# Fluxes across the sediment-water interface collected at Smith Island, Virginia in August of 2013 (Oyster Reef N2O Emission project)

**Website**: https://www.bco-dmo.org/dataset/721963
**Version**:
**Version Date**: 2018-03-19

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

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## Coverage

**Spatial Extent**: **Lat**:37.14919 **Lon**:-75.88523
**Temporal Extent**: 2013-08

## Dataset Description

Fluxes across the sediment-water interface using a batch style incubation from Smith Island and Smith Island Bay, VA in August of 2013.

**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: 2014 Seasonal Field Data
* Smith Island N cycle: 2014 Seasonal Fluxes

### Methods & Sampling

For this 2013 Flux dataset, the first flux values were measured before any 15NO3 addition and determined by monitoring concentration over time. Isotope pairing technique (IPT) fluxes were determined relative to the T0 Core. IPT was used for denitrification, measured on a MIMS. DNRA was determined using the diffusion technique and samples which were extracted using KCl.

**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 physicochemical 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)
* 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.

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## Data Files

| File |
| --- |
| **Smith_Island_2013_Flux.csv** (Comma Separated Values (.csv), 6.02 KB)<br>MD5:ee2fde0fcc3efce4181af8d3ca84b9a8<br>Primary data file for dataset ID 721963 |

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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
*Results*
,
*Methods*

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## Parameters

| Parameter | Description | Units |
| --- | --- | --- |
| Treatment | Treatment name | unitless |
| Light | Light treatment | unitless |
| ID | Indentifier | unitless |
| N2_Flux | Dinitrogen (N2) flux value before any 15NO3 addition, dertermined by N2/Ar | micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1) |
| DIC | Dissolved Inorganic Carbon (DIC) flux value before any 15NO3 addition | millimoles per meter squared per hour (mmol m-2 hr-1) |
| NOx_Flux | Nitrate plus nitrite (NOx) flux value before any 15NO3 addition | micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1) |
| NH4_Flux | Ammonium (NH4) flux value before any 15NO3 addition | micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1) |
| N2O | Nitrous oxide (N2O) flux value before any 15NO3 addition | micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1) |
| Dw | 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) | micromoles of nitrogen per meter squared per hour (µmol N m-2 hr-1) |
| Dn | 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) |
| D14 | Denitrification of ambient 14NO3-, 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) |
| D15 | Denitrification of added 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) |

| | | |
|---|---|---|
| NOx_Flux_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_Flux_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) |
| N2O_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) |
| potDNRA | Potential dissimilatory nitrate reduction to ammonium (DNRA) based on the 15NO3- addition, 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) |
| actDNRA | Actual dissimilatory nitrate reduction to ammonium (DNRA) based ambient 14NO3, 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) |
| DW | Dry weight of clams per core | grams (g) |
| Indv | Number of individual clams contained in each core | per individual |
| Biomass | Biomass density of clams per core calculated based on surface area of the incubation container | dry weight grams per meter squared (g DW m-2) |
| Density | Density of clams calculated based on the surface area of the incubation container | individuals per meter squared (Indv/m2) |
| Lat | Smith Island latitude | decimal degrees |
| Lon | Smith Island longitude | decimal degrees |

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## Deployments

**Smith_Island_Song**

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|---|---|
| **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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