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Biogenic Breakwaters as a Living Shoreline Protection Strategy

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Biogenic Breakwaters as Living Shoreline Protection Strategy

Hampton Roads Sea Level Rise/Flooding Adaptation Forum

Resilient Shorelines for Multiple Benefits

By Russell Burke

Christopher Newport University

10 May 2019

Benefits of Biogenic Breakwater Reefs

Biogenic Breakwater Reefs are Shell-Embedded Concrete Structures Designed To:

- Provide a Reprieve from Erosive Wave Forces Generated by Both Wind and Boat Traffic
- Substantially Increase the Surface Area for the Recruitment of Oysters, Mussels, and Other Reef-Associated Species
- Address Site-Specific Physical Conditions and Project-Specific Budgetary Constraints Through
- Custom Reef Solutions

Benefits of Biogenic Breakwater Reefs

Biogenic Breakwater Reef Technology Provides:

- Proof of Concept with > 5 years of Field Assessment
- Enhancement of Economically-Important Fish & Crabs
- Configurations that Maximize Wave Attenuation and Facilitate Biogenic Reef Development
- A Green, Sustainable Solution for Shoreline Loss of Both Private, Commercial, and Municipal Properties
- Biogenic Systems that Mimic Historic Oyster Reefs and are Capable of Keeping Pace with Sea-Level Rise

Horn Harbor Project: 120 Diamond Reefs with Gaps

- Individual Diamond-Reef Dimensions:
 - 3'L x 2'W x 1'H
 - ~75 lbs
- Diamond Reef Details:
 - 120 Reefs Across 4 Nearshore Breakwaters



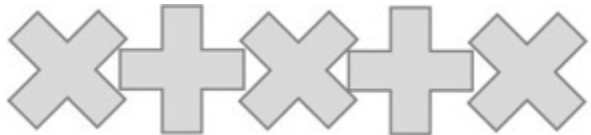
**Example of the Biogenic Breakwater Design
Composed of Interlocked Diamond Reefs**





Horn Harbor Project: 1.2-ft Tall X-Reefs

- Individual X-Reef Dimensions/Details:
 - 3'L x 3'W x 1.2'H,
 - ~225 lbs
- X-Reef Details:
 - 5 X-Reefs Located Beneath a Pier



**Example of the Biogenic Breakwaters
Composed of Interlocked X-Reefs**

Horn Harbor Project Summary Findings:

- The diamond and X-reefs successfully recruited oysters, mussels, barnacles, snails, and macroalgae
- The reefs also significantly attenuated wave energy such that sand and silt built up behind (and beneath, in the case of X-Reefs) the reefs, and marsh grass began to recover landward of the reefs
- These reefs have been stable in place for more than five years and continue to maintain a thriving oyster reef community



Gwynn's Island Project: 2-ft Tall X-Reefs



Ten 2-ft tall X-Reefs were placed perpendicular to the Gwynn's Island shoreline in 2014 and have persisted in place with a fully-developed oyster reef community on its vertical and horizontal faces

Gwynn's Island Project: Three Years Post-Deployment



Fort Norfolk (USACE) Project: 3-ft Tall X-Reefs



- The Norfolk District of the United States Army Corps of Engineers (USACE) ordered three 3-ft tall X-Reefs for deployment at Fort Norfolk.
 - The reefs were placed in June 2017 and are the largest pre-fabricated reefs in the Elizabeth River
- The VA Port Authority ordered forty 2-ft tall X-Reefs for their Craney Island Eastward Expansion Mitigation Oyster Reef Project
 - Placement is set to occur in summer 2018

Original Breakwater Design for the Town of Saxis



Saxis Post-Hurricane Sandy, 2012



Saxis Pier Rebuilt Post-Hurricane Sandy



© 2015 Google

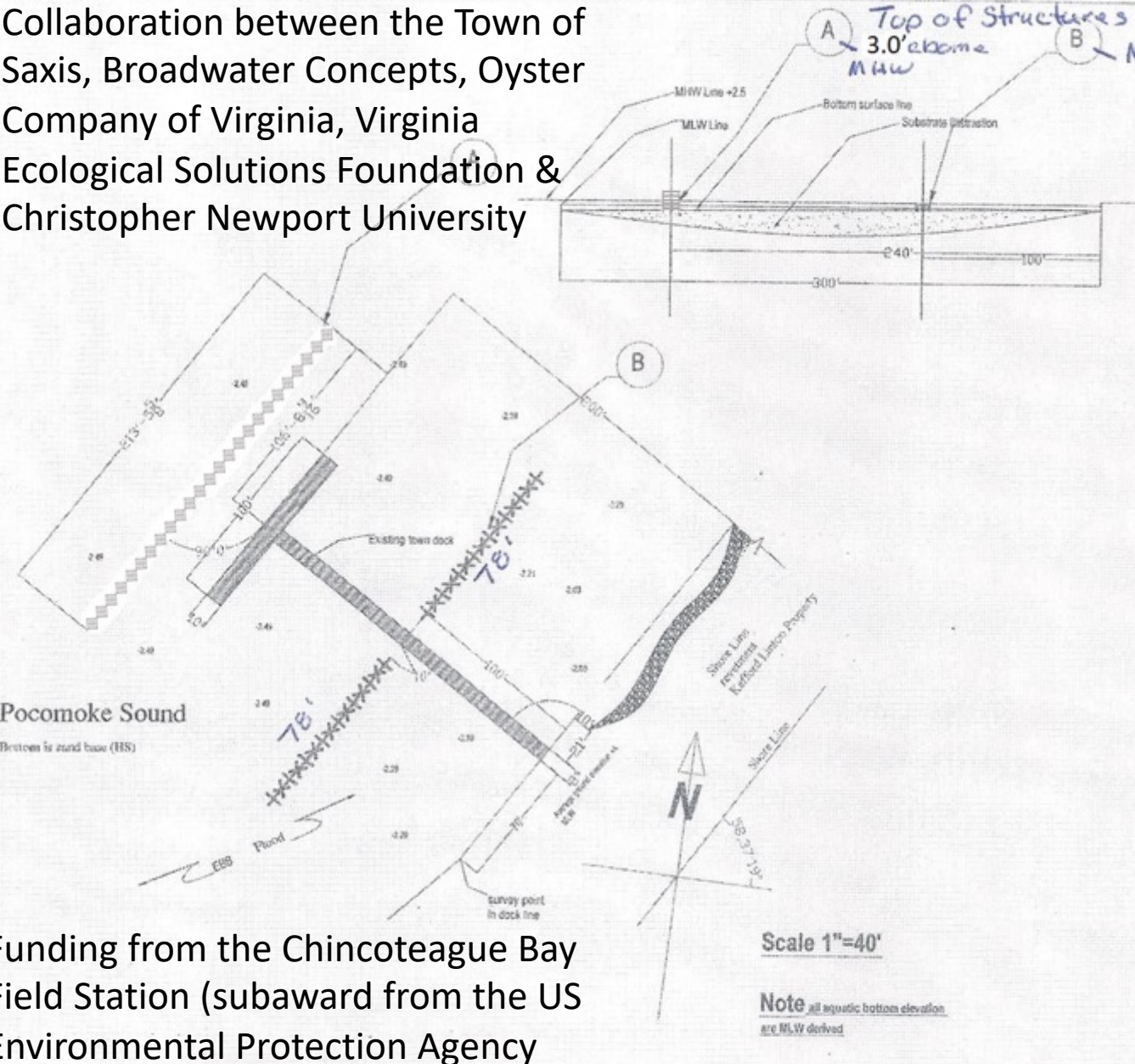
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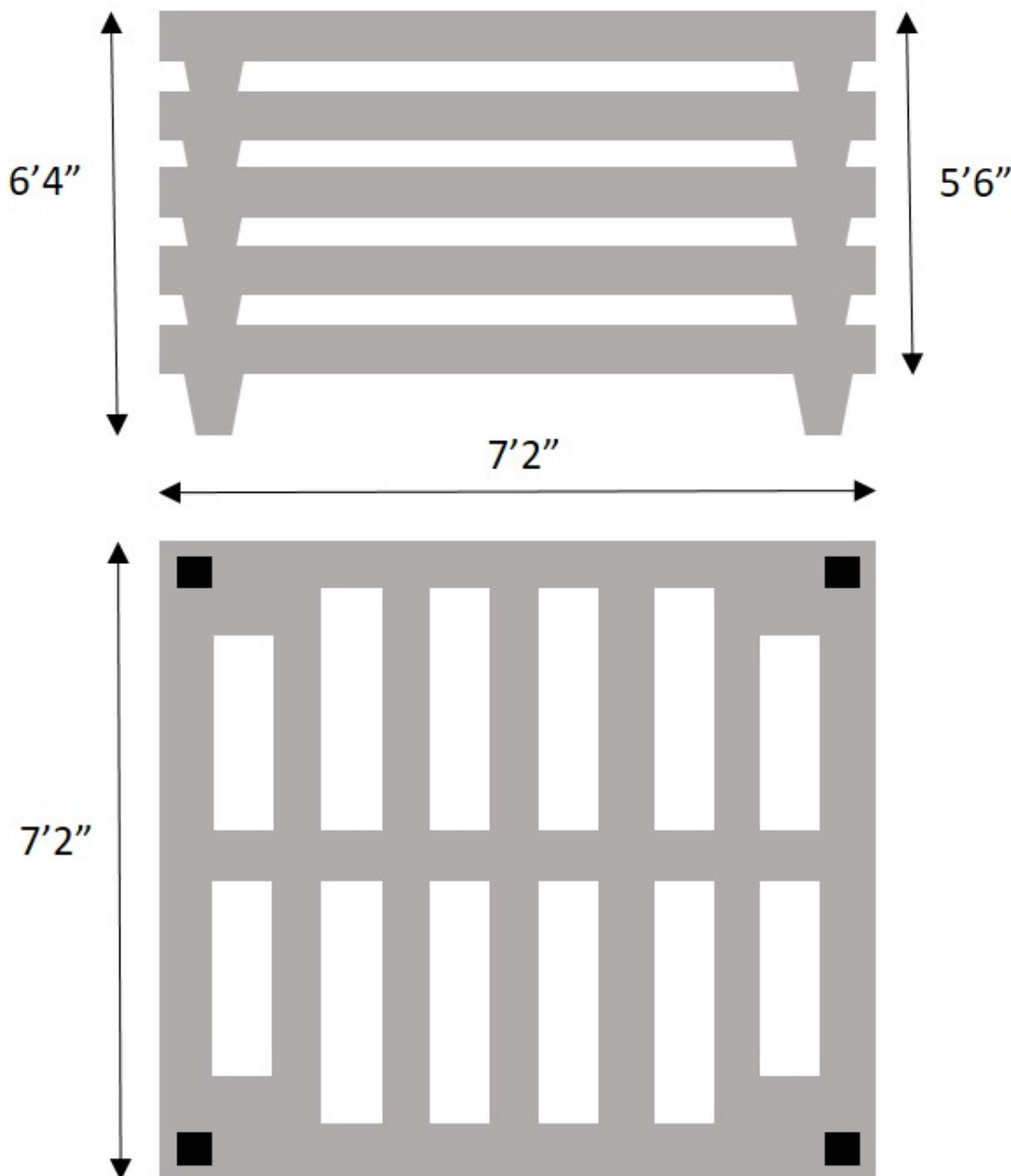
Imagery Date: 10/19/2013 lat 37.921054° lon -75.730022° elev 0 ft eye alt 433 ft

Collaboration between the Town of
Saxis, Broadwater Concepts, Oyster
Company of Virginia, Virginia
Ecological Solutions Foundation &
Christopher Newport University



Funding from the Chincoteague Bay
Field Station (subaward from the US
Environmental Protection Agency)

Saxis Water Front Project



K.B. Designs	
Owner	
W.L.G.	Scale

Saxis Pier Protection Project: 4-ft Tall X-Reefs

The Town of Saxis, like many other Eastern Shore communities has experienced increasing rates of shoreline erosion and sea-level rise. In addition, Hurricane Sandy severely damaged the Saxis Community Fishing Pier.

- In response, thirty 4-ft tall X-Reefs were constructed and deployed to protect the pier in late 2017
- The reefs have held up to ice immersion and gale-force winds and will be sampled for oyster settlement in fall 2018



Saxis Pier Project: (“If you build it. . .”)



Saxis Pier Project: Field of Reefs


(“they will come.”)







Permit # 17-0418

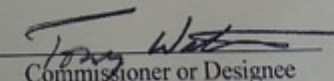


Commonwealth of Virginia
Marine Resources Commission
Authorization

A Permit has been issued to: Town of Saxis
Post Office Box 156
Saxis, VA 23427

The Permittee is hereby authorized to:
install a 214-foot long (shell and concrete) structure approximately 40 feet channelward of the
existing Town fishing pier and install two smaller 78-foot long (shell and concrete) structures
inshore of the pier's T-head along Pocomoke Sound in the Town of Saxis. The structures will form
an artificial fishing reef to promote recreational fishing and to help protect the Town fishing pier
from storms.

Issuance Date: April 18, 2017 Expiration Date: April 30, 2020


Commissioner or Designee

This Notice Must Be Conspicuously Displayed At Site Of Work



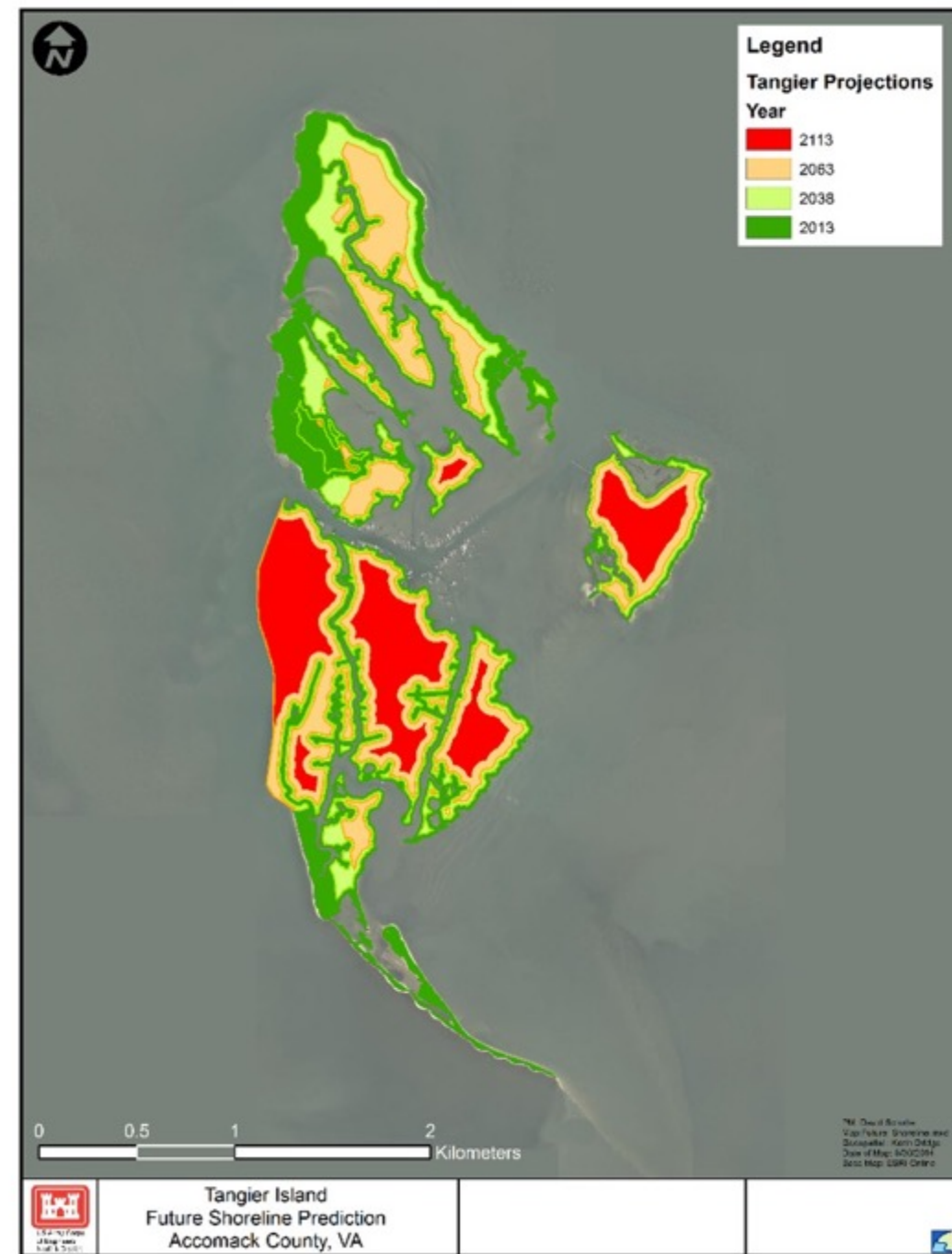
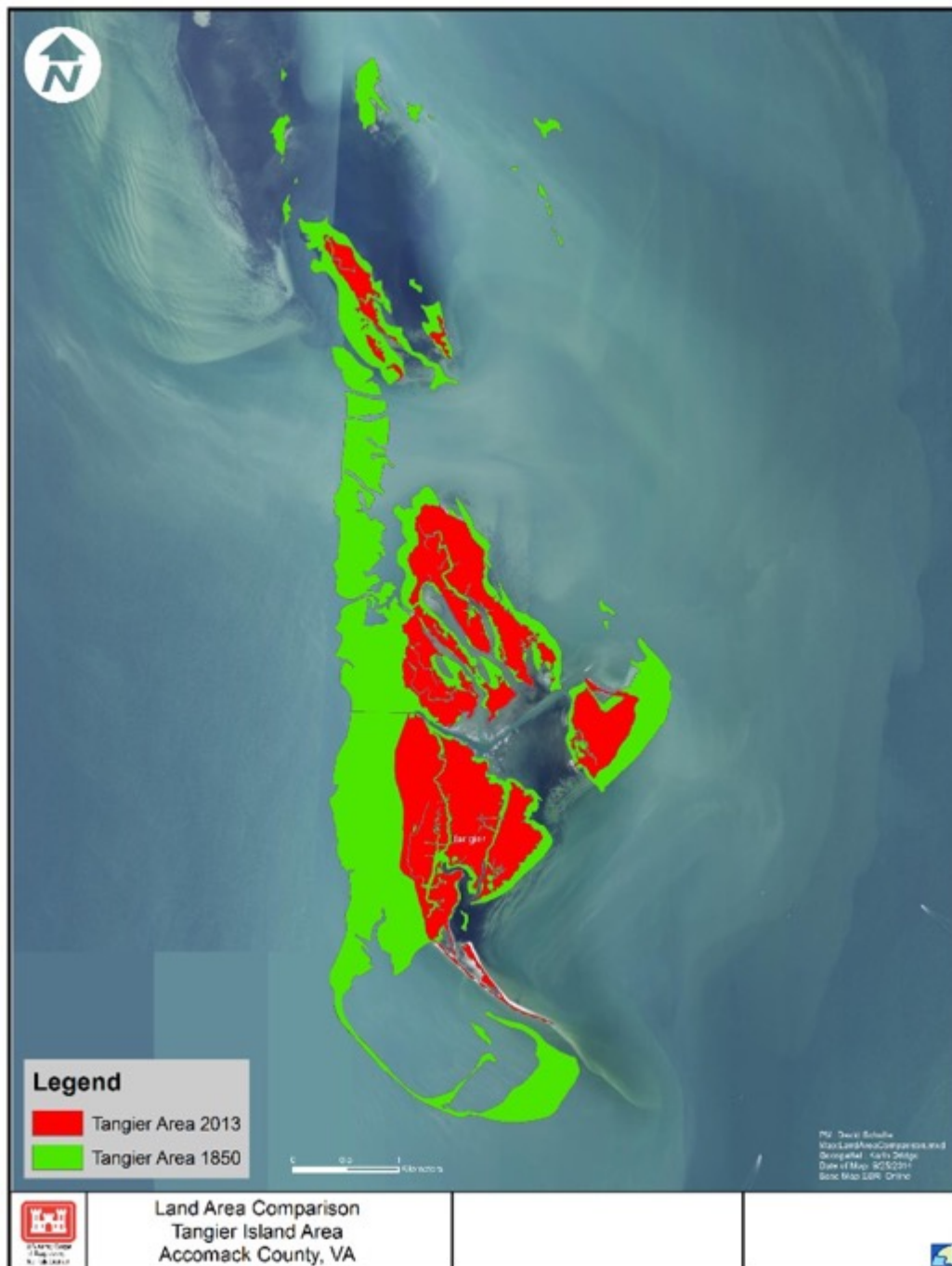


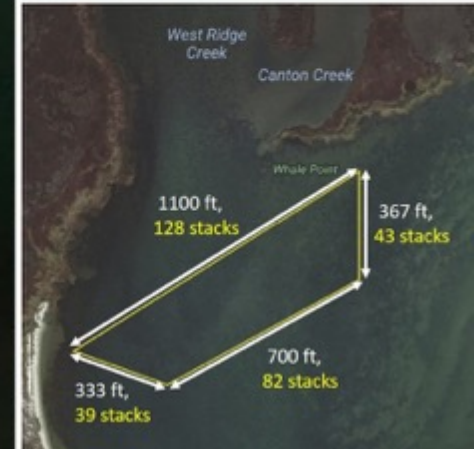
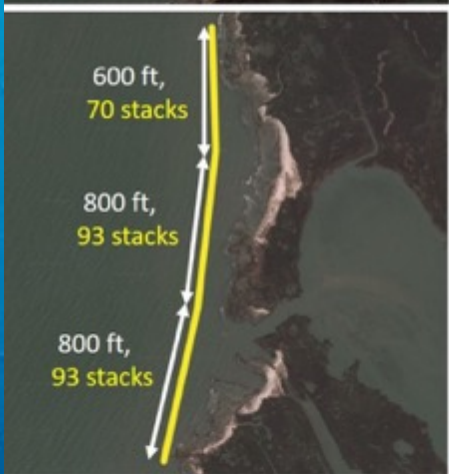




Coming Soon to the Towns of Saxxis and Tangier







Horn Harbor Project, Revisited



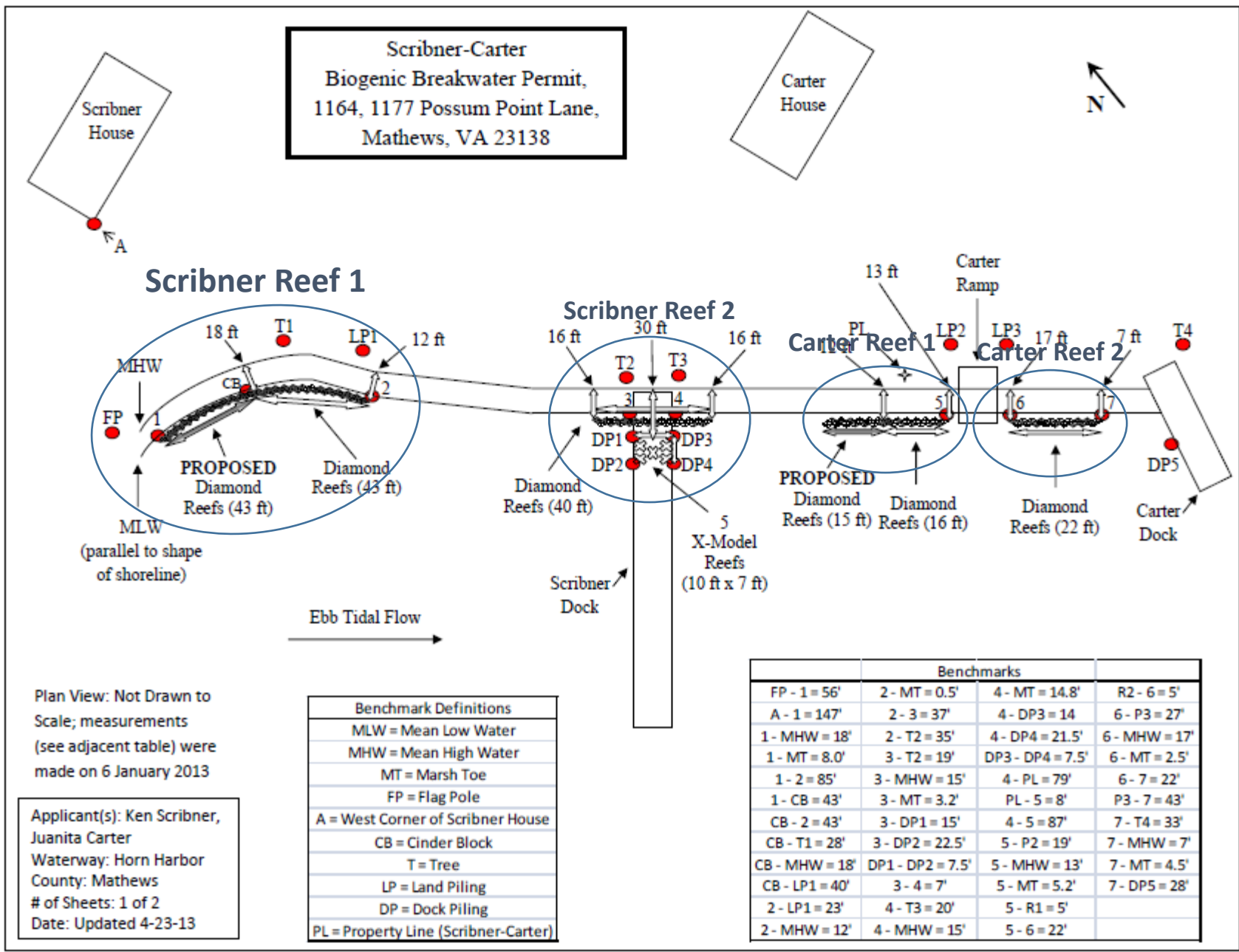












March 2013





03/24/2013 12:10



April 2013



03/24/2013 12:10



04/07/2013 12:55



04/07/2013 12:55



04/07/2013 12:54



04/07/2013 12:52



04/07/2013 12:54



04/07/2013 12:55





04/07/2013 12:56

August 2013





April 2014















April 2015





April 2016



April 2016





New
grass
growth

















Dock and Shading Impacts

- Shading allows oysters to feed more and decreases temperature stress in the summer.
- Less algae
- Increased population of:
 - Oysters
 - Mussels
 - Snails

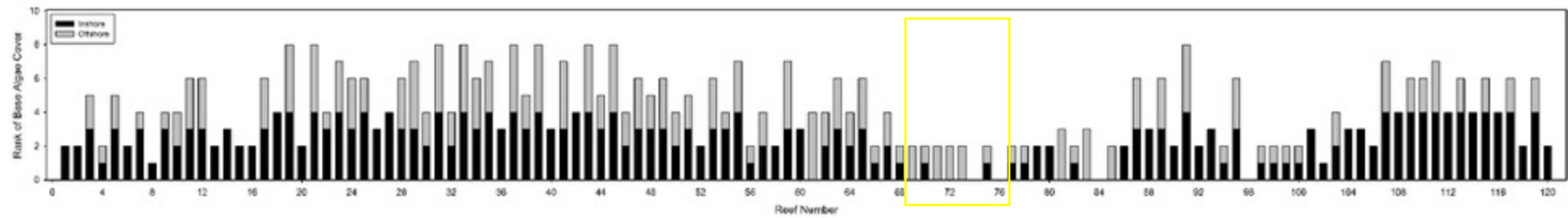


Algal Impact

- Algae may be a fouling factor for:
 - Oysters
 - Snails
 - Mussels



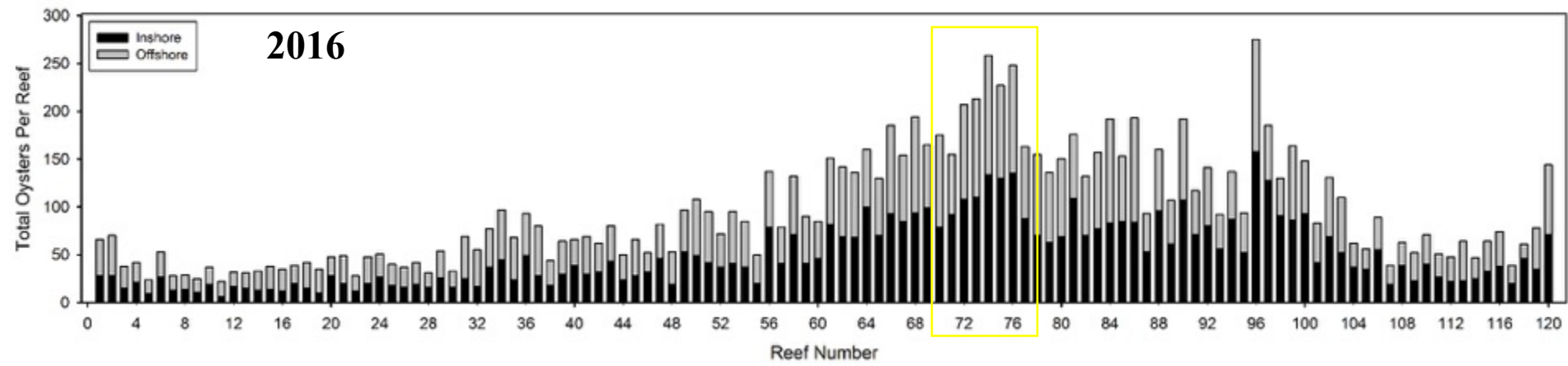
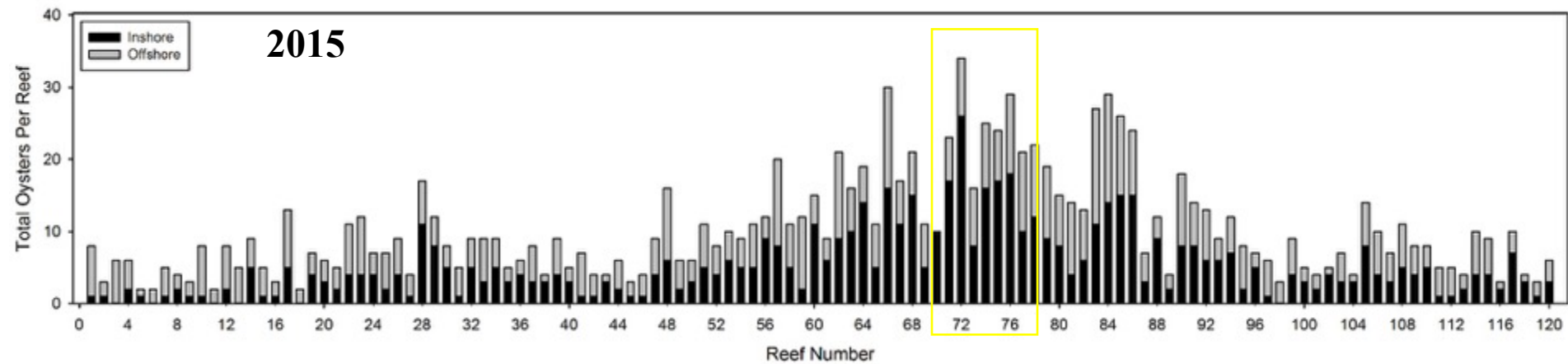
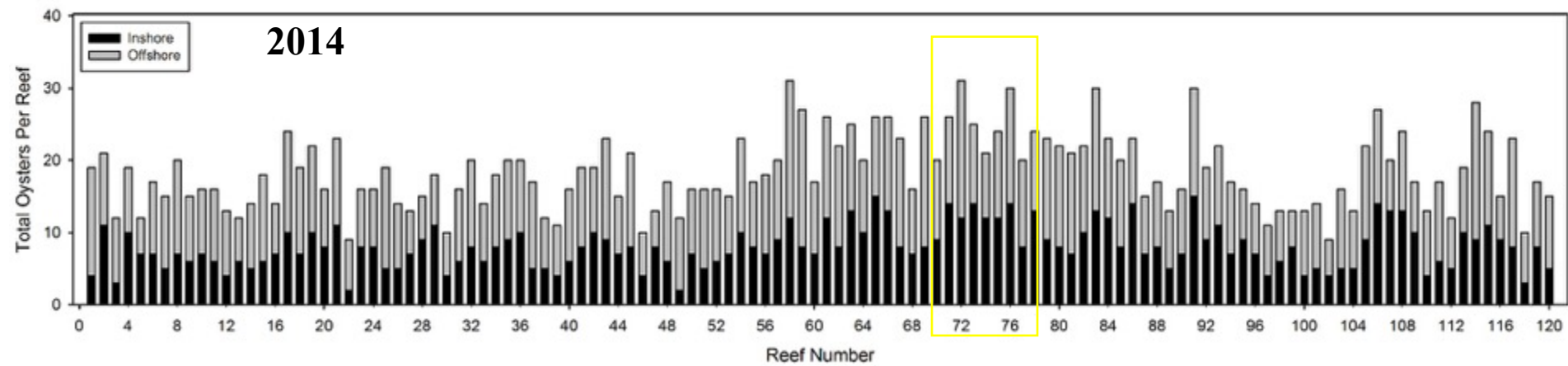
Macroalgae Across the Reefs



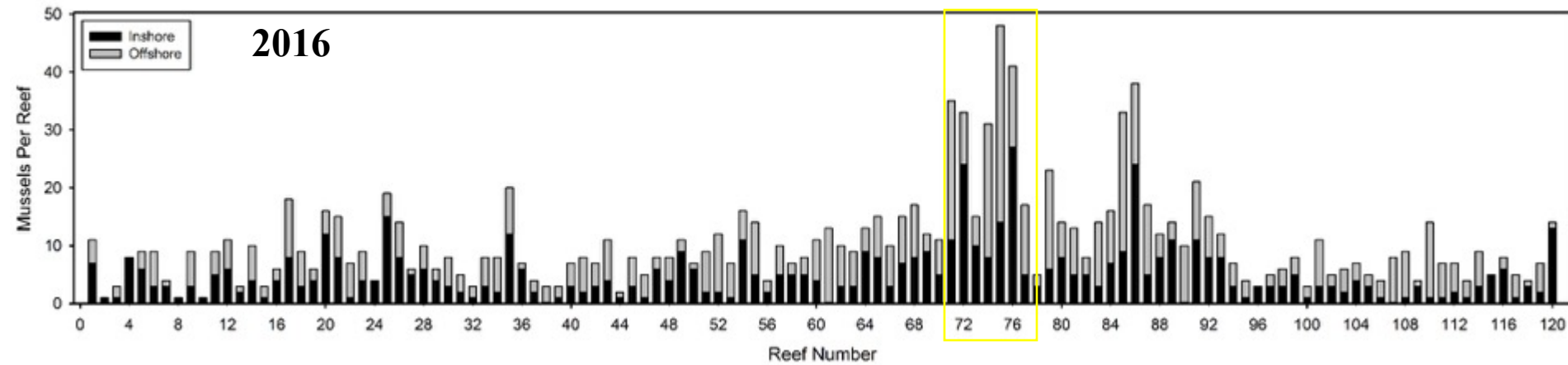
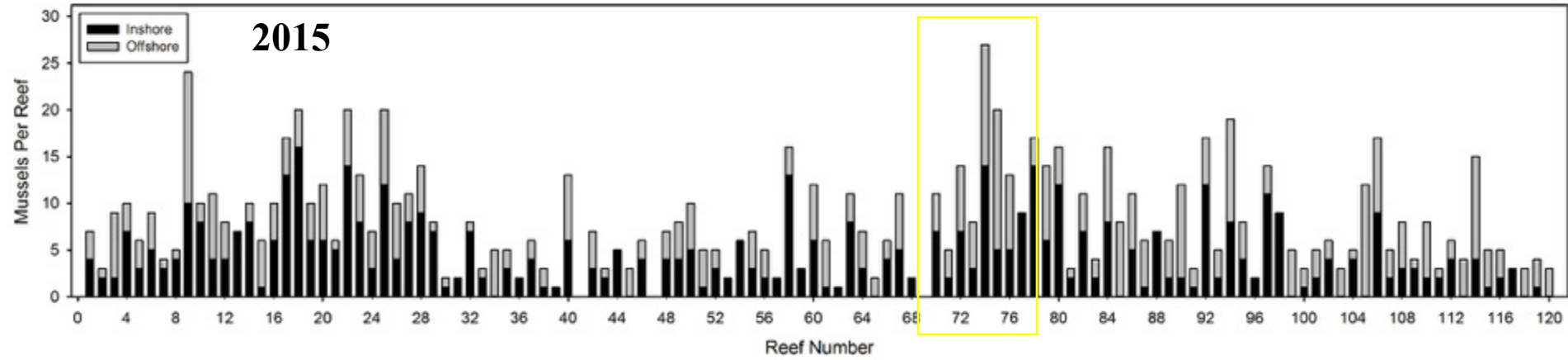
Settlement Events

- Poor settlement in 2013 and 2014
- Good settlement in early summer and fall of 2015



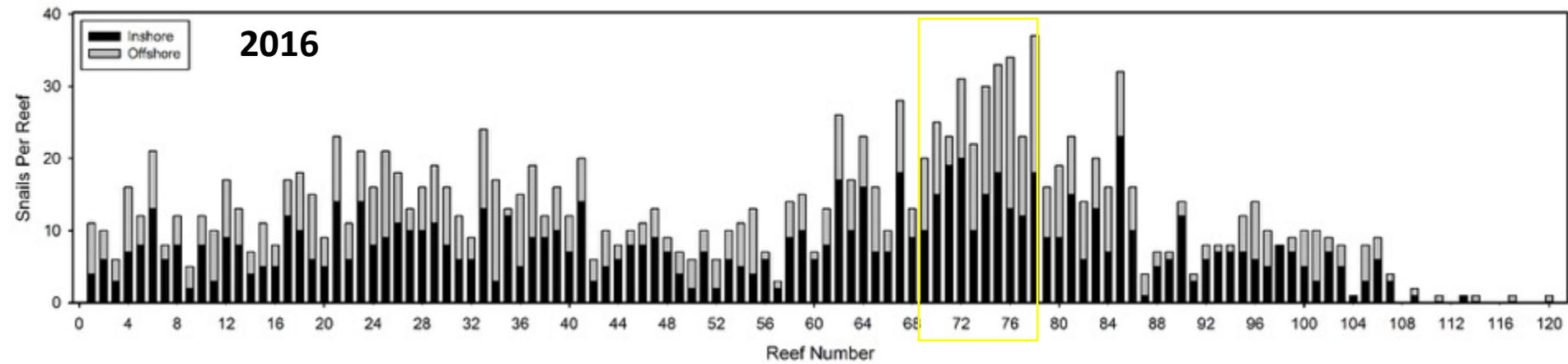
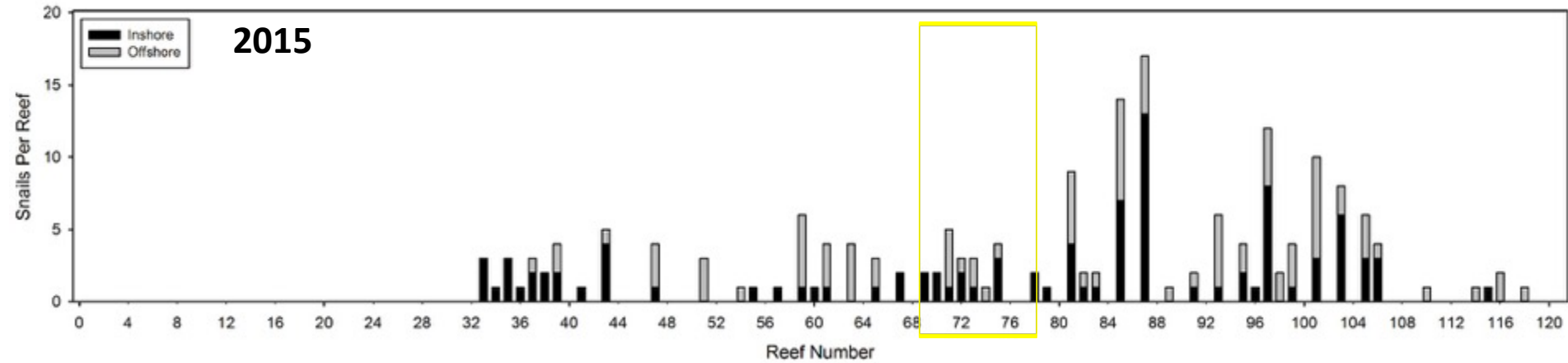


Mussels Across the Reefs





Snails Across the Reefs



	Mean Live Spat	Mean Live Adult	Mean Dead Spat	Mean Dead Adult	Mean Barnacle Count	Mean Snail Count	Mean Mussel Count
Inshore Face	41.2	8.5	3.0	0.4	7.4	7.4	5.1
Offshore Face	36.7	9.5	3.1	0.6	11.2	5.3	5.6
*Shaded Area Inshore Face	98.3	11.3	4.6	1.1	16.5	15.3	13.0
*Shaded Area Offshore Face	96.3	12.9	6.0	1.1	18.0	12.4	15.9

*Shaded reefs also benefitted from the offshore breakwater X-reefs

Thank You!



The background is a deep blue underwater scene. Numerous small, light-colored bubbles are scattered throughout, with a higher concentration near the top where light rays penetrate the water. In the center of the image, there is a faint, stylized smiley face composed of several bubbles of varying sizes.

Questions?