Jun 22nd, 10:45 AM - 11:00 AM

Case Studies VI: Dynamics of the 2015 Spawning Migration of American Shad (Alosa sapidissima) in the Connecticut River

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Dynamics of the 2015 spawning migration of American shad (Alosa sapidissima) in the Connecticut River

Jason M. Boucher, PhD\textsuperscript{1,2}
Richard S. McBride, PhD\textsuperscript{1}

Fish Passage Conference 2016
June 22, 2016

2. Integrated Statistics
American shad (*Alosa sapidissima*)

- Range from Canada to the St. Johns River, Florida
- Home to natal river to spawn
- Latitudinal variability in parity:
  - St. Johns River, FL: 0%
  - York River: 23%
  - Connecticut River: 38%
  - St. John River, NB: 73%
Project Scope & Methods

• **Major goals**
  • Estimate & compare annual fecundity
  • Estimate spawning rates and batch fecundity
  • Estimate ages and parity (virgin/repeat)
  • Estimate condition

• **Aging and fecundity workup**
  • Aging
    • Scales by CT-DEEP (Jacque Benway)
    • Otoliths by MA-DMF (Scott Elzey)
  • Reproductive biology
    • Ovary histology (Mass Histology, E. Towle)
    • Oocyte size distribution (E. Towle)
    • Fecundity (E. Towle)
  • Condition by USGS (Steve McCormick)
Sampling Protocol & Locations

- Weekly from 4/30 – 6/30
- Two locations per week
- Sample from 0800 – 1300
- 30 females and 15 males
### Fish Collected

- Total of 640 individuals:
  - 239 males
  - 401 females

<table>
<thead>
<tr>
<th>Location</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vernon Dam</td>
<td>45</td>
<td>41</td>
</tr>
<tr>
<td>Cabot Power Station</td>
<td>78</td>
<td>45</td>
</tr>
<tr>
<td>Hadley Power Station</td>
<td>177</td>
<td>96</td>
</tr>
<tr>
<td>Lower River</td>
<td>28</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sex</th>
<th>Fork Length Means</th>
<th>Group</th>
<th>Body Weight Means</th>
<th>Group</th>
<th>Somatic Weight Means</th>
<th>Group</th>
<th>Gonad Weight Means</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>450.56</td>
<td>a</td>
<td>1264.93</td>
<td>a</td>
<td>1094.20</td>
<td>a</td>
<td>170.68</td>
<td>a</td>
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<tr>
<td>Male</td>
<td>403.03</td>
<td>b</td>
<td>828.75</td>
<td>b</td>
<td>779.40</td>
<td>b</td>
<td>49.35</td>
<td>b</td>
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</table>

### Sex Ratio

<table>
<thead>
<tr>
<th>Location</th>
<th>Females</th>
<th>Males</th>
<th>Sex Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower River</td>
<td>50</td>
<td>101</td>
<td>0.331</td>
</tr>
<tr>
<td>Holyoke</td>
<td>195</td>
<td>176</td>
<td>0.526</td>
</tr>
<tr>
<td>Cabot</td>
<td>41</td>
<td>107</td>
<td>0.277</td>
</tr>
<tr>
<td>Vernon</td>
<td>31</td>
<td>46</td>
<td>0.403</td>
</tr>
<tr>
<td>Cabot - DS</td>
<td>28</td>
<td>5</td>
<td>0.848</td>
</tr>
<tr>
<td>Holyoke - DS</td>
<td>439</td>
<td>559</td>
<td>0.440</td>
</tr>
</tbody>
</table>

**Note:**
- More Male indicates a higher number of males.
- More Females indicates a higher number of females.

**Data Source:** NOAA, U.S. Navy, NOAA, DEBCO

© 2015 Google Image Landsat
Size Distribution

- Vernon Dam
- Cabot Power Station
- Hadley Power Station
- Lower River

**Females**

- Fork length of male American shad in 2015
- p < 0.05

- Fork length of female American shad in 2015
- p > 0.05

- Body weight of male American shad in 2015
- p < 0.05

- Body weight of female American shad in 2015
- p < 0.05

**Males**

- Fork length of male American shad in 2015
- p > 0.05

- Fork length of female American shad in 2015
- p < 0.05

- Body weight of male American shad in 2015
- p < 0.05

- Body weight of female American shad in 2015
- p < 0.05
Otolith-Derived Ages

*No significant difference in age between locations or time

Mean age-at-maturity (Leggett & Carscadden 1978):

- Females: 4.8
- Males: 4.1

Age truncation
Repeat Spawners

### Ratio of repeat spawners:
- **Total:** 13:640 2%
- **Females:** 10:401 2.5%
- **Males:** 3:239 1.2%

### Historical data:
- **38%**

### Spawners by Location:
- **Vernon Dam**
  - Females: 6/3
  - Males: 1
- **Cabot Power Station**
  - Females: 5/13 1
  - Males: -
- **Hadley Power Station**
  - Females: 5/19 2*
  - Males: 5/26 1
  - Males: 6/18 - 1 (ds)
- **Lower River**
  - Females: 4/30 2
  - Males: 5/5 3
  - Males: 5/6 1*
Actively Spawning Females

- Vernon Dam: 3 Up, 3 Down
- Cabot Power Station: 9 Up, 3 Down
- Hadley Power Station: 15 Up, 6 Down
- Lower River

Data SIO NOAA, U.S. Navy, NOAA, DEBCO © 2015 Google Image Landsat
Connecticut River PAFs

<table>
<thead>
<tr>
<th>Study</th>
<th>Method</th>
<th>Annual Fecundity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leggett (1969)</td>
<td>Determinate</td>
<td>256,000</td>
</tr>
<tr>
<td>McBride et al (in prep)</td>
<td>Determinate</td>
<td>303,000 ± 73,400</td>
</tr>
<tr>
<td>Current study</td>
<td>Indeterminate</td>
<td>325,100 ± 11,300</td>
</tr>
</tbody>
</table>

Student’s t-test, $P > 0.05$
Annual Fecundity Estimates

Potential Annual Fecundity (n) in Thousands for various rivers:

- St. Johns River (FL)
- York River
- Connecticut River
- St. John River (NB)
- Miramichi River

The chart shows a descending trend in potential annual fecundity from the St. Johns River to the Miramichi River.
“... intraspecies variation in reproductive characteristics represents a fine tuning of life history to long term features of the environment by natural selection.”
– Leggett & Carscadden (1978)
Acknowledgements

- **USGS**
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  - Robert Johnston
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  - Ken Sprankle
- **CT DEEP**
  - Tom Savoy
  - Jacque Benway
- **MA DMF**
  - Scott Elzey
- **Holyoke Gas & Electric**
  - Richard Murray
- **First Light**
  - Robert Stira
  - Joe Lucas
- **Transcanada**
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  - Jennifer Griffin
  - John Ragonese
  - Stephen Gottardi
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  - Brittney LaFlamme
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- **Mass Histology**