Long-term improvements to aquatic connectivity in the GTA

Chris Edge, Monica Choy, and David Lawrie

The Living City® Foundation

Toronto and Region Conservation for The Living City®

Member of Conservation Ontario

The problems

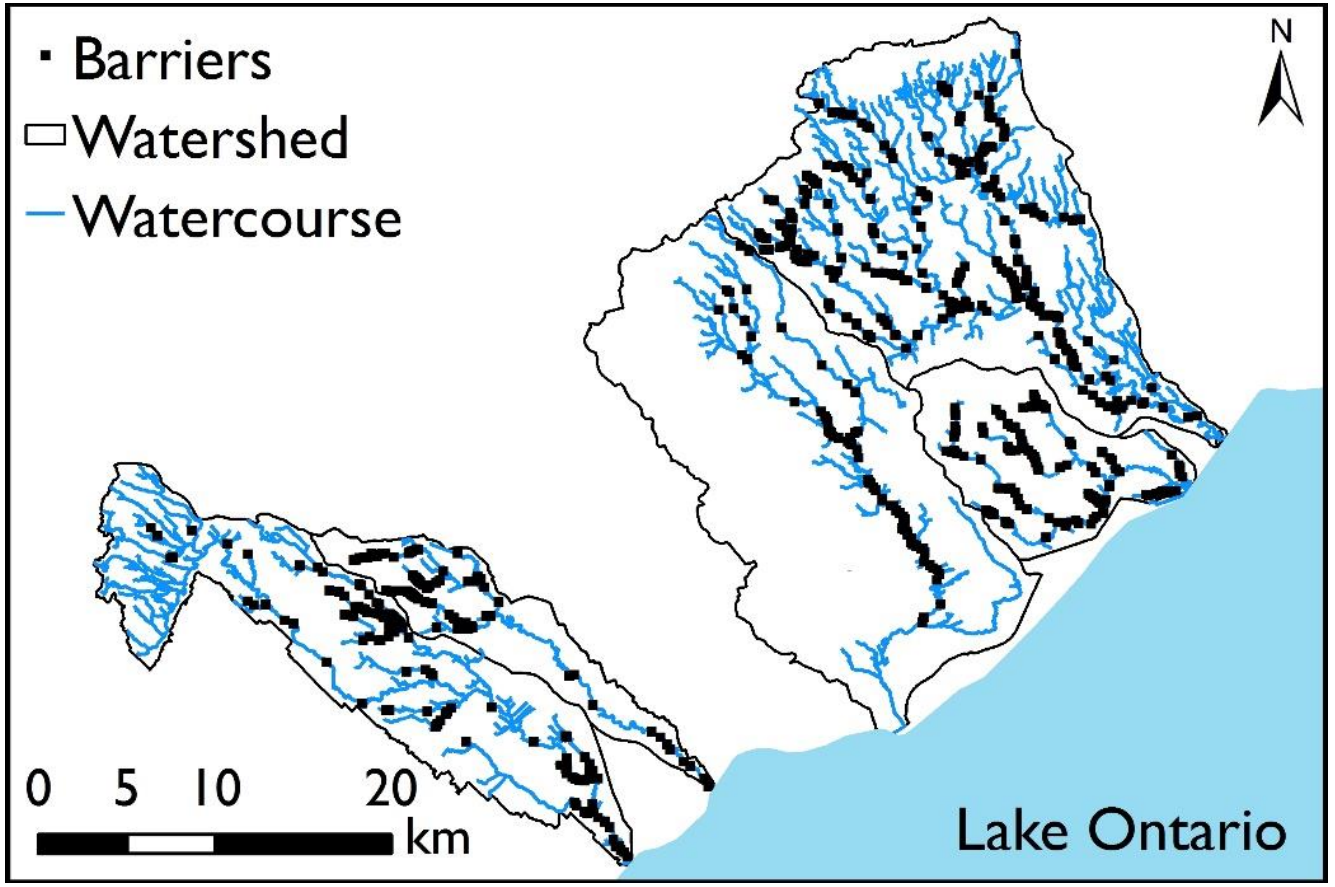
1. Streams in the Toronto Region are fragmented

2. There are lots of barriers

Improvement?

- Can we quantify improvement to aquatic connectivity
- Amount of upstream habitat available
- Amount of unimpeded stream available
- Fish return to spawning sites
- Successful spawning

More than a couple dams…



Fish barriers

Dendritic Connectivity Index (DCI)

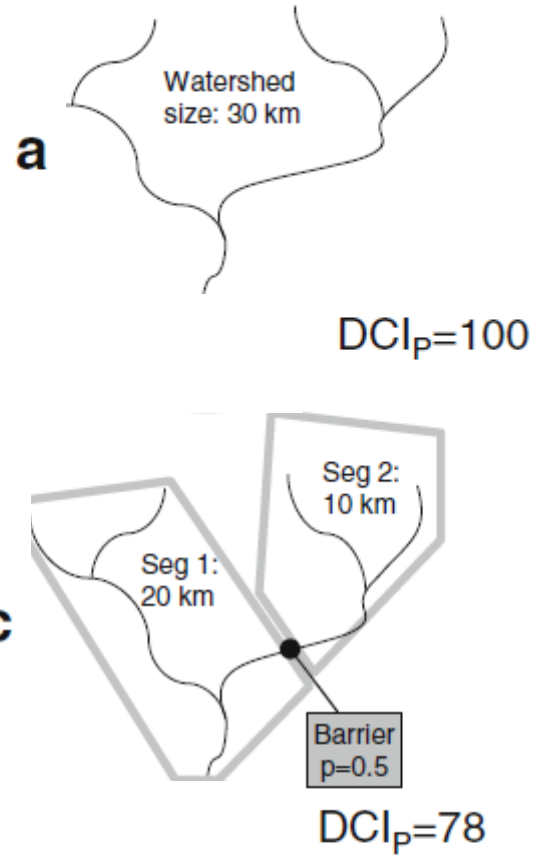
$$\mathrm{DCI_P} = \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}\frac{l_i}{L}\frac{l_j}{L} * 100$$

$$c_{ij} = \prod_{m=1}^{M} P_m^u P_m^d$$

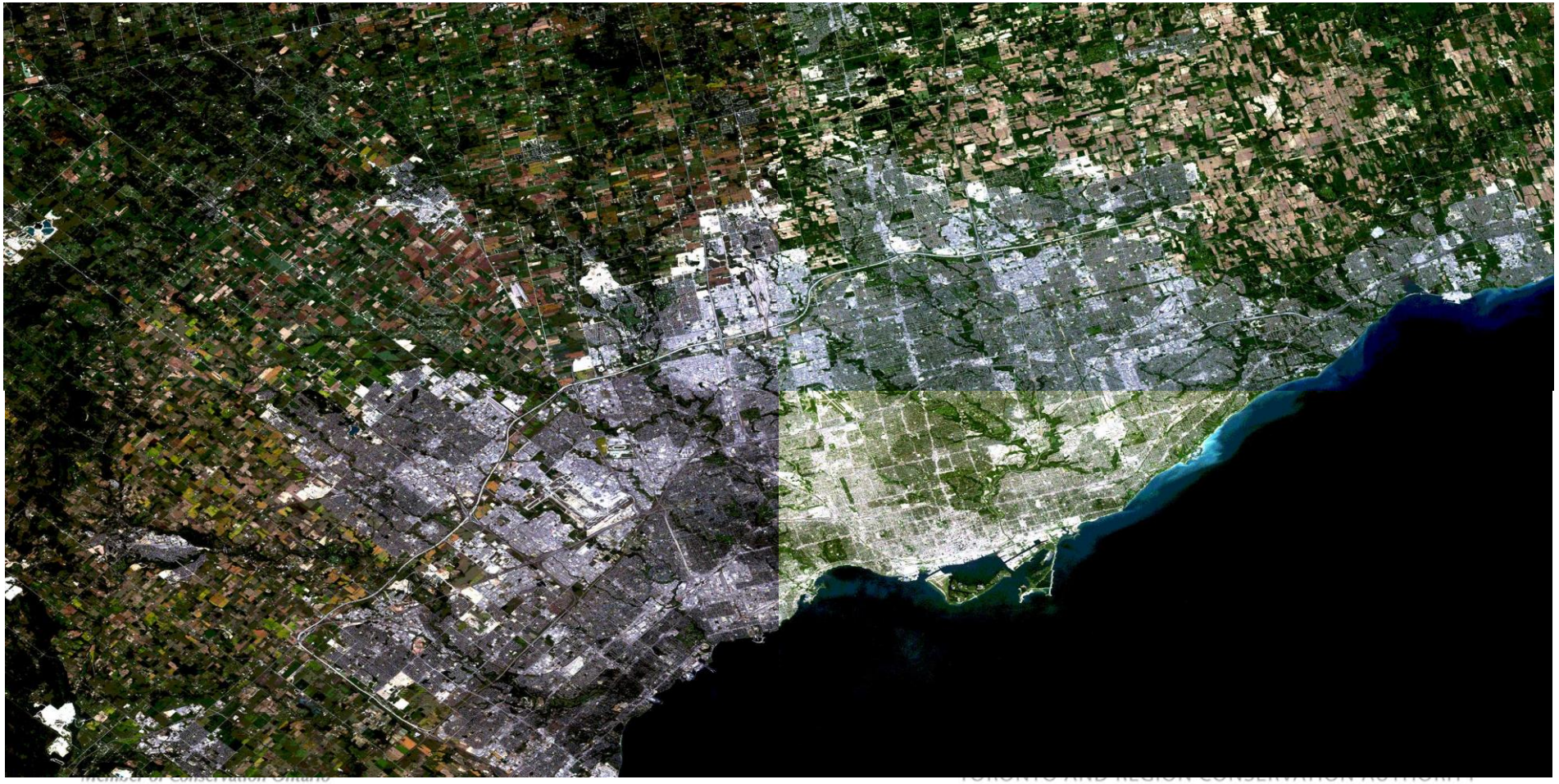
$$\mathrm{DCI_S} = \sum_{i=1}^{n} c_{ij}\frac{l_i}{L} * 100$$

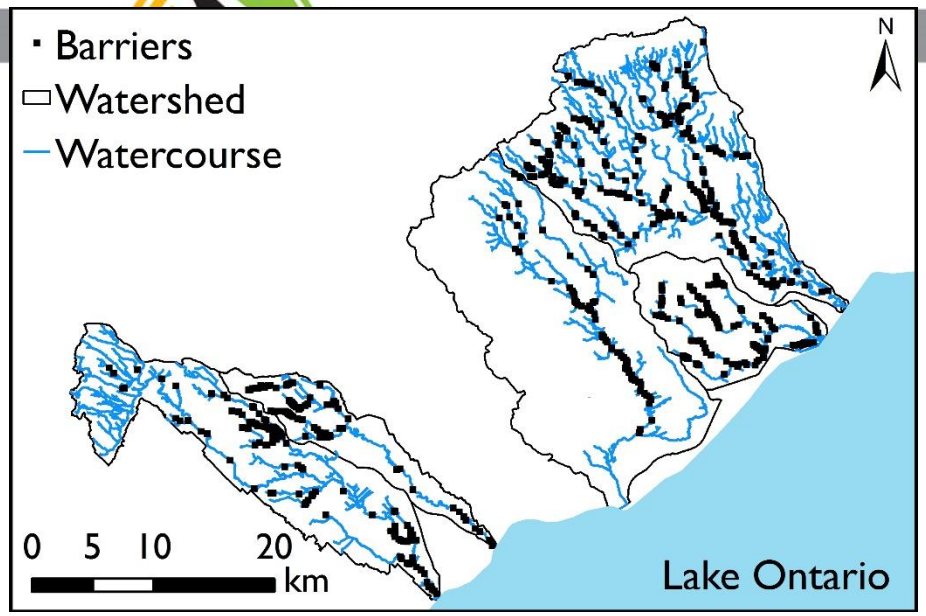
DCIp: Percent of natural connectivity remaining in the network

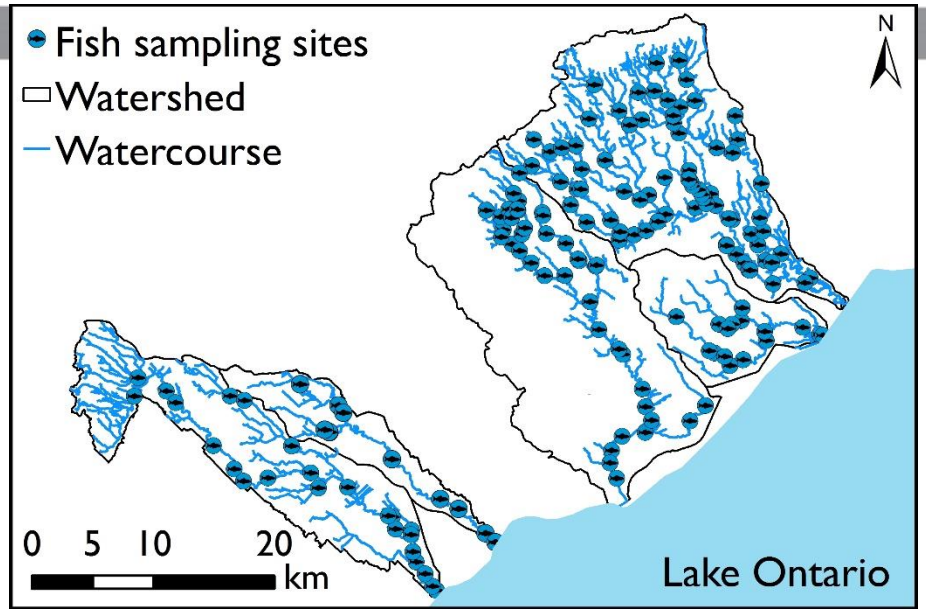
DCIs: Percent of natural connectivity between a segment and any other segment in the network



Cote et al. 2009

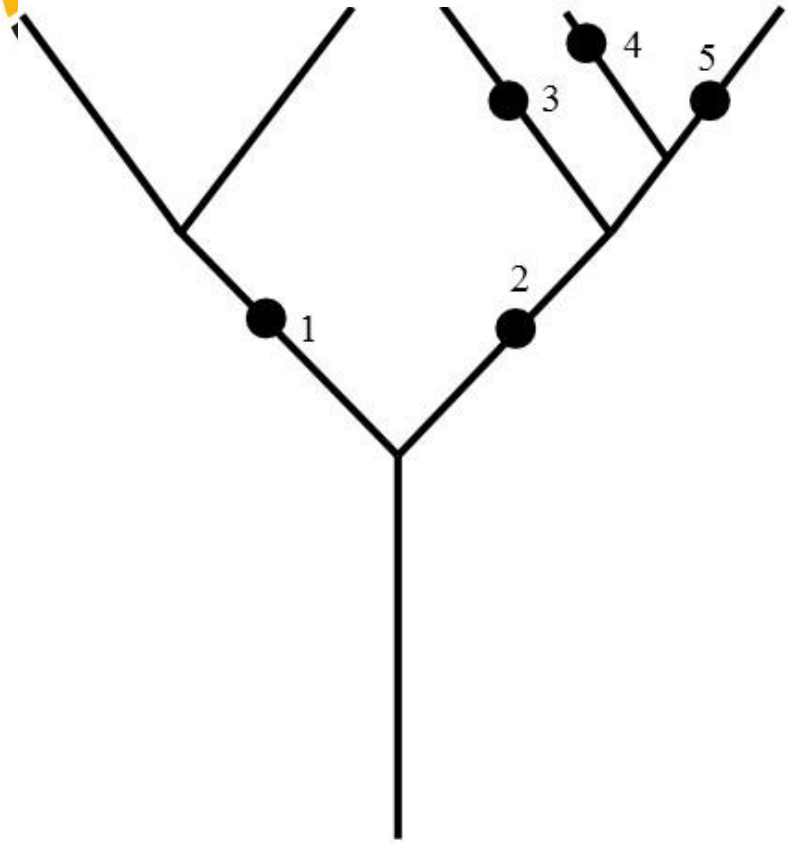






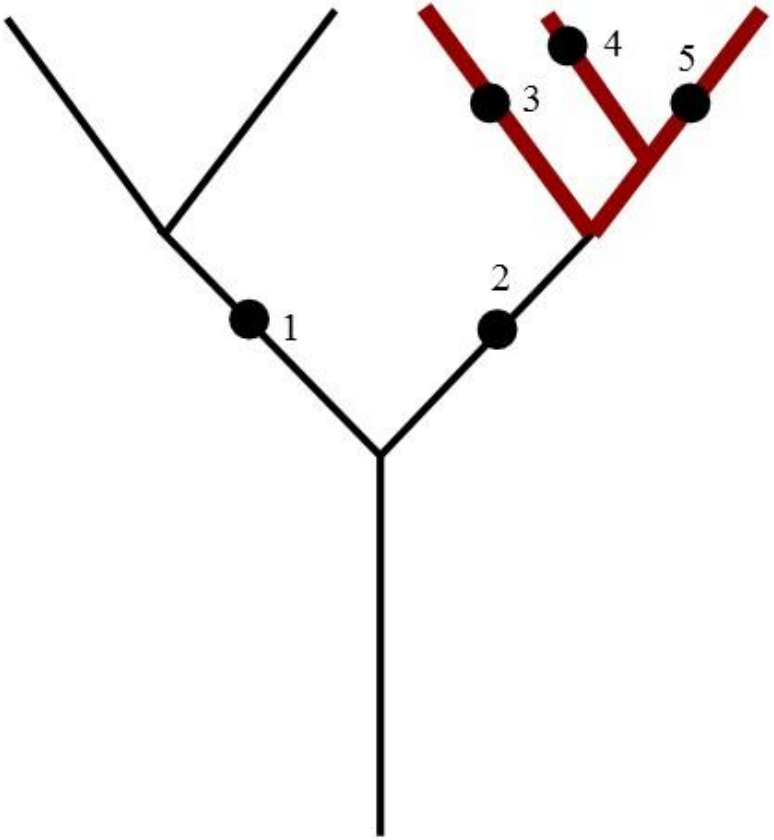
Stream	Area (ha)	Barriers
East Don	35806	81
Etobicoke	21164	146
Highland	10157	142
Mimico	7709	119
Rouge	33287	343

Alpha diversity



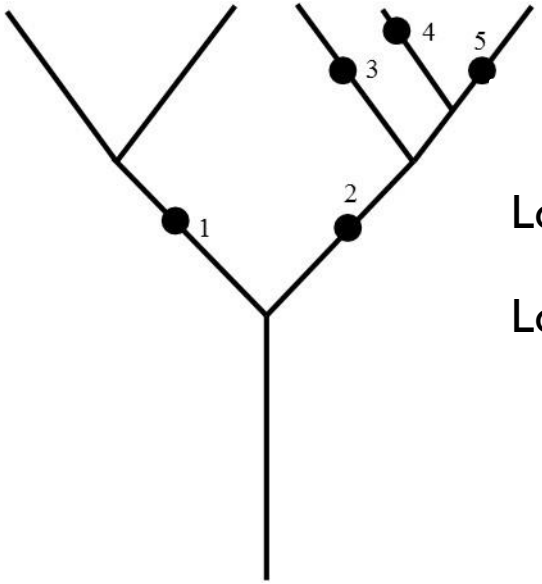
Species richness
Shannon's diversity index

Beta diversity

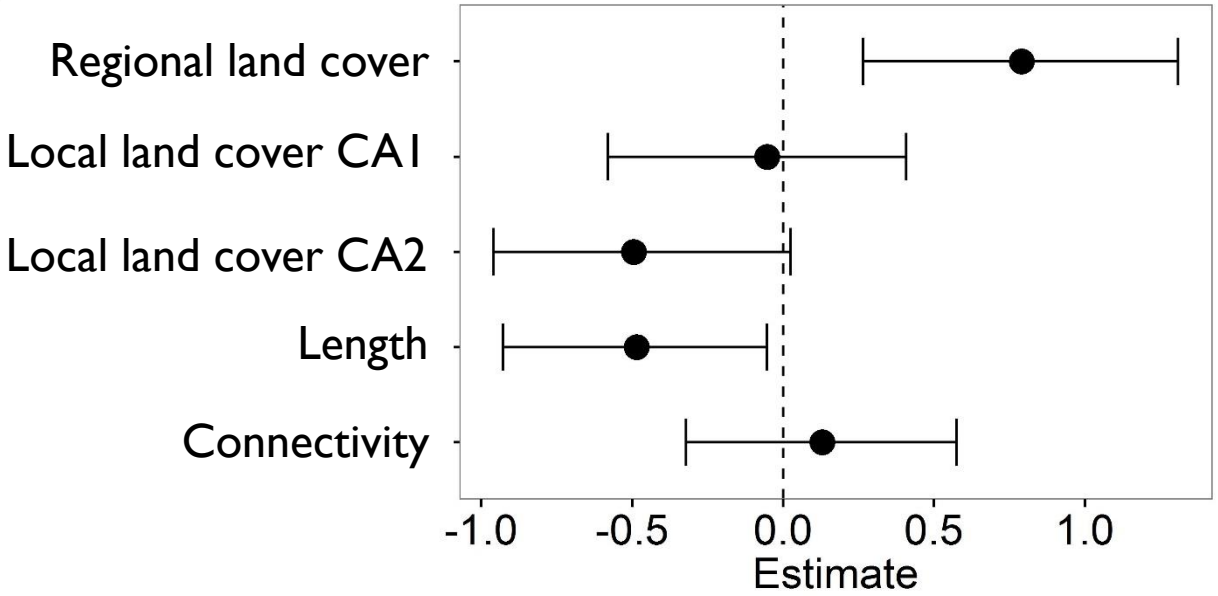


Total dissimilarity (βSor)
Turnover (βSim) – Habitat change
Species loss (βSne) – Fragmentation
Baselga 2010

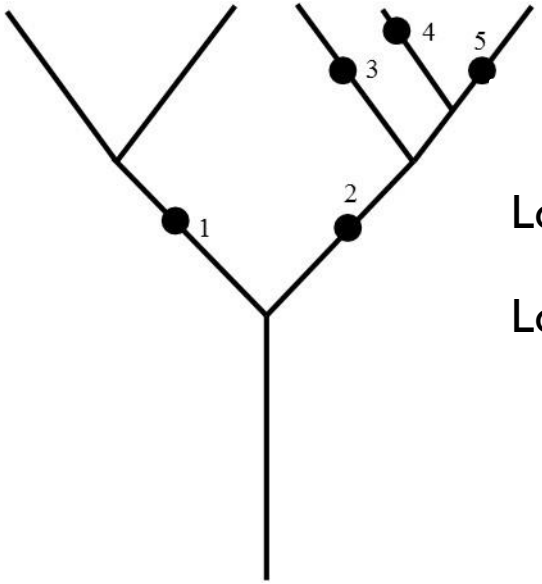
Alpha diversity



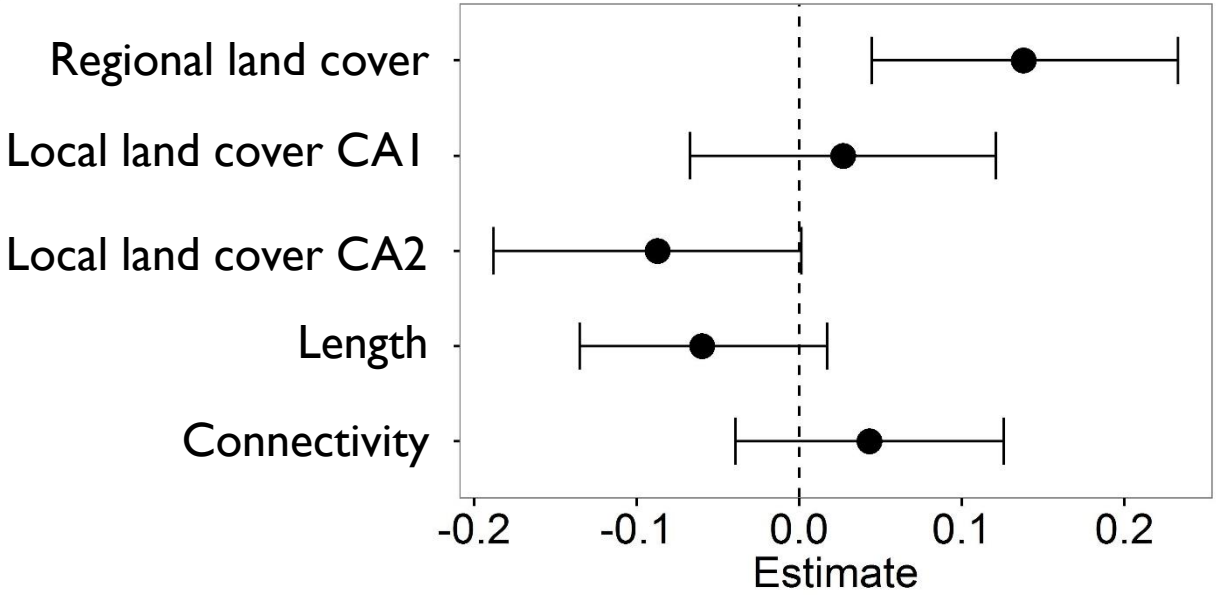
Species richness



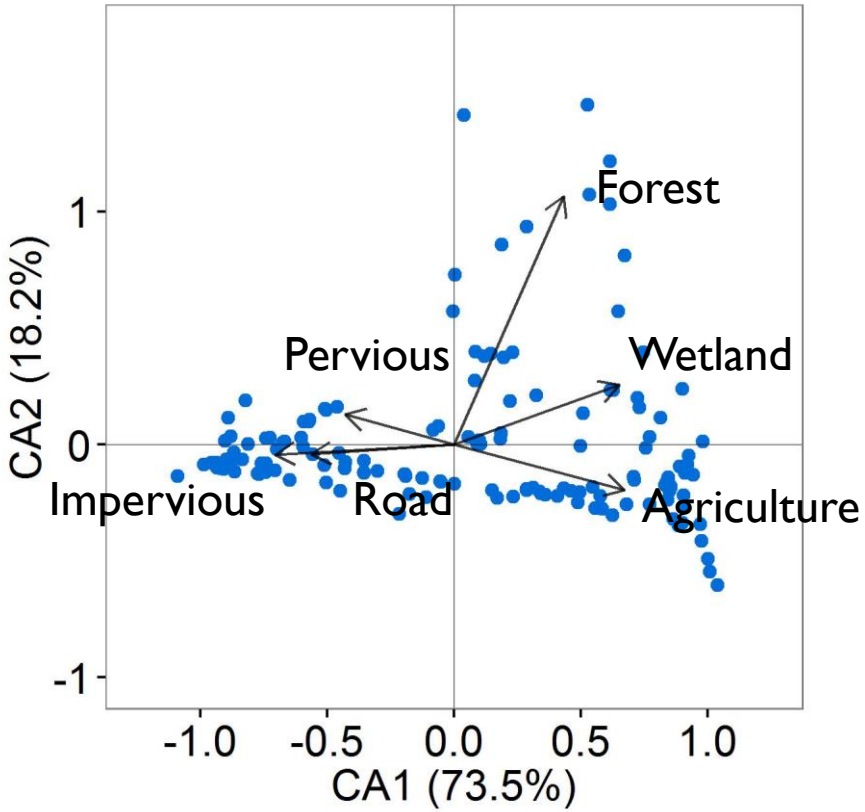
Alpha diversity



Shannon's Diversity

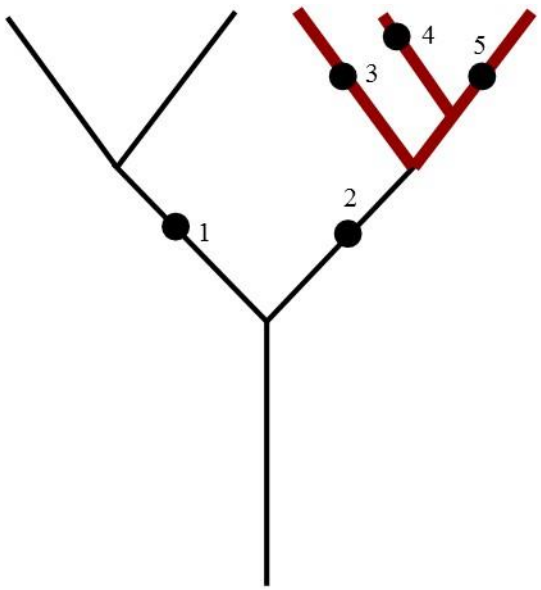


Regional land cover

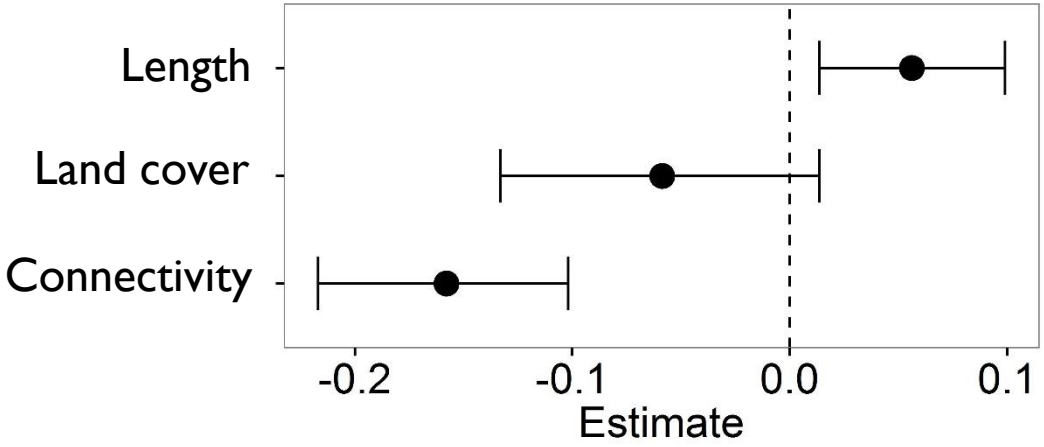


Higher species richness and Shannon's diversity in agricultural regions with wetlands

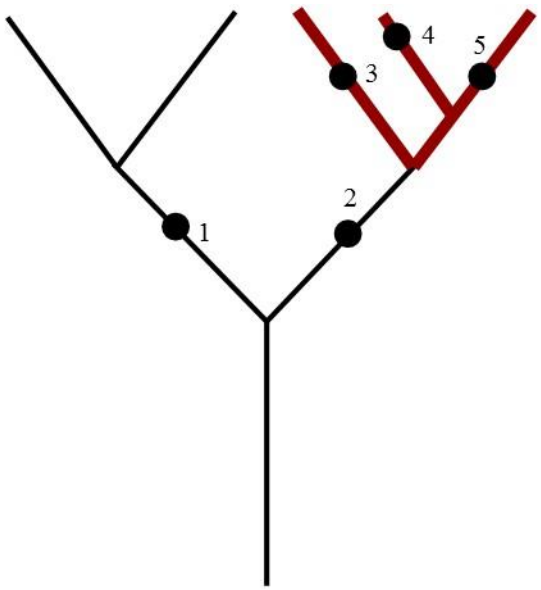
Beta diversity



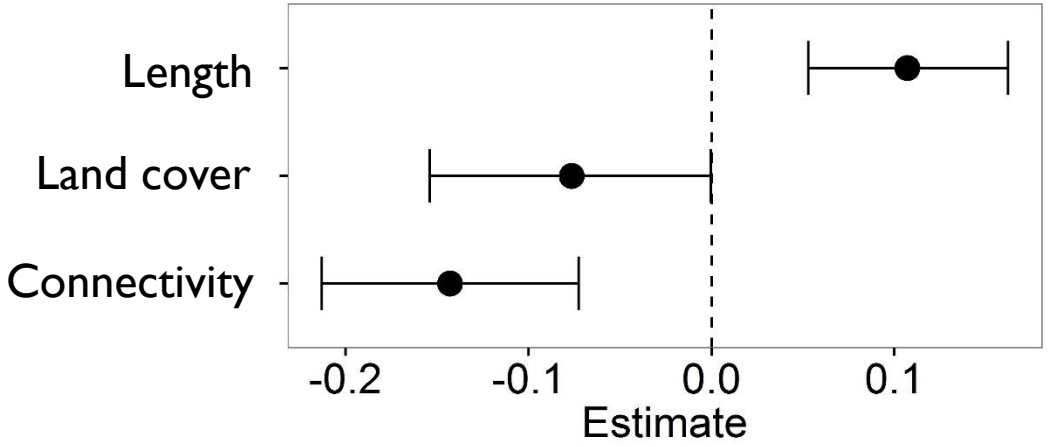
Total dissimilarity (βSor)



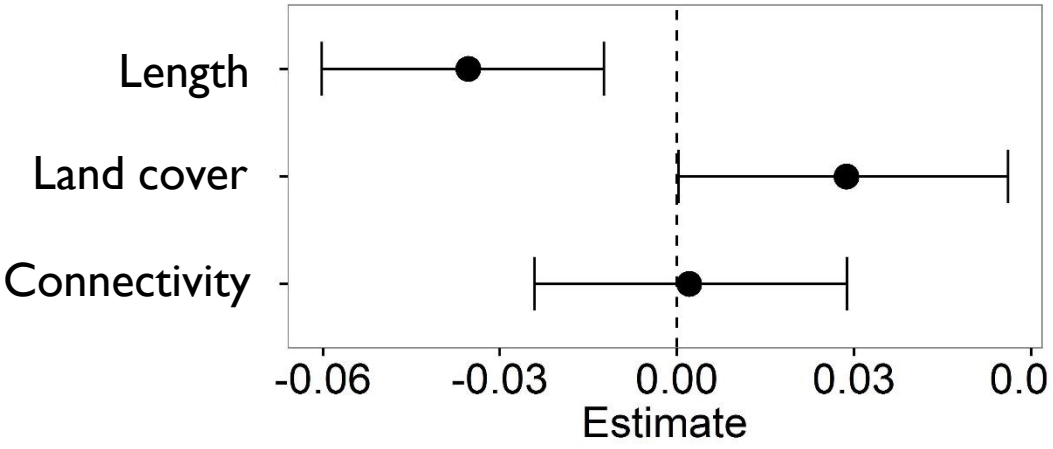
Beta diversity



Turnover (βSim)



Species loss (βSne)



Scale dependent results

Alpha diversity

Land cover at the regional scale

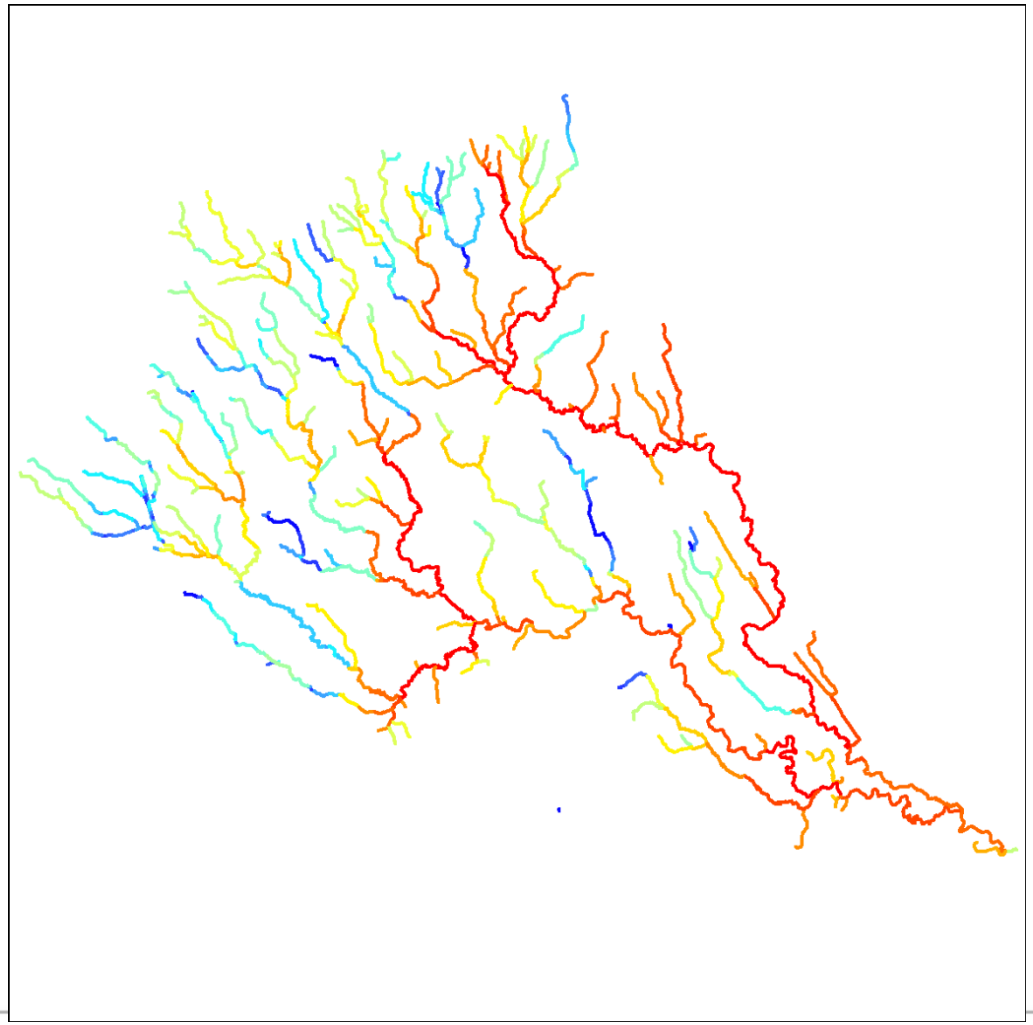
Beta diversity

Connectivity and amount of habitat

Land cover

Edge et al. Accepted. Landscape Ecology

Connectivity mapped, DCIs



Remedial Action Plan – Improvement

- Compiled an inventory of completed barrier mitigation projects
- Use the inventory to look back in time and measure improvement to connectivity
- Quantify improvement for
  - Migratory salmonids
  - Resident species
  - Species of interest

Remedial Action Plan – Improvement

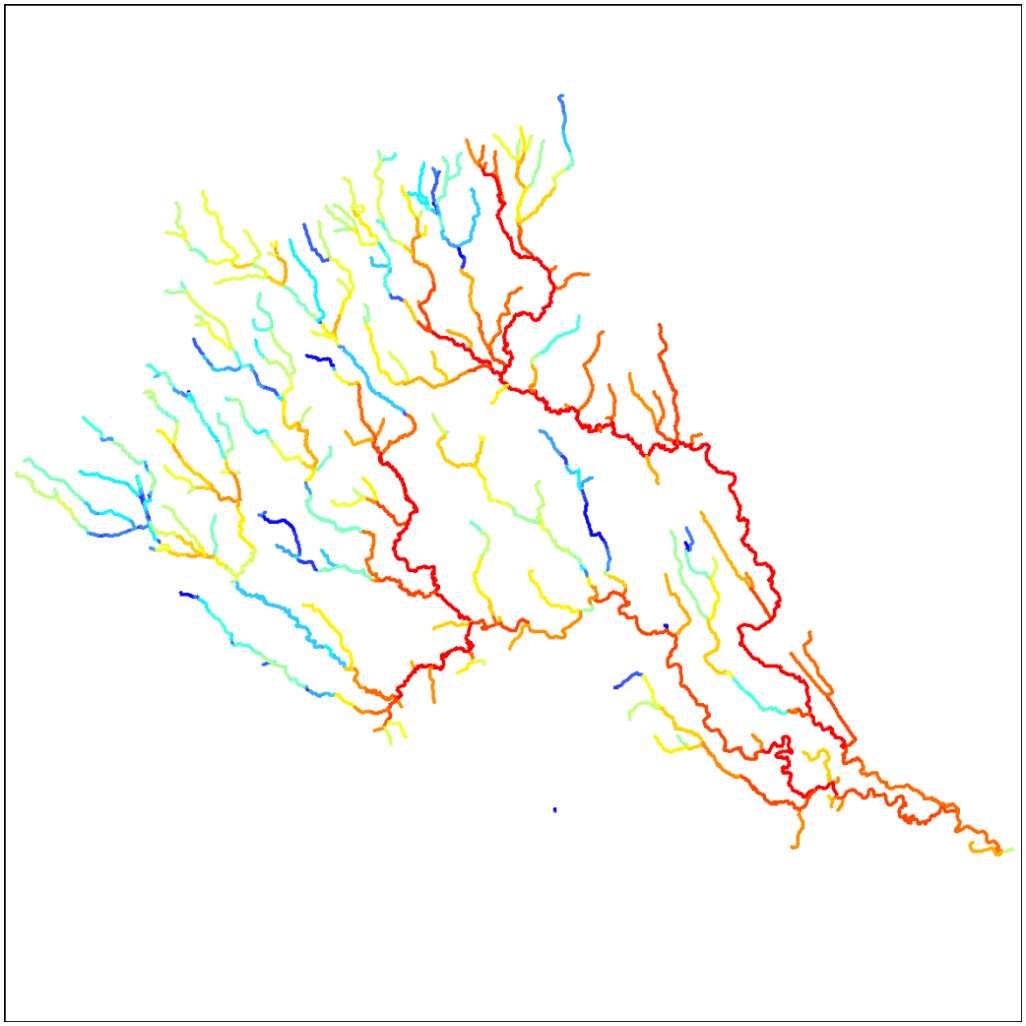
Stream	Current barriers	Mitigated barriers
Don	81	27
Etobicoke	146	9
Highland	142	4
Mimico	119	4
Rouge	343	27

Remedial Action Plan – Improvement

Barrier Type	Mitigated	Remaining
Dam	13	57
Damaged Infrastructure	1	12
Online Pond	1	?
Pedestrian Crossing	7	538
Road Crossing	13	816
Weir	36	440
Total	**71**	**1863**

Next steps

- Continue analyzing data
- Connectivity at four time steps
  - 1990, 2000, 2010, today
- Migratory species and resident species
  - Larger improvement for migratory
- Among sensitive habitat (e.g. cold water)
- Expected completion March 2017

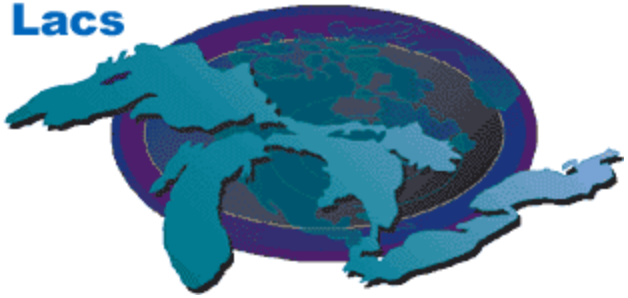


Prioritization

- Identify best barrier for mitigation
  - Migratory
  - Resident
  - Species at Risk / of interest
- Balance trade-off with invasive species
- Accept that some barriers are permanent (e.g. Sea Lamprey)
- Completion Winter 2017

Questions?

Great Lakes Sustainability Fund / Le Fonds de durabilité des Grands Lacs



Toronto and Region Conservation for The Living City®

UNIVERSITY OF TORONTO