

# Landscape connectivity shapes invertebrate biodiversity in urban ponds

Chaz Hyseni & Frank Johansson

 <http://specevgen.net>



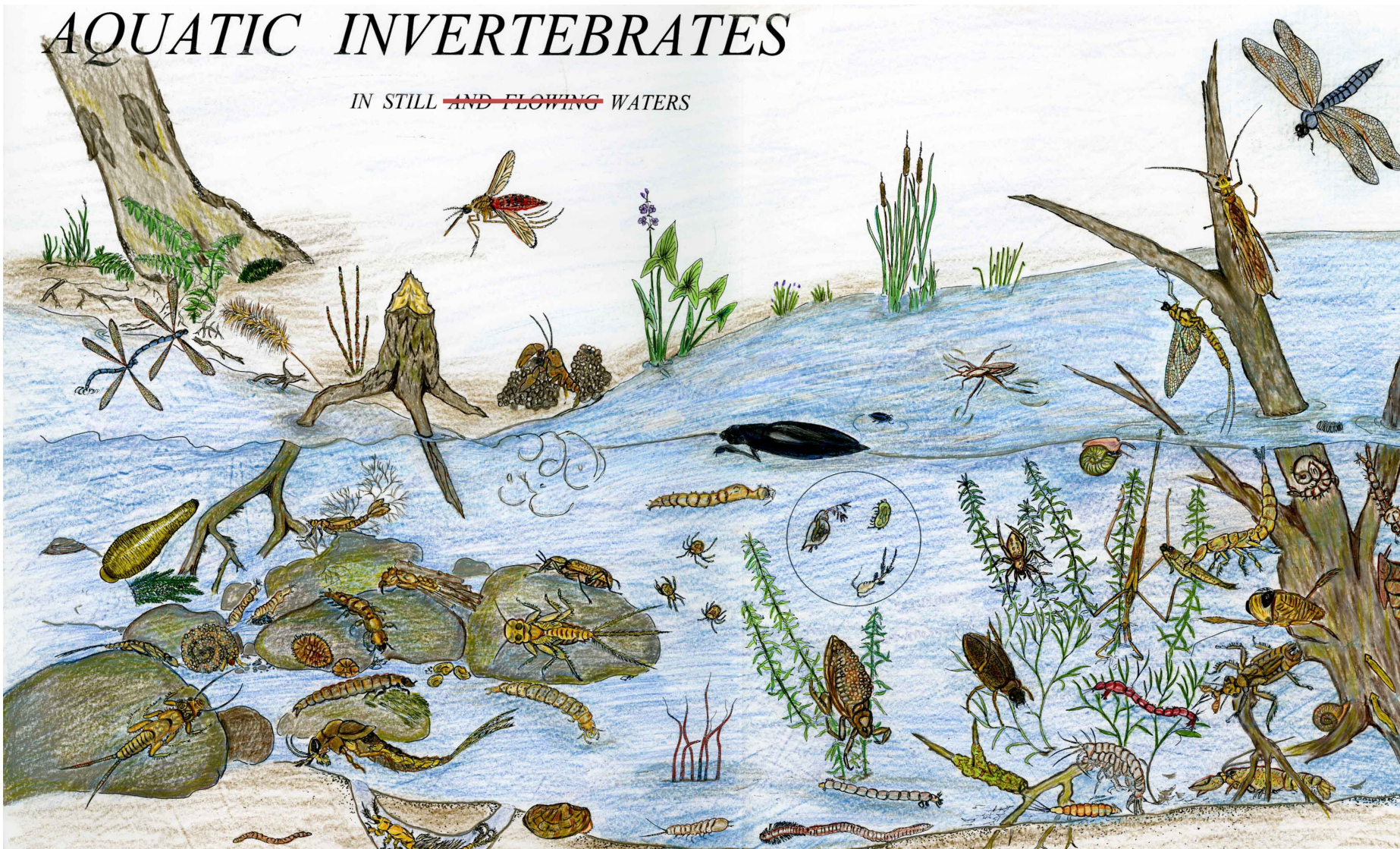
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# Sampling: Pond Invertebrates

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

## AQUATIC INVERTEBRATES

IN STILL ~~AND FLOWING~~ WATERS

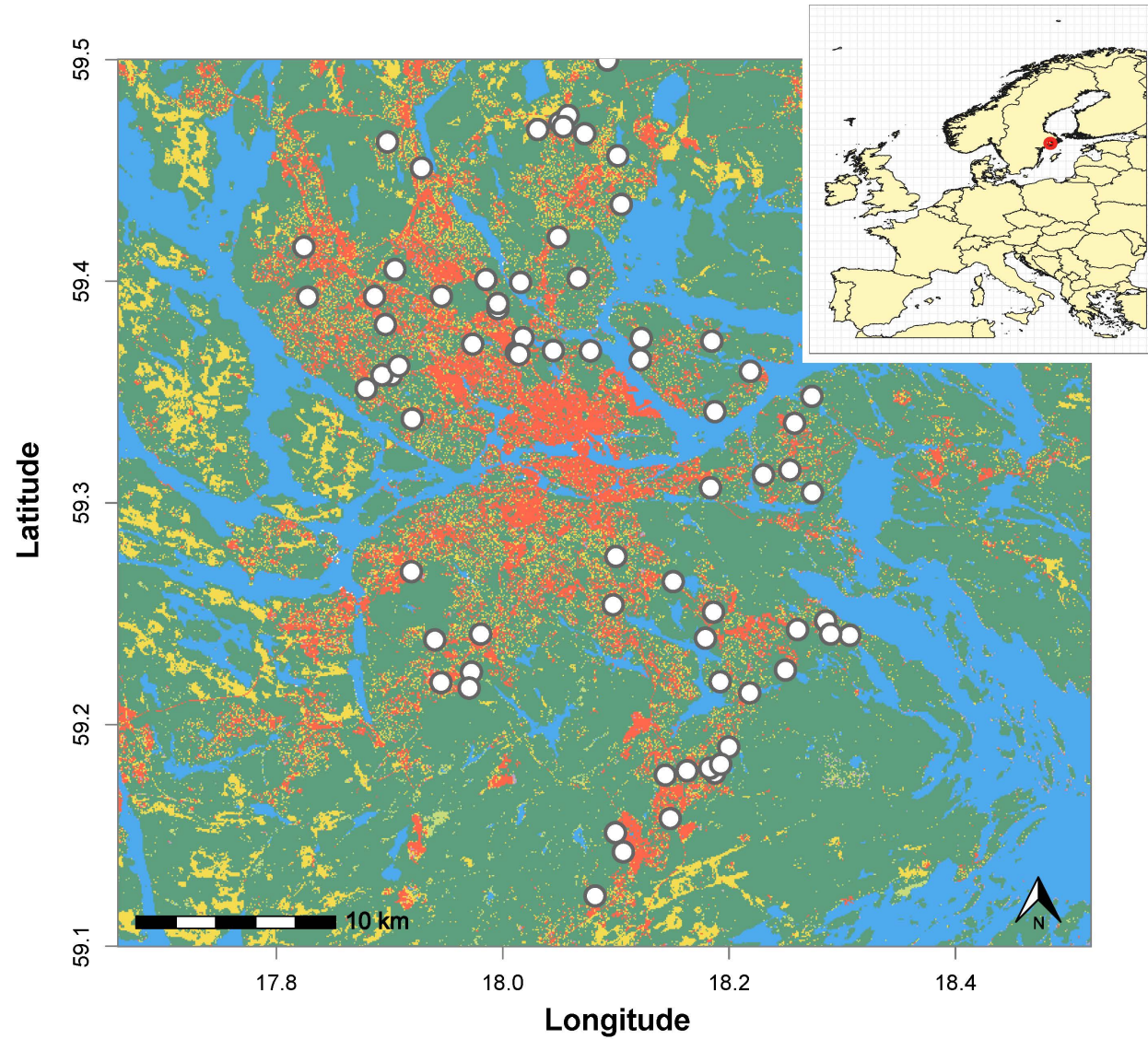


- Coleoptera**  
(beetles)
- Hemiptera**  
(true bugs)
- Odonata**  
(damselfly- and dragonflies)
- Trichoptera**  
(caddisflies)
  
- Gastropoda**  
(freshwater snails)

Drawing: Carie Nixon  
Illinois Natural History Survey

# Sampling: Stockholm Metro

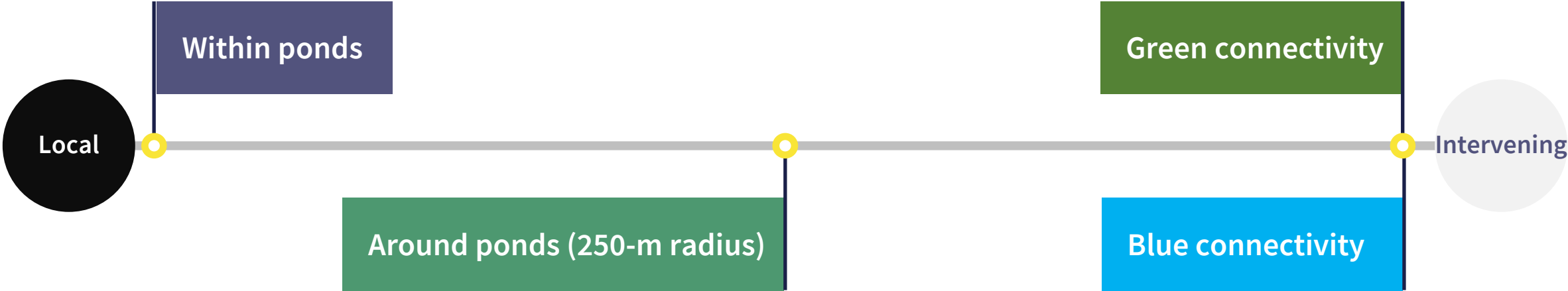
80 sites



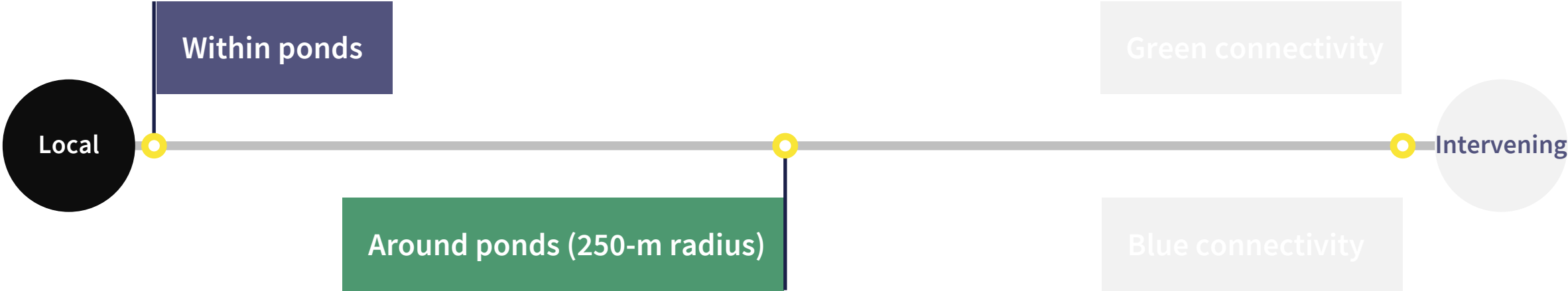
# Questions

- **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



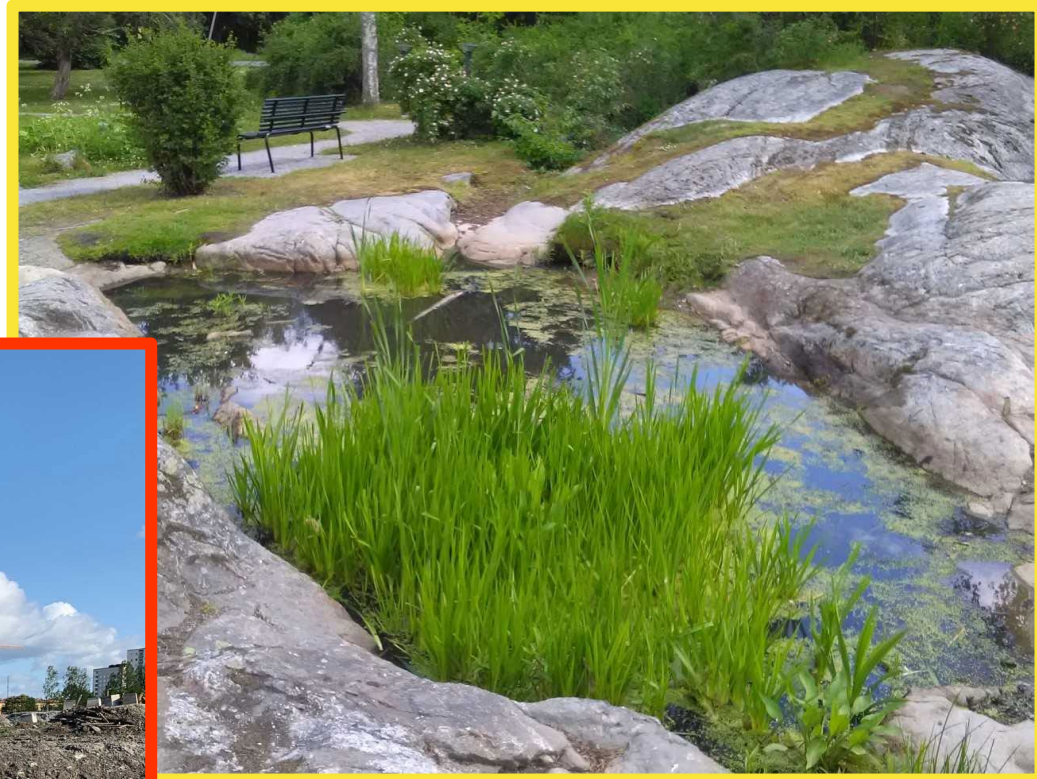
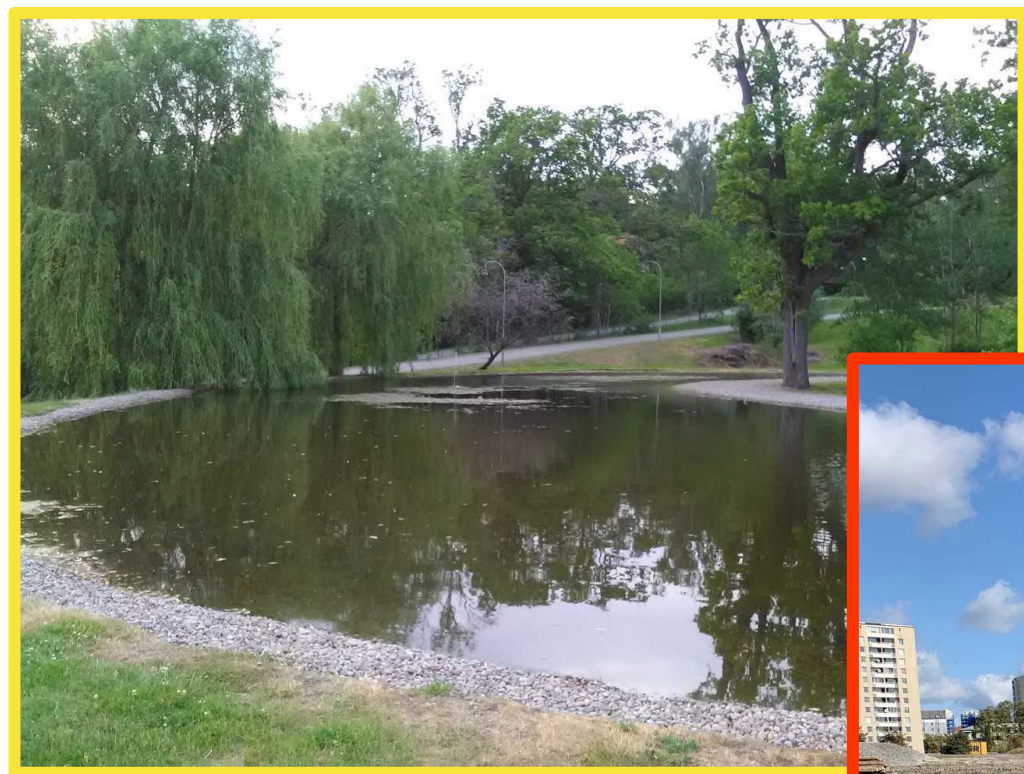
# Continuum of Influence on Community Composition



# Sampling



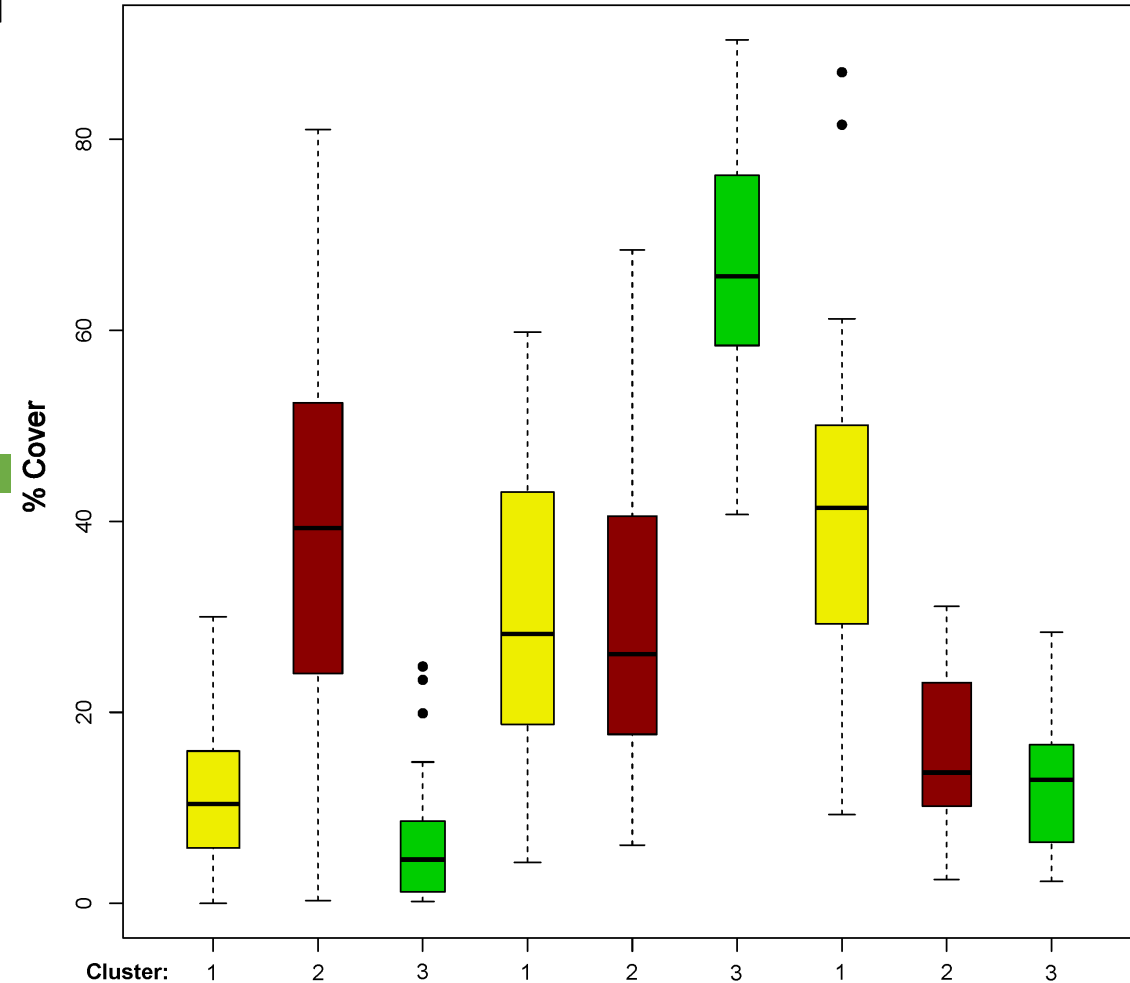
# Sampling



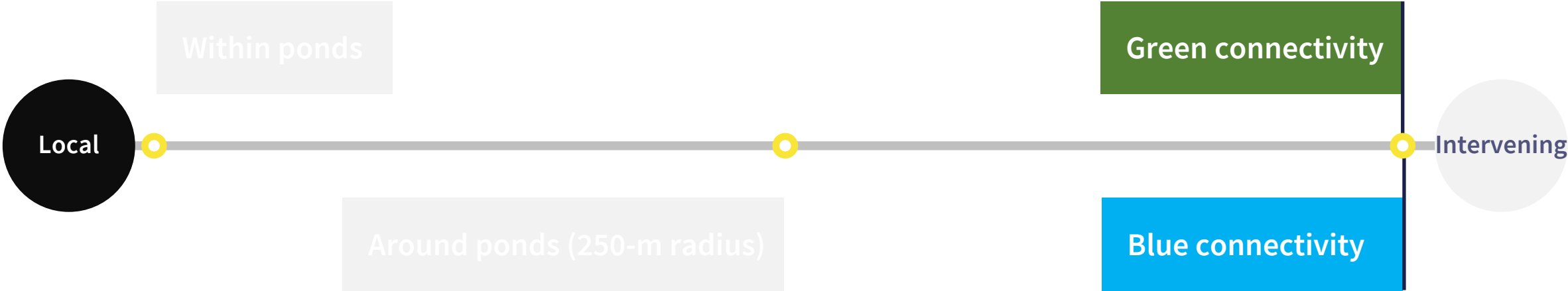


# Local Environment

		Cluster 1: Grassland		Cluster 2: Artif. Surf.		Cluster 3: Forest	
		Median	25%-75%	Median	25%-75%	Median	25%-75%
Within	area (m2)	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]
Around	artif. surf.	10.4	[5.8-16]	<b>39.3</b>	<b>[24-52.4]</b>	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]	<b>65.6</b>	<b>[59-75.9]</b>
	shrubs	<b>41.5</b>	<b>[29.2-50.1]</b>	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]



# Continuum of Influence on Community Composition



# Circuit Theory & Landscape Ecology

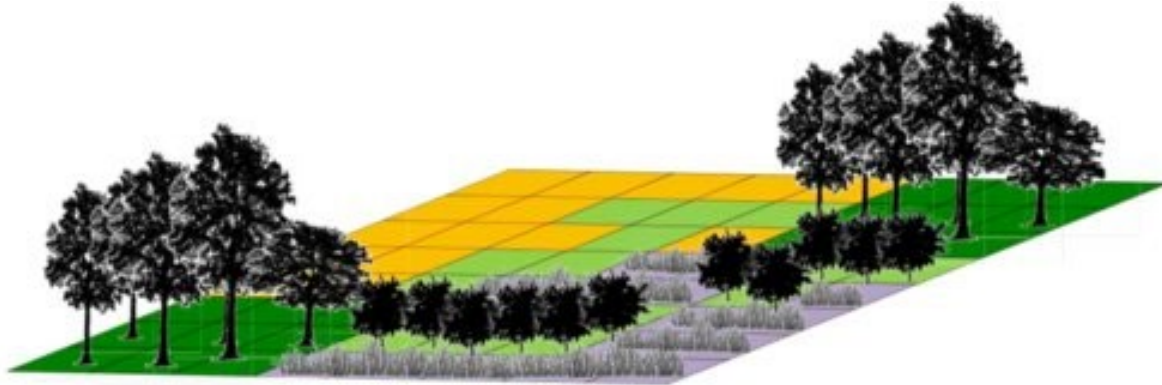


McRae. *Evol.* 2006

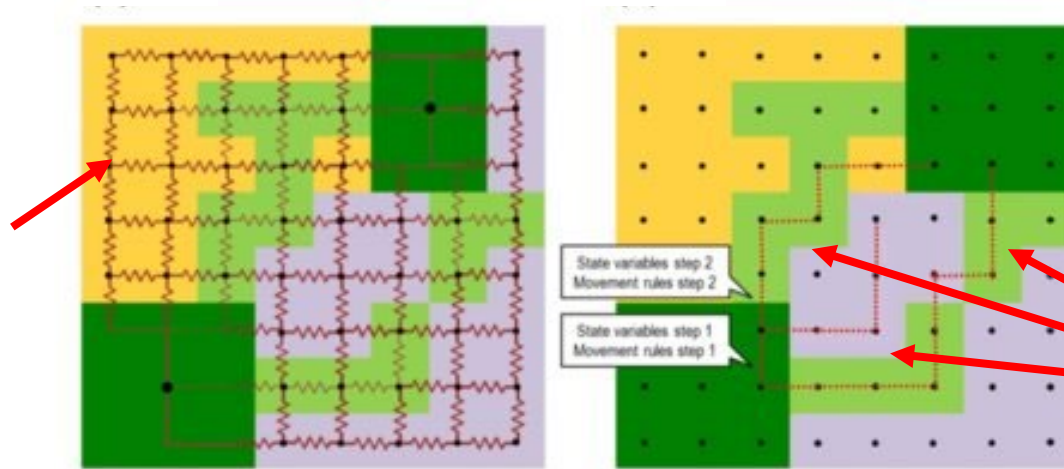
McRae *et al. Ecol.* 2008

Shah & McRae. *SciPy.* 2008

Anantharaman *et al. JuliaCon.* 2020



Resistance to  
flow of electricity



Paths of least resistance  
across the circuit

Diniz *et al. Landsc. Ecol.* 2020

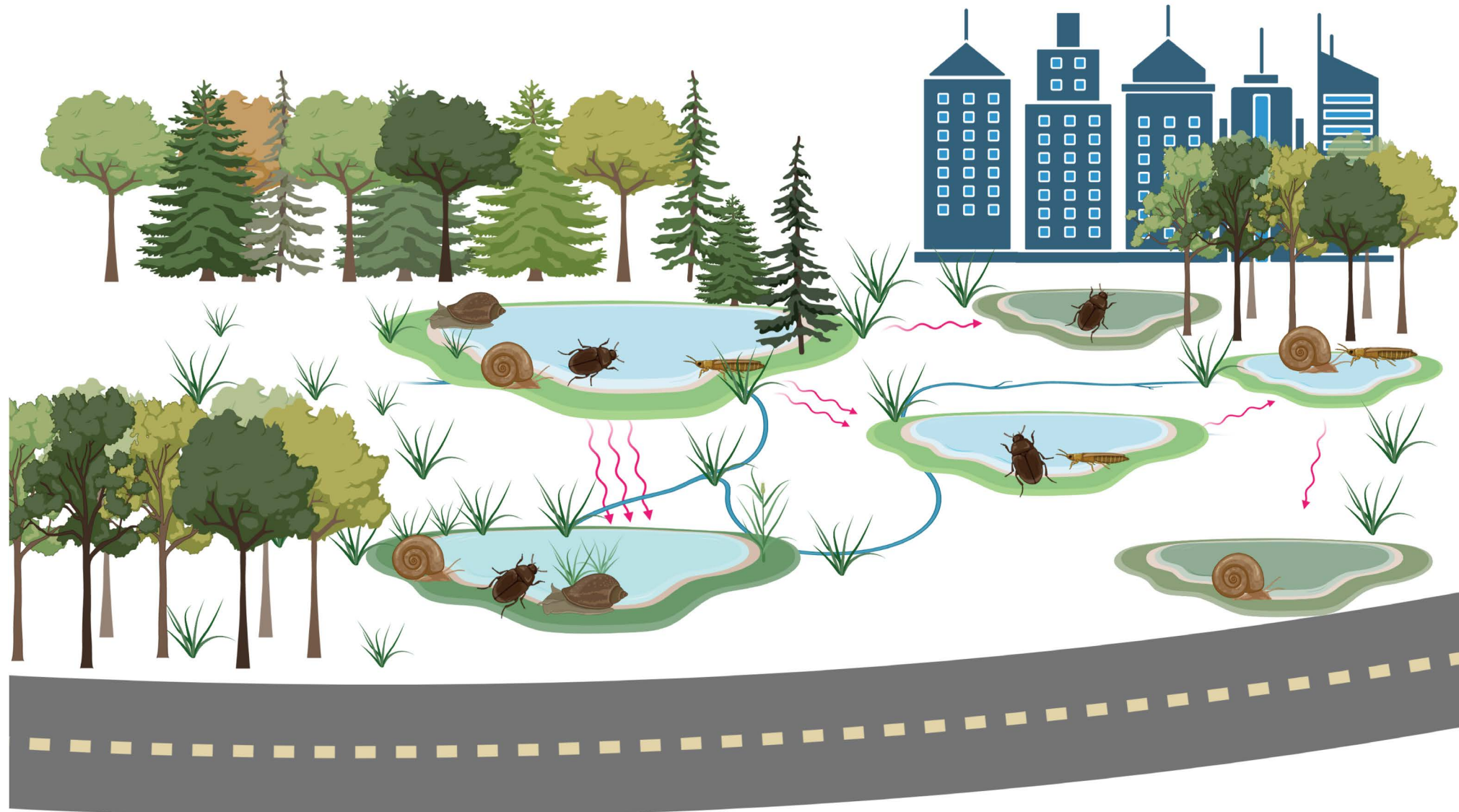
# Landscape Resistance to Movement: Species (Genetic Differences)



# Landscape Resistance to Movement: Communities (Species Differences)

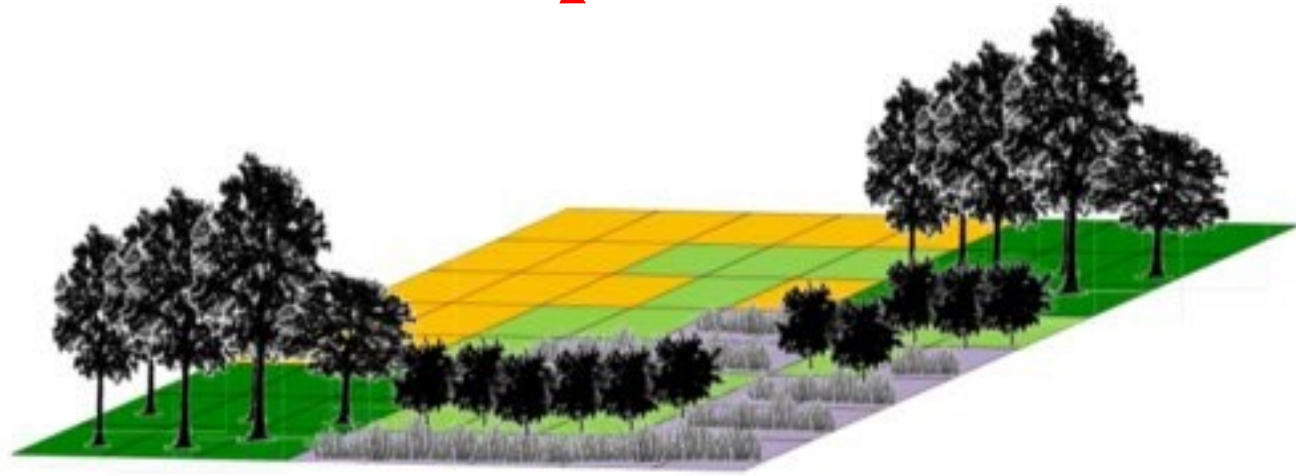


# Landscape Resistance to Movement: Connectivity among Ponds

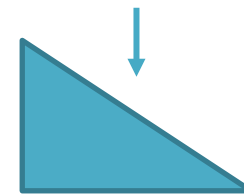
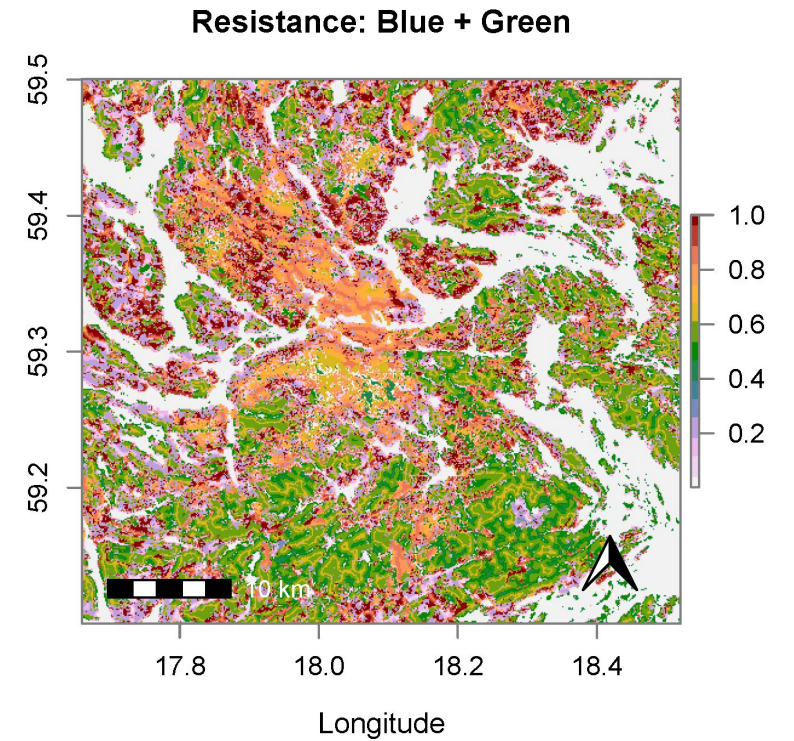
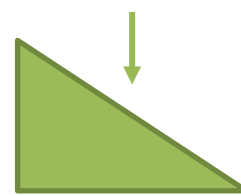
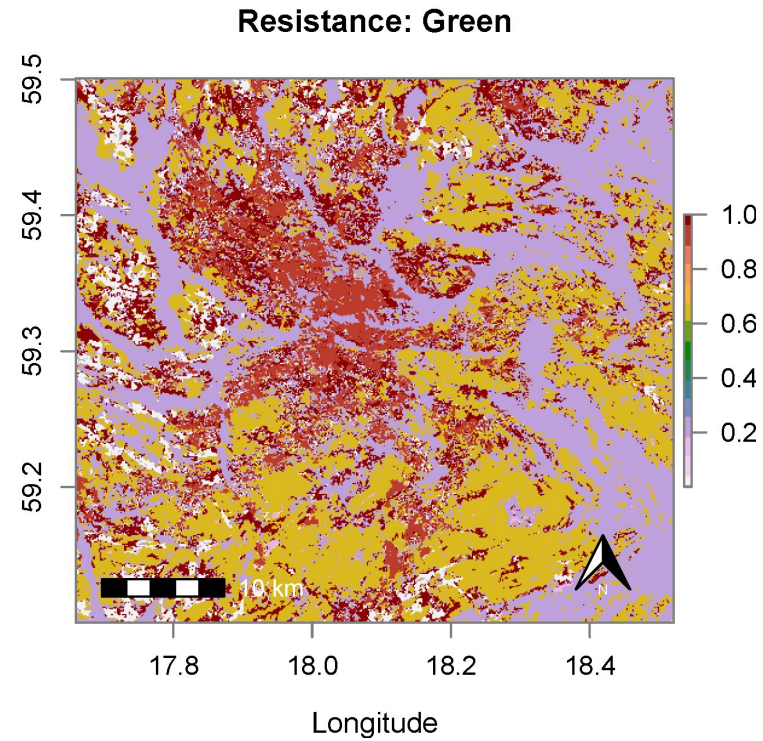
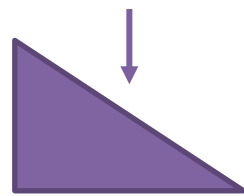
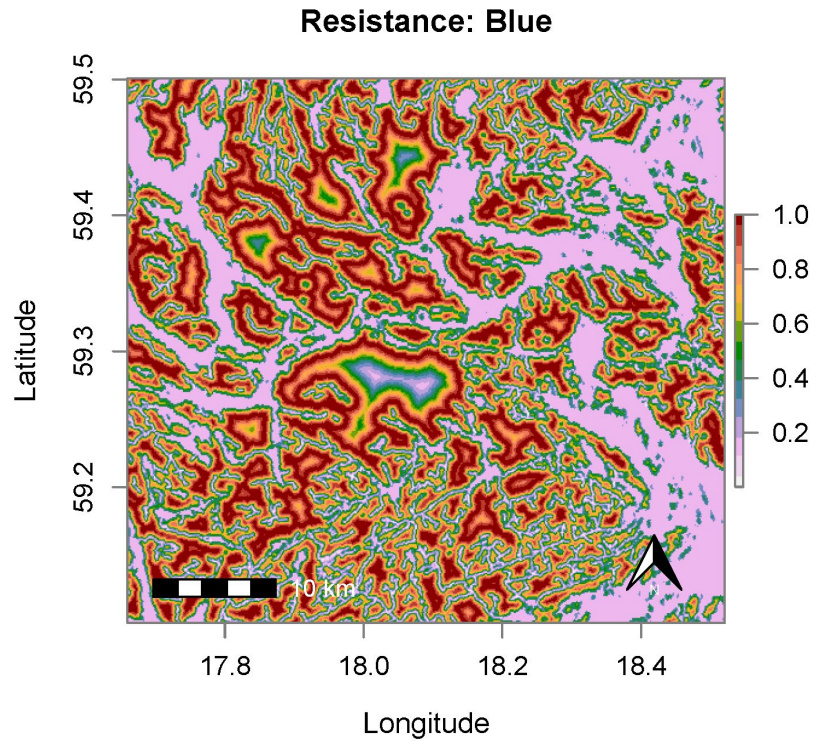


# Giving Landscape Features Resistance Scores

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

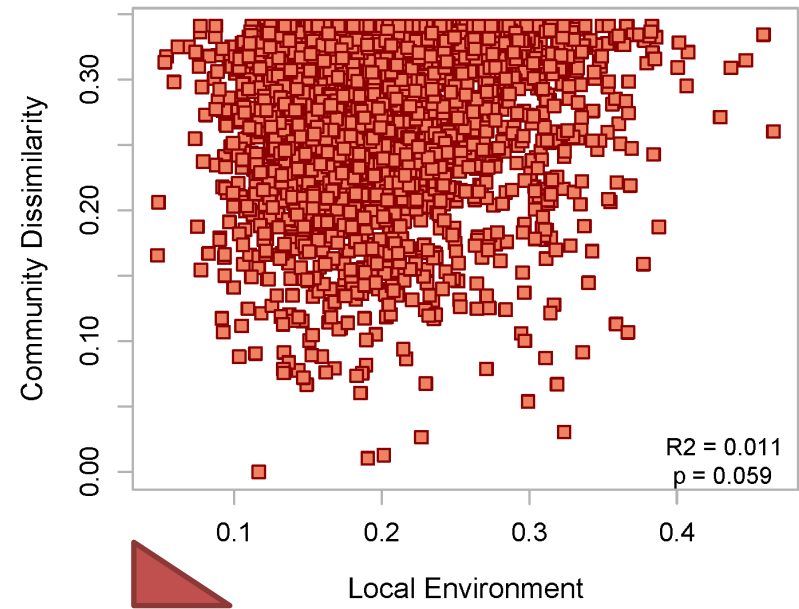
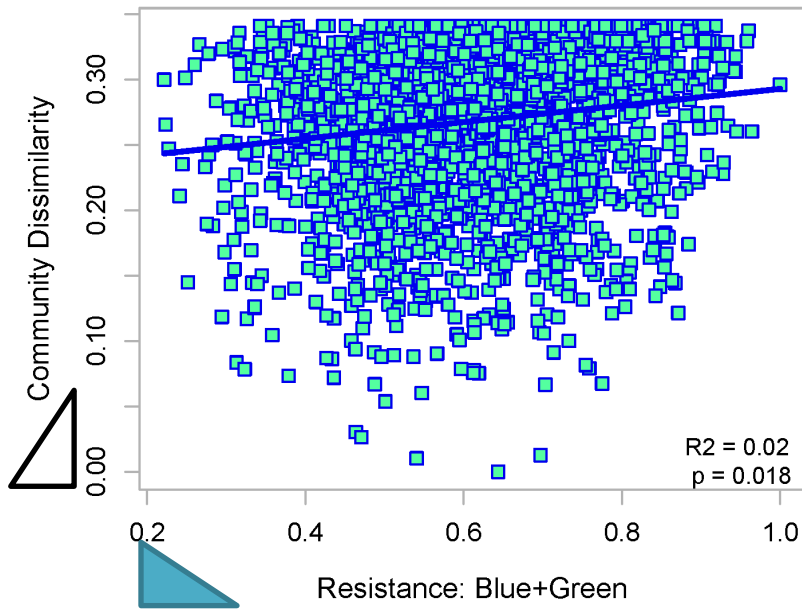
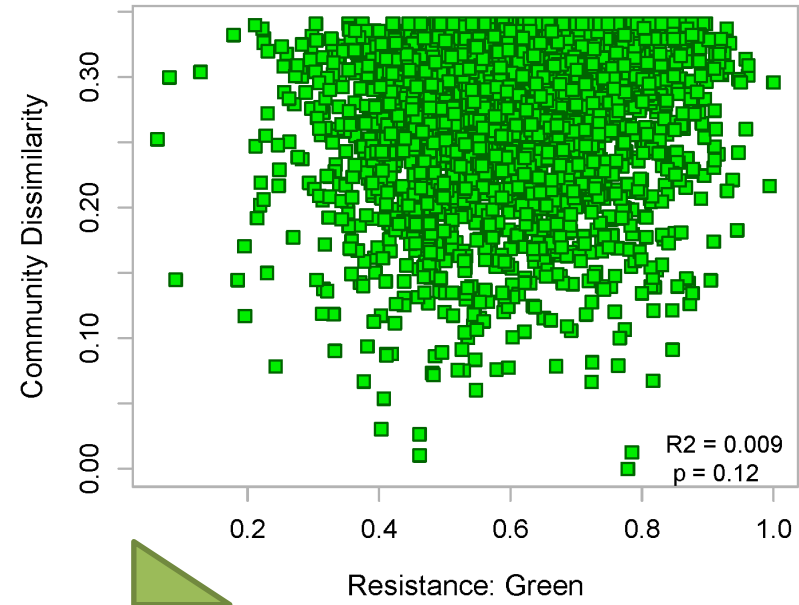
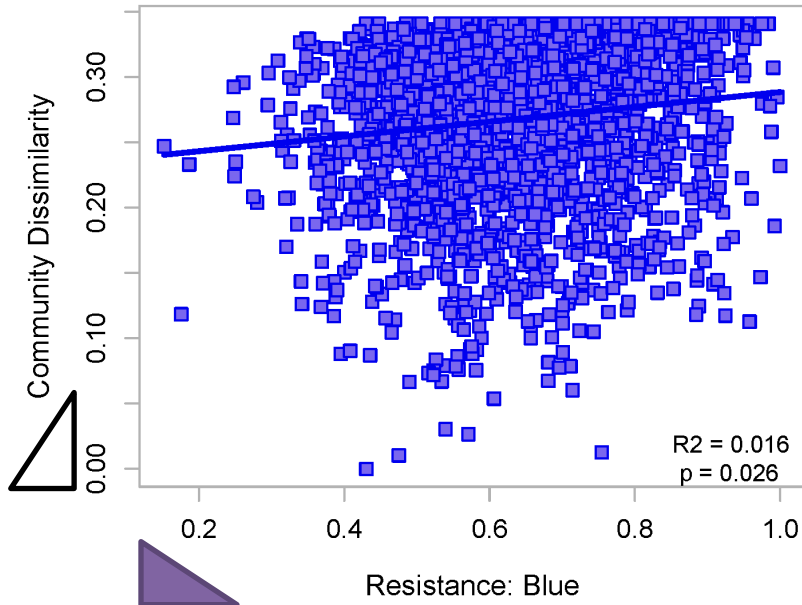


# Optimized (and Automated) Parameterization of Resistance Surfaces



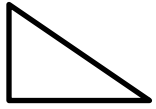


# Effect of Connectivity on Community Composition

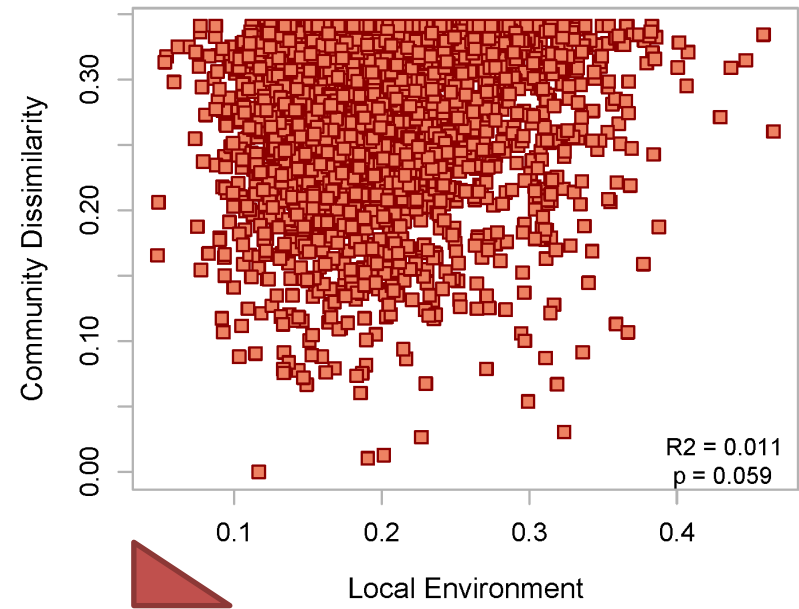
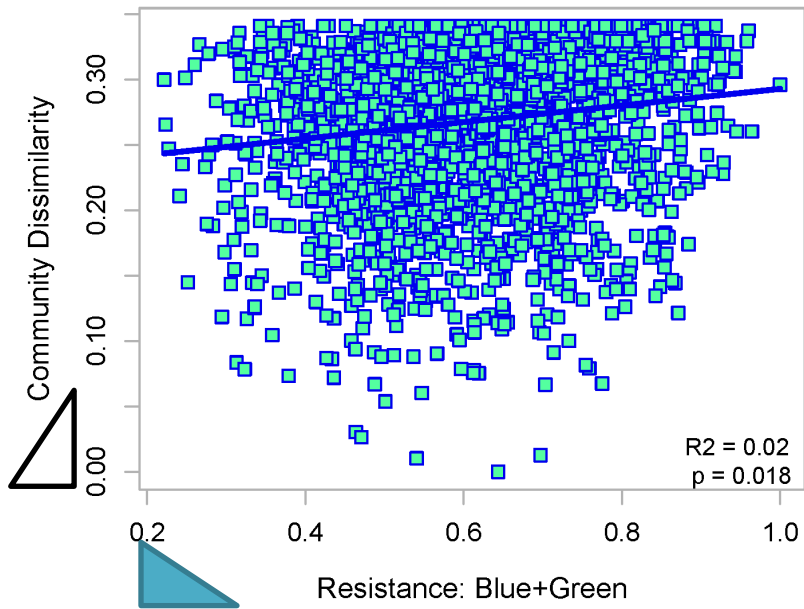
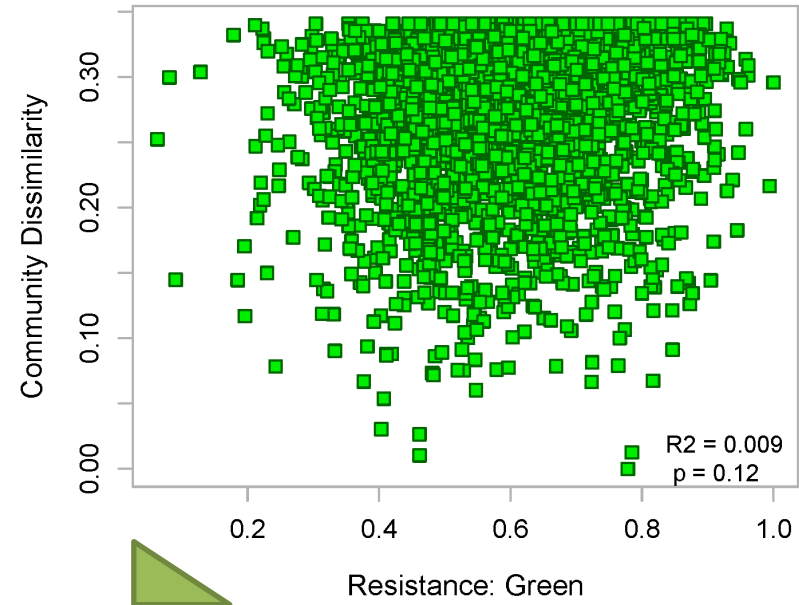
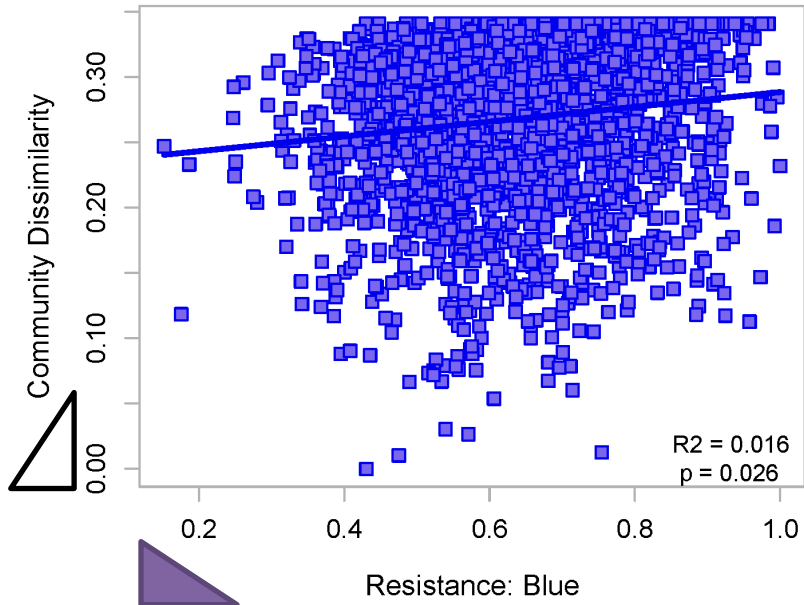
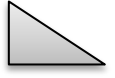


# Effect of Connectivity on Community Composition

Response:

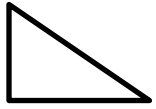


Predictors:

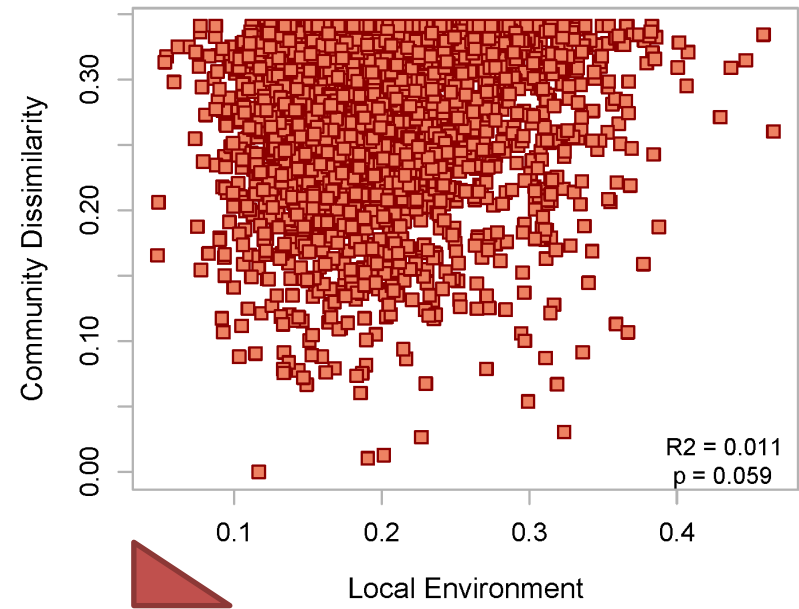
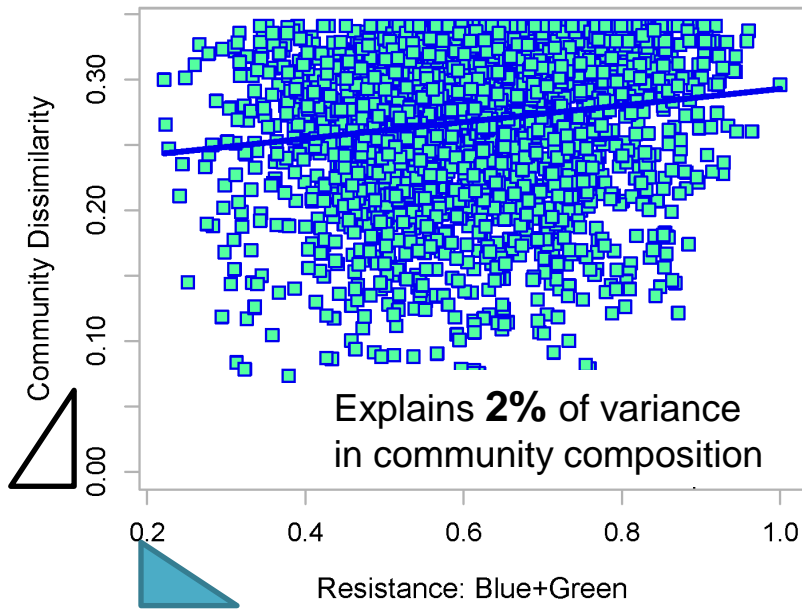
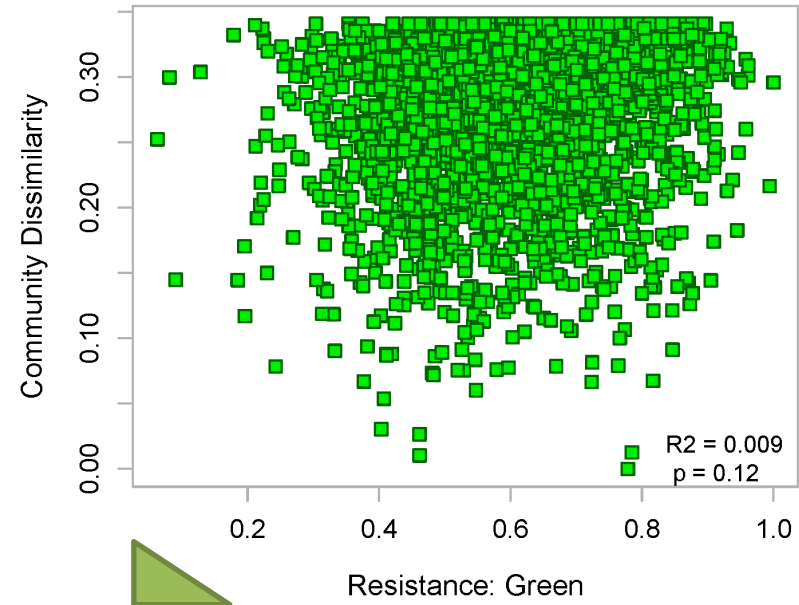
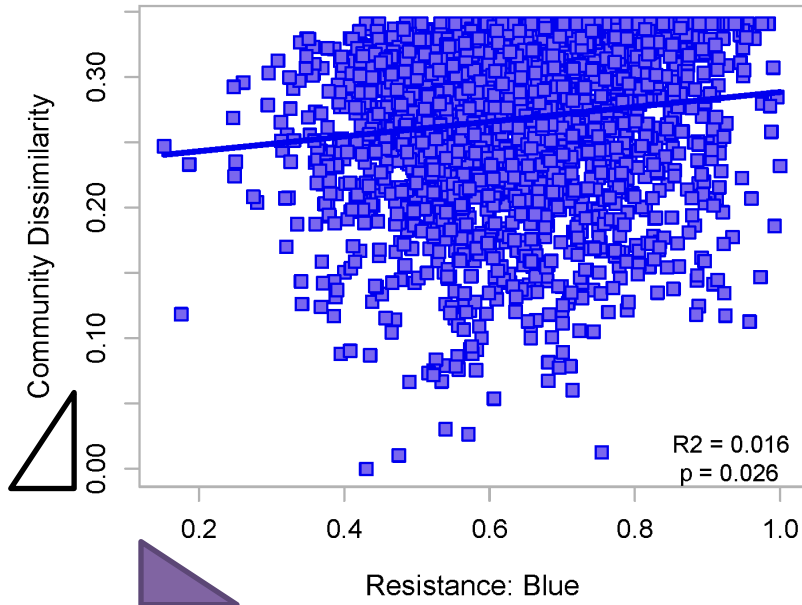
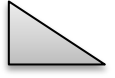


# Effect of Connectivity on Community Composition

Response:

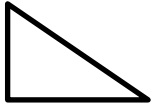


Predictors:

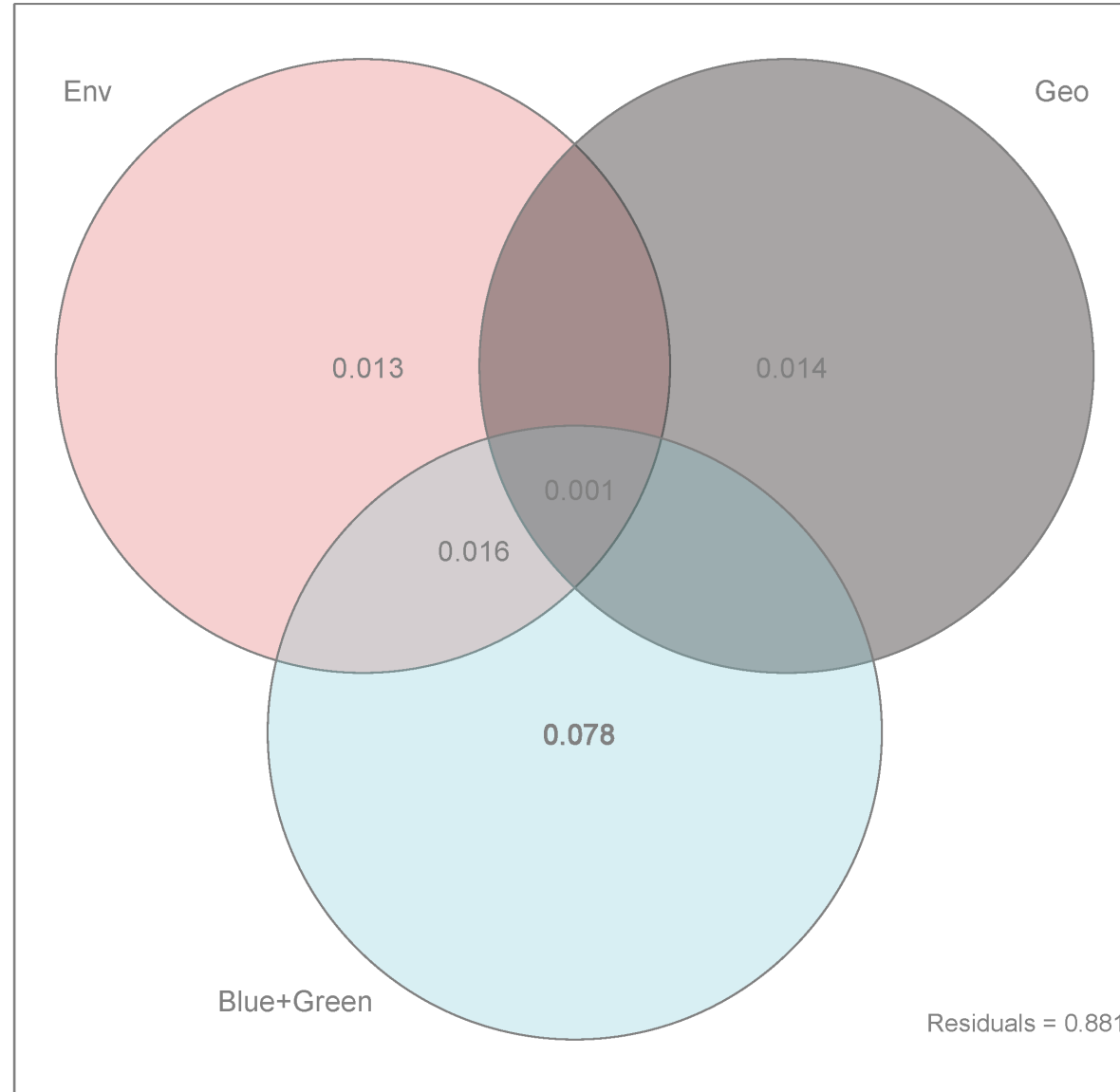
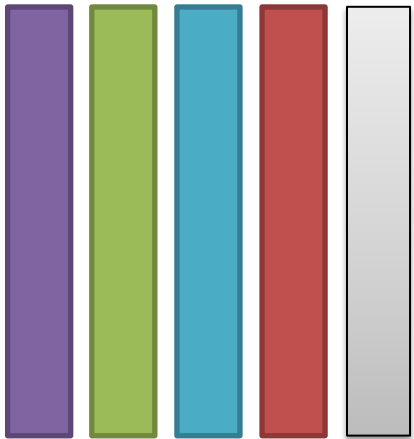


# Effect of Connectivity on Community Composition

Response:

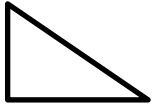


Predictors:

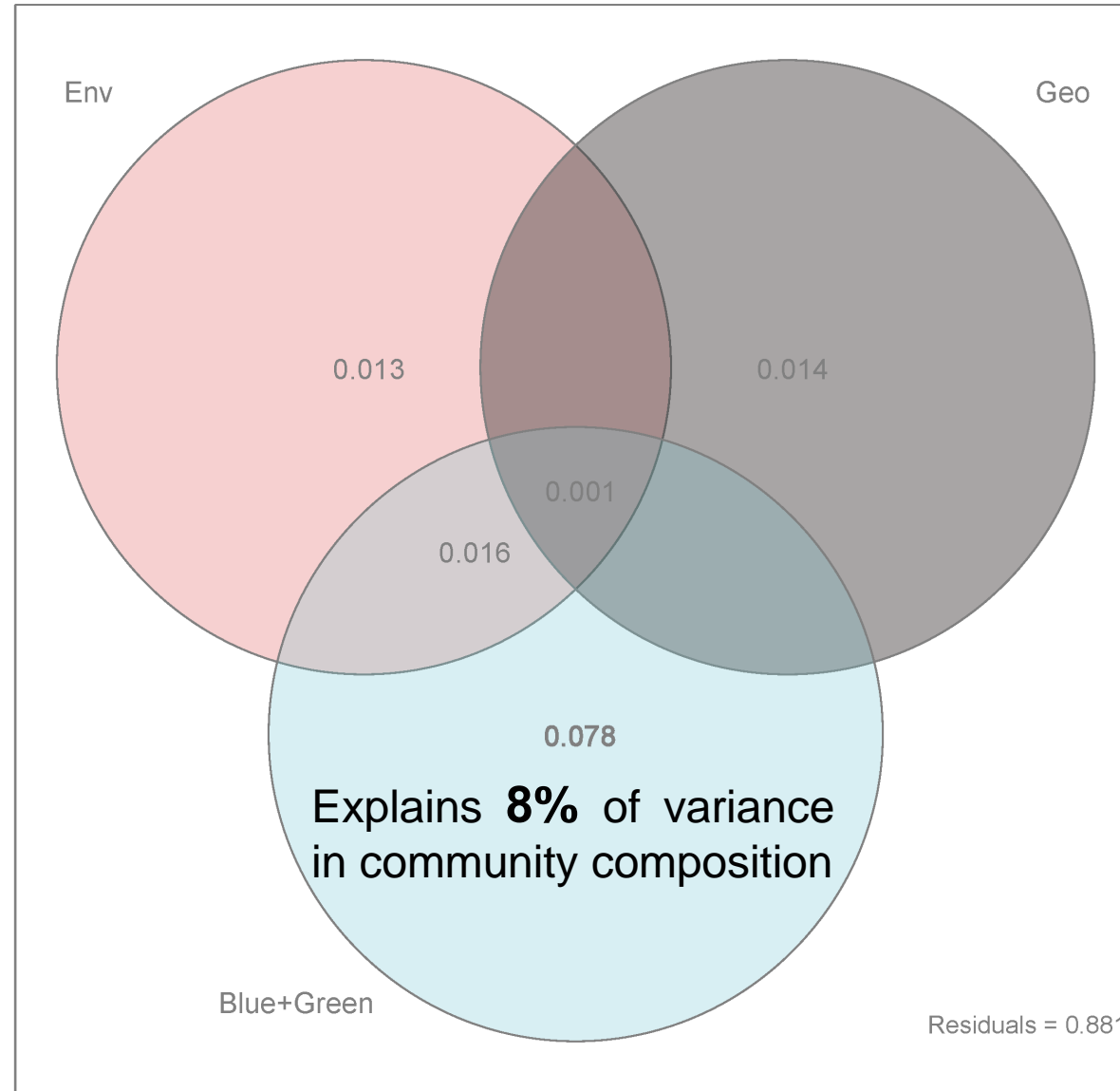
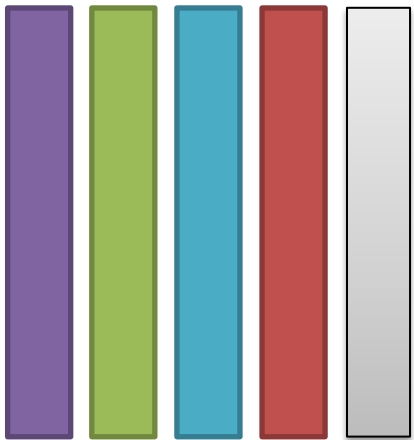


# Blue + Green Connectivity is Important to Urban Meta-Communities

Response:

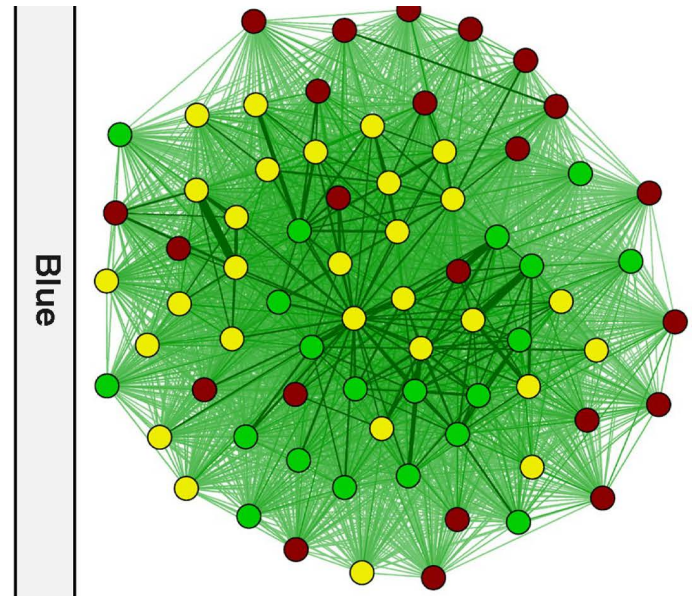
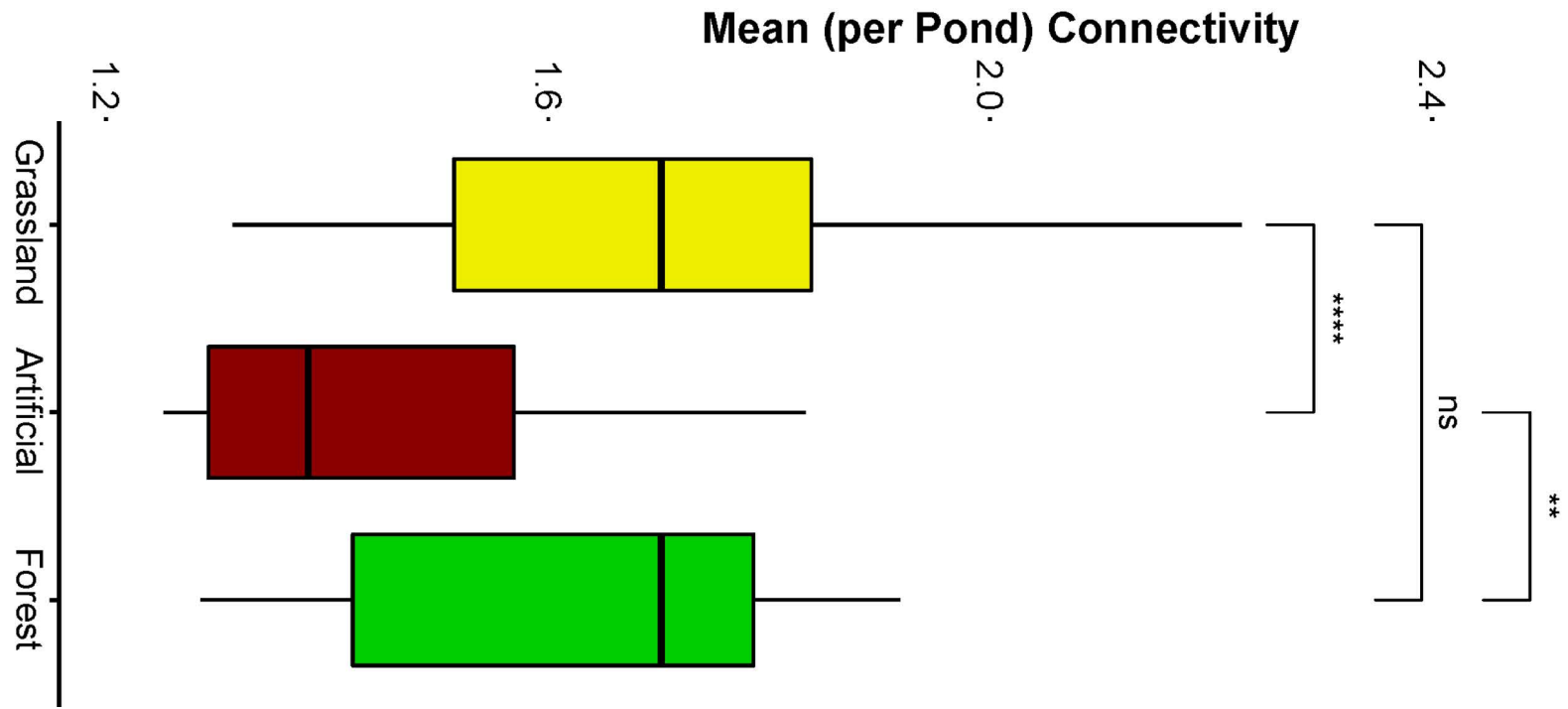


Predictors:

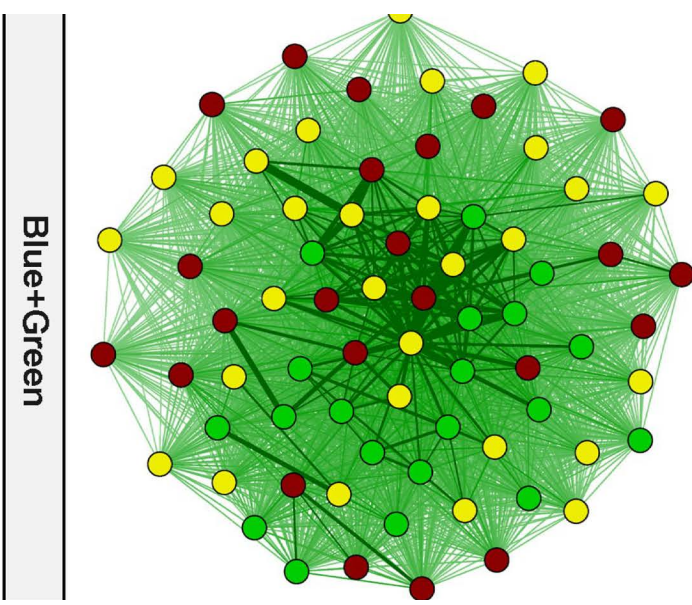
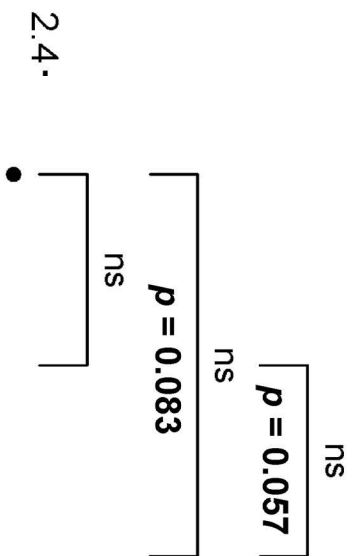
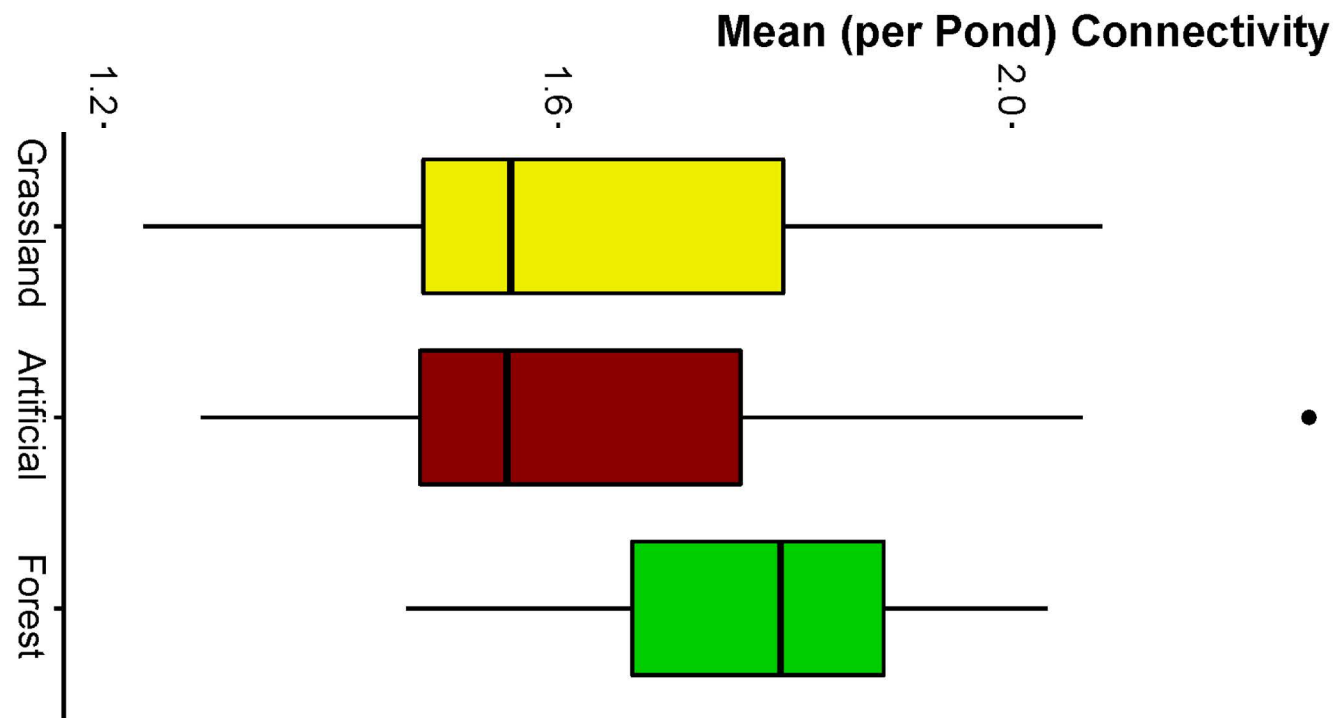


*How does landscape connectivity vary (by environment)?*

# Blue Connectivity & Level of Urban Development



# Blue + Green Connectivity & Level of Urban Development





*What about community composition in these environments?*

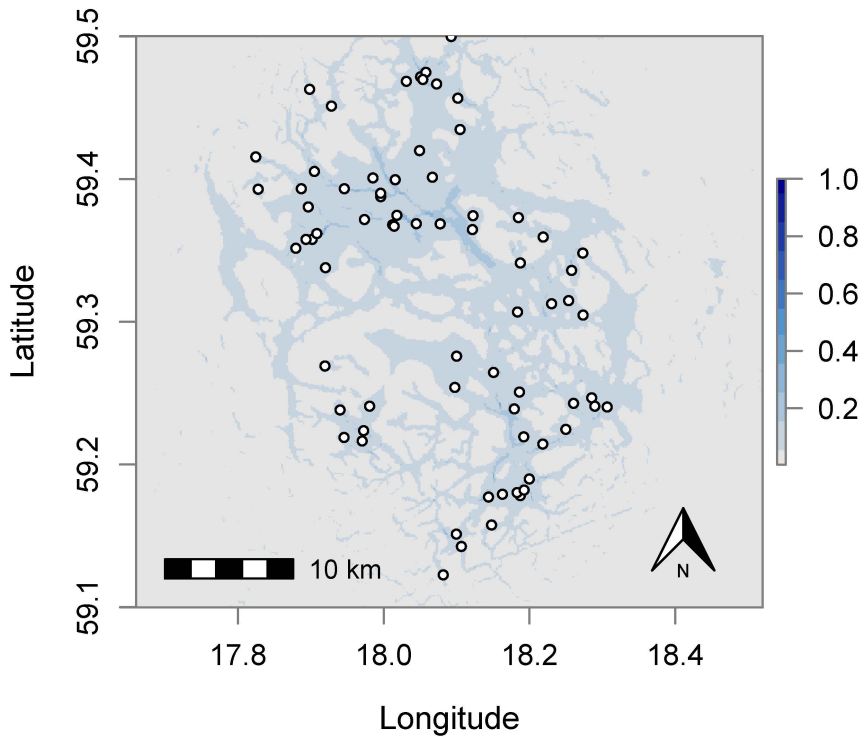
# Community Composition & Level of Urban Development

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

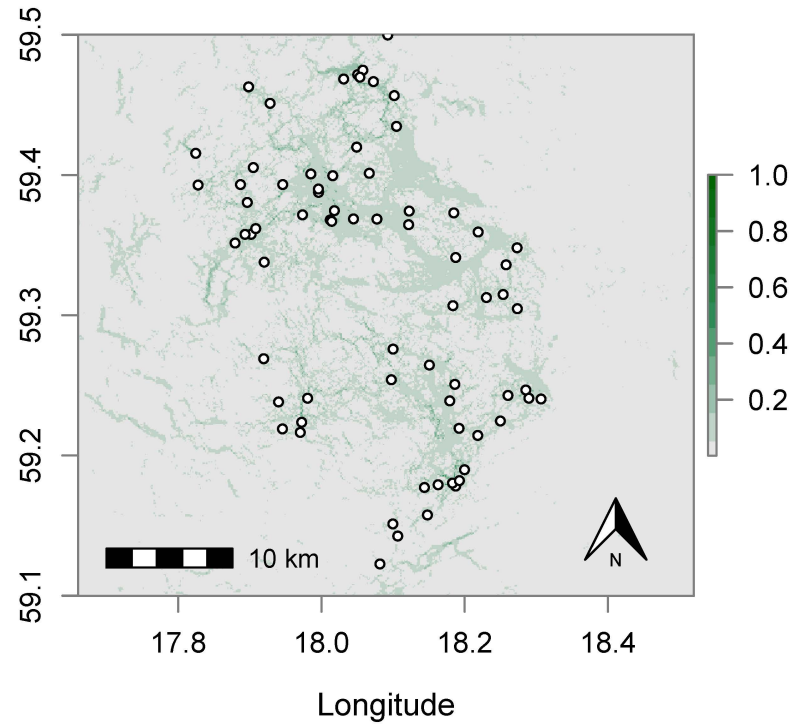
*How would we improve connectivity in more urban/developed areas?*

# Density of Electrical Current – Connectivity Pathways/Corridors

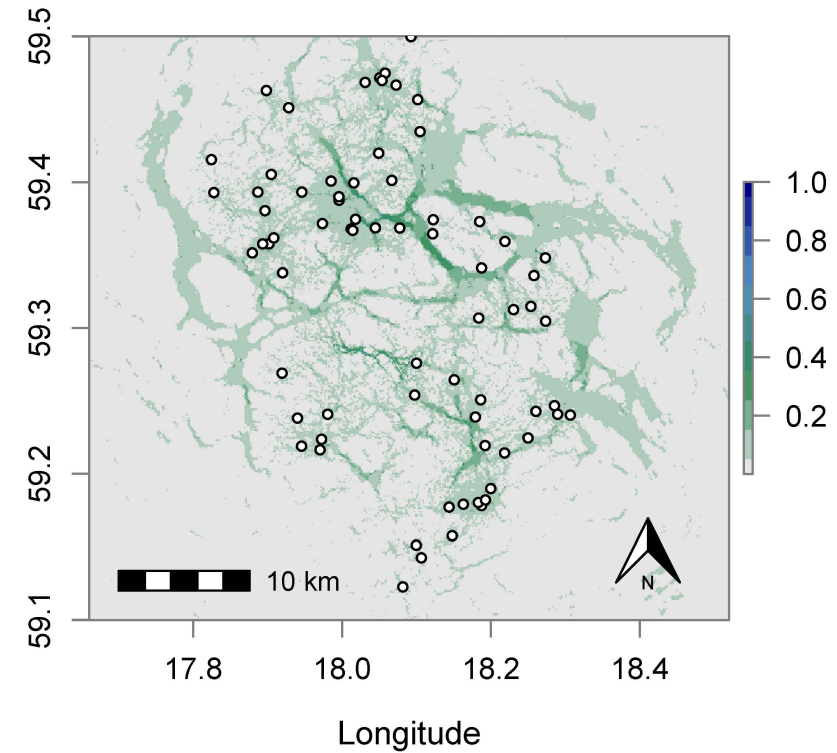
Current Density: Blue



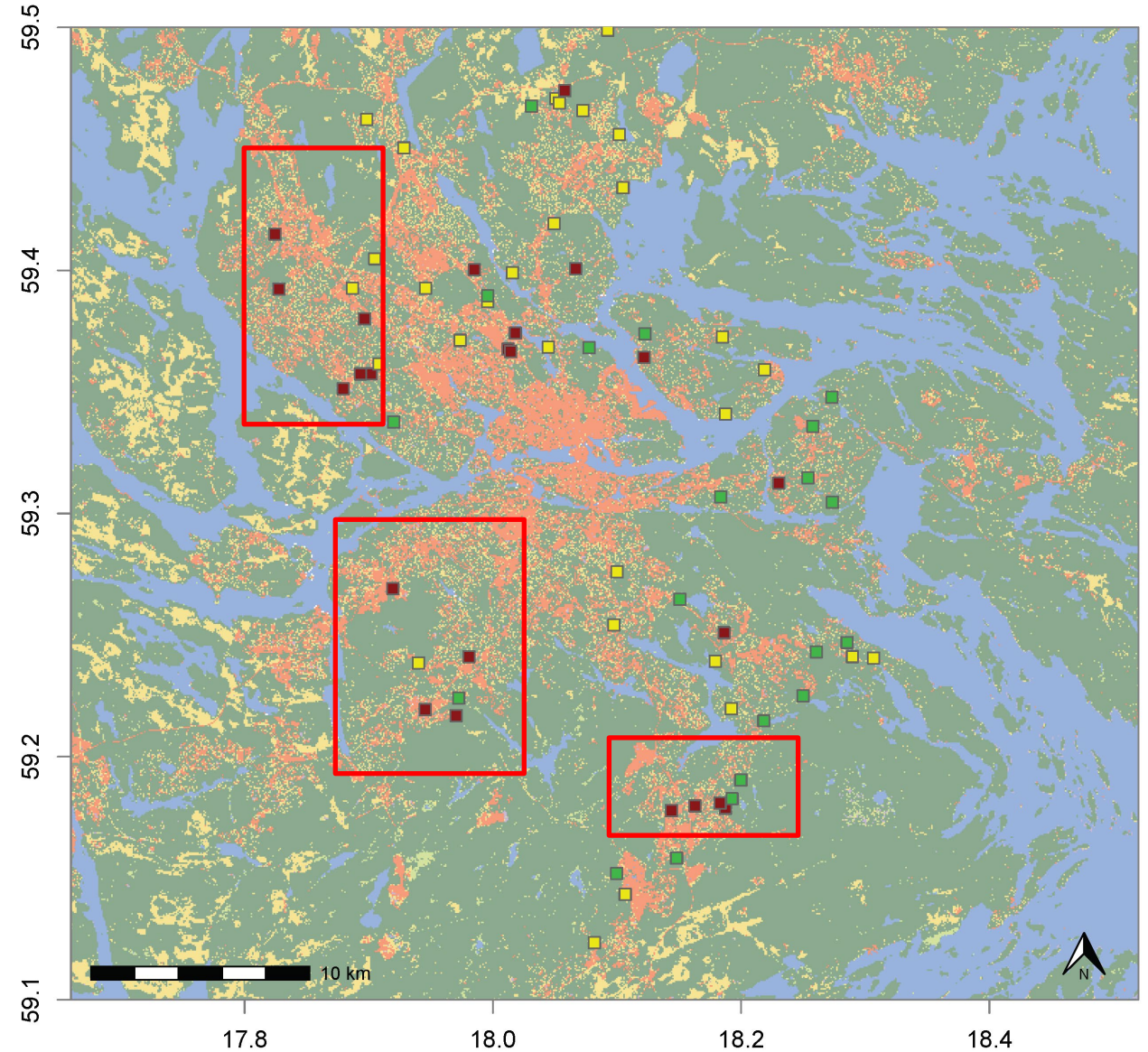
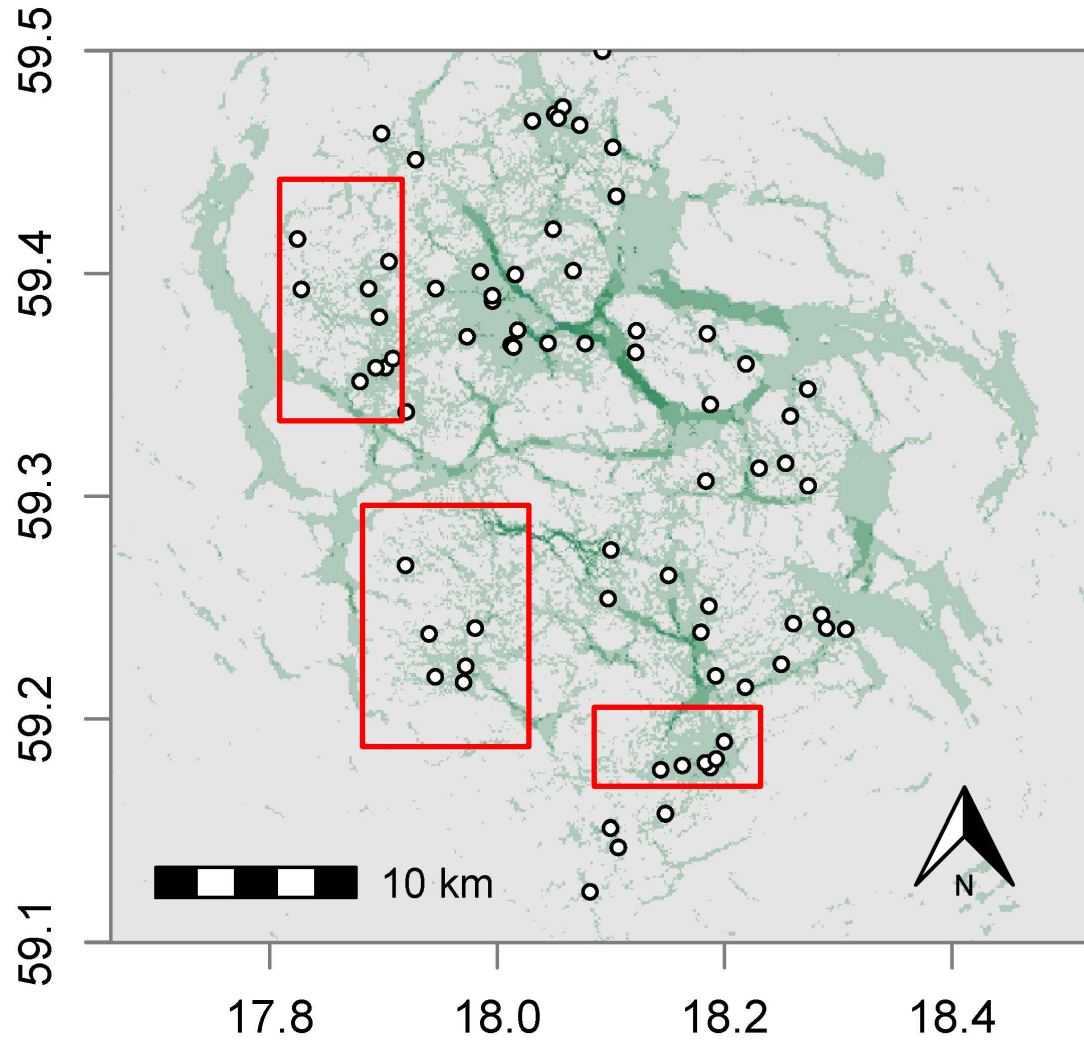
Current Density: Green



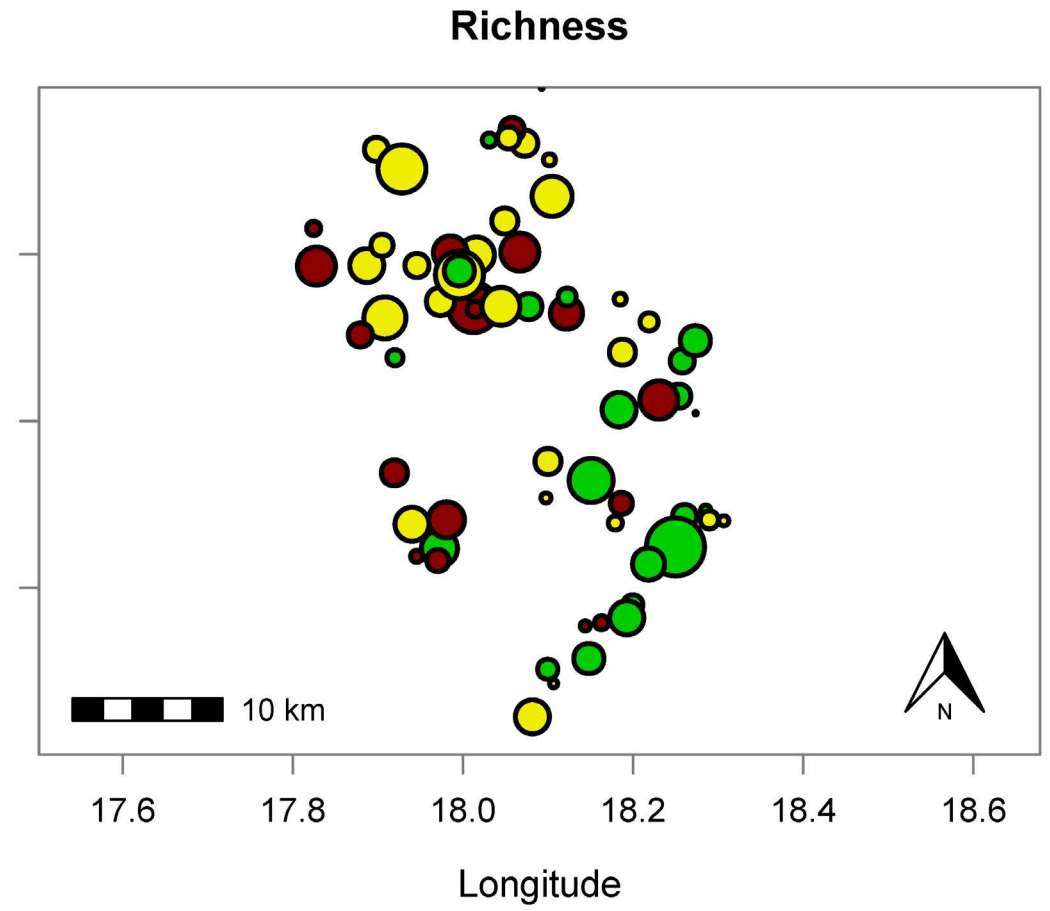
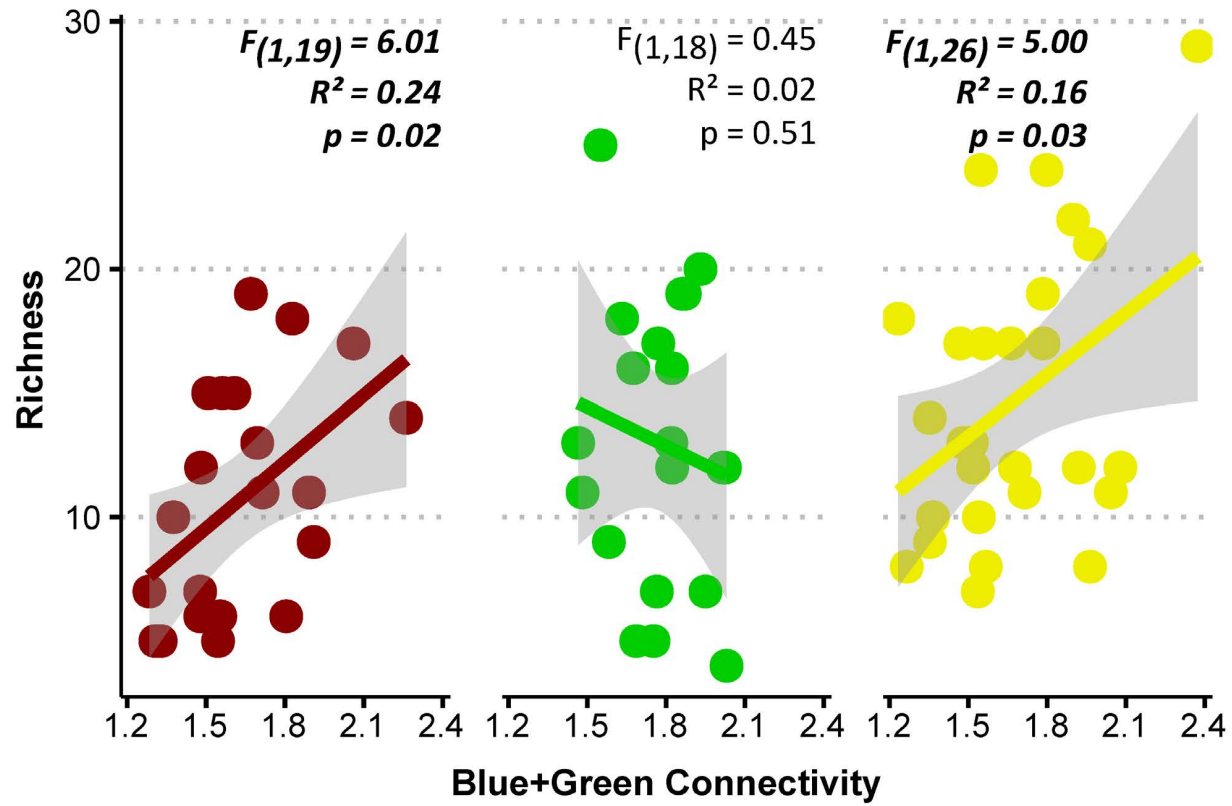
Current Density: Blue+Green



# 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

 <http://specevgen.net>



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