



WETLANDS WATCH

Protecting and Conserving Wetlands

Climate Change, Sea Level Rise, and Virginia's Tidal Shoreline

Skip Stiles

Executive Director, Wetlands Watch

Virginia Coastal Partners Workshop

December 6, 2010



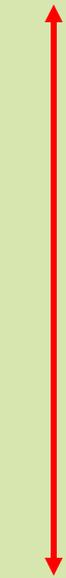
Virginia Climate Change Commission: Climate Change Impacts

- **At Least 2.3 feet of sea level rise (up to 5.2 feet) in next 100 years**
- **3.1 °C increase in average temperature**
- **Increase in Rainfall Intensity (~11%)**

Sea Level Rise – Virginia's Biggest Challenge

Recent Historical Sea Level Rise

Hot

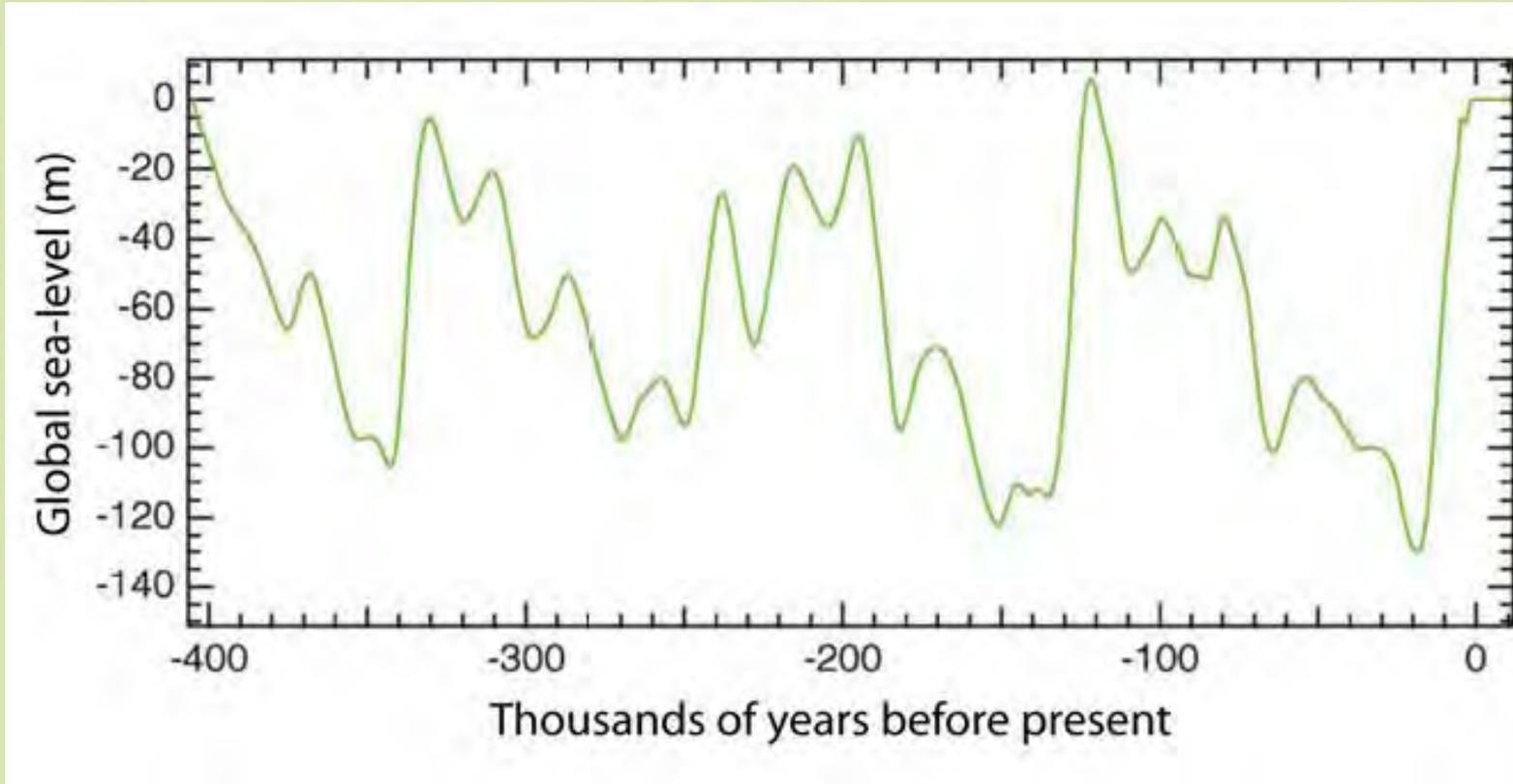


Cold

Rise +

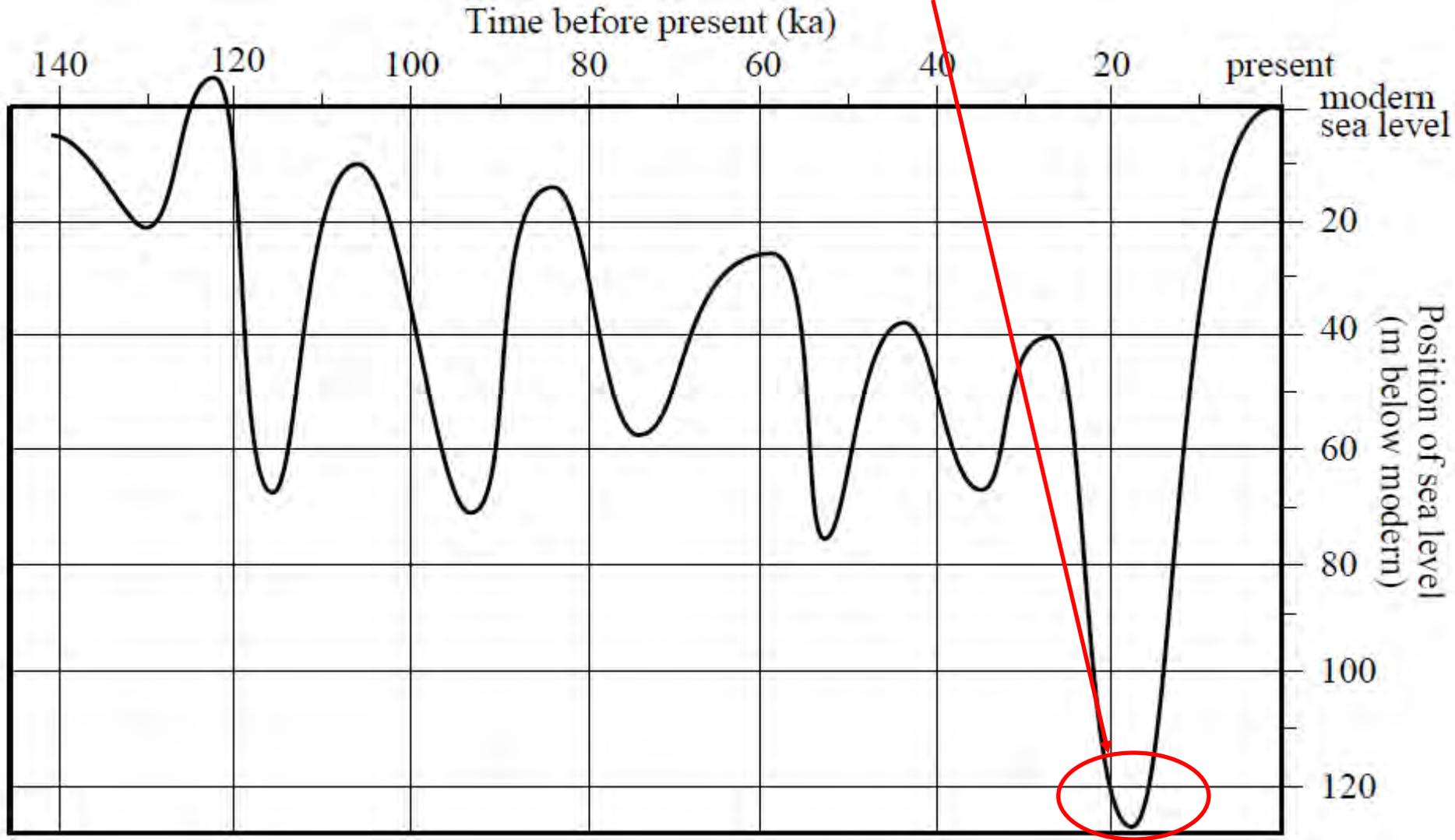


Fall -



Recent Historical Sea Level Rise

**Glaciers 2 miles thick over New York =
Sea Level 360 feet lower**



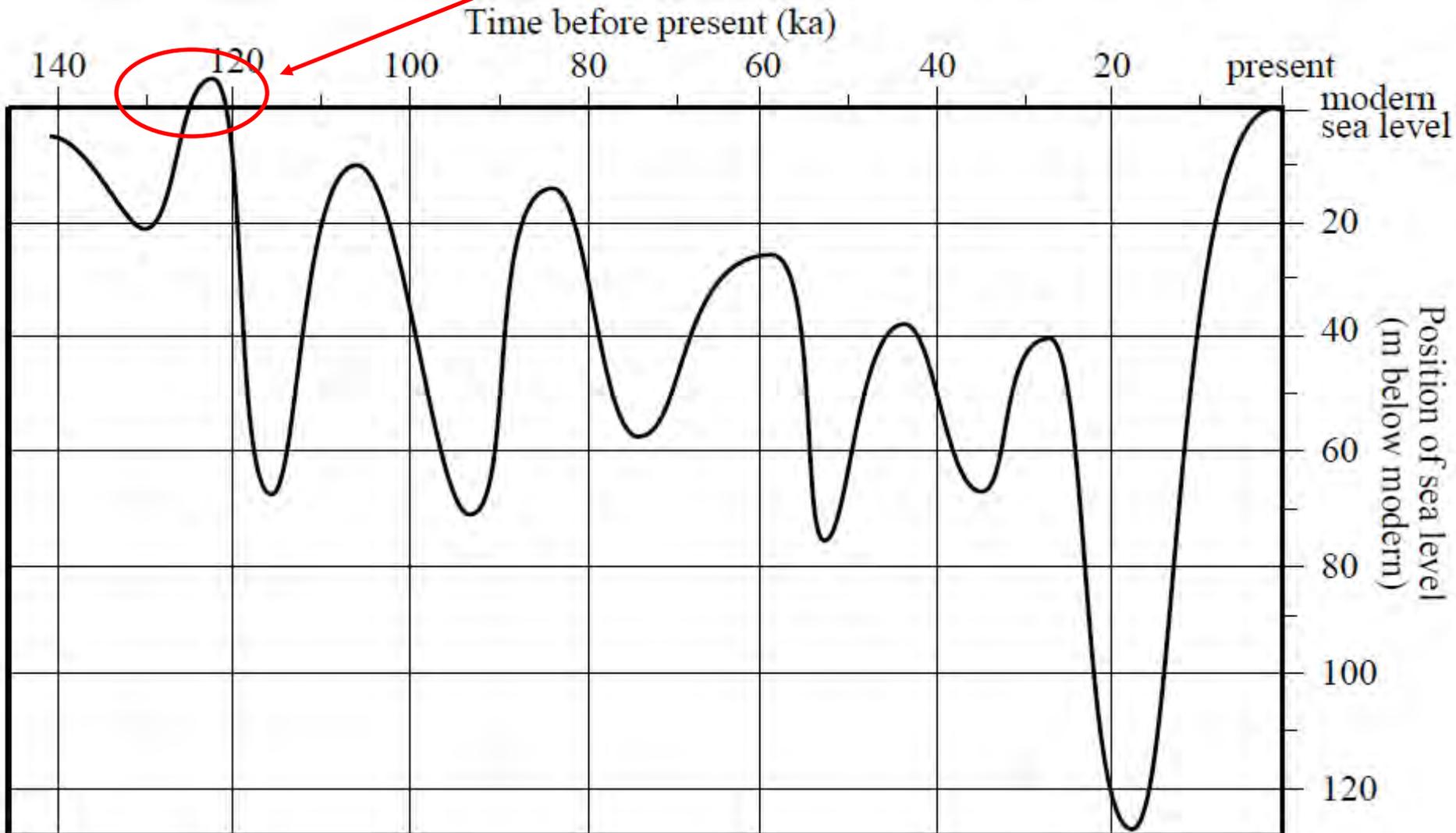
MID-ATLANTIC COASTLINE ~ 20,000 Years Ago

- 360 Feet



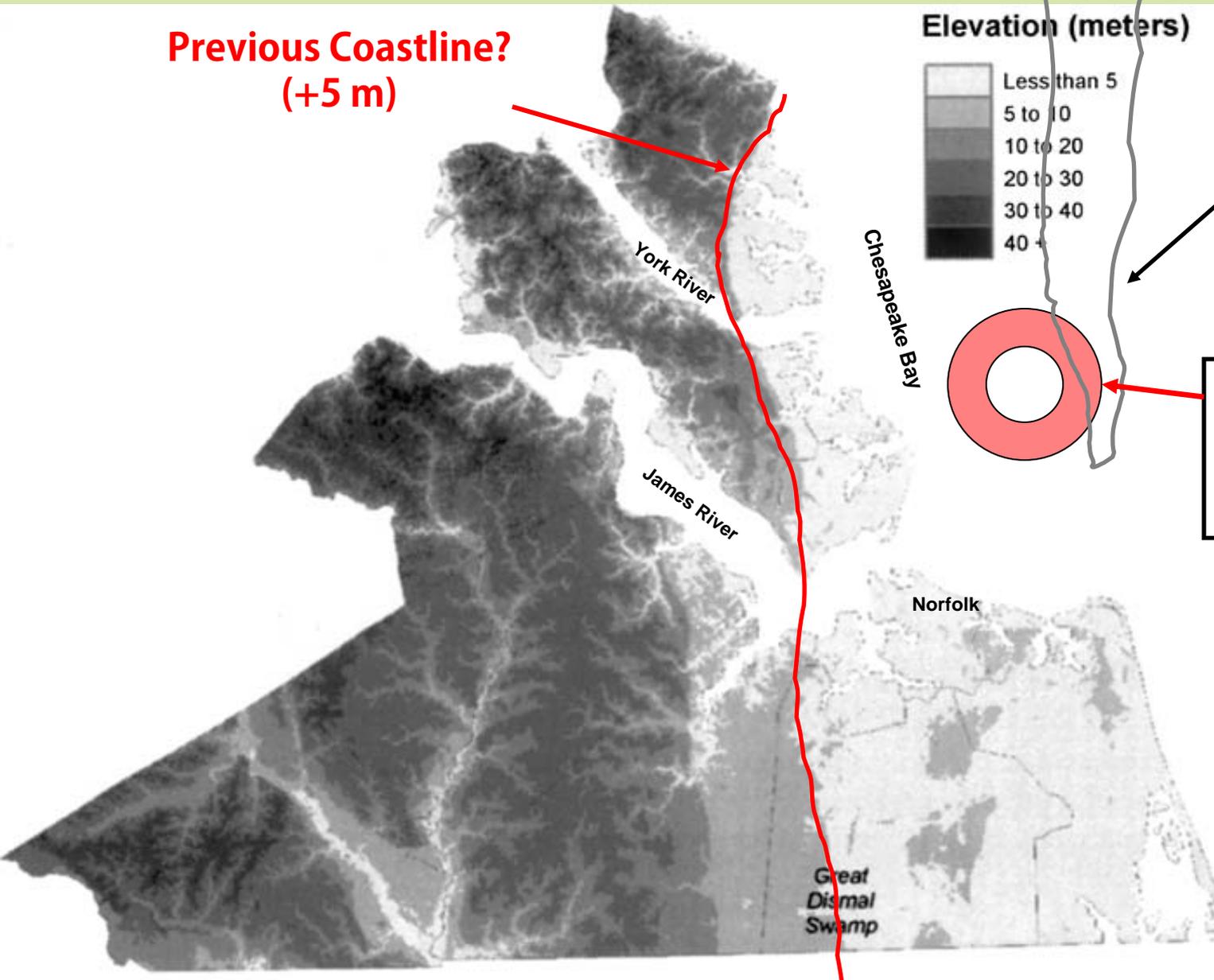
Recent Historical Sea Level Rise

Last “Big Melt” of glaciers = oceans 4-6 m above present sea level with +3 °C temperatures

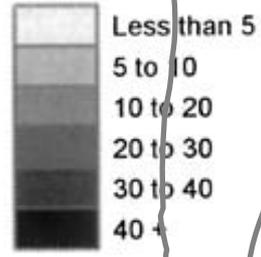




**Previous Coastline?
(+5 m)**



Elevation (meters)

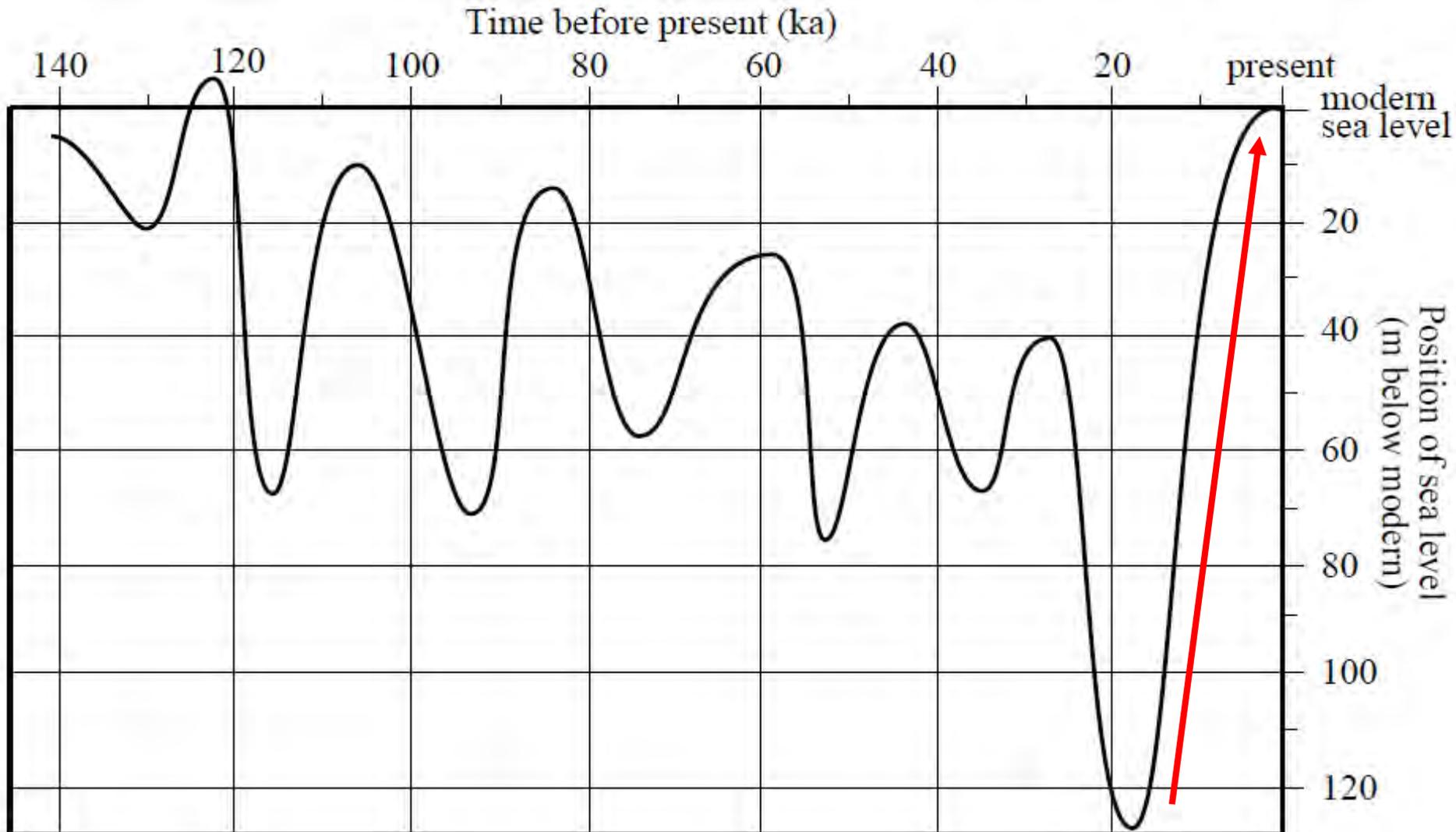


Eastern Shore

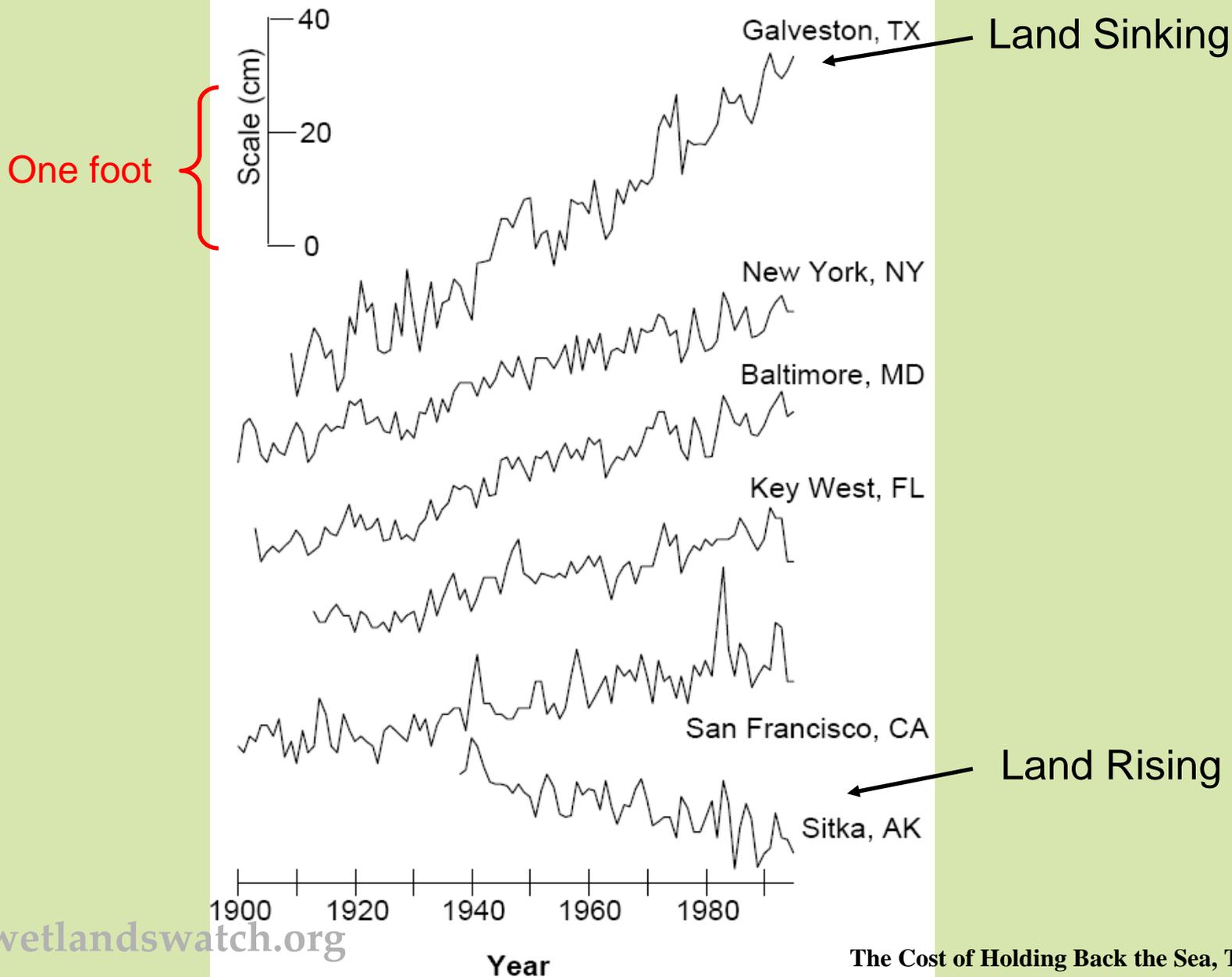
**Impact Crater
~ 35 million
years ago**

Atlantic Ocean

Recent Historical Sea Level Rise



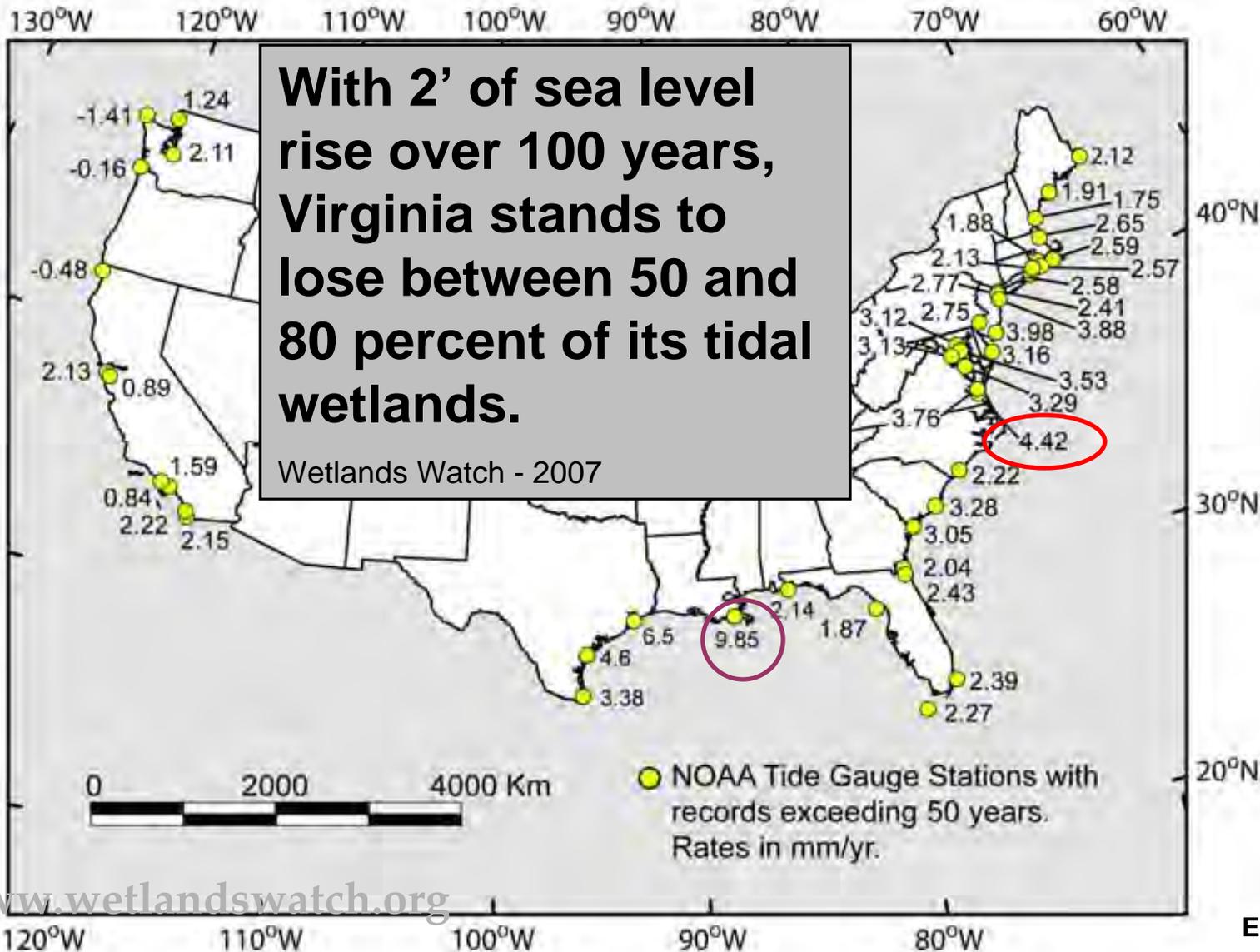
U.S. Sea Level Trends: 1900-97

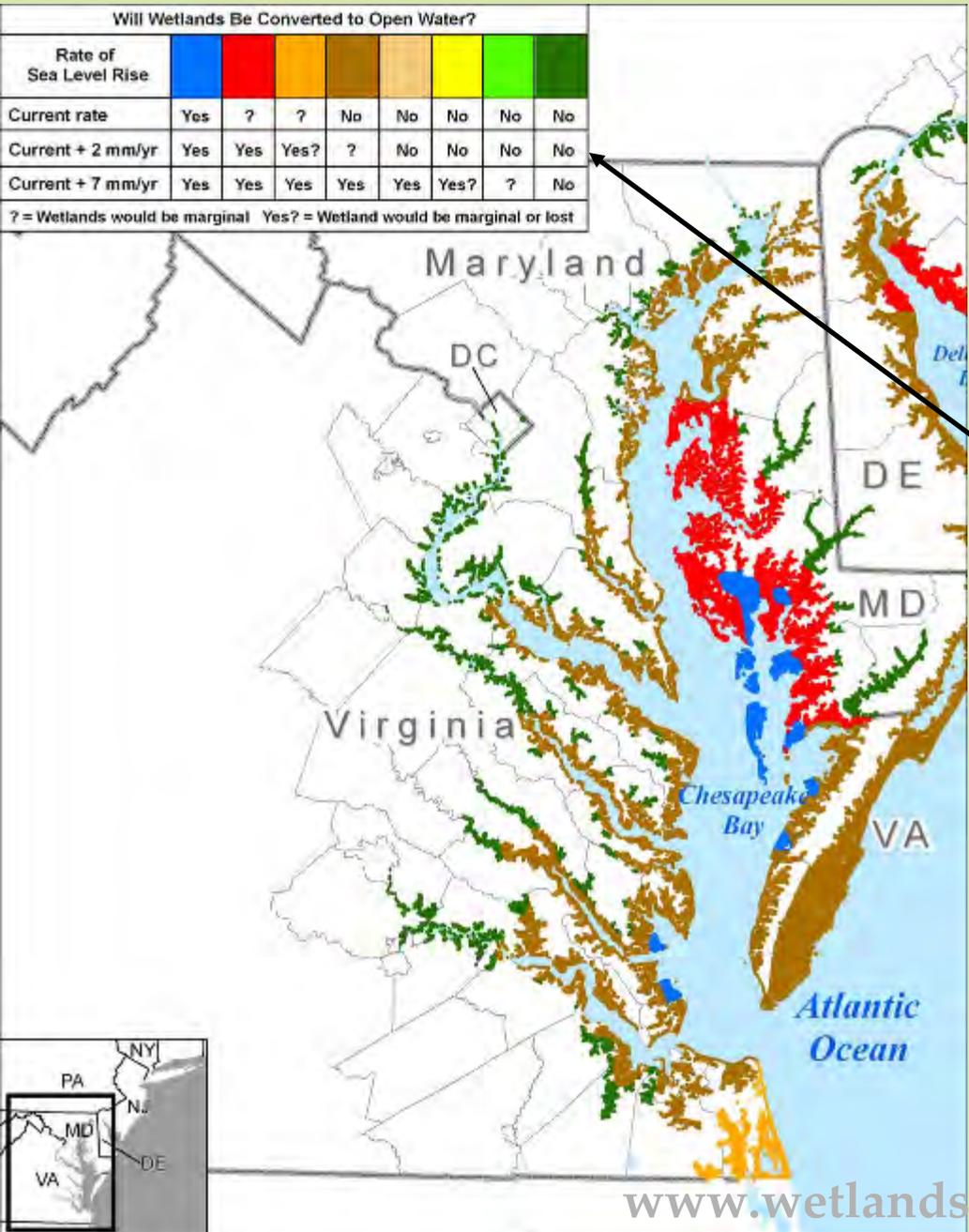


Virginia has the highest NOAA current and predicted sea level increases on East Coast

With 2' of sea level rise over 100 years, Virginia stands to lose between 50 and 80 percent of its tidal wetlands.

Wetlands Watch - 2007





Wetlands at risk from Sea Level Rise in mid-Atlantic

Blue, Red, Orange, and Brown reaches will all see wetlands converted to open water at current predicted rates of sea level rise



Wetlands Watch Adaptation Efforts

Planning Grant: 2008 – Develop a local government-based adaptation strategy to protect the coastal ecosystem (wetlands) from climate change impacts

– examine outreach and education tools as well as legal authorities to address the problem

GOAL: Develop a local government-based adaptation strategy to protect the coastal ecosystem (wetlands) from climate change impacts

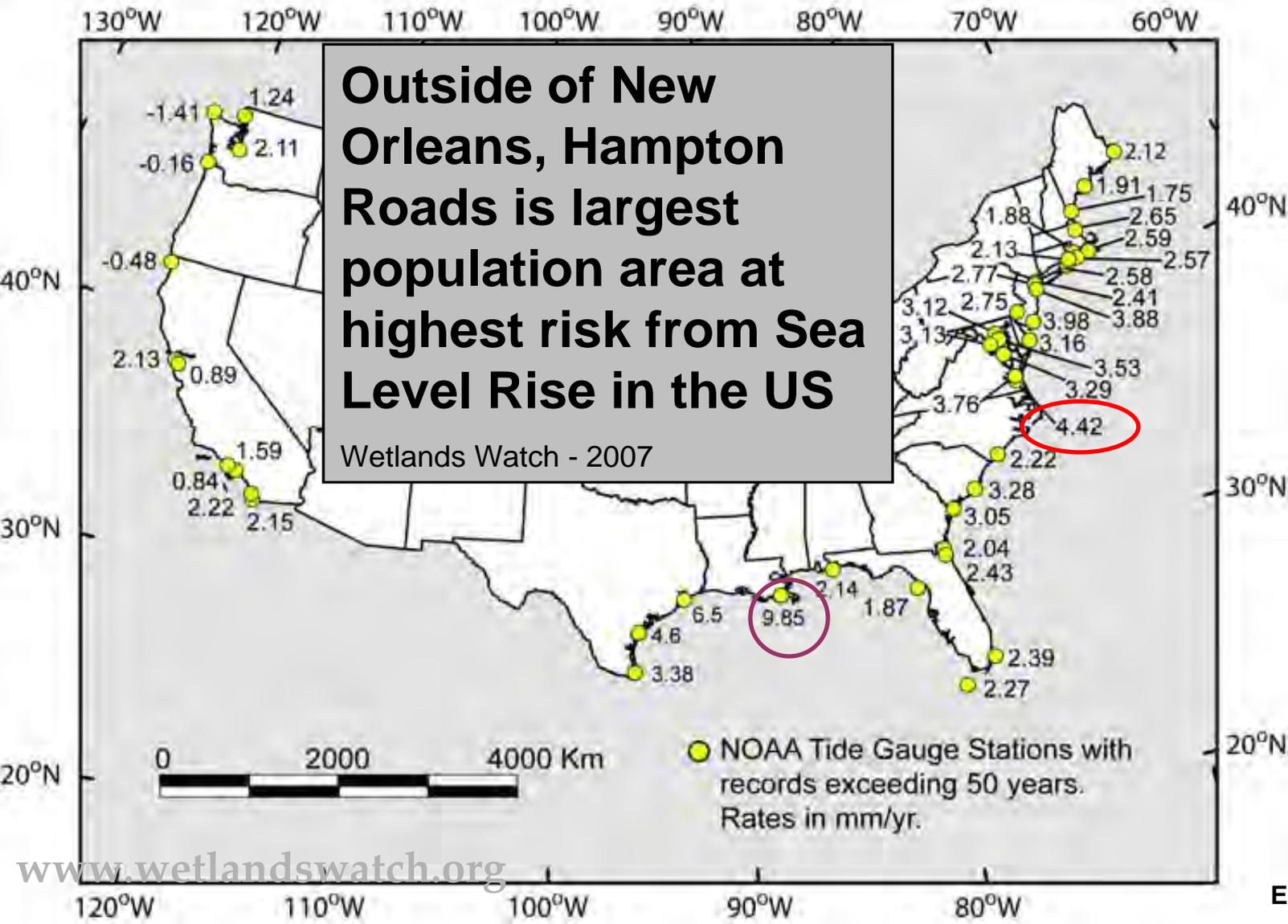
PROBLEM...

1) No one cares about wetlands...

2) Discussions of “climate change” generate controversial distractions

3) No one wants to “adapt” (pay money, forego gain, experience inconvenience) to an event decades away

Virginia has the highest NOAA current and predicted sea level increases on East Coast



Sea Level Rise is Here/Now

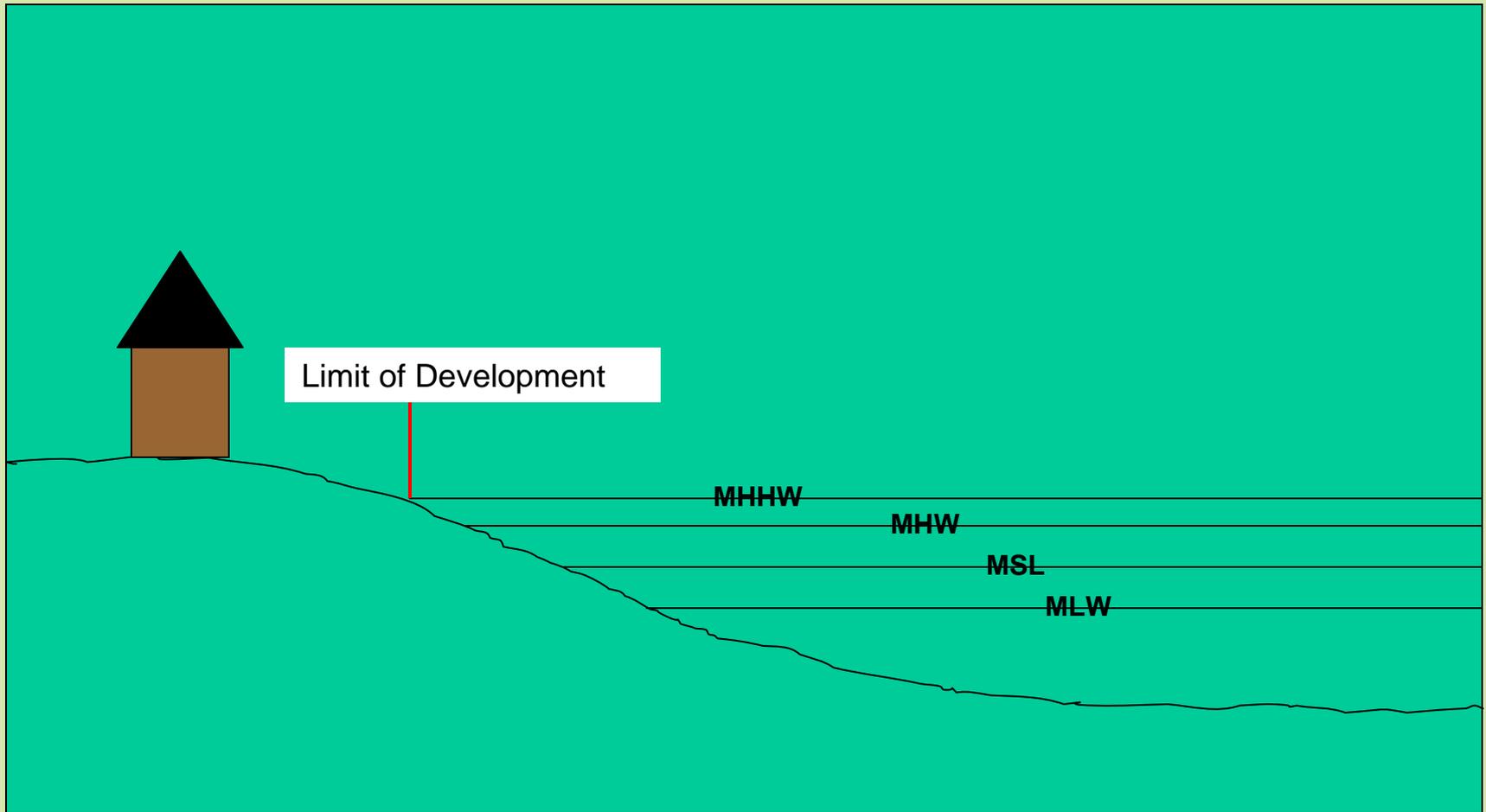
**Storm Surges Make Sea Level Rise
“Real”**



DATE	STORM TYPE	ABOVE MHHW
August 23, 1933	Hurricane	6.27 feet
September 18, 2003	Hurricane Isabel	5.12 feet
March 7, 1962	Ash Wednesday Storm	5.05 feet
November 12, 2009	Veterans Day nor'easter	4.99 feet
September 18, 1936	Hurricane	4.92 feet
September 16, 1933	Hurricane	4.36 feet
November 22, 2006	Thanksgiving nor'easter	3.96 feet
October 6, 2006	Columbus Day nor'easter	3.76 feet
January 28, 1998	Twin nor'easters (#1)	3.26 feet
September 16, 1999	Hurricane Floyd	3.21 feet
February 5, 1998	Twin nor'easters (#2)	3.12 feet

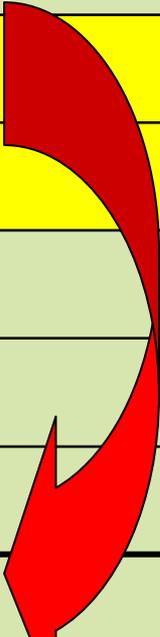


Mean Higher High Water = lower limit of development, settlement

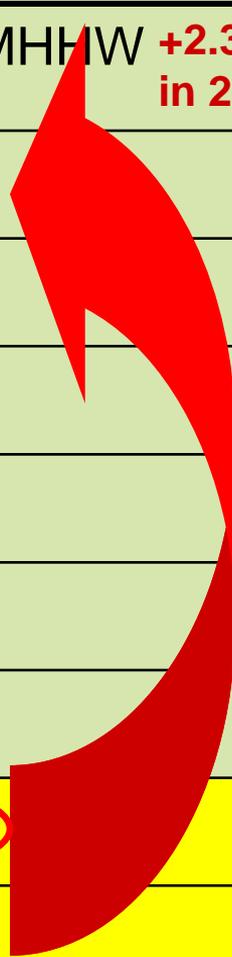




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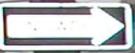


DATE	STORM TYPE	ABOVE MHHW +2.3 feet in 2106
August 23, 1933	Hurricane	6.27 feet
September 18, 2003	Hurricane Isabel	5.12 feet
March 7, 1962	Ash Wednesday Storm	5.05 feet
November 12, 2009	Veterans Day nor'easter	4.99 feet
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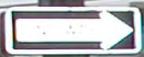
Built 1904



Built 1902



Holland House
APARTMENTS
622-5443



Same nor'easter in 2106

Oct '06 nor'easter in 1906

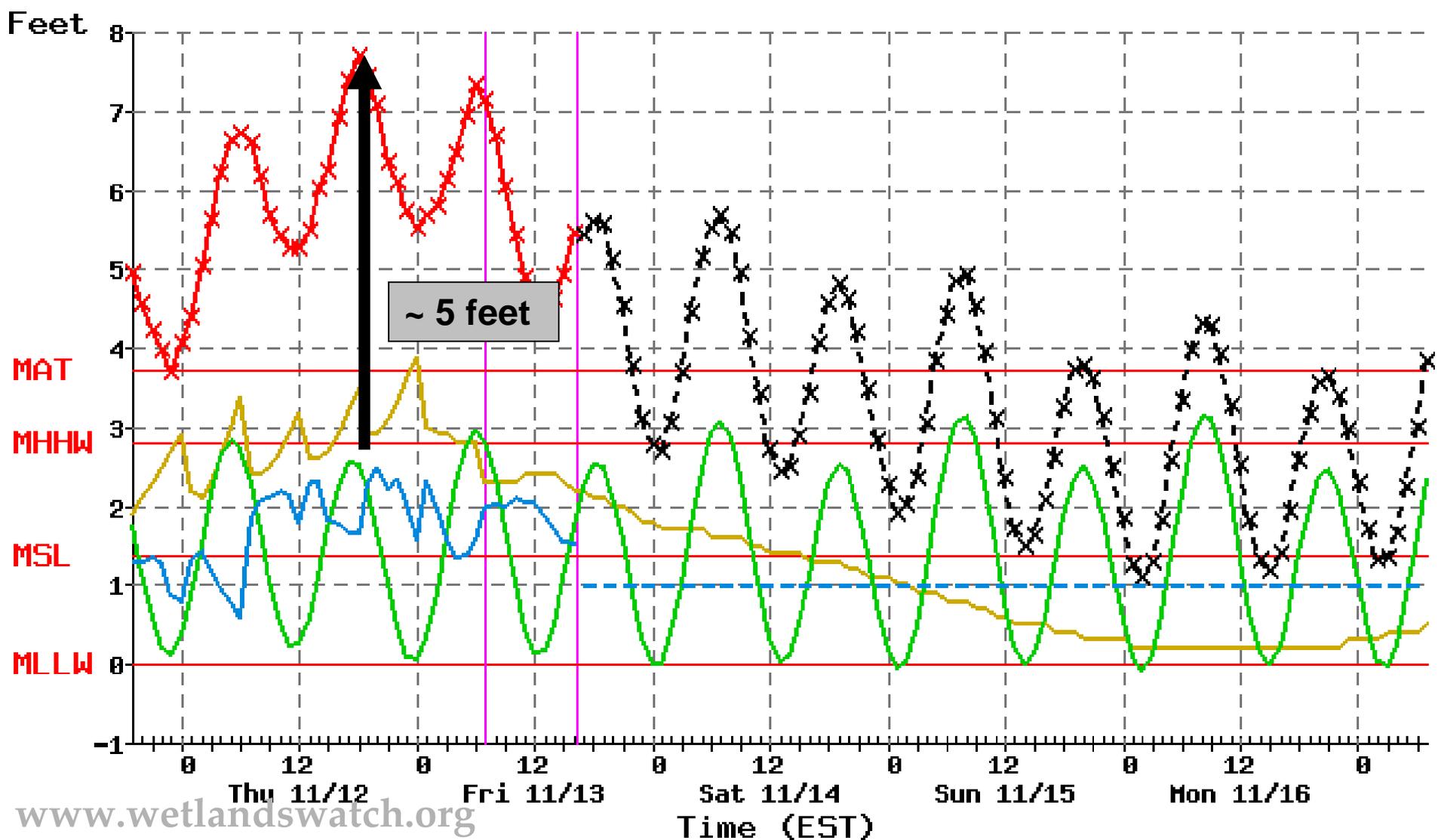


Holland House
APARTMENTS
622-5443

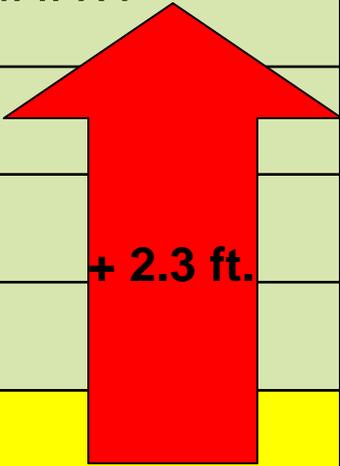
Veterans' Day Noreaster

Surge Tide Observation Forecast Anomaly=(Obs.-(Tide+Surge))

Hampton Roads (Sewells Pnt), VA : 11/13/2009 4:19 PM EST

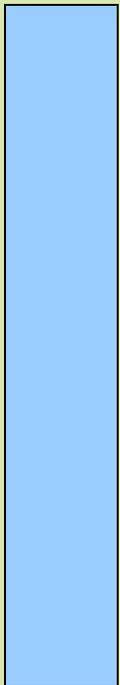


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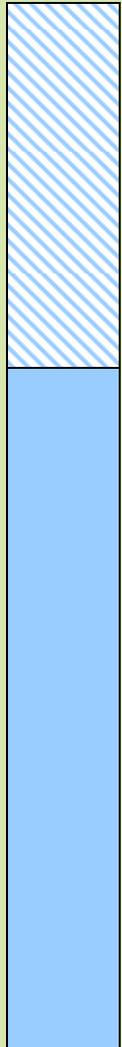
Examples of Climate Change Challenges

What Does 2.3 feet of Sea Level Rise Mean for Storm Surge?



Category 1 storm surge = 4 feet

What Does 2.3 feet of Sea Level Rise Mean for Storm Surge?



2.3 feet of Relative Sea Level Rise

+

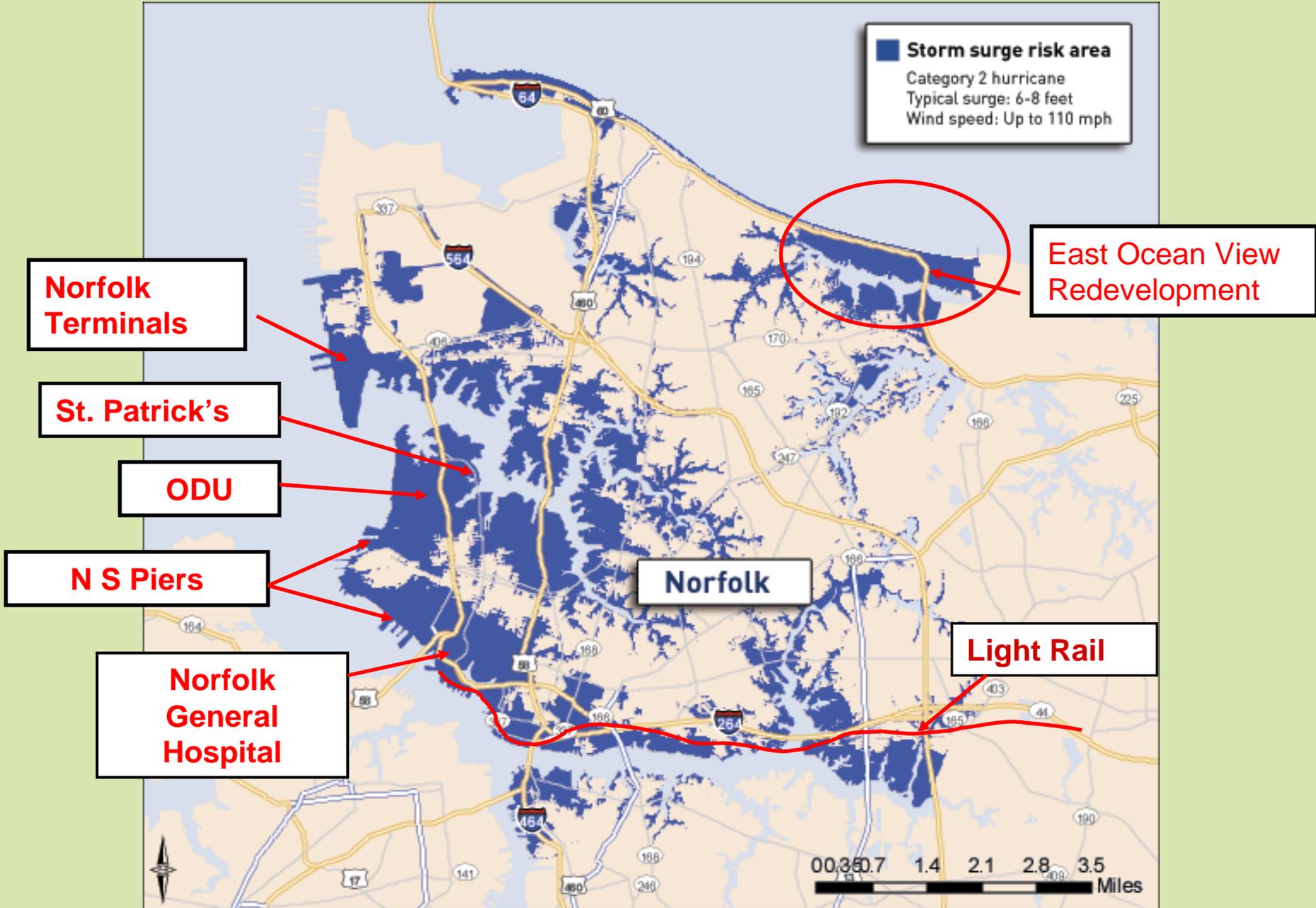
Category 1 storm surge = 4 feet

What Does 2.3 feet of Sea Level Rise Mean for Storm Surge?

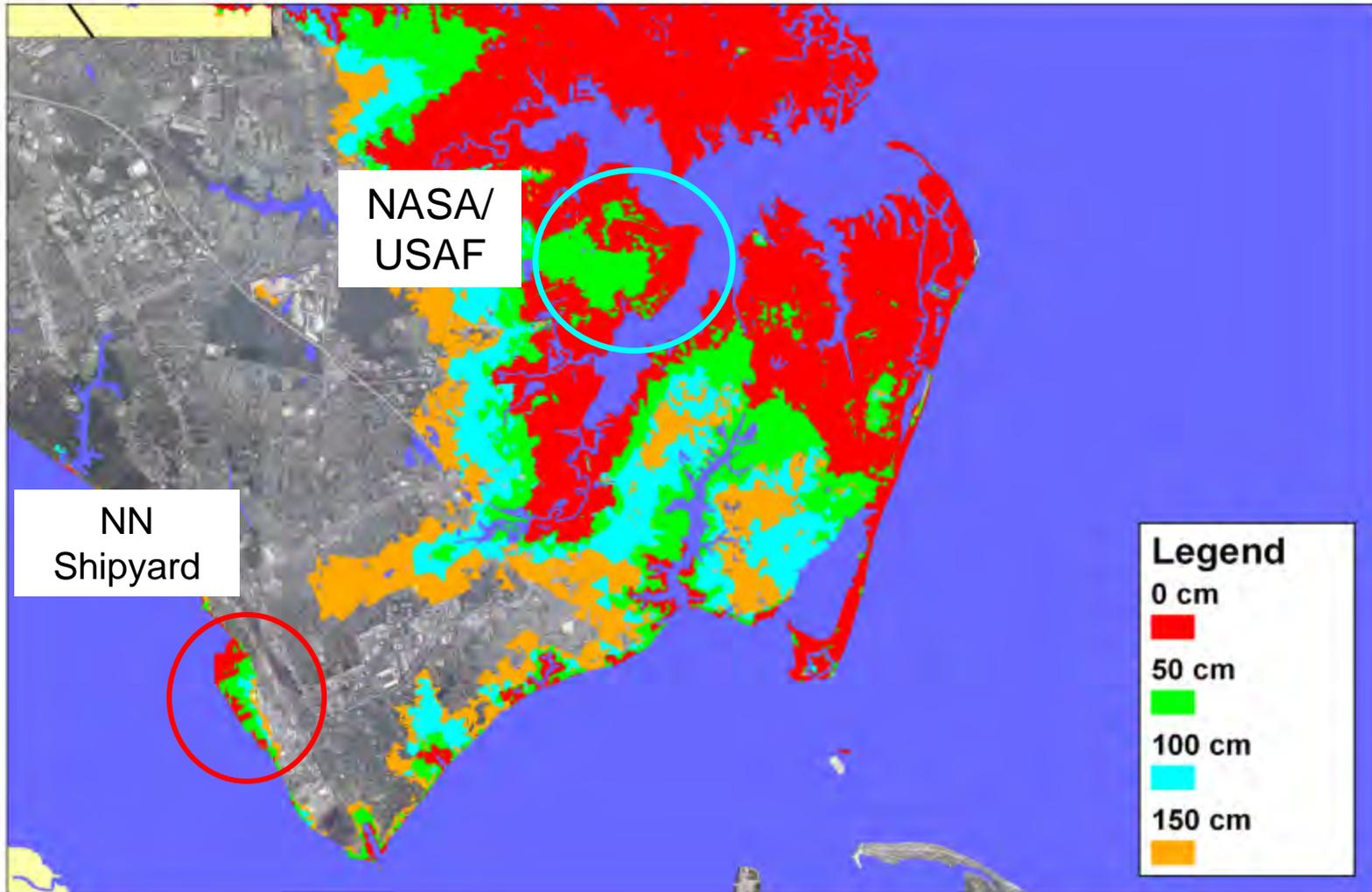


In 100 years, a Category 1 hurricane surge will flood today's Category 2 surge zones (6-8 feet)

2110 Category 1 Surge Flooding



Hurricane Isabel - Hampton/Poquoson Inundation versus Sea Level Rise



Regional downscaling and its applications to sea-level rise impacts

Impacts of Hurricane Isabel on the Northrop Grumman Ship Yard

Record high water level at the Shipyard

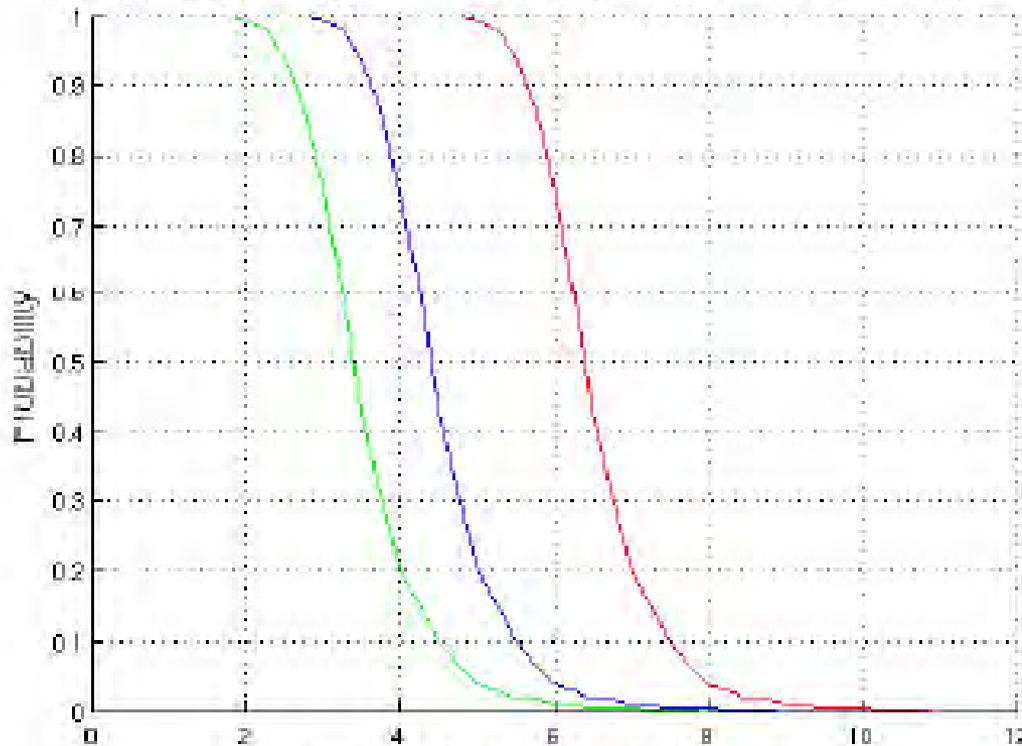
James River spilling into dry dock #1



Sea-Level Rise Notional Scenarios

Probability that Tide at Sewells Pt exceeds:

Historical (Green), Present Day (Blue), Historical + 3' (Red)



Highest Tide of the Month (feet)

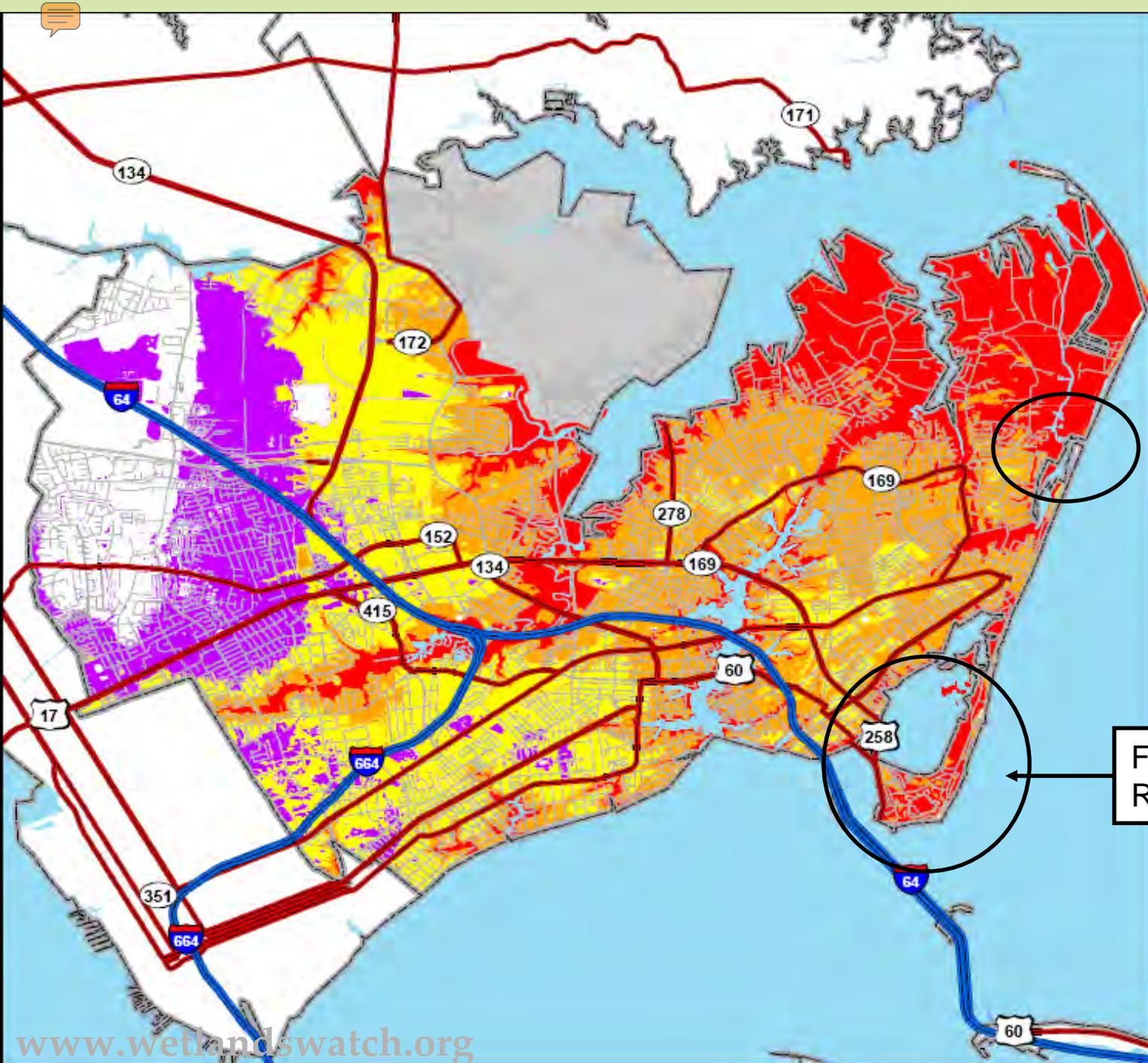
Increasing Sea Level combined with storm surge frequencies alters the risk analysis

Modest levels of rise on the average increase the frequency of extreme events dramatically

Average Number of Years Between Inundation Events						
Event Severity	Flood Stage	Gauge Level(ft)	Sea Level Rise change (Ft)			
			Hist	Hist		
			Historical	Present	+2'	+3'
Flood	5.00		1.71	0.33	0.10	0.08
Moderate	6.00		7.32	1.71	0.33	0.10
Major	7.00		26.83	7.32	1.71	0.33
Record	8.02		80.50	26.83	7.32	1.71

Sea-level rise reduces the time between (increases the frequency of) record-level inundation events.

Colors represent relative risk.



Storm Surge Inundation Zones

- Area Not Included
- Category 1
- Category 2
- Category 3
- Category 4
- Interstates
- Primary Roads



Ft. Monroe
Redevelopment

Hampton's Bayside and location of proposed development





**\$4.5 million program in Norfolk –
\$26 million state-wide in Virginia**





House fine. Roads, storm water systems, etc.????



Raise one block 18"

~\$1.24 million



The New York Times

Front-Line City in Virginia Tackles Rise in Sea





Hampton Roads 2150??

(Cedar Island, VA)



Stephen M. Katz/Virginian-Pilot

Impact of Sea level Rise on Beaches

Bruun Rule

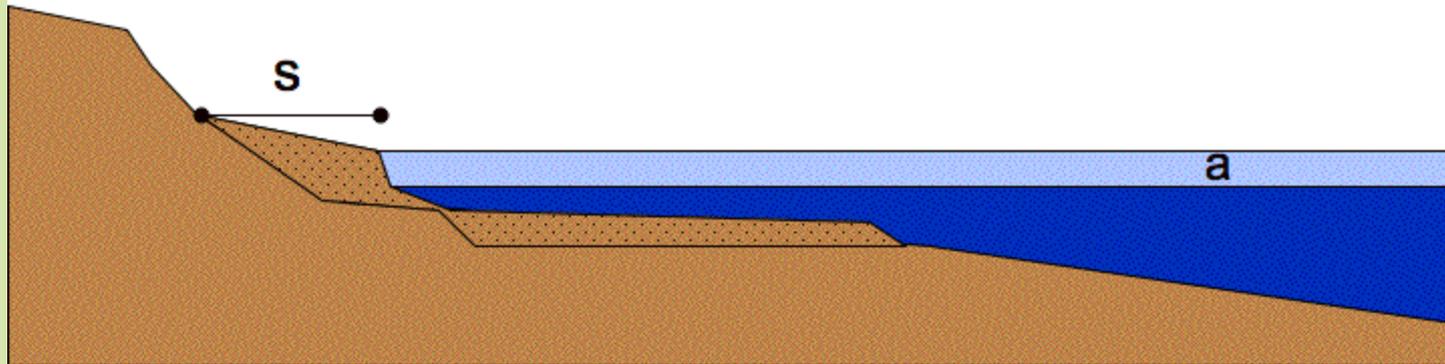
$$s = \sim 50 \text{ to } 200a$$

s = beach recession

a = sea-level rise

Eastern US: $s = 110 \text{ to } 181a$

18 cm rise ---> ~20 m recession



Impact of Sea Level Rise on Virginia Beach



Impact of Sea Level Rise on Virginia Beach



2 foot sea level rise = loss of 200+ feet of beach

2100 Shoreline (max)

Virginia Beach – Summer 2007



Virginia Beach – Summer 2107





OECD Environment Working Papers
No. 1

Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes

EXPOSURE ESTIMATES

R. J. Nicholls^{*}, S. Hanson, C. Herweijer,
N. Patmore, S. Hallegatte,
J. Corfee-Morlot, J. Château,
R. Muir-Wood

**Hampton Roads # 10 in the World = total assets
at risk from Sea Level Rise/Climate Extremes**

Climate Change Impacts Can be Seen Now in Virginia



New Point Comfort Lighthouse

Mathews, VA

From 1885 to now – shoreline has moved ½ mile

 **Mathews Coastline on the Move – who's responsible for this house in 5-10 years?**



ROAD



Sea-level rise on VA's Eastern Shore



2100 - global sea level rise = +27.2 inches

NWF Study on
Ches Bay

Contamination and Climate Change: Examining the Relationship between Virginia's Hazardous Waste Sites and Public Health

Martha Ellen Wingfield · Emily Russell · Peter deFur
Environmental Stewardship Concepts · Richmond, VA · 2009

Abstract

The loss of coastal and inland wetlands, an increased frequency of extreme weather events and precipitation, and a rise in sea level are all anticipated to impact Virginia in the next 100 years. However, neither the Governor's *Climate Change Action Plan* nor the federal report, *Global Climate Change Impacts on the United States* mention hazardous waste sites in connection to climate change. We focused specifically on the future of Virginia's public health vis-a-vis increased mobility of hazardous waste through our water systems with the onset of climate change.

In Virginia, 21 sites on the National Priorities List, those which are recognized by the federal government as uncontrolled hazardous waste sites, lie near or immediately on bodies of water. In the event of predicted extreme weather and sea level rise, this proximity translates into the likely spread of chemicals into surface and ground waters, leading to long-term economic and environmental damage. Heavy rainfall can compromise the efficiency and efficacy of treatment plants, meaning that contamination is likely to spread to drinking water. Communities near military bases, such as Hampton Roads, with groundwater contamination have been shown in studies to have a greater frequency of negative health effects such as cancer and developmental problems.

The solution to these threats lies in prioritizing the remediation of hazardous waste sites. Preparation for severe storm events is also key, including anticipating storm surges and how a site may be secured to prevent off-site transport of chemicals through our water bodies. By doing so, we can prevent the uncontrolled spread of hazardous waste throughout Virginia's ecosystems and communities, thereby protecting human health in the face of drastic environmental change.

The Numbers on Virginia

30 sites on the National Priority List	38 out of 95 counties completely dependent upon well water (and therefore groundwater)
21 sites near or on waterways	50 billion gallons of groundwater used each year
19 sites currently undergoing remediation	7,769,089 residents with the potential to be harmed by contaminants if extreme weather carries them into our waterways
7,769,089 Virginia residents within 1 mile of a site	
239,300 residents in counties with NPL sites	
2,472,523 residents in counties with NPL sites	

Virginia's Common Contaminants, Listed by Health Effect

Damage to Vital Organs	Damage to Nervous System	Carcinogenic	Damage to Reproductive System
Thallium	Carbon Tetrachloride	Carbon Tetrachloride	Benzene
Toluene	Manganese	Vinyl Chloride	Toluene
Carbon Tetrachloride	Thallium	Arsenic	Vinyl Chloride
Vinyl Chloride	Chloroform	Chloroform	Manganese
Chloroform	Lead	DDT	PCBs
Antimony	DDT	PCBs/Dioxins	
Cadmium	PCBs/Dioxins	Bieldrin	
Lead		PAHs	

- PCB Fish Consumption Advisories
- Mercury Fish Consumption Advisories
- PCB and Mercury Fish Consumption Advisories
- Kepone Fish Consumption Advisories



Many sites in Virginia lie on or near bodies of water, many of which are already subject to public health advisories.

Impacts of Climate Change on Water Resources

- A. Higher temperatures — Drought — Less recharge and less groundwater — Less dilution of pollutants in water bodies (i.e. higher concentrations)
- B. Extreme precipitation events — Inundation of sewage systems and greater runoff rates — Exponential increases in sediment and pollution loadings to water bodies

How these Impacts May Spread Contaminants

Urban Storm Water Runoff
Flooding
Agriculture & Irrigation
Fluctuating Water Table

Results of widespread Contamination

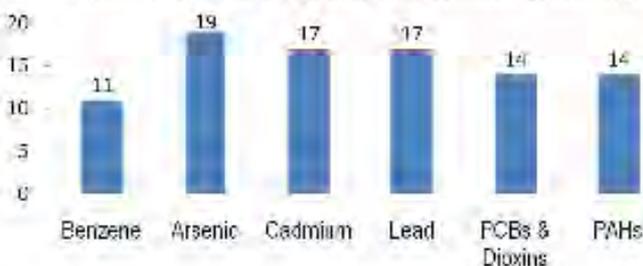
Increased levels of contaminants in groundwater & water bodies
More fish, benthic invertebrates, birds, and mammals with impaired health
Greater number of impaired waterways and aquifers used for drinking water

Effects on Human Health

Prevalent food & water borne diseases
Increased cancer rates
Impacts on reproductive health & fetus development
Impaired development in early childhood
Elevated blood pressure
Increased heart disease

The average time to clean up a Superfund site is 13 to 15 years, within which time we will already be seeing effects of climate change. Studies have linked autism, birth defects, and cancer to living in proximity to a hazardous waste site. Virginia should prioritize the cleanup of hazardous waste sites to prevent the spread of contamination throughout the state.

Number of Virginia NPL Sites with Common Contaminants



**Awareness and Urgency is
Growing**



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

Farmer’s no longer doing business within two miles of ocean coast or one mile of tidal Bay

USAA – withdrawing new coverage

Economic Impact Becomes Clearer

We will see the ocean creep up into backyards and witness increased flooding during rainstorms and at high tide. Only those with no concern for the future can afford to ignore this development.

State of the Region – Hampton Roads 2009

Federal Response Has Started

CECW-CE

Circular
No. 1165-2-211

Department of the Army
U.S. Army Corps of Engineers
Washington, DC 20314-1000

EC 1165-2-211

1 July 2009

EXPIRES 1 JULY 2011
WATER RESOURCE POLICIES AND AUTHORITIES
INCORPORATING SEA-LEVEL CHANGE CONSIDERATIONS
IN CIVIL WORKS PROGRAMS

October 2009

CLIMATE CHANGE ADAPTATION

Strategic Federal
Planning Could Help
Government Officials
Make More Informed
Decisions



**Recognition is
growing of key role
federal agencies will
play in adaptation...**

Climate Adaptation Planning is Already Underway in Virginia

Storm Surge/Sea Level Rise Adaptation has Started



NOTICE

DURING PERIODS OF HIGH WATER
WHICH MAY CAUSE FLOODING, THESE
TIDE GATES WILL BE CLOSED IN ORDER
TO PROTECT THE GENERAL PUBLIC
DEPT. OF PUBLIC WORKS
CITY OF NORFOLK
FOR FURTHER INFORMATION
CALL 823-4000



2010 Comprehensive Economic Development Strategy (CEDS)

“Vision Hampton Roads”

IV. ANALYSIS OF ECONOMIC DEVELOPMENT PROBLEMS AND OPPORTUNITIES

Threats

- Flat/Slow Port Growth Forecast
- Decrease in DoD Spending
- Continued Deterioration of Infrastructure, Traffic
- Competition from Other States for Military Forces Based in the Region
- **Rising Sea Levels and other Potential Impacts of Climate Change**
- Lack of Ultra Broadband Infrastructure (High-Speed Internet Telecommunications)
- Lack of Regional Water Strategy

Federally-Mandated Planning Opportunities

US DOT

FEMA

HAMPTON ROADS 2030 LONG-RANGE TRANSPORTATION PLAN




HAMPTON ROADS
PLANNING DISTRICT COMMISSION
December 2007

T07-10

SOUTHSIDE HAMPTON ROADS HAZARD MITIGATION PLAN



DRAFT
FEBRUARY 2006

PREPARED BY




Virginia's Long-Range Multimodal Transportation Plan

Climate Change

Climate change poses a serious and growing threat to Virginia's roads, railways, ports, utility systems, and other critical infrastructure. Higher temperatures, rising sea levels, increased potential of flooding, more buckled pavements due to heat, and lower employee productivity due to increased illness are some of the potential implications of climate change. Elevated atmospheric temperatures will lead to rising sea levels that will cause storm surges, coastal flooding, and erosion more severe than occurs today. Temperature rise and the threat of more frequent and intense heat waves can also seriously impair critical infrastructure such as roads and bridges as they will be more prone to failure due to

4.2.4 Sea Level Rise

As part of the 2009 update to this plan, an analysis for Poquoson's risk to sea level rise was accomplished using sea level trend data from NOAA (see Figures 8 and 9) and GIS analysis. Sea level rise rates were estimated based on NOAA data at <http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml>. This page describes rates of sea level rise at two points near Poquoson: Gloucester Point (0.0125 ft/yr) and Sewells Point (0.0146 ft/yr). Based on these historic rates of rise, a conservative estimate of sea level rise is one foot in the next 70-80 years (68 years based on the Sewells point data, and 80 years based on Gloucester Point data). The approximate inundation area was estimated using the City's detailed contour layer, which has 1 foot contour intervals. The analysis used the one foot contour (one foot above mean sea level) as the future shoreline in 70-80 years. According to a visual study, scanning at 500-foot scale, if the sea level rose one foot in elevation from the current shoreline, no existing structures would be affected. Analyzing the two foot contour had the same results, with only one exception. There is one structure that would be affected by a 2 foot rise, a property at Messick Boat Access Ramp with an assessed value of \$406,200. While the direct impacts of sea level rise appear minimal, the indirect impacts will be considerable, as the increase in sea level will also increase the depth of flooding over time and potentially exacerbate flood and hurricane storm surge losses, even in properties currently elevated to the base flood elevation.

For the 2009 update, Poquoson building officials provided completed Elevation Certificate information for 540 new or recently elevated structures in the City. Thirty-four (34) of the structures are currently located outside the SFHA in Zone X. Using this structural information, and assuming that the base flood elevation will increase in conjunction with sea level (one foot in 70-80 years), the effects of sea level rise on these elevated structures can be shown. This subset of Poquoson's structures is assumed by most owners to be adequately protected from flood, and so the analysis of existing and future "freeboard" is useful.



Virginia Citizen's Guide to
FLOODPLAIN MANAGEMENT
guidance for those living & developing in the floodplain

2.4 Climate Change and Sea Level Rise

It has been widely studied and debated that our planet's temperature is rising and that this change in temperature is contributing to higher sea levels through melting of the Arctic ice caps and glaciers. If the earth's temperature is rising, this will have an effect on ocean temperatures as well. An increase in ocean temperature will likely increase the frequency and severity of coastal storms. Combined these factors mean that even less-severe coastal storms may produce more damaging floods.

Scientists at the Virginia Institute of Marine Science (VIMS) compared the affects observed in the Hampton Roads area caused by the August 1933 hurricane and 2003's Hurricane Isabel, which was a category one storm when it hit Virginia. Despite being a categorically weaker storm, Isabel brought water levels that were comparable to those seen in the 1933 storm. Data shows that the monthly mean sea level during Isabel was approximately 1.4 feet higher than the mean sea level from seventy years prior (Pizer, 2009).

NOAA scientists have calculated that sea level in the region has risen an average of about four millimeters per year relative to the land since 1928. A recent report by the U.S. Climate Change Science Program, suggests an additional sea-level rise of more than three feet by 2100(Pizer, 2009).

The Middle Peninsula Planning District Commission (MPPDC) and VIMS are currently being funded by the Department of Environmental Quality's Coastal Zone Management Program to study and map the predicted sea level rise for the Middle Peninsula. These maps will be available in the Fall of 2009. When more data becomes available the County should evaluate the potential impact of climate change on the community, particularly with respect to its wetlands, and consider potential management options.

level



Consultants work on flood plan as tides rise and Norfolk sinks

Virginian Pilot August 26th, 2010

Staff Recommendations

- Base adaptation strategy on YR 2050 projection of a 1.0 - 1.6 ft. rise in sea level.
- Incorporate sea level rise in the design of all new buildings requiring SE approval.
- Evaluate the impact of sea level rise during the design of planned flood protection projects in coastal areas.
- Investigate larger freeboard and/or setback for proposed construction in areas influence by tidal flooding (Zoning Ordinance Amendment).
- Inventory public facilities in vulnerable areas and evaluate impacts.
- Acquire tools to perform a more detailed analysis of impacts of sea level rise on floodplain elevations in coastal areas.

Natural Resources Planning Tools

State/Federal Planning Efforts

- **Virginia Wildlife Action Plan (mandated/included in VA)**
- **Coastal Zone Program Plans (mandated/included in VA)**
- **Local and Regional Water Supply Planning (mandated)**
- **George Washington/Jefferson National Forest Management Plan update (mandated/will be included)**

Comprehensive Land Use Planning

- **Done in every locality every five years**
- **Takes a long-range view of locality's development**
- **Public involvement guaranteed**
- **Can lead to changes in zoning, etc.**

Respecting the Past, Creating the Future:

Accomack County Comprehensive Plan



Adopted May 14, 2008

1-g Collaborate with local, regional, and state agencies in planning for climate change.

Planning for climate change can help county decision makers address the problem of sea level rise, and assess potential economic opportunities in responding to changing business and industrial markets. Such efforts should be done in conjunction with other government entities, including Northampton County, A-NPDC, and the Virginia state government.

Comp Plans Starting to Discuss Climate Change

chapter seven



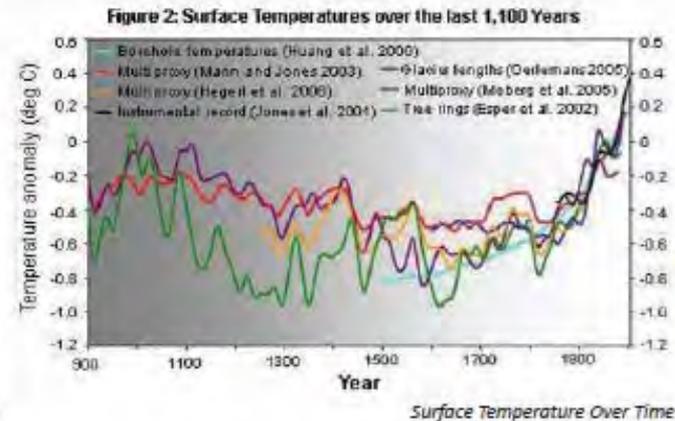
CLIMATE CHANGE

It is well established by the scientific community that global warming is a real and growing problem. Even though there are varied opinions on the extent of human activity as a cause of this phenomenon, there is widespread concern and a call for action from government and citizenry alike to address climate change. The City should consider global warming as a reality, as local examples abound of this fact – increasing range of fire ants, increasing salinities in bottomland swamps causing species changes, and migratory pattern changes for bird and fish species. (as referenced in the document library at www.ourfuturevb.com)

In 2007, the Virginia Commission on Climate Change was tasked by Governor Kaine to develop a Climate Action Plan to reduce Virginia's greenhouse gas emissions by 30 percent by the year 2025, in response to Executive Order 59. This will require a reduction of 69 million metric tons of carbon dioxide equivalent (MMte CO₂), reducing Virginia emissions to 161 MMte CO₂. These documents are available in the document library at www.ourfuturevb.com.

While responding to this challenge is a complex task, the City should begin efforts by:

- » Undertaking research to identify and then lower its carbon footprint by modifying the manner and location in which City activities are conducted and City facilities are constructed.
- » Implementing State and Federal programs that are designed to address the issues associated with climate change.



- » Developing and utilizing its own programs, and assisting the community in carrying out these programs to reduce climate change threats to residents.

RECOMMENDATIONS:

- » Build Leadership in Energy and Environmental Design (LEED™) structures or their equivalent.
- » Retrofit buildings to save on energy use.
- » Adapt to a fleet of vehicles that uses less carbon based fuel.
- » Increase our urban forest canopy in order to absorb more CO₂.
- » Recycle materials, especially for construction purposes.
- » Use energy efficient lighting and reduce wasteful electricity use.

Mathews County Comprehensive Plan 2030

Preserving and Sustaining the Pearl of the Chesapeake



Next Steps?

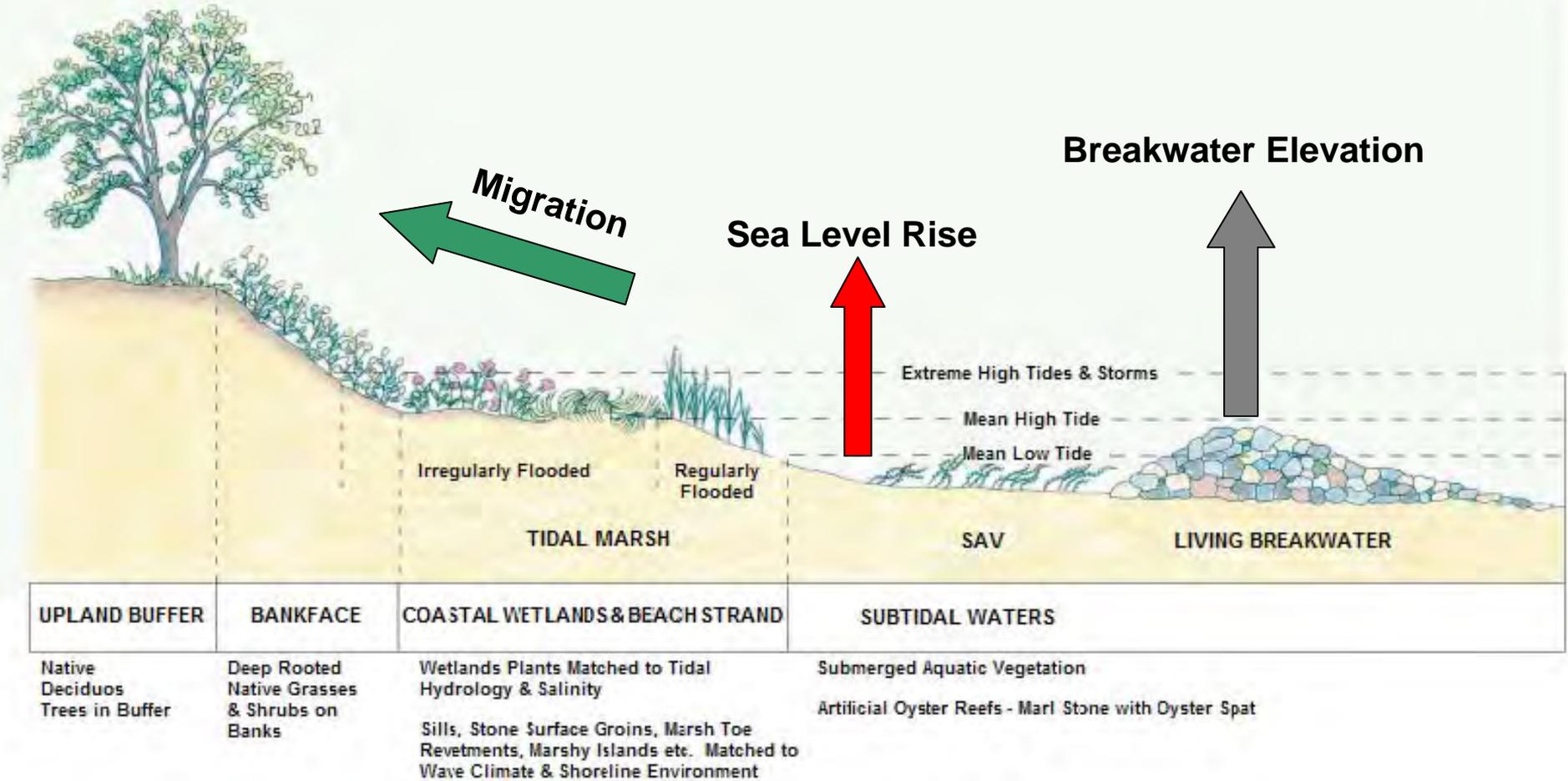
Mapping – Modeling - Impact Assessments

Begin to Develop Shoreline Solutions

Develop a Local Government “Toolkit” and start using it

Outreach and Education – Social Marketing to Generate a Response

Living Shorelines and Sea Level Rise



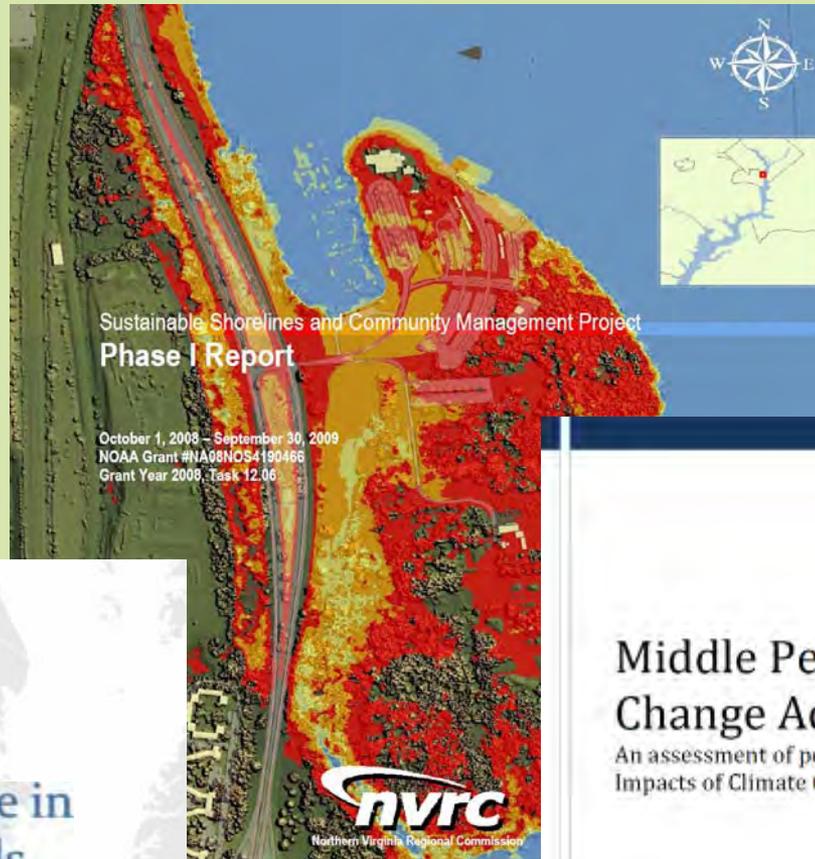
Local Government Adaptation Toolkit Nearly Finished!



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Climate Change in Hampton Roads

Impacts and Stakeholder Involvement

HAMPTON ROADS
PLANNING DISTRICT COMMISSION
February 2010

Middle Peninsula Climate Change Adaptation

An assessment of potential Anthropogenic and Ecological Impacts of Climate Change on the Middle Peninsula



This project was funded by the Virginia Coastal Zone Management Program of the Department of Environmental Quality through Grant FY2008 NA08NOS4190466 Task 12.04 of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended. The views expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Department of Commerce, NOAA, or any of its sub-agencies.



The Challenge

“Convincing people that you're right about an issue--say, the scientific consensus about the threat posed by global warming--can seem vitally important, but in the end may be somewhat beside the point. **In the long run, you have to move the debate beyond beliefs, and into *incentives*: lining up the economic and social incentives such that the right choices are the easy, natural ones To do that, we need smart and effective policies. Appeals to people's reason may help, but rational belief alone won't carry the day.”**

Clark Williams-Derry, Sightline Institute

Summary.....

Sea Level Rise is being experienced today in Virginia – in tidewater we see it as higher storm surges, but it is real now.

Localities must plan for sea level rise/climate change using land use, emergency management, economic, and natural resources planning tools – some Virginia localities have started.

Planning work must be accompanied by social marketing to develop public support for the expensive and disruptive adaptation work to come

Climate Change Work Pays off in the Present



If I'm Getting Wet, I want a Solution

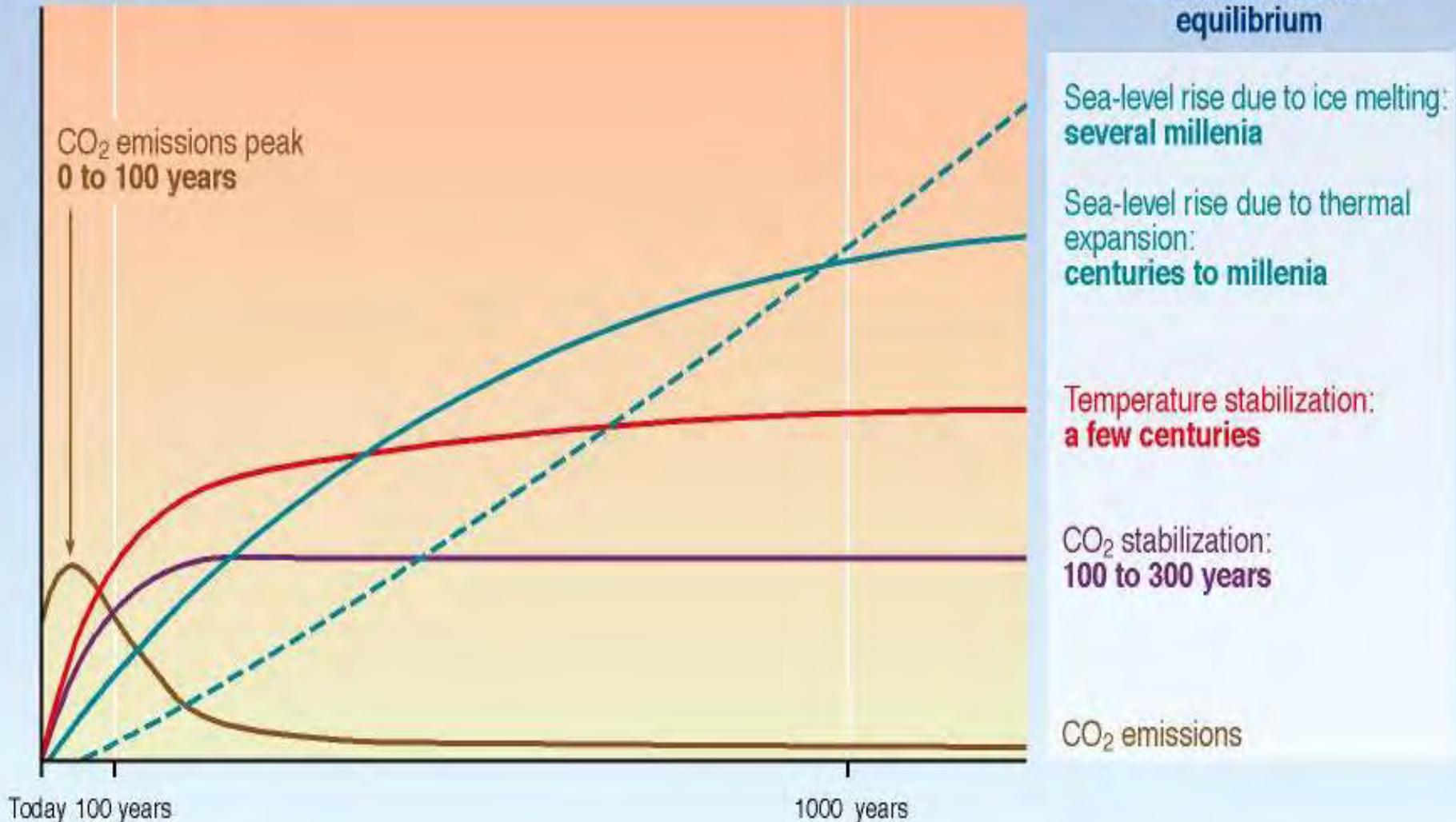
CLOSING ARGUMENTS



The Job is Never Done

Magnitude of response

Time taken to reach equilibrium



Virginia
Environmental
Endowment

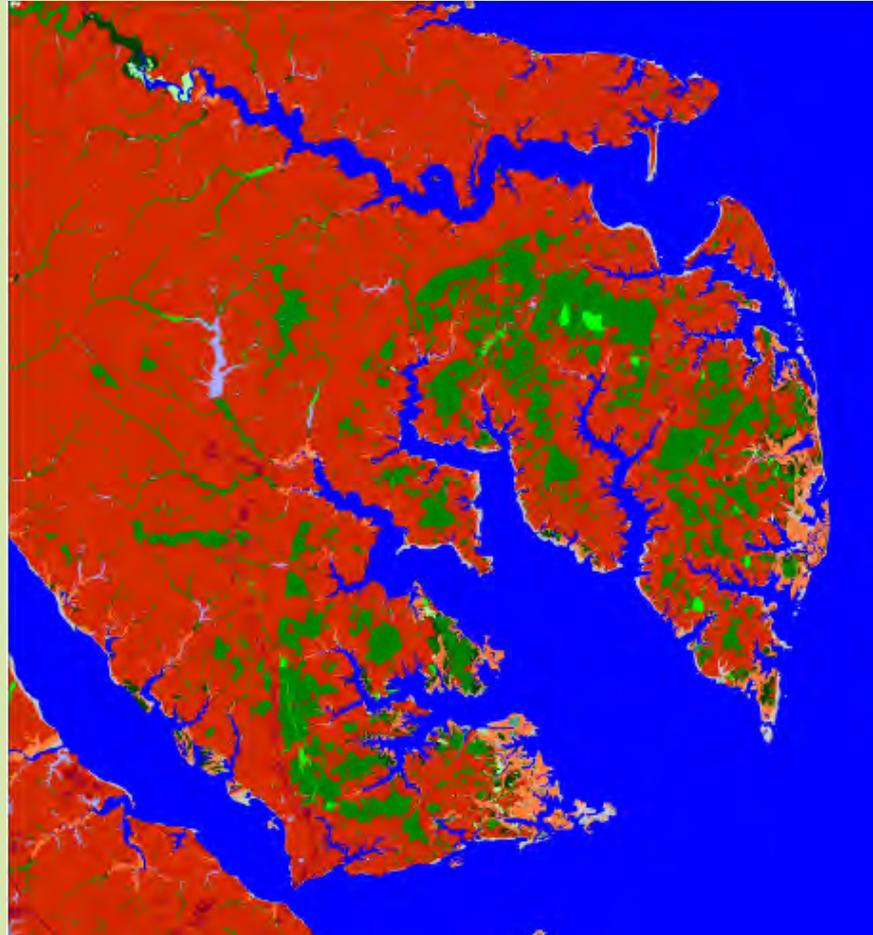


LET'S TALK !



Now

Middle Peninsula



National Wildlife Federation –Sea Level rise and Coastal Habitats in the Chesapeake Bay Region

**+.39
meters**

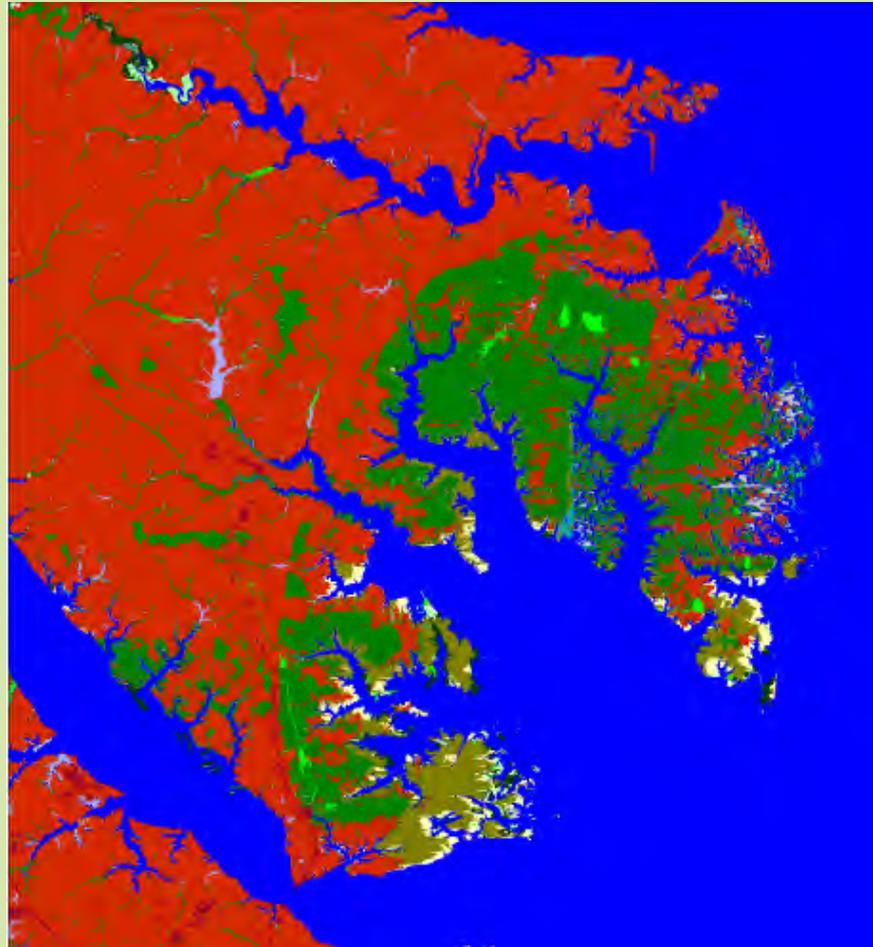
Middle Peninsula



**National Wildlife Federation –Sea Level rise and Coastal Habitats in the
Chesapeake Bay Region**

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meters**

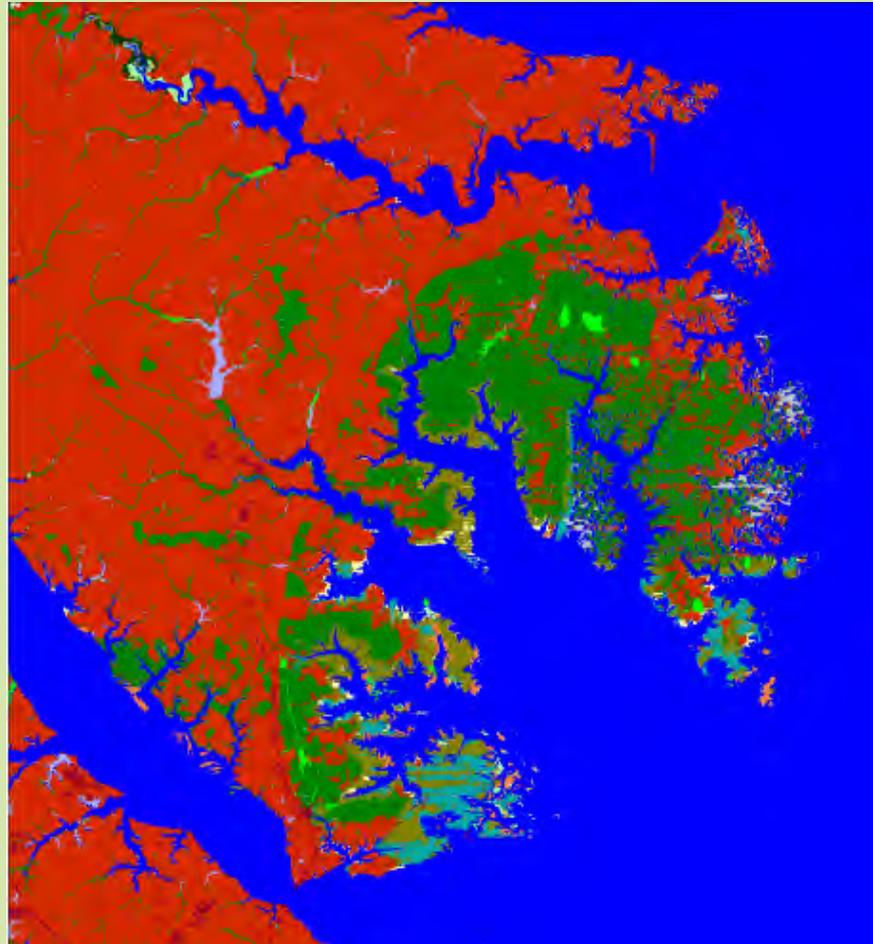
Middle Peninsula



**National Wildlife Federation –Sea Level rise and Coastal Habitats in the
Chesapeake Bay Region**

+ 1 meter

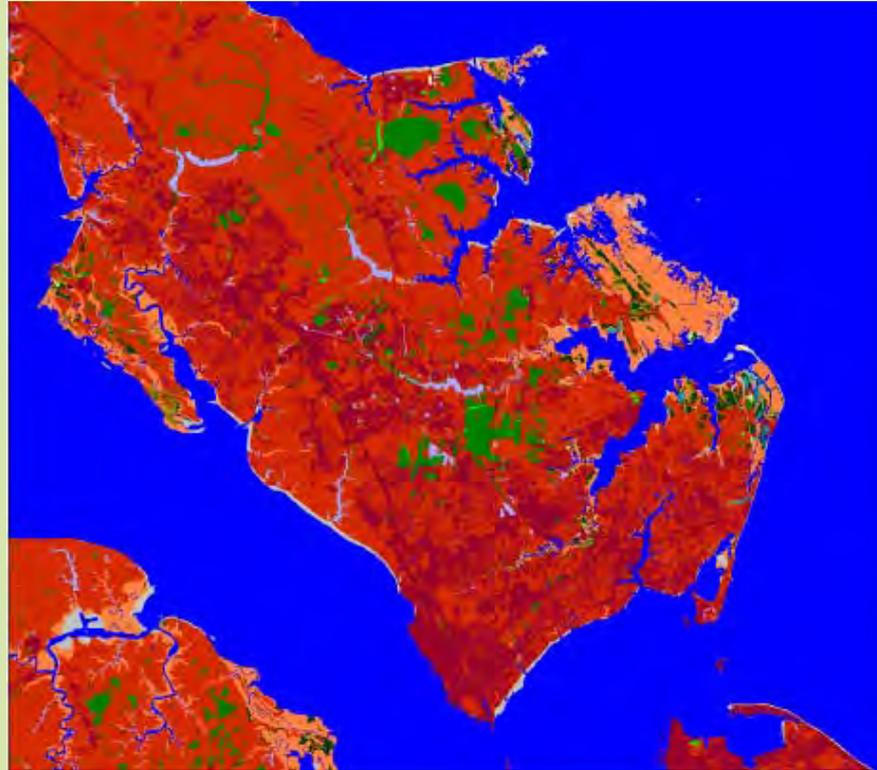
Middle Peninsula



**National Wildlife Federation –Sea Level rise and Coastal Habitats in the
Chesapeake Bay Region**

Now

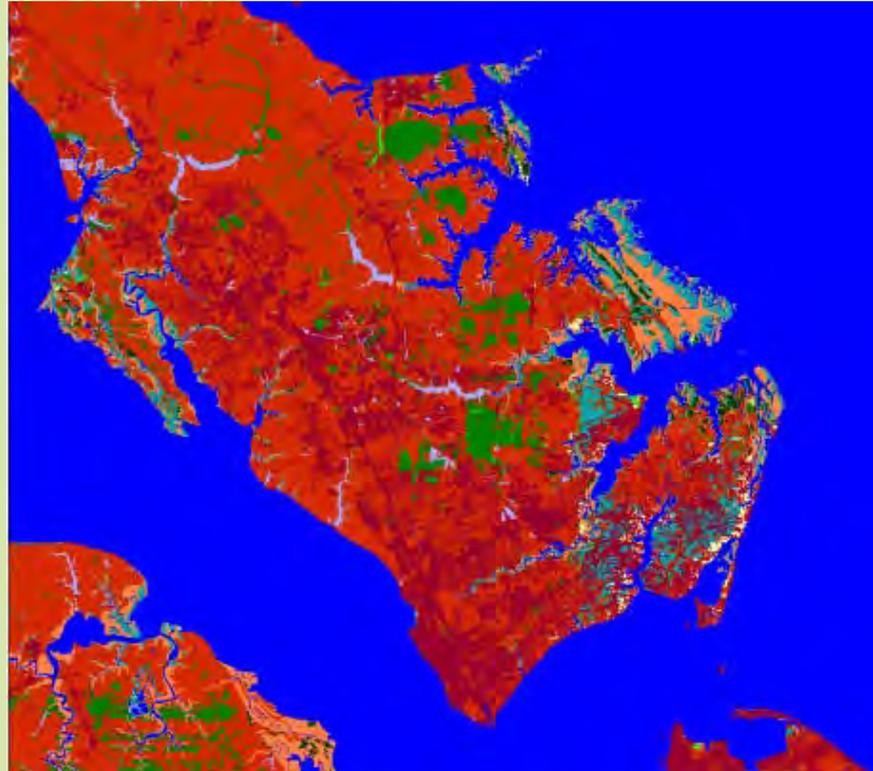
Lower Peninsula



National Wildlife Federation –Sea Level rise and Coastal Habitats in the Chesapeake Bay Region

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meters**

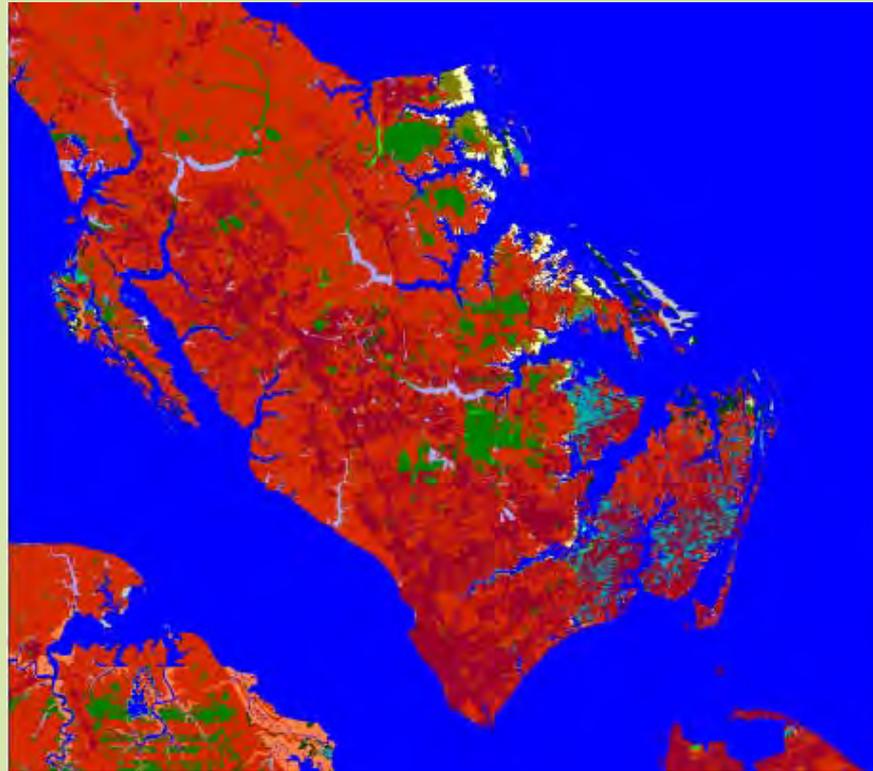
Lower Peninsula



**National Wildlife Federation –Sea Level rise and Coastal Habitats in the
Chesapeake Bay Region**

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meters**

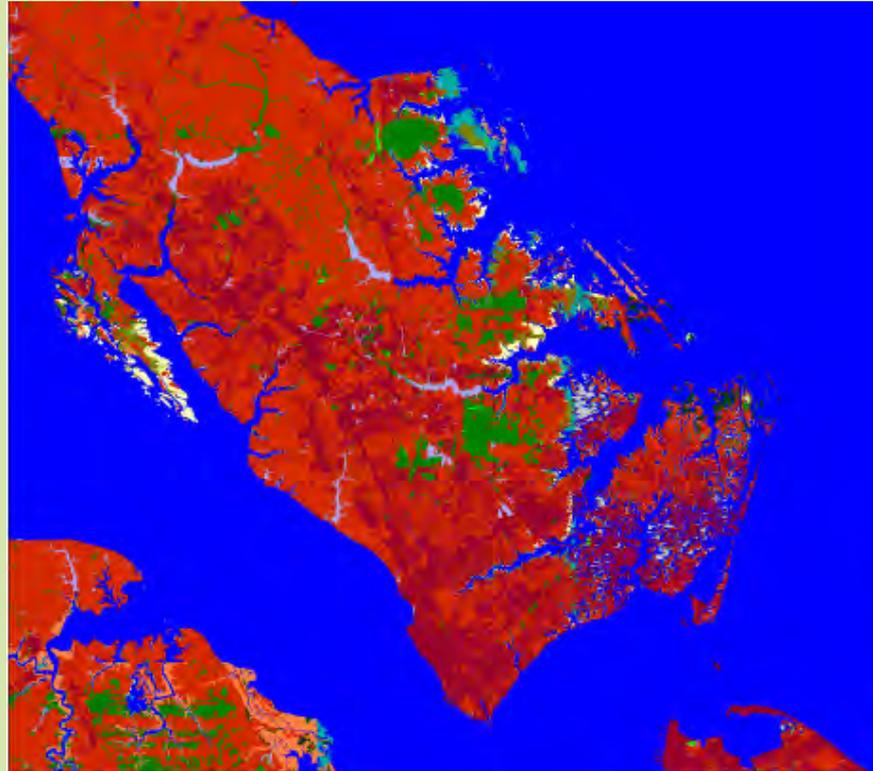
Lower Peninsula



**National Wildlife Federation –Sea Level rise and Coastal Habitats in the
Chesapeake Bay Region**

+ 1 meter

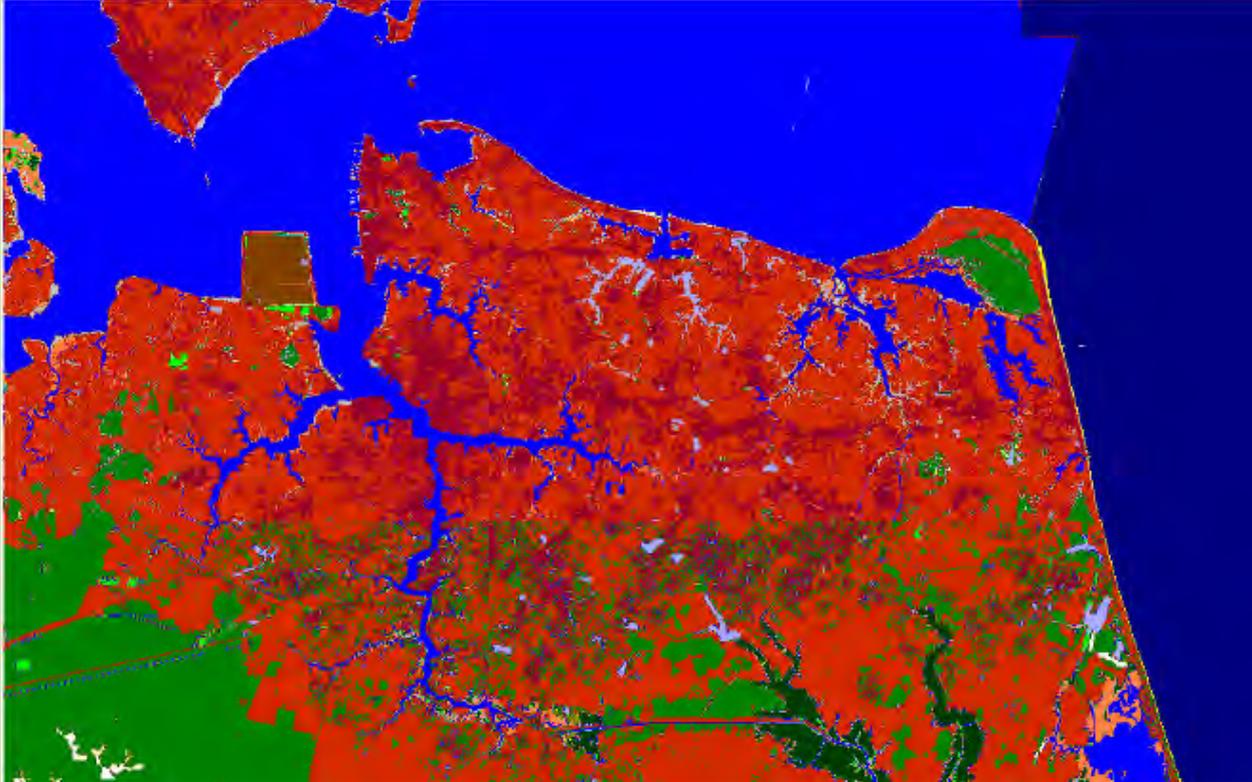
Lower Peninsula



National Wildlife Federation –Sea Level rise and Coastal Habitats in the Chesapeake Bay Region

Now

Southern Hampton Roads



**National Wildlife Federation –Sea Level rise and Coastal Habitats in the
Chesapeake Bay Region**

Southern Hampton Roads

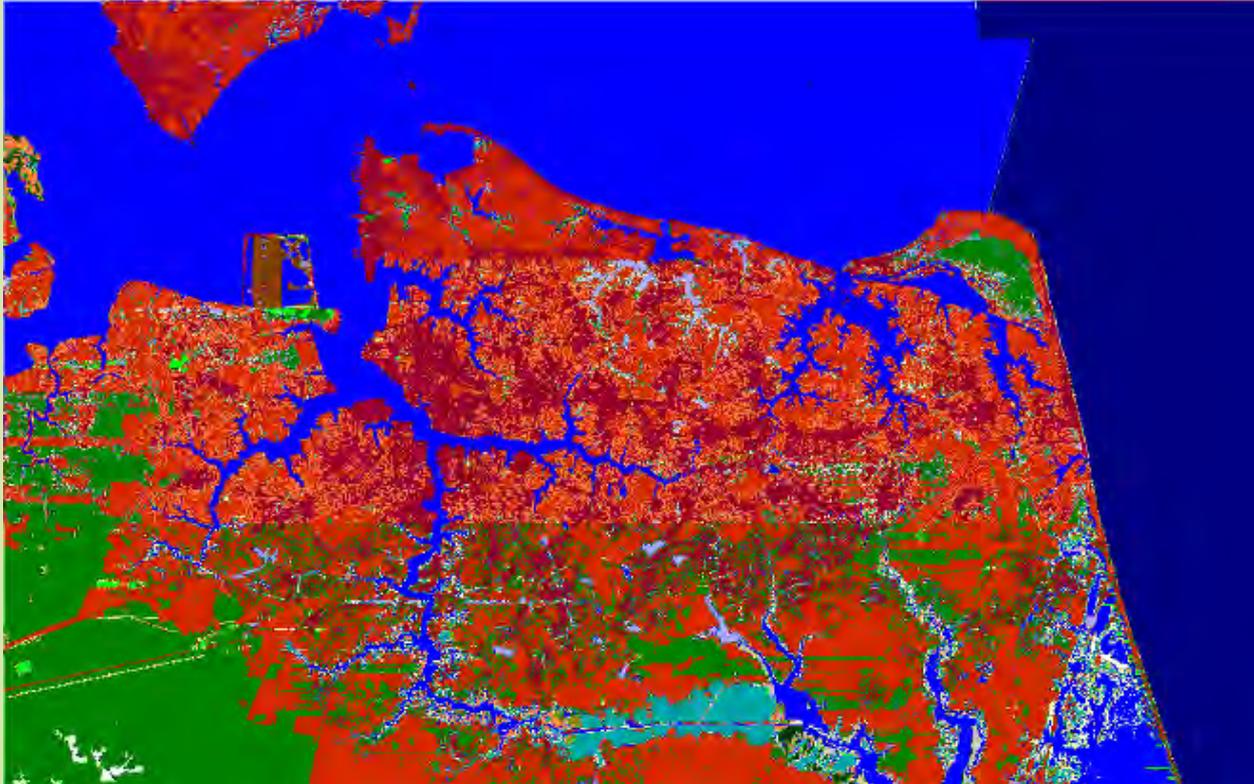
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**National Wildlife Federation –Sea Level rise and Coastal Habitats in the
Chesapeake Bay Region**

Southern Hampton Roads

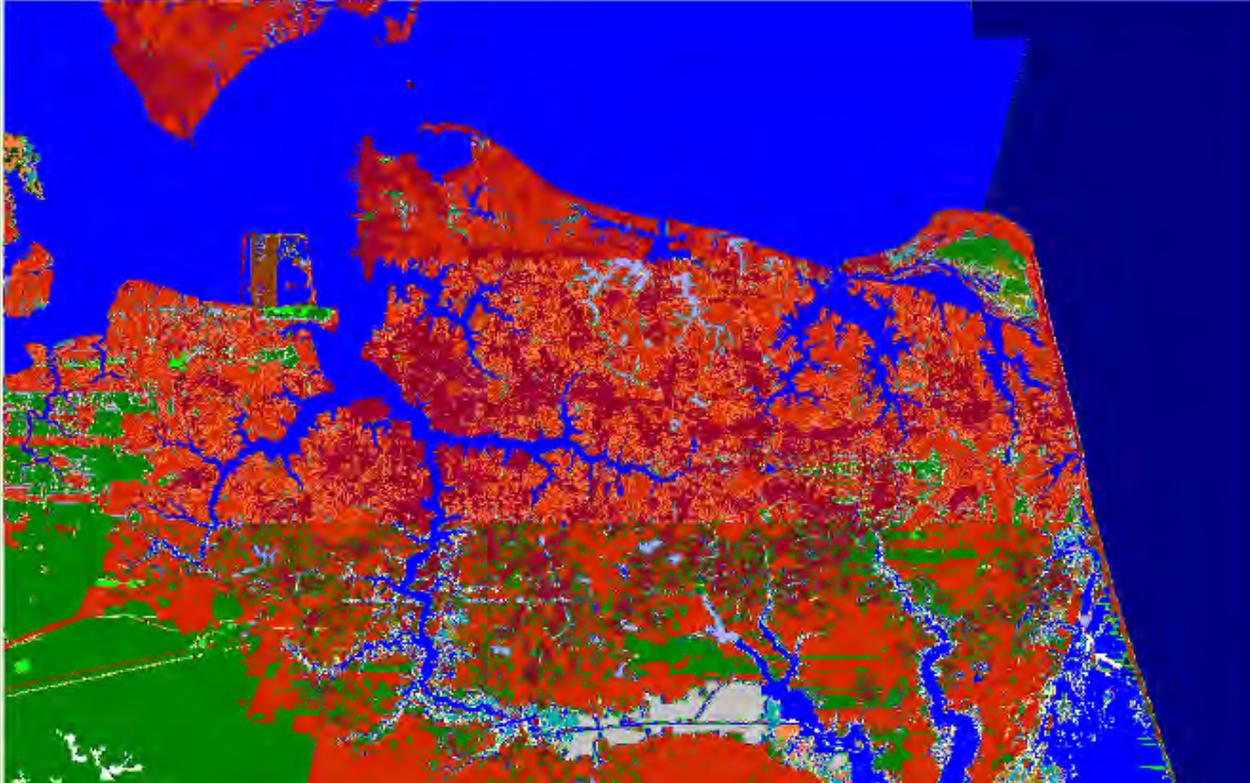
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**National Wildlife Federation –Sea Level rise and Coastal Habitats in the
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+ 1 meter

Southern Hampton Roads



National Wildlife Federation –Sea Level rise and Coastal Habitats in the Chesapeake Bay Region