Spawning stock characteristics, egg deposition and post emergent survival in the lake sturgeon (*Acipenser fulvescens*): The relative importance of potential barriers to recruitment

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Lake Sturgeon: Population Decline

Two Facts:
Populations have declined
No Recovery

One Potential Reason:
Recruitment may be too low to rebuild existing populations

<table>
<thead>
<tr>
<th>Year</th>
<th>Larvae Captured</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>780</td>
</tr>
<tr>
<td>2001</td>
<td>2975</td>
</tr>
<tr>
<td>2002</td>
<td>1691</td>
</tr>
<tr>
<td>2003</td>
<td>16,417</td>
</tr>
<tr>
<td>2004</td>
<td>437</td>
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Basic Research Needs

1. Need information about the aspects of the species’ early life history and reproductive ecology

2. Need information on factors that are potential barriers to lake sturgeon reproductive success
Research Objectives

1. Determine the importance of annual spawning stock abundance, size and age structure, and sex ratios to reproductive success
2. Estimate fertilization rates as a function of spawner number and sex ratios
3. Determine sources and magnitude of egg predation
4. Determine factors that influence larval survival during drift
Unique Study Site - Black Lake, MI

Lake Huron

Lower Black River

Black Lake

Upper Black River

MICHIGAN
Unique Study Site – Upper Black River

Map showing the Upper Black River with labeled points:
1. Kleber Dam
2. Larval Sampling
3. Larval Sampling (red bridge)
4. Adult Migration

Spawning Sites marked at intervals.
Decomposing a Complicated Life History

Stage 1: Spawning Adults
- Spawning stock abundance
- Size class structure
- Sex ratios
- Spawning frequency
- Fertilization rates

Stage 2: Eggs
- Egg abundance
- Deposition
- Incubation times
- Predation

Stage 3 & 4: Larvae/Juvenile
- Larval drift
- Growth
- Predation
- Movement
- Habitat selection
- Over winter survival
- Parentage analysis

Stage 5: Adults
- Recruitment
- Growth rates
- Population estimates
- Survivorship
Stage 1: Spawning Adult Sturgeon

- Methods -

- Migration was restricted at the mouth of the river
- Movement was monitored using a video camera
- Adult sturgeon were netted at the spawning grounds
- Fish were tagged using both external and internal methods
- Biological information was collected
- Fin clips were taken for genetic analysis
Differences in size structure?

**Males**
- Chi-square= 340.8
- DF= 279
- P= 0.0067

**Female**
- Chi-square= 213.5
- DF=189
- P= 0.1066
### Number of Spawners and Sex Ratios

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>Sex Ratio</th>
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<tbody>
<tr>
<td>2001</td>
<td>115</td>
<td>1.50 :1</td>
</tr>
<tr>
<td>2002</td>
<td>104</td>
<td>2.06 :1</td>
</tr>
<tr>
<td>2003</td>
<td>121</td>
<td>1.95 :1</td>
</tr>
<tr>
<td>2004</td>
<td>100</td>
<td>3.00 :1</td>
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</table>

- Recruiting males into the spawning population
- Spawning frequencies of males and females
2003 Field Season
-Stage-Based Approach-

2003
N=121
Sex Ratio = 1.95 :1

[Histogram showing total number of Lake Sturgeon by sex and total length (cm)]
**Adult Migration and Spawning**

**2003**

- **N = 42**
  - 30 males, 12 females
  - Sex Ratio = 2.50 : 1

- **N = 79**
  - 50 males, 29 females
  - Sex Ratio = 1.70 : 1

**Females in the first group were larger than females in the second**

ANOVA: Girth: \( P = 0.033 \)

**Males in the first group were smaller than males in the second**

ANOVA: Length: \( P = 0.001 \)

ANOVA: Weight: \( P = 0.003 \)
Stage 2: Egg Deposition

-Methods-

- Stream transects were run starting above the spawning group
- Kick nets were conducted every meter
- Transects were continued down stream every three meters
- Flow, stream discharge and substrate size at each location
| 0 0 0 0 1 3 0 3 10 12 55 23 42 322 16 0 4 3 3 |
| 0 0 0 0 0 1 2 0 0 0 24 4 150 55 58 65 24 11 0 2 |
| 0 0 0 0 0 1 0 1 0 0 1 16 16 4 24 70 200 75 5 9 0 |
| 0 3 0 0 0 0 0 1 0 6 22 12 25 6 2 30 25 15 20 38 3 |
| 0 0 0 0 1 0 2 9 6 43 18 200 250 42 2 41 14 10 |
| 0 0 0 3 0 0 1 0 2 5 12 22 16 12 7 24 0 0 |
| 16 1 0 0 0 0 4 12 6 56 20 20 10 16 2 0 1 |
| 1 2 2 0 5 4 1 41 16 19 18 27 16 0 0 |
| 3 3 2 5 3 5 30 29 16 12 10 2 0 0 0 |
| 0 3 0 1 7 17 15 11 36 4 5 8 1 1 |
Egg Deposition

- Stepwise Multiple Regression
- Dependent variable: Egg Abundance
- Independent variables:
  - Stream depth
  - Stream flow
  - Average substrate size
  - Downstream distance from the spawning group
  - Stream channel position

<table>
<thead>
<tr>
<th>Step</th>
<th>Model Variables</th>
<th>F</th>
<th>P</th>
<th>$R^2$ (adjusted)</th>
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<tbody>
<tr>
<td>1</td>
<td>Average Substrate Size</td>
<td>104.989</td>
<td>&lt;0.001</td>
<td>0.343</td>
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<tr>
<td>2</td>
<td>Ave. Substrate Size Stream Channel Position</td>
<td>73.738</td>
<td>&lt;0.001</td>
<td>0.428</td>
</tr>
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</table>
Stage 3: Larval Sturgeon

- Methods -

- D-frame drift nets were used to sample larval sturgeon
- Deployed two meters apart across the stream channel
- Sampling was conducted during a five hour time period
- Collection cups are emptied every hour
- The number of larval sturgeon in each net are counted
Larval Drift Profile

A total of 16,314 larval sturgeon were captured

N = 79
Sex Ratio = 1.70 : 1
351 larval sturgeon

N = 42
Sex Ratio = 2.50 : 1
15,963 larval sturgeon
What was different?

**Site B vs Site C**

- Large Substrate Sizes
- Deep
- Slower Water Velocity

- Smaller Substrate Sizes
- Shallow
- Faster Water Velocity
Discussion and Conclusions

Power of the stage based approach

- The potential barriers to lake sturgeon recruitment can be decomposed into several different stages.
- One or more of these stages may have a large impact on lake sturgeon survival and recruitment.
- The impact of each stage may change from year to year.
- Knowledge of all these factors will be critical to designs of reintroduction programs.
Acknowledgements

- Michigan Department of Natural Resources
- MDNR Fisheries Division, Gaylord MI
- Sturgeon For Tomorrow Inc.
- Wolf Lake Fish Hatchery
Questions?