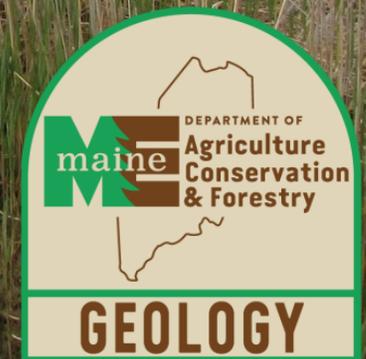# Introducing Green Infrastructure for Coastal Resilience
Living Shorelines and Decision Support Tools

Peter Slovinsky, Marine Geologist
**Maine Geological Survey**

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.**

Traditional "Gray" Approaches

"Grayer" Approaches ⟶
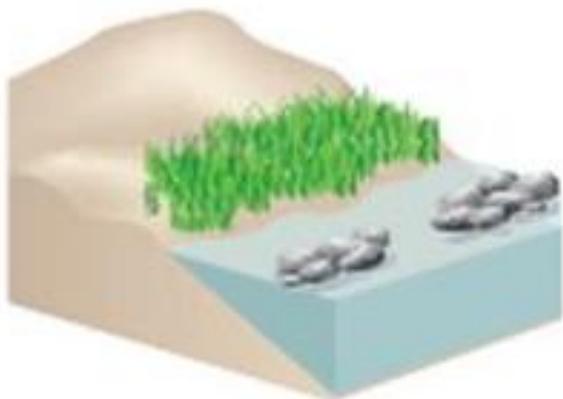
BREAKWATER -
(vegetation optional) - Offshore structures intended to break waves, reducing the force of wave action, and encourage sediment accretion. Suitable for most areas.
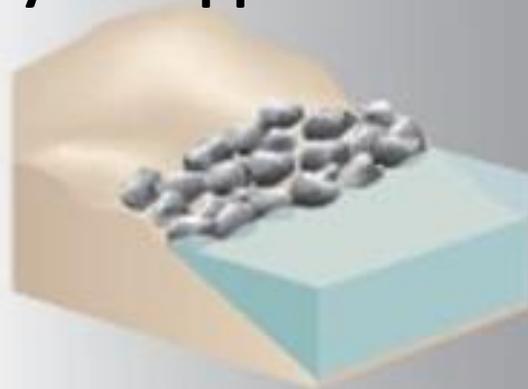
REVETMENT -
Lays over the slope of the shoreline and protects it from erosion and waves. Suitable for sites with existing hardened shoreline structures.
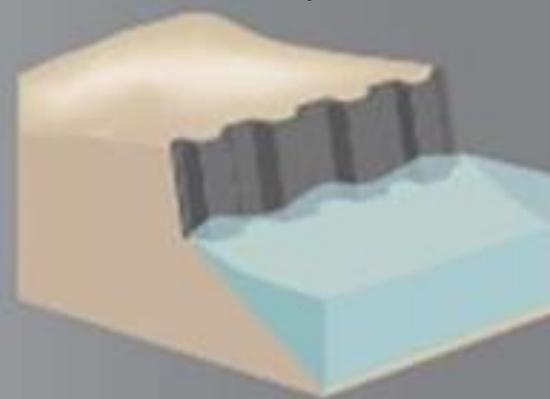
BULKHEAD -
Vertical wall parallel to the shoreline intended to hold soil in place. Suitable for high energy settings and sites with existing hard shoreline structures.

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

Living Shoreline "Green" Approaches
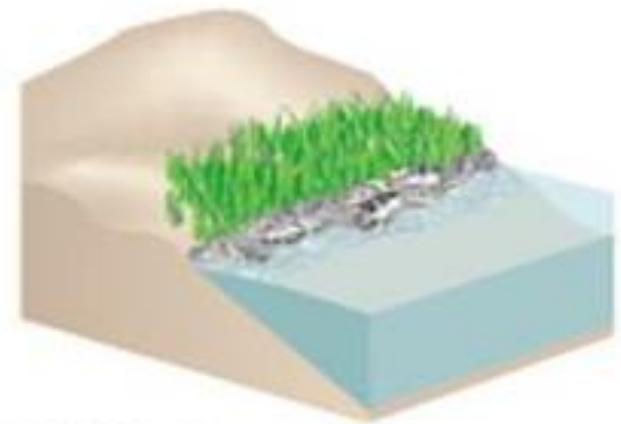
← —————————— "Greener" Approaches
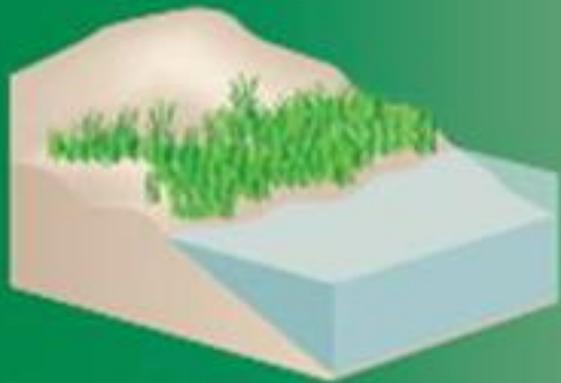
VEGETATION ONLY -
Provides a buffer to upland areas and breaks small waves. Suitable for low wave energy environments.

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)
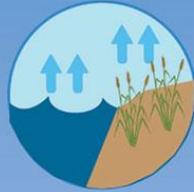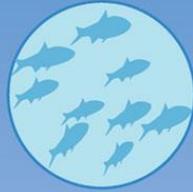
Why Living Shorelines?

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.

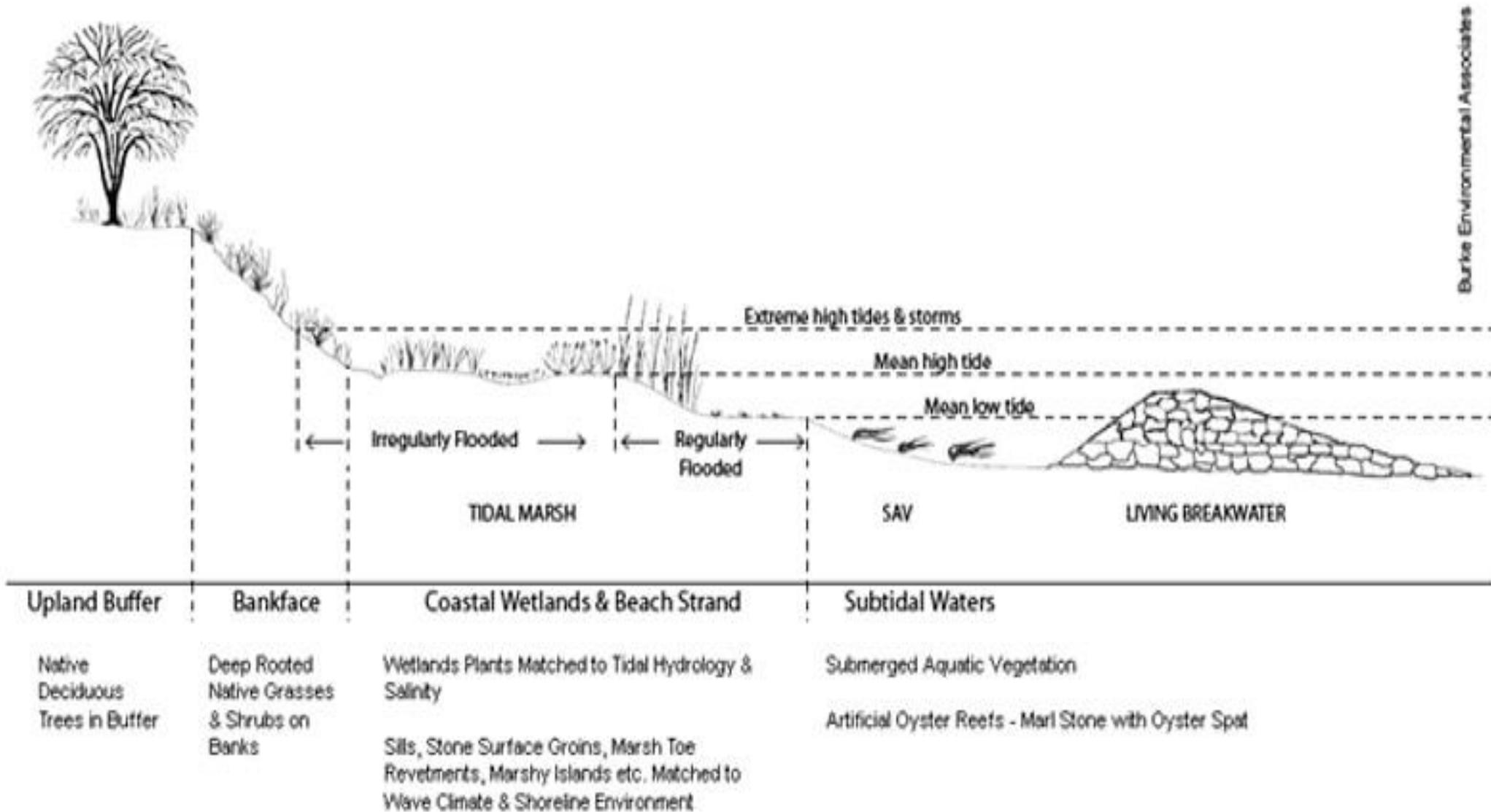**33%** of shorelines in the U.S. will be **hardened** by **2100**, decreasing fisheries habitat and biodiversity.

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

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

Where can living shorelines be implemented?

Coastal Shoreline Continuum & Typical "Living Shorelines" Treatments

Burke Environmental Associates

Extreme high tides & storms
Mean high tide
Mean low tide

Irregularly Flooded → | ← Regularly → | Flooded

TIDAL MARSH   SAV   LIVING BREAKWATER

Upland Buffer	Bankface	Coastal Wetlands & Beach Strand	Subtidal Waters
Native Deciduous Trees in Buffer	Deep Rooted Native Grasses & Shrubs on Banks	Wetlands Plants Matched to Tidal Hydrology & Salinity	Submerged Aquatic Vegetation
		Sills, Stone Surface Groins, Marsh Toe Revetments, Marshy Islands etc. Matched to Wave Climate & Shoreline Environment	Artificial Oyster Reefs - Marl Stone with Oyster Spat

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

T. Barry, CCSWCD

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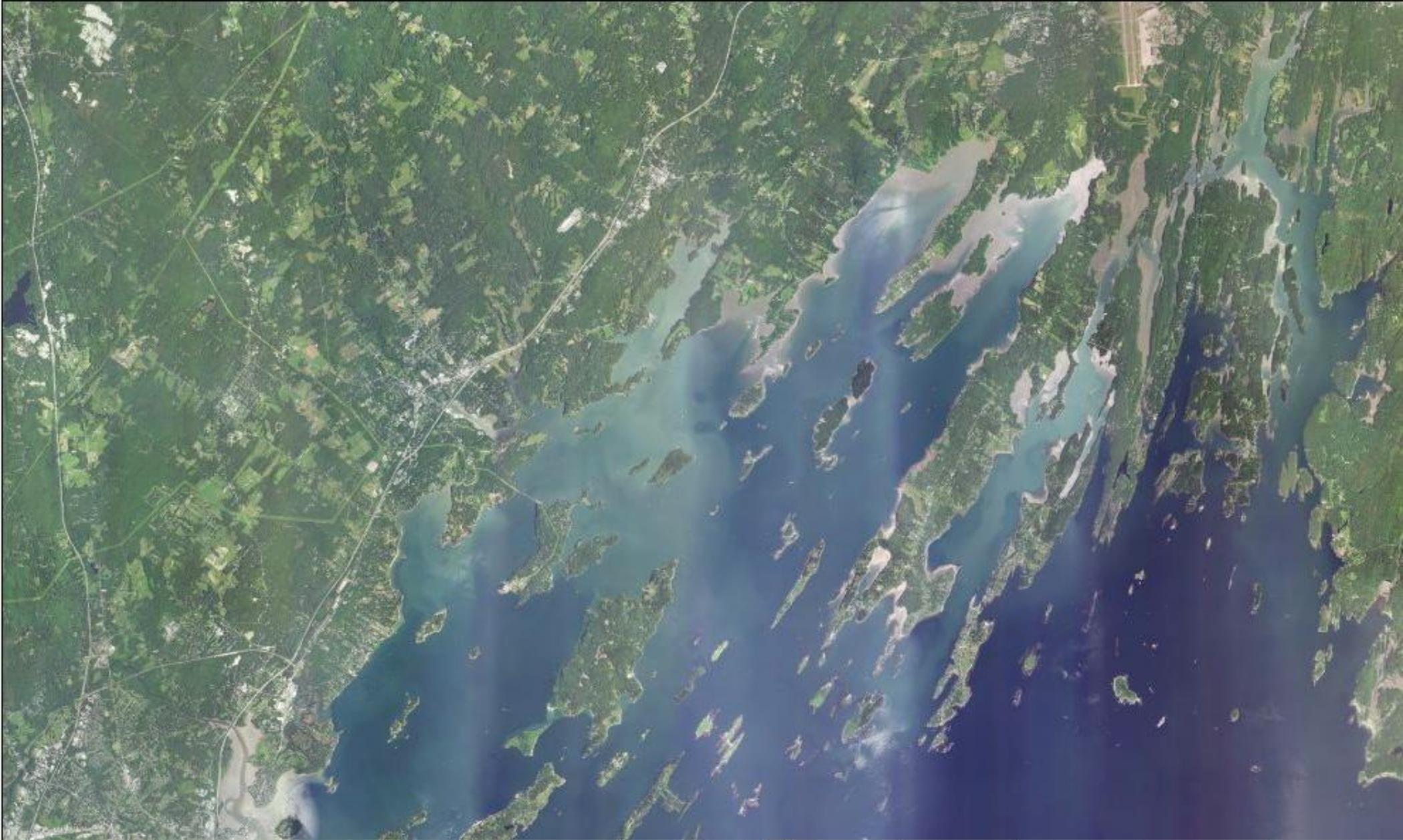
Developing a GIS-based decision support tool for living shoreline suitability in Casco Bay

Maine Geological Survey

Step 1 – Literature Review

Modeling Site Suitability of Living Shorelines in Connecticut

Overview

Enhancing coastal resilience in Connecticut through web-mapping decision support tool

by jayz0113

Last Modified: April 22, 2016

Web Mapping Application

View Application

Details

★★★★★ 0 ratings, 2,910 views

Created: November 18, 2015

Size: 70 KB

API: JavaScript

Purpose: Ready To Use

Owner

Description

In an attempt to improve coastal resilience in Connecticut, this study developed an automated geospatial model which determines the suitability for various living shoreline methods along Long Island Sound in Connecticut. Living shorelines are nature-based shoreline protection strategies which also enhance natural habitat and ecosystem services. The model uses coastal conditions and site characteristics to determine stretches of coastline suitable for living shorelines. The model takes into consideration system, hydrodynamic, and terrestrial parameters such as

Mid-Atlantic Veg. Treatment Guidelines
NROC Living Shoreline Report
RAE Living Shoreline Conference, NOAA Living Shoreline Guidance
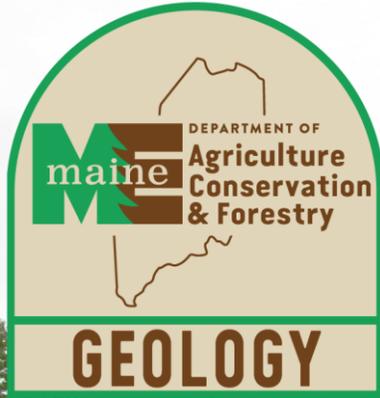Maryland   Virginia   Connecticut   North Carolina
Alabama   Delaware   New Jersey

# Step 2: Form a Technical Working Group

MEDEP

Step 3: Determine Factors (and their importance) Influencing Living Shoreline Suitability
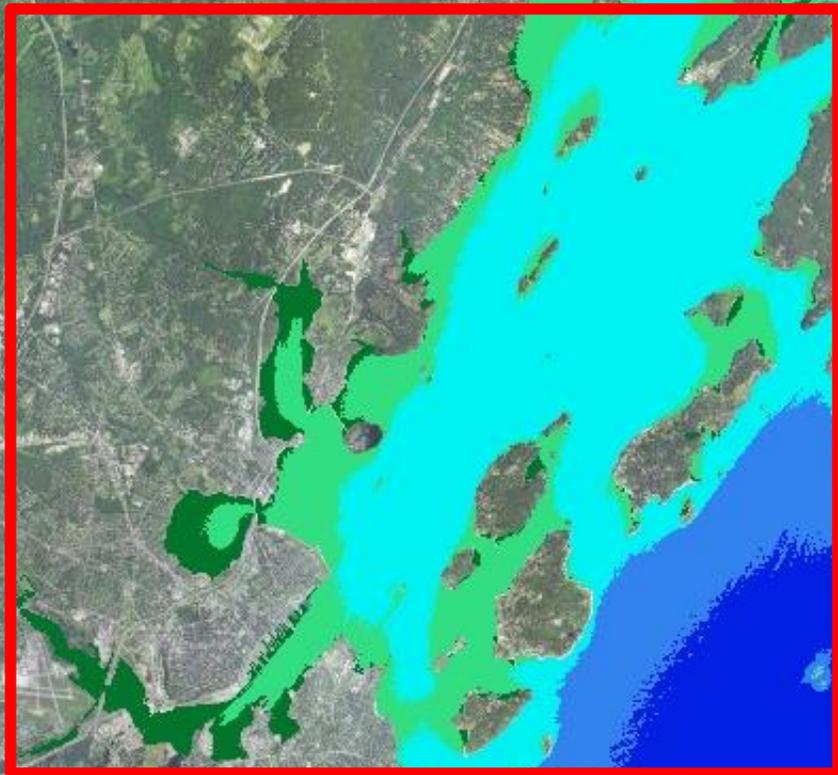
- **Annualized Weighted Fetch (predominant wind directions)**
- **Nearshore Bathymetry (within 100 feet of the shoreline)**
- **Dominant Landward Shoreline Type**
- **Dominant Seaward Shoreline Type**
- **Upland Relief (within 50 feet of the shoreline)**
- **Upland Slope (within 50 feet of the shoreline)**
- **Presence or Absence of Special Habitat Types**
  - **Eelgrass, Tidal Wading Birds, Shellfish**
- **Aspect (sunlight exposure, southeast to southwest)**

Annualized Weighted Fetch – USGS Fetch Tool

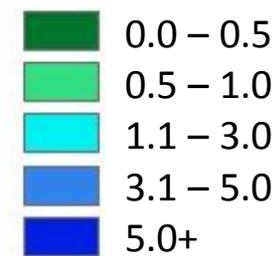Hourly Wind Data from NDBC 44007 (2006-2016)
12 NM Southeast of Portland, ME

source: NDBC Buoy 44007
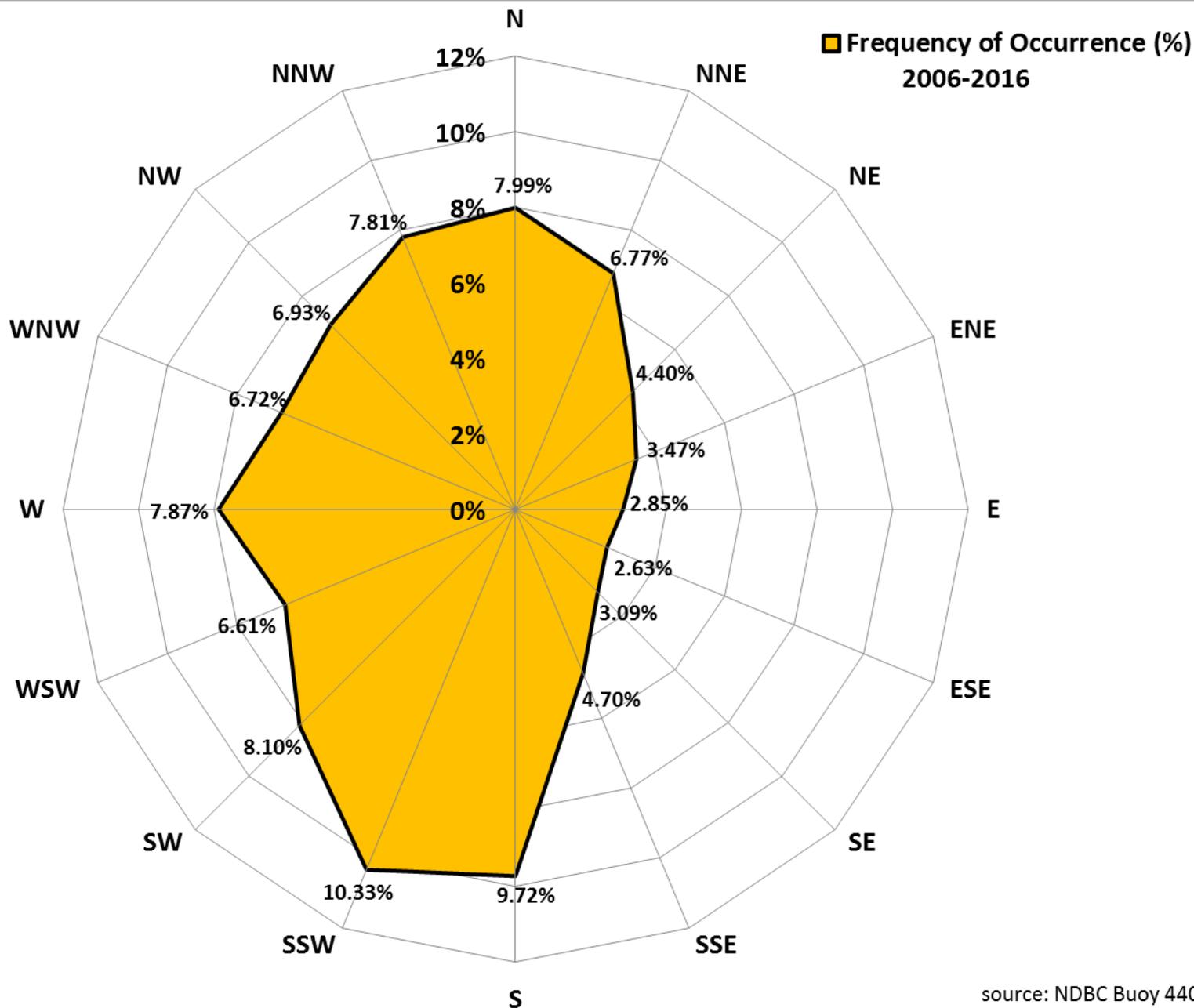
Weighted Fetch – USGS Fetch Tool

Living Shoreline Shoreline Factors
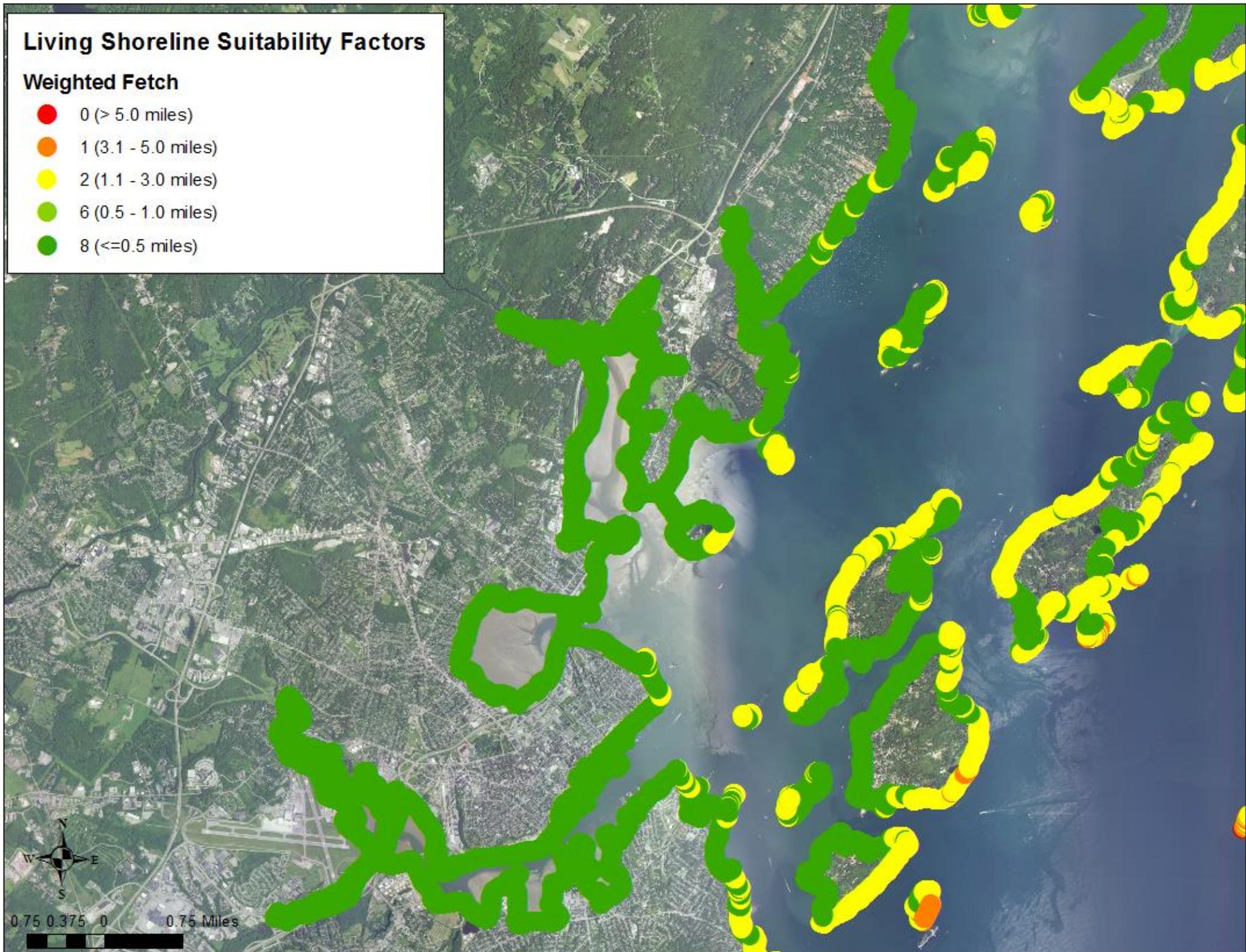Casco Bay, ME

Weighted_Fetch

Distance (miles)

- 0.0 – 0.5
- 0.5 – 1.0
- 1.1 – 3.0
- 3.1 – 5.0
- 5.0+

maine DEPARTMENT OF Agriculture Conservation & Forestry

1   0   2 Miles

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)

0.75 0.375 0   0.75 Miles

Living Shoreline Suitability Factors

Nearshore Bathymetry

- 🔴 0 (Deeper than 1 m w/in 100 ft)
- 🟢 6 Shallower than 1 m w/in 100 ft)

0.75 0.375 0   0.75 Miles
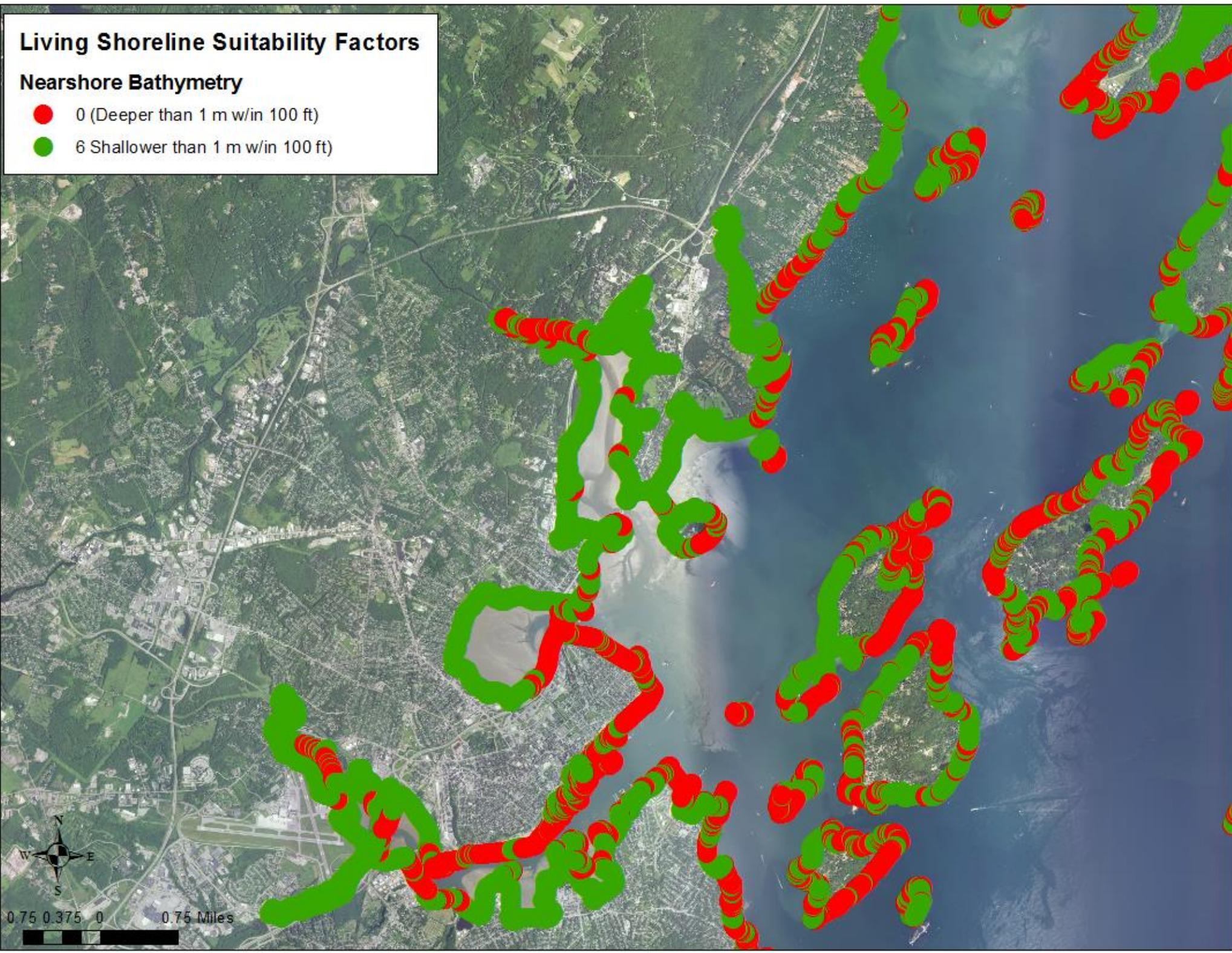
Living Shoreline Suitability Factors

Landward Shore Type

- 1 (exposed hard shorelines)
- 3 (Sheltered hard shorelines, riprap)
- 5 (Beaches, dunes, banks)
- 6 (Wetlands, swamps, marshes)

0.75 0.375 0   0.75 Miles
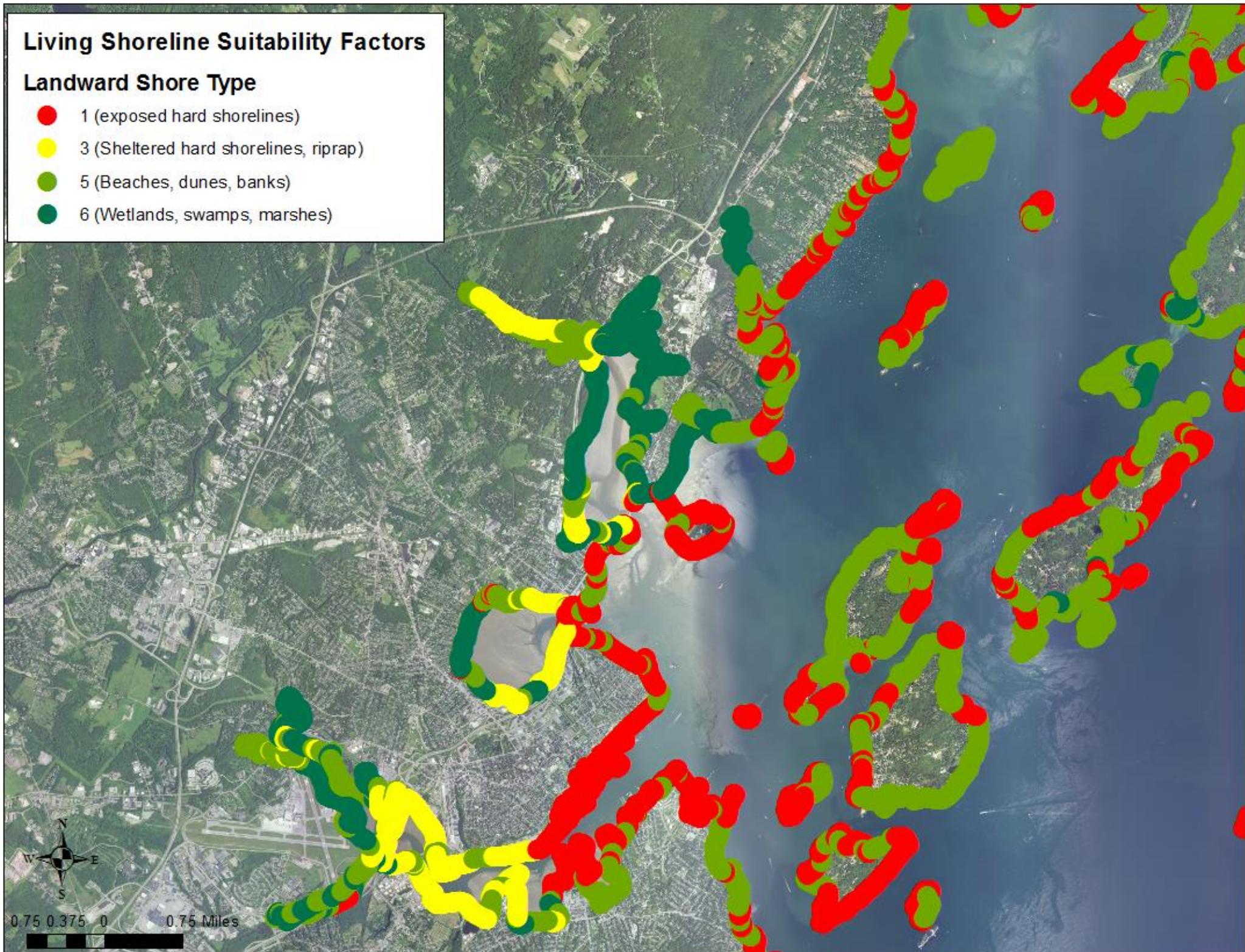
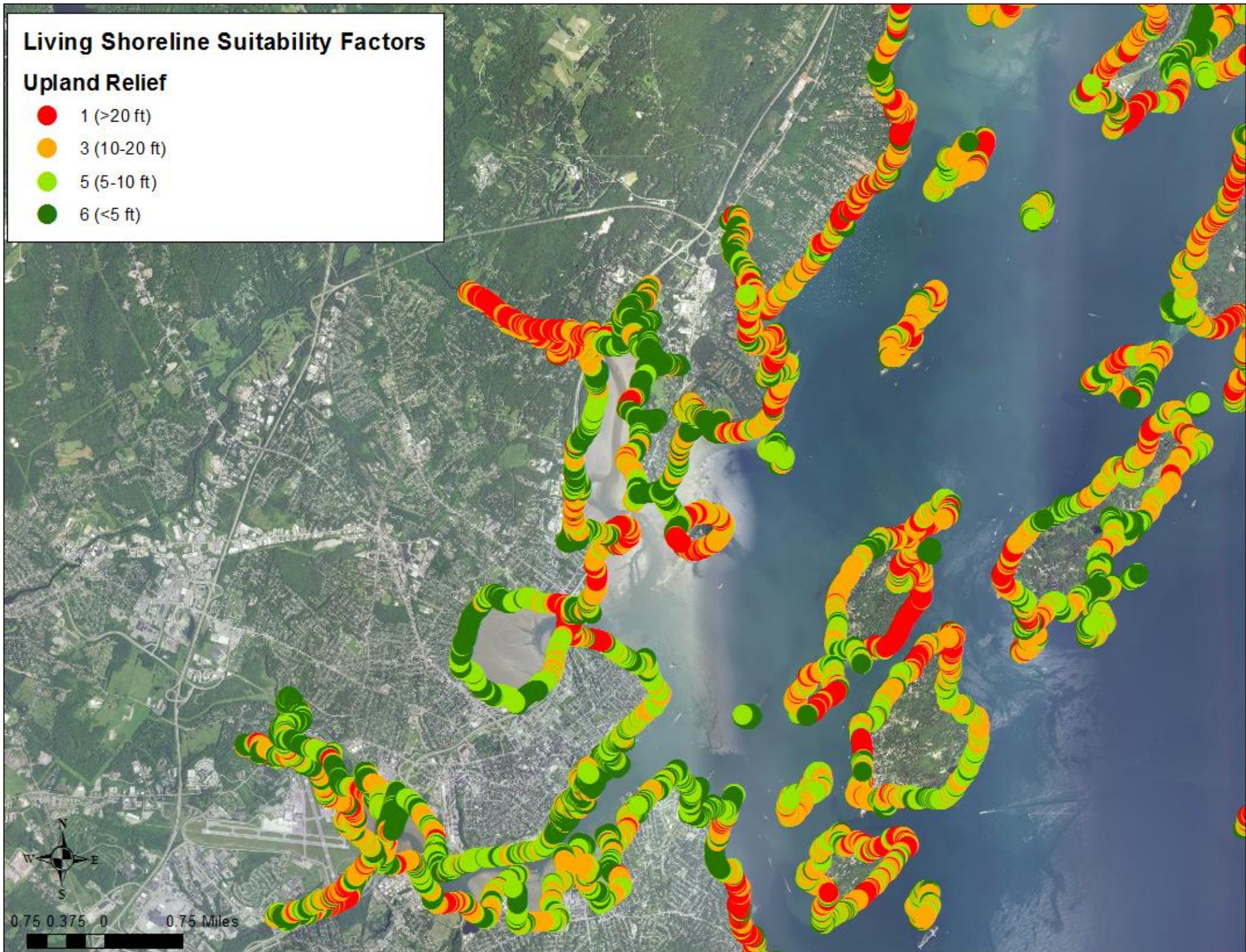**Living Shoreline Suitability Factors**

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)

0.75 0.375 0   0.75 Miles
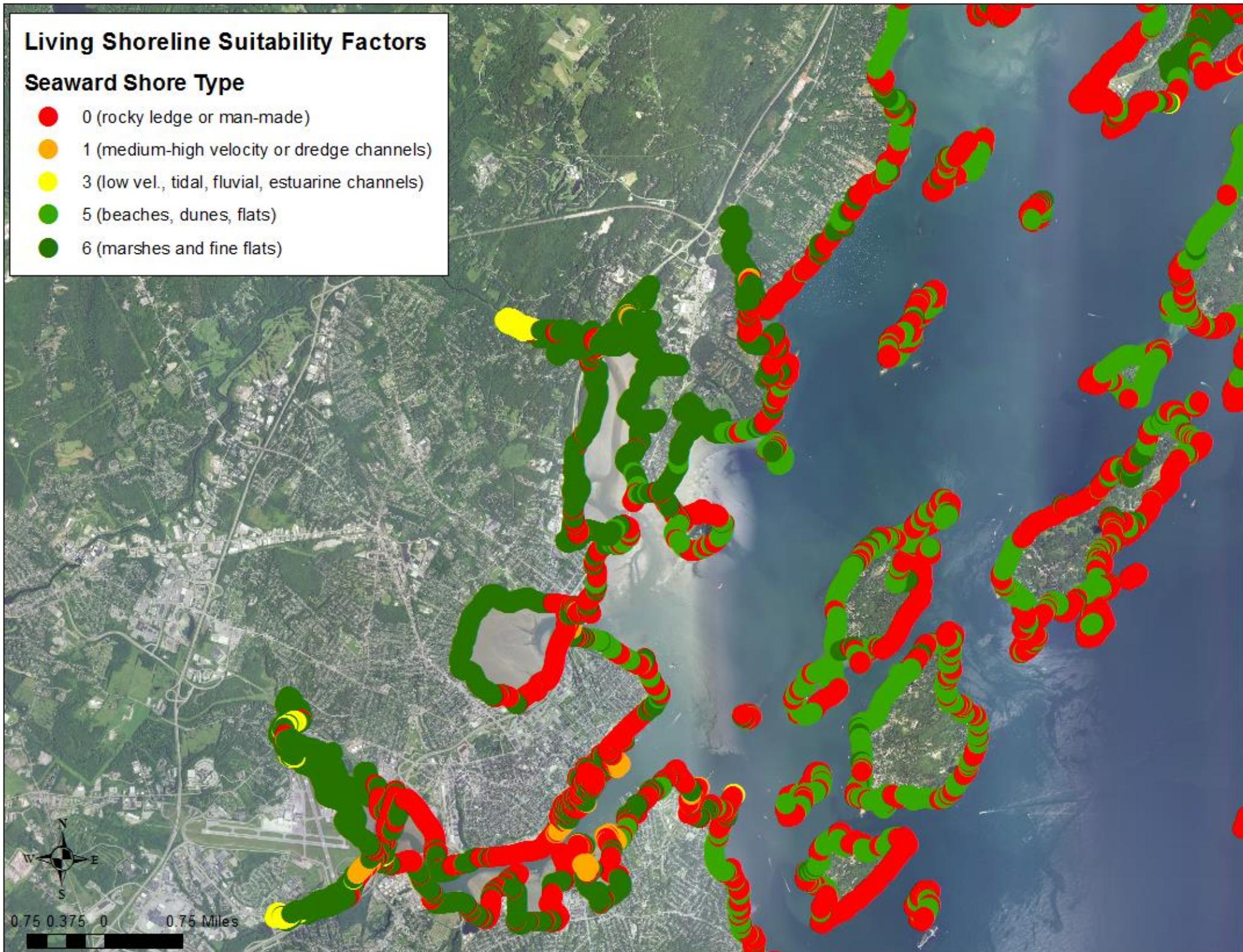
Living Shoreline Suitability Factors

Upland Relief

- 🔴 1 (>20 ft)
- 🟠 3 (10-20 ft)
- 🟢 5 (5-10 ft)
- 🟢 6 (<5 ft)

0.75 0.375 0   0.75 Miles

Living Shoreline Suitability Factors

Upland Slope
- 1 (>30%)
- 2 (16-30%)
- 4 (10-15%)
- 5 (4-10%)
- 6 (0-3%)

0.75 0.375 0   0.75 Miles
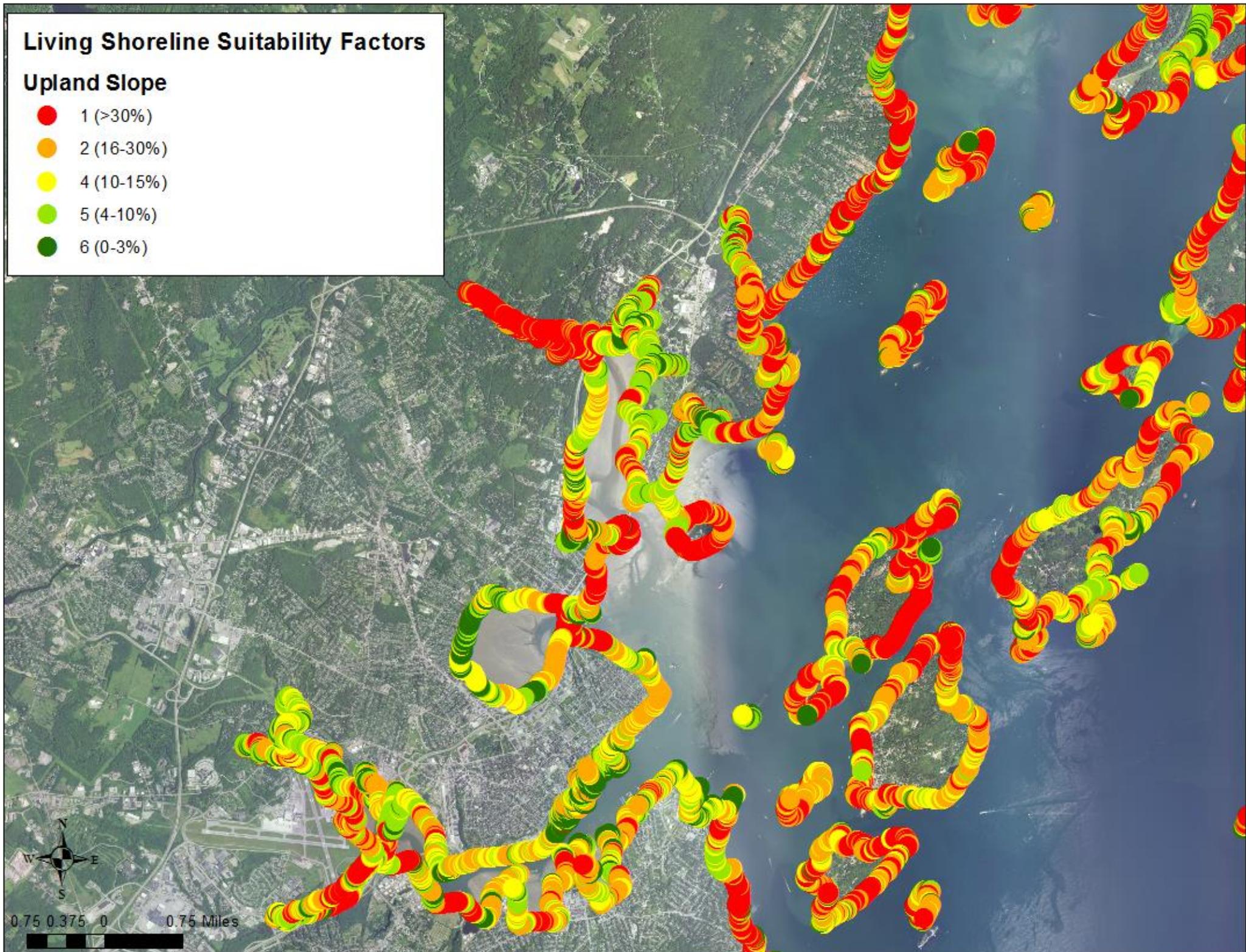
Living Shoreline Suitability Factors

Eelgrass Habitat

- 🔴 0 (Absent)
- 🟢 2 (Present)

0.75 0.375 0   0.75 Miles

Living Shoreline Suitability Factors

Shellfish Habitat

- 0 (Absent)
- 2 (Present)

0.75 0.375 0   0.75 Miles
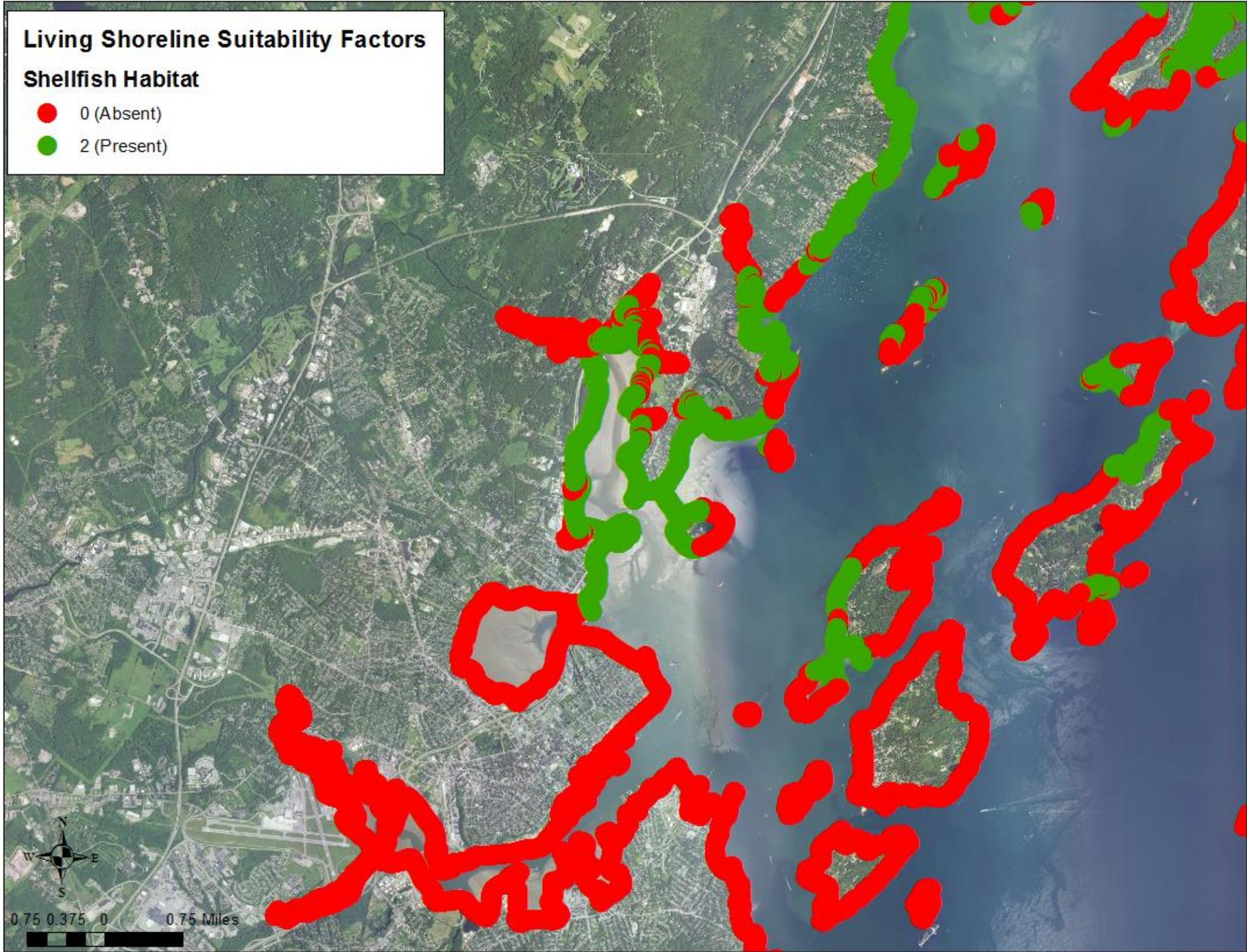
Living Shoreline Suitability Factors

Tidal Wading Bird Habitat

- 0 (Absent)
- 2 (Present)

0.75 0.375 0 0.75 Miles
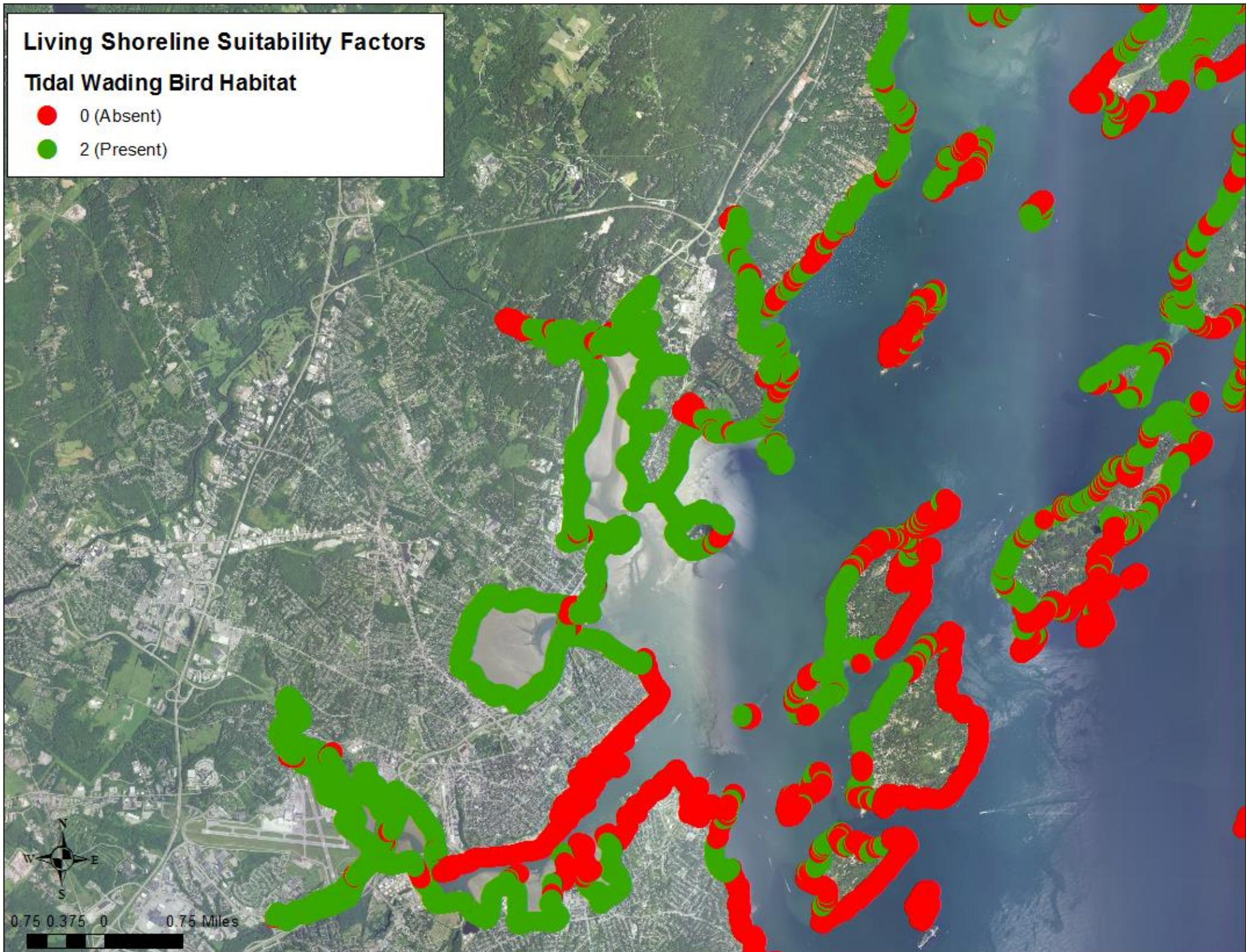
Living Shoreline Suitability Factors

- 0 (Not Suitable)
- 1 (Suitable, SE to SW)
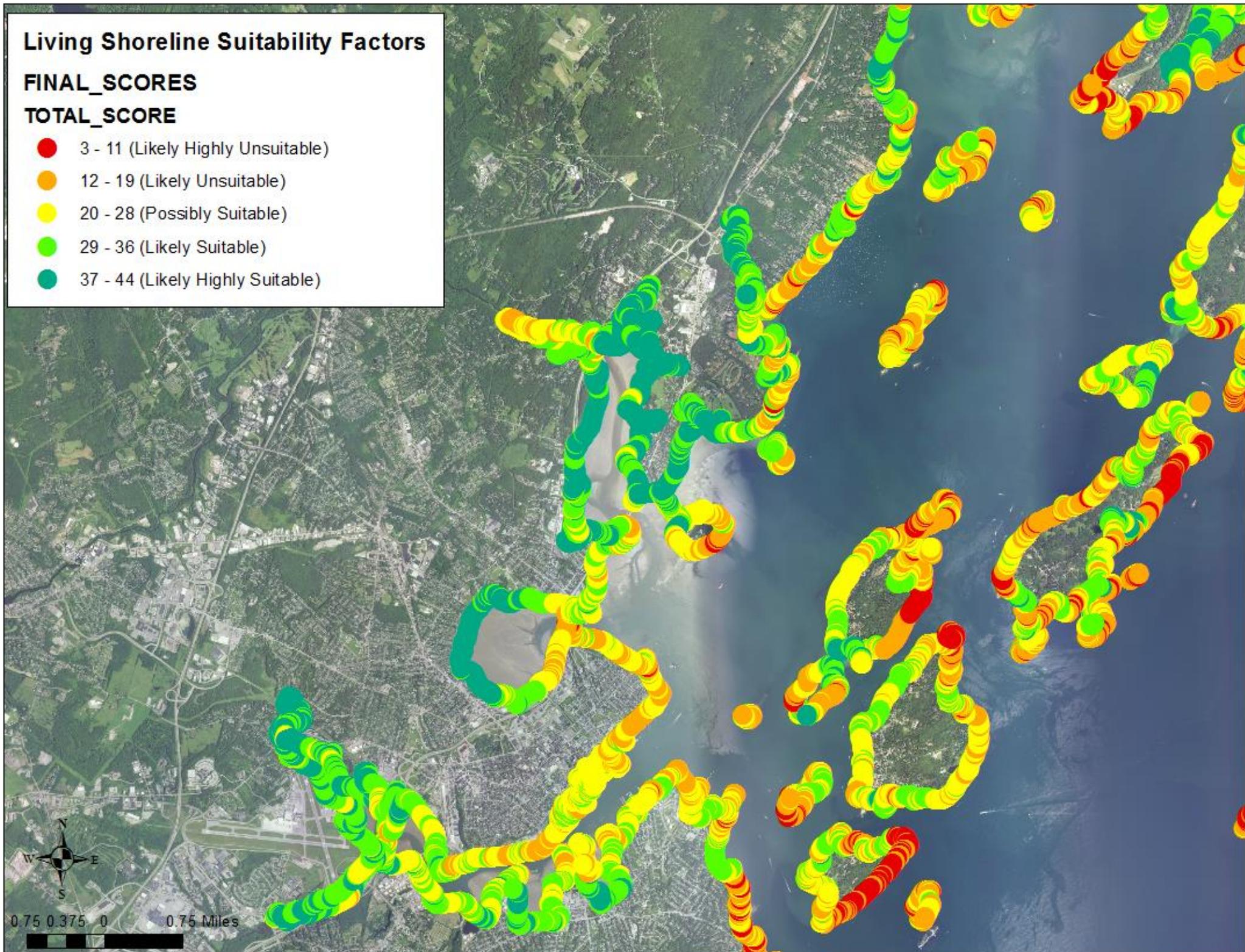
Aspect

0.75 0.375 0   0.75 Miles
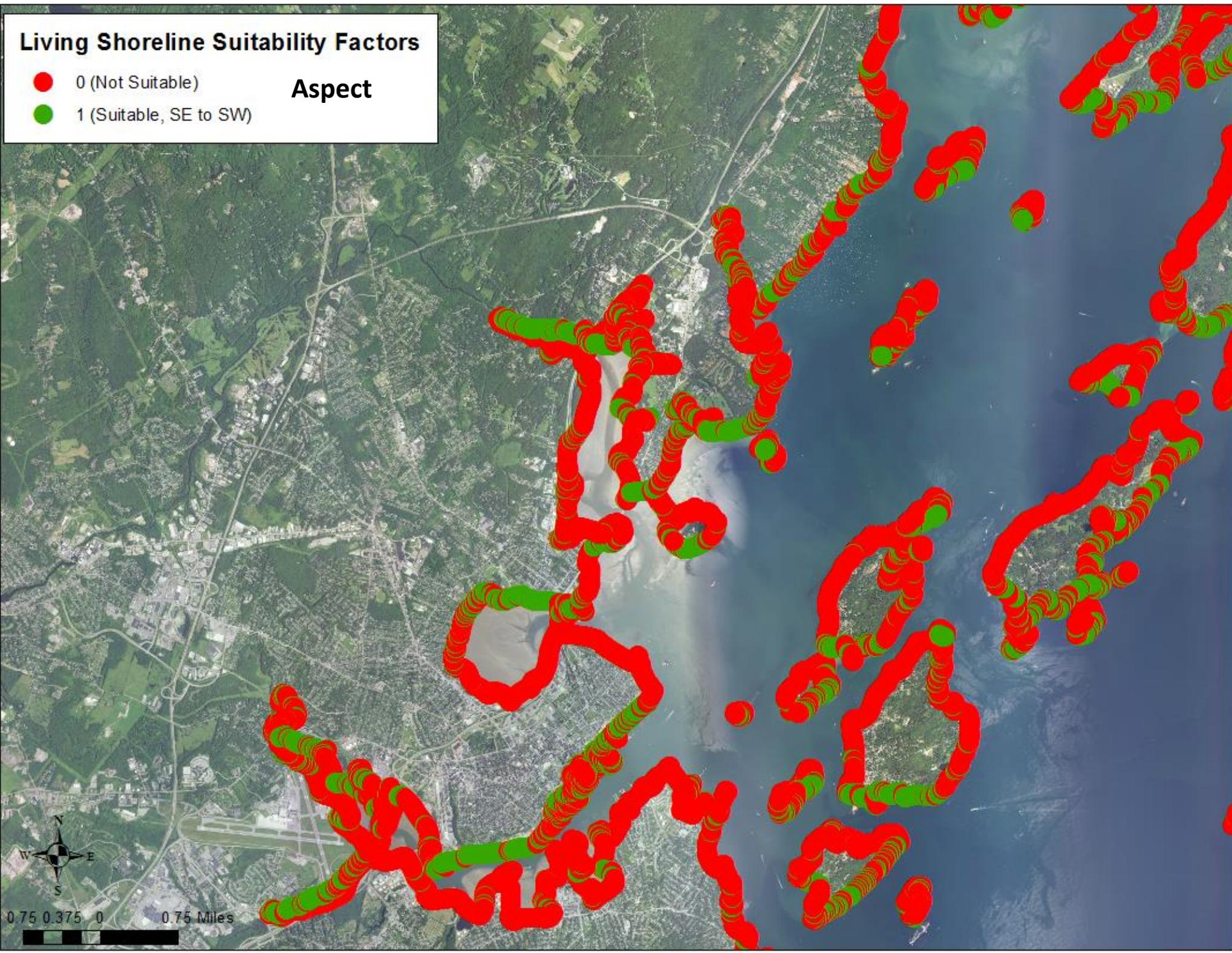
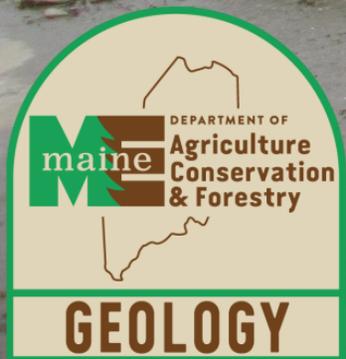**Living Shoreline Suitability Factors**

FINAL_SCORES

TOTAL_SCORE

- ● 3 - 11 (Likely Highly Unsuitable)
- ● 12 - 19 (Likely Unsuitable)
- ● 20 - 28 (Possibly Suitable)
- ● 29 - 36 (Likely Suitable)
- ● 37 - 44 (Likely Highly Suitable)

0.75 0.375 0   0.75 Miles

Thank you!

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