Response of benthic communities in Narragansett Bay to changing temperature and nitrogen input

By: Shaina Harkins

Background

- Decrease in WWTF nitrogen input – why?
  - Weak summer stratification
  - Eutrophication
  - Strong spring neap tide
- Continued increase in development and warming
- Monitoring benthic organisms gauges overall health of the Bay
  - A wealth of historical data exists

Comparing current data to historical data

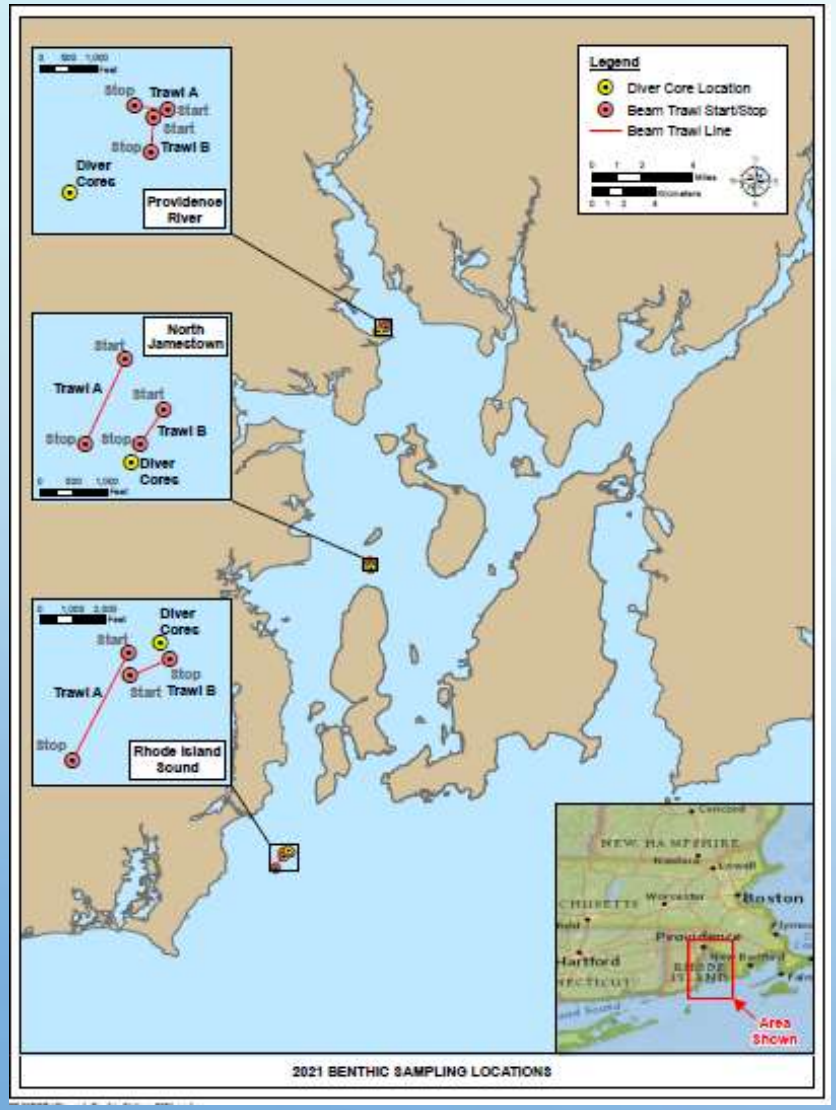
Study	Phelps 1958	Chowder Marchi-ng 1967	Hale 1974	Pratt & Bisagni 1976	Myers & Phelps 1978	Hyland 1981	Hughes 1983	French et al 1993	Calabre-tta 2008
Dates/ Interval sampled	3/1957	8/1967	11/1974	7/1975	**7/1975-7/1976 quarterly**	**8/1977-8/1978 quarterly**	**8/1983-4/1986 monthly**	6/1990-9/1990 monthly	**6/2000-6/2010 yearly**
Stations sampled	RI	PR, NJ, RI	NJ	PR	**PR, NJ**	**NJ**	**NJ**	PR, NJ, RI	**PR, NJ**
Sampling method	Clam shell bucket	Van Veen grab	Smith-McIntyre grab	Smith-McIntyre grab	**Diver collected cores**	**Diver collected cores**	**Diver collected cores**	Smith-McIntyre grab	**Diver collected cores**
Area sampled (cm^2)	2000	1000	1000	400	**175/322**	**420**	**17.35**	470	**8.04**
Smallest sieve size (µm)	500	500	750	750	**500**	**300**	**300**	500	**300**

Comparing current data to historical data

- Preserving water-sediment interface
- Considering epifauna vs macrofauna
  - Epifauna = **on sediment**
    - Larger, more mobile predators
  - Macrofauna = **in sediment**
    - Smaller deposit & suspension feeders
- Biomass measurements
  - Most historical studies consider abundance
  - Biomass can be used for production estimates and Bay food webs

Objectives

- To compare current macrofaunal community composition between north, mid, and south stations in the West Passage of Narragansett Bay
- To compare current epifaunal community composition between the same stations
- To compare current north and mid station macrofaunal community composition to historical data against nitrogen and temperature
- To obtain biomass and production measurements of current macrofaunal and epifaunal communities at each station



Field methods

- Sampling occurred end of June 2021 and 2022 from Cap'n Bert:
  - Diver-collected cores
  - Beam trawl
- 3 sampling stations:
  - Providence River (upper bay)
  - North Jamestown (mid bay)
  - Rhode Island Sound (lower bay)

Field methods

- For each station:
  - 15 replicate sediment cores for macrofauna
  - Top 2 cm and overlying water, bottom 8 cm
  - 2 replicate 15-minute beam trawl tows for epifauna
  - All samples stored in 4% pH buffered formaldehyde & dyed with rose Bengal
  - YSI data including bottom oxygen, temperature, salinity

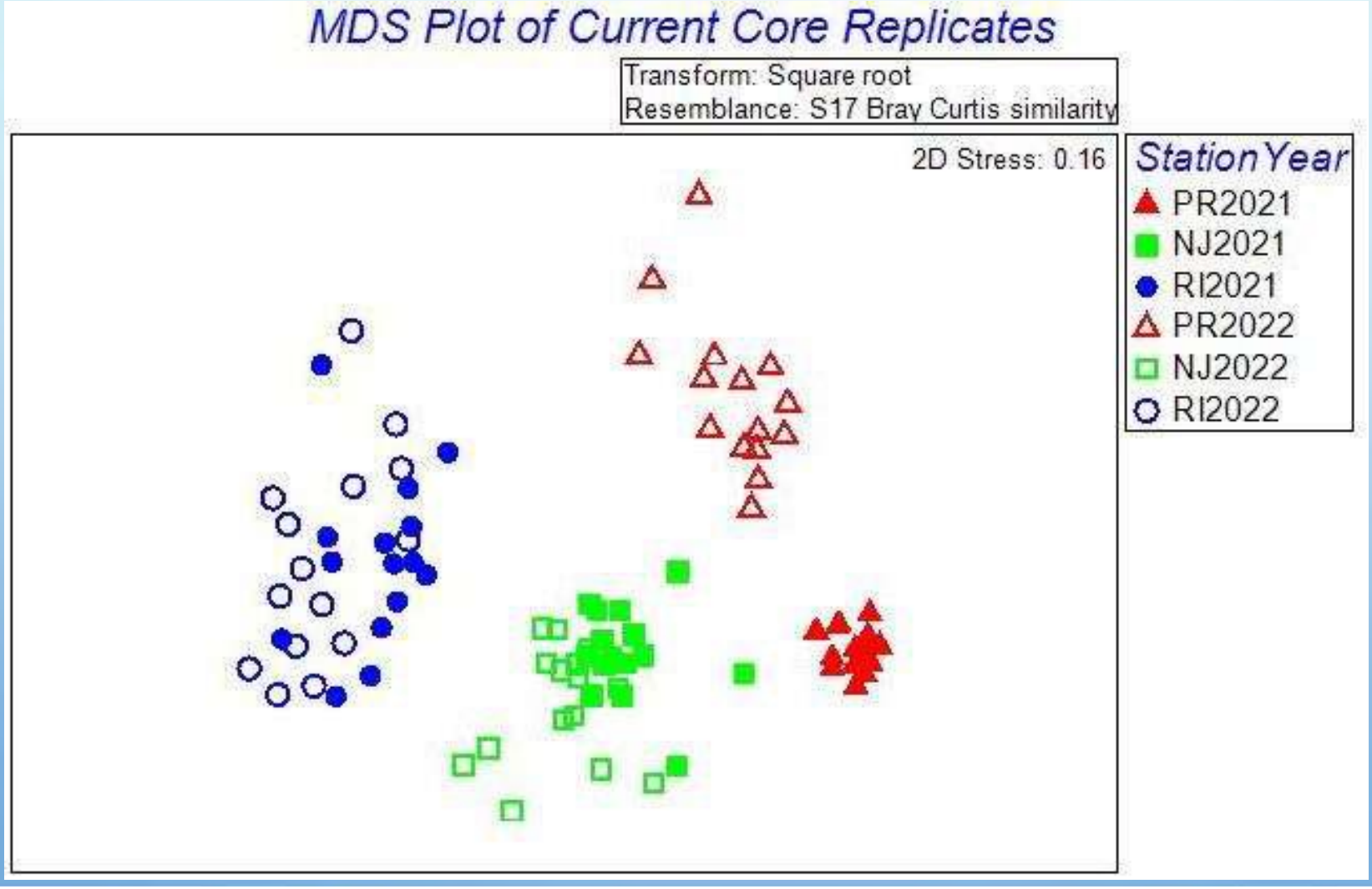
Laboratory methods

- Samples sieved through 500 µm mesh
- Identified to lowest possible taxonomic group
  - Long-term storage in 70% ethanol
- Biomass measurements
  - Large epifauna weighed on boat
  - Pooled masses on gram scale
  - Individual masses on microgram scale

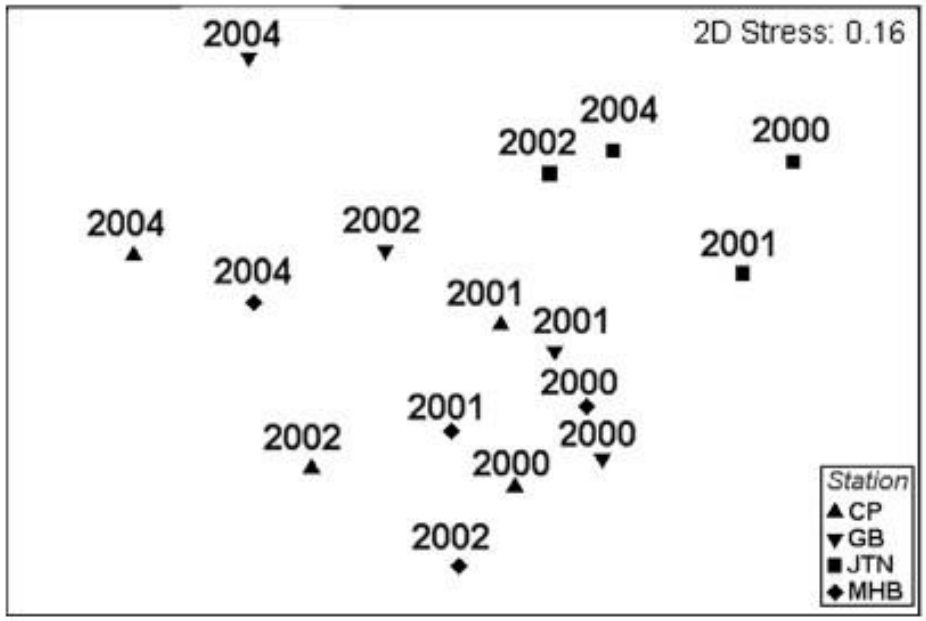
Statistical analysis

- Current study macrofauna and epifauna
  - Bray-Curtis similarity matrix
  - **Multi-dimensional scaling (MDS)**
  - **Abundance/biomass comparison curves**
- Macrofauna through time
  - Bray-Curtis similarity matrix
  - Euclidean distance matrix
  - **MDS plot**
  - Analysis of Similarities (ANOSIM)
  - Similarity Percentages (SIMPER)
  - **BIO-ENV + BVSTEP (BEST)**

Results: Macrofaunal MDS

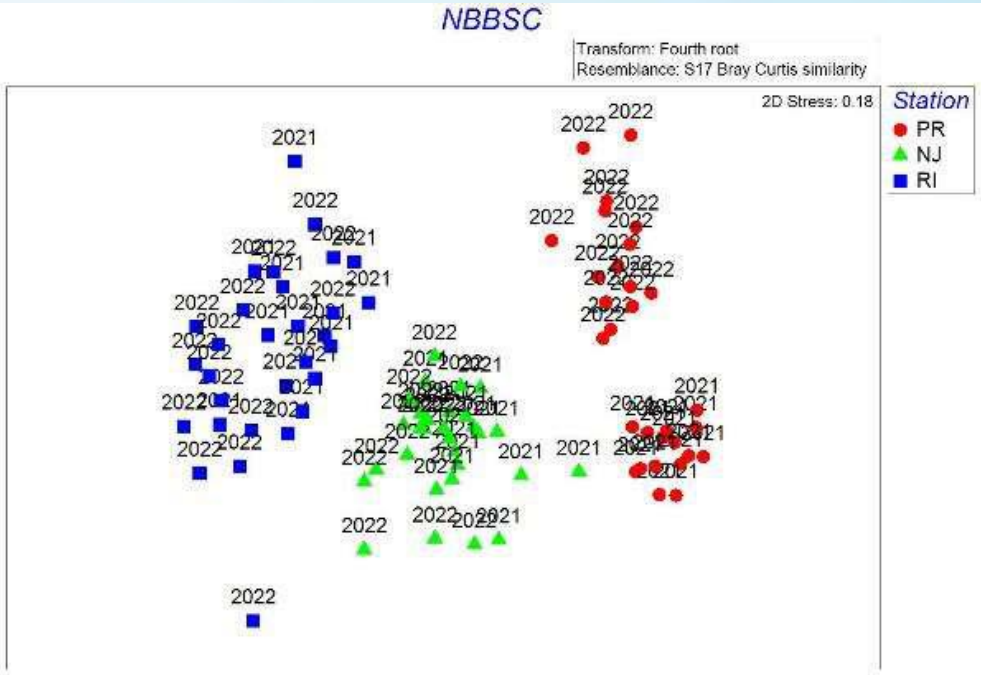


Multidimensional scaling comparison



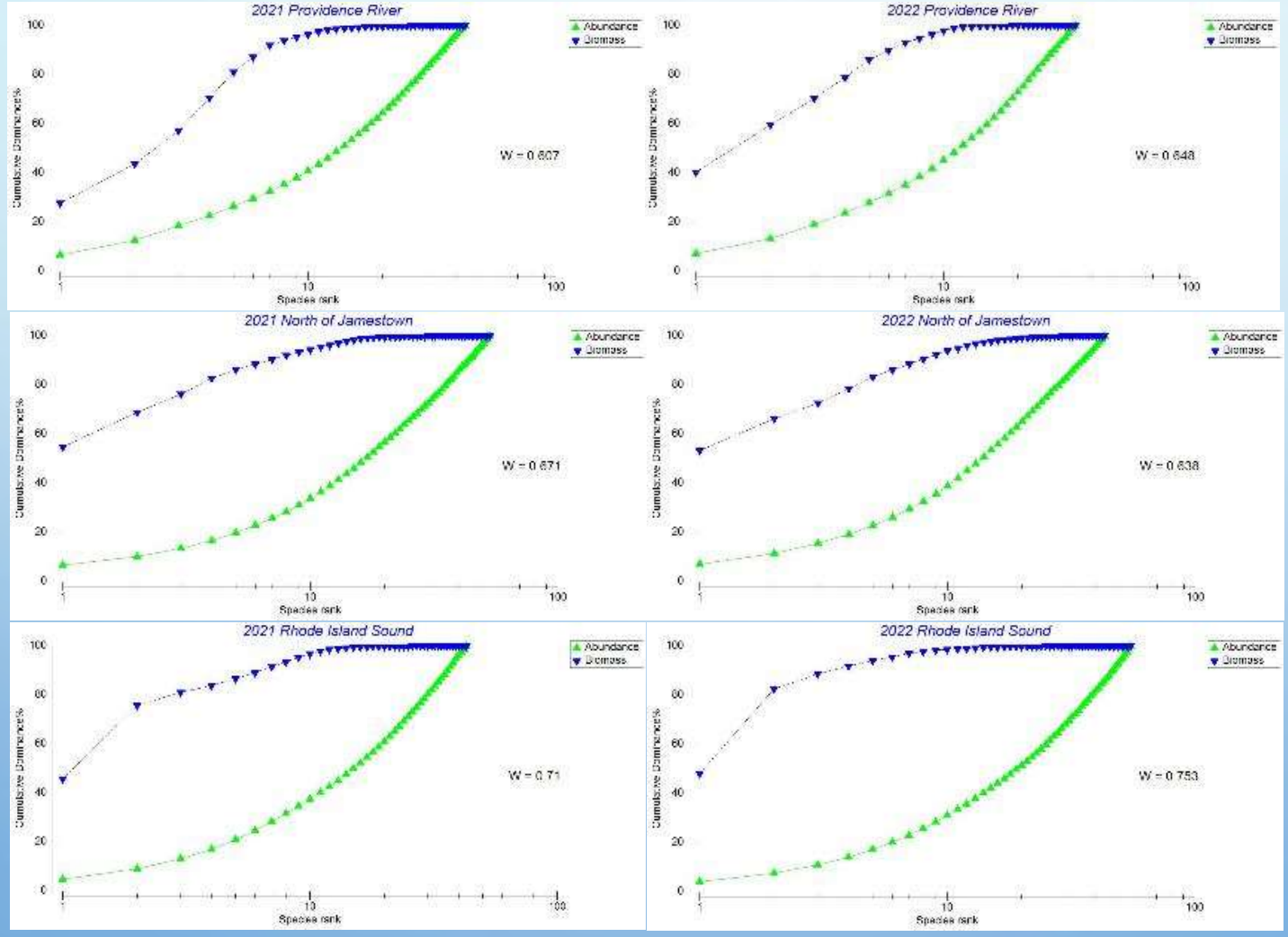
Calabretta & Oviatt (2008) gradation between years and between stations

CP = Conimicut Point GB = Greenwich Bay
JTN = North Jamestown MHB = Mount Hope Bay

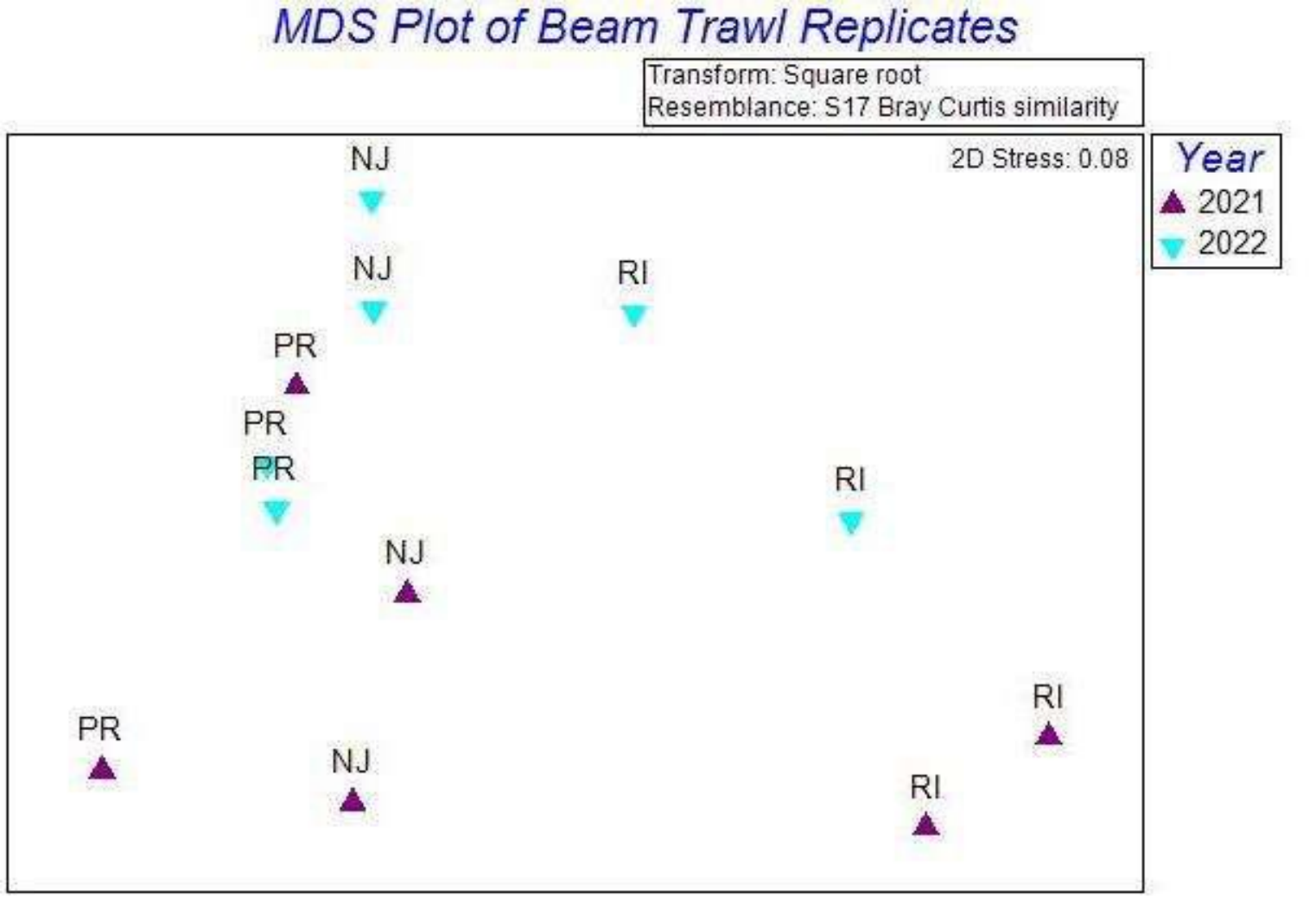


Current study: between year Providence River gradation

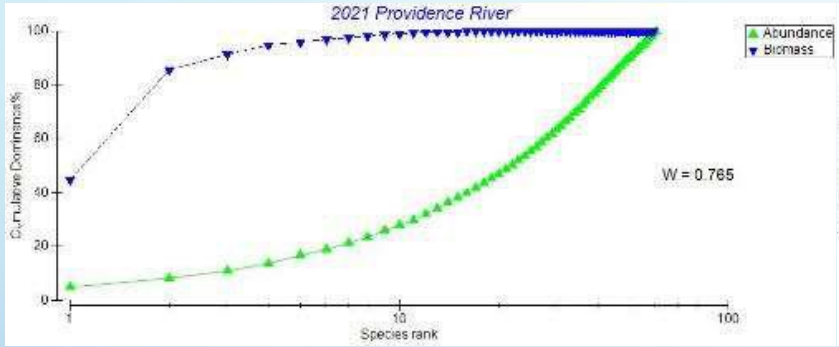
Macrofaunal ABC Curves

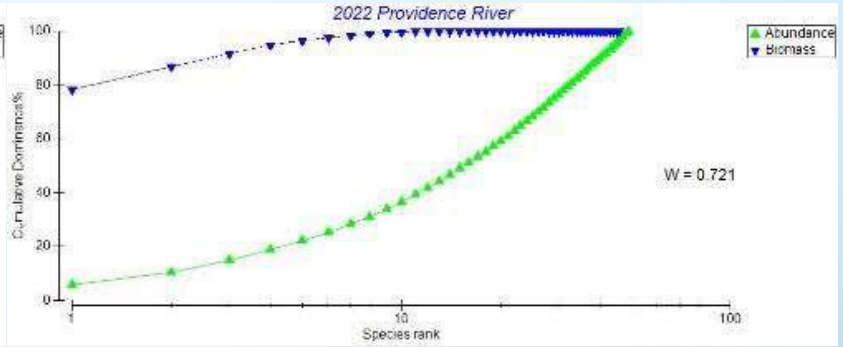


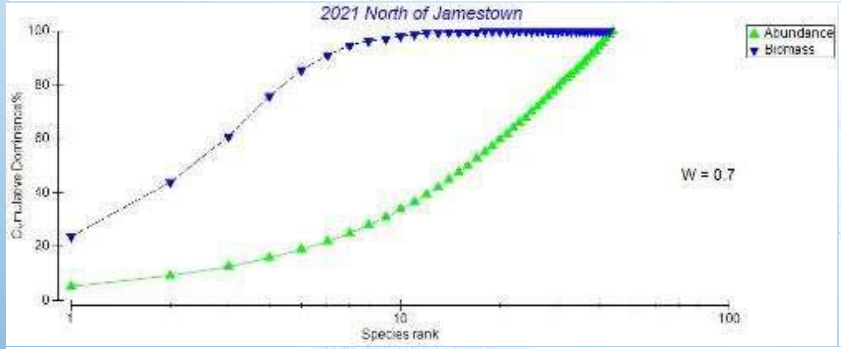
Epifaunal MDS

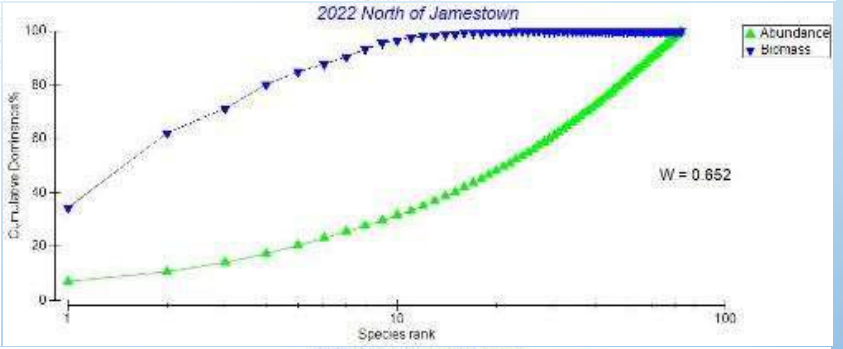


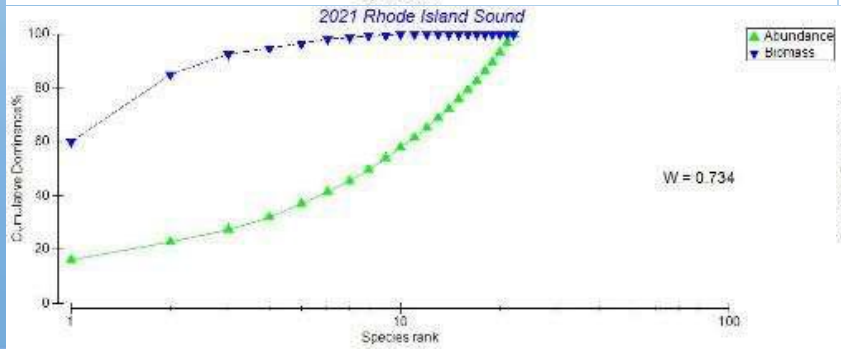
Epifaunal ABC Curves

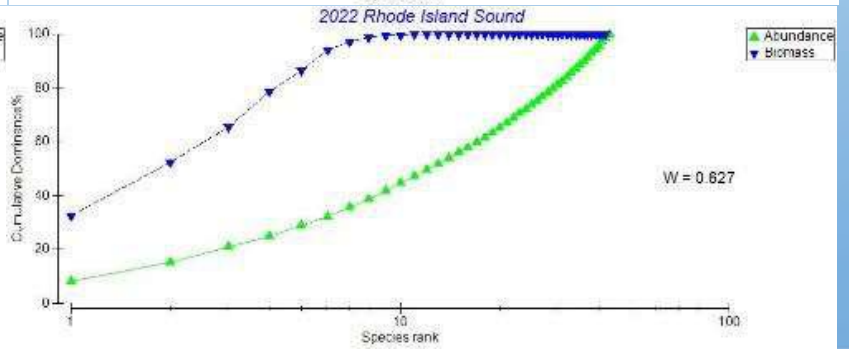




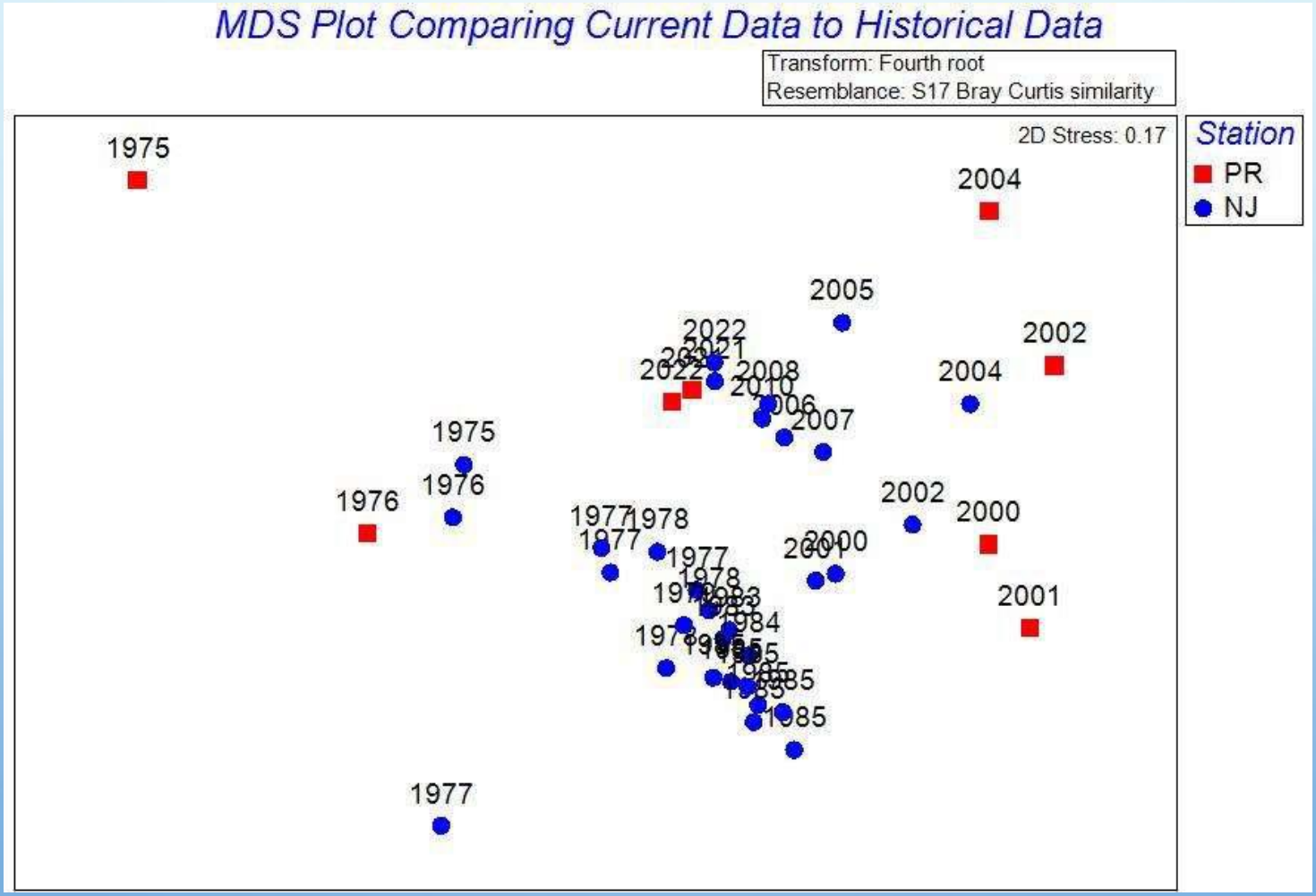




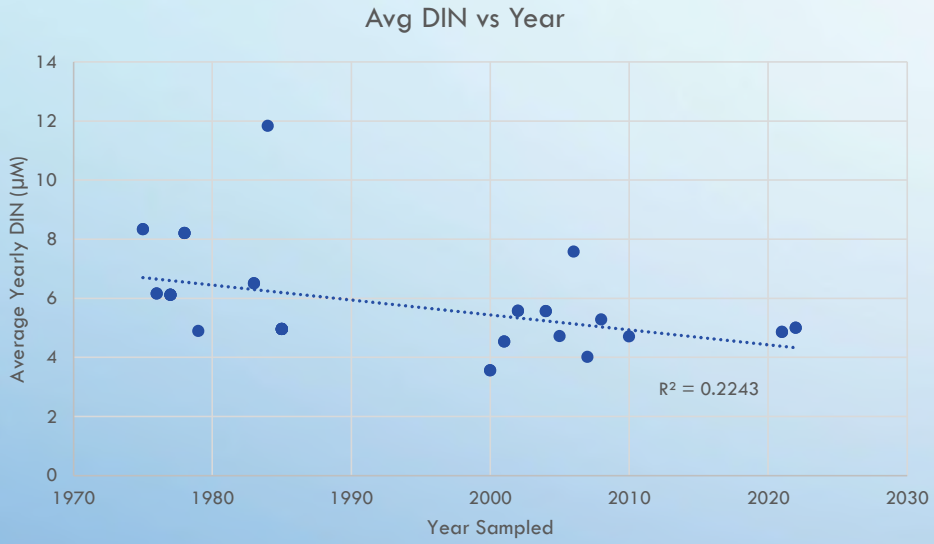


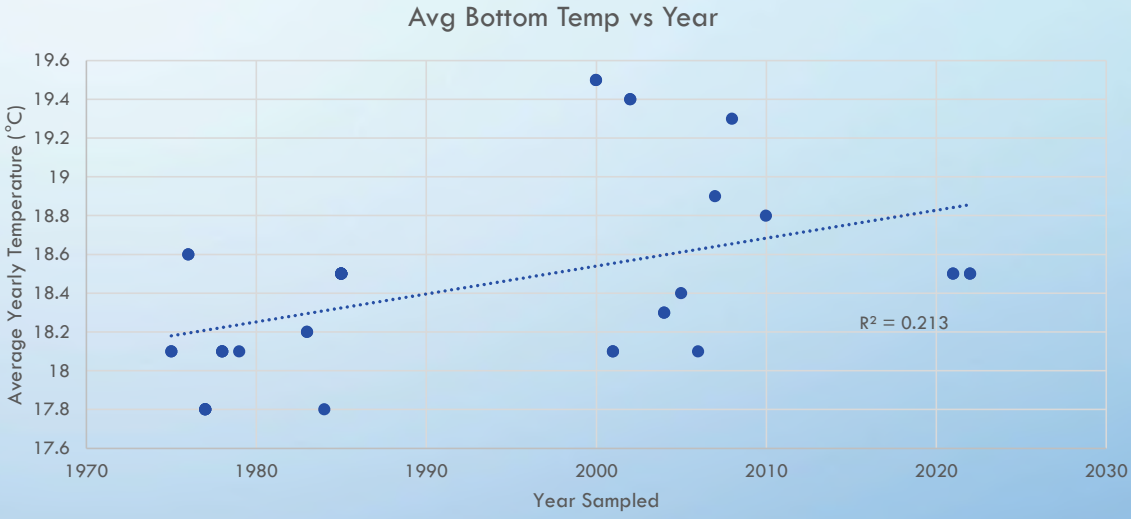


Temporal Macrofaunal MDS



Temporal Macrofaunal BEST Analysis





- BEST Analysis showed macrofaunal community composition did not change significantly with average yearly temperature (ρ=-0.121) or average yearly nitrogen (ρ=0.037)

Macrofaunal and Epifaunal Biomass and Energy Content

Macrofaunal (per m^2)

	PR 2021	NJ 2021	RI 2021	PR 2022	NJ 2022	RI 2022
Total Biomass (mg)	139888.5	94297.36	86557.92	54098.38	35545.33	75156.1
Total Energy (J)	3217435	2168839	1990832	1244263	817542.5	1728590
Total Energy (KJ)	3217.435	2168.839	1990.832	1244.263	817.5425	1728.59

Epifaunal (per m^2)

	PR 2021	NJ 2021	RI 2021	PR 2022	NJ 2022	RI 2022
Total Biomass (mg)	264.7736	107.6452	58.11006	543.7911	248.5239	216.7073
Total Energy (J)	6089.792	2475.84	1336.531	12507.2	5716.049	4984.268
Total Energy (KJ)	6.089792	2.47584	1.336531	12.5072	5.716049	4.984268

Conclusions

- Macrofaunal community composition between year shift still exists
- ABC curves showed undisturbed through communities throughout
- Biomass measurements obtained for both macrofauna and epifauna at different points in Bay

Conclusions – further?

- No significant change with nitrogen or temperature through time for macrofaunal community
  - Still an outcome to mitigation
  - Indirect effects
- We know the communities changed with time, what caused it?
  - Mandated decreases in heavy metals and hydrocarbons
  - Ammonium or nitrate alone
  - Functional feeding groups or significance at higher taxon level

Acknowledgements

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  - Captain Steve

GSO

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Questions?