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**2005 Great Bay
Organic Nitrogen (PON & DON) and
Light Extinction (PAR) Monitoring Program**

A Final Report to
The New Hampshire Estuaries Project

Submitted by

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Table of Contents

Introduction	2
Project Goals and Objectives	2
Methods	3
Results and Discussion	3
Conclusions and Recommendations	4
References	4
Appendix 1 (Meta-Data)	5
Appendix 2 (Data CD)	Inside Back Cover

Introduction

Nitrogen is most often considered to be the limiting nutrient for plant growth in marine waters. As a result, knowledge of nitrogen loading and ambient water-column concentrations are considered to be critical to understanding the response of aquatic ecosystems to nutrient over-enrichment—a process known as eutrophication when it results in the excess production of organic matter.

Plant production in many estuarine systems may also be limited by light availability as a result of high levels of turbidity in the water resulting from sediments, dissolved organic matter, and phytoplankton in the water column. Light limitation resulting from human-induced increases in turbidity is known to be particularly deleterious to seagrass production/distribution in some ecosystems and also play an important role in determining how phytoplankton respond to nutrient enrichment.

EPA is developing water quality criteria for estuaries that require knowledge of both total nitrogen and light availability (measured as photosynthetically active radiation, PAR). Through the National Estuarine Research Reserve (NERR) System-Wide Monitoring Program (SWMP), inorganic nutrient concentrations, chlorophyll-a concentration, and a number of hydrographic and water quality parameters are sampled on a monthly basis at 7 sites in the Great Bay system.

This project takes advantage of these existing monitoring activities to collect and analyze for particulate organic nitrogen (PON), dissolved organic nitrogen (DON) and photosynthetically active radiation (PAR) at existing sample sites in the New Hampshire seacoast region. When combined with existing dissolved inorganic nitrogen measurements, PON and DON allow the entire Total Nitrogen (TN) pool to be quantified. PAR measurements provide an estimate of the light availability in the system.

Project Goals and Objectives

UNH completed this project under contract to the NH Estuaries Project (Project ID #05-M-3). The project goals and objectives per the contract were to:

- (1) Conduct PON, DON, and PAR monitoring for the April – December sampling season at the Lamprey River (LR), Squamscott River (SQ), Chapman’s Landing (CL), Oyster River (OR), Great Bay (GB) and Coastal Marine Lab (CML).

The goal was to provide 125 measurements for PON and DON and 66 measurements of PAR during the sampling period. The final work product was agreed to be an Excel data file containing

hydrographic, PON, DON and PAR data for all of these sites.

Methods

The methods for this project followed the procedures specified in the approved QA Project Plan (Pennock and Trowbridge, 2003).

Results and Discussion

Overall, as shown in the table below, we were able to obtain 70 discrete estimates for the attenuation coefficient (PAR), 125 measurements for particulate nitrogen (PN) and 124 measurements of particulate carbon (PC), 204 measurements of total dissolved nitrogen (TDN) and 197 measurements of dissolved organic nitrogen (DON). We performed replicate analyses on all parameters except for PAR (triplicate PAR analyses was performed at 6 stations during the 2005 sampling period.) Laboratory analyses fell within the accepted guidelines detailed in the approved QA Project Plan (Pennock and Trowbridge, 2003).

Statistical analysis on replicate data showed the following error estimates for field replicates:

Parameter	Location	Stations	Analyses	Mean	SD	% SE
PAR	All Data	104	70	-1.731		
PAR	QA	6	17	-1.985	0.12	6.35%
POC	All Data	68	124	1.1639		7.77%
PON	All Data	68	125	0.1480		10.82%
TDN	All Data	104	204	0.3326		13.16%
DON	All Data	104	197	0.2001		14.95%

Summary statistical analyses were performed on data for which there were successful duplicates run and for which both samples were above the MDL. For POC, a parameter that is not called for in the monitoring program but which is obtained for no additional cost as part of the PON analysis, field replicates were good to +/- 7.77%, while PON measurements showed a percent error of 10.82%. TDN measurements, which require a significant amount of analytical processing, showed a percent error of +/- 13.16% for field replicates while DON, displayed a percent error of +/- 14.95%.

Separate replicate samples for PAR were collected six times during normal monthly sampling. This analysis suggests that our estimates of light attenuation should be expected to be good to +/- ~6.5%.

The CD included with this report contains data files in an Excel format that is consistent with NERR SWMP CDMO requirements. Included are the following required parameters for this project: Record #; Funding Source for Sampling Effort; Sample Date; Site/Station Name; Tidal Stage; Bottom Depth; Temperature; Salinity; Oxygen Concentration; Oxygen Percent Saturation; pH; Total Dissolved Nitrogen (TDN); Dissolved Organic Nitrogen (DON); Particulate Organic Carbon (POC); Particulate Organic Nitrogen (PON); and Attenuation Coefficient (K_d).

Please note that for analyses that were above zero and below the MDL, a value of one-half the MDL was inserted into the raw data file. Nutrient values that fall below prescribed MDL's have been changed to '-9999' in the 'complete' data file that will be submitted to CDMO and is included as a separate worksheet in the Excel data file.

Differences between POC, PON and TDN replicate samples were compared to data quality objectives of 30% RPD and 0.5, 0.1 and 0.5 mg/L, respectively. Replicate samples that failed both tests were should be rejected.

Data contained in this file are scheduled to be submitted to NERR CDMO on May 15th, 2006. It is subject to review and potential revision by the NERR CDMO.

Conclusions and Recommendations

The PON, DON and PAR monthly monitoring program provides important data on nitrogen concentration and light availability in the Great Bay estuary. When combined with the NERRS SWMP program, these data provide comprehensive coverage of the Great Bay estuary and allow total nitrogen concentrations to be calculated for use in nutrient criteria measurements.

References

Pennock and Trowbridge (2003) UNH Nutrient and Light Extinction Monitoring Program Quality Assurance Project Plan, Version 4, Final. University of New Hampshire and NH Estuaries Project, August 8, 2003.

2005 Organic Nitrogen (PON & DON) and Light Extinction (PAR) Monitoring Program Meta-Data (Appendix 1)

Research Methods

Monthly monitoring is conducted during ice-free seasons (generally April through December) as part of the GB NERR System-Wide Monitoring Program and National Coastal Assessment at the following locations:

Funding Source	Station Name	Station ID	Tide Stage	Lat Deg	Lat Minute	Long Deg	Long Minute
NERR	Adams Point	AP	L&H	43	5.495	70	51.821
NERR	Great Bay	GB	L	43	4.367	70	52.311
NERR	Lamprey River	LR	L&H	43	4.697	70	56.092
NERR	Oyster River	OR	L&H	43	8.400	70	54.100
NERR	Squamscott Railroad Bridge	SQ	L	43	3.182	70	54.754
NERR	Squamscott Chapman's Landing	CL	L&H	43	2.500	70	55.569
NERR	Coastal Marine Lab	CML	L&H	43	4.350	70	42.640

Samples are generally collected by small boat except for the Coastal Marine Lab site, which is accessed by vehicle. During certain periods of particularly stormy weather or when the channel markers are not present (generally in April), a subset of the normal stations may be sampled by vehicle; these cases are noted in the meta-data.

At each station, a hand-held YSI multi-probe is used to measure temperature, salinity, dissolved oxygen, and dissolved oxygen percent saturation in the surface water (~0.5m). Nutrient samples are collected in acid-washed and DI-water rinsed 1-liter HDPE bottles at ~0.5m depth, placed on ice in a cooler and processed upon return to the laboratory. Photosynthetically Active Radiation (PAR) profiles are made at as many stations as possible using a LiCor Quantum Irradiance Meter.

All nutrient processing and analysis methods and PAR profiling methods are detailed in the 2003 UNH Nutrient and Light Extinction Monitoring Program Quality Assurance Project Plan (Pennock & Trowbridge, 2003).

Deviations in Sampling Procedures for 2005

January

- Icing Conditions; no samples collected.

February

- Icing Conditions; no samples collected.

March

- Icing Conditions; no samples collected.

April

- NERR samples collected by vehicle due to the lack of channel markers, no access to SQ site.
- Limited PAR measurements taken as a result of vehicle-based sampling.

May

- No PAR taken at OR (low tide); less than 0.3m depth.

June

- No PAR taken at CML; LiCor instrument unavailable.

July

- No PAR taken at OR (low tide); less than 0.3m depth.

August

- No PAR taken at OR (low tide); less than 0.3m depth.
- High Tide samples on 8/24 taken by car.

September

- No PAR taken at OR (low tide); less than 0.3m depth.

October

- No data collected at CL (high tide) on 10/12; no site access due to high water and rough conditions.
- No PAR taken at OR (low tide); less than 0.3m depth.

November

- Most sampling on 11/8 done by car; limited PAR measurements as a result of shallow water.

December

- Limited PAR measurement due to vehicle-based sampling.