Nonnative predation on razorback sucker larvae in Lake Mohave

CHASE EHLO, MELODY SALTZGIVER, THOMAS DOWLING AND PAUL MARSH

MARSH & ASSOCIATES, LLC

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Larval Predation

- Razorback sucker is federally endangered throughout its range

- Larval predation by nonnative fish can exacerbate declines

- Few observations of razorback larvae predation
  - Marsh and Langhorst (1988) positively identified larvae in the gut of green sunfish

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Limitations to identification

- Prey items in stomachs (Marsh and Langhorst 1988)
  - Can become visually unrecognizable
  - Particularly after digestion has proceeded for periods of more than a few hours

- Detecting razorback sucker larval remains (Schooley et al. 2008)
  - Positive identification of razorback sucker larvae as only 50% 30 min post-consumption
  - Only 3% at 60 min post-consumption

[Images of Green Sunfish at 15 min and 60 min post-consumption, with measurements]
Identification of larval DNA

- Advances in molecular techniques have enabled the identification of DNA of prey in stomachs

- Ley et al. (2014)
  - Utilized quantitative PCR (qPCR) to identify razorback DNA in stomachs of green sunfish and western mosquitofish
  - Able to identify razorback sucker DNA in 87.5% of stomachs 2 h post-feeding
  - 75% of stomachs 12 h post-feeding

- Visual identification of larvae in the stomach can significantly underestimate the extent of predation
Study area and objectives

• Lake Mohave
  - Population once numbered over 100 thousand fish
  - Population now numbers ~3200 fish

• Tequila Cove
  - Spawning is prevalent
  - Larvae are found in abundance
  - Non-native fish are found in abundance

• Evaluate the extent of larval predation by non-native fish
  - Collect potential non-native fish predators in Tequila Cove and extract stomach contents
  - Use advanced molecular techniques to identify razorback sucker DNA in stomach contents.
Methods (field collections)

- Sampling was conducted on 2 April 2014

- Three types of gear: minnow traps (12), hoop nets (6), and boat electrofishing.

- Nets were set in the early evening and retrieved ~4 hours later

- ~1200 sec of electofishing

- All nonnative fish were euthanized (MS222) and preserved (70% isopropyl)
Methods (dissections)

- Fish were transferred to 95% ethanol in the lab
- Identified to species and measured for total length
- Stomach contents were then dissected and stored in vials with 95% ethanol
- Vial was labeled with a unique numeric code
Methods (genetic techniques)

• Standard phenol-chloroform extraction

• Every sample and control ran in triplicate

• Standard control (pure razorback DNA) serially diluted over orders of magnitude (100, 10, 1, 0.1, 0.01 ng/µl)

• All gut samples ran at 100 ng/µl

• 40 cycles of 95 C° for 5 sec, 60 C° for 1 min

• MxPro QPCR System
Results

- Collected 4 species and 103 fish
  - Largemouth bass (2)
    - Mean length of 91 mm (76-106 mm)
  - Smallmouth bass (1)
    - 165 mm
  - Green sunfish (43)
    - 72 mm (41-174 mm)
  - Bluegill sunfish (56)
    - 58 mm (34-305 mm)
Results

- 11 samples tested positive for razorback sucker DNA
  - 6 green sunfish, 4 bluegill, 1 smallmouth bass
  - 35 mm – 174 mm
  - 7 electrofishing, 4 nets

- 87 samples had no razorback sucker DNA
  - 9 samples were borderline
  - 5 green sunfish and 4 bluegill (41 mm – 80 mm)

- 4 samples could not be run
Size classes

- Total
- DNA detected

- Size classes: 31-50, 51-70, 71-90, 91-110, 111-130, >130
Implications?

- This is an obvious bump (or mountain?) in the road for razorback sucker recovery
- Are there any larvae surviving past the swim up stage?
  - Papoulias and Minckley (1990) found that larvae disappear at an average size of 10.6 mm
- Is it species specific?
- Are nonnative predators the only threat to larvae?
- At what extent is larvae predation occurring?
Is it species specific?

- 23% of green sunfish had razorback DNA in the gut
- Only 14% of bluegill sunfish had razorback DNA in the gut
- Werner and Hall (1977) found that bluegill shifts to feeding on smaller prey in the presence of green sunfish

Something to note

- The only smallmouth bass captured and analyzed had razorback DNA in its gut
- Could that bass have eaten a sunfish that had razorback larvae in its gut?
Is predation the prime suspect?

- Hypolimnethic withdrawals from Lake Mead
  - Cooler water temperature decreases both hatching success and growth rate of larval razorback sucker (Marsh 1985; Bestgen 2008)
  - Other papers of note on the subject (Bozek et al. 1990; Clarkson and Childs 2000)

- Food-limited mortality?
  - Papoulias and Minckley (1990) suggested that food limited mortality could contribute to the absence of larvae

- Lethal or Sub-lethal effects?
Whats next?

• Take another sample
  ○ Closer to peak spawning for razorback sucker
  ○ Preserve in ethanol rather than isopropyl

• At what extent is larval predation occurring?
  ○ Estimate the number of larvae in Tequila
  ○ Estimate the number of non-native predators in Tequila
  ○ Feeding rate of sunfish – Literature?

• In-situ experiment on food-limited mortality and thermal tolerance of razorback sucker larvae.
Conclusion

- The obvious thing to take away from this is that larvae are being preyed upon in Tequila Cove.

- This just reiterates what we’ve discovered time and time again.

- No chance at recruitment.
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