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Isotopic Niche Analysis of Silver Carp and Gizzard Shad

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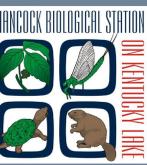
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Investigating Isotopic Niche Overlap Between Silver Carp and Gizzard Shad in Kentucky Lake

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Introduction

- Silver Carp (*Hypophthalmichthys molitrix*) have invaded much of the Mississippi River Basin
- In 2004 the first Silver Carp was reported in Kentucky Lake
- Studies by Sampson et al. (2009) and Irons et al. (2007) have suggested competition between Silver Carp and Gizzard Shad (*Dorosoma cepedianum*)
- Objectives:
 - 1.) Determine if the potential for competition exists between Silver Carp and Gizzard Shad in a large mesotrophic reservoir
 - 2.) Investigate temporal and ontogenetic shifts in isotopic niche area and overlap between Silver Carp and Gizzard Shad

Methods

- Silver Carp and Gizzard Shad samples were collected via cast netting, gill netting, and boat electrofishing
- Isotopic ratios from fish tissues ($\delta^{15}\text{N}$ and $\delta^{13}\text{C}$) were obtained using a Costech Elemental Combustion System 4010 along with a Thermo Delta V Plus Isotope Ratio Mass Spectrometer
- Isotopic niche area and isotopic niche overlap were calculated using the packages SIBER and SIAR in R version 3.2.2 "Fire Safety"
- Isotopic niche overlap $\geq 60\%$ were considered significant

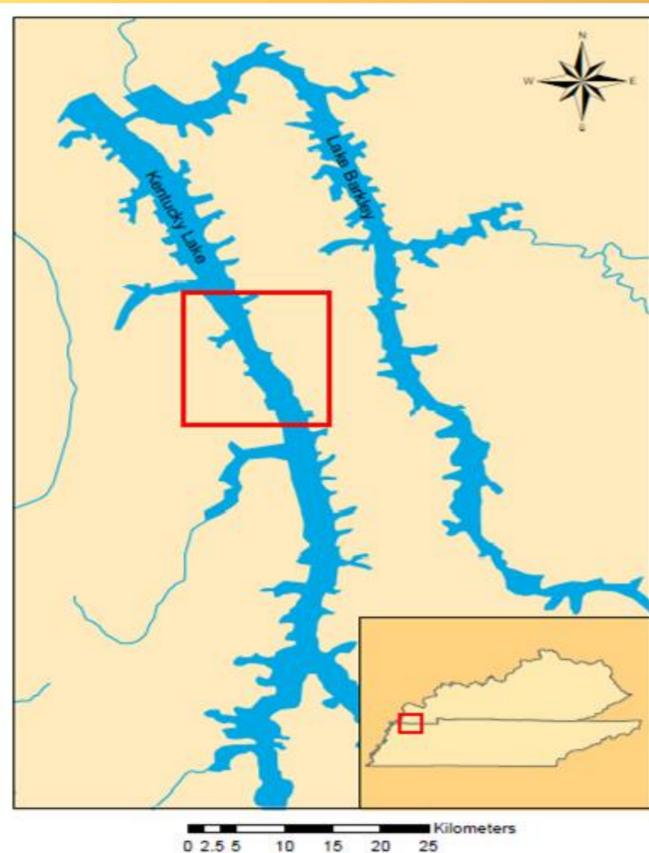


Figure 1: A map of Kentucky Lake and Lake Barkley. The study area is indicated by the red box.

Results

- Isotopic niche area varied monthly for both Silver Carp and Gizzard Shad, overlap was: 16% in May, 6% in June, and 29% in August (Figure 2)
- Silver Carp $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ signatures are generally more depleted than Gizzard Shad signatures (Figure 2)
- Ontogenetic shifts in Silver Carp resource use were observed (Figure 3)
- Adult Silver Carp $\delta^{15}\text{N}$ signatures were generally more enriched than young of the year (YOY) $\delta^{15}\text{N}$ signatures (Figure 3)

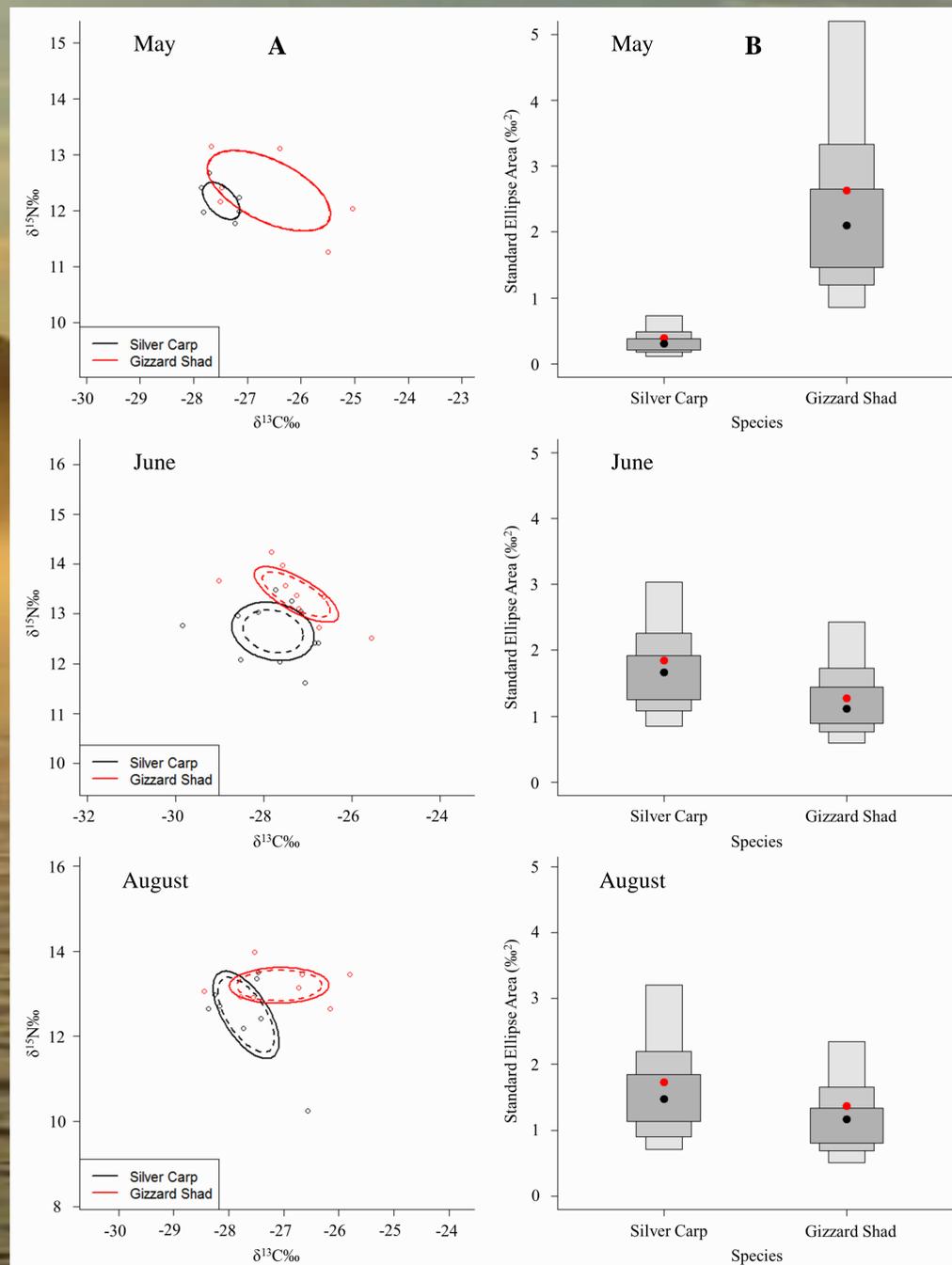


Figure 2: Column A consists of two dimensional isotopic niche plots with fitted standard ellipse area (SEA) ellipses containing approximately 40% of their respective data points (solid lines) and 95% confidence intervals around the bivariate means (dashed lines). Column B consists of highest density region box plots of the SEA of Silver Carp (group 1) and Gizzard Shad (group 2). The black and red dots represents the maximum likelihood estimates of the SEA and standard ellipse area controlling for small sample size (SEAc) respectively.

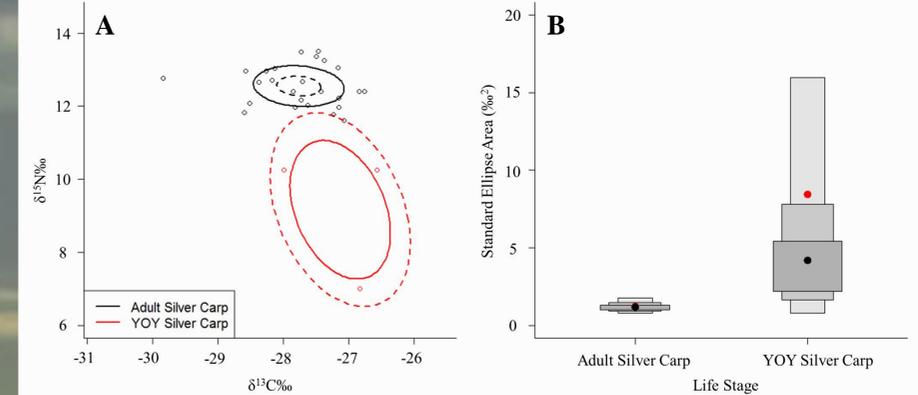


Figure 3: Panel A is a two dimensional isotopic niche plot with fitted SEA ellipses containing approximately 40% of their respective data points (solid lines) and 95% confidence intervals around the bivariate means (dashed lines). Panel B is a highest density region box plot of the SEA of adult Silver Carp and YOY Silver Carp. The black dots and red dots on panel B represents the maximum likelihood estimates of the SEA and maximum likelihood estimates of the SEAc, respectively.

Conclusions

- The potential for competition between Silver Carp and Gizzard Shad in Kentucky Lake appears to be low under current population levels
- Temporal shifts in isotopic niche area suggest that Silver Carp and Gizzard Shad resource use shifted throughout the study period
- Isotopic niche overlap was low throughout the study period which suggests that Silver Carp and Gizzard Shad use different resources
- Silver Carp likely consume a larger proportion of prey items at a lower trophic position than Gizzard Shad
- Young of the year Silver Carp may not be able to feed on zooplankton due to differences in gill raker pore size

Future Work

- Characterize isotopic niche shifts throughout the seasons
- Estimate Silver Carp and Threadfin Shad isotopic niche overlap
- Determine isotopic niche overlap between YOY: Silver Carp, Gizzard Shad and Threadfin Shad
- Determine if isotopic signatures and niche overlap estimates between Silver Carp, Gizzard Shad, and Threadfin Shad are similar in other systems

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Literature Cited

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