Re-evaluating least-disturbed reference streams in Arkansas’ ecoregions

Jessie J. Green
Clean Water Act of 1972
- “fishable/swimmable”
- Provide basis for development, review and adoption of water quality standards
- Define chemical, physical, and biological parameters of least-impaired streams
Objectives

- Ecoregions
- Site selection
- Range of watershed sizes
- Critical survey periods
Objectives

- Ecoregions

- Ozark Highlands
- Boston Mountains
- Arkansas River Valley
- Ouachita Mountains
- Gulf Coastal Plains
  - Typical
  - Spring Influenced
- Delta
  - Least Disturbed
  - Channel Altered
Objectives

- Site selection
  - 36 Sites
  - Most representative of ecoregion
  - Least disturbed
Objectives

- Range of watershed sizes
  - 20-50 mi²
  - 100-200 mi²
  - 300-500 mi²
Objectives

- Critical survey periods
  - Late Summer
    - Temp
    - Dissolved Oxygen
Data Collected 1983-1986

Chemical
- Q, cfs
- Temperature, °C
- pH
- Turbidity, ntu
- TSS, mg/L
- TDS, mg/L
- BOD-5, mg/L
- BOD-20, mg/L
- Nitrates
- Total Phosphorus, mg/L
- PO₄-P, mg/L
- NO₂+NO₃-N, mg/L
- NH₃-N, mg/L
- Cl -, mg/L
- SO₄ =, mg/L
- Fe, mg/L
- Conductivity, µmho
- Alkalinity, mg/L
- Chlorophyll a, µg/L
- Fecal Coliform
- Dissolved Oxygen

Physical
- Drainage area
- Watershed land use
- Stream Gradient
- Mean Channel Width
- Mean Stream Width
- Mean Stream velocity
- Observed Flow
- Average Substrate Type
- Mean Instream Cover
- Riffle/Pool ratio of Transects
- Mean Bank Overstory Cover
- Mean Bank Ground Cover
- Mean Bank Stability
- Mean Stream Canopy

Biological
- Fish
- Macroinvertebrates
1983-1985: Original Survey (36)

1993-1994: Ozark Highlands Revisit (3)

1998: Boston Mountains Revisit (1)

2003: Gulf Coastal Plains Revisit (8)

2004: Ouachita Mountains Revisit (6)

2005: Arkansas River Valley Revisit (3)

2009: Boston Mountains Revisit (5)

2014
Least Disturbed Ecoregion Reference Streams – Fish Revisited

- 25 of 36
Least Disturbed Ecoregion Reference Streams – Fish Revisited

- Ambient and roving water quality monitoring stations
Least Disturbed Ecoregion
Reference Streams – Fish Revisited

- Land-use Land-cover
- Fish community structure index
  - Ecoregion
  - Site specific
Land-use Land-cover

- 1986
- 1992
- 1999
- 2006

Categories
- Forest
- Agriculture and pasture
- Urban
## Fish Community Structure Index

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Total Score</th>
<th>Category</th>
<th>Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozark Highlands</td>
<td>25-32</td>
<td>Mostly Similar</td>
<td>Comparable to the best situation to be expected. Balanced trophic structure and optimum community structure present.</td>
</tr>
<tr>
<td>Boston Mountains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ouachita Mountains</td>
<td>24-17</td>
<td>Generally Similar</td>
<td>Community structure less than expected. Taxa richness lower than expected. Some intolerant taxa loss. Percent contribution of tolerant forms may increase.</td>
</tr>
<tr>
<td>AR River Valley</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical Gulf Coastal</td>
<td>16-9</td>
<td>Somewhat Similar</td>
<td>Obvious decline in taxa richness due to the loss of tolerant forms. Loss of Key and Indicator taxa.</td>
</tr>
<tr>
<td>Spring-Influenced Gulf Coastal</td>
<td>0-8</td>
<td>Not Similar</td>
<td>Few taxa present and normally dominated by one (1) or two (2) taxa.</td>
</tr>
</tbody>
</table>
Fish Community Structure Index

- % Sensitive
- % Cyprinidae
- % Ictaluridae
- % Centrarchidae
- % Percidae
- % Primary Feeders
- % Key Individuals
- Diversity
Outline

- Ouachita Mountains
- Gulf Coastal Plains
- Boston Mountains
- Arkansas River Valley
- Ozark Highlands
Outline

- **Ouachita Mountains**
  - Board Camp Creek
  - Caddo River
  - Cossatot River
  - Little Missouri River
  - Saline River
  - South Fork Ouachita River
- **Gulf Coastal Plains**
- **Boston Mountains**
- **Arkansas River Valley**
- **Ozark Highlands**
Ouachita Mountains

### 1983-1985
- **Forest:** 90%
- **Ag:** 5%
- **Urban:** 5%

### 2004
- **Mostly Similar**: 85%
- **Generally Similar**: 5%
- **Somewhat Similar**: 5%
- **Not Similar**: 5%

- **Forest:** 70%
- **Ag:** 5%
- **Urban:** 25%
Ouachita Mountains

- Forest
- Ag
- Urban

1983-1985 vs. 2004:
- 100%
- 80%
- 60%
- 40%
- 20%
- 0%

1983-1985:
- 0%
- 20%
- 40%
- 60%
- 80%
- 100%

2004:
- 0%
- 20%
- 40%
- 60%
- 80%
- 100%

% Percidae:
- rho = 0.57, p = 0.01

% Urban:
- rho = 0.50, p = 0.10

% Key Individuals:
- Forest
- Ag
- Urban
Impaired - Not Supporting Fisheries Designated Use

- **Caddo River**
  - Cause: Silt - Source: Resource extraction
- **Saline River**
  - Cause: Turbidity, TDS - Source: Surface erosion, Unknown

Impaired – Supporting Fisheries Designated Use

- **Little Missouri River**
  - Cause: Copper - Source: Unknown
- Ouachita Mountains
- Gulf Coastal Plains
  - Big Creek
  - Cypress Creek
  - Derriuseaux Creek
  - East Fork Tulip Creek
  - Freeo Creek
  - Hudgens Creek
  - L’Aigle Creek
  - Moro Creek
- Boston Mountains
- Arkansas River Valley
- Ozark Highlands
Gulf Coastal Plains

1983-1985

1983-1985

2003

2003

Mostly Similar

Generally Similar

Somewhat Similar

Not Similar

Forest

Ag

Urban

0%

100%

20%

30%

40%

50%

60%

70%

80%

90%

100%
Impaired - Not Supporting Fisheries Designated Use

- Big Creek
  - Cause: Turbidity - Source: Surface Erosion

Turbidity (NTU)

Typical GCP

- All Flows
- Standard

1985 Average
Big Creek
Typical Gulf Coastal Plains

Mostly Similar
Generally Similar

[Bar charts showing environmental categories and percentage changes from 1985 to 2003]

[Bar charts showing fish family changes from 1985 to 2003]
- Ouachita Mountains
- Gulf Coastal Plains
- **Boston Mountains**
  - Hurricane Creek
  - Illinois Bayou
  - Indian Creek
  - Lee Creek
  - Mulberry River
- Arkansas River Valley
- Ozark Highlands
Boston Mountains

**Graph:**
- **1983-1985:**
  - Forest: 80%
  - Ag: 20%
- **1999,2009:**
  - Mostly Similar: 100%
  - Generally Similar: 0%
  - Somewhat Similar: 0%
  - Not Similar: 0%

- **Legend:**
  - Forest
  - Ag
  - Urban
  - Mostly Similar
  - Generally Similar
  - Somewhat Similar
  - Not Similar
Mulberry River
Boston Mountains

Mostly Similar
Somewhat Similar

0% 20% 40% 60% 80% 100%
1985 2009

Mostly Similar:
- Lepisosteidae
- Cyprinidae
- Catostomidae
- Ictaluridae
- Atherinopsidae
- Fundulidae
- Centrarchidae
- Percidae
- Sciaenidae

Somewhat Similar:
- Forest
- Ag
- Urban
Outline

- Ouachita Mountains
- Gulf Coastal Plains
- Boston Mountains
- Arkansas River Valley
  - North Fork Cadron Creek
  - Mill Creek
  - Petit Jean River
- Ozark Highlands
Impaired - Not Supporting Fisheries Designated Use

- Petit Jean River
  - Cause: Turbidity - Source: Sediment Erosion
Outline

- Ouachita Mountains
- Gulf Coastal Plains
- Boston Mountains
- Arkansas River Valley

**Ozark Highlands**
- Flint Creek
- Kings River
- Yocum Creek
Ozark Highlands

For the Ozark Highlands, the percentage of land use change from 1983-1985 to 1993-1994 is as follows:

- **Forest**: 20%
- **Ag**: 40%
- **Urban**: 40%

The chart shows that the majority of the land use change is similar between the two periods, with a significant portion being forested land. The bar chart indicates that most of the land use in 1983-1985 and 1993-1994 is considered "Mostly Similar," suggesting a high degree of consistency in land use changes over the years.
Impaired – Supporting Fisheries Designated Use

- Kings River
  - Cause: TDS - Source: Unknown
1983-1985: Original Survey (36)

2013: Ozark Highland

2014: Boston Mountains

2016: Ouachita Mountains
Arkansas River Valley
Conclusions

- Need more data
- Standardize methods
  - 1983-1985: rotenone, mini-fyke nets, electrofishing
  - Present: electrofishing
Questions