Offshore Fish Community
Ecological Interactions
Lake Superior – State of the Lake 2005

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### Offshore Community

<table>
<thead>
<tr>
<th>Predators</th>
<th>Siscowet</th>
<th>Burbot</th>
<th>Sea Lamprey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prey Fishes:</td>
<td>Deepwater Sculpin</td>
<td>Kiyi</td>
<td>Cisco (i.e., lake herring)</td>
</tr>
<tr>
<td>Invertebrates:</td>
<td>Mysis relicta</td>
<td>Diporeia</td>
<td>Zooplankton</td>
</tr>
</tbody>
</table>
Offshore Ecological Interactions

Structure and Function

How do the pieces fit together?

How does the structure affect interactions?

• Energy and nutrient flow
• Feedback to the structure
Ecology and Fish Community Objectives


- Modeled potential management actions in food web context
- Feedbacks created outcomes more complex than simple linear dynamics
- Heuristic tool – suggests constraints to fish community objectives given current structure
- Spatial context to recognize heterogeneity
Available Information Since 2000

• Phase II Acoustic Study - Lakewide
• June Siscowet Surveys
• Updated Predator Consumption Study
• Lower Trophic Level Survey
• Diel Vertical Migration Studies
• Integrated Sampling Strategies
• Stable Isotopes
Conceptual Offshore Food Web

Day

Pelagic

Cisco

Zooplankton

Night

Benthic
Conceptual Offshore Food Web

Day

Cisco
Zooplankton

Night

Pelagic

Siscowet

Benthic

Kiyi
Mysis
Diporeia

Burbot

DW Sculpin
Day Benthic Food Web

Diets of fish species documented, but mostly for shallower waters.

* but weak negative correlation with deepwater sculpin

Siscowet has strong positive correlation with kiyi...

Impact of sea lamprey on siscowet?

Siscowet Density (fish/ha)

Kiyi Density (fish/ha)

R² = 0.6338
Conceptual Offshore Food Web

Day

Night

Pelagic

Cisco

Zooplankton

Benthic

Siscowet

Burbot

Kiyi

Mysis

Diporeia

DW Sculpin
Diel Vertical Migration

Paired t-test
P = 0.0008
Conceptual Offshore Food Web

Day

Pelagic

Cisco
Zooplankton

Siscowet

Benthic

Kiyi
Mysis
Diporeia

Night

Cisco
Zooplankton

Diaporeia
DW Sculpin
Burbot
Mysis
Siscowet
Cisco
Zooplankton
Night Pelagic Food Web

Night MTR Catch
9 Cisco (342 mm)
23 Kiyi (155 mm)
Conceptual Offshore Food Web

**Day**
- Cisco
- Zooplankton

**Night**
- Siscowet
- Kiyi
- Mysis
- Zooplankton

**Pelagic**
- Cisco
- Zooplankton

**Benthic**
- Siscowet
- Burbot
- DW Sculpin
- Mysis
- Diporeia
- Kiyi
Offshore Pelagic-Nearshore Benthic Coupling
Nearshore-Offshore Benthic Coupling

From Structure to Function to Structure

Lake Whitefish

Energy/Nutrient Flow and Cycling

Where are net losses and gains?

Daily/seasonal/annual scales?

Predator-mediated interactions?

Fish Community

Objectives?

Jul-Aug 2006
11.8 MIL

Large Cisco (no/ha)

- 0 - 10
- 11 - 50
- 51 - 100
- 101 - 500
- 501 - 913

Kilometers

Length (mm)

Delta C

-30 -26 -22
-18 -14 -10

Depth (m)

Delta N

300

0 25 50 75 100 125 150 175

Day Night

0 2 4 6 8

Jan-Feb 2006
10.7 MIL

Nov 2006
63.7 MIL
Ecology and Fish Community Objectives

Extend work of Kitchell et al. (2000)

• Impact of targeted siscowet fishery on offshore and nearshore communities?
• Impact of invaders on energy/nutrient flow?
• Importance of cisco recruitment variability to large-scale energy movement?
• Influence of size-based interactions to energy and nutrient flow within/across habitats?
• Re-evaluate constraints and opportunities for ecosystem management