

Language barriers in conservation science: consequences and solutions

Tatsuya Amano



@tatsuya_amano



Centre for Biodiversity and
Conservation Science



Australian Government
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Transcending language barriers to environmental sciences

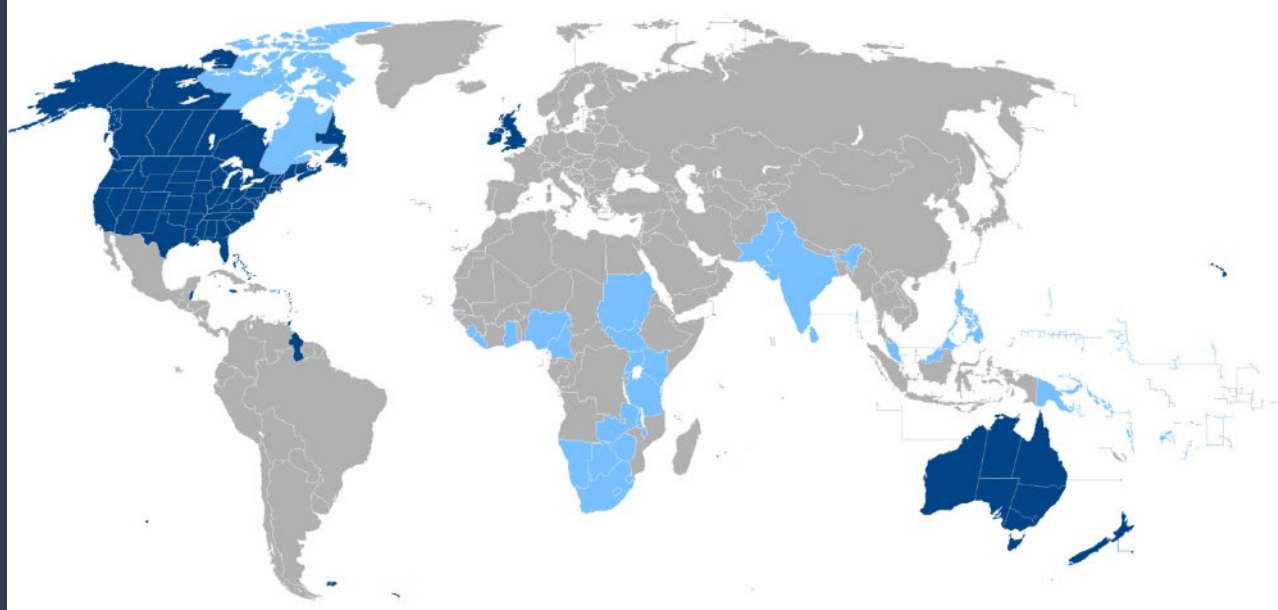
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Why **language** in biodiversity conservation?

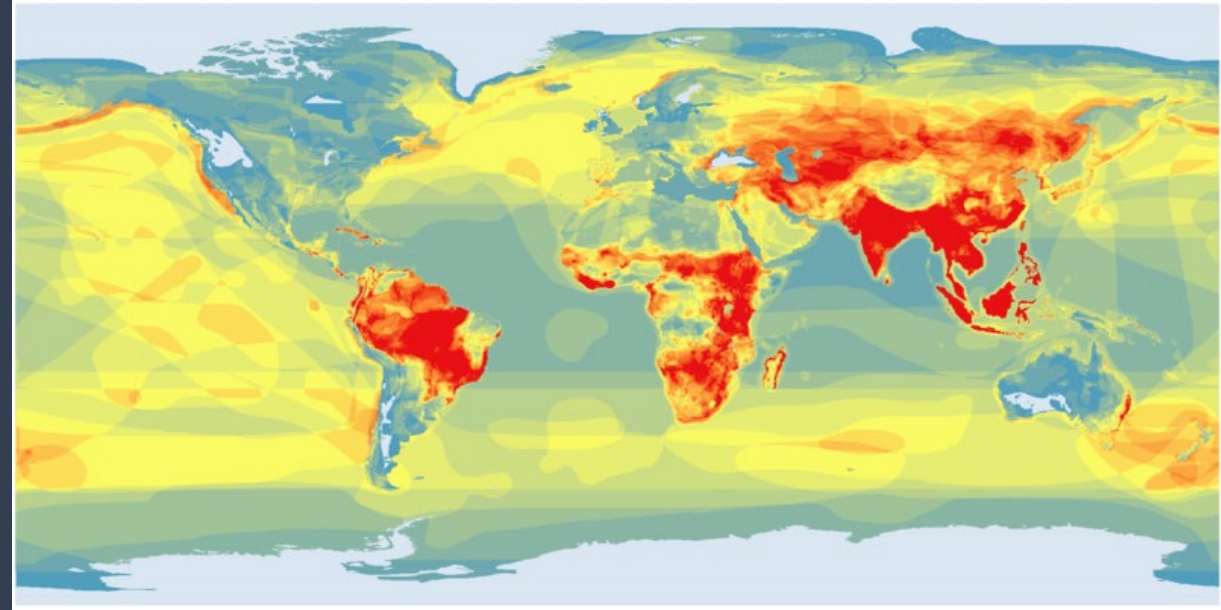
States/territories where English is the first language of the majority of population



<https://commons.wikimedia.org/wiki/File:Anglospeak.png>

en:User:Iamvered, CC BY 2.0 AT

Richness of threatened amphibians, birds and mammals



<https://www.iucnredlist.org/resources/other-spatial-downloads>

Language barriers to:

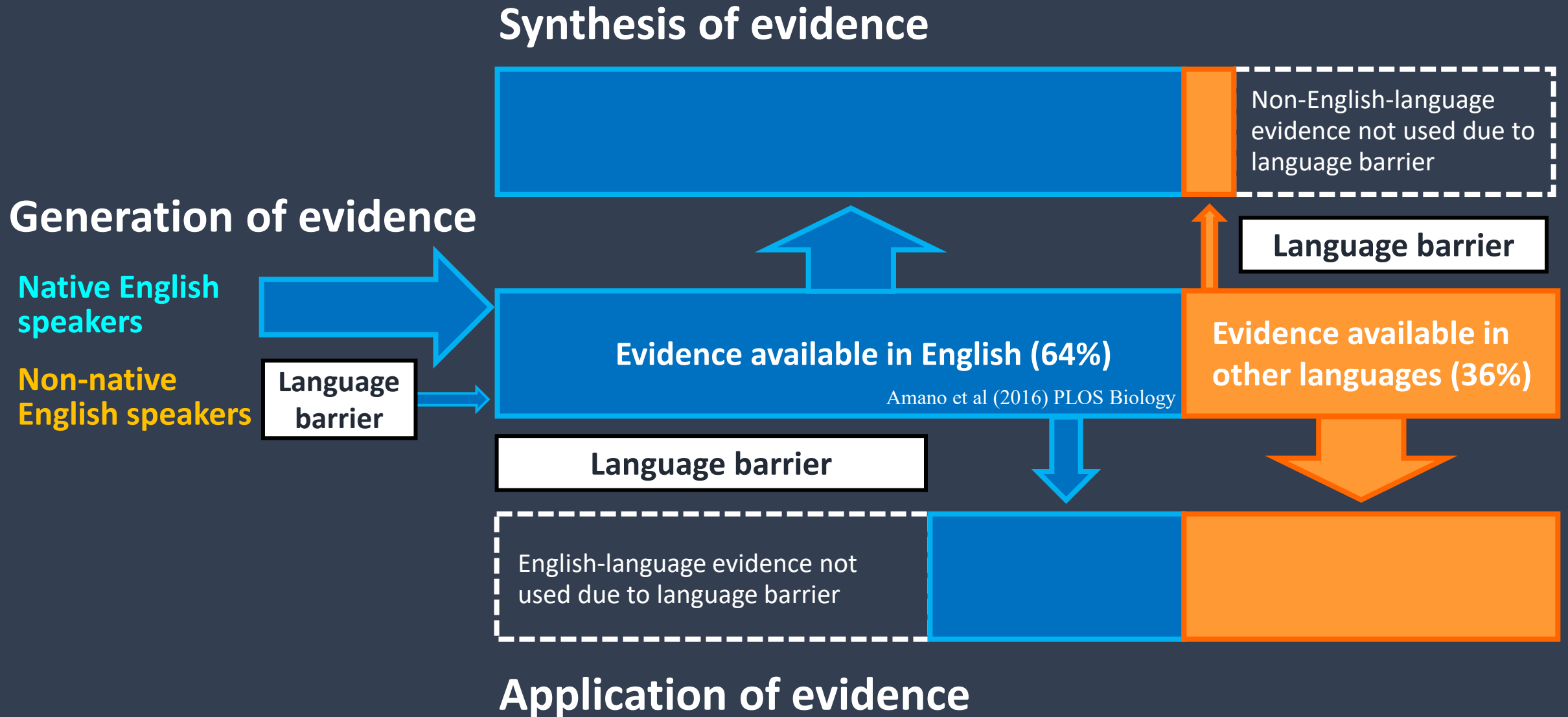
- The **global synthesis** of scientific evidence
- The **local application** of scientific evidence
- The **generation** of scientific evidence by non-native English speakers

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Transcending language barriers to environmental sciences

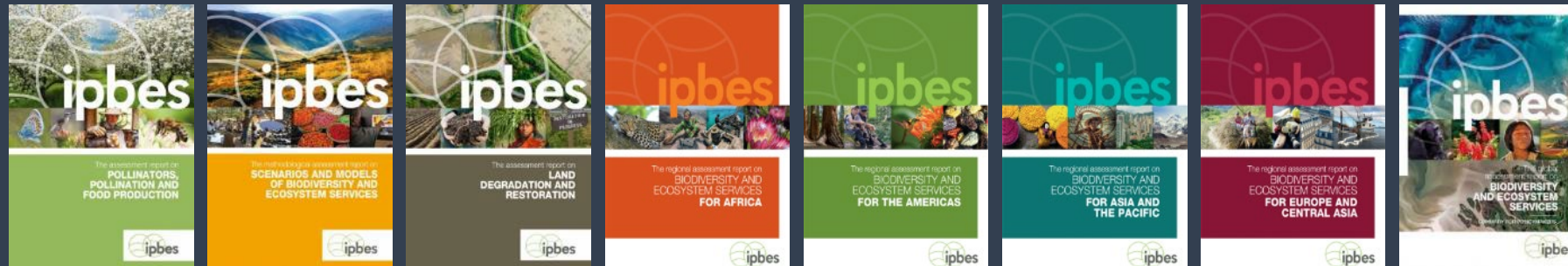
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Language barriers to the synthesis/application/generation of evidence



How is **non-English-language science** used in global evidence syntheses?

On average, **96.6%** of the references cited in eight IPBES assessments were in **English**



Existing conservation literature
(Amano et al 2016)

English	93.3	93.1	98.0	98.0	94.7	100	94.0	96.3	64%
Spanish	3.3	1.3	0.7		5.3			1.4	vs
French	2.0	3.1	1.3	2.0				1.1	36%
Indonesia	0.7							0.1	
Portuguese	0.7	0.6						0.2	
German		0.6					0.7	0.2	
Italian		0.6						0.1	
Russian		0.6					4.7	0.7	
Uzbek							0.7	0.1	

What are the consequences of ignoring **non-English-language science**?

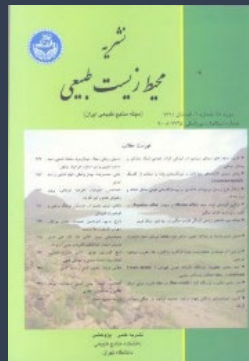
1. Losing access to a non-negligible amount of evidence

Identified **1,234 non-English-language studies** that test the effectiveness of conservation interventions

4,412 English-language studies stored in Conservation Evidence

List of 466 peer-reviewed journals in ecology & conservation in 19 languages

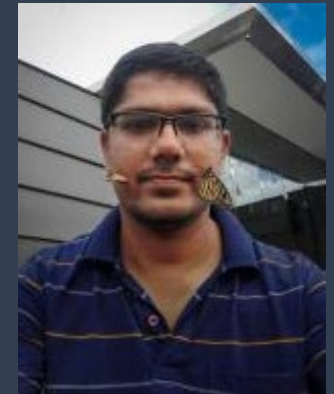
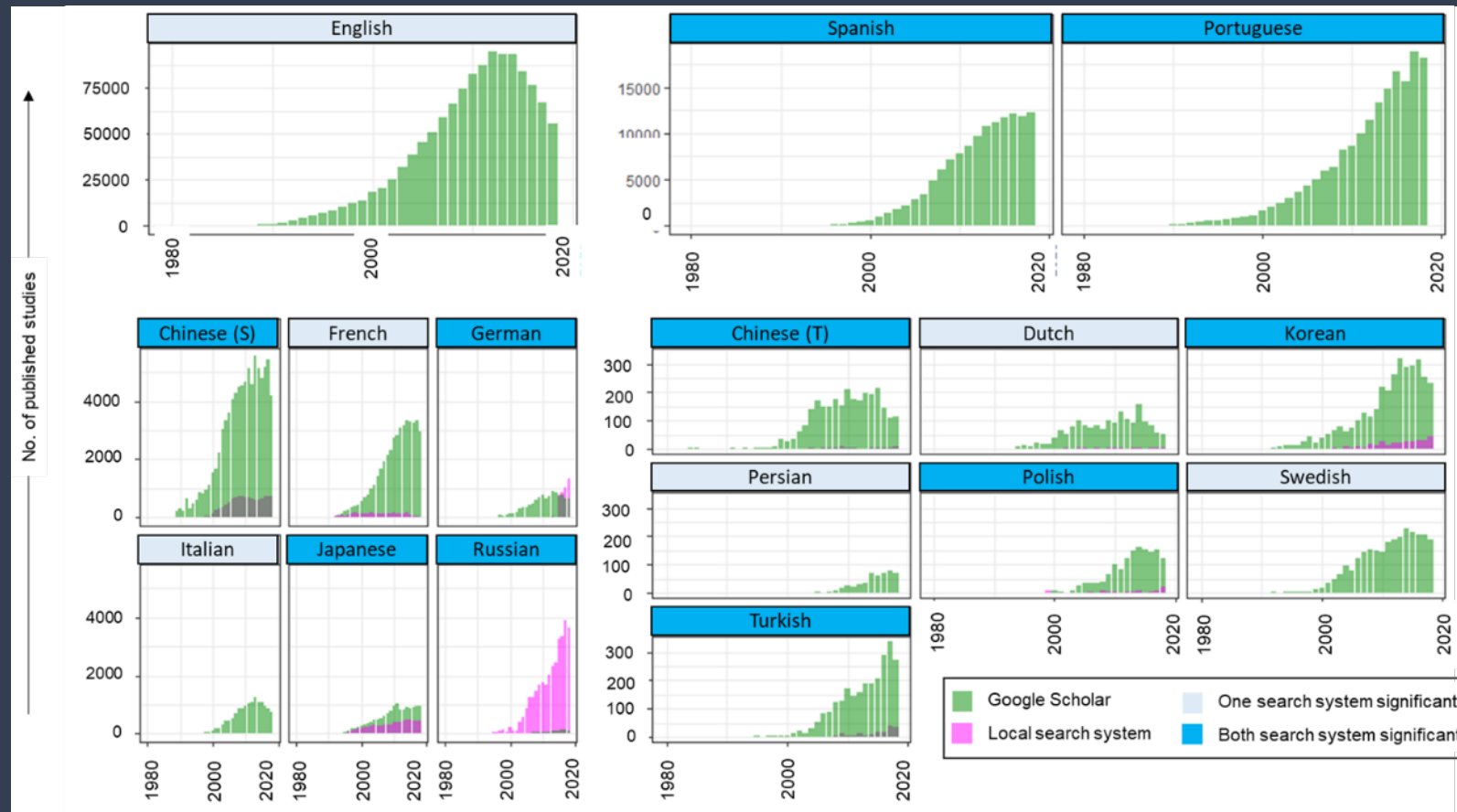
<https://translatesciences.com/resources/#journals>



What are the consequences of ignoring **non-English-language science**?

1. Losing access to a non-negligible amount of evidence

The number of conservation articles published in non-English languages is increasing



Shawan Chowdhury

Yearly changes in the number of scientific documents on conservation in 16 languages

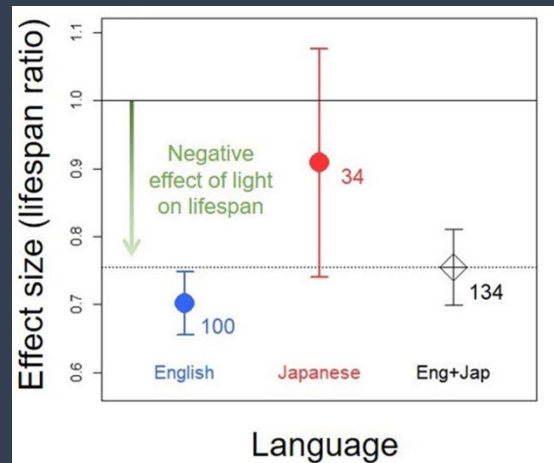
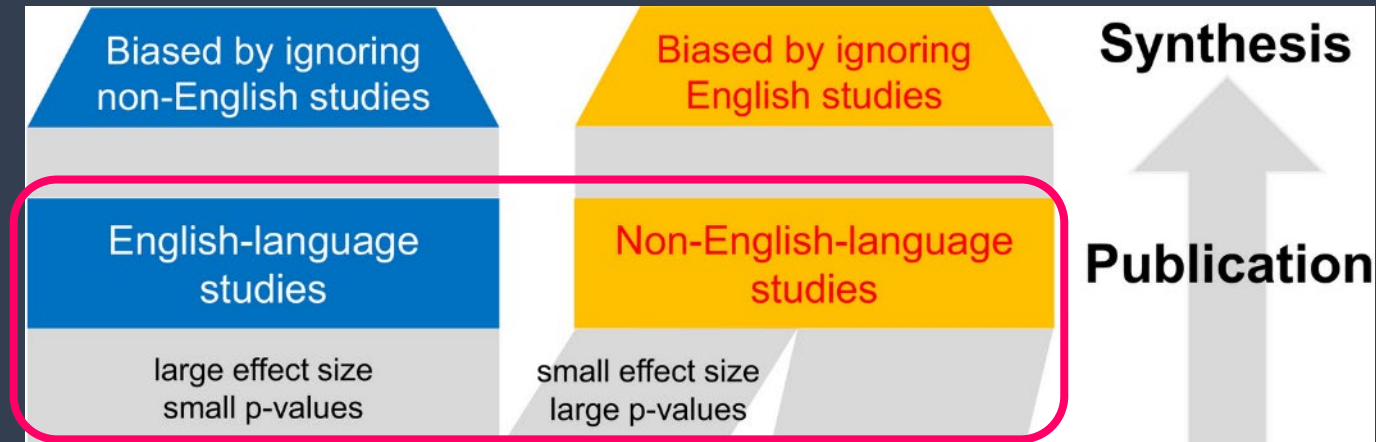
Chowdhury et al (2022) Conserv Biol

What are the consequences of ignoring **non-English-language science**?

2. Causing biases in our understanding

Language bias in evidence synthesis

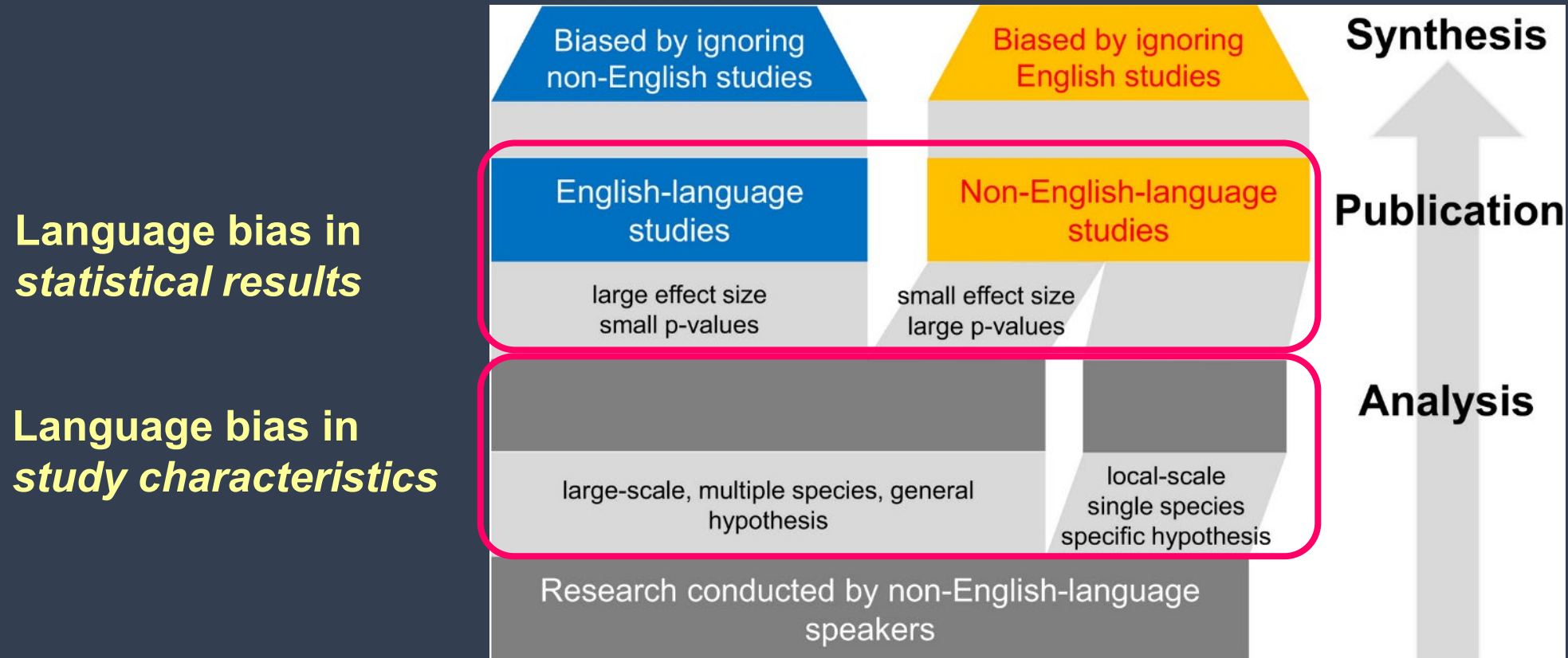
**Language bias in
*statistical results***



What are the consequences of ignoring **non-English-language science**?

2. Causing biases in our understanding

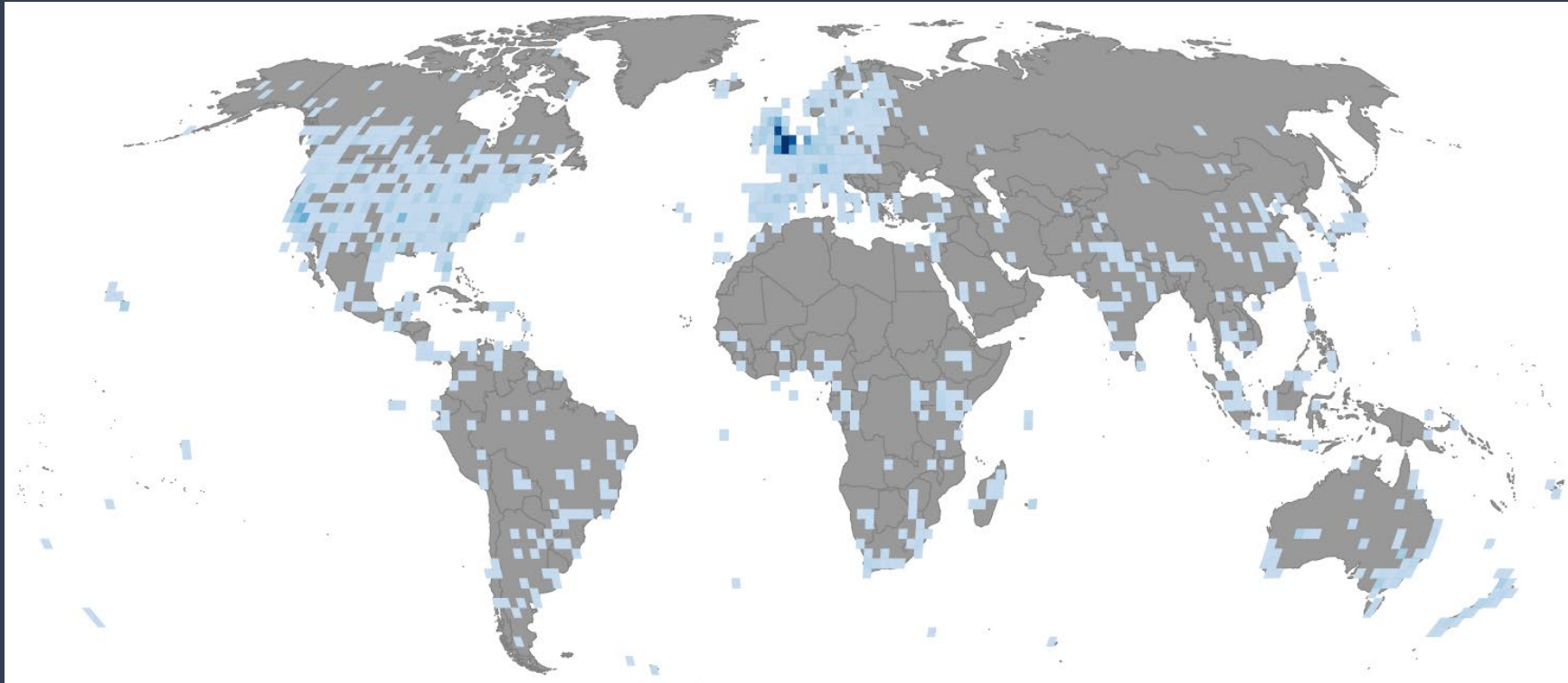
Language bias in evidence synthesis



What are the consequences of ignoring **non-English-language science**?

2. Causing biases in our understanding

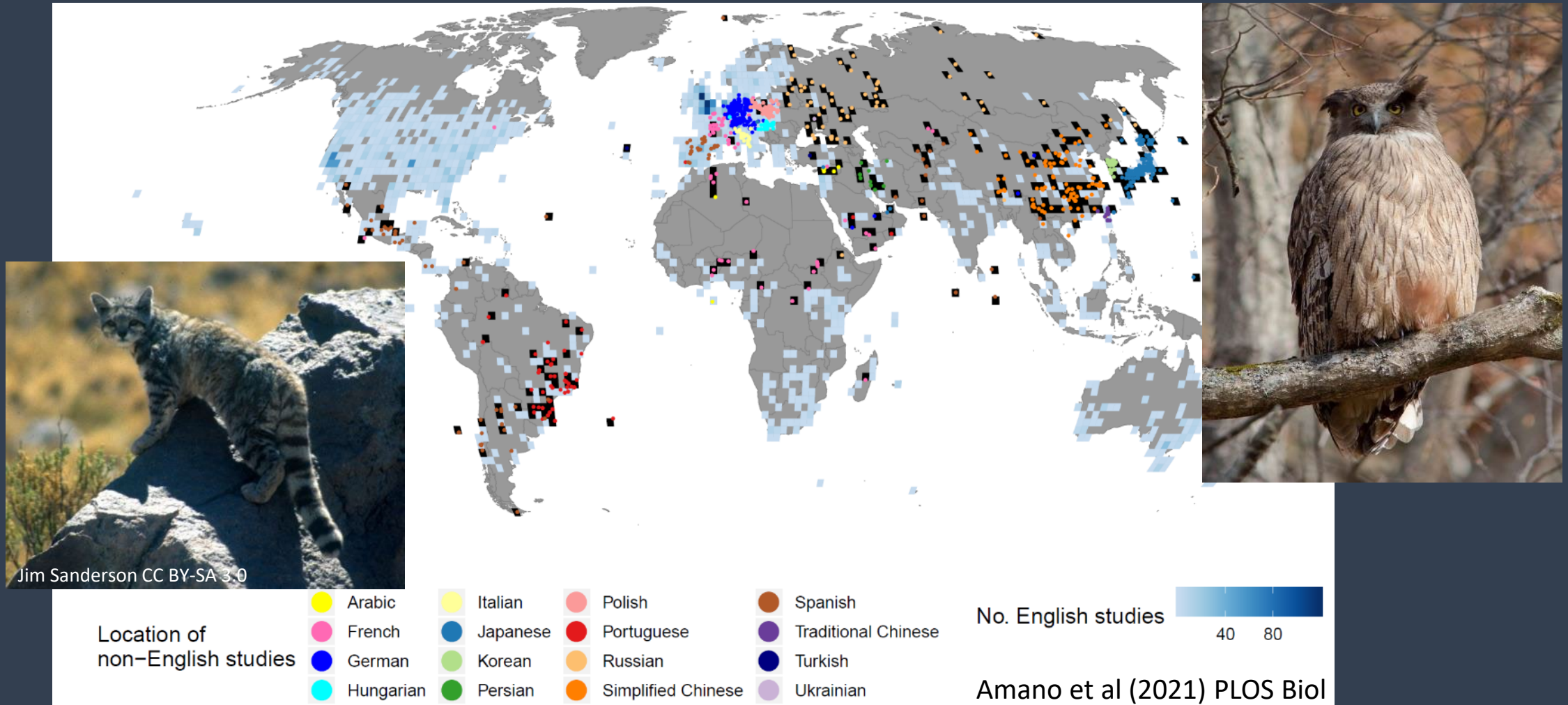
Study location of **English-language** studies testing conservation interventions



What are the consequences of ignoring **non-English-language science**?

2. Causing biases in our understanding

Study location of **English-** vs **non-English-language** studies testing conservation interventions

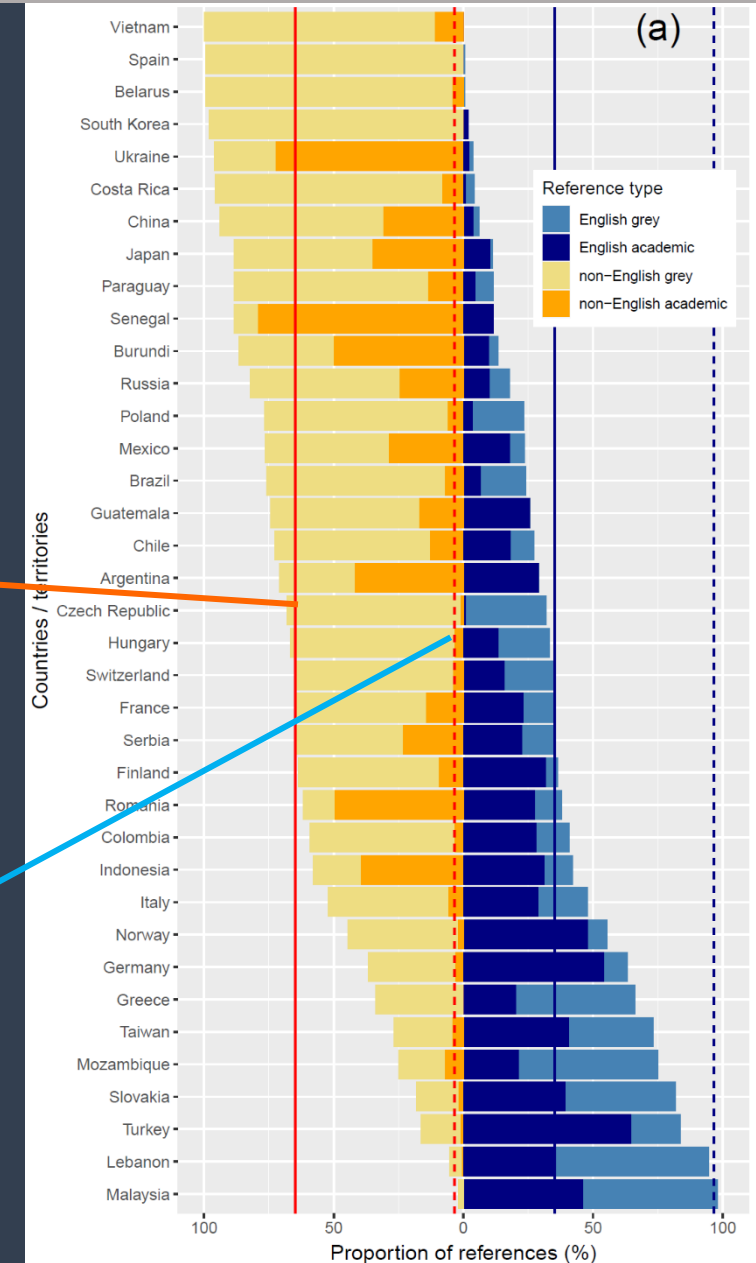


How is evidence available in **different languages** used in local decision making?

Proportion of **non-English-** vs **English-language** references cited in national reports on biodiversity conservation among 37 countries/regions

On average, **65%** of the references cited in the reports were in **non-English languages**

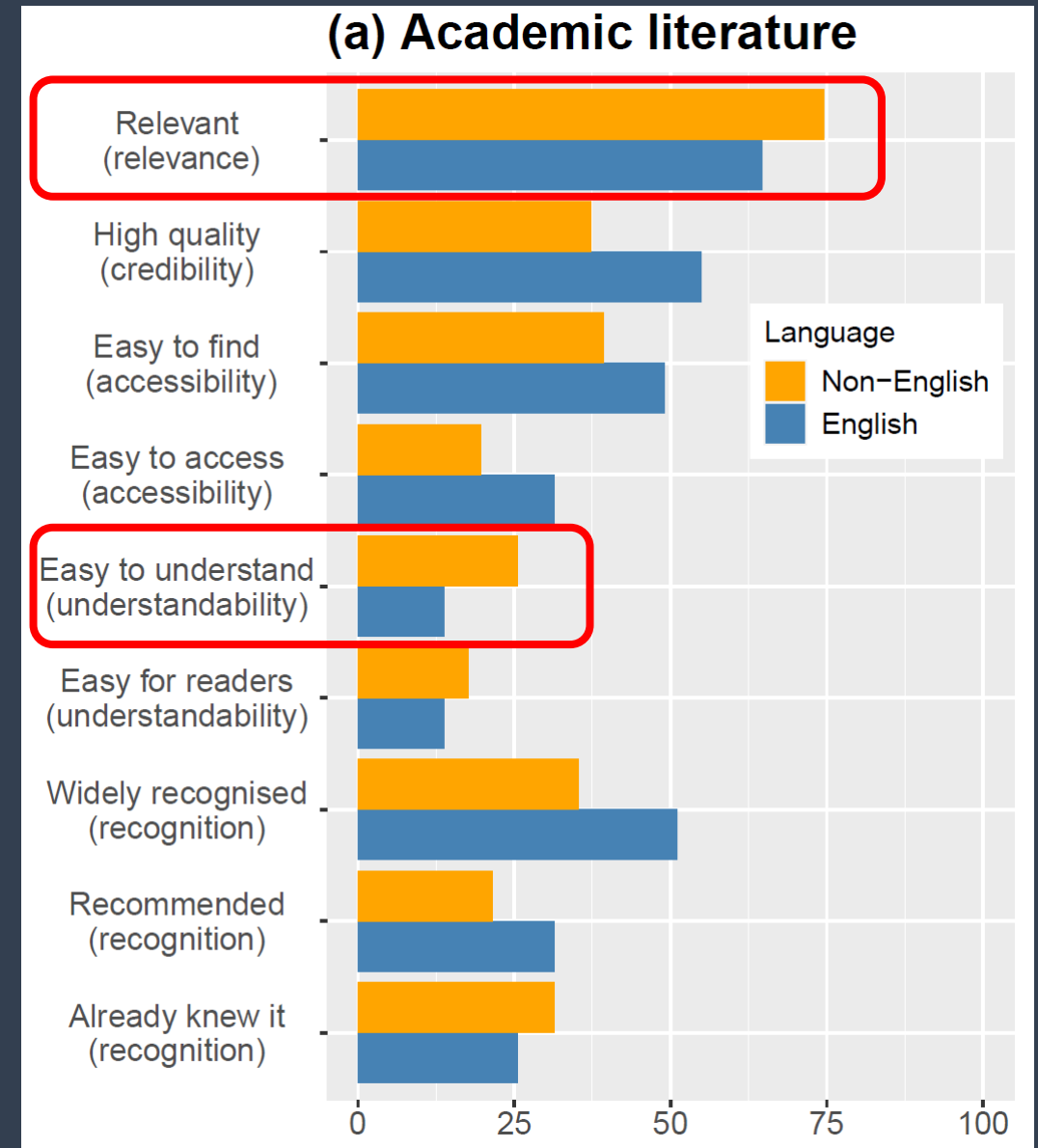
The result is in stark contrast to IPBES assessments with only **3.4%** of the references in **non-English languages**



How is evidence available in **different languages** used in local decision making?

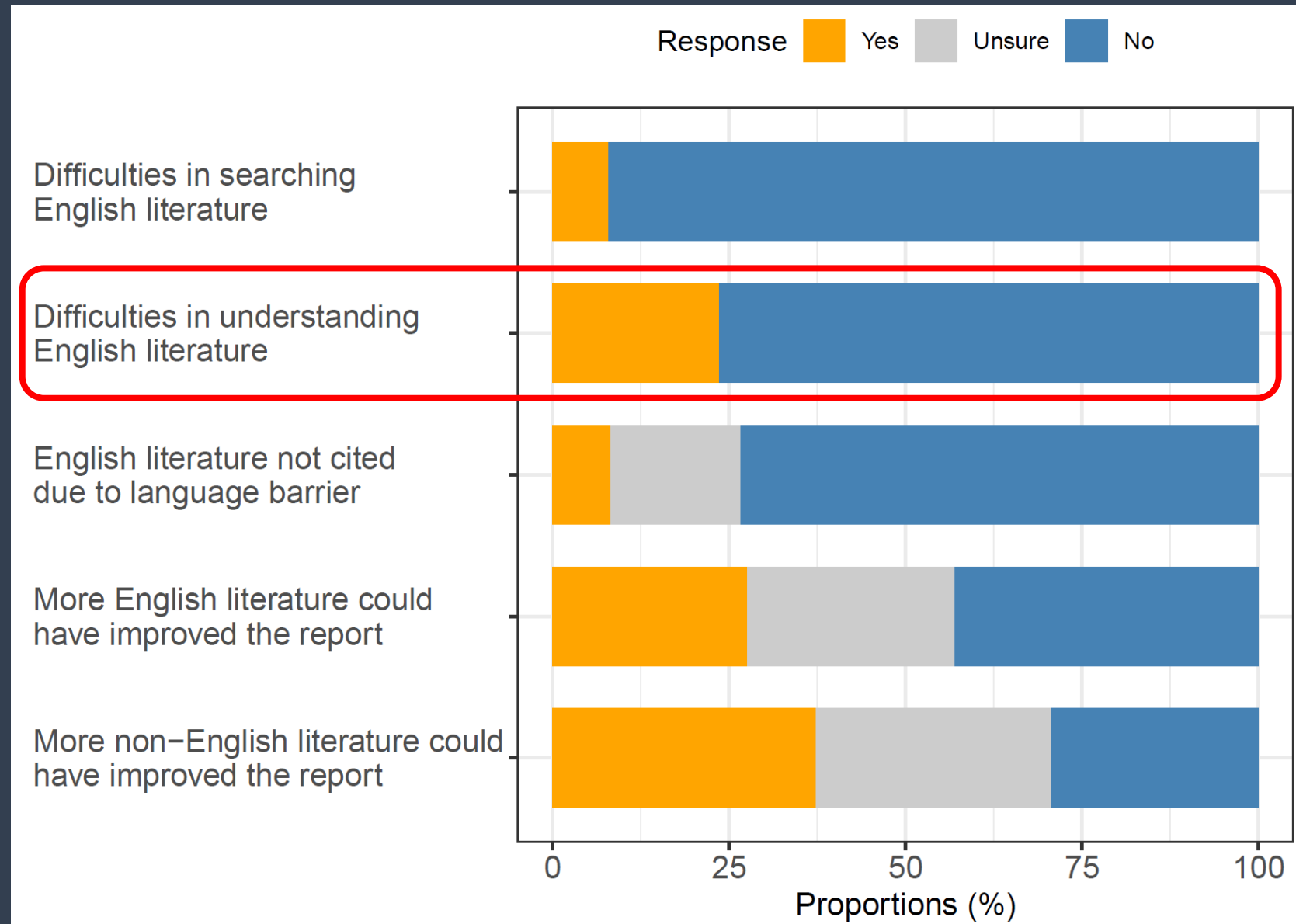
75% of the report authors recognise non-English-language papers as a **relevant** information source

Only **25%** of the report authors recognise non-English-language papers as an **easy-to-understand** source



How do language barriers impede the uptake of English-language science?

A quarter of the report authors struggle with understanding English-language literature



Language barriers to the **generation** of evidence by non-native English speakers

Trends in Ecology & Evolution

Paper reading

Scientific Life

A solution for breaking the language barrier

Rassim Khelifa^{1,2,3,8,*}, Tatsuya Amano^{4,5} and Martin A. Nuñez^{6,7}

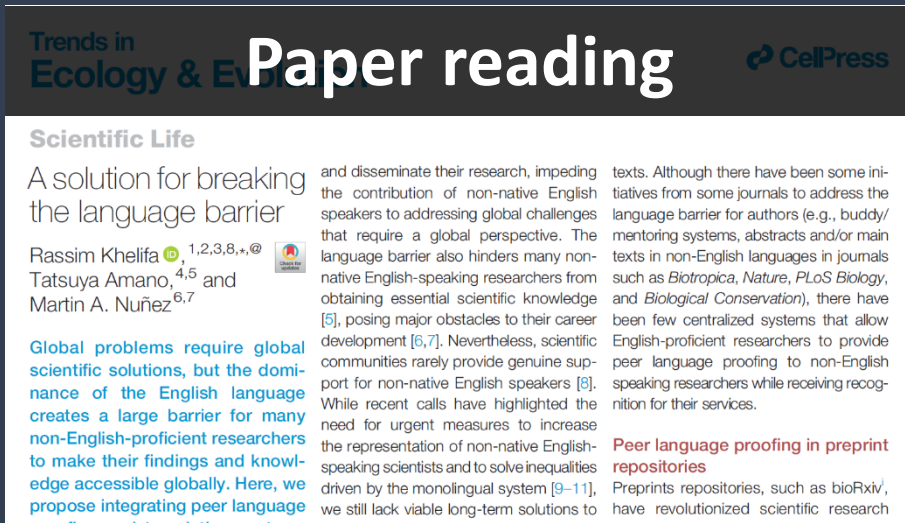
Global problems require global scientific solutions, but the dominance of the English language creates a large barrier for many non-English-proficient researchers to make their findings and knowledge accessible globally. Here, we propose integrating peer language

and disseminate their research, impeding the contribution of non-native English speakers to addressing global challenges that require a global perspective. The language barrier also hinders many non-native English-speaking researchers from obtaining essential scientific knowledge [5], posing major obstacles to their career development [6,7]. Nevertheless, scientific communities rarely provide genuine support for non-native English speakers [8]. While recent calls have highlighted the need for urgent measures to increase the representation of non-native English-speaking scientists and to solve inequalities driven by the monolingual system [9–11], we still lack viable long-term solutions to

texts. Although there have been some initiatives from some journals to address the language barrier for authors (e.g., buddy/mentoring systems, abstracts and/or main texts in non-English languages in journals such as *Biotropica*, *Nature*, *PLoS Biology*, and *Biological Conservation*), there have been few centralized systems that allow English-proficient researchers to provide peer language proofing to non-English speaking researchers while receiving recognition for their services.

Peer language proofing in preprint repositories

Preprints repositories, such as bioRxiv, have revolutionized scientific research

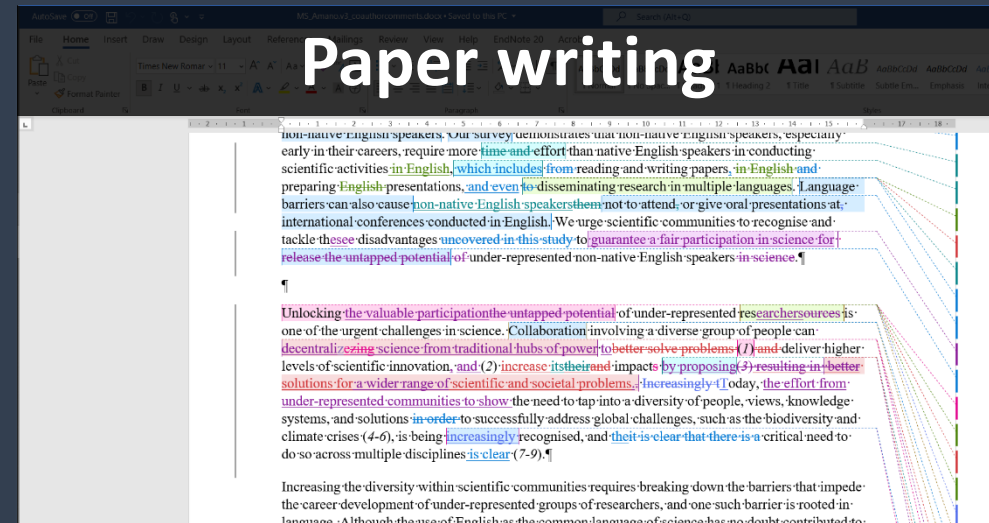


Paper writing

non-native English speakers. Our survey demonstrates that non-native English speakers, especially early in their careers, require more time and effort than native English speakers in conducting scientific activities in English, which includes from reading and writing papers, in English and preparing English presentations, and even to disseminating research in multiple languages. Language barriers can also cause non-native English speakers to not attend, or give oral presentations at, international conferences conducted in English. We urge scientific communities to recognise and tackle these disadvantages uncovered in this study to guarantee a fair participation in science for release the untapped potential of under-represented non-native English speakers in science.

Unlocking the valuable participation the untapped potential of under-represented researchers sources is one of the urgent challenges in science. Collaboration involving a diverse group of people can decentralize science from traditional hubs of power to better solve problems (1) and deliver higher levels of scientific innovation, and (2) increase its their and impacts by proposing (3) resulting in better solutions for a wider range of scientific and societal problems. Increasingly today, the effort from under-represented communities to show the need to tap into a diversity of people, views, knowledge systems, and solutions in order to successfully address global challenges, such as the biodiversity and climate crises (4-6), is being increasingly recognised, and their is clear that there is a critical need to do so across multiple disciplines is clear (7-9).

Increasing the diversity within scientific communities requires breaking down the barriers that impede the career development of under-represented groups of researchers, and one such barrier is rooted in language. Although the use of English as the common language of science has no doubt contributed to



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Publication

Home Page for Dr Tatsuya Amano

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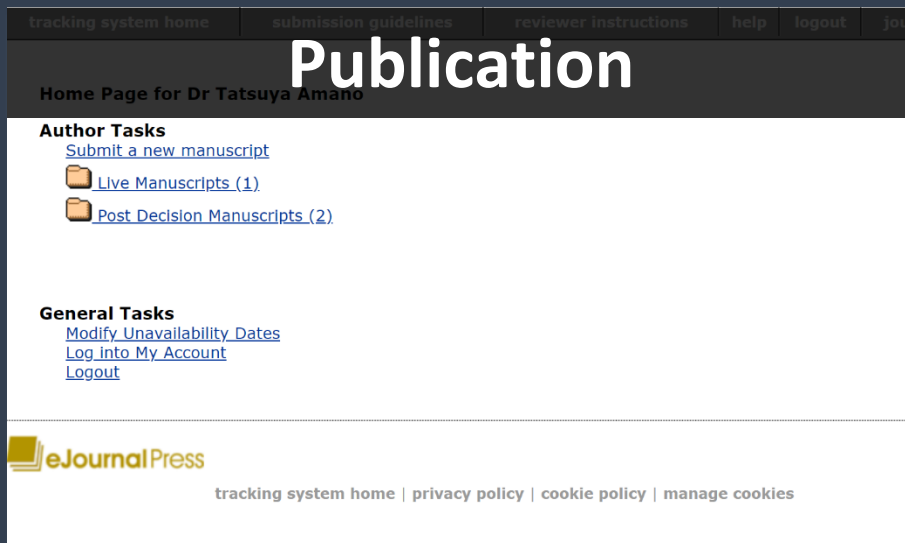
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Language barriers to the **generation** of evidence by non-native English speakers

Survey to quantify the amount of effort needed to conduct scientific activities in English

908 environmental scientists with at least one first-authored paper publication in English

8 target nationalities stratified by English proficiency and income level

	Low English proficiency	Moderate English proficiency	English as an official language
Lower-middle income	Bangladeshi (108) Nepali (82)	Bolivian (100) Ukrainian (66)	Nigerian (40)
High income	Japanese (294)	Spanish (108)	British (112)

Number of participants in parentheses

Language barriers to the **generation** of evidence by non-native English speakers

50% of non-native English speakers often decide not to give an oral presentation

30% of non-native English speakers often decide not to attend a conference

Presentation

Need **94% more time** to prepare and practice

Paper revision

Frequency of language related revision is **12.5 times higher**

Non-native



Native

Reading

Need **91% more time** to read a paper

Writing

Need **51% more time** to write a paper

Paper rejection

Frequency of language related rejection is **2.6 times higher**

How can we overcome **language barriers** in science?

Ten tips for overcoming language barriers in science

Language barriers
to evidence
synthesis

1. Disseminate research in multiple languages
2. Use scientific knowledge sourced from multiple languages
3. Increase the visibility of non-English-language science

Language barriers
to evidence
application

4. Translate scientific terms
5. Provide genuine support to non-native speakers
6. Distinguish language skills from scientific quality

Language barriers
to evidence
generation

7. Consider language balance in scientific activities
8. Acknowledge efforts to overcome language barriers
9. Be considerate of non-native speakers
10. Make use of existing resources and opportunities

Disseminate research in **multiple languages**

Ecological Solutions
and Evidence

AER Applied
Ecology
Resources

BRITISH
ECOLOGICAL
SOCIETY

REVIEW | Open Access |

Training future generations to deliver evidence-based conservation and ecosystem management

Harriet Downey , Tatsuya Amano, Marc Cadotte, Carly N. Cook, Steven J. Cooke, Neal R. Haddaway, Julia P. G. Jones, Nick Littlewood, Jessica C. Walsh, Mark I. Abrahams ... [See all authors](#)

First published: 25 January 2021 | <https://doi.org/10.1002/2688-8319.12032>

Handling Editor: Costanza Rampini

SECTIONS



PDF



TOOLS



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Abstract

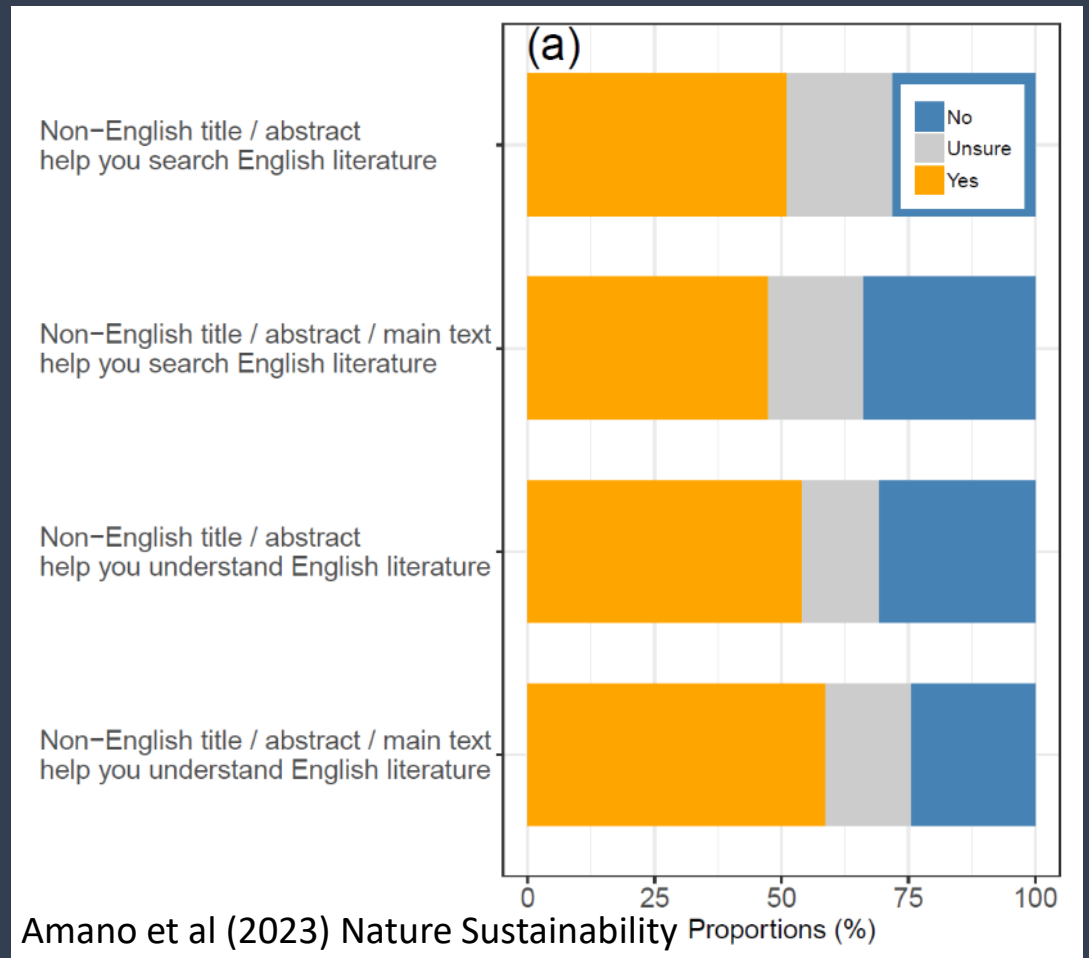
EN ES DE **JA** ZH-HANT PT FR

エビデンスに基づいた保全と生態系管理を促進するための次世代教育

1. 生物多様性をより効果的に保全していくために、次世代の実務者はエビデンスに基づいた意思決定の方法とエビデンスを統合することの価値を深く理解し、また批判的な思考を備える必要がある。

2. 生物多様性保全に関する教育課程においてこの課題を取り扱わなければ、現在の学生が今後の保全活動に対して効果的な貢献を行うようにはならないだろう。

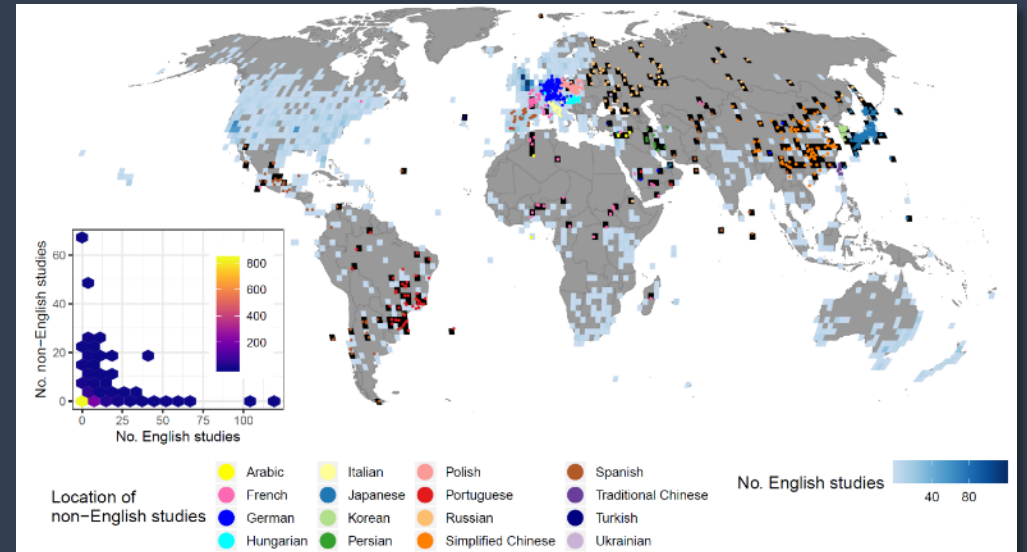
Non-English titles and abstracts would help **half the report authors** search and understand English-language literature



Use scientific knowledge sourced from **multiple languages**

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Transcending language barriers to environmental sciences



Amano et al (2021) PLOS Biol

Use scientific knowledge sourced from multiple languages

List of 466 peer-reviewed non-English-language journals in ecology and conservation

Language	Country/Region	Journal title in English	Journal title in the non-English language	First publication year	Latest publication year	URL
Arabic	Lebanon	Journal of King Abdulaziz University: Environmental Design Science	مجلة جامعة الملك عبد العزيز: علوم تصميم البيئة	2003	2017	https://scielolibrary.org/
Arabic	Lebanon	The Arab Journal for Arid Environments	المجلة العربية للبيئات الجافة	2009	2018	https://scielolibrary.org/
Arabic	Lebanon	Afak Ilmia journal	مجلة آفاق علمية	2017	2020	https://scielolibrary.org/
Arabic	Lebanon	Marsh Bulletin	مجلة الاهوار	2006	2020	https://scielolibrary.org/
Arabic	Lebanon	Journal of Agricultural, Environmental and Veterinary Sciences	مجلة العلوم الزراعية والبيئية والبيطرية	2017	2020	https://scielolibrary.org/
Arabic	Lebanon	Baghdad Science Journal	مجلة بغداد للعلوم	2004	2020	https://scielolibrary.org/
Arabic	Lebanon	Journal of King Abdulaziz University: Economics and Administration	مجلة جامعة الملك عبد العزيز: الاقتصاد والإدارة	1988	2020	https://scielolibrary.org/
Arabic	Lebanon	Journal of King Abdulaziz University: Marine Sciences	مجلة جامعة الملك عبد العزيز: علوم البحار	1990	2018	https://scielolibrary.org/
Arabic	Lebanon	Tishreen University Journal for Research and Scientific Studies - Biology	مجلة تشرين للبحوث والدراسات العلمية - سلسلة العلوم البيولوجية	2001	2020	https://scielolibrary.org/
Arabic	Lebanon	Journal of Marine Sciences and Environmental Techniques	مجلة علوم البحار والتقنيات البيئية	2015	2019	https://scielolibrary.org/
Arabic	Lebanon	Journal of thi-qar science	مجلة علوم ذي قار	2008	2018	https://scielolibrary.org/
Arabic	Lebanon	Journal of Plant Protection	مجلة وقاية النبات العربية	1983	2020	https://scielolibrary.org/
Dutch	Belgium	Mededelingen van de Faculteit Landbouwwetenschappen Universiteit Gent				https://scielolibrary.org/
Dutch	Netherlands	Natuurhistorisch Maandblad				
Finish	Finland	Memoranda Societatis pro Fauna et Flora Fennica				
French	Africa	African Agronomy	Agronomie Africaine	2000	2019	https://scielolibrary.org/
French	Canada	The Canadian Naturalist	Le Naturaliste Canadien	1868	2020	https://scielolibrary.org/
French	France	Alauda	Alauda	1929	2020	https://scielolibrary.org/
French	France	Rural alternatives	Alternatives rurales	2014	2019	https://scielolibrary.org/
French	France	Annals of the national water and forest school and of the research and	Annales de l'école nationale des eaux et forêts et de	1923	1963	https://scielolibrary.org/
French	France	Scientific annals of Limousin	Annales Scientifiques du Limousin	1985	2019	https://scielolibrary.org/
French	France	Biotechnology, Agronomy, Society and Environment	Biotechnologie, Agronomie, Société et Environnement	2004	2020	https://scielolibrary.org/
French	France	Tropical Woodlands and Forests	Bois et Forêts des Tropiques	1947	2020	https://scielolibrary.org/
French	France	Bulletin of the French herpetological society	Bulletin de la société herpétologique de France	1976	2020	https://scielolibrary.org/
French	France	Bulletin of the Vaud Natural Sciences Society	Bulletin de la Société Vaudoise des Sciences Naturelles	1864	2019	https://scielolibrary.org/
French	France	Bulletin of the French zoology Society	Bulletin de la Société zoologique de France	1876	2020	https://scielolibrary.org/
French	France	Bulletin Français de la Pêche et de la Pisciculture				
French	France	Scientific Letters from the regional natural Park of Luberon and the	Courrier scientifique du Parc naturel régional du Luberon	1997	2016	https://scielolibrary.org/
French	France	Ecologia mediterranea	Ecologia mediterranea	1975	2020	https://scielolibrary.org/
French	France	Ecological science	Écoscience	2015	2020	https://scielolibrary.org/
French	France	Applied aquatic ecology	Hydroécologie Appliquée	1989	2018	https://scielolibrary.org/
French	France	Earth and life (Revue d'écologie)	La terre et la vie (Revue d'écologie)	1931	2018	https://scielolibrary.org/
French	France	Lambillionea	Lambillionea	1900	2020	https://scielolibrary.org/
French	France	The avocet	L'avocette	1976	2012	https://scielolibrary.org/
French	France	Naturae	Naturae	2017	2020	https://scielolibrary.org/
French	France	Nature Sciences Society	Natures Sciences Sociétés	1993	2019	https://scielolibrary.org/
French	France	Rencontre Recherche Ruminants				
French	France	Revue Étude et Gestion des Sols		1994	2020	https://scielolibrary.org/
French	France	French forestry journal	Revue forestière française	1949	2019	https://scielolibrary.org/
French	France	Water and Land Sciences	Sciences Eaux et Territoires	2010	2020	https://scielolibrary.org/
French	France	Scientific reports of the Vanoise national park	Travaux scientifiques du Parc national de la Vanoise	1970	2009	https://scielolibrary.org/
French	France	Scientific reports of the Port-Cros national park	Travaux Scientifiques du Parc National de Port-Cros	1975	2019	https://scielolibrary.org/

Language-specific literature search system

Language	Database	URL
Spanish	SciELO	https://scielo.org/en
Portuguese	SciELO	https://scielo.org/en
Chinese (Simplified)	CNKI	https://cnki.net/
Chinese (Traditional)	Airiti Library	https://www.airitilibrary.com/
French	Persee	https://www.persee.fr/
German	BASE	https://de.base-search.net/
Japanese	J-Stage	https://www.istage.ist.go.jp/browse/-char/en
Korean	Korean Citation Index	https://www.kci.go.kr/kciportal/main.kci?locale=en
Polish	Polska Bibliografia	https://pbn.nauka.gov.pl/core/#/home

Chowdhury et al (2021)
Conserv Biol

Box 1. Strategies for and challenges in synthesising non-English-language literature

Searching effectively and understanding non-English-language literature can be a challenging task, with the lack of relevant language skills often being a key reason for excluding non-English-language literature in evidence synthesis [8]. Here, we summarise how we can practically synthesise non-English-language literature under such restrictions.

How to choose languages

Including more languages would make a synthesis more comprehensive, but given that

Provide genuine support to **non-native speakers**



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We are launching a pilot program to provide cost-free language support to potential authors! We seek to appoint a coordinator and team of editors for this program. Coordinator applications due May 1!

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- **EELS Coordinator**
Applications due May 1
- **EELS Editors**
Applications accepted on a rolling basis



Wader Study
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Why publish in Wader Study?

Language support – We particularly provide help to those whose first language is not English.

(3/9)

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Animal Behavior Society
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New this year at [#ABS2022](#): Multilingual Buddy Program!

In an effort to promote [#inclusivity](#), we are starting a Multilingual Buddy Program at [#ABS2022](#) as a way to make this meeting [#accessible](#) for people not fluent in English.

Sign up here by March 25th: bit.ly/3IWWOPX

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ABS 2022 COSTA RICA

Provide genuine support to non-native speakers

EDITORIAL

ChatGPT is fun, but not an author

In less than 2 months, the artificial intelligence (AI) program ChatGPT has become a cultural sensation. It is freely accessible through a web portal created by the tool's developer, OpenAI. The program—which automatically creates text based on written prompts—is so popular that it's likely to be "at capacity right now" if you attempt to use it. When you do get through, ChatGPT provides endless entertainment. I asked it to rewrite the first scene of the classic American play *Death of a Salesman*, but to feature Princess Elsa from the animated movie *Frozen* as the main character instead of Willy Loman. The output was an amusing conversation in which Elsa—who has come home from a tough day of selling—is told by her son

Happy, "Come on, Mom. You're Elsa from *Frozen*. You have ice powers and you're a queen. You're unstoppable." Mash-ups like this are certainly fun, but there are serious implications for generative AI programs like ChatGPT in science and academia.

ChatGPT (Generative Pre-trained Transformer) was developed with a technique called Reinforcement Learning from Human Feedback to train the language model, enabling it to be very conversational. Nevertheless, as the website states, "ChatGPT sometimes writes plausible-sounding but incorrect or nonsensical answers." Several

examples show glaring mistakes that it can make, including referencing a scientific study that does not exist.

Many concerns relate to how ChatGPT will change education. It certainly can write essays about a range of topics. I gave it both an exam and a final project that I had assigned students in a class I taught on science denial at George Washington University. It did well finding factual answers, but the scholarly writing still has a long way to go. If anything, the implications for education may push academics to rethink their courses in innovative ways and give assignments that aren't easily solved by AI. That could be for the best.

More worrisome are the effects of ChatGPT on writing scientific papers. In a recent study, abstracts created by ChatGPT were submitted to academic reviewers, who

only caught 63% of these fakes. That's a lot of AI-generated text that could find its way into the literature soon.

For years, authors at the *Science* family of journals have signed a license certifying that "the Work is an *original*" (italics added). For the *Science* journals, the word "original" is enough to signal that text written by ChatGPT is not acceptable: It is, after all, plagiarized from ChatGPT. Further, our authors certify that they themselves are accountable for the research in the paper. Still, to make matters explicit, we are now updating our license and Editorial Policies to specify that text generated by ChatGPT (or any other AI tools) cannot be used in the work, nor can figures, images, or graphics be the products of such tools. And an AI program cannot

be an author. A violation of these policies will constitute scientific misconduct no different from altered images or plagiarism of existing works. Of course, there are many legitimate data sets (not the text of a paper) that are intentionally generated by AI in research papers, and these are not covered by this change.

Most instances of scientific misconduct that the *Science* journals deal with occur because of an inadequate amount of human attention. Shortcuts are taken by using image manipulation programs such as Photoshop or by copying text from other sources. Altered images and copied text

may go unnoticed because they receive too little scrutiny from each of the authors. On our end, errors happen when editors and reviewers don't listen to their inner skeptic or when we fail to focus sharply on the details. At a time when trust in science is eroding, it's important for scientists to recommit to careful and meticulous attention to details.

The scientific record is ultimately one of the human endeavor of struggling with important questions. Machines play an important role, but as tools for the people posing the hypotheses, designing the experiments, and making sense of the results. Ultimately the product must come from—and be expressed by—the wonderful computer in our heads.

—H. Holden Thorp



H. Holden Thorp
Editor-in-Chief,
Science journals.
hthorp@aaas.org;
@hholdenthorp

Machines play an important role, but as tools for the people posing the hypotheses... and making sense of the results."




we are now updating our license and Editorial Policies to specify that text generated by ChatGPT (or any other AI tools) cannot be used in the work, nor can figures, images, or graphics be the products of such tools.

H.H. Thorp, Editor-in-Chief of Science, 26 January 2023

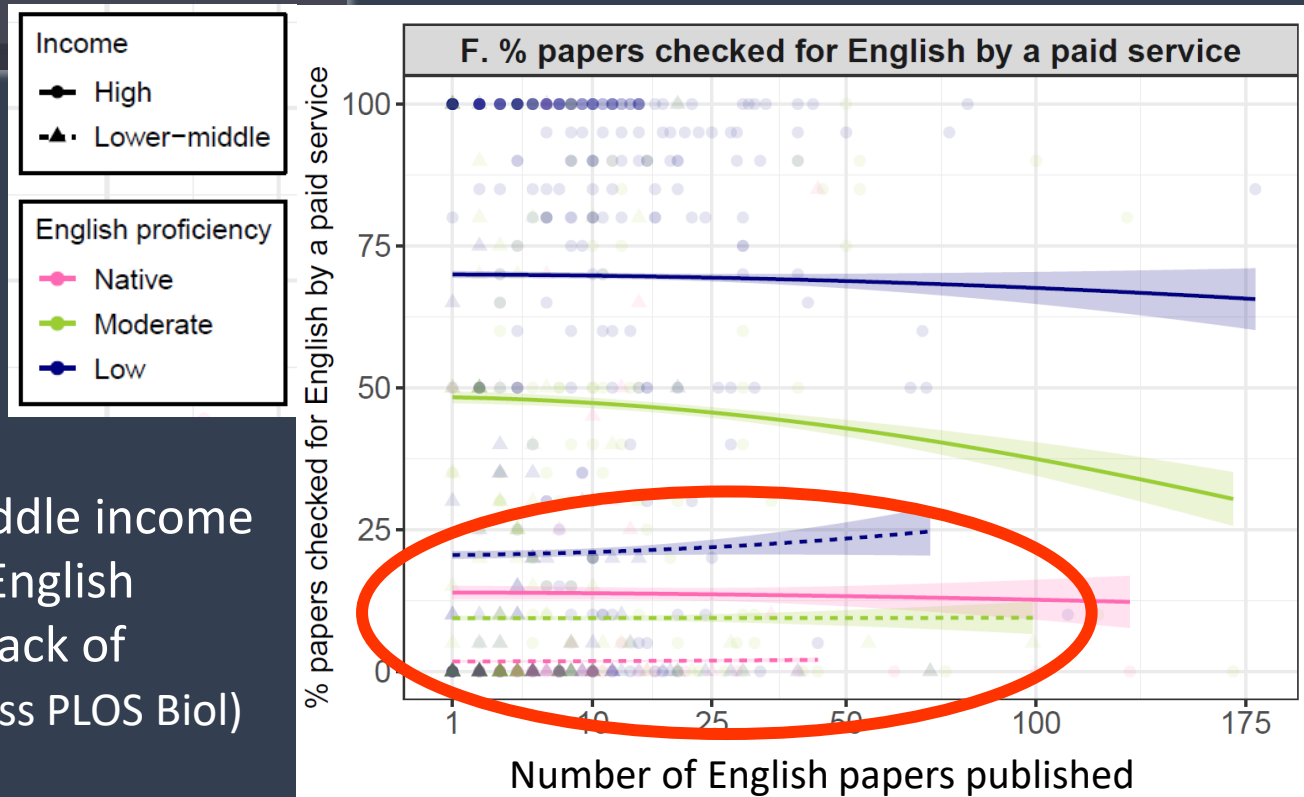
10.1126/science.adg7879

Provide genuine support to **non-native speakers**

T Edit the following sentences in a more easily understandable way: we are now updating our license and Editorial Policies to specify that text generated by ChatGPT (or any other AI tools) cannot be used in the work, nor can figures, images, or graphics be the products of such tools.

 We're updating our policies to clarify that anything created by AI tools, like ChatGPT, can't be used in our work. That includes text, images, and graphics.  

Researchers from low-middle income countries don't use paid English editing services due to a lack of funding (Amano et al in press PLOS Biol)



Provide genuine support to **non-native speakers**

AI tools can improve equity in science

In his Editorial “ChatGPT is fun, but not an author” (27 January, p. 313), Editor-in-Chief H. H. Thorp describes *Science’s* position on using artificial intelligence (AI) in scientific papers. The updated policy essentially bans the use of text generated from AI, machine learning, or similar algorithmic tools in articles. However, Thorp overlooks the potential of AI tools to improve equity in science by alleviating linguistic disparities.

Research has shown that nonnative English speakers need to invest much more effort than native English speakers when writing papers in English (1). Journals are more likely to reject or request revisions

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Violeta Berdejo-Espinola

before acceptance of papers written by nonnative English speakers (2, 3). Human English translation and editing services are costly and time-consuming (4), creating a profound disadvantage for the career development and fair participation of nonnative English speakers in science.

Emerging AI tools, such as ChatGPT and DeepL, can proofread English text with high accuracy (5, 6). The availability of quality, free (or affordable) English editing presents an opportunity for nonnative English speakers, especially those in low-income countries, who often cannot afford to use human English editing services (1, 4). Reducing the technical and financial burden of editing and proofreading papers for nonnative English speakers would be a substantial step toward achieving equity in science.

Our relationship with AI should be a partnership, not a competition. Journal policies should allow authors to use AI tools to edit and proofread their manuscripts. Journal editors can ensure that humans wrote the original text by using the detection tools available [e.g., (7)]. In addition, they can request that authors declare the use of AI tools, as *Nature* does (8), or submit the original version as well as the AI-edited version of the manuscript for full transparency. Regardless of whether they use AI tools, authors will always be responsible for the language used and the content in their final text.

Violeta Berdejo-Espinola* and Tatsuya Amano
School of Biological Sciences, The University of Queensland, Brisbane, QLD 4072, Australia and Centre for Biodiversity Conservation and Science, The University of Queensland, Brisbane, QLD 4072, Australia.

*Corresponding author.
Email: v.berdejoespinola@uq.edu.au

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Editor’s note

Science is aware that there may eventually be acceptable uses of ChatGPT and related tools in the preparation of scientific papers. However, we believe it is prudent to wait until we have more clarity on what uses the scientific community will see as permissible.

Image editors are now important tools in editing scientific figures, but when they were introduced in the 1990s, no guardrails were in place to guide their use. The resulting confusion blurred the lines between beautification and misconduct and may have contributed to the image manipulation challenges we still face today.

Dealing with uses of ChatGPT that are considered permissible now but deemed unacceptable later would undermine scientific productivity. Therefore, we encourage a broad conversation among the scientific community about the potential applications of ChatGPT to scientific papers and guidelines for its ethical use. If a consensus emerges that is inconsistent with our policies, we will consider adjusting them at that time.

H. Holden Thorp^{1*} and Valda Vinson²

¹Editor-in-Chief, *Science* journals. ²Executive Editor, *Science* journals.

*Corresponding author. Email: hthorp@aaas.org

10.1126/science.adh3689

Science is aware that there may eventually be **acceptable uses of ChatGPT and related tools in the preparation of scientific papers.**

...

If a consensus emerges that is inconsistent with our policies, **we will consider adjusting them at that time.**

H.H. Thorp, Editor-in-Chief, & V Vinson, Executive Editor of *Science* journals, 9 March 2023

Thanks to over 130 collaborators: <https://translatesciences.com/people/>

Ten tips for overcoming language barriers in science

1. Disseminate research in multiple languages
2. Use scientific knowledge sourced from multiple languages
3. Increase the visibility of non-English-language science
4. Translate scientific terms
5. Provide genuine support to non-native speakers
6. Distinguish language skills from scientific quality
7. Consider language balance in scientific activities
8. Acknowledge efforts to overcome language barriers
9. Be considerate of non-native speakers
10. Make use of existing resources and opportunities

Amano et al (2021) Nature Human Behaviour

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