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Coastal Geology and the Science of Storms, Sediment Transport, and Coastal Evolution on Martha's Vineyard

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Director of Coastal Processes**

Martha's Vineyard Coastal Conference
Vineyard Haven, MA
06 October 2026





Talk Outline

Coastal Geology

Coastal Geology
Sediment Transport

Coastal Geology
Sediment Transport

Coastal Evolution



Take Home Messages

Coastal Geology
Waves

Sediment Transport

Storms

Coastal Evolution

COASTAL GEOLOGY 101

Waves

- 1 cubic meter of seawater = 1 metric tonne
- On average a wave hits the shoreline every 6 seconds
 - 600/hr
 - 14,400/day
 - 5.3 million/year

COASTAL GEOLOGY 101

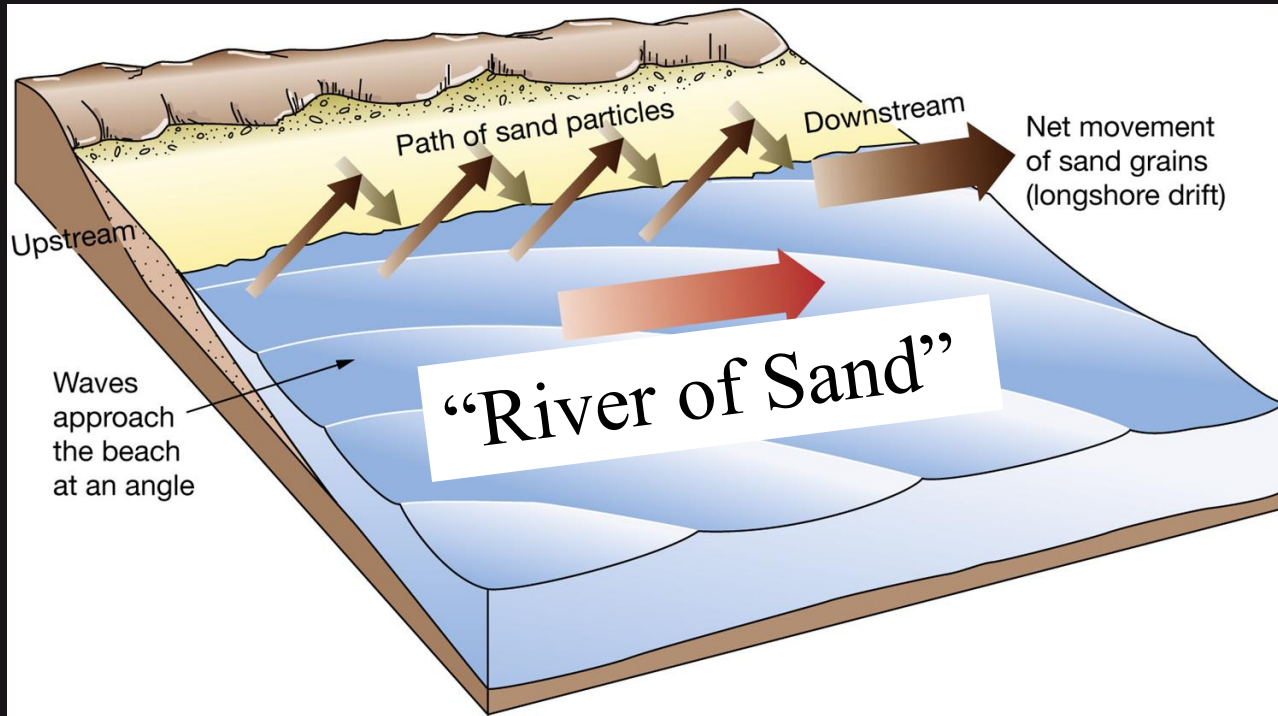
Waves



Long Point Martha's Vineyard 9/4/16

Coastal Sediment Transport

Longshore and Cross-shore



(b)

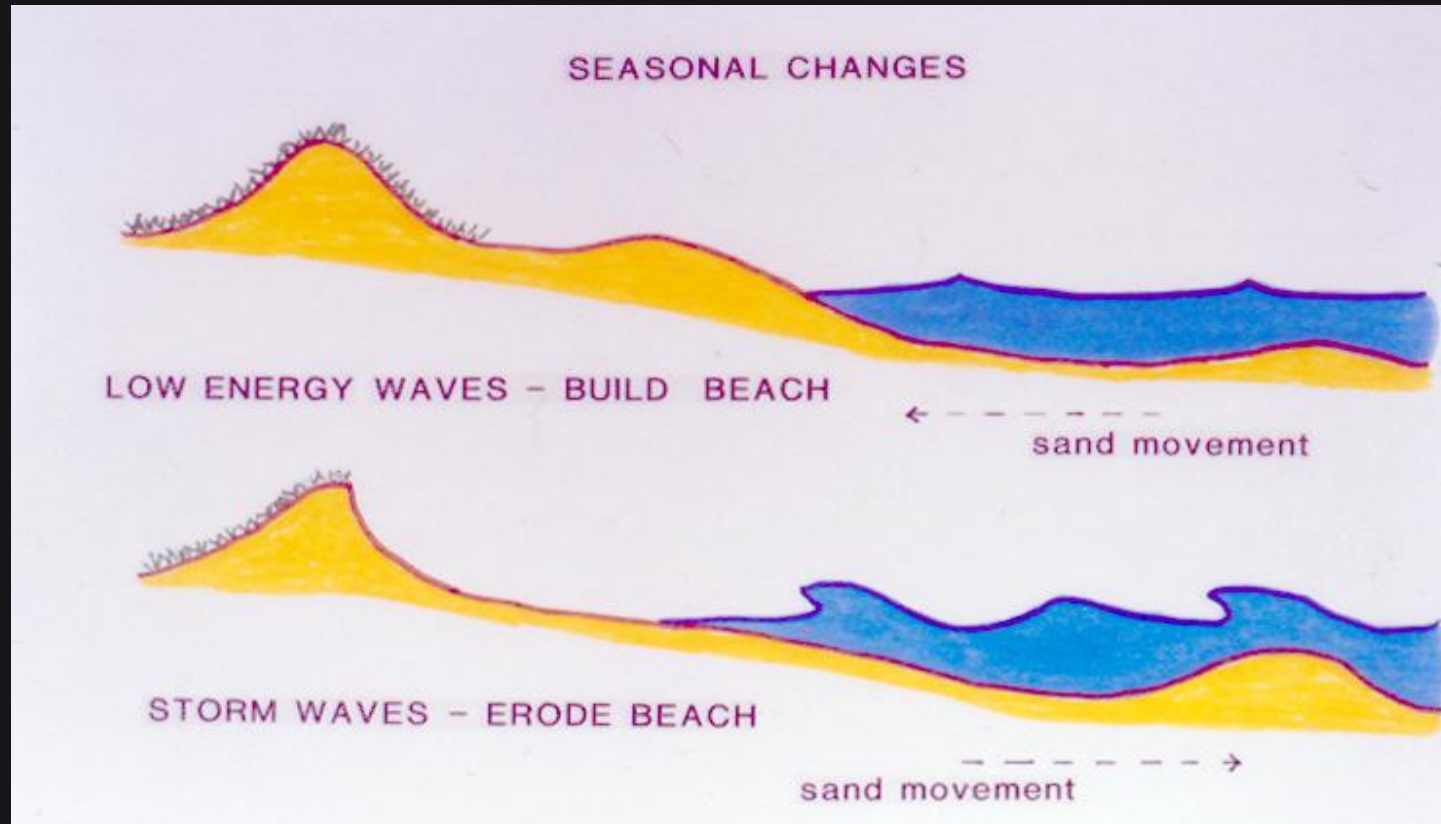
Rates of Longshore Sediment Transport

- ~400,000 - 500,000 cubic yards of LST/year
- 1000-1500 cubic yards of LST/day
- 100-150 Dump Trucks of sand/day
- One every ~10-15 minutes!



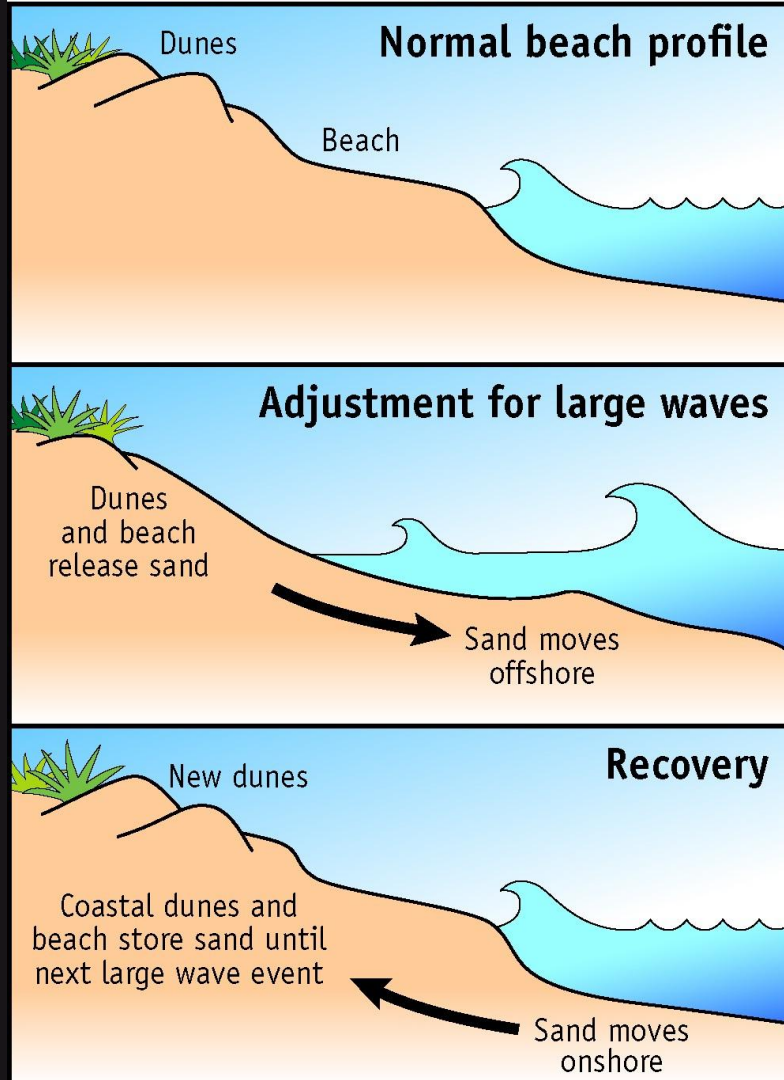
Coastal Sediment Transport

Longshore and Cross-shore



Equilibrium

in Coastal Geology state the balance for beach continuing to fluctuate about an equilibrium that changes with time





(b)



(a)

COASTAL STORMS

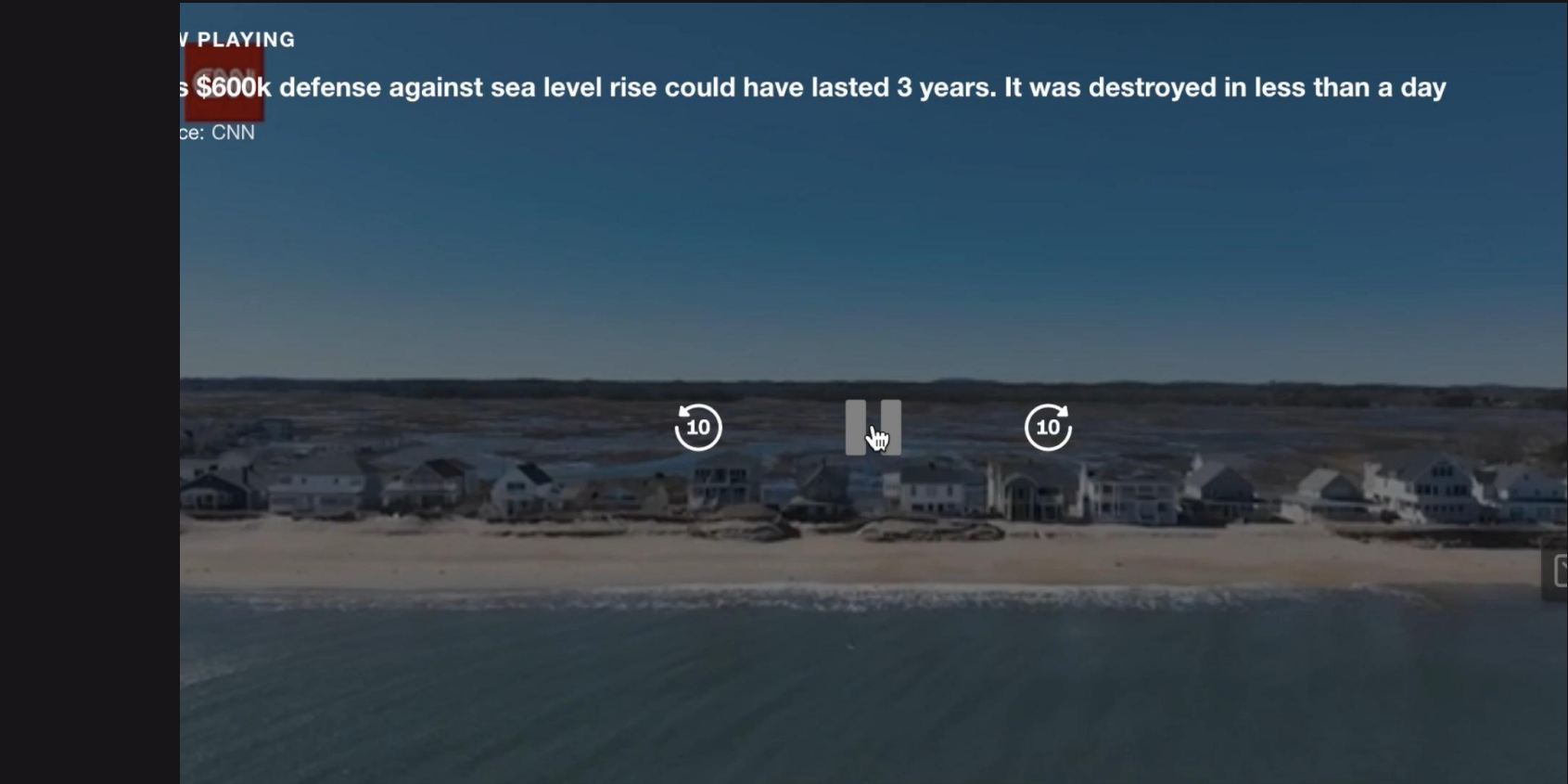
Peggotty Beach

Scituate

2/9/2016 High Tide

This \$600k defense against sea level rise could have lasted 3 years. It was destroyed in less than a day

<https://www.cnn.com/videos/us/2024/03/13/massachusetts-dune-sea-level-rise-climate.cnn>



Quick Quiz!

A _____ft rise in MSL would enable a 10-year storm to flood areas that today are only flooded by 100-year storms

a) 0.5

b) 1

c) 2

d) 3

e) 4

3-5 January 2018

Thursday, Jan 4 2018, 17:54 GMT
Predictions: 12.008ft.
Verified: 15.12ft.
(Observed - Predicted): 3.11ft.

NOAA/NOS/Center for Operational Ocean

— Predictions — Verified — Preliminary — (Observed - Predicted)

From:

Jan 3 2018

To:

Jan 5 2018

Standard

Timezone

GMT

Datum

MLLW

Back 1 Day Forward 1 Day

Interval

6 min 1 hr H/L Day Month

Update

Plot Data Only

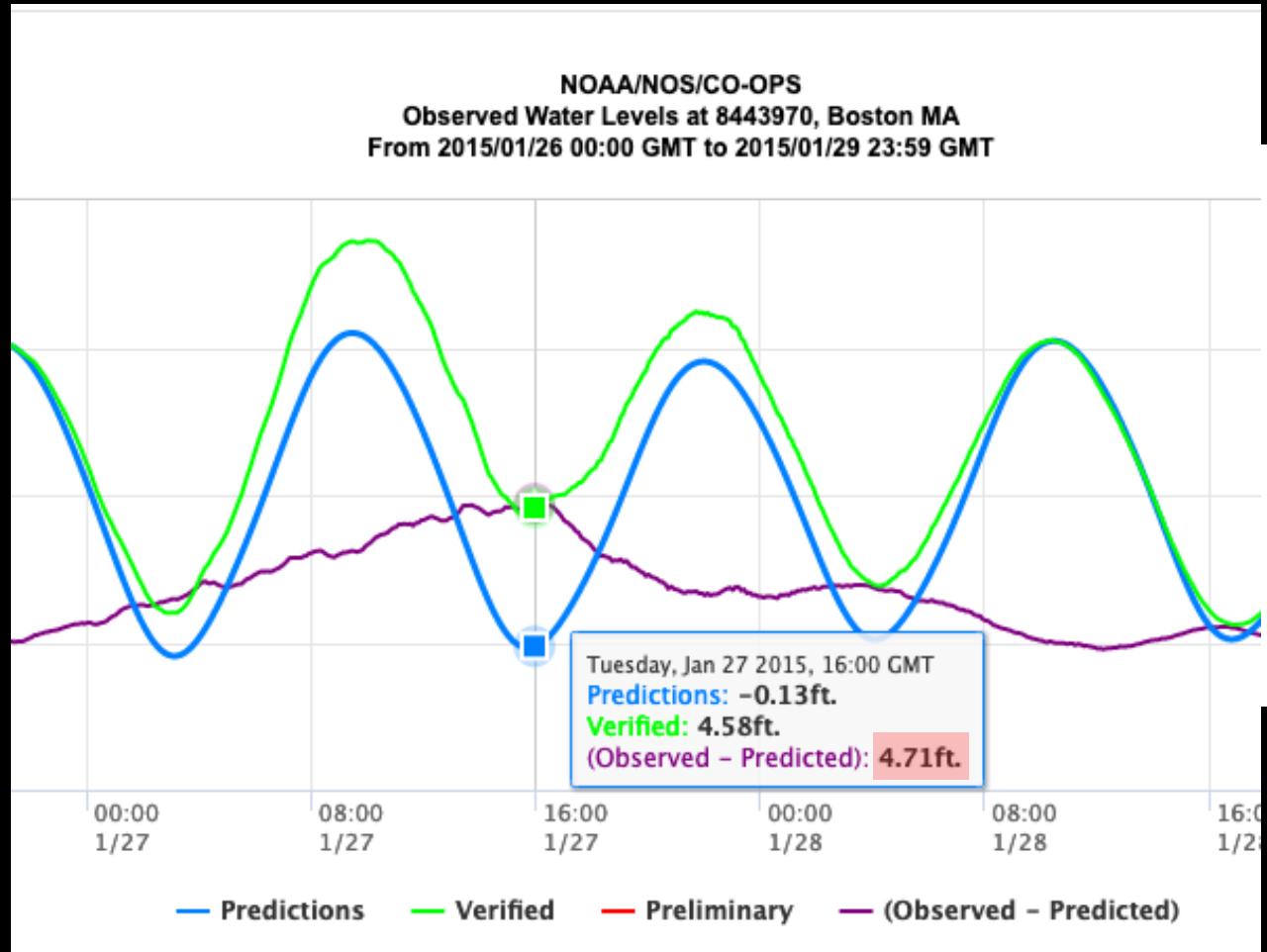


The January 27th storm of 2015

2018 – SS 3.1 ft TWL 15.12 ft

2015 - SS 4.7 ft TWL 4.58 ft

2015 SS + 2018 WL 16.72 ft



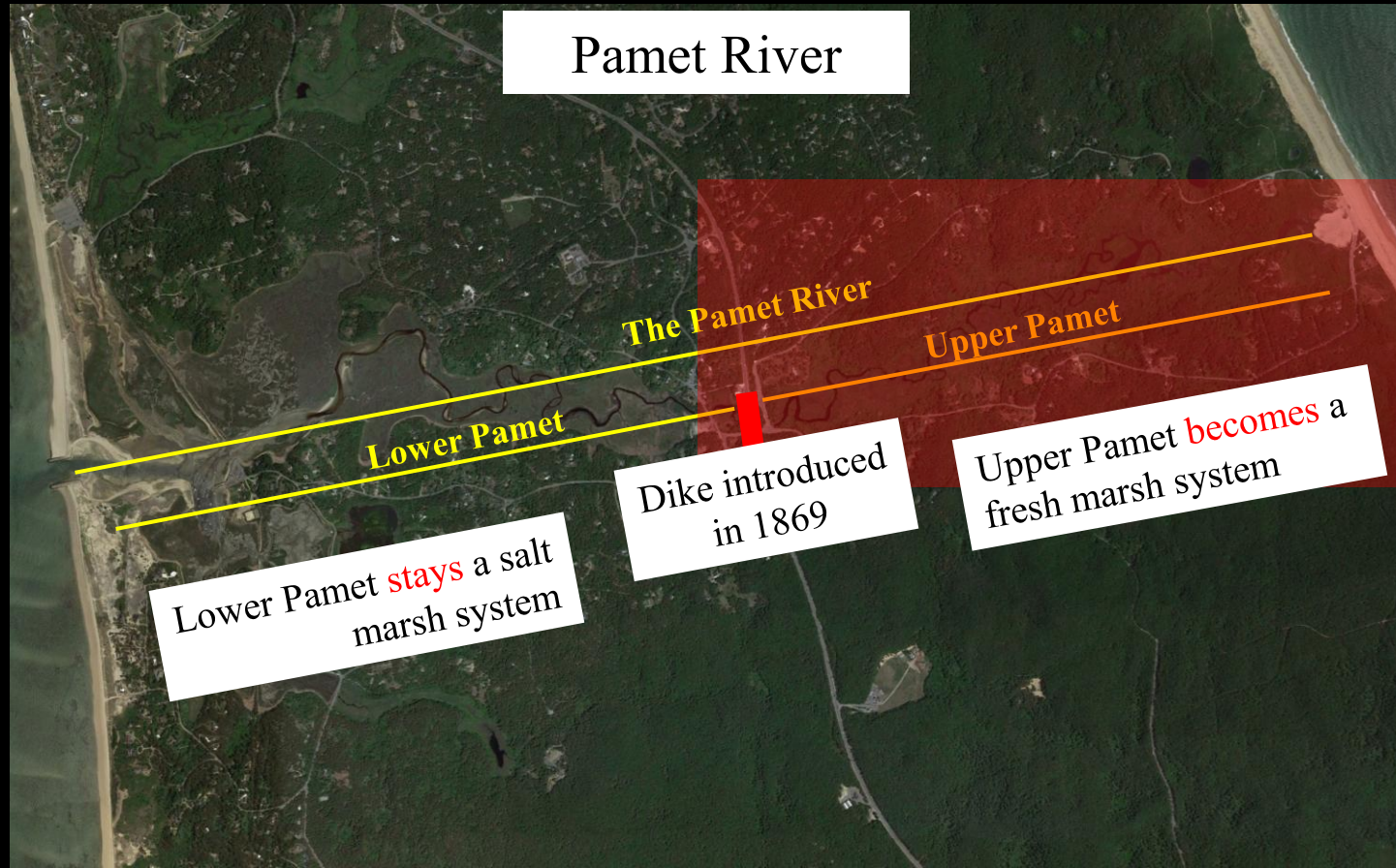


2015 SS + 2018 WL 16.72 ft

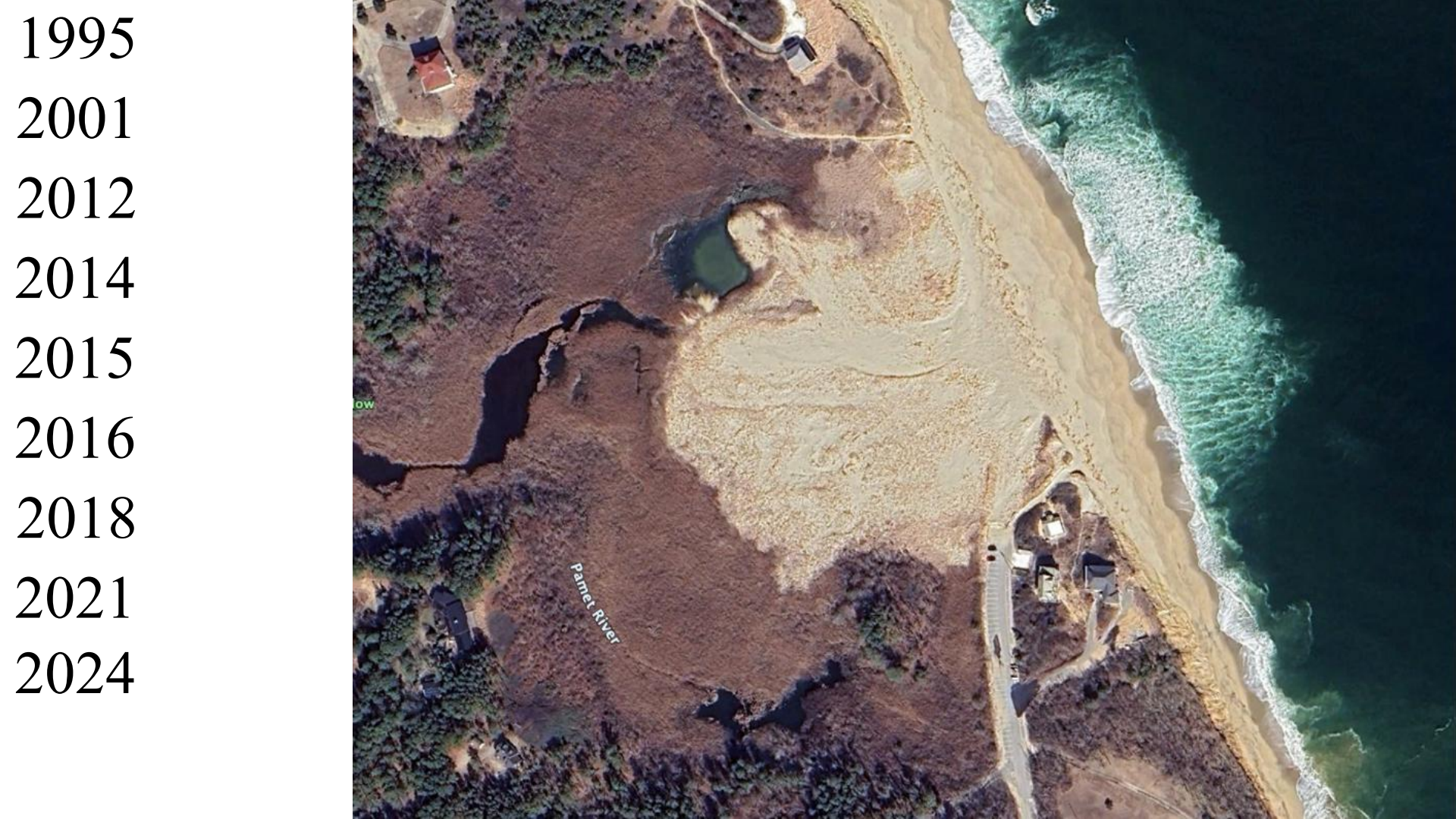
1.5 ft higher than 2018



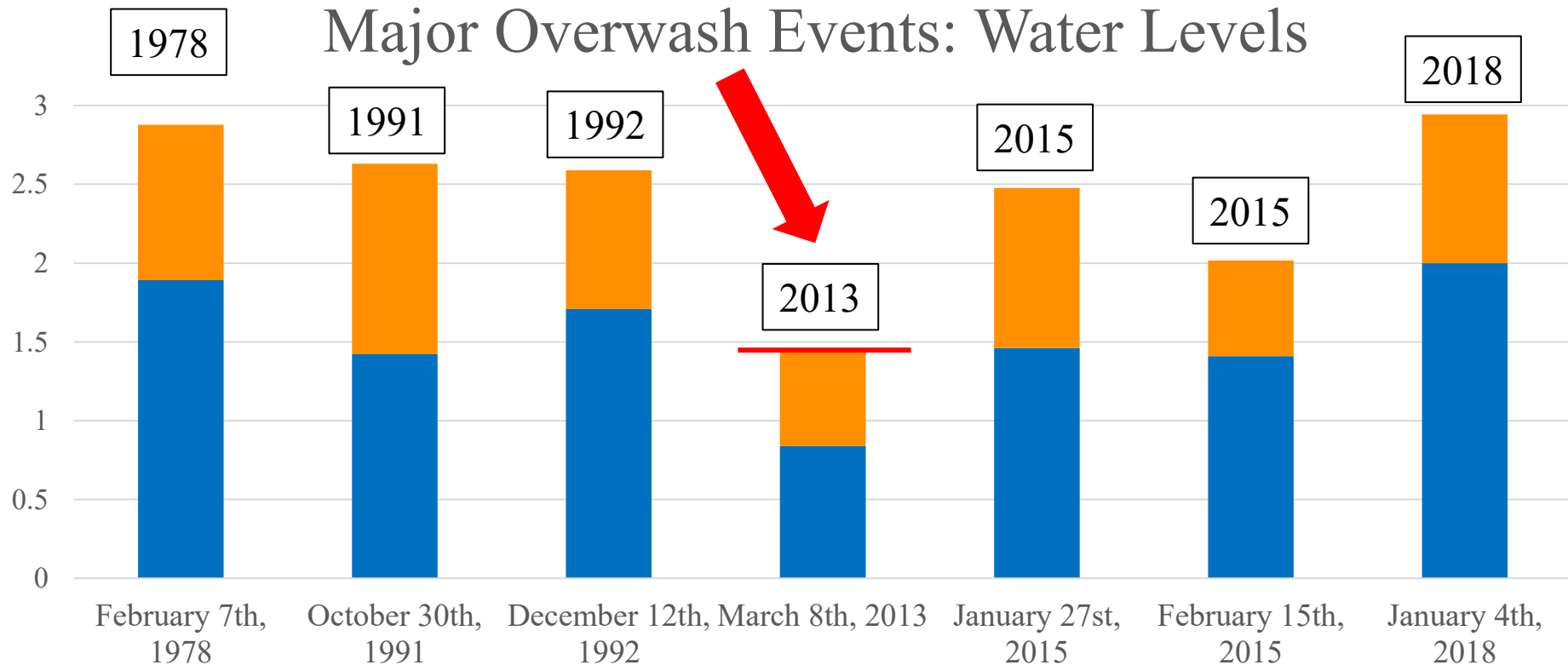
Managing with
Nature
vs.
The Managing
of Nature







Major Overwash Events: Water Levels



■ Storm Surge (m, NAVD88)

■ Predicted Tide (m, NAVD88)



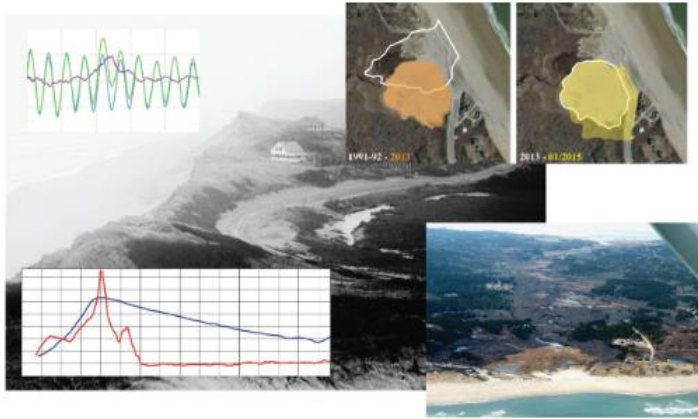


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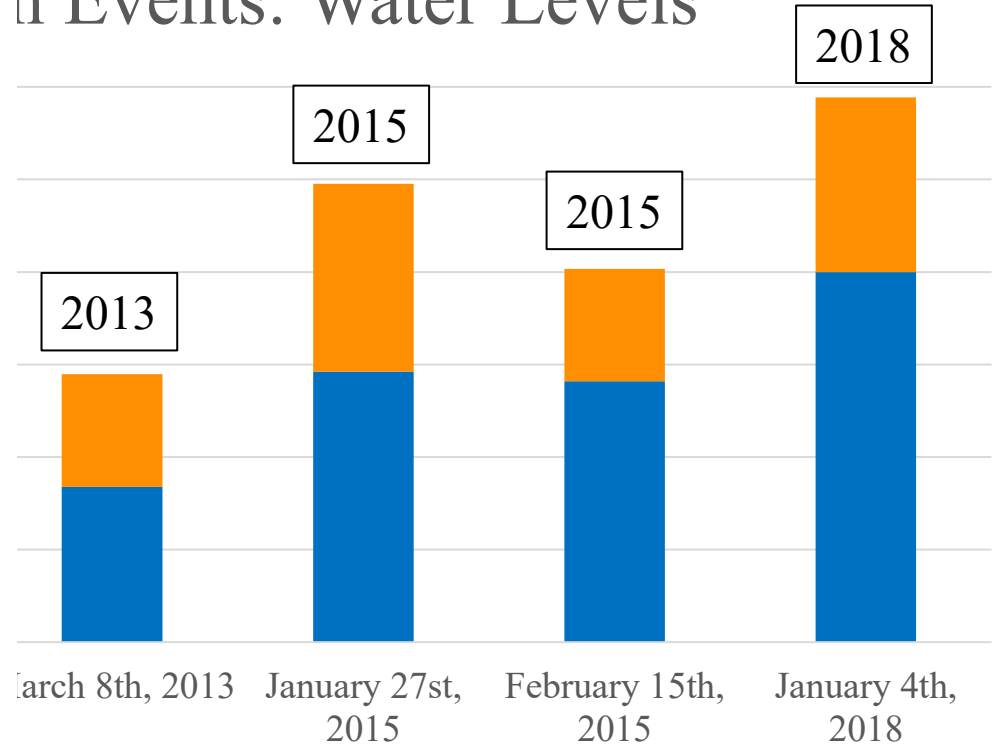
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Ballston Beach Overwash: Understanding Overwash Events for Science-based Management



Center for Coastal Studies, Provincetown Massachusetts
Department of Marine Geology
Mark Borrelli, Graham S. Giese, Stephen T. Mague, Theresa L. Smith
Submitted to the Town of Truro | CCS-DMG Report: 16-01

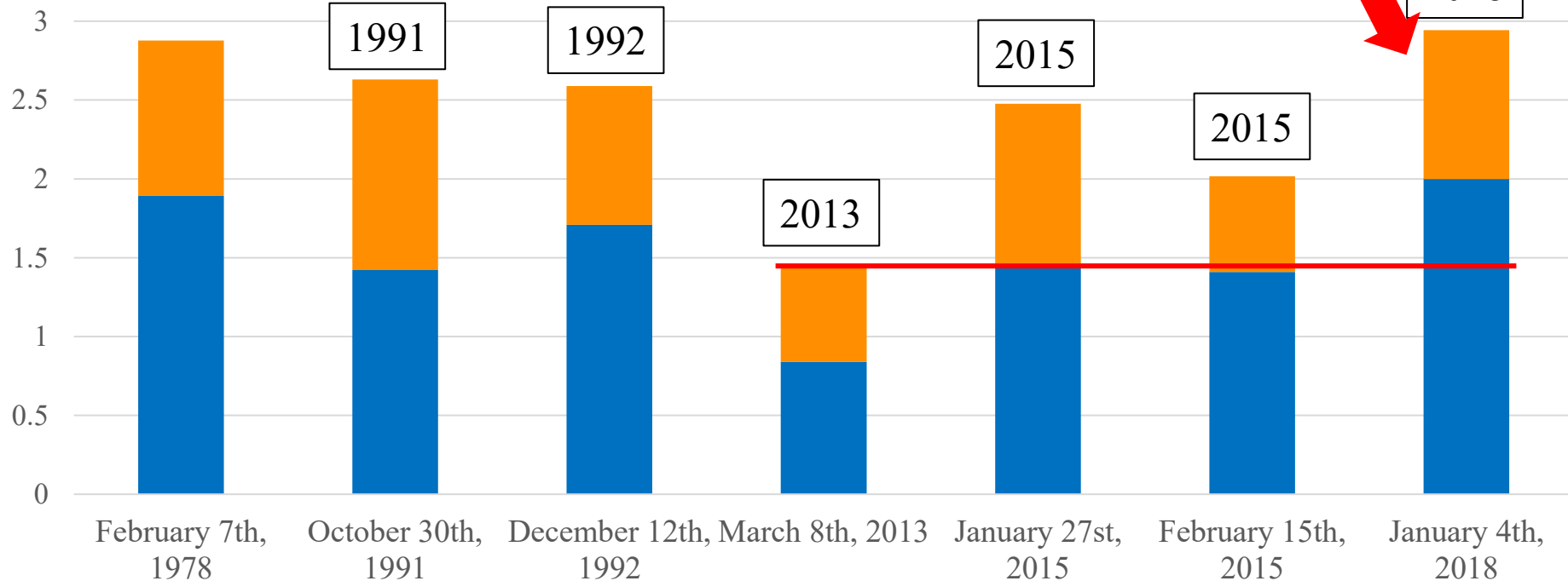
h Events: Water Levels



e (m, NAVD88)

ide (m, NAVD88)

Major Overwash Events: Water Levels



■ Storm Surge (m, NAVD88)

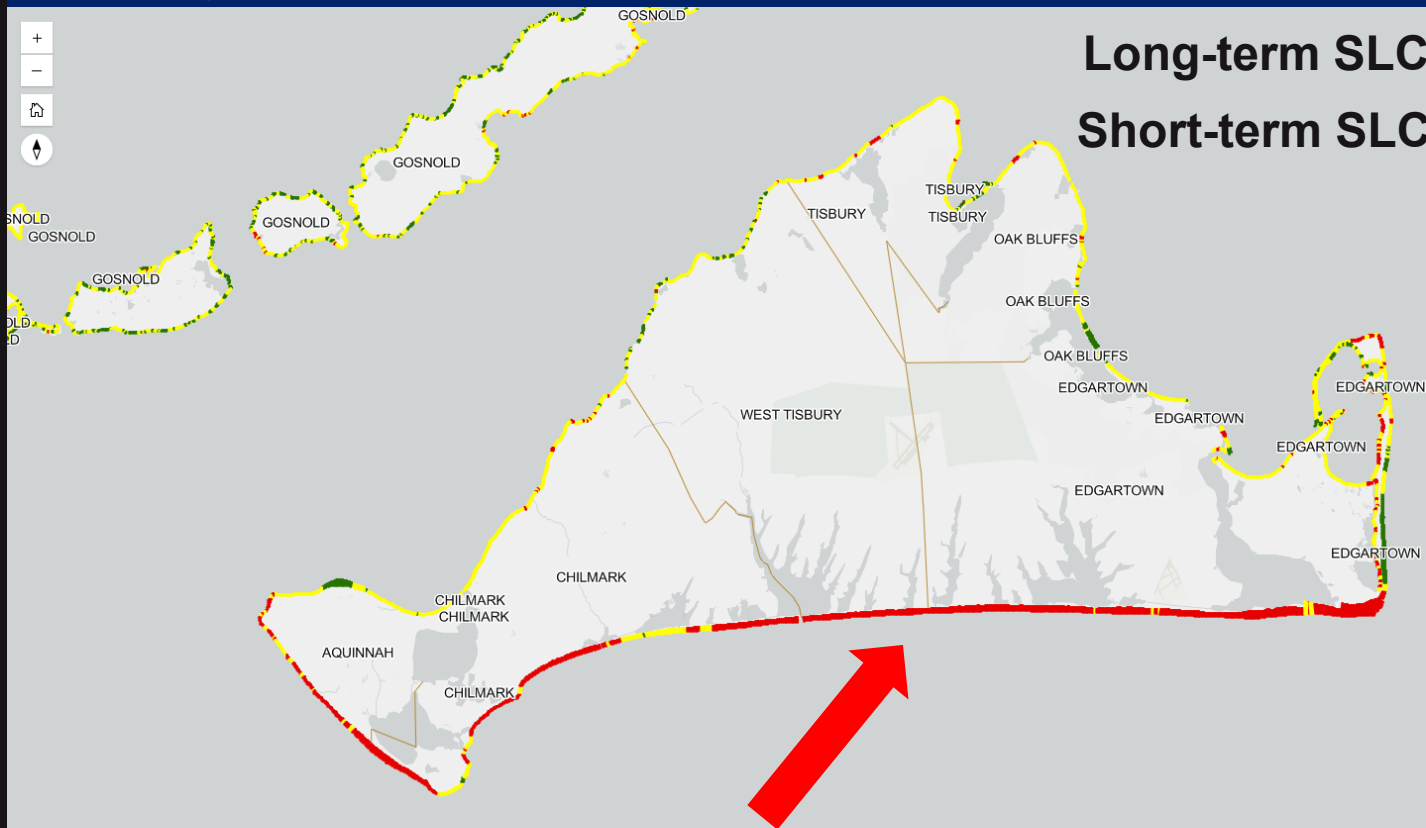
■ Predicted Tide (m, NAVD88)



2012

2024





Long-term SLC Rates

Short-term SLC Rates

Click magnifying glass to search by address or place

Search Transect ID

Short-Term Change Transects (1970-2018)

Change

- Accreting
- Eroding
- No Statistical Change

Zoom in to view mean high water shorelines (1844-2018)

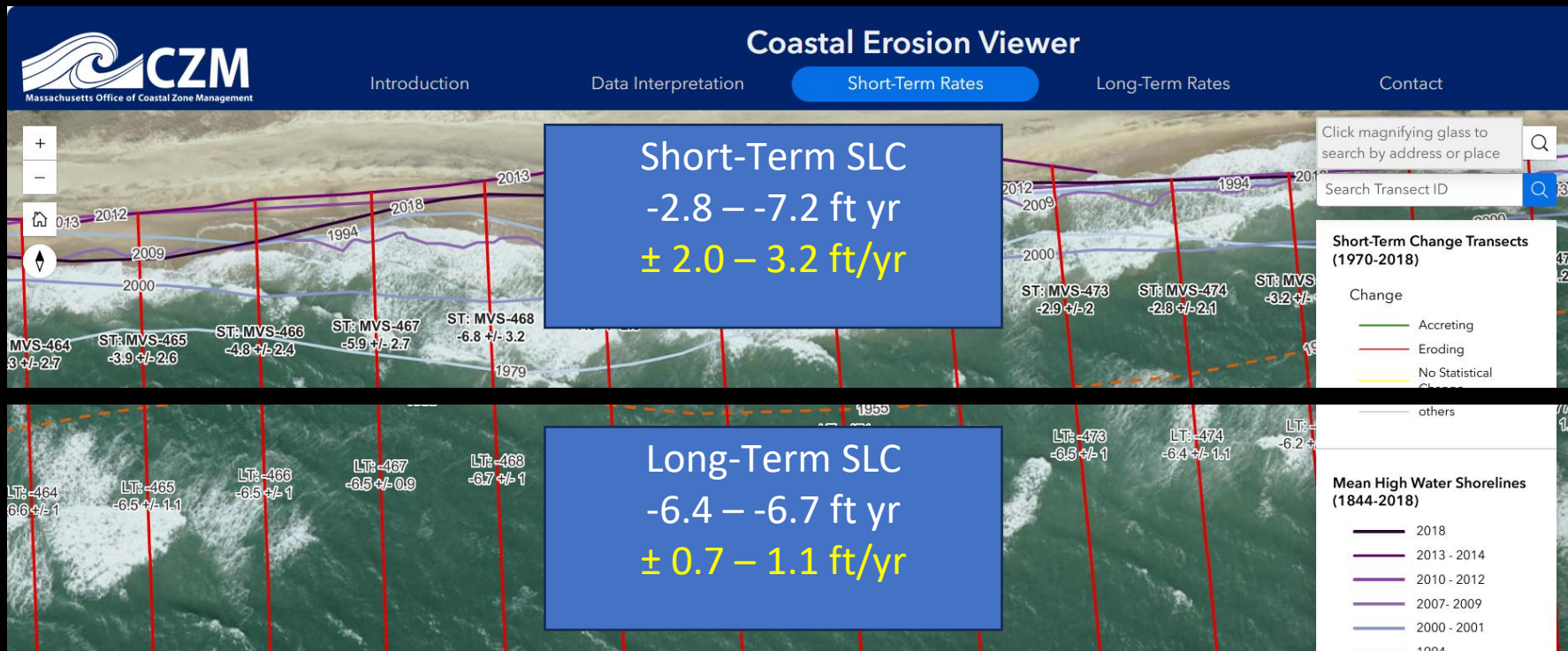
Click on a transect to view additional information

2 mi

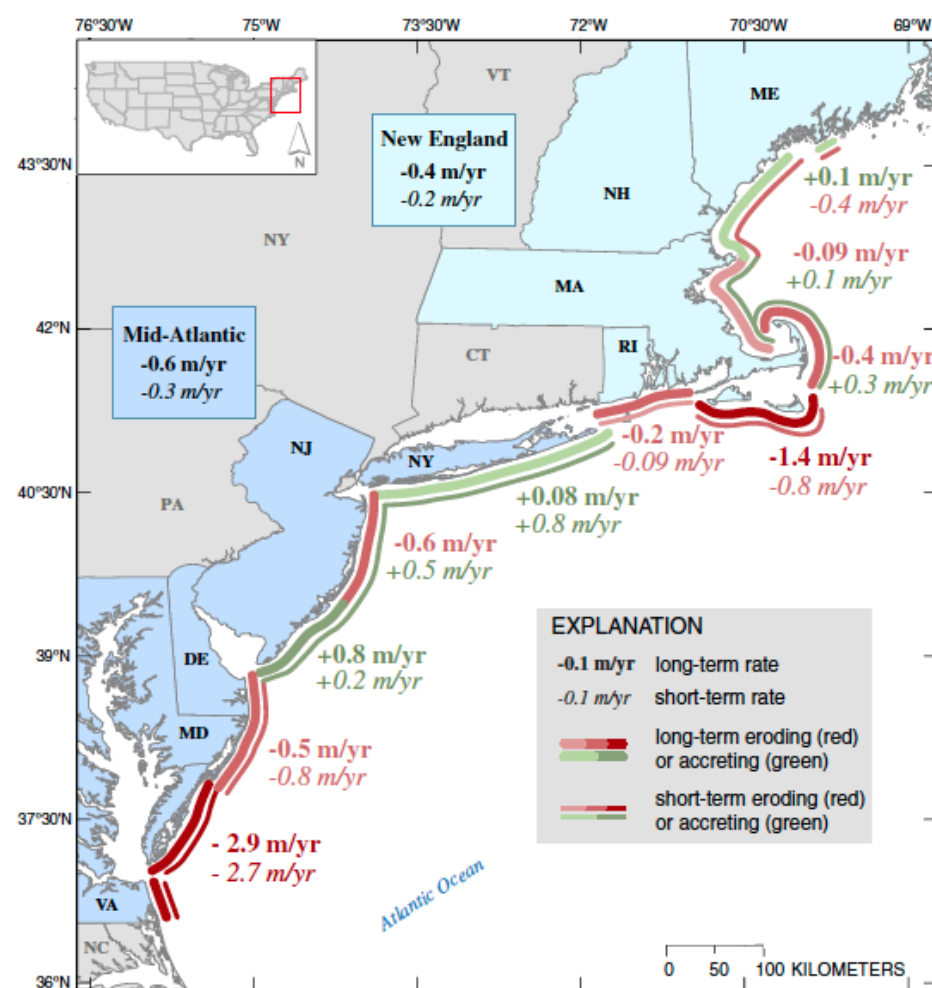
Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS | Massachusetts Office of Coastal Zone Management | Contact Person: Daniel ... Powered by Esri

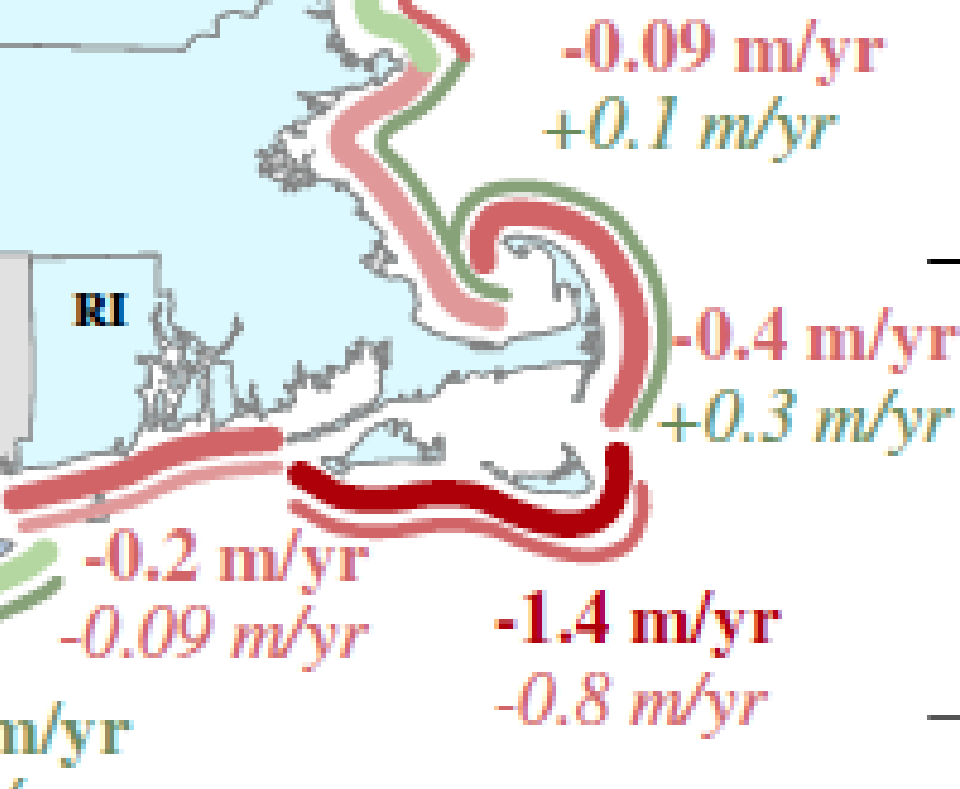


T#	465	466	467	468	469	470	471	472	473	474
ST	-3.9±2.6	-4.8±2.4	-5.9±2.7	-6.8±3.2	-7.3±2.6	-6.7±2.6	-5.1±2.5	-3.9±2.3	-2.9±2.0	-2.8±2.1
LT	-6.5±1.1	-6.5±1.0	-6.5±0.9	-6.7±0.8	-6.6±0.7	-6.6±0.7	-6.6±0.8	-6.6±0.9	-6.5±1.0	-6.4±1.1









EXPLANATION

- 0.1 m/yr long-term rate
- 0.1 m/yr short-term rate
- long-term eroding (red) or accreting (green)
- short-term eroding (red) or accreting (green)