

Reporting Summary

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Statistical parameters

When statistical analyses are reported, confirm that the following items are present in the relevant location (e.g. 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
- ☐ ☒ An indication of 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 statistics 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
- ☐ ☒ Clearly defined error bars
State explicitly what error bars represent (e.g. SD, SE, CI)

Our web collection on [statistics for biologists](#) may be useful.

Software and code

Policy information about [availability of computer code](#)

Data collection not applicable

Data analysis R version 3.4.4

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 upon request. 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

Data supporting the findings of this study are available from the authors upon request.

Field-specific reporting

Please select 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/authors/policies/ReportingSummary-flat.pdf](https://www.nature.com/authors/policies/ReportingSummary-flat.pdf)

Ecological, evolutionary & environmental sciences study design

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

Study description	Hierarchical design with multiple levels of plant species richness per experiment. Thirty nine experimental grassland ecosystems and 1699 plots.
Research sample	All experiments contributing data manipulated plant species diversity in a grassland experiment and had collected primary plant biomass annually for at least three years. With at least three years (or timepoints) of data, we are able to estimate ecosystem stability, which is the primary response variable in our study.
Sampling strategy	We performed an extensive search of the literature and contacted colleagues that worked on similar questions. Our dataset (which includes published and unpublished studies), is the most comprehensive one assembled to date with raw data (i.e. not effect sizes).
Data collection	Not applicable. All raw data was sent to corresponding author and harmonized across datasets for analysis.
Timing and spatial scale	For each experiment, we used primary plant biomass collected annually as a proxy for grassland productivity. The length of each study varied considerably, most lasted at least three years but at least six studies lasted more than four. Most studies conducted their experiments using 1m x 1m plots.
Data exclusions	We excluded functional trait data if individual observations were considered likely to be erroneous (using a protocol established by the database managers).
Reproducibility	Not applicable. In some ways, we use data from 39 experiments with sufficiently similar experimental designs to test reproducibility.
Randomization	Many studies allocated the location of plots randomly, and also determined the composition of multi-species communities randomly.
Blinding	Blinding was not relevant to our study because it is a meta-level study and we expected for there to be a positive relationship between plant species richness and ecosystem stability. We used structural equation modeling to test additional hypotheses about additional co-variables simultaneously and reported these tests in our manuscript.
Did the study involve field work?	☐ Yes ☒ No

Reporting for specific materials, systems and methods

Materials & experimental systems

n/a	Involved in the study
☒	☐ Unique biological materials
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology
☒	☐ Animals and other organisms
☒	☐ Human research participants

Methods

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