Bulk tissue stable isotope analysis of zooplankton samples collected by MOCNESS from R/V Sally Ride and R/V Roger Revelle cruises in the southern California Current Ecosystem from 2020-2023

Website: https://www.bco-dmo.org/dataset/971975
Data Type: Cruise Results
Version: 1
Version Date: 2025-08-22

Project
» Resolving vertical trophic linkages between surface and deep pelagic food webs (DeepSeaWebs)

Contributors	Affiliation	Role
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Abstract
We estimated the trophic positions of abundant gelatinous zooplankton (chaetognaths, cnidarians, ctenophores, molluscs, and pelagic tunicates) in the southern California Current Ecosystem using stable carbon and nitrogen isotope analysis. Gelatinous zooplankton were collected on four research cruises on the R/V Sally Ride and R/V Roger Revelle between 2020 and 2023 and from 0 to 3,000 meters depth using a 10-square-meter Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS). 561 samples of gelatinous zooplankton from thirteen taxonomic groups were chosen for bulk tissue stable isotope analysis. An additional twenty samples from seven gelatinous genera were chosen for nitrogen compound-specific isotope analysis of amino acids because they were abundant across our region and represented a range of hypothesized feeding guilds and depth habitats (0 – 1,025 meters). Gelatinous zooplankton were briefly thawed to remove visible gut contents using forceps and a scalpel. Samples were then lyophilized and homogenized. To ensure sufficient sample mass for stable isotope analysis, samples often contained multiple individuals from the same net, taxonomic group, and size class. The number of individuals per sample was typically fewer than 100, with a larger number of individuals pooled for some samples of Pantachogon spp. and Hormiphora spp. Samples were processed for bulk tissue stable isotope analysis at the University of Hawaii at Manoa and the University of California Merced. This dataset includes the bulk tissue stable isotope measurements of carbon and nitrogen as well as specimen metadata (e.g., animal body size, collection location/time).

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Coverage

Location: Southern California Current Ecosystem
Spatial Extent: **N**:33.79 **E**:-118.33 **S**:30.13 **W**:-125
Temporal Extent: 2020-08-24 - 2023-10-25

Methods & Sampling

Gelatinous zooplankton were collected on four research cruises between 2020 and 2023 at seven stations representing four nearshore and escarpment, and two offshore regions within the Southern California Bight. We conducted depth-discrete sampling of gelatinous zooplankton using a 10-square-meter (m^2) Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) equipped with five depth-discrete nets (mesh sizes 5-millimeter (mm), Wiebe et al., 1985). The 10 m^2 MOCNESS was towed obliquely as the ship traveled at a speed between 1 to 2 knots, with depth-discrete collections occurring on the upcast. Sampling stations and depth intervals varied across stations and cruises, but there were typically two depth intervals sampled within the upper 500 meters (m) and larger depth intervals below 500 m. The maximum depth of sampling increased from 1,250 m nearshore to 3,000 m offshore, corresponding with the deepening of the water column.

Upon recovery, samples were stored in chilled seawater and kept at 5 degrees Celsius (°C) until processing. All sample processing was performed on ice to preserve body condition. Gelatinous zooplankton were identified to the most specific taxonomic level using published keys. The concentration of carbon and/or nitrogen can be low in gelatinous individuals (Lüskow et al., 2021), so we pooled multiple gelatinous individuals into a single sample, while standardizing size ranges. Individuals within a taxonomic group were split into relative size classes. The minimum, median, and maximum lengths of individuals within each size class were recorded to the nearest millimeter. Bell diameter was measured for medusae, body diameter for ctenophores, and total length for pelagic tunicates, molluscs, and chaetognaths. The number of individuals per size class was counted and then weighed as a group to the nearest 0.01 gram (g) using a motion-compensating scale (Marel M2400), which was routinely calibrated at sea following manufacturer instructions. Samples were stored in Whirl-Paks at -80°C until further processing in the laboratory.

561 samples of gelatinous zooplankton representing 13 taxonomic groups were chosen for bulk tissue stable carbon and nitrogen isotope analysis. Gelatinous zooplankton were briefly thawed to remove visible gut contents using forceps and a scalpel, which were cleaned with ethanol between samples. Both gelatinous zooplankton and mesozooplankton samples were then lyophilized and homogenized in Whirl-Paks. To ensure sufficient sample mass for stable isotope analysis, samples often contained multiple individuals from the same net, taxonomic group, and size class. The number of individuals per sample was typically fewer than 100, with a larger number of individuals pooled for some samples of *Pantachogon* spp. and *Hormiphora* spp.

Dried, homogenized tissues were packaged into tin capsules (1.5 to 4 milligrams (mg) per sample) for bulk tissue stable isotope analyses, which were conducted at the University of Hawaii at Manoa and the University of California Merced. Briefly, samples were run on a Costech 4010 Elemental Combustion System coupled to either a ThermoScientific DELTA V Advantage, ThermoScientific DELTA V+, or a ThermoFinnigan DeltaPlus XP isotope ratio mass spectrometer through a ThermoScientific Conflo IV interface. Stable isotope values are reported in the standard per mille notation (‰), compared to the standards atmospheric $N_2$and Vienna Pee Dee Belemnite for nitrogen and carbon, respectively. To ensure accuracy and instrument precision, both labs used a combination of international reference materials (from the United States Geological Survey or the National Institute of Standards and Technology) and in-house reference materials (squid or tuna) with known δ15N and δ13C values. Based on analyzed reference materials, sample reproducibility was ± 0.2‰ for samples run at the University of Hawaii at Manoa, and sample reproducibility was ± 0.4‰ for samples run at UC Merced.

BCO-DMO Processing Description

- Imported original file "gelatinous_zooplankton_bulk_stable_isotopes.csv" into the BCO-DMO system.
- Created Date_UTC column in YYYY-MM-DD format.
- Saved final file as "971975_v1_bulk_sia_gelatinous_zooplankton.csv".

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Data Files

File
971975_v1_bulk_sia_gelatinous_zooplankton.csv (Comma Separated Values (.csv), 95.46 KB) MD5:0a3769549cc2c6702415da325bec317d Primary data file for dataset ID 971975, version 1

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Related Publications

Chavarry, J., Hetherington, H., Close, H., Choy, C. A. (under review) Using stable isotopes to describe the trophic structure of gelatinous zooplankton across the deep pelagic. Limnology and Oceanography.
Results

Lüskow, F., Galbraith, M., Hunt, B., Perry, R., & Pakhomov, E. (2021). Gelatinous and soft-bodied zooplankton in the Northeast Pacific Ocean: organic, elemental, and energy contents. Marine Ecology Progress Series, 665, 19–35. https://doi.org/10.3354/meps13663
Methods

Wiebe, P. H., Morton, A. W., Bradley, A. M., Backus, R. H., Craddock, J. E., Barber, V., … Flierl, G. R. (1985). New development in the MOCNESS, an apparatus for sampling zooplankton and micronekton. Marine Biology, 87(3), 313–323. doi:10.1007/bf00397811 https://doi.org/10.1007/BF00397811
Methods

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Parameters

Parameter	Description	Units
specimen_number	sample identifier	unitless
phylum	sample phylum	unitless
genus	sample genus	unitless
best_taxonomic_ID	the finest taxonomic level the gelatinous zooplankton were identified to	unitless
tow	the tow number when the sample was collected	unitless
net	the net number when the sample was collected	unitless
Date_UTC	date the sample was collected (UTC)	unitless
year	the year the sample was collected (UTC)	unitless
month	the month the sample was collected (UTC)	unitless

day	the day the sample was collected (UTC)	unitless
specimen_count	the number of individual gelatinous zooplankton in that sample	number of individuals
EA_mass	the mass of the dried sample analyzed on the elemental analyzer	milligrams
nitrogen_ug	the sample's nitrogen mass detected by the elemental analyzer	micrograms
d15N_bulk	nitrogen isotope ratio relative to atmospheric N2 detected by the isotope ratio mass spectrometer	parts per thousand
carbon_ug	the sample's carbon mass detected by the elemental analyzer	micrograms
d13C_bulk	carbon isotope ratio relative to Vienna Pee Dee Belemnite detected by the isotope ratio mass spectrometer	parts per thousand
sia_lab	University of Hawaii at Manoa	unitless
SIA_reproducibility	the reproducibility of the stable isotope ratio values, as reported by the stable isotope labs	parts per thousand
length_type	the way the gelatinous zooplankton individuals were measured dependent on taxonomy, either bell diameter, body diameter, or total length	unitless
median_length_mm	the median length of individuals in a sample	millimeters
taxa_wmd_rounded_25_m	the weighted mean depth of the taxonomic grouping across all locations and sampling years, rounded to the nearest 25 m depth	meters
min_depth_m	the minimum depth of collection for the net that collected the sample	meters
max_depth_m	the maximum depth of collection for the net that collected the sample	meters
mean_depth_m	the mean depth of collection for the net that collected the sample	meters
latitude	the latitude of where the sample was collected	decimal degrees
longitude	the longitude of where the sample was collected	decimal degrees

sampling_location	the region within the southern California Current Ecosystem where the sample was collected, either "nearshore", "escarpment", or "offshore"	unitless
sampling_time	the time of sample collection, either "day" or "night"	unitless
season	the season of collection, either "summer" or "fall"	unitless

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Instruments

Dataset-specific Instrument Name	ThermoScientific Conflo IV interface
Generic Instrument Name	Continuous Flow Interface for Mass Spectrometers
Dataset-specific Description	used for the determination of stable isotope ratios of carbon and nitrogen
Generic Instrument Description	A Continuous Flow Interface connects solid and liquid sample preparation devices to instruments that measure isotopic composition. It allows the introduction of the sample and also reference and carrier gases. Examples: Finnigan MATConFlo II, ThermoScientific ConFlo IV, and Picarro Caddy. Note: This is NOT an analyzer

Dataset-specific Instrument Name	Costech 4010 Elemental Combustion System
Generic Instrument Name	Costech International Elemental Combustion System (ECS) 4010
Dataset-specific Description	used for the determination of stable isotope ratios of carbon and nitrogen
Generic Instrument Description	The ECS 4010 Nitrogen / Protein Analyzer is an elemental combustion analyser for CHNSO elemental analysis and Nitrogen / Protein determination. The GC oven and separation column have a temperature range of 30-110 degC, with control of +/- 0.1 degC.

Dataset-specific Instrument Name	ThermoFinnigan Deltaplus XP isotope ratio mass spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	used for the determination of stable isotope ratios of carbon and nitrogen
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	10 m2 Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS)
Generic Instrument Name	MOCNESS
Dataset-specific Description	used to collect gelatinous zooplankton at sea
Generic Instrument Description	The Multiple Opening/Closing Net and Environmental Sensing System or MOCNESS is a family of net systems based on the Tucker Trawl principle. There are currently 8 different sizes of MOCNESS in existence which are designed for capture of different size ranges of zooplankton and micro-nekton Each system is designated according to the size of the net mouth opening and in two cases, the number of nets it carries. The original MOCNESS (Wiebe et al, 1976) was a redesigned and improved version of a system described by Frost and McCrone (1974). (from MOCNESS manual)

Dataset-specific Instrument Name	Marel M2400 motion compensating scale
Generic Instrument Name	scale or balance
Dataset-specific Description	used to weigh gelatinous zooplankton at sea
Generic Instrument Description	Devices that determine the mass or weight of a sample.

Dataset-specific Instrument Name	ThermoScientific DELTA V Advantage isotope ratio mass spectrometer
Generic Instrument Name	Thermo Fisher Scientific DELTA V Advantage isotope ratio mass spectrometer
Dataset-specific Description	used for the determination of stable isotope ratios of carbon and nitrogen
Generic Instrument Description	The Thermo Scientific DELTA V Advantage is an isotope ratio mass spectrometer designed to measure isotopic, elemental, and molecular ratios of organic and inorganic compounds. The DELTA V Advantage is the standard model of the DELTA V series of isotope ratio mass spectrometers, which can be upgraded to the DELTA V Plus. The DELTA V Advantage can be operated in Continuous Flow or Dual Inlet mode. The standard collector configuration is the Universal Triple Collector. H2 collectors with online hydrogen capability are optional. The DELTA V Advantage is controlled by an automated, integrated Isodat software suite. A magnet, whose pole faces determine the free flight space for the ions, eliminates the traditional flight tube. The magnet is designed for fast mass switching which is further supported by a fast jump control between consecutive measurements of multiple gases within one run. The sample gas is introduced at ground potential, eliminating the need for insulation of the flow path, ensuring 100 percent transfer into the ion source. The amplifiers register ion beams up to 50 V. The DELTA V Advantage has a sensitivity of 1200 molecules per ion (M/I) in Dual Inlet mode and 1500 M/I in Continuous Flow mode. It has a system stability of < 10 ppm and an effective magnetic detection radius of 191 nm. It has a mass range of 1 - 80 Dalton at 3 kV.

Dataset-specific Instrument Name	ThermoScientific DELTA V+ isotope ratio mass spectrometer
Generic Instrument Name	Thermo Fisher Scientific DELTA V Plus isotope ratio mass spectrometer
Dataset-specific Description	used for the determination of stable isotope ratios of carbon and nitrogen
Generic Instrument Description	The Thermo Scientific DELTA V Plus is an isotope ratio mass spectrometer designed to measure isotopic, elemental and molecular ratios of organic and inorganic compounds. The DELTA V Plus is an enhanced model of the DELTA V series of isotope ratio mass spectrometers, which can be upgraded from the DELTA V Advantage. The DELTA V Plus can be operated in Continuous Flow or Dual Inlet mode and can accommodate up to 10 collectors, ensuring flexibility to cover many applications. The DELTA V Plus is controlled by an automated, integrated Isodat software suite. A magnet, whose pole faces determine the free flight space for the ions, eliminates the traditional flight tube. The magnet is designed for fast mass switching which is further supported by a fast jump control between consecutive measurements of multiple gases within one run. The sample gas is introduced at ground potential, eliminating the need for insulation of the flow path, ensuring 100 percent transfer into the ion source. The amplifiers register ion beams up to 50 V. The DELTA V Plus has refined optics, enabling greater ion transmission than the DELTA V Advantage. It has a sensitivity of 800 molecules per ion (M/I) in Dual Inlet mode and 1100 M/I in Continuous Flow mode. It has a system stability of < 10 ppm and an effective magnetic detection radius of 191 nm. It has a mass range of 1 - 96 Dalton at 3 kV.

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Deployments

SR2007

Website	https://www.bco-dmo.org/deployment/971990
Platform	R/V Sally Ride
Start Date	2020-08-22
End Date	2020-09-04
Description	More information is available from R2R: https://www.rvdata.us/search/cruise/SR2007

SR2212

Website	https://www.bco-dmo.org/deployment/971993
Platform	R/V Sally Ride
Start Date	2022-11-25
End Date	2022-11-30
Description	More information is available from R2R: https://www.rvdata.us/search/cruise/SR2212

SR2323

Website	https://www.bco-dmo.org/deployment/971996
Platform	R/V Sally Ride
Start Date	2023-10-11
End Date	2023-10-25
Description	More information is available from R2R: https://www.rvdata.us/search/cruise/SR2323

RR2104

Website	https://www.bco-dmo.org/deployment/948513
Platform	R/V Roger Revelle
Start Date	2021-06-12
End Date	2021-07-01
Description	More information is available from R2R: https://www.rvdata.us/search/cruise/RR2104

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Project Information

Resolving vertical trophic linkages between surface and deep pelagic food webs (DeepSeaWebs)

Coverage: Southern California Current

NSF Award Abstract:
This CAREER award is advancing our understanding of connections between surface and deep water ocean food webs, which in turn has important implications for carbon cycling in the ocean. Although marine ecosystems deeper than 200 m encompass Earth's largest single habitat, the food web relationships of deep-sea organisms are poorly resolved. The investigator is evaluating active transport by fishes, squids, crustaceans, and gelatinous animals that move organic matter from the more productive surface into deeper waters through feeding and diel vertical migration. She is using a combination of data on abundance and distribution of species with measurements of stable isotope biomarkers to understand trophic relationships

and connect community composition and migratory behavior with food-web processes in the southern California Current ecosystem. The investigator is from a group traditionally underrepresented in science, and she has designed a comprehensive educational plan to train a more diverse, inclusive generation of seagoing biological oceanographers through hands-on field and research experiences. In addition to providing support for graduate and undergraduate students to participate directly in this research, the investigator is creating a novel and cohesive undergraduate curriculum involving a seagoing laboratory course to teach interdisciplinary field methods to conduct research on pelagic ecosystems and a seminar course highlighting Native and Indigenous knowledge alongside more traditional oceanographic research. The overall goal is to broaden participation in science by combining hands-on interdisciplinary research, mentoring, and expanding networks of minority and majority scientists.

This study centers around Vinogradov's "ladder of migrations" as a conceptual framework, with the goal of understanding cumulative downward transport of organisms and organic matter to the deep ocean by overlapping vertical migrations and feeding. It is focusing on the role of micronekton, defined as ~2-20 cm fishes, cephalopods, crustaceans, and gelatinous animals, as active transporters of surface-derived organic matter across epipelagic, mesopelagic, and upper-bathypelagic layers in the southern California Current Ecosystem. One research cruise is sampling deep pelagic micronekton communities comprehensively and systematically and complements long-term data collected in the surface waters of this ecosystem. Depth-discrete MOCNESS tows are sampling organisms to assess micronekton abundance, biomass, and extent of diel vertical migrations to understand how relative compositions of taxa drive vertical connectivity. Analysis of bulk carbon and nitrogen stable isotopes and compound-specific isotopic analyses of amino acids (AA-CSIA) in organism tissue are providing quantitative assessments of deep-pelagic food webs and measuring the relative strength and composition of trophic linkages between surface and deeper water assemblages across distinct environmental gradients.

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.

This award is funded in whole or in part under the American Rescue Plan Act of 2021 (Public Law 117-2).

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2048210

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