

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
<i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| ☐ | ☒ 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
<i>Give P values as exact values whenever suitable.</i> |
| ☒ | ☐ 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 | <div>Provide a description of all commercial, open source and custom code used to collect the data in this study, specifying the version used OR state that no software was used.</div> |
| Data analysis | <div>We performed all computations with R statistical software, version 4.1.0. We performed carbonate system calculations using the package seacarb, using equilibrium constants from Lueker et al. We computed linear mixed models using the lmer function in the lmerTest package in R and focused on assessing likely candidate parameters (see text) as fixed factors, and mussel collection date as a random intercept to account for natural seasonal differences between cohorts. Conditional R2 was calculated with the package MuMIn. We determined parameters for non-linear fits employed to model dissolution rates by minimizing the sum of squares of model residuals using the optim function. Colors for plots were chosen from color palettes in the cmocean package in R.</div> |

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](#)

Data will be made available at the Biological and Chemical Oceanography Data Management Office (BCO-DMO).

Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research](#).

Reporting on sex and gender	NA
Population characteristics	NA
Recruitment	NA
Ethics oversight	NA

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	This study measured gross calcification rates in <i>Mytilus californianus</i> when exposed a variety of carbonate chemistry conditions. Gross calcification was calculated as net calcification measured with the alkalinity anomaly technique after subtracting out the contributions of abiotic dissolution determined with separate incubations.
Research sample	A sample consisted of calcification rate measured with the alkalinity anomaly technique for a single adult <i>Mytilus californianus</i> .
Sampling strategy	No methods to predetermine sample size were used. Sample sizes used (n=324) were sufficient in assessing response to predictors of gross calcification rate.
Data collection	Incubations data were recorded manually and later entered into a computer spreadsheet. Alkalinity titrations and spectrophotometric determination of pH were conducted with Metrohm Tiamo and Shimadzu UVProbe software, respectively.
Timing and spatial scale	Mussels were sampled over the course of two and a half years (between January 2020 and April 2022). Mussels were haphazardly sampled from the mid-intertidal zone at a single site in multiple sampling efforts.
Data exclusions	We excluded from our analysis any experimental days where background alkalinity changes exceeded 5 $\mu\text{mol/kg}$ and these data do not appear in the dataset.
Reproducibility	Each mussel collection event reproduced results, though each tested slightly different regions within the carbonate system, except for a mussel collection event in August 2020 where control incubations indicated that background alkalinity changed by > 5 $\mu\text{mol/kg}$ and these were not included in the final dataset.
Randomization	Mussels were haphazardly sampled from the mid-intertidal zone at a single site in multiple sampling efforts. These multiple sampling events were accounted for with a random intercept in the final gross calcification model. In the lab, mussels were assigned to treatments haphazardly.
Blinding	No blinding effort was made but the results are based on chemistry measurements completed after the incubations making it impossible to observe results as the experiments proceeded.

Did the study involve field work? ☐ Yes ☒ No

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

Methods

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