

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 (<i>n</i>) 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. <i>F</i> , <i>t</i> , <i>r</i>) with confidence intervals, effect sizes, degrees of freedom and <i>P</i> 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 <i>d</i> , Pearson's <i>r</i>), 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	R Statistical Software 4.3.1 R packages: readr 2.1.4 dplyr 1.1.2 sf 1.0-13 RColorBrewer 1.1-3 ggplot2 3.5.1 gbm 2.2.2 caret 6.0-94 caretEnsemble 2.0.2 vip 0.3.2 pdp 0.8.1 raster 3.6-20 lme4 1.1-33 fitdistrplus 1.2-2 performance 0.13.0 DHARMa 0.4.7

```
car 3.1-2
jtools 2.3.0
pals 1.7
mgcv 1.8-42
flextable 0.9.4
viridis 0.6.3
gratia 0.8.1
gstat 2.1-1
flexOR 1.0.0
corrplot 0.95
spdep 1.3-8
spatialsample 0.6.0
ggrepel 0.9.3
gridExtra 2.3
```

All code generated in this project can be accessed at our Figshare repository: doi: 10.6084/m9.figshare.25639080

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](#)

All associated data is available at our Figshare repository: doi: 10.6084/m9.figshare.25639080

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

Reporting on race, ethnicity, or other socially relevant groupings

Population characteristics

Recruitment

Ethics oversight

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

We assessed the role of sodium as a constraint for large herbivore populations in Africa. First, we developed high-resolution maps of plant sodium concentration across sub-Saharan Africa using a large database of plant sodium concentrations and an ensemble of machine learning tools. Using these maps, we modeled dietary sodium availability for large herbivore populations spatially. Linking this with a large dataset of sodium concentration in herbivore faeces, we validated the assumption that herbivore sodium intake is regulated by plant sodium concentrations. Finally, we assessed if/where plant sodium concentrations constrain large herbivore abundance using a large dataset of herbivore population density across the region.

Research sample	Vascular plants, split into two groups: C3- and C4-photosynthesising plants. Large mammalian herbivores (>3kg)
Sampling strategy	Data was first mined from literature sources. However, in cases where data were scant, additional observations were collected from unpublished field studies and a specific field survey specifically for this paper. All available data known to the authors were collated
Data collection	All available data was collated.
Timing and spatial scale	Data was collected during the period 1982-present day.
Data exclusions	Data associated with plants using the CAM photosynthesis pathway was excluded, as this data group was very small (n<10).
Reproducibility	Plant and faecal data were collected from across many field sites, which were mostly assessed once. However, for field sites where multiple field campaigns were deployed, we compared results for reproducibility. For herbivore density measurements, densities were calculated over multiple years.
Randomization	Samples were grouped by functional traits (e.g., photosynthetic pathway, diet) or by species.
Blinding	We did not use blinding during our analysis.

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions	Samples were collected by foot, vehicle or horseback. Conditions varied by wildlife reserve and season. Temperature varied from cool to very hot, precipitation varied from minimal to moderate.
Location	Southern Africa
Access & import/export	All samples were collected in wildlife reserves with permission from governing bodies.
Disturbance	Samples (plant and faeces) were collected non-invasively, aiming to disturb the soil, plant and wildlife communities as little as possible.

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	N/A
Wild animals	N/A
Reporting on sex	It was not possible to collect information on the sex of individuals in this study. Sex may be important for analysis as nutritional requirements could vary between sex. However, in this paper we were most interested in overall population effects, which were captured within our sampling protocol. Effects of sex were mentioned in the Discussion.

Field-collected samples	Fresh faecal samples were collected in the field from large herbivore mammal species and stored in labeled plastic bags. All samples were immediately frozen at -20C. Samples were transported as frozen to various laboratories for analysis. All faecal samples were disposed of using university disposal services.
Ethics oversight	Data used in this study was reviewed and approved by the University of Pretoria Research and Animal Use and Care Committees (Reference EC043-18, EC043-18-A1 and NAS115/2021). Provincial permits for transport of faecal samples between provinces of South Africa were obtained from Province of the Eastern Cape Rural Development and Agrarian Reform Veterinary Services, Province of the Eastern Cape Department of Agriculture, Limpopo Provincial Government Department of Agriculture and the South African Department of Agriculture, Forestry and Fisheries (DAFF-18/02/2019 and DAFF-12/11/1/8(1933NC).

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Dual use research of concern

Policy information about [dual use research of concern](#)

Hazards

Could the accidental, deliberate or reckless misuse of agents or technologies generated in the work, or the application of information presented in the manuscript, pose a threat to:

No	Yes
☒	☐ Public health
☒	☐ National security
☒	☐ Crops and/or livestock
☒	☐ Ecosystems
☒	☐ Any other significant area

Experiments of concern

Does the work involve any of these experiments of concern:

No	Yes
☒	☐ Demonstrate how to render a vaccine ineffective
☒	☐ Confer resistance to therapeutically useful antibiotics or antiviral agents
☒	☐ Enhance the virulence of a pathogen or render a nonpathogen virulent
☒	☐ Increase transmissibility of a pathogen
☒	☐ Alter the host range of a pathogen
☒	☐ Enable evasion of diagnostic/detection modalities
☒	☐ Enable the weaponization of a biological agent or toxin
☒	☐ Any other potentially harmful combination of experiments and agents

Plants

Seed stocks	No seed stocks were collected as we assessed leaf samples only.
Novel plant genotypes	Leaf samples from common plants were collected only; specific genotypes were not assessed.
Authentication	Experienced field botanists were used to collect all plant samples and ensure that plant samples were correctly identified.