

Processed CTD depth profile data from Saanich and Tofino inlets in British Columbia, collected in July 2025 from the R/V Rachel Carson (RC0140)

Website: <https://www.bco-dmo.org/dataset/1008244>

Data Type: Cruise Results

Version: 1

Version Date: 2026-09-24

Project

» [Collaborative Research: The effects of SUP05 cells and virocells on nitrogen cycling in marine oxygen minimum zones](#) (SUP05, Viruses, and Nitrogen)

Contributors	Affiliation	Role
Morris, Robert	University of Washington (UW)	Principal Investigator

Abstract

A team of researchers from the University of Washington, Stanford, Florida State University, and the University of Southern Florida were funded by the US National Science Foundation to study the diversity and activity of marine bacteria and their viruses in low dissolved oxygen and anoxic waters. These regions account for only 1% of the ocean by volume, but bacteria in these regions catalyze 30-50% of marine nitrogen loss. Our goal is to enhance understanding of the roles that keystone groups of bacteria and viruses have in nitrogen cycling processes in these waters. Seasonally anoxic fjords off the coast of Vancouver Island in British Columbia are ideal locations to conduct this research. We visited anoxic basins in Saanich Inlet and Tofino Inlet on a research cruise from July 15-27 in 2025. Research activities were conducted from onboard the R/V Rachel Carson using a conductivity, temperature, and density (CTD) instrument equipped with 12, 10 L Niskin bottles and sensors to measure, oxygen, pH, fluorescence, and beam transmission. Samples for chemical analyses (e.g. carbon, nitrogen, phosphorus), bacteria, and viruses were also collected for laboratory analysis.

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Coverage

Location: Saanich and Tofino Inlets, Vancouver Island, British Columbia

Spatial Extent: N:49.225333 E:-122.449667 S:47.711667 W:-125.693333

Temporal Extent: 2025-07-15 - 2025-07-26

Methods & Sampling

Two anoxic fjords off the coast of Vancouver Island in British Columbia were visited as part of a project investigating the diversity and activity of marine bacteria and their viruses in low dissolved oxygen and anoxic waters. Sampling was conducted in Saanich Inlet and Tofino Inlet in 2025 aboard the R/V Rachel Carson from July 15th through July 27th. Water collection and environmental/oceanographic measurements were performed using a CTD rosette equipped with a SeaBird SBE-911 plus CTD, twelve 10 Liter Niskin bottles, and sensors to

measure oxygen (Sea-Bird SBE 43), pH (Sea-Bird SBE 18), fluorescence (WETLabs ECO-FL-RTD), and beam transmission (SeaBird C-Star CST-25-DR). Sampling was done throughout the water column from the surface down to ~300 meters. Samples for chemical analyses (e.g. carbon, nitrogen, phosphorus), bacteria, and viruses were also collected for laboratory analysis.

Data Processing Description

The data were processed according to the GO-SHIP Repeat Hydrography Manual (McTaggart et al., 2010) using Software Version Seasave V 7.26.7.107 and with the following parameters.

- Data Conversion
- Align CTD – default settings
- Bottle Summary
- Wild Edit – default settings
- Filter – default settings
- Cell Thermal Mass – default settings
- Loop Edit – default settings
- Derive TEOS-10
- Bin Average – 0.5-db bins and only the downcast

BCO-DMO Curation Notes

Curation Performed on Primary Data File:

- Loaded SUP05_Titan_Master_CTDfile.csv as table 1008244_v1_sup05titan_processed_ctd_data, treating empty strings and “nd” as missing values
- Converted Lat and Lon from degrees–decimal minutes to decimal degrees using regex-based parsing
- Standardized the Date column by replacing “Jul” with “July”
- Converted Date from text in the format %B %d %Y to a date field formatted as %Y-%m-%d
- Set column types: Bottle (integer), CStarTr0 (number), Cast (string), Date (date), DepSM (number), FIECO-AFL (number), Lat (number), Lon (number), Ph (number), Potemp090C (number), PrDM (number), Sal00 (number), Sbox0Mm/Kg (number), Station (string), and T090C (number)
- Rounded Lat and Lon to six decimal places, preserving trailing zeros
- Renamed Sbox0Mm/Kg to Sbox0MmKg
- Renamed FIECO-AFL to FIECOAFL
- Updated field metadata for all columns, including descriptions, standard name IDs, supplied units, and primary parameter designations
- Saved the final table as 1008244_v1_sup05titan_processed_ctd_data.csv

Problem Description

The dataset authors have reported no known issues with the collection of this data.

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Parameters

Parameter	Description	Units
Cast	Sequential CTD cast number.	unitless
Station	Sampling locations (MB=Puget Sound main basin, SI=Saanich Inlet, TI=Tofino Inlet).	unitless
Lat	Latitude of CTD measurements and Niskin sampling in decimal degrees; a positive value indicates a northern coordinate.	decimal degrees
Lon	Longitude of CTD measurements and Niskin sampling; a negative value indicates a western coordinate.	decimal degrees
Bottle	Niskin bottle number associated with the sample cast.	unitless
Date	Date of sampling.	unitless
PrDM	Pressure from the Digiquartz pressure sensor.	decibar (dB)
DepSM	Depth derived from pressure using latitude-dependent conversion.	meters (m)
T090C	Temperature from CTD primary temperature sensor.	degrees Celsius
Potemp090C	Potential temperature referenced to surface pressure.	degrees Celsius
Sal00	Practical salinity derived from conductivity, temperature, and pressure.	PSU
Sbox0MmKg	Dissolved oxygen concentration from the SBE 43 sensor.	umol/kg
FIECOAFL	Fluorescence from a WETS Labs ECO fluorometer.	mg/m ³
CStarTr0	Beam transmissometer output; measure of light transmission.	percent transmission
Ph	Hydrogen ion activity (pH).	unitless

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Instruments

Dataset-specific Instrument Name	SeaBird SBE-911 plus CTD
Generic Instrument Name	CTD Sea-Bird 911
Dataset-specific Description	Used to conduct water column sampling and environmental/oceanographic measurements throughout the water column (surface to ~300 m) in Saanich and Tofino Inlets, mounted with 12 Niskin bottles and auxiliary sensors.
Generic Instrument Description	The Sea-Bird SBE 911 is a type of CTD instrument package. The SBE 911 includes the SBE 9 Underwater Unit and the SBE 11 Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 and SBE 11 is called a SBE 911. The SBE 9 uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 and SBE 4). The SBE 9 CTD can be configured with 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	Sea-Bird SBE 18
Generic Instrument Name	Sea-Bird SBE 18 pH Sensor
Dataset-specific Description	A Sea-Bird SBE 18 sensor, integrated as part of the SBE-911 suite, was used to measure pH.
Generic Instrument Description	A pH sensor using a pressure-balanced glass-electrode Ag ₂ AgCl-reference pH probe to provide in-situ measurements at depths up to 1200m. The replaceable pH probe is permanently sealed and is supplied with a soaker bottle attachment that prevents the reference electrode from drying out during storage.

Dataset-specific Instrument Name	Sea-Bird SBE 43
Generic Instrument Name	Sea-Bird SBE 43 Dissolved Oxygen Sensor
Dataset-specific Description	A Sea-Bird SBE 43 sensor, integrated as part of the SBE-911 suite, was used to measure dissolved oxygen.
Generic Instrument Description	The Sea-Bird SBE 43 dissolved oxygen sensor is a redesign of the Clark polarographic membrane type of dissolved oxygen sensors. More information from the manufacturer: https://www.seabird.com/products/sbe-43-dissolved-oxygen-sensor

Dataset-specific Instrument Name	WETLabs ECO-FL-RTD
Generic Instrument Name	Sea-Bird WETLabs ECO FLNTU(RT)D combined fluorometer and turbidity sensor
Dataset-specific Description	A WETLabs ECO-FL-RTD sensor, integrated as part of the SBE-911 suite, was used to measure fluorescence.
Generic Instrument Description	This optical sensor is available in combinations of backscattering, turbidity, and fluorescence measurements. It records in real-time and does not store data. ECOs feature optional active anti-fouling and internal batteries for long-term deployments. This instrument has a user-selectable sample rate up to 8 Hz. The fluorometer can typically measure pigment concentrations in the range 0-75 ug/l, with a sensitivity of 0.037 ug/l, at wavelengths of 470 or 695 nm. The turbidity sensor can measure within the range 0-200 NTU, with a sensitivity of 0.098 NTU, at a wavelength of 700 nm. The instrument is stable over a temperature range of 0-30 degC and is rated to a depth of 6000 m.

Dataset-specific Instrument Name	SeaBird C-Star CST-25-DR
Generic Instrument Name	WET Labs {Sea-Bird WETLabs} C-Star transmissometer
Dataset-specific Description	A SeaBird C-Star CST-25-DR sensor, integrated as part of the SBE-911 suite, was used to measure beam transmission.
Generic Instrument Description	The C-Star transmissometer has a novel monolithic housing with a highly integrated opto-electronic design to provide a low cost, compact solution for underwater measurements of beam transmittance. The C-Star is capable of free space measurements or flow-through sampling when used with a pump and optical flow tubes. The sensor can be used in profiling, moored, or underway applications. Available with a 6000 m depth rating. More information on Sea-Bird website: https://www.seabird.com/c-star-transmissometer/product?id=60762467717

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Deployments

RC0140

Website	https://www.bco-dmo.org/deployment/1008250
Platform	R/V Rachel Carson (UW)
Start Date	2025-07-15
End Date	2025-07-27

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Project Information

Collaborative Research: The effects of SUP05 cells and virocells on nitrogen cycling in marine oxygen minimum zones (SUP05, Viruses, and Nitrogen)

Website: <https://www.ocean.washington.edu/story/show/19810>

Coverage: North Pacific Anoxic Fjords

NSF Award Abstract:

Bacteria and the viruses that infect them (phages) play a major role in marine ecosystems. Their host-virus interactions can alter community structure, preserve genetic diversity, and impact nutrient cycling. Up to a third of the bacteria that dominate marine oxygen minimum zones (OMZs) are infected with phages, yet the consequences of the host-virus interactions are unknown. Environmental DNA sequence data suggest that a dominant lineage of OMZ bacteria (SUP05) is comprised of species and subspecies that carry out different steps in marine nitrogen cycling and that these cells are often infected by viruses. The nitrogen cycling capacity of diverse SUP05 cells can drive the accumulation of nitrogen cycle intermediates in the oceans or lead directly to significant nitrogen loss. The outcome may be driven in part by phages, by causing cell death, metabolic rewiring of infected cells (virocells), or through the expression of phage-encoded auxiliary metabolic genes (AMGs). This project is testing the overarching hypothesis that SUP05 populations are comprised of diverse nitrogen respiring cell types and that their interactions with phages can determine the fate of fixed nitrogen. The investigators are studying SUP05 cells and viruses from OMZs to detail their combined effects on nitrogen cycling and loss processes in OMZs. The project is providing graduate and undergraduate students with hands-on collaborative field and laboratory research experiences, with a focus on broadening participation in oceanography. Through local science festivals, open houses, and interactive classroom lessons, K-12 students are learning about OMZs, nitrogen cycling, and viral infection. Results are being presented at national and international conferences and published in peer-reviewed journals, and all sequence and biogeochemical data, as well as new cultures of SUP05 and phage isolates are being made available to the broader scientific community.

Up to 25% of the fixed nitrogen in the ocean is lost as gaseous products through denitrification and other microbial processes in OMZs. These regions are also hotspots for nitrous oxide (N₂O) production and emission to the atmosphere. While sulfur oxidizing chemoautotrophs from the SUP05 clade of marine bacteria and their viruses are abundant in marine OMZs, the roles of host-virus interactions in biogeochemical processes are largely unknown. This interdisciplinary study is evaluating SUP05 cells and phages in stable OMZ fjord systems using a combination of in situ measurements, DNA and RNA sequencing, and laboratory experiments to link the metabolic activities of SUP05 with the underlying nitrogen transformations they mediate in the ocean. The collective expertise of team members using field approaches to study microbial and viral diversity in nature, cultivation studies to test genomic predictions under controlled laboratory conditions, and isotope analyses to identify the rates and mechanisms underlying microbial nitrogen cycling and loss are being combined to provide new information about the conditions and activities that regulate SUP05 nitrogen cycling and loss in marine OMZs. Ultimately, this multi-faceted approach is filling critical gaps in our understanding of SUP05 cells and phages and how they collectively influence the marine nitrogen cycle.

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-2333925
NSF Division of Ocean Sciences (NSF OCE)	OCE-2333926
NSF Division of Ocean Sciences (NSF OCE)	OCE-2333927
NSF Division of Ocean Sciences (NSF OCE)	OCE-2333928

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