Quantifying Fidelity Across Multiple Higher Taxa

National Science Foundation

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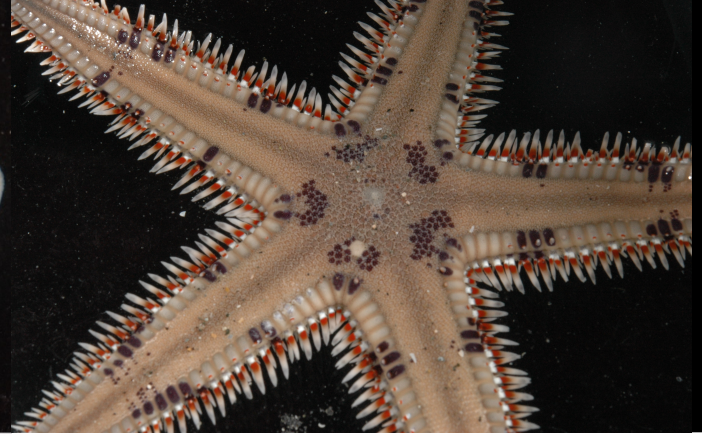
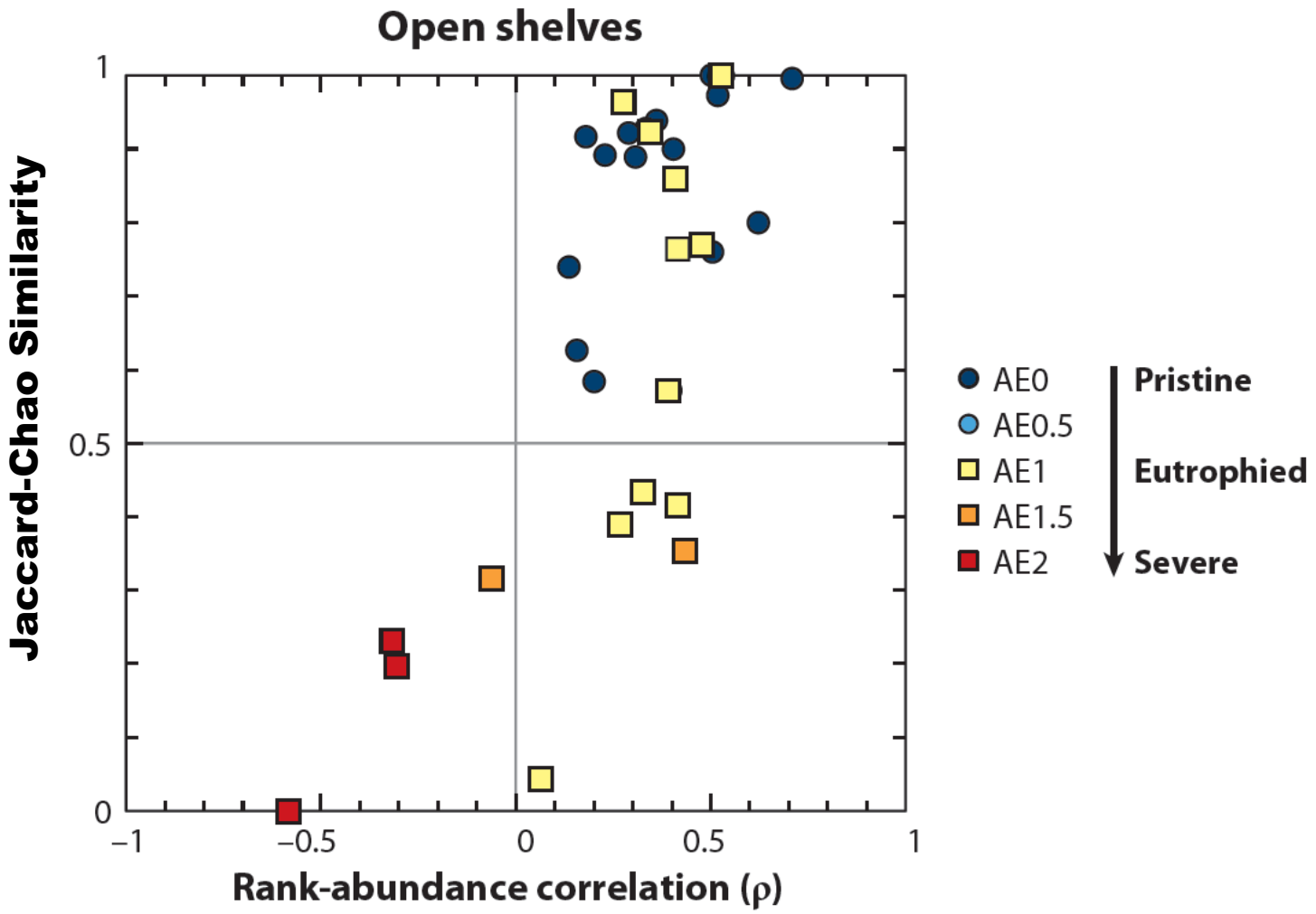



When we simultaneously examine multiple higher taxa, how accurately does the fossil record represent the paleocommunity?

Compositional Fidelity

Good Live-Dead Match in Molluscs



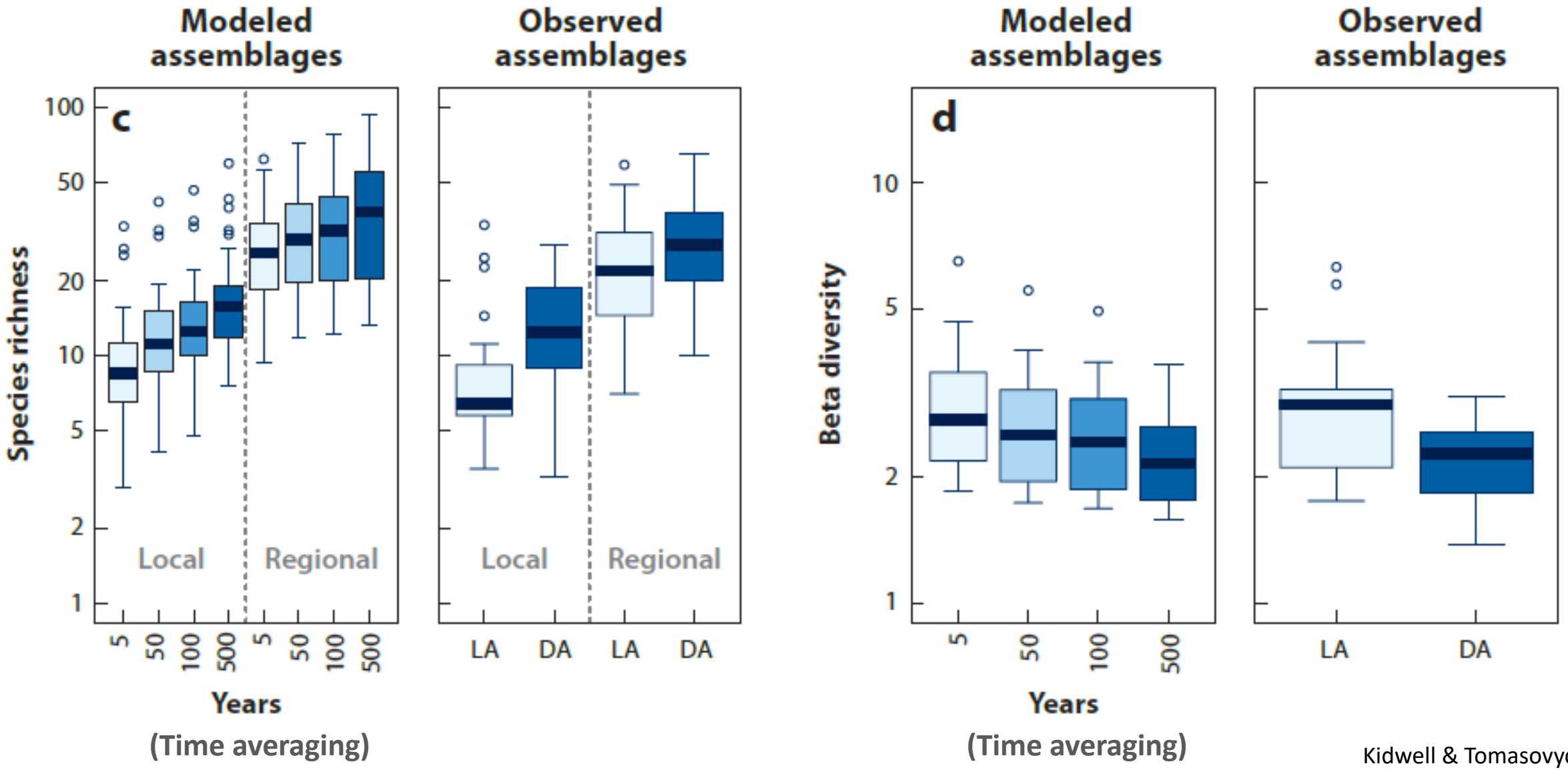
Kidwell & Tomasovych (2013)
Ann. Rev. Ecol. Evol. Sys.

Many single-taxon studies have been carried out so far:

- Mollusks
- Corals
- Echinoids
- Diatoms
- Sponges
- Mammals
- Vascular plants
- Etc.

Multi-taxon studies are lacking

Fidelity of Alpha and Beta Diversity (**Mollusks Only**)



Kidwell & Tomasovych (2013)
Ann. Rev. Ecol. Evol. Sys.

High Fidelity is a Prerequisite of Conservation Paleobiology

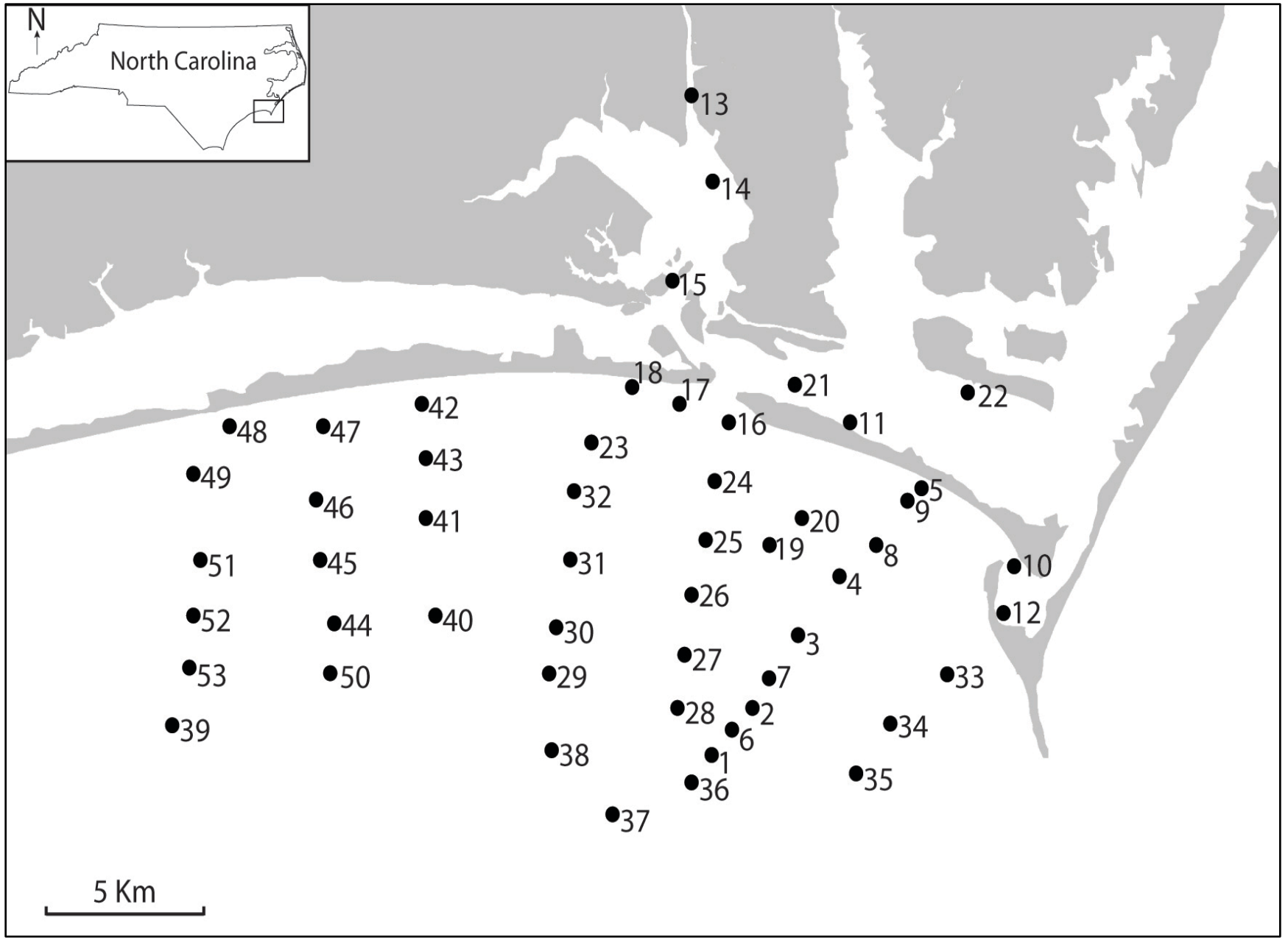
- Fidelity studies limited to one phylum or class (mostly mollusks)
- Most studies focused on compositional fidelity, but few dealt with spatial fidelity

NEEDED: Comprehensive fidelity analyses based on multiple higher taxa (a more realistic proxy of the whole-community data)

This Study

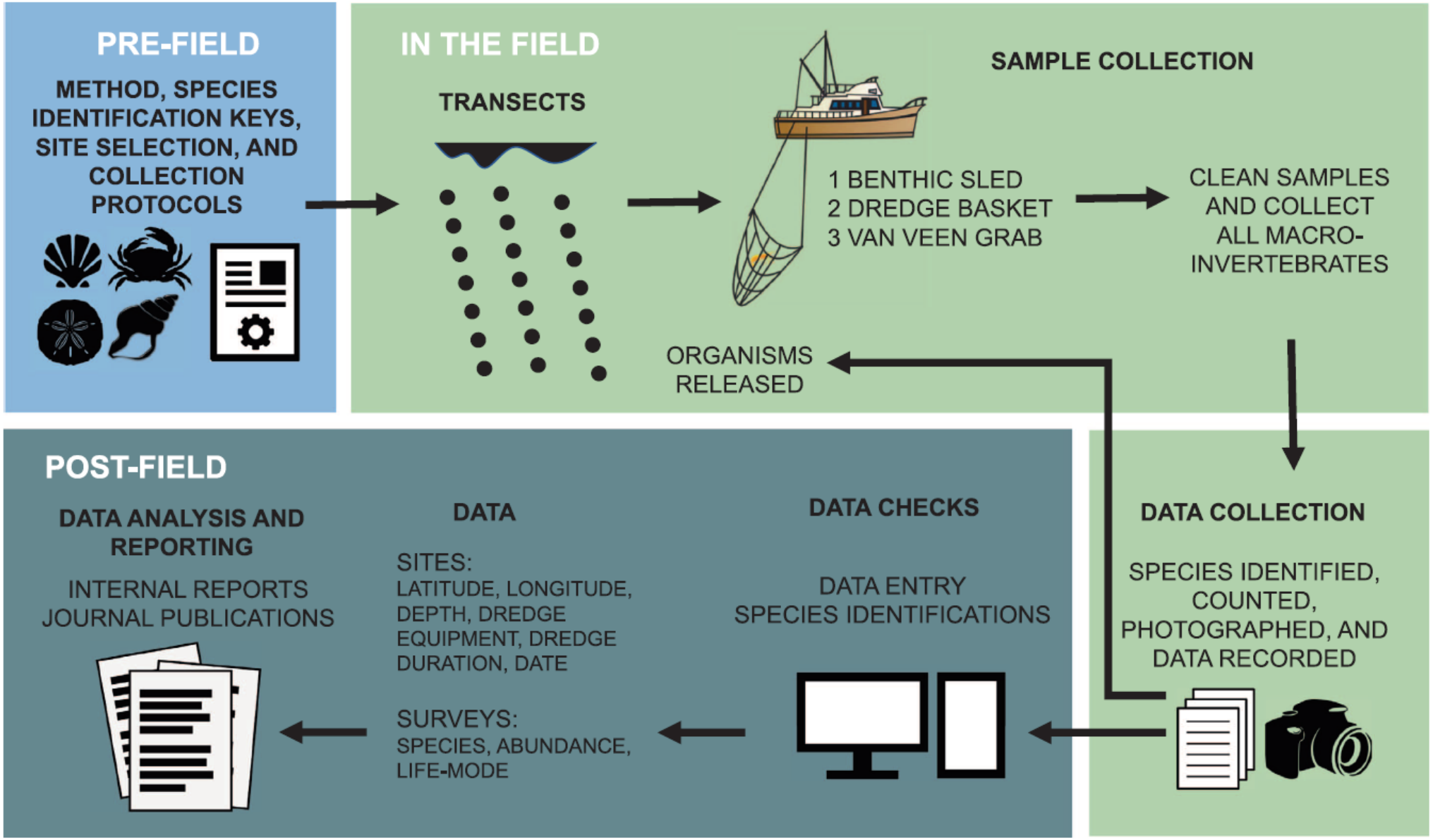
- Targets all macroscopic benthos

- Explicitly focuses on beta diversity and spatial structuring of local communities



Tyler and Kowalewski (2014) *PLoS One*

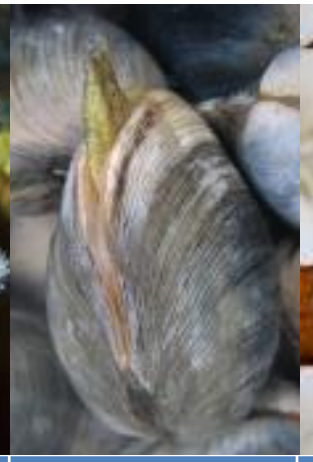
Sampling Design



Tyler and Kowalewski (2018) *Scientific Data*

Our Data

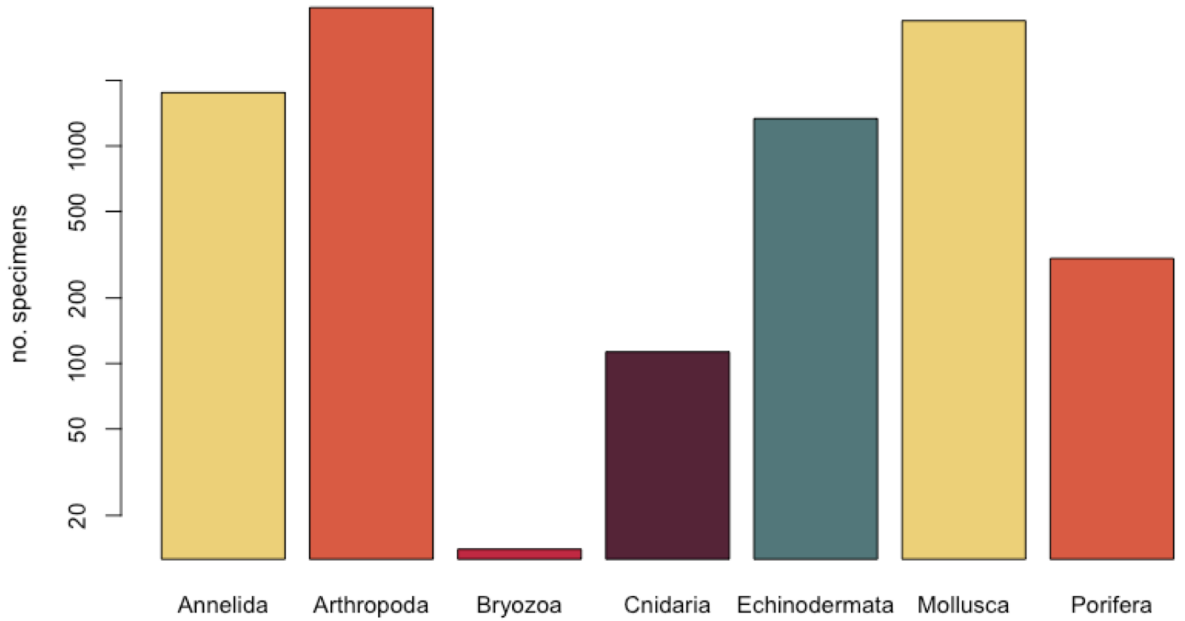




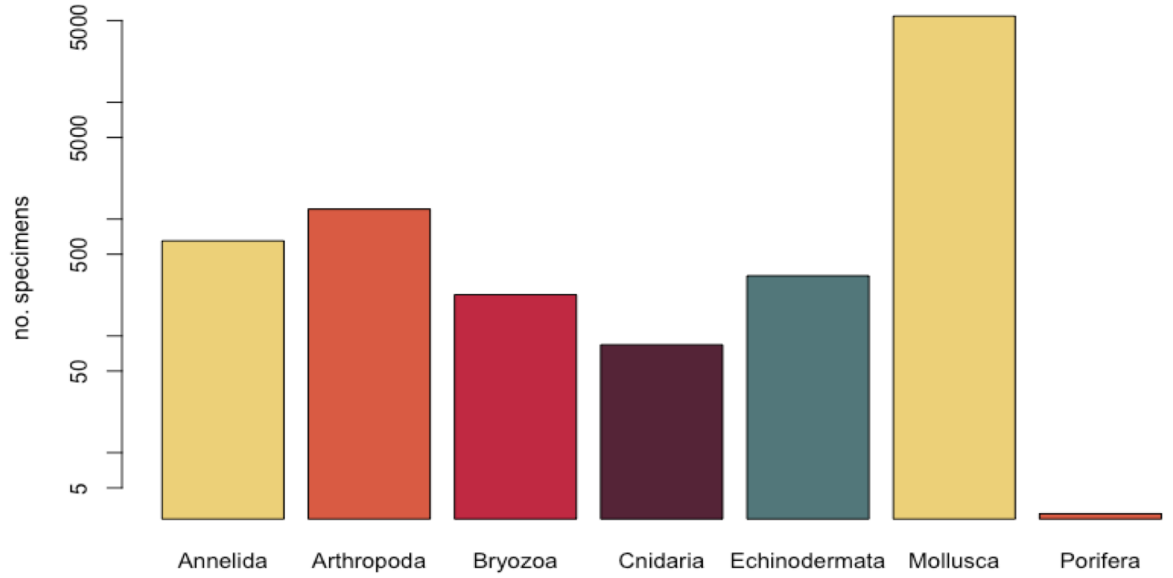
	Live Assemblage	Live Mollusks	Live 'Robust' Mollusks	Death Assemblage	Death Assemblage (Mollusks)
Number of phyla	7	1	1	7	1
Number of species	179	95	55	160	117
Number of individuals	11,551	3,762	2,971	57,611	12,681

Phylum Level Fidelity

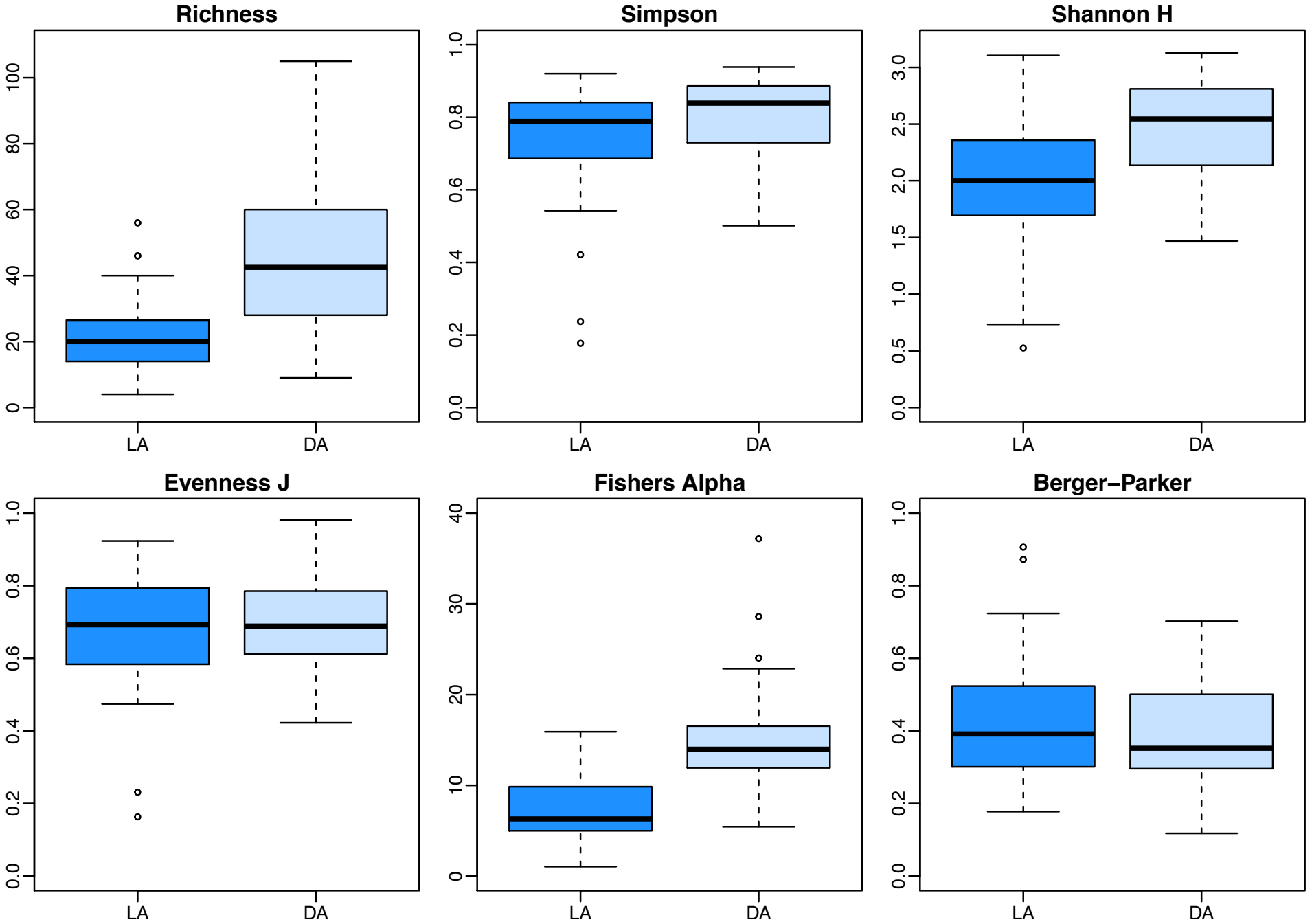
Live



Dead



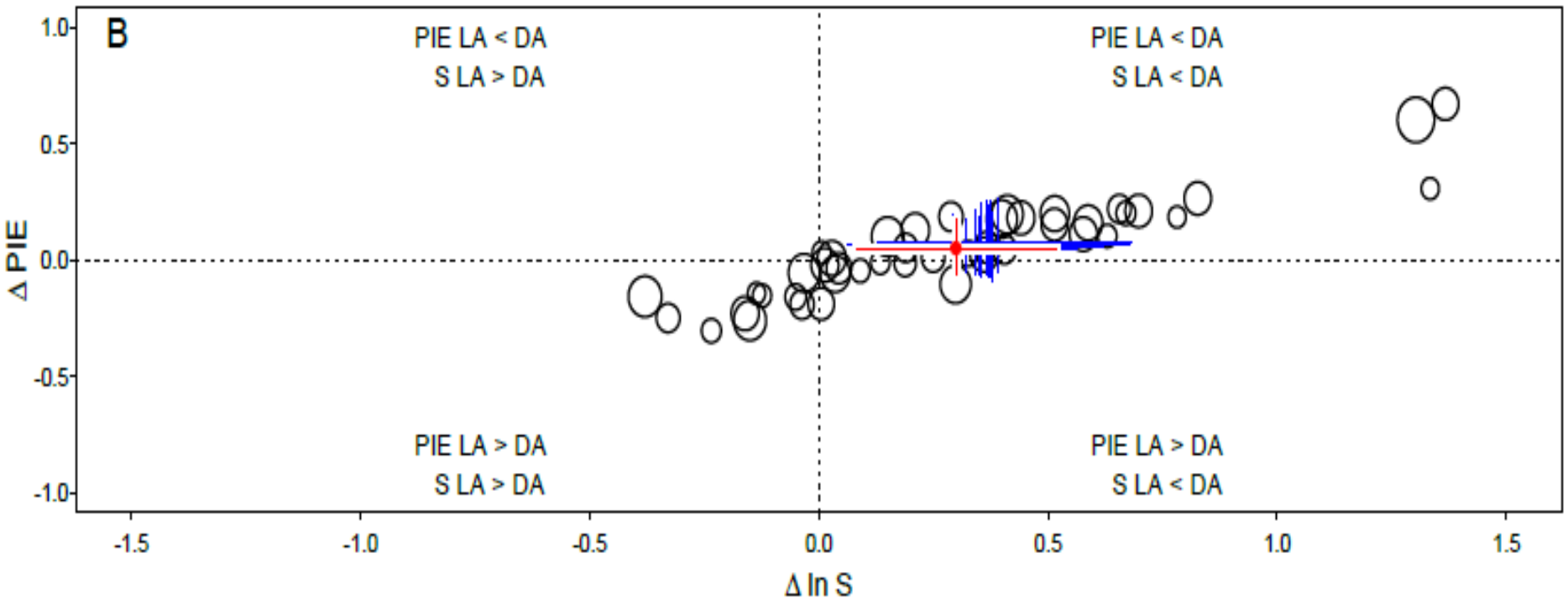
$r = 0.82$
$p = 0.03$


Richness
0
20
40
60
80
100
LA
DA
Simpson
0.0
0.2
0.4
0.6
0.8
1.0
LA
DA
Shannon H
0.0
0.5
1.0
1.5
2.0
2.5
3.0
LA
DA
Evenness J
0.0
0.2
0.4
0.6
0.8
1.0
LA
DA
Fishers Alpha
0
10
20
30
40
LA
DA
Berger–Parker
0.0
0.2
0.4
0.6
0.8
1.0
LA
DA

Fidelity of Alpha Diversity & Evenness

- Spatial and temporal mixing results in inflated Alpha diversity and evenness

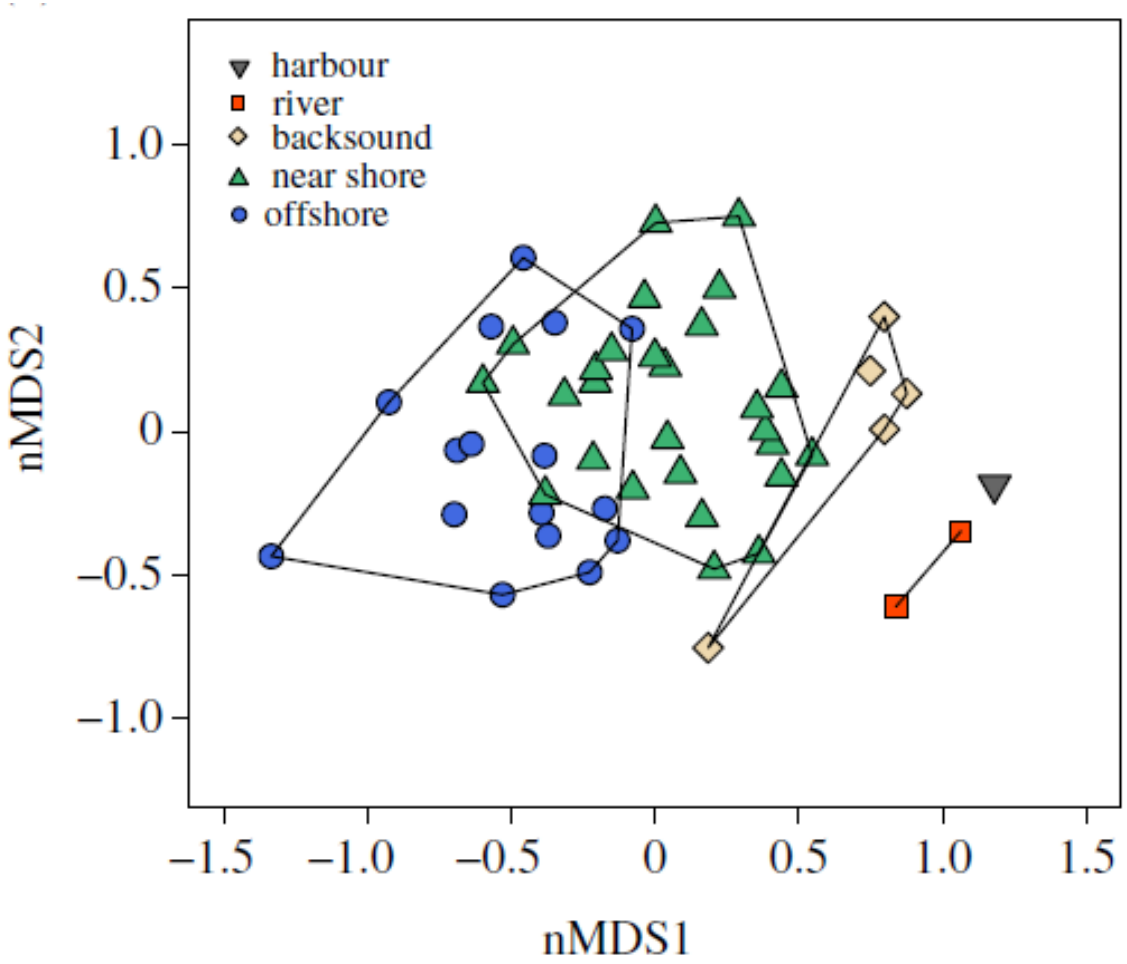
Evenness



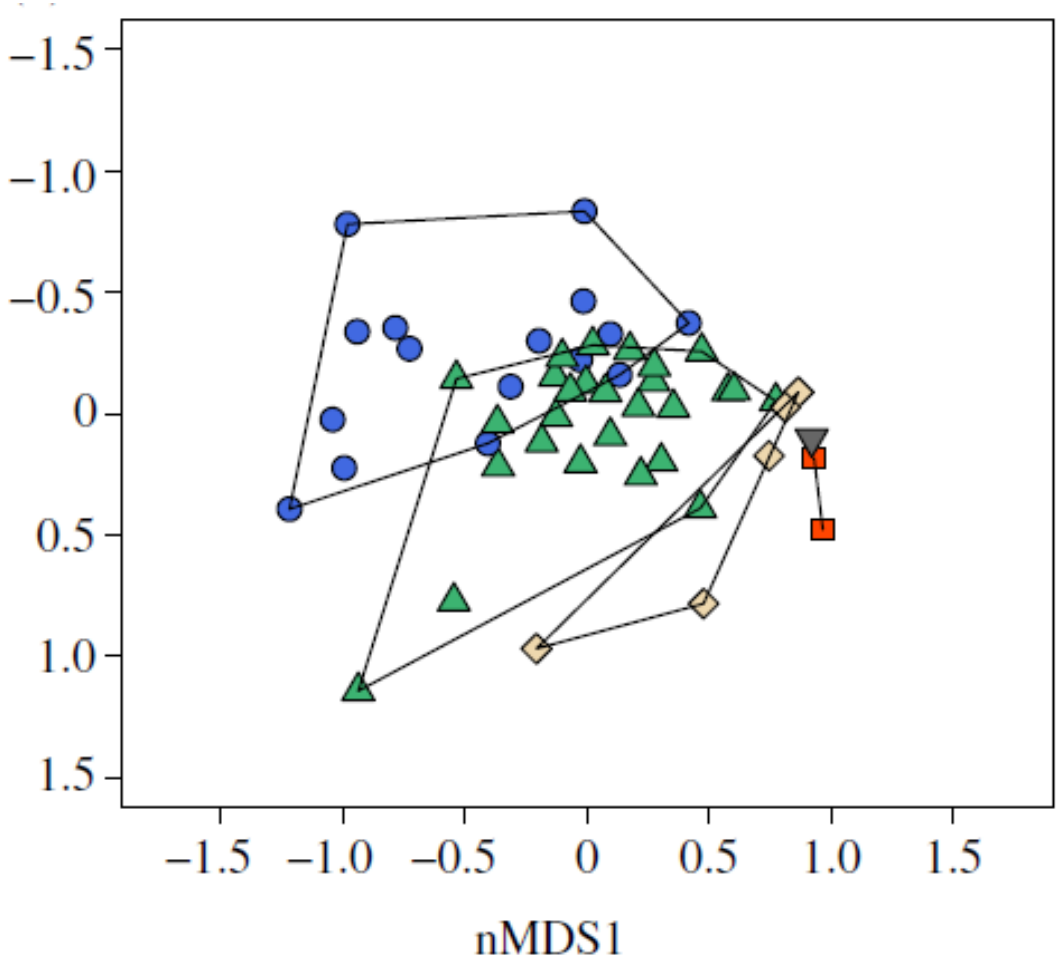
Tyler and Kowalewski (2017), *Proc. Roy. Soc. B*

Spatial Fidelity (LA vs. DA)

Live Assemblage



Death Assemblage



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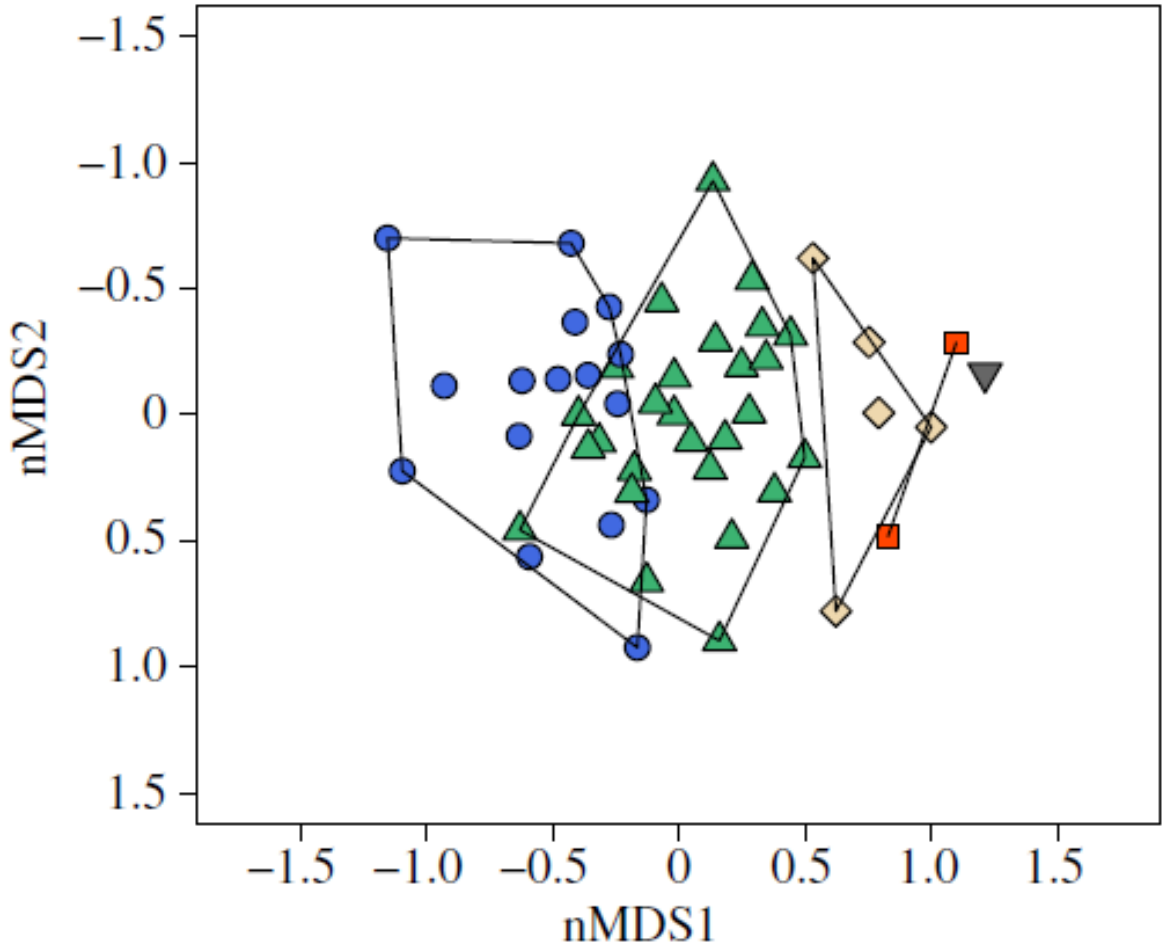
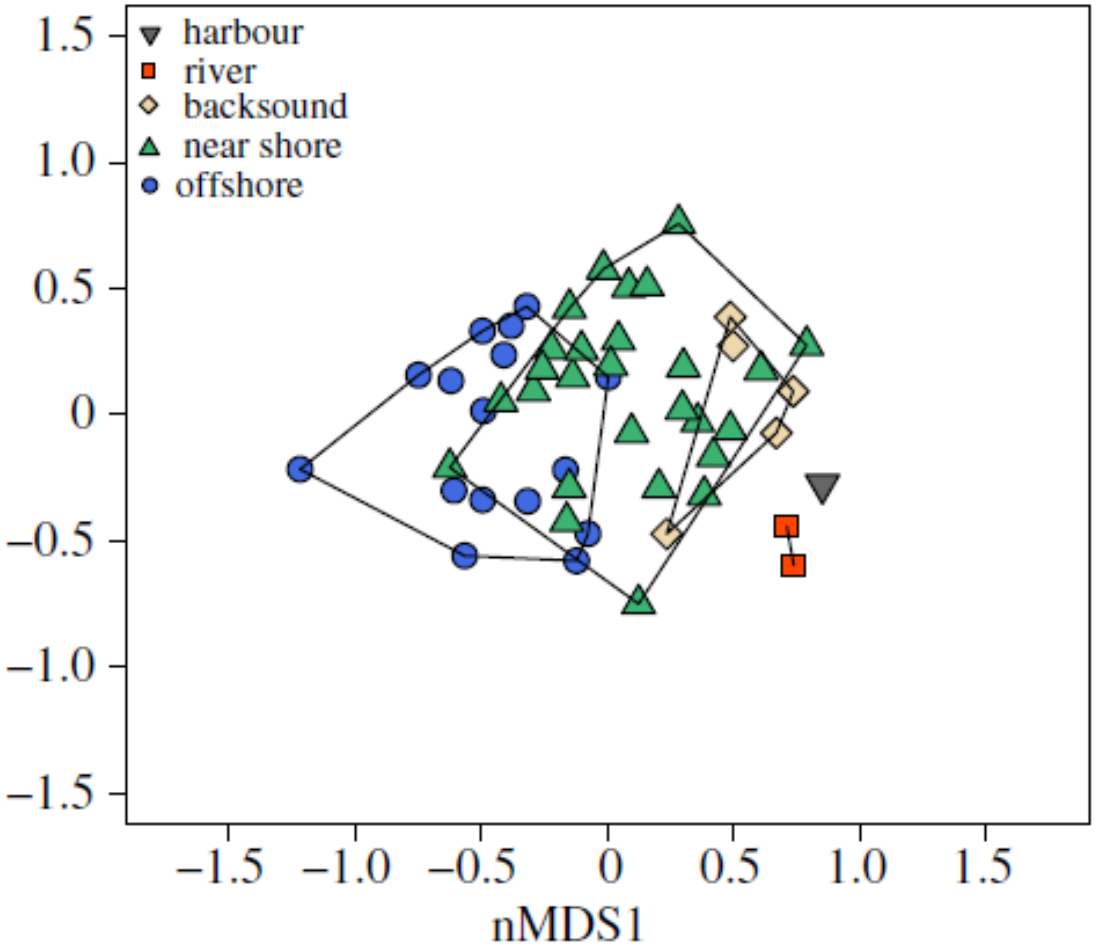
Spatial Fidelity (Mollusks vs. Non-Mollusks)

Live Assemblage (Mollusks)



Live Assemblage (non-Mollusks)



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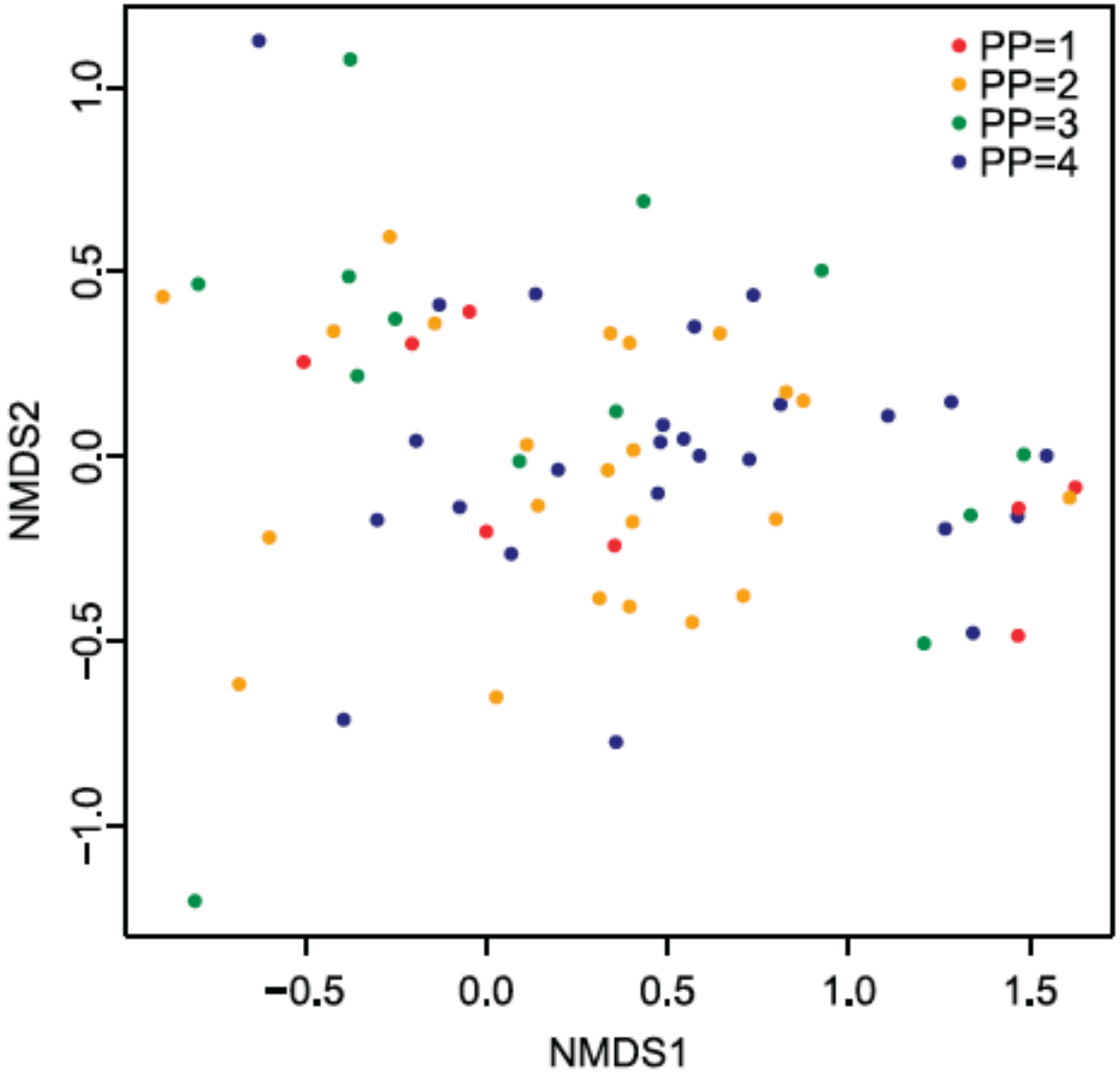
Spatial Fidelity: Depth Gradient and Preservation Potential



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Beta Diversity

Table 1. Measures of $\beta_{VARIANCE}$ for the six compared datasets. Sample-standardized values based on datasets subsampled to locality minima (the smallest *n*-values observed in a given locality across the six datasets). Reported values are means of 1 000 replicate standardized datasets. Symbols: *S*, number of species in a dataset; *N*, number of individuals in a dataset; shared *S* and shared *N*, percentage of species and specimens, respectively, retained in the datasets produced by subsetting LA or DA; *T SS*, total sum of squares; β_{VAR}, beta variance; β_{SH}, Beta Shannon; β_{DISP}, multivariate dispersion; β^*_{VAR}, β^*_{SH}, and β^*_{DISP} represent estimates based on sample-standardized datasets. All measures of β-diversity are positively and significantly correlated (electronic supplementary material, figure S4 and table S7).

	S	*N*	shared *S* (%)	shared *N* (%)	*T SS*	β_{VAR}	β^*_{VAR}	β_{SH}	β^*_{SH}	β_{DISP}	β^*_{DISP}
LA	179	11 551	100	100	18.12	0.36	0.39	1.48	1.82	0.59	0.60
DA	160	57 116	100	100	15.61	0.31	0.32	0.75	1.32	0.55	0.49

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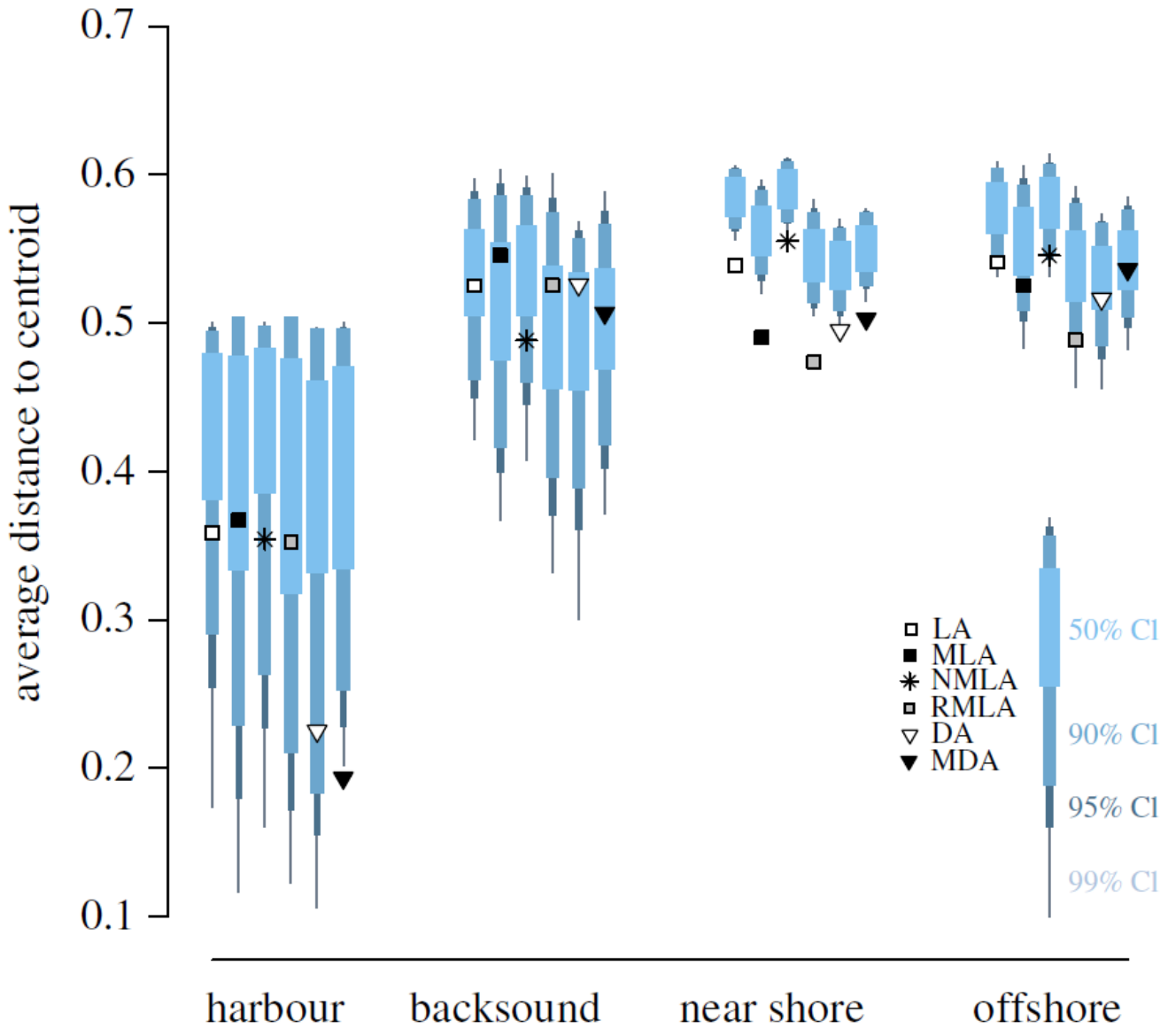
Comparative Beta Fidelity by Habitat



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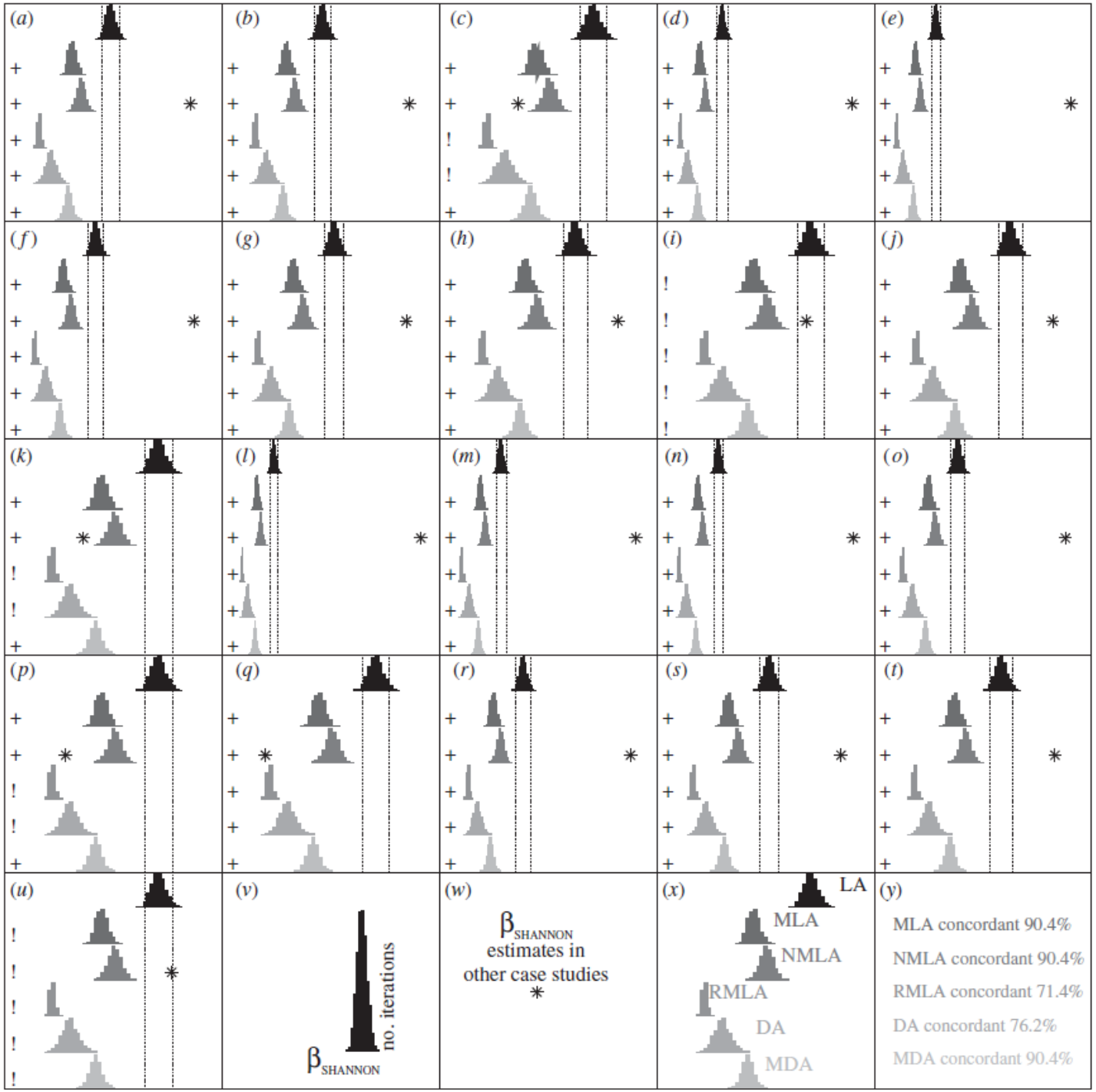
Comparative Fidelity of Beta Diversity



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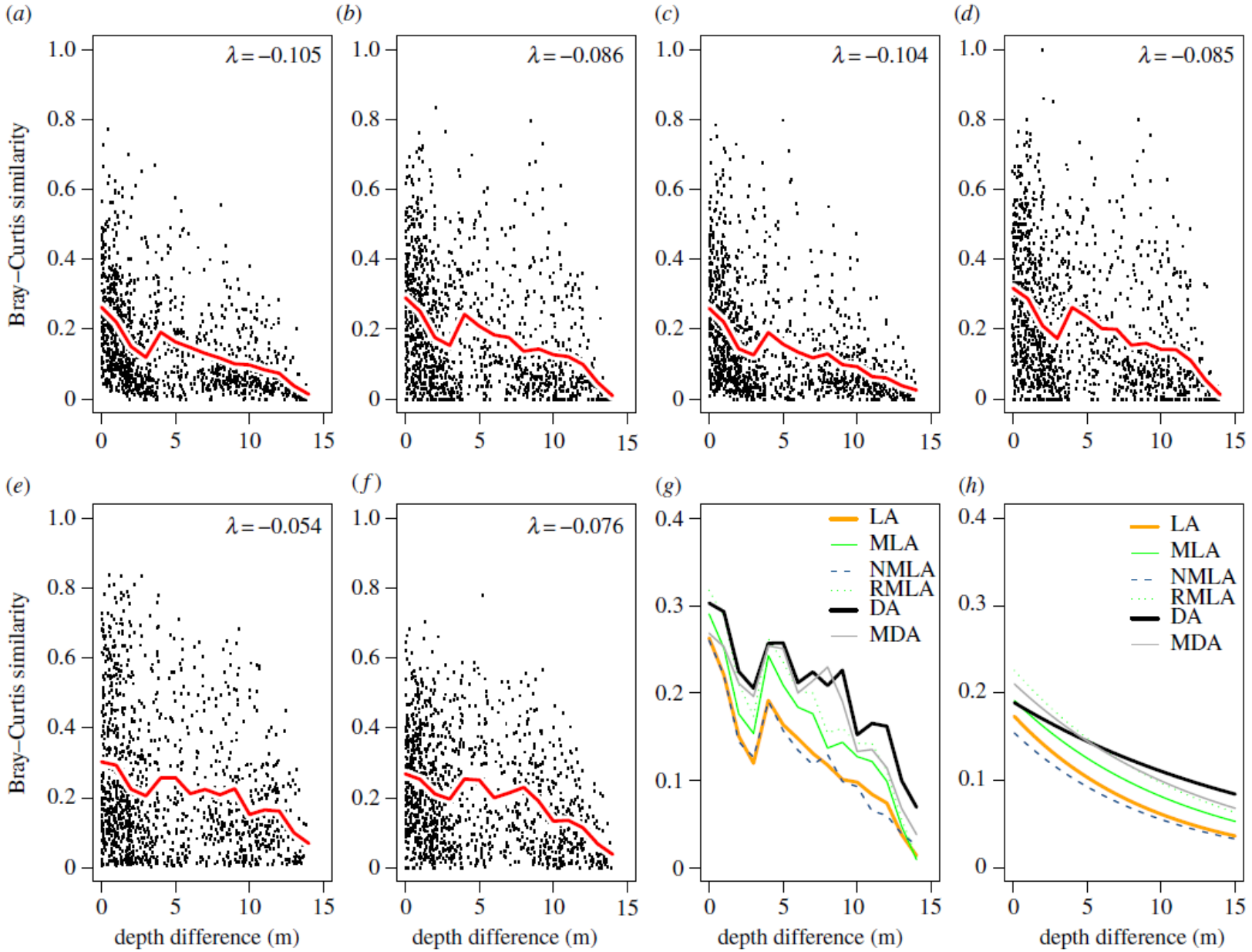
Fidelity of Beta Turnover



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Conclusions

- **Compositional fidelity is high at phylum level but lower at species level**
- **Alpha diversity is slightly elevated and beta diversity slightly depressed in death assemblages (consistent with single-taxon studies)**
- **Despite low compositional fidelity, death assemblages track spatial patterns observed in live associations**
- **This study supports the emerging consensus that the youngest fossil record provides meaningful quantitative ecological estimates, including spatial structuring of local communities**

Acknowledgments

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Participants in the Atlantic Coastal Plain Field Course, 2011

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