Why an Update?

Expected Change 1990s to 2020

- Unknown (0)
- No Change (32)
- Worsen (62)
- Improve (6)

(as percent of 139 US systems)

http://www.eutro.us  http://ian.umces.edu/neea
We Need You!!

To:

- Enter data for US systems
- Develop:
  - regional and national summaries
  - recommendations for monitoring, research and management
  - a national strategy to address nutrient related water quality problems

http://www.eutro.us
http://ian.umces.edu/neeaa
### The Problem – The Assessment Approach

#### Symptoms and Consequences of Nutrient Enrichment

<table>
<thead>
<tr>
<th>Nutrient Inputs and Processing</th>
<th>Primary Impacts</th>
<th>Secondary Impacts</th>
<th>Consequences of Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased N and P concentration</td>
<td>High algal production (Chl)</td>
<td>Loss of SAV</td>
<td>Fish kills</td>
</tr>
<tr>
<td></td>
<td>Loss of water clarity</td>
<td>Low D.O</td>
<td>Loss of habitat</td>
</tr>
<tr>
<td></td>
<td>Epiphyte problems</td>
<td>Nuisance/Toxic blooms (HABs)</td>
<td>Human health risks</td>
</tr>
<tr>
<td></td>
<td>Macroalgal problems</td>
<td></td>
<td>Loss of tourism</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Closed fishing grounds</td>
</tr>
</tbody>
</table>

**ASSETS: Pressure - State - Response**

- **P:** Influencing Factors – Natural processing + Human Nutrient Load
- **S:** Overall Eutrophic Condition – Condition of waterbody
- **R:** Future Outlook – What will happen in the future?

http://www.eutro.us  
http://ian.umces.edu/neea
The NEEA approach may be divided into three parts:

- Division of estuaries into homogeneous areas
- Evaluation of data completeness and reliability
- Application of indices

Tidal freshwater (<0.5 psu)
- Mixing zone (0.5-25 psu)
- Seawater zone (>25 psu)

Spatial and temporal quality of datasets (completeness)
Confidence in results (sampling and analytical reliability)

Overall Eutrophic Condition index
Influencing Factors index
Future Outlook index
ASSETS combined rating
Indicators and Criteria

Susceptibility:
- Flushing (tide ht, FW inflow/Est volume)
- Dilution (Stratification, Dilution volume)

Nutrient Inputs:
- from watershed, and ocean (ratio watershed/oceanic)

Waterbody Condition:
Primary symptoms
- chlorophyll a (90th percentile, spatial, frequency occurrence)
- macroalgae (detrimental impact to biology)

Secondary symptoms
- dissolved oxygen (10th percentile, spatial, frequency, occurrence)
- HAB occurrence (nuisance or toxic; duration, frequency occurrence)
- seagrass spatial distribution (change)

secchi (10th percentile)
Data Sources and Issues

Who?
State / Federal Agencies
Universities
Non-Profit Organizations
Citizen Groups
(400+ participants in NEEA)

What?
Long-term monitoring studies
Several year academic projects
One time sampling efforts

How?
Survey questionnaire
Web accessible database
Literature search
Site visit

Long Island Sound Study
Since 1991
Monthly samples
20 stations

Narragansett Bay Study
Since 1996
Daily (DO) Index pd sample
3 stations

Chl a since 2001
Monthly (Chl a) Index pd sample
27 stations
Influencing Factors

Susceptibility + Nutrient Inputs = Overall Human Influence

dilution & flushing
land based or oceanic

Overall Human Influence

Moderate

Low

Moderate

Moderate

Low

High

Moderate

High

Low

Moderate

Low

High

Moderate

Low

Nutrient Pressures
Overall Eutrophic Condition

NEEA Methodology

1) Determine **Chl a, macroalgae, D.O., SAV loss and HABs** condition for each zone (conc/observance, spatial coverage, frequency of occurrence)

2) Determine expression for primary (average symptom values) and secondary (highest symptom value)

3) Combine primary and secondary for estuary condition

\[ S_l = \sum_{i=1}^{n} \left( \frac{A_z}{A_e} E_l \right) \]

Where:
- \( A_z \): Surface area of zone
- \( A_e \): Total estuarine surface area
- \( E_l \): Expression value at each zone
- \( n \): Number of estuarine zones

- Level of expression is based on data, cumulative frequency (Chl a = 90th percentile; DO = 10th percentile); hueristic for HABs, macroalgae; spatial coverage for seagrasses
- GIS or GRID: Spatial area determined by GIS or Grid
### Overall Eutrophic Condition

**e.g. Decision/Logic Example for Chl a**

<table>
<thead>
<tr>
<th>IF</th>
<th>AND</th>
<th>AND</th>
<th>THEN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concentration</strong></td>
<td><strong>Spatial Coverage</strong></td>
<td><strong>Frequency</strong></td>
<td><strong>Expression</strong></td>
</tr>
<tr>
<td><strong>Hypereutrophic</strong></td>
<td>High</td>
<td>Periodic</td>
<td>High</td>
</tr>
<tr>
<td>or</td>
<td>Moderate</td>
<td>Periodic</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
<td>Periodic</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Very Low</td>
<td>Periodic</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Episodic</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>Episodic</td>
<td>Moderate</td>
</tr>
<tr>
<td>Low/Very Low</td>
<td>Episodic</td>
<td>Low</td>
<td>0.25</td>
</tr>
<tr>
<td>Any Spatial Coverage</td>
<td>Unknown</td>
<td>Flag A</td>
<td>0.5</td>
</tr>
<tr>
<td>Unknown</td>
<td>Any Frequency</td>
<td>Flag A</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Flags are used to identify impacts for which not enough data was available for the components. In these cases, assumptions were made based on conservative estimates that unknown spatial coverage is at least 10 percent of the zone, unknown duration is at least days, and unknown frequency is at least episodic.
Overall Eutrophic Condition

Primary symptoms: average of values for Chl a and macroalgae

Secondary symptoms: highest or worst impact is selected using a precautionary approach
Future outlook is based on susceptibility and projected changes in nutrient pressures:

**Susceptibility** is the capacity of a system to dilute or flush nutrients.

**Nutrient pressure** changes are based on expected population changes, future treatment and remediation plans and changes in watershed use (particularly agricultural).
# Influencing Factors

<table>
<thead>
<tr>
<th>Region</th>
<th>Human Influence (M – H)</th>
<th>&gt;50% NPS</th>
<th>Primary NPS from Ag*</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Atlantic (18)</td>
<td>33</td>
<td>78</td>
<td>0</td>
</tr>
<tr>
<td>Mid Atlantic (22)</td>
<td>100</td>
<td>91</td>
<td>60</td>
</tr>
<tr>
<td>So. Atlantic (22)</td>
<td>81</td>
<td>100</td>
<td>81</td>
</tr>
<tr>
<td>Gulf of Mexico (38)</td>
<td>95</td>
<td>100</td>
<td>85</td>
</tr>
<tr>
<td>Pacific (39)</td>
<td>82</td>
<td>89</td>
<td>50</td>
</tr>
<tr>
<td>US Total (139)</td>
<td>68</td>
<td>92</td>
<td>56</td>
</tr>
<tr>
<td>Portugal (10)</td>
<td>30</td>
<td>89</td>
<td>67</td>
</tr>
<tr>
<td>China (4)</td>
<td>75</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

as percentage of systems

US from SPARROW model estimates, PT from Ferreira et al 2003

*for US: >30% though most are >70% from ag, for PT: ag is most significant nonpt source
Overall Eutrophic Conditions

http://ian.umces.edu/neea
Future Outlook

- Unknown
- No Change
- Worsen
- Improve

Countries:
- Spain
- China

Regions:
- Tagus
- Sado
- Mira
- Ria Formosa
- Mondego
- Douro
- Ria de Aveiro
- Minho
- Lima
- Guadiana
- Formosa
## ASSETS Synthesis

<table>
<thead>
<tr>
<th>Level</th>
<th>US</th>
<th>PT</th>
<th>CN</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Good</td>
<td>19</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Moderate</td>
<td>28</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>53</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Bad</td>
<td>18</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>19</td>
<td>4</td>
<td></td>
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</table>
# Changes 1990 – 2004*

<table>
<thead>
<tr>
<th></th>
<th>Chl</th>
<th>Macroal</th>
<th>DO</th>
<th>SAV</th>
<th>HABs</th>
<th>Overall Conds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narragansett Bay</td>
<td>W</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>Long Island Sound</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barnegat Bay</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td>NC</td>
</tr>
<tr>
<td>Chincoteague Bay</td>
<td>W</td>
<td></td>
<td>I</td>
<td>W</td>
<td>W</td>
<td>W</td>
</tr>
<tr>
<td>MD Coastal Bays</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NC</td>
</tr>
<tr>
<td>Patuxent River</td>
<td></td>
<td></td>
<td>W</td>
<td></td>
<td></td>
<td>NC</td>
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<tr>
<td>Potomac River</td>
<td></td>
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<td>I</td>
<td></td>
<td>W</td>
<td>NC</td>
</tr>
<tr>
<td>Indian River Lagoon</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td>W</td>
<td>NC</td>
</tr>
<tr>
<td>Biiscayne Bay</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>Charlotte Harbor</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tampa Bay</td>
<td></td>
<td></td>
<td>W</td>
<td>W</td>
<td></td>
<td>NC</td>
</tr>
<tr>
<td>Apalachicola</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mobile Bay</td>
<td></td>
<td></td>
<td>I</td>
<td>W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hood Canal</td>
<td>W</td>
<td></td>
<td>W</td>
<td></td>
<td></td>
<td>W</td>
</tr>
</tbody>
</table>

*These are preliminary results from the National Estuarine Eutrophication Assessment Update

W = worsen  I = Improve  NC = No Change  blank = No Change or Unknown
Future Updates and other Activities

National and International partnerships to develop:

- Type Classification
- Improved Assessment Method
- Human Use/Socioeconomic Assessment Method
- Predictive capability
- Tools/Recommendations for Research and Management
- Periodic update reports (every 2 years? every 5 years?)
Evaluation of required response
Monitoring, Research, Management

Evaluation of State based on eutrophic symptoms

Assess drivers i.e. source apportionment, apply management measures

Determine (a) Pressures (b) Modifications to improve State

Nutrients
Sewage
Industry
Agriculture
Atmosphere

Trend analysis

Relate Pressure to State i.e. Modeling, type comparison

Response
No change
Better
Worse

Response
No change

Verify change in pressures

Make changes (i.e. implement measures)

Anthropogenic

Interdiction, mitigation, enforcement

Natural

Monitor state

High
Good
Moderate
Poor
Bad

High
Good
Moderate
Poor
Bad

Nutrients
Sewage
Industry
Agriculture
Atmosphere