outfalls. In response to the identification of these impairments, the City of Manchester implemented a Section 319 restoration project in the watershed which was designed to eliminate excessive sediment transport to the lake. NHDES provided comprehensive information on the steps that the City has taken to remove the deltas, install BMPs, and reduce storm water discharges to the lake. Since removal of the deltas and the sediment sources, recreational uses are no longer impaired. EPA supports delisting on this basis.

Crystal Lake, Manchester (NHLAK700060703-02-01)
Crystal Lake, Town Beach (NHLAK700060703-02-02)

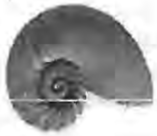
14. The NHDES moved one AU impaired for primary contact recreation due to E. coli to Category 2 (Fully Supporting for primary contact recreation). This AU was listed because of an illicit discharge. A follow-up investigation identified two sources. Both sources were disconnected in 2007. Follow-up outfall monitoring revealed E. coli concentrations of <30/100 mL in the pipe. In-situ sampling from 2003 to the present revealed no exceedences of the single sample or geometric mean water quality criteria in the 55 samples collected. EPA concurs with the State's decision to remove this AU from the 303(d) List.

Lamprey River/MaCallen dam (NHIMP600030709-03)

Waters impaired by nonpoint sources of pollution

The State properly listed waters with nonpoint sources causing or expected to cause impairment, consistent with Section 303(d) and EPA guidance. Section 303(d) lists are to include all WQLSs still needing TMDLs, regardless of whether the source of the impairment is a point and/or nonpoint source. EPA's long-standing interpretation is that Section 303(d) applies to waters impacted by point and/or nonpoint sources. In 'Pronsolino v. Marcus,' the District Court for Northern District of California held that Section 303(d) of the Clean Water Act authorizes EPA to identify and establish total maximum daily loads for waters impaired by nonpoint sources. Pronsolino v. Marcus, 91 F. Supp. 2d 1337, 1347 (N.D.Ca. 2000). This decision was affirmed by the 9th Circuit court of appeals in Pronsolino v. Nastri, 291 F.3d 1123 (9th Cir. 2002). See also EPA's Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act – EPA Office of Water—July 29, 2005.

Exhibit 5



My comments on the Great Bay nutrient criteria draft document

Matt Liebman to: Alfred Basile, Phil Colarusso, 11/21/2008 01:11 PM

From: Matt Liebman/R1/USEPA/US

To: Alfred Basile/R1/USEPA/US@EPA, Phil Colarusso/R1/USEPA/US@EPA, David Pincumbe/R1/USEPA/US@EPA, Jean

Al, and the rest of the crew, here are my final comments. I won't address issues that I think the rest of you will be addressing.

A good introductory sentence that praises there efforts would be good. I like the overall weight of evidence approach, and that they are applying a conceptual model that tests whether there is a dose response relationship in the data. And, most importantly, they find secondary, or independent, impacts from increasing concentrations of nutrients. These secondary impacts are independently related to use impairments. Thus, they are following a sound scientific approach to determine nutrient and chlorophyll thesholds above which impairments are likely to occur.

We discussed the issue about phosphorus limitation in the tributaries. We should stress that since the data indicate that phosphorus may be a limiting nutrient in the tributaries, it is important to move forward with protective criteria for phosphorus in rivers and streams.

They eliminated some data below detection limit. This may introduce some bias in the dataset, so it is worthwhile to find out how many samples were excluded.

I have no problem with using a 90th percentile approach for a swimming threshold, but a little more explanation of the 20 mg/l chlorophyll standard is called for, since that influences the criterion strongly. As we discussed, we are concerned that the threshold for freshwater is 15 ug/l, but for saltwater it is 20 ug/l. Can that be reconciled, or explained? This is important, because that would result in a nitrogen criterion closer to 0.55 mg/l TN.

To convert the threshold from yearly to summer, they applied the ratio of the summer to the year for one tributary (Squamscott), but I'm wondering if the same ratio holds for the other tributaries.

Re-reading the last paragraph on the bottom of page 41, I think he misstated his conclusion. He says that organic matter may be responsible for 47% of turbidity. That was the conclusion from the previous paragraph. In this paragraph, he is correlating turbidity with nitrogen (not particulate matter).

Anyway, the next paragraph opening sentence is the key sentence. He says that chlorophyll and half of turbidity are causally linked to nitrogen. This will be an objectionable sentence to some people, because the data are correlations, not causal. So, we should stress that even though the data are correlative, because of the strong relationships exhibited in the data, and because many components of the conceptual model seem to be corroborated, it is very likely that nitrogen strongly contributes to turbidity in the water column, resulting in impacts to eelgrass. The question would be where does the nitrogen in the particulate matter come from? Does it come from terrigenous sources, salt marsh detritus, or decomposition from eelgrass, macroalgae, or phytoplankton sources. I wonder if that has been studied in Great Bay. I'm sure it has been studied in other estuaries like Great Bay.

Hope that helps.

Matthew Liebman
Environmental Biologist
US EPA New England
One Congress Street
Suite 1100 (COP)
Boston, MA 02114-2023

liebman.matt@epa.gov
tel: 617-918-1626
fax: 617-918-0626

Exhibit 6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
1 CONGRESS STREET, SUITE 1100
BOSTON, MASSACHUSETTS 02114-2023

December 9, 2009

RECEIVED
DEC 14 2009
DEPARTMENT OF
ENVIRONMENTAL SERVICES

Harry T. Stewart, P.E., Director
Water Division
Department of Environmental Services
29 Hazen Drive
Concord, New Hampshire 03301

Dear Harry:

We have reviewed the draft document, "Preliminary Watershed Nitrogen Loading Thresholds for Watersheds Draining to the Great Bay Estuary". Overall, we are impressed with the comprehensiveness of the technical analysis and we believe it represents a scientifically valid approach for identifying the load reductions needed to fully restore water quality in the Great Bay Estuary system. We have major concerns, however, with the proposed nitrogen limits for municipal wastewater treatment facilities and do not believe those limits will achieve water quality goals. We also have a few technical comments relative to the report and these are included as an attachment to this letter.

Our major concerns are with the New Hampshire Department of Environmental Services' (NHDES) recommendations contained in the report. These concerns are outlined below:

- The nitrogen targets for each sub-estuary reach must be consistent with fully restoring designated uses as defined in the Surface Water Quality Regulations. Applicable regulations include:

> *"All surface waters shall be restored to meet the water quality criteria for their designated classification, including existing and designated uses, and to maintain the chemical, physical, and biological integrity of surface waters."*
>
> *"The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region."*
>
> *"Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function."*

Wherever eelgrass historically existed, nitrogen reduction targets must be consistent with achieving the nitrogen criteria established for the restoration and protection of eelgrass habitat. It is not sufficient to establish nitrogen targets that only achieve dissolved oxygen criteria (rather than the lower nitrogen criteria needed to protect eelgrass) in tidal rivers where eelgrass historically existed. If restoring eelgrass is not feasible, and such a demonstration can be made consistent with the Use Attainability Analysis provisions in state and federal regulations, the state can pursue a change to the standards.

- The report recommends wastewater treatment facility limits for nitrogen of 8.0 mg/l. Based on the analysis in the report, however, those limits would still result in excessive nitrogen loading and violations of water quality standards, unless nonpoint source loads are reduced by 68 - 78%. Such a dramatic reduction in nonpoint source loads could not be achieved without substantial new statutory and regulatory requirements, along with enforcement authority and sufficient funding. We would like to discuss whether there is a realistic plan to achieve those reductions. If not, an 8.0 mg/l limit for wastewater treatment facilities is inconsistent with the requirement to meet water quality standards.

Affordability issues for wastewater treatment facilities associated with meeting lower nitrogen limits can and should be evaluated on a case by case basis in accordance with federal affordability guidelines.

Given the severe impairments, including near total loss of eelgrass from tidal rivers and from Little Bay, we believe it is imperative to act quickly to begin to reduce nitrogen loads. Full restoration of this important resource will be significantly enhanced if we can begin the process of recovery before the remaining eelgrass in Great Bay is lost. As you know, the eelgrass remaining in Great Bay is showing clear signs of impaired health.

To this end we would like to meet with NHDES at your earliest convenience to discuss a permitting strategy that is consistent with the requirements of the Clean Water Act and that will result in permits that we can defend before the Environmental Appeals Board from challenges that are likely to come from a diverse group of stakeholders. Please contact me at (617) 918-1501 at your earliest convenience to arrange such a meeting.

Also, please contact me if you have any questions or if you want to discuss any of the issues raised in our letter.

Sincerely,

Stephen Perkins, Director
Office of Ecosystem Protection

Technical Comments

1. Did the USGS studies that formed the basis for the attenuation assumptions include rivers and streams experiencing cultural eutrophication resulting from excessive phosphorus loadings? Rivers and streams experiencing phosphorus driven cultural eutrophication may have artificially high attenuation rates for nitrogen. As the cultural eutrophication is controlled, the delivery rate of nitrogen may increase.

2. The sensitivity analysis only varied salinity by 10% when the variability within sub-estuaries can vary by much more. We recognize that simplifying assumptions were necessary and that a representative station for each sub-estuary had to be chosen, but it is important to note that the upper part of most sub-estuaries will have significantly lower salinities and potentially higher nitrogen levels than predicted for the representative stations.

3. Calibration to measured nitrogen concentrations was achieved by reducing the annual stream flow variable by 25%. To the extent that other factors, e.g., uptake by micro and macro-algae, might explain the over prediction of ambient nitrogen levels, this should be discussed in the report.

Exhibit 7

ATTORNEY / CLIENT

Stephen Silva/R1/USEPA/US
02/11/2010 03:59 PM

To Carl Deloi/R1/USEPA/US@EPA
cc Brian Pitt/R1/USEPA/US@EPA, David Pincumbe/R1/USEPA/US@EPA, Ken Moraff/R1/USEPA/US@EPA, Lynne
bcc
Subject Re: Great Bay SWA legislation

Hi Carl,

Thanks, this is very interesting.

A few initial thoughts based on the meeting this morning. For Great Bay we need the following one way or the other:

1) TN WQBELs for the WWTPs, - either 5 mg/l (with CLFs agreement not to appeal) or 3 mg/l (likely with a longer implementation schedule)
2) A detailed phased and quantified Watershed Management Plan covering how necessary N reductions will occur:
- septic system N load reduction
- regulated and unregulated urban stormwater runoff N load reduction[1]
- agriculture N load reduction
3) A reliable N load reduction implementation funding source for each N source component:
- WWTPs, schedule for projected user charge increases and SRF support
- regulated and nonregulated urban runoff and septic systems, a utility district of sorts with an annual charge based on estimated annual N load of each municipal and private property owner (to provide a steady income base to support urban stormwater BMPs and septic system N load abatement)
- agriculture, 319 and EQUIP funding or equivalent, possibly include ag in any utility district and assess a charge based on estimate N load
4) Items 1 through 3 could be incorporated in a baywide TMDL with loading capacity estimates based on the state's current salinity model, if desired. We could also do mini segment specific impervious cover TMDLs for urban stormwater or segment specific agricultural TMDLs for more local coverage, if desired.

[1] For urban stormwater we need about 1 year's monitoring on SW N BMP effectiveness and optimization from the UNH Stormwater Center or another source to calibrate our BMP performance analysis model.
http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/BMP-Performance-Analysis-Report.pdf

Steve

Carl Deloi   I recommend reading this, it's short. Keep in min...   02/11/2010 10:32:59 AM

Carl Deloi/R1/USEPA/US
02/11/2010 10:32 AM

To Stephen Silva/R1/USEPA/US@EPA, Ken Moraff/R1/USEPA/US@EPA, Mel Cote/R1/USEPA/US@EPA, Lynne Hamjian/R1/USEPA/US@EPA, Brian Pitt/R1/USEPA/US@EPA, David Pincumbe/R1/USEPA/US@EPA
cc
Subject Great Bay SWA legislation

I recommend reading this, it's short. Keep in mind that, despite what the legislation says, a majority of the municipal energy is still focused on fighting EPA permit limits.

CHAPTER 22C SWA.doc

Carl R. DeLoi, Chief
Wetlands & Information Branch
EPA-New England
5 Post Office Square
Suite 100 (OEP05)
Boston, MA 02109-3912
617-918-1581

Great Bay Estuary - DRAFT

The Great Bay Estuary has a watershed area of 1023 square miles and includes the waters of Great Bay, Little Bay, the Piscataqua River and several other tidal rivers feeding these water bodies. All or portions of approximately 42 New Hampshire and 10 Maine communities are located in the Great Bay Estuary watershed

Great Bay and Little Bay are fed by five tidal rivers (the Bellamy, Oyster, Lamprey, Exeter/Squamscott, and Winnicut) and drain to the Piscataqua River at Dover Point. The Upper Piscataqua (above Dover Point) is formed by the confluence of three other tidal rivers, the Salmon Falls, the Cocheco and the Great Works. The Lower Piscataqua is defined as the section of the river below the confluence of the Upper Piscataqua and Great Bay/Little Bay (see attached map).

Great Bay, Little Bay, the Upper and Lower Piscataqua, and all of the tidal rivers draining to Great Bay and Little Bay are impaired due to excessive nitrogen loadings. Eelgrass loss in the tidal rivers to Great Bay and Little Bay ranges from 97 percent – 100 percent in all except the Winnicut River (5 percent loss). Great Bay has lost only 5 percent of its eelgrass, but there are clear signs of deteriorating health. Little Bay has lost 97 percent of its eelgrass. Eelgrass loss in the Upper Pisctaqua is 97 percent and in the Lower Piscataqua is 82 percent.

In June, 2009, the New Hampshire Department of Environmental Services (DES) proposed numeric criteria for nitrogen in the Great Bay Estuary for the protection of eelgrass habitat and for the prevention of low dissolved oxygen. The criteria for the prevention of eelgrass loss is 0.3 mg N/L and the criteria for prevention of the dissolved oxygen standard is 0.45 mg/l. DES used these criteria to determine that most of the Great bay Estuary was impaired for nitrogen and to add these impairments to New Hampshire's 2008 303(d) list.

Nitrogen is delivered to the Great Bay Estuary system via point sources and non-point sources (NPS) originating in both New Hampshire and Maine. DES estimates that during normal conditions (2003-2004) approximately 1025 tons of nitrogen per year are discharged to the estuary by POTWs (250 tons), nonpoint sources (760 tons), groundwater (9 tons), and atmospheric deposition to tidal waters (5 tons) [1]. While NPSs are the dominant load (about 75 percent overall with 78 percent for Great Bay/Little Bay and 59 percent for the Upper Piscataqua), point source loadings are significant. There are 14 municipal wastewater discharges in New Hampshire (EPA issued permits) and 4 municipal wastewater discharges in Maine (delegated permits program) contributing approximately 19 MGD of wastewater to the Great Bay Estuary. The combined design flow of these facilities is 31 MGD (see Table 1).

Deleted: and

NHDES has recently completed a nitrogen allocation analysis[2], which EPA intends to use in reissuing overdue permits. The analysis provides estimates of wastewater treatment plant loads and non point source loads, but does not have the ability to discriminate nonpoint source loads into specific components (e.g. storm water, septic systems, agricultural runoff). The analysis utilizes a simple steady state mixing model based on salinity and identifies reductions in current nitrogen loadings that are necessary to meet appropriate nitrogen concentration targets in all parts of the Estuary (with the exception of the Lower Pisctaqua, which was not able to be modeled due to salinities being nearly equal to ocean water salinity). The analysis evaluated

Deleted: had intended

[1] SeeTable 19 of Draft Preliminary Watershed Nitrogen Loading Thresholds for Watersheds Draining to Great Bay Estuary, October 30, 2009

[2] Draft Preliminary Watershed Nitrogen Loading Thresholds for Watersheds Draining to Great Bay Estuary, October 30, 2009 ("the October 30, 2009 Nitrogen Thresholds Report")

nitrogen loading reductions necessary to restore eelgrass everywhere it historically occurred and, alternatively, only in Great Bay, Little Bay and the Upper Piscataqua River (while meeting the less stringent dissolved oxygen based nitrogen target in the tidal rivers). The analysis and New Hampshire DES's recommendations for permit limits were released publicly in draft form at the end of October without consultation with EPA.

Three different conditions were modeled (dry year, normal year, and wet year) and seven different WWTP source treatment levels ranging from no treatment to 3.0 mg/l at current discharge flows. The analysis showed that to achieve nitrogen concentrations consistent with the restoration of eelgrass to all of its historic range under normal condition would require nitrogen reductions ranging from 51 percent in the Bellamy River to 74 percent in the Cocheco River[3]. Table 2 below shows ranges of POTW and non point source reduction that would achieve water quality goals. For example, if POTW were required to achieve effluent total nitrogen (TN) concentrations of 8 mg/l, the necessary non point source reductions would be 68 percent in Great Bay and Little Bay, and 78 percent in the Upper Piscataqua. If the POTWs were required to achieve effluent limitations of 3 mg/l, the corresponding non point source reduction would be 58 percent and 60 percent.

Deleted:

NHDES is recommending that eelgrass only be restored to Great Bay, Little Bay, and the Upper Piscataqua, and that the percent reduction in point sources and NPSs should be approximately the same. This translates to 8.0 mg/l limits for all treatment facilities at current discharge flows (assuming a normal year). This scenario would require a 45 percent reduction in the NPS loadings to Great Bay and Little Bay and a 61 percent reduction in the NPS loadings to the Upper Piscataqua. With limits of 3.0 mg/l at current flows, the required NPS reduction to Great Bay and Little Bay would be 35 percent and the required NPS reduction to the Upper Piscataqua would be 44 percent.

Issues:

* Water quality standards require restoring eelgrass to all of its historic range. Even if all facilities were at 3.0 mg/l at current flows, this would require a 58 percent reduction in the NPS loadings to Great Bay and Little Bay and a 60 percent reduction in the NPS loadings to the Upper Piscataqua (see Table 2 below comparing eelgrass restoration alternatives).

* Even if a comprehensive NPS program with regulatory authority and enforcement capability was developed and implemented, the NPS reduction required is very large under all scenarios and is greatest in scenarios that do not include high levels of control for POTWs. There is no track record of successfully reducing NPS loadings of nitrogen. Reductions of nitrogen in storm water are particularly difficult to achieve because, unlike phosphorus, nitrogen is not typically attenuated in soils, meaning that reductions in impervious area would not necessarily result in significant reductions in nitrogen discharged to receiving waters.

* Limits of 8.0 mg/l would be difficult to defend if challenged, since they do not ensure attainment of eelgrass criteria unless an unprecedented level of control of NPS loads is assumed. The Conservation Law Foundation, which has been heavily involved in Great Bay issues, would be expected to appeal limits of 8.0 mg/l and might appeal limits of 5.0 mg/l.

[3] See Table 28 from October 30, 2009 Nitrogen Thresholds Report

Table 1

State	POTW	Discharge Location	Average Flow (MGD)[4]	Design flow (MGD)
New Hampshire	Exeter	Squamscott River (tidal)	1.792	3
	Newfields	Squamscott River (tidal)	0.049	0.117
	Epping	Lamprey River	0.235	0.5
	Newmarket	Lamprey River (tidal)	0.67	0.85
	Durham	Oyster River (tidal)	0.952	2.5
	Farmington	Cocheco River	0.218	0.35
	Rochester	Cocheco River	3.462	5.03
	Milton	Salmon Falls River	0.069	0.1
	Somersworth	Salmon Falls River	1.201	2.4
	Rollinsford	Salmon Falls River	0.099	0.15
	Dover	Upper Piscataqua River (tidal)	2.837	4.7
	Newington	Lower Piscataqua River (tidal)	0.128	0.29
	Pease ITP	Lower Piscataqua River (tidal)	0.529	1.2
	Portsmouth	Lower Piscataqua River (tidal)	4.886	4.8
Maine	Berwick	Salmon Falls River	0.387	1.1
	South Berwick	Salmon Falls River (tidal)	0.327	0.567
	North Berwick	Great Works River	0.143	1
	Kittery	Lower Piscataqua (tidal)	1.023	2.5
	Total		19.007	31.154

[4] Average flow for 2003-2004

Table 2

Restoration Level	Eelgrass in all areas except tidal rivers			Eelgrass in all areas		
Nitrogen Discharge Limit	8.0 mg/l	5.0 mg/l	3.0 mg/l	8.0 mg/l	5.0 mg/l	3.0 mg/l
Great Bay and Little Bay (NPS Reduction Required	45%	39%	35%	68%	62%	58%
Upper Piscataqua River (NPS Reduction Required)	61%	51%	44%	78%	67%	60%

Exhibit 8

NKMS

Nelson Kinder Mosseau & Saturley PC
ATTORNEYS AT LAW

E. Tupper Kinder, Esquire
Manchester Office
Direct Dial: 603-606-5002
Email: ekinder@nkms.com

April 9, 2010

Thomas Burack, Commissioner
NHDES
29 Hazen Drive, PO Box 95
Concord, NH 03301

Curt Spalding, Regional Administrator
US EPA, Region 1
5 Post Office Square - Suite 100
Boston, MA 02109-3912

Re: Nutrient Criteria: Request for Rulemaking and Open Peer Review Process for NHDES Approach to Developing Nutrient Water Quality Standards for the Great Bay Estuary

Dear Commissioner Burack and Regional Administrator Spalding:

The City of Portsmouth on behalf of the New Hampshire communities of Dover, Durham, Exeter, Newmarket and Rochester request that NHDES initiate a formal rule making proceeding including an open and independent peer review of the scientific approach which NHDES utilized to develop the nutrient water quality standards for the Great Bay Estuary. The new standards will result in hundreds of millions of dollars of additional treatment costs for the New Hampshire communities and the Great Bay Estuary. Yet, there is little to suggest that the criteria and the corresponding expenditure of funds will deliver a measurable environmental benefit. With the severe demands on municipal and town budgets, it is imperative that there be a sound scientific basis for the nutrient criteria. Each community has an interest in protecting and promoting water quality, but there must be a demonstrated cause and effect. This demands that the technical validity for NHDES's new approach to setting water quality criteria be independently assessed.

There are two basic reasons for our concerns. First, the NHDES approach to setting nutrient water quality criteria is procedurally flawed. Although the nutrient criteria fall clearly within the definition of "rules" as set forth in RSA 541A, NHDES has failed to initiate a rulemaking proceeding or to apply any of the due process safe guards required under RSA 541A. Moreover, NHDES has sought EPA Region 1's approval of these nutrient criteria and requested EPA to use its Office of Science and

Technology to perform a closed peer review that further violates the due process rights of the New Hampshire communities. The EPA internal peer review process does not purport to comply with due process requirements, but rather engages in a closed process involving internally hand-picked reviewers to address a limited list of NHDES-developed questions. This process is not a fair or open process required by rulemaking procedures established by law and does not provide any of the effected New Hampshire communities or independent scientists with an opportunity to have input into the review process.

From a substantive approach, the establishment of the nutrient water quality criteria for the Great Bay Estuary is also flawed. This unprecedented approach assumes that nitrogen directly impairs eelgrass populations without confirming that nutrients are the cause of eelgrass impairment or establishing that nutrient control will remedy the current concerns about the loss of eelgrass habitat. It short, this approach is a radical departure from published criteria development methods that have always been premised on a clear scientific demonstration of causation and need.

As you are aware, EPA has historically conducted an independent peer review of new scientific approaches before utilizing such approaches in the water quality criteria development process (see, e.g., Science Advisory Board Review of EPA's Approach to Emerging Contaminants and EPA's 2006 Peer Review Handbook). The purpose of an independent peer review is to ensure EPA is basing its regulatory program requirements on scientifically defensible and well-documented evidence linking the environmental concern to a workable regulatory solution. You are likely also aware that EPA's Office of Water recently requested the Science Advisory Board (SAB) to review the agency's draft guidance document entitled *Empirical Approaches for Nutrient Criteria Derivation*. In response to the agency's request, the Science Advisory Board Ecological Processes and Effects Committee, augmented with additional experts, has been meeting to conduct a review of the guidance. This approach recognizes that independent peer review is the preferred and required process evaluating a new approach to the setting of nutrient criteria which will undoubtedly have such wide-reaching ramifications.

Given the importance of having scientifically defensible procedures for generating nutrient standards, we respectfully request that you direct the NHDES and the EPA Office of Water to submit the NHDES nutrient criteria for the Great Bay Estuary for independent peer review at the Science Advisory Board. We believe it is highly probable that the nutrient criteria established by NHDES and approved by EPA Region I will not result in any meaningful ecological improvements and that this open and fair review process is critical to developing criteria that will be both cost effective and beneficial to the Great Bay Estuary.

Very truly yours,

City of Portsmouth

By its attorneys,

Nelson, Kinder, Mosseau & Saturley, P.C.

E. Tupper Kinder, Esquire

ETK/sma/ljl

cc: The Honorable Governor John H. Lynch
The Honorable Judd A.Gregg, United States Senate
The Honorable Jeanne Shaheen, United States Senate
Congresswoman Carol Shea-Porter
Congressman Paul W. Hodes
John Bohenko, Portsmouth City Manager
J. Michael Joyal, Jr., Dover City Manager
John Scruton, Rochester City Manager
Becky I. Benvenuti, Durham Town Clerk
Todd Selig, Durham Town Administrator
Russell J. Dean, Exeter Town Manager
Harry Stewart, NHDES

Paul Currier, NHDES
Orville B. Fitch, II, Esquire Deputy Attorney General
Carl Dierker, Esquire U.S. EPA Region 1 General Counsel
Ephraim King, Director, U.S. EPA Office of Science and Technology
Lauren J. Noether, Esquire Senior Assistant Attorney General

NK
MS
Nelson Kinder Mosseau & Saturley PC
ATTORNEYS AT LAW

E. Tupper Kinder, Esquire
Manchester Office
Direct Dial: 603-606-5002
Email: ekinder@nkms.com

May 12, 2010

Thomas Burack, Commissioner
NHDES
29 Hazen Drive, PO Box 95
Concord, NH 03301

Re: Nutrient Criteria: Request for Rulemaking and Open Peer Review Process for NHDES Approach to Developing Nutrient Water Quality Standards for the Great Bay Estuary

Dear Commissioner Burack:

As you know, on April 9, 2010, a letter was submitted by the New Hampshire communities of Dover, Durham, Exeter, Newmarket, Portsmouth and Rochester, requesting that NHDES initiate a formal rulemaking proceeding including an open and independent peer review of the scientific approach which NHDES utilized to develop Nutrient Water Quality Standards for the Great Bay Estuary. Our communities are intensely interested in the health of the Great Bay Estuary and rely upon it for the quality of life enjoyed by its citizenry. However, we are extremely concerned that NHDES's nutrient impacts and criteria evaluation has failed to fully and properly evaluate the effect of nutrients on eelgrass populations and measures necessary to ensure protection of the Great Bay Estuary resources. We believe that the current nutrient criteria analysis is misplaced because of inadequate data and lack of assessment tools needed to properly evaluate this complex system. This lack of critical information caused NHDES to make assumptions about the causal relationship between nutrient levels and the environmental health of the Bay, which are simply not warranted and not supported by reliable scientific data. If these misplaced assumptions are not corrected, the Great Bay's valued resources will not be restored or protected and an enormous waste of scarce municipal resources will occur. Such an occurrence is not in anyone's interests.

The concern expressed by these communities in the April 9, 2010 letter has been heightened by the development of additional information over the last month. On April 27, 2010, the Science Advisory Board ("SAB") finalized its review of EPA's guidance document, Empirical Approaches for Nutrient Criteria Derivation. At the time of the April 9, 2010 letter, the SAB's analysis was only in draft form. The final report demonstrates quite clearly that the type of approach taken by NHDES to

Very truly yours,

City of Portsmouth on behalf of
Dover,
Durham,
Exeter,
Newmarket,
Portsmouth, and
Rochester,

By Counsel for the City of Portsmouth,

Nelson, Kinder, Mosseau & Saturley, P.C.

E. Tupper Kinder, Esquire

ETK/sma
Encls.
cc: The Honorable Governor John H. Lynch
The Honorable Judd A.Gregg, United States Senate
The Honorable Jeanne Shaheen, United States Senate
Congresswoman Carol Shea-Porter
Congressman Paul W. Hodes
John Bohenko, Portsmouth City Manager
J. Michael Joyal, Jr., Dover City Manager
John Scruton, Rochester City Manager
Edward J. Wojnowski, Newmarket Town Administrator
Todd Selig, Durham Town Administrator
Russell J. Dean, Exeter Town Manager
Harry Stewart, NHDES
Paul Currier, NHDES
Orville B. Fitch, II, Esquire Deputy Attorney General
Carl Dierker, Esquire U.S. EPA Region 1 General Counsel
Ephraim King, Director, U.S. EPA Office of Science and Technology
Lauren J. Noether, Esquire Senior Assistant Attorney General
Peter H. Rice, City Engineer
Suzanne Woodward, Assistant City Attorney

EXHIBIT A

Assessment of Appropriate Peer Review Charge Questions For Evaluation of the Numeric Nutrient Criteria for the Great Bay Estuary, New Hampshire

Prepared by
Hall & Associates
Washington, D.C.

The New Hampshire Department of Environmental Services (DES) recently proposed draft numeric criteria for total nitrogen to protect eelgrass habitat in the Great Bay Estuary. [1] The Report indicates that multiple lines of evidence were used in a "weight-of-evidence" analysis to derive the proposed numeric nutrient criteria. The Report states that data sources were chosen based on relevance to a conceptual model of eutrophication in estuaries. This would imply that total nitrogen (TN) was the cause of excessive plant growth in the Great Bay Estuary, which in turn caused the reduced light penetration that adversely affected eelgrass growth. The evaluation concluded that low dissolved oxygen and loss of eelgrass habitat were the most important impacts to aquatic life from nutrient enrichment and recommended ambient thresholds for TN concentration to address these impacts. Correlations between TN concentrations and chlorophyll-a, dissolved oxygen, and water clarity were assessed using linear regressions to establish the proposed numeric criteria.

Unrelated to this development, the EPA Science Advisory Board, Ecological Processes and Effects Committee, recently considered draft guidance on Empirical Approaches for Nutrient Criteria Derivation developed by EPA.[2] This guidance document described regression techniques for evaluating data for nutrient criteria derivation, such as the linear regressions used by DES for the Great Bay Estuary. The SAB cited significant deficiencies in this approach. Prior to the issuance of the SAB report, the City of Portsmouth requested that the draft nutrient criteria undergo a similar peer review. The assessment below summarizes the SAB findings relevant to the empirical nutrient criteria development approach used for the Great Bay Estuary, critiques the charge questions suggested by DES and EPA, and presents more relevant charge questions for consideration by the peer review panel, given the SAB findings.

EPA Science Advisory Board Findings on Utility of Empirical Approaches for Nutrient Criteria Development

In general, the SAB found that empirical approaches cannot be used as a stand-alone demonstration that criteria are justified. In reviewing EPA's draft guidance manual, the SAB reached the following findings that are relevant to review of the draft total nitrogen criteria developed for Great Bay Estuary.

- A clear framework for statistical model selection is needed. This framework should include: 1) an assessment of whether analyses indicate that the stressor-response approach is appropriate; 2) selection criteria to evaluate the capability of models to consider cause/effect and direct/indirect relationships

[1] New Hampshire Department of Environmental Services. June 2009. Numeric Criteria for the Great Bay Estuary.

[2] US EPA Science Advisory Board, Ecological Processes and Effects Committee. April 27, 2010. SAB Review of Empirical Approaches for Nutrient Criteria Derivation.

between stressors and responses; 3) consideration of model relevance to known mechanisms and existing conditions; 4) establishment of biological relevance; and 5) ability to predict probability of meeting designated use categories. (at xix, first bullet response on Charge Question 6)

- Without a mechanistic understanding and a clear causative link between nutrient levels and impairment, there is no assurance that managing for particular nutrient levels will lead to the desired outcome. (at 6, first paragraph)
- [T]he empirical stressor-response approach does not result in cause-effect relationships; it only indicates correlations that need to be explored further. (at 41, bullet #1)
- In order to be scientifically defensible, empirical methods must take into consideration the influence of other variables. (at 24, 2nd bullet from bottom) The statistical methods in the Guidance require careful consideration of confounding variables before being used as predictive tools. ... Without such information, nutrient criteria developed using bivariate methods may be highly inaccurate. (at 24, first complete bullet)

EPA has also provided additional background documentation regarding what should constitute an acceptable "weight of evidence" approach used in criteria development. (*"Using Field Data and Weight of Evidence to Develop Water Quality Criteria", Cormier et al, 2008 SETAC*). That document, prepared by EPA's Office of Research and Development, specifies the following, with respect to criteria derivation:

> *Development of numeric WQC is based on 3 basic assumptions: First, causal relationships exist between agents and environmental effects. Second, these causal relationships can be quantitatively modeled. Finally, if exposures to the causal agent remain within a range predicted by the quantitative model, unacceptable affects will not occur and designated uses will be safeguarded. Therefore, for criteria to be valid there must be evidence that the criteria are based on reasonably consistent and scientifically defensible causal relationships.*

Issues of Concern with Numeric Nutrient Criteria Development

The findings in the SAB report are directly applicable to the evaluations presented in the Report to support the proposed numeric nitrogen criteria, particularly with regard to the assumed relationship between eelgrass habitat and annual median total nitrogen concentration in the Great Bay Estuary. The Report (at 55, et seq.) attempts to establish a linkage between eelgrass habitat and total nitrogen via its effect on water clarity (light attenuation). The Report presents a multivariate linear regression linking light attenuation to phytoplankton (chlorophyll-a), colored dissolved organic matter (CDOM), non-algal turbidity, and water. The Report cites a study by Morrison et al. (2008) that determined the relative contribution of each of these factors to the light attenuation coefficient, indicating the following contributions: water (32%), phytoplankton (12%), CDOM (27%) and non-algal turbidity (29%). These factors are reported to explain 95 percent of the variance in the observed light attenuation measurements. The Report then presents linear regression analyses relating *total nitrogen* to median turbidity and to median light attenuation coefficient as the basis to support the proposed total nitrogen criteria.

The Report presents no mechanistic model linking total nitrogen to non-algal turbidity and the total nitrogen – water clarity regression jumps over underlying factors influencing light attenuation. The SAB report repeatedly warns that such regressions do not demonstrate cause-and-effect, and such a demonstration is needed to provide assurance that compliance with the criteria will protect the designated use. For example, that fact that TN is associated with non-algal particulates (turbidity) does not mean that controlling TN from all sources will control turbidity. Rather, if non-algal particulates are somehow controlled, turbidity would be reduced and the nitrogen associated with these particulates will also be controlled. However, waste load allocations limiting TN from POTWs, which is primarily present in the dissolved form, will have no effect on non-algal particulates and would be inappropriate if the real goal was to reduce turbidity.

The Report must provide a mechanistic model linking the stressor (nitrogen) to the responses (water clarity, eelgrass habitat) before the proposed relationships can be accepted. Of the four factors acknowledged to influence light attenuation, only phytoplankton growth is mechanistically associated with nitrogen, but the Report does not present a regression analysis for phytoplankton and light attenuation. For biologically available nitrogen to affect light attenuation, changes in concentration or loading must result in phytoplankton (chlorophyll-a) changes that are significant with respect to light attenuation. However, the data presented in the Report indicate that algal levels are quite low given the available nutrients. The fact that median phytoplankton levels are low suggests that nutrient concentrations are <u>not</u> the primary factor controlling phytoplankton growth and, therefore, nitrogen control may not significantly affect phytoplankton levels. Moreover, given the assessment indicating that only 12% of the light attenuation coefficient is attributed to phytoplankton, there is no reasonable expectation that light attenuation is significantly related to median total nitrogen due to the effect of nitrogen on phytoplankton growth. *Consequently, it appears that the entire premise of the draft criteria is misplaced.*

To be scientifically defensible, these concerns regarding the relationship between nitrogen, phytoplankton, and light attenuation must be addressed. The Report needs to provide the following evaluations:

- An analysis demonstrating that median total nitrogen controls phytoplankton growth in the Great Bay Estuary;
- A mechanistic analysis demonstrating that a reduction in median phytoplankton concentration will occur, and the impact of this reduction on light penetration, if the proposed criteria are achieved;
- A mechanistic analysis demonstrating that a TN reduction is required to address non-algal turbidity;
- A mechanistic analysis demonstrating the light attenuation goals will be achieved by reducing dissolved forms of nitrogen;
- An assessment of factors influencing light penetration that co-vary with TN and may otherwise explain or control the available light for submerged aquatic vegetation; and

- An analysis showing that (1) eelgrass losses are tied to TN increases and (2) eelgrass will be restored if the proposed criteria are achieved.

Charge Questions

The DES and EPA suggested that the peer review panel evaluate the proposed nutrient criteria with respect to the following charge questions.

- **Transparency**

  Is the process for the development of the criteria well described and documented?

- **Defensibility**

  Were accepted sampling and analysis methods used?

  Was a QA/QC process used and documented?

  Are the designated uses of the Great Bay clearly articulated?

  Is there a clear discussion of the logic of how the criteria protect those designated uses?

- **Reproducibility**

  Does analysis of the available data reproduce the results included in the report?

These proposed charge questions do not address the concerns identified by the SAB on the use of empirical approaches to develop numeric nutrient criteria. The SAB noted that the relationship between nutrients and designated use impairments is often very complex, with many confounding factors. For this reason, the SAB recommended that nutrient criteria be developed using a weight-of-evidence approach that significantly reduces uncertainty and that a clear causative link be established between nutrient levels and use impairment. These concerns are not addressed with the proposed charge questions. The basic problem with the proposed peer review is that it fails to seek confirmation on whether the Great Bay nutrient criteria report has (1) established the existence of a direct causal relationship between light penetration, eelgrass losses and TN concentration, (2) fully evaluated the factors that influence light penetration and (3) demonstrated the impact of the suggested TN reductions on algal growth/light penetration improvement. These key issues, among others, should be the focus of the peer review.

In order to address the concerns raised by the SAB and to ensure that the final numeric criteria are scientifically defensible, we recommend that the following charge questions be posed to the peer review committee.

Proposed Charge Questions

1. To be scientifically defensible, the Numeric Nutrient Criteria for the Great Bay Estuary must be based on the correct underlying causal model that considers all of the

significant factors affecting the causal variable (light penetration) and designated uses of concern (eelgrass).

a. Has the report adequately documented that lower light penetration was the cause of eelgrass losses? Was the level of light penetration used to set nutrient targets demonstrated to be necessary to support healthy eelgrass growth?

b. Has the Report adequately confirmed that ambient TN concentration increases since 1997 were the cause of eelgrass losses in the Bay and that other factors were not responsible for this condition?

c. Do the linear regressions presented in the report demonstrate cause-and-effect relationships between total nitrogen and the designated use metric (light penetration)?

d. Is the linear regression relating TN to turbidity scientifically defensible and will TN control result in significant changes in turbidity with respect to light attenuation in the estuary?

e. Has the evaluation confirmed that TN is the factor controlling phytoplankton chlorophyll 'a' concentration and that reducing TN will significantly reduce the level of plant growth with respect to light attenuation?

f. Has the Report documented that dissolved forms of nitrogen discharged by wastewater facilities or present in runoff must be controlled to achieve light penetration goals?

2. Has the uncertainty in the regression analysis been addressed sufficiently to support a target of 0.25 – 0.30 mg N/L (annual median)?

3. The Report establishes a median annual instream concentration of total nitrogen and a 90^{th} percentile chlorophyll-a concentration as the basis for maintaining compliance with the instantaneous dissolved oxygen water quality standard.

   a. Is it scientifically defensible to establish an annual median total nitrogen concentration to protect an instantaneous minimum dissolved oxygen concentration?

   b. Is it scientifically defensible to establish a 90th percentile chlorophyll-a concentration to protect an instantaneous minimum dissolved oxygen concentration?

Please contact John C. Hall at 202-463-1166 or jhall@hall-associates.com if you have any questions regarding the information contained in this document

Exhibit 9

Re: New Hampshire Nutrient Criteria Great Bay response to Kinder Letter comments

Phil Colarusso to: Ellen Weitzler 07/06/2010 02:17 PM

Cc: Brian Pitt, Carl Deloi, Damien Houlihan, David Pincumbe, Lynne Hamjian, Matt Liebman,

From: Phil Colarusso/R1/USEPA/US

To: Ellen Weitzler/R1/USEPA/US@EPA

Cc: Brian Pitt/R1/USEPA/US@EPA, Carl Deloi/R1/USEPA/US@EPA, Damien Houlihan/R1/USEPA/US@EPA, David

Ellen,

Here's a couple of general thoughts that we should keep in mind as we proceed with responding to comments.

1. **Weight of evidence approach** - NHDES certainly considered a variety of response variables in relation to their nitrogen data. Certainly, areas that had high nitrogen concentrations and multiple response variables exceeding critical thresholds warrant some type of immediate action. That being said, we should be clear that we will not wait for multiple alarms to be triggered before we do something. If we take approach that we need multiple response variable to be triggered before we react, then we risk losing our most sensitive areas. Quite frankly, NHDES, in my opinion, took a fairly middle of the road to conservative approach. They chose eelgrass loss as a response variable. By the time that you can measure that, the battle has already been lost. There are other variables such as shoot density, aboveground biomass or depth of the deep edge of a meadow that will begin to change before the entire meadow is lost. This type of data exists in New Hampshire waters, but was not used in this analysis. Great Bay has recently experienced a %50 reduction in eelgrass biomass, but that change in and of itself would not warrant listing on the impairment list. We pushed the state to consider this, but for this round decided to stay with the loss approach. My points here are that 1. Any good scientist will consider all data available to them, you can label this a weight of evidence approach if you like, but I would call it standard scientific practice; 2. Ultimately, the most sensitive response variable will generally drive the ship; so you can call it a weight of evidence approach, but 1 thing is driving the decision. For Mount Hope Bay temperature limits, it was winter flounder, though we were concerned about the entire community.

2. **Cause and effect** - The favorite argument of people who don't want to do anything. In this situation, opponents will/have pointed to factors other than nitrogen causing the problem. They point out that correlation is not causation and if they haven't already, they will point out that in many cases, we don't have nitrogen data from the exact time that eelgrass was disappearing. Here's what we do have. Eelgrass has been lost in many areas and water column concentrations in those areas exceed concentrations that lab and field studies suggest are detrimental to eelgrass. The presence of high turbidity, colored dissolved organic

matter or other factors, do not detract from the need to control nitrogen. Those other factors need to be controlled as well (last time I checked these treatment plants had TSS limits that can be lowered). Dominion argued that global warming was partially responsible for the lack of fish in Mount Hope Bay (once we got over the irony of a coal-fired power plant blaming anything on global warming, it was a simple counterargument.); the other factors argument does not work in favor of the polluter, but should work against them.

Phil

Ellen Weitzler   The word document...   07/02/2010 02:23:56 PM

From:	Ellen Weitzler/R1/USEPA/US
To:	David Pincumbe/R1/USEPA/US@EPA, Phil Colarusso/R1/USEPA/US@EPA, Matt Liebman/R1/USEPA/US@EPA, Toby Stover/R1/USEPA/US@EPA
Cc:	Samir Bukhari/R1/USEPA/US@EPA, Damien Houlihan/R1/USEPA/US@EPA, Brian Pitt/R1/USEPA/US@EPA, Stephen Silva/R1/USEPA/US@EPA, Mel Cote/R1/USEPA/US@EPA, Lynne Hamjian/R1/USEPA/US@EPA, Carl Deloi/R1/USEPA/US@EPA
Date:	07/02/2010 02:23 PM
Subject:	New Hampshire Nutrient Criteria Great Bay response to Kinder Letter comments

The word document below is an outline for a response to some specific comments made by Tupper Kinder in his May 12, 2010 letter to NHDES on behalf of municipalities in the Great Bay watershed. In the "response" spaces you'll find suggested questions (highighted) to answer to respond to these comments. The letter from Tupper Kinder is also attached.

In an effort to prepare ourselves for similar comments which are likely to come in during public comment when NH eventually adopts the criteria into their water quality standards and on draft NPDES permits in the watershed, I would greatly appreciate your taking a look at the questions raised and outlining possible answers to them. After you have all taken a look at these, I propose that we meet (hopefully by mid July) and discuss any questions that might require extra time and effort to respond to.

Please let me know if you have any questions.

Thank you.

Ellen
[attachment "Memo to File re nitrogen July 2010.doc" deleted by Phil Colarusso/R1/USEPA/US] [attachment "Kinder letter to NHDES 5-12-2010.pdf" deleted by Phil Colarusso/R1/USEPA/US]

Ellen Weitzler, P.E.
Water Quality Standards Coordinator
US EPA Region 1
5 Post Office Square, Suite 100 (OEP06-2)
Boston, MA 02109-3912

Tel 617-918-1582
FAX 617-918-0582

Hall and Associates Comments

Phil Colarusso to: Ellen Weitzler, Toby Stover, 08/03/2010 10:44 AM
Cc: David Pincumbe

From: Phil Colarusso/R1/USEPA/US
To: Ellen Weitzler/R1/USEPA/US@EPA, Toby Stover/R1/USEPA/US@EPA, Matt Liebman/R1/USEPA/US@EPA, Stephen
Cc: David Pincumbe/R1/USEPA/US@EPA

Ellen, Toby,

There is alot of misinformed statements and accusations in their report, but I think there are 3 major concepts that management here should be aware of; the question of Cause and Effect, the effect of other stressors and Hall and Associates' alternative proposal. Management does not need to get into the argument over do phytoplankton levels contribute to SOD (the answer yes, despite what they say) and other such minutia.

1. **Cause and Effect**: Great scientific term and makes for good press. They hammer this argument throughout their comments. It is not possible to establish true cause and effect using field data retrospectively. This is not a lab experiment where you can control all the variables and manipulate just one to elicit a response. We do have many laboratory experiments that show that high levels of nitrogen are bad for eelgrass, we have ample field data to show that ambient water column nitrogen concentrations exceed levels that trigger bad results for seagrasses, we have ample data showing eelgrass being lost, we also have ample experience in other systems (Tampa Bay, Chesapeake Bay, Boston Harbor, New Bedford, Gloucester) that improving wastewater treatment is really the only thing that has triggered substantial natural recovery of seagrasses.

Finally, they describe nitrogen as acting differently than most pollutants and describe it as a threshold effect. I'm not sure that I agree with that characterization. I think of it as more as a continuum of effects and maybe that's just a long series of smaller thresholds, like a staircase. Well, I would put the States endpoints for their criteria development on the midpoint of that continuum. It is not overly aggressive, using eelgrass loss as the endpoint. There are certainly other measurable endpoints that would indicate a meadow is stressed/declining before it completely disappears. I think the state could be well within their right of choosing a more stringent endpoint, which certainly will be a discussion point on the next round of this analysis. Hall and Associates' comments suggest that the State/EPA must figure specifically what this threshold concentration is and set criteria at that level. Legally, the State or EPA are not obligated to maximize the level of discharge for any polluter. We do not have to set criteria right at the threshold level, so to speak, but can set it lower as a reasonable safety margin. This point was argued in a way in front of the EAB in the Brayton Point case, when the power company stated that it was up to EPA to set discharge limits that would give them their maximum amount of discharge that would also protect the balanced indigenous population. The EAB ruled that we did not have to maximize their discharge, but we did need to assure that the resources would be protected.

2. **Other stressors** : The real world is messy and nothing happens in isolation. The State/EPA are allowed/encouraged to consider cumulative effects of pollutants on resources. Hall and Associates uses this argument in the following way; other pollutants are the real problem so don't worry about nitrogen. They go on from there to suggest that controlling nitrogen will not restore eelgrass, because of the presence of other pollutants (TSS, CDOM, etc.). The way this actually plays out in the regulatory world is that they may be required to do even more, rather than less nitrogen control, because of the other stressors. In addition, we have the controlled lab studies that suggest the concentrations of nitrogen in Great Bay are problematic for eelgrass before we even consider the other stressors, so multiple things need to be controlled.

3. **Their Alternative** : Hall and Associates put forth a 7 part proposal, which contain the following parts:

1. Additional data collection: This could be done, but we don't need to stop building nitrogen control to do this.

2. Hydrodynamic model: Waste of time and money.

3. Low cost WWTP TN Reduction: Focuses on minor plant upgrades and operational changes. These should be implemented immediately, but again should not distract from the larger long term improvements

4. Stormwater improvements: Absolutely needed, not sure if they have anything specific in mind, but should not distract from long term nitrogen control at WWTPs

5. Eelgrass restoration: Waste of time and money in this system at the moment

6. Oyster restoration: Unproven technology and unlikely to be done on a scale that will make a measurable difference to water quality

7. Ongoing monitoring program: There are ongoing monitoring programs. They suggest that the Southeast Watershed Alliance be the group to coordinate this program. They are not an independent group, so I would suggest that the ongoing Estuary project is better suited to this task.

I talked to Fred Short yesterday and he had read the Hall and Associate's larger report and had the same take on it as we do. Dave and I will be speaking to Phil Trowbridge this afternoon.

Phil

Exhibit 10

Review of: Numeric Nutrient Criteria for the Great Bay Estuary, in light of comments made by John C. Hall and Thomas Gallagher (2010)

Matthew Liebman
September 1, 2010

Background

NH DES published Numeric Nutrient Criteria for the Great Bay Estuary in June 2009.[1] In response to requests by states, EPA published additional guidance to develop nutrient criteria based on stressor-response relationships.[2] The EPA Science Advisory Board published its review of the EPA stressor-response guidance.[3] Hall and Associates, assisted by Hydroqual, published a review of the NH DES Great Bay nutrient criteria document based on the findings of the SAB review.[4] The NH DES criteria document was reviewed by two independent reviewers in 2010 through EPA's N-Steps program.

NHDES developed the Great Bay estuary using multiple lines of evidence, including deriving criteria to protect designated uses related to swimming (based on the 90[th] percentile of chlorophyll concentrations) and aquatic life use. For aquatic life use, the endpoints included dissolved oxygen levels, eelgrass extent (based on water clarity and conversion to macroalgal beds), and extent of phytoplankton blooms (e.g. 90[th] percentile of measured concentrations). Most of the approaches were based on statistical relationships between causal (total nitrogen) and response variables (e.g. chlorophyll *a* concentrations).

The SAB review criticized the EPA stressor-response guidance for inadequate attention to highlighting the need for conceptual models to provide a foundation for the expected stressor-response relationships. The SAB stated that purported stressor-response relationships based on statistical associations are not sufficient to prove cause and effect unless supplemented by additional analyses, such as multiple regressions or classification to eliminate the effects of potentially confounding, or co-varying variables. In addition, the SAB emphasized that the strength of the stressor-response relationship and levels of uncertainty should be quantified. Hall and Gallagher emphasize these points in their review of the Great Bay estuary nutrient criteria.

Thus, I reviewed the Great Bay nutrient criteria to determine whether the authors of the NH DES criteria document provided enough information to establish a scientifically defensible cause and effect relationship. To be defensible and consistent with the concerns raised by the SAB and Hall and Gallagher, I looked at whether:

---

[1] Numeric Nutrient Criteria for the Great Bay Estuary. June 2009. Prepared by Philip Trowbridge, P.E. State of New Hampshire Department Of Environmental Services. R-WD-09-12.
[2] Empirical Approaches for Nutrient Criteria Derivation. Prepared by: United States Environmental Protection Agency, Office of Water, Office of Science and Technology. Science Advisory Board Review Draft August 17, 2009
[3] SAB Ecologoical Processes and Effects Committee Review of Empirical Approaches for Nutrient Criteria Derivation. April 27, 2010.
[4] Evaluation of Proposed Numeric Nutrient Water Quality Criteria for the Great Bay Estuary. John C. Hall (Hall and Associates) and Thomas Gallagher (Hydroqual, Inc.). DRAFT. June 30, 2010.

Was a reasonable conceptual model described to explain functional relationships and established based on both literature and site-specific data or models?
Were confounding variables eliminated as potential explanations of observed relationships"?
Was the level of uncertainty evaluated?

Overall, the document meets these conditions, but could be improved in some areas. Below I make some suggestions of additional data or analyses that could be emphasized to improve the confidence of the stressor-response relationships described in the NH DES criteria document.

Conceptual models

I think the document could do a better job of explaining the connections between nutrient enrichment and biological responses in a conceptual model. Instead, these connections are interspersed throughout the document, or incomplete. They rely on literature and only sparingly rely on established results from the estuary itself. It would be better to document some of the connections within the estuary itself.

Algal blooms

For example, on page 30, it is stated that median nitrogen concentrations are the best explanatory variable for peak chlorophyll *a* concentrations. The conceptual model should state more clearly why median concentrations of TN are associated with the *90th percentile (rather than a median concentration)* in chlorophyll *a* measurements. Perhaps the conceptual model should be clarified as follows: nitrogen is the major limiting nutrient throughout the Great Bay estuary (or in salinities greater than 10 psu?) and increases in TN result in increases in primary production resulting in increases in algal biomass (as represented by chlorophyll *a*). The probability of algal blooms, as represented by the 90th percentile of chlorophyll *a*, is increased when the average concentrations of chlorophyll *a* increase.

The evidence for nitrogen limitation is presented, and there is good supporting evidence that on a seasonal basis, when bioavailable nitrogen (and phosphorus) is depleted, chlorophyll *a* levels increase.

The correlations between total nitrogen and 90th percentile chlorophyll *a* levels by assessment unit or by trend monitoring station are strong, but does this discount other factors, such as salinity and wind, or stratification? Was as strong a relationship found between median nitrogen and median chlorophyll? Is there supporting information to suggest that the chlorophyll *a* levels observed in the estuary are consistent with a response from the measured or estimated nutrient loading to the estuary? Was primary production ever measured, and if so, would the production rates result in chlorophyll biomass or bloom conditions observed in the data? When were the bloom conditions found? Are they primarily in the spring before stratification sets up, or during mixing events? Related to this, why wasn't a shorter index period used, rather than the full year? Why would the full year provide a better statistical relationship? If so, how does that figure into the conceptual model? My understanding of the growth period of eelgrass in New England is April to October, yet year round data are used. Similarly, why is year round data used when dissolved oxygen problems are manifested only in summer months?

Macroalgae

On page 37, in the discussion on macroalgae, it is stated that the macroalgae mats have now replaced areas formerly occupied by eelgrass. The conceptual model is that as TN increases, eelgrass is replaced by macroalgae, but the actual mechanism is not sufficiently explained. Are macroalgae better able to utilize nutrients in enriched conditions and thus outcompete eelgrass? Are there any literature or mesocosm experiments in Great Bay that document this? There is literature from Waquoit Bay, but is this area similar enough to Great Bay to explain the process?

Although there does seem to be supporting evidence of this replacement based on one aerial surveys, there is insufficient documentation of the loss of eelgrass and coincident replacement by macroalgae. There are two years of observations (1996 and 2007) for eelgrass, and only one year for macroalgae. Are there other observations that would support this model of replacement of eelgrass by macroalgae?

Light extinction

The section titled Conceptual Model on page 4 doesn't mention light extinction, although this is addressed later on. On page 15, the authors state that eelgrass is sensitive to water clarity without citing the specific experimental evidence in the Great Bay estuary. Fred Short and colleagues have conducted experiments in mesocosms and in the field (I think) showing that phytoplankton shade and intercept light, affecting eelgrass growth. For example, do the mesocosm experiments show the effects of increasing nitrogen enrichment on eelgrass in terms of light attenuation, or lengthening of blades, or loss of carbohydrate stores, or epiphytic growth? Are these loadings similar to loadings into Great Bay and are the responses in Great Bay expected based on the mesocosm experiments?

Page 55 has a nice summary of the conceptual model of eutrophication and light extinction that affects eelgrass. And, the model for light extinction[5] is corroborated by the data on presence and absence of eelgrass in the estuary. In areas of more light extinction, there is less eelgrass. So, this is corroboration of the model, but also a good example of a weight of evidence approach.

Confounding factors

Chlorophyll a

The authors did not sufficiently evaluate whether salinity is more important than nitrogen in controlling phytoplankton abundance. The data presented clearly shows that nitrogen tracks salinity (see Figure 6; there is higher nitrogen in the upstream, less saline tributaries). Does chlorophyll *a* track salinity as well? It does seem that there is also a gradient from upstream to downstream in chlorophyll *a* levels (see Figures 13 and 14). It would be nice to figure out what kind of suspended algae, i.e. phytoplankton, are contributing to the blooms -- are they marine or

[5] It would be good to explain how light extinction was calculated. Is it based on percent of light at 1 meter below the surface?

freshwater algae? This would provide supporting material to document that the chlorophyll *a* response is controlled primarily by nutrients, rather than habitat changes (i.e. low salinity vs. higher salinity zones).

Benthic indicators

In contrast, the authors in some cases considered confounding factors to explain the benthic indicator data. For example, the discussion of whether organic matter derived from phytoplankton blooms contributes to organic enrichment and benthic community changes in sediments on page 40 (Benthic invertebrates and sediment quality) is evaluated in the context of salinity changes, in addition to nutrient enrichment. Here they evaluated the effect of nutrient enrichment on an Index of Biotic Integrity (IBI), and found that salinity may be the controlling factor. This is based on the original work to develop the IBI, but also on reasonableness. In this case, salinity is a confounding factor and one that has been shown in the literature to be a major influence of biological communities as well.

The authors state (on page 40) that organic matter comes from primary producers, but they don't evaluate the effect of organic matter from terrestrial sources, especially in the upper parts of the estuary. On page 41, they state that the regressions prove that total organic carbon in sediments is associated with nitrogen and chlorophyll *a* concentrations in the water column, but they don't say that they are caused by them.[6] I suspect that terrestrial sources from nonpoint and sewage treatment effluent are more important than autotrophic sources of organic matter.

Dissolved oxygen

The dissolved oxygen section on page 45 presents an incomplete conceptual model, because they do not address other sources of organic matter, including sewage treatment effluent, and terrestrial runoff. Although the graphs are good, they don't really get at the actual dissolved oxygen response, which could be daily dissolved oxygen swings, or a lag, or very low dissolved oxygen in the mornings in the summer. In addition, the relationships could be confounded by salinity stratification, or flushing, rather than nitrogen. The sonde data sources for low dissolved oxygen are all in the tributaries, which are really different than the Great Bay areas, and therefore the low dissolved oxygen could be partly related to poor circulation and salinity wedges and other sources of organic matter (e.g. terrestrial organic matter). Additional information should be presented to discount these other factors.

The discussion about determining an appropriate criterion related to dissolved oxygen on page 51 should be graphed, rather than shown in text. Then we would be able to see the confidence intervals described there.

---

[6] So I think they should soften the language a little, eliminating the expression of "proof".

Light extinction

The authors make an excellent effort to determine whether light extinction is caused by algal material or non-algal material, and they conclude based on a multiple regression, that algal material is an important source of controllable light extinction.

On page 63 and in Figure 34[7] the authors suggest that the particulate organic matter in the water column expressed as turbidity is caused by nitrogen and that this particulate matter is autochthonous (i.e. derived from phytoplankton). But, there should be supplemental evidence that discounts the possibility that this organic matter is related to the salinity gradient and is from upstream sources of terrestrial runoff.

Level of uncertainty:

Uncertainty was addressed throughout the document (with a few exceptions) by characterizing the confidence intervals around the regressions. In addition, the authors sought to meet strict levels of variability and did not extrapolate beyond the regression lines.

---

[7] By the way, the two lines in Figure 34 are not fully explained.

Exhibit 11

Memorandum of Agreement between
The Great Bay Municipal Coalition
and
New Hampshire Department of Environmental Services
relative to
Reducing Uncertainty in Nutrient Criteria
for the Great Bay / Piscataqua River Estuary

WHEREAS, the Department of Environmental Services (DES) has published a Clean Water Act 305(b)/303(d) report for 2010 (the 2010 list) that lists aquatic life impairments due to nutrient-related parameters in assessment units of the Great Bay Estuary as shown in Table I (attached); DES has compiled the 303(d) list in accordance with the 2010 Consolidated Assessment and Listing Methodology (CALM); the CALM procedures for assessment of nitrogen effects on aquatic life are based on Numeric Nutrient Criteria for the Great Bay Estuary published by DES in June, 2009 (nutrient criteria); DES has published a draft Analysis of Nitrogen Loading Reductions for Wastewater Treatment Facilities and Non-Point Sources in the Great Bay Estuary Watershed dated December 2010 (loading analysis);

WHEREAS, the members of the Great Bay Municipal Coalition (Coalition) comprising the municipalities of Exeter, Dover, Durham, Newmarket, Portsmouth and Rochester, each operate a wastewater treatment facility discharging to an assessment zone listed on the 2010 list as impaired for aquatic life due to nitrogen, and each stand to incur significant costs for construction and operation of upgraded treatment facilities to reduce nitrogen loads from these facilities;

WHEREAS, DES and the Coalition agree that, relative to impairments on the 2010 303(d) list attributed to dissolved oxygen (DO) and nitrogen, there is uncertainty about the extent to which nitrogen is a causative factor relative to other factors in the listed assessment units and further agree that a dynamic, calibrated hydrodynamic and water quality model could reduce the uncertainty;

WHEREAS, DES and the Coalition agree that a weight of evidence approach such as presented in the nutrient criteria is appropriate as it relates to impairments related to eelgrass loss, there is uncertainty in the line of evidence for eutrophication as a causative factor, and additional analyses are required for macroalgae proliferation and epiphyte growth as causative factors;

WHEREAS, DES and the Coalition agree that the results of the loading analysis indicate that existing nitrogen loadings from treatment facilities operated by Coalition and other municipalities are as shown in Table II (attached); and

WHEREAS, DES and the Coalition agree that, given the uncertainties stated above and the potential financial burden of treatment plant upgrades to the Coalition municipalities, an adaptive management approach to water quality improvement is required to reduce impairments to aquatic life use in the Great Bay Estuary.

NOW, THEREFORE, IT IS MUTUALLY AGREED THAT :

I. The best way to resolve the scientific uncertainties with respect to assessment units impaired for DO and nitrogen is a collaborative effort to build a dynamic, calibrated hydrodynamic and water quality model, starting with the Squamscott River, that includes all of the major factors affecting the DO regime. This effort would include additional data collection as needed to calibrate and verify the model and will be substantially completed by January 2012.

II. EPA action to finalize and issue the draft Exeter permit, and any other draft permits that may be released, should be stayed so that municipal resources may be focused on resolving collaboratively with DES the uncertainties concerning the relationship between DO and nitrogen in the Squamscott and Lamprey Rivers.

III. Additional work on the multiple lines of evidence for the relationship between nitrogen and eelgrass loss should be conducted before the nutrient criteria are used to set permit limits for protection of eelgrass in assessment units on the 2010 list as impaired for nitrogen and eelgrass loss.

THE COALITION AGREES TO:

I. Construct, calibrate, and validate a dynamic hydrodynamic and water quality model for the Squamscott River, using a public domain model. Prior to commencing work, prepare a workscope and quality assurance project plan (QAPP) for the model in accordance with EPA guidance and generally accepted practice, to be submitted to DES for comment and approval;

II. Collect data required to calibrate and validate the model. Prior to commencing work, prepare a workscope and QAPP for data collection in accordance with EPA guidance and generally accepted practice, to be submitted to DES for comment and approval;

III. Provide DES with data collected in II, and all applicable metadata, in a format that can be easily entered into the DES Environmental Monitoring Database. Provide DES with source code and a compiled version of the model used in I. All modeling shall be substantially completed by January 2012;

IV. Use the model to propose site-specific nitrogen criteria for the Squamscott River, as well as wasteload allocations / NPDES permit limits for the Exeter wastewater treatment plant for nitrogen, phosphorus, and BOD;

V. Enter into a process jointly with DES, under the auspices of the Southeast Watershed Alliance (SWA) or Piscataqua Region Estuary Partnership (PREP), to address the uncertainties with the transparency, macroalgae, and epiphyte lines of evidence of the nutrient criteria for associated eelgrass loss;

VI. Commit to achieve 8 mg/l Total Nitrogen (seasonal average) effluent limit for wastewater treatment facilities discharging to the Great Bay impairment zone via the Squamscott and Lamprey Rivers and promptly begin the process to design such facilities; and

VII. Commit to optimize the existing facilities discharging to the Piscataqua River and its tributaries to promote cost-effective TN reduction and complete engineering evaluations to determine the degree of modifications needed to achieve an 8 mg/l TN (seasonal average) effluent limit, should such limits be found necessary to achieve DO standards.

DES AGREES TO:

I. Review the modeling and monitoring workscopes and QAPPs developed by the Coalition pursuant to this Memorandum of Agreement in a timely and constructive fashion to ensure that the collaborative approach to the model will serve all parties.

II. Publish site-specific nitrogen criteria for each assessment unit on the 2010 list with impairments attributed to dissolved oxygen (DO) and nitrogen as soon as practicable after results of a calibrated, verified dynamic hydrodynamic and water quality model are available for the assessment unit.

III. With full participation of Coalition municipalities, work with PREP or SWA to conduct a study with robust multiple lines of evidence for nitrogen as a cause of eelgrass loss for assessment units with impairments on the 2010 list attributed to eelgrass loss and documented criteria thresholds for nitrogen to restore Great Bay to attainment of the aquatic life designated use.

IV. Commit to supporting a delay in EPA's issuance issuing final NPDES permits for Coalition wastewater treatment facilities until applicable site-specific nitrogen criteria have been developed.

By signing this agreement, each signatory certifies that it is fully authorized to enter into this agreement:

Thomas S. Burack, Commissioner
NH Department of Environmental Services

Edward J. Wojnowski, ~~Town Administrator~~
for the Town of Newmarket

J. Michael Joyal, Jr., City Manager
for the City of Dover

John P. Bohenko, City Manager
for the City of Portsmouth

Russell J. Dean, Town Manager
for the Town of Exeter

Daniel Fitzpatrick, City Manager
for the City of Rochester

Table I: Aquatic Life Impairments for Nutrient-Related Parameters in the Great Bay Estuary from New Hampshire's 2010 303(d) List

Assessment Zone	Parameter	Impairment Category*
WINNICUT RIVER	Estuarine Bioassessments	5-P
SQUAMSCOTT RIVER	Chlorophyll-a	5-P
	Oxygen, Dissolved	5-P
	Light Attenuation Coefficient	5-P
	Estuarine Bioassessments	5-P
	Nitrogen (Total)	5-P
LAMPREY RIVER	Chlorophyll-a	5-M
	Dissolved oxygen saturation	5-M
	Oxygen, Dissolved	5-P
	Light Attenuation Coefficient	5-P
	Estuarine Bioassessments	5-P
	Nitrogen (Total)	5-P
OYSTER RIVER	Chlorophyll-a	5-P
	Dissolved oxygen saturation	5-M
	Oxygen, Dissolved	5-P
	Light Attenuation Coefficient	5-P
	Estuarine Bioassessments	5-P
	Nitrogen (Total)	5-P
BELLAMY RIVER	Estuarine Bioassessments	5-P
	Nitrogen (Total)	5-M
COCHECO RIVER	Chlorophyll-a	5-M
	Nitrogen (Total)	5-P
SALMON FALLS RIVER	Chlorophyll-a	5-M
	Dissolved oxygen saturation	5-M
	Oxygen, Dissolved	5-P
	Nitrogen (Total)	5-M
UPPER PISCATAQUA RIVER	Light Attenuation Coefficient	5-P
	Estuarine Bioassessments	5-P
	Nitrogen (Total)	5-P
GREAT BAY	Light Attenuation Coefficient	5-P
	Estuarine Bioassessments	5-P
	Nitrogen (Total)	5-M
LITTLE BAY	Light Attenuation Coefficient	5-M
	Estuarine Bioassessments	5-P
	Nitrogen (Total)	5-M
LOWER PISCATAQUA RIVER	Estuarine Bioassessments	5-P
PORTSMOUTH HARBOR	Light Attenuation Coefficient	5-M
	Estuarine Bioassessments	5-T
	Nitrogen (Total)	5-M
SAGAMORE CREEK	Estuarine Bioassessments	5-P
LITTLE HARBOR/BACK CHANNEL	Light Attenuation Coefficient	5-M
	Estuarine Bioassessments	5-P
	Nitrogen (Total)	5-M

* 5-M = Marginal impairment, 5-P = Serious Impairment, 5-T = Threatened

Table II: Existing Nitrogen Loads to Assessment Zones from Point and Non-Point Sources*
(Source: draft Analysis of Nitrogen Loading Reductions for Wastewater Treatment Facilities and Non-Point Sources in the Great Bay Estuary Watershed dated December 2010)

	Winni-cut River	Squam-scott River	Lamprey River	Oyster River	Bellamy River	Cocheco River	Salmon Falls River	Upper Piscataqua River	Great Bay	Little Bay	Lower Piscataqua River	Ports-mouth Harbor	Sagamore Creek	Little Harbor/ Back Channel
Point Sources														
Durham				11.76						11.76	TBD	TBD	TBD	TBD
Exeter		42.69							42.69	42.69	TBD	TBD	TBD	TBD
Newfields		1.58							1.58	1.58	TBD	TBD	TBD	TBD
Newmarket			30.42						30.42	30.42	TBD	TBD	TBD	TBD
Dover								103.69			TBD	TBD	TBD	TBD
South Berwick							5.53	5.53			TBD	TBD	TBD	TBD
Kittery								0.40	0.74	5.29	TBD	TBD	TBD	TBD
Newington								0.07	0.13	0.96	TBD	TBD	TBD	TBD
Portsmouth								0.95	1.76	12.56	TBD	TBD	TBD	TBD
Pease ITP								0.16	0.31	2.19	TBD	TBD	TBD	TBD
Farmington						2.66		2.66			TBD	TBD	TBD	TBD
Rochester						127.47		127.47			TBD	TBD	TBD	TBD
Epping			4.31						4.31	4.31	TBD	TBD	TBD	TBD
Berwick							9.52	9.52			TBD	TBD	TBD	TBD
Milton							1.59	1.59			TBD	TBD	TBD	TBD
Rollinsford							2.84	2.84			TBD	TBD	TBD	TBD
Somersworth							10.56	10.56			TBD	TBD	TBD	TBD
North Berwick							1.94	1.94			TBD	TBD	TBD	TBD
Subtotal	0.00	44.27	34.73	11.76	0.00	130.13	31.98	267.39	81.94	111.76	TBD	TBD	TBD	TBD
Non-Point Sources	30.94	167.25	204.14	48.61	47.92	151.15	303.89	474.69	443.46	553.92	TBD	TBD	TBD	TBD
Total	30.94	211.52	238.87	60.37	47.92	281.29	335.88	742.07	525.40	665.68	TBD	TBD	TBD	TBD

*Units: Delivered nitrogen load to the assessment zone (tons per year). Average values for 2003-2008.

Exhibit 12

Transparency, Macroalgae, and Epiphyte impacts to eelgrass in the Piscataqua Estuary Assessment
Meeting Minutes
July 29, 2011

Attendees: John Hall, Steve Jones, Larry Ward, Rich Langan, Alison Watts, Dean Peschel, Ted Diers, Phil Trowbridge, Fred Short, Phil Colarusso, and Christian Mancilla

The meeting got a late start as a result of an earlier meeting running longer that planned. Following introductions, John Hall initiated the meeting with an overview of the Memorandum Of Agreement between NHDES and the Great Bay Municipal Coalition followed by a description of the issues the group needs to clarify, which include the extent to which transparency, macroalgae and/or epiphytes are responsible for eelgrass decline in the Piscataqua estuary and whether other important ecological factors need to be addressed to protect the ecological resources of the Bay in addition to nutrient reductions.

John Hall indicated that the Coalition also intends to develop an alternative proposal to the EPA permitting approach that would include a combination of preliminary efforts in an adaptive management framework including (1) treatment plant reductions (2) bioremediation and restoration such as oyster beds and eelgrass replanting (3) recommendations on a watershed non-point source reduction program and (4) additional field studies to ensure reduction efforts are properly targeted. The input Committee would be sought on this proposal also.

A lively discussion followed regarding the amount of research available to confirm the causes of eelgrass decline in the estuary system and the options to resolve an uncertainties regarding the degree of TN control necessary. John Hall indicated that macroalgae are a problem but the research on these species is lacking. John thought a field study might be best for confirming how different TN levels impact eelgrass and macroalgae growth. Phil Trowbridge indicated that some existing studies from Fred Short and Art Mathieson could provide insight on TN impacts and appropriate nutrient target levels. It was requested that the studies be supplied the group. It was also suggested that a mesocosm study could be useful on resolving the appropriate TN conc to protect eelgrass resources. . Fred Short explained that in Great Bay, transparency is not a major issue impacting eelgrass as when the tide is out the eelgrass is exposed and receives sufficient light for growth. The distinction was made between the shallow water systems Great Bay, Little Bay and the tributaries versus the deeper water systems of the Piscataqua and Portsmouth Harbor where transparency may be more of an issue. John Hall indicated that the algal growth information for the Piscataqua River should be reviewed to determine the degree to which nutrients are influencing transparency in that area.

On the topic of epiphytes, Fred Short commented that epiphytes are not and, to his knowledge, never have been a significant problem to eelgrass in the estuary. Epiphytes appear to be controlled by grazers in the estuary and the attached epiphytes that do occur are shed as the older shoots of eelgrass dye off from the plants.

Fred Short indicated that macroalgae were considered the primary problem impacting eelgrass in Great Bay. It was agreed by all that Arthur Mathieson, who was not at the meeting, needs to weigh in on this issue.

There was a discussion on whether addressing TN for DO concerns in the tidal rivers would resolve any TN concerns in the Bay. John Hall indicated that the Squamscott River model was intended to address the relationship between low DO and increased algal growth.

A follow up meeting will be scheduled in the near future to continue the process.

Great Bay Municipal Coalition nitrogen meeting
9/26/011 9:30- 12:00
NHDES office room A

Present: Alison Watts, Candace Dolan, SWA; Steve Jones, Rich Langdon, Art Matheson, Larry Ward, UNH; Dean Peschel, City of Dover; David Green, City of Rochester; Mark Allenwood, Brown and Caldwell; Sean Greig, Town of Newmarket; Cristhian Mancilla, Tom Gallagher, Hydroqual; John Hall, Hall and Associates; Ted Diers, Phil Trowbridge, NHDES; Jennifer Perry, Town of Exeter.

John Hall: General scope of the current study(s): 3 main activities are identified by the MOA, 1. Modeling of Swampscott River: what is driving it, also hydromantic modeling of Bay including fate and transport. From Portsmouth to the head of Bay are areas to consider, but only Exeter/Swampscott will be detailed. 2. Tech review of factors impacting eel grass health in Great Bay i.e. transparency, epiphytes, macro algae. Which is the main concern? As part of this we will look at background information. 3. WWTF 2 main plants will go to 8 mg/l N, others agreed to see what upgrades needed to get to target N removal rate.

Alison: Clarify goal of these meetings. Is it to get feedback from the group are we going in the correct direction?

Dean: More to identify what people who have been doing work in the estuary over the past years have learned, and ask them to share their knowledge to help guide the studies.

Tom: Information could be then used by the Coalition to guide the restoration process to spend the dollars better.

Ted: This group is a discussion, but not really a “thing”: DES would like a “thing” to identify the elements of a holistic approach, information gathering which would result in a better understanding... move to PREP TAC or NERRS TAC, which would give unification of groups, and a more formalized approach for the Bay restoration.

Larry: This group should not be considered a peer review group.

Some general discussion and agreement that this group provides input to the process, but is NOT a peer review.

Steve: The process brings specific questions to the group for discussion.

Rich Langan: Hopes that the end goal is a holistic approach to restoration, and that the “thing” buys into what the goals are so we have a plan on the table… Again, who is going to lead this?

Discussion of Great Bay Loading Model - Phil Trowbridge.

Part 1. Septic survey study, maps Census blocks of what % is sewered, asked each town to proof them, communicate with the towns feedback from 30 of the 52 towns, mostly non-sewered, nothing from other towns. Needs to know if they are reasonable? Will end up with # of people not on sewer, from which will develop estimates of N contribution from septic systems… Also needs Towns to provide N levels in WWTF effluent (current data is 4 years old). It is important to get this information back as soon as possible so can move on to the next step.

Peter: Pease has nitrite and N sampling

Phil: Using the Nitrogen Loading Model (NLM) from WHOI and BU to estimate non-point source loads. NLM chosen because it accounts for atmospheric deposition, fertilizer use, and wastewater to calculate nitrogen delivered to the estuary.

Alison: Another watershed loading model is coming from complex systems (UNH) group. It could be helpful to compare/validate models if relevant.

Phil: Part 2 will be Turf maps: Mapping golf courses, town parks and a model for residential turf, towns will be asked to proof it by supplying info about fertilizer, frequency and product used town properties i.e. schools, ball fields etc. are 10% of the issue. Residential lawns are 10x as large a potential issue. Towns can help identify fertilizer use. 250 separate polygons mapped for the study.

Phil: Part 3 will be Agriculture: Farm specific info is protected by farm bureau. Depends on crop, manure management, smallest unit of data is county level and is protected. Will need town level information.

Next phase will be modeling delivered loads from all sources. After that, DES will estimate cost and cost effectiveness for removing nitrogen from each source in each watershed. Need to decide how we will deal with different species. Model can accommodate different N species (although it is harder). We already know that because of delivery (transport paths) losses closest to estuary will be bigger. E.g. residential septic and turf will be bigger contributors if they are closer to the estuary.

John H. – How will this information be used? What cost effective options exist for limiting TN or DIN loadings from septic tanks?

Phil: We don't know the answer to that question.

ACTION ITEM – Remaining towns to respond to septic survey

Discussion of Squamscott River Sampling and Model - Tom Gallagher (*this is hard to follow in notes; see attached presentation)*

Tom: We designed a field program on the Squamscott to survey from the Exeter dam down to Great Bay. 10 stations sampled to provide spatial profiles along the Exeter on two sampling days in August. High water/slack low tide and low water/slack high tide. Data sondes were also deployed to understand the DO balance in river. Note that the data is very new so this discussion is preliminary. These data still need a QA/QC check. In the afternoon there is high DO, and the chlorophyll average peak is very high, below outfall (mile 3) the system flushed out. Exeter Lagoons: 490 mg/l chlorophyll.

Sampling was challenged by weather, but some of the chlorophyll in Squamscott ties to low flow . Very little NH4, uptake may transform to NO2 or NO3. The high algal population would explain the substantial nutrient uptake during the first survey. The second survey, much lower algal levels and lower uptake was apparent. Phosphorus may also be uptaken.

Art: anything on uptake by benthic diatoms? Steve: No. Light extinction profound. Perhaps benthic diatoms re-suspend.

Tom: A key question is "How would the river respond if the lagoons were not seeding the system?" Growth rate is impressive. How much is growth from the system, how much re-suspended? Thames River example: salinity dependant death rate for phytoplankton? Death or dilution?

Thoughts: How high would phyto grow without the influence of Exeter WWTF algal discharge? D.O. variation is considerable.

John: This is a significant complication: If we are trying to figure out the acceptable nutrient target for the model in the future when the Squamscott would not have chlorophyll A coming from Exeter. Can we cut the algae level exiting the pond and then resurvey? Is the river being "seeded" and then you have a population increase? The second survey had very little apparent algal growth – so which is the most likely in the future?

Phil: what about the data sondes records collected during the 2011 survey? Cannot interpret what is going on higher up in the system based on data collected at the river mouth. (Tom agreed historical data sondes reflect the Bay, not algal growth or DO in the river.)

What is coming out of the ponds? if you know what is coming out can develop a mass balance.

Art: Can you identify the key organism composition of the phytoplankton populations?

Alison: What are the next steps? Phil to Tom: Data report? Yes. Peter: Can we answer some of the questions for now, with existing (new) information so we can address EPA deadline without having the hydrodynamic model completed? There may be funding issues and would prefer to make sure we're going in the right direction before finalizing model.

Tom: we will report next steps including what has been modeled. So far we have put together the model grid. John: It will be ready fairly soon, it still needs to be updated with bathometry. Phil: Still need QAPP for both data collection and model.

60% of salt marsh in GB is in the Swampscott system. Art: has there been any work on the benthic system or contributions of the salt marshes? It is one of the most important communities in the system.

Steve: we did take one of the datasondes and placed it near the oxbow to see if there is any change there related to the DO regime.

Art: no question there is. It is a large system and needs to be considered.

Discussion of Macroalgae in Great Bay – Art Mathesion *(see attached notes)*
The Swampscott Is dominated by salt marshes and heavy river sediment, not many rocks or seaweeds, no eelgrass seen growing there in past 50+ years. The '73-'81 baseline data was not continued because of funding.

System as a whole is impacted by green tides. There is massive amounts of material which can be taken as indicators of eutrophication. Problems are also algal problems (see notes) in early 80's the lower muddy intertidal shores were open but now are being colonized by opportunistic species. There are now massive greens and reds moving in. Red alga have become more pervasive in the past 12-14 years. Invasive species finding an opportunity.

John: How much is a result of nutrients and how much just opportunity? Art: The two new Asian species have high nutrient requirements and can tolerate desiccation.

Ulva are very efficient in picking up N. Ulva has been present since the 1980s but is now in much greater amounts. What happens when they die? Ulva can reproduce many generations in a year and it has the potential for massive regeneration. High nutrient requirement and high ability to regenerate has given it an opening to colonize. It has moved into a vacuum. It can even uptake ammonia depending on the species. The "cast of characters" has changed in the past 25 years. No question there is a seaweed/nutrient problem in GB (Swampscott not of interest to Art as it is the "land of Spartina grass."). Ammonia and nitrate are the primary nitrogen forms stimulating plant growth. The appropriate allowable level of DIN to control macroalgae in the estuary is not known at this time; but it is currently too high now and reduction needs to begin sooner than later.

John: Are there some studies Art might recommend for more insight? Art: This needs a big literature survey- worldwide. John Raven from Great Britain has done a lot of research on this topic. Always issues with lab/macrocosm experiments. To try and add nutrients in a field test would be unacceptable in the bay!

Steve: Next steps for information. Seaweeds are here what is the problem presented by them? Heavy epiphyte loads vs. eel grass they will overwhelm Zostra and reduce light…they will compete for light and reduce oxygen…they are pulling nutrients but recycling it in decomposition …what is the impact on D.O.?

Tom: what if inorganic nutrients were reduced to earlier levels (1986 or before). Art: UNH decided in '81 that it cost too much money and asked us to stop long term monitoring… In the early 80's we did not have the problems…

John: Early in season there is a bigger flow and more inorganic nitrogen from non-point; this changes later in the season when point sources may dominate. Which period is of greater concern for these species? Art: Phyto in spring and macro in summer as they require high light and are temperature sensitive. John: If that is so, we may get a big bang for first reductions at the point sources if the timing is right.

Phil: Art and I discussed using the old data to determine what the N was back then. The results show that Total Nitrogen concentrations were less than or equal to 0.3 mg N/L when macroalgae populations were in control. This result supports the existing nutrient criteria for the estuary of 0.3 mg N/L. Peter: by focusing on TN you are driving it lower than may be really necessary. Phil: DIN is important but criteria have developed for TN because uptake by algae can change DIN concentrations.

Peter: if the focus is DIN then the focus should be on DIN (the most reactive form) if the reservoir is in macro algae harvesting it would help.

Phil: We are not seeing anything that changes our approach. Model can make predictions of nitrogen loads in 1986 based on older land use data with input from towns. Tom: If Exeter reduced from 15 to 5, 2 mg would be inorganic…my guess is that Ulva growth would be reduced if they just did TN.

Larry: Look at the literature to find out. Art: you have to remember all the bays are different…real algal problem is within GB proper, there may be areas where algae is accumulating, for instance Nanny's Island. If this is a depository maybe there are opportunities to take it out in targeted areas. General removal from the mudflats too muddy and dangerous. More damage would be done to the mudflat ecosystem. Recommends detailed literature search, is willing to help, but not to manage. John: Could it be done by a student? Steve says there are students available.

Discussion of Restoration – All

Bioremediation with oysters: John: are there particular spots? Rich: Target tidal rivers, implement in other areas in the Bay particularly nursery areas as at that point they are fast growing. Phil: starting a project with NOAA looking at bio extraction in the bay (Ray Grizzle estimates they can remove up to 12 tons through bivalve bioextraction). Cost estimates for oyster restoration are $50,000 per acre. Also there is interest in growing kelp from some people in Maine and there are other ways of growing biomass which would result in removing nitrogen as the product is harvested.

Alison: There is lots of existing information about restoration strategies; PREP Action Plan, rivers advisory committees etc. What we need is to build on these for more specific action plan. Where will be the most effective area? Phil: all the elements are in the PREP management Plan.

John: Septic tanks – If you conclude the tanks are delivering more than they should. Do we have a plan to reduce that?

Phil: We expect that we will see that tanks closer to the estuary will be bigger contributors. One option may be extending sewers? After we know where it is coming from we can better decide. John: extending sewers may only deliver the load more efficiently.

Peter: It seems like a consensus that DIN is the issue, and is the dominant source of the problem, in which case the improvements from the WWTFs will be bigger than thought. Better not to make any strong statements about retrofitting septic tanks at this point. This has been a very useful exercise.

John: This was very useful feedback today on issues related to the appropriateness of the draft TN criteria. We greatly appreciated Art's input on the nitrogen species question and importance of macroalgae control to the system. Other questions addressed previously include how much is transparency a controlling factor in GB? How much are epiphytes an issue or macro algae? I'm not sure that there are any other significant issues left. This group could help guide what specific restoration steps are needed and could be fostered by our municipal coalition.

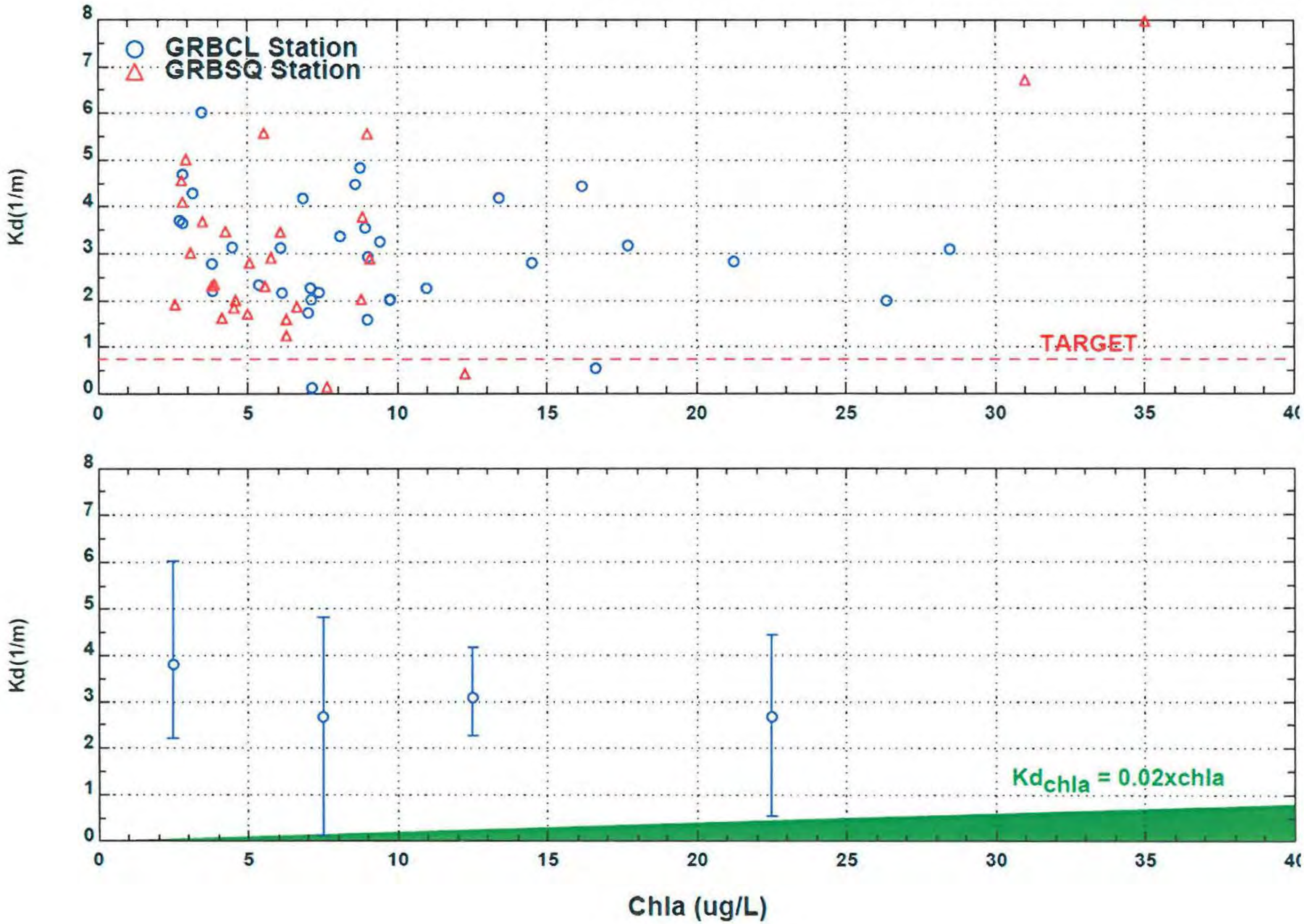
Peter: lots of people already doing things - how do we bring them together, rather than start a new uncoordinated effort? Phil: the PREP action plan has a list of pending activities already in place. But they need to be done.

Attachments:

1. Mathieson discussion of algal blooms GES.
2. Gallagher Squamscott River WQ Update Sept 26 2011

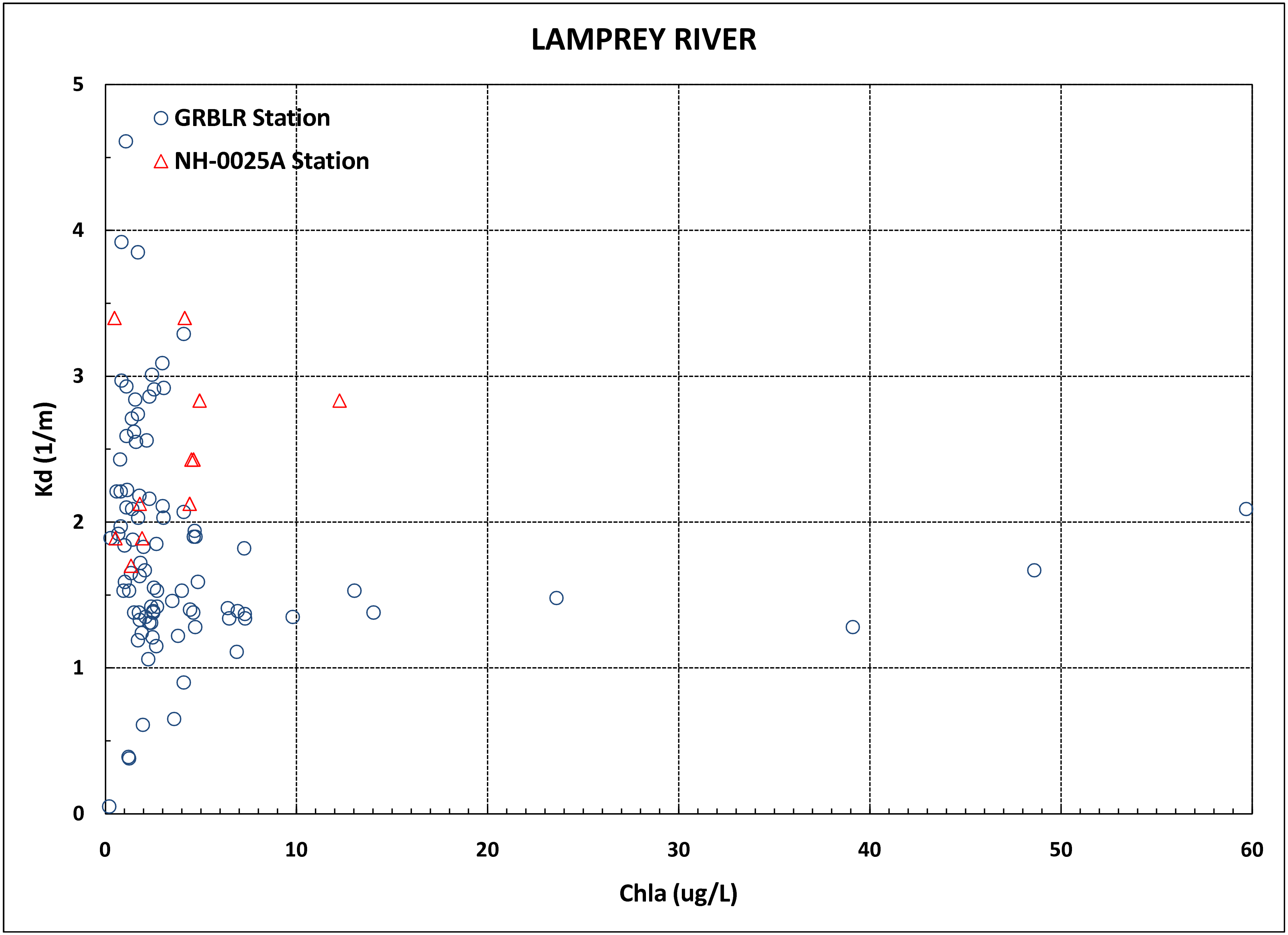
Post meeting note: As requested, Phil has provided information on the PREP Comprehensive Conservation and Management Plan which is available at: http://www.prep.unh.edu/plan.pdf. The action plans that are directly relevant to nutrient load reductions, oyster restoration, and eelgrass restoration are: WR-5, WR-8, WR-9, WR-10, WR-11, WR-12, WR-13, WR-14, WR-15, WR-16, LR-1, and LR-3. Each action plan has lists of activities, outputs, outcomes, and performance metrics. There is also a theme discussion about reducing nutrient loads on page 12. The plan also covers issues related to stormwater, geomorphology, climate change, and land use. For a holistic restoration approach, all of the actions from the plan should be implemented.

Exhibit 13



GRBCL Station
GRBSQ Station
TARGET
Kd(1/m)
Kd(1/m)
Kdchla = 0.02xchla
Chla (ug/L)

Exhibit 14



LAMPREY RIVER
GRBLR Station
NH-0025A Station
Kd (1/m)
0
1
2
3
4
5
0
10
20
30
40
50
60
Chla (ug/L)

Exhibit 15

Upper Piscataqua River
Measured Chla and Kd (2003-2008)

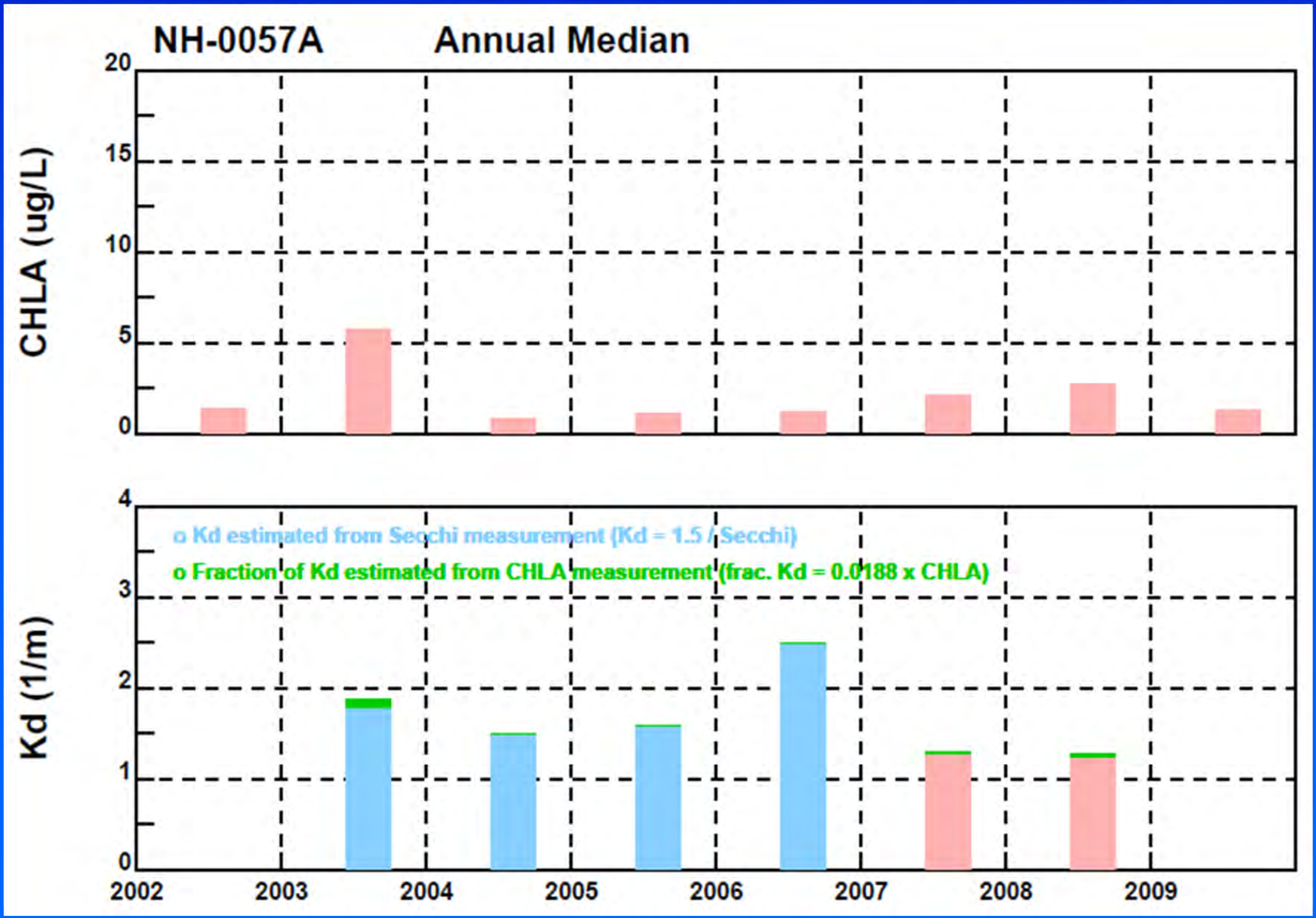


Exhibit 16

Phone Log

Contact: Fred Short, UNH
Phone #: (603) 659-3313
Date: November 14, 2011
RE: Light Attenuation/Macro Algae Issues in Great Bay

In a several recent meetings Coalition Communities have informed us that according to Fred Short at UNH the decline in eelgrass in Great Bay is due to macro algae and not to issues associated with light attenuation. I called Fred to see if this characterization is correct either to Great Bay proper or the Great Bay Estuary as a whole.

Fred informed me that the issue with Great Bay proper is mostly macro algae. Because the eelgrass beds in this portion of the estuary are intertidal (i.e. exposed at low tide) the plants are able to receive a significant amount of light during low tides. However, he did say that light attenuation is still an issue in this area because during high tide the plants are not getting enough light due to high light attenuation coefficients in the water column. In other portions of the estuary the eelgrass beds are subtidal (i.e. submerged during all phases of the tide) and light attenuation is a major issue in these areas.

Another issue which Fred has been noticing is that the eelgrass in the estuary is putting significant energy into reproduction. The plants are produces a very high number of seeds. This is a typical survival response. When stressed, the plants will put more energy into reproduction to maintain the population. This takes away energy from plants growing and creating more shoots. Fred noticed there was a bed of eelgrass that appeared in Little Bay this year (his did not indicate the size) where it had disappeared. He said this bed is unlikely to survive because of it is intertidal and the light attenuation is poor.

DJA

Phone Log

Contact: Fred Short, UNH
Phone #: (603) 659-3313
Date: November 18, 2011
RE: Eelgrass issues in Great Bay

In the adaptive management plan submitted to EPA and NHDES, the Coalition cites several items that came from the technical review committee. One of these items is the following:

> "Eelgrass losses in Great Bay do not appear to be a result of either insufficient transparency or excessive epiphyte growth"

I called Fred to see if this characterization was correct. We had previously discussed the light attenuation issue and how its importance varies throughout the estuary depending on whether or not the eelgrass beds are intertidal or subtidal. For the subtidal beds light attenuation is a significant issue. For the intertidal beds light attenuation is not the major issue since the beds can get their light needs at low tide. However, as the tide rises the light attenuation is an issue.

With respect to epiphytes, Fred told me that epiphytic growth has historically not been an issue in Great Bay because this growth seemed to be controlled by grazers. However, this year he has noted an increase in the amount of epiphytic growth in Great Bay proper.

Exhibit 17

From: Fred Short [mailto:fred.short@unh.edu]
Sent: Thursday, December 22, 2011 10:33 AM
To: perkins.stephen@epa.gov; Dan Arsenault; Deloi.Carl@epamail.epa.gov
Cc: Peschel, Dean; Rachel Rouillard; PHIL COLARUSSO; Philip Trowbridge; Mathieson Art
Subject: Response to the Great Bay Municipal Coalition Adaptive Management Plan

Response to: Great Bay Municipal Coalition Adaptive Management Plan
by Fred Short, JEL, UNH fred.short@unh.edu

I write as a research scientist based at the Jackson Estuarine Laboratory, UNH, with close to 30 years of experience and work in the Great Bay Estuary which has provided me with the opportunity to observe the health of the estuary in detail and to research the eelgrass ecosystem that is to important to the Estuary's well-being. I respond to the Adaptive Management Plan put forth by the Coalition in which there are many misstatements of fact as well as misconceptions and an overall lack of clarity. If we don't get the facts and the science stated correctly at this stage, how will we reduce the impairment effectively?

First, I am very supportive of the principles of the adaptive management approach in general, but in order to implement adaptive management, a "watershed management plan" must be in place (see quote from Coalition document). Unfortunately, the approach taken by the Coalition is to start adaptive measures ad hoc and without the focused plan needed to remediate a situation like the one facing the Great Bay Estuary. What the Coalition presents is really more of a concept document rather than a "plan."

The statement that "the precise causes of and solutions to eelgrass-related impairments are uncertain" is not true. My long-term research and annual monitoring of eelgrass in the Estuary have clearly demonstrated that eelgrass is disappearing from the Estuary due to excess algal growth caused by increasing nitrogen levels in the water. There is simply no doubt about this fact.

Furthermore, the Coalition documents states that "adaptive management is used when there is significant uncertainty regarding the efficacy and scope of various remediation efforts necessary to restore impaired uses." That is indeed when adaptive management is best employed, but that is not the situation in the Great Bay Estuary. We have certainty as to the impairment, its cause, and the remediation needed so a statement trying to create a sense of uncertainty where none exists only delays critical action and restoration of the environment.

The Coalition document states that a review committee was established to look at the MOA – but to my knowledge, there was no such committee established, certainly not under the auspices of the SWA as stated here. Rather, the Coalition invited a number of scientists (including me) and agency people to attend a meeting to discuss the Estuary. It was never put forth as an invitation to join a committee or participate in a review of the MOA. I attended the first of two meetings and it was clear the Coalition consultant did not understand the characteristics of the Great Bay Estuary or the nature of the issues involved with the health of the ecosystem.

To understand the current impairment in the Estuary, we need to first distinguish the parts of the Estuary, which are unclear and even contradictory in the Coalition document. This is important because the losses or impairments present differently in different parts of the Estuary. The "Estuary" refers to the Great Bay Estuary in its entirety, including Great Bay itself, Little Bay, the Piscataqua River , and Portsmouth Harbor and all the associated tidal rivers. When statements are made about the Estuary, all these parts should be considered. Referencing " Great Bay " alone should always mean the Bay itself, from Furber Straits south. Throughout the

Coalition's document, there is a confusion of issues that originates with mis-naming of areas of concern.

Being clear about the parts of the Estuary is important to understand their characteristics as water bodies and how this is revealed in their impairment by nitrogen. Here is how the parts of the Estuary stack up with regard to eelgrass loss and the nitrogen-related causes of that loss:

In Portsmouth Harbor , eelgrass has been declining for the last five years as a result of reduced water clarity caused by rising nitrogen inputs that foster increased phytoplankton growth in the water (microscopic algae). The water is measurably less clear than a decade ago even though it still looks "clear" to the eye. Light transmission is reduced and the eelgrass has disappeared from the deep edge of the beds and receding toward the shallow, high-light areas where it still receives adequate light to grow. Portsmouth Harbor receives a large volume of clear Gulf of Maine water twice a day with the tides; despite this fact, it is losing eelgrass.

The Piscataqua River and Little Bay are relatively deep water bodies which in the past had a narrow fringe of eelgrass growing as a near-continuous strip on both sides in their shallower areas. With loss of water clarity due to increased phytoplankton growth, again caused by increasing nitrogen loading, the eelgrass disappeared completely from both these areas beginning in 2001. Again, as in Portsmouth Harbor, my students at UNH and I have documented the disappearance of eelgrass first in the deeper parts of the River and Little Bay, then observed eelgrass growing shallower and shallower until the beds disappeared.

In Great Bay , and recalling this is the Bay itself south of Furber Straits, the average depth is less than a meter at low tide except in the channels. On many of the shallow flats covering 80% of the Bay, eelgrass formerly created dense intertidal beds and meadows. With the increase in nitrogen entering the Bay, these beds are declining, losing biomass, and becoming overgrown with nuisance macroalgae (seaweeds). The fact that the Bay is so shallow means that light reaches the eelgrass at low tide sufficiently for eelgrass to persist and maintain a fairly wide distribution, even though it is stressed by both the macroalgae and the reduced water clarity conditions. The beds have gradually grown thinner, with lower shoot density and less biomass as the mats of nuisance seaweeds (along with algal epiphytes and phytoplankton) have proliferated. Also in Great Bay , eelgrass has been lost from the deeper parts of the Bay, indicative of loss of water clarity.

It is frustrating to see the Coalition not understanding these important distinctions and features of the Great Bay Estuary and perpetuating the confusion by inaccurate references to "Great Bay" or "the Bay" when they really mean the entire Estuary. Since different nitrogen-related impacts are playing out in different areas, it's important to make the distinction.

So, for example, in bullet one of the Coalition document, when it states, "Eelgrass losses in Great Bay do not appear to be a result of either insufficient transparency or excessive epiphyte growth;" – this statement is not true for any part of the Estuary and it's hard to know if the Coalition means the entire Estuary or just Great Bay itself. In the Piscataqua River and Little Bay, the eelgrass losses were predominantly a result of reduced transparency and, to a lesser extent, excessive epiphyte growth. In Great Bay , both these factors occur to some extent but the predominance of nitrogen-induced overgrowth by nuisance entangling macroalgae has dominated as a cause of eelgrass loss.

The second bullet in the Coalition's document is mostly a true statement although the rapid proliferation of macroalgae (and the appearance of invasive macroalgal species) has occurred over the past ten years, not the last three decades.

The fourth bullet is partly correct. Excessive macroalgal growth is stimulated by DIN, but dissolved organic nitrogen (DON) and other forms of nitrogen are rapidly converted to DIN once they enter the Estuary and are used directly by the macroalgae. Attempting to blame the whole problem on DIN loading is mistaken and total nitrogen (or TN) is the better parameter upon which to assess nitrogen loading.

Bullet five is confused. Like so much of what the Coalition says, it is only partially correct. A vast scientific literature exists on the growth response of seaweed to increasing nitrogen concentrations. If the statement were re-written in terms of total nitrogen it would be more productive in negotiations about how to improve health of the Estuary.

Regarding the Coalition's proposed "series of actions" (1 – 5), #1 is a useful action although it should refer to total nitrogen rather than DIN. Actions #2 – 5 are not necessary for the reduction of estuarine impairment or providing needed information for adaptive management. The Coalition actions, I believe, should stress reduction in the sources of nitrogen that are creating the impairment of the Estuary. Coalition actions should establish a clear plan to increase the amount and health of eelgrass in the Estuary and (as mentioned in the permit) to reduce hypoxia in the tributaries. Both eelgrass and oxygen status should be monitored to demonstrate the reduction of impairments. Note that the current series of actions proposed by the Coalition do not include the word "eelgrass"! Or the word "oxygen."

As for the specific components of the "adaptive management approach," I agree with all the PREP objectives and most of the Coalition responses. I disagree with the Coalition proposed "permit condition" of a 10-year time frame. This time frame seems like another delaying tactic. All the WWTF in the watershed (based on the need to reduce nitrogen from all point sources) should advance to a discharge limit of 8 mg/l in 2 to 3 years (with a plan to upgrade to 5 or 3 mg/l if needed) and work toward reducing the current impairment of the Great Bay Estuary. The Estuary is at a critical stage and delays in reduction in nitrogen loading may very well push the system beyond the point where rapid recovery and management is feasible.

-- end--

~~~~~~~~~~~~~~~~~~~~~~~~

)) ><{{{•>)))))))

Dr. Frederick T. Short
University of New Hampshire
Department of Natural Resources
and the Environment
Jackson Estuarine Laboratory
85 Adams Point Road
Durham , NH 03824 USA

603-862-5134 office
603-659-3313 cell
603-862-1101 fax
<fred.short@unh.edu>
www.marine.unh.edu/jel/faculty/fred2/fredshort.htm
www.SeagrassNet.org
~~~~~~~~~~~~~~~~~~~~~~~~

Exhibit 18

GREAT BAY MUNICIPAL COALITION

January 23, 2012

<u>VIA E-MAIL AND U.S. FIRST CLASS MAIL</u>

Dr. Frederick T. Short
University of New Hampshire
Department of Natural Resources and the Environment
Jackson Estuarine Laboratory
85 Adams Point Road
Durham, NH 03824
E-mail: fred.short@unh.edu

RE: Dec. 22, 2011, Dr. Fred Short Response to Great Bay Municipal Coalition Adaptive Management Plan

Dear Dr. Short:

The Great Bay Municipal Coalition ("the Coalition") is an organization dedicated to the establishment of appropriate and cost-effective restoration measures to protect Great Bay and its resources. The Coalition represents five of the major communities whose wastewater flows into various parts of the Great Bay system – Dover, Exeter, Newmarket, Portsmouth, and Rochester. As you know, these communities are directly impacted by proposed EPA permits establishing nitrogen reduction requirements for Great Bay. The Coalition views the EPA position as unduly restrictive and has presented an Adaptive Management Plan (AMP) to address various ecological concerns in a more holistic manner. It is important to note that the Coalition does not challenge the concept that nitrogen discharges to the estuary need to be reduced. In fact, the Coalition has committed to major reductions to be accomplished in the near future. However, the reduction which you seem to claim is necessary is not supported by scientific data.

The Coalition and its expert, HydroQual, an internationally recognized environmental consulting firm which has been studying conditions in the estuary for nearly two years, have reviewed your comments on the AMP that were submitted to EPA Region I on December 22, 2011, as well as the currently available data on Great Bay and its environs. This analysis indicates that virtually all of the major scientific assertions of importance in your letter are not supported by objective, scientific analysis of the available data. (See Attachment A – Evaluation of Eelgrass and Water Quality in Great Bay Estuary.) Specifically, HydroQual has confirmed that there are <u>no</u> analyses or data in the record showing the following:

a. transparency has materially decreased during the period of significant eelgrass decline,
b. existing transparency in Great Bay, Little Bay, or Portsmouth Harbor is insufficient given the tidal variation in the system,
c. nitrogen has triggered excessive phytoplankton growth, significantly lowering ambient transparency levels in the Estuary, or
d. suspended algal growth is a substantial component affecting water column transparency anywhere in the Estuary.

Therefore, your central contention that eelgrass losses were caused by (1) increased TN levels which (2) significantly increased phytoplankton growth and (3) thereby significantly reduced transparency is unsupported, if not demonstrably incorrect.

In addition, your response asserted that the AMP statement “[e]elgrass losses in Great Bay do not appear to be a result of either insufficient transparency or excessive epiphyte growth” is “not true for any part of the Estuary.” As you may recall, you *explicitly* stated at the July 29, 2011, MOA technical group meeting that transparency is *not* a significant concern in Great Bay because sufficient light exists to support eelgrass growth due to the tidal variation and shallow nature of the Bay. (See Attachment B – July 29, 2011, MOA Group Meeting Minutes.) However, you now make a contrary claim. We know of no new data or information that has come to light in the past six months that would support this change in position. In fact, your latest eelgrass survey confirms that the areal extent of eelgrass in Great Bay has increased for the third year in a row. It is now near “normal” levels found in the 1990’s based on the acreage of eelgrass cover, which DES has specified is the most reliable indicator of eelgrass health. (See Attachment C – Figure A.) Your correspondence to EPA neglected to mention this critical fact showing significant eelgrass recovery is ongoing with existing water quality levels. As the person responsible for completing these essential surveys, it is disturbing that you failed to present this highly relevant information and instead asserted: “The Estuary is at a critical stage and delays in reduction in nitrogen loading may very well push the system beyond the point where rapid recovery and management is feasible.”

While you claim that the Coalition misunderstands the situation and makes mere generalizations, in reality you have not provided objective, scientific data to support the claims made regarding your research in your correspondence to EPA and in other public forums. As a result, the Coalition hereby requests that you provide the data and analysis which confirm the following statements in your correspondence to EPA are true:

Transparency Caused Eelgrass Loss due to Increased Algal Growth

1. My long-term research and annual monitoring of eelgrass in the Estuary have clearly demonstrated that eelgrass is disappearing from the Estuary due to excess algal growth caused by increasing nitrogen levels in the water. (Para. 3, line 2.)

Portsmouth Harbor

2. Eelgrass (in Portsmouth Harbor) has been declining for the last five years as a result of reduced water clarity caused by rising nitrogen inputs that foster increased phytoplankton growth in the water (microscopic algae). (Para. 8.)

Piscataqua River/Little Bay

3. With loss of water clarity due to increased phytoplankton growth, again caused by increasing nitrogen loading, the eelgrass disappeared completely from both these areas (Piscataqua River and Little Bay) beginning in 2001. (Para. 9, line 3.)
4. In the Piscataqua River and Little Bay, the eelgrass losses were predominantly a result of reduced transparency and, to a lesser extent, excessive epiphyte growth. (Para. 12, line 4.)

Great Bay

5. Also in Great Bay, eelgrass has been lost from the deeper parts of the Bay, indicative of loss of water clarity. (Para. 10, line 10.)
6. The rapid proliferation of macroalgae (and the appearance of invasive macroalgal species) has occurred over the past ten years, not the last three decades. (Para. 13.)

Total Nitrogen versus Inorganic Nitrogen

7. Dissolved organic nitrogen (DON) and other forms of nitrogen are rapidly converted to DIN once they enter the Estuary and are used directly by the macroalgae. (Para. 14, line 2.)

In closing, you have made serious claims to state and federal regulatory agencies that our Coalition's understanding of the factors controlling eelgrass losses is incorrect and that our proposed AMP is inadequate. By making these claims as a lead UNH researcher who has received state and federal funding to assess these issues, people (including regulatory agencies) are likely to believe that these statements are true and rely on them for regulatory decisions. The economic and social ramifications of your claims, if not true, are profound. As such, you have an obligation to provide objective scientific data to support these scientific claims to ensure that state and local resources are not misdirected and that you are accurately reporting the scientific findings of your state- and federally-funded research. We appreciate your prompt review and response to this request.

Sincerely,

Dean Peschel

For the Coalition

Enclosures

cc: Coalition Members
John Aber, Provost, UNH
Jan Nisbet, Senior Vice Provost for Research, UNH
Ted Diers, DES
Harry Stewart, DES
Commissioner Thomas Burack, DES
Curt Spalding, USEPA
U.S. Senator Kelly Ayotte
U.S. Senator Jeanne Sheehan
U.S. Representative Frank Guinta

Attachment A

Evaluation of Eelgrass and Water Quality in Great Bay Estuary

This evaluation was prepared in response to the email from Dr. Frederick T. Short to Stephen Perkins on December 22, 2011. In that email, Dr. Short made several statements regarding the cause of eelgrass loss in the Great Bay Estuary. Specifically, the email asserts that eelgrass losses in Portsmouth Harbor, Piscataqua River, Little Bay and Great Bay are due to (a) decreasing water clarity due to (b) excess phytoplankton growth caused by (c) increasing nitrogen levels. These statements are contrary to the available data on eelgrass cover, phytoplankton chlorophyll-a levels, transparency, and nutrient concentrations for the estuary. The specific data and evaluations confirming that Dr. Short's position is misplaced are summarized below.

General Observation: The Available Data Show that Eelgrass Loss is NOT due to Excessive Phytoplankton Growth

There is no analysis anywhere in the record showing:

a. transparency has decreased during the period of significant eelgrass decline,
b. existing transparency in Great Bay, Little Bay, or Portsmouth Harbor is insufficient given the tidal variation in the system,
c. nitrogen has triggered excessive phytoplankton growth lowering ambient transparency levels, or
d. suspended algal growth is a substantial component affecting water column transparency anywhere in the Estuary.

Absent such information, there can be no conclusion that increasing nitrogen levels are contributing to excess phytoplankton growth and/or reduced transparency causing eelgrass decline, as claimed in Dr. Short's email of December 22, 2011.

Analyses prepared by the Coalition's consultants [1,2] confirm that transparency in the Estuary was not materially impacted by increased phytoplankton growth during the period of significant eelgrass decline (1996 – 2001). During this period, phytoplankton chlorophyll-a levels in the Estuary were low and essentially constant. Slight increases in water column chlorphyll-a level only occurred <u>after</u> the significant eelgrass decline. This is precisely the same observation that led DES to agree that a change in suspended sediment (TSS) level in the Bay (another factor influencing transparency) was <u>not</u> the cause of eelgrass declines in the Bay because increases in suspended sediment also occurred <u>after</u> 2001.

In a 2010 meeting with EPA, DES and the Coalition, Dr. Short acknowledged that transparency and epiphyte growth are not major factors limiting eelgrass growth in Great Bay as originally presumed. Dr. Short's recent email reverses this position and is contrary to the data and analyses presented in Exhibits 1 and 2 indicating that phytoplankton levels were not responsible for

---

[1] Gallagher, T. June 14, 2010. Review of Proposed Numeric Nutrient Criteria for Great Bay Estuary. (Exhibit 1)
[2] Gallagher, T. and C. Mancilla. January 10, 2011. Technical Memorandum: Review of New Hampshire DES Total Nitrogen Criteria Development for the Great Bay Estuary. (Exhibit 2)

reductions in transparency and that suspended algal growth is a minor component influencing water column transparency.

Dr. Short's assertions that reduced transparency is adversely affecting eelgrass growth in Great Bay, the lower Piscataqua River, and Portsmouth Harbor, and that increased nitrogen is the cause of reduced transparency and eelgrass reductions, are equally misplaced. For nitrogen to affect transparency, it must cause increased and excessive phytoplankton chlorophyll *a* levels. The historical data evaluations presented for Great Bay confirm that average phytoplankton growth increases between 1990 and 2001 have been negligible. Therefore, increased phytoplankton growth could not have been the underlying cause of eelgrass decline occurring throughout the system. The PREP Environmental Indicators Report - 2009 shows that from 1993-2000 suspended chlorophyll *a* levels did not increase and averaged about 2.5 µg/l. (See 2009 PREP Report, Figure NUT3-5.) This was also confirmed by time series analysis of the data (Figure 1) showing chlorophyll-a levels remained relatively constant from 1988 – 2001 while transparency remained constant or improved. Therefore, phytoplankton growth-influenced transparency could not have played a significant role in eelgrass declines during the 1996 – 2001 period of significant eelgrass decline. This same PREP Report figure shows that chlorophyll-a levels in Great Bay increased by about 1 µg/l from 2001-2008. These are very low levels of primary productivity and minor changes in average system productivity that produced trivial changes in light penetration. These phytoplankton levels did not and could not cause a significant reduction in water column transparency. Such suspended algal growth in the Bay was demonstrated by Morrison to be a minor component affecting transparency. (*See* Exhibit 1, Figure 7 from 2009 DES Report @ 61) EPA's peer review also noted that the Great Bay did not exhibit substantial phytoplankton growth and that, therefore, only limited transparency benefits could be obtained by attempting to reduce suspended algal growth in the Bay.

The 2003 and 2006 PREP reports confirm that even though nitrogen levels have increased by 59% in the past 25 years, the negative effects of excessive nitrogen, such as algal blooms, are not evident. Thus, the ability of nitrogen to affect transparency through phytoplankton growth in this system, at this time, is not very significant. These observations and reports directly contradict the statement that excessive suspended algal growth caused by increasing nitrogen levels has caused the disappearance of eelgrass from the Estuary.

Portsmouth Harbor

Dr. Short also claims that eelgrass in Portsmouth Harbor has been declining for the last five years as a result of reduced water clarity caused by rising nitrogen inputs that foster increased phytoplankton growth in the water. This claim is not supported by the available data on nitrogen levels or chlorophyll-a levels in Portsmouth Harbor.

Eelgrass levels in Portsmouth Harbor remained relatively constant between 1999 and 2003, when continuous annual records are available (*See* Figure HAB2-4 and HAB12-4, PREP 2009 Report). Over the five year period from 2004 – 2008, eelgrass cover decreased (HAB2-4) by a small amount (264 acres to 212 acres). At the same time, eelgrass biomass increased to about 175 metric tons from 2004 – 2006 (HAB12-4) in comparison with the 1999 – 2003 period (~100 metric tons) and only shows a decrease from the earlier period in 2008. Over this period, the median chlorophyll-a concentration in the harbor has been less than 2 µg/L (*See* Figure 13 and

Table 6, NHDES 2009 – Numeric Nutrient Criteria for the Great Bay Estuary). This level of phytoplankton growth has a negligible impact on transparency and there is no evidence that a biologically significant change in suspended algal growth has occurred in this area. Moreover, even with increased TN levels, we would not expect chlorophyll-a concentrations to increase in the Harbor due to the limited detention time in this part of the system. The tidal exchange in this area is substantial and would be expected to limit phytoplankton growth to minimal levels.

Coincidently, the time when eelgrass cover decreased in the Harbor area corresponds almost precisely with a period of greatly elevated rainfall (*See* Figure 2). This markedly elevated rainfall would cause a significant increase in runoff and sediment loading to the Harbor. This is more likely the cause of reduced transparency if, in fact, water clarity was responsible for the changes in eelgrass reported by Dr. Short.

Piscataqua River and Little Bay

Dr. Short's email also asserts that eelgrass disappeared completely from the Piscataqua River and Little Bay beginning in 2001 due primarily to a loss of water clarity due to increased phytoplankton growth caused by increasing nitrogen load, and, to a lesser extent, due to excessive epiphyte growth. These assertions are also unsupported by the available data. Data on eelgrass cover (*See* Table HAB2-1, PREP 2009 Report) show variable eelgrass cover from 1999 – 2006 with peak coverage occurring after 2001 in the Piscataqua River and Little Bay when phytoplankton chlorophyll-a levels <u>increased</u> somewhat in Great Bay. Eelgrass cover did not disappear completely until 2007. These data, developed by Dr. Short, show that eelgrass losses are equally high in the Piscataqua River where lower TN and phytoplankton levels occur and water quality is otherwise excellent. (*See* Exhibit 1, Figure 9). The cause of this dramatic eelgrass decline is unknown but certainly not caused by suspended algal growth. The undisputable fact that eelgrass declined in areas with both elevated and low TN concentrations indicates that it cannot be presumed that lowering TN levels will result in eelgrass restoration in the tidal rivers or the Bay. Moreover, there are no data showing increased phytoplankton growth caused biologically significant reductions in transparency in these areas.

Great Bay

No demonstration has been provided to show that eelgrass losses in the Bay are, in fact, correlated to reduced transparency. If they were, eelgrass losses from the deeper Bay waters would be the most prevalent – they are not. Recently, Dr. Short acknowledged that the large tidal fluctuation in Great Bay allow the eelgrass to receive sufficient light and therefore transparency is not likely a controlling factor in this area. (Personal discussion T. Gallagher and F. Short at Southeast Watershed Alliance Symposium and statements at Coalition/DES meeting of July 29, 2011.) In contrast to the transparency theory of eelgrass loss, higher losses appear to have occurred in shallower environments where the <u>most light</u> is available while eelgrass is <u>healthiest</u> in the deeper waters. (*See* Figure HAB2-2, 2009 PREP Report.) This <u>could</u> evidence that macroalgae or shoreline development is adversely impacting eelgrass populations. Therefore, the assumed connection between eelgrass loss and transparency was plainly misplaced.

Data on chlorophyll *a* levels and secchi depth confirm that transparency did not materially change in Great Bay during the period of eelgrass reduction and that chlorophyll *a* increases are not associated with eelgrass decline. (*See* Exhibit 2.) These data confirm that transparency was not a causative agent in the eelgrass decline of the 1990s and that, in fact, transparency appears better today than during the mid-1990s. Moreover, the data further support the conclusion that transparency (as measured by secchi depth) is not materially impacted by the chlorophyll *a* level in this system, as Morrison had also determined (*See*, Exhibit 1, Figure 7). Consequently, controlling TN levels to control phytoplankton growth will have no material impact on water column transparency. The Upper Piscataqua has a <u>lower</u> transparency level than Great Bay, but also <u>lower</u> chlorophyll *a* levels, indicating that other factors are controlling transparency in this system. In fact, the difference in median chlorophyll *a* concentration in all of these areas is negligible (1-3 µg/l). This difference in chlorophyll *a* could not physically account for the wide range of light attenuation occurring in the various areas (0.5-2.3 Kd m^{-1}). Thus, Dr. Short's assumption that reducing TN will produce significant improvement in water column transparency is not supported by the available information or any scientifically defensible analysis presented to the Coalition for consideration.

In conclusion, throughout the late 1990s as eelgrass declined, chlorophyll *a* levels remained constant, even though data indicate that TIN levels increased by 40%. These data confirm that phytoplankton growth in the system is not significantly responding to increase inorganic nitrogen levels (the component of nitrogen that supports plant growth). The assertion that excessive phytoplankton growth caused by increasing TN levels in the system is causing widespread eelgrass impairment is simply not justified based on the available data.

Form of Nitrogen requiring Control

In the December 2011 email, Dr. Short also asserted that dissolved organic nitrogen (DON) and other forms of nitrogen are rapidly converted to dissolved inorganic nitrogen (DIN) once they enter the Estuary and are used directly by the macroalgae. Consequently, control of total nitrogen (TN) loading, not DIN, is necessary to control the growth of macroalgae. This statement concerning the rapid conversion of DON into DIN and the need to control TN is not supported by the available information for the Great Bay Estuary. In response to a Freedom of Information Act (FOIA) request to EPA, the Agency confirmed to the Coalition that it had no information on whether or how rapidly organic and particulate forms of nitrogen (not available for plant growth) were converted into DIN in Great Bay Estuary. Consequently, the claim that these forms are rapidly converted into DIN for use by macroalgae is purely speculative.

The Coalition agrees that macroalgae may be stimulated by excess amounts of readily available nitrogen. DIN is the only readily available form of nitrogen capable of stimulating such algal growth. There is no information or analysis indicating that other forms of nitrogen are rapidly converted to DIN in the Estuary, or that these forms significantly influence plant growth in the Estuary. Consequently, at this time, there is no basis to claim that organic nitrogen cycling plays a significant role in stimulating plant growth in this system, or that organic nitrogen control is necessary to control macroalgae. However, DIN control will substantially reduce the amount of nitrogen that is readily available to stimulate plant growth. (*See*, HDR | HydroQual Technical Memorandum – Estimation of DIN Loads to the Great Bay Estuary System, January 16, 2012) An adaptive management approach that targets DIN reduction will target the appropriate form of nitrogen and will allow for post-implementation assessment without imposing overly stringent and expensive treatment requirements prior to a demonstration of need.

Figure 1

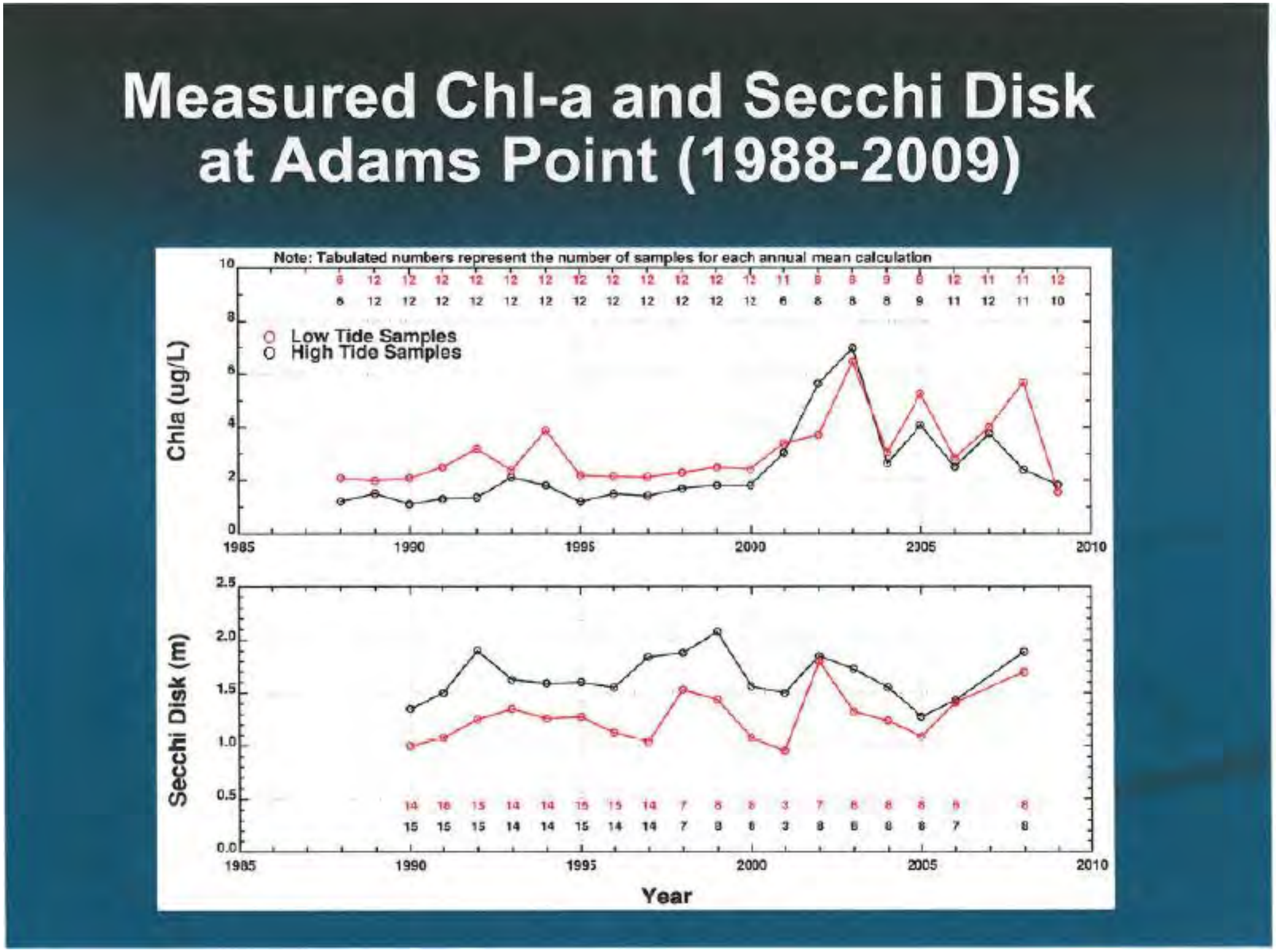

Measured Chl-a and Secchi Disk at Adams Point (1988-2009)
Note: Tabulated numbers represent the number of samples for each annual mean calculation
Low Tide Samples
High Tide Samples
Chla (ug/L)
Secchi Disk (m)
Year

Figure 2

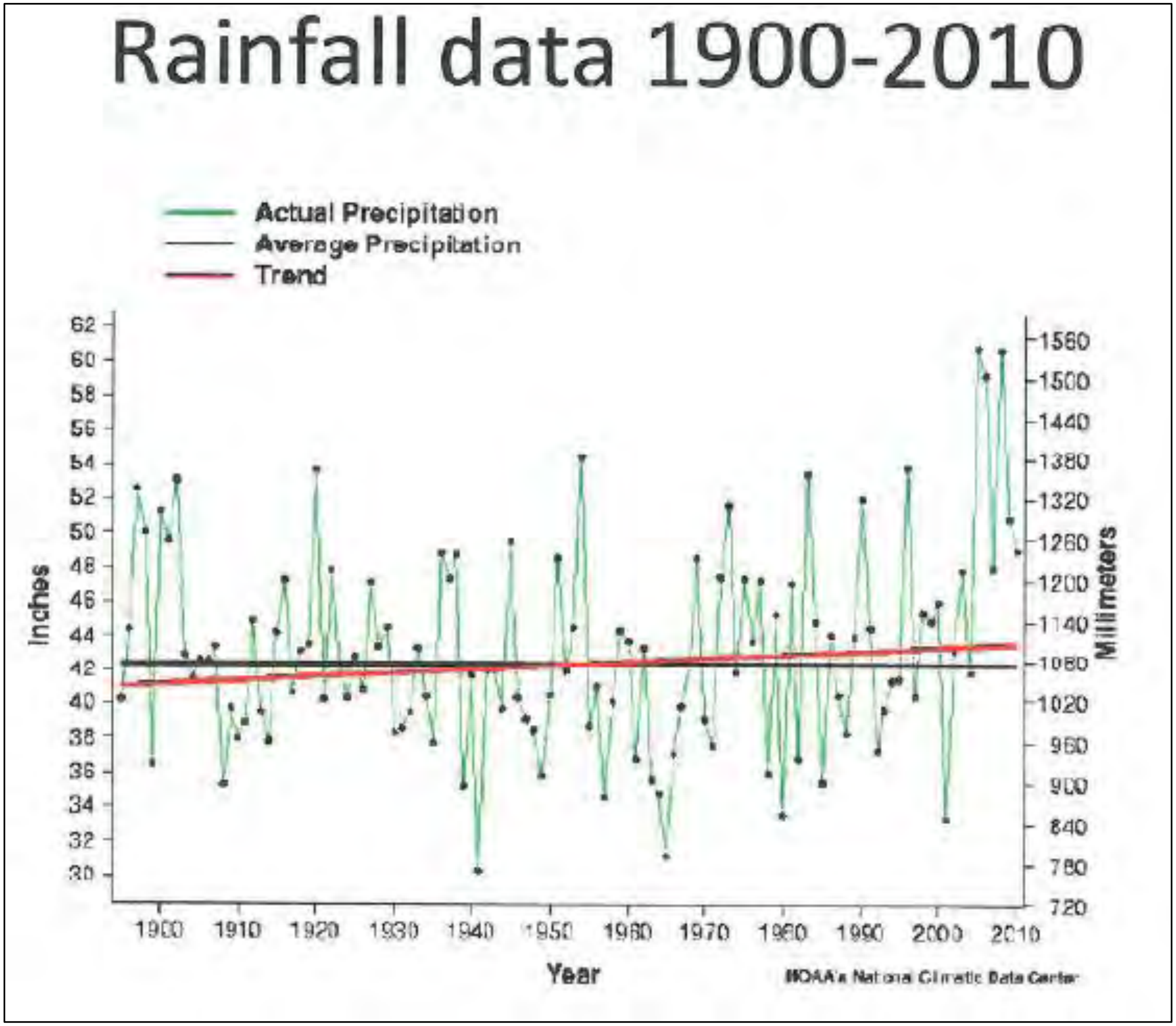

Rainfall data 1900-2010
Actual Precipitation
Average Precipitation
Trend
Inches
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
Millimeters
1560
1500
1440
1380
1320
1260
1200
1140
1080
1020
960
900
840
780
720
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Year
NOAA's National Climatic Data Center

Exhibit 1
Technical Memorandum from T. Gallagher to J. Hall
June 14, 2010

TECHNICAL MEMORANDUM

TO:	JOHN HALL	DATE:	JUNE 14, 2010
		RE:	REVIEW OF PROPOSED NUMERIC NUTRIENT CRITERIA FOR GREAT BAY ESTUARY
FROM:	THOMAS W. GALLAGHER	FILE:	HAAS.004

INTRODUCTION

The purpose of this memorandum is to review the technical analyses contained in the report by New Hampshire Department of Environmental Services (NHDES) entitled, "Numeric Nutrient Criteria for the Great Bay Estuary – June 2009." The Great Bay Estuary includes waters of Great Bay, Little Bay, the Upper and Lower Piscataqua River, Portsmouth Harbor and the tidal segments of rivers tributary to these waters. A map of Great Bay Estuary is sown in Figure1. The technical analyses presented in this report were performed by NHDES with considerable assistance from the Piscataqua Region Estuarine Partnership (PREP). Numeric nutrient criteria were derived from an analysis of water quality data collected between January 1, 2000 and December 31, 2008 at the monitoring stations shown in Figure 2.

A summary of the proposed numeric nutrient criteria for the New Hampshire estuarine waters in the Great Bay Estuary is presented in Table 1. For primary contact recreation a 90th percentile chlorophyll-a threshold concentration of 20 μg/L is proposed. This criterion has been used by DES for 305(b) assessments since 2004. Currently this criterion is not violated in the waters of the Great Bay Estuary, but if this criterion is violated NHDES will list the waterbody as impaired for nitrogen based on regression analyses of 90th percentile chl-a versus nitrogen. To achieve the current dissolved oxygen criteria for aquatic life support NHDES has proposed median total nitrogen (TN) and 90th percentile chl-a criteria of 0.45 mg/L and 10 μg/L, respectively. These criteria apply in sections of Great Bay Estuary where eelgrass has not historically existed, which are typically the upper reaches of the tidal rivers. To protect eelgrass NHDES has proposed light attenuation coefficients for different eelgrass restoration depths that provide 22% of surface light on the estuary bottom. Through regression analyses NHDES has equated various light attenuation coefficients with median TN concentrations. Initially a restoration depth of 2.0 meters is proposed for areas of Great Bay Estuary where eelgrass has historically existed except for the Lower Piscataqua River – South, Portsmouth Harbor, and Little Harbor/Back Channel areas where a restoration depth of 2.5 to 3.0 meters will be determined after further research. Median TN criteria for eelgrass restoration depths of 2.0 m, 2.5 m, and 3.0 m are 0.30 mg/L, 0.27 mg/L, and 0.25 mg/L, respectively. NHDES considers nitrogen to be the limiting nutrient in Great Bay Estuary and has therefore not established phosphorus criterion for Great Bay Estuary waters.

The following is a brief review and critique of the TN and chl-a criteria established to achieve existing dissolved oxygen criteria and provide sufficient light for eelgrass.

Nitrogen and Chl-a Criteria for Meeting Dissolved Oxygen Criteria

As a first attempt to determine TN and 90^{th} percentile chl-a criteria to meet the minimum DO criterion of 5 mg/L, NHDES plotted minimum DO versus 90^{th} percentile chl-a and median TN (Figures 27 and 29 of NHDES Nutrient Criteria Report). NHDES rejected these regressions due to unacceptable uncertainty. Although this approach was abandoned, it is appropriate to critique this approach because the same concepts apply to the approach NHDES finally used. The minimum DO at the monitoring stations used in these regressions is measured at various locations throughout the Great Bay Estuary including the tidal rivers, Great Bay, and Portsmouth Harbor. The minimum DO at each of these stations is affected by site specific factors including BOD oxidation, ammonia oxidation, sediment oxygen demand (SOD), atmospheric reaeration, and algal photosynthesis and respiration. It is highly unlikely that all these factors are identical at each of these diverse locations and the only discriminating variable between sites is algal photosynthesis and respiration represented by 90^{th} percentile chl-a and median total nitrogen. The only method to determine the effect of algae on minimum DO levels is to develop a dissolved oxygen model that properly represents each component of the dissolved oxygen balance including algal photosynthesis and respiration. If algal photosynthesis is an important component of the total DO balance a nutrient-algal model should be developed to quantitatively relate nitrogen concentrations to algal photosynthesis and respiration.

NHDES developed 90^{th} percentile chl-a and median TN criteria to meet the minimum DO standard of 5 mg/L from an analysis of continuous DO data recorded at stations in Great Bay Estuary coupled with chl-a and TN data. Figures 3 and 4 present the datasonde minimum DO measurements recorded at six stations in Great Bay Estuary in addition to 90^{th} percentile chl-a and median TN data. The minimum DO criterion is achieved in Great Bay and the Coastal Marine Laboratory stations and violated in the upper tidal reaches of the Lamprey River, Salmon Falls River, Oyster River, and the Squamscott River with the most severe DO violations occurring in the Lamprey River. In their report NHDEP first notes that at the two stations (GRBGB and GRBCML) where the minimum DO was acceptable the 90^{th} percentile chl-a and median total nitrogen are 3.3 μg/L and 0.30 mg/L respectively for GRBCML an 9.3 μg/L and 0.39 mg/L for GRBGB respectively. From this information NHDES concludes that the maximum measured 90^{th} percentile chl-a and median TN at stations not impaired for DO are 9.3 μg/L and 0.39 mg/L respectively. NHDES then states that the Lamprey River low DO recorded with the datasonde is influenced by stratifications that occurs at neap tide and possibly sediment oxygen demand and may not be representative of typical conditions and therefore excludes this data from further consideration. NHDES then observes that the minimum 90^{th} percentile chl-a at the remaining three DO impaired river stations is 12.1 μg/L at the Squamscott River and the minimum median TN is 0.52 mg/L at the Salmon Falls River station. The final criteria for 90^{th} percentile chl-a and median TN is established as the midpoint between the Great Bay chl-a (9.3 μg/L) and TN (0.39 mg/L) values and the minimum chl-a (12 μg/l) and TN (0.52 mg/L) measured in the DO impaired tidal tributaries yielding a median 90^{th} percentile chl-a criterion of 10 μg/L (rounded down from 10.7 μg/L) and a median TN criterion of 0.45 mg/L.

This analysis suffers from the same problem indicated in the discussion of the attempted regressions of minimum DO versus 90th percentile chl-a and median TN, i.e., the minimum DO at each of these monitoring stations is the result of site specific factors including degree of stratification, SOD, and atmospheric reaeration and therefore should not be grouped together to develop chl-a and TN criteria. These conditions are likely to be significantly different between the tidal river stations and the Great Bay station. Secondly, the minimum DO data from the Lamprey River was excluded on the basis of neap tide stratification and the likely presence of SOD. No data is presented to indicate that the minimum DO at the other three upper tidal river stations do not experience periodic stratification and have no significant SOD. In summary there is clearly no sound science in this method of establishing chl-a and TN criteria for the tidal river waters in Great Bay Estuary. The only scientifically based approach to developing chl-a and TN criteria for each of these tidal rivers is to develop site specific water quality models that relate nutrients to algae and minimum DO. The application of these models may also show that algal concentrations and minimum DO levels in these upper tidal rivers may be more effectively controlled by limiting phosphorus levels instead of nitrogen concentrations.

Total Nitrogen criteria to provide Sufficient Light for Eelgrass Survival

There has been a substantial decline in eelgrass in various waters of the Great Bay Estuary since 1996 and an increase in macroalgae. NHDES has considered the potential effects of nitrogen on macroalgae growth and reduction in water column light through nitrogen stimulation of primary productivity. Based on a regression analysis of the water column light attenuation coefficient versus median total nitrogen, NHDES has concluded that water column light attenuation considerations yields a more stringent total nitrogen criterion than macroalgae effects. This part of the numeric nutrient criteria review evaluates the scientific soundness of the relationship between water column light extinction and total nitrogen.

NHDES has adopted the Chesapeake Bay Program Office target bottom light of 22% of surface light for the survival of eelgrass. Light at any depth can be computed from the equation

$$I_z = I_o e^{-k_d z} \tag{1}$$

where

I_z = light intensity at depth z
I_o = surface light intensity
K_d = light attenuation coefficient (1/m)

Equation 1 can be rearranged to compute a K_d that would provide a defined percentage of surface light at a specified depth.

$$K_d = \frac{\ln(I_z / I_o)}{z} \tag{2}$$

For I_z/I_o = 0.22

$$K_d = \frac{1.51}{z} \tag{3}$$

For eelgrass restoration depths of 2.0 m, 2.5 m, and 3.0 m, the equivalent values of K_d are 0.75/m, 0.60/m and 0.50/m. These are the K_d values contained in the proposed numeric nutrient criteria summarized in Table 1.

NHDES developed a regression of median light attenuation versus median TN for eight Great Bay Estuary monitoring stations that is reproduced in this memorandum as Figure 5. As previously indicated for a target eelgrass restoration depth of 2.0 meters the equivalent light attenuation coefficient is 0.75/m. As shown in Figure 5, the regression line indicates that a 0.75/m attenuation coefficient will occur at a median total nitrogen of 0.30 mg/L which is the proposed nitrogen criterion contained in Table 1 for a restoration depth of 2.0 m.

The light attenuation coefficient K_d is due to the absorption and scattering of light by water, colored dissolved organic matter (CDOM), turbidity, and suspended algal cells as indicated by chl-a. NHDES acknowledges that water column light extinction due to water and CDOM is not controllable. CDOM is largely based on delivery of dissolved organic carbon from the decomposition of plants and organic soils in the watershed. NHDES believes that point and nonpoint source nitrogen control will reduce phytoplankton levels and detrital particulate organic matter derived from primary productivity in the water and terrestrial productivity. The regression shown in Figure 6 (Figure 35 of NHDES report) leads NDES to conclude that a significant component of turbidity in Great Bay Estuary waters is associated with particulate organic matter which is controllable by point and nonpoint source nitrogen reduction.

The regression of turbidity versus particulate organic carbon (POC) shown in Figure 6 can easily be analyzed to estimate the contribution of particulate organic matter to turbidity. Particulate organic carbon concentration can be converted to organic matter concentration with the approximation that organic matter is 50% carbon. The equivalent organic matter concentration or TSS associated with the POC is indicated by the red values on the x axis of Figure 6. For example, a POC concentration of 4 mg/l is approximately equivalent to a TSS concentration of 8 mg/l for organic matter that is 50% carbon. Although there is no single relationship between turbidity and TSS because of variations in particle sizes and composition, a conversion factor relating turbidity to TSS generally falls within a reasonably narrow range. In a report entitled, "Using Moored Arrays and Hyperspectral Aerial Imagery to Develop Nutrient Criteria for New Hampshire's Estuaries – September, 2008" by Morrison et al. conversion factors of 0.30 and 0.51 $\mathrm{NTU\,g^{-1}\,m^{3}}$ are given in Table 7.3 (note: the units for TSS were mistakenly reported as g/L rather than g/m^3 or mg/L). Conversion factors between turbidity and TSS similar to these values are reported in numerous studies. Converting the TSS (mg/L) values shown in red to turbidity (NTU) with a factor of 0.50 NTU $g^{-1}m^3$ results in the green line shown in Figure 6. For example, a TSS concentration of 8 mg/L (or 8 g/m^3) is approximately equivalent to a turbidity of 4 NTU. As indicated in Figure 6, the organic matter component of turbidity derived from this analysis is less than 10% of the total turbidity. Even allowing for variability in the factors used to relate POC to turbidity, it is clear that a significant component of Great Bay Estuary turbidity is associated with inorganic matter and that control of nitrogen alone will not reduce water column turbidity.

Figure 7 is a reproduction of Figure 8.5 from the Morrison et al. report and indicates the relative contribution of water, turbidity, CDOM, and chl-a to the light attenuation coefficient at the Great Bay Buoy for the period April 4, 2007 through December 1, 2007. The fraction of the water column light attenuation coefficient associated with water, turbidity, CDOM, and chl-a was derived from a multiple linear regression of the water column light attenuation coefficient and these variables. Point and nonpoint source nitrogen control will not reduce the water and CDOM components of K_d. Nitrogen control may slightly reduce Great Bay chl-a levels below their median level of 3.4 μg/L and slightly reduce the small organic matter component of turbidity. It is likely there will not be an appreciable reduction in the long term Great Bay median light attenuation coefficient of 1.11/m (Table 8 NHDES report) to the target value of 0.75/m with just nitrogen control. Further improvement in Great Bay Estuary water clarity may come with turbidity reduction through implementation of BMP's or, possibly restoration of the bivalve population in Great Bay Estuary waters.

In 2009 a note in Estuaries and Coasts 32: 202-305 entitled, "Subtidal Eelgrass Declines in the Great Bay Estuary, New Hampshire and Maine, USA" was written by Nora Beem and Frederick Short. Long-term monitoring of eelgrass beds in the central subtidal portion of the Great Bay Estuary showed declines in both transplanted sites and reference beds. A map of these eelgrass sites is shown in Figure 8 with the T1 and T3 sites representing the transplanted sites and the DP, R2 and OCC the reference sites. A plot of the eelgrass biomass at each of these stations between 2001 and 2007 is shown in Figure 9. Also shown in Figure 9 is the median TN, chl-a, and K_d in these assessment areas with the number of measurements (N). The Lower Piscataqua River South area experienced a complete loss of eelgrass between 2001 and 2007 with what appears to be TN, chl-a and K_d values representative of good water quality. Although the K_d data are limited it appears that factors other than nitrogen and turbidity may be affecting eelgrass survival in Lower Piscataqua River South. A similar observation is true for Lower Piscataqua North although the data are more limited. Station DP in Little Bay has TN, chl-a, and K_d values similar to Great Bay and lost all eelgrass between 2005 and 2007 while Great Bay did not experience a precipitous decline in eelgrass during this same period. Although the authors indicate an increase in impervious area in the Great Bay Estuary watershed with a concurrent increase in turbidity and nitrogen, there is no quantitative link between turbidity, total nitrogen and the survival of eelgrass in each of the assessment zones of the Great Bay Estuary. Until this link is established it is scientifically unacceptable to establish TN targets for the waters of Great Bay Estuaries on the basis of the regression analysis presented in the NHDES numeric nutrient criteria report.

Conclusions

The total nitrogen and chl-a criteria developed for Great Bay Estuary for achieving the DO criteria are scientifically unsound in that NHDES develops TN and chl-a criteria by interpolating between the lowest values in the upper tidal tributaries (excluding the Lamprey River) and Great Bay which has minimum DO above the criterion of 5.0 mg/L. The TN and chl-a criteria of 0.45 mg/L and 10 μg/L respectively are based on an approach that ignores the difference in factors that affect the minimum DO in the upper tidal rivers and Great Bay including sediment oxygen demand, atmospheric reaeration, and stratification. In addition, it is assumed that the upper tidal Lamprey River is different than the other tributaries in terms of stratification and sediment oxygen without any data to support this assumption.

The TN criterion of 0.30 mg/L to achieve 22% of surface light on the bottom for eelgrass survival is based on an incorrect assumption that organic matter comprises a significant component of turbidity and that nitrogen control will significantly reduce organic matter and consequently significantly reduce turbidity. An analysis of the fraction of turbidity produced by organic matter indicates that inert solids are the major component of turbidity in Great Bay and that point and nonpoint source control of nitrogen to achieve a median TN of 0.30 mg/L in Great Bay will not achieve the target of 22% of surface light at the bottom.

TWG/lkj
HAAS.004\HALL14JUN10TECHMEM

Table 1. Proposed Numeric Nitrogen and Chl-a Criteria for Great Bay Estuary

Use	Parameter	Threshold	Statistics
Primary Contact	chl-a	20 ug/L	90th percentile
Aquatic Life - DO	TN	0.45 mg/L	median
	chl-a	10 ug/L	90th percentile
Aquatic Life - Eelgrass	TN	0.30 mg/L (1)	median
		0.27 mg/L (2)	median
		0.25 mg/L (3)	median
	Kd	0.75 /m (1)	median
		0.60 /m (2)	median
		0.50 /m (3)	median

Notes:

(1) Eelgrass restoration depth = 2.0 m

(2) Eelgrass restoration depth = 2.5 m

(3) Eelgrass restoration depth = 3.0 m

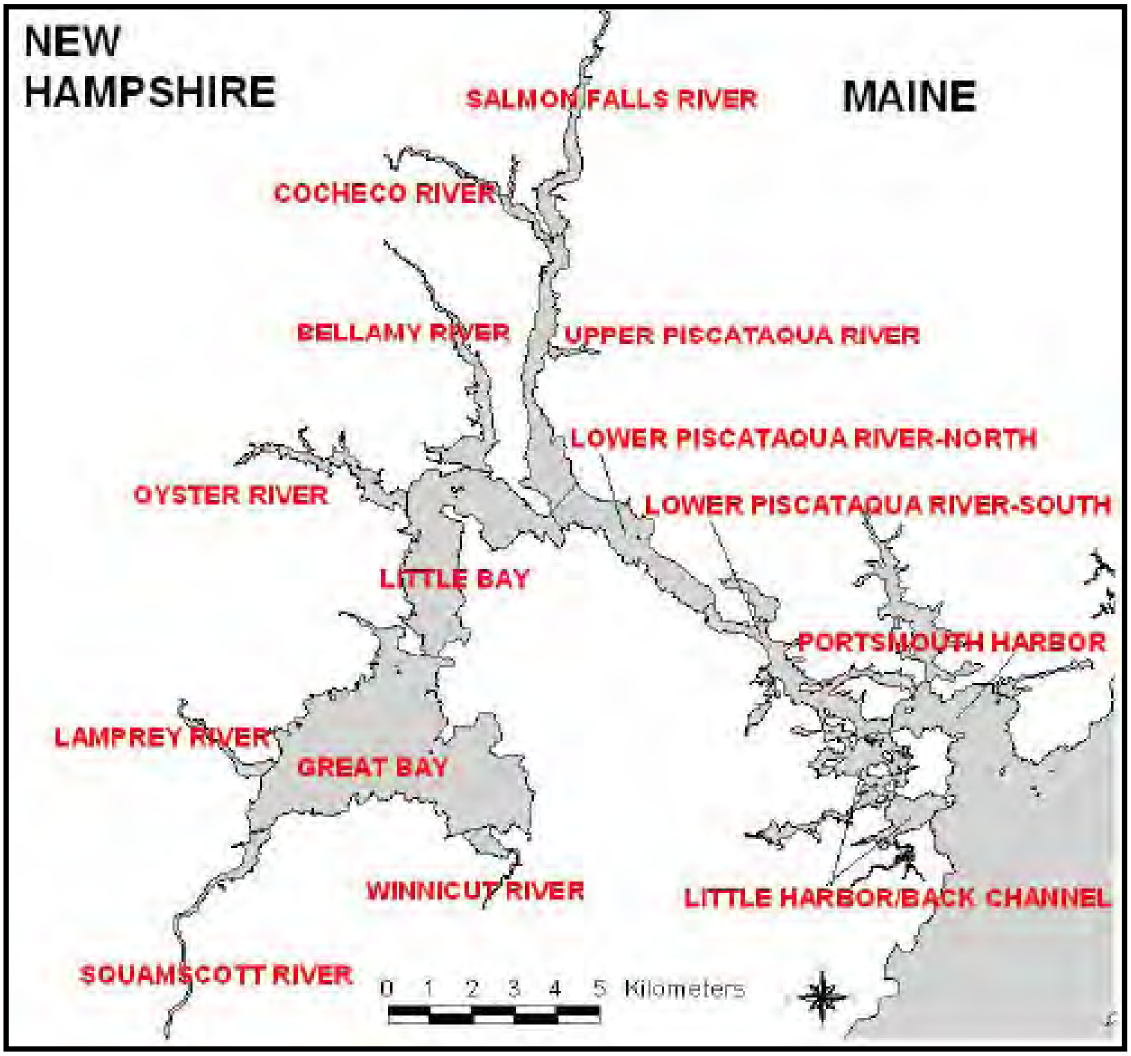


Figure 1. Assessment Zones in the Great Bay Estuary (New Hampshire DES, 2009)

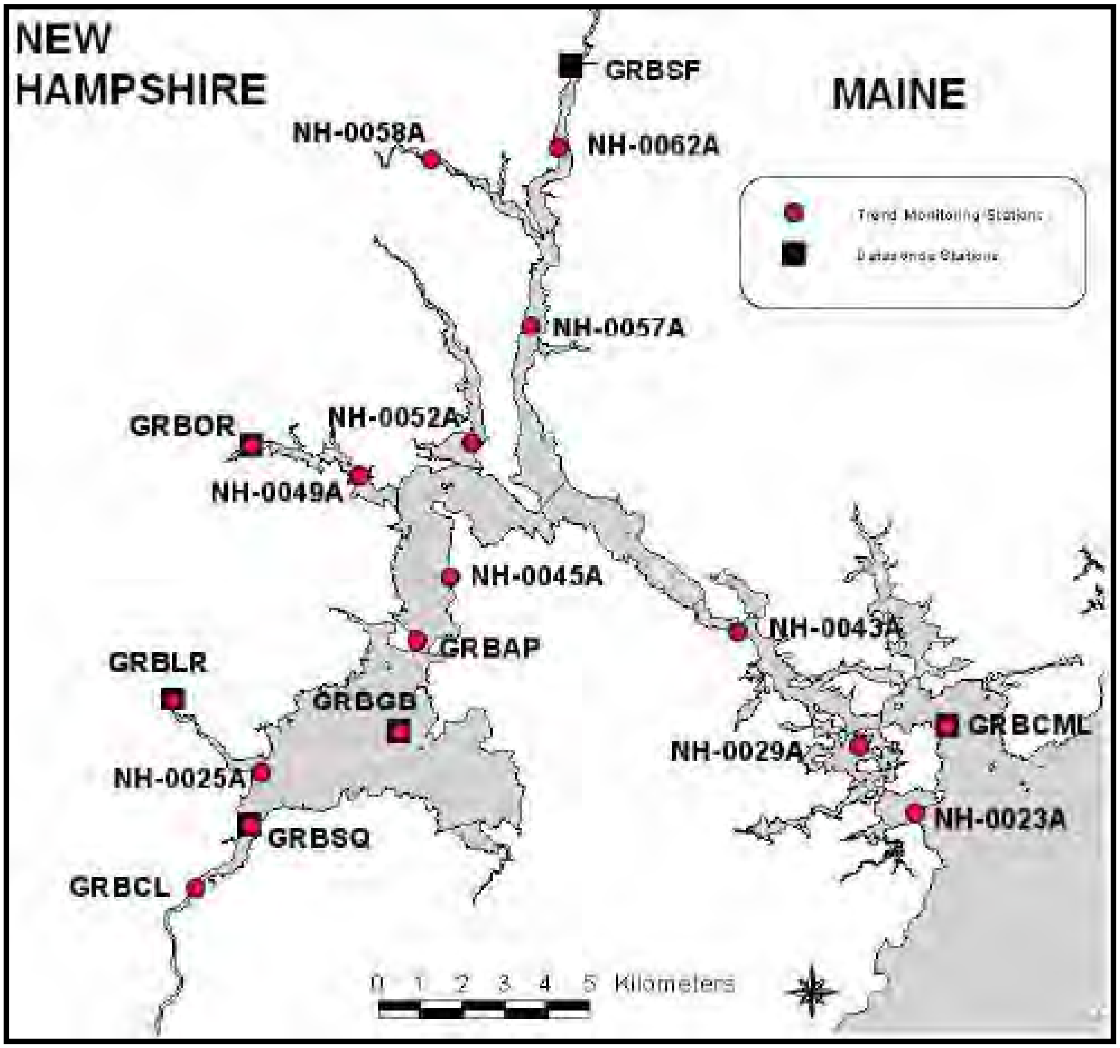


Figure 2. Trend Monitoring Stations for Water Quality in the Great Bay Estuary (New Hampshire DES, 2009)

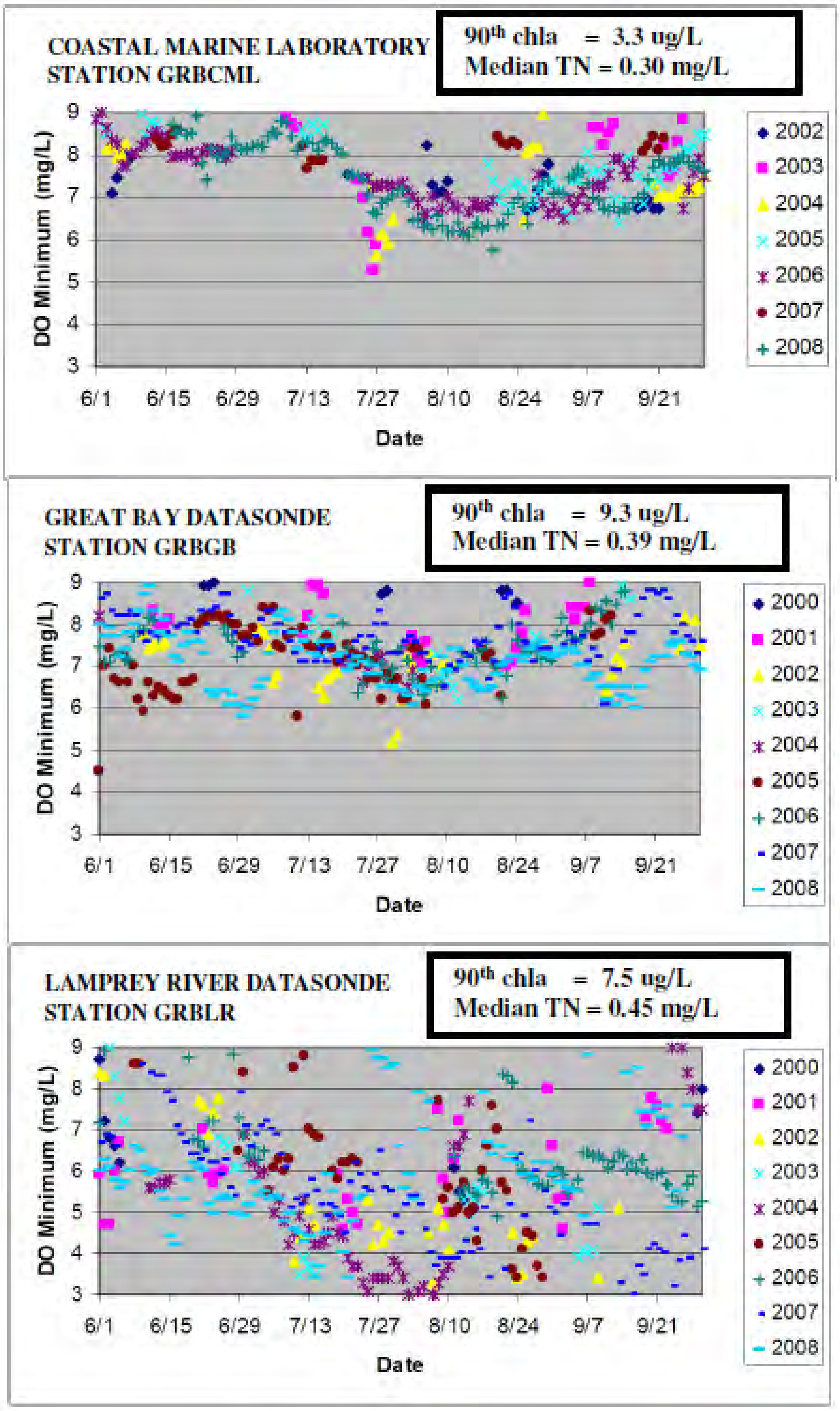


Figure 3. Daily Minimum DO (mg/L), June-September, 2000-2008. Stations GRBCML, GRBGB, GRBLR (New Hampshire DES, 2009)

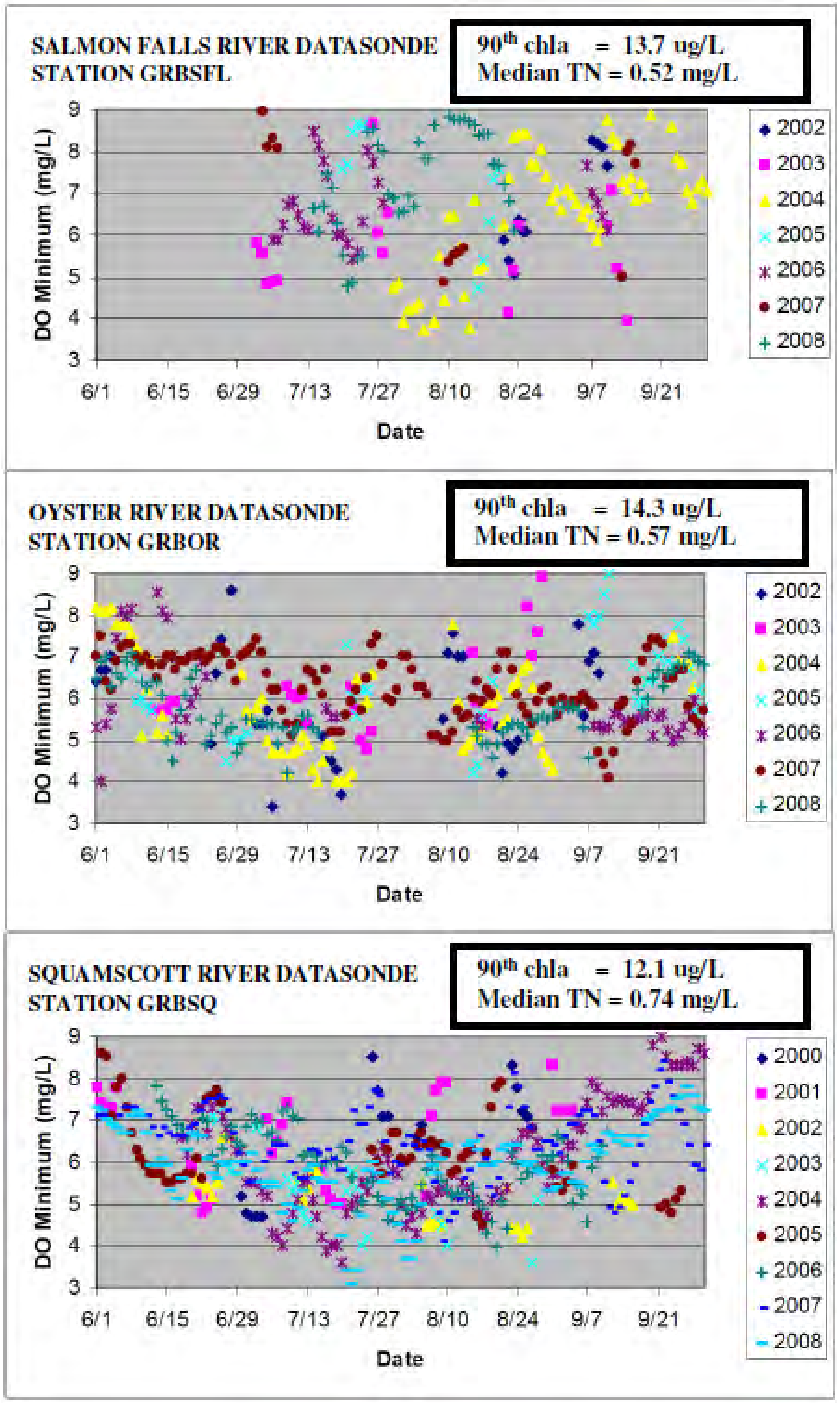


Figure 4. Daily Minimum DO (mg/L), June-September, 2000-2008. Stations GRBSFL, GRBOR, GRBSQ (New Hampshire DES, 2009)

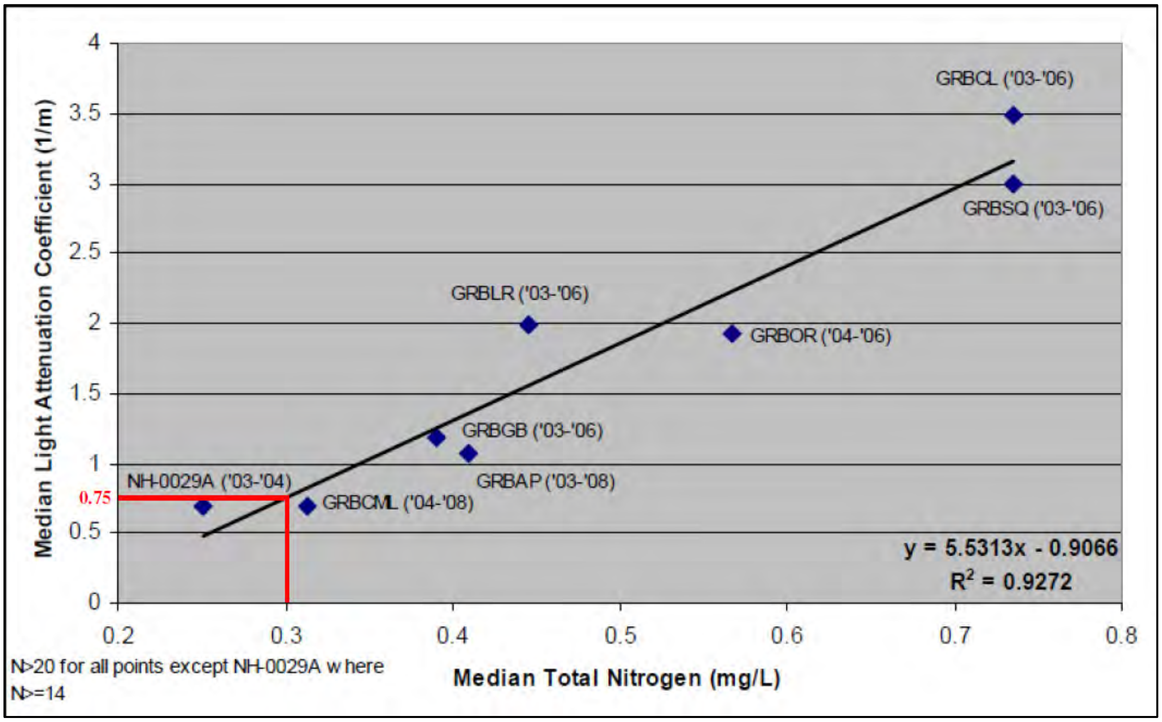


Figure 5. Relationship between Light Attenuation Coefficient and TN at Trend Stations (New Hampshire DES, 2009)

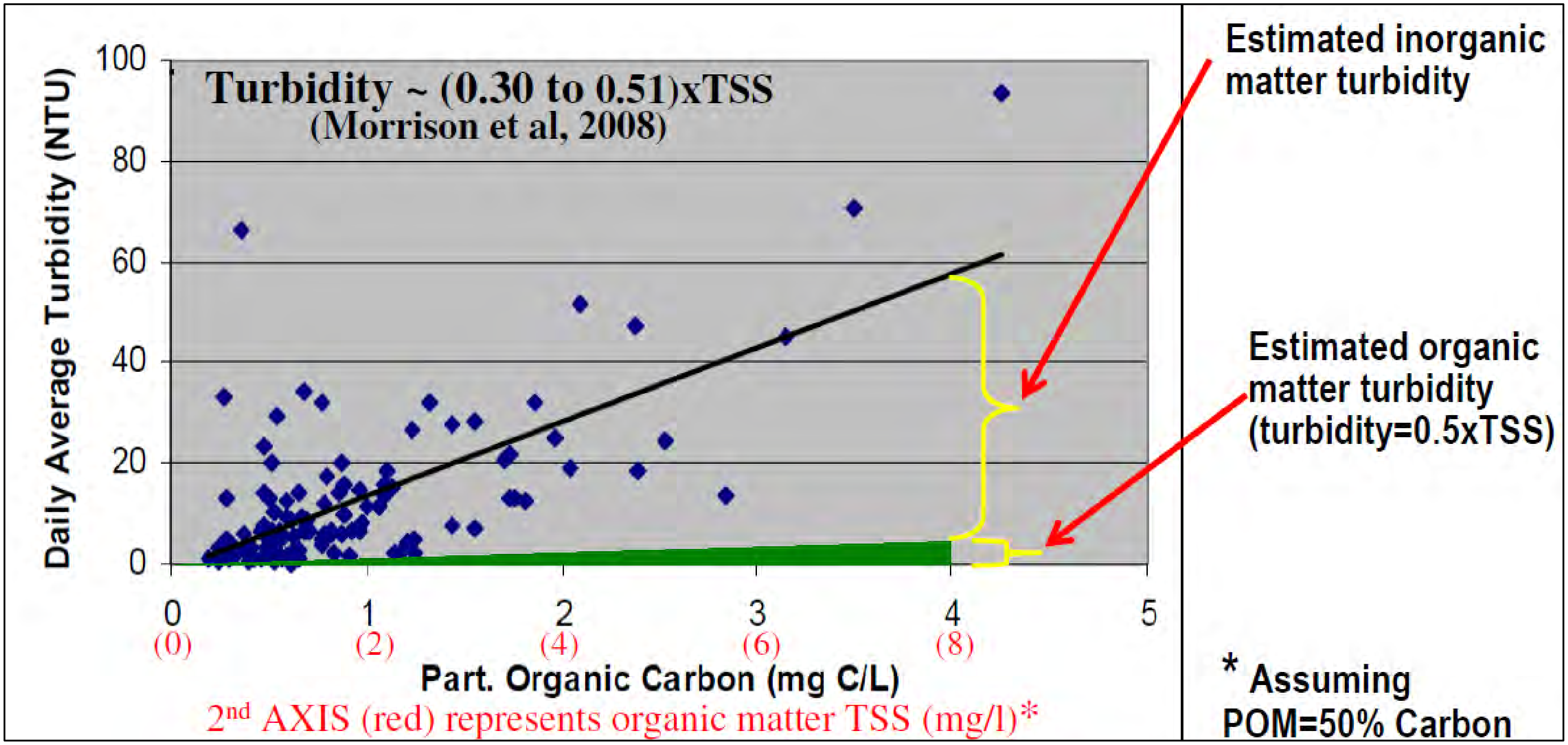


Figure 6. Measured Daily Average Turbidity vs. Particulate Organic Carbon (2000-2007)

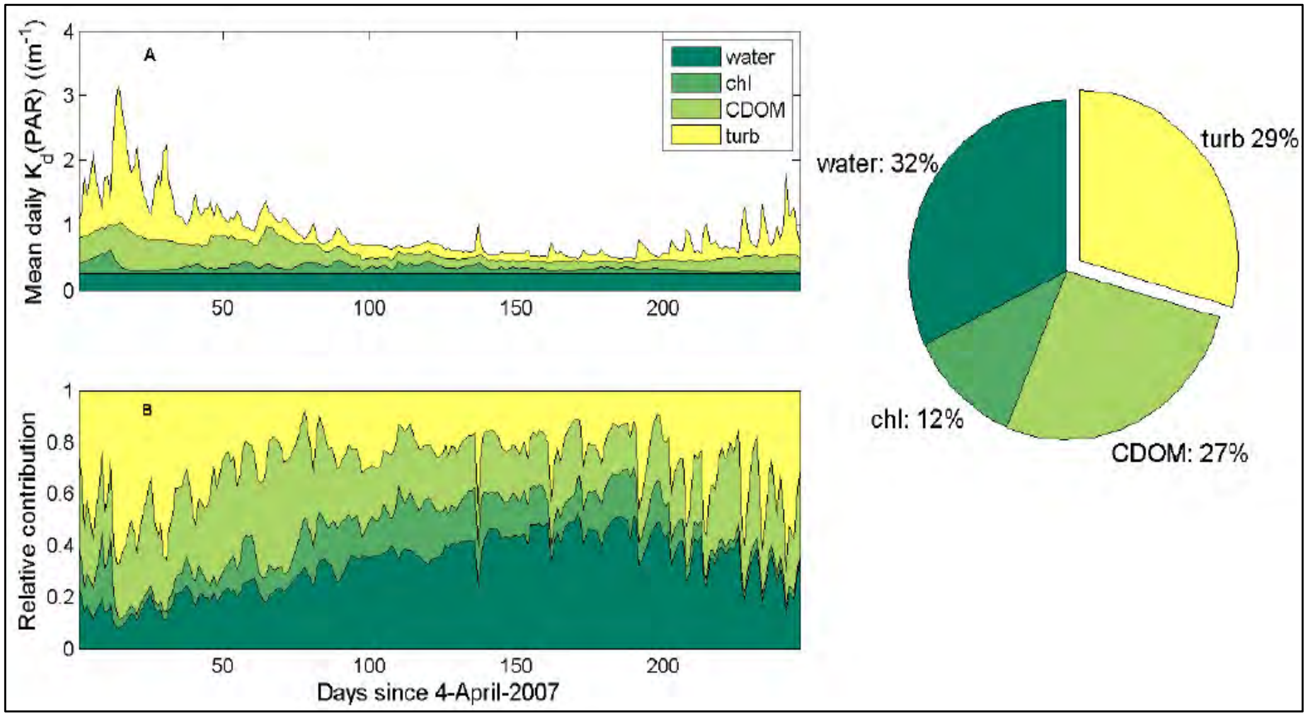


Figure 7. Contributions to Kd (PAR) measured at the Great Bay Buoy (From Morrison et al, 2008)

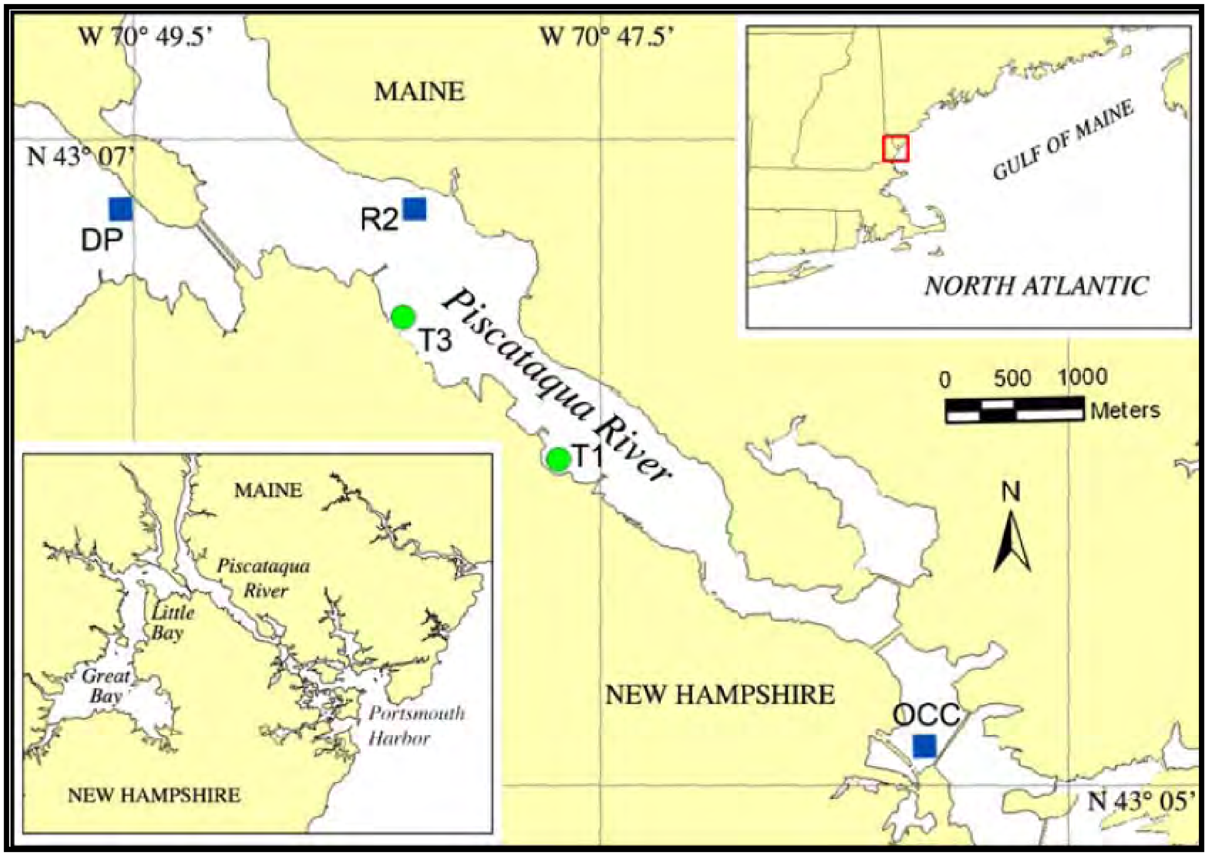


Figure 8. NHPA Eelgrass Monitoring Sites within the Piscataqua River and Little Bay (Nora T. Beem & Frederick T. Short, 2009)

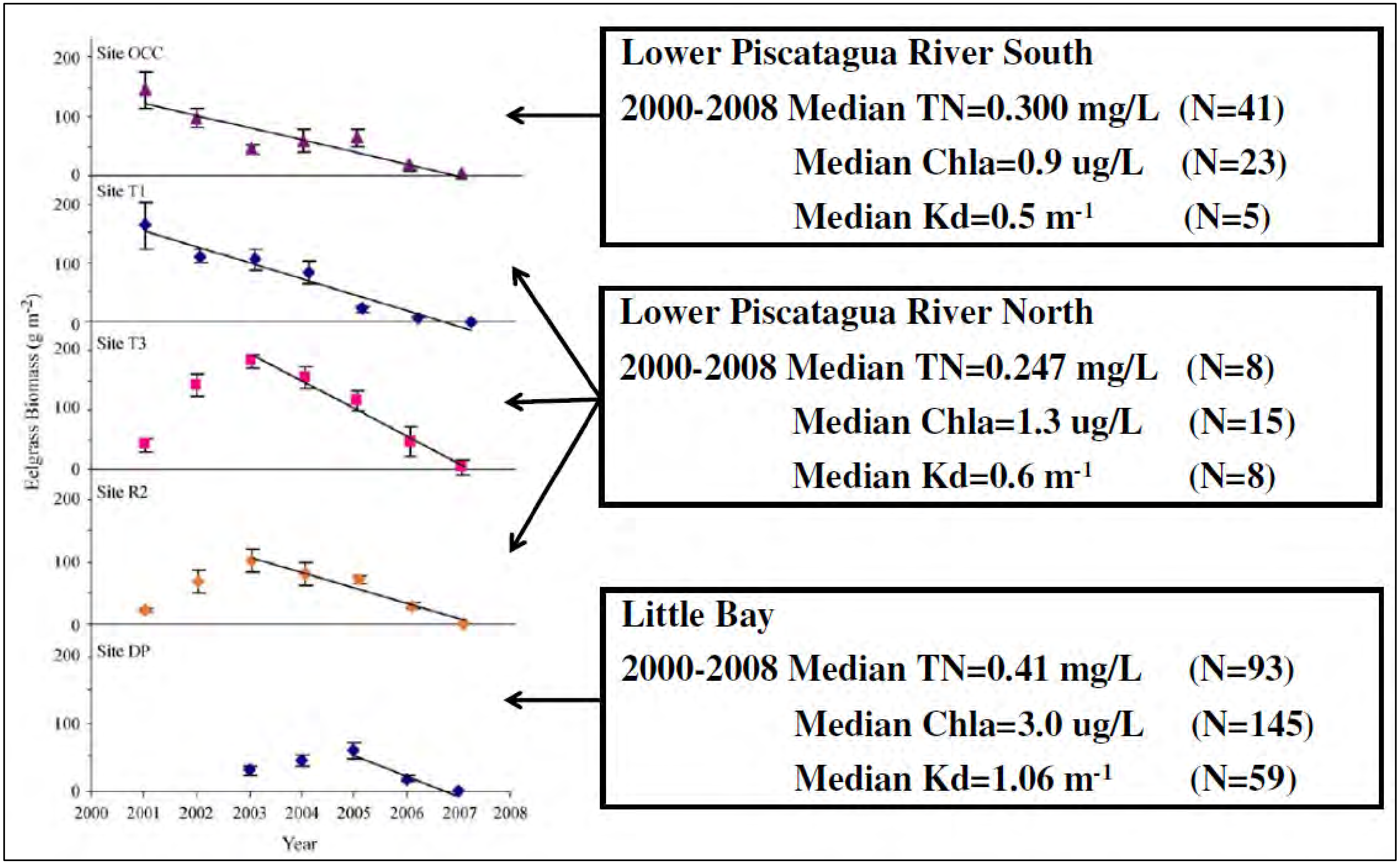


Figure 9. NHPA Eelgrass Monitoring Sites within the Piscataqua River and Little Bay (N. Beem & F. Short, 2009)

Exhibit 2
Technical Memorandum from T. Gallagher and C. Mancilla to J. Hall
January 10, 2011

TECHNICAL MEMORANDUM

TO: JOHN HALL

DATE: JANUARY 10, 2011

RE: REVIEW OF NEW HAMPSHIRE DES TOTAL NITROGEN CRITERIA DEVELOPMENT FOR THE GREAT BAY ESTUARY

FROM: THOMAS W. GALLAGHER
CRISTHIAN MANCILLA

FILE: HAAS.006.000

1. INTRODUCTION

The purpose of this memorandum is three-fold:

a) To review an analysis of eelgrass and nitrogen temporal trends performed by new the Hampshire Department of Environmental Services (NHDES) as presented in Figure 1;
b) To review the NHDES conclusions drawn from Figure 8 with respect to dissolved oxygen (DO) diurnal swings and primary productivity; and
c) To analyze a set of water quality data collected during the summer of 2010 to test the validity of a previous HydroQual analysis that concluded that a significant component of Great Bay Estuary turbidity is associated with inorganic matter and that control of nitrogen alone will not reduce water column turbidity.

2. SUMMARY OF NHDES TN CRITERIA DEVELOPMENT TO PROVIDE SUFFICIENT LIGHT FOR EELGRASS SURVIVAL

There has been a substantial decline in eelgrass in various waters of the Great Bay Estuary since 1996 and an increase in macroalgae. NHDES has considered the potential effects of nitrogen on macroalgae growth and reduction in water column light through nitrogen stimulation of primary productivity. Based on a regression analysis of the water column light attenuation coefficient versus median total nitrogen, NHDES has concluded that water column light attenuation considerations yields a more stringent total nitrogen criterion than macroalgae effects.

NHDES has adopted the Chesapeake Bay Program Office target bottom light of 22% of surface light for the survival of eelgrass. For eelgrass restoration depths of 2.0 m, 2.5 m, and 3.0 m, the equivalent values of K_d are 0.75/m, 0.60/m and 0.50/m. These are the K_d values contained in the proposed NHDES numeric nutrient criteria. NHDES developed a regression of median light attenuation versus median TN for eight Great Bay Estuary monitoring stations. As previously indicated for a target eelgrass restoration depth of 2.0 meters the equivalent light attenuation coefficient is 0.75/m. The regression analysis performed by NHDES indicated that a 0.75/m attenuation coefficient will occur at a median total nitrogen of 0.30 mg/L which is the proposed nitrogen criterion for a restoration depth of 2.0 m.

3. SUMMARY OF NHDES NITROGEN TEMPORAL TRENDS ANALYSIS AND WITHIN DAY DO VARIABILITY ANALYSIS

As shown in Figure 1, NHDES has compared temporal plots of nitrogen (nitrate and dissolved inorganic nitrogen) with changes in eelgrass coverage in acres from 1974 to 2009. Based on these temporal plots, some of the conclusions proposed by NHDES are: a) the apparent increase in inorganic nitrogen is an indicator of an increase in total nitrogen loading to the system; b) since 1995 nitrate levels have exceeded 50 ug/L which they state is the threshold to produce direct effects (toxicity) on eelgrass.

Figure 8 presents DO measurements (%DO saturation) recorded by an in-situ datasonde in the tidal portion of the Squamscott River. Based on this figure, NHDES concluded that primary productivity, via photosynthesis and respiration, is the reason for the DO diurnal swings from supersaturation to 60%-70% saturation.

4. ADDITIONAL DATA ANALYSES AND REVIEW OF NHDES NITROGEN TEMPORAL TRENDS ANALYSIS

HydroQual performed an analysis of temporal trends for several constituents besides the nitrogen forms studied by NHDES. Figures 2 to 4 present temporal plots of annual values of several nitrogen forms, salinity, dissolved oxygen (DO), water temperature, chlorophyll-a, total suspended sediments (TSS), and phosphate (PO4). To be consistent with the NHDES analysis methodology all annual values depicted on these plots represent annual median values. The tabulated values for each year represent the number of samples employed for each annual median computation. For these figures, in contrast to the NHDES analysis that included low tide measurements only, low as well as high tide measurements were considered for the 1988-2009 dataset. Therefore, 24 (2 per month, 1 low and 1 high) is the maximum number of possible samples for each year. The 1973-1981 dataset contained a maximum of 12 samples per year (1 per month) with no indication of the tide stage. The entire database (1973-1981, 1988-2009) provided to HydroQual by NHDES did not contain the required nitrogen forms to compute total nitrogen concentrations. Because the inorganic nitrogen forms included at these plots show an apparent increase for data post 1988, several other constituents were simultaneously analyzed. Salinity was employed to examine for any possible sampling bias with respect to freshwater and ocean water content of the samples. The salinity annual values concurrent with the annual measured nitrogen values, for both time periods, show similar magnitudes and therefore imply a similar freshwater content. Also, DO, PO4 and water temperature show comparable levels for both time periods. Pre 1981 chlorophyll-a shows higher values than then 1988-2000 time period values, but post 2000 chlorophyll-a values represent an increase with respect to previous years. TSS for the period 1993-1998 shows rather constant levels although NHDES considers 1996 as the beginning of the eelgrass decline and asserts that TSS fluctuations are fully explained by changes in eelgrass.

Eelgrass biomass was considered to be a better indicator of eelgrass abundance and therefore used instead of eelgrass coverage. Eelgrass biomass values for several years (1990-2004) were digitized from a report prepared by Morrison et al. (2008). Figure 5 indicates that for several years nitrate levels were greater than or equal to 50 ug/L with no identifiable decrease in eelgrass biomass. For example, in Figure 5 (1973-1981 data), no available eelgrass is available but it is assumed that eelgrass was abundant despite the stated nitrate threshold of 50 ug/L being exceeded during several years. In several occasions, in Figure 5 (1988-2009 data), eelgrass biomass seems stable or even increasing when nitrate levels are greater than the stated nitrate threshold.

The use of inorganic nitrogen (Figure 2) as an indicator of total nitrogen trends can be inaccurate because with declining eelgrass levels less inorganic nitrogen is taken up from the water column (uptake) by eelgrass primary productivity. Figures 6-1 and 6-2 provide a seasonal analysis (monthly) of several constituents at Adams Point. From these figures, temperature seasonal trends could explain the seasonal variations of water column inorganic nitrogen as the eelgrass nitrogen uptake rate is directly related to temperature.

If a more comprehensive analysis of Great Bay total nitrogen concentrations indicates that there are no increasing trends when eelgrass declines, total nitrogen may not be the cause of declining eelgrass. A comprehensive analysis should identify temporal trends on non-point source and point source total nitrogen loads into the system. Figure 7 is similar to Figure 2 but includes some total nitrogen data at Adams Point queried from Great Bay water quality databasets and used by NHDES for the development of the total nitrogen threshold for eelgrass protection. On this figure, the total nitrogen temporal trends don't follow the inorganic nitrogen trends and depict a more steady pattern. These dissimilar trends could be explained by a re-distribution of nitrogen species for the similar total nitrogen levels due to eelgrass uptake, macroalgae uptake or an unidentified mechanism.

5. REVIEW OF NHDES CONCLUSIONS ON PRIMARY PRODUCTIVITY AND DO DIURNAL VARIATION

Figure 8 presents dissolved oxygen measurements (% saturation) recorded by an in-situ datasonde in the tidal portion of the Squamscott River. NHDES asserts that primary productivity is the reason for the diurnal swings. Although there is evidence of primary productivity as indicated by the supersaturated DO, much of the diel variability is due to tidal translation rather than primary productivity. The evidence for the effect of tidal translation is indicated by peak DO values at night and the one hour per day shift in the diel DO pattern consistent with the shift in the tidal phase by approximately one hour each day. In addition the steep decline in DO within the day can be associated with ebb tide drainage of adjacent marshes with low DO concentrations.

To provide some insight into the tidal translation effects in the DO diurnal variation, high frequency data (15 minutes) was obtained from the National Estuarine Research Reserve System website for the Squamscott River Monitoring Station. The dissolved oxygen saturation data presented in Figure 8 (NHDES) presents data recorded in July 2008, days 16^{th} to 20^{th}. Figure 9-1 presents temporal plots of dissolved oxygen saturation, water depth and turbidity for the same time period depicted in Figure 8. From Figure 9-1, it is evident that the diurnal DO variability is due to tidal translation as the DO saturation values within a day are consistent with the measured tidal phase. Furthermore, other factors may also be responsible for the DO diurnal variation, e.g., increasing turbidity trends seem to correspond to decreasing DO saturation trends. Alternatively, the same graphical analysis was performed with data recorded in July 2005 and similar conclusions can be drawn. Figure 9-2 presents the July 2005 DO analysis. The DO at this river location is the result of site specific factors including degree of stratification, SOD, and atmospheric reaeration and therefore additional data collection and the development of a water quality model are required for the estimation of each component of the DO balance.

6. ANALYSIS OF 2010 WATER QUALITY DATA

As previously indicated, NHDES used a regression of light attenuation coefficient versus total nitrogen to establish a total nitrogen criterion of 0.3 mg/L for eelgrass survival. This relationship implies that nitrogen contributes significantly to a reduction in the water column light attenuation coefficient. The mechanism by which nitrogen may contribute to a reduction in water column clarity is stimulation of the growth of phytoplankton. In addition, organic nitrogen is a surrogate for organic matter (which can lower the water column transparency) associated with non point source loads.

In June 2010, HydroQual performed a review of the NHDES nitrogen criteria development and a preliminary data analysis that suggests that a high percentage of the light reduction associated with turbidity is due to non-volatile suspended solids (NVS) and therefore unrelated to nitrogen. These inert particles are unrelated to effects of nitrogen and are actually silts and clays that are probably resuspended from the bay bottom or brought in with river flows.

In June 2010, HydroQual proposed a short term field program to test the hypothesis that particular organic matter is a small component of the water column turbidity. The sampling program was conducted during the summer of 2010 with the collection of water quality constitutes to compute the non-volatile suspended solids fraction in Great Bay. Five stations were sampled in Great Bay, August 5th to September 2nd 2010. Measurements included: wind speed, tide stage, temperature, salinity, TSS, NVS, POC, PON, CDOM, chlorophyll-a and secchi disk. Measurements of temperature, salinity, TSS, and VSS were taken at surface, mid and bottom depths. The remaining parameters were taken at mid depths only. Figure 10 depicts the station locations. Temporal plots of several constituents are shown in Figures 11 and 12. From these figures it can be seen that chlorophyll-a levels are relatively low. The volatile suspended solids (VSS) concentrations were computed as the difference between TSS and NVS. Temporal plots presented in Figures 11 and 12 include all 5 sampled locations, therefore chlorophyll-a variability for the same sampling day is due to variability across stations while the variability for temperature, salinity, TSS, and NVS is due to variability across stations and also sample depth. Appendix A presents temporal plots for the same water quality parameters included in Figures 11 and 12 but for individual stations.

A regression analysis of NVS versus TSS is shown in Figure 13. The results indicate that NVS is approximately 85% of the TSS concentrations thus supporting HydroQual's assumption that nitrogen is not a significant factor in contributing to a reduction in water column clarity. The remaining 15% of TSS is VSS associated with algae (chlorophyll-a) and detritus. Because chlorophyll-a is quite low (~ 3 ug/L), algae are a minor contributor to a reduction in water column transparency. These results are in agreement with the analysis presented by Morrison et al. (2008) as shown in Figure 14.

7. CONCLUSIONS

a) The nitrogen temporal trends analysis performed by NHDES is not sufficient to affirm that there has been an increasing temporal trend in total nitrogen loading to the system. The use of inorganic nitrogen as an indicator of total nitrogen trends can be inaccurate because with declining eelgrass levels less inorganic nitrogen is taken up from the water column by eelgrass primary productivity. A comprehensive nitrogen temporal trend analysis should identify temporal trends on non-point source and point source total nitrogen loads into the system.

b) The NHDES proposed nitrate threshold of 50 ug/L has been exceeded several years in the past when abundance of eelgrass beds was assumed. Furthermore, the proposed nitrate threshold has also been exceed for several years for which eelgrass coverage and biomass measurements are available and these show steady abundance patterns over such years.

c) The measured diurnal DO variability in the tidal portion of the Squamscott River is due to tidal translation rather than primary productivity. Additional data collection and the development of a mechanistic water quality model are requited for the estimation of the DO balance components.

d) The analysis of the 2010 water quality dataset shows that nitrogen effects are not a significant factor in reducing water column transparency and therefore the establishment of a total nitrogen criteria of 0.3 mg/L from a regression of water column light attenuation coefficient versus nitrogen is inappropriate. About 15% of TSS is VSS associated with algae (chlorophyll-a) and detritus, because chlorophyll-a is quite low, algae are a minor contributor to a reduction in water column transparency. As a consequence of this analysis, total nitrogen load reductions to Great Bay will not substantially improve the water column transparency.

TWG/amm
WordProcessing\Jobs\HAAS\006.000\Hall10Jan11TMEM

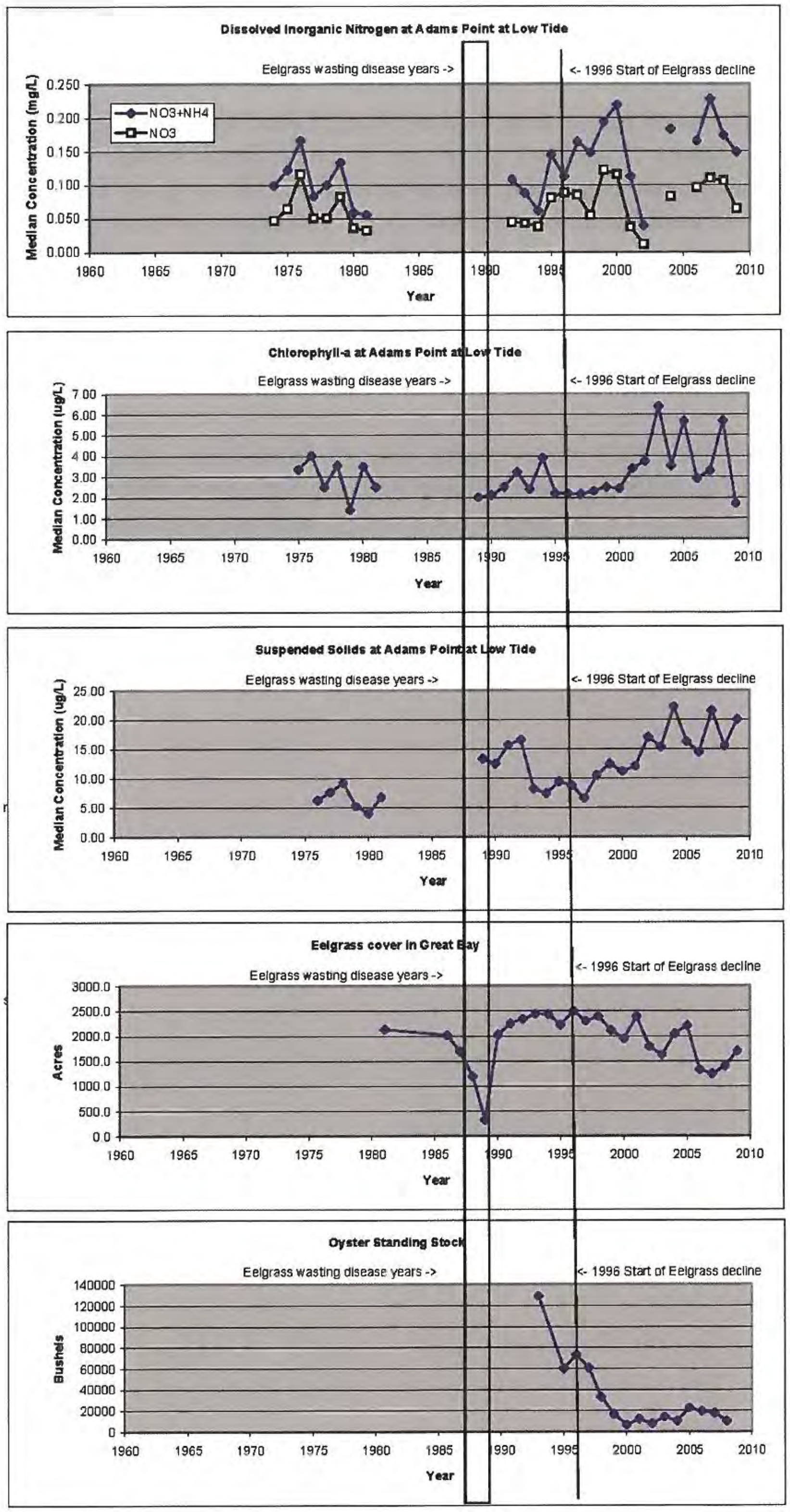


Figure 1. NHDES Temporal Trends Analysis

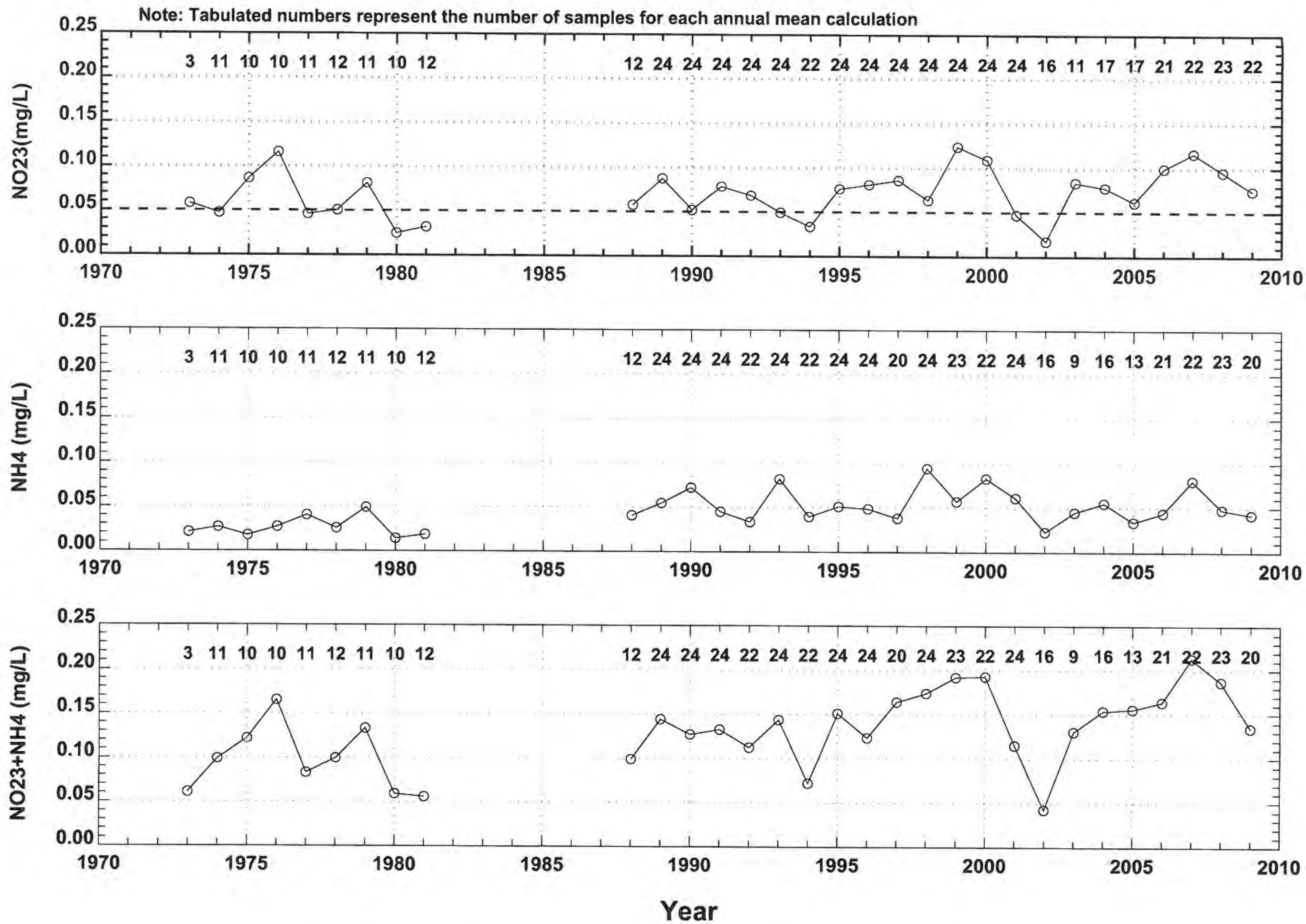


Figure 2. DES Monitoring Data (1973-2009), Adams Point

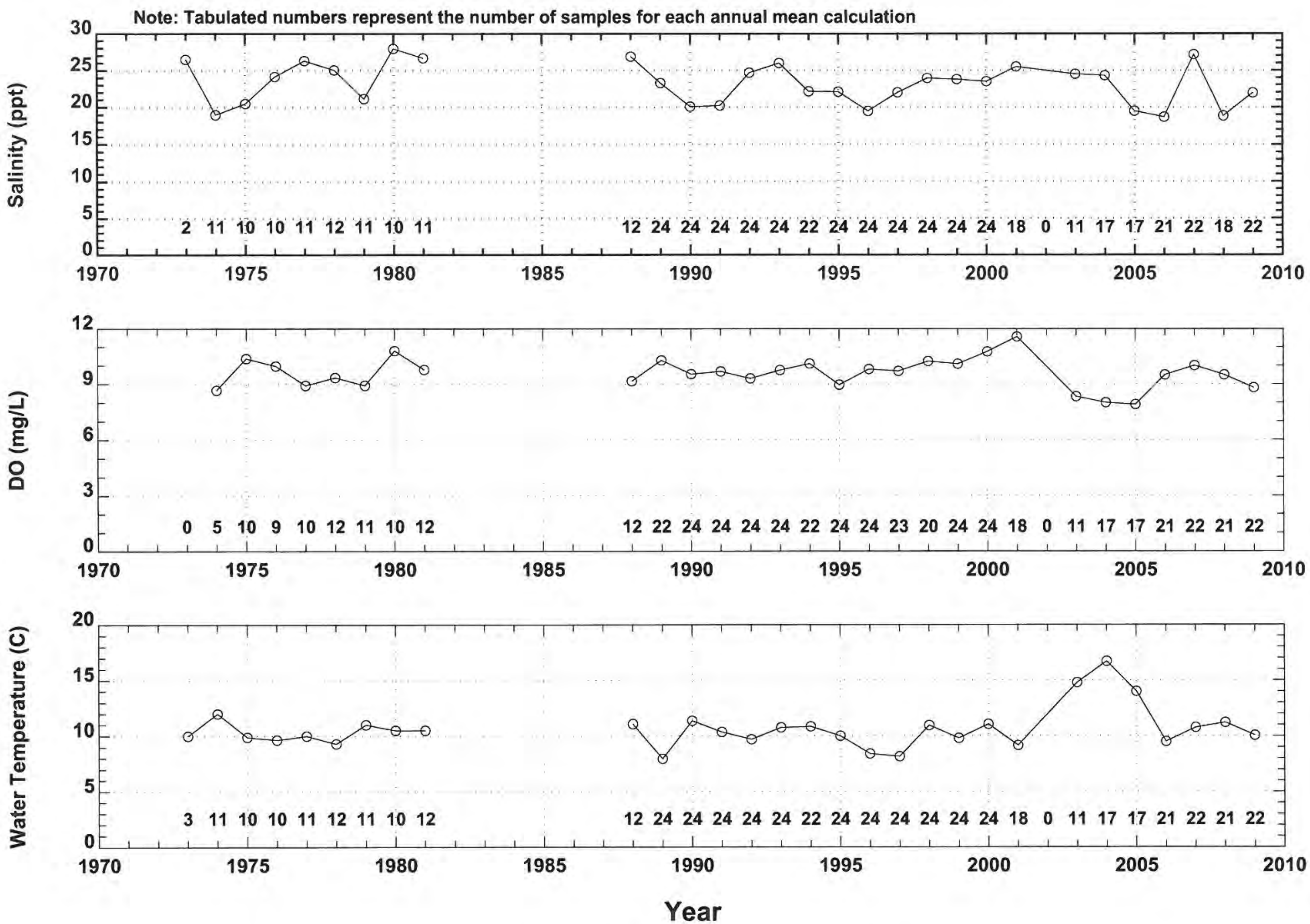


Figure 3. DES Monitoring Data (1973-2009), Adams Point

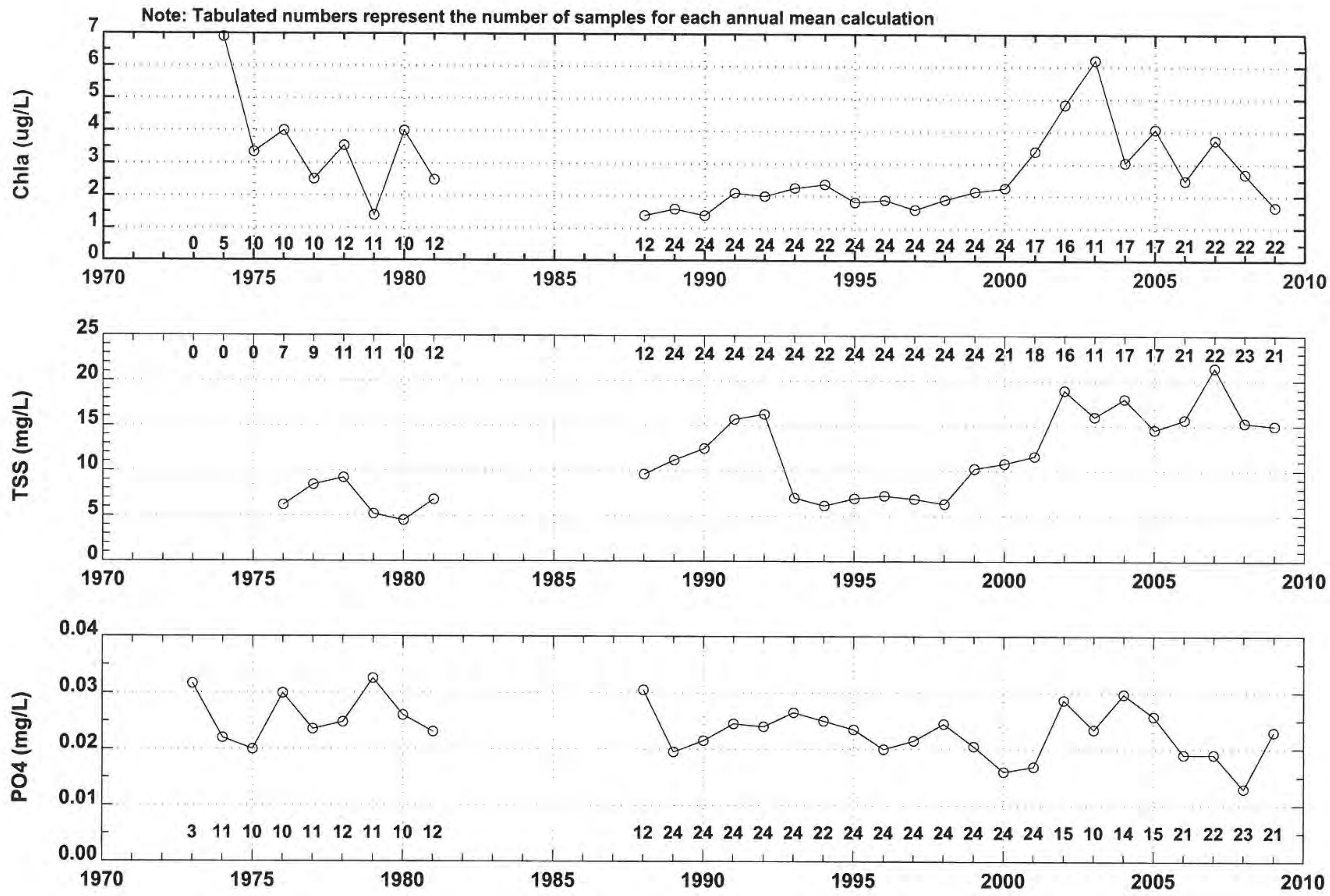


Figure 4. DES Monitoring Data (1988-2009), Adams Point

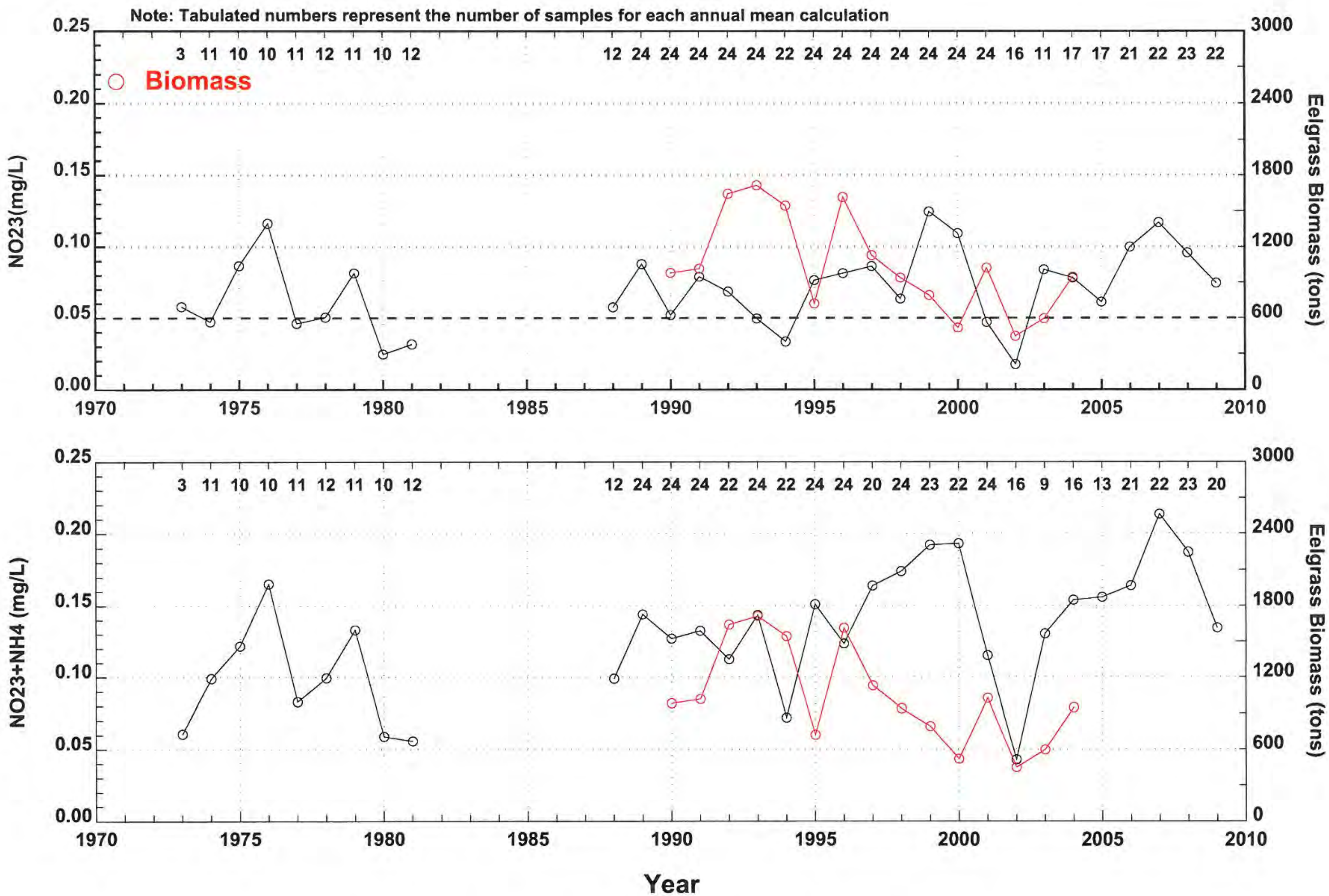


Figure 5. DES Monitoring Data (1973-2009), Adams Point

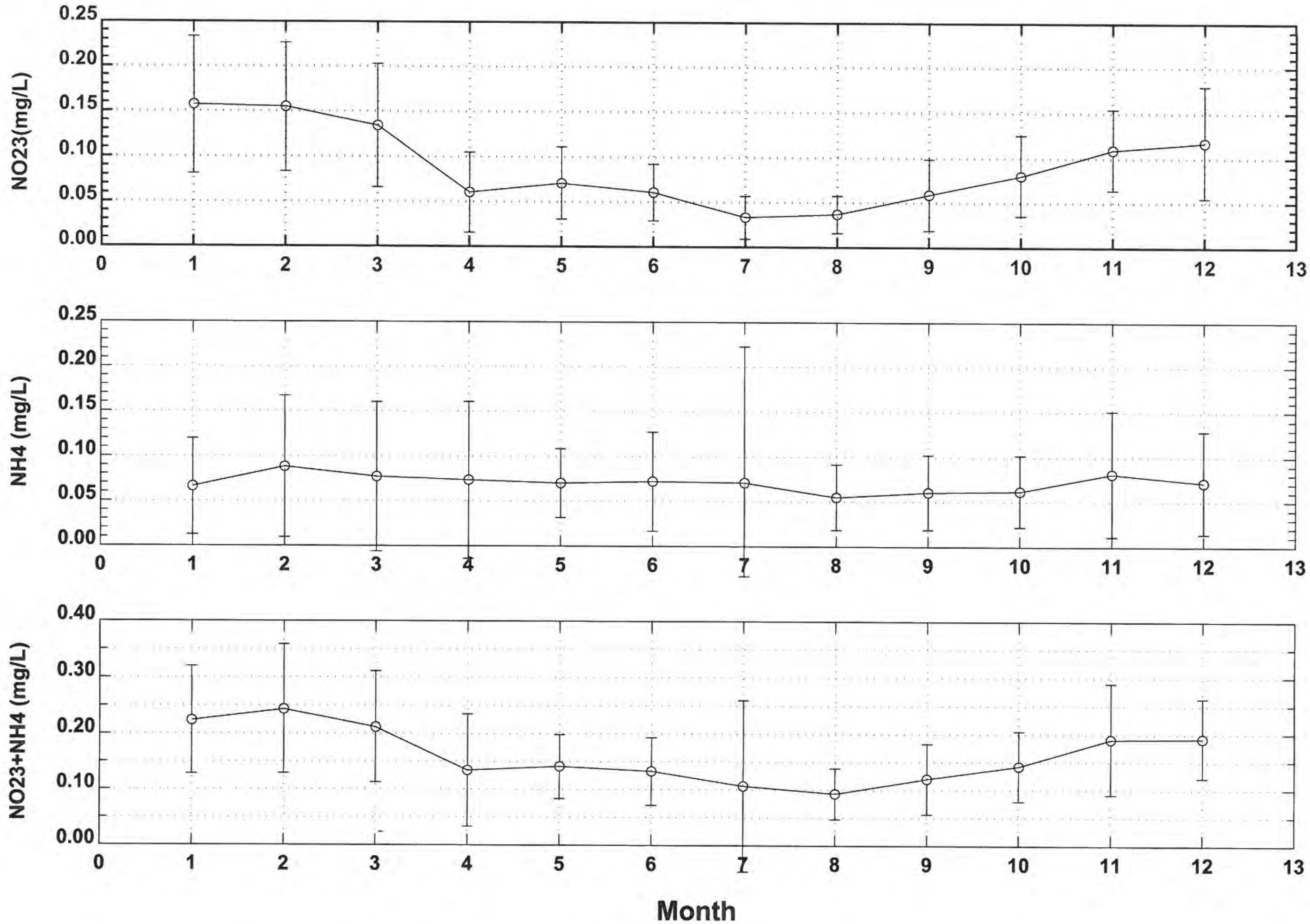


Figure 6-1. DES Monitoring Data (1988-2009), Adams Point

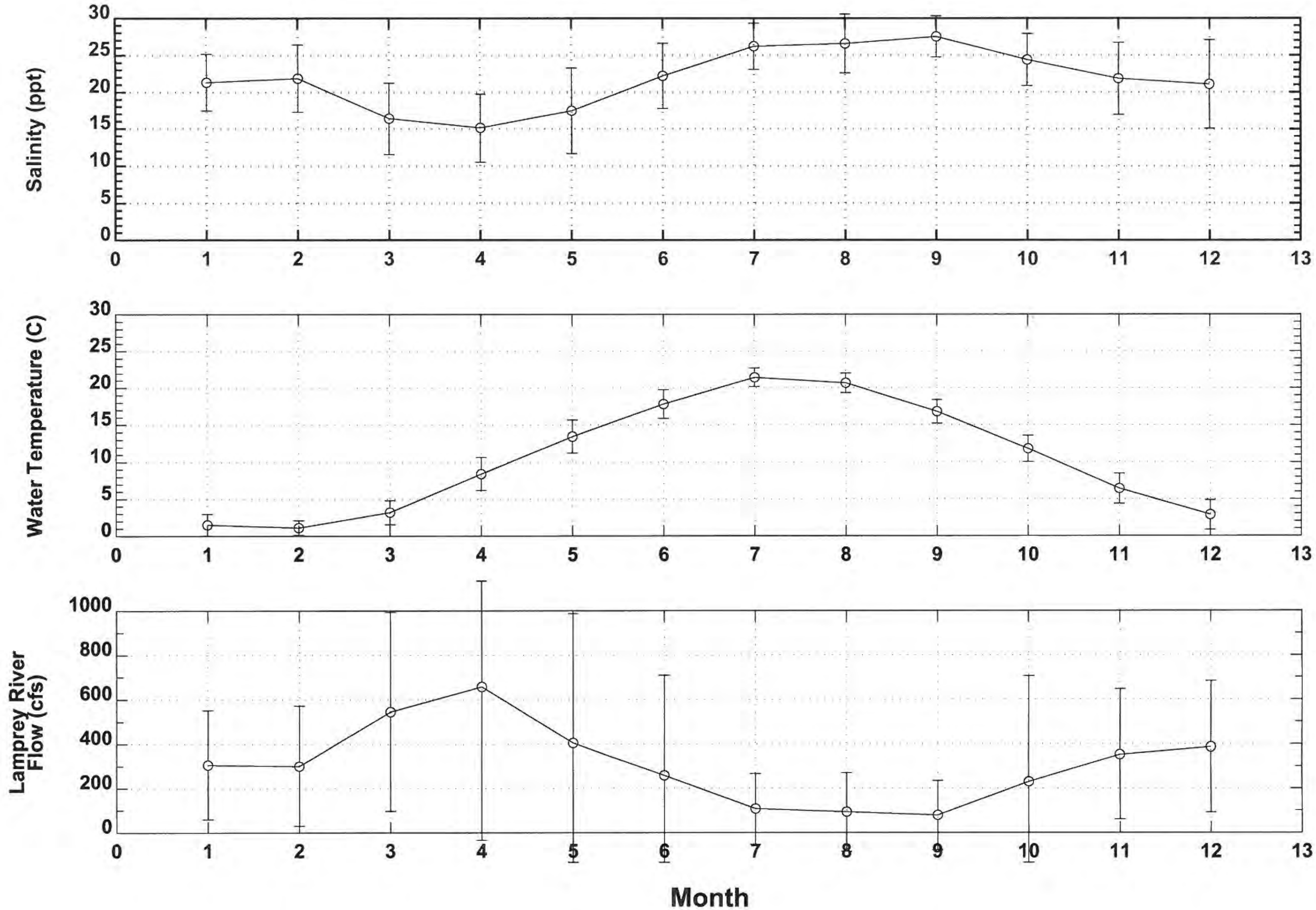


Figure 6-2. DES Monitoring Data (1988-2009), Adams Point

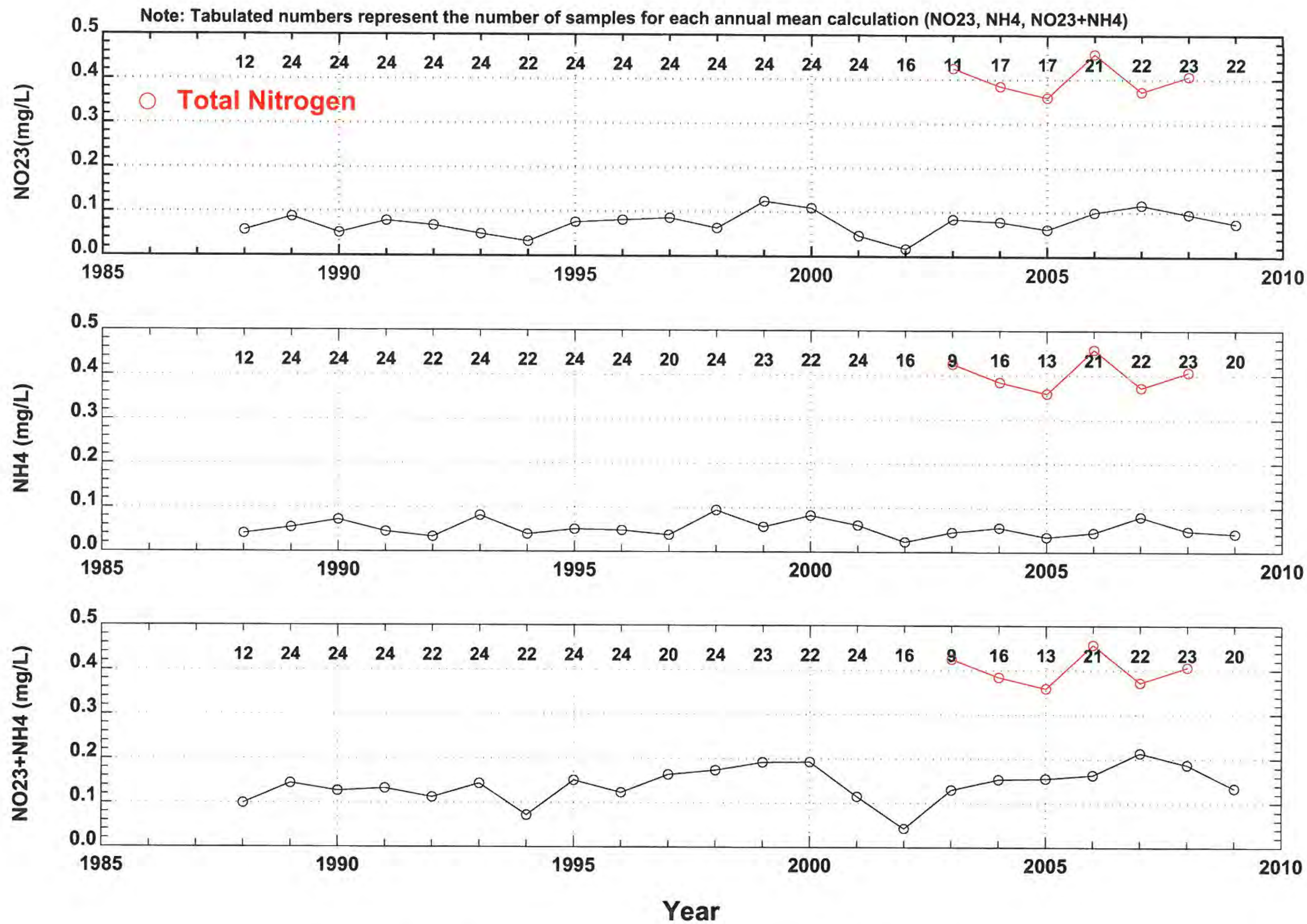


Figure 7. DES Monitoring Data (1988-2009), Adams Point

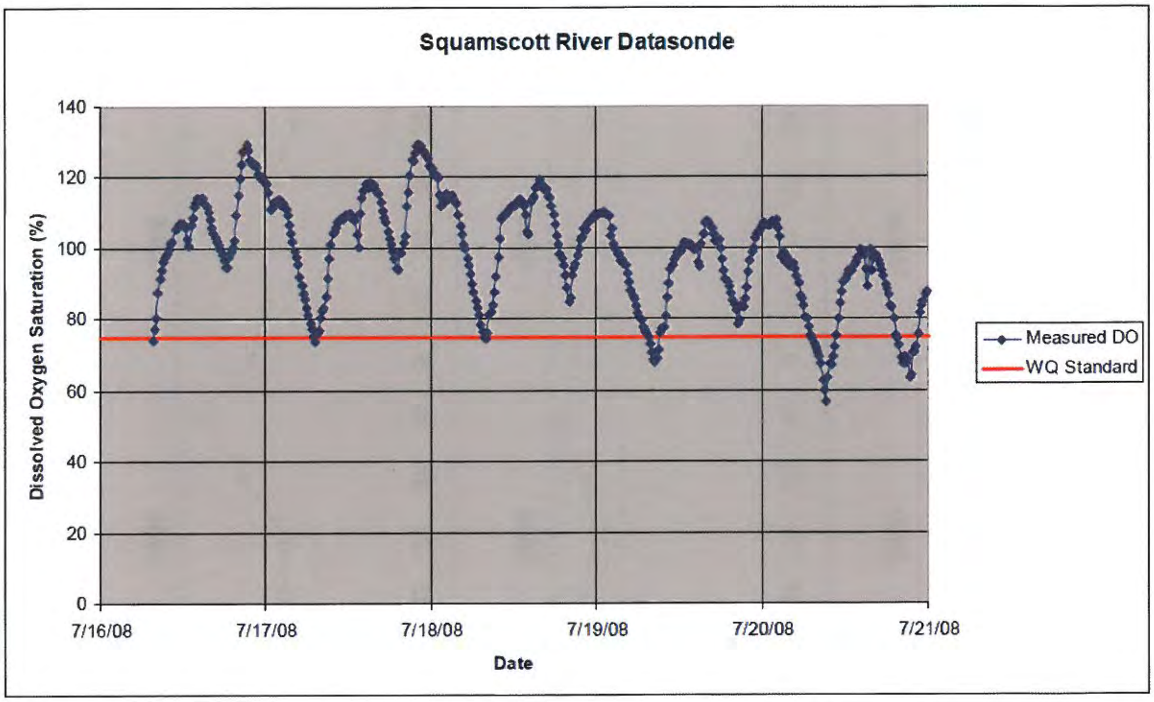


Figure 8. Dissolved Oxygen at the Squamscott River Datasonde Location

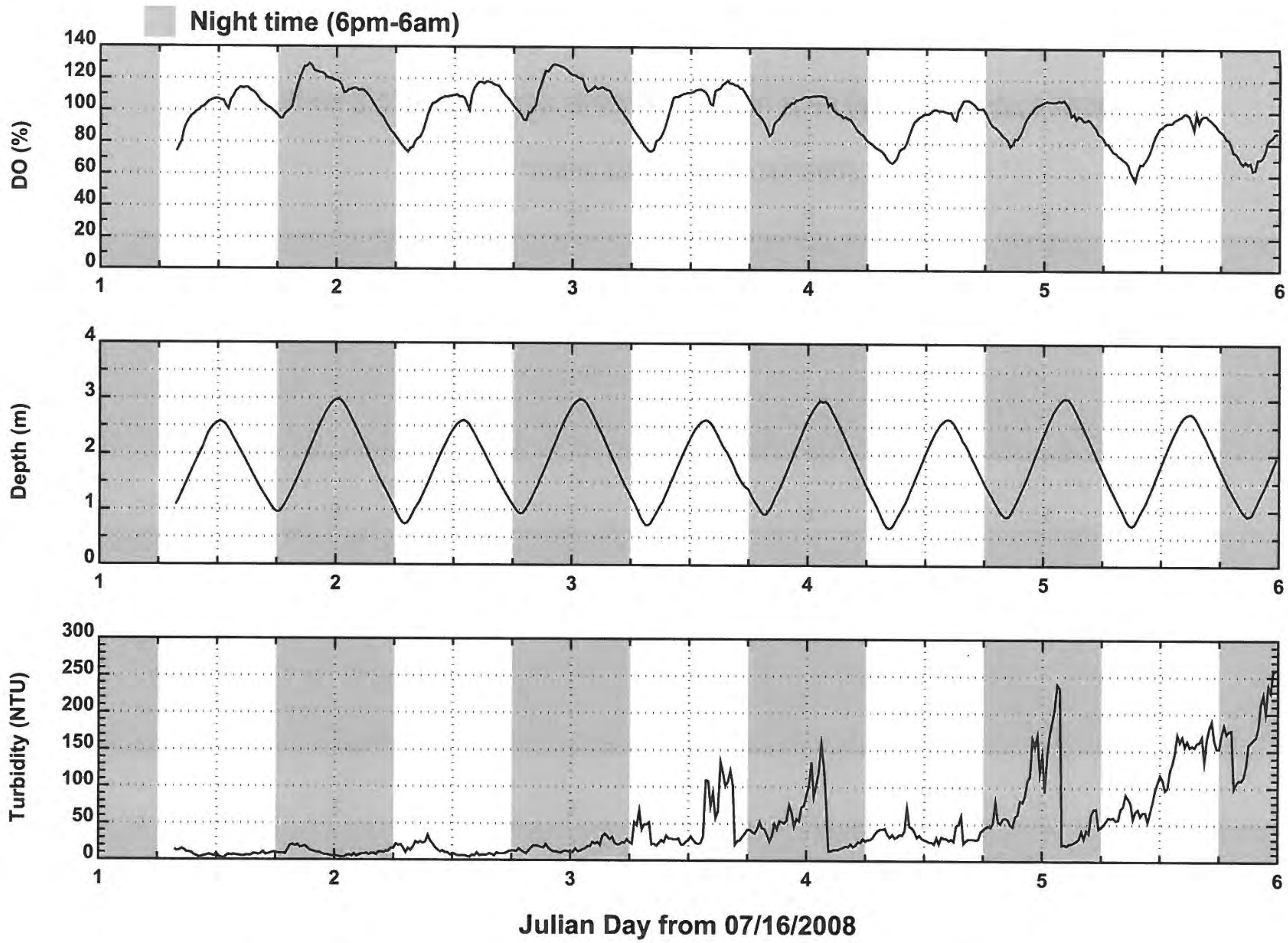


Figure 9-1. Squamscott River Monitoring Data (07/16/2008-07/20/2008)

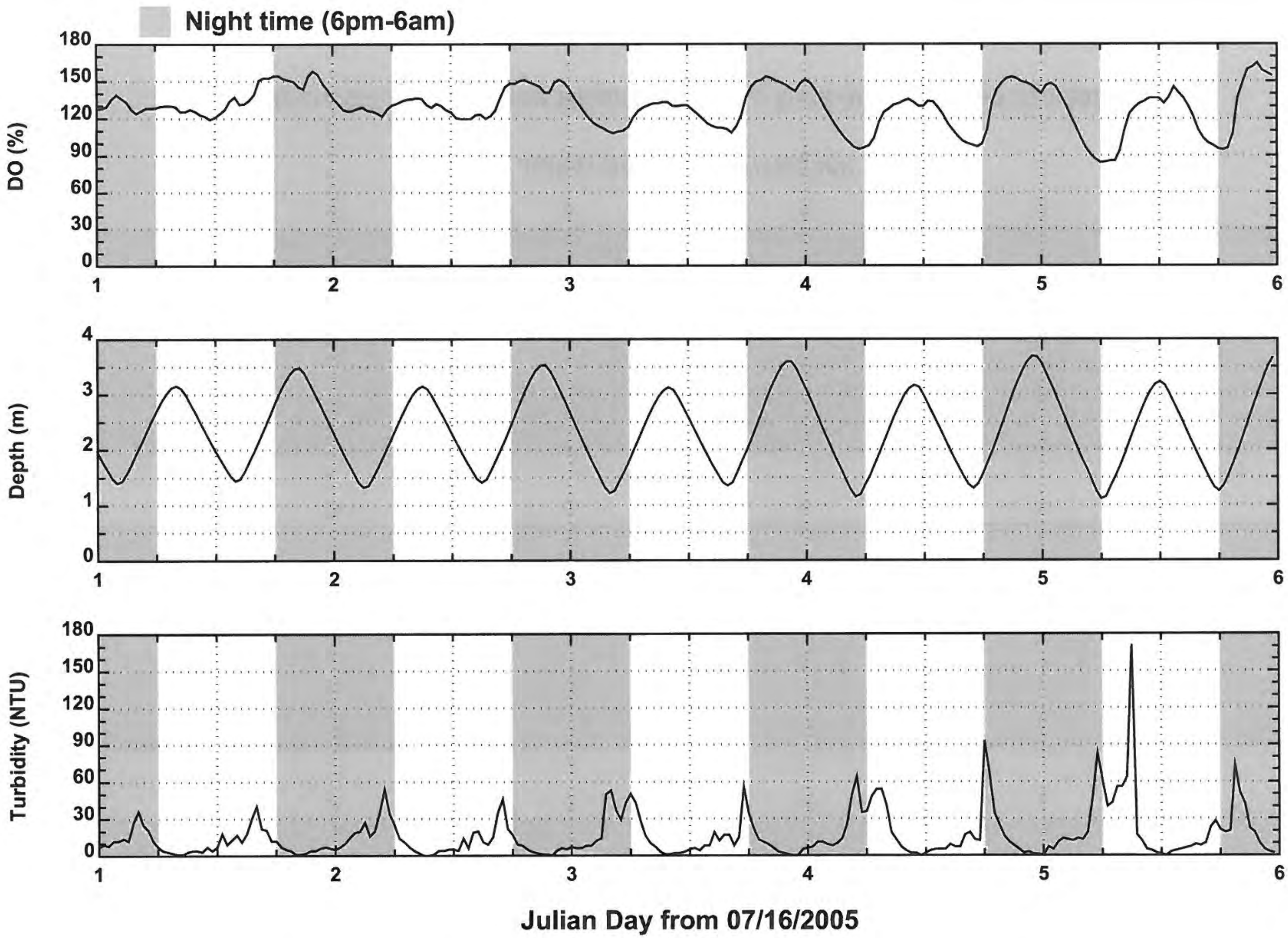


Figure 9-2. Squamscott River Monitoring Data (07/16/2005-07/20/2005)

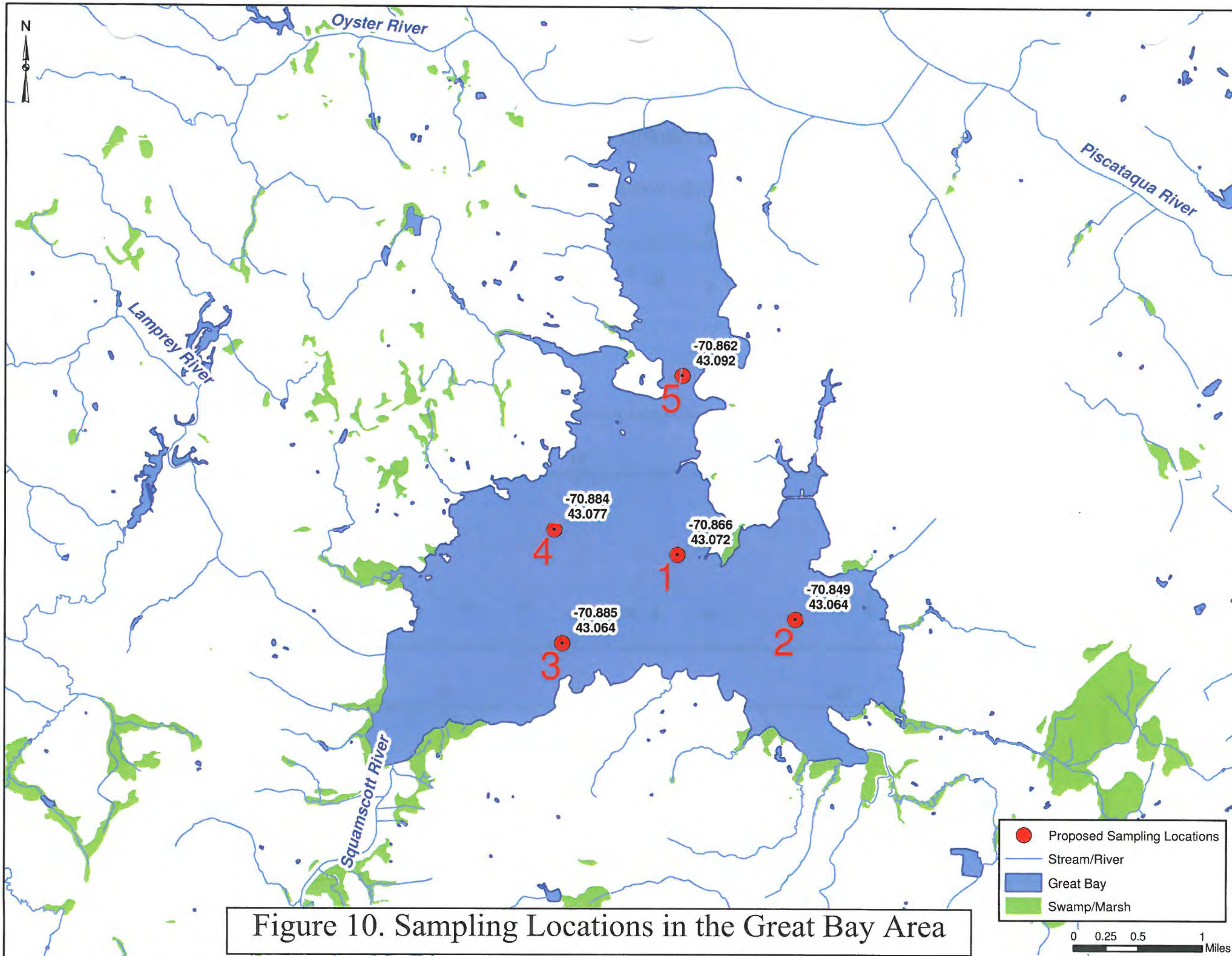


Figure 10. Sampling Locations in the Great Bay Area

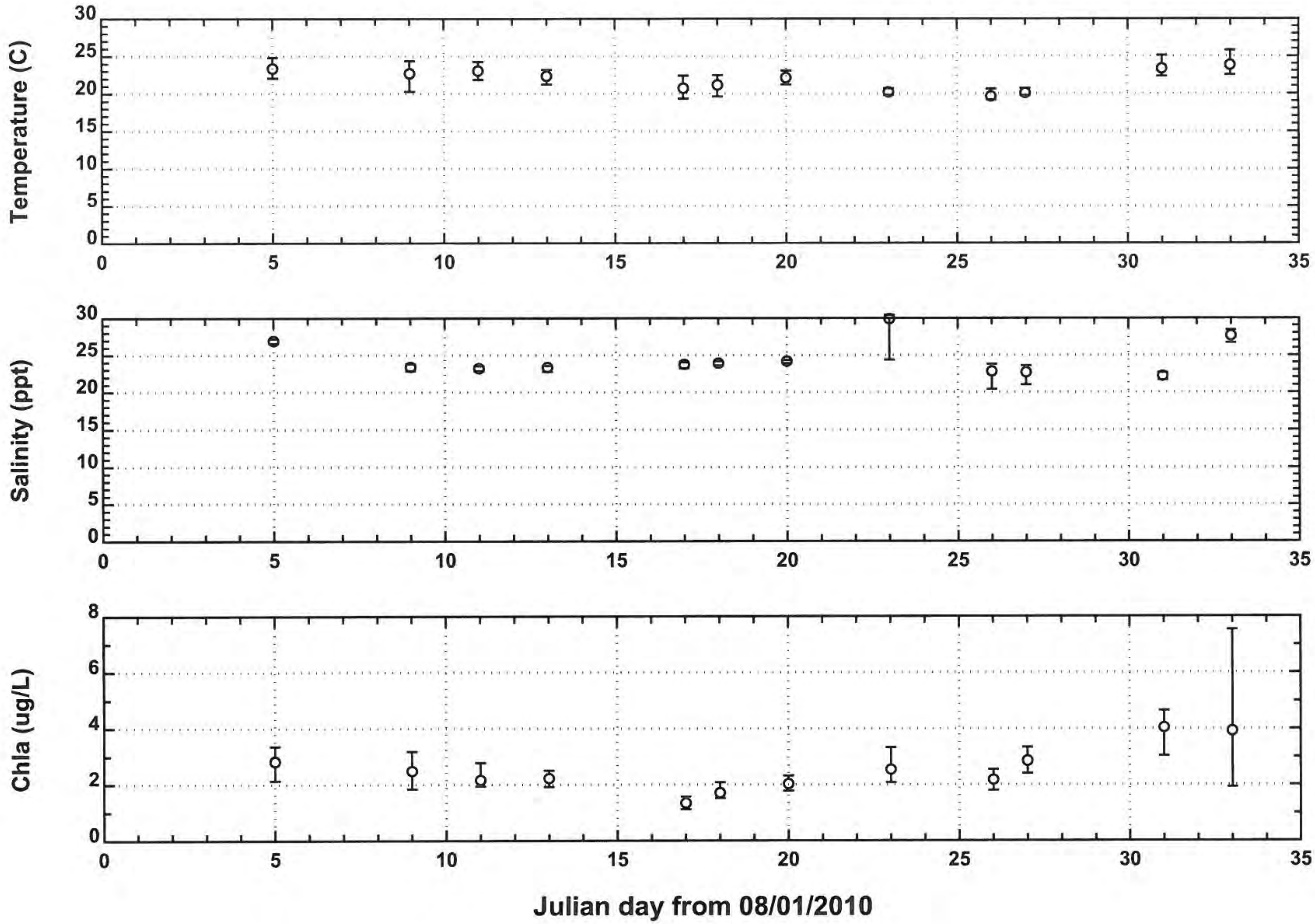


Figure 11. 2010 Great Bay Water Quality Data (Station 1-5)

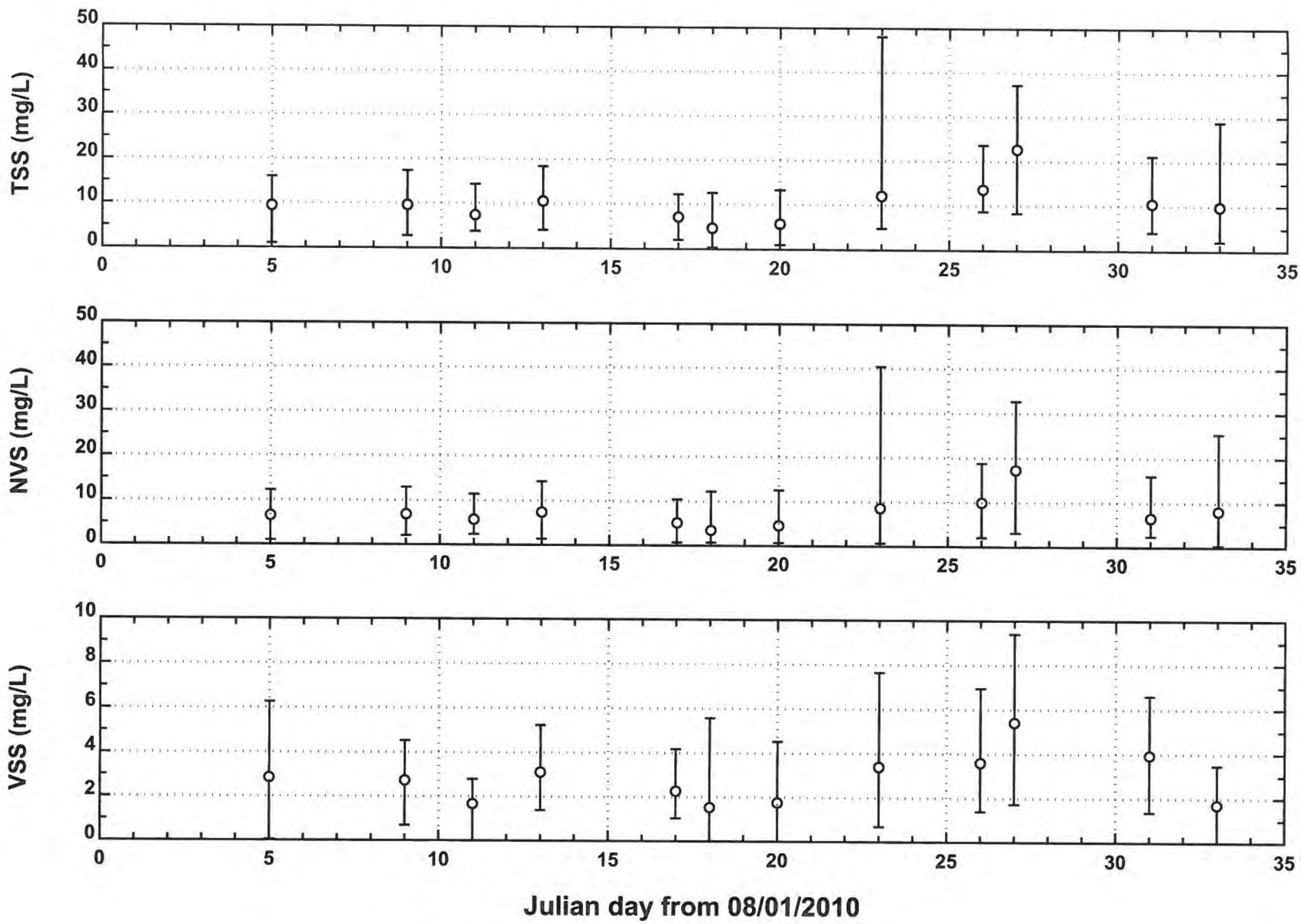


Figure 12. 2010 Great Bay Water Quality Data (Station 1-5)

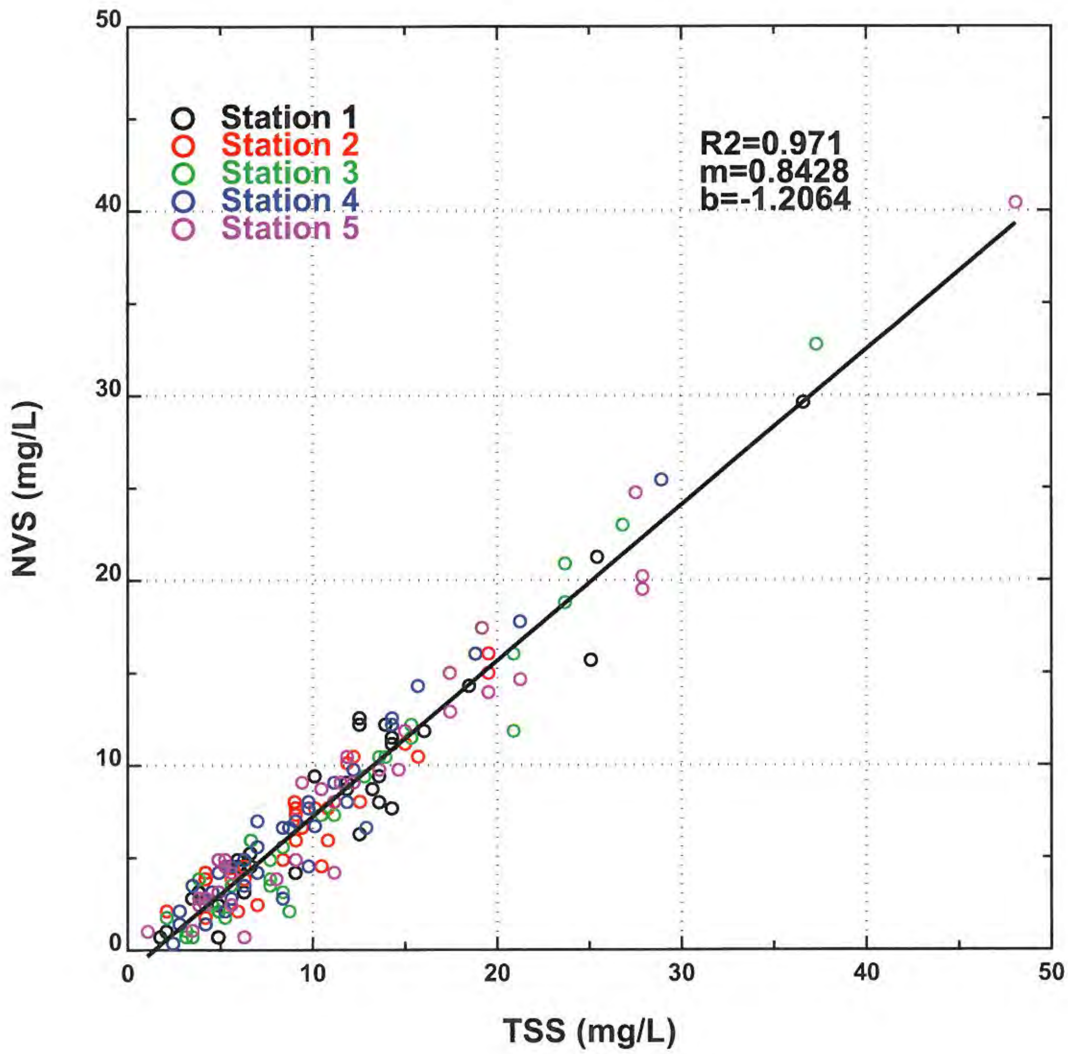


Figure 13. 2010 Great Bay Water Quality Data

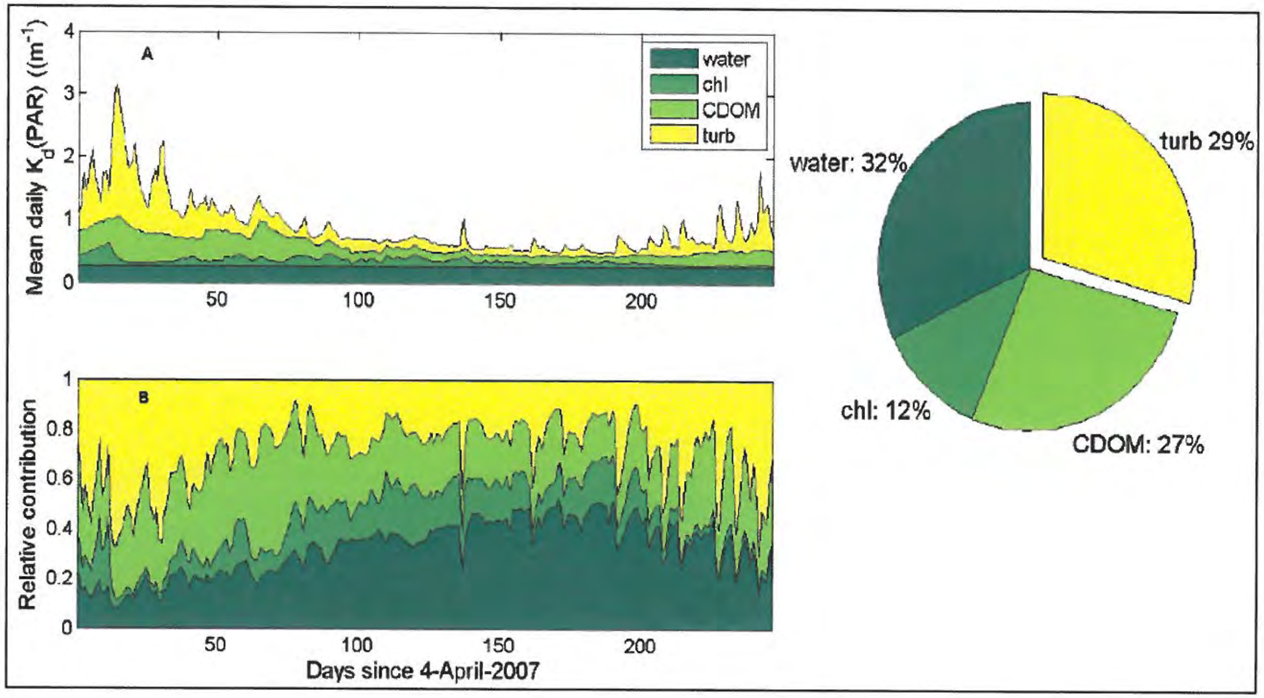


Figure 14. Contributions to Kd (PAR) measured at the Great Bay Buoy (From Morrison et al, 2008)

APPENDIX A

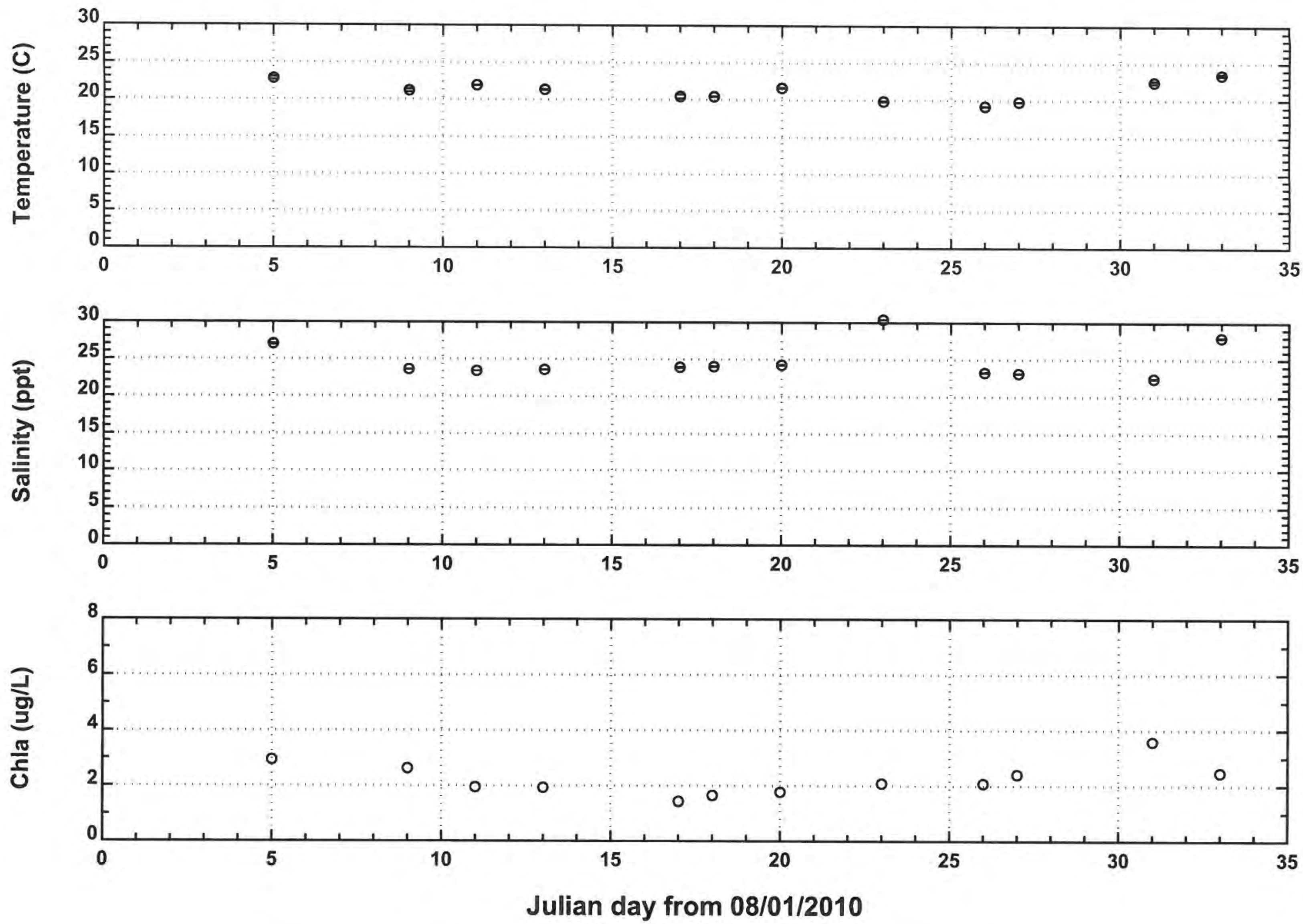


Figure 1-1. 2010 Great Bay Water Quality Data, Station 1

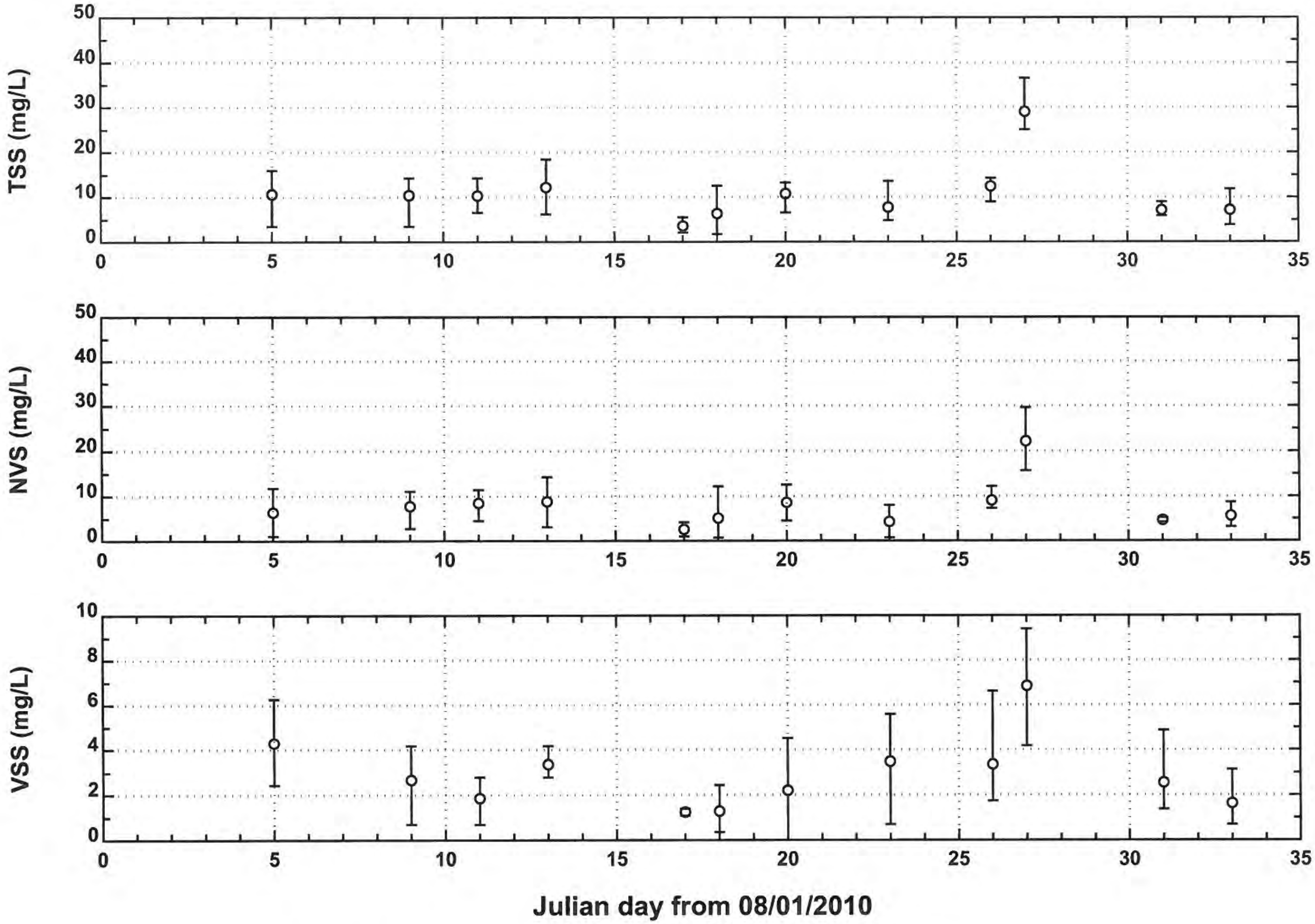


Figure 1-2. 2010 Great Bay Water Quality Data, Station 1

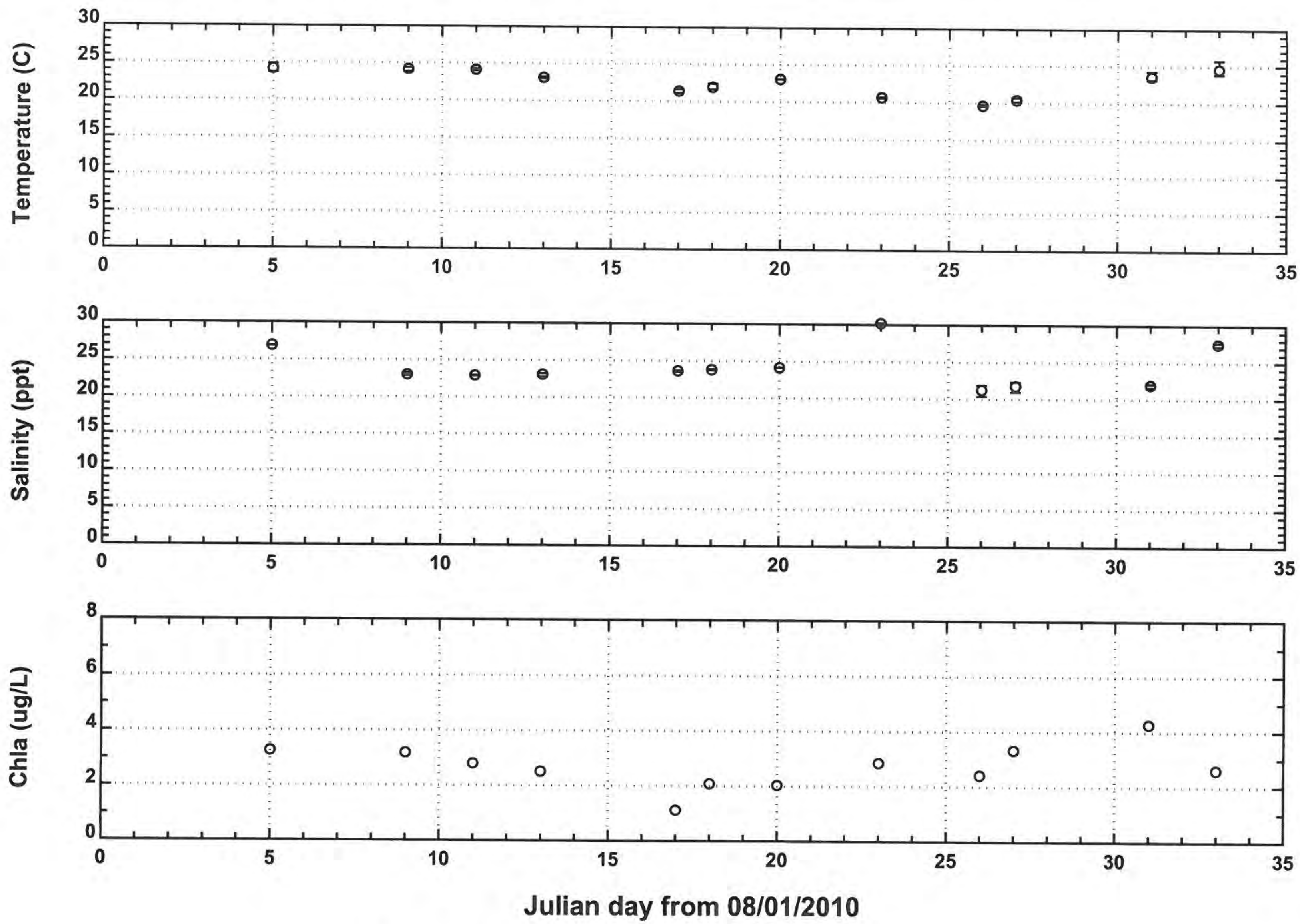


Figure 2-1. 2010 Great Bay Water Quality Data, Station 2

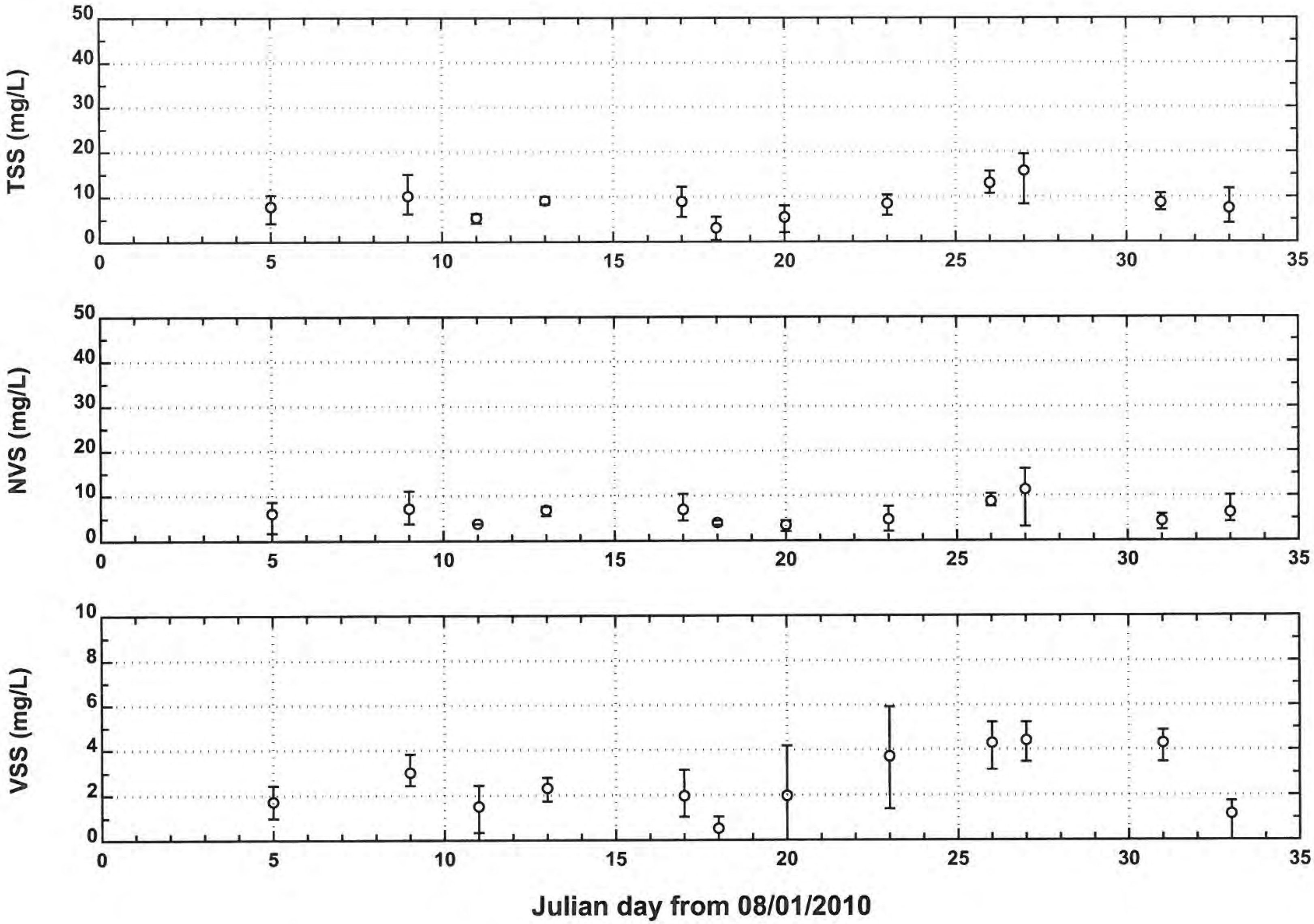


Figure 2-2. 2010 Great Bay Water Quality Data, Station 2

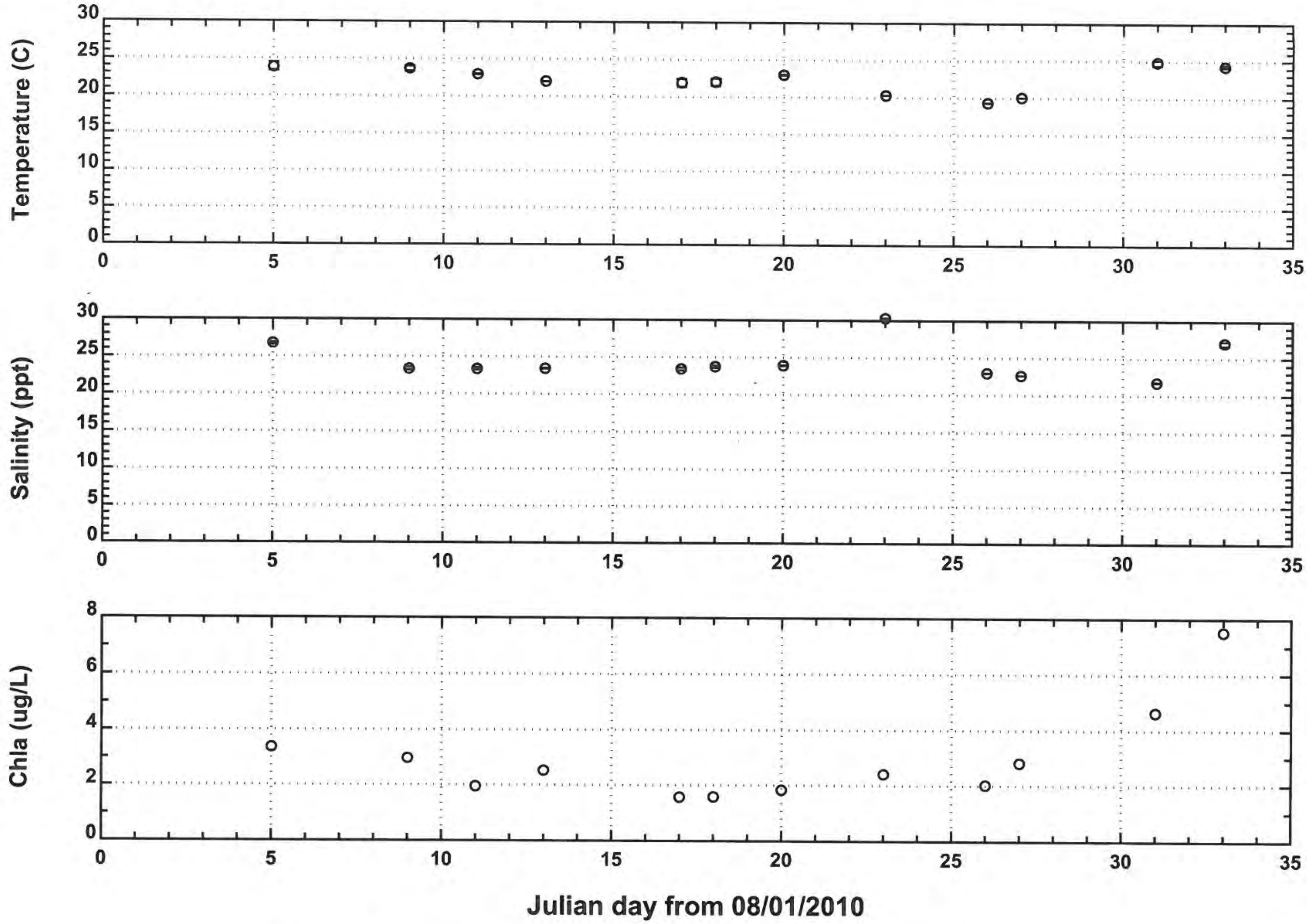


Figure 3-1. 2010 Great Bay Water Quality Data, Station 3

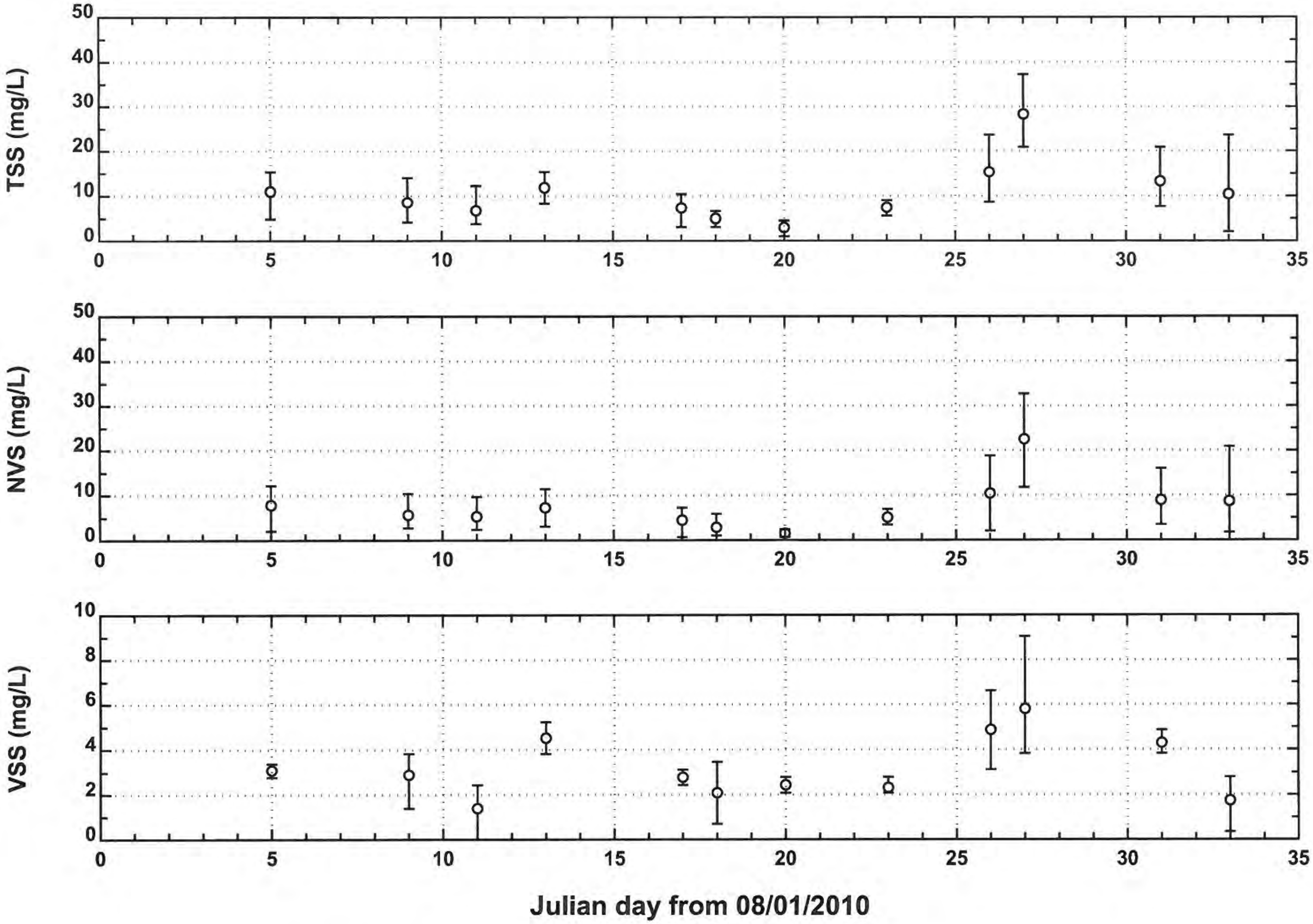


Figure 3-2. 2010 Great Bay Water Quality Data, Station 3

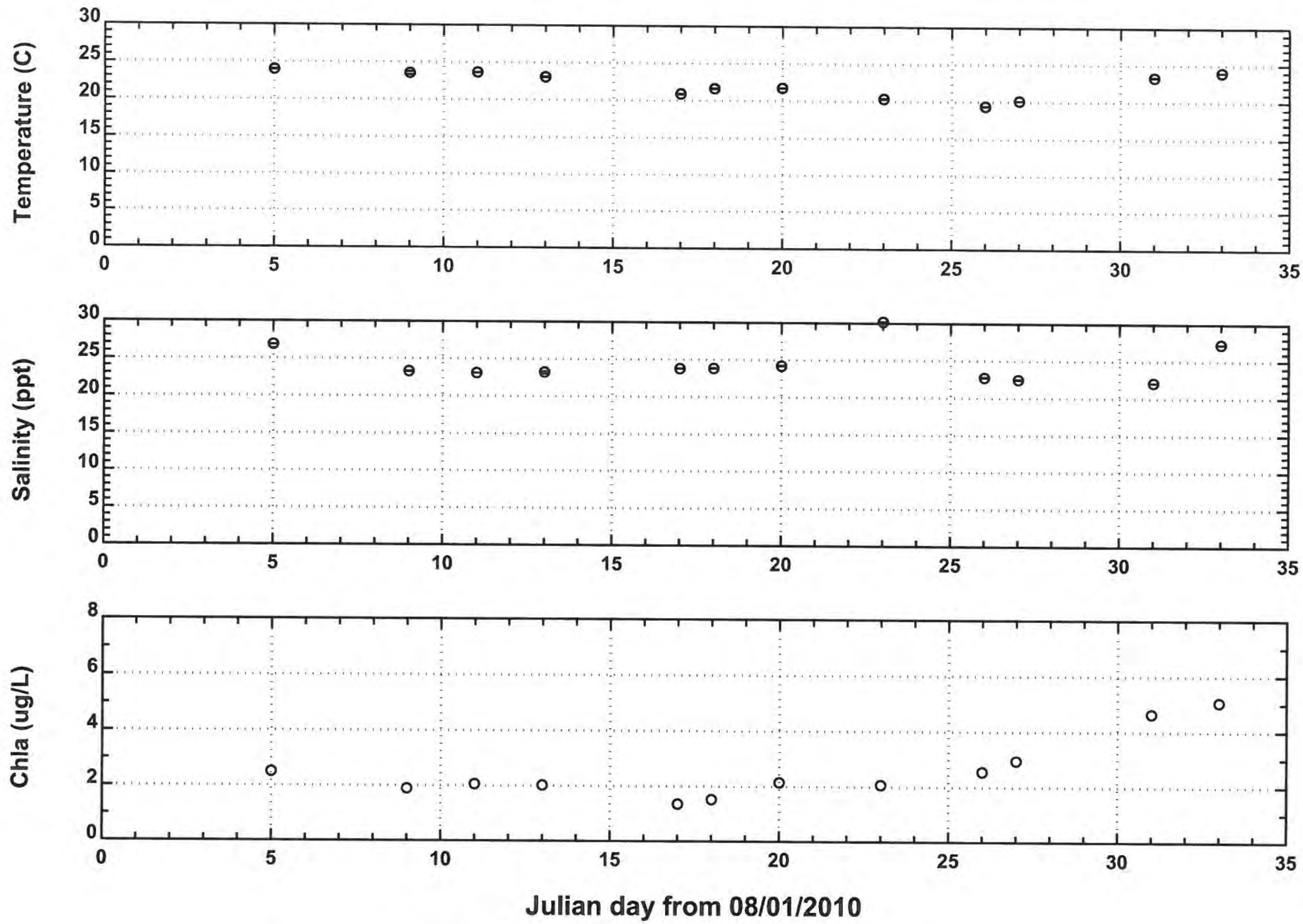


Figure 4-1. 2010 Great Bay Water Quality Data, Station 4

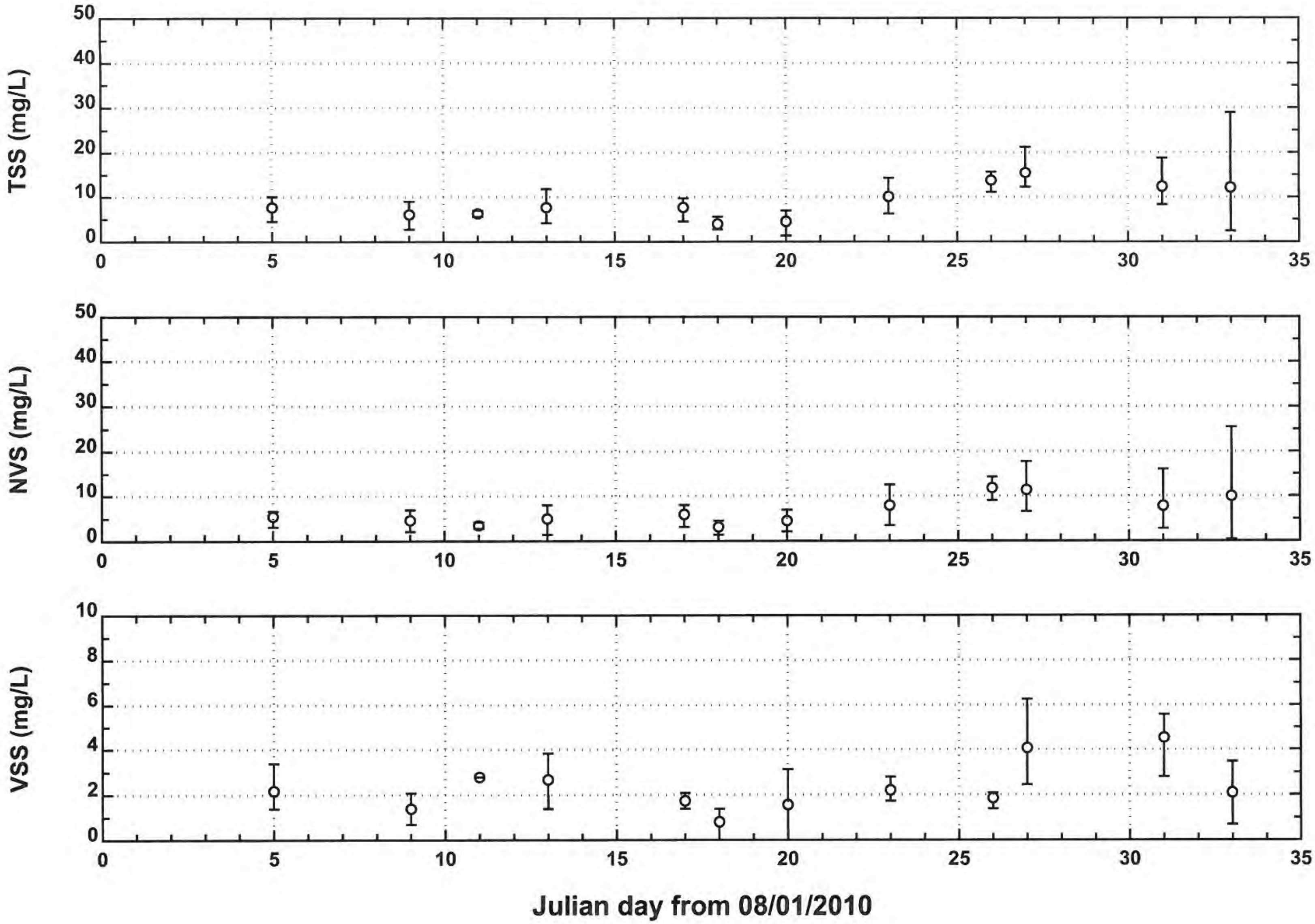


Figure 4-2. 2010 Great Bay Water Quality Data, Station 4

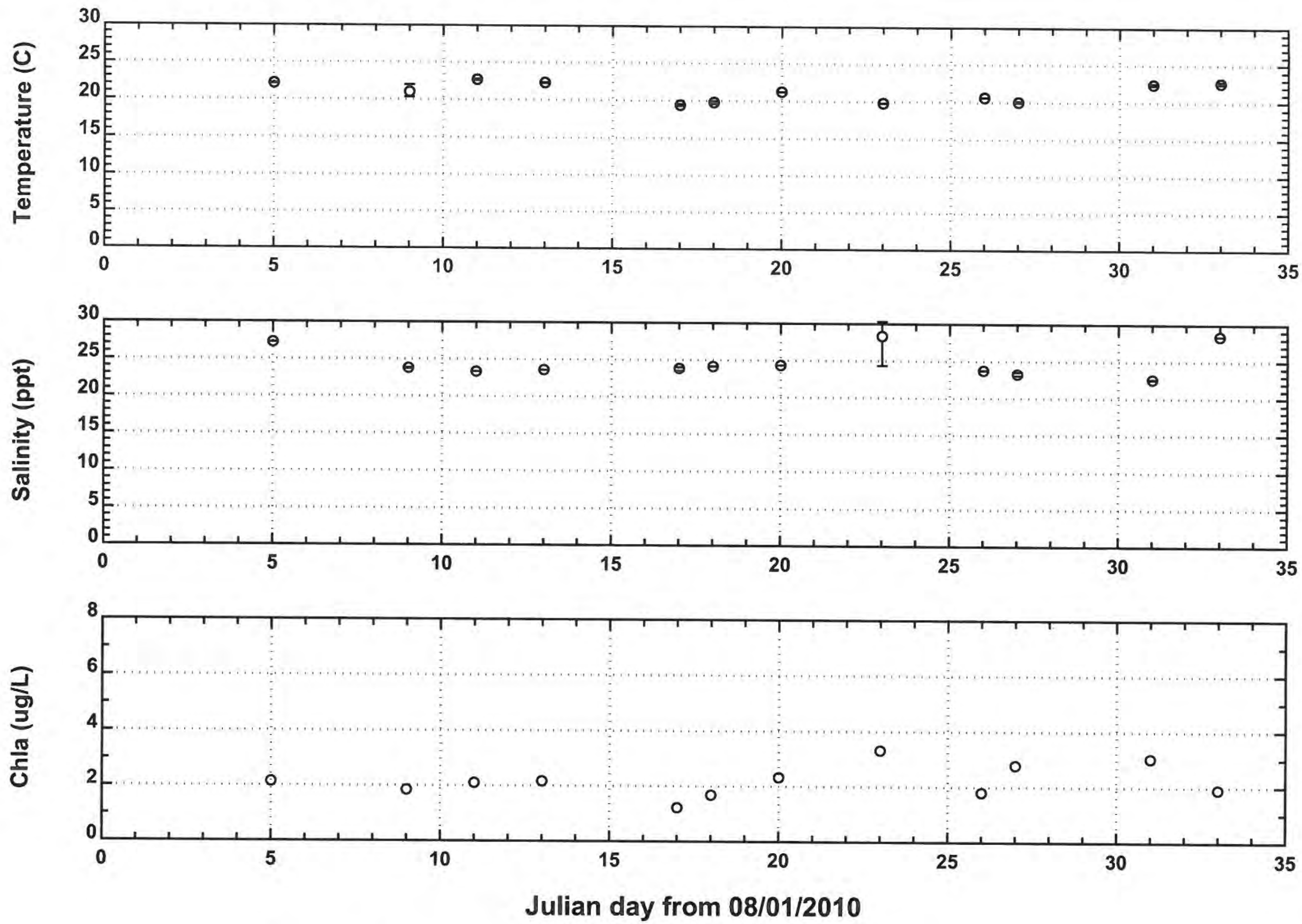


Figure 5-1. 2010 Great Bay Water Quality Data, Station 5

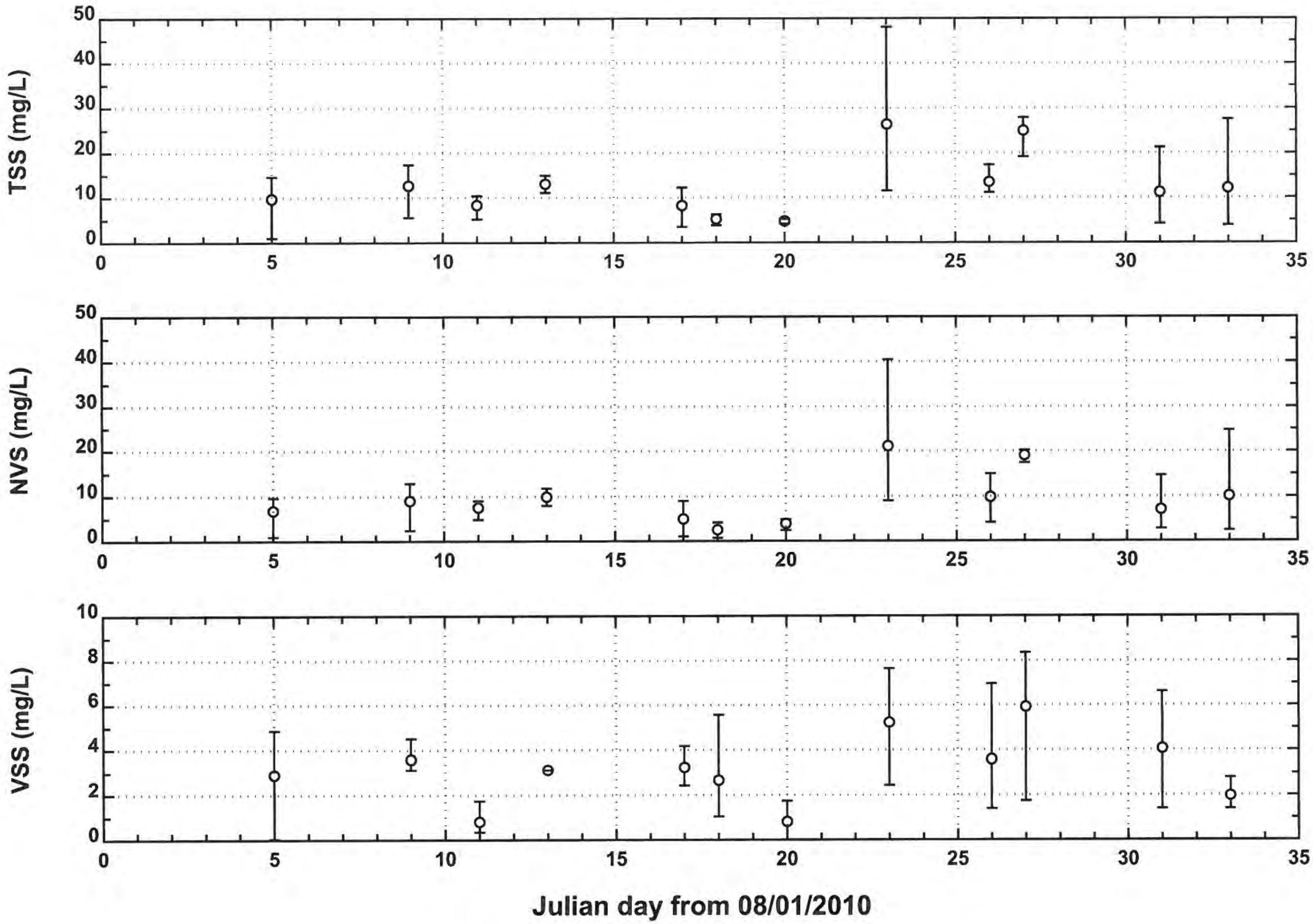


Figure 5-2. 2010 Great Bay Water Quality Data, Station 5

Attachment B

Transparency, Macroalgae, and Epiphyte impacts to eelgrass in the Piscataqua Estuary Assessment
Meeting Minutes
July 29, 2011

Attendees: John Hall, Steve Jones, Larry Ward, Rich Langan, Alison Watts, Dean Peschel, Ted Diers, Phil Trowbridge, Fred Short, Phil Colarusso, and Christian Mancilla

The meeting got a late start as a result of an earlier meeting running longer that planned. Following introductions, John Hall initiated the meeting with an overview of the Memorandum Of Agreement between NHDES and the Great Bay Municipal Coalition followed by a description of the issues the group needs to clarify, which include the extent to which transparency, macroalgae and/or epiphytes are responsible for eelgrass decline in the Piscataqua estuary and whether other important ecological factors need to be addressed to protect the ecological resources of the Bay in addition to nutrient reductions.

John Hall indicated that the Coalition also intends to develop an alternative proposal to the EPA permitting approach that would include a combination of preliminary efforts in an adaptive management framework including (1) treatment plant reductions (2) bioremediation and restoration such as oyster beds and eelgrass replanting (3) recommendations on a watershed non-point source reduction program and (4) additional field studies to ensure reduction efforts are properly targeted. The input Committee would be sought on this proposal also.

A lively discussion followed regarding the amount of research available to confirm the causes of eelgrass decline in the estuary system and the options to resolve an uncertainties regarding the degree of TN control necessary. John Hall indicated that macroalgae are a problem but the research on these species is lacking. John thought a field study might be best for confirming how different TN levels impact eelgrass and macroalgae growth. Phil Trowbridge indicated that some existing studies from Fred Short and Art Mathieson could provide insight on TN impacts and appropriate nutrient target levels. It was requested that the studies be supplied the group. It was also suggested that a mesocosm study could be useful on resolving the appropriate TN conc to protect eelgrass resources. . Fred Short explained that in Great Bay, transparency is not a major issue impacting eelgrass as when the tide is out the eelgrass is exposed and receives sufficient light for growth. The distinction was made between the shallow water systems Great Bay, Little Bay and the tributaries versus the deeper water systems of the Piscataqua and Portsmouth Harbor where transparency may be more of an issue. John Hall indicated that the algal growth information for the Piscataqua River should be reviewed to determine the degree to which nutrients are influencing transparency in that area.

On the topic of epiphytes, Fred Short commented that epiphytes are not and, to his knowledge, never have been a significant problem to eelgrass in the estuary. Epiphytes appear to be controlled by grazers in the estuary and the attached epiphytes that do occur are shed as the older shoots of eelgrass dye off from the plants.

Fred Short indicated that macroalgae were considered the primary problem impacting eelgrass in Great Bay. It was agreed by all that Arthur Mathieson, who was not at the meeting, needs to weigh in on this issue.

There was a discussion on whether addressing TN for DO concerns in the tidal rivers would resolve any TN concerns in the Bay. John Hall indicated that the Squamscott River model was intended to address the relationship between low DO and increased algal growth.

A follow up meeting will be scheduled in the near future to continue the process.

Attachment C

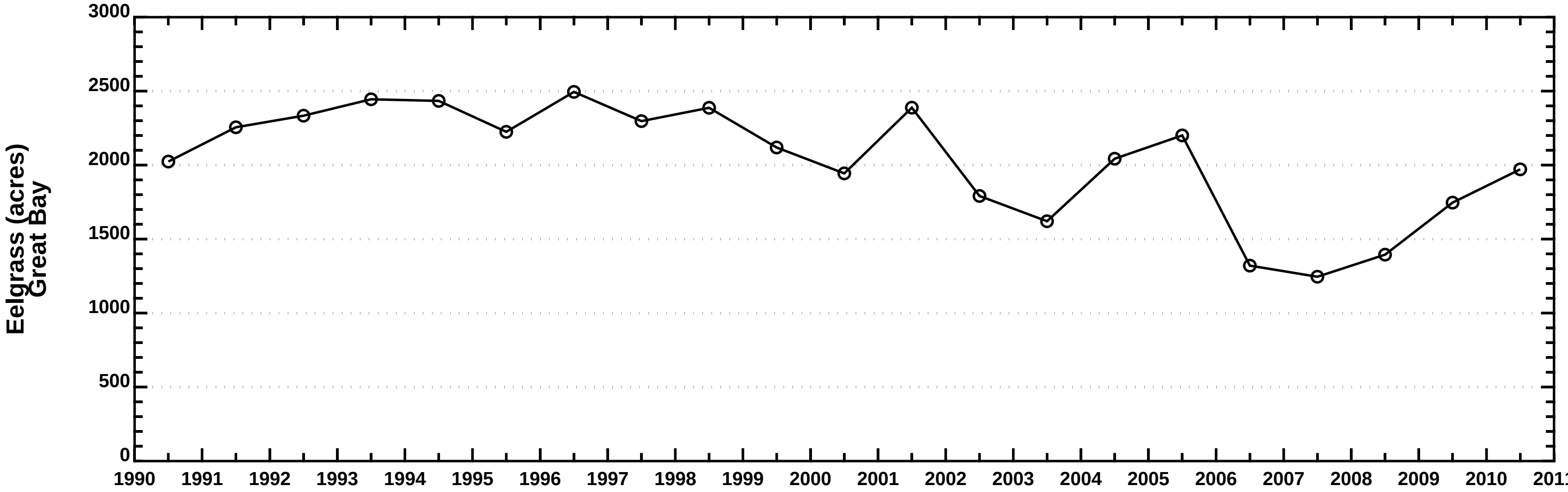


Figure A. Eelgrass Coverage in the Great Bay (1990-2010)

Source: Environmental Indicators Report, PREP 2009 (June 2009)
Eelgrass Distribution in the Great Bay Estuary for 2009, Frederick T. Short (September 2010)
Eelgrass Distribution in the Great Bay Estuary for 2010, Frederick T. Short (June 2011)

GREAT BAY MUNICIPAL COALITION

February 9, 2012

Dr. Frederick T. Short
University of New Hampshire
Department of Natural
Resources and the Environment
Jackson Estuarine Laboratory
85 Adams Point Road
Durham, NH 03824

Re: **Response to Great Bay Municipal Coalition Adaptive Management Plan**

Dear Fred:

I write in response to your email message to me dated February 2, 2012. I also received the peer reviewed articles as email attachments which you reference in your email as relevant scientific research in this matter. These articles, although important, do not supply the supporting data requested in my original letter. As an initial matter, my letter was not intended to, and did not, impugn your character or motives. Nor did it depart from the standards of civility and good faith with which we have continued to comply in our dealings with the regulatory agencies and researchers, such as yourself, on whose work they have relied. My letter to you of January 24, 2012 was simply an effort to obtain from you the data and analysis which you contend supports certain critical conclusions you have drawn, on which the regulatory agencies are relying.

Let me reiterate a few fundamental facts. First, the City of Dover and the other members of the Great Bay Municipal Coalition are committed to the goal of improving the health of the Great Bay Estuary. To that end, we have entered into a Memorandum of Agreement with the New Hampshire Department of Environmental Services and proposed an Adaptive Management Plan which we believe represents the most rationale means of accomplishing that goal. This plan produces major reductions in nitrogen loading to Great Bay. Second, we strongly disagree with the (preliminary) conclusion of the Environmental Protection Agency (EPA) that requiring the relevant municipal POTWs to meet a total nitrogen limit of 3 milligrams per liter is necessary to achieve water quality standards. Third, and most importantly for purposes of our communications with you, EPA is relying heavily on <u>your</u> research and statements to justify that conclusion. (See the attached email and telephone transcripts produced by EPA.) Fourth, the total estimated costs to the members of the Coalition to construct, operate, and finance facilities necessary to meet such a standard is $588,000,000. The costs were reported in "Economics of Seacoast Nutrient Removal", an economic analysis prepared by Applied Economic Research of Laconia NH for the Coalition. These costs will impose an exorbitant financial burden on the relevant municipalities, and potentially drive away residents and businesses. As you should know by now, our central point is that while reduction in DIN discharges is warranted and makes good sense, there is no scientific support for the severe restrictions which are being required by EPA. The difference between a Water Quality Standard of .3 mg/L TN, as has been proposed by NHDES and EPA, and claimed to be necessary by yourself, and a less stringent one focusing on DIN, which we believe science indicates would be equally protective of the Great Bay estuary, is potentially hundreds of millions of dollars. The municipalities do not feel that they are being "uncivil" or are acting in "bad faith" in asking you for the data and analysis which supports statements you have made on which the regulatory agencies are relying.

For that reason, we reiterate our request that you provide the specific data and analysis which confirm that the following statements in your correspondence to EPA are true:

Transparency Caused Eelgrass Loss due to Increased Algal Growth

1. My long-term research and annual monitoring of eelgrass in the Estuary have clearly demonstrated that eelgrass is disappearing from the Estuary due to excess algal growth caused by increasing nitrogen levels in the water. (Para. 3, line 2.)

Portsmouth Harbor

2. Eelgrass (in Portsmouth Harbor) has been declining for the last five years as a result of reduced water clarity caused by rising nitrogen inputs that foster increased phytoplankton growth in the water (microscopic algae). (Para. 8.)

Piscataqua River/Little Bay

3. With loss of water clarity due to increased phytoplankton growth, again caused by increasing nitrogen loading, the eelgrass disappeared completely from both these areas (Piscataqua River and Little Bay) beginning in 2001. (Para. 9, line 3.)
4. In the Piscataqua River and Little Bay, the eelgrass losses were predominantly a result of reduced transparency and, to a lesser extent, excessive epiphyte growth. (Para. 12, line 4.)

Great Bay

5. Also in Great Bay, eelgrass has been lost from the deeper parts of the Bay, indicative of loss of water clarity. (Para. 10, line 10.)
6. The rapid proliferation of macroalgae (and the appearance of invasive macroalgal species) has occurred over the past ten years, not the last three decades. (Para. 13.)

Total Nitrogen versus Inorganic Nitrogen

7. Dissolved organic nitrogen (DON) and other forms of nitrogen are rapidly converted to DIN once they enter the Estuary and are used directly by the macroalgae. (Para. 14, line 2.)

As mentioned above, the peer-reviewed articles forwarded with your email communications do not contain data or analysis that address the specific questions posed above. Thus, we reiterate our request for the data and analysis which you contend support the above statements. If we do not receive a substantive response to this request, we will assume that there is no such support for the specific ecological and water quality conclusions presented in your communications with EPA.

We look forward to your response to this request.

Very truly yours,

Dean Peschel
For the Great Bay Municipal Coalition

cc: Administrator Curt Spalding, EPA
Stephen Perkins, EPA
Dan Arsenault, EPA
Carl Deloi, EPA
Phil Colarusso
Rachel Rouillard
Philip Trowbridge, DES
Art Mathieson
John Aber
Jan Nisbet
Commissioner Thomas Burack, DES
Ted Diers, DES
Harry Stewart, DES
Senator Jeanne Shaheen
Congressman Frank Guinta
Peter Rice

Exhibit 19

Relationship between Light Attenuation Coefficient and TN at Trend Stations

(New Hampshire DES, 2009)