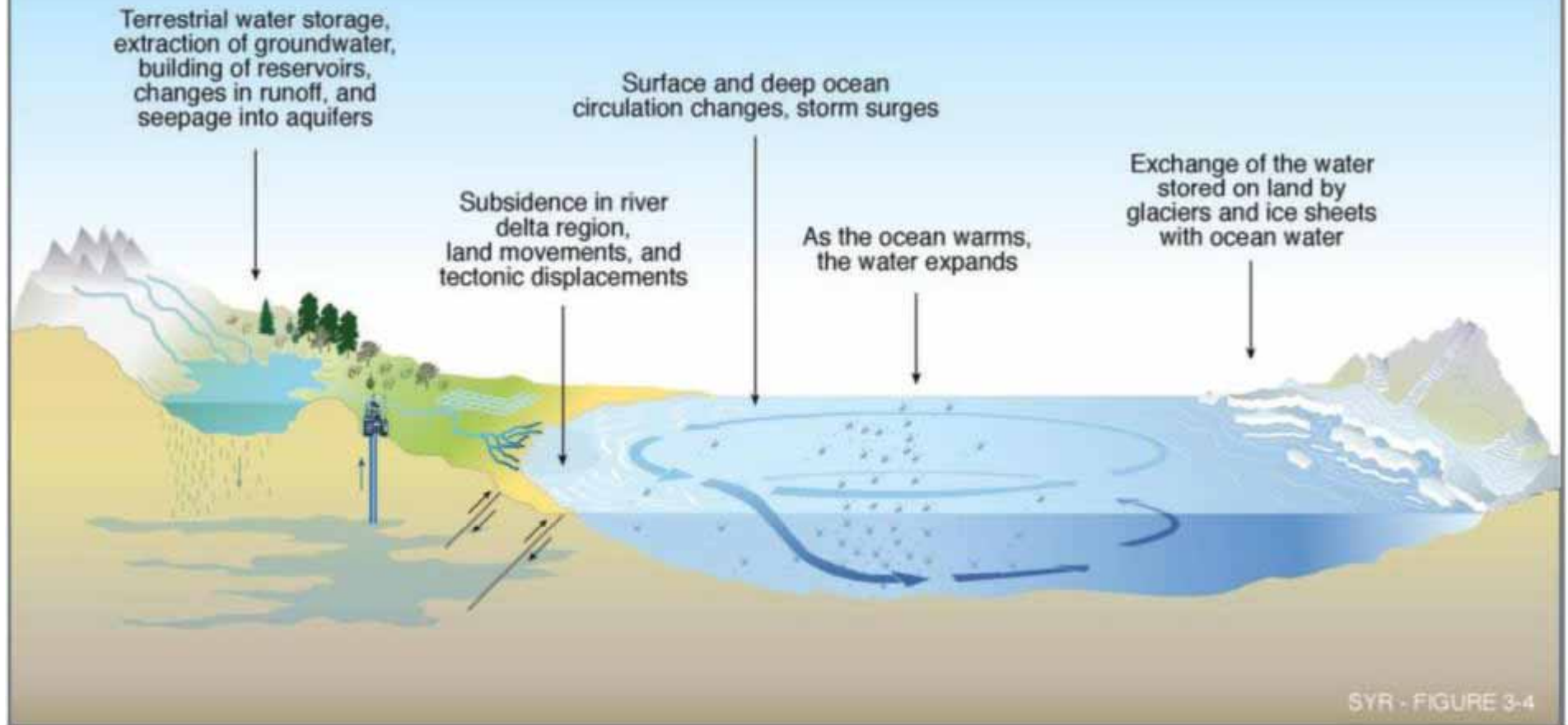


Future Impacts to Land Subject to Coastal Storm Flowage



Julia Knisel
Coastal Shoreline &
Floodplain Manager

What causes the sea level to change?



IPCC, 2001

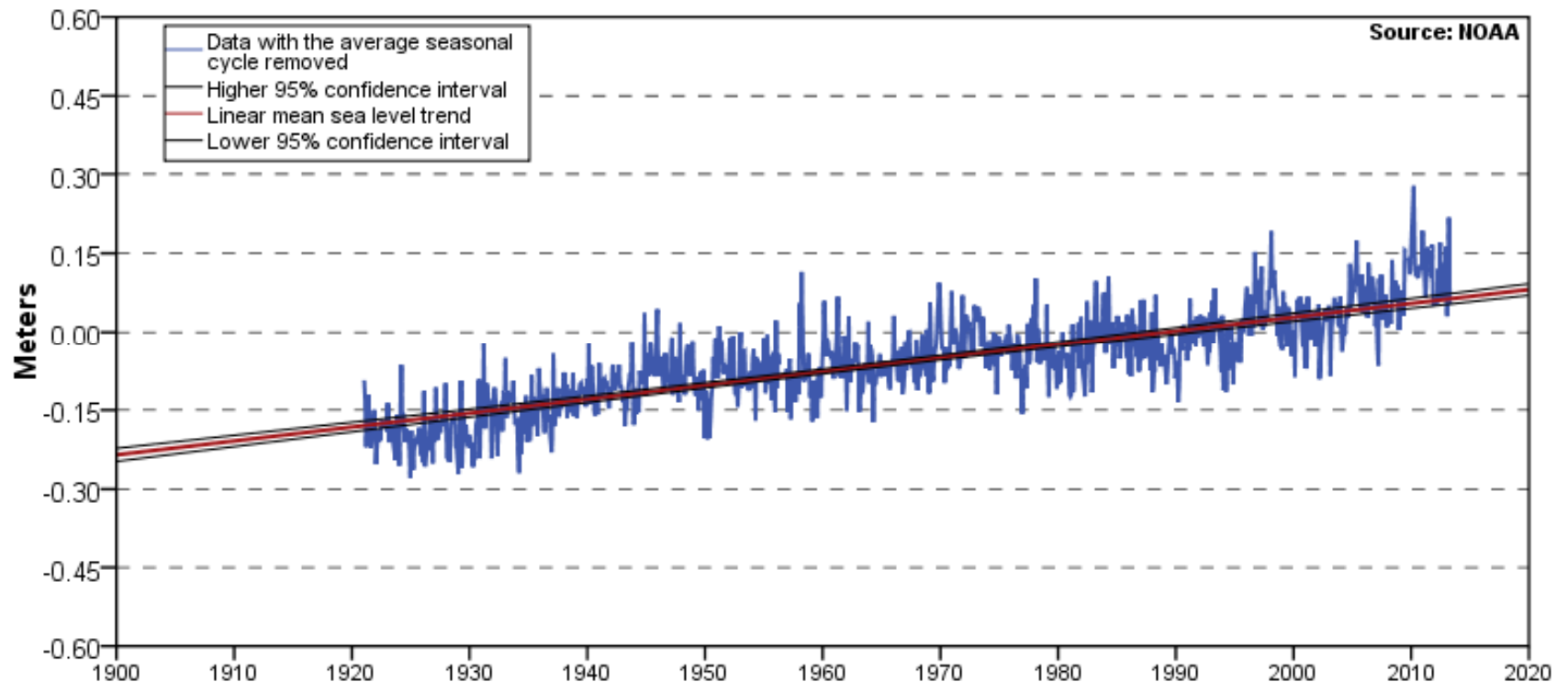


Historic Rate of Sea Level Rise (Boston Tide Gauge)

Mean range (MHW-MLW) = 9.5 feet

Record = 1921-2012 (91+ years)

Sea level rise = 0.9 feet/100 years

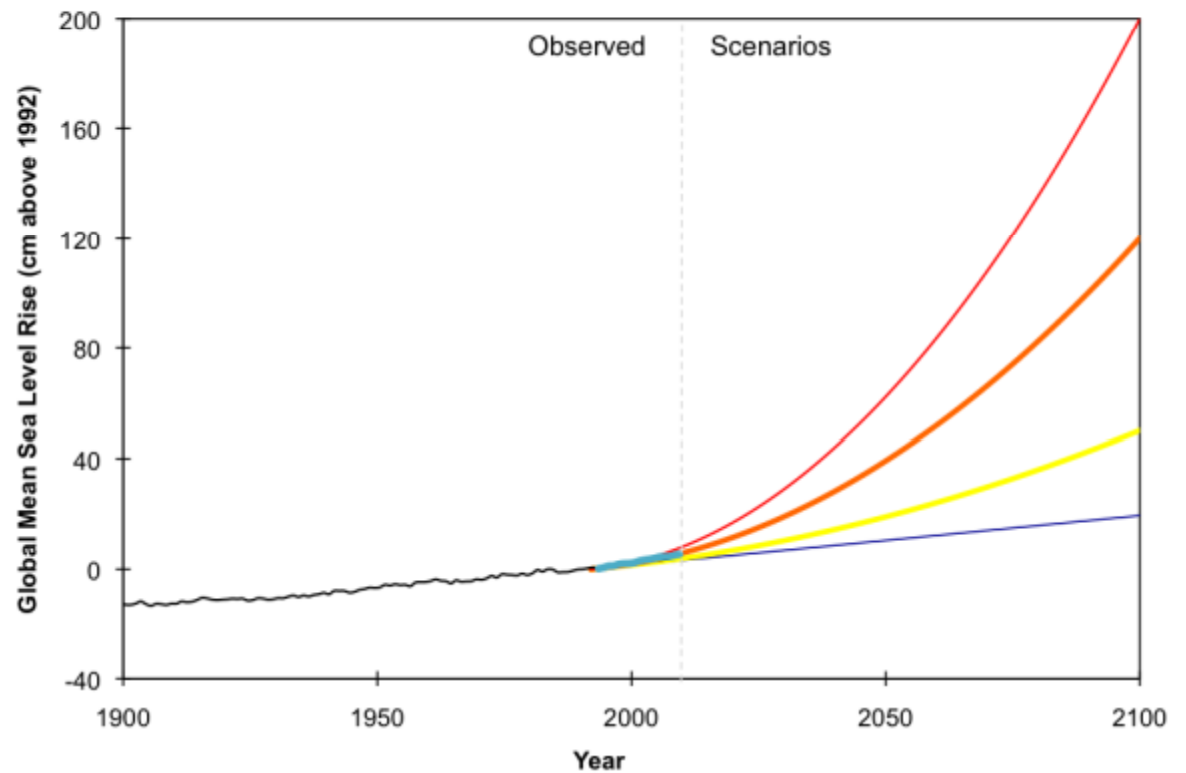
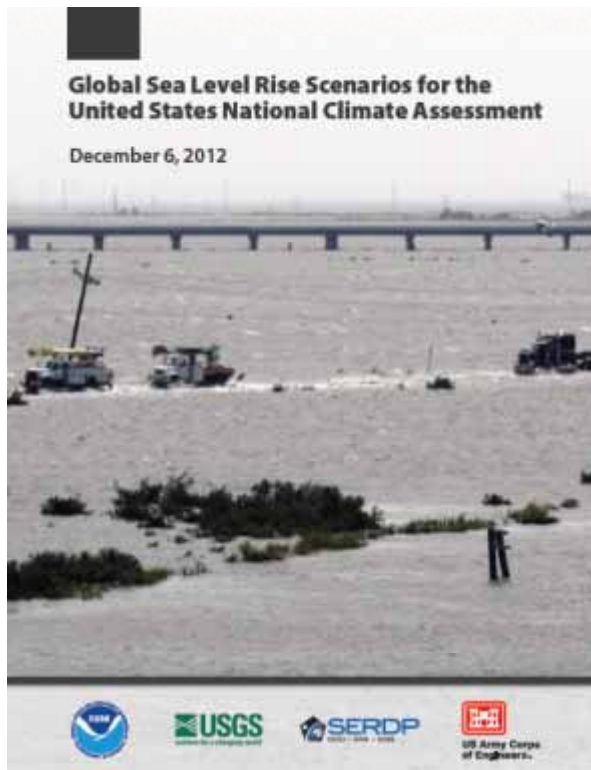


Historic Sea Level Trends from 1921 to 2006-2012 (Boston)



- Linear mean sea level rates (◆) & 95% confidence intervals (mm/yr) calculated from 1921 to recent years (2006-2012) at the NOAA Boston tide gauge station
- Values are trend of entire data period up to that year

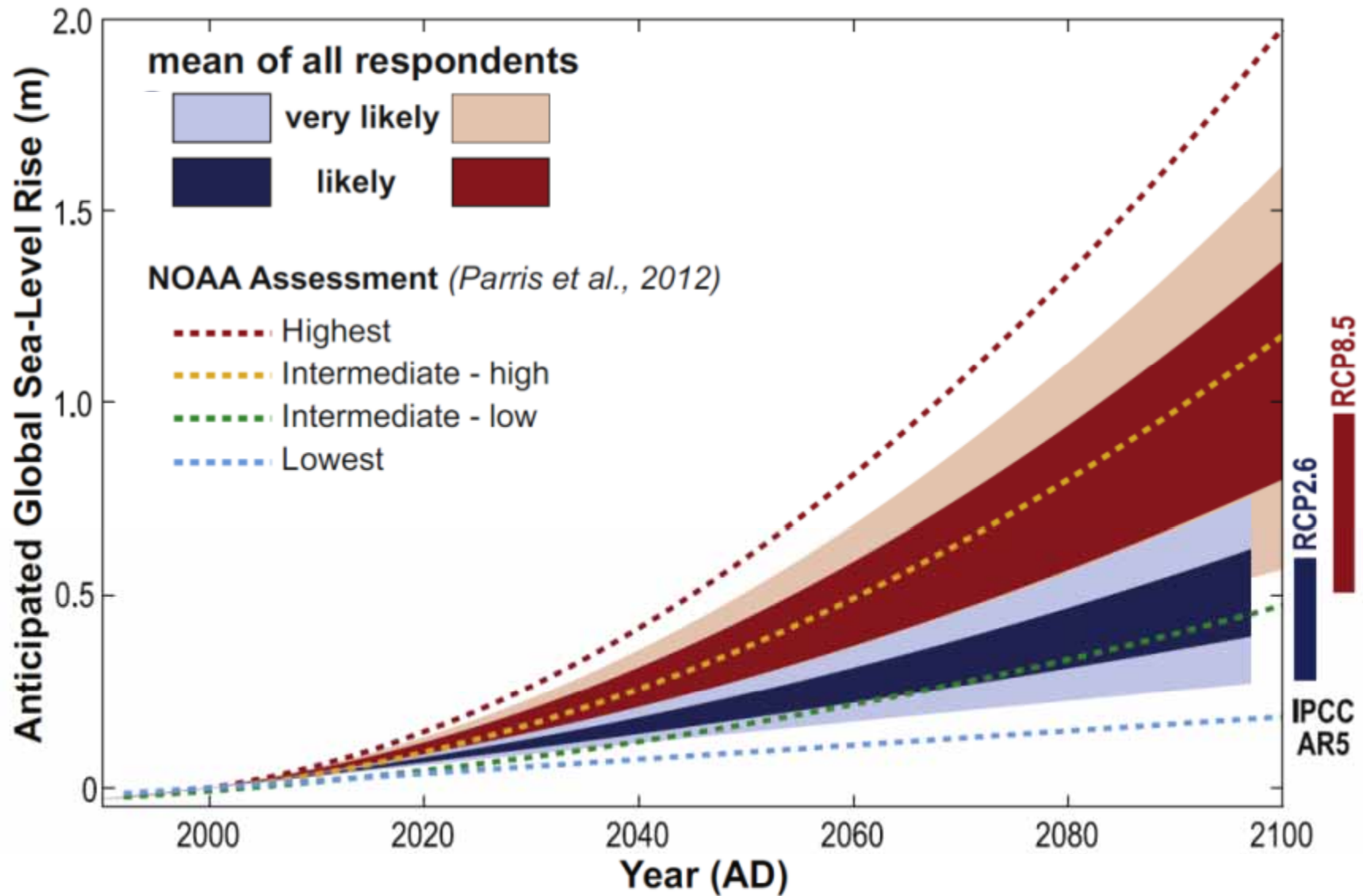
Global Sea Level Rise Projections/Scenarios



Scenario	SLR by 2100 (m)*	SLR by 2100 (ft)*
Highest	2.0	6.6
Intermediate-High	1.2	3.9
Intermediate-Low	0.5	1.6
Lowest	0.2	0.7

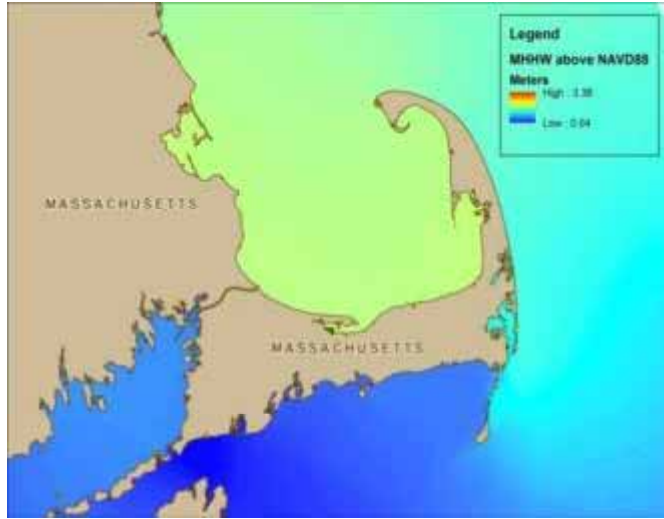
* Using mean sea level in 1992 as a starting point.

Recent Expert Assessment of Sea Level Rise Projections



Horton et al., 2013

Coastal Inundation Mapping Elements



- **Water Level:**
 - Local tide ranges
 - Sea level rise data & projections
 - Flood event data (surge & precipitation)
- **High Resolution Elevation Data:**
 - Topographic & bathymetric LIDAR
 - Digital elevation models referenced to tidal datums
- **Natural & Human Responses:**
 - Current ecosystems (beaches & wetlands)
 - Landform changes (erosion & accretion)
 - Physical barriers to migration (development, seawalls, culverts, etc.)

Buzzards Bay Potential Flood Zone Expansion with Sea Level Rise (static)

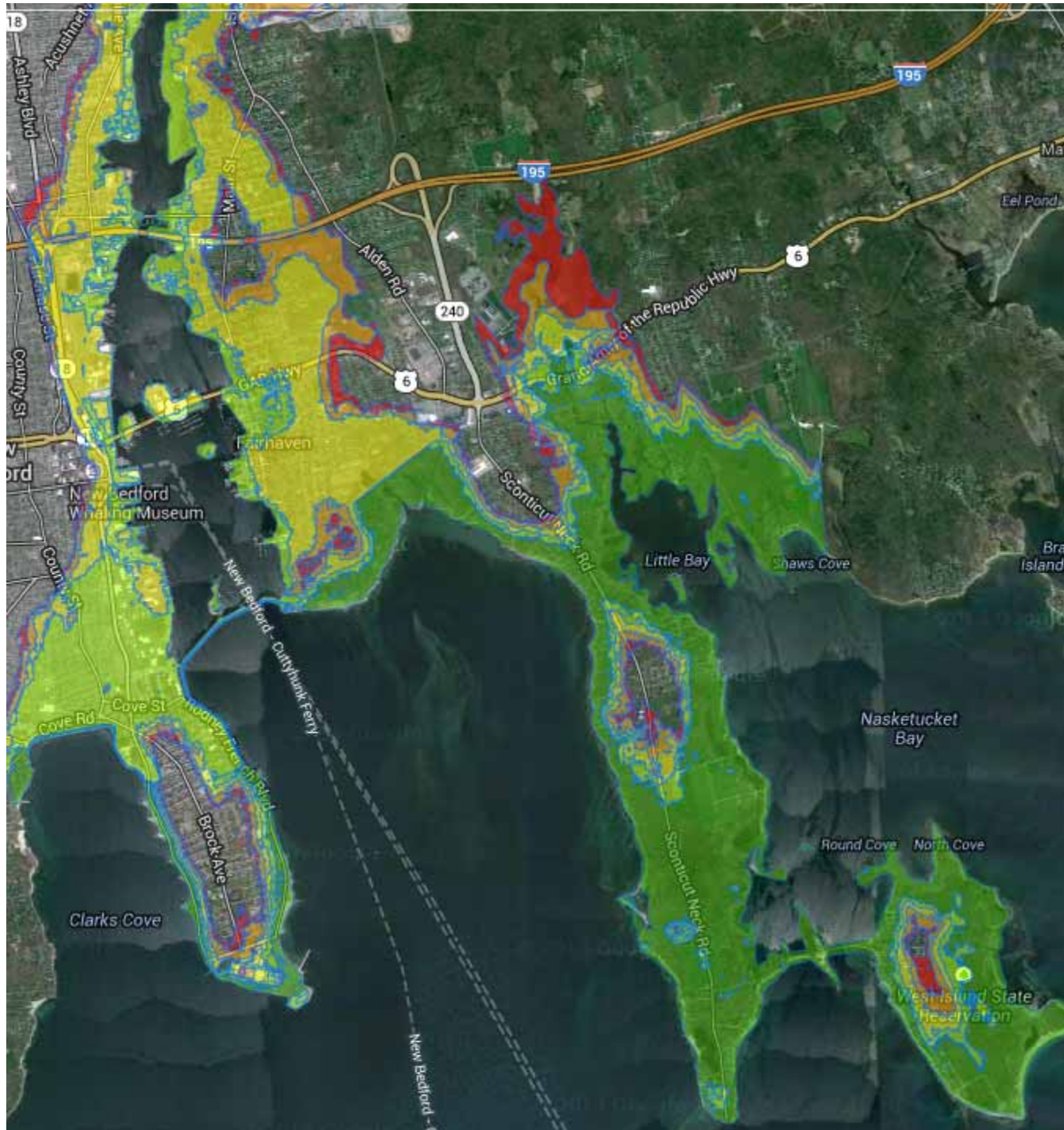


Buzzards Bay



National Estuary
Program

Buzzards Bay Potential Hurricane Impacts with Sea Level Rise (dynamic)



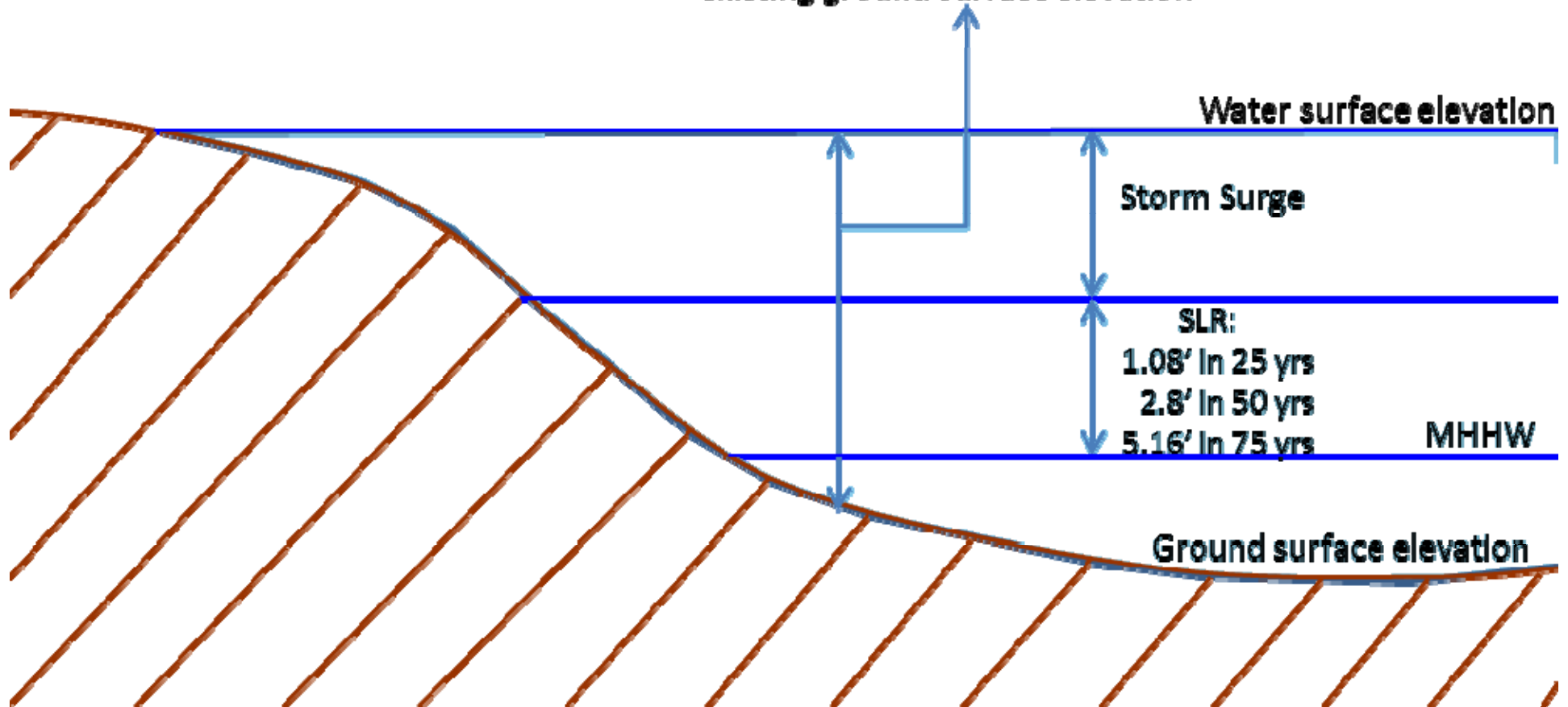
Hurricane Scenarios

- ☐ Hurricane Scenarios 0ft SLR
- ☐ Hurricane Scenarios 1ft SLR
- ☐ Hurricane Scenarios 2ft SLR
- ☒ Hurricane Scenarios 4ft SLR

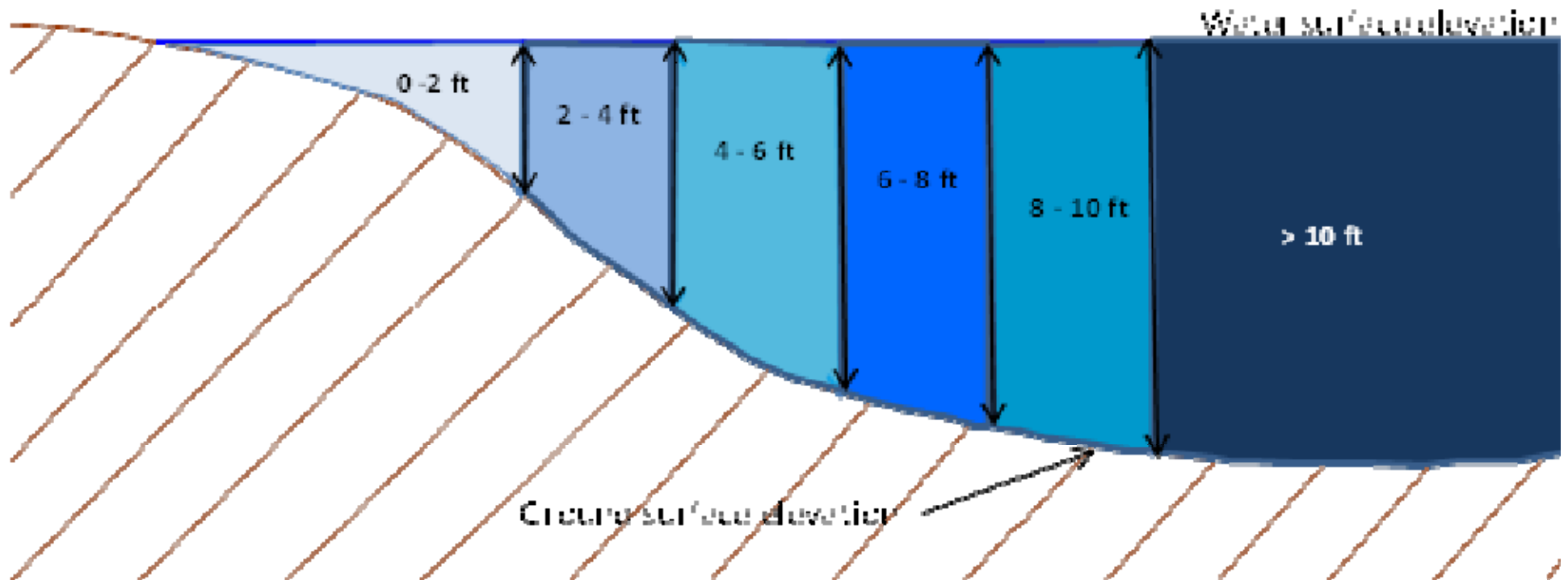
- Category 1
- Category 2
- Category 3
- Category 4
- Category 4 (Extreme)

South Shore Coastal Inundation Depth Scenarios (dynamic)

Inundation depth = Water surface elevation –
existing ground surface elevation



South Shore Coastal Inundation Depth Classification



South Shore Potential Nor'easter Impacts with Sea Level Rise (5 ft, dynamic)

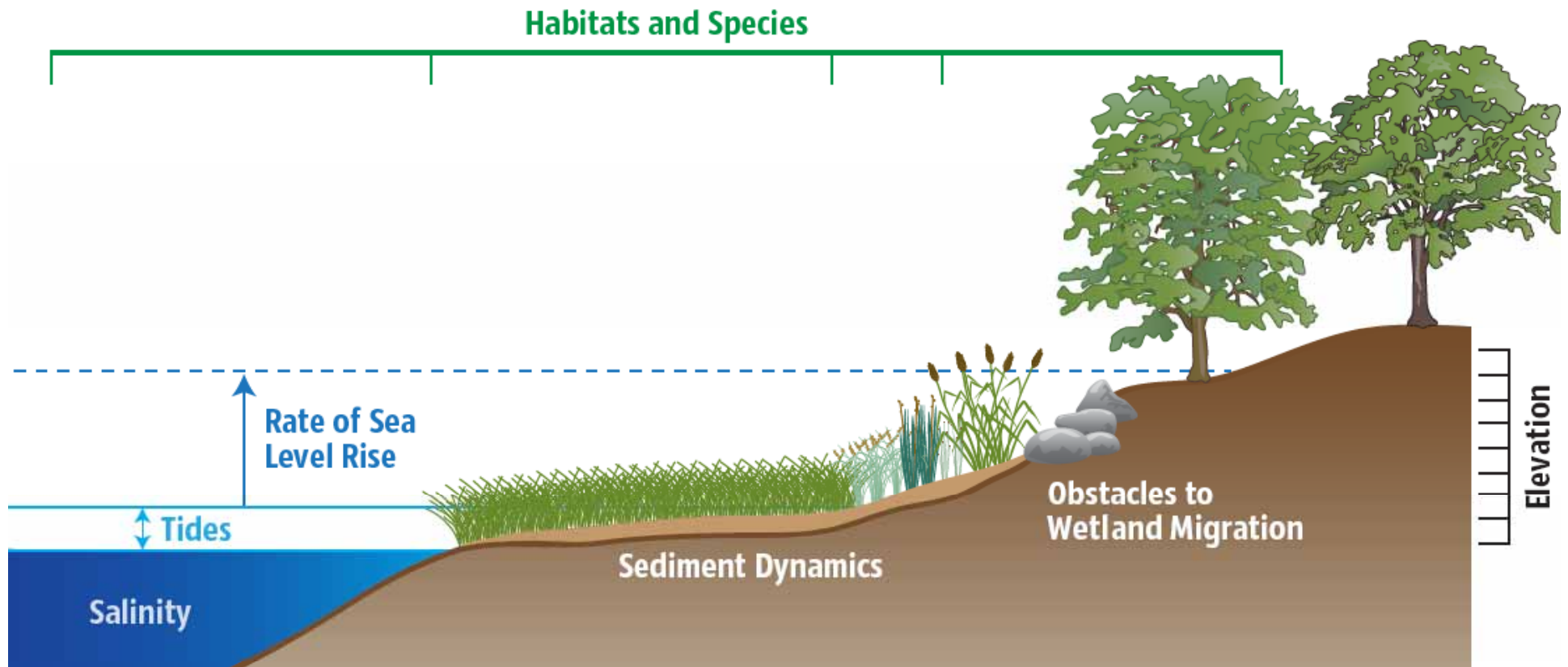




3D Coastal Inundation Depth (with 5 ft of Sea Level Rise & Nor'easter Storm Surge)



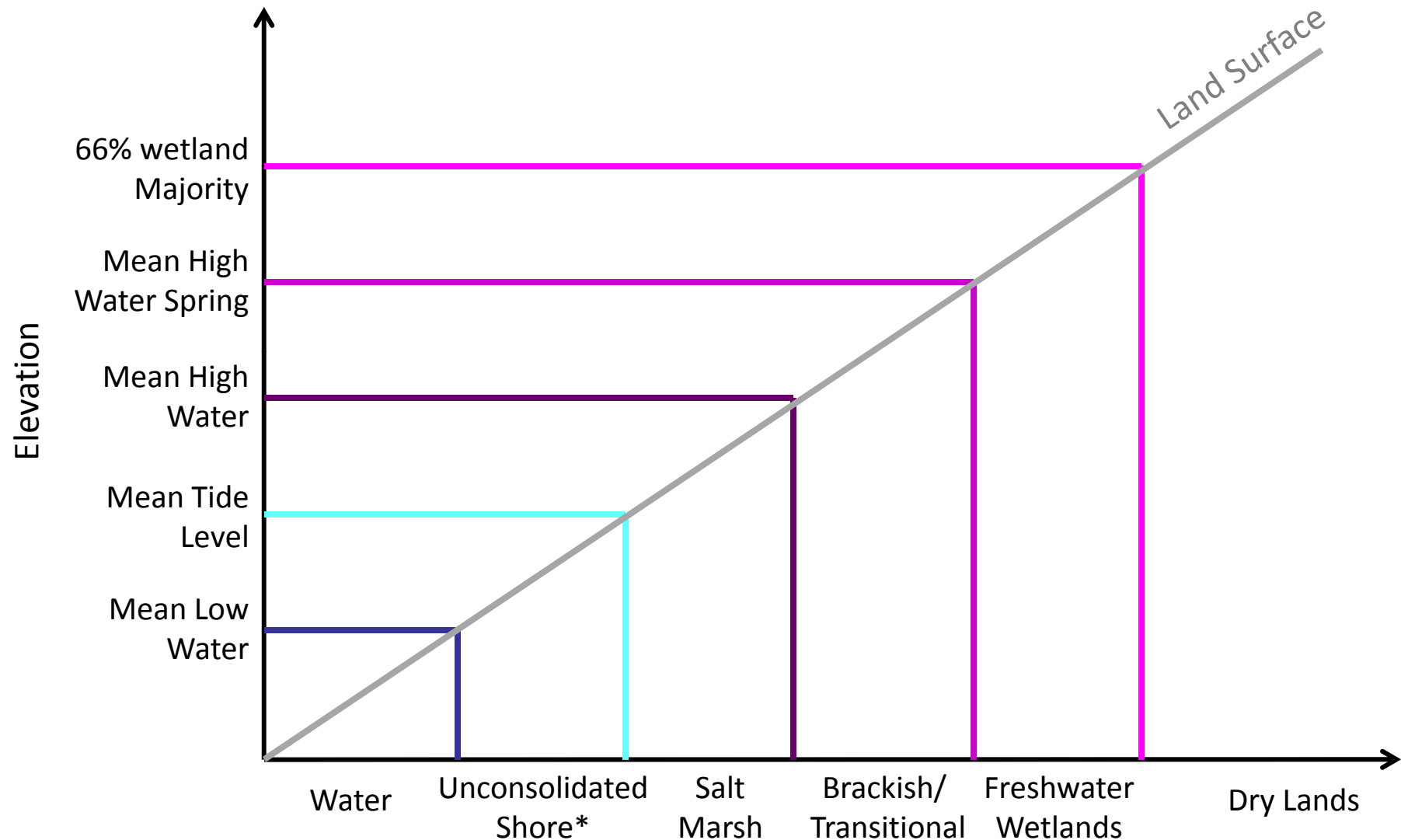
Critical Parameters for Modeling Marsh Migration



Marshes on the Move, 2011

- If sediment accretes (traps on surface or accumulates) as fast as sea level rises, then marsh may avoid being converted or submerged

Wetland Types & Tidal Ranges



*includes silt, sand, or gravel that is subject to inundation and redistribution due to the action of water; substrates lack vegetation



Sea Level Rise and Coastal Flooding Impacts

Beta

Sea Level Rise Confidence **Marsh**

Vulnerability Flood Frequency

Marsh Impacts/Migration ?

Current MHHW

Advanced Options

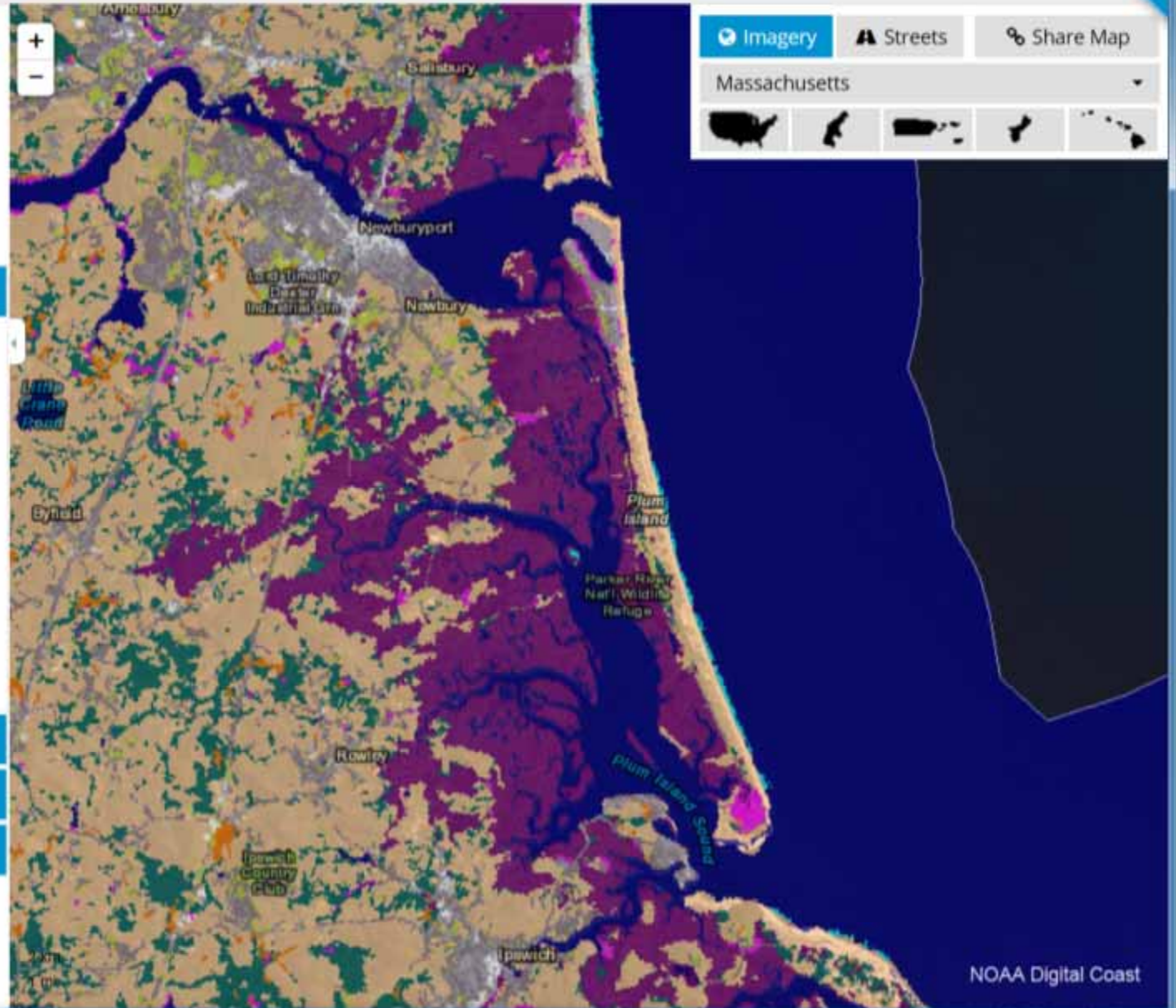
Legends

- High Intensity Developed
- Medium Intensity Developed
- Low Intensity Developed
- Developed Open Space
- Upland
- Freshwater Forested Wetland
- Freshwater Shrub Wetland
- Freshwater Emergent Wetland
- Brackish/Transitional Marsh
- Saltwater Marsh
- Unconsolidated Shore
- Water

Overview

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Sea Level Rise and Coastal Flooding Impacts

Beta

Sea Level Rise Confidence **Marsh**

Vulnerability Flood Frequency

Marsh Impacts/Migration ?



1 ft SLR

Advanced Options

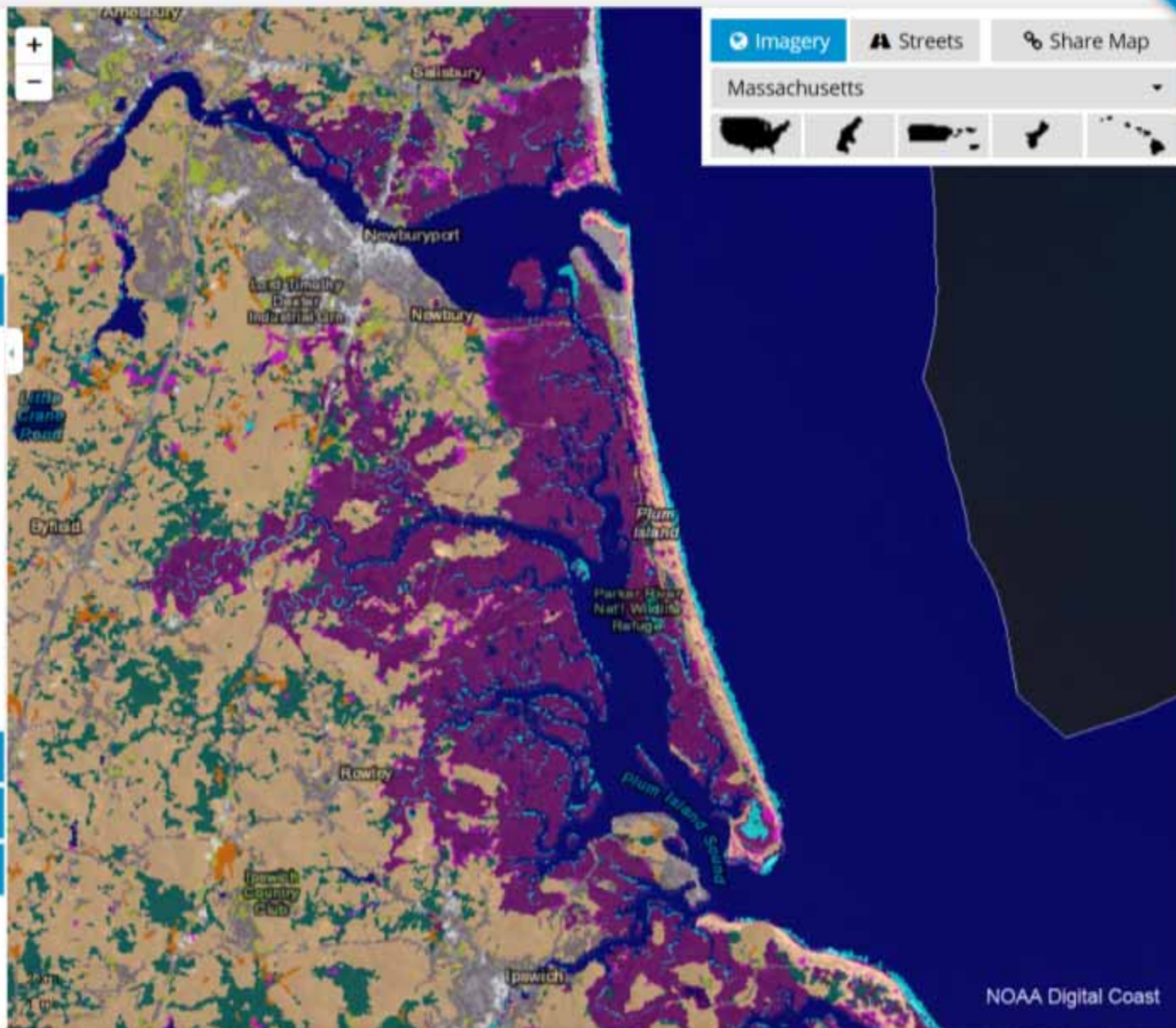
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NOAA Digital Coast



Sea Level Rise and Coastal Flooding Impacts

Beta

Sea Level Rise Confidence **Marsh**

Vulnerability Flood Frequency

Marsh Impacts/Migration ?

2 ft SLR

Advanced Options

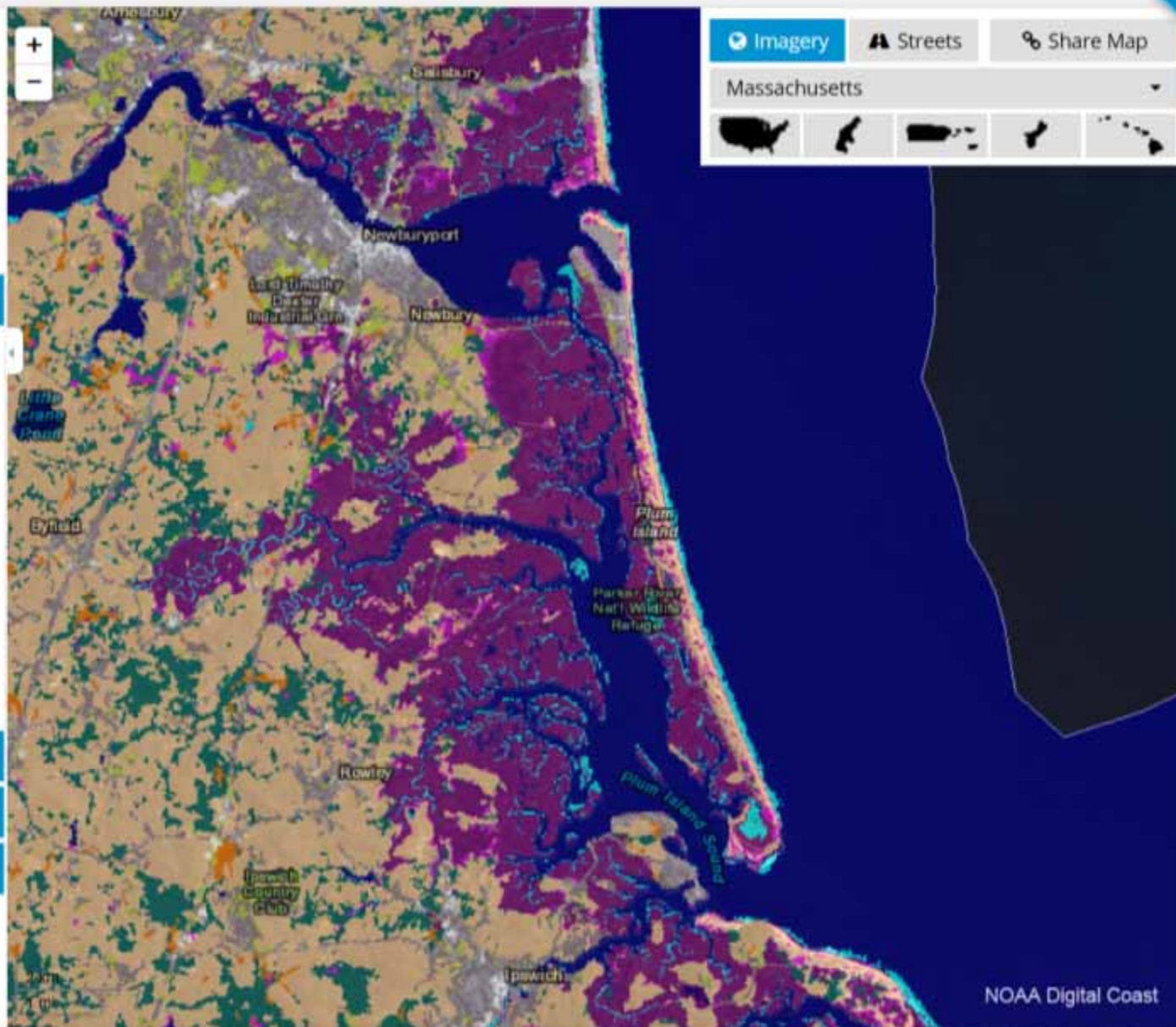
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Sea Level Rise and Coastal Flooding Impacts

Beta

Sea Level Rise Confidence **Marsh**

Vulnerability Flood Frequency

Marsh Impacts/Migration ?



3 ft SLR

Advanced Options

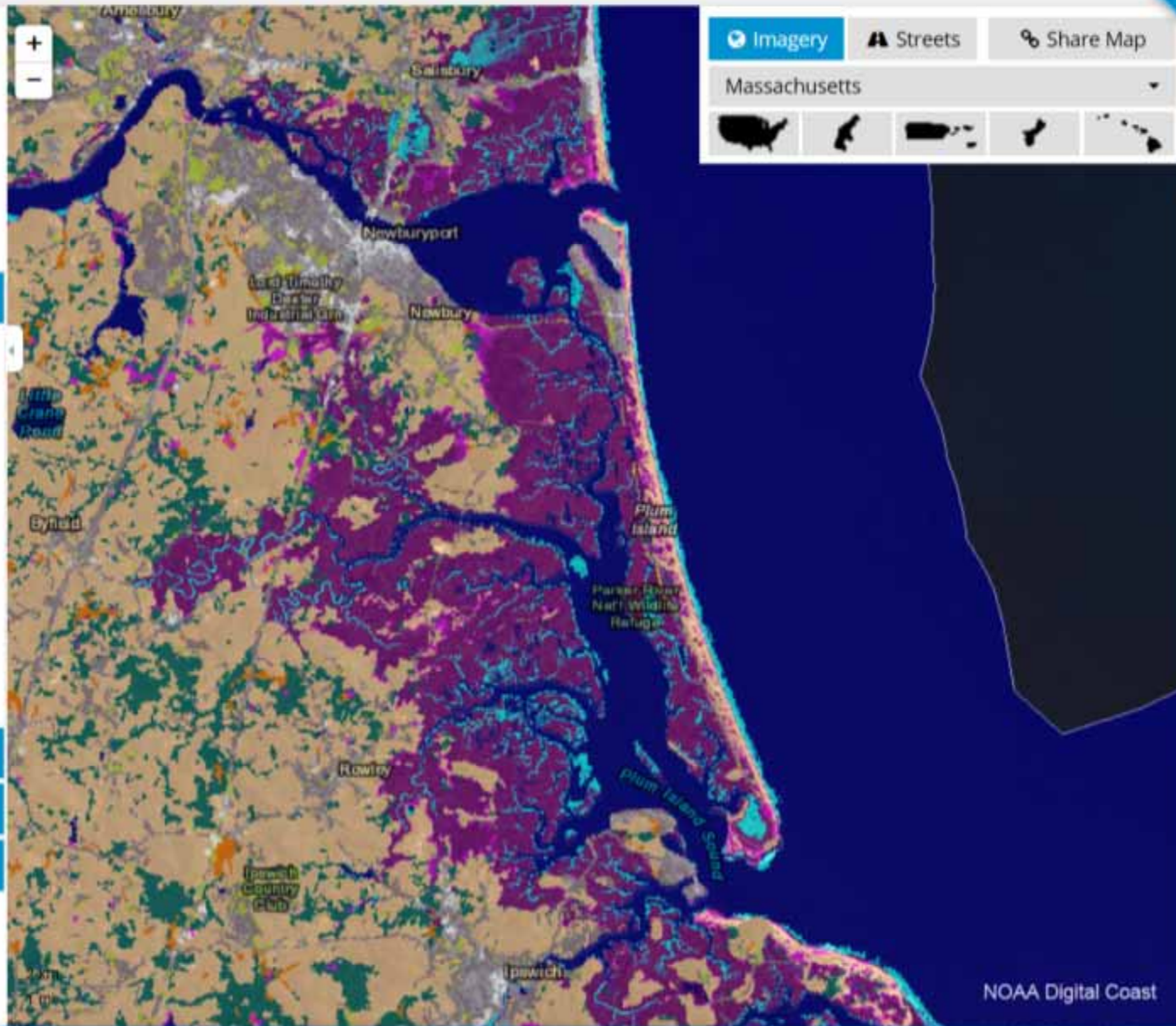
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Imagery

Streets

Share Map

Massachusetts



NOAA Digital Coast



Sea Level Rise and Coastal Flooding Impacts

Beta

Sea Level Rise Confidence **Marsh**

Vulnerability Flood Frequency

Marsh Impacts/Migration ?



4 ft SLR

Advanced Options

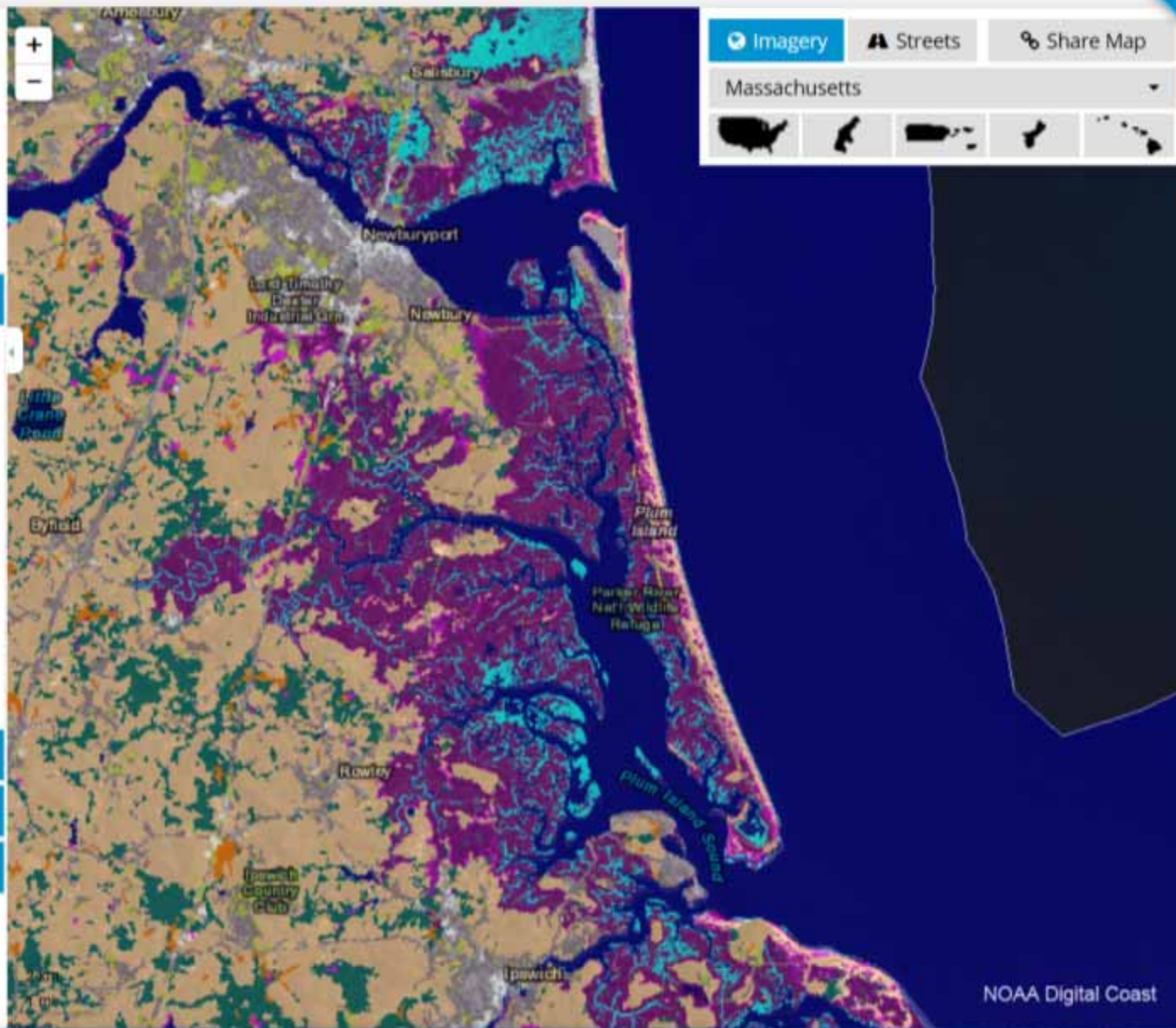
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NOAA Digital Coast



Sea Level Rise and Coastal Flooding Impacts

Beta

Sea Level Rise Confidence **Marsh**

Vulnerability Flood Frequency

Marsh Impacts/Migration ?

5 ft SLR

Advanced Options

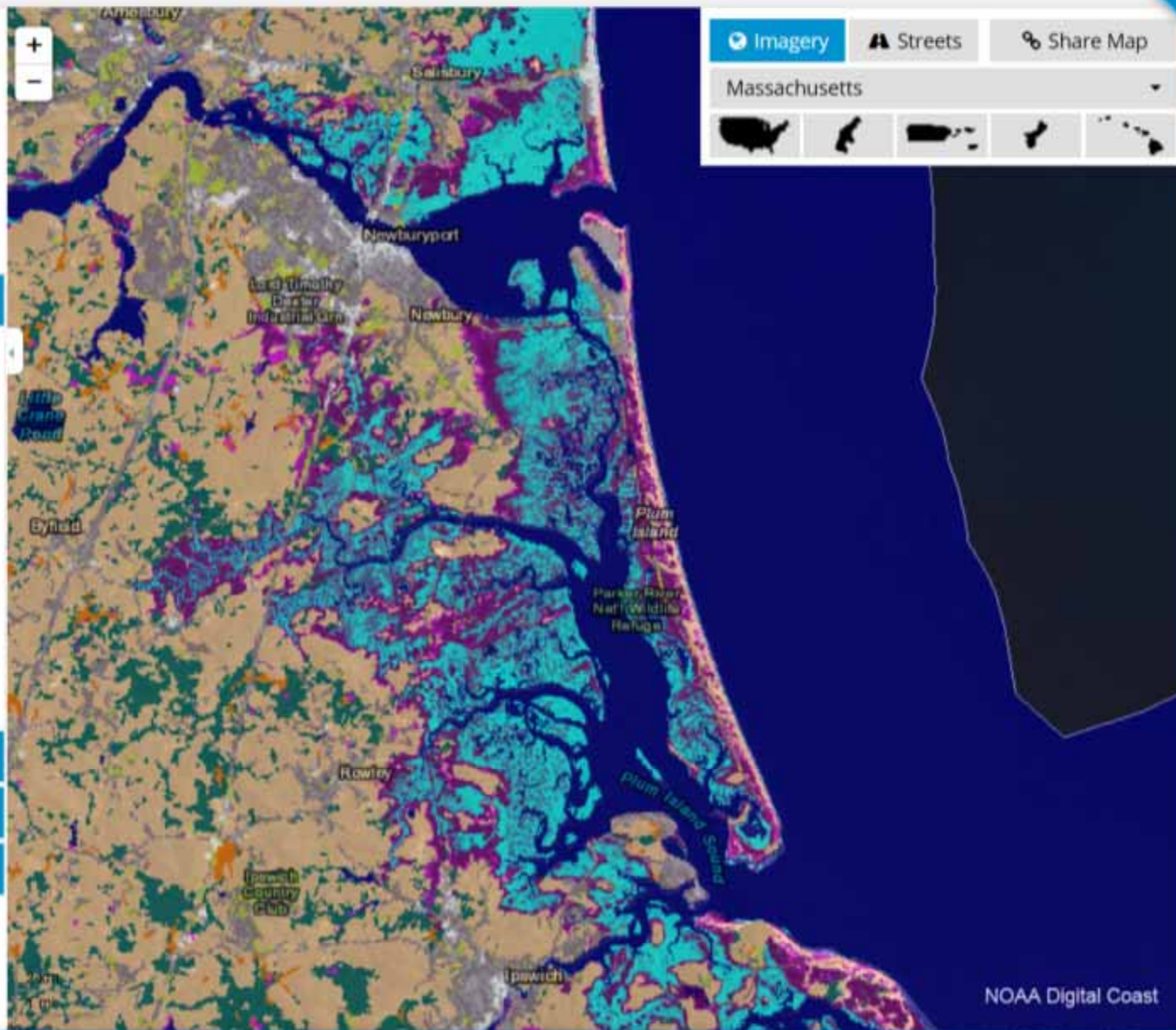
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NOAA Digital Coast



Sea Level Rise and Coastal Flooding Impacts

Beta

Sea Level Rise Confidence **Marsh**

Vulnerability Flood Frequency

Marsh Impacts/Migration ?

6 ft SLR

Advanced Options

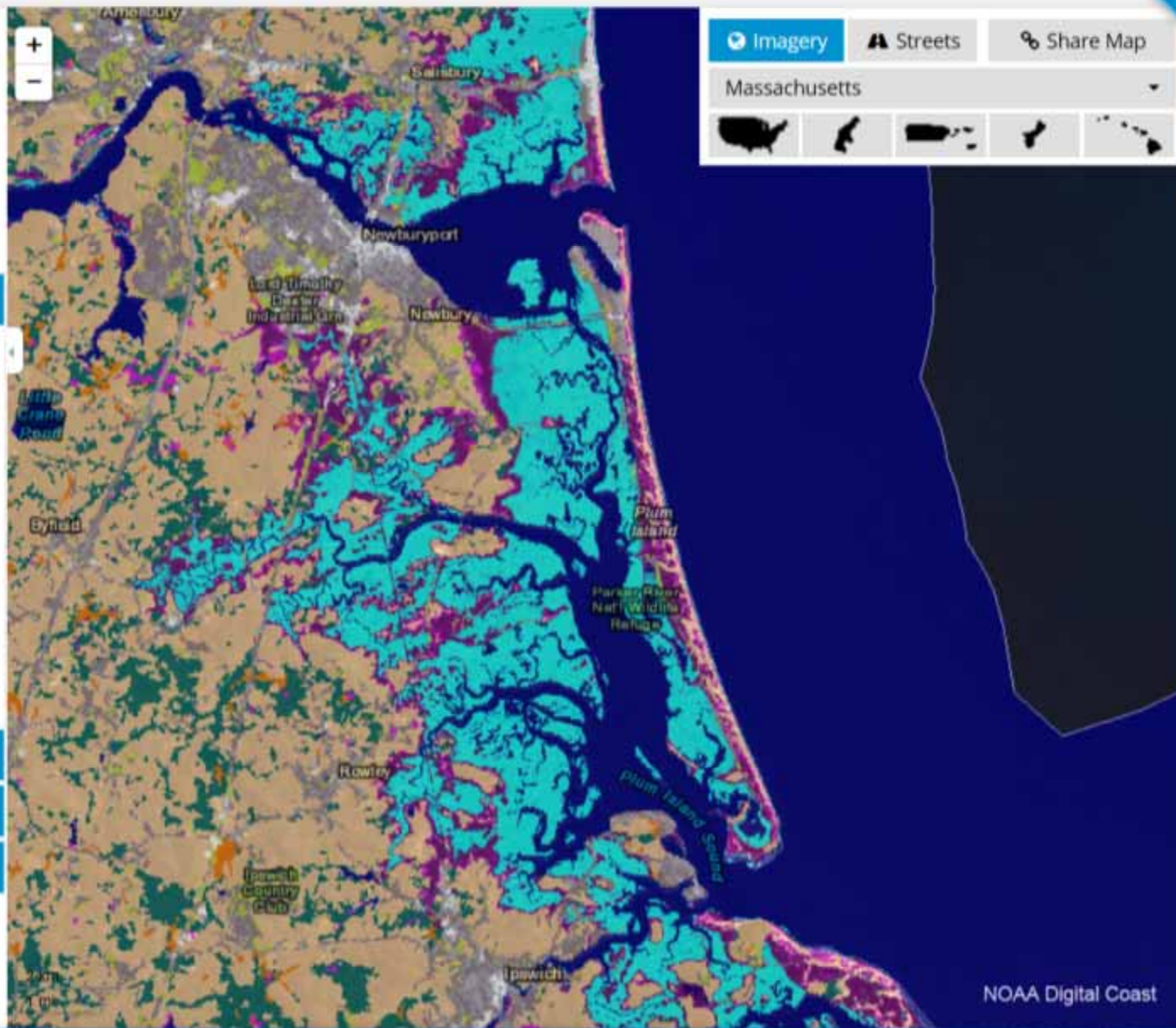
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NOAA Digital Coast



Sea Level Rise and Coastal Flooding Impacts

Beta

Sea Level Rise Confidence **Marsh**

Vulnerability Flood Frequency

Marsh Impacts/Migration ?

6 ft SLR

Advanced Options

Accretion Rate

No Low Mid High

100 years

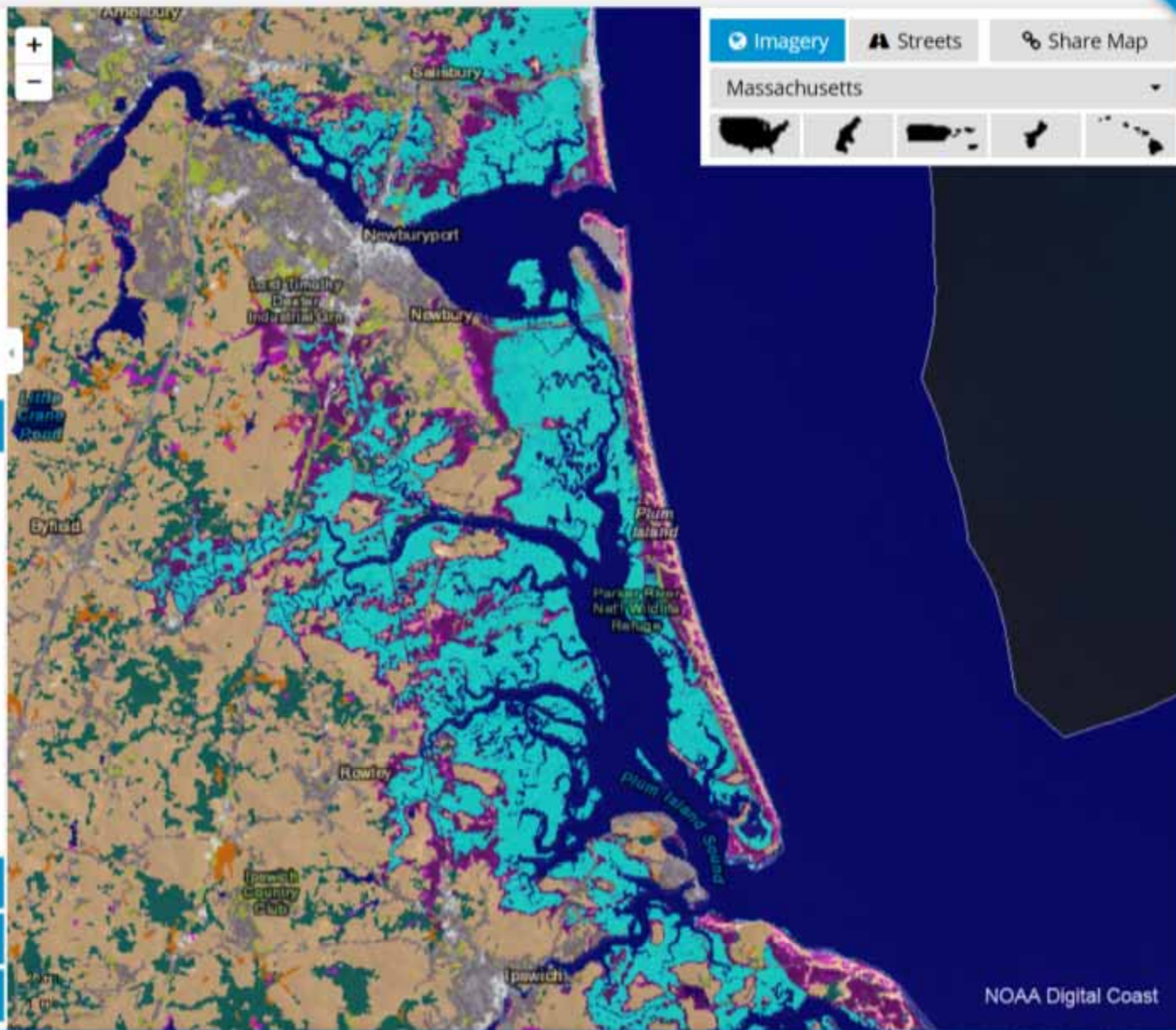
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Sea Level Rise and Coastal Flooding Impacts

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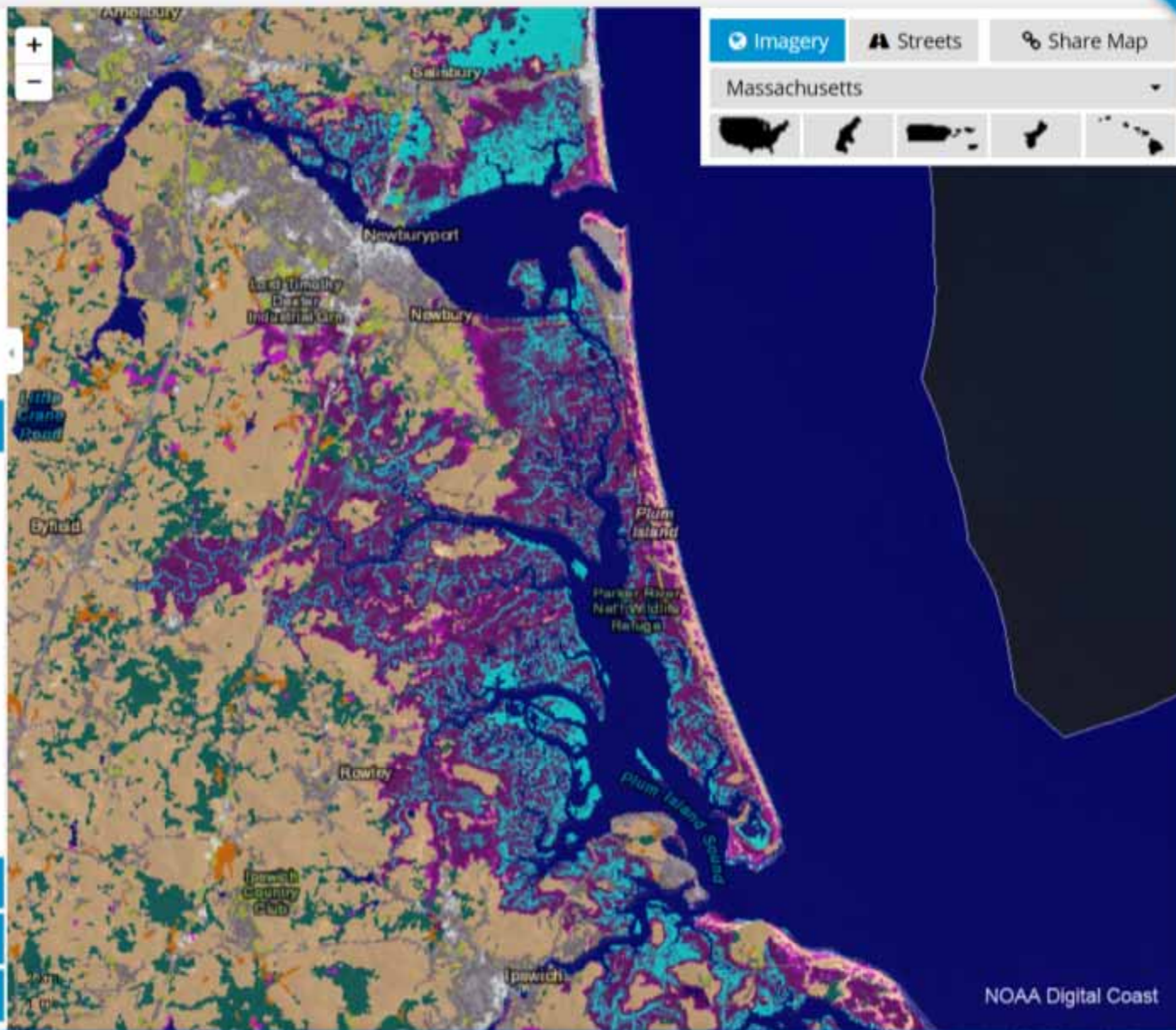
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NOAA Digital Coast

Marsh Conversion to Unconsolidated Shore (Gloucester)



Current



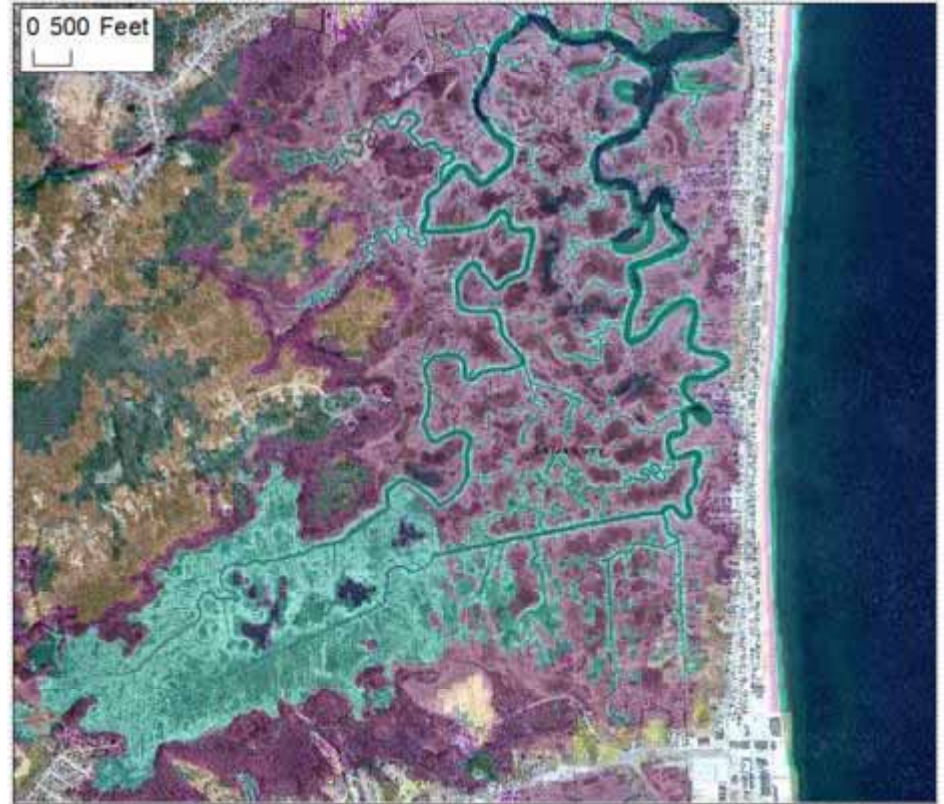
75-Year Time Horizon (2080)

**Net marsh impact = MHHW +
4.5 ft sea level rise – 1 ft accretion**

Marsh Conversion to Unconsolidated Shore (Salisbury)



Current



75-Year Time Horizon (2080)

**Net marsh impact = MHHW +
4.5 ft sea level rise – 1 ft accretion**

Marsh Migration Limited by Development & Infrastructure (Newbury)



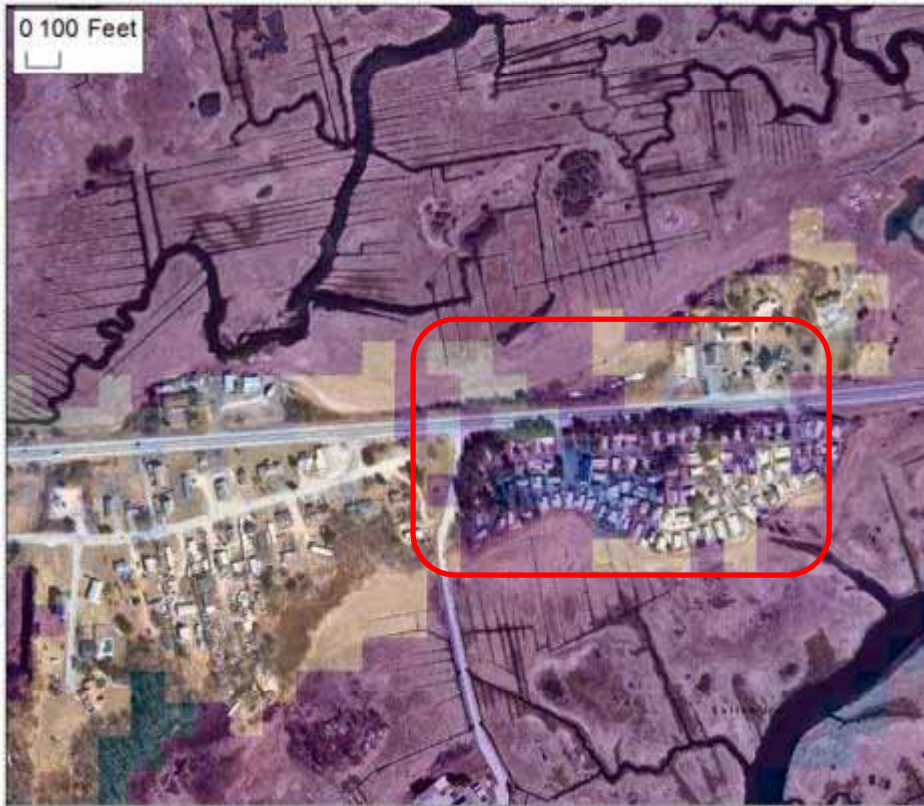
Current



75-Year Time Horizon (2080)

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Marsh Migration Limited by Development & Infrastructure (Salisbury)



Current



75-Year Time Horizon (2080)

**Net marsh impact = MHHW +
4.5 ft sea level rise – 1 ft accretion**

Summary of Sea Level Rise Projections & Impacts

- Historic rate of sea level rise (~ 1 ft/century) has shaped our shoreline
- Current rate accelerating
- 1.5 – 3x current rate reasonable by 2100 with climate mitigation measures...but uncertain
- Data exists to evaluate potential impacts & communities are actively engaged in projects
- Communities are vulnerable without shoreline migration/erosion
- Loss of wetlands increases reach of storm surge & flooding
- Preparation is extremely important

