Multivariate Analysis to Synthesize Benthic Data Collected During the Deep Gulf of Mexico Benthos (DGoMB) Project

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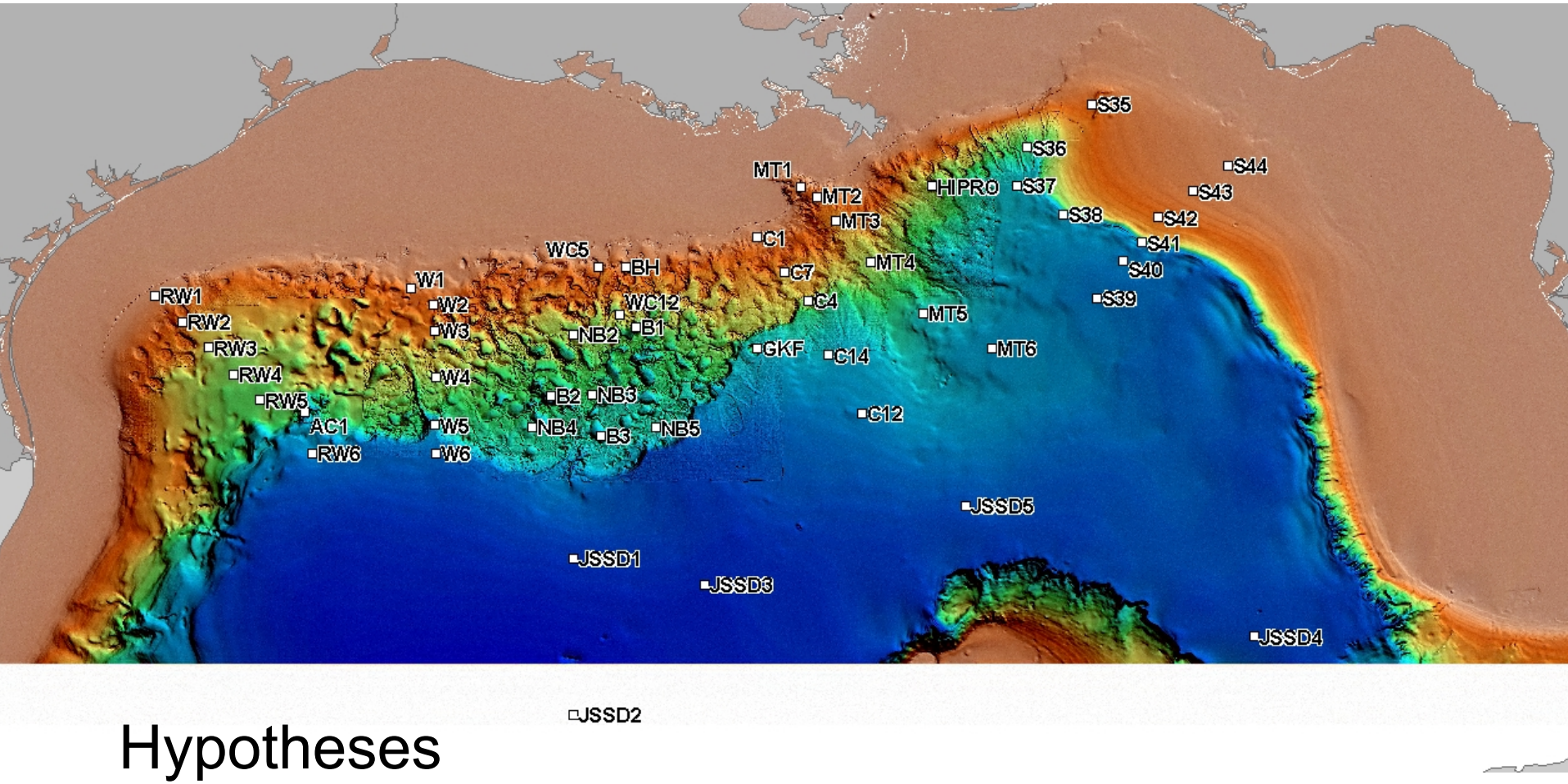
Deep Gulf of Mexico Benthos (DGoMB)

- Determine in greater detail the structure and function of northern Gulf of Mexico continental slope communities
  - Bacteria → Meiofauna → Macrofauna → Megafauna
  - Grain size → Trace metals → Organics → Geochemistry
  - Physical setting
- Infer relationships with local conditions and major driving processes by testing specific hypotheses

DGoMB Experimental Design



Hypotheses

- H_{01} – Depth
- H_{02} – Longitude
- H_{03} – Basins
- H_{04} – Canyon
- H_{05} – Escarpment
- H_{06} – Primary Prod

Analytical Approach

- Multivariate Analysis to link environmental variables with biotic variables
- Environmental variables number reduced using Principle Components Analysis (PCA)
- Biotic variables number reduced to calculated metrics
- Correlate new PC environmental variables with biotic metrics
- Nonparametric Multi-Dimensional Scaling (MDS) used to compare community structure

Data Pre-treatment

- Only 39 stations used because of missing data at 14 stations
- All data first average by station, transformed

Pre-Analyses

- Number of variables can drive a PCA so classes of variables were reduced
  - Metals 29 → 4 (explaining 70% var)
  - Summed all PAH

Measurements Used

- Environmental Variables
  - Water Column
    - Chl-*a*
    - POC, DOC, NH_4, NO_3
  - Sediment Characteristics
    - Grain size composition
      - Sand, silt, clay
    - Chemistry
      - PAH
      - Ca, Cr, Sn, Sr
      - TON, TOC,
- Biotic Variables
  - Meiofauna Taxa
    - Harpacticoida Species
  - Macrofauna Taxa
    - Polychaeta
    - Crustacea
      - Amphipoda
      - Isopoda
      - Cumacea
    - Mollusca
      - Bivalvia
      - Aplocophora

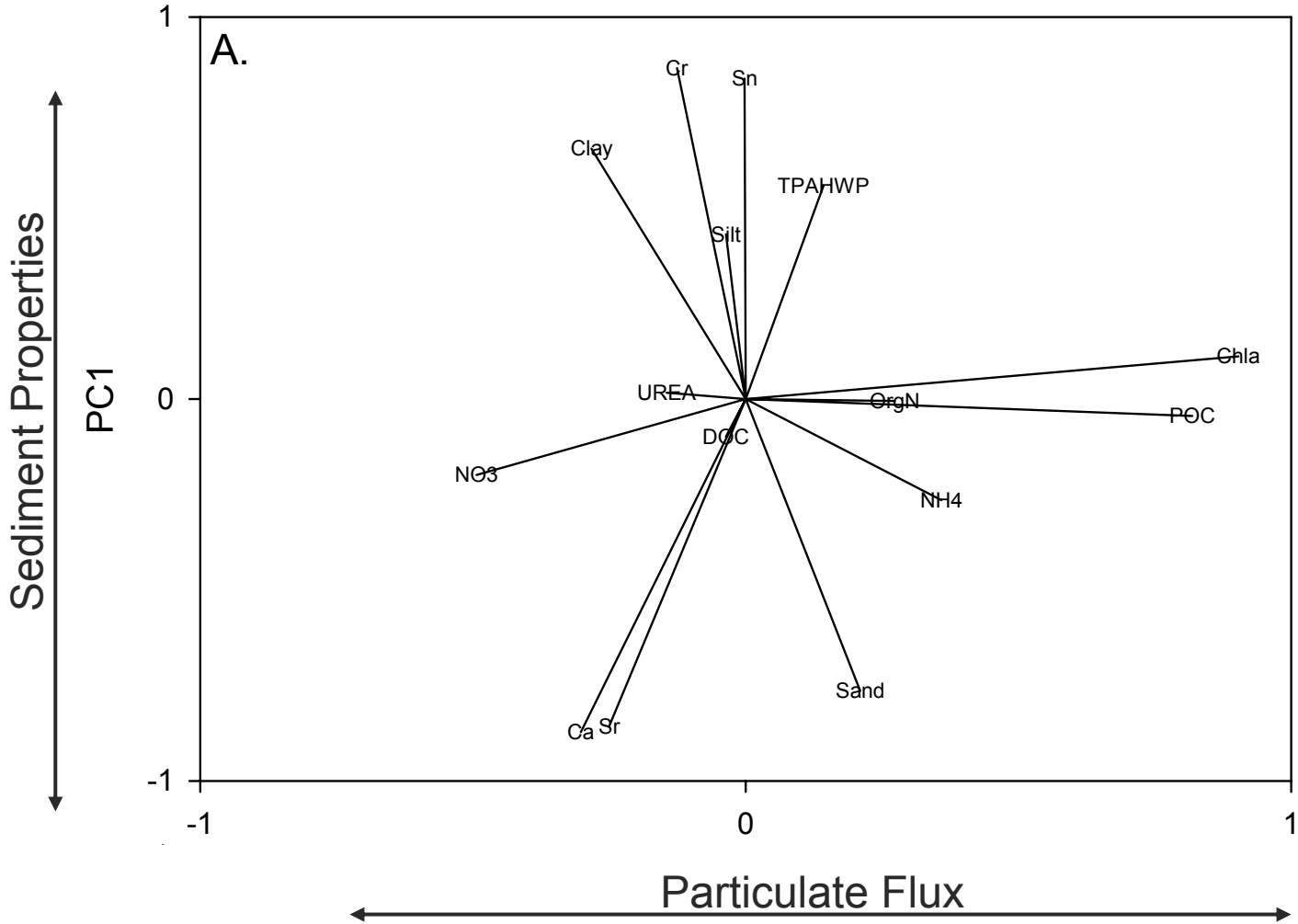
Metrics

Mean metric for all samples, per core basis

	Harpacticoid	**Crustacea**	**Mollusca**	**Polychaeta**
n	91	32	21	60
S	52	32	21	60
J′	0.95	0.87	0.84	0.86
N1	43	20	14	30

Metric abbreviations: *n* = abundance, S = species number, J′ = evenness, N1 = Hill's Diversity index

Environmental PCA



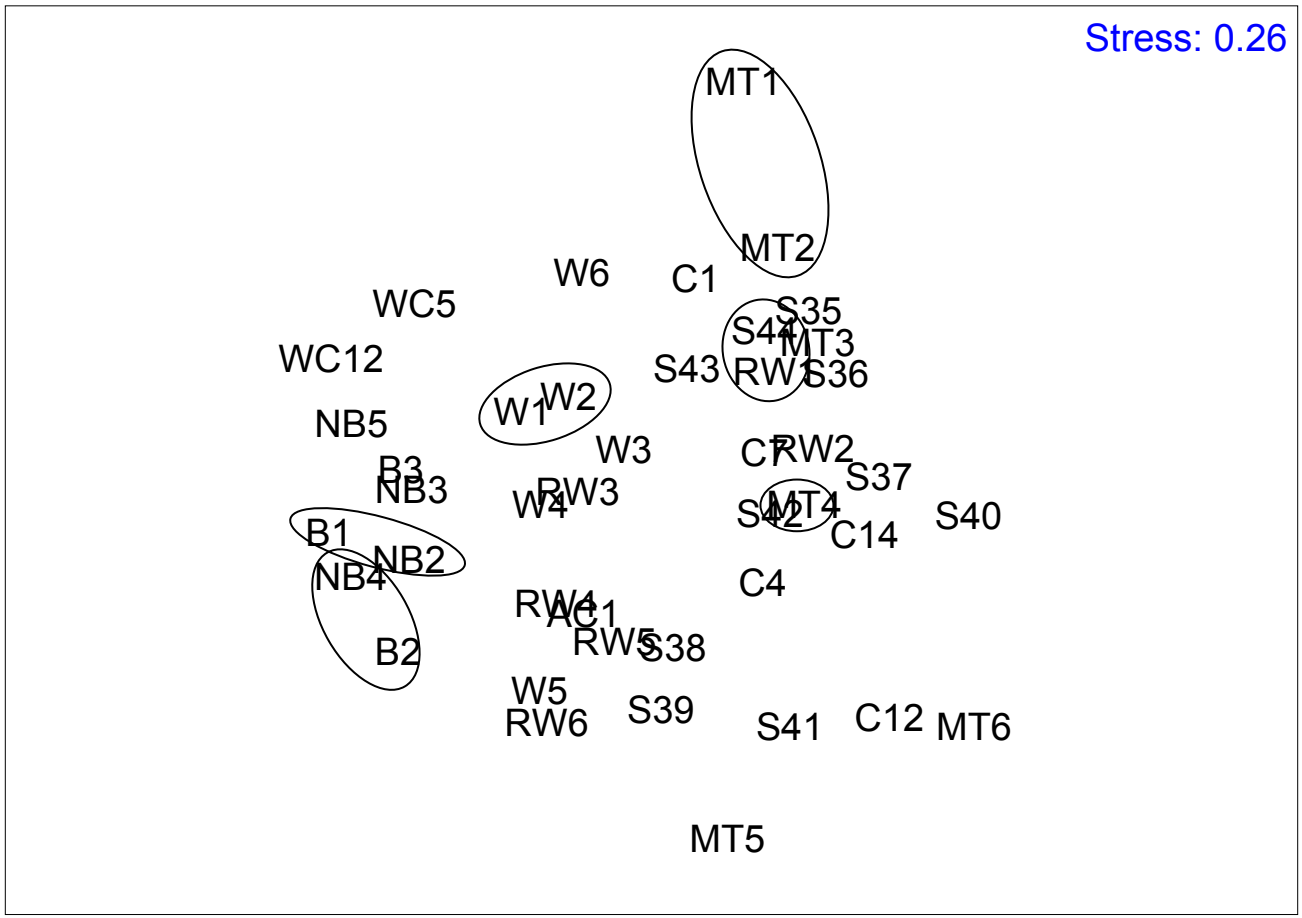
Correlation (r) Between Environmental Factors and Biota

Significance levels: *=0.05 - 0.01, **=0.01-0.001, ***=0.001-0.0001, ****<0.0001, *n* = 39 stations

	Abundance							Diversity (N1)			
	Meio	Macr	Bact	Harp	Poly	Crus	Moll	Harp	Poly	Crus	Moll
PC1	0.48 **	0.33 *	0.39 *	-	-	0.39 *	0.53 ***	-	-	-	-0.32 *
PC2	0.56 ***	0.70 ****	0.47 **	0.55 ***	0.73 ****	0.49 **	0.52 ***	-	0.38 *	-	-

Community Structure (MDS)

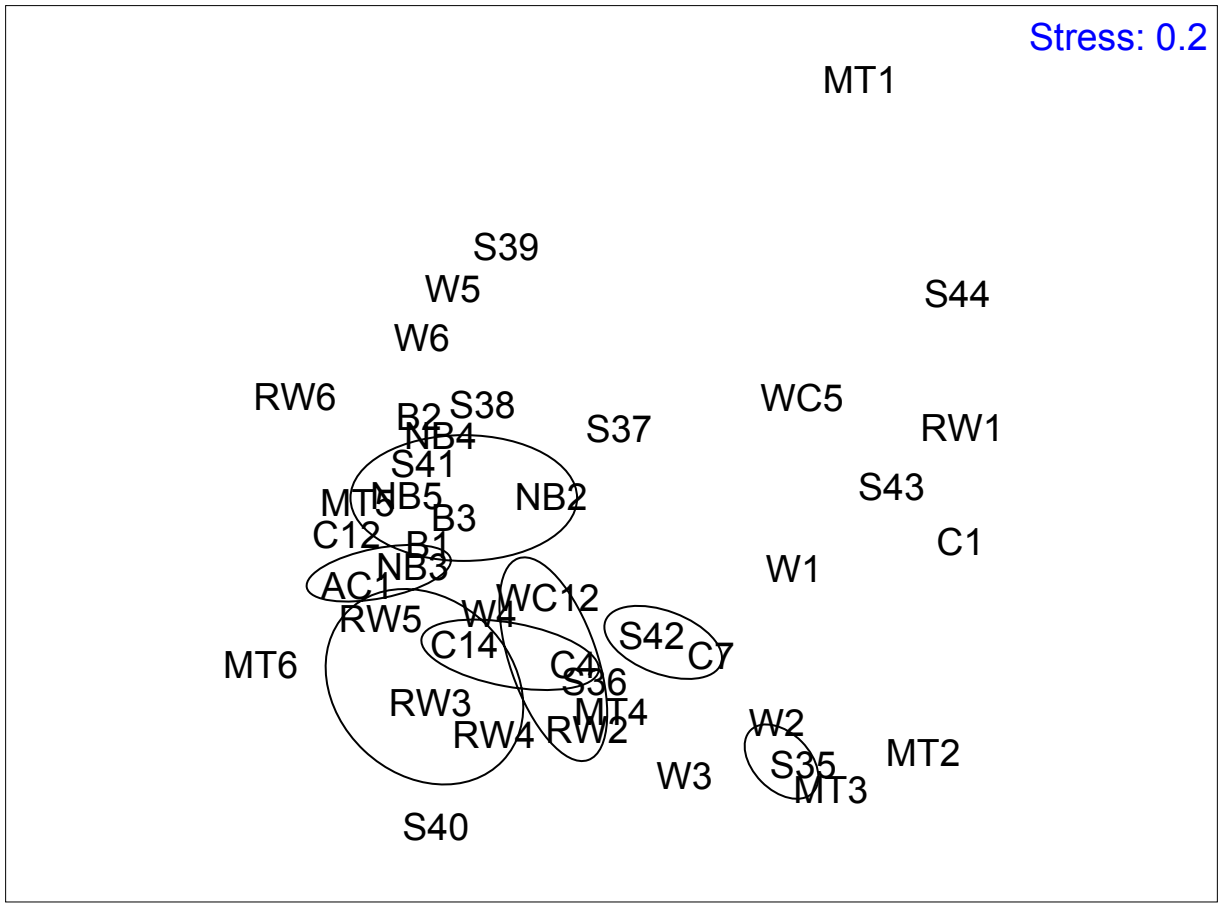
Harpacticoida



0 = 35% Similarity

Community Structure (MDS)

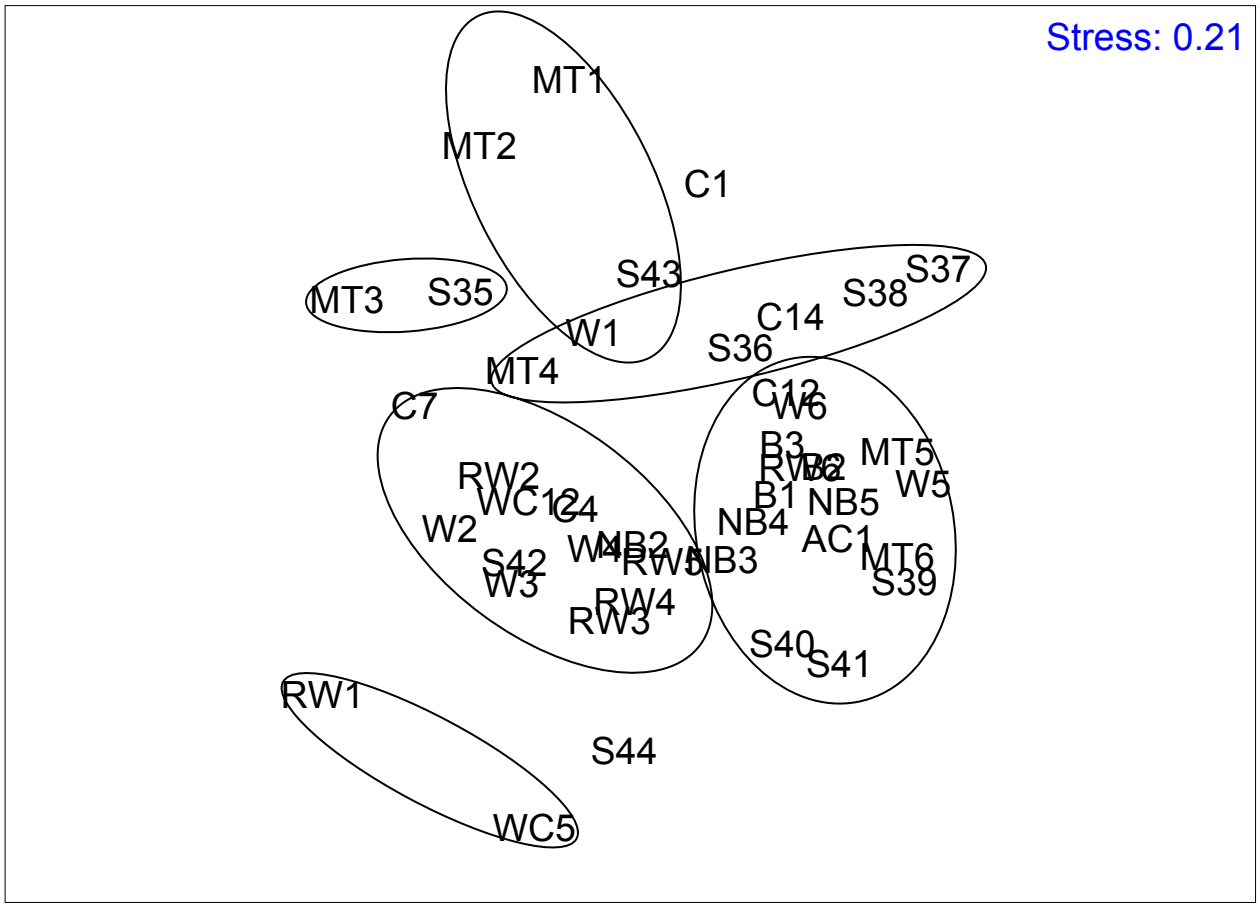
Crustacea



0 = 35% Similarity

Community Structure (MDS)

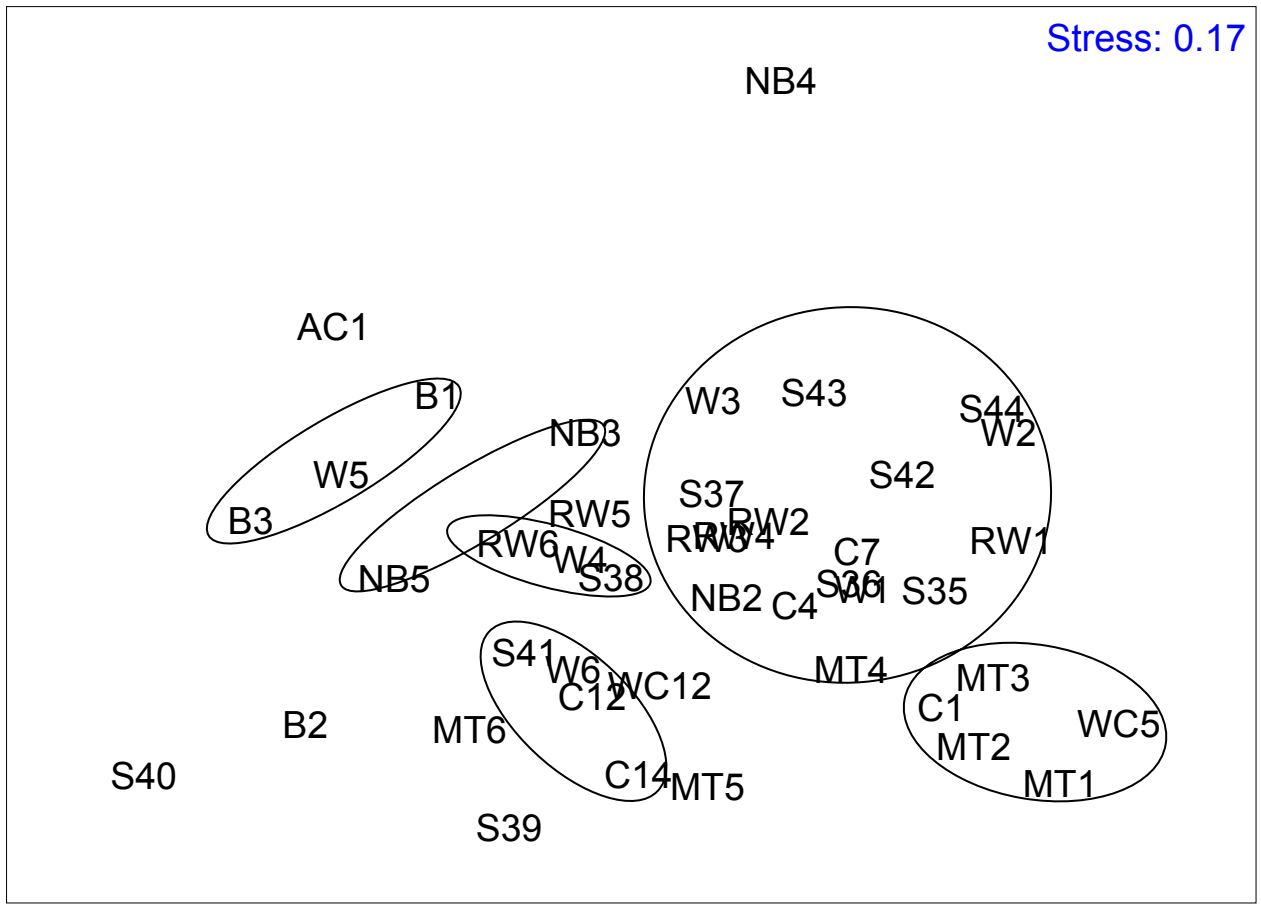
Mollusca



0 = 35% Similarity

Community Structure (MDS)

Polychaeta



0 = 35% Similarity

Community Structure Relatedness

Sample statistic (Rho), which tests the matching of the two MDS patterns, and the significance level.

	Crust	Moll	Poly
Harp	0.21 ***	0.17 ***	0.35 ***
Crust		0.61 ****	0.42 ***
Moll			0.32 ***

Conclusions: Linking Environment and Benthos

- PC1 and PC2 station scores were significantly correlated with bacterial, meiofaunal, and macrofaunal total abundance
- Association with PC2 was much stronger than with PC1; thus, total abundance of the three main groups increase with increasing fine sediment structure and particulate organic matter flux
- Diversity had few and weaker significant correlations with PC1 and PC2
- Trends indicate that total meiofauna (predominantly nematodes) and polychaetes abundance increases with increasing flux to bottom
- Community structure patterns same in all groups (harpacticoids, crustacea, polychaetes and mollusks)