Biogeochemical measurements from R/V Blue Heron BH10-01, BH10-06, BH10-13, BH10-22, BH09-SINC1 in the Lake Superior from 2009 to 2010 (SINC project)

Website: https://www.bco-dmo.org/dataset/3665
Version: 20 July 2012
Version Date: 2012-07-20

Project
» Sources and Sinks of Stoichiometrically Imbalanced Nitrate in the Laurentian Great Lakes (SINC)

Program
» Laurentian Great Lakes Ecosystem Studies (Laurentian Great Lakes Ecosystem Studies)

Contributors	Affiliation	Role
Sterner, Robert W.	University of Minnesota Twin Cities (UMTC)	Principal Investigator, Contact
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Dataset Description

Bio Geo Chemistry Data collected during 2009 and 2010
Cruises SINC 1, SINC 5, SINC 6, SINC 10, SINC 11

Methods & Sampling

Detailed Acquisition and Processing Metadata for All Parameters
Metadata generated from original file "2010 Great Lakes Biogeochem Data.xlsx, Sheet: Metadata" contributed by Bob Sterner
See Individual Deployments/Data Info for cruise specific sampling notes.

Data Processing Description

Detailed Acquisition and Processing Metadata for All Parameters
Metadata generated from original file "2010 Great Lakes Biogeochem Data.xlsx, Sheet: Metadata" contributed by Bob Sterner
See Individual Deployments/Data Info for cruise specific sampling notes

BCO-DMO Processing/Edits
- Data generated from original files:

"2009 Great Lakes Biogeochem Data.xlsx
"2010 Great Lakes Biogeochem Data.xlsx, Sheet: Data"
contributed by Bob Sterner
- Date reformatted to YYYYMMDD
- LATITUDE/LONGITUDE columns added and values for these inserted from Standard Stations dataset
- Parameter names modified to conform to BCO-DMO conventions (blanks to underscores, etc.)
- Parameter WATER_DEPTH changed to SAMPLE_DEPTH
- Parameter "sed/core/water" changed to SAMPLE_TYPE
- Spaces in CRUISE CODES removed
- Station STEC changed to STE-C
- "nd" (no data) value inserted in blank cells
- Updated positions for Grab and UWM stations (14June2012/srg)
- SINC 10 "WM" station data for August 20 2010 deleted (18July2012/srg)
- SINC1/2009 data incorporated with 2010 data and served as a single SINC BioGeoChem file (20July2012/srg)

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Data Files

File
SINC_BioGeoChem.csv (Comma Separated Values (.csv), 329.45 KB)   MD5:4601bd8b3a396a3a071c712c0ab42487
Primary data file for dataset ID 3665

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Parameters

Parameter	Description	Units
LOG_NUMBER	A unique internal sample identifier Detailed Acquisition and Processing Metadata for All Parameters	Dimensionless
CRUISE_CODE	Name of cruise when sample was taken Detailed Acquisition and Processing Metadata for All Parameters	Dimensionless
SAMPLE_DATE	Date sample was taken from lake Detailed Acquisition and Processing Metadata for All Parameters	YYYYMMDD
STATION	Station occupied when sample was taken Detailed Acquisition and Processing Metadata for All Parameters	Dimensionless
LATITUDE	Station Latitude from Standard Stations Dataset (South is negative) Detailed Acquisition and Processing Metadata for All Parameters	Decimal degrees
LONGITUDE	Station Longitude from Standard Stations Dataset (West is negative) Detailed Acquisition and Processing Metadata for All Parameters	Decimal degrees
SAMPLE_DEPTH	Depth sample was taken. BioGeoChem depth data -- Upon collection, we trigger the Niskin at the "depth" reported by the SeaBird (not pressure), which takes into effect the ~2% change for the conversion in fresh water of pressure in decibars to depth in meters. Thus these values truly are depth, not pressure. Detailed Acquisition and Processing Metadata for All Parameters	m
CORE_SEGMENT	Core slice upper and lower bounds. Detailed Acquisition and Processing Metadata for All Parameters	cm
FRACTION	Pore size of filter used to fractionate before sample collection. Detailed Acquisition and Processing Metadata for All Parameters	m * 10-6
STORAGE	Method of sample preservation Detailed Acquisition and Processing Metadata for All Parameters	Dimensionless

VOL_FILT	Volume of sample filtered. Detailed Acquisition and Processing Metadata for All Parameters	mL
REP	Integer value; replicate number. Detailed Acquisition and Processing Metadata for All Parameters	Dimensionless
SAMPLE_TYPE	Type of sample (sed/core/water) Detailed Acquisition and Processing Metadata for All Parameters	Dimensionless
DIC	Dissolved inorganic carbon. Detailed Acquisition and Processing Metadata for All Parameters	mg/L
DOC	Dissolved organic carbon Detailed Acquisition and Processing Metadata for All Parameters	mg/L
TDN	Total dissolved nitrogen. Detailed Acquisition and Processing Metadata for All Parameters	mg/L
POC	Particulate Organic Carbon Detailed Acquisition and Processing Metadata for All Parameters	ug/L
PON	Particulate Organic Nitrogen Detailed Acquisition and Processing Metadata for All Parameters	ug/L
Sed_OC	Sediment organic carbon. Detailed Acquisition and Processing Metadata for All Parameters	Percent by wt.
Sed_ON	Sediment organic nitrogen Detailed Acquisition and Processing Metadata for All Parameters	Percent by wt.
Sed_TC	Sediment total carbon. Detailed Acquisition and Processing Metadata for All Parameters	Percent by wt.
Sed_TN	Sediment total nitrogen. Detailed Acquisition and Processing Metadata for All Parameters	Percent by wt.
Chl_a	Sample filtered onto 25 mm 0.2 um cellulose nitrate filter and frozen. Extracted with 90% Acetone in the refrigerator for 20-24 h (no grinding of filer). Then measured on a Turner 10-AU using narrow band width filters per Welschmeyer xxxx. Once every 4 y Turner Design liquid standard is used for recalibration. Solid standard used in between. Detailed Acquisition and Processing Metadata for All Parameters	ug/L
PP	Particulate phosphorus Detailed Acquisition and Processing Metadata for All Parameters	uM
NH4	Ammoniuum Detailed Acquisition and Processing Metadata for All Parameters	uM
NO3	Nitrate Detailed Acquisition and Processing Metadata for All Parameters	uM

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Instruments

Dataset-specific Instrument Name	Bottom Sediment Grab Samplers
Generic Instrument Name	Bottom Sediment Grab Samplers
Dataset-specific Description	Ponar Sampler Detailed Acquisition and Processing Metadata for All Parameters Metadata generated from original file "2010 Great Lakes Biogeochem Data.xlsx, Sheet: Metadata" contributed by Bob Sterner See Individual Deployments/Data Info for cruise specific sampling notes.
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	CTD Sea-Bird SBE 911plus
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	Sea-Bird SBE 9 Detailed Acquisition and Processing Metadata for All Parameters Metadata generated from original file "2010 Great Lakes Biogeochem Data.xlsx, Sheet: Metadata" contributed by Bob Sterner See Individual Deployments/Data Info for cruise specific sampling notes.
Generic Instrument Description	The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics

Dataset-specific Instrument Name	Lachat Flow Injection Analyzer
Generic Instrument Name	Flow Injection Analyzer
Dataset-specific Description	Lachat flow injection analyzer Detailed Acquisition and Processing Metadata for All Parameters Metadata generated from original file "2010 Great Lakes Biogeochem Data.xlsx, Sheet: Metadata" contributed by Bob Sterner See Individual Deployments/Data Info for cruise specific sampling notes.
Generic Instrument Description	An instrument that performs flow injection analysis. Flow injection analysis (FIA) is an approach to chemical analysis that is accomplished by injecting a plug of sample into a flowing carrier stream. FIA is an automated method in which a sample is injected into a continuous flow of a carrier solution that mixes with other continuously flowing solutions before reaching a detector. Precision is dramatically increased when FIA is used instead of manual injections and as a result very specific FIA systems have been developed for a wide array of analytical techniques.

Dataset-specific Instrument Name	Turner 10-AU Fluorometer
Generic Instrument Name	Fluorometer
Dataset-specific Description	Turner 10-AU Fluorometer Detailed Acquisition and Processing Metadata for All Parameters Metadata generated from original file "2010 Great Lakes Biogeochem Data.xlsx, Sheet: Metadata" contributed by Bob Sterner See Individual Deployments/Data Info for cruise specific sampling notes.
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	Multi Corer
Generic Instrument Name	Multi Corer
Dataset-specific Description	Multicorer Detailed Acquisition and Processing Metadata for All Parameters Metadata generated from original file "2010 Great Lakes Biogeochem Data.xlsx, Sheet: Metadata" contributed by Bob Sterner See Individual Deployments/Data Info for cruise specific sampling notes.
Generic Instrument Description	The Multi Corer is a benthic coring device used to collect multiple, simultaneous, undisturbed sediment/water samples from the seafloor. Multiple coring tubes with varying sampling capacity depending on tube dimensions are mounted in a frame designed to sample the deep ocean seafloor. For more information, see Barnett et al. (1984) in Oceanologica Acta, 7, pp. 399-408.

Dataset-specific Instrument Name	Niskin bottle
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Detailed Acquisition and Processing Metadata for All Parameters Metadata generated from original file "2010 Great Lakes Biogeochem Data.xlsx, Sheet: Metadata" contributed by Bob Sterner See Individual Deployments/Data Info for cruise specific sampling notes.
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	Perkin Elmer 2400 CHN Analyzer
Generic Instrument Name	Particulate Organic Carbon/Nitrogen Analyzer
Dataset-specific Description	Perkin Elmer 2400 CHN Analyzer Detailed Acquisition and Processing Metadata for All Parameters Metadata generated from original file "2010 Great Lakes Biogeochem Data.xlsx, Sheet: Metadata" contributed by Bob Sterner See Individual Deployments/Data Info for cruise specific sampling notes.
Generic Instrument Description	A unit that accurately determines the carbon and nitrogen concentrations of organic compounds typically by detecting and measuring their combustion products (CO_2 and NO).

Dataset-specific Instrument Name	TNM-1 Attachment
Generic Instrument Name	Total Nitrogen Analyzer
Dataset-specific Description	Shimadzu VCSH TNM-1 AttachmentDetailed Acquisition and Processing Metadata for All Parameters Metadata generated from original file "2010 Great Lakes Biogeochem Data.xlsx, Sheet: Metadata" contributed by Bob Sterner See Individual Deployments/Data Info for cruise specific sampling notes.
Generic Instrument Description	A unit that accurately determines the nitrogen concentrations of organic compounds typically by detecting and measuring its combustion product (NO). See description document at: http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/totalnit.pdf

Dataset-specific Instrument Name	Shimadzu VCSH
Generic Instrument Name	Total Organic Carbon Analyzer
Dataset-specific Description	Shimadzu VCSHDetailed Acquisition and Processing Metadata for All Parameters Metadata generated from original file "2010 Great Lakes Biogeochem Data.xlsx, Sheet: Metadata" contributed by Bob Sterner See Individual Deployments/Data Info for cruise specific sampling notes.
Generic Instrument Description	A unit that accurately determines the carbon concentrations of organic compounds typically by detecting and measuring its combustion product (CO_2). See description document at: http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/bs116.pdf

Deployments

BH10-01

Website	https://www.bco-dmo.org/deployment/58774
Platform	R/V Blue Heron
Report	http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/BH10-01_SINC5_synopsis.pdf
Start Date	2010-05-14
End Date	2010-05-16
Description	Cruise Name: SINC 5 Dates: May 14-16, 2010 Vessel: R/V Blue Heron UNOLS Cruise ID: BH10-01 Participants: R. Sterner, B. Beall, S. Brovold, S. Queen, B. Scott, C. Small Cruise information and original data are available from the NSF R2R data catalog. **Methods & Sampling** Refer to BH10-01/SINC 5 Cruise Synopsis for detailed descriptions of acquisition and processing methodologies **Processing Description** Refer to http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/BH10-01_SINC5_syn... target="_blank">BH10-01/SINC 5 Cruise Synopsis for detailed descriptions of acquisition and processing methodologies

BH10-06

Website	https://www.bco-dmo.org/deployment/58775
Platform	R/V Blue Heron
Report	http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/BH10-06_SINC6_synopsis.pdf
Start Date	2010-06-25
End Date	2010-06-27
Description	Cruise Name: SINC 6 Dates: June 25-27, 2010 Vessel: R/V Blue Heron UNOLS Cruise ID: BH10-06 (Not verified srg/13April2012) Participants: R. Sterner, B. Beall, S. Brovold, O. Kutovaya, C. Small, H. Carrick Cruise information and original data are available from the NSF R2R data catalog. **Methods & Sampling** Refer to BH10-06/SINC 6 Cruise Synopsis for detailed descriptions of acquisition and processing methodologies **Processing Description** Refer to http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/BH10-06_SINC6_syn... target="_blank">BH10-06/SINC 6 Cruise Synopsis for detailed descriptions of acquisition and processing methodologies

BH10-13

Website	https://www.bco-dmo.org/deployment/58776
Platform	R/V Blue Heron
Report	http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/BH10-13_SINC10_synopsis.pdf
Start Date	2010-08-18
End Date	2010-08-20
Description	Cruise Name: SINC 10 Dates: August 18-20, 2010 Vessel: R/V Blue Heron UNOLS Cruise ID: BH10-13 Participants: J. Finlay, G. Bullerjahn, S. Brovold, C. Small, B. Scott, M. Mukherjee Cruise information and original data are available from the NSF R2R data catalog. **Methods & Sampling** Refer to BH10-13/SINC 10 Cruise Synopsis for detailed descriptions of acquisition and processing methodologies **Processing Description** Refer to http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/BH10-13_SINC10_sy... target="_blank">BH10-13/SINC 10 Cruise Synopsis for detailed descriptions of acquisition and processing methodologies

BH10-22

Website	https://www.bco-dmo.org/deployment/58773
Platform	R/V Blue Heron
Report	http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/BH10-22_SINC11_synopsis.pdf
Start Date	2010-10-05
End Date	2010-10-07
Description	Cruise Name: SINC 11 Dates: October 05-07, 2010 Vessel: R/V Blue Heron UNOLS Cruise ID: BH10-22 Participants: R. Sterner, H. Carrick, S. Brovold, C. Small, B. Scott, B. Beall Cruise information and original data are available from the NSF R2R data catalog. **Methods & Sampling** Refer to BH10-22/SINC 11 Cruise Synopsis for detailed descriptions of acquisition and processing methodologies **Processing Description** Refer to http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/BH10-22_SINC11_sy... target="_blank">BH10-22/SINC 11 Cruise Synopsis for detailed descriptions of acquisition and processing methodologies

BH09-SINC1

Website	https://www.bco-dmo.org/deployment/58798
Platform	R/V Blue Heron
Report	http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/BH09-SINC1_Cruise_synopsis.pdf
Start Date	2009-11-10
End Date	2009-11-12
Description	Cruise Name: SINC 1 Dates: 10 - 12 November 2009 Vessel: R/V Blue Heron UNOLS Cruise ID: (tbd) Participants: R. Sterner, S. Brovold, Aaron Myers, Brenda Scott, Nick Sterner **Methods & Sampling** Refer to BH09-SINC 1 Cruise Synopsis for detailed descriptions of acquisition and processing methodologies **Processing Description** Refer to http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/BH09-SINC1_Cruise... 1 Cruise Synopsis for detailed descriptions of acquisition and processing methodologies

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Project Information

Sources and Sinks of Stoichiometrically Imbalanced Nitrate in the Laurentian Great Lakes (SINC)

Website: http://www.tc.umn.edu/~stern007/

Coverage: Lake Superior; Great Lakes

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

Over large scales encompassing heterogeneous conditions, biogeochemical mechanisms act to achieve a stoichiometric balance between nitrogen and phosphorus. Locally, however, imbalances can develop. The Laurentian Great Lakes are a vast freshwater system where nitrate has been steadily accumulating for decades. Previous work has shown that in Lake Superior, the headwaters of the system, nitrate enters the lake water primarily due to in-lake biogeochemical processes, not due to passive accumulation of nitrate as a conservative substance as previously believed. An extreme stoichiometric imbalance of nitrate/phosphate ratios (~ 10,000 by moles) is present and is apparently growing. This set of prior findings opens up two major questions. First, what are the principal biogeochemical control points that tip the N cycle toward buildup of excess nitrate? And second, how does the extreme stoichiometric imbalance affect the ecology and evolution of Lake Superior's biota?

In this project, researchers at the University of Minnesota - Twin Cities and the Bowling Green State University, who previously documented the nitrate buildup in Lake Superior, will continue their research program and address these two questions. The project is organized around making comparative measurements of N assimilation, nitrification, denitrification, anammox, and microbial community structure in Lake Superior and in the central basin of Lake Erie. These two environments differ greatly in many ways including redox state and organic carbon production rates. From the standpoint of N balancing mechanisms, they can be considered end members within the Laurentian Great Lakes. Additional data will be collected across a larger region of the Upper Great Lakes including Lake Huron. Up-to-date mass balance budgets of nitrogen of the most of the Great Lakes (Lake Superior is already done) will be constructed and linked with hydrologic fluxes to gain insights into the dynamics of N across the entire Laurentian Great Lakes System. Observations of water chemistry will be made with ship-board sampling together with field-deployed nitrate sensors in shallow and deep waters. Process studies will be performed in the water column and at the sediment-water interface and will involve sensitive stable isotope techniques. These will include measurements of NO_3 and NH_4^+ uptake into different size fractions, exchanges of different forms of N and C between the water column and sediments, nitrification, denitrification, and anammox. The diversity and abundance of ammonia oxidizing Archea (AOA) and bacteria (AOB) will be studied using quantitative real time PCR and DGGE. Similarly, the genetic composition

of denitrifyers and anammox bacteria will be studied to see if they too are represented by novel clades in Lake Superior. Cultured nitrifyers will be characterized in terms of growth under different conditions typically encountered across the Great Lakes. The project will yield valuable information and insight into the operation of the nitrogen cycle under conditions that promote stoichiometric imbalances.

Previous work (2004-2007) by this team of investigators and others investigated the intersection of the nitrogen cycle with the phosphorus and iron cycles in Lake Superior and included studying the responses of plankton communities to differing nutrient supply regimes. Prior to 2004, many of the same investigators conducted research on the existence, mechanisms, spatial-temporal extent, and significance of trace metal limitation to primary production in Lake Superior. This early research was designed to quantify and characterize total and bioactive trace metal concentrations of Al, Fe, Mn, Zn, Cu, Cd, and Co in Lake Superior. The project included immunological and fluorescence assays to assess metal deficiency in algae in the natural environment and trace metal enrichment experiments in the laboratory to assess limitation experimentally.

The Laurentian Great Lakes are a valuable regional resource and an immense reservoir of planetary fresh water. Lake Superior is often considered to be relatively pristine but the ultimate source of the N converted to nitrate in the lake is as yet unknown and may involve past changes to the watershed or other anthropogenic factors.

Program Information

Laurentian Great Lakes Ecosystem Studies (Laurentian Great Lakes Ecosystem Studies)

Website: http://www.tc.umn.edu/~stern007/

Coverage: Laurentian Great Lakes

A series of studies concerned with the chemistry and biology of the Laurentian Great Lakes. These different studies share a focus on the dynamics of organic pools of carbon, nitrogen and phosphorus, and the stoichiometric linkages among these elements. At different times, work also has focused on trace metal dynamics and interactions with biota, the rates of primary production and herbivory, rates and patterns of primary productivity, and the century-long, steady trend of increasing nitrate in Earth's largest lake by area. Microbial populations have been investigated and linked to these chemical properties.

This Program was created by BCO-DMO staff to bring various Laurentian Great Lakes Research projects under one umbrella for improved discovery and access.

Dates: 1998 - 2014
Funding: NSF/OCE and Minnesota Sea Grant

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0927512
NSF Division of Ocean Sciences (NSF OCE)	OCE-0927277