CTD and in situ Sonde field data collected on Lake Superior and Lake Erie aboard the R/V Blue Heron and R/V Gibraltar III from May 2021 to May 2024

Website: https://www.bco-dmo.org/dataset/967649
Data Type: Cruise Results
Version: 1
Version Date: 2025-08-18

Project
» Collaborative Research: Cyanobacteria, Nitrogen Cycling, and Export Production in the Laurentian Great Lakes (Cyanos Great Lakes)

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Abstract
This dataset includes the CTD and Sonde data from 11 cruises on Lake Superior aboard the University of Minnesota Duluth R/V Blue Heron from May 2021 to May 2024 (May, July, August, and October), as well as 11 cruises on Lake Erie (May, July, August, and October). The data are from five stations (two on Lake Superior; Siskiwit Bay and Western Mooring, and three on Lake Erie; Central Anoxic Basin, Lorain, and North Bass). This project is led by PIs Joe Werne at University of Pittsburgh, Silvia Newell at University of Michigan, Emily Elliott at University of Pittsburgh, Trinity Hamilton at University of Minnesota, and Richard Ricketts at University of Minnesota Duluth, and was funded by NSF Chemical Oceanography.

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Coverage

Location: Lake Erie-North Bass: 41.70 N, 82.85 W; Lorain: 41.71 N, 82.13 W; Central Anoxic Basin: 41.98 N, 81.63 W; Lake Superior-Western Mooring 47.31 N, 89.80 W; Siskiwit Bay: 46.89 N, 91.11 W
Spatial Extent: **N**:47.32494 **E**:-81.63803 **S**:41.63001 **W**:-91.11304
Temporal Extent: 2021-05-11 - 2024-05-16

Methods & Sampling

The CTD methodology applies to all data associated with Lake Superior and August Lake Erie. All of the other Lake Erie data is covered by the Sonde methodology.

SeaBird Model 911 plus CTD profiler

At each site, the SeaBird Model 911 plus CTD profiler was moved over the site using the A-frame at the rear of the *R/V Blue Heron*. The profiler was then lowered into the water and allowed to collect the data on the way down to the bottom of the water column. This is based on the water depth at each site, which ranged from about 7m to over 160m. Once at the bottom of the water column, the profiler was then raised back through the water column. During this process, the profiler was stopped at select water depths based on the site. This was done so the onboard 8L Niskin bottles could be used to collect the water at the selected sites. For each site, several casts of the profiler were necessary to collect the desired amount of water. Despite this, representative casts from each site during each cruise were selected to avoid unnecessary confusion and cluttering of the files with redundant data. The profiler produced two different data sets, marked as ASC1 and ASC2, both of which are included as supplemental files. The ASC1 files are continuous readings from the CTD as it moved through the water column. The ASC2 files is the same data set, but has been binned into 1m increments. Data from the ASC2 files were converted to Excel format and included in the main dataset, as that matches the data collected with the Sonde.

Eureka Manta 2 Sonde

At each site, the Eureka Manta 2 Sonde was placed into the water off the side of the *R/V Gibraltar III*. The Sonde was slowly lowered through the water column and was stopped every meter. At each meter increment the data readout from the Sonde was recorded into a notebook. The Sonde was lowered through the entire water column, but was only used to record water conditions on the way down through the water column. There are no associated raw files for this data, as the data was recorded directly from a real-time readout.

2021 Cruises

May 12-13: Superior cruise R/V Blue Heron (BH21-02)
July 12-14: Erie cruise R/V Gibraltar III
Aug 8-15: Superior cruise R/V Blue Heron (BH21-09)
Aug 24-28: Erie cruise R/V Blue Heron (BH21-10)
Oct 11-13: Erie cruise R/V Gibraltar III
Oct 18-20: Superior cruise R/V Blue Heron (BH21-20)

2022 Cruises

May 25-27: Superior cruise R/V Blue Heron (BH22-05)
May 31-June 2: Erie cruise R/V Gibraltar III
July 5-7: Erie cruise R/V Gibraltar III
July 12-14: Superior cruise R/V Blue Heron (BH22-11)
Aug 14-16: Lake Superior cruise R/V Blue Heron (BH22-15)
Aug 20-24: Lake Erie cruise R/V Blue Heron (BH22-15)
Oct 3-5: Erie cruise R/V Gibraltar III
Oct 10-12: Superior cruise R/V Blue Heron (BH22-26)

2023 Cruises

May 23-25: Superior cruise R/V Blue Heron (BH23-04)
May 31-June1: Erie cruise R/V Gibraltar III
July 6-9: Superior cruise R/V Blue Heron (BH23-07)
July 12-13: Erie cruise R/V Gibraltar III
Aug 15-17: Superior cruise R/V Blue Heron (BH23-10)
Aug 21-25: Erie cruise R/V Blue Heron (BH23-10)
Oct 10-13: Superior cruise R/V Blue Heron (BH23-21)

2024 Cruises

May 1-16: Erie cruise R/V Gibraltar III

Data Processing Description

In exporting the raw data, the 1m binned data from the SeaBird Model 911 plus CTD profiler was used, but it was not processed beyond converting the ASC2.asc files into usable Excel formatting.

BCO-DMO Processing Description

- Imported "CyanosNSF Great Lakes Master Spreadsheet.xlsx", sheet 1 into the BCO-DMO system
- Renamed parameter names to comply with BCO-DMO guidelines, removing special characters and units
- Combined year and month into Year_Month in ISO 8601 format
- Combined Year_Month and day into Date in ISO 8601 format
- Combined Date and time into ISO_DateTime_UTC in ISO 8601 format
- Remove extra temporal fields
- Replaced comma with period on row 1387 of Chlorophyll_a_RFU
- Exported file as "967649_v1_ctd_sonde_great_lakes.csv"

Problem Description

While this is not an issue, the Sonde data does not include some of the data types collected by the CTD profiler and the CTD profiler does not include some of the data types collected by the Sonde. Additionally, the Chlorophyll-a(ug/L), Chlorophyll-a(RFU), Pressure(PSI), and Phyco(RFU) data is not included with each Sonde dataset due to a shift in data focus.

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Data Files

File	
967649_v1_ctd_sonde_great_lakes.csv	(Comma Separated Values (.csv), 518.54 KB) MD5:22933fe7741047898cddabb72b9dce7a
Primary data file for dataset ID 967649, version 1	

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Supplemental Files

File	
967649_ctd_raw_data.zip	(ZIP Archive (ZIP), 80.12 MB) MD5:7de7814847c20fdf470663d867071b82
Zip file containing raw CTD data files	
967649_ctd_raw_data_inventory.tsv	(Tab Separated Values (.tsv), 20.25 KB) MD5:7c727f27216483524f0d38bc2a7e8e4c
Inventory of raw CTD data files with size and checksum information	

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Parameters

Parameter	Description	Units
Year_Month	Month of data collection	unitless
Date	Date of date collection	unitless
ISO_DateTime_UTC	Datetime of data collection in UTC	unitless
Lake	Lake where data was collected	unitless
Site	Site ID of data collection	unitless
Latitude	Physical location of CTD/Sonde, North is positive	decimal degrees
Longitude	Physical location of CTD/Sonde, West is negative	decimal degrees
Depth	Depth of CTD or sonde	Meters (m)
Pressure_Digiquartz	Pressure at CTD depth	Decible (db)
Temperature	Temperature of the water at CTD or sonde depth	Degrees C
Conductivity	Conductivity of the water at CTD depth	MicroSiemens per centimeter (µS/cm)
Specific_Conductance	Conductivity of the water at CTD or sonde depth normalized to a standardized temperature (25C)	MicroSiemens per centimeter (µS/cm)
Salinity_Practical	Salt content of water at CTD depth	Practical Salinity Unit (PSU)
Fluorescence_WET_Labs_WETstar	Concentration of Pigments at CTD depth	Milligram per meter cubed (mg/m3)
Oxygen_SBE_43_mg_l	Oxygen concentration at CTD or sonde depth	Milligram per liter (mg/L)
Oxygen_SBE_43_pct_saturation	Oxygen concentration at CTD or sonde depth	Percent (%)
Fluorescence_WET_Labs_CDOM	Concentration of colored dissolved organic matter at CTD depth	Milligram per meter cubed (mg/m3)

Beam_Transmission_WET_Labs_C_Star	Absorbance properties of water at CTD depth	Percent (%)
PAR_Irradiance_Biospherical_Licor	Measures Photosynthetically Available Radiation at CTD depth	µEinsteins/m2/s
Oxidation_Reduction_Potential	The redox conditions of the water at CTD depth	Millivolts (mV)
pH	pH from CTD or Sonde	pH scale
Descent_Rate	Speed with which the CTD decended through the water column	Meters per second (m/s)
Time_Elapsed	Length of CTD deployment at CTD depth	Seconds (s)
Altimeter	Altitude; relationship of CTD to sea level	Meters (m)
Flag	CTD Issue detection system	unitless
Chlorophyll_a_ug_L	The quantity of chlorophyll at sonde depth	micrograms per liter (ug/L)
Chlorophyll_a_RFU	The quantity of chlorophyll at sonde depth	Relative Fluorescence Units (RFU)
Pressure_PSI	Water Pressure measured at sonde depth	PSI
Turbidity	The measure of relative clarity of a liquid at sonde depth	Nephelometric Turbidity Unit (NTU)
Phyco_RFU	Concentration of phycocyanin pigment at sonde depth	Relative Fluorescence Units (RFU)

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Instruments

Dataset-specific Instrument Name	SeaBird Model 911 plus CTD profiler
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	At each site, the SeaBird Model 911 plus CTD profiler was moved over the site using the A-frame at the rear of the R/V Blue Heron.
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	8L Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Once at the bottom of the water column, the profiler was then raised back through the water column. During this process, the profiler was stopped at select water depths based on the site. This was done so the onboard 8L Niskin bottles could be used to collect the water at the selected sites. For each site, several casts of the profiler were necessary to collect the desired amount of water.
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	Eureka Manta 2 Sonde
Generic Instrument Name	Water Quality Multiprobe
Dataset-specific Description	At each site, the Eureka Manta 2 Sonde was placed into the water off the side of the R/V Gibraltar III.
Generic Instrument Description	An instrument which measures multiple water quality parameters based on the sensor configuration.

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Deployments

BH21-02

Website	https://www.bco-dmo.org/deployment/968531
Platform	R/V Blue Heron
Start Date	2021-05-12
End Date	2021-05-13
Description	Great Lakes Cyanos

BH21-09

Website	https://www.bco-dmo.org/deployment/968534
Platform	R/V Blue Heron
Start Date	2021-08-10
End Date	2021-08-12
Description	Great Lakes Cyanos

BH21-10

Website	https://www.bco-dmo.org/deployment/968537
Platform	R/V Blue Heron
Start Date	2021-08-19
End Date	2021-08-31
Description	Great Lakes Cyanos

BH21-20

Website	https://www.bco-dmo.org/deployment/968539
Platform	R/V Blue Heron
Start Date	2021-10-18
End Date	2021-10-20
Description	Great Lakes Cyanos

BH22-05

Website	https://www.bco-dmo.org/deployment/968542
Platform	R/V Blue Heron
Start Date	2022-05-25
End Date	2022-05-27
Description	Great Lakes Cyanos 2022

BH22-15

Website	https://www.bco-dmo.org/deployment/968551
Platform	R/V Blue Heron
Start Date	2022-08-16
End Date	2022-09-01
Description	Great Lakes Cyanos 2022

BH22-26

Website	https://www.bco-dmo.org/deployment/968556
Platform	R/V Blue Heron
Start Date	2022-10-10
End Date	2022-10-12
Description	Great Lakes Cyanos 2022

BH23-04

Website	https://www.bco-dmo.org/deployment/968563
Platform	R/V Blue Heron
Start Date	2023-05-23
End Date	2023-05-26
Description	Cyanobacteria, Nitrogen Cycling, and Export Production

BH23-07

Website	https://www.bco-dmo.org/deployment/968568
Platform	R/V Blue Heron
Start Date	2023-07-06
End Date	2023-07-08
Description	Sinking and Suspended Microplastic Particles in Lake Superior

BH23-10

Website	https://www.bco-dmo.org/deployment/968574
Platform	R/V Blue Heron
Start Date	2023-08-15
End Date	2023-08-20

BH23-21

Website	https://www.bco-dmo.org/deployment/968577
Platform	R/V Blue Heron
Start Date	2023-10-10
End Date	2023-10-12
Description	Cyanobacteria, Nitrogen Cycling, and Export Production

BH22-11

Website	https://www.bco-dmo.org/deployment/982678
Platform	R/V Blue Heron
Start Date	2022-07-12
End Date	2022-07-14
Description	Great Lakes Cyanos 2022

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Project Information

Collaborative Research: Cyanobacteria, Nitrogen Cycling, and Export Production in the Laurentian Great Lakes (Cyanos Great Lakes)

Coverage: Lake Superior and Lake Erie

NSF Award Abstract:
The Great Lakes hold about 20% of the freshwater on Earth and have been increasingly impacted by human activities in recent decades. Lake Erie suffers from large, annually recurring, toxic cyanobacterial blooms in summer, whereas Lake Superior experiences smaller, localized cyanobacterial blooms after storm events. Cyanobacterial blooms have harmful ecological, human health, and economic implications. These blooms are a global phenomenon, observed in lakes and oceans, and can lead to low oxygen conditions and the production of toxins, both of which can be harmful for ecosystems. Understanding how different types of cyanobacteria influence nutrient cycling remains a major knowledge gap. This project aims to provide a deeper understanding of the long-term state of the Great Lakes ecosystem. The research approach combines new and established methods. Project results and implications will be shared with local and regional water interests in partnership with the Pittsburgh Collaboratory for Water Research, Education, and Outreach, the Great Lakes Commission Harmful Algal Blooms Collaborative, and the Lake Erie Area Research Network. Education is a central part of this project and training opportunities target next generation of scientists, including postdoctoral, graduate, and undergraduate students. The students and postdoc will receive state-of-the-art training in the rapidly developing fields of biogeochemistry and geomicrobiology, while working with an interdisciplinary team of scientists.

This study will examine nitrogen cycling, phytoplankton community composition, and the nitrogen isotopic composition of chloropigments in order to evaluate cyanobacterial productivity in the modern Laurentian Great Lakes as well as the historical record of cyanobacterial blooms over the past several hundred years. The nitrogen isotope composition of chloropigments is expected to provide a powerful new proxy for understanding primary productivity and the relative importance of cyanobacteria to export production and nitrogen cycling. This proxy would be valuable not only for management of modern systems but has important implications for increasing our understanding of the role of cyanobacteria throughout Earth history. This project would test this molecular isotopic proxy in contemporary aquatic ecosystems to assess its efficacy for: (1) determining the relative contributions of cyanobacteria vs eukaryotic algae (e.g., diatoms) to primary production; (2) evaluating export production of cyanobacterial productivity (including blooms); and (3) constraining historical cyanobacteria productivity in the sedimentary record. Comparison of a system characterized by eutrophication and seasonal cyanobacterial blooms (Lake Erie) with one characterized by picocyanobacteria productivity, but the near-absence of large-scale cyanobacterial blooms (Lake Superior), will provide information about the range of impacts that cyanobacteria can have on carbon and nitrogen cycling. Further information regarding nitrogen cycling will be derived from analysis of solid and dissolved nitrogen species throughout the annual cycle, as well as seasonal studies of sediment processes to measure associated sediment nitrogen removal rates through different processes.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1948787
NSF Division of Ocean Sciences (NSF OCE)	OCE-1948739
NSF Division of Ocean Sciences (NSF OCE)	OCE-1948646
NSF Division of Ocean Sciences (NSF OCE)	OCE-1948058

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