



**CESAB**  
CENTRE DE SYNTHÈSE ET D'ANALYSE  
SUR LA BIODIVERSITÉ

# Biodiversity knowledge synthesis: an introduction to meta-analyses and systematic reviews

## Why do we need systematic review and evidence maps?

*October 2023*

Beillouin Damien  
Chercheur CIRAD- Hortsys



# Seeing the forest for the trees

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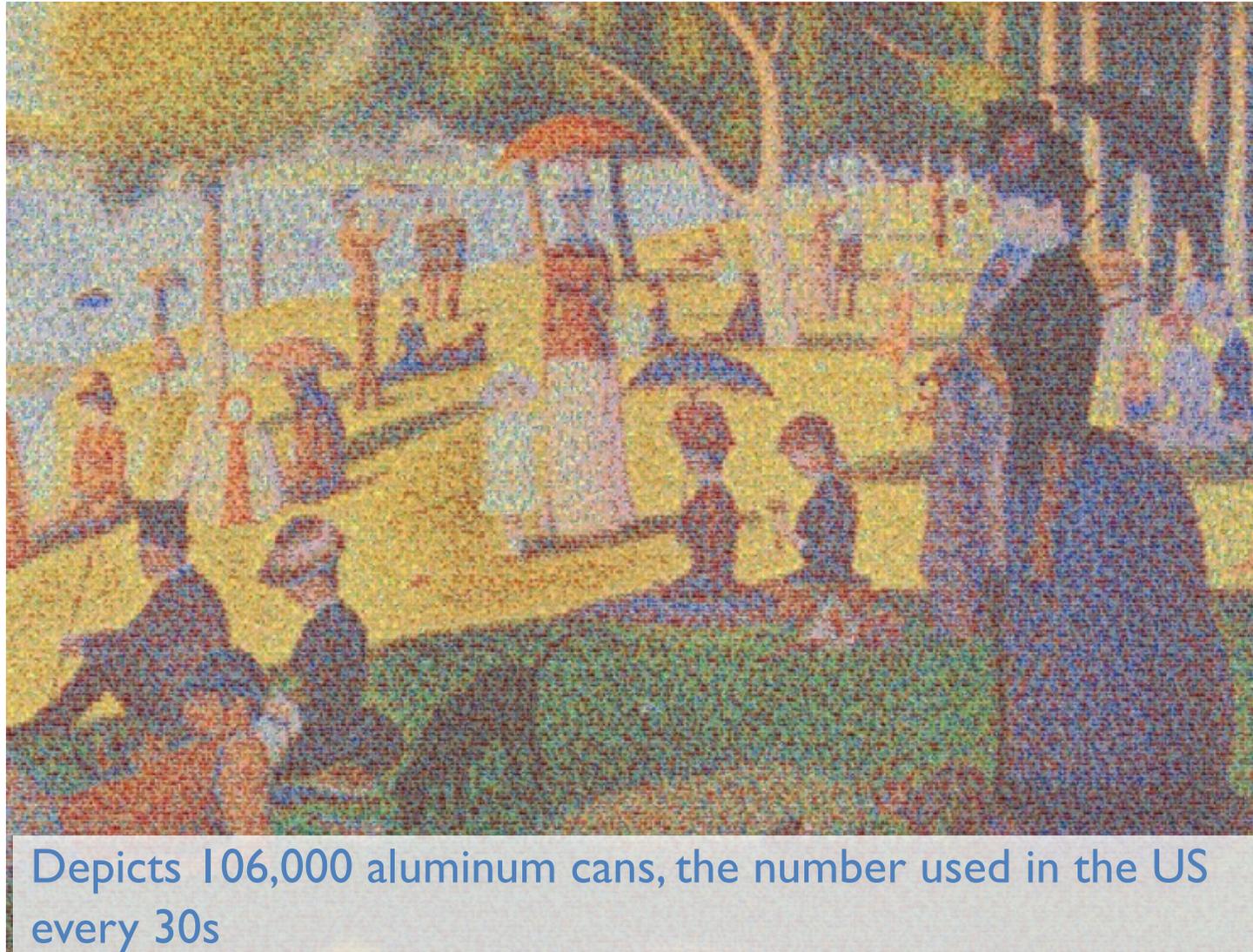


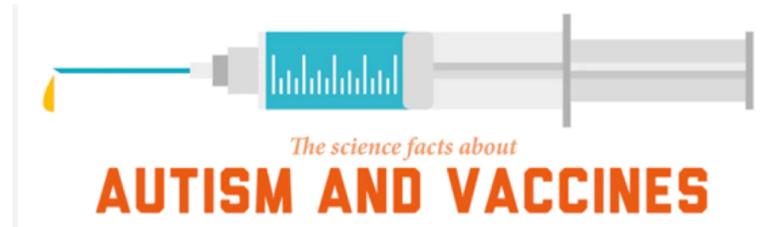
Systematic reviews are the remote-sensing tools of ecology. They allow us to step back & see a broader, albeit less detailed overview of how a system operates.  
(Hillebrand & Cardinale 2010)

# Focus...



# Step back!

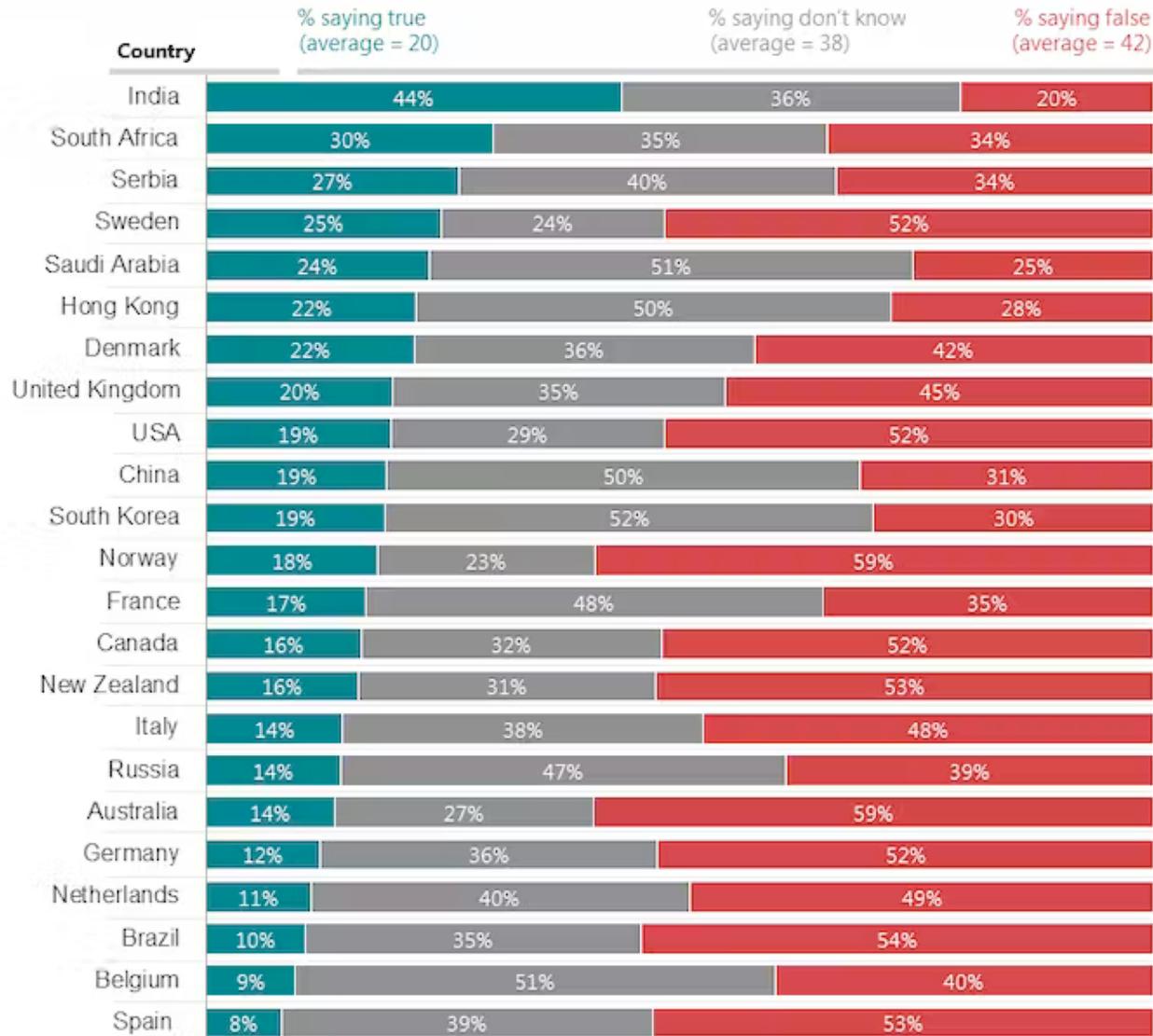




Do you think the following statement is true or false?

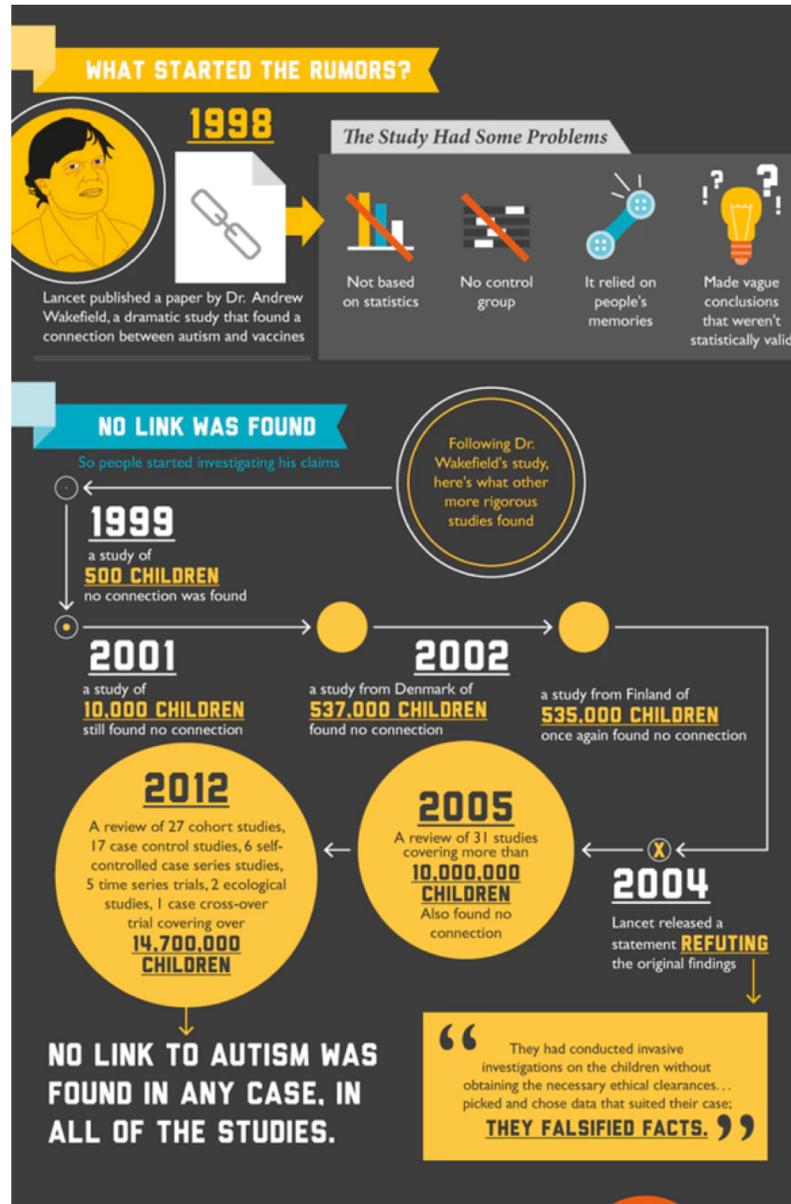
« Some vaccines cause autism in healthy children. »

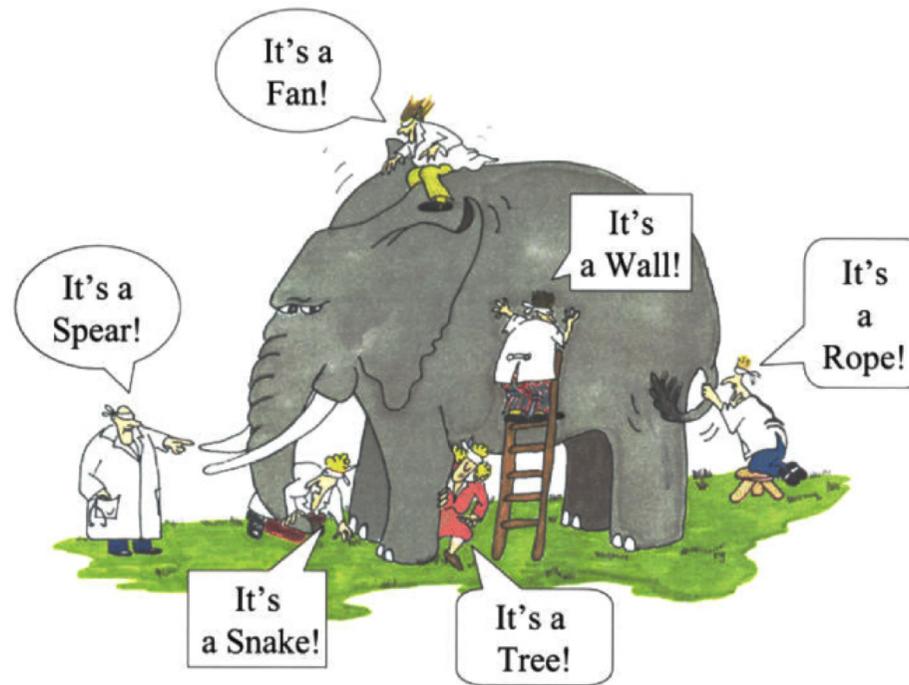
# Misinformation



Please see <http://perils.jpss.com/> for full details of all sources.

# Misinformation







## Le Monde

Se connecter

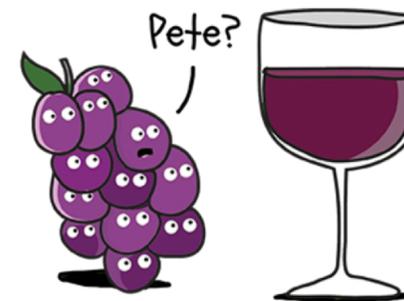
Consulter  
le journal

ACTUALITÉS ▾ ÉCONOMIE ▾ VIDÉOS ▾ DÉBATS ▾ CULTURE ▾ M LE MAG ▾

DÉBATS

### Deux verres de vin rouge n'augmentent pas les risques de cancer

Mieux vaut boire raisonnablement que s'abstenir en mangeant mal, estiment David Servan-Schreiber, Richard Béliveau et Michel de Lorgeril.



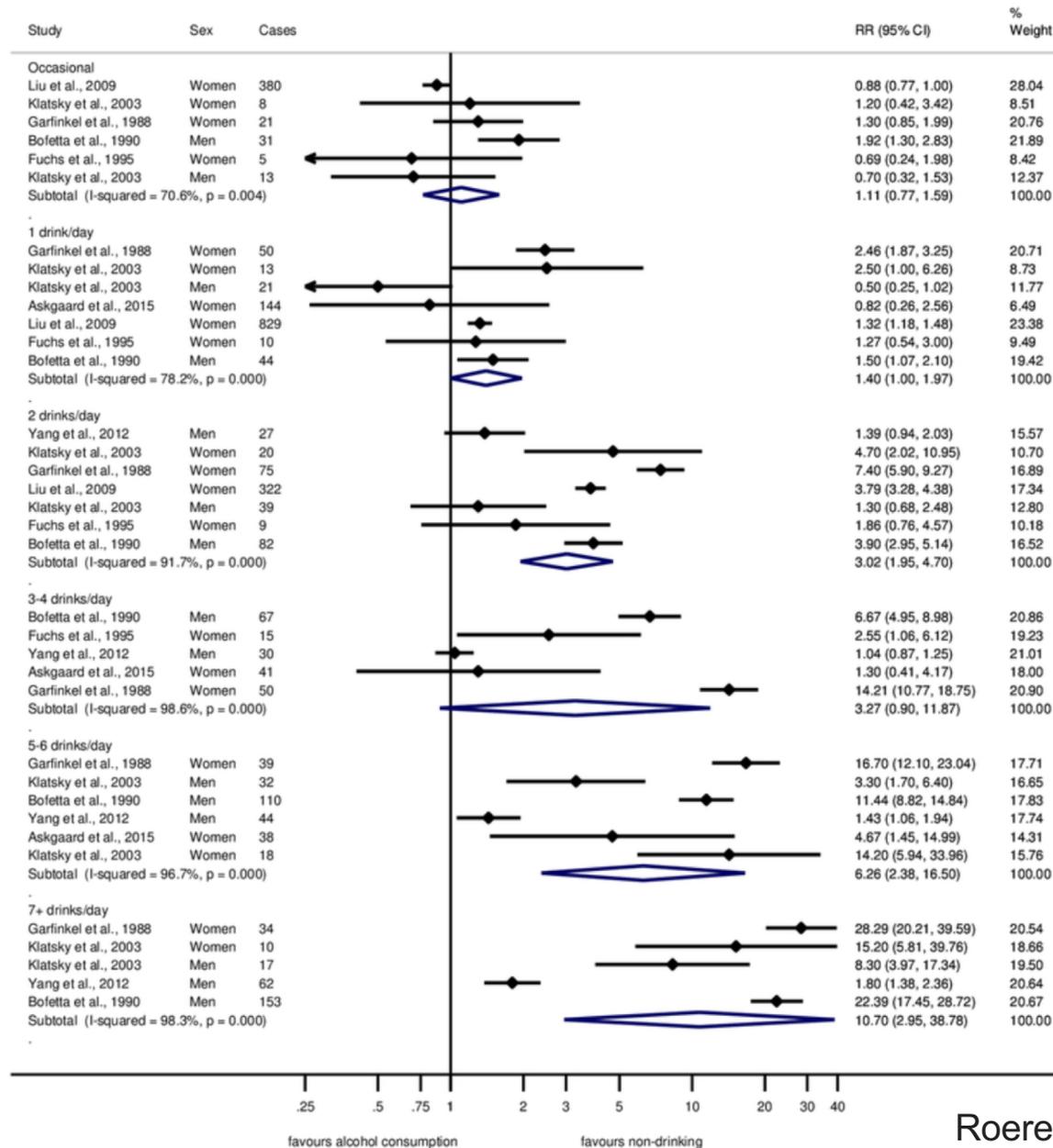
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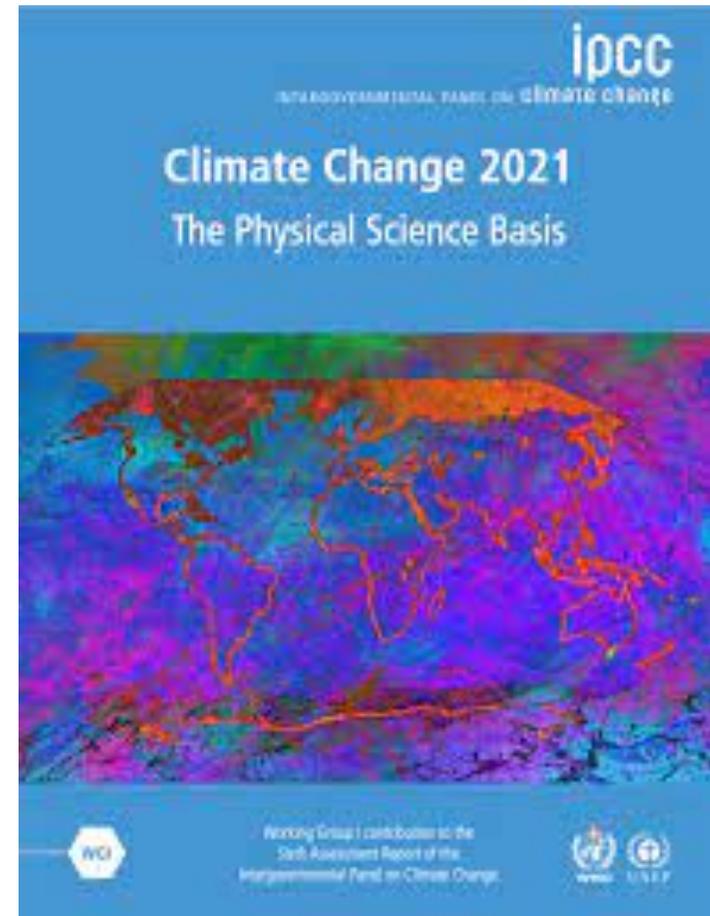
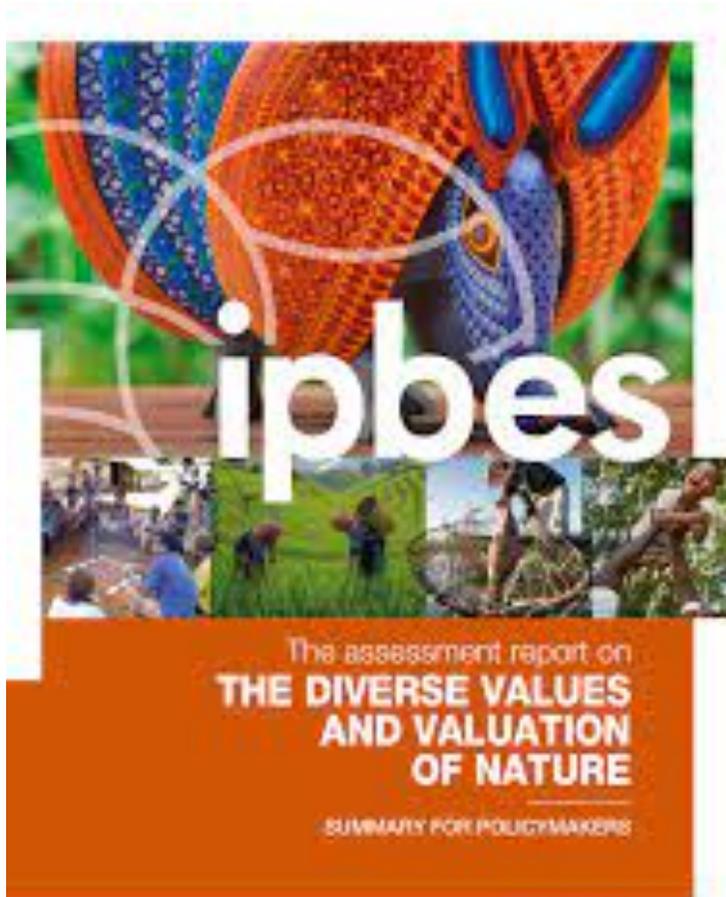
Médecine | Santé Publique | Bien-être | Famille | Sex

Actualités Santé > Santé publique

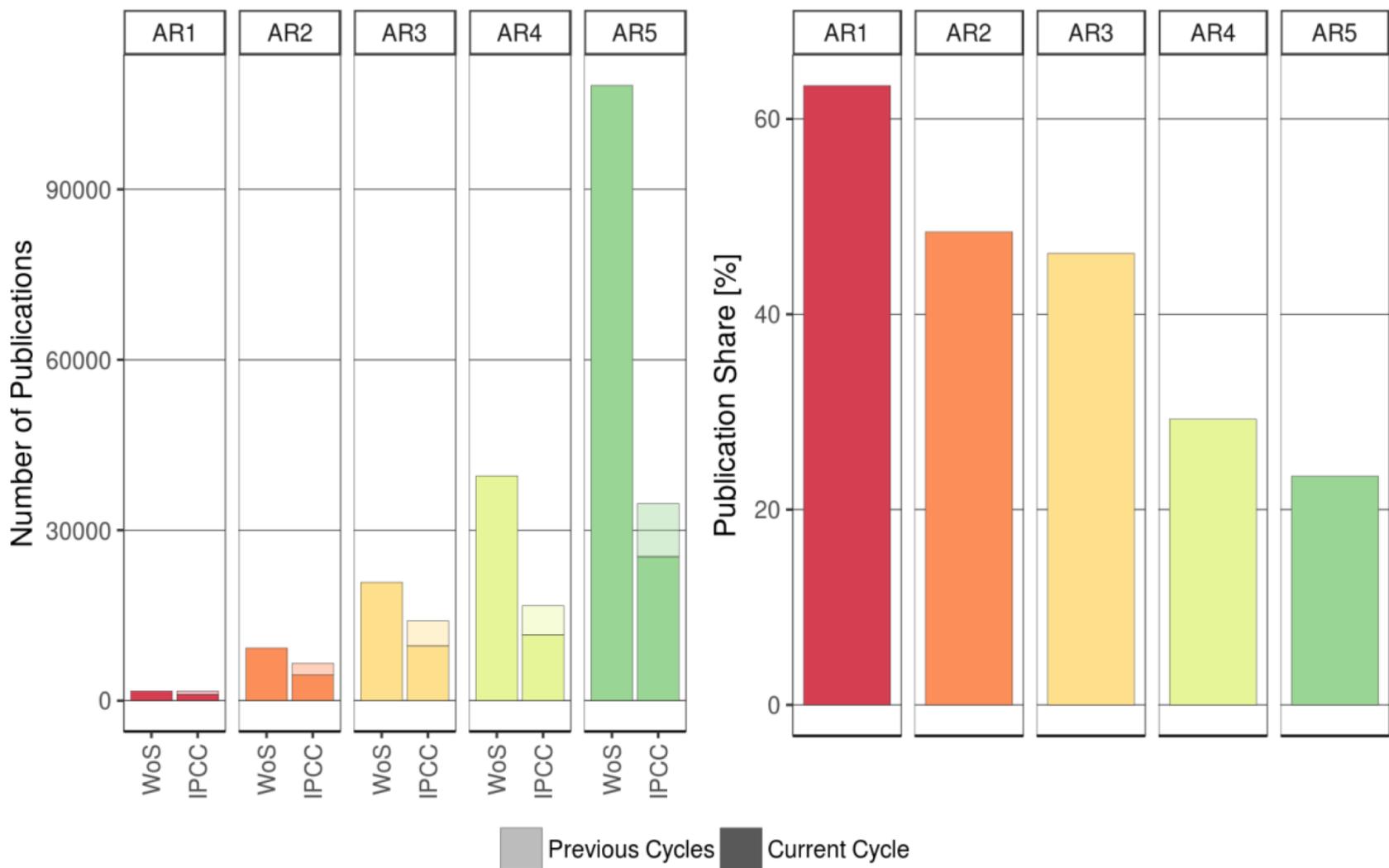
# Un verre de vin quotidien suffit à augmenter le risque de certains cancers

# Contradictory evidence





# A plethora of scientific articles



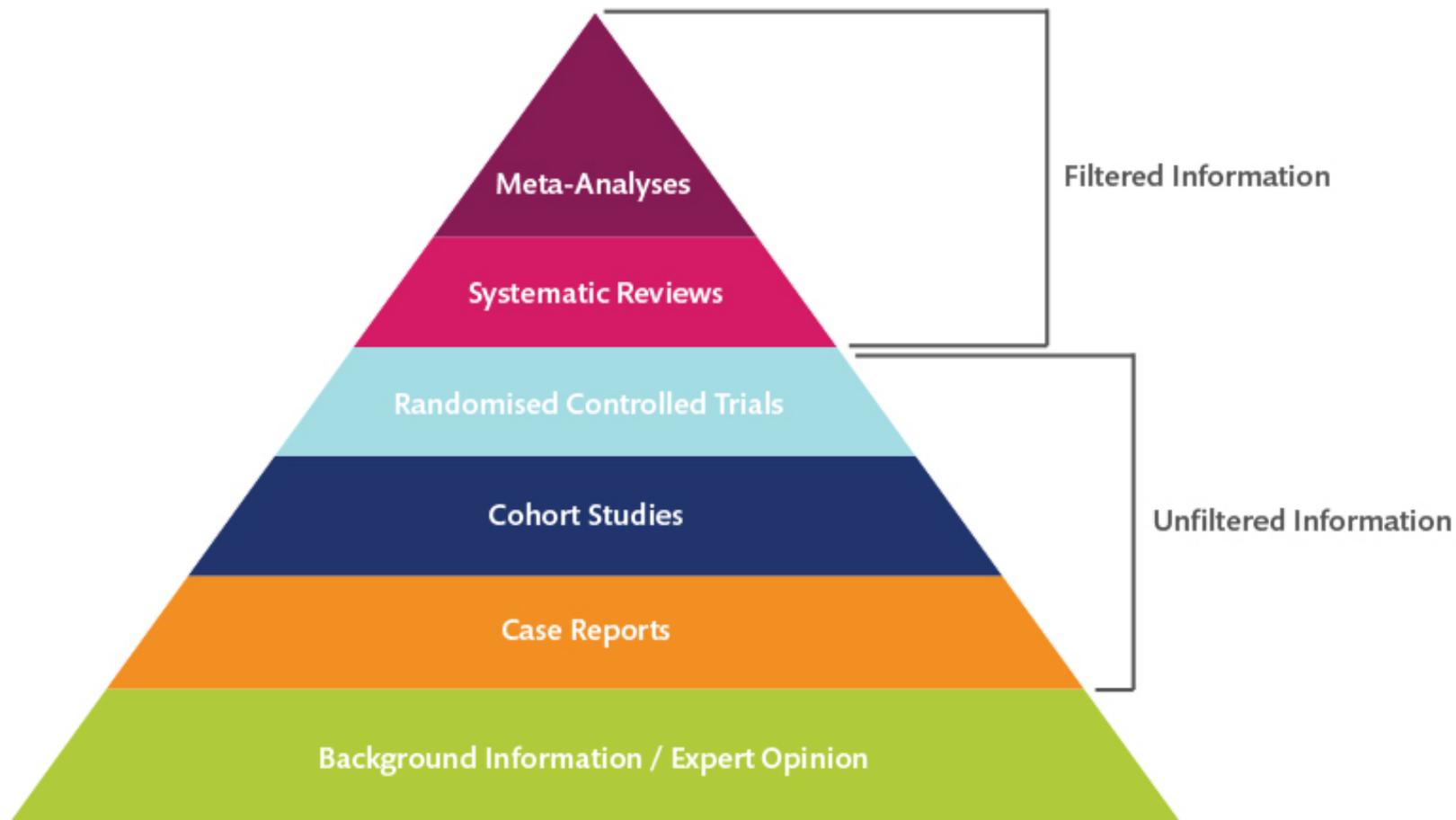


# A real need for reliable evidence

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- Objectify knowledge
- Accurately estimate phenomena and their effects

# Levels of evidence pyramid



# Research synthesis are trendy...



# Some labs specifically focus on synthesis

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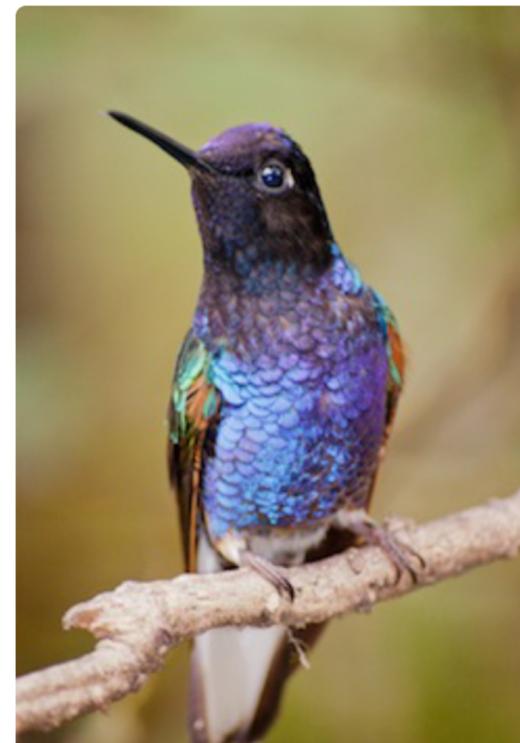
## The PREDICTS project

PREDICTS - Projecting Responses of Ecological Diversity In Changing Terrestrial Systems - is a collaborative project aiming to use a meta-analytic approach to investigate how local biodiversity typically responds to human pressures such as land-use change, pollution, invasive species and infrastructure, and ultimately improve our ability to predict future biodiversity changes.

Human activities are causing major changes in biological communities worldwide, and these changes can harm biodiversity and ecosystem function. Ecosystem function is important in supporting plant and animal communities, as well as ensuring the long-term survival of human populations. Understanding how human pressures influence global biodiversity at a local scale can help us make predictions of future changes, and can inform conservation policy at national and global levels.

Read more about [conservation and global biodiversity declines](#).

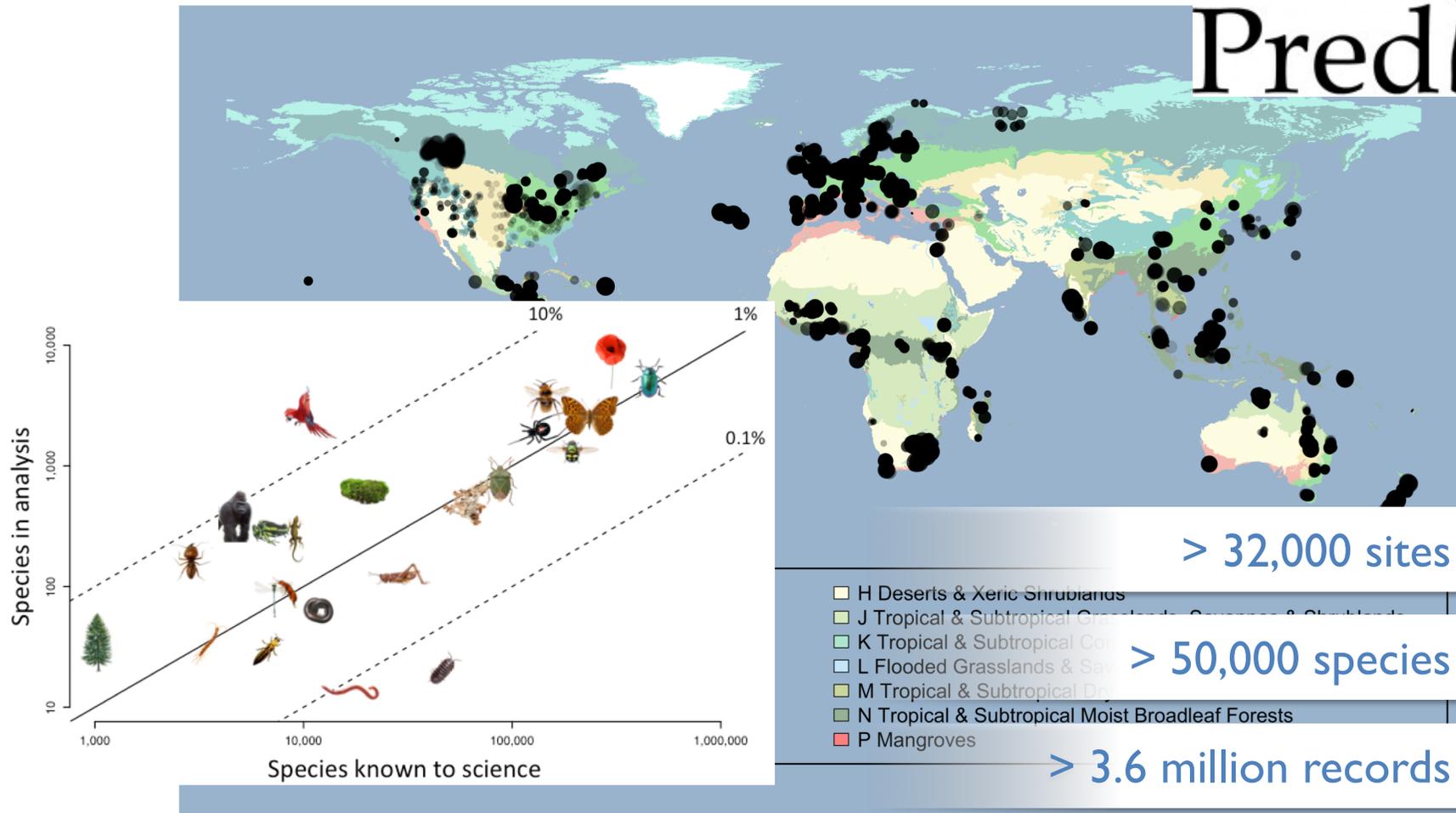
## We need more data!



# Predicts Database



# Predicts





## Has land use pushed terrestrial biodiversity beyond the planetary boundary? A global assessment

Tim Newbold,<sup>1,2\*</sup> Lawrence N. Hudson,<sup>3</sup> Andrew P. Arnell,<sup>1</sup> Sara Contu,<sup>3</sup> Adriana De Palma,<sup>3,4</sup> Simon Ferrier,<sup>5</sup> Samantha L. L. Hill,<sup>1,3</sup> Andrew J. Hoskins,<sup>5</sup> Igor Lyenko,<sup>4</sup> Helen R. P. Phillips,<sup>3,4</sup> Victoria J. Burton,<sup>3</sup> Charlotte W. T. Chng,<sup>3</sup> Susan Emerson,<sup>3</sup> Di Gao,<sup>3</sup> Gwilym Pask-Hale,<sup>3</sup> Jon Hutton,<sup>1,6</sup> Martin Jung,<sup>7,8</sup> Katia Sanchez-Ortiz,<sup>3</sup> Benno I. Simmons,<sup>3,4</sup> Sarah Whitmee,<sup>2</sup> Hanbin Zhang,<sup>3</sup> Jörn P. W. Scharlemann,<sup>1,8</sup> Andy Purvis<sup>3,4</sup>

Land use and related pressures have reduced local terrestrial biodiversity, but it is unclear how the magnitude of change relates to the recently proposed planetary boundary ("safe limit"). We estimate that land use and related pressures have already reduced local biodiversity intactness—the average proportion of natural biodiversity remaining in local ecosystems—beyond its recently proposed planetary boundary across 58.1% of the world's land surface, where 71.4% of the human population live. Biodiversity intactness within most biomes (especially grassland biomes), most biodiversity hotspots, and even some wilderness areas is inferred to be beyond the boundary. Such widespread transgression of safe limits suggests that biodiversity loss, if unchecked, will undermine efforts toward long-term sustainable development.

Land use and related pressures have been the main drivers of terrestrial biodiversity change (1) and are increasing (2). Biodiversity has already experienced widespread large net losses (3), potentially compromising its contribution to resilient provision of ecosystem functions and services, such as biomass production and pollination, that underpin human well-being (4–7). Species-

removal experiments suggest that loss of ecosystem function accelerates with ongoing species loss (5), implying that there may be thresholds beyond which human intervention is needed to ensure adequate local ecosystem function (8, 9). The loss of 20% of species—which affects ecosystem productivity as strongly as other direct drivers (5)—is one possible threshold, but it is unclear by which



## ARTICLE

doi:10.1038/nature14324

## Global effects of land use on local terrestrial biodiversity

Tim Newbold<sup>1,2\*</sup>, Lawrence N. Hudson<sup>3\*</sup>, Samantha L. L. Hill<sup>1,3</sup>, Sara Contu<sup>3</sup>, Igor Lyenko<sup>4</sup>, Rebecca A. Senior<sup>1†</sup>, Luca Börger<sup>5</sup>, Dominic J. Bennett<sup>4†</sup>, Argyrios Choimes<sup>3,4</sup>, Ben Collen<sup>6</sup>, Julie Day<sup>4†</sup>, Adriana De Palma<sup>3,4</sup>, Sandra Díaz<sup>7</sup>, Susy Echeverria-Londoño<sup>3</sup>, Melanie J. Edgar<sup>3</sup>, Anat Feldman<sup>8</sup>, Morgan Garon<sup>4</sup>, Michelle L. K. Harrison<sup>4</sup>, Tamara Alhousseini<sup>4</sup>, Daniel J. Ingram<sup>4†</sup>, Yuval Itescu<sup>8</sup>, Jens Kattge<sup>9,10</sup>, Victoria Kemp<sup>4</sup>, Lucinda Kirkpatrick<sup>4†</sup>, Michael Kleyer<sup>11</sup>, David Laginha Pinto Correia<sup>3</sup>, Callum D. Martin<sup>4</sup>, Shai Meiri<sup>8</sup>, Maria Novosolov<sup>8</sup>, Yuan Pan<sup>4</sup>, Helen R. P. Phillips<sup>3,4</sup>, Drew W. Purves<sup>2</sup>, Alexandra Robinson<sup>4</sup>, Jake Simpson<sup>4</sup>, Sean L. Tuck<sup>12</sup>, Evan Weiher<sup>13</sup>, Hannah J. White<sup>4†</sup>, Robert M. Ewers<sup>4</sup>, Georgina M. Mace<sup>6</sup>, Jörn P. W. Scharlemann<sup>1,14</sup> & Andy Purvis<sup>3,4</sup>

Human activities, especially conversion and degradation of habitats, are causing global biodiversity declines. How local ecological assemblages are responding is less clear—a concern given their importance for many ecosystem functions and services. We analysed a terrestrial assemblage database of unprecedented geographic and taxonomic coverage to quantify local biodiversity responses to land use and related changes. Here we show that in the worst-affected habitats, these pressures reduce within-sample species richness by an average of 76.5%, total abundance by 39.5% and rarefaction-based richness by 40.3%. We estimate that, globally, these pressures have already slightly reduced average within-sample richness (by 13.6%), total abundance (10.7%) and rarefaction-based richness (8.1%), with changes showing marked spatial variation. Rapid further losses are predicted under a business-as-usual land-use scenario; within-sample richness is projected to fall by a further 3.4% globally by 2100, with losses concentrated in biodiverse but economically poor countries. Strong mitigation can deliver much more positive biodiversity changes (up to a 1.9% average increase) that are less strongly related to countries' socioeconomic status.



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# iDiv



## German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig

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## German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig

### Hotspot in Biodiversity Science

iDiv is a DFG research centre with more than 450 employees and members based primarily in Halle, Jena and Leipzig. Here, researchers from 40 nations establish the scientific basis for the sustainable management of our planet's biodiversity.

Biodiversity refers to the diversity of life – not only species diversity but also genetic diversity, diversity of functions, interactions and ecosystems. We know that our actions dramatically change this diversity: species become extinct, genetic information and entire ecosystems



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# But there is another one..

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# Le CESAB



News Events FR



ABOUT THE FOUNDATION

THE FRB IN ACTION

BIODIVERSITY CHALLENGES

PUBLICATIONS

## CESAB

CESAB – Centre for the Synthesis and Analysis of Biodiversity – is a key program of the FRB (Foundation for Research on Biodiversity) and is an original, innovative and internationally recognized tool that offers researchers a place and time to synthesize and analyze already existing data and information in the field of biodiversity research.



With the major crisis facing biodiversity, the need to synthesize scientific data in ecology has never been greater. An unprecedented work has been initiated by international experts within [IPBES](#) to assess the current status of biodiversity and its contribution to human societies. These reports are based on studies already published in scientific journals and databases already compiled. When pooled, these existing data can be used to address new issues, significantly advance knowledge and provide recommendations for decision-makers



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CENTRE FOR THE SYNTHESIS AND ANALYSIS  
OF BIODIVERSITY

### CONTACT

Claire SALOMON  
*Deputy director*  
[Page](#) – [Mail](#)

Nicolas MOUQUET  
*Scientific director*  
[Page](#) – [Mail](#)

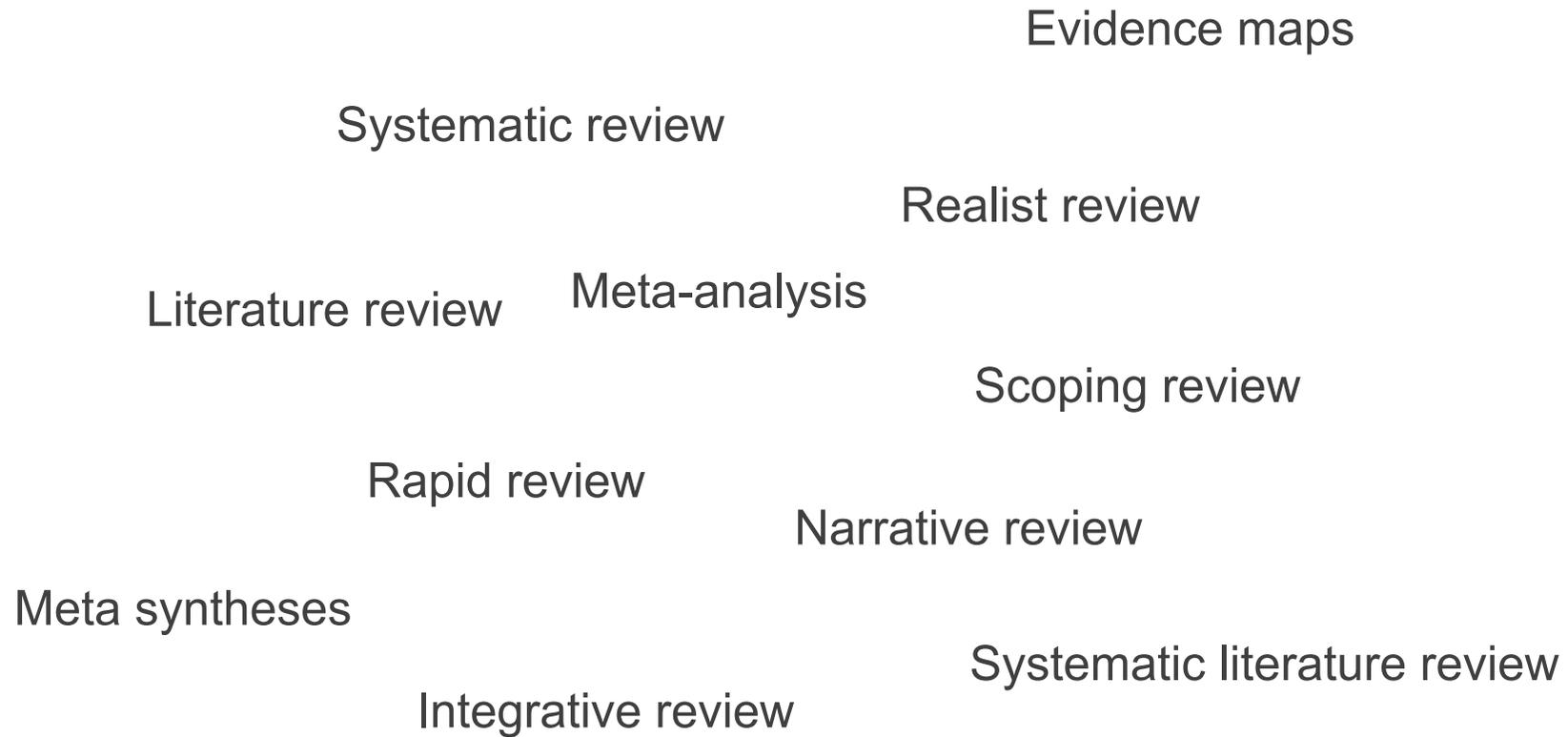
Maud CALMET  
*Administrative Manager*  
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# A review is ....?

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an overview or summary of existing research



# What types of reviews exist ?

- Rapid Evidence Assessment (REA)
- Scoping Review (SR)
- Non-systematic reviews (NSR)
- **Systematique Review (SR)**
- **Systematic maps (SM)**
- **Meta-analysis (MA)**

Consultation-based

Document-based

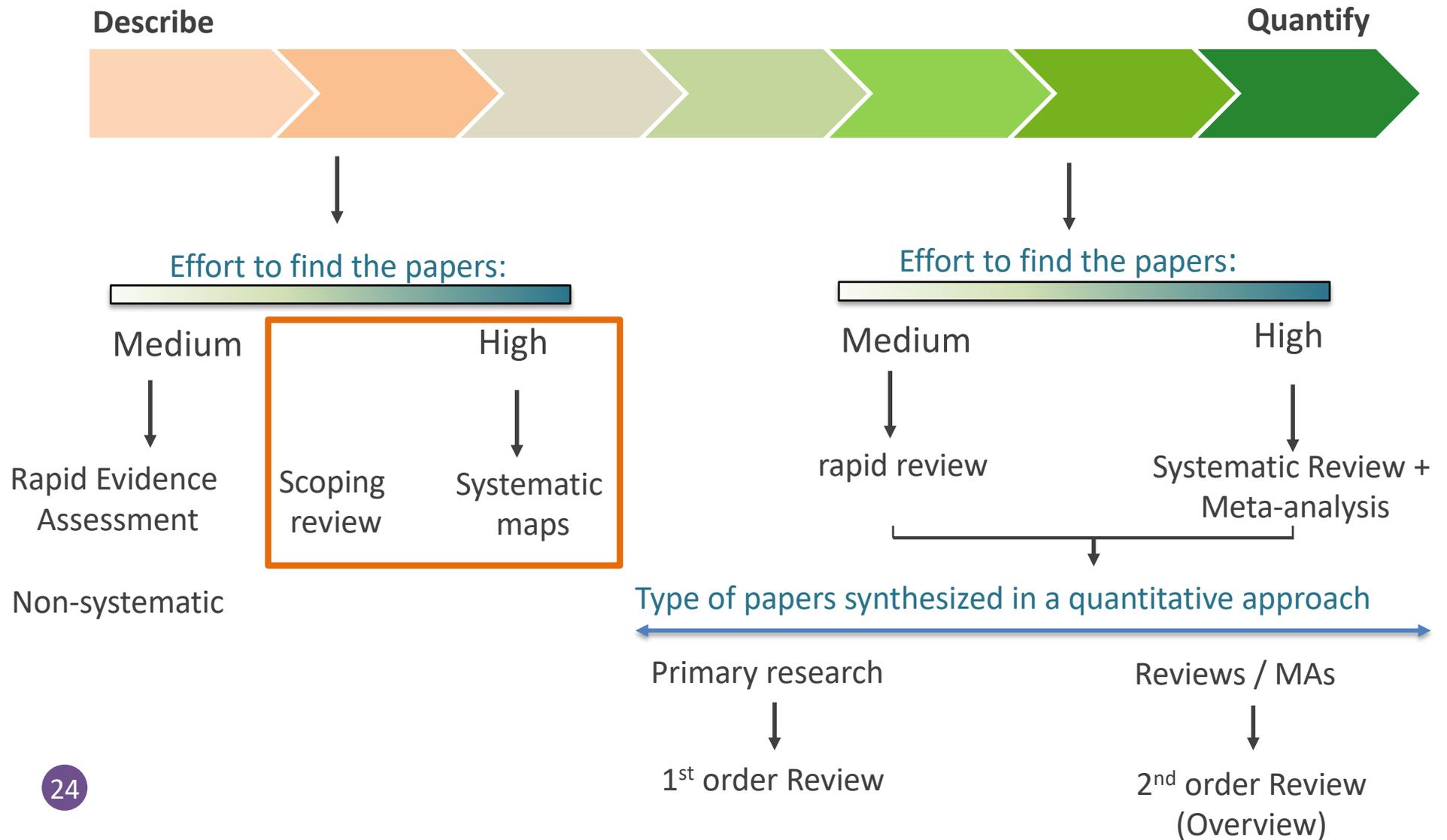


- Quick
- Less expensive

- Time consuming
- More Expensive
- Rigorous, objective, transparent, reproducible

- Expert consultation (EC)
- Multiple Expert Consultation with Formal Methods (Delphi)
- Focus Groups (FG)
- Discourse Analysis (DA)

# What types of reviews exist ?

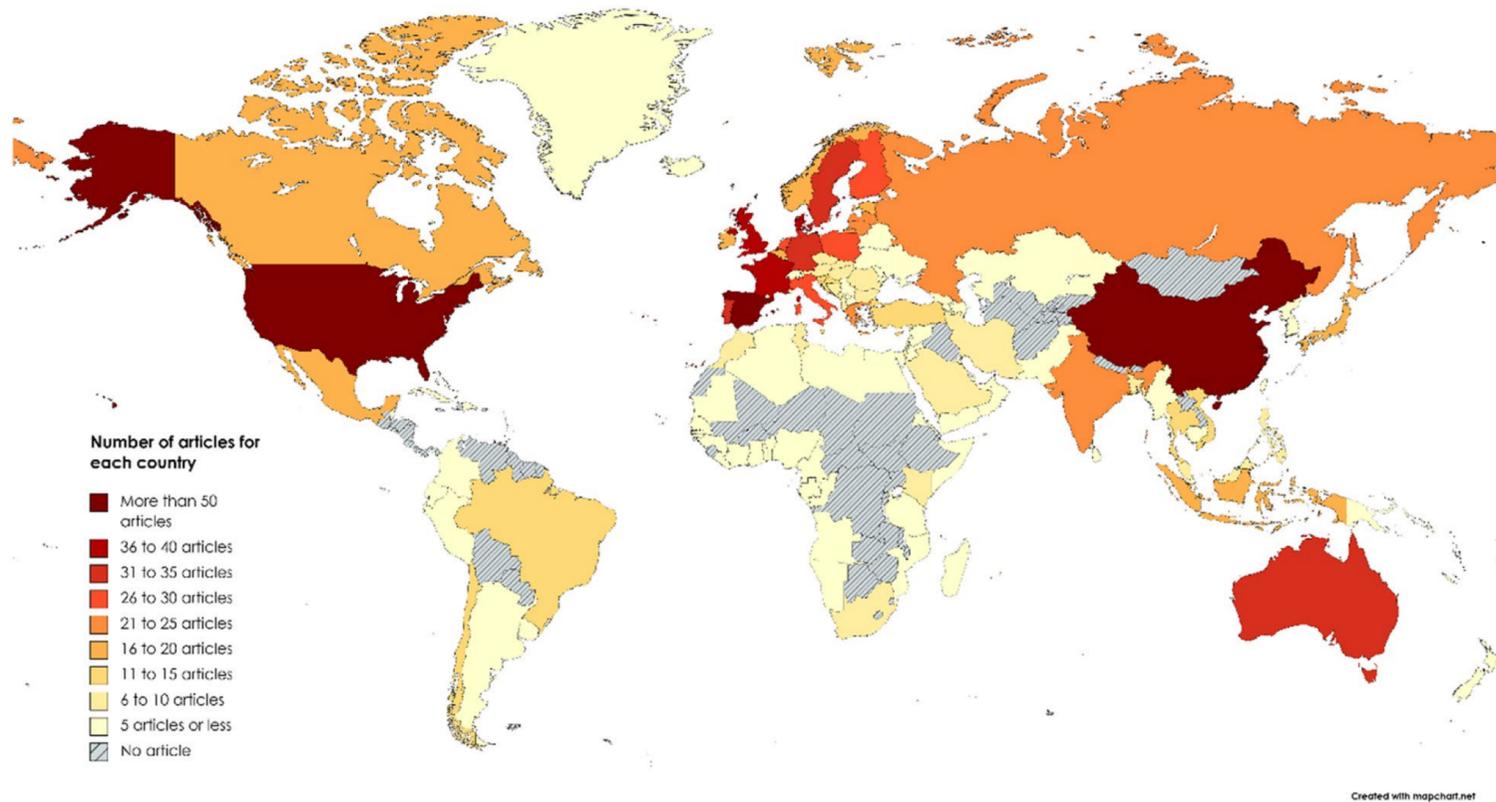


# Systematic (evidence) map

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- **Purpose:** they provide an overview or “landscape of knowledge” on a given issue.
  - > It does not evaluate/quantify the results of primary studies.
- **They aim to highlight:**
  - Knowledge “gaps” = prioritization for research ?
  - Knowledge “clusters”

## Geographical analysis



**Fig. 3** Spatial distribution of the number of articles per country

# Systematic (evidence) map

## Contingency tables

**Table 5** Distribution of the number of articles per ecosystem service values and components (cells are shaded according to the high (dark) and low (light) values for each column separately)

		Food provision	Raw materials	Genetic materials	Water provision	Water purification	Air quality regulation	Coastal protection	Climate regulation	Weather regulation	Nutrients cycling	Habitat provision	Pest and disease control	Symbolic and aesthetic	Recreation	Tourism	Cognitive effects	Educational opportunities
Total		433	50	17	28	53	18	89	183	20	41	40	19	64	93	87	42	43
Economic	196	139	36	12	16	31	13	46	51	12	17	19	11	37	53	52	26	28
Socio-cultural values	22	17	5	4	4	5	1	6	2	2	1	3	5	9	12	12	7	6
Biophysical	592	397	29	8	17	39	9	64	165	14	35	29	12	37	61	56	26	26

# Strengths of evidence maps

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1. Visual representation of the knowledge accumulated/gaps

(i.e. no need to read hundreds of primary studies!)



2. Typology/categorization of the research

(often term and definition varies a lot to represent a same phenomena/practice )



3. Offer a foundation for further, more focused research synthesis

(a first step for a new meta-analysis)



4. Political/scientific agenda for future research

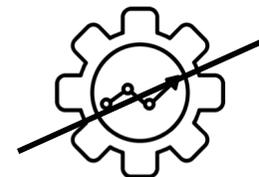


# Weakness of evidence maps

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## 1. Only descriptive – no analyses

(i.e. do not inform on the effectiveness of the tested interventions)



## 2. The results could also be presented in meta-analyses

(beware of redundancies!)



# What are the differences ?

**Describe**

**Quantify**



Effort to find the papers:



Medium

High

Rapid Evidence Assessment

Scoping review

Systematic maps

Non-systematic



Effort to find the papers:



Medium

High

Meta-analysis /  
rapid review

Systematic Review



Type of papers synthesized in a quantitative approach



Primary research

Reviews / MAs



1<sup>st</sup> order Review

2<sup>nd</sup> order Review  
(Overview)

# Meta-analysis

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- **Purpose:** they provide an quantification on an effect, identify source of heterogeneity, identify the effect of moderators.
  - > It integrates “all” primary publication on a subject, and weight their evidence by their precision.

# Meta-analysis

7608

# Experiments



138

# Effect\_sizes

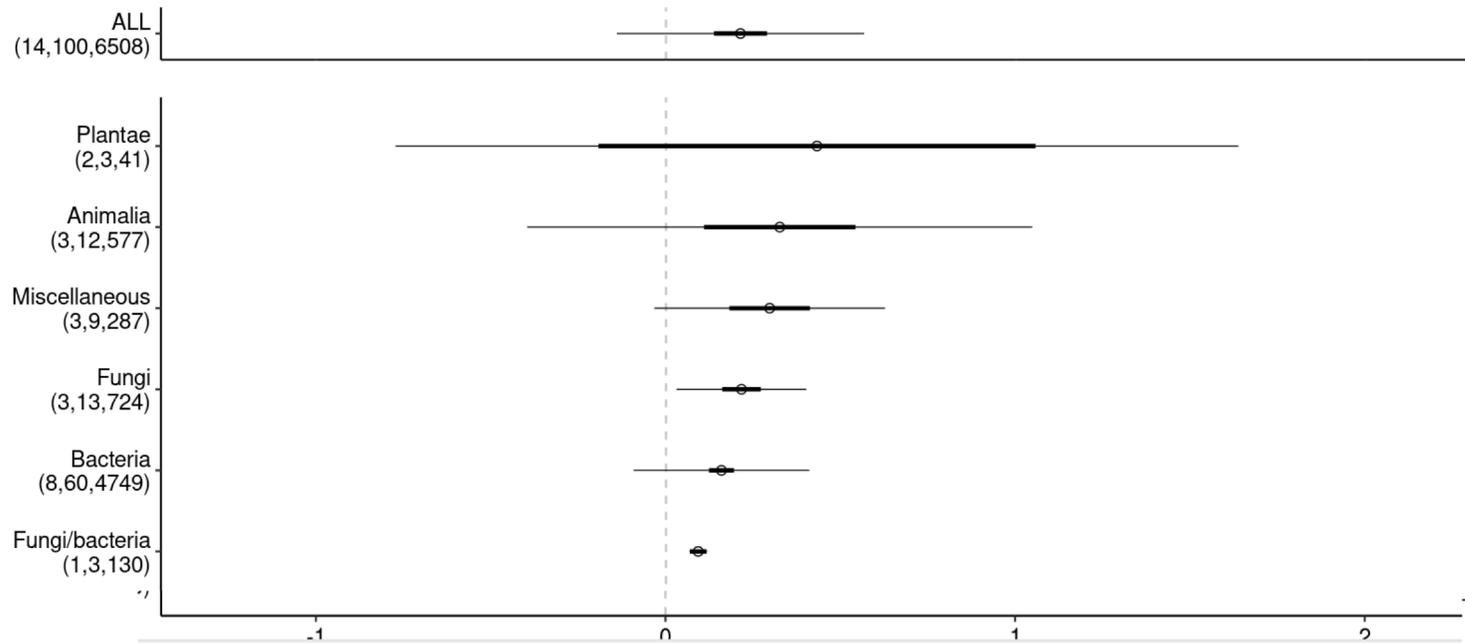


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# Meta-analyses



Effect sizes for **ALL** diversification strategies



Effect of crop diversification on associated Biodiversity (log RR)

# Strengths of meta-analyses

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## 1. See the forest for the trees

(i.e. see effects and relationships that might not be visible in individual studies)



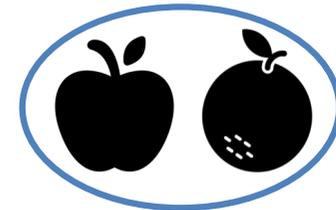
## 2. Synthesize knowledge on controversial issues

(find average effect while trying to minimize bias)



## 3. Can compare apples and oranges (to some degree)

(meta-analysis is specifically designed to deal with heterogeneity)



## 4. Examine reasons for variation (to some degree)



# Weakness of meta-analyses

## 1. See the tree for the forest

(i.e. apply results to individuals)



## 2. Cannot overcome bias

(e.g. partial synthesis, publication bias, subjective methods choices)



## 3. Comparing apples and oranges

(combining things that should not be combined)



## 4. Not representative

(Study population = scientific studies, **≠ population of interest**)

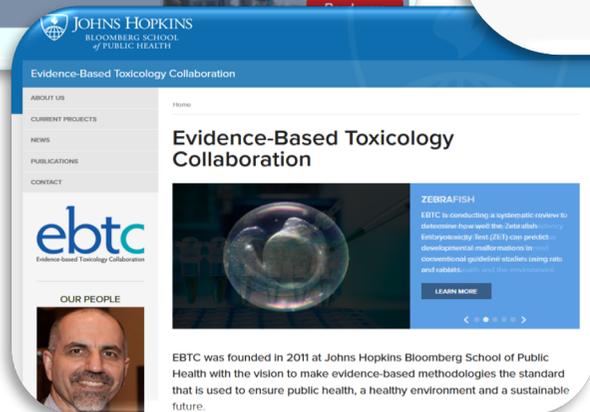
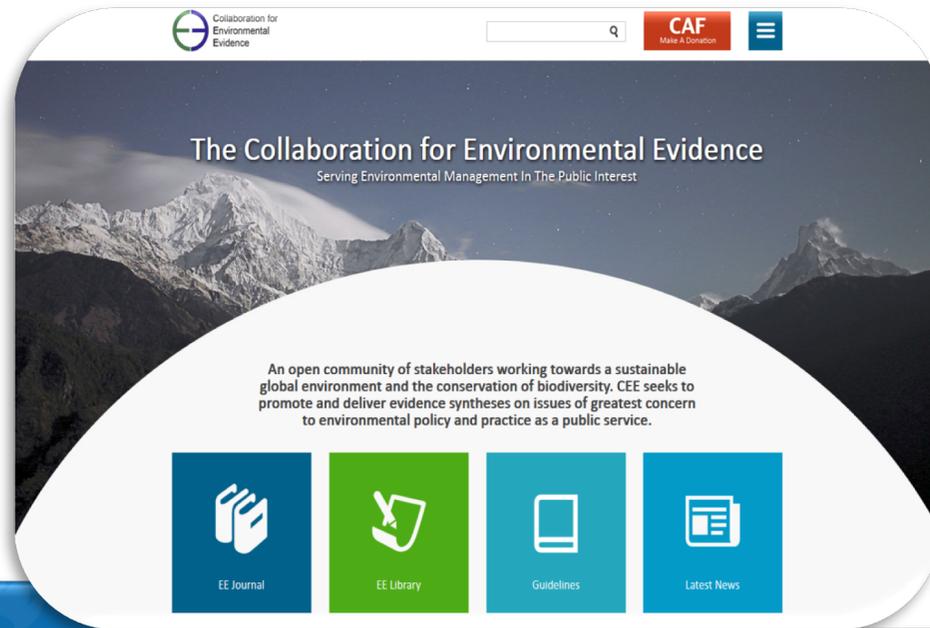


## 5. Not able to examine causality



# La revue systématique : 4 collaborations internationales

- Method originating in the medical field (Cochrane) intended to objectify decision-making (medical treatments).
- Now the approach is fully developed in the field of ecology (Collaboration for Environmental Evidence) and in the social sciences (Campbell collaboration).





# Un point commun : une méthode particulièrement robuste et transparente

**Cochrane Training** Trusted evidence. Informed decisions. Better health.

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## Cochrane Handbook for Systematic Reviews of Interventions

Español 简体中文

### Handbooks

- Handbook
- Browse online
- Supplementary material
- Updates and corrections
- What's new?

**June 2017: Handbook Editors' Update**

The Handbook editorial team is currently updating Handbook versions 5.0, 5.1 and 5.2 for a planned release of Version 6 in 2018. This is a major update. Senior Scientific Editors Julian Higgins and James Thomas have reorganized some material to include recent developments. There are also several new chapters including writing a protocol, equity and specific populations, complex interventions, network meta-analysis, and synthesizing findings using non-statistical methods. Please note following the introduction of the Methodological Expectations for Cochrane Intervention Review (MECIR) standards, we set out to produce a minor Handbook update, version 5.2 to include these standards. Due to limited editorial capacity, we only produced a limited number of chapters. These chapters are 1, 8, 9, 10, 11, 12, and 21 and are available as pdf versions for Cochrane members. These chapters only include minor edits to improve clarity, some limited new material and updating. There are currently no substantive changes to methods in these chapters, we expect to include these in Version 6. For more details see the What's new? page.

[Click here to browse Handbook version 5.1 online](#)

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## So you want to write a Campbell systematic review?

We welcome proposals for new reviews to be registered with the Campbell Collaboration and, subsequently, published in the Campbell Library.

There are three stages in the production of a Campbell review: (1) title registration, (2) protocol, and (3) review. You will find a Word template for each of these three stages, with a 'Campbell template instructions' document in our online library.

The editorial process for your review will be managed by one Campbell's Coordinating Groups.

General guidance can be found in Campbell's Policies and Guidelines and Expectations and guidance for systematic review authors. See the bottom of this page for a list of links to the resources needed.

### 1. Title registration

The first step is to complete the title registration form (TRF). Please read the document 'Campbell template instructions' before filling in the form.

The proposed title for your systematic review should clearly state the scope of the review. This scope should be determined in consultation with key stakeholders including intended end users. Guidance on formulating the review title may be found in the [Cochrane Handbook](#), which is the basis for the suggested title format you will find in the TRF template.

An additional resource to assist at the title stage is [The Equity Checklist](#).

The completed TRF should be sent directly to the Managing Editor of the Coordinating Group with which the review

- So you want to write a Campbell systematic review?
- Expectations and guidance for systematic review authors
- Information retrieval guide
- Methods Policy Briefs
- The Equity Checklist
- User Involvement in the Review Process
- Guidance on establishing, managing Stakeholder Advisory Review Groups
- Methods Link
- Effect Size Calculator

## Guidelines and standards: a need for rigour, objectivity and transparency

**Collaboration for Environmental Evidence**

CAF Make A Donation

## How We Work

### Guidelines for Authors

# Guidelines and Standards for Evidence Synthesis in Environmental Management

## VERSION 5.0

### 2018

Please note that these guidelines will be periodically updated and each update recorded (see [Updates and Corrections](#)). Major updates will be announced through social media.

[Read the guidelines online here](#)

**Please cite as:**

Collaboration for Environmental Evidence. 2018. *Guidelines and Standards for Evidence synthesis in Environmental Management*. Version 5.0. [www.environmentalevidence.org/information-for-authors](http://www.environmentalevidence.org/information-for-authors) [date of access].

**Acknowledgements:**

Thanks to the editorial team for this version of the CEE Guidelines and Standards (in alphabetical order): Geoff Frampton, Barbara Livorelli, Gillian Petrokofsky and Andrew Pullin

We thank all authors contributing to this version of the CEE Guidelines and Standards and the papers on which some sections were based (in alphabetical order): Helen Bayliss, Alison Bethel,

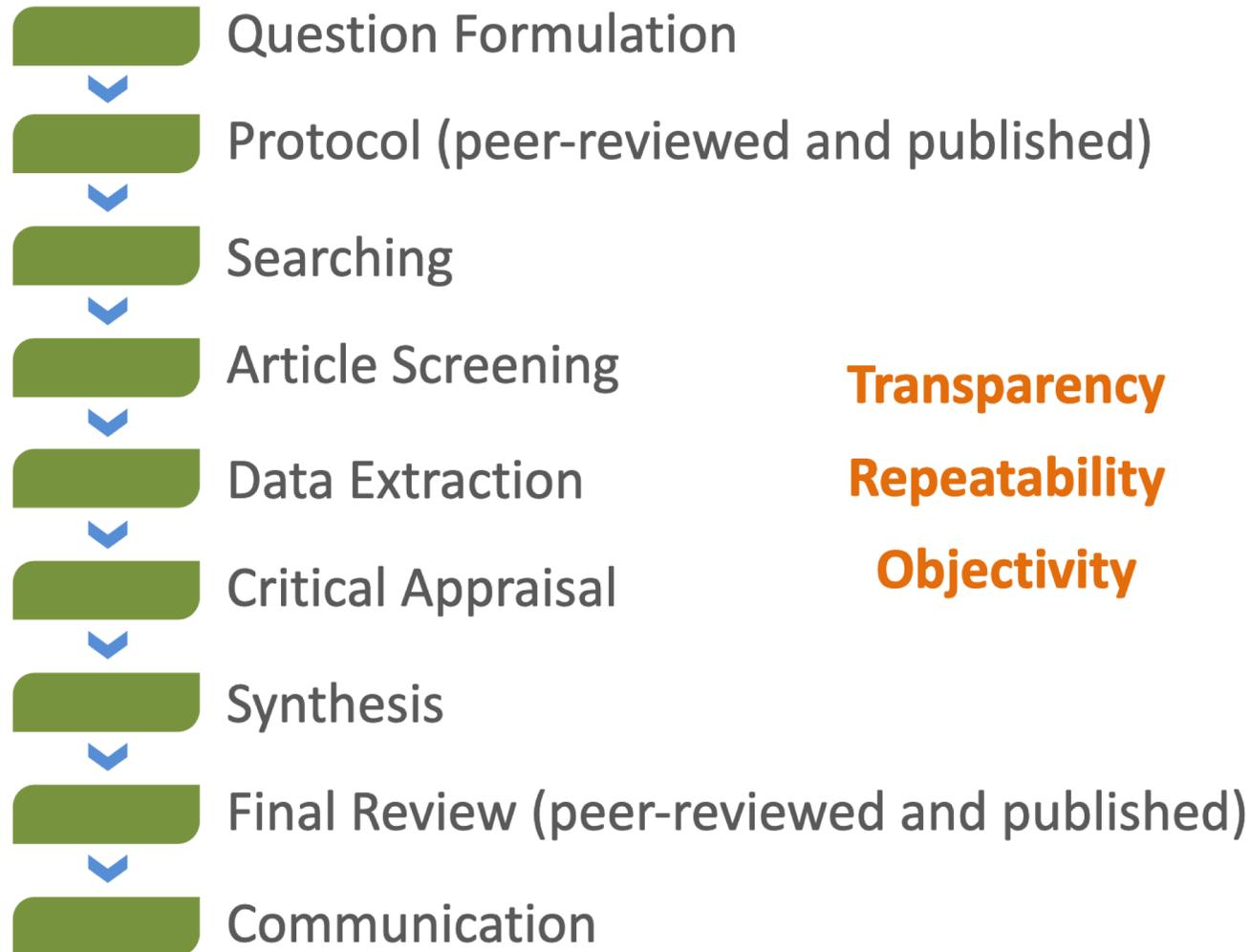
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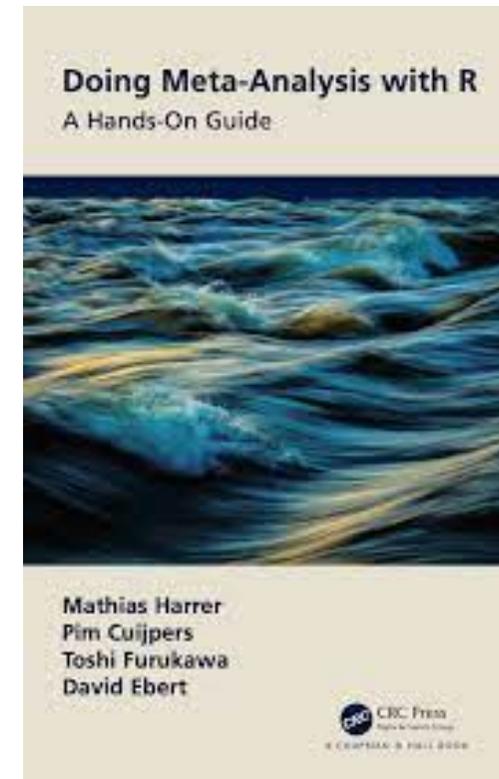
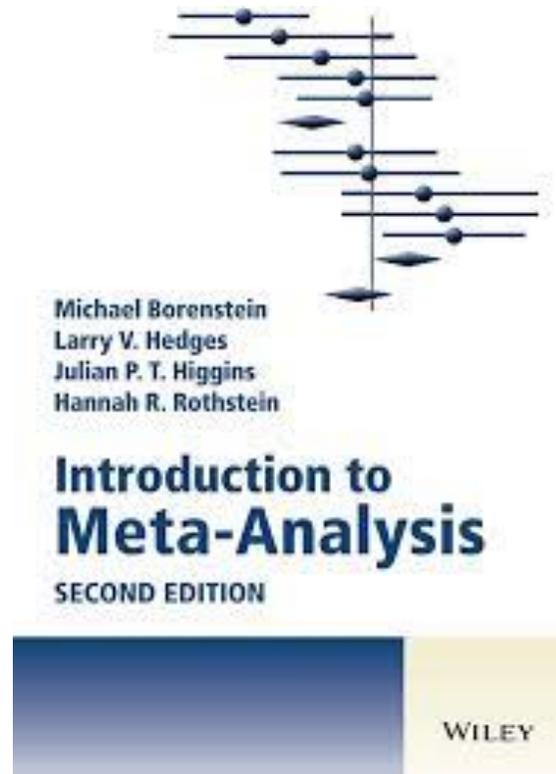
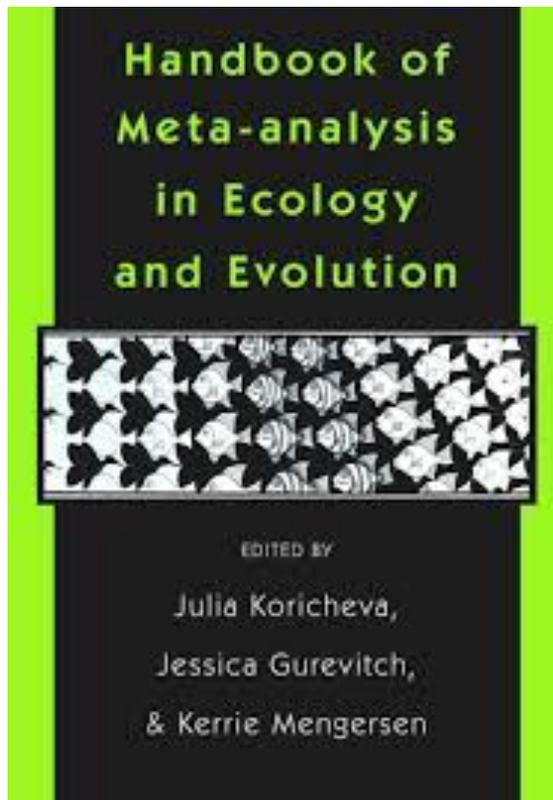
In France, The FRB is the representing scientific structure for the CEE network.

# The different steps to perform a systematic review

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# Recommended literature



+ All pots/stackoverflow of Viechtbauer W.