

ASSESSING THE BENEFITS OF OYSTER RESTORATION

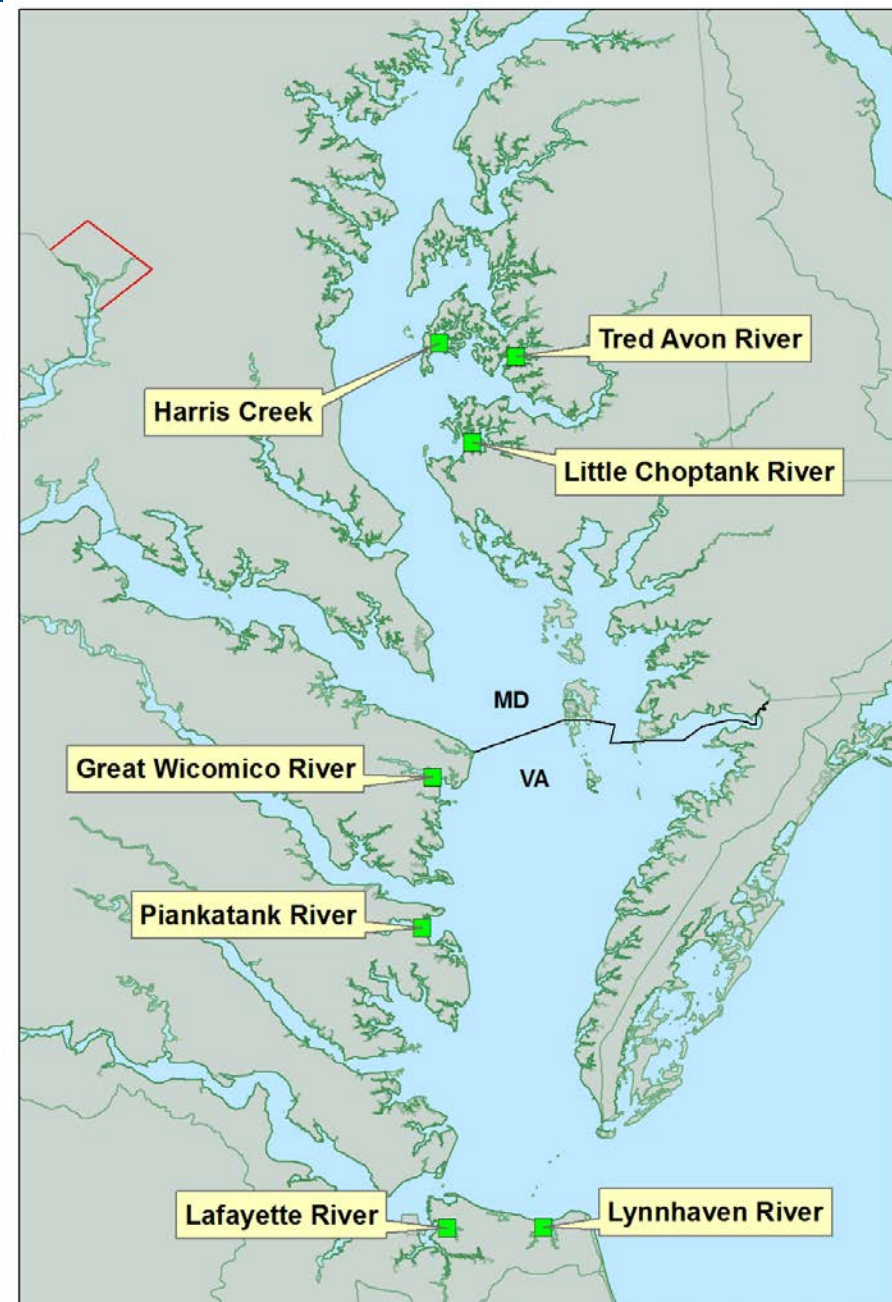
A Summary of Chesapeake Bay Ecosystem Services Research



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Office of Habitat Conservation
Chesapeake Bay Office

Chesapeake Bay Oyster Reef Ecosystem Services (ORES) Projects



General Research Themes

- Nutrient Flux and Sequestration
- Macrofauna, Large Crustacean, and Finfish: Utilization, Production, and Trophic Pathways
- Economic Valuation

Nutrient Flux and Sequestration

- University of Maryland Center for Environmental Science (UMCES)/VIMS, “Integrated Assessment of Oyster Reef Ecosystem Services: Quantifying Denitrification Rates and Nutrient Fluxes”
Principal Investigators: J. Cornwell, M. Owens, L. Kellogg.
Project period: Mar. 2015-2018
- *UMCES, “Natural Engineers in Ecosystem Restoration: Modeling Oyster Reef Impacts on Particle Removal and Nutrient Cycling”*
Principal Investigators: L. Harris, J. Testa, E. North, L. Sanford. 2014 Award
Project period: Oct. 2014-2018

Utilization, Production, and Trophic Pathways

- Virginia Institute of Marine Science (VIMS), *“Ecosystem Services of Restored Oyster reefs in the Lower Chesapeake Bay”*
Principal Investigators: R. Lipcius, R. Seitz
Project period: Oct. 2014-2018
- University of Maryland/VIMS, *“Macrofaunal and Productivity Utilization, Secondary Production, and Nutrient Sequestration”*
Principal Investigators: K. Paynter, L. Kellogg, P. Ross
Project period: Mar. 2015-2018
- VIMS, *“Fish and Crustacean Utilization, Secondary Production, and Trophic Linkages”*
Principal Investigators: L. Kellogg, M. Luckenbach, P. Ross.
Project period: Feb. 2015-2018

Utilization, Production, and Trophic Pathways (continued)

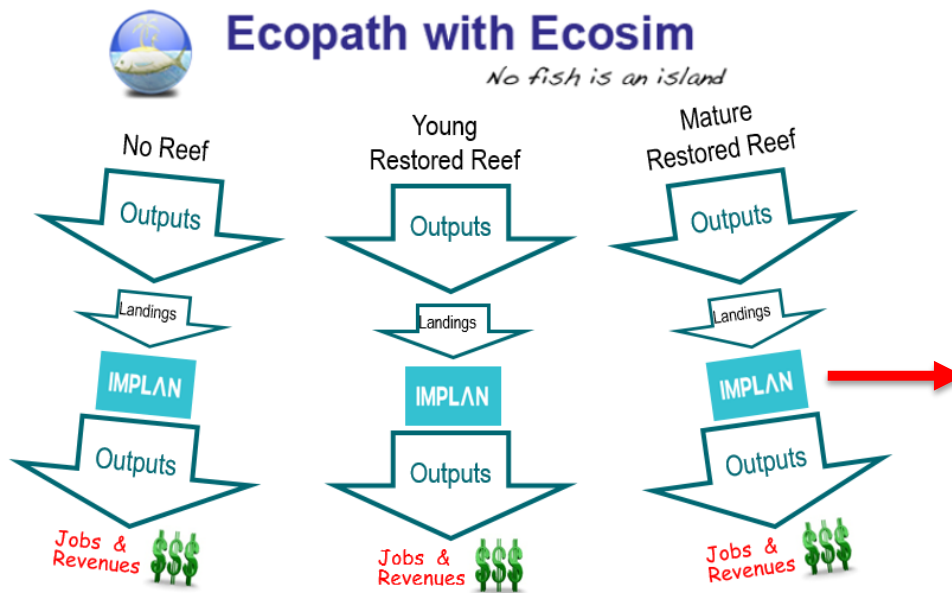
- *Virginia Commonwealth University (VCU), "Pathways to Production: An assessment of fishery responses to oyster reef restoration and the trophic pathways that link the resource to the reef"*
Principal Investigator: S. McIninch
Project period: Feb. 2016-2018
- *Smithsonian Environmental Research Center (SERC), "Application of Dual-frequency Imaging Sonar to the Study of Oyster Reef Ecosystem Services"*
Principal Investigators: A. Hines, M. Ogburn
Project period: Feb. 2015-2018
- *NOAA Chesapeake Bay Office, "Fish Utilization of Restoration Sites in the Little Choptank and Tred Avon (MD) Oyster Sanctuaries"*
Principal Investigator: D. Bruce
Project period: May 2014-2018

Economic Valuation

- Morgan State University , *“Choptank River Complex Habitat Focus Area: Quantifying Ecosystem Services”*

Principal Investigators: S. Knoche, T. Ihde, J. Holzer, D. Lipton

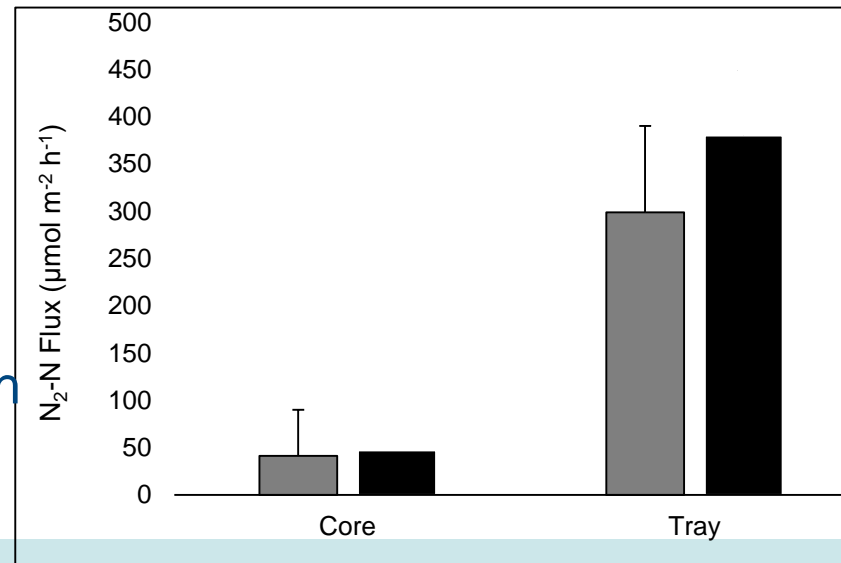
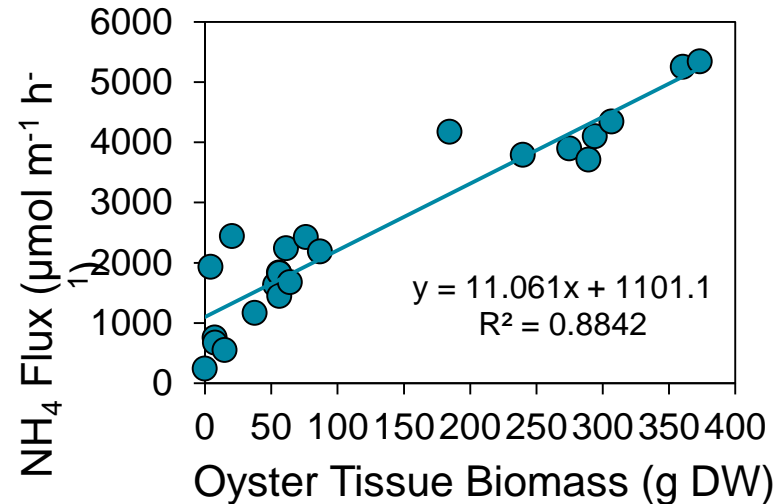
Ecosystem-Based Fisheries Management



IMPLAN:
economic Impact Analysis

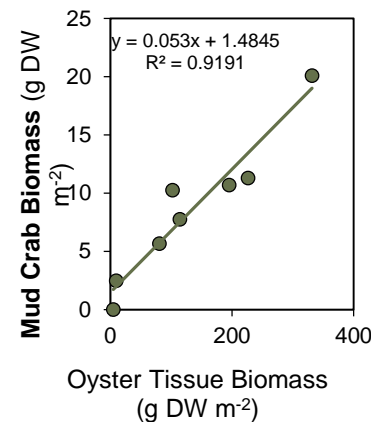
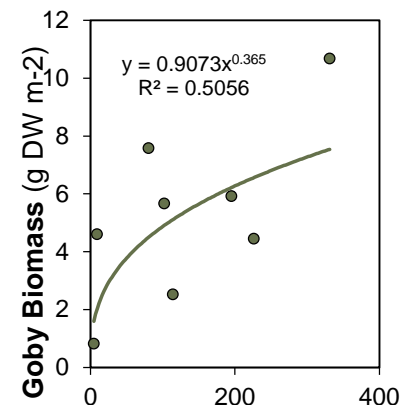
Highlights: Nutrient Flux and Sequestration

- Rates of nitrogen (NH_4 , NO_x , N_2) flux greater on restoration sites than on reference sites. Rates related to oyster abundance
- Denitrification rates at Harris Creek sites less than more mature restoration sites elsewhere in the Choptank River system
- 2017: incubated oysters without the sediment. Results are very clear that most denitrification occurs in the oyster clumps
- Nutrient Cycling Model: model components function reasonably well. Initial predictions lower than field observations (Kellogg et. al. 2013), which is being addressed by final calibration and validation work



Highlights: Utilization, Production, and Trophic Pathways: Harris Creek MD

- Biomass of some reef dependent macro-organisms positively related to oyster density
- No difference in larger finfish abundance between restored and non-restored sites
- Juvenile striped bass show a greater dependence on benthic prey than on forage fish relative to other Bay studies
- Abundance of finfish and crabs from DIDSON sonar being related to video derived habitat quality scores



Score = 0

Score = 1

Score = 2

Score = 3

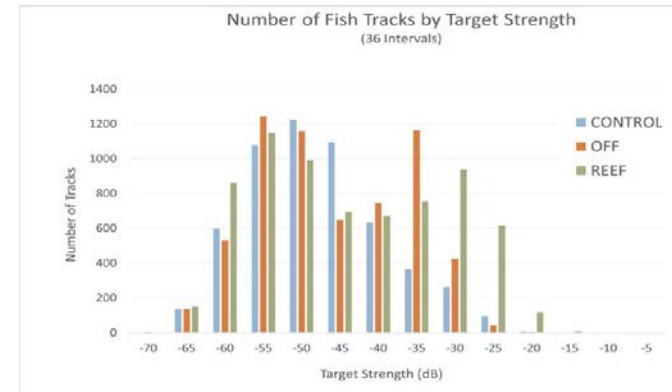
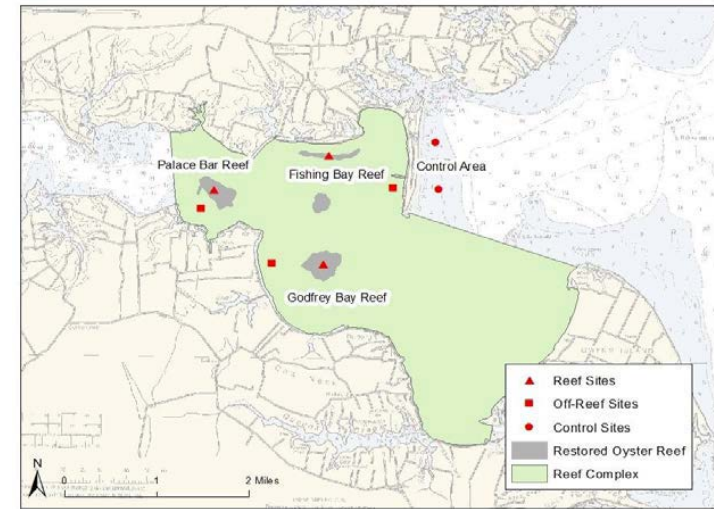
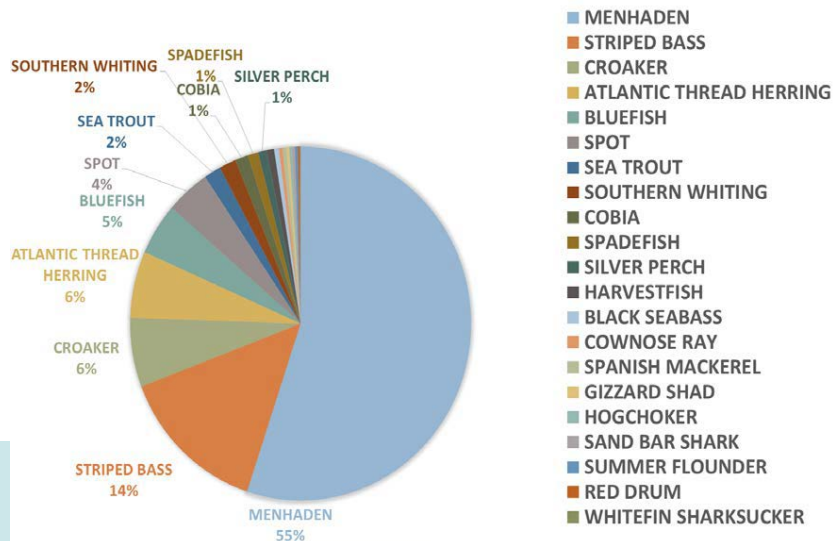
Score = 4



Highlights: Utilization, Production, and Trophic Pathways:

Piankatank River VA

- Gillnet and acoustic surveys indicate higher use of oyster reef habitats during night time
- Larger fish more prevalent on reef sites than on reference sites
- Gillnet catch is dominated by menhaden and striped bass

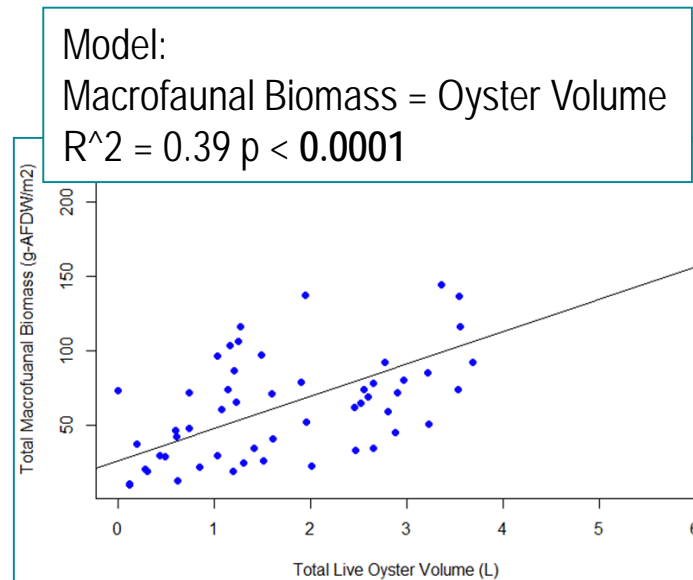


Target Strength to estimated fish length for 420 kHz

TS (dB)	Fish Length (cm)
-25	115.0
-30	63.0
-35	34.5
-40	18.9
-45	10.3
-50	5.7
-55	3.1
-60	1.7
-65	0.9

Highlights: Utilization, Production, and Trophic Pathways: Four Western Shore VA Tributaries

- Macrofaunal biomass and density positively related to oyster density
- Density of resident reef fishes positively related to oyster density
- Salinity has a strong effect on which species use oyster habitat in different tributaries
- Daily consumption rate and diet composition linked to oyster reef habitat for silver perch, but less so among spot and croaker

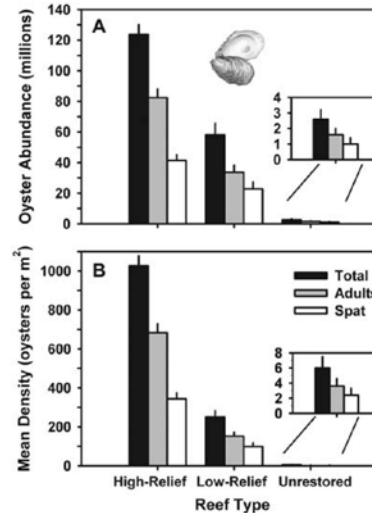


Silver Perch Mean Daily Consumption Rate

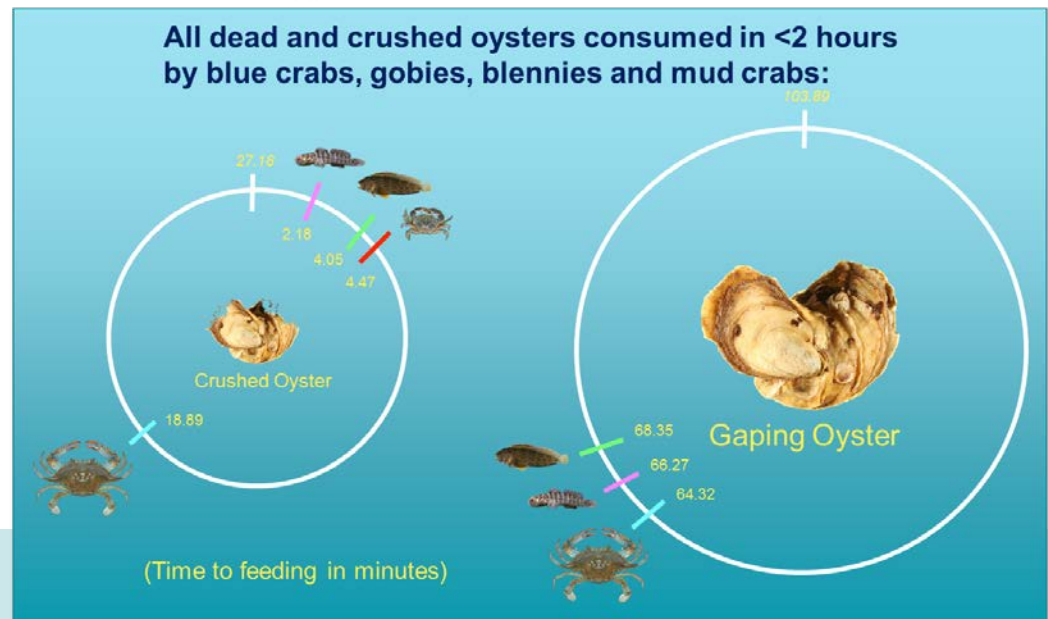
Month	Habitat	Consumption (S.E.)
July	Reef	0.020 (0.007)
	Control	0.011 (0.006)
Sept	Reef	0.018 (0.005)
	Control	0.003 (0.001)

Highlights: Utilization, Production, and Trophic Pathways: Habitat and Food Web

- High-relief reefs maximize ecosystem services through enhanced oyster biomass
- Pathway of energy flow on oyster reefs must include blue crab and other scavengers on dead oysters; this pathway may be much more important than pathway of live oysters to predators



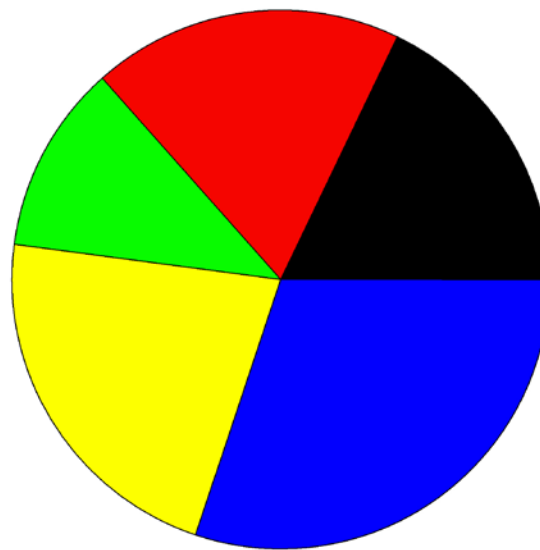
- Great Wicomico River
- Lynnhaven River
- Piankatank River
- All show same results for reef height



Highlights: Fish Utilization, Little Choptank and Tred Avon Rivers, MD

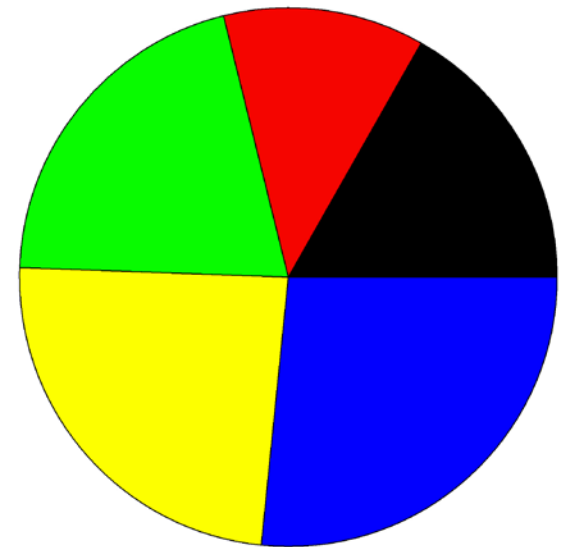
Species Composition

Little Choptank
2014-2017



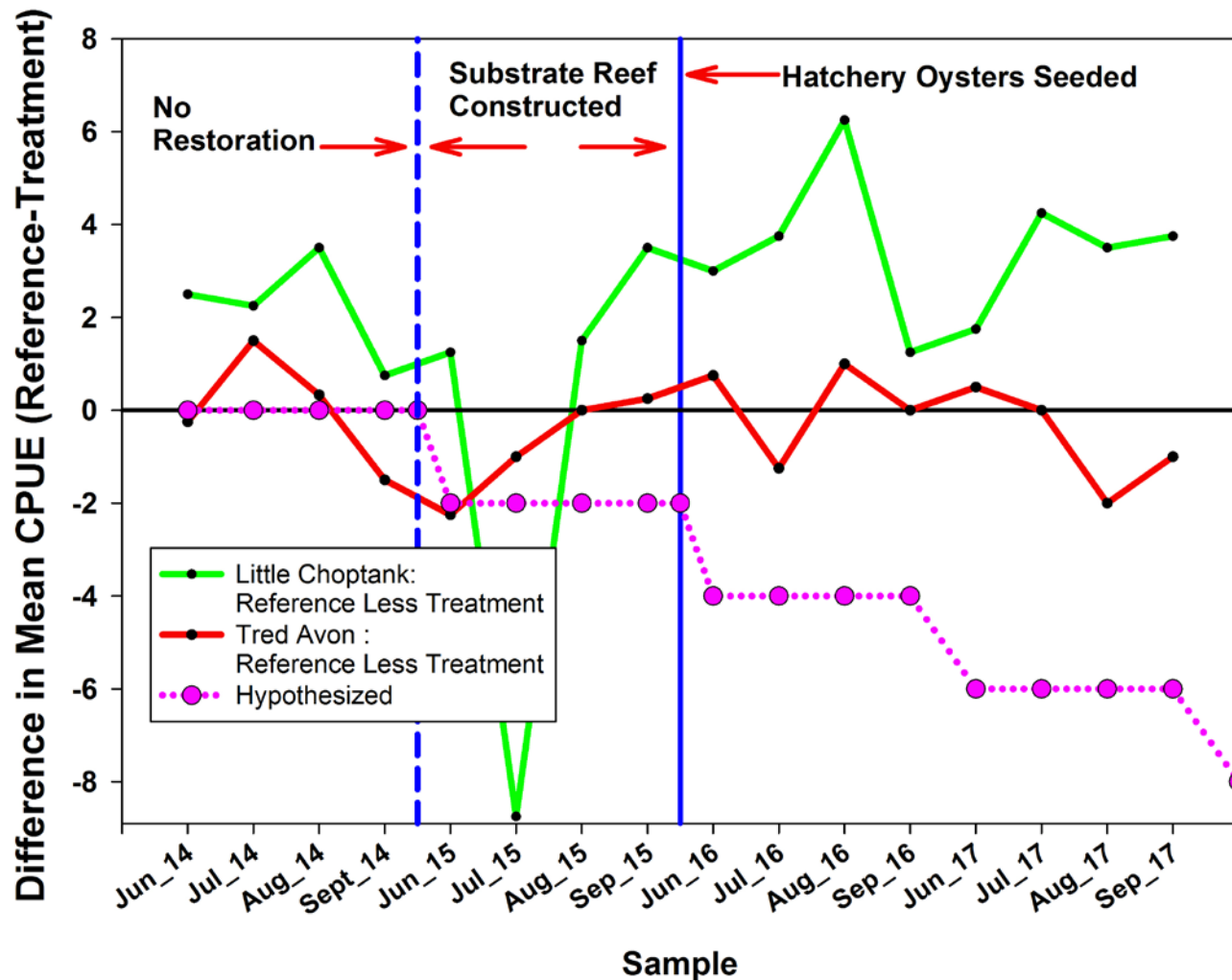
OTHER (7 species)
AMERICAN EEL
WHITE PERCH
OYSTER TOADFISH
BLUE CRAB

Tred Avon
2014-2017



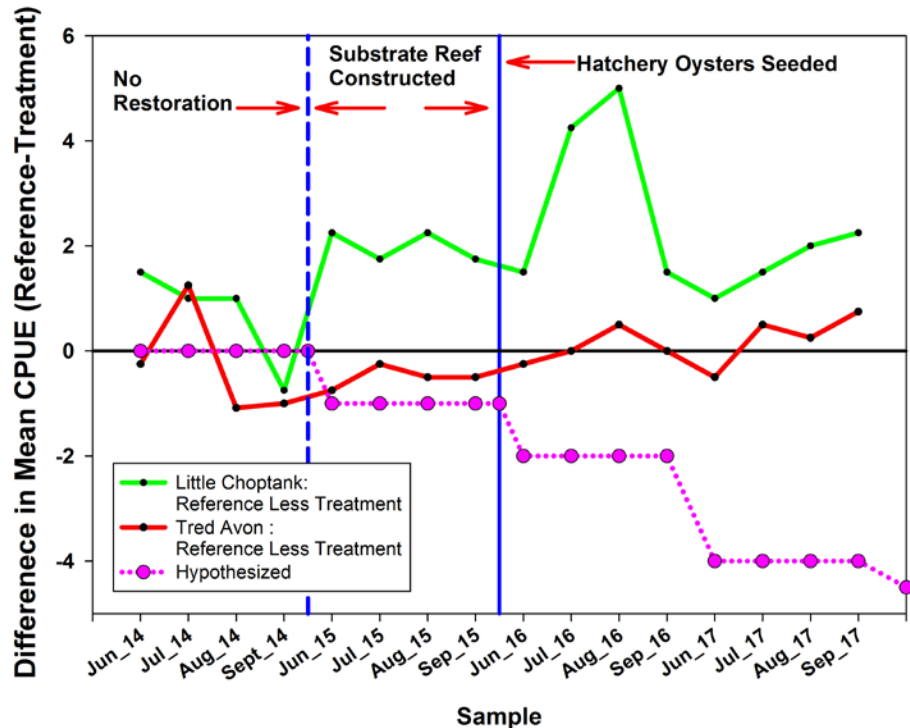
OTHER (8 species)
AMERICAN EEL
WHITE PERCH
OYSTER TOADFISH
BLUE CRAB

Catch-Per-Unit-Effort Time Series on Constructed Substrate Reefs and Reference Sites All Species Pooled

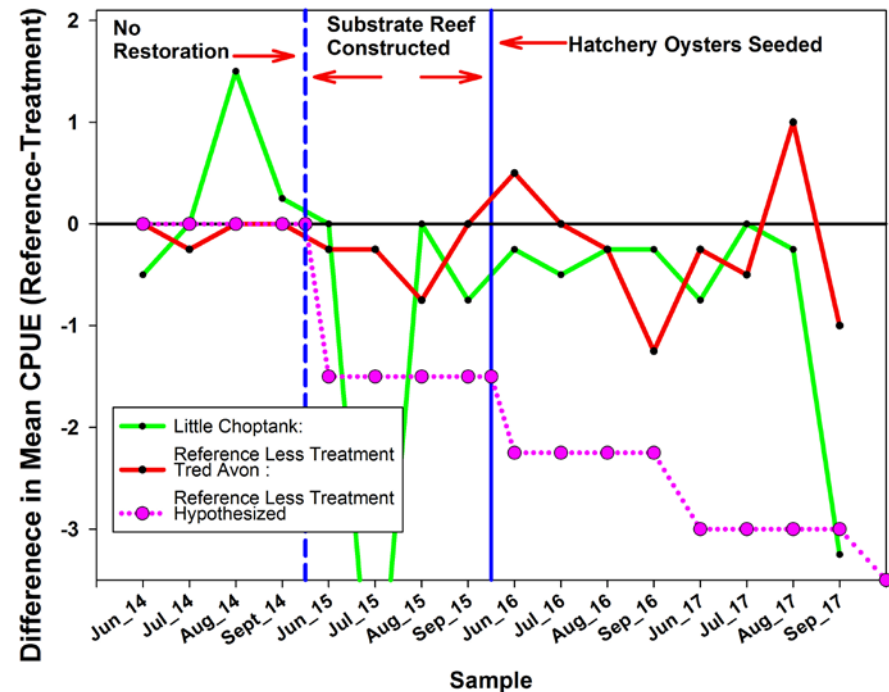


Catch-Per-Unit-Effort Time Series on Constructed Substrate Reefs and Reference Sites

Blue Crab

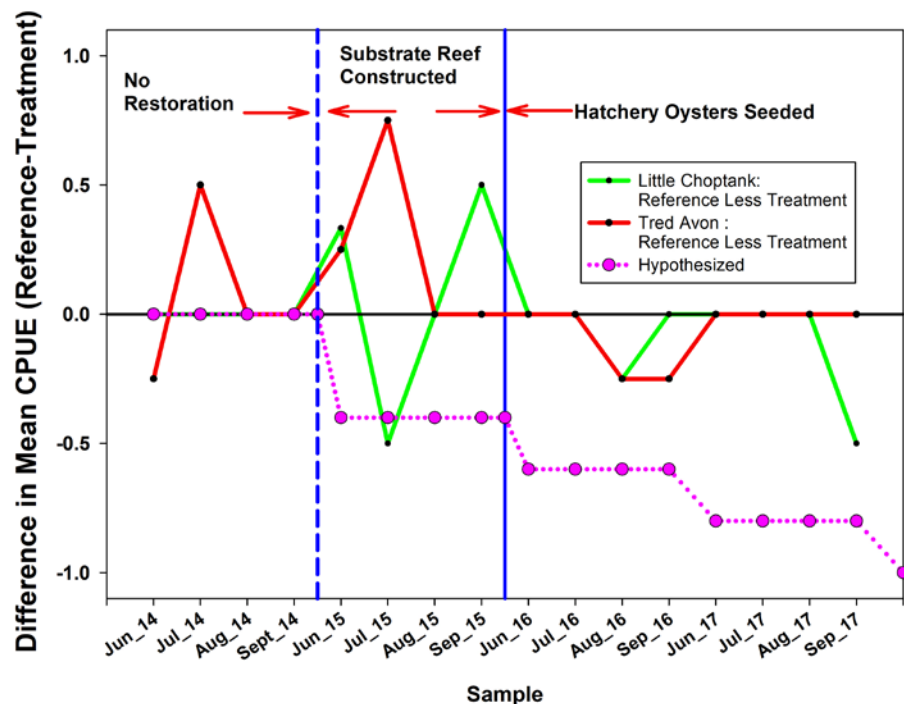


American Eel

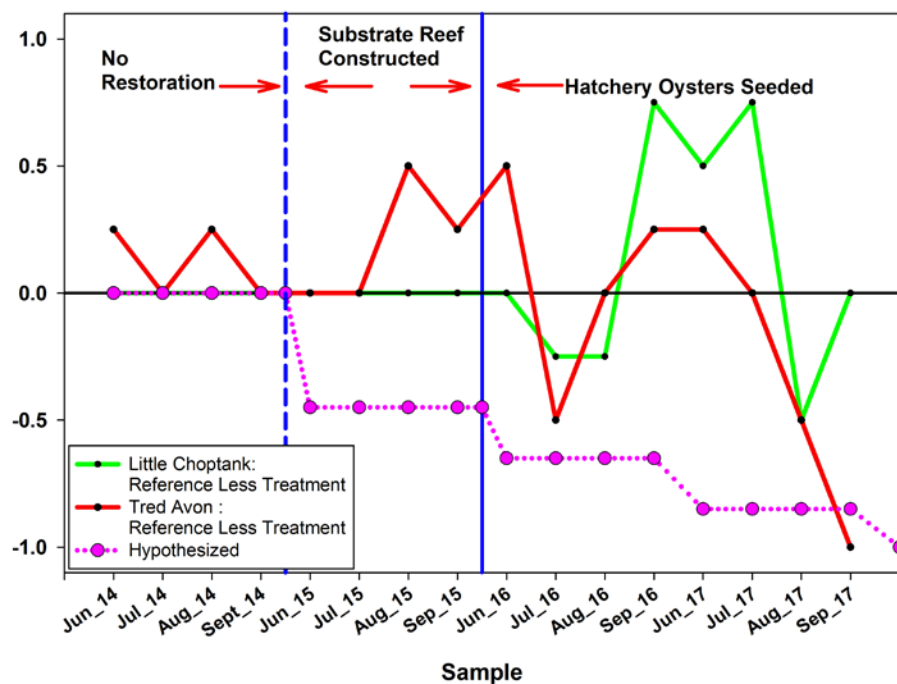


Catch-Per-Unit-Effort Time Series Constructed Substrate Reef Restoration

White Perch



Oyster Toadfish



Choptank River Economic Valuation: Project Status

I. Initial Investment Analysis – IMPLAN, 1st application

COMPLETE:

- Industry Category Codes
- Updated IMPLAN software,

II. Ecosystem Modelling – Ecopath with Ecosim

COMPLETE

- Food web model (Ecopath) & Dynamic model (Ecosim)
- Literature and data review
- Scenario runs → Dockside landing estimates (Nov)

IN PROGRESS

- Fact sheets initiated & drafts refined
- Tweaking scenarios based on first run of IMPLAN

III. IMPLAN – Restored Oyster Reef Impact Analysis

COMPLETE

- Watermen and Angler interviews (fishery cost data)
- Scenario runs

IN PROGRESS

- Collaborate with NEFSC economist (IMPLAN guru) to apply IMPLAN to Choptank Region (Oct-present)
- Final documentation & formatting of products, including factsheets, literature/data reviews

IV. Nutrient Reduction – FARM model (Suzanne Bricker)

IN PROGRESS

- Modeling & documentation nearing completion
- Conversion from aquaculture application to restored reef estimates specific to the Choptank R.



Closing Comments

- Unique opportunity to study oyster reef ecosystems removed from fishing industry effects
- Short term studies so ecosystem function relative to reef maturity is not addressed
- Bay-wide salinity gradients result in variation in reef community composition and potentially other ecosystem functions
- Reef utilization patterns by larger more transient species are difficult quantify

Looking Forward : All ORES Projects

- 2018 wrap up
- Winter 2018 Investigators Meeting: present 2017 findings and summarize entire projects
- Discuss venue and format for final synthesis

ORES Research Updates on NCBO Website

<http://www.chesapeakebay.noaa.gov/images/stories/habitats/2017oresresearchupdate.pdf>



2017 Oyster Reef Ecosystem Services (ORES) Research Update

covering research from field season 2016

July 2017

In order to quantify the ecosystem benefits provided by restored oyster reefs, the NOAA Chesapeake Bay Office (NCBO) initiated the Oyster Reef Ecosystem Services (ORES) project in 2013. The ORES project consists of three primary efforts intended to quantify the ecosystem benefits provided by restored oyster reefs:

- an NCBO-implemented field study of fish utilization of a variety of sites in the Choptank River area;
- NCBO-funded research projects being carried out by research institutions on fish, crab, and other species' use of reef areas and denitrification carried out by reefs and their associated communities; and
- computer modeling to explore ecosystem and economic benefits of restored reefs.

Large-scale oyster restoration projects in the Chesapeake Bay, under way to meet the Chesapeake Bay Watershed Agreement's goal to restore oysters in 10 tributaries by 2025, provide unprecedented opportunities in which to conduct this type of research. The size of the reefs, combined with oyster densities on those reefs, are a unique *in situ* laboratory. Many of the reefs where research is under way have only recently seen completion of the initial in-water restoration work, including seeding with spat-on-shell. Researchers working at this time are gaining insight into how reefs develop and mature, and how their benefits to the ecosystem may evolve over the years.

Researchers are starting to develop a quantifiable picture of the ways in which restored oyster reefs can benefit their ecosystem. Reefs can be important not only for species many Chesapeake Bay-area residents recognize—like blue crabs and striped bass—but also for forage species critical to the health of the ecosystem. Researchers are finding that each tributary is unique—that even though they may be located near each other in the Bay or have roughly the same salinity level, there can be differences in how oyster reefs function, and which species they support, in neighboring tributaries.

While research is still in progress, and field work and data collection continue, scientists are noting some trends at and near restored reefs:

- enhanced nitrogen removal
- increased oyster biomass
- increased density and biomass of macrofauna (used as food by fish and crabs)
- additional foraging habitat for fish
- new seagrass colonization
- measurable positive effects on water column health

Interest in the benefits restored oyster reefs bring to the ecosystem reaches beyond resource managers. The Choptank River watershed was designated a NOAA Habitat Focus Area in 2014; information gathered from the ORES project is of great interest to partners in the Choptank Habitat Focus Area effort, including community organizations, interested citizens, and educators and students.



ORES research is under way in tributaries around the Chesapeake Bay.

