

# Landscape connectivity shapes invertebrate biodiversity in urban ponds

Chaz Hyseni & Frank Johansson



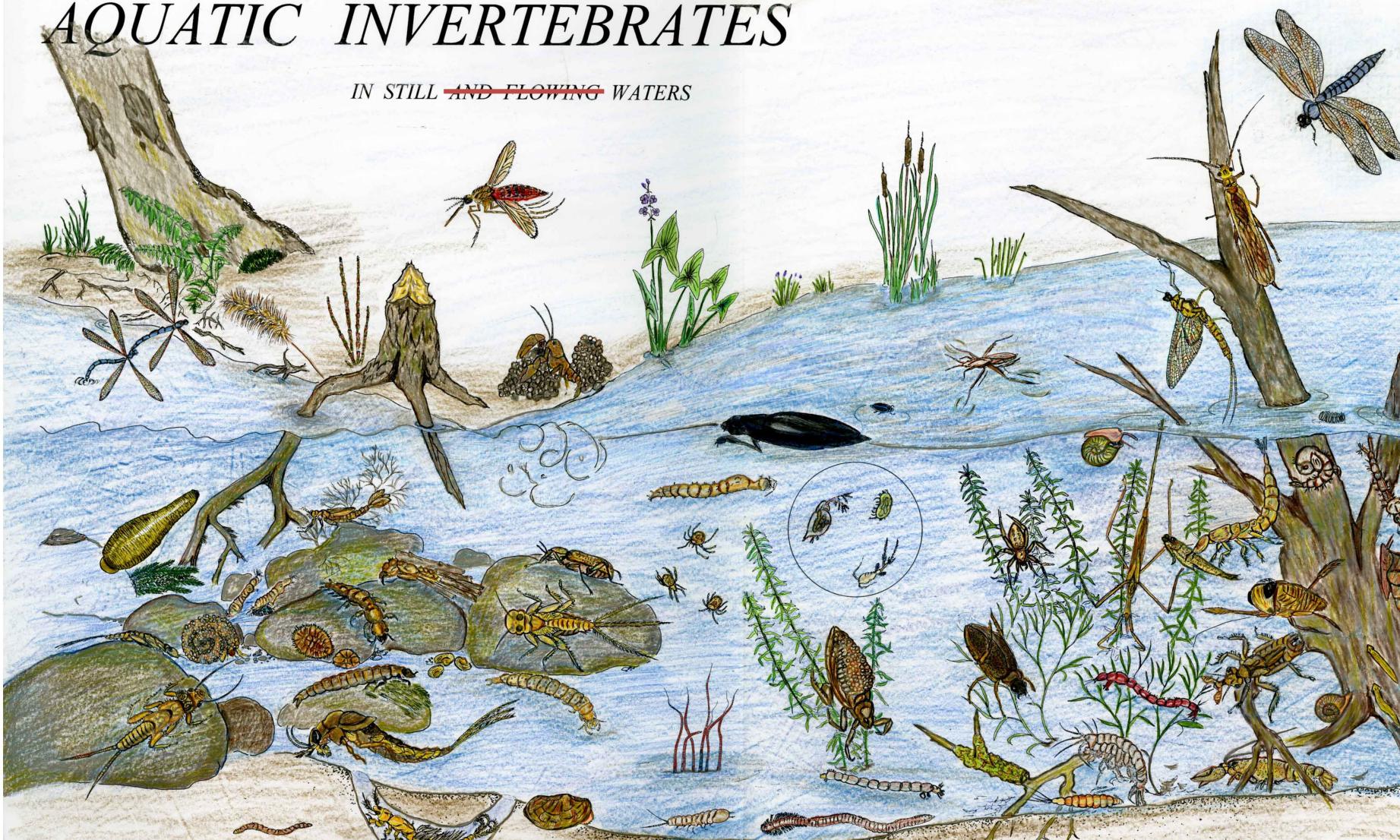
UPPSALA  
UNIVERSITET

# Sampling: Pond Invertebrates

~160 species  
~90 species (>5% sites)

## AQUATIC INVERTEBRATES

IN STILL ~~AND FLOWING~~ WATERS



Coleoptera  
(beetles)  
Hemiptera  
(true bugs)  
Odonata

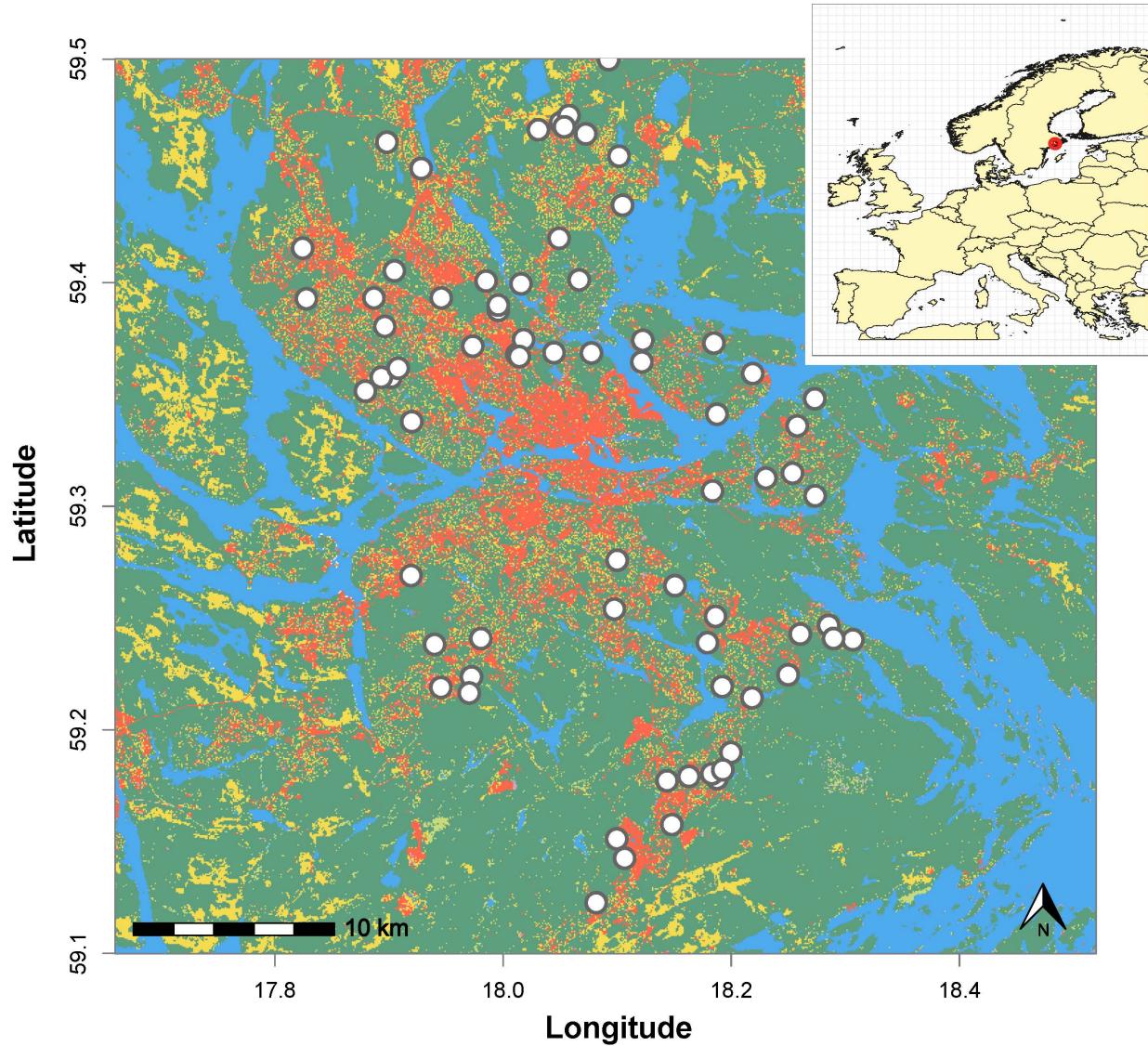
(damsel- and dragonflies)  
Trichoptera  
(caddisflies)

Gastropoda  
(freshwater snails)

Drawing: Carie Nixon  
Illinois Natural History Survey

# Sampling: Stockholm Metro

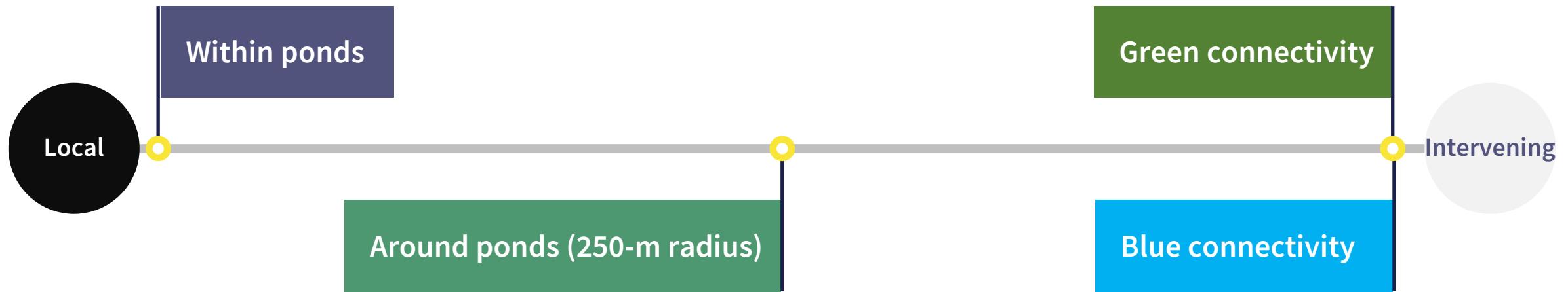
80 sites



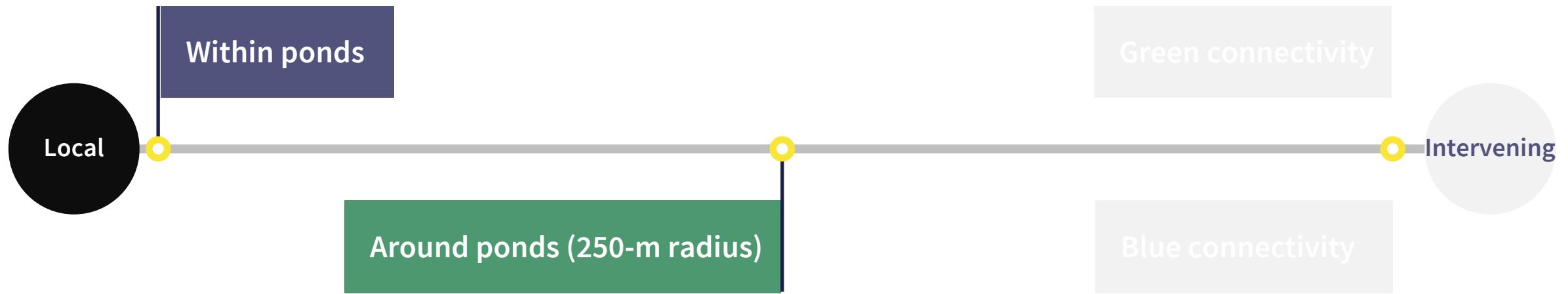
# Questions

- **What landscape features are meta-communities shaped by?**
  1. The local environment:
    - What is the environment within (and around) ponds?
  2. The intervening landscape between ponds:
    - Are communities more similar in neighboring ponds (structural connectivity)?
    - How does the landscape affect dispersal (functional connectivity)?
- **What are the pathways of dispersal for these meta-communities?**

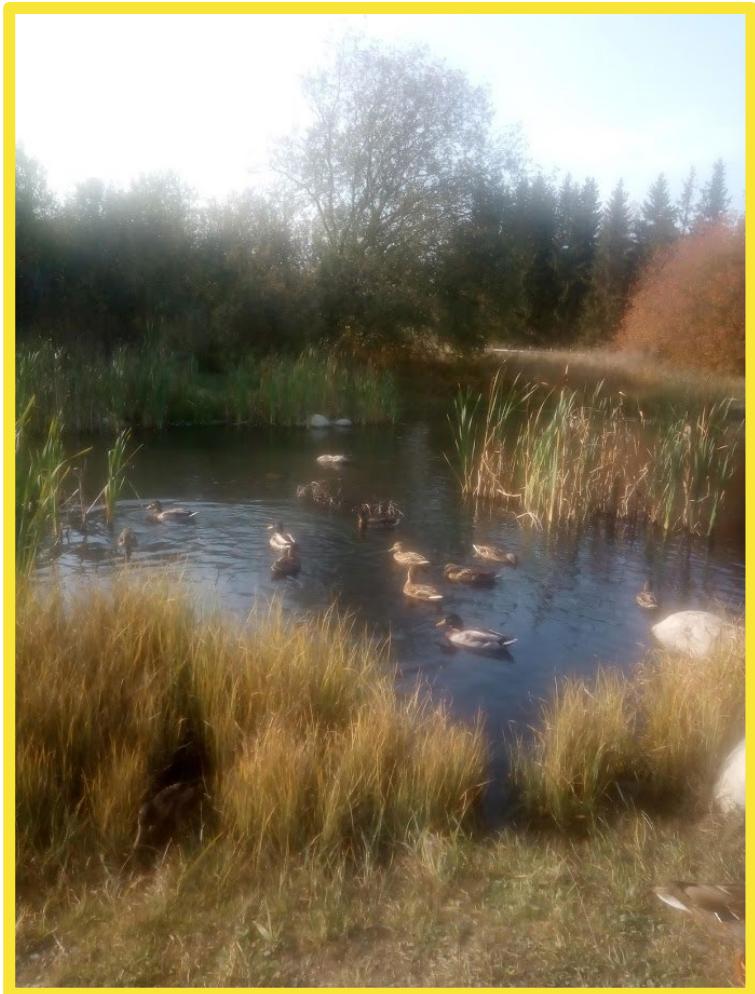
# Continuum of Influence on Community Composition



# Continuum of Influence on Community Composition



# Sampling



Photos: Chaz

# Sampling



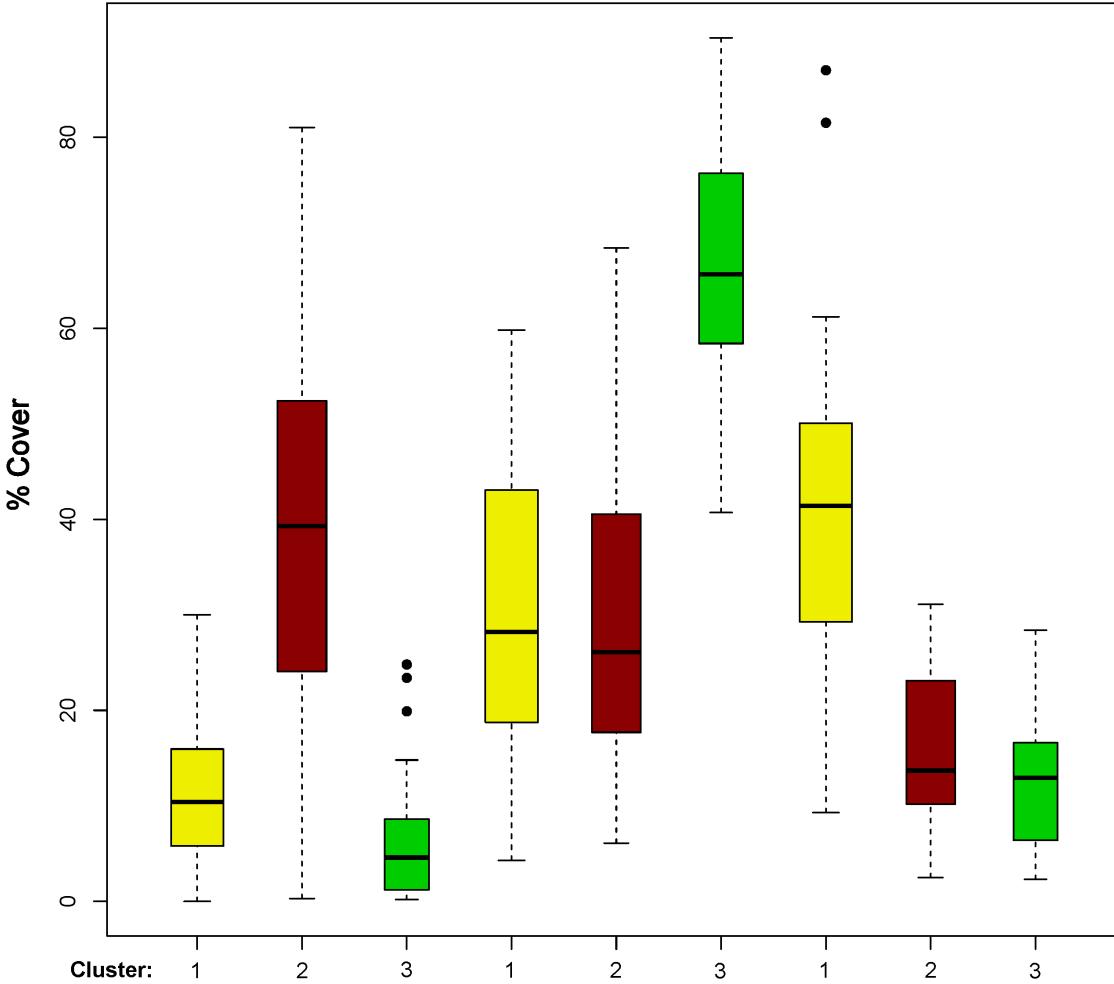
Photos: Frank

# Local Environment

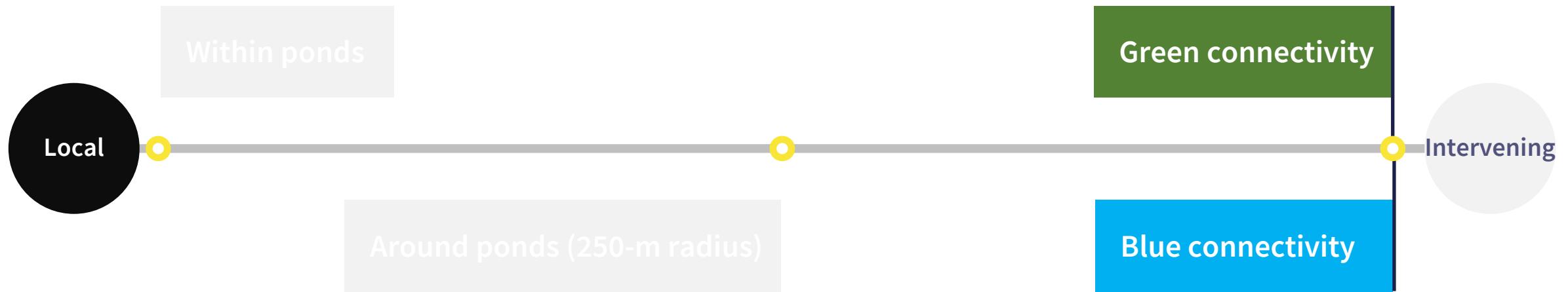
Within

|                        | Cluster 1: Grassland |                | Cluster 2: Artif. Surf. |              | Cluster 3: Forest |              |
|------------------------|----------------------|----------------|-------------------------|--------------|-------------------|--------------|
|                        | Median               | 25%-75%        | Median                  | 25%-75%      | Median            | 25%-75%      |
| area (m <sup>2</sup> ) | 1105.0               | [738.5-1973.5] | 503.0                   | [206-1089.5] | 2008.0            | [640.5-4019] |
| depth (m)              | 0.6                  | [0.4-0.8]      | 0.7                     | [0.4-0.9]    | 1.1               | [0.6-1.5]    |
| pH                     | 7.4                  | [7.1-7.6]      | 7.3                     | [7-7.5]      | 7.2               | [6.9-8]      |
| float. veg.            | 2.0                  | [0-3]          | 2.8                     | [0-4.5]      | 2.0               | [0.3-4.5]    |
| emerg. veg.            | 3.2                  | [2-5.5]        | 3.0                     | [1.5-4.5]    | 2.0               | [1-3]        |
| bushes                 | 2.0                  | [1-3]          | 3.0                     | [1-4]        | 2.5               | [1-4]        |
| bare ground            | 0.0                  | [0-1.3]        | 0.0                     | [0-5.5]      | 0.0               | [0-0.8]      |
| TOC                    | 15.6                 | [12.2-20.7]    | 16.1                    | [10.2-18.6]  | 16.9              | [13.1-20.7]  |
| totN                   | 1.3                  | [0.9-1.7]      | 0.9                     | [0.7-1.4]    | 1.0               | [0.9-1.4]    |
| totP                   | 72.0                 | [30-148]       | 57.0                    | [21.9-148]   | 39.0              | [25.8-76.5]  |
| artif. surf.           | 10.4                 | [5.8-16]       | 39.3                    | [24-52.4]    | 4.6               | [1.4-8.4]    |
| cultiv. area.          | 9.8                  | [7-16.1]       | 11.4                    | [6.5-14.9]   | 3.5               | [1.9-7.2]    |
| tree cover             | 28.2                 | [18.8-43.1]    | 26.1                    | [17.7-40.5]  | 65.6              | [59-75.9]    |
| shrubs                 | 41.5                 | [29.2-50.1]    | 13.7                    | [10.2-23.1]  | 13.0              | [7.2-16.6]   |
| marsh/peat             | 1.5                  | [1-3.4]        | 1.1                     | [0.6-1.8]    | 3.3               | [1.2-7.5]    |
| nat. surf.             | 0.3                  | [0-0.8]        | 1.3                     | [0.8-2]      | 0.2               | [0.1-0.6]    |
| water                  | 0.0                  | [0-0.7]        | 0.0                     | [0-0]        | 0.0               | [0-0.6]      |

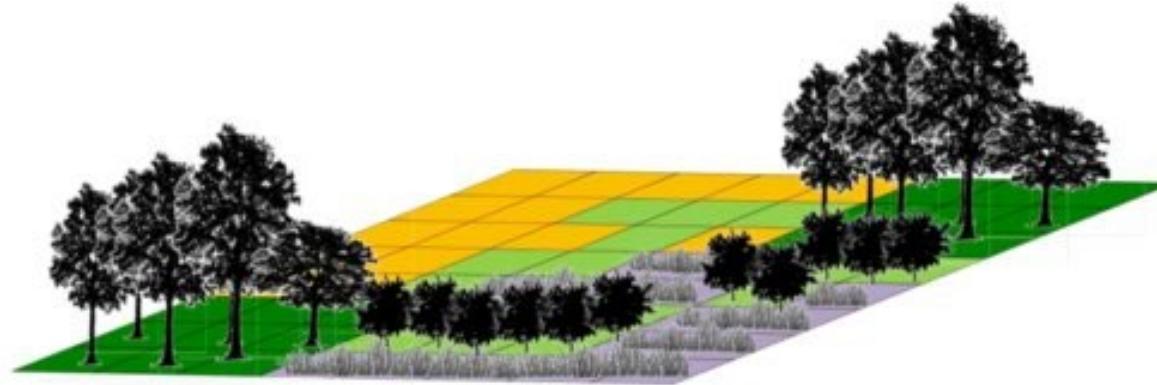
Around



# Continuum of Influence on Community Composition



# Circuit Theory & Landscape Ecology

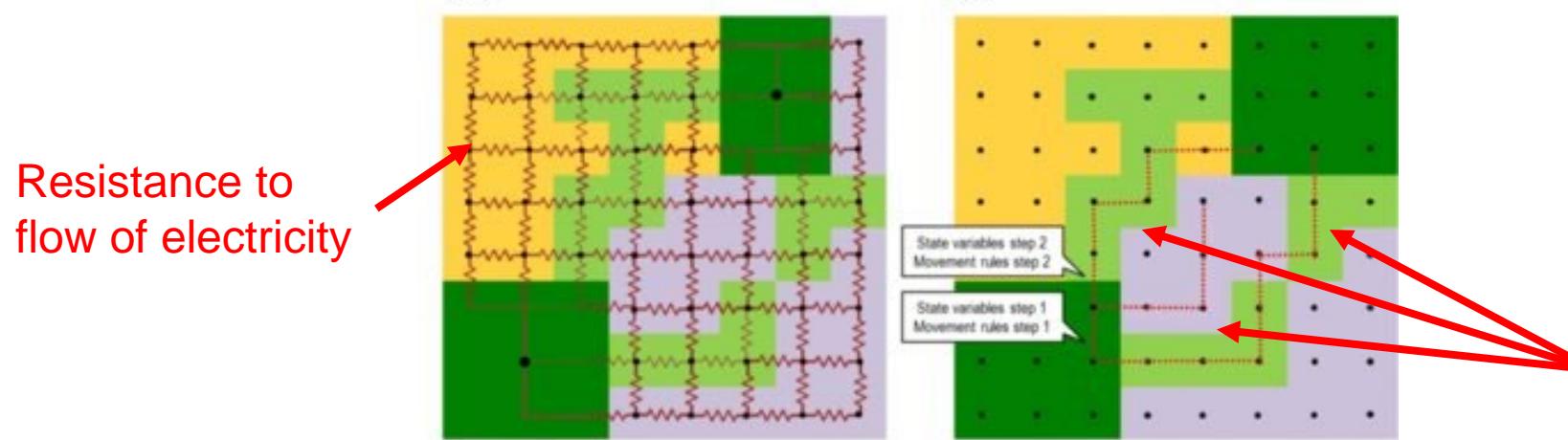


McRae. *Evol.* 2006

McRae *et al.* *Ecol.* 2008

Shah & McRae. *SciPy.* 2008

Anantharaman *et al.* *JuliaCon.* 2020



Diniz *et al.* *Landsc. Ecol.* 2020

# Landscape Resistance to Movement: Species (Genetic Differences)



Photo by:  
Alberto Di Donato  
HotSpotMedia

# Landscape Resistance to Movement: Communities (Species Differences)



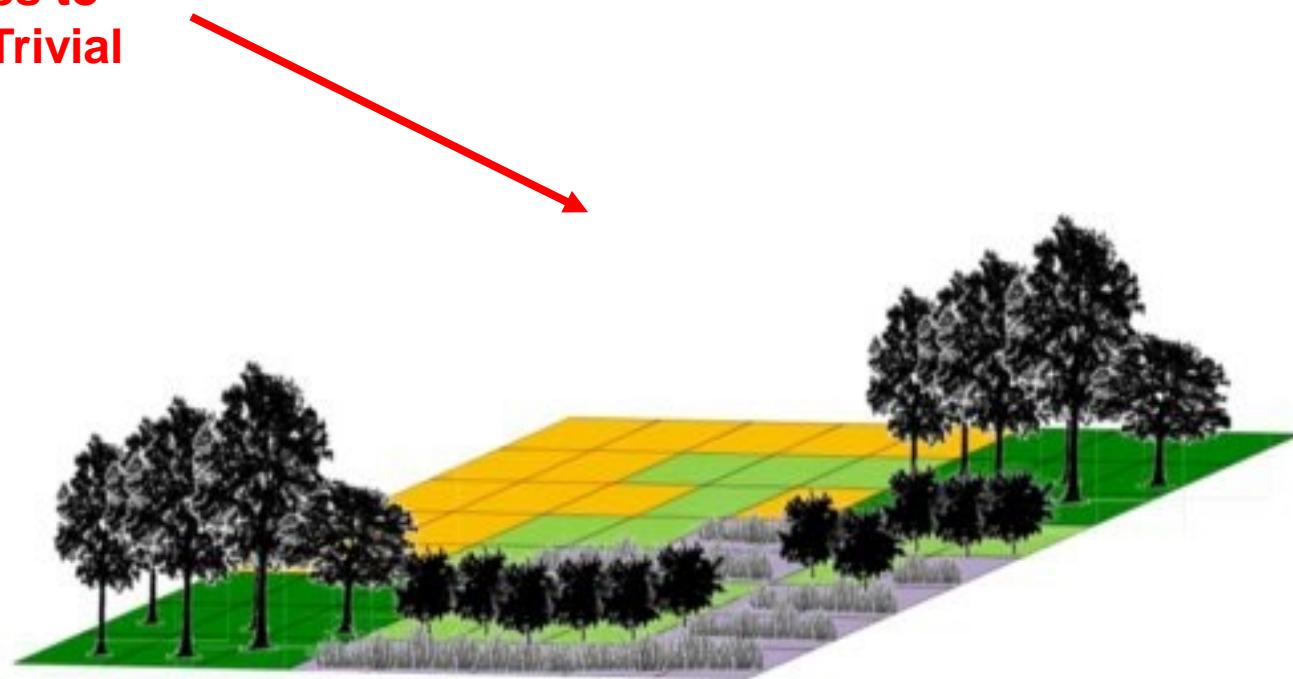
Photo by:  
Alberto Di Donato  
HotSpotMedia

# Landscape Resistance to Movement: Connectivity among Ponds

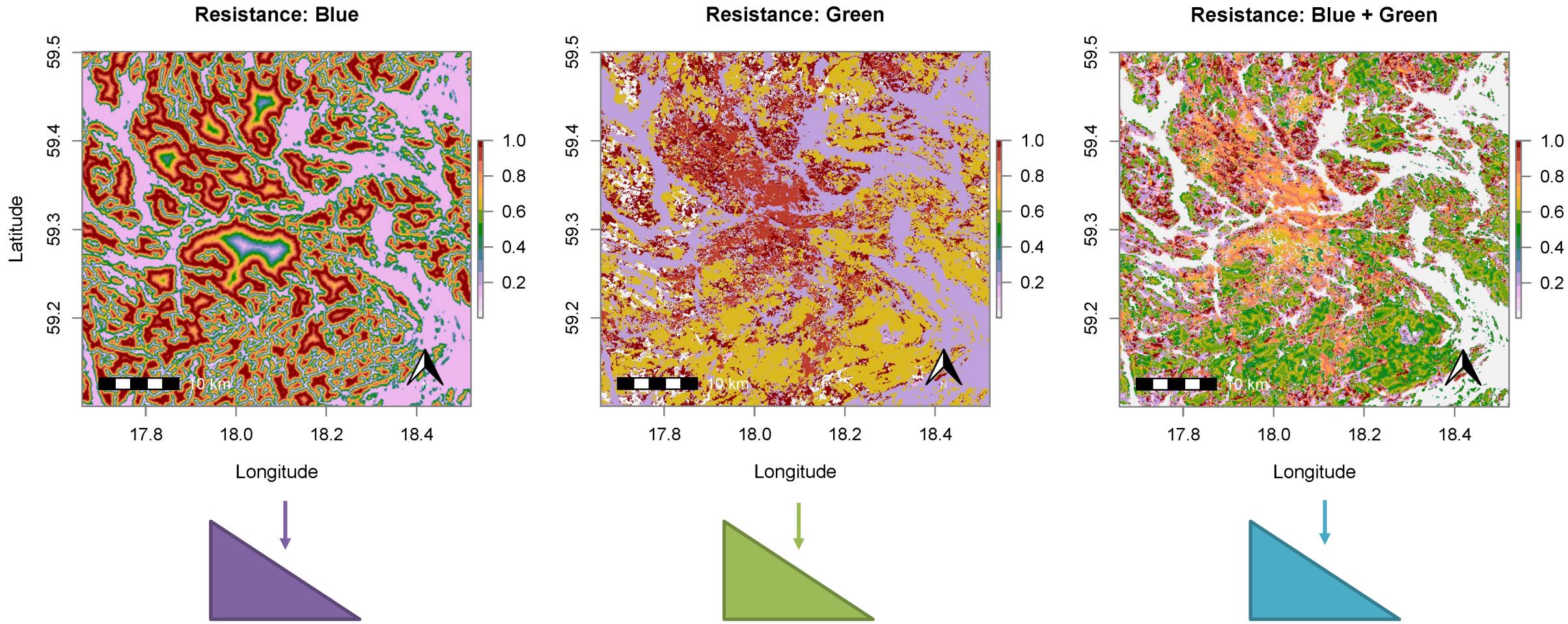


# Giving Landscape Features Resistance Scores

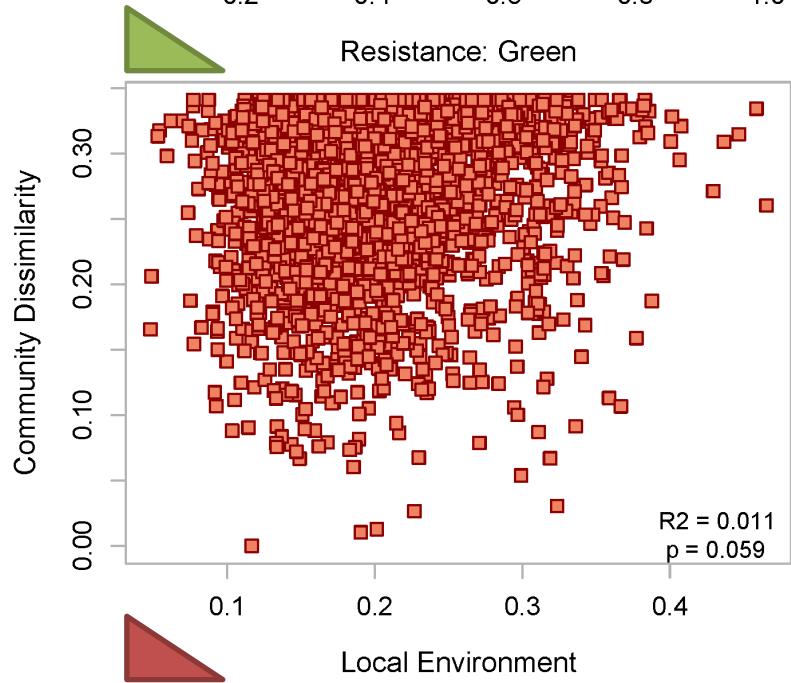
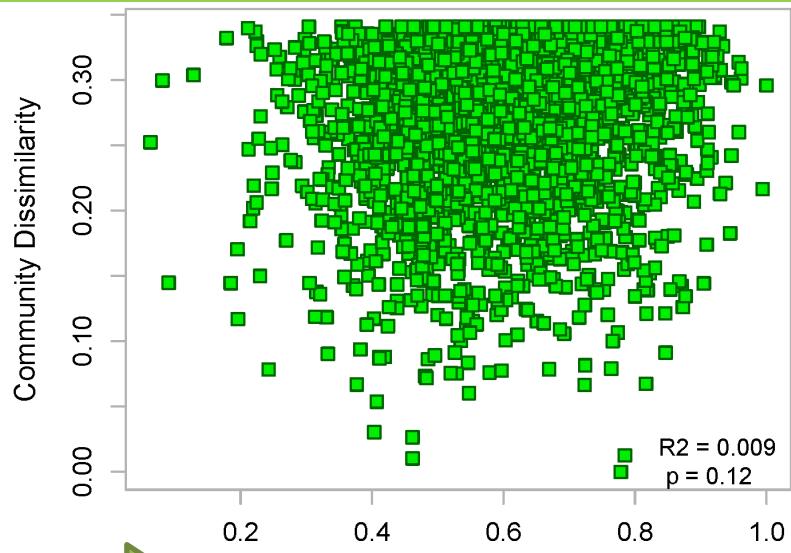
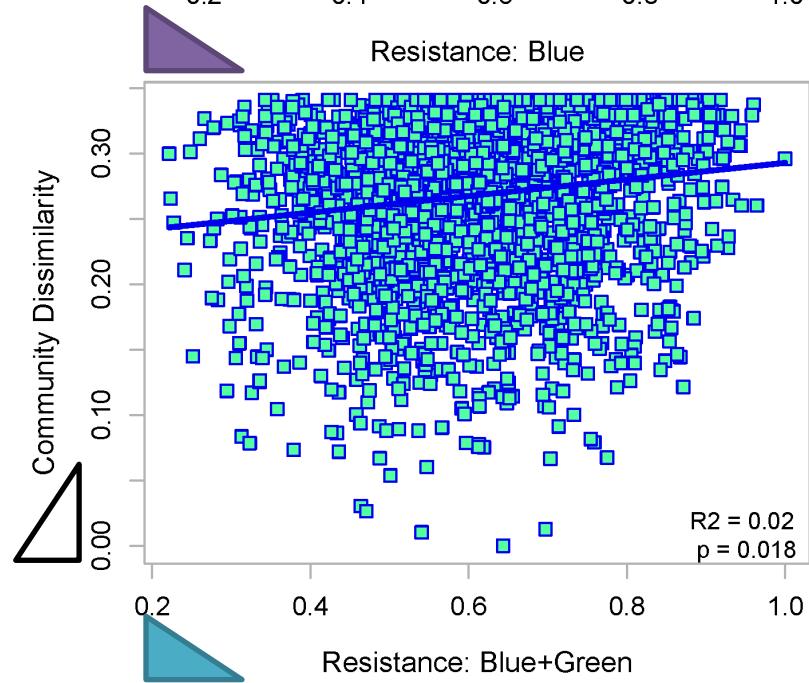
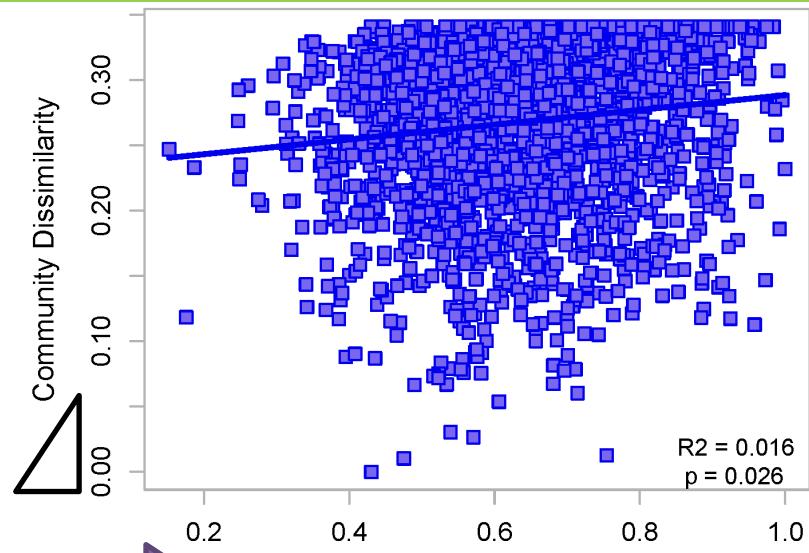
**From Landscape Features to  
Resistance Values: Not Trivial**



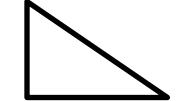
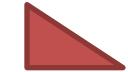
# Optimized (and Automated) Parameterization of Resistance Surfaces

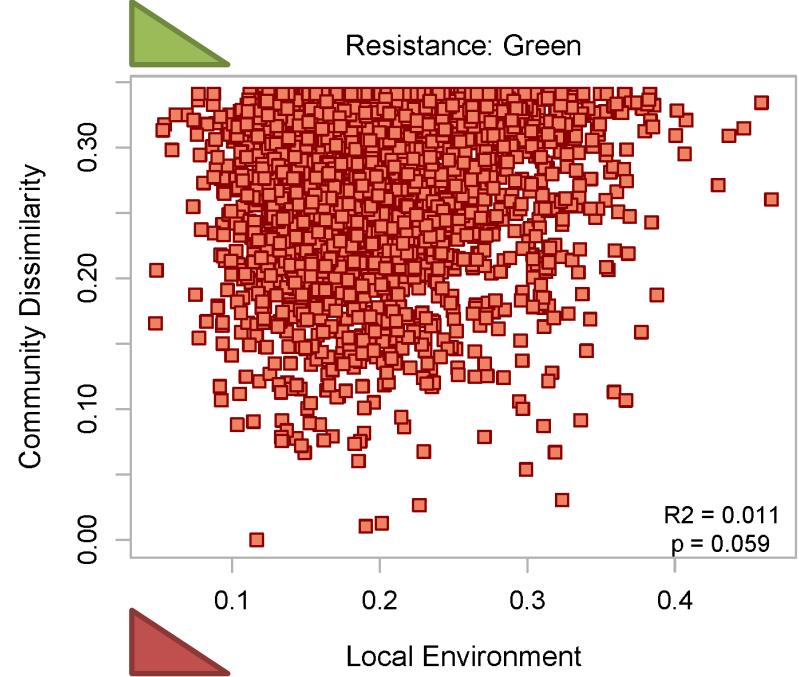
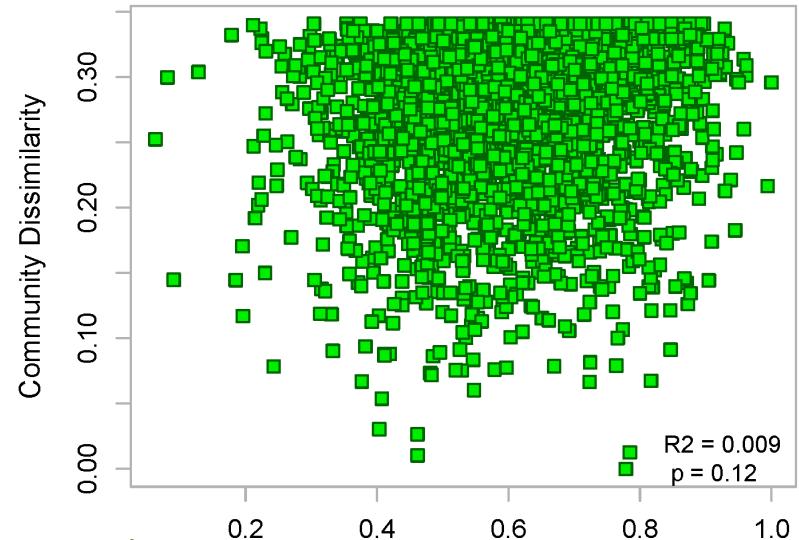
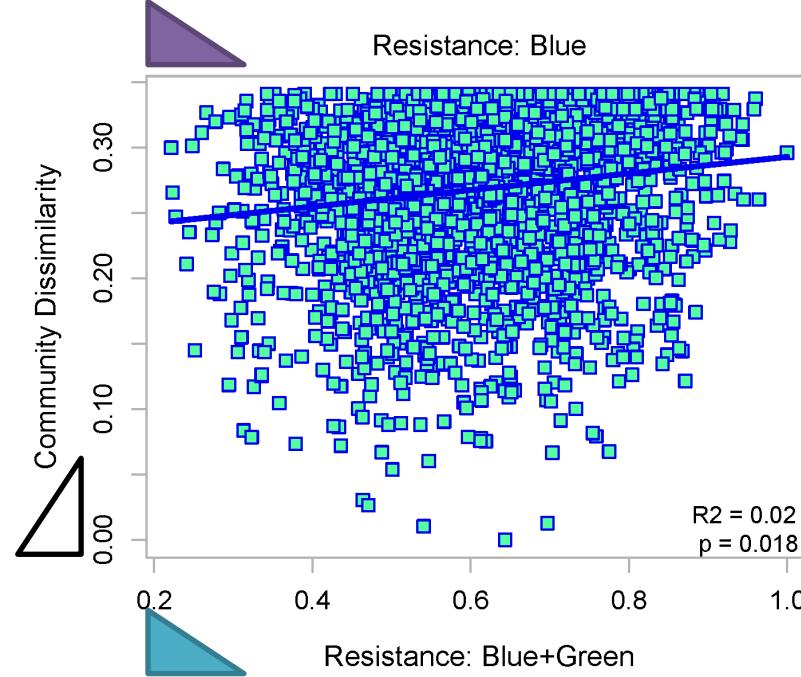
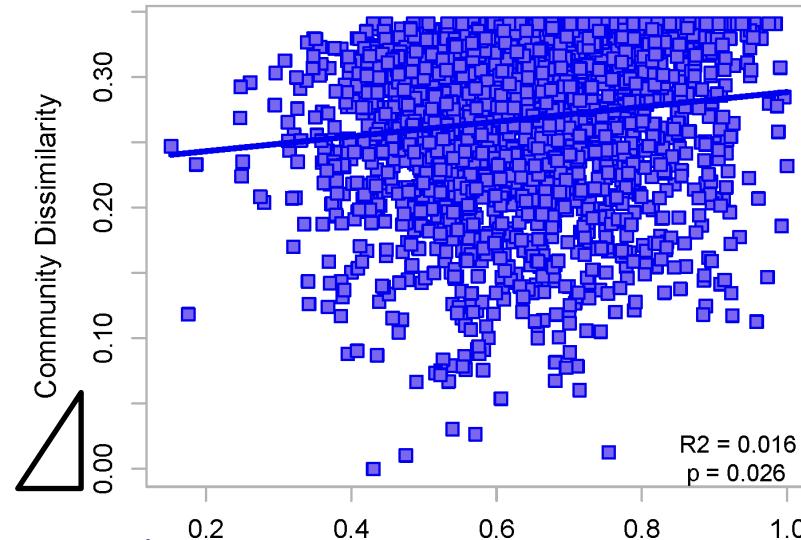


# Effect of Connectivity on Community Composition



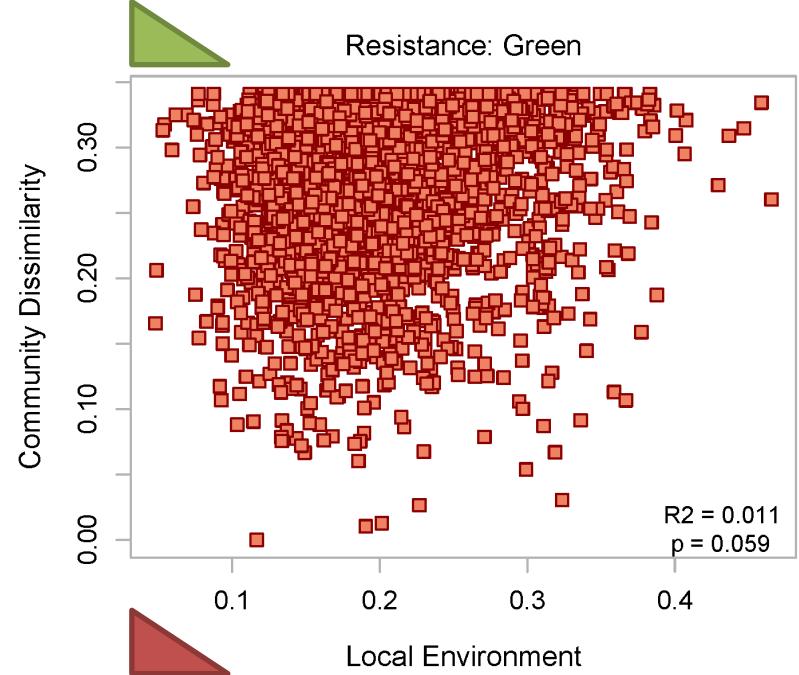
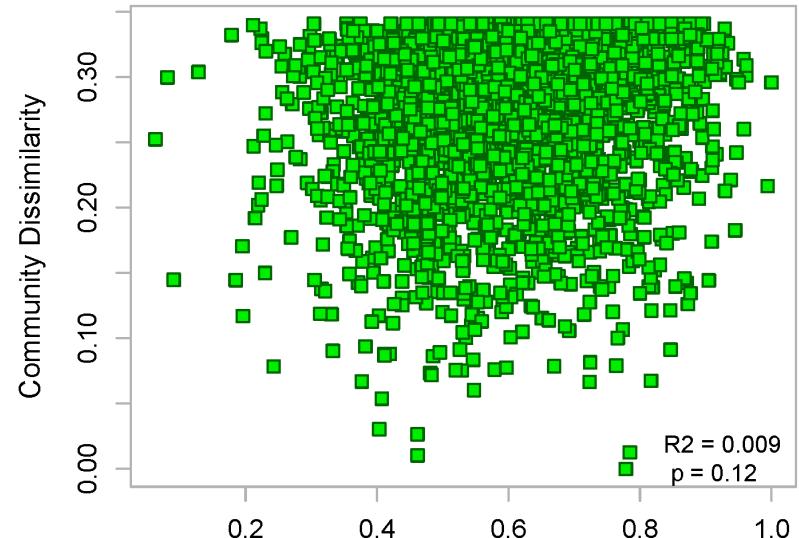
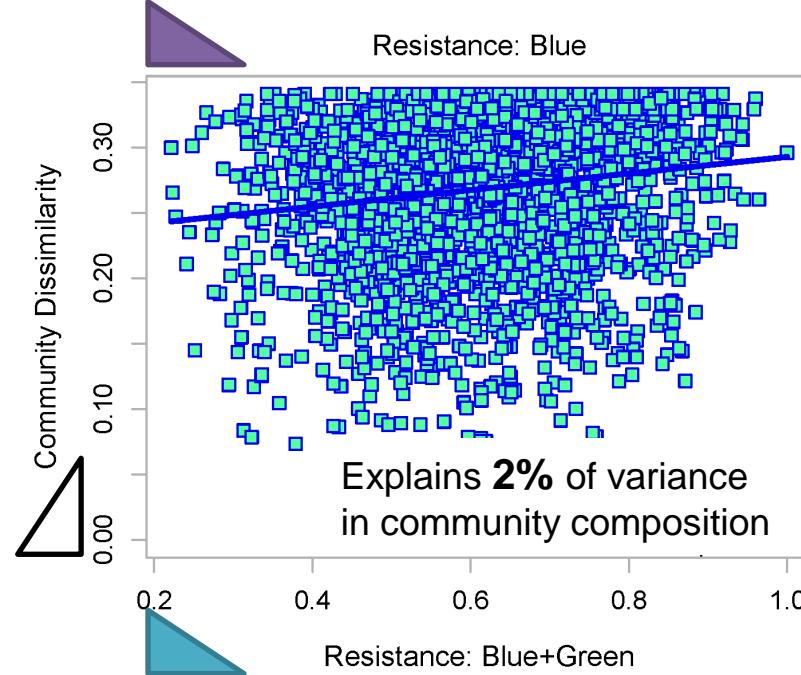
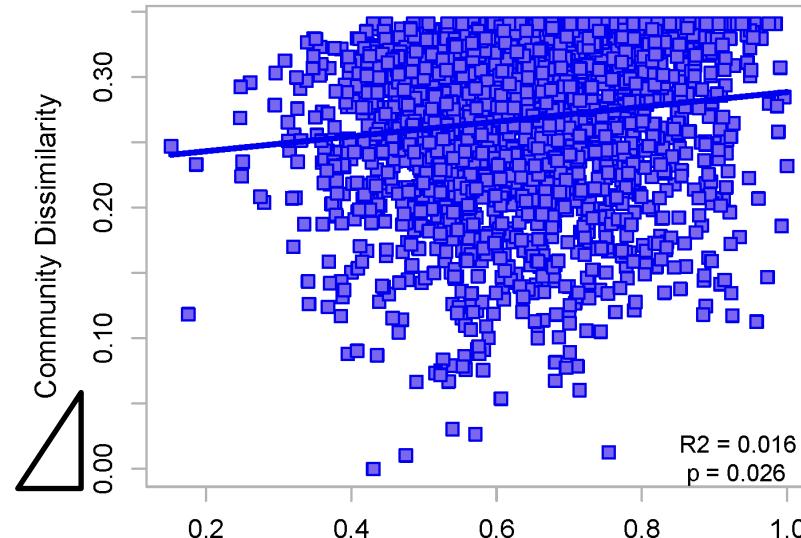
# Effect of Connectivity on Community Composition

Response:  
  
Predictors:  
  
  
  
  

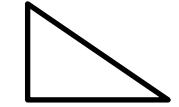
# Effect of Connectivity on Community Composition

Response:  
  
Predictors:  
  
  
  
  

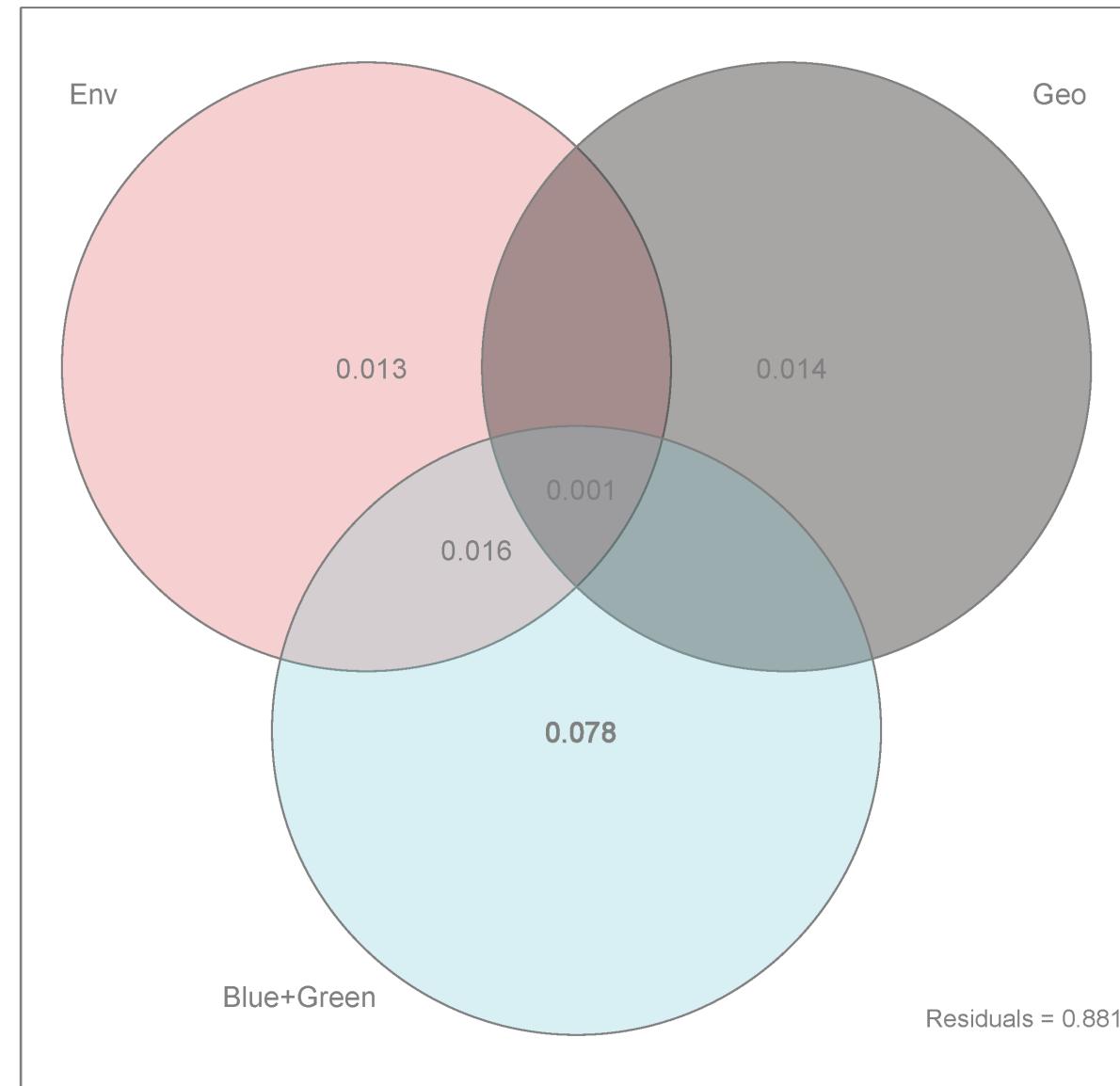
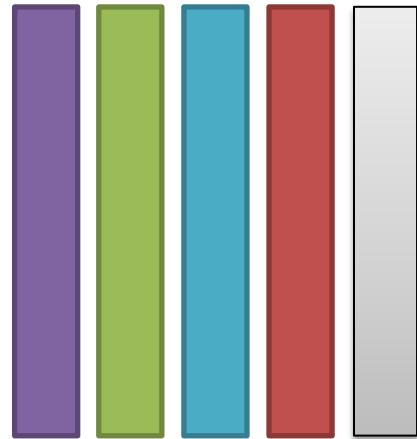



# Effect of Connectivity on Community Composition

Response:



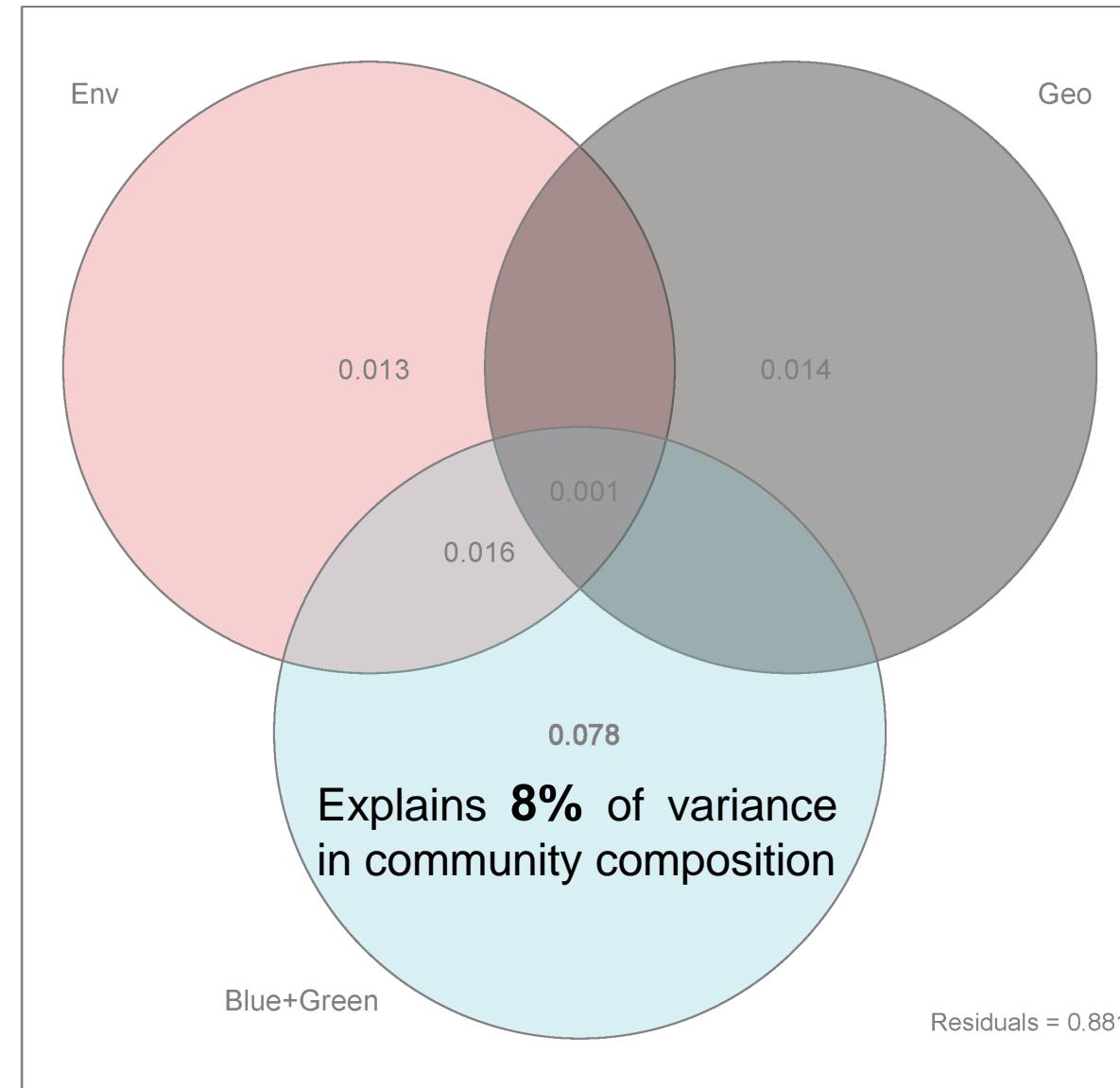
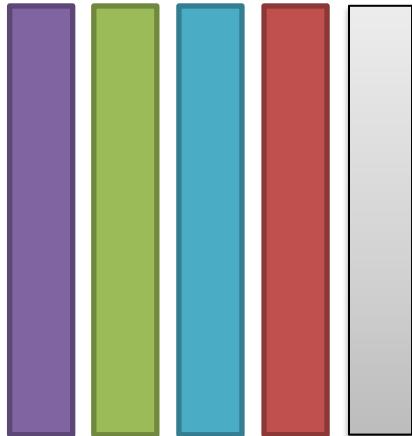
Predictors:



# Blue + Green Connectivity is Important to Urban Meta-Communities

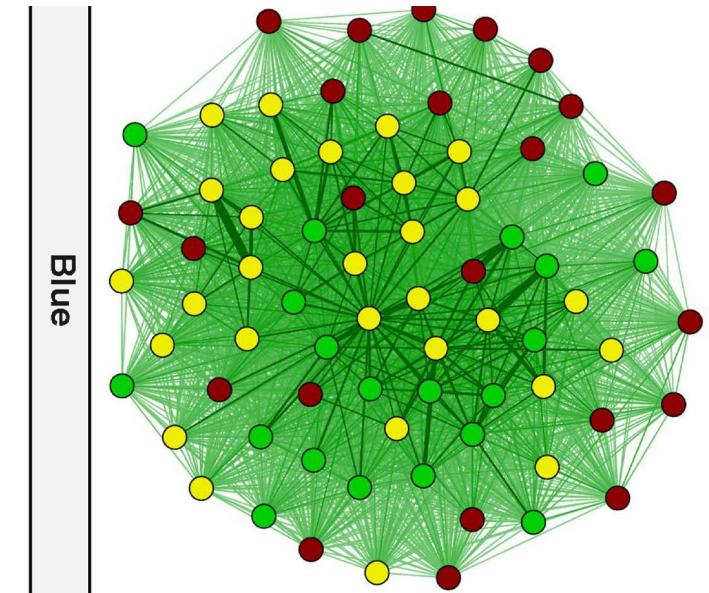
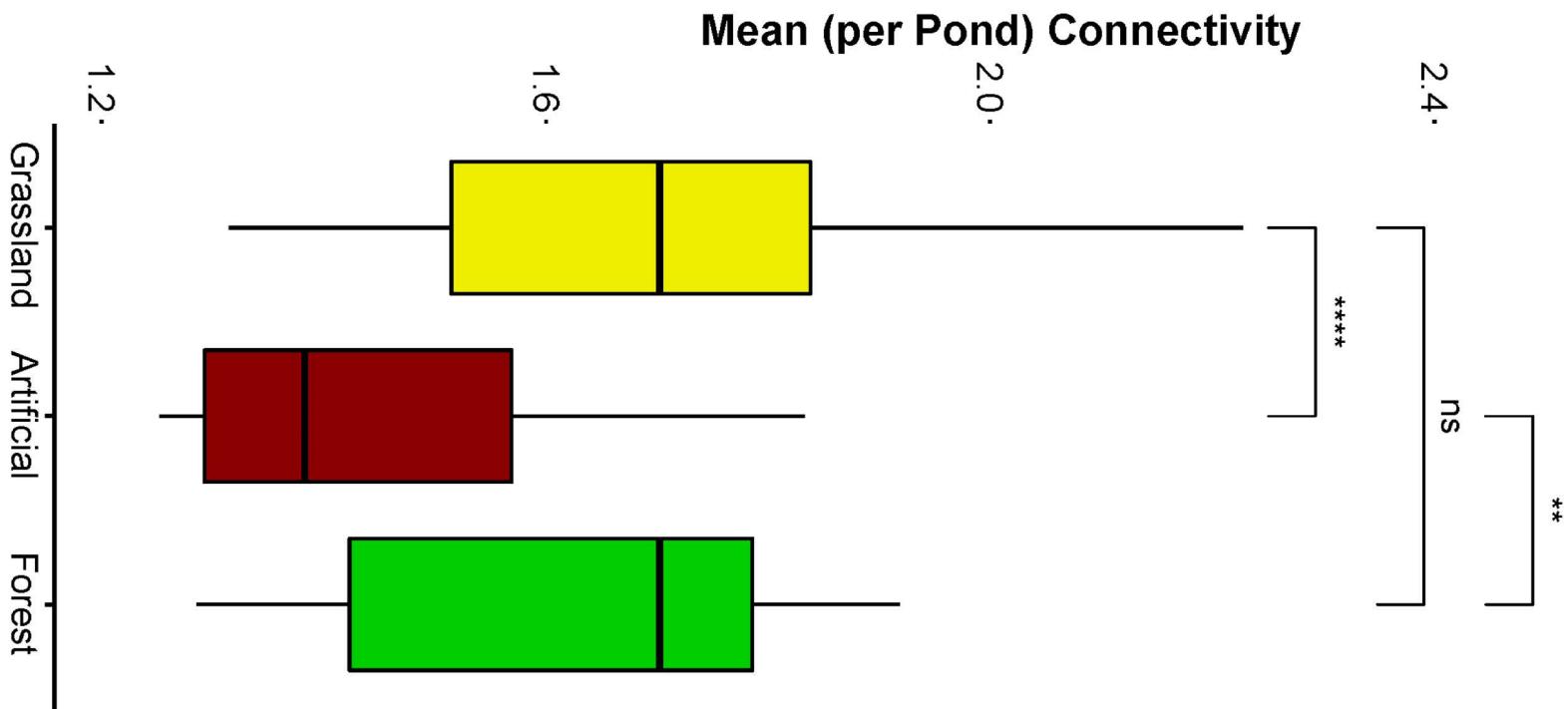
Response:  
△

Predictors:

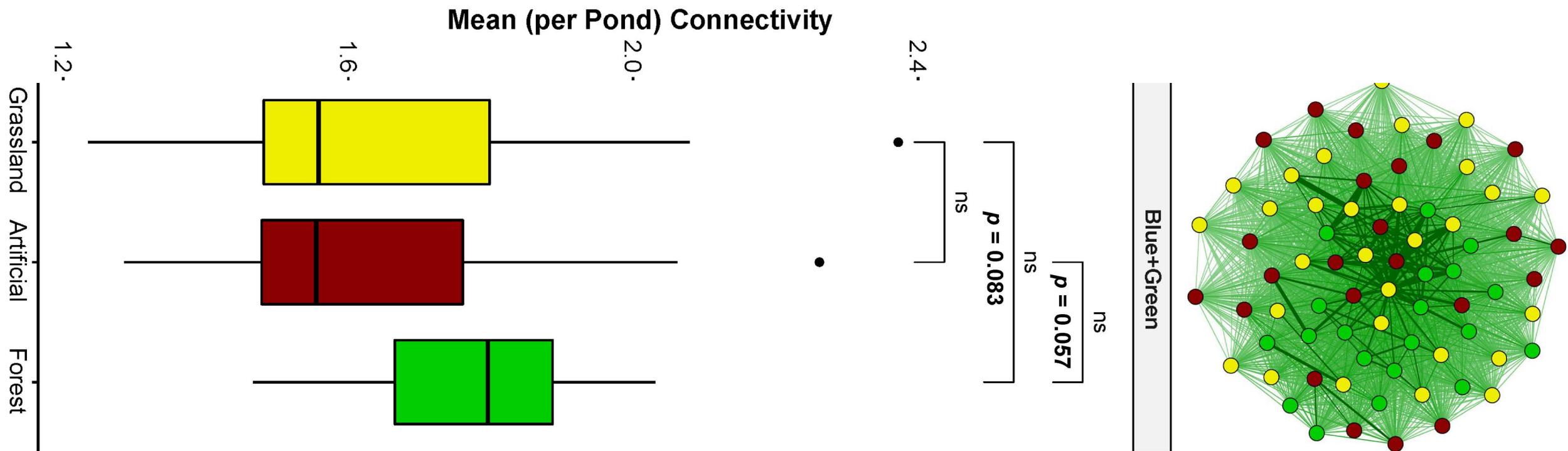


*How does landscape connectivity vary (by environment)?*

# Blue Connectivity & Level of Urban Development



# Blue + Green Connectivity & Level of Urban Development



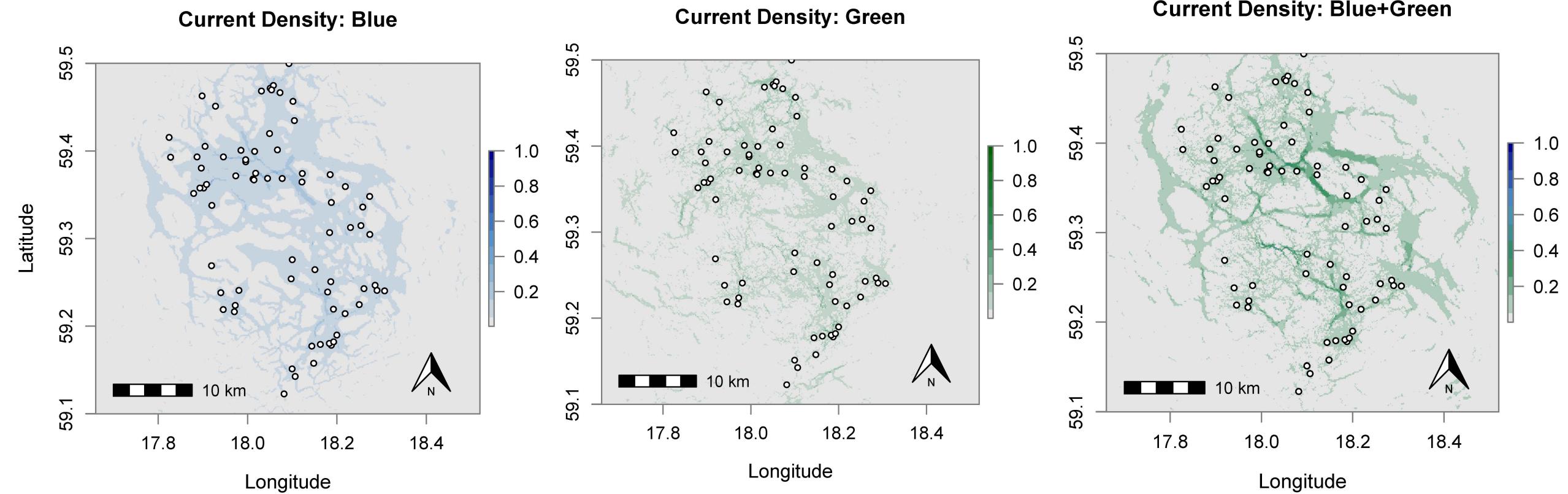
*What about community composition in these environments?*

# Community Composition & Level of Urban Development

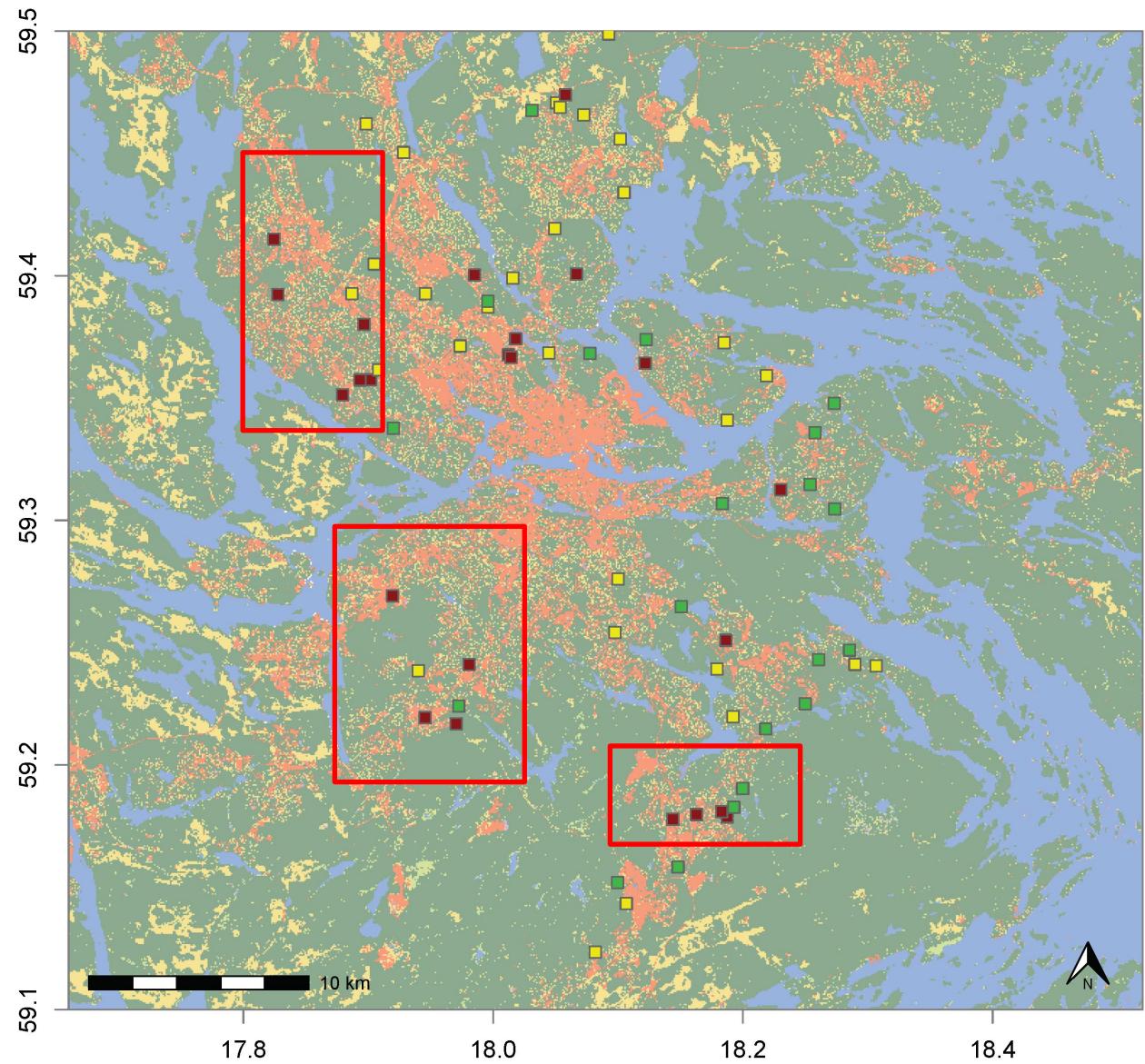
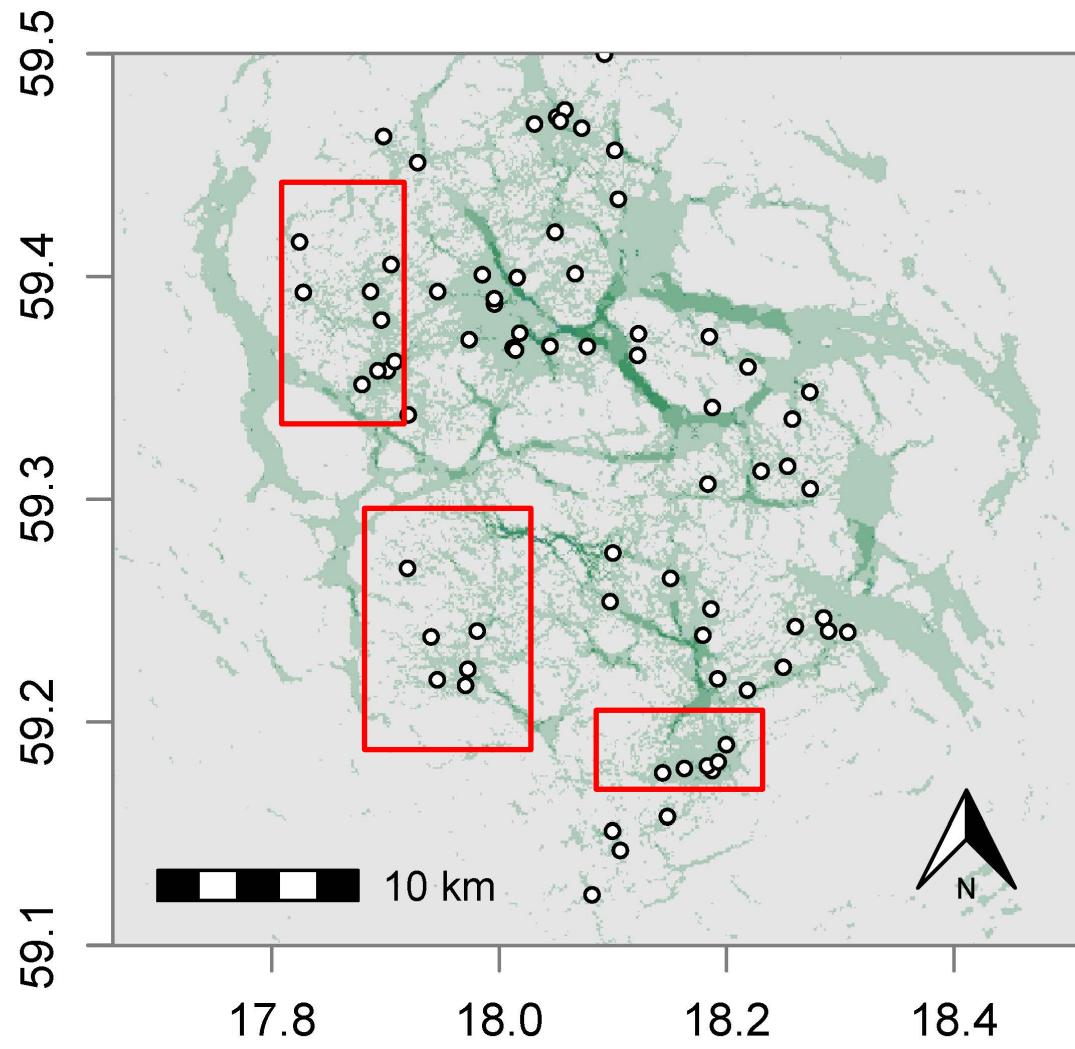
|                  |          | Grassland | Artif. Surf. | Forest |
|------------------|----------|-----------|--------------|--------|
| Richness:        | $\gamma$ | 84        | 67           | 80     |
|                  | $\alpha$ | 14.103    | 9.913        | 13.000 |
| Diversity:       | $H'$     | 2.250     | 1.780        | 2.302  |
|                  | $J'$     | 0.890     | 0.859        | 0.939  |
| Differentiation: | $\beta$  | 4.956     | 5.759        | 5.154  |
|                  | disp.    | 0.525     | 0.555        | 0.547  |
|                  | $F_{ST}$ | 0.184     | 0.256        | 0.205  |

*How would we improve connectivity in more urban/developed areas?*

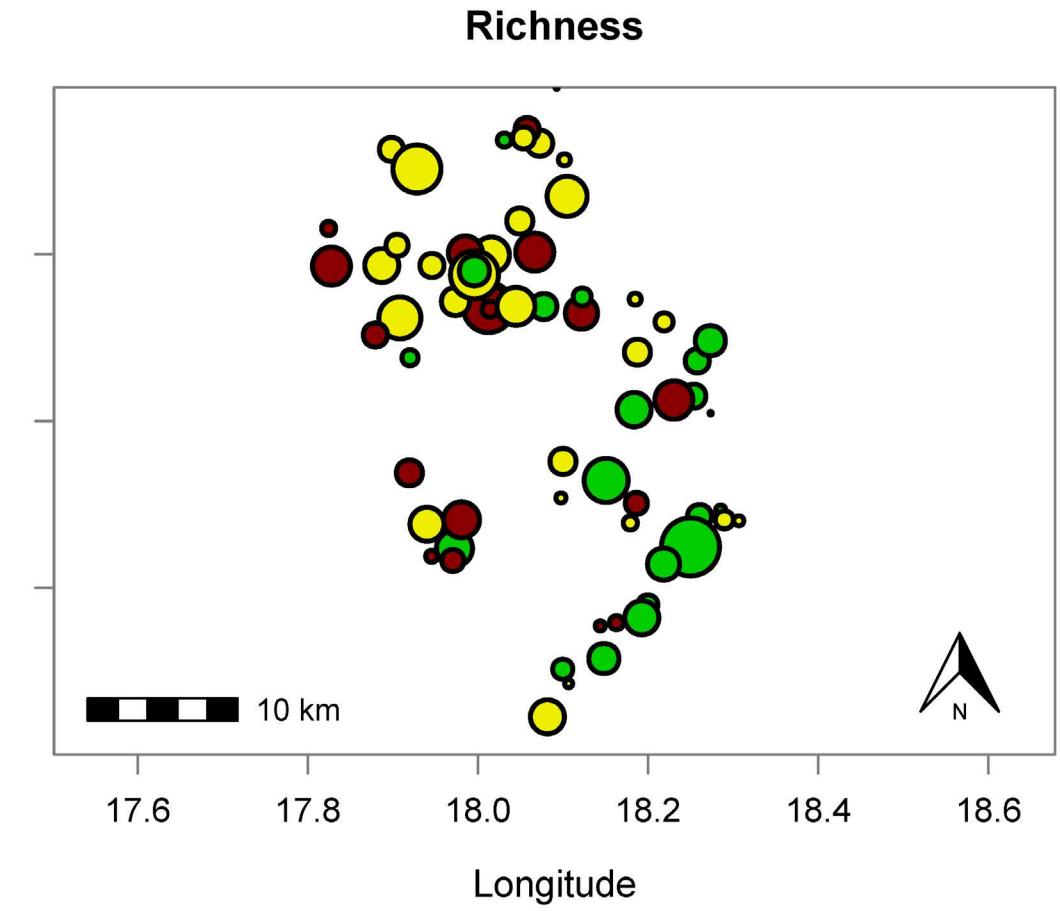
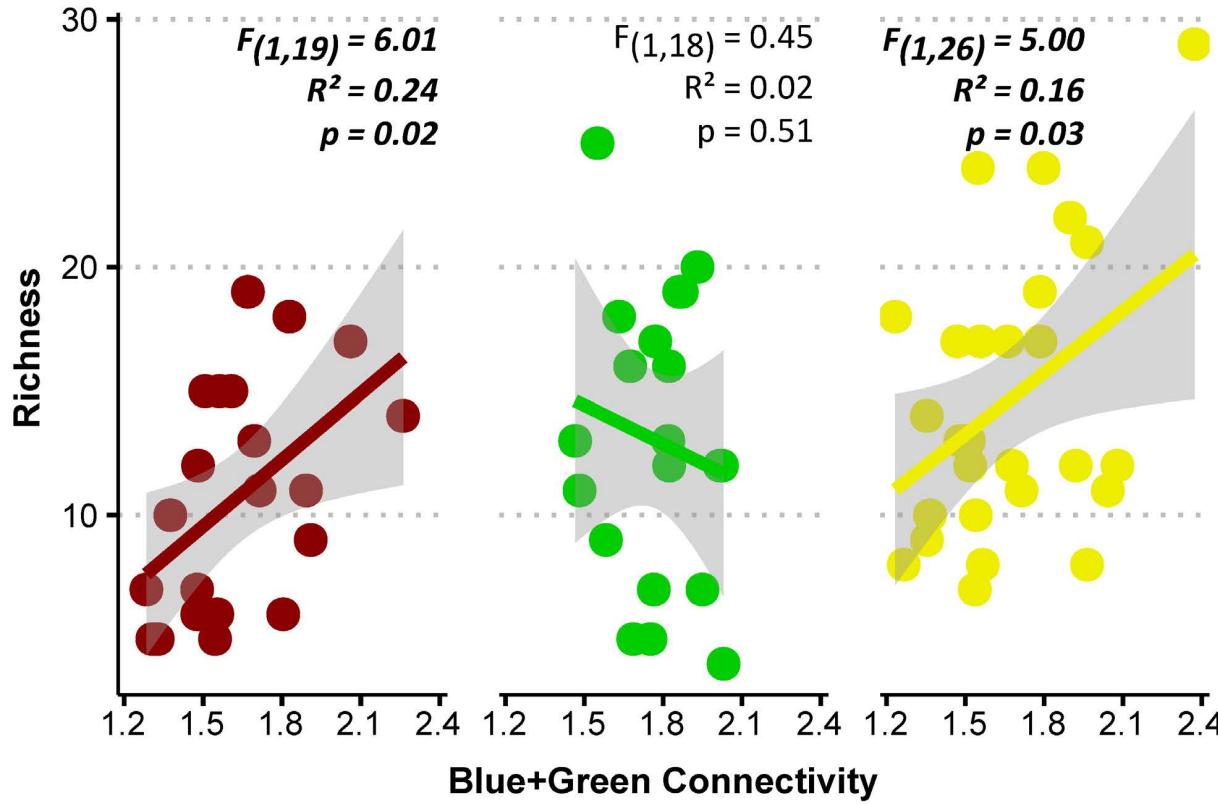
# Density of Electrical Current – Connectivity Pathways/Corridors



# Focus on Key Urban Areas – Add Corridors (Blue + Green Spaces)



# Some Ponds in More Urban Areas Already Have Good Connectivity



# Connectivity (LOWER) among *communities* in (MORE) *Urban Landscapes*

(Lower) Biodiversity of Aquatic Invertebrates in (**more urban areas of**) Stockholm

Chaz Hyseni



UPPSALA  
UNIVERSITET