Mixed Stock Analysis of Atlantic Sturgeon from Coastal Locales and a Non-Spawning River

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Objectives

• To determine the stock origin of migratory subadult and adult Atlantic sturgeon from coastal locales

• To determine the stock origin of subadult Atlantic sturgeon in a river in which spawning currently does not occur
Why?

• To better protect populations or DPS that have failed to rebound and that may be vulnerable as bycatch in coastal fisheries or to other anthropogenic threats

• To determine and compare the migratory patterns of subadults from different populations or DPS
Strategy

• Characterize YOY, age 1, and adult Atlantic sturgeon (<50 cm and 130 cm TL) from reference rivers using mtDNA control region sequence and multi-loci microsatellite analyses

• Characterize Atlantic sturgeon from coastal locales and non-spawning rivers using the same suite of informative genetic markers

• Use assignment testing and mixed stock analysis to determine the stock origin of individual and aggregations of Atlantic sturgeon from coastal and non-natal river locales
Methods

• Fish were collected from five coastal locales and one non-spawning river
  – Bay of Fundy
  – Central Long Island Sound
  – Delaware Coast
  – North Carolina Coast (winter)
  – Observers Program
  – Connecticut River
• All fish were characterized at sequence in the mtDNA control region and at 11 informative microsatellite markers
• All genotyping of unknown fish done at NYU and results compared to previous characterizations of fish from nine reference rivers and five DPS (mtDNA-NYU) (microsatellites- USGS)
• Assignment testing using GeneClass and mixed stock analysis using ONCOR done at USGS
General Collection Localities (Sample Sizes)

- Hudson R. (53)
- Delaware R. (83)
- James River (65)
- Albemarle Sound (25)
- Savannah R. (34)
- Ogeechee R. (37)
- Altamaha R. (49)
- St. John R. (31)
- Kennebec R. (34)

Atlantic sturgeon
(*Acipenser oxyrinchus oxyrinchus*)

Figure 1
Bay of Fundy

N=178, Mean TL= 1510, 2008-2010
Bay of Fundy
nDNA and mtDNA

MSA

Assignment Test

GOM
NYB
CB
Carolina
SE

GOM
NYB
CB
Carolina
SE

St_John
Kennebec
Hudson
Delaware
CB
Albemarle
Savannah
Ogeechee
Altamaha

St_John
Kennebec
Hudson
Delaware
CB
Albemarle
Savannah
Ogeechee
Altamaha
Bay of Fundy

5 DPS

9 POPS

- SE
- Carolina
- CB
- NYB
- GOM

- Altamaha
- Ogeechee
- Savannah
- Albemarle
- James
- Delaware
- Hudson
- Kennebec
- St_John
Connecticut River

Lower 50 km w/most collections at lower 3 arrows
N=69, Mean TL= 975, 1991, 2005-2010
Connecticut River
nDNA and mtDNA

MSA

Assignment Test

- GOM
- NYB
- CB
- Carolina
- SE

- St_John
- Kennebec
- Hudson
- Delaware
- CB
- Albemarle
- Savannah
- Ogeechee
- Altamaha
Connecticut River

5 DPS

9 POPS

Legend:
- SE
- Carolina
- CB
- NYB
- GOM
- Altamaha
- Ogeechee
- Savannah
- Albemarle
- James
- Delaware
- Hudson
- Kennebec
- St_John
Relative catch of Atlantic sturgeon, 2006-2009 by area
N=275, Mean TL= 1238, 2006-2010
Long Island Sound
nDNA and mtDNA

MSA

Assignment Test

- GOM
- NYB
- CB
- Carolina
- SE

- St. John
- Kennebec
- Hudson
- Delaware
- CB
- Albemarle
- Savannah
- Ogeechee
- Altamaha
Delaware Coast
N=105, Mean TL= 1736, April 2009-2010
Delaware Coast
nDNA and mtDNA

MSA

Assignment Test

GOM
NYB
CB
Carolina
SE
St_John
Kennebec
Hudson
Delaware
CB
Albemarle
Savannah
Ogeechee
Altamaha
North Carolina Coast (Winters)

Bold circle = sturgeon collected, Open circle = no sturgeon collected (1988-2006)
N=163, Mean TL=1048, Jan-Feb. 2000-2010
North Carolina Coast
nDNA and mtDNA

MSA

Assignment Test

GOM
NYB
CB
Carolina
SE
St_John
Kennebec
Hudson
Delaware
CB
Albemarle
Savannah
Ogeechee
Altamaha

GOM
NYB
CB
Carolina
SE
St_John
Kennebec
Hudson
Delaware
CB
Albemarle
Savannah
Ogeechee
Altamaha
Haul Locations Where Samples Were Collected From Atlantic Sturgeon

Observers’ Program

N=89, Mean Length=1171, 2009-2010
Observers’ Program
nDNA and mtDNA

MSA

Assignment Test

GOM
NYB
CB
Carolina
SE

St_John
Kennebec
Hudson
Delaware
CB
Albemarle
Savannah
Ogeechee
Altamaha
Summary

- Subadult and adult Atlantic sturgeon from all populations undergo long migrations and mix in coastal aggregations and are likely vulnerable to distant anthropogenic impacts.
- But, fish tend to aggregate within the geographic region of their spawning river.
- Subadults from many populations occur and mix in at least one non-natal estuary seasonally.
Future Needs

• Evaluate temporal stability of markers in reference populations

• More genetic characterization of known and “newly discovered” spawning populations
  – More individuals and more markers

• More in-depth analysis of use of non-spawning and spawning estuaries by subadults from other spawning populations

• Partition stock origin in coastal bycatch by
  – Location
  – Season
  – Gear type
**X² Comparison of mtDNA Haplotypes Among Years of Adult Collections of Atlantic Sturgeon from the Hudson River ($p$ value)**

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<td>1992</td>
<td>0.37 (0.7793)</td>
<td>4.02 (0.4906)</td>
<td>2.65 (0.3667)</td>
<td>1.54 (0.9579)</td>
<td>2.06 (0.7670)</td>
<td>1.44 (0.8089)</td>
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<td>1993</td>
<td>4.98 (0.3240)</td>
<td>3.78 (0.2479)</td>
<td>1.64 (0.9316)</td>
<td>1.55 (0.9017)</td>
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<td>1994</td>
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<td>2.29 (0.4599)</td>
<td>2.40 (0.6898)</td>
<td>5.00 (0.4438)</td>
<td>6.70 (0.2096)</td>
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<td>1997</td>
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<td>3.89 (0.5038)</td>
<td>4.20 (0.3823)</td>
<td>2.95 (0.6304)</td>
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<td>2006</td>
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<td>2.51 (0.8956)</td>
<td>3.39 (0.7421)</td>
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<td>2009</td>
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<td></td>
<td></td>
<td></td>
<td>3.27</td>
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Acknowledgments

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• John Waldman- Queens College
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  – Sierra Wehrell and Mike Dadswell
  – Tom Savoy
  – Dewayne Fox and Matthew Breece
  – Wilson Laney
  – K.B. McArdle
mt DNA only

mtDNA and nDNA

- Altamaha
- Ogeechee
- Savannah
- Albemarle
- James
- Delaware
- Hudson
- Kennebec
- St_John
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<tr>
<th>Data type</th>
<th>9 Populations</th>
<th>5 ESLs(^1) or DPSs(^2)</th>
<th>3 ESLs or DPSs</th>
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<tr>
<td>All (nDNA + mtDNA)</td>
<td>84.6</td>
<td>96.0</td>
<td>98.1</td>
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<td>nDNA only (11 loci)</td>
<td>82.4</td>
<td>93.6</td>
<td>98.1</td>
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<td>mtDNA only (1 locus)</td>
<td>48.2</td>
<td>67.5</td>
<td>74.6</td>
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\(^1\)Evolutionarily significant lineages  
\(^2\)Distinct population segments