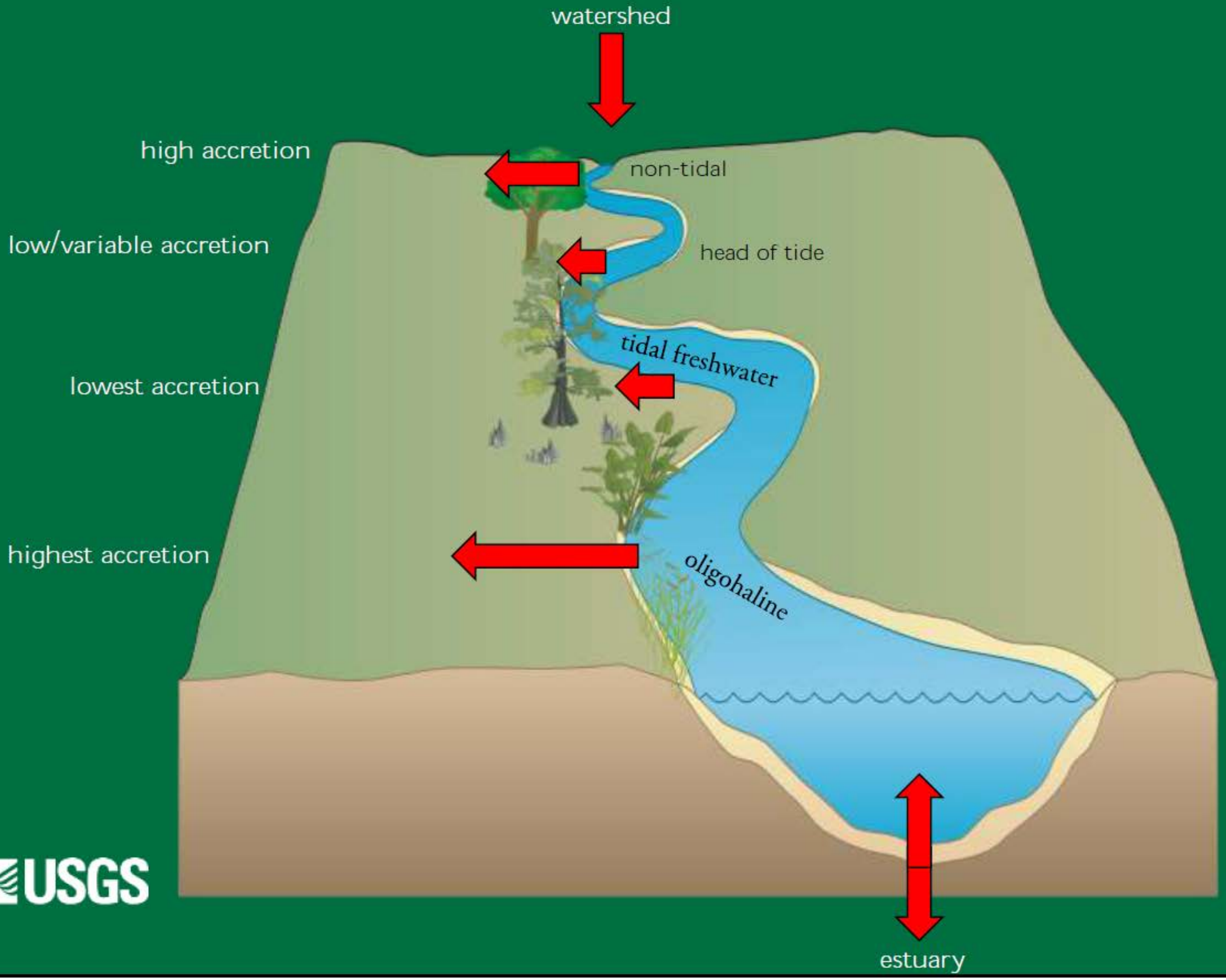
Magnitudes of sediment sources change along tidal river gradient



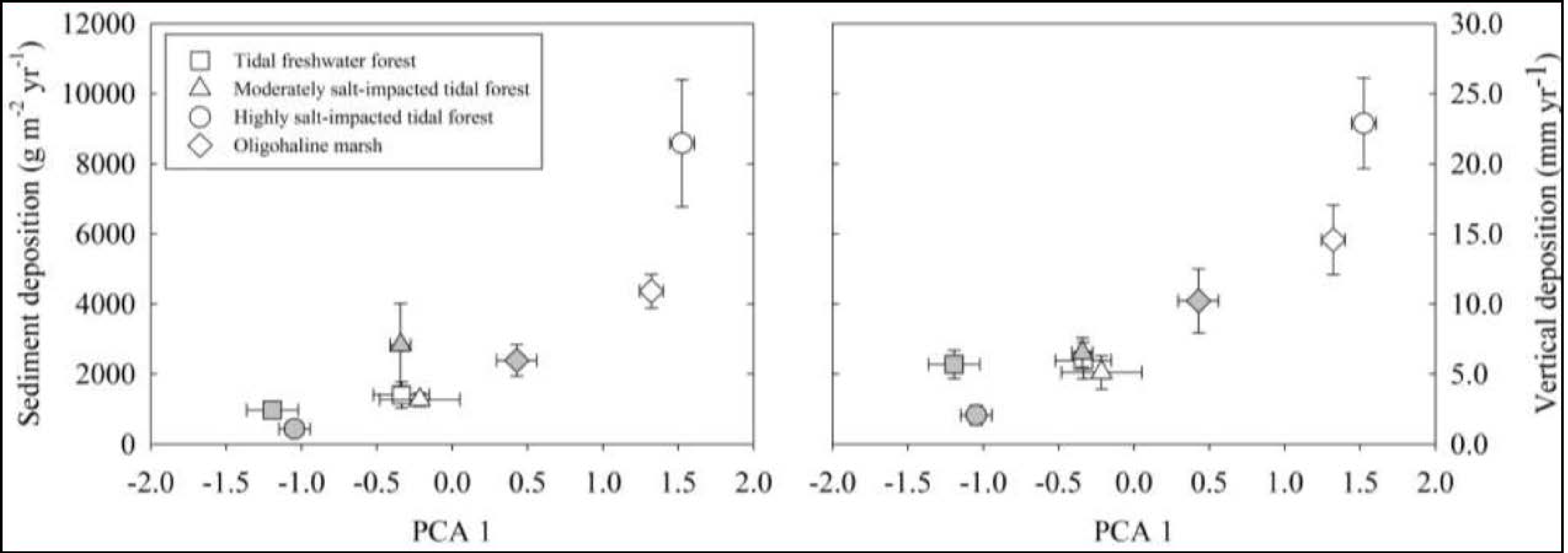
- His research focus is how tidal fresh forested wetlands (TFFW) regulate transport of sediment and materials to downstream estuaries

- He has a particular focus on effects of sea level rise, but much of the work informs our questions too

how do sediment deposition patterns change along salinity gradient?

Sediment sources change along gradient

Metal and organic chemistry of deposited sediment



Watershed → ← Estuary Watershed → ← Estuary

Noe et al. 2016, *Estuaries & Coasts*

- In freshwater sites, markers of watershed sediment

- More saline sources as you go down – so sediment sources change (not so much watershed)

- Comparing tidal swamps with nontidal floodplains and downstream OH marsh
  - Nontidal floodplains match tidal fresh sediment concentrations; both are low relative to OH marsh.

- With regard to short-term sediment accretion:
  - Greater in OH than in nontidal and lower TFFW.

Choptank was an exception; higher rates in head-of-tide TFFW.

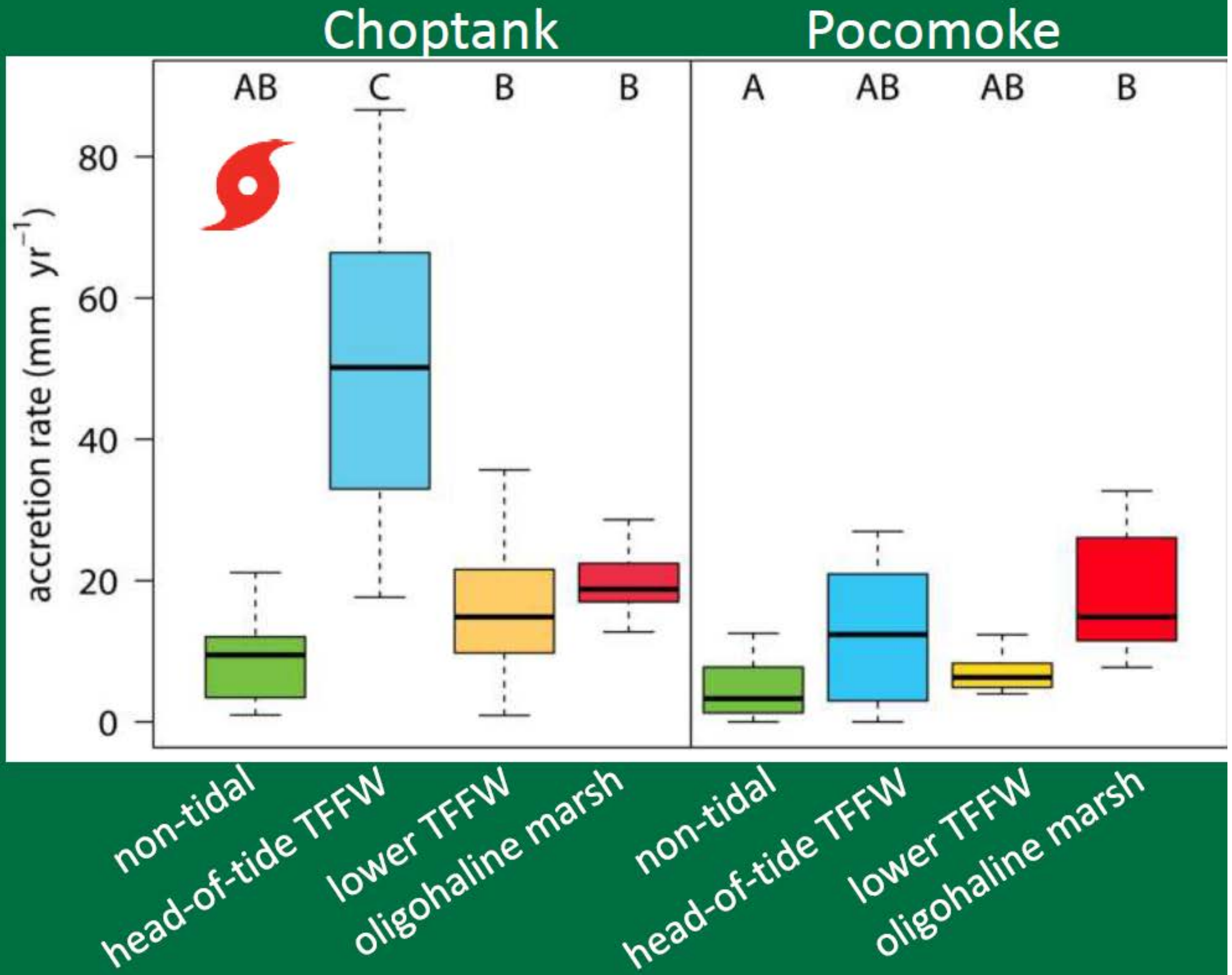
- Hypothesized that Hurricane Irene generated a large sediment pulse that was trapped in the TFFW.

Patterns in the Pocomoke also differed a bit. One

- hypothesis was less available sediment→
- “upstream TFFW cases a sediment shadow until you reach ETM”.

What happens once river loads hit tide?

Wetland sedimentation



Ensign et al. 2014. *JGR-ES*

Sediment delivery from the watershed to the Chesapeake Bay

- Tidal rivers are poorly studied but occupy key landscape position
- Tidal freshwater rivers and wetlands create a sediment shadow, limiting sediment delivery from watersheds to estuaries (6 out of 6 rivers studied)
  - Also due to lowland, Coastal Plain non-tidal floodplains
  - Probably not the largest, embayed rivers
  - Probably not during largest floods
- Greater sediment availability is critical to sediment trapping by TFFW and their ability to keep up with sea level rise
- Hummock/hollow microtopography is critical to ecosystem dynamics and services, but very sensitive to changing watershed inputs and estuarine transgression
- Deep sediment coring along Pamunkey and Mattaponi to occur later this year to examine long-term changes and C/N/P/sediment sequestration

USGS

Pulling it together:

- Watershed sediment supply is going through NT coastal floodplains, but some is getting to head of tide.
- Estuarine sediment is sloshing back and forth, getting to OH system and maybe sometimes a little farther upstream.
- High accretion rates in nontidal floodplain; highest accretion in OH; low/variable in head of tide, and lowest accretion rate in lower tidal fresh.

Conclusions: sediment availability is running out until you get to where estuarine sediment is available.

- “Sediment shadow” is not occurring everywhere, or all the time. How widespread is it, and when?

Discussion:

York estuary is loaded with sediment. If sediment’s not getting into the York from upstream, then where is it coming from?

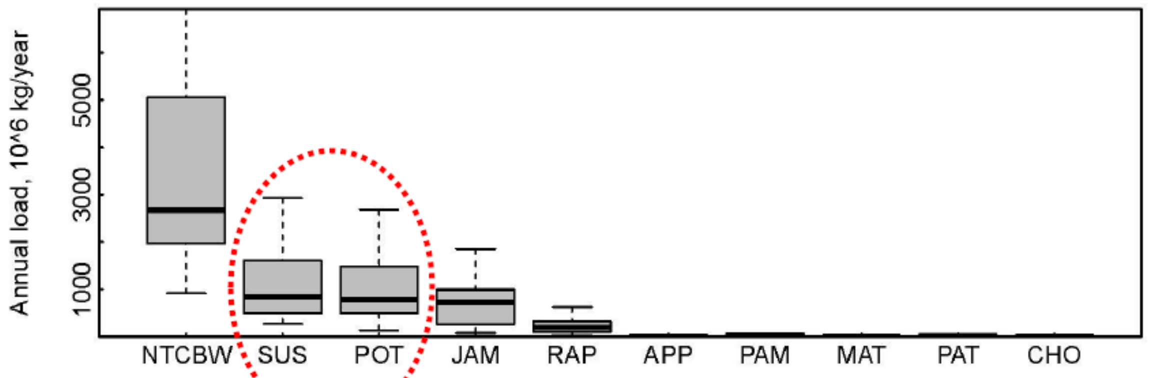
- historical artifact; legacy sediment from greater loads in past centuries.
- Recent watershed loads have decreased
- Could be that large events sediment is still shooting down past upper tidal reaches into the mainstem York. Then some of that could slosh back upstream again. → “modern or historical bypass”
- Shoreline erosion

Many of these swamps have been shown to be artifacts of post-colonial erosions. There is evidence that head-of-tide port cities are cut off from tidal rivers

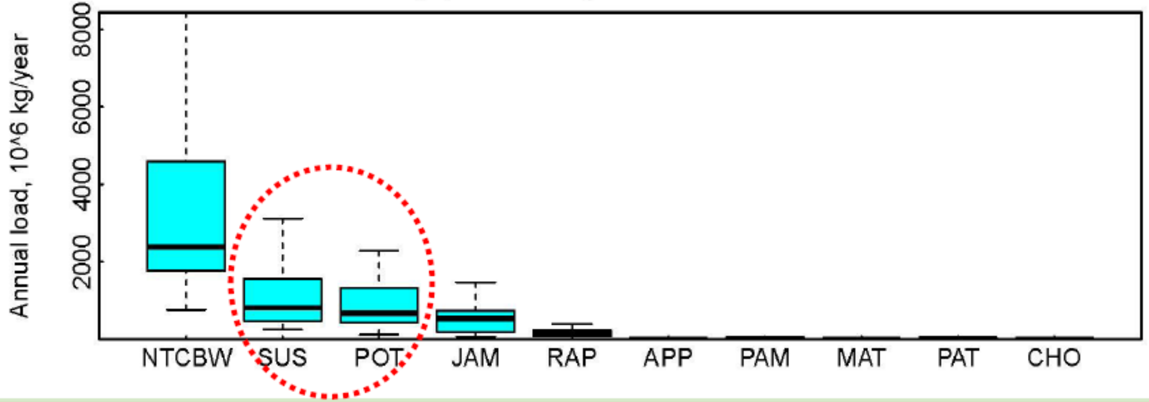
How do we tie these findings to Qian and Joel’s?

Spatial patterns of SS and SS$_{fine}$ export

(a) Suspended Sediment

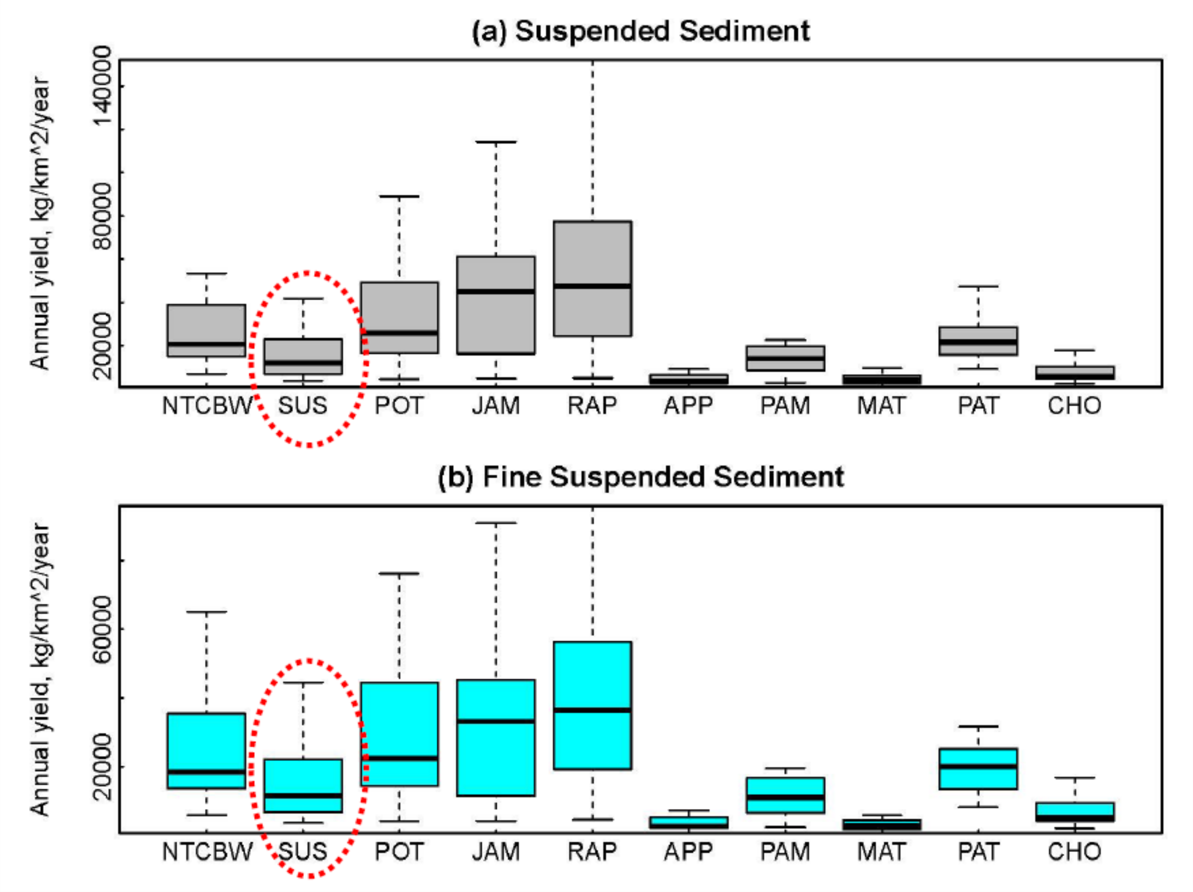


(b) Fine Suspended Sediment



1. The annual loads of SS and SS$_{fine}$ are dominated by the three largest rivers.
2. The similar magnitude between Susquehanna and Potomac loads is likely related to historical trapping in the lower Susquehanna reservoirs.
3. The smaller tributaries have low loads but can be important locally.

Spatial patterns of SS and SS$_{fine}$ export

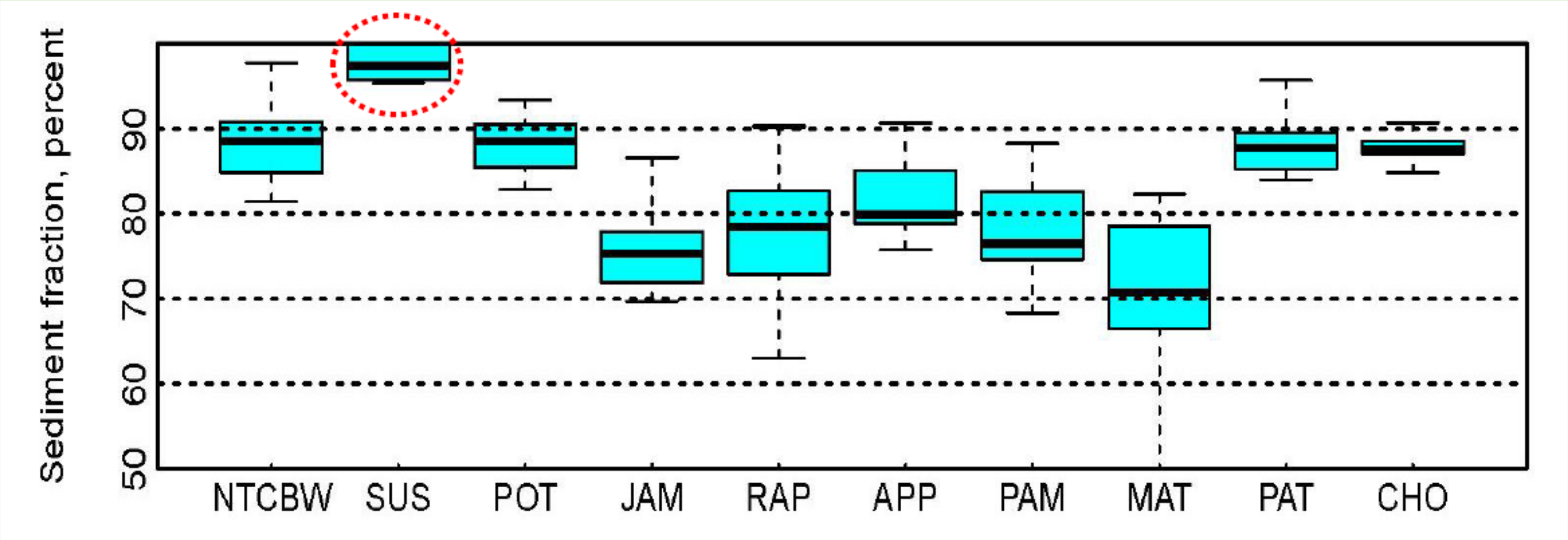

(a) Suspended Sediment

(b) Fine Suspended Sediment

1. The annual yield (flux/unit area) of SS and SS$_{fine}$ exhibits the following general order: Rappahannock > James > Potomac > Patuxent > NTCBW> Pamunkey > Susquehanna > Choptank > Appomattox, Mattaponi.

2. The larger tributaries generally have higher yields except the Susquehanna where yield is small due to reservoir trapping.

Spatial patterns of SS and SS$_{fine}$ export

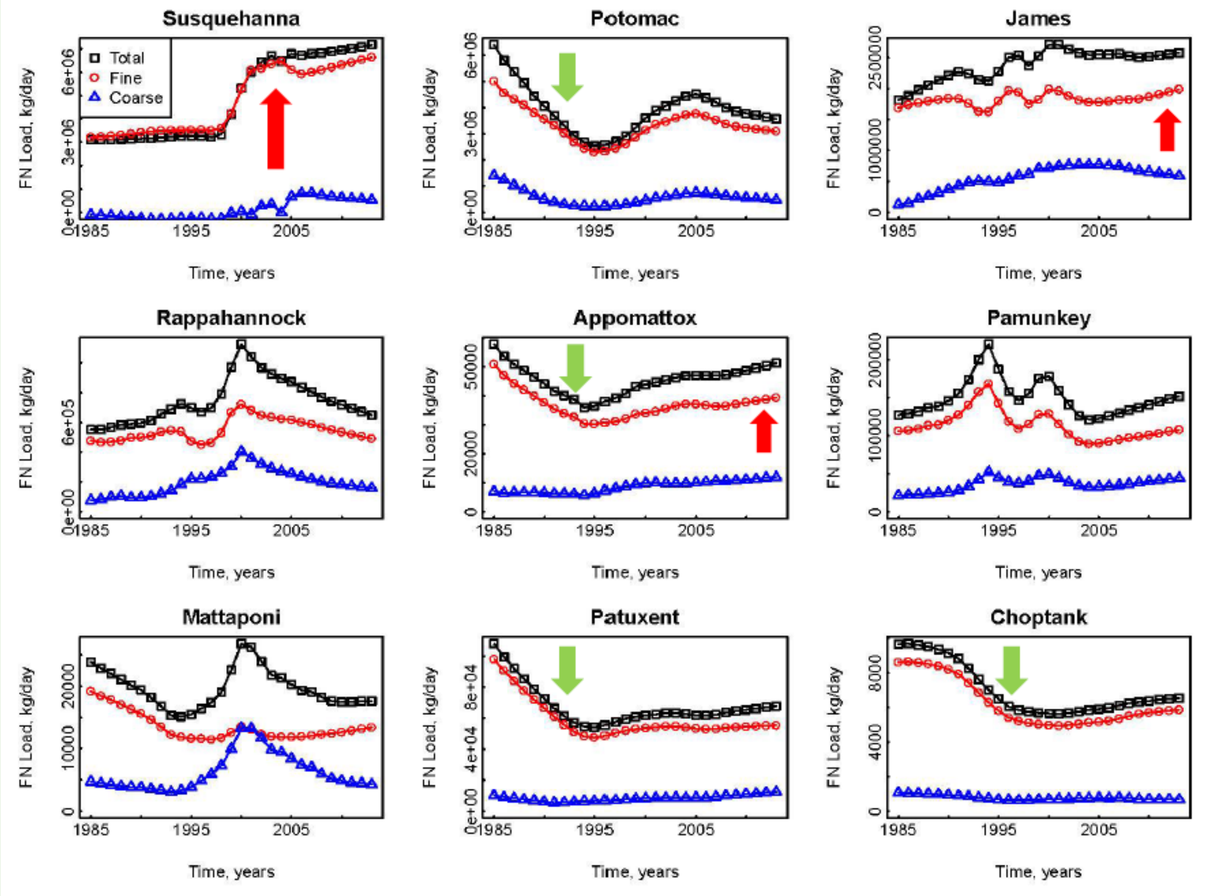


1. SS$_{fine}$ is always the dominant fraction (>50%) of SS in all tributaries.

2. The fraction of fine sediment exhibits the following general order: Susquehanna (~95%) > NTCBW, Potomac, Patuxent, Choptank (~90%) > Virginia rivers (~70%-80%).

3. The dominance of fine sediment in Susquehanna @ Conowingo strongly indicates reservoir modulation of sediment sizes.

Temporal patterns of SS and SS_{fine} fluxes



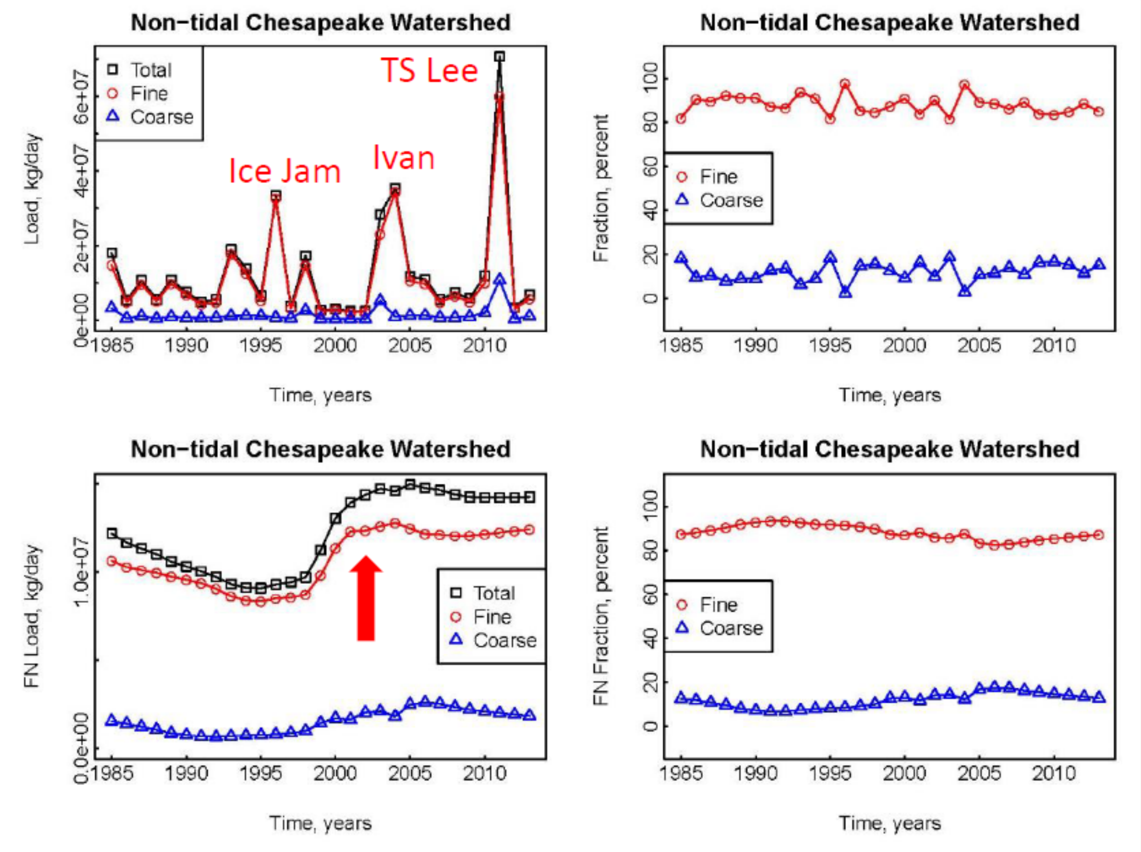
1. SS flux shows *recent increase* in Susquehanna, James & Appomattox.

2. SS flux shows *early decline* in Potomac, Appomattox, Patuxent & Choptank.

3. SS_{fine} flux trend closely follows SS trend in all tributaries except Mattaponi.

4. In most rivers, the long-term trends and variability in SS flux is largely controlled by changes in SS_{fine} in these rivers.

Long-term export of SS and SS_{fine} from the NTCBW



1. NTCBW SS flux is heavily affected by Susquehanna input: all SS fractions reached maximum in 2011 (TS Lee), 2004 (Ivan) & 1996 (ice jam).

2. In terms of *relative fraction*, both true-condition and flow-normalized data indicate relatively constant contributions by SS_{fine} (~90%) and SS_{coarse} (~10%).

3. In terms of *temporal trend*, SS, SS_{fine}, and SS_{coarse} all exhibit increasing trend since around 1995, which is largely related to Susquehanna reservoirs.