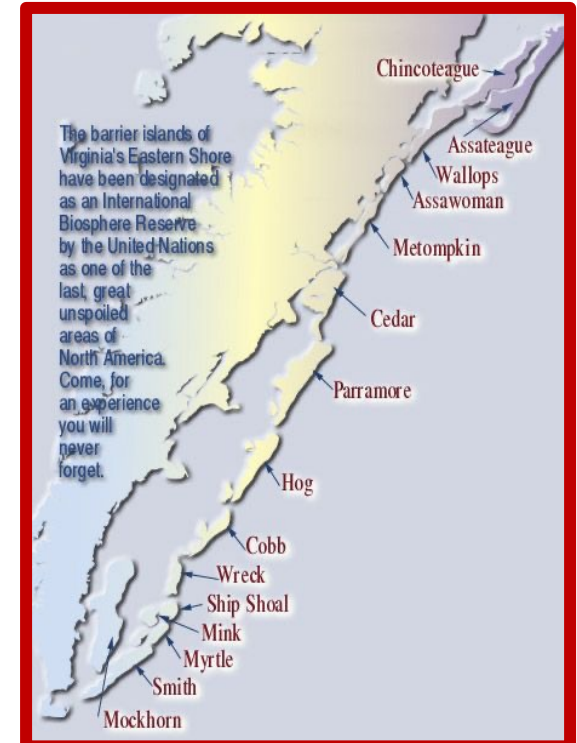


# Lifetime Learning Institute, June 21, 2022



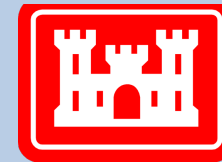
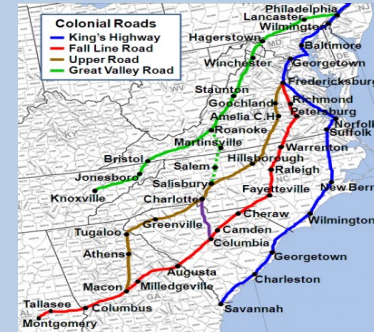
## 22SU09 – GEOLOGIC HISTORY OF THE CHESAPEAKE BAY AND VIRGINIA'S BARRIER ISLANDS.

*Barry Centini, Ph.D.*

[barry.centini@verizon.net](mailto:barry.centini@verizon.net)

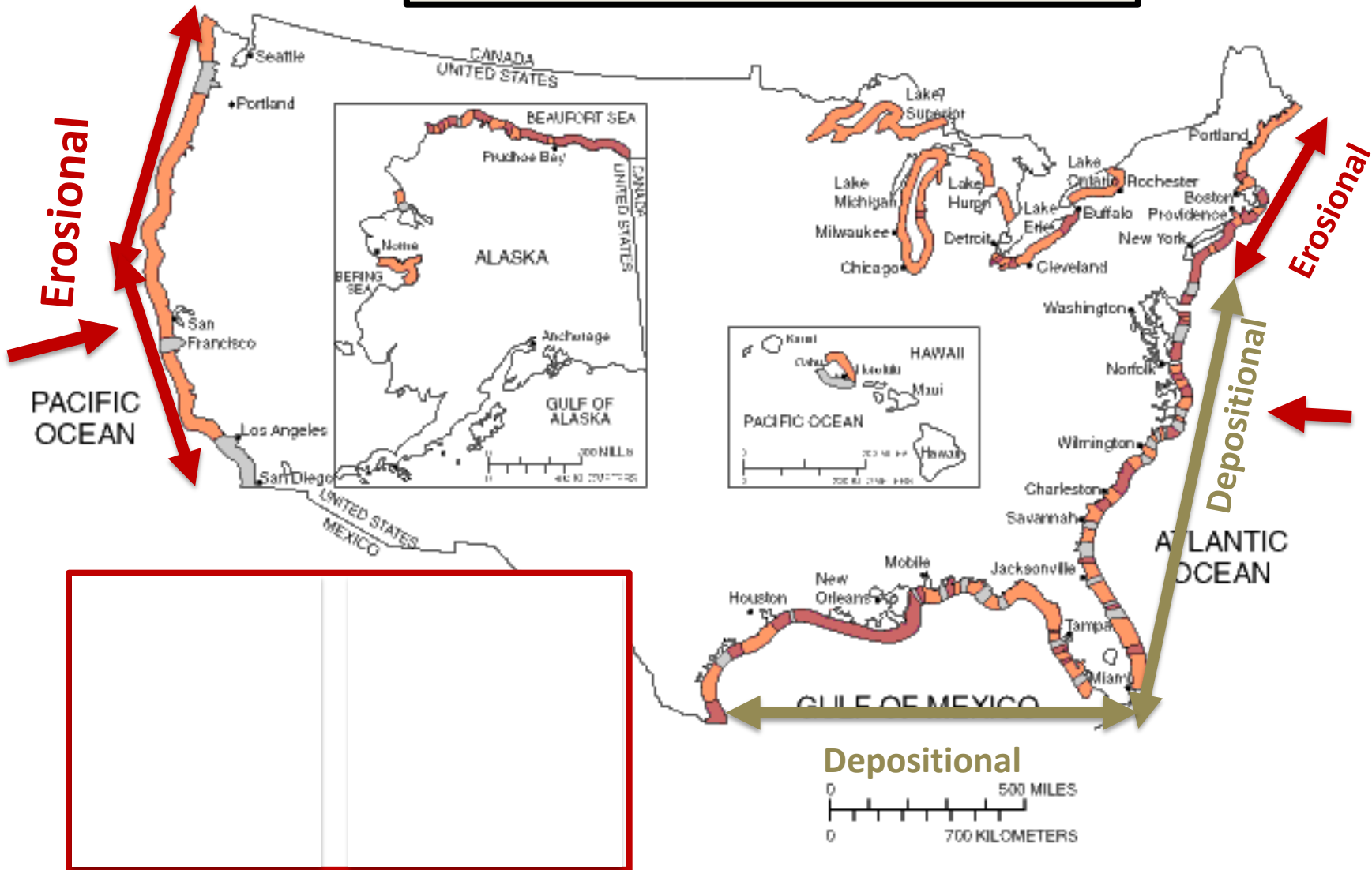
# WHAT WE WILL TALK ABOUT

- Virginia's Coastal Plain
  - ✓ Geologic History
  - ✓ Coastal Plain
  - ✓ Fall Line
- Chesapeake Bay's Watershed
- Impact Origin of the Bay
- Subsequent Modifications of the Bay
- Virginia's Barrier Islands
  - ✓ Origins
  - ✓ Natural Modifications
- Climate Change

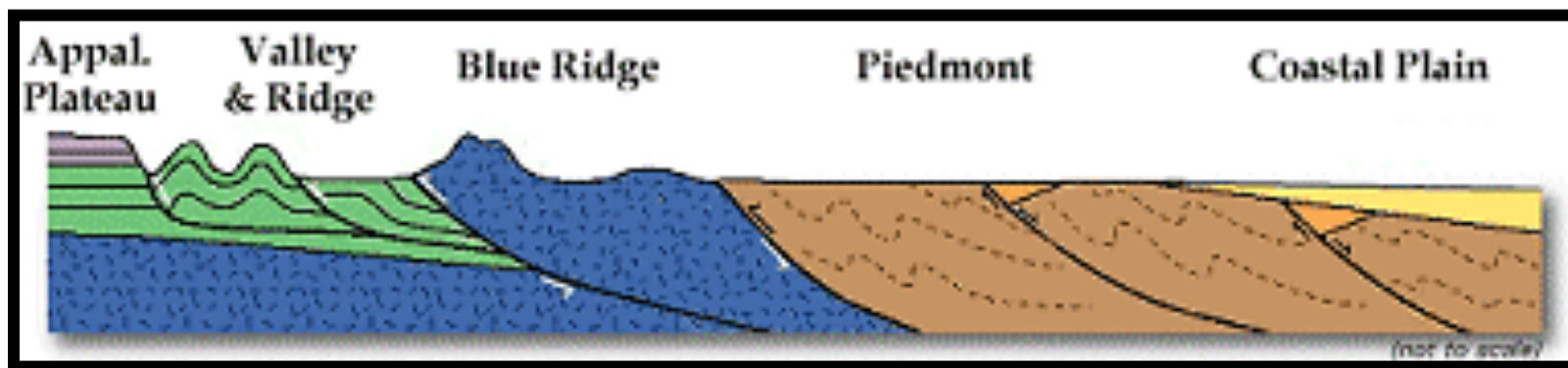
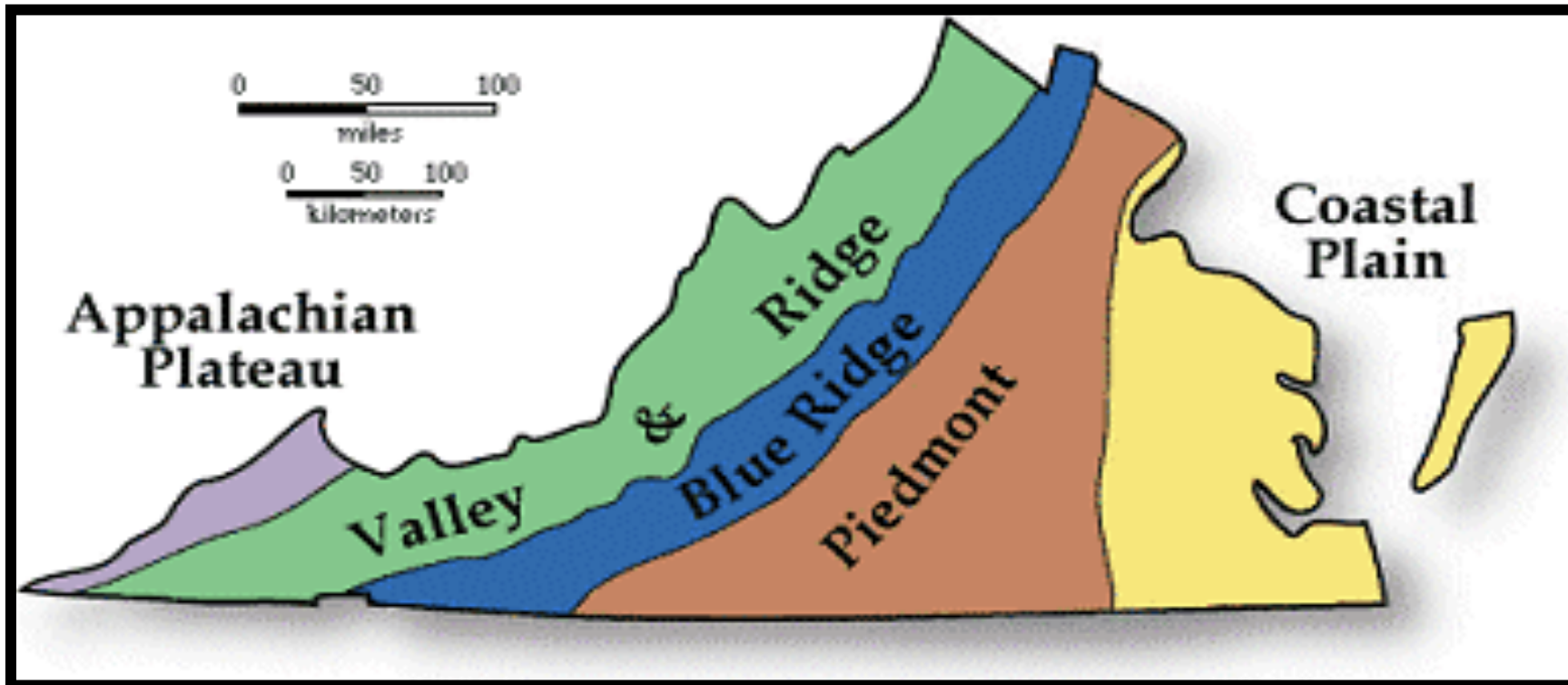


**US Army Corps  
of Engineers®**

# EROSIONAL & DEPOSITIONAL COASTS OF US



# Physiographic Provinces of Virginia

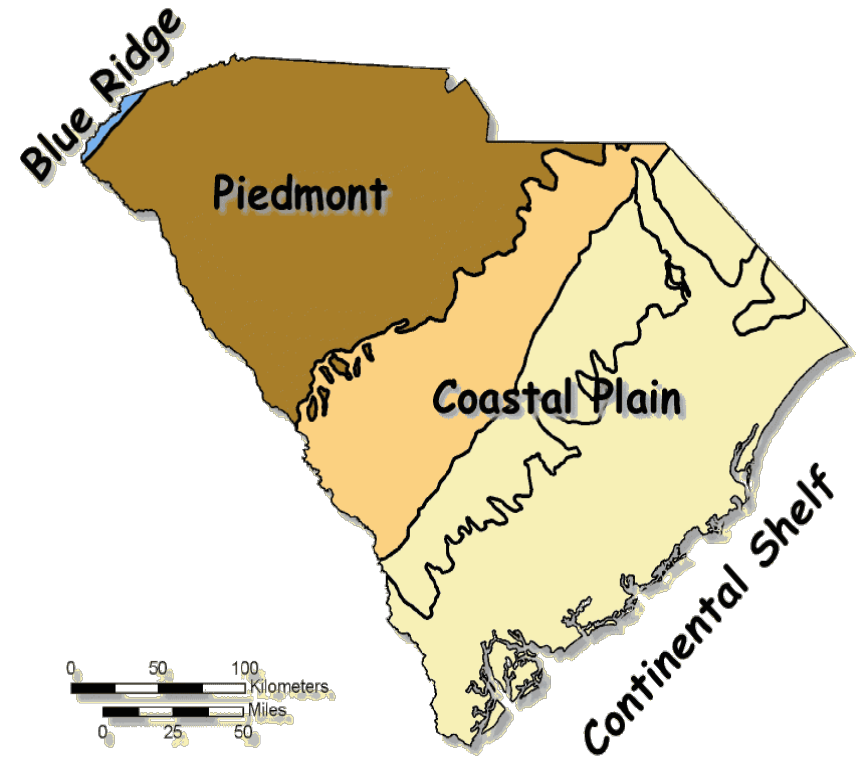


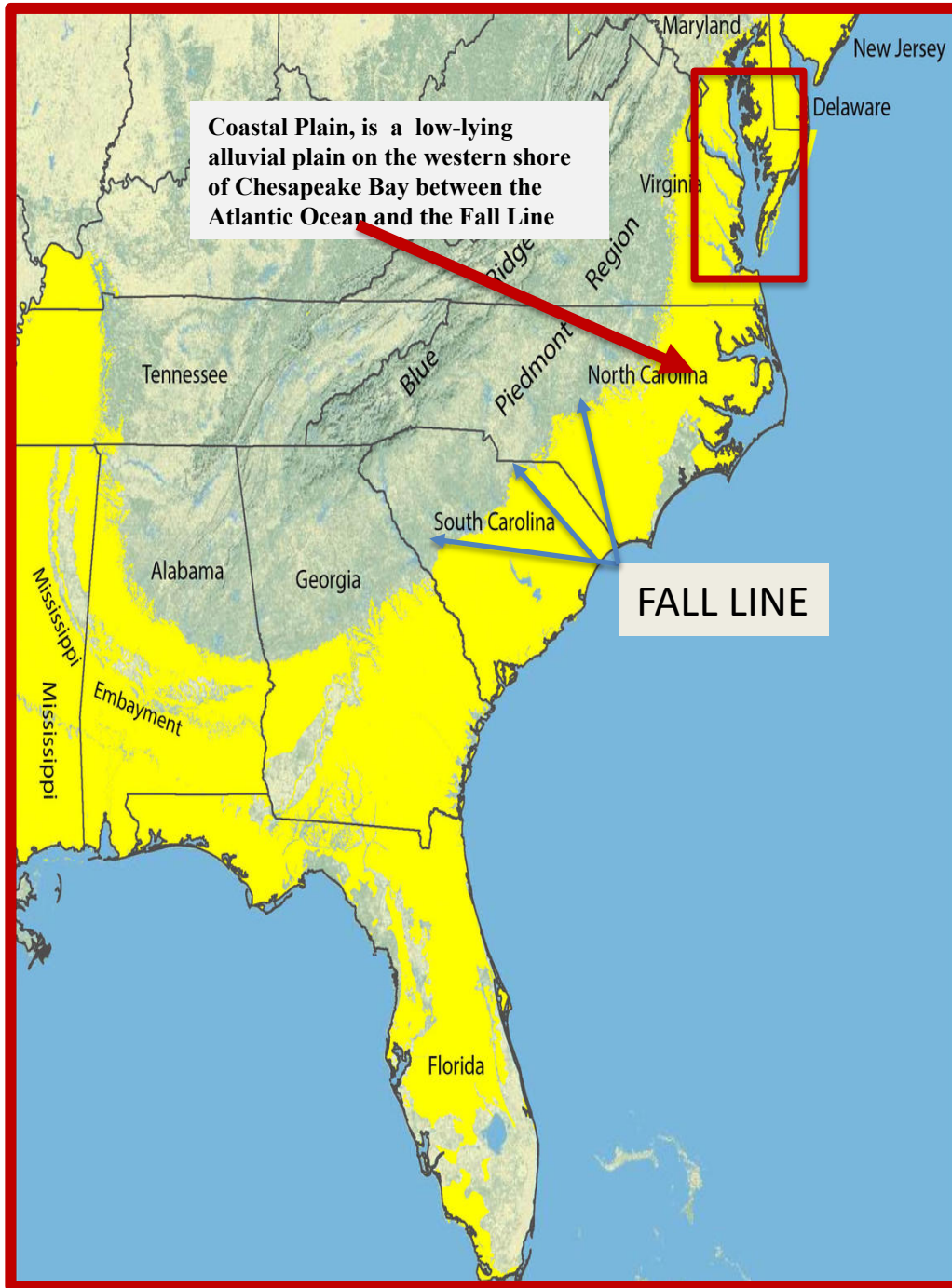
# Geologic Cross Section Map of Virginia

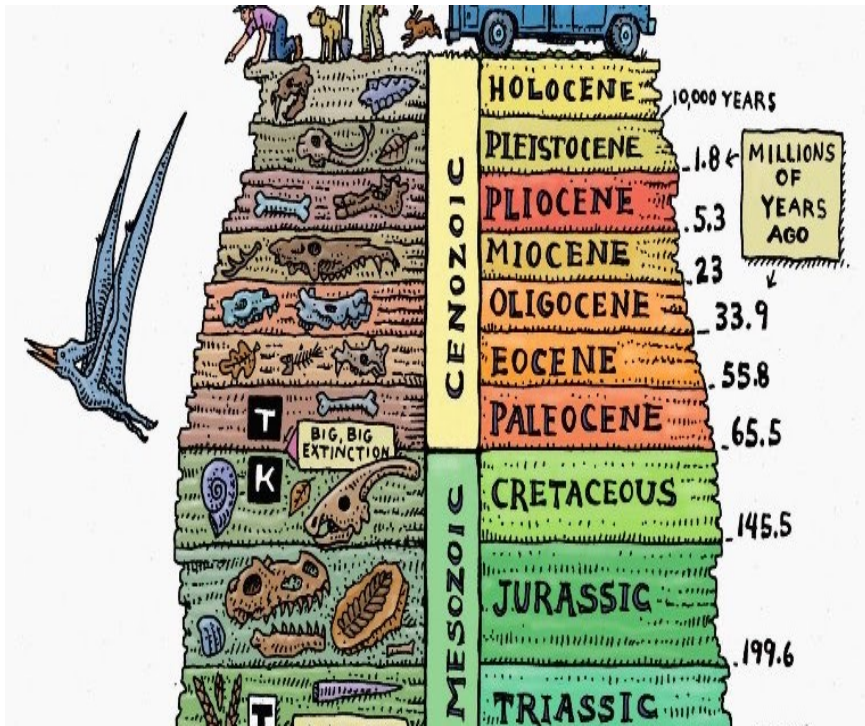


# How Geology Affects What You Eat (with the help of Ed McKnight)

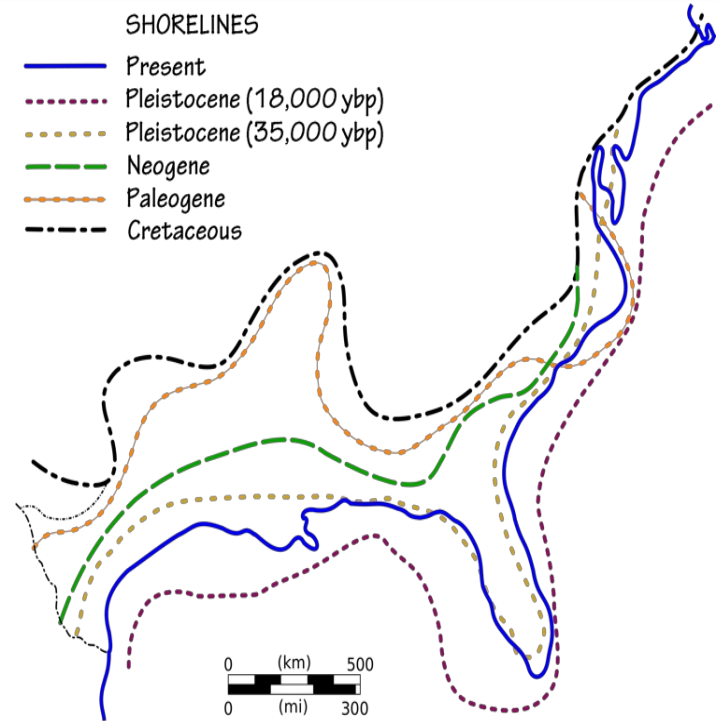
**Tell me what you barbecue you eat and I'll tell you  
what physiographic province you are from.**



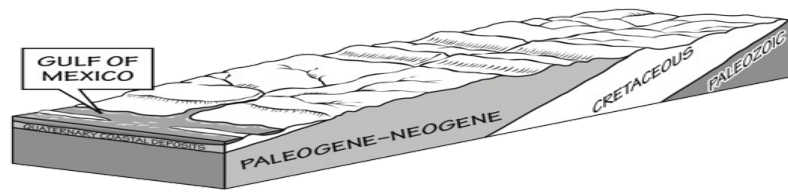




**Generalized Geologic Time Scale**



**Shoreline positions along the Coastal Plain during the past 70 million years**



**Millions of years of sediment accumulation in the basins caused coastal areas to subside, creating a gentle slope toward the Gulf of Mexico.**



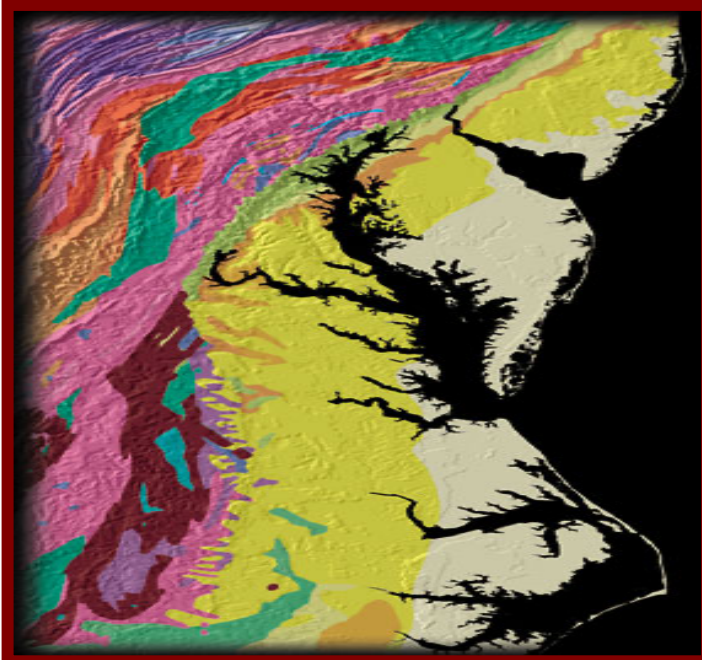
## Fall Line



**A fall line is a contact between hard crystalline basement rocks and softer sedimentary rocks causing rapids or waterfalls.**

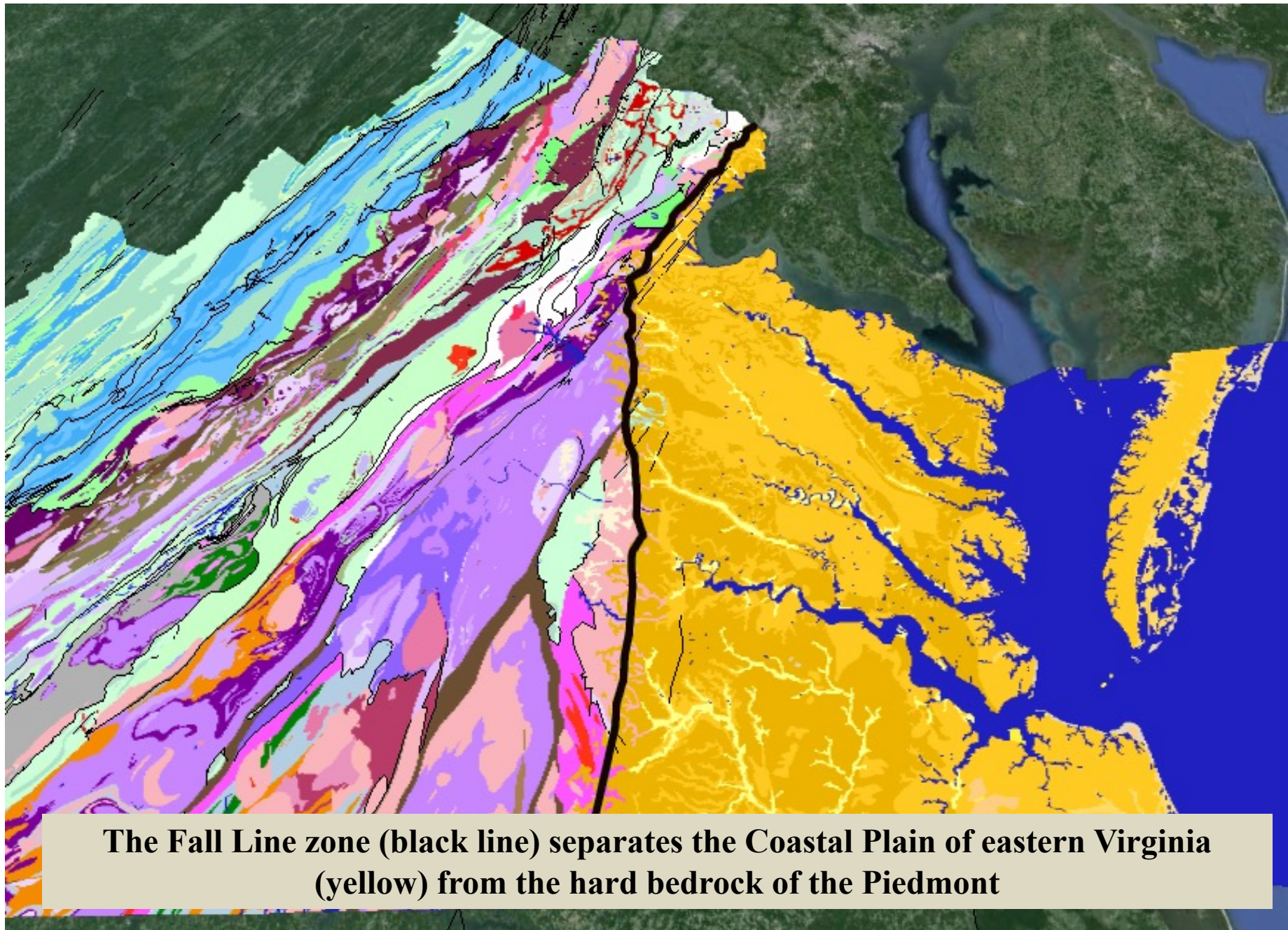
**Because of these features, riverboats cannot travel any farther inland without portaging, unless locks are built there.**

**On the other hand, falls make it a good location for water mills, grist mills, and sawmills.**



**Because of this, settlements often develop where rivers cross a fall line.**





**The Fall Line zone (black line) separates the Coastal Plain of eastern Virginia (yellow) from the hard bedrock of the Piedmont**

## Fall Line Cities

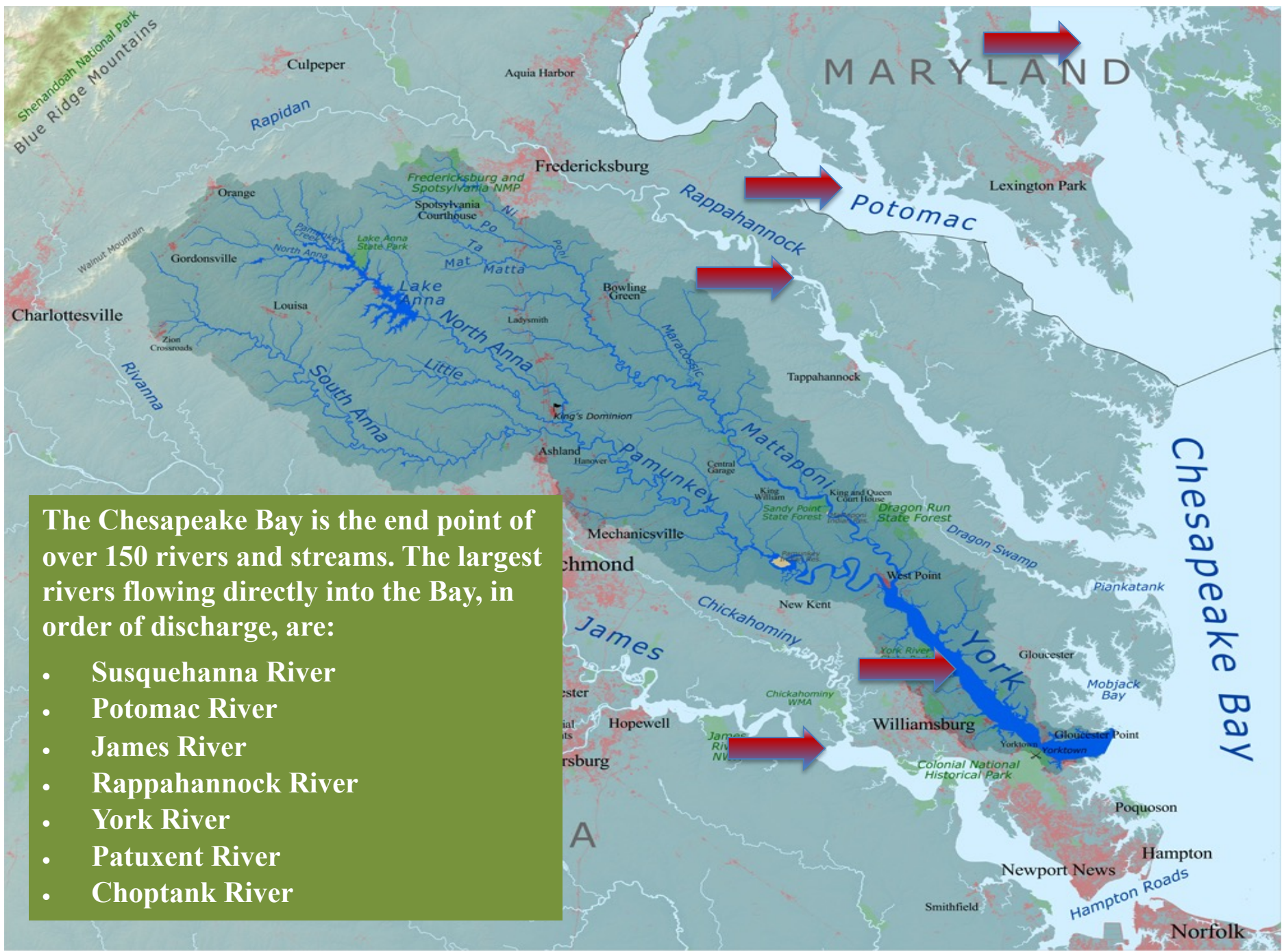
- **Wilmington, Delaware**
- **Baltimore, Maryland**
- **Washington, DC**
- **Richmond, Virginia**
- **Durham, North Carolina**
- **Raleigh, North Carolina**
- **Columbia, South Carolina**
- **Augusta, Georgia**
- **Milledgeville, Georgia**
- **Macon, Georgia**
- **Columbus, Georgia**
- **Montgomery, Alabama**





The Chesapeake Bay is the end point of over 150 rivers and streams. The largest rivers flowing directly into the Bay, in order of discharge, are:

- Susquehanna River
- Potomac River
- James River
- Rappahannock River
- York River
- Patuxent River
- Choptank River







**CHESAPEAKE WATERSHED**  
 The word Chesepiooc is an Algonquian word referring to a village "at a big river."



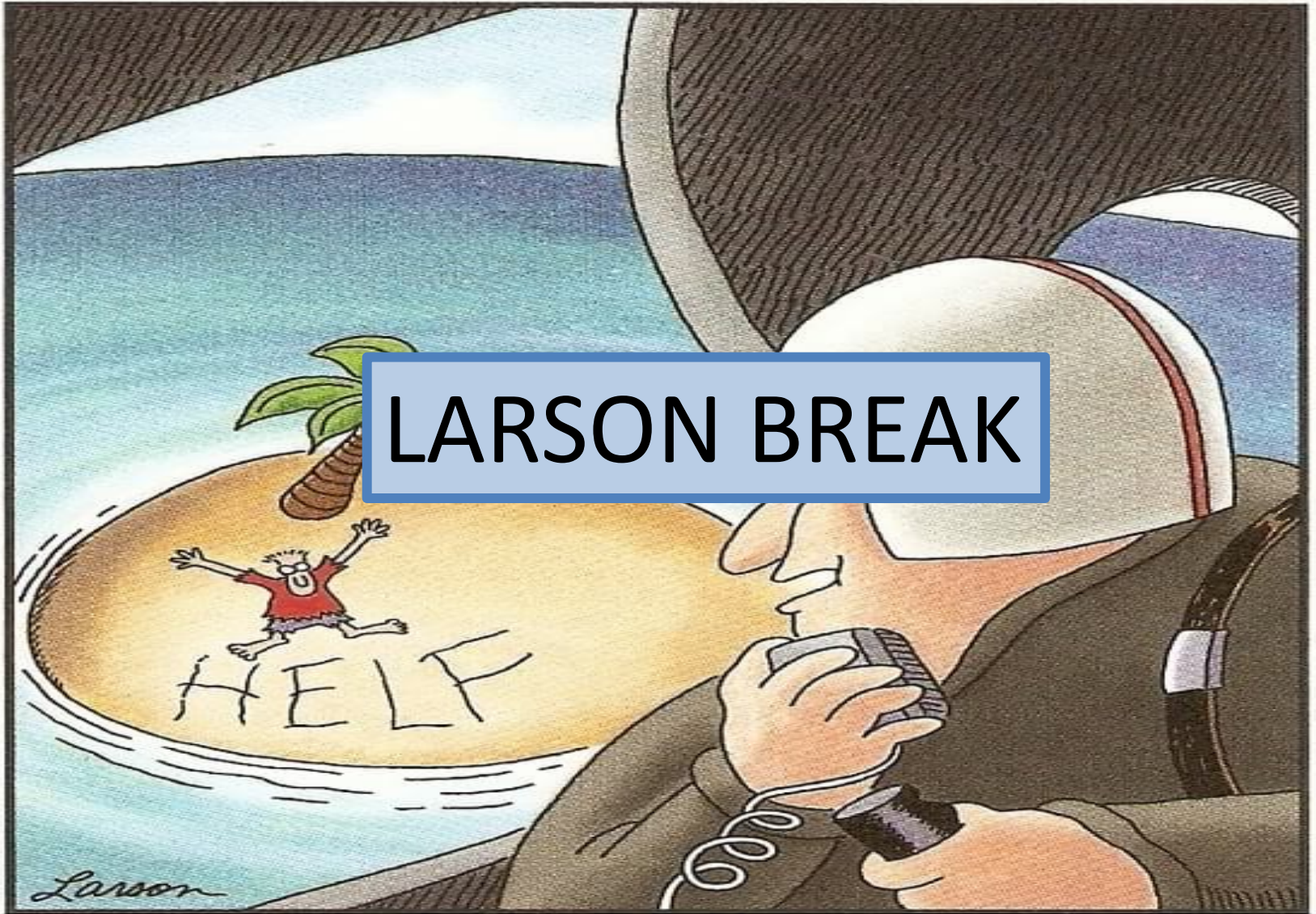
My Hometown:  
 Born in Chesapeake Watershed in 1937

Wrong side of the ridge story

Live today in Chesapeake Watershed area.







“Wait! Wait! Cancel that. ... I guess it says ‘helf.’”

Era	Period	Epoch	Age
Cenozoic	Quaternary	Holocene	0.01 Ma
		Pleistocene	
	Tertiary	Pliocene	1.8 Ma
		Miocene	5 Ma
		Oligocene	24 Ma
		Eocene	34 Ma
		Paleocene	55 Ma
		Late	65 Ma
Mesozoic	Cretaceous	Early	99 Ma
		Late	144 Ma
	Jurassic	Middle	159 Ma
		Early	180 Ma
		Early	206 Ma

Ma: Million years before present



**Chesapeake Bay impact**

**Popigai**

**Cretaceous–Tertiary extinction**, a global extinction event responsible for eliminating approximately 80 percent of all species of animals at the boundary between the Cretaceous and Paleogene periods, about 66 million years ago.

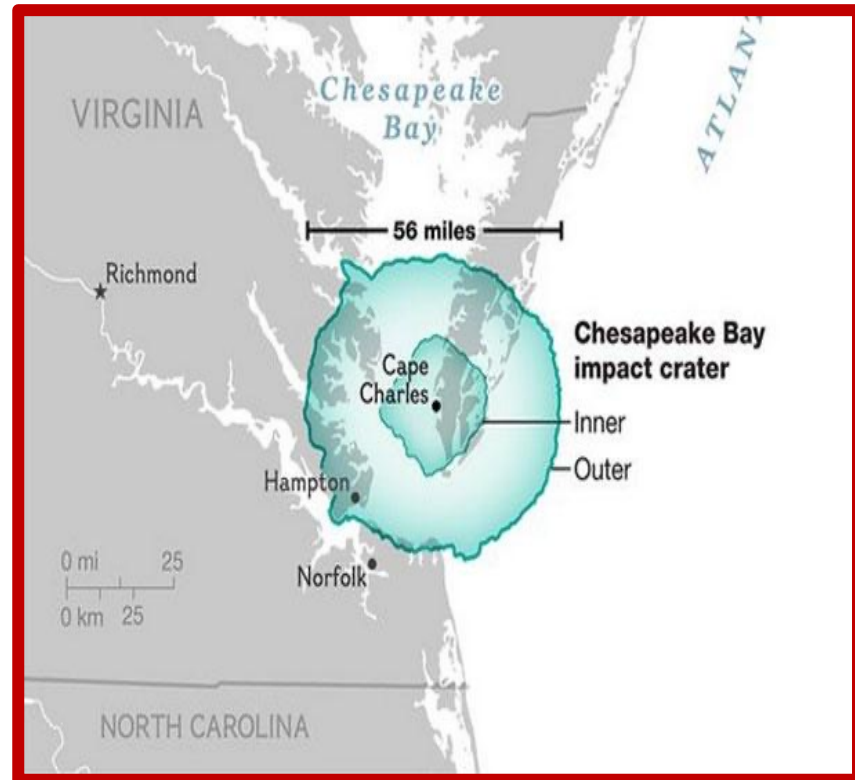
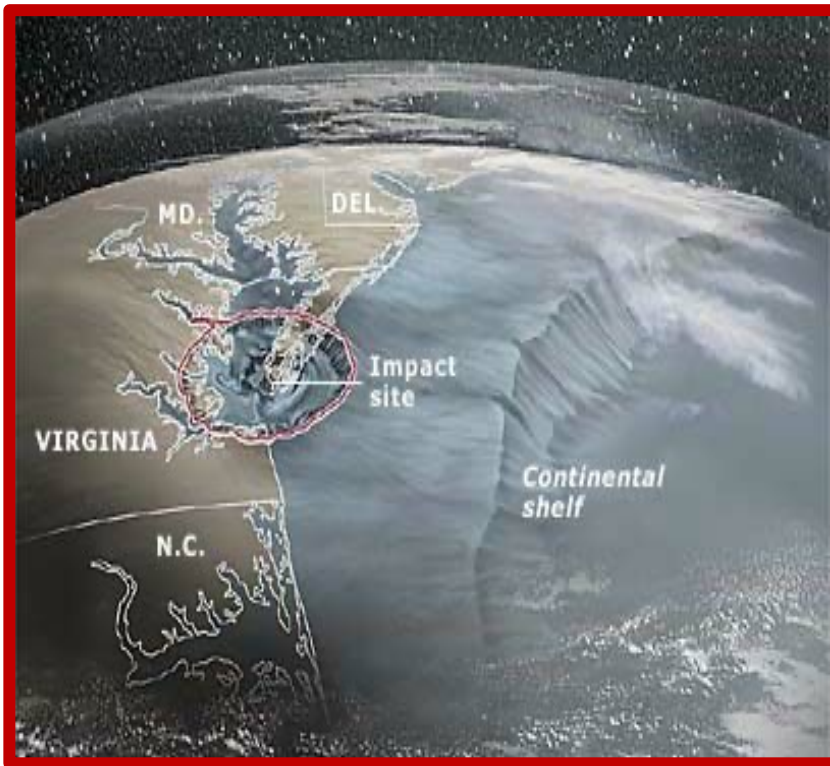
- ✓ The **Popigai** crater in [Siberia, Russia](#), is for the [fourth largest](#) verified [impact crater](#) on [Earth](#).<sup>1</sup> A large [bolide](#) impact created the 62 mi diameter crater approximately 35 million years ago.
- ✓ It might be linked to the [Eocene–Oligocene extinction event](#)







- ✓ Thirty-five million years ago, sea levels were much higher, and the coastline of present-day North America was much further to the west.
- ✓ Much like today, a broad continental shelf lay beneath the ocean, extending east toward the edge of the coastal plain.
- ✓ It was into this continental shelf that a 2-to-3 mile wide bolide (meteoroid) collided.
- ✓ It is one of the best-preserved "wet-target" impact craters in the world



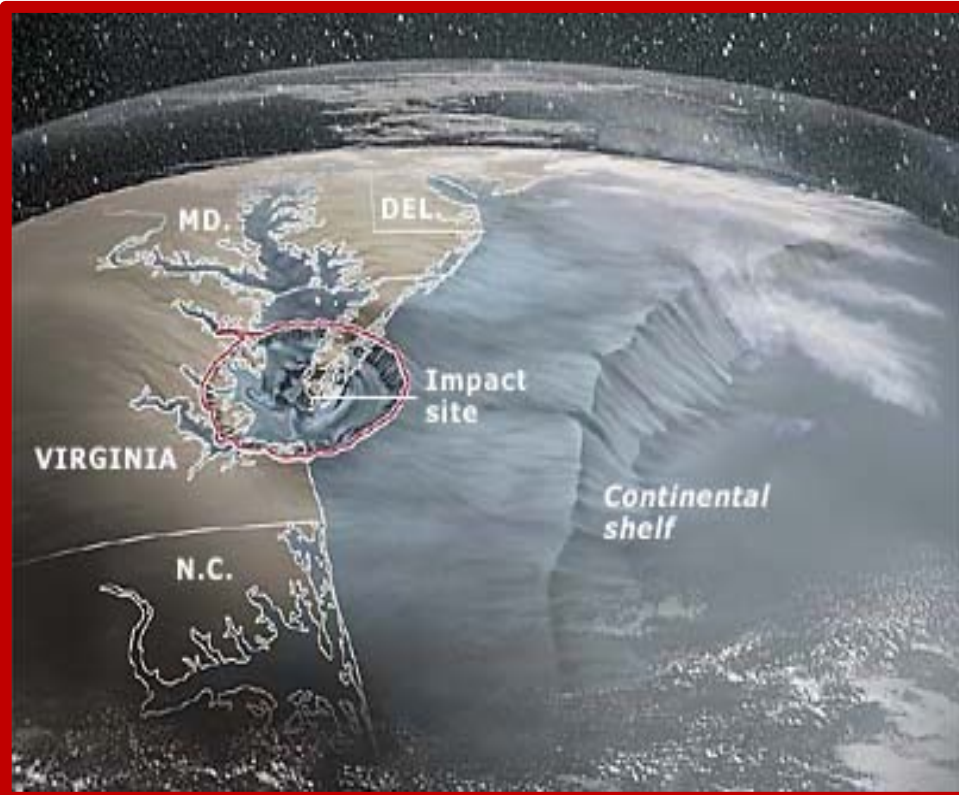
- ✓ The bolide created a crater as deep as the Grand Canyon and as wide as Rhode Island.
- ✓ For 35 million years the crater has been filled with thousands of feet of sediment.
- ✓ However, the crater created a depression in the landscape toward which rivers converged, and helped to determine the location of the Chesapeake Bay
- ✓ Other processes key to the formation of the Chesapeake Bay, the Delmarva Peninsula and consequently Assateague Island are:
  - ❖ sea-level fluctuations
  - ❖ erosion
  - ❖ deposition



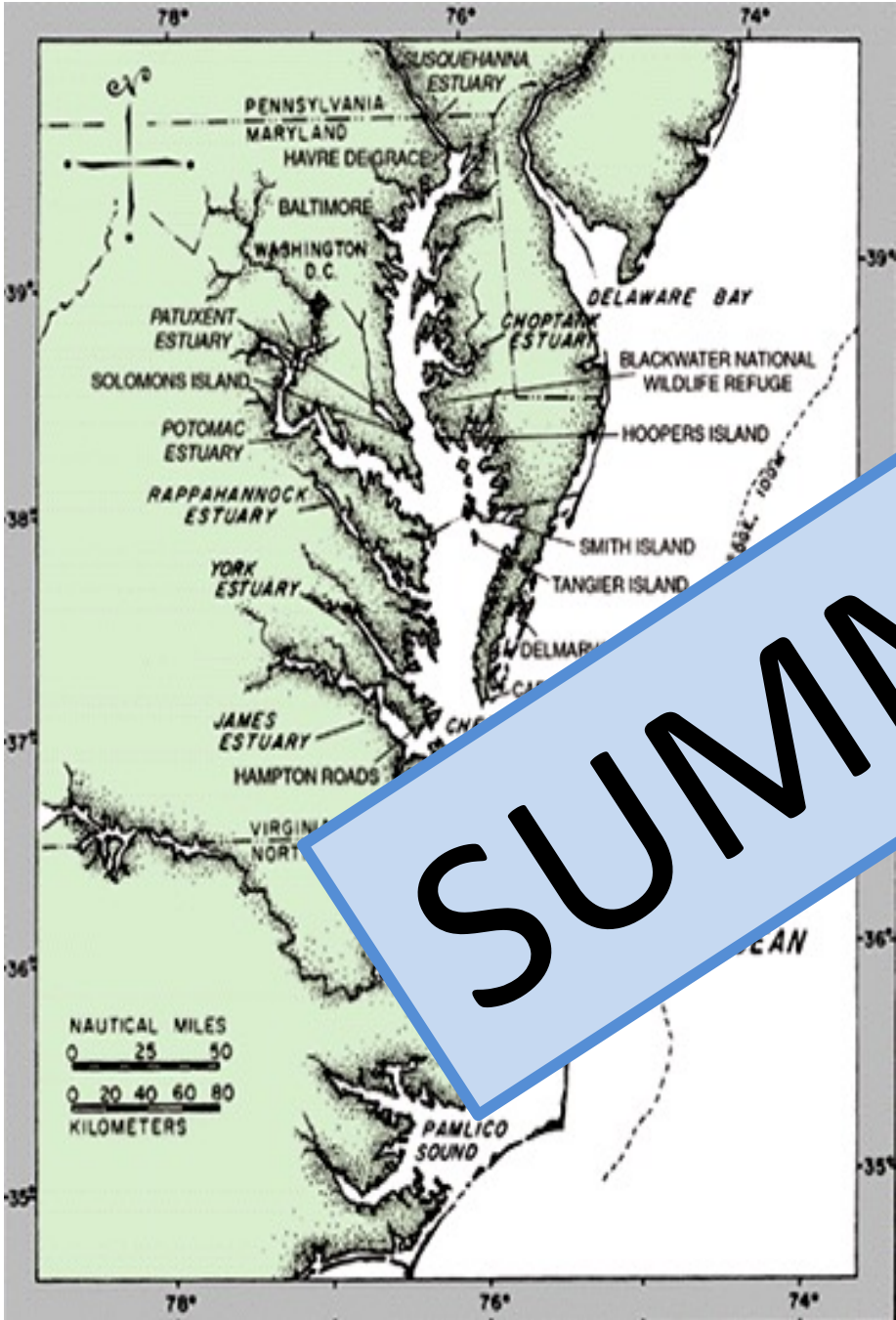
- ❑ **18,000 years ago, the bay region was dry land.**
- ❑ **Last great ice sheet lowered sea level 320 feet exposing what is now bay bottom and continental shelf.**
- ❑ **Low sea level allowed major rivers to cut narrow valleys.**
- ❑ **10,000 years ago, ice sheets melted rapidly.**
- ❑ **Sea level rose flooding shelf and the coastal river valleys.**
- ❑ **The flooded valleys became major modern estuaries, like Delaware Bay and Chesapeake Bay.**



- ❑ The rivers of the Chesapeake region converged at a location **directly over the buried crater**.
- ❑ While most rivers, like the Rappahannock, flow southeastward to the Atlantic, the York and James Rivers make sharp turns northeast near the outer rim of the crater.
- ❑ Over the past century, Chesapeake Bay waters have risen about 1 foot, and are predicted to rise another 1.3 to 5.2 feet over the next 100 years.
- ❑ This is faster than the global average because the land around the Bay is sinking through a process called isostatic subsidence.

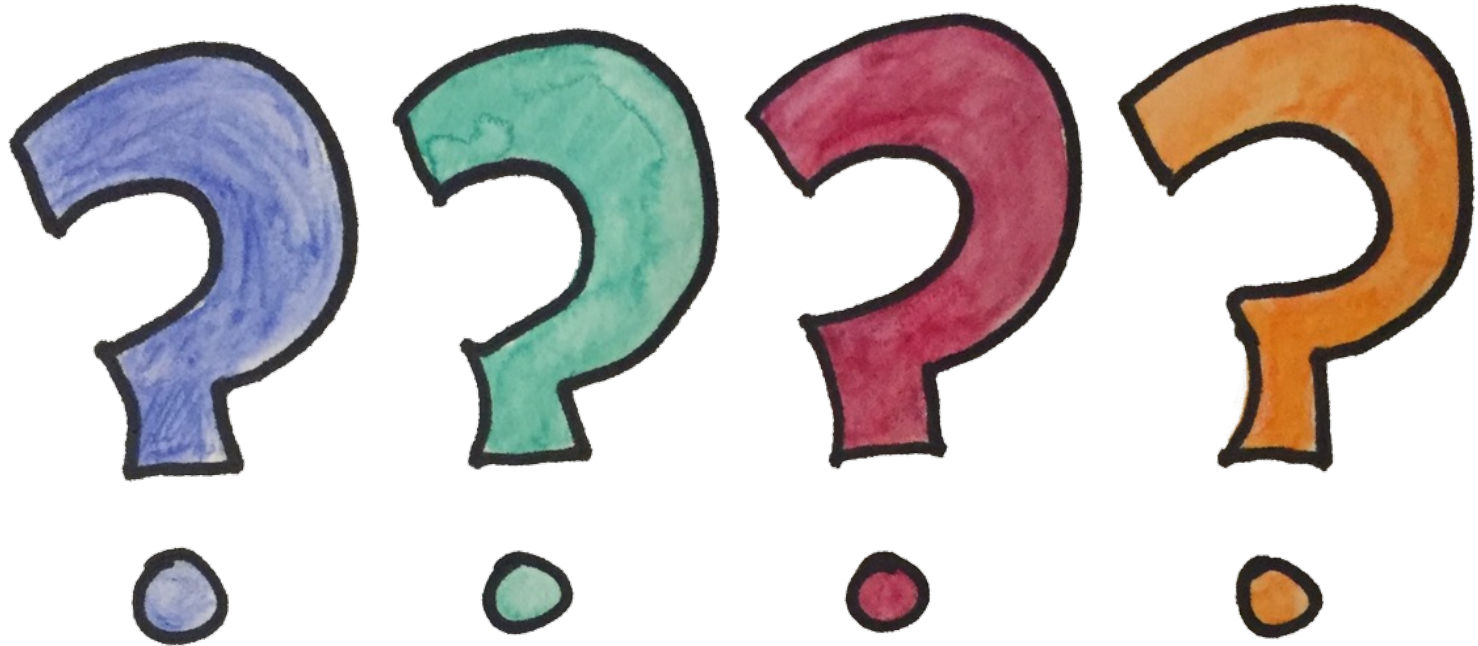






# SUMMARY

- ✓ The Chesapeake Bay is the drowned, ancestral valley of the Susquehanna River.
- ✓ 18,000 years ago, the Susquehanna river flowed to the edge of the continental shelf. At that time, sea level was approximately 100 meters lower than the present level.
- ✓ At the end of the last glacial epoch, sea level rose as continental glaciers melted.
- ✓ Between 6,000 and 7,000 years ago, submergence began to slow, and the Bay took on its characteristic drowned river valley pattern.
- ✓ Sea level at that time stood 9 meters lower than the present level.





CHESAPEAKE  
SEPTIC SYSTEM  
AND  
DRAINAGE OVERFLOW  
AND RUNOFF TANK

I  
PREFERRED  
'BAY.'



CARTOONSTOCK  
A CARTOON COLLECTIONS COMPANY

TOLES

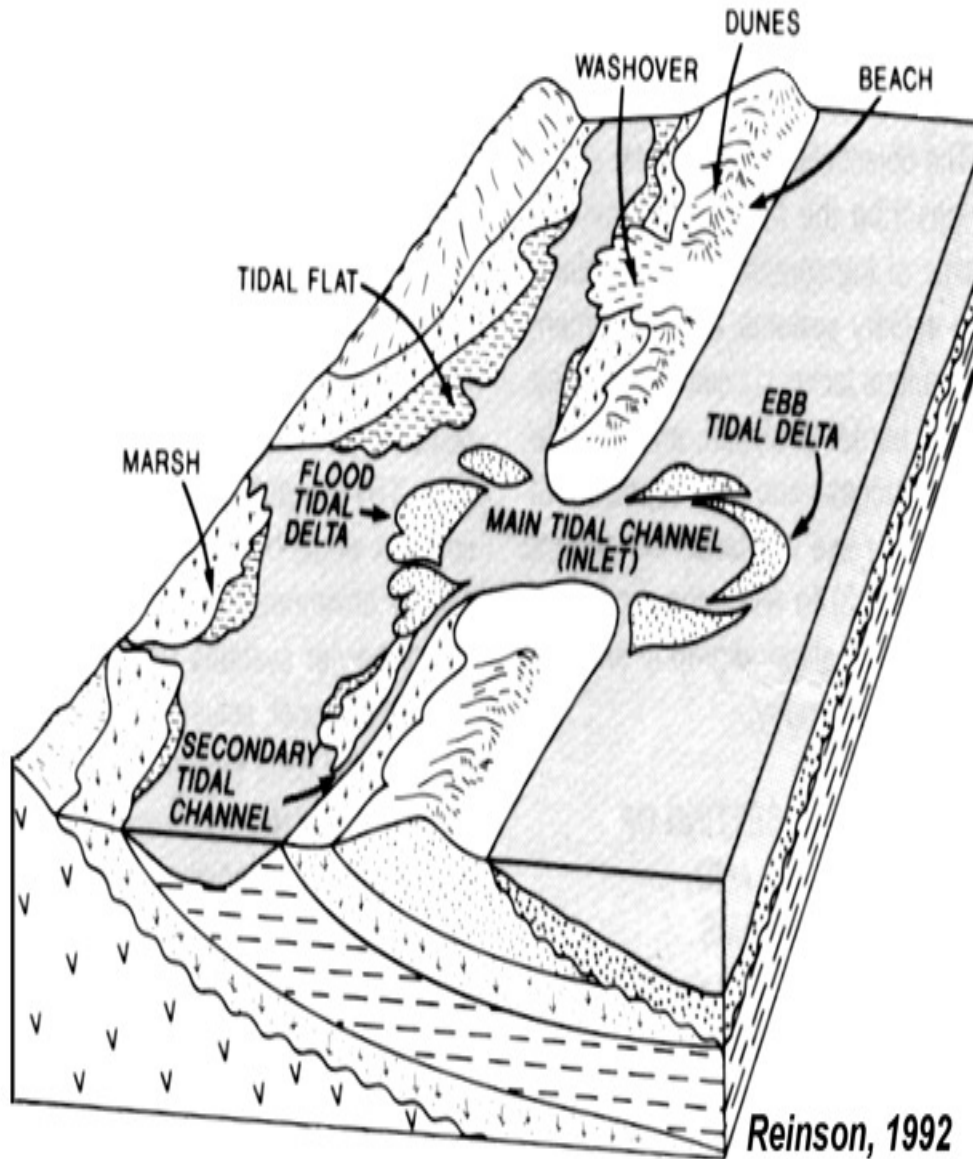
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WHAT FISH SAY  
ISN'T 'SPEECH.'

11.23.12

© Tom Toles/Distributed by Universal Uclick via CartoonStock.com

# BARRIER ISLANDS



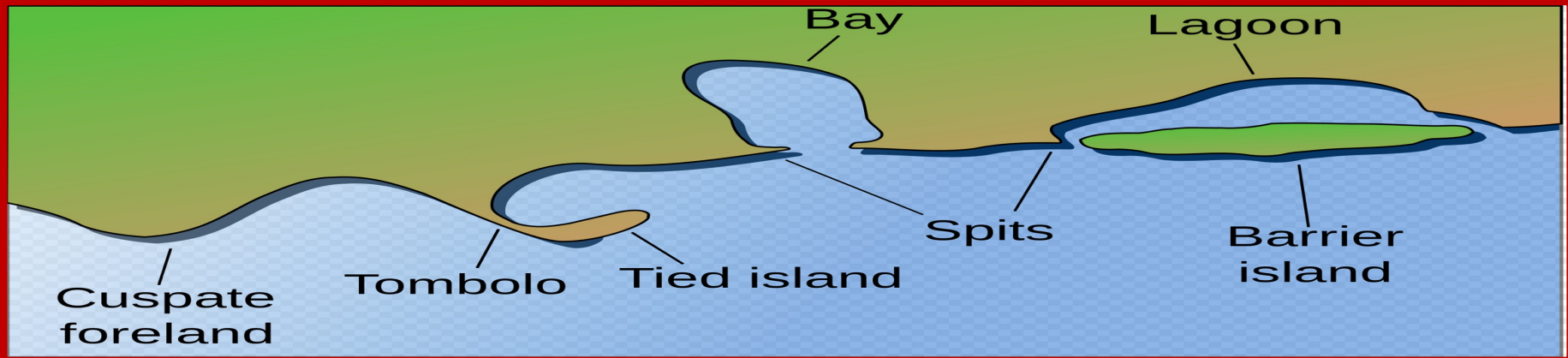
## Common Components of a Barrier Island System.

1. **Beach** - Seaward deposits of well-sorted sands with a steeply sloping bank into the ocean.
2. **Dunes** - Located just landward of the beach is dune complex or backshore setting
3. **Washovers** are formed when storm surges overrides the island and transports deposits of dune and beach sand all the way to the back barrier lagoon and marsh.

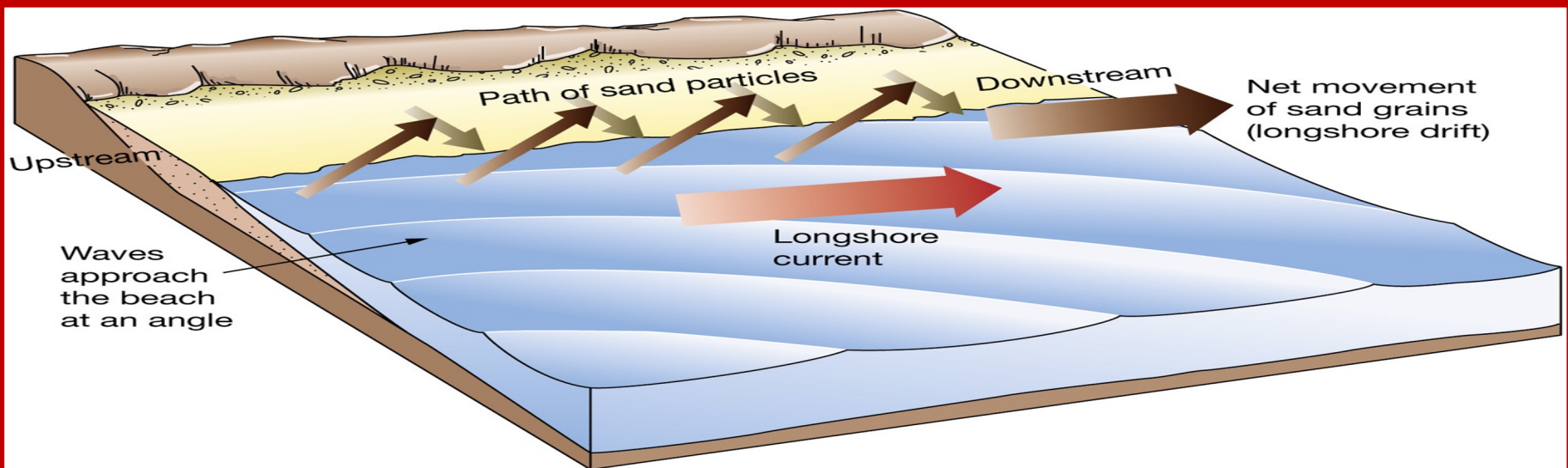


## What is a barrier island?

A barrier island is a **constantly changing deposit of sand** that forms parallel to the coast.



**LONGSHORE CURRENTS:** The difference between longshore current and longshore drift is that longshore currents travel parallel to the beach whereas longshore drift transports the sediments along a coast, parallel to the shoreline.



(b)

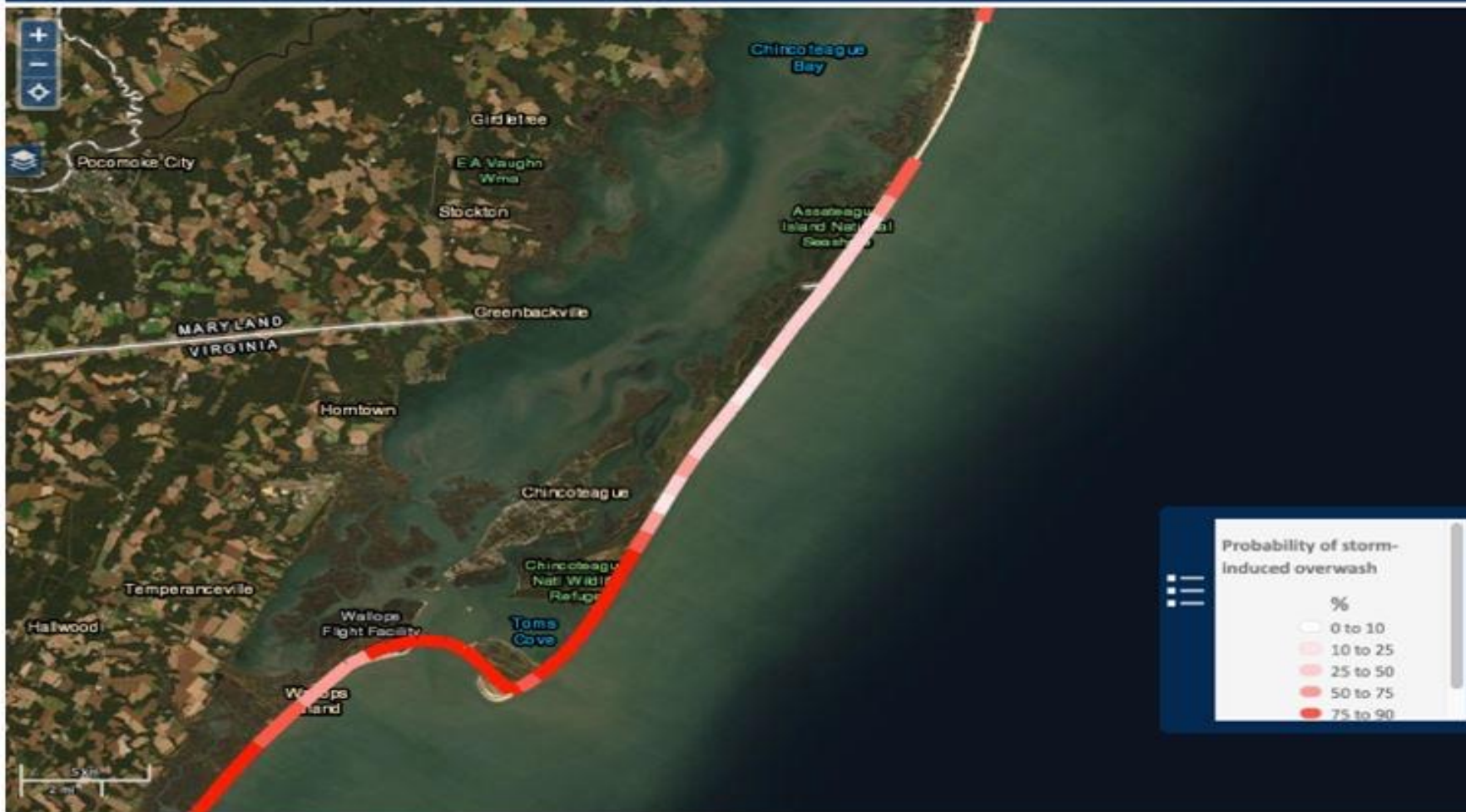
Over time many barrier islands move landward, toward the shore. This typically happens because local sea levels rise, so waves wash over the islands during storms, moving sand from the ocean side to the inland side.



## Coastal Change Hazards Portal

All ▾

Search...

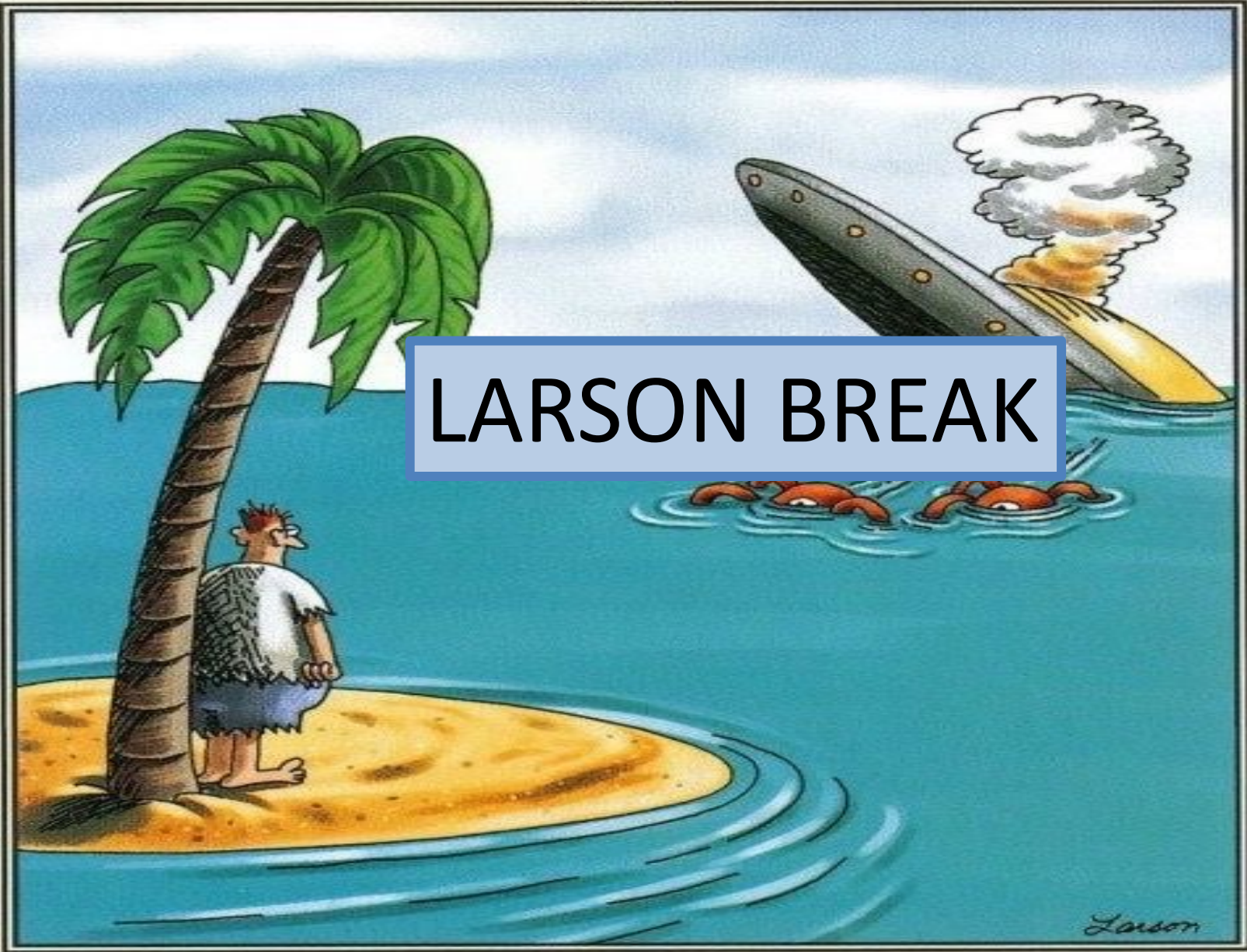




6/4/84

# LARSON BREAK

Larson



❑ The Virginia Barrier Islands are a continuous chain of long, **barrier islands**, separated by narrow **inlets** and shallow marshy tidal bays along Virginia end of the **Delmarva Peninsula**.

❑ The **Virginia** barrier islands terminate to the south at the mouth of **Chesapeake Bay** and north at **Fenwick Island\***.

❑ They are, in order from north to south:

- **Assateague Island**
- **Chincoteague Island**
- **Wallops Island**
- **Assawoman Island**
- **Metompkin Island**
- **Cedar Island**

\* a barrier spit, not a true island









- The combined effects of years of storms and consequent sand movement have pushed the barrier islands westward.
- Assateague has been marching westward toward the mainland for about 2,000 years.
- The layers of coarser material were likely deposited during times of increased wind and wave action.



- ❑ This movement is extremely evident in aerial images taken by NASA. The first image shows Assateague Island in 1985; the second is [Assateague Island](#) in 2019.
- ❑ [As you can see](#), the island has extended southward significantly. Assateague Island is also moving westward, slowly converging with Chincoteague Island.
- ❑ This east to west movement is mostly a result of storm processes.
- ❑ Storms can have huge impacts on the form and location of Assateague Island.
- ❑ Hurricanes and Nor'easters move sand from the eastward, ocean side of the island across to the western, land-facing side.
- ❑ Evidence of this movement can be seen in overwash fans and sand deposits in the marshy bays on the western side of the island.



Back





## Assateague Island and Hurricane Sandy

- ✓ Assateague was also impacted by Hurricane Sandy in 2012. The southern end of Assateague experienced erosion and loss of sand.
- ✓ The next two images show from 2009 and 2012 how the beach has been pushed westward toward the mainland significantly, and an inlet has formed where the storm breached the narrow coastline.



- ✓ Aerial photographs taken of Assateague Island National Seashore before (top) and after (bottom) Hurricane Sandy.
- ✓ Overwash deposits can be seen in the after photo and are evidence of landward sand transport.
- ✓ The yellow arrows point to the same feature and provide a reference for how far the sand has moved.



## Assateague Today

- ❑ Assateague Island continues to be shaped and changed by a number of processes today, particularly by storms and changing sea-levels.
- ❑ Longshore currents are the result of the energy released parallel to the shore when a wave hits land.
- ❑ During the winter, strong longshore currents caused by increased wind and wave action move vast quantities of sand from the northern end of Assateague to the southern end.
- ❑ Wave action is controlled by sea floor and shoreline features as well as the depth of the water.
- ❑ This movement of sediment has caused Assateague to migrate southward.

GREETINGS

*from*

**WILDWOOD**  
N.J.

PLACE  
STAMP  
HERE

**A TOTAL BARRY/CAROL SLIDE**





# Why Wildwood's beaches are so big

By Diane Stopyra · November 11, 2016







FEMALE

MALE

IDENTIFYING THE "PROGRESSIVE" HORSESHOE CRAB

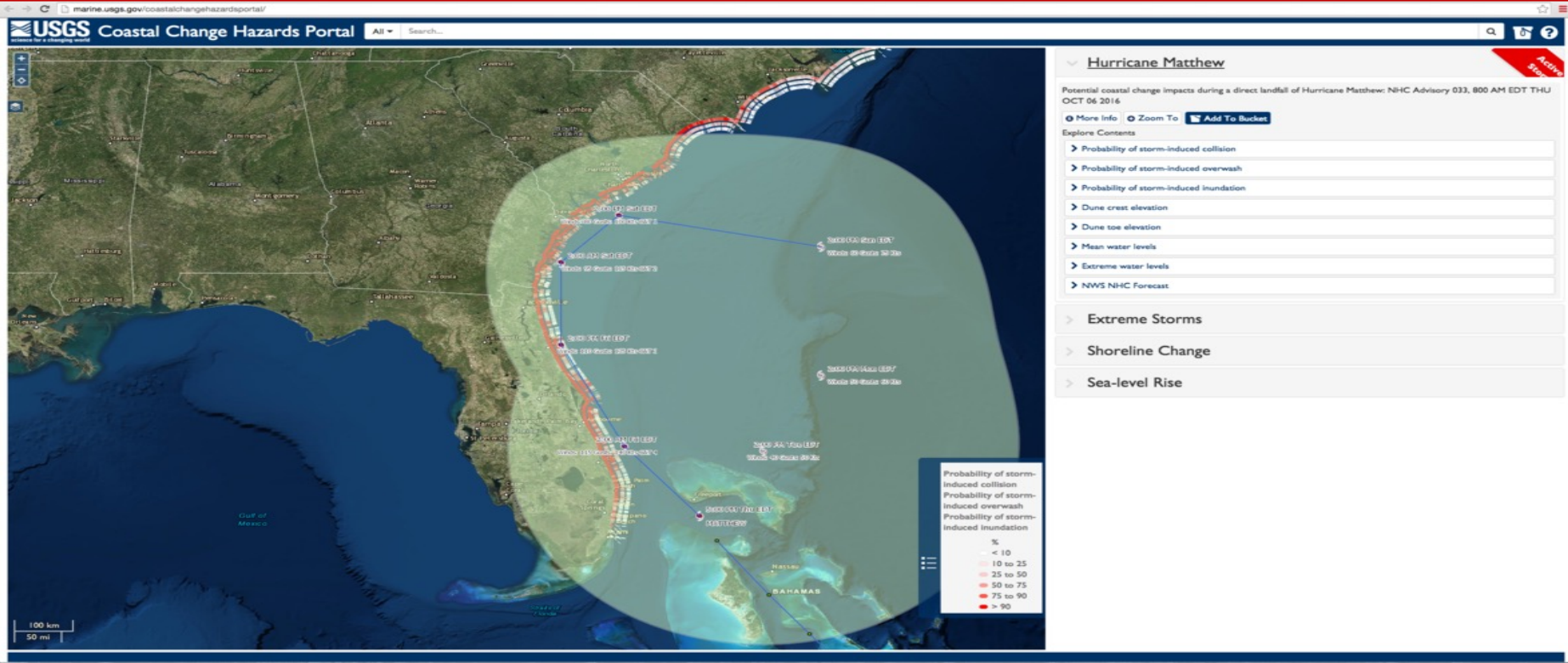


- ❑ The water surrounding Maryland's coasts is slowly but steadily creeping up probably as a consequence of global climate change,
- ❑ Scientists have forecasted an increase of as much as 2.1 feet in the Chesapeake Bay by 2050.
- ❑ And by the end of this century, that number could be 3.7 feet or higher.
- ❑ Scientists have identified several reasons:
  - ✓ As oceans around the world grow hotter, they also expand because of the chemistry of salt water.
  - ✓ Glaciers and ice caps, including the icy regions around Greenland, are melting.
  - ✓ Since the end of the last ice age, the land around Maryland has been naturally sinking a tiny bit each year — a trend that has accelerated over recent decades.

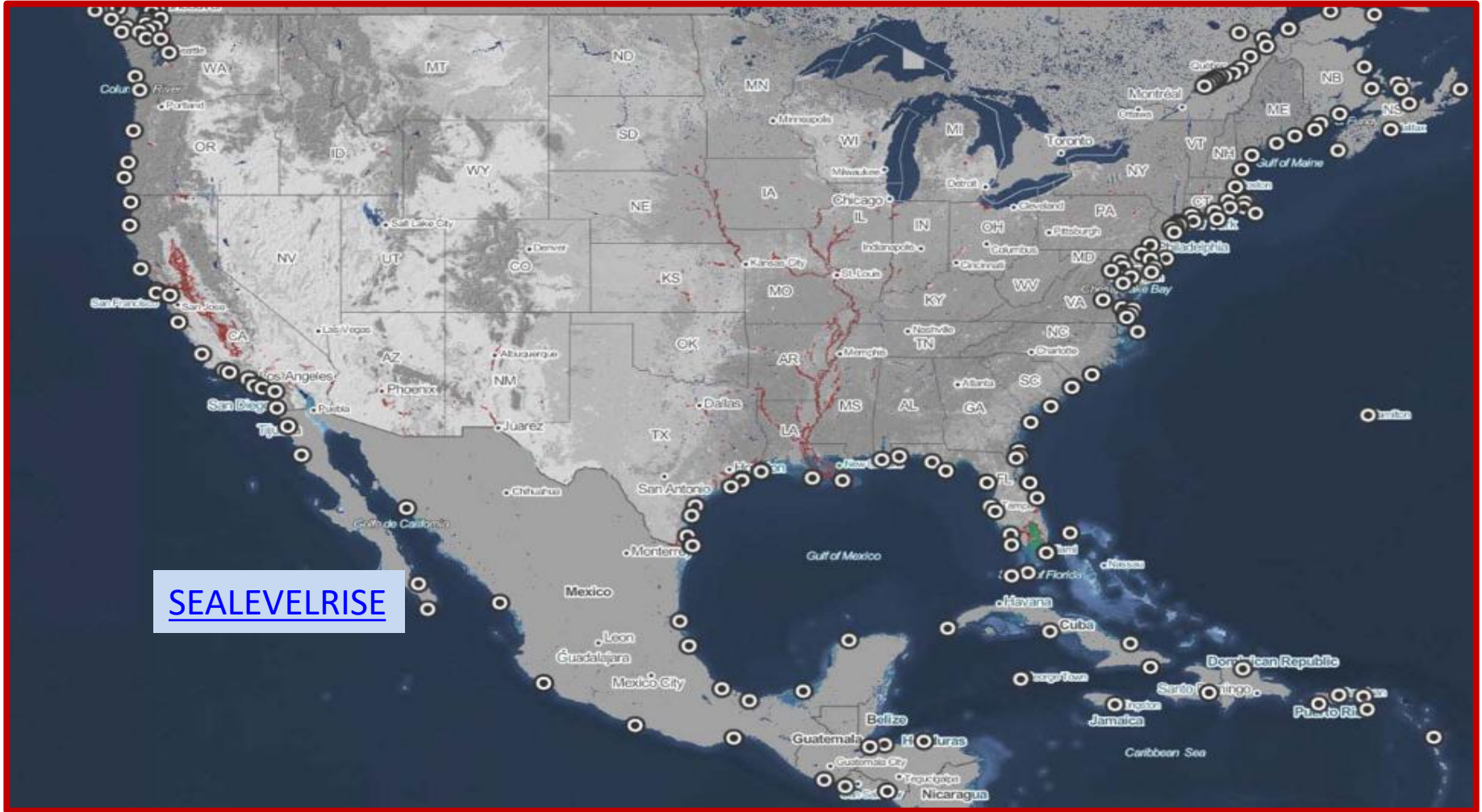


**Chesapeake Bay's Vanishing Island**





- ✓ The U.S.G.S.'s [Coastal Change Hazard Portal](#) predicts how coastlines will be affected by major storm events like Hurricane Sandy.
- ✓ This science will help to predict which areas of the coast are most vulnerable to storm-related forces and will be key to the management of [coastal systems](#) by other agencies.
- ✓ The model uses coastal elevations, wave forecasts, and storm surge projections to determine the probability and extent of shore and dune erosion.



- ❑ By 2050, sea-level rise will push average annual coastal floods higher than land now home to 300 million people.
- ❑ High tides could permanently rise above land occupied by over 150 million people.
- ❑ Without advanced coastal defense and planning, populations in these areas may face permanent flooding within 30 years.



## **What are some immediate threats to the Chesapeake Bay?**

- Heavy storms increase soil erosion, sewer overflows, flooding, and polluted runoff.**
- **Dump nitrogen, phosphorus, and sediment into rivers and Bay.**
- **More dead zones and algal blooms.**

## **How is climate change affecting the Chesapeake Bay?**

**A changing climate puts all life in the Chesapeake Bay at risk.**

**Some of the agents are:**

- **Warming temperatures**
- **Rising sea levels**
- **More extreme weather events**
- **Coastal flooding**
- **Eroding shorelines**
- **Changes in abundance/migration patterns of wildlife**
- Increasing SEA LEVEL**



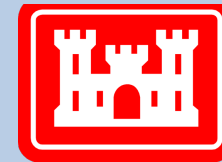
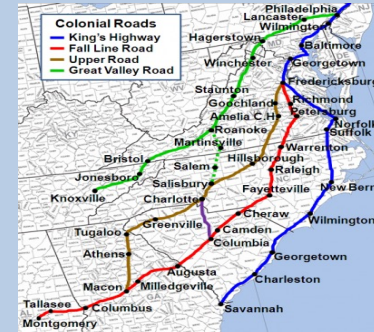
©SHANNON  
WHEELER

*“Have you tried turning it off and on again?”*



# WHAT WE TALKED ABOUT

- ☐ Virginia's Coastal Plain
  - ✓ Geologic History
  - ✓ Fall Line
- ☐ Chesapeake Bay's Watershed
- ☐ Impact Origin of the Bay
- ☐ Subsequent Modifications of the Bay
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  - ✓ Natural Modifications
- ☐ Climate Change



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of Engineers®**

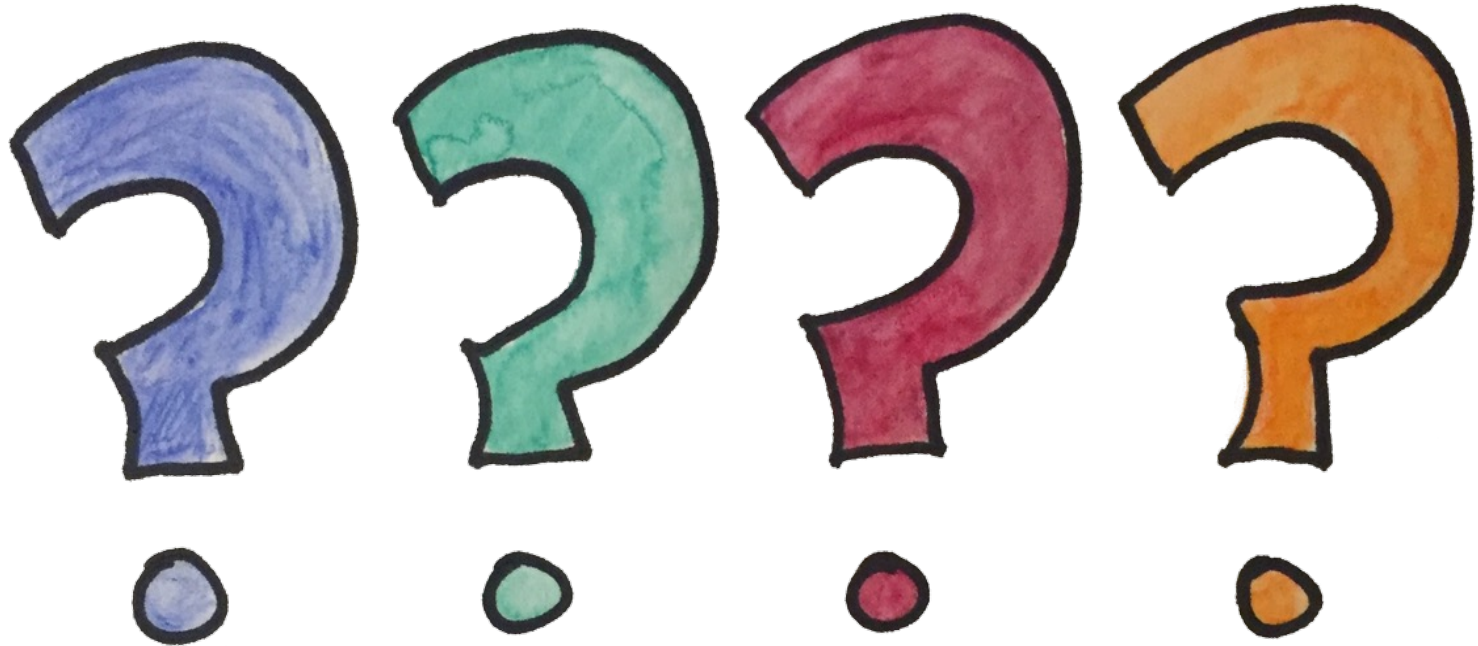
What the hell  
was I thinking?



Shanahan

**CREATOR'S REMORSE**





THANK YOU  
FOR BEING HERE





**COMING**

**RIVERS OF DISTRESS: *The world's water crisis***

**ZOOM: OCTOBER 18, 2022**

**SOON!**

**Endangered Rivers Plagued by  
Pollution, Climate Change, and  
Outdated Management**

*The annual list of America's Most Endangered Rivers includes practical calls to action to turn the tide on threatened U.S. waterways.*

- ✓ **Geomythology: Myths, Hollywood,, and Geology**
- ✓ **Carbon: The good, the bad, and the Ugly**
- ✓ **Oceans: Past, Present, and Future**
- ✓ **Everyone Complains But Nobody Does Anything About It**
- ✓ **Natural and Man-made Geological Disasters**
- ✓ **Fire and Ice, Geology of Iceland and the Alps**
- ✓ **Those Bombastic Italian Volcanoes**
- ✓ **Mass Extinctions: Past, Present, and Future**
- ✓ **Our Sun's Planets, Their Sun's Planets, and Unwanted Visitors**
- ✓ **Rocky Mountain High: How the Mountains Got Where They are Today**
- ✓ **Natural and Man -Made Disasters**
- ✓ **Water, Everywhere and Nowhere Part 1 -- Ground and Surface Water**
- ✓ **Water, everywhere and nowhere –Part II Oceans**
- ✓ **A Geologic Second: The Last 10,000 Years of Earth's History**
- ✓ **Philosophy of Science**
- ✓ **4 Es (Earth, Environment, Energy, Economics )**
- ✓ **4 Es PART II**
- ✓ **Climate/Weather Part 1 – Weather**
- ✓ **Climate/Weather Part 2 -- Climate**
- ✓ **Geology, Anthropology and the History of Man**
- ✓ **Volcanoes: The Fire Next Time**

# **PAST PRESENTATIONS**

# **PAST PRESENTATIONS**



- ✓ **Climate and Geoengineering: A Delicate Balance**
- ✓ **Geology in the News**
- ✓ **Geological Record - The Detective Work of Geology:**
  - ✓ **Canadian Rockies**
  - ✓ **Drilling**
  - ✓ **Day the Dinosaurs Died**
  - ✓ **Geology and Geopolitics**
  - ✓ **Geological Record**
  - ✓ **Planets**
  - ✓ **Whole Lot of Fracking Going On**
  - ✓ **Pseudoscience**
  - ✓ **Denial of Science and the Science of Denial**
  - ✓ **Humboldt**
  - ✓ **Methane**

## **PAST PRESENTATIONS**

**22SU09 – GEOLOGIC HISTORY OF THE CHESAPEAKE BAY AND VIRGINIA'S BARRIER ISLAND**

- A Total of **34** not counting Today.
- I have a proposal in for this Fall on  
**RIVERS of DISTRESS**