Key Findings from Joint Report of Peer Review Panel

Conceptual Model Adequacy

- […] *the DES conceptual model to the Great Bay Estuary failed to address several influencing factors identified by the NEEA protocol and needed to fully evaluate the effects of nitrogen on eelgrass. Many of the factors explicitly indicated by the NEAA, for example; hydraulic flushing and water residence time (Bricker 1999), were not considered in the DES model* (Kenworthy, 11).

- If *epiphytes are not contributing significantly to light attenuation, and chlorophyll-a is only a minor contribution to light attenuation, nitrogen cannot be directly implicated as the major cause of light attenuation and eelgrass declines in the Great Bay estuary* (Kenworthy, 12).

Is Transparency the Factor Controlling Eelgrass

- *A critical deficiency in the DES 2009 Report was the fact that DES did not attempt to present evidence for ruling out the other factors listed above that could be controlling the presence or absence of eelgrass (e.g., temperature, water motion, wave action, bathymetry, water residence time, substrate type, substrate quality, severe storms, disease, epiphytes, and plant reproduction)* (Kenworthy, 14).

- *The data and analyses in the DES 2009 Report did not adequately demonstrate that transparency is the controlling factor in Great Bay Estuary because it did not explicitly investigate any of these confounding factors* (Bierman, 13).

Other Factors Affecting Eelgrass Abundance

- *Eelgrass growth, abundance and distribution are also controlled by temperature, nutrient availability (primarily nitrogen and phosphorus), tidal range, water motion, wave action, water residence time, bathymetry, substrate type, substrate quality, severe storms, disease, plant reproduction and anthropogenic disturbances* […] (Kenworthy, 13).

- *The DES 2009 Report did not adequately demonstrate that nitrogen is the primary factor in the Great Bay Estuary because it did not explicitly consider any of the other important, confounding factors in developing relationships between nitrogen and the presence/health of eelgrass* (Bierman, 18).

- *There is no basis for a scientifically defensible linkage between nitrogen impairment and eelgrass impairment presented in the report* (Kenworthy, 19).

Eelgrass Impairment Listings

- […] *the preliminary analysis using the more current eelgrass cover data affirms scientifically defensible DES concerns for eelgrass declines in the Great Bay estuary; however, by no means does this infer a direct relationship with nitrogen impairment as suggested by the original assessment in WD Doc R-WD-08-18, Methodology and Assessment Results related to Eelgrass and Nitrogen in the Great Bay Estuary for Compliance with Water Quality Standard for the New Hampshire 2008 Section 303(d) List. In fact, this new analysis confirms a fundamental flaw in the DES approach to setting nitrogen concentration criteria using the regression method in the DES 2009 Report* (Kenworthy, 20).

Assessment of Regression Methods used in TN Criteria Development

- *An immediate observation is that not only is chlorophyll-a a small component of Kd, median chlorophyll-a concentrations in Great Bay are low and range between 1-7 µg/l (Table 6). It is unlikely that reductions in nitrogen concentration could cause significant improvements in light by causing reductions in chlorophyll-a concentration* (Bierman, 24).

- Regressions *Kd versus nitrogen concentration are based on weak evidence and are unreliable due to lack of explicit consideration of all the underlying direct/indirect linkages among the relevant stressor variables, response variables and confounding variables* (Bierman, 25).

- *The statistical methods used to derive the numeric thresholds were not based on acceptable scientific methods and the results of these analyses are not reliable for predicting the complexity of responses to changes in nitrogen concentration in the system, including DO, transparency, eelgrass, macroalgae and phytoplankton* (Bierman, 35).

- The results in the 2009 report are not *acceptable or reliable for setting nutrient criteria* (Reckhow, 38).

Macroalgae Impacts and Relationship to TN

- *As weight of evidence for determining nitrogen thresholds based on the status of macroalgae in the Great Bay estuary, DES was unable to definitively document spatial or temporal trends in macroalgae distribution and abundance for the period during which eelgrass declines were documented. …Hence, any relationship between nitrogen impairment, macroalgae growth and eelgrass abundance cannot be supported* (Kenworthy, 27).

- *The data and arguments provided in the DES 2009 Report to support the weight of evidence for a relationship between nitrogen concentration, macroalgal abundance and eelgrass loss are neither compelling nor scientifically defensible.* [Subsequent data from 2008, 2009, and 2010 indicate] macroalgae were not limiting eelgrass growth (Kenworthy, 27).

Low DO Relationship to TN

- The analyses in *the DES 2009 Report for statistical relationships between DO and nitrogen concentrations, and the conclusions drawn from these results, are weak and unreliable because univariate linear regression approaches do not adequately represent the underlying direct/indirect cause-effect mechanisms* (Bierman, 31).

- *To assess if nitrogen reductions will improve DO conditions, data on the origin, quantity, and quality of organic matter in the various assessment regions of Great Bay are needed.* […] *In particular, relating DO to nitrogen concentration as in figures 28 and 29 of the DES 2009 Report without accounting for the co-varying influence of these factors is too simple* (Diaz, 33).

- […] *the DES 2009 Report provides insufficient information on the distribution and abundance of macroalgae to link macroalgae to low DO and any implications for nitrogen reduction and eelgrass protection* (Kenworthy, 33).

Weight of Evidence

- *Relative to weight of evidence, the data presented are likely sound but are not properly applied to linking benthic conditions with low DO and subsequently to linking low DO with total nitrogen concentrations* (Diaz, 46).

- […] *the DES "weight of evidence" does not support the conclusion that excess nitrogen was the primary factor that caused the decline of eelgrass and the inability of eelgrass to repopulate specific areas* (Kenworthy, 46).

- *The NNC data for Little Harbor/Back Channel provide the best evidence for a downward trend in eelgrass coverage. However, the next two figures do not present a very strong case for eelgrass response to TN changes* (Reckhow, 47).

- *Eelgrass cover data subsequent to the DES 2009 report (Table 1) indicates eelgrass is declining in locations (reference locations) where the nitrogen concentrations are similar to the proposed criteria; hence other factors must be operating to affect the changes in eelgrass cover* (Kenworthy, 49).

- *Scientific knowledge indicates a causal linkage between TN and DO, due to the growth and decomposition of algae. However, the data analysis does not support this TN-DO linkage in the NH DES data* (Reckhow, 48).

Proper Consideration of Data for Other Systems

- The 2009 Report *failed to acknowledge the relevance of some very important differences between the MEP* [Massachusetts Estuary Program] *program's approach and the DES approach. Also, important differences in some the physical characteristics of Great Bay and the embayments of Massachusetts were not acknowledged, implying that DES did not consider the relevance of the differences and how they could affect interpretation of water quality monitoring data. Furthermore, by making a simple comparison to the MEP program without a comprehensive evaluation of the status of that program, DES was irresponsible in making the comparison and implying that it supports total nitrogen criteria proposed for the Great Bay* (Kenworthy, 50).

- […] *a simple comparison of total nitrogen values derived in the MEP cannot support the nitrogen concentration proposed by DES* (Kenworthy, 51).

- *The proposed DES total nitrogen criteria in Great Bay (annual median of 0.25 – 0.30 mg total nitrogen) are about half the threshold concentration identified by Wazniak et al. (2007), so it appears that the DES criteria are more conservative and potentially more protective of eelgrass than identified for the Maryland coastal bays* (Kenworthy, 52).

- *To help better identify the potential total nitrogen criteria for Great Bay, DES should also consider the results of a recent study conducted in collaboration with the MEP program in Massachusetts (Bensen et al. 2013). These results corroborate values reported by Wazniak et al. (2007) discussed above, indicating that concentrations on the order of about 0.6 mg/l total nitrogen correspond with degrading eelgrass beds* (Kenworthy, 52).

Form of Nitrogen

- *Yes, TN is the correct form of nitrogen on which to focus to address cultural eutrophication* (Bierman, 57).

- *For Great Bay Estuary it is not possible to answer the question about the influence of detention times on conversion of nitrogen from unavailable to available forms within the watershed or estuary. To answer this question, a load-response mass balance model would be required that incorporates estuarine hydrodynamics, and nitrogen cycling in the water column and bedded sediments. Such a model does not presently exist for Great Bay Estuary* (Bierman, 57).

- *Given that DON and PON can be converted to DIN and taken up directly by macroalgae, a key question with regards to which fractions of nitrogen to control would be: How much of the DON and PON fractions within Great Bay are converted to DIN and how much is taken up directly as DON? Based on the information in the DES 2009 Report, it is not possible to determine the rate of conversion of organic nitrogen to DIN or direct uptake* (Diaz, 58).

Suggested Updated Approach

- […] *DES should: 1) incorporate the more recent eelgrass data (Table 1) into their assessment and align these data more closely in time and space with a more rigorous analysis of the water quality and light attenuation data; 2) follow the most recent guidelines by EPA and its' expert panel reviews which recommend a broader approach to the assessment process by incorporating stressor response analyses, appropriate reference conditions, and process based modelling; 3) consider addressing the different zones in the Great Bay estuary independently for the assessment of eelgrass, water quality status, and reference condition; 4) improve the assessment by quantitatively recognizing and treating the status of eelgrass and eutrophication in the different zones as either a conservation and maintenance problem or a restoration problem; 5) incorporate more basic information and understanding of eelgrass biology (e.g., reproductive biology) and ecology as it pertains to eutrophication, eelgrass loss, and eelgrass recovery; and 6) review and evaluate the more recent basic and applied scientific literature cited in this review to gain a better understanding of the problem in Great Bay and refinements in the assessment process* (Kenworthy, 68).

NOTE: Italicized language is exactly quoted from the Joint Report of Peer Review Panel (2/13/14).