



Navigating Climate Change in Maritime Archaeology



Maryland-District of Columbia
2022 Environmental Conference
October 13, 2022

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The Science We Need for the Ocean We Want!



**2021
2030** United Nations Decade
of Ocean Science
for Sustainable Development



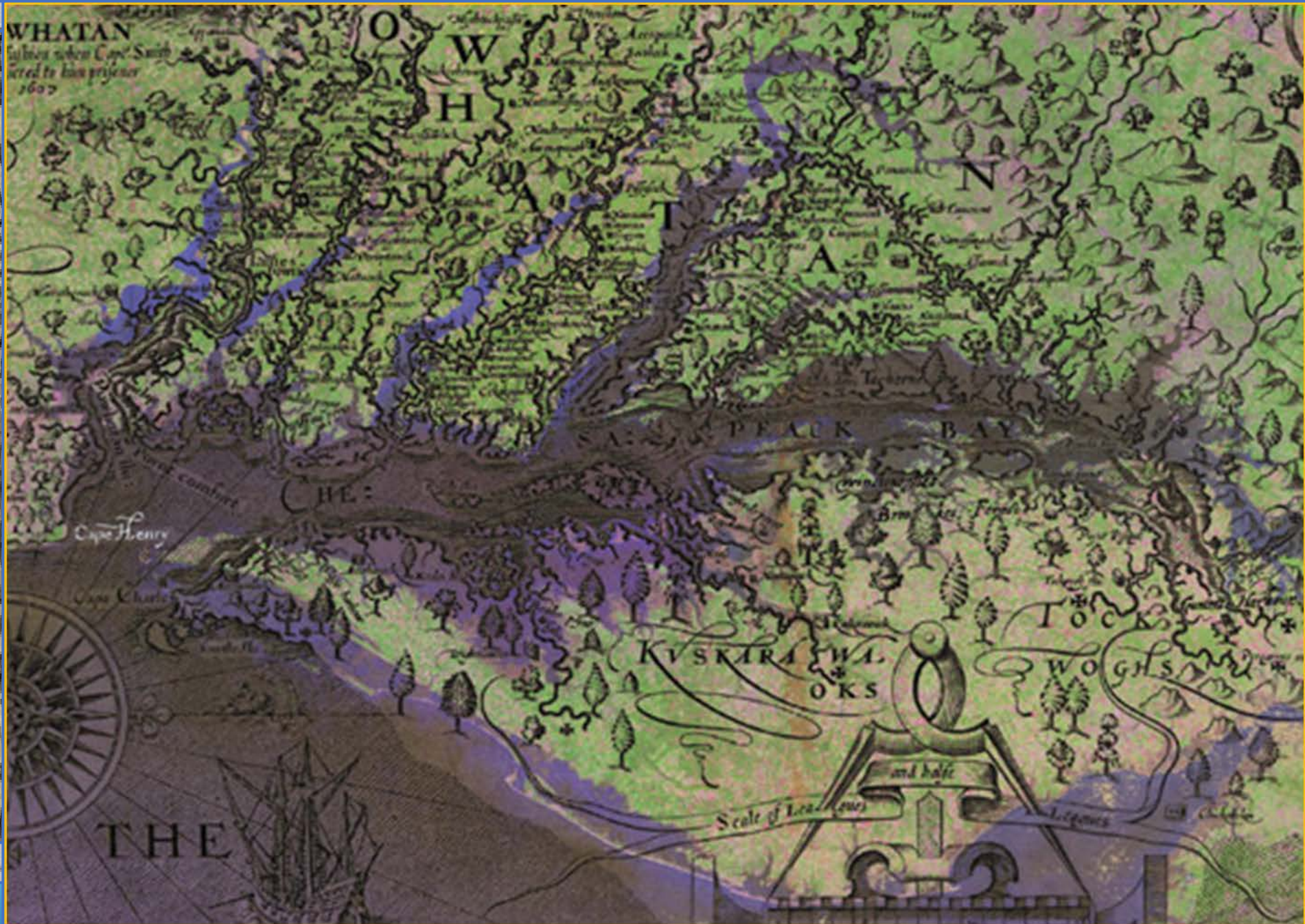
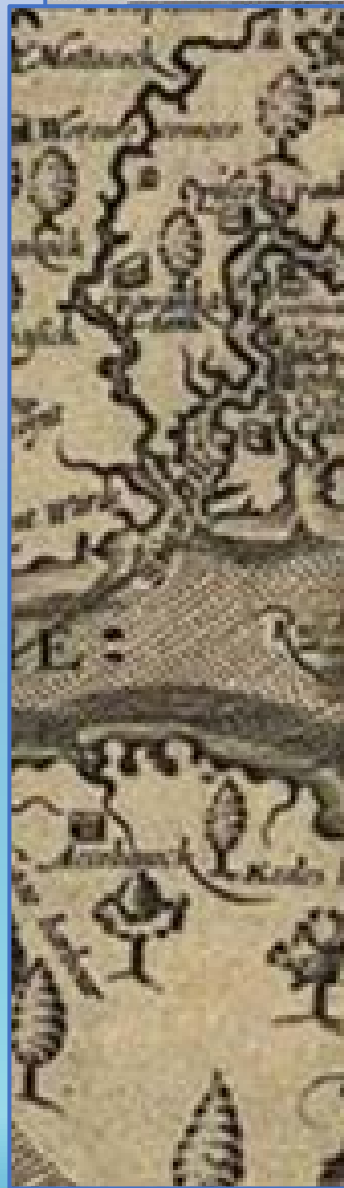
Ocean Decade Heritage Network

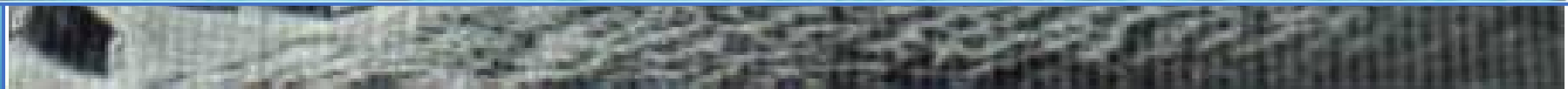
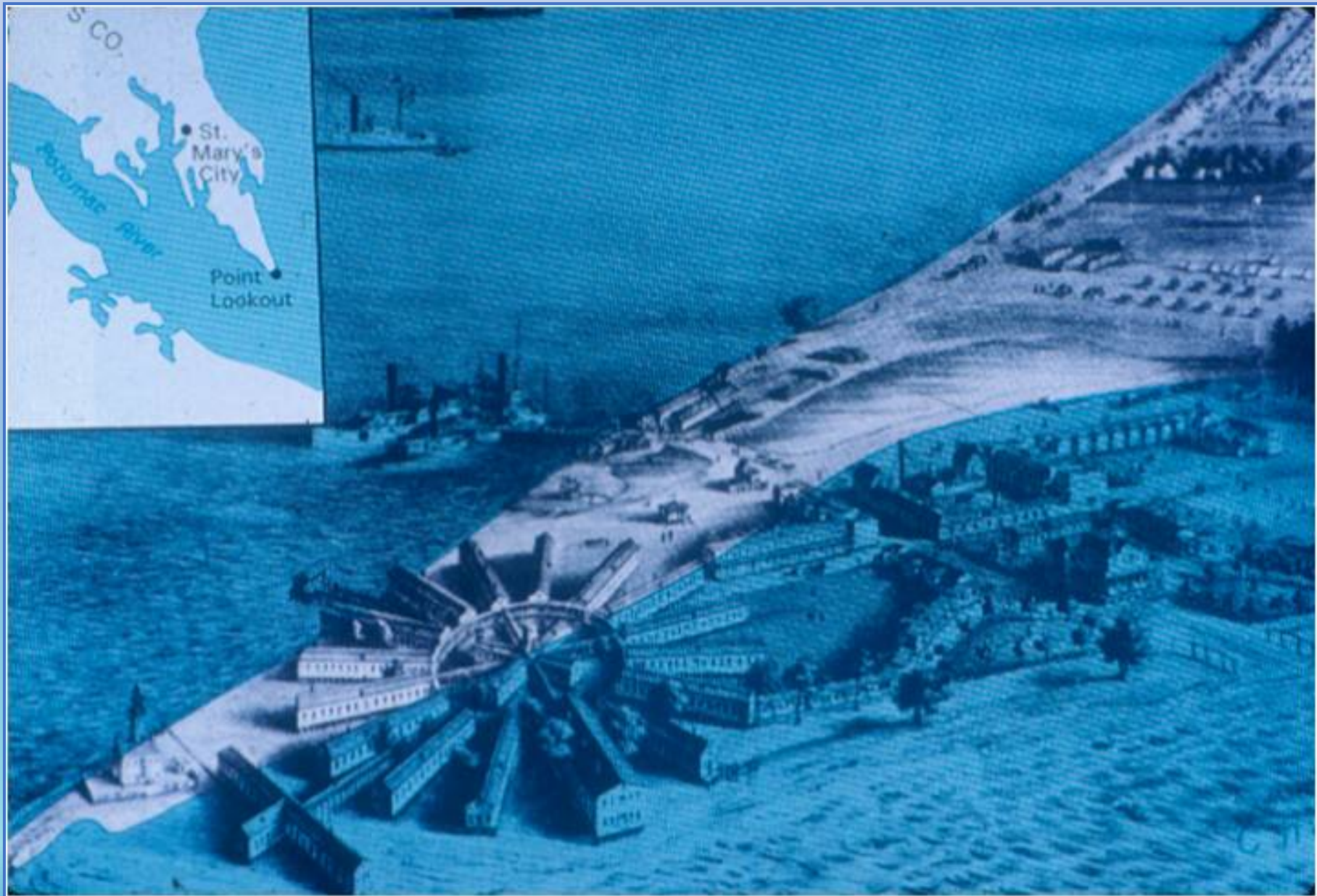
https://oceandecade.org/assets/The_Science_We_Need_For_The_Ocean_We_Want.pdf#:~:text=The%20Science%20We%20Need%20for%20the%20Ocean%20We,SUPPORT%20THE%20SUSTAINABLE%20DEVELOPMENT%20OF%20OUR%20SHARED%20OCEAN.



2021-2030 UN Decade of Ocean Science for Sustainable Development

76°40'W 76°20'









JAMES ISLAND (1847 - 1994)

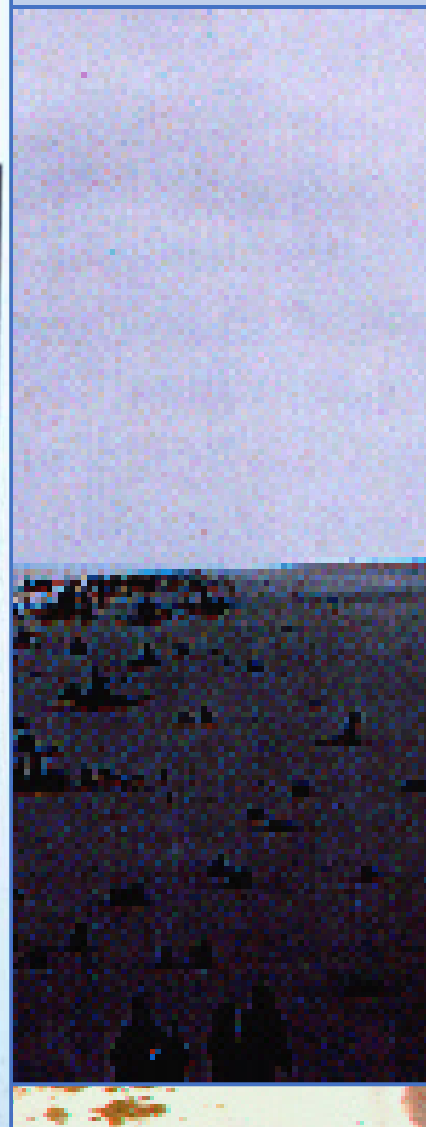


— 1847
— 1942

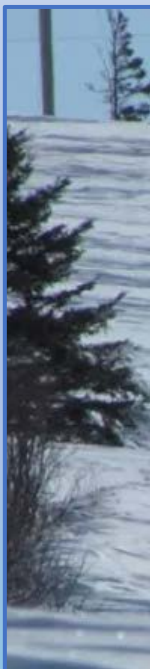
SCALE 1:24000



DOQQ produced by the Maryland Dept. of Natural Resources:
Date of photography 4/8/94. Digital shorelines compiled
by the Maryland Geological Survey: 1997.







Climate change spells turbulent times ahead for air travel

-The Guardian

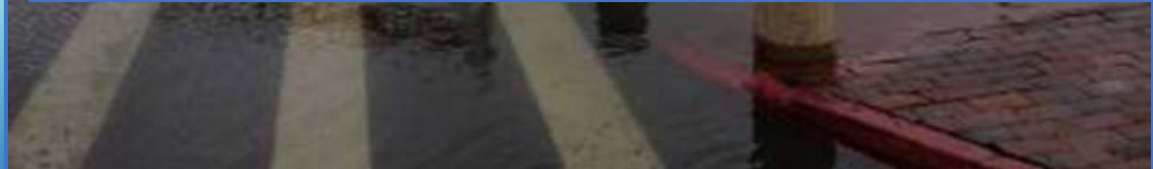
Climate Change Will Increase Violent Turbulence On Airline Flights

-Forbes

-Violent turbulence expected to increase by several hundred percent over North America, Europe and the North Pacific by mid-century, when CO₂ in the atmosphere is double its pre-industrial concentration.

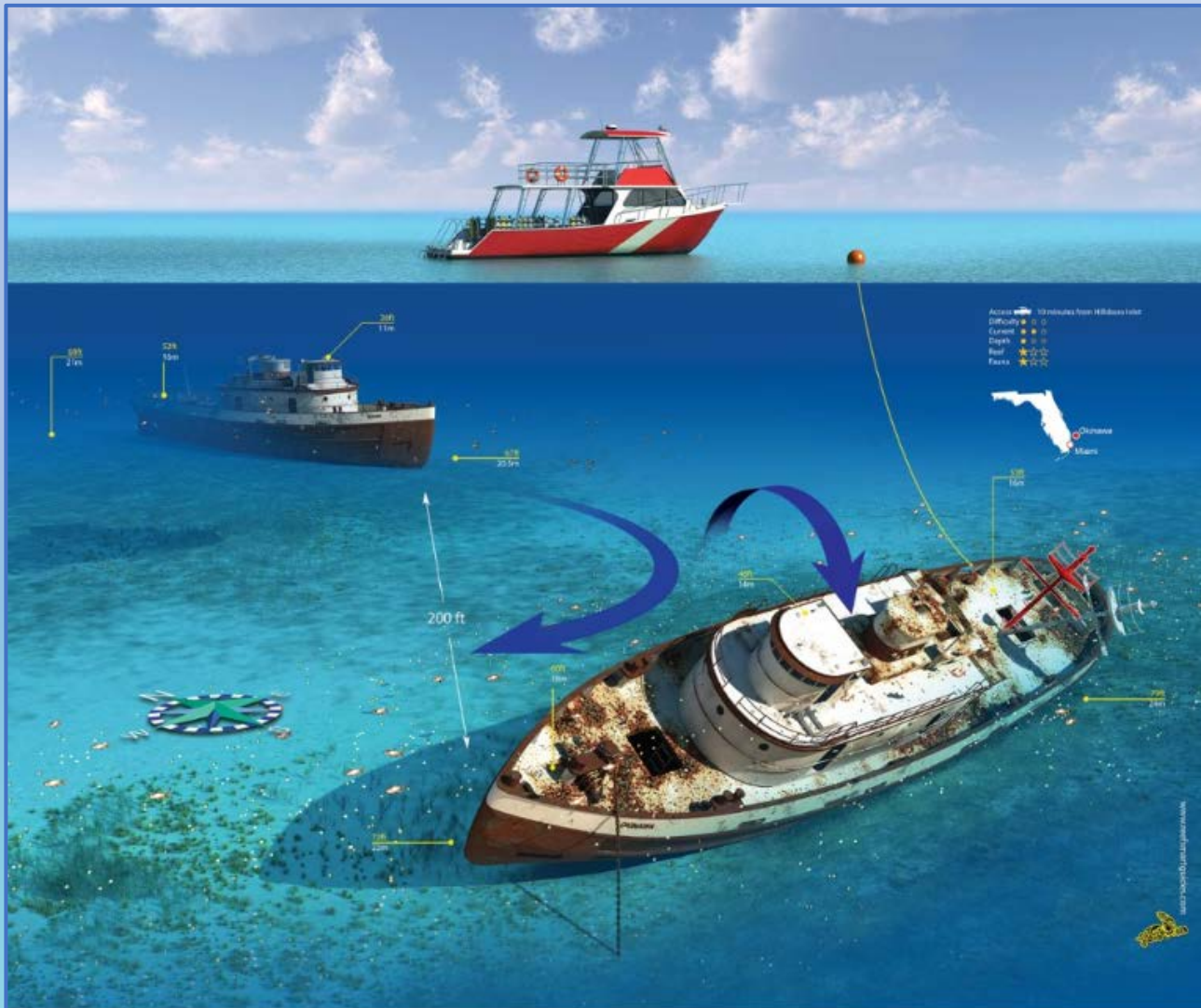
-It is expected to rise 149% in the busy North American flight corridor











Okinawa

Type: U.S. Army long tug | Length: 107 ft. (34.5 m) | Tonnage: 350 GRT | Construction: New Orleans, 1953 | Sunk: August 19, 2017

Okinawa is one of the newest sites and so is structurally sound. It had been facing South at a depth of 70' before Irma moved it more than 200' across the bottom and turned it to face Southwest.



Ancient Mariner had its superstructure sheared off by Irma. It is also in 70' of water.

Similarly, off NC, the 180' long vessel USCGC *Spar*, in 110' of water was moved 200' also.

Not isolated incidents, other damage was reported up to 300' deep

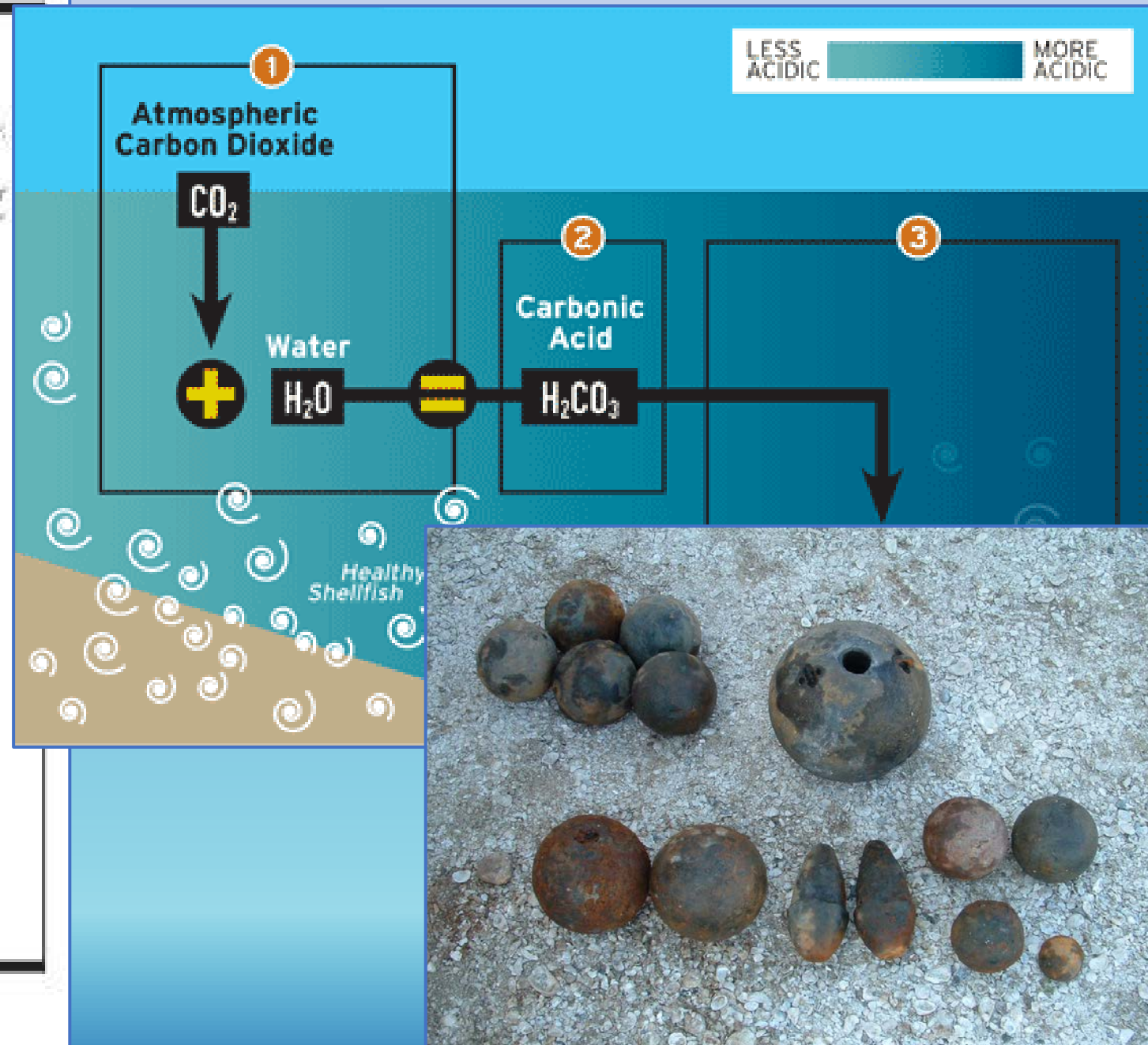
What is pH?



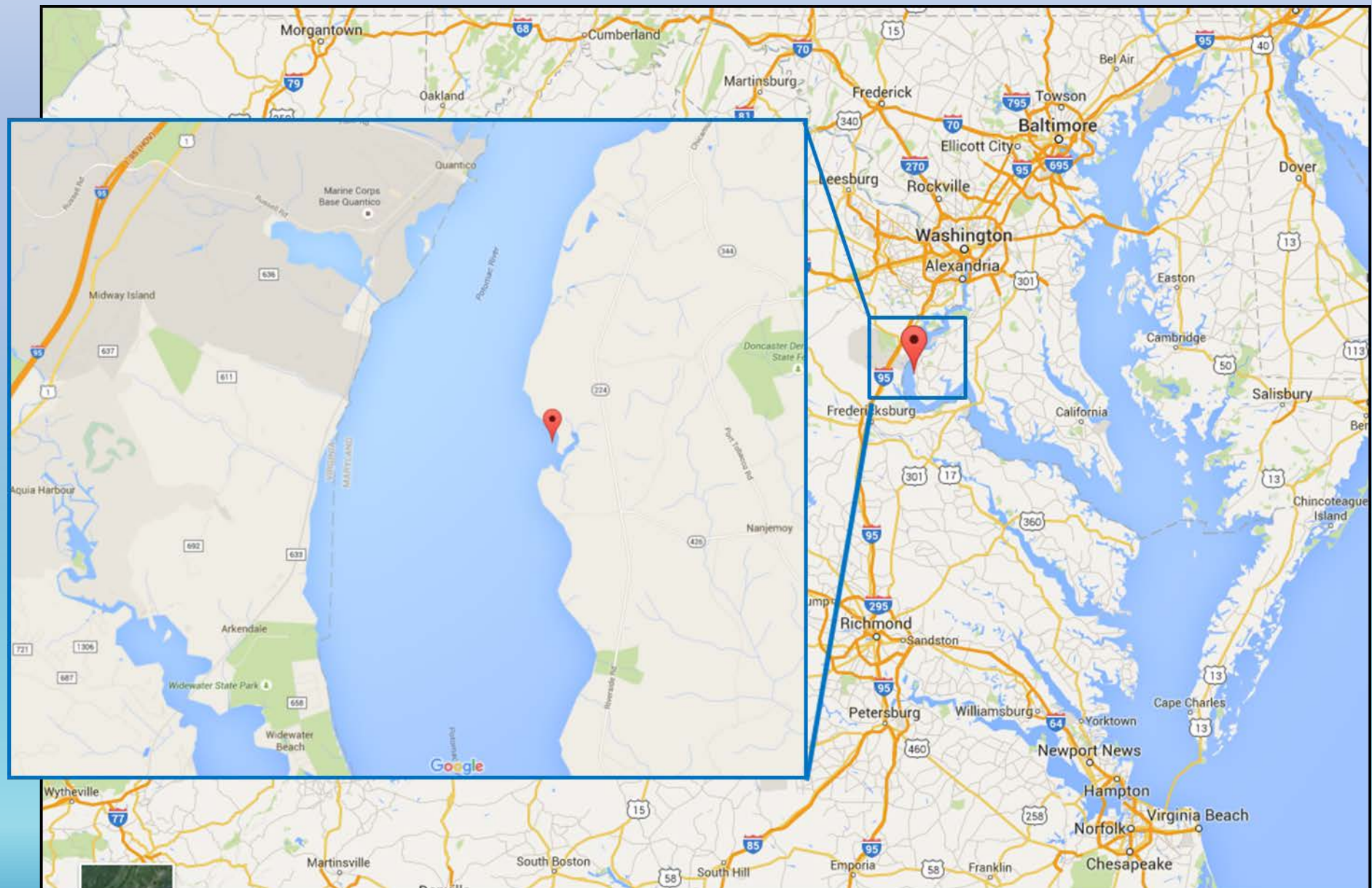
pH is a measure of acidity. On the pH scale, 7.0 is neutral, with points higher on the scale being "basic" and points lower being "acidic."

The pH of our ocean surface waters has already fallen by about 0.1 units from about 8.16 to 8.05 since the beginning of the Industrial Revolution around 200 years ago,¹ and it may fall by as much as 0.4 units by 2100.¹

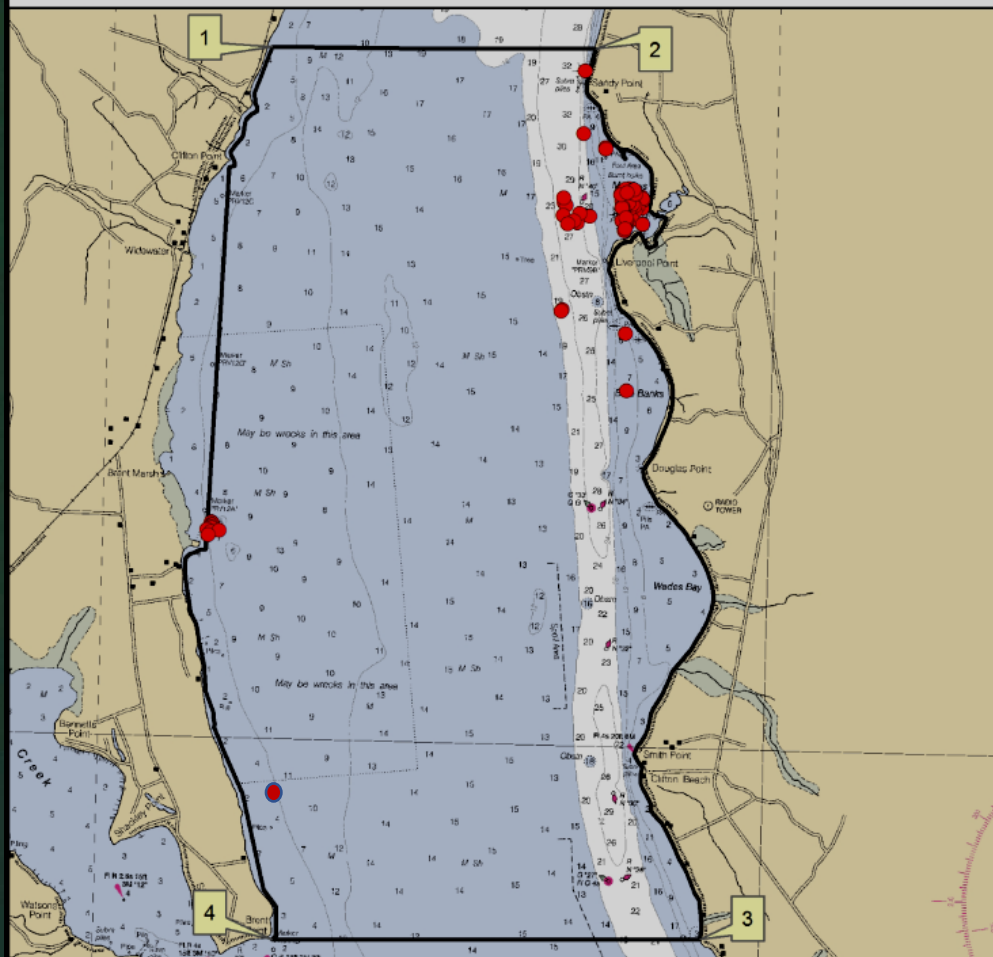
The oceans have not seen a change in pH this abrupt and large for at least 650,000 years, and many sea creatures require stable conditions to survive.



Source: Feely, Richard A., et al. (2006)
Carbon Dioxide and Our Ocean Legacy. Pew Trust



Map 1 of 1: Mallows Bay - Widewater Historical and Archaeological National Register District NOAA Chart 12288

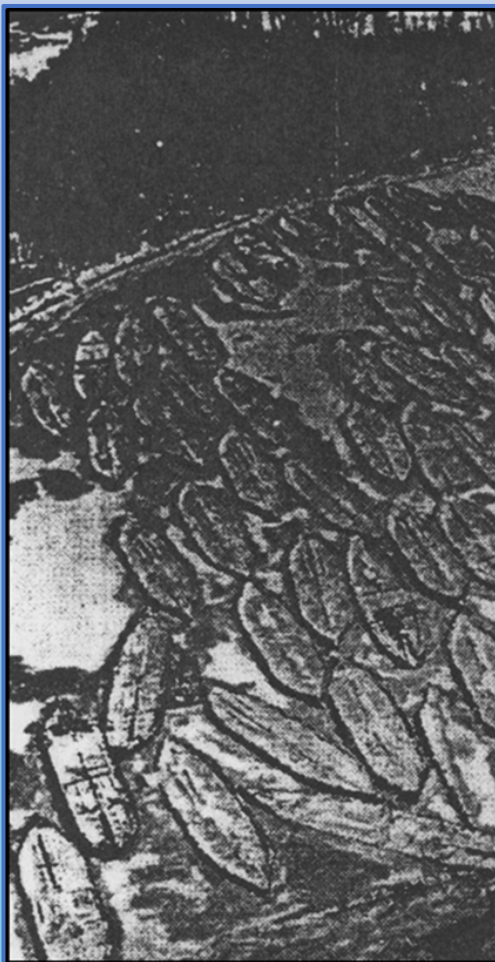


1. 4,262,158 N 298,204 E / 38.484933 N 77.313604 W
 2. 4,262,139 N 301,738 E / 38.485539 N 77.273109 W
 3. 4,252,380 N 30,2879 E / 38.397933 N 77.257294 W
 4. 4,252,380 N 298,201 E / 38.396890 N 77.310835 W

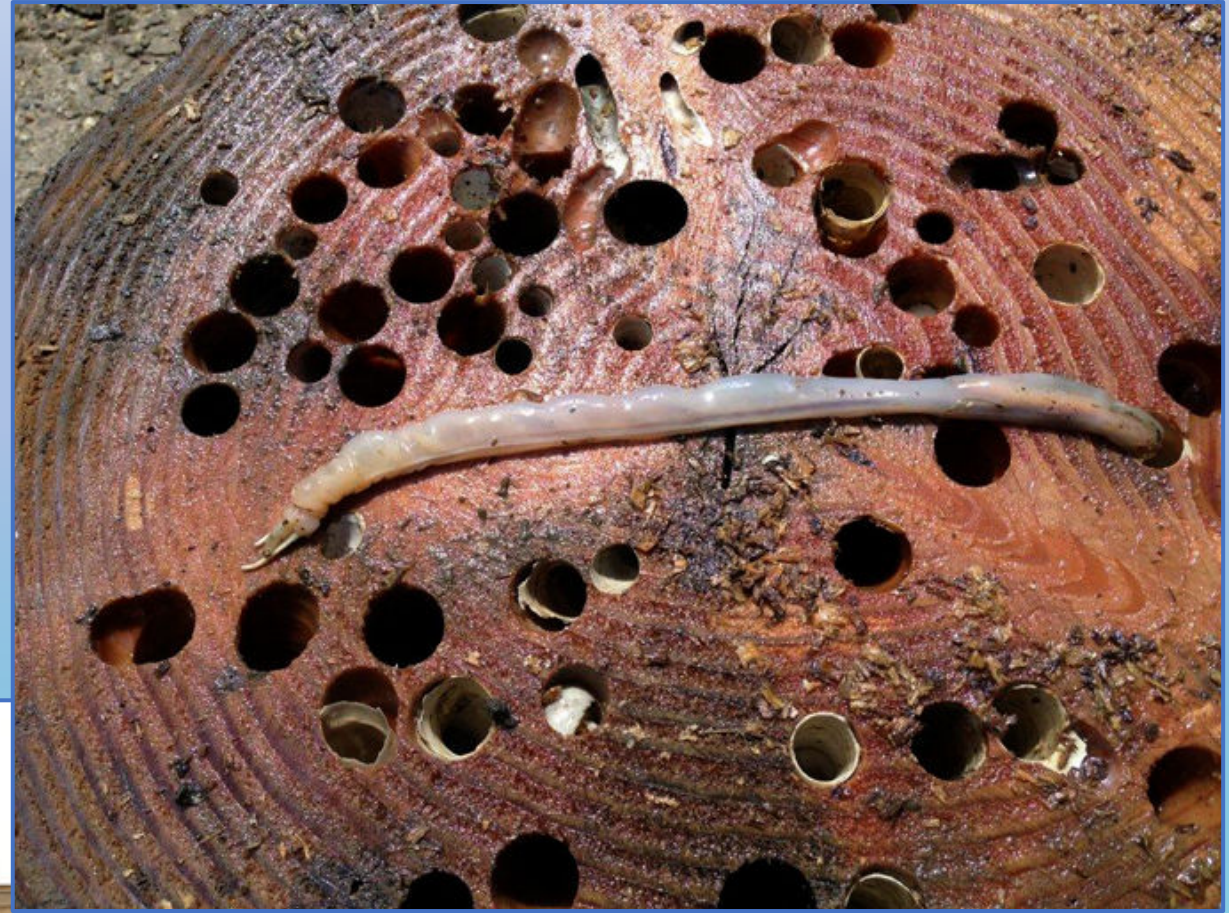
● Mallows Bay - Widewater Sites

□ Mallows Bay - Widewater NR District

0 1 2 3 Km









MARINE RESEARCH

Arctic shipworm discovery alarms archaeologists

Sunken log full of tunneling mollusks poses mystery

By Eli Kintisch, aboard the RV Helmer Hansson off Svalbard, Norway

Marine scientists made a surprise catch last month while trawling for sea creatures in the icy depths of Rippjorden, a remote bay in this Arctic archipelago: a log the size of a battering ram. Steel chains hauled the tree trunk up from the sea floor 250 meters below, startling crew and scientists alike. "In 15 years of coming here I've never seen such a big piece of wood from a bottom trawl," said marine biologist Jørgen Berge of the University of Tromsø (UT) in Norway, the cruise leader. Then, an even bigger surprise: The 7-meter log was infested with living shipworms, white and gooey.

The researchers were astonished because shipworms—mollusks adapted to tunnel into and eat wood—had never been documented so far north, just 1100 kilometers from the North Pole, and at such a depth, where the temperature was -1.8°C . Were the borers a southerly species that had moved north with warming seas, or a previously undescribed Arctic native? Either way, "this is a fantastic discovery, something we never would have dreamed of," Berge said.

For another team member, marine archaeologist Øyvind Ødegård of the Norwegian University of Science and Technology, Trondheim, the sight of the 6-centimeter-long creatures was more akin to a nightmare. Historical records suggest more than 1000 shipwrecks dot the coasts around Svalbard, harboring centuries of secrets.

Ødegård expected them to be safe from borers. "I believed because of the low temperatures we wouldn't find shipworms," he said. Now, he worries that they could devour the wrecks before scientists find them. Arctic shipworms would be "a disaster" for archaeologists, Berge predicts.

Mariners have cursed species in the genus *Teredo* since wooden ships first set sail. Individuals grow to a meter long, riddling hulls, piers, and other wood structures with undulating tunnels. Shipworms devoured three of Christopher Columbus's ships in 1503, during his fourth voyage to the Americas, marooning the crews. Today, the mollusks cause an estimated \$1 billion in damages annually, and have consumed wrecks from the tropics to southern Sweden.

As the oceans have warmed in recent decades, scientists have noticed the borers moving to higher latitudes. A few years ago, they infested a wooden dock at Longyear-



The burrowing mollusk's heads resemble drillbits.

byen, Svalbard's biggest town, says UT chemist Bjørn Altermark. To gauge shipworm abundance, in 2014 he placed a sample of spruce on a mooring near shore; a year later it had been attacked by a single borer. Researchers speculated that Atlantic currents might have swept shipworm larvae up from the south, or ships discharging ballast water might have released them.

Intrigued, Ødegård, the archaeologist, ran an experiment to determine their range. Last year, he and Berge placed oak planks in a nearby fjord that also receives Atlantic water, as well as in the distant Rippjorden, which is fed by the colder Arctic Ocean to the north. The Rippjorden samples were "meant to be a control," Ødegård recalls. He didn't expect to see shipworms in the frigid bay, and hadn't yet retrieved the planks when the log surfaced. "Astonishing," he says.

Scientists are now debating how the Rippjorden mollusks—now yet definitively identified—could thrive. Studies suggest that the most common shipworm species, *T. navalis*, cannot reproduce at temperatures below 10°C . So one scenario is that the log became infested in warmer waters to the south or east of Svalbard, then recently drifted into the fjord and sank.

But several factors hint at a second possibility: that researchers have discovered a new species or variant able to thrive near the freezing point of saltwater. Ample black sediments inside the log, as well as stringy marine organisms growing on its side, suggest it may have been on the sea floor for a year or more. And when researchers sliced open the wood, they found worms in many stages of development—including young "fresh worms," as Berge calls them—which suggested the community had been around a while. (Svalbard is treeless, but there is plenty of driftwood for shipworms to infest.)

"I'm depressed either way," Ødegård says. He takes some solace, however, from what he saw at a wreck that the *Helmer Hansson* visited just a few days after the log's discovery. The wooden whaler *Figaro* sank near Longyearbyen in 1908. Despite more than a century in the sea, however, digital pictures showed just minor traces of shipworm damage. Still, Ødegård worries that the hulk "is not going to do very well" over the next century if shipworms become more common in the Arctic.

More clues to the origins of the Rippjorden shipworms are expected soon. On the last day of the cruise, a researcher used a chainsaw to cut slices from the log. They've been distributed to scientists, including some who are using genetic markers to figure out whether the mollusks are something new to science—or just a familiar face in an unusual place. ■

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Shipworms Are Eating a Wreck That Could Be Captain Cook's 'Endeavour' | Smart News | Smithsonian Magazine

SMART NEWS

Shipworms Are Eating a Wreck That Could Be Captain Cook's 'Endeavour'

Marine biologist Reuben Shipway is sounding the alarm about the so-called termites of the sea

Sarah Kuta

Daily Correspondent

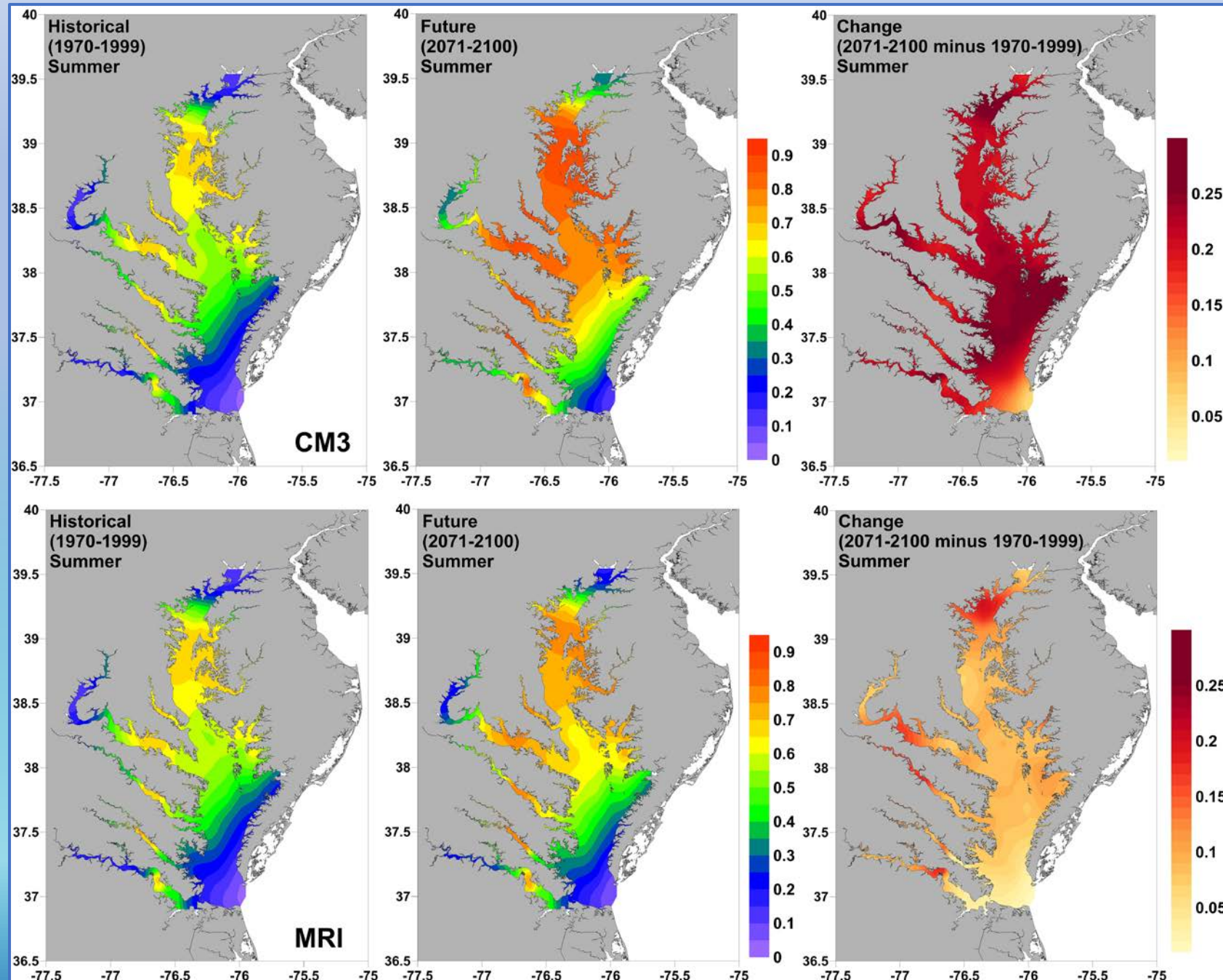
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James Cook, who began his famous voyage on the *Endeavour* in 1768 Public domain via Wikimedia Commons

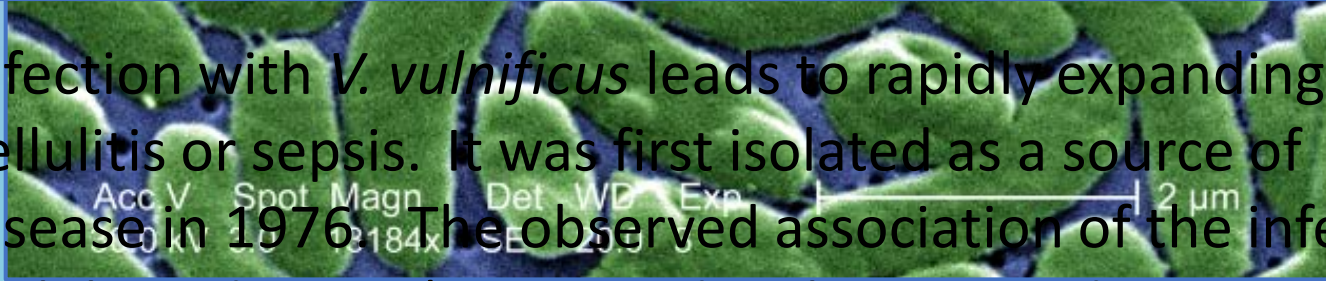
https://www.smithsonianmag.com/smart-news/shipworms-are-destroying-the-ship-believed-to-be-captain-cooks-endeavour-180980599/?utm_source=... 1/6





The probability of *Vibrio vulnificus* occurring in the water during the summer in Chesapeake Bay on a scale of 0 to 1. The X and Y axes are latitude and longitude.

Blue colors indicate little or no chance of warming and red indicates higher chances; 0.1 on the scale means 10% probability of occurring, while 0.25 means 25 % chance of occurring. The panels at left show the recent past, those in the middle show projections for the end of this century, and the panels at right show the difference.



Infection with *V. vulnificus* leads to rapidly expanding cellulitis or sepsis. It was first isolated as a source of disease in 1976. The observed association of the infection with liver disease (associated with increased serum iron) might be due to the capability of more virulent strains to capture iron bound to transferrin.

Fast-acting bacteria; frequently leads to amputation or death.



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Archeological sites

More than 12,600 archeological sites have been inventoried statewide

A total of 2611 archeological sites are potentially vulnerable within the 0-5 ft boundaries. This represents 20% of all recorded archeological sites statewide, and 32% of all of the sites recorded in the coastal counties studied.

The types of sites represented are predominantly prehistoric, ranging from Paleoindian to the contact period, but nearly a third have historic components, including 57 with identified 17th century components.

Most at risk:

Paleoindian (9,000-11,000 BC)

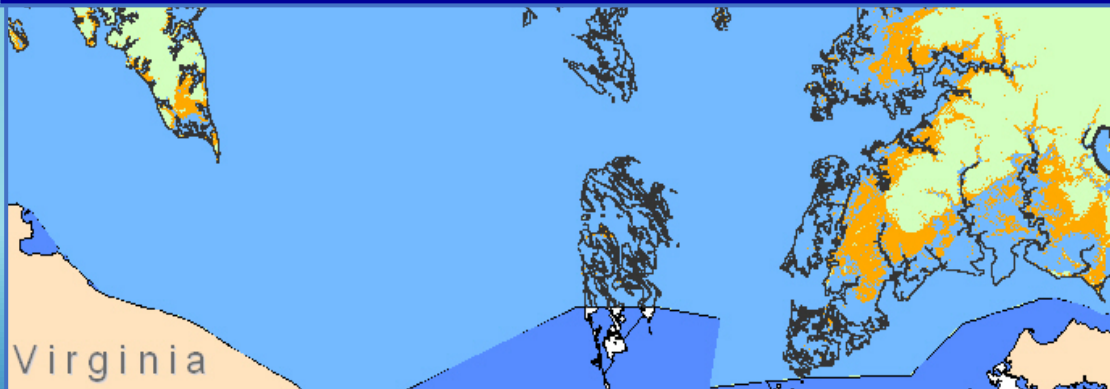
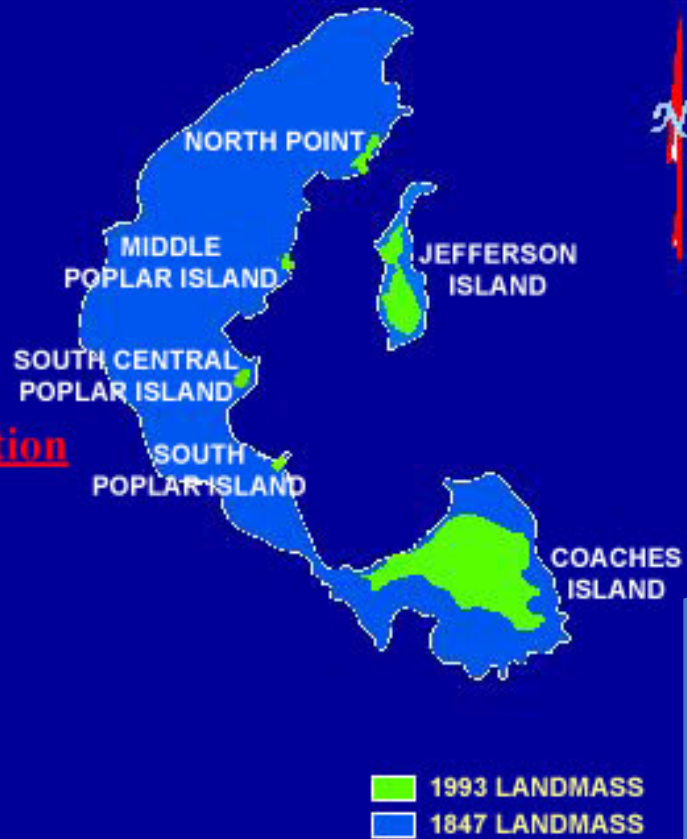
Contact Period and 17th Century

Total of 228 sites statewide

12 are already partially submerged



Poplar Island
Historic Configuration

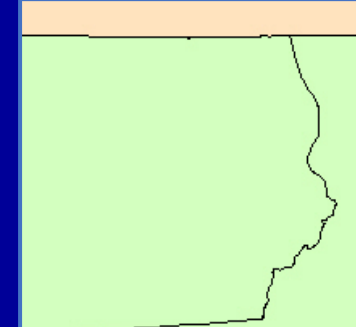


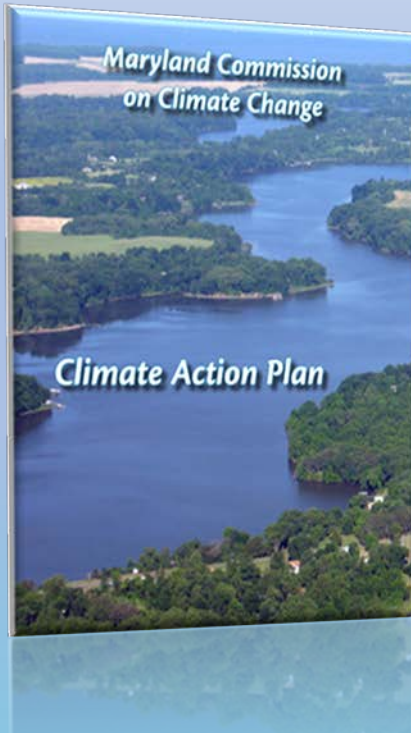
Recent Maryland Shoreline

- 5 ft inundation (year 2050 - 2100 est.*)
- 2 ft inundation (year 2000-2050 est.*)

Estimated timeframe for sea level rise

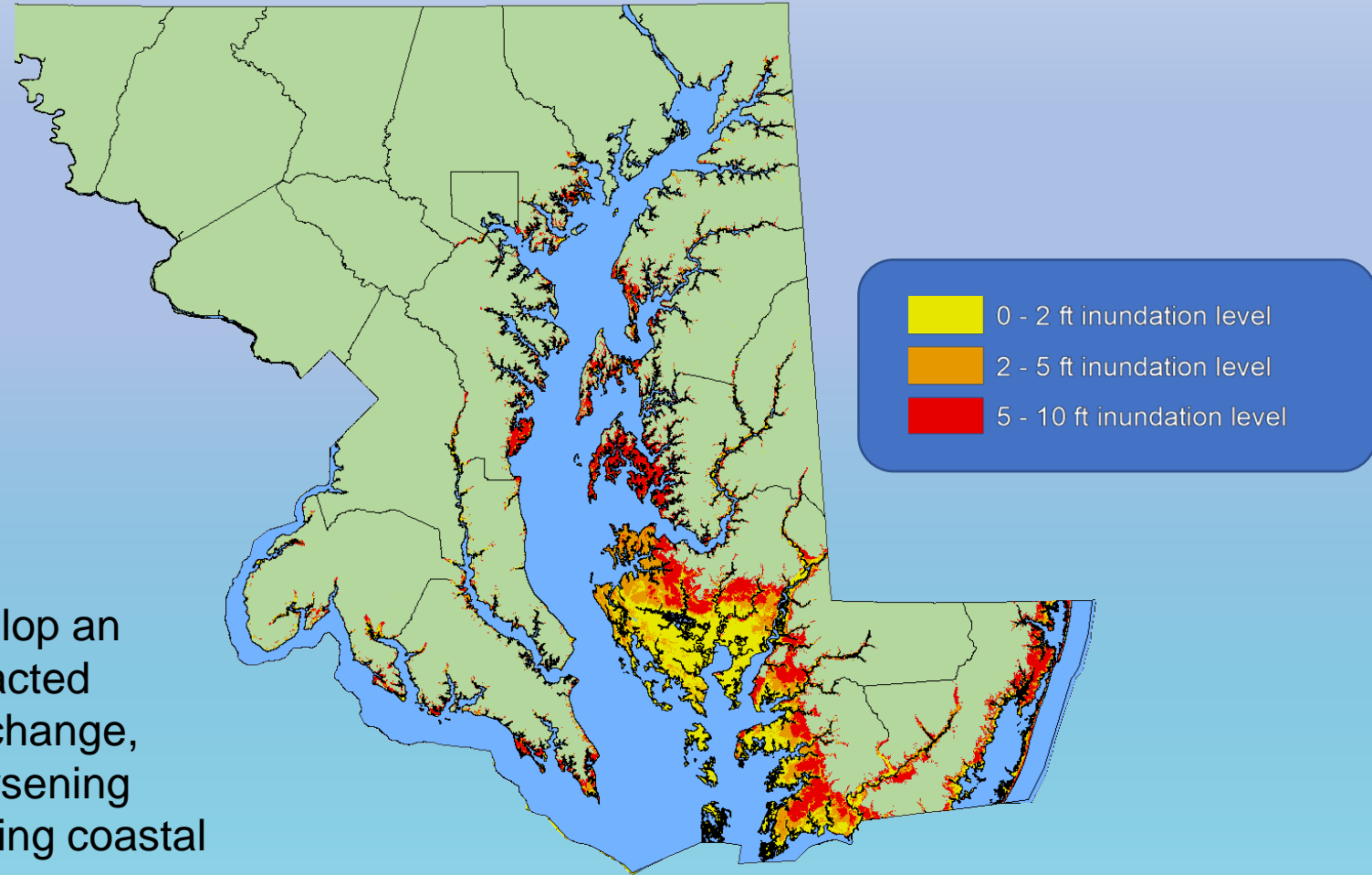
According to the MD Climate Change Action Plan





Identify resources and develop an inventory of potentially impacted infrastructure from climate change, including sea-level rise, worsening coastal storms, and worsening coastal erosion

Identify areas along Maryland's shoreline that are vulnerable to sea-level rise



	NHL		NRHP		Easements		MIHP		Eligible MIHP		Archeo		Eligible Archeo	
County	0-2 ft	2-5 ft	0-2 ft	2-5 ft	0-2 ft	2-5 ft	0-2 ft	2-5 ft	0-2 ft	2-5 ft	0-2 ft	2-5 ft	0-2 ft	2-5 ft
Anne Arundel	5	1	18	5	10	3	64	67	10		371	51	4	1
Baltimore County			5				22	8	5	3	26	16		
Calvert	2		9		3		66	37	5		102	20	2	
Caroline			7		2		24	12	9	2	35	6		1
Cecil	1		11	2	3	1	35	14	4	4	47	17	2	
Charles			6	1			35	9	9	1	140	28	4	1
Dorchester			8	3	1		98	154	3	4	283	50	4	
Kent	2		13	2	5	2	33	29	4	2	104	18		
Queen Annes			8	4	3	1	46	30	9	3	268	92	1	3
Saint Marys	3		15	4	7		63	55	6	8	302	66	8	3
Somerset			45	10	5	6	75	181	5	4	198	34		
Talbot	5		47	4	5	2	90	98	5	3	192	30	1	
Wicomico			7		2	2	37	52	10	4	48	6	1	
Worcester			8	4			15	41	6	9	47	14	1	
	18	1	207	39	46	17	703	787	90	47	2163	448	28	9
Statewide Totals	19		246		63		1490		137		2611		37	

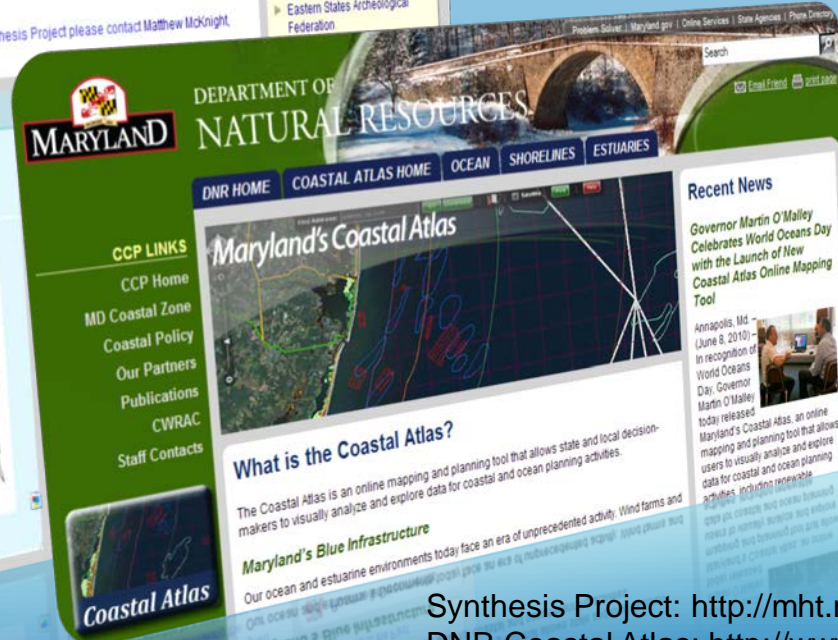




Phase II – Model Enhancement

Data:

- Phase II/III Data from Archeological Synthesis Project (High Research Potential)
- Erosion Vulnerability Assessment
- Shoreline rates of change
- Shoreline Inventory – general condition



Synthesis Project: http://mht.maryland.gov/archeology_synthesis.html
DNR Coastal Atlas: <http://www.dnr.state.md.us/ccp/coastalatl/index.asp>

CoastSmart Communities: Partners in Adaptation

- Provides tools, assistance, training, and funding to local governments to increase on-the-ground resiliency to coastal hazards and sea level rise.

