

# Integrated assessment of oyster reef ecosystem services in Harris Creek, MD

M. Lisa Kellogg, Paige G. Ross, Mark W. Luckenbach,  
and Kennedy T. Paynter

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# Integrated Assessment

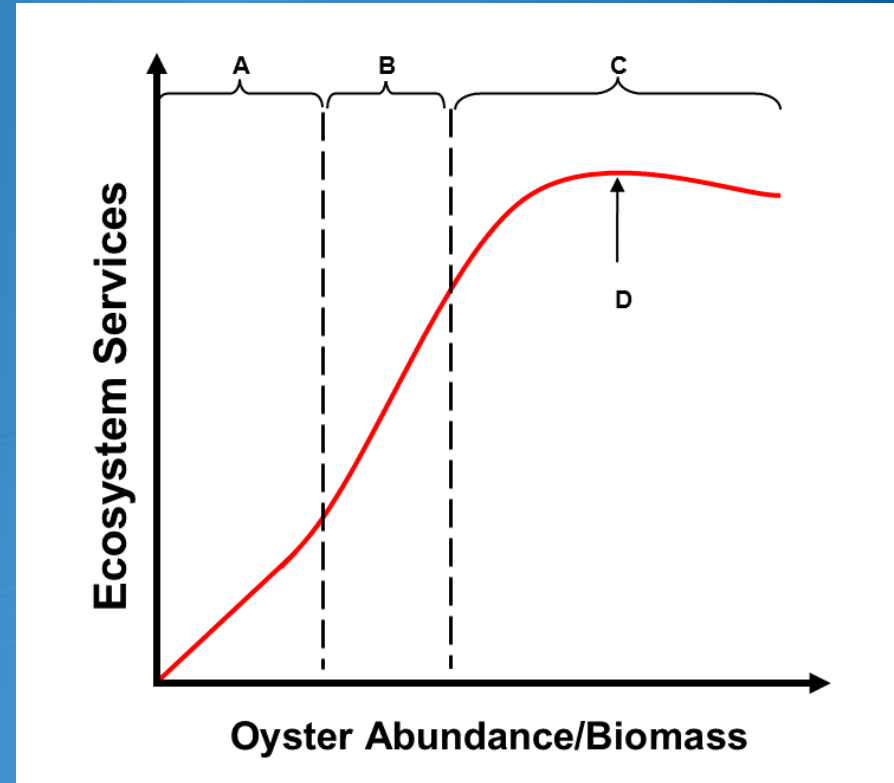
Goal: Quantify benefits provided by the restoration effort

Primary Objective:

Identify relationships between easily measured reef characteristics and ecosystem services and functions

Approach: Three integrated projects

- 1) Macrofaunal community
  - Ken Paynter (UMD)
- 2) Fish utilization and diets
  - P. G. Ross and Mark Luckenbach (VIMS)
- 3) Biogeochemical fluxes with focus on denitrification rates
  - Jeff Cornwell and Mike Owens (UMCES)



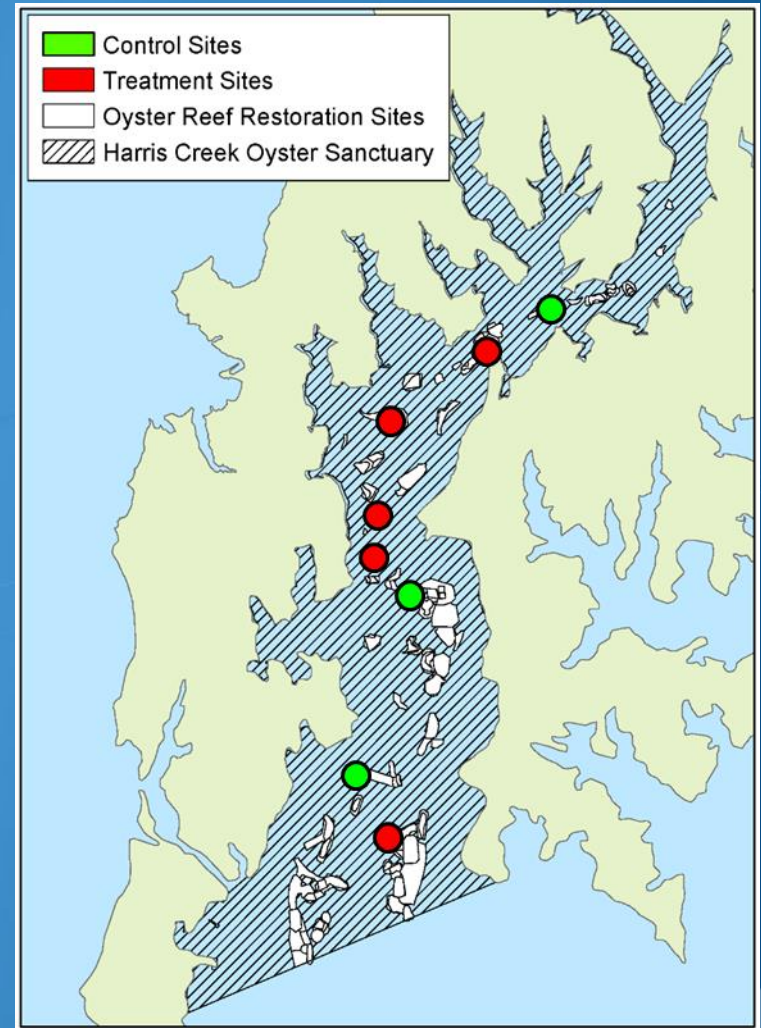
# Macrofauna Experimental Design

Focused on eight reefs:

- 5 restored sites
  - Planted in 2012 with spat on shell
- 3 non-restored sites
  - Suitable for restoration but no restoration activities

Sampled in spring, early summer, late summer, fall and winter

Divers collected all material within a 0.1 m<sup>2</sup> area. All organisms retained on 1-mm mesh assessed for identity, abundance and biomass.



# Macrofauna Results

Reefs provide habitat for ~50 species of macrofauna

- Anemones (2 spp.)
- Bivalves
  - Clams (6 spp.)
  - Mussels (2 spp.)
  - Oysters (1 spp.)
- Crustaceans
  - Amphipods (6 spp.)
  - Barnacles (? spp.)
  - Blue crabs (1 spp.)
  - Grass shrimp (3 spp.)
  - Isopods (6 spp.)
  - Mud crabs (1 spp.)
  - Other (1 spp.)
- Fish (6 spp.)
- Gastropods (6 spp.)
- Tunicates (1 spp.)
- Worms (>5 spp.)
- Other (2 spp.)





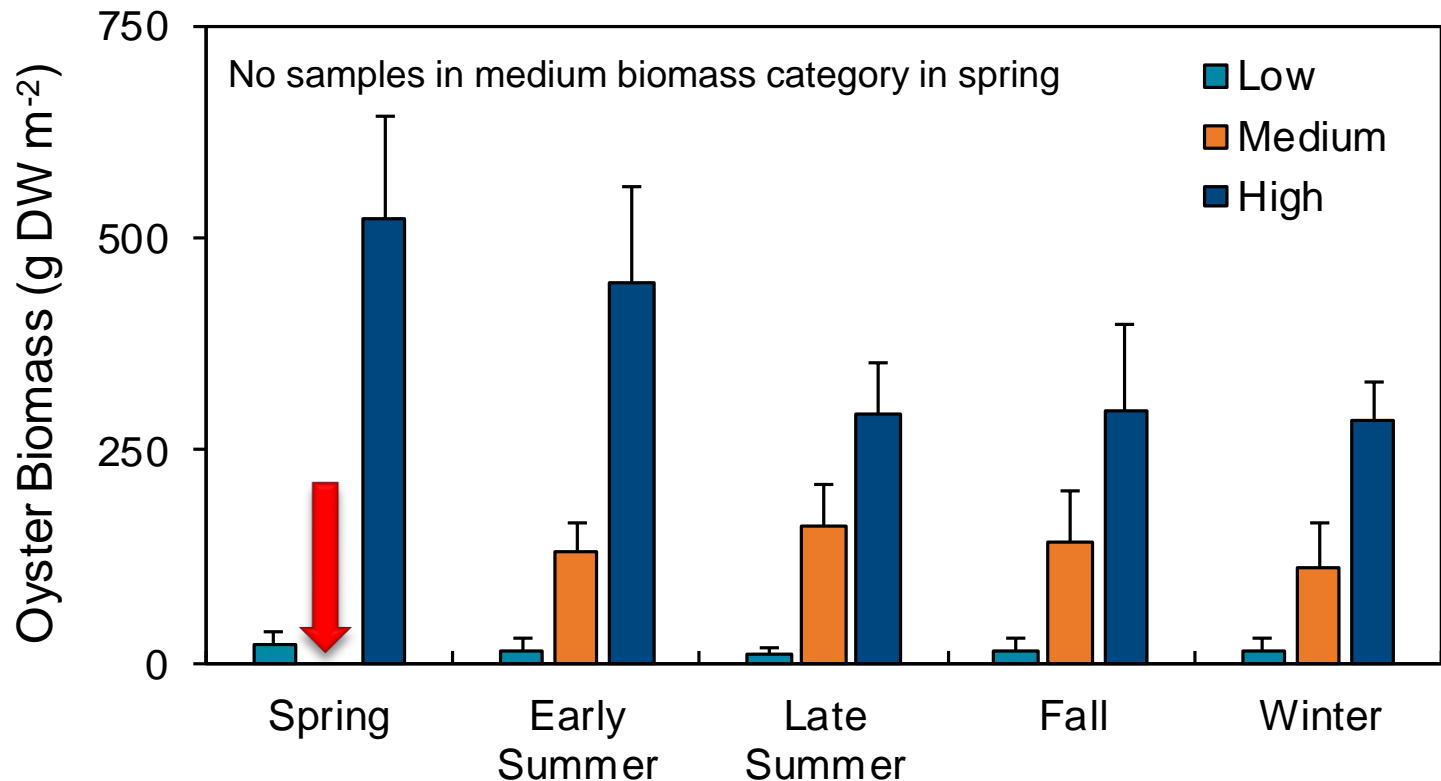
# Macrofauna Results

Oyster biomass in each sample categorized

Low <50 g DW m<sup>-2</sup>

Medium 50-224.9 g DW m<sup>-2</sup>

High ≥ 225 g DW m<sup>-2</sup>

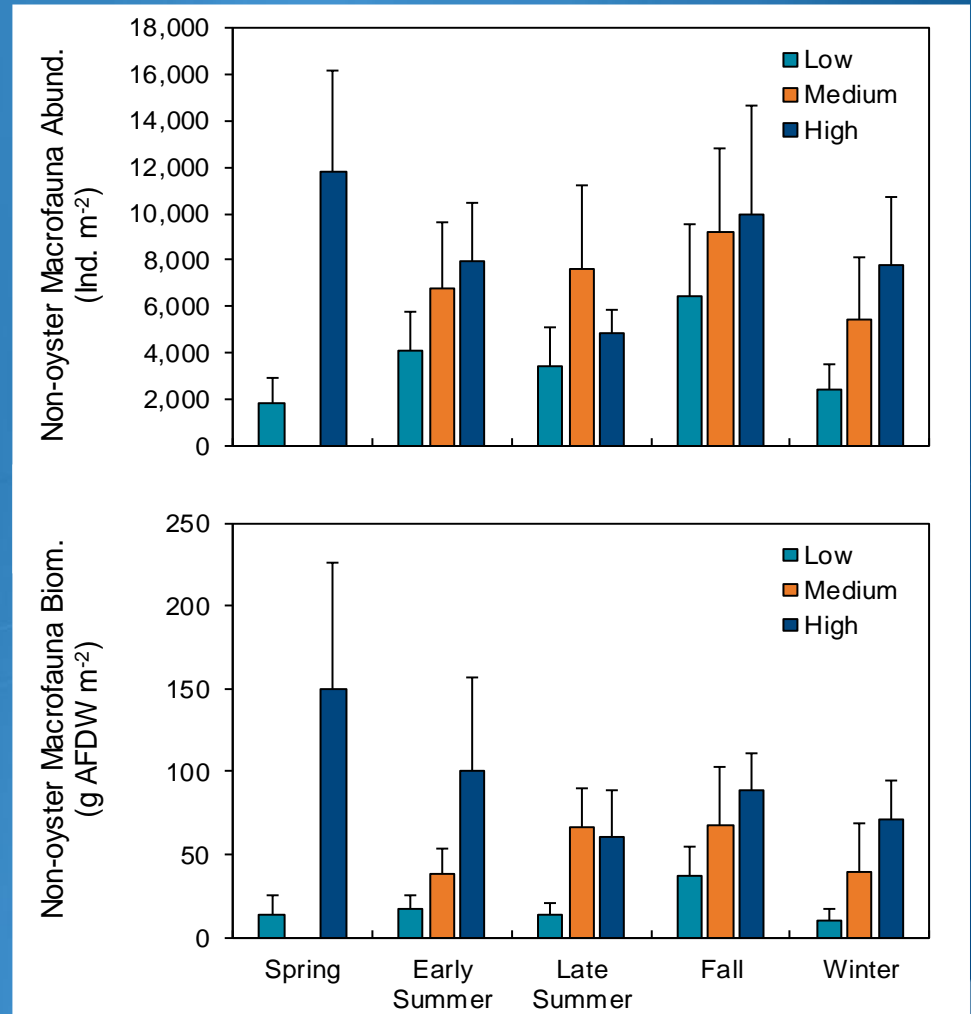


# Macrofauna Results

High oyster biomass density treatment:

- Habitat for >5,000 individuals  $\text{m}^{-2}$  in all seasons
- Habitat for ~10,000 individuals  $\text{m}^{-2}$  in spring and fall
- Biomass of non-oyster macrofauna exceeded 60 g AFDW  $\text{m}^{-2}$  in all seasons and was as high as 150 g AFDW  $\text{m}^{-2}$  in some seasons.

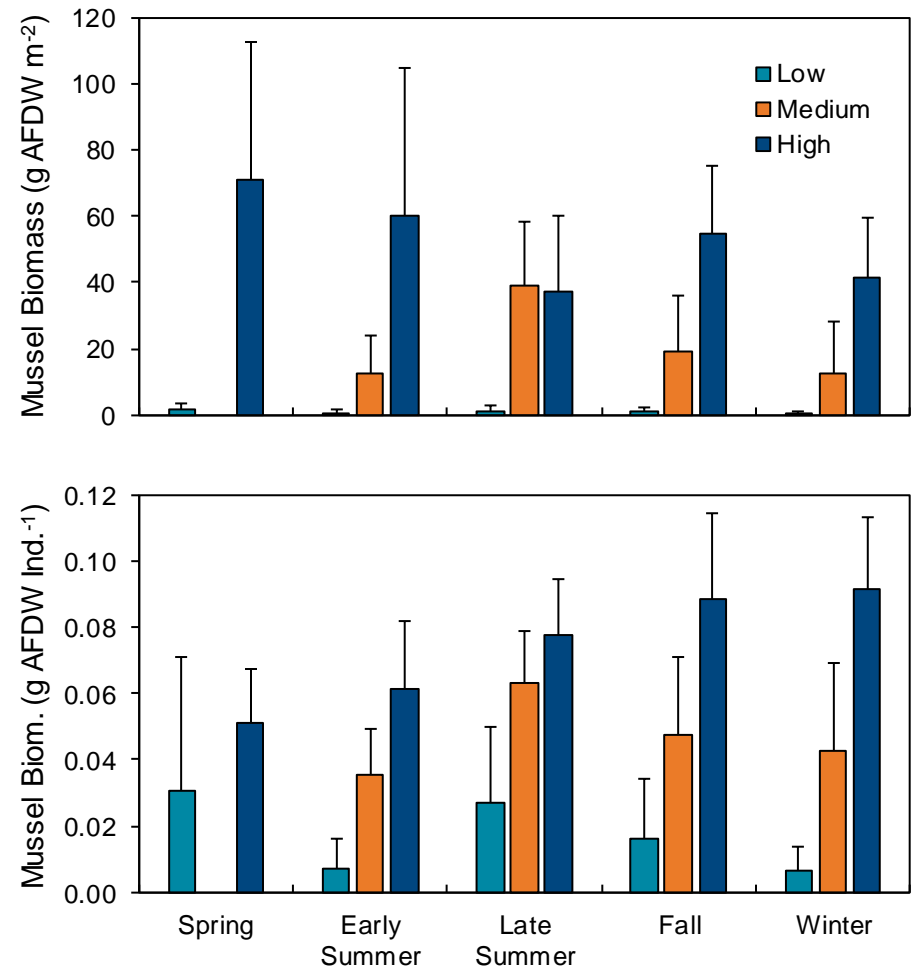
Generally a positive relationship between non-oyster macrofauna biomass and oyster biomass.



# Macrofauna Results

Relationship between oyster biomass density and the biomass density of sessile and mobile macrofauna varied by species

- Both mussel total biomass and mussel individual biomass tended to increase with increasing oyster biomass density

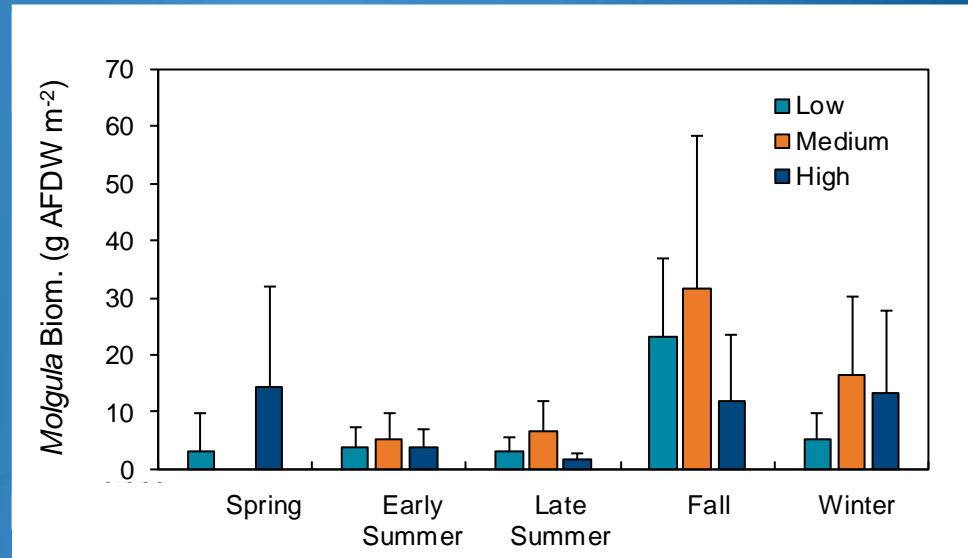




# Macrofauna Results

Relationship between oyster biomass density and the biomass density of sessile and mobile macrofauna varied by species

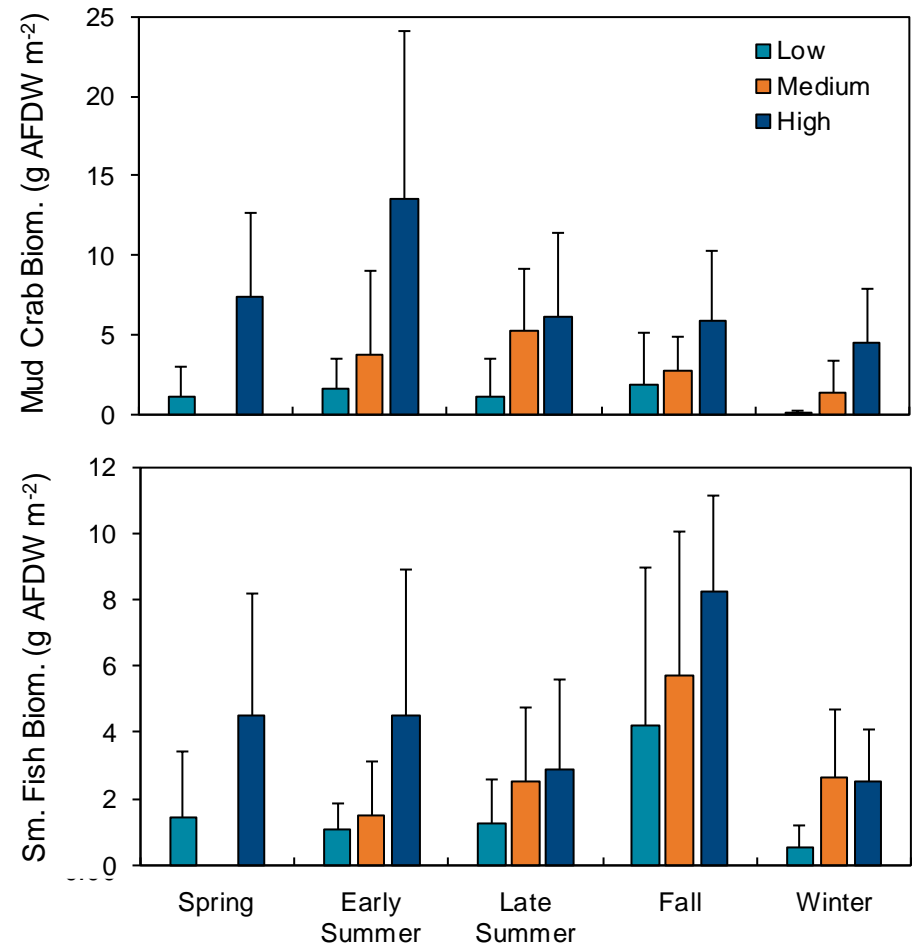
- Both mussel total biomass and mussel individual biomass tended to increase with increasing oyster biomass density
- The relationship between biomass of the sea squirt *Molgula manhattensis* and oyster biomass was not consistent



# Macrofauna Results

Relationship between oyster biomass density and the biomass density of sessile and mobile macrofauna varied by species

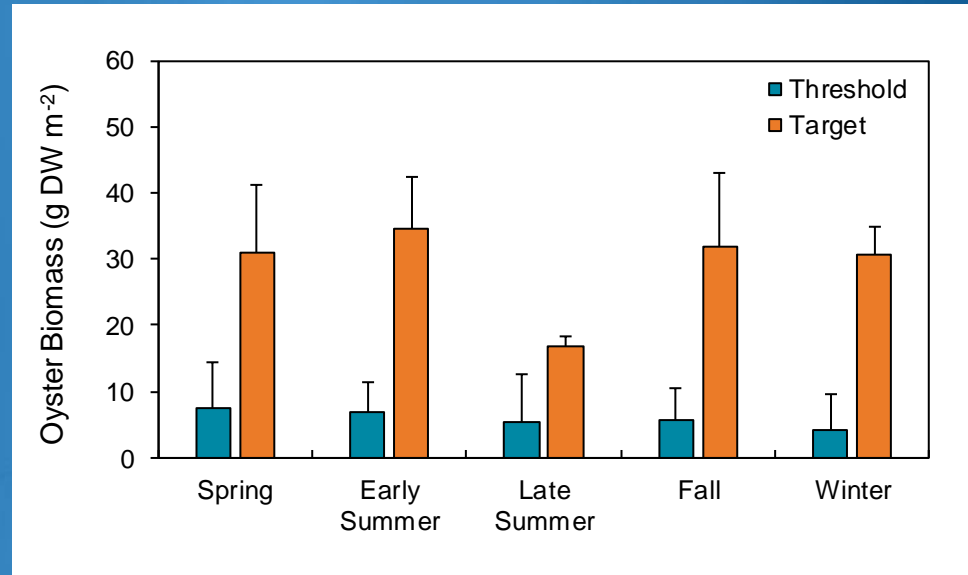
- Both mussel total biomass and mussel individual biomass tended to increase with increasing oyster biomass density
- The relationships between biomass of the sea squirt *Molgula manhattensis* and oyster biomass was not consistent
- The biomass of both mud crabs and small fish (gobies and blennies) tended to increase with increasing oyster biomass.



# Macrofauna Results

Additional analyses of the low biomass density treatment parsed the samples into two categories:

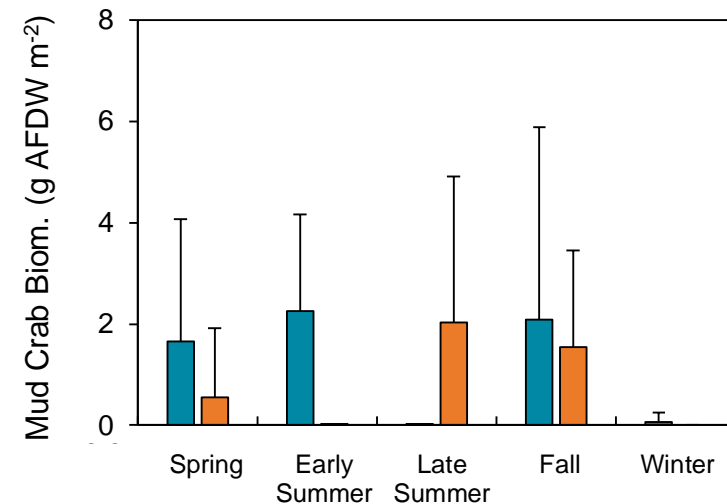
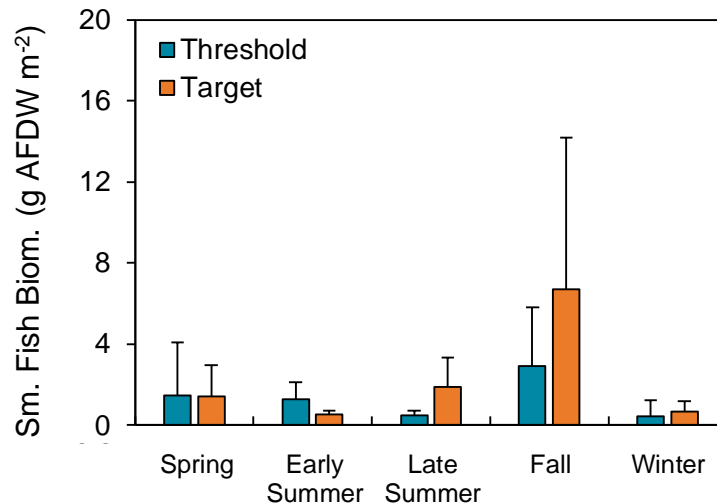
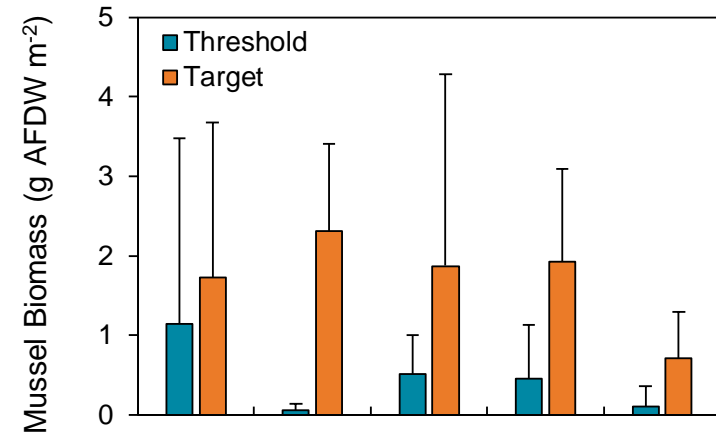
- “Threshold” = samples with oyster biomass density  $<15 \text{ g DW m}^{-2}$
- “Target” = samples with oyster biomass density between  $15 \text{ g DW m}^{-2}$  and  $50 \text{ g DW m}^{-2}$



# Macrofauna Results

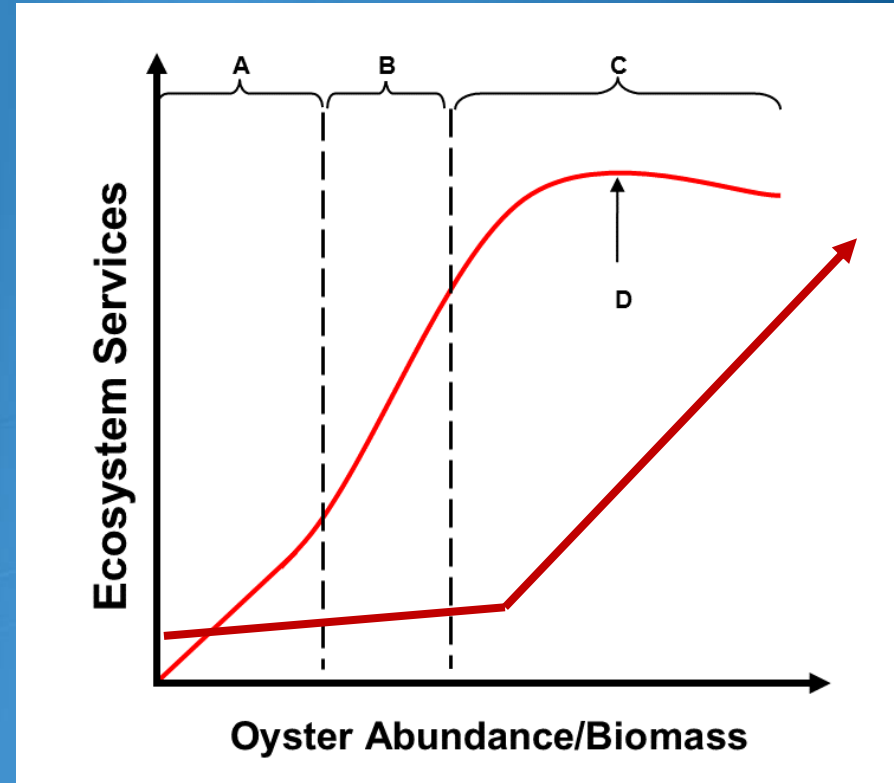
Target vs. threshold oyster biomass:

- Mussels were the only major faunal group whose biomass was significantly higher in the target treatment than in the threshold treatment.



# Macrofauna Conclusions

- Restored reefs in Harris Creek with high oyster biomass provide habitat for ~5,000 to 10,000 individuals from macrofaunal organisms per square meter depending on season.
- Although relationships varied with species and season, the biomass of most major taxa tended to increase with increasing oyster biomass in most seasons.
- With the exception of mussels, increasing biomass from levels below the threshold for restoration to levels between the threshold and target for restoration does not significantly enhance the biomass of major macrofaunal groups.



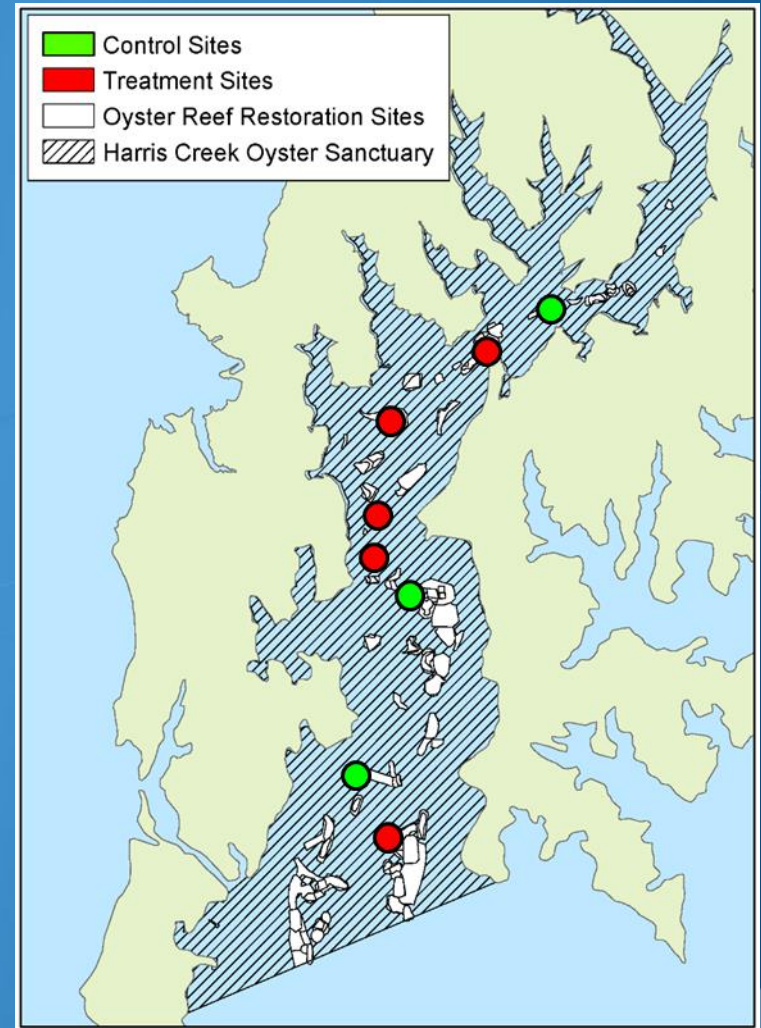
# Finfish Experimental Design

## Preliminary study:

- Comparison of finfish diets from fish caught using gillnets versus trawls

## Primary study:

- 8 reefs (5 restored, 3 non-restored)
- Sampled monthly May through October at dusk using gillnets with three different mesh sizes
- Gillnets set in pairs with one set on the reef and one off the reef at each site
- Focused on striped bass and white perch diets





# Finfish Results

## Gillnet vs. Trawl Diet Data

- Reef resident macrofauna species more common in gill net samples

Predator Common Name	Gear	Goby/Blenny Mean Biomass (g WW)	<i>Molgula manhattensis</i> Mean Biomass (g WW)	Mud Crab Mean Boimass (g WW)
White Perch	Gill	0.1027	0.6686	0.0020
White Perch	Trawl	0	0	0
Striped Bass	Gill	0.1082	0	0.0137
Striped Bass	Trawl	0.0089	0	0

# Finfish Results

Gillnet difference in CPUE between on-reef and off-reef sites

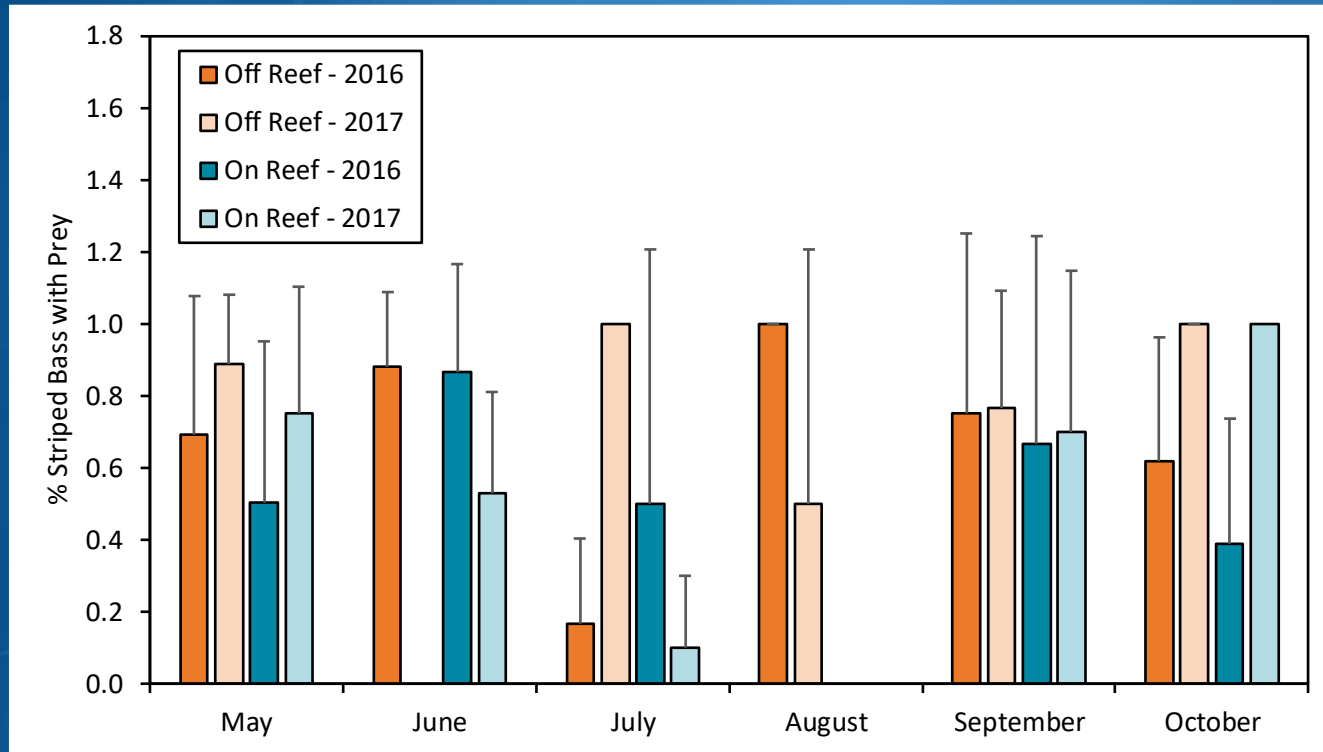
- Positive values indicate greater catch on reef than off reef

Month	Restoration Status	Silver Perch	Spot	Striped Bass	Weakfish	White Perch
May	Non-restored	0.00	0.00	-0.56	0.00	-0.66
	Restored	0.00	0.00	-0.24	0.00	-0.28
June	Non-restored	0.00	-3.73	-0.22	0.00	0.11
	Restored	0.00	-2.06	0.50	0.00	0.30
July	Non-restored	0.00	-1.78	0.06	0.00	0.28
	Restored	0.00	-0.53	0.07	-0.03	0.60
August	Non-restored	0.00	0.17	0.17	-0.22	0.17
	Restored	0.00	-0.23	0.03	-0.47	0.37
September	Non-restored	0.06	0.00	-0.06	-0.83	1.00
	Restored	0.13	-0.10	0.00	-0.73	0.84
October	Non-restored	-0.11	0.06	-0.11	-0.33	0.50
	Restored	0.14	0.00	-0.43	-0.30	0.67

# Finfish Results

Proportion striped bass with prey in gut

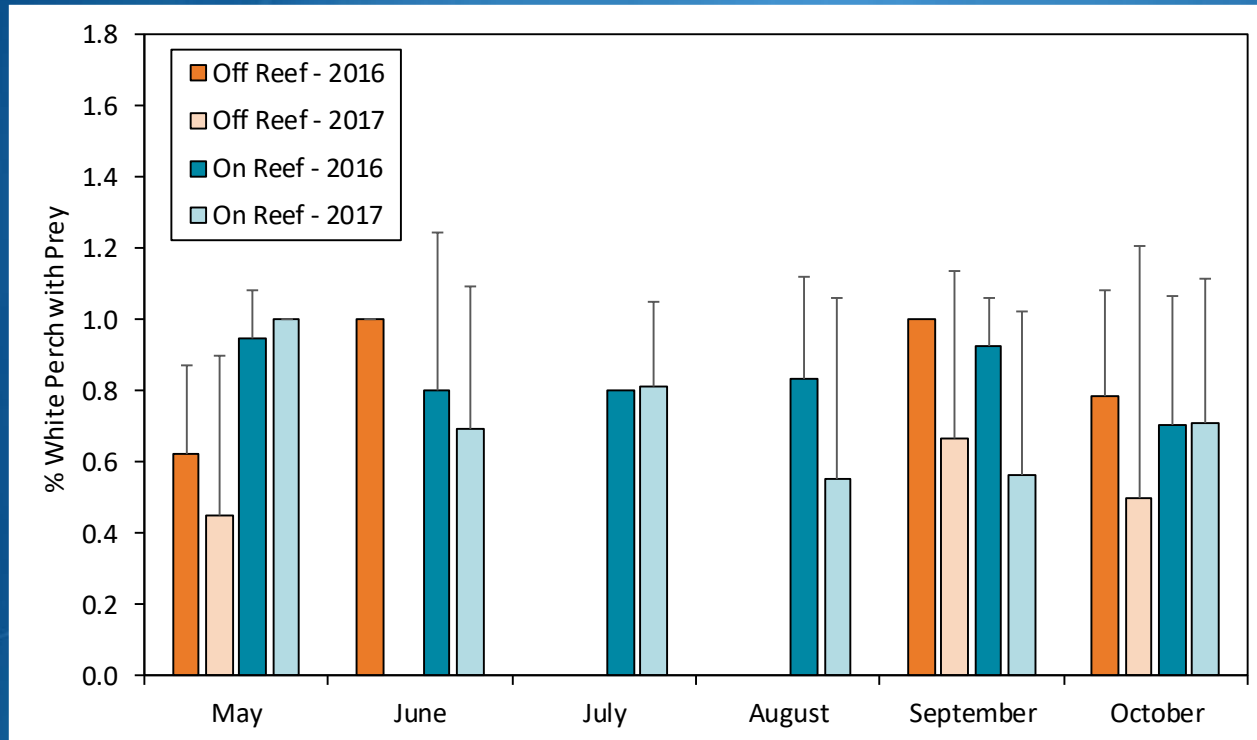
- Highly variable; no significant effect of location relative to reef



# Finfish Results

Proportion white perch with prey in gut

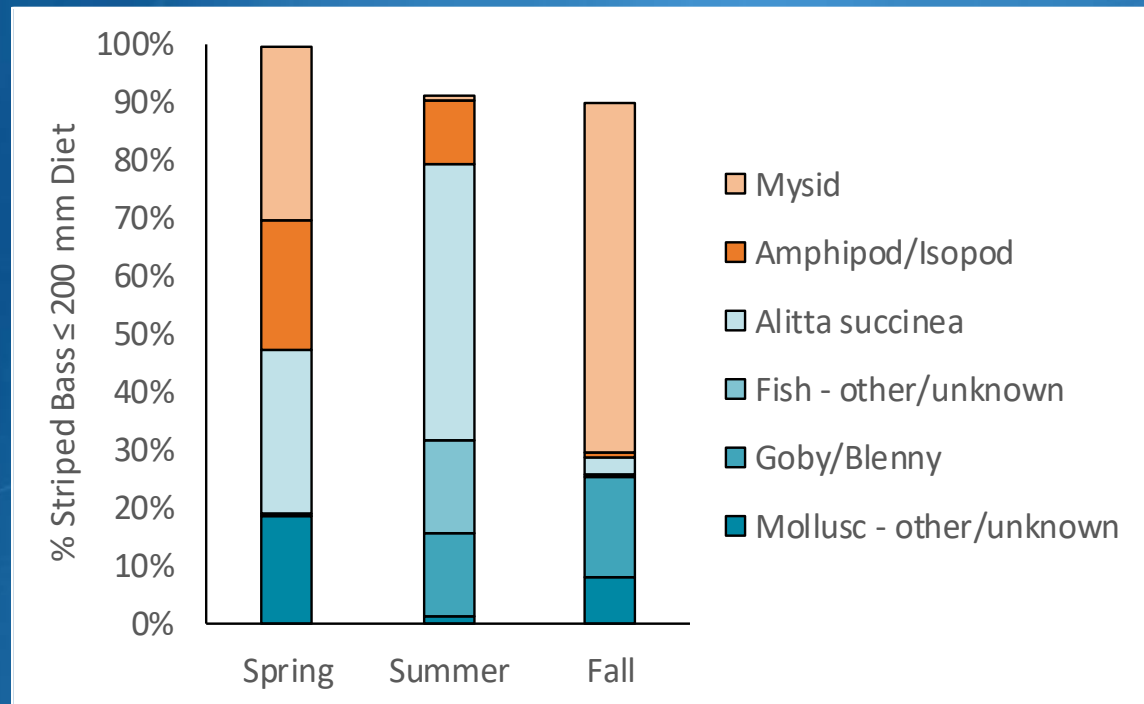
- Highly variable; no significant effect of location relative to reef



# Finfish Results

Diet of striped bass  $\leq 200$  mm in Harris Creek

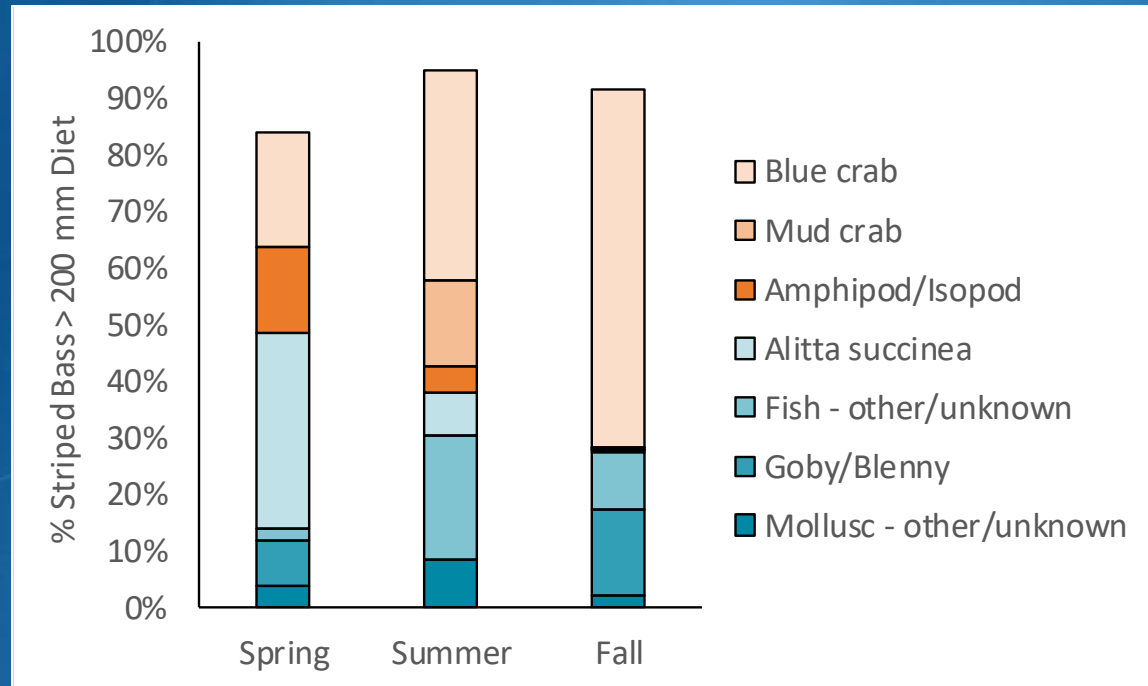
- Only 16% of diet consisted of fish.
- Diet of striped bass collected as part of the CHESFIMS sampling program included 53% fish (Ihde et al. 2015)



# Finfish Results

Diet of striped bass > 200 mm in Harris Creek

- Only 19% of diet consisted of fish.
- Diet of striped bass collected as part of the CHESFIMS sampling program included 97% fish (Ihde et al. 2015)

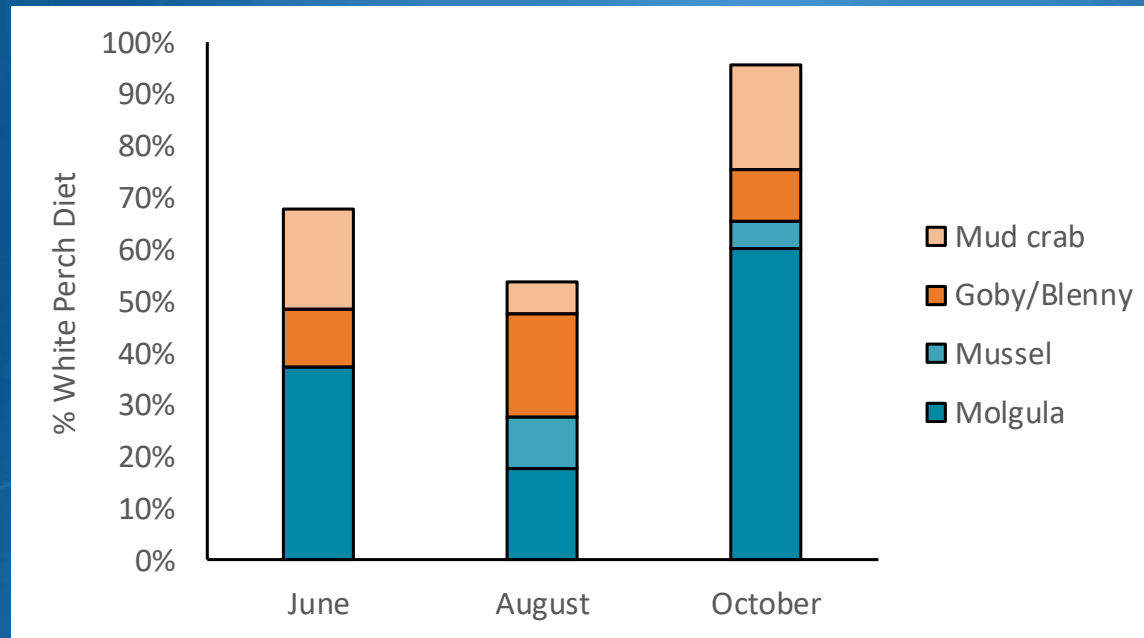




# Finfish Results

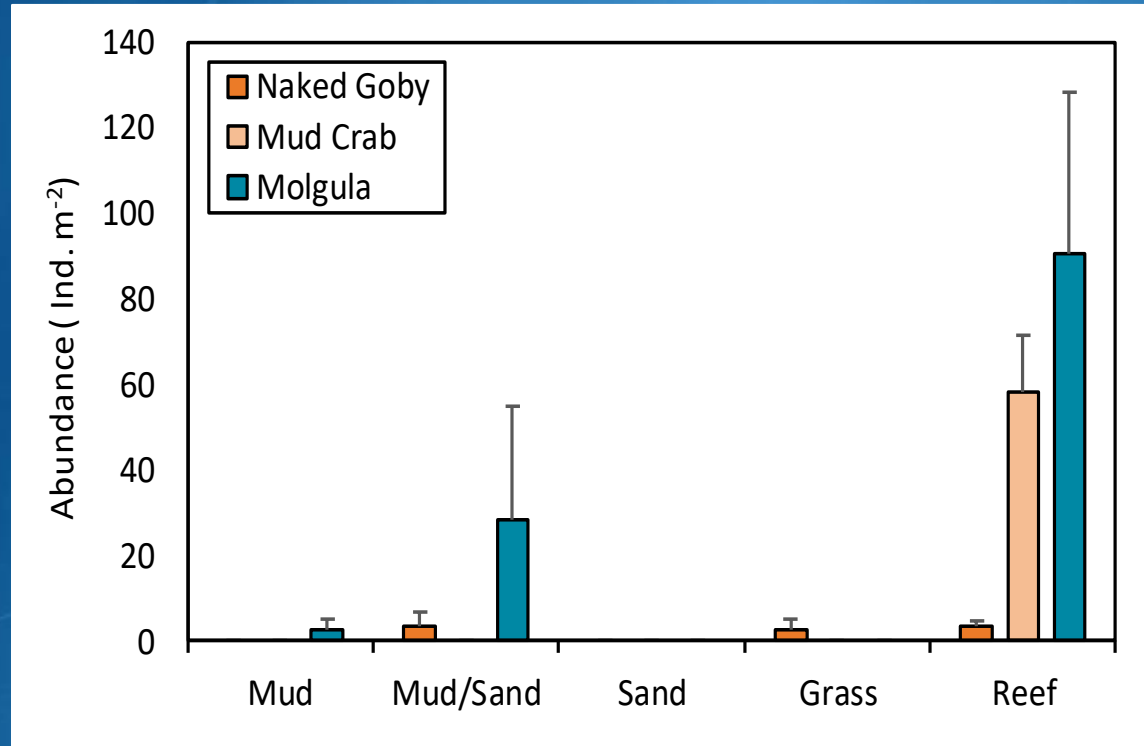
## Diet of white perch in Harris Creek

- The sea squirt *Molgula manhattensis* is a major component of diet
- *Molgula* is not mentioned in a recent review of existing data on the dietary habits of white perch in Chesapeake Bay (Ihde et al. 2015)



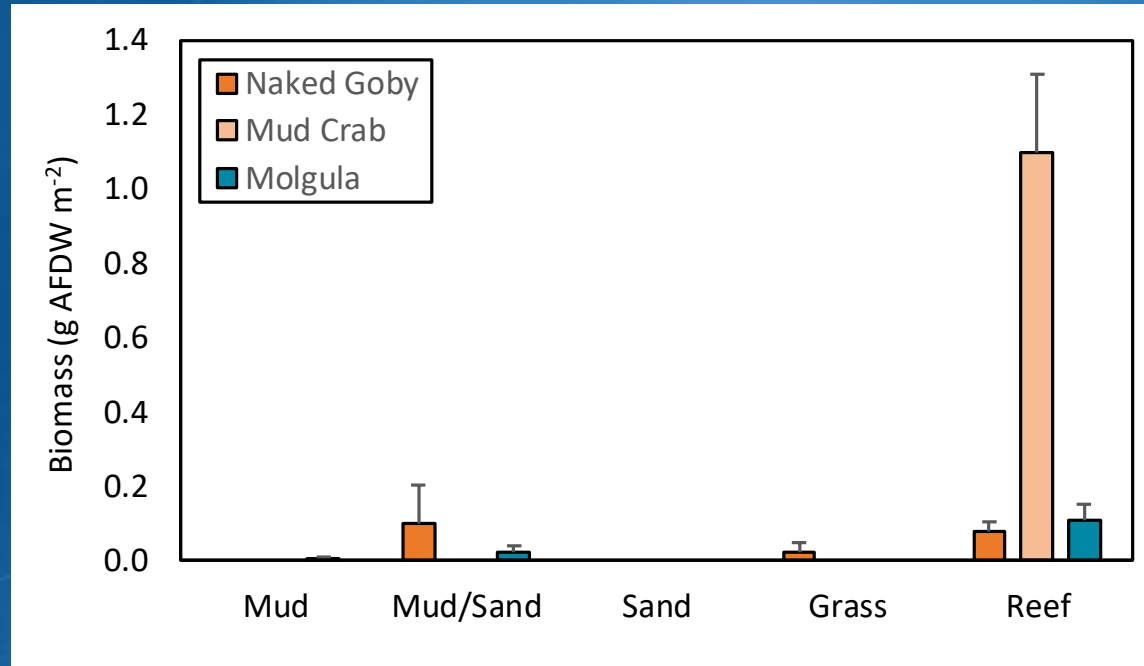
# Finfish Results

Distribution of common white perch prey in Harris Creek



# Finfish Results

Distribution of common white perch prey in Harris Creek



# Finfish Conclusions

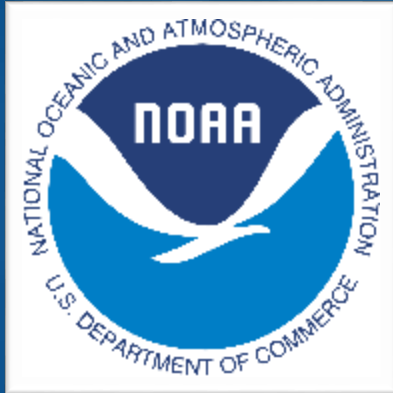
- The proportion of striped bass and white perch that contained prey in their guts was highly variable and showed no consistent patterns with respect to location relative to oyster reefs.
- Striped bass diets in Harris Creek were less dependent on fish in comparison to other studies of striped bass diets in Chesapeake Bay.
- White perch diets in Harris Creek rely heavily on benthic species commonly found in high abundance and/or biomass on oyster reefs and differ substantially from diets previously reported for white perch in Chesapeake Bay.

# Take Home Messages...

- Macrofauna biomass increases with increasing oyster biomass far above restoration target biomass density
- Reef resident macrofauna species are a significant source of prey for white perch and striped bass
- Our current understanding of finfish diets in Chesapeake Bay may underestimate the importance of species found in structured habitats like oyster reefs

# Acknowledgements

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# Acknowledgements

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# Questions?

