Environmental YSI EXO1 Sonde Probe data from Orcas Island, WA, USA Coastal Ocean (2m depth) from 2021-05-27 to 2021-06-18

Website: https://www.bco-dmo.org/dataset/984153
Data Type: Other Field Results
Version: 1
Version Date: 2025-09-10

Project
» Collaborative Research: Rhythm and Blooms: Deciphering metabolic, functional and taxonomic interactions over the life cycle of a phytoplankton bloom (Rhythm and Blooms)

Contributors	Affiliation	Role
Kubanek, Julia	Georgia Institute of Technology (GA Tech)	Principal Investigator
Nunn, Brook L.	University of Washington (UW)	Principal Investigator
Rynearson, Tatiana A.	University of Rhode Island (URI)	Principal Investigator
Mudge, Miranda	University of Washington (UW)	Scientist
Timmins-Schiffman, Emma	University of Washington (UW)	Scientist, Data Manager
Bartlett, Evelyn	University of Washington (UW)	Student
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset contains environmental YSI EXO1 Sonde Probe data from Orcas Island, WA, USA Coastal Ocean (2m depth) from 5/27/21 to 6/18/21 collected as part of the following study. Study abstract Floating, single-celled algae, or phytoplankton, form the base of marine food webs. When phytoplankton have sufficient nutrients to grow quickly and generate dense populations, known as blooms, they influence productivity of the entire food web, including rich coastal fisheries. The present research explores how the environment (nutrients) as well as physical and chemical interactions between individual cells in a phytoplankton community and their associated bacteria act to control the timing of bloom events in a dynamic coastal ecosystem. The work reveals key biomolecules within the base of the food web that can inform food web functioning (including fisheries) and be used in global computational models that forecast the impacts of phytoplankton activities on global carbon cycling. A unique set of samples and data collected in 2021 and 2022 that captured phytoplankton and bacterial communities before, during, and after phytoplankton blooms, is analyzed using genomic methods and the results are used to interrogate these communities for biomolecules associated with blooms stages. The team mentors undergraduates, graduate students, and postdoctoral researchers in the fields of biochemical oceanography, genome sciences, and time-series multivariate statistics. University of Washington organized hackathons to develop publicly accessible portals for the simplified interrogation and visualization of 'omics data, accessible to high schoolers and undergraduates. These portals are implemented in investigator-led undergraduate teaching modules in the University of Rhode Island Ocean Classroom. The research team also returns to Orcas Island, WA, where the field sampling takes place, to host a series of annual Science Weekends to foster scientific engagement with the local community. Phytoplankton blooms, from initiation to decline, play vital roles in biogeochemical cycling by fueling primary production, influencing nutrient availability, impacting carbon sequestration in aquatic ecosystems, and supporting secondary production. In addition to influences from environmental conditions, the physical and chemical interactions among planktonic microbes can significantly modulate blooms, influencing the growth, maintenance, and senescence of phytoplankton. Recent work in steady-state open ocean ecosystems has shown that important chemicals are transferred amongst plankton on time-dependent metabolic schedules that are related to diel cycles. It is unknown how these metabolic schedules operate in dynamic coastal environments that experience perturbations, such as phytoplankton blooms. Here, the investigators are examining metabolic scheduling using long-term, diel sample sets to reveal how chemical and biological signals associated with the initiation, maintenance, and cessation of phytoplankton blooms are modulated on both short (hrs) and long (days-weeks) time scales. Findings are advancing the ability to predict and manage phytoplankton dynamics, providing crucial insights into ecological stability and future oceanographic sampling strategies. Additionally,

outcomes of this study are providing a new foundational understanding of the succession of microbial communities and their chemical interactions across a range of timescales. In the long term, this research has the potential to identify predictors of the timing of phytoplankton blooms, optimize fisheries management, and guide future research on carbon sequestration.

Table of Contents

Coverage

Location: Coastal waters, East Sound, WA, USA, depth 2 m
Spatial Extent: **Lat**:48.6765 **Lon**:-122.883233
Temporal Extent: 2021-05-27 - 2021-06-18

Dataset Description

Additional funding description:
This dataset was supported by NSF OCE-2401646, OCE-2401645, OCE-2401644, University of Washington Royalty Research Fund, NIH NIEHS grant R21ES034337-01, NSF IOS-2041497, NIH fellowship F31 ES032733-01A1

Methods & Sampling

A HOBO data logger (HOBO Pendant MX Temperature/Light Data Logger) was also deployed at the site to conduct constant measures of depth, temperature, and light (luminosity/ft^2).

An EXO1 Multiparameter Sonde (YSI) was deployed at the collection site at a constant depth of 2 m and set to collect *in situ* measurements every 10 minutes. The probe had four probe-ports which were fitted with sensors (YSI) to measure conductivity/temperature (YSI EXO Conductivity and Temperature Smart Sensor, SKU 599870), dissolved oxygen (EXO Optical Dissolved Oxygen Smart Sensor, SKU 599100-01), pH (EXO pH Smart Sensor, SKU 577601), and Total Algae (Chlorophyll, Phycocyanin, Phycoerythrin; EXO Total Algae PE Smart Sensor, SKU 599103-01). Data from the probe was manually downloaded each day at 14:00 before redeployment and the probe was calibrated every 5 days. The Total Algae sensor covers a range of 0.1 to 400 $\mu g\,L^{-1}$ (0 to 100 RFU), with a detection limit of ~0.1 $\mu g\,L^{-1}$, and a resolution of 0.1 $\mu g\,L^{-1}$ Chl (0.1% RFU). Total algae measurements taken every 10 minutes were plotted as chlorophyll *a* concentrations in $\mu g\,L^{-1}$

Methodology is from the results paper Nunn et al. (2024, doi:10.1038/s41597-024-04013-5).

Data Processing Description

Total nutrient analysis was performed in triplicate by the University of Washington Marine Chemistry Lab to determine concentrations of nitrate, nitrite, ammonium, silicate, and phosphate following standard methods outlined in UNESCO, 1994.

Data processing is from the results paper Nunn et al. (2024, doi:10.1038/s41597-024-04013-5).

BCO-DMO Processing Description

* Sheet 1 of submitted file "Nunn_OrcasIsland_Data_Probe.xlsx" was exported as csv and imported into the BCO-DMO data system for this dataset. Table will appear as Data File: 984153_v1_probe.csv (along with other download format options).

Missing Data Identifiers:
* In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]

* Local Date_PT column was converted to ISO 8601 format. (no time zone change).
* Column DateTime renamed "DateID_PT" for consistency with other datasets in the project.
* Additional column ISO_DateTime_UTC added from Date and Time (local US/Pacific timezone) columns.

[table of contents | back to top]

Data Files

File
984153_v1_probe.csv(Comma Separated Values (.csv), 491.79 KB) MD5:8ad424b800b9119813143d3a2aec6872 Primary data file for dataset ID 984153, version 1

[table of contents | back to top]

Related Publications

Mudge, M. C., Riffle, M., Chebli, G., Plubell, D. L., Rynearson, T. A., Noble, W. S., Timmins-Schiffman, E., Kubanek, J., & Nunn, B. L. (2025). Harmful algal blooms are preceded by a predictable and quantifiable shift in the oceanic microbiome. Nature Communications, 16(1). https://doi.org/10.1038/s41467-025-59250-y
Results

Nunn, B. L., Timmins-Schiffman, E., Mudge, M. C., Plubell, D. L., Chebli, G., Kubanek, J., Riffle, M., Noble, W. S., Harvey, E., Nunn, T. A., Rynearson, T., Huntemann, M., LaButti, K., Foster, B., Roux, S., Palaniappan, K., Mukherjee, S., Reddy, T. B. K., … Eloe-Fadrosh, E. A. (2024). Microbial Metagenomes Across a Complete Phytoplankton Bloom Cycle: High-Resolution Sampling Every 4 Hours Over 22 Days. Scientific Data, 11(1). https://doi.org/10.1038/s41597-024-04013-5
Results

[table of contents | back to top]

Related Datasets

IsRelatedTo

L. Nunn, B., Timmins-Schiffman, E., Mudge, M. C., Plubell, D. L., Chebli, G., Kubanek, J., Riffle, M., Noble, W. S., Harvey, E., Nunn, T., Huntemann, M., Clum, A., Foster, B., Foster, B., Roux, S., Palaniappan, K., Mukherjee, S., Reddy, T. B. K., Daum, C., … Eloe-Fadrosh, E. A. (2024). *Microbial Metagenomes across a Full Phytoplankton Bloom: High-Resolution Sampling Every 4 Hours for 22 Days* [Data set]. figshare.

https://doi.org/10.6084/M9.FIGSHARE.26882737 https://doi.org/10.6084/m9.figshare.26882737

Nunn, B, & Timmins-Schiffman, E. (2025). Nunn-Lab/Publication-2021-Orcas-Island-Time-Series: Nat.Comm Harmful algal blooms are preceded by a predictable and quantifiable shift in the oceanic microbiome (Orcas_metaproteomics). Zenodo. https://doi.org/10.5281/zenodo.14976385

Nunn, B. L., Kubanek, J., Rynearson, T. A., Timmins-Schiffman, E., Mudge, M., Bartlett, E. (2025) **Flow cytometry data from samples collected from Orcas Island, WA, USA Coastal Ocean (2m depth) every four hours from 2021-05-28 to 2021-06-18.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-09-09 doi:10.26008/1912/bco-dmo.984014.1 [view at BCO-DMO]
Relationship Description: These data were used in results publications from this project Nunn et al (2024, doi: 10.1038/s41597-024-04013-5) and Mudge et al. (2025, doi: 10.1038/s41467-025-59250-y).

Nunn, B. L., Kubanek, J., Rynearson, T. A., Timmins-Schiffman, E., Mudge, M., Bartlett, E. (2025) **Metagenomic sample information, genetic accession identifiers (NCBI SRA, JGI IMG), and estimated gene copies from Orcas Island coastal waters (2 m depth) from 2021-05-27 to 2021-06-18.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-09-10 doi:10.26008/1912/bco-dmo.984169.1 [view at BCO-DMO]
Relationship Description: These data were used in results publications from this project Nunn et al (2024, doi: 10.1038/s41597-024-04013-5) and Mudge et al. (2025, doi: 10.1038/s41467-025-59250-y).

Nunn, B. L., Kubanek, J., Rynearson, T. A., Timmins-Schiffman, E., Mudge, M., Bartlett, E. (2025) **Nutrient data for samples collected every 4 hours from Orcas Island, WA, USA Coastal Ocean (2m depth) during the period from 2021-05-27 to 2021-06-18.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-09-09 doi:10.26008/1912/bco-dmo.984065.1 [view at BCO-DMO]
Relationship Description: These data were used in results publications from this project Nunn et al (2024, doi: 10.1038/s41597-024-04013-5) and Mudge et al. (2025, doi: 10.1038/s41467-025-59250-y).

[table of contents | back to top]

Parameters

Parameter	Description	Units
Date_PT	Contains date of sample collection. Local time zone US/Pacific (PST/PDT).	unitless
Time_PT	Contains time of sample collection. Local time zone US/Pacific (PST/PDT).	unitless
DateID_PT	Character value for the combined date and time of sample collection. Local time zone US/Pacific (PST/PDT).	unitless
ISO_DateTime_UTC	Contains DateTime with timezone of sample collection in ISO 8601 format (UTC time zone).	unitless
Chlorophyll_RFU	chlorophyll relative fluorescence units	relative fluorescence units (RFU)
Chlorophyll_conc	Chlorophyll concentration	micrograms per liter (ug/L)
Conductivity	electrical conductivity of sample	microSiemens per centimeter (uS/cm)
Depth	depth the sample was collected at	meters (m)
ODO_sat	optical dissolved oxygen percent saturation	percent (%)
ODO_conc	optical dissolved oxygen concentration	milligrams per liter (mg/L)
Sal	salinity	Practical Salinity Units (PSU)
pH	pH	pH scale
Temp	temperature	degrees celsius
Latitude	Latitude sample was collected at	decimal degrees
Longitude	Longitude sample was collected at	decimal degrees

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	HOBO Pendant MX Temperature/Light Data Logger
Generic Instrument Name	Onset HOBO Pendant Temperature/Light Data Logger
Dataset-specific Description	A HOBO data logger (HOBO Pendant MX Temperature/Light Data Logger) was also deployed at the site to conduct constant measures of depth, temperature, and light (luminosity/ft2).
Generic Instrument Description	The Onset HOBO (model numbers UA-002-64 or UA-001-64) is an in-situ instrument for wet or underwater applications. It supports light intensity, soil temperature, temperature, and water temperature. A two-channel logger with 10-bit resolution can record up to approximately 28,000 combined temperature and light measurements with 64K bytes memory. It has a polypropylene housing case. Uses an optical USB to transmit data. A solar radiation shield is used for measurement in sunlight. Temperature measurement range: -20 deg C to 70 deg C (temperature). Light measurement range: 0 to 320,000 lux. Temperature accuracy: +/- 0.53 deg C from 0 deg C to 50 deg C. Light accuracy: Designed for measurement of relative light levels. Water depth rating: 30 m.

Dataset-specific Instrument Name	
Generic Instrument Name	YSI EXO multiparameter water quality sondes
Dataset-specific Description	EXO1 Multiparameter Sonde (YSI) with the following sensors: YSI EXO Conductivity and Temperature Smart Sensor, SKU 599870 EXO Optical Dissolved Oxygen Smart Sensor, SKU 599100-01 EXO pH Smart Sensor, SKU 577601 Chlorophyll, Phycocyanin, Phycoerythrin; EXO Total Algae PE Smart Sensor, SKU 599103-01 The Total Algae sensor covers a range of 0.1 to 400 µg L−1 (0 to 100 RFU), with a detection limit of ~0.1 µg L−1, and a resolution of 0.1 µg L−1 Chl (0.1% RFU).
Generic Instrument Description	Comprehensive multi-parameter, water-quality monitoring sondes designed for long-term monitoring, profiling and spot sampling. The EXO sondes are split into several categories: EXO1 Sonde, EXO2 Sonde, EXO3 Sonde. Each category has a slightly different design purpose with the EXO2 and EXO3 containing more sensor ports than the EXO1. Data are collected using up to four user-replaceable sensors and an integral pressure transducer. Users communicate with the sonde via a field cable to an EXO Handheld, via Bluetooth wireless connection to a PC, or a USB connection to a PC. Typical parameter specifications for relevant sensors include dissolved oxygen with ranges of 0-50 mg/l, with a resolution of +/- 0.1 mg/l, an accuracy of 1 percent of reading for values between 0-20 mg/l and an accuracy of +/- 5 percent of reading for values 20-50 mg/l. Temp ranges are from-5 to +50 degC, with an accuracy of +/- 0.001 degC. Conductivity has a range of 0-200 mS/cm, with an accuracy of +/-0.5 percent of reading + 0.001 mS/cm and a resolution of 0.0001 - 0.01 mS/cm.

[table of contents | back to top]

Project Information

Collaborative Research: Rhythm and Blooms: Deciphering metabolic, functional and taxonomic interactions over the life cycle of a phytoplankton bloom (Rhythm and Blooms)

Coverage: Coastal waters East Sound WA

NSF Award Abstract:

Floating, single-celled algae, or phytoplankton, form the base of marine food webs. When phytoplankton have sufficient nutrients to grow quickly and generate dense populations, known as blooms, they influence productivity of the entire food web, including rich coastal fisheries. The present research explores how the environment (nutrients) as well as physical and chemical interactions between individual cells in a phytoplankton community and their associated bacteria act to control the timing of bloom events in a dynamic coastal ecosystem. The work reveals key biomolecules within the base of the food web that can inform food web functioning (including fisheries) and be used in global computational models that forecast the impacts of phytoplankton activities on global carbon cycling. A unique set of samples and data collected in 2021 and 2022 that captured phytoplankton and bacterial communities before, during, and after phytoplankton blooms, is analyzed using genomic methods and the results are used to interrogate these communities for biomolecules associated with blooms stages. The team mentors undergraduates, graduate students, and postdoctoral researchers in the fields of biochemical oceanography, genome sciences, and time-series multivariate statistics. University of Washington organized hackathons develop publicly accessible portals for the simplified interrogation and visualization of 'omics data by high schoolers and undergraduates and are implemented in investigator-led undergraduate teaching modules and the University of Rhode Island Ocean Classroom. The research team also returns to Orcas Island, WA, where the field sampling takes place, to host a series of annual Science Weekends to foster scientific engagement with the local community.

Phytoplankton blooms, from initiation to decline, play vital roles in biogeochemical cycling by fueling primary production, influencing nutrient availability, impacting carbon sequestration in aquatic ecosystems, and supporting secondary production. In addition to environmental conditions, the physical and chemical interactions between individual phytoplankton can significantly modulate blooms, influencing the growth, maintenance, and senescence of phytoplankton. Recent work in steady-state open ocean ecosystems has shown that important chemicals are transferred amongst plankton on time-dependent metabolic schedules that are related to diel cycles. It is unknown how these metabolic schedules operate in dynamic coastal environments that experience perturbations, such as phytoplankton blooms. Here, the investigators are examining metabolic scheduling using long-term, diel sample sets to reveal how chemical and biological signals associated with the initiation, maintenance, and cessation of phytoplankton blooms are modulated on both short (hrs) and long (days-weeks) time scales. Findings are advancing the ability to predict and manage phytoplankton dynamics, providing crucial insights into ecological stability and future oceanographic sampling strategies. Additionally, outcomes of this study are providing a new foundational understanding of the succession of microbial communities and their chemical interactions across a range of timescales. In the long term, this research has the potential to identify predictors of the timing of phytoplankton blooms, optimize fisheries management, and guide future research on carbon sequestration.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2401646
NSF Division of Ocean Sciences (NSF OCE)	OCE-2401645
NSF Division of Ocean Sciences (NSF OCE)	OCE-2401644
National Institute of Environmental Health Sciences (NIEHS)	R21ES034337-01
NSF Division of Integrative Organismal Systems (NSF IOS)	IOS-2041497
National Institutes of Health (NIH)	ES032733-01A1

[table of contents | back to top]