Effects of Hydrology on Growth and Survival of Juvenile *Procambarus alleni* and *Procambarus fallax* from South Florida

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GEER CONFERENCE
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Crayfish from the Everglades

*Procambarus fallax*
(Slough crayfish)

*Procambarus alleni*
(Everglades crayfish)
Morphology

Slough

Everglades

gonopods

ventricular annulus

eggs
Importance of Crayfish

- Keystone species in most ecosystems
- Critical ecological role at all trophic levels:
  - Herbivores, Detritivores, Omnivores
  - Predators/Prey
  - Burrows (refugia during dry season)
- Alter community structure
- Indicators for hydrology and pollution
- Mostly neglected in SE US unless used in aquaculture
Conceptual Model

**Crayfish Trophic Role:**
- Aquatic Tertiary consumers/higher predators (see Figure 1, Tables 2)
- Secondary consumers/omnivores (see Figure 1, Table 2)
- Primary consumers/herbivores

*Note: Crayfish can function as top aquatic predators under certain hydrologic conditions (see text).*
Hydrology

- Depth
- Quality
- Hydroperiod (length of inundation)
- Timing
- Delivery
- Seasonal (managed areas, flooding, drying events)
Importance of Hydrology

1) survival and reproductive strategies (mating, release of hatchlings, burrows)
2) availability of crayfish, affect trophic roles, food webs, substrate (vegetation, soil)
3) choices of habitat may be determined seasonally
4) a) Everglades crayfish: short hydroperiods; shallow, ephemeral bodies of water
   b) slough crayfish: long hydroperiods; deeper, more permanent waters

(Hendrix, 2000; Hendrix and Loftus, 2000; Dorn and Trexler, 2007)
Research Question

Does hydrology affect growth and survival of juvenile *Procambarus alleni* (Everglades crayfish) and *P. fallax* (slough crayfish)?
Collecting Areas and Historic Everglades Flow Patterns

Jonathan Dickinson

Corbett Area

Grassy Waters

West Palm Beach

WCA-1

Boca Raton
Dupuis Management Area

30-60cm

slough crayfish only
Dupuis Management Area

about 12-15cm deep

Everglades crayfish only
Grassy Waters marsh

47 to 80cm
slough crayfish only
Collecting Sites
J. W. Corbett Wildlife Management Area

Everglades and slough crayfish (syntopic)
40cm

slough crayfish only
<15cm
Materials and Methods
(first study of this type)

1) Laboratory studies
2) Berried females collected from natural areas or adults mated in lab
3) Hatchlings same age from birth to 12 weeks (both species)
Water Levels

**Natural areas**

**Everglades slough**

- Corbett Area: 40 cm (syntopic) 15 cm
- DuPuis: 12-15 cm 30 cm
- Grassy Waters: 47-80 cm

**Experimental levels**

- Low: 12.7 cm
- High: 25.4 cm
- Drying began at 25.4 cm decreased 3.6 cm bi-weekly
Procedural Design
Summer 2002

1) 12 weeks
2) 120 tanks
3) 16.5 liters
4) replicates
5) 1320 juvenile crayfish

- Biweekly-measure, weigh, clean tanks
- data analysis –ANOVA, PCA
Set up Ecology-Survival and Growth

- High water, high food
- Drying conditions
Young Crayfish

2 weeks old, about 1.3 cm

MTL

2 or 3 days old, 0.5 - 0.6 cm
Results
Survival and Growth
<table>
<thead>
<tr>
<th>water level</th>
<th>survival</th>
<th>time weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, Low</td>
<td>highest</td>
<td>0-6</td>
</tr>
<tr>
<td>Drying</td>
<td>lowest</td>
<td>0-5</td>
</tr>
<tr>
<td>Drying</td>
<td>highest</td>
<td>6-12</td>
</tr>
<tr>
<td>Low</td>
<td>lowest</td>
<td>6-12</td>
</tr>
</tbody>
</table>

**slough**

<table>
<thead>
<tr>
<th>water level</th>
<th>survival</th>
<th>time weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>highest</td>
<td>0-2</td>
</tr>
<tr>
<td>Drying</td>
<td>lowest</td>
<td>0-7</td>
</tr>
<tr>
<td>High</td>
<td>highest</td>
<td>4-7</td>
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<tr>
<td>Drying</td>
<td>highest</td>
<td>7-12</td>
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<tr>
<td>Low</td>
<td>lowest</td>
<td>6-12</td>
</tr>
<tr>
<td></td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>----------------</td>
<td>-----</td>
<td>------</td>
</tr>
<tr>
<td>Everglades</td>
<td>52</td>
<td>55</td>
</tr>
<tr>
<td>slough</td>
<td>54</td>
<td>57</td>
</tr>
</tbody>
</table>

*Underlined values are significant.*
Growth
(mean total length-MTL CM)

Total Length P. alleni weeks*water

P. fallax MTL 1.90 cm
12 weeks

P. alleni MTL 2.39 cm
12 weeks
## Summary of effect of water levels on growth (MTL cm)

<table>
<thead>
<tr>
<th>Water level</th>
<th>Growth</th>
<th>Time (weeks)</th>
</tr>
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<tbody>
<tr>
<td>drying</td>
<td>highest</td>
<td>2-10</td>
</tr>
<tr>
<td>low</td>
<td>lowest</td>
<td>2-10</td>
</tr>
<tr>
<td>low</td>
<td>highest</td>
<td>11-12</td>
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<tr>
<td>drying</td>
<td>lowest</td>
<td>11-12</td>
</tr>
<tr>
<td>slough</td>
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</tr>
<tr>
<td>drying</td>
<td>highest</td>
<td>2-8</td>
</tr>
<tr>
<td>drying, high, low</td>
<td>same</td>
<td>10-12</td>
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### Growth (MTL cm) at 12 weeks

<table>
<thead>
<tr>
<th></th>
<th>low</th>
<th>high</th>
<th>drying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Everglades</td>
<td>2.4</td>
<td>2.4</td>
<td>2.3</td>
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<tr>
<td>slough</td>
<td>1.9</td>
<td>1.9</td>
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- Underlined values are significant
<table>
<thead>
<tr>
<th></th>
<th>p</th>
<th>F</th>
<th>Df</th>
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<tbody>
<tr>
<td>Pa survival</td>
<td>0.0149</td>
<td>2.118</td>
<td>12</td>
</tr>
<tr>
<td>growth</td>
<td>0.0001</td>
<td>3.761</td>
<td>12</td>
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<tr>
<td>Pf survival</td>
<td>0.0001</td>
<td>3.458</td>
<td>12</td>
</tr>
<tr>
<td>growth</td>
<td>not significant</td>
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Discussion
Survival at 12 weeks

1) Water levels had a significant effect on survival of Everglades and slough crayfish

2) Slough crayfish had significantly higher survival in drying conditions than Everglades crayfish (67 versus 56 %) (larger gills?)

3) Drying conditions (fluctuating water levels)
   oxygenate water, Everglades crayfish here first? Canals as transport systems?

4) Quality of water may have more impacts on new Everglades hatchlings (anoxic water in burrows)
Discussion

Growth at 12 weeks

1) Water levels had a significant effect on growth of Everglades, but not slough crayfish

2) Everglades crayfish grew significantly larger than slough crayfish (2.39 versus 1.90 MTL cm)
   a) adults PA grow larger in short hydroperiod wetlands than in deep water sloughs

3) Size also impacted by shortened hydroperiods

4) Slough crayfish developed more first and second gonopods by 12 weeks, matured earlier than Everglades crayfish
Conclusions

1) Little data available on effects of hydrology (quality, quantity) on life cycle stages

2) Seasonal hydrology may affect distribution and abundance of each species differently
   a) peak hatching for Everglades crayfish is March-May in burrows, minor peak in Oct/Nov (lack of water may disturb survival/growth of hatchlings)
   b) slough crayfish may reproduce all year, with peaks at those same times

3) Hydrology affects growth, smaller crayfish may molt early to adults
Conclusions

3) Crayfish may shift sensitivity to hydrology during early growth, most stressful time of their lives

4) Hydrology may be driving genetic adaptation

5) Everglades juvenile population more size structured, known to grow larger and have more aggression as adults

6) Larger crayfish probably better able to survive impacts from adverse environmental conditions

7) Each species has an advantage as hydrology changes
Future Research

- Life history studies (seasonally)
- Food sources (isotopes) (Everglades food webs)
- Hydrology (quantity, quality, timing, duration)
- Burrow ecology
- Genetics
- Distribution/Abundance
- Integration of field and lab data
THANK YOU!!

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Measuring and Weighing