

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

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|-------------------------------------|-------------------------------------|--|
| ☐ | ☒ | 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.

Data analysis All analyses were carried out with the functions and additional packages specified in the methods section in the free and open-source environment R [version 4.3.0, except version 4.5.1 for spatial analyses; R Core Team. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. (2023, 2025)]. The specific codes to reproduce the results will be made openly available in Zenodo before the publication.

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 will be openly published in Zenodo before the publication.

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	NA
Reporting on race, ethnicity, or other socially relevant groupings	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](https://www.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 study uses butterfly data from a before-after control-impact (BACI) experimental design in 18 boreal mire complexes (hereafter mires) located in Finland. Each mire contains three sites: 1) a site drained for forestry during 1960s–1970s that was restored after the first observation period ('restored'), 2) a site drained for forestry that was not restored and remained in forestry use ('drained'), and 3) an undrained pristine site ('pristine'). All mires were monitored for butterflies (Lepidoptera: Papilionoidea) one year before restoration (monitoring 1), 1–3 years after restoration (monitoring 2) and 9–19 years after restoration (monitoring 3).
Research sample	The sample is the butterfly individuals observed for each site in each monitoring period.
Sampling strategy	Butterflies were observed by line transect sampling. Each site contained two 250 m transects (ca. 80 m apart). Locations of the transects were selected to cover the main habitat types of the site and was considered adequate.
Data collection	In the line transect method, the observer recorded butterflies within a 5 m × 5 m area in front of her/him, while walking the transect at uniform pace. The monitoring was done by specialists able to identify butterfly species reliably.
Timing and spatial scale	The data consists of two mire sets that were monitored partially in different years, because the initial set of nine mires (set 1) was later accompanied by another nine mires (set 2). Mires in set 1 were monitored in 2003 (monitoring 1) and 2007 (monitoring 2) whereas mires in set 2 were monitored in 2010 (monitoring 1) and 2015 (monitoring 2). Mires in both sets were monitored again in 2022 (monitoring 3). How many times the sites were visited during the summer varied for different mires and monitoring, being highest at monitoring 1 (mean = 10.7, min = 7, max = 15), followed by monitoring 2 (mean = 8.6, min = 7, max = 10) and lowest at monitoring 3 (mean = 6.9, min = 6, max = 7). The spatial scale was hierarchical: the study was conducted in 18 mires with a latitudinal span of ca. 61–64 degrees, and a longitudinal span of ca. 22–31 degrees. Each site contains three sites, with variable size, and they each contain two transects of 250m.
Data exclusions	No exclusions.
Reproducibility	There are no measures taken to repeat the experiment itself due to the large spatial and temporal scale.
Randomization	The restoration treatment for the drained sites was not randomized. The sites chosen for restoration were selected by the Metsähallitus Parks & Wildlife Finland who conducted the restoration and is generally responsible for restoring state-owned peatlands in Finland. We were not able to control the effect on non-randomization but the issue and its effects are discussed.
Blinding	Blinding was not possible because the status of a site (restored/drained/pristine) is apparent when conducting field work.
Did the study involve field work?	☒ Yes ☐ No

Field work, collection and transport

Field conditions	Sampling started when <i>Boloria freija</i> emerged, usually in mid-May. Transects were counted at temperatures between 13 and 17 °C on sunny days (less than 60% of the sky without clouds) or when temperatures were >17 °C (without rain), mainly between 11 a.m.
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	and 4 p.m.
Location	The spatial scale was hierarchical: the study was conducted in 18 mires with a latitudinal span of ca. 61-64 degrees, and a longitudinal span of ca 22-31 degrees. Each site contains three sites, with variable size, and they each contain two transects of 250m.
Access & import/export	Sites are visited following principles to minimize all possible erosion to the sites, mainly through minimized walking. The data collection has been done in collaboration with Metsähallitus Parks & Wildlife Finland, which as a governmental institution is also the administrator to all protected areas in Finland including these study sites. Metsähallitus Parks & Wildlife Finland is part of the government owned enterprise Metsähallitus, which governs all state-owned land in Finland.
Disturbance	The disturbance was minimal: the transects were marked with a small number of narrow tubes in the field. The butterfly species were mainly visually recorded.

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

Animals and other research organisms

Policy information about [studies involving animals](#); [ARRIVE guidelines](#) recommended for reporting animal research, and [Sex and Gender in Research](#)

Laboratory animals	NA
Wild animals	The study involved observing butterflies on the field. The individuals were caught only if the recorder was not able to identify their species without closer inspection. Caught individuals were set free immediately after their species was identified.
Reporting on sex	No information of the sex of the butterflies observed was recorded.
Field-collected samples	No samples were collected from the field.
Ethics oversight	No ethics oversight was necessary as the study involved observations, together with catch-and-release of butterflies on the field.

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

Plants

Seed stocks	NA
Novel plant genotypes	NA
Authentication	NA