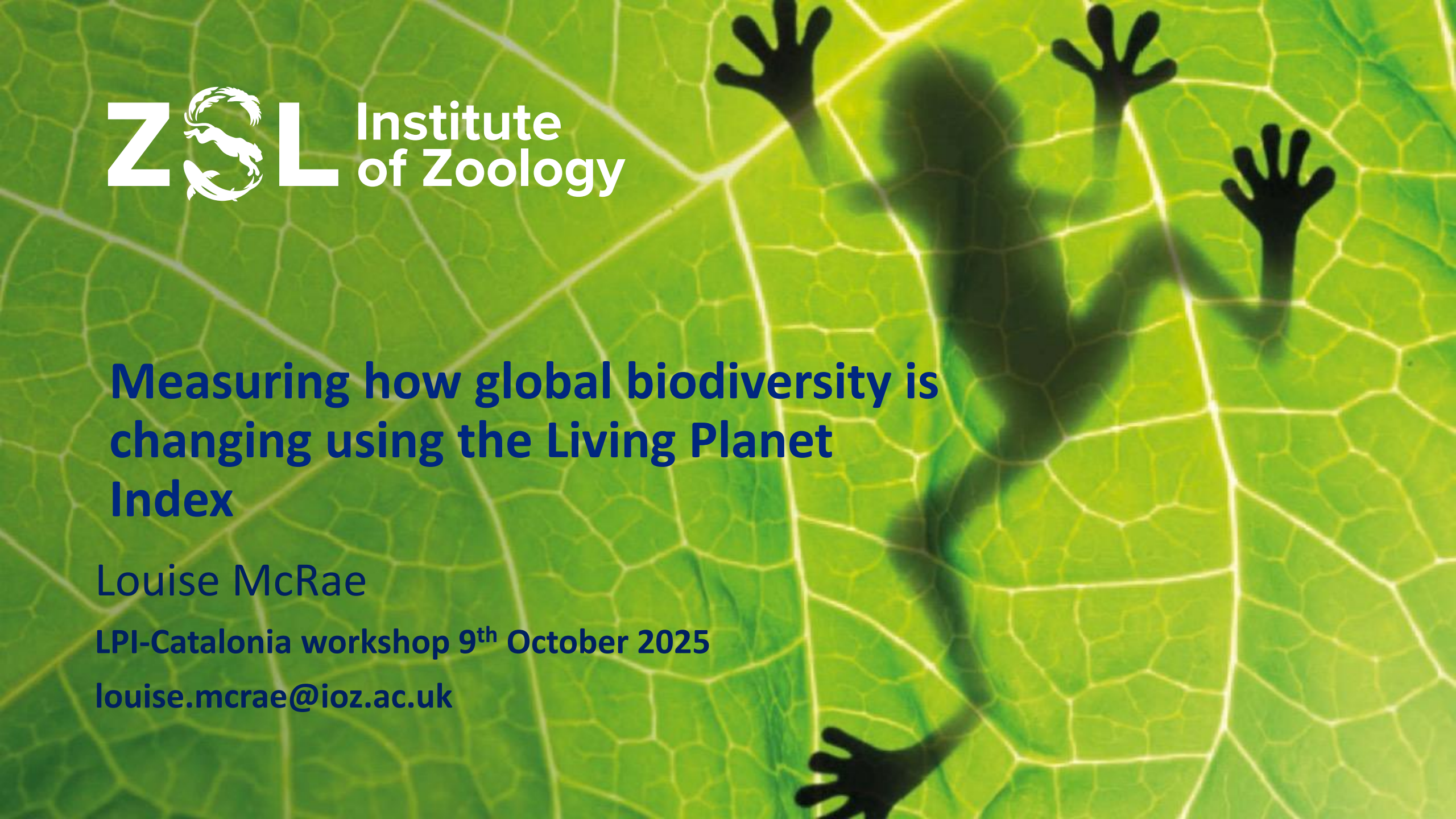


Institute of Zoology

Measuring how global biodiversity is changing using the Living Planet Index

Louise McRae

LPI-Catalonia workshop 9th October 2025

louise.mcrae@ioz.ac.uk

Talk outline

ZSL Institute of Zoology

Introduction

Latest results

Data and methods

Challenges & solutions

Living Planet Index team


Robin Freeman


Stefanie Deinet

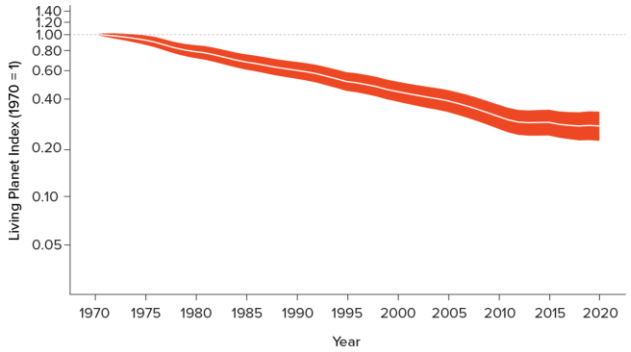

Valentina Marconi


Louise McRae

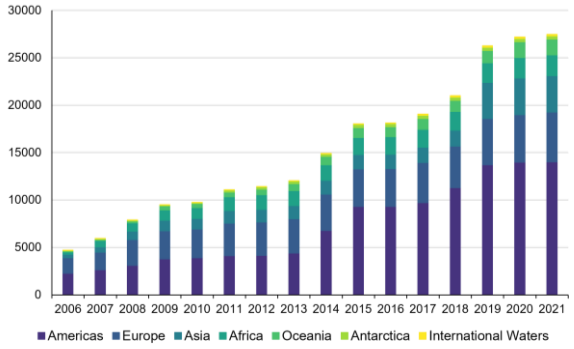

Hannah Puleston


Pip Oppenheimer

Living Planet Index

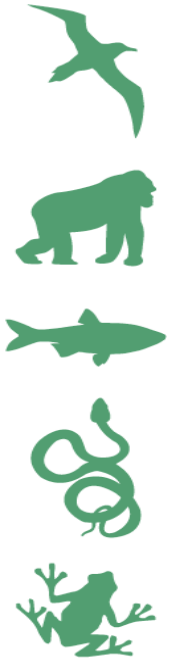


An indicator of relative abundance used to indicate trends in biodiversity

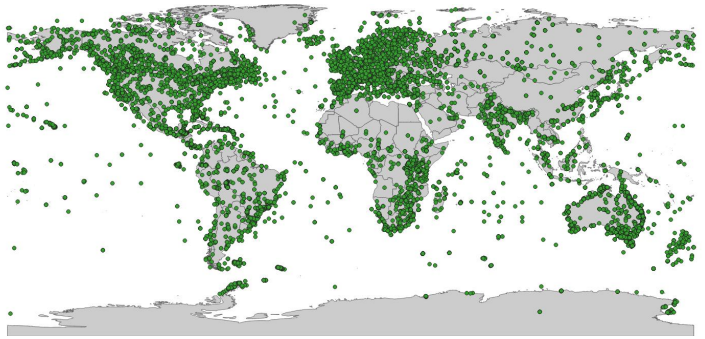


Comprising a growing database of population trends

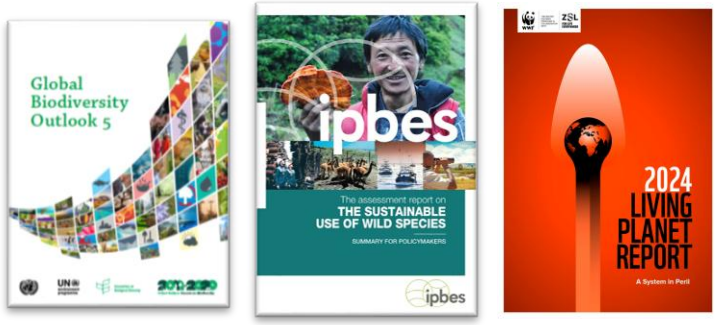
<u>42,000 populations, 5,500 species</u>



Based on population trends of vertebrate species



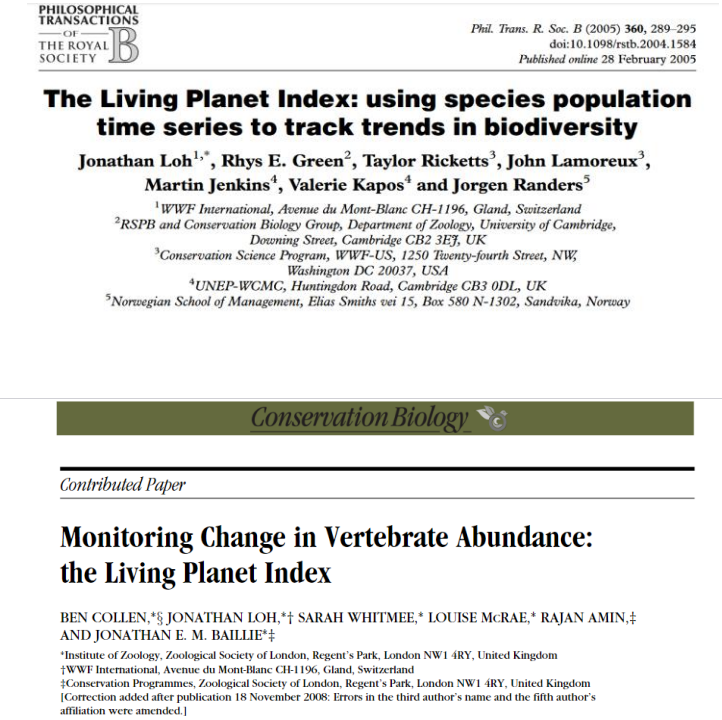
For thousands of sites in terrestrial, freshwater and marine habitats



Published in global policy assessments and in WWF's Living Planet Report

Over 25 years of the LPI

- Developed in 1997 by WWF
- First Living Planet Report in 1998
- Adopted as indicator for the CBD and other MEAs
- Partnership with ZSL in 2006
- Ongoing development through expert workshops and collaborations

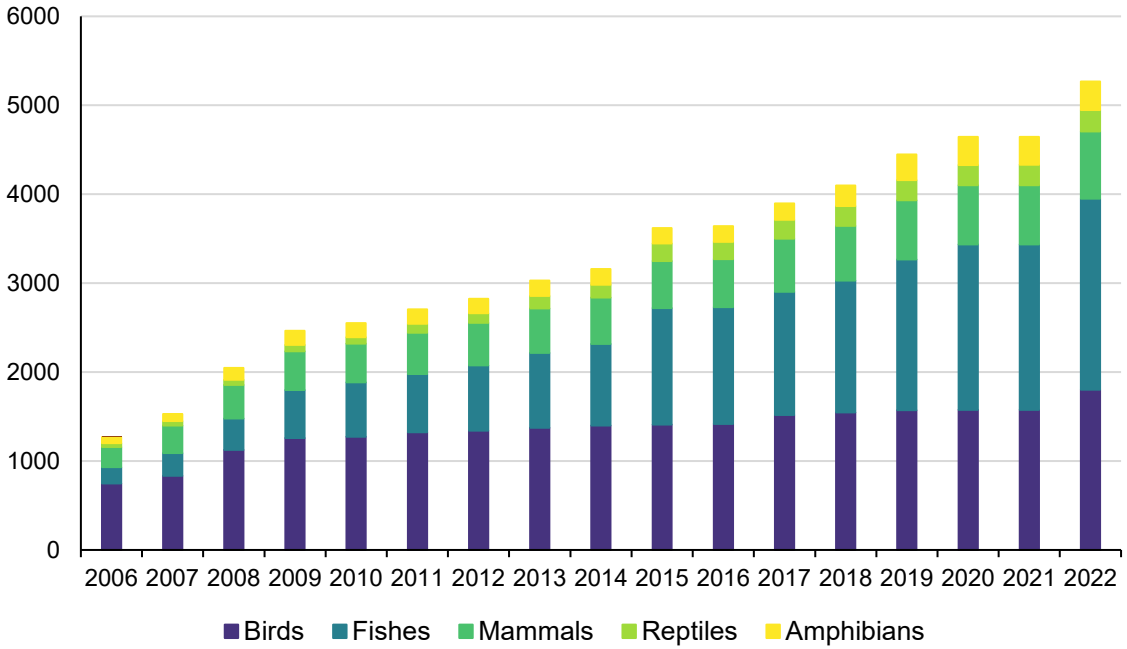


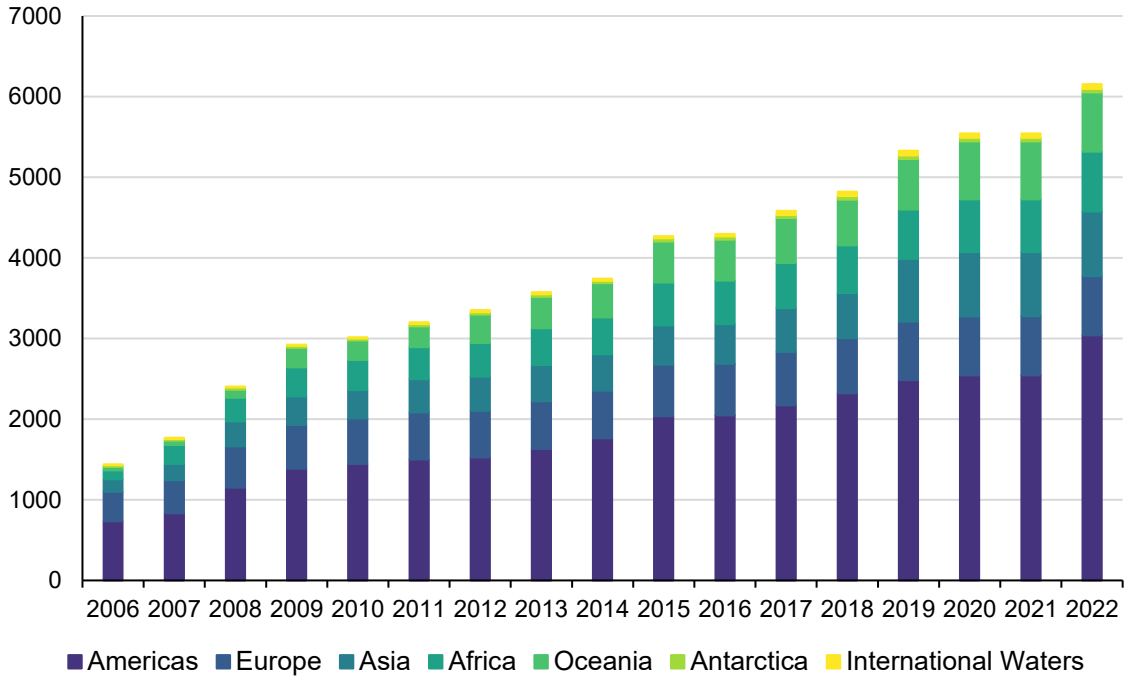
Ledger, S.E.H., Loh, J., Almond, R. *et al.* Past, present, and future of the Living Planet Index. *npj biodivers* **2**, 12 (2023)

A growing resource

- 42,000 time-series
- 5,500 species
- 7,500 sites
- 200 countries
- 500,000 data points

- 60 staff, students and volunteers
- 1,500 days of data entry

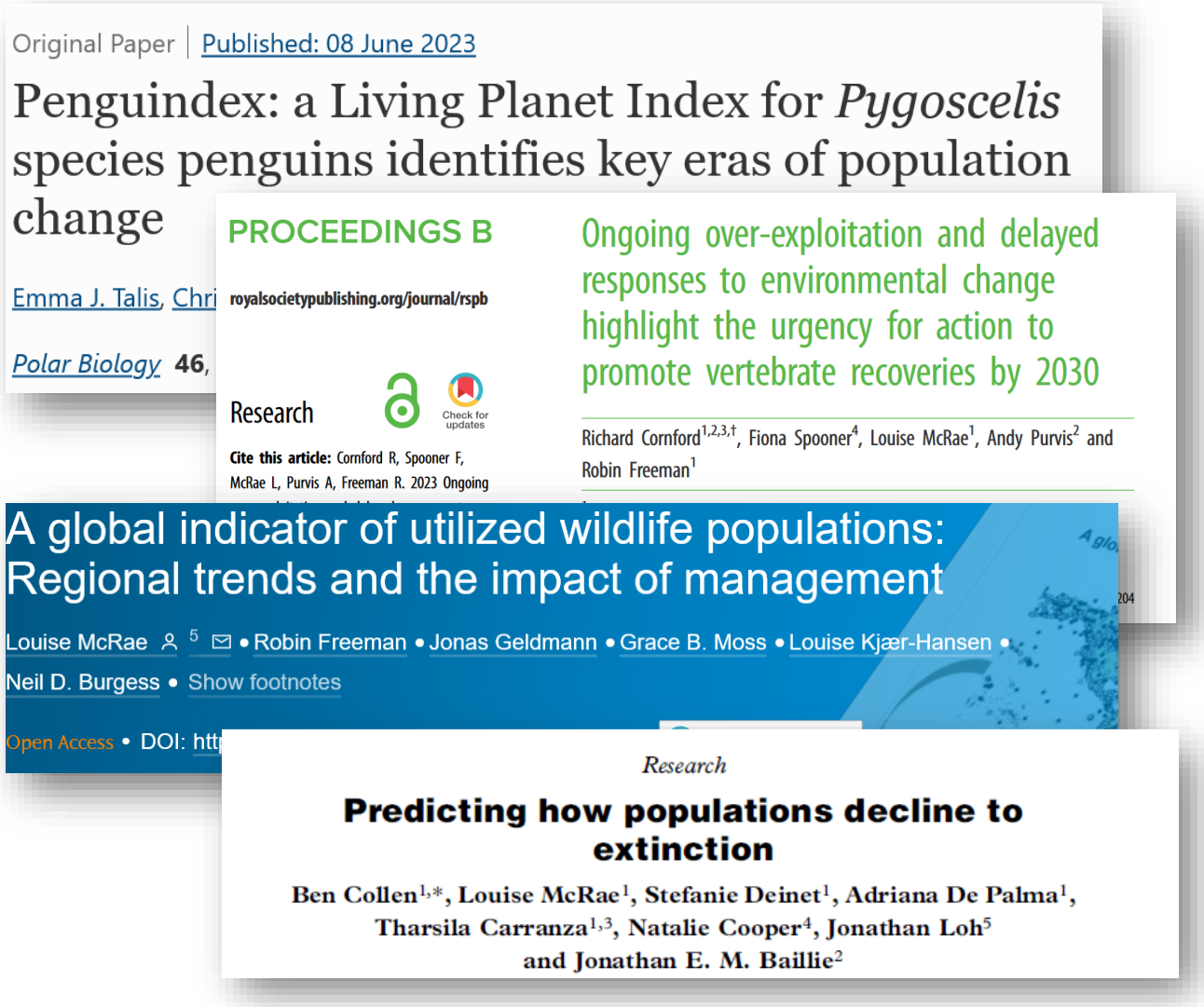




Ledger *et al.* 2023 *npj Biodiversity*

Living Planet Database – uses of data

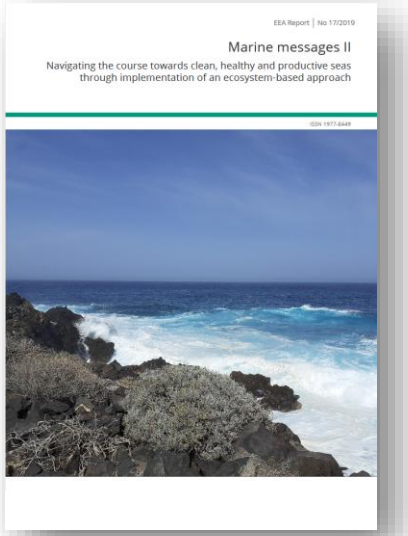
- Regional and taxonomic trends
- Impact of conservation
- Impact of threats
- Progress towards global and national policy targets
- Education and training

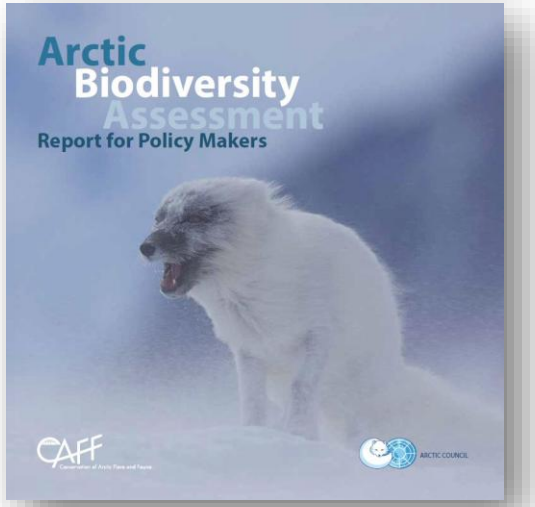


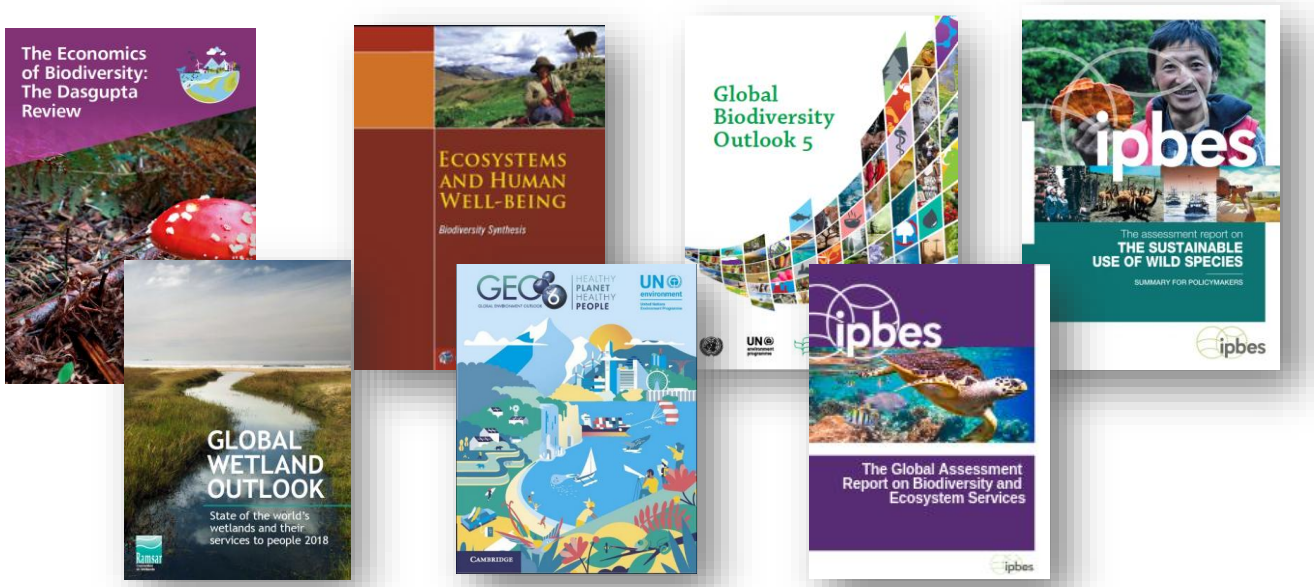
International policy

- LPI adopted in 2006 to measure progress towards 2010 target

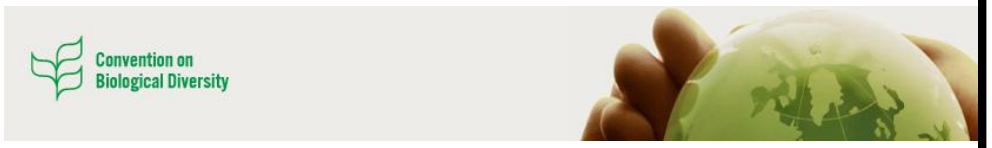
- Convention on Biological Diversity, RAMSAR, Convention on Migratory Species, IPBES







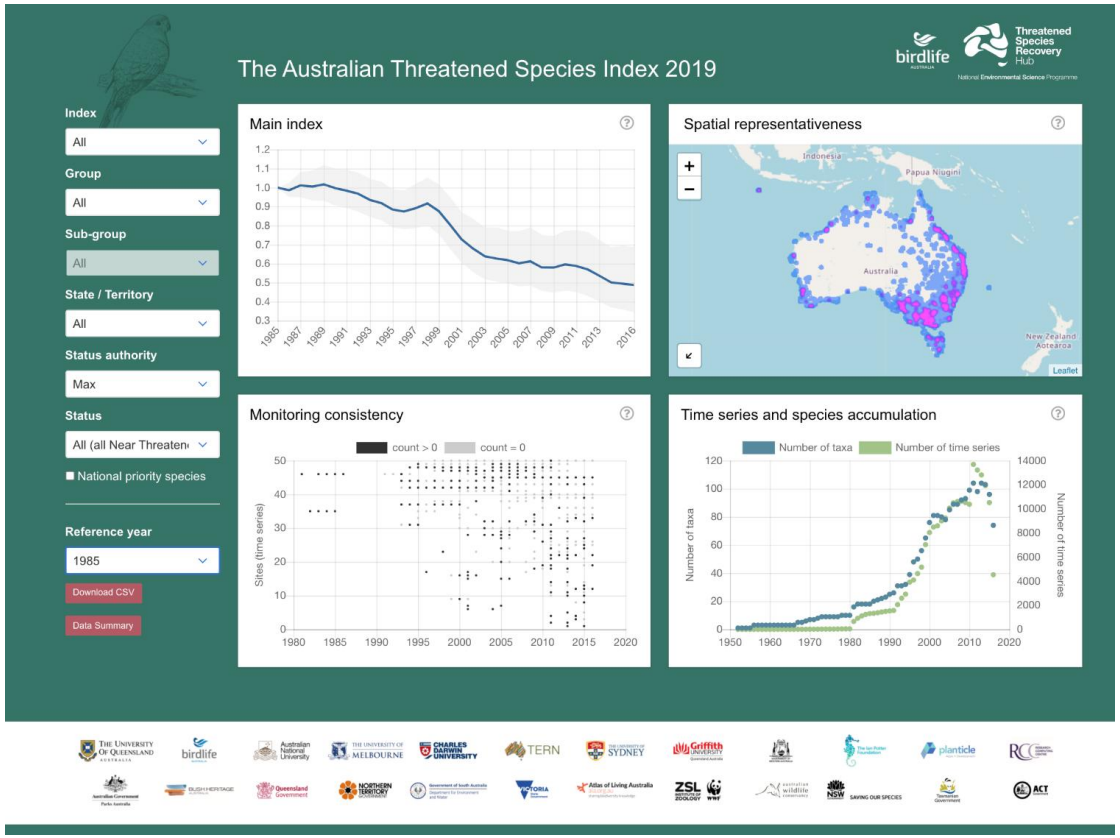
Kunming–Montreal
GLOBAL BIODIVERSITY FRAMEWORK



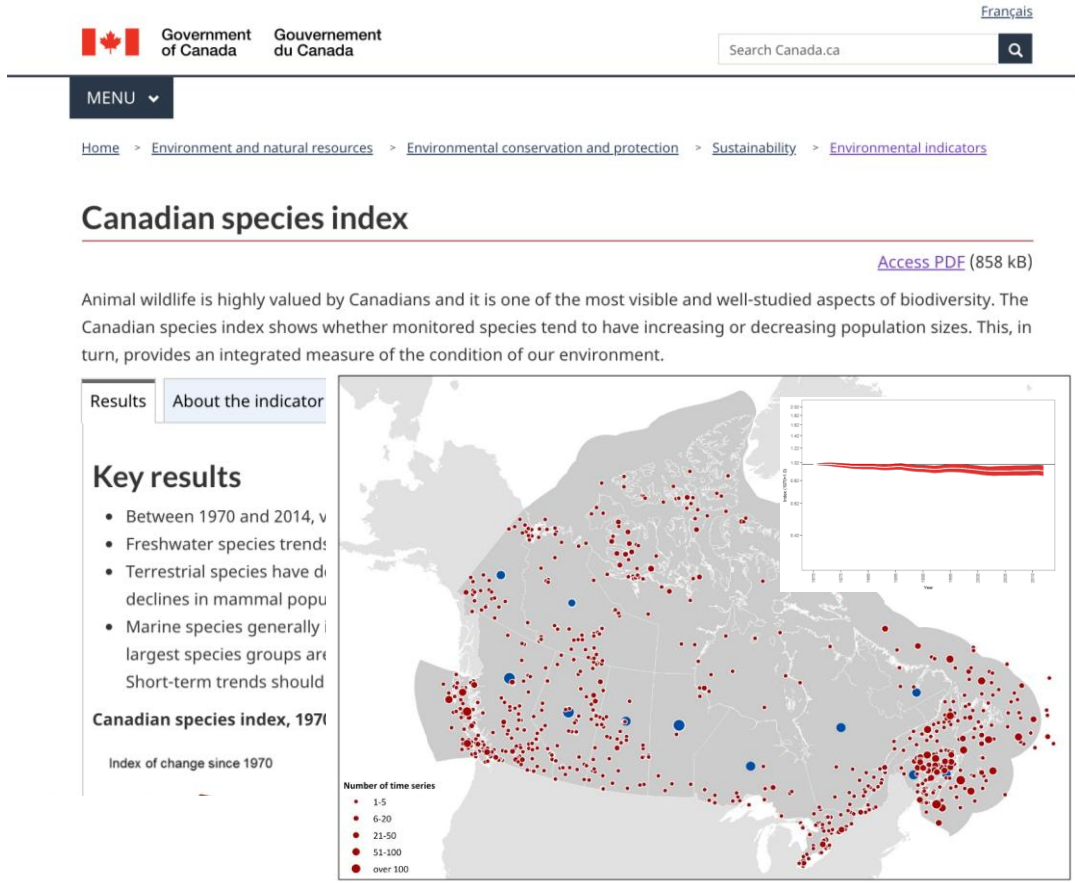
SCAN ME

McRae et al. 2025 The utility of the Living Planet Index as a policy tool and for measuring nature recovery. Phil. Trans. R. Soc. B 380: 20230207.

National policy



Bayraktarov *et al* (2021) Con Sci & Practice



Marconi *et al* (2021) Ecol. Indicators

Global biodiversity framework

GOAL A

The integrity, connectivity and resilience of all ecosystems are maintained, enhanced, or restored, **substantially increasing the area of natural ecosystems** by 2050;

Human induced extinction of known threatened species is halted, and, by 2050, **the extinction rate and risk of all species are reduced tenfold** and **the abundance of native wild species is increased** to healthy and resilient levels;

The **genetic diversity within populations of wild and domesticated species, is maintained**, safeguarding their adaptive potential.

Target 4

Halt Species Extinction, Protect Genetic Diversity, and Manage Human-Wildlife Conflicts

Ensure urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, in particular threatened species, to significantly reduce extinction risk, as well as to maintain and restore the genetic diversity within and between populations of native, wild and domesticated species to maintain their adaptive potential, including through in situ and ex situ conservation and sustainable management practices, and effectively manage human-wildlife interactions to minimize human-wildlife conflict for coexistence.

Target 5

Ensure Sustainable, Safe and Legal Harvesting and Trade of Wild Species

Ensure that the use, harvesting and trade of wild species is sustainable, safe and legal, preventing overexploitation, minimizing impacts on non-target species and ecosystems, and reducing the risk of pathogen spill-over, applying the ecosystem approach, while respecting and protecting customary sustainable use by indigenous peoples and local communities.

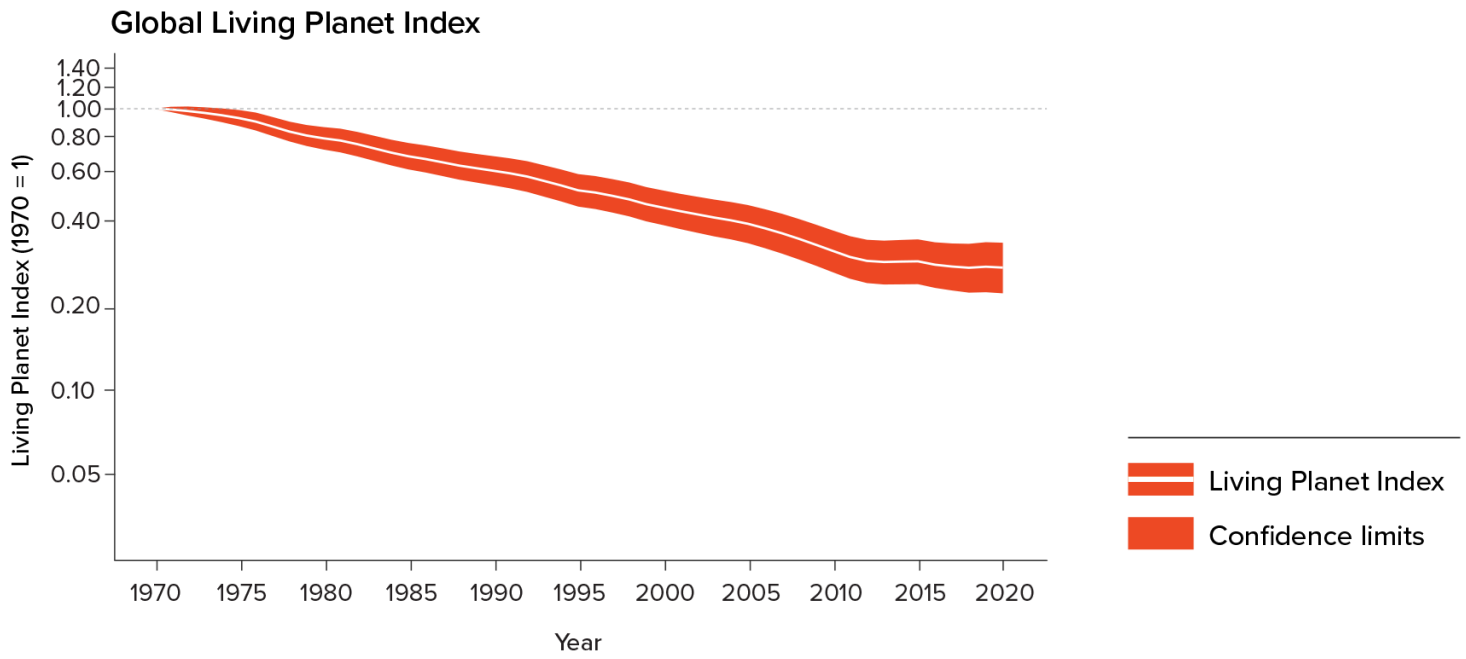
Latest results

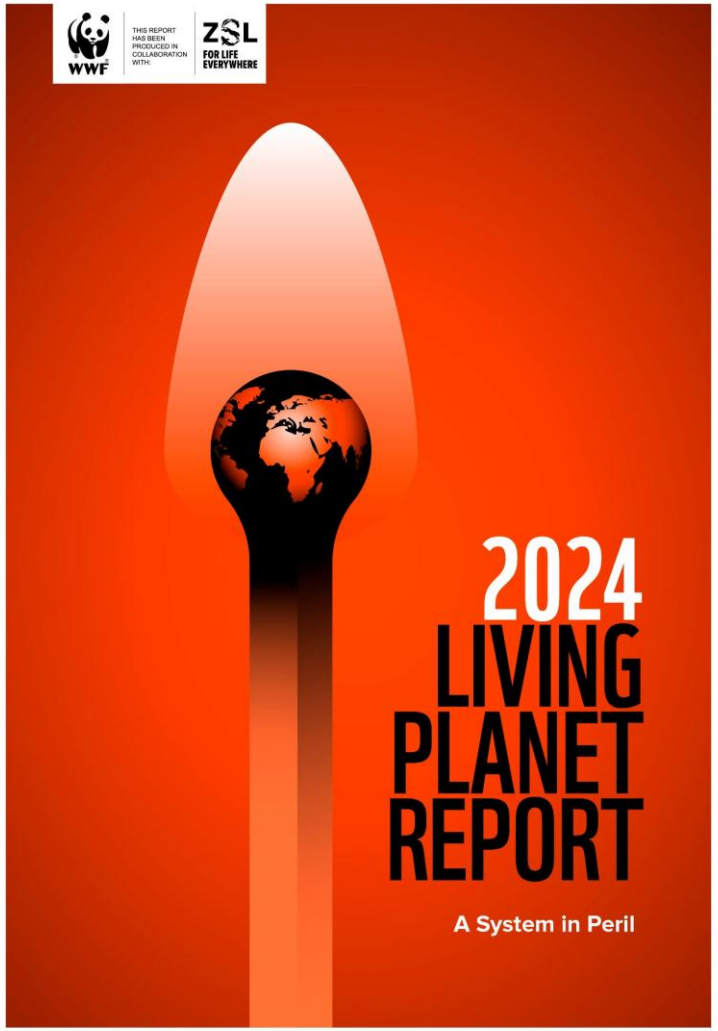
ZSL Institute of Zoology

Latest results

Global Living Planet Index 1970-2020

73% average decline in the size of monitored wildlife populations over 50 years

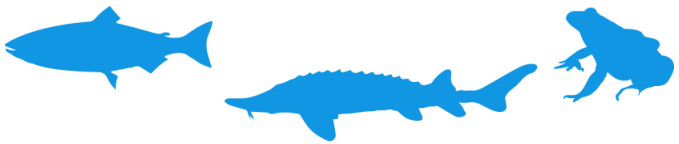


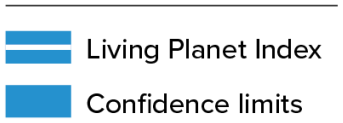


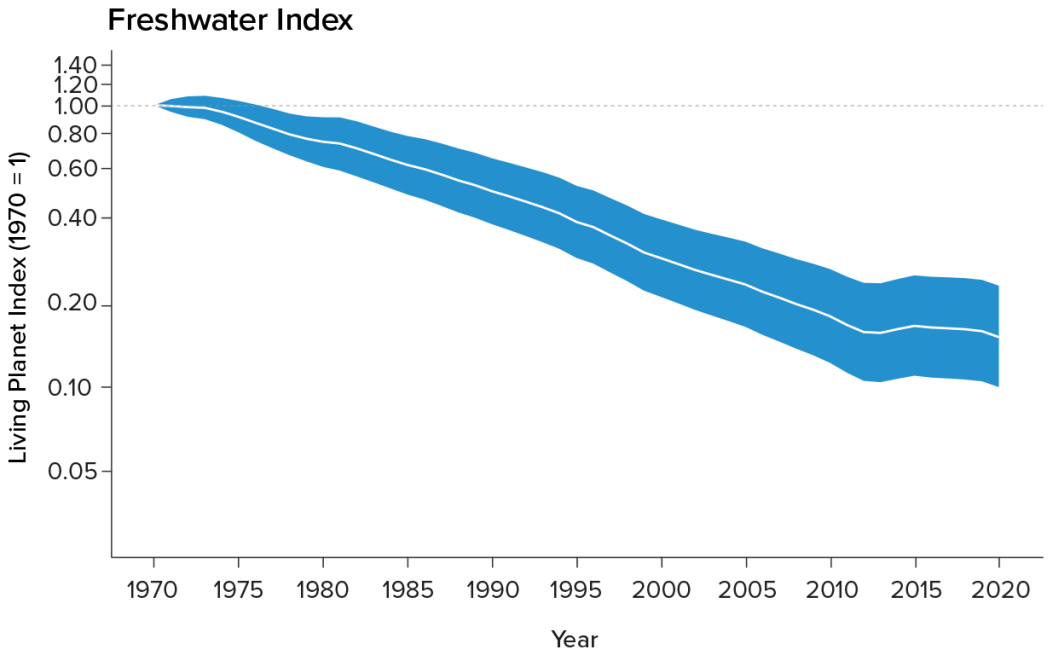
Latest results

Freshwater index

85% decline

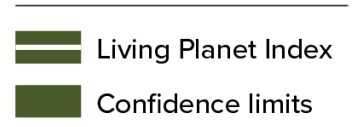


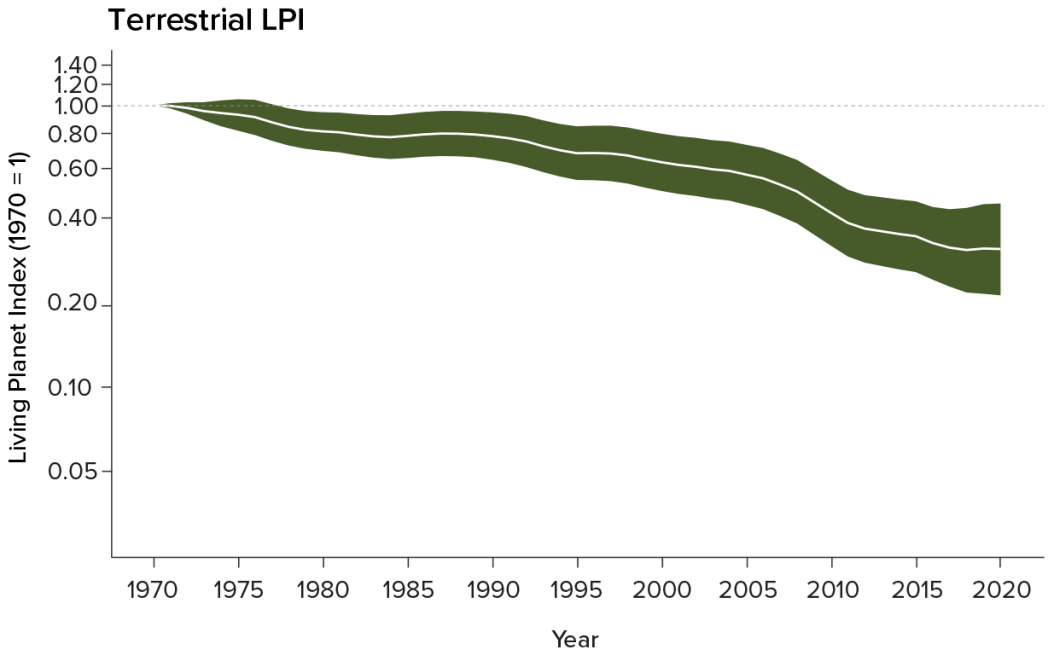




Terrestrial index

69% decline

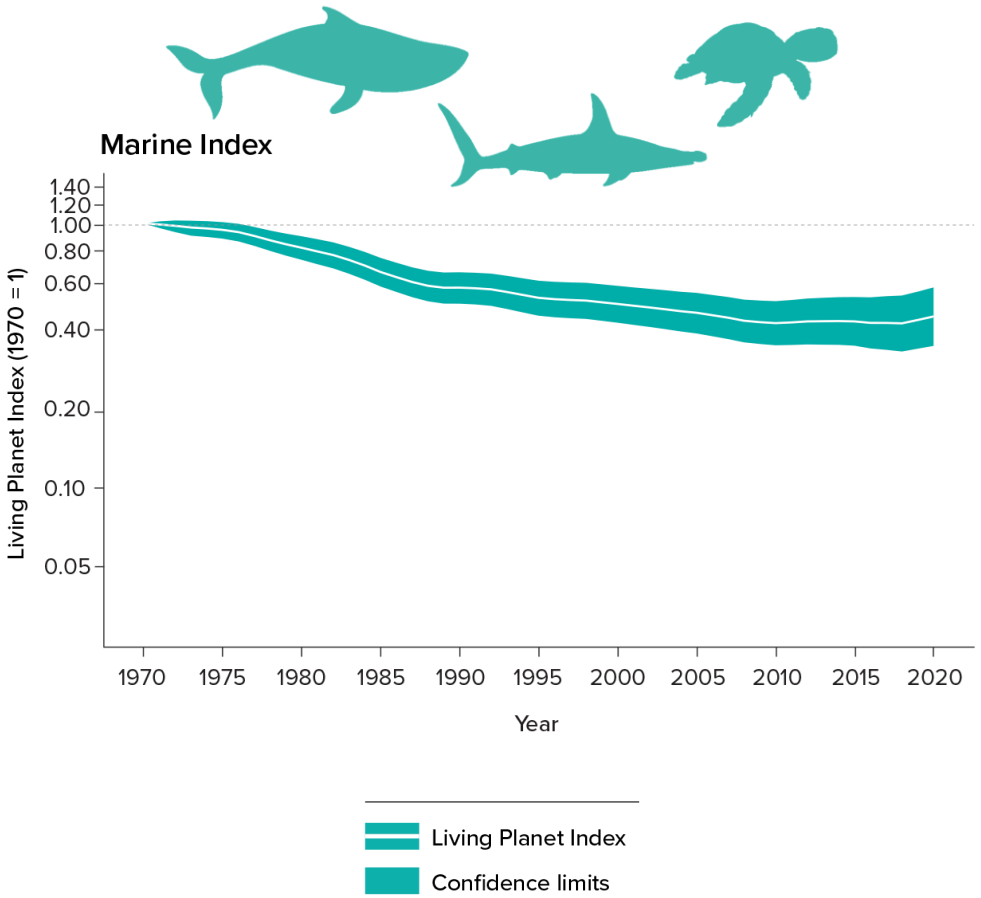




Marine index

Latest results

56% decline



© Jürgen Freund / WWF

Technical supplement

Latest results

Living Planet Index

Home About Us The Index Data Indicators Projects Publications

Latest Results

The global Living Planet Index is the main indicator derived from our data. The Living Planet Index (LPI) is a measure of the state of the world's biological diversity based on population trends of vertebrate species from terrestrial, freshwater and marine habitats. The LPI has been adopted by the Convention of Biological Diversity (CBD) as an indicator of progress towards the post-2020 goals and targets of the Kunming-Montreal Global Biodiversity Framework.

To see some frequently asked questions about the LPI, please see our about the index page

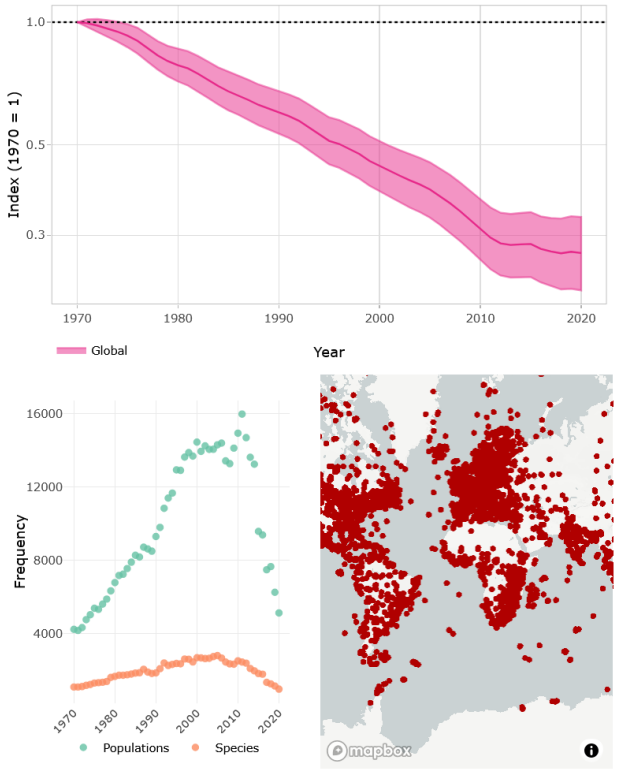
View trends from the Living Planet Report

Trend

Global

The Living Planet Index: 1970 to 2020. The bold line shows the index values and the shaded areas represent the statistical certainty surrounding the trend (95%). The index represents 34,836 populations of 5,495 species. All indices are weighted by species richness, giving species-rich taxonomic groups in terrestrial, marine and freshwater systems more weight than groups with fewer species. Index values are smoothed using a 3-year running average but keeping the first and final index values fixed.

Download Data: Living Planet Report 2024, WWF/ZSL

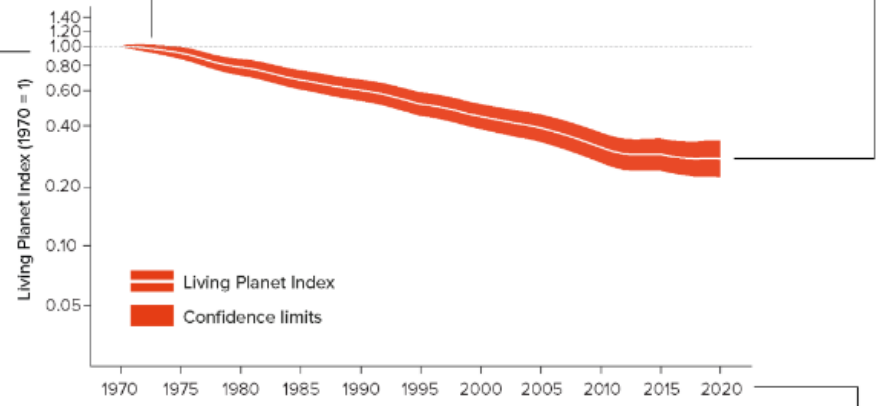


Baseline

The index starts at a value of 1. If the LPI and confidence limits move away from this baseline, we can say there has been an increase (above 1) or decline (below 1) compared to 1970.

Index Values

These values represent the average change in population abundance – based on the relative change and not the absolute change – in population sizes. The shaded areas show 95% confidence limits. These illustrate how certain we are about the trend in any given year relative to 1970. The confidence limits always widen throughout the time-series as the uncertainty from each of the previous years is added to the current year.



Logged y axis

The index is presented on a logged y-axis. This is so that trends are more accurately depicted and interpreted, particularly towards the end of the index when the values become small. See Section 2.5 for more detail.

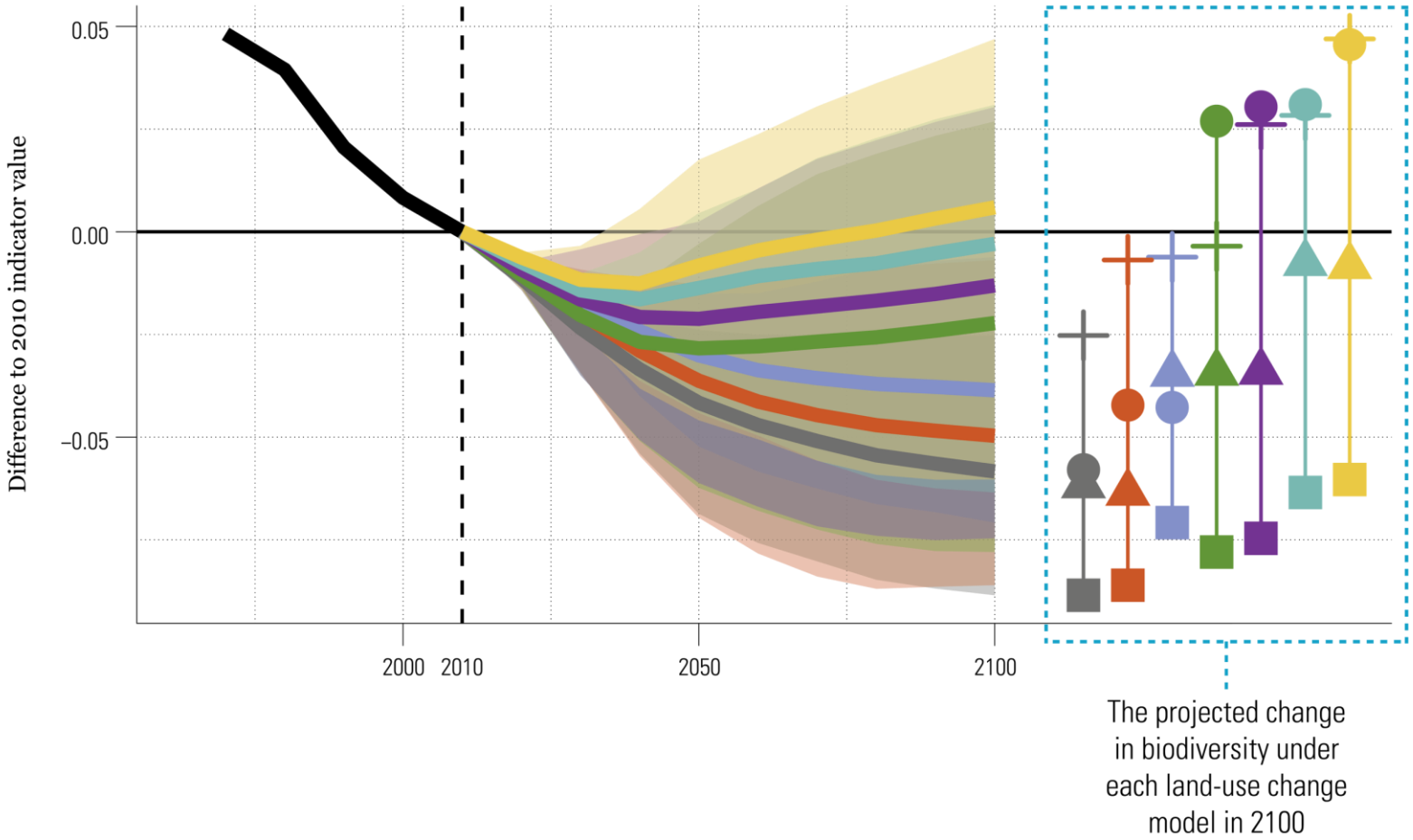
Cut-off

The final year of the index depends on data availability and is the latest year for which we have a good amount of data. For the final year, this is because it takes time to collect, process and publish monitoring data, so there can be a time lag before these can be added to the LPI.

Figure 2. Explanation of the basic terms necessary for the interpretation of the LPI.

Scenario modelling

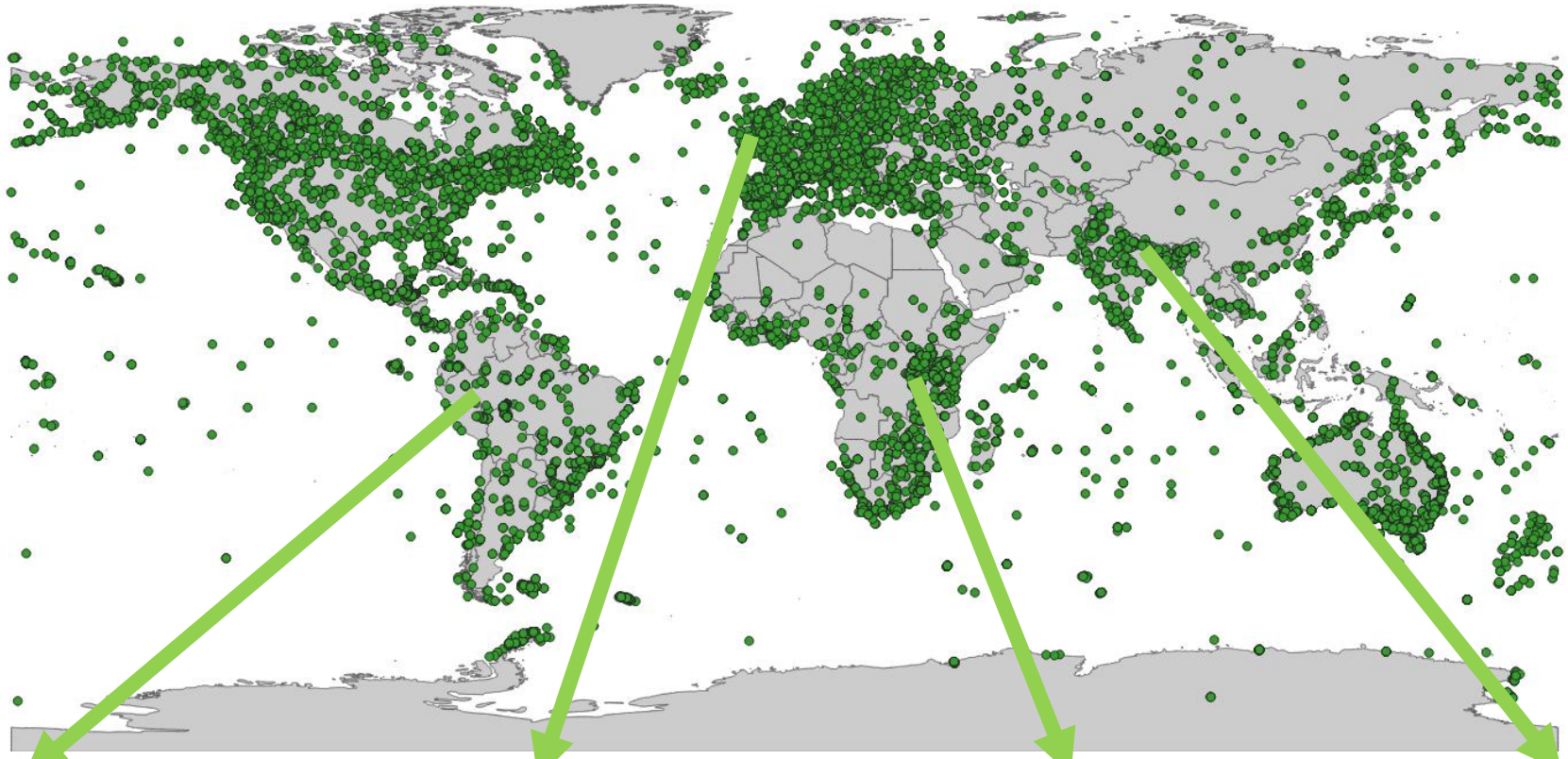
Latest results



Leclère D, Obersteiner M, Barrett M, Butchart SH, Chaudhary A, De Palma A, DeClerck FA, Di Marco M, Doelman JC, Dürauer M, Freeman R et al. (2020) Bending the curve of terrestrial biodiversity needs an integrated strategy. Nature. Sep 10:1-6.

Data and methods

Monitoring sites



Criteria for data inclusion

Systematic searches (ongoing)

Targeted/keyword searches (ad hoc)

Species level	2+ years of data
Known location	Standardised method

Data we can use

Bird, mammal, fish, amphibian & reptile:

- Full population counts
- Estimates (e.g. population size estimated from measured parameters)
- Densities (including converted camera trap data)
- Indices
- Proxies (e.g. breeding pairs, nests, tracks)
- Measures per unit effort (e.g. fish caught per net per hour)
- Biomass (e.g. spawning stock biomass)
- Samples (e.g. where a proportion of the population is regularly monitored)

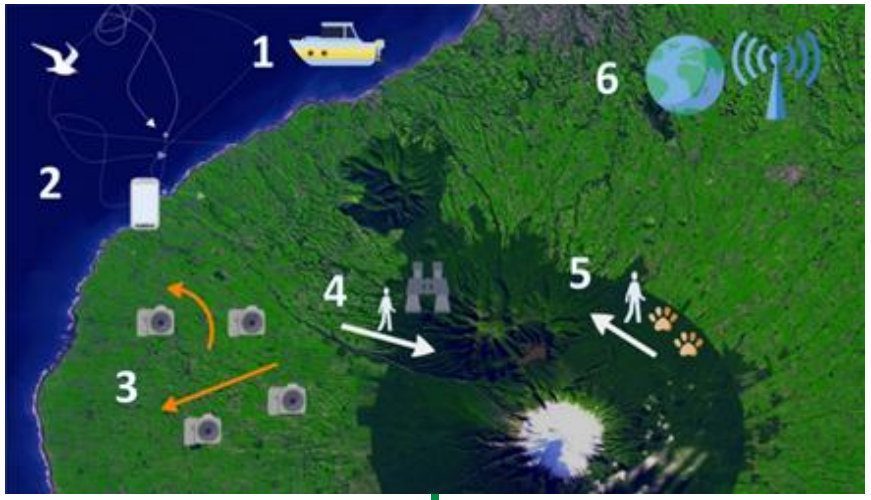
Data we may use in future

- Occupancy data
- Data for plants and invertebrates

Data we can't use

- Data from experimental observations
- Survival rates
- Recruitment data e.g. number of eggs or young
- Catch or hunting data with no measure of effort
- Data where method has changed (unless corrected for)
- Opportunistic sighting data

From the field



Source of the data	What was the data collection for?					
		Long term monitoring	Ecological research	Tracking declining species	Managing species for conservation	Managing species as a natural resource
	Scientific journal	617	948	249	514	162
	Government report	214	258	27	132	258
	Other published sources	211	78	41	135	29
	Pers. Comm. or unpublished	156	55	21	44	10

Data analysis

Considerations

1. Different units and scale of monitoring
2. Populations of different sizes – rare island endemics to common species
3. Duration and frequency of time-series varies
4. Taxonomic and geographic representation

SCAN ME

Loh et al 2005
Phil Trans B

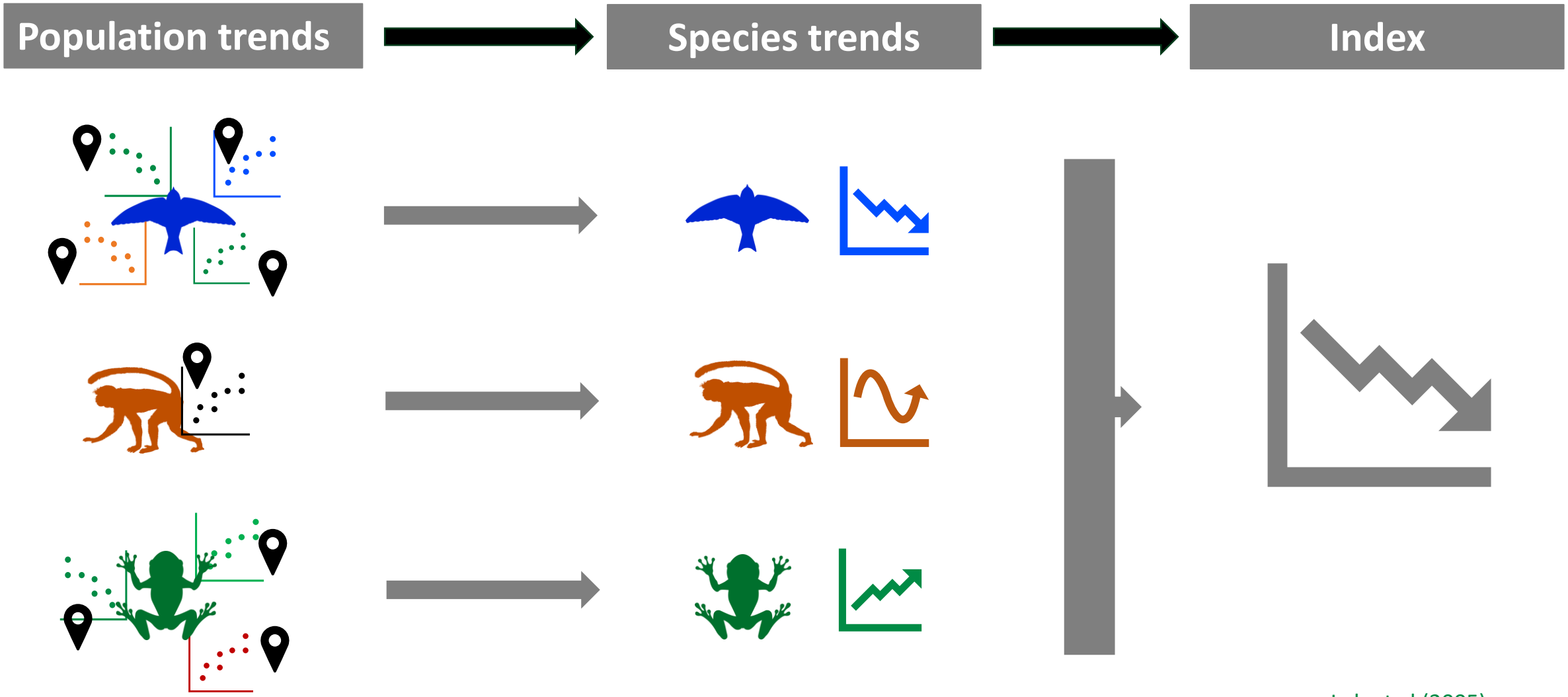
SCAN ME

Collen et al 2009
Cons Biol

Decisions

1. Inclusive of all available data: 2+ data points and 2+ years
2. Include zero values. Transformed by adding 1% mean to all values in the time-series
3. Cap annual trends to a limit of a 10-fold increase/decrease within a single year
4. Exclude influential populations – single populations or species which cause a data effect in a regional or global trend
5. Apply a Generalised Additive Modelling framework
6. Aggregate index using a geometric mean

Index aggregation

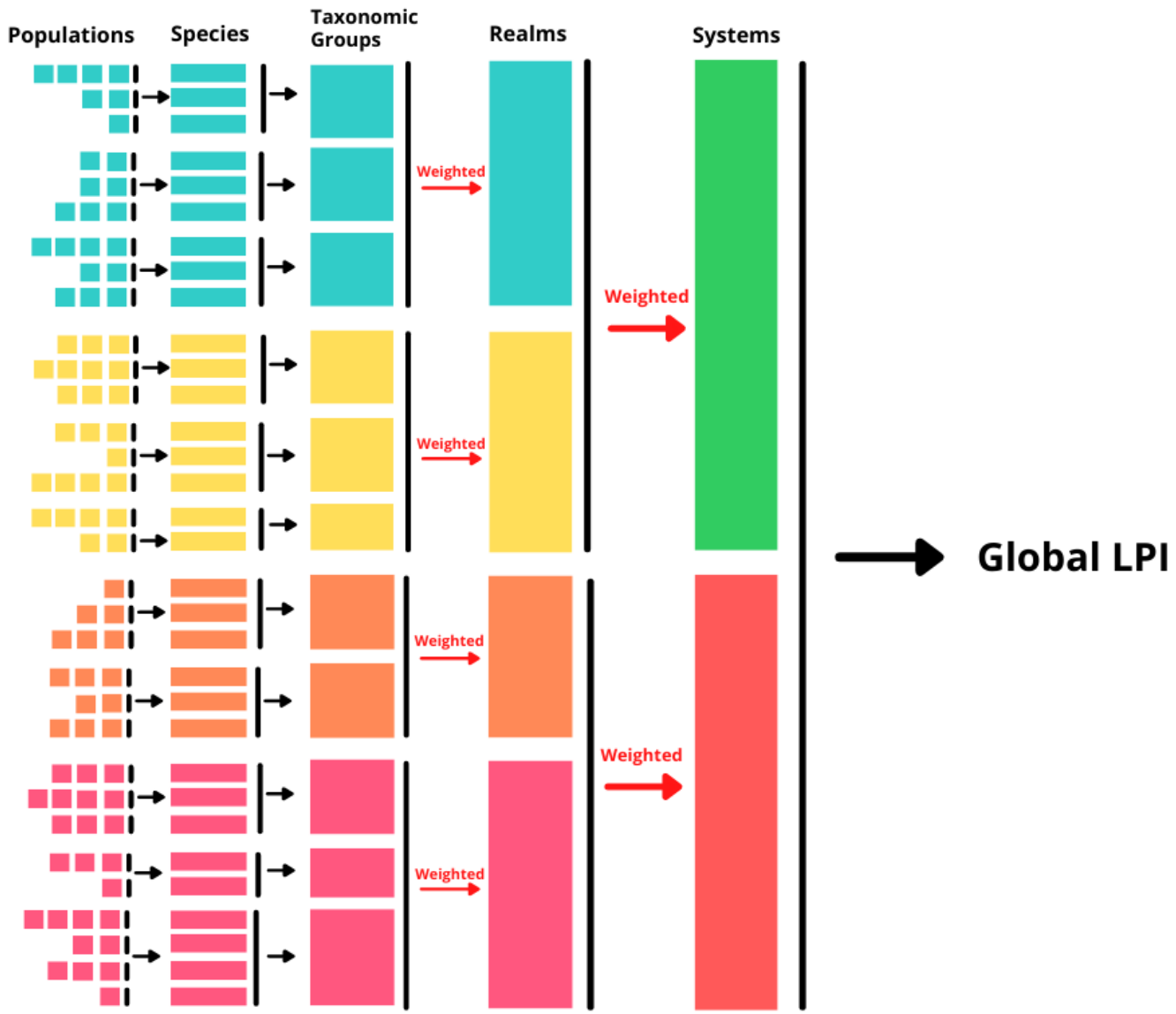


Loh et al (2005);
Collen *et al* (2009)

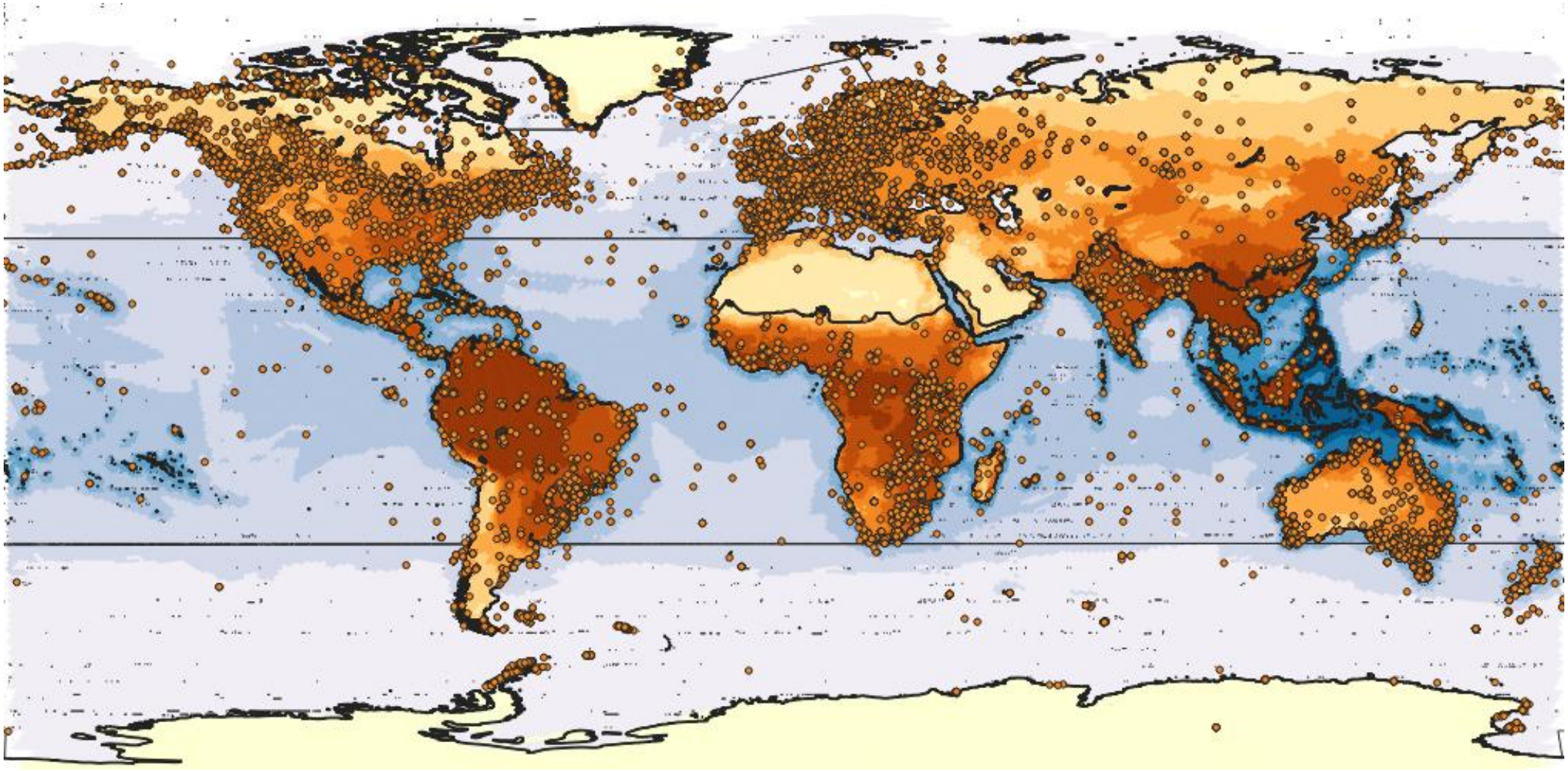
Index aggregation

Geometric mean

- Allows for aggregation of trends from disparate surveys
- Measures changes in relative abundance – treats rare and common species equally
- Sensitive to detecting change (Santini et al 2017; van Strien et al 2012)
- Used in other indicators



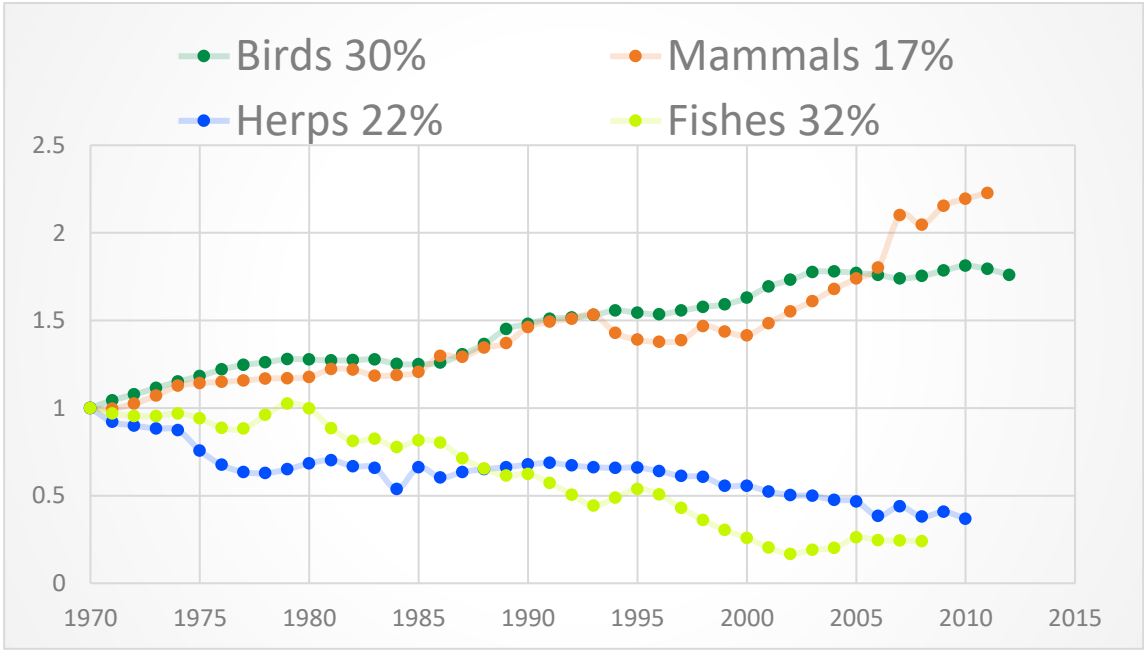
Weighting the index



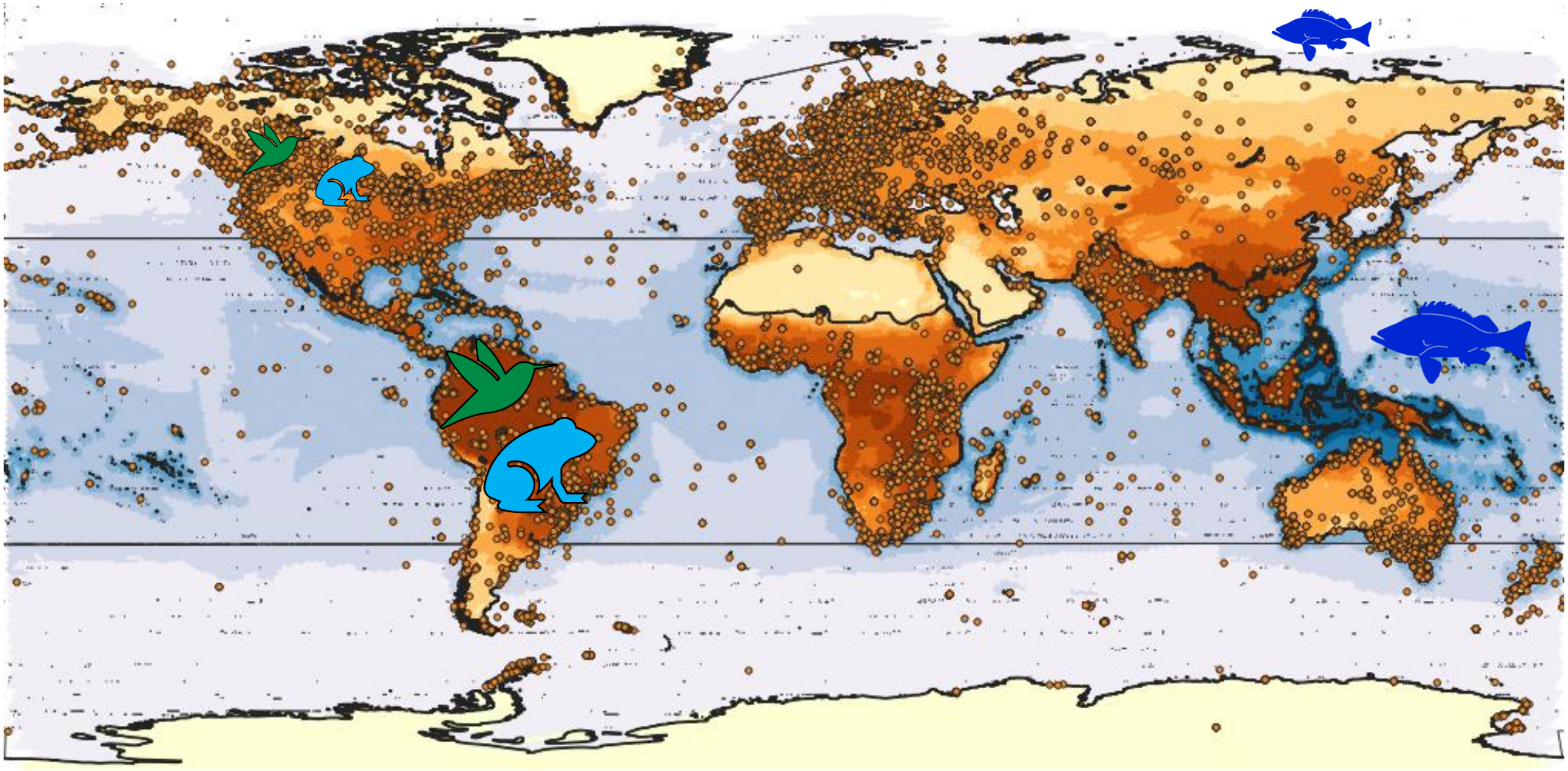
McRae *et al* 2017

Weighting the index

Bird species represent >60% of the data in the Palearctic LPI, yet only 30% of vertebrate species in the Palearctic are birds



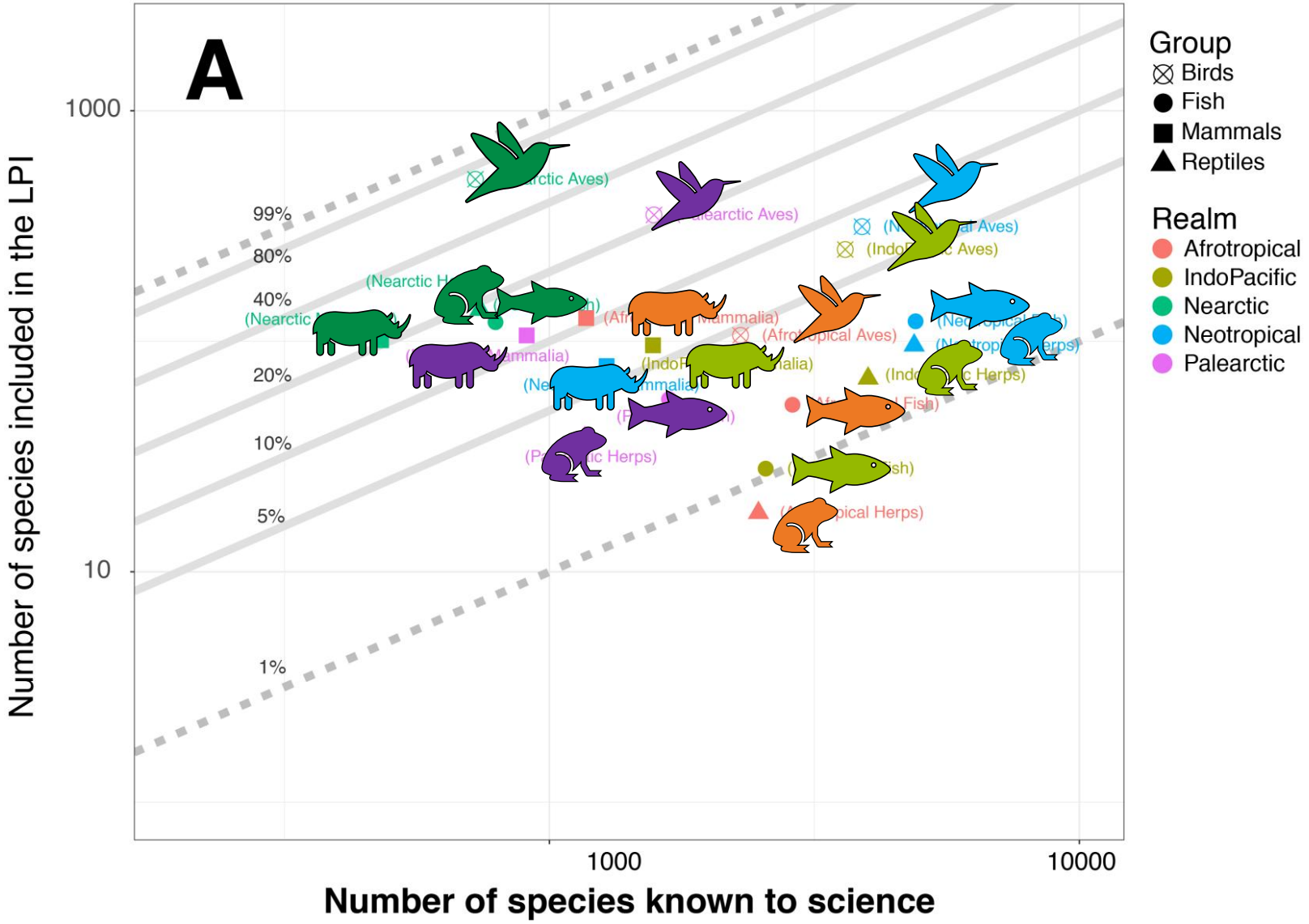
Weighting the index



McRae *et al* 2017

Data and methods

Limitations to weighting



SCAN ME

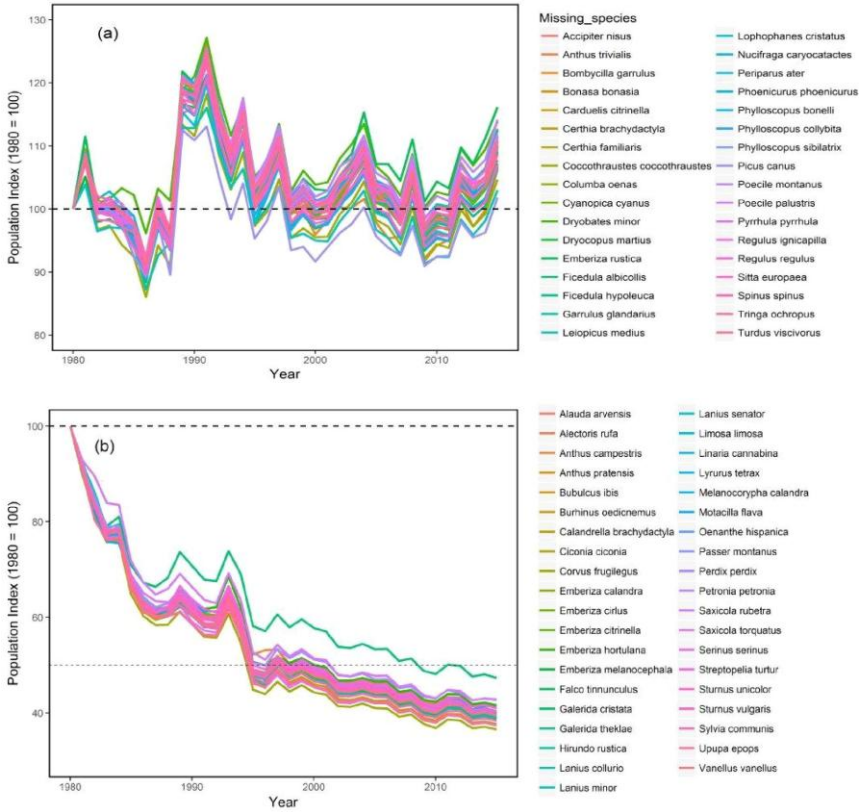
McRae et al 2017

Challenges and solutions

ZSL Institute of Zoology

Sensitivity of the geometric mean

- Geometric mean can be sensitive to outliers and to random fluctuations
- Rare species (Buckland *et al.* 2011; Korner-Nievergelt *et al.* 2022), zero values (Korner-Nievergelt *et al.* 2022), short or variable time-series, extreme trends (Leung *et al.* 2020)



Gregory *et al* (2019) Ecol. Indicators

Sensitivity to data inclusion

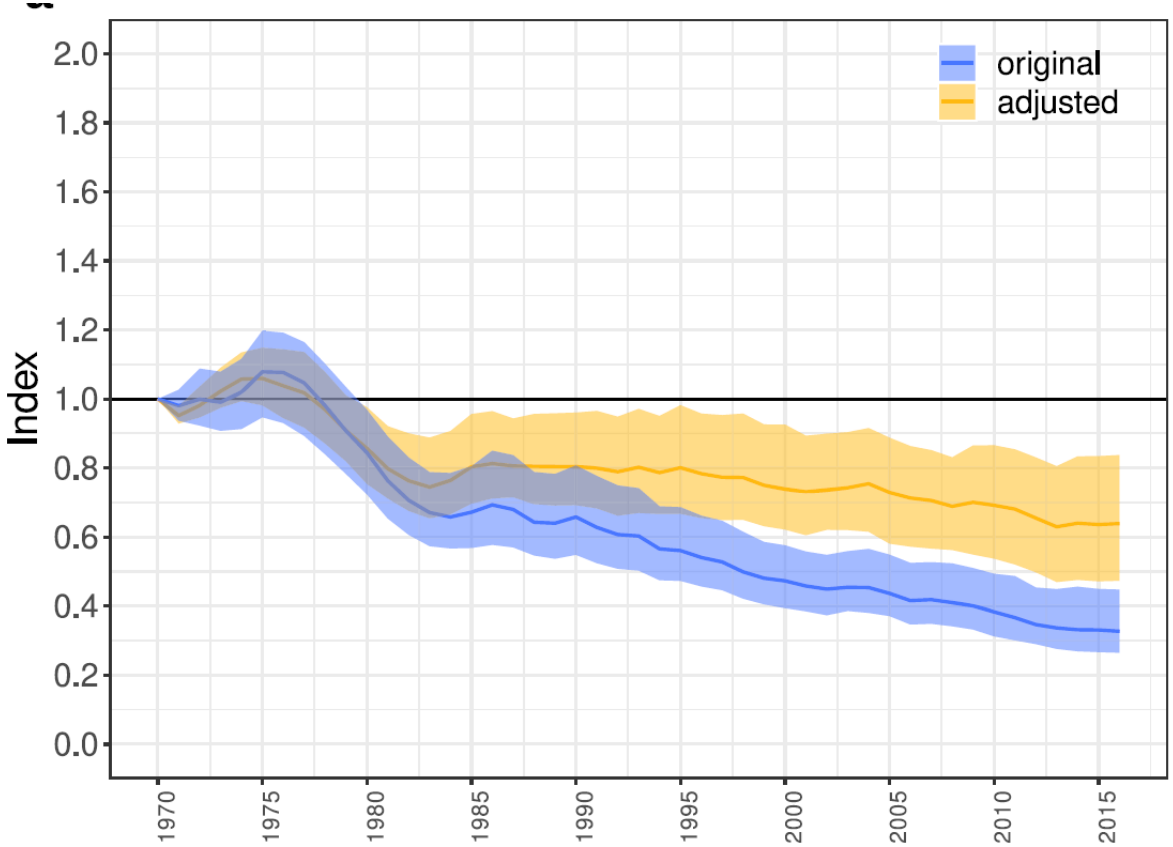
The LPI contains a mix of time-series with varying lengths and fullness

Two recommendations:

- Removed time-series with fewer than 5 data points
- Removed all zero values and divided time-series up where zeros occur in the middle

Conclusion:

- After these filters, the LPI shows a less negative trend



Toszogyova *et al* 2024

Exclude with caution

Removing short or sparse time-series.

- A significant trend from a few years likely to describe the trend direction of complete trend (Wauchope *et al.* 2019)
- Timeseries are from taxa which tend to be in decline (Marconi *et al.* 2021)

Risk of removing important data

- Some good quality studies sometimes only have two data points
- Time-series containing zeroes can represent Critically Endangered species
- Zeros are not missing values (immigrations, low-abundance, extirpations)

African savanna raptors show evidence of widespread population collapse and a growing dependence on protected areas

Phil Shaw, Darcy Ogada, Leah Dunn, Ralph Buij, Arjun Amar, Rebecca Garbett, Marc Herremans, Munir Z. Virani, Corinne J. Kendall, Barbara M. Croes, Martin Odino, Shiv Kapila, Peter Wairasho, Christian Rutz, André Botha, Umberto Gallo-Orsi, Campbell Murn, Glyn Maude & Simon Thomsett

Nature Ecology & Evolution **8**, 45–56 (2024) | Cite this article

Epidemic disease decimates amphibian abundance, species diversity, and evolutionary history in the highlands of central Panama

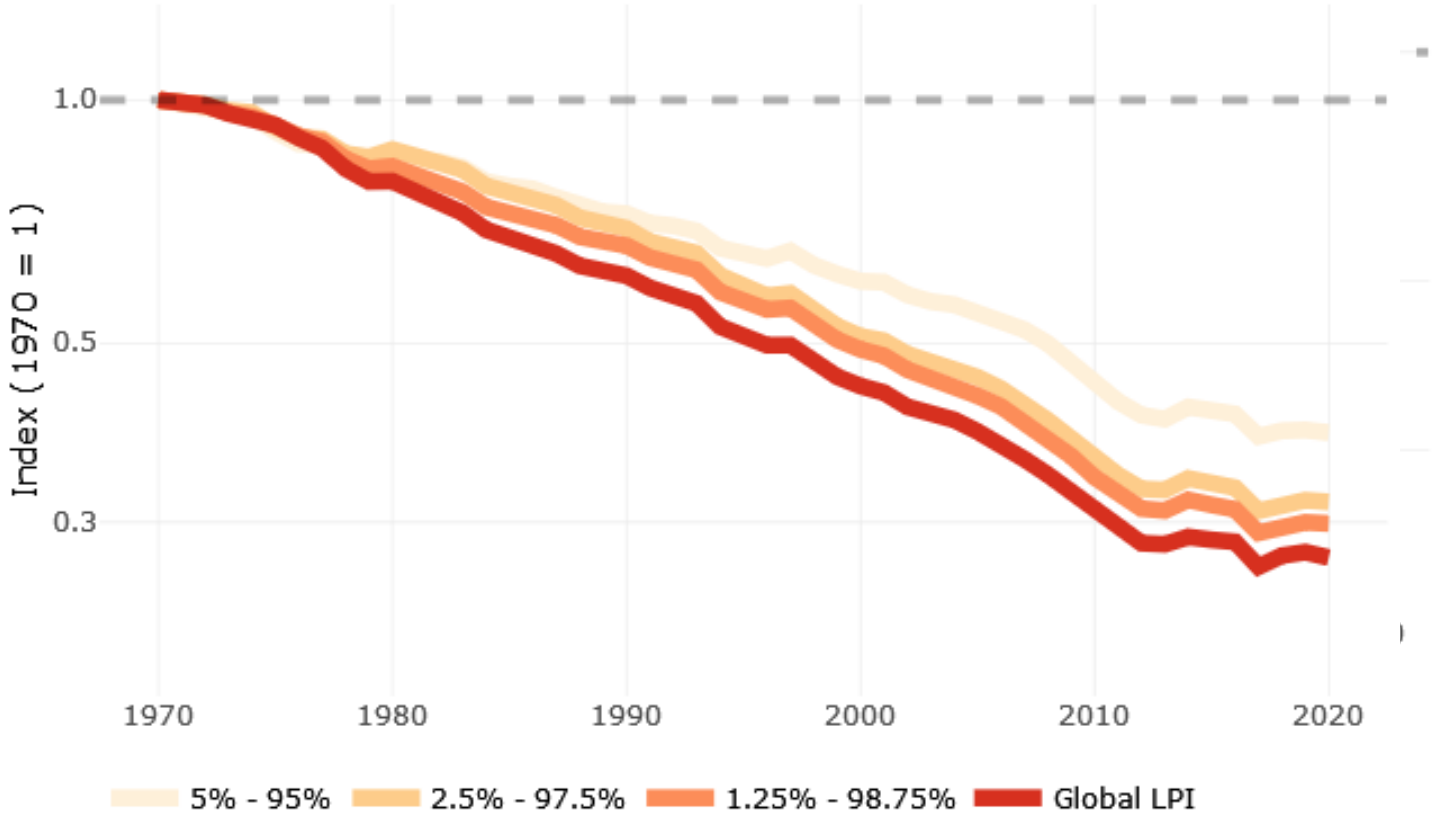
Andrew J. Crawford, Karen R. Lips, and Eldredge Bermingham Authors Info & Affiliations

Edited* by David B. Wake, University of California, Berkeley, Berkeley, CA, and approved June 22, 2010 (received for review December 7, 2009)

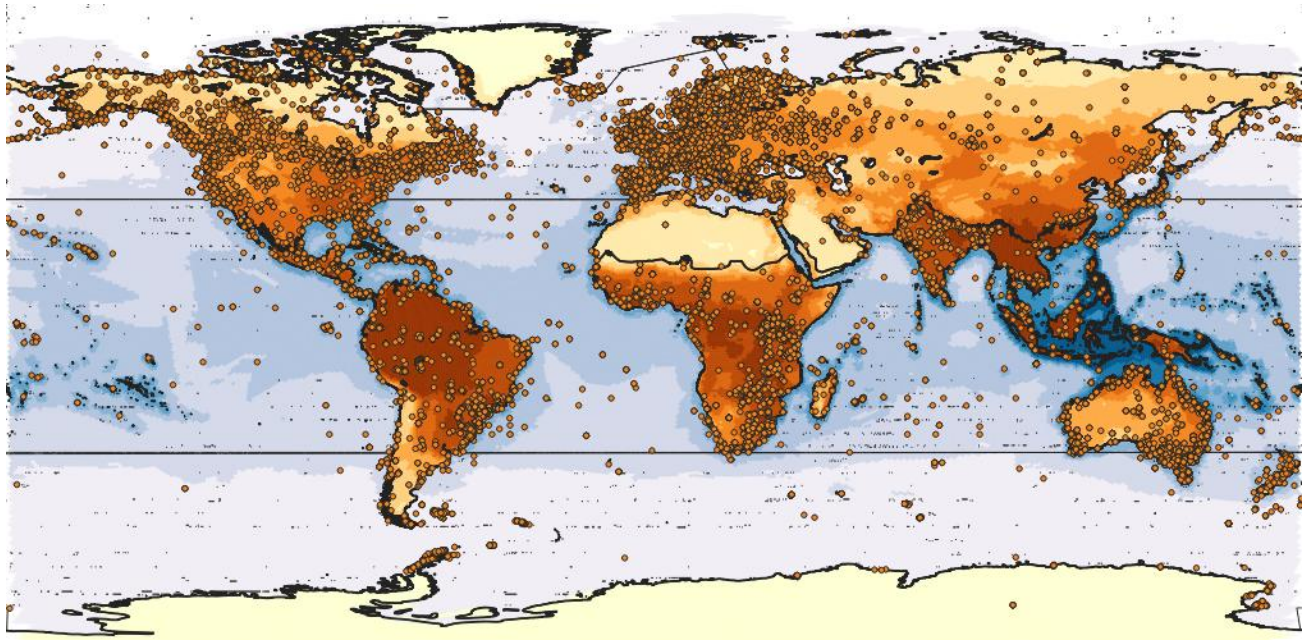
July 19, 2010 | 107 (31) 13777-13782 | https://doi.org/10.1073/pnas.0914115107

Sensitivity tests

- Diagnostic tests in the technical supplement accompany each new calculation of the global LPI
- Effect of time-series length
- Effect of removing outliers



LPI representation: taxonomic and spatial



McRae *et al* (2017) PLOS ONE

- Birds and mammals
- Terrestrial sites
- High income countries
- Critically Endangered reptiles / Near Threatened reptiles and fishes
- Protected areas (Murali *et al.* 2022 *Nature*)

Bias in biodiversity monitoring

Regional and taxonomic bias in GBIF (Boakes *et al* 2010; Amano *et al* 2016; Troudet *et al* 2017)

Birds and mammals

Terrestrial

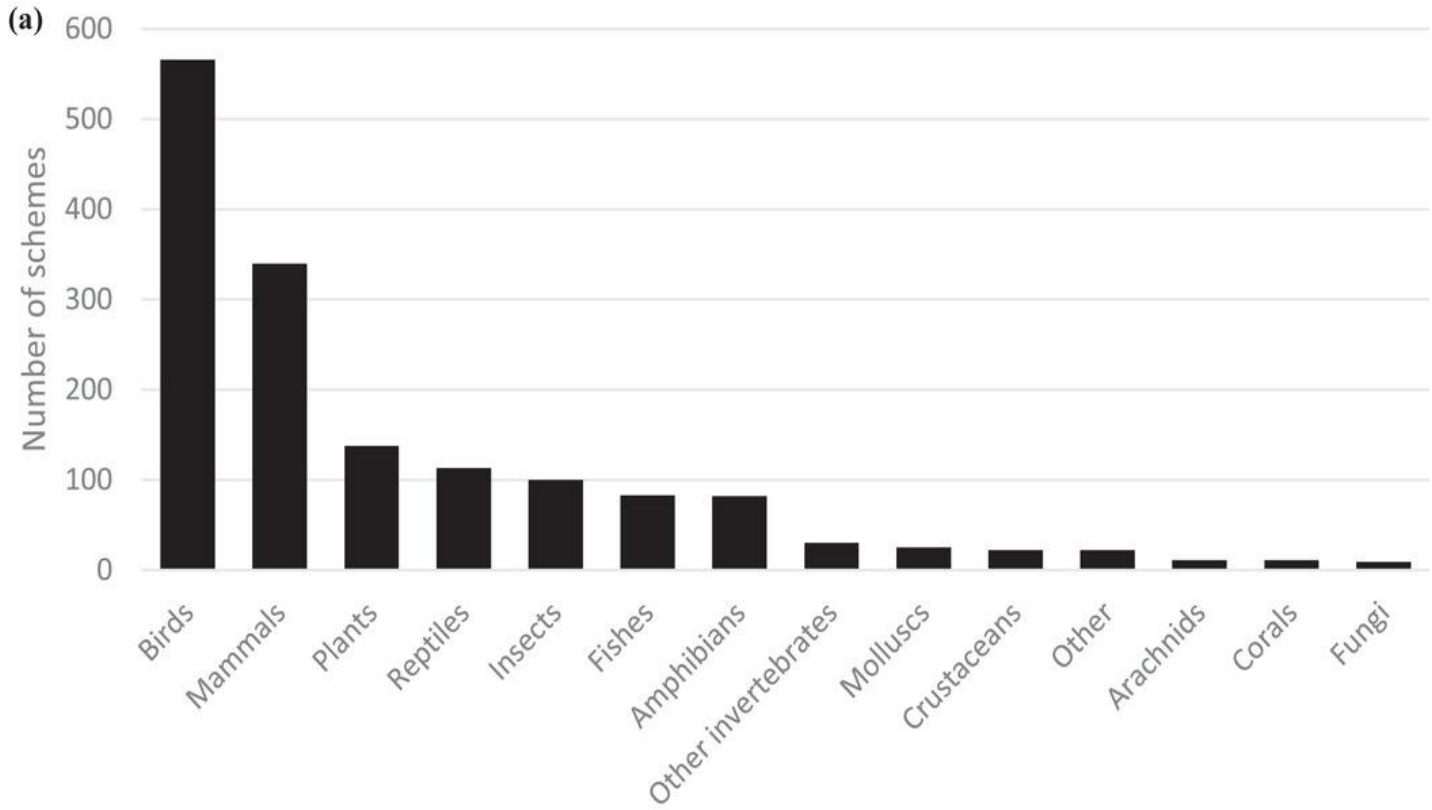
Europe and North America

Terrestrial ecological studies (Martin *et al* 2012)

Protected areas

Language bias in ecological literature: (Amano *et al* 2016, 2021)

Searches are primarily conducted in English yet a wealth of data exists in other languages



Moussy *et al* (2021) Conservation Biology

Challenges & solutions

Addressing language bias

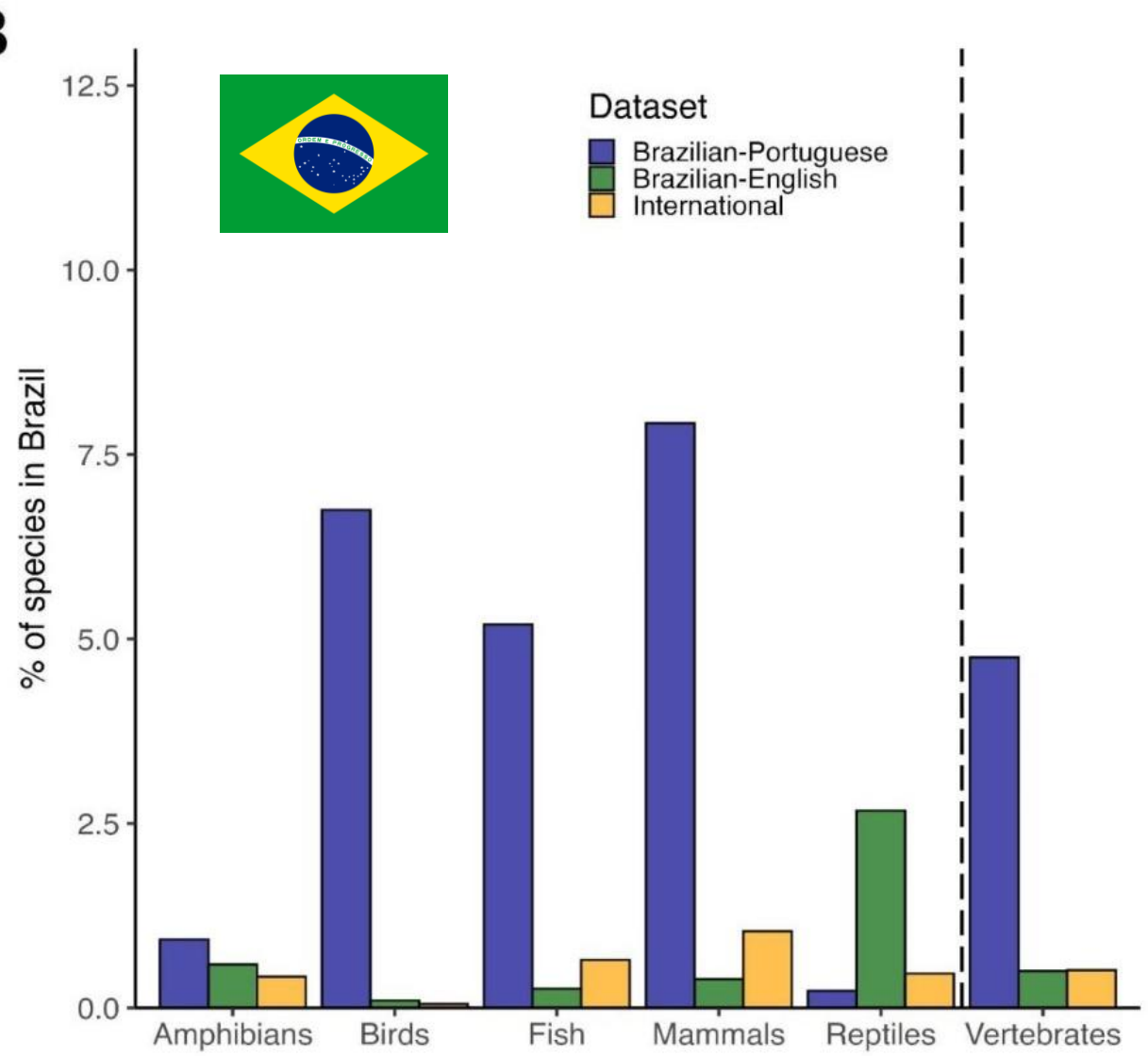
PERSPECTIVE

Languages Are Still a Major Barrier to Global Science

Tatsuya Amano[1,2]*, Juan P. González-Varo[1], William J. Sutherland[1]

1 Conservation Science Group, Department of Zoology, University of Cambridge, Cambridge, United Kingdom, **2** Centre for the Study of Existential Risk, University of Cambridge, Cambridge, United Kingdom

	Brazilian	International
Articles screened	20,067	535,434
Articles selected	73	30
# species	496	51
# populations	751	103



Serrano et al (*2025*)

Challenges & solutions

Addressing language bias

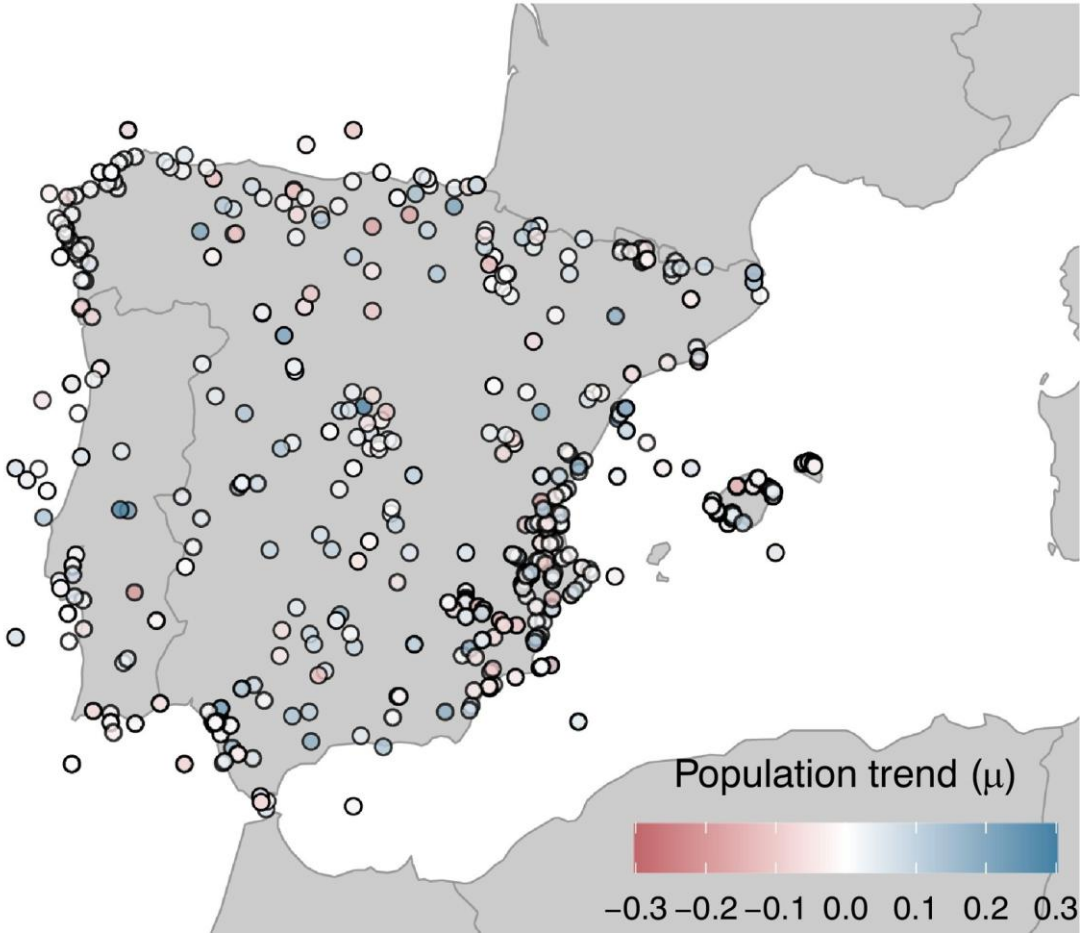
ELSEVIER

Biological Conservation

Volume 298, October 2024, 110755

The importance of locally sourced data in identifying population trends: Insights from Iberian vertebrates

- Data searches in English, Portuguese, Catalan, Spanish, Galician, Valencian
- Threefold increase in data compared to what is in the Living Planet Database



Communication

ZSL Institute of Zoology

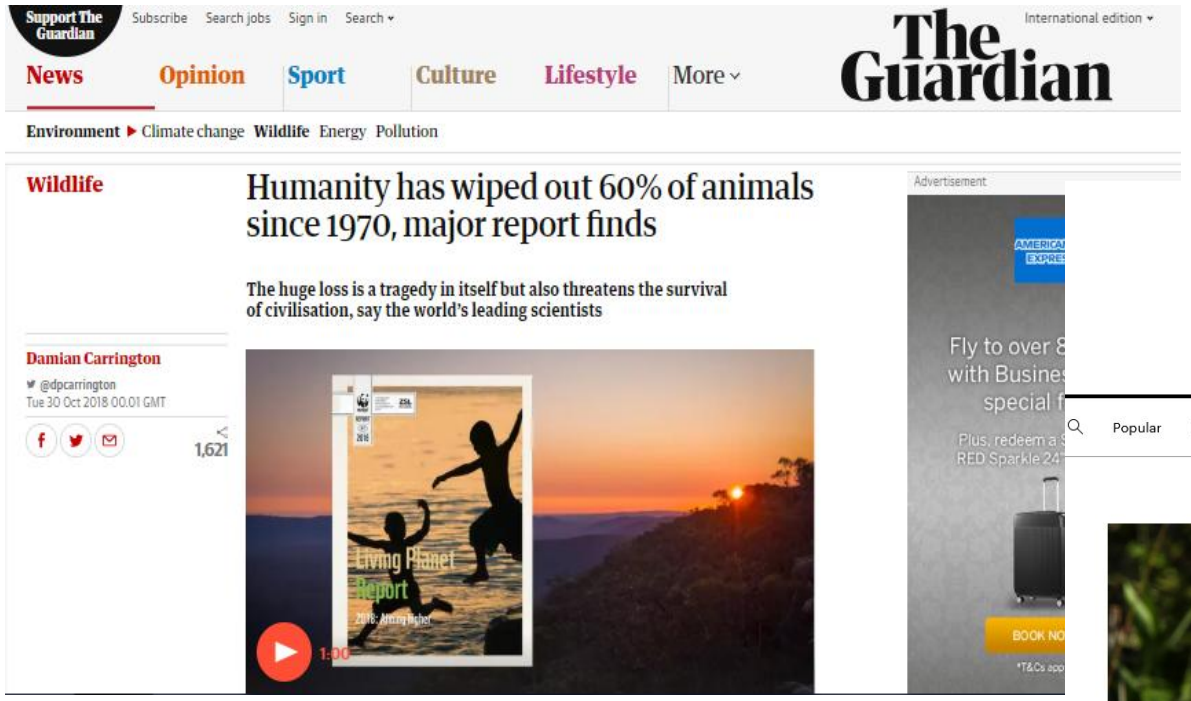
Conveys a complex topic into a single message for a broad audience

Living Planet Report 2020 (13th edition)

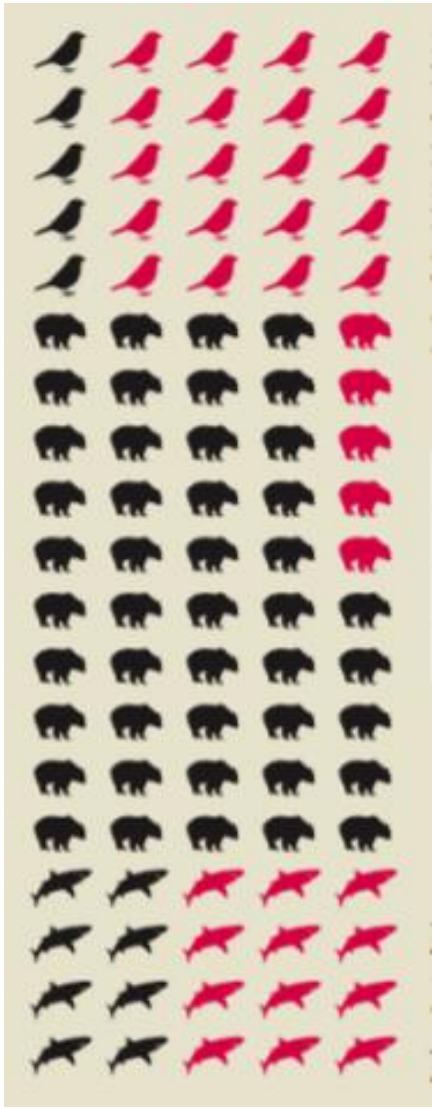
- translated into 16 languages and circulated around the world
- over 290 million social media views
- 3,560 mentions from monitored global news outlets within the first month of its launch
- 51% of online posts/articles mention LPI

Challenges & solutions

(Mis) Communication



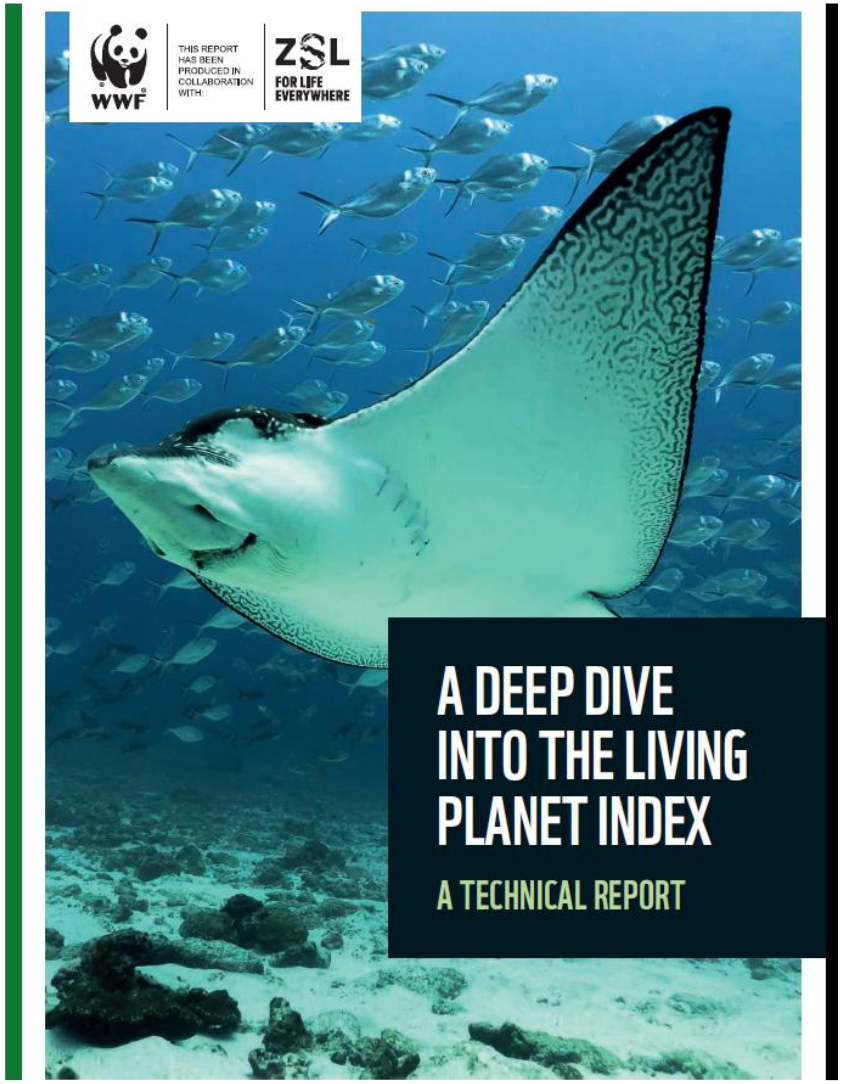
Addressing communication issues



- ❌ The LPI doesn't show numbers of species lost or extinctions
- ❌ It does not mean that 69% of species or populations are declining
- ❌ Or that 69% of populations or individuals have been lost

The Living Planet Index shows a xx% increase/decrease between 1970 and 2020. The LPI is based on average trends in xx monitored vertebrate populations from xx species.

The Living Planet Index, which tracks the average change in relative abundance of monitored vertebrate populations, has decreased by xx% since 1970



Summary

ZSL Institute of Zoology

- In the past quarter of a century the LPI has provided the foundation for many avenues of research into the patterns and drivers of biodiversity change
- Used as a biodiversity indicator in 15 Living Planet Reports and many global biodiversity assessments and policy reports
- Taxonomic and geographic data gaps persist but can be addressed through searches in multiple languages and use of large language models to automate data searches
- The method can be sensitive to the underlying data, so diagnostic tests are essential for transparency and for assessing robustness of the index
- The LPI is a powerful communication tool as long as care is taken to accurately convey the message

Thank you

ZSL Institute of Zoology

CREAF

WWF

WWF UK for providing funding for continued LPI development

Grateful thanks to the many generous data providers and the database assistants who have patiently processed all of the data

IIASA

MAPPPD

rspb giving nature a home

IUCN

Tour du Valat

WORLD FISH MIGRATION FOUNDATION

University of BRISTOL

WWF

Environment and Climate Change Canada
Environnement et Changement climatique Canada

De Vlinderstichting

Shoal

Butterfly Conservation
Saving butterflies, moths and our environment

BirdLife INTERNATIONAL

CMS

Rewilding Europe

TSX Threatened Species Index

tern

NCRIS

UN environment programme

WCMC

The 2024 Living Planet Report has been published. Read the full report here, learn about the latest results here and see our technical supplement here

Follow @LPI_Science

www.livingplanetindex.org

Extra slides

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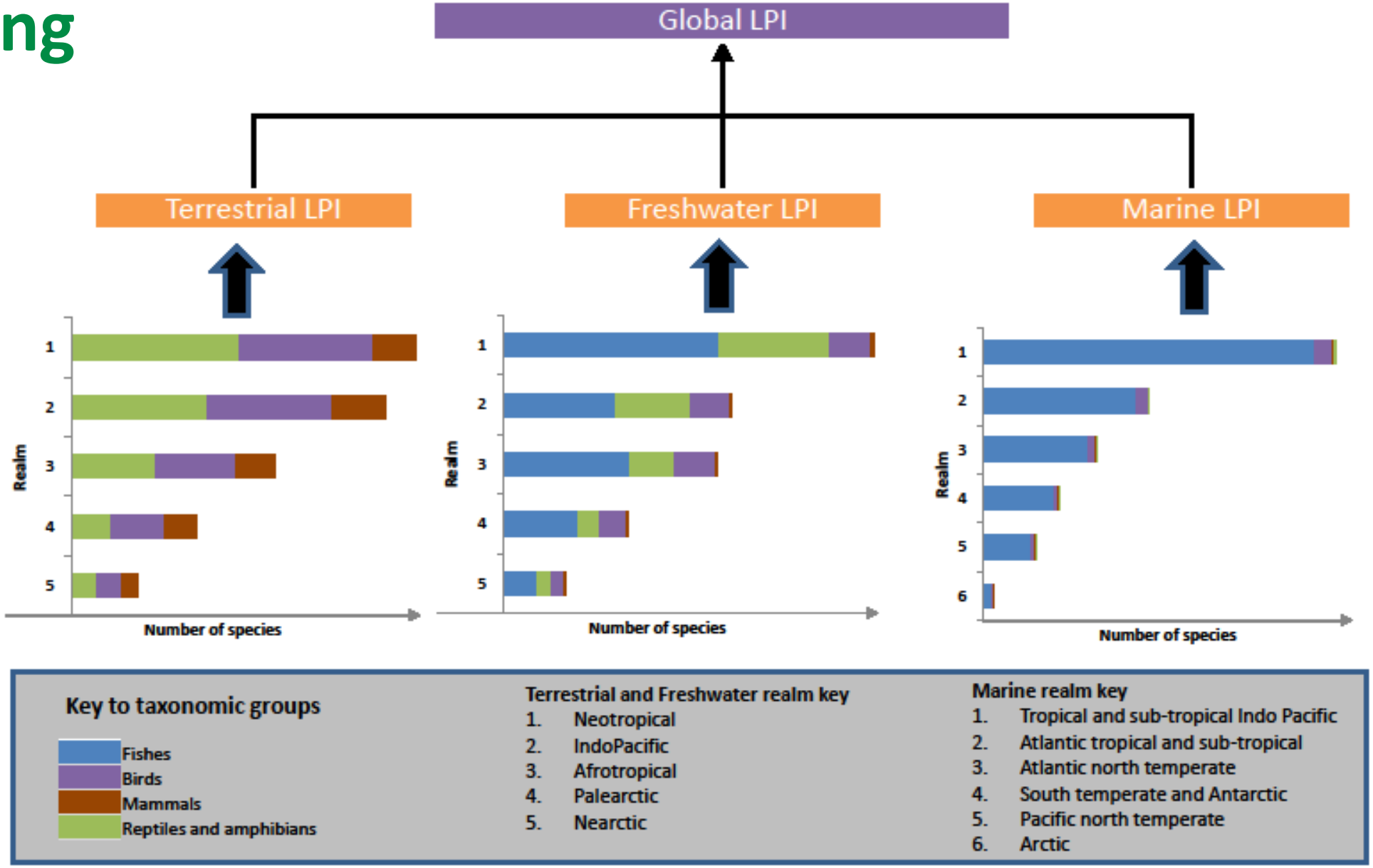
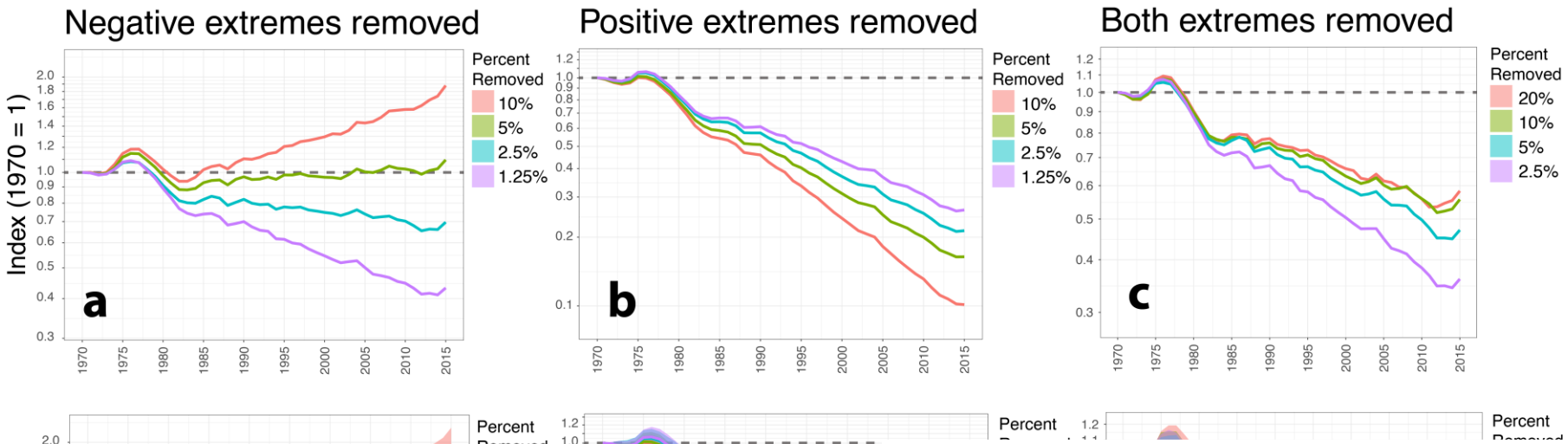
3. Weighting the index

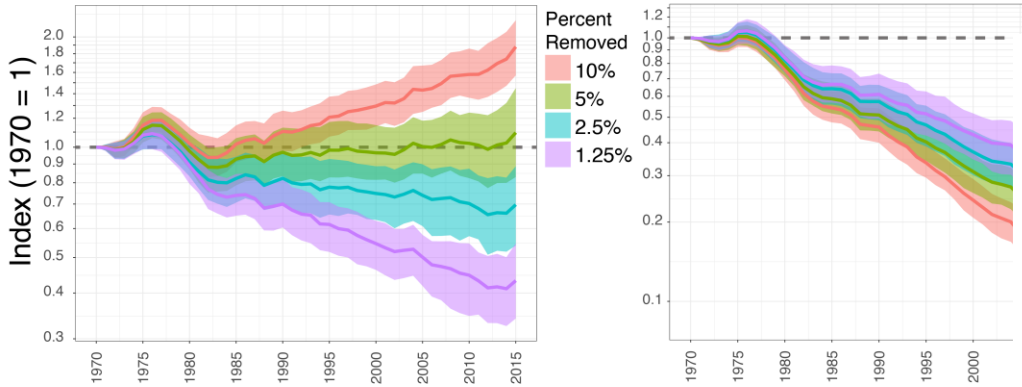


McRae et al 2017

Sensitivity of the LPI / geometric mean

Institute of Zoology





Matters arising

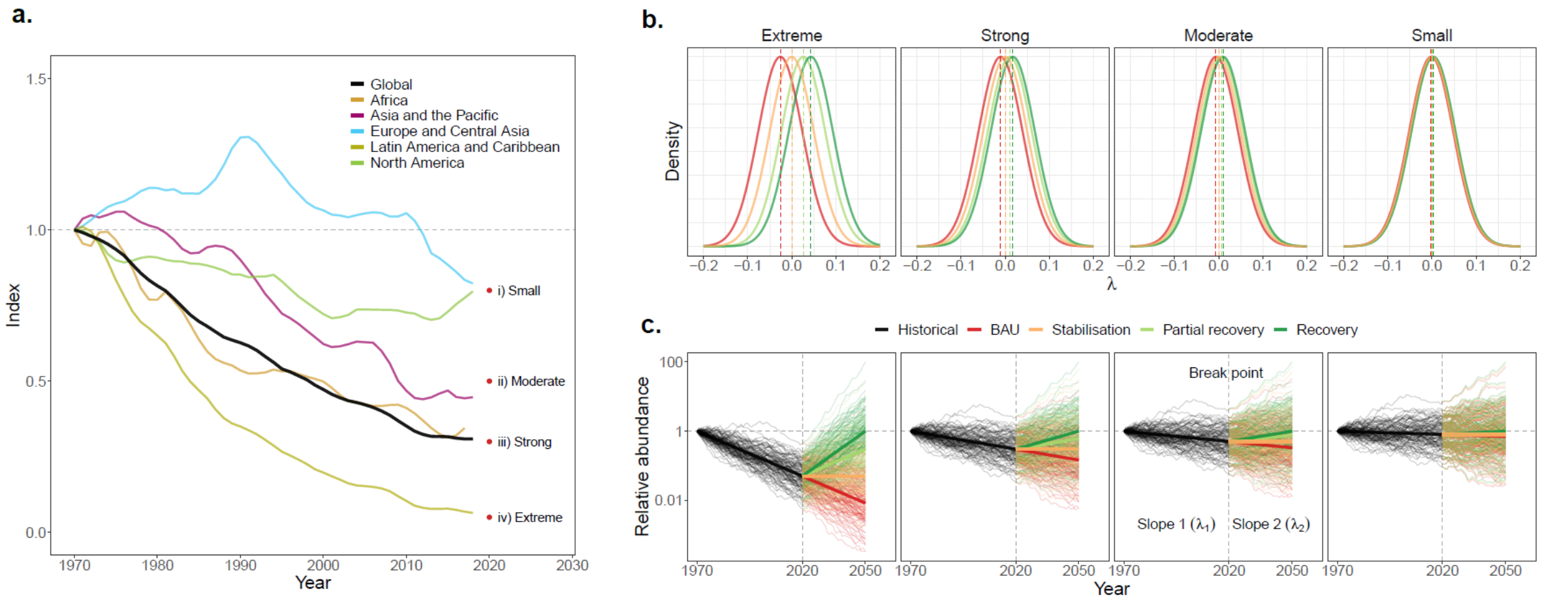
Emphasizing declining populations in the Living Planet Report

https://doi.org/10.1038/s41586-021-04165-z
Received: 14 January 2021
Accepted: 6 October 2021
Published online: 26 January 2022
Check for updates

Gopal Murali[1,2,5], Gabriel Henrique de Oliveira Caetano[1,2,5], Goni Barki[2,3,5], Shai Meiri[4,6] & Uri Roll[2,6]✉

ARISING FROM B. Leung et al. *Nature* https://doi.org/10.1038/s41586-020-2920-6 (2020)

Detecting recovery

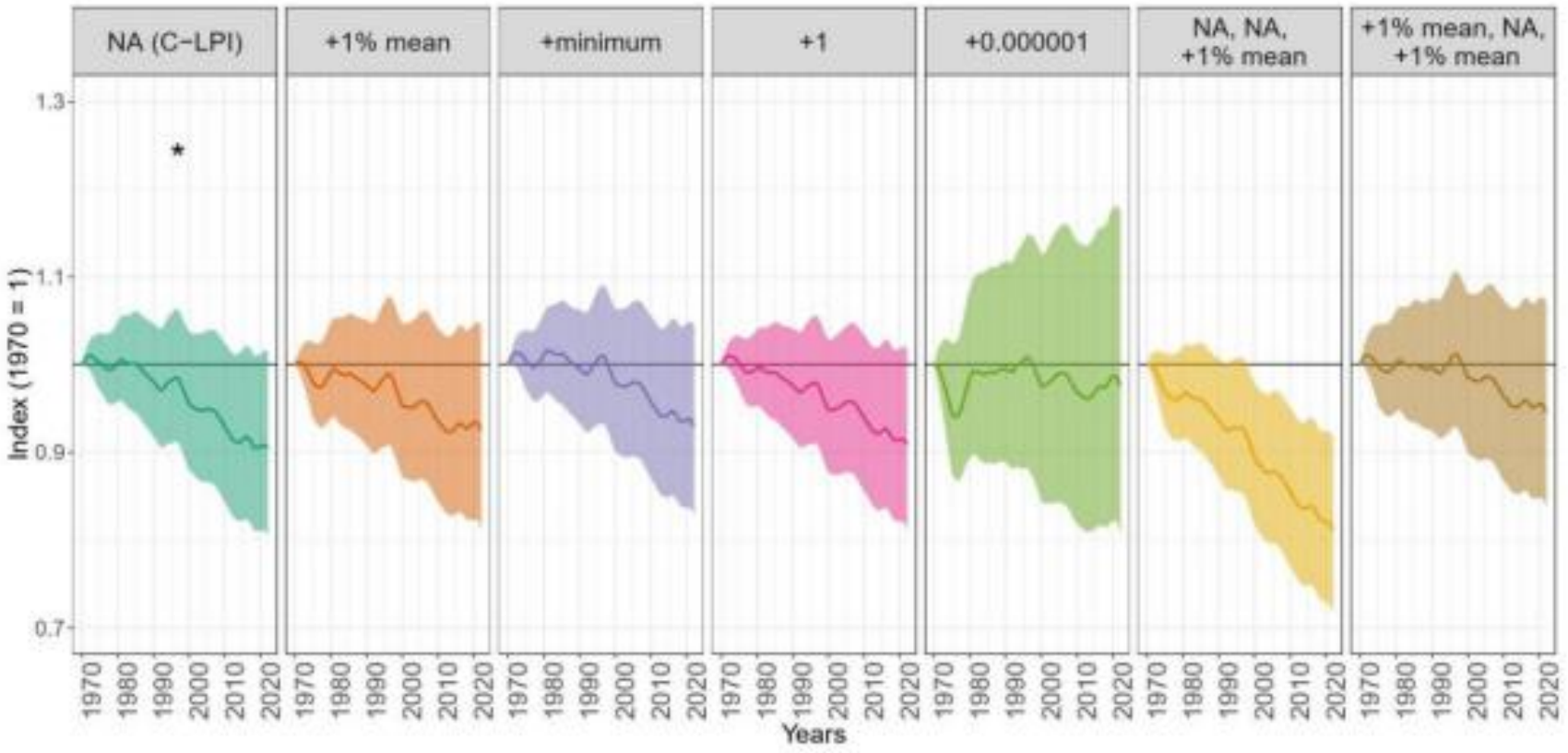


McRae et al (2025) Phil Trans B.

Alternative approaches to the treatment of zero values
A case study for Canada

ZSL Institute of Zoology

CANADIAN SPECIES INDEX
CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS



Currie et al. (in review) Navigating methodological decisions: Balancing rigor and data volume of the Canadian Living Planet Index.

bioRxiv
THE PREPRINT SERVER FOR BIOLOGY

Addressing criticism

Excluding data can introduce greater bias

Terrestrial

		Aves	Herptiles	Mammalia	Total
Original data set	Afrotropical	161	56	794	**1011**
	Indo-Pacific	466	84	278	**828**
	Nearctic	2233	127	690	**3050**
	Neotropical	375	225	211	**811**
	Palearctic	1358	54	855	**2267**
	Total	**4593**	**546**	**2828**	**7967**
Amended data set	Afrotropical	62	39	334	**435**
	Indo-Pacific	203	40	90	**333**
	Nearctic	1965	60	371	**2396**
	Neotropical	55	46	71	**172**
	Palearctic	1218	42	593	**1853**
	Total	**3503**	**227**	**1459**	**5189**
Percentage of populations removed	Afrotropical	61.5	30.4	57.9	**57.0**
	Indo-Pacific	56.4	52.4	67.6	**59.8**
	Nearctic	12.0	52.8	46.2	**21.4**
	Neotropical	85.3	79.6	66.4	**78.8**
	Palearctic	10.3	22.2	30.6	**18.3**
	Total	**23.7**	**58.4**	**48.4**	**34.9**

- Removing time-series with zeros more significantly removes tropical populations
- Biasing dataset towards Nearctic/palearctic where declines are less severe

SCAN ME

McRae et al (in review)

Weighted vs. “unweighted” trends

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