Fluxes across the sediment-water interface collected seasonally from April to November of 2014 at Smith Island, Virginia using continuous flow core incubation (Oyster Reef N2O Emission project)

Website: https://www.bco-dmo.org/dataset/721983
Version:
Version Date: 2018-03-19

Project
» Microbial Regulation of Greenhouse Gas N2O Emission from Intertidal Oyster Reefs (Oyster Reef N2O Emission)

Contributors	Affiliation	Role
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Coverage

Spatial Extent: **Lat**:37.14919 **Lon**:-75.88523
Temporal Extent: 2014-04 - 2014-11

Dataset Description

Fluxes across the sediment-water interface collected seasonally using continuous flow core incubations.

Note [2018-03-20] The dataset parameter descriptions and units are in the process of being added.

These data were utilized in the following publication:
Smyth, A., A. Murphy, I. Anderson, and B. Song (2017) Differential effects of bivalves on sediment nitrogen cycling in a shallow coastal bay. Estuaries and Coasts, DOI: 10.1007/s12237-017-0344-9

See related Smith Island Datasets:
* Smith Island N cycle: 2013 Seasonal Field Data
* Smith Island N cycle: 2013 Seasonal Fluxes
* Smith Island N cycle: 2014 Seasonal Fluxes

Methods & Sampling

Methodology

Sediment samples were collected near Smith Island, VA in Smith Island Bay. Smith Island is one of the southern barrier islands of the Delmarva Peninsula and part of the Virginia Coastal Reserve Long Term Ecological Research site. A restored oyster reef, isolated on a mudflat, clam bed used as part of an aquaculture lease and subtidal sand flat were established as sampling locations. Studies were conducted seasonally in August 2013, April 2014, July 2014, and November 2014. At each event, samples were taken for sediment biogeochemical flux incubations and sediment physico-chemical properties (sediment organic matter, benthic algal biomass, porewater nutrients).

For sediment flux incubations, triplicate sediment cores (9.5cm i.d. X 10 cm sediment depth) were collected by hand at each of the three locations: restored oyster reefs, clam aquaculture beds and subtidal bare sediments located approximately 50m from the reef and aquaculture. Samples from the oyster reef were collected directly adjacent to the reef. For the clam aquaculture samples, the predator exclusion net was taken off prior to sample collection. Associated infauna were not removed from any of the samples (i.e. live clams were included in the clam aquaculture cores). On average there were 4 clams per core with a mean biomass density of 493 ± 42.94g DW m-2. However, oyster reef cores did not contain live oysters. Water chemistry was assessed with a YSI and ~170 L of water was collected from Smith Island Bay for use in the continuous flow core incubations. Samples were also collected for dissolved nutrient analysis.

Upon collection, sediment cores and water were transported to an environmental chamber set to *in situ* temperature at The Virginia Institute of Marine Science (VIMS) in Gloucester Point, VA. Once at VIMS, cores were submerged in site water to mimic high tide (saturated) conditions and held in the dark for 12-16 hrs. The following day each core was sealed with gas tight lids equipped with an inflow and outflow port and incubated in a continuous flow system. Cores were acclimated for 24 hours before sampling to allow the system to reach steady state. Samples for dissolved nutrients and gasses were collected from the outflow port of each sediment core three times over the course of 24 hours after an initial pre-incubation period. A bypass line that flowed directly into the sample vial was used to determine the concentration of dissolved constituents entering the cores. This line also accounted for tubing and pump effects on water chemistry.

Isotopic enrichment experiments were conducted to determine rates of denitrification. After the initial sampling period, the reservoir water was enriched with 15N-NaNO3 (98atm%) to a final concentration of ~100 µmol L-1. Samples were collected for dissolved gas analysis three times after the initial 24-hour acclimation period after the reservoir was enriched. The concentration of 29N2 and 30N2 was measured using a membrane inlet mass spectrometer (MIMS). The details of methods are published in Smyth et al. (2017).

Nutrients and isotopic composition of N2 and NH4+ were used to calculate the fluxes and rates as reported in Smyth et al. (2017).

Data Processing Description

BCO-DMO Data Manager Processing Notes:
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions (no spaces, hyphens, names that start with numbers)
* "No Data" changed to "nd" which is a recognized value in the BCO-DMO system for no data.
* added site latitude and longitude (Lat,Lon) supplied by the contributor. Values were converted from degrees decimal minutes to decimal degrees and rounded to five decimal places.
* data parameter names changed due to unsupported
* original Excel file had merged cells to indicate columns for first flux, or IPT. Added _1st_flux or _IPT to data parameters to capture this information. See the "Parameters" section for full description of the data parameters.

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Data Files

File
Smith_Island_2014_Flux.csv (Comma Separated Values (.csv), 8.22 KB) MD5:fe96fb47bbb38ffeb52f4e1ea7148943 Primary data file for dataset ID 721983

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Related Publications

Smyth, A. R., Murphy, A. E., Anderson, I. C., & Song, B. (2017). Differential Effects of Bivalves on Sediment Nitrogen Cycling in a Shallow Coastal Bay. Estuaries and Coasts, 41(4), 1147–1163. doi:10.1007/s12237-017-0344-9
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Parameters

Parameter	Description	Units
Date	Month and day in format dd-mmm	unitless
Season	Season (Spring|Summer|Fall)	unitless
Temp	Temperature	degrees Celsius
Sal	Salinity	parts per thousand
Sample	Sample site description	unitless
Number_of_Clams	Count of clams contained in the incubation vial	individuals
Rep	Replicate number	unitless
O2_rate_1st_flux	Oxygen (O2) fluxes before any 15NO3 addition, determined by O2/Ar	micromoles of O2 per meter squared per hour (µmol O2 m-2 hr-1)
N2_1st_flux	Dinitrogen (N2) first flux value before any 15NO3 addition	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
O2	Dissolved oxygen measured in the water column from first flux value before any 15NO3 addition	milligrams per liter (mg/L)
NOx_1st_flux	Nitrate plus nitrite (NOx) from the first flux before any 15NO3 addition	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
NH4_1st_flux	Ammonium (NH4) flux from the first flux before any 15NO3 addition	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)

SRP_1st_flux	Phosphate (PO4-3) flux from the first flux before any 15NO3 addition	micromoles of phosphorous per meter squared per hour (µmol P m-2 hr-1)
p28_IPT	Produciton of N2 gas of mass 28 measured after the addition of 15NO3	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
p29_IPT	Produciton of N2 gas of mass 29 measured after the addition of 15NO3	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
p30_IPT	Produciton of N2 gas of mass 30 measured after the addition of 15NO3	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
D15_IPT	Potential denitrification of the 15NO3- added to the water column for the addition of 15NO3, see Smyth et al. 2017 for calculation details (isotope pairing technique (IPT) flux)	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
D14_IPT	Denitrification of ambient 14NO3- in the water after the addition of 15NO3, see Smyth et al. 2017 for calculation details (isotope pairing technique (IPT) flux)	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
D_total_IPT	Sum of D14_IPT and D15_IPT, the total amount of NO3 that was denitrified either from the addition of 15NO3 or ambient 14NO3	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
Inflow_14NOx_IPT	Concentration of 14NO3 in the resovior water prior to the addition of 15NO3	micromolar (µM)
Inflow_15NOx_IPT	Concentration of 15NO3 in the resovior after the addition of 15NO3	micromolar (µM)
Inflow_14NO3_to_15NO3_IPT	Ratio of 14NO3 in the resovior water to the 15NO3 in the resovior water	unitless
Dw_IPT	Denitrification rate of nitrate in the water column calculated based on the concentration (?M) of 15NO3- relative to 14NO3- in the inflow water times D15 (isotope pairing technique (IPT) flux), see Smyth et al. 2017 for details	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
Dn_IPT	Denitrification rate supported by nitrate produced through nitrification in the sediments calculated by the difference between D14 and Dw (isotope pairing technique (IPT) flux)	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)

NOx_IPT	Nitrate plus nitrite (NOx) flux after the 15NO3- addition (isotope pairing technique (IPT) flux)	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
NH4_IPT	Ammonium (NH4) flux after the 15NO3- addition (isotope pairing technique (IPT) flux)	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
DNRA15_IPT	Potential dissimilatory nitrate reduction to ammonium (DNRA) based on the 15NO3- added to the water column for the addition of 15NO3, see Smyth et al. 2017 for calculation details (isotope pairing technique (IPT) flux)	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
DNRA14_IPT	Dissimilatory nitrate reduction to ammonium (DNRA) ambient 14NO3- in the water after the addition of 15NO3, see Smyth et al. 2017 for calculation details (isotope pairing technique (IPT) flux)	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
DNRAw_IPT	Dissimilatory nitrate reduction to ammonium (DNRA) of nitrate in the water column calculated based on the concentration (?M) of 15NO3- relative to 14NO3- in the inflow water times DNRA15 (isotope pairing technique (IPT) flux), see Smyth et al. 2017 for details	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
DNRAn_IPT	Dissimilatory nitrate reduction to ammonium (DNRA) supported by nitrate produced through nitrification in the sediments calculated by the difference between DNRA14 and DNRAw (isotope pairing technique (IPT) flux)	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
Dt_to_N2O_IPT	Ratio of total denitrification to the N2O flux	unitless
N_N2O_flux_IPT	Nitrous oxide (N2O) flux after the 15NO3- addition (isotope pairing technique (IPT) flux)	micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1)
Lat	Smith Island latitude	decimal degrees
Lon	Smith Island longitude	decimal degrees

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Deployments

Smith_Island_Song

Website	https://www.bco-dmo.org/deployment/721959
Platform	shoreside Virginia

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Project Information

Microbial Regulation of Greenhouse Gas N2O Emission from Intertidal Oyster Reefs (Oyster Reef N2O Emission)

Extracted from the NSF award abstract:

Oyster reefs are biogeochemical hot spots and prominent estuarine habitats that provide disproportionate ecological function. Suspension-feeding eastern oysters, Crassostrea virginica, are capable of improving water quality and diminishing eutrophication by filtering nutrients and particles from the water and depositing them in the sediments. Remineralization of these deposits may enhance sedimentary denitrification that facilitates nitrogen removal in tidal estuaries. However, the scientific underpinning of oyster reef function has been challenged in various studies. In addition, recent studies of filter feeding invertebrates reported the production of nitrous oxide (N2O), a greenhouse gas, as an end product of incomplete denitrification by gut microbes. C. virginica could be another source of N2O flux from intertidal habitats. Preliminary work indicated substantial N2O production from individual oysters. The estimated N2O production from high density oyster reefs may exceed the N2O flux measured from some estuaries. With the new discovery of N2O emission and uncertainty regarding eutrophication control, the ecological value of oyster reef restoration may become equivocal.

This project will quantify N2O fluxes to understand the factors controlling N2O emission from oyster reefs. Sedimentary N processes will be examined to develop an oyster reef N model to estimate N2O emission from tidal creek estuaries relative to other N cycling processes. The PIs hypothesize that intertidal oyster reefs are a substantial source of N2O emission from estuarine ecosystems and the magnitude of emission may be linked to water quality. If substantial N2O flux from oyster reefs is validated, ecological benefits of oyster reef restoration should be reevaluated. This interdisciplinary research team includes a microbial ecologist, a biogeochemist, an ecologist and an ecosystem modeler. They will utilize stable isotope and molecular microbiological techniques to quantify oyster N2O production, elucidate microbial sources of N2O emission from oysters and sediments, and estimate seasonal variation of N2O fluxes from oyster reefs. Measurements from this study will be integrated into a coupled oyster bioenergetics-sediment biogeochemistry model to compare system level rates of N cycling on oyster reefs as a function of oyster density and water quality. Modeling results will be used to assess the relative trade-offs of oyster restoration associated with N cycling. They expect to deliver the following end products:1) estimation of annual N2O flux from oyster reefs as an additional source of greenhouse gases from estuaries, 2) a better understanding of the environmental and microbial factors influencing N2O and N2 fluxes in tidal estuaries, 3) transformative knowledge for the effect of oyster restoration on water quality enhancement and ecosystem function, 4) direct guidance for oyster restoration projects whose goals include water quality enhancement, and 5) a modeling tool for use in research and restoration planning.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1321373

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