Effects of Land-use change and non-native species on native fish species abundance patterns and biotic homogenization in the New River Basin

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- Fish Fauna (Jenkins and Burkhead, 1994)
  - 46 Native Species (lowest of any eastern U.S. drainage)


Rosyside Dace (*Clinostomus funduloides*)


White Sucker (*Catostomus commersoni*)

  - 8 Endemic Species (2nd highest proportion of any eastern U.S. drainage)


Candy Darter (*Etheostoma osburni*)


Bigmouth Chub (*Nocomis platyrhynchus*)

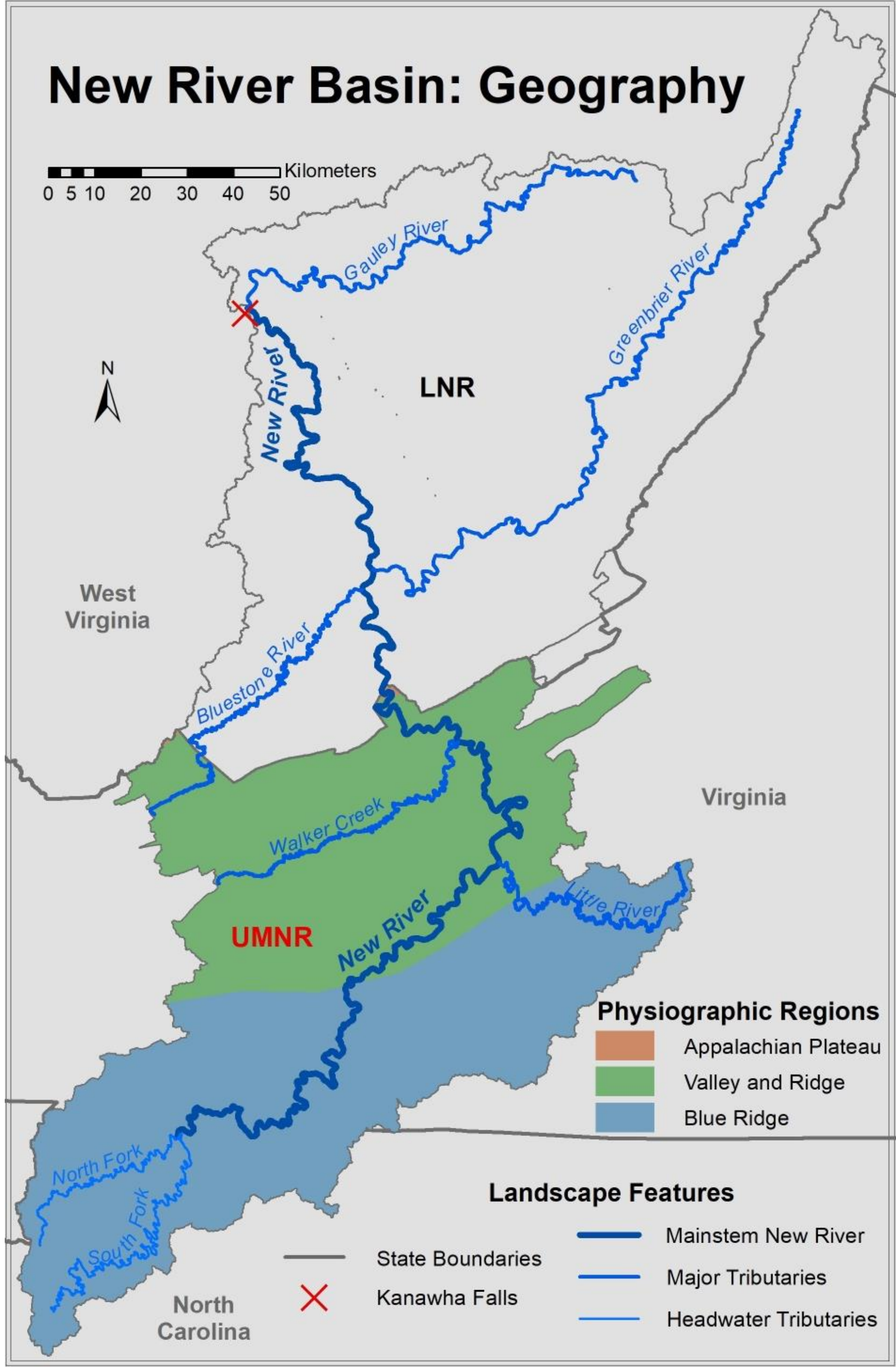
  - 42 Non-native Species (highest number and proportion of any eastern U.S. drainage)


Redbreast Sunfish (*Lepomis auritus*)


Whitetail Shiner (*Cyprinella galactura*)

Introduction: The New River Basin

- Geology
  - Relict of the ancient Teays River
  - Late Cenozoic glaciations
    - Altered the river's course
    - Created Kanawha Falls
  - Spans parts of the Appalachian Plateau, Valley and Ridge, and Blue Ridge physiographic provinces (regions)



Drivers of native declines (Non-native species vs. land-use change) and biotic homogenization: Objectives

1. Test the replacement vs. displacement hypotheses for spread/decline of native species faced with changing land use and invader introductions

2. Track potential biotic homogenization across time in UMNR and determine species and site contributions to regional species diversity

Torrent Sucker (*Thoburnia rhothoeca*)

Redline Darter (*Etheostoma rufilineatum*)

Objectives

1. Replacement vs. Displacement

2. Biotic Homogenization

Objective 1: Replacement vs. Displacement

- Non-native species and land-use change are commonly considered top causes of native species declines

- Very few studies compare these potential drivers of declines based on their impact on local populations of native species

- Replacement vs. Displacement

Objectives

1. Replacement vs. Displacement

2. Biotic Homogenization

- Step 1: Compile Land-use and Fish Community Data (1977-present)
    - NLCD, GIRAS, USGS Tiger Roads, VDOT Historical Roads
    - NAWQA, REMAP, VDGIF, FishNet2, Study Collections, etc.

Objectives

1. Replacement vs. Displacement

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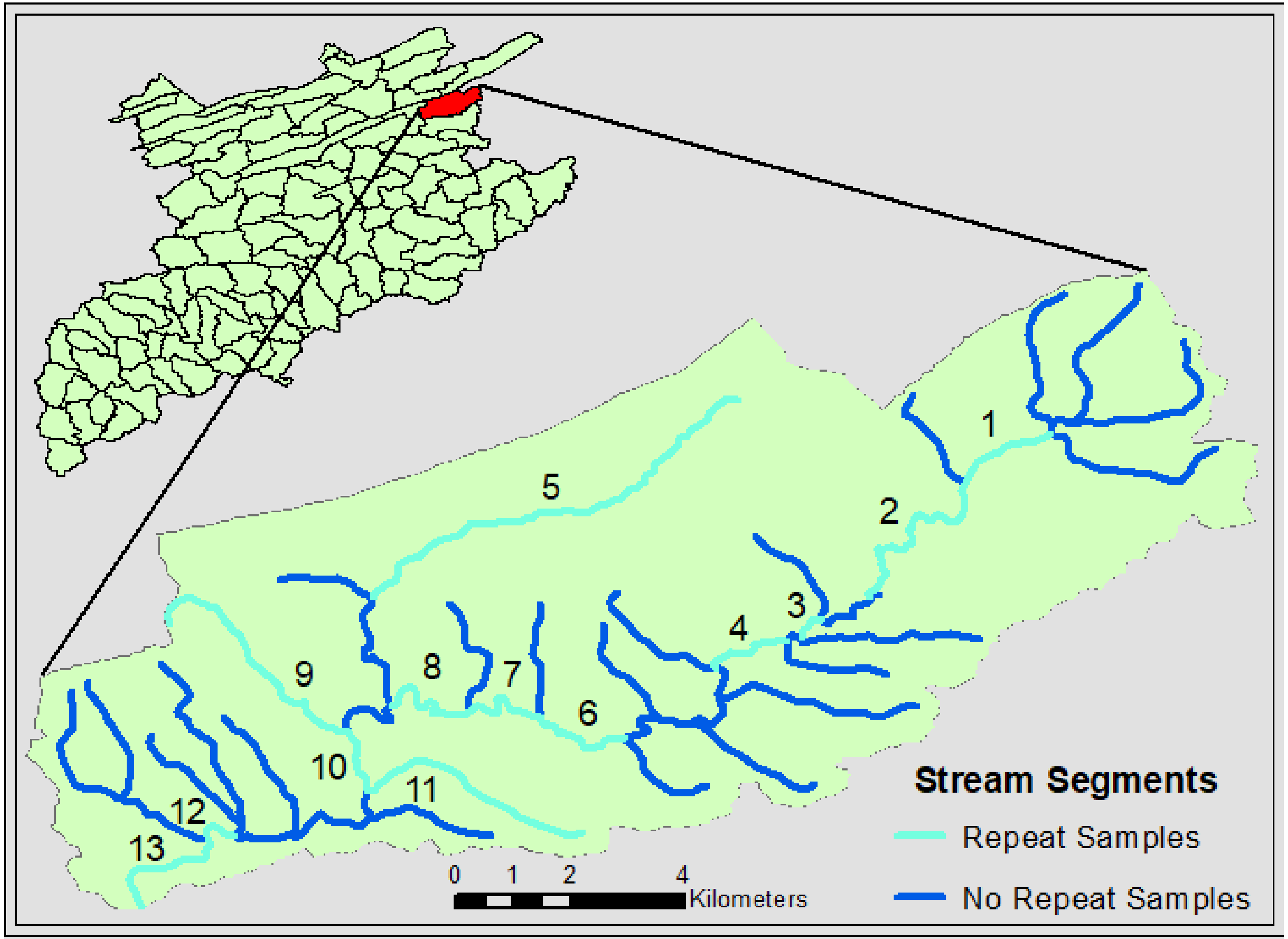
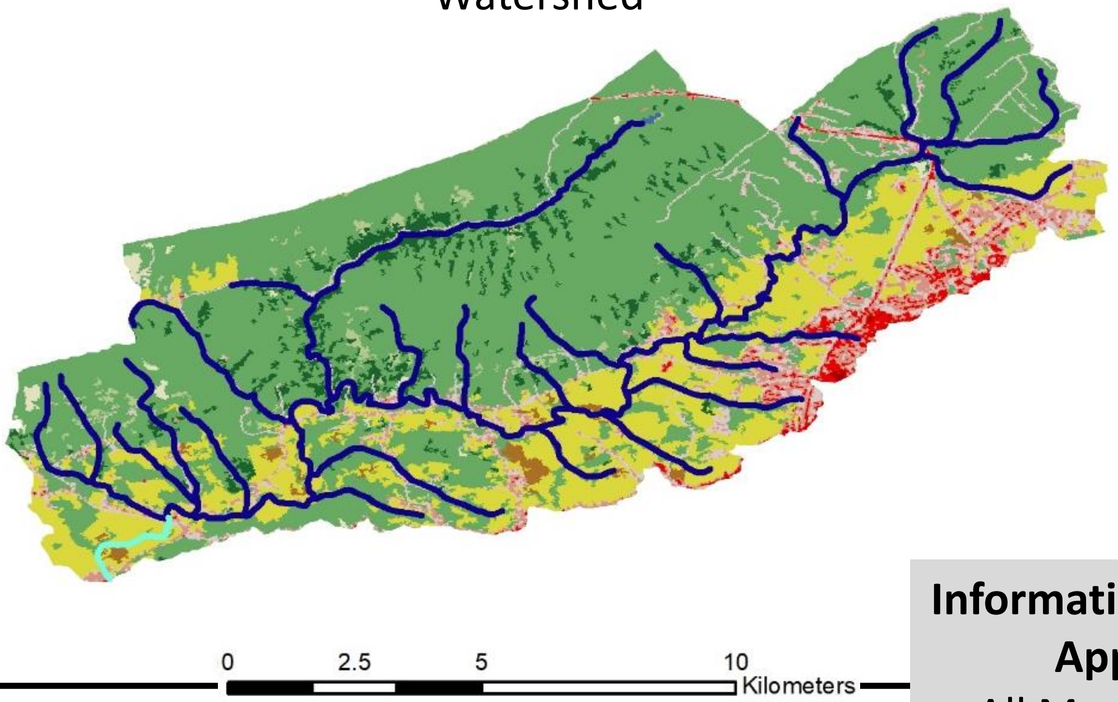
- Step 2: Identify stream segments in which repeat samples exist and bin species records into discrete time-step categories

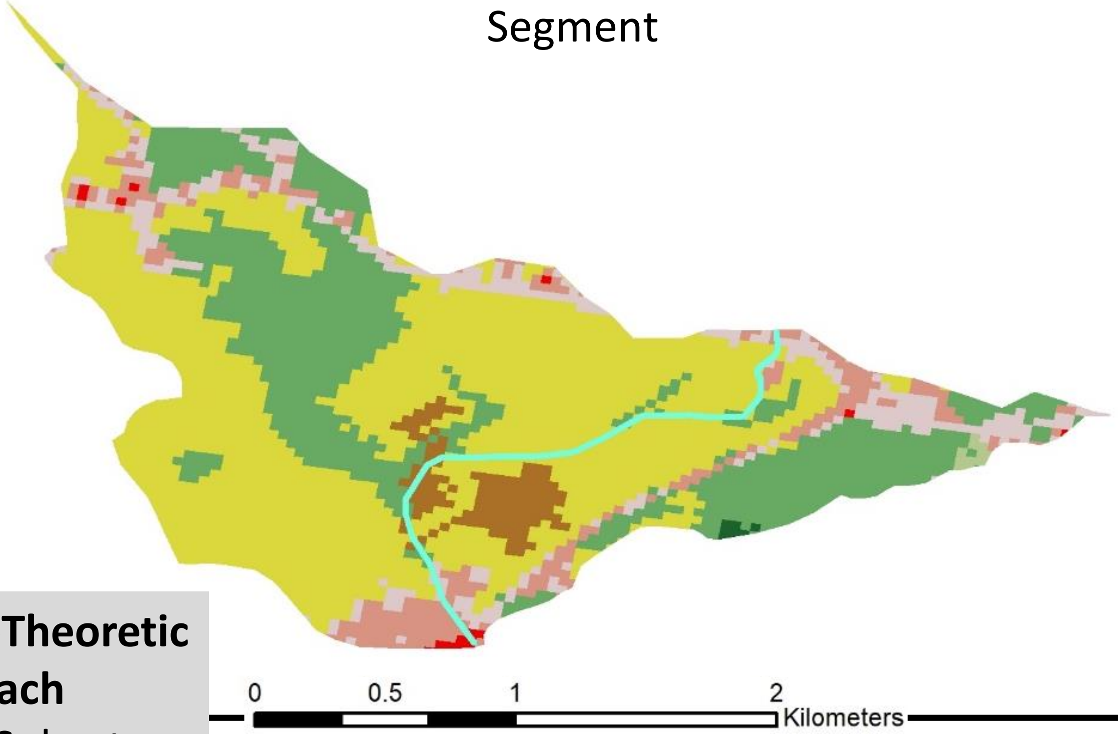


Watershed

Segment

Entire



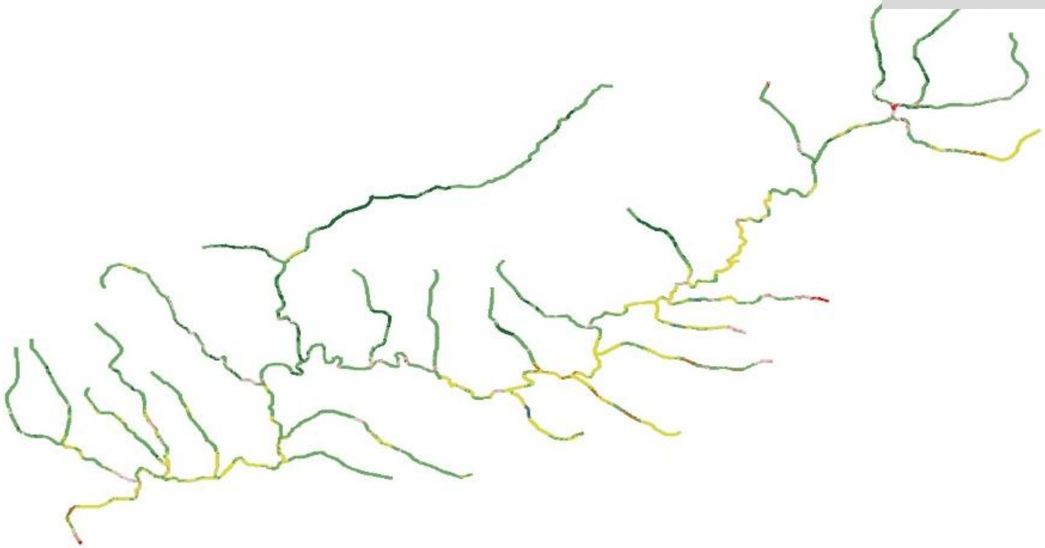


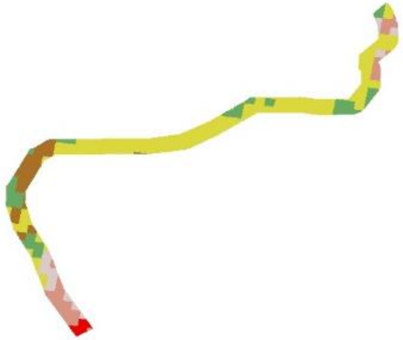
Information-Theoretic Approach

All Model Subsets

Null: Stream Order

Riparian





Objectives

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- Step 4: Normalize Count Data (Abundance + Relative Abundance + Rank Abundance) for each species in each sample
    - Plot scores to establish trends

				Species A						
				Raw Data			Normalized Data			
Site	**Time Series**	**# Individuals in Sample**	**# Species in Sample**	**Count**	**Proportion**	**Rank**	**Count**	**Proportion**	**Rank**	**Score**
Tom's 1	1	75	5	25	0.33	1	0.63	1.00	1.00	2.63
Tom's 1	3	200	12	40	0.20	2	1.00	0.60	0.92	2.52
Tom's 1	7	100	8	10	0.10	4	0.25	0.30	0.63	1.18
Tom's 1	8	150	10	10	0.07	5	0.25	0.20	0.60	1.05
			max:	***40***	***0.33***				***(1+Rich-Rank)/Rich***	***Sum***

Objectives

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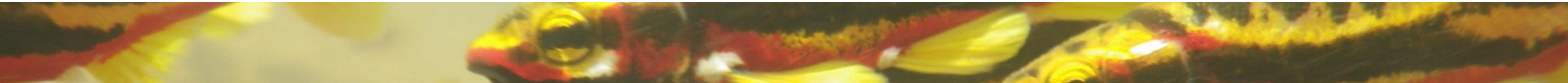
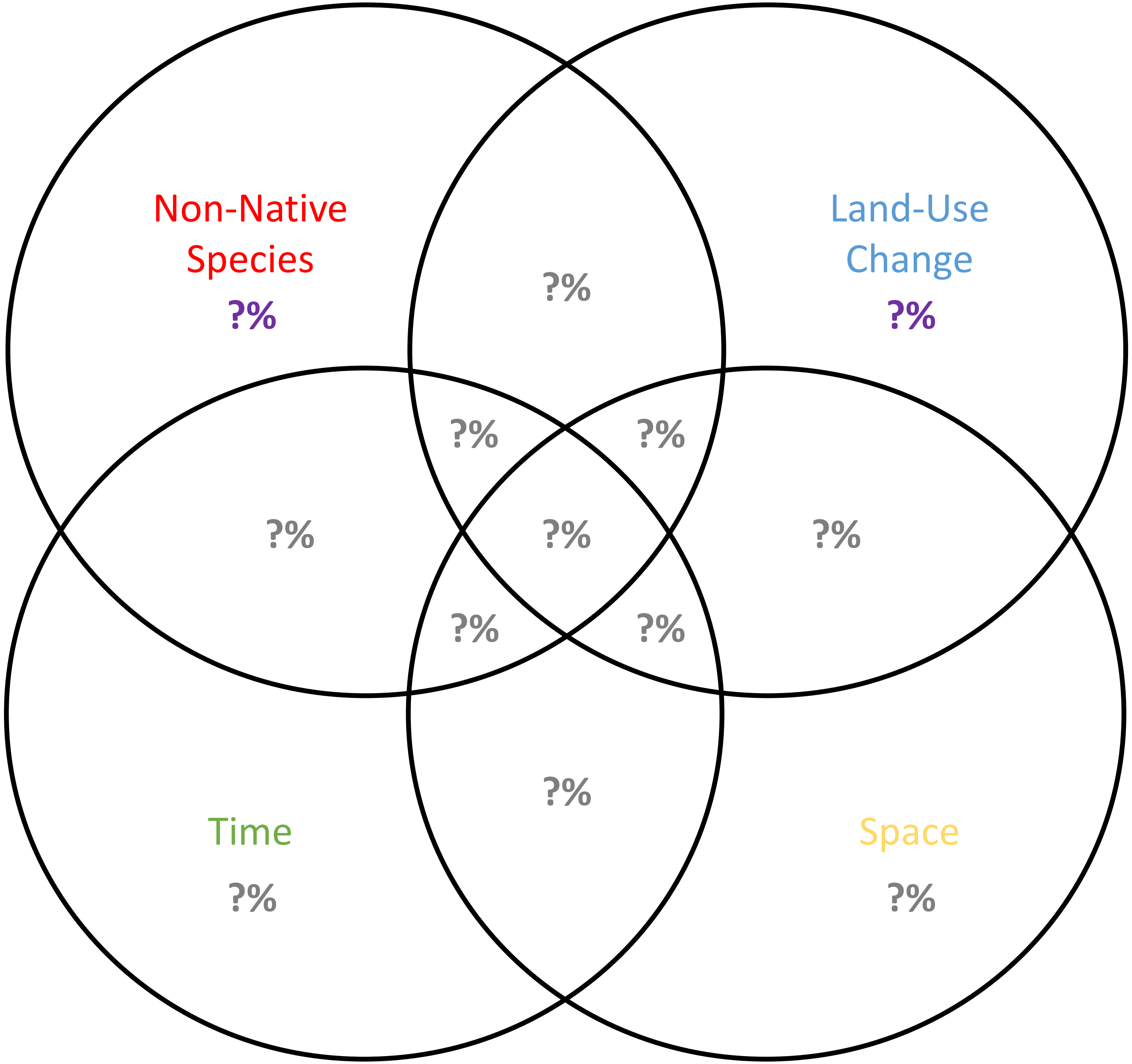
- Step 5: Partition the relative influence of non-native species abundance and land-use predictors on population trends of native species using RDA analysis

Native Species Matrix

Predictor Matrices

Site	Species A Scores	Time Series	Latitude	Longitude	Non-Native A Score	Non-Native B Score	% Forest	Road-Stream Xings
Tom's 1	2.50	1	37.24	-80.46		0.90	56	5
Tom's 1	2.32	3	37.24	-80.46		1.30	53	12
Tom's 1	1.13	7	37.24	-80.46	1.50	2.00	50	15
Tom's 1	1.00	8	37.24	-80.46	2.10	2.20	43	15
Strouble's 1	3.00	6	37.22	-80.43	2.30	2.50	36	7
Strouble's 1	2.30	8	37.22	-80.43	2.10	1.60	30	8
Walker Creek 2	2.45	3	37.27	-80.71	1.50		70	9
Walker Creek 2	2.45	7	37.27	-80.71	1.70		67	11
Walker Creek 2	2.01	8	37.27	-80.71	2.50	3.00	60	13





Unexplained
Variance
?%

Objectives

1. Replacement vs. Displacement

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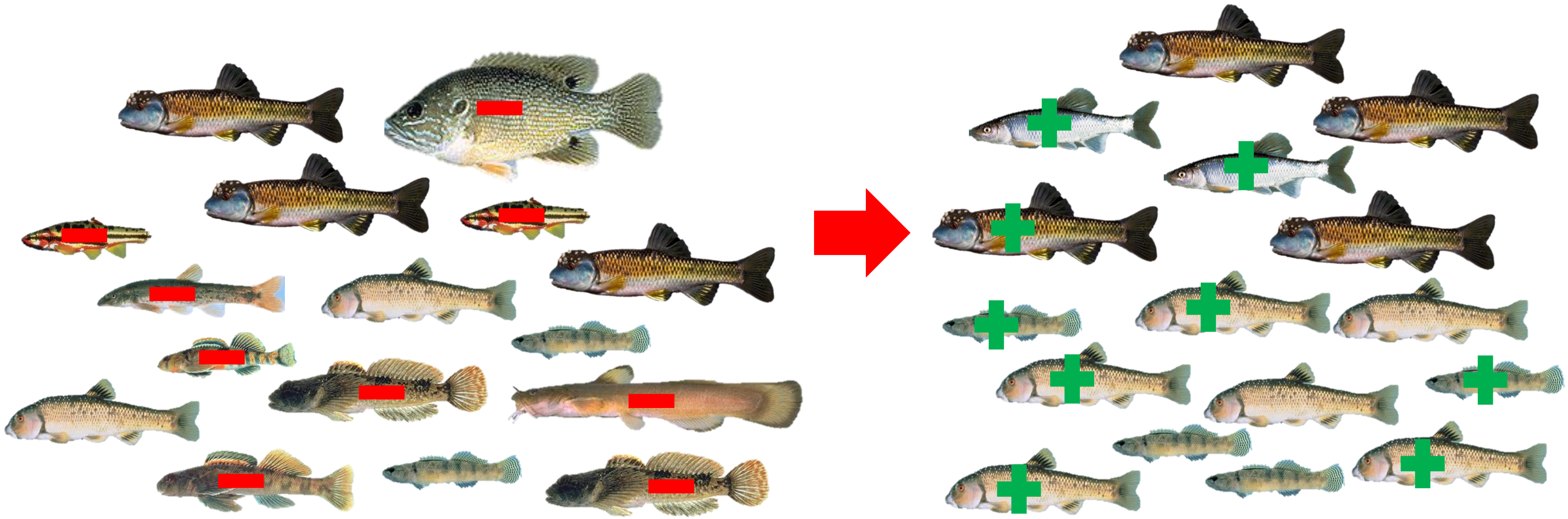
Objective 2: Biotic Homogenization

- Are fish communities becoming more similar (less unique) across time within the UMNR?
- If so, which constituent species are driving this change and where is homogenization most prevalent?



Objectives

1. Replacement vs. Displacement

2. Biotic Homogenization

Conserving Uniqueness?

- Unique assemblages are the most likely to be lost

- Economic and ecological advantages over single-species conservation

- Balanced conservation strategies, considering the needs of all component species in a community at once

Objectives

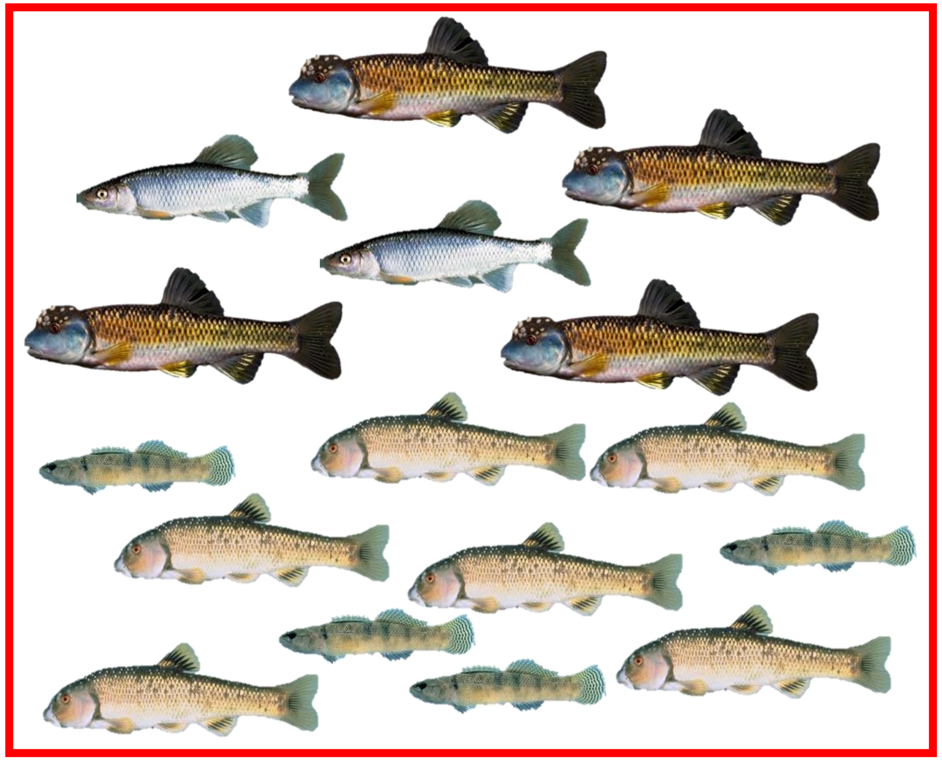
1. Replacement vs. Displacement

2. Biotic Homogenization

Measuring Uniqueness: β Diversity

- β Diversity – A measure of species turnover between sites

$$(10 - 3) + (4 - 3) = 8$$



Objectives

1. Replacement vs. Displacement

2. Biotic Homogenization

Measuring Uniqueness: β Diversity Partitioning

- β Diversity Measurement
  - Metric: Composite Species Scores (Abundance + Proportion + Dominance)
    - Species-specific β
    - Site-specific β

Objectives

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Hierarchical Cluster Analysis: Species Composite Scores

Objectives

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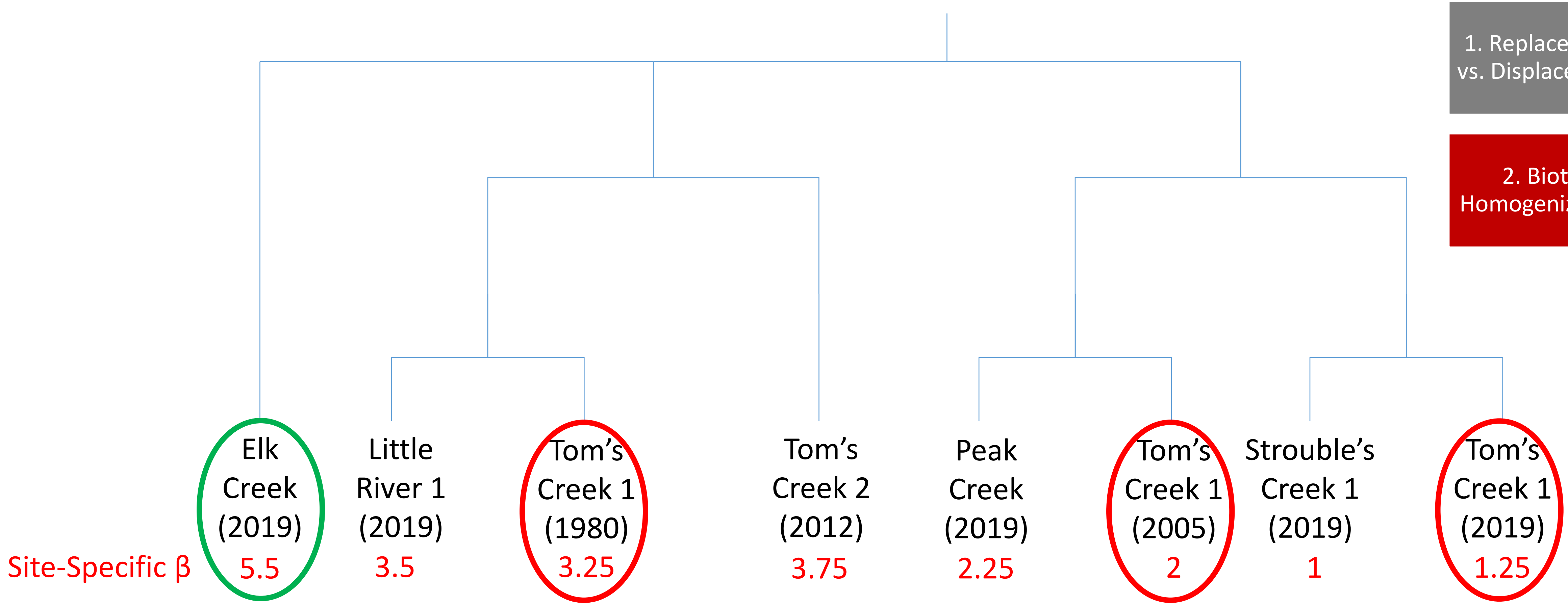

Biotic Homogenization

Unique Community - Conservation Target?

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VIRGINIA DGIF

COLLEGE OF NATURAL RESOURCES AND ENVIRONMENT
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Questions?