Shoreline Armoring: Is it Good? Bad? Or Ugly?

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Introduction

- Florida has **> 80 ecosystems**, many unique to the state (Ecosystems & Species, 2025, July 31).
- About **72.5 million dollars** have been invested in 12 habitat restoration projects in Florida (NOAA Fisheries, 2025).
- Florida has **8,436 miles of shoreline statewide (**NOAA Shoreline Website**)**
- Shoreline armoring techniques (seawalls, jetties, groans, etc) can accelerate the speed of sand erosion, meaning loss of beaches and tidal wetlands (Gittman et al, 2015).
- **Natural shorelines** are being considered over **Armored shorelines** in some areas to save natural habitats while also protecting shorelines **at a portion of the cost.**
  - **44%** of people living along shorelines in the Florida Keys reported **no repairs** for mangroves.
  - If repairs needed, cost **only about $64.33** where armored shorelines cost $105.14 (O'Donnell et al, 2022).
- FSU PC has both armored and natural shoreline types for erosion control
- Armored shoreline added to campus circa 2015 to help control active lawn erosion behind Holley Building
- We wanted to measure relative effectiveness of the shoreline management methods.

Fig 1: Map of sample sites on the FSU PC Campus

Research Question:

How does shoreline armoring on our campus impact erosion and biodiversity?

Fig 2: FSU PC shoreline pre seawall (2007)

Fig 3: FSU PC shoreline immediately post sea wall (2015)

Discussion

Beach Profile

❖ Natural shorelines, close to armored shorelines, have higher erosion rates

Wave energy

❖ Natural shorelines had potential for developing destructive and constructive waves.

Biodiversity

❖ Armored shoreline sites were higher in species richness, but natural sites were higher in species diversity.

Conclusions

- Unfortunately, **the data does not fully determine how armored shorelines impact erosion and biodiversity.**
- Experiment did provide more crucial information on how armored and natural shorelines affect the environment.

Methods

Experimental Protocol

Beach Profile Protocol:

- Established 24 m transect, every 3 m marked with flag
- Used Emery method to compare changes in pole heights with horizon line
- Measured 8 slopes across transect

Wave Energy Protocol:

- Used graduated PVC pipe (2cm increments) to measure wave properties
- Determined crest and trough for wave height
- Used stopwatch to measure time between subsequent wave crests for wave period
- Used stopwatch to measure number of wave crests per 10 seconds for wave frequency
- Used pole parallel to water surface to measure distance between two wave crests (wavelength)

Biodiversity Protocol:

- Randomly threw 1m^2 quadrat to establish sample site
- Set 10 minute timer to search for organisms
- Visual search for swimming, crawling, stationary organisms
- Sandy substrate was sifted for organisms
- Live seagrass was lightly agitated with a net to find hidden organisms
- Live seagrass was also identified and quantified

Experimental Design

- Independent Variables: Shoreline type (armored versus natural)
- Response Variables: Beach profile, wave energy measurements, biodiversity
- Armored N = 3 sites, Natural N = 6 sites (3 east of armored, 3 west of armored)
- Data collected in October and November 2025

Table 1: Number of replicates for each measure

Armored	Beach Profile	Wave Energy	Biodiversity
	N = 3	N = 15	N = 3
Natural	**Beach Profile**	**Wave Energy**	**Biodiversity**
	N = 6	N = 30	N = 6

Fig 4: Shannon Index formula

$$H' = -\sum_{i=1}^{S} pi \ln pi$$

https://theory.labster.com/diversity_index/

Data Analysis

Beach Profile

- Calculated elevation change using slope values
- Graphed absolute elevation at each point
- Compared 8 slope points across 24-m transects

Wave Energy

- Wave height = crest – trough
- Wave period = time between 2 crests
- Wave frequency = wave count per 10 s / 10s
- Wavelength = distance between two crests
- Calculated averages and ranges for each

Biodiversity

- Each unique species ID'd and individuals counted
- Counted seagrass plugs in ¼ quadrat, multiplied by 4
- Calculated species richness and evenness using Shannon Index (H) to compare diversity across shoreline types

Fig 5: Armored elevation changes across armored sites.

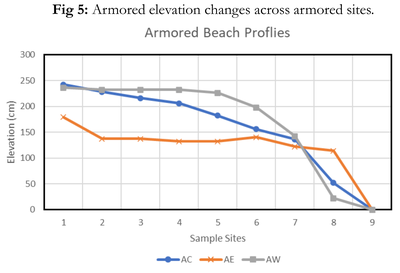
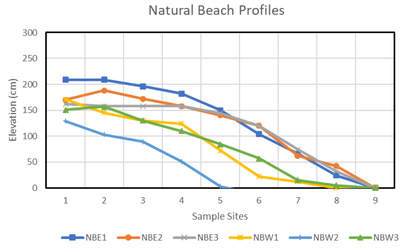


Fig 6: Natural elevation changes across natural sites.



Results

Table 2: Wave energy averages and ranges at armored sites.

	Wave Height	Wavelength	Wave Period	Wave Frequency
MIN	1	8	0.46	0.9
AVG	4.1	51.73	0.99	1.26
MAX	8	84	2.14	1.8

Table 3: Wave energy averages and ranges at natural sites.

	Wave Height	Wavelength	Wave Period	Wave Frequency
MIN	1	20	0.43	0.8
AVG	2.27	48.6	0.94	1.17
MAX	6	84	2.76	2.10

Fig 7: Species richness & evenness at armored sites.

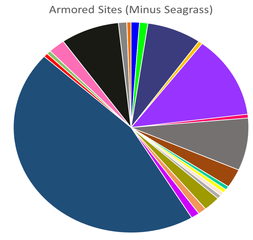
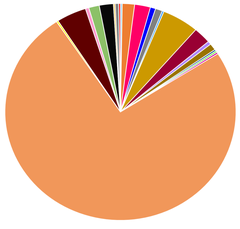


Fig 8: Species richness & evenness at natural sites.



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