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 (2\textsuperscript{nd} 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*)
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
• 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

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

Objectives

1. Replacement vs. Displacement
2. Biotic Homogenization
Step 3: Determine appropriate land-use context

Watershed Segment

Entire Riparian

Information-Theoretic Approach
All Model Subsets
Null: Stream Order

Objectives
1. Replacement vs. Displacement
2. Biotic Homogenization
- Step 4: Normalize Count Data (Abundance + Relative Abundance + Rank Abundance) for each species in each sample
  - Plot scores to establish trends

<table>
<thead>
<tr>
<th>Site</th>
<th>Time Series</th>
<th># Individuals in Sample</th>
<th># Species in Sample</th>
<th>Raw Data</th>
<th>Normalized Data</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Count</td>
<td>Proportion</td>
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<tr>
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max: 40 0.33

\[(1+\text{Rich-Rank})/\text{Rich}\] Sum

Objectives

1. Replacement vs. Displacement
2. Biotic Homogenization
Step 5: Partition the relative influence of non-native species abundance and land-use predictors on population trends of native species using RDA analysis.

<table>
<thead>
<tr>
<th>Site</th>
<th>Species A Scores</th>
<th>Time Series</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Non-Native A Score</th>
<th>Non-Native B Score</th>
<th>% Forest</th>
<th>Road-Stream Xings</th>
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Objectives

1. Replacement vs. Displacement
2. Biotic Homogenization
Non-Native Species

Land-Use Change

Time

Space

Unexplained Variance

Objectives
1. Replacement vs. Displacement
2. Biotic Homogenization
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?
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
Measuring Uniqueness: $\beta$ Diversity

- $\beta$ Diversity – A measure of species turnover between sites

$$\text{(10 - 3)} + \text{(4 - 3)} = 8$$
Measuring Uniqueness: $\beta$ Diversity Partitioning

- $\beta$ Diversity Measurement
  - Metric: Composite Species Scores (Abundance + Proportion + Dominance)
    - Species-specific $\beta$
    - Site-specific $\beta$
Hierarchical Cluster Analysis: Species Composite Scores

Biotic Homogenization

Unique Community - Conservation Target?
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Questions?