nature portfolio

Corresponding author(s): Xiaowei Jin

Last updated by author(s): Dec 10, 2023

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	No software was used.
Data analysis	Data analyses: R version 4.0.5 (R Core Team, 2019). Graphing software: ArcGIS 10.7, R version 4.0.5 (R Core Team, 2019), Adobe Illustrator 2022. Reference manager software: EndNote X9.

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

The data of China's annual land cover product (CLDD) can be accessed at https://zenodo.org/record/5210928#.YcZ_nWBByUk. CRU TS climate data could be

downloaded from the Centre for Environmental Data Analysis (CEDA: http://data.ceda.ac.uk//badc/cru/data/cru_ts/) and the CRU website: https://crudata.uea.ac.uk/cru/data/hrg/. All data that support the findings of this study are available in figshare at https://doi.org/10.6084/m9.figshare.24499699.

Human research participants

Policy information about studies involving human research participants and Sex and Gender in Research.

Reporting on sex and gender	*Use the terms sex (biological attribute) and gender (shaped by social and cultural circumstances) carefully in order to avoid confusing both terms. Indicate if findings apply to only one sex or gender; describe whether sex and gender were considered in study design whether sex and/or gender was determined based on self-reporting or assigned and methods used. Provide in the source data disaggregated sex and gender data where this information has been collected, and consent has been obtained for sharing of individual-level data; provide overall numbers in this Reporting Summary. Please state if this information has not been collected. Report sex- and gender-based analyses where performed, justify reasons for lack of sex- and gender-based analysis.*
Population characteristics	*Describe the covariate-relevant population characteristics of the human research participants (e.g. age, genotypic information, past and current diagnosis and treatment categories). If you filled out the behavioural & social sciences study design questions and have nothing to add here, write "See above."*
Recruitment	*Describe how participants were recruited. Outline any potential self-selection bias or other biases that may be present and how these are likely to impact results.*
Ethics oversight	*Identify the organization(s) that approved the study protocol.*

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	The present study combined a continuous 30-year-long biomonitoring dataset from Dongting Lake with satellite imagery to investigate the drivers of local ecosystem change. This study aimed at analyzing the temporal trends of the taxonomic and functional diversity of macroinvertebrates and nutrient loadings. We conducted routine monitoring of macroinvertebrates, nutrients, and algal blooms at eight transects of the main Dongting Lake from 1988 to 2018.
Research sample	Samples of macroinvertebrates, nutrients, and algal blooms were collected in eight transects, which were distributed in the key habitats of Dongting Lake (southern, western, and eastern parts of Dongting Lake). In situ monitoring was conducted each year from 1988 to 2018. However, no data were collected in 2002, 2003, 2015, and 2016 due to objective reasons such as water level changes. All transects were sampled every January, May, and September to capture variability among those seasons.
Sampling strategy	Samples were collected from three locations along each transect; two samples were collected at 100 m from either bank, and two samples were collected from the middle of the transect. These samples were then mixed for subsequent chemical analysis and species identification.
Data collection	The routine monitoring was conducted by the Dongting Lake Eco-Environment Monitoring Centre of Hunan Province from 1988 to 2017 using a standard protocol. All the contributions to the data collection were specified in the "Author contributions" Statement. Please check the protocol below: Macroinvertebrate samples were sampled with a 1/16 m2 modified Peterson dredger. The samples with animal specimens were sieved, washed through a 40-mesh copper sieve, and placed in a sealed pocket for storage. On the same day, after screening and washing, the samples were put into the white porcelain dissecting plate and sorted under cold light. Then, put the selected animal sample into a 50 ml sample bottle and fix it with a 10 % formalin solution. The animals were identified and fixed in the laboratory. Specimen identification mainly referred to relevant literature and was identified at the genus level. Phytoplankton samples were collected by filtering 20 L of water through a plankton net (20 mesh). The precipitates were fixed with Lugol's solution for 48 hours and counted under the microscope. The algal bloom intensity was defined as the annual average abundance of planktonic algae. For Nutrients, the duplicated 1 L surface water samples were used to measure nutrient variables, including total phosphorus (TP) and total nitrogen (TN), following the Chinese national standard "Environmental quality standards for surface water (GB 3838-2002)".

Timing and spatial scale	The field works were conducted in eight transects of the Dongting Lake from 1988 to 2018. All transects were sampled every January, May, and September to capture variability among those seasons.
Data exclusions	No data were excluded from the analysis.
Reproducibility	All the samples were collected from three locations along each transect. Two sub-samples were collected at 100 m from either bank and two sub-samples were collected from the middle of the transect. All transects were sampled every January, May, and September to capture variability among those seasons. The protocol used in the field work and data collection have been thoroughly checked and described in the "Method" section. All the analysis performed in this study followed established standard procedures and references were cited in the "Method" section.
Randomization	Samples of macroinvertebrates, nutrients, and algal blooms were collected in eight transects, which were distributed in the key habitats of Dongting Lake (southern, western, and eastern parts of Dongting Lake). The sub-samples were randomly distributed along the transects. All transects were sampled every January, May, and September to capture variability among those seasons. These samples were then mixed for subsequent chemical analysis and species identification.
Blinding	Blank samples and certified standards were used in the chemical analysis (nutrients). Macroinvertebrate and algal samples were identified by multiple experts to verify the taxonomic identifications.

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions	The filed works were conducted from 1988 to 2018. The annual temperature and precipitation were described in Figure 1.
Location	The samples were collected in eight transects of the Dongting Lake. Please refer to Supplementary Table 1 and Supplementary Figure 1 for details.
Access & import/export	All the samples were collected by the Dongting Lake Eco-Environment Monitoring Centre of Hunan Province in accordance with the relevant permits and local laws.
Disturbance	The routine monitoring of macroinvertebrates, nutrients, and algal blooms did not cause any disturbance of the local environment.

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