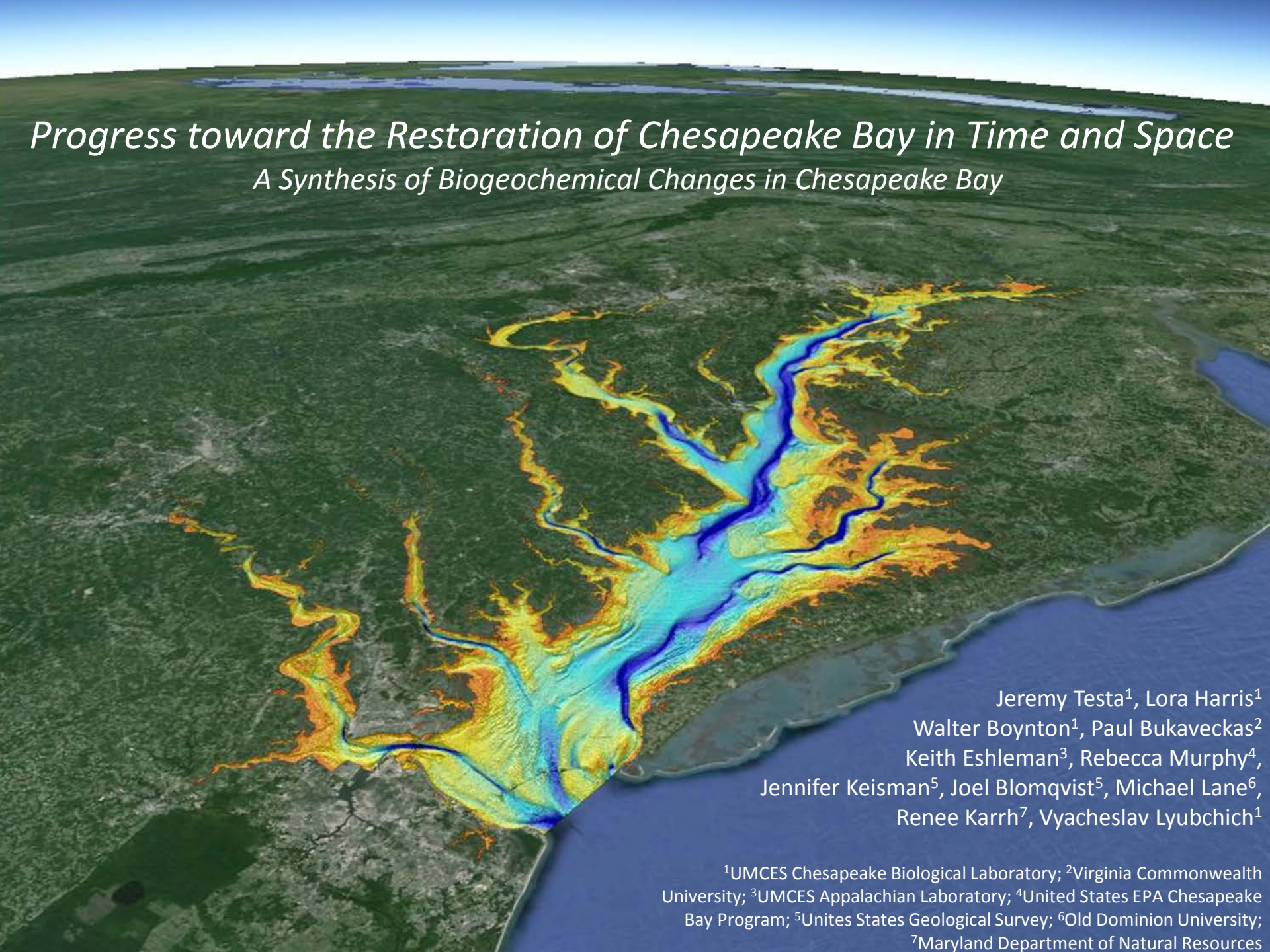
Progress toward the Restoration of Chesapeake Bay in Time and Space

A Synthesis of Biogeochemical Changes in Chesapeake Bay



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Jennifer Keisman[5], Joel Blomqvist[5], Michael Lane[6],
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Workgroup Goals

(1) Review our conceptual model of eutrophication

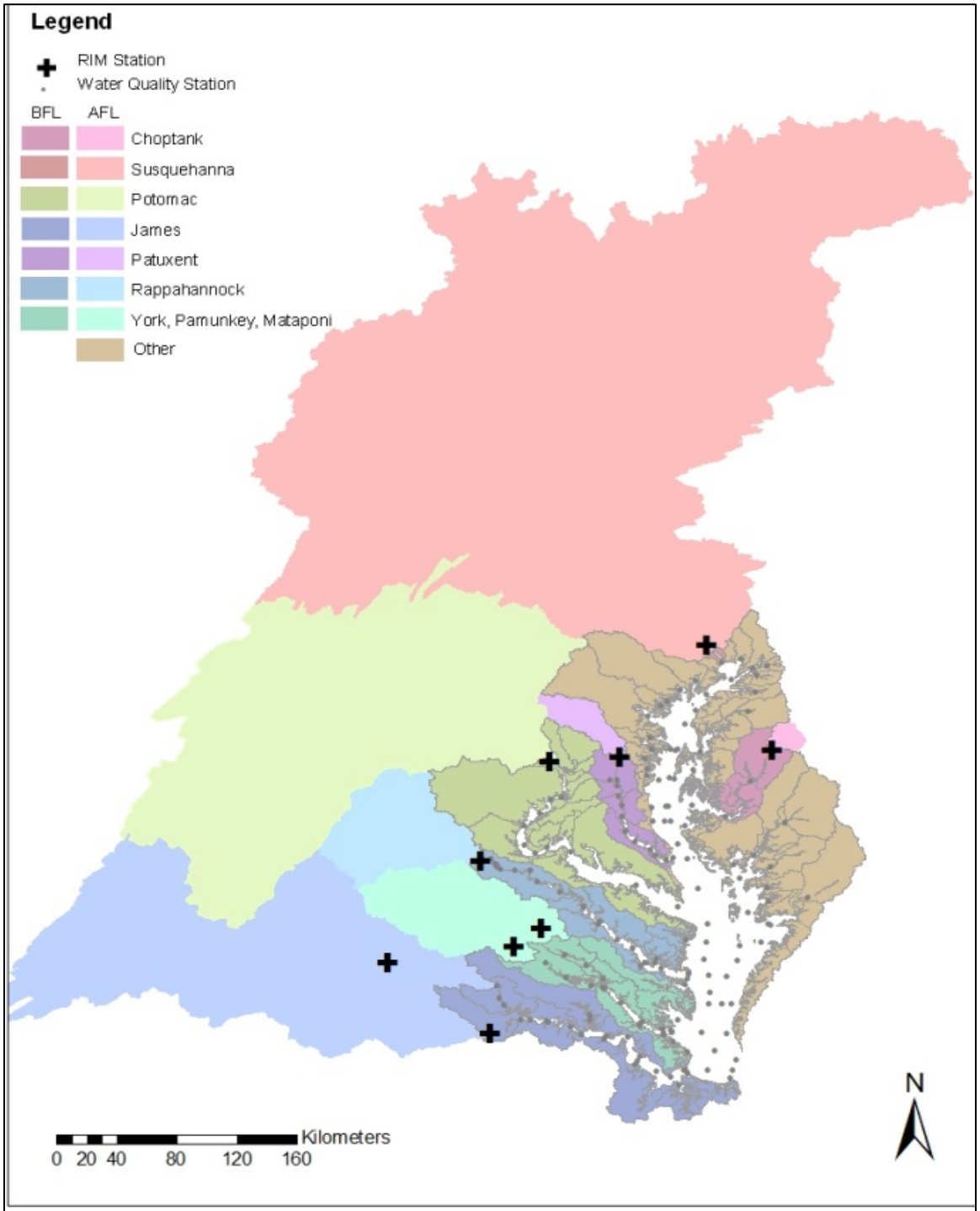
(2) Examine changes in N and P loading for all 92 water quality segments and the associated change in N and P concentration, chlorophyll-a, and other variables

(3) Review case-studies of *both* restoration success and resistance to change

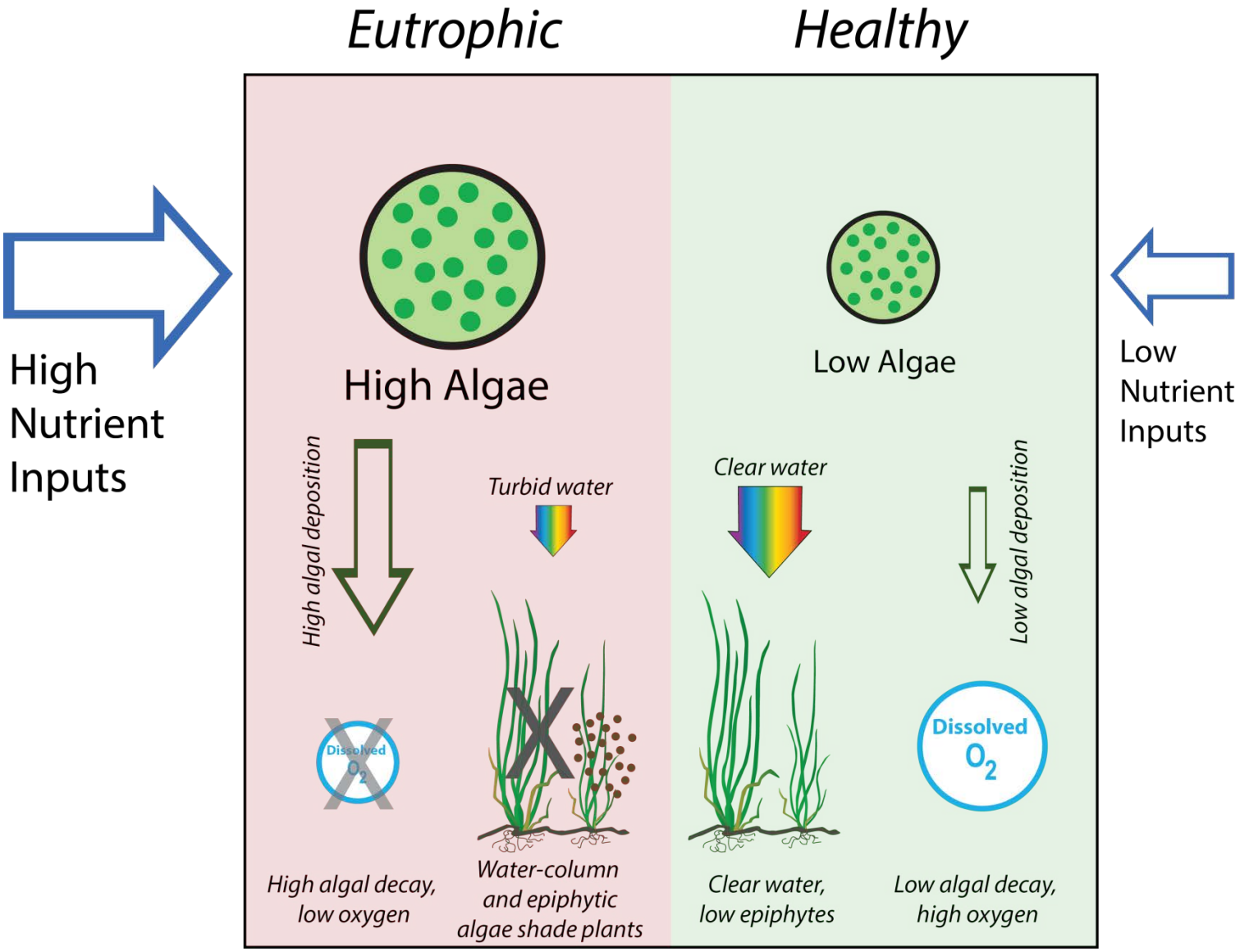
(4) Identify consistent themes where restoration actions have led to improved WQ, or not (both in Chesapeake and globally)

Data

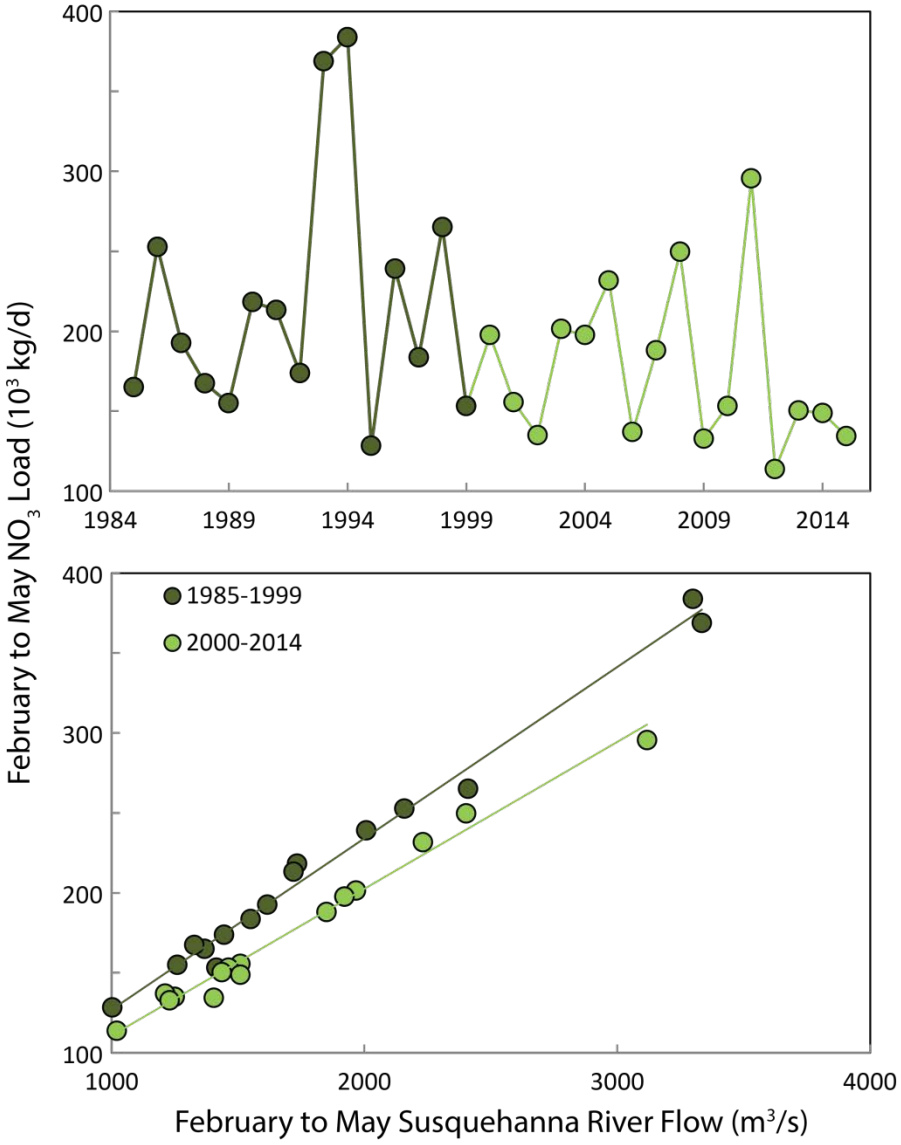
(1) N, P, freshwater loading from 9 USGS RIM
(2) TN, TP, loading from Phase 6 watershed model for below fall-line (point, non-point)
(3) Nutrients, chlorophyll, oxygen Secchi Depths from CBP at 140+ stations

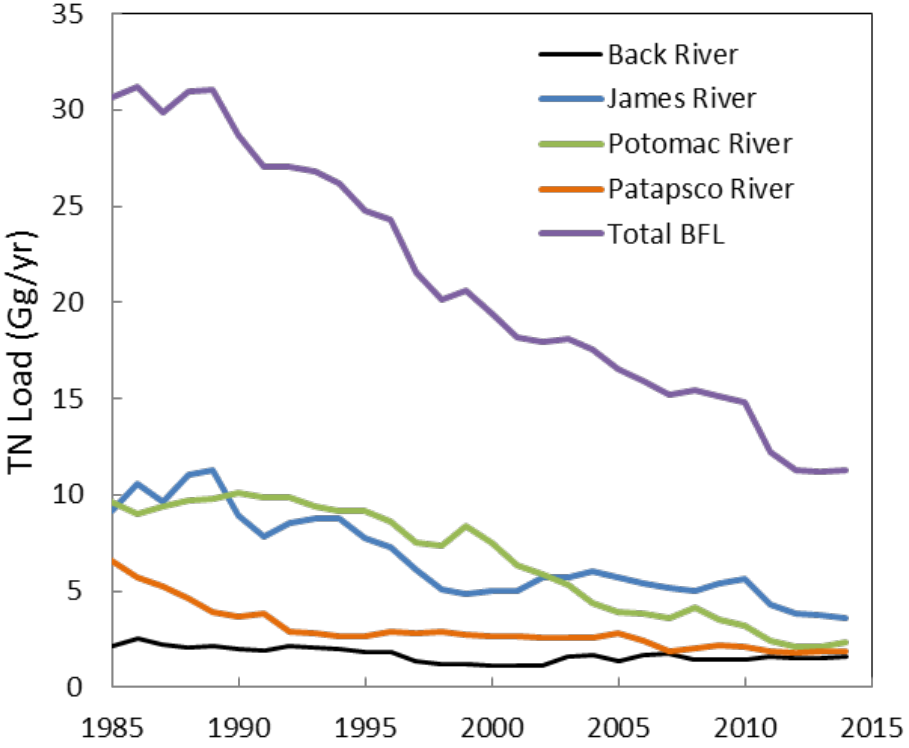


Our Most Basic Conceptual Model



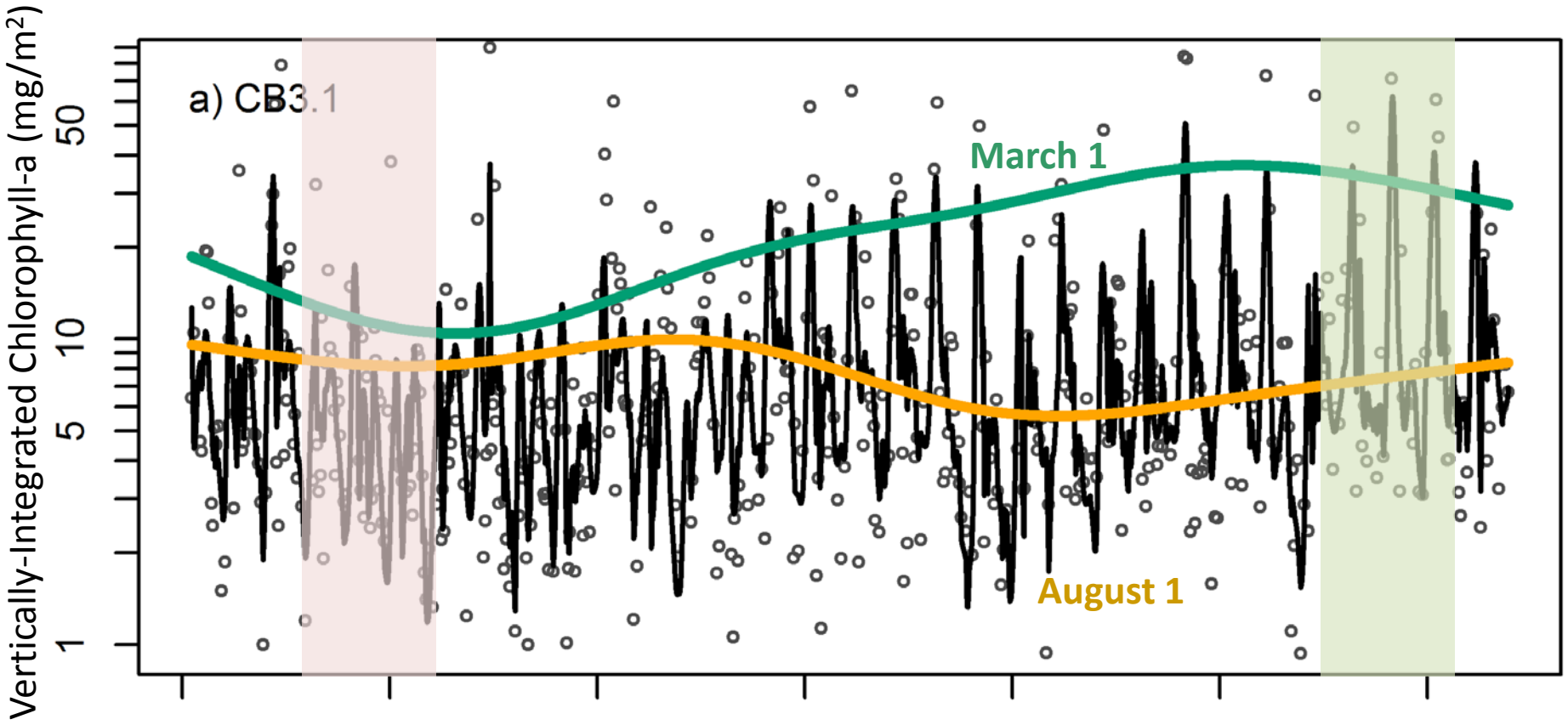
Evidence of Load Declines





- Large declines in wastewater treatment plant loads
- 60% declines since 1980s, from 18-10% of total loads
- Inter-annual flow variability still dominant
- Dissolved N and P down more than totals

Approaches to Examine Estuarine Change



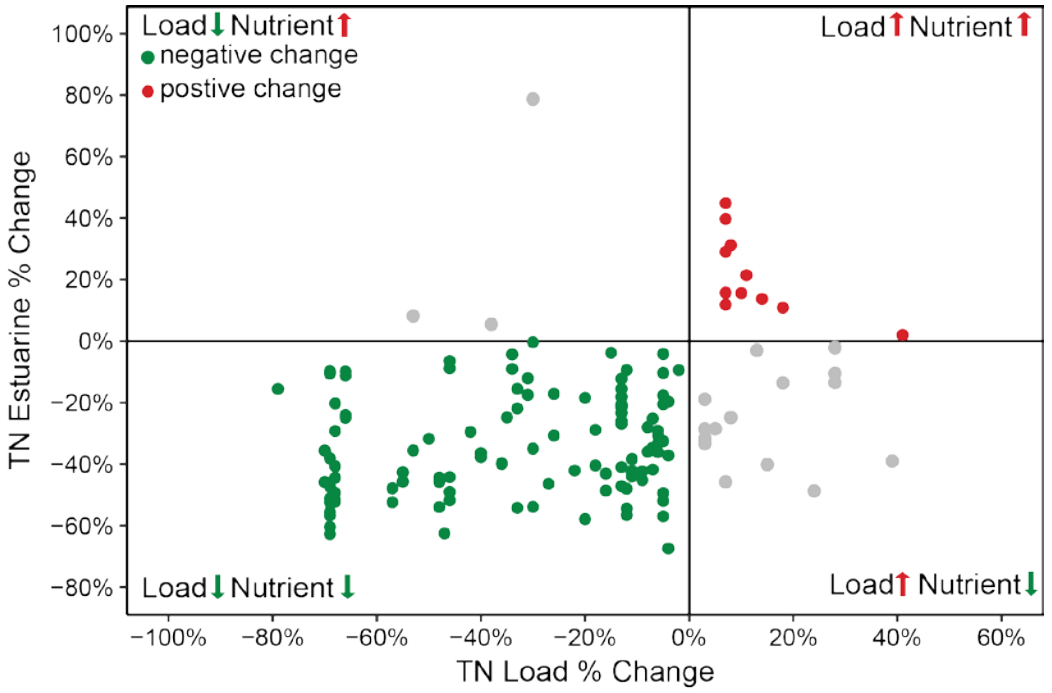
*GAM for estimates of long-term change, trends

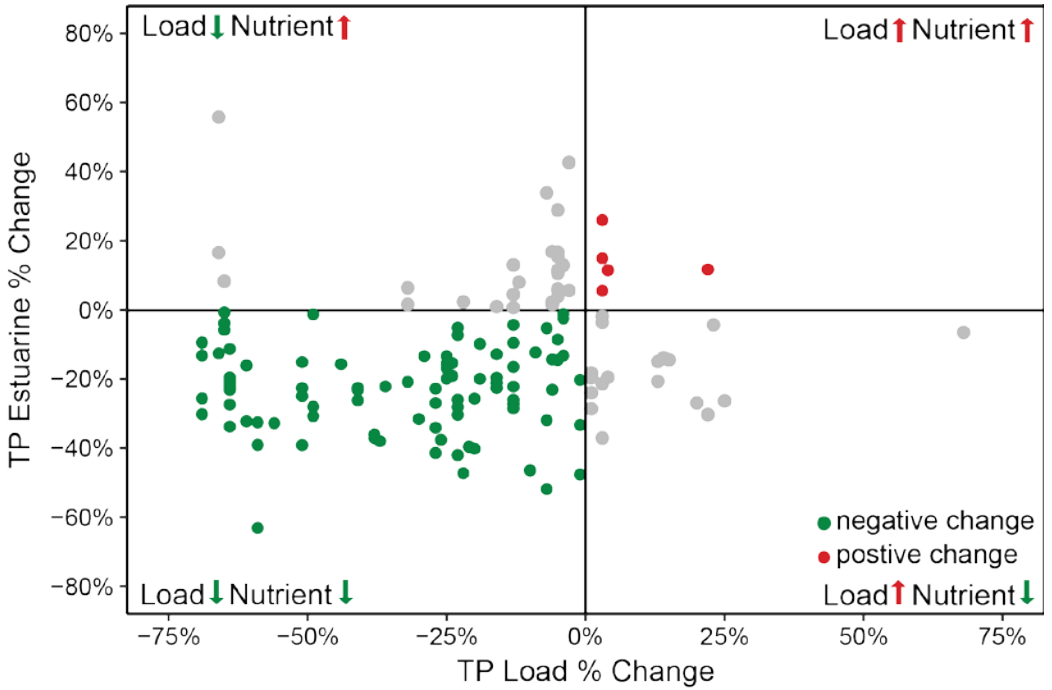
*Comparison of historic and modern conditions (% change from ’89-’91 to ‘12-’14)

*Case studies and literature review

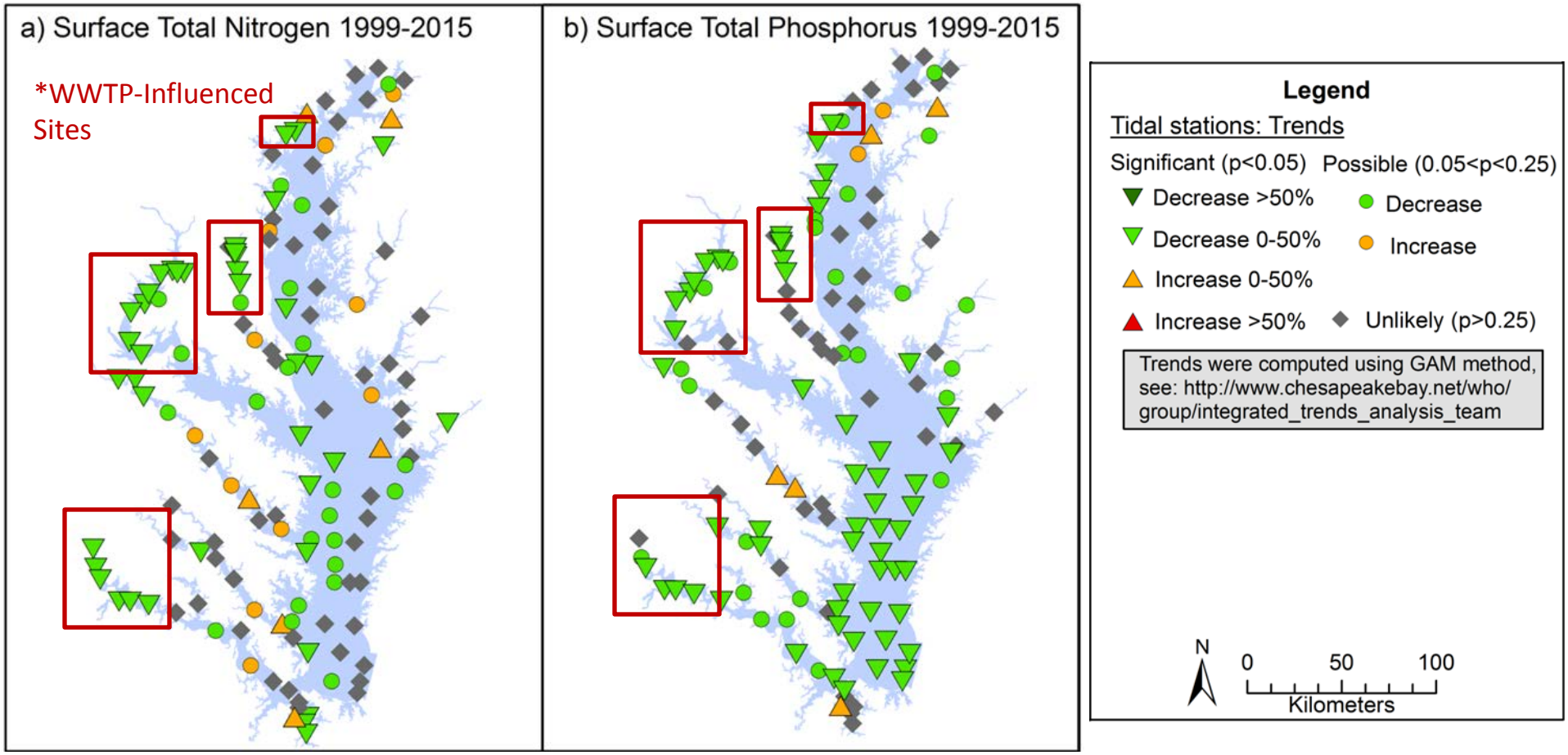
Load Declines Generally Correspond to Concentration Declines

- Predominance of load and concentration declines for TN and TP (79% and 62% of all sites for TN and TP, respectively)
- Not all improvements significant
- Some sites exhibited load and concentration increases (8% and 4% for TN and TP)
- 13% (TN) and 34% (TP) of sites showed unexpected patterns





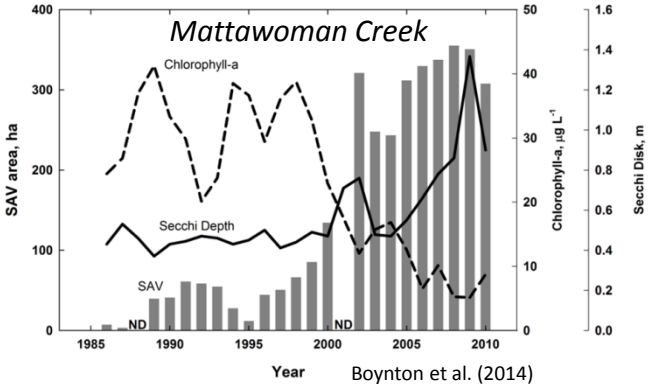
TN and TP Concentration Declines Widespread



Estuarine Response: Case Studies

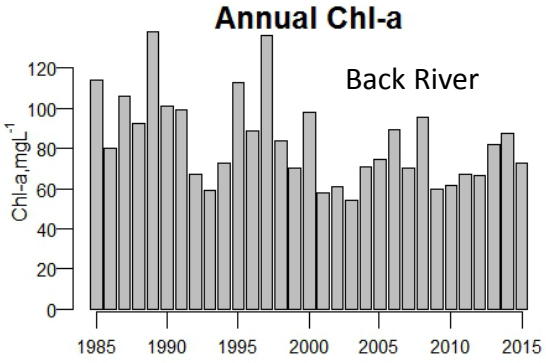
(1) Improvements Clear with WWTP Upgrades:

Potomac (+ Mattawoman)
Patuxent, James, Back

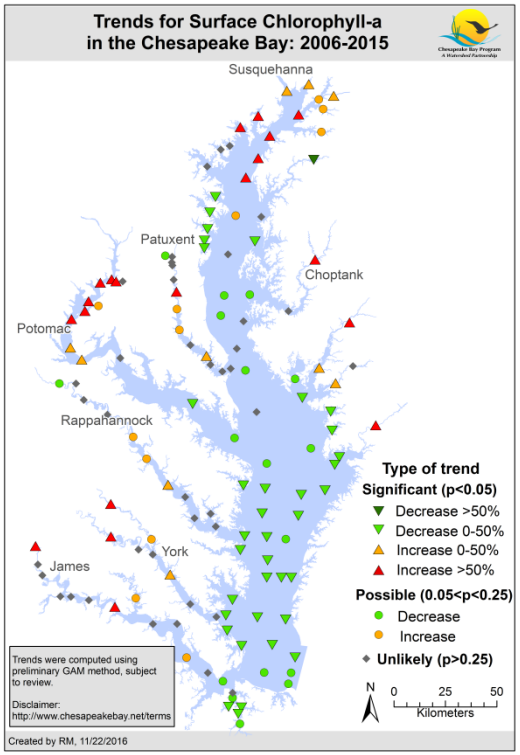


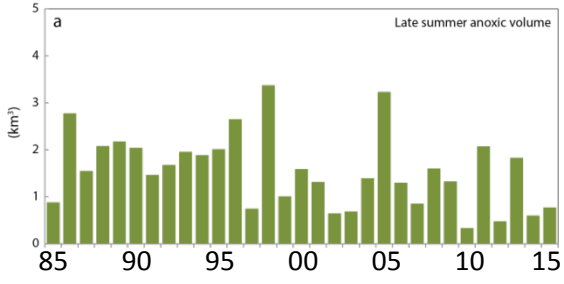
Boynton et al. (2014)

…but these systems often remain eutrophic



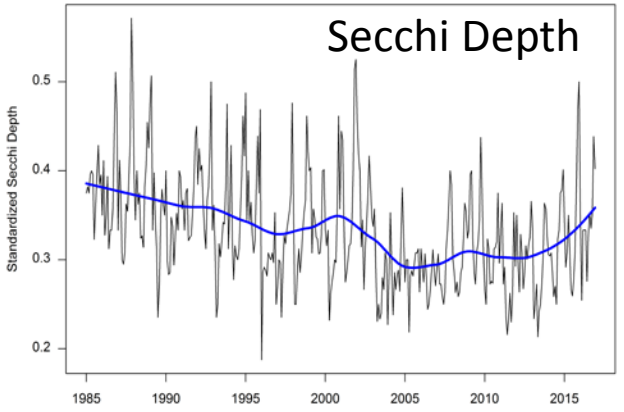
(2) Mainstem Improvements:

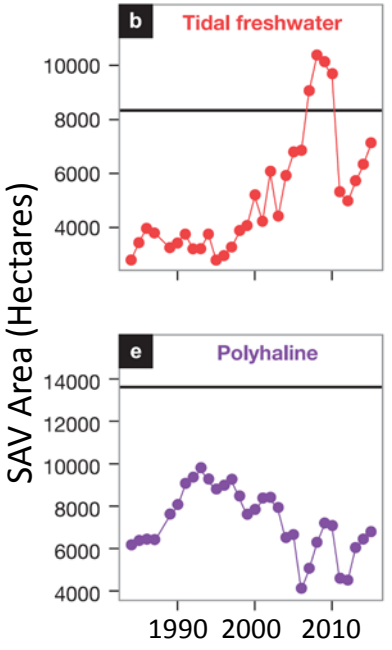




Testa et al. (2017)

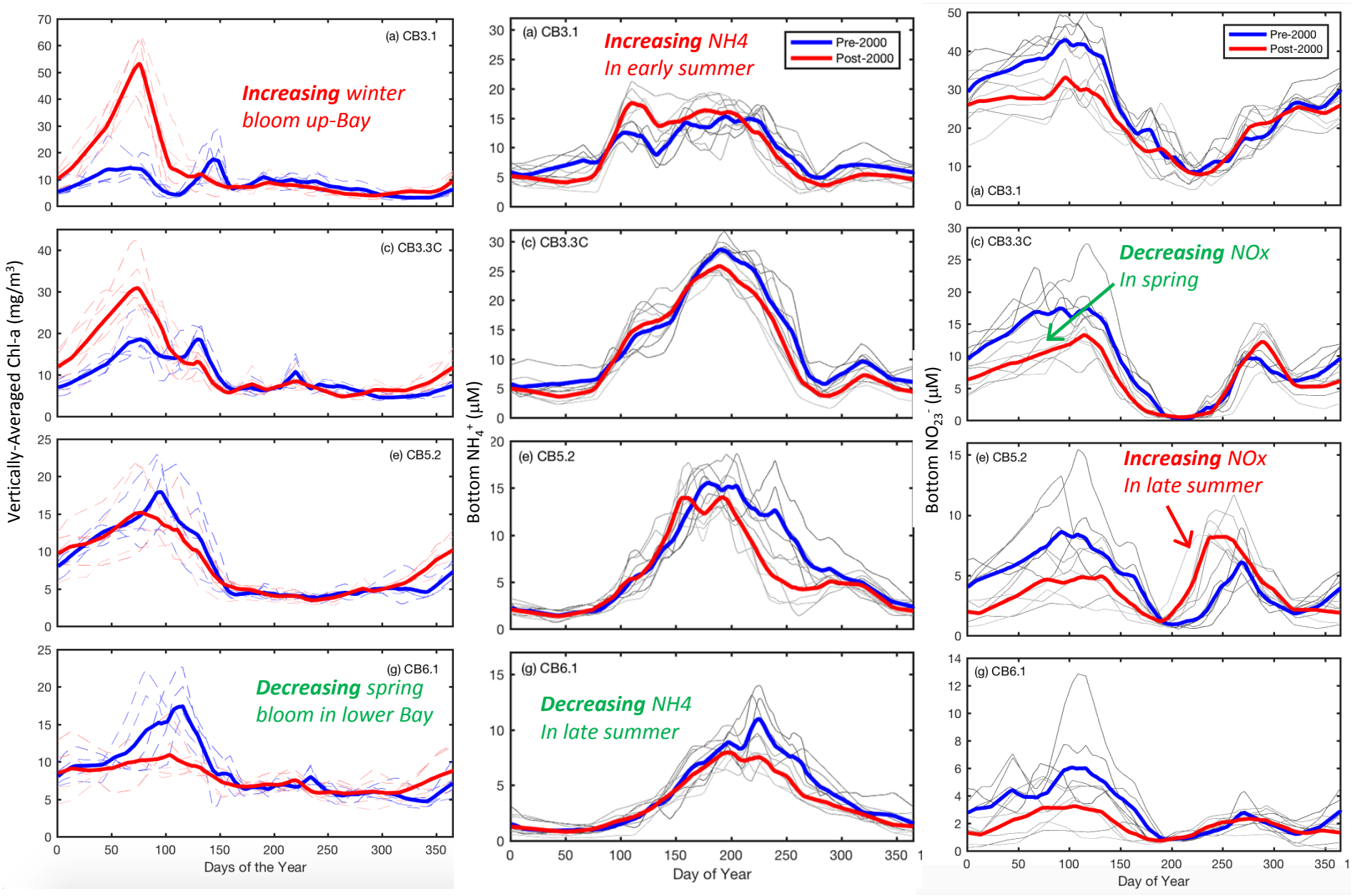
(3) Continued Degradation?:





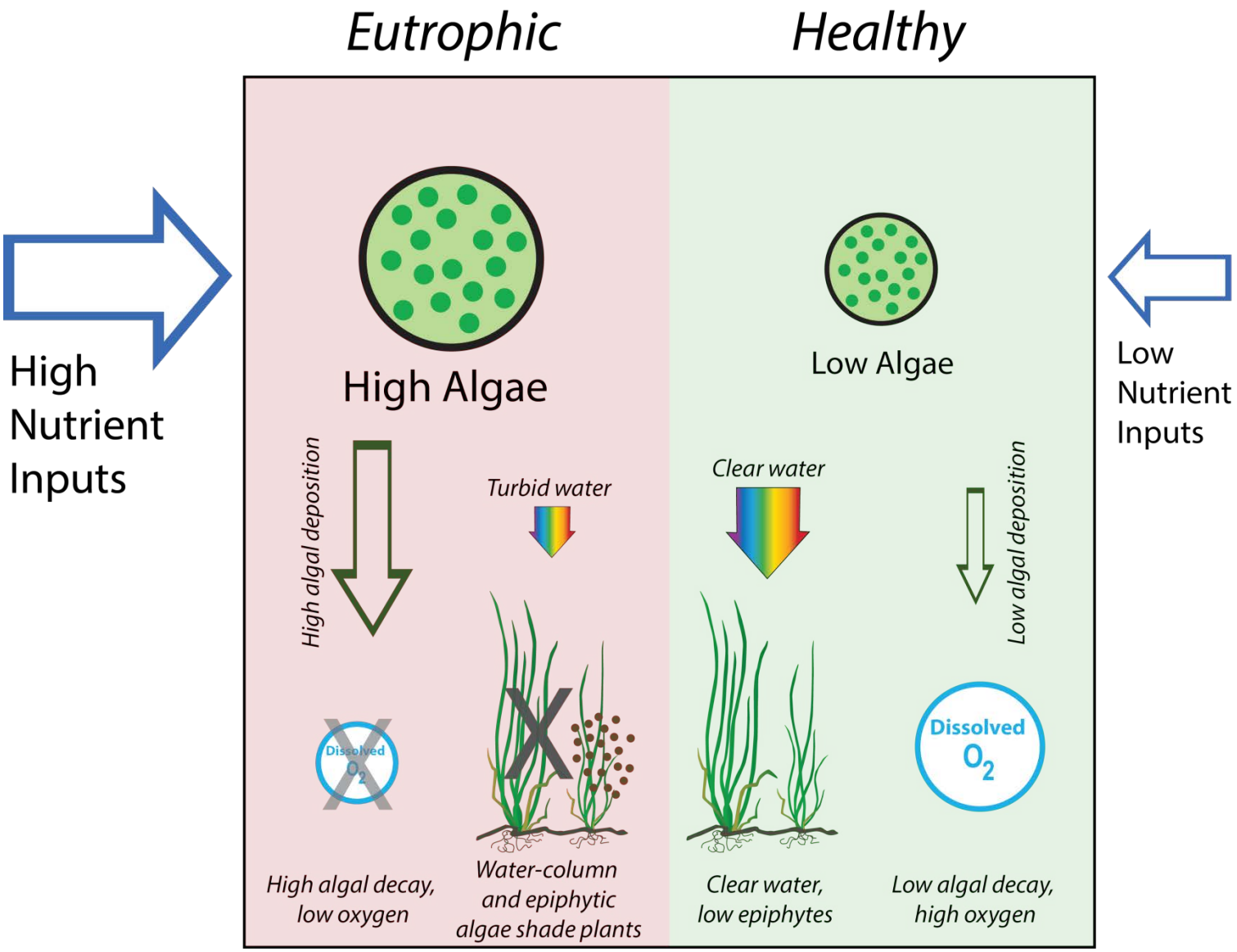
Orth et al. (2017)

Long-Term Change is Seasonal and Regional

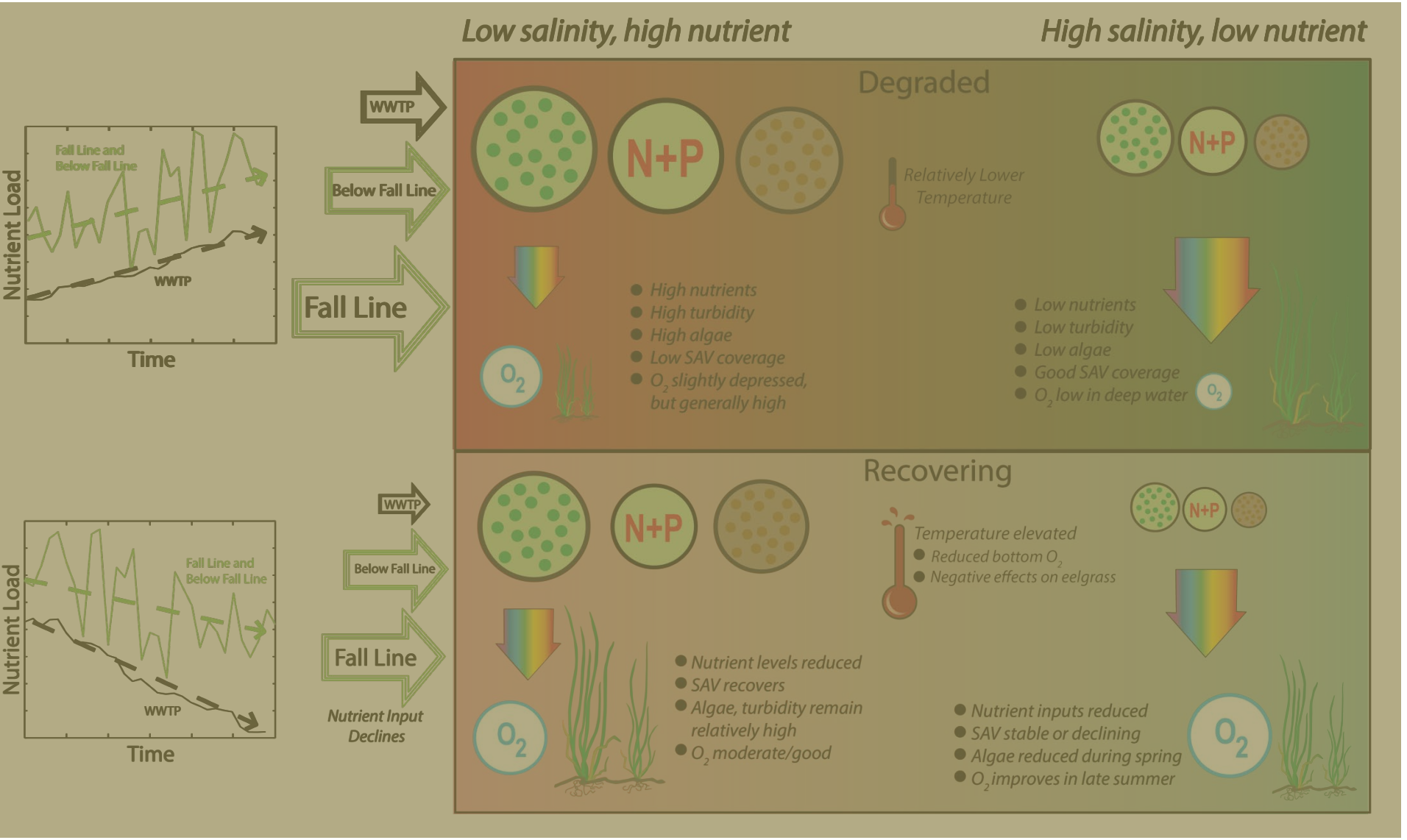


Has Our Thinking Changed?

Yes and NO



Conceptual Model Evolution



Key Results

Sewage Treatment Plant Upgrades Work. Our synthesis, combined with prior studies in the Chesapeake Bay and around the globe, indicated that sewage treatment plant upgrades are an effective means to reduce eutrophication in places where they are the dominant nutrient source.

Evidence of BOTH N and P are declines in the estuary. BUT, estuaries are complex environments where the components of TN and TP have their own seasonal varability. The fact that nitrogen and phosphorus may be important limiting, or co-limiting, nutrients for algal growth was recognized early in Chesapeake Bay eutrophication research and it remains true today.

The *Space and Time* of 'oligotrophication'. It has become increasingly clear that the response of an estuarine region to restoration depends on its location along the estuarine salinity gradient. While TN and TP loads and concentrations have generally declined throughout Chesapeake Bay, only a subset of Bay regions have shown evidence for clear recovery.

Products

(1) White Paper (longer form) and Executive Summary (short form)

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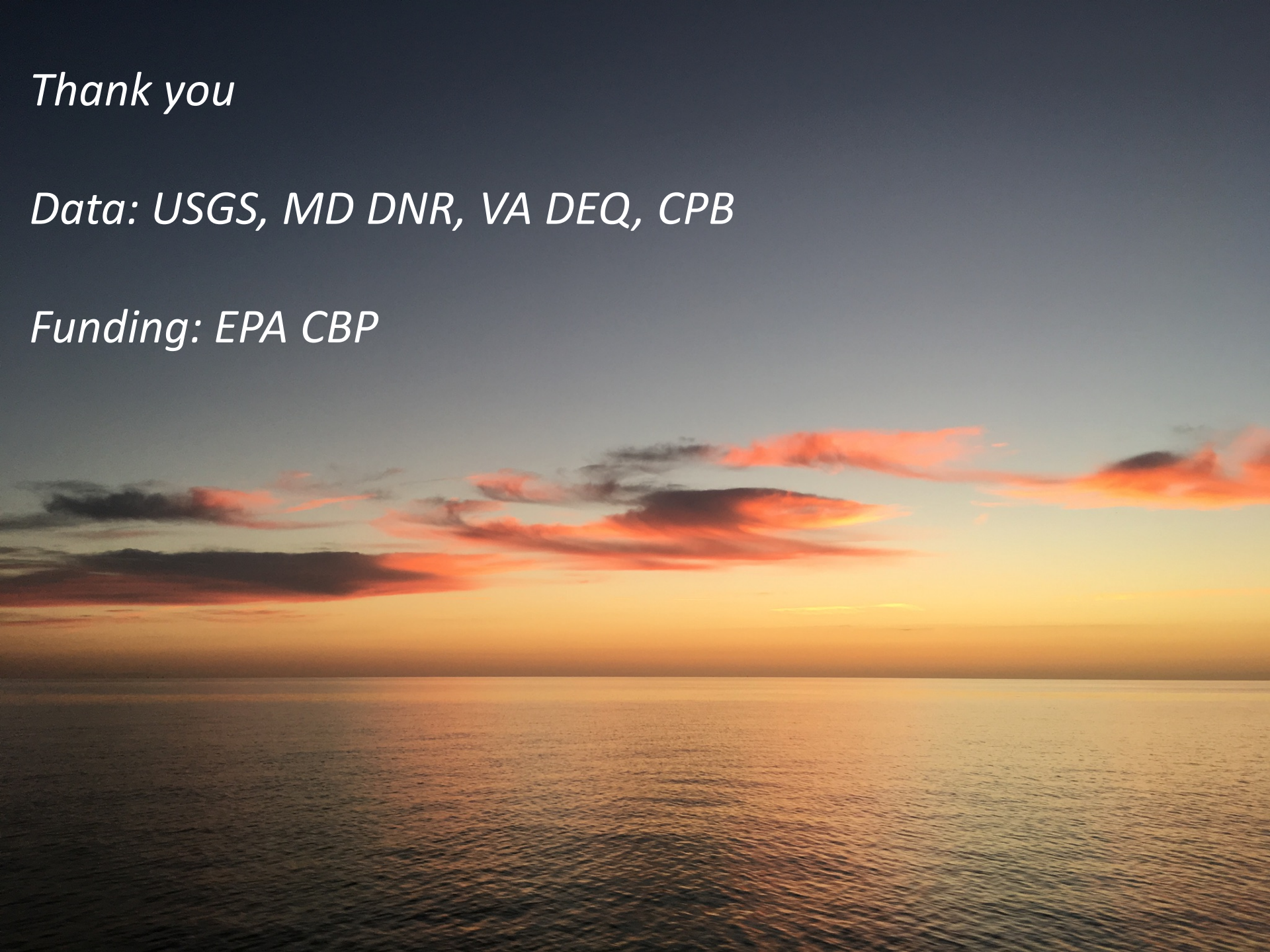
(2) Review paper in scientific literature


Thank you
Data: USGS, MD DNR, VA DEQ, CPB
Funding: EPA CBP