

# 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)

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## 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.

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## 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

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## 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 at night from the research vessel, and towed the length of the transects in an undulating manner at 2.5 m/s (vessel speed 5 kts), 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 per cruise, 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 (JADE, <https://sixclear.com/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 computer's 16TB internal 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 PST/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.

\* One value in Time column "2023-08-14 02:36:48" was corrected to "2023-08-14 02:36:48.000000" to match format of column. The submitter verified that indeed it should be microseconds .000000 and was a real time that had the trailing zeroes removed during processing workflow.

## 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 ISIS-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  $\mu\text{E/s}$ , >0.1  $\mu\text{E/s}$ , or NA flagged as 1. Values between 0-0.1  $\mu\text{E/s}$  are 0.

pH\_flag: values <7 or NA flagged as 1. Values  $\geq 7$  are 0.

Oxygen\_flag: NA values flagged as 1, otherwise 0.

Chl\_a\_flag: values <0  $\mu\text{l/l}$ , > 45  $\mu\text{l/l}$ , or NA flagged as 1. Values between 0 and 45  $\mu\text{l/l}$  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 ISIS-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)

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## Data Files

File
<b>942686_v1_isiis-environmental-data.csv</b> (Comma Separated Values (.csv), 156.90 MB) MD5:9e88934fd0118181d9b17333093abd97 Primary data file for dataset ID 942686, version 1

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## Supplemental Files

File
<b>ISIIS-3 Sampling Summary- Summer 2022</b> filename: S22_ISIIS_samplng_transect_summary.csv (Comma Separated Values (.csv), 1.26 KB) MD5:48d21ee4a6b21eff1442ea213ffc8c9b A summary of the transects sampled with the ISIIS-3 imager in the summer of 2022. Includes transect names, start and end date times (PDT), transect start and end Latitude and Longitude (Decimal degrees), direction of transect, and length of transect in nautical miles and kilometers.
<b>Summer 2023 ISIIS transect information</b> filename: ISIIS_s23_transects_dists.csv (Comma Separated Values (.csv), 1.42 KB) MD5:8d1081a3abb0a0911ebff1e15adfce98 A summary file for the transects sampled with the ISIIS-3 during August 2023. Contains the start/end dates and times, start/end latitude and longitudes, and the length of the transects in km and nautical miles.

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## 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>  
*Software*

SixClear - JADE Application Development Environment. (n.d.). <https://sixclear.com/jade/>

## Parameters

Parameter	Description	Units
Time	Time of sampling, in time zone Pacific Time (PST/PDT). Measurements from individual sensors merged based on millisecond timestamp using Python code	unitless
Cruise_ID	Cruise identifier	unitless
ISO_DateTime_UTC	Time of sampling, in time zone (UTC).	unitless
Temperature	Water temperature, degrees Celsius, Sea-Bird SBE 49 FastCAT mounted on ISIS-3 . Quality flag is in the column 'Temperature_flag', see column description for more information about what data are flagged.	degrees Celsius
Conductivity	Water conductivity, measured using SeaBird SBE 49 FastCAT mounted on ISIS-3. Quality flag is in 'Conductivity_flag', see column description for more information about what data are flagged	Siemens per meter (Siemens/m)
Pressure	Pressure measured using SeaBird SBE 49 FastCat mounted on ISIS-3. Quality flag is in 'Pressure_flag', see column description for more information about what data are flagged	decibars (dBar)
Depth	Depth measured using SeaBird SBE 49 FastCat mounted on ISIS-3. Quality flag is 'Depth_flag', see column description for more information about what data are flagged	meters (m)
Salinity	Salinity measured using SeaBird SBE 49 FastCat mounted on ISIS-3. Quality flag is 'Salinity_flag', see column description for more information about what data are flagged	Practical Salinity Units (PSU)
Altitude	Imagenex Model 850 Altimeter mounted on ISIS-3. Altitude of ISIS-3 instrument from seafloor. Only measures within 50m of seafloor, values where ISIS-3 is greater than 50m above seafloor are blank values (null).	meters (m)
Horizontal_Speed	Relative horizontal speed of ISIS instrument through the water, from Valeport Model 803 ROV Current Meter mounted on ISIS-3. Quality flag is 'Horizontal_Speed_flag,' see column description for more information about what data are flagged	centimeters per second (cm/s)

Vertical_Speed	Relative vertical speed of ISIS instrument through the water, from Valeport Model 803 ROV Current Meter mounted on ISIS-3. Quality flag is 'Vertical_Speed_flag,' see column description for more information about what data are flagged	centimeters per second (cm/s)
Fluoro	Fluorescence measured with Wet Labs FLRT mounted on ISIS-3. Quality flag is 'Fluoro_flag,' see column description for more information about what data are flagged	counts
Latitude	Latitude from ship data streams. Merged with sensor data based on millisecond time stamp	decimal degrees
Longitude	Longitude from ship data streams. Merged with sensor data based on millisecond time stamp	decimal degrees
PAR	Photosynthetically active radiation, Biospherical QCP-2300 mounted on ISIS-3. Quality flag is 'PAR_flag,' see column description for more information about what data are flagged	microEinsteins per square centimeter (uEinsteins per cm <sup>2</sup> )
pH	Water pH from SBE 18 mounted on ISIS-3. Quality flag is 'pH_flag,' see column description for more information about what data are flagged	unitless
Oxygen	Dissolved oxygen from SBE 43 mounted with SBE 5M pump on ISIS-3. Quality flag is 'Oxygen_flag' see column description for more information about data flagging	milliliters per liter (ml/L)
chl_a_ul	Conversion from fluorometer counts to chlorophyll-a. Relationship between fluorescence at chlorophyll-a from WetLabs calibration, calculated from a phytoplankton monoculture relationship. Quality flag is 'chl_a_flag', see column description for more information about what data are flagged	microliters per liter (uL/L)
Temperature_flag	Value is 1 where Depth is less than 1m or greater than 110m	unitless
Conductivity_flag	Value is 1 where Pressure is less than 1dbar, or greater than 110 dbar, or blank value (null).	unitless
Pressure_flag	Value is 1 for salinity values <20 psu or blank value (null).	unitless
Depth_flag	Value is 1 where Conductivity < 3 S/m or blank value(null).	unitless
Salinity_flag	Value of 1 where blank value (null).	unitless

Horizontal_Speed_flag	Value of 1 where 'Horizontal_Speed' is less than -500 cm/s, greater than 500 cm/s, or blank value (null).	unitless
Vertical_Speed_flag	Value of 1 where 'Vertical_Speed' is greater than 4000 cm/s, less than 0 m/s or blank value (null).	unitless
Fluoro_flag	Value of 1 where Fluorometer value is blank value (null)., less than 0, or greater than 4000	unitless
PAR_flag	Value of 1 where PAR is greater than 0.1 $\mu\text{E/s}$ , less than 0 $\mu\text{E/s}$ or blank values (null).	unitless
pH_flag	Value of 1 where pH is blank value (null) or less than 7	unitless
Oxygen_flag	Value of 1 where blank value (null).	unitless
chl_a_flag	Value of 1 where chl_a_ul is blank value (null)., less than 0 microliters per liter, or greater than 45 microliters per liter	unitless
flag_totals	Total sum of all flags in data. Ranges from 0 to 12, where 0 has no quality flags, and 12 represents data that are the most likely to contain errors or extreme data to be highly scrutinized	unitless

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## Instruments

<b>Dataset-specific Instrument Name</b>	Altimeter (ImageNex 850)
<b>Generic Instrument Name</b>	Altimeter
<b>Dataset-specific Description</b>	Instrumentation associated with ISIIS-3.
<b>Generic Instrument Description</b>	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.

<b>Dataset-specific Instrument Name</b>	Flowmeter (Valeport 803 ROV Current Meter)
<b>Generic Instrument Name</b>	Flow Meter
<b>Dataset-specific Description</b>	Instrumentation associated with ISIS-3.
<b>Generic Instrument Description</b>	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.

<b>Dataset-specific Instrument Name</b>	Fluorescence (WetLabs ECO-FLRT, S/N FLRT-2611)
<b>Generic Instrument Name</b>	Fluorometer
<b>Generic Instrument Description</b>	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.

<b>Dataset-specific Instrument Name</b>	
<b>Generic Instrument Name</b>	In Situ Ichthyoplankton Imaging System
<b>Dataset-specific Description</b>	Instrumentation associated with ISIS-3 are listed in the "Instruments" section of this dataset page except: Two linescan cameras (55 µm/pixel resolution, Bellamare ISIS-DPI) **imagery data is not associated with this dataset "ISIS Environmental Data"
<b>Generic Instrument Description</b>	The In Situ Ichthyoplankton Imaging System (ISIS) 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 ISIS 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. ISIS 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 (ISIS): system design and preliminary results. Limnol. Oceanogr. Methods. 6:126-132. doi:10.4319/lom.2008.6.126



<b>Dataset-specific Instrument Name</b>	pH sensor (Seabird SBE 18)
<b>Generic Instrument Name</b>	pH Sensor
<b>Dataset-specific Description</b>	Instrumentation associated with ISIS-3.
<b>Generic Instrument Description</b>	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+).

<b>Dataset-specific Instrument Name</b>	Photosynthetically active radiation/irradiance (Biospherical QCP-2300)
<b>Generic Instrument Name</b>	Photosynthetically Available Radiation Sensor
<b>Dataset-specific Description</b>	Instrumentation associated with ISIS-3.
<b>Generic Instrument Description</b>	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.

<b>Dataset-specific Instrument Name</b>	Dissolved oxygen (Sea-Bird 43) with pump (SBE M5)
<b>Generic Instrument Name</b>	Sea-Bird SBE 43 Dissolved Oxygen Sensor
<b>Dataset-specific Description</b>	Instrumentation associated with ISIS-3.
<b>Generic Instrument Description</b>	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

<b>Dataset-specific Instrument Name</b>	CTD (Sea-Bird SBE 49 FastCAT)
<b>Generic Instrument Name</b>	Sea-Bird SBE 49 FastCAT CTD Sensor
<b>Dataset-specific Description</b>	Instrumentation associated with ISIS-3
<b>Generic Instrument Description</b>	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 autonomous (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).

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## Deployments

### MGL2207

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/923370">https://www.bco-dmo.org/deployment/923370</a>
<b>Platform</b>	R/V Marcus G. Langseth
<b>Start Date</b>	2022-07-18
<b>End Date</b>	2022-07-30

### SR2317

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/923378">https://www.bco-dmo.org/deployment/923378</a>
<b>Platform</b>	R/V Sally Ride
<b>Start Date</b>	2023-08-09
<b>End Date</b>	2023-08-21

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## 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 (ISIS) 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.

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-2125408</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-2125407</a>

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