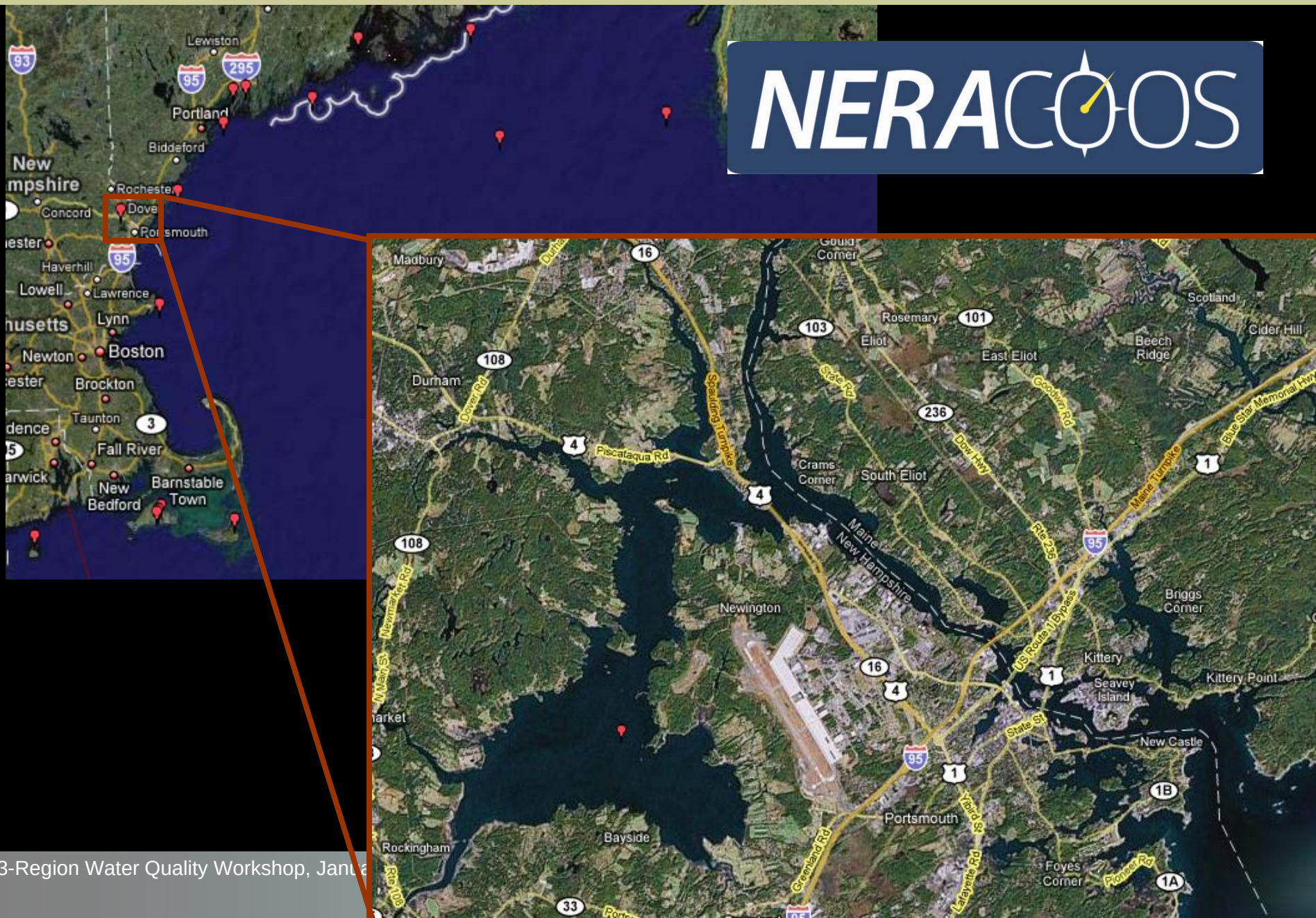
Using multiple data streams to develop eelgrass-based nutrient criteria for New Hampshire's Great Bay Estuary

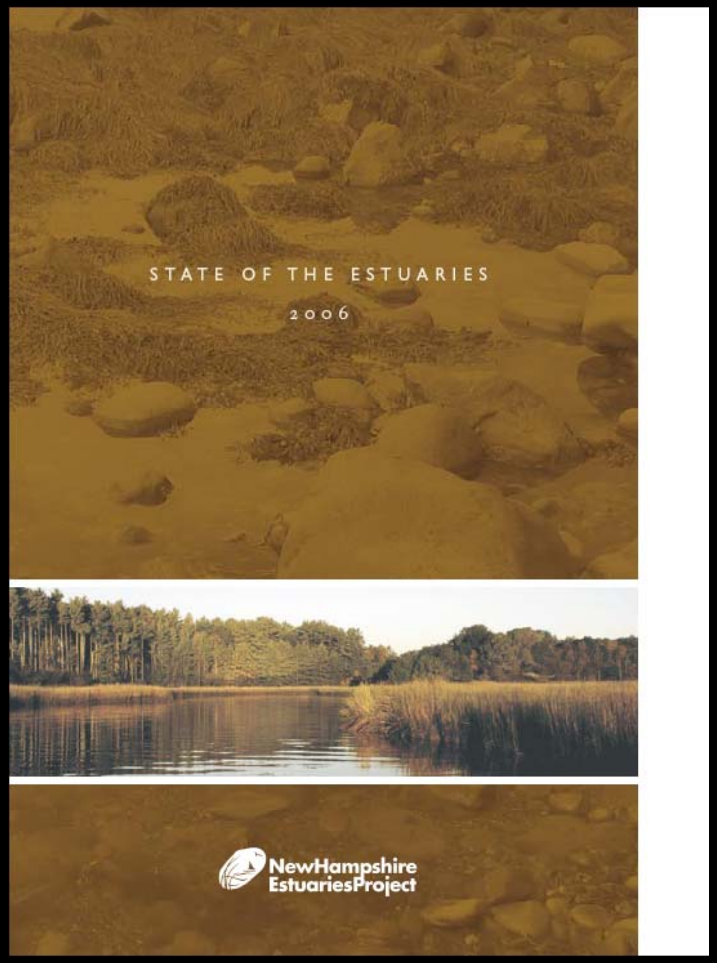
J. Ru Morrison (NERACOOS),
Paul Currier (NHDES),
Phil Trowbirdge (PREP/NHDES),
Shachak Pe'eri (UNH)
Frederick T. Short (UNH)

IOOS Observation Registry

Sensor Platforms Map

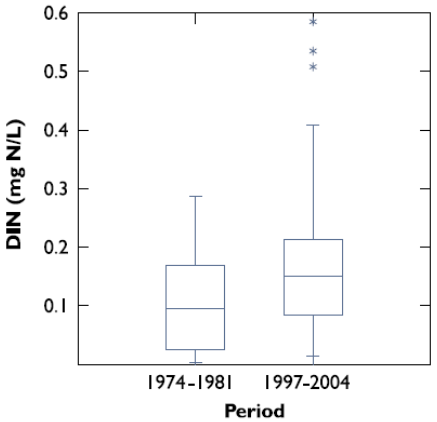


Water Quality Issue



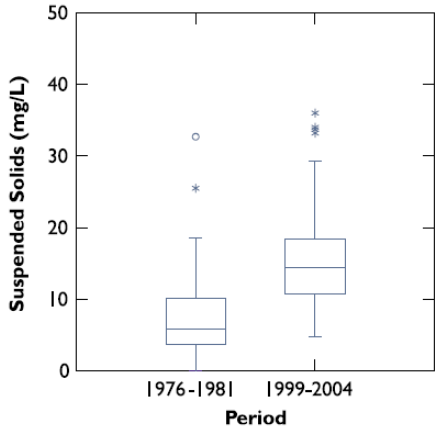
Dissolved inorganic nitrogen concentrations measured at Adams Point at low tide (Figure 6)

Data Source: UNH Jackson Estuarine Laboratory



Suspended solids concentrations measured at Adams Point at low tide (Figure 7)

Data Source: UNH Jackson Estuarine Laboratory



1974-1981 Data recovered as part of the buoy data discovery process

User Community

- *Coastal and inland managers including NH Department of Environmental Services(NHDES) and the Piscataqua Region Estuaries Project (PREP); scientists;*
- *public and industry in the watershed of the Great Bay Estuary*

Process

Great Bay Data from Many monitoring efforts including:

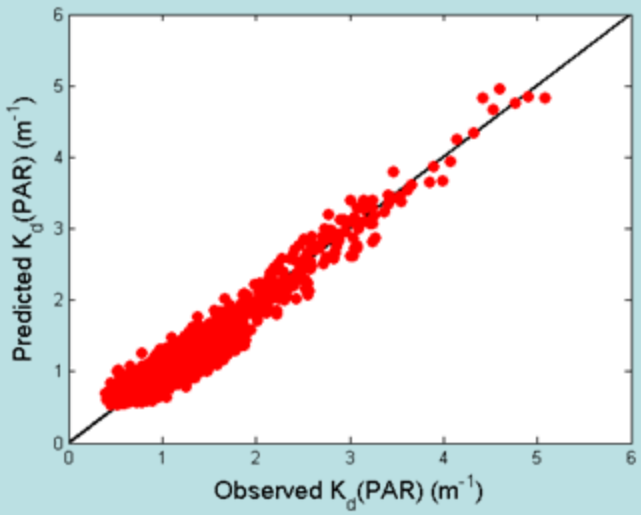
- NERR
- PREP
- IOOS funded NERACOOS buoy
- EPA funded Hyperspectral Aerial Imagery

IOOS – Buoy Measurements

- Surface Irradiance (Hyperspectral 350 nm – 800 nm)
- Subsurface Irradiance (1.1 m)
- FLNTUS – Chlorophyll and Turbidity
- FLCDS – CDOM

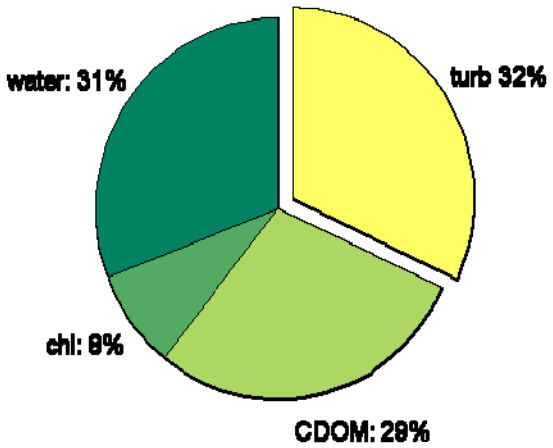
And much more……

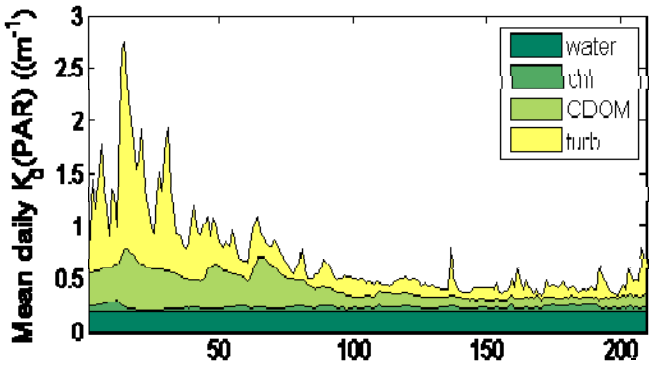
Buoy relationship –PAR



$$\frac{K_d(PAR)}{D_o} = 0.2449 + 0.0188.[Chl] + 0.0101.[CDOM] + 0.0784.[NAP]$$

$r^2 > 0.95$



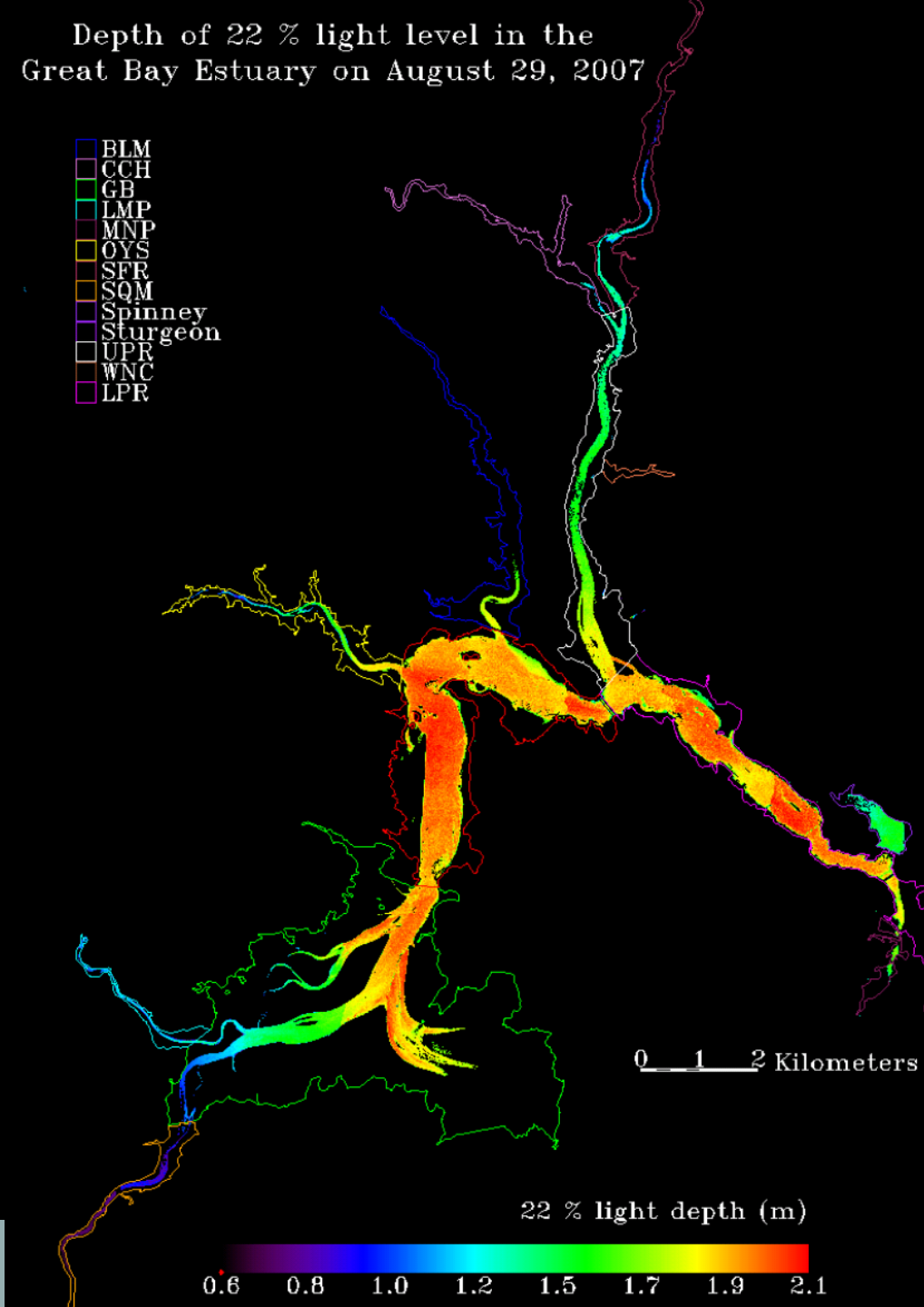


150
HONDA

0 1 2 Kilometers
Kd(PAR) (1/m)
0.5 0.7 0.9 1.2 1.4 1.6 1.8 2

Eelgrass Survival Depth.

$$z_{survive} = \frac{\ln(22/100)}{K_d(PAR)}$$

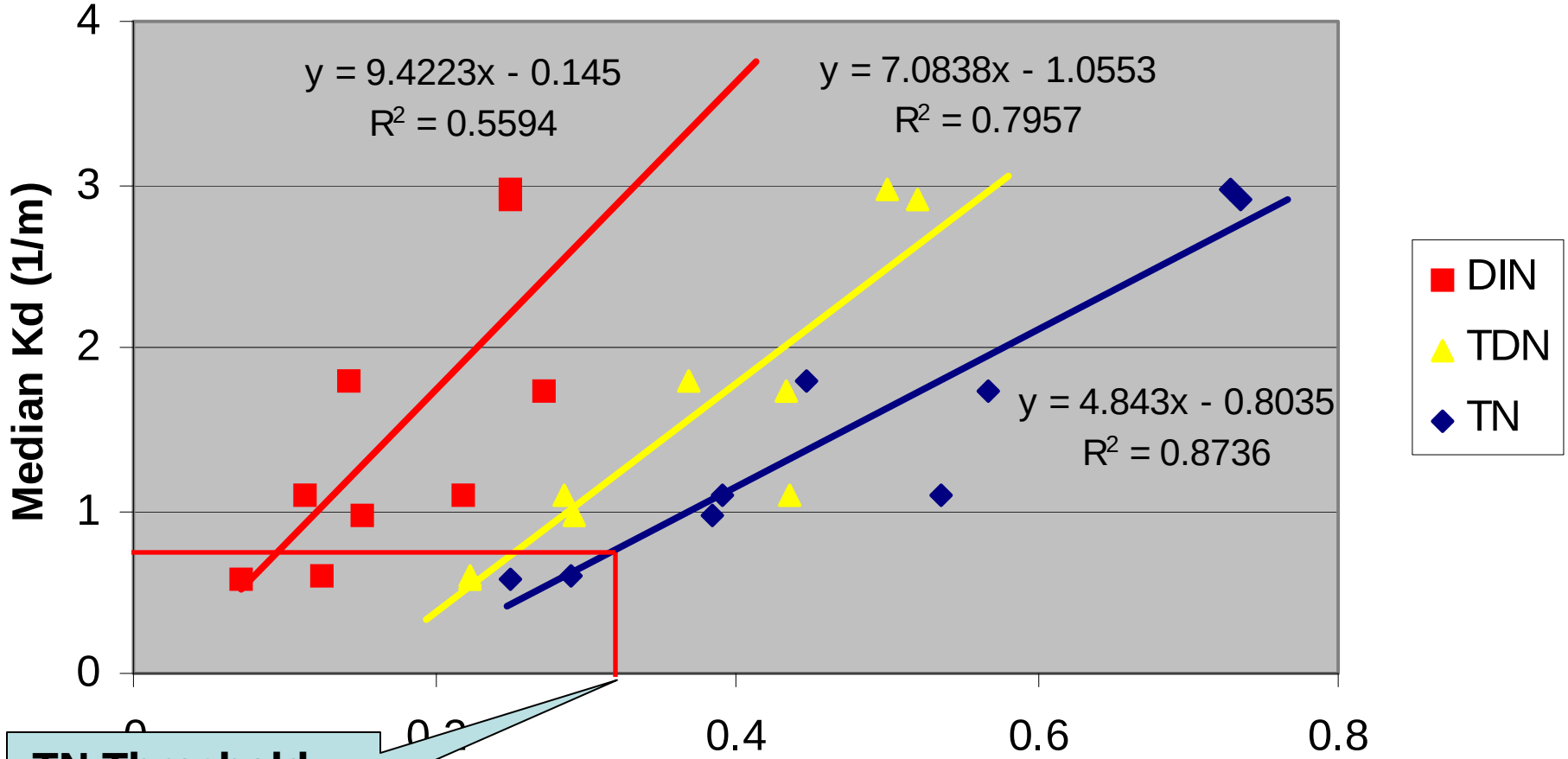


Great Bay Eelgrass & Macroalgae

Eelgrass

Macroalgea

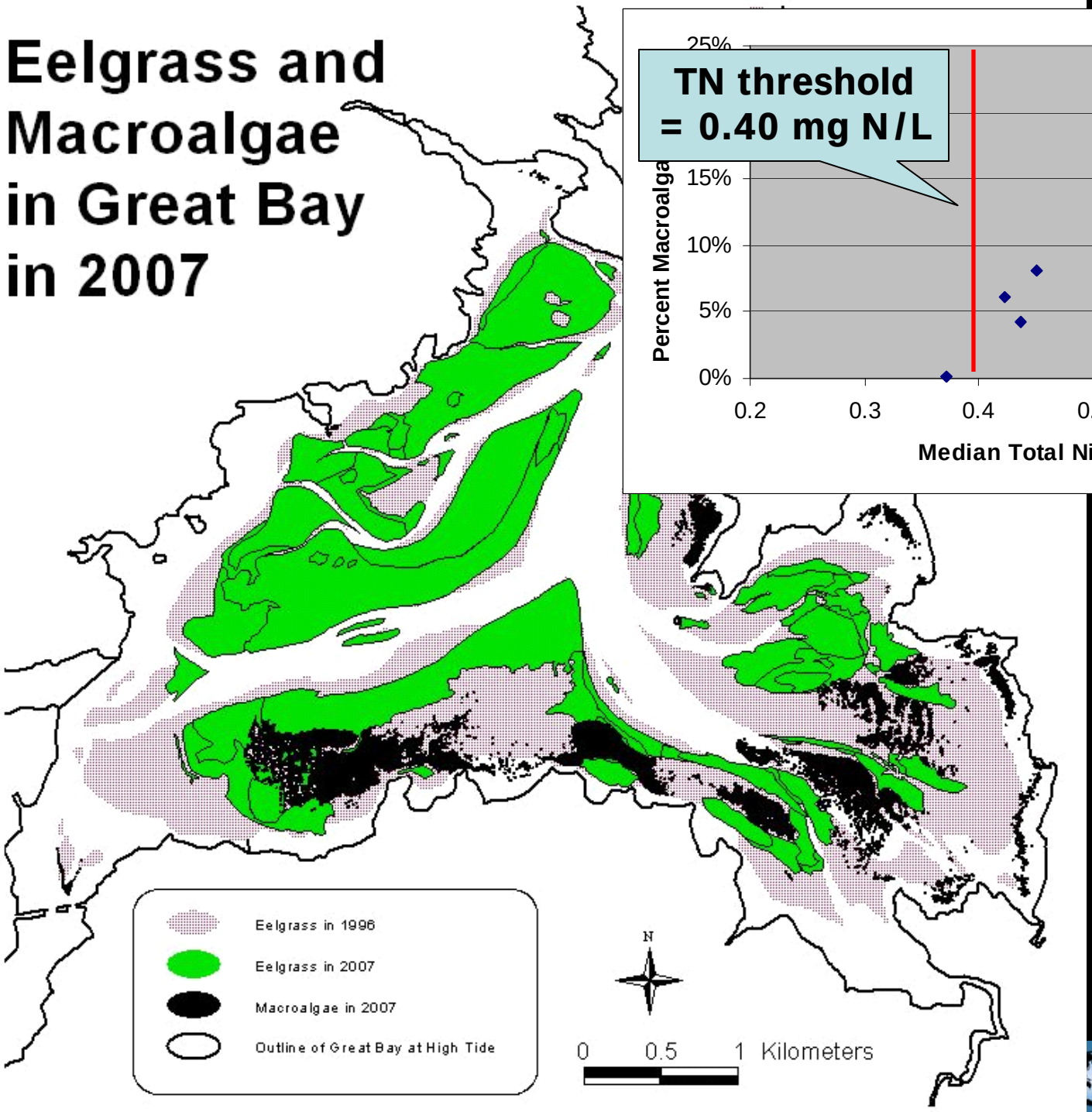
Water Clarity Decreases with Increasing Nitrogen Concentrations

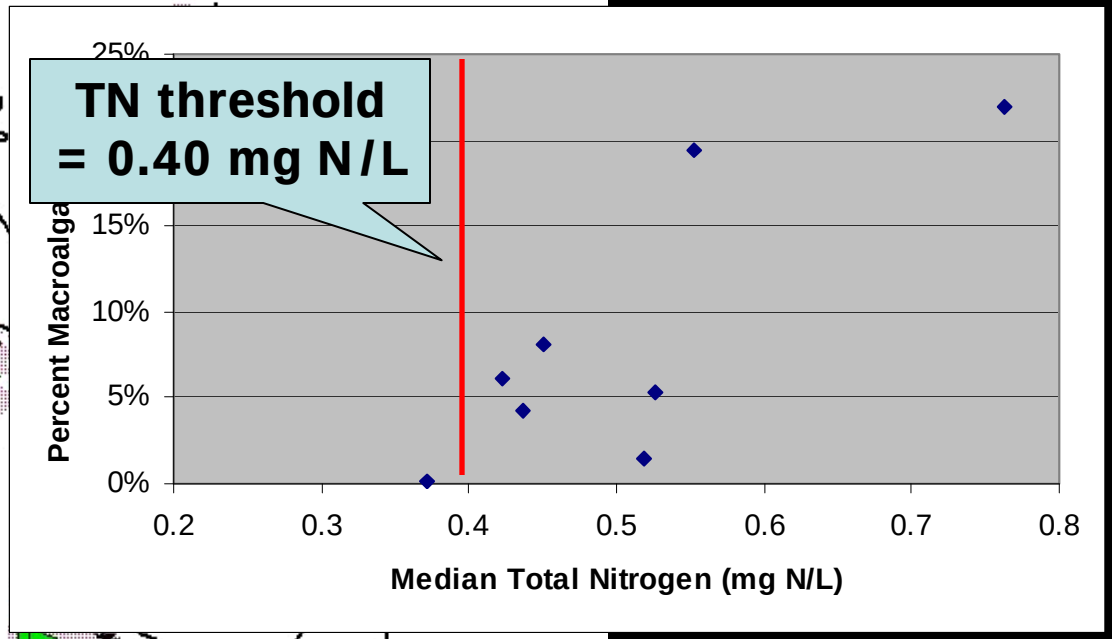


TN Threshold = 0.32 mg N/L

N>12 ex. six TDN points with N=9-10, one Kd point with N=7

Eelgrass and Macroalgae in Great Bay in 2007





Median TN in Great Bay = 0.42 mg N/L

An Area with Obvious Macroalgae Proliferation

From Pe'eri et al. (2008)

Nutrient Criteria to Prevent Eelgrass Loss

- Maximum light attenuation coefficient to maintain eelgrass
  - Kd = 0.75 (1/m)
- TN associated with Kd threshold from regressions
  - TN = 0.32 mg N/L
- Macroalgae proliferation
  - No problems for TN<0.40 mg N/L
- Ocean background
  - TN = 0.24 mg N/L
- Reference concentration where eelgrass still exists (Portsmouth Hbr)
  - TN = 0.32 mg N/L (75th percentile)
- TN thresholds set for other estuaries in NE
  - TN = 0.35-0.38 mg N/L (Mass. Estuaries Project, Nantucket Sound)
- Weight of evidence threshold
  - TN threshold for eelgrass in GBE = 0.32 mg N/L

Outcomes - Proposed Numeric Nutrient Criteria for the Great Bay Estuary

Designated Use / Regulatory Authority	Parameter	Threshold	Statistic	Comments
Primary Contact Recreation [1] (Env-Wq 1703.14)	Chlorophyll-a	20 ug/L	90th percentile during summer	Applies to all areas of the Great Bay Estuary
Aquatic Life Use Support – to protect Dissolved Oxygen [1] (RSA 485-A:8)	Total Nitrogen	0.45 mg N/L	Median	Applies to all areas of the Great Bay Estuary
	Chlorophyll-a	12 ug/L	90th percentile during summer	
Aquatic Life Use Support – to protect Eelgrass [1,2] (Env-Wq 1703.14)	Total Nitrogen	0.32 mg N/L	Median	Portsmouth Harbor, Little Harbor, Piscataqua River, Great Bay, Little Bay, and areas of tidal tributaries where eelgrass has existed in the past
	Light Attenuation Coefficient (Water Clarity)	0.75 m^{-1}	Median	

Outcomes - Management Implications for Nitrogen Impairments

- NPDES permitted sources for nitrogen must hold their loadings at the existing levels (e.g., WWTFs, MS4s).
- New permitted sources (e.g., AoT or CGP permittees) within the upstream watershed of an impaired waterbody would have to demonstrate zero additional loads of nitrogen or arrange for trading within the watershed.
- The “hold the load” restriction would continue until a TMDL is completed, at which point the load allocations from the TMDL would become effective. The TMDL allocations will likely require reductions in loading.

Acknowledgements

Thanks to:

- Mike Novak, Anna Brook, Tom Gregory, Paul Currier
- All those who collected the historical data
- Dave Shay and the faculty and staff of Jackson Estuarine Laboratory
- Chris Hunt and Shawn Shelito for help with the flow through measurements
- The captain and crew of the R/V Gulf Challenger
- Rich Lagan and Jon Pennock, University of New Hampshire
- Darrell Adams, Cyril Dempsey, and all at Satlantic Inc.
- Andrew Barnard, Ian Walsh, Alex Derr, Ron Zaneveld and all at WET Labs, Inc.
- EPA and NOAA for the funding
- NHEP and NHDES
- SpecTIR who flew the HS mission