August 2024

Observing the Fouling Community:

Use of fouling as ecological indicators and to characterize marsh habitats

Morgan Martinez

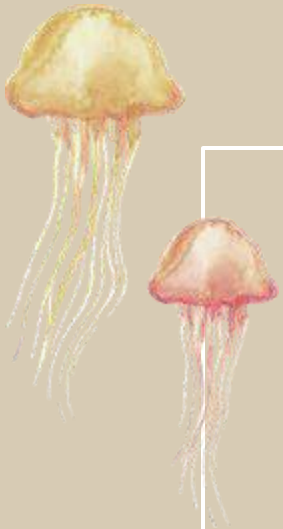
What is fouling?

Growth and accumulation of aquatic microorganisms, algae, and other sessile organisms on surfaces

Ecological Indicator Species Background

Example:

- Species which can provide information on ecological changes and give early warning signals regarding ecosystem processes in site-specific conditions due to their sensitive reactions to them
- Observed through their presence, absence, or abundance
- **Fouling as Ecological Indicator Species**
  - Fouling is easily accessible and exists throughout the world
  - AI Machine Learning identification



What biofouling organisms are sensitive to certain induced disturbances?

Treatments - Indicator Project

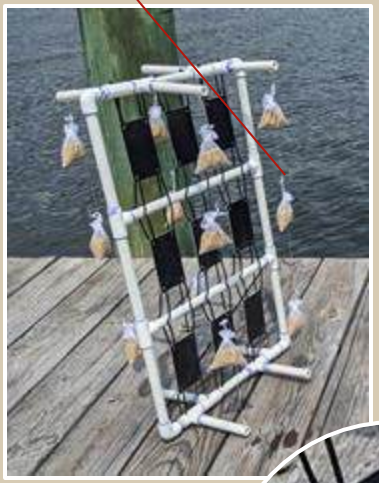
Zinc Based Antifouling Paint

Nitrogen and Phosphorus based Plant Fertilizer

Control

Setup - Indicator Project

Fishing Line



Mesh bags with Fertilizer

- 9 collection plates secured to PVC frames
- 3 frames total
  - Paint frame
  - Nutrient frame
  - Control Frame
- Suspended from Peterson Pier

Collection plates with antifouling paint

Marsh Grass Background

Phragmites

Invasive

Spartina

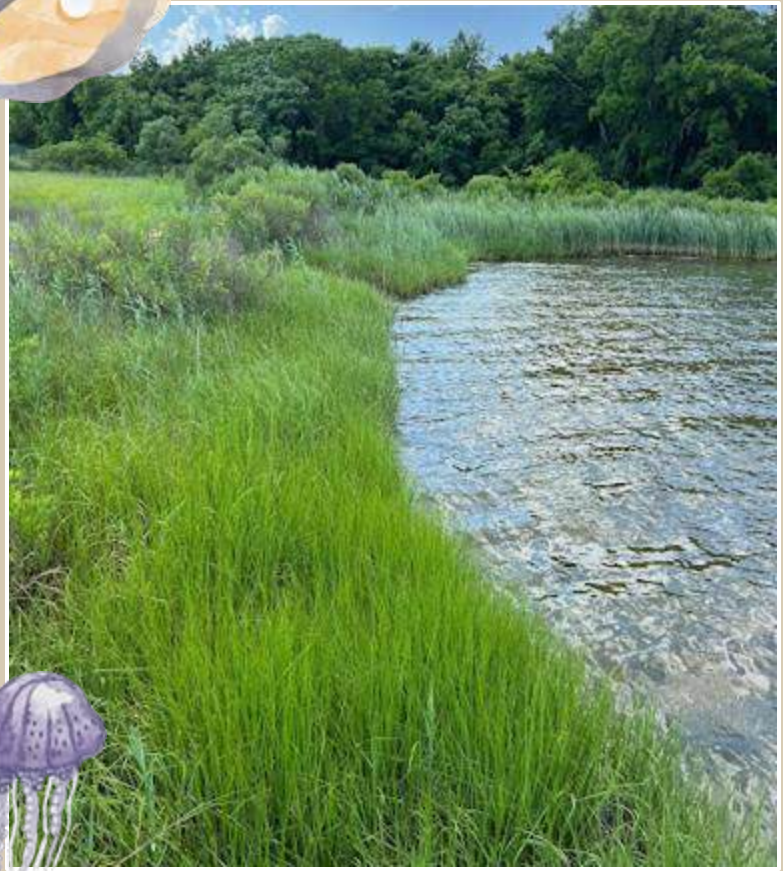
Native

Do the biofouling communities that grow in **Phragmites** dominated marshes differ from the biofouling communities that grow in **Spartina** dominated marshes?

Locations - Marsh Project

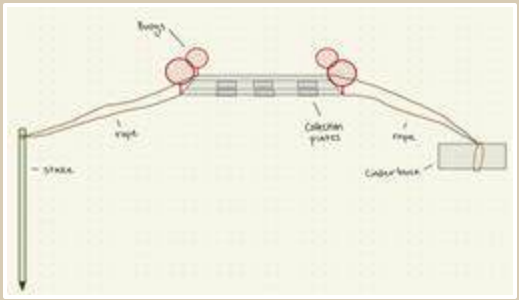
- 2 Spartina Sites
- 2 Phragmites Sites
- 2 Mixed Sites
- 1 Control Sites

Locations - Marsh Project



Setup - Marsh Project

- **At each site:**
- 6 panels attached to floating frame
  - Secured as close to shoreline as possible without being exposed at low tide
- 6 panels attached to base of marsh grass
- 12 panels at each site = 84 panels total



Field Data Collection

- **Plate Sampling (Weekly)**
  - Randomly selected one plate from each setup at each site
  - Marsh plates bagged underwater to prevent organisms falling off when removed

- **Field Measurements (Weekly)**
  - Water Temperature (°C)
  - Salinity (ppt)
  - Dissolved Oxygen (mg/L)
  - Secchi Turbidity (cm)
  - Nutrient Levels (Indicator only)
    - Nitrate, Nitrite, Ammonia (ppm)

Lab Data Collection

- **Biofouling Community Composition**
- For each side of sampled plate
  - Count abundance of each group of organisms we are able to identify
  - Observations are recorded as percent coverage of entire plate
    - Tube worms also counted individually

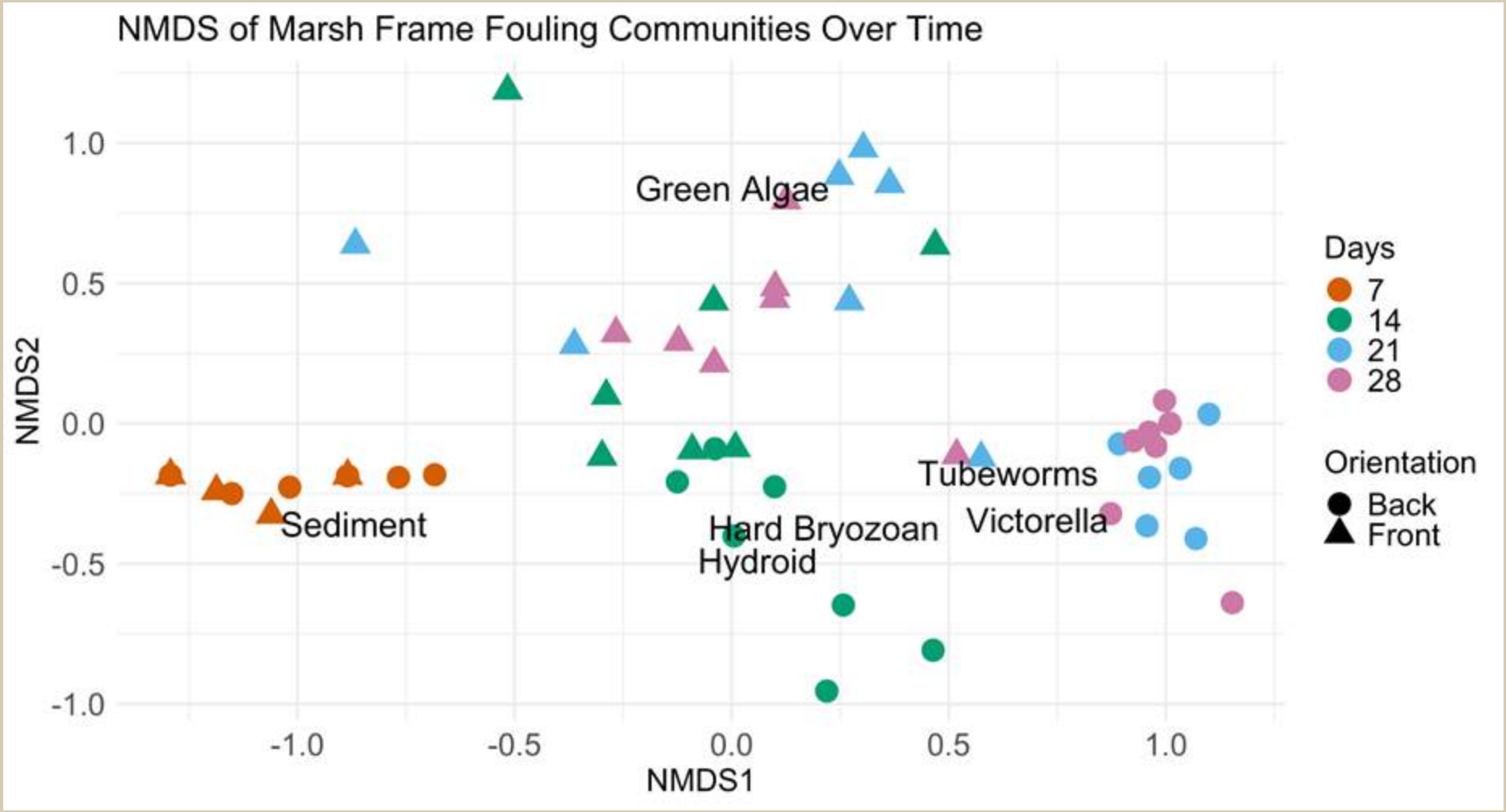
- **Common groups observed**
  - Tubeworms
  - Victorella - Soft Bryozoans
  - Filamentous Green Algae
  - Membranipora membranacea - Hard Bryozoans
  - Various colonial hydroids
  - Motile crustaceans (mostly amphipods)
  - Lots of worms!

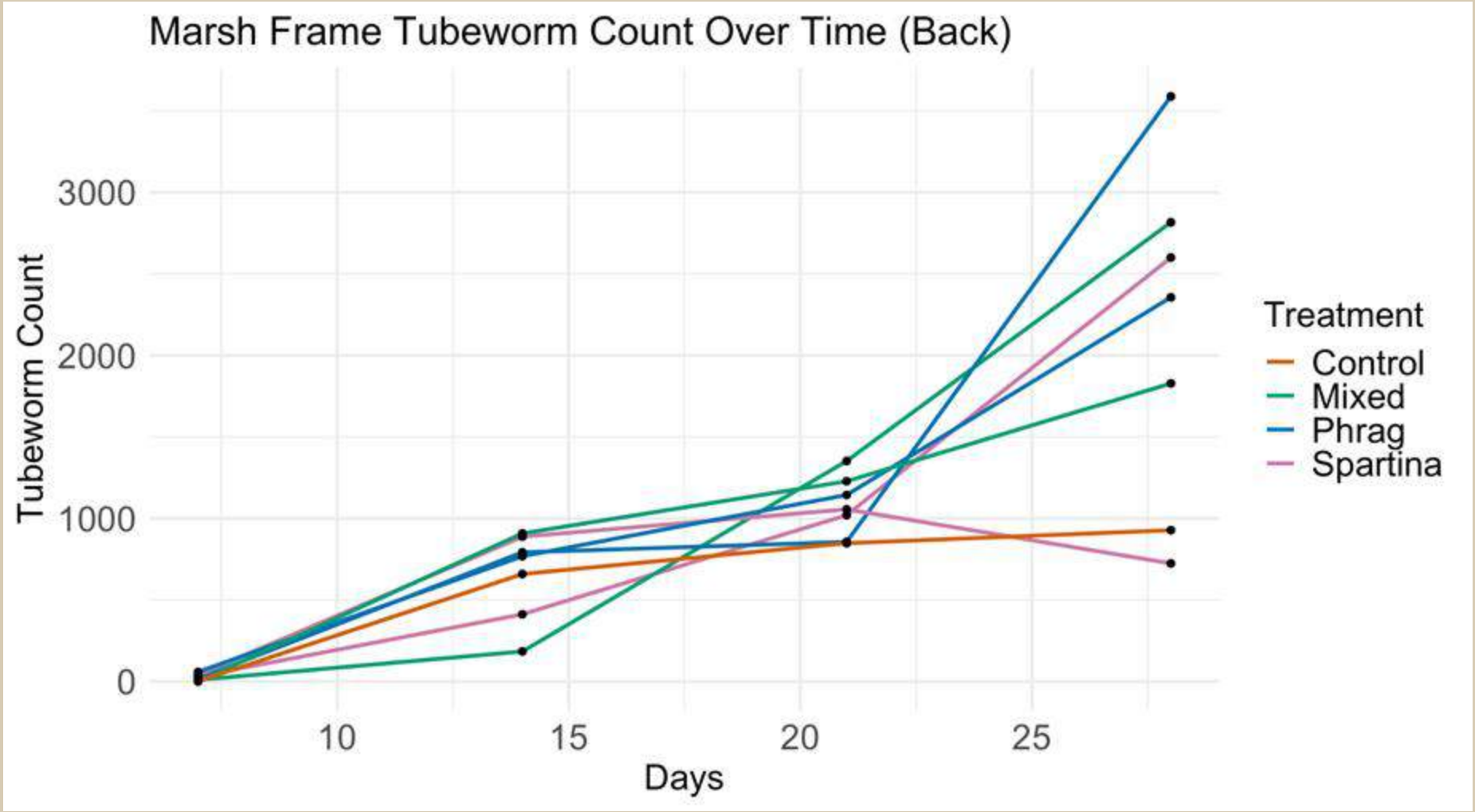
Fieldwork Issues

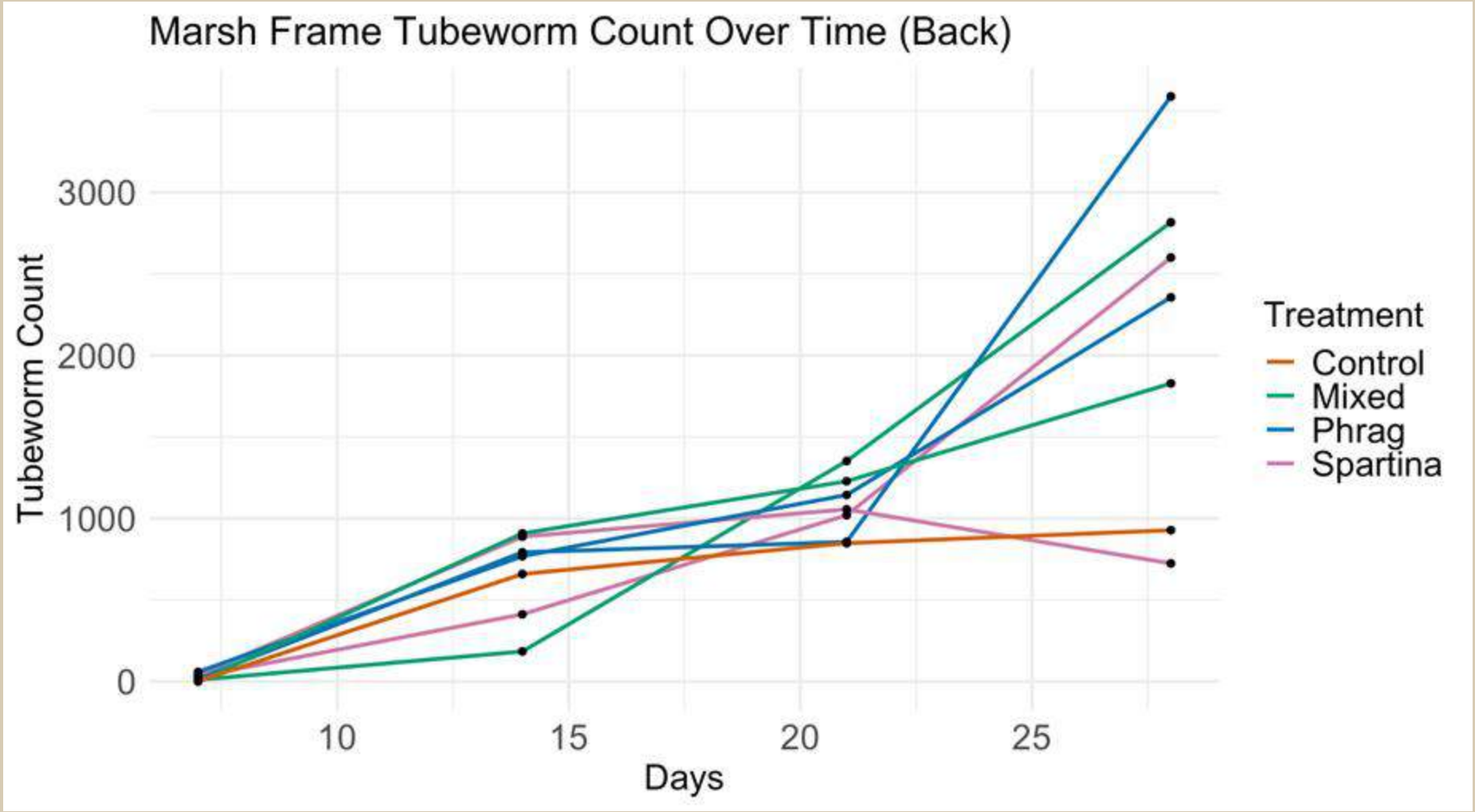
- **Embedded Marsh Plates**
  - Lost or buried
- **Field Measurements**
  - Nutrient testing at depth
  - Secchi turbidity in shallow sites without stirring water
  - Flow measurements at low energy sites

PERMANOVA Marsh Frame

	Df	SumOfSqs	R2	F	Pr(>F)
Days	1	4.7761948	0.351147068	35.3076550	0.001
Orientation	1	1.7280454	0.127046341	12.7744435	0.001
Treatment	3	0.3687488	0.027110509	0.9086492	0.487
Site	1	0.1002964	0.007373819	0.7414337	0.520
Residual	49	6.6284081	0.487322262	*NA*	*NA*
Total	55	13.6016936	1.000000000	*NA*	*NA*


NMDS of Marsh Frame Fouling Communities Over Time
NMDS2
NMDS1
1.0
0.5
0.0
-0.5
-1.0
-1.0
-0.5
0.0
0.5
1.0
Green Algae
Sediment
Hard Bryozoan
Hydroid
Tubeworms
Victorella
Days
7
14
21
28
Orientation
Back
Front


Marsh Frame Tubeworm Count Over Time (Back)
Tubeworm Count
3000
2000
1000
0
10
15
20
25
Days
Treatment
Control
Mixed
Phrag
Spartina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Tubeworm Count
3000
2000
1000
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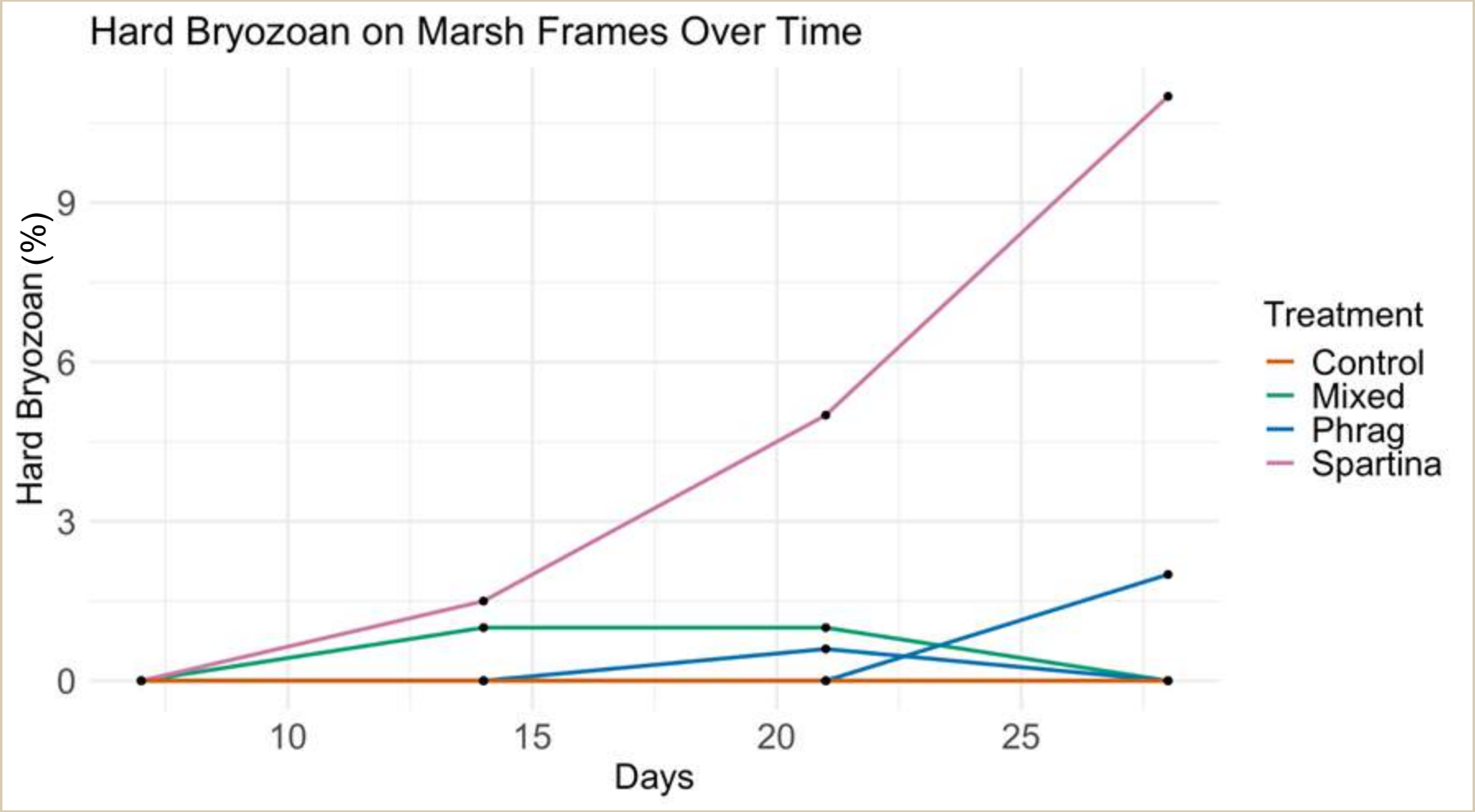
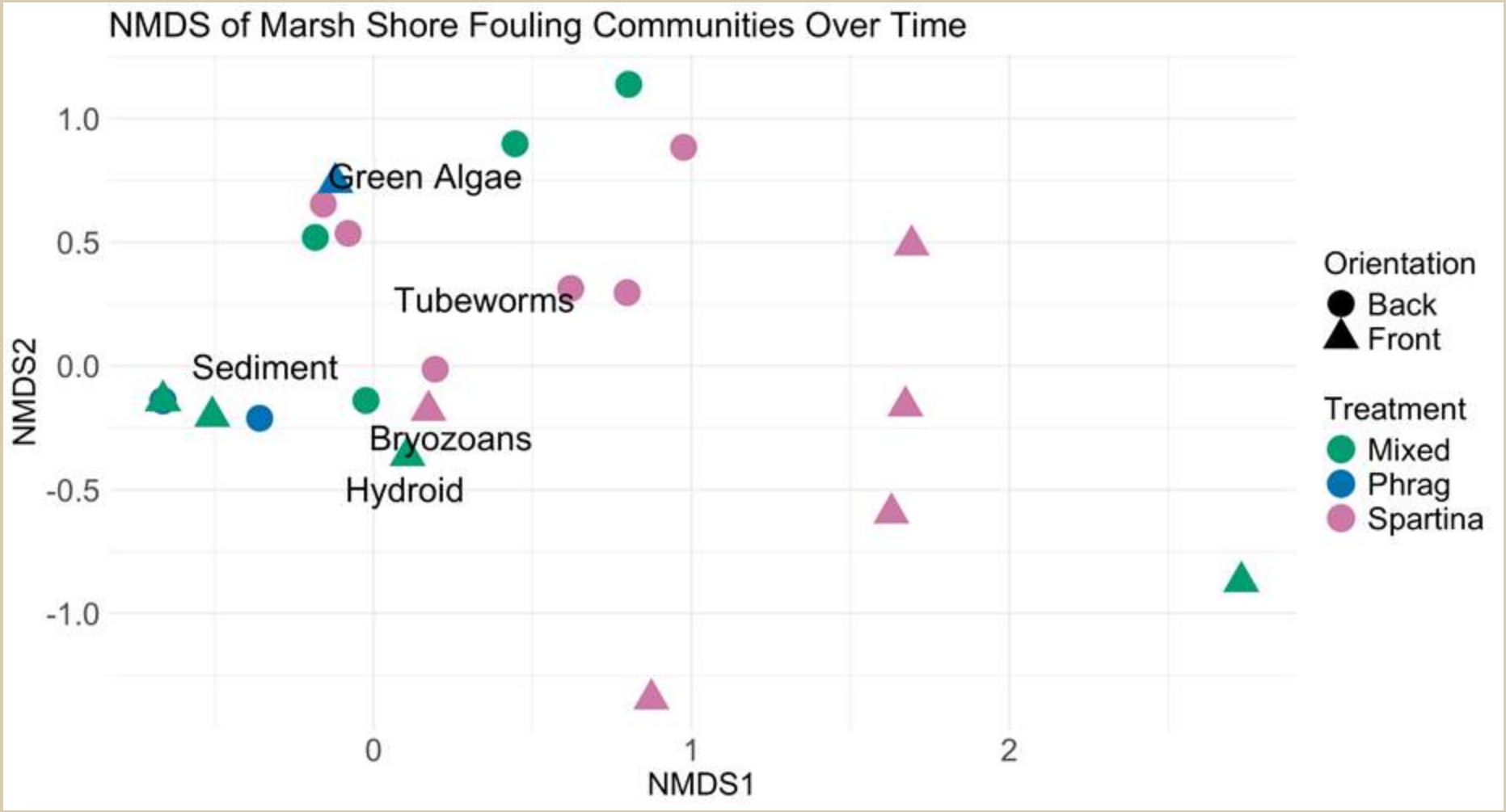
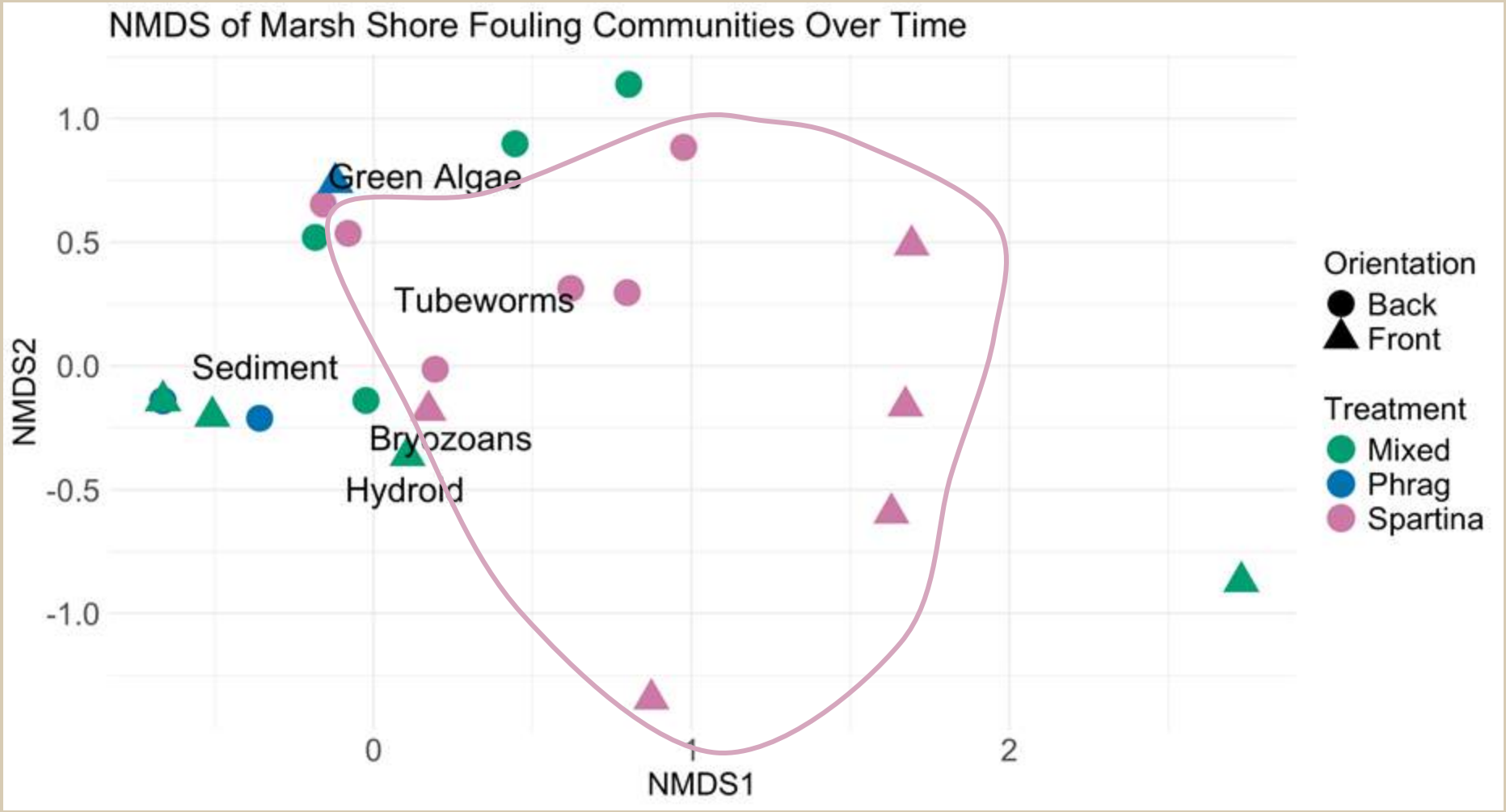
10
15
20
25
Days
Treatment
Control
Mixed
Phrag
Spartina


Hard Bryozoan on Marsh Frames Over Time
Hard Bryozoan (%)
0
3
6
9
10
15
20
25
Days
Treatment
Control
Mixed
Phrag
Spartina

PERMANOVA Marsh Shore

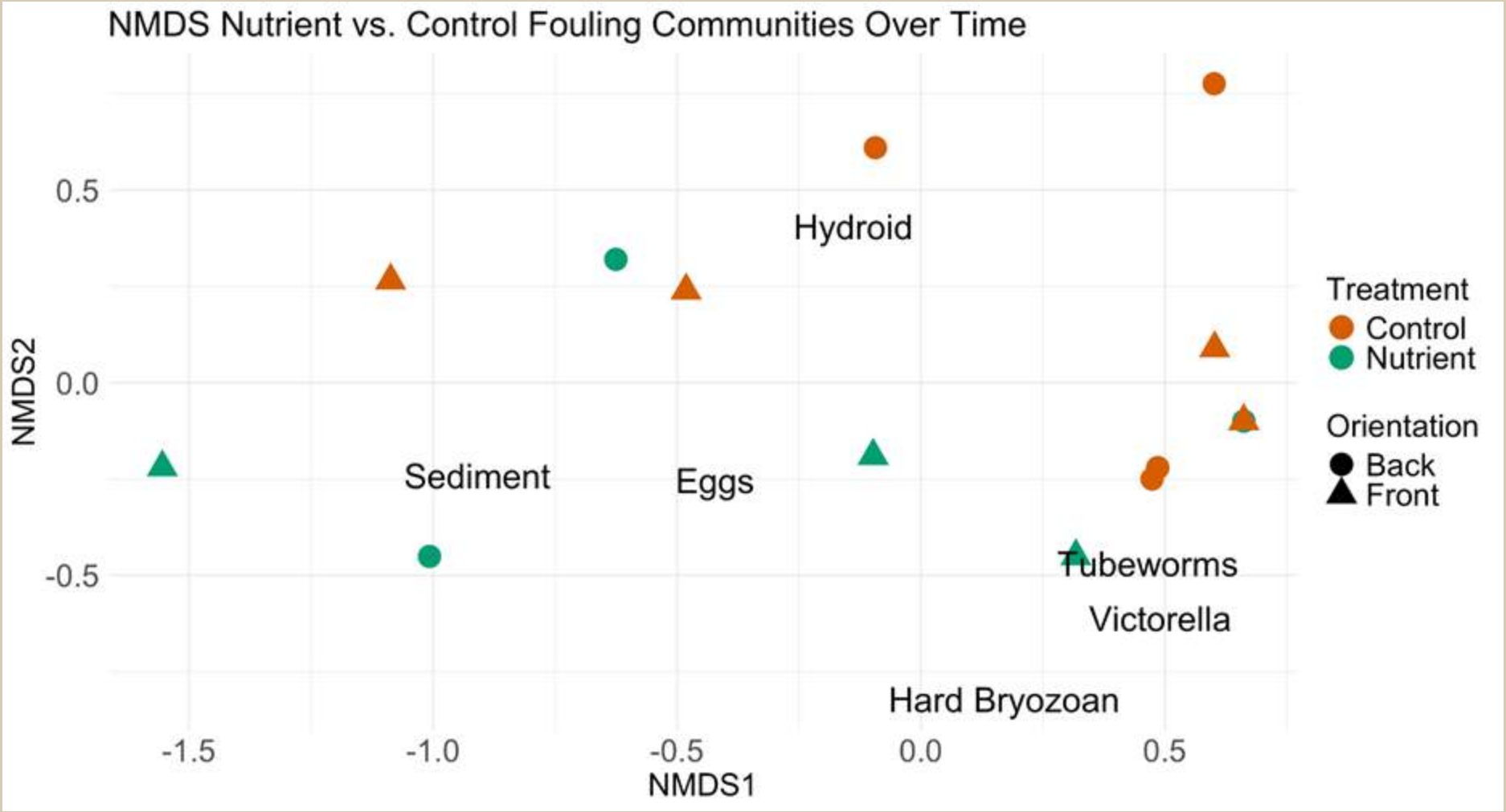
	Df	SumOfSqs	R2	F	Pr(>F)
Days	1	0.8478130	0.06785230	3.673728	0.008
Orientation	1	0.7053394	0.05644983	3.056364	0.015
Treatment	2	3.4130258	0.27315177	7.394630	0.001
Site	1	0.3747044	0.02998839	1.623662	0.134
Residual	31	7.1540968	0.57255771	*NA*	*NA*
Total	36	12.4949794	1.00000000	*NA*	*NA*

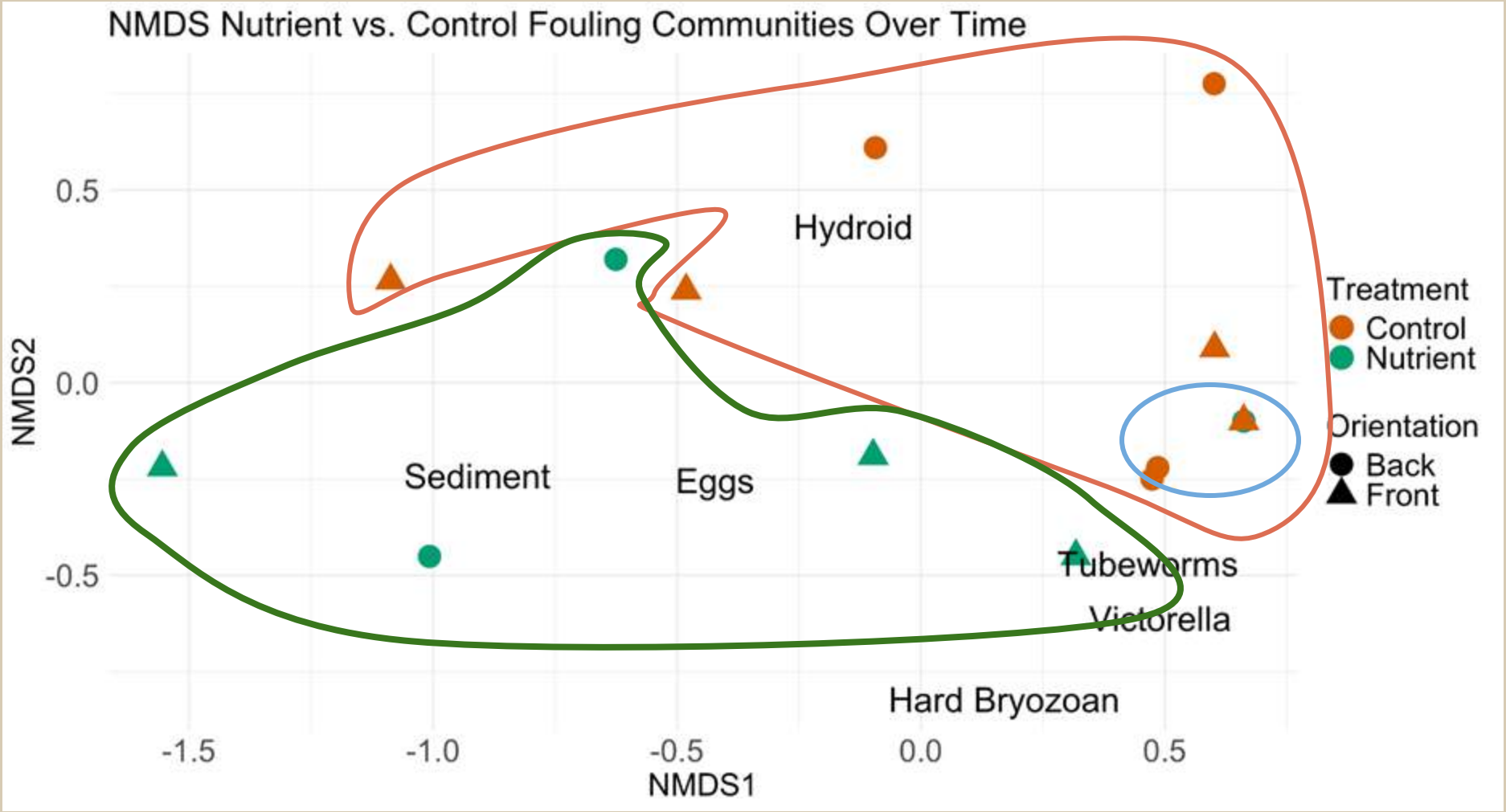

NMDS of Marsh Shore Fouling Communities Over Time
Green Algae
Tubeworms
Sediment
Bryozoans
Hydroid
NMDS1
NMDS2
1.0
0.5
0.0
-0.5
-1.0
0
1
2
Orientation
Back
Front
Treatment
Mixed
Phrag
Spartina

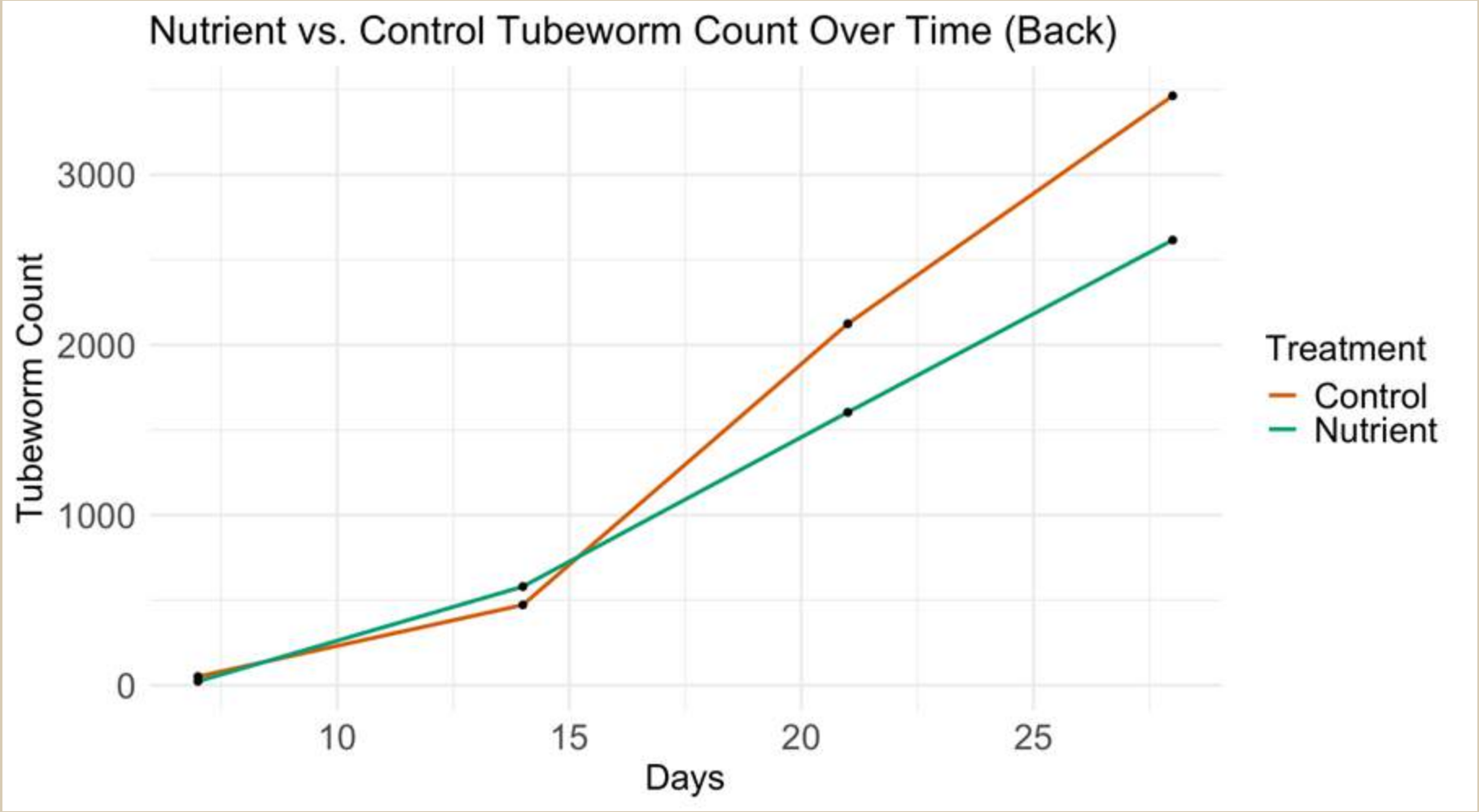

NMDS of Marsh Shore Fouling Communities Over Time
Green Algae
Tubeworms
Sediment
Bryozoans
Hydroid
NMDS1
NMDS2
1.0
0.5
0.0
-0.5
-1.0
0
1
2
Orientation
Back
Front
Treatment
Mixed
Phrag
Spartina

Nutrient vs. Control PERMANOVA

	Df	SumOfSqs	R2	F	Pr(>F)
Days	1	1.73054902	0.51571978	15.0008780	0.001
Orientation	1	0.09072688	0.02703746	0.7864457	0.440
Treatment	1	0.14996537	0.04469108	1.2999413	0.273
Residual	12	1.38435819	0.41255168	*NA*	*NA*
Total	15	3.35559946	1.00000000	*NA*	*NA*

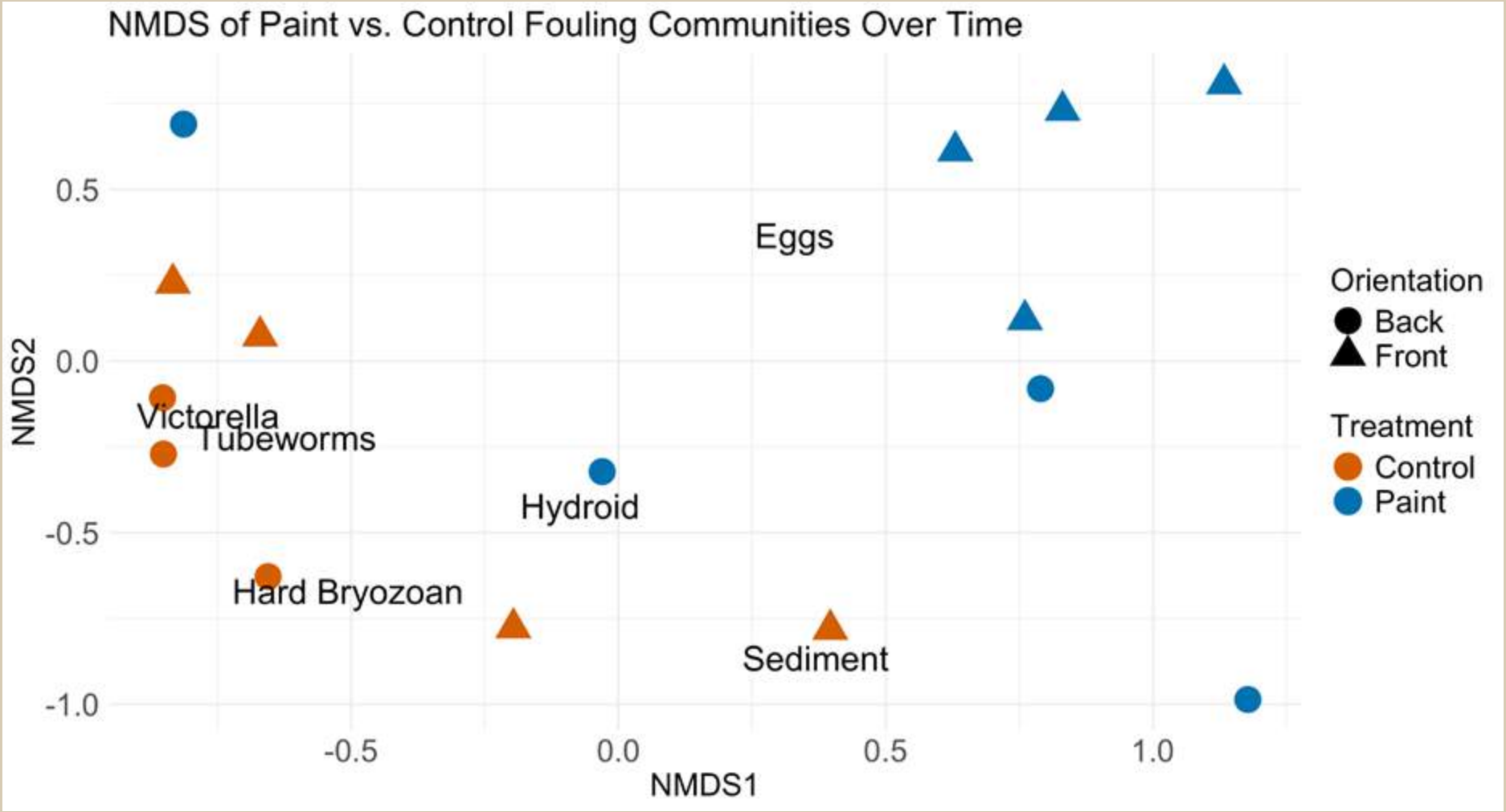

NMDS Nutrient vs. Control Fouling Communities Over Time
0.5
0.0
-0.5
NMDS2
-1.5
-1.0
-0.5
0.0
0.5
NMDS1
Hydroid
Sediment
Eggs
Tubeworms
Victorella
Hard Bryozoan
Treatment
Control
Nutrient
Orientation
Back
Front

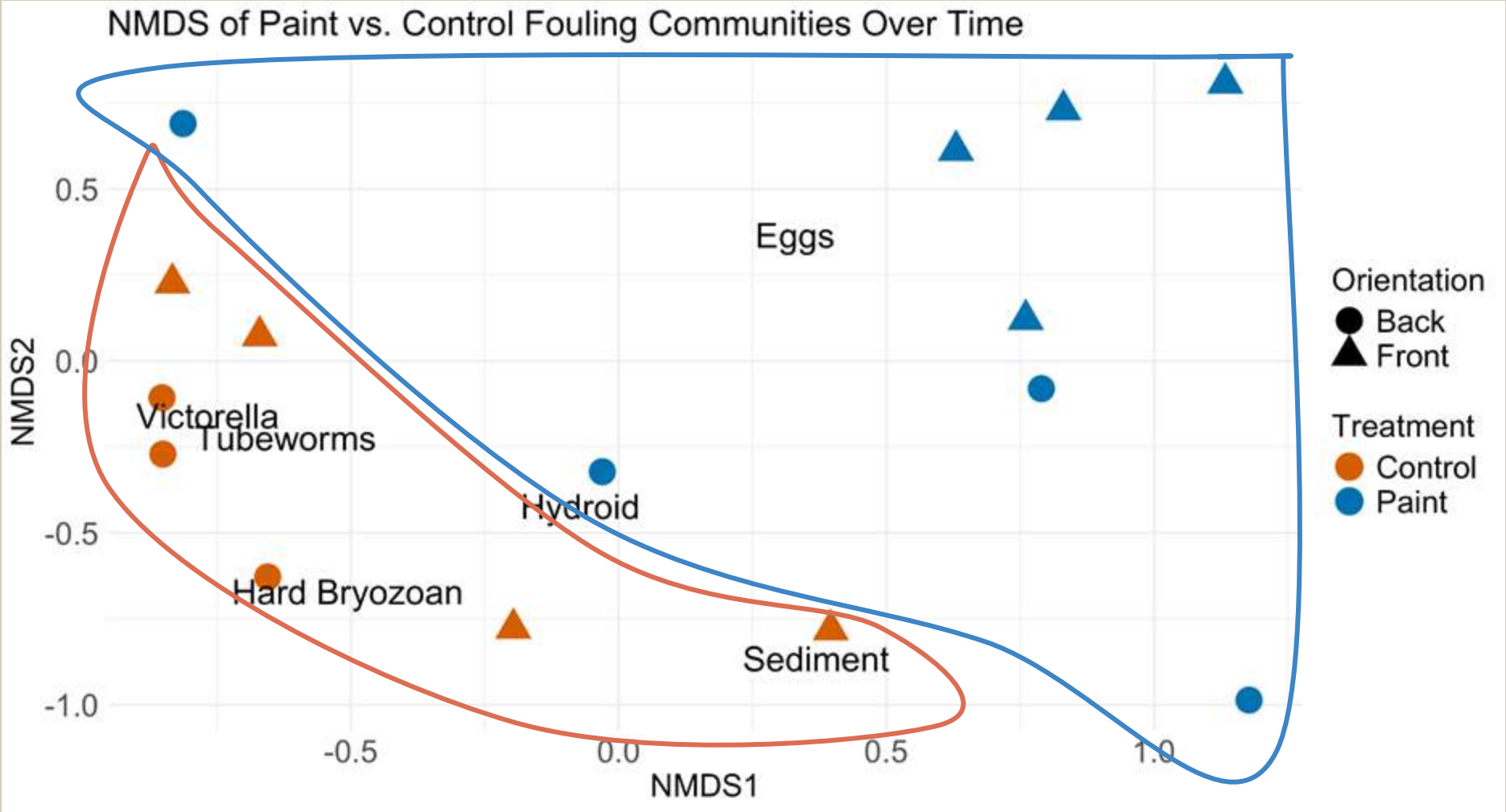

NMDS Nutrient vs. Control Fouling Communities Over Time
Hydroid
Sediment
Eggs
Tubeworms
Victorella
Hard Bryozoan
Treatment
Control
Nutrient
Orientation
Back
Front
NMDS1
NMDS2
0.5
0.0
-0.5
-1.5
-1.0
-0.5
0.0
0.5


Nutrient vs. Control Tubeworm Count Over Time (Back)
Tubeworm Count
3000
2000
1000
0
10
15
20
25
Days
Treatment
Control
Nutrient

Paint vs. Control PERMANOVA

	Df	SumOfSqs	R2	F	Pr(>F)
Days	1	0.6766147	0.12060091	2.5451969	0.017
Orientation	1	0.2565106	0.04572087	0.9649066	0.460
Treatment	1	1.4871584	0.26507354	5.5941897	0.001
Residual	12	3.1900779	0.56860469	*NA*	*NA*
Total	15	5.6103616	1.00000000	*NA*	*NA*


NMDS of Paint vs. Control Fouling Communities Over Time
NMDS2
NMDS1
0.5
0.0
-0.5
-1.0
-0.5
0.0
0.5
1.0
Eggs
Victorella
Tubeworms
Hydroid
Hard Bryozoan
Sediment
Orientation
Back
Front
Treatment
Control
Paint


NMDS of Paint vs. Control Fouling Communities Over Time
Eggs
Victorella
Tubeworms
Hydroid
Hard Bryozoan
Sediment
NMDS1
NMDS2
0.5
0.0
-0.5
-1.0
-0.5
0.0
0.5
1.0
Orientation
Back
Front
Treatment
Control
Paint

Marsh Project Summary

- Frame Analysis
  - No significant differences between **marsh habitats**
  - Significant differences between **time** or **orientation**
    - Orientation differences at 21 days
    - Top of plate = more green algae
  - Tubeworm counts similar for first 3 weeks, then start to diverge at 4th week
    - But not significantly different
- Shore Analysis
  - Significant difference between **marsh habitats**, **time**, and **orientation**
  - Unreliable data

Indicator Project Summary

- Significant difference between **Paint** and **Control**
  - Paint plates did get some Tubeworms and Victorella
  - No hard bryozoans or colonial hydroids like Control plates
- No significant difference between **orientation** (vertical)
- No significant difference between **Nutrient** and **Control**
  - Observed possibly thicker Victorella on the Nutrient Plates

Next Steps

- **New areas of study from observations**
  - Victorella Rugosity (Thickness)
  - Understanding tubeworm tube size differences between plates
    - Species differences, result of available material, etc.
- **Setup/Experimental Design**
  - Higher separation between marsh grasses in chosen sites of study
  - New design for shore plates to decrease loss of samples and interference from sand
  - More time
    - Tubeworm count data seemed close to diverging between sites at week 4
- **Statistical Analysis**
  - Statistical tests to account for time
  - Compare community composition data with various field measurements

Acknowledgements

- Jefferson Patterson Park and Museum
  - Director: Rod Cofield
  - Assistant Director : Eric Frere

- Johns Hopkins Applied Physics Laboratory

Locations - Indicator Project

- Suspended from randomly selected locations on Peterson Pier