Muscle and carapace carbon and nitrogen isotope data from Atlantic Jonah crabs (Cancer borealis) collected in Southern New England in April and May 2022

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Project
» Collaborative Research: Sources and transformations of export production: A novel 50-year record of pelagic-benthic coupling from coral and plankton bioarchives (GoME Copepod Coral Export)

Contributors	Affiliation	Role
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Abstract
This dataset contains individual-level collection, biological, and bulk stable isotope data for 123 Jonah crabs (Cancer borealis) collected from two commercial fishing areas in southern New England between 13 April and 17 May 2022. Samples include 59 crabs from the inshore portion of Lobster Management Area (LMA) 2, within 6 kilometers (km) of shore, and 64 crabs from offshore LMA 3, approximately 150 km south-southeast of Newport, Rhode Island, near the continental shelf break. For each crab, the dataset reports collection area, National Marine Fisheries Service statistical area, landing date, carapace width, body mass, sex, and numbers of legs and claws. It also includes sample mass, percent carbon, percent nitrogen, carbon-to-nitrogen ratio, and bulk stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values for muscle and carapace tissues. These paired tissues represent different temporal windows of habitat use, with muscle integrating recent residence and carapace preserving an earlier residence signal. Both original isotope measurements and corrected values are provided. Carapace isotope values were adjusted to the muscle tissue plane using empirically derived tissue-correction factors, after which muscle and tissue-corrected carapace values were adjusted for trophic discrimination to facilitate comparison with regional particulate organic matter isoscapes. The data were collected to investigate Jonah crab movement ecology and habitat use across the southern New England continental shelf.

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Coverage

Location: Southern New England, Lobster Management Area 2 and 3
Spatial Extent: **N**:41.5 **E**:-70 **S**:39 **W**:-72
Temporal Extent: 2022-04-13 - 2022-05-17

Methods & Sampling

Jonah crabs (*Cancer borealis*) were collected in partnership with commercial fishing captains Al Eagles (FV *Catherine Ann*) and Jim Violet (FV *Excalibur*) from two primary fishing areas in southern New England. The inshore collection comprised 59 crabs caught in Lobster Management Area (LMA) 2, within approximately 6 kilometers (km) of shore at a mean water depth of 20 meters (m). The offshore collection comprised 64 crabs caught in LMA 3, approximately 150 km south-southeast of Newport, Rhode Island, at a mean water depth of 90 m. Crabs were collected using standard commercial lobster/Jonah crab traps deployed across more than 2,000 km² within each fishing area. Sampling occurred across multiple traps, fishing days, and vessels between 13 April and 17 May 2022.

Crabs were euthanized by freezing and stored at −20 degrees Celsius (°C) until dissection. Carapace width, body mass, sex, and numbers of intact legs and claws were recorded for each individual. Muscle tissue was dissected from the merus of the walking legs, avoiding legs that showed evidence of regeneration, and freeze-dried for 48 hours. Carapace samples were removed using a rotary tool fitted with a diamond cutting wheel and dried for at least 48 hours. External biota were removed from the carapace with a stainless-steel rotary brush, after which the carapace was ground to a homogeneous powder.

Because carapace contains both organic material and inorganic carbonate, powdered carapace samples were divided into separate subsamples for carbon and nitrogen isotope analysis. Subsamples used for carbon isotope analysis were treated repeatedly with 10% hydrochloric acid until effervescence ceased to remove inorganic carbonate. Subsamples used for nitrogen isotope analysis were not acidified because acid treatment can alter or increase variability in nitrogen isotope values. All muscle and carapace samples were dried and homogenized before analysis. Approximately 0.6 ± 0.1 milligrams (mg) of muscle, 2.5 ± 0.1 mg of acidified carapace for carbon isotope analysis, and 2.0 ± 0.1 mg of untreated carapace for nitrogen isotope analysis were weighed into tin capsules.

Data Processing Description

Stable isotope values are reported in standard delta notation in per mil (‰) relative to Vienna Pee Dee Belemnite for carbon ($\delta^{13}C$) and atmospheric nitrogen for nitrogen ($\delta^{15}N$). Samples were bracketed by laboratory working standards calibrated to international reference materials. Long-term analytical precision, expressed as the standard deviation of working standards, was ±0.2‰ for $\delta^{13}C$ and ±0.3‰ for $\delta^{15}N$.

The dataset contains both original measured isotope values and final corrected values. To account for differences in isotope values caused by the composition of muscle and carapace tissues, carapace measurements were first adjusted to the muscle isotope plane. Tissue correction factors of $\Delta\delta^{13}C = 1.6 \pm 0.6$‰ and $\Delta\delta^{15}N = 7.2 \pm 1.4$‰ were derived from seven crabs that had begun developing a new carapace beneath the existing hardened carapace. Because the new carapace and muscle were formed over the same period and at the same location, their isotope-value offsets were attributed to differences in tissue composition. The correction factors were added to the original carapace $\delta^{13}C$ and $\delta^{15}N$ values.

Muscle values and tissue-corrected carapace values were subsequently adjusted for trophic discrimination to facilitate direct comparison with a regional particulate organic matter (POM) isotope dataset. POM was assigned a trophic position of 1 and Jonah crab a trophic position of 3.98, corresponding to 2.98 trophic transfers. This number of transfers was multiplied by aquatic-invertebrate trophic discrimination factors of 0.5‰ per trophic transfer for $\delta^{13}C$ and 2.9‰ per trophic transfer for $\delta^{15}N$. The resulting offsets — 1.49‰ for $\delta^{13}C$ and 8.64‰ for $\delta^{15}N$ — were subtracted from the muscle and tissue-corrected carapace values to produce the final values reported in the dataset.

BCO-DMO Curation Notes

This section documents curation actions performed prior to publication review with the submitter, and additional information relevant to understanding and reusing this dataset. It distinguishes changes made to the submitted (meta)data from unresolved issues and/or enhancements that improve future reuse and interoperability.

CURATION ACTIONS PERFORMED ON DATA

- Imported the original file, "McMahon_Agvent_BCO-DMO_MEPS_2026_submission.xlsx" (sheet 1) into the BCO-DMO data processing system.
- Renamed columns to comply with BCO-DMO parameter naming conventions.

- Saved the final file as "1011486_v1_sne_jonah_crab_isotopes.csv".

CURATION ACTIONS PERFORMED ON METADATA

- BCO-DMO's standard metadata entry and text formatting steps were performed. See: https://www.bco-dmo.org/how-to/standard-curation-edits

ISSUES POTENTIALLY IMPACTING REUSE

- N/A

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Related Publications

Agvent, L. C., Piccone, S., Truesdale, C., & McMahon, K. W. (2026). Testing the ontogenetic migration hypothesis in the emerging Rhode Island Jonah crab fishery using stable isotope analysis. Marine Ecology Progress Series, 778, 1–14. CLOCKSS. https://doi.org/10.3354/meps15016
Methods

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Parameters

Parameter	Description	Units
Crab_ID	Unique identifier assigned to each individual Jonah crab; prefixes indicate inshore (In_) or offshore (Off_) collection.	unitless
Collection_location	General collection area: inshore for Lobster Management Area 2 or offshore for Lobster Management Area 3.	unitless
Statistical_area	National Marine Fisheries Service statistical-area code associated with the collection location: 539 for inshore or 537 for offshore.	unitless
Date_landed	Calendar date on which the crab was landed	unitless
Carapace_width_mm	Measured carapace width of the individual crab.	millimeters
Weight_g	Whole-body weight of the individual crab.	grams
Sex	Sex of the individual crab: M for male or F for female.	unitless
Leg_count	Number of legs present on the crab at sampling.	count
Claw_count	Number of claws present on the crab at sampling.	count

Muscle_carbon_percent	Carbon content of dried, homogenized muscle tissue as a percentage of sample dry mass.	percent
Muscle_nitrogen_percent	Nitrogen content of dried, homogenized muscle tissue as a percentage of sample dry mass.	percent
Muscle_CN_ratio	Carbon-to-nitrogen mass ratio of the muscle tissue, calculated from the carbon and nitrogen percentages.	unitless
Muscle_delta13C_original_permil	Original measured muscle-tissue stable carbon isotope value before trophic-discrimination correction, reported relative to Vienna Pee Dee Belemnite.	per mille
Muscle_delta15N_original_permil	Original measured muscle-tissue stable nitrogen isotope value before trophic-discrimination correction, reported relative to atmospheric nitrogen.	per mille
Muscle_delta13C_final_permil	Muscle stable carbon isotope value after trophic-discrimination correction for comparison with the regional particulate organic matter isoscape.	per mille
Muscle_delta15N_final_permil	Muscle stable nitrogen isotope value after trophic-discrimination correction for comparison with the regional particulate organic matter isoscape.	per mille
Carapace_carbon_percent	Carbon content of the acidified, dried, and homogenized carapace subsample as a percentage of sample dry mass.	percent
Carapace_nitrogen_percent	Nitrogen content of the untreated, dried, and homogenized carapace subsample as a percentage of sample dry mass.	percent
Carapace_CN_ratio	Carbon-to-nitrogen mass ratio of the carapace, calculated from the carbon and nitrogen percentages.	unitless
Carapace_delta13C_original_permil	Original measured stable carbon isotope value of the acidified carapace subsample before tissue-composition and trophic-discrimination corrections, reported relative to Vienna Pee Dee Belemnite.	per mille
Carapace_delta15N_original_permil	Original measured stable nitrogen isotope value of the untreated carapace subsample before tissue-composition and trophic-discrimination corrections, reported relative to atmospheric nitrogen.	per mille

Carapace_delta13C_final_permil	Carapace stable carbon isotope value after adjustment to the muscle tissue plane and subsequent trophic-discrimination correction.	per mille
Carapace_delta15N_final_permil	Carapace stable nitrogen isotope value after adjustment to the muscle tissue plane and subsequent trophic-discrimination correction.	per mille

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Instruments

Dataset-specific Instrument Name	Costech 4010 Elemental Analyzer
Generic Instrument Name	Costech International Elemental Combustion System (ECS) 4010
Dataset-specific Description	Stable carbon and nitrogen isotope measurements were made using a Costech 4010 Elemental Analyzer coupled to a Thermo Scientific Delta V Advantage isotope-ratio mass spectrometer at the University of Rhode Island Graduate School of Oceanography in Narragansett, Rhode Island, USA.
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	standard commercial lobster/Jonah crab traps
Generic Instrument Name	Lobster Trap
Dataset-specific Description	Crabs were collected using standard commercial lobster/Jonah crab traps deployed across more than 2,000 km² within each fishing area.
Generic Instrument Description	A lobster trap (often called a lobster pot) is a baited trap which traps lobsters or crayfish and is used in lobster fishing. A lobster trap can catch multiple lobsters at once and can be a various sizes. An opening permits the lobster to enter a tunnel of netting and proceed into a "chamber" or "kitchen", where there is bait, and then into the "parlor" from which it cannot escape.

Dataset-specific Instrument Name	Thermo Scientific Delta V Advantage isotope-ratio mass spectrometer
Generic Instrument Name	Thermo Fisher Scientific DELTA V Advantage isotope ratio mass spectrometer
Dataset-specific Description	Stable carbon and nitrogen isotope measurements were made using a Costech 4010 Elemental Analyzer coupled to a Thermo Scientific Delta V Advantage isotope-ratio mass spectrometer at the University of Rhode Island Graduate School of Oceanography in Narragansett, Rhode Island, USA.
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.

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Project Information

Collaborative Research: Sources and transformations of export production: A novel 50-year record of pelagic-benthic coupling from coral and plankton bioarchives (GoME Copepod Coral Export)

Coverage: Jordan Basin, Gulf of Maine (43 to 44.25N, 68.5 to 66.5W)

NSF Award Abstract:
Changes in ocean life, the environment, and the climate can influence the timing and composition of biological material that sinks to the sea floor. As this material sinks it is consumed by bottom-dwelling organisms such as deep-sea corals. Similar to tree rings, corals preserve a history of growth embedded in their skeletons, which can be analyzed using a new technique called microgeochemistry. This project is compiling a historic dataset from deep-sea corals spanning 50 years in the Gulf of Maine to understand how biological material sinking to the bottom has changed with time. Results from the coral analysis are being compared with archival samples of small planktonic crustaceans, copepods, to better understand the connection between productivity in the surface waters and the geochemical record in the coral tissue. A complementary modeling approach is identifying environmental and climatic drivers of decadal-scale oceanographic change with the sources and transformations of organic matter that connect the surface and the deep ocean. This cross-disciplinary project is unifying transformational research with broader impacts focused on science education and outreach that broaden the understanding of the links between climate, oceanography, and marine ecosystem response using a 50-year historical context. Two open-access, media-enhanced, and National curriculum standards-aligned educational lessons plans are being developed through partnerships with a science documentary filmmaker, K-12 teachers from RI and ME, and the PBS LearningMedia Program. The topics of these lesson plans are: 1) Deep-sea exploration: A window into the past and future, and 2) Changing food webs on a changing planet. The project's educational goals include training of three graduate students, career development of five early career researchers, and research experiences for undergraduates from underrepresented groups in STEM. The multi-faceted research and education effort is addressing a question

described as highest priority in the Ocean Sciences by the National Research Council: How are ocean biogeochemical and physical processes linked to today's climate and its variability?

Pelagic-benthic coupling regulates ocean production and food web dynamics, biogeochemical cycling, and climate feedback mechanisms through the export of surface production to the ocean interior. Yet access to long-term data sets of export production are scarce and urgently needed to test assumptions about 1) the sources and transformations of organic matter through different food web pathways, and 2) the variability of these processes across climatic, oceanographic, and ecological changes through time. The proposed work is testing key hypotheses about bottom-up mechanisms that link decadal-scale oceanographic changes in hydrography and biogeochemical cycling with phytoplankton community composition, zooplankton abundance and trophic dynamics, and the resulting composition of export production. Complementary approaches are generating multiple and independent 50+ year, annually resolved time series of phytoplankton community composition, zooplankton trophic dynamics, and export composition. Coral tissue and archived zooplankton samples are being analyzed using pioneering molecular geochemistry approaches to assess changes in diet related variation in primary production. Deep-sea corals are being collected using a remotely operated vehicle (ROV), and zooplankton are available through archival samples from a Gulf of Maine long-term monitoring program managed by NOAA. The stable isotope data are being integrated with additional data from existing long-standing ocean monitoring programs and incorporated into a unifying modeling approach to identify unique ecosystem states and their environmental drivers. The project is focused on Jordan Basin in the Gulf of Maine, which has a long history of oceanographic study and is experiencing significant changes due to climate warming, making it an ideal natural laboratory for testing hypotheses on drivers of change in the composition of exported organic matter, and the relative importance of primary (e.g., phyto-detritus) vs. secondary production (e.g., copepod fecal pellets), and large vs. small pelagic plankton dynamics.

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-2049307

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