Cobia Research in SC

Management Implications Along the Southeastern US Coast

Michael Denson, Wallace Jenkins and Tanya Darden
Cobia

- Pelagic, migratory species
- Commercial and recreational importance
- Harvests steady since 1996
- Recreational pressure increasing
  - Inshore aggregations
  - Overfishing potential
- Single stock management
  - GMFMC; SAFMC
SC Charter Boat Effort for Cobia

**When?**

Monthly Distribution of Cobia Caught by Charter Boats in SC
1997 - 2006
Source: SCDNR Charterboat Logbooks

**Where?**

Regional Distribution of Cobia Caught by Charter Boats in SC
1997 - 2006
Source: SCDNR Charterboat Logbooks
Why Cobia Research in SC?

- Attractive aquaculture species
  - Fast growth rates
  - Excellent flesh
- Applied Fisheries Research?
  - Best tags?
  - Movement?
  - Genetic tag development?
  - Spawning?
- Recreational fisherman
- Charter boat captains
- Conservation groups
  - Concerns about overfishing
  - Interest in understanding more about the life history
Research Questions

- Aquaculture Potential?
- Growth rates?
- Tolerance limits?


- Results of interest for fisheries management
  - Tagged fish return annually exhibiting site fidelity?
  - Recently collected broodstock spawn volitionally
  - Genetic tags developed and used successfully
Research Questions

- What is the age structure?
  - Fishery statistics
  - Mortality estimates
  - Survival estimates
- Sex ratio?
- Feeding habits?
- Spawning behavior?
  - Histological evaluation
  - Plankton sampling
Research Questions

- Genetic composition?
  - Population structure
  - Migration
  - Estuarine fidelity
- Role of seasonal inshore aggregations?
  - Challenges...
    - Relatively little known
    - Potential long distance migration
      - Distribution
      - Pelagic, oceanic nature
    - Annual inshore aggregations
    - GOM reproductive groups??
Today's Presentation

- Spawning aggregations
- Age Growth information
- Population structure (genetic)
Sample Collection?

- Fisheries dependent data
  - Freezer program
  - Charter boat captains
  - Recreational anglers
  - Tournaments
- Fisheries independent
  - DNR anglers
  - Plankton surveys
- Data collected—total length, fork length, total weight, site and time of capture, gonads, fin clips, sagittal otoliths, and stomach contents
Are fish spawning in estuaries?

- Gonad weighed and portion preserved
- Tissue processed by standard histological techniques
- Female samples staged according to ovarian development
Female Reproductive Cycle

- Immature
- Early Developing
- Late Developing
- Gravid
- 0-24 hours Post-spawn
  - 24-48 hours Post-spawn
  - Spent
  - Resting
2007 Data

- 149 female tissue samples

### Percent Composition of Development Stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>Percent Composition</th>
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<tbody>
<tr>
<td>Early Developing</td>
<td>3</td>
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<tr>
<td>Late Developing</td>
<td>125</td>
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<tr>
<td>Gravid</td>
<td>4</td>
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<td>0-24 hrs post-spawn</td>
<td>7</td>
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<tr>
<td>24-48 hrs post-spawn</td>
<td>9</td>
</tr>
<tr>
<td>Spent</td>
<td>1</td>
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Plankton Sampling

- 2007
  - April, May, & June
  - Time of capture, site of capture

- Plankton surveys
  - Anchored nets
  - Flood tides
  - 2 times per week
  - 2 estuaries

Photo: Brian Watkins
# Plankton Samples from Port Royal and St. Helena Sounds

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Early Eggs</th>
<th>Late Eggs</th>
<th>Larvae</th>
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<tbody>
<tr>
<td>May 6</td>
<td>PR</td>
<td>0</td>
<td>3</td>
<td>0</td>
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<tr>
<td>May 8</td>
<td>SHS</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<td>May 14</td>
<td>PR</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>May 21</td>
<td>SHS</td>
<td>12</td>
<td>121</td>
<td>5</td>
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<tr>
<td>May 28</td>
<td>SHS</td>
<td>2</td>
<td>29</td>
<td>7</td>
</tr>
<tr>
<td>May 29</td>
<td>PR</td>
<td>0</td>
<td>29</td>
<td>2</td>
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<td>June 3</td>
<td>SHS</td>
<td>520</td>
<td>152</td>
<td>12</td>
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<tr>
<td>June 5</td>
<td>PR</td>
<td>27</td>
<td>7</td>
<td>2</td>
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<td>June 12</td>
<td>PR</td>
<td>0</td>
<td>20</td>
<td>10</td>
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<tr>
<td>June 18</td>
<td>SHS</td>
<td>0</td>
<td>4</td>
<td>2</td>
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</table>

Eggs estimated 2-26 hrs old

- Cultured cobia eggs
- Wild caught cobia eggs
Estimating Survival and Mortality

- Conduct age validation studies in lab, and w/tagged fish in wild
- Use age composition and catch frequencies
- ***Catch curve accounts for some variation in year class
  - Assumptions: 1) survival rate is uniform with age 2) no change in mortality rate with time 3) sample is taken randomly 4) fishing and natural mortality individually uniform 5) only moderate fluctuations in recruitment
- Use only age classes that are fully recruited to sampling gear (3+ years for cobia)
- Instantaneous rate of mortality is $Z = l$ slope $l$
- Annual rate of survival is $S = e^{-z}$ (Ricker 1975)
- Annual rate of mortality is $1 - S$
Estimating Survival and Mortality

<table>
<thead>
<tr>
<th>Year</th>
<th>Sample (n)</th>
<th>Instantaneous Mortality (Z)</th>
<th>Annual Survival (S)</th>
<th>Annual Mortality (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>113</td>
<td>0.38</td>
<td>0.68</td>
<td>0.32</td>
</tr>
<tr>
<td>2006</td>
<td>53</td>
<td>0.28</td>
<td>0.76</td>
<td>0.24</td>
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<tr>
<td>2007</td>
<td>347</td>
<td>0.46</td>
<td>0.63</td>
<td>0.37</td>
</tr>
<tr>
<td>2008</td>
<td>283</td>
<td>0.43</td>
<td>0.64</td>
<td>0.36</td>
</tr>
<tr>
<td>2009</td>
<td>199</td>
<td>0.37</td>
<td>0.69</td>
<td>0.31</td>
</tr>
<tr>
<td>2005-2009</td>
<td>995</td>
<td>0.49</td>
<td>0.61</td>
<td>0.39</td>
</tr>
<tr>
<td>2007-2009</td>
<td>829</td>
<td>0.52</td>
<td><strong>0.59</strong></td>
<td>0.41</td>
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</tbody>
</table>
Evidence of Strong Recruitment

Cobia Catch Curve

The graph shows the frequency of occurrence of cobia catch over different ages for various years: 2007, 2006, 2005, 2008, and 2009. The peaks in the curves indicate periods of strong recruitment, with the highest frequency occurring in the 2007 data.
Fishery Statistics

### Cohort Catch Curve

<table>
<thead>
<tr>
<th>Year</th>
<th>Instantaneous Mortality (Z)</th>
<th>Annual Survival (S)</th>
<th>Annual Mortality (A)</th>
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</thead>
<tbody>
<tr>
<td>2002</td>
<td>0.53</td>
<td>0.59</td>
<td>0.41</td>
</tr>
<tr>
<td>2003</td>
<td>0.47</td>
<td>0.63</td>
<td>0.38</td>
</tr>
<tr>
<td>2004</td>
<td>0.31</td>
<td>0.73</td>
<td>0.27</td>
</tr>
</tbody>
</table>
Hyperstability?*

* Is a situation that often occurs in aggregating fishes...
* As a fish population declines, fish continue to aggregate or school and therefore their local population density remains constant. Although the number of schools or aggregations present may be declining, fishers will continue to fish these high-density schools, and despite a population decline CPUE remains high.

*Hilborn and Walters 1992
Appropriate Management Unit?

- Based on offshore collections
  - High movement along SE US and with GOM
  - Single population management as overfishing in one offshore area would impact another...
- Based on inshore aggregations
  - Suggestion of distinct population segments (DPSs)
  - Preliminary indications of estuarine fidelity
  - DPSs managed separately as localized inshore fishing pressure would primarily impact the local population
Tools

- **Suite of microsatellite loci**
  - Inherited in a Mendelian fashion,
  - Hardy Weinberg Equilibrium,
  - No linkage disequilibrium
  - Marker confidence
  - Identity non-exclusion: $9.7 \times 10^{-12}$

<table>
<thead>
<tr>
<th>Multiplex Group</th>
<th>Locus</th>
<th>Repeat Motif</th>
<th>Size Range (bp)</th>
<th># of Alleles</th>
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<td>1</td>
<td>Rca-H10</td>
<td>CA</td>
<td>119-139</td>
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<tr>
<td></td>
<td>Rca-A04</td>
<td>(CA)$_9$ (CACT)$_4$</td>
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<td>GT</td>
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<td></td>
<td>Rca-H09</td>
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<td>CA</td>
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<td>7</td>
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<tr>
<td>3</td>
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<td>Rca-C04</td>
<td>GT</td>
<td>217-253</td>
<td>16</td>
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</table>
Sample Collections

- Cooperating anglers, SCDNR staff
- April – July
- Field samples genotyped
- Field samples otolith-aged
  - 2008
    - SC (n=75)
    - SC_{off} (n=55)
    - VA (n=36)
    - FL_{off} (n=16)
    - NC_{off} (n=84)
Population Structure

- Pairwise
  - Distribution (G-test)
  - $\rho_{ST}$
- AMOVA
- IBD/Spatial autocorrelation
- Homogenous offshore groups
- Distinct inshore aggregations
  - $G$: $p=0.000$; $\rho_{ST}$: $0.032$, $p=0.000$
  - $G$: $p=0.000-0.003$; $\rho_{ST}$: $0.007-0.025$, $p<0.05$
  - AMOVA: $\rho_{ST}$: $0.014$, $p=0.000$
- Overall ‘little’ isolation
Inshore Aggregations

- Spawning function
  - Genetic structure
  - Fidelity
  - Plankton samples
    - Positive egg & larval identification
    - Histological evidence

- Fishing pressure targeting spawning groups??
- Temporal influences? (Collection vs. Migration timing)
Challenges for Cobia Management

- Life history and migration patterns
  - Limited knowledge
  - Limited accessibility (and confounding temporal issues)
- Primary fishing pressure
  - Occurs inshore where the aggregations are present
    - Implication for potential overfishing of the reproductive pool to occur while on the spawning grounds
  - Occurs offshore where aggregations are not present
- Data poor
  - Original plan (1983) developed for incidental catch
  - Burns et al. 1998
Williams (2001) Assessment of cobia in the GOM

- Not genetically distinct
- Rarely gather in large numbers
- Percent maturity at size and age fixed
- Very little information on age 0-1
- Suggest great uncertainty
- Some probability that the stock is overfished
Management Needs

- Commercial data limited to bycatch
- Random independent fishery indices not available
  - Charter boat logs
  - MRFSS data

Growth & Mortality Statistics
- Von Bertalanffy
- Survival and mortality
- Morphometrics

Spawning Stock
- Age at maturity
- Sex ratios
- Fecundity estimates
- Longevity

Genetic Identification
- Multiple stocks?
- Management unit?
Current management

- South Atlantic and Gulf of Mexico Fishery Management Council (considered one stock)
  - Coastal Pelagics Fishery Management Plan
- Limit of 2 fish/person/day
- Minimum fork length = 33 in (~84 cm)
  - Maturity
    - Females—80 cm, 2 years (near min. FL)
    - Males—60 cm, 1-2 years
SC Cobia Harvest  1997-2008
(commercial and charter boats)
### SC Recreational Cobia Catch 1986 - 2008

**Source:** MRFSS

<table>
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<tr>
<th>Year</th>
<th>PSE</th>
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<td>1986</td>
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<td>1987</td>
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<tr>
<td>1988</td>
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<tr>
<td>1989</td>
<td>31.4</td>
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<tr>
<td>1990</td>
<td>43.7</td>
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<tr>
<td>1991</td>
<td>56.6</td>
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<td>1992</td>
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<td>1999</td>
<td>32</td>
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<td>2000</td>
<td>53.2</td>
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<td>2002</td>
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<td>2003</td>
<td>31.4</td>
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<tr>
<td>2004</td>
<td>35.4</td>
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<td>2005</td>
<td>46.1</td>
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<td>2006</td>
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<tr>
<td>2007</td>
<td>34.3</td>
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<tr>
<td>2008</td>
<td>42.9</td>
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SC Charterboat Catch
1997 - 2008
Source: SCDNR Charterboat Logbooks

Number of Fish

Year


Released
Harvested
SC Commercial Cobia Landings by Region
1997-2006
Source: SCDNR Dealer Reporting

Year
White Pounds


Upstate
North Coast
Central Coast
Southern Coast