Quantifying Ecosystem Services of Restored Oyster Reefs

A Summary of Chesapeake Bay Research

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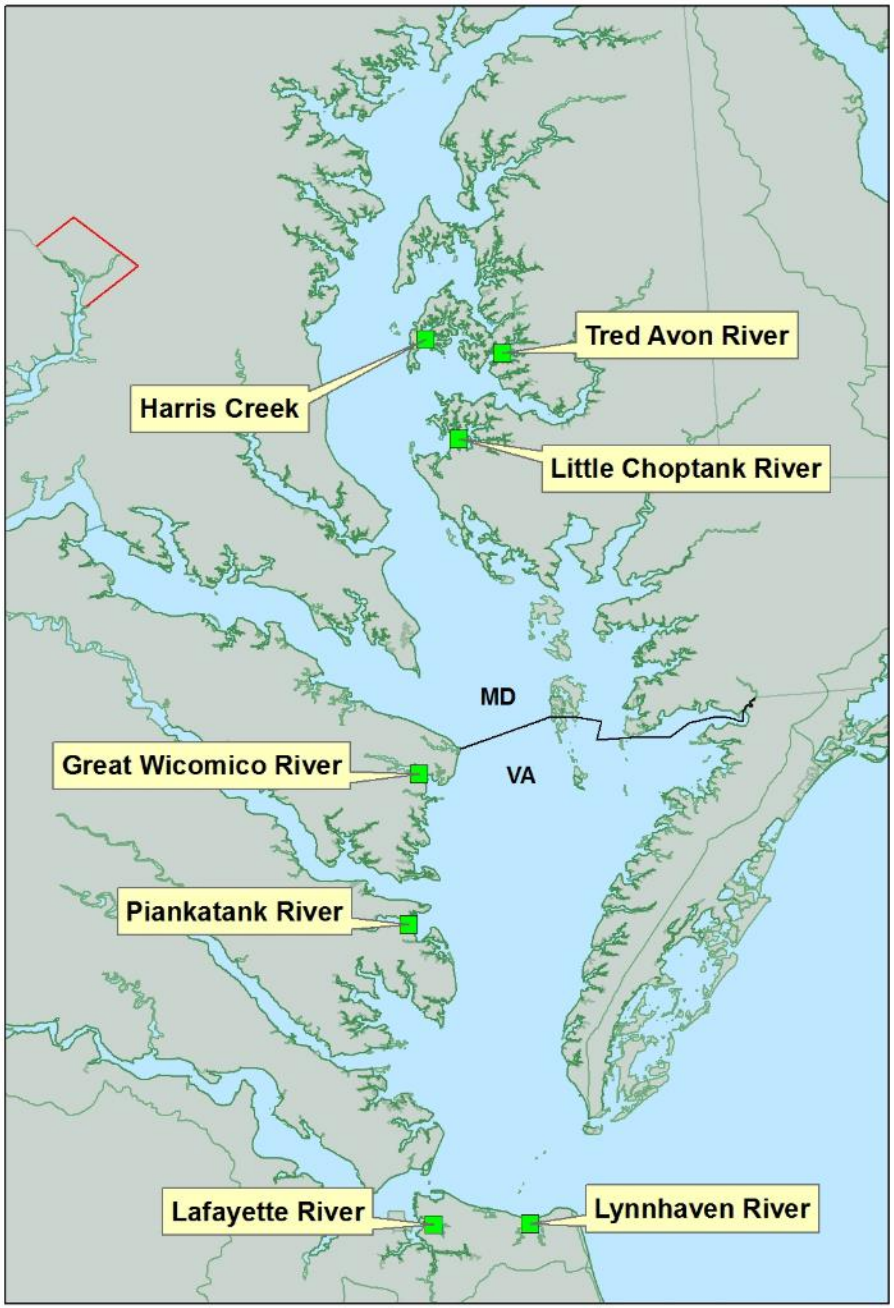
Chesapeake Bay Oyster Reef Ecosystem Services (ORES) Projects



General Research Themes

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

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/Finfish Productivity, Utilization, Secondary Production, and Nutrient Sequestration"*

  Principal Investigators: K. Paynter, L. Kellogg, M. Luckenbach, P. Ross

  Project period: Mar. 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"*

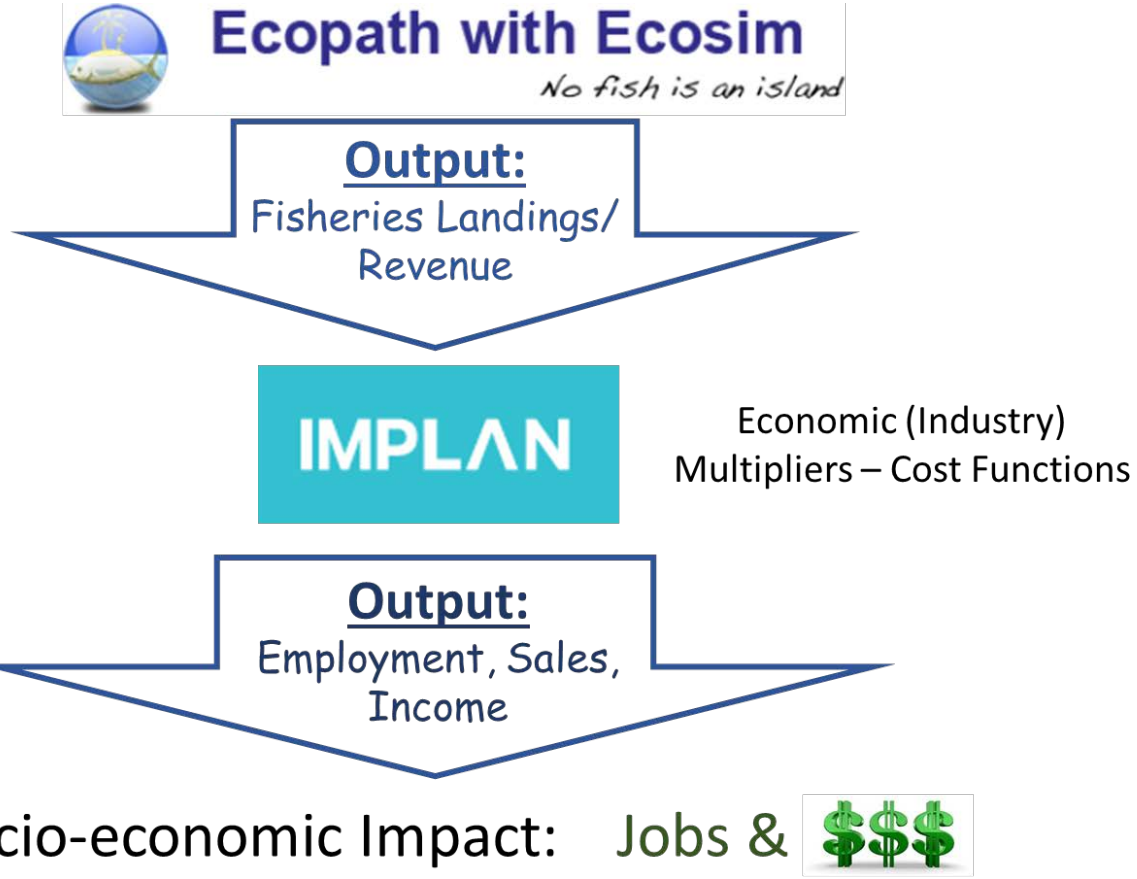
  Principal Investigator: D. Bruce

  Project period: May 2014-2018

Linking Ecology and Economics

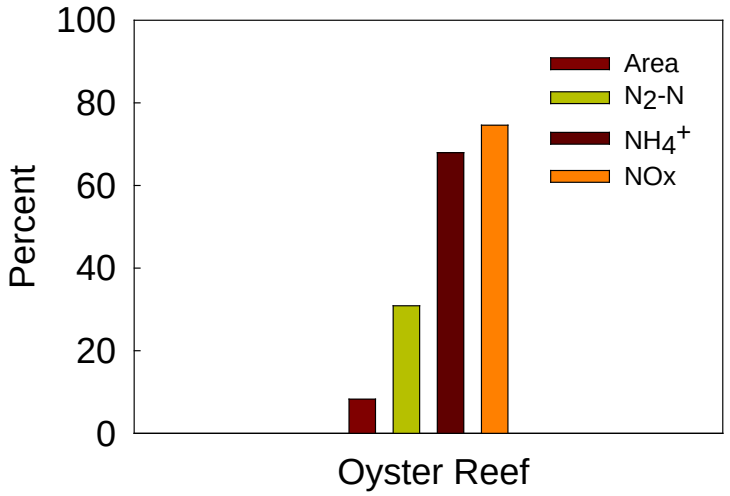
- Morgan State University , *"Estimating Regional Economic Impacts of Restored Oyster Reefs in the Choptank River Complex Habitat Focus Area*

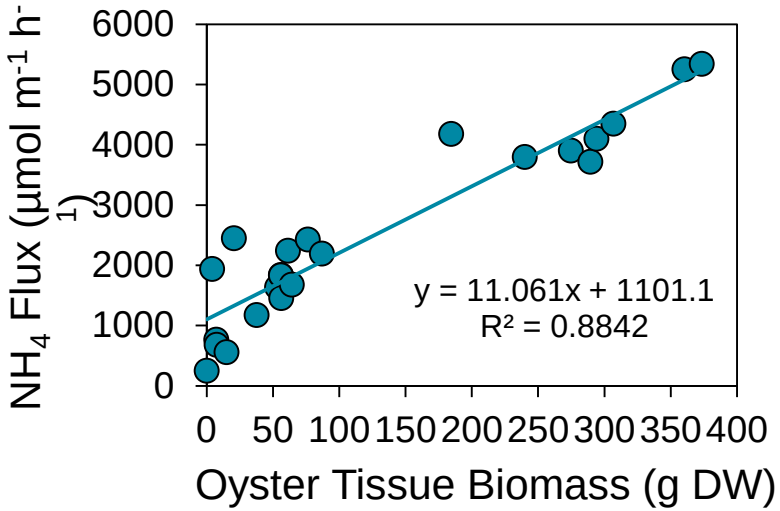
  Principal Investigators: S. Knoche, T. Ihde, J. Holzer, D. Lipton, G. Samonte



Highlights: Nutrient Flux and Sequestration, in Harris Creek, MD

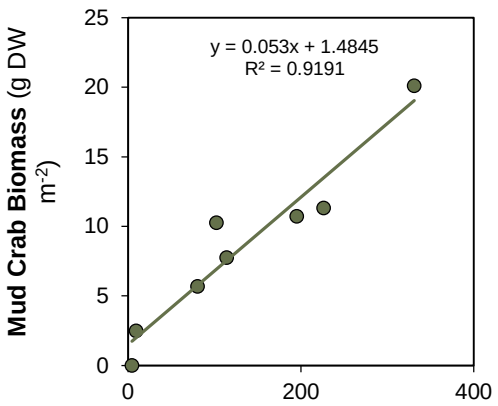
- Rates of nitrogen (NO_x, NH_4,N_2) flux greater on restoration sites than on reference sites. Rates related to oyster abundance
- Denitrification rates at Harris Creek sites less than more mature restoration sites elsewhere in the Choptank River system
- Incubated oysters with & without sediment. Results show that most denitrification occurs in the oyster clumps

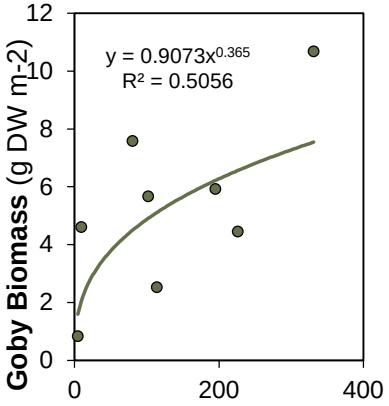




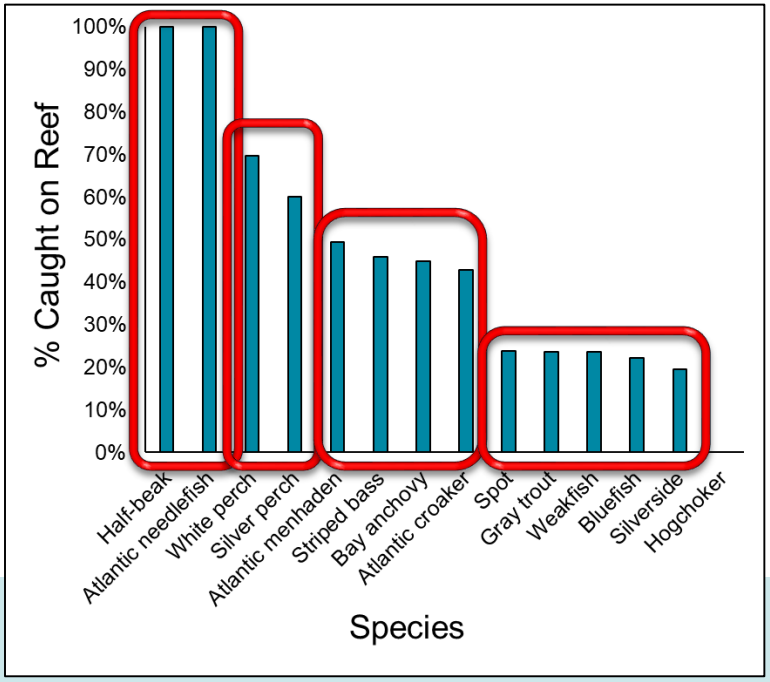
Highlights: Utilization and Trophic Pathways in Harris Creek, MD

- Strong relationships between oyster reef biomass and macrofauna biomass for some species in some seasons
- Some indication that some fish species are more likely to be caught on oyster reef sites than in adjacent soft sediment habitats
- Based on analyses of stomach contents white perch and juvenile striped bass are likely utilizing reefs as a prey resource



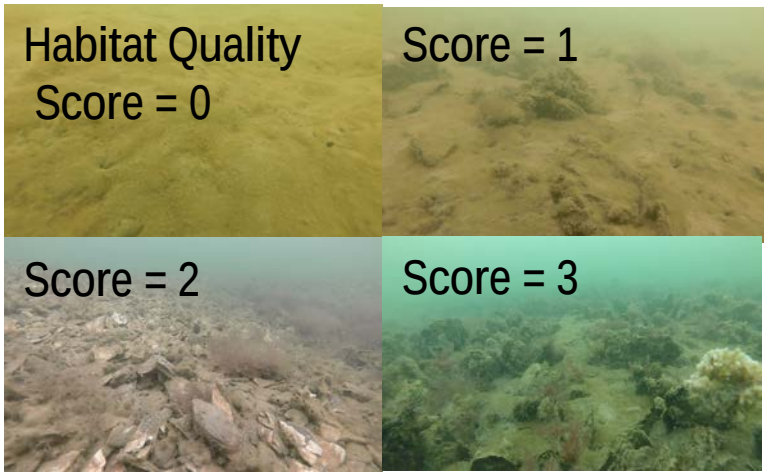


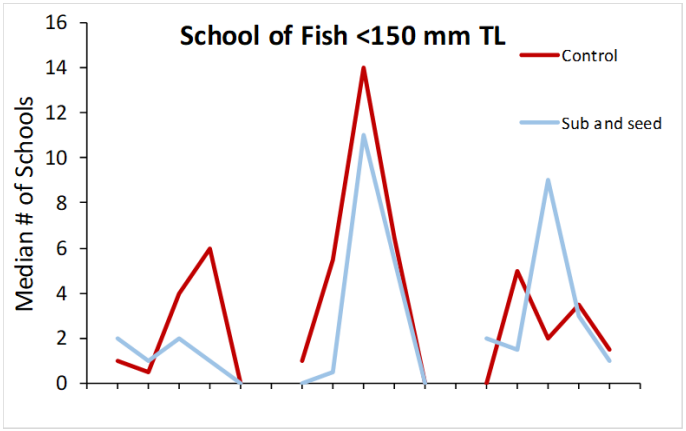
Oyster Tissue Biomass (g DW m^{-2})

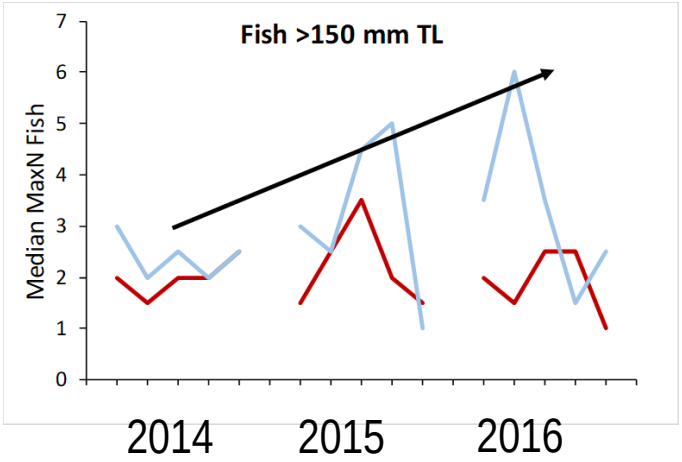


Highlights: Applications of Imaging Sonar and Video to Assess Fish Utilization and Habitat Quality

- Fish >150 mm TL tend to be more abundant on structured reefs than off, but no consistent differences in crab or schooling fish abundance.
- The proportion of high quality structured reefs is highest in Harris Creek and declines from Little Choptank to Tred Avon and Broad Creek.

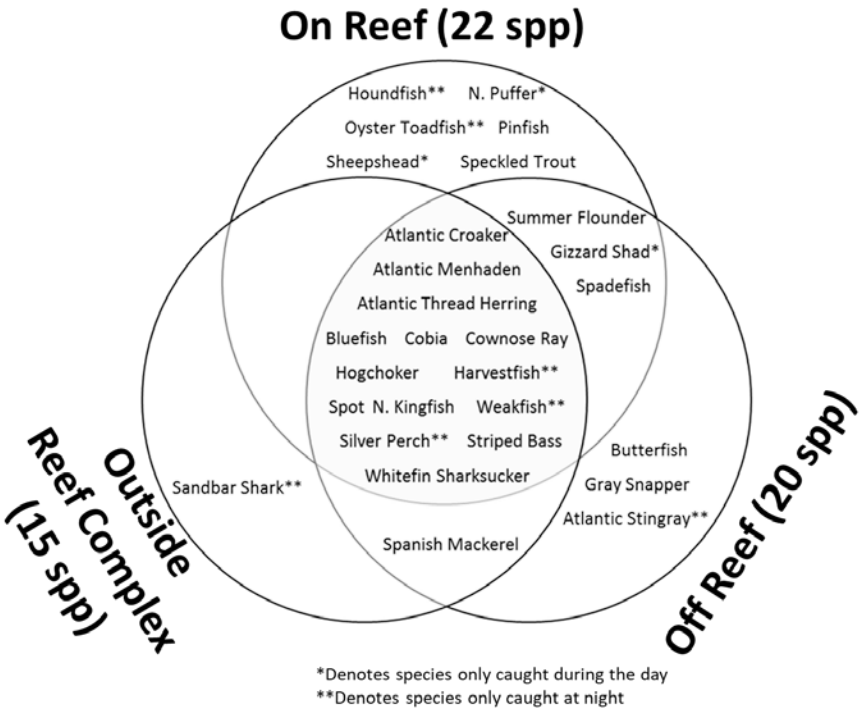


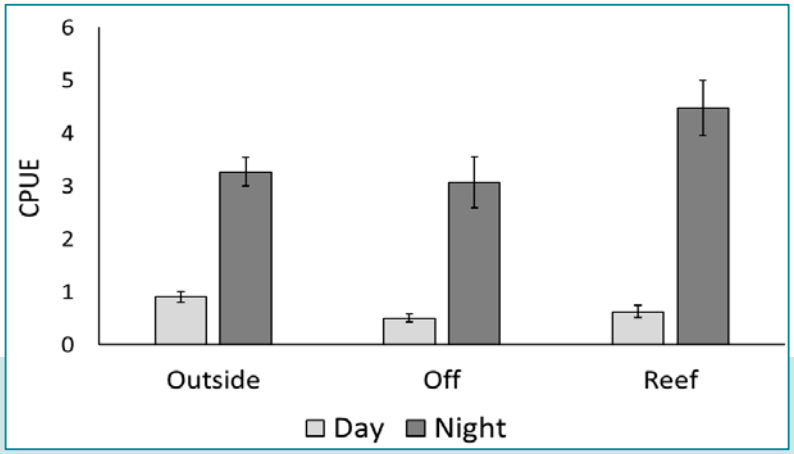




Highlights: Fish Community Response to Reef Restoration in the Piankatank River, VA

- Gillnet and acoustic surveys focusing on highly mobile/pelagic species on and off restoration sites.
- Fish diversity and abundance not significantly greater on restoration sites.
- Diversity and abundance significantly greater in night-time collections.
- Menhaden and striped bass comprised 68% of fish collected on restoration reefs

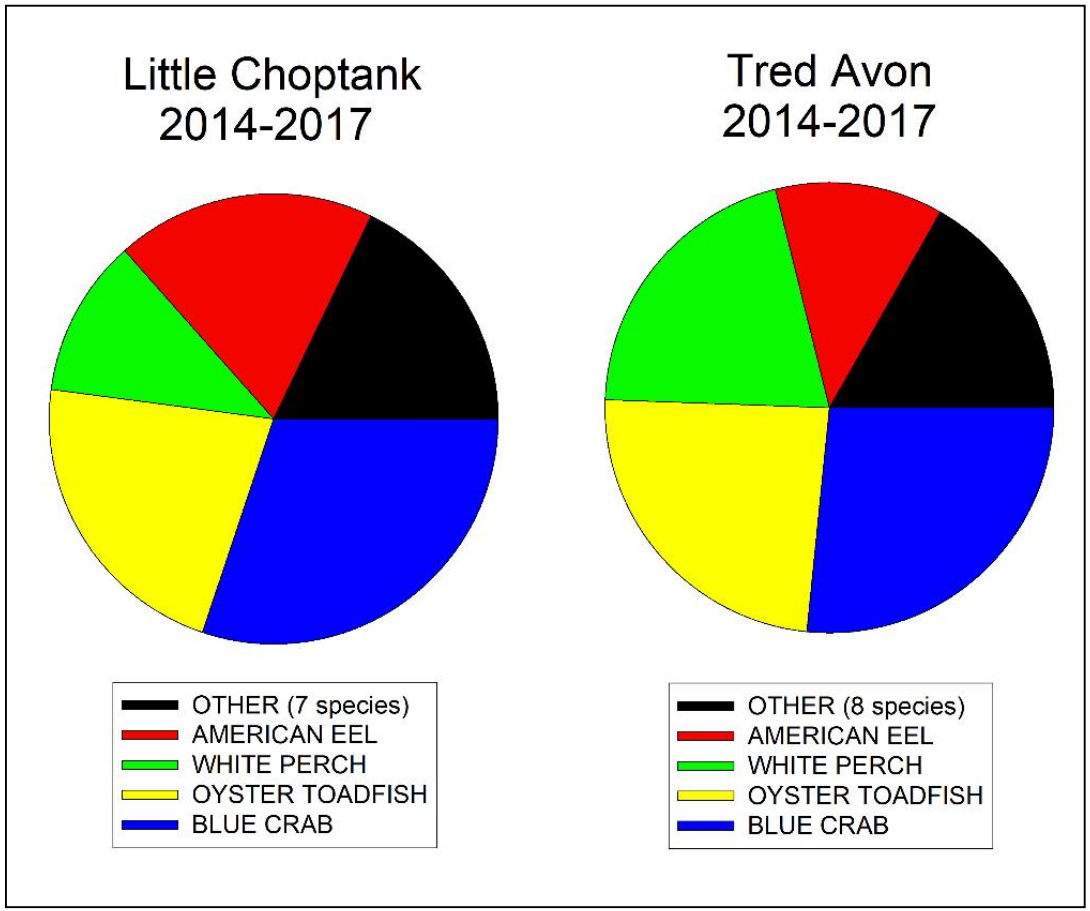




Highlights: Fish Utilization in the Little Choptank and Tred Avon Rivers, MD

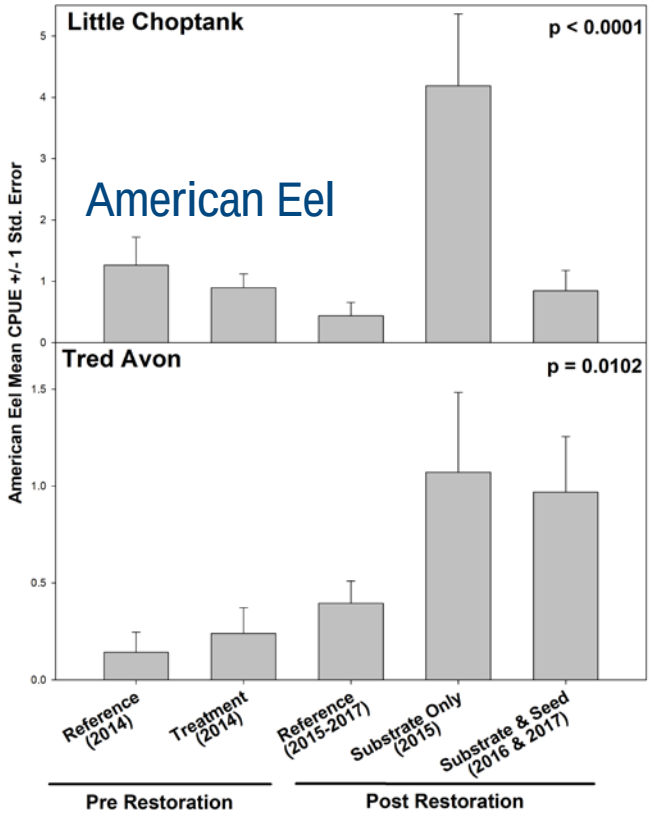
- Fish catch, using baited traps on restoration and reference sites, was dominated by American eel, blue crab, oyster toadfish, and white perch.

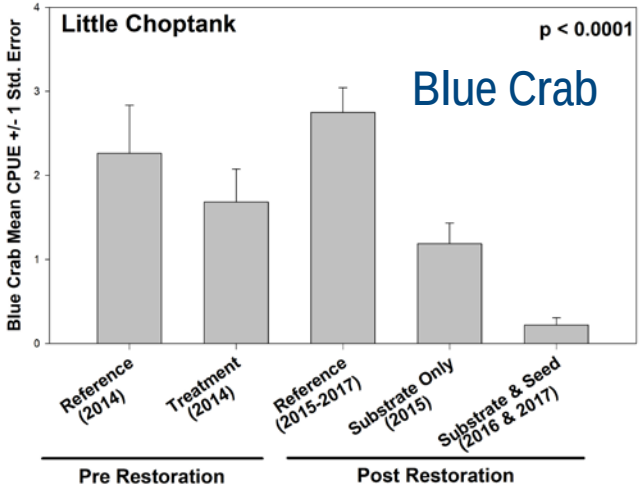
Species Composition



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

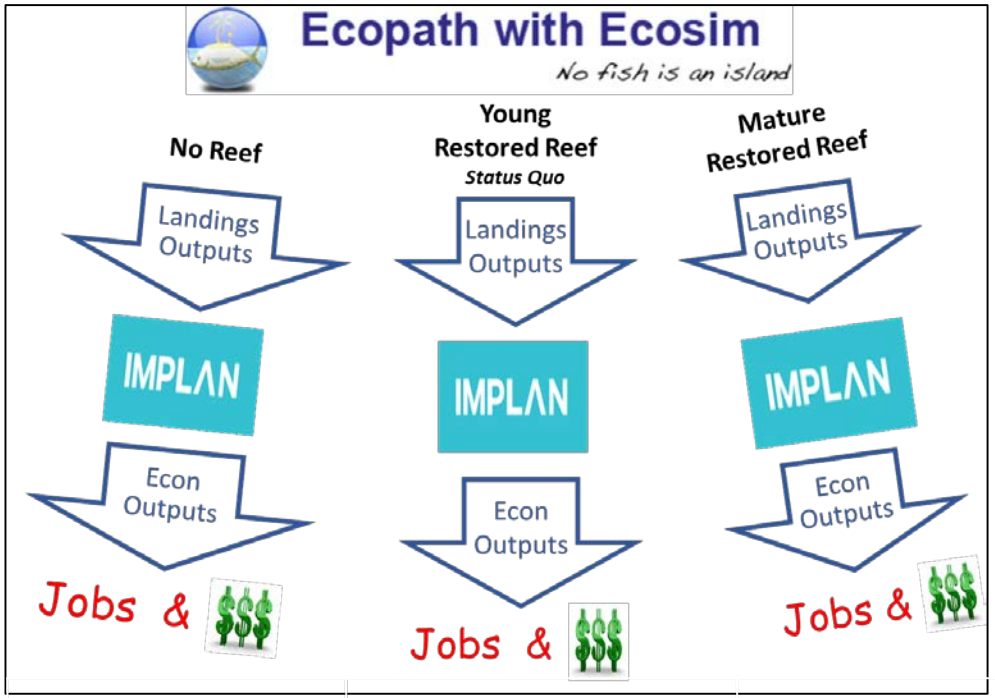
- Contrary to expectations, for white perch and oyster toadfish there was no strong affinity to restored reefs relative to un-restored reference sites.
- American eel catch was generally greater on restoration sites
- In the Little Choptank, blue crab catch was generally greater on reference sites than on restoration sites.





Linking Ecology and Economics

- Fish landings in analysis focus on active fisheries of the area (razor clam, crab, finfish, American eel).
- Differences in simulated outcomes driven by blue crab trotline harvest (most valuable fishery).
- Substantial gains to the region result from retaining restored oyster reefs and allowing them to mature
- Substantial losses result from eliminating sanctuaries



EwE with IMPLAN: *Annual values*

Scenario	Total Effect	Difference
Status Quo (current & incomplete, level of restoration)	$23M	--
Mature (restoration complete & protected)	$33M	**$10M**
No Restoration	$10M	**-$13M**

Closing Comments

- Unique opportunity to study oyster reef ecosystems that have largely been removed from fishing industry effects

- Short term studies so ecosystem function relative to reef maturity is not specifically addressed

- Reef utilization patterns by larger more transient species are difficult quantify

Looking Forward : All ORES Projects

- Projects are at different levels of completion
- In summer 2019 Principle Investigators will meet to discuss format for joint summary and project 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 tribuaries 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

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

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.