Do Silver Carp and Shad Species Share Resources in a Mesotrophic Reservoir?

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Background

• Invasive planktivorous fish species

• Introduced in 1971 for biofiltration and aquaculture (Cremer and Smitherman, 1980)

• Distributed throughout the Mississippi River Basin (Kolar et al. 2005)
Interactions in the Illinois River

- Reduced body condition of native planktivores (Irons et al. 2007)
  - Bigmouth Buffalo (*Ictiobus cyprinellus*)
  - Gizzard Shad (*Dorosoma cepedianum*)

- Gut content overlap with native planktivores (Sampson et al. 2009)
Silver Carp in Kentucky Lake

- Kentucky Lake is the largest reservoir east of Mississippi River.
- First reported in Kentucky Lake in 2004 (USGS 2015).
- What do we know about Silver Carp in Kentucky Lake?
  - Feed on plankton.
  - Successful reproduction.

[Dorosoma cepedianum](tpwd.texas.gov)
[Dorosoma petenense](www.arkansasstripers.com)
[Hypophthalmichthys molitrix](www.miseagrant.umich.edu)
Research Goals

1. Potential for competition between Silver Carp and shad species

2. Life stages affect the potential for competition
   • Juvenile vs Adult
   • Determined by age (<1 = juvenile)

3. Seasonal differences affect the potential for competition
   • Spring (March, April, May)
   • Summer (June, July, August)
Methods: Sampling

Gill Netting

Boat Electrofishing

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Virginia Department of Game and Inland Fisheries
Methods: Sample Processing

• Measured length, weight, and extracted aging structures and tissue samples from fish

• Tissue samples were dried at 50°C

• Tissue samples analyzed at Southern Illinois University-Carbondale

Photo Credit: Allison Lebeda
• Analyzed stable isotope samples for carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) ratios

• Plot core isotopic niche ellipses (40% of data) (Jackson et al. 2011)
  • Controls for small sample size ($\geq 10$)
  • Stable Isotope Bayesian Ellipses in R (SIBER)

• Isotopic niche is tightly correlated with trophic niche
  • Allows an estimate of shared resource use
Fish

Detritus

Phytoplankton

Zooplankton

Determine trophic position

Range of resource use (phytoplankton, detritus, etc.)
• Niche overlap does not equate to diet overlap
  • Indicate biologically important resources

• Adult Silver Carp and juvenile Threadfin Shad do not share resources
Spring

- Adult Silver Carp and adult Gizzard Shad share resources

- What about juvenile fish?
Spring

- Juvenile Silver Carp and juvenile Gizzard Shad share resources
- Adult Silver Carp and juvenile Gizzard Shad share resources
Summer

- No overlap between adult Silver Carp and juvenile Threadfin Shad
  - Trophic positions are similar
Summer

- No overlap between adult Silver Carp and juvenile Threadfin Shad
  - Trophic positions are similar

- Adult Silver Carp share resources with adult Gizzard Shad
Seasonal Shifts

• Centroid locations of each group in the spring

• Path direction indicates what is contributing to diet
Seasonal Shifts

- Adult Silver Carp and phytoplankton have similar path directions

- Phytoplankton = primary diet item
Seasonal Shifts

- Adult Gizzard Shad and zooplankton have similar path directions
- Zooplankton = primary diet item
Seasonal Shifts

- Juvenile Threadfin Shad do not follow path directions of end members

- Juvenile Threadfin Shad switch feeding mechanisms
Seasonal Shifts

- Groups become more enriched in nitrogen ($\delta^{15}\text{N}$) during the summer

- One exception, juvenile Threadfin Shad
Conclusions

Question 1 (Potential for competition)
• Yes, adults and juveniles share resources

Question 2 (Life stage affect the potential for competition)
• Yes, juvenile fish much more likely to compete

Question 3 (Seasonal differences affect isotopic niche overlap)
• Yes (Significant?)
• Slightly greater chance of shared resource use in the Spring
Management Implications

• Shad are primary consumers
  • Success of fishery depends on shad

• Provided information on feeding phenology

• Target juvenile Silver Carp to reduce competition

Photo Credit: Allison Lebeda
What don’t we know?

• Silver Carp population size?
  • Exponential population growth phase

• Resource availability?
  • More productive in the spring
  • Less productive in the summer

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Questions?