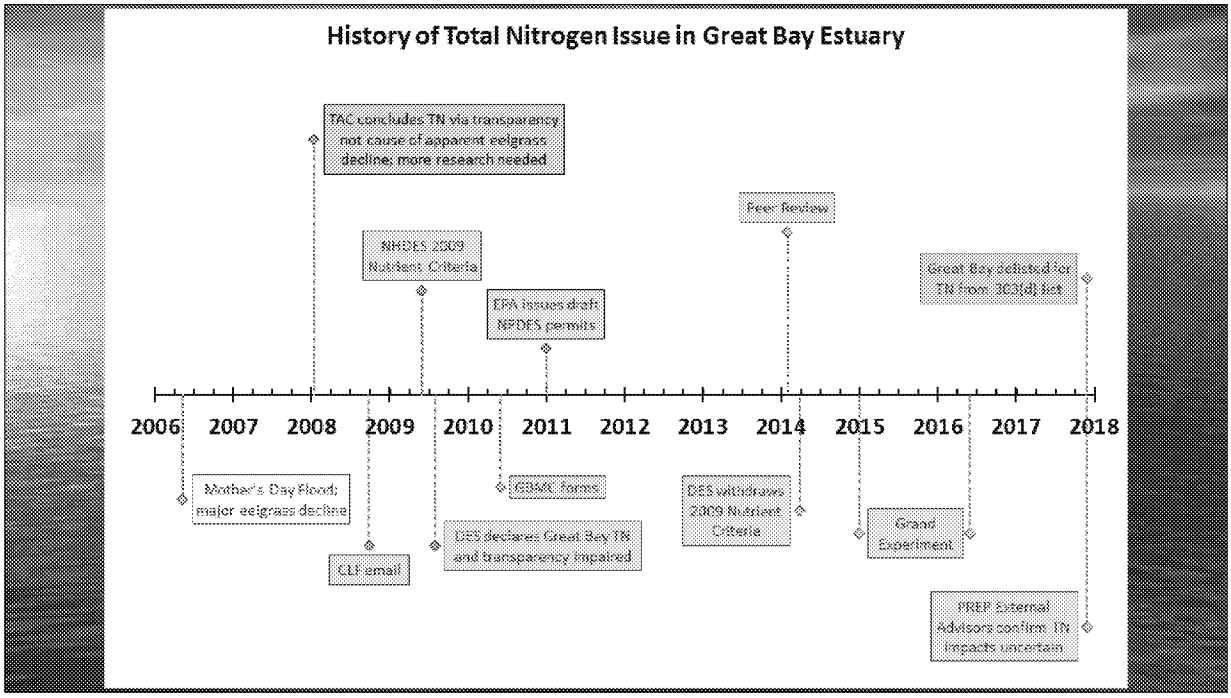

History of Total Nitrogen Issue in Great Bay Estuary
TAC concludes TN via transparency not cause of apparent eelgrass decline; more research needed
Peer Review
NHDES 2009 Nutrient Criteria
Great Bay delisted for TN from 303(d) list
EPA issues draft NPDES permits
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Mother's Day Flood; major eelgrass decline
IGBMC forms
DES withdraws 2009 Nutrient Criteria
Grand Experiment
CLF email
DES declares Great Bay TN and transparency impaired
PREP External Advisors confirm TN impacts uncertain

Review of Great Bay Estuary Total Nitrogen-Eelgrass Issues

John C. Hall, Dean Peschel, Ben Kirby
Great Bay Municipal Coalition
February 6, 2018

Overview

- Great Bay Characteristics
- Great Bay Eelgrass Trends
- Factors that Can Affect Eelgrass
- 2009 NHDES Nutrient Criteria
- 2013-14 Peer Review
- GBMC Research
- PREP 2018 State of Our Estuaries Report

NH Narrative Nutrient WQS (Env-Wq 1703.14)

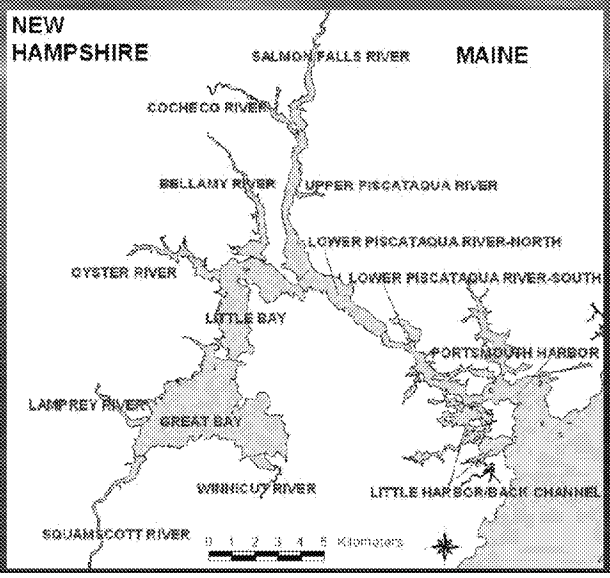
- (b) Class B waters shall contain no phosphorus or nitrogen *in such concentrations that would impair any existing or designated uses*, unless naturally occurring.
- (c) Existing discharges containing phosphorus or nitrogen, or both, *which encourage cultural eutrophication* shall be treated to remove the nutrient(s) to ensure attainment and maintenance of water quality standards.

Env-Wq 1702.14 "Criterion" means:

- (b) A narrative statement concerning that *pollutant that when not exceeded, will protect an organism, a population, a community, or a prescribed water use*

https://www.des.nh.gov/organization/commissioner/legal/rules/documents/env-wq1700.pdf

Great Bay Estuary, New Hampshire



Unique Great Bay Characteristics

- Shallow
- Large tidal range
- Large tidal exchange
- High velocity
- Elevated CDOM

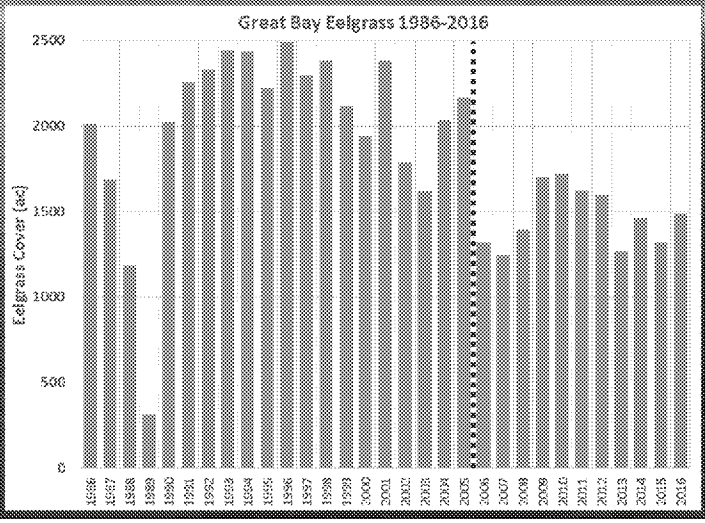
Great Bay is <u>not</u> Chesapeake Bay.

High Natural CDOM
Limits Transparency/Plant Growth

Problem Identification

Historical monitoring data on eelgrass cover (acreage) confirmed major decline after 2005.

Prior to 2006, System Not Considered Eelgrass Impaired

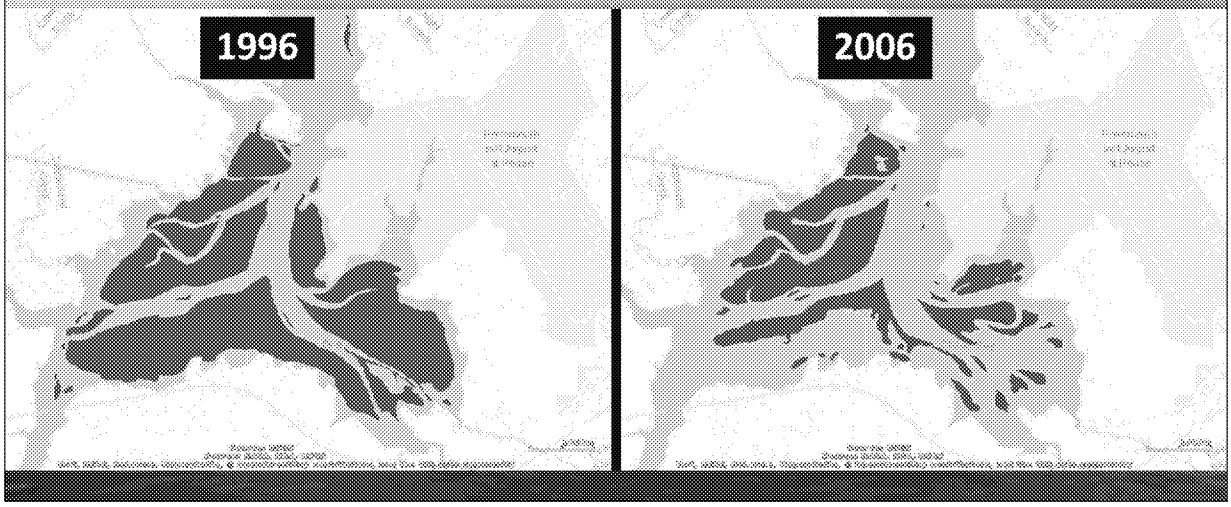


Information to Consider in Evaluation Eelgrass of Trends

- Multiple Wasting Disease Events
  - Major Outbreak: 1931-32 (wiped out East Coast)
  - Major Outbreak: 1984 (Little Bay, Piscataqua)
  - Major Outbreak: 1988-89
  - Other Outbreaks: 1995, 1999-2000, 2002-03
- Geese grazing on eelgrass beds

Great Bay Eelgrass Cover - 1996 vs. 2006

Post-Mother's Day Storm

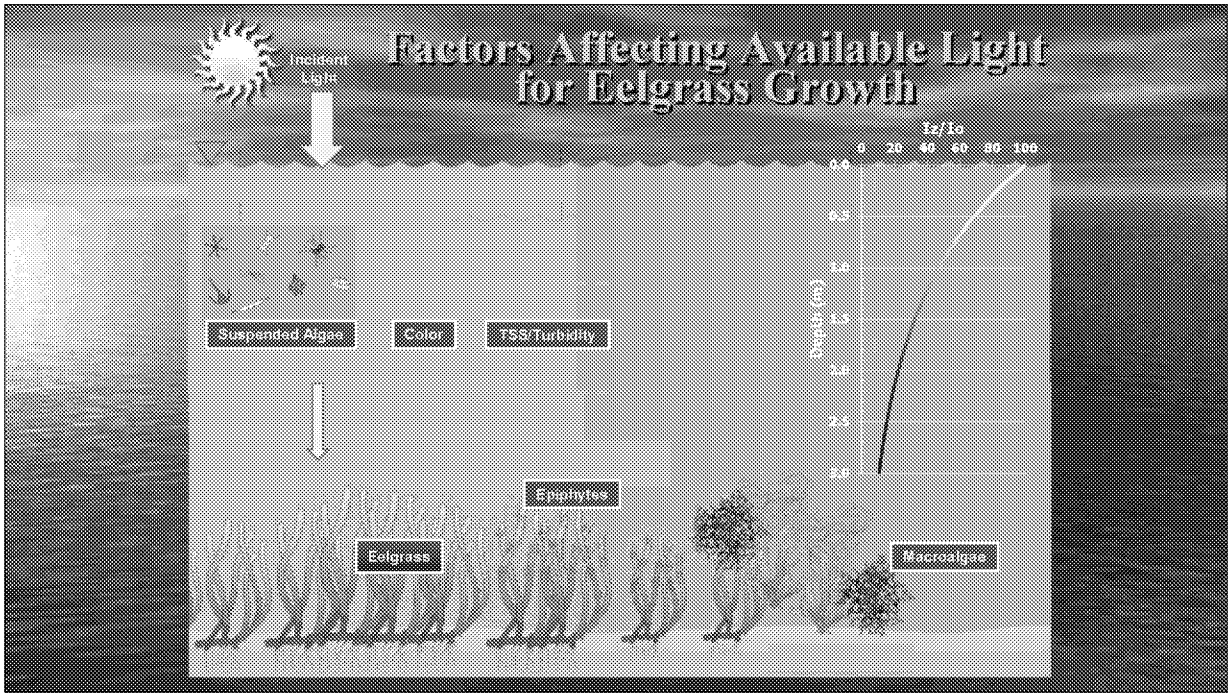


Factors Known to Affect Eelgrass

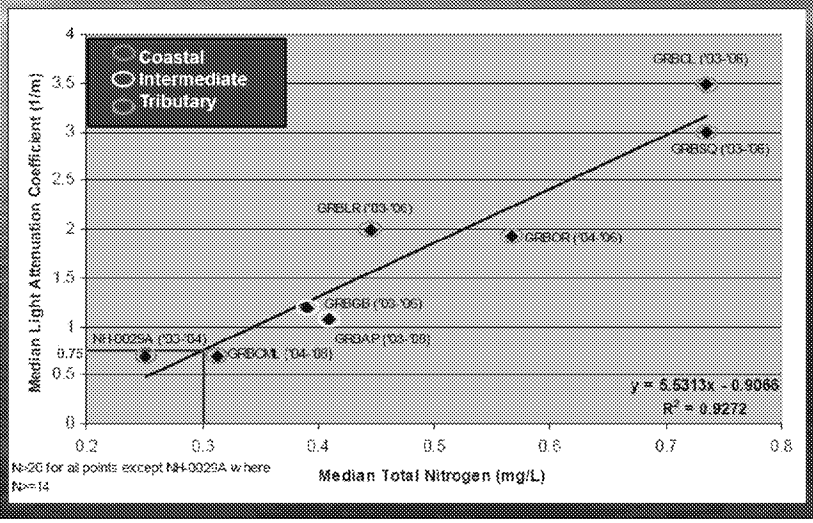
Light
- Phytoplankton
- CDOM/NAP (rainfall)
- TSS (wind)
- Macroalgae
- Epiphytes
- Depth

Non-light
- Wasting disease
- Geese/Grazers
- Extreme storms
- Ice scour
- High temperature
- Macroalgae (competition)
- Sediment (habitat)
- Desiccation

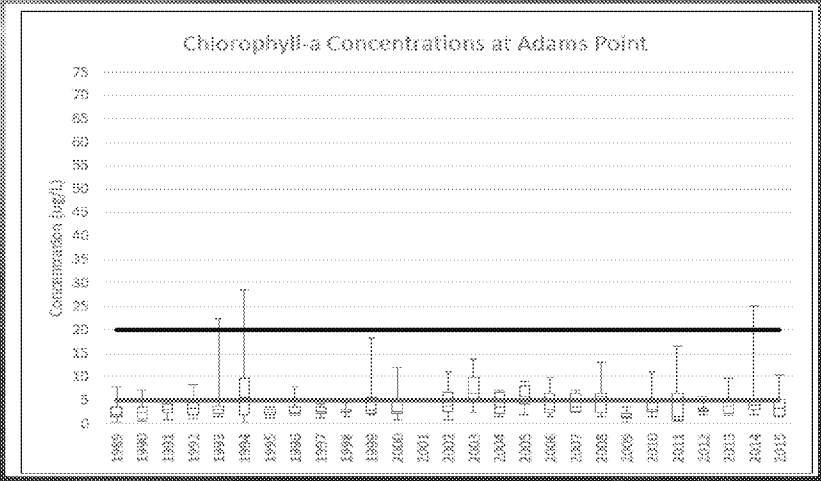
Other Potential Factors
- Other pollutants (herbicides)
- Invasive species
- Other biologicals


Factors Affecting Available Light for Belgrass Growth
Incident Light
Suspended Algae
Color
TSS Turbidity
Epiphytes
Belgrass
Macroalgae
Depth (m)
Ir/Io
0
20
40
60
80
100
1.0
0.8
0.6
0.4
0.2
0.0

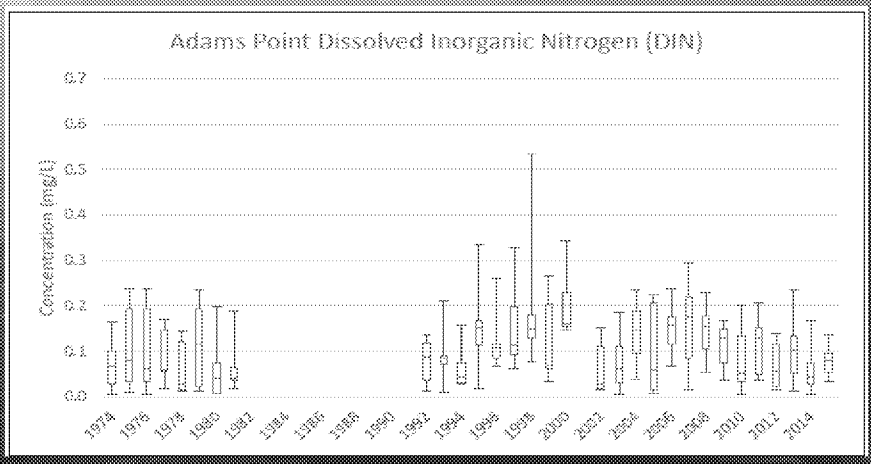
Erroneous Evaluation Method



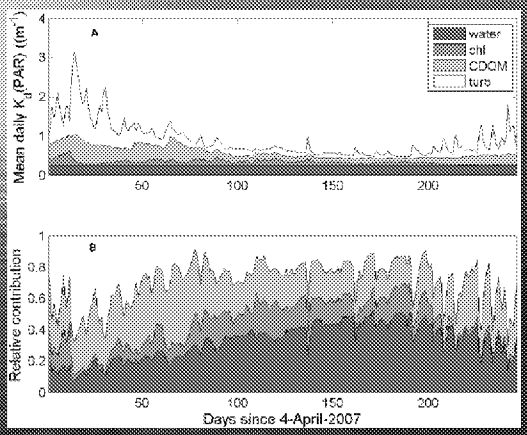
Chlorophyll-a Over Time

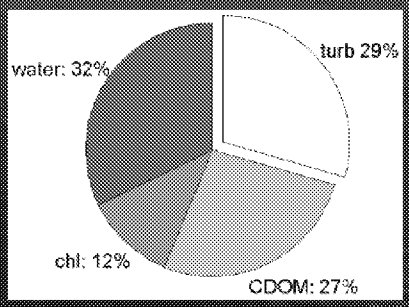


DIN at Adams Point



Factors Affecting Transparency K_d (PAR) Measured at the Great Bay Buoy



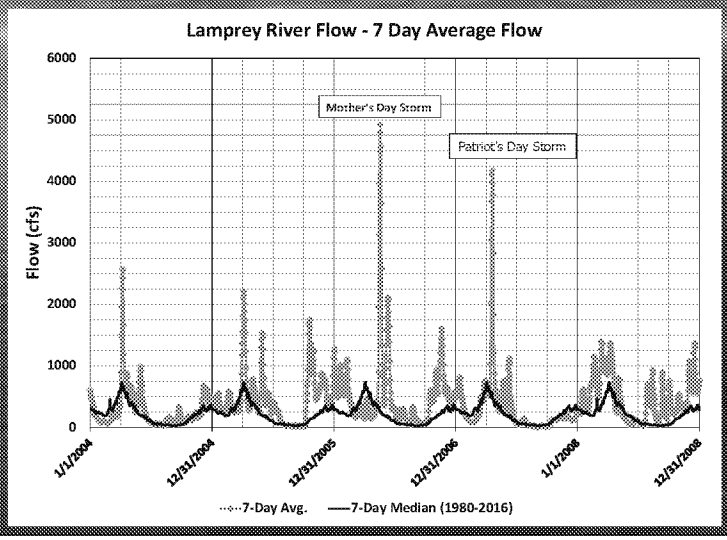


(From Morrison et al., 2008)

Chl-a in GB vs. Other Nearby Estuaries

Chl-a (ug/L)		
Description	Annual Mean	Source
Chesapeake Bay 1985-1994 - Mid-bay	9.03	EPA Region III
Narragansett Bay 1985-1990 - Station 7	38.3	Y. Li and T. J. Smayda
Delaware Estuary 1988-1990	9.75	Delaware Estuary Program
Long Island Sound 1995-2010 - Station A4	10.26	UConn - The Long Island Sound Integrated Coastal Observing System
Great Bay	2-4	PREP Reports

Mother's Day Storm (2006)



2014 Peer Review Confirms TN WQS Not Scientifically Defensible

Peer Review Panel of 2009 NHDES Numeric Nutrient Criteria

Dr. Vic Bierman - Estuary modeler

Dr. Robert Diaz - DO

Dr. Ken Reckhow - Statistics

Dr. Jud Kenworthy - Eelgrass

Peer Review Report

Reviewers concluded:

The DES 2009 Report did not adequately demonstrate that nitrogen is the primary factor in the Great Bay Estuary because it *did not explicitly consider any of the other important, confounding factors in developing relationships* between nitrogen and the presence/health of eelgrass. (Bierman at 18)

There is *no basis for a scientifically defensible linkage* between nitrogen impairment and eelgrass impairment presented in the report. (Kenworthy at 19)

Peer Review Report - Cont'd

Scientific knowledge indicates a causal linkage between TN and DO, due to the growth and decomposition of algae. However, the *data analysis does not support this TN-DO linkage* in the NH DES data. (Reckhow at 48)

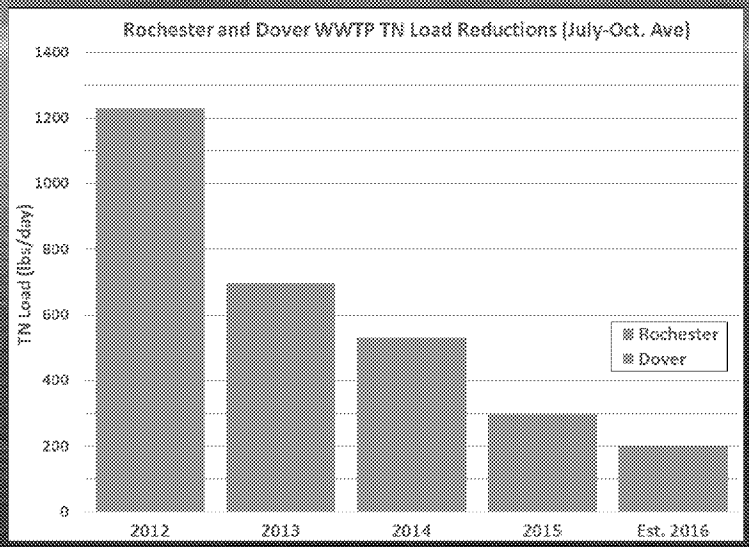
The results in the 2009 report *are not acceptable or reliable* for setting nutrient criteria. (Reckhow at 38)

[...] the DES "weight of evidence" *does not support the conclusion that excess nitrogen was the primary factor* that caused the decline of eelgrass and the inability of eelgrass to repopulate specific areas. (Kenworthy at 46)

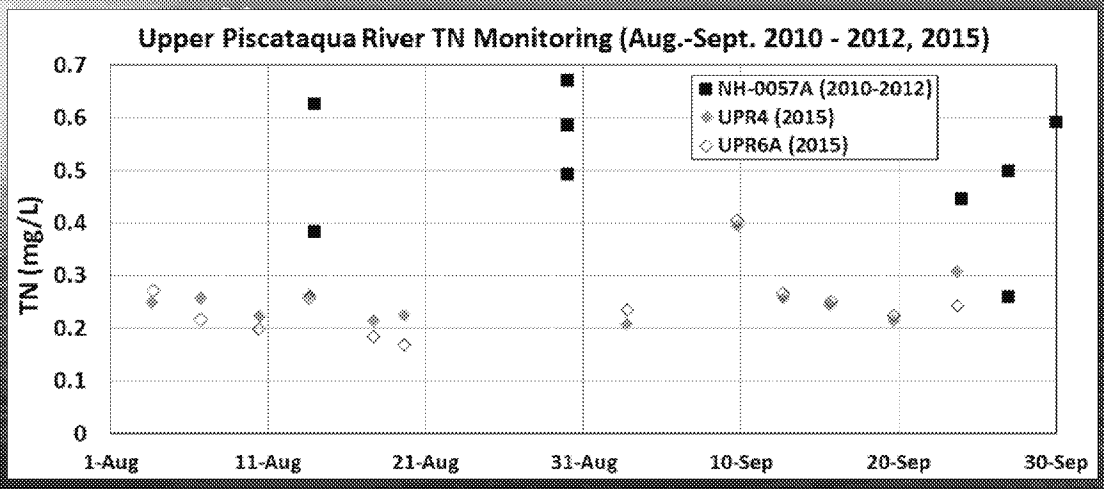
GBMC Initiates Grand Experiment 2014-16

- Major voluntary TN reductions at WWTPs
- Fund additional detailed modeling and monitoring to detect associated environmental response, if any
- No quantifiable environmental improvement found despite major TN load/concentration reductions

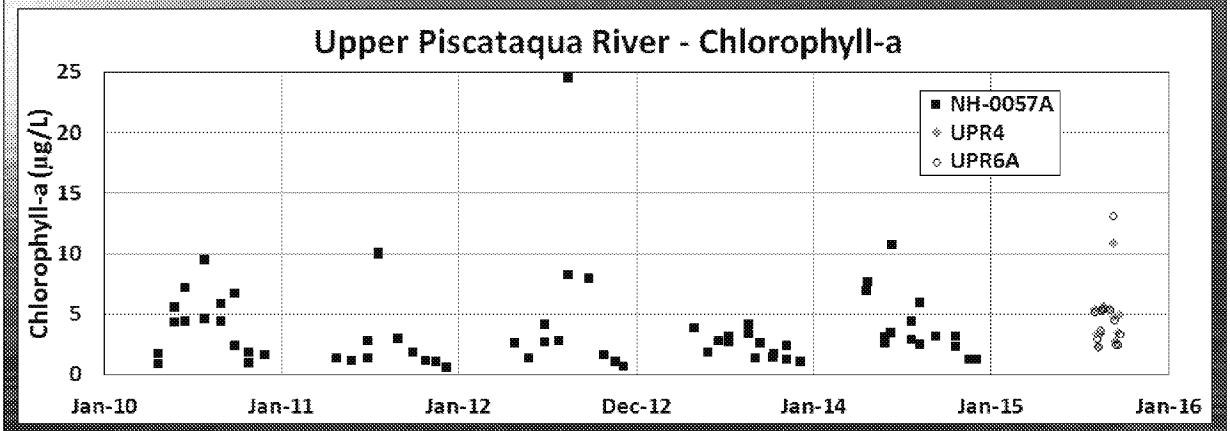
Grand Experiment WWTP TN Load Reductions



Grand Experiment UPR TN Concentration



Grand Experiment Chl-a Impacts (No Change)



2017 Change in Impairment Listing for Great Bay

"It is less clear, at this time, whether the response datasets demonstrate sufficient power to determine that the eutrophication effects on designated uses can be attributed to total nitrogen alone. *Given that uncertainty, impairment is not warranted under New Hampshire's narrative standard.* [T]his assessment zone has been assessed as Insufficient Information – Potentially Not Supporting (3-PNS) for total nitrogen." (TSD for GBE 2016 303(d) List at 33)

PREP 2018 State of Our Estuaries Report

PREP– 2018 State of Our Estuaries Report
Total Nitrogen

- [T]he Great Bay Estuary may have traits that *make it more tolerant of high nutrient levels* (such as high flushing rates) [. . .]. (SOOE at 8)
- Eelgrass decline may relate to episodic stressors, such as storms, but it is equally plausible that chronic stressors, such as decreased water quality, may have limited the resilience of eelgrass to episodic disturbances. *More comprehensive data is needed to better understand the interactive effects of these stressors.* (at 9)
- How much nitrogen reduction is enough or too much? *The data to answer this question do not currently exist.* (External Advisors at 239)

PREP– 2018 State of Our Estuaries Report Dissolved Oxygen

- Low dissolved oxygen events continue to occur in our tributaries, but these are *not necessarily caused by excess nitrogen.* (at 8)
- *More data and analysis is required* to understand the relative importance of temperature, tidal stage, time of day, freshwater inputs, organic matter loading, and nutrient loading as contributing factors to these low DO events. (at 23)

Other Information to Consider Regarding Current Conditions

- TN now below concentration literature reports is protective of eelgrass
- TN below levels when eelgrass thrived in Great Bay Estuary
- TN at levels 2009 Criteria reported would protect eelgrass

Conclusion

- Further research needed on the potential factors influencing eelgrass health
- Maintaining status quo pending further research is reasonable, protective, and recommended based on existing research and information
- Action level permit with reopener clause is appropriate

Proposed Permit Provision

"The permittee shall continue to operate its existing facilities to promote nitrogen reduction from mid-May through October, consistent with attainment of other specifically regulated pollutants."