Sample stations for the Neotrypaea COP (Community, Oxygen, & Productivity) Effects ground-truth cruises in 2021 and 2022

Website: https://www.bco-dmo.org/dataset/880760
Data Type: Cruise Results
Version: 2
Version Date: 2023-12-14

Project
» Environmental consequences of expanded recruitment of an ecosystem engineer on a hypoxia-influenced continental shelf (Neotrypaea COP Effects)

Contributors	Affiliation	Role
Henkel, Sarah K.	Oregon State University (OSU)	Principal Investigator
Reimers, Clare E.	Oregon State University (OSU)	Co-Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Benthic invertebrate communities, that the highly productive US West Coast fishery species and marine mammals rely on for food, are being increasingly impacted by low oxygen conditions. This project addresses the potential ecological consequences of a new member to these benthic communities, the ghost shrimp Neotrypaea. In estuaries, Neotrypaea continuously rework the sediment via their burrowing activities. Their high abundances and geological effects make them important in mitigating impacts of nutrient run-off (natural and human-induced), which can exacerbate low oxygen conditions. Neotrypaea are also considered threats to the oyster industry because of their sediment-excavating activities. An expansion of their distribution beyond estuaries may have additional consequences for the Dungeness crab fishery (regionally valued at $33-74M/y) as Neotrypaea sp. are both competitors with juveniles and prey for larger Dungeness crab. This project will ground-truth predictions of Neotrypaea's new offshore distribution with video and sample collections. Using box core samples we will document differences in potentially interacting benthic communities within the Neotrypaea beds as compared to areas not colonized by the shrimp. These new data are needed to determine whether the existing species composition is altered by the recruitment of Neotrypaea. We will estimate the shrimp's contribution to benthic oxygen and nutrient fluxes by using aquatic eddy covariance (EC) methods and core incubations in shelf areas with and without abundant shrimp. This dataset includes the sampling locations for the model ground-truthing/community changes (box core collections) and the EC lander deployment and slow core collections. Coastal waters along the OR-WA shelf are subject to growing human related management, extractive, cultural, and recreational activities. This research is particularly needed for commercial fisheries stakeholders in decisions regarding ocean-use planning and be valuable to oyster growers concerned over burrowing shrimp pest management.

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Coverage

Spatial Extent: **N**:46.9936 **E**:-124.027 **S**:44.3377 **W**:-124.559
Temporal Extent: 2021-10-19 - 2022-09-22

Methods & Sampling

Sampling was conducted along the Pacific Continental Shelf of Oregon and Washington (44.34 N to 46.99 N, depth 42 to 88 meters) during the following cruises (dates are provided in YYYY-MM-DD format):
COP2021 (2021-10-19) on R/V Pacific Storm,
COP2022A (2022-04-07) on R/V Pacific Storm,
COP2022B (2022-07-07 to 2022-07-10) on R/V Pacific Storm,
COP2022C, cruise IDs SP2215 and RS2215 (2022-07-22 to 2022-07-23) on R/V Gordon Sproul,
COP2022D, cruise ID SP2219 (2022-09-13 to 2022-09-19) on R/V Gordon Sproul,
COP2022E (2022-09-21 to 2022-09-22) on R/V Pacific Storm.

At each box core station, samples were collected with a modified Grey-O'Hara 0.1 square meter (m^2) box core. One box core sample was taken at each station. Depth was recorded from the vessel's echosounder at the time the box corer hit the bottom. Only samples with a penetration depth of at least 4 centimeters (cm) were accepted for processing. Approximately 80 milliliters (mL) of sediment were collected from the undisturbed surface layer for later grain size analysis. Any organisms noticed in the sediment subsample at the time of collection were removed and placed in the organism sample jar. Surface sediment samples were then stored in the ship's refrigerator. The remainder of the collected core was sieved onboard through a 1.0 millimeter (mm) mesh screen, and all organisms except the target shrimp *Neotrypaea* (both infauna living in the sediment and small epifauna which may have been on the surface, hereafter collectively called "macrofauna") as well as debris retained on the screen were preserved in 70% EtOH. *Neotrypaea* in good condition were placed in a cooler with collected sediment and battery-operated bubblers to keep for experiments at the Hatfield Marine Science Center. *Neotrypaea* deemed not suitable for experimental work were preserved in 95% EtOH and placed in the freezer.

At approximately every third station, vertical water-column profiles of conductivity, temperature, dissolved oxygen, pH, and fluorescence were obtained with a Sea-Bird Electronics CTD (conductivity, temperature, depth) unit equipped with additional sensors. At approximately every third station on COP2022B, a camera lander with two downward-facing video cameras was dropped and left on the seafloor for one minute and then retrieved. Those videos will be later analyzed for the presence of burrows holes attributable to the *Neotrypaea* and to be used to check for false negatives (places where the shrimp are present but not collected in the box core).

At each camera lander station, a camera lander with two downward-facing video cameras and a set of lights for each camera was dropped and left on the seafloor for one minute and then retrieved. The field of view of each camera is ~0.4 m^2. Burrows holes attributable to *Neotrypaea* were quantified on each video. In addition to quantification, these were used to check for false negatives (places where the shrimp are present but not collected in the box core).

The EC lander deployments yield high-resolution time-series measurements of near-bed velocities and dissolved oxygen from which benthic fluxes of oxygen have been derived for each 15-minute sampling interval.

The BBL lander is a platform that supports a Nortek Aquadopp velocity profiler and a triggered sampling device that collects water samples at discrete heights (1 to 100 cm) above the seabed. In cases where the near-bed gradients can be resolved, these data may be modeled to yield benthic fluxes.

The slow corer refers to a coring device that takes sediment cores (10.5 cm diameter) that typically have intact sediment water-interfaces and sediment column lengths of 50-60 cm. After collection, these are immediately moved to the cold van. These cores are utilized for core incubations made at sea to yield ex-situ benthic fluxes, and these cores are sectioned for post-cruise analyses of porosity, bulk density, grain size, total C and N, and inorganic C.

Data Processing Description

BCO-DMO Processing:
- renamed fields to comply with BCO-DMO naming conventions;
- replaced blanks with "No" in the VideoDive column (to distinguish from "no data");
- added date-time field in ISO8601 format;
- converted PDT dates to format YYYY-MM-DD;

- replaced blanks with "nd" (no data).

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Data Files

File
880760_v2_sample_stations.csv (Comma Separated Values (.csv), 33.08 KB) MD5:a13abf27df7755045b7b14dc55242fe6
Primary data file for dataset ID 880760, version 2

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Related Datasets

IsRelatedTo

Reimers, C. E., Henkel, S. K., Hughes, A., Fogaren, K. E. (2024) **Benthic dissolved oxygen and nutrient fluxes from sediment core incubations conducted aboard the R/V Oceanus and R/V Robert G. Sproul during nine cruises from 2018-2022 from the Oregon and Washington shelf.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-10-15 doi:10.26008/1912/bco-dmo.940414.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Sample	Sample number	unitless
Sample_Date	Combination of sample number with sampling month and year	unitless
Project	Project ("COP" = "Community, Oxygen, & Productivity")	unitless
Vessel	Name of the ship. "Sproul" = R/V Gordon Sproul; "Storm" = R/V Pacific Storm	unitless
CruiseID	Cruise ID number	unitless
Site	Name of sampling site	unitless
DecLat	Latitude; positive values = North	decimal degrees
DecLon	Longitdue; negative values = West	decimal degrees

Date_PDT	Sampling date (PDT time zone)	unitless
Time_PDT	Sampling time (PDT time zone)	unitless
ISO_DateTime_PDT	Sampling date and time (PDT) in ISO 8601 format	unitless
ISO_DateTime_UTC	Sampling date and time (UTC) in ISO 8601 format	unitless
Operation	Description of the sampling activity	unitless
CTDCast	CTD cast number	unitless
VideoDive	Indicates if camera lander was dropped at the site (Yes/No)	unitless
Depth_fa	Sampling depth in fathoms	fathoms (fa)
Depth_m	Sampling depth in meters	meters (m)
Pen_cm	Penetration depth (depth the box corer penetrated the seafloor sediment)	centimeters (cm)
Notes	Notes/comments	unitless

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Instruments

Dataset-specific Instrument Name	modified Grey-O'Hara box core
Generic Instrument Name	Box Corer
Dataset-specific Description	The sampler is a modified Grey-O'Hara 0.1 m² box core built by Halco welding in South Beach, Newport, OR.
Generic Instrument Description	General description of a box corer: A box corer is a marine geological tool that recovers undisturbed soft surface sediments. It is designed for minimum disturbance of the sediment surface by bow wave effects. Traditionally, it consists of a weighted stem fitted to a square sampling box. The corer is lowered vertically until it impacts with the seabed. At this point the instrument is triggered by a trip as the main coring stem passes through its frame. While pulling the corer out of the sediment a spade swings underneath the sample to prevent loss. When hauled back on board, the spade is under the box. (definition from the SeaVox Device Catalog) Box corers are one of the simplest and most commonly used types of sediment corers. The stainless steel sampling box can contain a surface sediment block as large as 50cm x 50cm x 75cm with negligible disturbance. Once the sediment is recovered onboard, the sediment box can be detached from the frame and taken to a laboratory for subsampling and further analysis. The core sample size is controlled by the speed at which the corer is lowered into the ocean bottom. When the bottom is firm, a higher speed is required to obtain a complete sample. A depth pinger or other depth indicator is generally used to determine when the box is completely filled with sediment. Once the core box is filled with sediment, the sample is secured by moving the spade-closing lever arm to lower the cutting edge of the spade into the sediment, until the spade completely covers the bottom of the sediment box. (definition from Woods Hole Oceanographic Institution).

Dataset-specific Instrument Name	Sea-Bird Electronics CTD
Generic Instrument Name	CTD Sea-Bird
Dataset-specific Description	The profiling CTD includes: SEALOGGER CTD - With modular temperature and conductivity sensors (SBE 3F and SBE 4C) and TC Duct, submersible pump, 350 m modular strain gauge pressure sensor. SBE 43 Dissolved Oxygen Sensor (Profiling Configuration). SBE 27 pH/ORP sensor. WET Labs ECO-FLNTU(RT), Chlorophyll & Turbidity sensor, 50 µg/l & 25 NTU range. The CTD was serviced by Seabird in January 2022.
Generic Instrument Description	A Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics. This instrument designation is used when specific make and model are not known or when a more specific term is not available in the BCO-DMO vocabulary. Refer to the dataset-specific metadata for more information about the specific CTD used. More information from: http://www.seabird.com/

Dataset-specific Instrument Name	a camera lander with two downward-facing video cameras
Generic Instrument Name	Underwater Camera
Dataset-specific Description	The camera lander consists of: Two sets of (4 total) DeepSea Power and Lights LED SeaLites. 1 Titanium CR2 CP underwater pressure housing holding three NMFS-5 NiMh batteries to power the lights. Two ParaLenz Vaquita underwater video cameras.
Generic Instrument Description	All types of photographic equipment that may be deployed underwater including stills, video, film and digital systems.

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Deployments

COP2021

Website	https://www.bco-dmo.org/deployment/880767
Platform	R/V Pacific Storm
Start Date	2021-10-19
End Date	2021-10-19

COP2022A

Website	https://www.bco-dmo.org/deployment/880768
Platform	R/V Pacific Storm
Start Date	2022-04-07
End Date	2022-04-07

COP2022B

Website	https://www.bco-dmo.org/deployment/880769
Platform	R/V Pacific Storm
Start Date	2022-07-07
End Date	2022-07-10

SP2215

Website	https://www.bco-dmo.org/deployment/916941
Platform	R/V Robert Gordon Sproul
Start Date	2022-07-22
End Date	2022-07-25
Description	More information is available at R2R: https://www.rvdata.us/search/cruise/SP2215

SP2219

Website	https://www.bco-dmo.org/deployment/916944
Platform	R/V Robert Gordon Sproul
Start Date	2022-09-14
End Date	2022-09-19
Description	More information is available at R2R: https://www.rvdata.us/search/cruise/SP2219

COP2022E

Website	https://www.bco-dmo.org/deployment/916947
Platform	R/V Pacific Storm
Start Date	2022-09-21
End Date	2022-09-22

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Project Information

Environmental consequences of expanded recruitment of an ecosystem engineer on a hypoxia-influenced continental shelf (Neotrypaea COP Effects)

Coverage: NE Pacific continental shelf

NSF Award Abstract:
Highly productive US West Coast fishery species and marine mammals rely on benthic invertebrate communities for food. However, these communities are changing. This project addresses the potential ecological consequences of a new member to these benthic communities, the ghost shrimp Neotrypaea. In estuaries, Neotrypaea continuously rework the sediment via their burrowing activities. The combination of high shrimp abundances and the effects of burrowing mitigate the impacts of nutrient run-off (natural and human-induced) that can exacerbate low oxygen conditions. However, Neotrypaea are also considered threats to the oyster industry because of their sediment-excavating activities. An expansion of their distribution beyond estuaries may have additional unforeseen consequences for the Dungeness crab fishery (regionally valued at $33-74M/y) as Neotrypaea are both competitors with juveniles and prey for larger Dungeness crab. Thus, new data are needed to determine how offshore benthic communities are being altered by the recruitment of Neotrypaea into new habitats. This study is comparing communities with high and low shrimp abundances to understand their impact on offshore benthic communities. The shrimp's contributions to oxygen and carbon cycling are being estimated through field measurements. Benthic community assessments are quantifying changes to food resources on the seafloor caused by the presence of these relatively large shrimp. The coastal waters along the Oregon-Washington shelf are commercially valuable, yet they are also subject to growing human-related impacts. Sustainable management requires optimizing extractive, cultural, and recreational activities. The broader impacts of this research include key data for managers, commercial fisheries' stakeholders and oyster growers that inform decisions regarding ocean-use planning and management of burrowing shrimp. This project is providing research training for three graduate students and two summer undergraduate students. Curriculum development for elementary school students is focused on the ecology of soft-bottom benthos. The ocean sandy/muddy benthos are often unknown to K-12 students on the West Coast who are usually more familiar with intertidal and kelp forest systems.

Changing environmental conditions in shelf waters along the Oregon and Washington coasts and elsewhere have included increasingly frequent and severe hypoxia events, ocean acidification, and warming. These changes have affected biological communities and altered species distributions. An abundant mid-shelf population of the burrowing ghost shrimp, Neotrypaea sp. was documented in shelf waters following the Marine Heat Wave of 2015. Neotrypaea are ecosystem engineers that were previously known to be abundant in intertidal estuary mudflats with an insignificant presence in the open ocean. In estuaries Neotrypaea continuously rework the sediment via their burrowing activities. The shrimp can increase oxygen cycling due to

burrow irrigation and reduce impacts of nutrient loading such as low-oxygen conditions. However, enhanced benthic oxygen consumption linked to Neotrypaea sp. beds could have the opposite effect on the shelf by intensifying regional hypoxia. This study is characterizing the environmental conditions associated with the expanded distribution of Neotrypaea using a habitat-suitability modeling approach. Model predictions are being validated through extensive field sampling via box coring and video lander observations. In addition, the benthic samples are documenting changes in the benthic invertebrate communities within the Neotrypaea beds and how this is potentially affecting biological interactions. Analyses of aquatic eddy covariance and of core incubations in shelf areas with and without abundant shrimp are providing estimates of the shrimp's contribution to benthic oxygen fluxes and organic carbon cycling. These data are being used to quantify the shrimp's and their burrows' effects on the overall productivity of the mid-shelf benthos relative to reference areas. How Neotrypaea alter seafloor structure and biogeochemistry need to be characterized to predict the impact of these ecosystem engineers on the food supply for higher trophic levels and fisheries.

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-2126112

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