Water nutrients measured at artificial reefs in Kāneʻohe Bay, Oʻahu in 2022 and 2023 as part of a reef halo dynamics study

Website: https://www.bco-dmo.org/dataset/987232
Data Type: Other Field Results
Version: 1
Version Date: 2025-10-16

Project
» CAREER: Decoding seascape-scale vegetation patterns on coral reefs to understand ecosystem health: Integrating research and education from organismal to planetary scales (Coral Reef Halos)

Contributors	Affiliation	Role
Innes-Gold, Anne	University of Hawaiʻi at Mānoa (HIMB)	Principal Investigator, Student
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
The goal of this dataset is to measure water nutrients at three artificial reefs constructed in Kāneʻohe Bay, Oʻahu, Hawaiʻi, from August 2022-December 2023. Water samples were taken monthly. One water sample was taken per artificial reef. Water samples were analyzed by the University of Hawaiʻi at Mānoa SOEST Laboratory for Analytical Biogeochemistry. They were analyzed for: Total Nitrogen, Total Phosphorous, Phosphate, Silicate, Nitrate + Nirite, Ammonia, and Chlorophyll.

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Coverage

Location: Kāneʻohe Bay, Oʻahu, Hawaiʻi
Spatial Extent: **N**:21.464275 **E**:-157.806783 **S**:21.464012 **W**:-157.806783
Temporal Extent: 2022-08 - 2023-12

Methods & Sampling

Water samples were taken monthly from August 2022 - December 2023. One water sample was taken per reef. The samples were analyzed for phosphate (µmol/L) and nitrate + nitrite (µmol/L). Water samples were analyzed by the University of Hawaiʻi at Mānoa SOEST Laboratory for Analytical Biogeochemistry. They were analyzed for: Total Nitrogen, Total Phosphorous, Phosphate, Silicate, Nitrate + Nirite, Ammonia, and Chlorophyll using a Seal Analytical AA3 HR Nutrient Autoanalyzer.

Sample collection: Water samples were collected in sterile 60ml plastic bottles, each rinsed three times from the sample area before a sample was taken.

Seal Analytical AA3 HR Nutrient Autoanalyzer:
This instrument is a fully automated/computerized analyzing system for nutrients in environmental waters. It is a five-channel segmented-flow continuous analyzer consisting of a sampler, a pump, five-reagent mixing and

reaction manifolds and five photometers. S-LAB utilizes the AA3 to simultaneously measure dissolved inorganic nitrate, nitrite, ammonium, phosphate, and silicate at low µM levels. Detection limits offered by this state-of-the-art instrument fulfill the detection needs of researchers wishing to analyze oligotrophic (low nutrient concentration) seawater, while also providing the capability of analyzing fresh and brackish waters, including soil water, sediment pore water, and groundwater. (Description from https://www.soest.hawaii.edu/S-LAB/equipment/slab_autoanalyzer.htm

The following describes the measurements in more detail.
* excerpt from University of Hawai'i at Mānoa SOEST Laboratory for Analytical Biogeochemistry's "Seal Analytical AA3 HR Nutrient Autoanalyzer" page https://www.soest.hawaii.edu/S-LAB/equipment/slab_autoanalyzer.htm)

Ammonium
Ammonium is measured fluorometrically following the method of Kerouel and Aminot (1997). The sample is reacted with o-phthalaldehyde (OPA) at 75°C in the presence of borate buffer and sodium sulfite to form a fluorescent species in a quantity that is proportional to the ammonium concentration. Fluorescence is measured at 460 nm following excitation at 370 nm.

Nitrate and Nitrite
Nitrate and Nitrite are analyzed via the diazo reaction based on the methods of Armstrong et al (1967) and Grasshoff (1983). This automated procedure involves reduction of nitrate to nitrite by a copper-cadmium reductor column. The nitrite then reacts with sulfanilamide under acidic conditions to form a diazo compound, which then couples with N-1-naphthylethylene diamine dihydrochloride to form a purple azo dye. The concentration is determined colorimetrically at 550 nm.

Silicate
Silicate measurement is based on the reduction of silicomolybdate in acidic solution to molybdenum blue by ascorbic acid (Grashoff and Kremling 1983). Oxalic acid is introduced to the sample stream before the addition of ascorbic acid to minimize interference from phosphates. The concentration is determined colorimetrically at 820 nm.

Phosphate
This automated procedure for the determination of orthophosphate is based on the colorimetric method of Murphy and Riley (1962) in which a blue color is formed by the reaction of orthophosphate, molybdate ion and antimony ion followed by reduction with ascorbic acid at a pH of 1. The reduced blue phospho-molybdenum complex is determined colorimetrically at 880 nm.

Total Phosphorus
Following the method developed by the University of Hamburg in co-operation with the Ocean University of Qingdao, this automated procedure for the determination of dissolved phosphorus in seawater takes place in three stages. First, the sample is irradiated in a UV digestor. In this digestion step organically bound phosphorus is released. Second, acid persulfate is added, which further promotes breakdown of orgniac matter that persists after UV digestion, and polyphosphates are converted to ortho-phosphate by acid hydrolysis at 90°C. Third, the ortho-phosphate is determined by reaction with molybdate, antimony and ascorbic acid, producing a phospho-molybdenum blue complex which is determined colorimetricallyat 880 nm.

Total Nitrogen
Following the procedure developed by the University of Hamburg, inorganic and organic nitrogen compounds are oxidized to nitrate by persulfate under alkaline conditions in an on-line UV digestor. The nitrate is reduced to nitrite in a cadmium column and then determined using the sulfanilamide/NEDD reaction with colorimetric detection at 520 nm.

BCO-DMO Processing Description

* The data table within the submitted file "nutrients_combined_v2.csv" (uploaded 2025-10-31) was imported into the BCO-DMO data system for this dataset. Values "NA" imported as missing data values. Table will appear as Data File: 987232_v1_kaneohe-bay-halos-nutrients.csv (along with other download format options).

* Changed column name Sillicate to Silicate.

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.

* N+N column name changed to NO3_plus_NO2 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]

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Data Files

File
987232_v1_kaneohe-bay-halos-nutrients.csv (Comma Separated Values (.csv), 5.06 KB) MD5:ec887a82e518c089c840d7f327faa201 Primary data file for dataset ID 987232, version 1

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Related Publications

Armstrong, F. A. J., Stearns, C. R., & Strickland, J. D. H. (1967). The measurement of upwelling and subsequent biological process by means of the Technicon Autoanalyzer® and associated equipment. Deep Sea Research and Oceanographic Abstracts, 14(3), 381–389. doi:10.1016/0011-7471(67)90082-4
Methods

Grasshoff, K., Kremling, K., and Ehrhardt, M. (1983). Methods of Seawater Analysis. Verlag Chemia, Florida
Methods

Innes-Gold, A. A., McManus, L. C., Lester, E., Ong, T. W., Cook McNab, A., Rahnke, S. A., Brett Pablo, J., Tokoyoda, A., Watson, D., & Madin, E. M. P. (2025). Herbivory and temperature mediate coral reef halo dynamics. The American Naturalist. https://doi.org/10.1086/738015
Results

Kérouel, R., & Aminot, A. (1997). Fluorometric determination of ammonia in sea and estuarine waters by direct segmented flow analysis. Marine Chemistry, 57(3–4), 265–275. https://doi.org/10.1016/s0304-4203(97)00040-6 https://doi.org/10.1016/S0304-4203(97)00040-6
Methods

Murphy, J., & Riley, J. P. (1962). A modified single solution method for the determination of phosphate in natural waters. Analytica Chimica Acta, 27, 31–36. doi:10.1016/s0003-2670(00)88444-5
Methods

SOEST Laboratory for Analytical Biogeochemistry (n.d.). Equiptment: Seale Analytical AA3 HR Nutrient Autoanalyzer. Available from https://www.soest.hawaii.edu/S-LAB/equipment/slab_autoanalyzer.htm
Methods

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Related Datasets

IsRelatedTo

Innes-Gold, A. (2025) **Fish community surveys at artificial reefs in Kāne‘ohe Bay, O‘ahu conducted in 2022 and 2023 as part of a reef halo dynamics study.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-11-21 doi:10.26008/1912/bco-dmo.985611.1 [view at BCO-DMO]
Relationship Description: Datasets collected at artificial reefs in Kāne‘ohe Bay, O‘ahu in 2022 and 2023 as part of a reef halo dynamics study (Innes-Gold, 2025; doi: 10.1086/738015).

Innes-Gold, A. (2025) **Temperature measured at artificial reefs in Kāne‘ohe Bay, O‘ahu in 2022 and**

2023 as part of a reef halo dynamics study. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-11-18 doi:10.26008/1912/bco-dmo.987237.1 [view at BCO-DMO]
Relationship Description: Datasets collected at artificial reefs in Kāneʻohe Bay, Oʻahu in 2022 and 2023 as part of a reef halo dynamics study (Innes-Gold, 2025; doi: 10.1086/738015).

Innes-Gold, A. (2025) **Vegetation surveys at artificial reefs in Kāneʻohe Bay, Oʻahu conducted in 2022 and 2023 as part of a reef halo dynamics study.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-11-18 doi:10.26008/1912/bco-dmo.987227.1 [view at BCO-DMO]
Relationship Description: Datasets collected at artificial reefs in Kāneʻohe Bay, Oʻahu in 2022 and 2023 as part of a reef halo dynamics study (Innes-Gold, 2025; doi: 10.1086/738015).

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Parameters

Parameter	Description	Units
Month	Month of observation	unitless
Year	Year of observation	unitless
Date	Date of observation (ISO 8601 format)	unitless
Reef_Number	The artificial reef number, 1-3 (R#)	unitless
Total_N	total nitrogen. See Methods & Sampling section.	micromoles per liter (umol/L)
Total_P	total phosphorous (dissolved phosphorus). See Methods & Sampling section.	micromoles per liter (umol/L)
Phosphate	Phosphate (orthophosphate, PO43-). See Methods & Sampling section.	micromoles per liter (umol/L)
Silicate	Silicate. See Methods & Sampling section.	micromoles per liter (umol/L)
NO3_plus_NO2	Nitrate (NO3-) plus Nitrite (NO2-). See Methods & Sampling section.	micromoles per liter (umol/L)
Ammonia	Ammonia (NH4+). See Methods & Sampling section.	micromoles per liter (umol/L)
Chlorophyll	Chlorophyll a. See Methods & Sampling section.	micromoles per liter (umol/L)
Latitude	Latitude	decimal degrees
Longitude	Longitude	decimal degrees

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Instruments

Dataset-specific Instrument Name	Seal Analytical AA3 HR Nutrient Autoanalyzer
Generic Instrument Name	Seal Analytical AutoAnalyser 3HR
Dataset-specific Description	Seal Analytical AA3 HR Nutrient Autoanalyzer: This instrument is a fully automated/computerized analyzing system for nutrients in environmental waters. It is a five-channel segmented-flow continuous analyzer consisting of a sampler, a pump, five-reagent mixing and reaction manifolds and five photometers. S-LAB utilizes the AA3 to simultaneously measure dissolved inorganic nitrate, nitrite, ammonium, phosphate, and silicate at low µM levels. Detection limits offered by this state-of-the-art instrument fulfill the detection needs of researchers wishing to analyze oligotrophic (low nutrient concentration) seawater, while also providing the capability of analyzing fresh and brackish waters, including soil water, sediment pore water, and groundwater. (Description from https://www.soest.hawaii.edu/S-LAB/equipment/slab_autoanalyzer.htm
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

CAREER: Decoding seascape-scale vegetation patterns on coral reefs to understand ecosystem health: Integrating research and education from organismal to planetary scales (Coral Reef Halos)

Website: http://oceansphere.org

Coverage: Hawai'i (field components) and global (synthetic components)

NSF Award Abstract:
Coral reefs worldwide are under increasing threat from a range of human-induced stressors. Climate change is understood to be a key global stressor threatening reefs, but the only proven levers for ecosystem managers to increase reef resilience is to mitigate local and regional stressors such as fishing pressure. A vexing question persists, however, which is how to measure the effects of fishing on ecosystems, particularly over the large spatial (e.g., >10s of meters) and temporal (multi-year) scales over which fishing occurs. One promising approach to doing so is using the large-scale vegetation patterns found on coral reefs globally, called "halos", to remotely observe when, where, and to what extent fishing pressure is affecting community structure and function. This program combines lab- and field-based experiments with cutting-edge satellite imaging technology and computer science approaches to provide a leap forward in our understanding of how species-level interactions can scale up in space and time to shape coral reef seascapes around the world. By drawing on these approaches, the synergistic education program: 1) integrates science and art (i.e., murals and satellite imagery) to educate and inspire Hawai'i's students and general public about coral reef ecology; 2) builds technological capacity in Hawai'i's underrepresented minority high school to graduate students, and 3) empowers these students with science communication skills to communicate with diverse audiences. By leveraging this research program and the cutting-edge technologies it will involve, the investigator establishes a strong foundation for long-term teaching and mentoring activities focused on increasing capacity within STEM-underrepresented minorities with Hawaiian and other Pacific Islander backgrounds. Decoding what coral reef halos can tell us about the effects of fishing on reef ecosystem health provides valuable knowledge to reef ecosystem managers and conservation practitioners as reefs continue to rapidly change due to human

stressors.

This project combines lab- and field-based experiments with cutting-edge satellite imaging technology and computer science approaches to address the goals of: 1) determining the mechanisms that create the “halos” that form around coral patch reefs, and 2) testing the predictions arising from these mechanisms in a global arena. This project uses a transdisciplinary approach – spanning ecology, oceanography, geospatial science, and computer science – to address these goals. This program has three scientific objectives: to determine 1) which species interaction mechanisms and environmental factors cause reef halos and what their relative importance is; 2) whether these mechanisms are globally consistent or vary geographically; and 3) whether halos can therefore be used as an indicator of aspects of coral reef ecosystem health. In the process, this research advances our understanding of how remote observation tools (satellite and drone imagery; camera traps) can be integrated with computer science (machine learning) and ecological approaches (mechanistic experiments) to generate emergent insights that would not otherwise be possible.

This project is jointly funded by the Biological Oceanography Program, the Established Program to Stimulate Competitive Research (EPSCoR), and Ocean Education Programs.

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-1941737

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