Management of Fish Food Resources in Off-channel Native Fish Habitats
PURPOSE

• Maximize quality and quantity of natural resource base for grow-out-stage razorback sucker in L. Mohave backwaters.

• Quantify dynamics in food resource availability using three experimental fertilization regimes in L. Mohave backwaters.

• Determine if mechanical fertilization of backwaters is a viable method of increasing productivity in the future.
METHODS / Study Sites

- Five ephemeral ponds in the North Nine Mile area (L. Mohave, NV).

- Monthly sampling (2011-2013)
  - Zooplankton
  - Phytoplankton (2011 data omitted)
  - Water Quality

- Quarterly zooplankton data (2009-10) not comparable to monthly data.

- Surface area range (0.18 – 0.4 ha).

- CONTROL ~ one quarter size of other backwaters.

- WILLOW only backwater stocked with RASU all three years of study.
METHODS / Fertilization

Table 2. Experimental fertilization regimes for selected Lake Mohave backwater grow-out ponds on 3 March 2011, 14 February 2012, and 21 February 2013.

<table>
<thead>
<tr>
<th>Backwater</th>
<th>[NH₄]₂PO₄ (kg)</th>
<th>Alfalfa (kg)</th>
<th>Rice Bran (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Nine Mile</td>
<td>19.8</td>
<td>0</td>
<td>36.5</td>
</tr>
<tr>
<td>2012</td>
<td>39.6</td>
<td>0</td>
<td>73.0</td>
</tr>
<tr>
<td>2013</td>
<td>59.1</td>
<td>0</td>
<td>109.5</td>
</tr>
<tr>
<td>Willow</td>
<td>22.7</td>
<td>45.4</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>45.4</td>
<td>90.7</td>
<td>0</td>
</tr>
<tr>
<td>2013</td>
<td>67.8</td>
<td>135.9</td>
<td>0</td>
</tr>
<tr>
<td>Nevada Egg</td>
<td>10.9</td>
<td>22.7</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>21.8</td>
<td>45.4</td>
<td>0</td>
</tr>
<tr>
<td>2013</td>
<td>32.4</td>
<td>67.8</td>
<td>0</td>
</tr>
<tr>
<td>Nevada Larvae</td>
<td>13.2</td>
<td>0</td>
<td>27.4</td>
</tr>
<tr>
<td>2012</td>
<td>26.3</td>
<td>0</td>
<td>54.9</td>
</tr>
<tr>
<td>2013</td>
<td>39.6</td>
<td>0</td>
<td>82.2</td>
</tr>
</tbody>
</table>

- Either rice bran or alfalfa used for organic applications.
- Preliminary water quality recorded January (2011-2013) prior to treatments.
- Fertilizer regimes increased threefold from beginning of study.
- Treatment quantities based on similar investigations to increase desired 1°productivity in experimental ponds of similar size (Barkoh et al. 2005; Ludwig and Tackett 1991; Barkoh and Rabeni 1990).
Methods / Analysis

• Focus on Cladocera / Copepoda Biomass
  • Also Total Phytoplankton Biovolume
• Repeated measures ANOVA, Log-transformed data, $\alpha = 0.1$
• Potential support for Fertilization Response
  • Interaction between Backwater and Year (None detected, $p > 0.4$).
  • Backwaters (Averaged over years): Fertilized BW > Control
  • Years (Averaged over BW): Increase over time
• Correlations: plankton abundance and WQ (Spearman’s rank)
RESULTS

Log10 Cladocera Biomass, 2011-2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Biomass (µg/L)</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>CONTROL</td>
<td>N9MILE (RB, No Fish)</td>
</tr>
<tr>
<td>2012</td>
<td>Years (p = 0.09)</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>BW (p = 0.18)</td>
<td></td>
</tr>
</tbody>
</table>

Fertilizer applications

Balancing Resource Needs
RESULTS

Log10 Copepoda Biomass, 2011-2013

<table>
<thead>
<tr>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>N9MILE</td>
<td>NVEGG</td>
</tr>
</tbody>
</table>

BW (p < 0.0001)
Willow ~ 2-8x > others

Year (p = 0.12)

Balancing Resource Needs
RESULTS

Log10 Total Phytoplankton Biovolume, 2012-2013

BW (p = 0.007)
N9Mile > Control, NVLarvae, Willow
NVEgg > NVLarvae, Willow
Year (p = 0.21)
RESULTS

% Cyanobacteria, 2012-2013

2012

2013

% Total Biovolume

Mean Water Temperature, 2011-2013

Mean Dissolved Oxygen, 2011-2013

Balancing Resource Needs
DISCUSSION

• Cause & effect?

• Statistical differences often due to one or two monthly peaks, some before fertilization.

• High variability among BW and over time, no replicates within BW: Low statistical power.

• No increase in Copepod abundance at WILLOW despite increased levels of fertilization.

• Water temperature and DO inversely related and most strongly related to plankton. Consistent at all BW except WILLOW.

• Plankton/fertilizer studies often use repeated applications each year and weekly samples for plankton and water quality over relatively short time period (Barkoh et al. 2005; Buynak et al. 2001).

• Measure Chorophyll a for phytoplankton response.
CONCLUSIONS & FUTURE RECOMMENDATIONS

• Natural food resource availability in L. Mohave backwaters unpredictable and highly variable.

• More comprehensive sampling and treatment schedules needed but not practical to develop more robust results.
  – Repeated sampling within backwaters or focus on a single backwater w/ control
  – Clear research / management objectives required to justify expense

• Adaptive management model for RASU stocking densities may maximize resource availability during grow-out phase.

• Mechanical aeration could be expanded based on harsh summer conditions:
  – Depletion of dissolved oxygen w/ increased temperatures
  – Algal mat biomass continues to be problematic at some backwaters
REFERENCES


