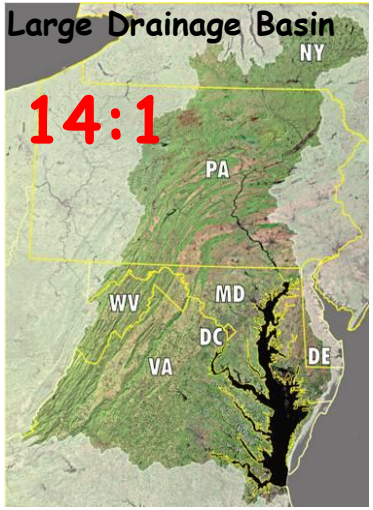
CHESAPEAKE BAY RESTORATION: A Bit of History, Value of Salt Marshes, and some ideas on the "Shape" of restoration

CBC Presentation Solomons, MD

September 2017

- 17 Million people
- Mixed land uses
- Shallow but seasonally stratified
- Estuary "flushes" slowly (4-6 mo)
- Many rivers connect land to Bay



Walt Boynton and Many Colleagues

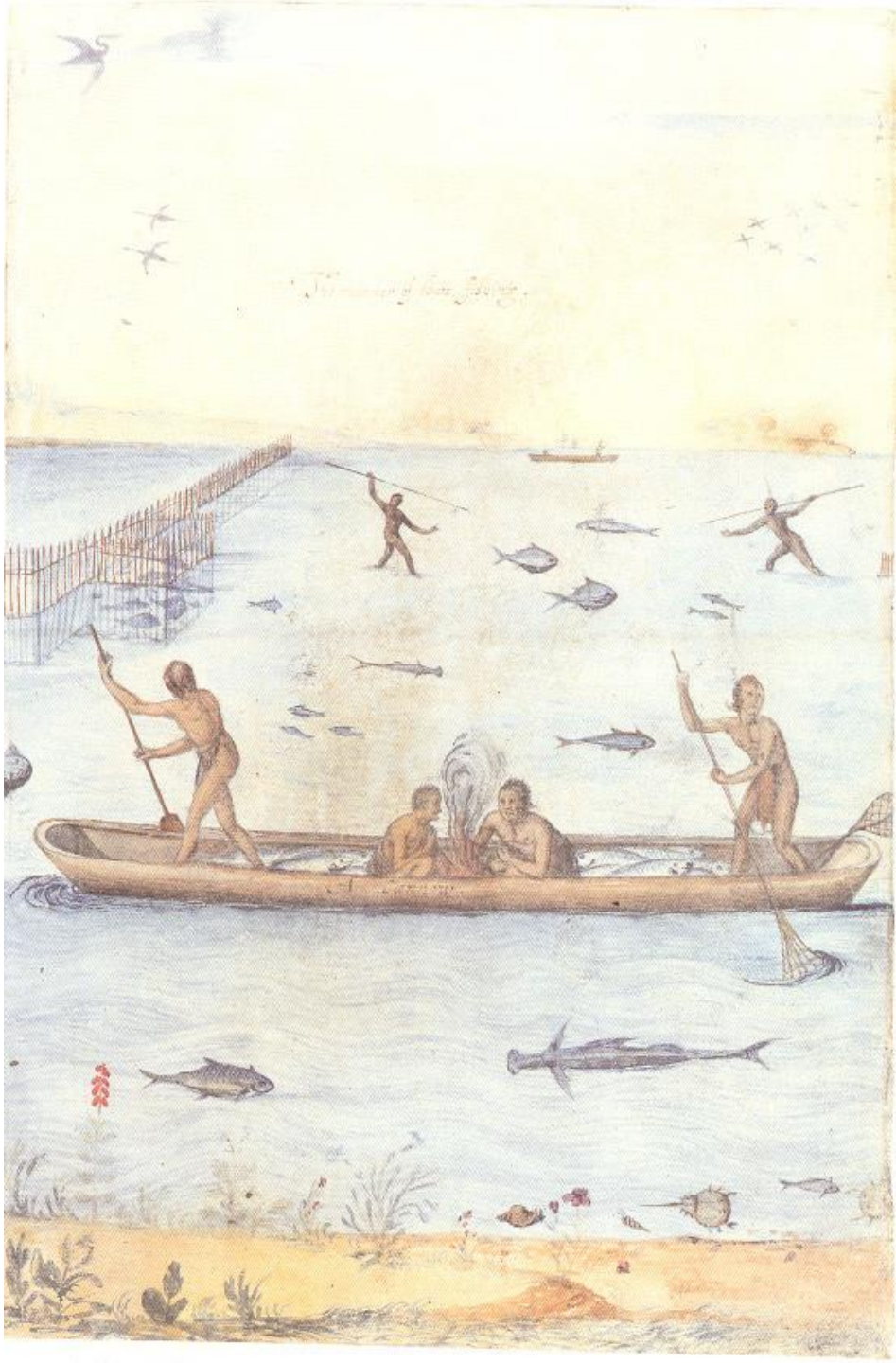
Chesapeake Biological Lab, Center for Environmental Science, Univ MD

A Famous Chesapeake Bay Painting…1588

- Clearly, fish were important

- Emphasis on shallow waters…and there are lots of these everywhere

- CLEAR WATER and SAV…a clear water benthic dominated painting and likely a benthic dominated ecosystem



From T. De Bry in Hariot 1588

A John Smith Diet

- Traded with natives for corn, venison, fish, oysters, nuts, beans, pumpkins…traded swords for turkeys (a 1 for 1 deal…probably not a good deal for the English)

- Tobacco…"it purges the superfluous phlegm and other gross humours and openeth all the pores and passages of the body" from Harriot who died of a nasal tumor in 1621…the 400 year tobacco wars are still with us.

- Jamestowners preferred a seaman's diet of pork, beefe, fish, wheat and barley (even with the ever present worms)…not too adaptive even when hungry

- Sturgeon (dried and pounded)

- The Starving Time (winter 1609-1610)…cats, dogs, horses and people…this was a very tough life indeed!

Hoobler 2006

Patuxent River Estuary Circa 1832

Water Quality and Habitat Conditions can be much improved…not to the 1832 condition and that may not be the optimal status

"So transparent are its waters that far out from shore you may see, in the openings of the sea-weed forest, on its bottom the flashing sides of the finny tribe as they glide over the pearly sands." *The Old Plantation by Hungerford (1859)*

Major Events in Chesapeake Bay History: Science, Management and Politics

1950-60s: Pollution not possible in estuaries because of tidal flushing. The Bay is just fine and productive. Almost no "Estuarine Science" literature available

1960s: There is nothing …and we mean nothing…wrong with Chesapeake Bay. Reports of pollution are false and unpatriotic. You can be fired for this sort of loose talk

1960-70s: The more nutrients we can pour into the Bay the better…farmers know that fertilization is good so lets get on with fertilizing the Bay. About 90% of SAV are gone and the causes are unclear

1970-80s: So, OK estuaries can be polluted…big deal. The only thing needed for restoration is control of PHOSPHORUS and that's easy. Restoration efforts need to focus on POINT SOURCES

1980-90s: Both NITROGEN and PHOSPHORUS from MANY SOURCES are killing Bay habitats …the bay is nutrient obese and needs a nutrient diet…big time. DIFFUSE SOURCES clearly a major player

2000-17: Restoration is hard and expensive. Fears that all aspects of the Bay have long memories proven false…Bay is responsive. However, pathways to restored conditions are not simple….expect some surprises

Lets look at Tidal Wetlands for a moment

Pocomoke River Marshes

We know a good bit about some marsh functions

- wildlife habitat
- nursery functions
- storm protection

What about tidal marshes as important NUTRIENT SINKS…A kidney in the landscape helping us achieve the TMDL?

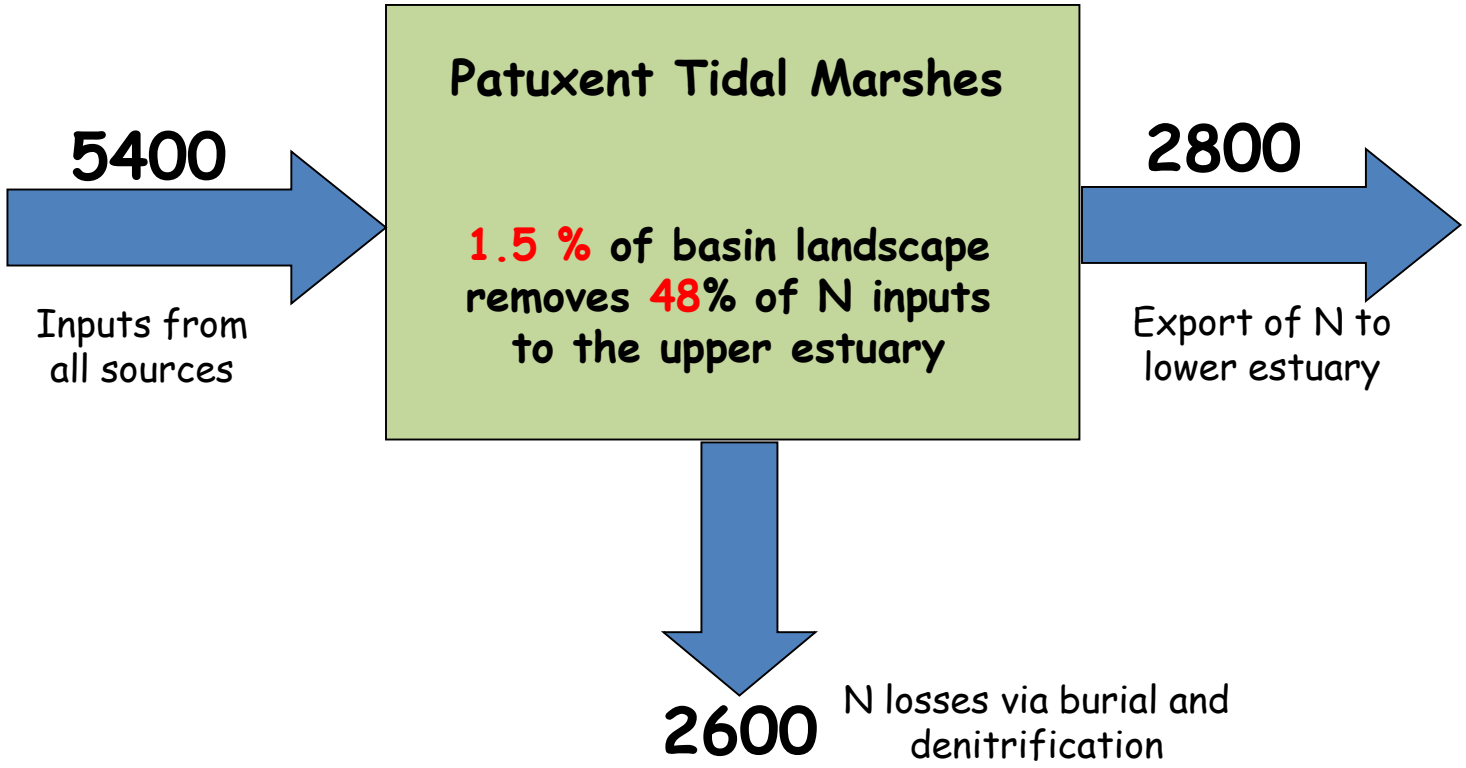
Naticoke River Marshes

Poplar Island: Salt Marsh Creation from Dredge Spoil

Patuxent River and Bay Tidal Marshes

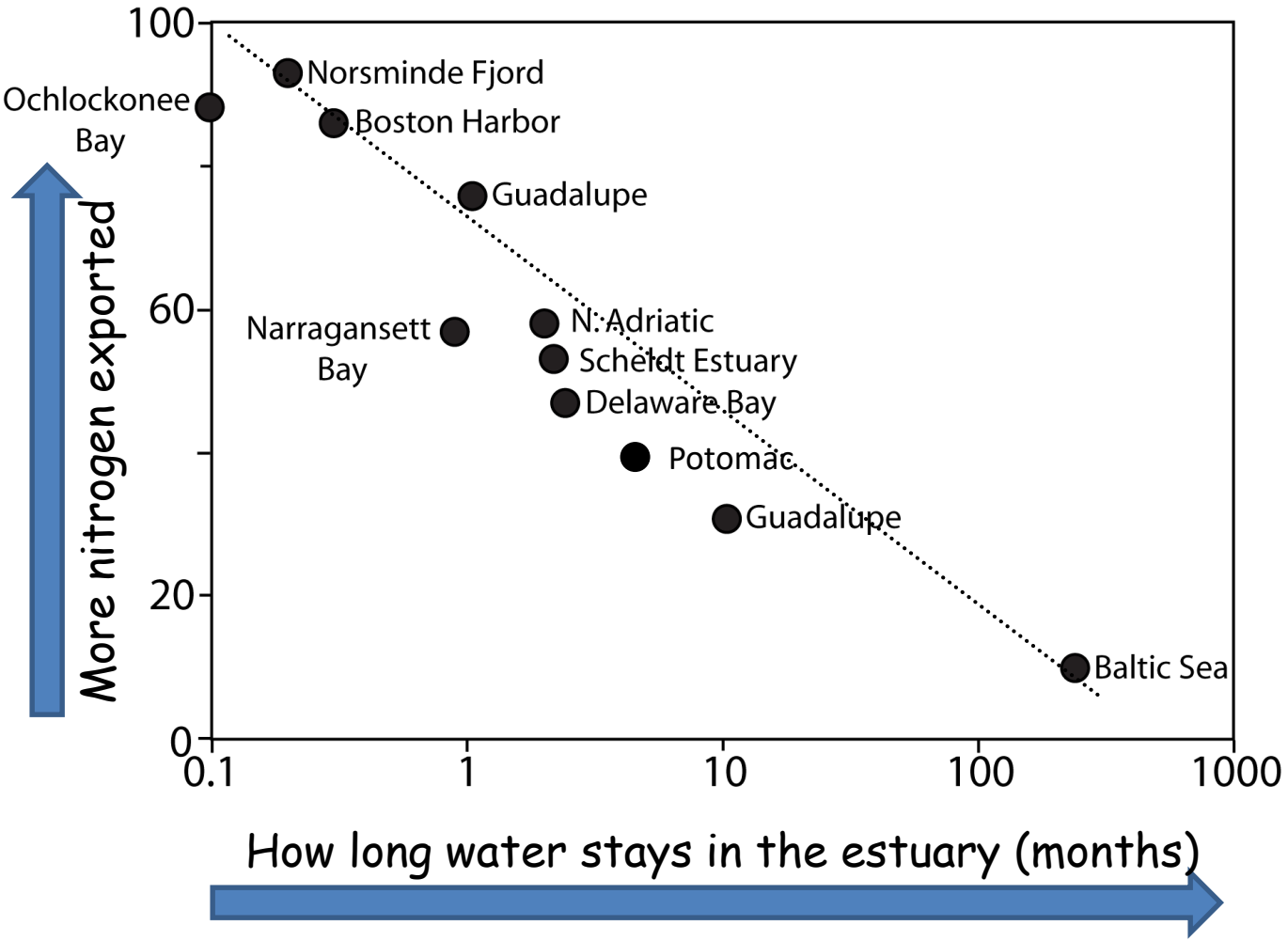
Tidal Wetlands: Nutrient Loss

Hotspots in the Landscape



Units = Kg N/day

Nitrogen Export: For these estuaries, the percent of TN input exported was inversely related to water residence time



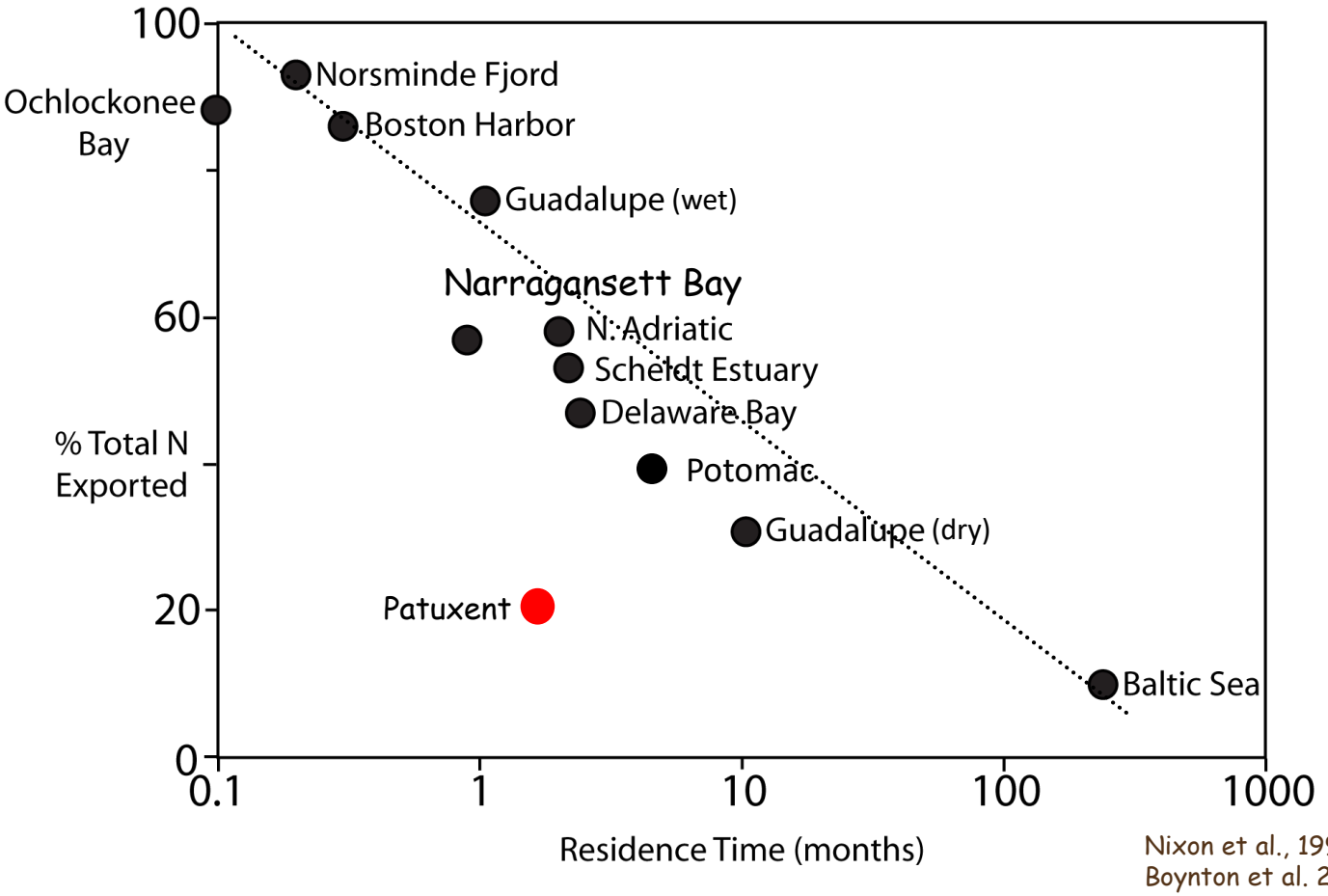
- "Give the bugs enough time and they will get rid of it" *Scott Nixon*

- N losses were via denitrification and long-term N burial…fisheries losses were small

Nixon et al., 1996

Synthesis Revised?

Nitrogen Export: Results from the Patuxent strongly diverged from other sites not characterized by extensive wetlands



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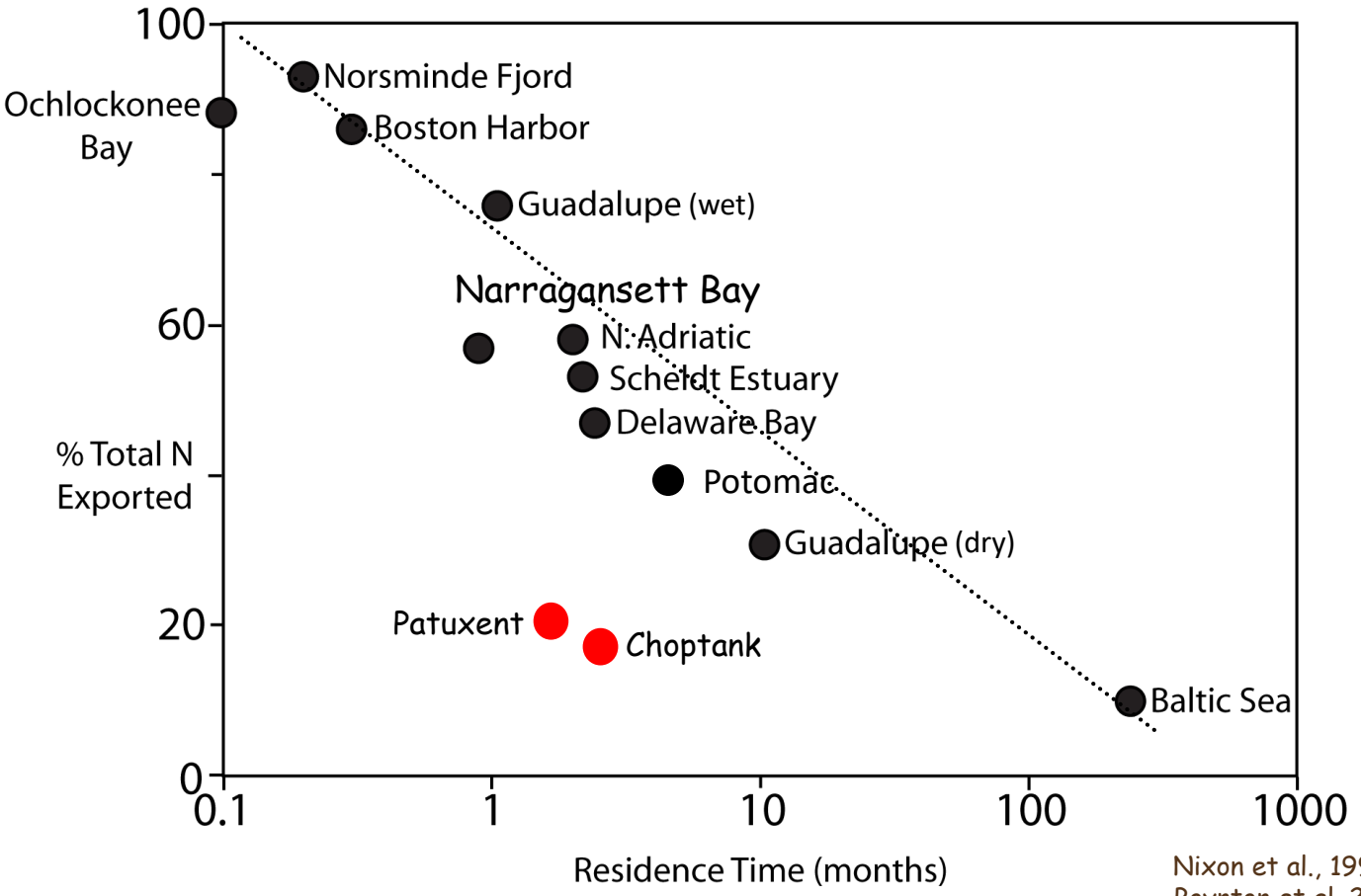
Boynton et al. 2008

Synthesis Revised

Nitrogen Export: And then aother Chesapeake system diverged, also having extensive wetlands at the land-sea margin



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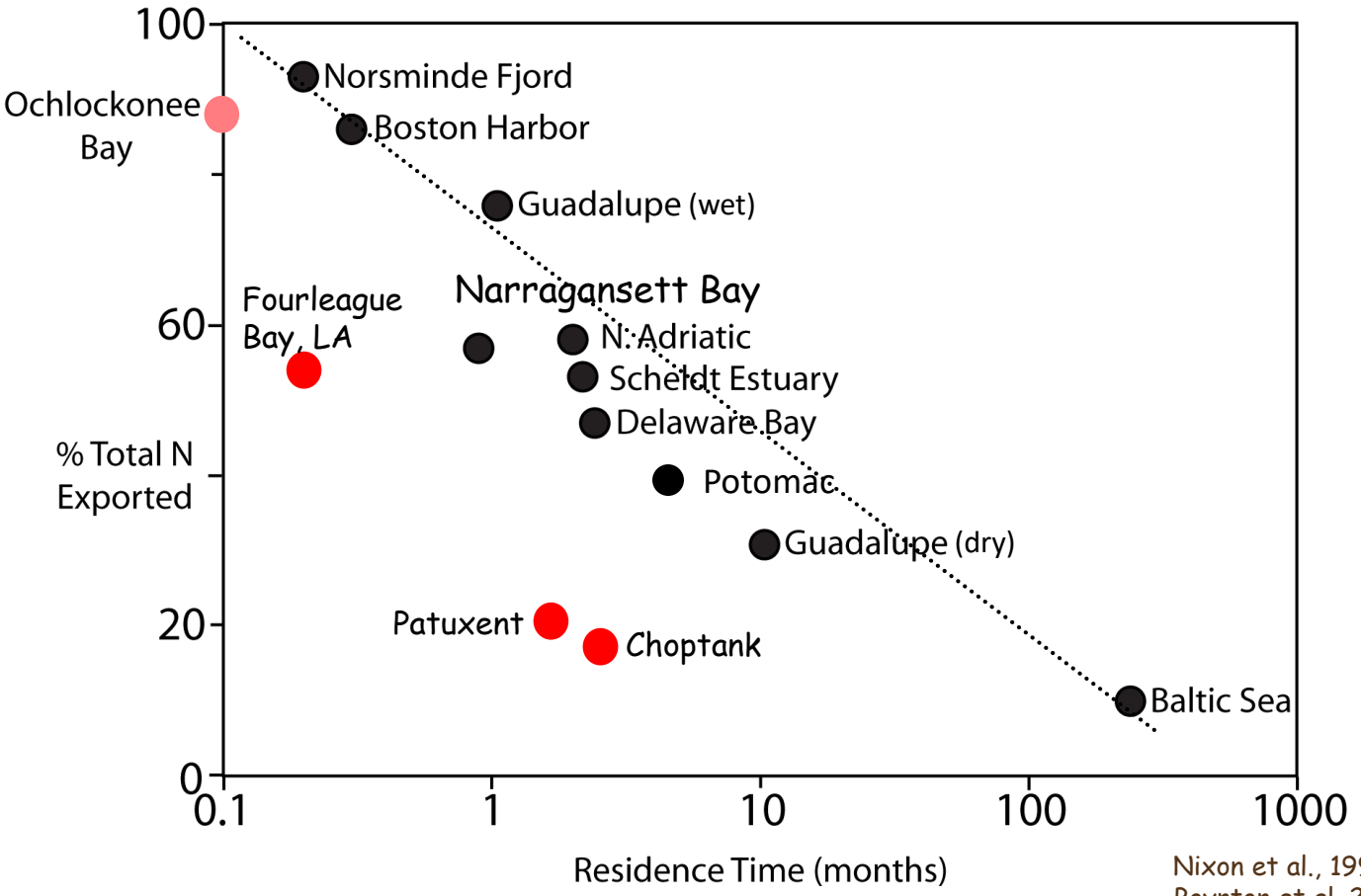
Synthesis Revised

Nitrogen Export: And then more systems diverged, all with extensive wetlands



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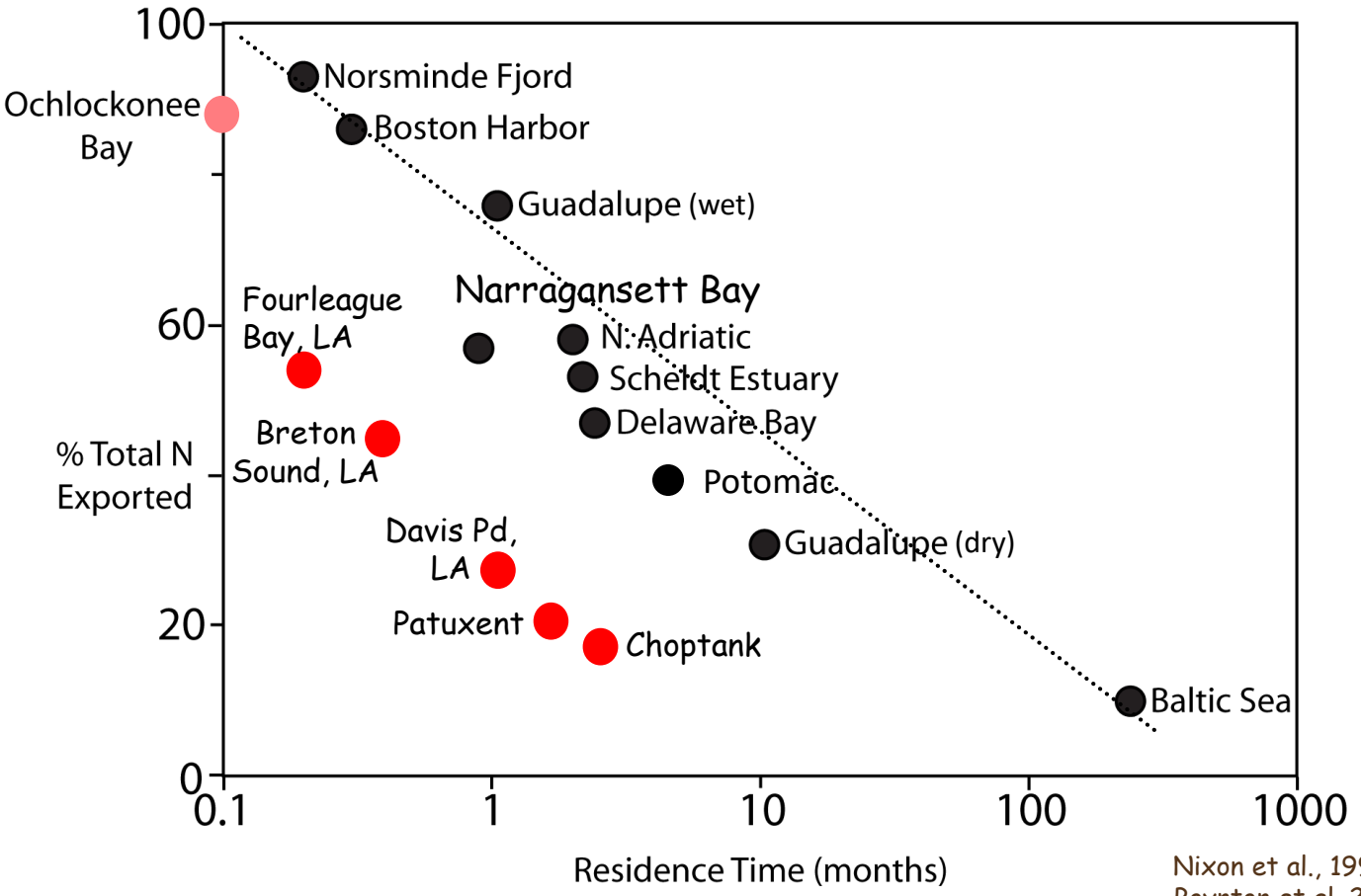

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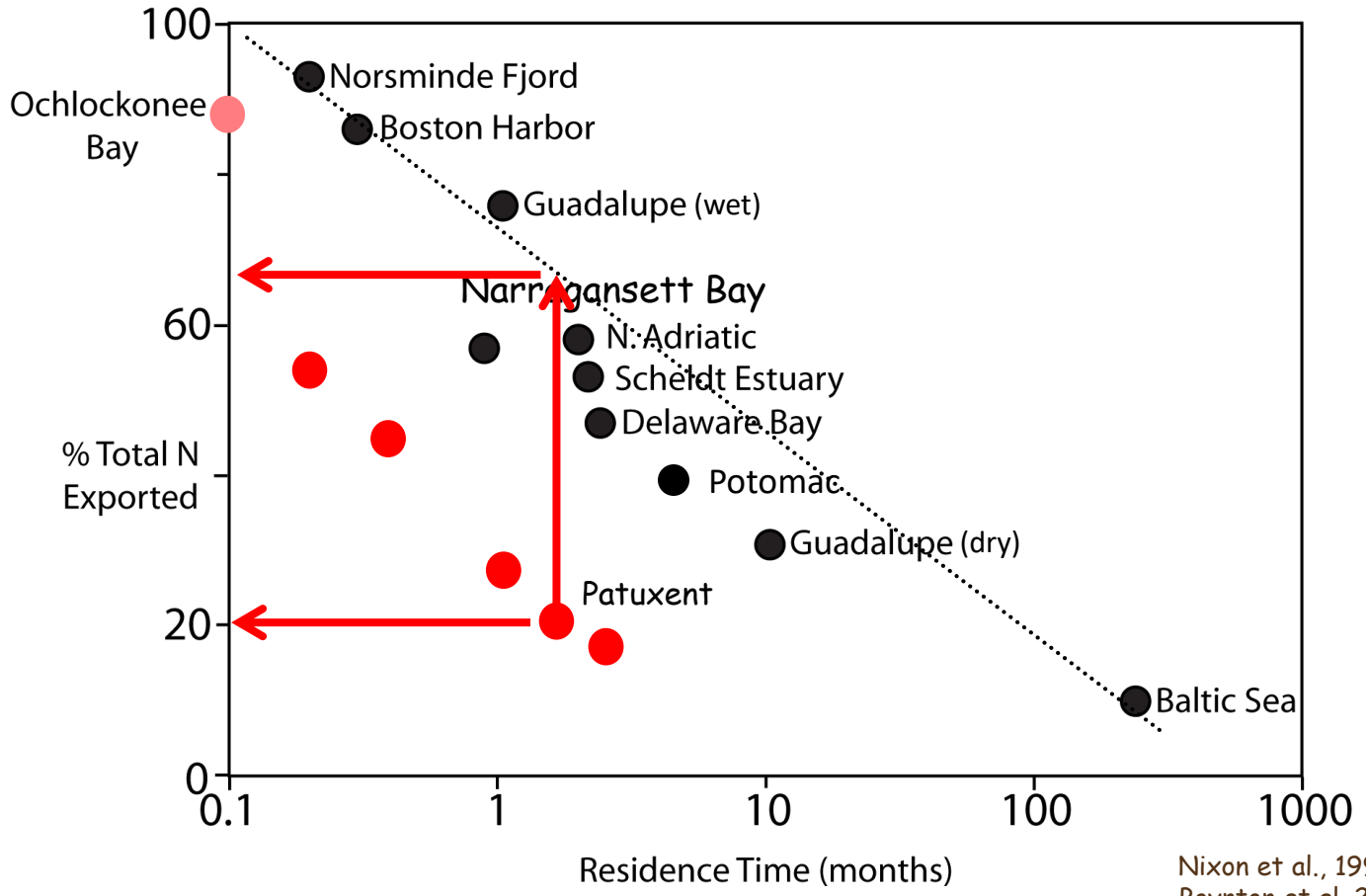

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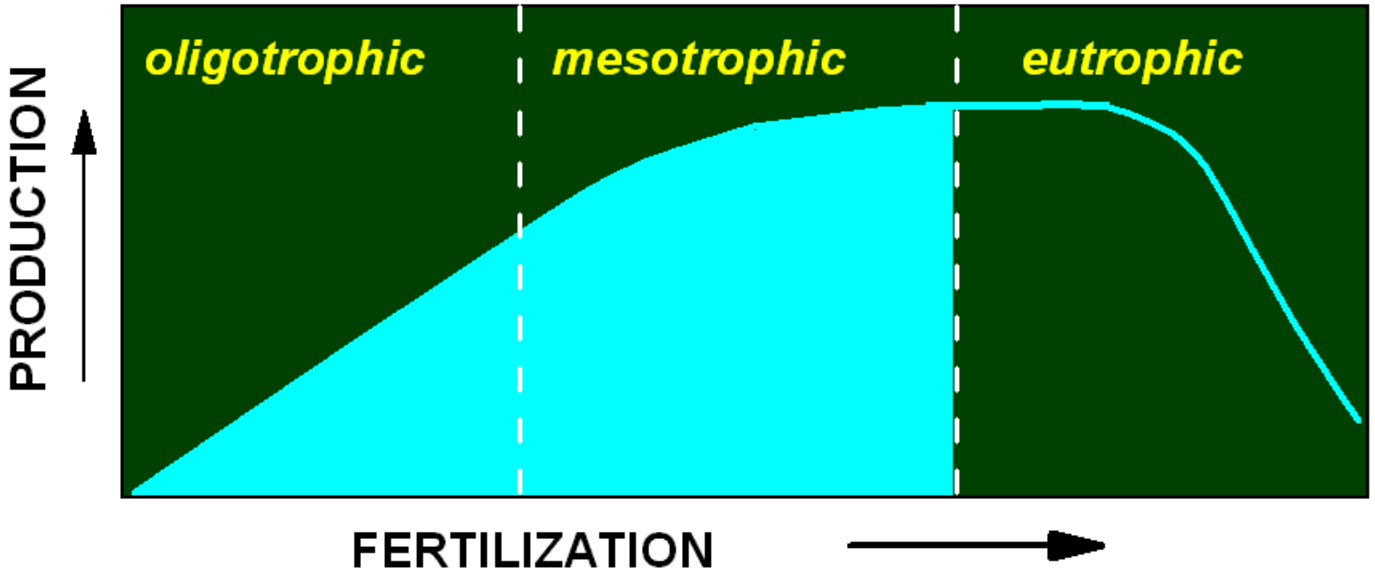
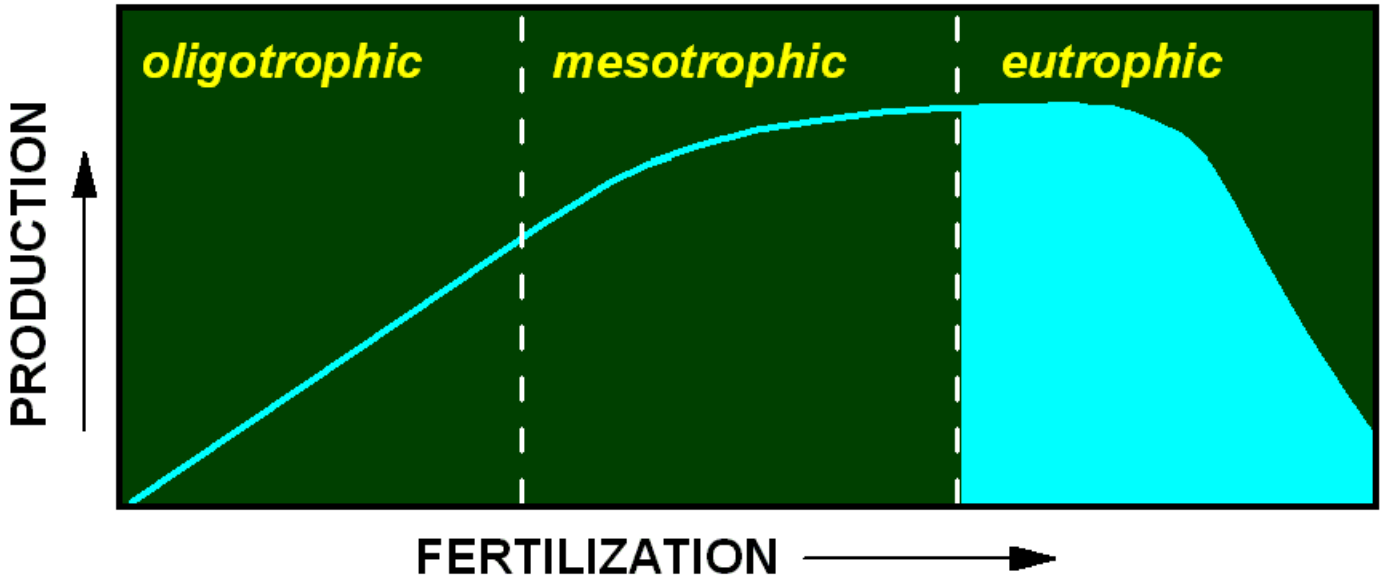
POSITIVE EFFECTS

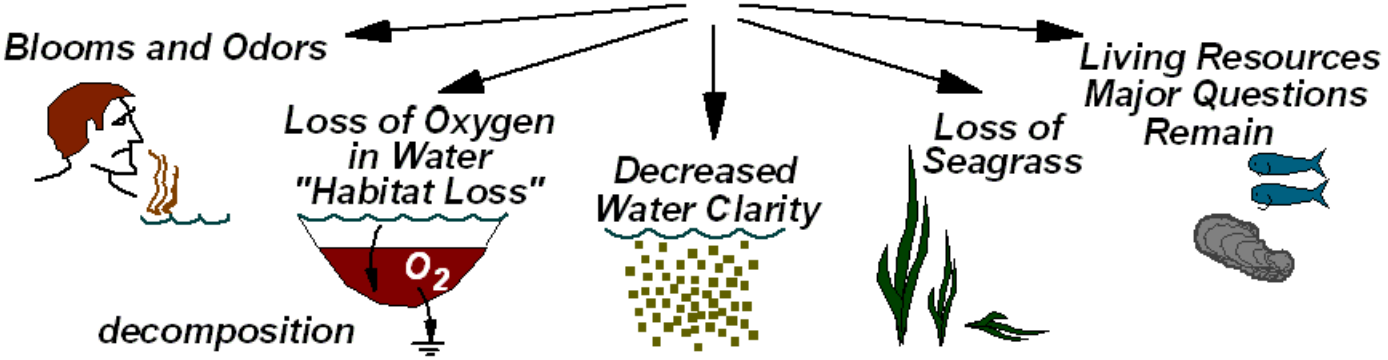


- Essential for plant growth. In most estuaries and the open ocean microscopic plants provide the basic food supply.
- Within limits, increased fertilization increases food supply and production of other organisms.

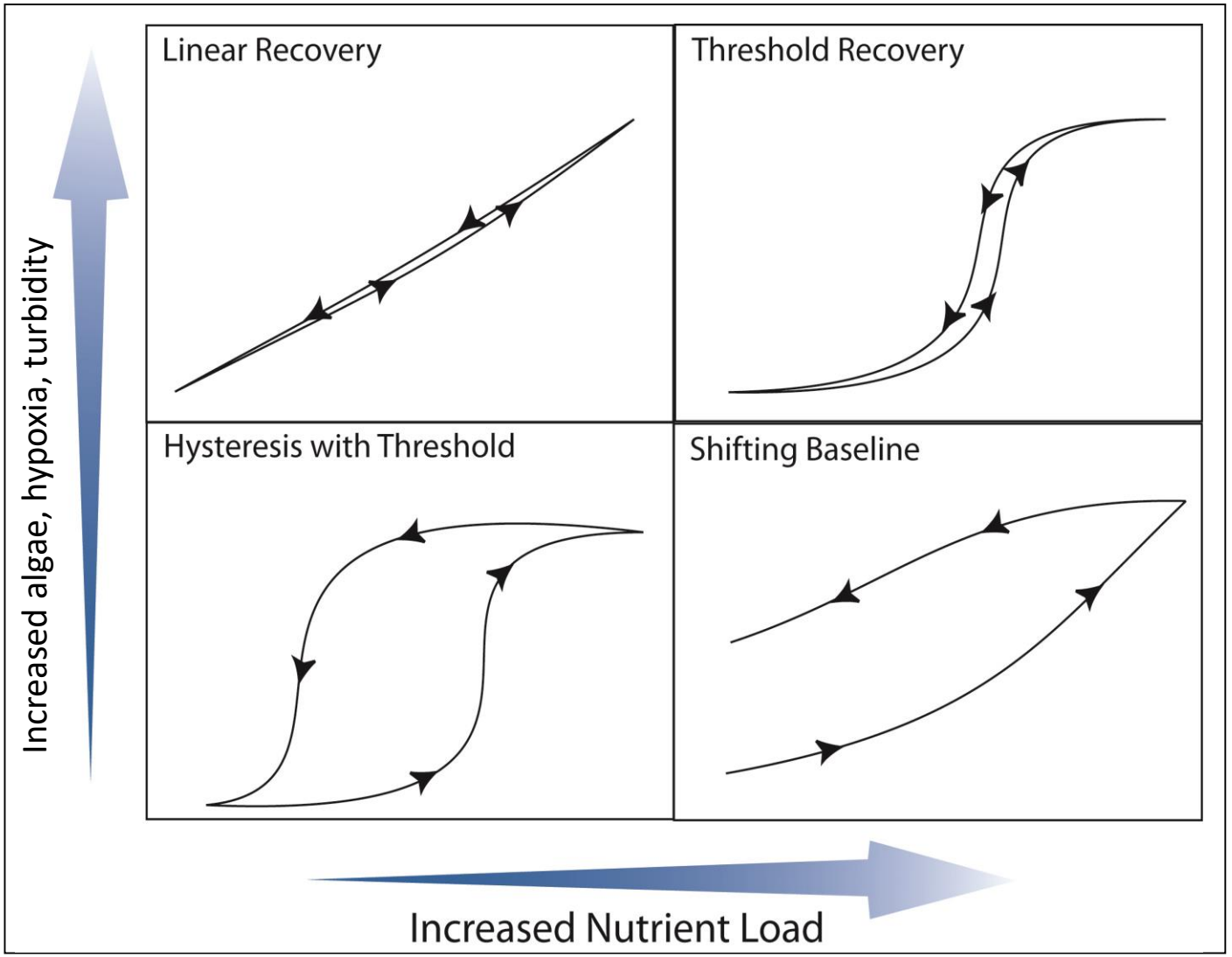
NEGATIVE EFFECTS



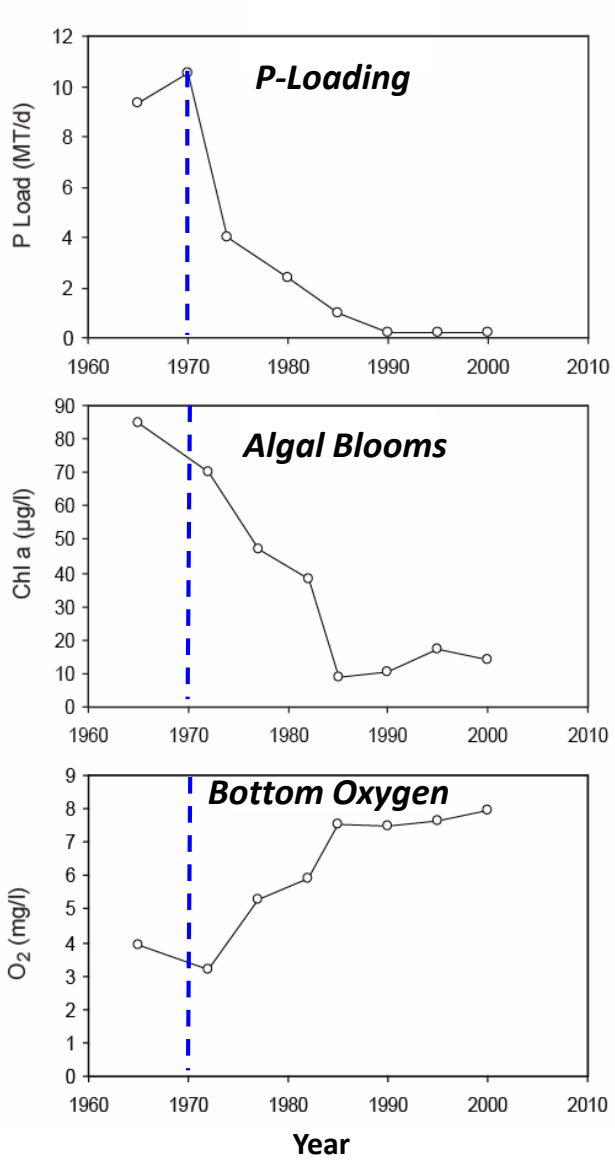
High levels of NUTRIENT ADDITIONS



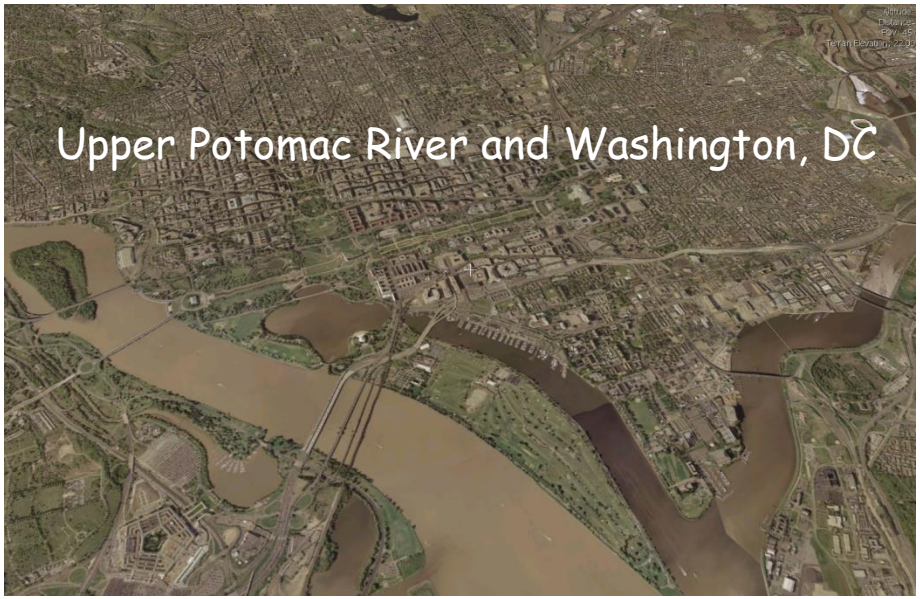
Ecosystem Responses to Nutrient Degradation and Remediation



A "Simple" Response to Nutrient Load Reduction

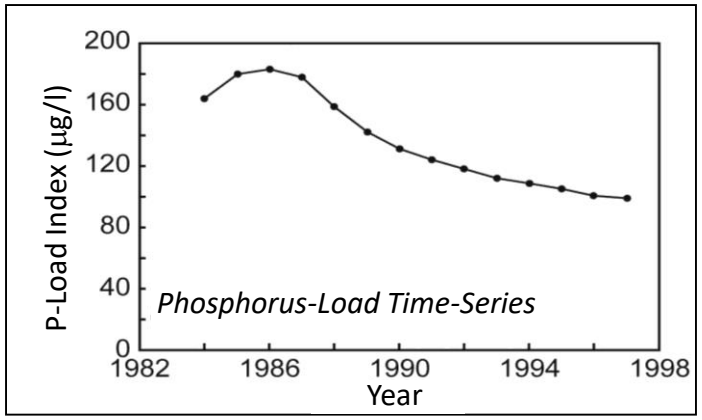


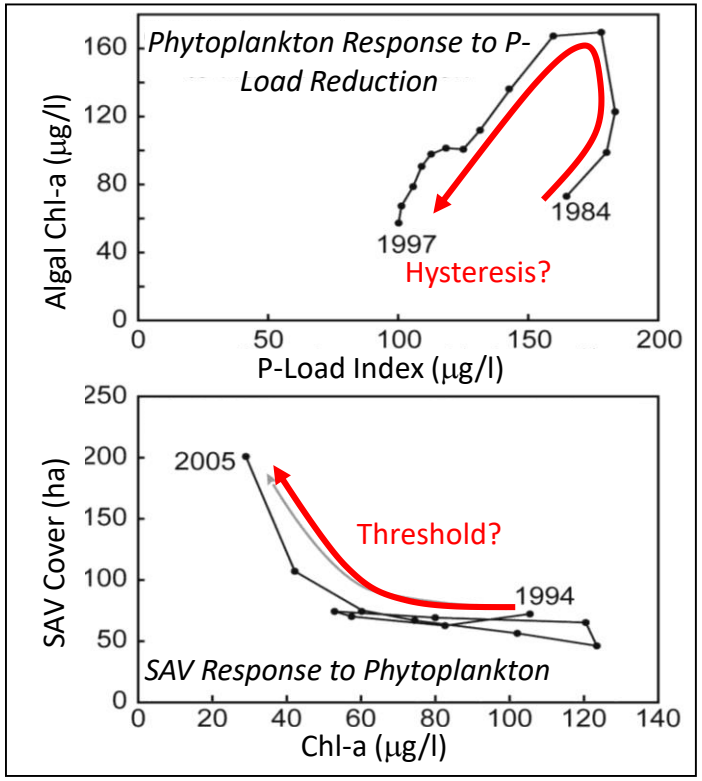
- Waste water treatment plants reduced P-loads by >90% in 30 years
- Algal blooms and bottom O_2 responded rapidly
- Underwater grasses also responded in a favorable fashion



(Kemp et al. 2005)

Complex Response to P-Load Reduction

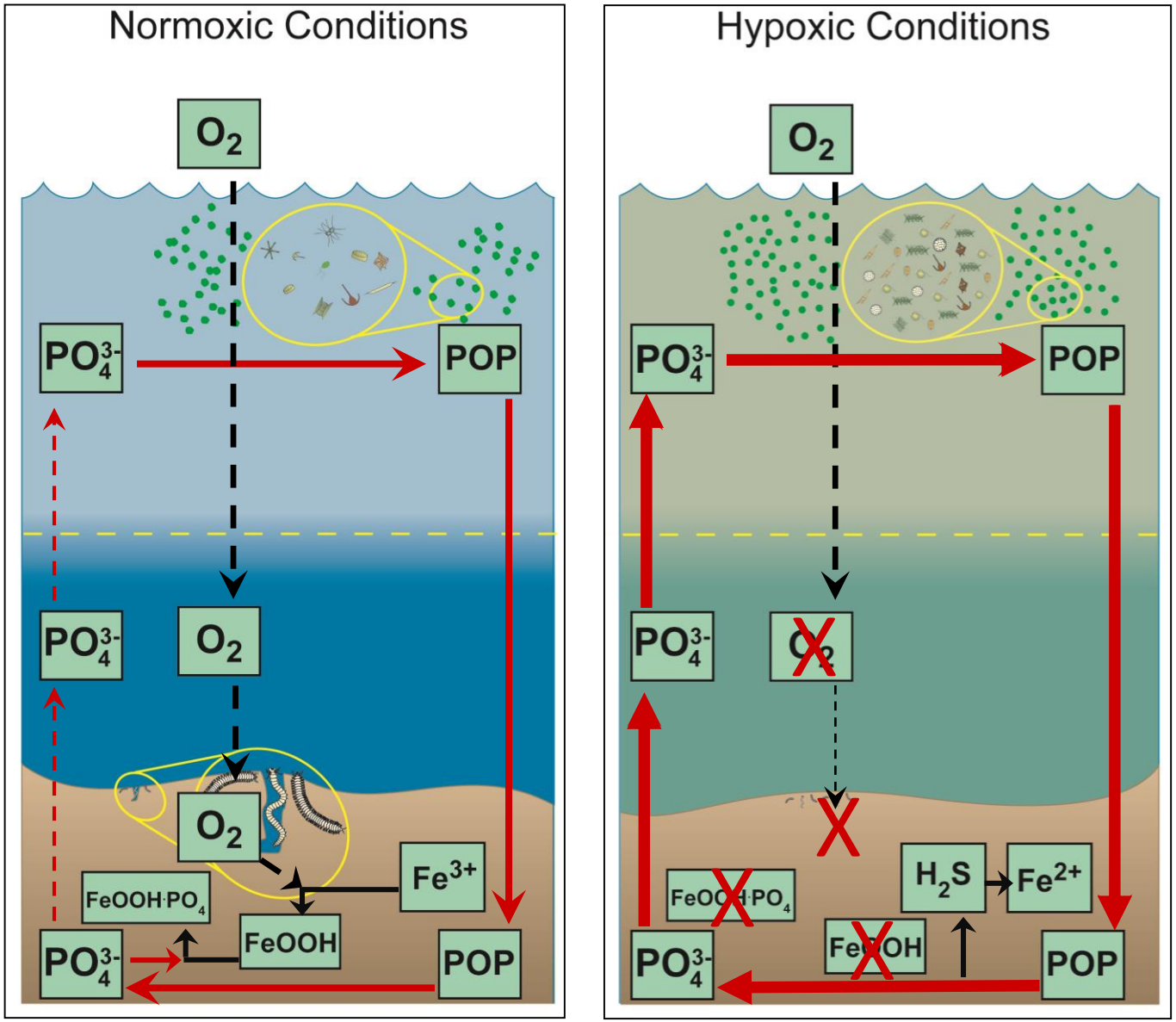




- Potomac River tributary
- Time-series of P-loading index includes periods of brief increase and gradual decline
- Phytoplankton chl-a shows response to P-load reduction after decade delay, probably due to slow purging of sediment DIP pools (hysteretic response pattern?)
- Reductions in phytoplankton chl-a improved water clarity until a light threshold was reached allowing growth and survival of submersed plants

Chris Jones, GMU

Model of O_2 Interactions with P-Cycle



Take-Home Points

- Basic ideas of enrichment and restoration are scientifically solid
- Substantial reductions of N and P result in improved water quality and better habitat conditions…the Bay is RESPONSIVE to load changes
- The pathways estuaries follow during degradation and restoration often involve time delays (lags), abrupt changes (thresholds) and other things not yet known or fully understood – or predictable!
- Restoration trends (and hints of trends) have been observed in both small and large Chesapeake systems…very good signs!
- Climate change and variability, continued and adaptive monitoring and analysis, control of diffuse sources all remain major challenges