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

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Water Quality Issue

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

- NWQMC
- April 28
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
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

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

\[r^2 > 0.95\]
Eelgrass Survival Depth.

\[ z_{\text{survive}} = \frac{\ln(22/100)}{K_d(PAR)} \]
Great Bay Eelgrass & Macroalgae
Water Clarity Decreases with Increasing Nitrogen Concentrations

\[ y = 9.4223x - 0.145 \]
\[ R^2 = 0.5594 \]

\[ y = 7.0838x - 1.0553 \]
\[ R^2 = 0.7957 \]

\[ y = 4.843x - 0.8035 \]
\[ R^2 = 0.8736 \]

Median Nitrogen (mg N/L)

Median Kd (1/m)

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
  - \( K_d = 0.75 \ (1/m) \)
- TN associated with \( K_d \) 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 (75\(^{th}\) 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

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