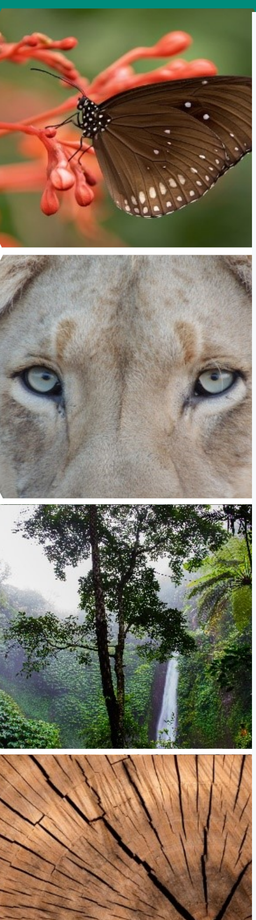
Building essential biodiversity variables (EBVs) through effective global coordination as well as local contributions



W. Daniel Kissling

Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam

4th Annual Meeting on Plant Ecology and Evolution (AMPEE4)
Royal Botanical Society of Belgium
23th of March 2018

Global biodiversity change

Alien invasive species, habitat destruction and fragmentation, overexploitation, climate change…

LETTER

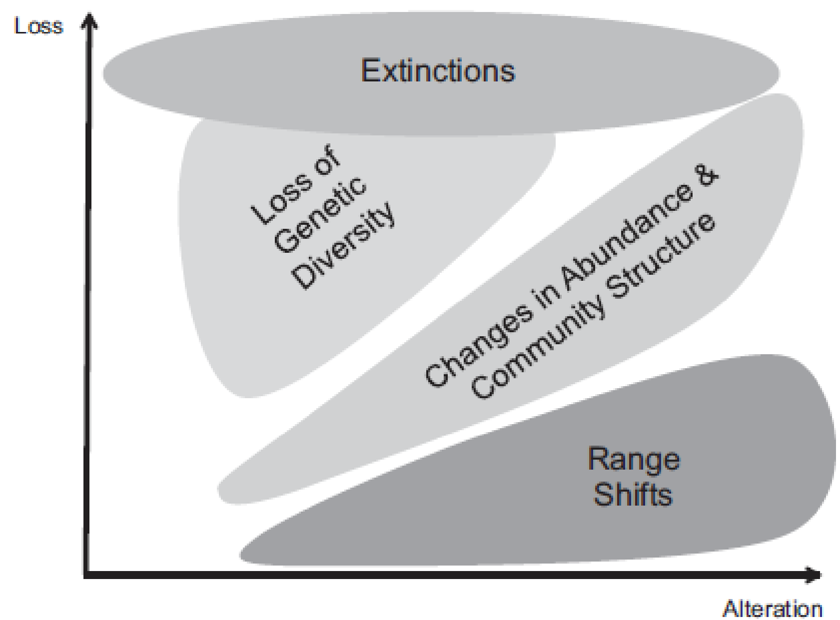
doi:10.1038/nature14910

Global exchange and accumulation of non-native plants

Mark van Kleunen[1], Wayne Dawson[1], Franz Essl[2], Jan Pergl[3], Marten Winter[4], Ewald Weber[5], Holger Kreft[6], Patrick Weigelt[6], John Kartesz[7], Misako Nishino[7], Liubov A. Antonova[8], Julie F. Barcelona[9], Francisco J. Cabezas[10], Dairon Cárdenas[11], Juliana Cárdenas-Toro[12,13], Nicolás Castaño[11], Eduardo Chacón[2,14], Cyrille Chatelain[15], Aleksandr L. Ebel[16], Estrela Figueiredo[17,18], Nicol Fuentes[19], Quentin J. Groom[20], Lesley Henderson[21], Inderjit[22], Andrey Kupriyanov[23], Silvana Masciadri[24,25], Jan Meerman[26], Olga Morozova[27], Dietmar Moser[2], Daniel L. Nickrent[28], Annette Patzelt[29], Pieter B. Pelser[9], María P. Baptiste[12], Manop Poopath[30], Maria Schulze[31], Hanno Seebens[32], Wen-sheng Shu[33], Jacob Thomas[34], Mauricio Velayos[10], Jan J. Wieringa[35,36] & Petr Pyšek[3,37,38]

Van Kleunen et al. 2015 *Nature*

Global Biodiversity Change: The Bad, the Good, and the Unknown



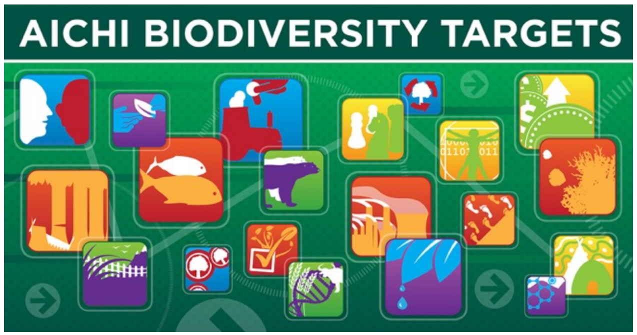
Pereira et al. 2012 *Annual Review of Environment and Resources*

Increasing demand for biodiversity data

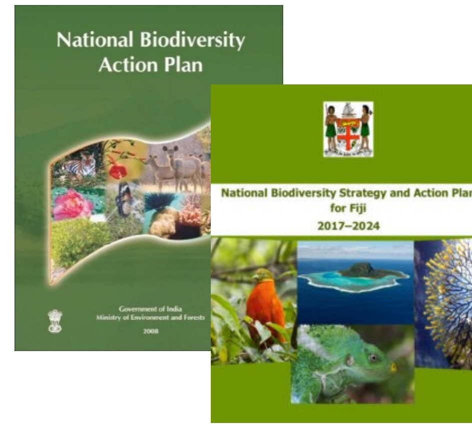
National and international policy goals

Increasing demand for biodiversity data

National and international policy goals



Convention on
Biological Diversity



Target 9
By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

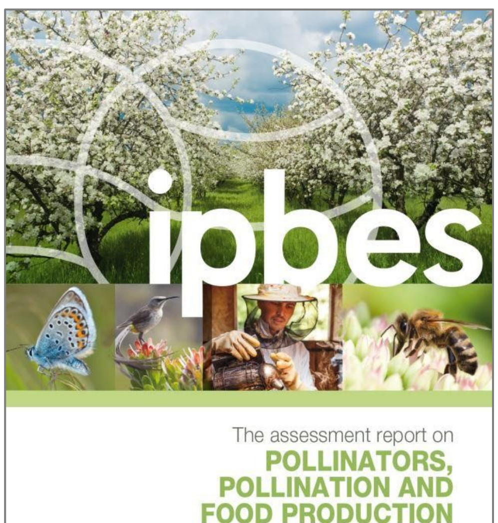
Target 12
By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

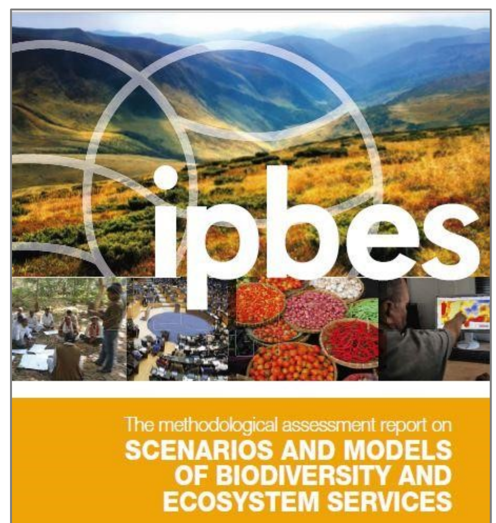
Increasing demand for biodiversity data

National and international policy goals

Increasing demand for biodiversity data

National and international policy goals





Towards global earth observation

<u>Group on Earth Observations (GEO)</u> = international and intergovernmental partnership

- 88 national governments and the European Commission
- 67 participating organisations (including about a dozen UN bodies)

Towards global earth observation

GROUP ON EARTH OBSERVATIONS

GEO BON

Group on Earth Observations Biodiversity Observation Network

http://geobon.org/

Vision

A **global biodiversity observation network** that contributes to effective management policies for the world's biodiversity and ecosystem services

Group on Earth Observations (GEO) = international and intergovernmental partnership

- 88 national governments and the European Commission
- 67 participating organisations (including about a dozen UN bodies)

Towards global earth observation

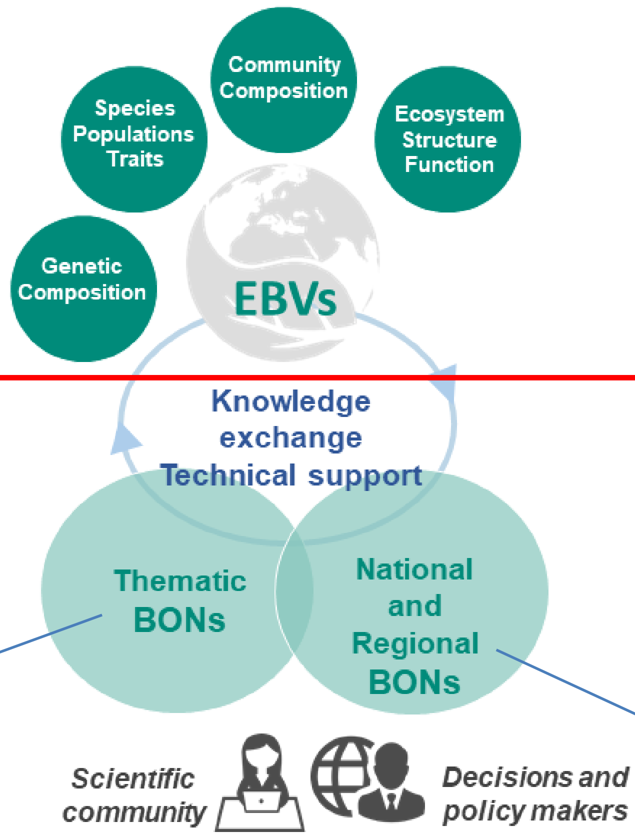
Mission of GEO BON

Improve the **acquisition**, **coordination** and **delivery** of biodiversity observations to decision makers and the scientific community

Towards global earth observation

Mission of GEO BON

Improve the **acquisition**, **coordination** and **delivery** of biodiversity observations to decision makers and the scientific community



Essential Biodiversity Variables (EBVs)

⇒ Key variables that are needed to detect biodiversity change

⇒ Top-down development

Biodiversity Observation Networks (BONs)

⇒ Observation systems to serve policy needs and sustainable development

⇒ Bottom-up development

Marine BON
Freshwater BON

Colombia BON, French BON, China BON
Asia Pacific BON, Arctic BON

Navarro et al. 2017 *Current Opinion in Environmental Sustainability*

Essential Biodiversity Variables (EBVs)

The EBV concept

POLICYFORUM

ECOLOGY

Essential Biodiversity Variables

A global system of harmonized observations is needed to inform scientists and policy-makers.

H. M. Pereira,[1*†] S. Ferrier,[2] M. Walters,[3] G. N. Geller,[4] R. H. G. Jongman,[5] R. J. Scholes,[3] M. W. Bruford,[6] N. Brummitt,[7] S. H. M. Butchart,[8] A. C. Cardoso,[9] N. C. Coops,[10] E. Dulloo,[11] D. P. Faith,[12] J. Freyhof,[13] R. D. Gregory,[14] C. Heip,[15] R. Höft,[16] G. Hurtt,[17] W. Jetz,[18] D. S. Karp,[19] M. A. McGeoch,[20] D. Obura,[21] Y. Onoda,[22] N. Pettorelli,[23] B. Reyers,[24] R. Sayre,[25] J. P. W. Scharlemann,[26,27] S. N. Stuart,[28] E. Turak,[29] M. Walpole,[26] M. Wegmann[30]

Reducing the rate of biodiversity loss and averting dangerous biodiversity change are international goals, reasserted by the Aichi Targets for 2020 by Parties to the United Nations (UN) Convention on Biological Diversity (CBD) after failure to meet the 2010 target (*1*, *2*). However, there is no global, harmonized observation system for delivering regular, timely data on biodiversity change (*3*). With the first plenary meeting of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) soon under way, partners from the Group on Earth Observations Biodiversity Observation Network (GEO BON) (*4*) are developing—and seeking consensus around—Essential Biodiversity Variables (EBVs) that could form the basis of monitoring programs worldwide.

Change (UNFCCC) (*8*). EBVs, whose development by GEO BON has been endorsed by the CBD (Decision XI/3), are relevant to derivation of biodiversity indicators for the Aichi Targets (*9*). Although CBD biodiversity indicators are designed to convey messages to policy-makers from existing biodiversity data (*1*), EBVs aim to help observation communities harmonize monitoring, by identifying how variables should be sampled and measured.

Given the complexity of biodiversity change (*3*), the challenge of developing a global observation system can appear insurmountable. Nearly 100 indicators have been proposed for the 2020 CBD targets (ongoing work seeks to identify a more limited subset) (*9*). Two-thirds of reports recently submitted by Parties to the CBD lacked evidence-based information on biodiversity change (*10*).

potentially fit this definition. We developed and tested a process, still ongoing, to identify the most essential (*11*). Dozens of biodiversity variables were screened to identify those that fulfill criteria on scalability, temporal sensitivity, feasibility, and relevance. These variables were scored for importance, checked for redundancy, and organized into six classes on the basis of commonalities, general enough for use across taxa and terrestrial, freshwater, and marine realms (see the table).

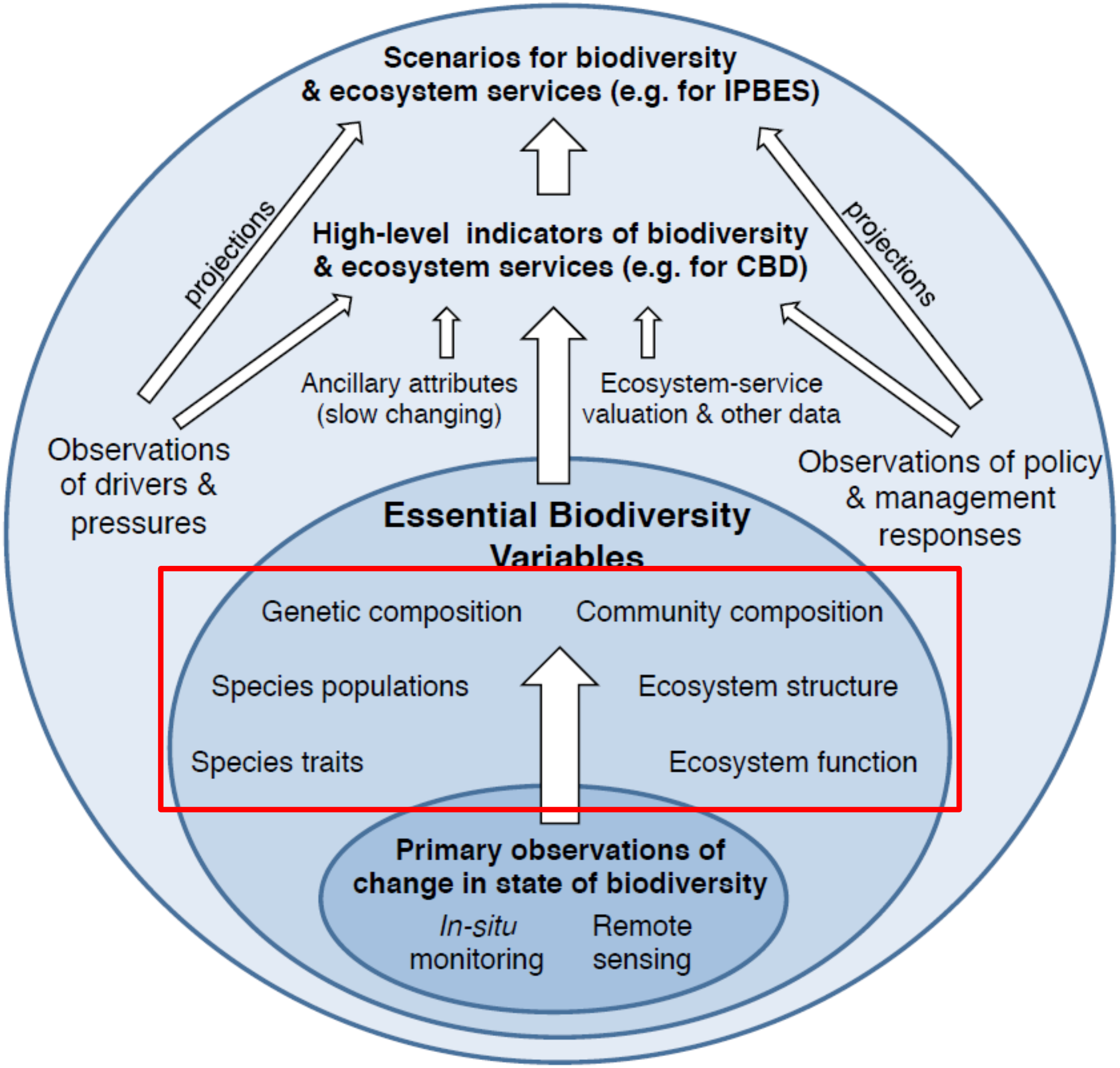
Often, it is not possible to generalize observations from point locations to the regional scale. Variables selected as EBVs harness remote sensing (RS) to measure continuously across space (e.g., habitat structure), or local sampling schemes that can be integrated to enable large-scale generalizations. For instance, citizen scientists con-

EBVs are

a **minimal set of biological variables**, complementary to one another, that can be obtained for large parts of the Earth with the aim to **study, report and manage biodiversity change** at national to global scales

Pereira et al. 2013 *Science*

Essential Biodiversity Variables (EBVs)



6 EBV classes with 22 candidate EBVs

Pereira et al. 2013 *Science*

Essential Biodiversity Variables (EBVs)

Three examples of EBVs

EBV class	EBV examples	Measurement and scalability	Temporal sensitivity	Feasibility	Relevance for CBD 2020 targets and indicators
Species populations	Population abundance	Population counts for groups of species easy to monitor and/or important for ecosystem services, over an extensive network of sites with geographic representativeness.	1 year	Population counts underway for a number of species. Most of these extensive networks are geographically restricted. Much of the data are currently being collected by citizen science networks.	Targets: 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15. Indicators: Population and extinction risk trends of target species, species that provide ecosystem services; trends in invasive alien species; trends in climatic impacts on populations.

Pereira et al. 2013 *Science*

Essential Biodiversity Variables (EBVs)

Three examples of EBVs

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Species traits	Phenology	Timing of periodic biological events for selected taxa/phenomena at defined locations. Examples: timing of leaf coloration and flowering.	1 year	Several ongoing initiatives (Phenological Eyes Network, PhenoCam etc.).	<u>Targets</u>: 10, 15. <u>Indicators</u>: Phenology changes in relation to climate change

Pereira et al. 2013 *Science*

Essential Biodiversity Variables (EBVs)

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Community composition	Species interactions	Studies of important interactions or interaction networks in selected communities (e.g. plant-pollinator or plant-frugivore).	5-25 years	Some studies have monitored the structure of species interaction networks	Targets: 7, 9, 14, 15. Indicators: Trends in species interactions affecting ecosystem functioning and services.

Pereira et al. 2013 *Science*

Essential Biodiversity Variables (EBVs)

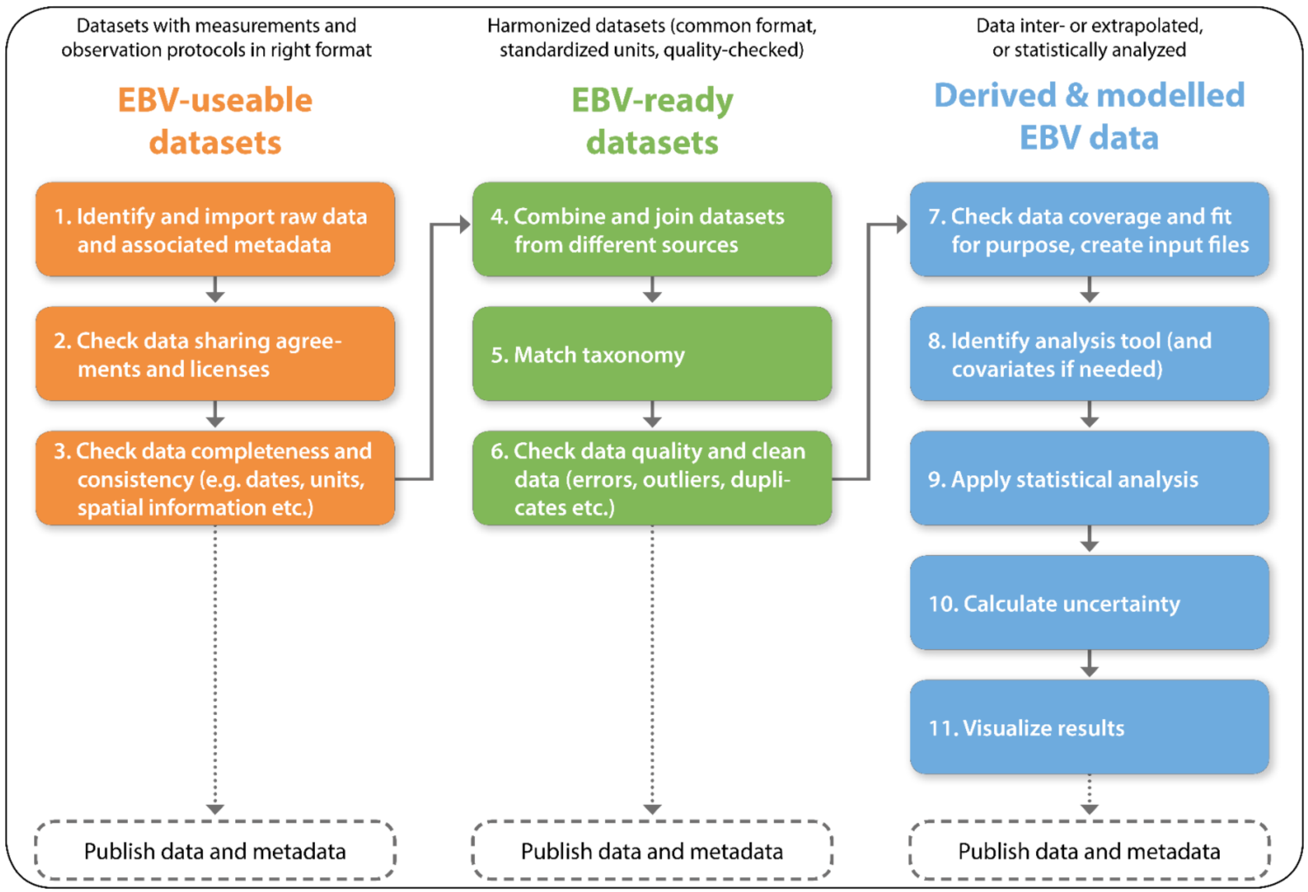
Workflows and EBV data products

GLOBIS-B

EUROPEAN COMMISSION

HORIZON 2020

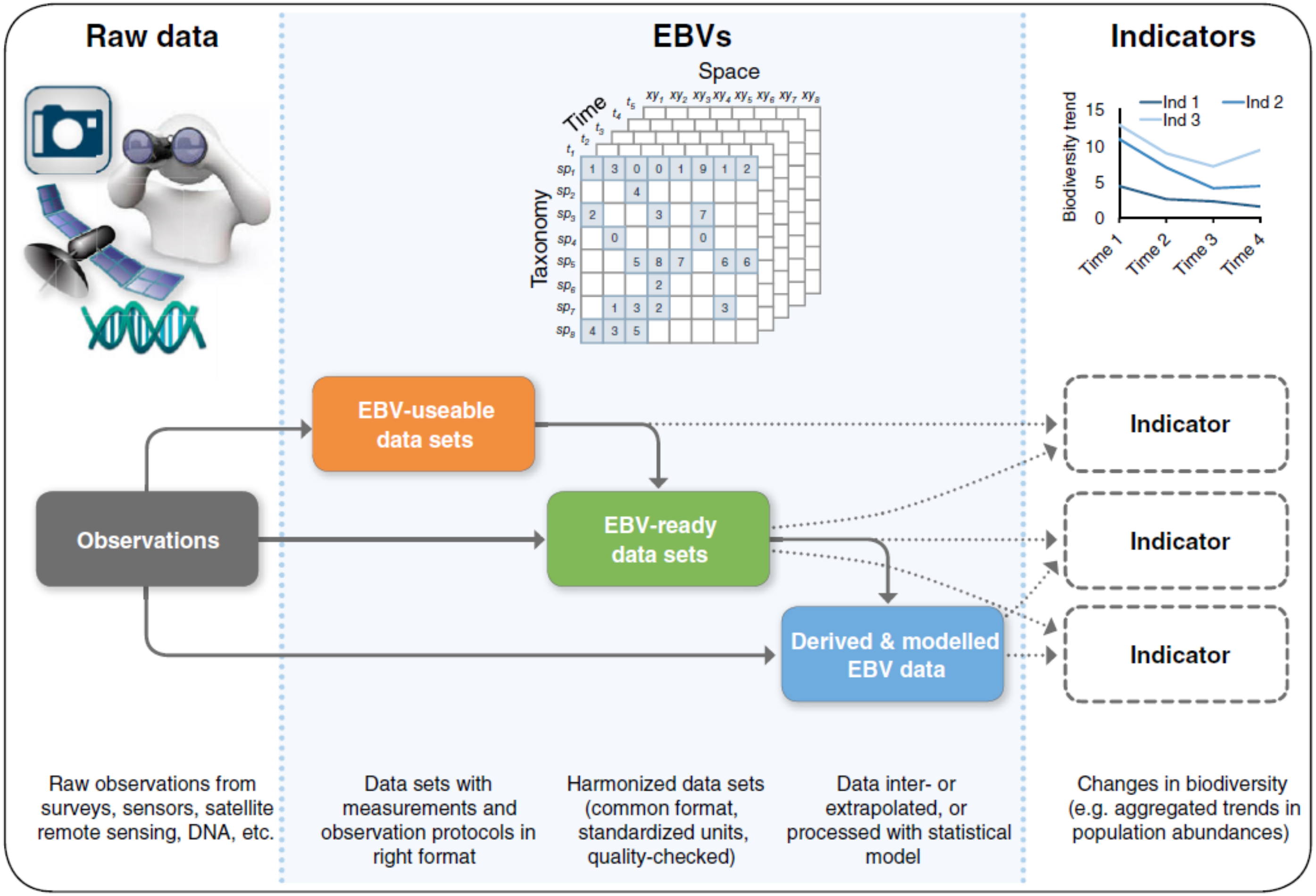
www.globis-b.eu



Kissling et al. 2018 *Biological Reviews*

Essential Biodiversity Variables (EBVs)

Workflows and EBV data products



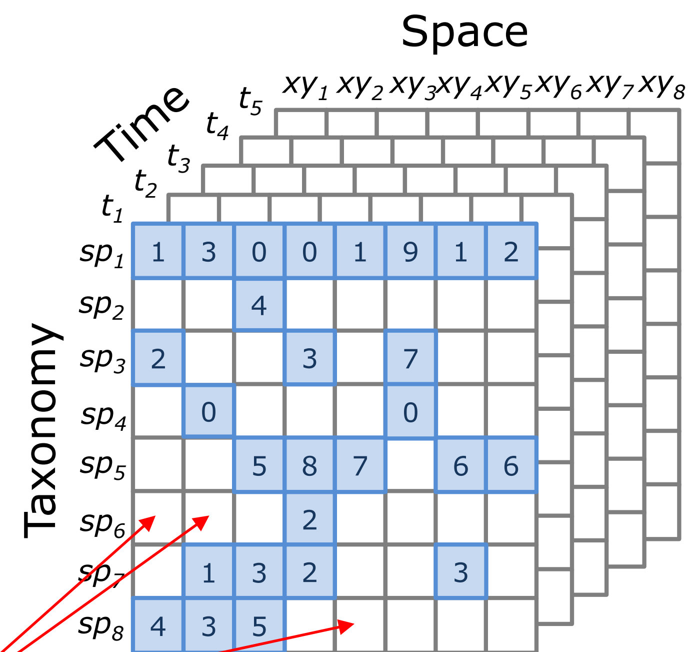
Kissling et al. 2018 *Biological Reviews*

Essential Biodiversity Variables (EBVs)

Challenges for building EBVs

Raw data

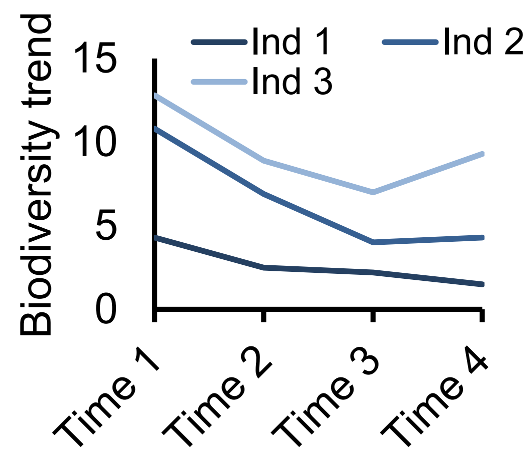
EBV data cube



	xy_1	xy_2	xy_3	xy_4	xy_5	xy_6	xy_7	xy_8
sp_1	1	3	0	0	1	9	1	2
sp_2			4					
sp_3	2			3		7		
sp_4		0				0		
sp_5			5	8	7		6	6
sp_6				2				
sp_7		1	3	2			3	
sp_8	4	3	5					

Knowledge gaps

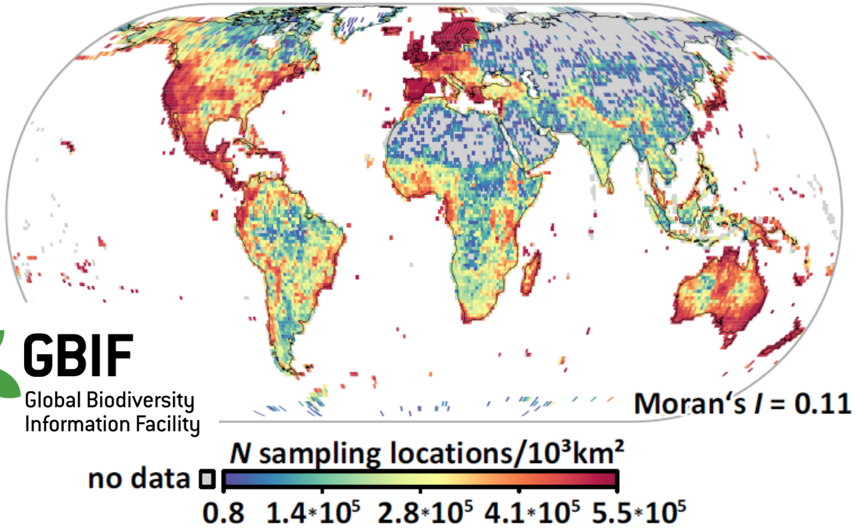
Indicators



Kissling et al. 2018 *Biological Reviews*

Knowledge gaps

Presence-only records of plants from GBIF

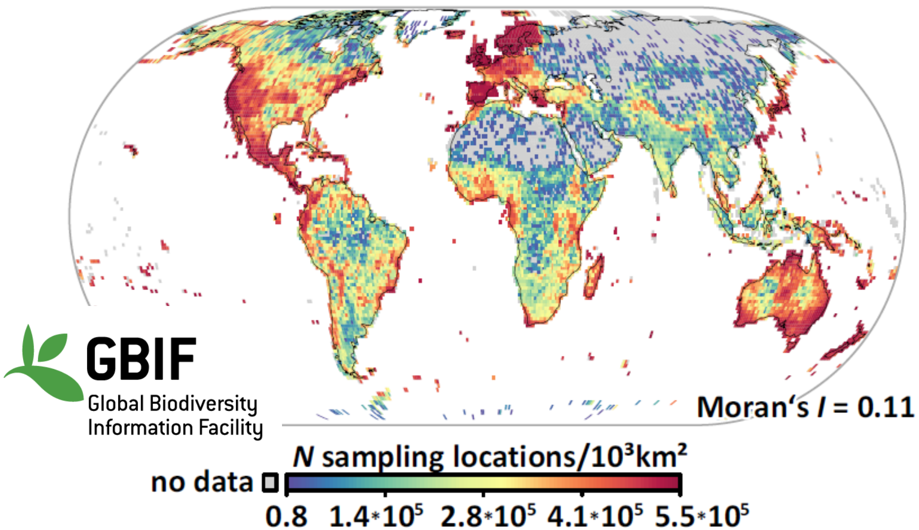


GBIF
Global Biodiversity Information Facility

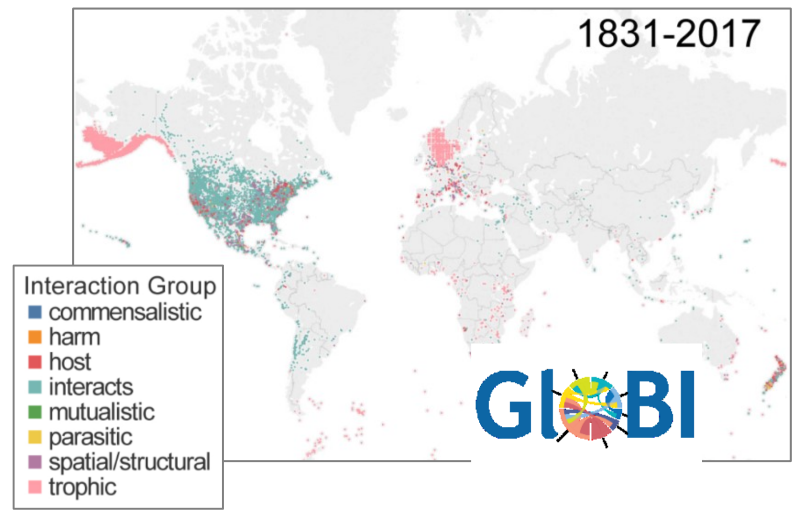
Meyer et al. 2016 *Ecol. Lett.*; Poelen et al. 2014 *Ecol. Inf.*
Pereira et al. 2012 *Ann. Rev. Env. Res.*

Knowledge gaps

Presence-only records of plants from GBIF



Species interaction records from GloBI



Meyer et al. 2016 *Ecol. Lett.*; Poelen et al. 2014 *Ecol. Inf.*
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Knowledge gaps

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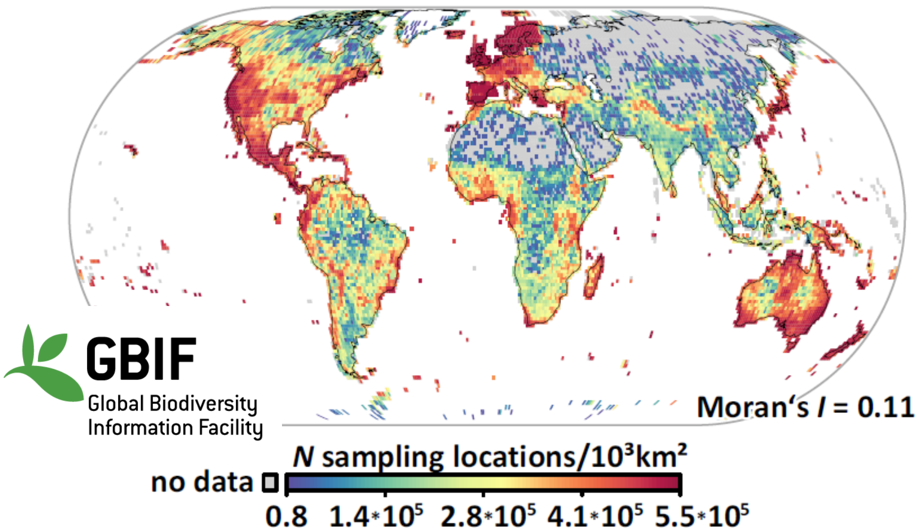
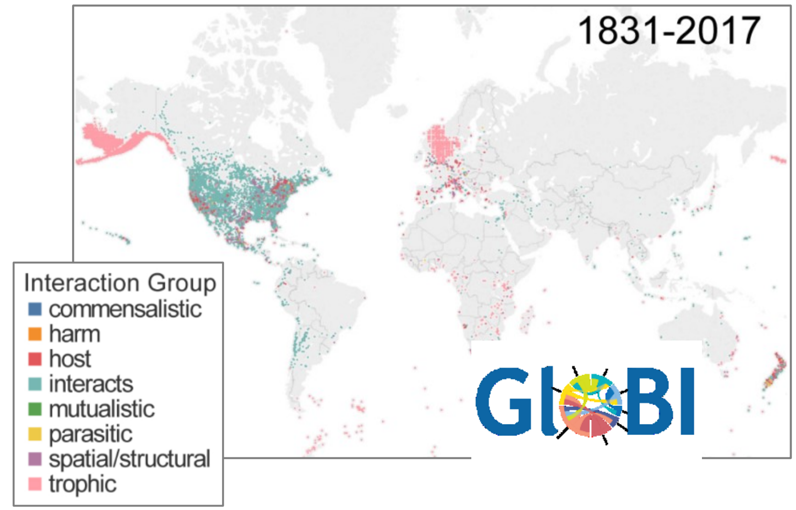
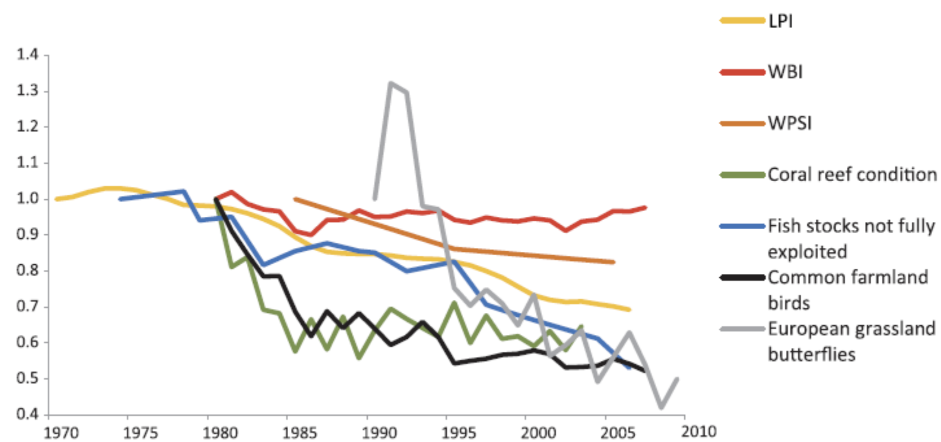


Species interaction records from GloBI



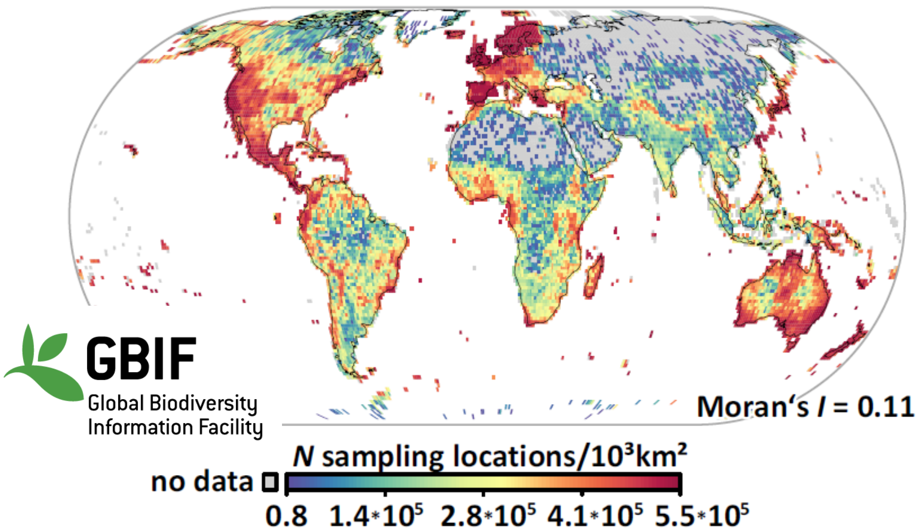
Indicators of biodiversity change



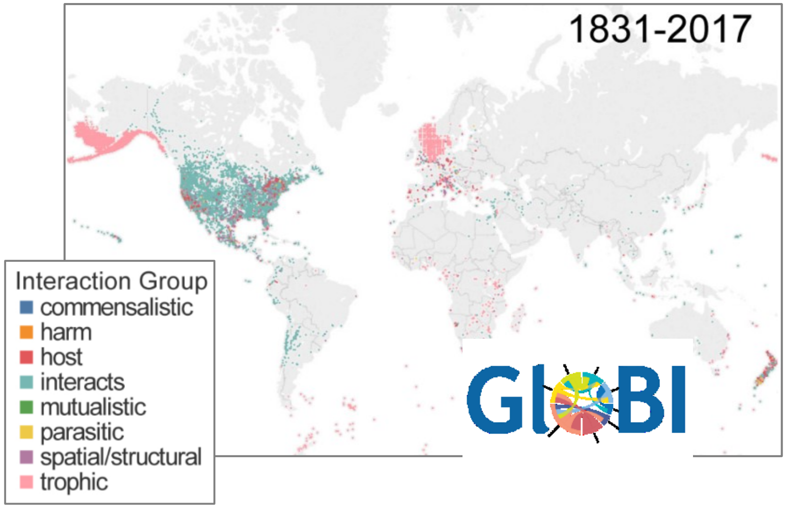
Meyer et al. 2016 *Ecol. Lett.*; Poelen et al. 2014 *Ecol. Inf.*
Pereira et al. 2012 *Ann. Rev. Env. Res.*

Knowledge gaps

Presence-only records of plants from GBIF



Species interaction records from GloBI

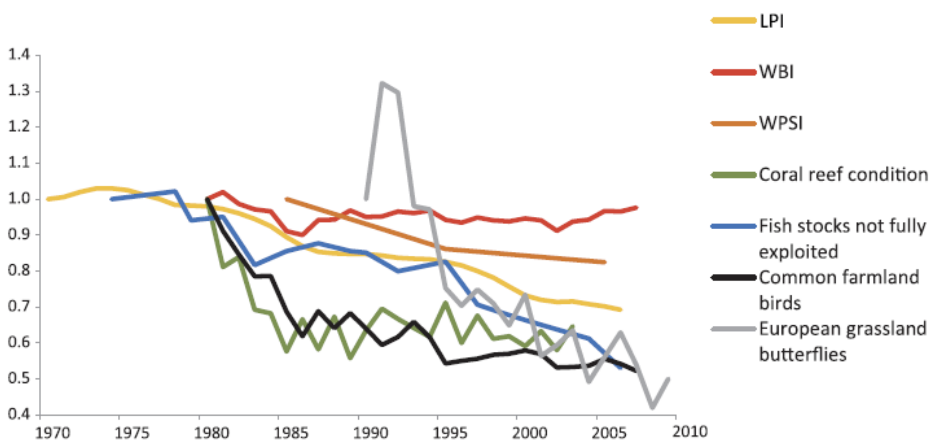


Spatial gaps

Taxonomic gaps

Temporal gaps

Indicators of biodiversity change



Meyer et al. 2016 *Ecol. Lett.*; Poelen et al. 2014 *Ecol. Inf.*
Pereira et al. 2012 *Ann. Rev. Env. Res.*

Knowledge gaps

Long-term observations

Population abundance

Phenology

Species interactions

Sensor networks

Citizen science

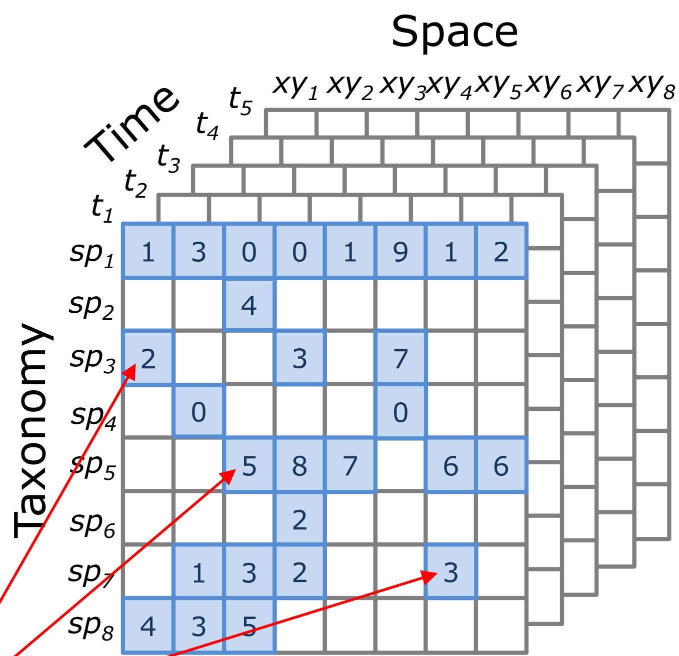
Stay or get involved in monitoring plant populations, e.g. at long-term observation sites, with sensor networks or through citizen science projects

Essential Biodiversity Variables (EBVs)

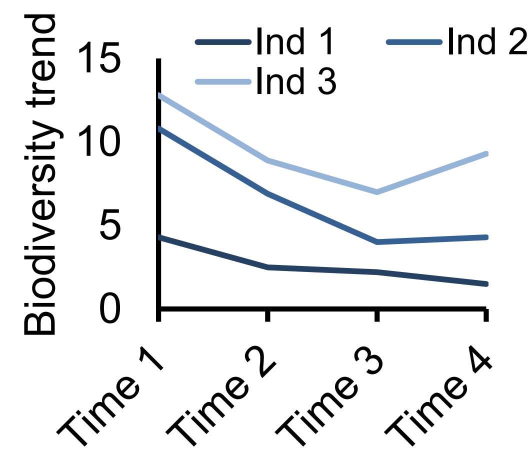
Challenges for building EBVs

Raw data

EBV data cube



Indicators



Discovery and accessibility of data

Kissling et al. 2018 *Biological Reviews*

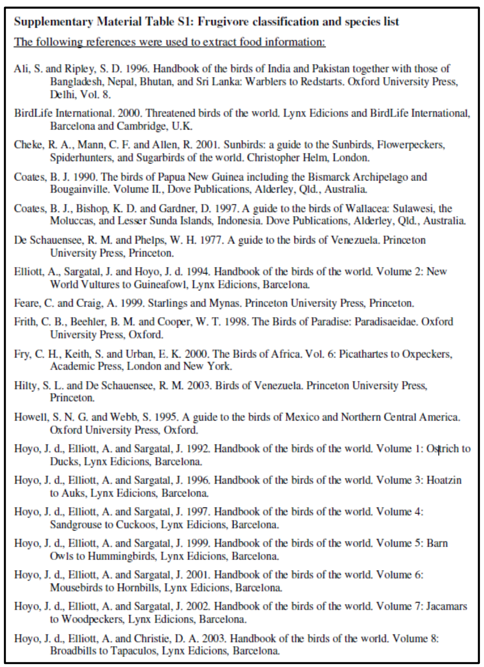
Data discovery and accessibility

Share your data and make them findable

Data discovery and accessibility

Share your data and make them findable

Supplementary material | **Digital data repositories** | **Platforms with data discovery**



Supplementary Material Table S1: Frugivore classification and species list

The following references were used to extract food information:

Ali, S. and Ripley, S. D. 1996. Handbook of the birds of India and Pakistan together with those of Bangladesh, Nepal, Bhutan, and Sri Lanka: Warblers to Redstarts. Oxford University Press, Delhi, Vol. 8.

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Fry, C. H., Keith, S. and Urban, E. K. 2000. The Birds of Africa. Vol. 6: Picathartes to Oxpeckers, Academic Press, London and New York.

Hilty, S. L. and De Schauensee, R. M. 2003. Birds of Venezuela. Princeton University Press, Princeton.

Howell, S. N. G. and Webb, S. 1995. A guide to the birds of Mexico and Northern Central America. Oxford University Press, Oxford.

Hoyo, J. d., Elliott, A. and Sargatal, J. 1992. Handbook of the birds of the world. Volume 1: Ostrich to Ducks, Lynx Edicions, Barcelona.

Hoyo, J. d., Elliott, A. and Sargatal, J. 1996. Handbook of the birds of the world. Volume 3: Hoatzin to Auks, Lynx Edicions, Barcelona.

Hoyo, J. d., Elliott, A. and Sargatal, J. 1997. Handbook of the birds of the world. Volume 4: Sandgrouse to Cuckoos, Lynx Edicions, Barcelona.

Hoyo, J. d., Elliott, A. and Sargatal, J. 1999. Handbook of the birds of the world. Volume 5: Barn Owls to Hummingbirds, Lynx Edicions, Barcelona.

Hoyo, J. d., Elliott, A. and Sargatal, J. 2001. Handbook of the birds of the world. Volume 6: Mousebirds to Hornbills, Lynx Edicions, Barcelona.

Hoyo, J. d., Elliott, A. and Sargatal, J. 2002. Handbook of the birds of the world. Volume 7: Jacamars to Woodpeckers, Lynx Edicions, Barcelona.

Hoyo, J. d., Elliott, A. and Christie, D. A. 2003. Handbook of the birds of the world. Volume 8: Broadbills to Tapaculos, Lynx Edicions, Barcelona.

DRYAD

doi DIGITAL OBJECT IDENTIFIER

GBIF Global Biodiversity Information Facility

figshare

GloBI

re3data.org REGISTRY OF RESEARCH DATA REPOSITORIES

TRY Plant Trait Database

low **Machine-readable discovery** high

Data discovery and accessibility

Make data open with unrestricted access

Creative Commons (CC) licenses

Open access

- CC0 — PUBLIC DOMAIN
- CC BY — BY
- CC BY-SA — BY SA
- CC BY-NC — BY NC
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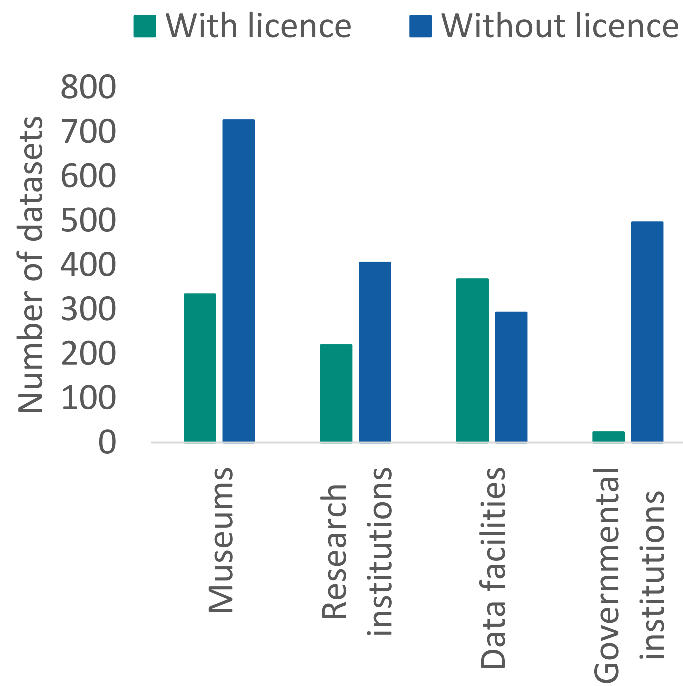
More restriction



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Kissling et al. 2018 *Biological Reviews*

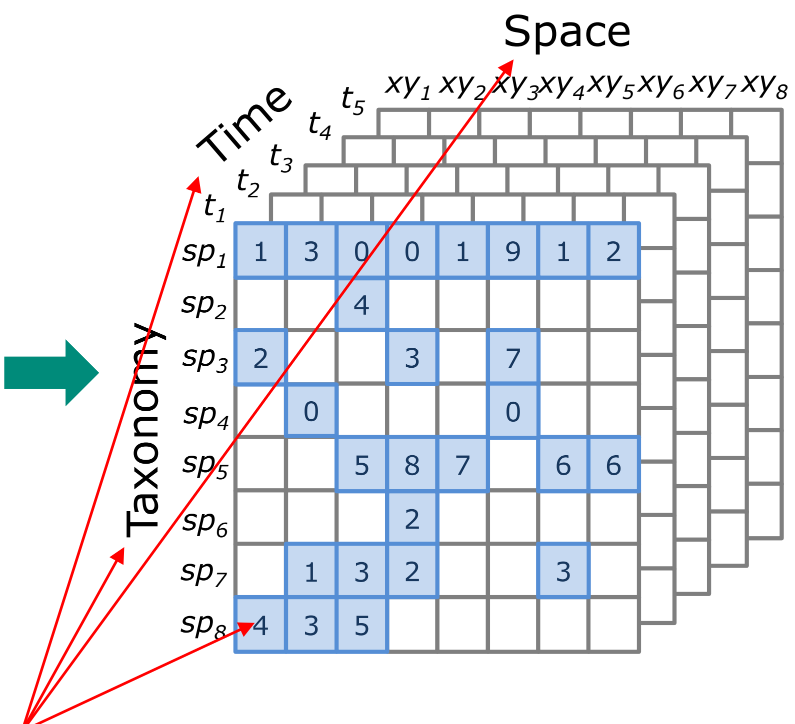
Modified from Groom et al. 2017 *J. Appl. Ecol.*

Essential Biodiversity Variables (EBVs)

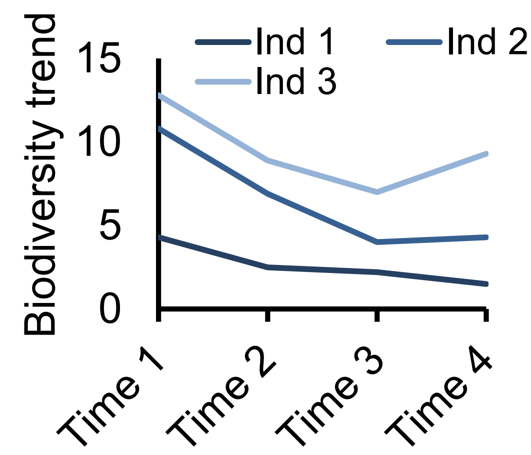
Challenges for building EBVs

Raw data

EBV data cube



Indicators

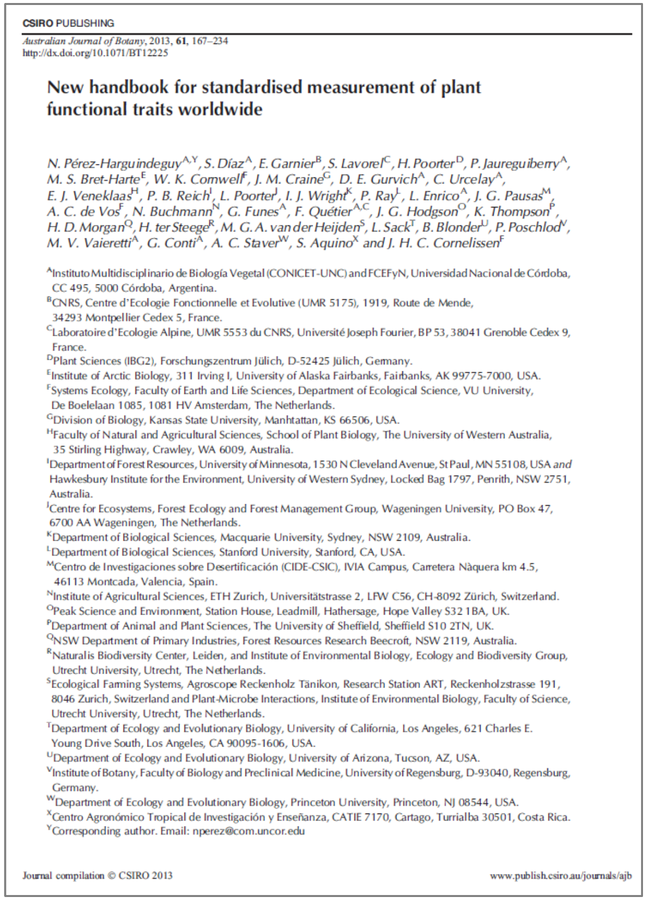


Kissling et al. 2018 *Biological Reviews*

Data and metadata standardisation

Standardise measurements and terms

Standardized measurement protocols



CSIRO PUBLISHING

Australian Journal of Botany, 2013, **61**, 167–234
http://dx.doi.org/10.1071/BT12225

New handbook for standardised measurement of plant functional traits worldwide

N. Pérez-Harguindeguy[A,Y], S. Díaz[A], E. Garnier[B], S. Lavorel[C], H. Poorter[D], P. Jaureguiberry[A], M. S. Bret-Harte[E], W. K. Cornwell[F], J. M. Craine[G], D. E. Gurvich[A], C. Urcelay[A], E. J. Veneklaas[H], P. B. Reich[I], L. Poorter[J], I. J. Wright[K], P. Ray[L], L. Enrico[A], J. G. Pausas[M], A. C. de Vos[F], N. Buchmann[N], G. Funes[A], F. Quétier[A,C], J. G. Hodgson[O], K. Thompson[P], H. D. Morgan[Q], H. ter Steege[R], M. G. A. van der Heijden[S], L. Sack[T], B. Blonder[U], P. Poschlod[V], M. V. Vaieretti[A], G. Conti[A], A. C. Staver[W], S. Aquino[X] and J. H. C. Cornelissen[F]

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[B]CNRS, Centre d'Ecologie Fonctionnelle et Evolutive (UMR 5175), 1919, Route de Mende, 34293 Montpellier Cedex 5, France.
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[K]Department of Biological Sciences, Macquarie University, Sydney, NSW 2109, Australia.
[L]Department of Biological Sciences, Stanford University, Stanford, CA, USA.
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[N]Institute of Agricultural Sciences, ETH Zurich, Universitätstrasse 2, LFW C56, CH-8092 Zürich, Switzerland.
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[U]Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, AZ, USA.
[V]Institute of Botany, Faculty of Biology and Preclinical Medicine, University of Regensburg, D-93040, Regensburg, Germany.
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[X]Centro Agronómico Tropical de Investigación y Enseñanza, CATIE 7170, Cartago, Turrialba 30501, Costa Rica.
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Pérez-Harguindeguy et al. 2013 *Australian Journal of Botany*

Data and metadata standardisation

Standardise measurements and terms

Standardized measurement protocols

CSIRO PUBLISHING

Australian Journal of Botany, 2013, **61**, 167–234
http://dx.doi.org/10.1071/BT12225

New handbook for standardised measurement of plant functional traits worldwide

N. Pérez-Harguindeguy[A,Y], S. Díaz[A], E. Garnier[B], S. Lavorel[C], H. Poorter[D], P. Jaureguiberry[A], M. S. Bret-Harte[E], W. K. Cornwell[F], J. M. Craine[G], D. E. Gurvich[A], C. Urcelay[A], E. J. Veneklaas[H], P. B. Reich[I], L. Poorter[J], I. J. Wright[K], P. Ray[L], L. Enrico[A], J. G. Pausas[M], A. C. de Vos[F], N. Buchmann[N], G. Funes[A], F. Quétier[A,C], J. G. Hodgson[O], K. Thompson[P], H. D. Morgan[Q], H. ter Steege[R], M. G. A. van der Heijden[S], L. Sack[T], B. Blonder[U], P. Poschlod[V], M. V. Vaieretti[A], G. Conti[A], A. C. Staver[W], S. Aquino[X] and J. H. C. Cornelissen[F]

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[Y]Corresponding author. Email: nperez@com.uncor.edu

Standardized terms and vocabularies

Top — A Terminological Resource for Plant Functional Diversity

HOME | FACETED SEARCH | HIERARCHY SEARCH | INDEX SEARCH | REFERENCES | API | ADMINISTRATION

Browse the Hierarchy

Treeview

- **Plant characteristics**
  - Environmental association
  - Plant trait
    - Flower and dispersule trait
      - Dispersule dry mass trait
      - Dispersule fresh mass trait
      - Dispersule length trait
      - Dispersule mass trait
      - Dispersule thickness trait
      - Dispersule width trait
      - Flower color
      - Flower heterostyly type
      - Flower pollination syndrome
      - Plant dichogamy type
      - Plant dicliny type
      - Plant dispersal syndrome
      - Plant flowering begin trait
      - Plant flowering duration trait
      - Plant flowering end trait
      - Plant flowering phases number trait

Example plant phenology

<u>Flowering time</u>

Onset of flowering	Julian day
Time of peak flowering	Julian day
Flowering duration	Number of days
Flowering frequency	Number per year

Pérez-Harguindeguy et al. 2013 *Australian Journal of Botany*   http://www.top-thesaurus.org/; Garnier et al. 2017 *J. Ecol.*

Data and metadata standardisation

Map data to ontologies

Example plant phenology

Pan European PEP725 Phenology DB

Terms & vocabularies

https://www.plantphenology.org/; https://github.com/PlantPhenoOntology/ppo

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Map data to ontologies

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Terms & vocabularies

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PHENOCAM

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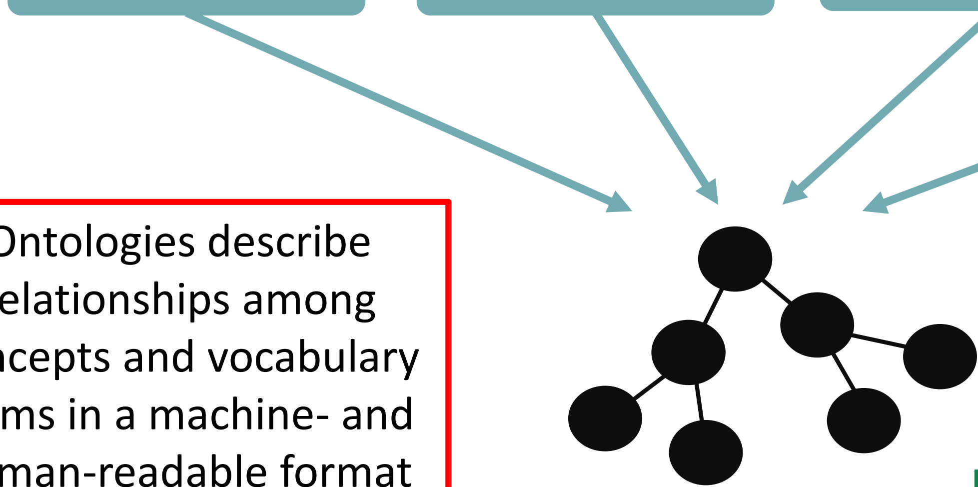
Terms & vocabularies | Terms & vocabularies | Terms & vocabularies | Terms & vocabularies



Ontologies describe relationships among concepts and vocabulary terms in a machine- and human-readable format

Plant Phenology Ontology (PPO)

Global Plant Phenology Data Portal

https://www.plantphenology.org/; https://github.com/PlantPhenoOntology/ppo

Data and metadata standardisation

Apply data and metadata standards

Darwin Core (DwC)

Occurrence

occurrenceID | catalogNumber | recordNumber | recordedBy | individualCount | organismQuantity | organismQuantityType | sex | lifeStage | reproductiveCondition | behavior | establishmentMeans | occurrenceStatus | preparations | disposition | associatedMedia | associatedReferences | associatedSequences | associatedTaxa | otherCatalogNumbers | occurrenceRemarks

Organism

organismID | organismName | organismScope | associatedOccurrences | associatedOrganisms | previousIdentifications | organismRemarks

MaterialSample | LivingSpecimen | PreservedSpecimen | FossilSpecimen

materialSampleID

Event | HumanObservation | MachineObservation

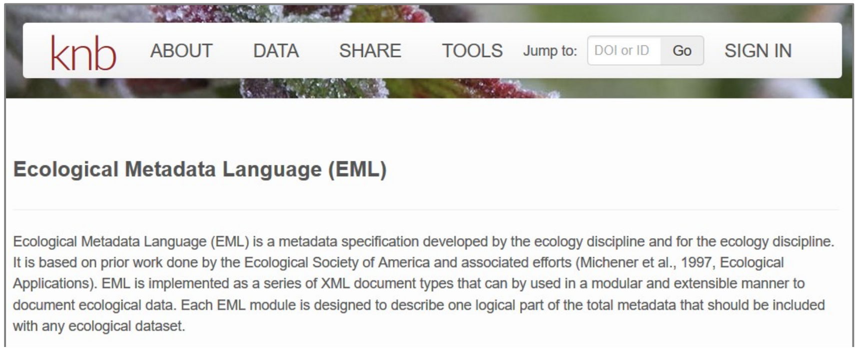
eventID | parentEventID | fieldNumber | eventDate | eventTime | startDayOfYear | endDayOfYear | year | month | day | verbatimEventDate | habitat | samplingProtocol | sampleSizeValue | sampleSizeUnit | samplingEffort | fieldNotes | eventRemarks

Location

locationID | higherGeographyID | higherGeography | continent | waterBody | islandGroup | island | country | countryCode | stateProvince | county | municipality | locality | verbatimLocality | minimumElevationInMeters | maximumElevationInMeters | verbatimElevation | minimumDepthInMeters | maximumDepthInMeters | verbatimDepth | minimumDistanceAboveSurfaceInMeters | maximumDistanceAboveSurfaceInMeters | locationAccordingTo | locationRemarks | decimalLatitude | decimalLongitude | geodeticDatum | coordinateUncertaintyInMeters | coordinatePrecision | pointRadiusSpatialFit | verbatimCoordinates | verbatimLatitude | verbatimLongitude | verbatimCoordinateSystem | verbatimSRS | footprintWKT | footprintSRS | footprintSpatialFit | georeferencedBy | georeferencedDate | georeferenceProtocol | georeferenceSources | georeferenceVerificationStatus | georeferenceRemarks

Darwin Core (http://rs.tdwg.org/dwc/terms/)

Ecological Metadata Language (EML)



knb ABOUT DATA SHARE TOOLS Jump to: DOI or ID Go SIGN IN

Ecological Metadata Language (EML)

Ecological Metadata Language (EML) is a metadata specification developed by the ecology discipline and for the ecology discipline. It is based on prior work done by the Ecological Society of America and associated efforts (Michener et al., 1997, Ecological Applications). EML is implemented as a series of XML document types that can by used in a modular and extensible manner to document ecological data. Each EML module is designed to describe one logical part of the total metadata that should be included with any ecological dataset.

EML (https://knb.ecoinformatics.org/#tools)

Data and metadata standardisation

Apply data and metadata standards

Darwin Core (DwC)

Occurrence

occurrenceID | catalogNumber | recordNumber | recordedBy | individualCount | organismQuantity | organismQuantityType | sex | lifeStage | reproductiveCondition | behavior | establishmentMeans | occurrenceStatus | preparations | disposition | associatedMedia | associatedReferences | associatedSequences | associatedTaxa | otherCatalogNumbers | occurrenceRemarks

Organism

organismID | organismName | organismScope | associatedOccurrences | associatedOrganisms | previousIdentifications | organismRemarks

MaterialSample | LivingSpecimen | PreservedSpecimen | FossilSpecimen

materialSampleID

Event | HumanObservation | MachineObservation

eventID | parentEventID | fieldNumber | eventDate | eventTime | startDayOfYear | endDayOfYear | year | month | day | verbatimEventDate | habitat | samplingProtocol | sampleSizeValue | sampleSizeUnit | samplingEffort | fieldNotes | eventRemarks

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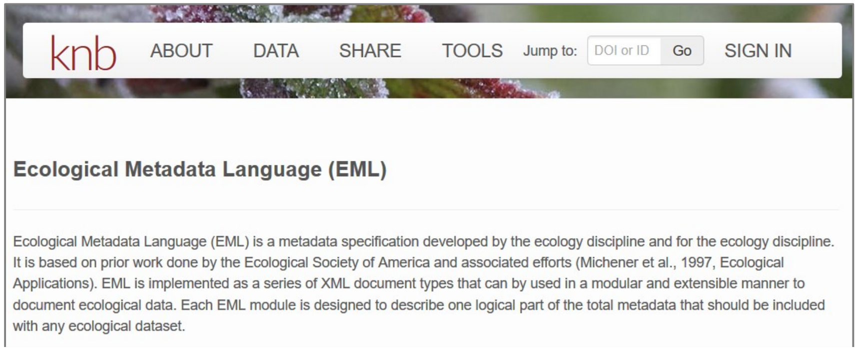

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EML (https://knb.ecoinformatics.org/#tools)

Integrated Publishing Toolkit (IPT)
https://www.gbif.org/ipt

GBIF
Global Biodiversity Information Facility

Darwin Core Archive

The Event Core brings together data from the same sampling area, connected via their 'parent' event.

Take home messages

You can help building EBV data products

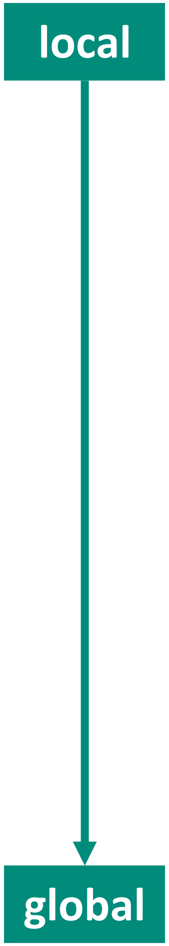
local

global

Take home messages

You can help building EBV data products

1. **Collect repeated and standardised measurements of plant populations through in-situ monitoring, citizen science or sensor networks** (e.g. on plant species distribution and abundance, species traits and species interactions)



Take home messages

You can help building EBV data products

local

1. **Collect repeated and standardised measurements of plant populations through in-situ monitoring, citizen science or sensor networks** (e.g. on plant species distribution and abundance, species traits and species interactions)

2. **Make your data findable and openly accessible** (e.g. through data repositories and online portals and by providing CC0 and CC BY licenses in machine-readable format)

global

Take home messages

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Take home messages

You can help building EBV data products

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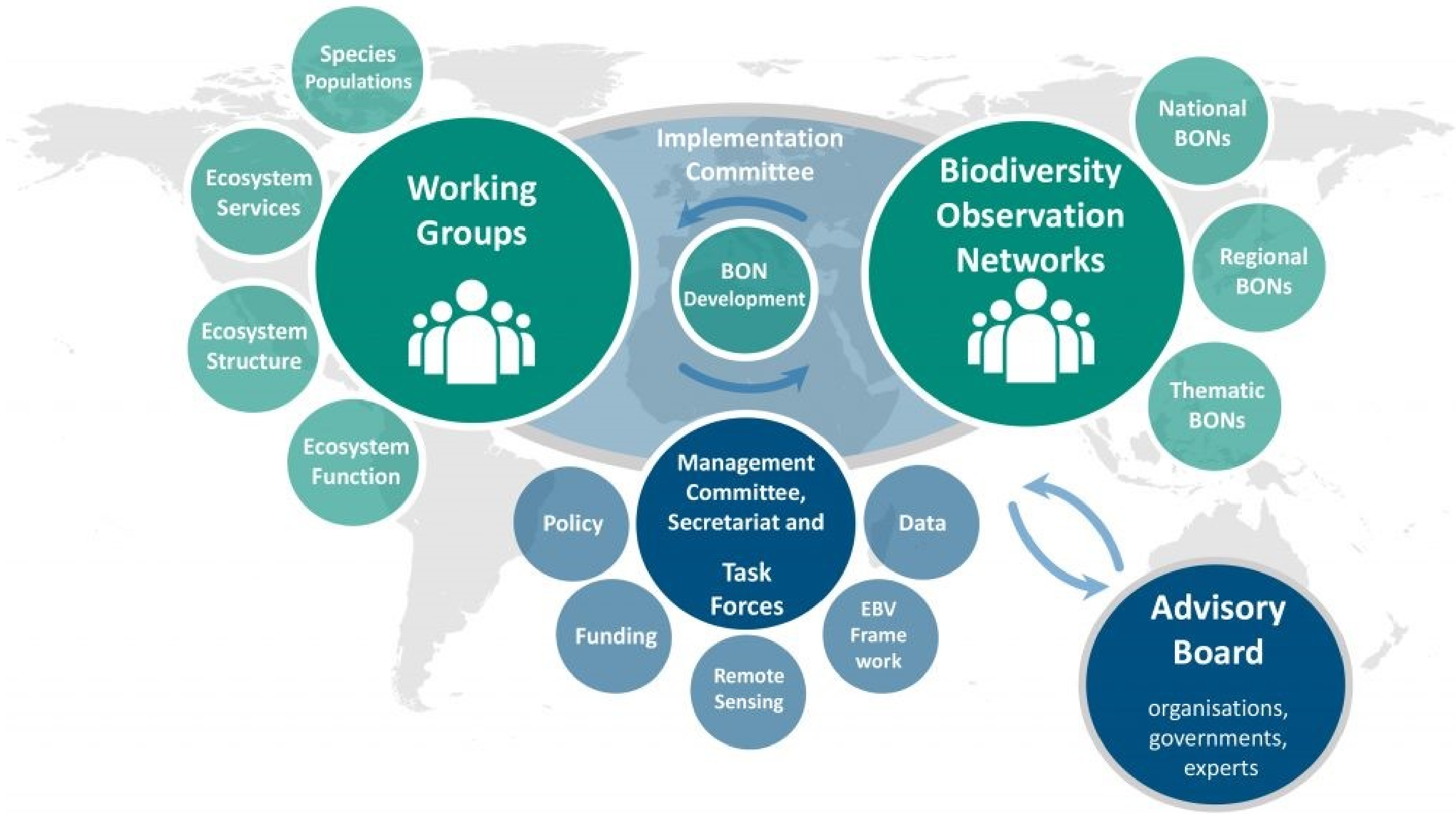
4. **Get involved in GEO BON and other global biodiversity activities** (e.g. participate in working groups, BONs, task groups, interest groups)

global

Take home messages

Governance structure of GEO BON



http://geobon.org/

Take home messages

Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in Environmental Sustainability

ELSEVIER

Monitoring biodiversity change through effective global coordination

Laetitia M Navarro[1,2], Néstor Fernández[1,2], Carlos Guerra[1,2], Rob Guralnick[3], W Daniel Kissling[4], Maria Cecilia Londoño[5], Frank Muller-Karger[6], Eren Turak[7,8], Patricia Balvanera[9], Mark J Costello[10], Aurelie Delavaud[11], GY El Serafy[12,13], Simon Ferrier[14], Ilse Geijzendorffer[15], Gary N Geller[16,17], Walter Jetz[18,19], Eun-Shik Kim[20], HyeJin Kim[1,2], Corinne S Martin[21], Melodie A McGeoch[22], Tuyeni H Mwampamba[9], Jeanne L Nel[23,24], Emily Nicholson[25], Nathalie Pettorelli[26], Michael E Schaepman[27], Andrew Skidmore[28,29], Isabel Sousa Pinto[30], Sheila Vergara[31], Petteri Vihervaara[32], Haigen Xu[33], Tetsukazu Yahara[34], Mike Gill[35] and Henrique M Pereira[1,2,36]

Thank you!

BIOLOGICAL REVIEWS

Cambridge Philosophical Society

Biol. Rev. (2017), pp. 000–000.
doi: 10.1111/brv.12359

Building essential biodiversity variables (EBVs) of species distribution and abundance at a global scale

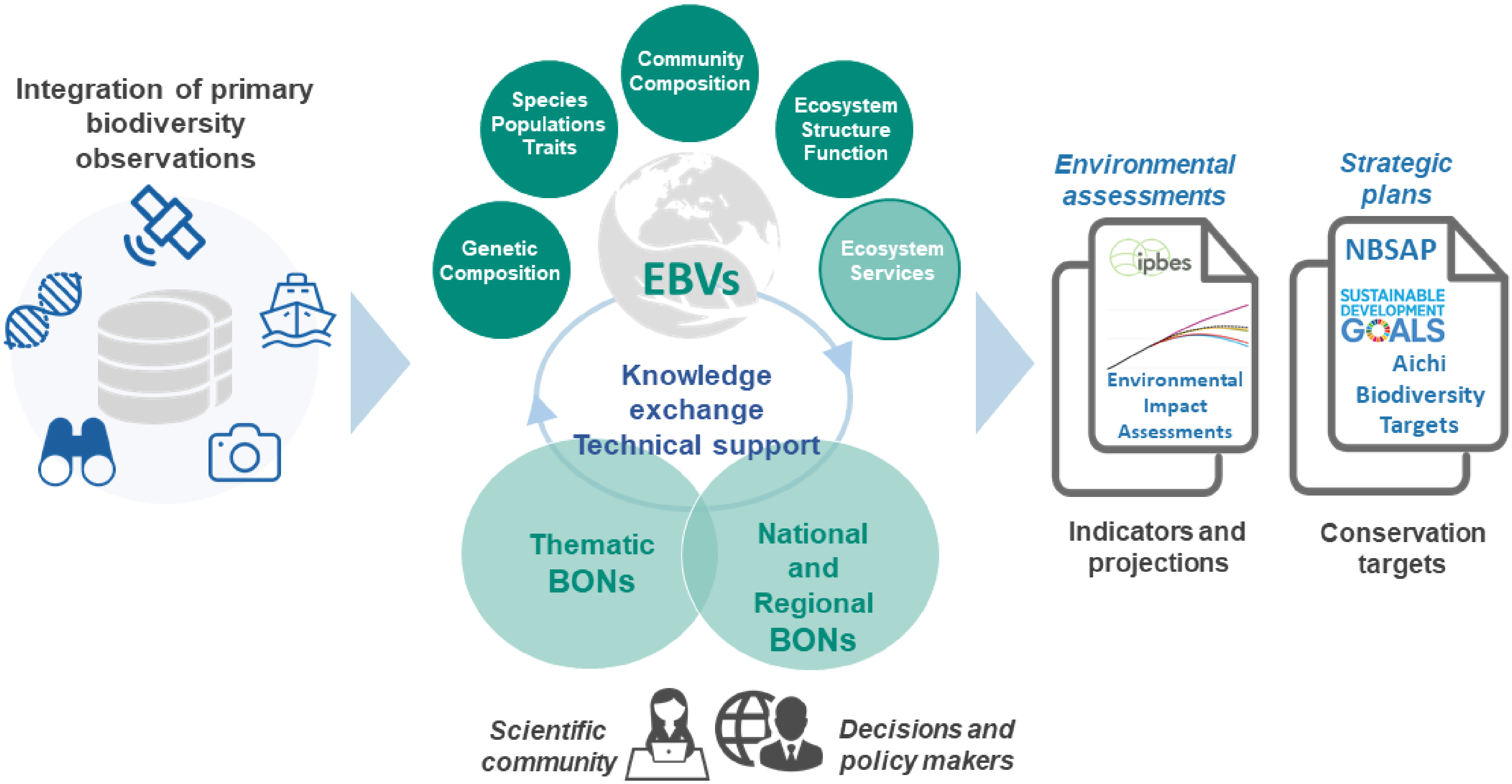
W. Daniel Kissling[1,*], Jorge A. Ahumada[2], Anne Bowser[3], Miguel Fernandez[4,5,6], Néstor Fernández[4,7], Enrique Alonso García[8], Robert P. Guralnick[9], Nick J. B. Isaac[10], Steve Kelling[11], Wouter Los[1], Louise McRae[12], Jean-Baptiste Mihoub[13,14], Matthias Obst[15,16], Monica Santamaria[17], Andrew K. Skidmore[18], Kristen J. Williams[19], Donat Agosti[20], Daniel Amariles[21,22], Christos Arvanitidis[23], Lucy Bastin[24,25], Francesca De Leo[17], Willi Egloff[20], Jane Elith[26], Donald Hobern[27], David Martin[19], Henrique M. Pereira[4,5], Graziano Pesole[17,28], Johannes Peterseil[29], Hannu Saarenmaa[30], Dmitry Schigel[27], Dirk S. Schmeller[13,31], Nicola Segata[32], Eren Turak[33,34], Paul F. Uhlir[35], Brian Wee[36] and Alex R. Hardisty[37]

Navarro et al. 2017 *Current Opinion in Environmental Sustainability*

Kissling et al. 2018 *Biological Reviews*

Essential Biodiversity Variables (EBVs)

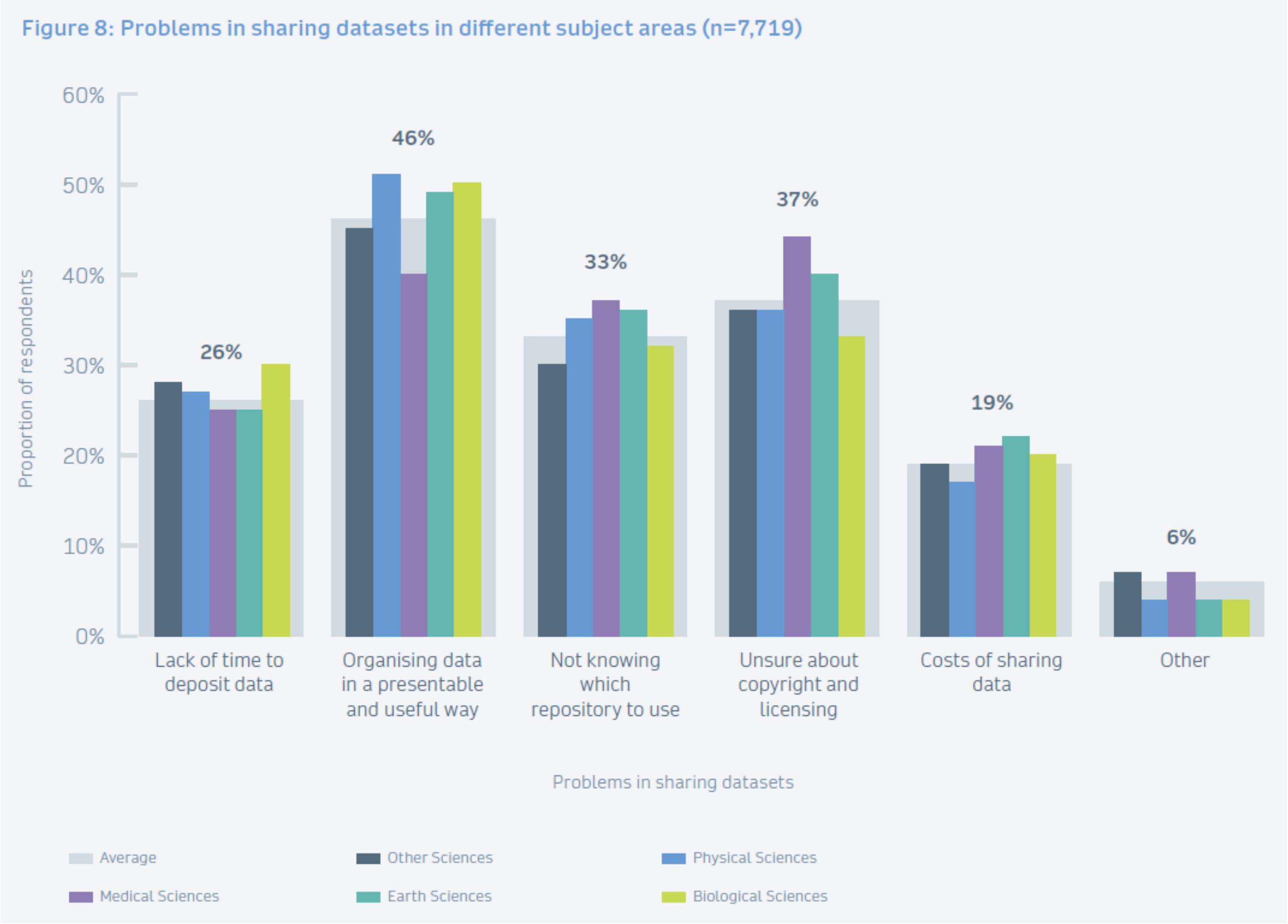
Between raw data and indicators



Navarro et al. 2017 *Current Opinion in Environmental Sustainability*

Data discovery and accessibility

Overcome problems in sharing data



Stuart et al. 2018 *Figshare*

Essential Biodiversity Variables (EBVs)

Characteristics of EBVs

- Relevant to scientific and policy questions
- Responsive in policy-relevant time-frames
- Biological state variables
- Equally applicable at local, regional and global scales (scalable)
- Measurable with available technologies at reasonable costs
- Stable enough to allow measuring them for decades to come
- Located between primary data observations (‘raw data’) and synthetic or derived indices (‘indicators’)

Walters et al. 2013 *SBSTTA notes*