Resource partitioning among sympatric species across saltmarsh ponds of coastal Louisiana

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Introduction

- Estuaries are productive ecosystems that serve as feeding grounds for a large diversity of aquatic organisms.
- High densities of sympatric species coexist in coastal Louisiana saltmarshes even in habitats with low connectivity.
- Intra- and inter-specific interactions are key drivers of ecological (and evolutionary) dynamics, as they play an important role in coexistence and therefore community assembly.
- Here, we present stable isotope ratios of carbon ($\delta^{13}C$), sulfur ($\delta^{34}S$) and nitrogen ($\delta^{15}N$) of six sympatric fish species from sites near Port Sulphur, Louisiana, with a focus on calculating trophic niche indices to evaluate resource use overlap.
- We expected to see a high potential for resource use overlap based on expected diets, with community compositions of different sites influencing the variation in resource use.

Figure 1: Aerial maps of the study areas. LHA and LHB are restored sites; LHC, PS7, WPH1 and WPH2 are natural.

Methods

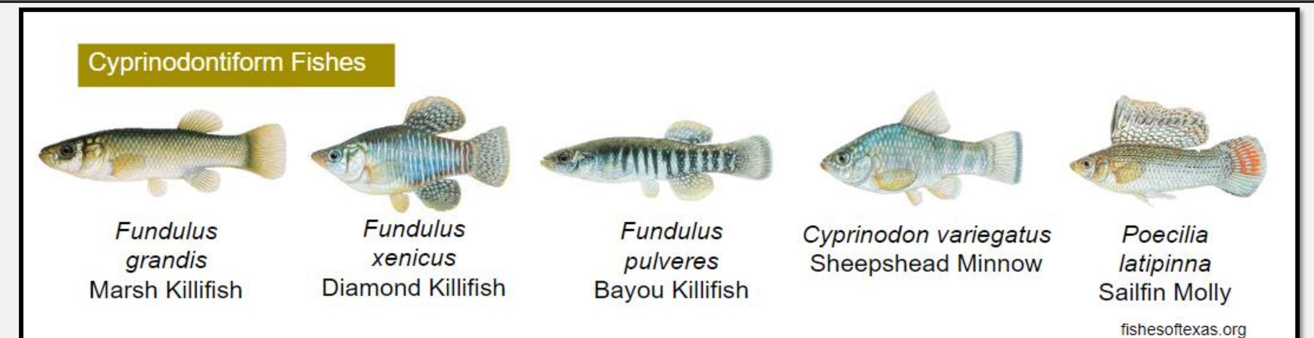
- Wire mesh traps (41 x 22 cm, with 3-mm mesh), baited with dog food were deployed for 60 minutes in three ponds at each of six sites in Port Sulphur area in May of 2019 (**Figure 1,2**).
- Fishes and invertebrates collected during each sampling event were identified and measured [standard length (SL) for fishes; carapace width (CW) for crabs] and weighed (g) (**Figure 3**).
- Muscle tissue samples were oven-dried, homogenized, and relative abundances of carbon ($^{13}C/^{12}C$), nitrogen ($^{15}N/^{14}N$) and sulfur ($^{34}S/^{32}S$) were determined on a Thermo-Fisher Delta V Advantage continuous-flow IRMS.
- Stable isotope data was analyzed using the tRophicPosition, nicheROVER and rgl packages in R Version 2022.07.1 to assess relative niche overlap and infer resource partitioning.

Figure 2: Saltmarsh landscape in Port Sulphur, Louisiana.

Figure 3: Diversity of species sampled.

Results

- *F. grandis* had the largest size range out of all species sampled.
- The range of $\delta^{34}S$ values was higher than that of $\delta^{15}N$ and $\delta^{13}C$ for each species.
- $\delta^{13}C$ values for *C. variegatus* and *P. latipinna* were more negative than the rest of the community. This corresponded with lower $\delta^{15}N$ for these species.



Species	n	Size range (TL, mm)	Mean δ13C	Mean δ15N	Mean δ34S
Fundulus xenicus	75	30-55	-18.81 ± 1.37	8.56 ± 1.07	6.60 ± 2.81
Cyprinodon variegatus	67	23-57	-18.49 ± 1.58	6.54 ± 1.34	4.81 ± 3.61
Fundulus grandis	138	31-125	-18.77 ± 0.95	8.28 ± 0.99	5.94 ± 3.50
Fundulus pulvereus	47	39-66	-19.14 ± 1.07	8.23 ± 1.18	5.58 ± 2.09
Gambusia affinis	28	24-49	-18.71 ± 1.72	8.61 ± 0.92	5.40 ± 2.17
Poecilia latipinna	38	28-55	-19.77 ± 1.90	5.81 ± 0.91	6.36 ± 4.77

Table 1: Mean stable isotope ratios of carbon ($\delta^{13}C$), sulfur ($\delta^{34}S$) and nitrogen ($\delta^{15}N$) for the six sympatric fish species used in this study.

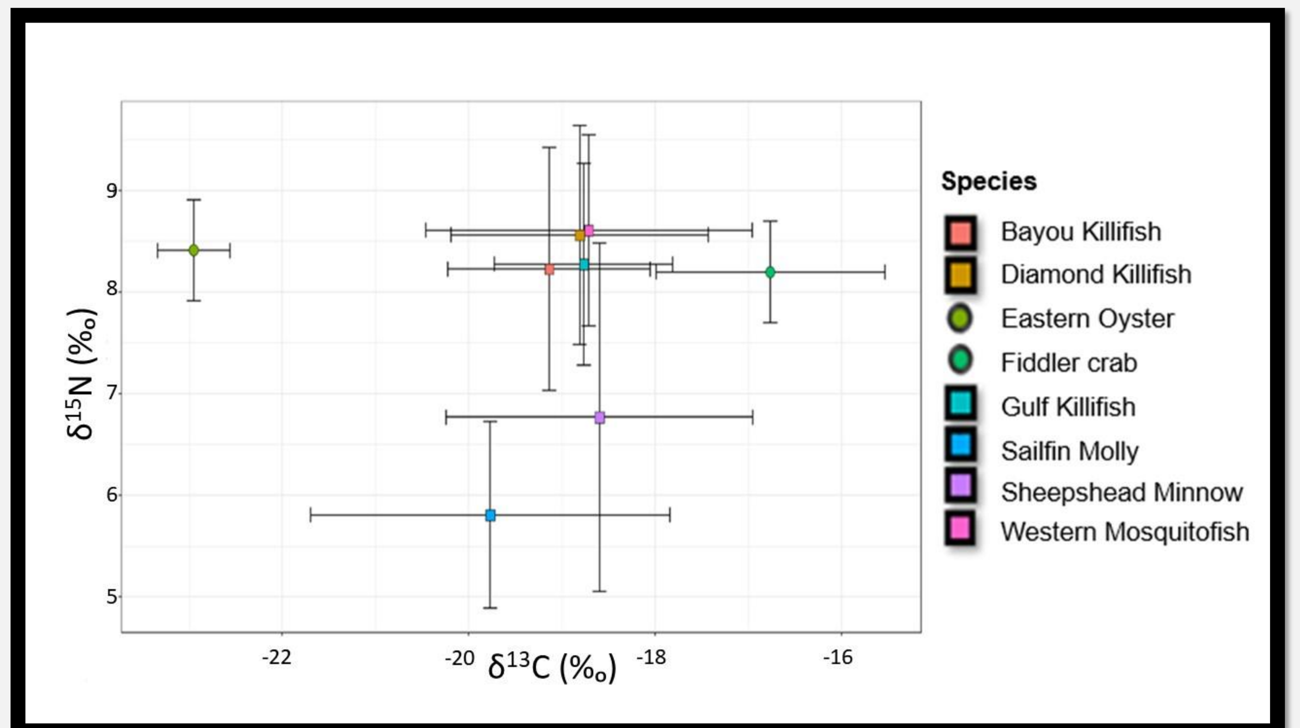


Figure 4: Biplot of the range of $\delta^{15}N$ and $\delta^{13}C$ values for the community sampled. Eastern oysters and fiddler crabs are used to represent the pelagic and benthic production baselines, respectively

- Carbon and nitrogen value ranges for Fundulid species are highly similar and more clustered.
- *P. latipinna* appear to occupy lower trophic positions and utilize a wider range of production sources.
- *C. variegatus* appears to be intermediate in niche occupation in comparison to the community.

- Mean overlap metrics calculated across iterations for all niche region sizes (alpha = .95) indicate a high percentage of overlap between fundulid species and *G. affinis*, ranging from 70.7% to 93.0% overlap between these species.
- *C. variegatus* (35.1% - 48.4%) and *P. latipinna* (19.7% - 41.3%) overlapped the least with this group.
- Percent overlap between *C. variegatus* and *P. latipinna* ranged from 73.7% to 80.6%.

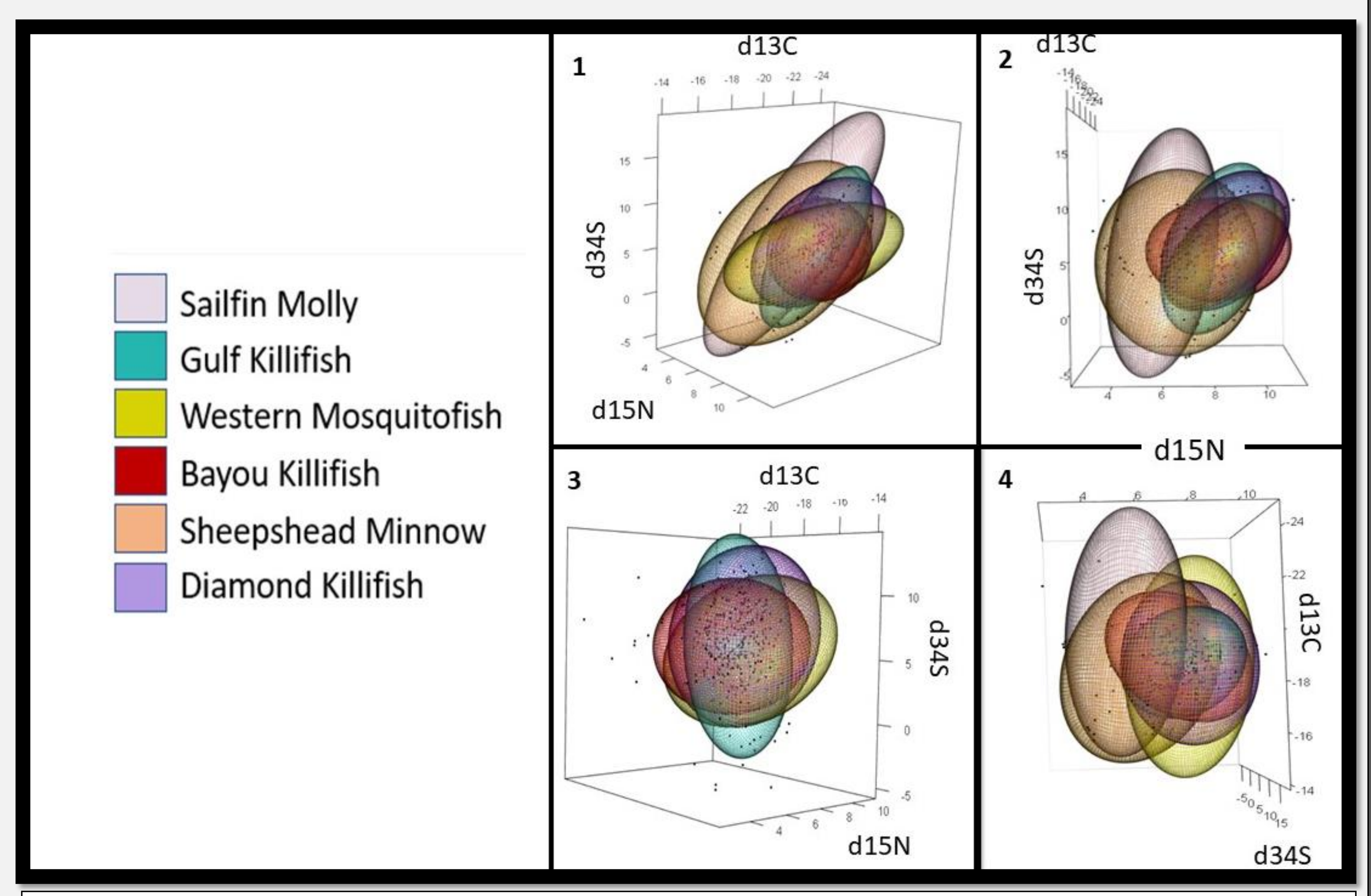


Figure 5: 75% ellipsoids generated using the carbon ($\delta^{13}C$), sulfur ($\delta^{34}S$) and nitrogen ($\delta^{15}N$) data. Plots **1**, **2**, and **4** depict the whole community with different orientations of the 3D model to emphasize each isotope. Plot **3** depicts the group of fundulids exhibiting a high degree of overlap.

Discussion

Primary production sources

- Isotopic niches can be myopic, as some isotopic compositions may not be contrasting enough and thus it's not always possible to tell the taxonomy of specific sources (Newsome et al. 2007).
- The addition of sulfur isotopes in our data appears to aid in distinguishing between primary production source contributions. Further studies should consider establishing a sulfur baseline for more precise primary producer baseline estimations.
- Carbon values suggest that the Fundulid species are similarly dependent on detrital or microphytobenthos primary production sources.

Trophic position

- Nitrogen values suggest that the Fundulid species occupy a similar trophic position.
- *P. latipinna* occupy the lowest relative trophic position in the sampled community, with *C. variegatus* occupying the largest range of $\delta^{15}N$ suggesting this species feeds across several trophic levels.

Conclusions

- Trophic position overlap shown from the tracers align with expectations based on related diet studies.
- Little evidence for resource partitioning was found amongst Fundulids and *G. affinis*, lending an argument that additional mechanisms of co-occurrence need to be considered.
- Fundulid species have been observed predating upon the eggs of other sympatric species, such as the diamond killifish (Hastings and Yerger 1971). This will inform our future research interests on the role of intra-guild predation as a form of resource partitioning.

Acknowledgements

Funding for this research was provided by the NOAA RESTORE Science Program award *"Linking Community and Food-Web Approaches to Restoration"*. We would like to thank our entire research team for their input and logistical support.

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