Three runs of six open system mesocosms run with 15N tracer addition from (oyster reef N2O emission project)

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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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Dataset Description

Three runs of six open system mesocosms run with 15N tracer addition. 3 tanks included oysters while 3 served as controls. Experiment were condcuted in the University of Connecticut Department of Marine Sciences.

Status (14 October 2016): Data are forthcoming and will be available as soon as possible. Please contact the PI for more information.

Methods & Sampling

Mesocosms were run as open system, steady-state type experiments in the dark and at constant temperature with a 4-day residence time. Each of the tanks contained 15 L of sand and 100 L of seawater filtered to 1m. Three of the tanks also contained juvenile oysters (*Crassostrea virginica*) at aquaculture density (~700 g live wt per tank), while three mesocosms did not contain oysters and served as controls. All tanks received continuous additions of the labeled substrate (15N-NH4+, 15N-NO3-, and 15N-phytoplankton). In each of the three experiments the tanks were sampled for 16 days, or 4 turn over times of the tank volume.

All six tanks in the nitrate and ammonium experiments were batch fed Shellfish Diet 1800 (Reed Mariculture Inc.) 3x daily at a concentration of 30,000 cells per ml. The 15N-phytoplankton treatment received no additional dissolved inorganic nitrogen (DIN) to the overlying water and twice daily feedings of a 15N labeled *Thalassiosira weissflogii* culture at concentrations of 25,000 cells per ml (Bigelow Laboratory) with no additional DIN input.

The fate of the heavy isotopic label in each experiment was assessed through time series samples of the concentration and enrichment of water column N2, DIN, and N2O as well as sediment bound NH4+. The concentrations and enrichments of these species yield rates including coupled denitrification (DNF), direct DNF, incomplete DNF, nitrification, and dissimilatory nitrate reduction to ammonium (DNRA). Additional time series

samples for rates of total system respiration and OM source are also taken. Elemental analysis of sediment samples show how oysters might be processing and altering OM reaching sediments. At the end of each experiment an SF6 tracer was added in order to calculate the gas transfer rate in each tank.

Samples for 15N2, 18O2 15N2O, and DIC were run on the IRMS. Samples for DIN concentration were run on the Smartchem auto analyzer (WestCo.). 15NO3- was done using the denitrifier method (Christensen et al. 1988), and 15NO2- and 15NH4+ were done using the Azide hypobromide method (Zhang et al. 2007) all of which were then run on the IRMS. Samples for POM, and sediment 15N and 13C were run on an elemental analyzer (EA) coupled to an IRMS. DOC was run on a total organic carbon analyzer (Shimadzu), while N2O and SF6 concentrations were measured on a gas chromatograph with electron capture detector (GC-ECD).

Related references:
Steingruber, S. M., Friedrich, J., Gächter, R., & Wehrli, B. 2001. Measurement of denitrification in sediments with the 15N isotope pairing technique. Applied and Environmental Microbiology, 67(9), 3771-3778. doi:10.1128/AEM.67.9.3771-3778.2001

Zhang, L., M. A. Altabet, T. Wu, O. Hadas. 2007. Sensitive measurement of NH4+ 15N/14N (15NH4+) at natural abundance levels in fresh and salt waters. Analytical Chemistry 79:5297-5303. doi:10.1021/ac070106d

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Smartchem auto analyzer
Generic Instrument Name	Discrete Analyzer
Dataset-specific Description	Samples for DIN concentration were run on the Smartchem auto analyzer (WestCo.).
Generic Instrument Description	Discrete analyzers utilize discrete reaction wells to mix and develop the colorimetric reaction, allowing for a wide variety of assays to be performed from one sample. These instruments are ideal for drinking water, wastewater, soil testing, environmental and university or research applications where multiple assays and high throughput are required.

Dataset-specific Instrument Name	elemental analyzer (EA)
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	Samples for POM, and sediment 15N and 13C were run on and elemental analyzer (EA) coupled to an IRMS.
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	gas chromatograph with electron capture detector (GC-ECD)
Generic Instrument Name	Gas Chromatograph
Dataset-specific Description	N2O and SF6 concentrations were measured on a gas chromatograph with electron capture detector (GC-ECD).
Generic Instrument Description	Instrument separating gases, volatile substances, or substances dissolved in a volatile solvent by transporting an inert gas through a column packed with a sorbent to a detector for assay. (from SeaDataNet, BODC)

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	total organic carbon analyzer
Generic Instrument Name	Total Organic Carbon Analyzer
Dataset-specific Description	DOC was run on a total organic carbon analyzer (Shimadzu).
Generic Instrument Description	A unit that accurately determines the carbon concentrations of organic compounds typically by detecting and measuring its combustion product (CO2). See description document at: http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/bs116.pdf

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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-1233372

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