Assessing the Ecosystem Services of Oyster Restoration

Sustainable Fisheries GIT Meeting

December 3, 2013

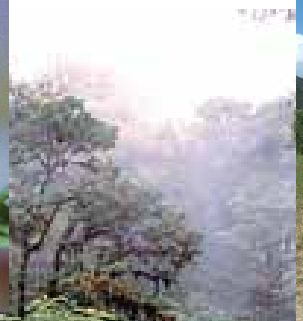
Interest in Oyster Reef Ecosystem Services (ORES)

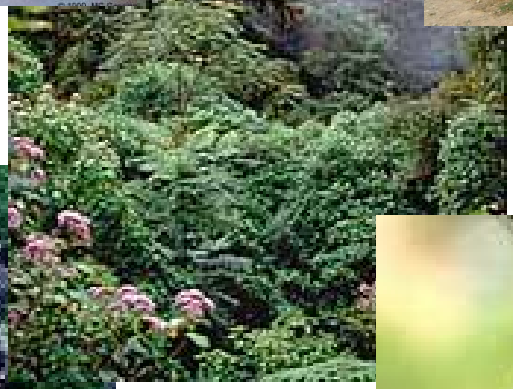
- Maryland's Oyster Restoration Plan: "Focus on targeted restoration strategies to achieve ecological and economic goals"
- NOAA Habitat Blueprint – regional habitat initiative: NCBO has a role to evaluate the habitat and understand the functioning of the ecosystem

Ecosystem Services

Are the wide array of goods and services

of value to people





Ecosystem Services – More Precisely

Boyd and Banzhaff 2007

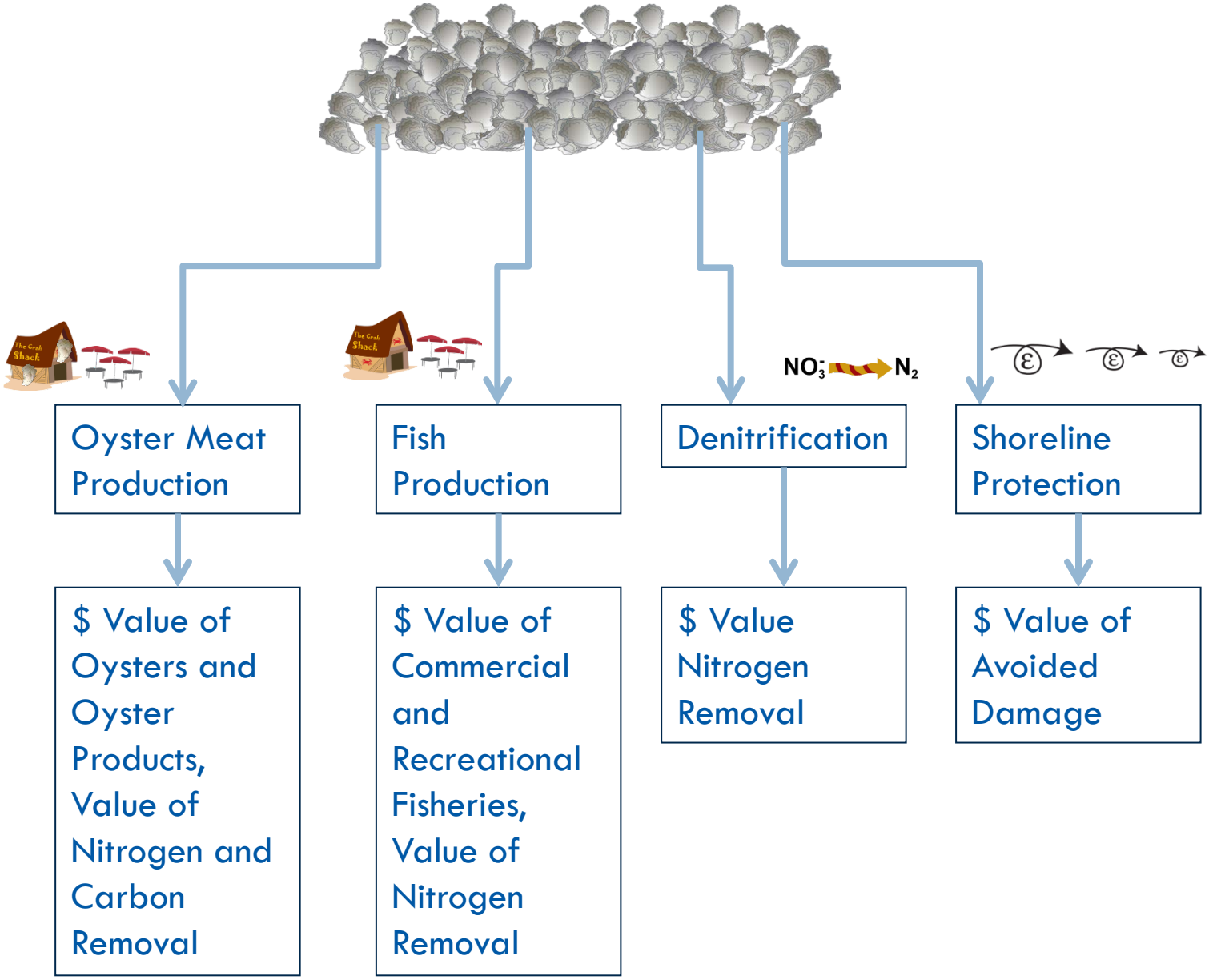
Final Ecosystem Services are

- Components of nature directly enjoyed, consumed, or used to yield human well-being
- End products of nature that people make choices about
- Arise from and depend on a broader set of ecological components, processes and functions

Partial List of Ecosystem Services

- Purification of air and water
- Mitigation of droughts and floods
- Generation and preservation of soils and renewal of their fertility
- Detoxification and decomposition of wastes
- Pollination of crops and natural vegetation
- Dispersal of seeds
- Cycling and movement of nutrients
- Control of potential pests
- Food production

Oyster Reef Ecosystem Services - Framework



Research on Oyster Reef Ecosystem Services

Breitburg, D.C., 1999. Are three-dimensional structure and healthy oyster populations the keys to an ecologically interesting and important fish community? In: Luckenbach, M.W., Mann, R., Wesson, J.A. (Eds.), Oyster Reef Habitat Restoration: A Synopsis and Synthesis of Approaches. Virginia Institute of Marine Science Press, Gloucester Point, VA, pp. 239–250.

Coen, L.D., M.W. Luckenbach, and D.L. Breitburg. 1999b. The role of oyster reefs as essential fish habitat: a review of current knowledge and some new perspectives. Pp. 438-454, in L.R. Benaka, (ed.). Fish habitat: essential fish habitat and rehabilitation. American Fisheries Society, Symposium 22, Bethesda, MD., D.C., 1999.

Coen, L. D. Robert D. Brumbaugh, D. Bushek, R. Grizzle, M.W. Luckenbach, M. H. Posey, S. P. Powers, S. G. Tolley. Ecosystem services related to oyster restoration. Mar Ecol Prog Ser 341: 303–307, 2007

Fulford RS, Breitburg DL, Luckenbach M, Newell RIE (2010) Evaluating ecosystem response to oyster restoration and nutrient load reduction with a multispecies bioenergetics model. Ecol. Appl. 20:915–934.

Grabowski, J.H., Robert D. Brumbaugh, Robert Conrad, Andrew G. Keeler, Jim Opaluch, Charles H. Peterson, Michael F. Piehler, Sean P. Powers, and Ashley R. Smyth. 2012. Economic Valuation of Ecosystem Services Provided by Oyster Reefs. BioScience 62:900-909.

Keeler BL, Polasky S, Brauman KA, Johnson KA, Finlay JC, O'Neill A, Kovacs K, Dalzell B. 2012. Linking water quality and well-being for improved assessment and valuation of ecosystem services. Proc Natl Acad Sci U S A. 2012 Oct 22. [Epub ahead of print]

Peterson, C. H., J. H. Grabowski, and S. P. Powers. 2003. Estimated enhancement of fish production resulting from restoring oyster reef habitat: quantitative valuation. Marine Ecology Progress Series 264: 251-256.

Tolley, S. G. & A. K. Volety. 2005. The role of oysters in habitat use of oyster reefs by resident fishes and decapod crustaceans. J. Shellfish Res. 24:1007–1012.

Zimmerman, R., T. Minello, T. Baumer & M. Castiglione. 1989. Oyster reef as habitat for estuarine macrofauna. Galveston, TX: National Oceanic and Atmospheric Administration, technical memorandum NMFS-SEFC-249.

Lots of studies but they need to be synthesized into a ORES Framework for proper accounting for the Chesapeake

What do we know/need to know?

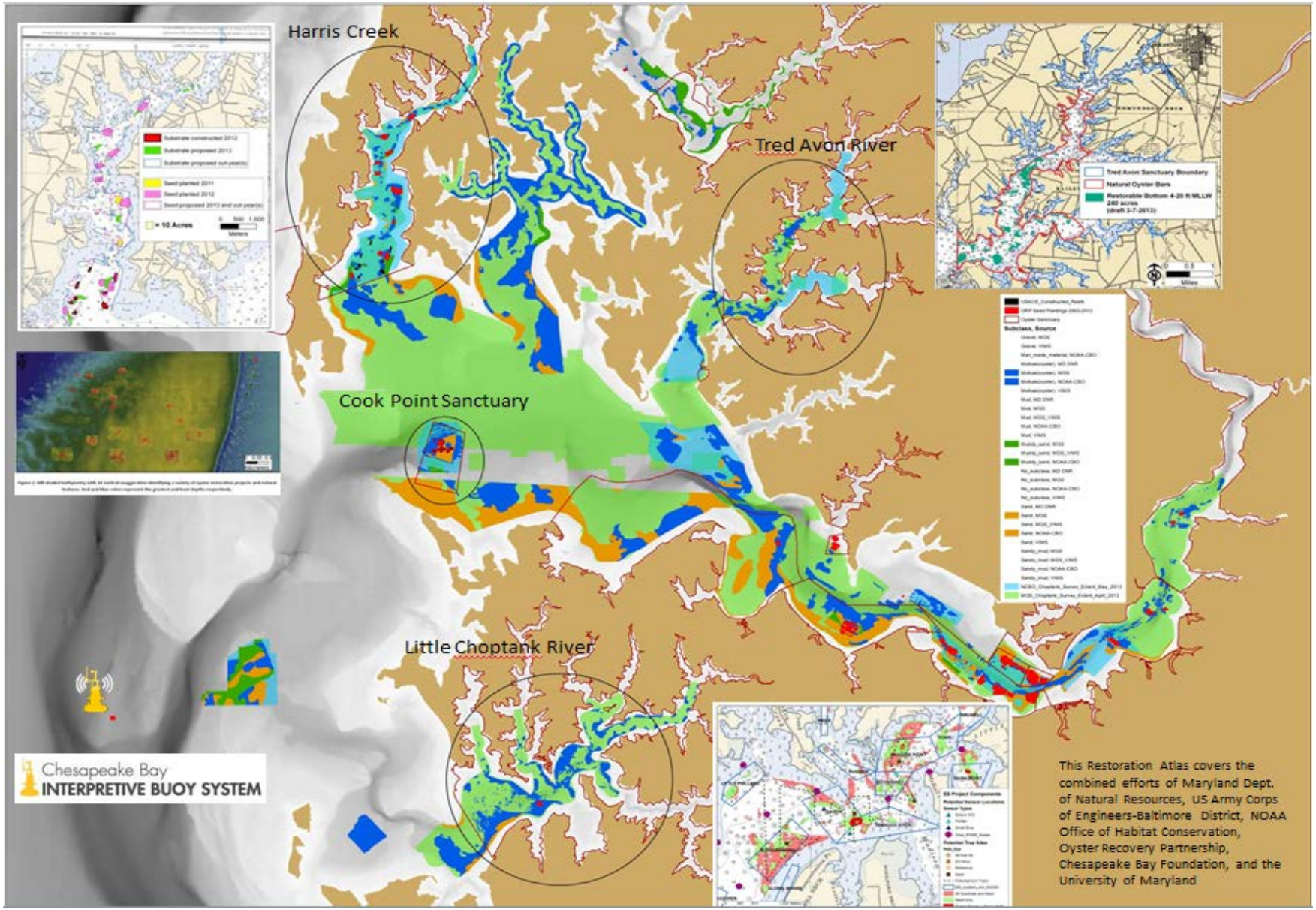
Oyster reefs provide a number of significant ecosystem services, including:

- Enhanced fish and invertebrate production
- Dentrification
- Water filtration
- Shoreline stabilization

Need additional information about impacts of

- Reef density,
- Reef size,
- Reef position in tributary,
- Salinity, hydrodynamics, etc.

Oyster Reef Ecosystem Services: Choptank Complex



Elements of the ORES project

1. **Habitat complexity**
2. **Water column**
3. **Fish sampling**
4. **Modeling**
5. **Economic analyses**

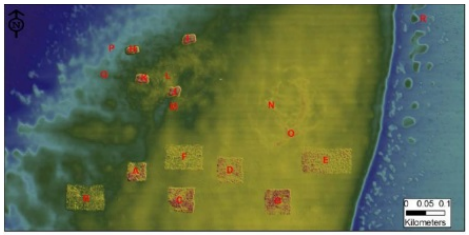
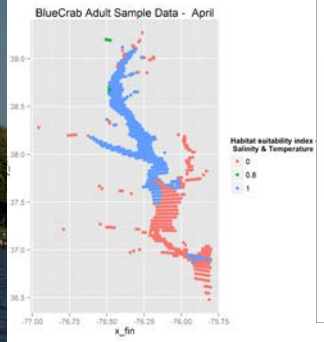
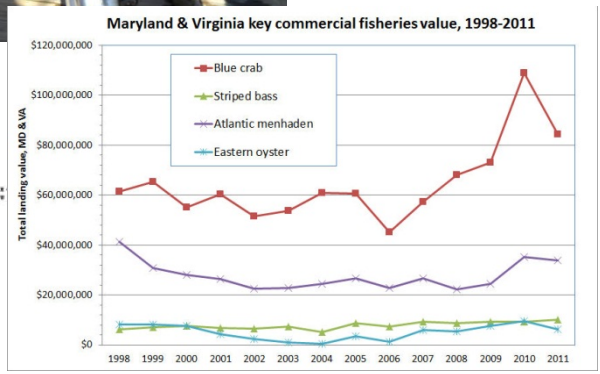
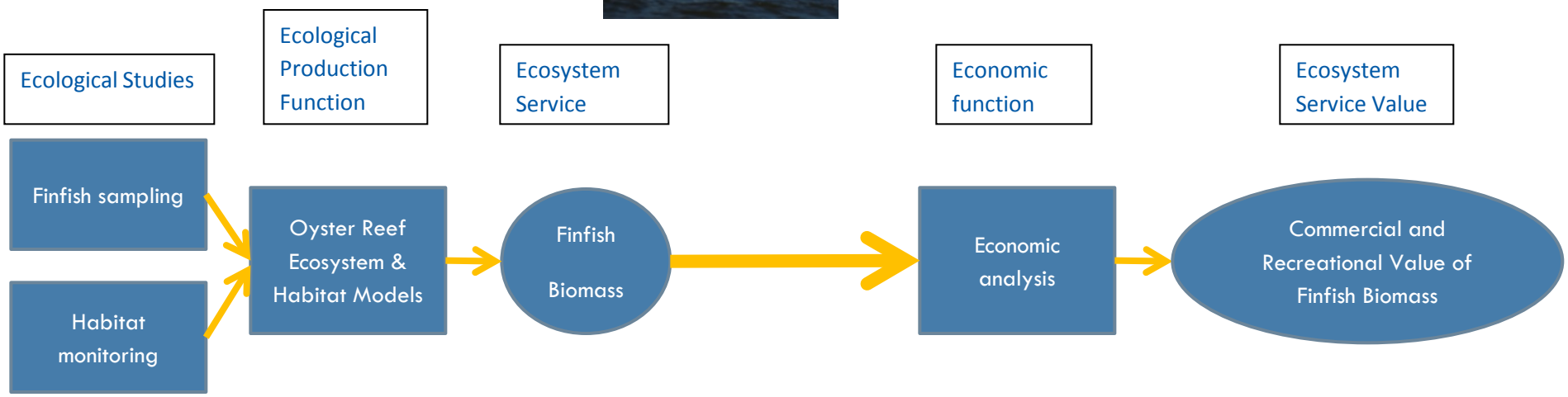


Figure 3. Hill-shaded bathymetry with 3X vertical exaggeration identifying a variety of oyster restoration projects and natural features. Red and blue colors represent the greatest and least depths respectively.



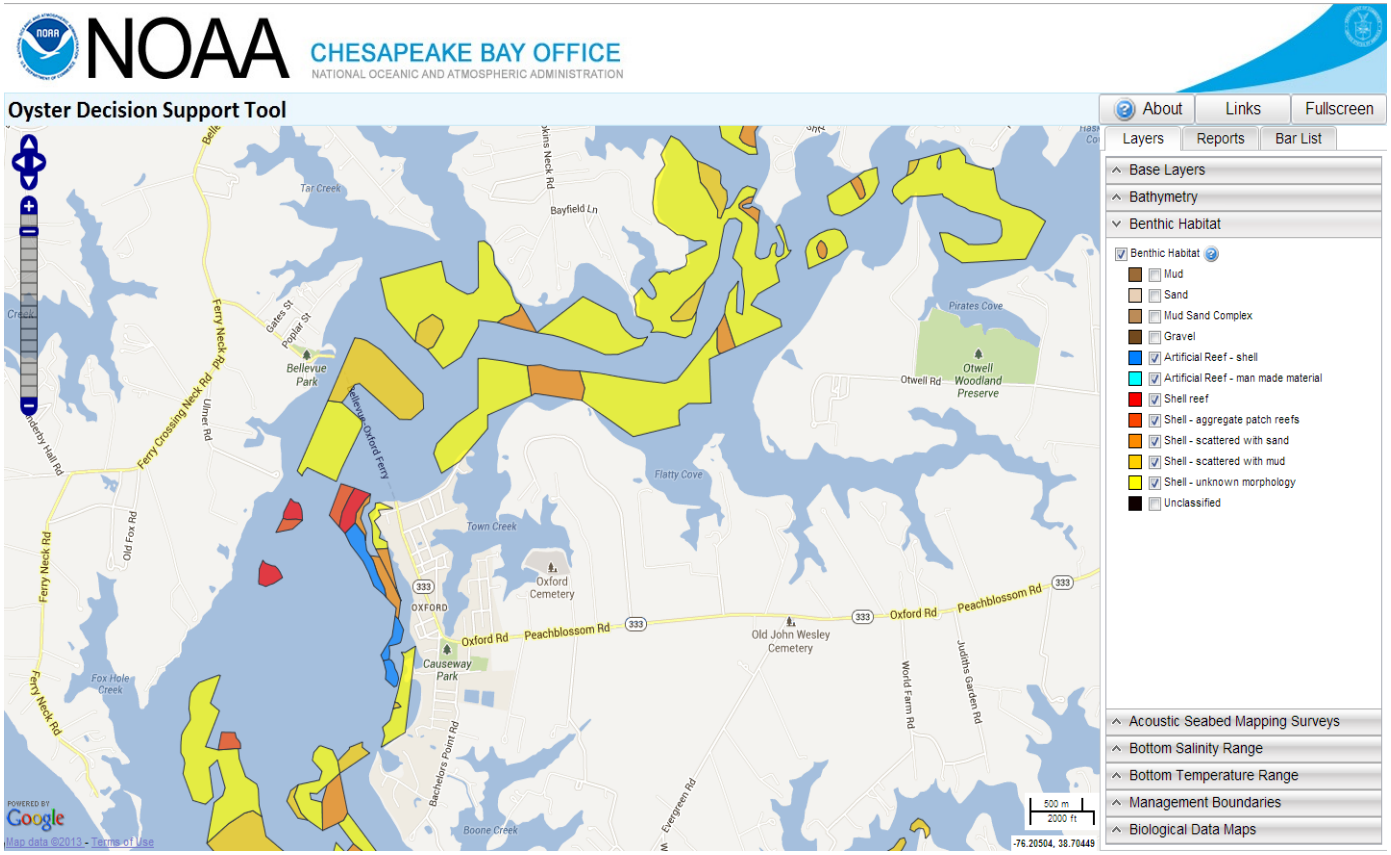




Element 1– Habitat Complexity

Identify relationships between oyster abundance, finfish community and benthic habitat morphology.

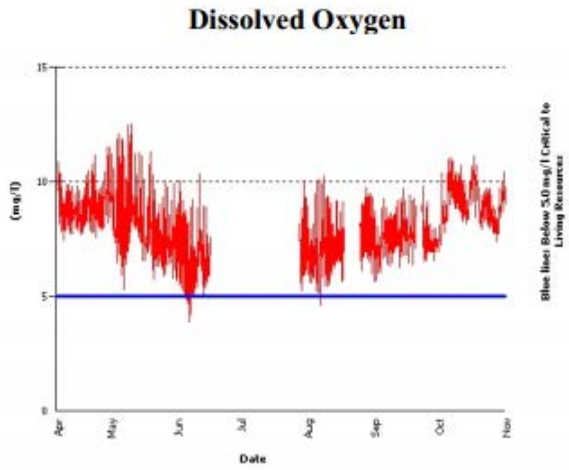
This work has been initiated and analysis is underway.

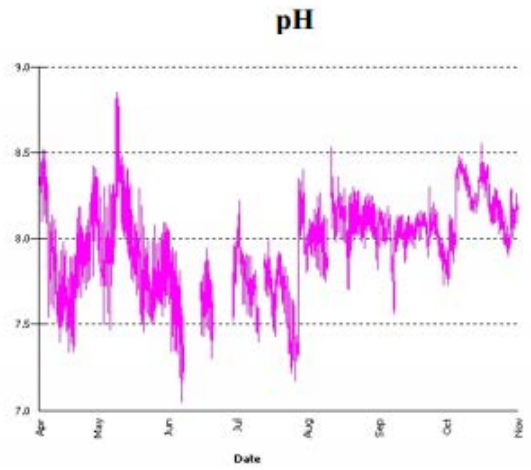


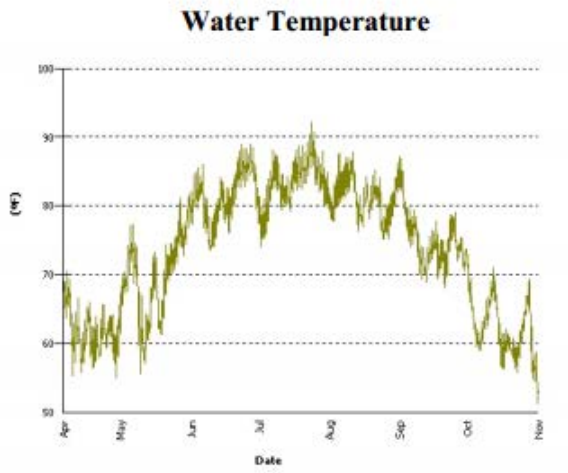
Element 2– Water Column

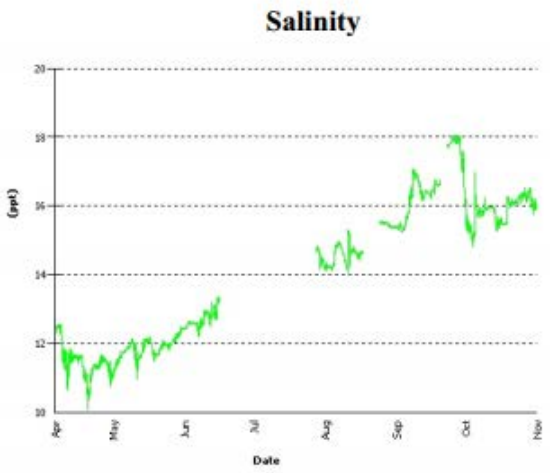
Monitor conditions in the water column habitat (e.g., temperature, salinity, DO) to help explain temporal changes in fish community structure.

This work has been planned and DNR-RAS is funded to provide continuous monitoring.









Element 3– Finfish Community

The traps set-up for data collection is complete.

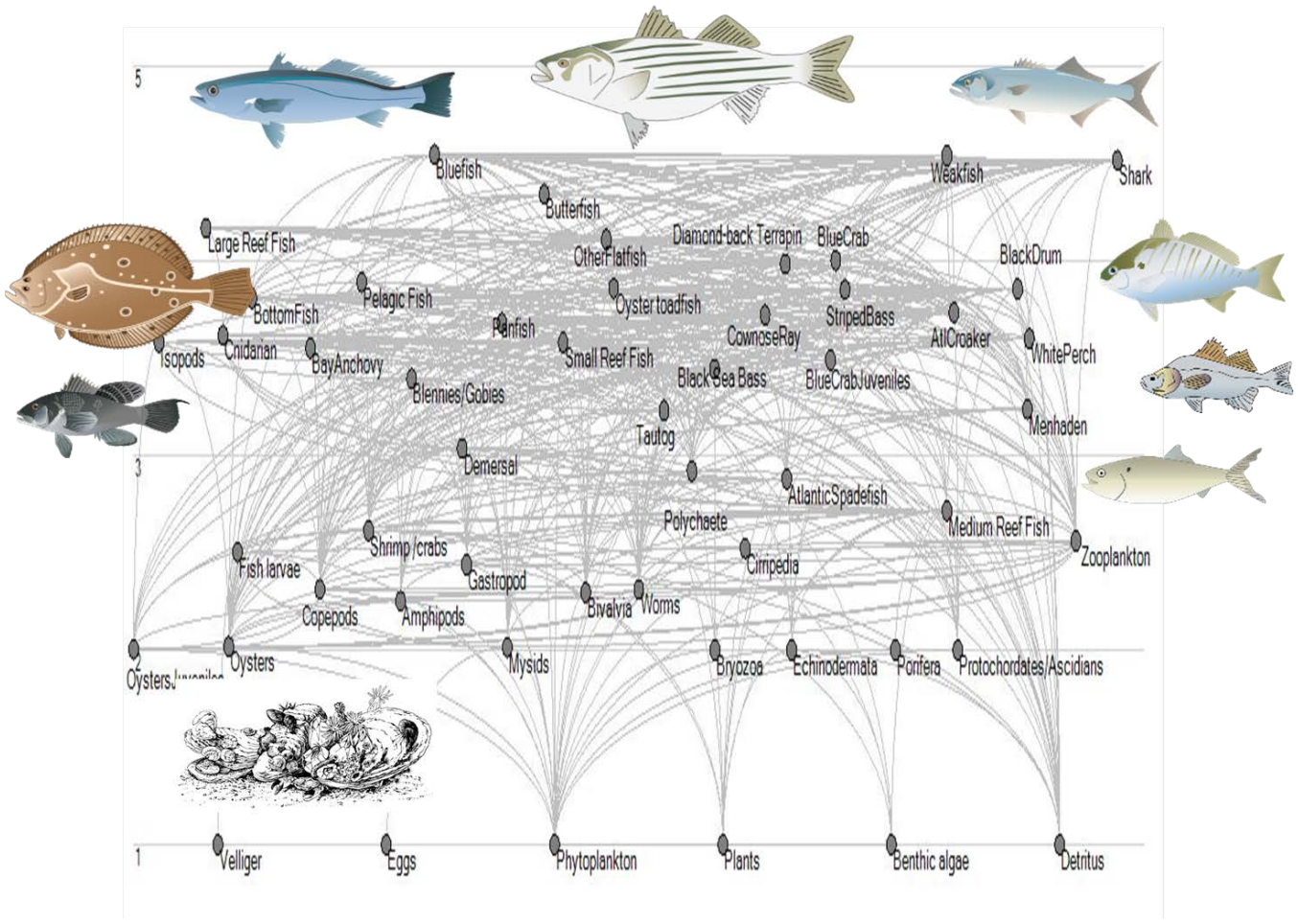
Gear testing is underway.

Sampling occurring throughout the summer and fall.

Element 4– Modeling

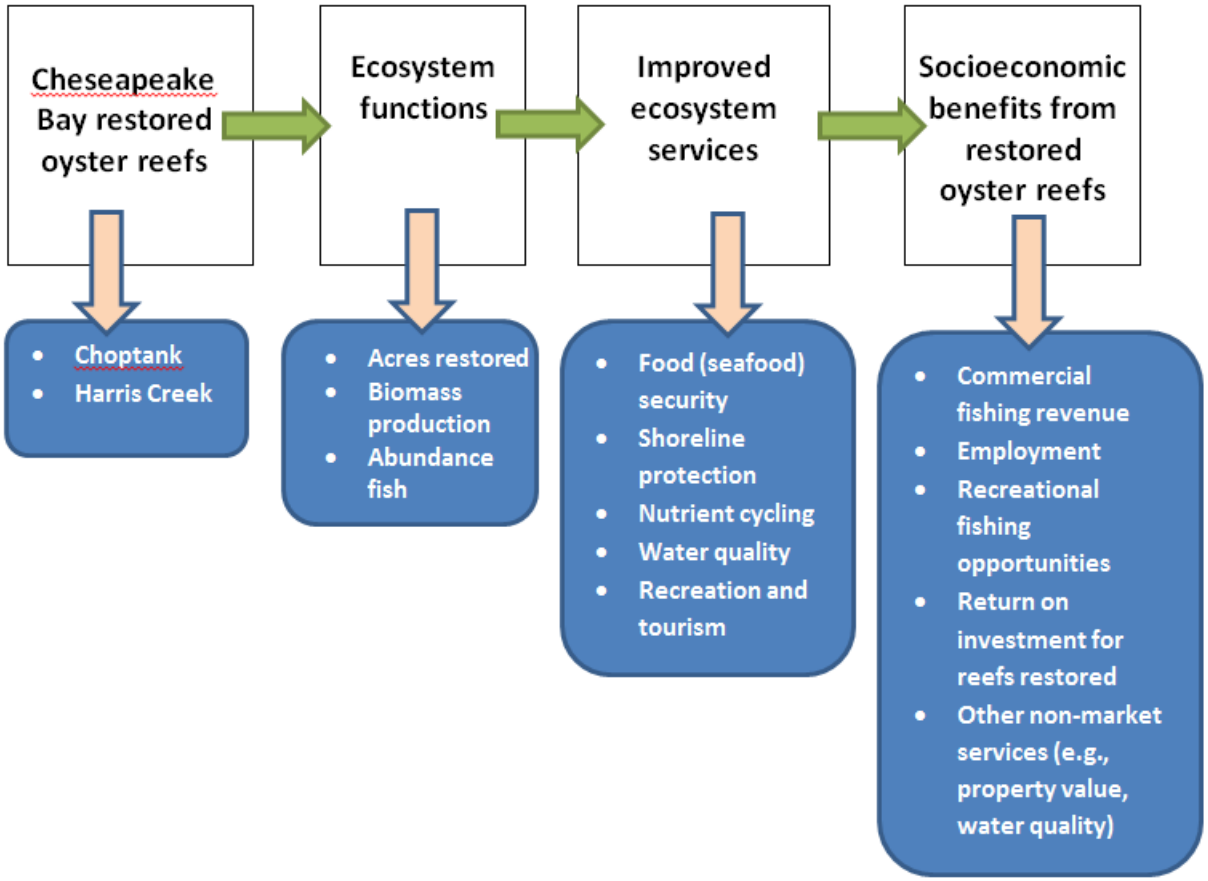
Quantify commercial and recreational fisheries production supported through trophic-habitat interactions

A model of a typical reef has been developed and manuscript is in progress. Modifications will be made based on other studies.



Element 5– Economic Analysis

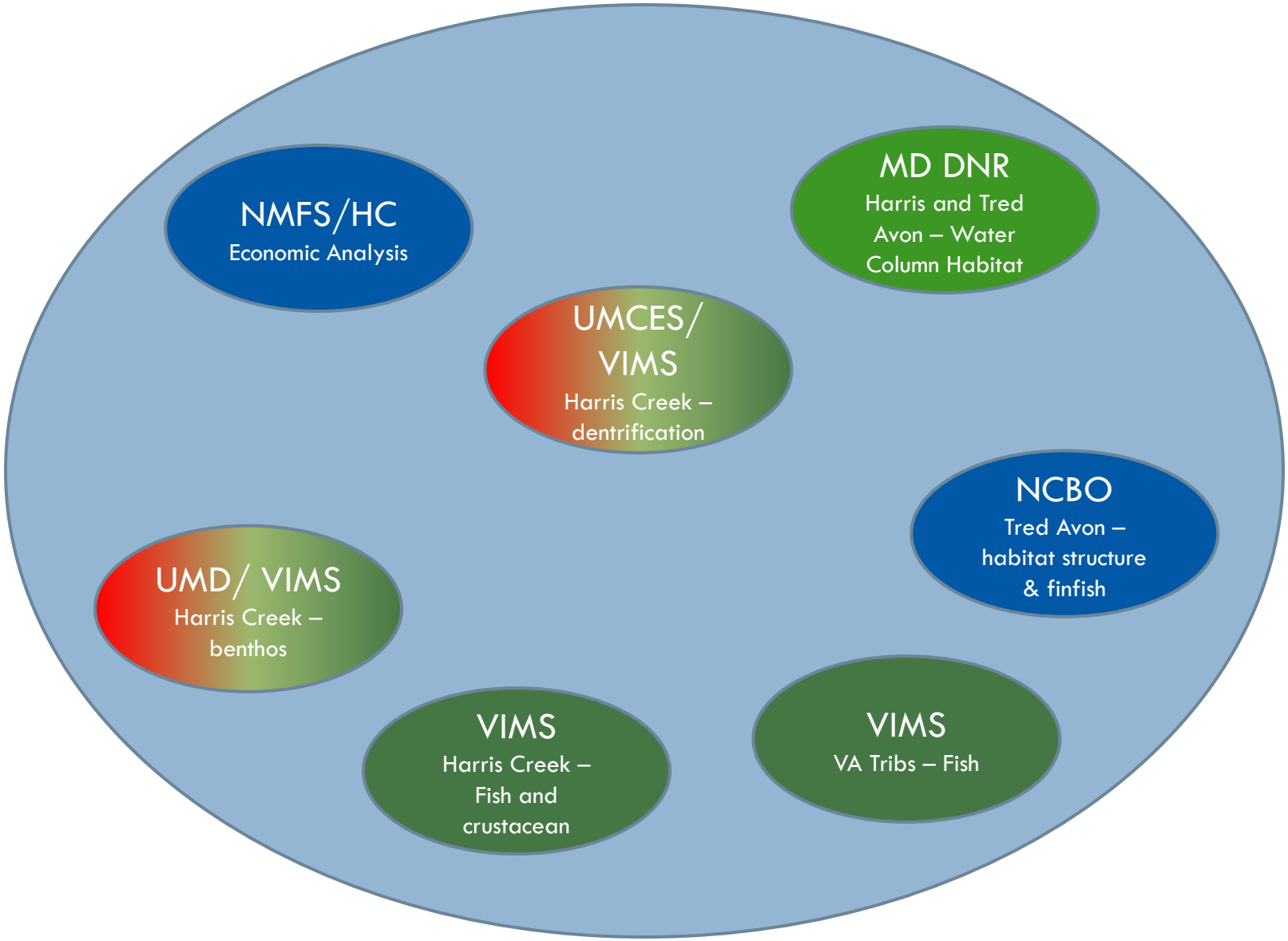
Focus on the economic valuation and impact of commercial and recreational fisheries as a result of enhanced ecosystem services from oyster reef restoration



Collaborative Research

Applicants	Title	Locations
Rom Lipcius & Rochelle Seitz, VIMS	Ecosystem services of restored oyster reefs in lower Chesapeake Bay (fish traps and video)	Great Wicomico, Lafayette, Lynnhaven
Ken Paynter UMD, Lisa Kellogg and Paige Ross VIMS	Integrated assessment of oyster reef ecosystem services: Macrofaunal and productivity utilization, secondary production and nutrient sequestration (benthic sampling)	Harris Creek
Mark Luckenbach, Lisa Kellogg and Paige Ross, VIMS	Integrated assessment of oyster reef ecosystem services: Fish and crustacean utilization, secondary production and trophic linkages (fish traps)	Harris Creek
Jeff Cornwell UMCES and Lisa Kellogg VIMS	Integrated assessment of oyster reef ecosystem services: Quantifying denitrification rates and nutrient fluxes (chambers with oysters moved to lab to use gas analyzer)	Harris Creek

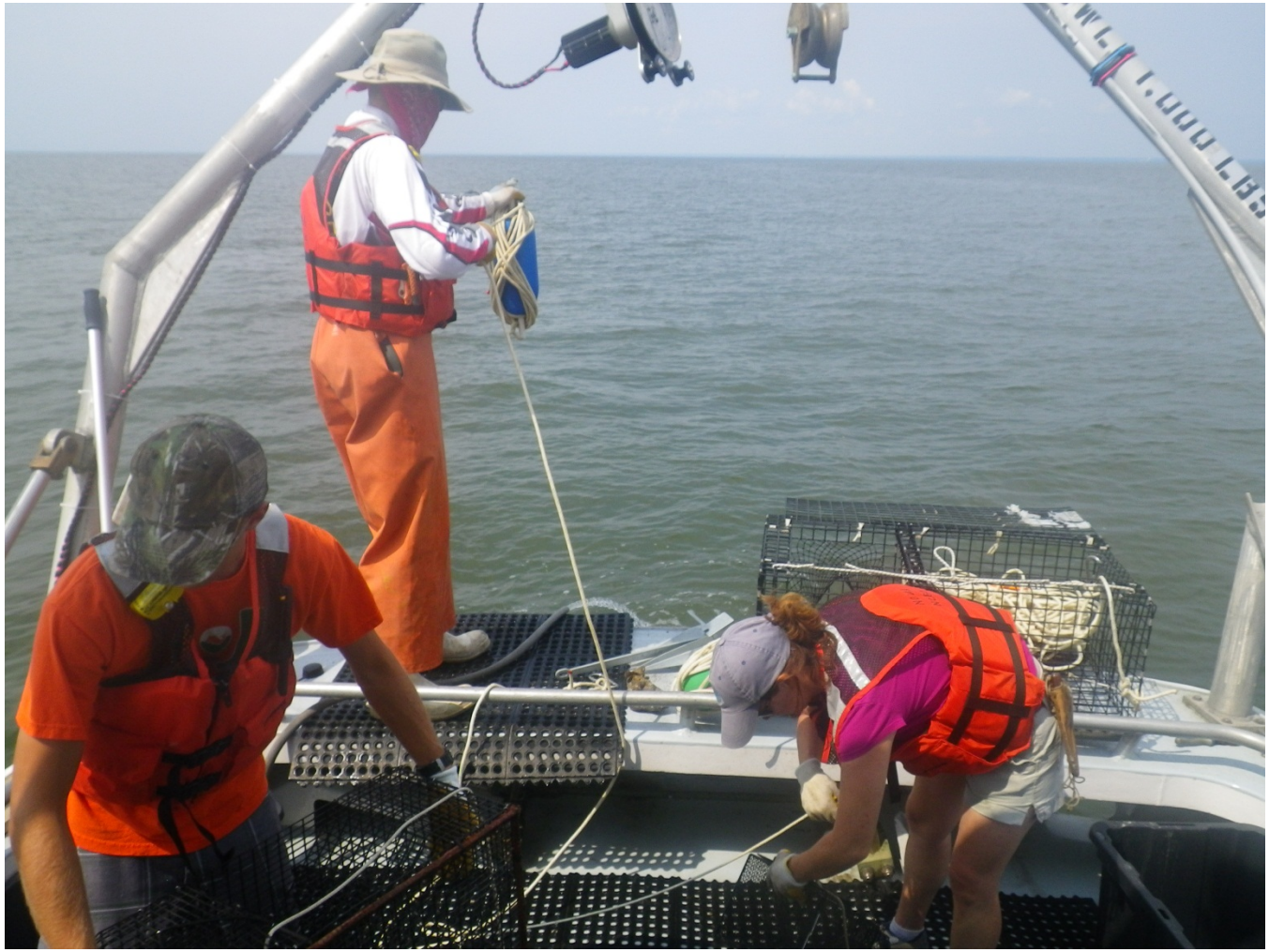
Collaborative Approach for ORES



Tred Avon Study: Preliminary Results

Pre-restoration baseline:

Sampling July-November 2013



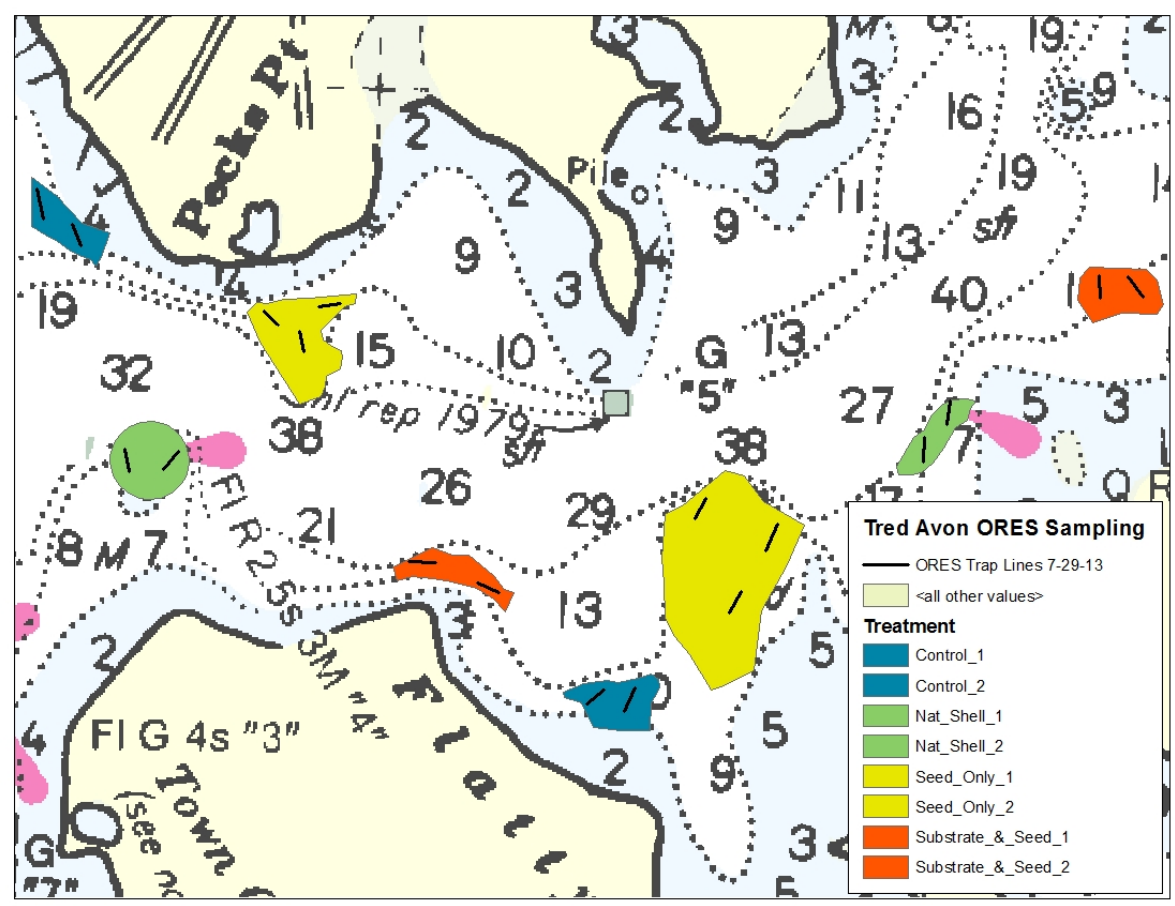
Methods: Site Selection and Site Description

1) Seed Only
Surface shell. Restored with hatchery spat on shell

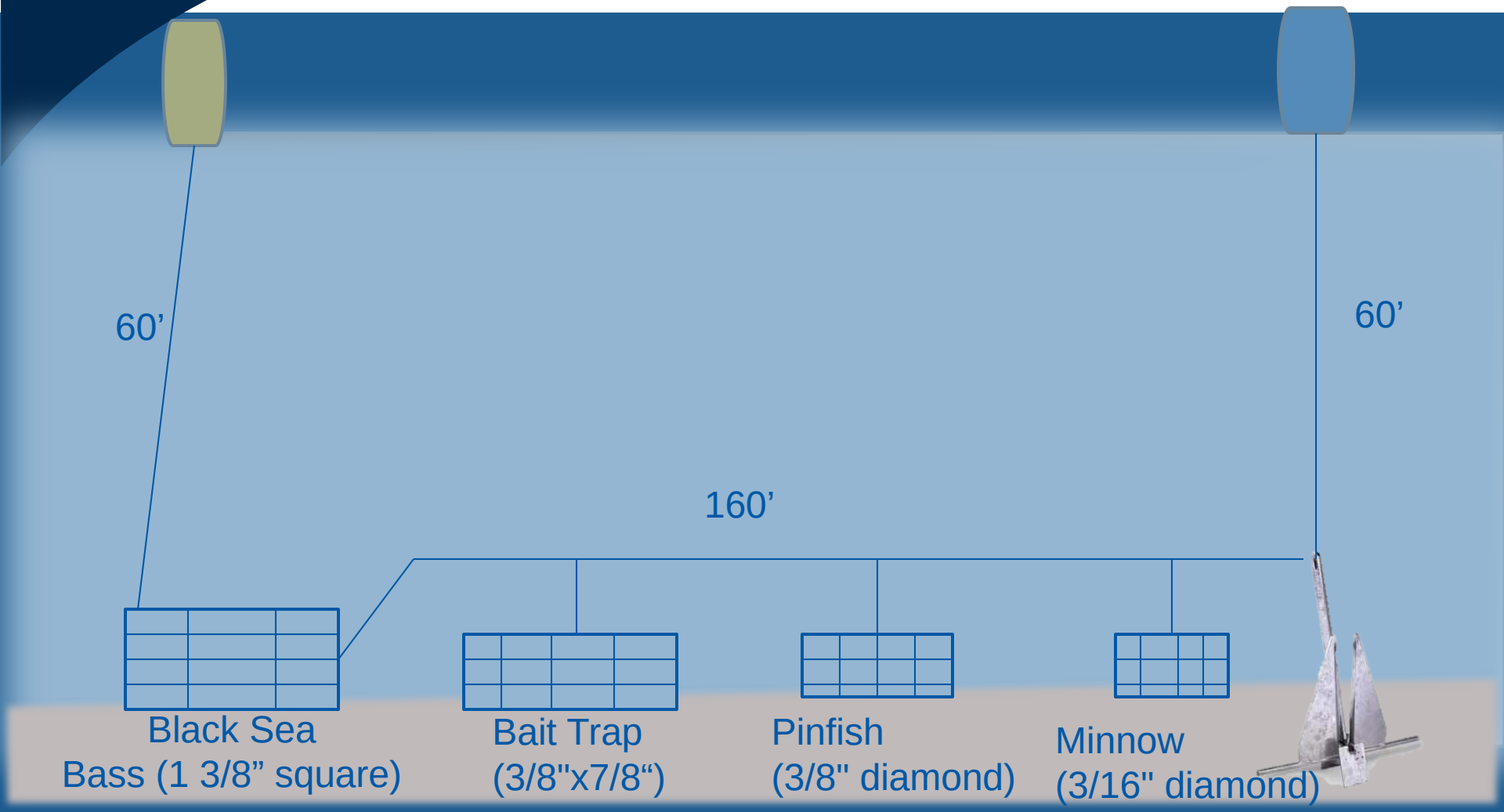
2) Substrate and Seed
Minimal surface shell on hard bottom. Restored with substrate & hatchery spat on shell

3) Control
Minimal surface shell on hard bottom. No restoration

4) Natural Shell
Surface shell & no restoration



Fish Sampling Methods: Gear Description



Results

Mean CPUE relative to site/treatment

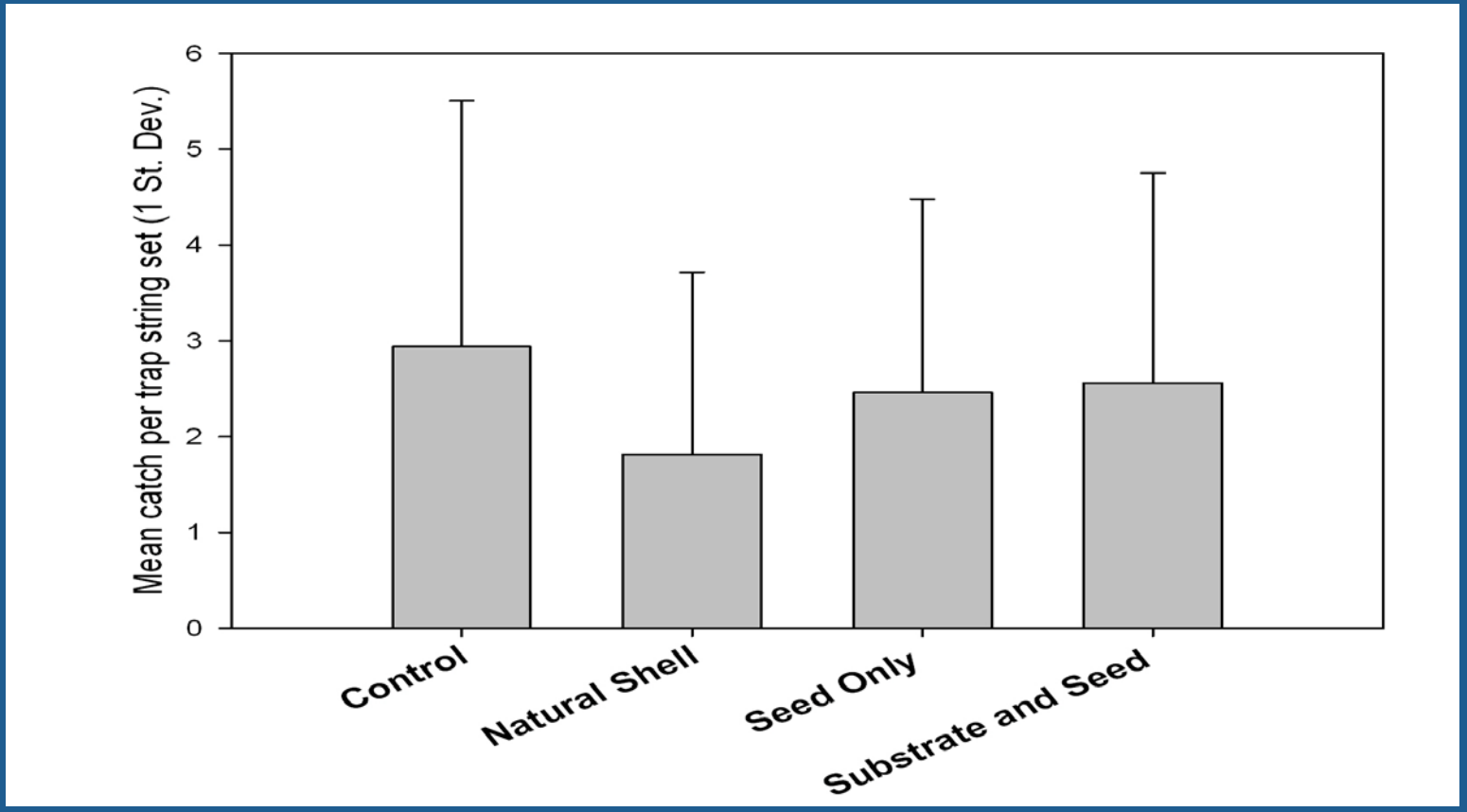
Trap string fishing effort (hours):

Mean = 22.4

Min = 20.0

Max = 24.4

N= 72



Results

Species composition relative to treatment

Treatment	Common Name	Number	Percent of total
Control	WHITE PERCH	23	48.9
Control	SPOT	13	27.7
Control	BLUE CRAB	7	14.9
Control	OYSTER TOADFISH	2	4.3
Control	STRIPED BASS	1	2.1
Control	ATLANTIC CROAKER	1	2.1
		47	
Natural Shell	WHITE PERCH	23	79.3
Natural Shell	BLUE CRAB	3	10.3
Natural Shell	OYSTER TOADFISH	1	3.4
Natural Shell	SILVER PERCH	1	3.4
Natural Shell	GREEN GOBY	1	3.4
		29	
Seed Only Restoration	WHITE PERCH	30	50.8
Seed Only Restoration	BLUE CRAB	12	20.3
Seed Only Restoration	SPOT	8	13.6
Seed Only Restoration	STRIPED BASS	3	5.1
Seed Only Restoration	OYSTER TOADFISH	2	3.4
Seed Only Restoration	HOGCHOKER	2	3.4
Seed Only Restoration	ATLANTIC CROAKER	1	1.7
Seed Only Restoration	NAKED GOBY	1	1.7
		59	
Substrate and Seed Restoration	BLUE CRAB	19	46.3
Substrate and Seed Restoration	SPOT	11	26.8
Substrate and Seed Restoration	WHITE PERCH	5	12.2
Substrate and Seed Restoration	OYSTER TOADFISH	2	4.9
Substrate and Seed Restoration	STRIPED BASS	2	4.9
Substrate and Seed Restoration	PUMPKINSEED	1	2.4
Substrate and Seed Restoration	ATLANTIC CROAKER	1	2.4
		41	

Results

Species Composition by Gear

- Four 3-5 min trawls

- Trawl treatment sites:

Control_1

Natural_Shell_2

Seed_Only_1

Substrate_Seed_2

Common_Name	Trawl number	Trawl Pct	Trap Pct	Trap number
WHITE PERCH	142	53.4	47.2	34
BLUE CRAB	51	19.2	33.3	24
SPOT	13	4.9	12.5	9
HOGCHOKER	12	4.5	0.0	0
STRIPED BASS	11	4.1	5.6	4
BAY ANCHOVY	10	3.8	0.0	0
MUD CRABS	8	3.0	0.0	0
SPOTTED SEATROUT	5	1.9	0.0	0
NAKED GOBY	5	1.9	0.0	0
ATLANTIC MENHADEN	4	1.5	0.0	0
COMMON GRASS SHRIMP	2	0.8	0.0	0
OYSTER TOADFISH	2	0.8	1.4	1
ATLANTIC CROAKER	1	0.4	0.0	0
	266	100	100	72

Trawl Date: 8/6/2013

Trap Date: 7/29/2013

Results

CPUE relative to date

Date	Mean CPUE (no./trap string set)	median	stdev	min	max	n	sum
7/29/2013	4.0	3.5	2.4	0	8	18	72
9/5/2013	2.7	2.0	2.1	0	7	18	48
9/25/2013	2.4	2.0	1.6	0	6	18	44
11/4/2013	0.7	1.0	0.7	0	2	18	12
							176

Results

Species composition relative to date

Date	Common Name	Number	Percent of total
7/29/2013	WHITE PERCH	34	47.2
7/29/2013	BLUE CRAB	24	33.3
7/29/2013	SPOT	9	12.5
7/29/2013	STRIPED BASS	4	5.6
7/29/2013	OYSTER TOADFISH	1	1.4
		72	
9/5/2013	WHITE PERCH	20	41.7
9/5/2013	SPOT	12	25.0
9/5/2013	BLUE CRAB	10	20.8
9/5/2013	ATLANTIC CROAKER	3	6.3
9/5/2013	OYSTER TOADFISH	1	2.1
9/5/2013	STRIPED BASS	1	2.1
9/5/2013	HOGCHOKER	1	2.1
		48	
9/25/2013	WHITE PERCH	22	50.0
9/25/2013	SPOT	11	25.0
9/25/2013	BLUE CRAB	4	9.1
9/25/2013	OYSTER TOADFISH	4	9.1
9/25/2013	STRIPED BASS	1	2.3
9/25/2013	SILVER PERCH	1	2.3
9/25/2013	HOGCHOKER	1	2.3
		44	
11/4/2013	WHITE PERCH	5	41.7
11/4/2013	BLUE CRAB	3	25.0
11/4/2013	OYSTER TOADFISH	1	8.3
11/4/2013	PUMPKINSEED	1	8.3
11/4/2013	NAKED GOBY	1	8.3
11/4/2013	GREEN GOBY	1	8.3
		12	

Summary

- **Lower than expected catch rates**
- **Little difference in relative abundance or species composition among treatments. Not surprising for pre-restoration condition.**
- **Reasonable capture of species composition by traps relative to trawl gear. Working with other Pis to fin tune gear and ensure consistency across sites.**
- **Apparent seasonality in rel. abundance. May need to shift schedule.**