

# Assessing the Oyster Reef Development and Shoreline Protection Functioning of Three Structure Types over a 7-Year Period

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Coastal Protection and  
Restoration Authority of Louisiana



committed to our coast



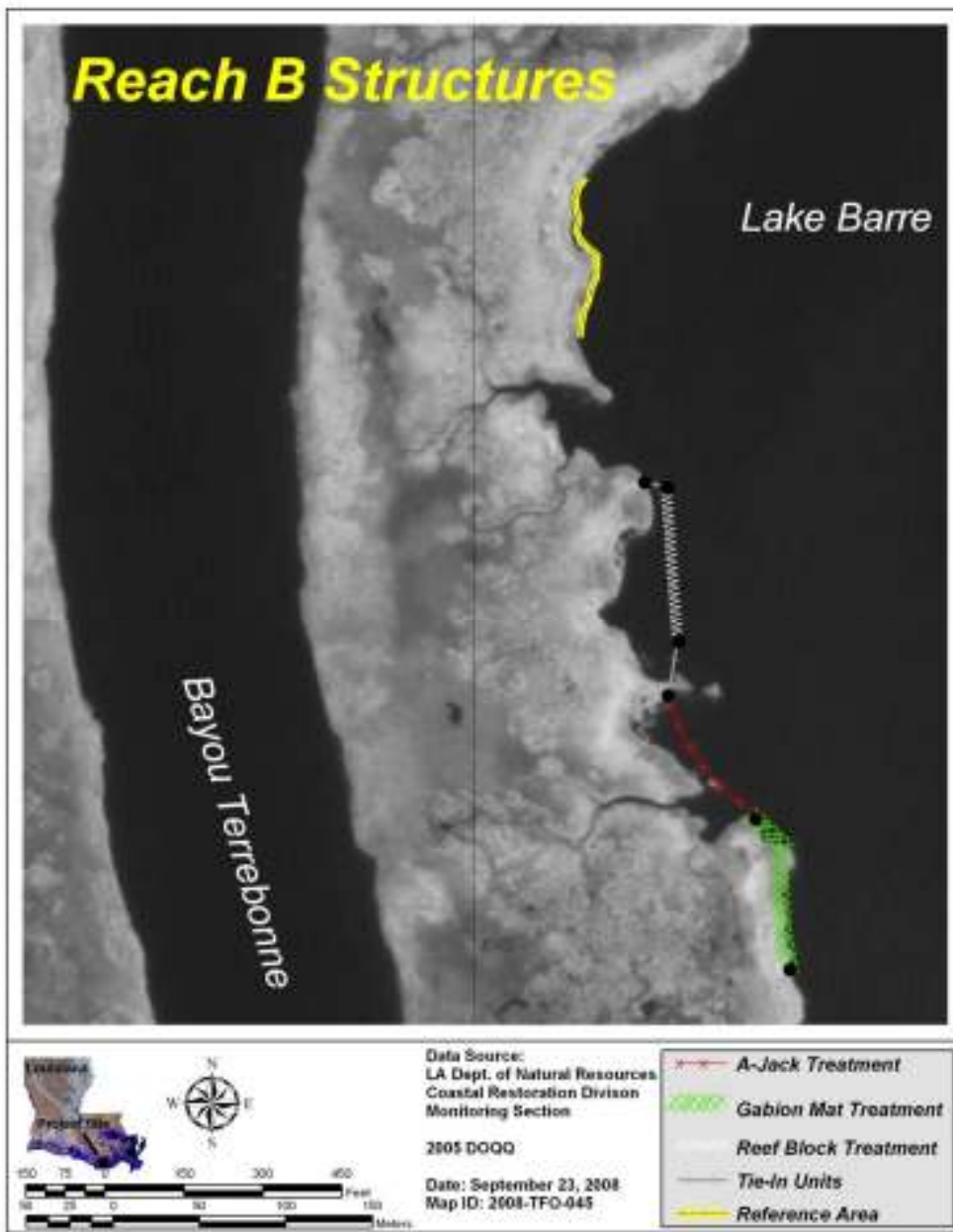
## **TERREBONNE BAY SHORE PROTECTION DEMONSTRATION PROJECT (TE-45) TIMELINE & HISTORY**

- **8 YEAR CWPPRA DEMONSTRATION PROJECT**
  - **SPONSERED** by USFWS & CPRA
  - **COMPLETED 7 YEAR STUDY (2008-2015)**
- **PLACED** on 10th CWPPRA PPL in **MAY 2000**
  - **LAKE BARRE SHORELINES SELECTED**
  - **HIGH OYSTER PRODUCTIVITY**
  - **HIGH RATES** of **SHORELINE EROSION**
- **E&D AUTHORIZED** in **JAN 2001**
  - **DESIGNED** to **CONSTRUCT 6 STRUCTURE TYPES** at **3 REACHES**
  - **EACH STRUCTURE 91.4 METERS (300 FEET)** in **LENGTH**
  - **5 REACHES INVESTIGATED**
  - **REACHES A, B, & E SELECTED**
- **CONSTRUCTION APPROVED** in **AUG 2003**



- TE-45 PROJECT MODIFIED & RE-BID in JUN 2007
  - 3 STRUCTURE TYPES ELIMINATED from DESIGN
  - GABION MAT, A-JACK, & REEFBLK STRUCTURES SELECTED
  - CONSTRUCTION BUDGET INCREASED
  - REACH B RELOCATED
  - CONTRACTOR SELECTED
- CONSTRUCTION
  - BEGAN on SEP 13, 2007
  - ENDED on DEC 19, 2007
  - COST \$1,653,301
- TE-45 PROJECT EVALUATED the 3 STRUCTURE TYPES for:
  - EFFECTIVENESS in REDUCING SHORELINE EROSION
  - ABILITY to DEVELOP & SUSTAIN OYSTER REEF HABITAT







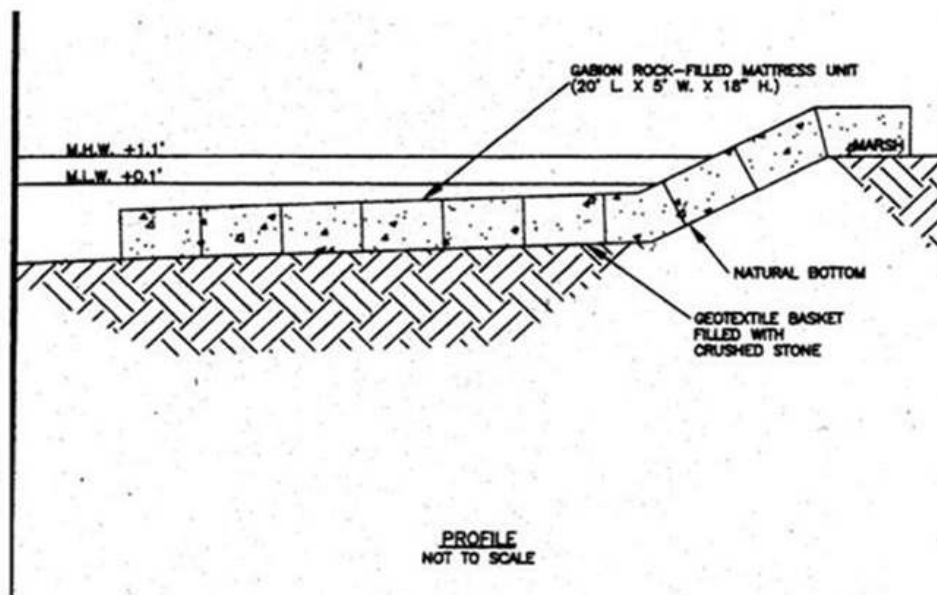
# Triton™ Gabion Mats (filled w/ limestone rocks) (an on-shore structure)

5'W x 20'L x 1'Deep

geotextile grid material formed into a basket and interconnected to form a mat.  
Each with galvanized steel anchors

Weight @ 10,000-15,000 lbs each

Cost per Linear Foot = \$536







# A-Jacks® (concrete) (fore-shore structure)

2' height and width for each A-Jack  
Two A-Jacks deep

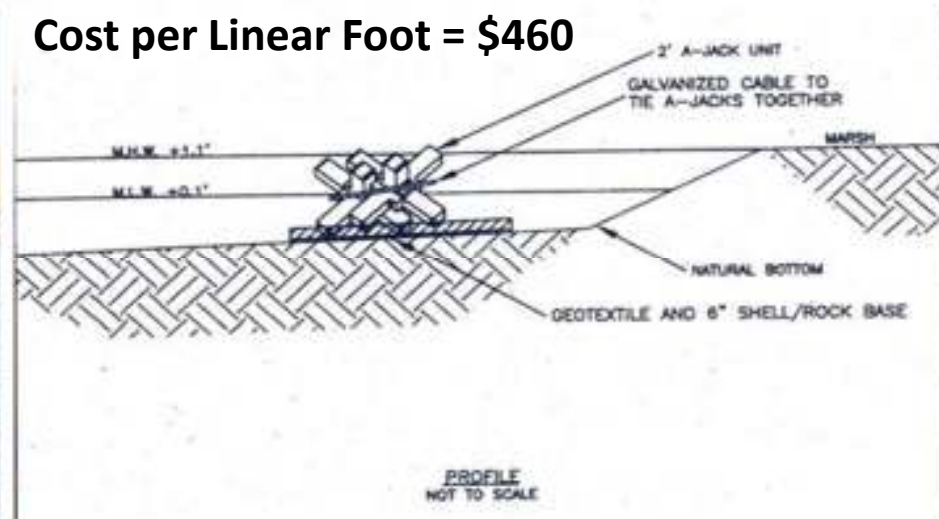
Tied together with galvanized steel cable in 8' lengths to form a unit.

With geotextile & 6" crushed stone base underneath for support

Weight per A-Jack @ 78 lbs

Weight of 8' unit @ 1,716 lbs

**Cost per Linear Foot = \$460**









**Reefblks™**  
**(filled w/ oyster shell)**  
**(fore-shore structure)**

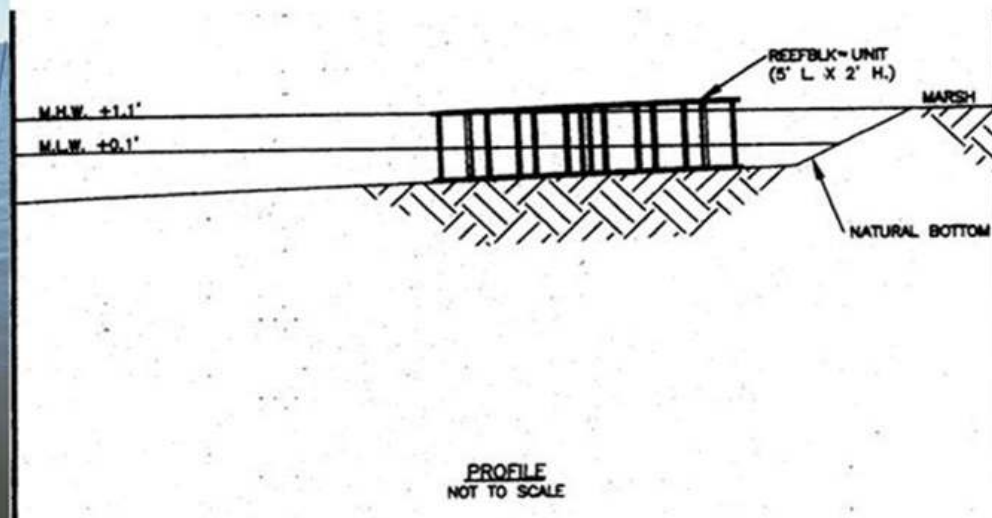
prefabricated double framed triangular steel units which hold plastic mesh bags that are filled with oyster shell.

With geotextile & 6" crushed stone base underneath for support

5' triangular base x 2' height

Weight per triangle @ 3,000 lbs

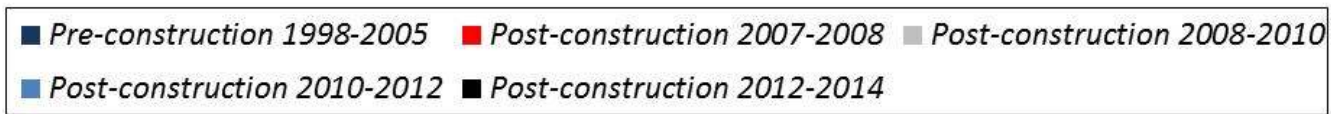
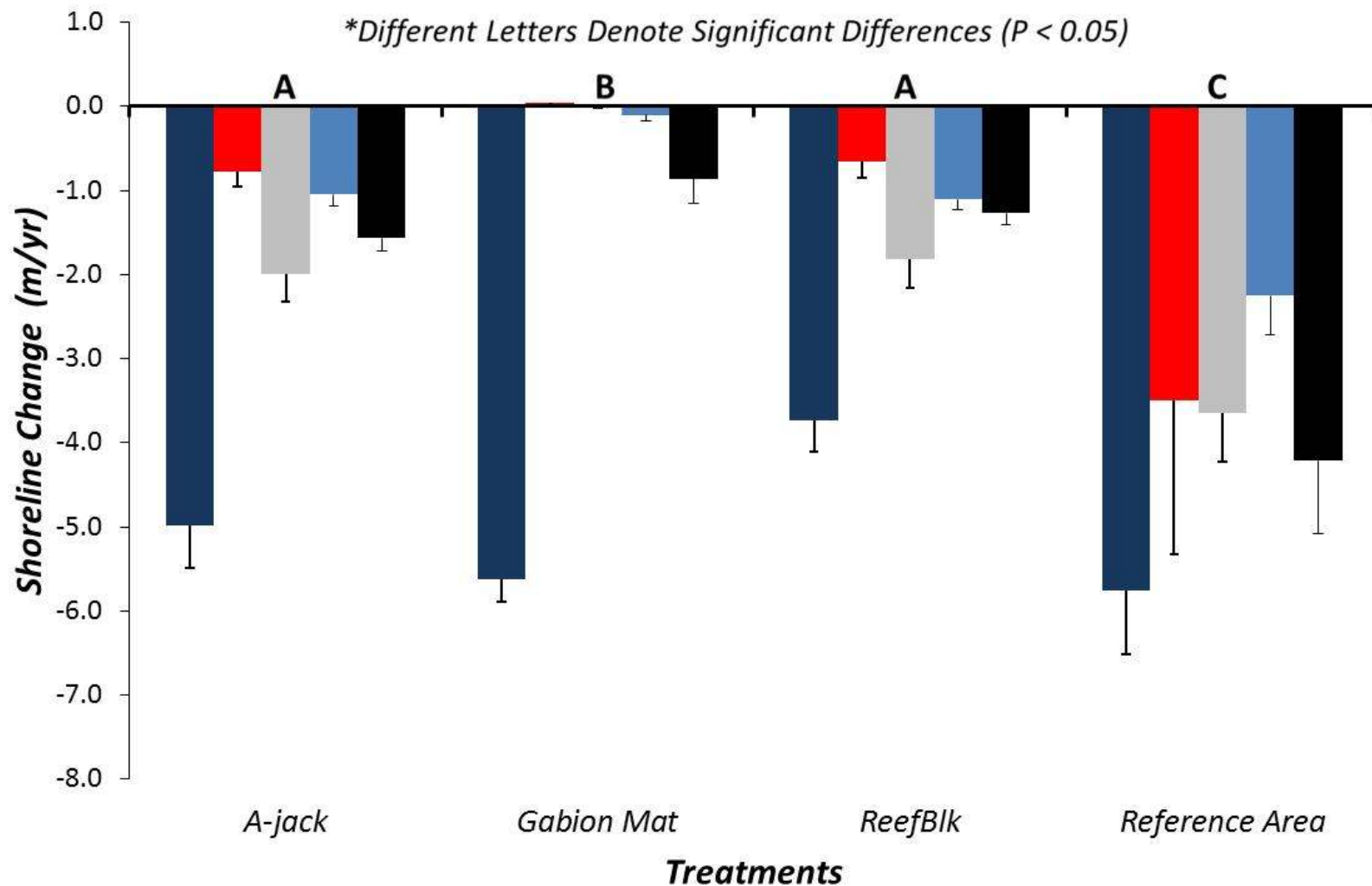
**Cost per Linear Foot = \$399**







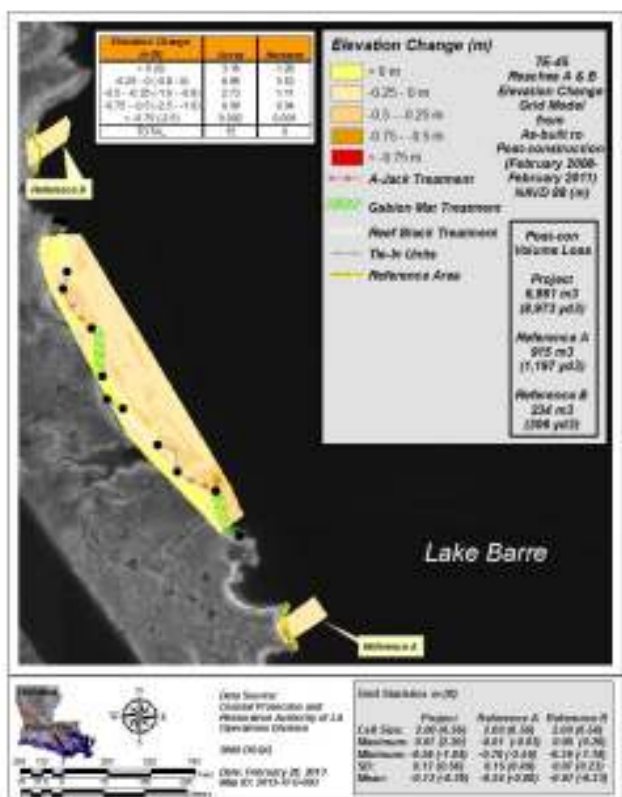
# 1998 – 2014 SHORELINE CHANGE BY TREATMENT



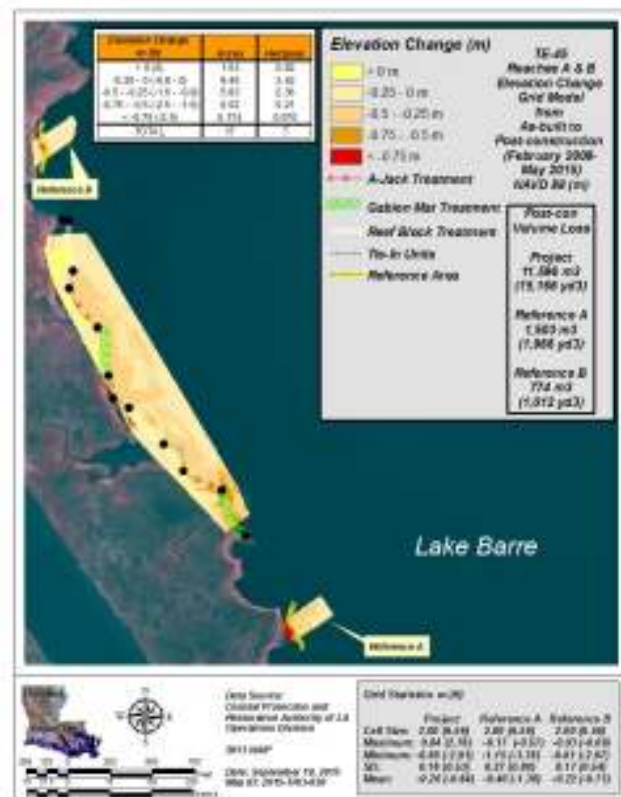


# REACH A & REACH B ELEVATION CHANGE

## 2008-2011 Change Grid



## 2008-2015 Change Grid

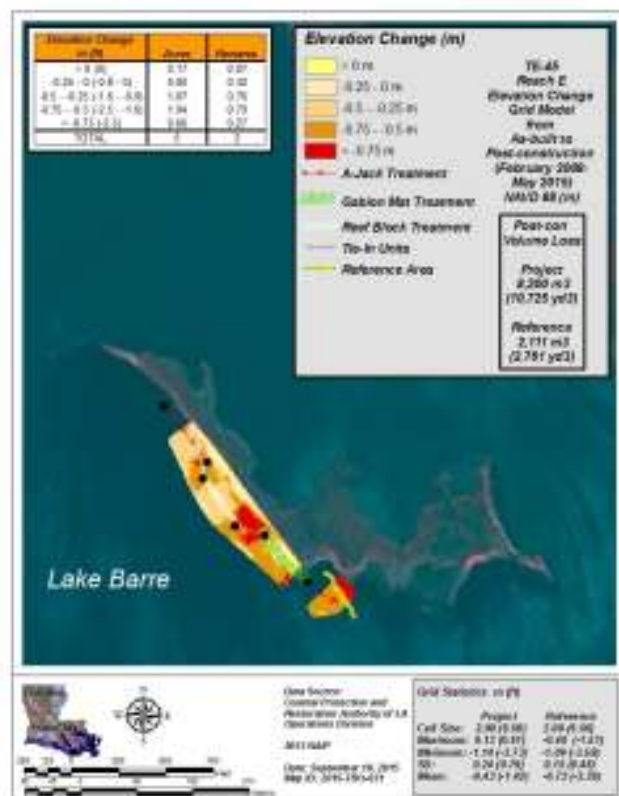
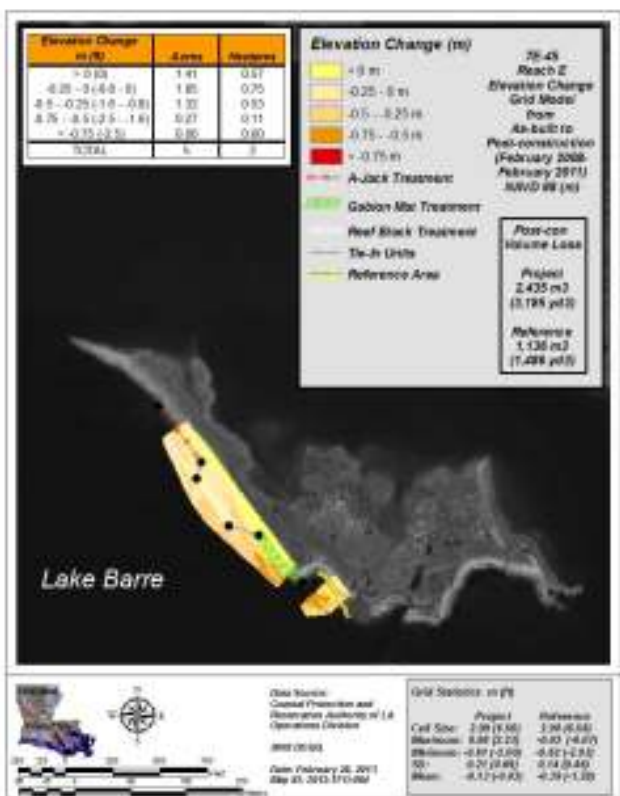




# REACH E ELEVATION CHANGE

## 2008-2011 Change Grid

## 2008-2015 Change Grid





## STRUCTURE SETTLEMENT 2008-2015

Reach	Treatment	Structure Settlement 2008-2011 m (ft)	Structure Settlement 2008-2015 m (ft)
A	A-Jack	-0.05 (-0.15)	<b>-0.17 (-0.57)</b>
B	A-Jack	-0.04 (-0.14)	-0.09 (-0.28)
E	A-Jack	-0.09 (-0.29)	-0.16 (-0.52)
A	Gabion Mat	-0.07 (-0.24)	<b>-0.25 (-0.81)</b>
B	Gabion Mat	-0.06 (-0.20)	<b>-0.20 (-0.66)</b>
E	Gabion Mat	-0.07 (-0.22)	<b>-0.17 (-0.57)</b>
A	ReefBlks	-0.01 (-0.04)	-0.05 (-0.17)
B	ReefBlks	-0.09 (-0.3)	-0.11 (-0.36)
E	ReefBlks	<b>-0.14 (-0.47)</b>	-0.16 (-0.53)
Mean	-	-0.07±0.01 (-0.23±0.04)	<b>-0.15±0.02 (-0.50±0.07)</b>



## SHORELINE EROSION & ELEVATION SUMMARY

- The pre-construction TE-45 shorelines transgressed at high and variable rates.
- All the structures and all the Reaches experienced reductions in shoreline erosion rates during the post-construction assessments.
- The Gabion Mat treatment is clearly the most effective shoreline protection structure at the TE-45 Reaches.
- The post-construction shoreline transgressions behind the ReefBlk and A-Jack treatments were temporally similar.
- All shoreline Reaches recorded volume losses during both pre- and post-construction intervals.
- The Reach A Gabion Mat and the Reach E structures have the lowest vertical profile.
- Gabion Mat structures incurred the greatest settlement.



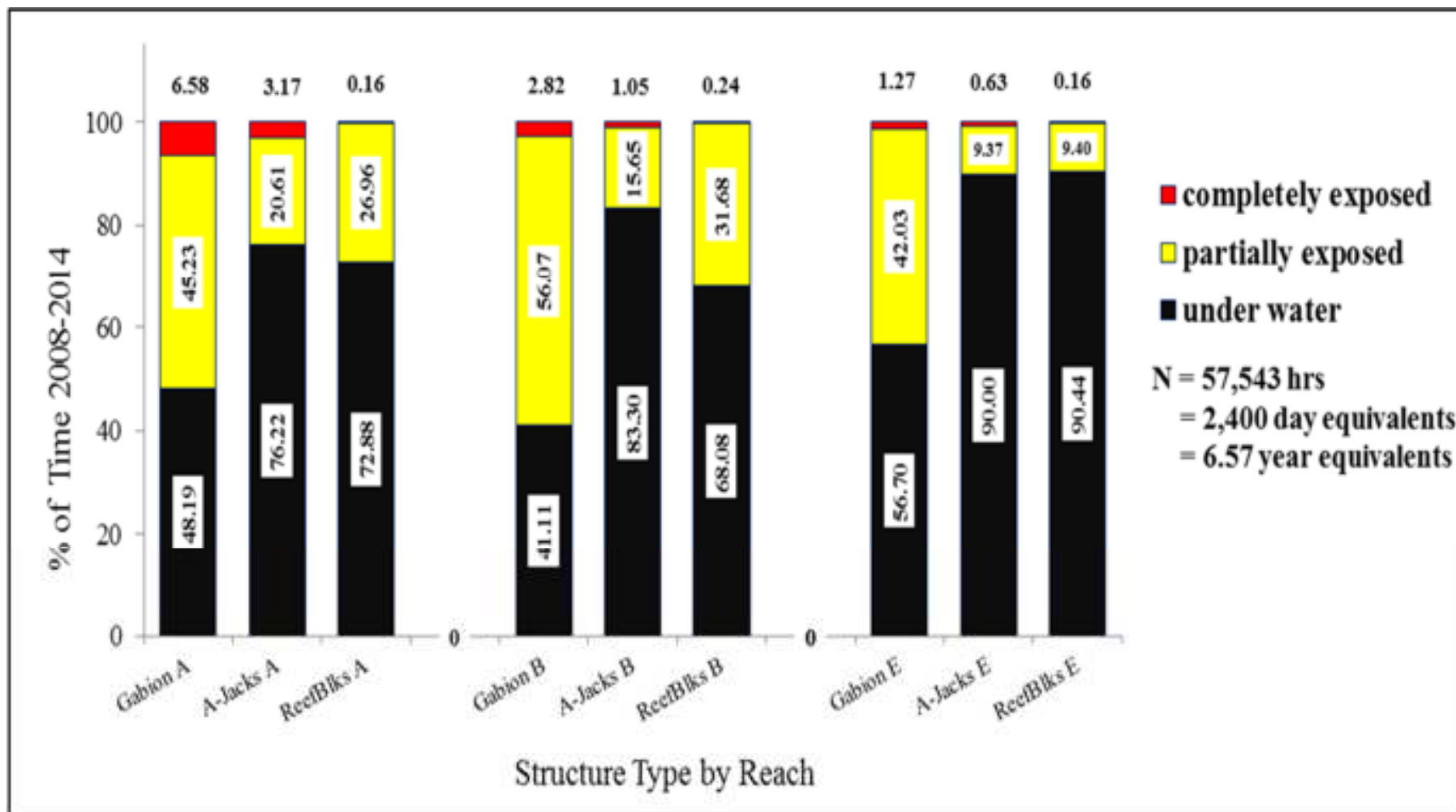


# BIOLOGICAL METRICS

- **Water Quality**
  - Discrete & Continuous Recorders:
    - Salinity & Water Temperature
    - Predictive Hourly Tide Levels = % Annual Inundation
    - Chl-a, TSS, POM, D.O.
- **Recruitment**
  - Quarry Tiles – Monthly
  - Oyster Shell Bags
- **Population Characterizations**
  - Quadrat Samples – Size Distributions, % Cover
  - Histology – Male:Female Ratio
  - Fouling – Mussels, Barnacles, Sponges, Stone Crabs
  - Photography – General Appearance
  - Natural Intertidal Oyster Reefs for Comparisons



## % Time of Complete and Partial Reef Exposure 2008-2014





## Population Characterizations ReefBlks 2-Yrs Post Construction

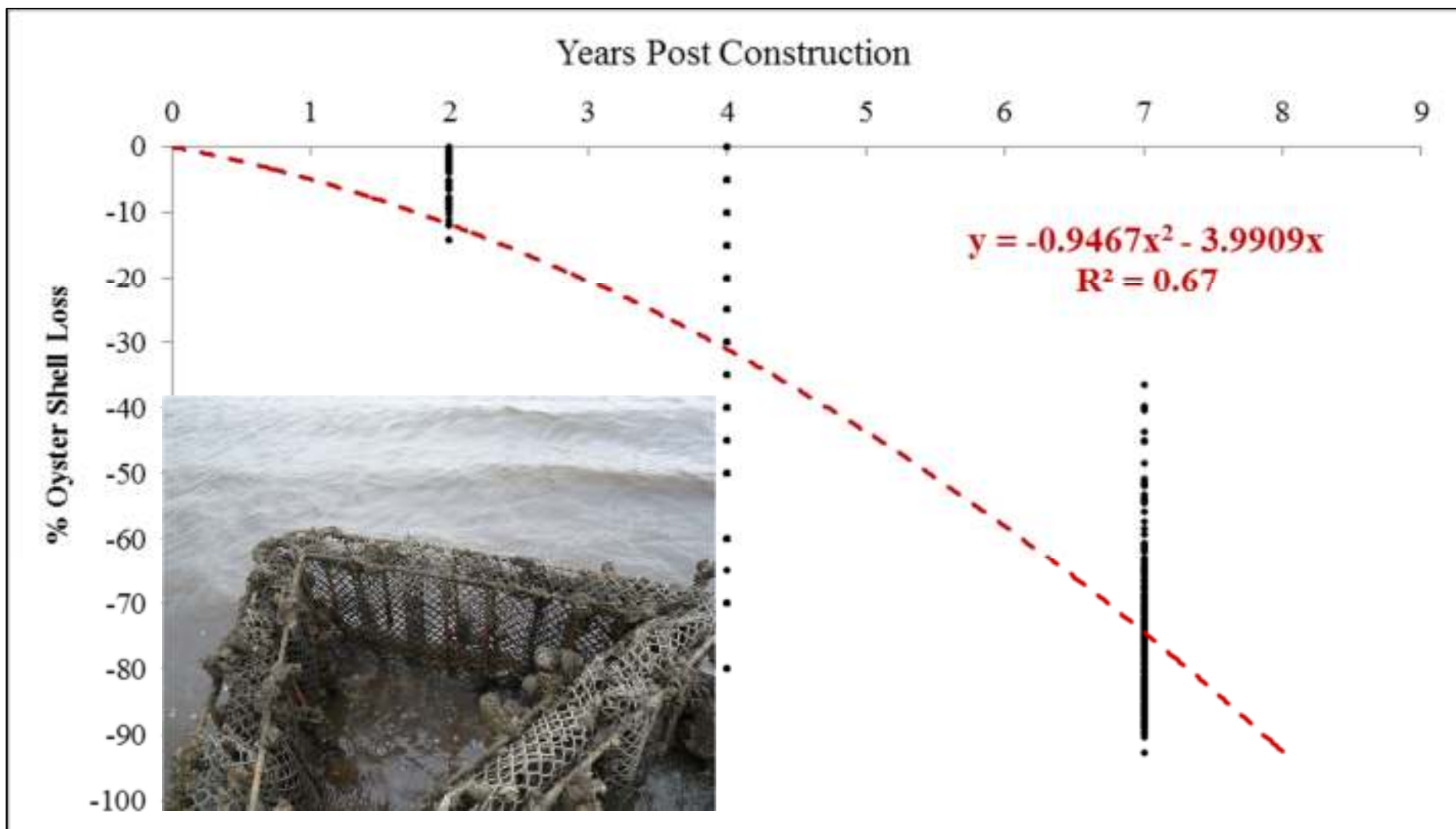


5/19/2010



# Oyster Shell Budget for ReefBlks

## Significant Subtidal Time - Recipe for Failure

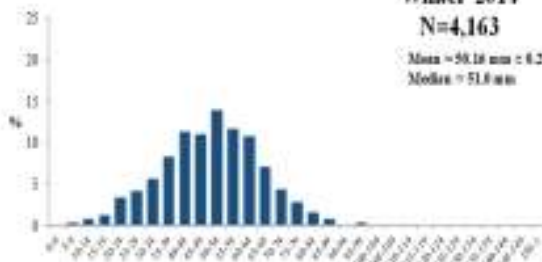




## Gabion Mats

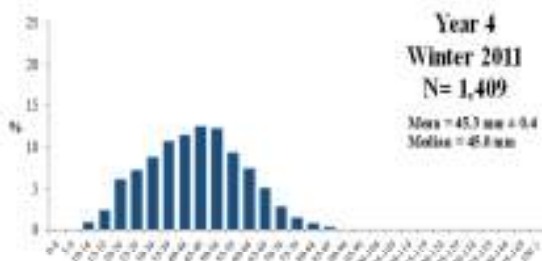
Year 7  
Winter 2014  
N=4,163

Mean = 58.18 mm ± 6.2  
Median = 51.0 mm



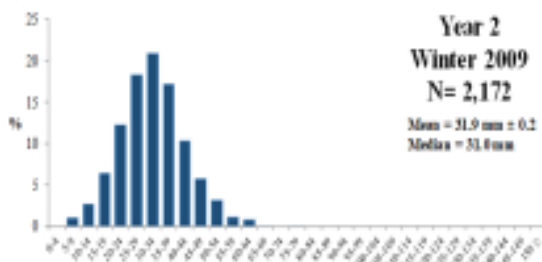
Year 4  
Winter 2011  
N= 1,409

Mean = 45.7 mm ± 5.4  
Median = 45.8 mm



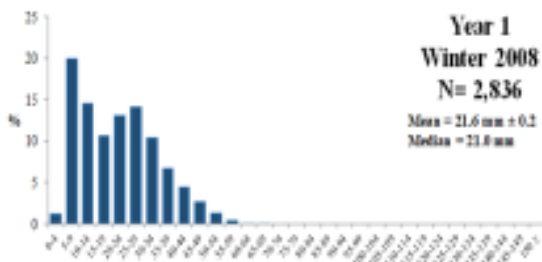
Year 2  
Winter 2009  
N= 2,172

Mean = 31.9 mm ± 6.2  
Median = 31.8 mm



Year 1  
Winter 2008  
N= 2,836

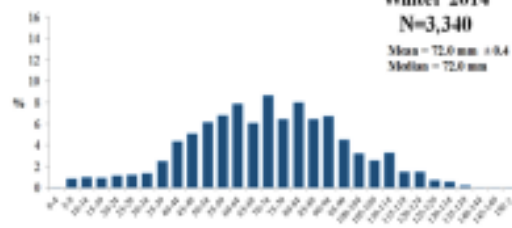
Mean = 21.6 mm ± 6.1  
Median = 21.8 mm



## A-Jacks

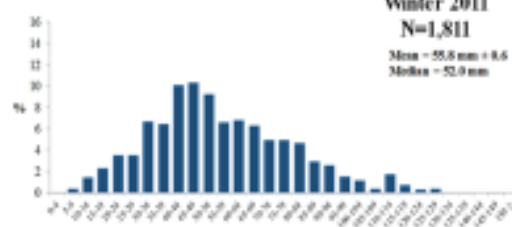
Year 7  
Winter 2014  
N=3,340

Mean = 72.0 mm ± 8.4  
Median = 72.0 mm



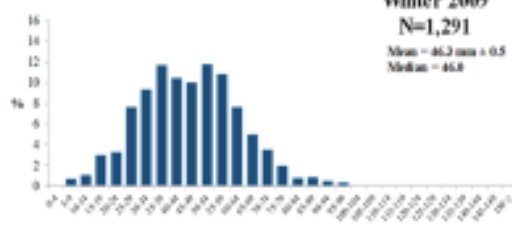
Year 4  
Winter 2011  
N=1,811

Mean = 55.8 mm ± 8.6  
Median = 52.0 mm



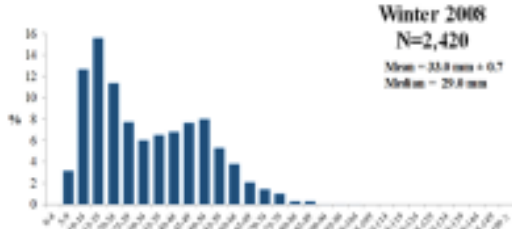
Year 2  
Winter 2009  
N=1,291

Mean = 46.2 mm ± 6.5  
Median = 46.8

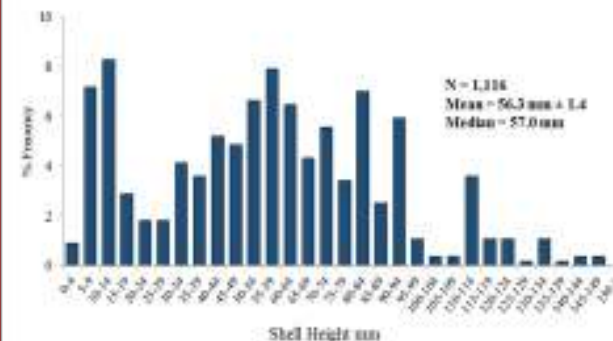


Year 1  
Winter 2008  
N=2,420

Mean = 33.8 mm ± 6.7  
Median = 29.8 mm



## Winter 2014 Natural Intertidal Reefs



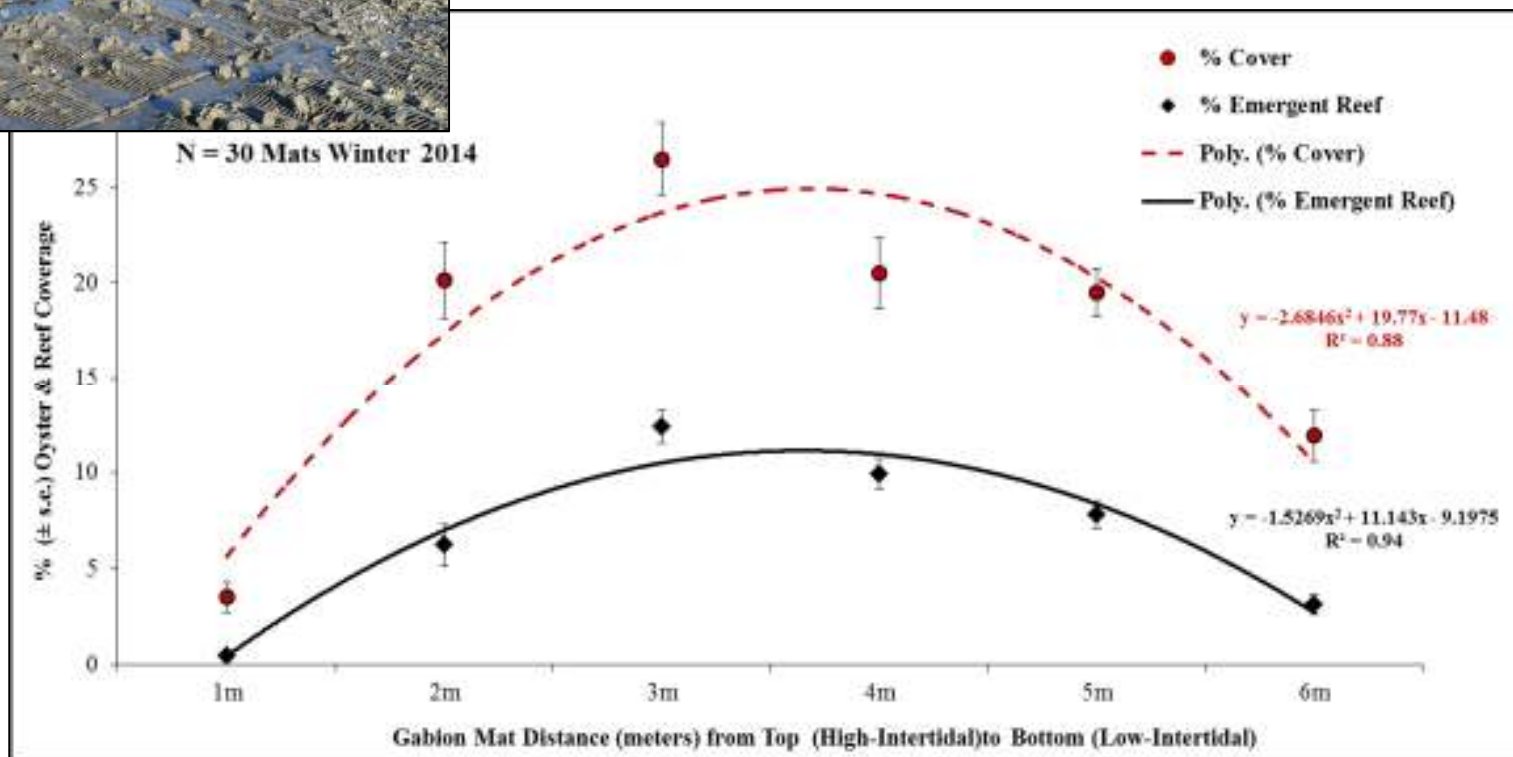
## Population Characterizations



# Population Characterizations



## Reef Development on Gabion Mats Contouring the shoreline

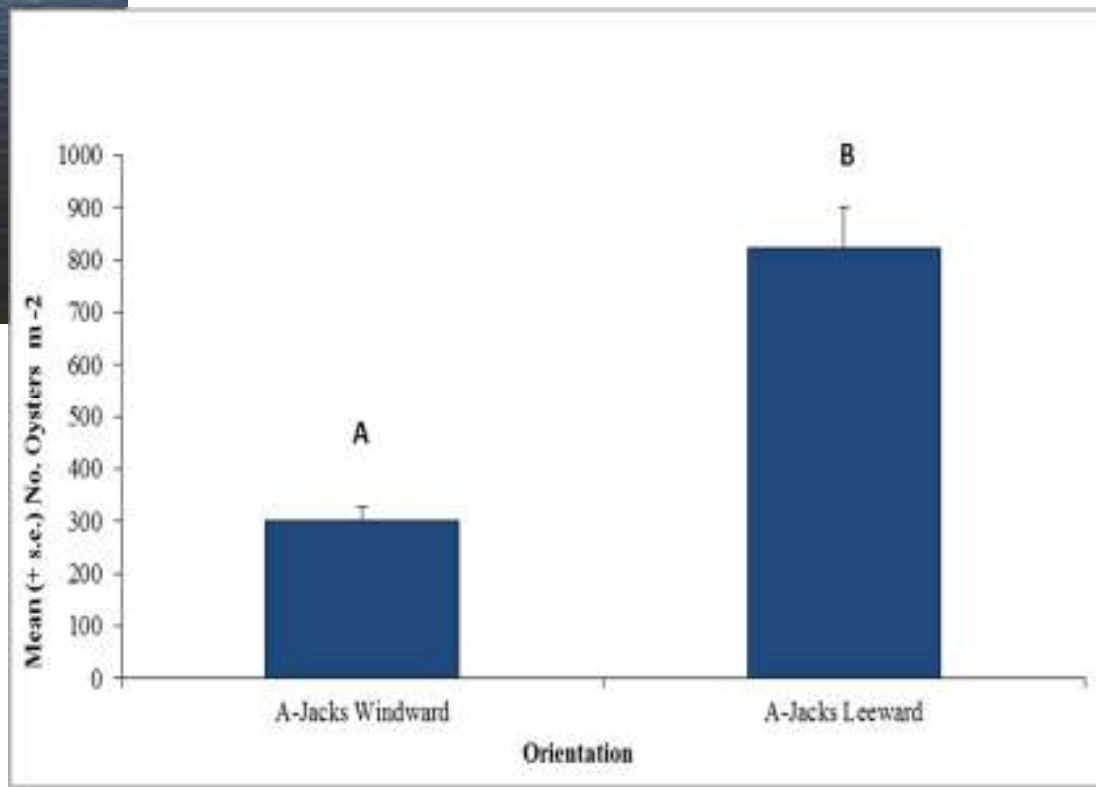




# Population Characterizations

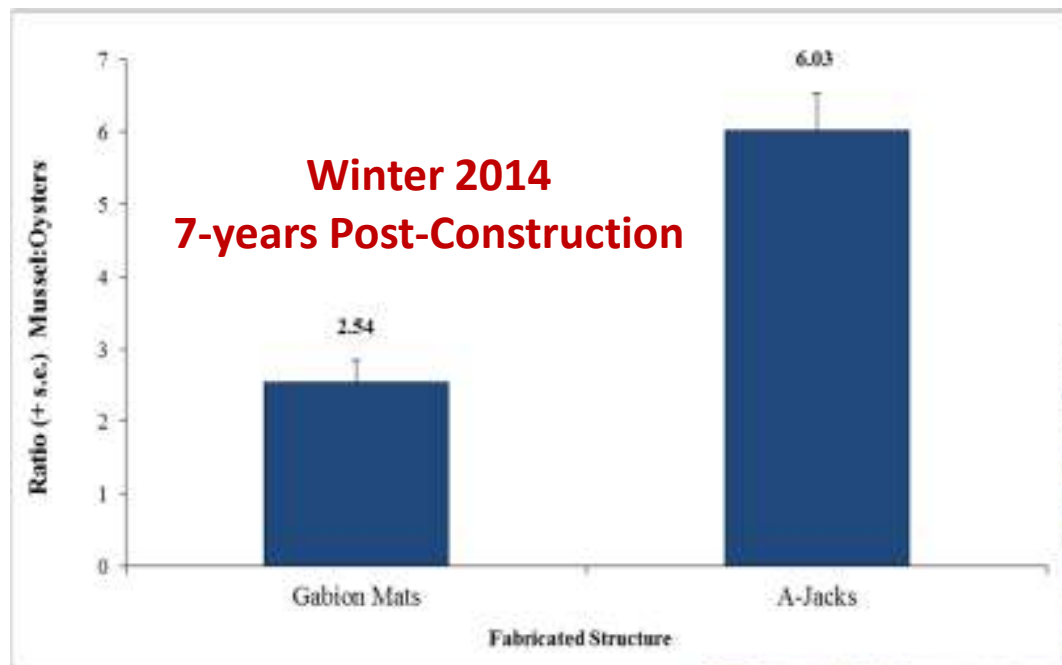


## A-Jacks Windward vs. Leeward

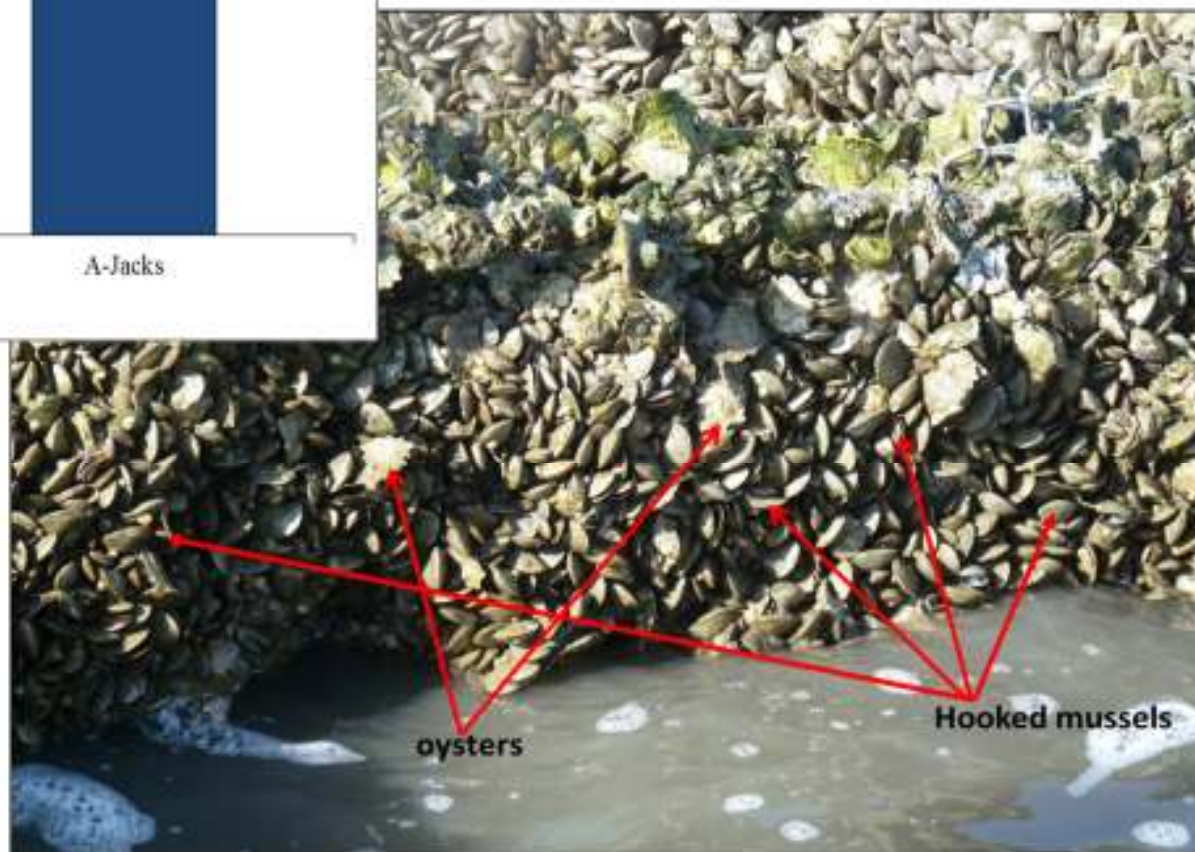




## Population Characterizations



## Hooked Mussels influence on Reef Development







# Influence on Gabion Mats of Shell Grit and Shell Rubble Washed Ashore from Bay

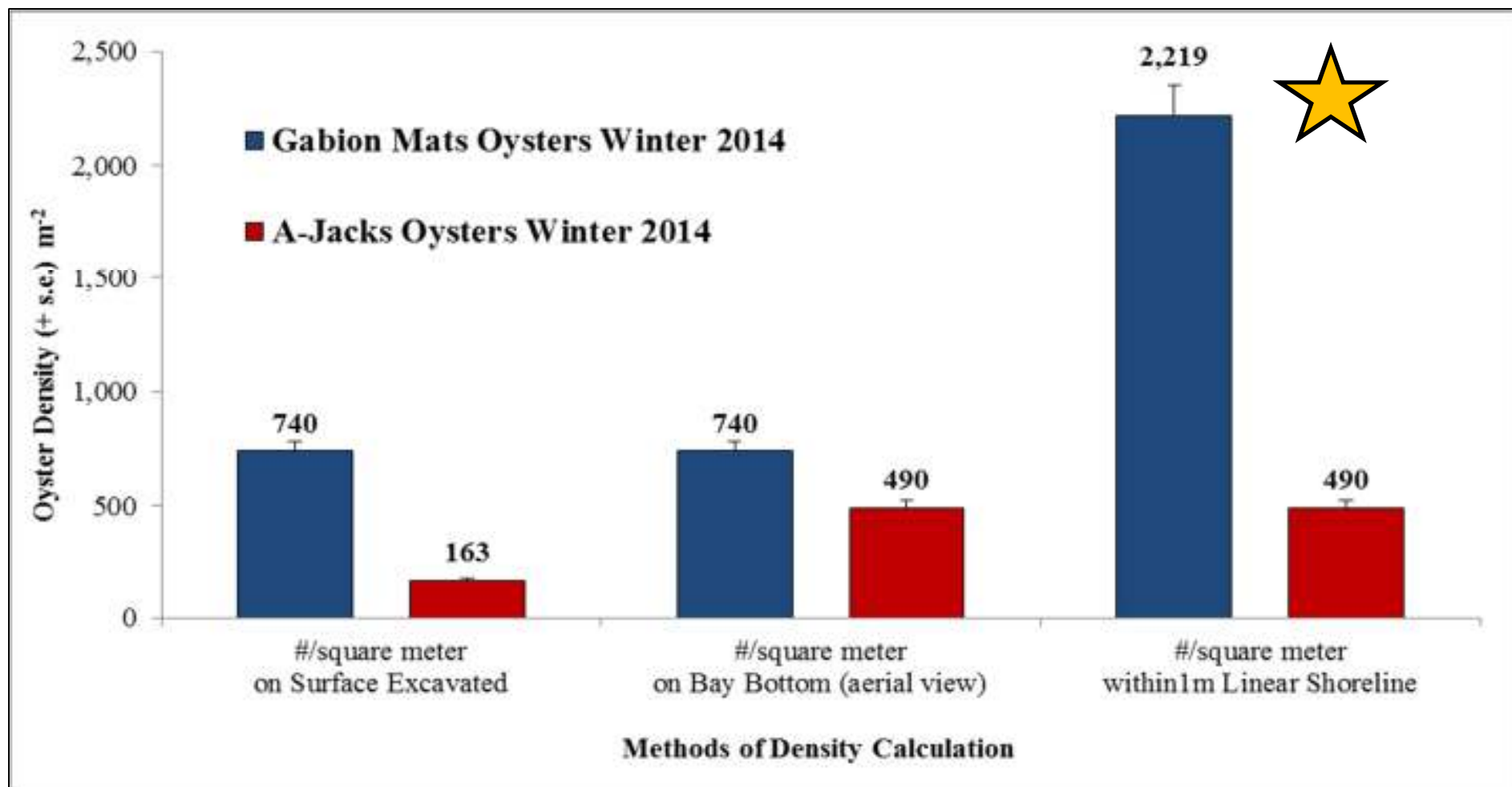




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## Challenges of Defining Density Metrics







## BIOLOGICAL SUMMARY by Winter 2014

- Good oyster population size distribution indicating good recruitment and survival.
- Consolidated reef on all the structures is the typical veneer-type.
- Gabion Mats and A-Jacks continue to function with oysters distributed as expected, while ReefBlks are failing.
- Oyster coverage on structures, A-Jacks  $60 \pm 2.5\%$  and Gabion Mats =  $58 \pm 1.3\%$ .
- Consolidated reef coverage on structures, respectively A-Jacks =  $32 \pm 3.0\%$  and Gabion Mats =  $30 \pm 1.5\%$ .



## **Six Master of Science theses were successfully completed by students working on the TE-45 project**

- Initial oyster recruitment patterns on fabricated Shoreline Structures,
- Influence of a high-energy habitat and degree of tidal immersion time on oyster population development,
- Abundance of populations of associated fish and invertebrate species on and near the fabricated structures; Fabricated structures' influence on fauna immigration and emigration along the fringing marsh,
- Comparison of fish diet between fabricated and natural reefs,
- Predation rate on oyster and hooked mussel populations; attraction of hooked mussels to live oysters versus oyster cultch,
- The filtration rate of a fabricated reef dominated by oysters and mussels.



## COST EFFECTIVENESS

Structure	Structure Cost \$/m (\$/ft)	Shoreline Change (m/yr)	Oyster Coverage (%)	# Oysters per Linear Meter of Shoreline	Structure Settlement (m)	Rank
Gabion Mat	\$1,758 (\$536)	-0.28	26.5 ± 1.9	2,219 ± 135	-0.21	<b>1</b>
A-Jack	\$1,510 (\$460)	-1.22	46.0 ± 2.5	490 ± 36	-0.14	<b>2</b>
ReefBlk	\$1,310 (\$399)	-1.19	<b>Failed</b>	<b>Failed</b>	-0.11	<b>3</b>



# ACKNOWLEDGEMENTS



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