Shoreline Change and Reef Development Analysis of a Restored Oyster Reef in Biloxi Marsh, Louisiana

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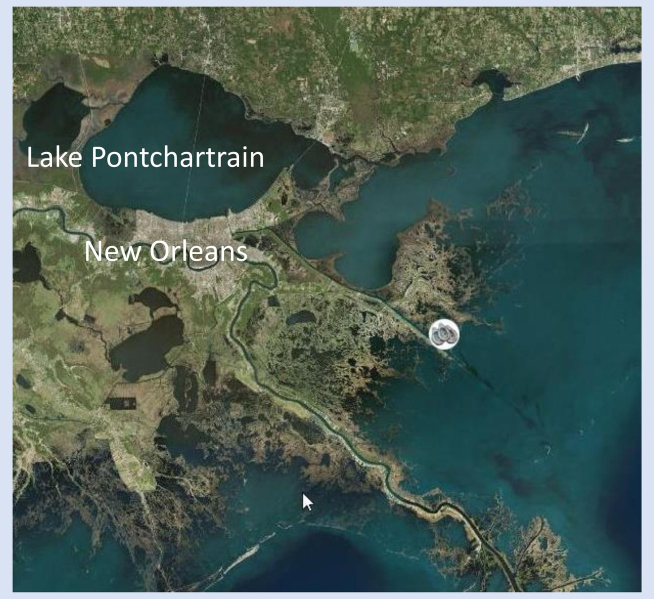
INTRODUCTION

In 2016, CRCL built a half-mile reef in Biloxi Marsh for habitat restoration. The reef is comprised of 434 gabion baskets filled with recycled oyster shells from local restaurants participating in our Oyster Shell Recycling Program (OSRP). Recycled shells act as a preferred substrate for oyster recruitment.

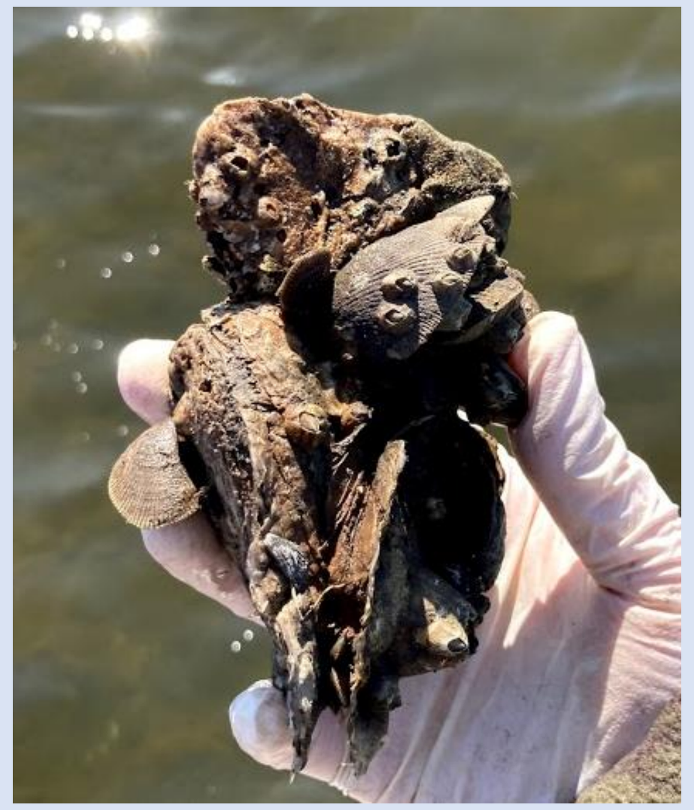
Annual monitoring includes:

- Shoreline erosion analysis for the reef and control sites
- Water quality assessment
- Survey of oyster and other encrusting organism recruitment



Location of the reef in Biloxi Marsh

Reef (1-4) and control (5-8) sampling sites



Cluster of newly recruited oysters from restored reef (December 15, 2020)

Christa Russell and Darrah Bach collecting an oyster sample (January 14, 2021)

Research Question

How do shoreline erosion and oyster recruitment differ between a restored oyster reef made from recycled shells and a control marsh site 5 years post reef construction?

METHODS

Shoreline Erosion Analysis

- Historic satellite images collected 1989 – 2015 for comparison of shoreline erosion before reef construction
- Aerial imagery of marsh edge captured as 'baseline' in 2016
- Shoreline position data collected manually until drone monitoring est. in 2019. FAA certified monitoring techs fly Phantom Drone over sites using Pix4dCapture. Imagery converted to orthomosaic map using Pix4dMapper
- Shoreline imagery analyzed using ArcMap's Digital Shoreline Analysis System (DSAS). Measures distance between baseline and year-to-year shoreline intersections along 100+ transects. Output statistics analyzed in Excel

Reef Sampling Protocol

- Sampling annually, during a low tide event (Dec. – Feb.)
- 8 sampling sites (4 reef, 4 control) marked by 5f PVC poles
- 12in diameter bucket filled to 10cm (7306.17 mL) with randomly collected reef substrate
- All live and dead organisms measured (mm), returned to reef
- Water quality measured 5m from the marsh edge
  - Temperature
  - Salinity (YSI)
  - Turbidity (Secchi disk)
- Analysis of reef development data in R Studio and Excel

RESULTS

Shoreline Erosion Analysis

The reef site has a significantly reduced mean rate of erosion compared to the control site (ANOVA α level of .05).

- Reef shoreline erosion is reduced compared to both historic erosion rate before reef construction and control site analyses
- Since 1989, the control site shoreline receded by a total of 11.88 meters more than the reef site (see Table 1)

Table 1: Comparison of reef and control site erosion

Shoreline Erosion Statistics	Reef (m)	Control (m)
Mean erosion rate pre-installation 1989-2015 (m/y)	-2.47	-2.7
Mean erosion rate post-installation 2016-2021 (m/y)	-1.64	-2.34
Total shoreline change 1989-2021	-63.08	-74.96

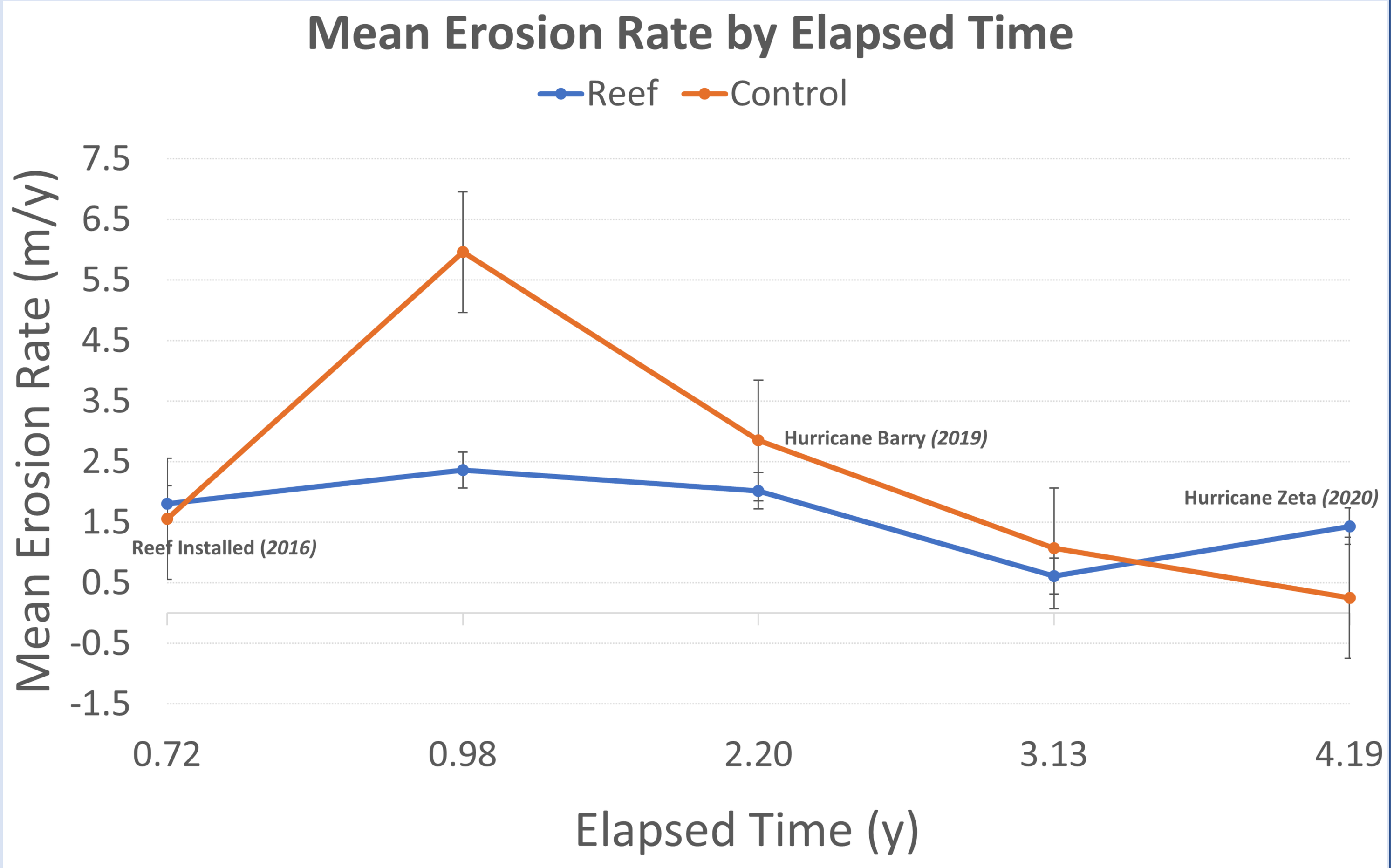


Fig. 1: Mean erosion rate comparison since reef installation

- In Fig. 1, distance between reef and control trajectory 0.72 to 2.20 years post-installation shows immediate impact of reef
- Control site has higher background erosion rate even before reef installation. Could be due to longitudinal location (farther south than reef), higher fetch, elevation differences
- Control sites have double the S.E. values than the reef sites, due to a high variability amongst sites
- High variability in shoreline erosion causation

Reef Development

- In 2021, 801 live oysters recorded from 4 sites across the reef
  - 2 visible spat sets recruited
  - Mean shell height (oyster length): 24.71 mm
  - Most live oysters per square meter recorded (see Table 2)
- Significant difference in shell height between all years demonstrates active, dynamic reef (Wilcox T Test, α level of .05)
- Significant difference in mean oyster density between years (Wilcox T Test, α level of .05)

Table 2: Mean live oyster density statistics

Mean Live Oyster Density (ind/m2)	
2017	20.81
2020	7.10
2021	42.66
Mean	**23.52**

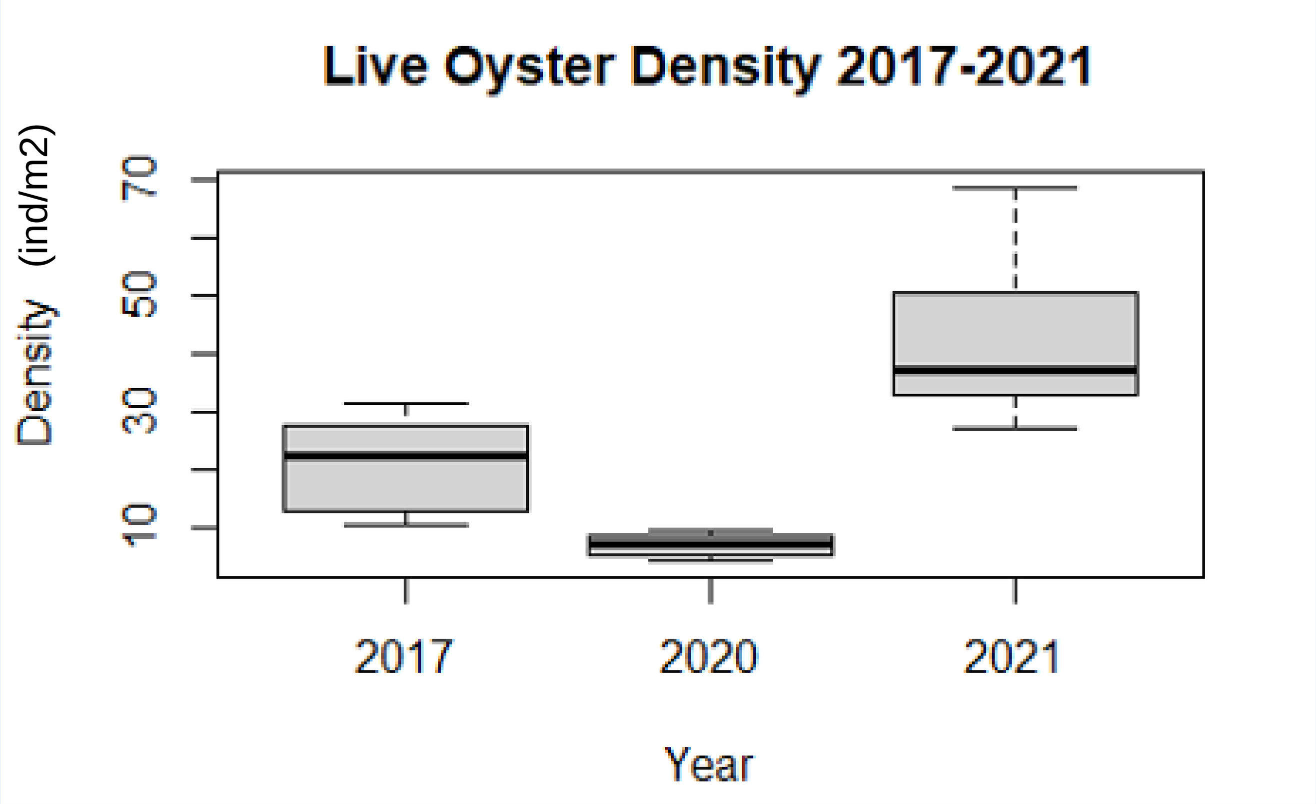


Fig. 2: Density of live oysters sampled over 3 years

- Reduced oyster density levels 2019-2020 (see also Table 2) likely due to salinity level changes induced by the opening of the Bonnet Carre Spillway. Recorded oyster density higher than ever in 2021 as salinity levels stabilized

CONCLUSIONS

- Annual oyster recruitment data indicate that the reef acts as a nursery for new generations of juvenile oysters
- Size/frequency distribution of live oysters indicate two spat sets between 2020-2021, suggesting the reef serves as a suitable habitat for larval oyster settlement and provides favorable conditions for growth
- The increase in density of live oysters in 2021 substantiates the ability of a recycled reef to recruit oysters long-term and generate lasting marsh protection
- The restored reef has contributed to a slowed rate of shoreline erosion and provides lasting ecosystem services to the Biloxi Marsh

ACKNOWLEDGMENTS

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