

Supplementary Material for

Water quality, isoscapes and stoichioscapes of seagrasses indicate general P limitation and unique N cycling in shallow water benthos of Bermuda

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Measurements of water Quality on the Bermuda Platform

Methods

From September 2007 to 2008, salinity (practical scale salinity) was measured using a handheld salinity, temperature and conductivity instrument (YSI 30, calibrated using a 50 mS/cm conductivity standard). Dissolved oxygen (DO) was also measured using a handheld instrument (YSI 550A, calibrated using 100% water-saturated air). DO (mg L^{-1}) was corrected for temperature, ambient salinity and altitude. All measurements were surface readings (probe suspended at about 20-30 cm below the water surface). From June 2008 on, salinity, temperature (YSI 6560 conductivity/temperature probe, calibrated using a 50 mS/cm conductivity standard), and DO (YSI 6150 ROX optical DO sensor, calibrated using 100% water-saturated air) were also measured using a YSI 650 MDS with YSI 600 XL sonde. DO was automatically corrected for salinity, temperature and barometric pressure. Field readings using the sonde system were done at approximately 1 m depth, and calibrations of the instruments were performed at the beginning of each monthly sampling trip.

Unfiltered water was collected directly into pre-acidified 250 ml HDPE sample bottles. For chlorophyll *a* (CHL*a*), 140 ml of water was collected via syringe and filtered by hand through 25 mm Whatman GF/F glass fiber filters. The filters were then placed in 1.8 ml plastic centrifuge tubes, capped, and kept frozen in a dark Nalgene bottle until analysis. Turbidity was measured

within 12 hours of sample collection using a Hach portable turbidimeter (model 2100P) and reported in NTU.

Unfiltered water samples were analyzed for total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), and silicate (SiO_4^{4-}). TOC was measured by direct injection onto hot platinum catalyst in a Shimadzu TOC-5000 after first acidifying to $\text{pH} < 2$ and purging with CO_2 -free air. TN was measured using an ANTEK 7000N Nitrogen Analyzer using O_2 as carrier gas to promote complete recovery of the nitrogen in the water samples (Frankovich and Jones, 1998). TP was determined using a dry ashing, acid hydrolysis technique (Solórzano and Sharp, 1980). SiO_4^{4-} was measured using the molybdosilicate method (Strickland and Parsons, 1972). Filtrate was analyzed for nitrate+nitrite (NO_x^-), nitrite (NO_2^-), ammonium (NH_4^+), and soluble reactive phosphorus (SRP) by flow injection analysis (Alpkem model RFA 300, (APHA, 1999)).

Filters for CHL_a ($\mu\text{g L}^{-1}$) to which 1.5 ml of 90% acetone/water were added (Strickland and Parsons, 1972) were allowed to extract for a minimum of 2 days at -20°C before analysis. Extracts were analyzed using a Gilford Fluoro IV Spectrofluorometer (excitation = 435 nm, emission = 667 nm). Some parameters were not measured directly but were calculated by difference. Nitrate (NO_3^-) was calculated as $\text{NO}_x^- - \text{NO}_2^-$, dissolved inorganic nitrogen (DIN) as $\text{NO}_x^- + \text{NH}_4^+$, and total organic nitrogen (TON) defined as $\text{TN} - \text{DIN}$. All elemental ratios discussed were calculated on a molar basis. Percent DO saturation in the water column (DO_{sat}) was calculated using the equations of (Garcia and Gordon, 1992).

Results

Reflecting its small size and position in the central Atlantic Ocean, water quality surrounding Bermuda reflected the influence of the ocean endmember, with generally high water clarity and low nutrient concentrations. There was little variability in salinity compared to more coastal continental locations, with a total range of 36.0 to 37.5. Turbidity averaged 0.57 ± 0.01 (+/- SE) NTU, and CHL_a in the water column ranged between 0.0 and $2.8 \mu\text{g L}^{-1}$, with a mean of $0.24 \pm 0.01 \mu\text{g L}^{-1}$.

NH_4^+ was the dominant form of DIN in the water column, with a mean concentration of $1.44 \pm 0.04 \mu\text{M}$, which was approximately 3x the mean of the sums of the concentrations of NO_3^- and

NO₂⁻. TN concentrations in the water column were ca. 10x as high as the sum of the concentrations of the DIN, indicating that the majority of N in the water column was in the form of organic N.

References Cited

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Supplementary Table 1. Summary of water quality data collected across the Bermuda platform, based on monthly sampling from 17 sites during the period 2007-2012. Sampling locations are indicated in Figure 1. SE = Standard Error of the Mean.

Parameter	Mean	SE	Minimum	Maximum	n
Temperature (°C)	23.3	0.1	15.0	31.2	1019
Salinity (PSU)	36.70	0.01	36.00	37.50	1020
Turbidity (NTU)	0.57	0.01	0.16	2.70	983
Dissolved O ₂ (% saturation)	107.6	0.3	55.4	178.7	983
Chlorophyll- <i>a</i> (µg L ⁻¹)	0.24	0.01	0.00	2.79	866
Total Organic Carbon (µM)	108.6	0.7	57.8	227.9	984
Dissolved Organic Carbon (µM)	102.7	0.7	27.1	197.3	984
NH ₄ ⁺ (µM)	1.44	0.04	0.06	10.03	984
NO ₂ ⁻ (µM)	0.02	<0.01	<0.01	0.25	984
NO ₃ ⁻ (µM)	0.48	0.02	0.01	14.54	984
Total Nitrogen (µM)	17.0	0.7	0.2	179.7	984
SRP (µM)	0.048	0.001	<0.001	0.278	984
TP (µM)	0.136	0.002	0.020	1.474	984
SiO ₄ ⁴⁻ (µM)	0.25	0.01	<0.01	2.292	984
TOC:N	9.2	0.1	0.6	28.7	984
TOC:P	895.9	10.6	67.2	4541.7	984
DIN:SRP	57.7	2.5	2.0	846.1	983
N:P	138.5	5.4	10.7	1932.8	983