Relationships Between Oyster Abundance, Restoration and Seabed Metrics Derived from MBES Data Chesapeake Bay, United States

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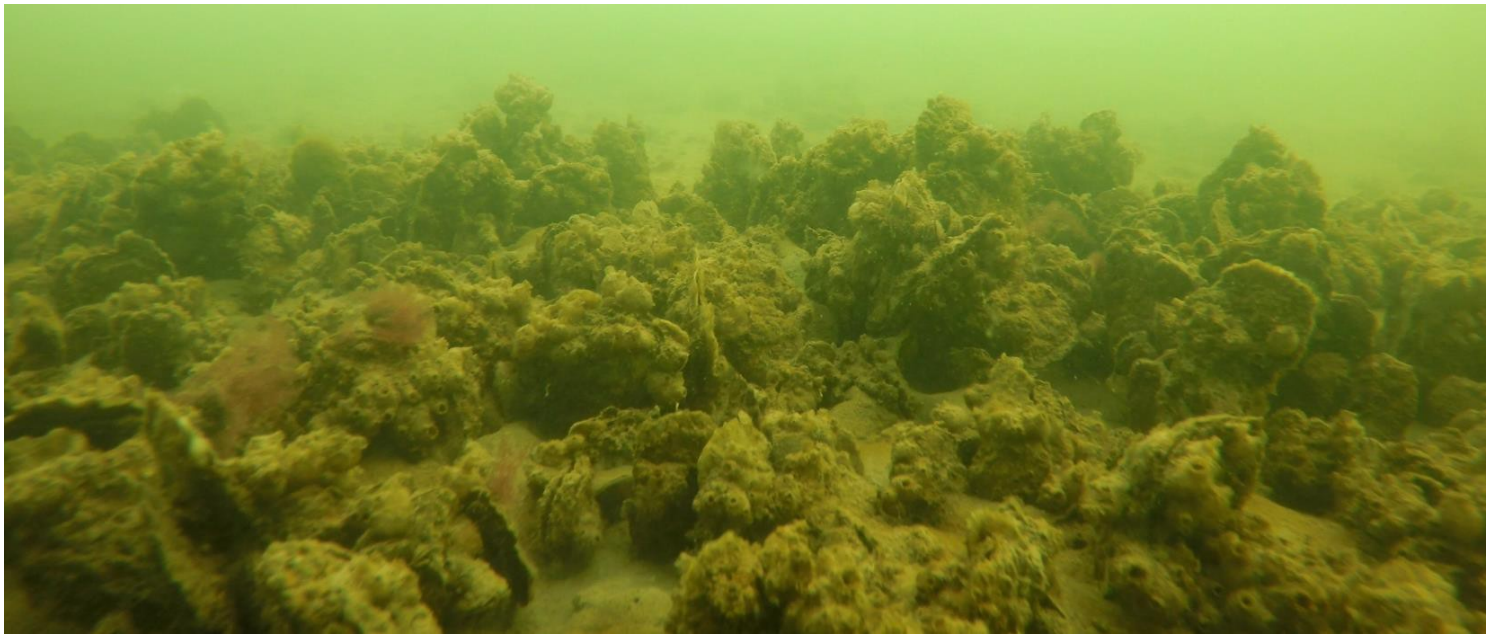
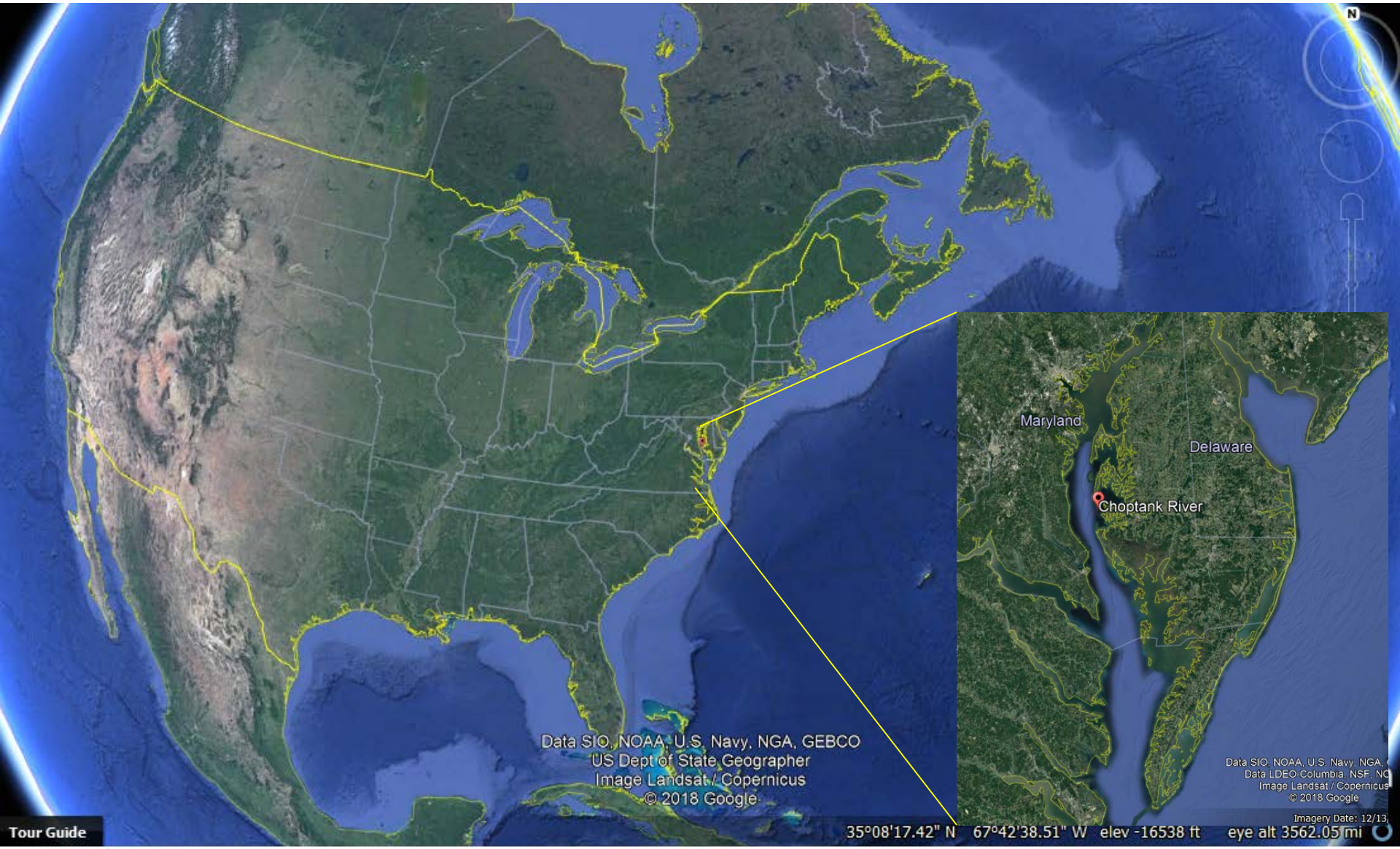
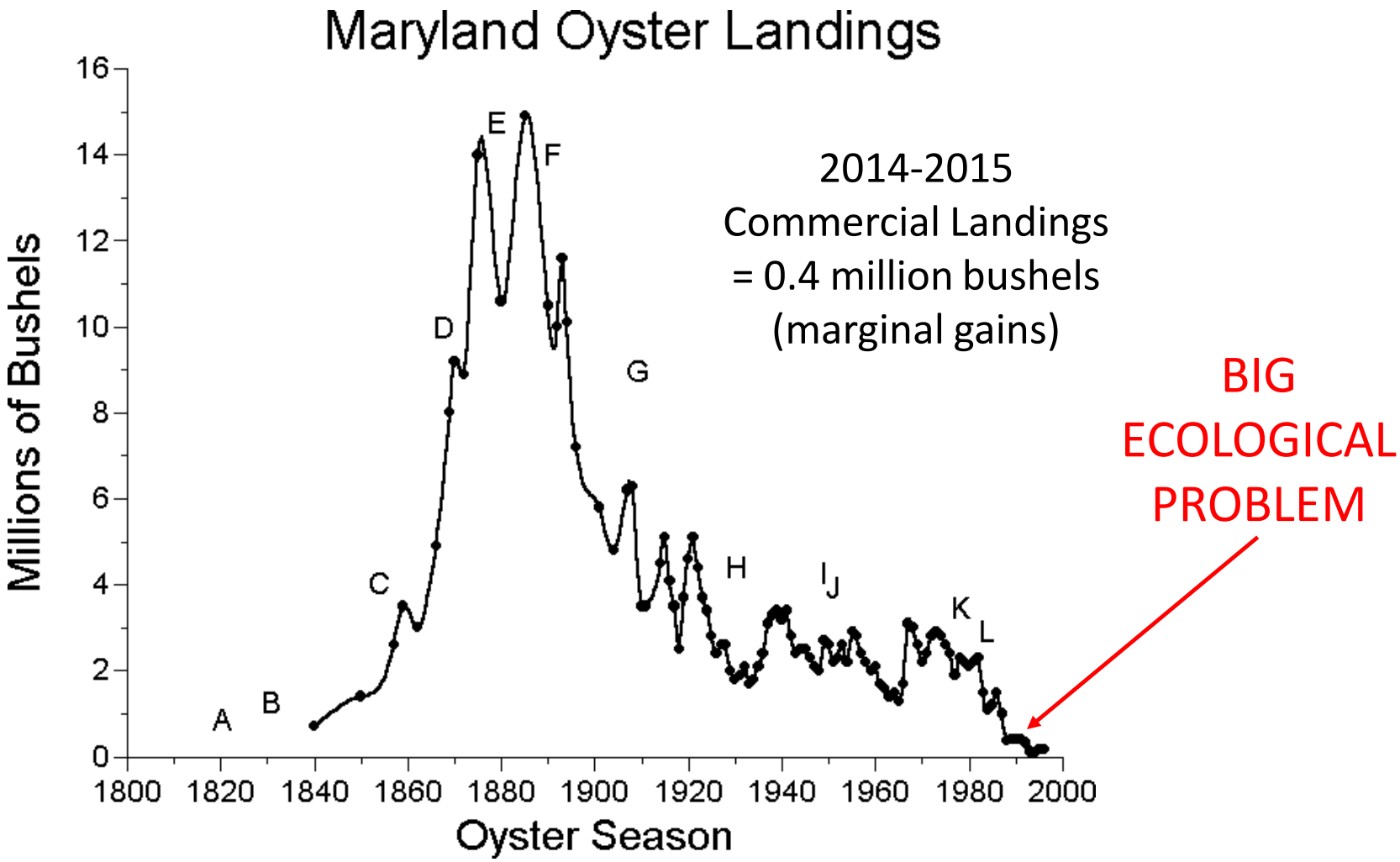


Chesapeake Bay, Maryland, United States of America

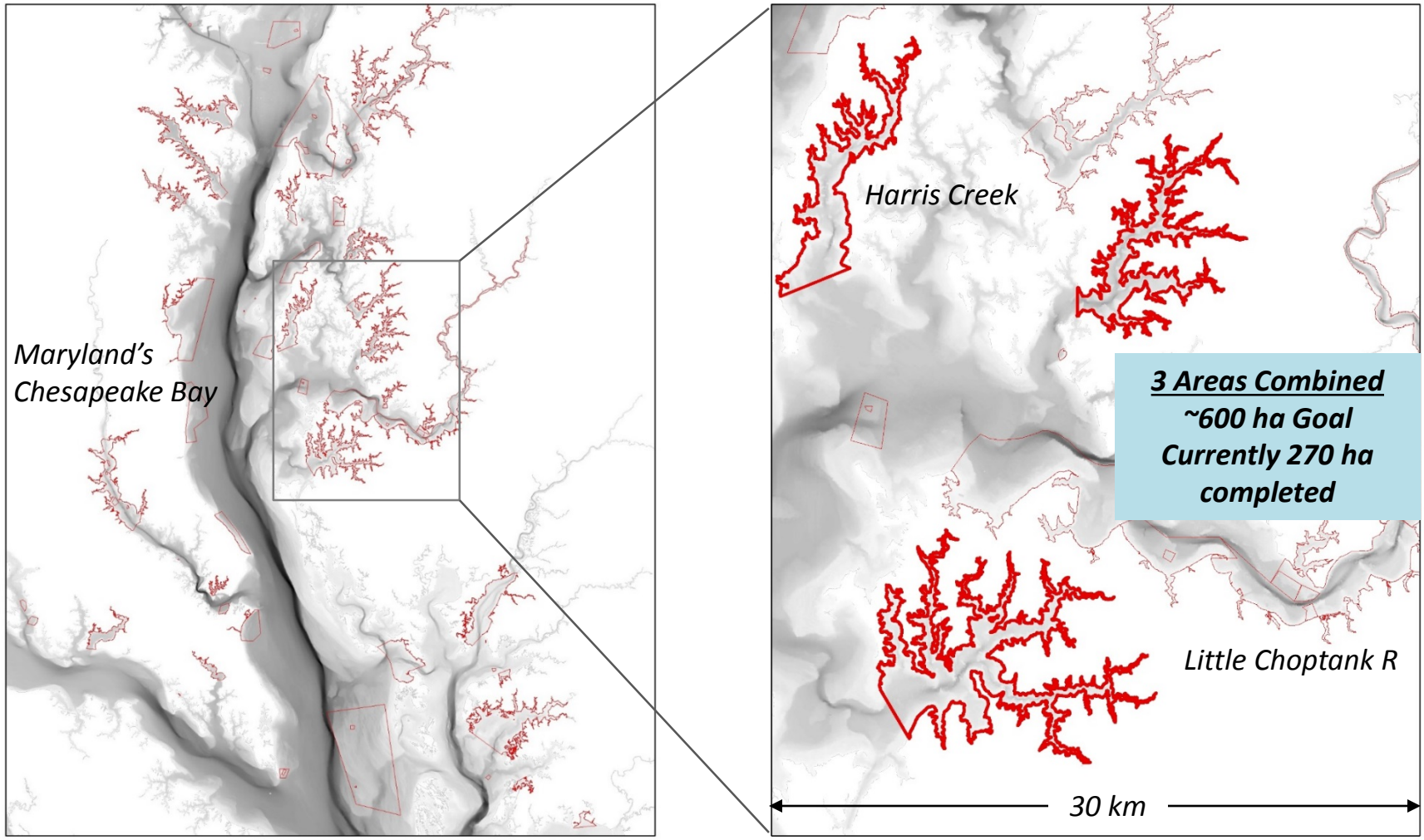


Background: Commercial Fishery Status



Maryland Oyster Recovery & Restoration

Sanctuary Designated (2010) and LSOR Areas Selected (2011)

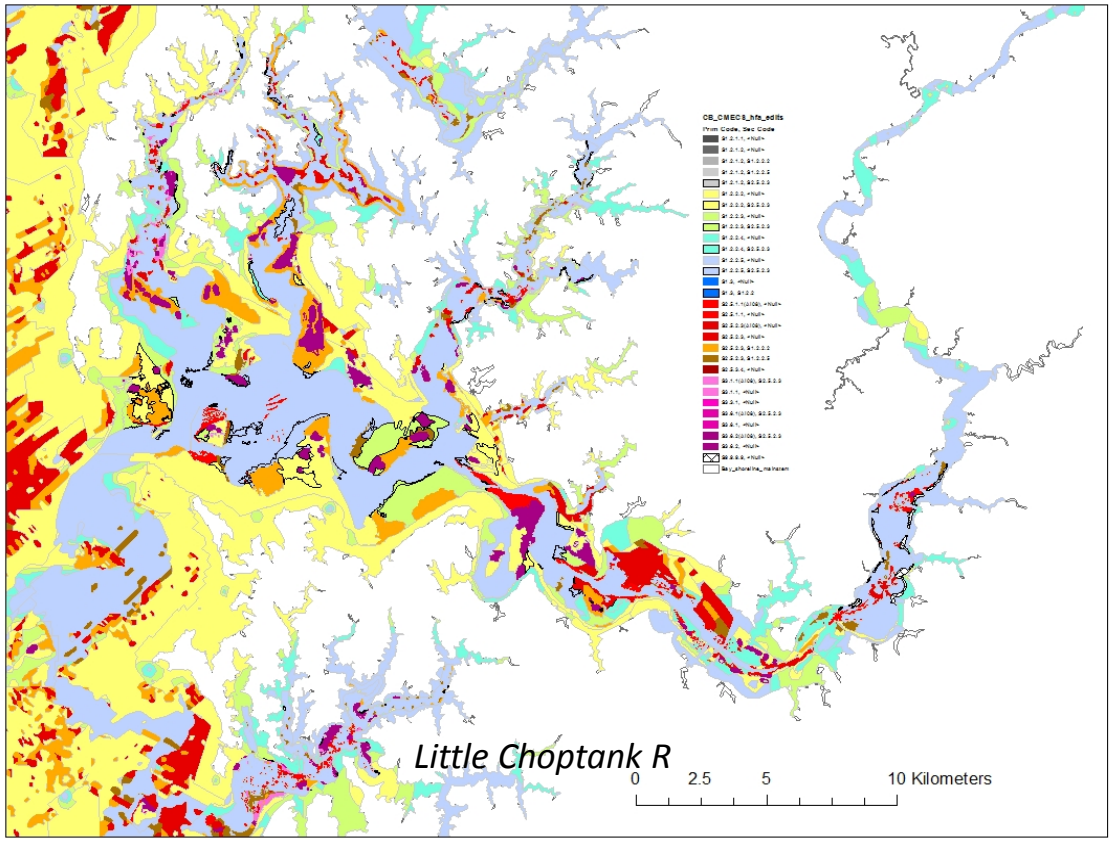


Seabed Surveys for Restoration Planning & Monitoring

- Acoustic surveys along with pre restoration population surveys used to select restoration sites- "pick the right spots"

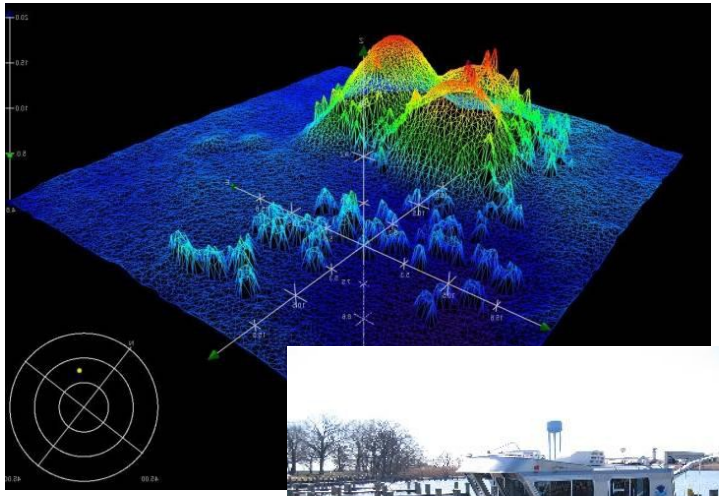
- Post restoration surveys verify project placement
- Post restoration surveys establish new chart depths
- Post restoration surveys monitor change in physical structure (subsidence, oyster growth, sedimentation)

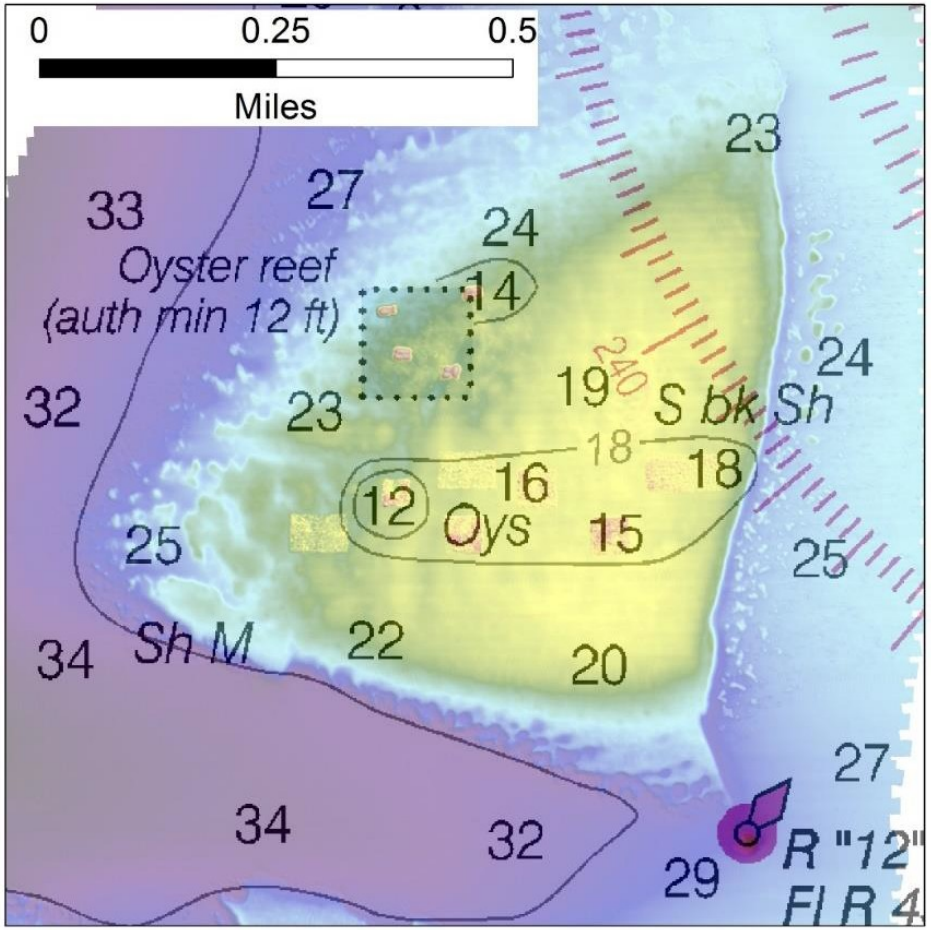
Harris Creek



CMECS Substrate Component Units

Acoustic Remote Sensing-
MBES Bathymetry and Backscatter



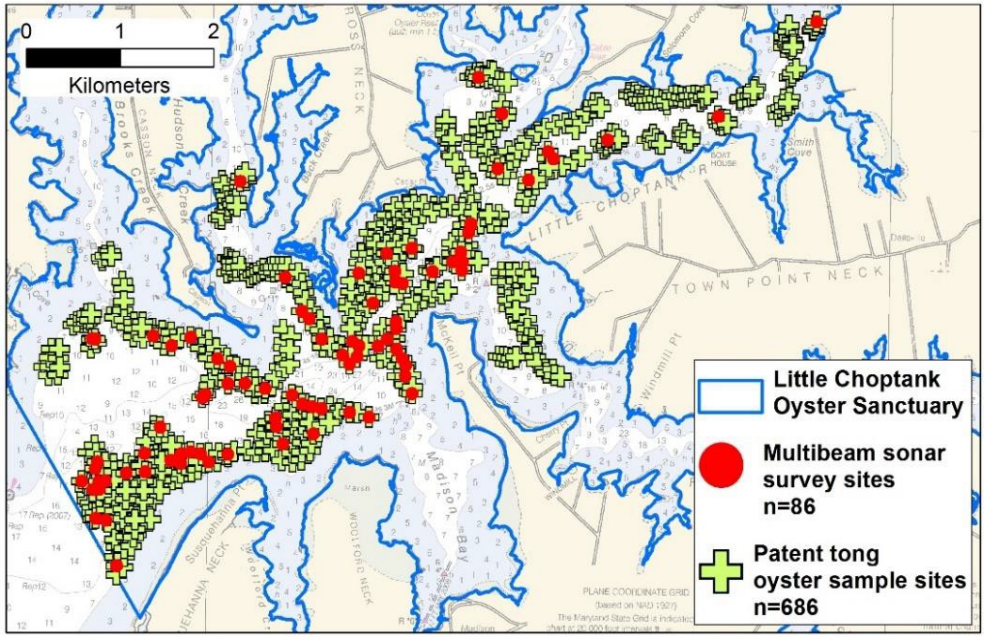


Question: Can We Observe Which Metrics are Better Predictors of Oyster Survival and Can This Guide Restoration?

Scale Dependent Ecological Assumptions

- Larval settlement increases with hardness (low sediment) and increased roughness (surface area)
- The greater the roughness, the greater the potential for interstices
- Interstitial spaces provide refuge from predation of spat (settled oyster larvae)
- Current velocities are increased along channel edges therefore higher slopes represent better habitat potential

Pre Restoration Oyster Abundance Surveys



Dependent Variables (pre-restoration/natural bottom)

Oyster density (#/m^2) binned into 3 size classes

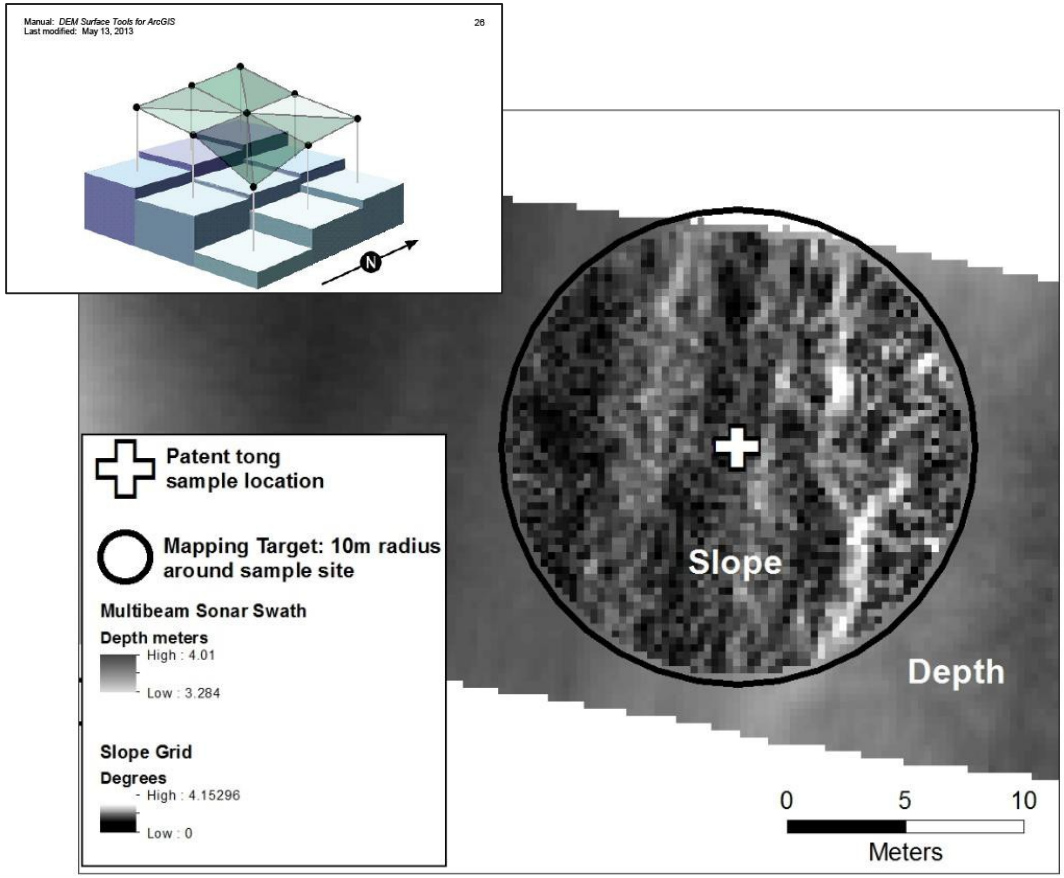
- Spat: < 40mm
- Small: 40-75m
- Market: > 75mm

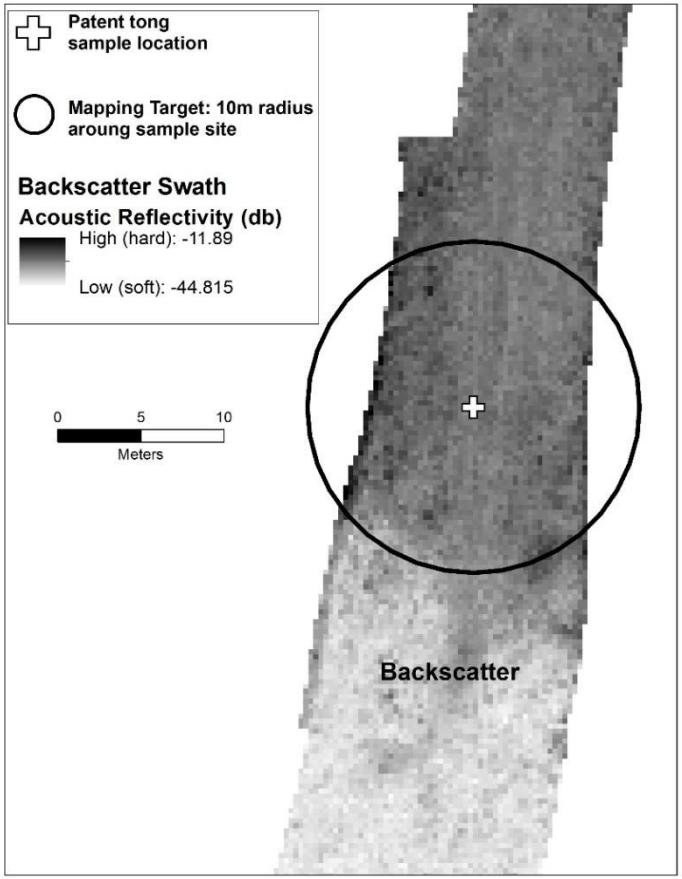
Independent Variables (Seabed metric- 0.25m grid cells)

Slope: Mean slope from within mapping target (degrees)

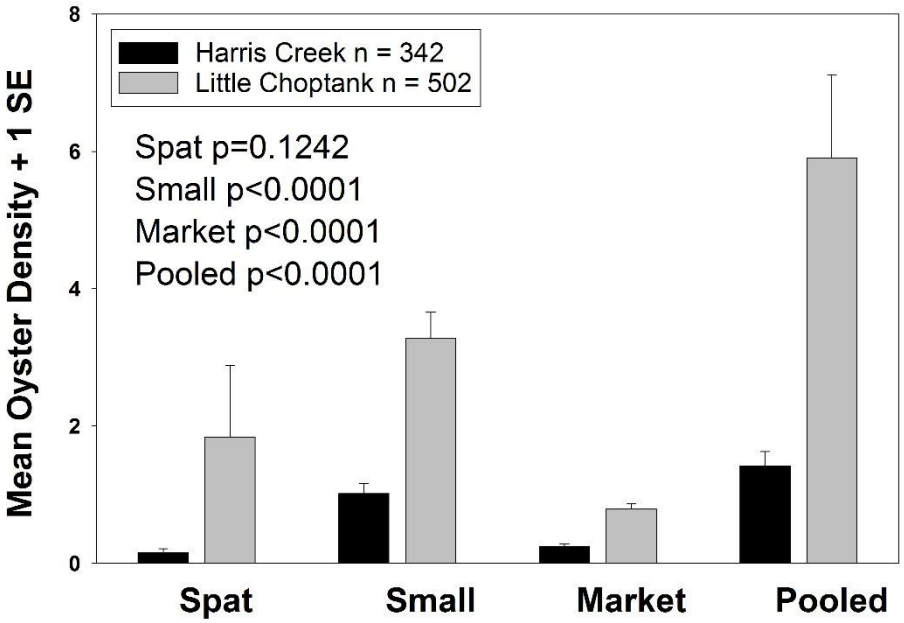
Roughness: Standard deviation of slope (degrees)

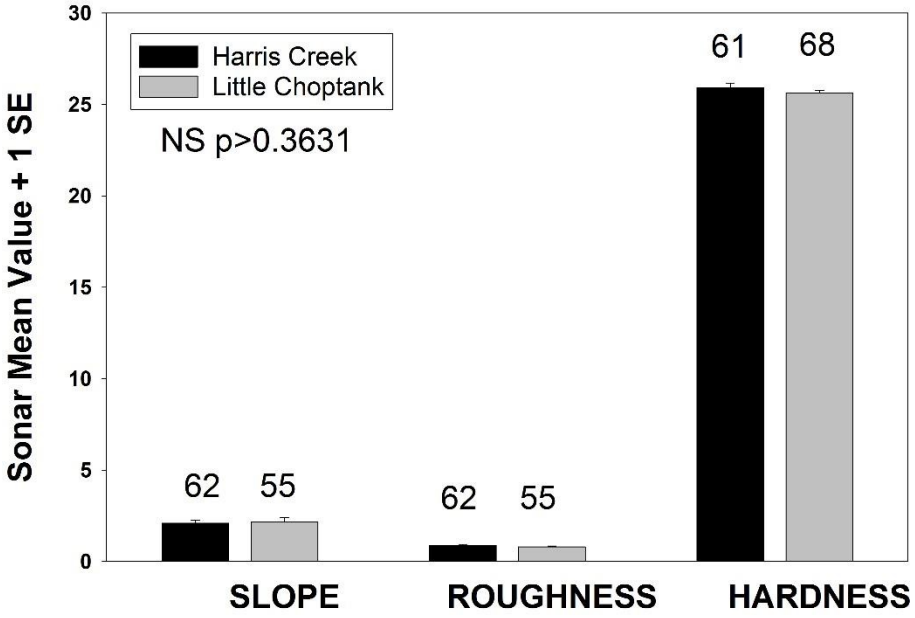
Hardness: Mean acoustic reflectivity from backscatter (-db)





One-Way ANOVA Location Comparisons of Oyster Density and Seabed Metrics





High Variability in Oyster Densities- not many in Harris Creek

Seabed Metrics show Low Variability- No one metric stands out

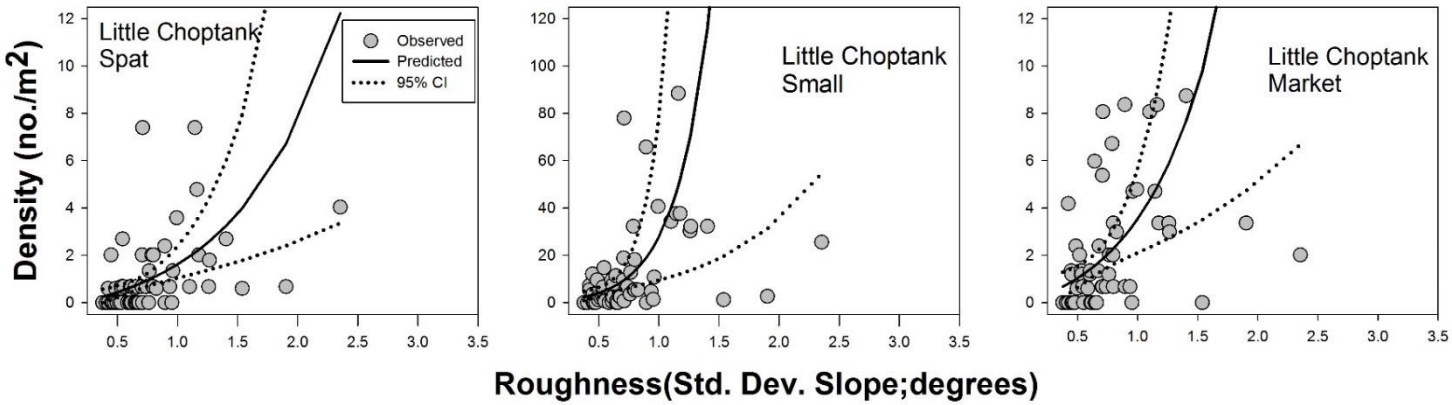
Corrected Akaike Information Criteria Values for Generalized Linear Models

(Inverse Gaussian Distribution with Log-link Function)

	Harris Creek			Little Choptank River		
Independent Variables	**Spat**	**Small**	**Market**	**Spat**	**Small**	**Market**
Slope + Roughness + Hardness	83.13	226.56	92.22	129.43	378.23	209.83
Slope + Roughness	90.69	252.04	95.07	129.74	375.91	207.58
Slope + Hardness	81.48*	228.56	90.02*	138.17	378.68	213.39
Roughness + Hardness	83.66	225.70*	92.79	127.14*	376.01	207.99
Slope	94.46	253.34	92.93	136.84	376.79	214.94
Roughness	90.24	250.0	96.11	127.87	373.77*	206.09*
Hardness	82.13	226.35	96.16	183.63	461.78	264.65

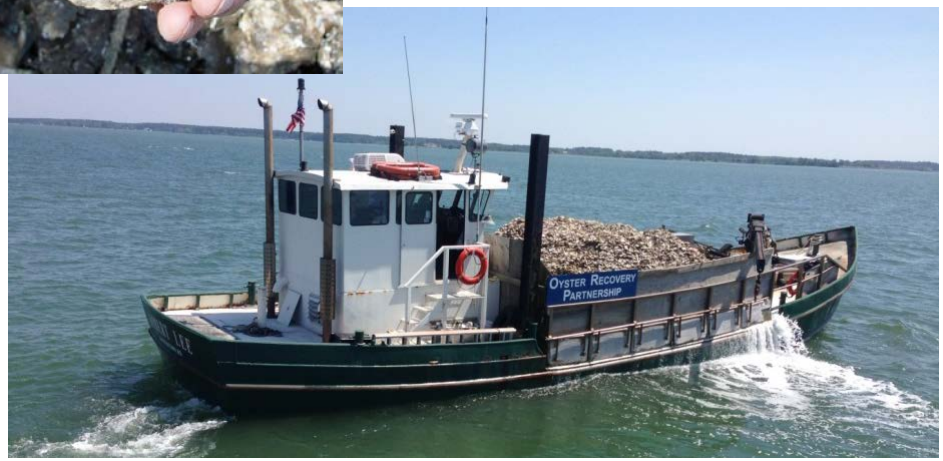
Parameter Estimates For Models Selected By C-AIC

		Slope			Roughness			Hardness		
Location	Size Group	Parameter Estimate	95% Confidence Interval	P	Parameter Estimate	95% Confidence Interval	P	Parameter Estimate	95% Confidence Interval	P
HC	Spat	-0.0727	-0.15 to 0.01	0.0724	-		-	-0.0158	-0.02 to -0.01	<0.0001
HC	Small	-		-	-0.3785	-0.74 to -0.02	0.0387	-0.0533	-0.07 to -0.04	<0.0001
HC	Market	0.1077	0.04 to 0.18	0.0048	-		-	-0.0059	-0.01 to 0.00	0.0780
LC	Spat	-		-	1.2280	0.69 to 1.76	<0.0001	0.0130	-0.00 to 0.03	0.0831
LC	Small	-		-	3.1529	2.62 to 3.68	<0.0001	-		-
LC	Market	-		-	1.4419	1.19 to 1.69	<0.0001	-		-



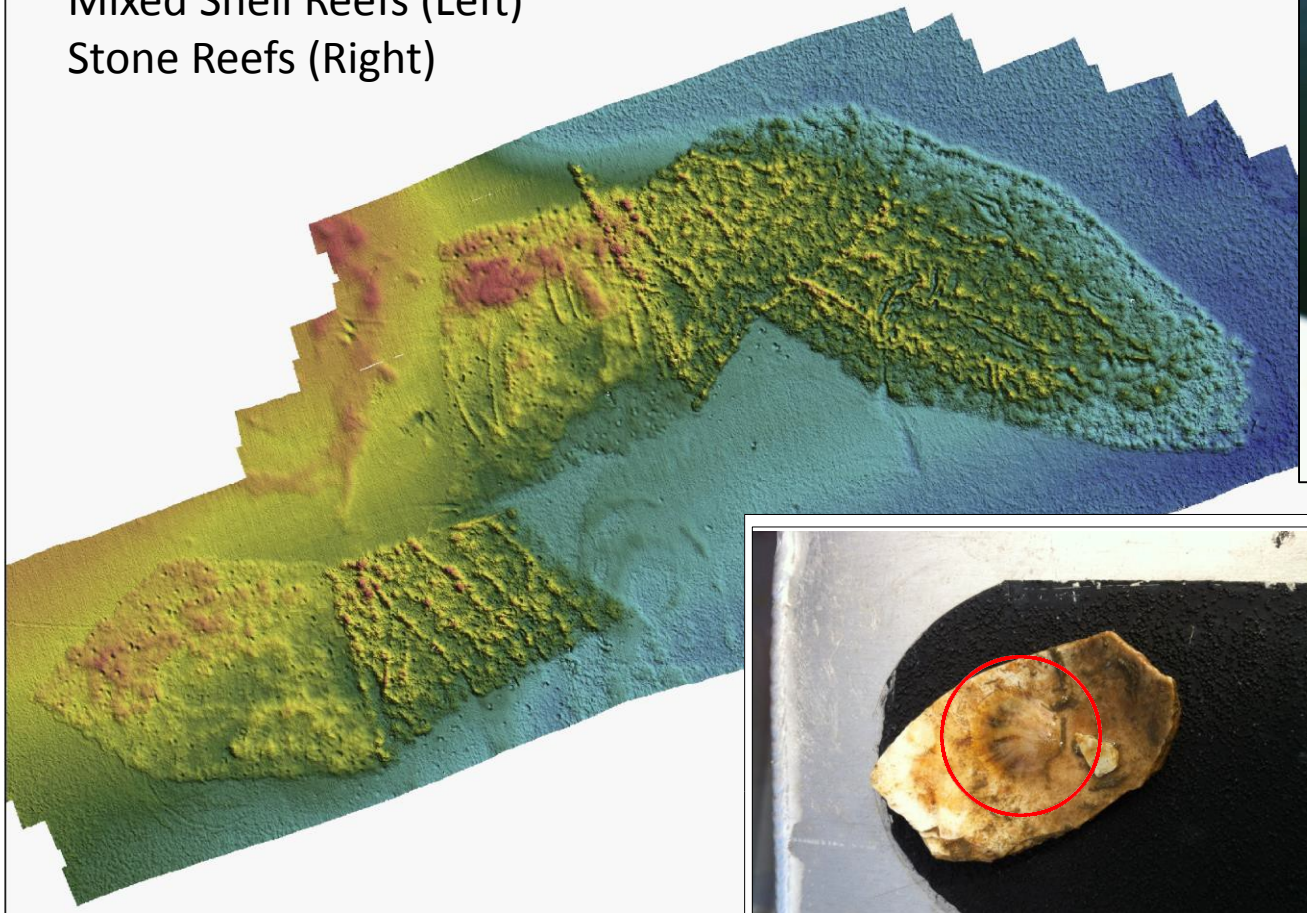
Restoration Implementation

Construct (or Not) > Produce > Distribute



Size Matters

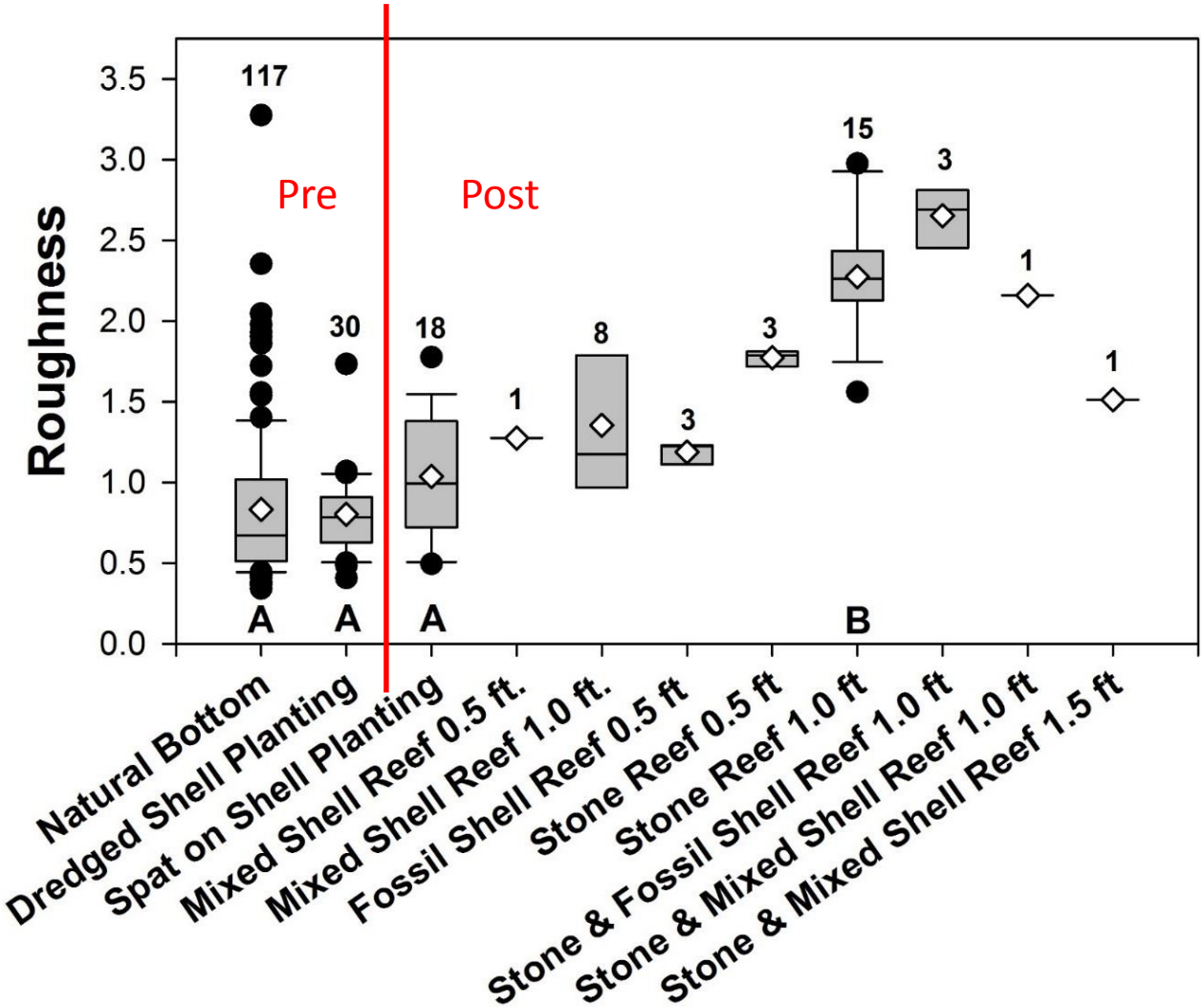
Mixed Shell Reefs (Left)
Stone Reefs (Right)

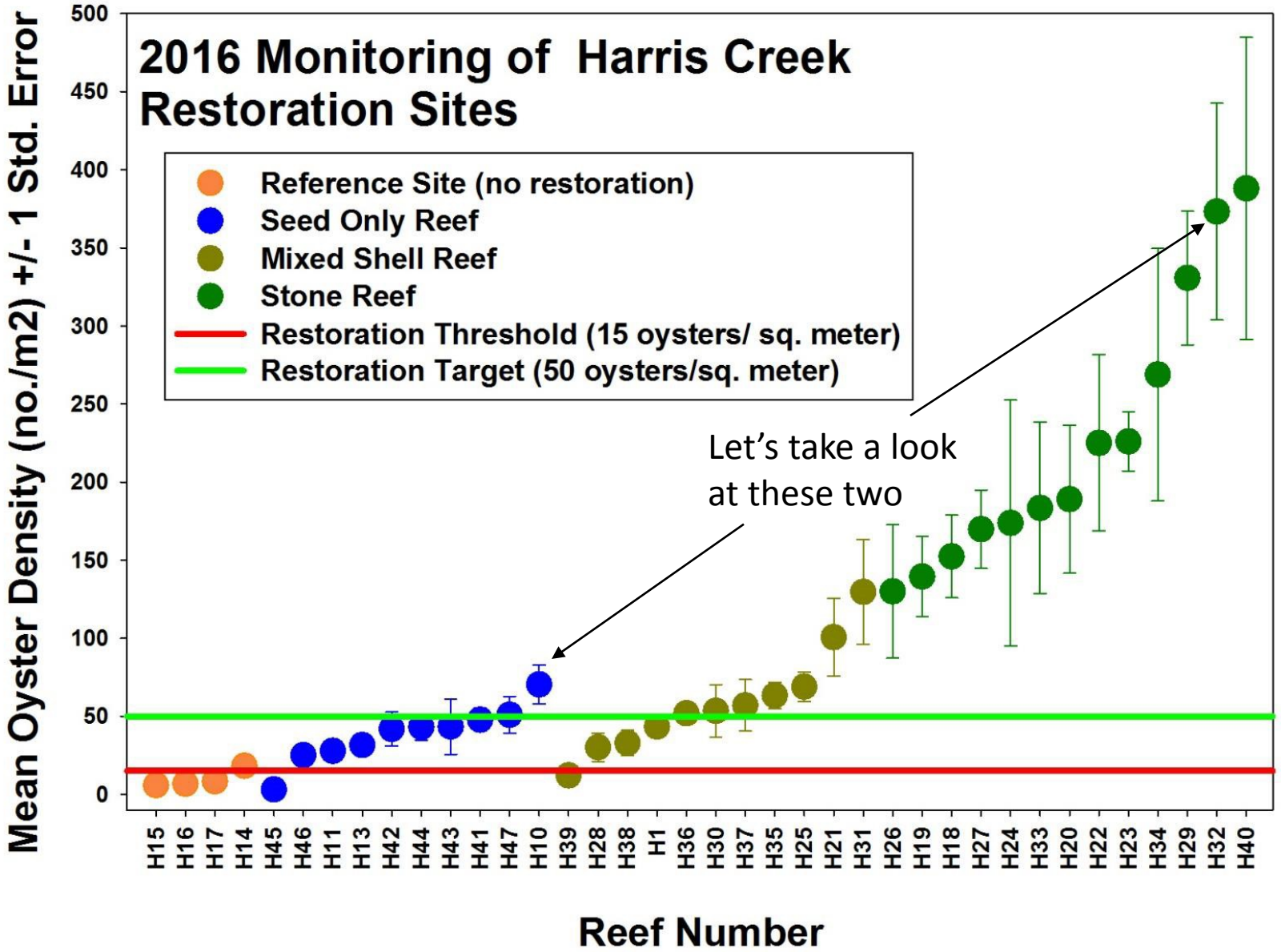


Wild juvenile oysters attached to shell fragments from mixed shell substrate reef

Exercise in Experimentation

Roughness of Restoration Sites Surveyed with MBES (0.25m cells)




2016 Monitoring of Harris Creek Restoration Sites
Reference Site (no restoration)
Seed Only Reef
Mixed Shell Reef
Stone Reef
Restoration Threshold (15 oysters/ sq. meter)
Restoration Target (50 oysters/sq. meter)
Let's take a look at these two
Mean Oyster Density (no./m2) +/- 1 Std. Error
500
450
400
350
300
250
200
150
100
50
0
H15 H16 H17 H14 H45 H46 H11 H13 H42 H44 H43 H41 H47 H10 H39 H28 H38 H1 H36 H30 H37 H35 H25 H21 H31 H26 H19 H18 H27 H24 H33 H20 H22 H23 H34 H29 H32 H40
Reef Number

Seed Only Video