

#### 5<sup>TH</sup> ANNUAL CAPE COASTAL CONFERENCE

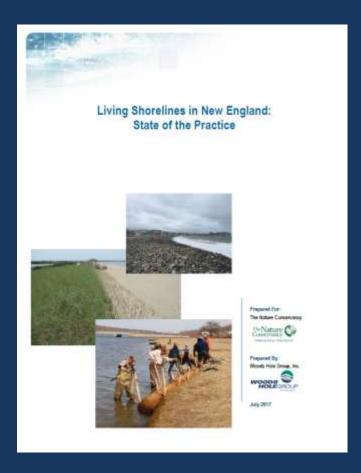
Can We Protect New England Coasts with Living Shorelines?

Part II: Profile Pages, Applicability Index & Case Studies

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## Living Shorelines in New England State of the Practice Report





### Outline

- Profile pages
- Applicability index
- Local living shoreline case studies





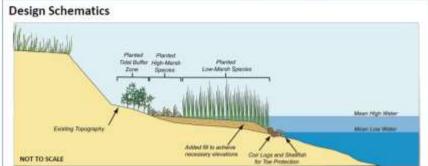
Profile Page Living Shoreline Categories	Specific Terminology Used in Other Sources				
1. Dune Restoration (Natural)	Dune nourishment				
	Dune restoration				
2. Dune Restoration (Engineered	Artificial dunes				
Core)	Dune nourishment				
	Cobble berm				
3. Beach Nourishment	Beach nourishment				
	Cobble berm				
4. Coastal Bank Protection (Natural)	Coir rolls with vegetation				
	Natural fiber blankets				
	Regrading				
	Natural fiber logs (or bio-logs)				
5. Coastal Bank Protection	Regrading w/sand tubes				
(Engineered Core)	Bank stabilization with coir envelopes				
6. Natural Marsh	Enhancement of marsh				
Creation/Enhancement	Creation of coastal wetlands				
	Fringe marsh creation				
7. Marsh Creation/Enhancement	Fringe marsh constructed with oyster or mussel				
(w/Toe Protection)	shells				
	Fringe marsh constructed with bio-logs				
	Marsh sill or reef balls with planted marsh				
8. Living Breakwaters	Oyster or mussel reef				
	Reef balls				



#### Marsh Creation/Enhancement w/Toe Protection

Marsh vegetation that is planted along the shoreline often benefits from toe protection to assist with marsh stabilization. Toe protection materials may include natural fiber rolls, shell bags or, in some cases, stone. The toe protection may also allow the design to achieve the appropriate grade in lieu of seaward fill, thereby decreasing the project footprint.

Objectives: dissipates wave energy, habitat creation, shoreline stabilization



Case Study	Project Proponent	City of Portsmouth, Stantec (wetlands consultant), UNH (assisted plan development)
North Mill Pond, Portsmouth, NH this project involved restoration of low and high marsh along	Status	Construction complete May 2016. Seginning year two of monitoring in 2017.
North Mill Poind, with about half of the area consisting of new marsh creation, and the other half of the area consisting of restoration of degraded low and high marsh through sediment addition (thin layer deposition).	Permitting Insights	NHOES and USACOE permits needed for drainage outfall into pand. Project impacted 600 of of coertal wetland. Salt marsh restoration was compensatory mitigation.
	Construction Notes	Imported fill to raise 12,060 of to suitable elevation for salt march (low march), planted 3,055 of thigh march area. Created micro-topography and interior drainage channels. 12-in diameter coir logs staked at seaward edge of march to stabilize tos. Placed large boulders to break-up winter ice sheets.
	Maintenance Issues	Long term monitoring and maintenance efforts are scheduled. Survival of low marsh plants is good; survival of high marsh salt hay is fair to poor. Survival 2016-2017 winter well.
The second second	Final Cost	\$60,000 (construction, monitoring & maintenance)
North Mill Pond March Sestoration, Portsmouth, NH Photo courtesy of Gavid Bundick (UAN)	Challenges	Construction did not have a provision for within plot drainage; many plants were washed out by runoff gullies in the first year. More time needs for filled sediment to settle before planting.

Design Overview									
Materials	Native marsh plants appropriate for salinity and site conditions. Plugs of marsh grass can be planted to augment bare areas. <sup>12</sup> Sediment may be necessary if area needs to be filled to obtain appropriate elevations. Toe protection materials may include natural fiber rolls, oyster/mussel shells bags, or in some cases, stane. Filter cloth placed prior to added fill and/or sill materials. <sup>18</sup> Bird exclusion fence to avoid predation while plants develop. <sup>18</sup>								
Habitat Components	Salt marsh; Tidal buffer landward of the salt marsh; Coastal beach; Mud flat.								
Durability and Maintenance	Plants that are removed or die during the early stages of growth must be replaced immediately to ensure the undisturbed growth of the remaining plants. The removal of debris and selective pruning of trees is also a good maintenance practice to ensure that sunlight reaches plants. After significant growth has occurred only periodic inspections may be necessary. Protection measures, such as fencing, can keep water-fowl from eating the young plants. Toe protection materials should also be replaced or re-installed if they are moved by a storm.* Coir logs must be securely anchored to prevent wave and tidal current-induced movement. Tongoing maintenance of invasive species and runoff issues will be important to the long-term success of the project.								
Design Life	It is important to recognize that design life may be shorter in the future given changes in sedimentation rates, accelerating sea-level rise and other climate change impacts.								
Ecological Services Provided	Increases water infiltration, uptake of nutrients, filtration, denitrification and sediment retention. <sup>2,3</sup> The extensive root systems of marsh vegetation help to retain the existing soil, thus reducing erosion while plant stems attenuate wave energy. <sup>2,4</sup> Marshes provide habitat for many species of plants and animals, and maintain the squatic/terrestrial interface. <sup>2,5</sup> Silf mitigates erosive waves and stabilizes shoreline. <sup>2,6</sup> Marine animals can access the marsh through gaps in the xill. <sup>2,4</sup> Marshes also provide better water quality, recreation and education opportunities, and carbon sequestration (blue carbon). <sup>2,4</sup>								
Unique Adaptations to NE Challenges (e.g. ice, winter storms, cold temps)	including roughened surfaces, such as logs, stones or emergent vegetation can break up ice sheets. 4.10 Fringing marsh projects will respond better to ice if designed with gentler slopes (6:1-10:1) and by incorporating shrubs. 8.15 Planting in the spring will allow vegetation to become established before it has to withstand ice. 8 Hardy, salt-tolerant shrubs are well-suited shorelines that are affected by ice. 15 Need to consider where in the tidal range oysters will be placed if they're used: too high may result in freezing.								



#### Marsh Creation/Enhancement w/Toe Protection

A toe protection structure holds the toe of an existing, enhanced or created marsh platform in place, and provides additional protection against shoreline erosion. A gapped approach to the toe protection structure allows habitat connectivity, and greater tidal exchange. Toe protection is particularly important where there is higher wave activity or threat of boat wakes.



	Regulatory and Review Agencies
Maine	Municipal Shoreland Zoning, Municipal Floodplain, ME Dept. of Environmental Protection, ME Land Use Planning Commission, ME Coastal Program, ME Department of Marine Resources, ME Department of Inland Fisheries and Wildlife, ME Geological Survey, and ME Submerged Lands Program.
New Hampshire	Local Conservation Commission, NH Natural Heritage Bureau, NH Department of Environmental Services (Wetlands Bureau, Shoreland Program, and Coastal Program), and NH Fish & Game Department.
Massachusetts	Local Conservation Commission, MA Dept. of Environmental Protection (Waterways and Water Quality), MA Division of Fisheries and Wildlife (Natural Heritage and Endangered Species Program), MA Environmental Policy Act, and MA Office of Coastal Zone Management.
Rhode Island	Coastal Resources Management Program, and Ri Dept. of Environmental Management.
Connecticut	Local Planning and Zoning Commission, and CT Department of Energy and Environmental Protection.
Federal (for all states)	U.S. Army Corps of Engineers, National Marine Fisheries Service, U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service.

Selection Characteristics	Detail
Energy State	Moderate. A sill may be necessary in medium energy sites (2-5 foot waves, moderate currents and sterm surge). **
Existing Environmental Resources	Coastal beach; mud flat; salt marsh
Searby Sensitive Resources	Endangered and threatened species. If the project is proposed in or adjacent to habitat for protected wildlife species or horseshoe crab spawning areas, there may be limitations on the time of year for construction. Shellfish beds and essential fish habitats will restrict where a marsh can be extended. Construction may produce short term habitat impacts, but in the long term, the marsh area should provide enhanced wildlife and fisheries habitat.
TR Tidal Range	Low to moderate. Sills are more suited to sites with a small to moderate tidal range, and are intended to be low-crested structures with a freeboard of between 0 and 1 ft above MHW.74138 However, shellfish sills should have a crest height at or near MLW since oysters and mussels can only remain out of the water for between 2 and 6 hours depending on the weather conditions.
EL Elevation	MLW to MHW, Above MHW. For low marsh, the lowest grade should be MTL and extend up to MHW. High marsh plantings should extend between MHW and MHHW. <sup>8</sup> Tidal buffer should be planted above highest observable tide.
S Intertidal Slope	Moderate. With slopes between 5:1 and 3:1 (base:height), sills should be added to the toe of the marsh. <sup>2</sup>
BS Bathymetric Slope	Flat to moderate
ER Erosion	Low to moderate
Other Characteristics	Detail
Boat Traffic	If boat wakes are expected to be the dominant force the sill should be designed accordingly. <sup>7</sup>
Ice Sensitivity	Gentle slopes and intermixed shrubs will handle ice the best. <sup>8</sup> Plant in the spring to allow plant to become established well before ice becomes a concern. <sup>8</sup>
Climate Vulnerability	If implemented carefully, this design can allow for inland migration. Planting higher, outside of the normal elevation range for the marsh grasses, may be useful in anticipation of sea level rise. It is important to recognize the uncertainty in future elevations. The effectiveness of a sill will be reduced over time as sea level rise gradually reduces the freeboard of the structure.7
Surrounding Land Use	Existing structures on site, like seawalls, may force living shoreline projects to have a steeper slope than desirable. Seawalls will limit the inland migration potential of the salt marsh in the future. Steeper slopes leave little opportunity for wave energy dissipation. <sup>18</sup> Marshes require sunlight to thrive; trees must be pruned or removed to allow for at least four to six hours of sunlight a day. <sup>8</sup> this will increase vogetation growth. <sup>18</sup> Although it is possible to create a marsh on most shorelines, marsh creation is not recommended for sites where they are not a natural feature along comparable natural shorelines. <sup>19</sup>



7 additional profile pages are also included in the report, on the TNC website, and at WHG table.

















## Profile Pages Summary

- Improve understanding of LS designs
- Facilitate communication among the public, regulators, practitioners and researchers



- Layout printable page for field or office
- Should <u>NOT</u> take the place of comprehensive site evaluation and design process



### Applicability Index – Interactive Tool

- Excel based tool designed to identify sitespecific living shoreline types
- User supplies site details

Results: Stoplight approach



Red: Unlikely

Yellow: Possible

Green: Likely



## Unpopulated Applicability Index

Site Specific Characteristics									
		Existing	Nearby						
		Environmenta	Sensitive			Intertidal	Bathymetric		
Site Name	Energy State	l Resource	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	
<insert name="" site=""></insert>									
Living Shorelines Applicability Matrix									
		Existing	Nearby						Living Shoreline
		Environmenta	Sensitive			Intertidal	Bathymetric		Type is Applicable
Living Shoreline Type	Energy State	l Resources	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	to Site?
Dune - Natural	0	0	0	0	0	0	0	0	Unlikely
Dune - Engineered Core	0	0	0	0	0	0	0	0	Unlikely
Beach Nourishment	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Coastal Bank - Natural	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Coastal Bank - Engineered Core	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Natural Marsh Creation/Enhancement	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Marsh Creation/Enhancement w/Toe Protection	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Living Breakwater	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

 When all site characteristics are filled in, applicability results will auto-populate



Site Specific Characteristics									
		Existing Environmental	Nearby Sensitive			Intertidal	Bathymetric		
Site Name	<b>Energy State</b>	Resource	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	
My Favorite Beach									
Living Shorelines Applicability Matrix									
		Existing	Nearby						Living Shoreline
		Environmental	Sensitive			Intertidal	Bathymetric		Type is Applicable
Living Shoreline Type	<b>Energy State</b>	Resources	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	to Site?
Dune - Natural	0	0	0	0	0	0	0	0	Unlikely
Dune - Engineered Core	0	0	0	0	0	0	0	0	Unlikely
Beach Nourishment	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Coastal Bank - Natural	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Coastal Bank - Engineered Core	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Natural Marsh Creation/Enhancement	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Marsh Creation/Enhancement w/Toe Protection	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Living Breakwater	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

- Enter site name
  - This is useful if you have more than one site (or sub-site) of interest



Site Specific Characteristics										
			Existing	Nearby						
			Environmental	Sensitive			Intertidal	Bathymetric		
Site Name	Energy	State	Resource	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	
My Favorite Beach	Moderat	Э	₹							
			Ī							
Living Shorelines Applicability Matrix										
			Existing	Nearby						Living Shoreline
			Environmental	Sensitive			Intertidal	Bathymetric		Type is Applicable
Living Shoreline Type	Energy	tate	Resources	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	to Site?
Dune - Natural	0	1	0	0	0	0	0	0	0	Unlikely
Dune - Engineered Core	0	\	0	0	0	0	0	0	0	Unlikely
Beach Nourishment	4.25	,	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Coastal Bank - Natural	4		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Coastal Bank - Engineered Core	3.5		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Natural Marsh Creation/Enhancement	2.5		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Marsh Creation/Enhancement w/Toe Protection	4.25	5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Living Breakwater	#N/	<b>4</b>	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

- Start populating site specific characteristics
- Scores auto-populate



	Existing	Nearby						
	Environmental	Sensitive			Intertidal	Bathymetric		
Energy State	Resource	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	
Moderate	<b>⊽</b>							
1	Existing	Nearby						Living Shoreline
	Evironmental	Sensitive			Intertidal	Bathymetric		Type is Applicable
Energy State	esources	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	to Site?
0	0	0	0	0	0	0	0	Unlikely
0	0	0	0	0	0	0	0	Unlikely
4.25	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	#N/	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3.5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2.5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4.25	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Energy State 0 0 4.25 4 3.5 2.5 4.25	Environmental Resource  Moderate  Existing Environmental Resources  Existing Environmental Resources  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Energy State  Moderate  Existing Environmental Energy State  Existing Environmental Resources  Nearby Sensitive Resources  0 0 0 0 0 0 0 0 0 0 4.25 #N/A #N/A 4 #N/A 3.5 #N/A #N/A 2.5 #N/A #N/A 4.25 #N/A #N/A #N/A	Energy State Resource Resources Tidal Range    Moderate     Existing Energy State     Existing E	Energy State Resource Resources Tidal Range Elevation    Moderate     Existing Energy State   Existing Energy State   Esources   Esources   Esources   Elevation	Energy State Resource Resources Tidal Range Elevation Slope    Moderate   Five Process   Five P	Energy State Resource Resources Tidal Range Elevation  Intertidal Slope Slope Slope  Moderate  Existing Energy State Energy State Energy State Energy State  Energy State  O  O  O  O  O  O  O  O  O  O  O  O  O	Energy State   Environmental Resource   Resources   Tidal Range   Elevation   Slope   Slope   Erosion

Start populating site specific characteristics

Energy State	
High	project site has waves greater than 5 feet, strong currents, high storm surge
Moderate	project site has 2 to 5 foot waves, moderate currents, moderate storm surge
Low	project site has waves less than 2 feet in height, low current, low storm surge



Site Specific Characteristics									
Site Specific Characteristics		Fullation -	Manulan						
		Existing	Nearby						
		Environmental	Sensitive		_	Intertidal	Bathymetric		
Site Name	Energy State	Resource	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	
My Favorite Beach	Moderate	Coastal Beach	¥						
Living Shorelines Applicability Matrix									
		Existing	Nearby						Living Shoreline
		Environmental	Sensitive			Intertidal	Bathymetric		Type is Applicable
Living Shoreline Type	Energy State	Resources	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	to Site?
Dune - Natural	0	0	0	0	0	0	0	0	Unlikely
Dune - Engineered Core	0	0	0	0	0	0	0	0	Unlikely
Beach Nourishment	4.25	5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Coastal Bank - Natural	4	2.25	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Coastal Bank - Engineered Core	3.5	1.75	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Natural Marsh Creation/Enhancement	2.5	3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Marsh Creation/Enhancement w/Toe Protection	4.25	3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Living Breakwater	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A



Site Specific Characteristics									
Site Name	Energy State	Existing Environmental Resource	Nearby Sensitive Resources	Tidal Range	Elevation	Intertidal Slope	Bathymetric Slope	Erosion	
My Favorite Beach	Moderate	Coastal Beach	None	Moderate	>MHW	Moderate	¥		
Living Shorelines Applicability Matrix									
		Existing	Nearby						Living Shoreline
		Environmental	Sensitive			Intertidal	Bathymetric		Type is Applicable
Living Shoreline Type	Energy State	Resources	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	to Site?
Dune - Natural	4.25	4.5	5	3.75	5	3.25	#N/A	#N/A	#N/A
Dune - Engineered Core	3.5	3.75	5	4.25	5	3.75	#N/A	#N/A	#N/A
Beach Nourishment	4.25	5	5	3.75	4.75	3.75	#N/A	#N/A	#N/A
Coastal Bank - Natural	4	2.25	5	4	5	4.25	#N/A	#N/A	#N/A
Coastal Bank - Engineered Core	3.5	1.75	5	4.5	5	4.5	#N/A	#N/A	#N/A
Natural Marsh Creation/Enhancement	2.5	3	5	4.25	1	3	#N/A	#N/A	#N/A
Marsh Creation/Enhancement w/Toe Protection	4.25	3	5	4.25	1	4.5	#N/A	#N/A	#N/A
Living Breakwater	0	0	0	0	0	0	0	0	Unlikely



Site Specific Characteristics									
		Existing	Nearby						
		Environmental	Sensitive			Intertidal	Bathymetric		
Site Name	Energy State	Resource	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	
My Favorite Beach	Moderate	Coastal Beach	None	Moderate	>MHW	Moderate	<b>v</b>		
Living Shorelines Applicability Matrix									
		Existing	Nearby						Living Shoreline
		Environmental	Sensitive			Intertidal	Bathymetric		Type is Applicable
Living Shoreline Type	Energy State	Resources	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	to Site?
Dune - Natural	4.25	4.5	5	3.75	5	3.25	#N/A	#N/A	#N/A
Dune - Engineered Core	3.5	3.75	5	4.25	5	3.75	#N/A	#N/A	#N/A
Beach Nourishment	4.25	5	5	3.75	4.75	3.75	#N/A	#N/A	#N/A
Coastal Bank - Natural	4	2.25	5	4	5	4.25	#N/A	#N/A	#N/A
Coastal Bank - Engineered Core	3.5	1.75	5	4.5	5	4.5	#N/A	#N/A	#N/A
Natural Marsh Creation/Enhancement	2.5	3	5	4.25	1	3	#N/A	#N/A	#N/A
Marsh Creation/Enhancement w/Toe Protection	4.25	3	5	4.25	1	4.5	#N/A	#N/A	#N/A
Living Breakwater	0	0	0	0	0	0	0	0	Unlikely

Tidal Range	
Low	tide range at project site is less than 3 feet
Moderate	tide range at project site is between 3 and 9 feet
High	tide range at project site is more than 9 feet

ntertidal Slope						
Steep	slopes 3:1 (base:height) and steeper					
Moderate	slopes between 3:1 and 5:1 (base:height)					
Flat	slopes 5:1 (base:height) and flatter					



Site Specific Characteristics									
Site Name	Emanou State	Existing Environmental Resource	Nearby Sensitive Resources	Tidal Range	Elevation	Intertidal Slope	Bathymetric Slope	Erosion	
	Energy State Moderate			Moderate	>MHW	-		Moderate	
My Favorite Beach	Moderate	Coastal Beach	Ivone	Moderate	>IVIH VV	Moderate	Steep	ivioderate	<u> </u>
Living Shorelines Applicability Matrix									
		Existing	Nearby						Living Shoreline
		Environmental	Sensitive			Intertidal	Bathymetric		Type is Applicable
Living Shoreline Type	Energy State	Resources	Resources	Tidal Range	Elevation	Slope	Slope	Erosion	to Site?
Dune - Natural	4.25	4.5	5	3.75	5	3.25	2	3	Likely
Dune - Engineered Core	3.5	3.75	5	4.25	5	3.75	2.25	4	Likely
Beach Nourishment	4.25	5	5	3.75	4.75	3.75	1.75	4	Likely
Coastal Bank - Natural	4	2.25	5	4	5	4.25	2.75	3.5	Likely
Coastal Bank - Engineered Core	3.5	1.75	5	4.5	5	4.5	3.25	4.25	Likely
Natural Marsh Creation/Enhancement	2.5	3	5	4.25	1	3	1.5	2.5	Unlikely
Marsh Creation/Enhancement w/Toe Protection	4.25	3	5	4.25	1	4.5	1.5	4	Possible
Living Breakwater	0	0	0	0	0	0	0	0	Unlikely

- Results auto-populate in right-hand column
- Purpose: informational planning tool only

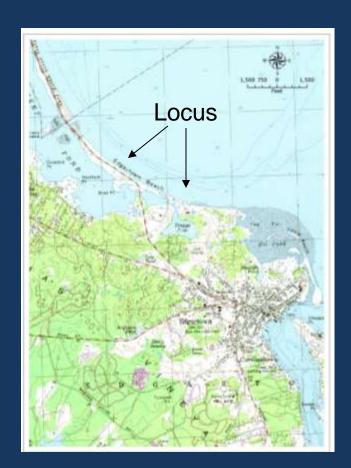


- Dune restoration (natural)
  - Cow Bay Beach, Martha's Vineyard
- Coastal bank w/engineered core & beach nourishment
  - Corporation Beach, Dennis
- Marsh creation w/toe protection
  - Chatham



# Living Shoreline Case Study Dune Restoration (Natural)

- Cow Bay Beach, Edgartown
- Erosion of beach and dune prompted project
- Implemented 2009
- Maintenance required (2011)





# Living Shoreline Case Study Dune Restoration (Natural)







# Living Shoreline Case Study Dune Restoration (Natural)

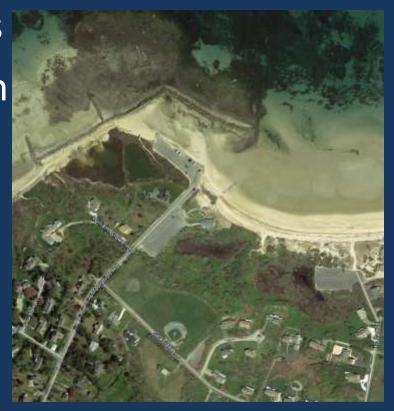






Coastal Bank w/Engineered Core & Beach/Dune Nourishment

- Corporation Beach, Dennis
- Erosion of 280-foot section of coastal bank prompted project
- Implemented 2015
- Materials: coir envelopes;
   ~2,100 cy of sand; plants





Coastal Bank Stabilization & Beach/Dune Nourishment





Coastal Bank Stabilization & Beach/Dune Nourishment







Marsh Establishment with Toe Protection

- Chatham property
- Project was the result of mitigation requirements
- Implemented 2015
- Coir envelopes and netting protect newly planted marsh
- Ongoing monitoring/maintenance



## Living Shoreline Case Study Coastal Bank Stabilization & Beach Nourishment





Disturbed site: February 2014



## Living Shoreline Case Study Coastal Bank Stabilization & Beach Nourishment



Summer 2015

