Environmental sensor data from an underwater imaging system (ISIIS-3) collected during R/V Langseth cruise MGL2207 July 20-28 2022 and R/V Sally Ride cruise SR2317 August 10-20 2023 in the Northern California Current

Website: https://www.bco-dmo.org/dataset/942686
Data Type: Cruise Results
Version: 1
Version Date: 2024-11-01

Project
» Collaborative Research: Plankton size spectra and trophic links in a dynamic ocean (Plankton Size Spectra)

Contributors	Affiliation	Role
Cowen, Robert K.	Oregon State University (OSU)	Principal Investigator
Sponaugle, Su	Oregon State University (OSU)	Co-Principal Investigator
Sutherland, Kelly Rakow	University of Oregon	Co-Principal Investigator
Corrales Ugalde, Marco	Princeton University	Scientist
Conser, Elena	Oregon State University (OSU)	Student
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
During July 20-28 2022 and August 10-20 2023 an underwater imager (In Situ Ichthyoplankton Imaging System 3, ISIIS-3) was deployed from the R/V Langseth and R/V Sally Ride, respectively. The ISIIS-3 deployments were carried out from these R/Vs in the northern California Current by a team affiliated with Oregon State University, the University of Oregon, and Portland State University. The ISIIS-3 was equipped with two line scan cameras for collecting plankton imagery in addition to six environmental sensors. This dataset contains the processed and quality controlled merged environmental data from the ISIIS imager on this cruise, consisting of temperature, conductivity, pressure, depth, salinity, fluorescence, oxygen, pH, photosynthetically active radiation, and chlorophyll a. Latitude, longitude, date, time, imager horizontal/vertical speeds, and altitude are also included in the dataset. Data were collected on six cross-shelf transects ranging geographically from the border of California and Oregon to southern Washington. Two transects, one following the Newport Hydrographic Line and the other near Gray's Harbor, Washington, were 70 nautical miles (~135 km) in length. The four others (near the Columbia River, Cape Meares, Heceta Bank, and the Rogue River) were 40 nautical miles (~73 km). ISIIS was towed continuously in an undulating motion ("tow-yos") between 0-100m depth, or within 2-5m of the seafloor where the bottom depth was less than 100m. Data were streamed on to the ship in real time using a fiber optic oceanographic cable and written into millisecond time-stamped data files for each sensor. Sensor data files from ISIIS-3, along with latitude and longitude data from ship data streams, were merged using Python scripts into a final dataset based on the millisecond time stamps of the sensors and GPS streams.

Table of Contents

Coverage

Location: Northern California Current
Spatial Extent: **N**:47.12751 **E**:-124.0613 **S**:42.49829 **W**:-126.1224
Temporal Extent: 2022-07-20 - 2023-08-20

Dataset Description

This dataset will be updated to include additional data from deployments from the winter of 2022 and winter of 2023.

Methods & Sampling

Location description: Six cross-shelf transects in the northern California Current, ranging from near the Oregon-California border (42.5°N) to southern Washington (47.1°N). Maximum depth of instrument is 100m or within 2-5m of the seafloor. A list of more detailed information about the individual transects is included (See Supplemental Files).

ISIIS-3 was deployed from the R/V Langseth, and towed the length of the transect in an undulating manner at 2.5 m/s, undulating between 1m and 100m depth, or within 2m of the seafloor in waters shallower than 100m depth. A total of six transects were sampled, with the longest transects split into inshore and offshore portions sampled over two nights. Each transect was sampled in the “tow-yo” fashion throughout the deployment of the instrument. ISIIS-3 was terminated to a fiber optic winch. Data were streamed to the shipboard ISIIS-3 computer in real time. A program manager written in JADE took the input data streams from both cameras, each sensor, and GPS data from the ship, and wrote into individual millisecond time-stamped files. Data were stored on the shipboard computers 16TB drives, then copied on to individual 6TB external drives in duplicate for each camera. Individual files were written for the CTD, GPS stream, voltage-based sensor readings (pH, dissolved oxygen, PAR), altimeter, and flowmeter, and files were written on the shipboard ISIIS-3 computer.

See Schmid et al. (2023, doi:10.3389/fmars.2023.1187771) for more information on ISIIS-3 imager and deployments on these research cruises.

Data Processing Description

Sensor data were written by individual publishers and millisecond time stamped. A Python script merge_environmental.py (Schmid et al., 2023, DOI: 10.5281/ZENODO.7739010) was used to merge these individual files into a final dataset based on the millisecond time stamps associated with each observation, creating a cohesive dataset over the time period sampled. Conversion factors and calibrations were applied to pH, oxygen, and irradiance voltage readings to yield final values, and chlorophyll-a was calculated using manufacturer conversions and calibration values. Conversion factors and calibrations were applied in R.

Histograms of sensor data values were used to determine extreme values to flag as potential outliers.

BCO-DMO Processing Description

* Data tables from submitted files "s22_ISIIS3_enviro.csv" and "s23_ISIIS3_enviro.csv" were imported into the BCO-DMO data system for this dataset and concatenated. Values "NA" were imported as missing data values.
** 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.

* ISO DateTime with timezone (UTC) column added in ISO 8601 format (converted from local "US/Pacific" timestamp in PDT/PDT time zone.

* Column "Cruise_ID" added.

* Lat,lon rounded to 5 decimal places as decided with data submitter. pH PAR and oxygen also rounded to 5 decimal places when over 5 places.

Problem Description

Note: This section refers to "NA" values to indicate missing data. Missing data values at BCO-DMO vary depending upon the format you download. For example blanks (null) are provided in csv format, NaN in Matlab files, etc.

[Problems/Issues for Summer 2022 Deployment]

There are known gaps from 2022-07-24 07:17:06-07:17:45, 07:14:06-07:14:59, and 07:28:04-07:28:21 where most sensors are missing data.

There are several additional single second gaps that similarly show NA values for many sensors. These are flagged in the flag columns. These data gaps are likely due to cable connection movement on the ISIIS-3 imager where data were unable to be transferred from the electronics pod to the oceanographic cable.

Flag columns were created for each of the sensor values based on histograms of the values to determine potential outliers or unreliable values. These are described below, plus in the parameter description file.

Depth_flag: values less than 1m, greater than 110m, or NA flagged as 1. Values between 1-110m are 0.
Pressure_flag: values less than 1dBar, greater than 110 dBar, or NA flagged as 1. Values between 1-110dBar are 0.
Salinity_flag: values less than 20 PSU or NA flagged as 1. Values greater than or equal to 20 PSU are 0.
Conductivity_flag: values <3 S/m or NA flagged as 1. Values greater than 3 S/m are 0.
Temperature flag: NA values are flagged as 1. Non-missing data are 0.
Horizontal_Speed_flag: values greater than 500 cm/s, less than -500 cm/s, or NA flagged as 1. Values between -500 and 500 cm/s are 0.
Vertical_Speed_flag: values <0 cm/s, greater than 4000 cm/s or NA flagged as 1. Values between 0-4000 cm/s are 0.
Fluoro_flag: values >4000 counts, <0 counts, or NA flagged as 1. Values between 0-4000 are 0.
PAR_flag: values < 0 µE/s, >0.1 µE/s, or NA flagged as 1. Values between 0-0.1 µE/s are 0.
pH_flag: values <7 or NA flagged as 1. Values ≥ 7 are 0.
Oxygen_flag: NA values flagged as 1, otherwise 0.
Chl_a_flag: values <0 µl/l, > 45 µl/l, or NA flagged as 1. Values between 0 and 45 µl/l are 0.
Flag_totals: total sum of flags for other columns. Ranges between 0 (no data flags) and 12 (data to be scrutinized or many extreme values)

[Problems/Issues for Summer 2023 Deployment]

The oxygen sensor and pump attached to the ISIIS-3 malfunctioned during all deployments. Therefore, the data for oxygen should not be used, and the quality control column is flagged for every value.

Occasionally, short periods of time do not have associated sensor values due to short data transfer lapses. In these cases, many of the instrumentation values read as NA, and

Flag columns were created for each of the sensor values based on histograms of the values to determine potential outliers or unreliable values. These are described below, plus in the parameter description file.

Depth_flag: values less than 1m, greater than 110m, or NA flagged as 1. Values between 1-110m are 0.
Pressure_flag: values less than 1dBar, greater than 110 dBar, or NA flagged as 1. Values between 1-110dBar are 0.
Salinity_flag: values less than 20 PSU or NA flagged as 1. Values greater than or equal to 20 PSU are 0.
Conductivity_flag: values <3 S/m or NA flagged as 1. Values greater than 3 S/m are 0.
Temperature flag: NA values are flagged as 1. Non-missing data are 0.
Horizontal_Speed_flag: values greater than 500 cm/s, less than -500 cm/s, or NA flagged as 1. Values between -500 and 500 cm/s are 0.
Vertical_Speed_flag: values <0 cm/s, greater than 4000 cm/s or NA flagged as 1. Values between 0-4000 cm/s

are 0.
Fluoro_flag: values >4000 counts, <0 counts, or NA flagged as 1. Values between 0-4000 are 0.
PAR_flag: values < 0 µE/s, >0.1 µE/s, or NA flagged as 1. Values between 0-0.1 µE/s are 0.
pH_flag: values <7 or NA flagged as 1. Values ≥ 7 are 0.
Oxygen_flag: NA values flagged as 1, otherwise 0.
Chl_a_flag: values <0 µl/l, > 45 µl/l, or NA flagged as 1. Values between 0 and 45 µl/l are 0.
Flag_totals: total sum of flags for other columns. Ranges between 0 (no data flags) and 12 (data to be scrutinized or many extreme values)

[table of contents | back to top]

Related Publications

Schmid, M. S., Daprano, D., Damle, M. M., Sullivan, C. M., Sponaugle, S., Cousin, C., Guigand, C., & Cowen, R. K. (2023). Edge computing at sea: high-throughput classification of in-situ plankton imagery for adaptive sampling. Frontiers in Marine Science, 10. https://doi.org/10.3389/fmars.2023.1187771
Methods

Schmid, M. S., Daprano, D., Damle, M. M., Sullivan, C., Sponaugle, S., & Cowen, R. K. (2023). Code for segmentation, classification, databasing, and visualization of in-situ plankton imagery on edge servers at sea (Version 1.0.0) [Computer software]. Zenodo. https://doi.org/10.5281/ZENODO.7739010
https://doi.org/10.5281/zenodo.7739010
Software

[table of contents | back to top]

Parameters

Parameters for this dataset have not yet been identified

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Altimeter (ImageNex 850)
Generic Instrument Name	Altimeter
Dataset-specific Description	Instrumentation associated with ISIIS-3.
Generic Instrument Description	An instrument that measures height above a fixed surface. The data can be used to map ocean-surface topography and generate gridded surface height fields.

Dataset-specific Instrument Name	Flowmeter (Valeport 803 ROV Current Meter)
Generic Instrument Name	Flow Meter
Dataset-specific Description	Instrumentation associated with ISIIS-3.
Generic Instrument Description	General term for a sensor that quantifies the rate at which fluids (e.g. water or air) pass through sensor packages, instruments, or sampling devices. A flow meter may be mechanical, optical, electromagnetic, etc.

Dataset-specific Instrument Name	Fluorescence (WetLabs ECO-FLRT, S/N FLRT-2611)
Generic Instrument Name	Fluorometer
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	
Generic Instrument Name	In Situ Ichtyoplankton Imaging System
Dataset-specific Description	Instrumentation associated wth ISIIS-3 are listed in the "Instruments" section of this dataset page except: Two linescan cameras (55 µm/pixel resolution, Bellamare ISIIS-DPI) **imagery data is not associated with this dataset "ISIIS Environmental Data"
Generic Instrument Description	The In Situ Ichthyoplankton Imaging System (ISIIS) is an underwater imaging system aimed at capturing in situ, real time images of marine zooplankton of relatively low abundance such as fish larvae and fragile gelatinous organisms. The first prototype, delivered in 2007, was attached to a relatively simple vehicle towed by an oceanographic vessel at a speed of five knots. The vehicle, and associated imaging system and sensors, was moved up and down through the water column by paying cable in and out via an oceanographic winch. Subsequently, a new vehicle has been designed with the capacity of self undulation using motor actuated dive fins. The ISIIS system utilizes a high-resolution line-scanning camera with a Light Emitting Diode (LED) light source, modified by plano-convex optics, to create a collimated light field to back-light a parcel of water. ISIIS was developed in collaboration between the University of Miami's Rosenstiel School of Atmospheric and Marine Science (RSMAS) and the subsea engineering company, Bellamare, LLC, located in San Diego CA. See complete description from RSMAS. Reference: Cowen RK and Guigand CM. 2008. In situ Ichthyoplankton Imaging System (ISIIS): system design and preliminary results. Limnol. Oceanogr. Methods. 6:126-132. doi:10.4319/lom.2008.6.126

Dataset-specific Instrument Name	pH sensor (Seabird SBE 18)
Generic Instrument Name	pH Sensor
Dataset-specific Description	Instrumentation associated with ISIIS-3.
Generic Instrument Description	An instrument that measures the hydrogen ion activity in solutions. The overall concentration of hydrogen ions is inversely related to its pH. The pH scale ranges from 0 to 14 and indicates whether acidic (more H+) or basic (less H+).

Dataset-specific Instrument Name	Photosynthetically active radiation/irradiance (Biospherical QCP-2300)
Generic Instrument Name	Photosynthetically Available Radiation Sensor
Dataset-specific Description	Instrumentation associated with ISIIS-3.
Generic Instrument Description	A PAR sensor measures photosynthetically available (or active) radiation. The sensor measures photon flux density (photons per second per square meter) within the visible wavelength range (typically 400 to 700 nanometers). PAR gives an indication of the total energy available to plants for photosynthesis. This instrument name is used when specific type, make and model are not known.

Dataset-specific Instrument Name	Dissolved oxygen (Sea-Bird 43) with pump (SBE M5)
Generic Instrument Name	Sea-Bird SBE 43 Dissolved Oxygen Sensor
Dataset-specific Description	Instrumentation associated with ISIIS-3.
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 Sea-Bird Electronics

Dataset-specific Instrument Name	CTD (Sea-Bird SBE 49 FastCAT)
Generic Instrument Name	Sea-Bird SBE 49 FastCAT CTD Sensor
Dataset-specific Description	Instrumentation associated with ISIIS-3
Generic Instrument Description	The SBE 49 FastCAT is a CTD sensor for use in autonomous platforms. It contains a SBE 3P temperature sensor, a SBE 4C conductivity sensor and a strain-gauge pressure sensor as standard. It can operate in autonomus (16 Hz per sec) or polled mode (transmits each sample). The sensor is depth-rated to 350 m (plastic housing) or 7000 m (titanium housing). Accuracy: +/- 0.002 deg C (temperature), +/- 0.0003 S/m (conductivity), 0.1% of full scale range (pressure).

[table of contents | back to top]

Deployments

MGL2207

Website	https://www.bco-dmo.org/deployment/923370
Platform	R/V Marcus G. Langseth
Start Date	2022-07-18
End Date	2022-07-30

SR2317

Website	https://www.bco-dmo.org/deployment/923378
Platform	R/V Sally Ride
Start Date	2023-08-09
End Date	2023-08-21

[table of contents | back to top]

Project Information

Collaborative Research: Plankton size spectra and trophic links in a dynamic ocean (Plankton Size Spectra)

Website: http://hmsc.oregonstate.edu/research-labs/planktonlab/current-research

Coverage: Northern California Current

NSF Award Abstract:
Marine plankton form the base of most ocean food webs that support valuable fisheries. This highly diverse and complex community is composed of organisms that drift with ocean currents. Planktonic organisms remain understudied: they are difficult to sample given that their sizes span more than six orders of magnitude from less than one micron to meters. Yet, understanding how these communities respond to climate change,

and ultimately how these responses affect valuable fisheries, and therefore food security, is critical. Because many ecological and physiological processes are dictated by relative size, the theory of size spectra (i.e., the relationship between size and organism abundance as it drives ecosystem properties such as food webs) provides a valuable framework for forecasting climate change impacts on marine ecosystems. A deeper understanding of the scope and nature of variability in size spectra under contrasting environmental conditions is needed. The dynamic, highly productive northern California Current off Oregon and Washington, during the summer and winter seasons, produces a patchwork of oceanographic conditions including those associated with hypoxia and ocean acidification. This study is sampling the plankton communities in this region to investigate how gradients of temperature, nutrients, dissolved oxygen, and pH conditions impact size spectra. The broader impacts include the training of students, building scientific resources, and outreach to broader communities. Undergraduate and graduate students are being trained in oceanography, field research and new technologies. The automated image analysis pipeline developed as part of the project is openly accessible to the oceanographic community and the image data are available through the novel Global Plankton Imagery Library, an open-access repository for plankton imagery. Size spectra data from this study are shared directly with ecosystem modelers. The project's flagship outreach activity is the collaboration with the Sitka Center for Art and Ecology and the hosting of an Artist-At-Sea Program. A professional artist is competitively selected to join the research cruises and to create artistic products that give a unique voice to oceanographic research and the organisms under study. The artwork is being assembled into a traveling public Art Exhibit with planned displays at the Sitka Center, Oregon State University's Hatfield Marine Science Center, University of Oregon's Charleston Marine Life Center and centers located in underserved coastal communities. Finally, imagery data from the project are being shared via the Plankton Portal, a public website developed in partnership with the Citizen Science Alliance's Zooniverse, that invites citizen scientists to participate in classifying plankton images.

The coupling of in situ plankton imagery and morphometric data allows quantifying scales of variation in plankton size spectra as well as testing predictions of how changes in environmental conditions (notably, temperature, nutrients, oxygen, pH) correlate with shifts in size spectra to reveal functional consequences to the food web. Plankton size spectra are being compared across environmental conditions by sampling in a habitat with steep environmental gradients and during two contrasting seasons. Planktonic organisms spanning 10 orders of magnitude in biomass are sampled using two complementary high-resolution imaging systems: the In Situ Ichthyoplankton Imaging System (ISIIS) and the Laser In-Situ Scattering and Transmissometry (LISST) particle imager. High-throughput image analysis software is used to create size distributions together with taxonomic classification. Depth-discrete meso-zooplankton samples are collected in parallel to examine community shifts in carbon, obtain length-to-carbon conversions and calibrate image data. The normalized biomass size spectra computed from the image data are tested for deviations from expected patterns. The plankton collections are also being analyzed for diet and reproductive status of gelatinous zooplankton, and diet and daily growth rate of representative larval fishes. These two groups have been historically understudied yet play central roles in ecosystem function. The data are being used to examine how these organisms are impacted by environmental conditions, and how they affect plankton size spectra. This study is foundational to the understanding of marine ecosystems within the context of climate change.

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2125408
NSF Division of Ocean Sciences (NSF OCE)	OCE-2125407

[table of contents | back to top]