UNIVERSITY of NEW HAMPSHIRE

February 19, 2013

Eric Spear, Mayor
City of Portsmouth

Dean Trefethen, Mayor
City of Dover

T.J. Jean, Mayor
City of Rochester

Dear Mayors Spear, Trefethen, and Jean;

We are writing to you in response to your request for input on research and monitoring in the Great Bay Estuary. Please accept our apologies for taking so long to respond. As University of New Hampshire professors, we feel it is part of our mission to provide technical information to citizens and municipal officials in cases where we have the knowledge and expertise to do so. In your letter, you cite claims attributed to the USEPA regarding conditions and cause and effect scenarios in the estuary. We are curious how these claims were expressed by EPA and would be interested in seeing the original documents from which they were excerpted if you are wiling to share them.

Regarding the questions you have posed, first of all, we were either principal investigators on studies that pertain to your questions, or have been involved in written review studies or lengthy discussions of all studies as part of PREP TAC and other meetings. Secondly, because of the way your questions are worded and your request that they focus solely on studies that have been conducted in 'this system, e.g., the Great Bay Estuary, the answers for most of the questions would be "no" with some qualifiers for a few of them. This is a function of two facts, the first of which is that most data used to frame our understanding of how nutrient dynamics in the estuary works and what causes changes in water quality conditions are generated by monitoring programs. The purpose of monitoring programs is generally to assess the status, and when extended over time and space, the trends for whatever is of concern and is being measured. Data generated from this framework are not designed to answer questions of cause and effect, source identification and other 'why' and 'how' questions; these require specific studies designed to answer them or to address hypotheses. The second fact is that there have been few or no published studies designed to answer these questions.

The comments below have been generated from our collective memory, or a quick reference to existing studies. We will not respond to these questions in depth because it would take significant time and effort to provide more thorough answers.

Transparency-related issues:

#1- NO

There are several aspects to this question that are assumptions not necessarily backed up by any available data, including 'increase in phytoplankton growth', and 'lowering water column transparency…', let alone the relationship between TN, chlorophyll *a* and transparency measures. The only measures of phytoplankton growth that we are aware of are the respiration measures conducted in the Squamscott River in 2011 as part of the Coalition-funded study; otherwise, phytoplankton population dynamics are inferred from chlorophyll *a* data collected as part of monitoring studies, that include a few more detailed studies like the early studies conducted by Langan as part of the early NERR monitoring program during phytoplankton blooms in Great Bay and the various spatially-intensive DO-water quality studies

conducted by Pennock (Lamprey), Jones (Squamscott & Lamprey), and the 2011 Coalition study in the Squamscott River that included measures of chlorophyll *a*. Otherwise, there are no places where we are aware of documented increasing phytoplankton populations, and in many areas chlorophyll *a* remains present at relatively low levels. Many areas of the estuary are turbid due to CDOM and suspended sediments, the latter is largely a function of re-suspension events caused by wind and waves at low tide across the shallow areas of the estuary and by relatively rare large scale runoff events. As for changing TN levels, even at Adams Point there has been little change since the late-1980's, and a review of the NHEP Technical Characterization Report (Jones 2000), authored by ALL JEL scientists, N levels in GBE tributaries (Oyster, Lamprey, Bellamy) were lower during the 1990's than during the late 1970's.

#2-There are two questions here; YES, to the first part (a) and NO to the second part (b).
a) YES. The study by Morrison et al. found phytoplankton/chlorophyll *a* concentration-related contribution to transparency limitation in Great Bay to be 12% (Great Bay buoy) of the total limitation from all factors; CDOM, water and suspended sediments were the major factors. The study did not include eelgrass growth measures. There was one verbalized interpretation of this finding at a TAC meeting where Morrison presented the results of his study that was not backed up by any analysis, yet it was accepted by some as feasible and promulgated thereafter, that even this relatively small influence was, "...enough to limit eelgrass growth..."
b) NO. Given the small degree to which phytoplankton contributes to transparency limitation, reductions in TN were not discussed in this report. TN reductions would not appear to provide much in the way of improving transparency through this mechanism, although no study has been conducted to address this. Given the large reserve of TN in sediments and its efflux during warm months to the water column, reducing TN loading may not have much influence on TN levels in the estuary for quite some time. What the study did state in the Executive Summary was that "...it would be predicted that water clarity in Great Bay, Little Bay and the Lower Piscataqua River was sufficient for eelgrass growth. Absence of eelgrass from any one of these areas is suggestive of factors other than water clarity controlling eelgrass distribution".

#3-NO & YES
We believe the habitat restoration document (O'Dell et al.) suggested that eelgrass restoration in a few of the rivers (Squamscott) is not feasible in part by poor transparency, although we'd have to go back and look at that. As well, it is well established that eelgrass will not grow in water that is too deep, so transparency becomes a factor limiting it's establishment and growth at lower depths within the estuary. For areas where it is and has been present, i.e., some of the shallow areas of the estuary, transparency has not, to our knowledge, been demonstrated as a primary factor limiting growth; myriad other factors have been cited as being primary limiting factors. Also see previous answer for a direct response to this question.

#4-NO
We have not seen any analysis, or even a comprehensive consideration of all of these factors that would enable discerning the relative influence of each on what happened to eelgrass in 2006. Emerging research on sediment re-suspension in Great Bay suggest extreme runoff events, like what happened during 2006, cause highly significant sediment re-suspension.

<u>Nitrate toxicity</u>:

#5: NO
No studies on nitrate toxicity in eelgrass in the GBE have been conducted, and we are not aware of any study showing this was a factor in 2006. This seems to be highly speculative, especially because nitrate levels did not change that drastically in 2006 compared to other years.

<u>Dissolved oxygen impacts:</u>

#6: NO
This question is a bit strange in that algal growth assumes photosynthesis and under these conditions DO is increased; at night algae respire and take up oxygen and can cause lower DO levels to occur. A 2005 study by Jones in the Squamscott River was designed to capture this latter condition by conducting river length surveys early in the morning under tidal conditions that were most frequently associated with

lower DO levels. That study and a similar one (Jones 2007) did not reveal any extensive low (<5 mg/L) levels, and low DO levels that did occur were not correlated with chlorophyll *a* levels.

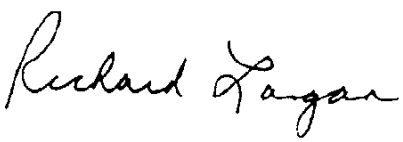
Macroalgae impacts:

#7: a qualified "NO"
Most studies addressing the decline of eelgrass list an array of factors affecting eelgrass populations in Great Bay. There are sparse data on macroalgae biomass trends, the little available data, along with many anecdotal accounts, suggest increases have occurred, although it is also well accepted that macroalgal blooms are ephemeral and unpredictable. There was a study that mapped eelgrass and macroalgae (Pe'eri et al. 2008) that left many suggestions for future studies but few conclusions from their actual study, and no conclusions of cause and effect. One weakness of their project was there was no ground-truthing of eelgrass at the time of the study. Given the accepted concept of how ephemeral macroalgal mats are in the estuary, this was acknowledged to be a significant factor that should be required in any new studies. No studies have demonstrated mechanisms for macroalgae growth causing decreases in eelgrass populations.

#8: NO
Not much data are available on this, though many people weigh in with anecdotal input that this may be happening. Our personal observations are that there has been an increased presence of macroalgae in intertidal and shallow subtidal areas of tidal rivers where water salinity is high enough, but its occurrence is ephemeral and not consistent over time, within seasons and between years. How this would affect establishment of eelgrass in the rivers is not something anyone has studied, to our knowledge.

In closing and with regards to your suggestion that we comment about types of research that need to be funded to answer these questions, please realize that in a climate of limited resources, these issues are among many that should be investigated through funded research to provide answers for critical problems in the NH Seacoast. The best next step in terms of prioritization of research and monitoring efforts should be in the context of all critical issues, to enable synergistic studies that can address multiple issues and thus leverage limited resources in the most efficient way possible. There are always new research efforts underway, including some addressing questions related to nutrient dynamics in the estuary.

Sincerely,



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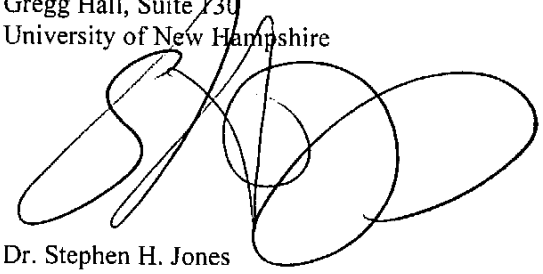

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