Spatiotemporal characterization of nirK and nirS abundance from R/V Polaris monthly San Francisco Bay USGS Water Quality cruises from July of 2011 to June of 2012 (N-Cycling Microbial Communities project)

Website: https://www.bco-dmo.org/dataset/684207
Data Type: Cruise Results
Version:
Version Date: 2017-07-03

Project
» Spatial and Temporal Dynamics of Nitrogen-Cycling Microbial Communities Across Physicochemical Gradients in the San Francisco Bay Estuary (N-Cycling Microbial Communities)

Contributors	Affiliation	Role
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Coverage

Spatial Extent: **N**:38.048 **E**:-121.152 **S**:37.698 **W**:-122.37
Temporal Extent: 2011-07-13 - 2012-06-20

Dataset Description

This dataset contains data related to spatiotemporal characterization of nirK and nirS Abundance in San Francisco Bay. Data include sampling information (e.g. latitude, longitude, date, water temperature), bottom chemistry (e.g. salinity, nitrate, ammonium), sediment chemistry (e.g. porosity, total carbon, Mg, C/N), and sediment nirK and nirS gene abundance per ng DNA and per gram dry sediment.

nirK = copper-containing nitrite reductase
nirS = cytochrome-cd1 nitrite reductase

These data were published in Lee and Franics, 2017:
Lee, J. A., and C. A. Francis. 2017. Spatiotemporal characterization of San Francisco Bay denitrifying communities: a comparison of *nirK* and *nirS* diversity and abundance. *Microbial Ecology* 73(2): 271-284. doi: 10.1007/s00248-016-0865-y

For related datasets, click on the project link at the top of the page.

Methods & Sampling

Field sampling:

Sampling was conducted between July 2011 and June 2012 aboard monthly full-bay cruises on the R/V *Polaris* carried out by the US Geological Survey (USGS; Menlo Park, CA, external link). Sediment samples were collected by overboard Van Veen grab. Surface cores were collected using sterile 1-cc and 6-cc cut-off syringes, placed immediately on dry ice, and stored at -80C until processing. Bottom water was caught in the grab simultaneously with the sediment. Due to logistical difficulties, no samples were collected at site 21 in December 2011, or at any sites in April 2012.

Sediment and water chemical measurements. Salinity and temperature were measured

on-site using a YSI 556 MPS handheld multiparameter instrument (YSI Inc, OH). Subsamples of water for nutrient analyses were filtered through a 0.2 um PES syringe filter, placed on dry ice, and then stored at -80C until processing. Bottom water NO2- and NO3- concentrations were measured using a WestCo SmartChem 200 Discrete Analyzer (Unity Scientific, Brookfield, CT), and NH4+ was measured using the salicylate-hypochlorite method. In preparation for sediment chemical measurements, frozen sediment samples were thawed and air-dried, then ground, sieved, and homogenized. Total C and N were measured on a Carlo Erba NA1500 Elemental Analyzer (Val de Reuil, France) using an atropine standard curve, and total content of specific elements (Al, Cl, Mg, Na, P, S, Cu, Fe, Mn, Pb) was measured on a Spectro Xepos HE XRF Spectrometer (Kleve, Germany). Sediment samples were weighed before and after drying for calculation of gravimetric water content.

Nucleic acid extraction and gene abundance measurements:

Total DNA was extracted in triplicate, from the surface 1-cm of sediment of each of 3 cores from each site, using the FastDNA Spin Kit for Soil (MP Biomedicals, Solon, OH) following the manufacturer's instructions. Abundances of *nirK*, *nirS*, and bacterial 16S rRNA genes were measured using quantitative real-time PCR on the StepOnePlus Real-Time PCR system (Applied Biosystems, Foster City, CA), as described in Lee and Francis (2017). Each of the three DNA extractions from each sample was quantified in a separate reaction, with each reaction run in triplicate. A fresh 8-point standard curve was run on each reaction plate using 10-fold dilutions of a linearized plasmid containing an amplicon of the appropriate gene that had previously been PCR-amplified from San Francisco Bay sediment and sequenced.

From DNA samples collected at each site in July 2011, October 2011, January 2012, and May 2012, *nirK* and *nirS* gene fragments were PCR amplified, cloned, and sequenced, as described in Lee and Francis (2017). The nucleotide sequences reported in this study have been deposited in GenBank under accession numbers KR060094 - KR060621 (for *nirK*) and KR060622 - KR061281 (for *nirS*).

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Data Files

File
nirK_nirS.csv (Comma Separated Values (.csv), 13.18 KB) MD5:a88be4c587604265239942a8e8923bd4 Primary data file for dataset ID 684207

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Parameters

Parameter	Description	Units
Site	Site identifier	unitless
Month	Month of sampling in format mmm	unitless
Year	Year of sampling in format yyyy	unitless
Date	Date of sampling in format yyyy-mm-dd	unitless
Latitude	Latitude of sampling location	decimal degrees

Longitude	Longitude of sampling location; west is negative	decimal degrees
Temp	Temperture of bottom water where sample was taken	degrees Celsius
Sal	Salinity of bottom water where sample was taken	Practical Salinity Units (PSU)
NO3	Dissolved nitrate concentration in bottom water	micromolar (mM)
NH4	Dissolved ammonium concentration in bottom water	micromolar (mM)
porosity	Gravimetric water content of sediments	percent (%) by mass
Ctot	Total carbon content in dried sediment	percent (%) by mass
Ntot	Total nitrogen content in dried sediment	percent (%) by mass
C_N	Carbon to nitrogen ratio (by mass) of sediment	dimensionless
Al	Total aluminium content in dried sediment	percent (%) by mass
Cl	Total chlorine content in dried sediment	percent (%) by mass
Mg	Total magnesium content in dried sediment	percent (%) by mass
Na	Total sodium content in dried sediment	percent (%) by mass
P	Total phosphorus content in dried sediment	percent (%) by mass
S	Total sulfur content in dried sediment	percent (%) by mass
Cu	Total copper content in dried sediment	migrograms per gram (ug/g)
Fe	Total iron content in dried sediment	migrograms per gram (ug/g)
Mn	Total manganese content in dried sediment	migrograms per gram (ug/g)
Pb	Total lead content in dried sediment	migrograms per gram (ug/g)
nirK_mean_DNA	Average sediment nirK gene abundance per ng DNA	genes per ng DNA
nirK_sd_DNA	Standared deviation of sediment nirK gene abundance per ng DNA	genes per ng DNA
nirS_mean_DNA	Average sediment nirS gene abundance per ng DNA	genes per ng DNA
nirS_sd_DNA	Standared deviation of sediment nirS gene abundance per ng DNA	genes per ng DNA
bacterial_16S_mean_DNA	Average bacterial 16S gene abundance per ng DNA	genes per ng DNA
bacterial_16S_sd_DNA	Standard deviation of bacterial 16S gene abundance per ng DNA	genes per ng DNA
nirK_mean_dry	Average sediment nirK gene abundance per gram of dry sediment	genes per g dry sediment
nirK_sd_dry	Standared deviation of sediment nirK gene abundance per gram of dry sediment	genes per g dry sediment
nirS_mean_dry	Average sediment nirS gene abundance per gram of dry sediment	genes per g dry sediment
nirS_sd_dry	Standared deviation of sediment nirS gene abundance per gram of dry sediment	genes per g dry sediment
bacterial_16S_mean_dry	Average bacterial 16S gene abundance per gram of dry sediment	genes per g dry sediment
bacterial_16S_sd_dry	Standard deviation of bacterial 16S gene abundance per gram of dry sediment	genes per g dry sediment

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Instruments

Dataset-specific Instrument Name	Van Veen grab
Generic Instrument Name	Bottom Sediment Grab Samplers
Generic Instrument Description	These samplers are designed to collect an accurate representative sample of the sediment bottom. The bite of the sampler should be deep enough so all depths are sampled equally. The closing mechanism is required to completely close and hold the sample as well as prevent wash-out during retrieval. Likewise, during descent the sampler should be designed to minimize disturbance of the topmost sediment by the pressure wave as it is lowered to the bottom.

Dataset-specific Instrument Name	Carlo Erba NA1500 Elemental Analyzer
Generic Instrument Name	Carlo-Erba NA-1500 Elemental Analyzer
Dataset-specific Description	. Total C and N were measured on a Carlo Erba NA1500 Elemental Analyzer (Val de Reuil, France)
Generic Instrument Description	A laboratory instrument that simultaneously determines total nitrogen and total carbon from a wide range of organic and inorganic sediment samples. The sample is completely and instantaneously oxidised by flash combustion, which converts all organic and inorganic substances into combustion products. The resulting combustion gases pass through a reduction furnace and are swept into the chromatographic column by the carrier gas which is helium. The gases are separated in the column and detected by the thermal conductivity detector which gives an output signal proportional to the concentration of the individual components of the mixture. The instrument was originally manufactured by Carlo-Erba, which has since been replaced by Thermo Scientific (part of Thermo Fisher Scientific). This model is no longer in production.

Dataset-specific Instrument Name	WestCo SmartChem 200 Discrete Analyzer
Generic Instrument Name	Discrete Analyzer
Dataset-specific Description	Bottom water NO2 and NO3 concentrations were measured using a WestCo SmartChem 200 Discrete Analyzer (Unity Scientific, Brookfield, CT).
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	StepOnePlus Real-Time PCR system
Generic Instrument Name	qPCR Thermal Cycler
Dataset-specific Description	StepOnePlus Real-Time PCR system (Applied Biosystems, Foster City, CA)
Generic Instrument Description	An instrument for quantitative polymerase chain reaction (qPCR), also known as real-time polymerase chain reaction (Real-Time PCR).

Dataset-specific Instrument Name	Spectro Xepos HE XRF Spectrometer
Generic Instrument Name	Spectrometer
Dataset-specific Description	Total content of specific elements (Al, Cl, Mg, Na, P, S, Cu, Fe, Mn, Pb) was measured on a Spectro Xepos HE XRF Spectrometer (Kleve, Germany)
Generic Instrument Description	A spectrometer is an optical instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.

Dataset-specific Instrument Name	YSI 556 MPS handheld multiparameter instrument
Generic Instrument Name	YSI Professional Plus Multi-Parameter Probe
Dataset-specific Description	YSI 556 MPS handheld multiparameter instrument (YSI Inc, OH).
Generic Instrument Description	The YSI Professional Plus handheld multiparameter meter provides for the measurement of a variety of combinations for dissolved oxygen, conductivity, specific conductance, salinity, resistivity, total dissolved solids (TDS), pH, ORP, pH/ORP combination, ammonium (ammonia), nitrate, chloride and temperature. More information from the manufacturer.

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Deployments

USGS_WQ_SanFrancisco_2011-2012

Website	https://www.bco-dmo.org/deployment/707105
Platform	R/V Polaris
Start Date	2011-07-13
End Date	2012-06-20
Description	Monthly full-bay USGS Water Quality of San Francisco Bay Cruises (7/13/11, 8/17/11, 9/21/11, 10/19/11, 11/16/11, 12/14/11, 1/11/12, 2/8/12, 3/21/12, 5/22/12, 6/20/12)

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Project Information

Spatial and Temporal Dynamics of Nitrogen-Cycling Microbial Communities Across Physicochemical Gradients in the San Francisco Bay Estuary (N-Cycling Microbial Communities)

Coverage: San Francisco Bay

Description from the NSF award abstract:

This award is funded under the American Recovery and Reinvestment Act of 2009 (Public Law 111-5).

Although nitrogen (N) acts as a limiting nutrient in many marine ecosystems, from estuaries to the open ocean, N in excess can be extremely detrimental. Eutrophication is of particular concern in estuaries, with over half of the estuaries in the United States experiencing its effects. Harmful levels of N in estuaries can be diminished through tightly coupled processes in the microbial nitrogen cycle, including nitrification (chemoautotrophic oxidation of ammonia to nitrite and nitrate) and denitrification (the dissimilatory reduction of nitrate to N2 gas). In fact, coupled nitrification-denitrification can remove up to 50% of external dissolved inorganic nitrogen inputs to estuaries, thereby reducing the risk of eutrophication. Despite the biogeochemical importance of both nitrification and denitrification in estuarine systems, surprisingly little is known regarding the underlying microbial communities responsible for these processes, or how they are influenced by key physical/chemical factors.

The investigators will work in San Francisco Bay - the largest estuary on the west coast of the United States - using molecular, biogeochemical and cultivation approaches to explore how the distribution, diversity, abundance, and activities of key N-cycling communities are influenced by environmental gradients over temporal and spatial scales. Denitrifying communities will be studied using functional genes (nirK and nirS) encoding the key denitrification enzyme nitrite reductase, while genes encoding ammonia monooxygenase subunit A (amoA) will be used to study both ammonia-oxidizing bacteria (AOB) and the recently-discovered ammonia-oxidizing archaea (AOA)- members of one of the most ubiquitous and abundant prokaryotic groups on the planet, the mesophilic Crenarchaeota. Analyzing sediments from sites spanning a range of physical and chemical conditions in the Bay, seasonally over the course of several years, will represent an unprecedented opportunity to examine spatial, physical/chemical, and temporal effects on both denitrifier and ammonia-oxidizer communities in this large, urban estuary. Concurrently, an intensive cultivation effort will also be undertaken, in order to compile a novel culture collection of estuarine denitrifiers and ammonia-oxidizers, for which virtually nothing is currently known. Taken together, these complimentary approaches will help reveal how complex physical/chemical gradients influence the diversity and functioning of key estuarine N-cycling communities over time and space.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0847266

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