WETLANDS WATCH

Protecting and Conserving Wetlands

# Impact of Sea Level Rise on Virginia's Coast

Skip Stiles

Executive Director, Wetlands Watch

# MID-ATLANTIC COASTLINE – Full Glacial Melt

**+ 120 feet**

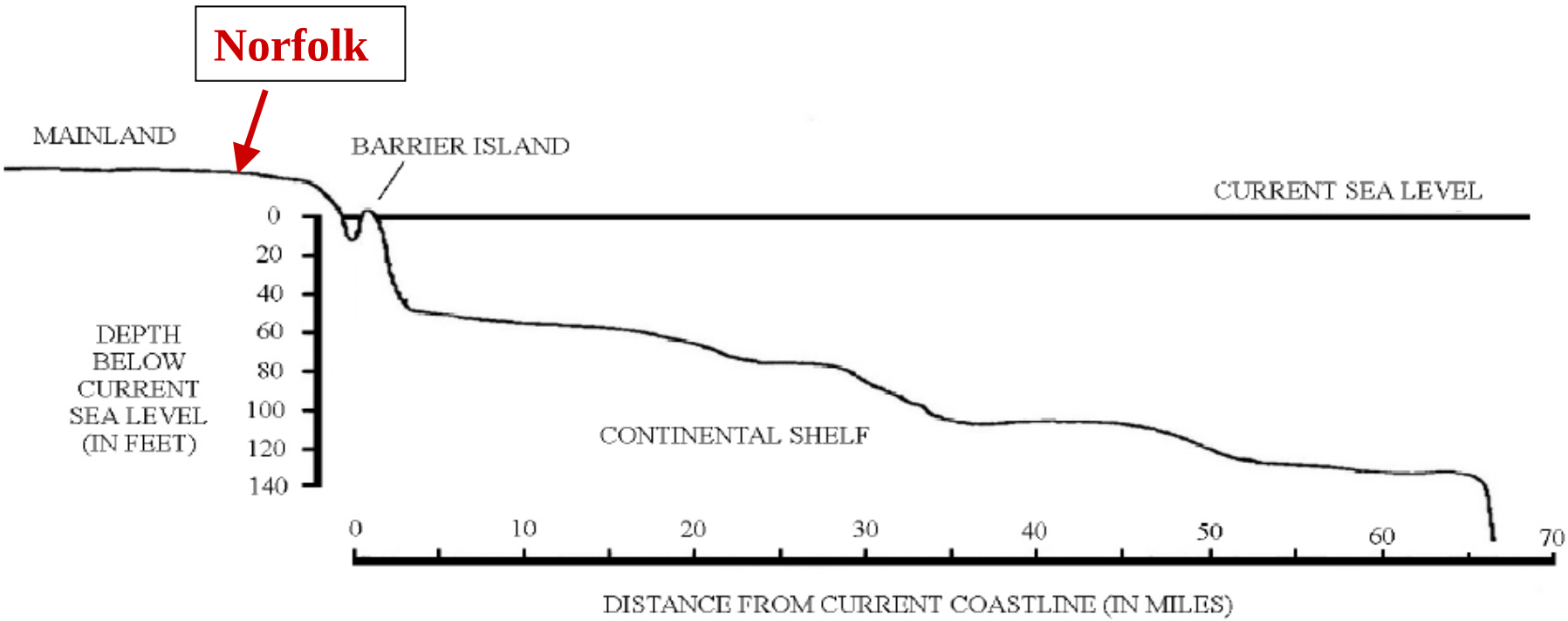

**John Earle /Virginian-Pilot**

# MID-ATLANTIC COASTLINE – 14,000 Years Ago

**- 120 Feet**


**John Earle /Virginian-Pilot**

# RECENT MID-ATLANTIC SEA LEVEL RISE




Source: UNC Research Laboratories of Archeology

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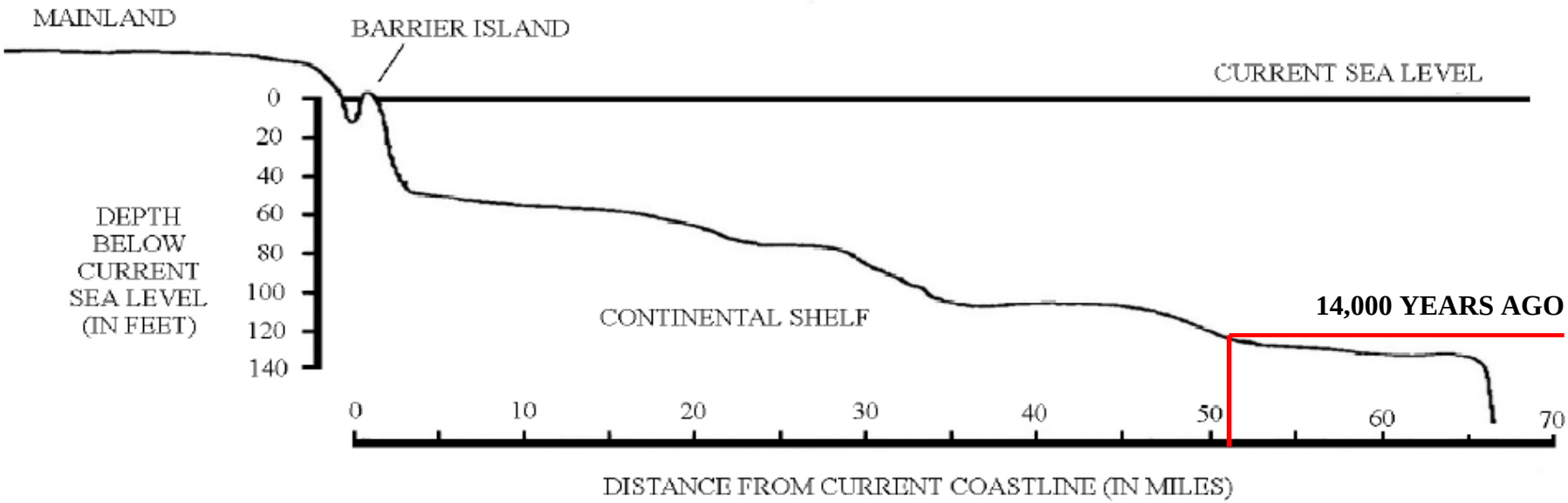


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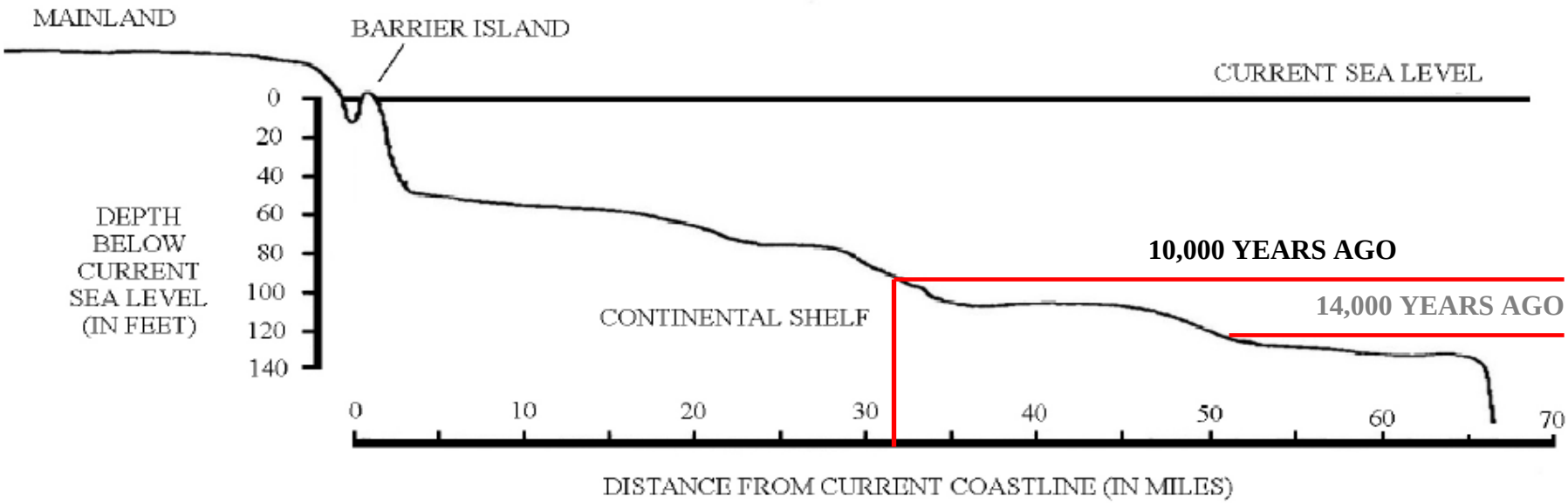


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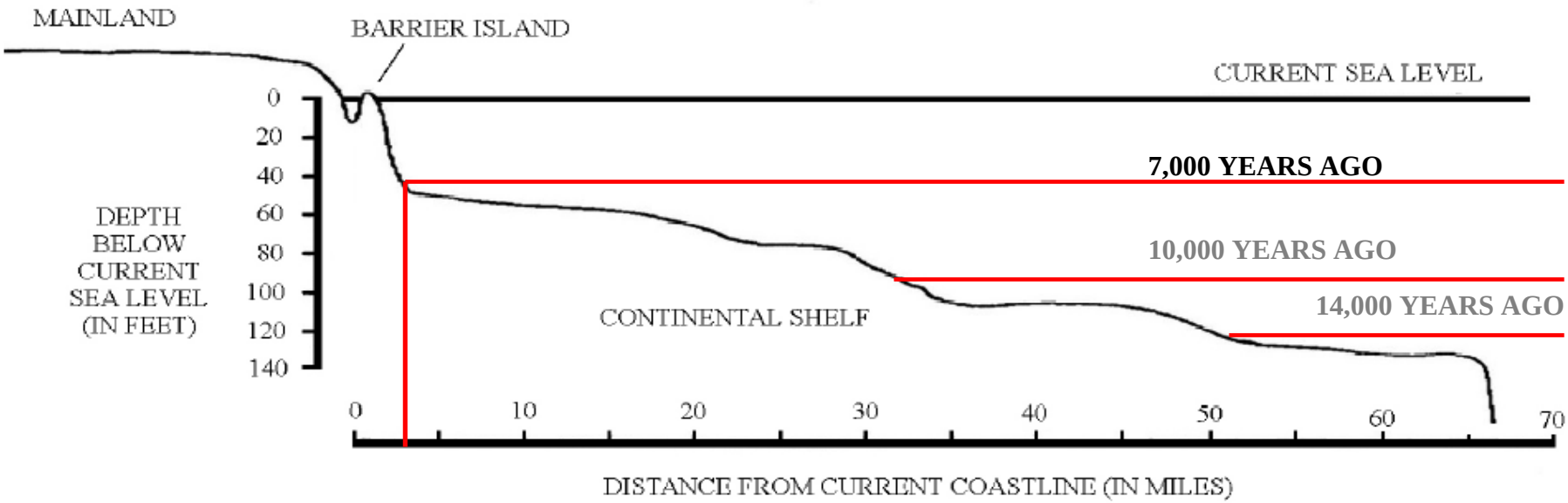


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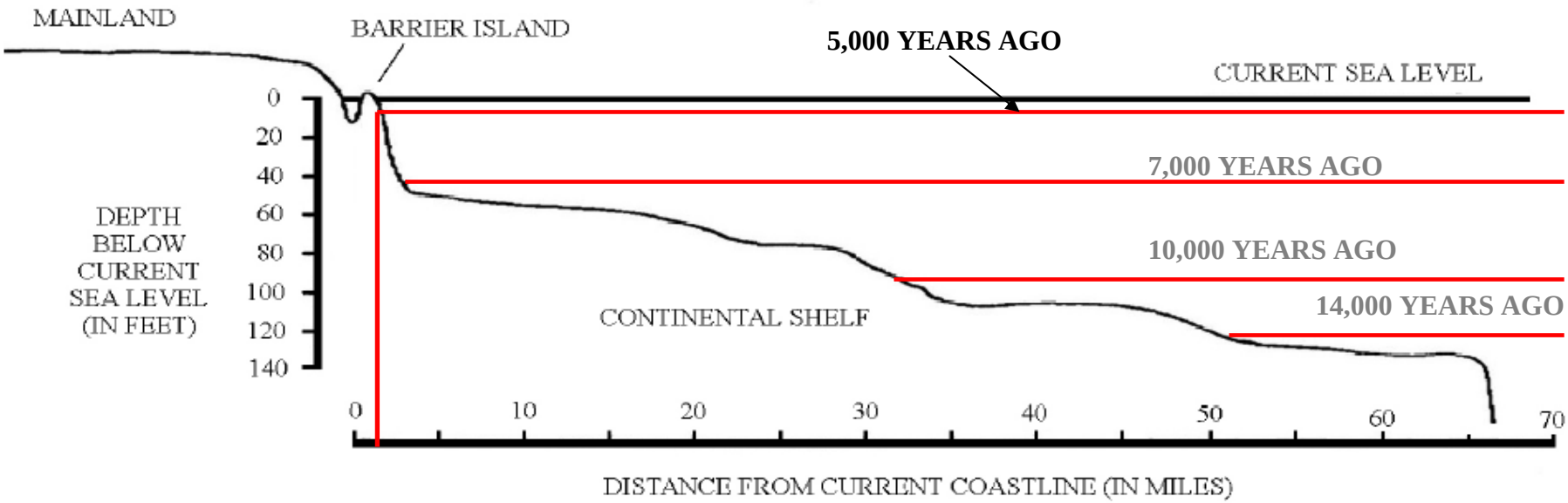


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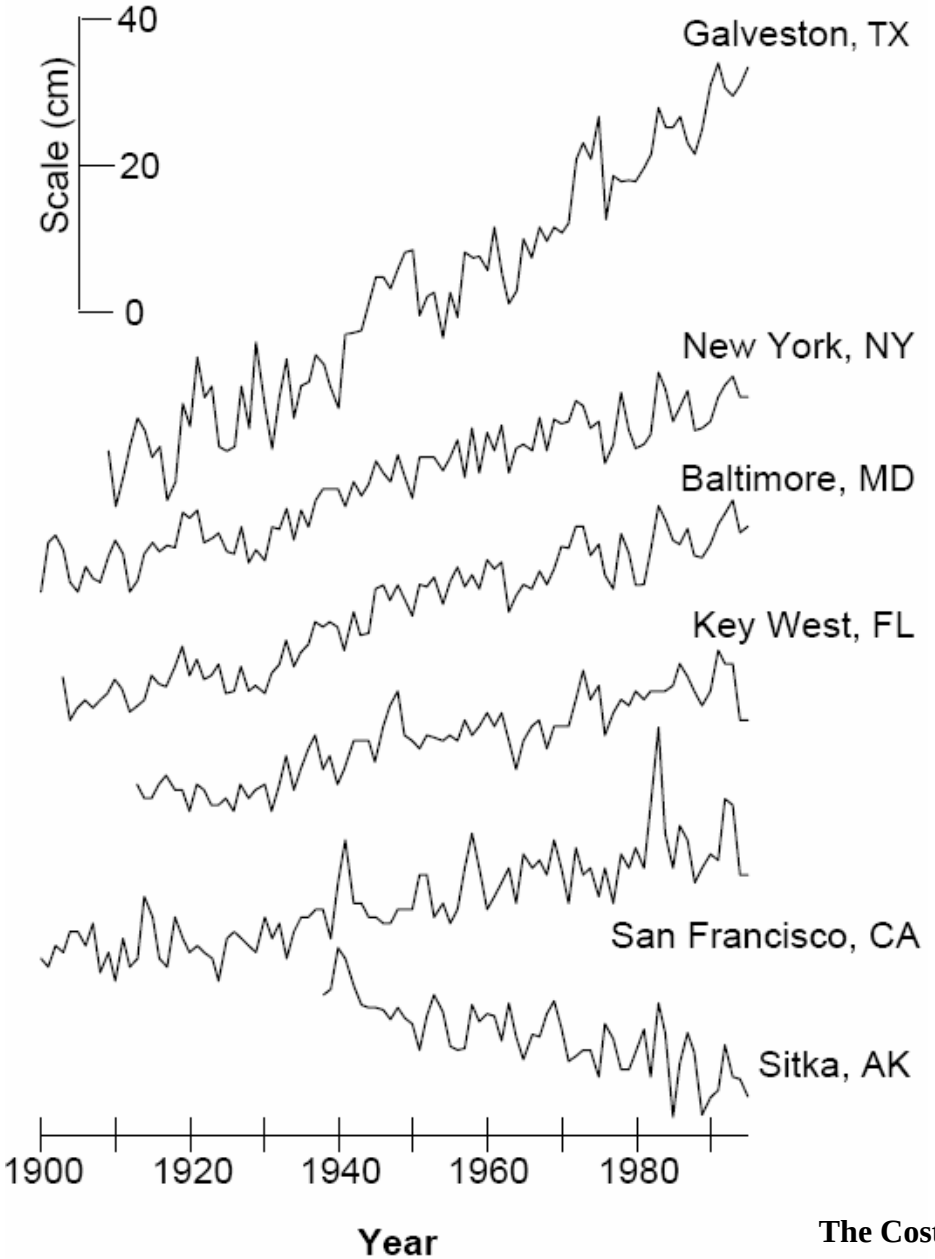
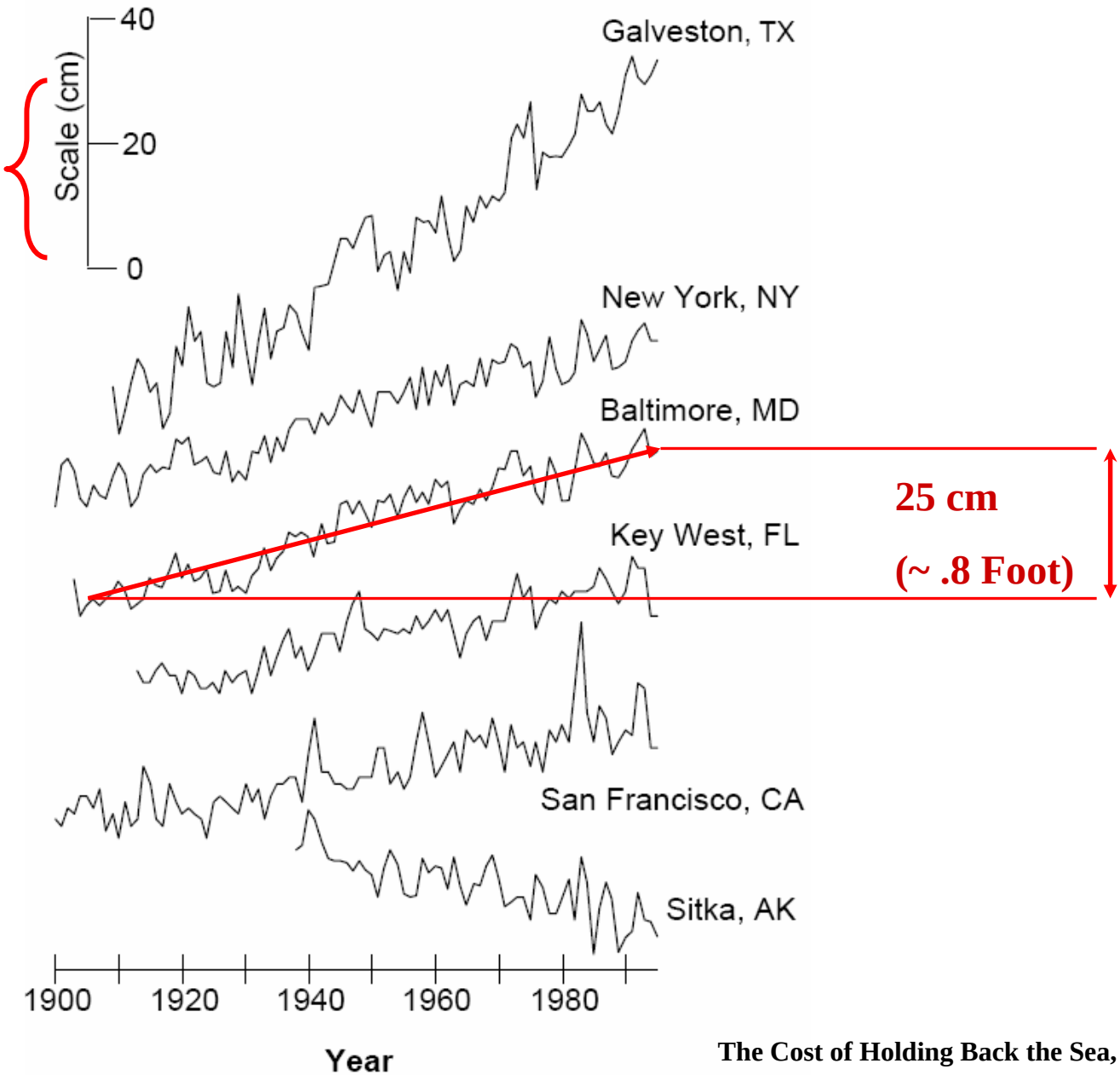
# U.S. Sea Level Trends: 1900-97



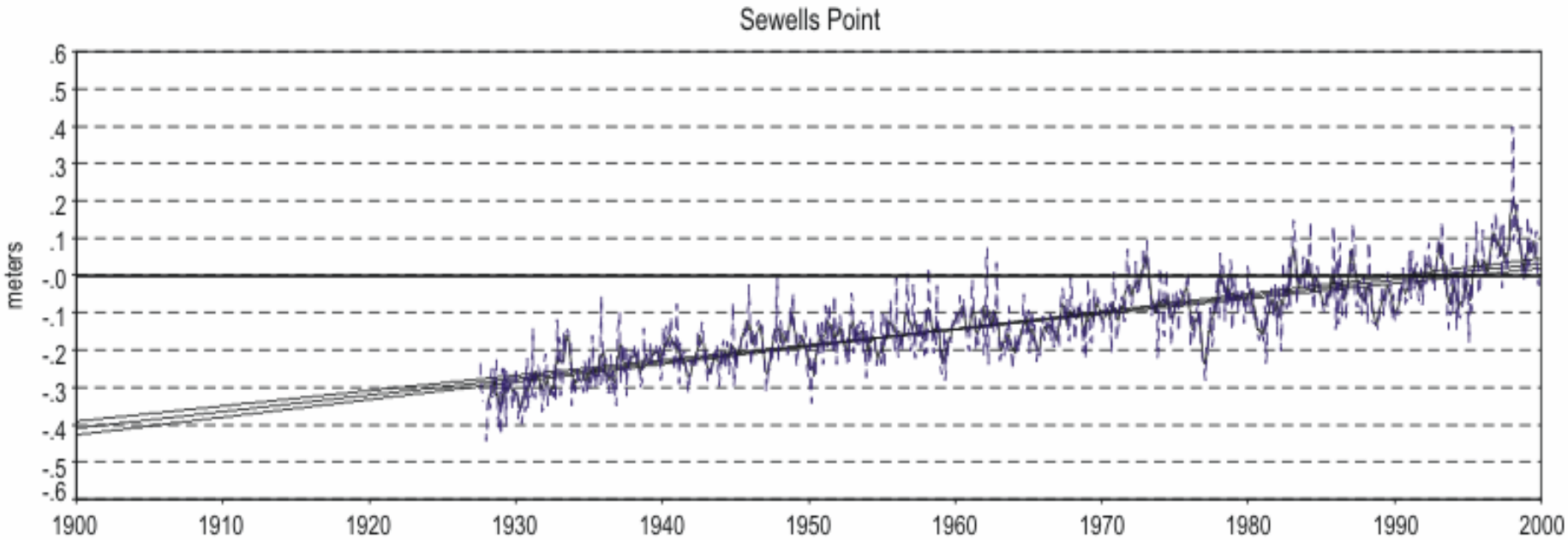

**The Cost of Holding Back the Sea, Titus, et al**

# U.S. Sea Level Trends: 1900-97




The Cost of Holding Back the Sea, Titus, et al

# Sewells Point Historical Sea Level Record




The mean sea level trend is 4.42 millimeters/year
(1.45 feet/century)

Monthly Mean Sea Level 1927 – 1999 (units in tenth of meter/yr)

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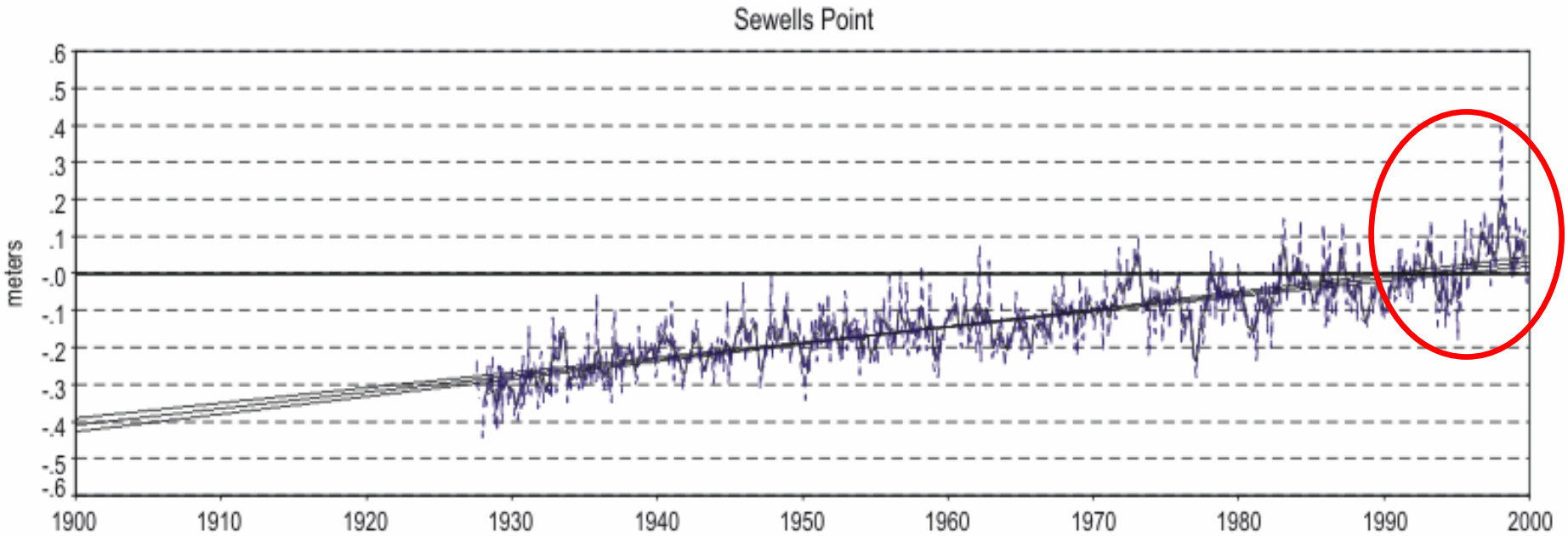


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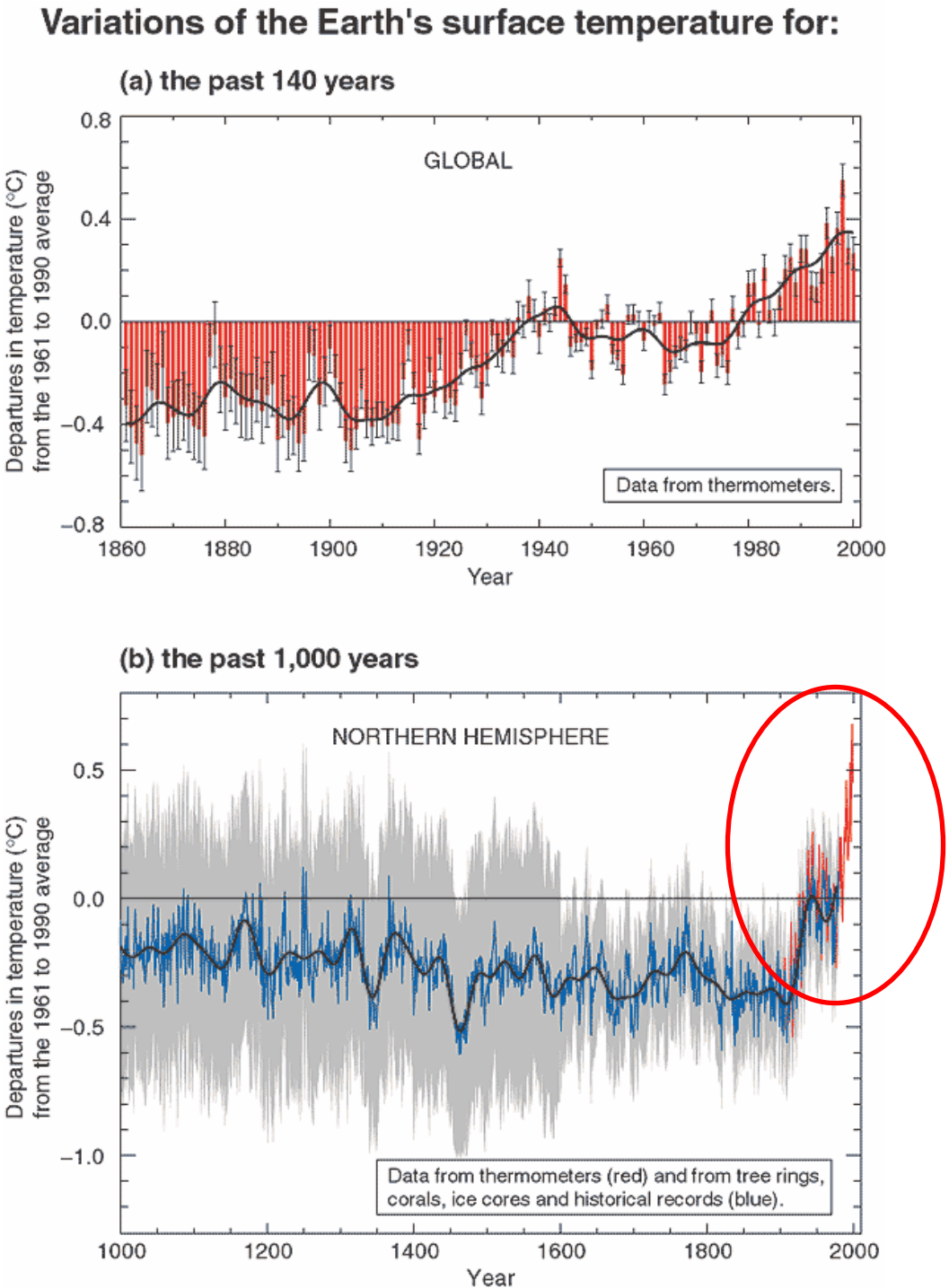


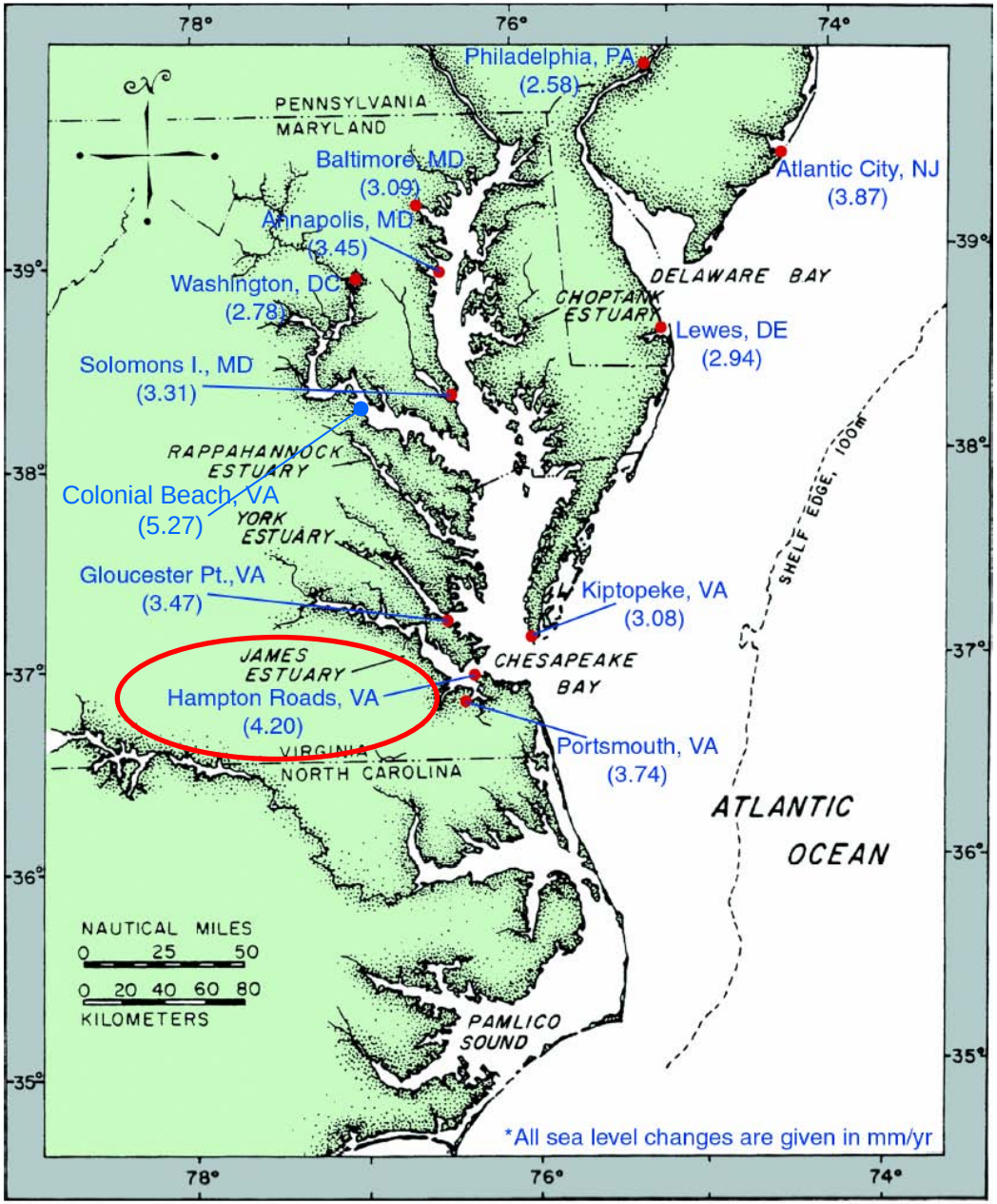

Sea level rise is driven by temperature rise

Temperature Rise is accelerating…

…FAST !

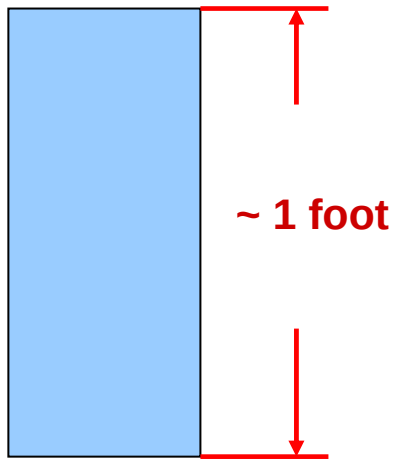
**IPCC 2000**

## SEA LEVEL TRENDS IN THE MID-ATLANTIC




Source: Larsen. 1998. *Rising Sea Level in the Chesapeake Bay*. USGS.

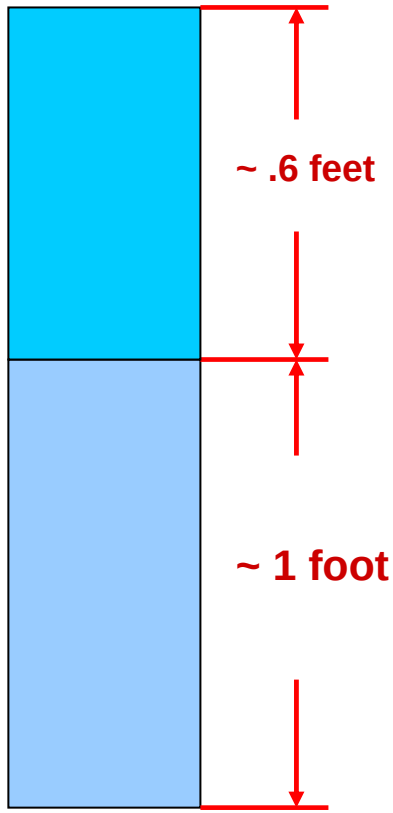
Hampton Roads has the highest NOAA predicted sea level increases on East Coast for major metro area




**100 year Sea Level Rise**

## SEA LEVEL RISE - BASE

1.8 – 2.8 mm/yr from thermal expansion and melting of land glaciers




**100 year Sea Level Rise**

## Relative Sea Level Rise in Hampton Roads

An additional ~2 mm/yr due to regional subsidence from

- isostatic rebound
- groundwater removal
- comet impact

SEA LEVEL RISE - BASE

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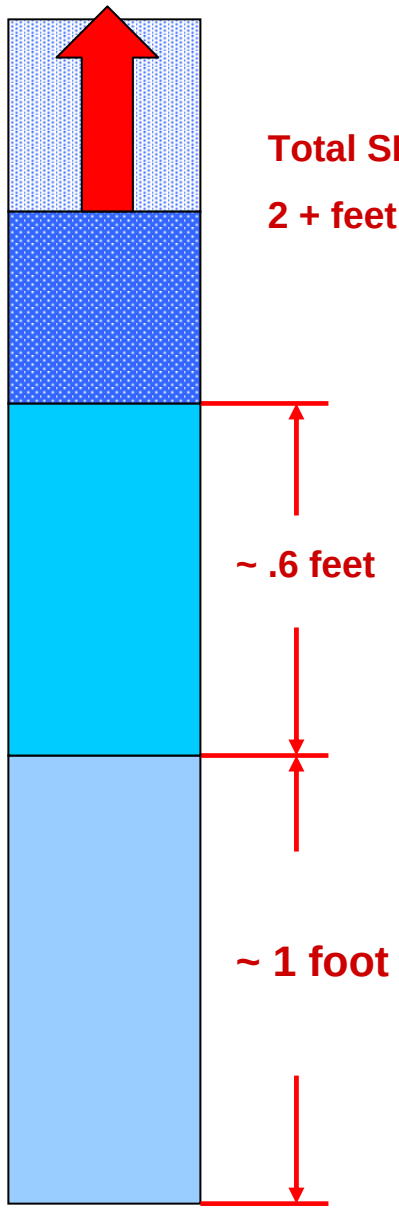



**100 year Sea Level Rise**

Localized Relative Sea Level Rise

> 7 mm/yr in some parts of H.R.

Relative Sea Level Rise in Hampton Roads

An additional ~2 mm/yr due to regional subsidence from

- isostatic rebound
- groundwater removal
- comet impact

SEA LEVEL RISE - BASE

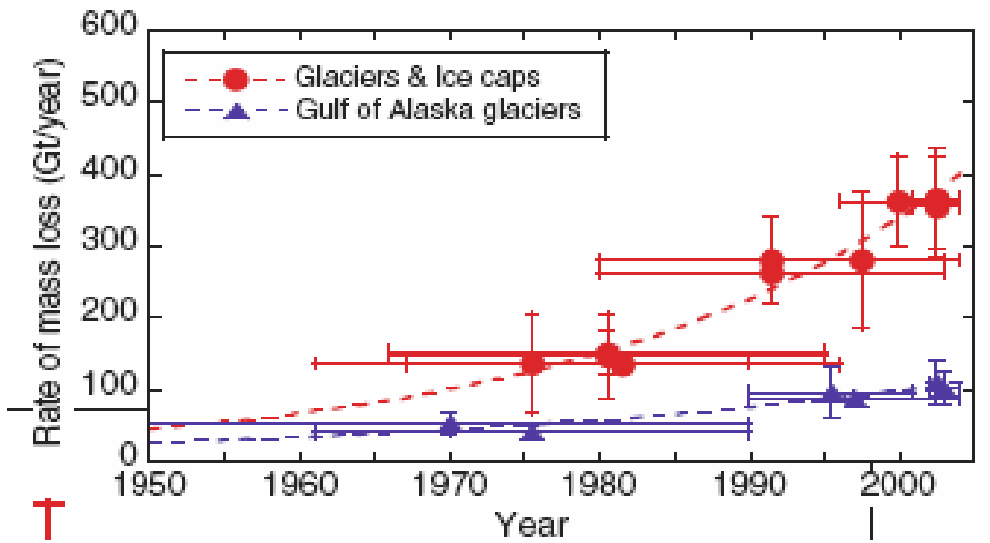
1.8 – 2.8 mm/yr from thermal expansion and melting of land glaciers


# A Semi-Empirical Approach to Projecting Future Sea-Level Rise

Stefan Rahmstorf

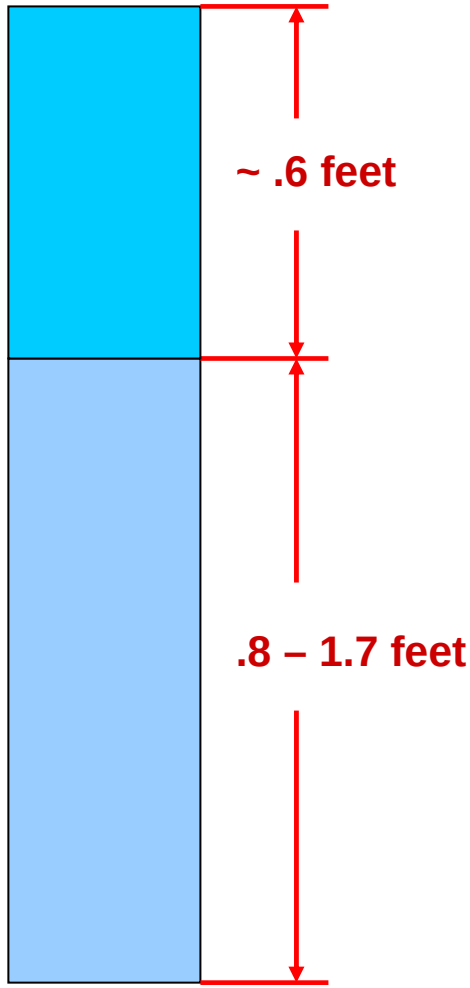
Base Projection = 28 – 53 cm by 2100


# Glaciers Dominate Eustatic Sea-Level Rise in the 21st Century




**Another 10 CM – 25 CM by 2100**

# Newest (8/2007) Estimates




100 year Sea Level Rise

Relative Sea Level Rise in Hampton Roads

An additional ~2 mm/yr due to regional subsidence from

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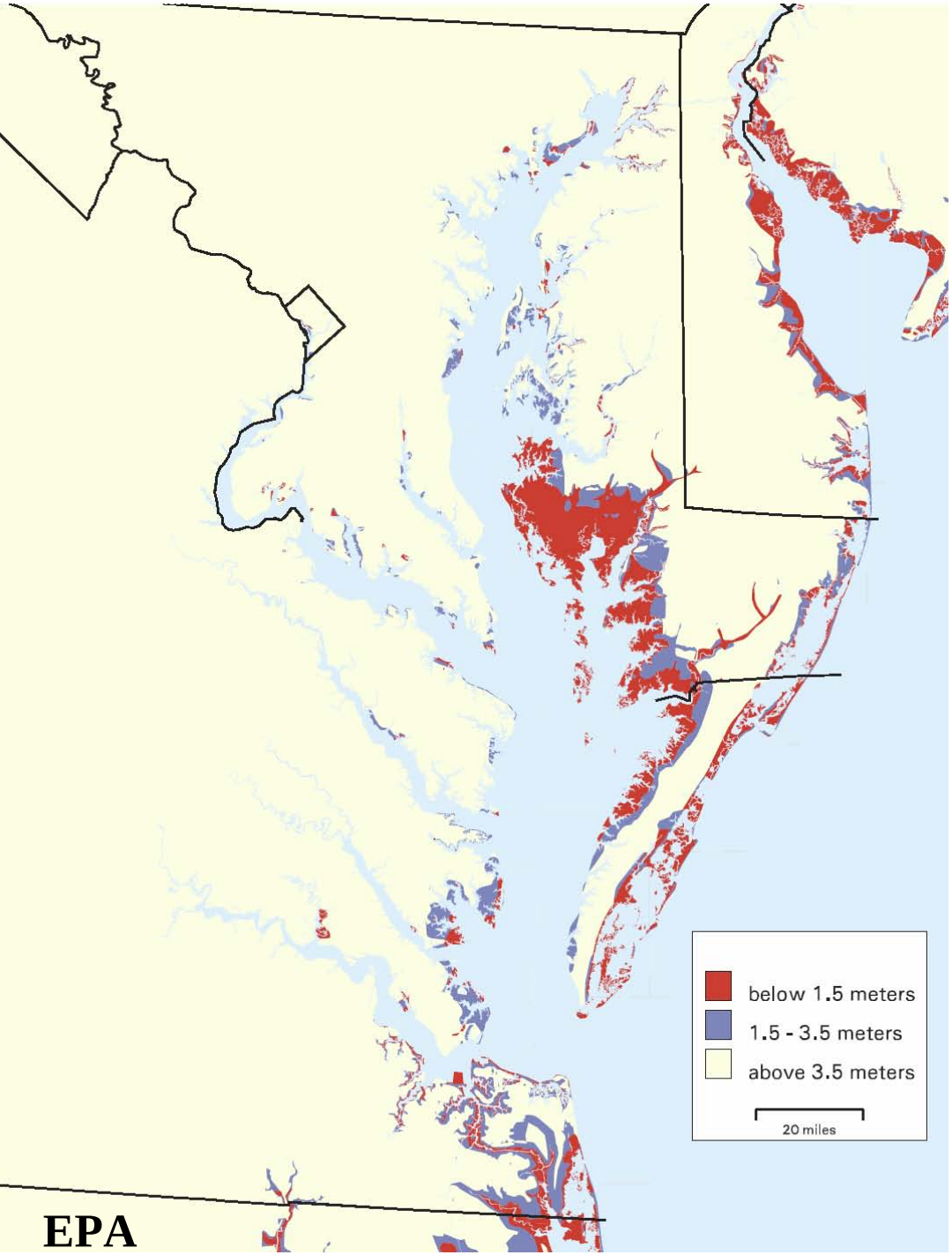
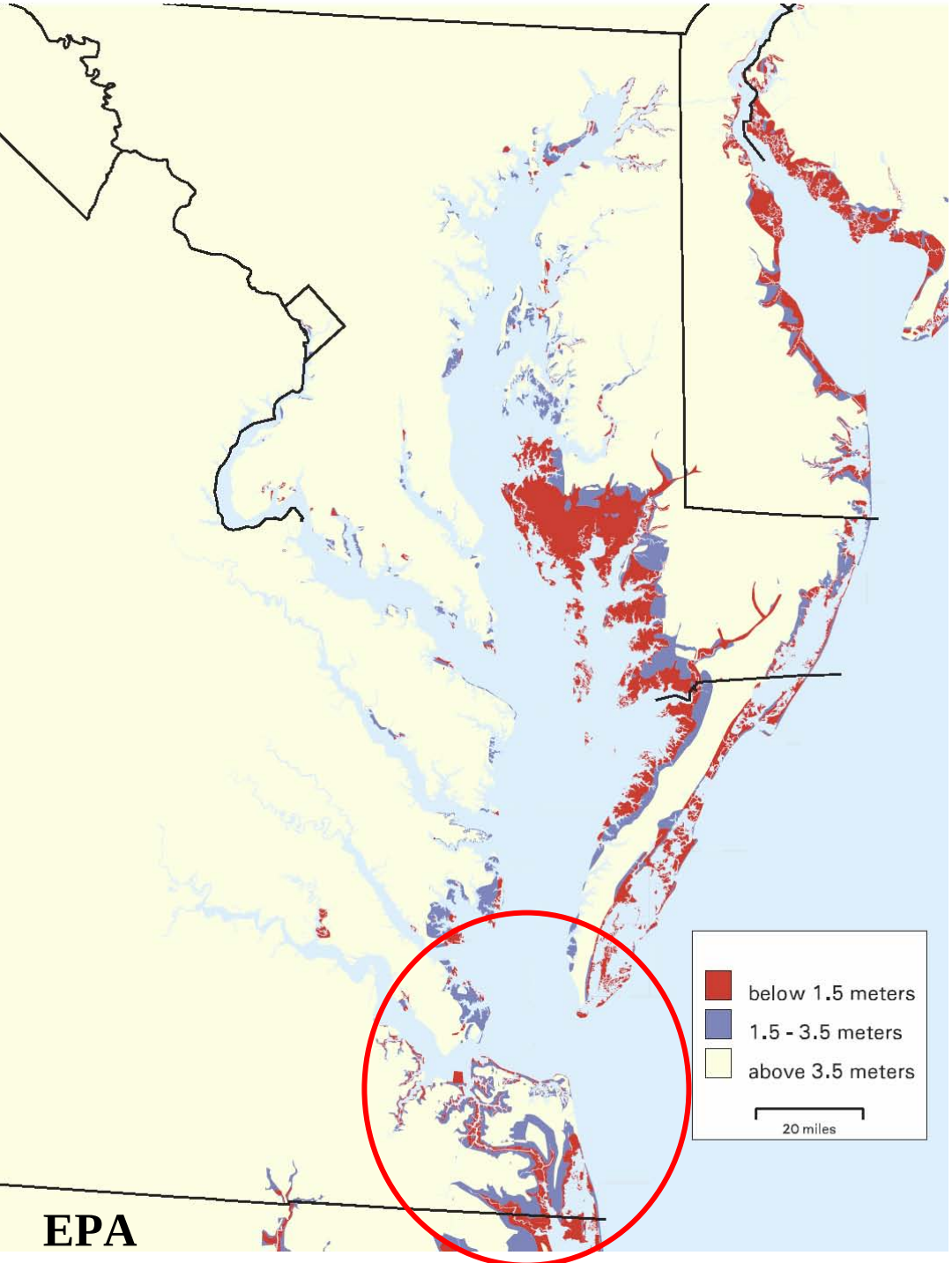
SEA LEVEL RISE - BASE

2.8 – 5.3 mm/yr from thermal expansion and melting of land glaciers (New Data)




Chesapeake Bay is at risk from sea level rise –

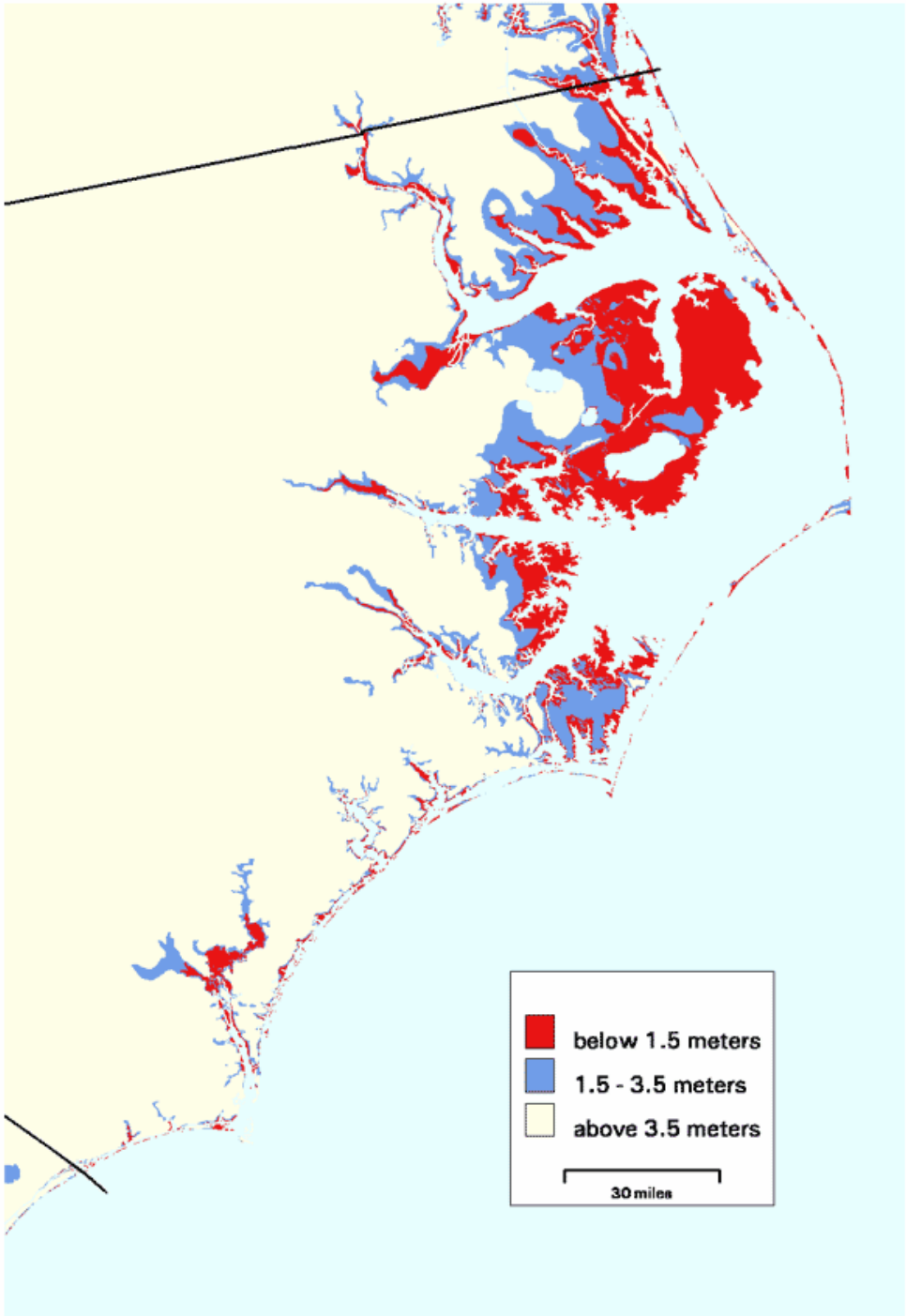
Loss of wetlands will be significant ~50-80%




Chesapeake Bay is at risk from sea level rise –

Loss of wetlands will be significant ~50-80%

Outside of New Orleans, Hampton Roads is largest population area at highest risk in the US.




North Carolina at risk as well – significant loss of tidal wetlands in critical waterfowl habitat

# Ecosystem Impacts

**All Atlantic Flyway Vegetated Tidal Wetland Ecosystems at risk.**

**Wetland-dependant fish and shellfish ecosystem threatened:**

**American Eel, Sturgeon, Alewife, Blueback Herring, Striped Bass, Atlantic Rangia Clam, Banded Killifish, Bay Anchovy, Blue Crab, Cobia, Grass Shrimp, Mummichog, Naked Goby, Red Drum, Sheepshead Minnow, Silversides, Spotted Sea Trout, Atlantic Croaker, Atlantic Menhaden, Shrimp, Southern Flounder, Striped Mullet, Black Sea Bass, Pinfish, Summer Flounder** (NC Division of Marine Fisheries)

# Economic Impacts on Virginia

**Commercial Fishery = $130 million in 2005**
**(VMRC 2005)**

**Saltwater Angling = $820 million in sales, $480 million in services, 9,000 jobs, $2 million in state saltwater fees (VOP 2007)**

**Waterfowl hunting = $14 million in 2001 (FWS 2001)**

**Wildlife Watching = $941 million (FWS 2007)**

| DATE | STORM TYPE | PEAK HIGH TIDE |
|---|---|---|
| August 23, 1933 | Hurricane | 9.8 feet |
| September 18, 1936 | Hurricane | 9.3 feet |
| March 7, 1962 | Ash Wednesday Storm | 9.0 feet |
| September 18, 2003 | Hurricane Isabel | 7.9 feet |
| September 16, 1999 | Hurricane Floyd | 7.1 feet |
| February 5, 1998 | Twin nor'easters (#2) | 7.0 feet |
| November 22, 2006 | Thanksgiving nor'easter | 6.8 feet |
| October 6, 2006 | Columbus Day nor'easter | 6.5 feet |
| January 28. 1998 | Twin nor'easter (#1) | 6.4 feet |
| September 1, 2006 | Tropical Depression Ernesto | 5.5 feet |

Source – Virginian Pilot

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$ 153,000 taxpayer dollars !


**$4.5 million program in Norfolk –**

**$26 million state-wide in Virginia**


FOR SALE
GSH
REAL EST

# Greenhouse Effect and Sea Level Rise: The Cost of Holding Back the Sea

**Titus, et.al., Coastal Management (1991), Volume 19, 171-204**

Previous studies suggest that the expected global warming from the greenhouse effect could raise sea level 50 to 200 centimeters (2 to 7 feet) in the next century.

The total cost for a one meter rise would be $270-475 billion, ignoring future development.

**To ensure the long-term survival of coastal wetlands, federal and state environmental agencies should begin to lay the groundwork for a gradual abandonment of coastal lowlands as sea level rises.**

United States
Environmental Protection
Agency

Policy, Planning,
And Evaluation
(2122)

EPA-230-R-95-900
September 1995

September 1995

# Anticipatory Planning For Sea-Level Rise Along The Coast of Maine

This report a joint effort in cooperation with State of Maine's State Planning Office.

**“THE STATE SHOULD PREVENT NEW DEVELOPMENT WHICH IS LIKELY TO INTERFERE WITH THE ABILITY OF NATURAL SYSTEMS TO ADJUST TO CHANGES IN SHORELINE POSITION.”**

# A SEA LEVEL RISE RESPONSE STRATEGY FOR THE STATE OF MARYLAND

Zoë Pfahl Johnson
NOAA Coastal Management Fellow

for

Maryland Department of Natural Resources
Coastal Zone Management Division
October, 2000


**North Carolina Dept of Environment and Natural Resources (2004)**

**NC LOSES ABOUT 780 ACRES OF TIDAL WETLANDS PER YEAR**

# FUTURE SEA LEVEL RISE AND THE NEW JERSEY COAST

## Assessing Potential Impacts and Opportunities

Matthew J.P. Cooper
Michael D. Beevers
Michael Oppenheimer

November 2005

Science, Technology and Environmental Policy Program

Woodrow Wilson School of Public and International Affairs
Princeton University

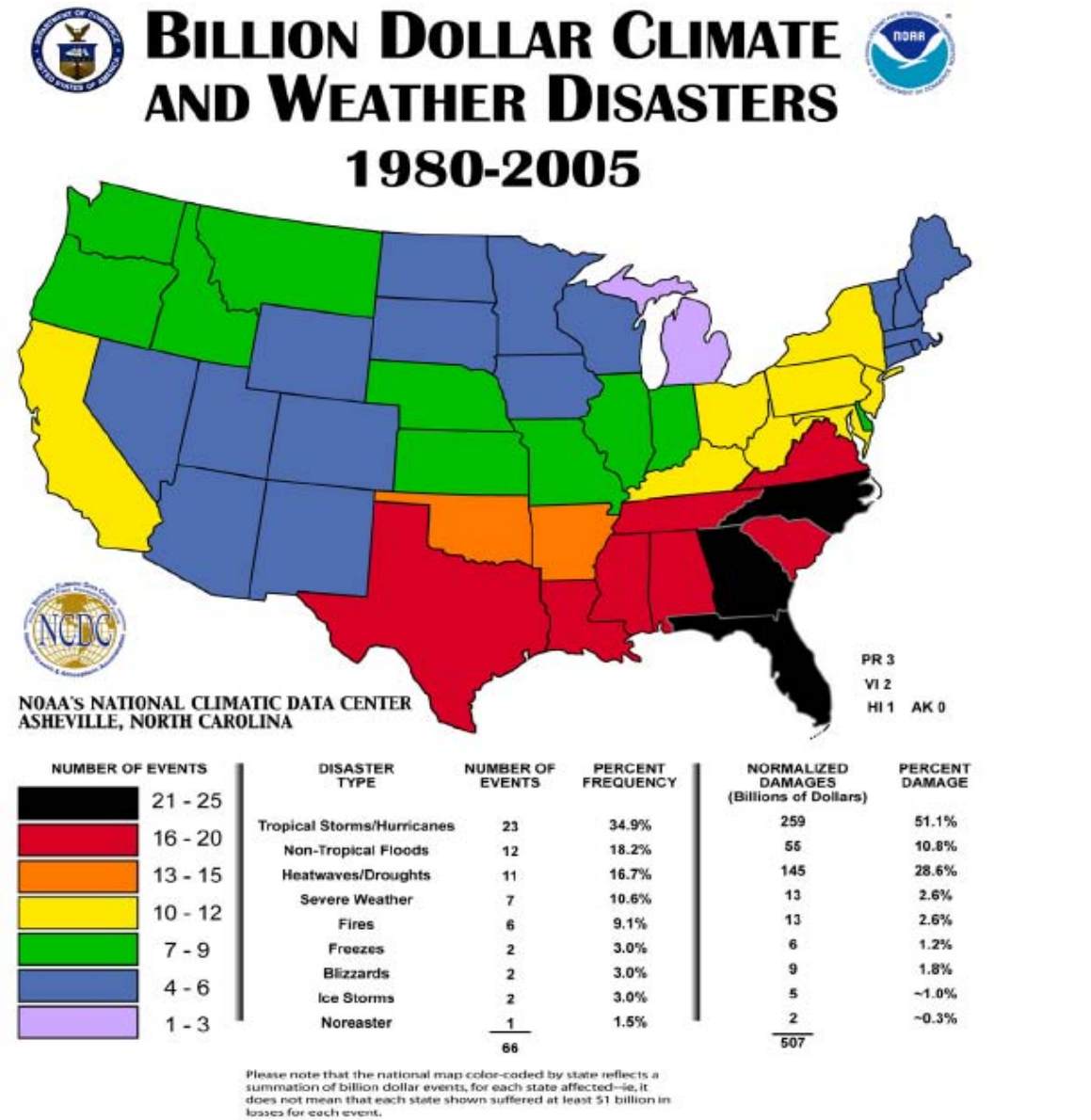


**Figure 2. National Map Showing Spatial Distribution of Events by State.**

# Private Insurance Companies "Blue Lining" Tidewater,VA

**Allstate stopped writing new policies in 19 coastal communities:**

**Accomack, Gloucester, Isle of Wight, King and Queen, Lancaster, Mathews, Middlesex, Northumberland, Northampton, Southampton, Surrey, Sussex, York counties and Chesapeake, Franklin, Hampton, Newport News, Norfolk, Virginia Beach**

**Nationwide withdrawing from any new coastal coverage**

**State Farm will not write new policies within one mile of shoreline**

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**Nationwide** withdrawing from any new coastal coverage

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**= 55% of private insurance market in Mid-Atlantic Region**

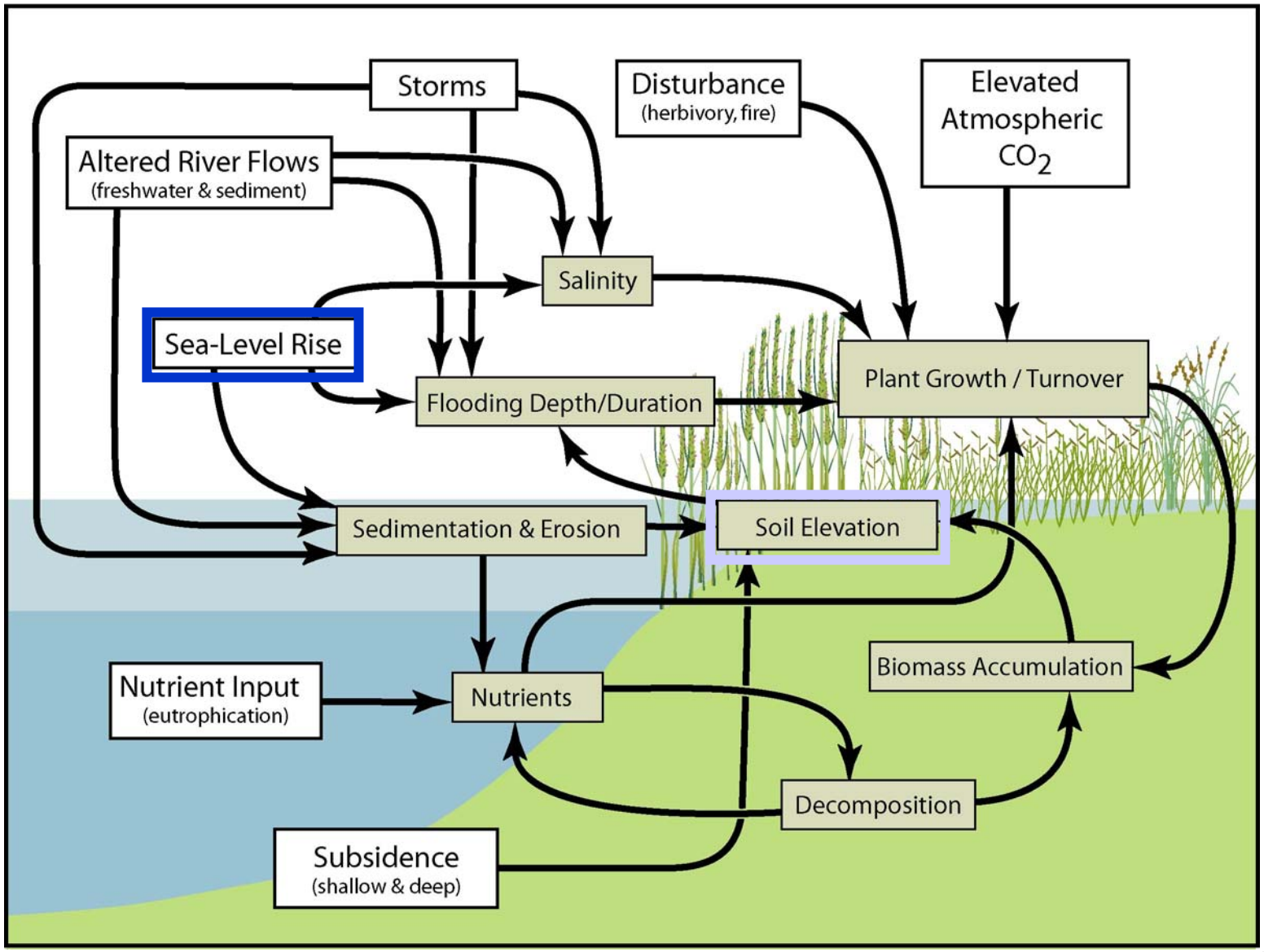
# Virginia's Plan????

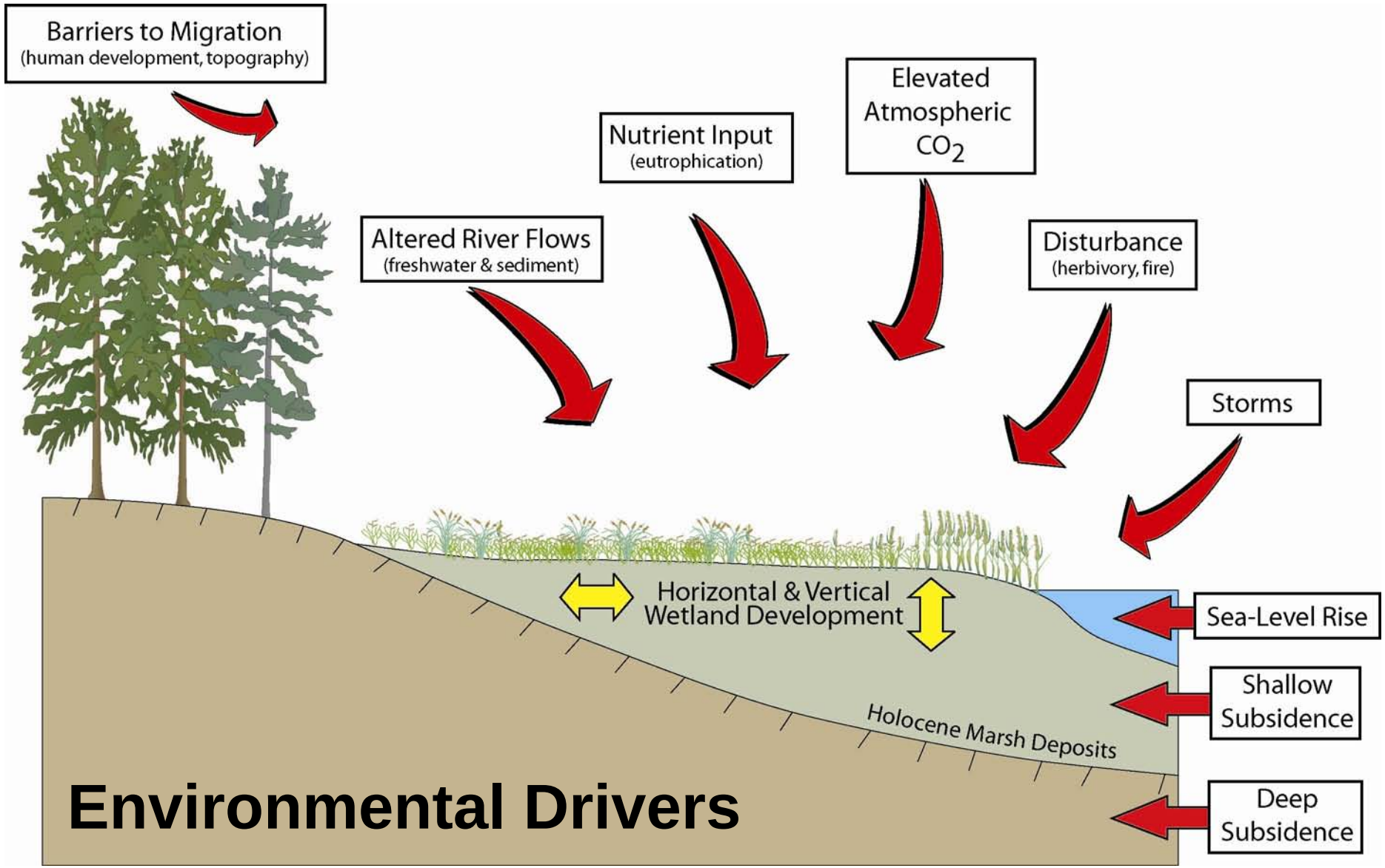
# CEDAR ISLAND (Eastern Shore of Virginia)

Stephen M. Katz/Virginian-Pilot

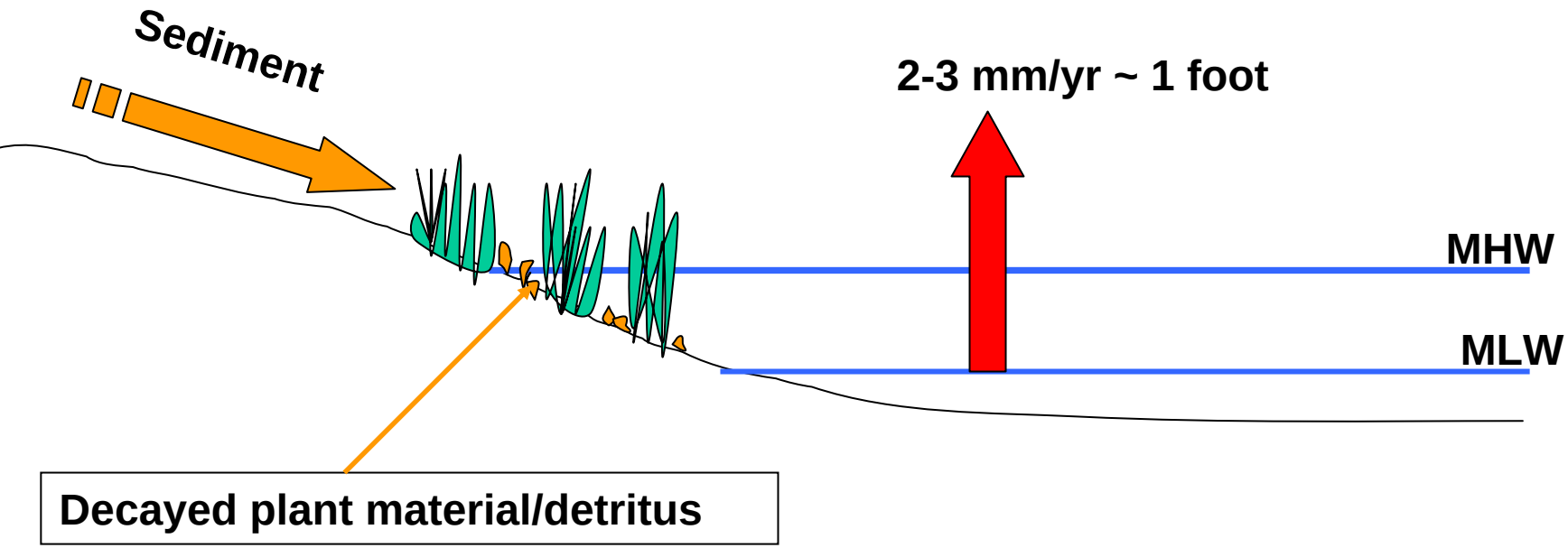

- Evaluate the potential impact of climate change on the Chesapeake Bay watershed, particularly with respect to its wetlands, and consider potential management options.

# Environmental Drivers & Biogeomorphic Process Controls on Vertical Wetland Development

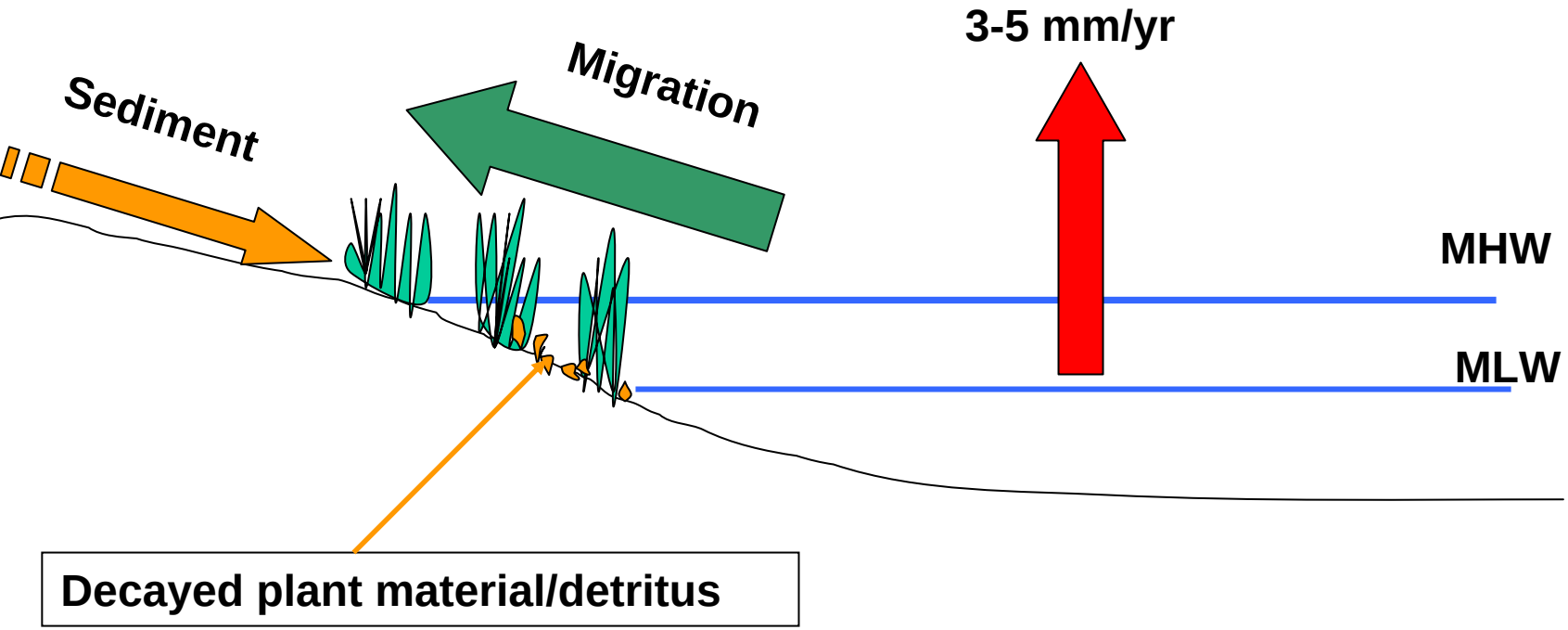



Barriers to Migration
(human development, topography)
Altered River Flows
(freshwater & sediment)
Nutrient Input
(eutrophication)
Elevated
Atmospheric
$CO_2$
Disturbance
(herbivory, fire)
Storms
Horizontal & Vertical
Wetland Development
Sea-Level Rise
Shallow
Subsidence
Holocene Marsh Deposits
Deep
Subsidence
Environmental Drivers

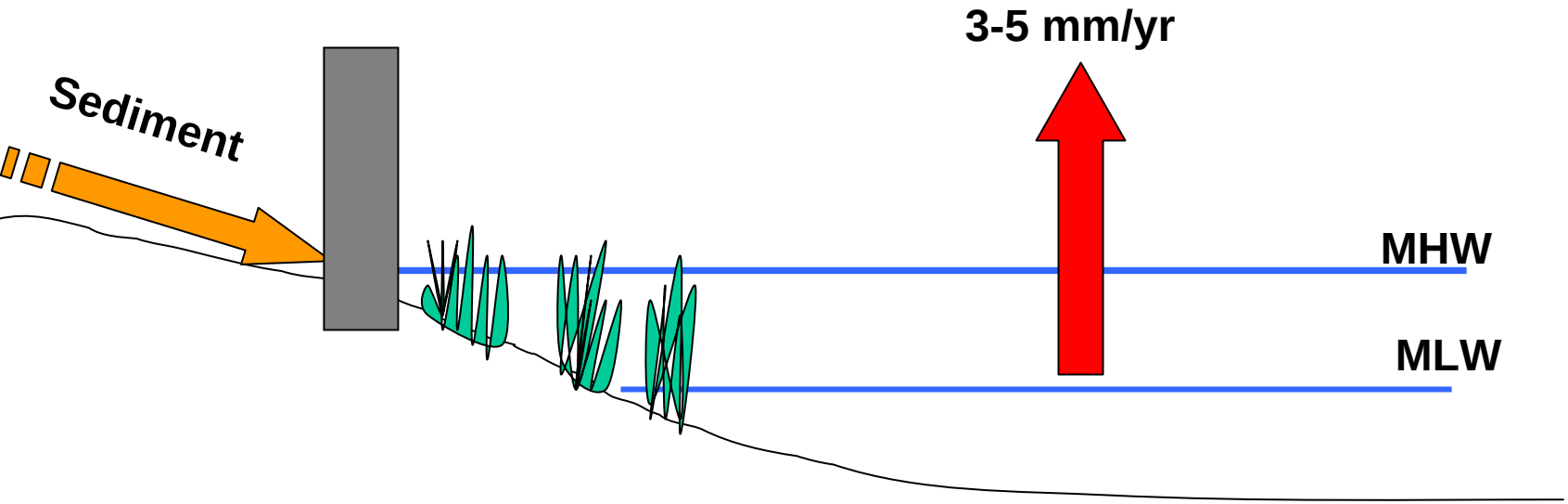
# Wetlands Can Maintain Elevation in Face of Modest Sea Level Rise



# Rapid Sea Level Rise forces Landward Migration



# ….Unless Barriers are Encountered



# Wetlands Have No Escape from Sea Level Rise

# Impact of Sea level Rise on Beaches

## Bruun Rule

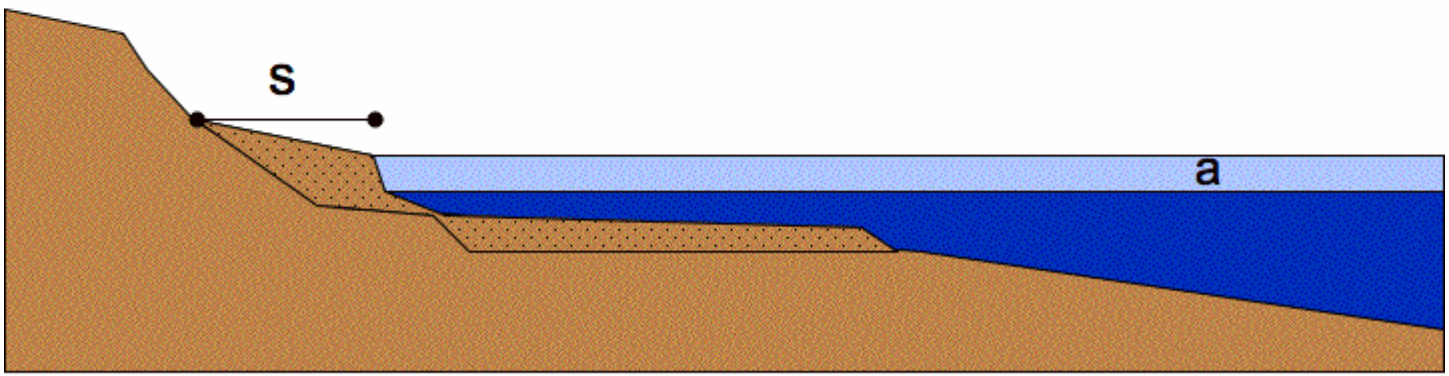
s = ~50 to 200a

s = beach recession

a = sea-level rise

Eastern US: s = 110 to 181a

18 cm rise ---> ~20 m recession



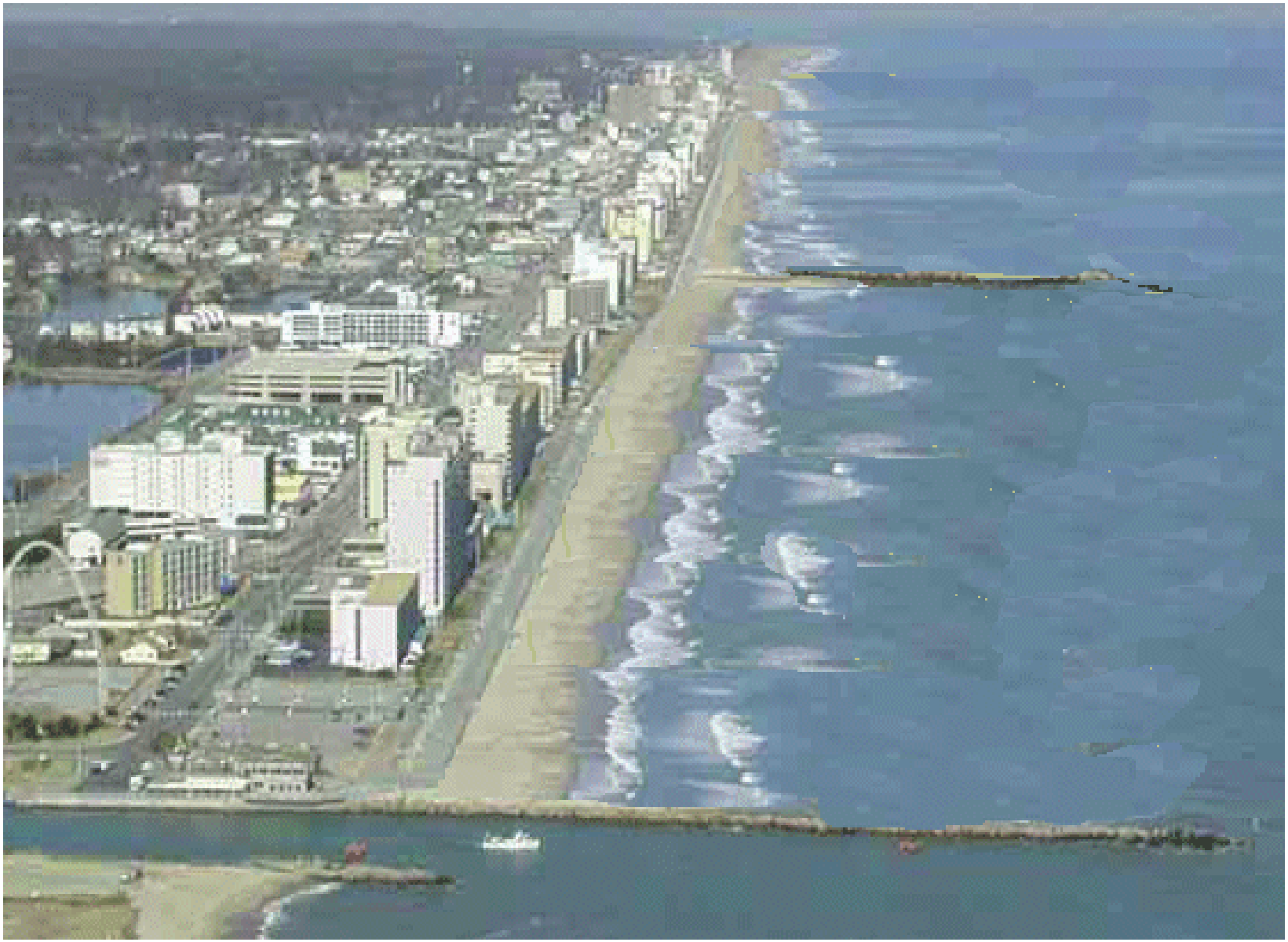

Leatherman et al. 2000

# Impact of Sea Level Rise on Virginia Beach

# Impact of Sea Level Rise on Virginia Beach

# Virginia Beach – Summer 2007

# Virginia Beach – Summer 2107

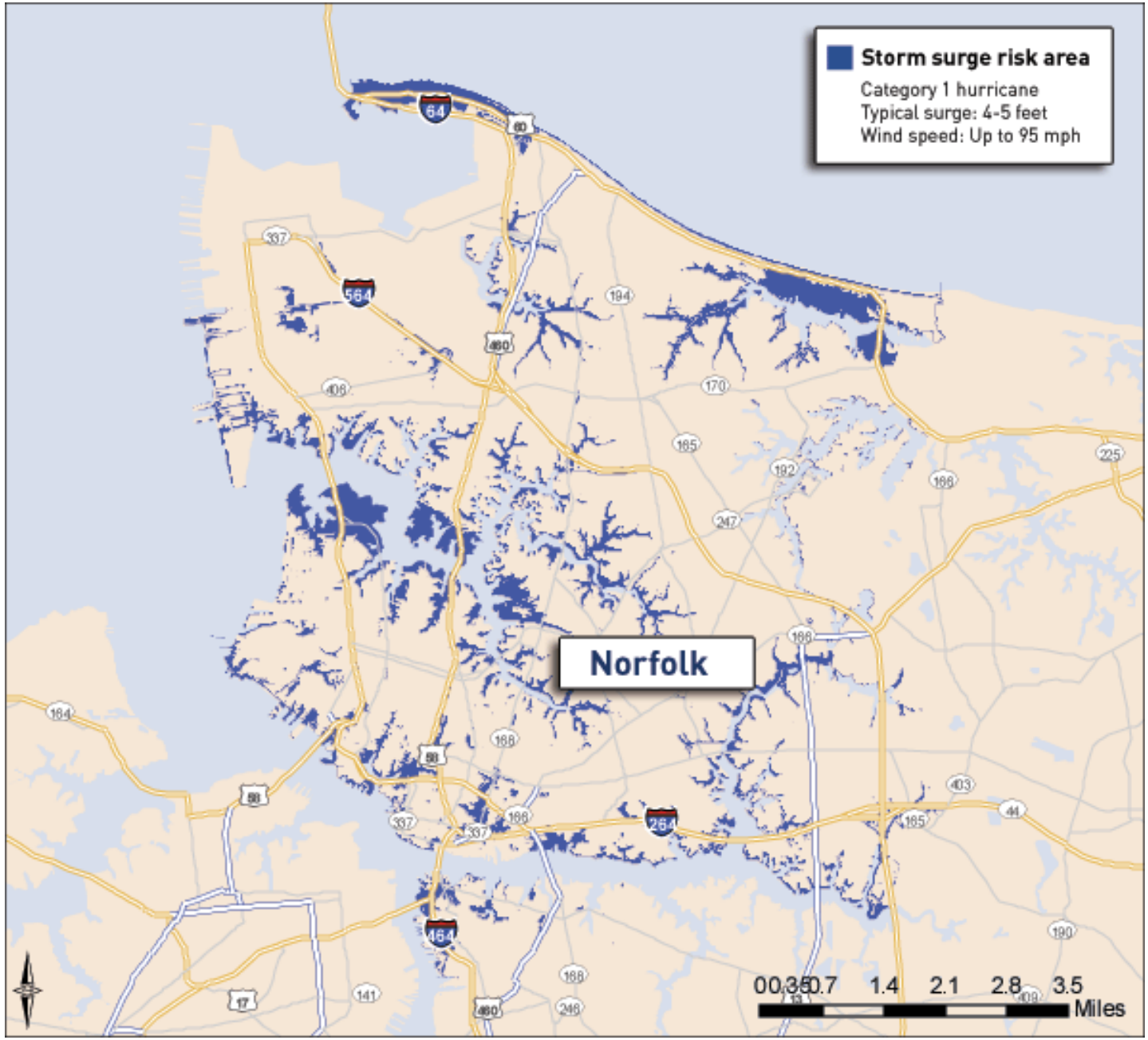


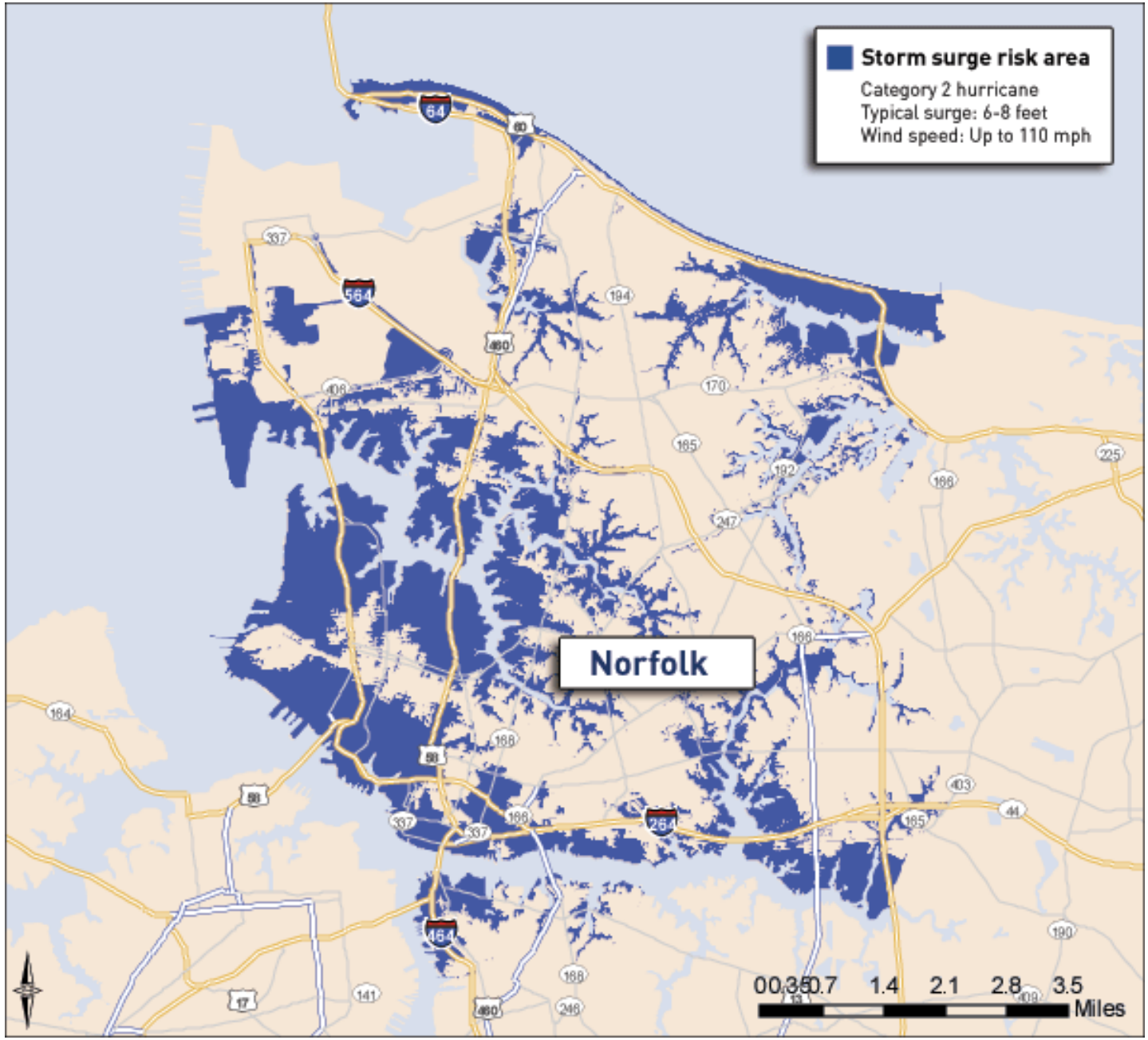
Sandbridge widened to 200 Feet

New Condominiums

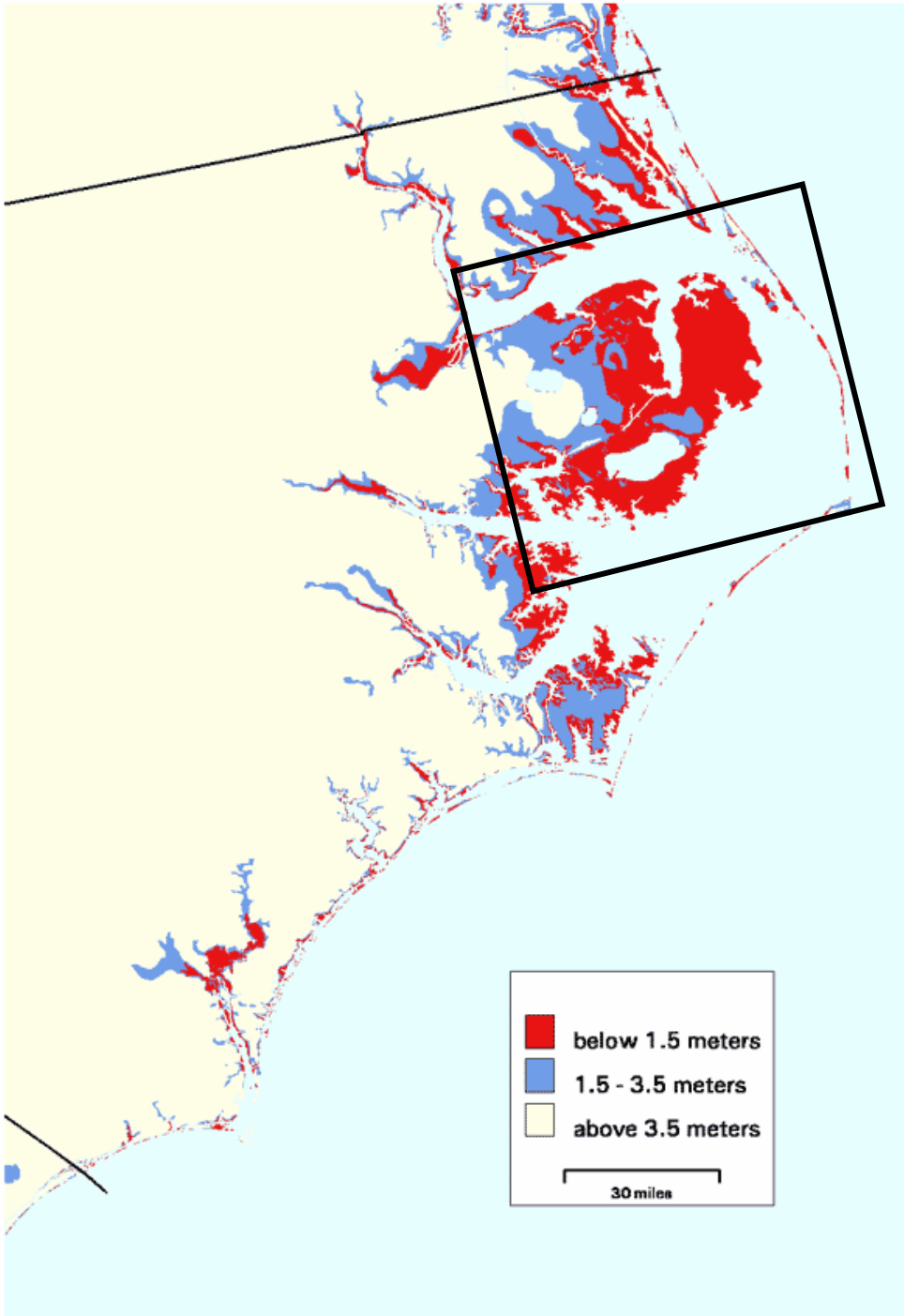
The “Sanctuary at False Cape”

2010 Shoreline

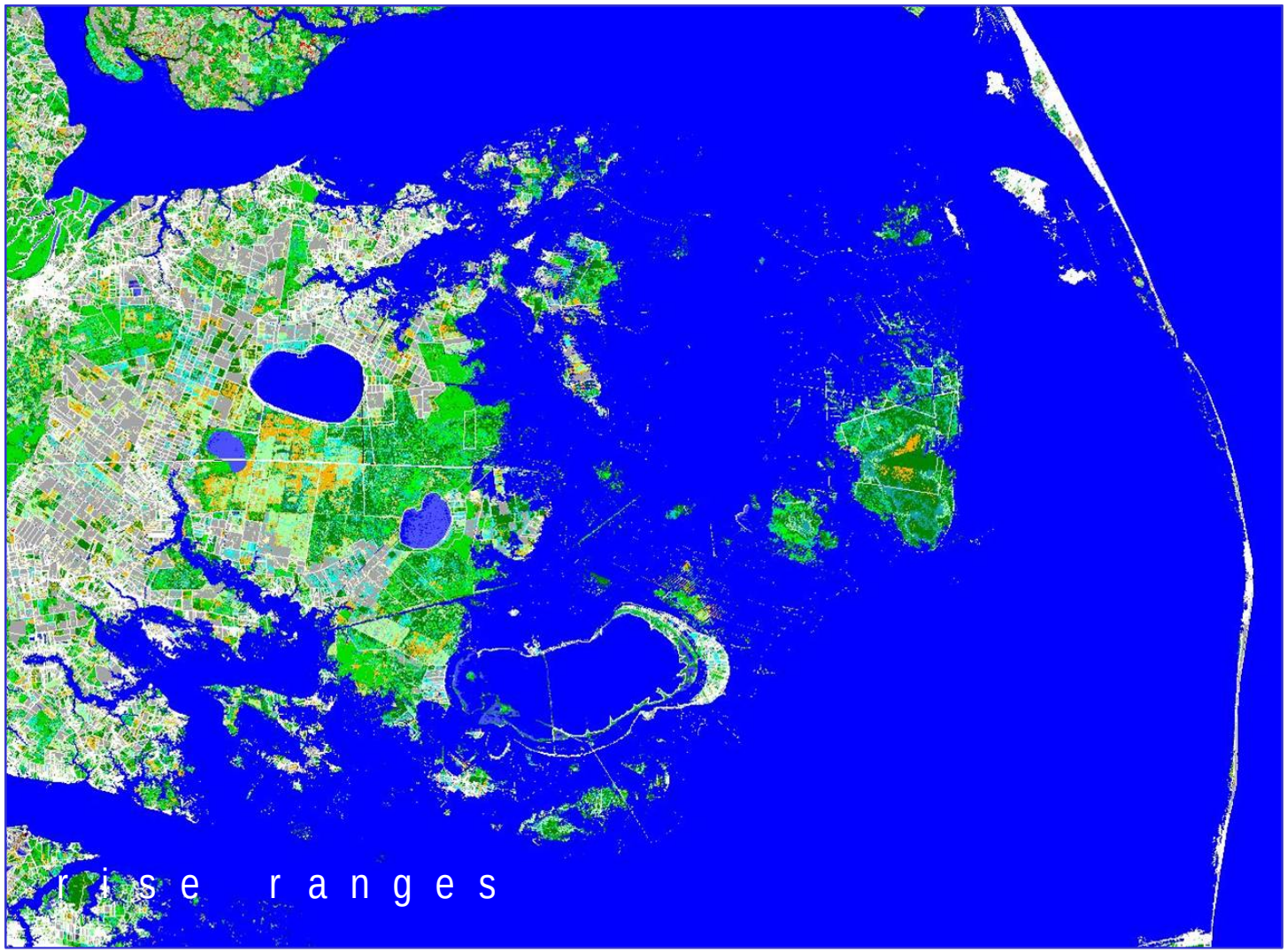

Storm surge risk area
Category 1 hurricane
Typical surge: 4-5 feet
Wind speed: Up to 95 mph
Norfolk
64
564
460
406
337
194
170
185
192
188
225
247
168
164
58
264
403
44
190
464
17
141
248
0 0.35 0.7 1.4 2.1 2.8 3.5
Miles


Storm surge risk area
Category 2 hurricane
Typical surge: 6-8 feet
Wind speed: Up to 110 mph
Norfolk
64
564
460
264
464
0 0.35 0.7 1.4 2.1 2.8 3.5
Miles

# One meter Sea Level Rise Impact – Hampton, VA


below 1.5 meters
1.5 - 3.5 meters
above 3.5 meters
30 miles

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH



# State Strategy for Virginia Sea Level Rise

**Live up to promises made in Chesapeake 2000 – PLAN!**

**Map coastal regions with 10 cm contours - LIDAR**

**Assess ecosystem impacts on coastal ecosystem – wetlands, dunes, buffers**

**Identify mitigation areas and begin protection**

**Develop land use “tool box”**

WETLANDS WATCH
WETLANDSWATCH.ORG

Governor Tim Kaine
Office of the Governor
Patrick Henry Building, 3rd Floor
1111 East Broad Street
Richmond, VA 23219

Dear Governor Kaine:

We are writing regarding sea leve
ecosystems. We have been reviev
its tidal tributaries, the coastal bay
and bays in the Currituck Sound v

With a relative sea level rise in th
feet in the next century), a "best g
remaining vegetated tidal wetland
at mitigation. Adjacent shoreline
adversely impacted.

The Virginian-Pilot
Our 142nd year | 06.07.07 | PILOTONLINE.COM

# STATE ISN'T PREPARED FOR RISING SEA, STUDY WARNS

By Scott Harper
*The Virginian-Pilot*

**NORFOLK**
Virginia stands to lose more from rising sea levels than almost any other state on the East Coast but is doing the least to understand and combat the problem, a new study concludes.

In a report released Wednesday, the Norfolk-based environmental group Wetlands Watch cites existing scientific estimates that between 50 and 80 percent of the state's tidal wetlands, coastal dunes and beaches could disappear under rising waters over the next 100 years.

If unchecked, such losses could be catastrophic, the group describes – enough to "negate any progress made toward restoration of the Chesapeake Bay's ecosystem."

Former Gov. Jim Gilmore, who is now a Republican presidential candidate, signed the Chesapeake Bay Agreements in 2000 that, among other actions, c[illegible]itted Virginia to "eva[illegible]ential impact of Chesape[illegible] particu[illegible] its we[illegible] potent[illegible] tions."

Th[illegible] along Virginia's coastlines could be drowned by rising sea levels in W[illegible] the next century, destroying wildlife habitats and natural filters for adm[illegible] the Chesapeake Bay, according to pin[illegible], an estimate[illegible] 2 feet – and perhaps more, depending on the extent of climate change – by 2107.

"Virginia is currently the only state in the mid-Atlantic region without a visible state reaction to the issue of sea level rise and its impacts on coastal ecosystems," the group's executive director, William A. "Skip" Stiles Jr., wrote in a May 31 letter to Kaine.

The assessment of Virginia's plight is not much different from what several environmental agencies and universities have been noting for years.

The U.S. Geological Surv[illegible] for example, in 1999 publishe[illegible] research that ranked Virginia's risks from sea level rise as "very high."

Such messages, however, have largely been drowned out by the debate over whether global warming and climate change even exist.

There is little doubt, though, that sea levels are rising – by about 4.2 millimeters a year along Virginia's coast; that rate is almost double what is being recorded elsewhere around the world, according to published research.

Kevin Hall, a spokesman for K[illegible]ine, responded Wednesday that sea level rise is an im[illegible] [illegible] Virgin[illegible]

**ENDANGERED WETLANDS**

**the report**

**The estimation** A group cites estimates that 50 to 80 percent of the state's tidal wetlands, coastal dunes and beaches could vanish under rising waters over 100 years.

**The warnings** The group, Wetlands Watch, describes catastrophic losses if action isn't taken.

**the requests**

**What the group wants** Wetlands Watch is calling on Gov. Timothy M. Kaine's administration to start analyzing and planning for an estimated sea rise of 2 feet by 2107.

**What Kaine says** A spokesman said the state is in the early stages of understanding climate change.

# Va. is urged to manage coast

In his letter to Kaine, the director of Wetlands Watch said [illegible]he group wants to work with [illegible] state and with local governments to get Virginia moving ahead.

[illegible] realize that this is a [illegible]cant undertaking and will require constant [illegible] decades to come," [illegible]es, the group's di-

[illegible]7) 446-2340, [illegible]otonline.com.

NORFOLK
Daily Press
THURSDAY
JUNE 7, 2007

# Tidal wetlands may see big loss

*Virginia could lose much of the natural filter for waterways this century as the sea level rises, a Norfolk group warns.*

BY PATRICK LYNCH
plynch@dailypress.com | 247-4534

**NORFOLK** — Virginia could lose 50 percent to 80 percent of its tidal wetlands this century as the rising sea level overwhelms marsh grasses, a Norfolk-based group said Wednesday.

One [illegible] consul[illegible] ginia In[illegible] ence, a b[illegible] of Willian[illegible] also is unde[illegible] state of Nort[illegible] define its pote[illegible] sea level rise.

VIMS, howeve[illegible] the same work in[illegible] lack of funds, offic[illegible]

Carl Hershner, a w[illegible] pert at VIMS and di[illegible] the school's Center for[illegible] Resources Manageme[illegible] such research provides [illegible] makers with informed ch[illegible] about the future.

"You can argue whether essential in Virginia or no[illegible] [illegible]ershner said, "but it's del[illegible] [illegible]ood way to figure [illegible] occurring [illegible]ope

# The Washington Post

Thursday, June 7, 2007

# As Sea Level Rises, Disaster Predicted for Va. Wetlands

By David A. Fahrenthold
*Washington Post Staff Writer*

More than half of the wetlands [illegible] an estimate released yesterday by an environmental group.

The Norfolk-based group Wetlands Watch examined maps of low-lying marsh areas along the bay and the Atlantic Ocean and compared them with projections that water levels may rise 1½ feet or more in this area by 2107, Executive Director Skip Stiles said.

Stiles said the group determined that at least half, and perhaps as much as 80 percent, of the wetlands would be covered in too much water to survive if sea levels rise 1½ to two feet. He said that could be a crucial blow to a number of species, from fish to blue crabs to birds, that live in the marshes for some part of their lives. It would also harm the bay, which relies on wetlands to filter some pollutants, he said.

"You can lose a little bit here and there," Stiles said. "But when you

See WETLANDS, B[illegible] Col. [illegible]

# Governor Timothy M. Kaine

Testimony

Before the

## United States Senate Committee on Environment and Public Works

**Hearing on**

## "Climate Change and the Chesapeake Bay"

September 26, 2007

# Land Use Options

**Local Governments Take Conservation Easements (no shoreline hardening a condition) – Sec 10.1-1701**

**Tax Exemptions for shoreline features – Sec.58.1-3666**

**Expanded Buffers under CBPA – 9VAC10-20-80 B(4)**

**No exemptions for CBPA – 9VAC10-20-150 C(1)(d)**

**Make Shoreline protection part of subdivision process**

# Regulatory Options

**Better Integration of CBPA/Wetlands & Primary Dune Regulations**

**Phase out of exemptions for wetlands alterations**

**“Grazing, haying, and cultivating and harvesting agricultural, forestry or horticultural products” [Code of Virginia Sec 28.2-1302(3)(5)]**

**“normal residential gardening, lawn and landscape maintenance, or other similar activities that are incidental to an occupant's ongoing residential use of property and of minimal ecological impact” [§62.1-44.15:21]**

# Land Use Options

**Special Zoning Districts:**

**Waterfront Residential Overlay District - Lancaster County**

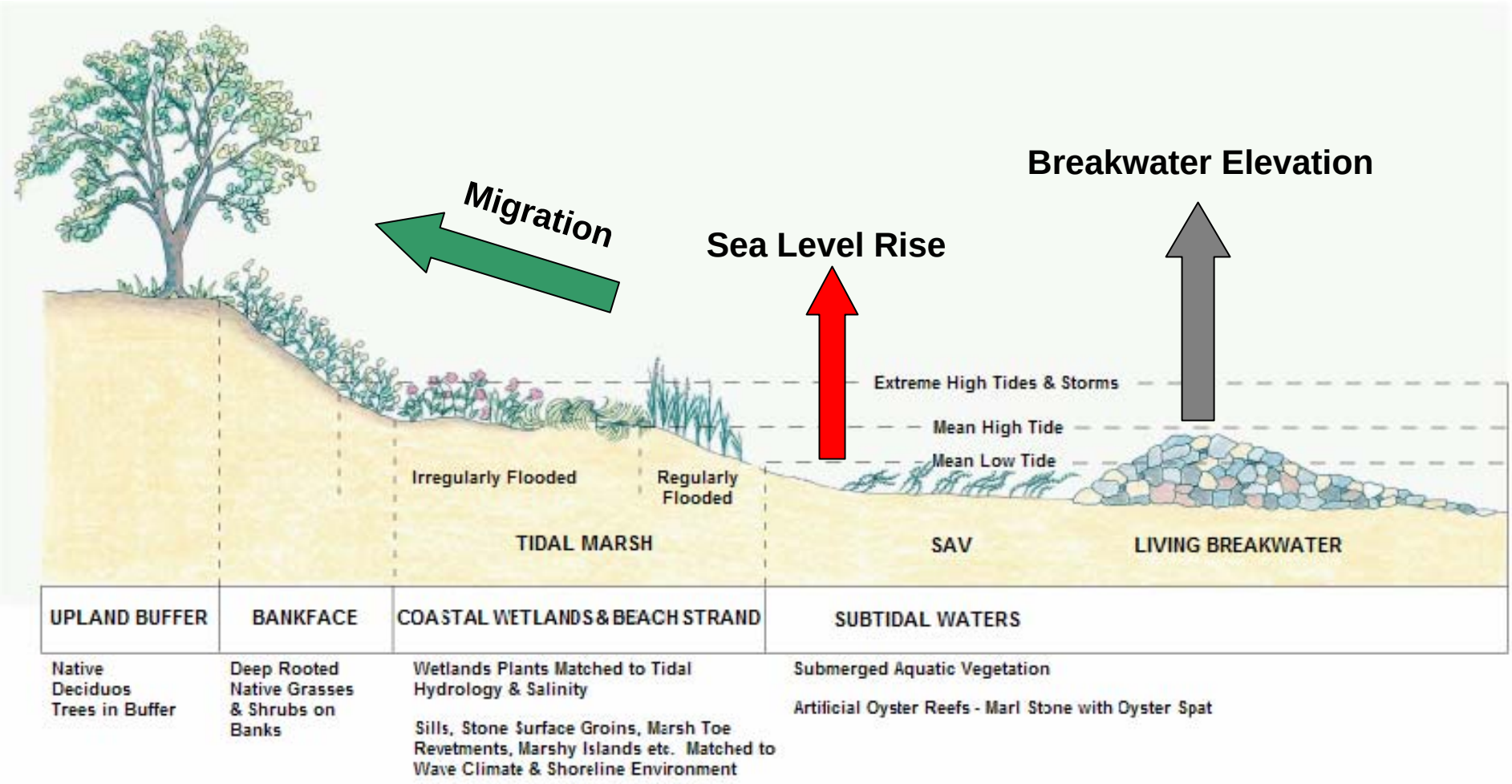
**Sensitive Natural Resource Area Preservation Overlay District – Northampton County**

**Mathews County Comprehensive Plan –**

**uses elevation from sea level to designate development policies = lower lands have lower density**

**“Wherever possible, vegetative approaches are to be preferred over man- made structures.”**

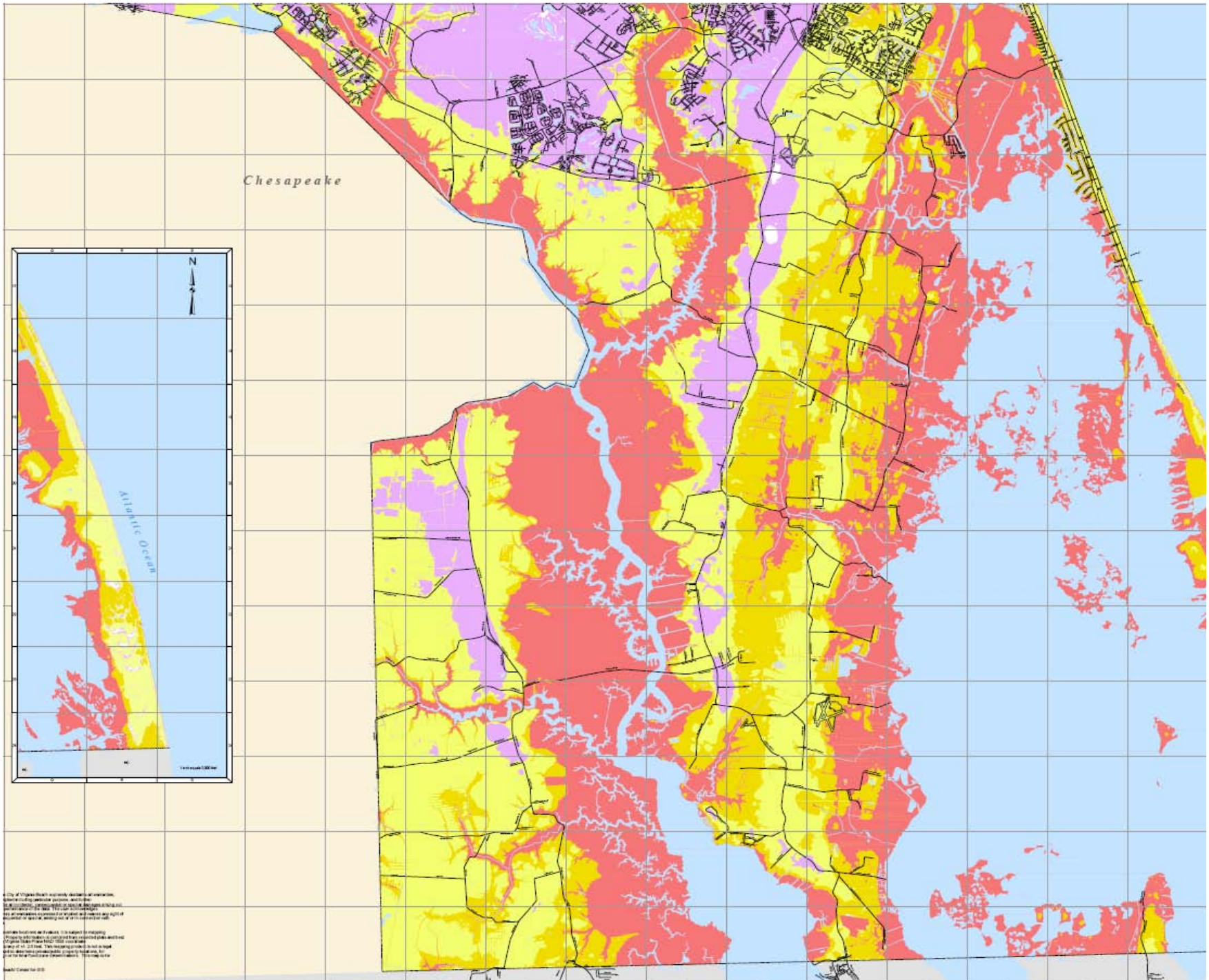
# Living Shorelines and Sea Level Rise

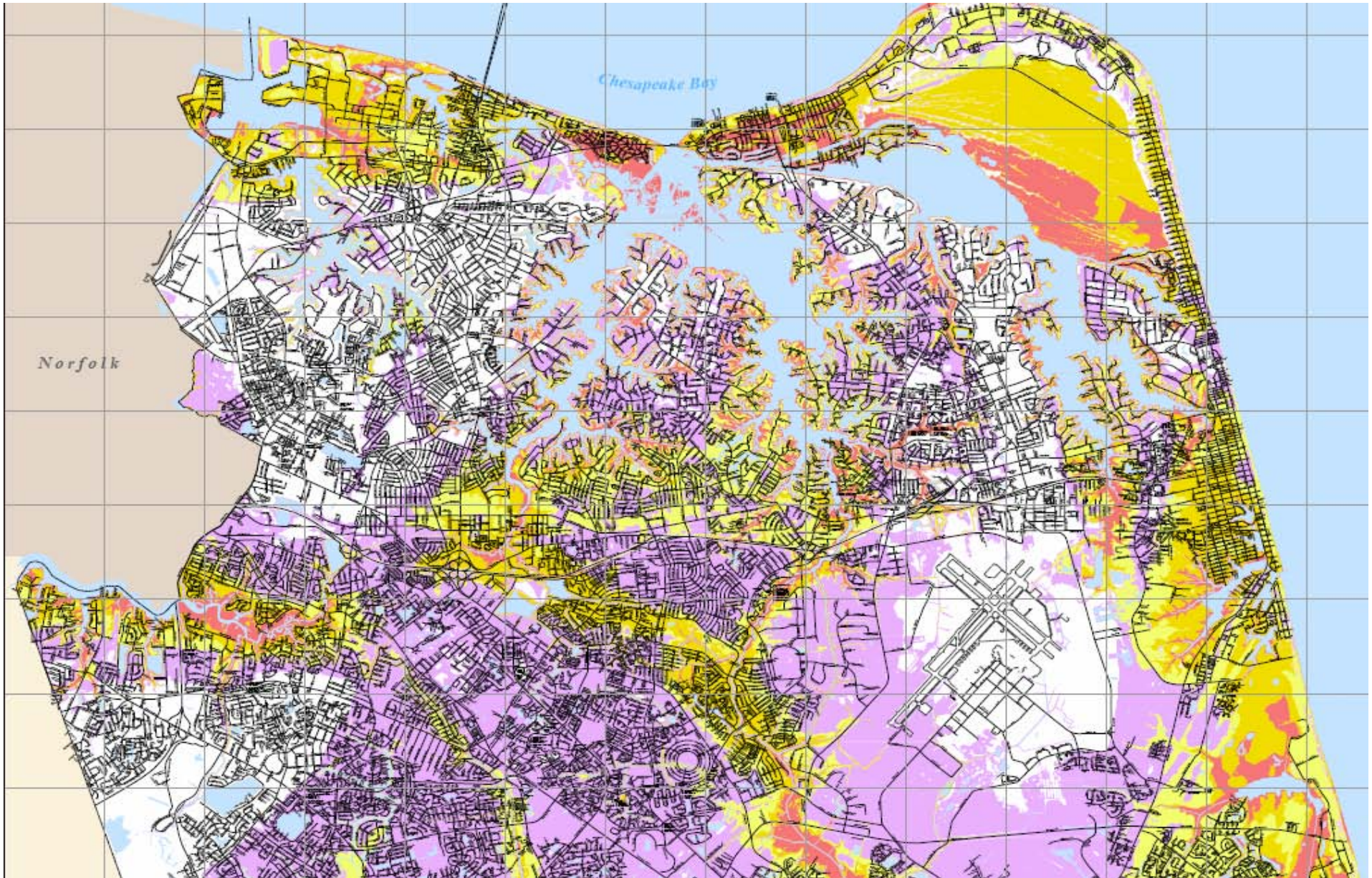



# Thank You

**www.wetlandswatch.org**

The Campbell Foundation


Chesapeake
N
Atlantic Ocean


Chesapeake Bay
Norfolk

# Regulatory Options

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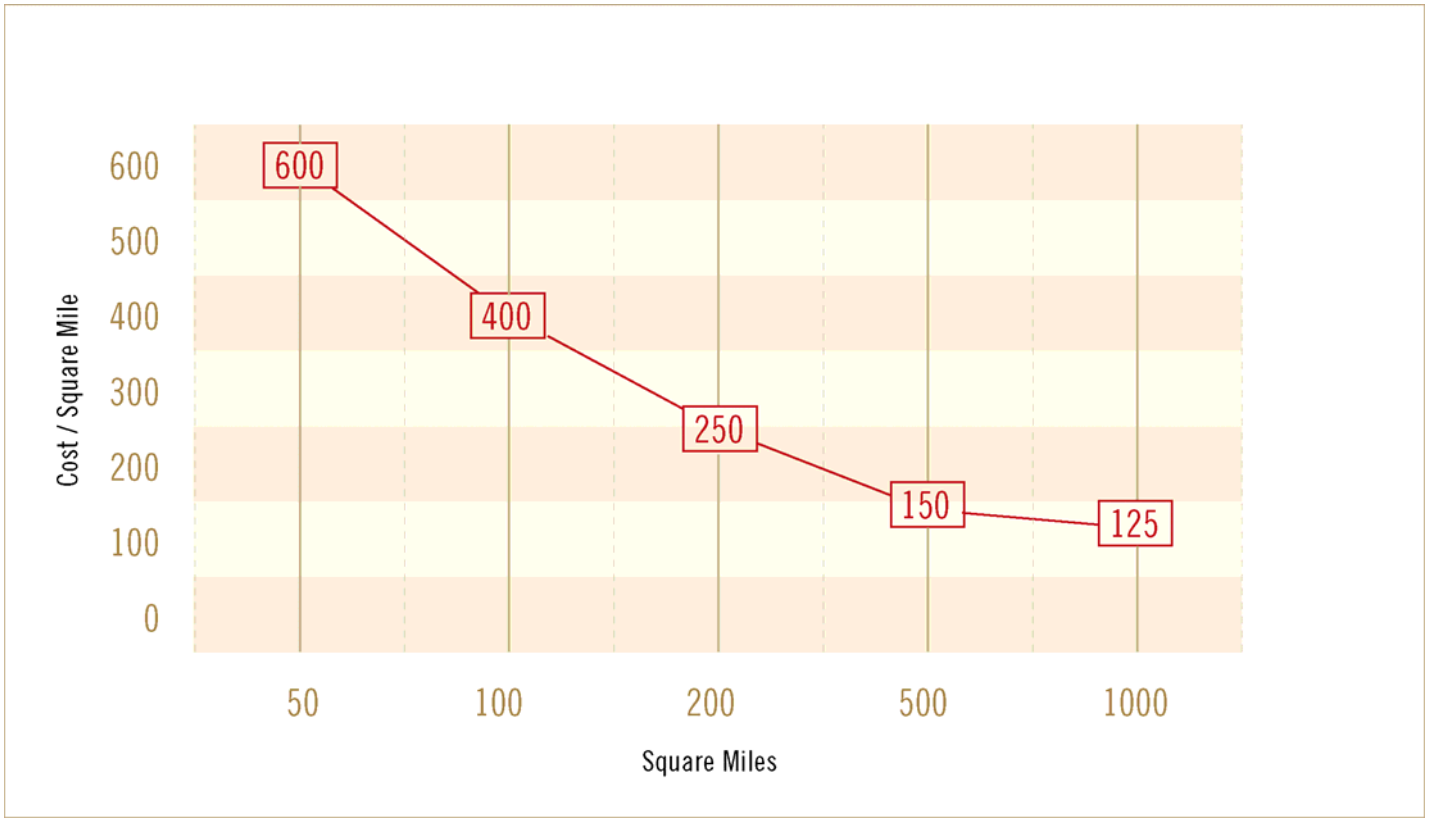
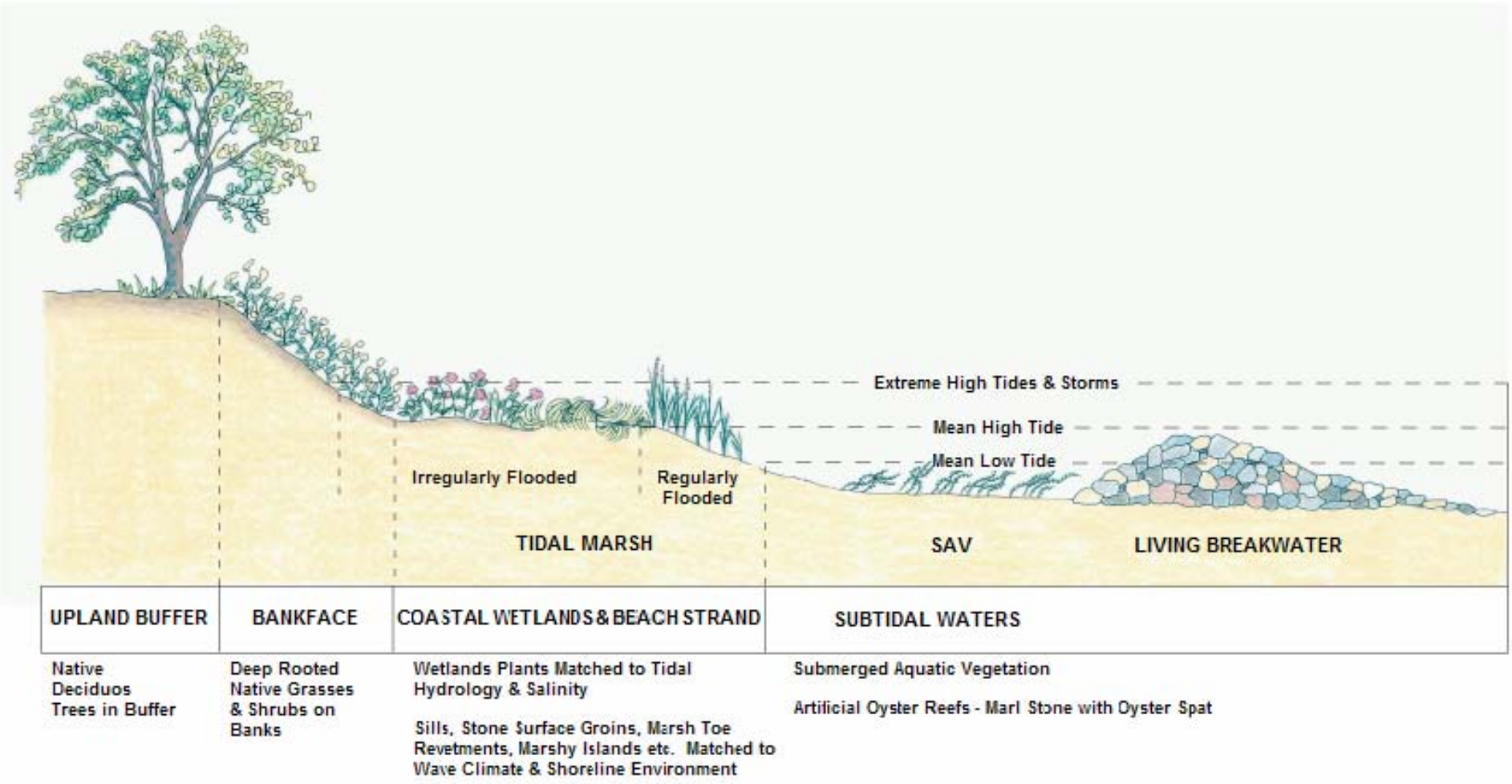
# LIDAR Pricing Trends




- **Average bare earth DEM pricing runs about $300/sq.mile (small areas) to less than $100/sq mile and is falling as technology improves.**
- **Large areas would further decrease price**

**Sanborn Mapping Company**

# Living Shorelines and Sea Level Rise



# Living Shorelines and Sea Level Rise