Costs and Effectiveness of Living Shorelines

An Analysis of Five New Jersey Projects

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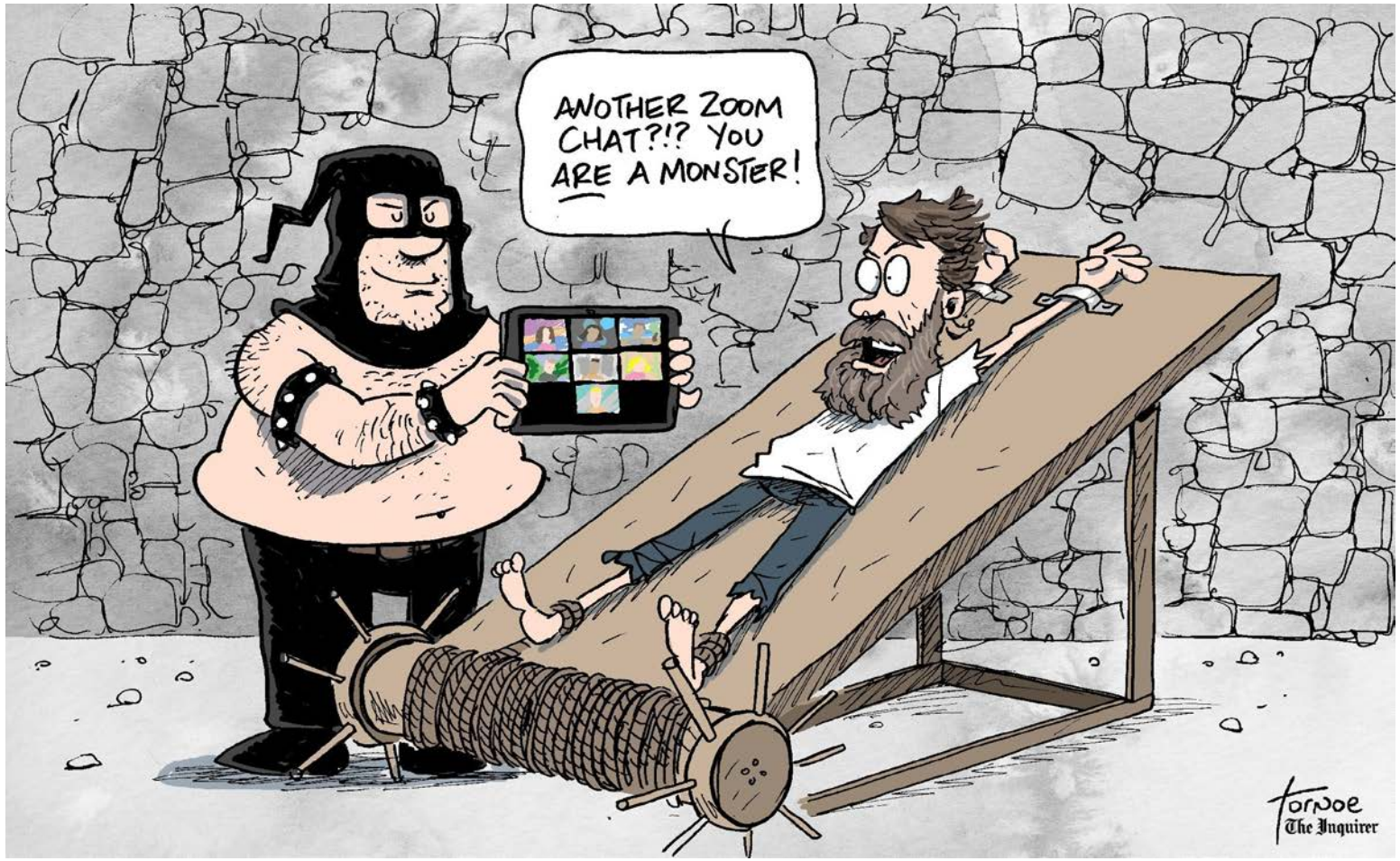
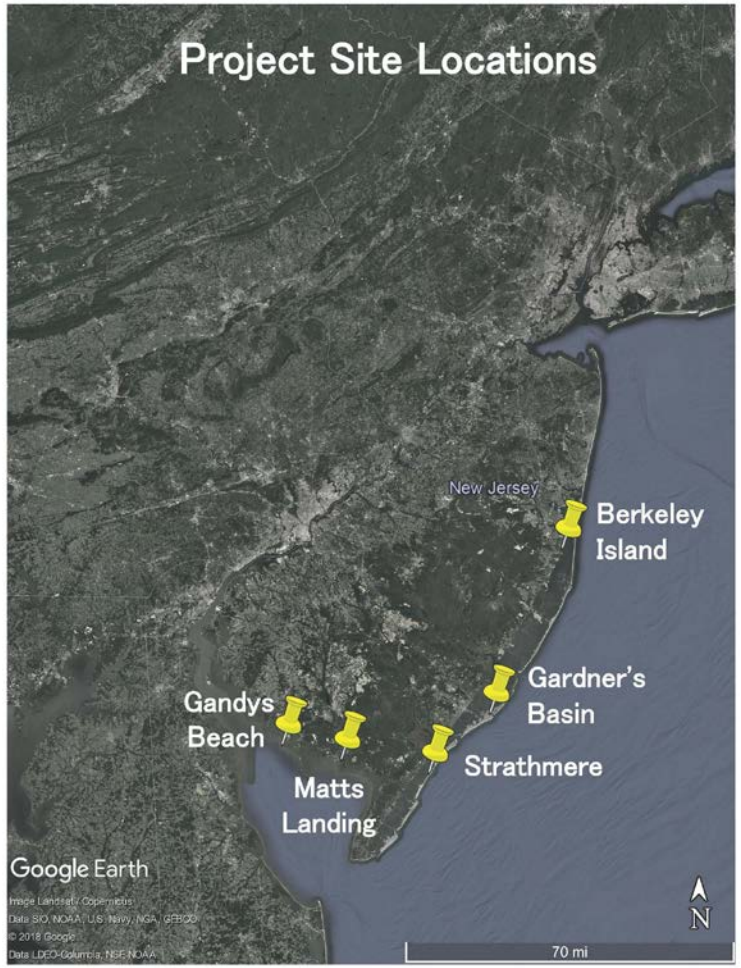
Outline

- Site/project overview
- Cost analysis discussion
  - Project cost analysis
  - Long-term cost analysis
- Effectiveness discussion
  - Shoreline stability
  - Wave attenuation
- Conclusions



Site and Project Overview

Berkeley Island



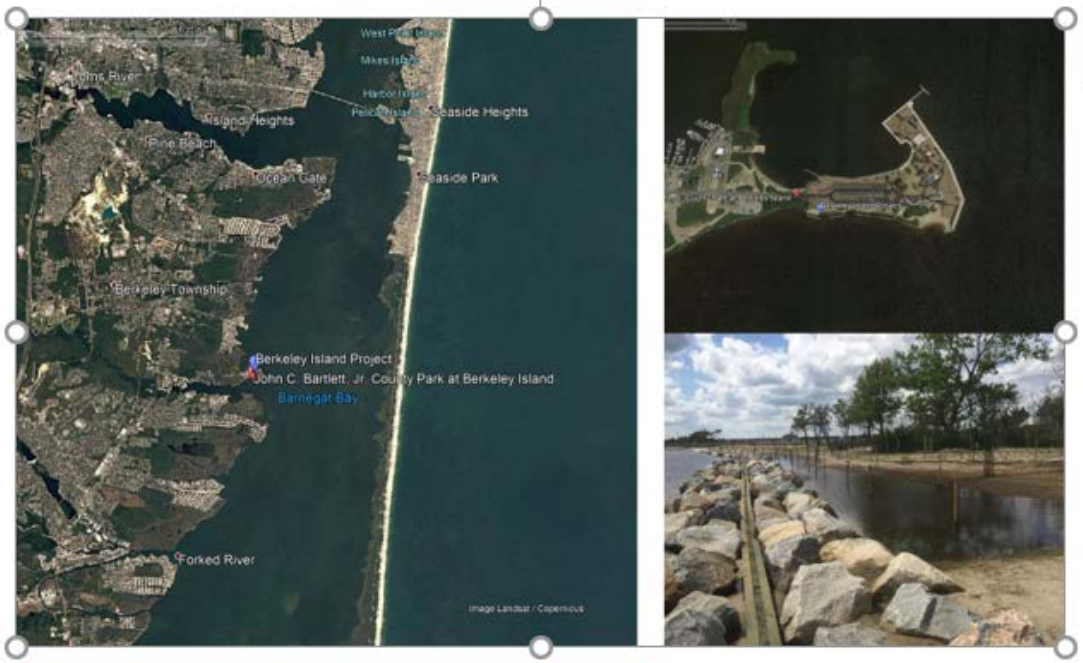
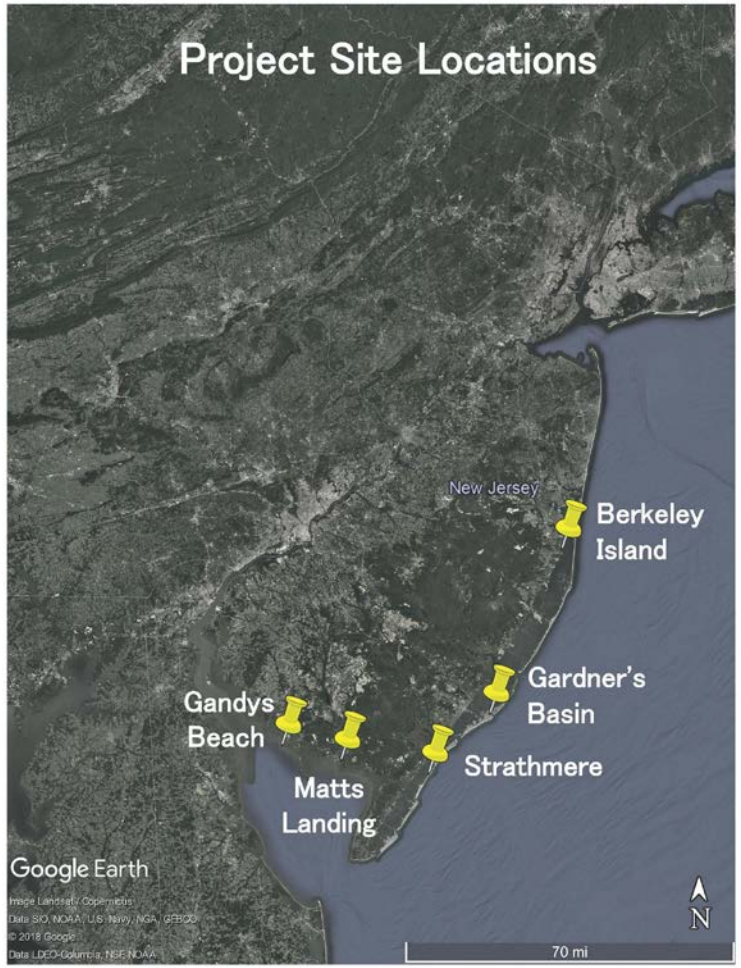


Figure 3: Site map and project photo of the Berkeley Island living shorelines site.

Figure 4: Google Earth Image (May 2019) showing Berkeley Island County Park, Berkeley Township, NJ. The red and blue lines on the left are the baseline for the "control" area of the shoreline stability analysis. The red and blue line, landward of the breakwater/sill structures is the baseline for the study site used in the shoreline stability analysis. Note: North is directed up in this image.

Gardner's Basin



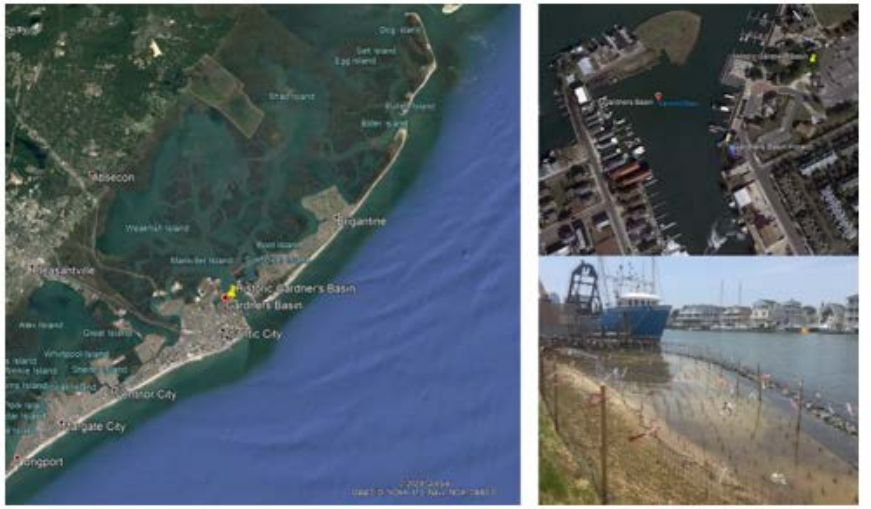


Figure 9: Site map and project photo of the Gardner's Basin living shorelines site.

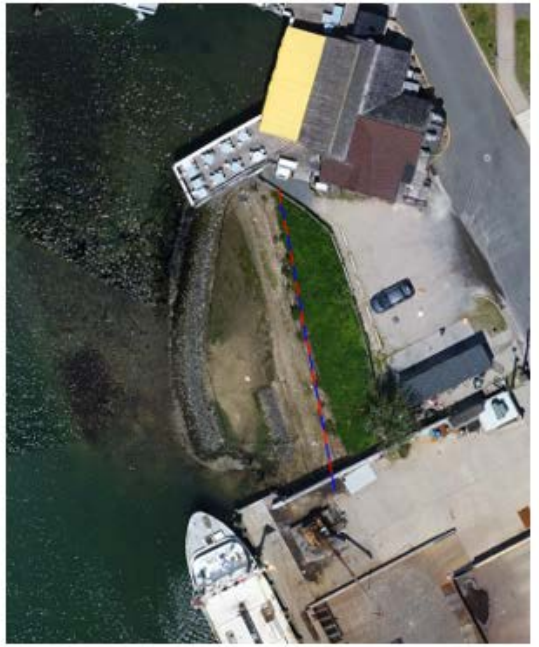


Figure 10: Orthomosaic from Imagery collected on May 7, 2020, showing Gardner's Basin, Atlantic City, NJ. The red and blue line located landward of the sill is the baseline for this project site that was used in the shoreline stability analysis. There is no suitable control area for this project site as the surrounding region is bulkheaded and developed. Note: North is directed up in this image.

Strathmere

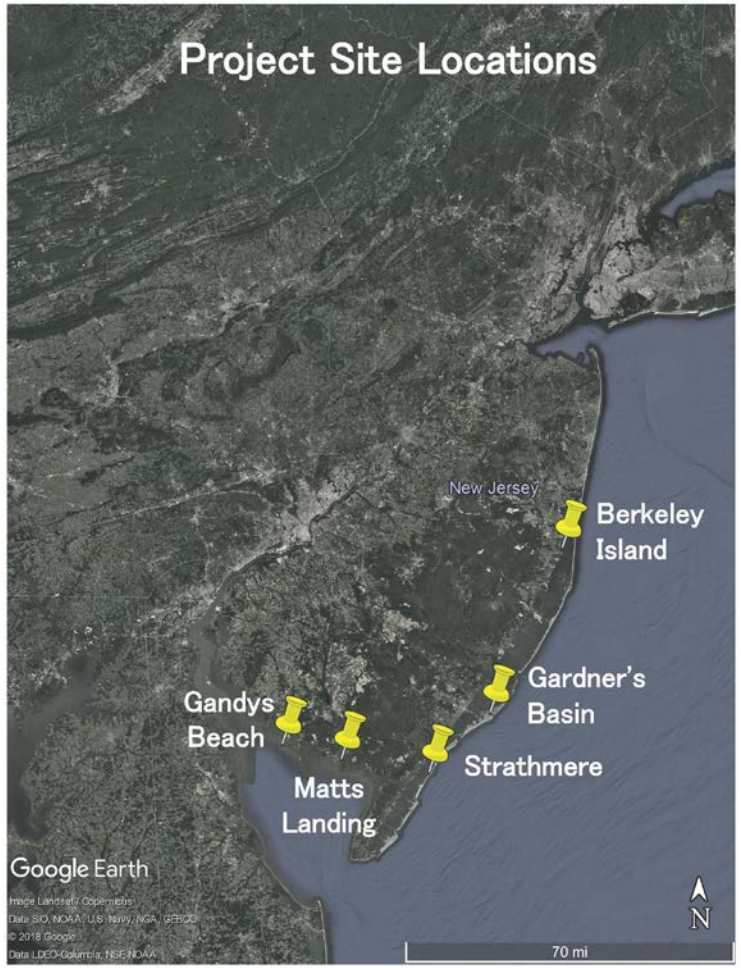


Figure 15: Site map and project photo of the Strathmere living shorelines site.

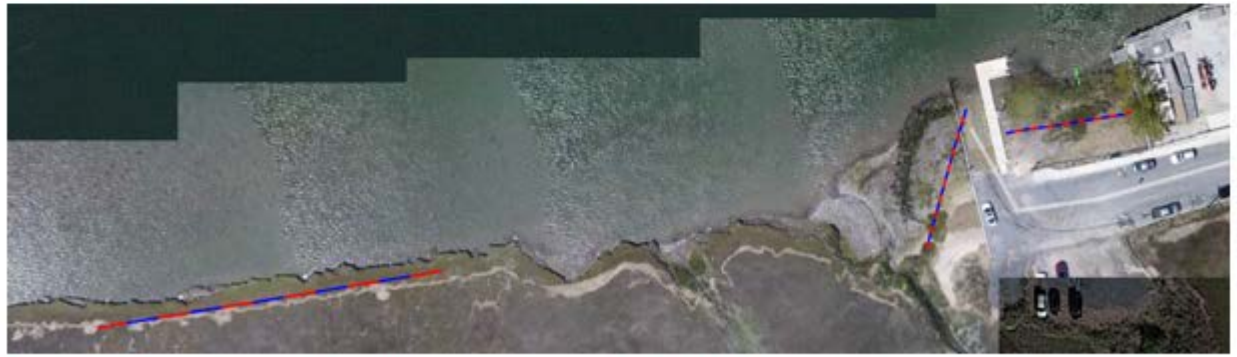


Figure 16: Orthomosaic created from UAV imagery collected on May 7, 2020, showing Strathmere, Upper Township, NJ. The red and blue lines to the left of the image is the baseline for the "control" area of the shoreline stability analysis. The two red and blue lines, landward of the sill and landward of the vegetated shoreline, to the right of the image are the baselines for the study site used in the shoreline stability analysis. Note: North is directed up in this image.

Gandys Beach

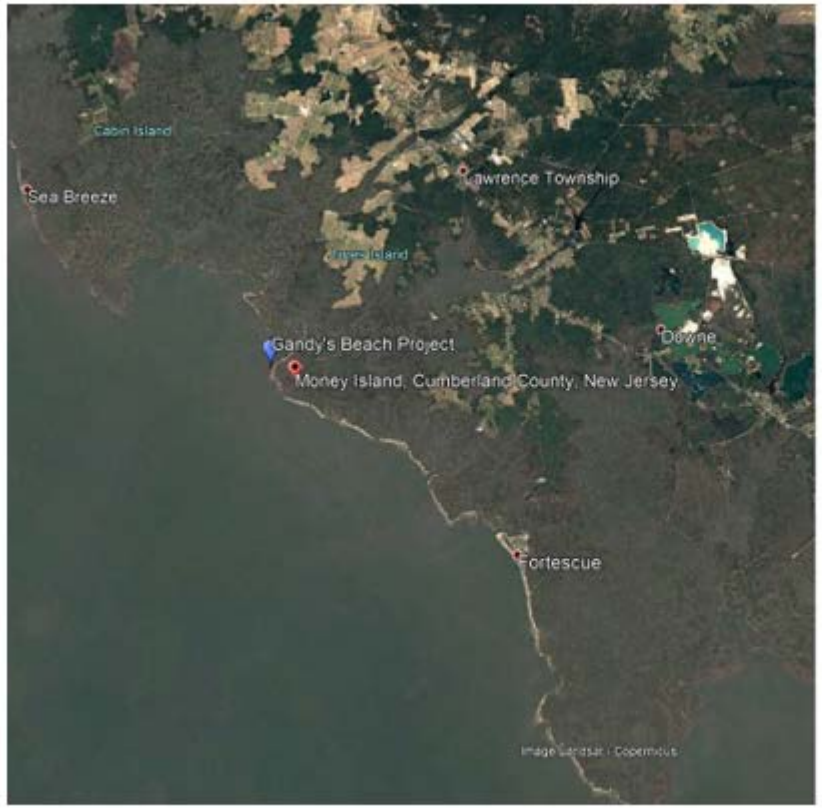


Figure 19: Site map and project photo of the Gandys Beach living shorelines project site.

Matts Landing

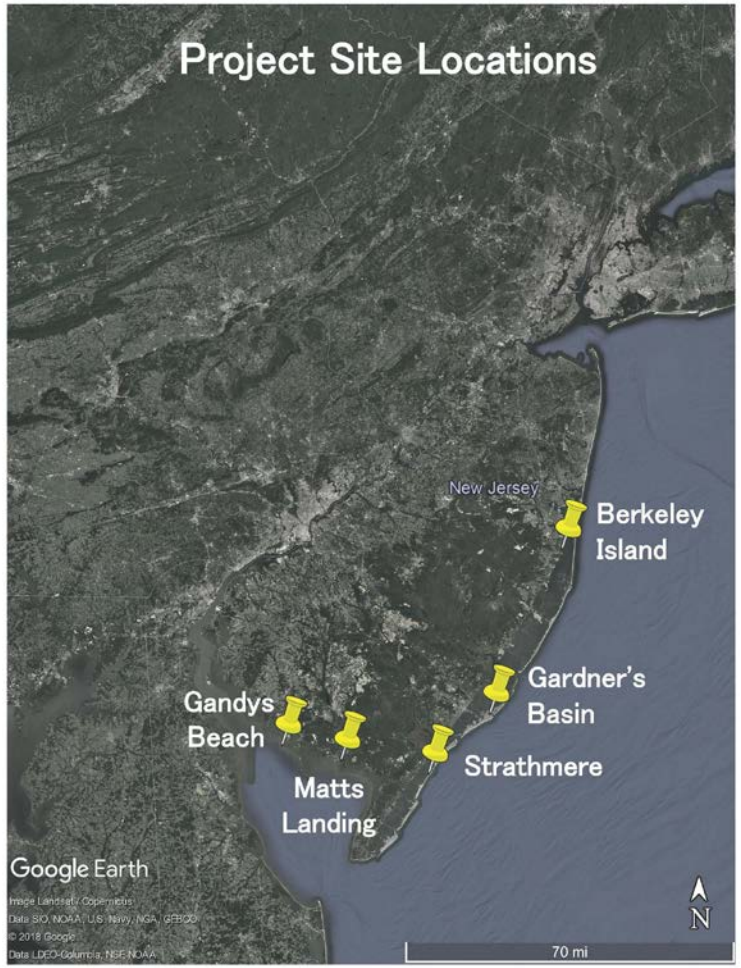


Figure 25: Site map and project photo of the Matts Landing site.

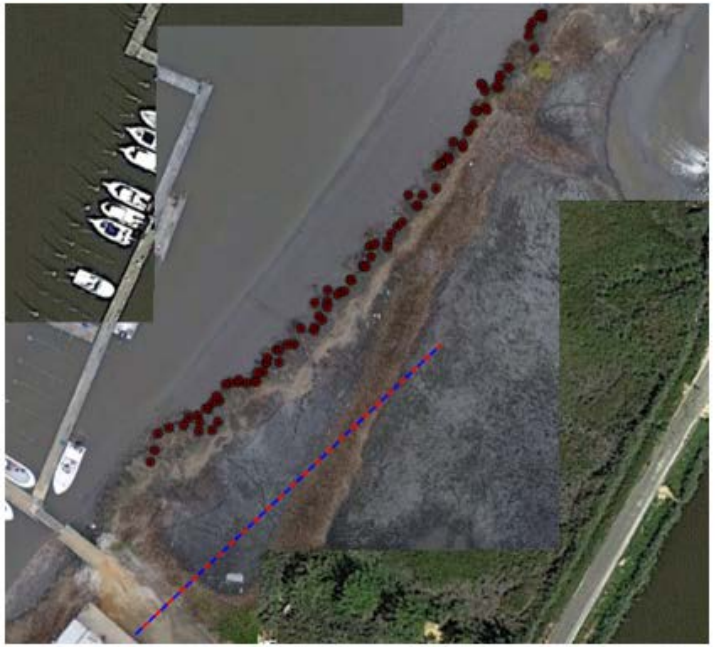


Figure 26: Orthomosaic created from UAV imagery collected on April 7, 2020, showing Matts Landing, Heislerville, NJ. The red and blue line is the baseline for both the "control" and project area of the shoreline stability analysis. The shoreline treatment is along the southern edge of this strip of shoreline, and the control is immediately to the North. Note: North is directed up in this image.

Cost Analysis

Cost Analysis

Project Cost Analysis

1. Data collected for “green” and nearby “gray” projects
2. Reflects information provided/available
3. Costs categorized & summarized – Mobilization, Materials, Labor, Design and Permitting, Maintenance, Adaptive Management, Monitoring

Long-term Cost Analysis

1. Utilized Hudson River Sustainable Shorelines Project methodology updated for New Jersey
2. Costs categorized - Initial Cost (IC), Maintenance and Repair Cost (MC), Damage Cost (DC), Replacement Cost (RC), and Monitoring and Adaptive Management.

Project Cost Analysis Summary

Costs varied widely – ranges more relevant than project specific costs

Living shorelines project costs ranged from $88/lf to $2,018/lf

Estimated Costs	Gandy's	Strathmere LS	Matts	Berkley/Iowa	Gardners
Project Length (ft)	**2,750**	**100**	**81**	**500**	**100**
Mobilization	$ 26,100	$ 1,760	Unknown	$ 66,690	$ 15,000
Materials	$ 95,040	Unknown	$ 3,656	$ 712,920	$ 75,000
Labor	$ 252,707	Unknown	Unknown	$ 51,028	$ 45,000
Material+Labor	$ 347,747	$ 38,967	$ 3,656	$ 763,948	$ 120,000
Total Construction	$ 373,847	$ 40,727	$ 3,656	$ 830,638	$ 135,000
Design and Permitting	$ 108,064	$ 1,716	Unknown	$ 56,721	$ 39,000
Maintenance	$ 8,000	Unknown	$ 1,200	Unkonown	Unknown
Adaptive Management	$ 74,516	Unknown	$ 2,290	$ 40,686	Unknown
Monitoring	$ 443,063	Unknown	Unknown	$ 81,200	Unknown
Total (inc monitor)	$ 1,007,489	$ 42,443	$ 7,146	$ 1,009,244	$ 174,000
Cost/LF (inc monitor)	$ 366	$ 424	$ 88	$ 2,018	$ 1,740
Total (exc monitor)	$ 564,427	$ 42,443	$ 7,146	$ 928,044	$ 174,000
Cost/LF (exc monitor)	$ 205	$ 424	$ 88	$ 1,856	$ 1,740
Cost (Const only)	$ 373,847	$ 40,727	$ 3,656	$ 830,638	$ 135,000
Cost/LF (Const only)	$ 136	$ 407	$ 45	$ 1,661	$ 1,350

Project Cost Analysis Summary

Costs varied widely – ranges more relevant than project specific costs

Living shorelines project costs ranged from $88/lf to $2,018/lf

Traditional gray infrastructure project costs ranged from $462/lf to $3,558/lf

Estimated Costs	Gandy's Wood	Gandy's Steel	Gandy's Comp	Strathmere BH	Gardners Gray
Project Length (ft)	**394**	**394**	**394**	**201**	**1,083**
Mobilization	Unknown	Unknown	Unknown	$ 5,225	Unknown
Materials	Unknown	Unknown	Unknown	Unkown	$ 2,973,512
Labor	$ 57,571	$ 57,571	$ 57,571	Unknown	$ 596,386
Material+Labor	$ 494,967	$ 532,699	$ 598,545	$ 82,611	$ 3,797,991
Total Construction	$ 552,538	$ 590,270	$ 656,116	$ 87,836	$ 3,797,991
Design and Permitting	Unknown	Unknown	Unknown	$ 5,094	$ 30,775
Maintenance	Unknown	Unknown	Unknown	Unknown	Unknown
Adaptive Management	Unknown	Unknown	Unknown	Unknown	Unknown
Monitoring	Unknown	Unknown	Unknown	Unknown	$ 24,615
Total (inc monitor)	$ 552,538	$ 590,270	$ 656,116	$ 92,930	$ 3,853,381
Cost/LF (inc monitor)	$ 1,402	$ 1,498	$ 1,665	$ 462	$ 3,558
Total (exc monitor)	$ 552,538	$ 590,270	$ 656,116	$ 92,930	$ 3,828,766
Cost/LF (exc monitor)	$ 1,402	$ 1,498	$ 1,665	$ 462	$ 3,535
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Cost/LF (Const only)	$ 1,402	$ 1,498	$ 1,665	$ 437	$ 3,507

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Traditional gray infrastructure project costs ranged from $462/lf to $3,558/lf

Design and permitting, maintenance and adaptive management, and monitoring costs were higher for living shorelines projects

Percentage of Total Cost - Green					
	Gandy's	Strathmere LS	Matts	Berkley/Iowa	Gardners
Mobilization	2.59%	4.15%	NA	6.61%	8.62%
Materials	9.43%	NA	51.16%	70.64%	43.10%
Labor	25.08%	NA	NA	5.06%	25.86%
Material+Labor	34.52%	91.81%	51.16%	75.70%	68.97%
Total Construction	37.11%	95.96%	51.16%	82.30%	77.59%
Design and Permitting	10.73%	4.04%	NA	5.62%	22.41%
Maintenance	0.79%	NA	16.79%	NA	NA
Adaptive Management	7.40%	NA	32.04%	4.03%	NA
Monitoring	43.98%	NA	NA	8.05%	NA
Total (incl monitor)	**100.00%**	**100.00%**	**100.0%**	**100.0%**	**100.00%**

Percentage of Construction Cost - Green					
	Gandy's	Strathmere LS	Matts	Berkley/Iowa	Gardners
Mobilization	6.98%	4.32%	NA	8.03%	11.11%
Materials	25.42%	NA	100.00%	85.83%	55.56%
Labor	67.60%	NA	NA	6.14%	33.33%
Material+Labor	93.02%	95.68%	100.00%	91.97%	88.89%
Total Construction	100.00%	100.00%	100.00%	100.00%	100.00%
Design and Permitting	28.91%	4.21%	NA	6.83%	28.89%
Maintenance	2.14%	NA	32.82%	NA	NA
Adaptive Management	19.93%	NA	62.63%	4.90%	NA
Monitoring	118.51%	NA	NA	9.78%	NA
Total (incl monitor)	**269.49%**	**104.21%**	**195.45%**	**121.50%**	**128.89%**

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Size and complexity linked to cost

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Long-term Cost Analysis Example

Long-term Cost Estimate - Strathmere Living Shoreline										
			P1 (2020-2040)		P2 (2040-2060)		P3 (2060-2080)		Total (2020-2080)	
Category	Storm T_r	% IC	# Events	*Cost	# Events	*Cost	# Events	*Cost	Ext Cost	% Final
Initial Cost (IC)	NA	NA	NA	NA	NA	NA	NA	NA	$ 40,727	16.3%
Damage Cost (DC)	50	0%	0.62	$ -	1.83	$ -	5.45	$ -	$ -	0.0%
Damage Cost (DC)	40	0%	0.77	$ -	2.28	$ -	6.80	$ -	$ -	0.0%
Damage Cost (DC)	25	10%	1.22	$ 5,049	3.64	$ 15,472	10.81	$ 47,361	$ 67,882	27.1%
Damage Cost (DC)	10	5%	2.98	$ 6,159	6.45	$ 13,725	26.32	$ 57,643	$ 77,527	31.0%
Damage Cost Ice	NA	25.0%	2.00	$ 20,663	1.00	$ 10,637	0.00	$ -	$ 31,300	12.5%
Replacement Cost (RC)	NA	0.0%	0.00	$ -	0.00	$ -	0.00	$ -	$ -	0.0%
Maintenance Costs (MC)	NA	10.0%	1.00	$ 4,133	1.00	$ 4,255	1.00	$ 4,381	$ 12,768	5.1%
Mon & Adapt Man (MA)	NA	0.0%	0.00	$ -	0.00	$ -	0.00	$ -	$ -	0.0%
		HRSSP					Post-Construction Costs (DCs+RC+MC+MA)		$ 207,699	83.0%
		Assumed					Design and Permiting Costs		$ 1,716	0.7%
								Total Cost	$ 250,142	100.0%

	Total (2020-2080)	
	Ext Cost	% Final
	$ 87,836	22.8%
39	$ 73,777	19.2%
	$ -	0.0%
71	$ 73,201	19.0%
	$ -	0.0%
	$ -	0.0%
	$ 91,765	23.9%
24	$ 13,769	3.6%
	$ -	0.0%
A)	$ 291,810	75.8%
ts	$ 5,091	1.3%
ost	$ 384,737	100.0%

Long-term Cost Analysis Summary

Costs of the living shorelines projects are more evenly distributed through time – DC, MC, AM, etc

Costs for the traditional shoreline stabilization approaches are more concentrated – IC, RC

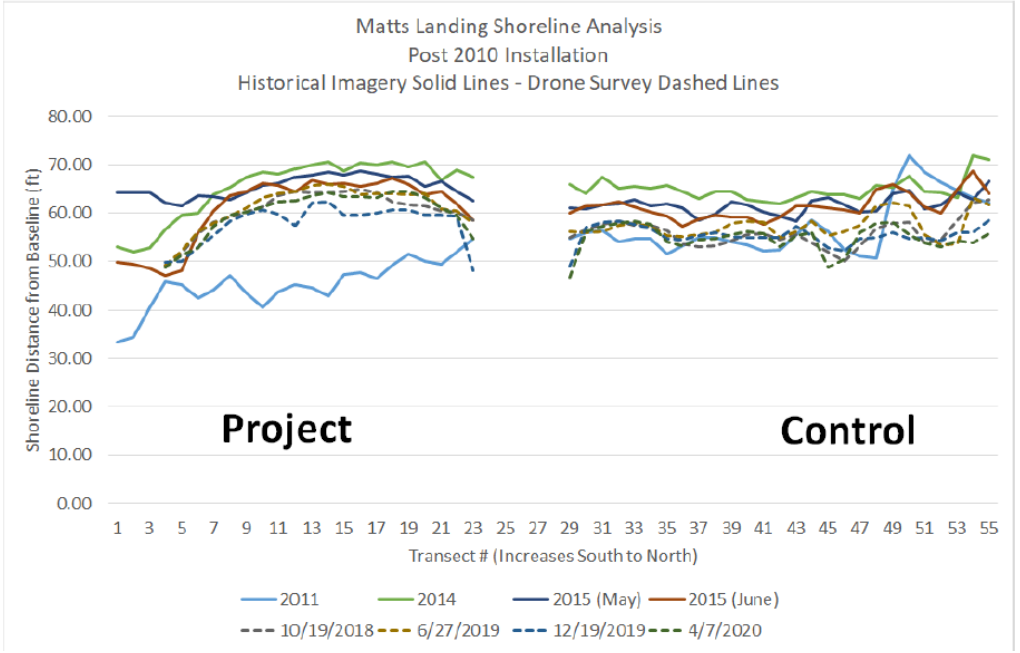
Project	Estimated 60-yr Cost	Post-Construction Cost Percentage
Living Shorelines Projects		
Berkeley Island	$ 3,251,497.67	86%
Gardners Basin	$ 466,569.10	63%
Strathmere	$ 250,142.02	83%
Gandys Beach	$ 1,841,382.33	74%
Matts Landing	$ 26,114.82	86%
Traditional Projects		
Garners -Bulkhead	$ 11,828,835.51	68%
Strathmere - Bulkhead	$ 384,737.34	76%
Gandys - Wood	$ 2,648,028.63	79%
Gandys - Steel	$ 2,551,275.63	77%
Gandys - Composite	$ 2,856,170.06	77%

Effectiveness

Effectiveness

Shoreline Stability

1. Employed a “BACI” design where possible
2. Utilized a combination of historic Google Earth & UAS aerial imagery



Wave Attenuation

1. Wave data collected in front of and behind wave attenuating structures
2. Deployments ranged from several days to several weeks

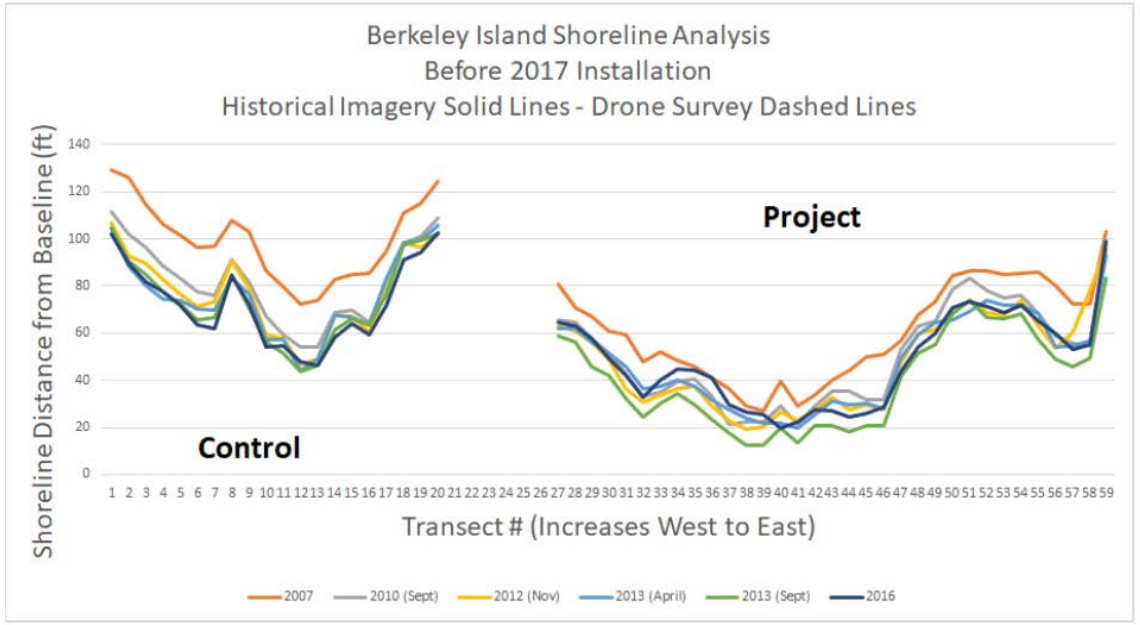
Summary of Shoreline Stability Analysis

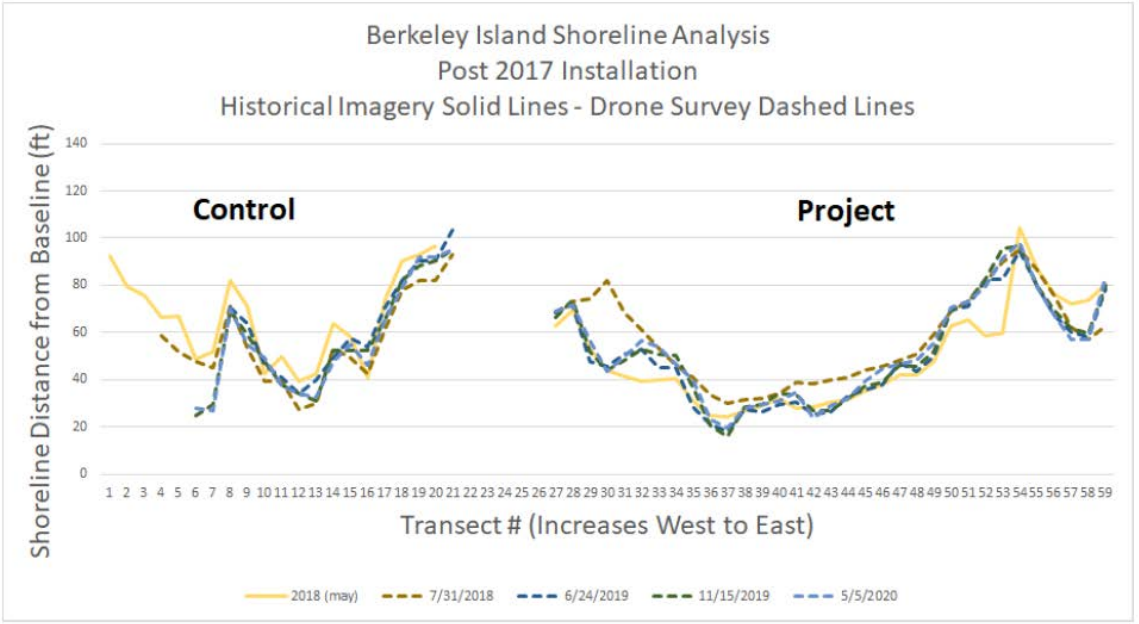
3 of 5 projects were clearly effective in stabilizing the shoreline

Other projects unclear due to low quality imagery

2 sites have experienced shoreline advancement

Study Area	Shoreline Identifier	Annual Rate of Shoreline Change (ft/yr)			
		Living Shoreline		Control Site	
		Before Install	After Install	Before Install	After Install
Berkeley Island	wet/dry (2nd veg)	-1.7	0.0	-3.1	-5.8
Gardner's Basin	vegetation	-0.7	-0.9	n/a	n/a
Strathmere "Beach"	wet/dry line	-0.4	-0.3	-0.6	-0.3
Gandys Beach	vegetation	-1.5	0.5	-3.5	-9.7
Matts Landing	vegetation	1.4	1.1	0.8	-0.6



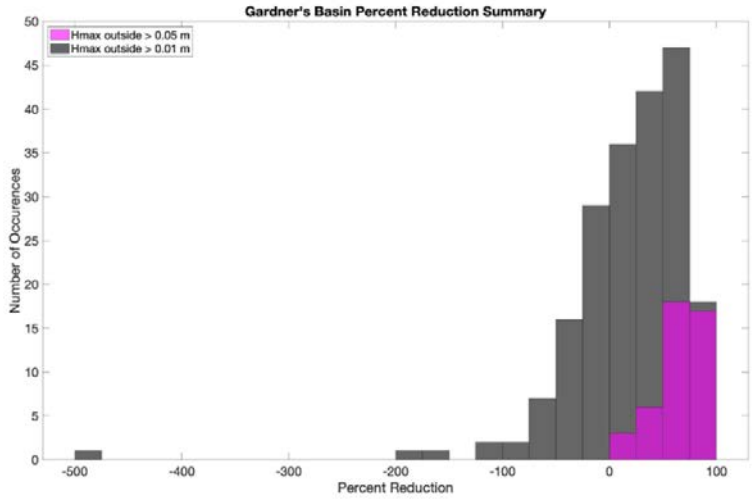


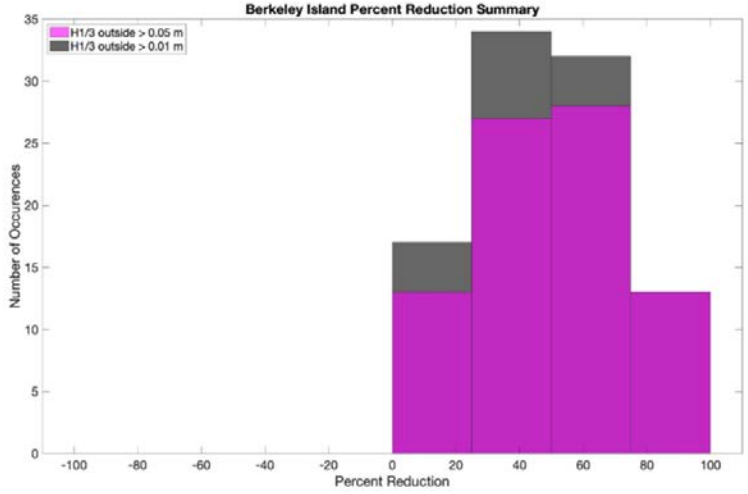
Summary of Wave Attenuation Analysis

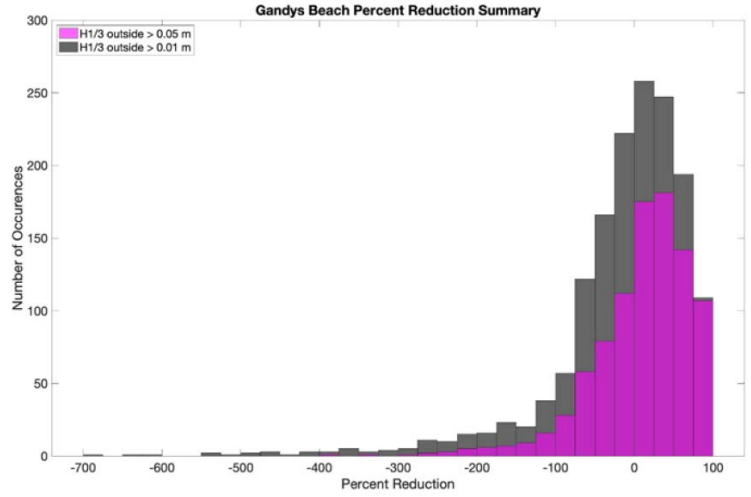
All 3 projects successfully attenuated waves larger than 5 cm

Attenuation of between 20% & 80% most common

	Avg % Reduction (H > 1 cm) (%)	Avg % Reduction (H > 5 cm) (%)
Gardner's Basin	20.7	65.9
Gandys Beach	-15.8	5.2
Berkeley Island	48.8	52.1

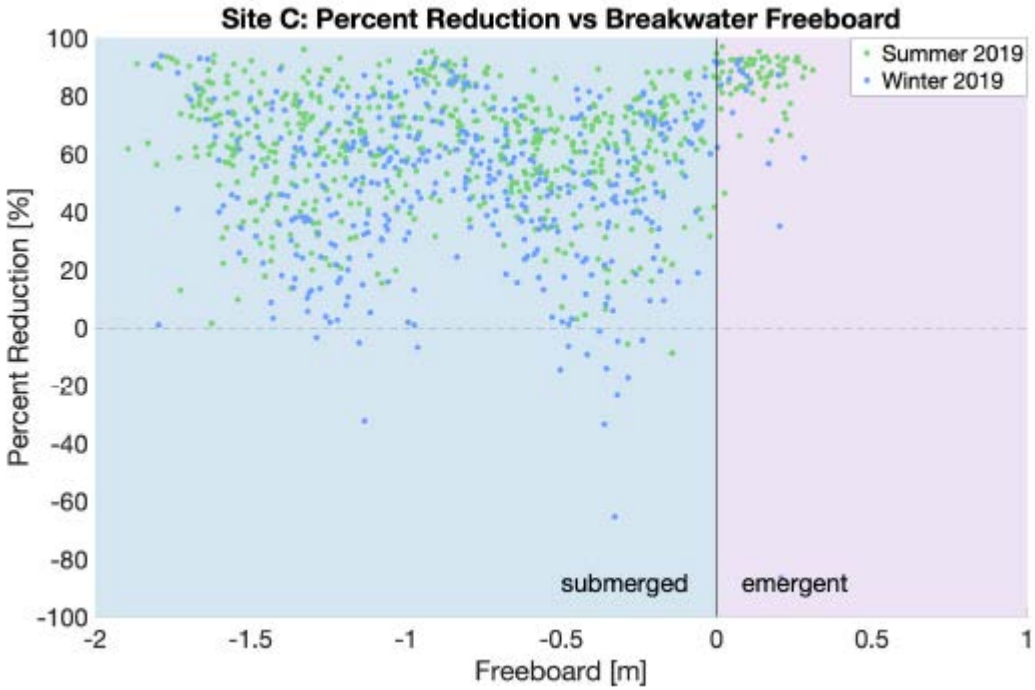


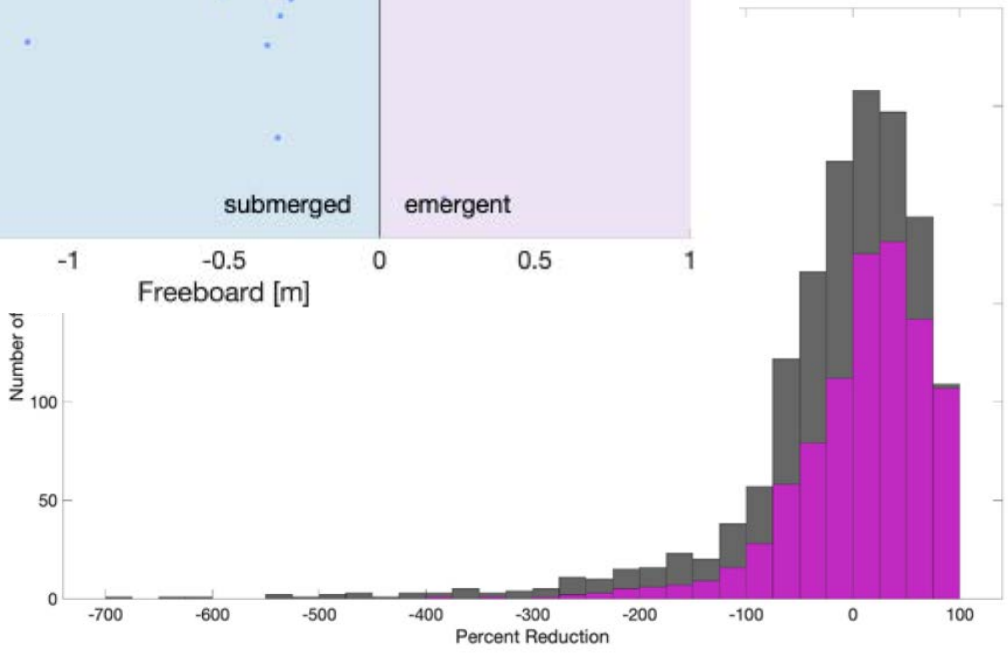




Something to look into further…

At Gandys Beach some of the waves measured behind the structures were larger than the waves measured in front of the structures





Conclusions

Conclusions

1. Costs for traditional shoreline stabilization were higher (88$/lf to $2,018/lf vs $462/lf to $3,558/lf)
2. Costs for both traditional and living shorelines projects increased with complexity
3. For the projects considered, design & permitting, maintenance and adaptive management, and monitoring costs were higher for living shorelines projects
4. Living shorelines project costs are more evenly distributed over time; whereas traditional projects are dominated by discrete events – different cost model
5. Each of the living shorelines sites with clear data was able to successfully stabilize the project shoreline
6. All of the sill projects successfully attenuated waves > 5 cm*

*further analysis needed for the most complex sites

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