Rapid recovery of sediment nutrients in Mosquito Lagoon's restored reefs

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OIMMP Workshop

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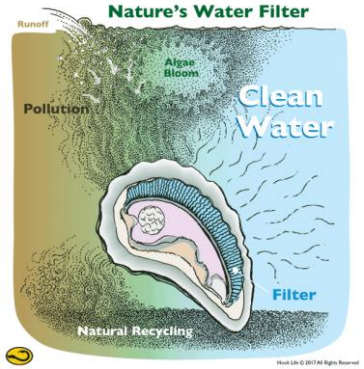
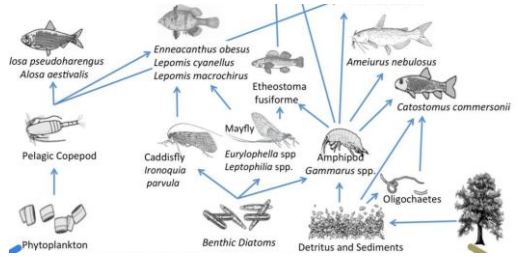
Knowledge gap in oyster reef recovery

Placement of loose oyster shell

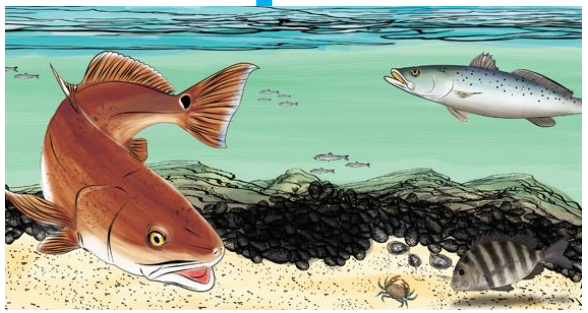
Weeks



2-5 months +



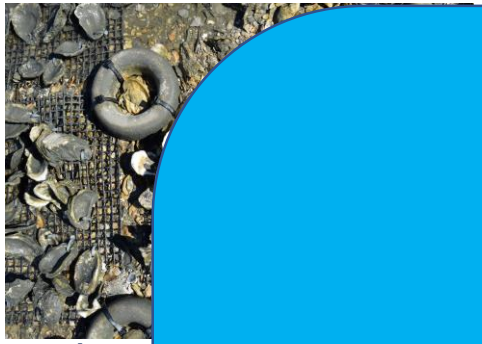
6-8 Months



2 years

226 % ↑ **in fisheries value**

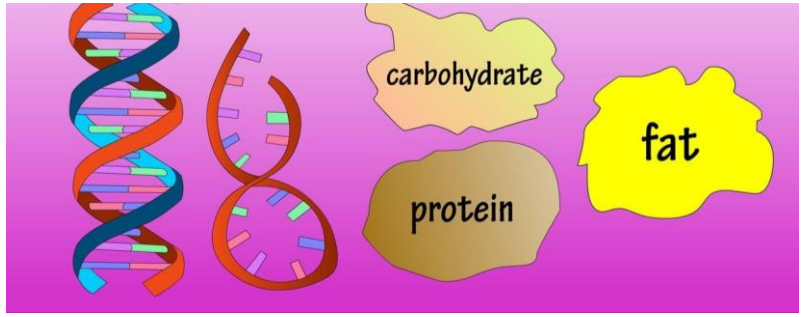
Knowledge gap in oyster reef recovery



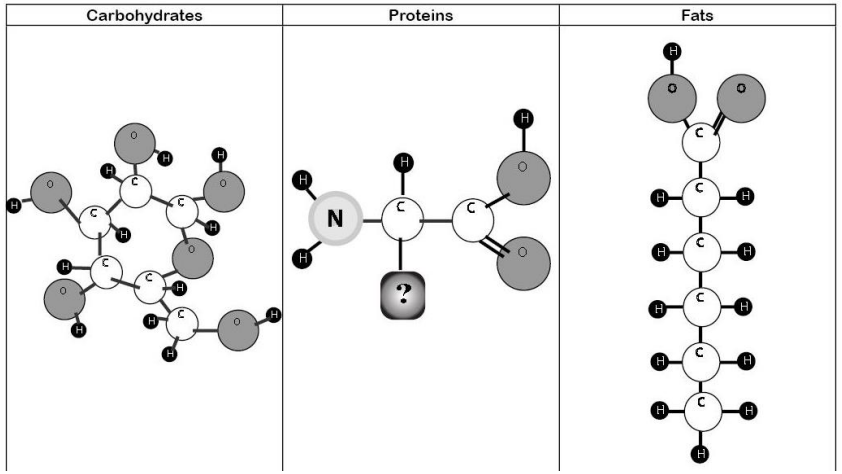
Place
o

Recovery of Biogeochemical cycling?

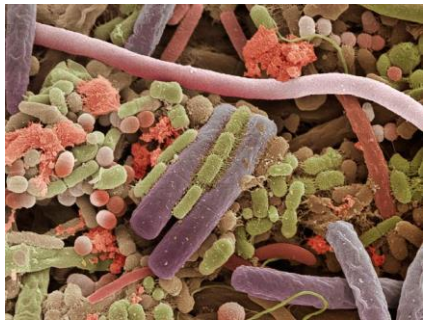
Elemental Cycling



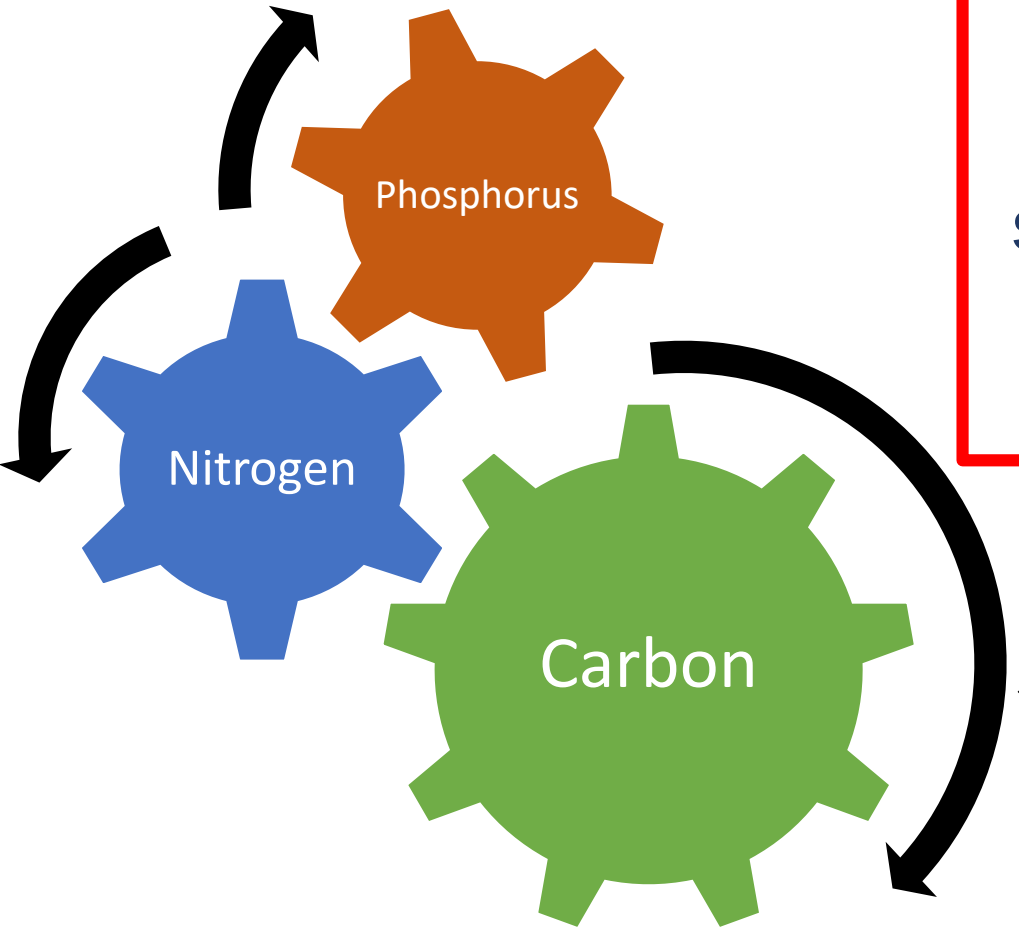
Degradation



Controls community structure and ecosystem functioning

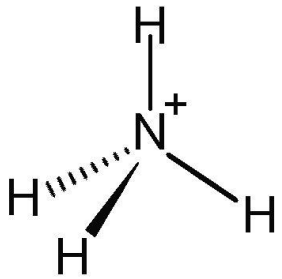


Mineralization

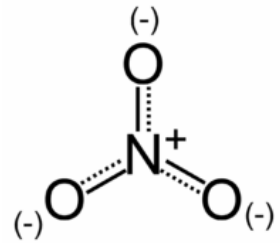


Biological uptake

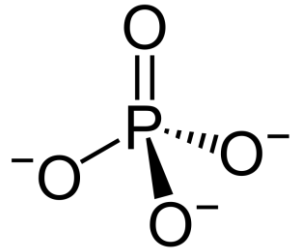
Ammonium



Nitrate

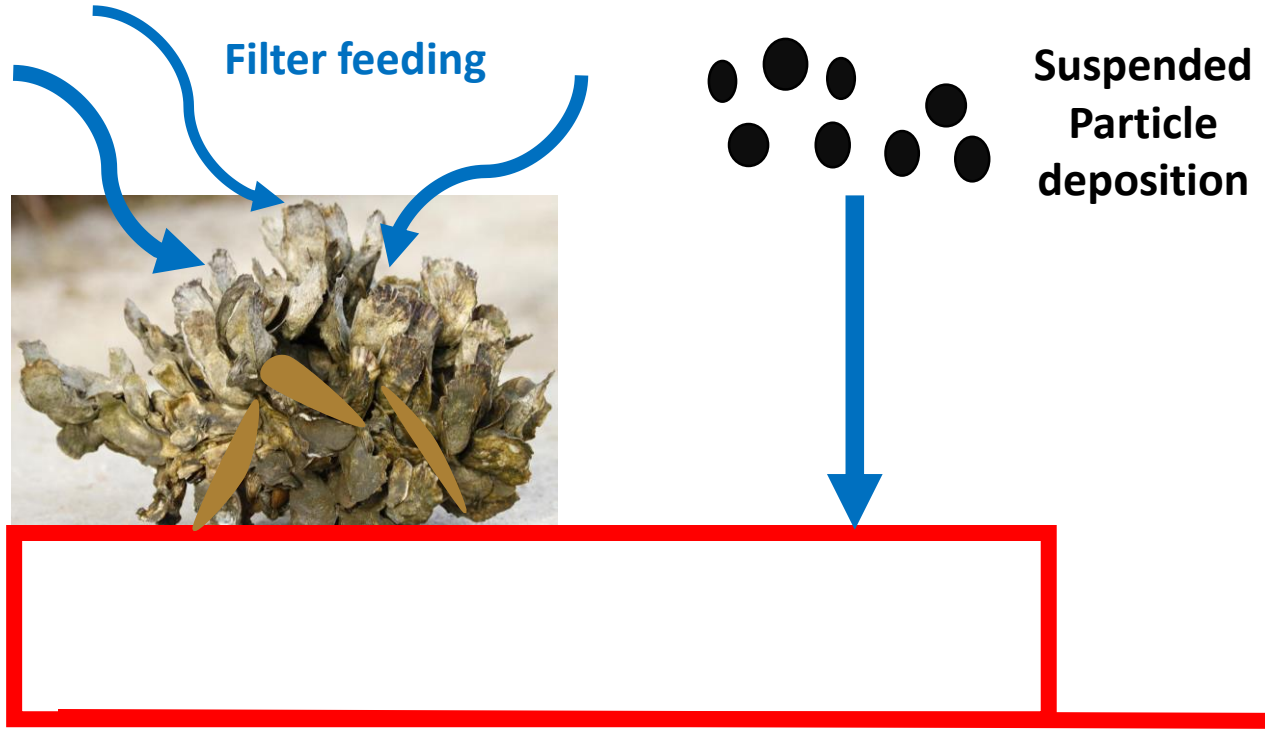


Phosphate



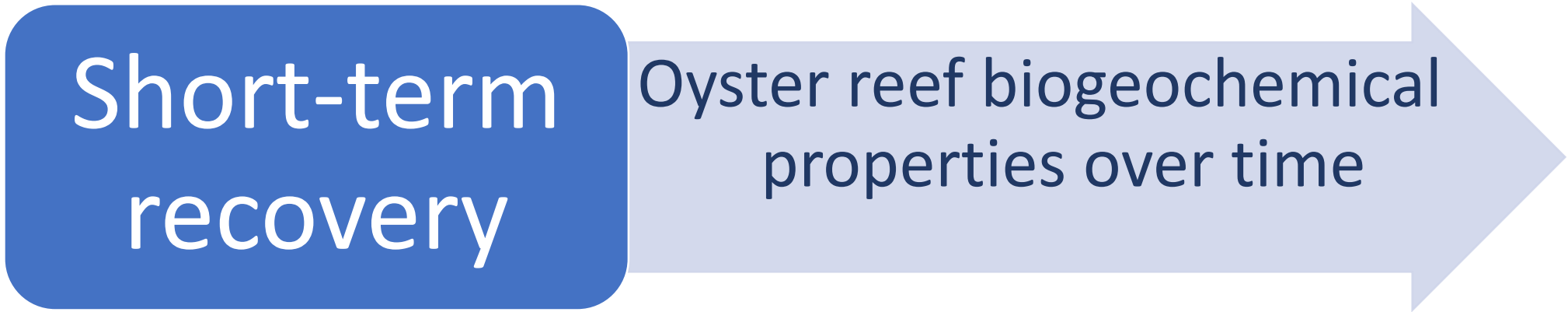
Biogeochemical hotspots

- Biotic factors (filter feeding and microbial transformation)
- Abiotic factors (hydrodynamics and deposition)



CEE Lab

Research questions



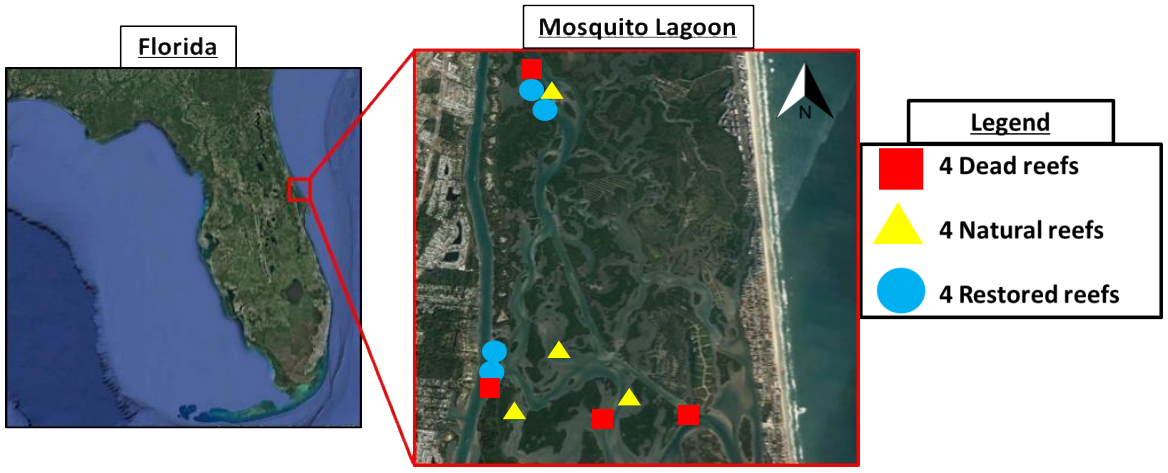
1) When do sediment nutrient pools in restored reefs reach the levels measured in natural reefs?

2) Do nutrient pools differ between dead, restored and natural oyster reefs?

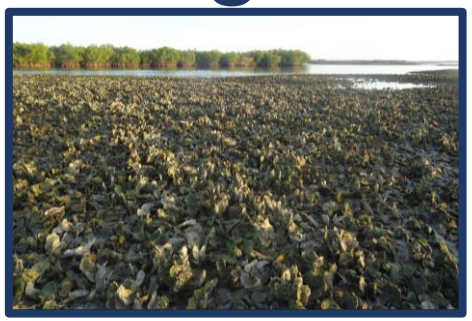
3) How do sediment nutrients relate to reef biophysical properties?

Methods

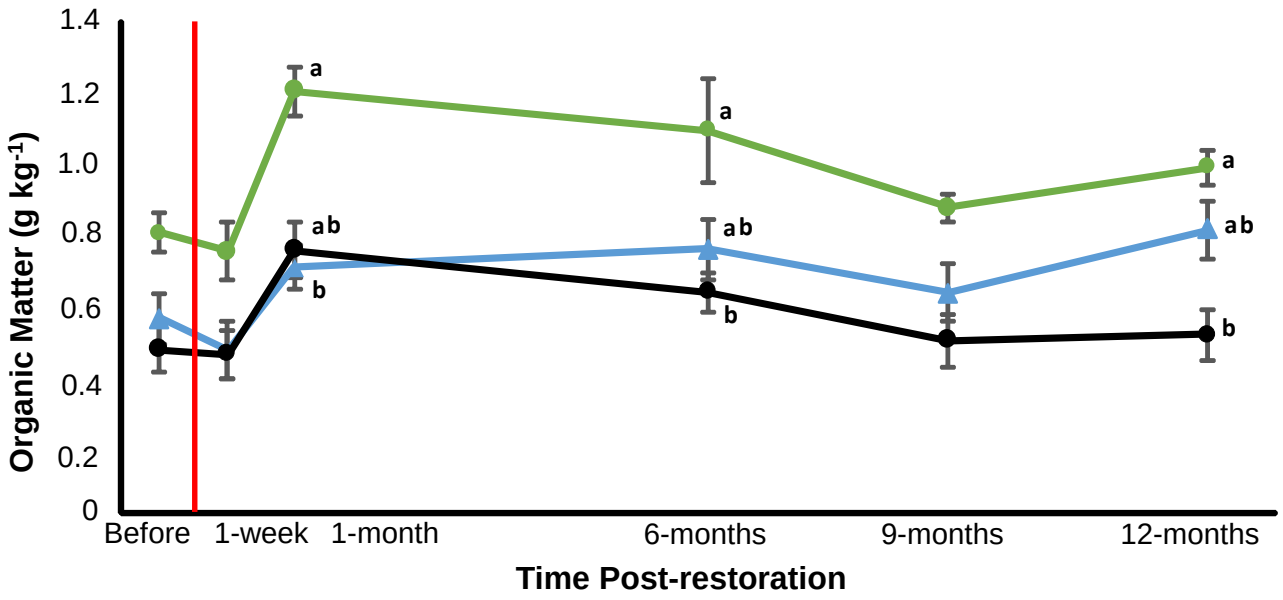
- UCF Biology's Mosquito Lagoon restoration program
- (May 2017) Before restoration, 1-week, 1-month, 6-months, 9-months and 12-months post-restoration (June 2018)
- Surface layer (0-5 cm) of sediment
- Linear mixed effects models in R
  - Reef type and time as fixed effects and reefs 1-4 as random effects



Sediment organic matter



Natural Reefs Dead Reefs Restored Reefs



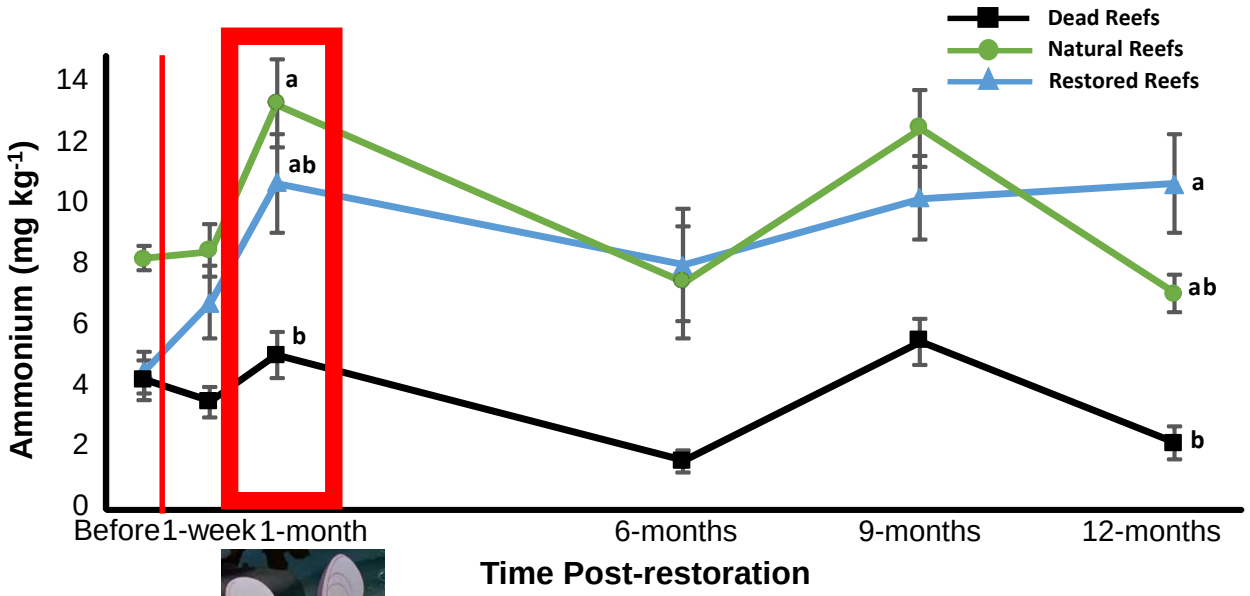
LME Model p values	Organic M
Treatment	0.079
Time	**<0.001**
Treatment:Time	**0.045**
Random Reef	**<0.001**

- Restored reef sediments 75% increase from pre-restoration to twelve months, dead reefs 12% and natural reefs 32%

Nitrogen – ammonium (NH_4^+)

- 1-month post-restoration → significant increase

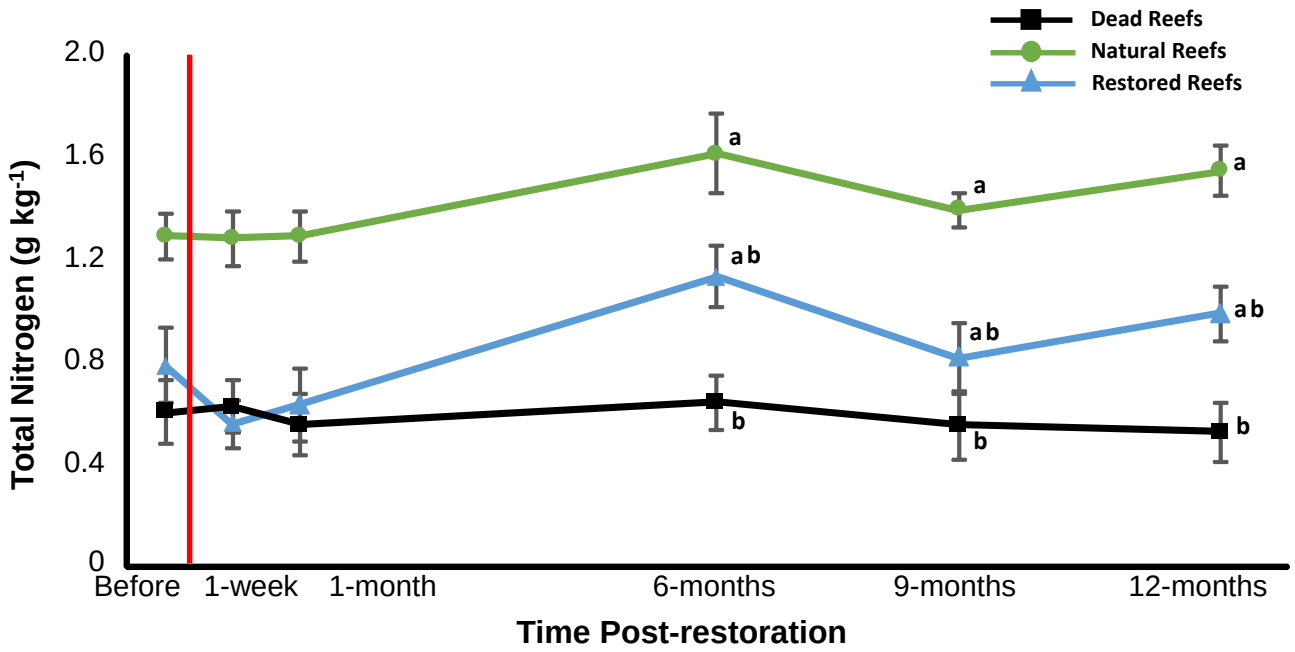
- After 12 months, 136% increase in restored reefs
- negative % change in dead and natural reefs



LME Model p values	NH_4^+
Treatment	0.082
Time	**<0.001**
Treatment:Time	**<0.001**
Random Reef	**<0.001**

Nitrogen – total (organic + inorganic)

- After 12 months, 78% increase in restored reefs



LME Model p values	Total N
Treatment	**0.049**
Time	**<0.001**
Treatment:Time	**0.032**
Random Reef	**<0.001**

Reef biophysical properties

- Recorded at 6, 9 and 12 months
- live oyster densities (# oysters 0.25 m^{-2})
- shell lengths (mm)
- reef height (mm)

- Track sediment nutrients with development of reefs

- As oyster density, shell length, and reef height increases biodeposition and structural complexity increases

Reef biophysical properties

- Correlation coefficients between sediment nutrients and biophysical characteristics
- Bold $p < 0.05$, bold and italics $p < 0.01$

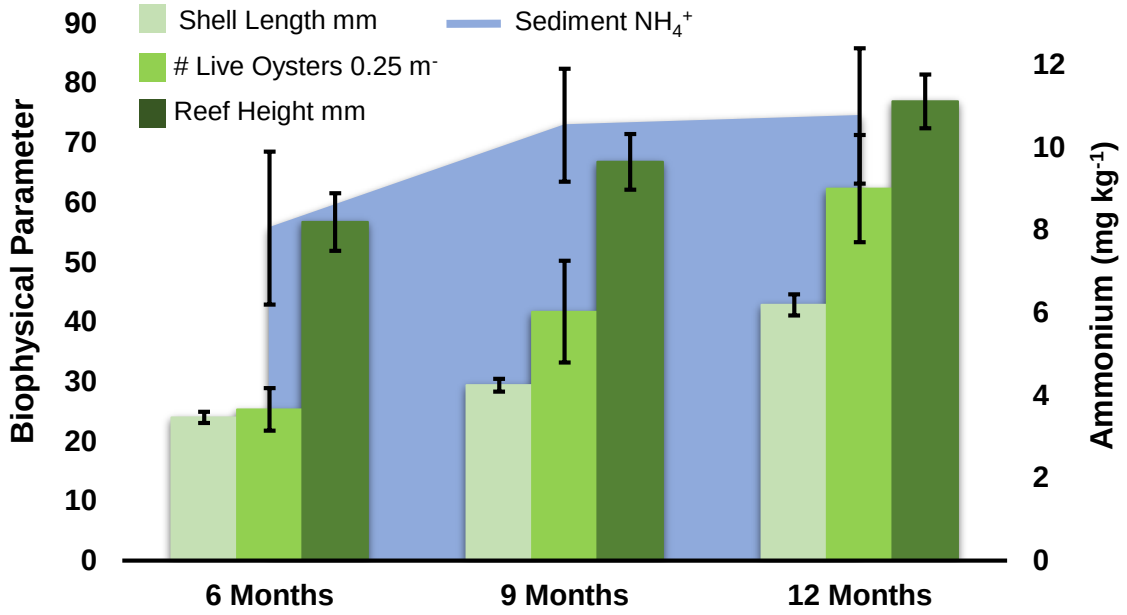
	Months	OM	DOC	TC	NO_3^-	NH_4^+	TN	SRP	TP
Oyster	6	***0.390***	0.043	0.014	-0.067	0.203	***0.643***	***-0.480***	***0.622***
Density	9	***0.548***	***0.519***	0.179	-0.195	0.229	***0.488***	-0.273	***0.465***
	12	***0.531***	***0.596***	0.181	0.132	***0.657***	***0.540***	-0.158	***0.512***
Reef	6	***0.368***	0.072	0.033	-0.057	**0.352**	***0.715***	***-0.599***	***0.650***
Height	9	***0.485***	***0.384***	-0.035	-0.227	***0.462***	***0.538***	***-0.452***	***0.548***
	12	***0.593***	***0.416***	0.150	0.186	***0.584***	***0.577***	-0.138	***0.575***
Shell	6	***0.374***	-0.091	-0.124	-0.105	0.100	***0.634***	***-0.596***	***0.559***
Length	9	***0.645***	0.119	-0.066	0.033	**0.357**	***0.634***	***-0.614***	***0.595***
	12	***0.607***	**0.346**	0.216	0.182	***0.469***	***0.586***	-0.245	***0.495***

- Significant correlations:
  - Organic matter
  - Total nitrogen
  - Total phosphorus

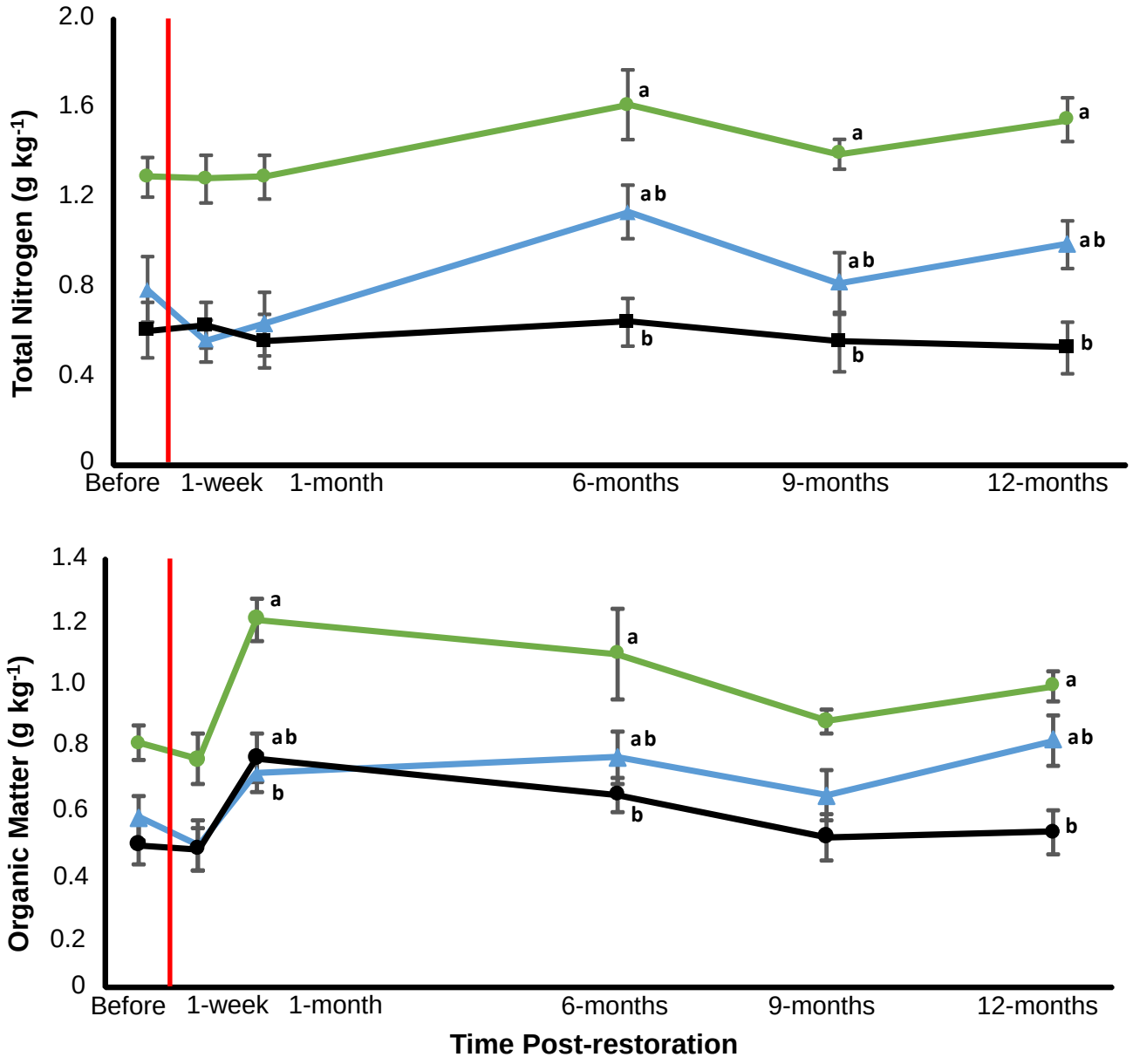
- Oysters can contribute to sediment nutrient increase

Biophysical parameters to NH_4^+

- 33% increase in NH_4^+
- 146% increase in oyster density
- 79% increase in shell length
- 36% increase in reef height



Monitoring sediment nutrients



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Monitoring sediment nutrients

- Total Carbon/Total Nitrogen Analysis
  - UC Davis analytical services $90 set up cost plus $36/sample
  - UVM $20/sample
  - 20 reefs sampled twice per year with 5 samples per reef
  - 200 samples per year = $7,380 per year
- Organic Matter Content
  - 8ft polycarbonate tube $30
  - Beakers/ceramic cups $100
  - Precision balance
    - $500 to $1,500
  - Drying oven
    - $400 for 20L and $700 for 85L
  - Benchtop muffle furnace
    - $1,400 to $3,500
  - $ 2,300 - 5,700 total

- Indicator of ecosystem health
- Compare results to other restored reefs

Acknowledgements

NSF Coupled Natural Human Systems Grant

Aquatic Biogeochemistry Lab

Coastal and Estuarine Ecology Lab

Field Help

Aquatic Biogeochemistry Laboratory

COASTAL & ESTUARINE ECOLOGY