

Reporting Summary

Nature Research 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 Research policies, see [Authors & Referees](#) 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 No software was used to collect data.

Data analysis All statistical analyses were done using the R statistical computing environment (version 3.3.3), except for PERMANOVAs, which were done using the PERMANOVA add-on in PRIMER version 6.1.13. We used the following R packages for analyses: nlme (version 3.1.137), vegan (version 2.5-2), lsmmeans (version 2.27-52), lmodel2 (version 1.7-3).

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/reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research [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 list of figures that have associated raw data
- A description of any restrictions on data availability

All data from the experiment have been uploaded to Zenodo repository and is open to the public (<https://doi.org/10.5281/zenodo.3974299>). Source data for Figures 2-5 and S1-S3 can be provided with the paper.

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	We factorially manipulated grazer loss (one non-removal treatment; three single removal treatments involving removal of either <i>Patella</i> spp., <i>Littorina littorea</i> or <i>Gibbula umbilicalis</i> and one combined removal treatment in which all three grazer taxa were removed simultaneously) and two levels of physical perturbation (i.e. perturbed and unperturbed) within 48 discrete shallow rock pools on an exposed atlantic shore. The 12 treatment combinations were each replicated 4 times.
Research sample	We surveyed the relative abundance of 60 different macroalgal taxa found within each plot. Taxa were identified to species or genus level.
Sampling strategy	We measured the percent cover of macroalgae within experimental plots periodically using a quadrat.
Data collection	We measured the percent cover of macroalgae using a 25 x 25 cm quadrat with 64 intersections, positioned centrally within plots to avoid sampling edge effects. Species present within the quadrat but not occurring underneath any of the intersections were assigned a cover value of 1%. To determine whether percent cover served as a reliable proxy for macroalgal biomass, we took destructive samples from the central 25 x 25 cm area in each experimental plot on the final sampling date to estimate biomass of each macroalgal species, following drying to constant mass at 60°C. All data were collected by LW.
Timing and spatial scale	We surveyed each experimental plot every month from May 2016 until July 2017, resulting in a time series of 15 time points over a 14 month period. This sampling regime is adequate to characterize biomass dynamics over time. Perturbed plots had 50% macroalgal cover removed manually with a chisel as a single pulse perturbation event four months after grazer treatment manipulation to allow sufficient time for transient dynamics to attenuate.
Data exclusions	No data were excluded from analyses
Reproducibility	Each treatment combination was replicated 4 times, with replicates being true biological replicates indicating biological variation.
Randomization	Experimental plots were randomly assigned to treatments. Within perturbed plots the orientation of the cleared patch was randomised among plots.
Blinding	No blinding was applied during data acquisition. However, given the high number of experimental plots and treatments, the considerable variation among plots, and the randomisation of experimental treatments across plots, no systematic observer bias is expected.
Did the study involve field work?	☒ Yes ☐ No

Field work, collection and transport

Field conditions	Monthly in situ surveys of algal communities were done during low Spring tides from May 2017 to July 2017. Mean monthly temperatures varied between 6.5 and 17.5 degrees Celcius and mean monthly light intensity varied from 40 to 140 lumens ft-2 in the local intertidal region during the course of the experiment, weather conditions were highly variable.
Location	Our experiment was done within shallow rock pools (depth < 12 cm) in the mid-shore region (2 - 2.5 m above Chart Datum) of an exposed Atlantic rocky shore at Glansagh Bay, Fanad, Co. Donegal, Ireland (55°26'5"N, 7°6'5"W).
Access and import/export	No access or permits were required by law for the installation of stainless steel cages on the shore, translocation of gastropods or the removal of algal samples at the end of the experiment.
Disturbance	Stainless steel cages were removed promptly from the shore at the end of the experiment to minimise disturbance to the local habitat, algal and invertebrate communities quickly colonised any patches that had been cleared as a result of the cages.

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
☐	☒ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data

Methods

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

Animals and other organisms

Policy information about [studies involving animals](#); [ARRIVE guidelines](#) recommended for reporting animal research

Laboratory animals	The study did not involve laboratory animals.
Wild animals	No wild animals were killed as part of our study. Individuals of <i>Patella</i> spp., <i>Littorina littorea</i> and <i>Gibbula umbilicalus</i> were removed from selected experimental plots to other areas on the shoreline.
Field-collected samples	The study did not involve animal samples collected from the field. Gastropods were weighed and measured on the shore. Measures of functional and compositional stability were based on monthly surveys but required destructive sampling of macroalgal communities at the end of the experiment to quantify relationships between percentage cover and biomass.
Ethics oversight	Given that the study was done in the field and involved removing invertebrate grazers from plots and replacing them elsewhere on the shore, the study did not require ethical approval.

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