Dissolved nutrient data from samples collected from 1998 through 2025 from the surface waters of Tatoosh Island, Makah Reservation, Washington, USA

Website: https://www.bco-dmo.org/dataset/1004161
Data Type: Other Field Results
Version: 1
Version Date: 2026-08-11

Project
» The role of microbes in driving productivity and carbon fixation in seaweeds (kelp and their microbiome)

Contributors	Affiliation	Role
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Abstract
To better understand the interplay of water nutrient availability and the dynamics of the local shoreline biota, nutrient samples were collected from the surface waters of Tatoosh Island, Makah Reservation, Washington, USA, typically at monthly intervals, during spring and summer from August 1998 to August 2025. Samples were collected regularly from 10 sites around the periphery of the island, and from 4 sites at increasing distances from the island following spring tides. Additional data were collected adjacent to a site with high-resolution sampling of water conditions in 2001, 2015, 2016 and 2022. Samples were filtered through GF/F filter paper, frozen, and shipped to the University of Washington Marine Chemistry Laboratory for analysis of NO3, NO2, NH4, PO4, and Si(OH)4. The data provide a picture of long-term nutrient dynamics in the eastern Pacific Ocean at the entry to the Strait of Juan de Fuca.

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Coverage

Location: Northeastern Pacific surface waters adjacent to Tatoosh Island, Makah Reservation, Washington, USA
Spatial Extent: **N**:48.39518 **E**:-124.71266 **S**:48.38962 **W**:-124.74557
Temporal Extent: 1998-08-24 - 2025-08-23

Methods & Sampling

All censusing was done from shore or with small boats. Sampling stations were established on the shoreline of Tatoosh Island and adjacent offshore sites to the east of the island beginning in August 1998. Seven of the sites (Finger, Glacier Control, Hedophyllum Cove, Ladd's Finger, Simon's Landing, Strawberry Point, Toad Point) corresponded to wave-exposed shores on the periphery of the island used in a prior nutrient manipulation

experiment (Wootton et al. 1996), and an eighth (Northwest Point) was another wave-exposed shore selected to expand peripheral coverage of the island. Two additional relatively wave-sheltered sites were also added to the sampling, both located inside extensive kelp beds: Main Beach and Strawberry Draw. Water at all these sites was collected 2-3 hours after a strong spring tide on a day when the investigators were departing from the island to facilitate rapid sample freezing. Water samples were collected in 2001, 2015, 2016, and 2022 at an additional shoreline site (Hydrolab Pool) subject to intensive sampling of ocean conditions. In 2000, four offshore sampling sites were established at varying distances from the island (Inside Kelp, ~30 meters (m); Outside Kelp, ~100 m; Gut, ~0.6 kilometers (km); Mushroom Rocks, ~ 1.8 km from island, ~0.5 km from the mainland). Water at the offshore sites was collected by boat approximately 4-5 hours after the tide. Water was extracted from the ocean at the surface using 50-milliliter (mL) syringes, which were first rinsed in the water at the site before a sample was drawn. The sample was then pushed through a syringe filter loaded with a disk of Whatman GF/F glass fiber filter paper, and collected in 40 mL acid-washed Nalgene bottles, leaving enough headspace to allow water expansion when frozen.

Water samples were kept in coolers following collection and immediately frozen at -20 degrees Celsius upon return to the mainland field base. Frozen water samples were express shipped to the University of Washington Ocean Chemistry Laboratory, where they were analyzed following the methods outlined in (UNESCO 1994) using a Seal Analytical AA3 nutrient autoanalyzer. In 2025, the analysis of samples from all dates/sites was carried out by the Moss Landing Marine Laboratory Environmental Analytical Laboratory, by colorimetric analysis using a Lachat QuickChem 8000 Flow Injection Analyzer and 50 mL Falcon Tubes as sample containers. We sent duplicate samples from 29 May 2025 and 23 August 2025 to the University of Washington Marine Chemistry Laboratory for comparative purposes.

Data Processing Description

No significant data processing, except in 2025, where relationships between University of Washington and Moss Landing labs were developed and data transformed following these relationships to make Moss Landing analyzed samples more equivalent to University of Washington samples for sample dates without University of Washington lab analysis. The relationships were derived from linear regression on log-transformed data of University of Washington nutrient data on Moss Landing nutrient data for each nutrient considered.

BCO-DMO Curation Notes

- Imported the original file "Tatoosh Water Nutrients Long BCODMO.csv" into the BCO-DMO data processing system.
- Renamed column Si(OH)4 to SiOH4 to comply with BCO-DMO naming conventions.
- Converted Date and Time columns (parsed as %Y-%m-%d and %H:%M respectively) into new datetime column ISO_DateTime_Local, formatted as %Y-%m-%dT%H:%M.
- Converted Date and Time columns (local Pacific time, PST8PDT) into a new datetime column ISO_DateTime_UTC, converting to UTC and formatted as %Y-%m-%dT%H:%MZ.
- Saved the final file as "1004161_v1_tatoosh_island_nutrient_data.csv".

Problem Description

This dataset does not cover conditions from mid-September to the following April or May. Offshore sampling did not start until 2000. With the exception of samples from the Hydrolab Pool (limited to 2001, 2015, 2016, 2022), sampling only occurred once per month at the same tidal stage, so the data largely do not provide detailed information on nutrient dynamics on a daily time scale. Due to limited funding and an interest in expanding the temporal resolution of sampling, in 2022 we stopped sampling from Glacier Control, Ladd's Fingers, Northwest Point, Strawberry Draw, Toad Point, and the Gut sites. Sometimes a sample was lost at some point in the analysis chain. Occasionally there are large outliers, particularly for the Main Beach site. Some of these were episodes associated with known incursions of large groups of sea lions onto shore in the vicinity of this site. For most uses, data labeled with Lab column "ML" are probably best excluded from analyses. Data collected in 2025 were sent to the Moss Landing Marine Laboratory Environmental Analytical Laboratory, with a subset also sent to the University of Washington Marine Chemistry Laboratory. We found substantial deviations between the two measures, which need to be accounted for if these data are used. For consistency with the bulk of the data series, we recommend that these data from MLML be converted to match UW data or

omitted.

The dataset contains the matched samples from the two laboratories, untransformed to allow development of this relationship. We used linear regression on log-transformed data (avoids estimates <0) to estimate a correction relationship from MLML to UW scales, and report these estimates, rather than raw estimates, for MLML data without a paired UW sample. For consistency, the paired untransformed MLML data should probably be omitted when UW data are available too.

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Data Files

File	
1004161_v1_tatoosh_island_nutrient_data.csv	(Comma Separated Values (.csv), 225.57 KB) MD5:946c332a8c1902bacf4f918304b9bbac
Primary data file for dataset ID 1004161, version 1	

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Related Publications

Hochroth, A., & Pfister, C. A. (2024). Ammonification by kelp associated microbes increases ammonium availability. Plos One, 19(3), e0296622. https://doi.org/10.1371/journal.pone.0296622
Results

Pfister, C. A., Altabet, M. A., & Weigel, B. L. (2019). Kelp beds and their local effects on seawater chemistry, productivity, and microbial communities. Ecology, 100(10). Portico. https://doi.org/10.1002/ecy.2798
Results

Pfister, C. A., Stanfield, E., Bogan, M., Weigel, B. L., Volbrecht, S., & Scorza, K. (2025). Foundational kelp species reveal links between host traits, the environment and the associated microbial community. Royal Society Open Science, 12(10). https://doi.org/10.1098/rsos.250637
Methods

Pfister, C. A., Wootton, J. T., & Neufeld, C. J. (2007). The relative roles of coastal and oceanic processes in determining physical and chemical characteristics of an intensively sampled nearshore system. Limnology and Oceanography, 52(5), 1767–1775. Portico. https://doi.org/10.4319/lo.2007.52.5.1767
Results
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Methods

UNESCO. 1994. Protocols for the Joint Global Ocean Flux Study (JGOFS) Core Measurements. IOC Manual and Guides Number 29. Paris, France. 129 p.
Methods

Wootton, J. T., & Pfister, C. A. (2012). Carbon System Measurements and Potential Climatic Drivers at a Site of Rapidly Declining Ocean pH. PLoS ONE, 7(12), e53396. https://doi.org/10.1371/journal.pone.0053396
Results

Wootton, J. T., Pfister, C. A., & Forester, J. D. (2008). Dynamic patterns and ecological impacts of declining ocean pH in a high-resolution multi-year dataset. Proceedings of the National Academy of Sciences, 105(48), 18848–18853. https://doi.org/10.1073/pnas.0810079105
Results

Wootton, J. T., Power, M. E., Paine, R. T., & Pfister, C. A. (1996). Effects of productivity, consumers, competitors, and El Niño events on food chain patterns in a rocky intertidal community. Proceedings of the National Academy of Sciences, 93(24), 13855–13858. https://doi.org/10.1073/pnas.93.24.13855
Methods

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Parameters

Parameter	Description	Units
ISO_DateTime_Local	Date and time in the local time zone (PDT) in ISO 8601 format	unitless
ISO_DateTime_UTC	Date and time of sampling converted to UTC in ISO 8601 format	unitless
Date_local	Date of sampling in the local time zone (PDT)	unitless
Time_local	Time of sampling in the local time zone (PDT)	unitless
Site	Name of sampling site	unitless
Latitude	Latitude of sampling site	Decimal degrees N
Longitude	Longitude of sampling site	Decimal degrees W
NO3	Nitrate concentration	micromolar (uM)
NO2	Nitrite concentration	micromolar (uM)
NH4	Ammonium concentration	micromolar (uM)
PO4	Orthophosphate concentration	micromolar (uM)
SiOH4	Silicic Acid concentration	micromolar (uM)
Lab	Analysis laboratory: UW (University of Washington Marine Chemistry Lab), ML (Moss Landing Marine Lab Environmental Laboratory), MLtoUW (Analyzed at Moss Landing, converted to University of Washington measurements)	unitless

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Instruments

Dataset-specific Instrument Name	Lachat QuickChem 8000 Flow Injection Analyzer
Generic Instrument Name	Lachat QuikChem 8000 flow injection analyzer and Ion Chromatography (IC) system
Dataset-specific Description	Analysis was carried out by the University of Washington Marine Chemistry Laboratory using a Seal Analytical AA3 nutrient autoanalyzer, and by the Moss Landing Marine Laboratory Environmental Analytical Laboratory using a Lachat QuickChem 8000 Flow Injection Analyzer.
Generic Instrument Description	The Lachat QuikChem 8000 can operate flow injection analysis and ion chromatography simultaneously and independently on the same instrument platform. Instrument includes sampler, dilutor, sampling pump, electronics unit, and data station. Analysis takes 20-60 seconds, with a sample throughput of 60-120 samples per hour. Measurements are in the range of parts per trillion to parts per hundred.

Dataset-specific Instrument Name	Seal Analytical AA3 nutrient autoanalyzer
Generic Instrument Name	Seal Analytical AutoAnalyser 3HR
Dataset-specific Description	Analysis was carried out by the University of Washington Marine Chemistry Laboratory using a Seal Analytical AA3 nutrient autoanalyzer, and by the Moss Landing Marine Laboratory Environmental Analytical Laboratory using a Lachat QuickChem 8000 Flow Injection Analyzer.
Generic Instrument Description	A fully automated Segmented Flow Analysis (SFA) system, ideal for water and seawater analysis. It comprises a modular system which integrates an autosampler, peristaltic pump, chemistry manifold and detector. The sample and reagents are pumped continuously through the chemistry manifold, and air bubbles are introduced at regular intervals forming reaction segments which are mixed using glass coils. The AA3 uses segmented flow analysis principles to reduce inter-sample dispersion, and can analyse up to 100 samples per hour using stable LED light sources.

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Project Information

The role of microbes in driving productivity and carbon fixation in seaweeds (kelp and their microbiome)

Website: https://pfisterlab.uchicago.edu/basic-page/

Coverage: Northeast Pacific Ocean, coastal Washington state

NSF Award Abstract:
It is increasingly recognized that species in the ocean host a diverse set of microbes and that these microbes can determine the functioning of the host. Yet, the discovery of microbial taxa in nature far outpaces our understanding of their functions. Primary producers in the ocean show rich microbial communities and may contribute to the significant role that macrophytes play in coastal communities. This project focuses on a species of canopy kelp that is a foundational species along the shores of the northeast Pacific Ocean, the bull kelp *Nereocystis luetkeana*. The research explores the role of a diverse set of microbes in association with bull kelp. Using experimental manipulations of newly isolated microbial taxa from kelp, tests of whether interactions are positive, negative, or neutral are performed. Specific assays of whether microbes provision vitamins and enhance access to nutrients are carried out, as well as tests of whether kelp exudates benefit microbial metabolism and growth. Working directly with Tribal youth through an internship program, as well as with

undergraduate, post-baccalaureate, and graduate students, helps train the next generation of ocean scientists. Communication channels with Tribal and State governments inform efforts to understand kelp declines. Host-microbe interactions are a component of the persistence of ocean species and this research informs the factors that underly these relationships.

The advent of DNA sequencing, imaging, and other molecular approaches have revealed that many key species in the ocean are a 'holobiome', and their fate is entwined with the microbes they host. Yet, this discovery of microbial taxa in nature far outpaces our understanding of microbial function. *Nereocystis luetkeana*, or bull kelp, and the bacteria the investigators have isolated from the kelp surface, present an opportunity to quantify host-microbe interactions, including how stressors of host health, such as ocean warming, alter these interactions. Experiments tracing stable nitrogen isotopes and manipulations with hosts and bacterial isolates are used to investigate possible exchanges and the currencies underlying interactions. Metabolomic, proteomic, and genomic analyses are used to quantify host-microbe interactions and linkage between taxa and their functions. Key microbial metabolisms being investigated include nutrient provisioning, vitamin synthesis, and the response to reactive oxygen species, among others. The demonstrated alteration of host-microbe interactions in the ocean when hosts are stressed suggest the findings of this study have application to understanding the factors that promote persistence of eukaryote-prokaryote partnerships.

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-0928232
NSF Division of Ocean Sciences (NSF OCE)	OCE-1851489
NSF Division of Ocean Sciences (NSF OCE)	OCE-0117801
NSF Division of Ocean Sciences (NSF OCE)	OCE-0452687
NSF Division of Environmental Biology (NSF DEB)	DEB-0919420
NSF Division of Environmental Biology (NSF DEB)	DEB-1556874
NSF Division of Ocean Sciences (NSF OCE)	OCE-2329475
National Oceanic and Atmospheric Administration (NOAA)	NOAA-COCA NA16OAR4310155
Washington State Department of Natural Resources (WDNR)	WDNR 93099282
Washington State Department of Natural Resources (WDNR)	WDNR 93100399

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