EXHIBIT 10 (AR L.3)

National Oceanic and Atmospheric Administration

Experts from the Pacific Coast region add and evaluate data at the National Estuarine Eutrophication Assessment Update Workshop. More than 50 experts attended the workshop to share data and review the Update's procedures and products.

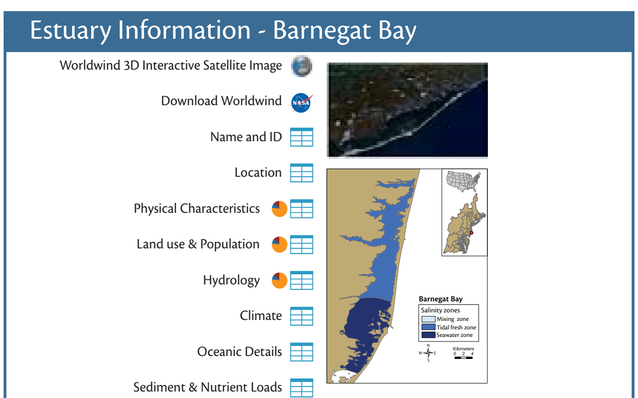
measured and diagnostic indicators available for describing eutrophic changes in different systems.

If participants wish to analyze their own data, they can enter data by using the instructions provided on the website. Once the data have been entered, the survey automatically calculates the expression values for each indicator and the overall eutrophic condition (see *Chapter 2: Approach*). The website then generates graphics of the results, which can be downloaded from the site. Thus, participants can retrieve site-specific information based on the data entered (Figure 1.4a,b).

The survey automatically generates several additional graphics for participants. These include a summary page with printable graphics and a conceptual diagram illustrating the conditions in the participant's system (Figure 1.4a, b). In addition to improving the survey with the online tool, the survey has also been enhanced by increased accessibility. This update and future assessments will be available online at *ian.umces.edu/neea* or *www.eutro.us*. Online access enables a greater number of experts to participate, and also facilitates periodic updates of the assessment in the future (every two to five years).

Access resource library

c.



Physical Characteristics

Parameter	Value	Metadata
Estuary Area (km^2)	182	Estuary area, calculated from NOAA shapefiles
Tidal Fresh Zone (km^2)	0	Tidal Fresh area, calculated from NOAA shapefiles
Mixing Zone Area (km^2)	99	Mixing Zone area, calculated from NOAA shapefiles
Saltwater Zone Area (km^2)	83	Saltwater area, calculated from NOAA shapefiles
Tidal Fresh Blackwater	No	Refers to whether the Tidal Fresh Zone in this estuary is considered to be Blackwater
Mixing Zone Blackwater	No	Refers to whether the Mixing Zone in this estuary is considered to be Blackwater
Seawater Blackwater	No	Refers to whether the Seawater Zone in this estuary is considered to be Blackwater
Estuary Volume (m^2)	118300000	Best estimate of volume from digital bathymetric chart if available; otherwise NOAA planimetry
Estuary Depth (m)	0.65	From digital athymetric chart if available; otherwise NOAA

Resource library

In addition to collecting data, the online tool provides participants with a library of resources they can download and use for their analyses. For example, participants can download estuary information such as physical and hydrologic data, salinity zone and remote sensing maps, land use statistics, and other descriptive data for context (Figure 1.4c). Participants also can refer to previous eutrophication and water quality reports such as the *National Estuarine Eutrophication Assessment 1999* (Bricker et al. 1999) and the *State of Maryland's Coastal Bays* (Wazniak et al., 2004). Thus, the online tool provides a means for data collection, analysis, and distribution.

APPLICATION OF THE UPDATE

How is information generated by the update applied?

Information about eutrophic status:
- Provides a basis for management action;
- Tracks the success of management strategies; and
- Identifies the possible causes of eutrophication, and potential solutions.


National Oceanic and Atmospheric Administration

NEEA updates can help develop sound management strategies such as the wetlands restoration project shown here. After the new stalks of *Spartina* are planted in a vulnerable estuary in coastal Louisiana, they will help to improve water quality and increase shoreline stability.

This in-depth look at the present trophic status of the Nation's coastal systems and changes since the 1999 assessment provides a basis for the sound management of precious coastal resources. Future updates will track the successes of management strategies by monitoring changes and trends in the trophic status of systems.

The 1999 assessment concluded that estuarine eutrophication is indeed a problem of national significance. The original study indicated that human-related nutrient sources, both nearby and far removed, are substantial contributors to eutrophic conditions within estuaries. Furthermore, many estuarine watersheds cross state boundaries, requiring regional, subregional, and interagency cooperation. Similarly, there are many important needs with regard to research, monitoring, and assessment that call for a cogent national strategy. In many instances, eutrophication research has been conducted on a parochial and piecemeal basis, which can impede rapid advances in scientific understanding of the linkages between eutrophication and marine resources. A strategy is needed to address these problems, especially one that effectively integrates watershed-specific approaches to assessment and management into a comprehensive approach.

The results of this update should be used to help better focus national attention on existing and emerging priority areas for action. The framework incorporates the overall eutrophic condition of an estuary, its natural susceptibility to retain nutrients and develop related problems, and the level of nutrient inputs. This information will help to set priorities for successful management.

The report is organized to describe the approach and methods used for the assessment (Chapter 2) and the results on a national (Chapter 3) and regional (Chapter 4) basis. Chapter 5 is a collection of case studies highlighting the different manifestations of coastal eutrophication in systems in the United States, Europe, China, and Australia. Chapter 6 describes the ongoing improvements to the assessment methods. Finally, Chapter 7 describes the recommended research, monitoring, and management actions to be taken, given the results of the assessment.

EXHIBIT 10 (AR L.3)

2. APPROACH

EVALUATING EUTROPHICATION

How do we evaluate eutrophication?

The eutrophic condition of a system is evaluated by examining the following three components:

- **Influencing factors:** physical, hydrologic, and anthropogenic.
- **Overall eutrophic condition:** derived from data for five eutrophic symptoms (Figure 2.2).
- **Future outlook:** expected changes in the system.

These components are then combined to provide a single rating for the estuary, called ASSETS.

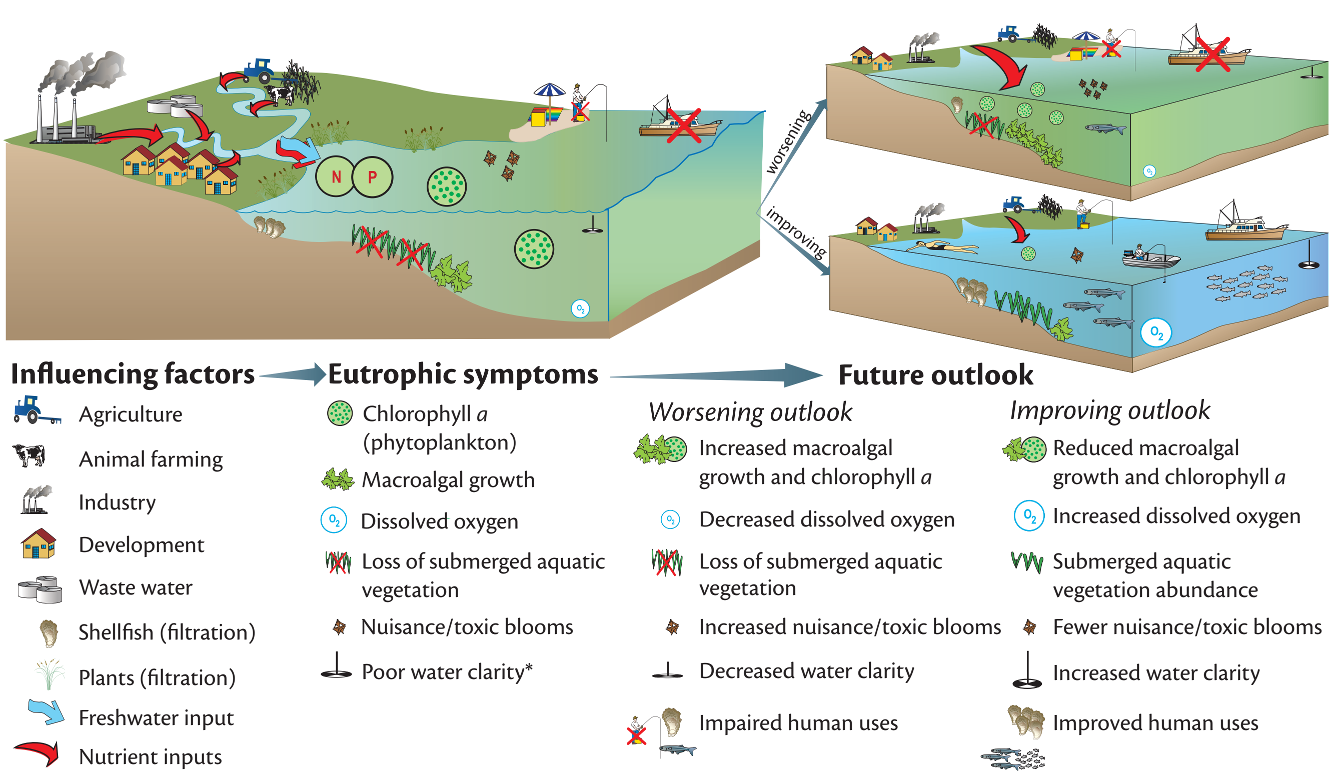
Influencing factors

In order to provide a sound basis for coastal resource management, this assessment evaluates the factors that influence water quality (Figure 2.1). This evaluation requires the inclusion of national data sets such as physical and hydrologic characteristics and nutrient loading. Influencing factors help establish a link between a system's natural sensitivity to eutrophication and the nutrient loading and eutrophic symptoms actually observed. This understanding also helps illustrate the relationship between eutrophic conditions and use impairments.

Overall eutrophic condition

The assessment of a system's eutrophic condition is based on a compilation of information for five water quality variables related to nutrient enrichment (Figure 2.2). The data set includes concentration or occurrence of problem conditions, and also characteristics such as duration, spatial coverage, frequency of occurrence of observed conditions, and data confidence. An increase in two of the primary symptoms—chlorophyll *a* (phytoplankton biomass) and macroalgal abundance—represents the first possible stage of water quality degradation associated with eutrophication. In the 1999 assessment, epiphytes were also used as a primary symptom indicator (Bricker et al. 1999). However, they have been omitted from the current assessment due to the lack of a standard measure and data availability (Bricker et al. 2006, Scavia and Bricker 2006). The three secondary symptoms represent more serious impacts: low dissolved oxygen levels, loss of submerged aquatic vegetation, and occurrences of nuisance/toxic algal blooms. Nutrient concentrations are not used because they reflect the net biological, physical, and chemical processes such that even a severely degraded water body may exhibit low

Figure 2.1. The NEEA update evaluates influencing factors, eutrophic symptoms, and future outlook for the system.



*A symptom not included in rating system

Figure 2.2. A description of the eutrophic symptoms included in this assessment.

Primary symptoms	Description
Chlorophyll *a* (Phytoplankton)	A measure used to indicate the amount of microscopic algae (phytoplankton) growing in a water body. High concentrations can lead to low dissolved oxygen levels as a result of decomposition.
Macroalgal blooms	Large algae commonly referred to as "seaweed." Blooms can cause losses of submerged aquatic vegetation by blocking sunlight. Additionally, blooms may smother immobile shellfish, corals, or other habitat. The unsightly nature of some blooms may impact tourism due to the declining value of swimming, fishing, and boating.
Secondary symptoms	**Description**
Dissolved oxygen	Low dissolved oxygen is a eutrophic symptom because it occurs as a result of decomposing organic matter (from dense algal blooms), which sinks to the bottom and uses oxygen during decay. Low dissolved oxygen can cause fish kills, habitat loss, and degraded aesthetic values, resulting in the loss of tourism and recreational water use.
Submerged aquatic vegetation	Loss of submerged aquatic vegetation (SAV) occurs when dense algal blooms caused by excess nutrient additions (and absence of grazers) decrease water clarity and light penetration. Turbidity caused by other factors (e.g., wave energy, color) similarly affects SAV. The loss of SAV can have negative effects on an estuary's functionality and may impact some fisheries due to loss of a critical nursery habitat.
Nuisance/toxic blooms	Thought to be caused by a change in the natural mixture of nutrients that occurs when nutrient inputs increase over a long period of time. These blooms may release toxins that kill fish and shellfish. Human health problems may also occur due to the consumption of contaminated shellfish or from inhalation of airborne toxins. Many nuisance/toxic blooms occur naturally, some are advected into estuaries from the ocean; the role of nutrient enrichment is unclear.

concentrations due to uptake by phytoplankton and macroalgae. Conversely, a relatively healthy system might have high nutrient concentrations due to low algal uptake as a result of light-limiting turbid waters, or may simply flush nutrients so quickly that phytoplankton do not have the opportunity to bloom extensively. For these reasons, nutrient concentrations may not serve as accurate indicators.

In many estuaries, primary symptoms lead to more serious secondary symptoms, including low dissolved oxygen, loss of submerged aquatic vegetation (SAV), and nuisance/toxic blooms. In some cases, secondary symptoms can exist in the estuary without originating from primary symptoms. This occurs in many North Atlantic estuaries, where toxic algal blooms are transported into the system from the coastal ocean. Such systems were consequently given a lower rating for nuisance/toxic blooms. Low ratings were also used because it is unclear whether offshore nuisance/toxic algal blooms grow and are maintained as a result of land-based nutrient sources (an increasing problem, regardless of bloom origin).

Future outlook

The assessment also evaluates the future outlook for a system to try to forecast national trends over long periods of time. In this update, future outlook combines the susceptibility of a system and the predicted future nutrient loads to determine whether conditions will worsen or improve. In addition, recommendations for potential management responses to eutrophication were developed from conclusions based upon the evaluation of influencing factors and future outlook.

Primary and secondary symptoms

Primary symptoms (phytoplankton and macroalgal abundance) represent the first possible stage of water quality degradation due to eutrophication. Because short-term nutrient measurements are highly variable, nitrogen and phosphorus concentrations cannot be used as a measure of eutrophication.

Secondary symptoms often represent a more advanced stage of eutrophication. In some cases, secondary symptoms can exist without the presence of primary symptoms.

DETERMINING INFLUENCING FACTORS

How are influencing factors evaluated?

The influencing factors for a system take into account both the natural characteristics of, and human impacts to systems. They are determined by calculating susceptibility and nitrogen load:

- Susceptibility is a measure of a system's nutrient retention based upon flushing and dilution.
- Nitrogen loads are the amount of nitrogen input to a system. For influencing factors, nitrogen loads are estimated as a ratio between ocean and land inputs (see pages 12-13).

Jane Thomas, University of Maryland Center for Env. Science

Flushing, one of the components of susceptibility, refers to an estuary's ability to move freshwater out to the ocean. Above, waters of different salinities mix in Ocean City Inlet, Maryland.

Susceptibility

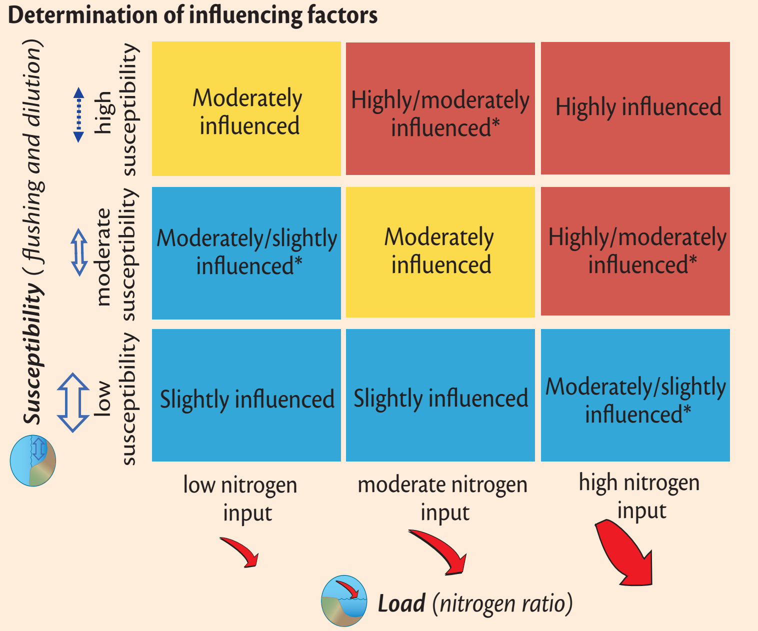
Susceptibility is an estimate of the natural tendency of an estuary to retain or flush nutrients. In general, susceptibility is influenced by the flow of water. The flushing capability of a system is determined by tidal action and the amount of freshwater flowing in from its tributaries. In most cases, if the water (and therefore nutrients) are flushed quickly, there is insufficient time for eutrophic symptoms to develop (i.e., low susceptibility). However, if the estuary has a long residence time, there is time for nutrients to be taken up by algae and for blooms to develop. This assessment uses physical and hydrologic data to separately define dilution and flushing ratings. When combined, these produce a susceptibility rating.

In addition to evaluating influencing factors, susceptibility can be used to forecast not only the extent to which eutrophic symptoms may occur, but also what symptoms may potentially occur. For example, in some shallow lagoonal systems, additional nutrients will result in increased macroalgal abundance rather than high concentrations of phytoplankton/chlorophyll *a* (Nobre et al. 2005). A typology of these systems is being developed in order to increase projection accuracy by accounting for differences in how systems respond to nutrient inputs (see *Chapter 6*).

Calculating influencing factors

Overall, the impact of influencing factors for an estuarine system is determined by a matrix (figure at right). Several calculations were made to create the matrix. First, both susceptibility and load were determined for each estuary and placed in one of three categories: low, moderate, or high. The load refers to a ratio of land-based to oceanic nitrogen inputs, with a high rating indicating primarily land-based inputs (Bricker et al. 2003; Ferriera et al. 2007). The estuary's susceptibility and nutrient loads were compared in a matrix and given an influencing factors rating. For example, an estuary with low nutrient loads and moderate susceptibility is moderately/slightly influenced. Each of the systems in the survey can fall into one of five categories: slightly influenced, moderately/slightly influenced, moderately influenced, highly/moderately influenced, and highly influenced (see Bricker et al. 1999 for details).

Determination of influencing factors



Due to the uncertainty in loading estimates, moderately/slightly and slightly influenced have been combined to both be slightly influenced, and highly/moderately and highly influenced are combined to be highly influenced throughout the report (colors indicate grouping).

Nitrogen load

Nitrogen loads are the critical component for determining an influencing factors score. Although there are data for both nitrogen and phosphorus loads, only nitrogen is analyzed because it is typically the limiting nutrient in estuaries and coastal waters. However, it is known that in some systems or seasons phosphorus may be the limiting nutrient. While natural processes contribute some nitrogen inputs, for many systems, inputs are now mostly human-related, from concentrated point sources such as wastewater treatment, or non-point sources such as urban runoff, agriculture, and atmospheric deposition.

In this update, two sources are used for load estimates: the online survey entries and the Watershed Assessment Tool for Evaluating Reduction Strategies for Nitrogen model (WATERSN, see box at right). The online survey allowed experts to enter information regarding the magnitude and projected changes for nutrient loads. Results from the WATERSN model were used as a source of load data for systems where this information was not entered online.

The USGS SPARROW model (SPAtially Referenced Regressions On Watershed Attributes) load estimates (Smith et al. 1997) were used in the 1999 assessment but were unavailable for this study. A comparison of WATERSN and SPARROW results was made to determine the suitability of the WATERSN results for use here. When the SPARROW results (only base year 1987 available) were compared statistically with WATERSN model results (base year 1997), they were found to be significantly different. In general, the WATERSN estimates were higher than the SPARROW load estimates. The WATERSN results were compared statistically with the loads entered into the online survey by participants for 11 systems (only systems where both were available) and found to be not significantly different. Furthermore, the WATERSN estimates use a time frame similar to the data entered in the online survey and had a much more recent base year than the SPARROW estimates. Therefore, WATERSN estimates were used in areas where participants did not provide loads. Due to the change in load estimate methods between the two assessments, a trend analysis was not performed.

For this assessment, the loading component is estimated as the ratio of nitrogen coming from the land (i.e., human-related) to that coming from the ocean and is given a rating of low, moderate, or high (Bricker et al. 2003; Ferreira et al. 2007). For example, a high rating means that greater than 80% of the nutrient load comes from land, whereas a low rating signifies a land-percentage of less than 20%. This rating also provides insight into loading management, since loads to systems with primarily ocean-derived nitrogen are not easily controlled. Understanding the sizes of current and expected future loads provides further insight into the application and success of management measures.


Suzanne Bricker, NOAA

NEEA participants, experts from each region or system, contribute data to the NEEA website.

Determining load using the online survey and WATERSN estimates

Load estimates, when available, were contributed by participants who either attended the national workshop, or remotely accessed the NEEA online database. The most current loading estimates were used, though the methods for calculating loads may vary. The online survey offered the option of including estimates for dissolved inorganic nutrients or total nitrogen and phosphorus, to strengthen the resulting database with all available nutrient information for each estuary.

For those systems which had no available loading information, a model was used. The model, called WATERSN (Castro et al. 2001), provided loading data for 32 systems along the Atlantic and Gulf coasts. These loading estimates were based on watershed attributes, using 1997 as a base year for data.

After being compiled, the loading estimates were used to help determine the influencing factors of each individual system and to expand the depth of the NEEA database.