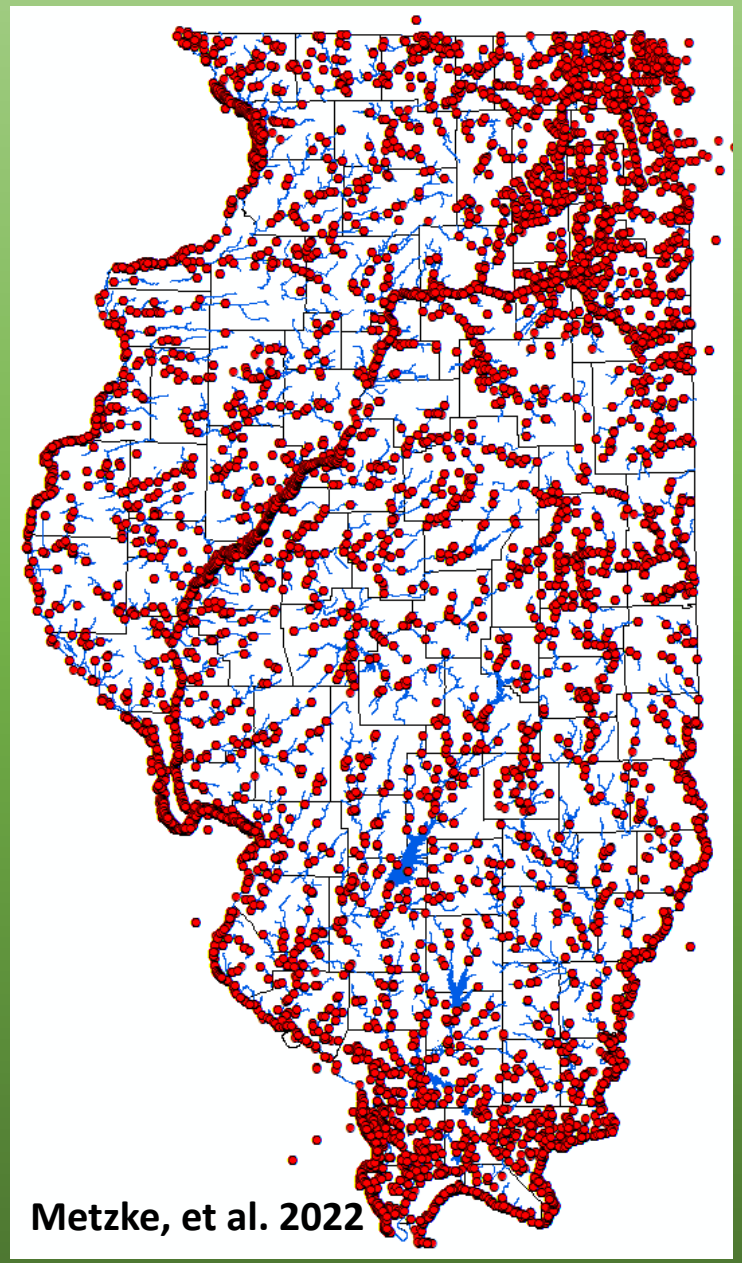
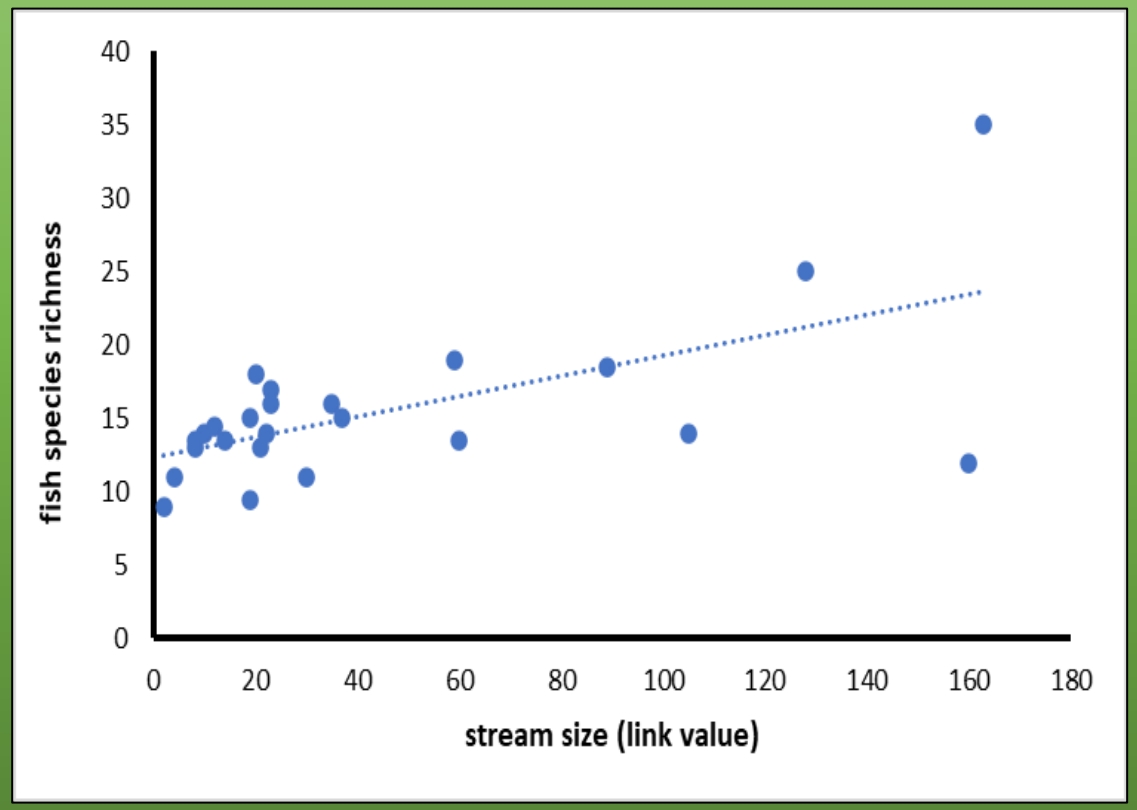
Spatial autocorrelation of assemblage composition reveals scale of mussel metacommunities

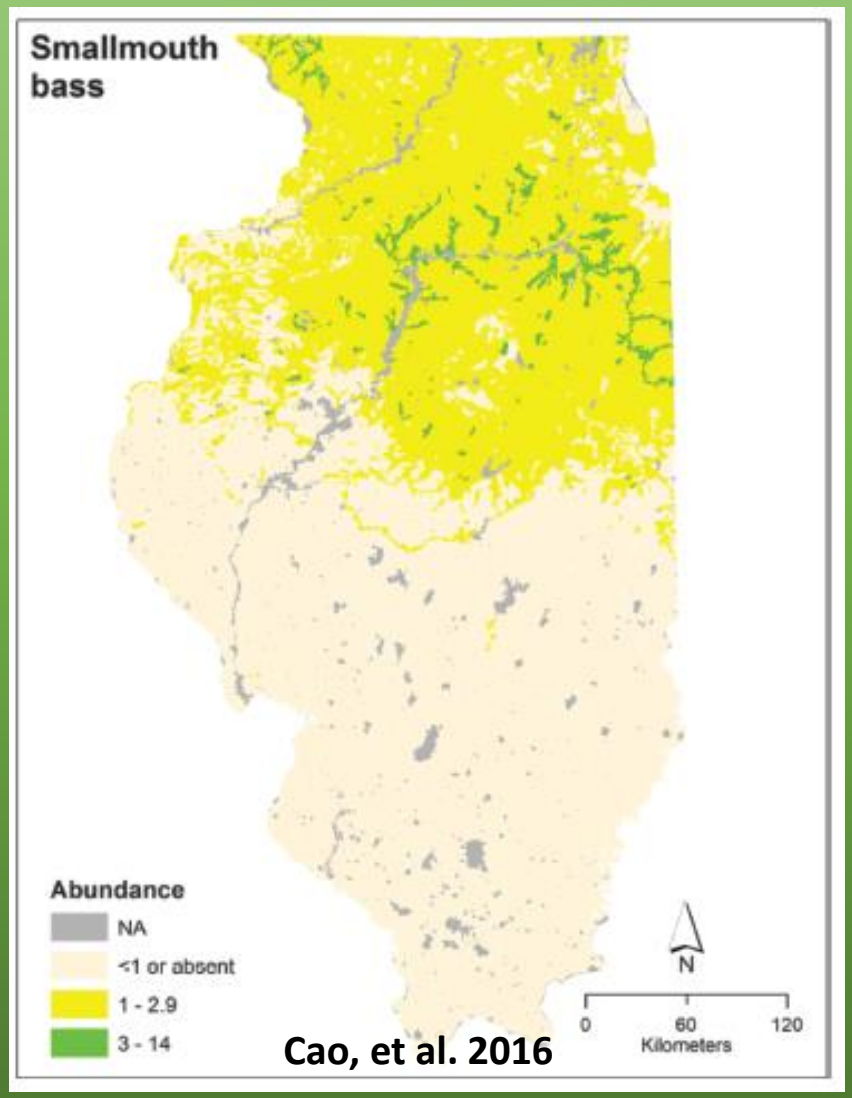
Fish Occurrence Records 1980-2020

- <10% of stream segments have fish records
- <4% of stream segments have mussel records



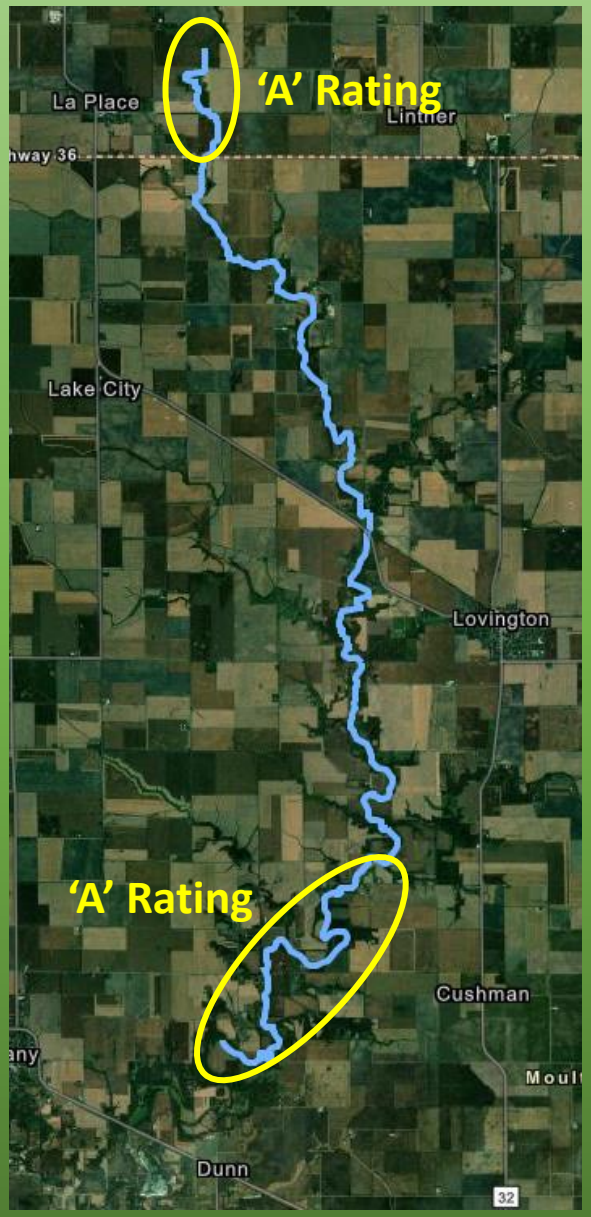
How do overcome information gaps?





Cao, et al. 2016

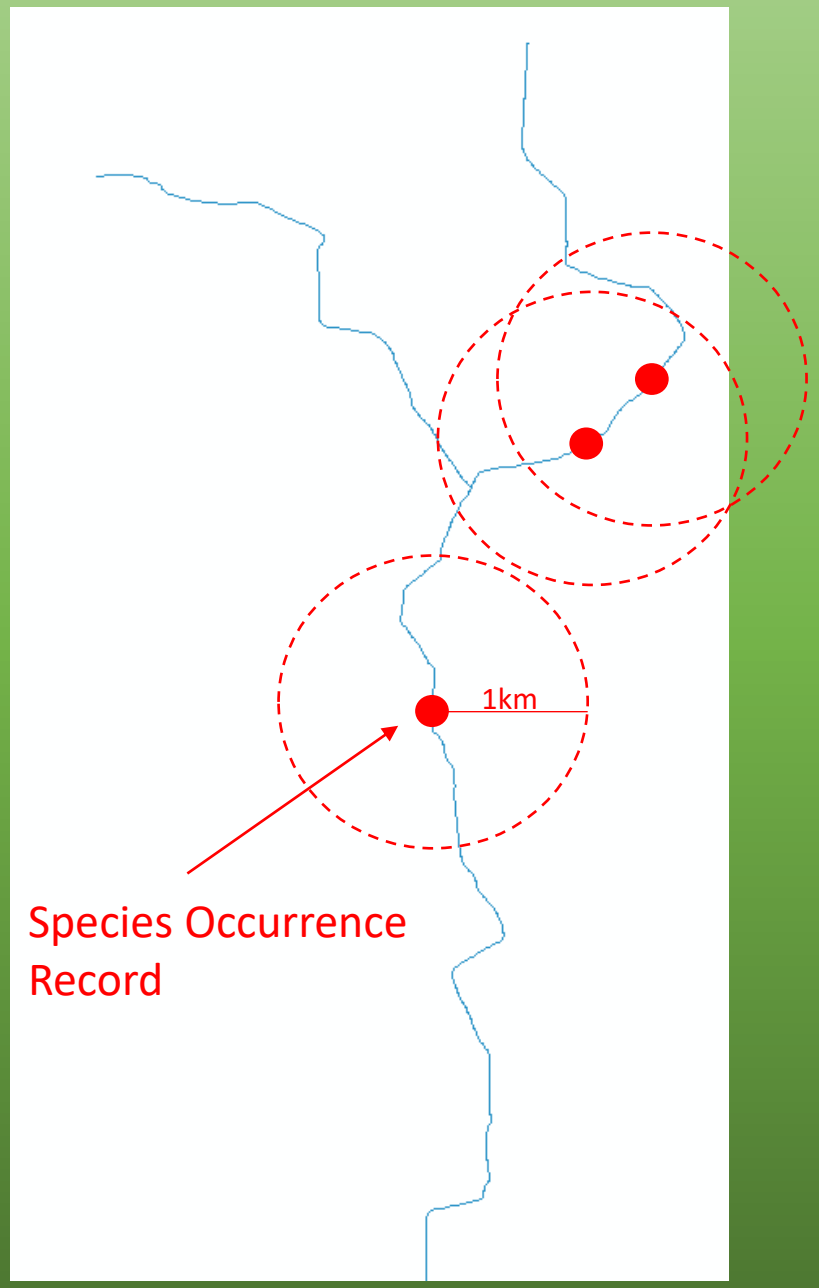
West Okaw River Biologically Significant Stream Reach



Extrapolation or interpolation of survey data

- e.g., Biologically Significant Streams (Bol, et al. 2007)

Grouping by proximity



Buffers to group data or delineate homogenous conditions/distribution

- e.g., NatureServe occurrence record guidance

Are these inferences (and their underlying assumptions) reasonable?

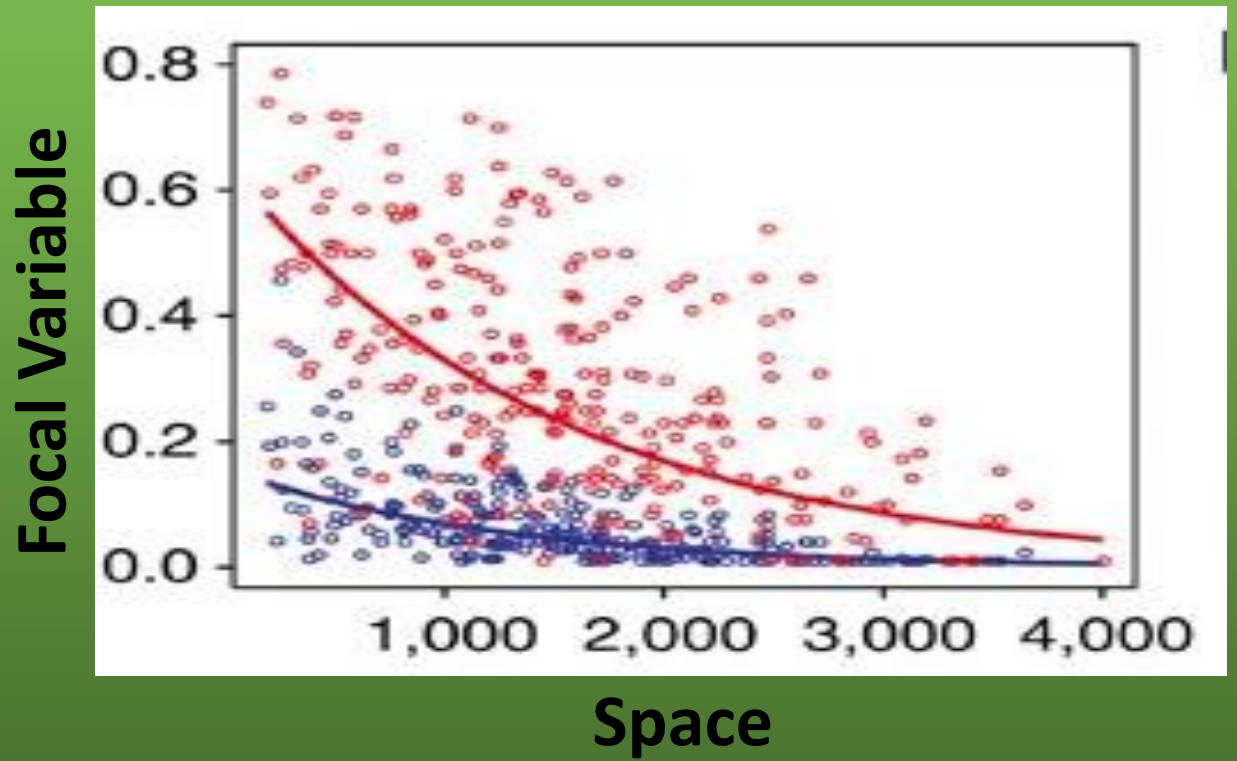
Do we have confidence in these inferences/assumptions?

How do we measure our confidence?

What is spatial autocorrelation?

"Everything is related to everything else. But near things are more related than distant things". Waldo Tobler's (1969) First Law of Geography

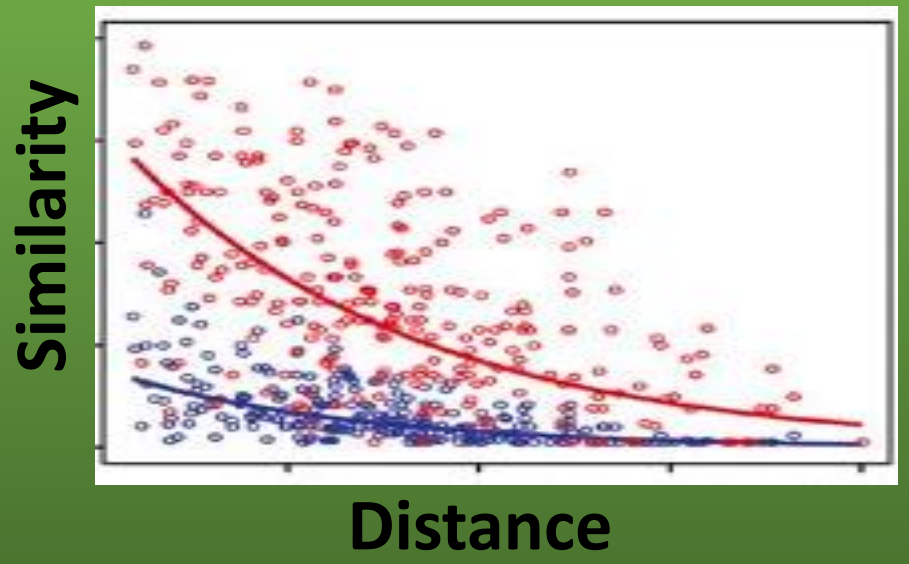
- The association (intensity and direction) of observations in relative space.
- Can be measured using indices, visualizations, statistics



Study Goal and Objectives:

Evaluate patterns of spatial autocorrelation in mussel assemblages

1) visualize similarity decay
    a) evaluate shape of similarity decay
    b) estimate intercept
    c) estimate slope



Why mussels?

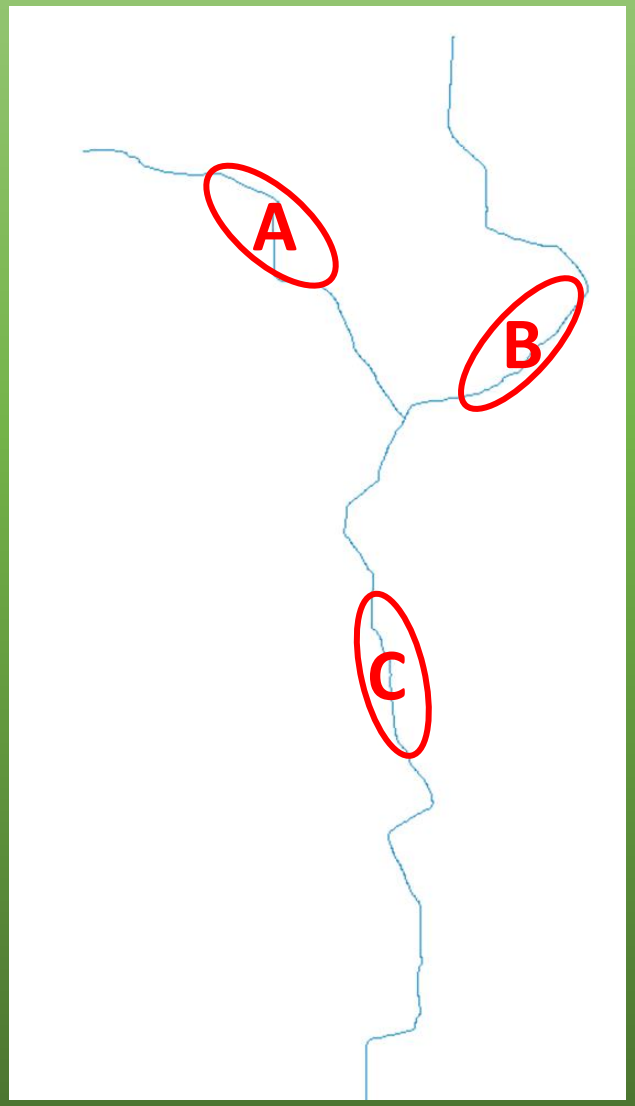
- A need to elucidate their ecology to improve conservation strategies
- Unique dispersal pattern
- Very little information regarding composition of mussel assemblages in space

What are our expectations for distance decay in stream mussel assemblages?

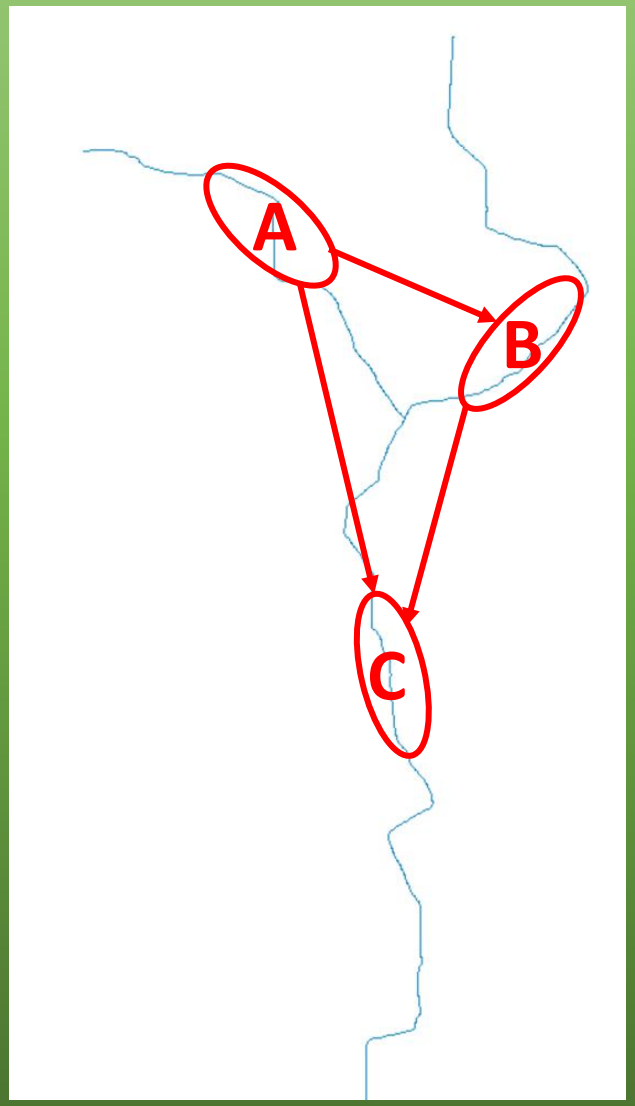
What are our expectations for distance decay in stream mussel assemblages?

- Distance: A<B<C
- Assemblage Similarity: A>B>C

Distance Measures



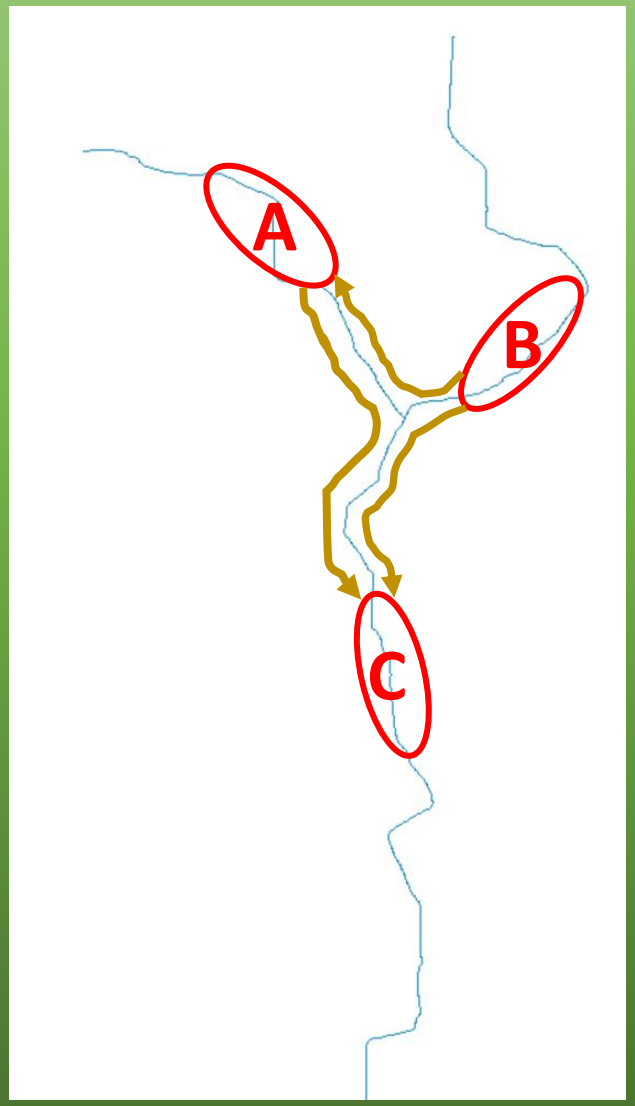
Distance Measures



- **Euclidean**

A-B < B-C < A-C

Distance Measures



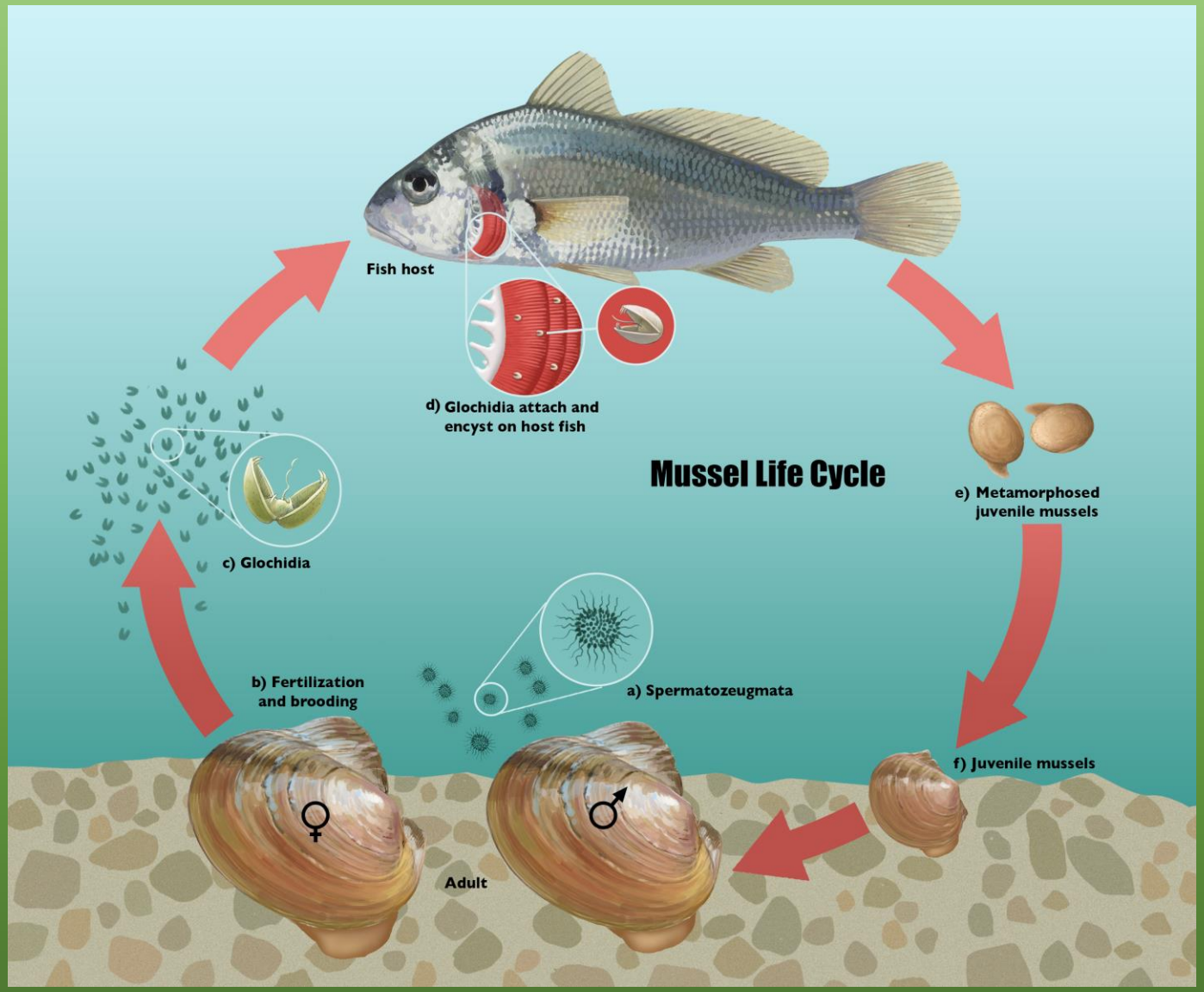
- **Euclidean**

  A-B < B-C < A-C

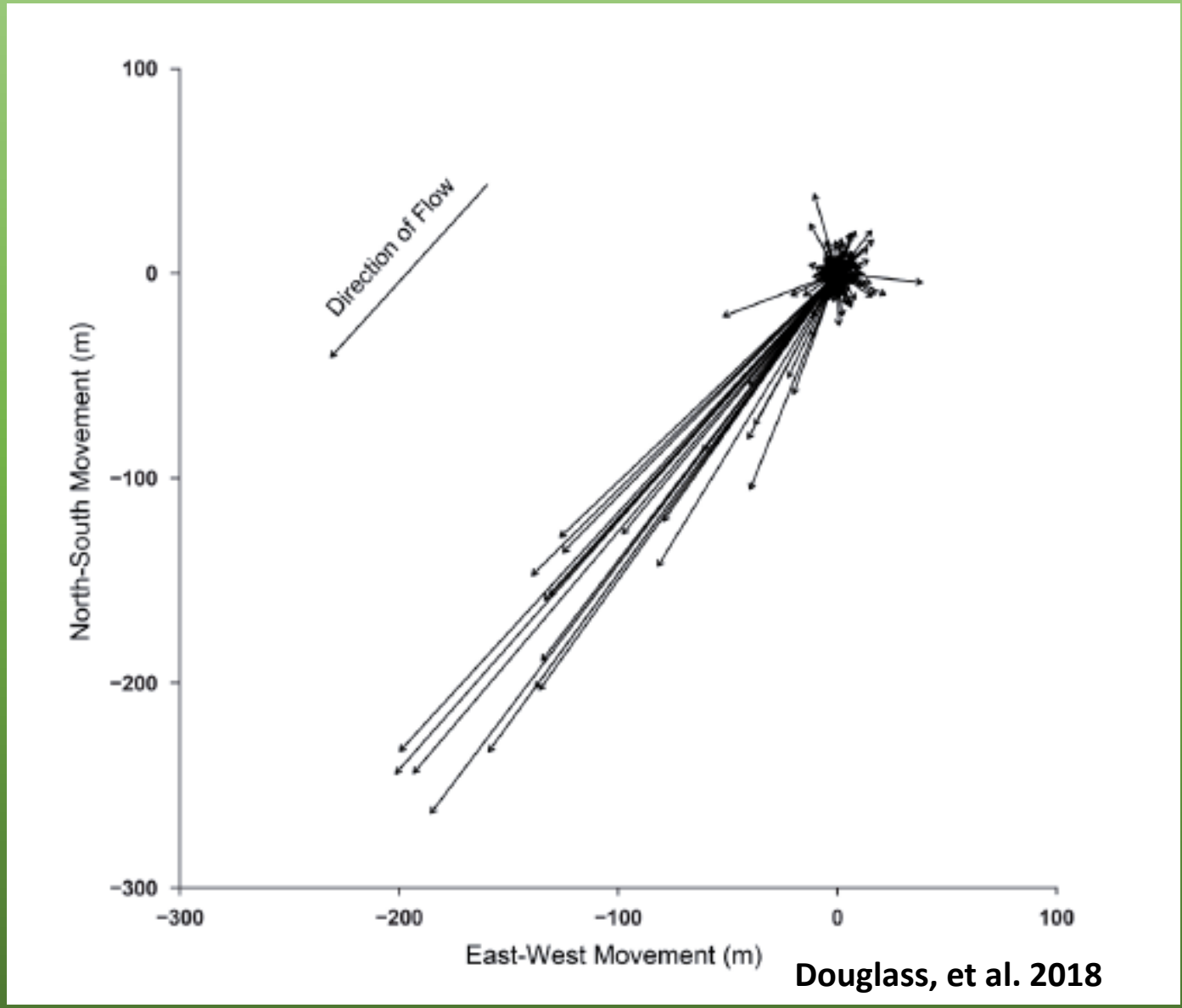
- **Waterway**

  Euclidean < waterway

Mussel Dispersal

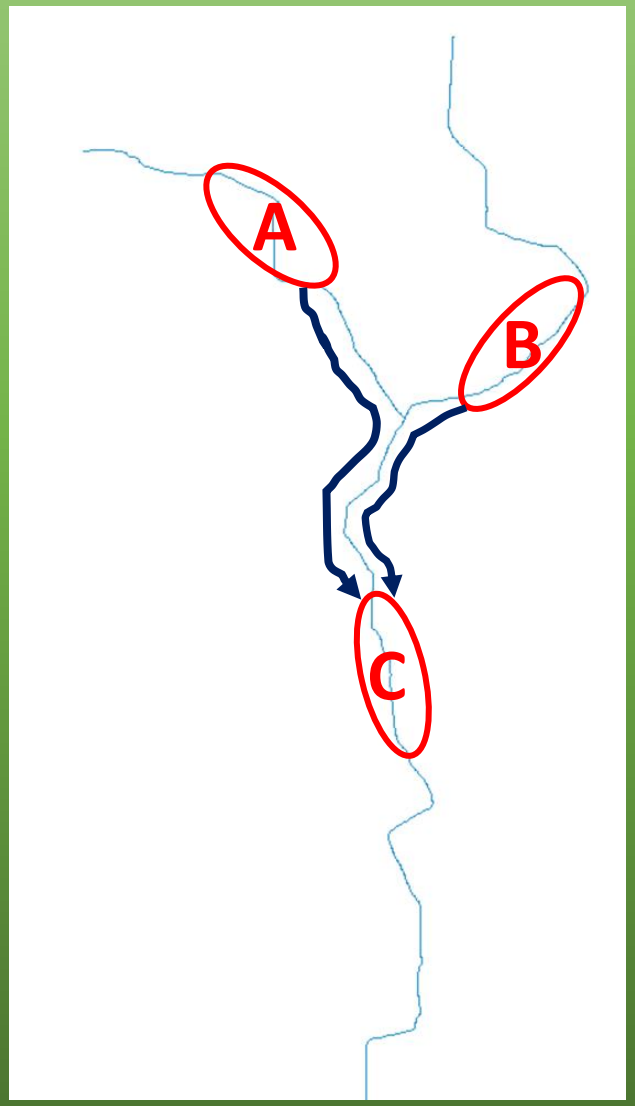


Mussel Dispersal

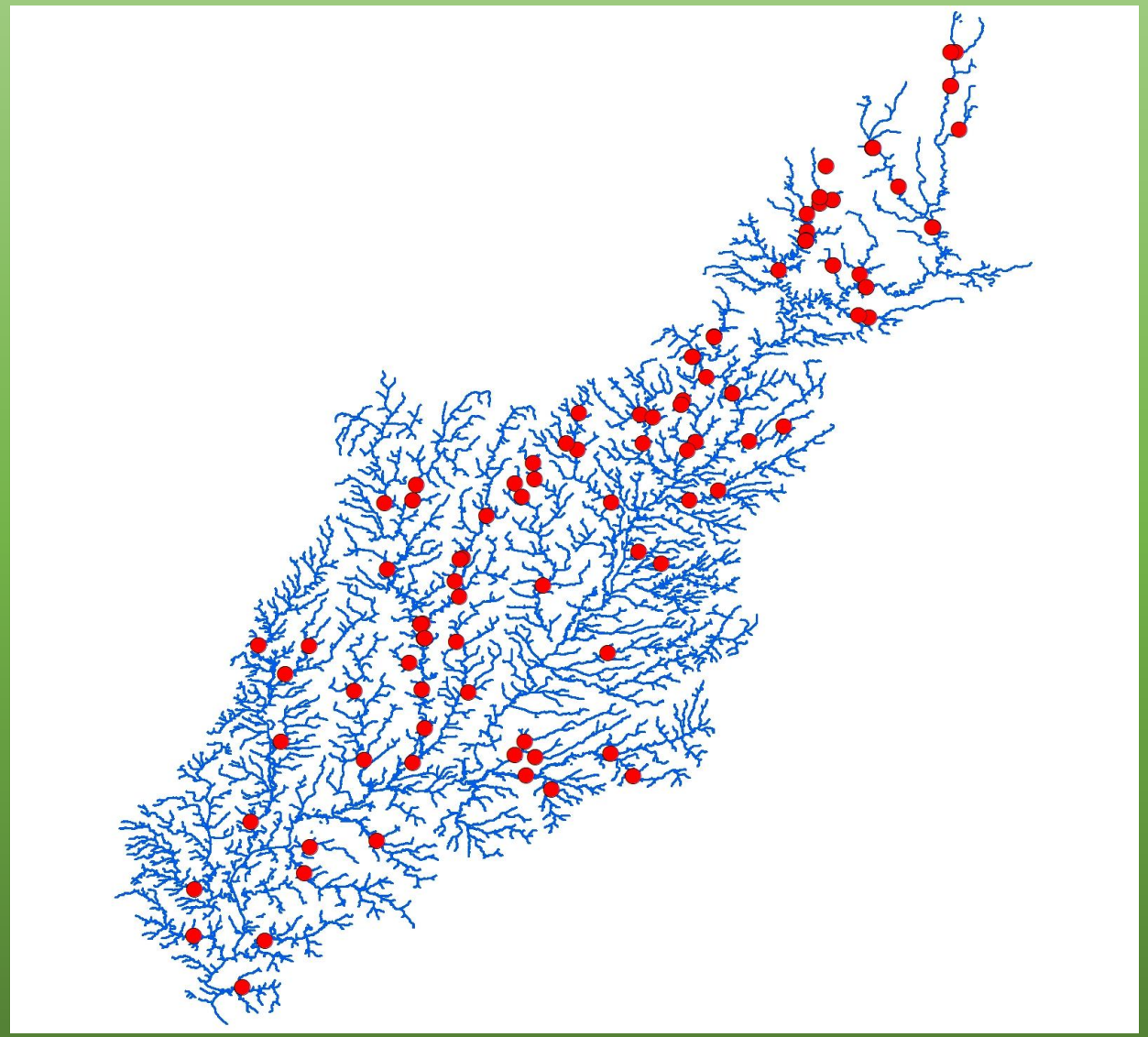


Douglass, et al. 2018

Distance Measures



- **Euclidean**
  A-B < B-C < A-C
- **Waterway**
  Euclidean < waterway
- **Flow Connected**
  downstream bias



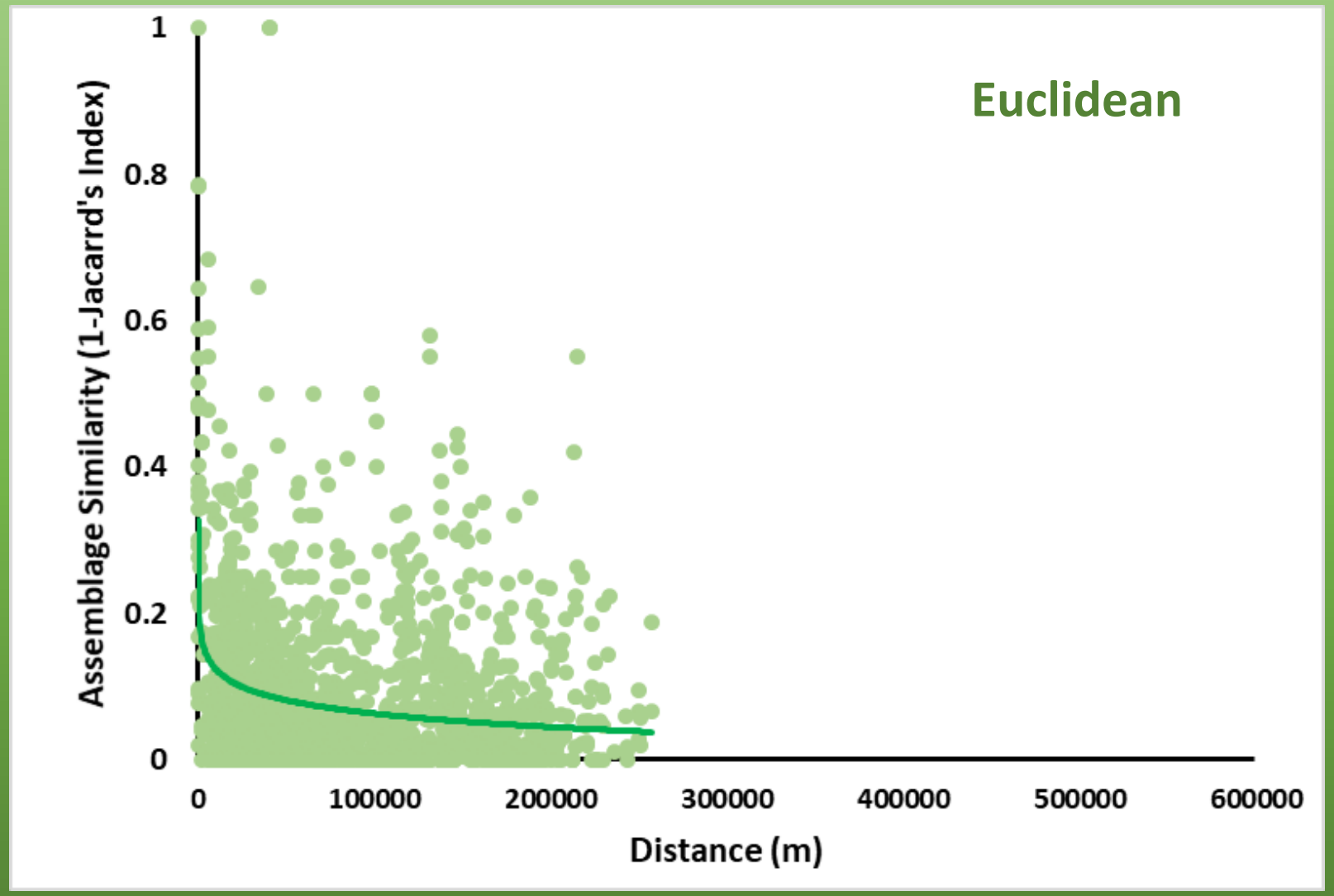
- Kaskaskia River basin
- 2010-2017
- Community samples
- 4 person-hour
- 64 surveys completed

(Dis)Similarity Calculations

- Dissimilarity calculated for each pairwise comparison
- Jaccard's Index
- Converted to similarity

Site	1	2	3	4	5	6
1						
2	0.90					
3	1.00	0.99				
4	1.00	0.91	1.00			
5	1.00	0.94	1.00	0.88		
6	1.00	0.64	0.99	0.93	0.92	

Distance decay of mussel assemblages



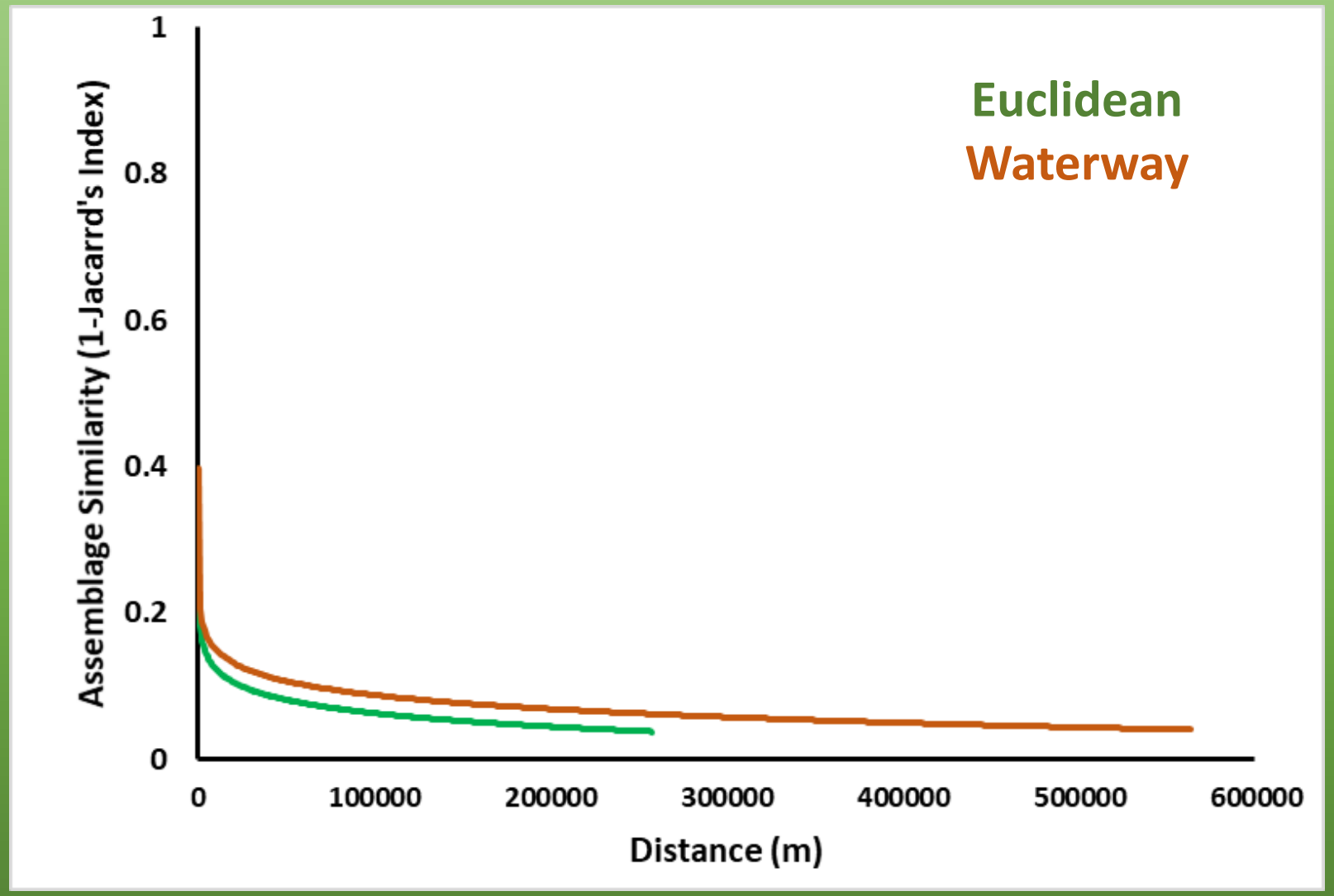
Euclidean:

n = 1793

r^2 = 0.094

intercept = 0.369

Distance decay of mussel assemblages



Euclidean:

n = 1793

r^2 = 0.094

intercept = 0.369

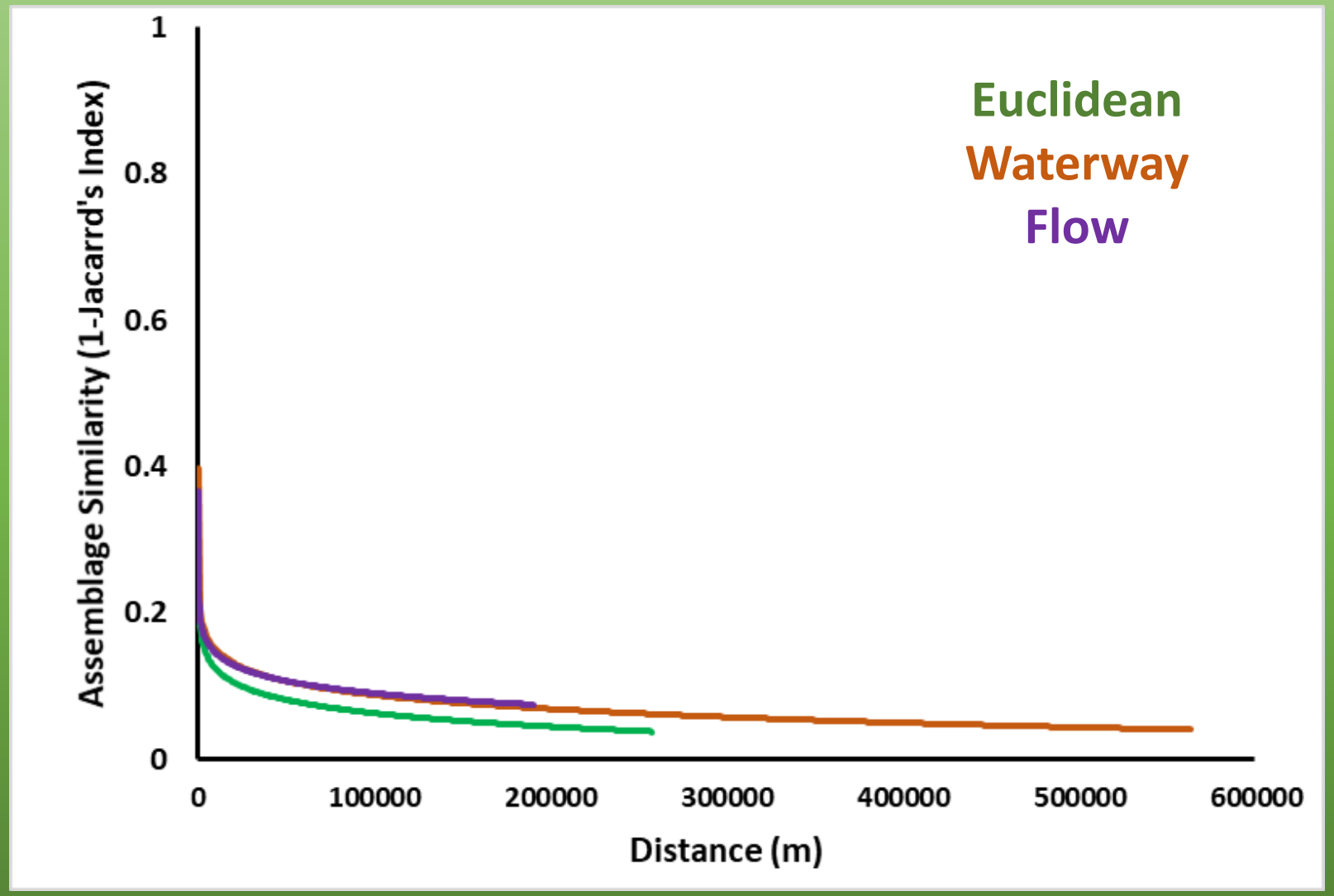
Waterway:

n = 1418

r^2 = 0.134

intercept = 0.404

Distance decay of mussel assemblages

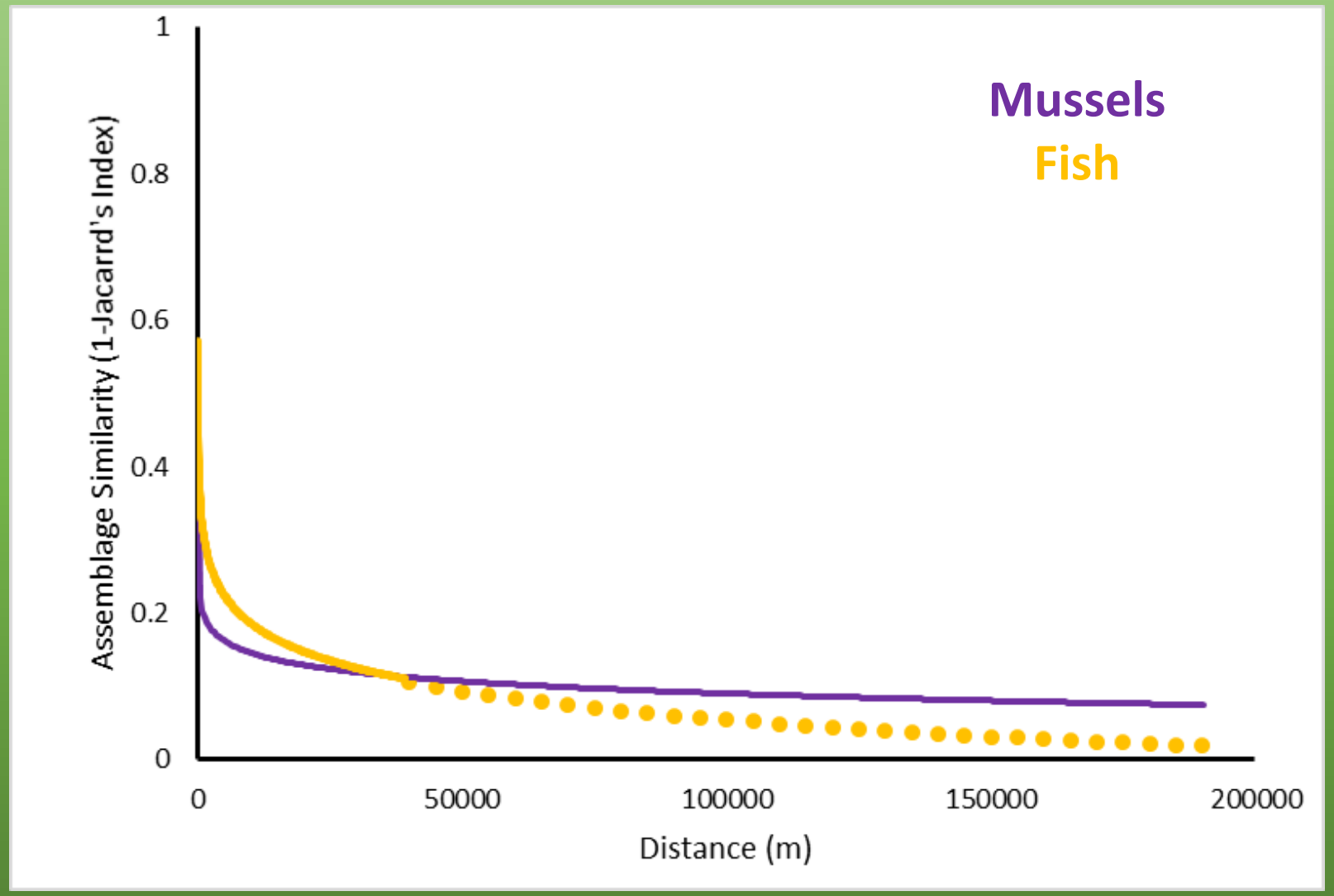


Euclidean:
n = 1793
r^2 = 0.094
intercept = 0.369

Waterway:
n = 1418
r^2 = 0.134
intercept = 0.404

Flow:
n = 145
r^2 = 0.182
intercept = 0.369

Distance decay of fish and mussel assemblages



Mussel Flow:

n = 145

r^2 = 0.182

intercept = 0.369

Fish Flow:

n = 219

r^2 = 0.265

intercept = 0.699

Conclusions

- Mussel assemblage similarity is low, even over small spatial scales.
- Mussel assemblage similarity begins lower and decays more quickly than that of fish assemblages.
- Caution should be used when making inferences.

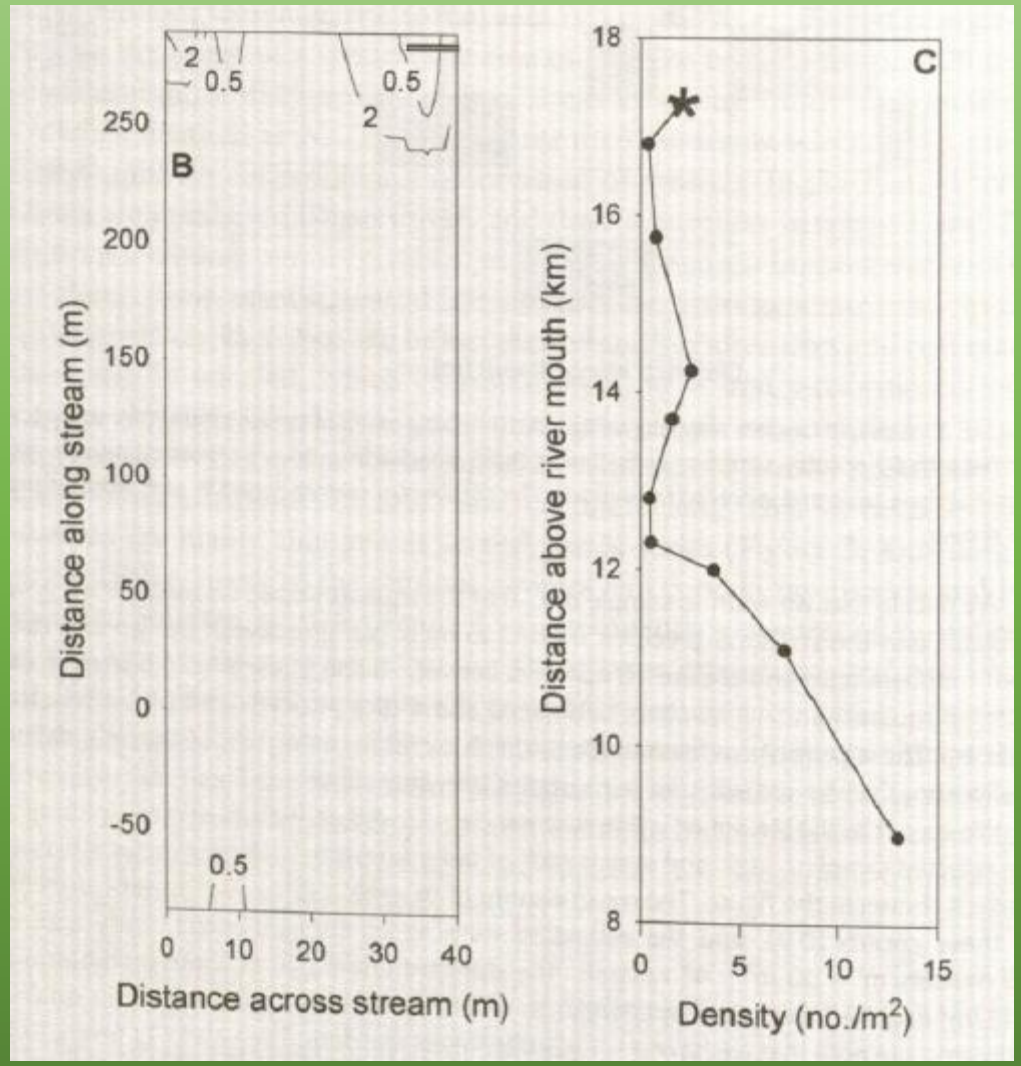
Explanations for these patterns

1. Environmental setting varies greatly over small spatial scales.
2. Mussels are dispersal-limited.
3. Survey extent does not cover extent of local community.
4. Survey efficiency is low.
5. Mussel assemblages vary greatly over small temporal scales.

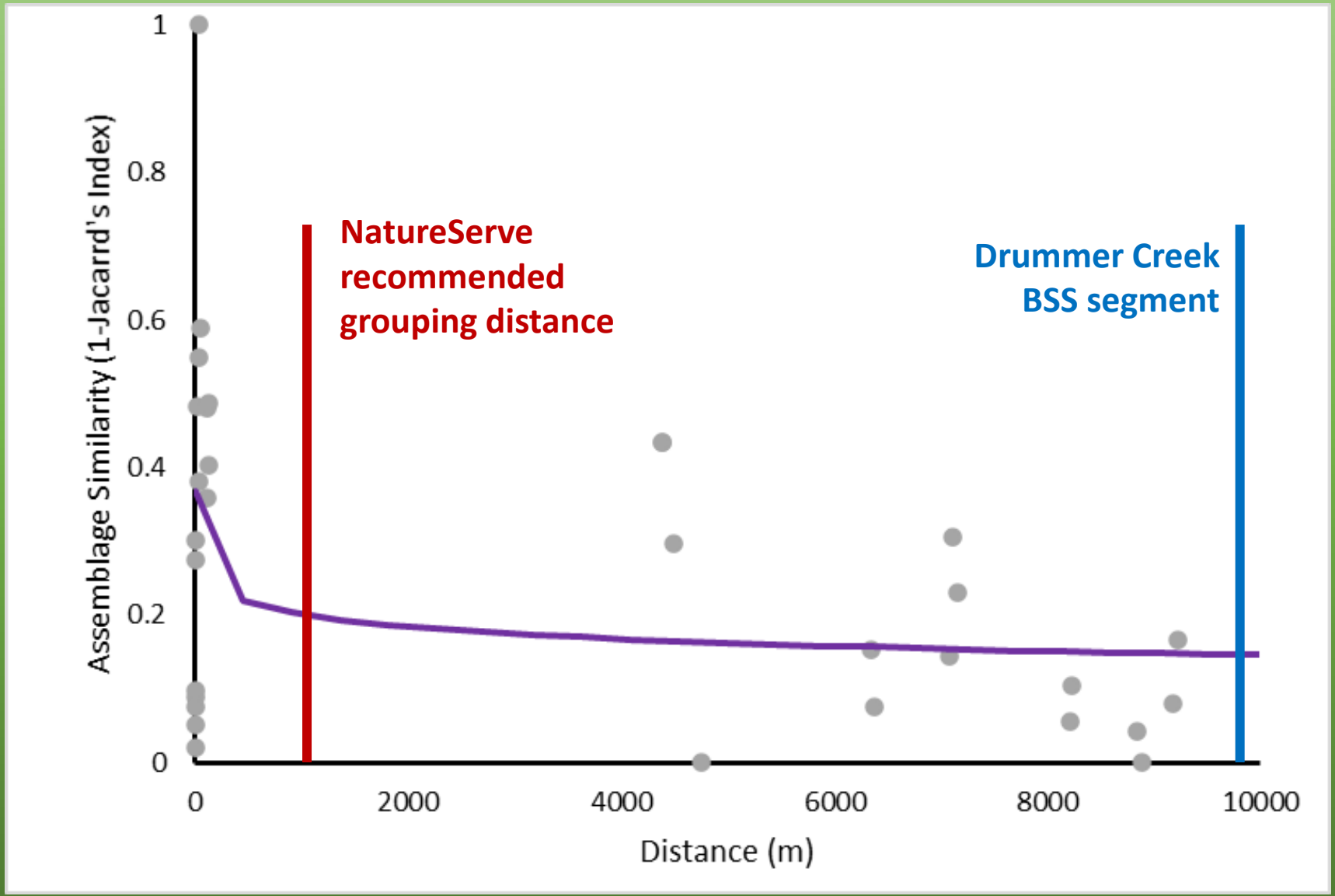
Acknowledgements:

- Mussel assemblage data: Alison Stodola, Sarah Douglass, Dianne Shasteen (IDNR SWG T-53); INHS CREP stream bioassessment team

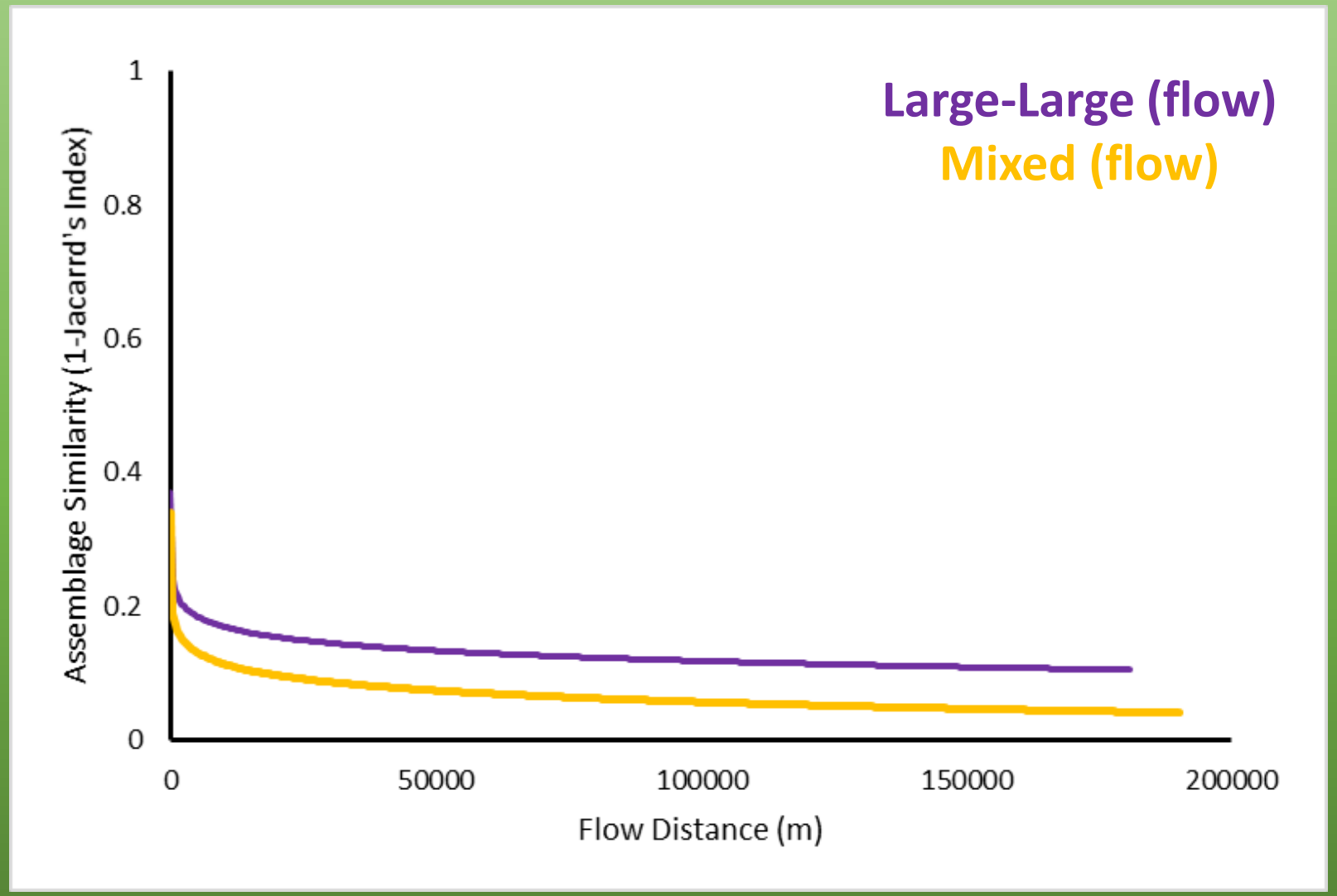
- Fish assemblage data: Trent Thomas, Randy Sauer (IDNR basin surveys), INHS CREP stream bioassessment team


B
2
0.5
0.5
2
0.5
250
200
150
100
50
0
-50
0
10
20
30
40
Distance along stream (m)
Distance across stream (m)
C
*
18
16
14
12
10
8
0
5
10
15
Distance above river mouth (km)
Density (no./m²)

Mussel similarity decay over small spatial extent



Distance decay of mussel assemblages



Large streams only:

n = 82

r^2 = 0.183

intercept = 0.375

Mixed:

n = 62

r^2 = 0.152

intercept = 0.343