Introduction to Conowingo presentations and panel discussion

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STAC Quarterly Meeting

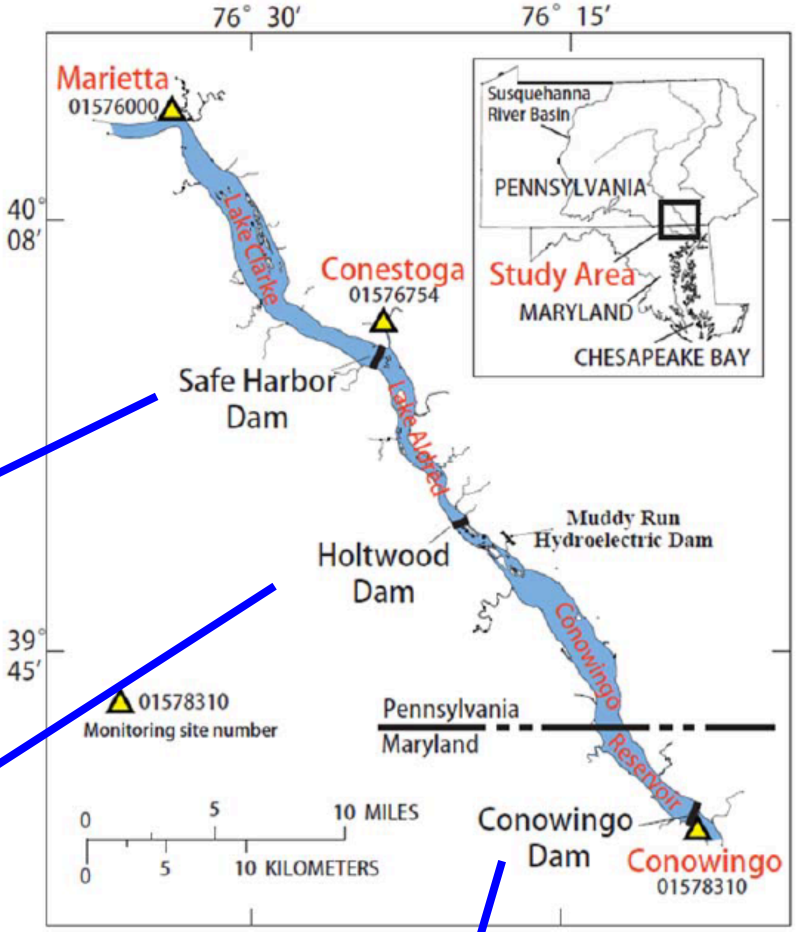
September 13, 2021

- Summary of previous investigations and STAC involvement
  - Lower Susquehanna River Watershed Assessment (2014 Draft, 2016 Final Report)
  - STAC Review of LSRWA (2014)
  - USGS long-term analyses of sediment and nutrient flux
  - STAC Workshop on Conowingo Reservoir Infill (2016)
  - UMCES Reports on Biogeochemistry, Geology and Physics of Conowingo Reservoir and Upper Chesapeake Bay (2017)
  - 2019 USGS analysis of orthophosphorus flux trends
  - 2020 STAC comment and recommendation to FERC on Exelon Agreement

- Today’s session:
  - Summary of previous findings on long-term trends affecting Conowingo Reservoir mass balance
  - Brief review of additional previous findings from LSRWA, STAC review, and STAC workshop
  - Presentations by invited speakers:
    - Cindy Palinkas, UMCES
    - Joel Blomquist, USGS
    - Matt Rowe, Maryland Department of Environment
    - Deni Chambers and colleagues, Northgate Environmental
  - Panel discussion with invited speakers, moderated by Kathy Boomer

Three Reservoirs in the Lower Susquehanna

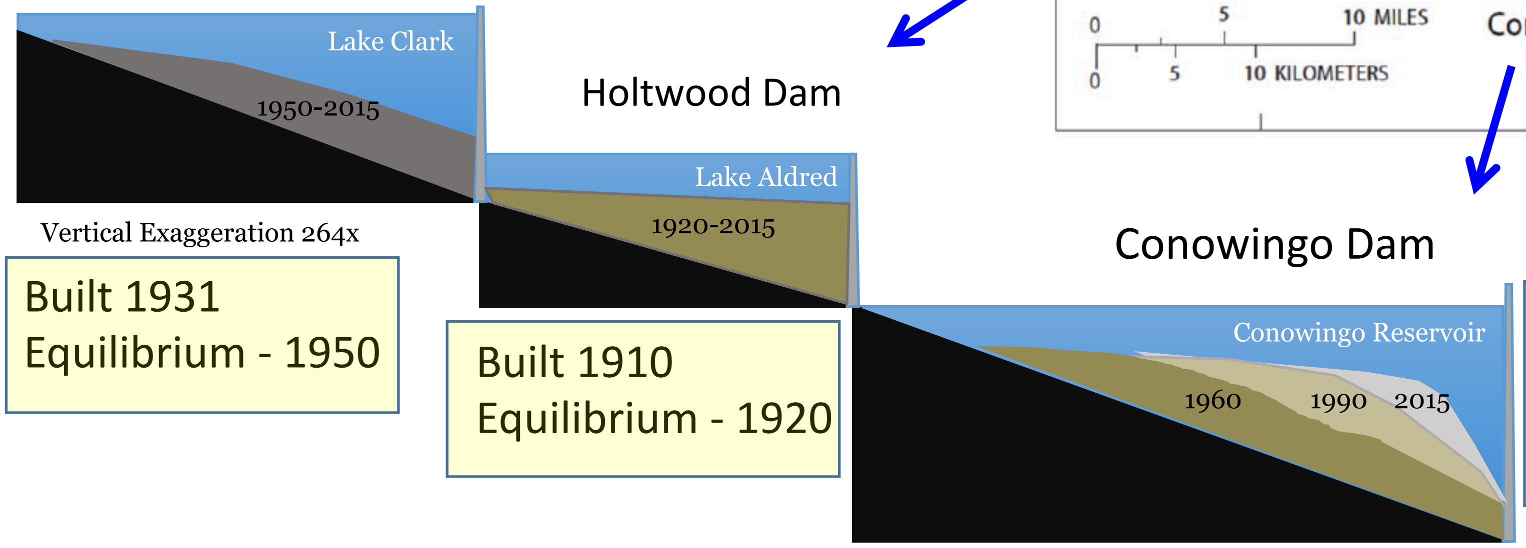
The System of Reservoirs has been filling over time.



Safe Harbor Dam

Holtwood Dam

Conowingo Dam



Built 1931
Equilibrium - 1950

Built 1910
Equilibrium - 1920

Built 1928
Equilibrium – around 2010
(First evidence - late 1970s)

Source: Langland and Blomquist, USGS, personal communication

It has been known for more than 40 years that Conowingo was trapping large volumes of Susquehanna River sediment and associated contaminants, and could export a decade's worth of sediment in a single large flood

Table from Gross et al., 1978

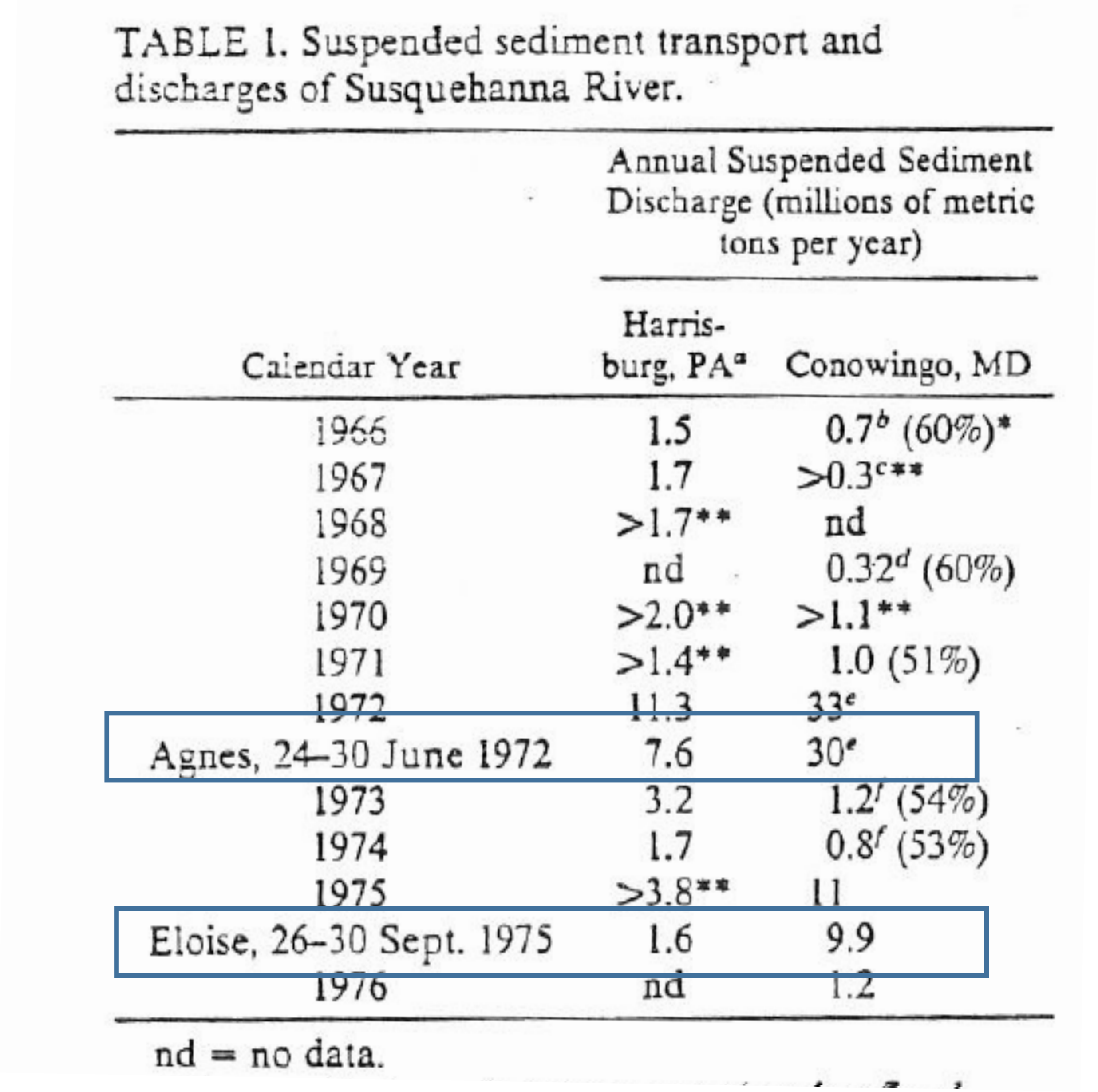


TABLE I. Suspended sediment transport and discharges of Susquehanna River.

	Annual Suspended Sediment Discharge (millions of metric tons per year)	
Calendar Year	Harrisburg, PA[a]	Conowingo, MD
1966	1.5	0.7[b] (60%)*
1967	1.7	>0.3[c]**
1968	>1.7**	nd
1969	nd	0.32[d] (60%)
1970	>2.0**	>1.1**
1971	>1.4**	1.0 (51%)
1972	11.3	33[e]
Agnes, 24–30 June 1972	7.6	30[e]
1973	3.2	1.2[f] (54%)
1974	1.7	0.8[f] (53%)
1975	>3.8**	11
Eloise, 26–30 Sept. 1975	1.6	9.9
1976	nd	1.2

nd = no data.

Lower Susquehanna River Reservoirs

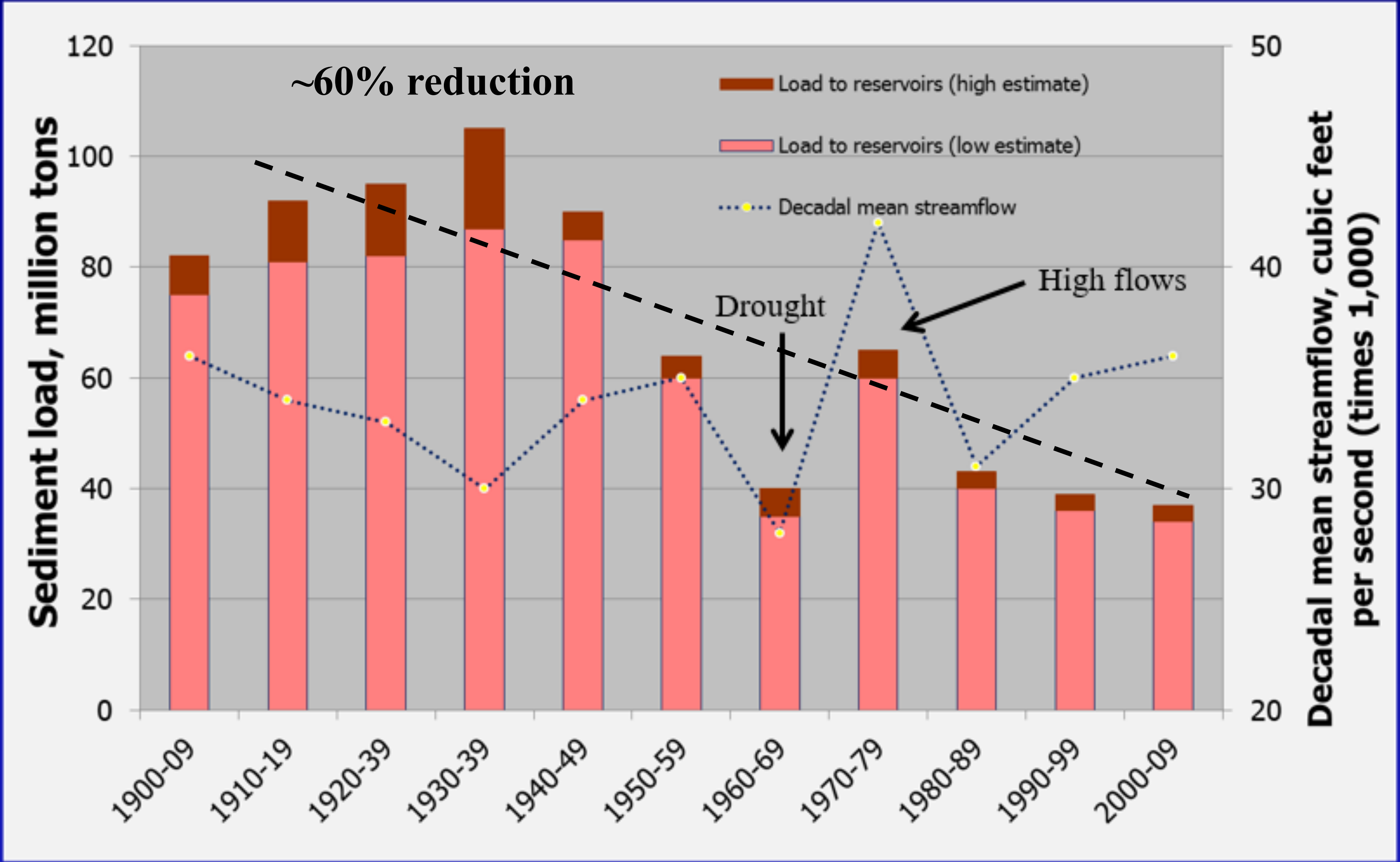
Physical Characteristics

Dam/Reservoir Name	Dam Height (feet)	Original Design Capacity (ac ft)	Remaining Sediment Capacity (ac ft) (year)	Total Sediment Deposition (tons) (2010)
Safe Harbor / Lake Clarke	75	150,000	0 (1950)	92,400,000
Holtwood / Lake Aldred	55	60,000	0 (1920)	13,600,000
Conowingo / Conowingo	105	310,000	11,000	184,000,000
Total		**520,000**	**11,000**	**290,000,000**

Langland, 2016

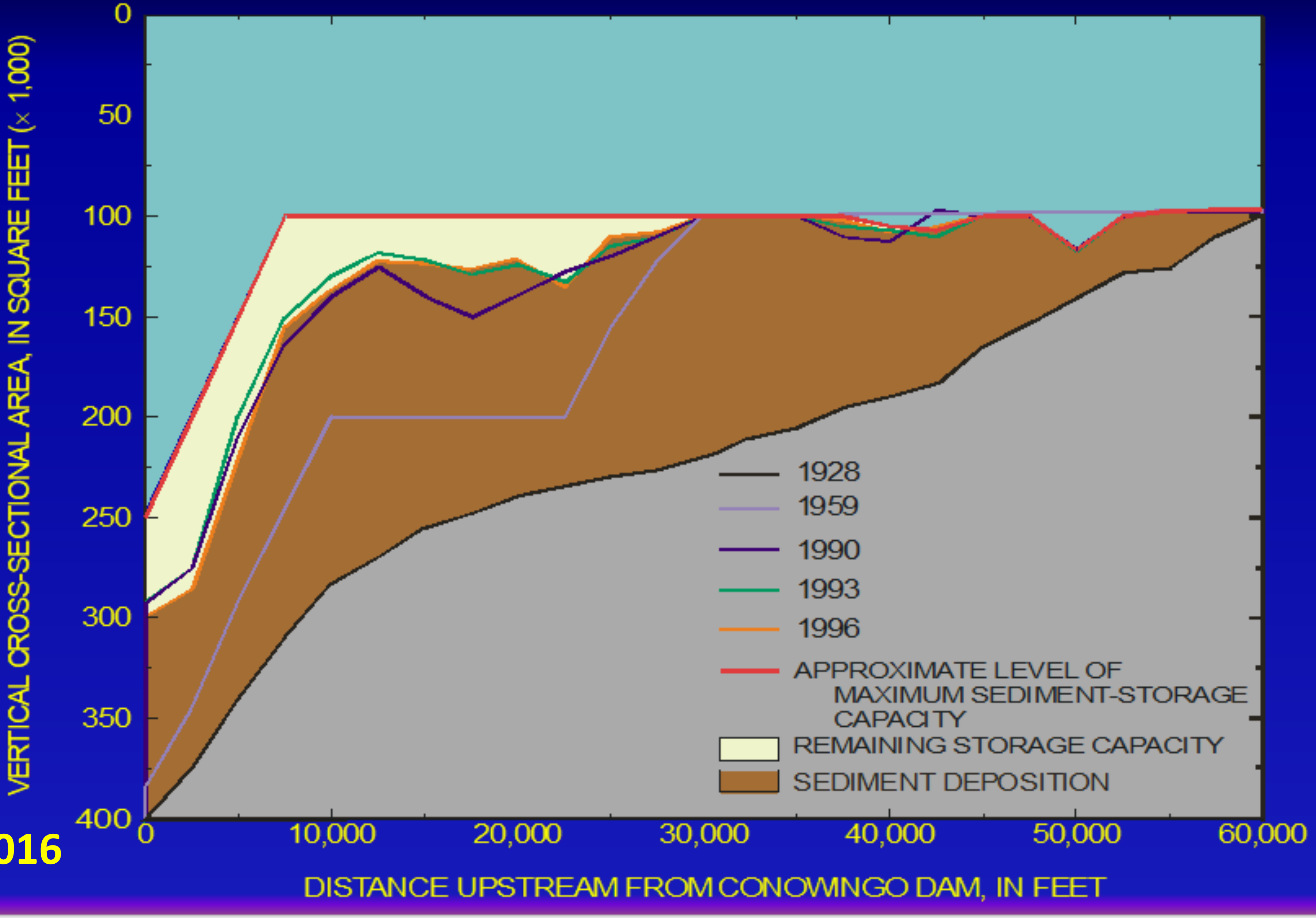
Estimated Sediment Loads to Reservoirs 1900-2009

Climatic Variability



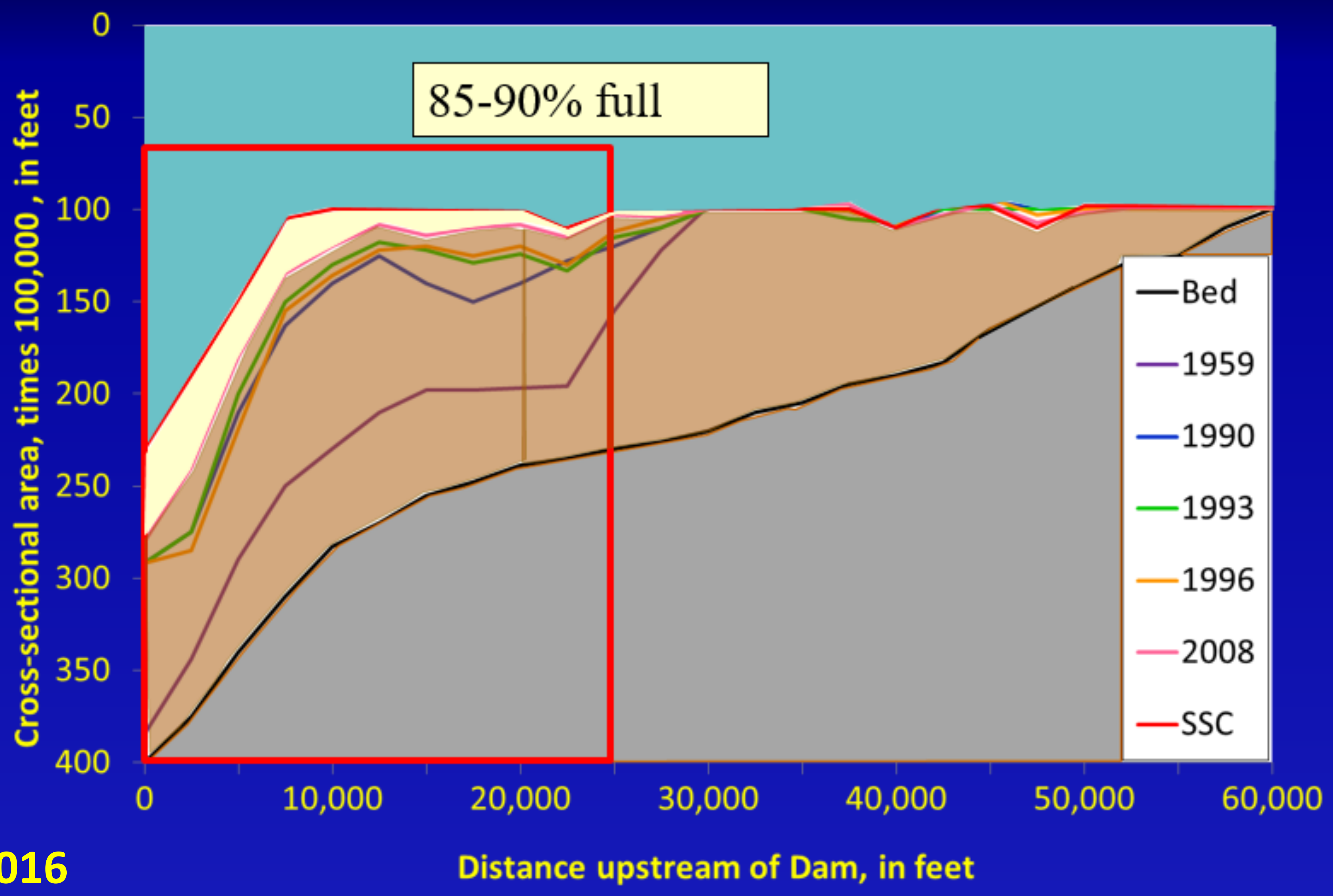
Langland, 2016

Conowingo Dam - Bathymetry Change



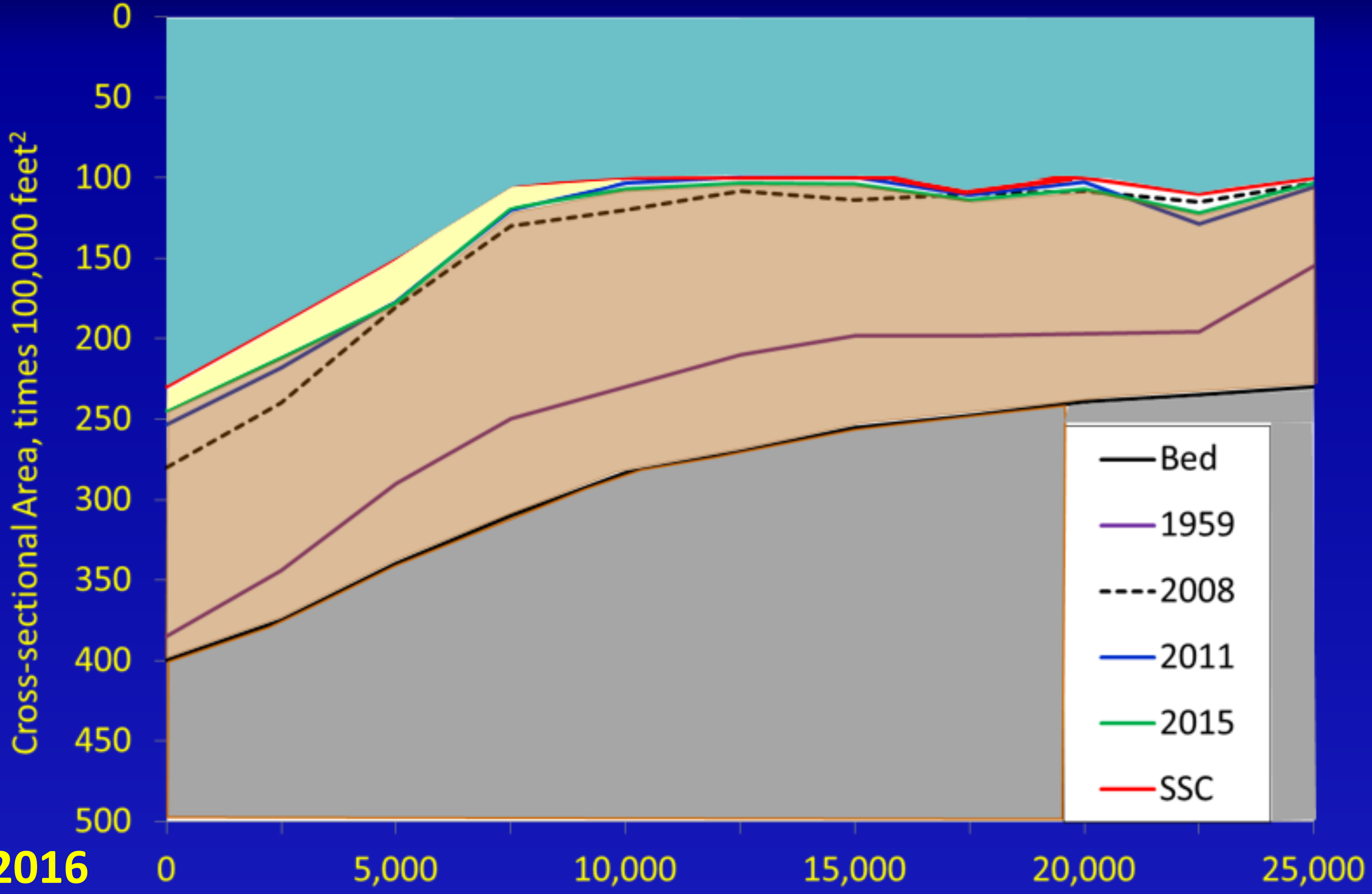
Langland, 2016

Conowingo Dam - Bathymetry Change



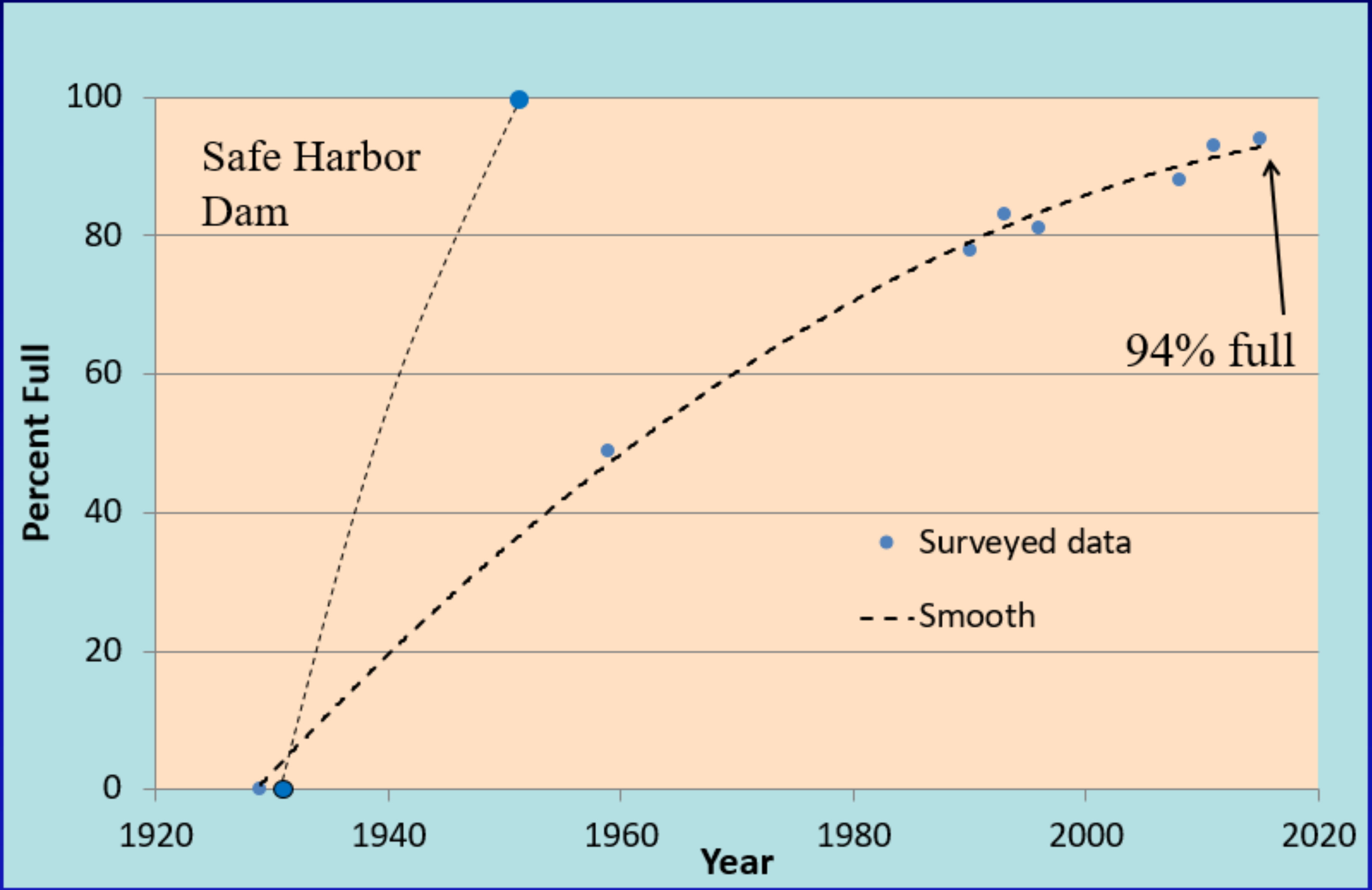
Langland, 2016

Conowingo Dam – Bathymetry Change



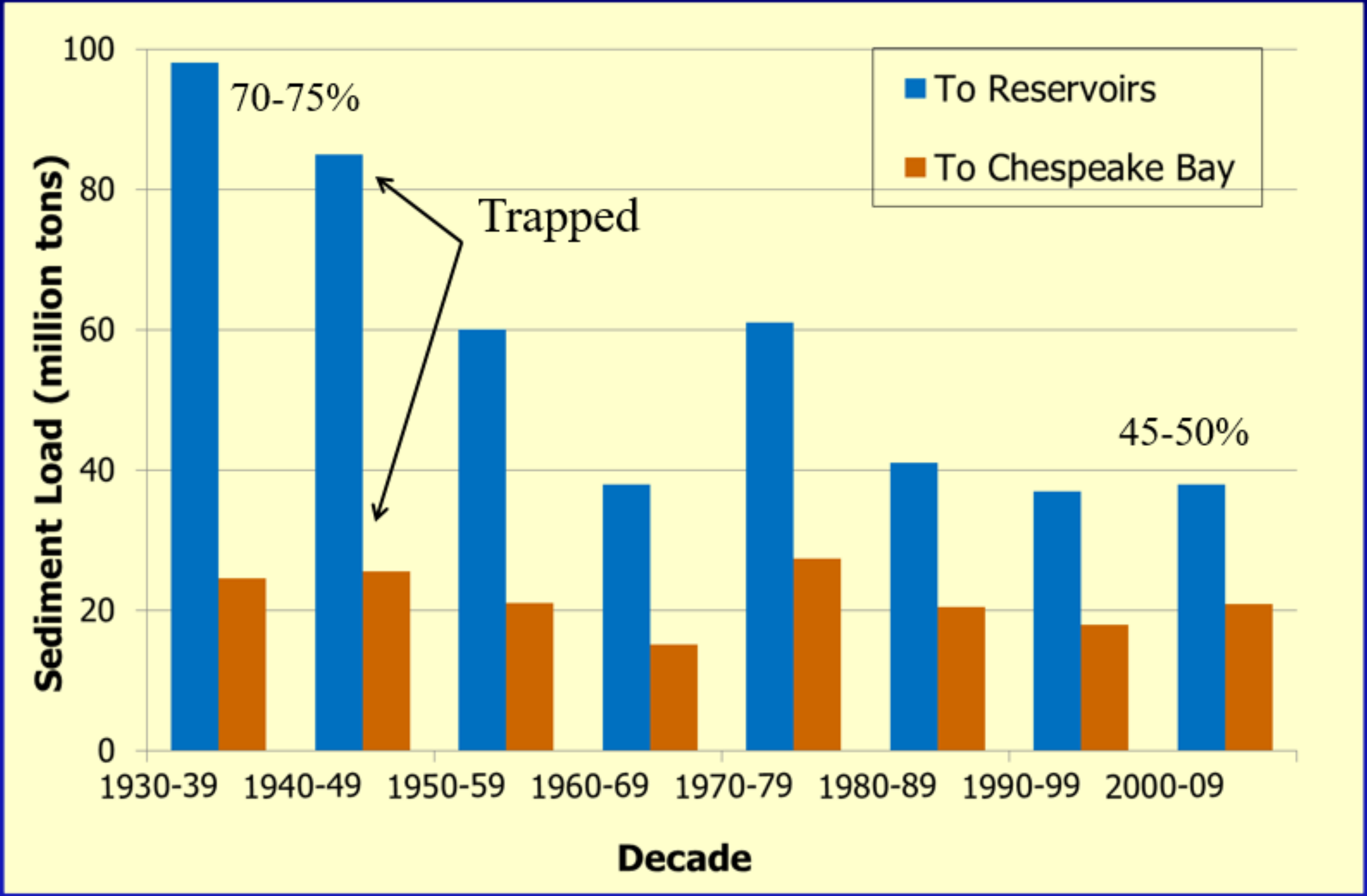
Langland, 2016

Conowingo Dam – loss of sediment storage capacity (SSC)



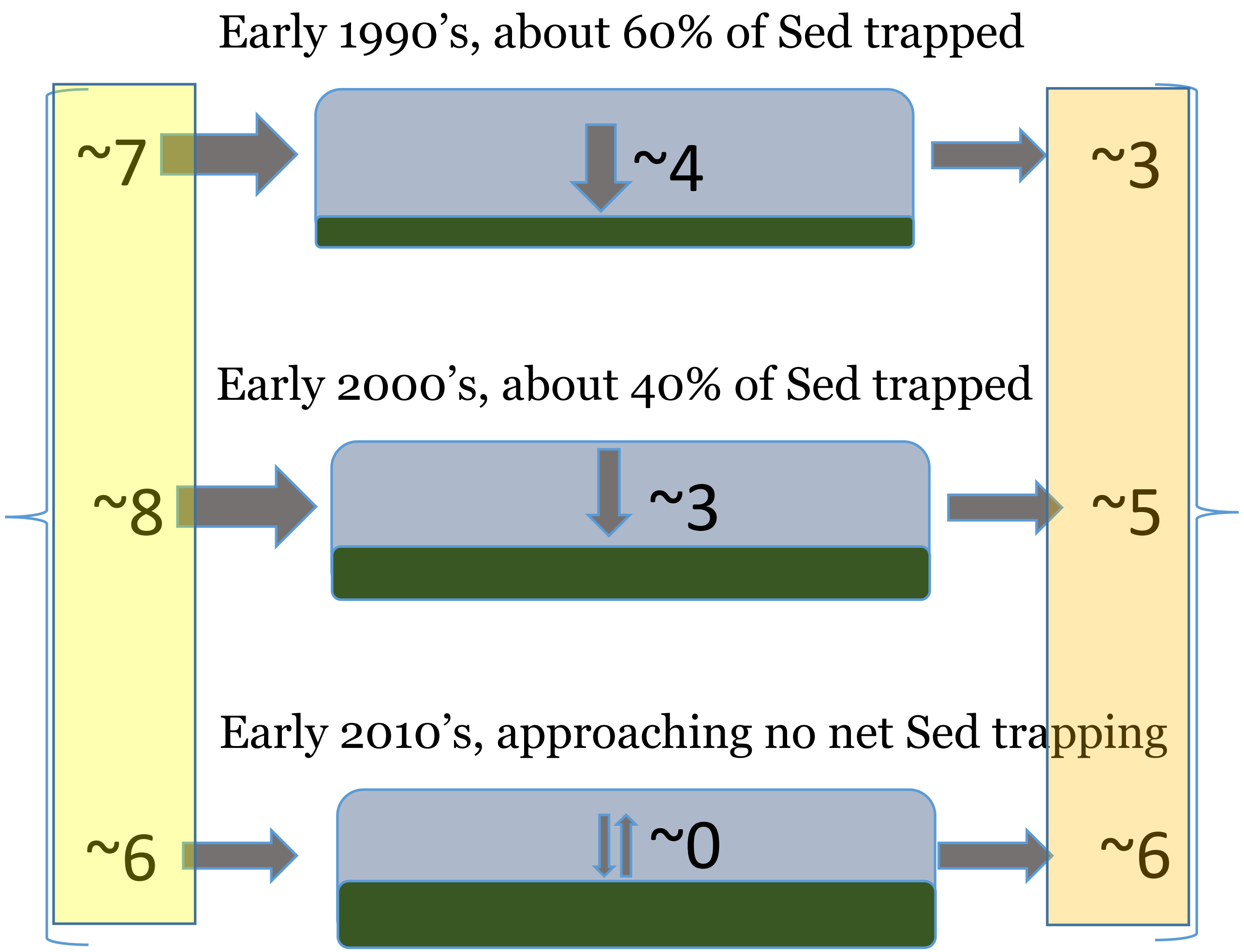
Langland, 2016

Predicted Decadal Sediment “Budget”



Langland, 2016

Sediment Loads Into, Trapped Within and Exiting the Reservoir System: 1990s-2010s



Loads Into Reservoir System
Long term improving trend

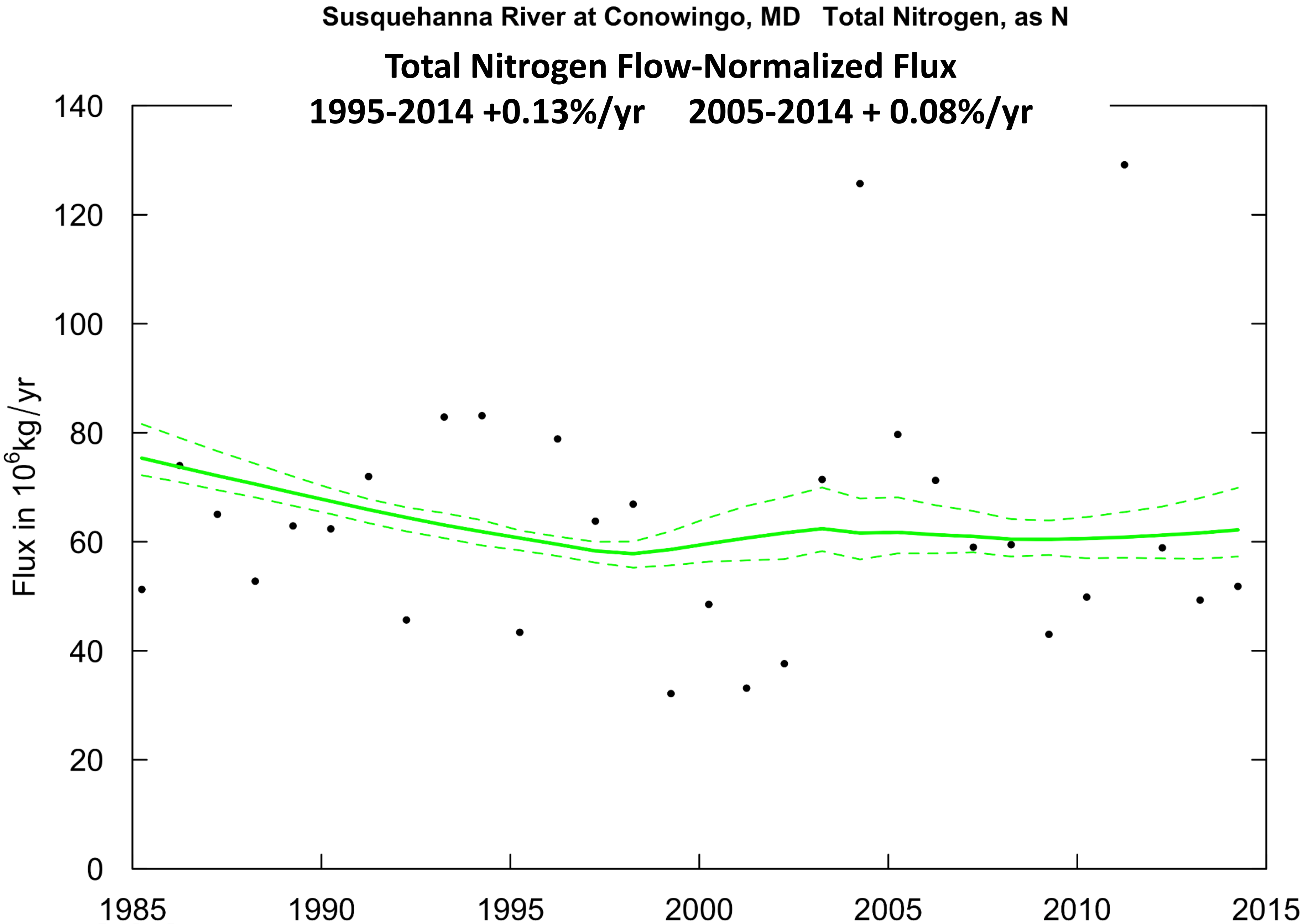
Loads Out of Reservoir System - Conowingo
Long term degrading trend

From the 2016 Conowingo Infill Webinar

Source: Data from USGS (2016), http://cbrim.er.usgs.gov/loads_query.html
loads are approximate and in units of billion lbs/year using estimates for 1992, 2002, and 2012

Total Nitrogen Flow-Normalized Flux

1995-2014 +0.13%/yr   2005-2014 + 0.08%/yr

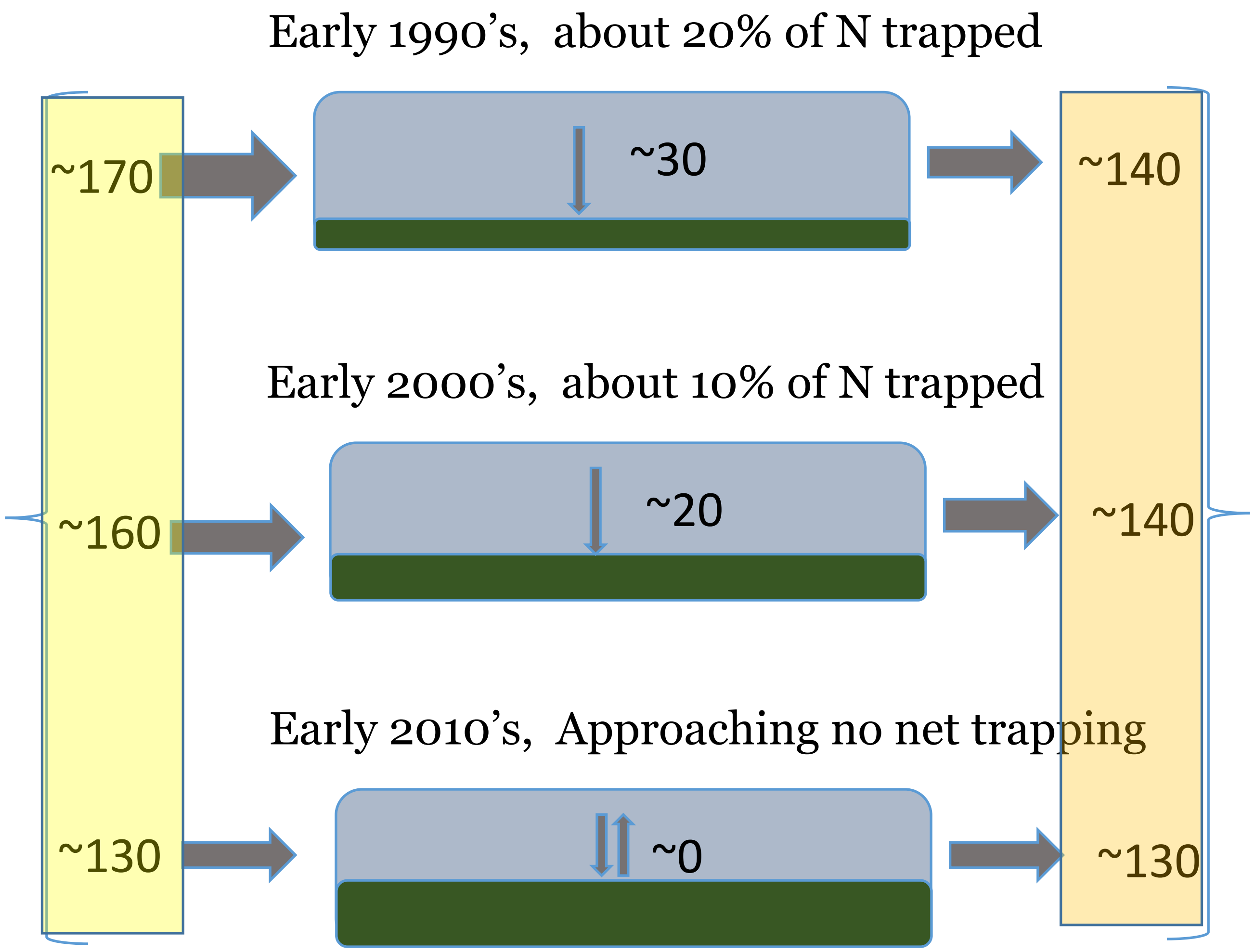


Hirsch, 2016

USGS

Nitrogen Loads Into, Trapped Within and Exiting the Reservoir System: 1990s-2010s

Loads Into Reservoir System
Long term improving trend



Early 1990's, about 20% of N trapped

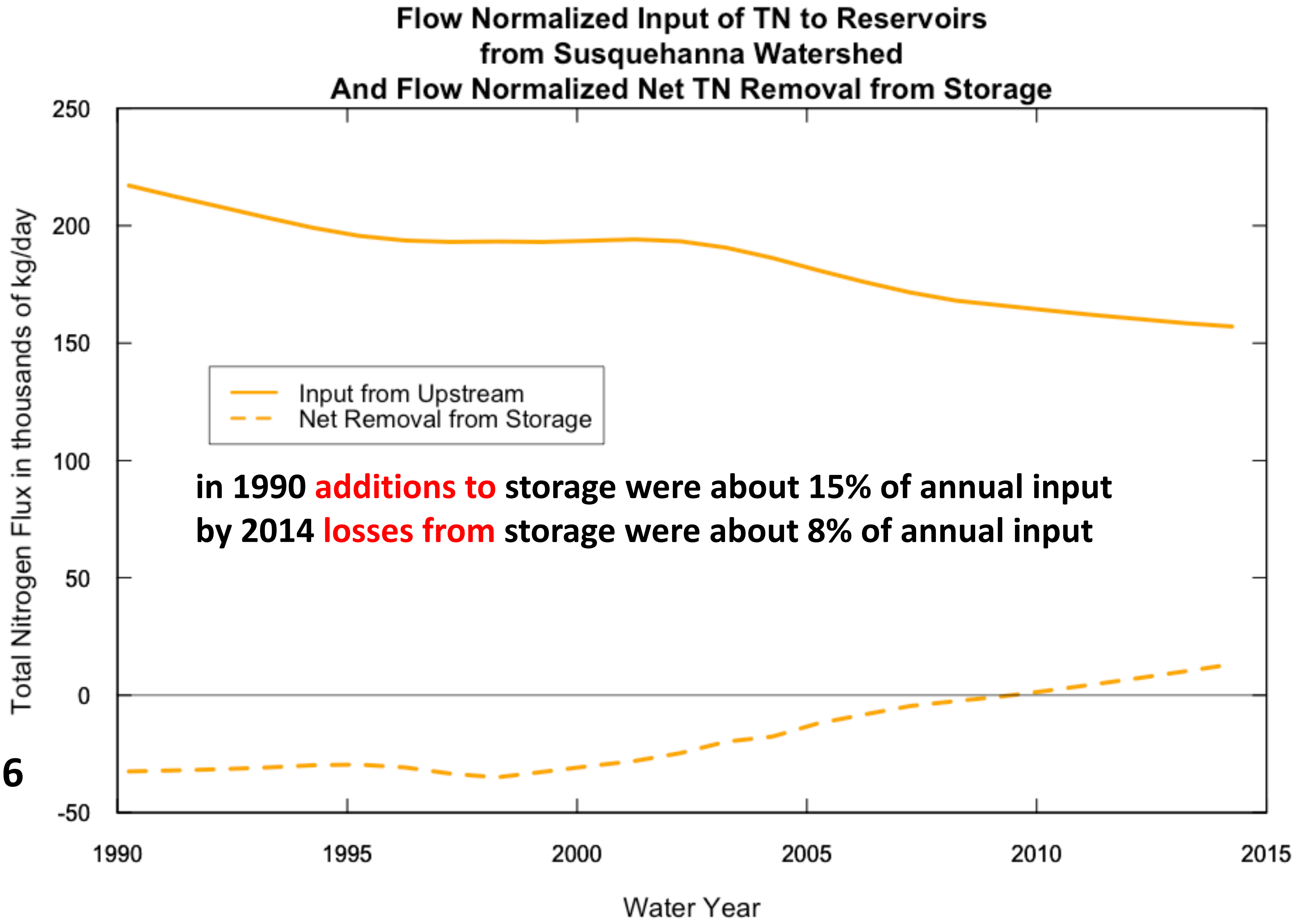
Early 2000's, about 10% of N trapped

Early 2010's, Approaching no net trapping

Loads Out of Reservoir System - Conowingo
long term improving trend

From the 2016 Conowingo Infill Webinar

Source: Data from USGS (2016), http://cbrim.er.usgs.gov/loads_query.html
loads are approximate and in units of million lbs/year using estimates for 1992, 2002, and 2012



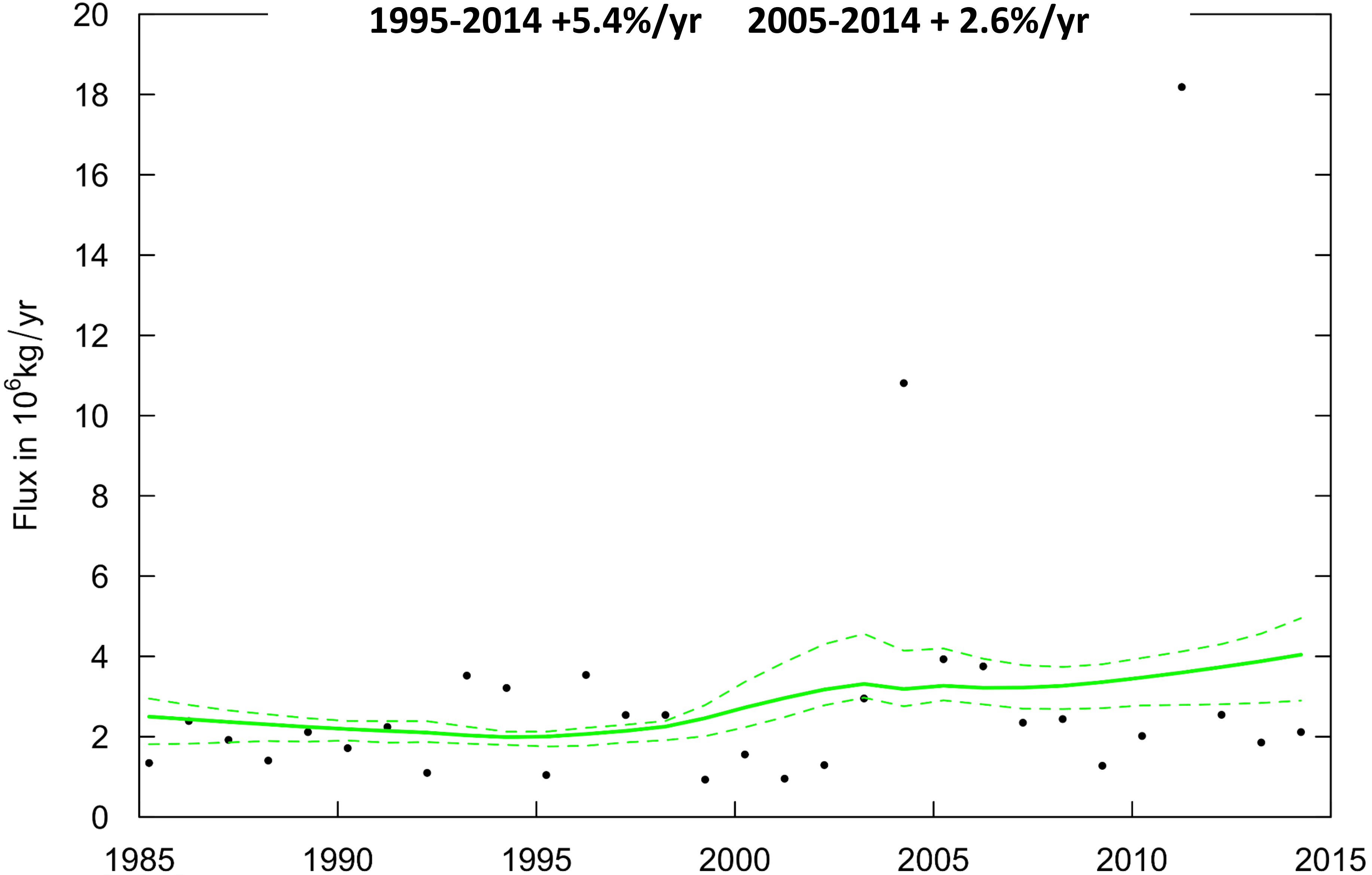
in 1990 additions to storage were about 15% of annual input
by 2014 losses from storage were about 8% of annual input

Hirsch, 2016

Susquehanna River at Conowingo, MD   Total Phosphorus

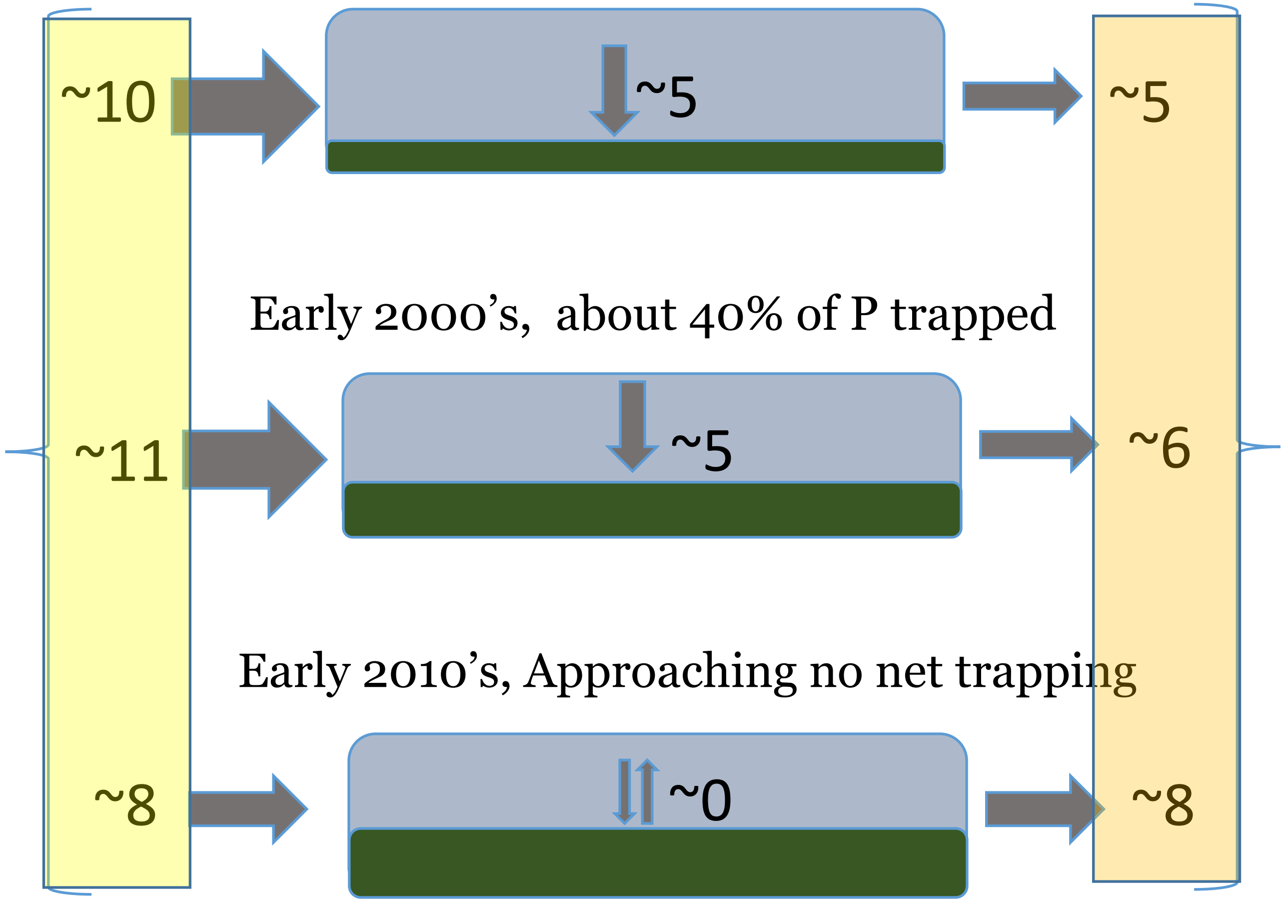
Total Phosphorus Flow-Normalized Flux

1995-2014 +5.4%/yr   2005-2014 + 2.6%/yr



Hirsch, 2016

Phosphorus Loads Into, Trapped Within and Exiting the Reservoir System: 1990s-2010s



Loads Into Reservoir System
Long term improving trend

Early 1990's, about 50% of P trapped

~10 → ~5 → ~5

Early 2000's, about 40% of P trapped

~11 → ~5 → ~6

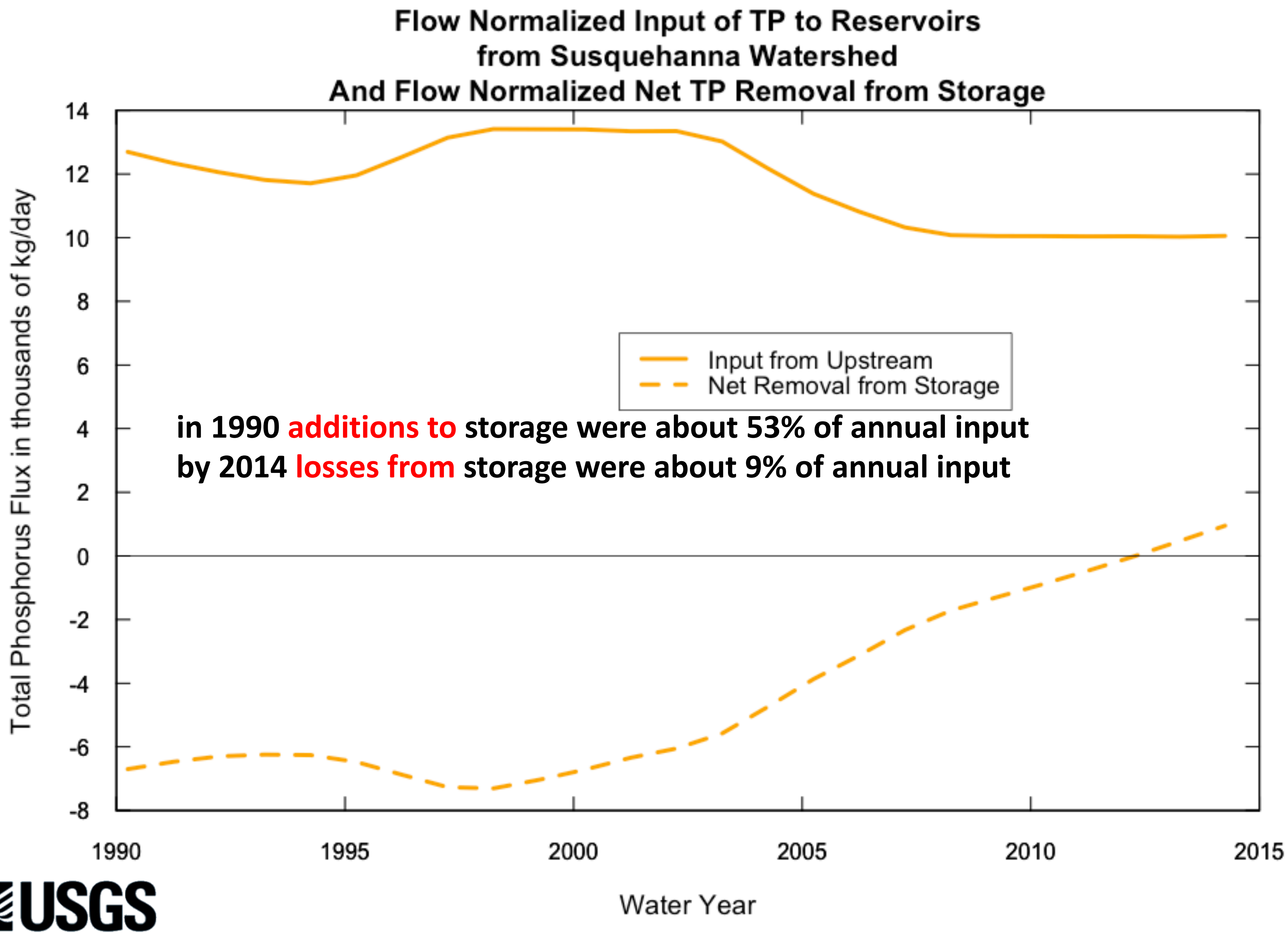
Early 2010's, Approaching no net trapping

~8 → ~0 → ~8

Loads Out of Reservoir System - Conowingo
Long term degrading trend

From the 2016 Conowingo Infill Webinar

Source: Data from USGS (2016), http://cbrim.er.usgs.gov/loads_query.html
loads are approximate and in units of million lbs/year using estimates for 1992, 2002, and 2012


Flow Normalized Input of TP to Reservoirs
from Susquehanna Watershed
And Flow Normalized Net TP Removal from Storage

in 1990 additions to storage were about 53% of annual input
by 2014 losses from storage were about 9% of annual input

Hirsch, 2016

USGS

Implications for the watershed model

- TN: the reservoir sink was an average of about 30,000 kg/day in the 1990's. Now it is a source of near 10,000 kg/day.
- TP: the reservoir sink was an average of about 7,000 kg/day in the 1990's. Now it is a source of about 1,000 kg/day.
- The model must represent this behavior recognizing that it varies greatly as a function of discharge and season.
- The model must credibly simulate the 1990's condition, the recent condition, and the likely future condition.

USGS

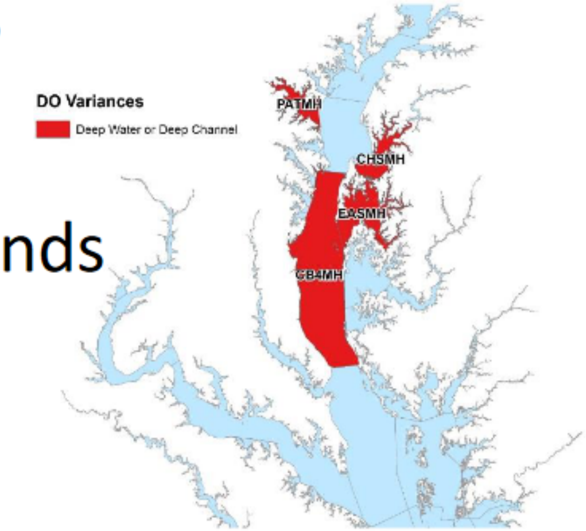
Langland, 2016

Estimated Loads to the Bay with Conowingo Dam and Reservoir at Infill Conditions

Additional Nitrogen Load: 13 million pounds

+

Additional Phosphorus Load: 1.8 million pounds



HOWEVER: These are less bioavailable nutrients and its delivery to Bay is dependent on large storm events. Therefore, only a smaller than expected (2 percent increase) in non-attainment in Middle Central Chesapeake Bay Deep-Channel. Equivalent to 6 million pounds of Nitrogen and 0.26 million pounds of Phosphorus

Lower Susquehanna River Watershed Assessment

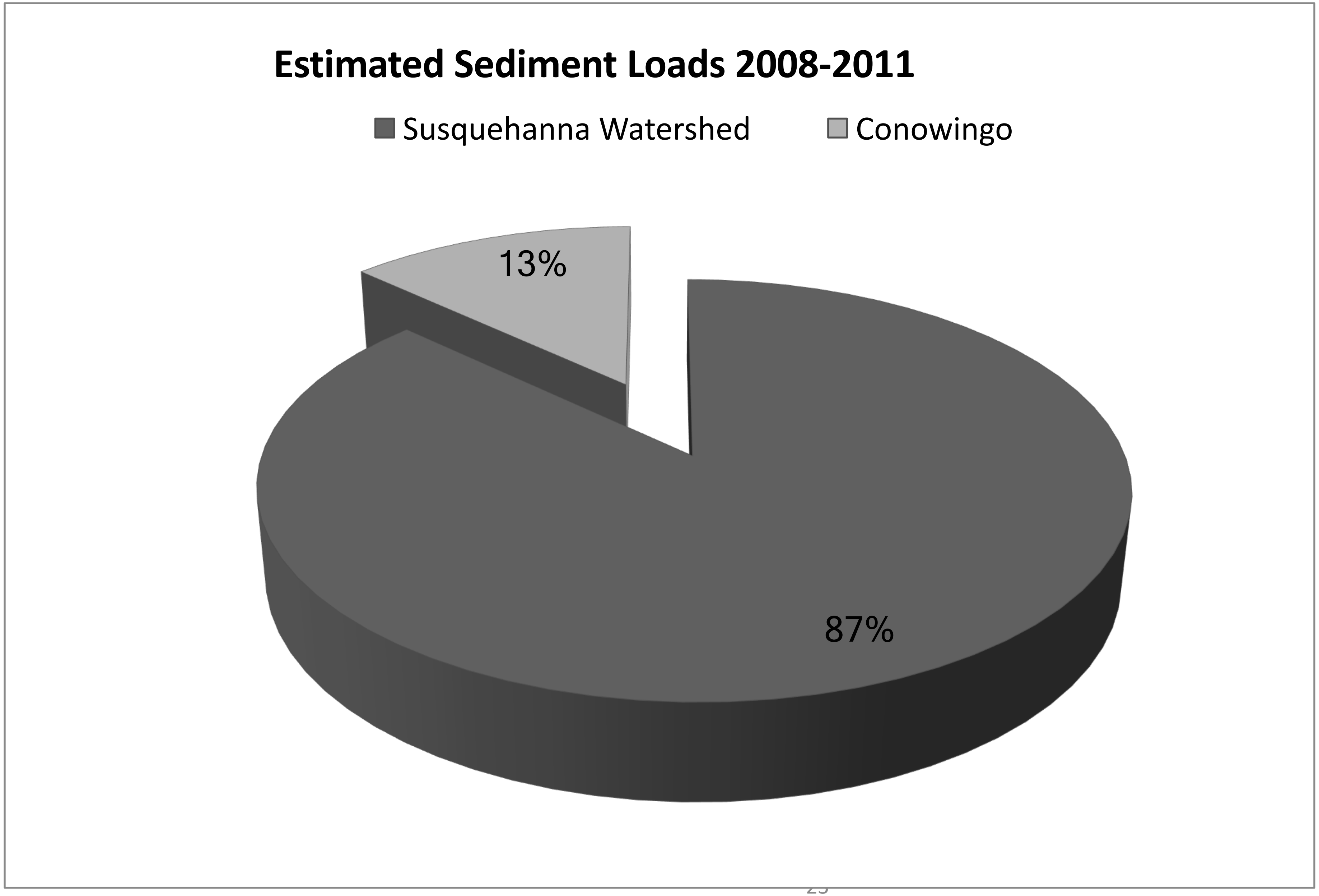
Key Findings

Anna Compton
USACE

Graphic courtesy of SRBC

Scientific and Technical Advisory Committee Workshop
January 13, 2016

Finding 3 Continued:



Finding 3 Continued:

With or Without the Dams, Large Storms Will Continue To Contribute Sediment and Nutrients to the Bay

February 2013 Storm

Photo credit: NASA

Finding 4: Dredging, Bypassing, and Dam Operational Changes, By Itself, Does Not Provide Sufficient Benefits to Offset Impacts From the Loss of Long-Term Trapping Capacity

- Dredging = Minimum, Short Lived Water Quality Benefits
- Cost: $15-270 Million Every Year
- Back to Mid-1990’s = $496 million to $2.8 billion
- Only ‘Keeping Up’ With Inflowing Sediment
- Reducing Nutrients at Their Source <u>More</u> Effective

2014 STAC Review of LSRWA report:

- The Conowingo Reservoir is essentially at full capacity and is no longer a long-term sink helping to prevent sediment-associated nutrients (primarily particulate phosphorus) from entering the Chesapeake Bay.
- Increases in particulate phosphorus loads entering the Bay as a result of the full reservoir are likely causing significant impacts to the health of the Chesapeake Bay ecosystem.
- Sources of nutrients upstream of the Conowingo reservoir have far more impact on the Chesapeake Bay ecosystem than do the increases in nutrients caused by scour plus reduced deposition in the reservoir.
- Managing sediment via large-scale dredging, bypassing and/or operational changes are clearly not cost-effective ways to offset Chesapeake Bay water quality impacts from the loss of long-term trapping of sediment-associated nutrients.

2014 STAC Review of LSRWA report:

- As soon as possible, follow-up studies should more fully quantify the impact on Chesapeake Bay water quality from increases in sediment-associated nutrients brought about by reservoir infilling.
- There is no compelling reason to reduce sediment loads *per se* from the Susquehanna watershed to compensate for increased sediment passing out of the Conowingo reservoir. Nutrients are the main problem, not sediments.
- Additional particulate phosphorus load reductions from the Susquehanna watershed (beyond present WIPs) should be considered to compensate for changes to the Conowingo.

From the STAC Workshop on Conowingo Infill

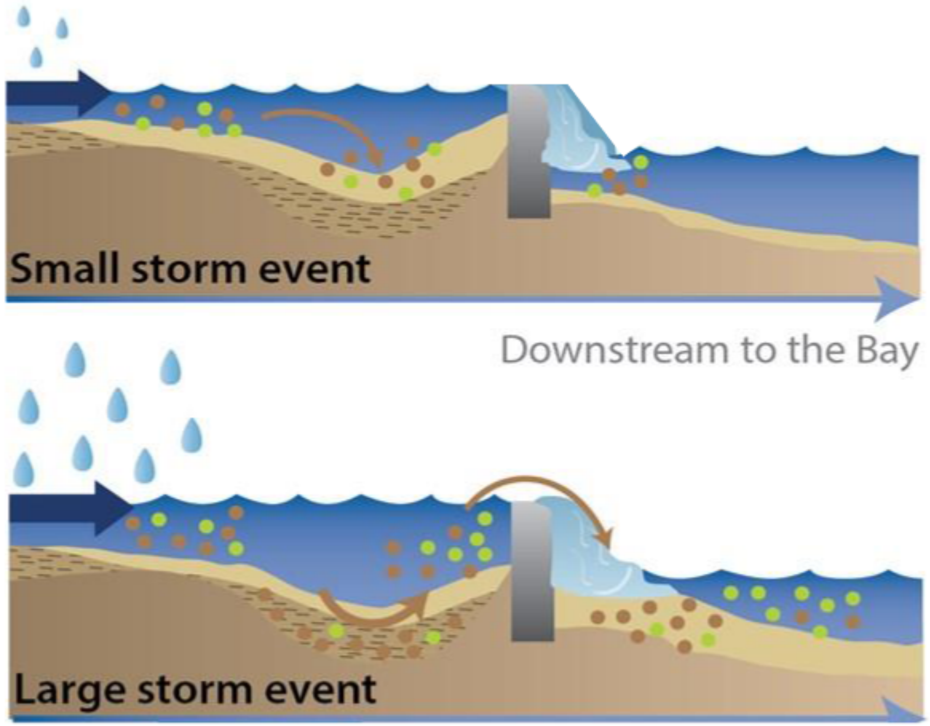
- Suspended solids loads produced by a Conowingo scour event are relatively non-detrimental to Bay water clarity and SAV survival.
- The organic matter and nutrients associated with the solids are, however, detrimental.
- This material settles to the estuary bottom and is mineralized in bed sediments. Nutrients are recycled to the water column and stimulate algal production.
- As a result of a winter scour event, computed bottom-water DO in the subsequent summer declines up to 0.2 g m^{-3} although the decline is 0.1 g m^{-3} or less when averaged over the summer season.

The 2016 STAC workshop included these conclusions:

- Infilling of the Conowingo Reservoir primarily influences particulate nutrient delivery, **with negligible influence on fresh water discharge or dissolved nutrient delivery to the Chesapeake Bay system. Most nitrogen is transported in dissolved form**.
- Under low to moderately high flow conditions, it is likely most of the sediment loading from the Susquehanna is trapped (and buried) by processes at or before the Estuarine Turbidity Maximum (ETM).
- There is significant bypassing of the ETM under very high flow conditions, but when and how much remains to be determined

Estimated Loads to the Bay with Conowingo Dam and Reservoir at Infill Conditions

Dec. 2017
WQGIT
Midpoint
assessment



- Almost all of the nutrients are from upstream sources
- Much of the nutrients are biologically available to algae when they enter tidal waters

- Some of the nutrients are scoured from the bottom sediments behind the dam
- Much of these scoured nutrients are not biologically available to algae when they enter tidal waters

Therefore, the determination of nutrient loads to be reduced to account for Conowingo infill must factor in the type of nutrients and the timing of delivery

A new problem – reported in 2019

USGS scientists observed increases in dissolved phosphorus loads from Conowingo that appear to be associated with biogeochemical processes within the reservoir sediment and water column, and could have implications for water quality that have not been considered previously by the watershed partnership. **The reservoir ecosystem is largely unexamined and poorly understood. This information was not available when the TMDL was written.**

STAC therefore posted a statement to the Federal Energy Regulatory Commission in reference to the Exelon Agreement on Jan. 17, 2020 which summarizes the reasons for concern and then says:

> **STAC recommends that MDE consider using some of the funds from the Exelon agreement to undertake new programs of monitoring within Conowingo Reservoir and its environs that will allow better understanding of trends affecting the flux of dissolved nutrients, and particularly dissolved phosphorus, to the upper Bay.**

Conowingo Dredging and Innovative and Beneficial Reuse Project

Questions from STAC for the panel discussion:

- Does Conowingo currently function largely as a run-of-river system, or does it have the potential to function as a kind of super-BMP with strategic dredging?
- What monitoring/modeling would be needed to confirm, modify, or reject previously published conclusions about the potential role of dredging?
- What locations were chosen for the pilot studies and why?
- Will the pilot studies include assessment of near-term and long-term nutrient and sediment reductions, including potential nutrient and sediment releases during dredging?
- What plans have been made for monitoring and for evaluation of monitoring results associated with the pilot projects?
- How will this evaluation be scaled up to inform decisions about whether dredging is to be implemented as a part of the overall effort for mitigation of the additional loads anticipated from Conowingo?