Spatial Patterns in Texas Lotic Fish Communities

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Factors Impacting Rivers and Streams

- Industrialization, urbanization, and agriculture
  - Reservoir construction
  - Increased freshwater diversions
  - Additional wastewater loads
  - Pollution
  - Dredging
  - Saline intrusions
  - Proliferation of exotic species
The National Rivers and Streams Assessment

- First implemented by the EPA in 2008-2009
  - 55% of the nation’s rivers and streams did not support healthy populations of aquatic life (1)

- Second NRSA project completed 2013-2014
  - The Environmental Institute of Houston (EIH) conducted these surveys across Texas in collaboration with TCEQ
Expectations

Fish Communities
- Vary considerably across Texas
- Shift towards greater evenness in statewide diversity\(^{(1)}\)

Longitudinal Gradient
- Exists along western Gulf slope drainages\(^{(2)}\)

Land use/Land cover
- Land disturbances (i.e. development and agriculture) negatively affect fish communities\(^{(3)}\)

\(^{(1)}\) Anderson et al. 1995, \(^{(2)}\) Conner & Suttkus 1986, \(^{(3)}\) Allan 2004
Objectives

- Describe fish community metrics in Texas watersheds and review historic trends
- Evaluate potential longitudinal gradients observed across sample sites
- Assess the relationship between fish community metrics and land use/land cover
Site Selection

- Sampling frame derived from National Hydrography Dataset (NHD); randomly selected sites classified as “boatable” or “wadeable”
- Each site was located with GPS coordinates determined by the EPA
Sampling Methods

- Fish Community
- Benthic macroinvertebrates and periphyton
- Streamflow
- Water quality
- Physical Habitat
  - Instream
  - Riparian
  - Slope & Bearing
Boatable

Small Non-wadeable River: Channel Width < 12.5 m

Medium Non-wadeable River: Channel Width 12.5 m to 25 m

Large Non-wadeable River: Channel Width > 25 m

Wadeable

Small Wadeable Stream: Channel Width < 12.5 m

Medium Wadeable Stream: Channel Width 12.5 m to 25 m

Large Wadeable Stream: Channel Width > 25 m

*At medium & large rivers, if < 500 individuals have been collected after minimum sampling reach, continue fishing to next transect (alternating banks) until 500 individuals are collected or Transect K is reached. (20 subreaches fished)
Fish Community Metrics

- Species richness and Shannon’s diversity were computed for each sample site

- Indexes of biotic integrity (IBIs) adjusted for each ecoregion were calculated for each site

(1) Linam et al. 2002
Relative proportions of families were computed for each drainage and compared:

- To each other with respect to our data
- To (approximated) historical proportions from 1953 and 1986\(^{(1)}\)
Longitudinal Gradients

- Conducted regressions for species richness and diversity against longitude
  - Analyzed all sites as a whole
  - Analyzed sites separated into drainages
GIS Analysis

- Watersheds relative to each sample site were mapped using ArcGIS software.
- Upstream drainage area as well as land use/land cover (LULC) were examined for each site’s watershed.
Comparing fish communities to LULC

- Principal Component Analysis (PCA) conducted to ordinate sites and basins relative to LULC

- Percent disturbed land was regressed against fish community metrics
  - Species richness
  - Shannon’s diversity
  - Index of Biotic Integrity (%)
Community Composition

- In 51 sampling events:
  - 28,442 individuals
  - 20 families
  - 45 genera
  - 91 species

- Richness ranged from 2 to 25
- Diversity ranged from 0.37 to 2.70
# Index of Biotic Integrity

<table>
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<tr>
<th></th>
<th>Sabine</th>
<th>Neches</th>
<th>Trinity</th>
<th>Brazos</th>
<th>Colorado</th>
<th>SanGuad</th>
<th>Nueces</th>
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</tbody>
</table>

**Index of Biotic Integrity**

![Box plot of IBI (%) for different basins](image.png)

- **n=3** for Sabine, Neches, Trinity, Brazos, Colorado, SanGuad, Nueces
- **n=5** for Sabine, Neches, Trinity, Brazos, Colorado, SanGuad
- **n=9** for Trinity, Brazos, Colorado, SanGuad, Nueces
- **n=14** for Trinity, Brazos, Colorado, SanGuad
- **n=10** for Trinity, Brazos, Colorado, SanGuad, Nueces
- **n=5** for Trinity, Brazos, Colorado, SanGuad, Nueces
- **n=4** for Trinity, Brazos, Colorado, SanGuad

10/15/2015
Historical Comparison

West

East

Relative proportion of fish families in different rivers:
- Sabine
- Neches
- Trinity
- Brazos

Families include:
- Aphredoderidae
- Atherinopsidae
- Catostomidae
- Centrarchidae
- Cichlidae
- Clupeidae
- Cyprinidae
- Cyprinodontidae
- Ictaluridae
- Marine families
- Percidae
- Poeciliidae

Scatterplot of Richness vs Longitude

N = 51
$R^2 = 0.044$
P = 0.140
Scatterplot of Richness vs Longitude

- **Basin**
  - N = 10
  - $R^2 = 0.561$
  - $P = 0.013$

- **Colorado**
  - N = 14
  - $R^2 = 0.363$
  - $P = 0.023$
PCA: LULC

The figure shows a Principal Component Analysis (PCA) plot for LULC (Land Use/Land Cover) categories. The plot is based on the first two principal components (PC I and PC II), with PC I accounting for 26.5% of the variance and PC II accounting for 20.4% of the variance.

The LULC categories represented include:
- Shrubland
- Developed
- Forest
- Wetlands
- Water
- Barren
- Agriculture
- Herbaceous

The categories are differentiated by color and shape, with labels indicating the type of land use and the specific region or river basin they represent.
Land Disturbance

![Bar chart showing land disturbance in different regions]

- **Sabine**: Undisturbed - 80%, Disturbed - 20%
- **Neches**: Undisturbed - 90%, Disturbed - 10%
- **Trinity**: Undisturbed - 70%, Disturbed - 30%
- **Brazos**: Undisturbed - 50%, Disturbed - 50%
- **Colorado**: Undisturbed - 30%, Disturbed - 70%
- **SanGuad**: Undisturbed - 60%, Disturbed - 40%
- **Nueces**: Undisturbed - 100%

Percent (%)

- Undisturbed
- Disturbed
Diversity Regression

Diversity (H)

% Disturbed Land

R^2 = 0.108
P = 0.020
Summary

Fish community metrics

- Richness: 2-25, Diversity: 0.37-2.70
- Examining diversity across our sample sites indicates a shift towards evenness in statewide diversity
- Variable findings in regards to historical trends
Summary

Longitudinal gradients

- Significant longitudinal gradients observed in Brazos and Colorado drainages
- Attributable to greater longitudinal span and potentially the distribution of sample sites across a region of steadily shifting topography
Summary

Land use/land cover

- Sabine/Neches: forested, wetlands, open water
- Trinity/Brazos: agriculture, development
- Colorado/Nueces: arid shrubland
Future Work

- As observed in other studies\(^1,2\), LULC will be analyzed within a buffer of rivers/streams

- Physical habitat data collected at sites:
  - Mesohabitat
  - Riparian zones

- Additional analysis required to examine:
  - Hydrology
  - Gear bias
  - Historical data

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(1) Lammert & Allan 1999  (2) Diana et al. 2006
Acknowledgements

We would like to especially thank

- The EPA and TCEQ for funding and project oversight
  - Robert Cook
  - Christine Kolbe
  - Michele Blair
- EIH staff, students, and interns for site reconnaissance, trip preparation, and many long, hot days collecting data in the field.
Questions?
National Wetland Condition Assessment 2016

- EIH will be conducting these surveys this coming summer – those interested contact:
  - Jenny Oakley – oakley@uhcl.edu