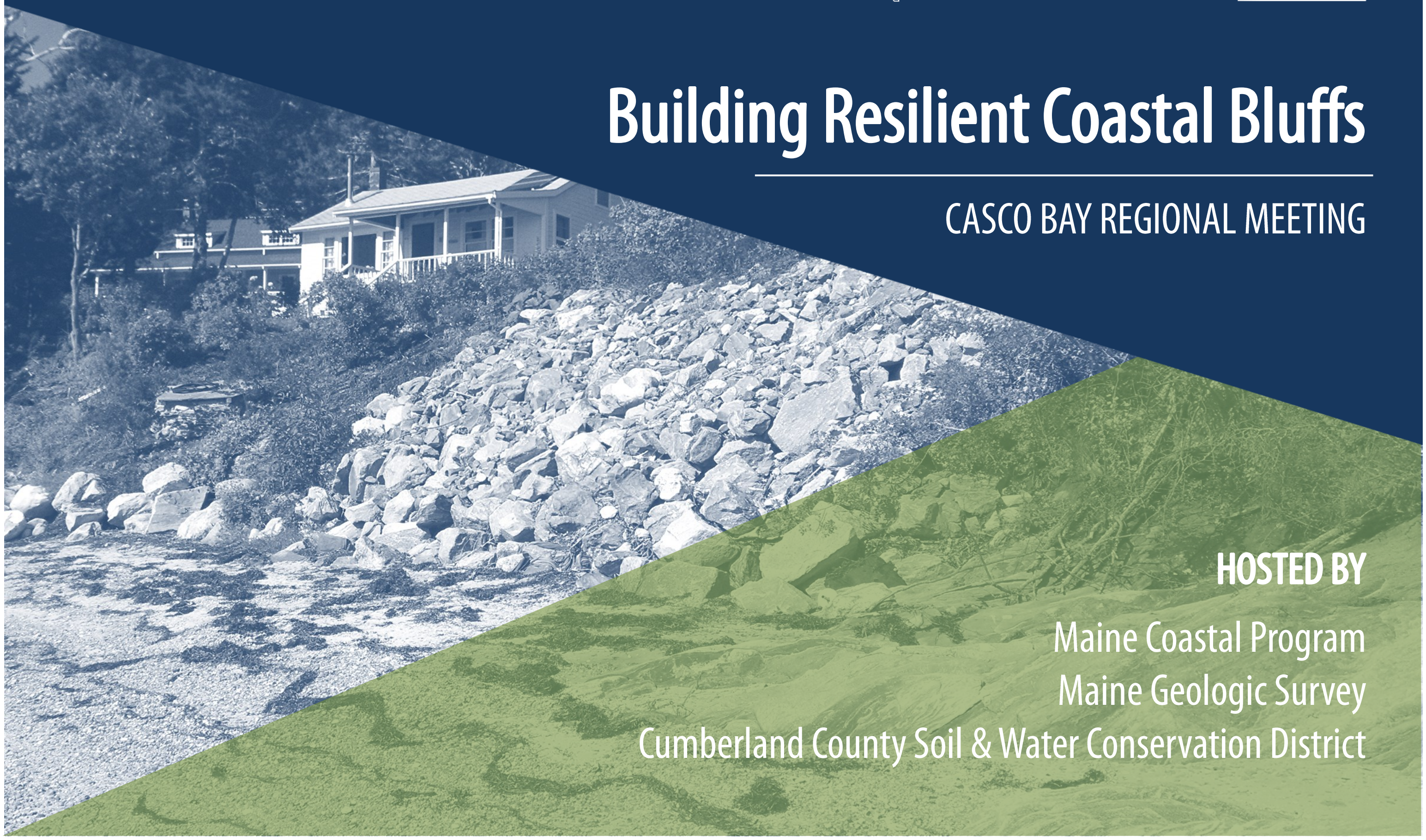
September 11, 2017 Final Workshop Materials

1. Event Flier
2. Workshop Agenda
3. Dickson Presentation – State of the Science, Part 1
4. Slovinsky Presentation – State of the Science, Part 2
5. Barry and Yakovleff Presentation – Applied Science, Decision Tree, Tools, Horticulture Guide
6. Woolston Presentation – Town of Brunswick's Coastal Work Group
7. Slovinsky Presentation – Regulatory Considerations

Cumberland County Soil & Water Conservation District

DEPARTMENT OF Agriculture Conservation & Forestry



Building Resilient Coastal Bluffs

CASCO BAY REGIONAL MEETING

HOSTED BY

Maine Coastal Program
Maine Geologic Survey
Cumberland County Soil & Water Conservation District

FREE

September 11, 2017 | 1:00 - 4:30 p.m.
GPCOG | 970 Baxter Boulevard, Portland

RSVP: Damon Yakovleff
dyakovleff@cumberlandswcd.org | 892.4700

AGENDA

1:00	Introductions & Overview
1:20	State of the Science (presentation + Q&A)
2:20	Break with refreshments
2:30	Applied Science: decision tree, plant guide, case studies (presentation + Q&A)
3:30	Brunswick Coastal Workgroup presentation
4:00	Regulatory Considerations
4:15	Next steps + discussion
4:30	Adjourn

Engineering PDHs available

Join the Maine Coastal Program, the Maine Geologic Survey, and the Cumberland County Soil & Water Conservation District to learn about the past 24 months of work to develop guidelines for utilizing living shorelines to stabilize Maine's coastal bluffs.

Partners will present information about:

- The group's case studies to determine appropriate applications for living shorelines.
- Decision-making tools developed to help determine the applicability of living shorelines in various locations.
- The plant selection guide developed for Maine's climate and coastal conditions.
- Regulatory considerations for coastal living shorelines.

Cumberland County Soil & Water Conservation District
35 Main Street, Suite 3
Windham, ME 04062
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Building Resilient Coastal Bluffs
CASCO BAY REGIONAL MEETING
September 11, 2017
GPCOG Office
970 Baxter Blvd., Portland ME

Agenda

1:00 PM	Introductions and Overview *Kathleen Leyden, Director, Maine Coastal Program*
1:10 PM	State of the Science. 30 min presentation, 30 min Q&A *Stephen M. Dickson, Ph. D., Maine Geological Survey; Peter Slovinsky, Maine Geological Survey*
2:10 PM	BREAK – Light refreshments
2:30 PM	Applied Science: Decision Tree, tools, horticulture guide, and case studies. 30 min presentation, 30 min Q&A *Troy Barry, Fluvial Geomorphologist; Cumberland County Soil and Water Conservation District Staff*
3:30 PM	Presentation on Brunswick Coastal Workgroup *Jared Woolston, Planner, Town of Brunswick*
4:00 PM	Regulatory Considerations Report Back *Peter Slovinsky, Maine Geological Survey;*
4:15 PM	Next steps and open discussion
4:30 PM	Adjourn

Coastal Bluffs
State of the Science

Stephen M. Dickson & Peter A. Slovinsky
Maine Geological Survey, DACF

Geography of Land Loss

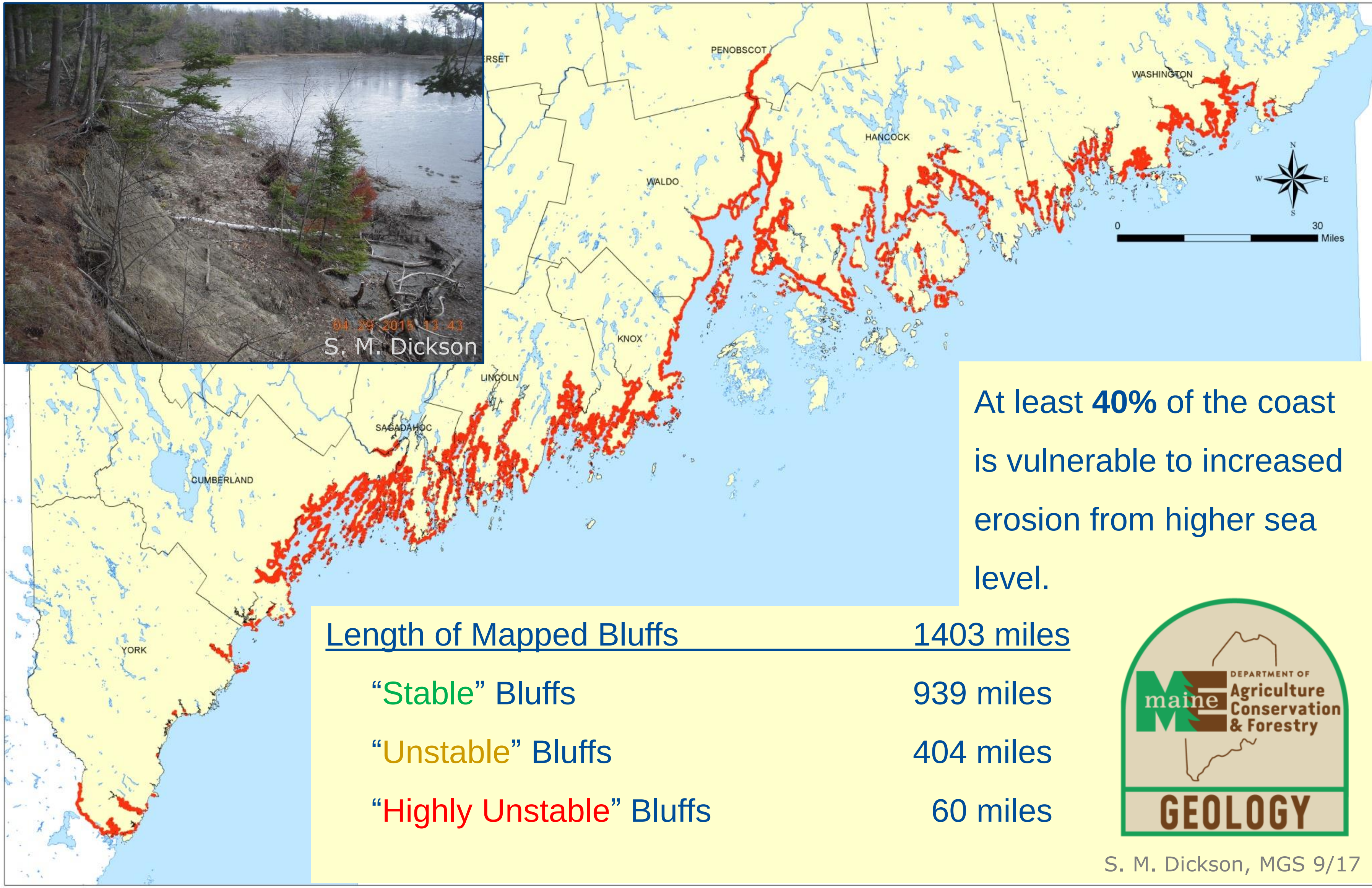
Bluff and Landslide Hazard Maps

Geological Processes

Engineering with Nature

Building Resilient Coastal Bluffs, GPCOG, September 11, 2017

Maine's Bluff Coast



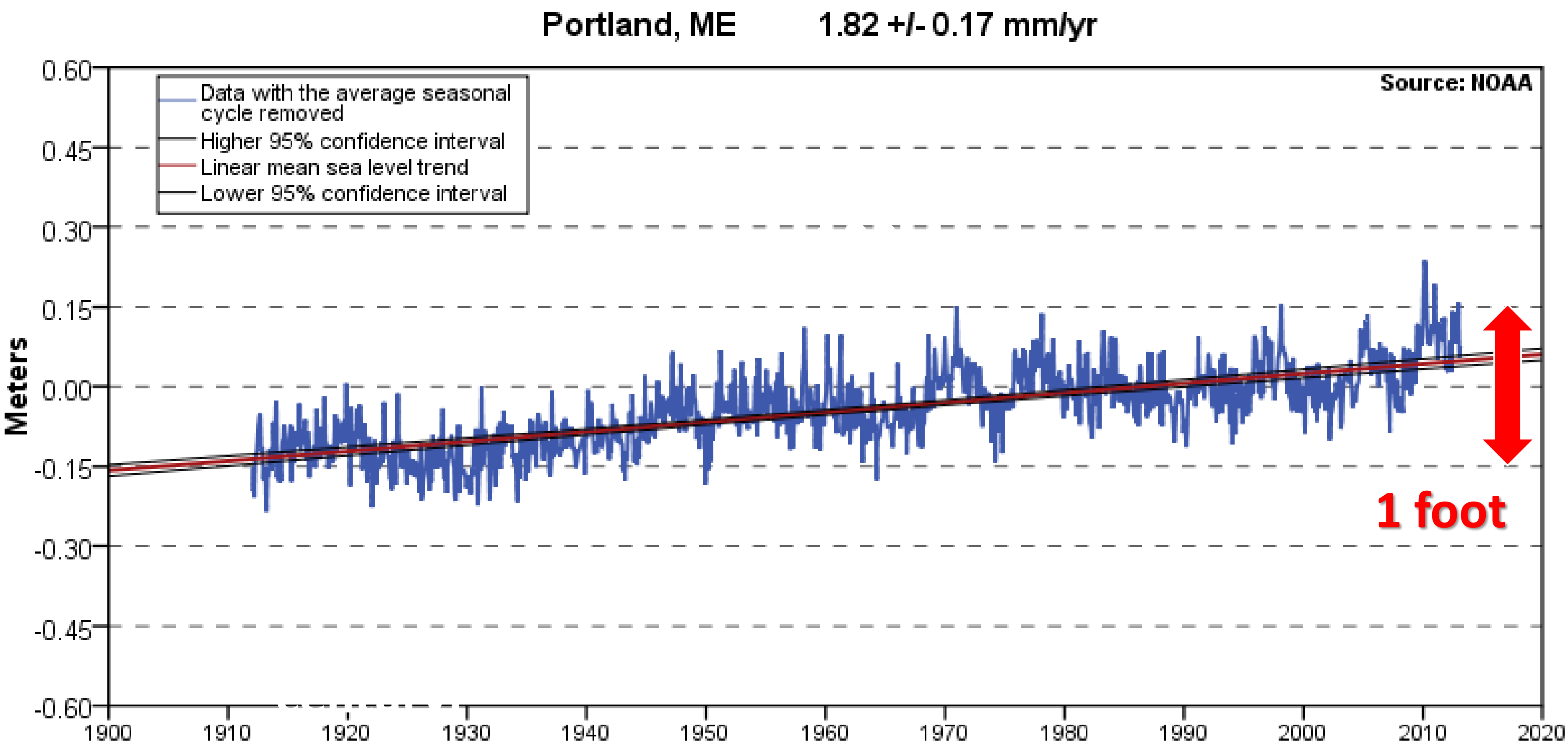
At least **40%** of the coast is vulnerable to increased erosion from higher sea level.

Length of Mapped Bluffs	1403 miles
"Stable" Bluffs	939 miles
"Unstable" Bluffs	404 miles
"Highly Unstable" Bluffs	60 miles

maine DEPARTMENT OF Agriculture Conservation & Forestry GEOLOGY

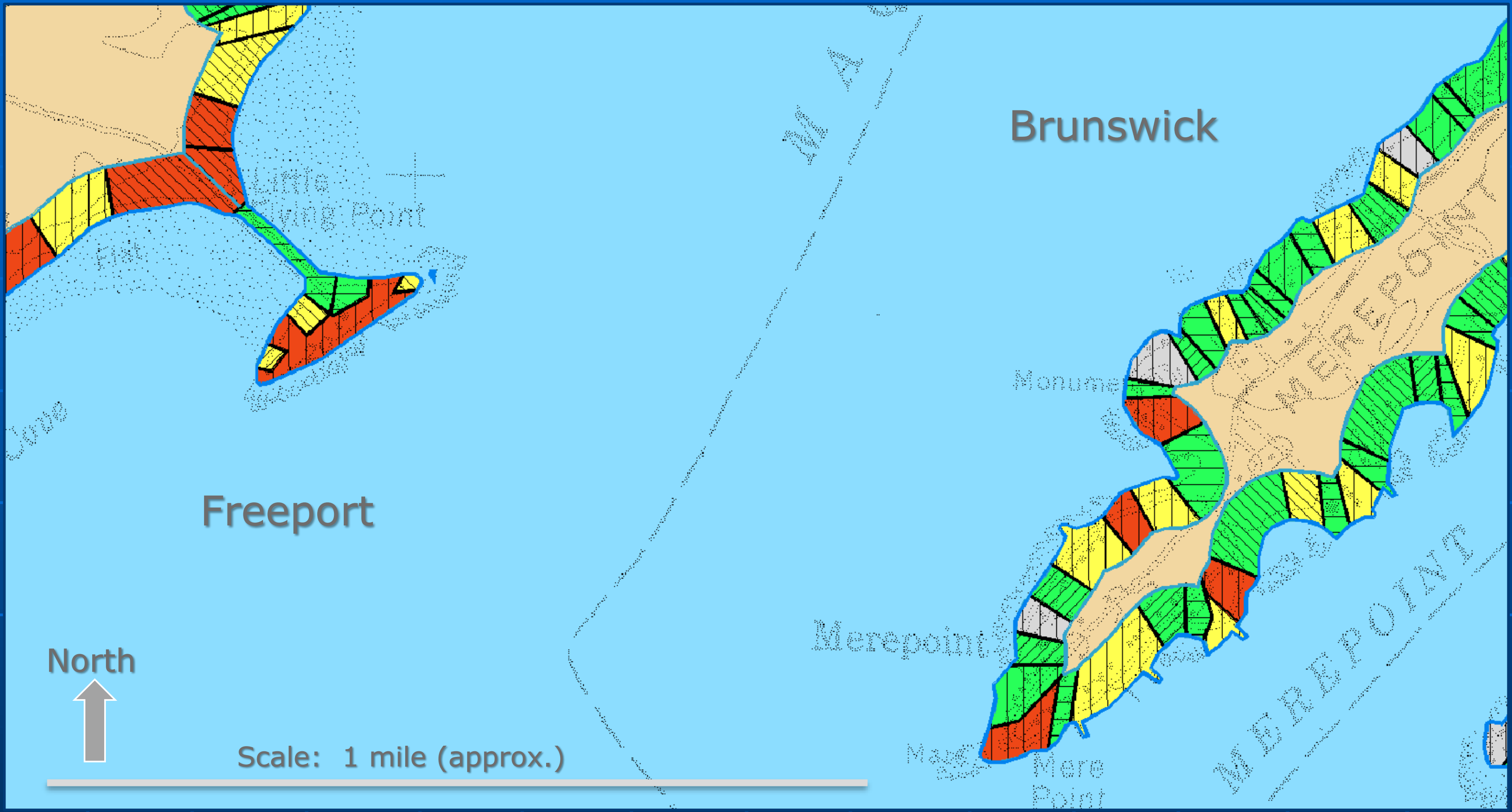
S. M. Dickson, MGS 9/17

Tides: The Last 100 Years



http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8418150

Coastal Bluff Map



Red = “Highly Unstable”

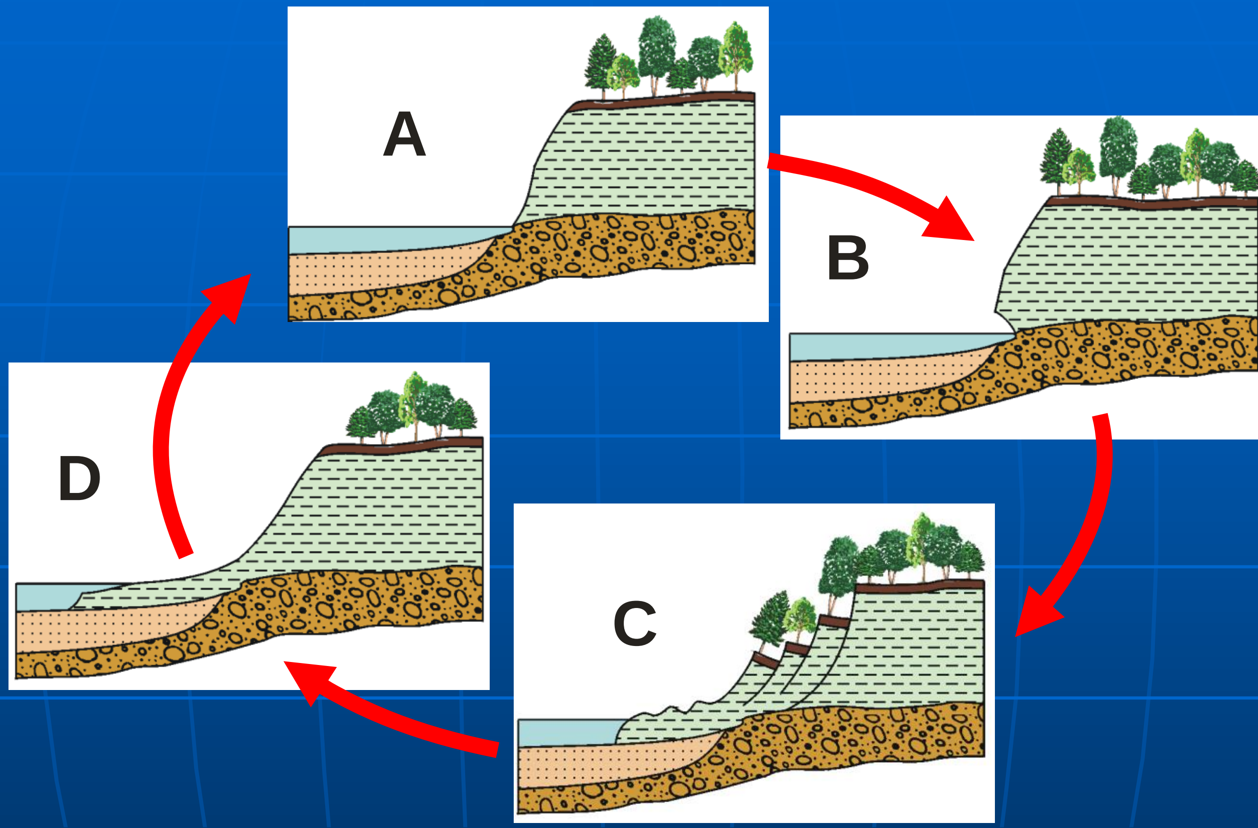
Yellow = “Unstable”

Green = “Stable”

Online as PDFs or GIS layer
Freeport Quadrangle
MGS Open-File No. 02-188

S. M. Dickson, MGS 9/17

Bluff Erosion Cycle



A steep bluff (A) is undercut by waves, tides, and coastal flooding (B). Oversteepening can lead to loss from the bluff face or to a more dramatic landslide (C). Slump blocks protect the toe for years (D).

Slope Failure

- Onto the tidal flat

Reworked

- Sediment for shore protection

- Mud for sea-level rise on flats & marshes

- Net loss of upland

S. M. Dickson

2007 Patriots' Day Storm, Mere Point, Brunswick

J. T. Kelley

Natural Protection

Fringing salt marshes form on slumped bluff sediment. This deposit reduces toe erosion for decades and stabilizes the bluff.

Freshwater & Ice

- Groundwater release mid-slope
- Frozen ground
- Freeze-thaw cycles
- Shore-fast ice

S. M. Dickson

S. M. Dickson

Mitchell Field, Harpswell, Case Study Site, March 6, 2017

Trees

Slide down slope

Support the bluff from the toe

Biodegrade over time

Break waves

S. M. Dickson

S. M. Dickson

Mackworth Island, Falmouth
Case Study Site
March 10, 2017

Erosion reduced by trees
- Dead
- Living

Stabilization

Then

S. M. Dickson

Anything goes…

Now

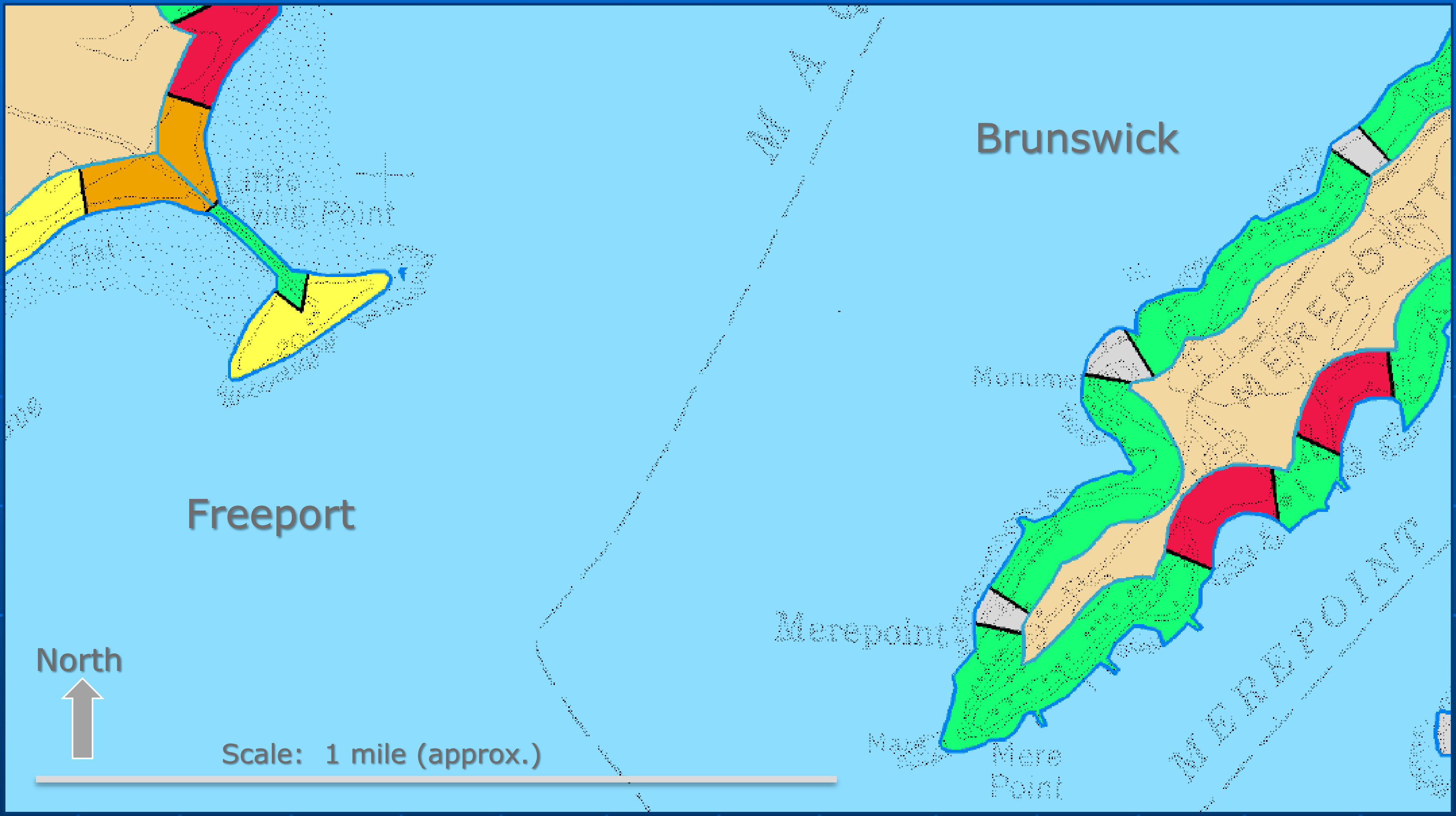
S. M. Dickson

Sediment supply cut off to tidal area
Wave reflection causes toe scour

S. M. Dickson, MGS 9/17


Rockland Harbor April 1996
A stabilization challenge
http://digitalmaine.com/mgs_publications/301/

Coastal Landslide Map



Red = Known Landside Site

Orange = Landslide Risk Area

Yellow = Potential Landslide Area

Green = Low Coastal Bluff

Online as PDFs or GIS layer
Freeport Quadrangle
MGS Open-File No. 01-517

S. M. Dickson, MGS 9/17

Shoreline Stabilization

BUSINESS SUNDAY

LAWTON: AS HOUSE MARKET COOLS, WHAT YOU CAN EXPECT F4

The Motley Fool/F2
The Bottom Line/F4
Weather/F6

Sunday, October 1, 2006 — Maine Sunday Telegram — SECTION F

MICHELLE SINGLETARY
THE COLOR OF MONEY

Time is right to re-evaluate your insurance

It's time for open enrollment. That means millions of workers will be evaluating their health, life and disability insurance options as part of their employee benefit's package.

I don't know about you, but when that fat envelope comes in the mail I cringe. There's just so much information to pore over my head hurts just looking at the package.

Trying to decide what coverage to get for yourself or your family can be a trying experience. According to a survey conducted by Aetna and the Financial Planning Association, nearly two-thirds of women are responsible for family health care decisions and 35 percent of them do not know basic information about health benefits and more than half (54 percent)

BLUFFS TAKE A BEATING

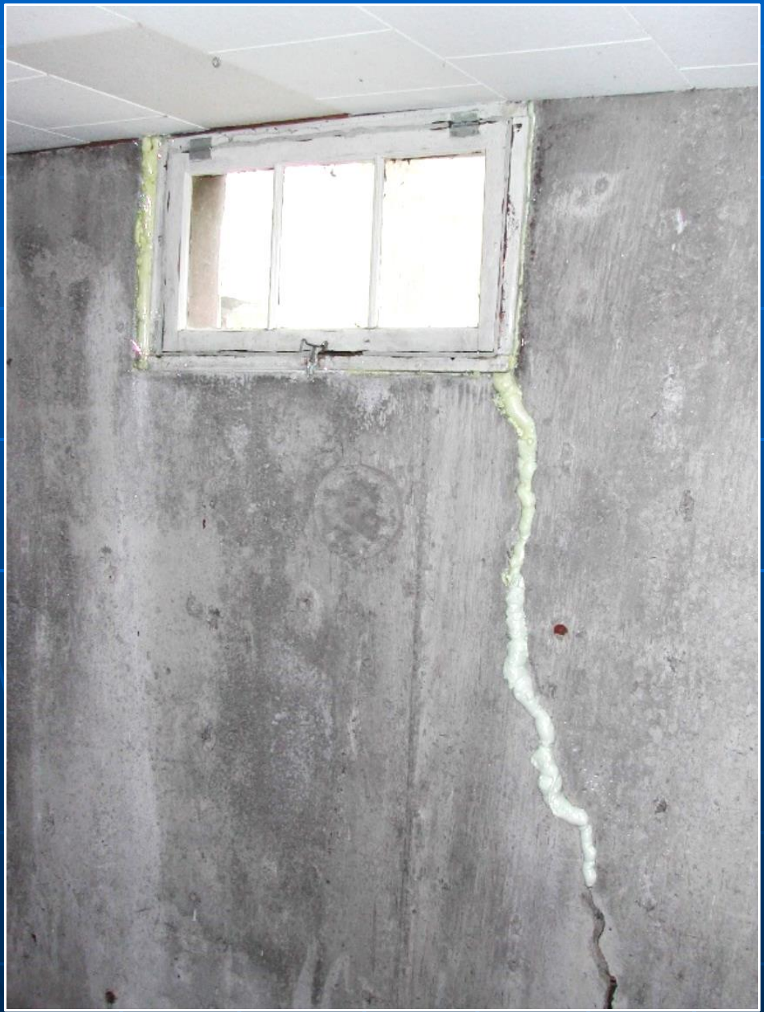
Some of the state's priciest shorefront real estate is also its most vulnerable. As sea level climbs, some homeowners are getting an expensive lesson in geology.

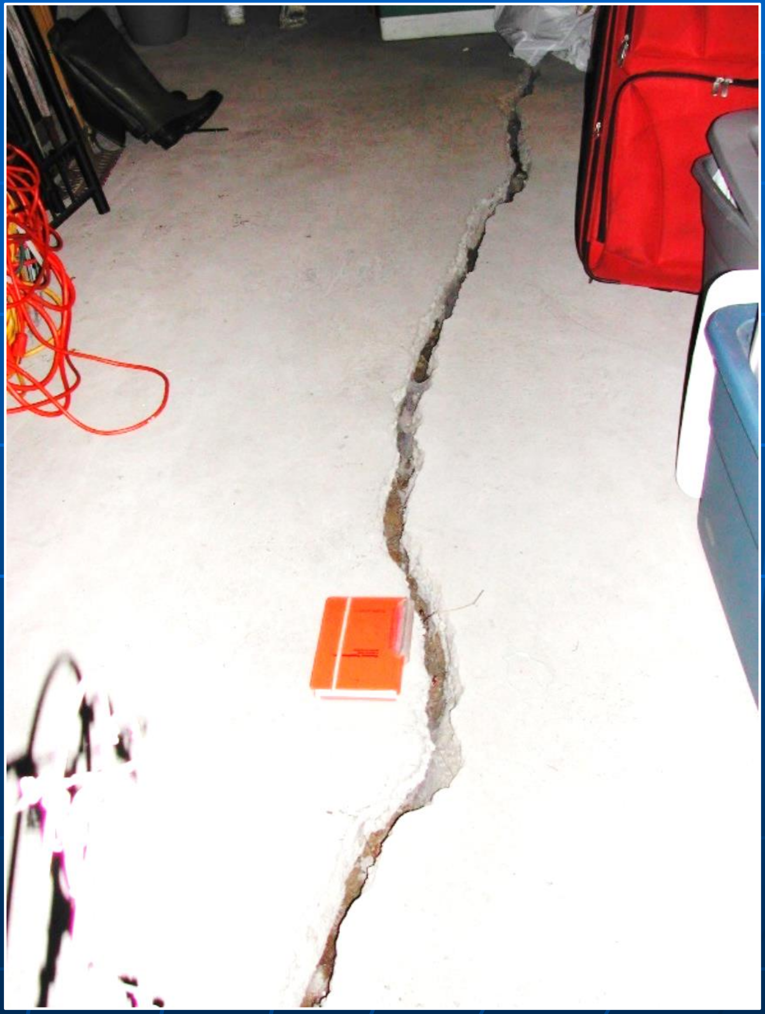
Photo courtesy of Jim Gilson

LAST MARCH:

Slope remediation and risk reduction involves geological and geotechnical analysis, earthworks, shoreline armor, and expense.

The Longer You Wait, the Harder it Gets to Stabilize





Is There a Better Way?
Without
...... ?
04.29.2015 13:24
S. M. Dickson, MGS 9/17

Building Resilient Coastal Bluffs – Casco Bay Regional Meeting
Living Shorelines

Peter Slovinsky, Marine Geologist
Maine Geological Survey

maine Department of Agriculture Conservation & Forestry
GEOLOGY

Maine DEP

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:

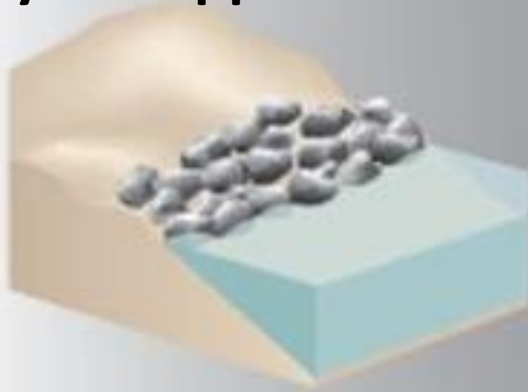
- has a footprint that is made up **mostly of native material**.
- **incorporates vegetation** or other living, natural "soft" elements **alone or in combination with** some type of harder shoreline structure (e.g. oyster reefs or rock sills) for added stability.
- **maintains continuity of the natural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

Adapted from NOAA's Guidance for Considering the Use of Living Shorelines (2015)

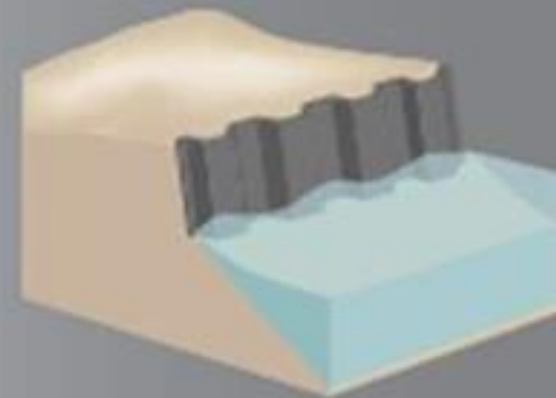
Traditional “Gray” Approaches

“Grayer” Approaches →

BREAKWATER - (vegetation optional) - Offshore structures intended to break waves, reducing the force of wave action, and encourage sediment accretion. Suitable for most areas.



REVETMENT - Lays over the slope of the shoreline and protects it from erosion and waves. Suitable for sites with existing hardened shoreline structures.

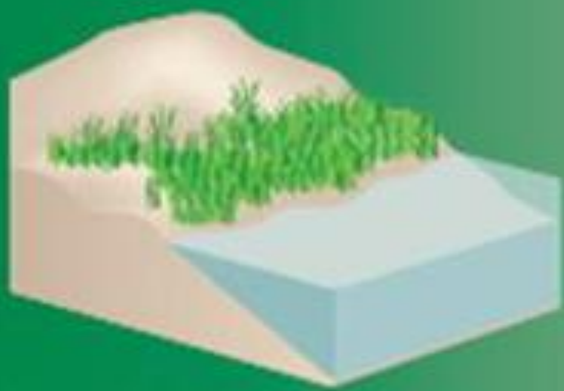


BULKHEAD - Vertical wall parallel to the shoreline intended to hold soil in place. Suitable for high energy settings and sites with existing hard shoreline structures.

Adapted from NOAA’s Guidance for Considering the Use of Living Shorelines (2015)

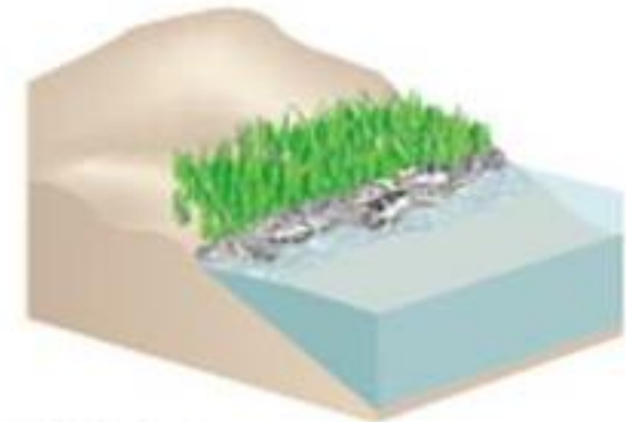
Living Shoreline "Green" Approaches

← **"Greener" Approaches**



VEGETATION ONLY - Provides a buffer to upland areas and breaks small waves. Suitable for low wave energy environments.

EDGING - Added structure holds the toe of existing or vegetated slope in place. Suitable for most areas except high wave energy environments.



SILLS - Parallel to vegetated shoreline, reduces wave energy, and prevents erosion. Suitable for most areas except high wave energy environments.

Adapted from NOAA's Guidance for Considering the Use of Living Shorelines (2015)

Why Living Shorelines?

Living shorelines use plants or other natural elements—sometimes in combination with harder shoreline structures—to stabilize estuarine coasts, bays, and tributaries.

One square mile of salt marsh stores the carbon equivalent of **76,000 gal of gas** annually.

Marshes trap sediments from tidal waters, allowing them to **grow in elevation** as sea level rises.

Living shorelines improve **water quality**, provide fisheries **habitat**, increase **biodiversity**, and promote **recreation**.

Marshes and oyster reefs act as natural **barriers** to waves. **15 ft** of marsh can **absorb 50%** of incoming wave energy.

Living shorelines are **more resilient** against storms than bulkheads.

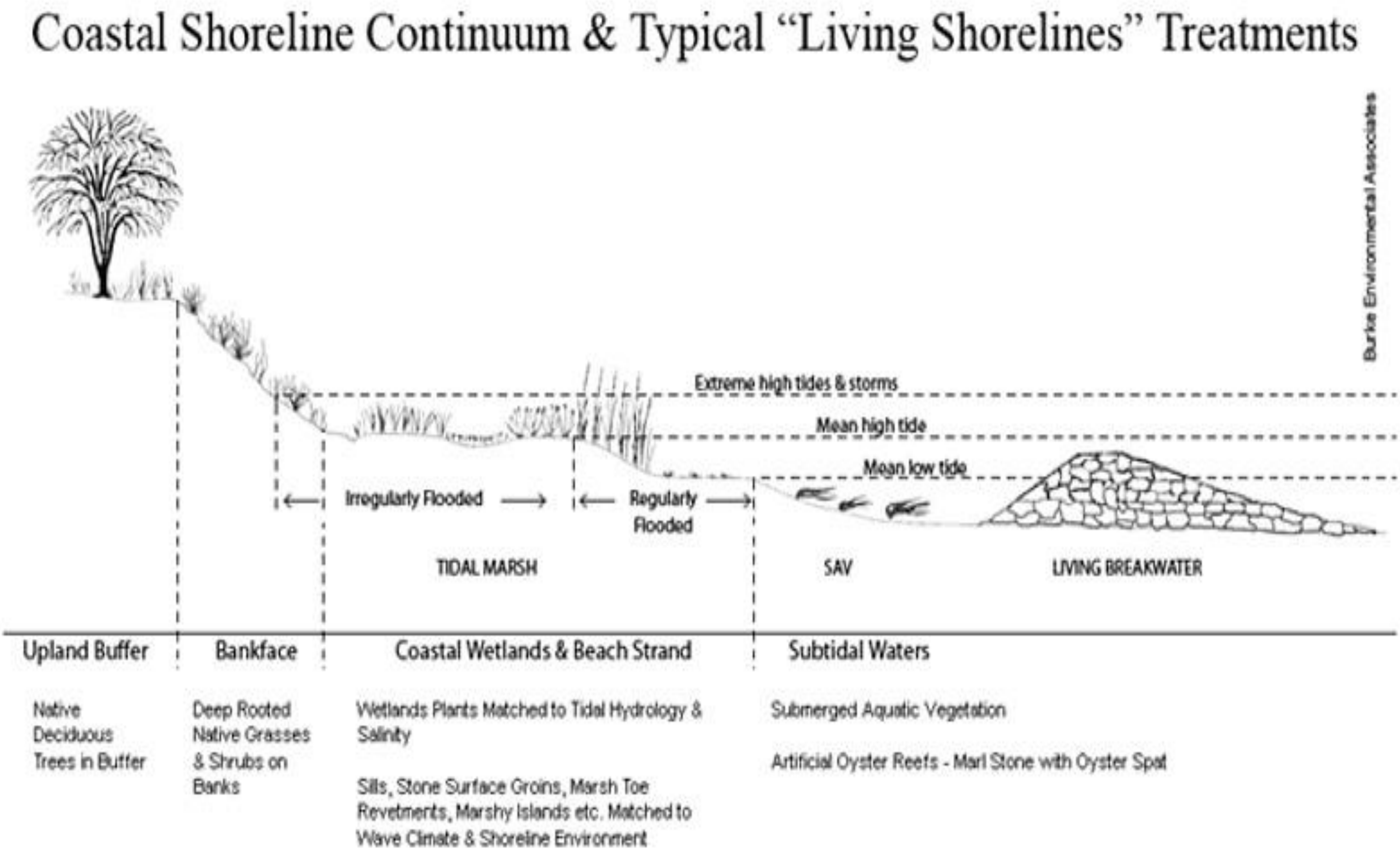
33% of shorelines in the U.S. will be **hardened** by **2100**, decreasing fisheries habitat and biodiversity.

Hard shoreline structures like **bulkheads** prevent natural marsh migration and may create seaward **erosion**.

The National Centers for Coastal Ocean Science | coastalscience.noaa.gov

Some graphics courtesy of the Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/symbols/)

Where can living shorelines be implemented?




Bluff regrading, planting, coir log toe
Bustins Island, Freeport
T. Barry


Hybrid bluff stabilization
Royal River, Freeport
06/04/2015
MEDEP


Dune Restoration
Ferry Beach, Saco
P. Slovinsky, MGS


Beach Nourishment
Western Beach, Scarborough
P. Slovinsky, MGS

Why are we researching living shorelines now?

- Increase in requests for permitting of shoreline stabilization projects, especially for **coastal bluffs** (both developed and undeveloped) and along coastal marshes
- Increased interest from municipalities for "softer" approaches
- NOAA funded Project of Special Merit: *Building Resiliency Along Maine's Bluff Coast*
- NOAA funded project: ***High Resolution Coastal Inundation Modeling and Advancement of Green Infrastructure and Living Shoreline Approaches in the Northeast***

High Resolution Coastal Inundation Modeling and Advancement of Green Infrastructure and Living Shoreline Approaches in the Northeast

Partners – NERACOOS, NROC, ME, NH, MA, RI, CT, and state universities

Track 1 – Advancing High Resolution Coastal Inundation Forecasting in the Northeast

Track 2 – Advancing Green Infrastructure and Living Shoreline Approaches

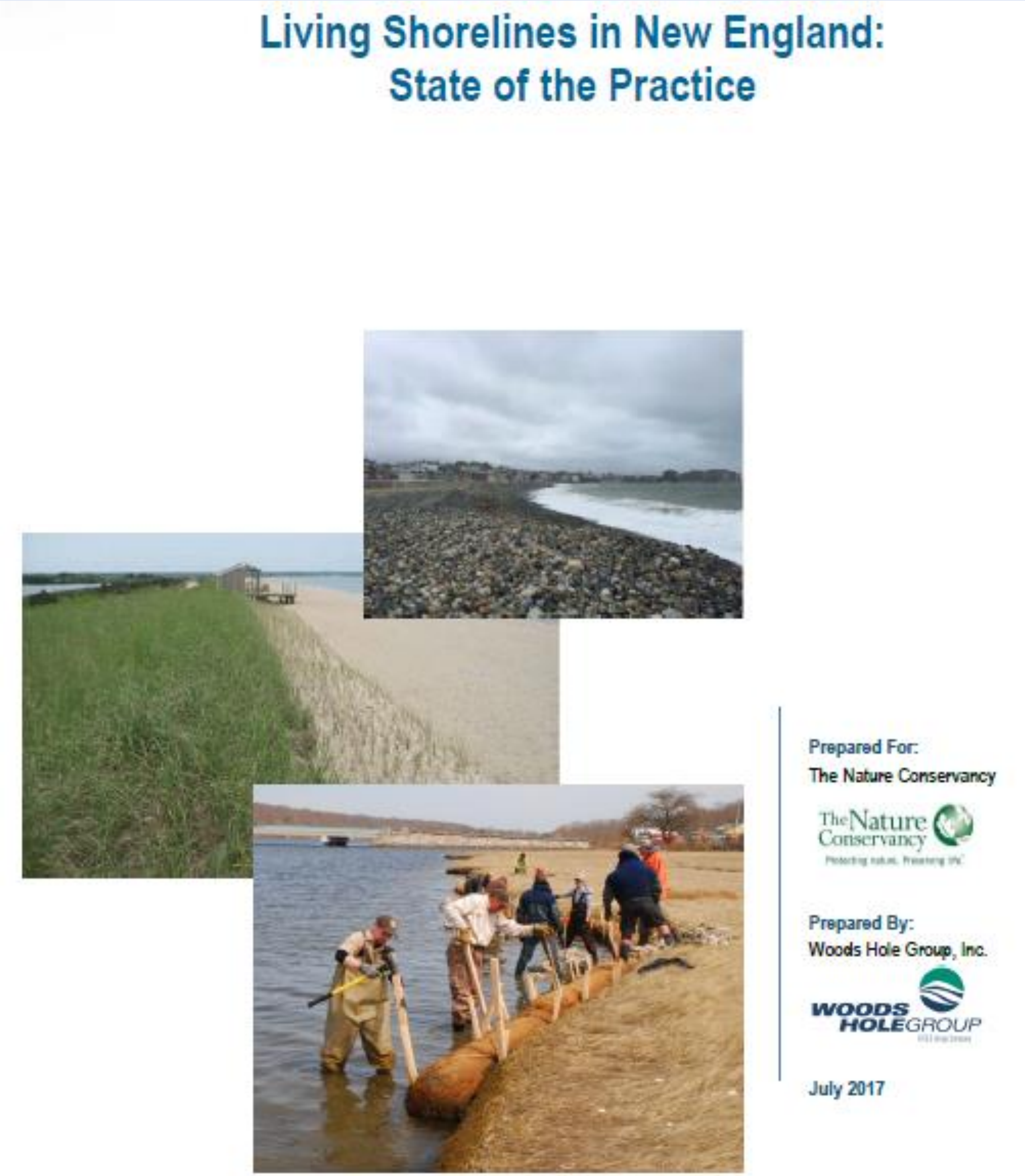
- Task 1 – Support The Nature Conservancy's work on **developing "state-of-the science" analysis of living shoreline and coastal green infrastructure** practice/project types, applicability, and performance.

- Task 2 – Examine, identify, and **address regulatory issues associated with green infrastructure/living shoreline practices** and develop efficiencies for permitting.

- Task 3 – Improve **understanding, capabilities, and proficiency of the availability and applicability** of green infrastructure/living shoreline practices.

- Task 4 – Community-based green infrastructure/living shoreline planning and assessment **pilot projects**.

Living shoreline refers to a set of coastal erosion control practices, ranging from **non-structural vegetated approaches to hybrid hard structural/restorative** natural methods, that address **erosion** and **inundation** in a manner that **improves or protects the ecological condition** of the coastline.



https://www.conservationgateway.org/ConservationPractices/Marine/Pages/new-england-living-shorelines.aspx

Living Shoreline Types: Profile Pages

Dune – Natural
Dune – Engineered Core
Beach Nourishment
Coastal Bank – Natural
Coastal Bank – Engineered Core
Natural Marsh Creation/Enhancement
Marsh Creation w/Toe
Living Breakwater

Living Shorelines Introduction

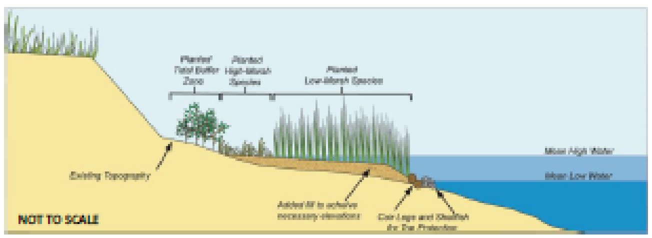
A detailed profile page was created for each of the eight (8) living shoreline types listed below. The purpose of these profile pages is to provide a comprehensive overview of the design recommendations, siting criteria and regulatory topics pertinent to a range of living shorelines designs that practitioners 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.



Case Study

One example case study, with the following information, is provided for each living shoreline type.

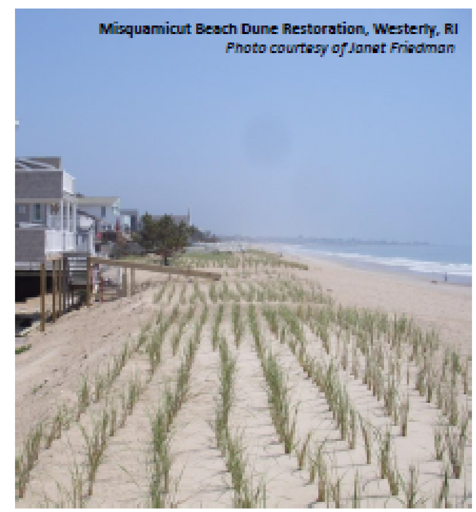
Project Proponent	The party responsible for the project.
Status	The status of the project (i.e. design stage, under construction, or completed) and completion date if appropriate.
Permitting Insights	This section notes any specific permitting hurdles that occurred, or any regulatory insights that might help facilitate similar projects in the future.
Construction Notes	This section identifies major construction methods or techniques, any unique materials that were used, or deviations from a traditional design to accommodate site specific conditions.
Maintenance Issues	If the project is complete and has entered the maintenance phase, this section will note whether the project has functioned correctly, if it is holding up, and/or if any specific maintenance needs have been required since construction.
Final Cost	This section provides costs for the project, broken down into permitting, construction, monitoring, etc. when possible.
Challenges	This sections highlights any unique challenges associated with a particular project and how they were handled.

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

cy	Cubic yards; one cubic yard equal 27 cubic feet. Project materials are often measured in cubic yards.
MHW	Mean High Water: The average of all the high water (i.e. high tide) heights observed over a period of time.
MTL	Mean Tide Level: The average of mean high water and mean low water.
MLW	Mean Low Water: The average of all the low water (i.e. low tide) heights observed over a period of time.
SAV	Submerged aquatic vegetation, which includes seagrasses such as eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*).
Sediment	Naturally occurring materials that have been broken down by weathering and erosion. Finer, small-grained sediments are silts or clays. Slightly coarser sediments are sands. Even larger materials are gravels or cobbles.



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

https://www.conservationgateway.org/ConservationPractices/Marine/crr/Documents/FINAL_CombinedProfilePages_7_12_2017.pdf

Living Shoreline Types: Profile Pages

Dune – Natural
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Living Shorelines Introduction

Overview of Regulatory and Review Agencies Table

This table is intended to provide a comprehensive list of all the regulatory and review agencies that would potentially need to be contacted for a particular type of living shoreline project. State agencies are listed separately for each of the five coastal northeast states (Maine, New Hampshire, Massachusetts, Rhode Island and Connecticut). Federal agencies that may need to be contacted for a project in any state are also listed. Note that these lists represent the full range of potential agencies. If projects do not exceed certain thresholds (e.g. extending below MHW, exceeding a certain footprint area) they may not be required to contact or receive a permit from all agencies listed.

City Beach Nourishment, Warwick, RI
Photo courtesy of Janet Freedman

Reef Ball Living Breakwater and Marsh Restoration
Stratford, CT
Photo courtesy of Jennifer Mattei

Use and Applicability of Profile Pages

The profile pages that follow have been developed to improve the understanding of eight (8) different living shoreline designs. They have been designed to facilitate communication among the public, regulators, practitioners and researchers and to provide a common starting place for more detailed design discussions to follow. They are one of many resources available to those interested in coastal resilience. The compact layout provides a printable 11" x 17" page that can be used in the field or office. The format captures the primary focus areas required to identify which living shoreline designs are a good fit for a specific site (note that there may be multiple living shoreline options for some sites). The reader is presented with specific site characteristics, a conceptualization of the overall design, the challenges and benefits associated with each living shoreline design type, identification of the regulatory agencies involved in approving a design, and an illustration of how all of those components come together in a case study for each living shoreline type. These profile pages are expected to be updated periodically as more data become available. These profile pages should not take the place of a more comprehensive site evaluation and design process, but are intended to help further engage stakeholders and experts in an informed discussion about various living shoreline types.

Explanation Key for Siting Characteristics and Design Considerations

Selection Characteristics	Definitions and Categories
ES Energy State	A measure of the wave height, current strength and storm surge frequency of a site that would be suitable for a particular living shoreline project type. 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
EE Existing Environmental Resources	Existing environmental resources that a proposed living shoreline project is able to overlap with. Coastal Bank, Salt Marsh, Vegetated Upland Coastal Dune, Mudflat Coastal Beach, Subtidal
SR Nearby Sensitive Resources	Nearby sensitive resources that, with proper planning and design, may be compatible with a particular living shoreline type. Endangered/Threatened Species Submerged Aquatic Vegetation (SAV) Shellfish Cobble or Rocky Bottom Habitat
TR Tidal Range	The magnitude of tidal range at a site that would be suitable for a particular type of living shoreline design. High: Tide range at project site is more than 9 feet Moderate: Tide range at project site is between 3 and 9 feet Low: Tide range at project site is less than 3 feet
EL Elevation	The elevation, with respect to the tide range, where a particular living shoreline project type should be sited. Above MHW: Project footprint is entirely above MHW MHW to MLW: Project footprint is located within the intertidal zone Below MLW: Project footprint is located in subtidal areas
IS Intertidal Slope	The intertidal slope appropriate for siting a particular living shoreline project type. Steep: Project site has an intertidal slope steeper than 3:1 (base:height) Moderate: Project site has an intertidal slope between 3:1 and 5:1 (base:height) Flat: Project site has an intertidal slope flatter than 5:1 (base:height)
BS Bathymetric Slope	The nearshore bathymetric slope appropriate for siting a particular living shoreline project type. Steep: Project site has an bathymetric slope steeper than 3:1 (base:height) Moderate: Project site has an bathymetric slope between 3:1 and 5:1 (base:height) Flat: Project site has an bathymetric slope flatter than 5:1 (base:height)
ER Erosion	The rate of coastal erosion at a site that would be suitable for a particular living shoreline project type. High: Erosion at project site is high (>3 feet/year) Moderate: Erosion at project site is moderate (1-3 feet/year) Low: Erosion at project site is low (<1 foot/year)

https://www.conservationgateway.org/ConservationPractices/Marine/crr/Documents/FINAL_CombinedProfilePages_7_12_2017.pdf

Living Shoreline Types: Profile Pages

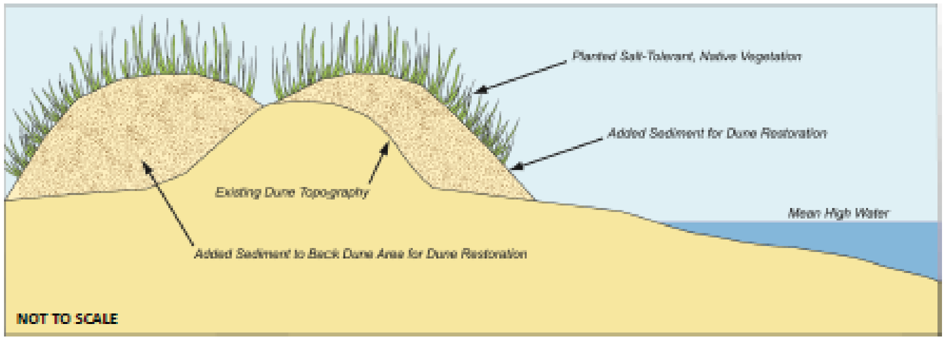
Dune - Natural

Dune - Natural

Dune building projects involve the placement of compatible sediment on an existing dune, or creation of an artificial dune by building up a mound of sediment at the back of the beach.[1] This may be a component of a beach nourishment effort or a stand alone project.

Objectives: erosion control; shoreline protection; dissipate wave energy; enhanced wildlife and shorebird habitat.

Design Schematics



Case Study

Ferry Beach, Saco, Maine

Relatively high beach and dune erosion (approximately 3 feet per year) prompted the FBPA to undertake a dune restoration project to help protect roads and homes from flooding and erosion. Given the relatively high erosion rate, it was decided that placing sediment for restoration seaward of the existing dune would be short-lived. A secondary frontal dune ridge landward of the existing dune crest was constructed instead, allowing native vegetation to establish.

Ferry Beach, Saco, ME
Photo courtesy of Peter Slovinsky

Project Proponent	Ferry Beach Park Association (FBPA)
Status	Completed 2009
Permitting Insights	Permit-by-Rule needed from Maine DEP
Construction Notes	An 800 foot long secondary dune was built to 1 foot above the effective FEMA 100-year BFE. A secondary dune was built because erosion of the front dune was considered too high (>3 feet per year) to have a successful project. 1,800 cy of dune-compatible sediment was delivered via truck from a local gravel pit. Construction and planting occurred in early spring. Volunteers planted native American Beach grass.
Maintenance Issues	Sand fencing was used to help trap sediment in the constructed dune, and to help maintain the seaward edge of the original dune. However, shoreline erosion has continued; as of May 2017 the restored dune has started to erode.
Final Cost	$29,000 and volunteer hours
Challenges	Trucking 90 dump-truck loads of sediment through the community. Construction and planting timing windows associated with piping plover nesting. Continued erosion.

Overview of Technique

Materials	Sediment is brought in from an offsite source, such as a sand and gravel pit or coastal dredging project.[1] Planting the dune with native, salt-tolerant, erosion-control vegetation (e.g., beach grass *Ammophilia breviligulata*) with extensive root systems is highly recommended to help hold the sediments in place.[1,11] Sand fencing can also be installed to trap windblown sand to help maintain and build the volume of a dune.[1,11]
Habitat Components	Dunes planted with native beach grass can provide significant wildlife habitat.[9]
Durability and Maintenance	The height, length, and width of a dune relative to the size of the predicted storm waves and storm surge determines the level of protection the dune can provide.[1] To maintain an effective dune, sediment may need to be added regularly to keep dune's height, width, and volume at appropriate levels.[1] The seaward slope of the dune should typically be less steep than 3:1 (base:height).[1,9] Dunes with vegetation perform more efficiently, ensuring stability, greater energy dissipation, and resistance to erosion.[10] If plantings were included, plants should be replaced if they are removed by storm or die.[1]
Design Life	Dunes typically erode during storm events. In areas with no beach at high tide, dune projects will be short lived as sediments are rapidly eroded and redistributed to the nearshore.[1] Designs should consider techniques that enhance or maintain the dune (e.g. sand fencing and/or vegetation to trap wind blown sand).
Ecological Services Provided	The added sediment from dune projects supports the protective capacity of the entire beach system (i.e., dune, beach, and nearshore area). Any sand eroded from the dune during a storm, supplies a reservoir of sand to the fronting beach and nearshore area.[1,9] Dunes dissipate rather than reflect wave energy, as is the case with hard structures.[1] Dunes also act as a barrier to storm surges and flooding, protecting landward coastal resources,[9] and reducing overwash events.[10] Sand dunes provide a unique wildlife habitat.[9]
Unique Adaptations to NE Challenges (e.g. ice, winter storms, cold temps)	Shorter planting and construction window due to shorter growing season. Utilization of irrigation to establish plants quickly. Presence of sensitive species may require design (e.g. slope, plant density) and timing adjustments.

Living Shoreline Types: Profile Pages

Dune - Natural

Dune - Natural

Dune projects may be appropriate for areas with dry beach at high tide and sufficient space to maintain dry beach even after the new dune sediments are added to the site, and can be done independently, or in conjunction with a beach nourishment project.

Duxbury Beach, Duxbury, MA
Photo courtesy of Woods Hole Group

Cow Bay Beach, Martha's Vineyard, MA
Photo courtesy of Woods Hole Group

Regulatory and Review Agencies

Maine	Municipal Shoreland Zoning, Municipal Floodplain, ME Dept. of Environmental Protection, ME Land Use Planning Commission, ME Coastal Program, ME Dept. of Marine Resources, ME Dept. of Inland Fisheries and Wildlife, and ME Geological Survey.
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 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.
Connecticut	Local Planning and Zoning Commission, and CT Department of Energy and Environmental Protection.
Federal (for all states)	U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service.

Siting Characteristics and Design Considerations

Selection Characteristics	Detail
ES Energy State	Low to high
EE Existing Environmental Resources	Coastal beach; coastal dune; coastal bank
SR Nearby Sensitive Resources	All. Dune projects can be successfully designed even in the presence of sensitive resource areas. However, special consideration is needed near salt marsh, horseshoe crab spawning grounds, and other sensitive habitats. Sediment can smother plants and animals if it is eroded quickly and carried to these areas. Impacts can be minimized by placing dunes as far landward as possible and using compatible grain size.[1] In addition, plantings may need to be thinned for dune projects in nesting habitat for protected shorebird and turtle species.[1,9]
TR Tidal Range	Low to high
EL Elevation	Above MHW. Dune projects require a dry high tide beach to be successful.
IS Intertidal Slope	Flat to steep
BS Bathymetric Slope	Flat to steep
ER Erosion	Low to high
Other Characteristics	**Detail**
Grain Size	It is important to utilize sediment with a grain size and shape compatible to the site.[5] The percentage of sand-, gravel-, and cobble-sized sediment should match, or be slightly coarser than, the existing dune sediments.[1] Mixed sediment dunes may be appropriate and necessary for some locations.[5] The shape of the material is also important, especially for larger sediment, and should be rounded rather than angular.[1]
Impairment Level	Consideration should be given to invasive species, level of existing armoring, and extent of public use.
Climate Vulnerability	The long-term climate vulnerability of the restored dune will be influenced by a number of factors, including what is behind the landform; if the dune/beach is backed by natural landscape, it will be able to respond naturally to storms and overwash and migrate over time. Hard landscape, such as seawalls, parking lots, roads, and buildings will prevent this movement, and may ultimately cause narrowing or disappearance of these resources.
Surrounding Land Use	Shoreline armoring changes the lateral movement of sediment, thereby affecting sediment flows to nearby dunes. Therefore, any armoring adjacent to a dune restoration site needs to be taken into consideration during the planning process.[5] Dune restoration will be most successful if it is located where the natural dune line should be and, if possible, tied into existing dunes.[11] Dunes are not well suited for major urban centers or large port/harbor facilities because of space requirements and the level of risk reduction required.[10]

Developing a GIS-based decision support tool for **living shoreline suitability** in Casco Bay

Living Shorelines Technical Working Group

Literature Review
Living Shoreline Suitability
Decision Support Tools

Vegetation for Tidal Shoreline Stabilization in the Mid-Atlantic States (USDA, 1980)
Living Shorelines in Cold Climates Report (NOAA, 2016)
Guidance for the Use of Living Shorelines (NOAA, 2015)
Living Shoreline Conference (RAE, 2015)

Decision Support Tools from:

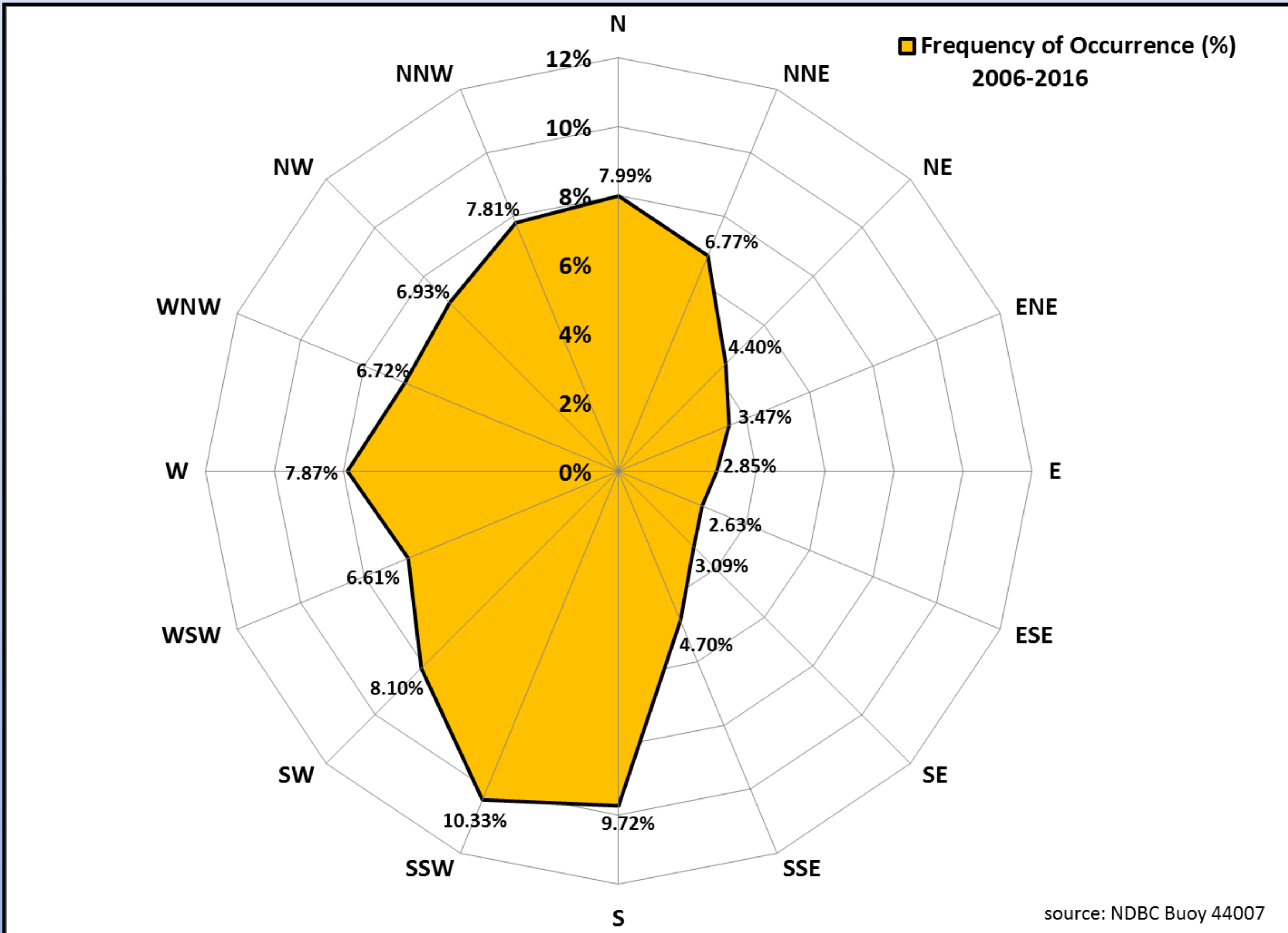
Maryland	Virginia	Connecticut	North Carolina
Alabama	Delaware	New Jersey	

Factors Influencing Living Shoreline Suitability

- **Annualized Weighted Fetch (predominant wind directions)**
- **Nearshore Bathymetry (within 100 feet of the shoreline)**
- **Dominant Landward Shoreline Type**
- **Dominant Seaward Shoreline Type**
- **Upland Relief (within 50 feet of the shoreline)**
- **Upland Slope (within 50 feet of the shoreline)**
- **Aspect (sunlight exposure, southeast to southwest)**
- **Presence or Absence of Special Habitat Types**
  - **Eelgrass, Tidal Wading Birds, Shellfish**

Annualized Weighted Fetch – USGS Fetch Tool

Hourly Wind Data from NDBC 44007 (2006-2016)
12 NM Southeast of Portland, ME



Annualized Weighted Fetch – Scoring Protocol

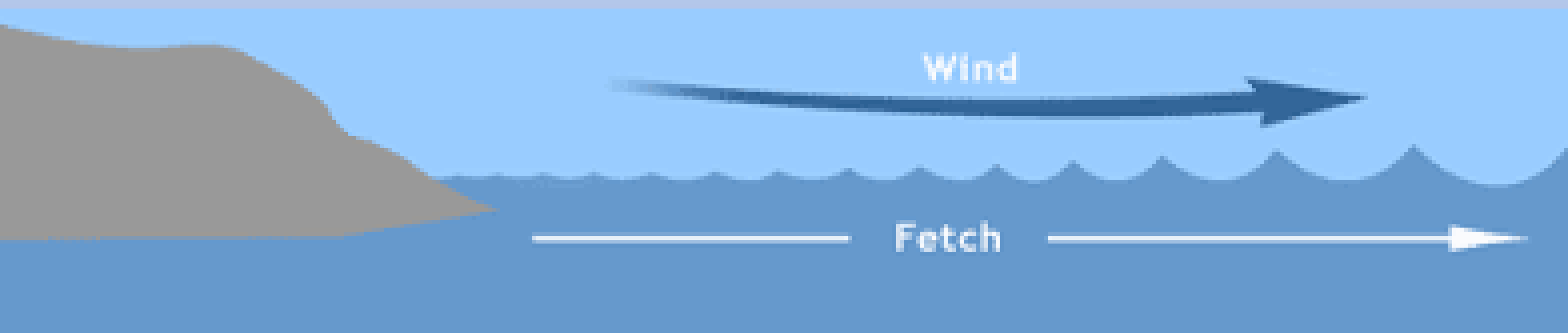
Very Low = 8
(<= 0.5 miles)

Low = 6
(>0.5 and ≤ 1.0 miles)

Moderate = 2
(>1.0 and ≤ 3 miles)

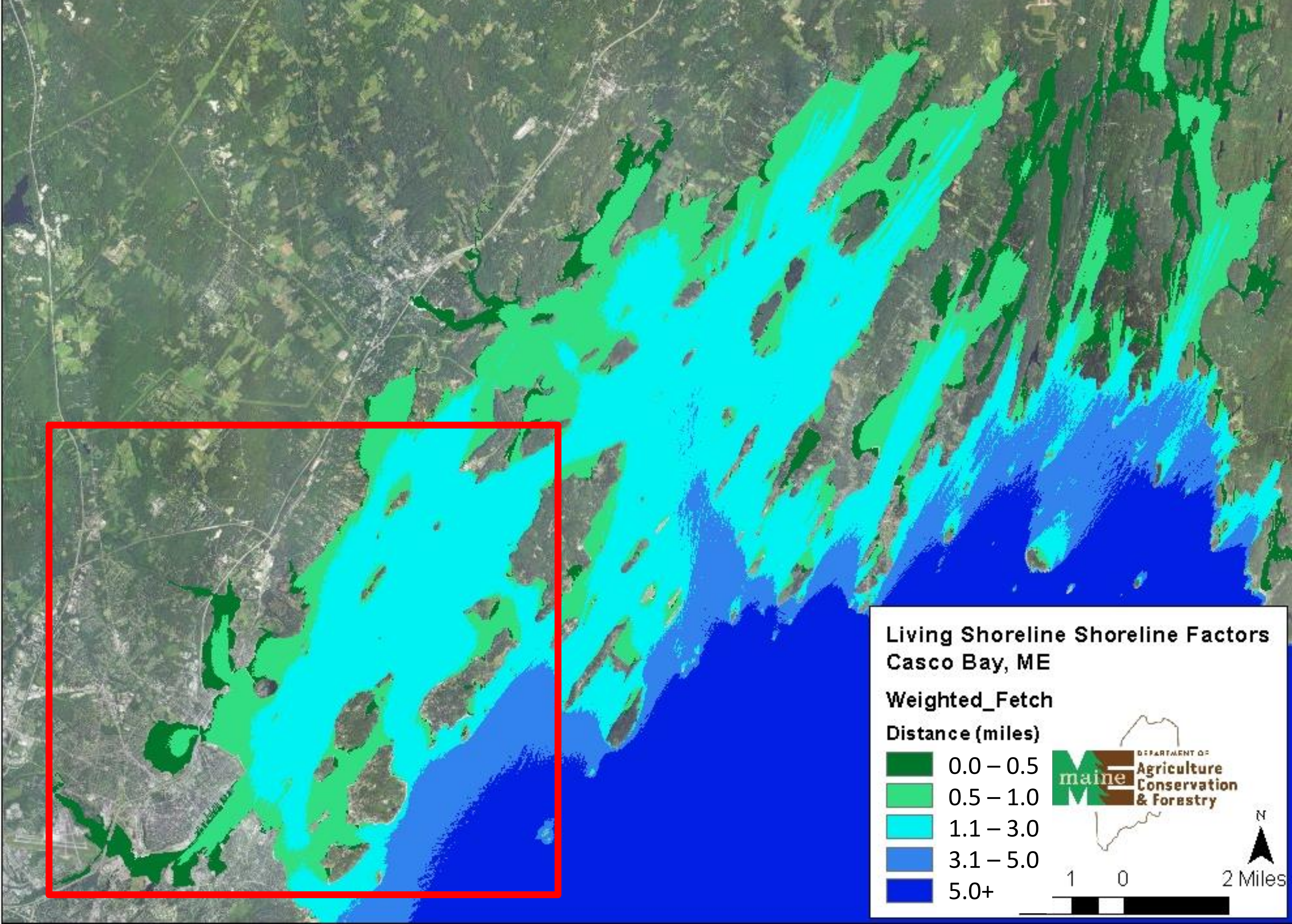
High = 1
(>3.0 and ≤ 5 miles)

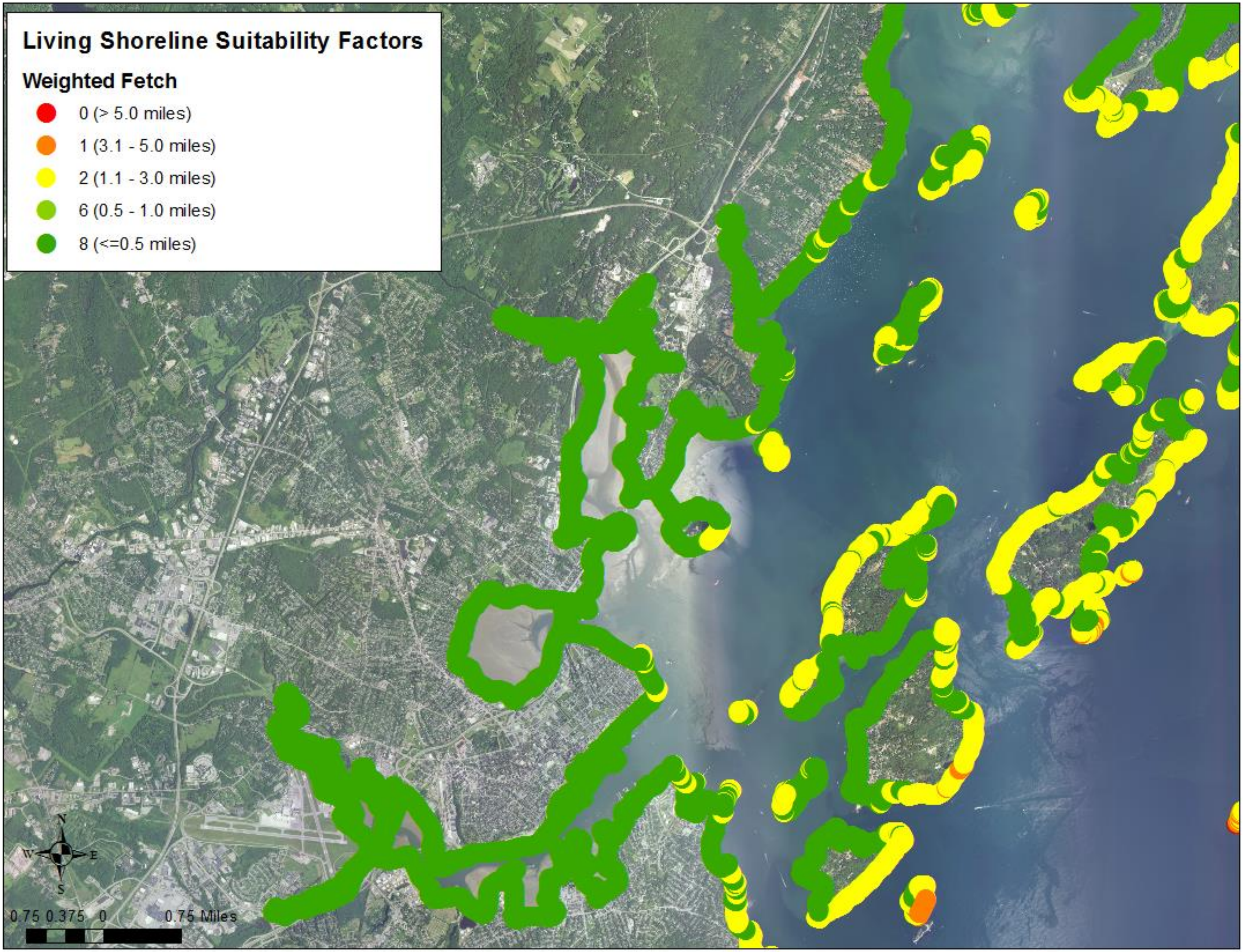
Very High = 0
(>5.0 miles)



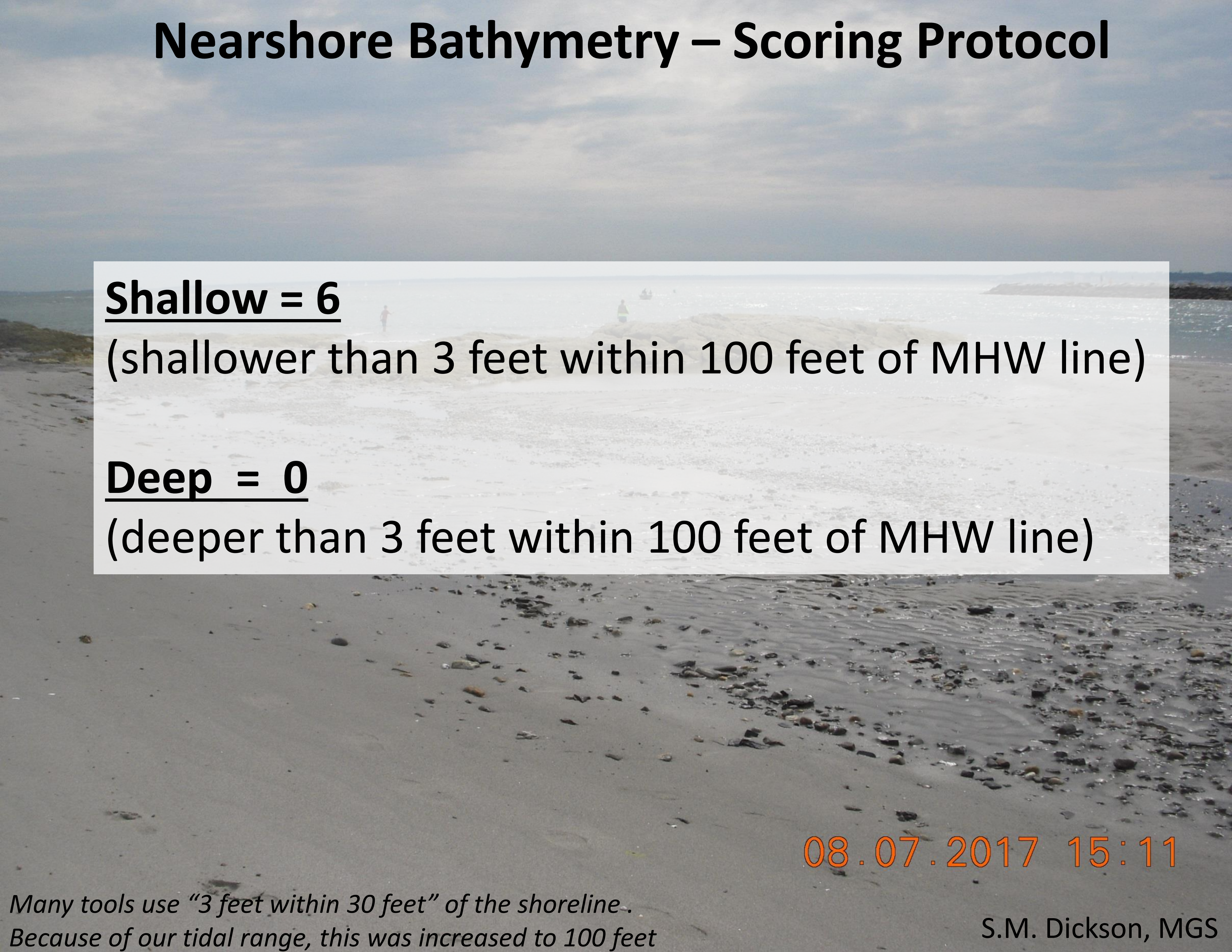
Scoring adapted from Virginia Living Shorelines methodology and Vegetative Treatment for Mid Atlantic States guidance

Weighted Fetch – USGS Fetch Tool




Living Shoreline Suitability Factors
Weighted Fetch
0 (> 5.0 miles)
1 (3.1 - 5.0 miles)
2 (1.1 - 3.0 miles)
6 (0.5 - 1.0 miles)
8 (<=0.5 miles)
N
W
E
S
0.75 0.375 0 0.75 Miles

Nearshore Bathymetry – Scoring Protocol



<u>Shallow = 6</u>

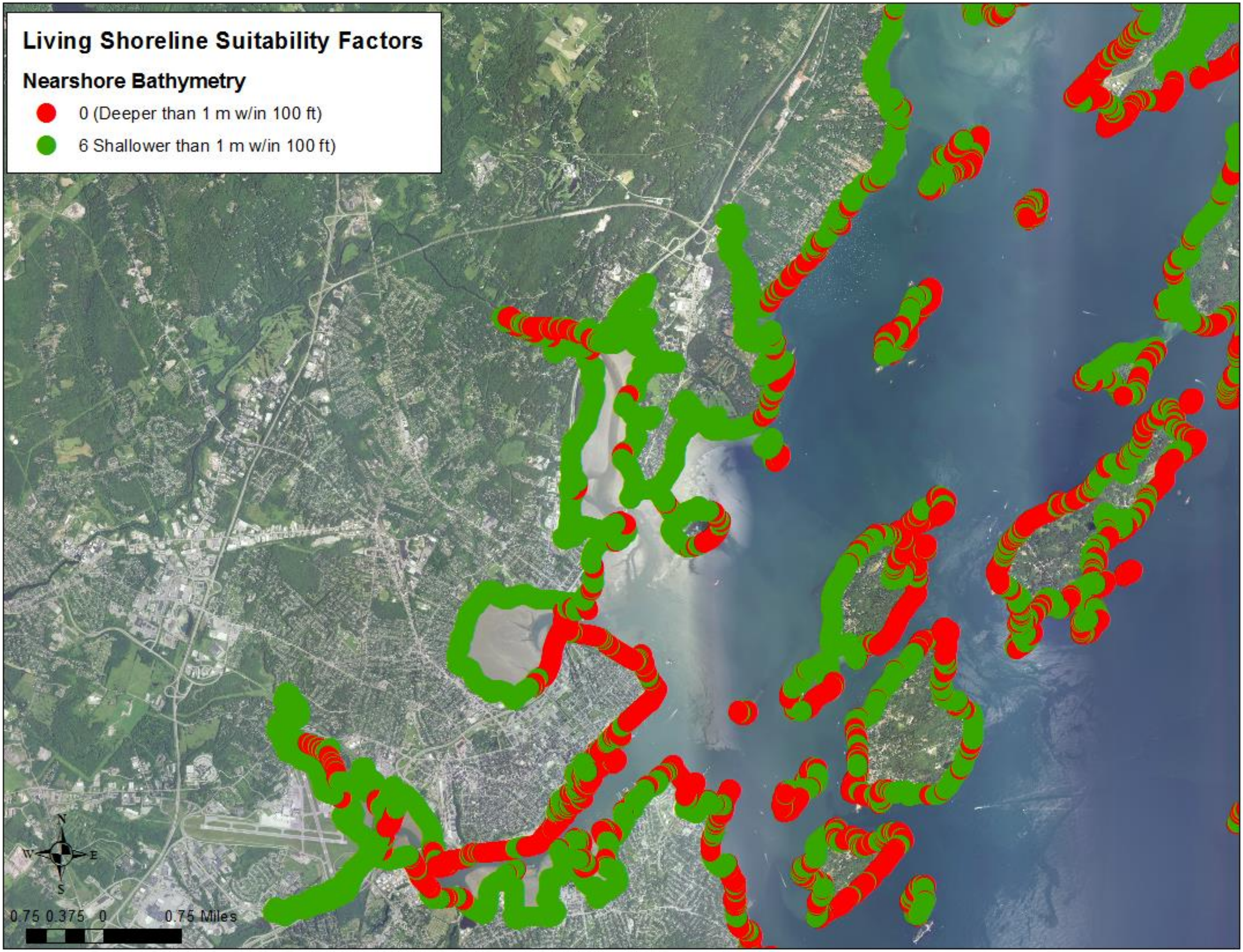
(shallower than 3 feet within 100 feet of MHW line)

<u>Deep = 0</u>

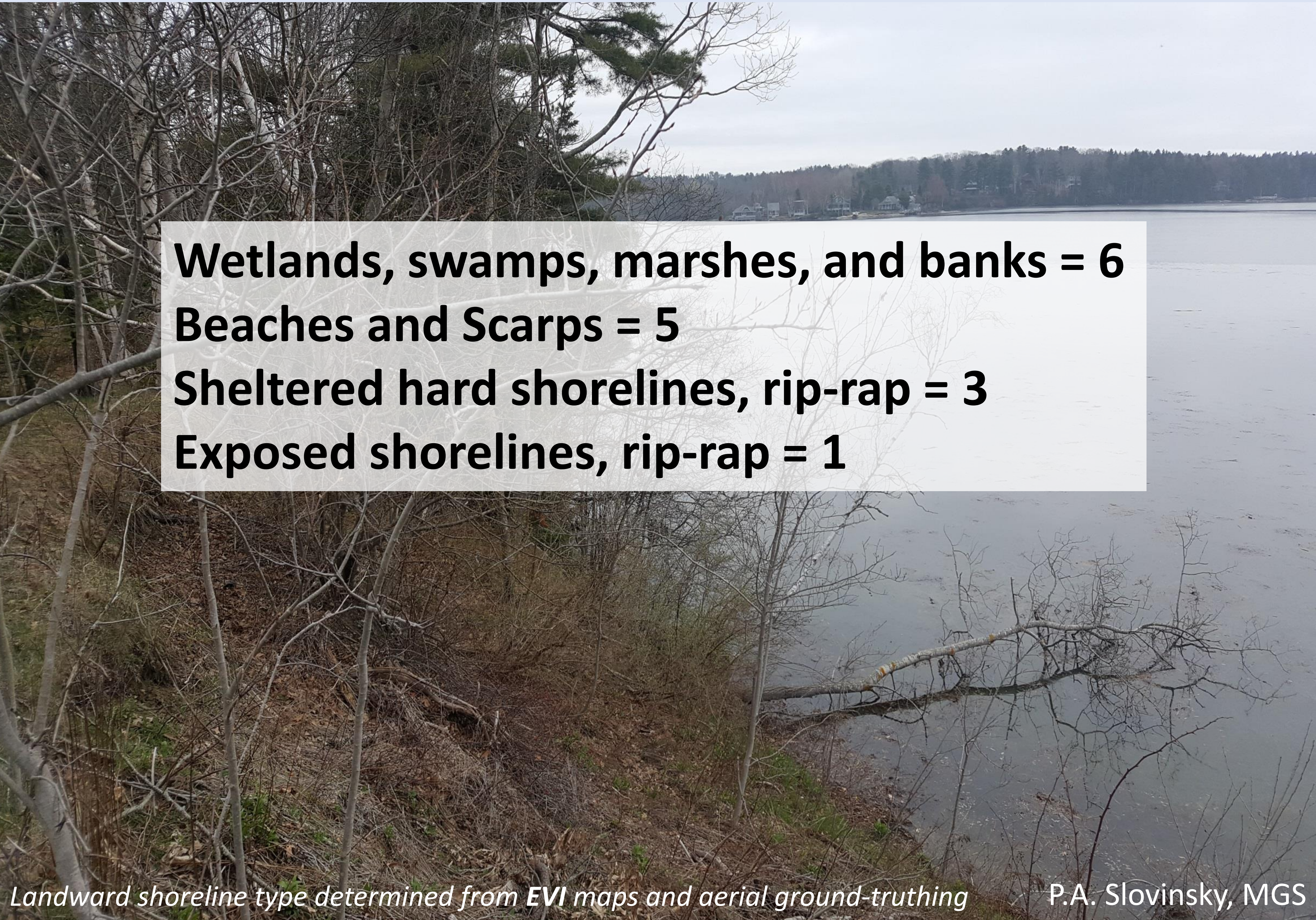
(deeper than 3 feet within 100 feet of MHW line)

Many tools use "3 feet within 30 feet" of the shoreline .
Because of our tidal range, this was increased to 100 feet

S.M. Dickson, MGS


Living Shoreline Suitability Factors
Nearshore Bathymetry
0 (Deeper than 1 m w/in 100 ft)
6 Shallower than 1 m w/in 100 ft)
N
W
E
S
0.75 0.375 0 0.75 Miles

Landward Shoreline Type – Scoring Protocol



Wetlands, swamps, marshes, and banks = 6

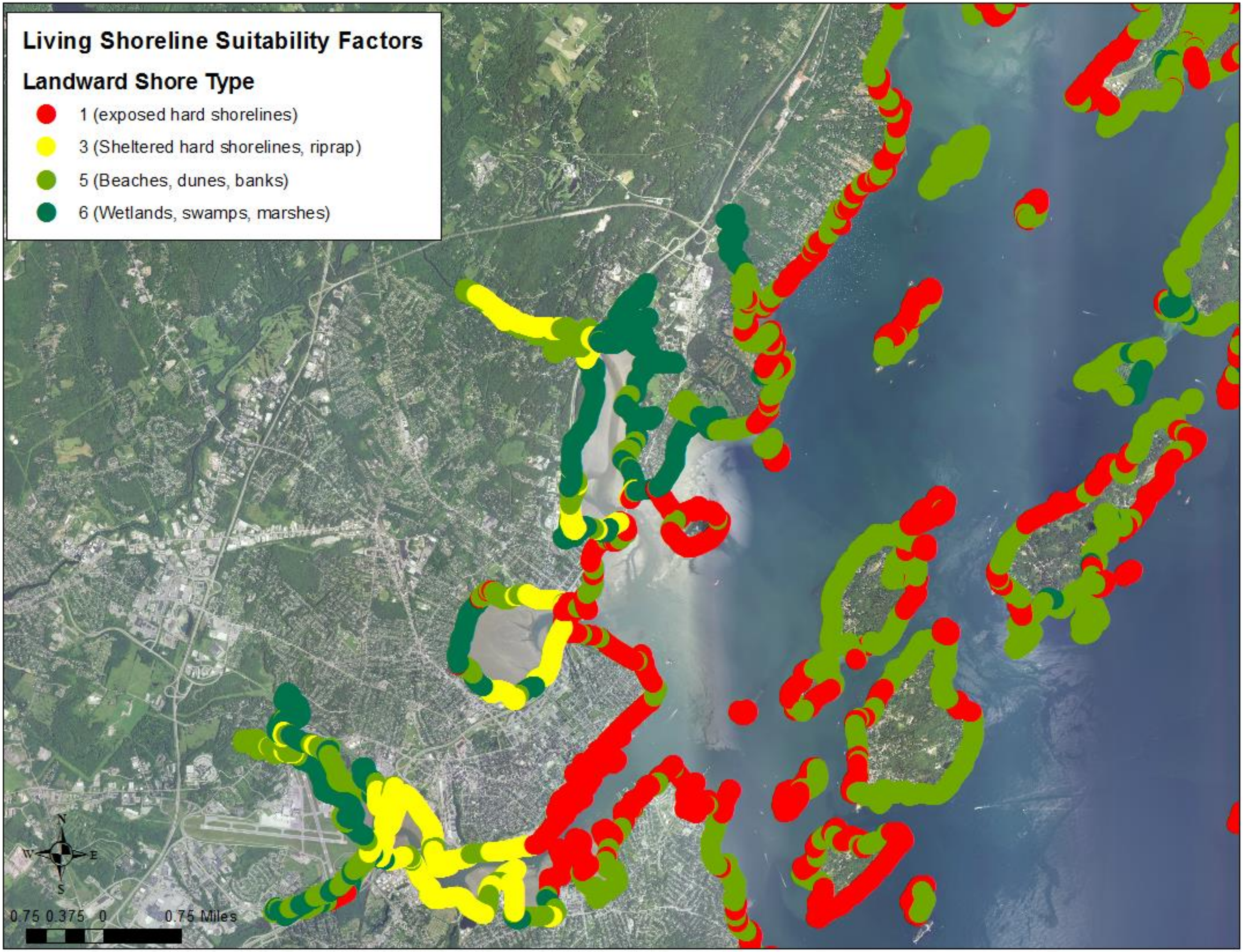
Beaches and Scarps = 5

Sheltered hard shorelines, rip-rap = 3

Exposed shorelines, rip-rap = 1

*Landward shoreline type determined from **EVI** maps and aerial ground-truthing*

P.A. Slovinsky, MGS



Living Shoreline Suitability Factors
Landward Shore Type
1 (exposed hard shorelines)
3 (Sheltered hard shorelines, riprap)
5 (Beaches, dunes, banks)
6 (Wetlands, swamps, marshes)
N
W
E
S
0.75 0.375 0
0.75 Miles

Seaward Shoreline Type – Scoring Protocol

Marshes and flats = 6

(fresh/brackish, fluvial, salt pannes/ponds, low and high salt marsh, mud flats, eelgrass flats, seaweed community, mussel bars)

Beaches, dunes and flats = 5

(boulder, gravel, sand, or mixed beaches, ramps, low energy beach, spit, washover fan , swash bars, dunes and beach ridges upper shoreface, coarse-grained flats)

Lower energy channels = 3

(tidal fluvial, abandoned, estuarine and low velocity channels)

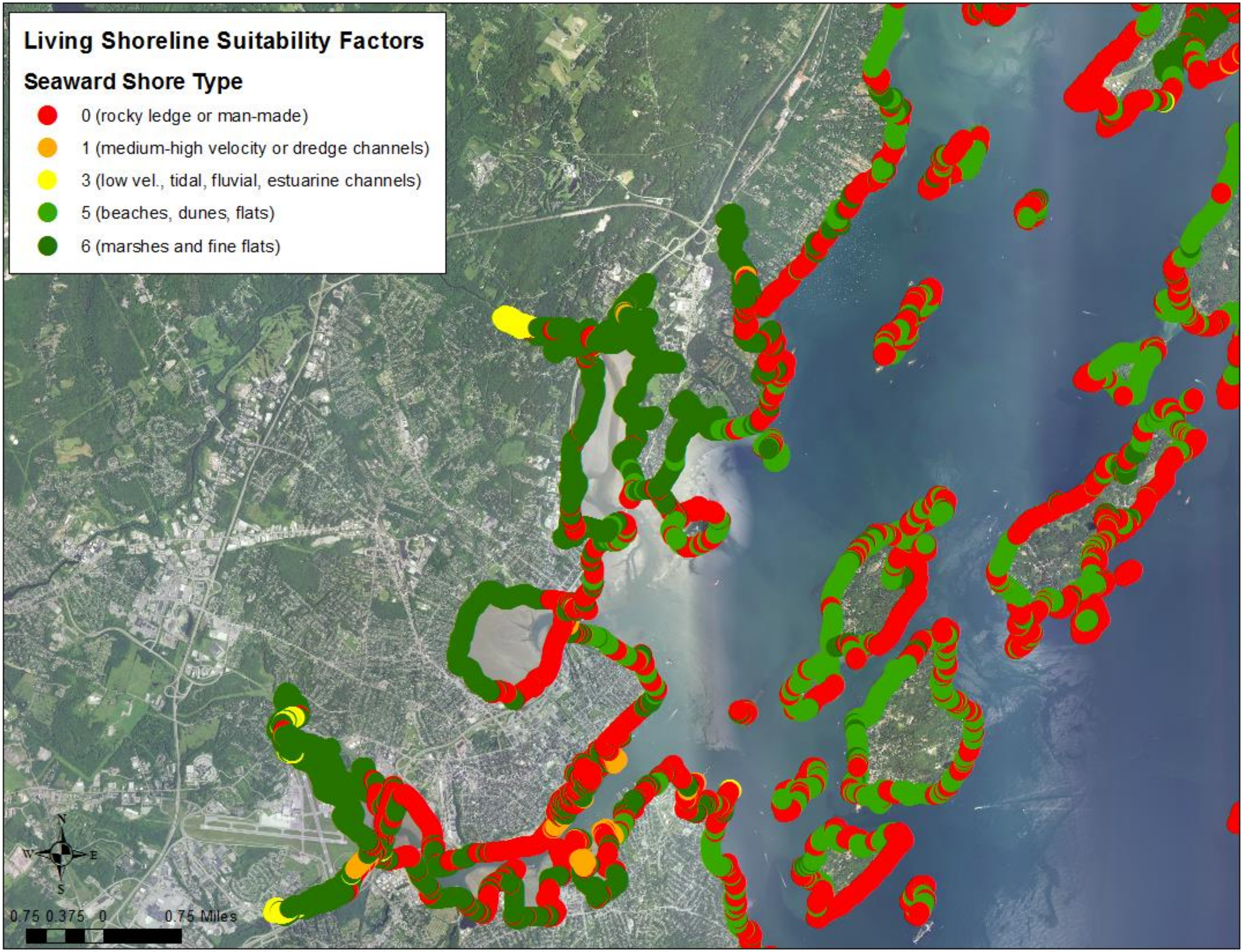
Higher energy channels = 1

(Medium, high velocity and dredged channels)

Ledge or man-made lands = 0

(rocky ledge or man-made lands/features)

*Seaward shoreline type determined from **CMGE** maps and aerial ground-truthing*


Living Shoreline Suitability Factors
Seaward Shore Type
0 (rocky ledge or man-made)
1 (medium-high velocity or dredge channels)
3 (low vel., tidal, fluvial, estuarine channels)
5 (beaches, dunes, flats)
6 (marshes and fine flats)
N
W
E
S
0.75 0.375 0 0.75 Miles

Upland Relief – Scoring Protocol

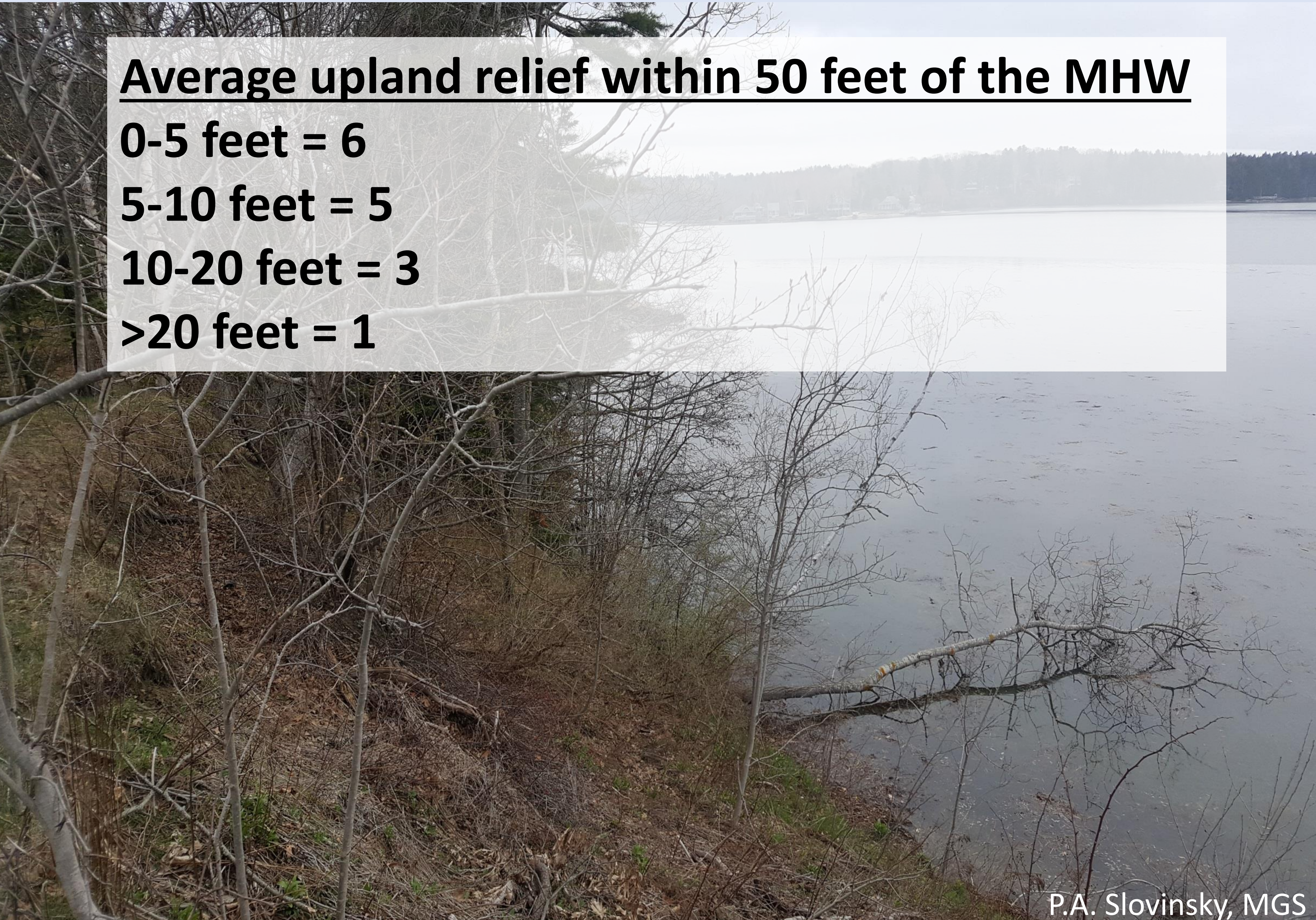
Average upland relief within 50 feet of the MHW

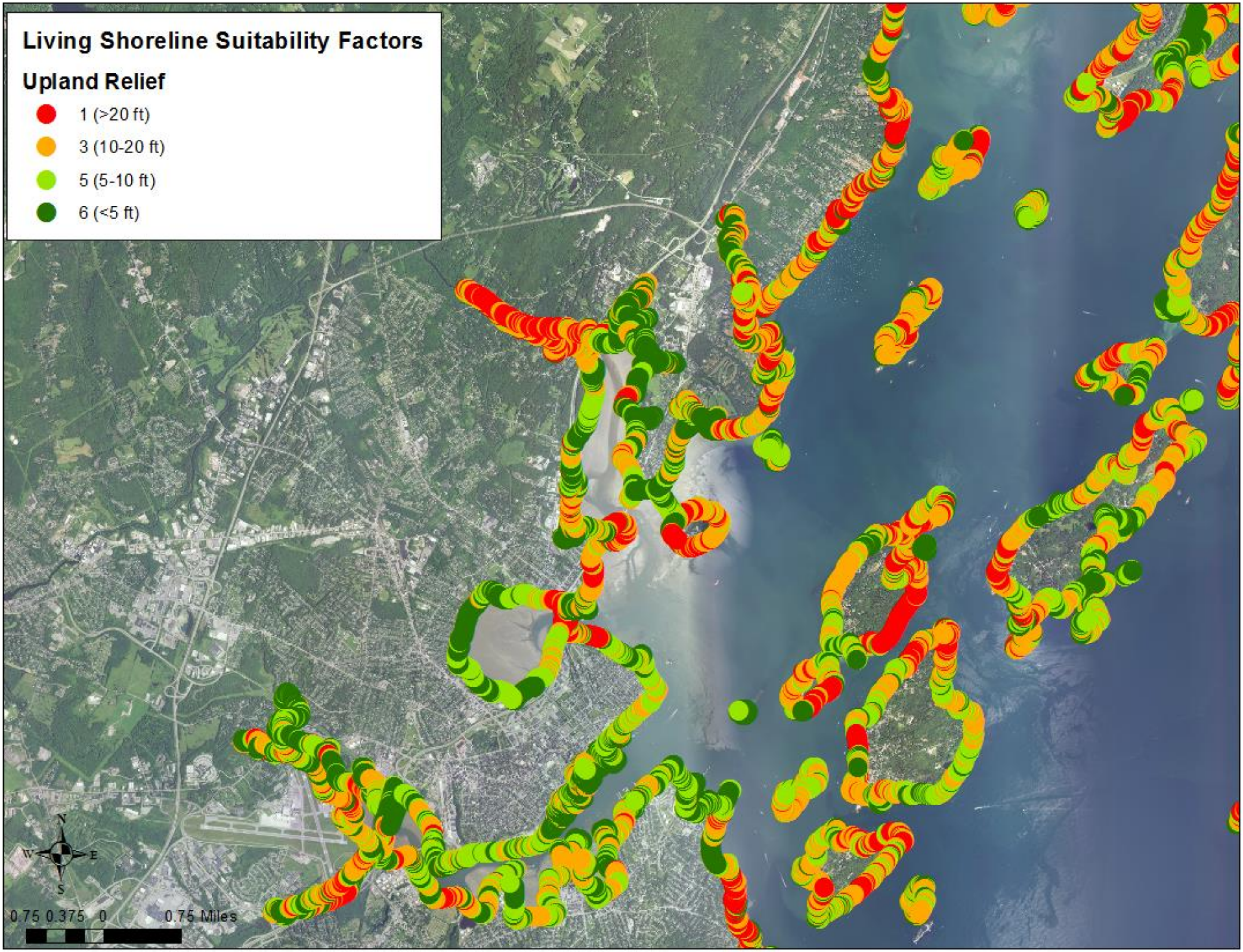
0-5 feet = 6

5-10 feet = 5

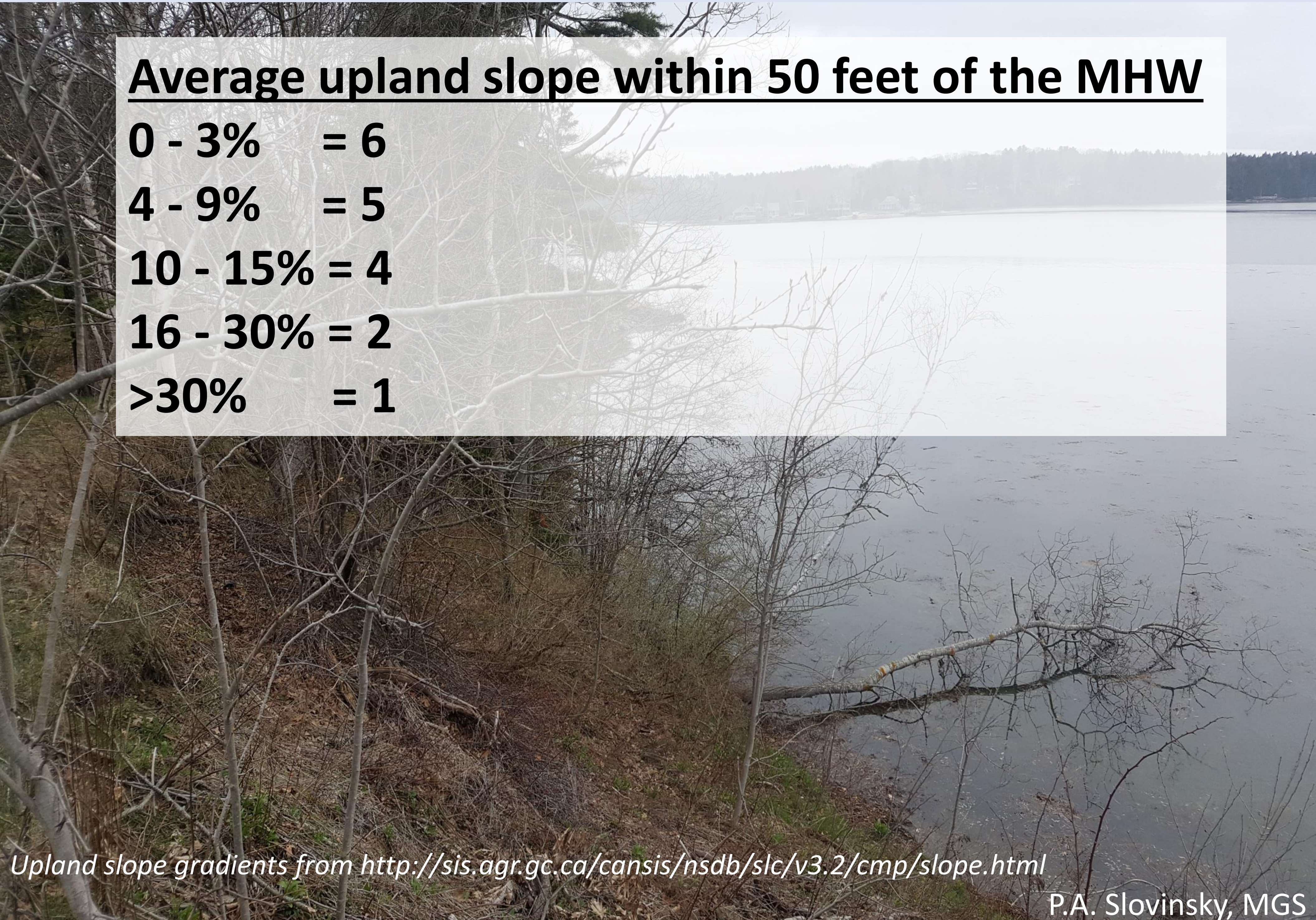
10-20 feet = 3

>20 feet = 1




Living Shoreline Suitability Factors
Upland Relief
1 (>20 ft)
3 (10-20 ft)
5 (5-10 ft)
6 (<5 ft)
N
W
E
S
0.75 0.375 0
0.75 Miles

Upland Slope – Scoring Protocol



<u>Average upland slope within 50 feet of the MHW</u>

0 - 3% = 6

4 - 9% = 5

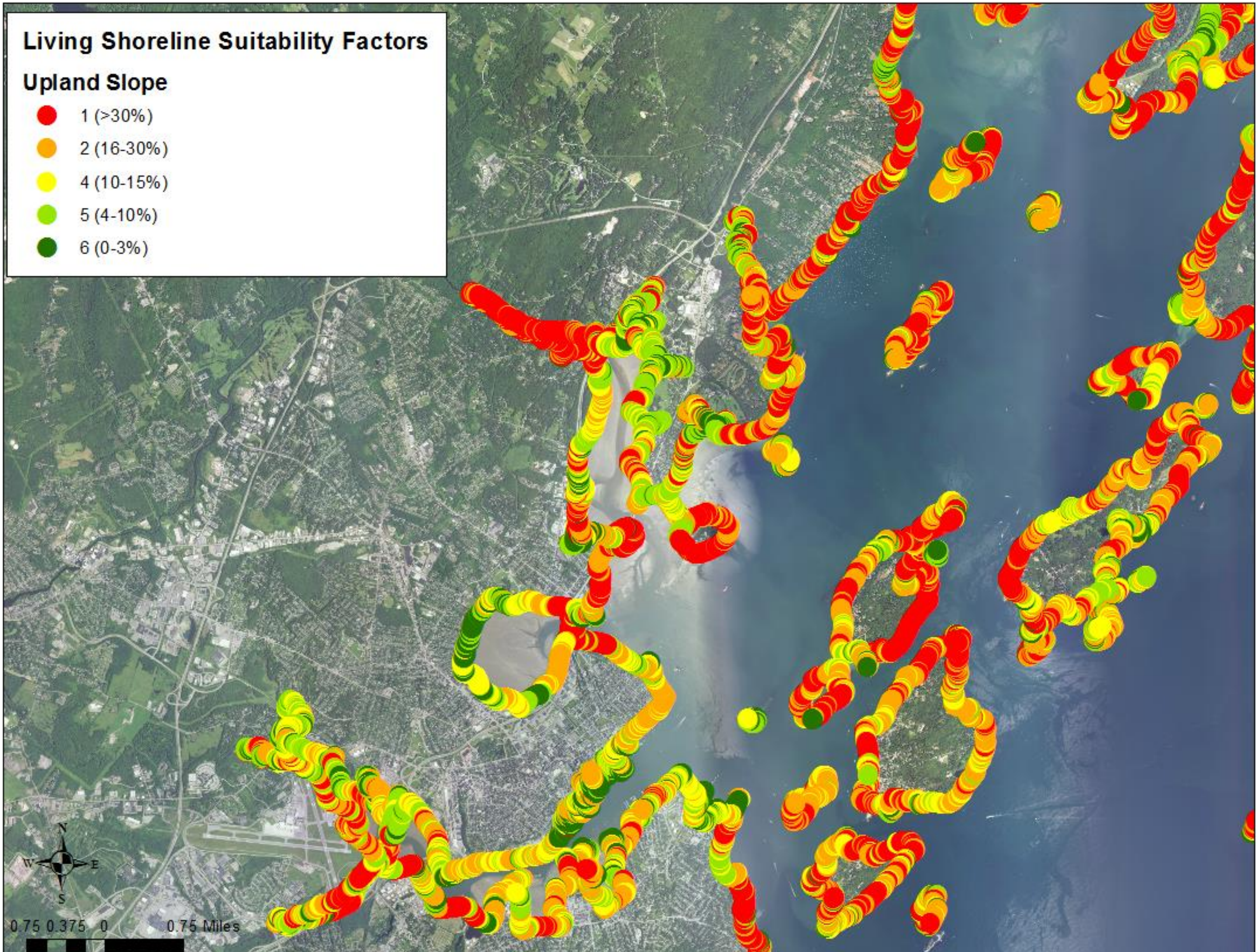
10 - 15% = 4

16 - 30% = 2

>30% = 1

Upland slope gradients from http://sis.agr.gc.ca/cansis/nsdb/slc/v3.2/cmp/slope.html

P.A. Slovinsky, MGS

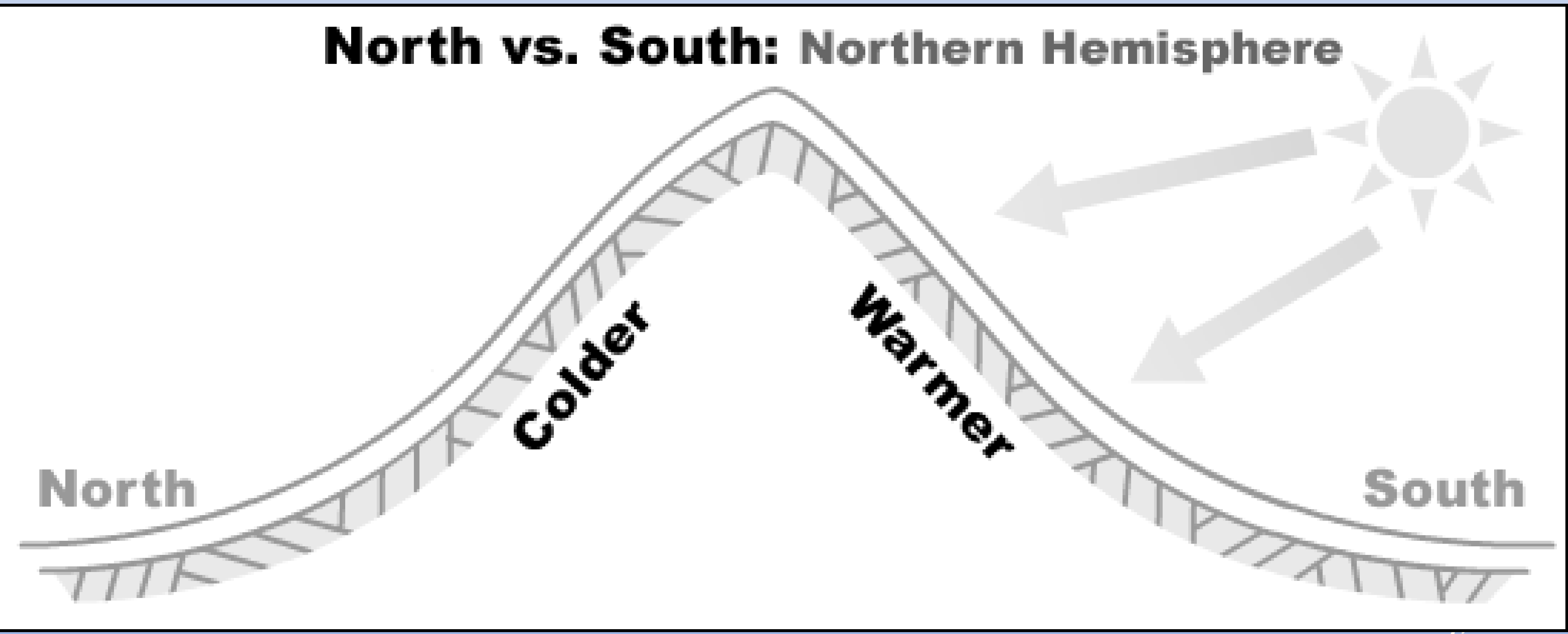


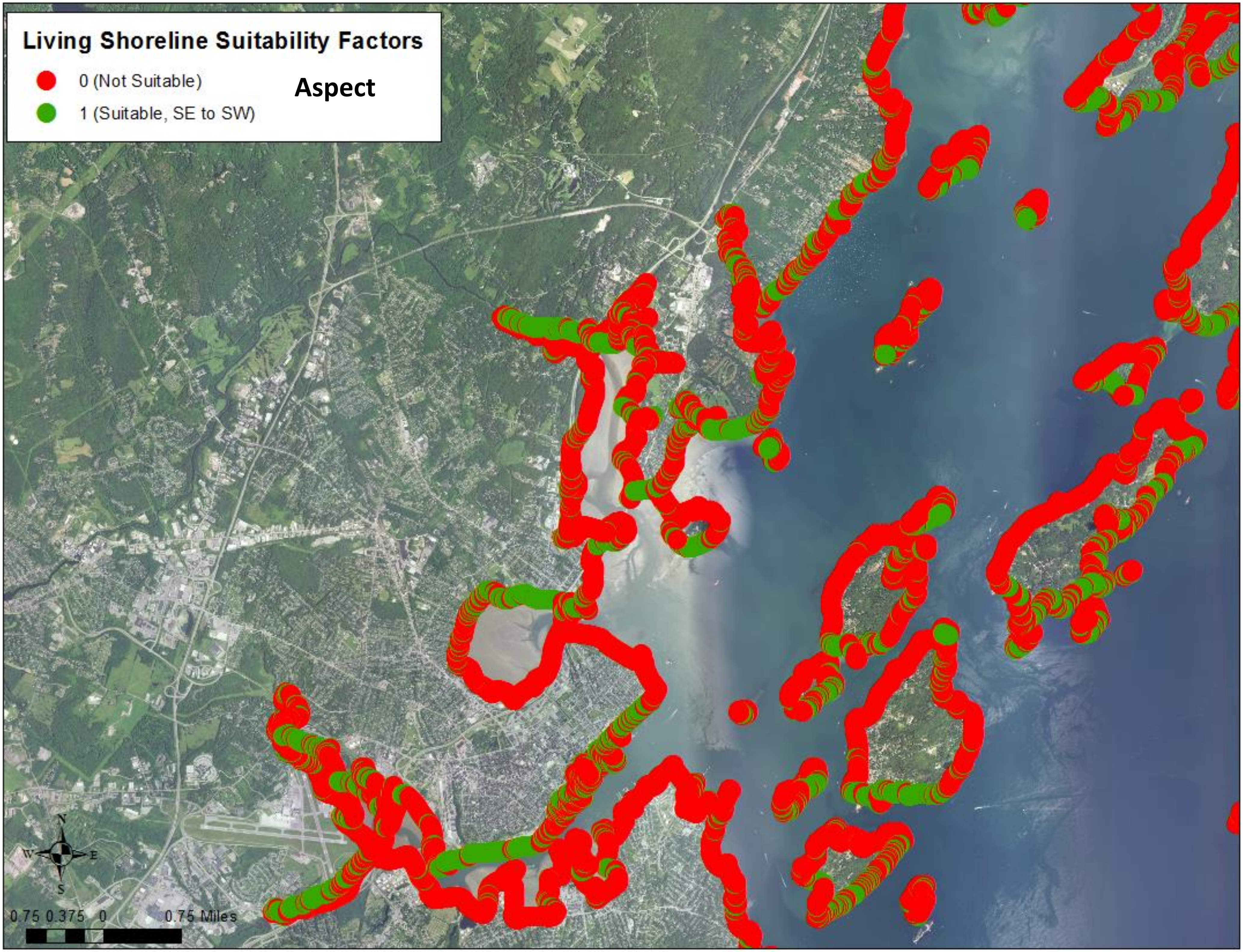
Living Shoreline Suitability Factors
Upland Slope
1 (>30%)
2 (16-30%)
4 (10-15%)
5 (4-10%)
6 (0-3%)
N
S
E
W
0.75 0.375 0 0.75 Miles

Shoreline Aspect – Scoring Protocol

<u>Southeast to Southwest facing = 1</u>
(125 to 225 degrees)

<u>Other aspects = 0</u>



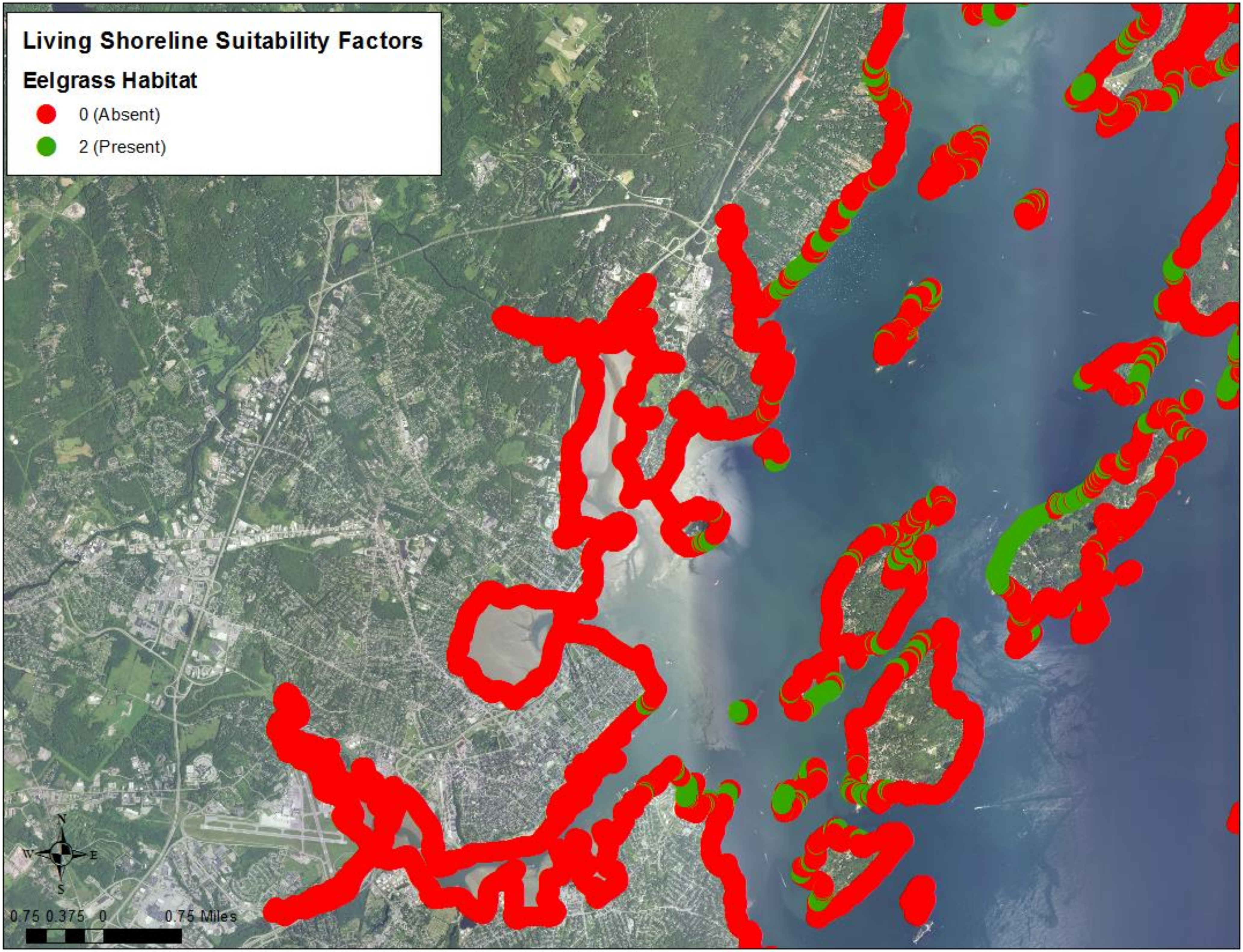


Living Shoreline Suitability Factors
0 (Not Suitable)
1 (Suitable, SE to SW)
Aspect
N
W
E
S
0.75 0.375 0 0.75 Miles

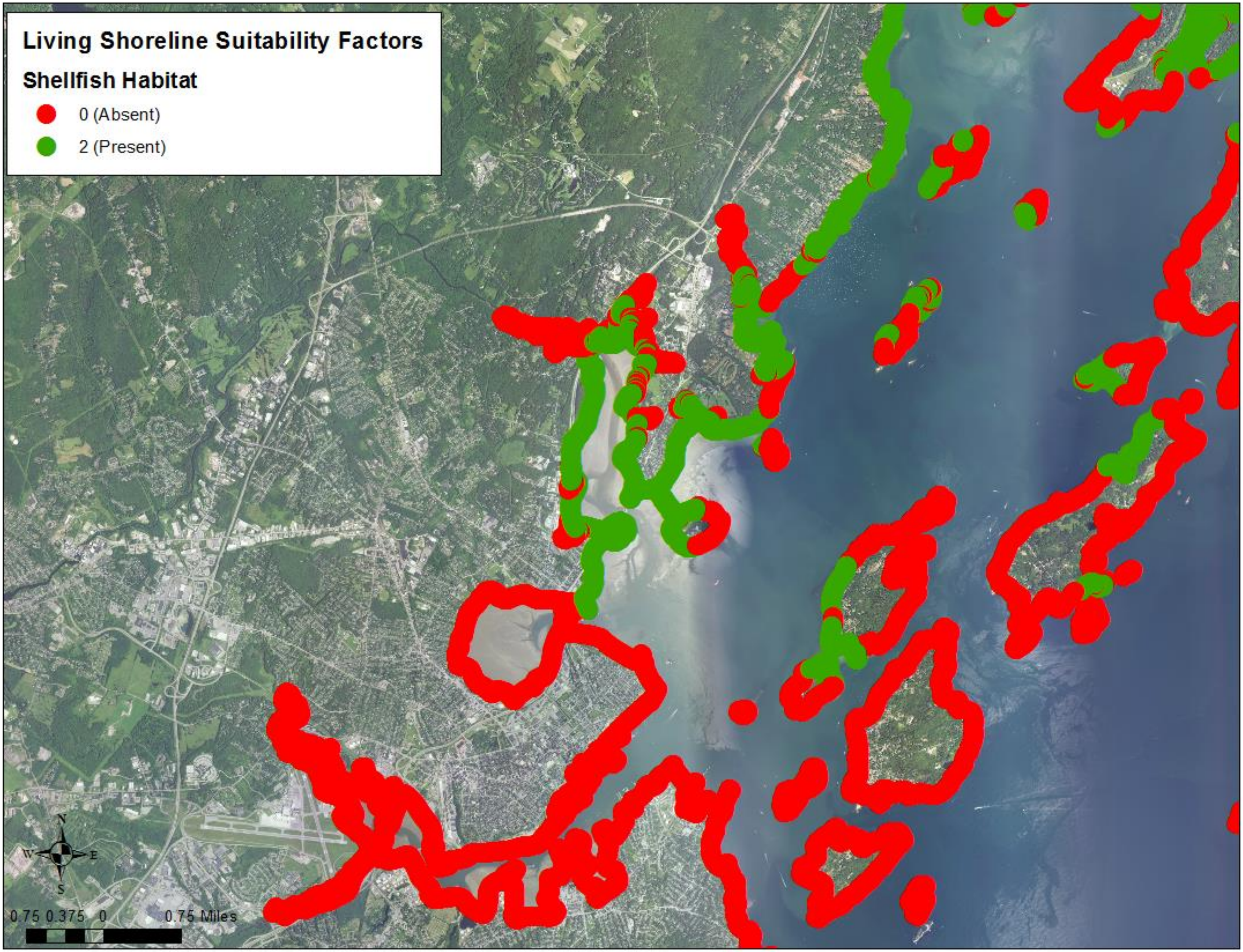
Habitat Considerations

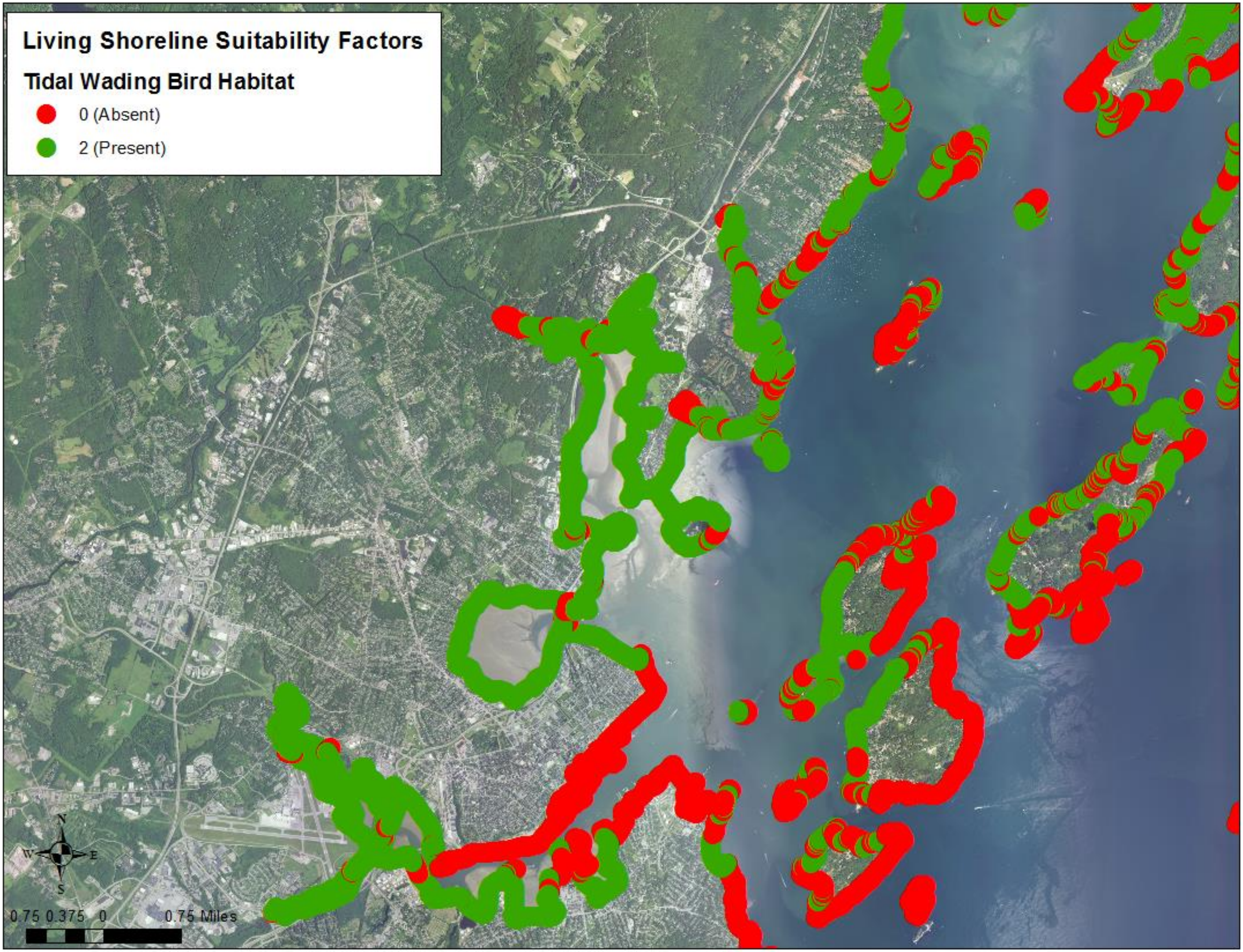
Presence or **Absence** of ***special mapped habitat types*** within 100 feet of the MHW:

- Eelgrass (2)
- Shellfish (2)
- Tidal Wading and Waterfowl (2)



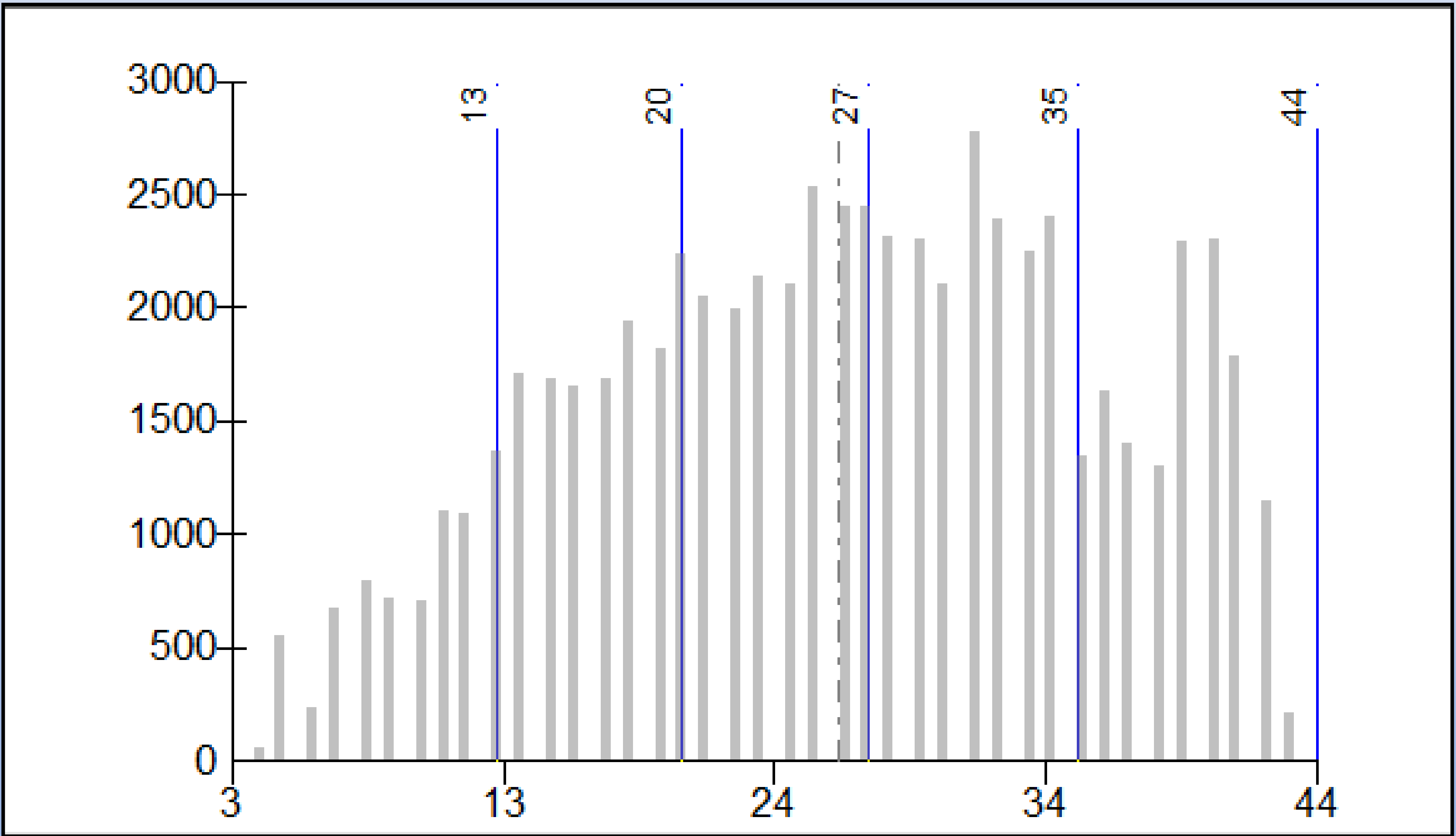
Living Shoreline Suitability Factors
Eelgrass Habitat
0 (Absent)
2 (Present)
N
W
E
S
0.75 0.375 0 0.75 Miles


Living Shoreline Suitability Factors
Shellfish Habitat
0 (Absent)
2 (Present)
N
S
W
E
0.75 0.375 0 0.75 Miles


Living Shoreline Suitability Factors
Tidal Wading Bird Habitat
0 (Absent)
2 (Present)
N
W
E
S
0.75 0.375 0 0.75 Miles

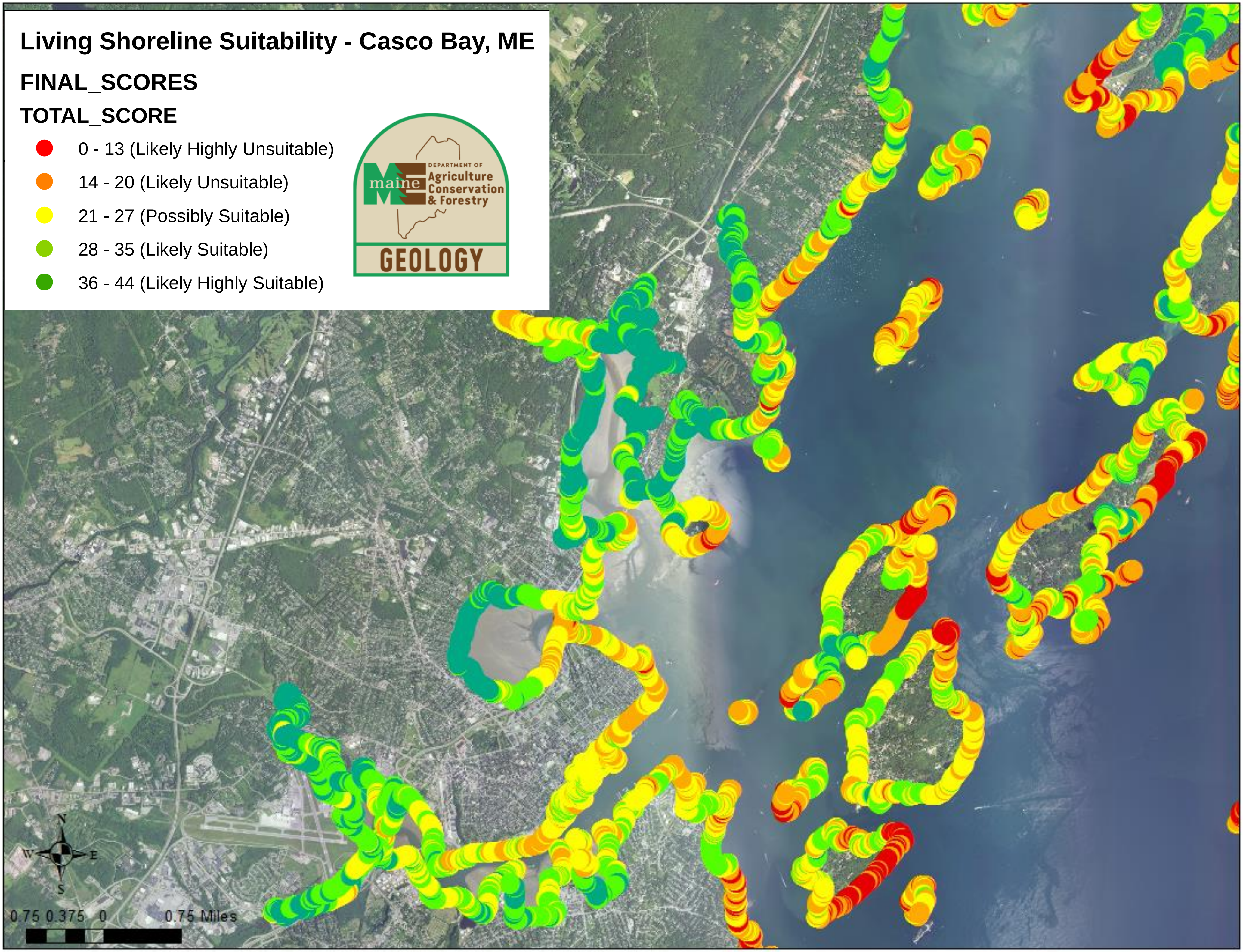
Total Living Shoreline Suitability Scores

Natural Breaks, or "Jenks" (data clustering method designed to determine the best arrangement of values into different classes) was used to initially classify total scores.



Total Living Shoreline Suitability Scores

- 0 - 13 (Likely Highly Unsuitable)
- 14 - 20 (Likely Unsuitable)
- 21 - 27 (Possibly Suitable)
- 28 - 35 (Likely Suitable)
- 36 - 44 (Likely Highly Suitable)


Living Shoreline Suitability - Casco Bay, ME
FINAL_SCORES
TOTAL_SCORE
0 - 13 (Likely Highly Unsuitable)
14 - 20 (Likely Unsuitable)
21 - 27 (Possibly Suitable)
28 - 35 (Likely Suitable)
36 - 44 (Likely Highly Suitable)
maine
DEPARTMENT OF
Agriculture
Conservation
& Forestry
GEOLOGY
N
W
E
S
0.75 0.375 0
0.75 Miles

MGS Living Shorelines DST Status

- At this point, the tool is meant to be used to **help guide where living shoreline approaches may be most successful in Casco Bay** – it has not been expanded yet.

- Note that in **preliminary** consultation with MEDEP, initial feedback was **to remove additional points associated with the presence of special habitats** from the suitability score.

- Instead, for any project in special habitat areas, it was suggested that **projects that minimize negative impacts to these habitats to the maximum extent practicable may be preferred** (e.g., vegetative treatments vs. armoring or hybrid living shoreline approaches)

MGS Living Shorelines DST Status

- MEDEP also suggested that **proximity of an existing structure (road or building) within 75 or 100 feet** to the shoreline be included.

- A similar tool is currently being **developed for the open coast, focusing on factors that may influence living shoreline success along dunes and beaches.**

- Incorporation of **storm surge/wave data from U. Maine work (once completed).**

Upcoming Work Efforts

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

Project Partners (Regional): TNC, NROC, ME, NH, MA, RI, CT

Direct Project Partners (Maine): MGS, MCP, MEDOT, TNC, CBEP, Town of Brunswick, MCHT, Brunswick-Topsham Land Trust

Other Partners (Maine): MEDEP, MEDMR, MEIFW

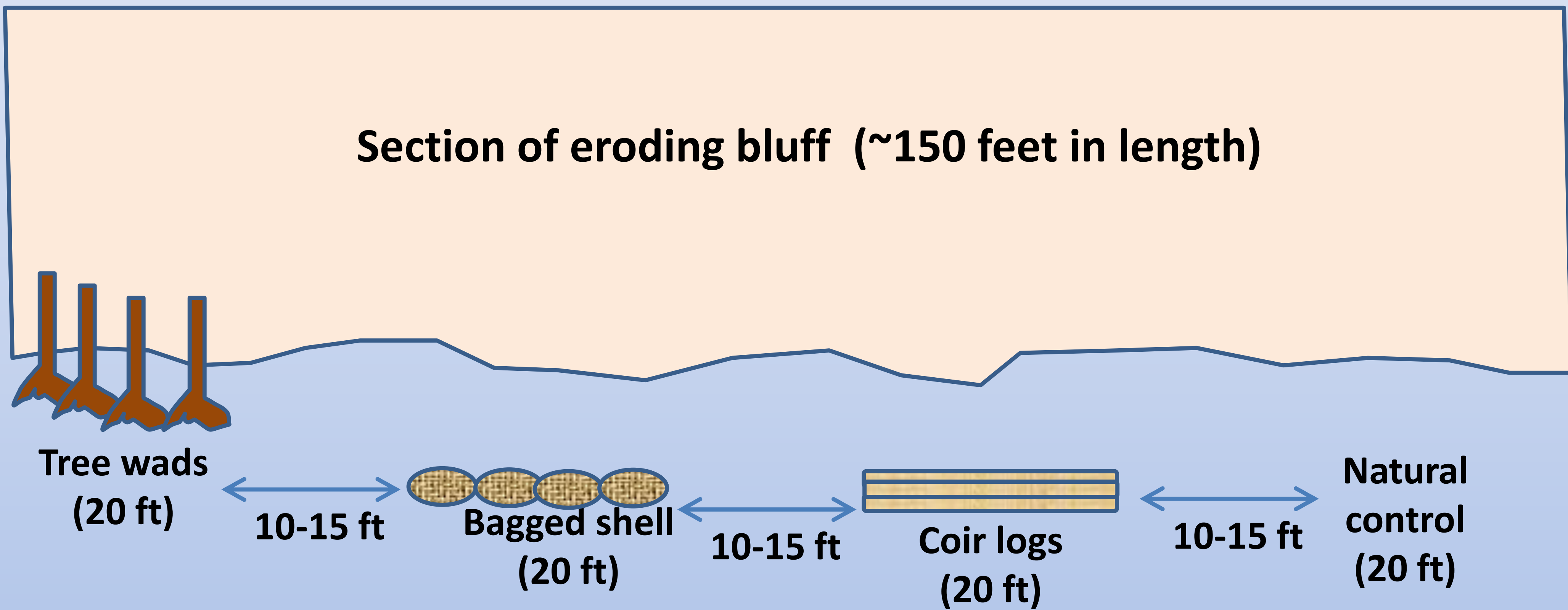
Increasing resilience and reducing risk through successful application of nature based coastal infrastructure practices in New England

- Develop a living shoreline monitoring protocol (for Maine, and possibly New England)
- In Casco Bay, implement **demonstration "living shoreline" treatments** at selected sites. 20 foot treatments to include:
  - Beneficial re-use of fallen trees (trunks, wads)
  - Beneficial re-use of shell material (oyster, soft-shell clam)
  - Coir logs
  - At toe of bluff and/or adjacent to toe of bluff
- Monitor sites using a standardized monitoring protocol (potentially implemented by volunteers)
- Develop or refine policy recommendations based on results of monitoring
- Outreach/education on findings

Can we beneficially reuse fallen trees to create nearshore sills to **help maintain eroding fringing marshes**?

Can we beneficially reuse fallen trees (either tree wads or trunks) to create **"toe" protection to help decrease bluff erosion**?

Potential Demonstration Treatments



Example of "demonstration" treatments (20 feet in width) at a selected project site. Some would be at the toe of the bluff (above HAT) and some would be below HAT to explore efficacy of natural "sills". Sites and treatments to be selected with input from Suitability DST and project partners.

Thank you!

Peter Slovinsky, Marine Geologist
Maine Geological Survey
Peter.a.slovinsky@maine.gov
(207) 287-7173

DEPARTMENT OF Agriculture Conservation & Forestry

GEOLOGY

Cumberland County Soil & Water Conservation District

Building Resiliency Along Maine's Bluff Coastline

Developing a Decision Tree and Coastal Stabilization Alternatives Along Casco Bay

Presented by Troy Barry, Fluvial Geomorphologist with Damon Yakovleff, CCSWCD

Building Resilient Coastal Bluffs: Casco Bay Regional Meeting | GPCOG Office, Portland | September 11, 2017, 1pm

Agenda

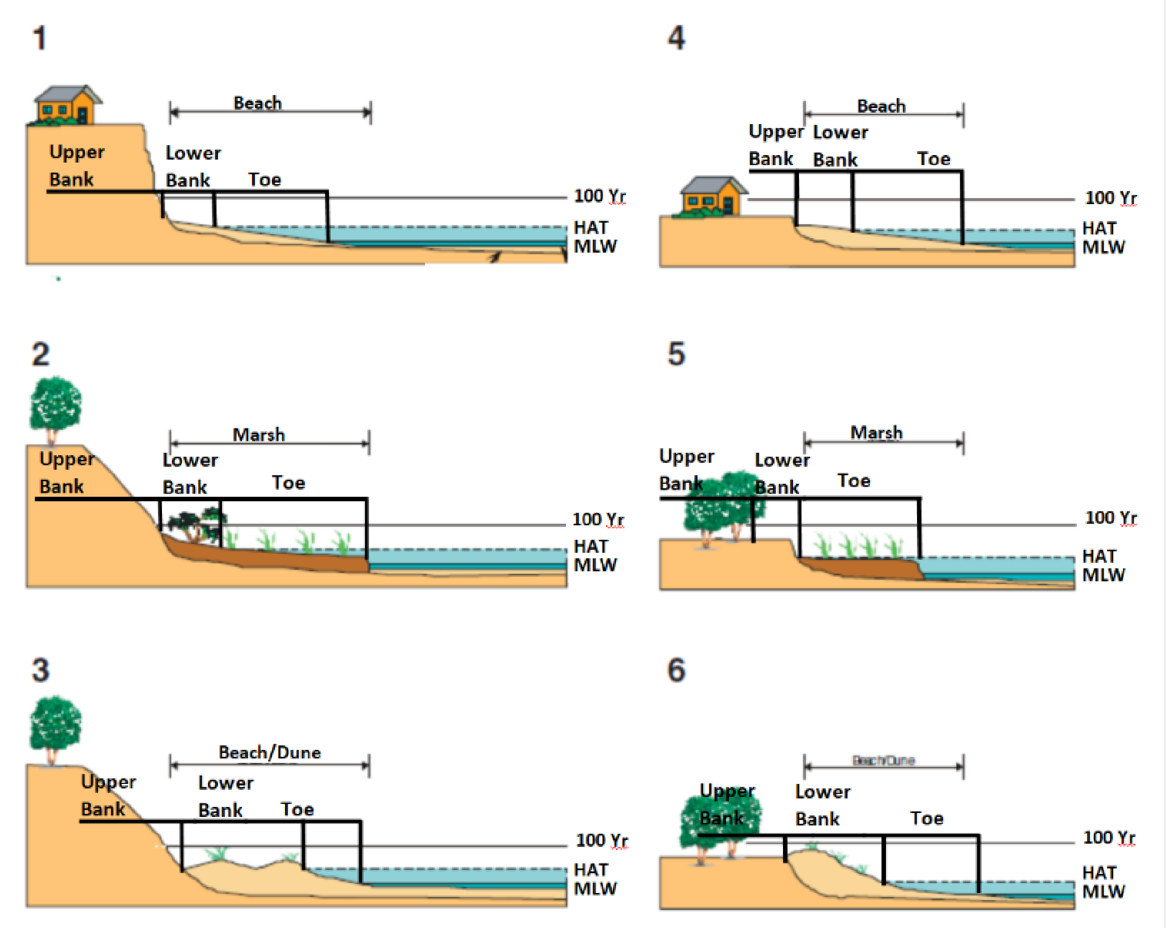
1. Overview of parameters affecting bluff erosion
2. Traditional vs. living shoreline restoration
3. Decision tree
4. Case studies

Bluff failure: Mere Point, Brunswick

Image source: CCSWCD

Review: Shoreline Types

- **Marsh:** Balanced sediment input & vegetation
- **Mudflat:** Shallow nearshore
- **Rock Dominated:** Intermittent
- **Sediment Bank:** Riparian zone
- **Pocket Beach:** Shallow intertidal



Toe, Lower Bank, and Upper Bank Zones

Image source: Hardaway and Byrne, 1999, revised by CCSWCD

Factors Contributing to Erosion of Bluffs

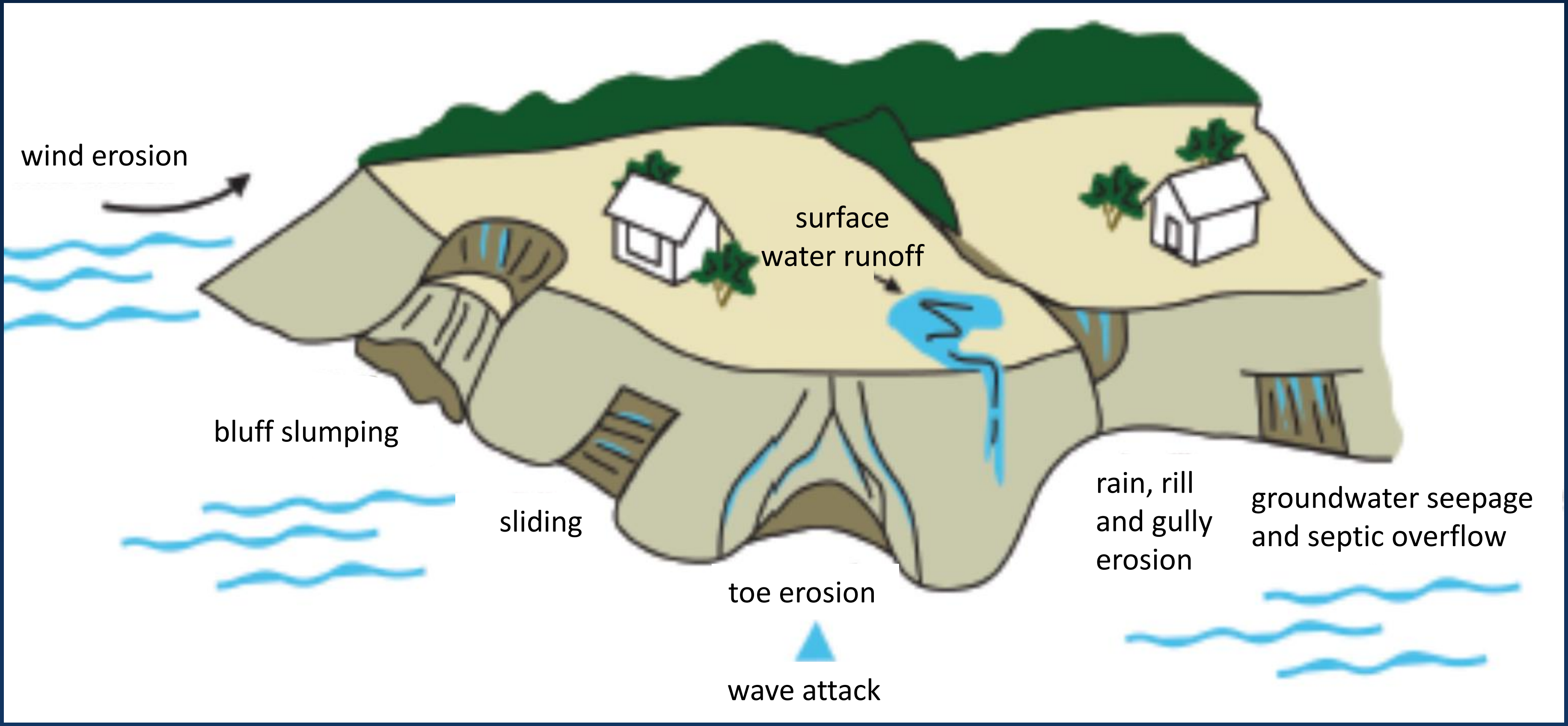
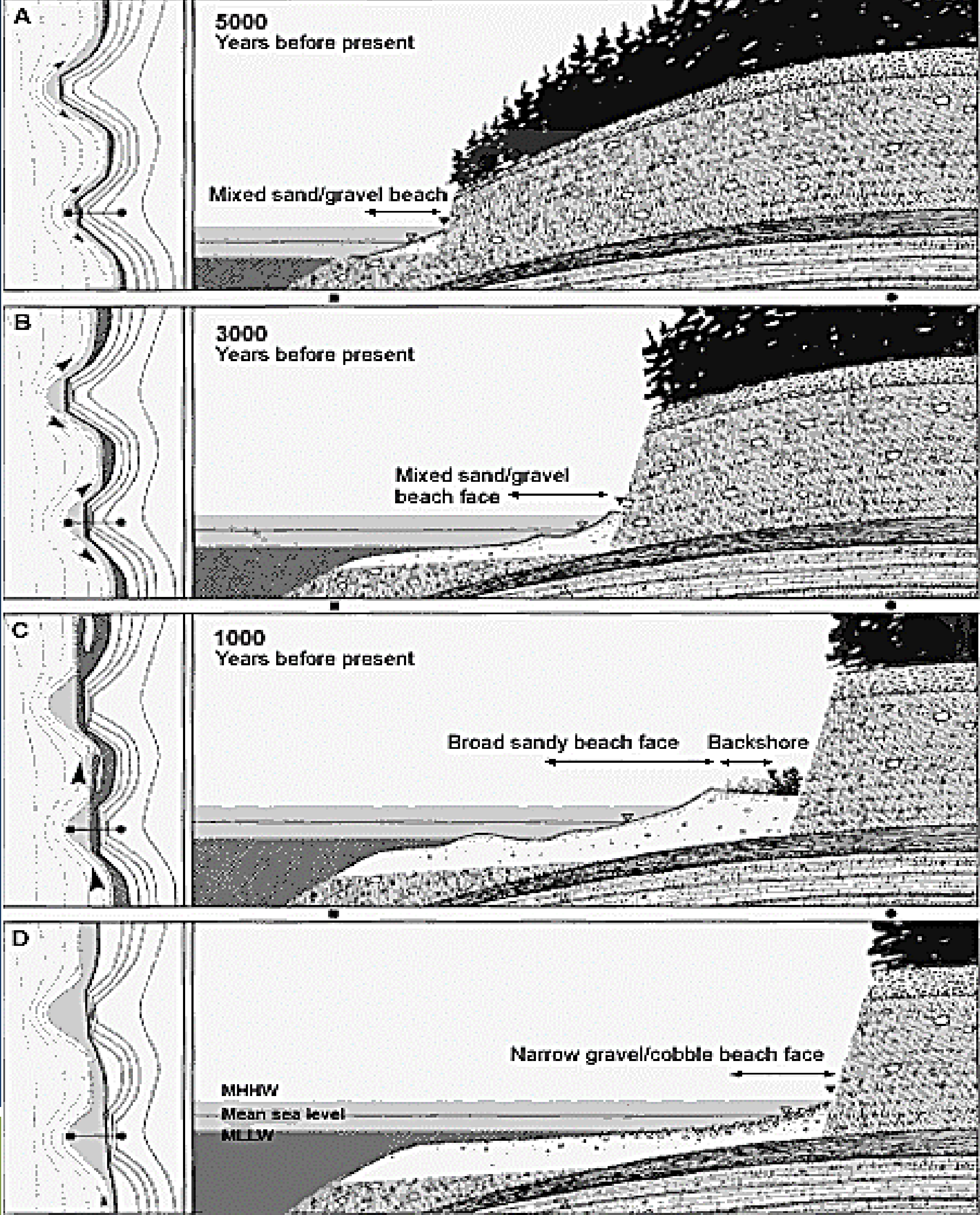


Image source: Keillor and White, 2003

Formation of Bluffs



Formation of bluffs
Image source: Washington State Department of Ecology, 1993

Traditional Stabilization Practices

- Riprap
- Bulkheads
- Jetties & Groins

Mackworth Island, Falmouth
Image source: CCSWCD

Bustins Island, Freeport
Image source: CCSWCD

Spring Point Light, South Portland
Image source: CCSWCD

Consequences of Traditional Stabilization

- Accelerated erosion
- New deposition pattern
- Increased turbidity
- Deflected energy
- Sediment interference
- Degraded fish habitat
- Loss of aquatic & terrestrial connectivity

Mackworth Island, Falmouth
Image source: CCSWCD

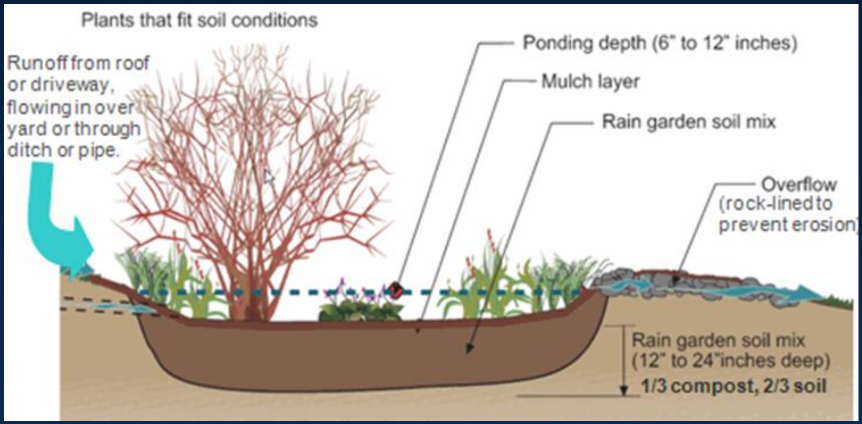
Living Stabilization

- What works for Maine
  - Each site is unique
  - Ecological & physical advantages
  - Project implementation, collaboration & monitoring
- Guidelines

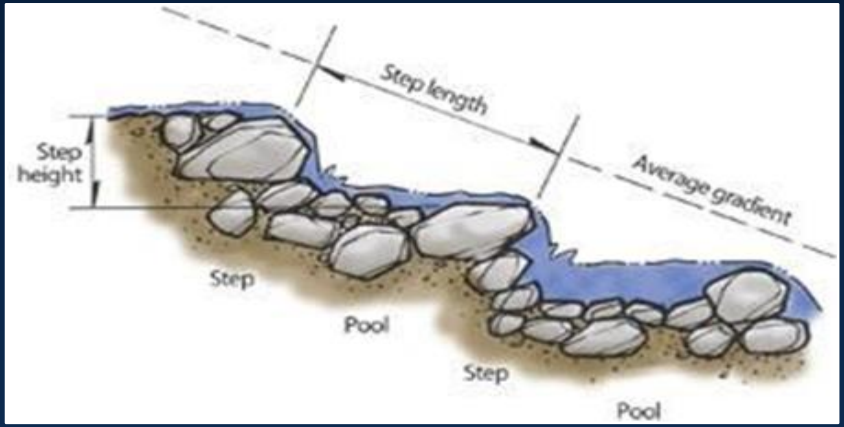
River shoreline stabilization, North Carolina

Image source: Troy Barry

Conceptual Biomimicry



Rain garden
Image source: Seattle Public Utilities, 2015



Step pools
Image source: Todd Moses, 2010

Root wads & brush mattress
Image source: Living Shoreline, South Freeport Rd, Freeport

Root wads & brush mattress
Image source: CCSWCD

Ecological & Physical Advantages

- Improves biodiversity
- Connects habitats
- Maintains natural aesthetic
- Improves water quality
- Absorbs wave energy, storm surge, and flood waters
- Maintains natural shoreline dynamics
- Reduces overall costs

Natural Harpswell shoreline
Image source: CCSWCD

Shoreline Management Assessment (SMA)

- Reconnaissance Level Assessment (RLA)
- Prediction Level Assessment (PLA)
- Design Level Assessment (DLA)

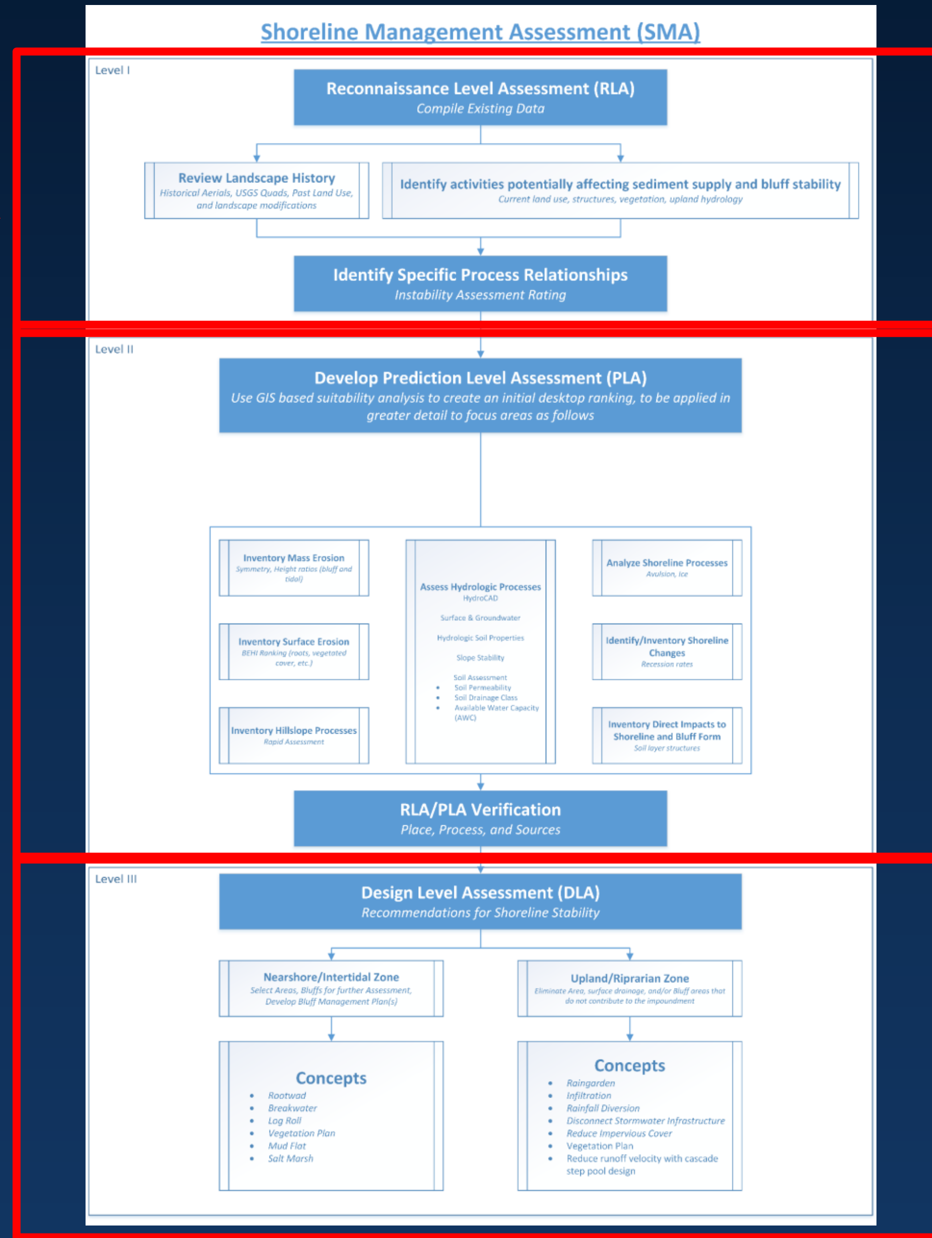
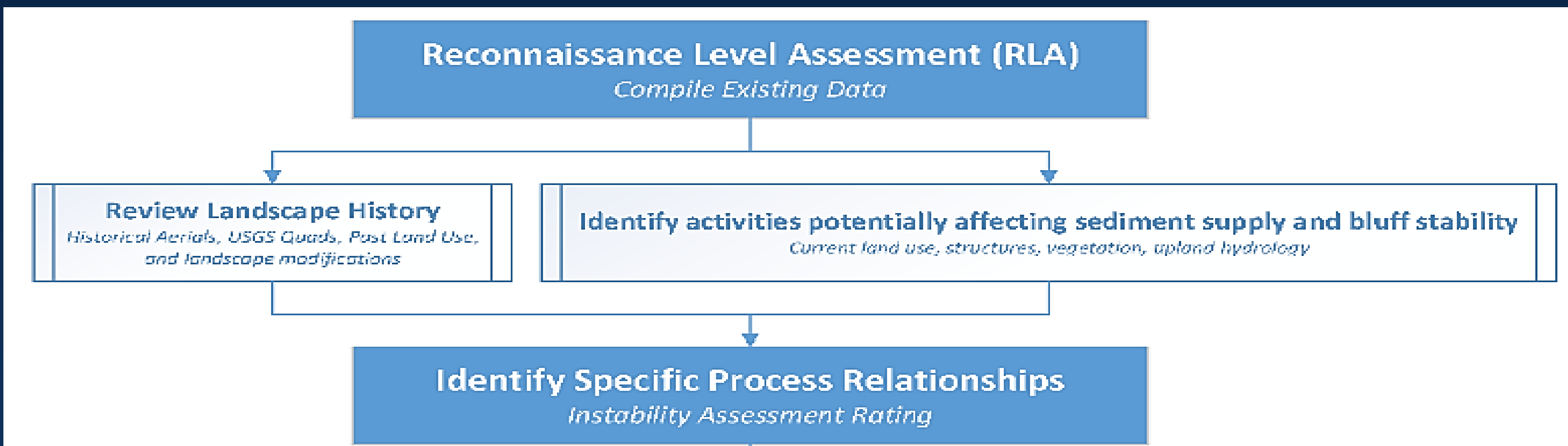


Image source: Developed by CCSWCD with Maine DACF, Maine Coastal Program, Maine Geological survey with funding from NOAA

Reconnaissance Level Assessment (RLA)



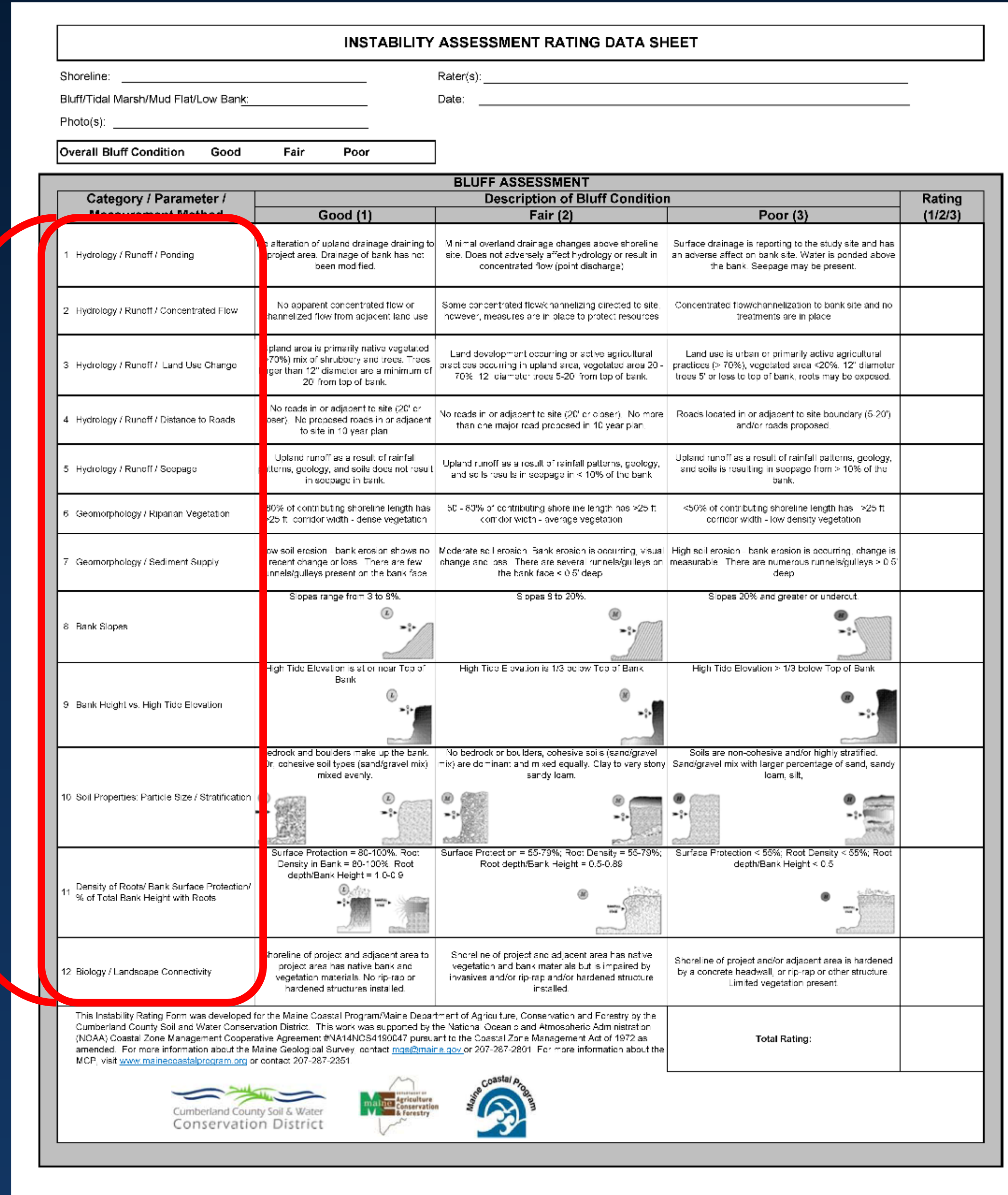
Site: Mitchell Field, Harpswell
Level: Reconnaissance Level Assessment

AREA	UPPER BANK	LOWER BANK	TOE	STORM FLOW
1				
Length: 12'-15' **Area:** 0.38 Acres **C-Value:** 0.30	Terrace	Blue Marine Clay 80° Bare Consolidated	Blue Marine Clay Mixed with Gravel 80° Unconsolidated	**2-yr:** 0.00 cfs **5-yr:** 0.00 cfs **25-yr:** 0.01 cfs **50-yr:** 0.04 cfs
Rating:	Good (1)	Fair/Poor (2.5)	Very Poor (3.5)	**Total Rating: 7**
2				
Length: 48' **Area:** 3.27 acres **C-Value:** 0.30	Terrace @ 15-20' Vegetated	Grassed 60° 15-20' Unconsolidated	Blue Marine Clay 70-80° 5' exposed	**2-yr:** 0.01 cfs **5-yr:** 0.05 cfs **25-yr:** 0.62 cfs **50-yr:** 1.31 cfs
Rating:	Good (1)	Fair/Poor (2.5)	Poor (3)	**Total Rating: 6.5**
3				
Length: **Area:** 0.58 acres **C-Value:** 0.30	Terrace 70°-80° *20'* *Ridge* *40'*	Veg. Grass, trees, brush 70°	Marine Clay 90° 5' exposed Linear Failure	**2-yr:** 0.01 cfs **5-yr:** 0.03 cfs **25-yr:** 0.23 cfs **50-yr:** 0.42 cfs
Rating:	Poor (1)	Good/Fair (1.5)	Poor (3)	**Total Rating: 5.5**
4				
Length: 51' **Area:** 0.0 acres **C-Value:** 0.30 *Slump 3'-12' up*	Exposed Failure 80°-90° Top Drainage?	Grassed/Trees Brush 70°-80° Rills, Mass Failure	Clay 80° Rills Mass Failure	**2-yr:** 0.00 cfs **5-yr:** 0.01 cfs **25-yr:** 0.04 cfs **50-yr:** 0.07 cfs
Rating:	Good/Fair (1.5)	Poor (3)	Very Poor (3.5)	**Total Rating: 9**
5				
Length: **Area:** 0.4 acres **C-Value:** 0.30 *Linear*	*40'* *20'* *Ridge*	Grassed-Trees 80°-70°	90° 3' exposed	**2-yr:** 0.00 cfs **5-yr:** 0.02 cfs **25-yr:** 0.17 cfs **50-yr:** 0.30 cfs
Rating:	Good (1)	Fair/Poor (2.5)	Poor (3)	**Total Rating: 7.5**

Refer to your handout

Instability Assessment Rating (Step 2 of RLA)

- 12 Parameters
- Good (1): 1-15
- Fair (2): 16-27
- Poor (3): 28-36



INSTABILITY ASSESSMENT RATING DATA SHEET

Shoreline: ______________________ Rater(s): ______________________

Bluff/Tidal Marsh/Mud Flat/Low Bank: ______________ Date: ______________________

Photo(s): ______________________

Overall Bluff Condition	Good	Fair	Poor

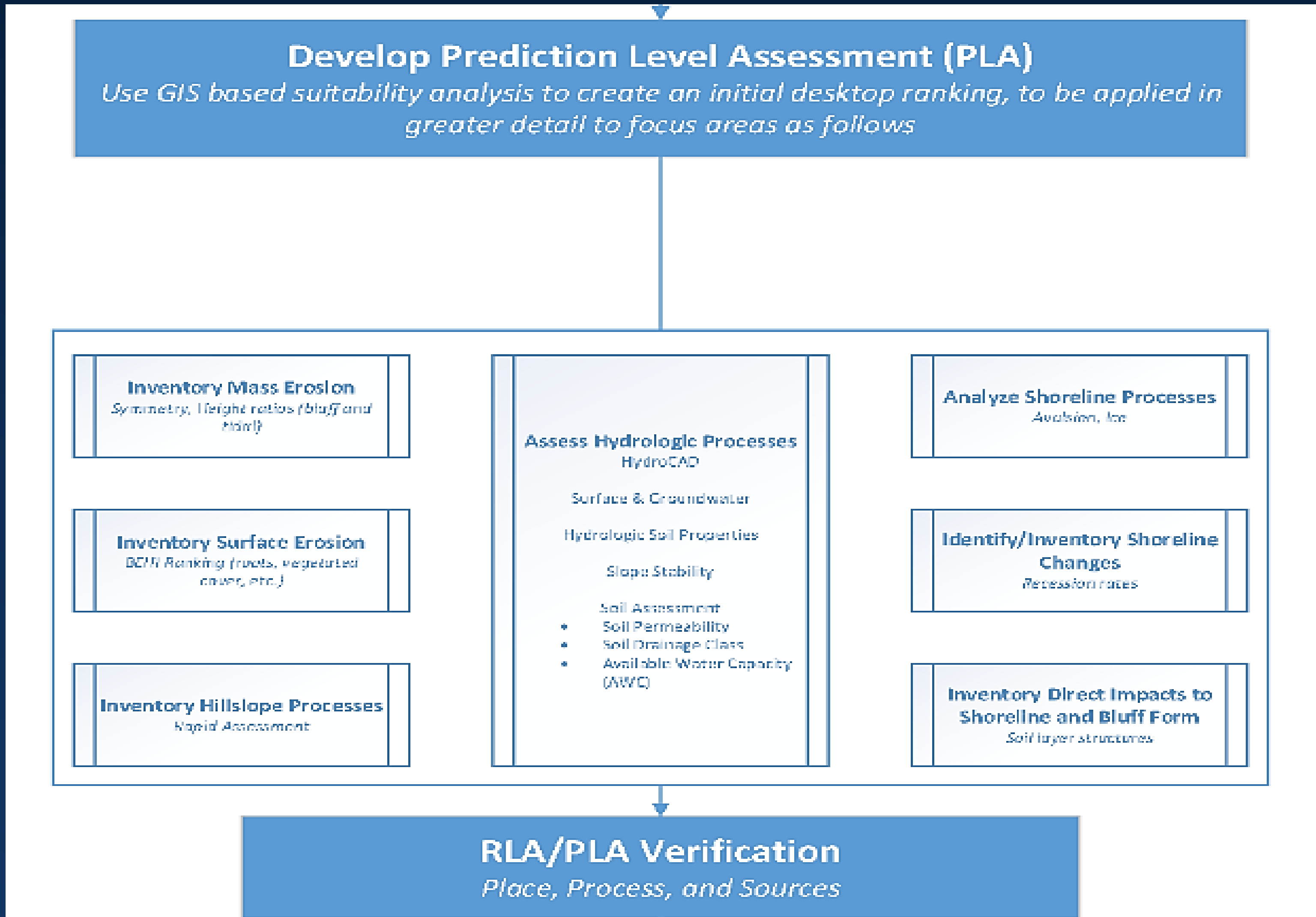
BLUFF ASSESSMENT

Category / Parameter / Measurement Method	Description of Bluff Condition: Good (1)	Fair (2)	Poor (3)	Rating (1/2/3)
1 Hydrology / Runoff / Ponding	No alteration of upland drainage draining to project area. Drainage of bank has not been modified.	Minimal overland drainage changes above shoreline site. Does not adversely affect hydrology or result in concentrated flow (point discharge)	Surface drainage is reporting to the study site and has an adverse affect on bank site. Water is ponded above the bank. Seepage may be present.	
2 Hydrology / Runoff / Concentrated Flow	No apparent concentrated flow or channelized flow from adjacent land use	Some concentrated flow/channelizing directed to site, however, measures are in place to protect resources	Concentrated flow/channelization to bank site and no treatments are in place	
3 Hydrology / Runoff / Land Use Change	Upland area is primarily native vegetated (>70%) mix of shrubbery and trees. Trees larger than 12" diameter are a minimum of 20' from top of bank.	Land development occurring or active agricultural practices occurring in upland area, vegetated area 20 - 70%. 12" diameter trees 5-20' from top of bank.	Land use is urban or primarily active agricultural practices (> 70%), vegetated area <20%. 12" diameter trees 5' or less to top of bank, roots may be exposed.	
4 Hydrology / Runoff / Distance to Roads	No roads in or adjacent to site (20' or closer). No proposed roads in or adjacent to site in 10 year plan	No roads in or adjacent to site (20' or closer). No more than one major road proposed in 10 year plan.	Roads located in or adjacent to site boundary (5-20') and/or roads proposed.	
5 Hydrology / Runoff / Seepage	Upland runoff as a result of rainfall patterns, geology, and soils does not result in seepage in bank.	Upland runoff as a result of rainfall patterns, geology, and soils results in seepage in < 10% of the bank	Upland runoff as a result of rainfall patterns, geology, and soils is resulting in seepage from > 10% of the bank.	
6 Geomorphology / Riparian Vegetation	80% of contributing shoreline length has >25 ft. corridor width - dense vegetation	50 - 80% of contributing shoreline length has >25 ft corridor width - average vegetation	<50% of contributing shoreline length has >25 ft corridor width - low density vegetation	
7 Geomorphology / Sediment Supply	Low soil erosion - bank erosion shows no recent change or loss. There are few runnels/gulleys present on the bank face	Moderate soil erosion. Bank erosion is occurring, visual change and loss. There are several runnels/gulleys on the bank face < 0.5' deep	High soil erosion - bank erosion is occurring, change is measurable. There are numerous runnels/gulleys > 0.5' deep	
8 Bank Slopes	Slopes range from 3 to 8%.	Slopes 8 to 20%.	Slopes 20% and greater or undercut.	
9 Bank Height vs. High Tide Elevation	High Tide Elevation is at or near Top of Bank	High Tide Elevation is 1/3 below Top of Bank	High Tide Elevation > 1/3 below Top of Bank	
10 Soil Properties: Particle Size / Stratification	Bedrock and boulders make up the bank. Or, cohesive soil types (sand/gravel mix) mixed evenly.	No bedrock or boulders, cohesive soils (sand/gravel mix) are dominant and mixed equally. Clay to very stony sandy loam.	Soils are non-cohesive and/or highly stratified. Sand/gravel mix with larger percentage of sand, sandy loam, silt,	
11 Density of Roots/ Bank Surface Protection/ % of Total Bank Height with Roots	Surface Protection = 80-100%. Root Density in Bank = 80-100%. Root depth/Bank Height = 1.0-0.9	Surface Protection = 55-79%; Root Density = 55-79%; Root depth/Bank Height = 0.5-0.89	Surface Protection < 55%; Root Density < 55%; Root depth/Bank Height < 0.5	
12 Biology / Landscape Connectivity	Shoreline of project and adjacent area to project area has native bank and vegetation materials. No rip-rap or hardened structures installed.	Shoreline of project and adjacent area has native vegetation and bank materials but is impaired by invasives and/or rip-rap and/or hardened structure installed.	Shoreline of project and/or adjacent area is hardened by a concrete headwall, or rip-rap or other structure. Limited vegetation present.	
This Instability Rating Form was developed for the Maine Coastal Program/Maine Department of Agriculture, Conservation and Forestry by the Cumberland County Soil and Water Conservation District. This work was supported by the National Oceanic and Atmospheric Administration (NOAA) Coastal Zone Management Cooperative Agreement #NA14NOS4190047 pursuant to the Coastal Zone Management Act of 1972 as amended. For more information about the Maine Geological Survey, contact mgs@maine.gov or 207-287-2801. For more information about the MCP, visit www.mainecoastalprogram.org or contact 207-287-2351			**Total Rating:**	

Cumberland County Soil & Water Conservation District

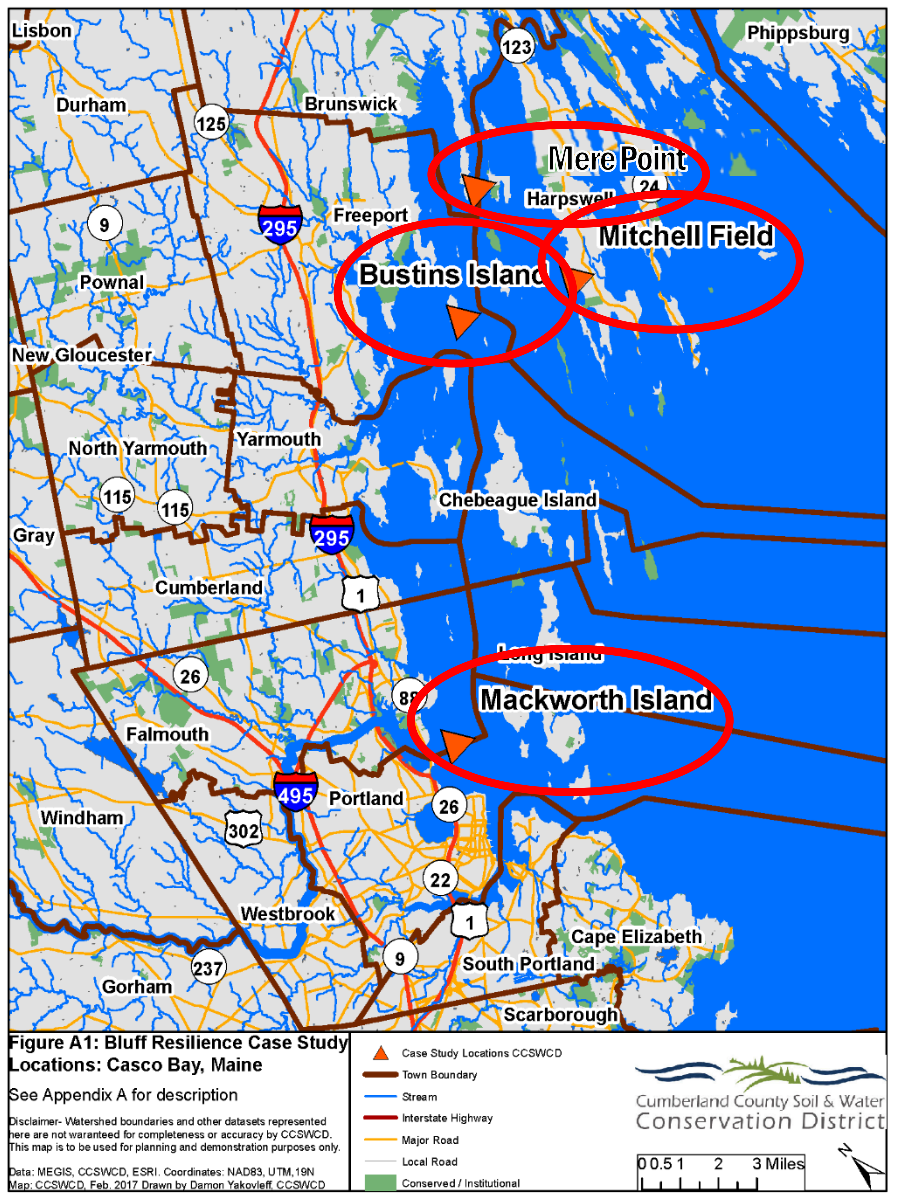
Refer to your handout

Prediction Level Assessment (PLA)



Case Studies

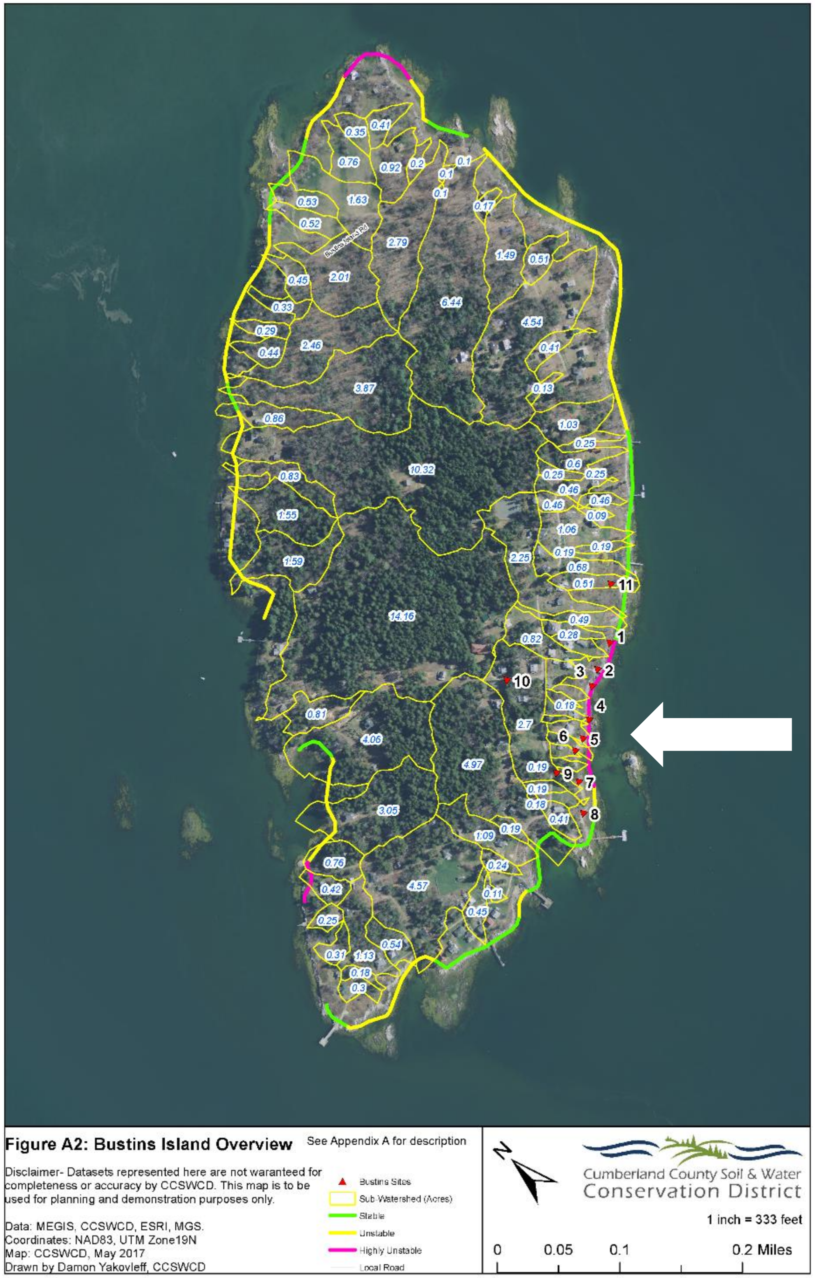
- Bustins Island, Freeport
- Mitchell Field, Harpswell
- Mackworth Island, Falmouth
- Mere Point, Brunswick



Case Study 1: Bustins Island, Freeport

Bluff failure at Site 6 (location of arrow)

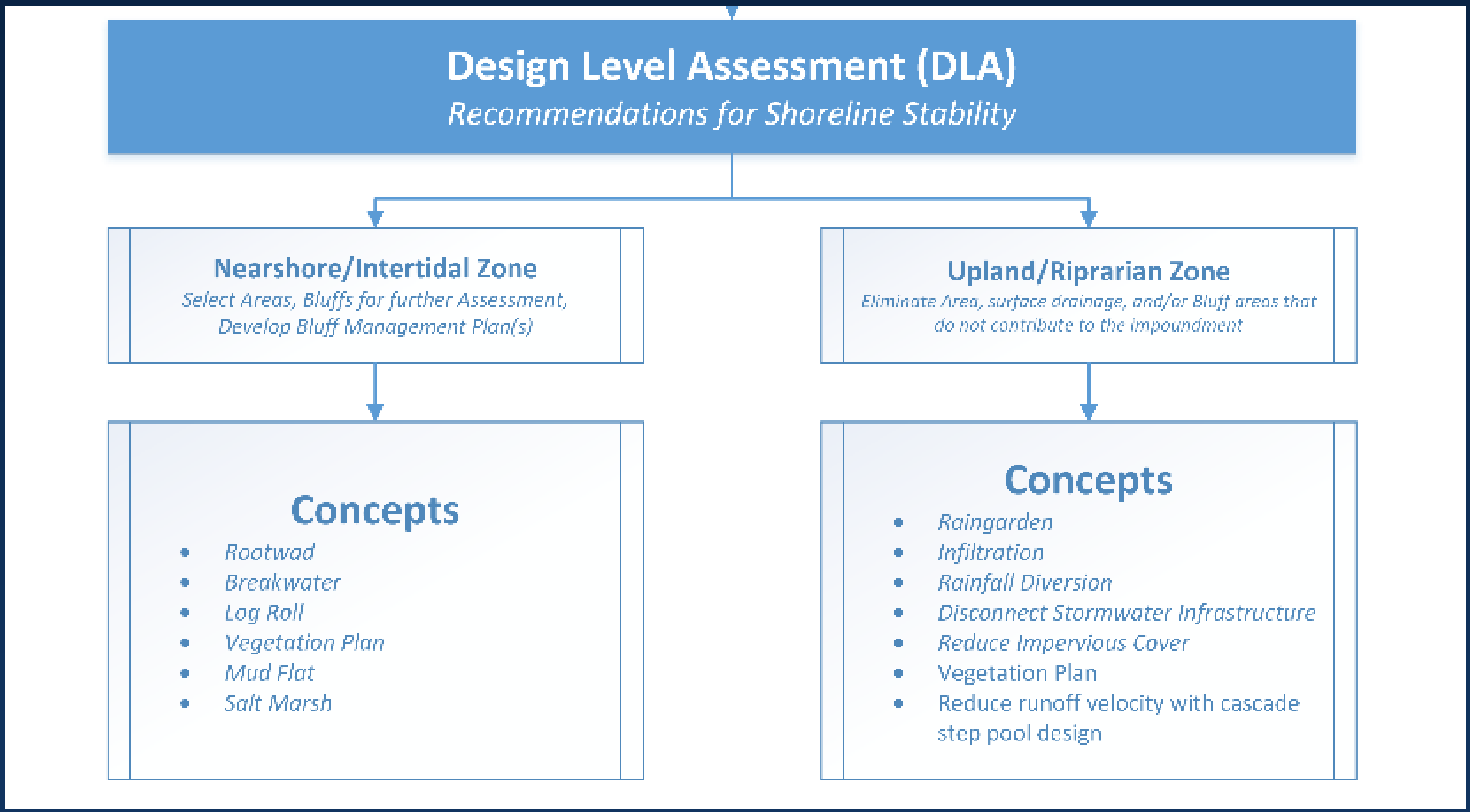
Image source: CCSWCD



Bustins Island Natural "Case Study" Vegetation vs. Riprap

Bustins Island
Image source: CCSWCD

Design Level Assessment (DLA)



Conceptual DLA on Bustins Island

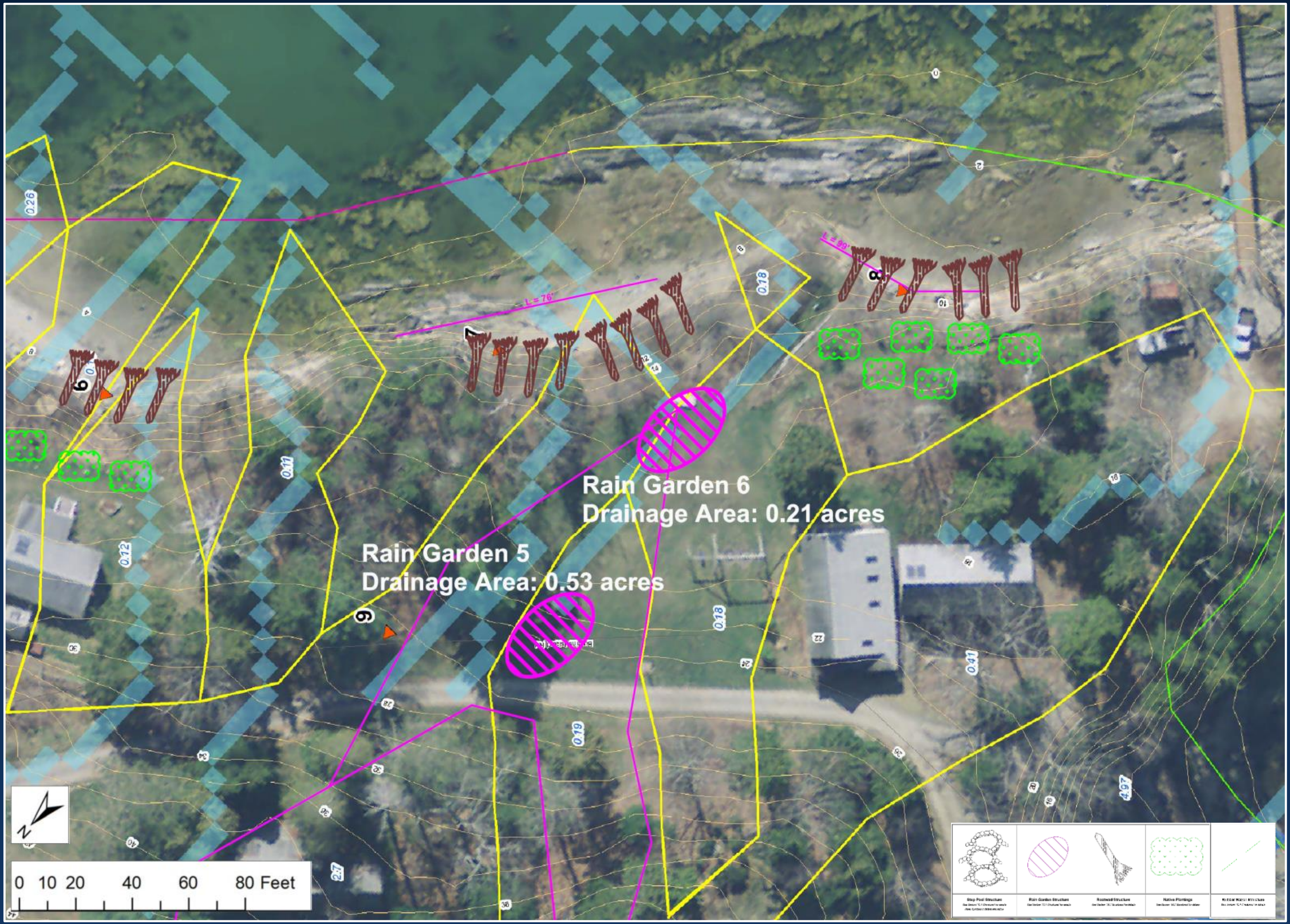


Image source:

Rain Garden Sizing

Rain Garden 1					
Drainage Area:	15254.73 ft^2	**AREA / 2π**	**b**	**a**	***check***
x0.10[1]	1525.47 ft^2	242.79	15.58	31.16	1525.47
x0.07[2]	1067.83 ft^2	169.95	13.04	26.07	1067.83
x0.04[3]	610.19 ft^2	97.11	9.85	19.71	610.19
x0.03[†]	457.64 ft^2	72.84	8.53	17.07	457.64

Rain Garden 5					
Drainage Area:	22874.04 ft^2	**AREA / 2π**	**b**	**a**	***check***
x0.10	2287.40 ft^2	364.05	19.08	38.16	2287.40
x0.07	1601.18 ft^2	254.84	15.96	31.93	1601.18
x0.04	914.96 ft^2	145.62	12.07	24.13	914.96
x0.03	686.22 ft^2	109.22	10.45	20.90	686.22

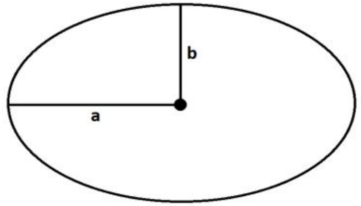
Rain Garden 2					
Drainage Area:	19088.19 ft^2	**AREA / 2π**	**b**	**a**	***check***
x0.10	1908.82 ft^2	303.80	17.43	34.86	1908.82
x0.07	1336.17 ft^2	212.66	14.58	29.17	1336.17
x0.04	763.53 ft^2	121.52	11.02	22.05	763.53
x0.03	572.65 ft^2	91.14	9.55	19.09	572.65

Rain Garden 6					
Drainage Area:	9266.31 ft^2	**AREA / 2π**	**b**	**a**	***check***
x0.10	926.63 ft^2	147.48	12.14	24.29	926.63
x0.07	648.64 ft^2	103.23	10.16	20.32	648.64
x0.04	370.65 ft^2	58.99	7.68	15.36	370.65
x0.03	277.99 ft^2	44.24	6.65	13.30	277.99

Rain Garden 3					
Drainage Area:	26733.6 ft^2	**AREA / 2π**	**b**	**a**	**check**
x0.10	2673.36 ft^2	425.48	20.63	41.25	2673.36
x0.07	1871.35 ft^2	297.83	17.26	34.52	1871.35
x0.04	1069.34 ft^2	170.19	13.05	26.09	1069.34
x0.03	802.01 ft^2	127.64	11.30	22.60	802.01
IN PARALLEL					
Rain Garden 4					
Drainage Area:	26733.6 ft^2	**AREA / 2π**	**b**	**a**	**check**
x0.10	2673.36 ft^2	425.48	20.63	41.25	2673.36
x0.07	1871.35 ft^2	297.83	17.26	34.52	1871.35
x0.04	1069.34 ft^2	170.19	13.05	26.09	1069.34
x0.03	802.01 ft^2	127.64	11.30	22.60	802.01

Ellipse

Surface Area = (pi)*a*b



The factors presented in the table reference requirements from four different sources in regards to sizing rain gardens based on the area of the space reporting to them. The sources of these factors are listed below:

[1] - *Bicknell, J., P.E., Kerr, K., P.E., Atre, V., Schultze-Allen, P., & Lu, Q. (n.d.). C.3 Stormwater Handbook (June 2016 ed.).*

[2] - *C.3 Stormwater Handbook (2005 ed.).*

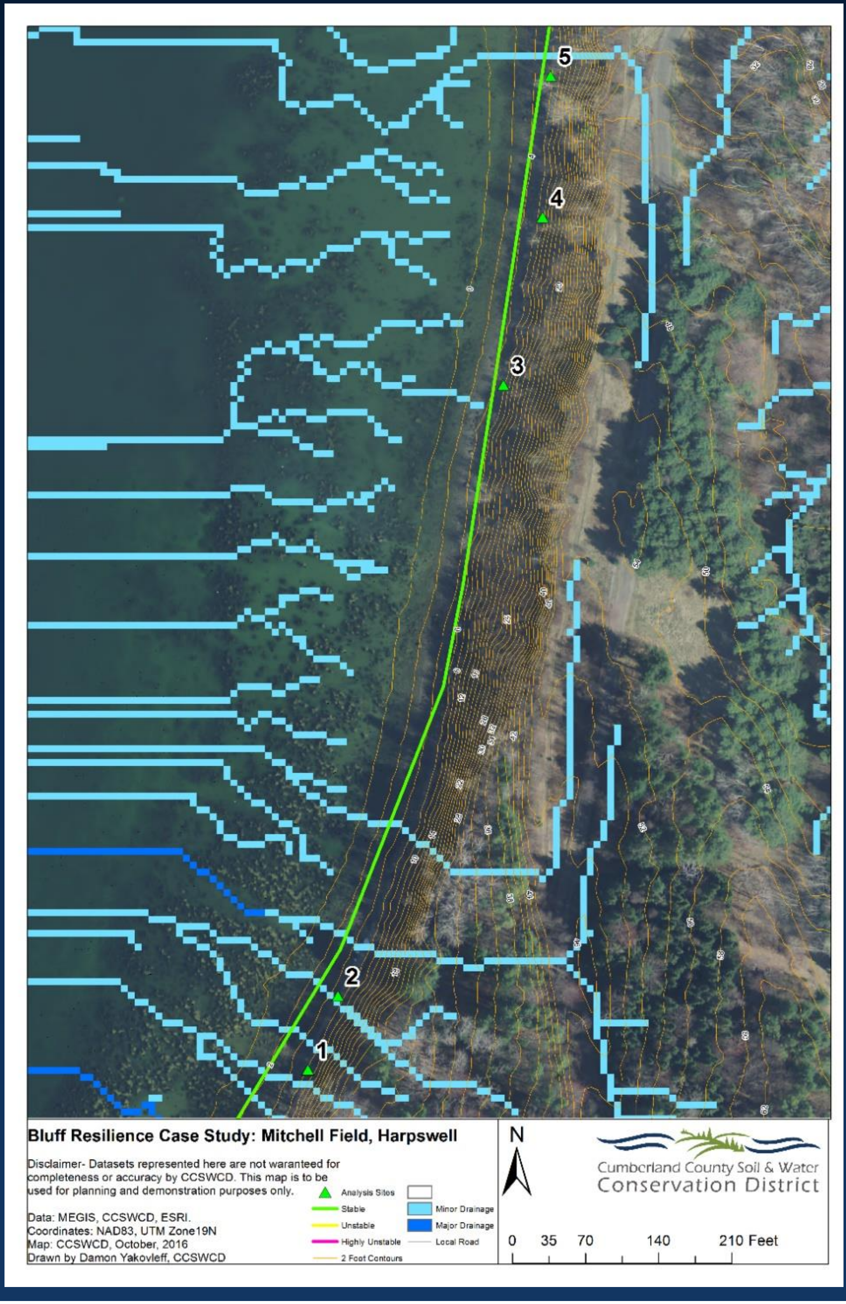
[3] - *Maine Stormwater Best Management Practices Manual, Volume III, Chapter 7.2 - Bioretention Filters.*

[†] - *City of Portland Stormwater Management Manual - August 2016, Chapter 2.3.4.5. Rain Garden.*

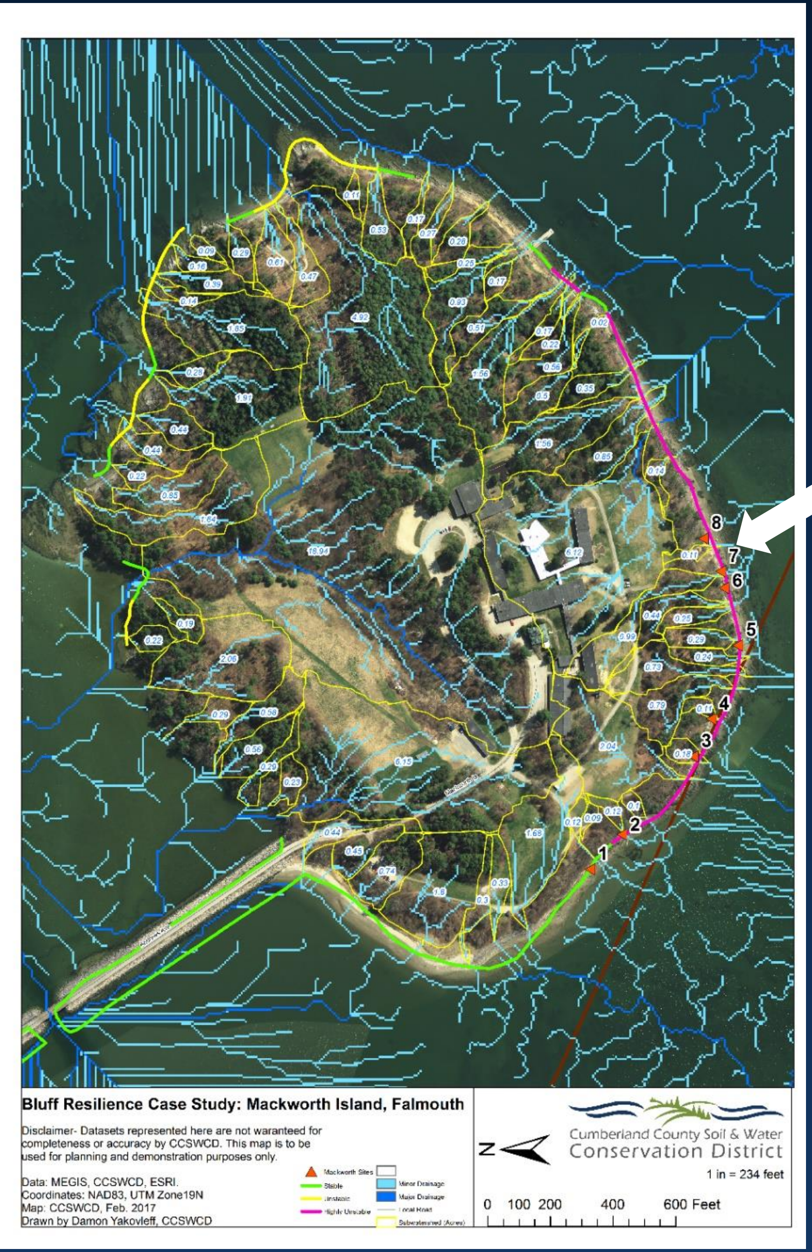
Case Study 2: Mitchell Field, Harpswell

Bluff instability at Mitchell Field

Image source: CCSWCD



Case Study 3: Mackworth Island, Falmouth



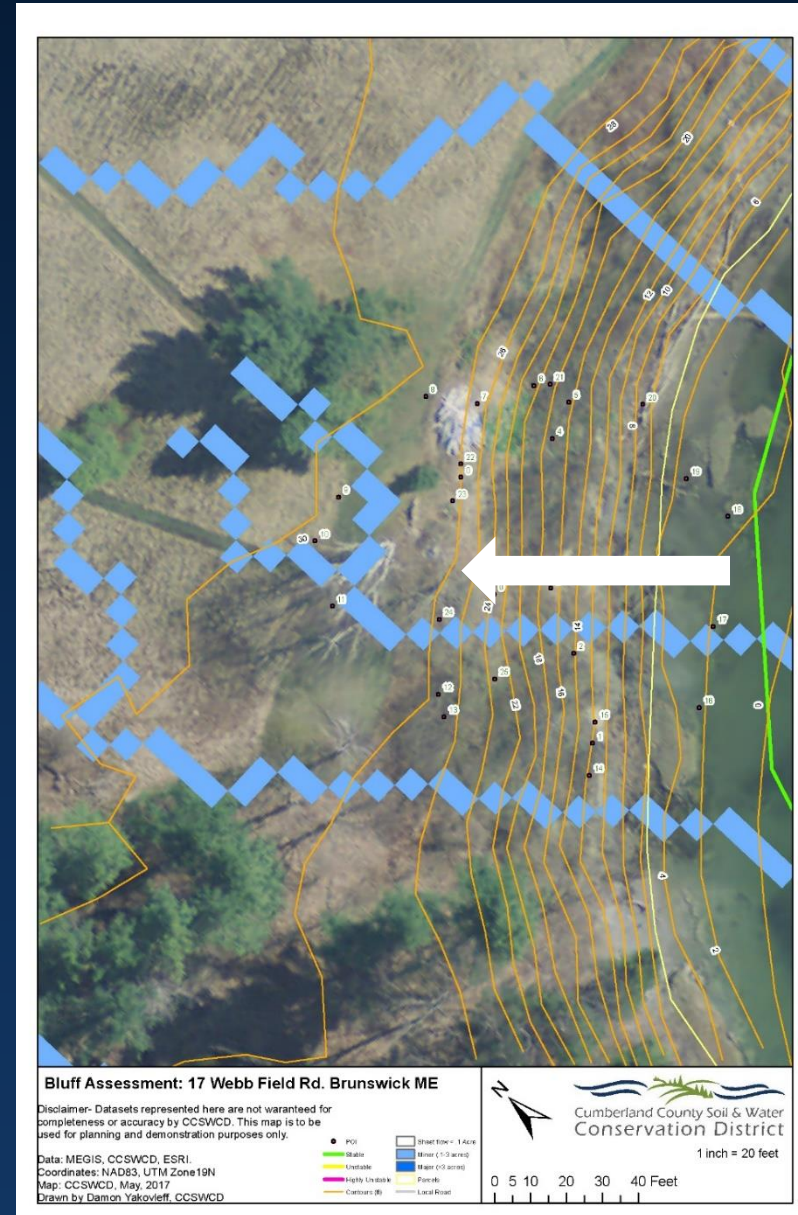
Bluff failure at Site 7 (location of arrow)

Image source: CCSWCD

Case Study 4: Mere Point, Brunswick

Bluff failure at Mere Point (location of arrow)

Image source: CCSWCD



Coastal Planting Guide

Advantages

- Cause: vegetation loss (intentional)
- Suitability: stable vegetation on adjacent properties
- Soil type: suitable
- Wave action: none

Challenges/Concerns

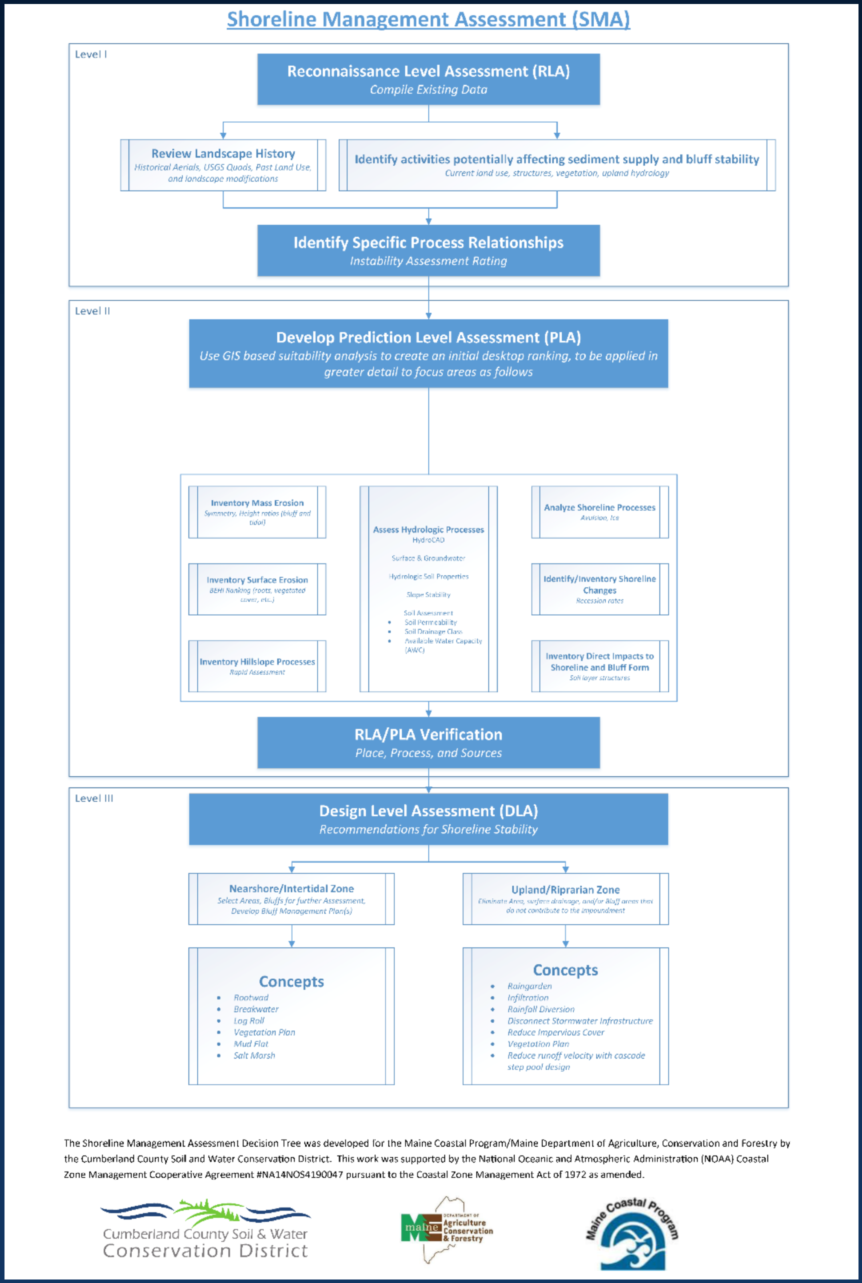
- Super-saturated soil

Summary: perfect candidate for a living shoreline

Bluff failure at Mere Point
Image source: CCSWCD

Shoreline Management Assessment Decision Tree

All the levels we just demonstrated



Refer to your handout

Full Image Sources

- Slide 3 (Shoreline Zones): Hardaway, C.S., Jr. and R.J. Byrne. 1999. "*Shoreline Management in Chesapeake Bay*". Special Report in Applied Marine Science and Ocean Engineering, No. 356. College of William and Mary, Virginia Institute of Marine Science, Gloucester Point.
- Slide 4 (Bluff Erosion): "*Living on the Coast : Protecting Investments in Shore Property on the Great Lakes*". Keillor and White. 2003
- Slide 5 (Formation of Bluffs): "*Slope Stabilization Erosion Control Using Vegetation: A Manual of Practice for Coastal Property Owners*." Publication #93-30. Washington State Department of Ecology. May 1993.
- Slide 9 (Shoreline Stabilization): Necanicum River Estuary in Seaside, Oregon. BioEngineering Associates, Inc. 2015. http://bioengineers.com/seaside/
- Slide 10 (Rain Garden): Seattle Public Utilities. 2015. http://www.700milliongallons.org/wp-content/uploads/2015/09/Raingarden-factsheet-v9-7-22-15.pdf
- Slide 10 (Step Pools): Todd Moses. "*Reconstructing Streams*", Public Works Magazine. 2010. http://www.pwmag.com/water-sewer/stormwater/reconstructing-streams

Building Resiliency Along Maine's Bluff Coastline

Project Partners:

Maine Coastal Program

University of Maine

Maine Geological Survey

Maine Department of Agriculture, Conservation & Forestry

Funding through NOAA

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Cumberland County Soil & Water Conservation District

Brunswick Maine Shoreline Erosion Working Group

Jared Woolston, Planner
jwoolston@brunswickme.org

Why?

- Negative citizen response to shoreline stabilization
- Town shoreland zoning ordinance deficient
- New England shoreline stabilization standards possibly antiquated - Living Shorelines?
- Town Manager direction to staff – guide policy

Assumptions for Shoreline Erosion Management:

1. Natural shoreline erosion is a community issue in Brunswick
2. Additional information is required for local management decisions

Project Needs: →	**Activities:** →	**Outputs:** →	**Outcomes:** →	**Impact:**
The following information is required to address community issues and management decisions. I. Erosion causes and effects II. Land uses III. BMPs IV. Priorities V. Concerns	If information needs are fulfilled then shoreline erosion management standards can be developed. **I. Organize working group(s) for information sharing** II. Report findings	If management standards are developed then policy changes can be made. I. Staff prepares recommenda-tion based on working group report II. Town Council considers adoption	If standards are implemented then citizens, staff, and review entities will benefit from informed decision-making and predictable project reviews.	If informed decision-making, and predictable reviews are achieved then a positive response from stakeholders and the equitable protection of natural systems is expected.

Planned work

Intended results

Who is Brunswick’s SEWG?

- Brunswick Staff
  - Planner, Marine Resource Officer / Harbor Master, Assistant Town Manager
- Brunswick Citizen Volunteers
  - Marine Resources Committee, Conservation Commission, Planning Board, Rivers and Coastal Waters Commission
- State & County Experts
  - Maine DEP, Maine IFW, Maine DACF, CCSWCD

Public SEWG Meetings

- Create project webpage on town website
- Notify public
  - Advertise on local TV3
  - Notify volunteer groups
  - Update town meeting calendar
- Stream live meetings on TV3

Project Scoping (logic model)

SEWG

Logic Model Assumption #1: Natural shoreline erosion is a community issue in Brunswick.

- Brunswick's shorelines
  - Androscoggin River
  - Freshwater streams
  - Coastal wetlands

Androscoggin River

- 13 miles of shoreline
  - -7 miles of tidal shoreline below Fort Andros dam
- Coastal bluffs (MGS)
- Wildlife habitat (MDIFW)
- Rare plant communities (MNAP)
- Federally protected sturgeon spawning and staging grounds, Atlantic salmon run (USFWS/DMR)
- Recreational uses
- Existing development – residences, businesses and public infrastructure

Freshwater Streams

- Recreational uses
- Natural value
- Existing and future development:
  - Four (4) urban impaired streams (Chapter 502)
- Mare Brook watershed assessment (2016) found erosion is a primary stressor to habitat

Coastal

- 37 Miles of southern shoreline
- State Resource agency priorities
  - mapped unstable & highly unstable bluffs
  - wildlife habitats
  - rare plant communities
- Town priorities
  - commercial fishing, upland development (existing and future), and recreational opportunities

Androscoggin River

Freshwater Streams (Mare Brook)

Long Reach

Mere Point

Maquoit Bay

Upper Maquoit Bay

Middle Bay

Simpsons Point

Woodward Cove

Wharton Point

Breezy Point

Bunganuc Point

Princess Point

Project Scope

- SEWG: Recommended studying all areas of shoreline erosion but primarily focus on Brunswick's coast.

Logic Model Assumption #2. Additional information is required for local management decisions.

- Restore Americas Estuaries (RAE) Conference
  - New Orleans, LA (December 2016)
    - Gulf of Mexico Living Shorelines
    - West Coast Living Shorelines
    - East Coast Living Shorelines
    - New England Living Shorelines…? Nope.
- Living Shoreline Suitability (2016-2017)
  - Project Manager: Pete Slovinsky, MGS
  - GIS score
  - Slope, Plants, Habitat, Aspect, Fetch…
- CCSWCD / Maine Coastal Program (2017)
  - Bluff decision tree and planting guide
- Living Shoreline Pilot Projects (2017-present)
  - NOAA Grant – New England states

SEWG:

Coastal Shoreline Erosion Is Systemic

- Surface water management
  - watershed size, topography, time of concentration (water volume and velocity), slope steepness & length, and infiltration
- Soils
  - clay and bedrock - limited infiltration but may be reconstructed
  - sand and gravel – high erosion when not vegetated
- Wind and wave energy
  - Degree of fetch
- Upland plants
  - Trees may cause or exacerbate instability - existing landslides and leaning trees are field indicators
  - Planting plans must be robust for Shoreland Zoning
- Aspect
  - Slope spring freeze / thaw & plant viability
  - Groundwater
- In-resource management – Living shorelines…
  - Artificial reef, marsh creation, temporary toe protection, root wads, live stakes, sill, breakwater
  - Permits requirements and laws (State NRPA and Shoreland Zoning, Federal Clean Water Act)
- Shoreline development
  - Policy consideration (draft) - setbacks, plant buffer management, grading, natural functions, commercial fishing, upland landowner protection, stormwater management, permanent vs temporary erosion control, sediment management, dynamic natural systems & maintenance

Questions?

Call Pete or Troy.

Building Resilient Coastal Bluffs – *Living Shorelines – Regulatory Considerations*

Bluff regrading, planting, coir log toe
Bustins Island, Freeport

T. Barry, CCSWCD

Hybrid bluff stabilization
Royal River, Freeport

MEDEP

Dune Restoration
Ferry Beach, Saco

P. Slovinsky, MGS

Beach Nourishment
Western Beach, Scarborough

P. Slovinsky, MGS

High Resolution Coastal Inundation Modeling and Advancement of Green Infrastructure and Living Shoreline Approaches in the Northeast

Partners – NERACOOS, NROC, ME, NH, MA, RI, CT, and universities

Track 2 – Advancing Green Infrastructure and Living Shoreline Approaches

- *Task 2 – Examine, identify, and* ***address regulatory issues associated with green infrastructure/living shoreline practices*** *and develop efficiencies for permitting.*

Living Shorelines: Regulatory Considerations

- Convened a **Maine regulatory working group** involving review and commenting agencies, including USACE, MEDEP, MELUPC, MCP, MGS, MFMP, Submerged Lands, MEDMR, and MEIFW.
- Developed an internal state-level memo – **Regulatory Framework for Living Shoreline Projects in Maine** for further consideration.
- Held a **New England regional workshop (ME, NH, MA, RI and CT)** on living shorelines trying to identify **common challenges and opportunities** (attended by MGS, MEDEP, USACE, Submerged Lands, MEDMR)

Living Shorelines: Regulatory Considerations

Some Maine Identified Challenges and Opportunities

- No **“living shoreline” permit**.
- Shoreline stabilization projects are permitted on a **case-by-case basis and don’t pursue understanding of cumulative impact.**
- Based on existing review process, it’s **easier to get a permit** to install a rip-rap wall above the HAT than to pursue a LS project that may extend below the HAT (“avoiding” the resource”).

Living Shorelines: Regulatory Considerations

Some Maine Identified Challenges and Opportunities

- As a result, there are **very few on-the-ground projects to help better understand the successes and failures of LS approaches in Maine**, or how LS projects may impact existing habitats.
- No **consistent monitoring protocol** for furthering the understanding of the above.
- There does appear to be **flexibility in existing Maine regulatory structure** to allow LS projects to occur.

Living Shorelines: Regulatory Considerations

Common New England *regionally* identified Challenges and Opportunities

- Lack of a **common federal and/or state definition**
- **US Army Corps NWP 54 (Living Shorelines)** –
  - can/should aspects of this be incorporated into existing state general permits for New England states?
- Balancing **habitat restoration vs. shoreline protection**? When is a LS one or the other?

Living Shorelines: Regulatory Considerations

- **Permitting complexity** – “avoiding” the resource – above HAT, but loss of resource over time.
  - **Habitat Tradeoffs** – past vs. current vs. future conditions *(heavily dependent upon resource agencies)*
  - **Monitoring requirements**/understanding of impacts of LS vs. traditional approaches *(heavily dependent upon resource agencies)*
- **Education on LS approaches** *(contractors, engineers, regulators, municipalities, property-owners)*

Living Shorelines: Regulatory Considerations

Questions and Discussion?