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

Website: https://www.bco-dmo.org/dataset/984065
Data Type: Other Field Results
Version: 1
Version Date: 2025-09-09

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
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Timmins-Schiffman, Emma	University of Washington (UW)	Scientist, Data Manager
Bartlett, Evelyn	University of Washington (UW)	Student
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Abstract
This dataset contains nutrient data for samples collected every 4 hours from Orcas Island, WA, USA Coastal Ocean (2m depth) during the period 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.

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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

Water samples for nutrients were collected by rinsing a 1 L Pyrex media bottle and a 60 mL HDPE syringe in triplicate with whole water. From a fresh collection of 1 L, we filtered 50 mL whole water using the cleaned syringe through a 25 mm 0.45 µm cellulose syringe filter (Nalgene, surfactant-free). Filtered water samples were collected in triple-rinsed 50 mL HDPE bottles and stored immediately at −20 °C. Bottles were transferred to the University of Washington for long-term storage at −20 °C.

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 (doi: 10.25607/obp-1409).

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_Nutrients.xlsx" was exported as csv and imported into the BCO-DMO data system for this dataset. Table will appear as Data File: 984065_v1_nutrients.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.
* After consulting with the data submitter, an issue was corrected with minutes mismatching between time and datetime fields. Some DateID_PT values had minutes as :01 where they all should have been :00.
Example correction: DateID_PT "5/28/2021 17:01" -> "5/28/2021 17:00" (matching Time_PT 17:00).
* Additional column ISO_DateTime_UTC added from Date and Time (local US/Pacific timezone) columns.

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Data Files

File	
984065_v1_nutrients.csv	(Comma Separated Values (.csv), 12.60 KB) MD5:e15d0e183bed1a5f737beb418fcb1a75
Primary data file for dataset ID 984065, version 1	

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Related Publications

Intergovernmental Oceanographic Commission (1994) Protocols for the Joint Global Ocean Flux Study (JGOFS) Core Measurements. Paris, France, UNESCO-IOC, 170pp. (Intergovernmental Oceanographic Commission Manuals and Guides: 29), (JGOFS Report; 19). DOI: https://doi.org/10.25607/OBP-1409
Methods

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

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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) **Environmental YSI EXO1 Sonde Probe data from Orcas Island, WA, USA Coastal Ocean (2m 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.984153.1 [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) **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).

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Parameters

Parameter	Description	Units
Date_PT	date the sample was collected. Local time zone US/Pacific (PST/PDT).	unitless
Time_PT	time the sample was collected. 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
Phosphate_Concentration	Phosphate concentrations	millimolar (mM)
Silicate_Concentration	Silicate concentrations	millimolar (mM)
Nitrate_Concentration	Nitrate concentrations	millimolar (mM)
Nitrite_Concentration	Nitrite concentrations	millimolar (mM)
Ammonium_Concentration	Ammonium concentrations	millimolar (mM)
Latitude	Latitudinal coordinate of where sample was collected	decimal degrees
Longitude	Longitudinal coordinate of where sample was collected	decimal degrees

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Instruments

Dataset-specific Instrument Name	HDPE bottles
Generic Instrument Name	High density polyethylene water bottle
Generic Instrument Description	A high density polyethylene (HDPE) water bottle. Often used for surface sampling from small boats. HDPE has a somewhat higher chemical resistance than low density polyethylene (LDPE). HDPE is also somewhat harder and more opaque and it can withstand higher temperatures (120 degrees Celsius for short periods, 110 degrees Celsius continuously).

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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.

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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

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