nature portfolio

Corresponding author(s): Jessica Lueders-Dumont

Last updated by author(s): Feb 5, 2026

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☐	☒	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☐	☒	A description of all covariates tested
☐	☒	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☒	☐	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☐	☒	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	Thermo Fisher Scientific Isotope Ratio Mass Spectrometry Software (Isodat version 3.0). ImageJ (version: 1.52k).
Data analysis	All data analysis was conducted in the software R (version: 4.1.2) using the following packages: tidyverse (version: 1.3.1), boot (version: 1.3-28), rlist (version: 0.4.6.2), onewaytests (version: 2.7), rstatix (version: 0.7.0), forcats (version: 0.5.1), and tidyr (version: 1.3.1) packages. For other statistical and mapping operations in R, we used ggmap (version: 3.0.0), ggrepel (version: 0.9.3), ggsn (version: 0.5.3), cowplot (version: 1.1), grid (version: 4.1.1), and fishualize (version: 0.2.3).

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

All the raw data supporting the findings of this study are publicly available on figshare (https://10.6084/m9.figshare.28811663).

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	N/A
Reporting on race, ethnicity, or other socially relevant groupings	N/A
Population characteristics	N/A
Recruitment	N/A
Ethics oversight	N/A

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	In this study, we measured nitrogen isotope abundances from preserved proteins of taxonomically-diagnostic fish ear stones (otoliths) and from preserved proteins of coral skeletons. Otolith and coral specimens were collected from pre-historical and modern coral sedimentary deposits from two distinct regions of the Caribbean Sea. With the resulting data, we were able to compare fish dietary patterns from pre-human-disturbance coral reefs and modern reefs, demonstrating the human influence on fish foraging behavior and energy flow on modern, human-impacted Caribbean coral reefs.
Research sample	136 fish otoliths (45 gobies, 40 cardinalfish, 19 silversides, 32 grunts) and 35 coral fragments were measured. Fish families were chosen for their distinct ecological roles from one another on coral reefs and for their high otolith abundances compared to other taxa in the sedimentary record. Coral species Porites furcata was chosen because members of this coral family (Poritidae) are robust archives of changes in the nitrogen isotope composition of primary producers in coral reef environments. Otolith samples are meant to provide the population-level patterns in fish foraging behavior for each family. Coral samples represent a spatially- and temporally-comparable archive to otoliths, providing a control for non-dietary nitrogen isotope differences between regions or time periods.
Sampling strategy	No statistical methods were used to predetermine samples sizes. To select otoliths for isotope analysis, specimens were randomly chosen from sub-localities within each region until n = 10-30 otoliths of each taxon from each region and time period were selected where available. Our sampling strategy focused on obtaining samples from a wide distribution of sub-localities within each region, with the rationale of capturing as much potential variability within each region and time period as possible. For protein extraction and isotopic analysis of otoliths weighing 0.06 mg to 5.5 mg, the whole sample was used. Otoliths >5.5 mg were crushed, homogenized, and subsampled to 4.0 ± 0.5 mg. Initial N isotope analyses involved pooled otoliths out of an abundance of caution to ensure sufficient N (i.e., >5nmol of nitrogen) for analysis. Subsequently, all isotopic analyses were conducted on individual otoliths as even the smallest specimens (otoliths as small as 0.06 mg) yielded sufficient nitrogen for isotope analysis .
Data collection	Isotope Ratio Mass Spectrometry, ImageJ.
Timing and spatial scale	Data collection was not time dependent. The sediment samples were collected between 2012 and 2014.
Data exclusions	No measurements were excluded.
Reproducibility	All batches of isotopic measurements included analyses of internationally-recognized standards and sample replicate analyses.
Randomization	Samples were organized by region and time period.
Blinding	Blinding was not relevant to the study design. The only extent of blinding was that the locality and time period associated with each specimen was not known during isotope analysis--only the taxonomic identity (based on otolith shape and sampleID).

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions	Otoliths and coral specimens were obtained from SCUBA-based sampling of modern coral reefs and from sedimentary sampling of fossil mid-Holocene coral reef deposits. For both the modern and fossil reef sampling, bulk sediments, ~9 kg per sample, were collected from reef frameworks using different methods depending on the time period. In the mid-Holocene sites, sediments were excavated from 3 m deep trenches, while in modern reefs, SCUBA divers collected sediment from 10–15 cm deep strata adjacent to living corals under water depths of 2–19 m. Sediment samples were sieved into size fractions (2 mm, 500 µm, 250 µm, and 106 µm) and then otoliths were manually extracted under a dissecting microscope. Otoliths were identified to their highest taxonomic resolution through comparisons with a region-specific modern otolith reference collection.
Location	Field sites were in the southeast Dominican Republic (-69.7, 18.5) and in Caribbean Panama (-82.3, 9.4).
Access & import/export	Collection permits for bulk sediment sampling of modern and mid-Holocene reefs were issued by the Ministerio de Ambiente, República de Panamá (Permit number SE/AO-4-18) and the Ministerio de Medio Ambiente y Recursos Naturales, República Dominicana (Permit number VAPB-02374).
Disturbance	In the case of the fossil reef site in Panama, disturbance was minimized by sampling sediments within a site where excavation was already being carried out for development of a hotel and resort. For the fossil site in the Dominican Republic, disturbance was minimized by sampling within exposed storm channels in the Enriquillo Basin. For modern reef sedimentary sampling in both regions, sediments were sampled adjacent to living coral but did not disturb the living coral.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☐	☒ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Palaeontology and Archaeology

Specimen provenance	Collection permits for bulk sediment sampling of modern and mid-Holocene reefs were issued by the Ministerio de Ambiente, República de Panamá (Permit number SE/AO-4-18) and the Ministerio de Medio Ambiente y Recursos Naturales, República Dominicana (Permit number VAPB-02374).
Specimen deposition	All otoliths measured destructively for stable isotope analysis were photographed prior to analysis, and the resulting images will be available on FigShare (https://10.0.23.196/m9.figshare.28811663). All additional otoliths from the same collections are available at the Naos Marine Laboratories of the Smithsonian Tropical Research Institute (STRI), Panama, under the category "otolith" without specimen numbers.
Dating methods	No new dates were obtained for this study.

☒ Tick this box to confirm that the raw and calibrated dates are available in the paper or in Supplementary Information.

Ethics oversight	Permits for bulk sediment sampling were issued by the Ministerio de Ambiente, República de Panamá and the Ministerio de Medio Ambiente y Recursos Naturales, República Dominicana. Ethical approval was not required for this study.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Plants

Seed stocks	N/A
Novel plant genotypes	N/A
Authentication	N/A