Advancing Hybrid Striped Bass Aquaculture
Hybrid Striped Bass

- Cross between

1. Striped Bass
   Morone saxatilis

2. White Bass
   Morone chrysops
Hybrid Striped Bass: Original Cross

- **1st cross of the two species**
  - Female striped bass
  - Male white bass

- Historically, referred to as the “original cross”

- Common name “Palmetto bass”
Hybrid Striped Bass: Reciprocal Cross

- 2nd cross of the two species
  - Male striped bass
  - Female white bass
- Historically, referred to as the “reciprocal cross”
- Common name “Sunshine bass”
Objectives

- Habituate wild white bass broodstock to captivity
- Perfect controlled spawning of white bass
- Develop *Morone* semen storage techniques
- Evaluate performance of geographical strains of white bass and hybrid striped bass
White Bass Domestication

- No domestic populations for culture
  - SIUC initiated domestication program
    - Collected wild white bass
    - Developed techniques
  - Habituated these fish to captivity
Collection of Wild Fish

- White bass broodstock collected from wild
  - Electrofishing
  - Hook and line
- Illinois River
Collection

- Broodstock hauled back to SIUC
Habituating Broodstock

- Broodstock were stocked into an indoor water recirculating system at SIUC
Habituating Broodstock

• Acclimated to recirculating system
• Treated for disease and parasites
• Feed-trained to formulated feeds
  • 50:50 dry trout feed to raw gizzard shad
  • Two-week weaning period
  • Transitioned to 100% dry feed
Habituating Broodstock

• Ultimately, white bass were fed dry feed for several months and became sexually mature in captivity.

Gravid white bass female
Controlled Spawning

• SIUC Goal:
  • To develop spawning protocol for prescribed times of the year using photothermal manipulations
Controlled Spawning

• Earlier spawns result from compressing the photothermal regime

• Photothermal manipulation
  • Light control
  • Temperature control
Controlled Spawning

- Hormone Research
- University of Wisconsin-Madison
  - Blood analysis
  - Sex steroids qualified
Human Chorionic Gonadotropin (hCG)

- Chorulon® FDA approved
- Research at SIUC
  - Target Animal Safety Study for FDA
    - Determined efficacious dosages
    - Conducted last pivotal study needed for approval
- Study expanded to other species
  - Chorulon® now labeled for all finfishes
## Ovulation Time and Hatching Results

<table>
<thead>
<tr>
<th>HCG Dosage (IU/Kg wet weight)</th>
<th>Mean Ovulation Time (hours)</th>
<th>Mean Percent Hatch</th>
</tr>
</thead>
<tbody>
<tr>
<td>1100</td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>830</td>
<td>31</td>
<td>36</td>
</tr>
<tr>
<td>280</td>
<td>28</td>
<td>58</td>
</tr>
<tr>
<td>250</td>
<td>39</td>
<td>44</td>
</tr>
<tr>
<td>150</td>
<td>38</td>
<td>47</td>
</tr>
<tr>
<td>50</td>
<td>37</td>
<td>55</td>
</tr>
<tr>
<td>25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Controlled Spawning

- White bass were injected with Chorulon® (hCG)
- Intermuscular (within the muscle) injection
- Above the lateral line of the female
Anesthesia

- Broodstock were anesthetized prior to manually stripping of gametes
- Finquel® recommended
  - Former trademark (MS-222)
  - 50-100 mg/L (ppm)
  - Buffer to pH 7 with sodium bicarbonate
Controlled Spawning

- Small sample of eggs were expressed to determine timing of egg maturation
  - Predict when fertilization should take place
Controlled Spawning

- Eggs examined microscopically
  - Mature eggs relatively clear, not bloodied
  - Single oil droplet and intact chorions
  - Successful fertilization
    - Two hour window within which fertilization must take place
Controlled Spawning

- Eggs squeezed into Teflon dish
Controlled Spawning

- Striped bass semen added to white bass eggs
- Produces Sunshine bass (reciprocal cross)
Controlled Spawning

• Extended semen being added to a white bass egg sample for fertilization/hatchability determinations
Controlled Spawning

- Fertilized *Morone* eggs being incubated in modified Heath trays
- Experimental conditions
Controlled Spawning

- Mass *Morone* eggs hatched in McDonald jars at commercial operations

*Keo Fish Farms, Inc.*
Controlled Spawning

- Swim-up fry allowed to freely enter larger tanks
- Producers control number of fry per tank by placing a set number of McDonald jars on tanks
Comparison of Hatching Rates Using Different Incubation Procedures

Percent Hatch (mean of six spawns)

- Heath Tray (no tannic acid)
- Heath Tray (tannic acid)
- McDonald Jar (tannic acid)
Controlled Spawning

- White bass were induced to spawn in all seasons of the year
  - One group of fish
    - Spawned in April following a spawn the previous October

### Controlled White Bass Spawning

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th># Spawning Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>March</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>May</td>
<td>11</td>
</tr>
<tr>
<td>1992</td>
<td>January</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>February</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>April</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>October</td>
<td>5</td>
</tr>
<tr>
<td>1993</td>
<td>March</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>April</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>October</td>
<td>2</td>
</tr>
<tr>
<td>1994</td>
<td>February</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>April</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>June</td>
<td>5</td>
</tr>
<tr>
<td>1995</td>
<td>April</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>May</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>June</td>
<td>2</td>
</tr>
</tbody>
</table>

*Previously spawned in October, 1992*
Develop *Morone* Semen Storage Techniques
Semen Storage Techniques

• Extender 13 proved to be the most efficacious treatment
**NaCl Extender Technique**

- Dissolve 17.5 g NaCl in 2.0 L distilled water and chill in refrigerator
- Collect semen with a chilled pipette
- Place semen in 40 mL tissue culture flask
- Add extender at 2:1 by volume and mix gently
- Cap tightly and refrigerate
NaCl Extender Technique

- Plastic 25 cc tissue culture flasks proved excellent for storing extended semen under refrigeration
  - Cap was open weekly to allow fresh air to circulate
Laval fish have been described as being “two eyes, a mouth and an anus.”
Larval Rearing Techniques

- *Morone* larvae are about the size of an eyelash!!
Larval Rearing Techniques

• With the successful development of out of season spawning of white bass, it became necessary to develop indoor larval rearing techniques.

• White bass remain difficult to rear as larvae, but hybrids have proved amenable.
<table>
<thead>
<tr>
<th>Species</th>
<th>Days</th>
<th>Feed</th>
<th>Size (day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Bass</td>
<td>4-21 (died when</td>
<td>small zooplankton</td>
<td>0.7 – 1.1 cm TL (21)</td>
</tr>
<tr>
<td></td>
<td>moved)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reciprocal Cross</td>
<td>4 – 11</td>
<td>small zooplankton</td>
<td>1.2 – 1.7 cm TL (30)</td>
</tr>
<tr>
<td></td>
<td>12 – 18</td>
<td>brine shrimp nauplii</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19 – 24</td>
<td>decapsulated brine shrimp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25 -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original Cross</td>
<td>4 – 10</td>
<td>brine shrimp nauplii</td>
<td>1.5 -2.0 cm TL (30)</td>
</tr>
<tr>
<td></td>
<td>11 – 16</td>
<td>decapsulated brine shrimp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17 – 30</td>
<td>prepared feed</td>
<td></td>
</tr>
</tbody>
</table>
White Bass Strain Evaluation

- Different geographical strains were evaluated to determine if “source” of white bass measurably affects performance of the hybrid (Sunshine Bass)
Broodstock Acquisition

- White Bass
  - Arkansas River, AR (AR)
  - Lake Poinsette, SD (SD)
  - Lake Erie, OH (LE) near Cleveland

- Extended Striped Bass Semen
  - Keo Fish Farm – Keo, AR
Pure white bass were spawn among all three strains and three crosses were performed using the same source of extended striped bass semen (a composite of 10 males collected from the Arkansas River).
Hatching Success

- Hatching success highest among pure white bass
- Lower hatch rate of hybrids result of lower sperm quality of striped bass
- Extended semen used as opposed to fresh semen used in pure white bass production

<table>
<thead>
<tr>
<th>Strain</th>
<th>Hatch%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD White Bass</td>
<td>30.5</td>
</tr>
<tr>
<td>LE White Bass</td>
<td>18.1</td>
</tr>
<tr>
<td>SD HSB</td>
<td>11.9</td>
</tr>
<tr>
<td>AR White Bass</td>
<td>11.0</td>
</tr>
<tr>
<td>AR HSB</td>
<td>4.3</td>
</tr>
<tr>
<td>LE HSB</td>
<td>2.4</td>
</tr>
</tbody>
</table>
Stain Evaluation

• Four-day old white bass and hybrid striped bass larvae were stocked at the SIUC Touch of Nature Aquaculture Pond Facility
Research Ponds

Average Surface Area

0.04 ha

Stocking Rates (#/ha)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I</td>
<td>500,000</td>
</tr>
<tr>
<td>Phase II</td>
<td>25,000</td>
</tr>
<tr>
<td>Phase III</td>
<td>4,940</td>
</tr>
</tbody>
</table>
Phase I

• Filled 5-10 days prior to stocking

SDWB   LEWB   SDHSB
ARWB   ARHSB   LEHSB

• Fertilization and liming
  • Initial
    • Ag lime at 680 kg/ha
    • Cottonseed meal at 350 kg/ha
  • 3 times weekly after stocking
    • Cottonseed meal at 75 kg/ha
    • Inorganic fertilizer (8:32:16) at 25 kg/ha

Each in quadruplicate
Phase I (cont’d)

- In-pond feed training
  - Initiated at day 21
  - Fry starter meal (48% protein) offered twice daily
- Harvest at 36-41 days
- Transported to wet lab
- Graded and enumerated for Phase II
Strain Evaluation

- Hybrid striped bass harvested at the end of Phase I
Phase I Results
(32 to 37 days post-stock)

<table>
<thead>
<tr>
<th>Stock</th>
<th>Average Weight (g)</th>
<th>Survival Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARKWB</td>
<td>1.95</td>
<td>2.2</td>
</tr>
<tr>
<td>LEWB</td>
<td>2.12</td>
<td>3.4</td>
</tr>
<tr>
<td>SDWB</td>
<td>2.36</td>
<td>2.3</td>
</tr>
<tr>
<td>ARKHSB</td>
<td>1.09</td>
<td>14.0</td>
</tr>
<tr>
<td><strong>LEHSB</strong></td>
<td><strong>2.77</strong></td>
<td>9.2</td>
</tr>
<tr>
<td>SDHSB</td>
<td>0.84</td>
<td>14.4</td>
</tr>
</tbody>
</table>

- LEHSB average weights significantly greater than ARKHSB and SDHSB average weights ($\alpha=.05$)
- Hybrid Striped Bass survival rates significantly greater than White Bass survival rates ($\alpha=.05$)
Phase II

- ARHSB and SDHSB stocked in triplicate, LEHHSB stocked in duplicate
  - White bass strains not evaluated
  - One triploid grass carp (*Ctenopharyngodon idella*) per pond for vegetation control
- Feeding regime (twice daily)

<table>
<thead>
<tr>
<th></th>
<th>sinking crumble</th>
<th>1.5 mm floating pellet</th>
<th>3.5 mm floating pellet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>45 %</td>
<td>40 %</td>
<td>40 %</td>
</tr>
</tbody>
</table>
Phase II Results

No significant differences detected for Percent Survival or Feed Conversion Efficiency
Phase III

- ARHSB, SDHSB, LEHSB stocked in quintuplicate
  - One triploid grass carp per pond
  - Held over winter
- Feeding regime (twice daily)
  - 5.5→7.5 mm floating pellet (all 40% protein)
  - Fed ad libitum, but not in excess of 56 kg/ha
- DO and temperature measured every morning
  - Emergency aeration provided as needed
- Harvested the following fall
Strain Evaluation

- Hybrid striped bass from all three strains evaluated reached marketable size in the second growing season (Phase III)
Strain Evaluation

• Samples of fish were analyzed for dress-out, gonadosomatic index (GSI), liversomatic index (LSI) and visceral fat
# Phase III Results

<table>
<thead>
<tr>
<th></th>
<th>LEHSB</th>
<th>SDHSB</th>
<th>ARHSB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Weight (kg)</td>
<td>0.65</td>
<td>0.57</td>
<td>0.64</td>
</tr>
<tr>
<td>Mean Length (mm)</td>
<td>345</td>
<td>329</td>
<td>338</td>
</tr>
<tr>
<td>Survival (%)</td>
<td>84.8</td>
<td>93.7</td>
<td>92.8</td>
</tr>
<tr>
<td>Production (kg/ha)</td>
<td>285.3</td>
<td>262.8</td>
<td>280.1</td>
</tr>
<tr>
<td>Feed Conversion</td>
<td>1.71</td>
<td>1.67</td>
<td>1.49</td>
</tr>
<tr>
<td>VSI</td>
<td>8.7</td>
<td>9.1</td>
<td>9.3</td>
</tr>
<tr>
<td>LSI</td>
<td>4.4</td>
<td>4.0</td>
<td>4.1</td>
</tr>
<tr>
<td>Percent Female</td>
<td>49.2</td>
<td>50.0</td>
<td>49.6</td>
</tr>
</tbody>
</table>

No significant differences within parameters
Phase III
Percent Dressout

No differences in performance detected between $\sigma$ and $\varphi$ among strains
Strain Evaluation

- Based on growth and dressout rates…
  - Lake Erie white bass proved under conditions in southern Illinois to be a promising strain for the hybrid striped bass industry
Current Research Areas at SIUC

- Nutrition
- Reproduction
- Physiology
- Immunology
Acknowledgments

- Southern Illinois University Carbondale
  - Fisheries & Illinois Aquaculture Center
  - Ryan L. Lane, PhD
- University of Wisconsin-Madison
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