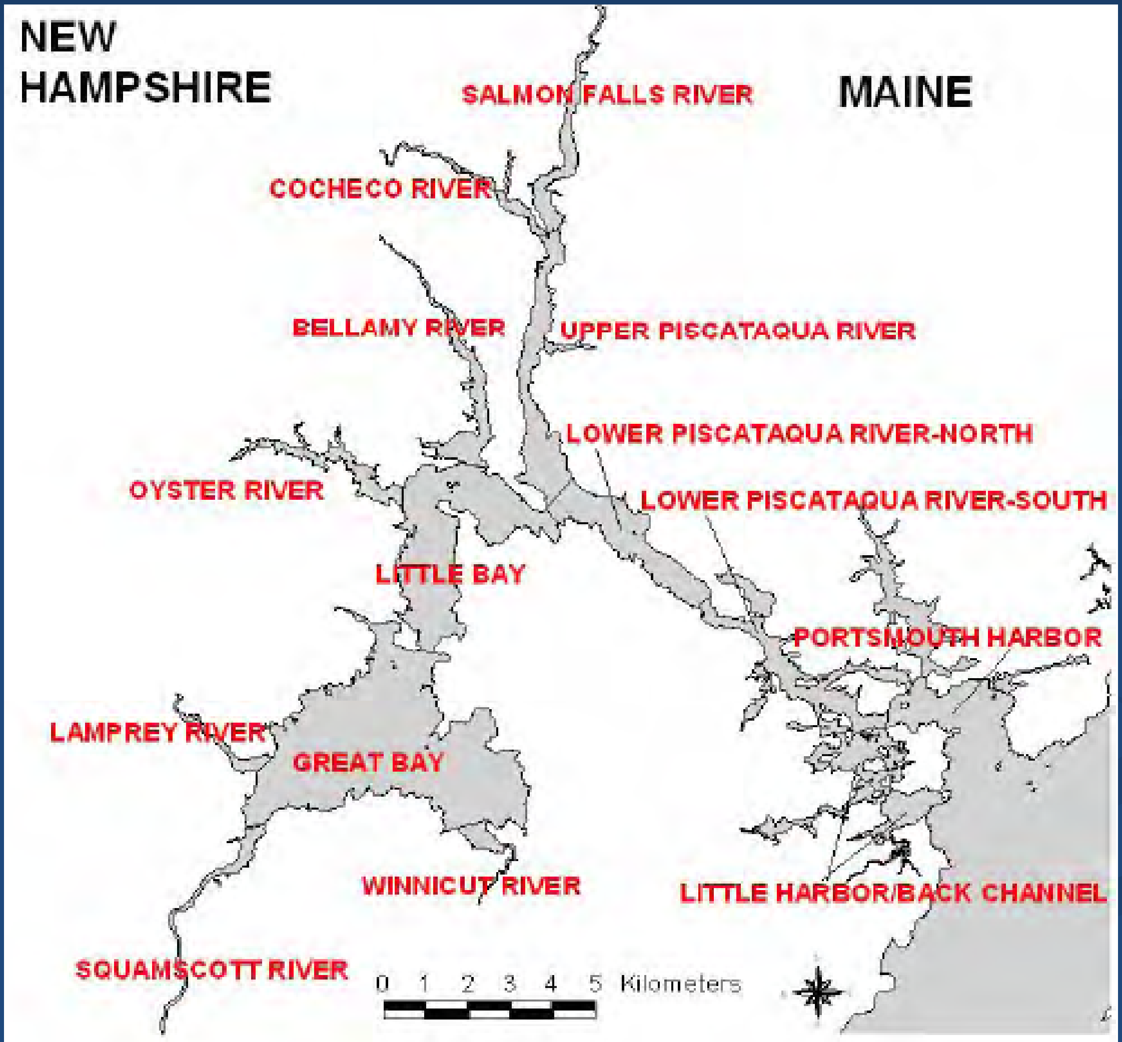
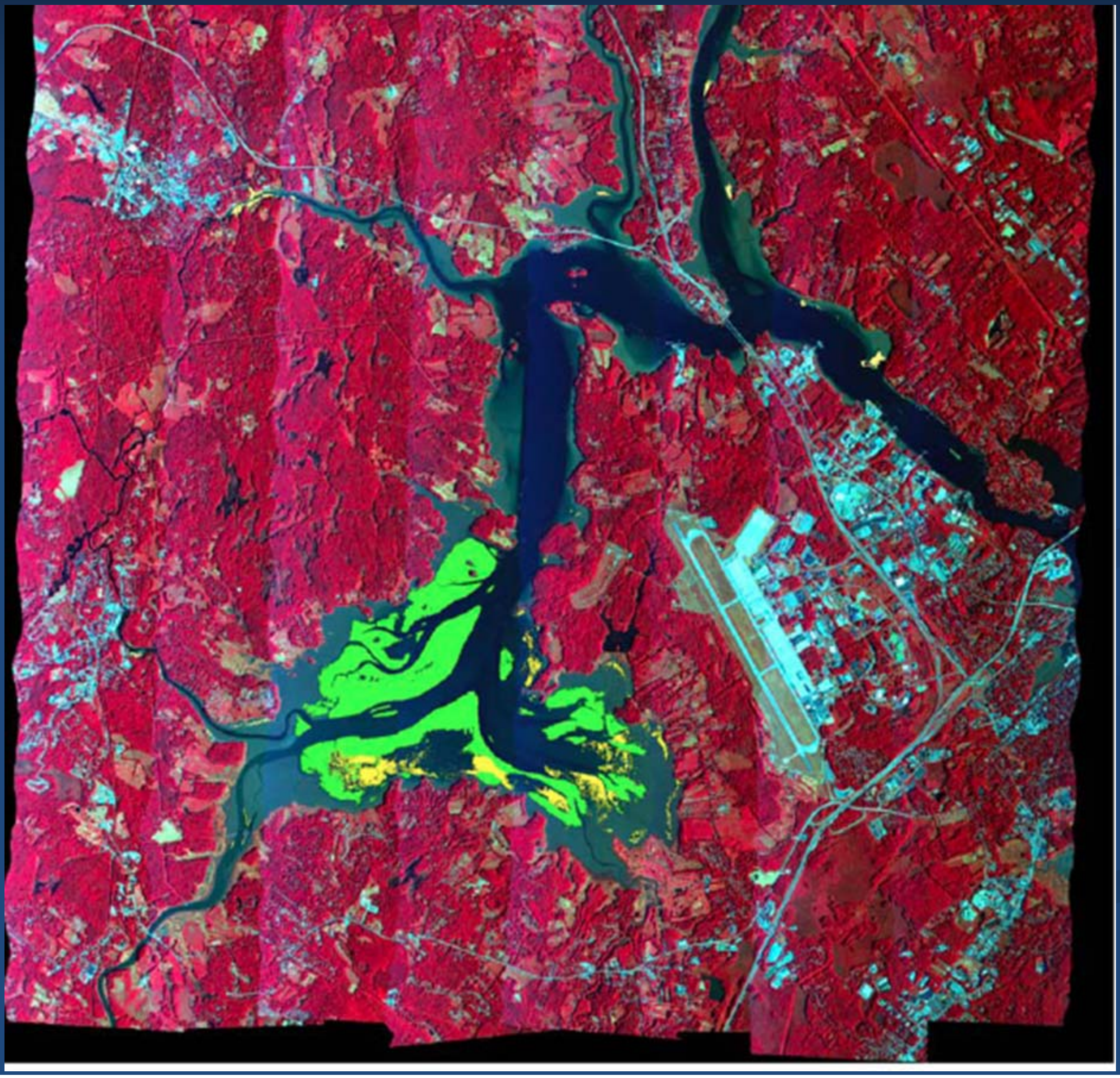
Overview of Great Bay Restoration Approach

Assessment Zones in the Great Bay Estuary

(New Hampshire DES, 2009)



Eelgrass and Macroalgae in Great Bay



Proposed Numeric Nitrogen Criteria for Great Bay Estuary

HydroQual
Environmental Engineers & Scientists

Use	Parameter	Threshold	Statistics
Primary Contact	chl-a	20 ug/L	90th percentile
Aquatic Life - DO	TN	0.45 mg/L	median
	chl-a	10 ug/L	90th percentile
Aquatic Life - Eelgrass	TN	0.30 mg/L (1)	median
		0.27 mg/L (2)	median
		0.25 mg/L (3)	median
	Kd	0.75 /m (1)	median
		0.60 /m (2)	median
		0.50 /m (3)	median

Notes:
(1) Eelgrass restoration depth = 2.0 m
(2) Eelgrass restoration depth = 2.5 m
(3) Eelgrass restoration depth = 3.0 m

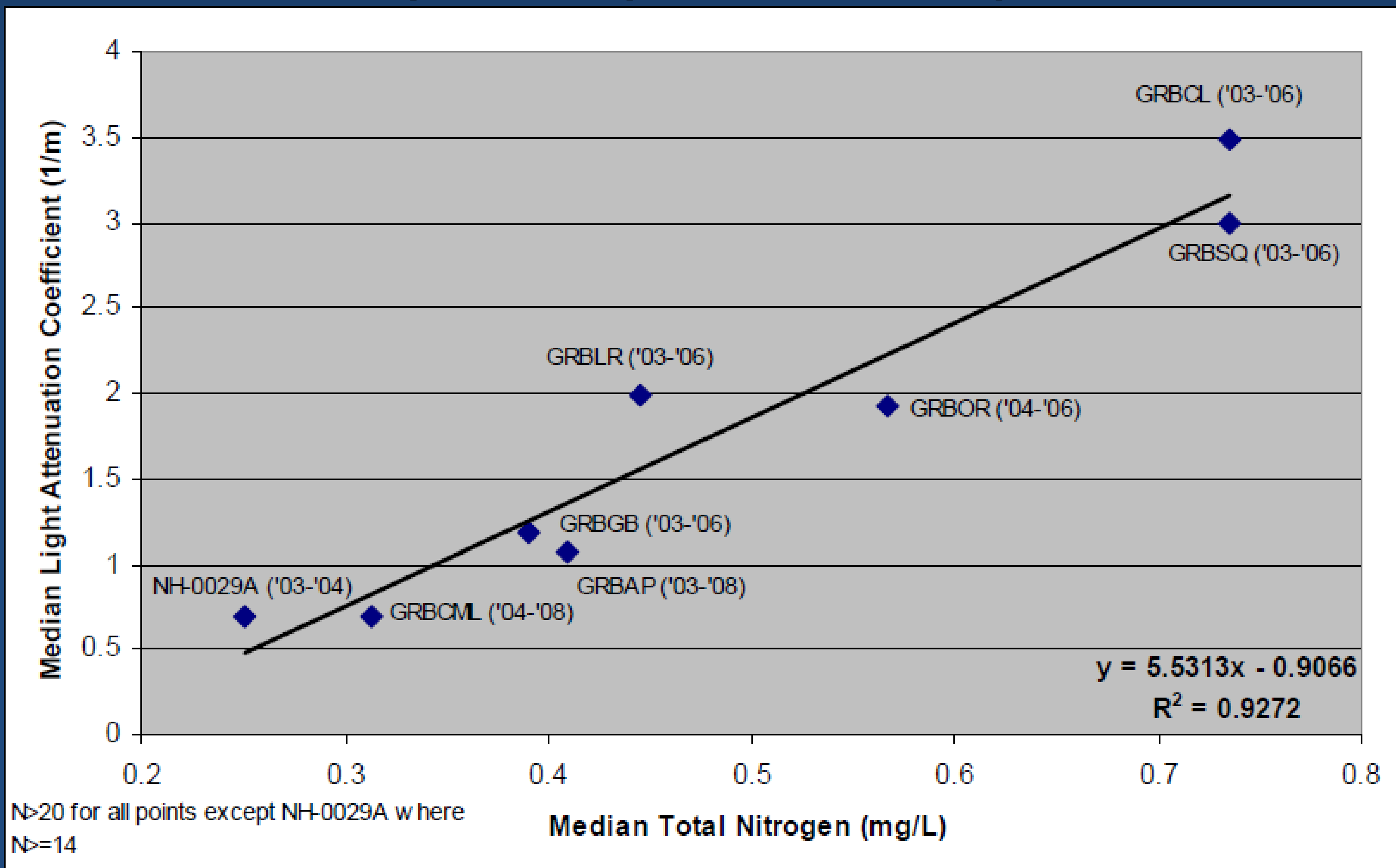
Focus of State Program

- Nutrient increases caused excessive plant growth in the Bay and Tidal Rivers
- Eelgrass needs more light reaching the bottom – reduce turbidity
- Controlling TN will allow eelgrass restoration
- Controlling TN will Improve River DO

Problem: The Data and Analyses Don't Support This Position

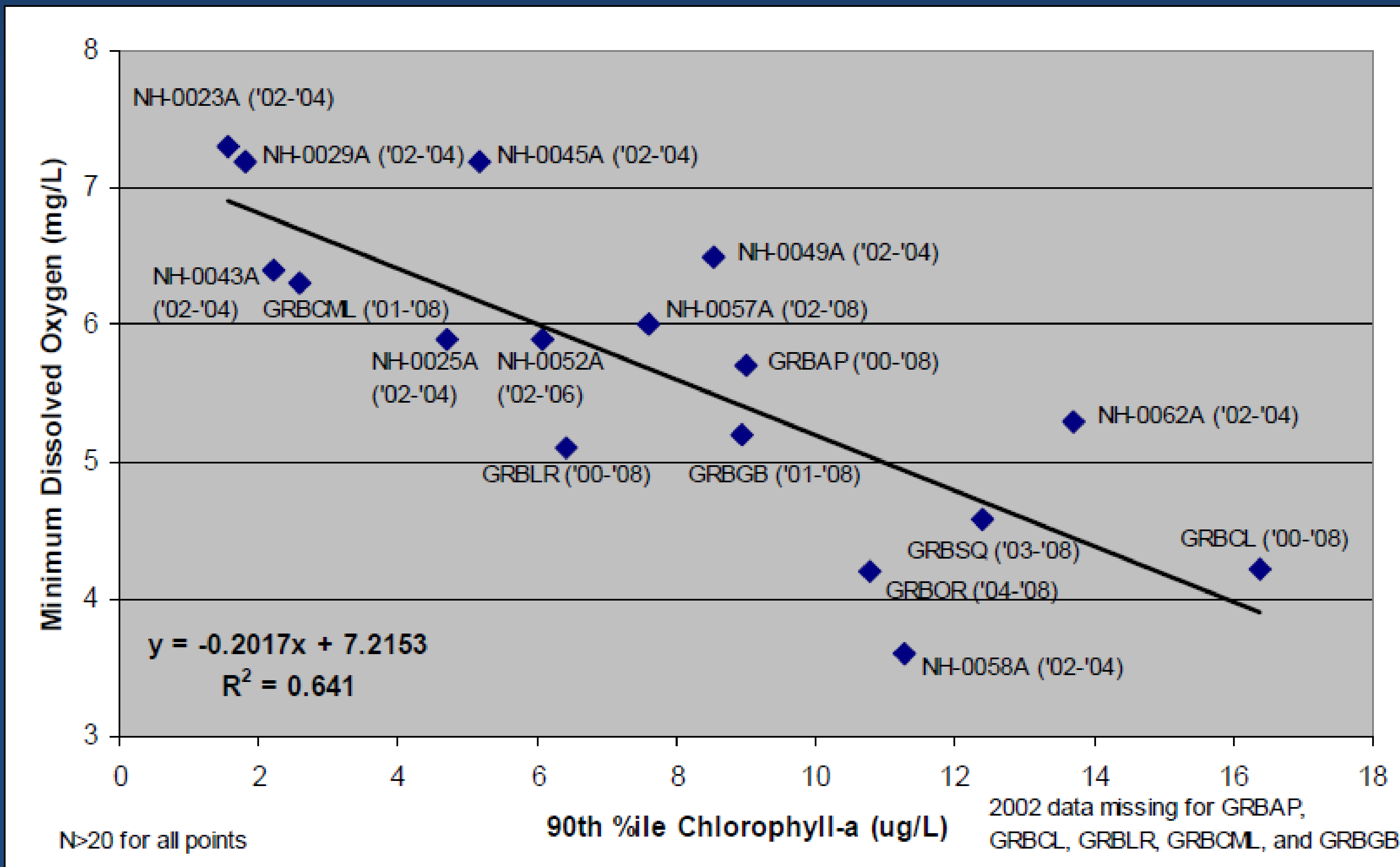
Relationship between Light Attenuation Coefficient and TN at Trend Stations

(New Hampshire DES, 2009)



Relationship between Minimum DO and Chlorophyll-a at Trend Stations

(New Hampshire DES, 2009)



Municipal Concerns With Proposed Approach

Overview of Municipal Concerns

- Stringent TN Regulation without “cause and effect” demonstration (SAB Report)
- Available data indicate TN control ineffective in protecting bay resources
- High social and economic cost of compliance with little likelihood of success
- Misdirects local resources; alternative programs likely to be more effective

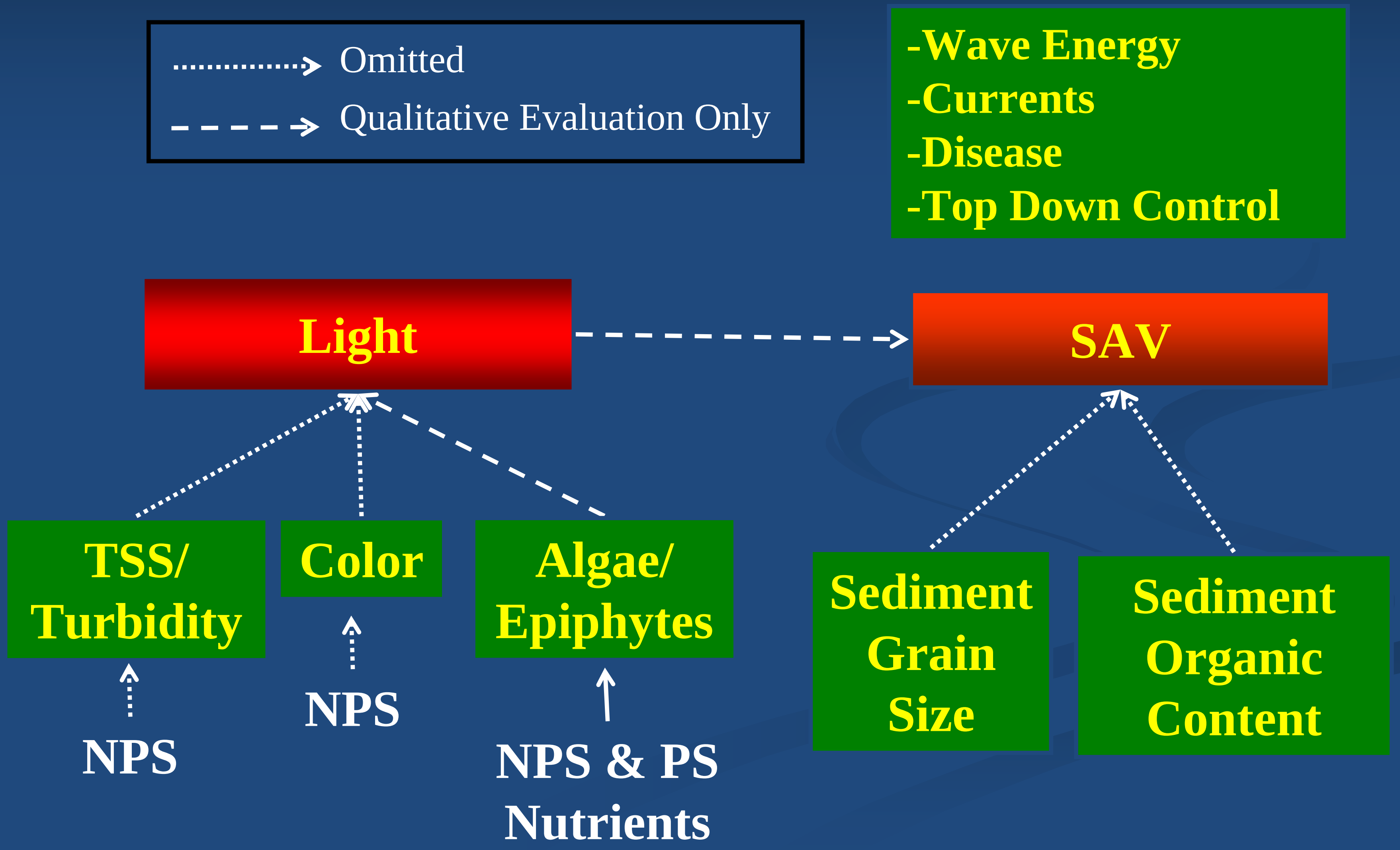
Cause and Effect Demonstration Necessary
SAB Report April 27, 2010

- *Without a mechanistic understanding and a clear causative link* between nutrient levels and impairment, there is *no assurance* that managing for particular nutrient levels *will lead to the desired outcome* (at 4); the Guidance needs to clearly indicate that the empirical stressor-response approach *does not result in cause-effect relationships*; it only indicates correlations that need to be explored further.

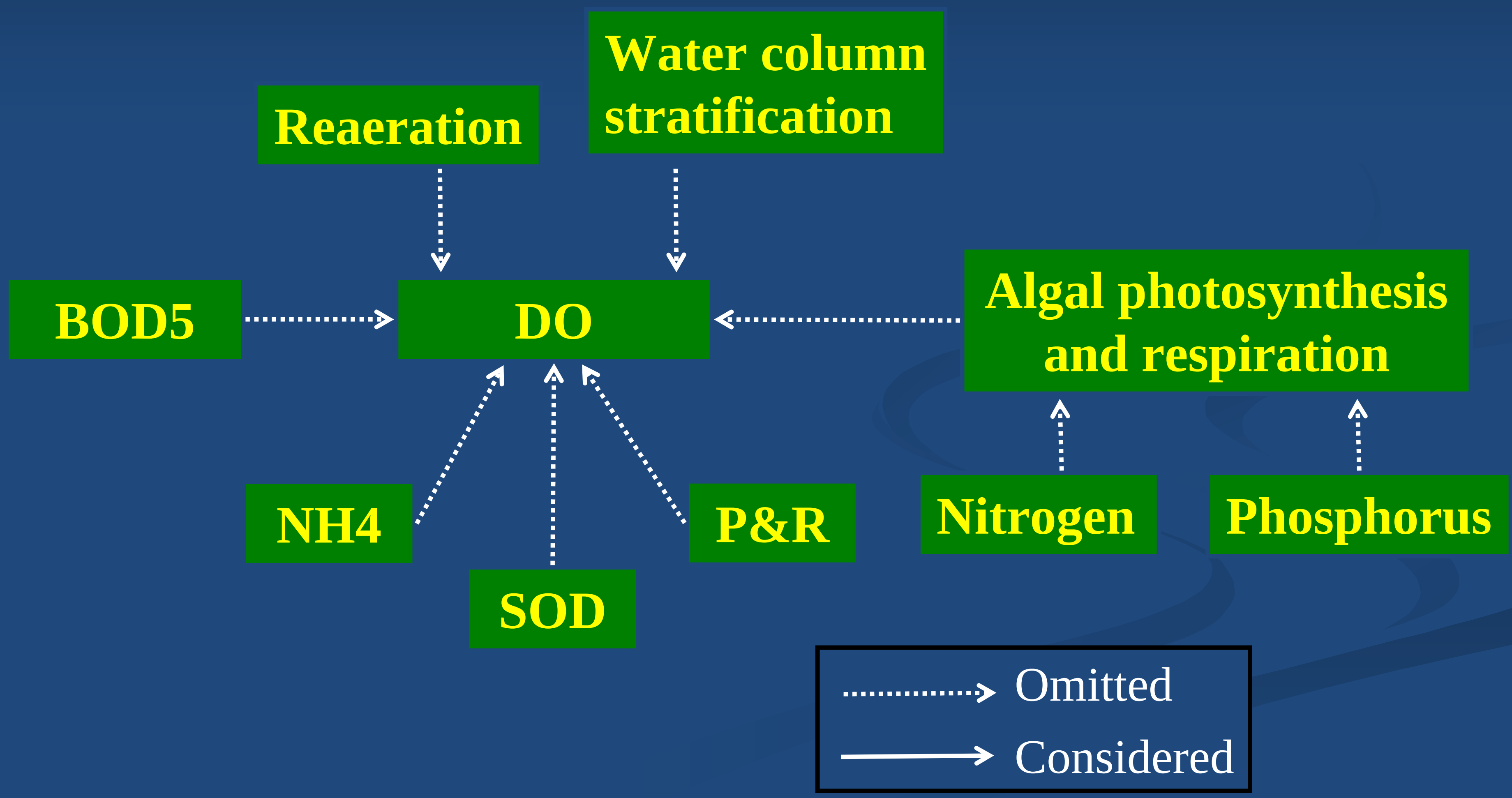
- In order to be scientifically defensible, empirical methods must take into consideration the influence of other variables…. The statistical methods in the Guidance require *careful consideration of confounding variables before being used as predictive tools*…. Without such information, nutrient criteria developed using bivariate methods may be *highly inaccurate*.

Factors Influencing Eelgrass Survival

HydroQual
Environmental Engineers & Scientists



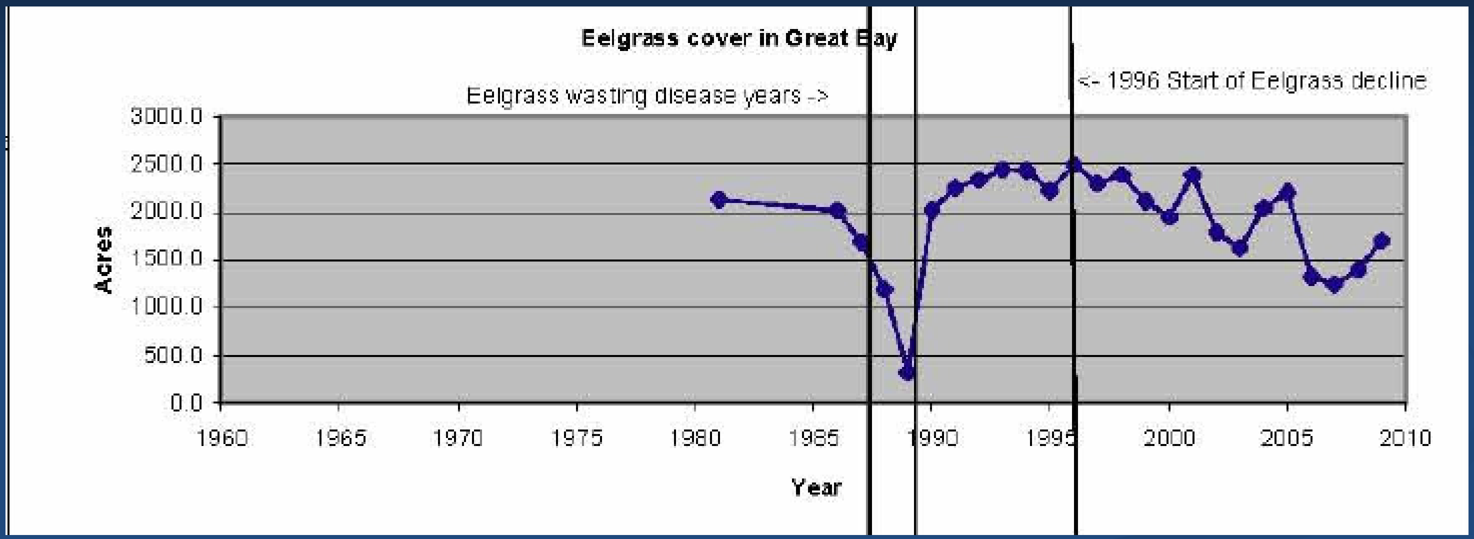
Factors Influencing Water Column Dissolved Oxygen



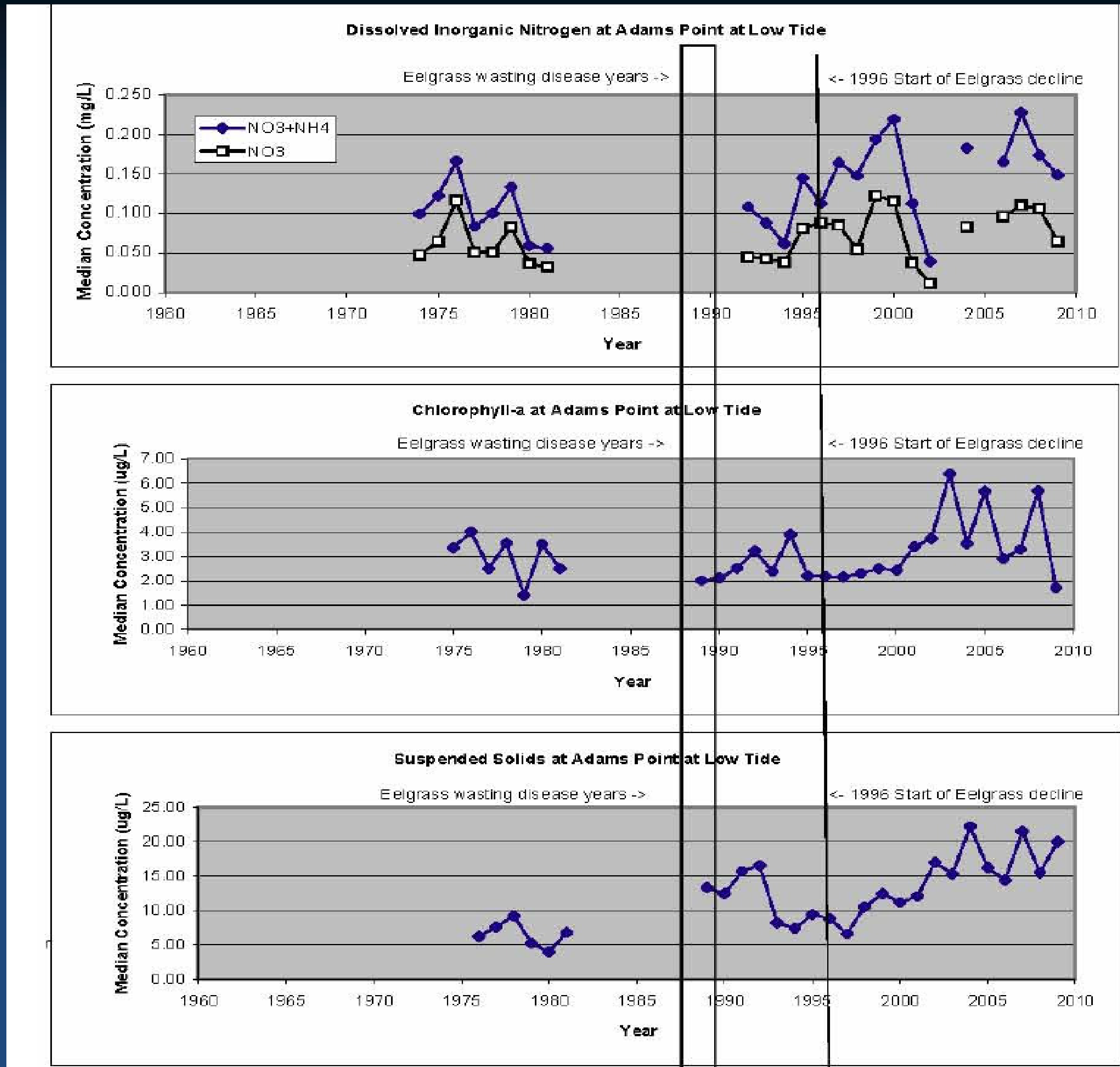
Missing Analyses

- Confirm TN concentrations control phytoplankton growth
- Demonstrate that a reduction in median phytoplankton concentration will occur and improve light penetration
- Demonstrate TN reduction is required to address non-algal turbidity
- Assessment of other factors that may explain or control the available light for submerged aquatic vegetation
- Confirm that eelgrass losses are tied to TN increases
- Show that the Chl ‘a’ levels in the estuary arms is cause of low DO
- Confirm that sediment oxygen demand was not the cause of DO depletion occurring in the estuary arms.
- Show that increased Chl ‘a’ levels in estuary arms resulted from growth in the saline and not fresh water sections of the watershed.

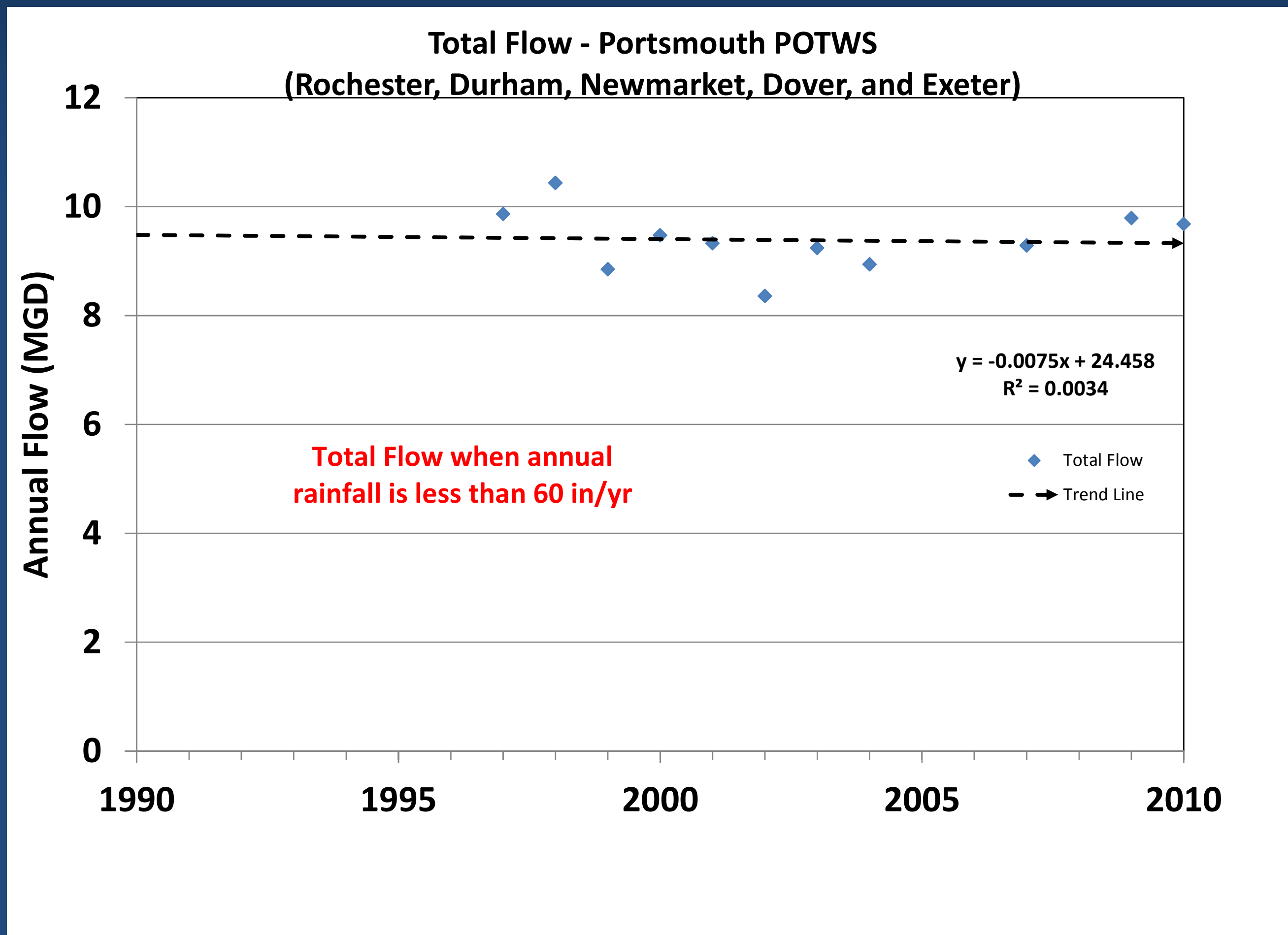
Trends Analysis Questions



- Does change in nitrogen correlate with eelgrass losses?
- Did WWTP loadings increase during this period?
- What other factors could have caused this?

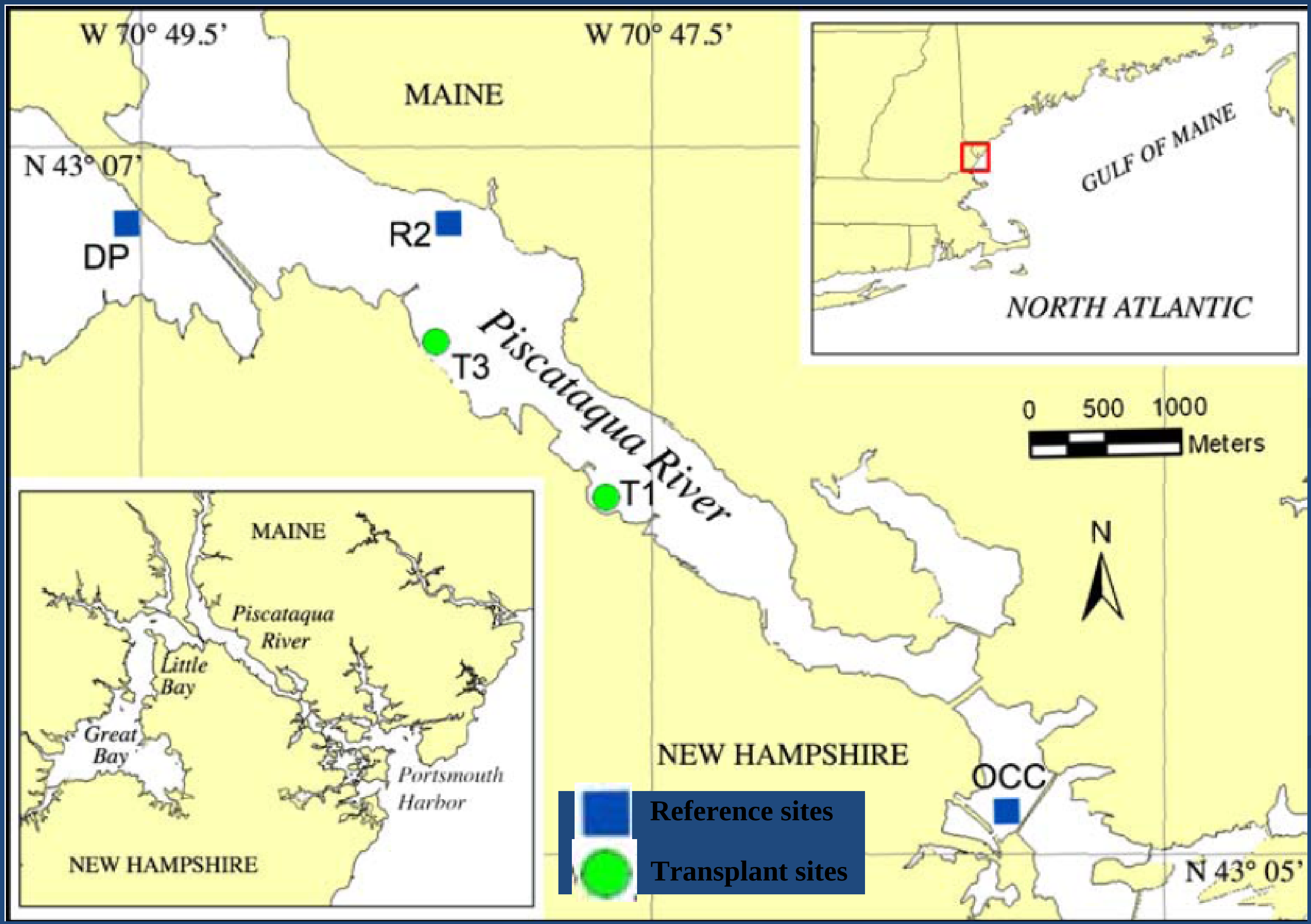

Dissolved Inorganic Nitrogen at Adams Point at Low Tide
Eelgrass wasting disease years ->
<- 1996 Start of Eelgrass decline
NO3+NH4
NO3
Median Concentration (mg/L)
Year
Chlorophyll-a at Adams Point at Low Tide
Eelgrass wasting disease years ->
<- 1996 Start of Eelgrass decline
Median Concentration (ug/L)
Year
Suspended Solids at Adams Point at Low Tide
Eelgrass wasting disease years ->
<- 1996 Start of Eelgrass decline
Median Concentration (ug/L)
Year

Trend Analysis – WWTP Loads/Flows



NHPA Eelgrass Monitoring Sites within the Piscataqua River and Little Bay

(Nora T. Beem & Frederick T. Short, 2009)



NHPA Eelgrass Monitoring Sites Within the Piscataqua River and Little Bay

(Nora T. Beem & Frederick T. Short, 2009)

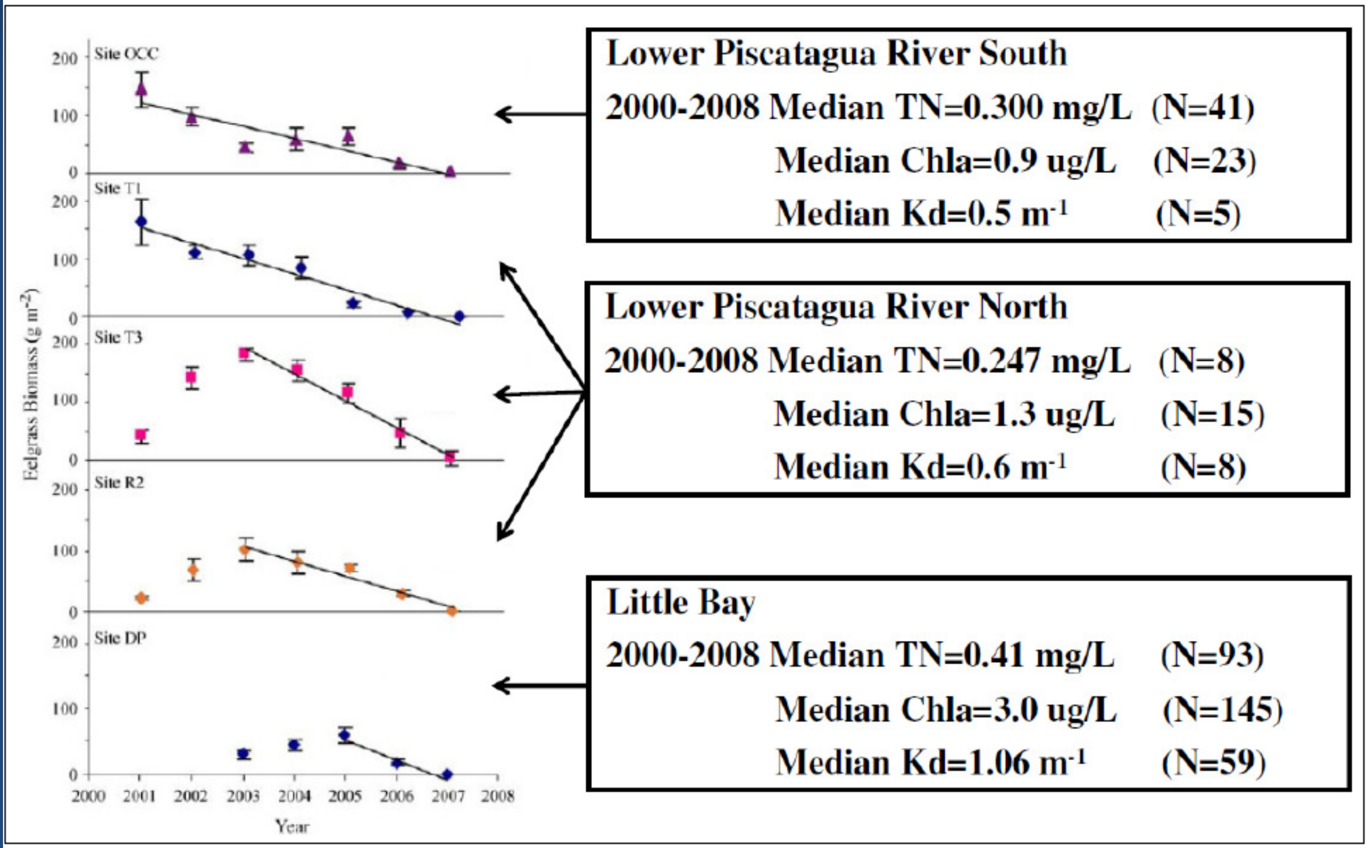


Figure 9. NHPA Eelgrass Monitoring Sites within the Piscataqua River and Little Bay (N. Beem & F. Short, 2009)

Conclusions of Trend Analysis

- WWTP load changes negligible
- Eelgrass decline started *before* change in nitrogen level or chlorophyll a increase
- Eelgrass declined even in areas of very low nitrogen levels
- Highly improbable that either of these factors triggered eelgrass losses

Factors Affecting Water Column Light Extinction (Kd)

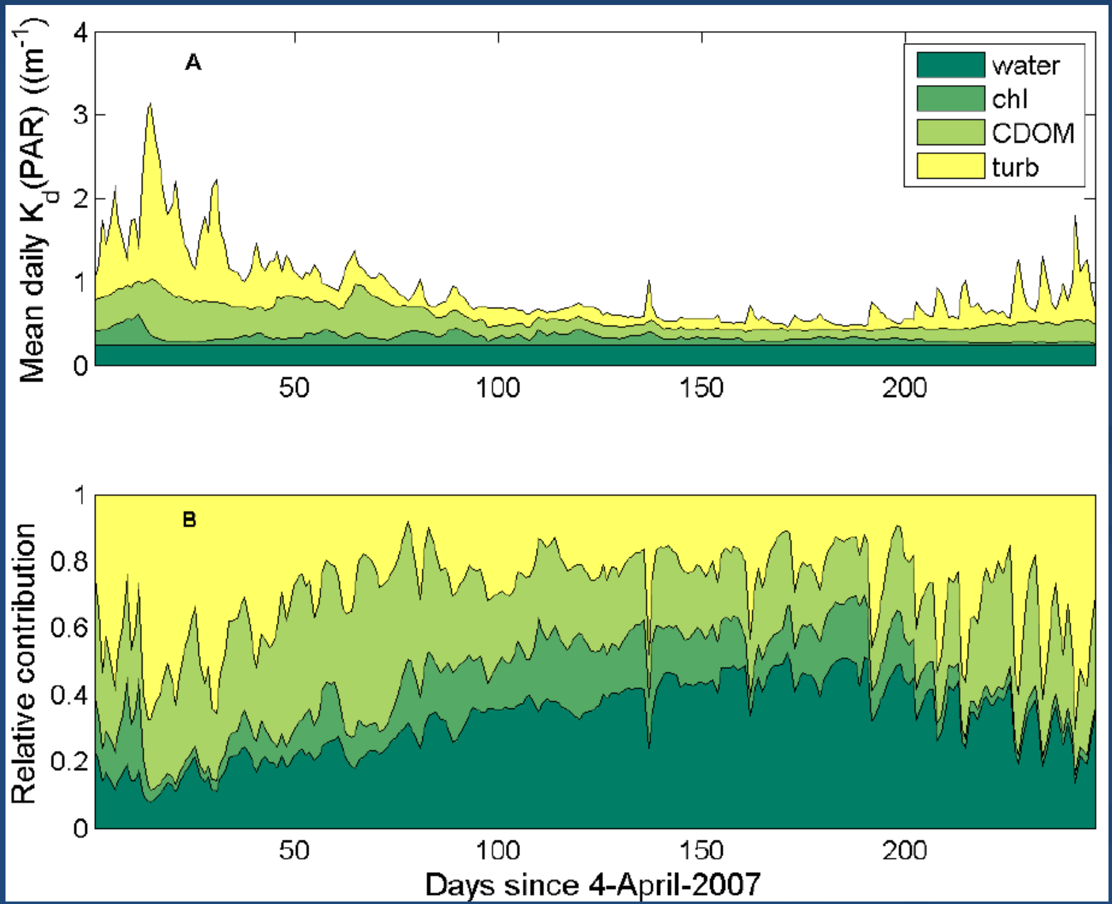
- Background Water
- Phytoplankton + Detritus (chla)
- Non-Algal Solids (NAS)
- Color (CDOM)

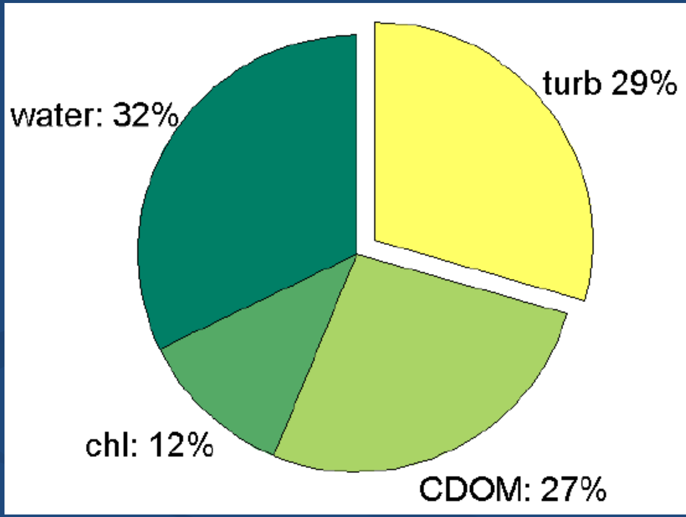
Therefore:

Kd = a + b*chla + c*NAS + d*CDOM

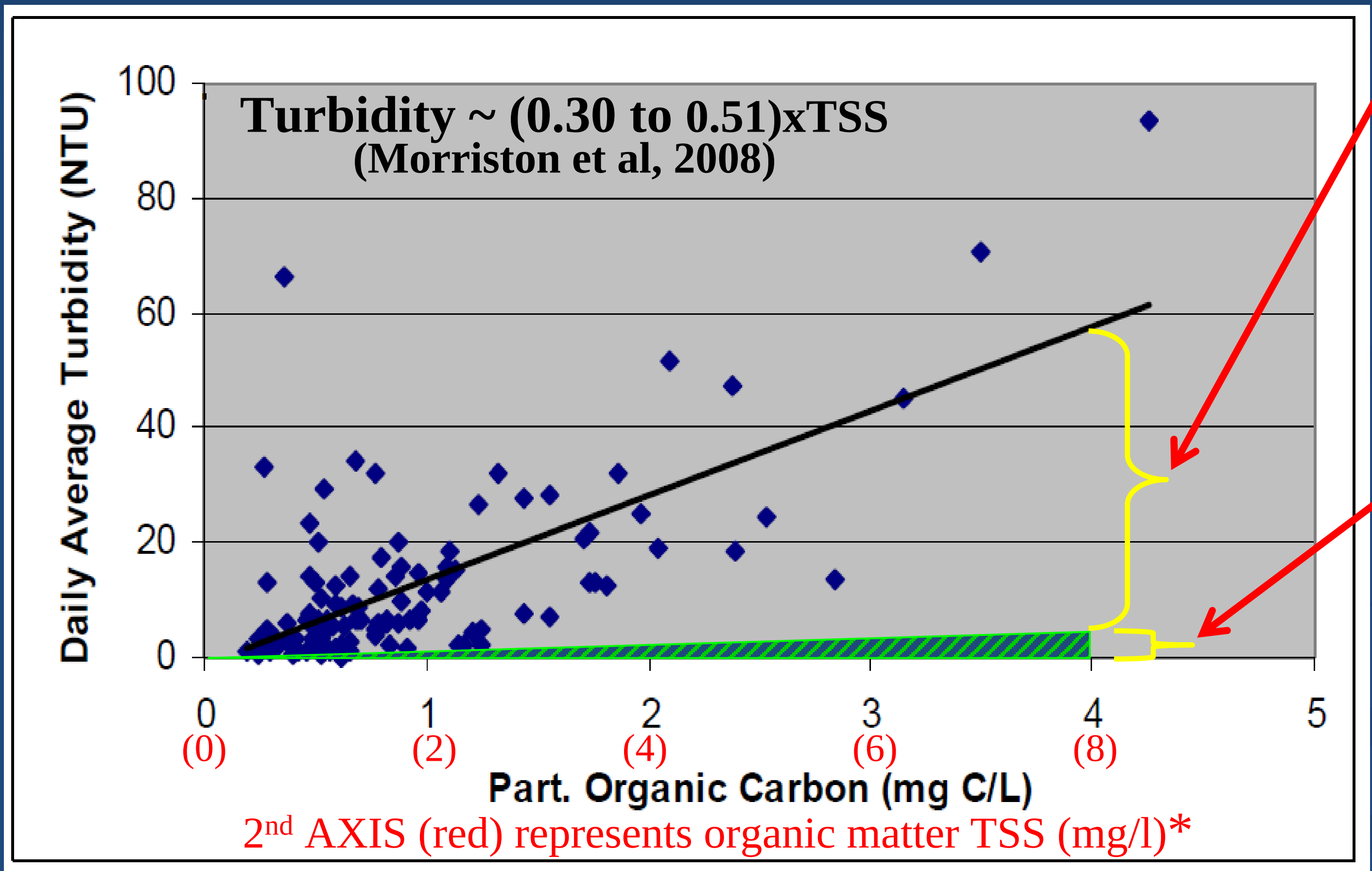
Contributions to Kd (PAR) Measured at the Great Bay Buoy

(From Morriston et al, 2008)





Measured Daily Average Turbidity vs. Particulate Organic Carbon (2000-2007)



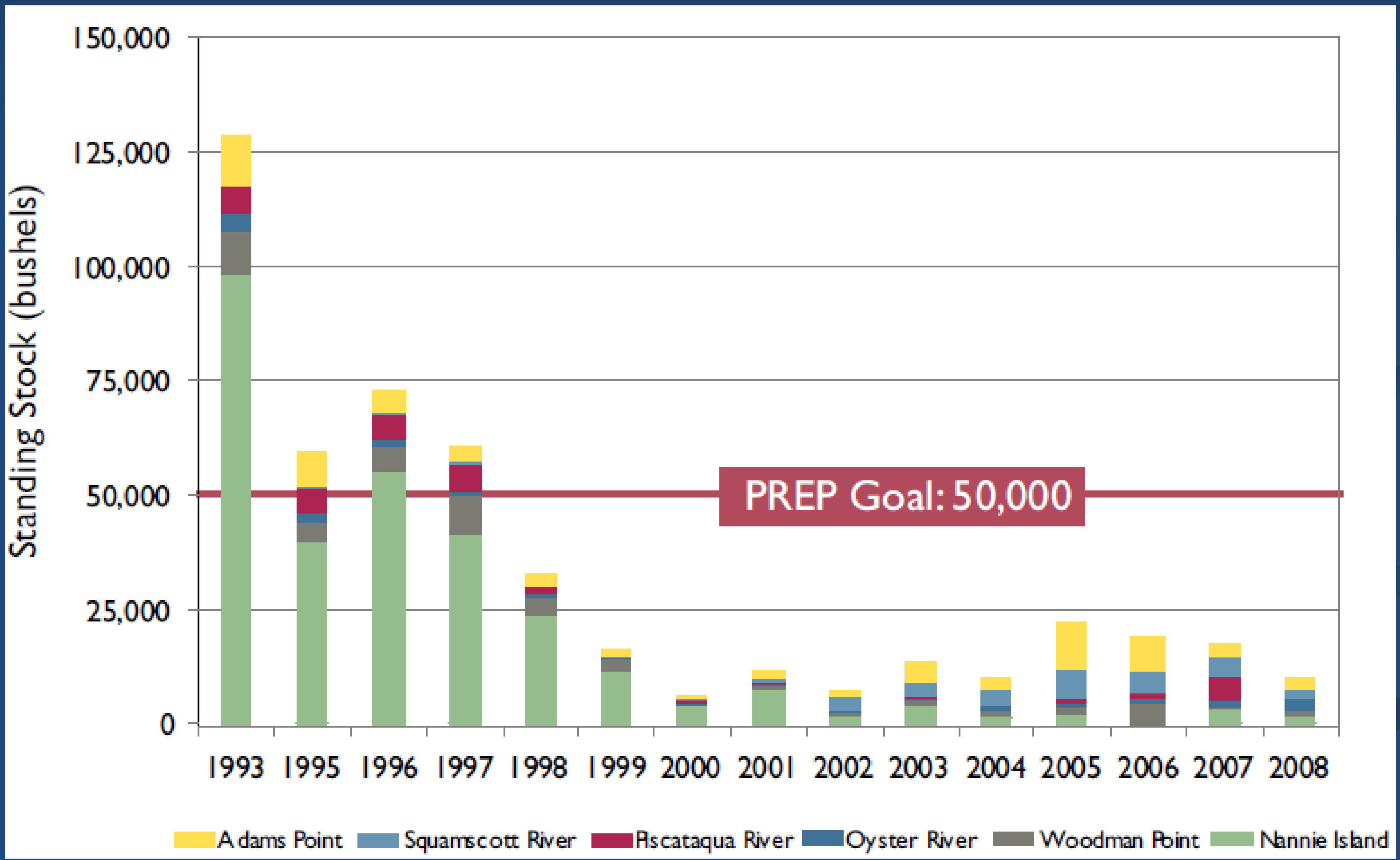
Estimated inorganic matter turbidity

Estimated organic matter turbidity

*** Assuming POM=50% Carbon**

Standing Stock of Adult Oysters (>80 mm) in the Great Bay Estuary

(Piscataqua Region – Estuaries Partnership, 2009)



Transparency Assessment

- Plant growth has a very minor impact on transparency
- UNH 2010 field study confirmed inert solids control light penetration
- Reducing TN might improve water clarity by 2-4%.
- Loss of oysters made matters worse
- Non-point source control best option to control inorganic solids

Tidal Impact on DO Levels

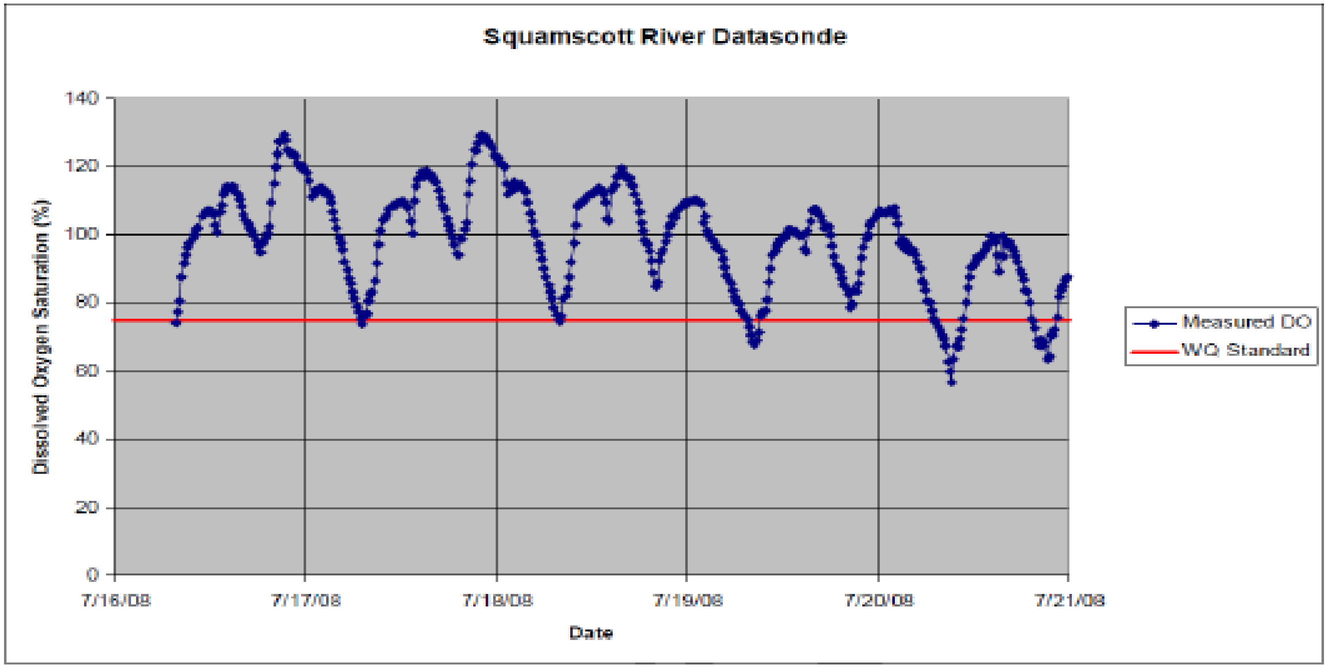
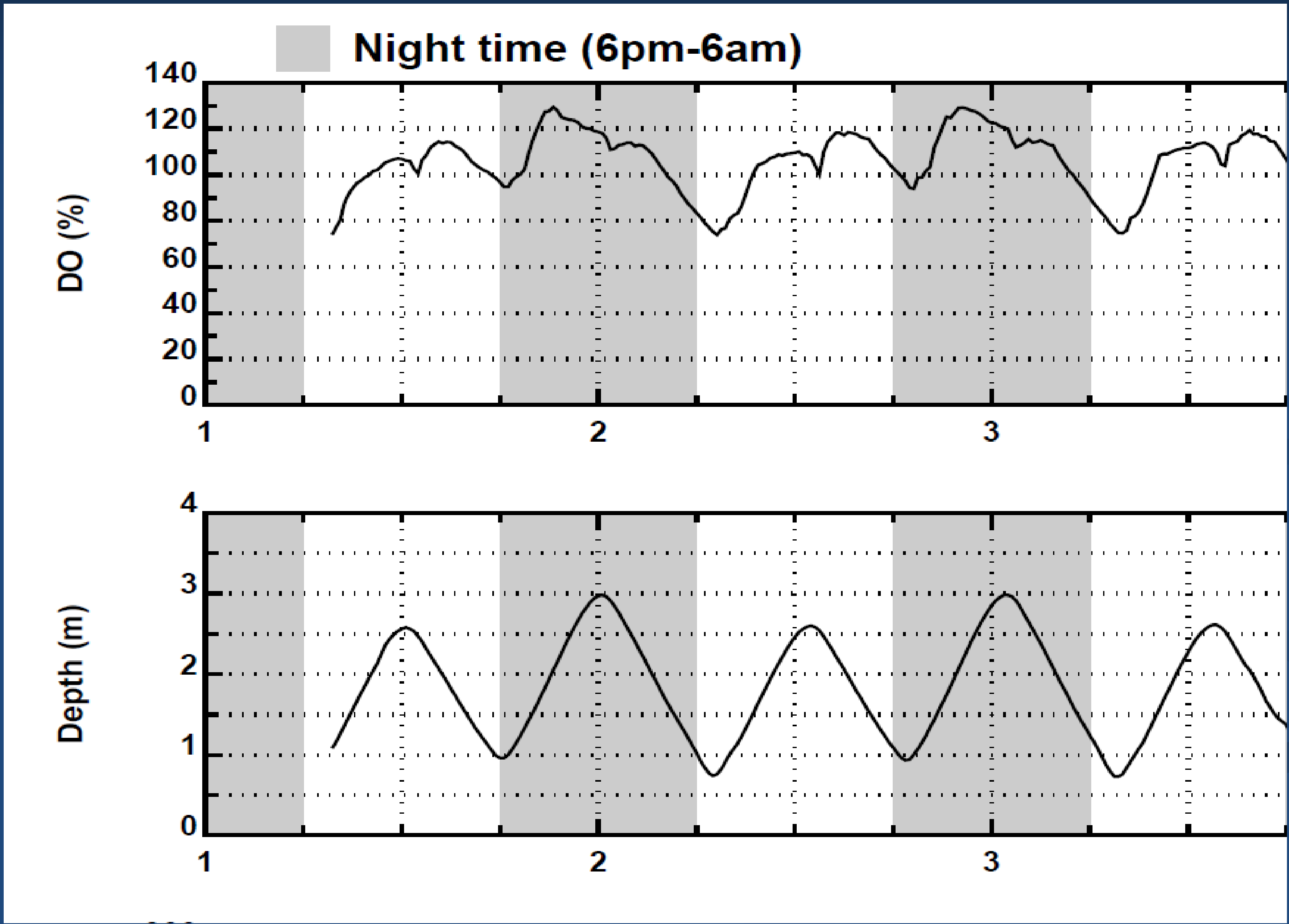


Figure 8. Dissolved Oxygen at the Squamscott River Datasonde Location

DO Variation – Tidal Effect



EPA Estuary SAB Findings (January 2011)

- Low DO a natural condition in many estuaries
- Eelgrass cause major DO fluctuations
- Eelgrass changes effect nutrient cycling and die-offs release stored nutrients

Conclusion of Evaluations

- Nitrogen is not significantly impacting water transparency
- WWTP load increases did not cause eelgrass losses
- DO variation in estuary arms not caused by nitrogen inputs or chlorophyll a growth
- Numerous other factors are influencing bay ecology and not adequately assessed

Reality of Situation

- Eelgrass losses due to wasting disease
- Oyster losses due to Asian bacteria
- Since 2000 higher stream flows
- These are difficult to control/correct conditions – cause increased turbidity
- Hard thinking, additional data collection and more diverse restoration efforts will be necessary

Peer Review for GB Estuary

- Municipal Groups identified major data gaps and uncertainties
- Requested Peer Review of Draft Criteria
- Interim Program for WQ Improvements Proposed (WWTP upgrades, BMPs and studies)
- State agreed to peer review to ensure scientific approach is correct
- Proposed schedule summer 2011

FOR MORE INFORMATION:

JOHN C. HALL

Hall & Associates

1620 I Street, NW

Suite 701

Washington, DC 20006

(202) 463-1166

jhall@hall-associates.com