Sediment fluxes of dissolved gasses and nutrients from the coast of North Carolina in 2010.

Website: https://www.bco-dmo.org/dataset/704346
Data Type: experimental
Version: 1
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Project
» Microbial Regulation of Greenhouse Gas N2O Emission from Intertidal Oyster Reefs (Oyster Reef N2O Emission)

Contributors	Affiliation	Role
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Abstract
Sediment fluxes of dissolved gasses and nutrients from the coast of North Carolina in 2010.

Table of Contents

Coverage

Spatial Extent: **N**:34.6951 **E**:-76.6081 **S**:34.6804 **W**:-76.626
Temporal Extent: 2010-06-28

Dataset Description

Nutrient flux data from several landscapes in coastal North Carolina.

Methods & Sampling

Methodology from **Smyth, A. R., Piehler, M. F. and Grabowski, J. H. (2015), Habitat context influences nitrogen removal by restored oyster reefs. J Appl Ecol, 52: 716–725. doi:10.1111/1365-2664.12435**

Within 4 h of collection, sediment cores were set up in a continuous flow core incubation system to measure steady-state nutrient and dissolved gas fluxes, described in Piehler & Smyth (2011). Briefly, cores were sealed with gas-tight lids, which had an inflow and outflow port. Water from a reservoir was pulled over the cores at a flow rate of 1 mL min−1. Triplicate dissolved gases and duplicate dissolved inorganic nitrogen samples were collected from the outflow and inflow periodically over the next 24 h. To examine how sediments from different habitat contexts responded to nitrate pulses, nitrate concentration in the reservoir water was elevated with $NaNO_3$ (~800 µm) after 48 h of sampling. Dissolved gas and inorganic nitrogen samples were then collected for an additional 48 h. Incubations were conducted in the dark and at ambient temperature (30 °C).

Water Quality Data:

Data Collected from Site using YSI in the field

From YSI	
Date	23-Jun-10
Temp (oC)	30.1
Salinity	34.94
Dissolved Oxygen (mg/l)	6.93
Dissolved Oxygen (%)	100%
Water Column NOx (uM)	0.17
Water Column NH4 (uM)	0.14

Data Processing Description

Methodology from **Smyth, A. R., Piehler, M. F. and Grabowski, J. H. (2015), Habitat context influences nitrogen removal by restored oyster reefs. J Appl Ecol, 52: 716–725. doi:10.1111/1365-2664.12435**

Fluxes across the sediment–water interface were calculated as $(Co-Ci) \times f/a$, where Co is the outflow concentration (µmol L^{-1}), Ci is the inflow concentration, f is the flow rate (0·06 L h^{-1}), and a is the sediment surface area (0·0032 m^2). Successive measurements from each core (triplicates for dissolved gas and duplicates for dissolved inorganic nutrients) were averaged to give core-specific values. This results in a net N_2flux (gross denitrification – gross nitrogen fixation) and does not distinguish between the sources of N_2. Consequently, denitrification refers to net N_2 production. Oxygen fluxes were calculated using the concentrations of O_2 obtained from the MIMS, presented as sediment oxygen demand (SOD), and serve as an indicator of organic matter quality, such that more labile organic matter is associated with higher SOD (Ferguson, Eyre & Gay 2003). To determine the influence of oyster reefs on sediment N_2 fluxes, the change in denitrification between the control and reef habitat pair in each zone was calculated (Kellogg et al. 2014). Denitrification efficiency was computed as the percentage of the dissolved inorganic nitrogen efflux that was N_2 (Piehler & Smyth 2011).

Statistical analyses were performed using r 2.13.1 (R Foundation for Statistical Computing 2011). Linear mixed-effects models (lme in R nlme package), where habitat nested in sampling location was included as a random effect for the intercept, were used to investigate the effects of oyster reef presence, habitat context, nitrate concentration (ambient vs. elevated) and the interaction between these factors on response variables. Fluxes of N_2, NOx ([math formula] + [math formula]) [math formula] , denitrification efficiency and SOD were analysed using all three fixed effects. For sediment organic matter, only habitat context and reef presence were included as fixed effects. The effects of ambient vs. elevated nitrate concentration and habitat context on oyster reef-mediated changes in denitrification were also analysed with a mixed-effects model (fixed effects: nitrate concentration × habitat context; random effects: habitat nested in location). Relationships between oyster density and habitat context were made using a mixed-effects model (fixed effects: habitat context; random effects: habitat nested in location). Comparisons were conducted using linear contrasts and judged against an alpha level of 0·05. Interactions were assessed using Tukey's HSD (lsmeans in R lsmeans package). Assumptions of homogeneity were tested using Levene's tests. Regression analyses were used to investigate the effect of oyster density on denitrification. Models with the lowest Akaike's information criterion corrected for small sample sizes (AICc) were chosen.

BCO-DMO Processing Notes:

- column names reformatted to comply with BCO-DMO naming standards.
- lat and lon columns added to correspond with locations.
- nd used to replace all blank cells with no data.

[table of contents | back to top]

Data Files

File
flux.csv(Comma Separated Values (.csv), 3.74 KB) MD5:930e21d79fe679d767300acc2c3544a6 Primary data file for dataset ID 704346

[table of contents | back to top]

Related Publications

Smyth, A. R., Piehler, M. F., & Grabowski, J. H. (2015). Habitat context influences nitrogen removal by restored oyster reefs. Journal of Applied Ecology, 52(3), 716–725. doi:10.1111/1365-2664.12435
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
date	Date of collection; YYYY/MM/DD	unitless
habitat	Type of substrate where oysters were measured	unitless
reefs	Indication of whether or not a reef was present	unitless
location	PI issued location IDs that correspond to specific coordinates and experimental treatments	unitless
lat	Latitude	decimal degrees
lon	Longitude	decimal degrees
nutrients	Indication of whether or not experimental levels of nutrients were used	unitless
N_N2	Nitrogen flux per hour	umol N m-2 hr-1
O2	Oxygen flux per hour	umol O2 m-2 hr-1
SOD	Sediment oxygen demand per hour	umol O2 m-2 hr-1
NOX	Nitrogen oxide flux per hour	umol N m-2 hr-1
NH4	Ammonium flux per hour	umol N m-2 hr-1
SOM	Sediment organic matter flux per hour; measured in the upper 2 cm	percent
density	Oyster density	count per square meter
eff	Denitrification efficiency	percent

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	IRMS
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	Lachat Quick-Chem 8000 automated ion analyser
Generic Instrument Name	Nutrient Autoanalyzer
Dataset-specific Description	Used to analyze dissolved inorganic nutrients
Generic Instrument Description	Nutrient Autoanalyzer is a generic term used when specific type, make and model were not specified. In general, a Nutrient Autoanalyzer is an automated flow-thru system for doing nutrient analysis (nitrate, ammonium, orthophosphate, and silicate) on seawater samples.

Dataset-specific Instrument Name	YSI 600 Series Sonde and Model 650 data logger
Generic Instrument Name	Temperature Logger
Dataset-specific Description	Used to collect water quality data
Generic Instrument Description	Records temperature data over a period of time.

[table of contents | back to top]

Deployments

Cheerystone_Inlet

Website	https://www.bco-dmo.org/deployment/700947
Platform	shoreside Virginia
Start Date	2013-05-01
End Date	2013-07-31
Description	Cheerystone Inlet of the Eastern Shore of Virginia: N37°18’30” and W76°1’0”

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1233372

[table of contents | back to top]