A Historic Look at Sediment Delivery and Coastal Systems

Jeffrey Halka

Maryland Geological Survey

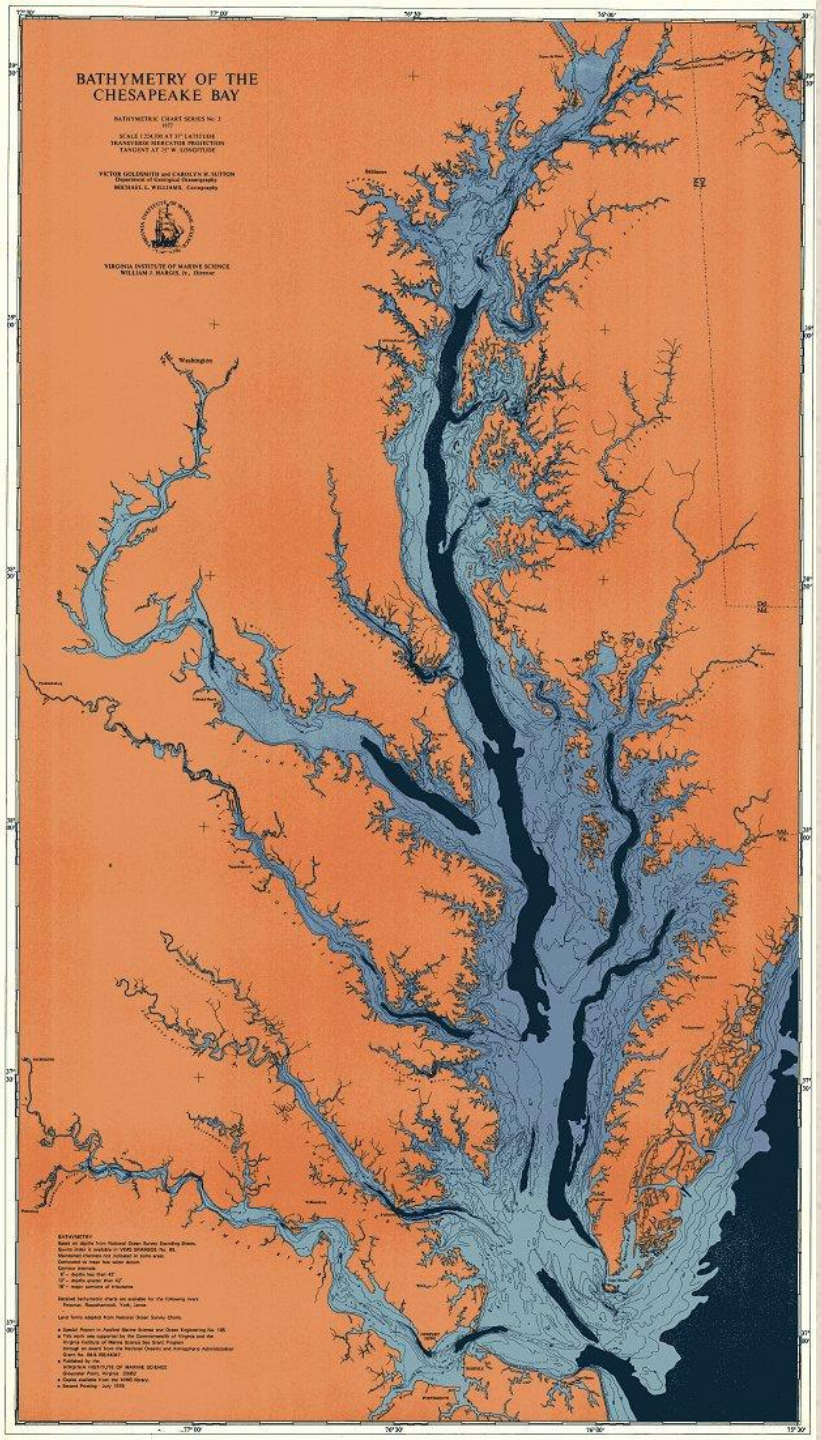
MD-Department of Natural Resources

STAC - Designing Sustainable Coastal Habitats

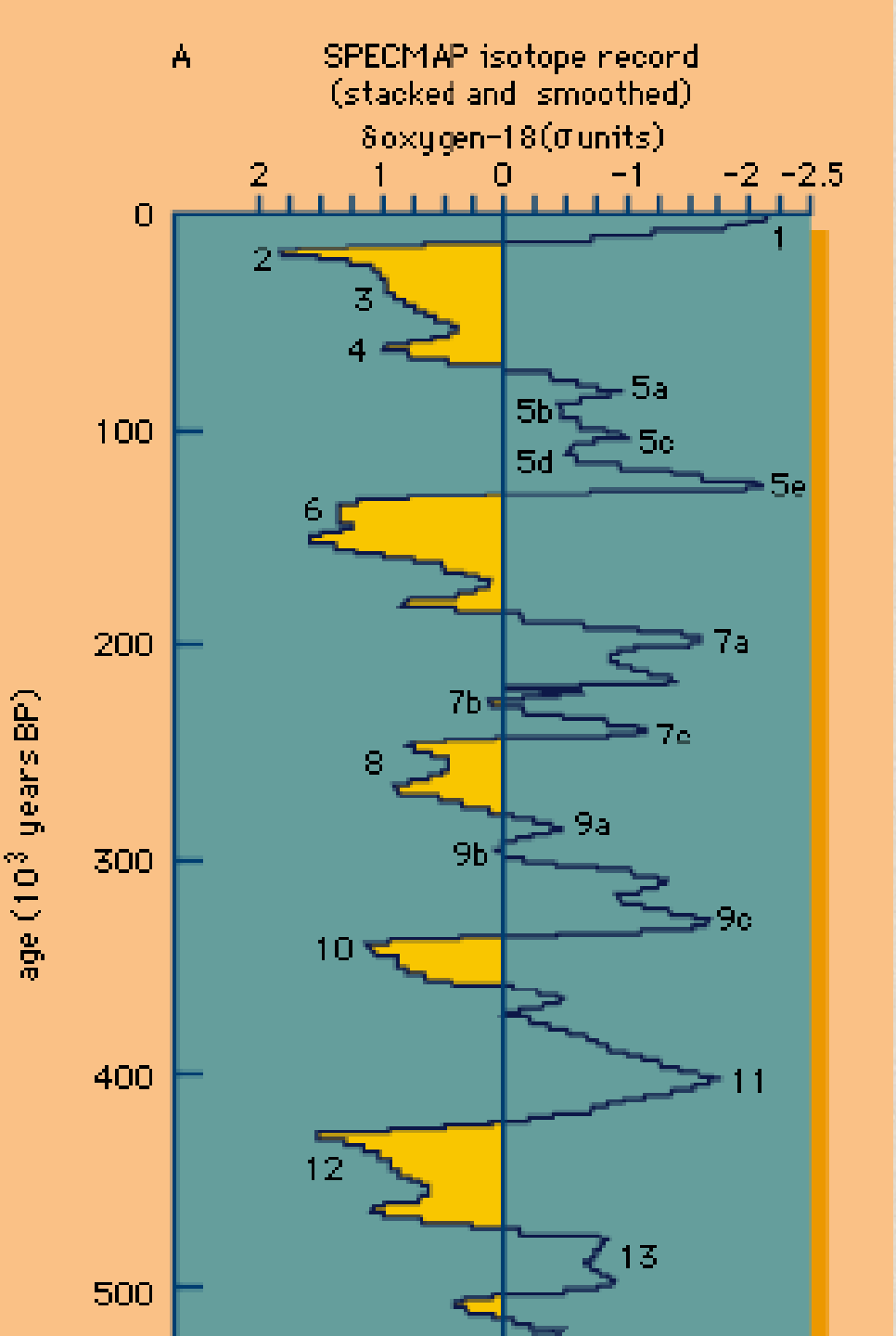
April 16, 2013

Chesapeake Bay

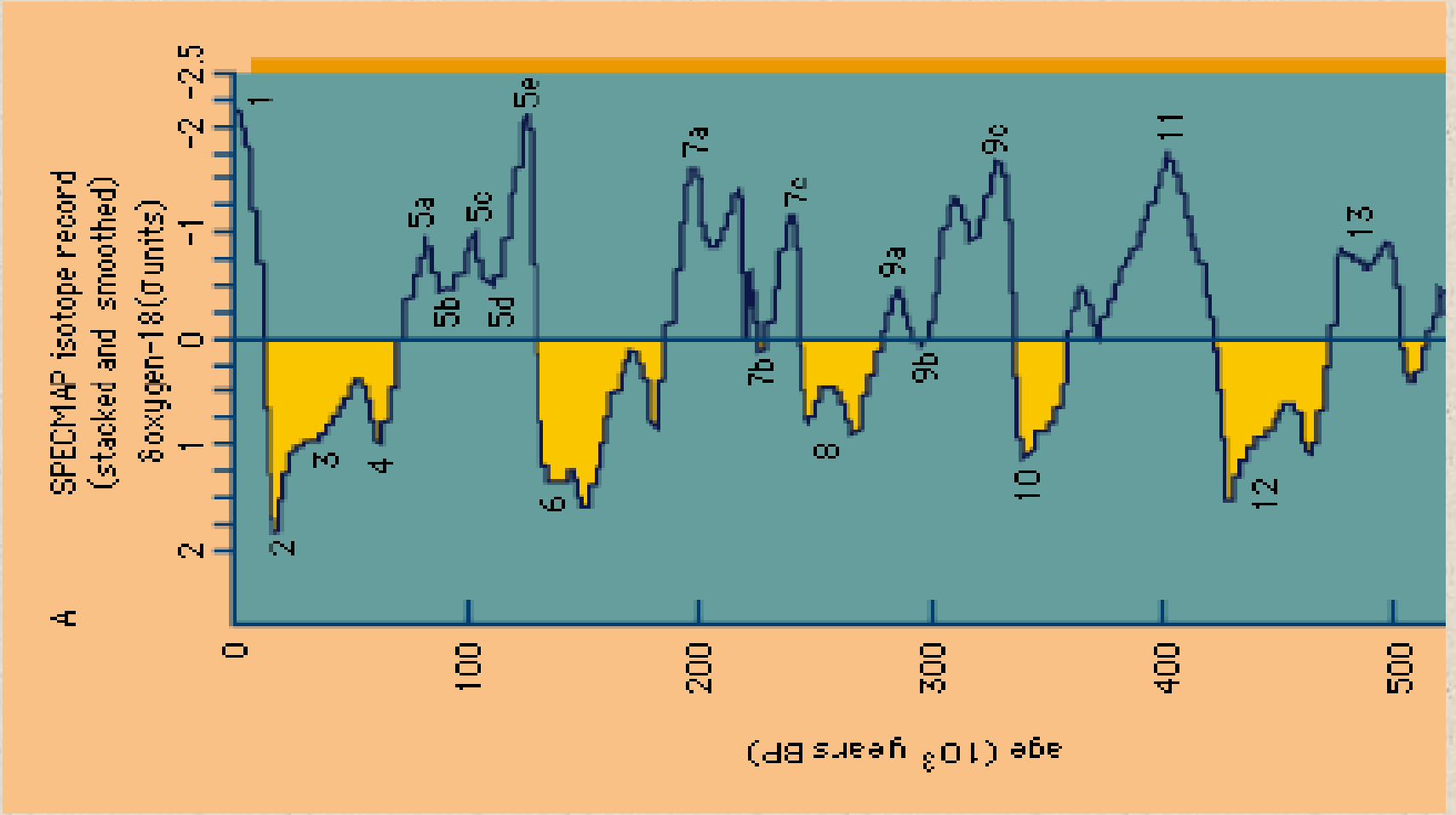
- 200 miles long (320 km)
- 6 to 35 miles wide (10-56 km)
- Average depth of ~ 7 meters
- 20% less than 2 meters depth
- Huge watershed area relative to volume
- Microtidal – max range just over ½ meter
- 50% freshwater from Susquehanna River
- 90% freshwater from 5 major rivers



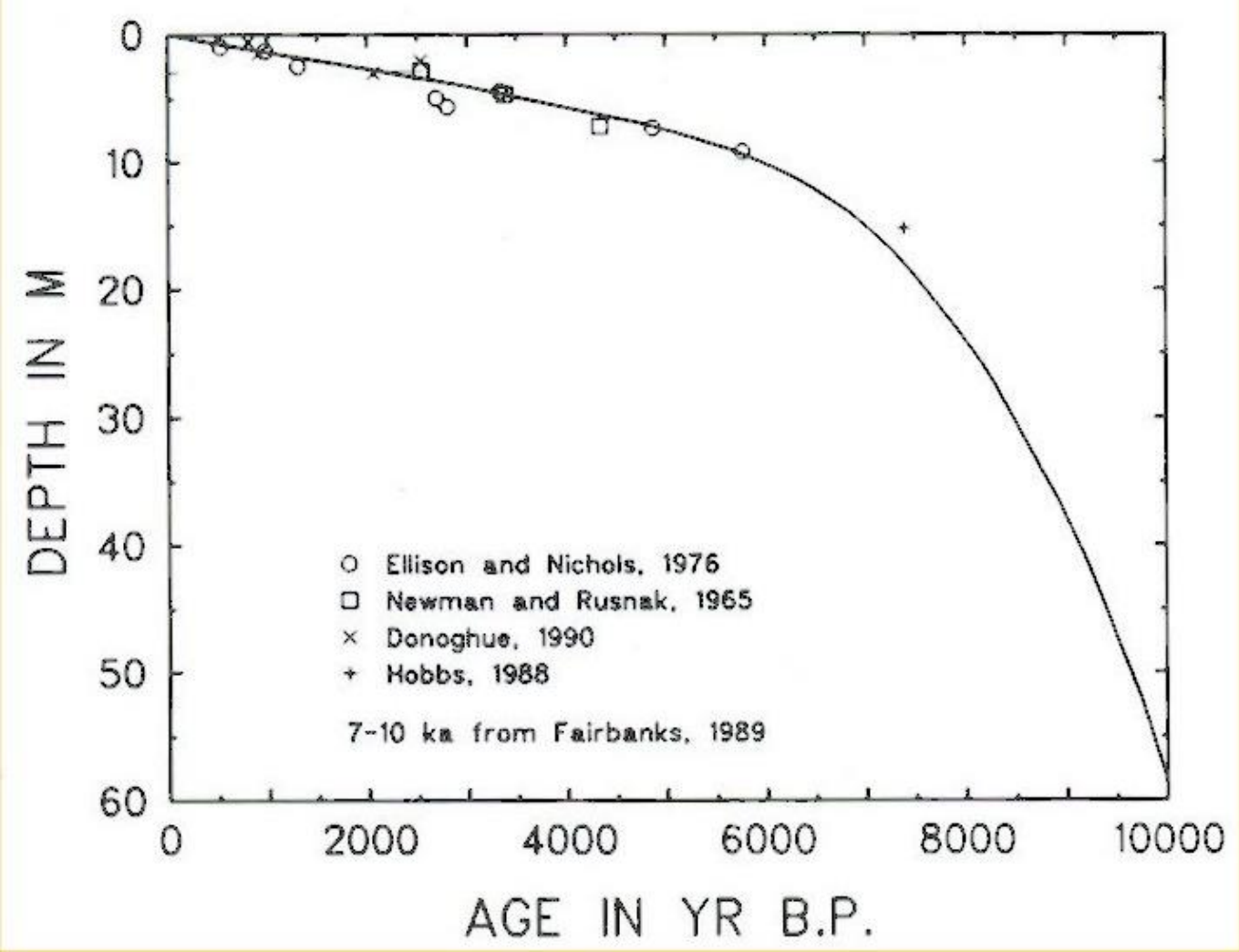
Pleistocene Sea levels (Oxygen Isotope)



Pleistocene Sea levels (Oxygen Isotope)



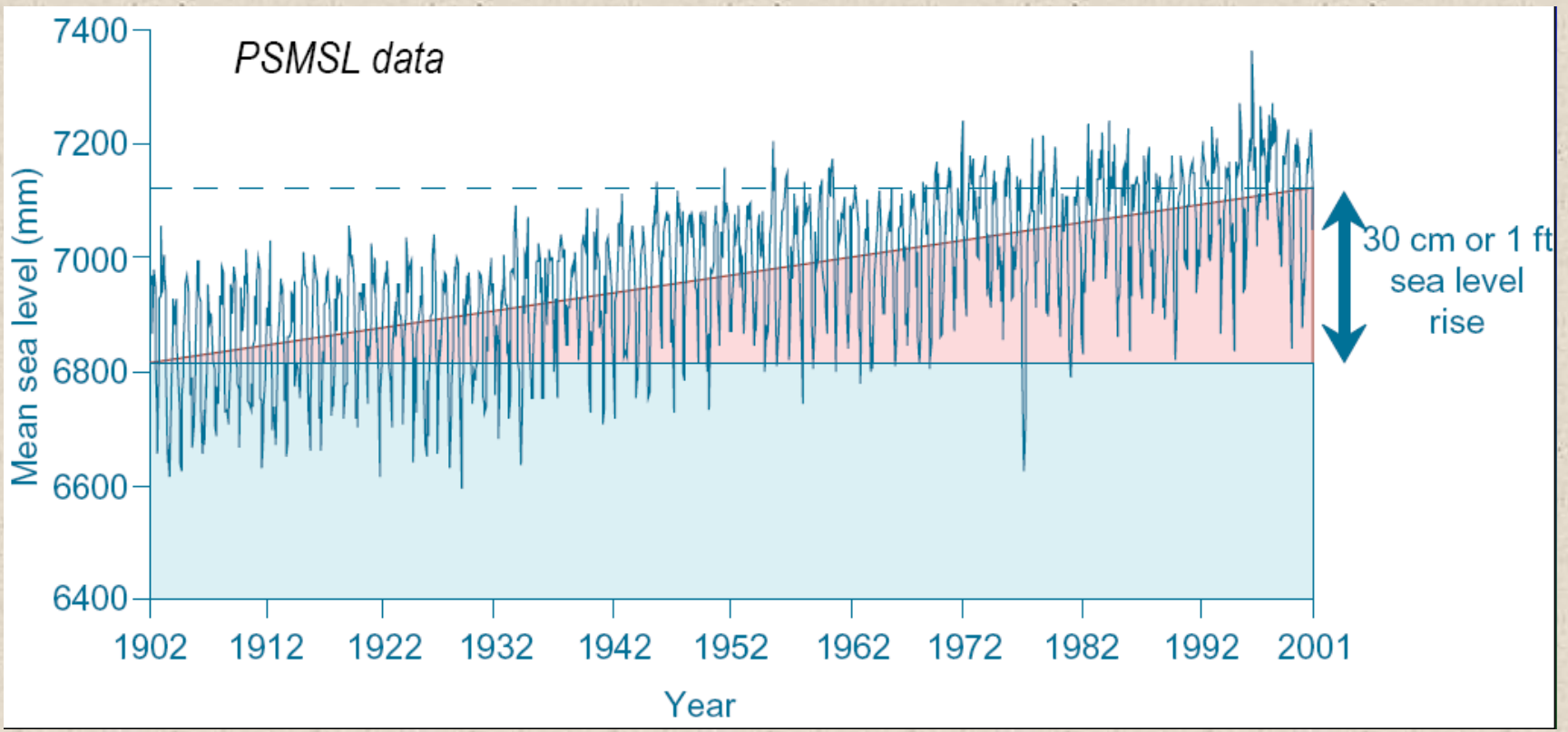
Relative Sea Level Curve for the Chesapeake Bay Area



From 10,000 to 7,000 years ago Rise from -60 m to -20 meters = 13 mm/yr

From 6,000 to present. Rise from -10 meters = 1.67 mm/yr

Baltimore Tide Gauge Record



Last 100 years sea level rise of 30 cm = 3 mm/year

Dominant Sediment Sources

Watershed – Fluvial

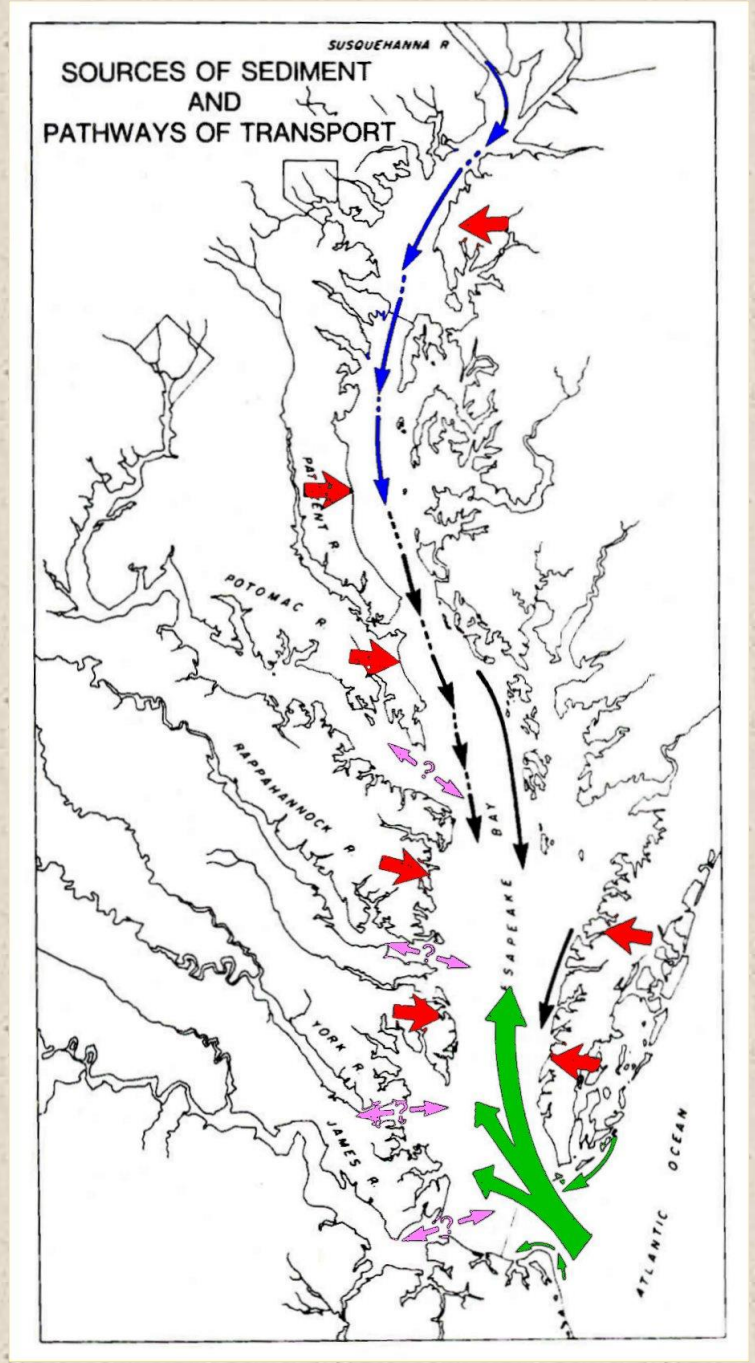
Shore Erosion

Oceanic Input

Internal Production

Complicating Factor

Internal Redistribution - Resuspension



Sources and pathways of sediments in the Bay

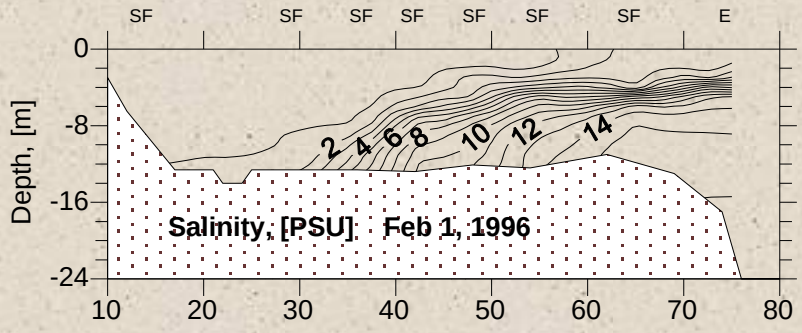
- Fluvial – watershed
- Shore erosion
- Oceanic input
- Internal production
- Resuspension

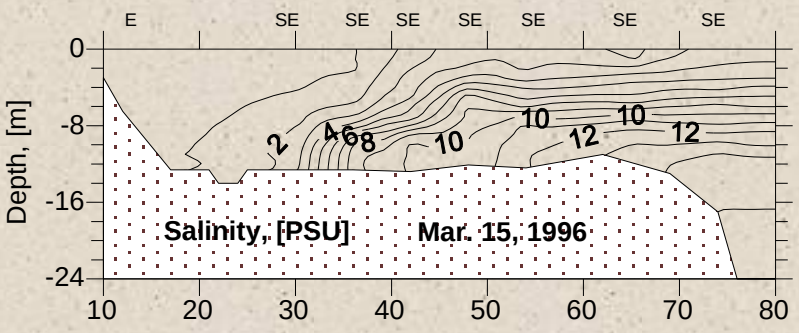

MODIS
3/22/05

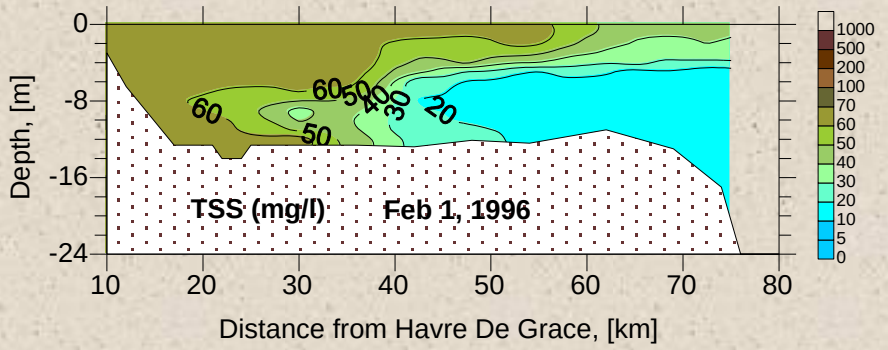

MODIS 4/09/05

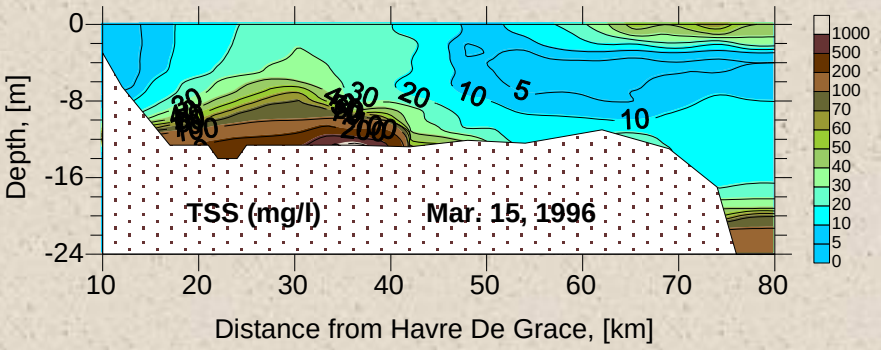
ETM Salinity and Suspended Sediments

Winter/Spring 1996



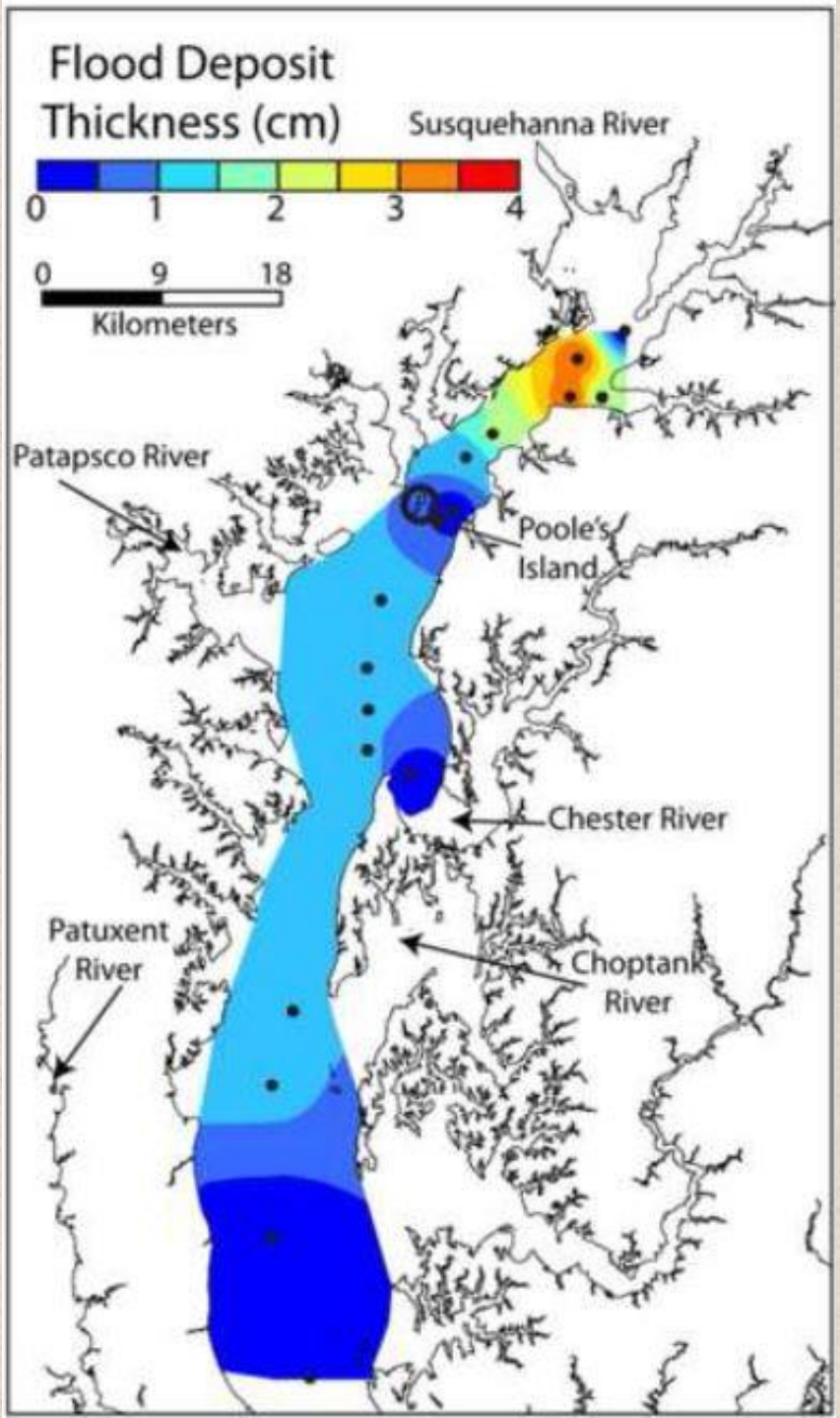


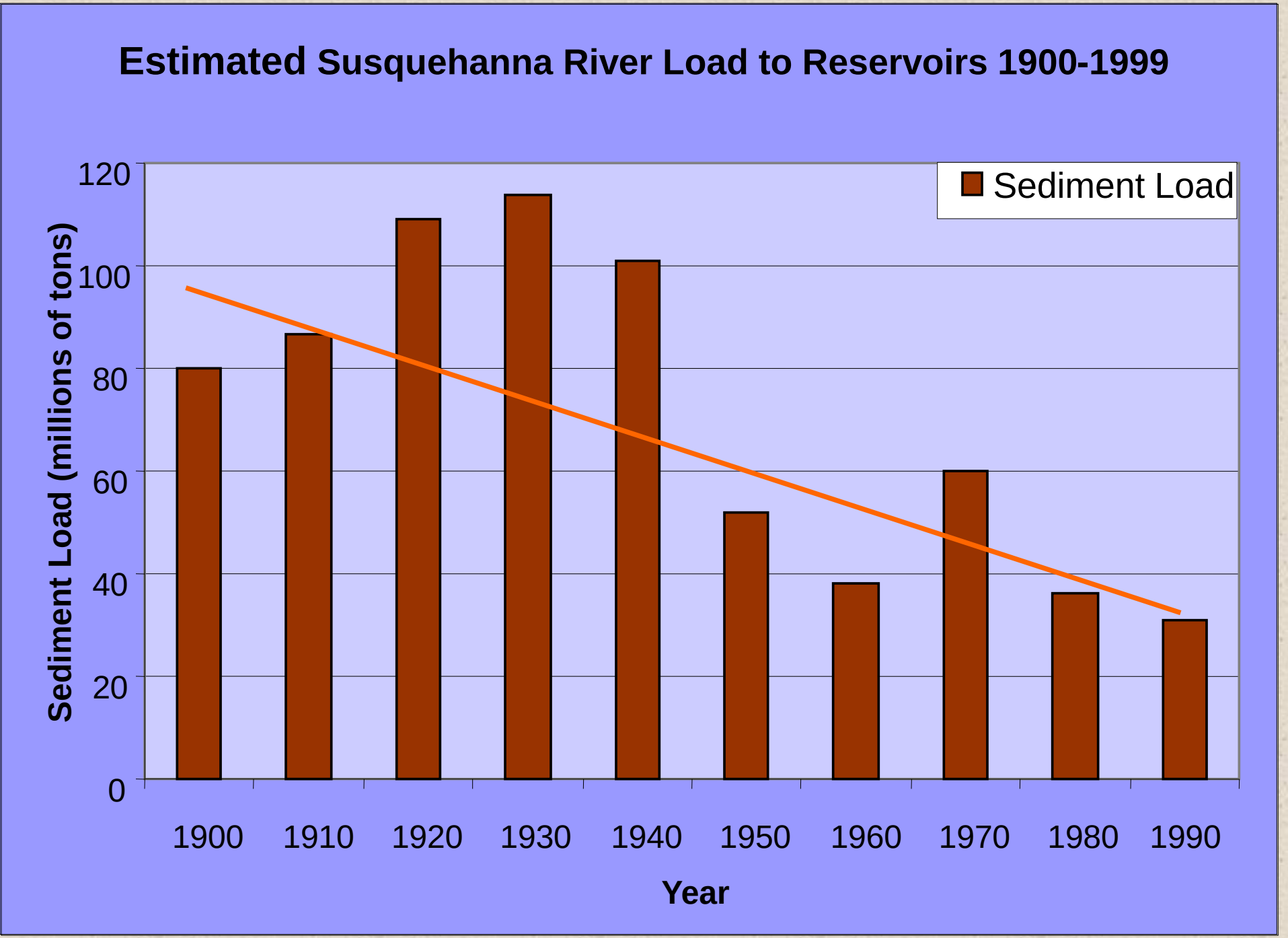


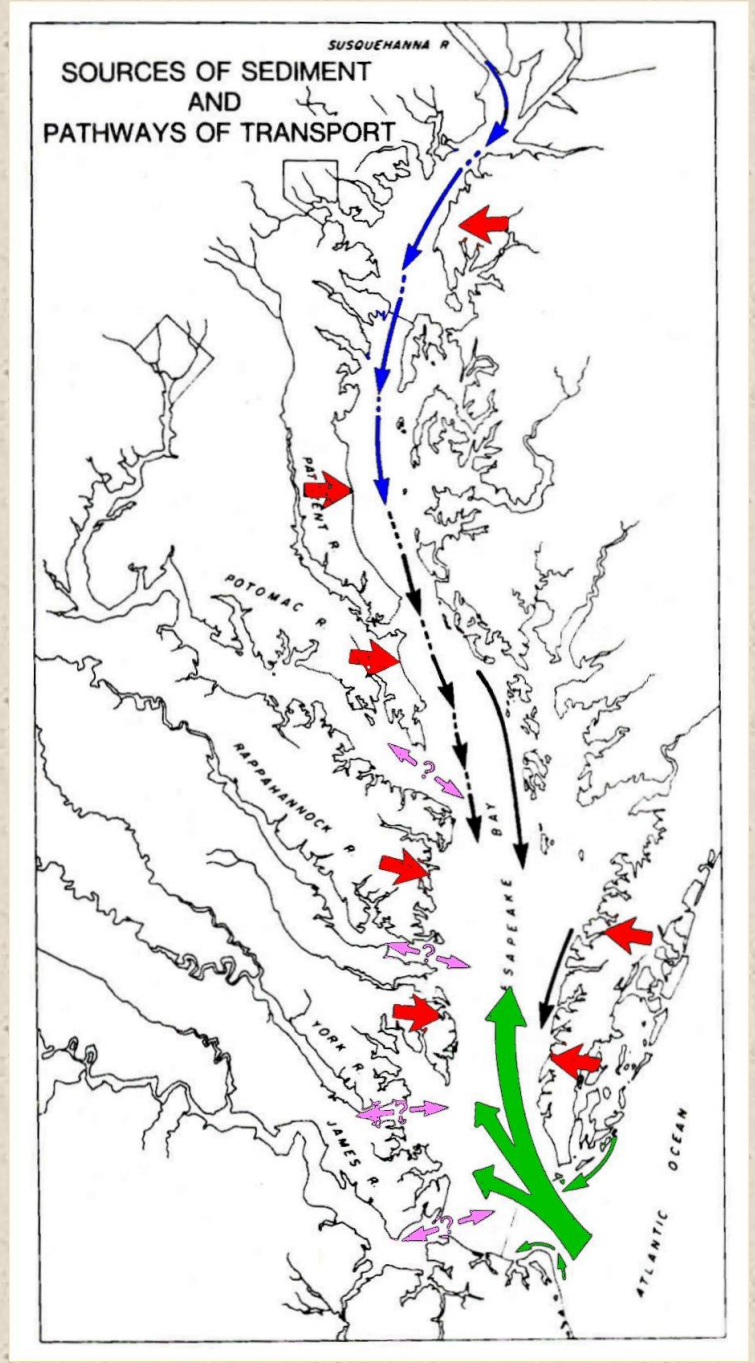


Tropical Storm

Lee: Fall 2011

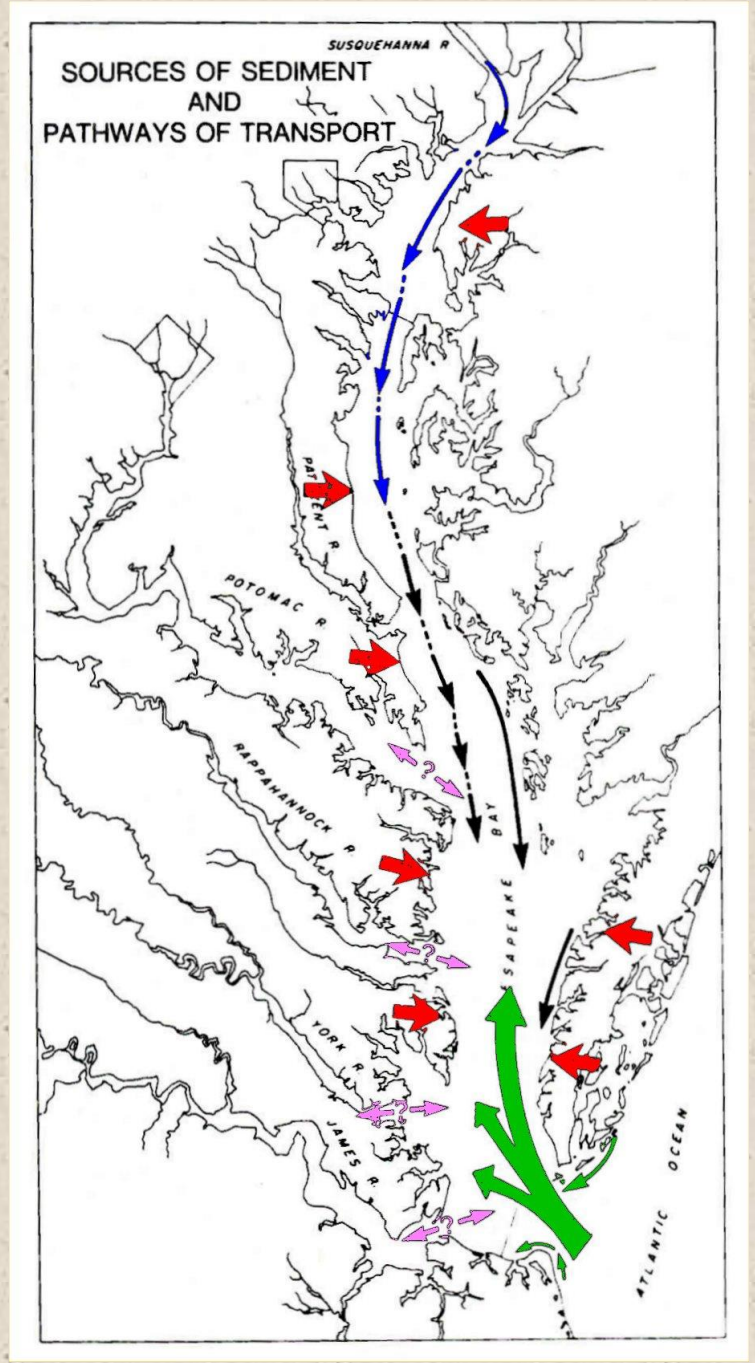



Estimated Susquehanna River Load to Reservoirs 1900-1999
Sediment Load
Sediment Load (millions of tons)
120
100
80
60
40
20
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
Year



Sources and pathways of sediments in the Bay

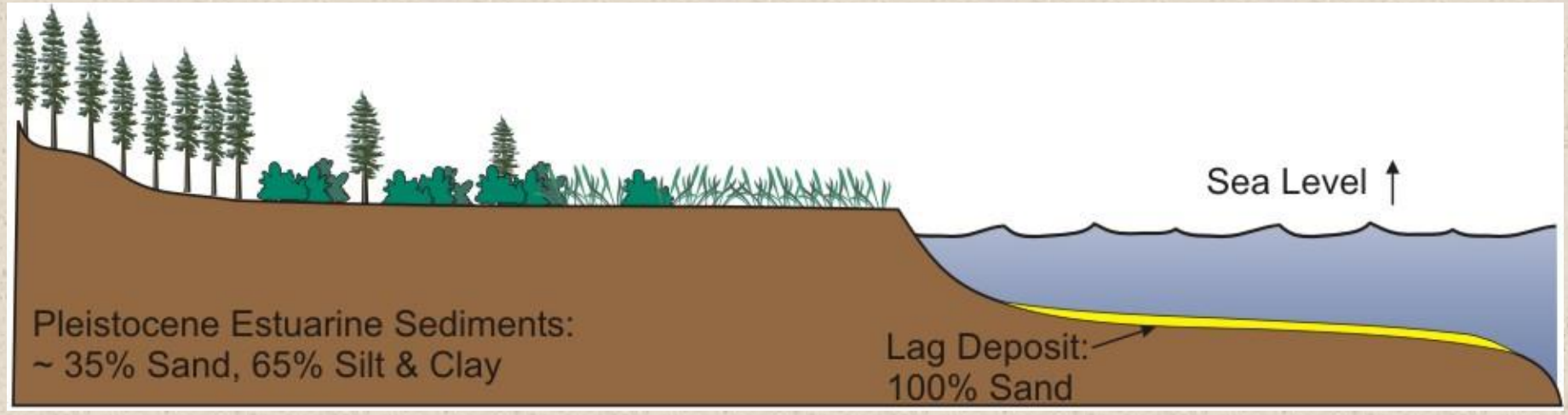
- Fluvial – watershed
  - 4.27×10^6 metric tons/yr
- Shore erosion
- Oceanic input
- Internal production
- Resuspension



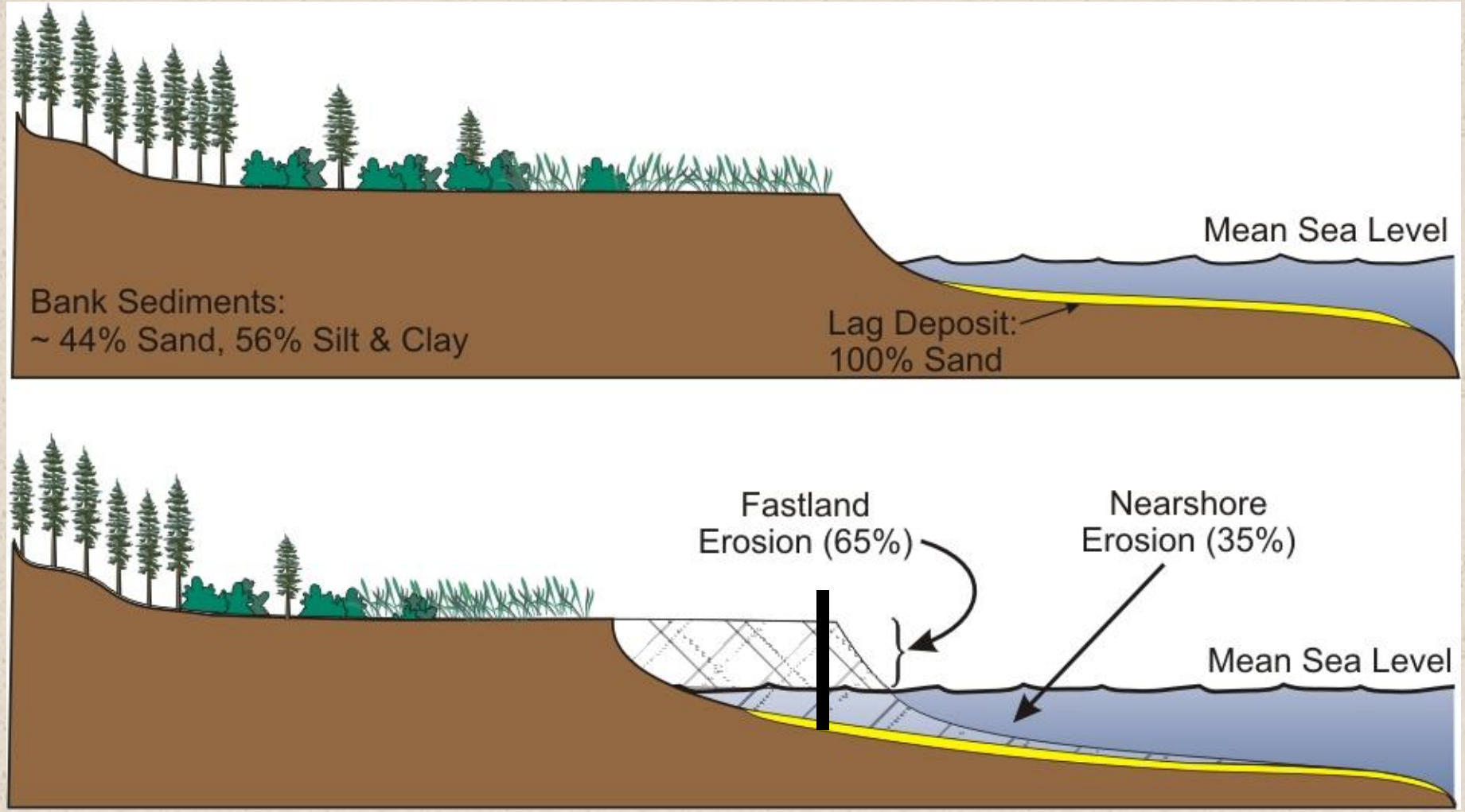
Sources and pathways of sediments in the Bay

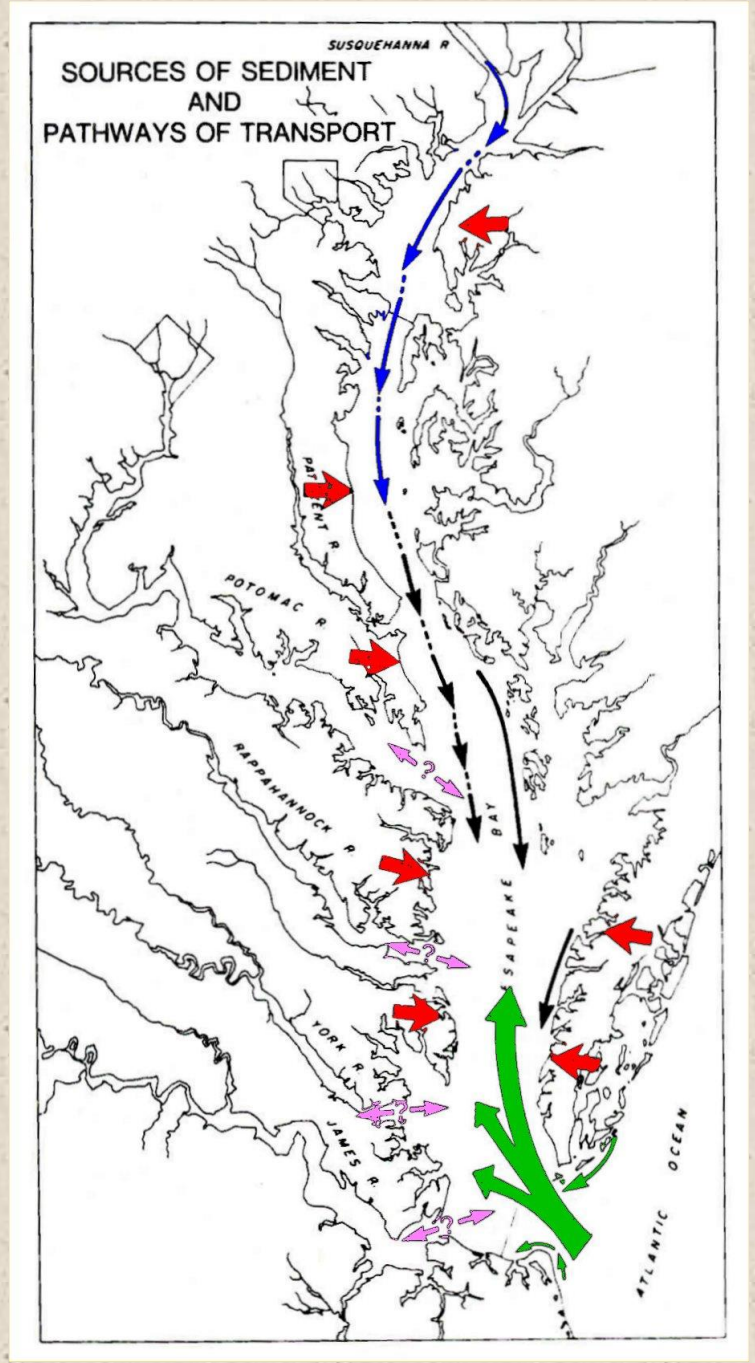
- Fluvial – watershed
- Shore erosion
- Oceanic input
- Internal production
- Resuspension

What is Shore Erosion?



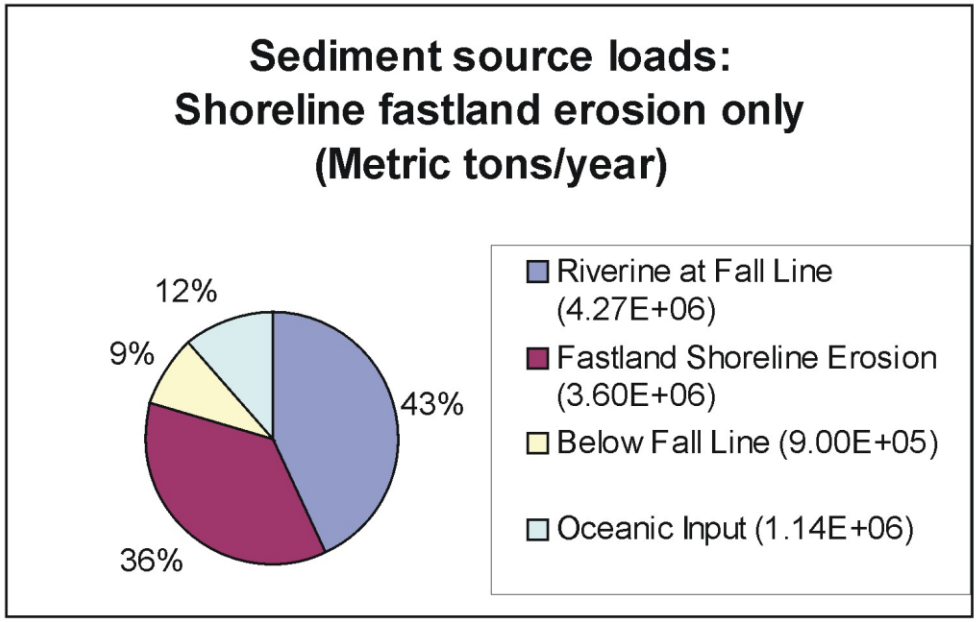
“Shore” Erosion – Fastland & Nearshore

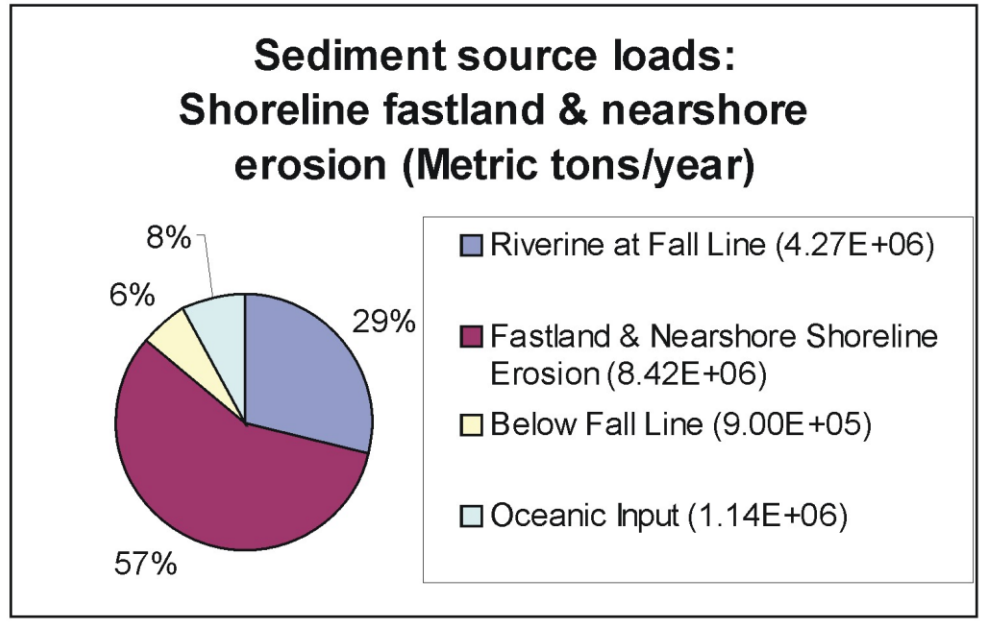




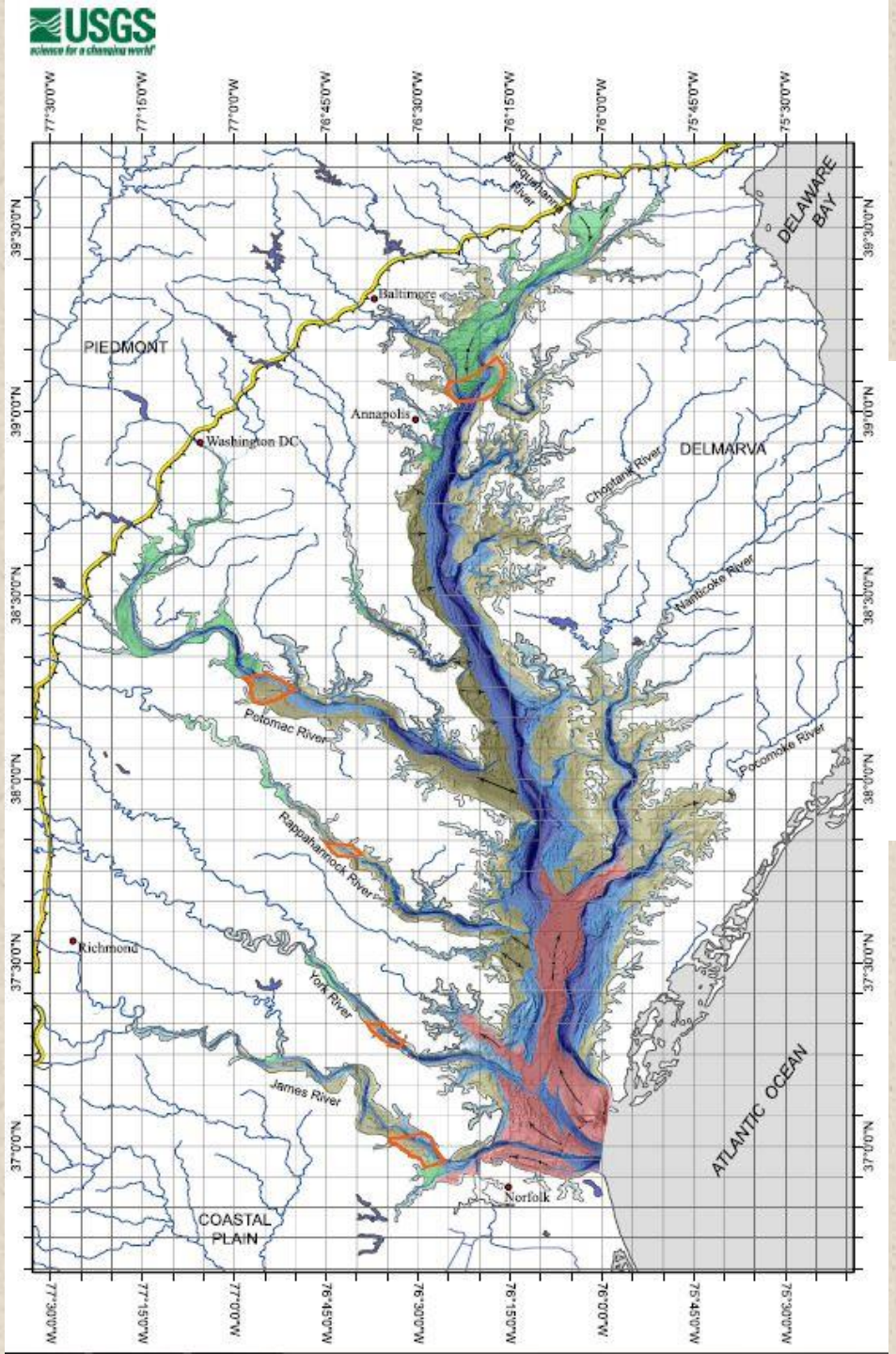
Sources and pathways of sediments in the Bay

- Fluvial – watershed
- Shore erosion
  - 8.42×10^6 metric tons/yr
- Oceanic input
- Internal production
- Resuspension





Estimated sediment loads to Chesapeake Bay



LEGEND

SEDIMENT SOURCES AND DEPOSITIONAL ENVIRONMENT

- **River Input Sediment** (deltas) from Piedmont and Appalachians (thicknesses range from 3-10m)
- **Coastal Erosion Sediment** from terraces, islands and steep bluffs of Coastal Plain outcrops (thicknesses range from 3 to 10 m)
- **Atlantic Sediment** from continental shelf and nearby coastal erosion (thicknesses range from 3 to 10 m, may exceed 15 m)
- **Thin Deposits** on Tertiary rock outcrops and buried Pleistocene channels; thick sediment stored in troughs along ancient thalweg (valley ways) of major rivers (as much as ~15m thick, locally may exceed 15 m)

Upper Estuary Characteristics

- Sands are deposited in “deltas” near fall line
- Turbidity maximum is effective trap for much of the finer grained sediment from the watershed
- Deposition rates in the deeper channels are much higher than on adjacent shallower platforms
- Finest particles are transported beyond the upper estuary, particularly during high flow periods

Mid and Lower Estuary Characteristics

- Fastland retreat and nearshore erosional platform development are major sediment sources
- These sediments can be locally composed of coarser grained sands along with silts and clays
- Finest particles transported from the upper estuary form relatively thin layers of accumulation in deeper waters
- Bay mouth has been a significant long-term source of sediments (10,000 years)
- Deposition rates in the deeper channels are much higher than those on the shallower platforms
- Platform deposition rates approximate the long-term rate of sea level rise (if not too fast)

From an Ecosystem Perspective Not all Sediment Input is Detrimental

- Sand component
  - Remains near source
  - Forms Beaches
    - Limited habitat type in the Bay
    - Recreational value
    - Buffers shore against continued erosion
  - Necessary for healthy SAV

From an Ecosystem Perspective Not all Sediment Input is Detrimental

- Silt/Clay (Mud) Component
  - Transported in suspension away from source
    - Close affinity with nutrients
    - Attenuates light, adversely affecting SAV
    - Interferes with filter feeding organisms
    - Contributes to burial of sessile benthic organisms (oysters)
    - Necessitates dredging shipping channels
  - Serves as sediment supply to tidal marshes, enhancing ability to keep pace with sea level rise


0 25 50 75 100 km
Chesapeake Bay – March 6, 2000 – MODIS/MODLAND/Descloitres