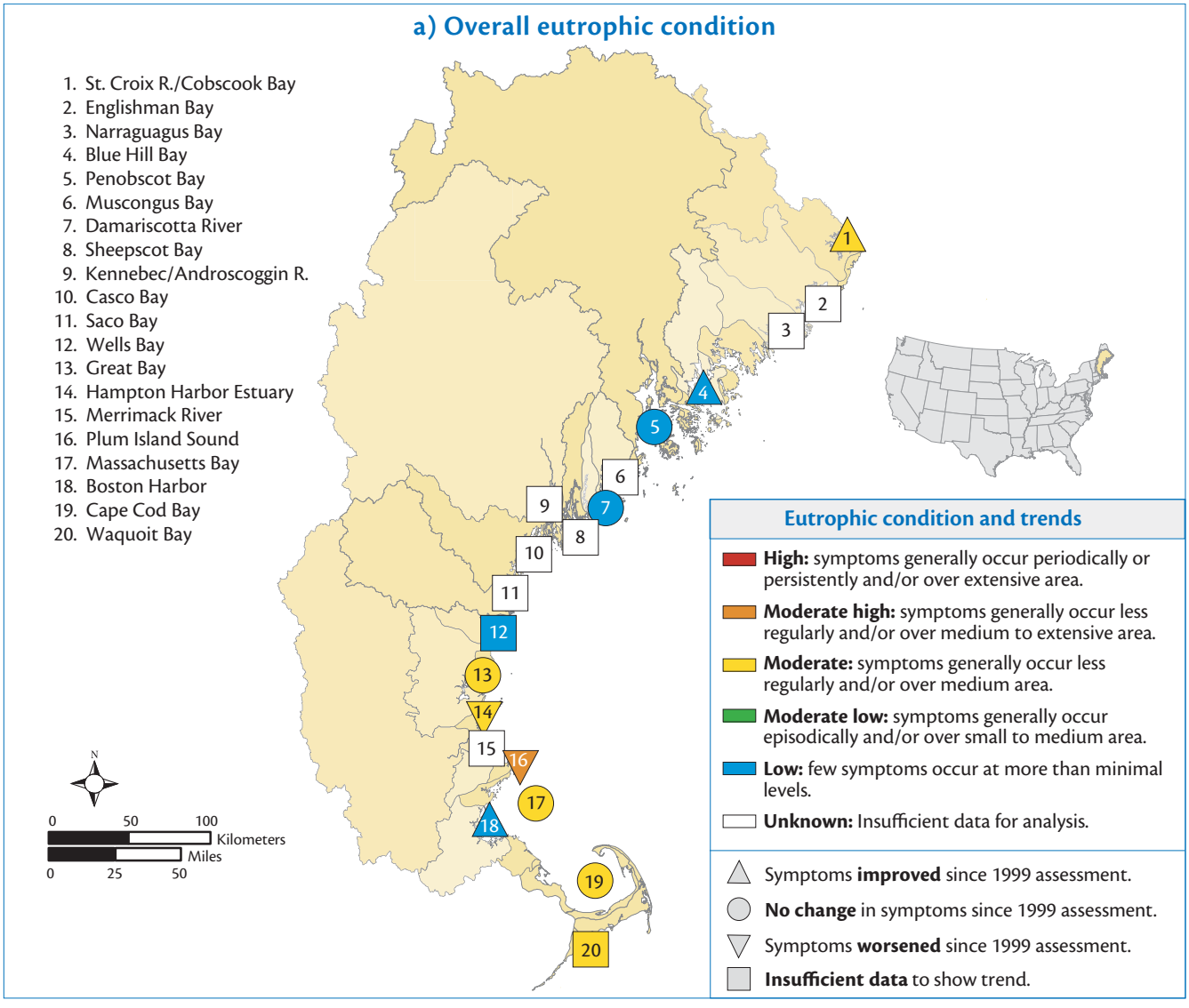
Overall eutrophic condition

- This is the least impacted region; no North Atlantic systems had high overall eutrophic condition (OEC).
- The majority of systems had a moderate or low OEC.
- There was some cause for concern for chlorophyll *a* and macroalgae.
- Toxic offshore blooms which leave cysts (potential future blooms) were an emerging issue.

The North Atlantic region is the least eutrophic region in the nation, with the majority of systems having moderate or low overall eutrophic condition (Figure 4.3a-b). Furthermore, no estuaries in this region recorded high overall eutrophic condition—a unique feature, as all other regions have at least one estuary with a high rating. One system was classified as having moderate high eutrophic conditions, with chlorophyll *a* and nuisance/toxic blooms as the major contributing symptoms.

One notable characteristic in systems of this region is the annual occurrence of nuisance/toxic blooms, which cause shellfish bed closures. However, for systems such as Massachusetts, Cape Cod, Saco, and Casco Bays, these blooms originate offshore and are advected into the systems. For this reason, the nuisance/toxic bloom rating for these systems has been adjusted to low since the blooms do not originate within the system. An emerging issue is the possibility that these blooms, mostly of *Alexandrium* spp., may eventually originate within estuaries, due to cysts that have settled in the estuarine sediments.

Figure 4.3. (a) Map of overall eutrophic condition (OEC) and (b) the combination of individual eutrophic symptoms which constitute OEC ratings in the North Atlantic region.



The overall confidence in the assessments for this region is low due to almost a third of the systems (eight) having inadequate data for assessment. Where data were available, confidence is moderate to high.

Eutrophic symptom expressions

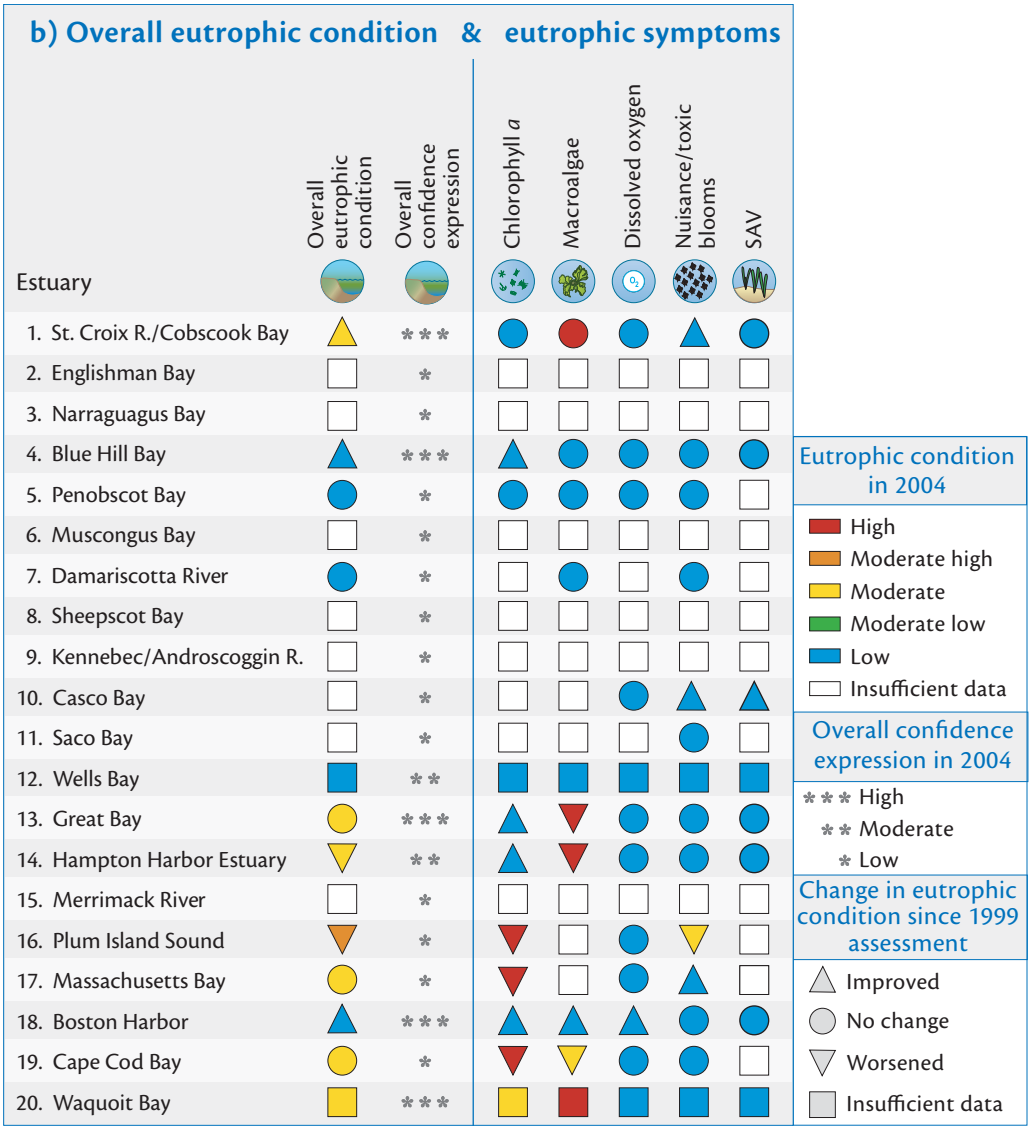
Systems with moderate or moderate high overall eutrophic condition were characterized by having one high symptom expression, which in this region was most often chlorophyll *a* and macroalgae.

While most estuaries had one high symptom expression, the majority of symptom expressions were low. For the primary symptoms, chlorophyll *a* was expressed as low in seven of the eleven estuaries for which the symptom was reported. Similarly, macroalgae symptom expressions were low in five of the ten reported estuaries. For the secondary symptoms, dissolved oxygen problems were low in all twelve systems, and losses of submerged aquatic vegetation (SAV) were low in all eight systems for which there were data.

Changes in eutrophic condition since the 1990s

Overall eutrophic conditions worsened in two systems, improved in three systems, and did not change in five when compared to the 1999 report (Figure 4.3a-b). Chlorophyll *a* changed in more systems than any of the other symptoms, showing improvements in four systems and worsening conditions in three systems. Of the data available, dissolved oxygen displayed the least amount of change.

Of particular interest is the improvement of eutrophic condition in Boston Harbor, which had moderate high eutrophic status in the 1990s, but currently has a rating of low. All symptom improvements were attributed to sewage treatment upgrades and the move of the wastewater outfall from the harbor into Massachusetts Bay.



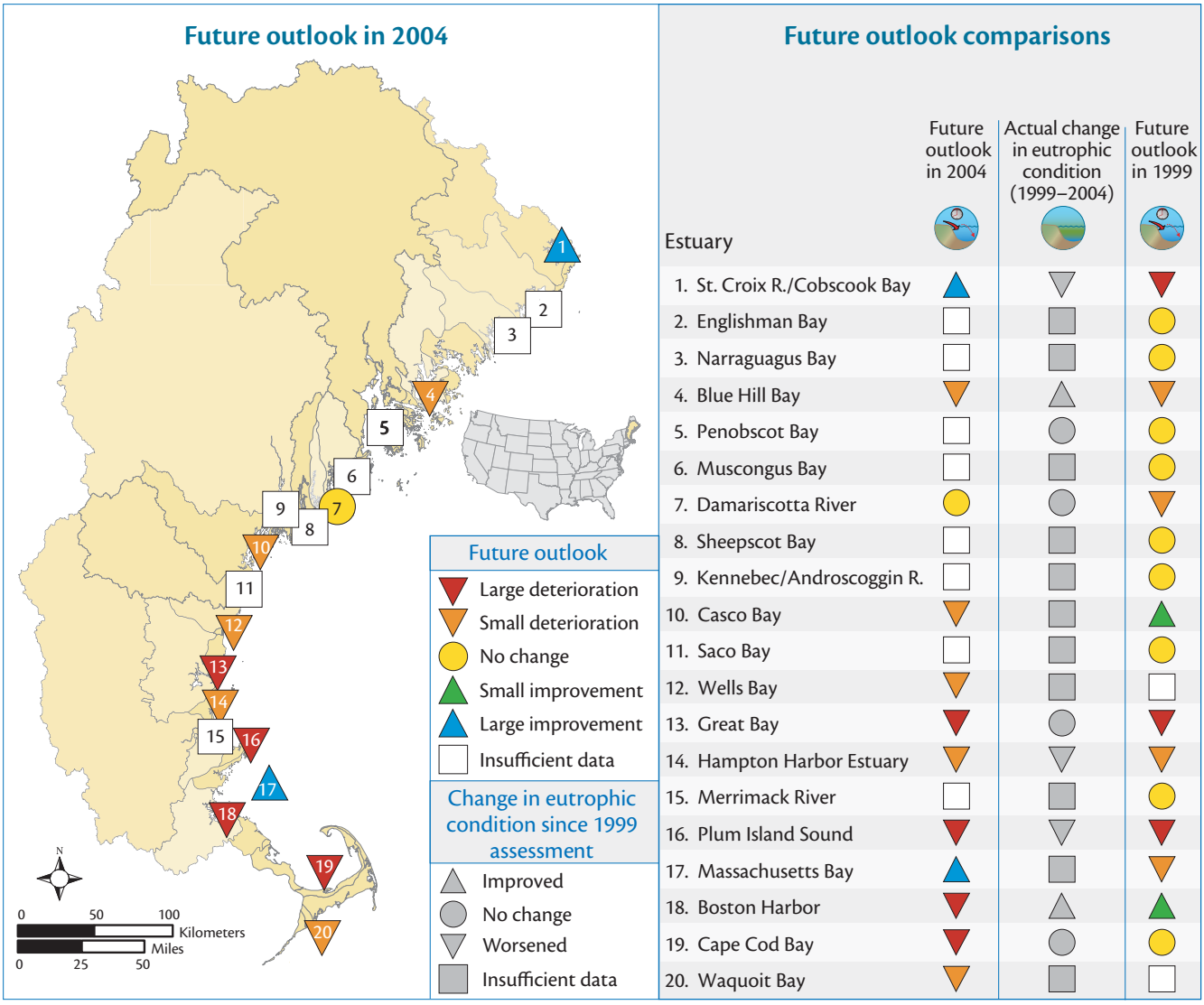
Future outlook

- There was a bleak outlook for future conditions; most systems for which an evaluation was made were expected to worsen in the future.
- The future outlook has not changed from the early 1990s.

The overall future outlook for the North Atlantic region predicts worsening conditions. Eutrophication symptoms were predicted to worsen in nine of the assessed systems and to improve in only two (Figure 4.4). For the nine systems expected to worsen, nutrient loads are anticipated to increase due to wastewater treatment, urban runoff, onsite septic tanks, combined sewer overflow (Cape Cod Bay only), atmospheric deposition, increasing impervious surfaces, and fertilizer use. For all systems, an increase in coastal population (affecting land use distribution and subsequent nutrient loads) is likely to augment nutrient loads from all of these sources.

Though it is premature to make conclusions about the accuracy of the 1999 assessment's future outlook, in six out of nine systems (for which comparison could be made), actual changes trended in the same direction as predicted. Worsening conditions due to increased nutrient loads are expected in Boston Harbor, Great Bay, Plum Island Sound, and Cape Cod Bay (Figure 4.4). Conversely, loads to St. Croix River/Cobscook Bay and Massachusetts Bay are expected to decrease due to improvements in onsite septic tanks, storm water management, restoration of eroding stream beds, and a reduction in salmon aquaculture. These changes are expected to occur by 2020.

Figure 4.4. Future outlook in 2004 and comparison with 1999 future outlook.



National Oceanic and Atmospheric Administration

Fishing boats tied up at the Portland Marine Trade Center in Portland, Maine. Monitoring use impairments is important to understanding how eutrophication influences commercial and recreational fishing.

Assessment of Estuarine Trophic Status (ASSETS)

There were seven systems for which an ASSETS rating (combination of influencing factors, overall eutrophic condition, and future outlook) could be made. Two systems were rated as good (Boston Harbor, Blue Hill Bay), four were rated as moderate (St. Croix River/Cobscook Bay, Great Bay, Massachusetts Bay, and Waquoit Bay), and one as poor (Plum Island Sound).

Impaired uses

- Three systems had impaired living resources.
- Causes of impairments were reported as river input, wastewater treatment, combined sewer outflow, urban runoff, fertilizer, and onsite septics.
- Six systems had human use impairments (primarily shellfish harvesting, and recreational and commercial fishing).
- There were no clear correlations between overall eutrophic condition and impacts to living resources.

Living resources were identified as being considerably impaired in only one estuary (Waquoit Bay), a result of onsite septic tanks and fertilizer. Two additional systems reported moderate to slight impacts (Boston Harbor and Great Bay) due to river inputs, wastewater treatment, combined sewer overflow (combination of WWTP and sewer overflow), and urban runoff. However, this information was available for only five of the twenty systems.

Use impairments were reported for six systems (Damariscotta River, Great Bay, Hampton Harbor, Boston Harbor, Cape Cod Bay, Waquoit Bay) with the most frequently noted impairment being shellfish harvesting. Other impacts include recreational and commercial fishing and fish consumption, aesthetics, and swimming.

There does not seem to be a clear correlation between the level of overall eutrophic condition and impacts to living resources. For instance, Waquoit Bay (moderate OEC) had considerably impacted living resources while St. Croix River/Cobscook Bay, also with moderate overall eutrophic condition, had no impacts. This is likely due to the quantitative nature of the OEC rating and the qualitative nature of use impairment reporting (i.e., these impairments occurred during the time period, but degree of impairment was not noted). The difference could also reflect the subtlety that nuisance/toxic blooms, which may be advected from offshore, are in many North Atlantic systems not considered a result of eutrophication. Therefore a comparison between the two is difficult. All systems with some level of eutrophic condition reported impairments.

Potential management concerns

The nutrient sources noted as the causes of impairments to living resources were combined sewer overflow, wastewater treatment, onsite septic tanks, urban runoff, fertilizer use, and river inputs. Atmospheric inputs were also noted as a cause for changes in load during the past decade. All of these warrant management attention given that they are also reported as potential causes of future nutrient increases and worsening conditions.

Data gaps and research needs

Monitoring

Approximately one third of the systems included in this region had insufficient data for assessment. It is recommended that there be an emphasis on better regional monitoring of all indicators, submerged aquatic vegetation and macroalgae in particular. This includes improved assessments of nutrient inputs from rivers, groundwater, and aquaculture so that the causes of observed problems can be identified and addressed. A monitoring program should provide a unified approach for sampling and analyzing indicators (i.e., macroalgae) in all systems, including annual sampling with more intensive sampling during seasons that are problematic (i.e., summer).

Research

A better understanding of circulation dynamics is needed in these systems. Also, improved estimates of population growth and land use impacts and distribution are needed in order to make accurate projections about future conditions. For systems with seasonal population changes, more research is needed in order to assess the effects of winter-summer population changes on eutrophic conditions in estuaries. Finally, improved macroalgal monitoring and assessment techniques are recommended.

Kate Boicourt, EcoCheck (NOAA/University of Maryland Center for Env. Science)

A volunteer taking water samples to monitor for toxic bloom species of algae in Penobscot Bay, Maine.

Management

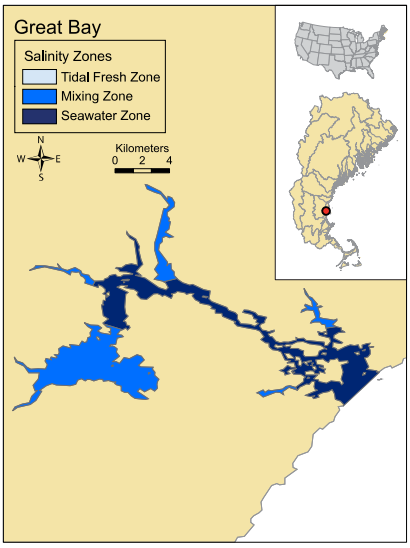
The survey should be adjusted to accurately reflect relative conditions in different systems. Participants at the NEEA workshop noted that the assessment method should be improved so that the relative conditions among systems in this region would be more accurately reflected. For instance, they argued that despite the improvements to Boston Harbor, the eutrophic conditions of Great Bay are still better than those of Boston Harbor, contrary to the results of the survey. It is important that the relative ratings accurately reflect conditions since this will impact the prioritization of systems needing management and thus the application of scarce resources to improve conditions. For the most part the systems in this region are not presently highly impacted.

EXHIBIT 10 (AR L.3)

Great Bay

SUMMARY

In Great Bay, increases in dissolved inorganic nitrogen have occurred over the past 20 years. Increases in chlorophyll a and turbidity have been identified with augmented eutrophication in the inner estuary. As a result, eelgrass biomass has declined by 70% in the last 10 years and the occurrence of nuisance macroalgae is becoming more evident.



Influencing Factors

Any level nitrogen input and low to moderate susceptibility (good ability to dilute and flush nutrients).

Eutrophic Conditions ***

Primary symptoms high but problems with more serious secondary symptoms still not being expressed.

Future Outlook

Nutrient related symptoms observed in the estuary are likely to substantially worsen.

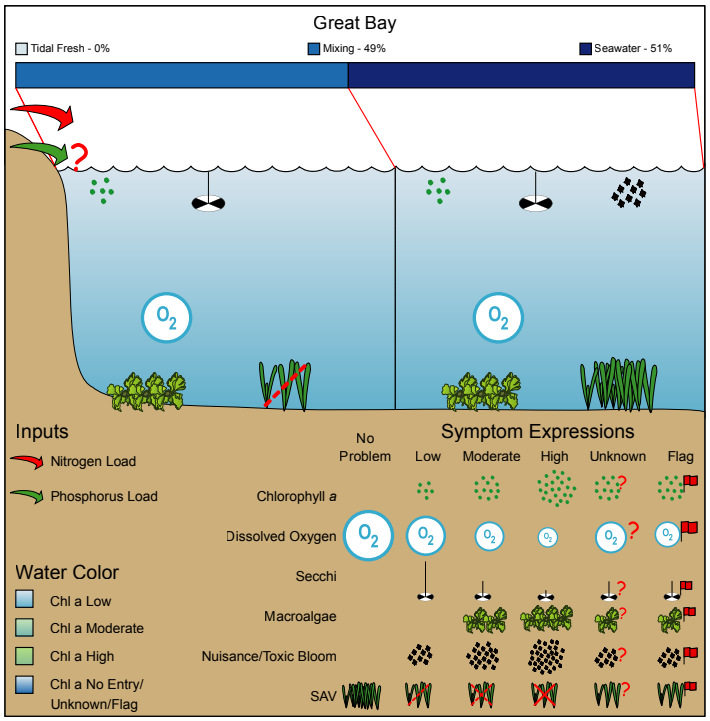
ASSETS Rating

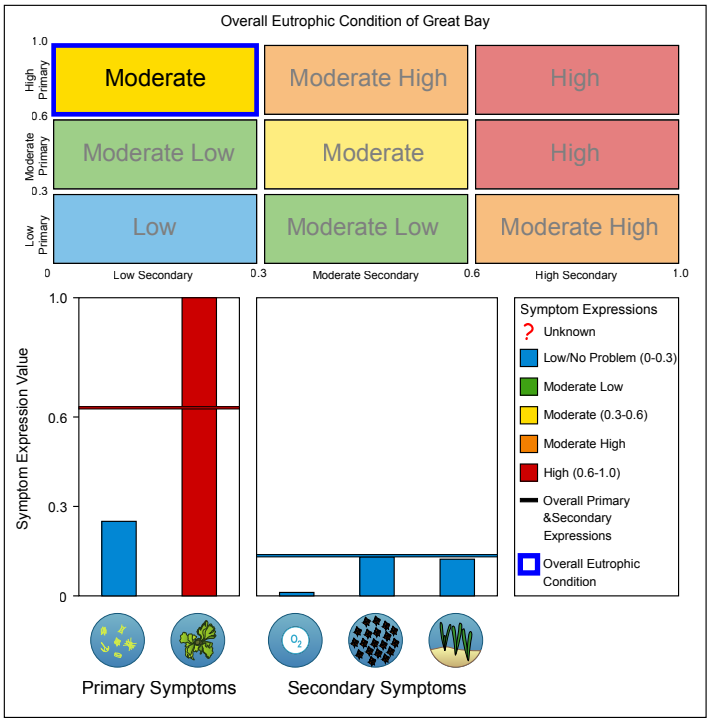
Assessment of Estuarine Trophic Status based on the three factors evaluated in NEEA.

Influence/eutro/future	Unknown	Low	Mod Low	Moderate	Mod High	High
ASSETS	Unknown	High	Good	Moderate	Poor	Bad

Reliability and Confidence: ? Unknown; * Low; ** Moderate; *** High

EUTROPHIC CONDITION





WATERSHED AND ESTUARY CHARACTERISTICS

Estuary		Landuse / Population		Watershed Details / Input Loads	
Area (km^2)	47	Urban (km^2)	477 (19.2%)	Area (km^2)	2,555
Tidal fresh zone area (km^2)	0	Agriculture (km^2)	202 (8.1%)	Mean elevation (m)	102
Mixing zone area (km^2)	23	Forest (km^2)	1,740 (70%)	Max. elevation (m)	470
Saltwater zone area (km^2)	24	Wetland (km^2)	65 (2.6%)	Watershed: estuary ratio	54.4
Volume (1,000 x m^3)	177,660	Range (km^2)	3 (0.1%)	TSS (tonne y^{-1})	48,800
Depth (m)	3.78	Barren (km^2)	0 (0%)	DIN (kg y^{-1})	905,000
Tide Height (m)	2.38	Total (km^2)	2,486 (0%)	DIP (kg y^{-1})	Unknown
Residence Time (d)	1	Population	236,203	TSS/est. area (tonne km^{-2} y^{-1})	1,038
		Popn: est. area ratio	5,026	DIN/est. area (kg km^{-2} y^{-1})	19,255
				DIP/est. area (kg km^{-2} y^{-1})	Unknown