Why mussels?

- Dominated biomass in rivers
- Ecosystem services
Why mussels?

• Dominated biomass in rivers
• Ecosystem services
• ~300 species in North America
Unionid mussel species richness.

Number endemic unionid mussels.

From Abell et al. 2000
Why mussels?

- Dominated biomass in rivers
- Ecosystem services
- ~300 species in North America
- Highly imperiled
Freshwater mussels

Very threatened as a group

3 federally listed species in the Kiamichi and Little Rivers
River Continuum Concept in a Nutshell

Functional feeding groups vary in a downstream direction.

There are also differences within functional groups!

Vannote et al. 1980
Study Area

-3 rivers
  - Kiamichi (18 species)
  - Little (16 species)
  - Mt. Fork (18 species)

-Mussels
  - 28 species included in analysis
  - High densities (up to 100 mussels/m²)

-Landuse
  - Primarily forest (70-80%)
  - Human use (water extraction, agriculture)
**Rivers of southeastern Oklahoma**

Relatively pristine water

High biodiversity, but imperiled

Source: The Nature Conservancy
Methods

• Mussel data
  – 28 species – how to describe the community?

  – Bray-Curtis Ordination (Bray & Curtis 1954, Ecology)
    • 1st – a dissimilarity matrix is computed among sites
    • 2nd – selection of 2 sites as poles (find the community separated by the greatest distance)
    • Ordination is projected (along a gradient)
Predictable Species Shifts

- Bray-Curtis value is indicative of community composition

- Communities that are the same distance from the headwaters are more similar
Explain

• What are the factors that lead to shifts in community composition?
  – Physiography?
  – Land use?
GIS Data

• DEM – extracted watersheds for each site
• NLCD – all landuses (%forest, %urban, etc.)
• SSURGO - CaCO$_3$, % frequently flooded
• DEM and NHD combined - stream gradient, 100 m buffers
• NAIP aerial photographs - verification
Multiple Spatial Scales

• Allan (2004) suggested the use of 3 spatial scales
  – Watershed (upstream of the site)
  – Buffer (100 m around all channels)
  – Site (buffer scale 1 km upstream from site)
Example

- Created 100-m buffer using spatial analyst
- Measured 1 km upstream and selected the buffer for that length
3 Scales

• For each scale I extracted:
  – Landuse
  – Information on soils

• Gradient was calculated different ways for each scale
  – Watershed – total change in elevation/stream length
  – Buffer – change in elevation 10 km upstream/10km
  – Site – change in elevation 1km/1km
<table>
<thead>
<tr>
<th>River</th>
<th>Site</th>
<th>Mainstem Distance Downstream (km)</th>
<th>% Open Water</th>
<th>% Urban</th>
<th>% Barren</th>
<th>% Forest</th>
<th>% Grassland/Shrub</th>
<th>% Agriculture</th>
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</tr>
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*Gradient considering the elevation and length of the entire mainstem channel

**The percentage of land area in which the chance of flooding is more than 50 percent in any year but is less than 50 percent in
Further Analysis

- Used Akaike’s Information Criterion (AIC) approach to select model to predict community composition*
- Several multiple linear regressions generated
- Provides the best compromise between predictive power and model complexity

* See Burnham and Anderson 2001 for more information
Watershed and buffer scale variables best at predicting mussel community composition
2 Most Predictive Scales – Watershed & Buffer

- Gradient best predictor in the model – geomorphic control (corroborates with Arbuckle and Downing 2002)
- %Open Water another good predictor (likely driven by Sardis Lake)
Management Implications

-- Water Management
-- Watershed Management
Other drivers

• Watershed Scale
  – %Urban in top 3 models

• Buffer Scale
  – Very variable

• Site Scale
  – %Agriculture in top models

• Not included
  – Fish
Why does this matter?

• Changes in hydrology and land use are influencing community composition
• Protecting site ≠ protecting the community
• Need to consider the buffer scale, and the whole watershed
New Biogeochemistry Data Corroborates

Biogeochemical signature is indicative of the watershed.

\[ y = 0.224x + 3.12 \]

\[ R^2 = 0.984 \]

\[ p < 0.0001 \]
Extinction Debt?

• Mussels are long-lived and slow-growing

• Time lag between disturbance and species extinctions

2011 Drought – Little River  
2011 Drought – Kiamichi River
Acknowledgements

- Vaughn lab / OK Biological Survey
- Robert S. Kerr Lab – Environmental Protection Agency
- Landowners
- Funding Sources:
  - Sigma Xi
  - OU College of Arts and Sciences
  - OU Graduate Student Senate
  - OU Zoology Dept.
“Mussels are not dismissible, even by those who have little interest in the natural world. Their presence is a signature of healthy aquatic ecosystems, to which they contribute as living water filters.”

- E.O. Wilson

ANY QUESTIONS?