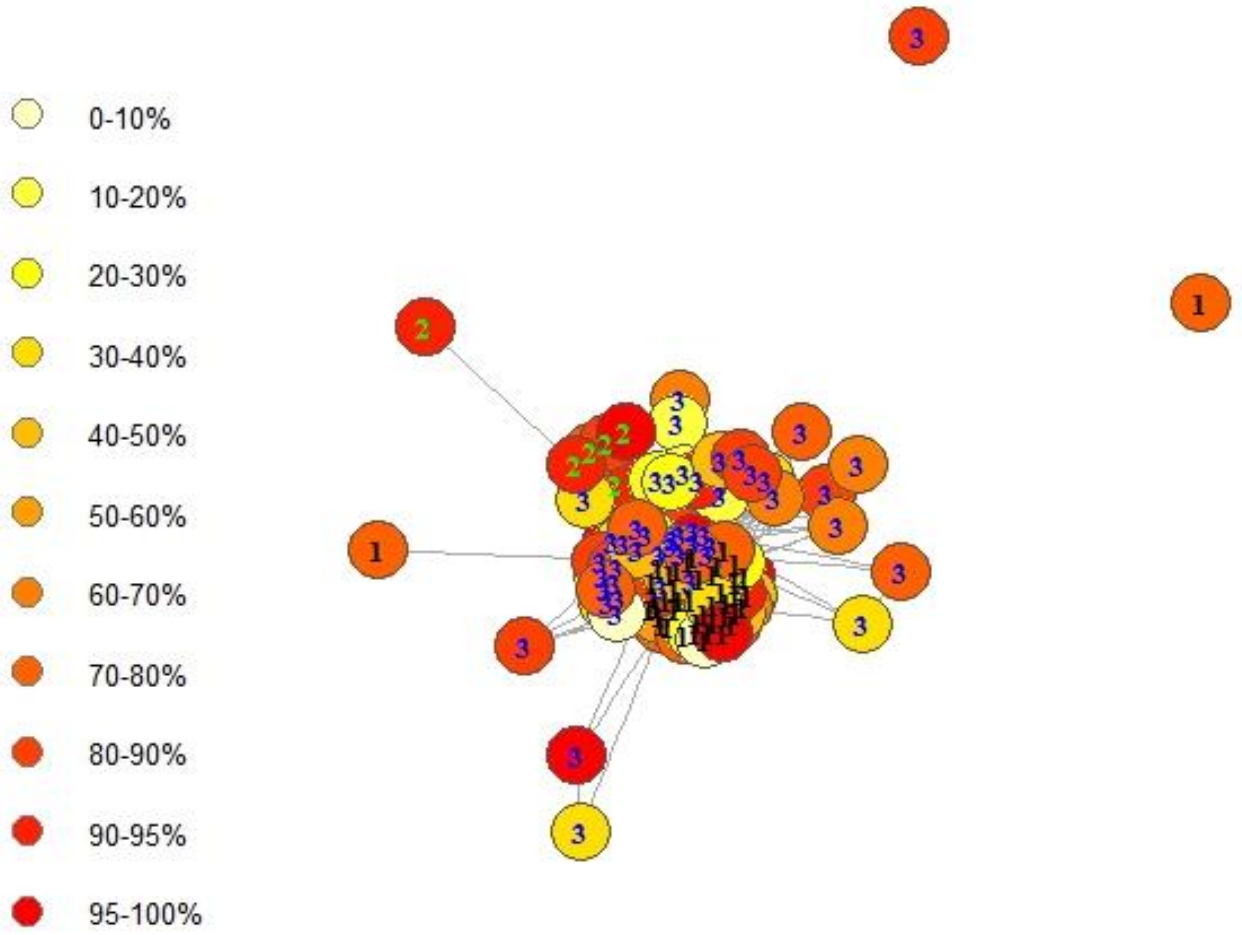
NMI = 0.4644127



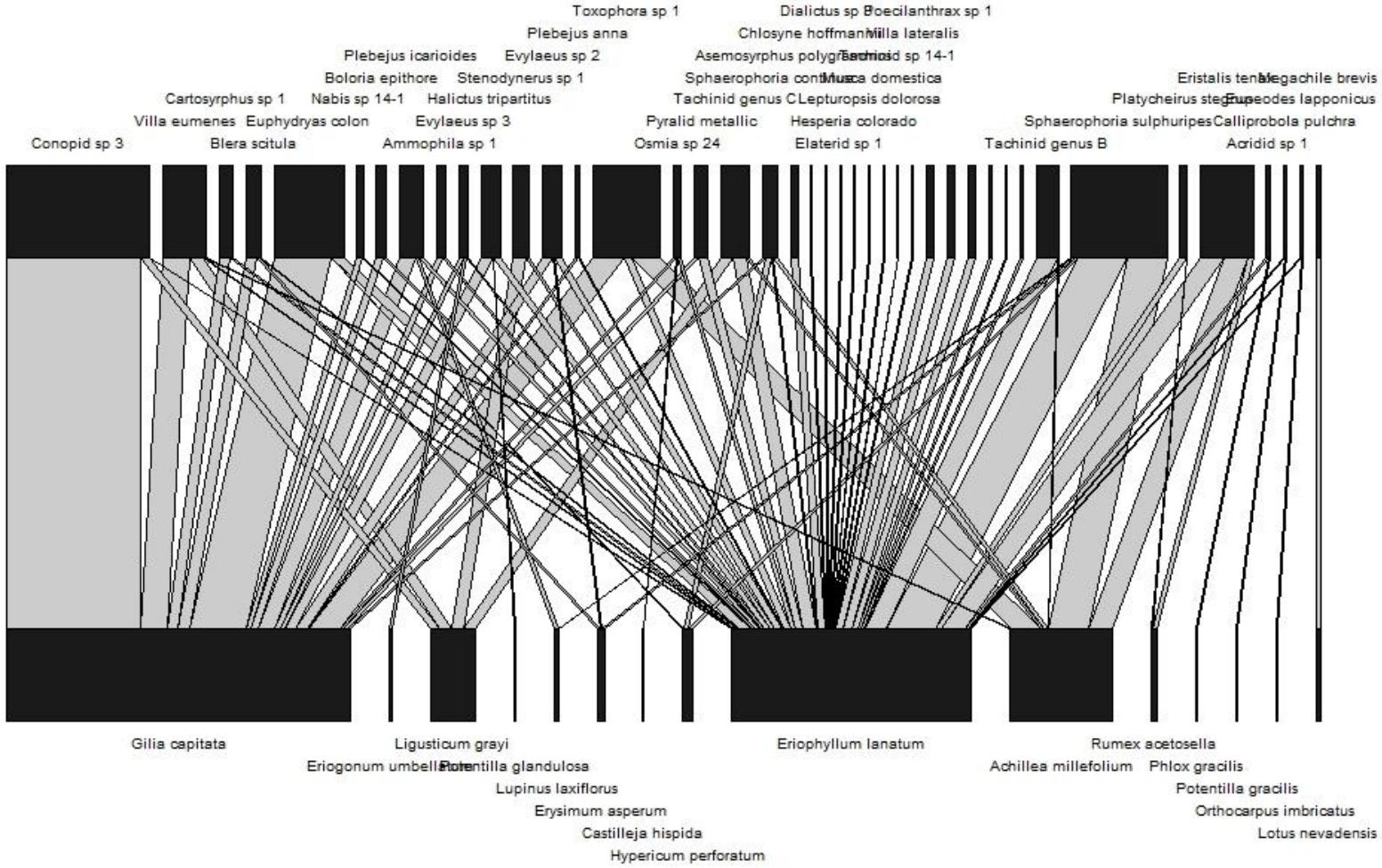

2014 mean body size decile (1-11)

| group | mean |
|---|---|
| 1 | 5.93 |
| 2 | **9.67** |
| 3 | 6.83 |

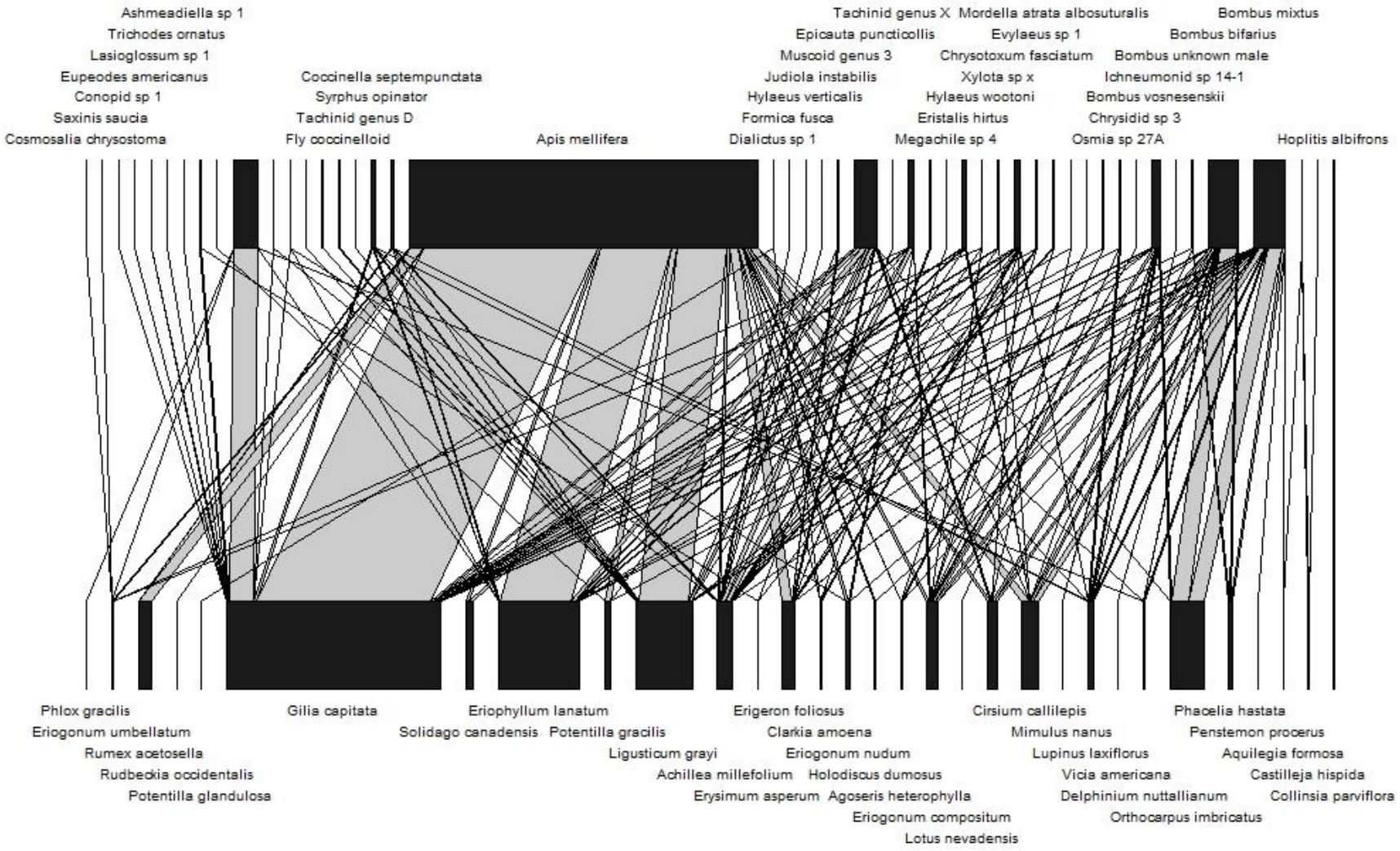
# Body size values more concentrated in 2014 modules



# 2014 Body Size module 1: body size diverse

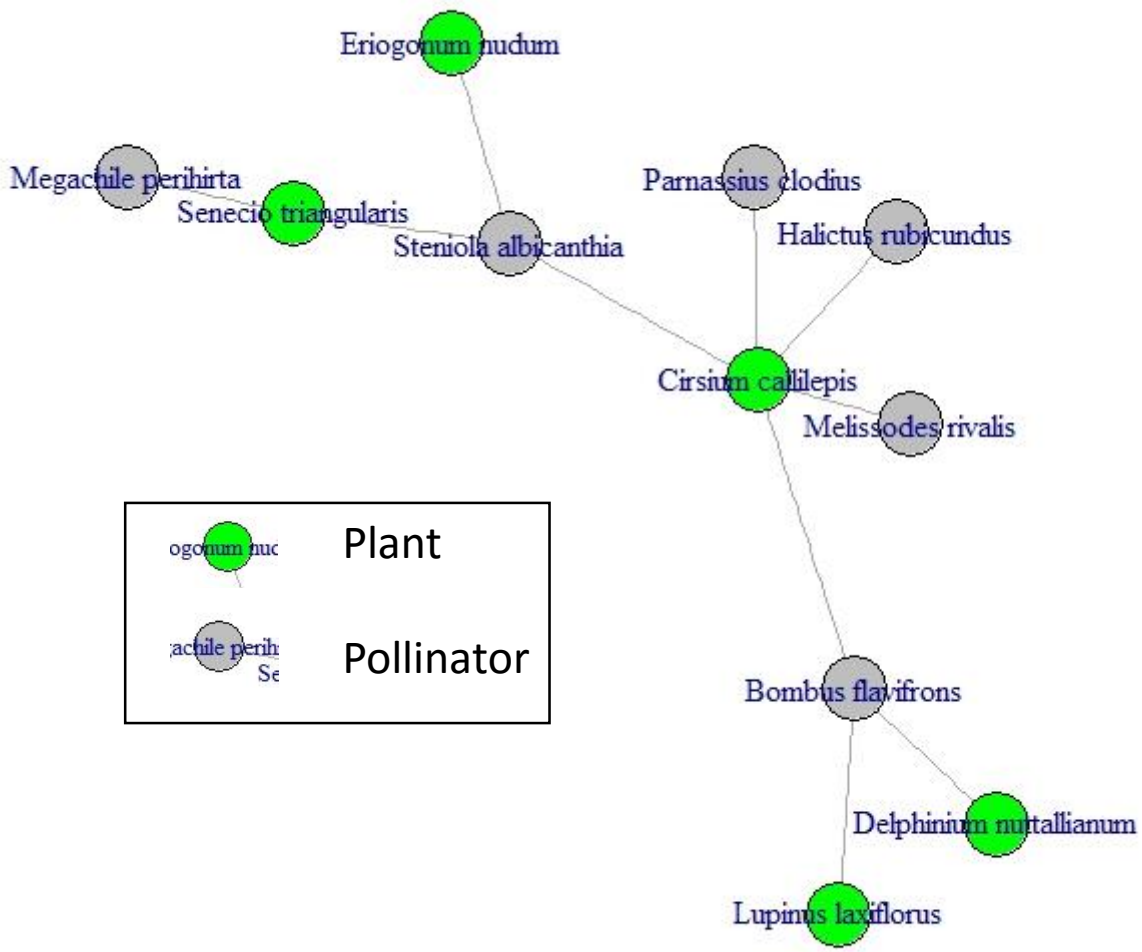


# 2014 Body Size module 3: body size diverse



# 2014 Body Size module 2: large-bodied pollinators

| Species | Size decile | Pollinator guild |
|---|---|---|
| Bombus flavifrons | 90-95% | social bee |
| Halictus rubicundus | 70-80% | halictine bee |
| Megachile perihirta | 90-95% | solitary bee |
| Melissodes rivalis | 80-90% | solitary bee |
| Parnassius clodius | 95-100% | herbivorous butterfly; diurnal |
| Steniola albicanthia | 90-95% | bee-predaceous wasp |



# Conclusions and further work

- Varies from year to year and subset to subset
- Further analysis and other approaches
  - Combinations of traits
  - Other subsets
  - Higher k
  - Filter out rare interactions
  - Plant traits
- Individual traits don’t have a strong effect on groupings overall
- Other factors: generalists, abundance, timing

# Acknowledgements


- Andy Moldenke
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