Monitoring Mussel Health Using Stable Isotope Analysis

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Stable isotope analysis can monitor the general health of mussel populations.

Abstract

Declines and extinctions in freshwater mussel populations have resulted in 16 species extirpated and 10 species listed as federally threatened or endangered in Indiana. Research priorities for freshwater mussels often have limited efforts towards monitoring health. As part of a larger project to develop comprehensive health monitoring protocols for freshwater bivalves in Indiana, our objectives were to develop and test a health monitoring protocol using stable isotope analysis to evaluate changes in resource use and detect changes in water quality and stream nutrients. We collected body tissue samples from 2 native mussel species and the Asian clam (*Corbicula fluminea*) from 3 sites in Indiana and analyzed them for carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotopes. Our results indicated a significant difference in $\delta^{13}C$ and $\delta^{15}N$ between and within sampling sites. We also identified overlap in signatures between species and within sites indicating interspecific competition between native mussels and the highly invasive Asian clam. By collecting and analyzing samples regularly, stable isotope analysis will allow managers to monitor for changes in mussel health and environmental conditions. Combined with measurements of other health parameters, these protocols can provide a comprehensive program for understanding challenges to mussel populations while informing management and conservation efforts.

Introduction

- **Freshwater mussel populations** have declined globally from habitat loss and exploitation leading to declines and extinctions[1].
  - In Indiana, 17 species have been extirpated and of the remaining 62, 10 are listed as federally endangered/threatened[2].
- **Mussels can be used as a reference** to track nutrient pollution and to identify the pollution source[4,3].
- **Health monitoring and response protocols** for mussels are limited and insufficient, allowing for rapid decline and mass mortality events.
- **Our objective** was to develop and test protocols using stable isotope analysis of native mussels and a non-native mollusk for mussel monitoring and comparisons of resource use to detect changes in water quality.

Methods

- We **collected tissue samples** from plain pocketbook (*Lampsilis cardium*), fatmucket (*Lampsilis siliquoidea*), and Asian clam (*Corbicula fluminea*) from 3 sites in Indiana, upstream of an urban area, downstream of the same urban area, and a rural site.
- **Samples were dried, ground, and weighed** in duplicate at the Purdue University Wildlife Physiology Lab.
- **Samples were analyzed for** carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) **isotopic signatures.**
- We **conducted** a multivariate analysis of variance (**MANOVA**) and **Tukey** post hoc multiple comparisons test to evaluate differences in sampling location and among species.
- We used **kernel density** area calculations to estimate isotopic niche area.

Results

- **Across the 3 species and sites** δ15N and δ13C were significantly different ($F_{(16, 308)} = 212.923$, $p = <0.001$; Wilks' $\Lambda = 0.007$) .
- **Species $\delta^{13}C$ values** were significantly different from each other between sites but not within except for the Asian clam.

Conclusions

- **The significant differences and clear patterns** in the isotope signatures among sites supports the use of this method to monitor changes in environmental quality.
  - **Agricultural run-off is detectable** using stable isotopes.
- We found overlap in isotopic signatures suggesting **interspecific competition** between native mussels and the highly invasive Asian clam upstream of the urban area and in the rural area.
- **Regular** and **frequent** sample collection can establish baseline values for comparison.
- Can monitor for **chronic disturbances** and **identify pollution sources**.
- We recommend using stable isotope analysis along with other health parameters to **monitor health of native mussels.**

Acknowledgments

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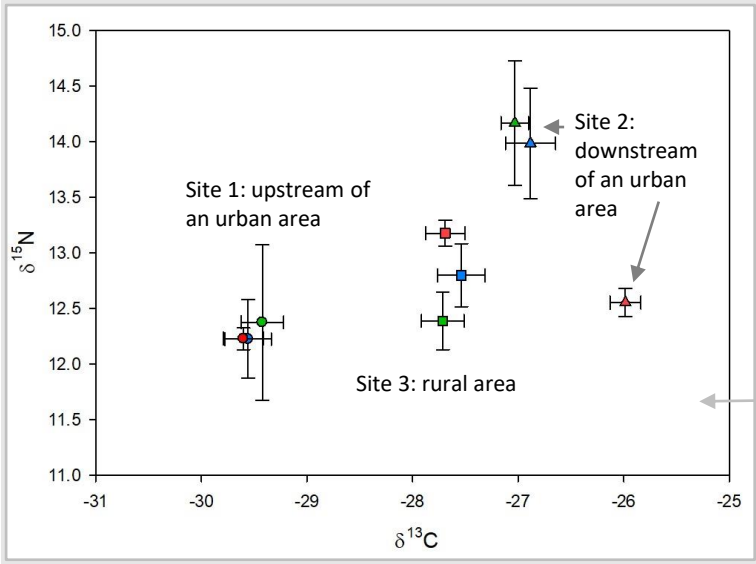
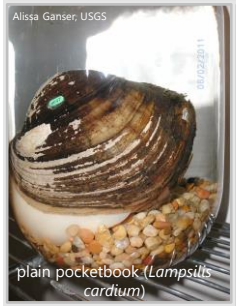


Figure 1. Mean ± standard deviation of δ15N and δ13C values (bottom) for Asian clam (*Corbicula fluminea*), fatmucket (*Lampsilis siliquoidea*), and plain pocketbook (*Lampsilis cardium*) samples collected in Central Indiana in June-July 2019 at 3 sampling sites.



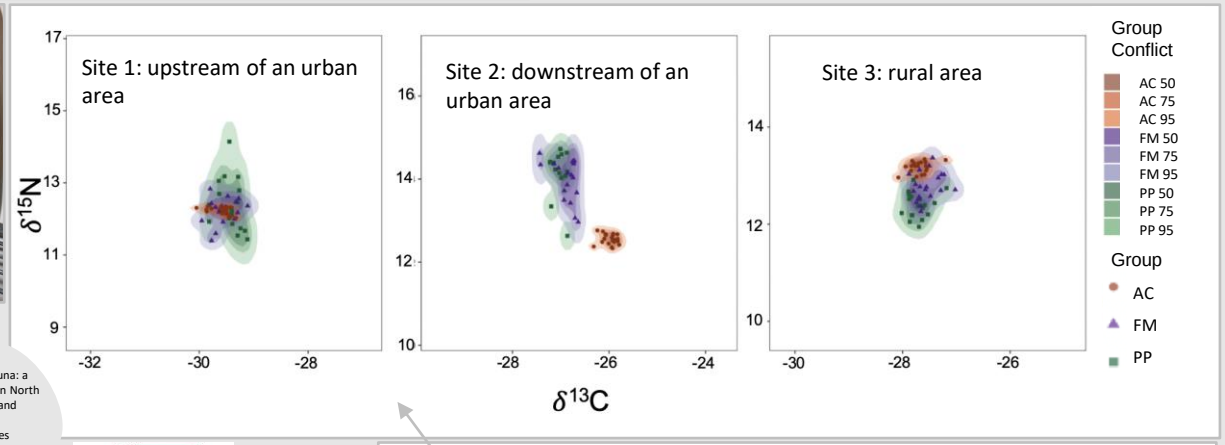


Figure 2. Isotopic niche data for the Asian clam (*Corbicula fluminea*), fatmucket (*Lampsilis siliquoidea*), and plain pocketbook (*Lampsilis cardium*) sampled in 2019. Size and overlap estimates were generated for 50%, 75%, and 95% contour levels with kernel utilization density estimates[5].

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