Testing Biodegradable and Hybrid Methods for Shoreline Stabilization
Saco Watershed Collaborative
March 22, 2022

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Funding from:
OFFICE FOR COASTAL MANAGEMENT
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

P.A. Slovinsky, MGS

What's a "Living Shoreline"?

Living shoreline is a broad term that encompasses a range of shoreline stabilization techniques along estuarine coasts, bays, sheltered coastlines, and tributaries. A living shoreline:

- has a footprint that is made up **mostly of native material**.
- **incorporates vegetation** or other living, natural "soft" elements **alone or in combination with** some type of harder shoreline structure (e.g. oyster reefs or rock sills) for added stability.
- **maintains continuity of the natural land–water interface** and reduce **erosion** while providing **habitat value** and enhancing **coastal resilience**.

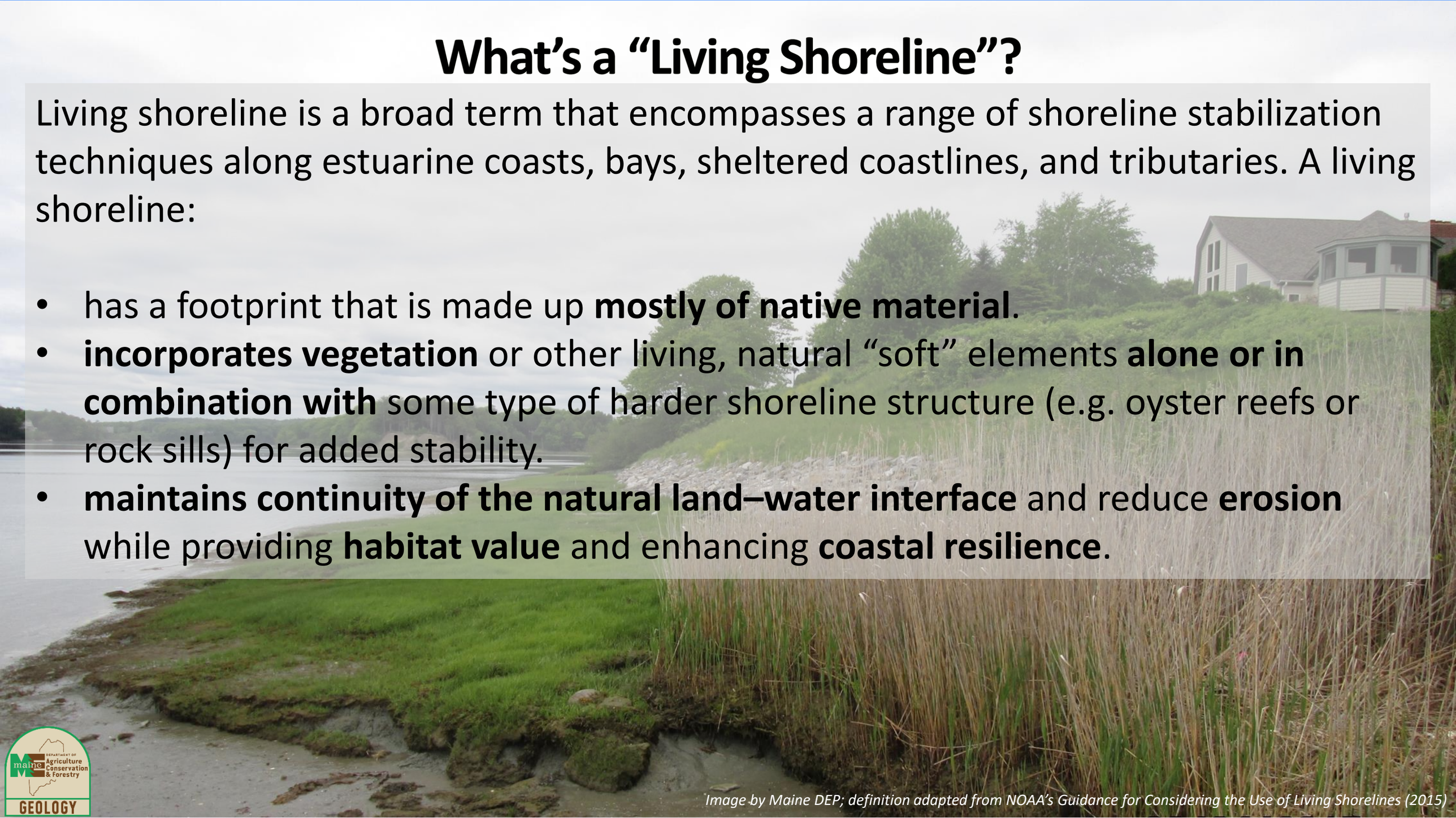

Image by Maine DEP; definition adapted from NOAA's Guidance for Considering the Use of Living Shorelines (2015)

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Most of Maine's experience with "living shorelines" has been related to dune restoration, construction and beach nourishment along the **open coast sand dune system** - this comprises *only* ***about 2%*** **of Maine's coastline**.

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48% of the Maine coast is made up of erodible coastal bluffs and 1/3 are eroding and are being **armored at high rates**. *Armoring bluffs cuts off the supply of sediment to nearby mudflats and wetlands, which are natural living shorelines and serve as buffers for storm waves.*

Bunganuc Bluff, Brunswick, ME, Walsh Engineering

There are approximately 22,408 acres of tidal marshes in Maine*. **Shoreline armoring inhibits the natural landward migration of marshes, impacts sediment transfer to the marsh, and reduces habitat**.

Cameron and Slovinsky, 2014

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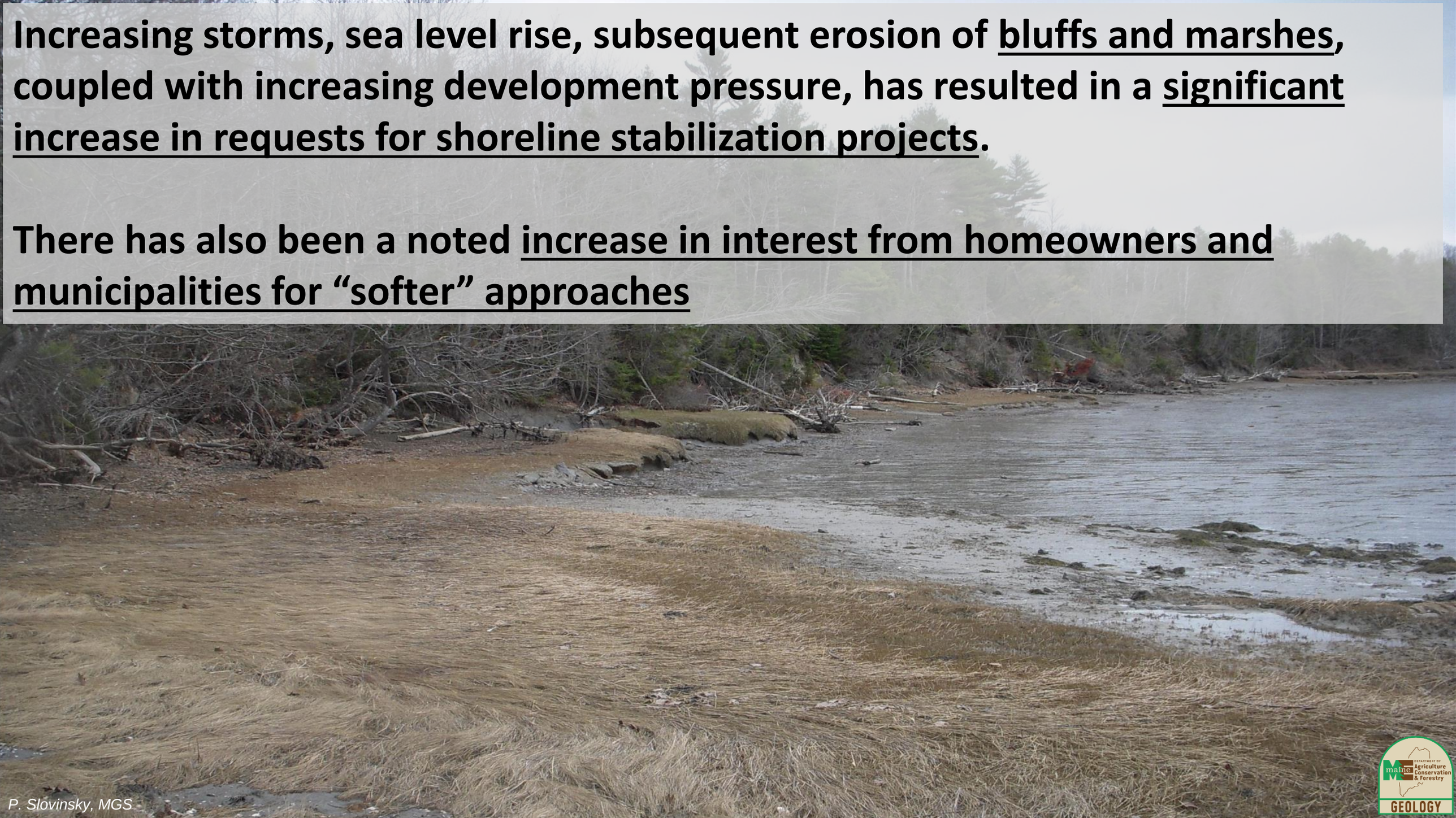
Increasing storms, sea level rise, subsequent erosion of bluffs and marshes, coupled with increasing development pressure, has resulted in a significant increase in requests for shoreline stabilization projects.

There has also been a noted increase in interest from homeowners and municipalities for "softer" approaches



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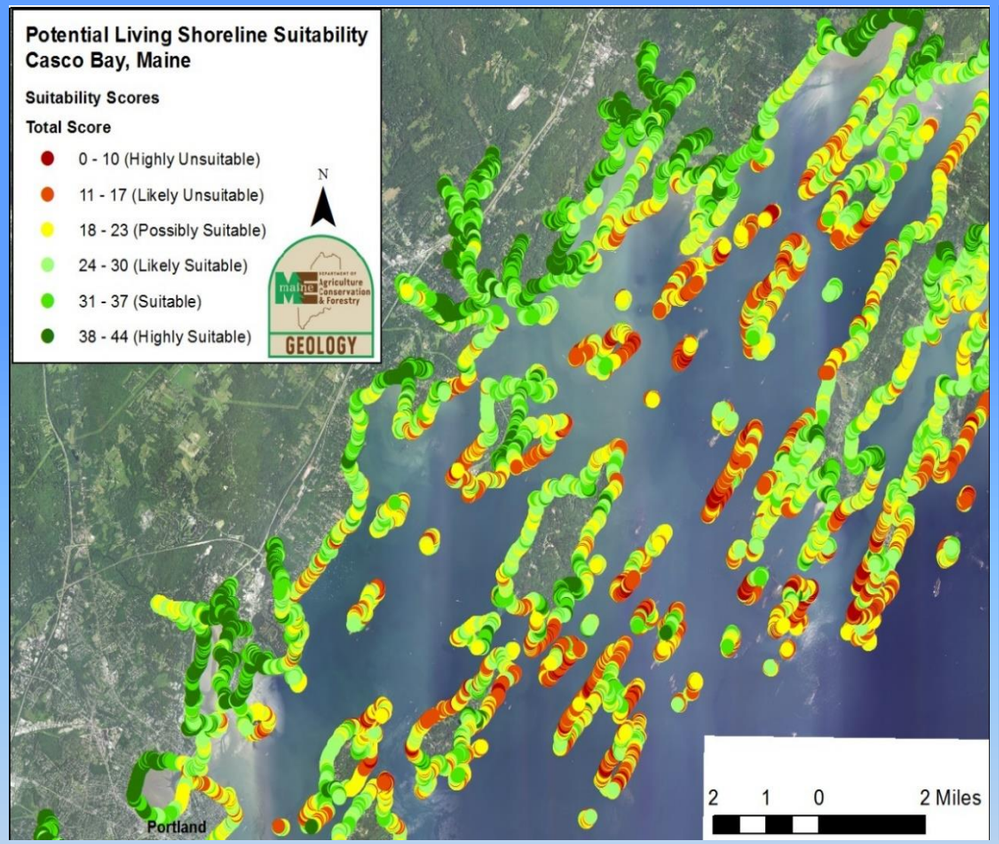
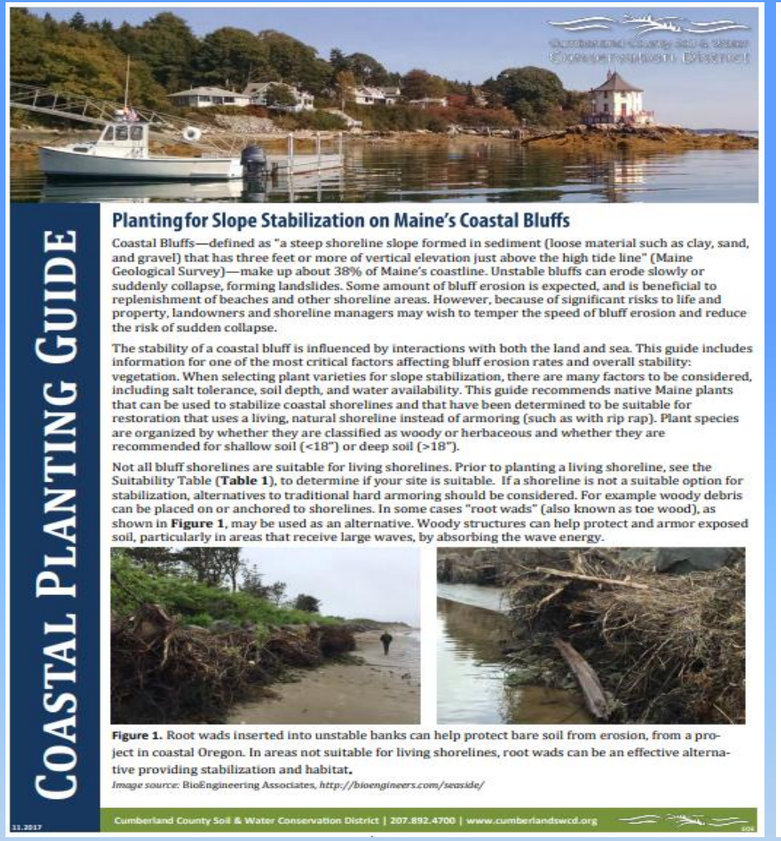
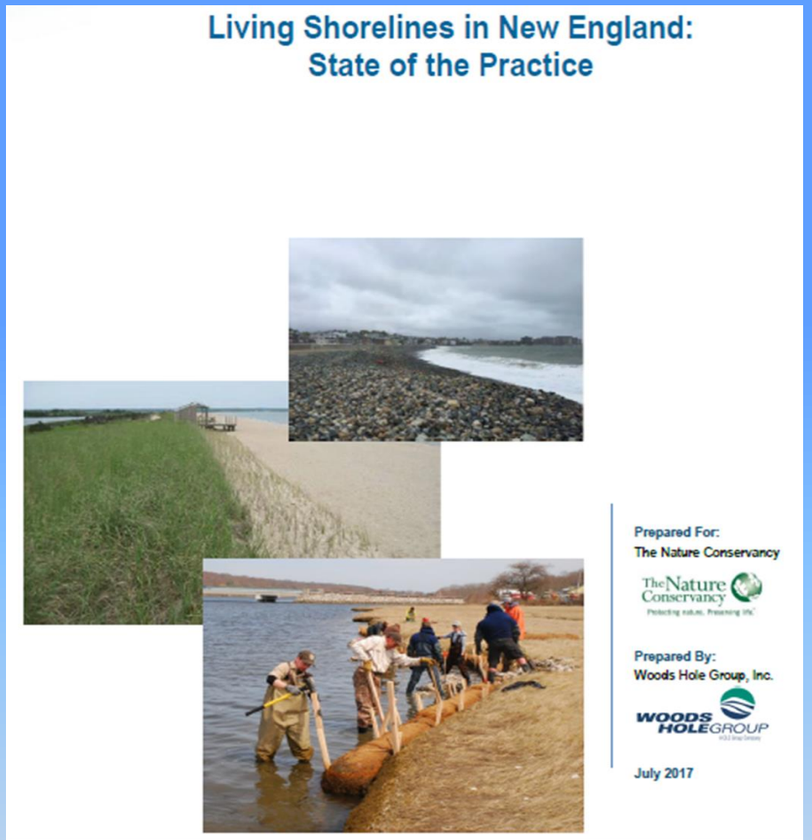
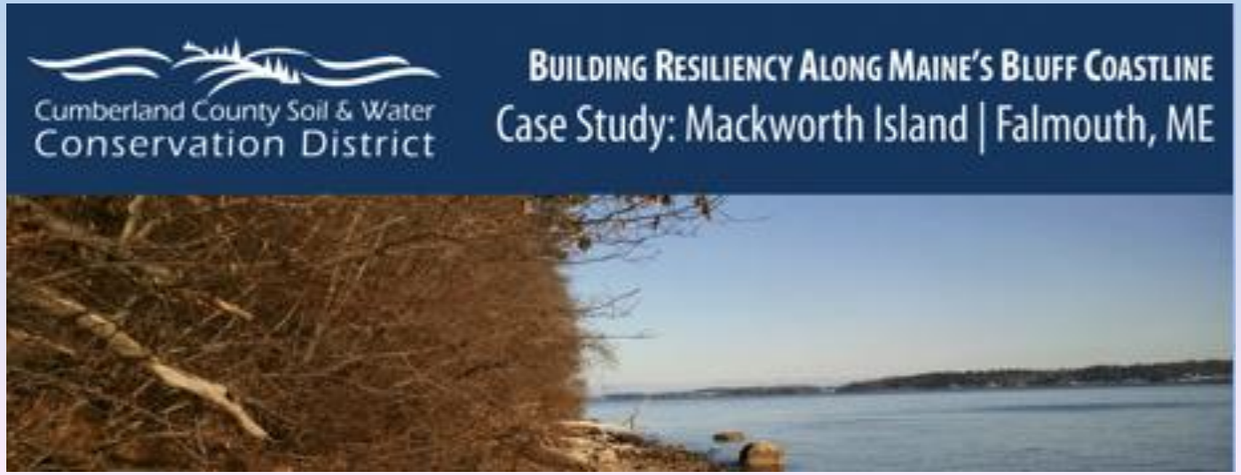
Living-shoreline related results from previous NOAA-funded Maine and regional efforts









Living Shorelines Introduction

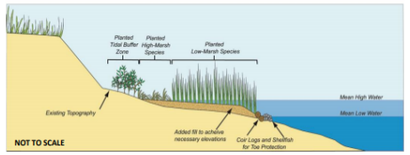
A detailed profile page was created for each of the eight (8) living shoreline types listed below. The purpose of these profile pages is to provide a comprehensive overview of the design recommendations, siting criteria and regulatory topics pertinent to a range of living shorelines designs that practitioners and regulators can use as a quick reference in the field or as an informational tool when educating home owners.

Living Shoreline Types

1. Dune – Natural
2. Dune – Engineered Core
3. Beach Nourishment
4. Coastal Bank – Natural
5. Coastal Bank – Engineered Core
6. Natural Marsh Creation/Enhancement
7. Marsh Creation/Enhancement w/Toe Protection
8. Living Breakwater

Design Schematics

The following living shoreline profile pages provide an example design schematic for each of the eight living shoreline types. Each schematic shows a generalized cross-section of the installed design. In addition, they illustrate each design's location relative to MHW and MLW, whether plantings are recommended, if fill is required, and any other major components of the design. It is important to note that these are not full engineering designs, and due to each sites unique conditions, a site specific plan, developed by an experienced practitioner is required for all living shoreline projects. Also note that these design schematics are meant to provide a general concept only, and are not drawn to scale.



Explanation of Design Overview Tables

Materials	A description of materials most commonly used to complete a living shoreline project of this type.
Habitat Components	A list of what types of coastal habitats are created or impacted by a living shoreline project of this type.
Durability and Maintenance	Although specific timelines are impossible to provide in this context, general guidelines and schedules for probable maintenance needs, and design durability are detailed here.
Design Life	Although specific design life timelines will vary by site for each living shoreline type, this section provides some insight into factors that could influence design life.
Ecological Services Provided	This section provides an overview of the ecological services that could be provided or improved through the installation of that particular type of living shoreline project.
Unique Adaptations to NE Challenges (e.g. ice, winter storms, cold temps)	This section provides any unique practices or design improvements that could be made to improve the performance of the design given New England climactic and tidal challenges.

Acronyms and Definitions

Misquamicut Beach Dune Restoration, Westerly, RI
Photo courtesy of Janet Friedman

Increasing resilience and reducing risk through successful application of nature based coastal infrastructure practices in New England

Expected Project Outcomes

- Pilot demonstration living shoreline treatments in all five New England states
- Documentation of required design and permitting process
- Development and implementation of regional, standardized monitoring metrics and protocols
- Development of state and federal policy recommendations to incentivize practices

New England Project Locations

Marsh Creation/Enhancement with Toe Protection

- North Mill Pond, Portsmouth NH
- South Mill Pond, Portsmouth NH
- Cutts Cove, Portsmouth NH
- Wagon Hill Farm, Durham NH
- Collins Cove, Salem MA
- Wharton Point, Brunswick ME
- Maquoit Conservation Lands, Brunswick ME

Dune Restoration/Nourishment

- Duxbury Beach, Duxbury MA (sand dune nourishment)
- Long Beach, Plymouth MA (cobble dune nourishment)

Coastal Bank - Natural

- Lanes Island, Yarmouth ME

Multi-Approach Projects

- Stratford Point Living Shoreline, Stratford CT – Living breakwater, marsh and dune restoration
- Rose Larisa Park, East Providence RI – Intertidal sill, coastal bank with engineered core, and marsh creation
- Gray's Beach, Kingston MA – Marsh creation/enhancement with toe protection, and dune nourishment
- Coughlin Park, Winthrop MA – Coastal bank with engineered core and cobble nourishment

Regional Demonstration Projects / Monitoring Sites

Increasing resilience and reducing risk through successful application of nature based coastal infrastructure practices in New England

Funding from:

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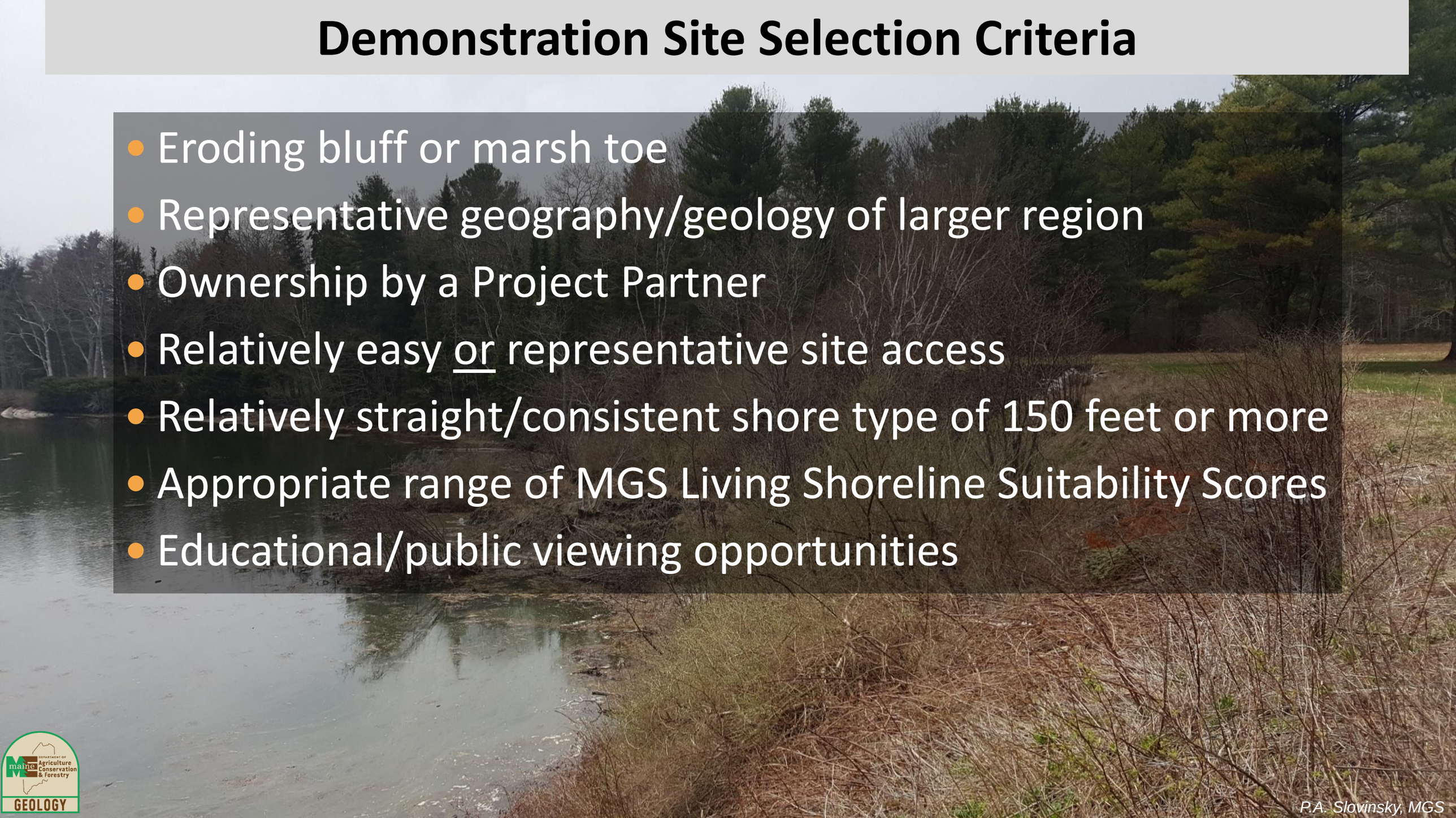
Can we implement low-cost biodegradable vs. synthetic treatments that ***beneficially reuse naturally occurring materials*** to *mitigate coastal erosion along marsh edges and coastal bluffs?*

Project goal: select, design, permit, construct, and monitor small transferable demonstration gray-green living shoreline treatments

Demonstration Site Selection Criteria

- Eroding bluff or marsh toe
- Representative geography/geology of larger region
- Ownership by a Project Partner
- Relatively easy or representative site access
- Relatively straight/consistent shore type of 150 feet or more
- Appropriate range of MGS Living Shoreline Suitability Scores
- Educational/public viewing opportunities



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Project Location:

Maquoit Bay, Town of Brunswick

Lanes Island, Town of Yarmouth

Casco Bay, Maine

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Maine Coast Heritage Trust

Casco Bay Estuary PARTNERSHIP

The Nature Conservancy

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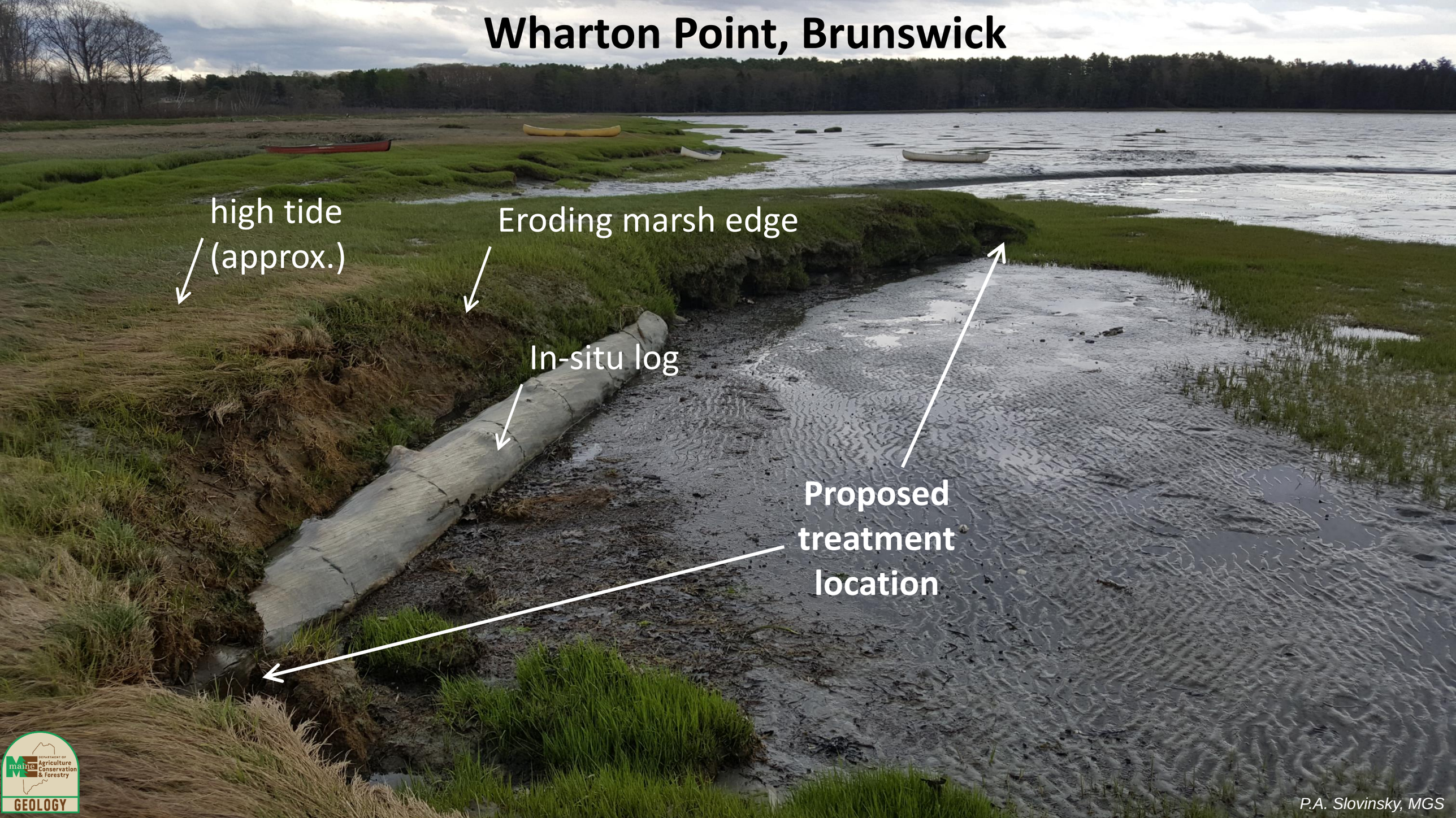
MGS Living Shoreline Suitability Tool
Wharton Point, Brunswick – Moderately to Highly Suitable (35 - 37 out of 44)

https://www.maine.gov/dacf/mgs/hazards/living_shoreline/index.shtml

Wharton Point, Brunswick



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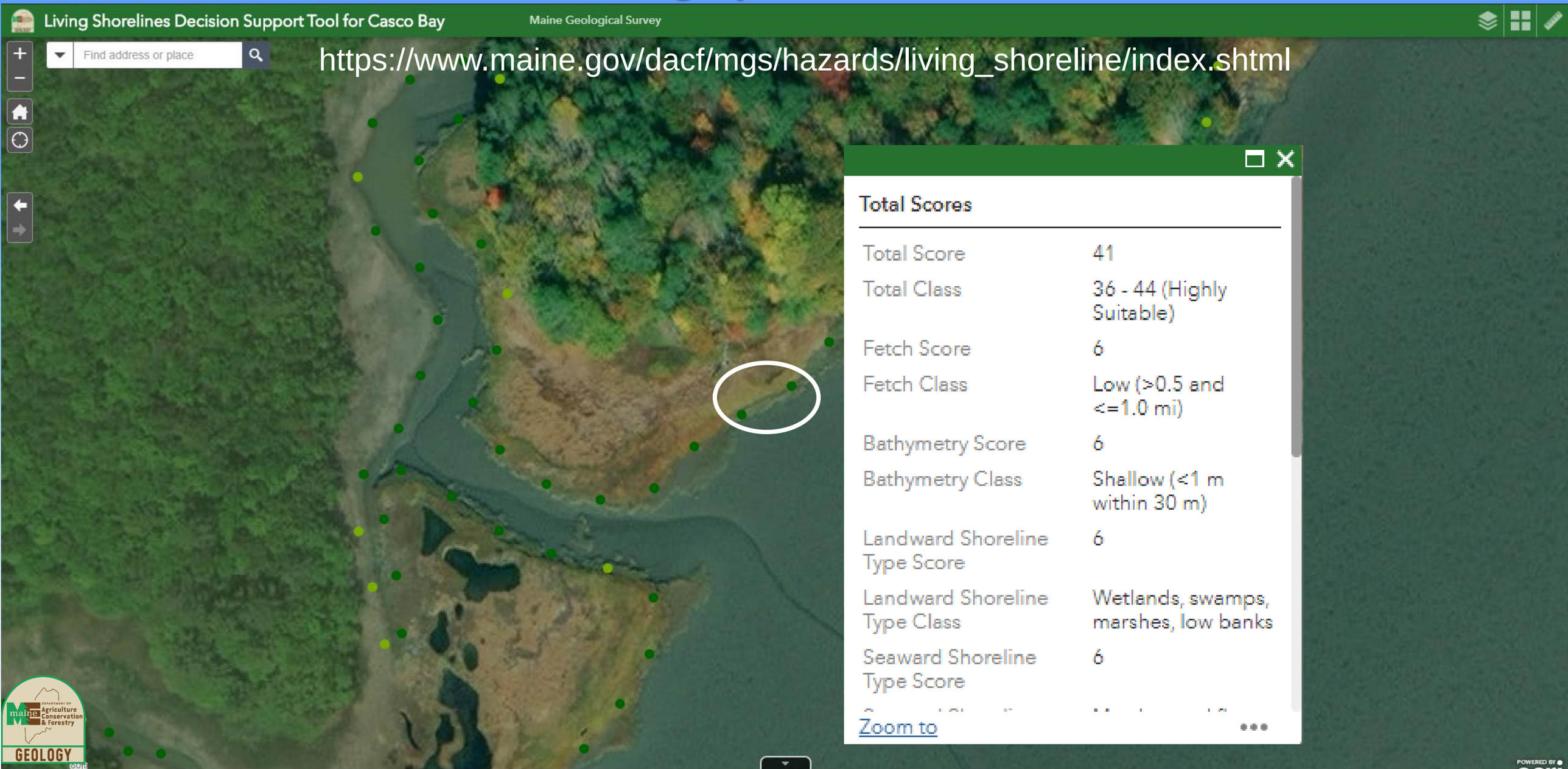
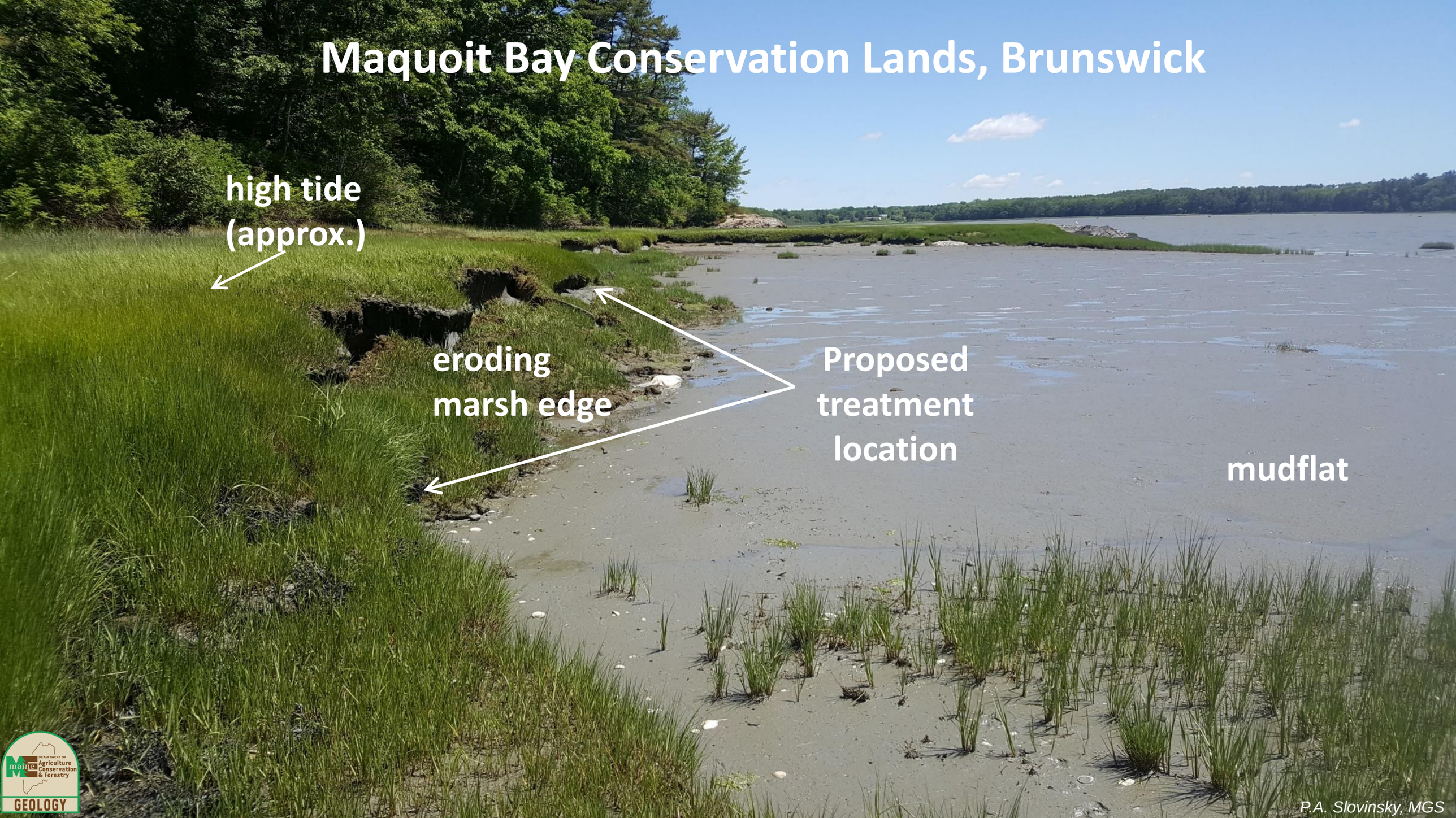
MGS Living Shoreline Suitability Tool
M. Bay Cons. Lands Brunswick – Highly Suitable (37 - 41 out of 44)



Maquoit Bay Conservation Lands, Brunswick



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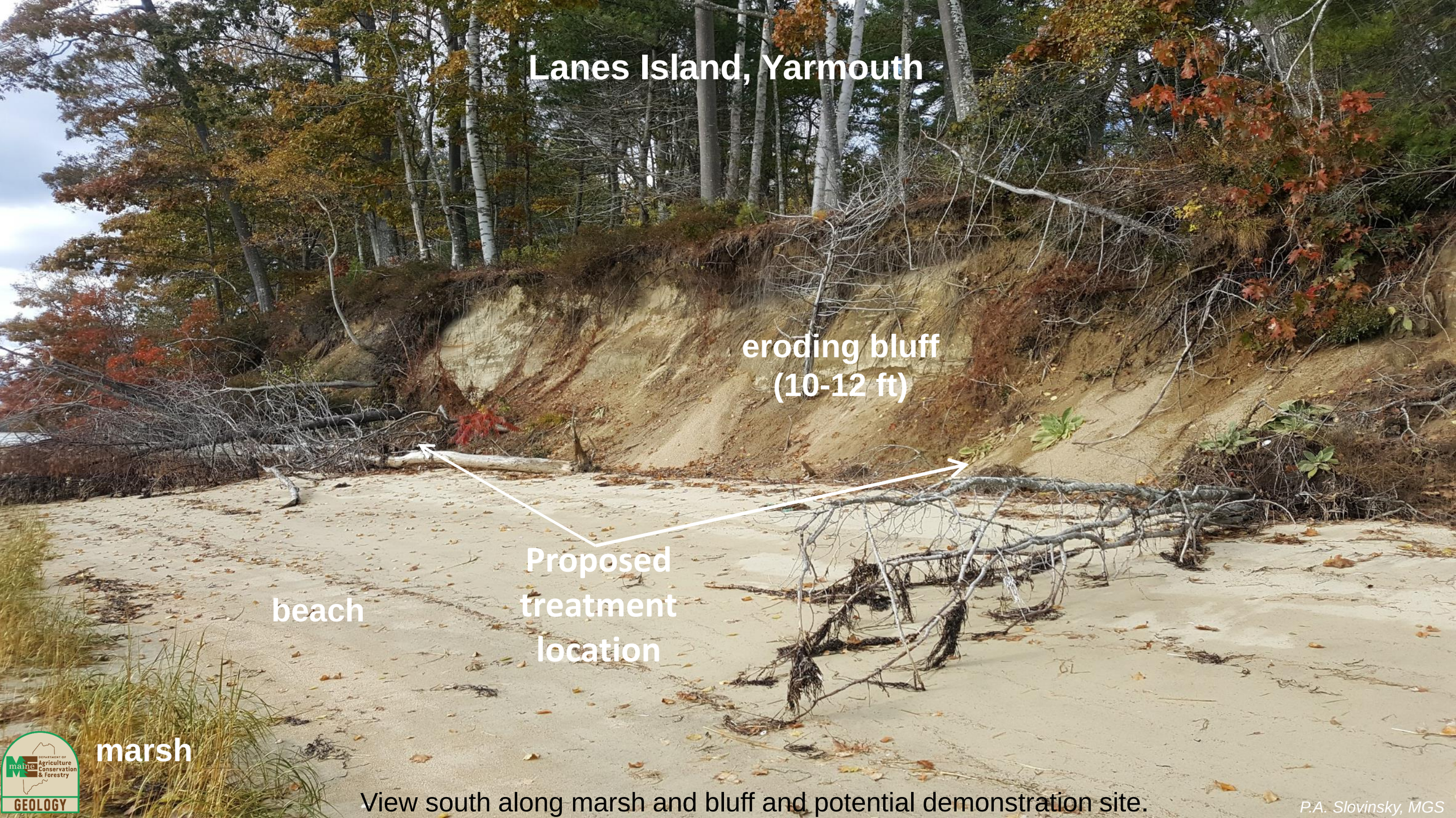
MGS Living Shoreline Suitability Tool
Lanes Island, Yarmouth – Low end of Moderately Suitable (30 - 31 out of 44)



View south along marsh and bluff and potential demonstration site.

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Some Project
CHALLENGES, SOLUTIONS and LESSONS LEARNED

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Permitting and review requirements and timeframes

- Pre-application meetings held with state and federal regulators (5/31/2019, 6/27/2019)
- **MGS served as applicant/agent for the property owners**, including Town of Brunswick, Brunswick-Topsham Land Trust, Maine Inland Fisheries and Wildlife, and Maine Coast Heritage Trust
- Brunswick review was internal since Brunswick was owner for the 2 Brunswick sites; Yarmouth Shoreland Zoning review was required for Lanes Island project
- **MEDEP Permit-by-Rule** and **USACE General Permit** applied for on **8/7/2019**
- **MEDEP Permit-by-Rule (Chapter 305)** was issued on **8/22/2019** with review and input from MEIFW, MEDMR, and SHPO under **13. Habitat creation or enhancement and water quality improvement activities** (available to resource agencies, DOT, and conservation groups, or municipality in conjunction with resource agency)
- **USACE Tier 2 General Permit** was issued on **12/11/2019** with review and input from US EPA, NOAA NMFS, USFWS, and Tribal HPOs
- Required **5 years of monitoring** with a specific focus on synthetic material degradation

Challenge: regulatory concerns about easily *degradable* plastics

MacDill AFB

Challenge: Account for the impacts of ice

Wharton Point

Maquoit Bay Conservation Lands

Solution: develop and test *new* heavy-fiber weave biodegradable oyster shell bags

D. Bannon, GEI

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Solution: test *new* UV and abrasion-resistant synthetic products

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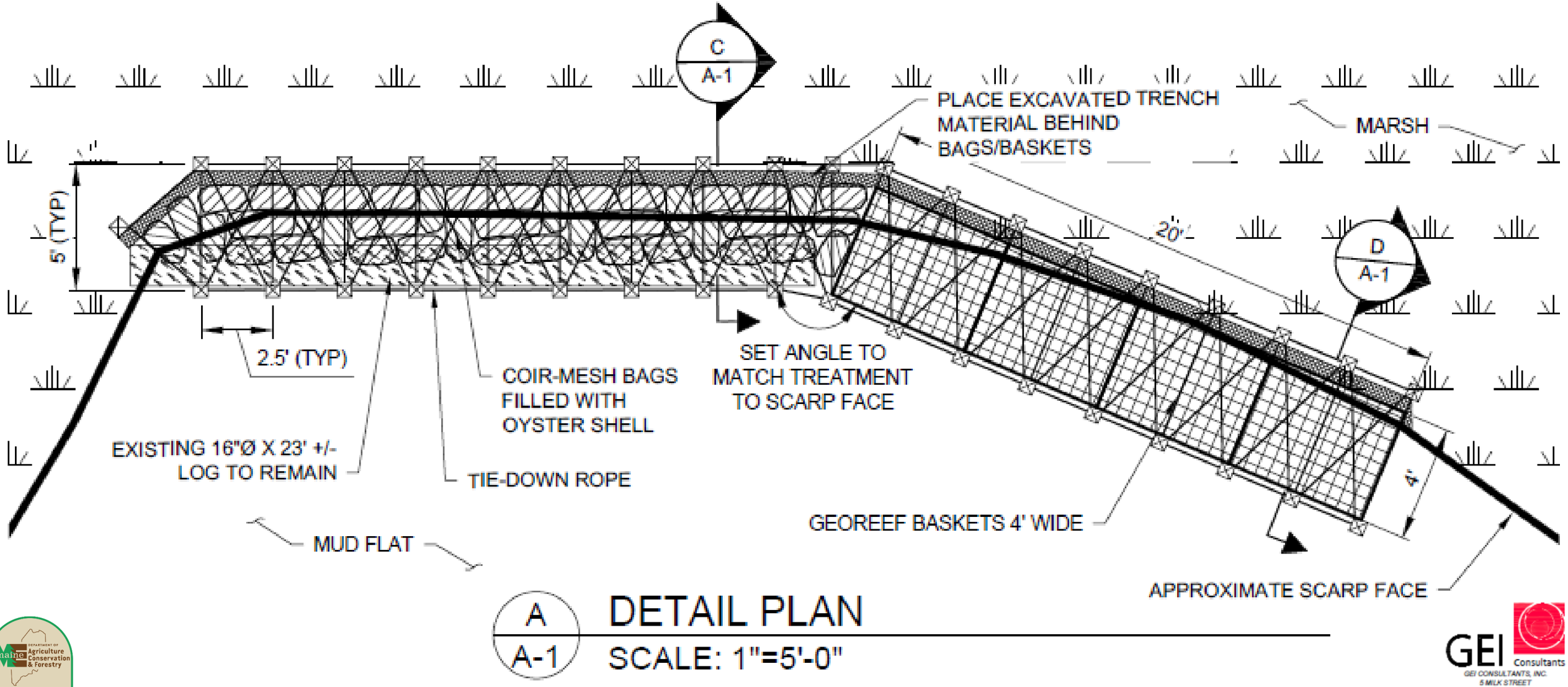
Challenge: Bagging oyster shell with volunteers (during a pandemic)
Solution: bagging stations, sewing stations, and dedicated volunteers

Integrate synthetic and biodegradable materials and trees

Wharton Point



A / A-1 DETAIL PLAN

SCALE: 1"=5'-0"

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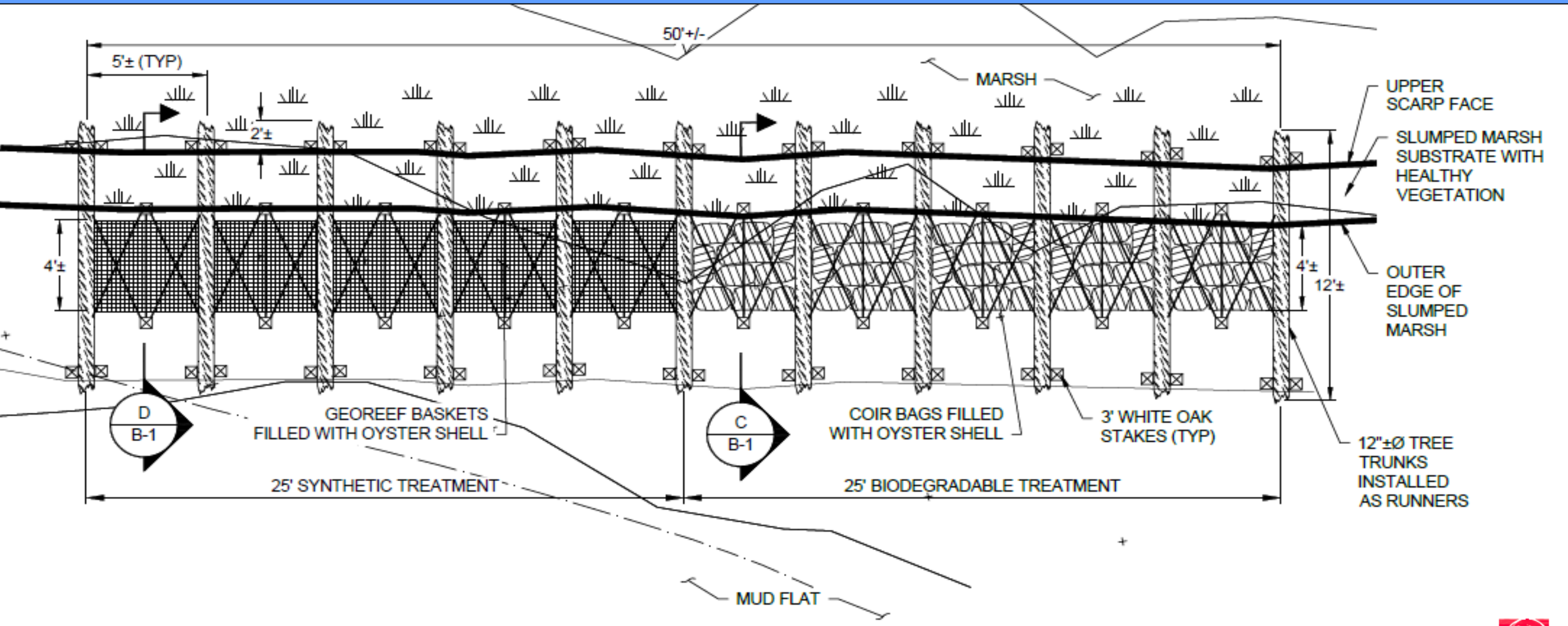
Solution: Integrate synthetic and biodegradable materials and trees

Maquoit Bay Conservation Lands



A / B-1 PLAN VIEW OF LIVING SHORELINE TREATMENT

SCALE: 1"=5'-0"

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Integrate *trees* into demonstration treatments to break up ice

Wharton Point

P. Slovinsky, MGS

Maquoit Bay Conservation Lands

D. Bannon, GEI

Challenge: “Dirty” oyster shell

D. Bannon, GEI

Solution: Develop an on-the-fly method to clean oyster shell

All images by P. Slovinsky, MGS

Challenge: delivering supplies while accounting for tides
Solution: Project partners, barges and airboats!

Images by S. Dickson and P. Slovinsky, MGS

Wharton Point

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All images by P. Slovinsky, MGS

Maquoit Bay Conservation Lands

Images by S. Dickson and P. Slovinsky, MGS

Wharton Point

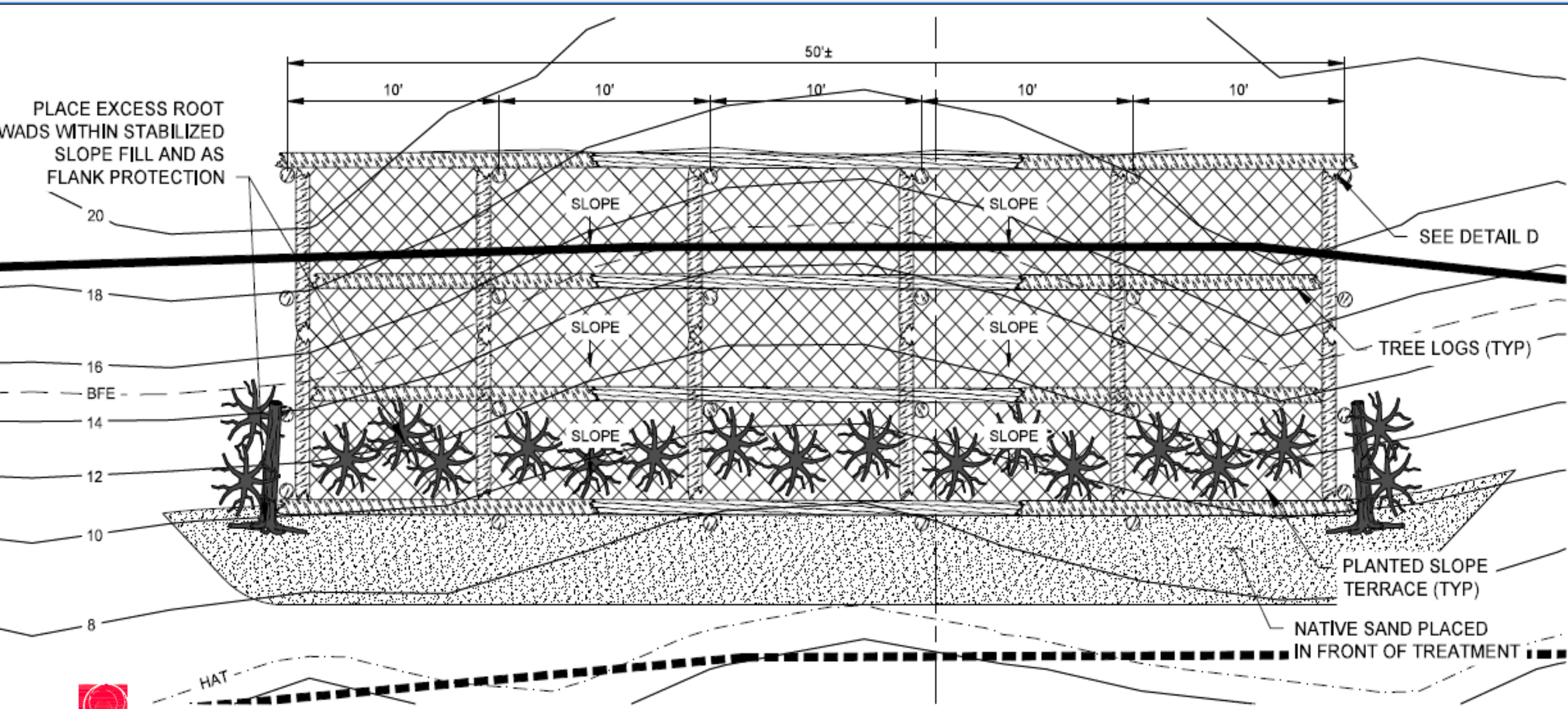
Maquoit Bay Conservation Lands

R. Harbison, GPCOG

Lanes Island, Yarmouth, ME

Challenge: Use a living shoreline to stabilize an unstable bluff <u>on an island</u> using trees = not an inexpensive proposition

Solution? regrade bluff and beneficially reuse trees



A / C-1 SLOPE STABILIZATION PLAN
SCALE: 1"=5'-0"

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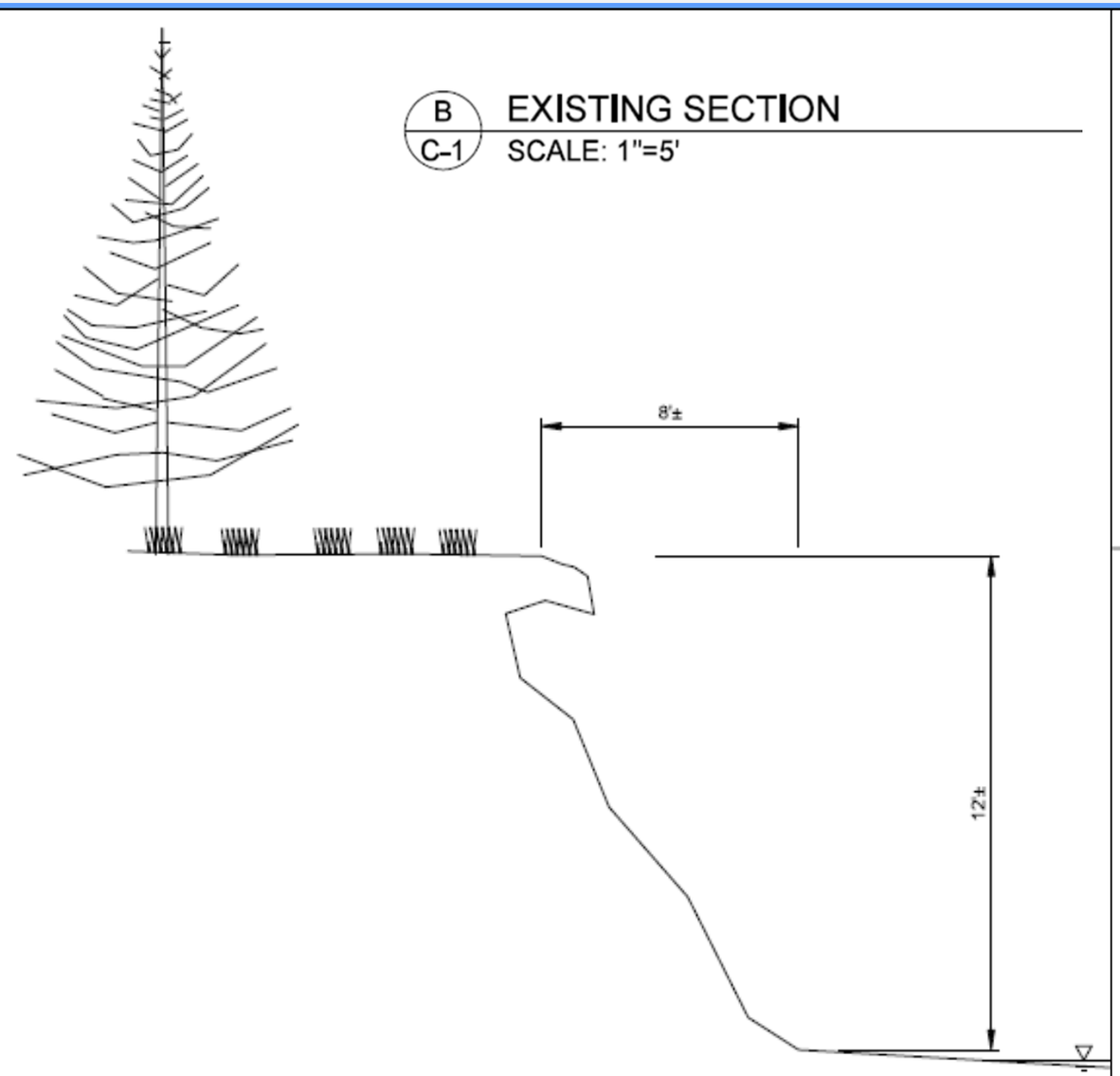
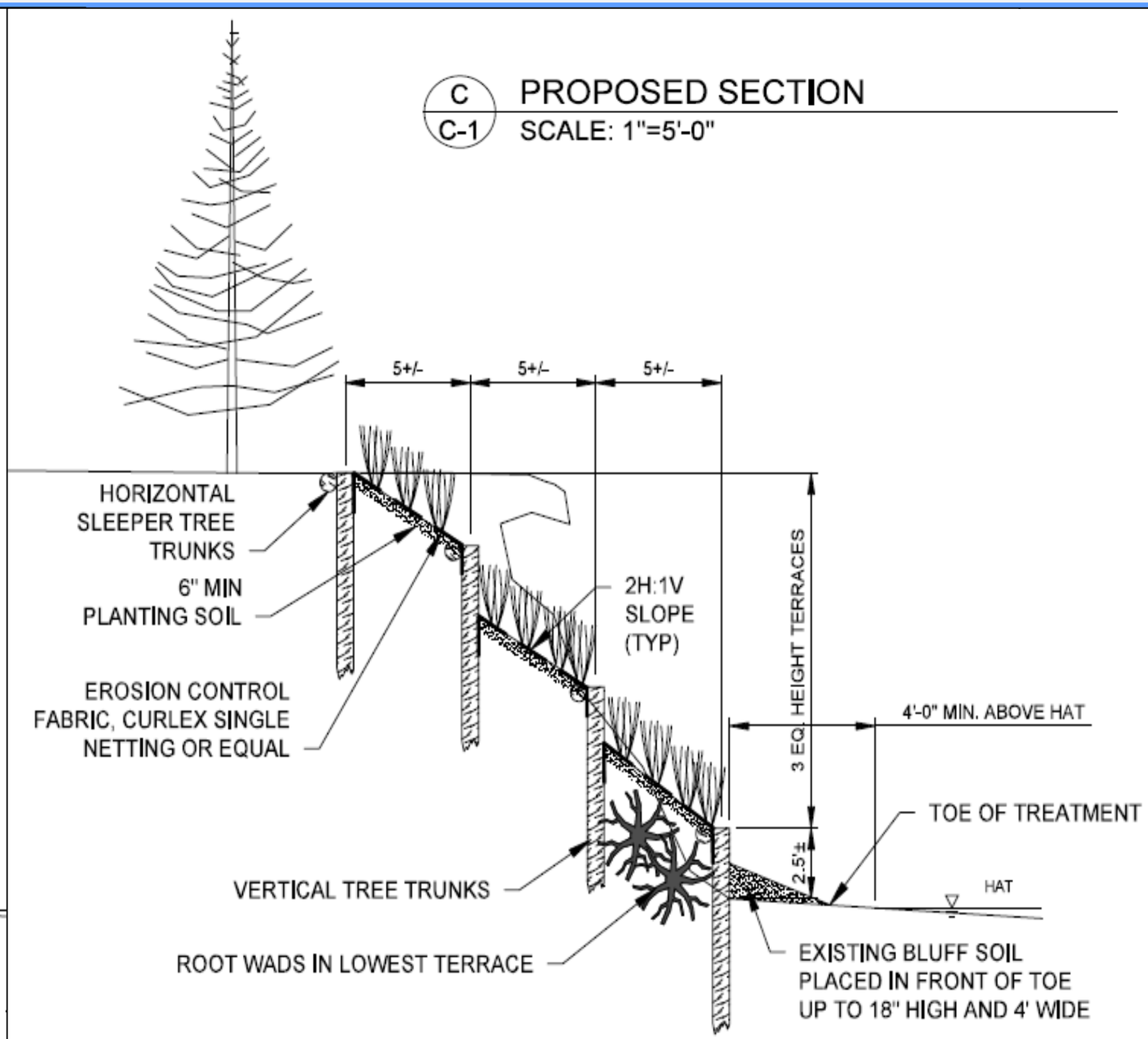
Solution? regrade bluff and beneficially reuse trees





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Lanes Island, Yarmouth

P. Slovinsky, MGS 10-2020

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Lanes Island, Yarmouth

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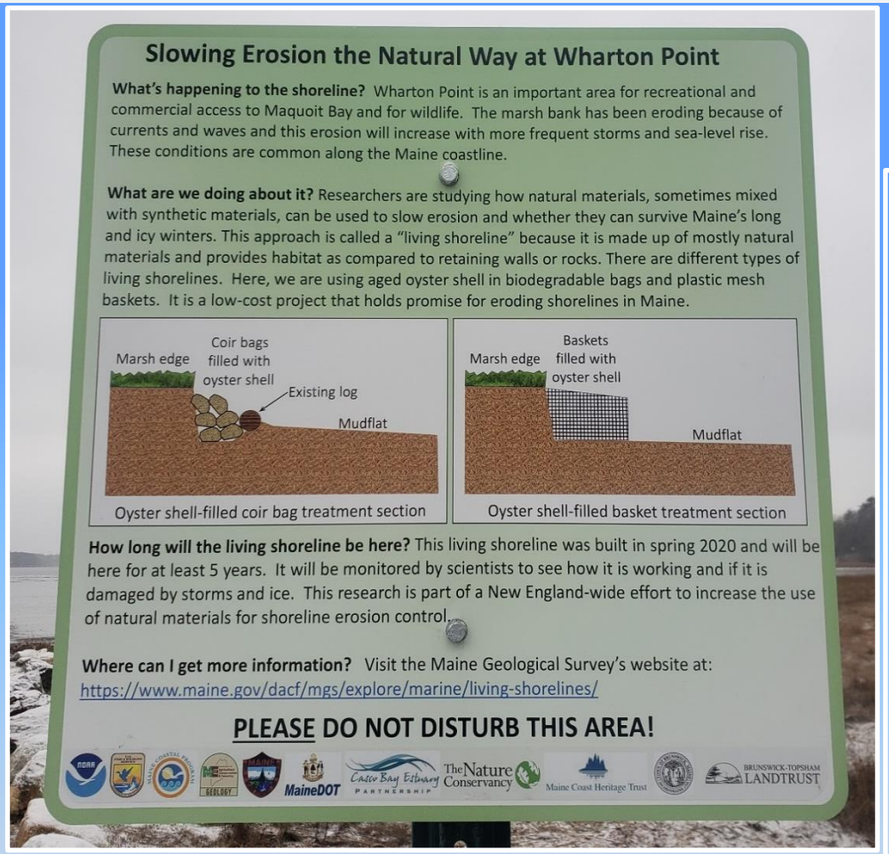
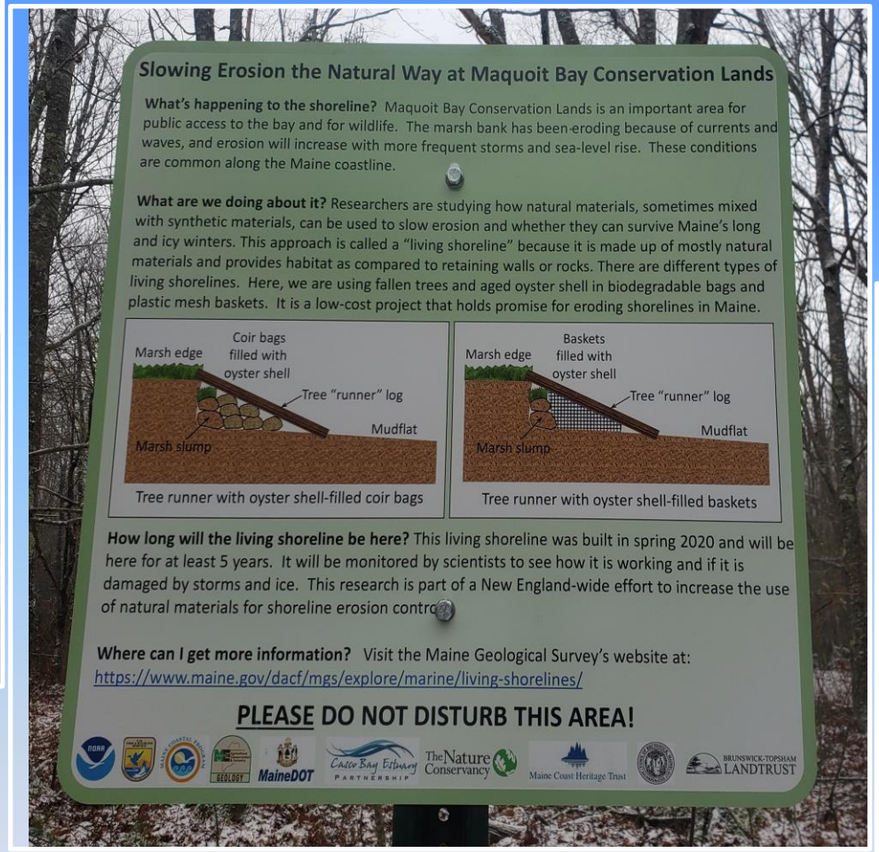
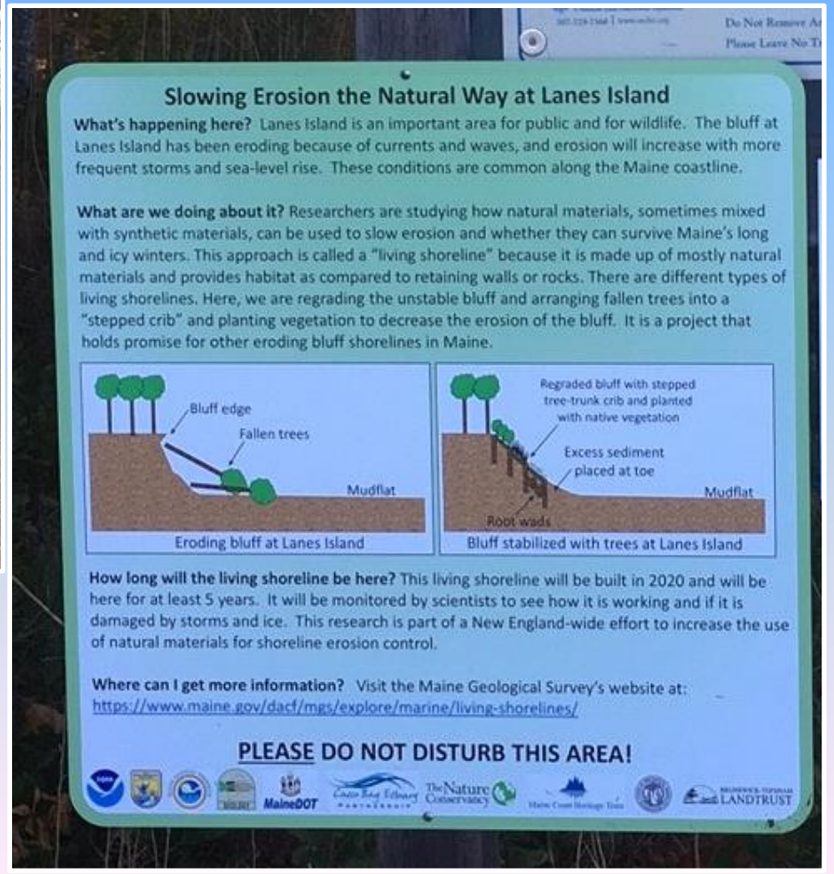
Informational Signage Placed at Each Site







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Construction Timeframe Summary

Ship oyster shell to Brunswick = 1 day, August 2019

Develop, test, and secure coir fiber bags = September 2019 to January 2020

Find, cut and store appropriate logs for MBCL = January 2020 to April 2020

Build bagging stations = April 2020

Secure Tensar GeoReef = April 2020

Prep and fill 400 shell bags = 3 days, 6-8 volunteers (May 2020)

Brunswick sites construction = 7 days, 6-8 volunteers (May – June 2020)

Lanes Island site construction = 17 days, SumCo Eco-Contracting (August – September 2020)

Project Monitoring – CBEP and MGS

- 5-year monitoring follows an **EPA-approved QAPP and regionally developed protocols**
- Focuses on **geophysical environment, erosive forces, biota, vegetation, structural integrity/movement, and plastic degradation.**
- **Topographic transect** lines established at each site and natural control sites
- **Vegetative and biologic plots** collected along transects
- **Photo monitoring** including game cameras
- Detailed monitoring for **pre-construction**, **as-built** (post-construction), and scheduled for **spring/early summer** (April-June), **fall/late summer** (August-October), and **Winter** (as possible).

Images by P. Slovinsky, MGS and M. Craig, CBEP

So how have the installations fared thus far?

Wharton Point (completed late May/early June 2020)

P.A. Slovinsky, 6-3-2020

Wharton Point

P.A. Slovinsky, 1-3-2022

Wharton Point (since June 2020)
Main Observations

Georeef

Very minor settlement
Has not had to be re-staked/re-twined
No replacement needed
Marsh edge has settled on top of reef
Sedimentation, algae and wrack
Baskets have not degraded

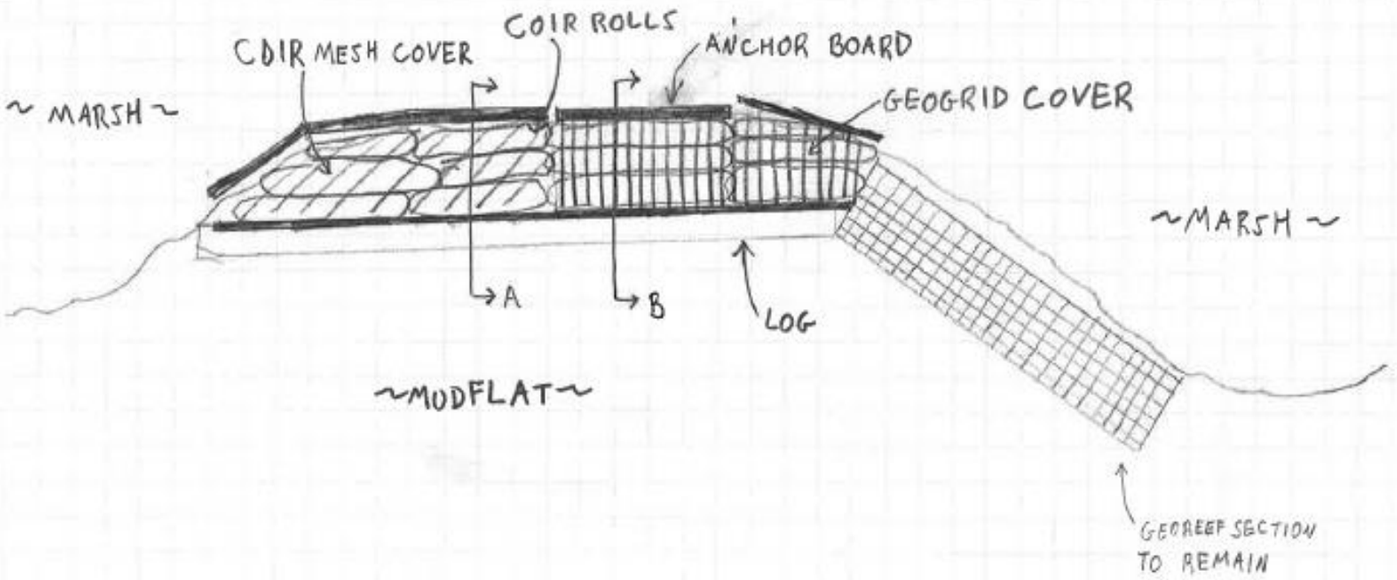
Very storm resistant

Bags

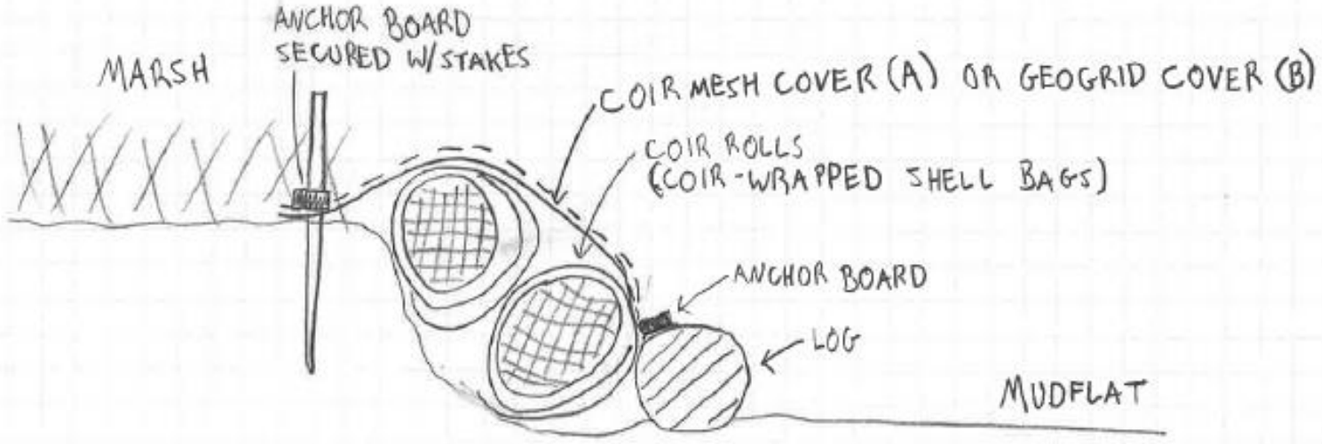
Constant shifting
Re-twined *twice*
Replaced 45 bags (2/21, 8/21)
Marsh continues to be eroded above bags
Release of shell into intertidal as bags break
Bags appear to fall apart <2 years regardless of twining failure

Not very storm resistant

Findings: *twining needs to be of a stronger material. Tie-down methods employed do not hold bags in place well. Individual light (<30 lb) bags are not robust enough to survive storm battering.*

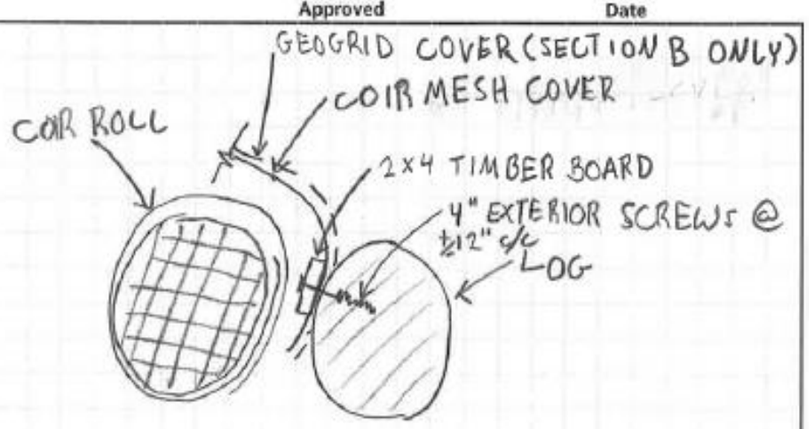


PLAN

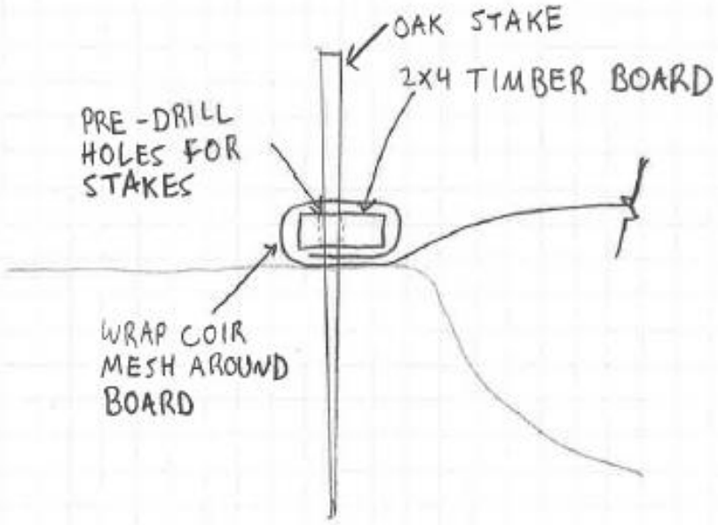


SECTION A/B

Approved Date



BOTTOM ANCHOR BOARD DETAIL



TOP ANCHOR BOARD DETAIL

Conceptual Wharton Point Improvements

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Maquoit Bay Conservation Lands (completed late May/early June 2020)

P.A. Slovinsky, 6-9-2020

Maquoit Bay Conservation Lands

P.A. Slovinsky, 4-27-2021

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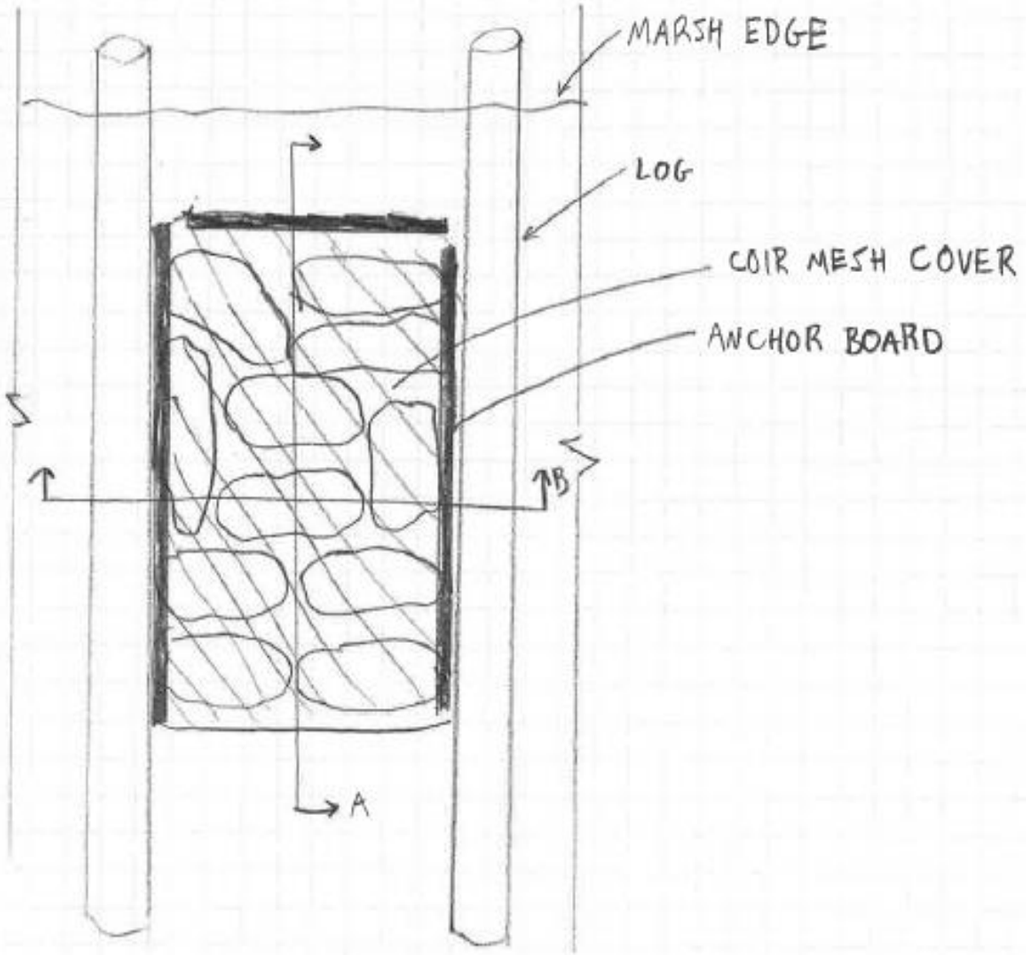
Maquoit Bay Conservation Lands

P.A. Slovinsky, 1-3-2022

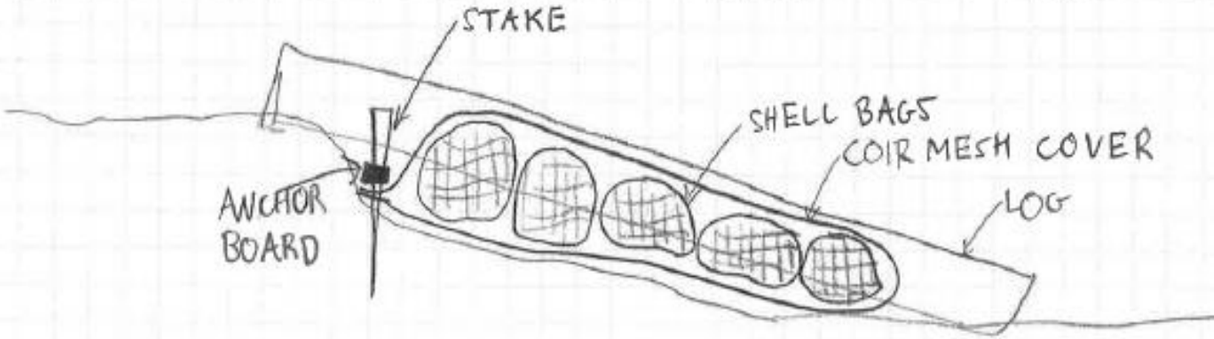
Maquoit Bay Conservation Lands (since June 2020)
Main Observations

Georeef	**Bags**	**Logs**
Minor settling	Minor shifting	Minor twisting/settling
No need to re-stake/re-twine	Re-twined once	No need to reanchor
No need to replace	Replaced 5 bags (4/21)	No need to replace
Marsh edge settled on top	Marsh eroded above	N/A
Sedimentation, algae and wrack	Sedimentation, algae and wrack	
Baskets have not degraded	All bags degraded and released shell into intertidal	
Storm resistant	Fairly storm resistant	

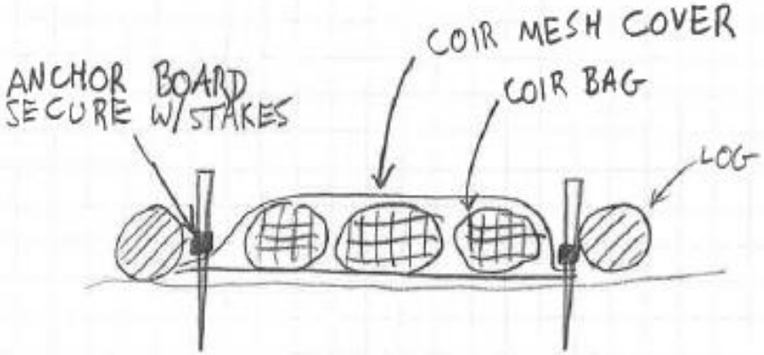
Findings: *twining needs to be of a stronger material. Although only had to replace a few bags due to storms, all bags have biodegraded < 2 years. Logs could be anchored a different way in the future (wrapped around log ends instead of attached to log ends)*



PLAN



SECTION A



SECTION B

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Lanes Island (completed mid-September 2020)

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P. Slovinsky, MGS, 10-20-2020

Lanes Island

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C. Gerber, MCHT, 1-13-2021

Lanes Island

P. Slovinsky, MGS 08-28-2021

Lanes Island (since Sept 2020)
Main Observations

Project hit by strong southeaster storms in November, December 2020 and January 2021
Extensive erosion along entire island (10-15 feet of bluff erosion measured as of 8/2021)
Loss of first “step” and some end-effect erosion
Sacrificial sediment placed above the HAT was lost within a month
Step failure released large amounts of sediment to the adjacent beach, as designed
Change rate exceeded planned monitoring
Extremely difficult winter monitoring
Site is likely *too dynamic* for living shoreline approaches

Findings: *log structure appears to be stable though sediment eroded. If project was constructed and plantings placed in late spring (as opposed to fall), it’s possible that project would be performing a bit better, but the extent of high erosion along the 400-foot bluff would still likely have caused erosion of the site.*

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Some Lessons Learned

Biodegradable Products Tested

- Biodegradable twine is *not adequate* for holding down bags. Once it gets wet, it stretches.
- Biodegradable bags, though easy to work with, are likely too light to hold up to storm events.
- Biodegradable bags, even when held in place, will fall apart in <2 years.
- We will implement **an adapted biodegradable design** to test for efficacy at the Wharton Point and MBCL sites. A **new staking approach** will also be implemented.

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Some Lessons Learned

Synthetic and Log Products Tested

- Tensar GeoReef, especially at Wharton Point where the baskets were filled to create the rectangle shape, appears to be holding up very well in terms of shape, stability, ability to hold shell, and degradation.

- Tensar GeoReef at MBCL could have been filled with more shell to help retain shape, but it is very difficult to do this under the log runners.

- Shore parallel log at Wharton Point may not be high enough to efficiently break up wave energy so close to the installation. Shore perpendicular log runners at MBCL have performed relatively well.

- Recommend altering future attachment to tree runners using duckbills in future.

Some Lessons Learned

Stepped Crib and Vegetative Plantings

- Lanes Island shoreline changes may be too dynamic for a “living shoreline”

- Scale is extremely important: a small scale, 50-foot treatment may not be appropriate for determining efficacy of a treatment type along long shoreline lengths that are highly eroding.

- Projects employing vegetative plantings should completed in the spring so that vegetation has an entire growing period to establish.

- Though the installation eroded, it performed as expected in terms of its “failure”. We still feel a stepped-crib approach that beneficially uses trees is a transferable technique that can work along eroding bluff shorelines.

Some Lessons Learned

Monitoring

- **Photographic documentation** and **shoreline change measurements** (using RTKGPS and total station) have been the **best source of monitoring data**.

- **Detailed biologic and vegetative monitoring** have not shown any significant changes and are extremely labor intensive and likely shouldn’t be implemented unless significant planting is part of a project.

- **Accessibility has been a key factor** in being able to obtain good monitoring data, especially during the winter months.

For more information on living shorelines in Maine

Living Shorelines in Maine (MGS)
https://www.maine.gov/dacf/mgs/explore/marine/living-shorelines/

Living Shorelines Demonstration Project Video (GPCOG)
https://vimeo.com/485528619

Living Shorelines in New England (TNC)
https://www.conservationgateway.org/ConservationPractices/Marine/Pages/new-england-living-shorelines.aspx

Living Shoreline Pilot Project Case Studies (TNC)
https://www.nature.org/en-us/what-we-do/our-priorities/protect-water-and-land/land-and-water-stories/northeast-living-shorelines/

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Funding from: