

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
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

As outlined below, we did not collect any polar bear data ourselves, but rather used previously published data that were collected during the 1989-1996 population assessment of the Western Hudson Bay subpopulation and during 1991-1997 & 2004-2009 for bear migration dates.

Sea ice projections were produced by the CESM Large Ensemble Community Project and the CESM Medium Ensemble using high-performance computing support from Yellowstone (ark:/85065/d7wd3xhc). Output is available on the Earth System Grid. Passive microwave satellite data are from the National Snow and Ice Data Center.

Data analysis

All analyses were conducted in MATLAB version R2016a; codes are available from the authors upon request.

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

CESM large ensemble output is available on the Climate Data Gateway at the National Center for Atmospheric Research via <https://www.earthsystemgrid.org>. The passive microwave satellite data are available from the National Snow and Ice Data Center, <https://doi.org/10.5067/8GQ8LZQVL0VL>. The polar bear data used in this study are available from the corresponding authors upon reasonable request.

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	As outlined in the manuscript, we did not collect any data for this study, but rather used data that were collected by other researchers on the body condition and migration dates of polar bears in the Western Hudson Bay subpopulation over the past decades. All data on the body condition of polar bears (body masses and body lengths) were collected by the late Malcolm Ramsay during a population assessment of the Western Hudson Bay subpopulation in 1989-1996. For this, bears were captured non-selectively in the on-shore portions of Western Hudson Bay that bears use in summer. The full dataset of this assessment was made available to the authors by Francois Messier of the University of Saskatchewan, who administered these data following M. Ramsay's death. The data were previously reported in various publications, including in our reference [53] as stated in the manuscript, where further details on the sampling procedures can be found. The full dataset of the population assessment was used in our analyses, with exclusions as described below. Dates of polar bear on-shore arrival and departure are from ref. [38] as stated in the Acknowledgments, and were provided to the authors by Andrew Derocher of the University of Alberta.
Research sample	As outlined above, the polar bear body condition data we use were collected independently by M. Ramsay and reported in previous publications, e.g. our reference [53]. The dataset consisted of 76 adult males, 41 solitary adult females, 61 adult females with cubs, and 22 adult females with yearlings.
Sampling strategy	Bears were located by helicopter and captured non-selectively following the standard protocols for population assessments. Once bears were immobilized, masses and lengths were obtained along with a series of morphometric and other measurements that are not used in this study. We do not know the details of how M. Ramsay determined sample sizes in 1989, but typically these would be set for the minimum number of bears that permit a population abundance estimate via mark-recapture techniques.
Data collection	cf. above
Timing and spatial scale	Body condition data were collected each summer from 1989-1996 during the polar bear on-shore fast from August to November by M. Ramsay and his students. Polar bear migration data were collected by Andrew Derocher and his students from 1991-1997 and 2004-2009 and were reported by them in our reference [38].
Data exclusions	All data on adult males and adult females collected during the Western Hudson Bay population assessment were used in our analyses, with the exception of three adult males and one adult female, for which either mass or length were not reported. If a bear was captured more than once during a given year, only the first capture was used in our analyses to avoid handling effects and/or pseudoreplication impacting results.
Reproducibility	As outlined above, all polar bear data are from a population assessment conducted during 1989-1996. Since these are observational rather than experimental data, they cannot be replicated. However, M. Ramsay followed standard methodologies for polar bear population assessments, so the data are comparable to subsequent assessments conducted in subsequent years.
Randomization	Polar bears were captured non-selectively by M. Ramsay following standard methodologies for polar bear population assessments. As we used the complete dataset in our analyses to fully represent population status during 1989-1996, and because these data are observational rather than experimental, randomization was not relevant to our study. Adult males, solitary adult females, adult females with cubs, and adult females with yearlings were analyzed separately due to their differing energetic requirements as outlined in the manuscript.
Blinding	As outlined above, our data are observational rather than experimental, so blinding was not relevant to our study.
Did the study involve field work?	☐ Yes ☒ No

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	Involvement in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology
☐	☒ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data

Methods

n/a	Involvement 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	N/A
Wild animals	As outlined above, we did not collect any data for this study, but rather used the existing data of the 1989-1996 population assessment of polar bears in Western Hudson Bay.
Field-collected samples	N/A
Ethics oversight	No ethics approval was required as we did not collect any data ourselves, but rather used existing and already published data that were collected by other researchers

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