

New Jersey Department of Environmental Protection
Comments on the DRAFT Report
Assessment of Nutrient Loading and Eutrophication in Barnegat Bay-Little Egg Harbor, New Jersey in Support of Nutrient Management Planning

An important expectation of this report was to determine the degree to which various stressors are responsible for the observed condition of the Barnegat Bay. In addition, if possible, the threshold levels for each relevant stressor that would result in an impaired vs. unimpaired condition. To be useful in crafting a management strategy, it is essential to know both the relative importance of the suite of stressors that are responsible for the observed biotic condition, and the threshold for each stressor that aligns with an acceptable biotic condition. The elements of an effective management plan would depend on 1) which factors have the greatest influence on biotic condition, 2) which ones are most outside of range needed for an acceptable biotic condition and 3) which factors can most cost effectively be remediated.

There are no key findings related to the USGS part of the report including the fact that lawn turf represented about 25% of the developed land area and represent a significant source of nutrients to the bay. The USGS data is an important study on its own, as it demonstrates the spatial and temporal variation of nutrient loads to north, central and southern regions of the Barnegat Bay – Manahawkin Bay - Little Egg Harbor estuary. This information is extremely important for developing watershed specific nutrient management plans for the future.

The development of the biotic index part of this study should be described here and the limitations to the outputs and scores listed below. Ultimately this part of the project was a modeling study meant to make more quantitative a subjective NOAA model (ASSETS). The results presented below exclude the serious caveats listed in the body of the report as to the Index's poor predictability at times due to uneven datasets (some years have no data for some variables) and how these affect model outputs. The researchers themselves state this reduces the applicability of the index. The more important point in the Key Findings section should be the accuracy and predictability of the model.

The water quality data collected as part of this project should be provided including, for each sample, value for each parameter, date and time collected, and GPS location (latitude and longitude), and depth, along with a map of the sample locations.

Report heavily weighted toward SAV; conclusions not in line with data:

The report acknowledges that multiple years of condition data for various indicators of biotic condition are lacking. Only one year of benthic data was deemed useable. Clam data is limited. Even though data for SAV are not available prior to 2004 and widgeon grass data was first gathered during this study, the focus of the report is on the condition of SAV, with some discussion of clams. Declines in both SAV and clams are attributed to nutrient loading, in that nutrient loading affects light availability and algal community structure. It is stated that both resources have declined absolutely and also correlative with an increase in nutrient loads. While absolute measures of SAV biomass and numbers of clams support that these two resources have experienced decline, the unconditional causation statement regarding nutrients is not well supported by data in the Bay and the literature.

Literature supports that light availability is an important factor regulating seagrass growth and distribution. But light availability is affected by both factors that respond to nutrient enrichment (algae in the water column and epiphytic, macroalgal shading) and suspended solids, which consist of both biotic and abiotic components (algae, sand and other inorganic particles). Further, light availability is not the only important factor regulating SAV success. Factors besides light availability noted in the literature include: physical exposure, substratum, carbon, nutrients, temperature, salinity, oxygen, sulphide, competition and grazing. An obvious example of the importance of other factors is salinity, which limits the distribution of eelgrass in northern Barnegat Bay; in the northern Bay, widgeon grass is the dominant SAV species, as it prefers less salty water. These other factors should be explicit in the report.

In addition to preferring more saline conditions, *Z. marina*, 1) prefers colder temperatures, with a range of -1° C in winter and 25° C in summer and 2) provided there is sufficient light for the species to succeed, at the lower end of the availability range, blade length increases and shoot density decreases, whereas with greater light availability, blade length decreases and shoot density increases. The study indicates the Barnegat Bay mean temperatures appear to be relatively steady, but monthly means as well as the maxima do exceed the 25° C threshold and appear to be trending upward in the north and central parts of the Bay. This suggests that temperature may be a significant stressor for eelgrass. An explanation is required for the selection of the temperature water quality threshold which produces a favorable temperature index value, with an improving trend, contradicting this literature information. Further, with the exception of macroalgal shading, light availability factors appear to be favorable in the Bay, challenging the notion that light availability reductions are a significant cause of eelgrass biomass declines. The exception is the index value for macroalgal shading, but there are only a few data points for this factor. An explanation is needed for how the threshold was selected for the index. While overall biomass has declined, it is noteworthy that the *Z. marina* in the Bay exhibits shorter blade lengths and higher shoot density currently compared to the beginning of the study period, the same pattern as would be expected with a favorable light availability (assuming it is within the required range in the first place), according to the literature.

Another problem with attributing SAV biomass decline solely to nutrients is that total nitrogen levels appear to be stable over the study period. On the other hand, temperature in the bay appears to approach and exceed the physiological limits for eelgrass survival. Physical threats, such as from use of watercraft in SAV areas, were not discussed at all. This would suggest that factors other than nutrients must be considered in determining if 1) SAV can be restored given the temperature regime and 2) if SAV are still viable in the Bay, what are the most important stressors to address to improve the condition of the SAV resource.

Thresholds are not clearly defined. As a result the development of raw and weighted scores as well as the overall index of eutrophication can't be properly evaluated

The selection of thresholds to be used in the assessment of eutrophication in Barnegat Bay was a topic of discussion at the March 28, 2012 meeting. Similar comments were raised in the comment letter on the April 15, 2012 quarterly progress report. Rutgers provided a response to explain what information would be considered in establishing the thresholds, however, it remains unclear what values were actually used and why.

The original expectation was to identify thresholds that could be applied to other coastal waters. The selection of thresholds must be clearly documented and transparent. Any limitations on the applicability to other waters should be noted. The report includes several references that were consulted. See: Ecosystem State: Water Quality (page 66), include the following statements:

- Kemp et al. (2004) list statistically derived concentrations of dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) beyond which submerged aquatic vegetation is not present at a variety of salinity regimes. See Table 3-3.
- Wazniak et al. (2007) summarized pertinent thresholds regarding dissolved oxygen, (see Table 3-4) and for total nitrogen, total phosphorus, and chlorophyll *a* (see Table 3-5)) for Maryland's coastal bays.
- For BB-LEH, dissolved oxygen thresholds were defined relative to the New Jersey standard of impairment, which is established at 4 mg L⁻¹

Kemp derived DIN and DIP concentrations of 0.15 TN and 0.01 TP which are expressed as median values calculated over the growing season, whereas Wazniak values for TN and TP are annual averages of 0.55 TN and 0.037 TP. Figures 2-1 thru 2-7 present the maximum, minimum and average concentrations by year. However, based on the threshold selected the data should be averaged appropriately and presented. Figure 5-2 presents nitrogen concentration by seasons. This figure should be revised to be consistent with the threshold selected. If KEMP is the basis, then the figure should present median concentrations during the growing season. If Wazniak is the basis then annual averages should be used.

The adopted water quality criteria for dissolved oxygen was used even though Table 3-4 includes criteria that might be more appropriate for Barnegat Bay. No discussion is provided to establish that indicates the adopted water quality criteria are the appropriate water quality criteria. The DO criteria developed for seagrasses for Maryland Inland Bays was included but ignored.

The Thresholds selected for Light Availability metrics are also unclear. Figure 3-20 identifies several studies with differing maximal depth limits, light attenuation coefficients and minimal light requirements. Associated light attenuation by various factors such as plankton (chlorophyll *a*), total suspended solids, macroalgae are indicated as Kennish et al. 2011 and provided in Table 3-7 but this table describes Area Normalized occurrence of macroalgae. It is necessary to explicitly define which thresholds were selected and on what basis.

The discussion on Biotic Response: Benthic Macroinvertebrates seems to indicate that several indices were considered but the REMAP index was used. The sources for other indices listed are not included as references. Please clarify what validation was done. See page 68 - "Validation of the methodology is conducted through comparison of multiple similar methods, and the response in 2011, as data from that year have been kept separate and out of analyses thus far."

Component selection incomplete and duplicative; threshold basis not documented; index derivation has weaknesses:

The researcher selected six components to use in describing the biotic condition. There is no definition of “eutrophic condition” so the term should be replaced with “biotic condition” as a less cause-based term. As defined, the components consider factors that overlap across component types, which would tend to afford greater importance to those factors. For example, watershed pressure considers TN and TP loading, while water quality considers TN and TP concentration. Light availability factors are dependent to some extent on the water quality factors. To partially alleviate this effect, in the derivation of the overall eutrophication index, the watershed pressure index is not included to avoid conflation of independent and dependent variables. However, other factors, like physical stressors are not considered in the index at all.

These other factors may be difficult or impossible to consider at this time, perhaps due to lack of data or lack of complete understanding regarding thresholds of affect. They may include community make up of algae, effect of entrainment/impingement in the Oyster Creek cooling water system and from extensive watercraft traffic, and the effects of resource harvest (has it been/is it at sustainable levels?). Only presence or absence of HAB are considered in the index, even though it is acknowledged that greater dominance of pico algal forms is likely to negatively impact clams. Failure to consider other relevant stressors increases the uncertainty of the findings and these uncertainties should be discussed. As stated, design of an effective management response depends on identifying the suite of significant stressors and determining the relative importance and role in cause and effect relationships with the biotic response indicators of concern.

To develop the index, the study relies on existing data supplemented for some factors by new data collection. Raw data for each factor are provided, not including the more recent data collected through the intensive Barnegat Bay study, which was beyond the SOW. For many years within the span of the study, there is little or no data on clams and benthic organisms. SAV data are sporadic. Only water quality data is generally available. Thresholds are selected for each factor to associate with assessments of highly degraded, poor, moderate, good, excellent. Given the methodology used to derive a unit-less score for the index, the index assessment for any given year is opportunistic (limited by the data available for a given year) and not deterministic (informed by data from the full suite of prospective relevant factors). As a result, the importance of setting thresholds against which observations are compared to determine the assessment cannot be overstated. As the value for each threshold is one of the most important elements in determining the outcome of applying the index, it is essential that the threshold values be solidly based in science. A key requirement expressed as part of earlier reviews of interim products was that the specific basis for selecting thresholds should be identified and substantiated. Instead, only a generic description of the types of sources used for selecting thresholds was provided. This deficiency must be addressed to allow a complete assessment of the tool.

Determination of index values blends raw scores (comparison of average of raw data to a selected threshold) and weighted scores (square of eigenvector value, considering the factors for which there was data in a given year). Weighted scores simply represent a measure of the variability of the factor, if it is present within a given year. If there is no data, the factor is given no weight. The purpose of blending the weighted score with the raw score is unclear. Supporting basis for the statistical approach is needed. Again, because the index score depends

entirely on the selected threshold, the basis for selecting thresholds must be thoroughly documented and justified. For the overall index, depending on data availability for various factors, the index may be derived from one or two factors. This is particularly problematic because, as previously stated, there has been no demonstration that the factors selected are the only (or even the most important) factors responsible for the biotic condition.

Suggests strong correlations and trends not supported by data and statistical tests; index conclusions unsound:

In the description of several factors, a negative trend of biotic factors over time is suggested, but then a variable response is described year by year and an overall conclusion is reached that the “decline” tracks with nutrient increases. Yet the water quality factors remain relatively constant according to the data presented. Under these circumstances, it is difficult to accept a cause/effect relationship between the two. Examples: macroalgae coverage is higher in 2004, lower in 2006, higher in 2008 and lower in 2010, with the 2010 levels lower than the 2004 levels; eelgrass biomass has gone down-up-down-up as well, with the 2010 levels lower than the 2004 levels; water quality parameters have varied slightly but are not largely different at the end of the study period compared to the beginning—except that TP has increased. A number of correlation comparisons are offered in the report along with a conclusion that there is a correlation. However, not surprisingly, based on the above examples, the r or R^2 value provided suggests little to no correlation. This uncertainty is not highlighted in the findings or the executive summary.

Even with the limitations already expressed with respect to developing the index, the researcher describes watershed pressure as moderate to good in Central and South, highly degraded in North; water quality as moderate or good in all three segments, except poor in 2010; light availability as moderate to excellent in North and South, but highly degraded Central; and seagrass response as highly degraded or poor in Central and South (eelgrass not present in North). So, using the index created in the report, it would seem difficult to conclude that water quality was the primary causal factor responsible for the condition of seagrass (data limitations here are that eelgrass data is absent prior to 2004 and widgeon grass was only quantified in this study; no earlier comparisons are possible). The overall index is given as moderate or better in Central and South, but poor in the North (where light availability is generally high, except for a dip in Secchi depth in 2008). With the inconsistencies between the biotic response and water quality, as well as the limitations noted (significant gaps in data), the findings must include caveats as to the uncertainties.

With only a few years of data it is hard to assess (and threshold value basis unknown), macroalgal coverage index is widely variable and very low in 2009. This would be a response indicator likely linked to nutrients and light availability, so warrants deeper investigation re: validity of the index threshold values as this could have a bearing on SAV, benthic organisms and DO. This data gap and its concomitant influences or uncertainties must be addressed.

Estuarine segmentation – in many places the report indicates that the north, central and south sections of BB-LEH behave differently. However, metrics, thresholds, data and conclusions do not appear to be based on segmenting the bay.

Quarterly progress report for the period January 1, 2012 thru March 31, 2012 included graphs showing data collected for water quality. Total Nitrogen was less than 800 ug/l for all years in all three segments. When the total nitrogen score were presented on a scale of 0 to 100, the scores for the central and south segments were generally 80 to 100 or “excellent”. The north section dipped to about 70 or “good”. While there appears to be a little more variability in the north section, the south and central are relatively stable. This does not support the key finding – “the condition of BB-LEH has progressively worsened over time for both nitrogen and phosphorus. The basis for the statement must be explicit.

It appears that several of the conclusions drawn are not supported based on the historical data provided in the Ecology of Barnegat Bay New Jersey, Kennish M.J. and R.A. Lutz 1984.

Macroalgae: Recurring macro algae blooms *Ulva lactuca*, *Gracilaria tikvahiae*, and *Enteromorpha intestinalis*, are listed as a cause impacting the growth of eelgrass. See page 87. From 1969 to 1973 *Ulva lactuca* was the most dominant macrophyte species present in the Barnegat Bay with some of the others listed being in the top ten. Is the current condition worse than what was documented in the late 60's and early 70's?

Phytoplankton: A portion of the NEIWPCC Report talks about the change of the phytoplankton to smaller species or picoplankton, which negatively impact the clam growth and is a sign of ecosystem change. What is not discussed is the large abundance of small plankton species present during the summer months (June thru Sept) that were called ultraplankton, very small plankton species, present in the Bay up to 800,000 cells/ml, during the late 60's and early 70's by Kent Mountford. See page 64. The presence of picoplankton is not new in Barnegat Bay.

Chlorophyll a: Chlorophyll a range in Barnegat Bay is generally 1-12 ug/l, with a maximum concentration in excess of 40 ug/l over between 1989 and 2010. Samples collected in the central portion of Barnegat Bay in a 22 month period from 1969 to 1970, shows generally the same general concentration of 1-12 ug/l with a maximum of 35 ug/l. See chart on page 69. It would appear that chlorophyll a levels have not changed much over the past forty years.

Hard Clams (*mercenaria mercenaria*): The Division of Fish and Wildlife studies have documented a population decline and poor recruitment in Hard Clams in the Little Egg Harbor. However, the hard clam population in the central portion of Barnegat Bay was determined to be less than 0.1 clams/ sq. meter in the 1960's. See page 178 -180. It appears that the historical levels were less than 0.7 clams/ sq. meter, the minimum density suggested to be necessary to sustain a viable population.

Nutrients: Nutrients (Total Nitrogen and Total Organic Nitrogen) in the Manahawkin Bay to Little Egg Harbor area seemed to have decreased from the 1970's to the current 2011-2012 data, even though these areas have seen some of the largest percentage change in population growth over the last 40 years. Stafford Township, 720% increase, Little Egg Harbor, 675%. Stafford grew from about 4,000 in 1970 to approximately 27,000 in 2010. Little Egg Harbor grew from 2,972 in 1970 to 20,065 in 2010. Data from research performed by Durand from Manahawkin Bay to Little Egg Harbor, in the book by Kennish M.J. and R.A. Lutz 1984, Ecology of Barnegat

Bay New Jersey, and comparing it to data collected during the Barnegat Bay Sampling from the summer of 2011 to the summer of 2012. In spite of the population increase over the last 40 years, Total Nitrogen (TN) and Total Organic Nitrogen (TON) concentrations in Manahawkin Bay have declined from an average of 510 ug/l TN and 489 ug/l TON, while the 2011-2012 data shows 340 ug/l TN and 291 ug/l TON. Reviewers would be interested in knowing the author's reasoning for the divergence of his historical data and current conclusions.

Comments associated with specific text in the Report

Page 13: First bullet - This is not a finding but a statement of condition. Loads need context (how high is this comparably) and the detailed USGS modeling info on both nitrogen and phosphorus, as well as the differences in spatial loadings from north to south.

Page 13: Second bullet -No context is provided. There are no indications of how frequent or what percentage of the measurements were exceedances for many variables and any trends analysis performed. An increasing or decreasing trend would be a key finding. The above statement also implies that all of the above referenced factors directly led to degradation of sea grass and led to mortality. This is not a finding of the model nor are some of the variables related to sea grass degradation (e.g. fewer hard clams and food web shifts).

Page 13: Third bullet: This needs clarification. Sea grass response "to what" is highly degraded. True, sea grass abundance and vitality were shown by project monitoring to be declining over time in the field studies. However they are but one set of variables among many in the model for assessing nutrient impacts. It's unclear what factors seagrass is responding to. Other stressors not included in this study are physical and mechanical impacts from boat traffic and bulk heading effects causing the loss of habitat. These variables were not included in the model nor studied in this project.

Page 13: Fourth bullet: "Data availability limits its power." What is the source of the variability, mentioned here only in passing, but discussed in much more detail within the body of the report. Until the researchers address these scientific concerns it's unclear whether the model outputs are accurate or significant. Understanding the limitations of the data inputs and model outputs will determine whether the Index of Eutrophication is ready for use with acceptable accuracy for environmental management purposes.

Page 13: Fifth bullet: These overall scores and statements about declining eco-health leave out the more detailed discussion of data limitations in text which highlight that due to data paucity of certain variables in different place and years the index may have different scores based only a few of the variables (e.g. there is no eel grass or brown tides in north).

Page 13: Sixth bullet: When a model plateaus and variability increases it usually indicates a problem with either data quality, model imbalances (weighting or scaling of variables), or other factors external to the model (stressor data not included in model). This variability should be explored mathematically by evaluating data sets and modeling parameters (equations). This analysis should be done before modeling scores are reported above, as its unclear if index scores outputs are meaningful.

Page 14: First full bullet - Does condition mean index score, or loadings, or specific ecological degradation (SAV, hard clams)? Regardless, this broad conclusion is not supported based on the historical data provided in the “Ecology of Barnegat Bay New Jersey,” Kennish M.J. and R.A. Lutz 1984. For example, recurring macro algae blooms are listed as a cause impacting the growth of eelgrass back then. Is the current condition worse than what was documented in the late 60’s and early 70’s? For phytoplankton, a portion of the Report indicates a change in phytoplankton to smaller species or picoplankton, which negatively impact the clam growth and is a sign of ecosystem change. In the late 60s and early 70s ultraplankton, very small plankton species, were present in the bay at up to 800,000 cells/ml. Thus the present of picoplankton is not new to Barnegat Bay. Between 1989 and 2010 the chlorophyll *a* range in Barnegat Bay was generally 1-12 ug/l, with a maximum concentration in excess of 40 ug/l over. Samples collected in 1969 - 1970 showed generally the same general concentration of 1-12 ug/l with a maximum of 35 ug/l. It would appear that chlorophyll *a* levels have not changed much over the past forty years. Reviewers would be interested in knowing the author’s reasoning for the divergence of his historical data and current conclusions.

Page 14: Second bullet: How is this statement supported by this model? How is it supported based on the historical data provided in the “Ecology of Barnegat Bay New Jersey,” Kennish M.J. and R.A. Lutz 1984? For example, nutrients (Total Nitrogen and Total Organic Nitrogen) in the Manahawkin Bay to Little Egg Harbor area seemed to have decreased from the 1970’s to the current 2011-2012 data, even though these areas have seen some of the largest percentage change in population growth over the last 40 years.

Page 14: Last bullet: If so, is there causal linkage to biota or are there other more important variables?

Page 26: “Since 2004, eutrophy has generally worsened in much of the BB-LEH, and the condition of the seagrass habitat has significantly degraded.” How is eutrophy defined? Increased chlorophyll *a*, low dissolved oxygen levels, excessive diurnal swings in dissolved oxygen, plant biomass or is the conclusion based on seagrass decline? Please add definitions to the report.

Page 27: “Seagrass now covers a 5260-ha area of the BB-LEH estuarine floor (Lathrop and Haag, 2011).” This means that seagrass covered about 20% of the bay bottom. Does this include wigeon grass in the northern part of BB? What percent of BB-LEH could/should support seagrass?

Page 27: “Designated as moderately eutrophic in the early 1990s, BB-LEH was later reclassified as highly eutrophic in the late 1990s, a designation reconfirmed in 2007.” Bricker’s approach was very subjective and heavily weighted towards brown tide blooms. The reason for this project was to develop an index appropriate for BB-LEH.

Page 29: “Exchange of bay and ocean water occurs through these three inlets. The continuity of the barrier island complex restricts the exchange of water with the coastal ocean, resulting in a protracted water residence time in the estuary amounting to 74 days in summer when

eutrophication is most problematic (Guo et al., 1997, 2004).” Barnegat Bay functions as three separate waterbodies and would be expected to have different retention times. How does this factor into the overall eutrophication index for the North, Central and South?

Page 31: Study Area Characteristics: Recommend including a table describing the physical and chemical characteristics of each segment of the estuary (e.g., include watershed and bay size, mean depth, sediment grain size, salinity, DO, mean P, mean N, etc). This should be done using the most recent data. Additional columns showing these characteristics at points in the past (where available) would be most useful.

Page 31: Water Quality – indicates several bases for high nutrients in the northern section. However, figure 5-2 seems to conflict with higher levels observed in the central section.

Page 34: “We have attempted to characterize the spatial and temporal dynamics of the nutrients within the estuarine system that could be used to establish the basis for developing accurate nutrient loading criteria. Based on these findings, we have modeled how estuarine health will likely change as a result of several important policies for land use and nutrient pollution control.” Elsewhere in the report, the limitations on the data are documented. Using the existing data set, it is unlikely than any attempt to develop nutrient loading criteria, along with the appropriate errors bars, would be technically justified. The data does not clearly support the the suggestion that, if we reduce the nutrient loading to a specific level, the seagrass beds will rebound, hard clam recruit and populations will improve and sea nettles will disappear.

Page 35: Watershed Nutrient Loading. The QAPP indicates that only secondary data collected by the Bureau of Marine Water Monitoring for the period 1989 thru 2010 would be considered. However, this section implies that data collected by the USGS and available thru NWIS was also considered. Did the USGS work look at both DEP and USGS data?

Page 35: What level precipitation and hydrologic data were used to segregate base flow from runoff?

Page 36: Shellfish data were collected at regular bi-monthly intervals from June to November. However the text indicates that the Department collected data from July 16 thru August 31, 2001. Please clarify or correct.

Page 37: Phytoplankton section describes the Department’s remote sensing program which started in 2011. How was the data used? Were only water samples collected in the blooms used? Also, other reports published by DEP and USEPA indicated other blooms of green and red tides occur periodically and in other parts of the bay beside LEH. Why wasn’t this data set used as well in HAB part of index?

Page 37: Light Availability. Several metrics are listed here. However, the researchers indicated that the percent of light available to seagrass leaves was a better indicator than secchi depth and includes chlorophyll a, total suspended solids, macroalgae coverage, and epiphyte coverage. Since these are factored into the calculation, incorporating separate measures for these parameters is essentially double counting. Please explain the rationale for the approach used.

Page 38: Benthic Macroinvertebrates – An expected outcome of this project was the development of a benthic indicator that could be used to assess current conditions and changes over time. It does not appear that a stand-alone benthic index has been considered. Benthic Invertebrate Response is blank on Table 3-2.

Page 43: Ecosystem State – Water Quality: The summary of current conditions should be consistent with the thresholds selected (annual average, annual median, growing season average). Based on the review of literature provided, none employ the maximum values.

Page 44: Ecosystem State- Light Availability: Many of the measurements were not useable because the secchi disk hit the bay bottom. In addition, on page 37, light availability was a better indicator than secchi depth. Please explain the value of this parameter.

Page 45: Indicates that Twilley documented 25 cm thick bloom-forming macroalgal. Since his work was conducted in Chesapeake, it might be better to delete “In the nutrient enriched waters of this coastal lagoon” or at least change it to read Chesapeake Bay.

Page 45: Macroalgae coverage. It appears that macroalgae sampling was limited to seagrass beds in the south and central segments. As this is a parameter included in the light availability factor, how is this factor addressed in the northern section or other areas without seagrass beds?

Page 45: Macroalgae Percent Cover: What percent cover had an initial effect on the seagrass based on the literature? Based on this section, 59% coverage does not impact the SAV/ecosystem. This parameter and percent value ranges need to be examined and linked to literature based values (i.e., on an empirical basis).

Page 46: Macroalgae coverage - It appears that macroalgae varies significantly from year to year. Based on the level of variability, is it reasonable to conclude a trend?

Page 49: Ecosystem Biotic Response – Eelgrass: This section needs to include basic information about eelgrass growth characteristics in terms of what is ‘normal’ or ‘unstressed’. For instance what is the timeframe (e.g., month, temperature, light intensity) when shoot density is normally highest during the year? The same information is needed for biomass, coverage, blade length, etc. This will help the reader understand the various seasonal data discussed.

Page 49: Eelgrass- While the research may show a decline in the condition of the seagrass beds from 2004, it does not support the finding that this decline is due to spatial or temporal nutrient loadings. The loading analysis provided indicates that 65% of the loadings originate from the Toms River and Metedeconk Watersheds, which are located in the northern section, while the seagrass beds are located in the south and central sections. Further, the loadings fluctuate based on precipitation. This supports the need for the dynamic water quality/quantity modeling the Department is conducting through a contract with USGS in order to define the relationship between nutrient loading and productivity in the bay.

Page 50: Eelgrass - Several metrics are used to evaluate the condition of the seagrass beds, some show improvement over time, while other show decline or no change. Which measures are most important and can they be aligned as to which are affected by nutrients versus other stressors such as water temperature or human disturbance?

Page 52: Widgeon Grass - The assessment of widgeon grass was added to ensure that the eutrophication index would work in areas with lower salinities that cannot support eelgrass. It does not appear than this work was factored into the overall assessment. How much additional information would be required to incorporate?

Page 52: Harmful Algal Blooms – this section should be rewritten. The statement “not been monitored in the estuary since 2004, and thus no observational HAB monitoring data are available over the past eight years” does not acknowledges the Department’s use of remote sensing with follow-up monitoring and species identification.

Page 53: Harmful Algal Blooms (HABs): “Dissolved organic nitrogen concentrations were not directly linked to the blooms, which may be more closely aligned with the concentrations of dissolved organic nitrogen in the estuary.” Sentence does not make sense, both factors mentioned are dissolved organic nitrogen.

Page 56: The researcher states that the subject Biotic Index of Eutrophication is the most comprehensive and holistic assessment of BB-LEH conducted to date. In order to assess the ~20 indicators, the index integrates over 74,400 observations among 85 variables. However, the sheer number of observations, variables and/or indicators used do not validate the index. Data availability is likely a big factor is whether the index reasonably performs. The uncertainty must be discussed, including the effect of data availability.

Page 56: “Data availability remains a major limitation to assessment of eutrophication condition for BB-LEH. While an increasing number of indicators are being monitored, aligning data collection through space and time and increasing sampling frequency will greatly improve future assessments.” A similar conclusion is presented on page 68. We definitely agree. This is so important it should be listed as a “KEY FINDING.”

Page 58: On the first bullet, just focusing on the Central section: Light availability is increasing but it's greatly worsened in the central section. Chlorophyll a is good, suspended solids is excellent, epiphyte coverage is excellent and the percent light reaching seagrass is good. The overall conclusion was that light did not penetrate deep enough. On page 75, the water quality index was described as moderate and sometimes good. Watershed pressure indicators are considered good. The conclusion provided on page 75 on the seagrass response index indicates the condition is “highly degraded” to “poor”. It appears that the factors don’t support the conclusion that water quality, watershed pressures or light availability are responsible for the decline in seagrass.

Page 61: Please provide a justification for averaging the six variables together.

Page 62: Note that applicability of the index to any given segment depends in part on availability of data within that segment. Does this mean that the eutrophication index can only be applied to areas with seagrass or that an index cannot be calculated if data on all six variables are not available? Considering the gaps in available data, it would appear that the index could only be calculated for a few years in some locations. Please clarify.

Page 66: How was the threshold for nutrient loadings determined, taking into consideration that the loadings are dependent on precipitation?

Page 67: The thresholds identified for harmful algal blooms are based on the magnitude of an observed bloom. As identified in these comments, the report includes statements that there has been no formal monitoring for HABs since 2004 and a bloom in 2010. How is the frequency of events or areal coverage factored into the metric?

Page 74: The index values are presented with the descriptors ranging from excellent to highly degraded. Were any other breaks considered such as eutrophic, mesotrophic, oligotrophic? Is there a breakpoint between acceptable and unacceptable conditions?

Page 90: Synthesis and Management Recommendations - This is more a literature summary of impairments and eco-shifts already covered in introduction due to human impacts and the need to develop a holistic plan to reduce these stressors. This section should describe what actions are needed to address the data gaps and uncertainties.

Page 91: figure 5-2 should be revised to reflect the expression of nitrogen based on the selected threshold.

Page 91: Human factors should also include recreational usage although not evaluated thru this project. Example –watercraft may be resuspending sediment and damaging SAV beds.

Page 92: This section should include some information generated by the USGS study completed as part of this project.

Page 95: The report suggests that extensive macroalgal blooms were recorded and have persisted through ensuing years (2008-2010). However, Table 2-1 shows June-July 2008 had the highest percent macroalgae cover at 20% while most other periods the coverage was less than 10%. Please provide a description and basis for the threshold used to conclude that macroalgal coverage is “extensive and persistent”.

Page 97: “When TN loading exceeds some critical threshold value there is a triggering of phytoplankton and macroalgal blooms, as well as increased epiphytic growth, that can significantly reduce light transmission to seagrass beds, leading to acute die-offs of the seagrass and the resident shellfish and other benthic invertebrates inhabiting the beds.” Please provide the threshold value nitrogen loading as well as the scientific basis for the selected threshold.

Page 98: The first paragraph indicates that the dissolved oxygen listing was based on continuous monitoring while the second paragraph indicates that this level of monitoring has not been done in Barnegat Bay. This conflict should be corrected.

Page 99: This statement is not correct and should be removed. “The occurrence of sea nettle blooms in the north segment has resulted in extensive non-swimmable waters in violation of the Clean Water Act (Figure 5-6).” Sharks, alligators and sea nettles are not pollutants subject to restrictions under the Clean Water Act.

Page 295, Sensitivity analysis: “Therefore, under the multi-year scenario (1999-2010) that includes total phosphorus, the weightings are: temperature 15%, dissolved oxygen 8%, total nitrogen 13%, and total phosphorus 65%.” Does this indicate that the order of importance is total P, temperature, TN and DO? Therefore, TP is more important than TN in terms of the water quality component index? The importance of TP should be discussed in the text and weighed versus other conclusions on TN. A critical examination of the appropriateness of the sensitivity analysis in light of the multiple comments above (e.g., availability of data, weightings, etc) also needs to be completed. This examination should answer questions about whether the sensitivity analysis is robust or weak due to the variability in data availability.

Figure 3-39, Overall Eutrophication Index: A trend line should be fitted to each segment in order to evaluate the estimated direction/trend of the index. However, the feasibility and appropriateness of fitting a line should be considered after other comments have been addressed.