nature portfolio

Peer Review File

Participatory monitoring drives biodiversity knowledge in global protected areas

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Web links to the author's journal account have been redacted from the decision letters as indicated to maintain confidentiality

3rd Apr 23

Dear Ms Mandeville,

Your manuscript titled "Participatory monitoring drives biodiversity knowledge in global protected areas" has now been seen by 2 reviewers, and I include their comments at the end of this message. They find your work of interest, but some important points are raised. We are interested in the possibility of publishing your study in Communications Earth & Environment, but would like to consider your responses to these concerns and assess a revised manuscript before we make a final decision on publication. Specifically, the revision should meet our top editorial threshold as outlined below.

Provide sufficient justification on the claims and the statement in the manuscript

We therefore invite you to revise and resubmit your manuscript, along with a point-by-point response that takes into account the points raised. Please highlight all changes in the manuscript text file.

We are committed to providing a fair and constructive peer-review process. Please don't hesitate to contact us if you wish to discuss the revision in more detail.

Please use the following link to submit your revised manuscript, point-by-point response to the referees' comments (which should be in a separate document to any cover letter) and the completed checklist:
[link redacted]
** This url links to your confidential home page and associated information about manuscripts you may have submitted or be reviewing for us. If you wish to forward this email to co-authors, please delete the link to your homepage first **

We hope to receive your revised paper within six weeks; please let us know if you aren't able to submit it within this time so that we can discuss how best to proceed. If we don't hear from you, and the revision process takes significantly longer, we may close your file. In this event, we will still be happy to reconsider your paper at a later date, as long as nothing similar has been accepted for publication at Communications Earth & Environment or published elsewhere in the meantime.

We understand that due to the current global situation, the time required for revision may be longer than usual. We would appreciate it if you could keep us informed about an estimated timescale for resubmission, to facilitate our planning. Of course, if you are unable to estimate, we are happy to accommodate necessary extensions nevertheless.

Please do not hesitate to contact me if you have any questions or would like to discuss these revisions further. We look forward to seeing the revised manuscript and thank you for the opportunity to review your work.

Best regards,

Jinfeng Chang, PhD
Editorial Board Member

Communications Earth & Environment
orcid.org/0000-0003-4463-7778

Alienor Lavergne, PhD
Editorial Board Member
Communications Earth & Environment

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Furthermore, please align your manuscript with our format requirements, which are summarized on the following checklist:
Communications Earth & Environment formatting checklist

and also in our style and formatting guide Communications Earth & Environment formatting guide .

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In particular, the Data availability statement should include:
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- If applicable, a statement regarding data available with restrictions
- If a dataset has a Digital Object Identifier (DOI) as its unique identifier, we strongly encourage including this in the Reference list and citing the dataset in the Data Availability Statement.

DATA SOURCES: All new data associated with the paper should be placed in a persistent repository where they can be freely and enduringly accessed. We recommend submitting the data to discipline-specific, community-recognized repositories, where possible and a list of recommended repositories is provided at http://www.nature.com/sdata/policies/

repositories.

If a community resource is unavailable, data can be submitted to generalist repositories such as figshare or Dryad Digital Repository. Please provide a unique identifier for the data (for example a DOI or a permanent URL) in the data availability statement, if possible. If the repository does not provide identifiers, we encourage authors to supply the search terms that will return the data. For data that have been obtained from publically available sources, please provide a URL and the specific data product name in the data availability statement. Data with a DOI should be further cited in the methods reference section.

Please refer to our data policies at http://www.nature.com/authors/policies/availability.html.

REVIEWER COMMENTS:

Reviewer #1 (Remarks to the Author):

The manuscript titled “Participatory monitoring drives biodiversity knowledge in global protected areas” describes an interesting, original and timely analysis of the role of citizen science and other participatory monitoring approaches in the accumulation of knowledge about biodiversity in protected areas. This work is particularly timely in the context of the recently agreed 2030 Global Biodiversity Framework as adequate knowledge will be essential to ensure global biodiversity targets are met, as the authors correctly point out.

I find the manuscript generally well framed and well written. The introduction clearly contextualizes the problem and provides a good overview of the potential benefits and challenges associated with participatory monitoring of biodiversity. The study objectives are clearly defined and addressed thoroughly in the results section. The methods used in the analysis are solid and the results section provides a detailed account of the analysis. The discussion is detailed, nuanced and thoughtful, contextualizing the results and highlighting options for further strengthening the contribution of participatory monitoring to biodiversity conservation and management of protected areas.

Overall, I think this is a great manuscript with solid analyses and clearly written and I would like to commend the authors on their great work. There are only two minor aspects that I would like to put forth to the authors consideration for discussion. One is the increasing availability of biodiversity data in other digital platforms (such as social media) that can be seen as a form of participatory monitoring. The contribution of such data has been highlighted before (e.g. see Jaric et al. 2020) and I believe this adds strength to the argument that the author’s analysis is a conservative estimate of the contribution of such data to biodiversity knowledge. The second aspect is the known socio-cultural drivers of biases in samples derived from participatory monitoring (and indeed non-participatory as well), including for example the cottage effect (e.g. see Millar et al. 2019). The authors refer to the need for national-level policies to create an enabling environment for participatory monitoring, but I wonder if there is also a role for tailored community-level actions, which could perhaps be more effective at shaping recorder behavior for those already participating in monitoring efforts.

References
Jarić, I., Correia, R.A., Brook, B.W., Buettel, J.C., Courchamp, F., Di Minin, E., Firth, J.A., Gaston, K.J., Jepson, P., Kalinkat, G., Ladle, R., Soriano-Redondo, A., Souza, A.T., Roll, U., 2020. iEcology: Harnessing Large Online Resources to Generate Ecological Insights. Trends in Ecology & Evolution. https://doi.org/10.1016/j.tree.2020.03.003

Millar, E.E., Hazell, E.C., Melles, S.J., 2019. The 'cottage effect' in citizen science? Spatial bias in aquatic monitoring programs. International Journal of Geographical Information Science 33, 1612–1632. https://doi.org/10.1080/13658816.2018.1423686

Reviewer #3 (Remarks to the Author):

Participatory monitoring drives biodiversity knowledge in global protected areas

Summary

The authors present a novel summary of how participatory monitoring has contributed to biodiversity data in protected areas, based on of the number and proportion of entries in GBIF. Their analyses reveal "a growing dominance of participatory monitoring data within protected areas" in GBIF.

General Comments

The paper presents interesting trends that are important to consider, for researchers who use GBIF as the basis for their studies or understanding of biodiversity patterns on the landscape, as well as for broader understanding of how biodiversity research is resourced and assessed.

Major Concerns:

I do have some concerns with the paper. First, I think the authors claim a bit too much power for what GBIF represents. For example, they state that present "a global overview of how participatory monitoring has changed the landscape of biodiversity knowledge in protected areas." However, it is not clear to me that GBIF represents a good measure of "biodiversity knowledge in protected areas" as these areas, at least in the Global North, frequently have their own databases of biodiversity and employ biologists and facilitate partnerships with academic and other researchers who also collect biodiversity data on their lands. I believe that much of these data are not contributed to GBIF. In addition, some of the comparisons and statements made by the authors are unclear or not fully supported by the data. See below for additional below.

Minor Editorial suggestions

Line 24: Not critical but the authors consider listing "the world's largest biodiversity data repository" by name in the abstract (Global Biodiversity Information Facility (https://www.gbif.org/)

Lines 177-179: The following sentence is a bit unclear in its current phrasing- "Though our results generally support the expectation that an emphasis on charismatic and easily identified species will drive a skewed distribution of data between species, they reveal that participatory monitoring achieves a similar or less skewed distribution compared to non-participatory monitoring for birds, reptiles, and amphibians." I suggest rephrasing in the following way "Though our results generally support the expectation that participatory monitoring emphasizes charismatic and easily identified species and thus results in a skewed distribution of data across species, we also find that participatory monitoring achieves a similar distribution compared to non-participatory monitoring for birds, reptiles, and amphibians."

Lines 186-187: The authors write “Impacts of a growing reliance on participatory monitoring will be exacerbated by the parallel decline in sharing of biodiversity data from other sources.” This statement is confusing because, until this point in the manuscript, I was not aware until this point that the authors quantified/evaluated data sharing nor that they found a decline in it. I suggest mentioning something about this in the results and/or research questions earlier in the manuscript as this seems to be a central point of interest for the authors.
Line 223: The authors write “This may be due to limited capacity to support locally-managed participatory monitoring programs.” It is unclear whom the authors expect to have limited capacity- the smaller protected areas or the smaller/more focused monitoring programs? I suggest rephrasing to clarify this.
Line 229: I suggest removing “However” at the start of the paragraph.
Line 236: I suggest adding “may” so that the phrase says: “These programs may have significant…” since we don’t really know the impact of “these programs.”
Lines 263-264: When the authors write “Further, nations can enact policies supporting open data infrastructure and incentivization…” I think it would be helpful if they could list 1-2 examples of the kind of policies that can be enacted in support of this.
Lines 268-269: The authors write “We show that the sharing of non-participatory data from protected areas has declined, pointing to a need for continued support for both biodiversity monitoring and open data sharing.” This statement is a bit misleading and vague. The authors do not appear to quantify trends in sharing of non-participatory data broadly, not to GBIF specifically. They quantify the proportion of participatory research out of all, and this appears to be increasing, but trends in numbers of non participatory data do not appear to be reported. If the authors wish to discuss these trends, then I suggest they add some explicit quantification of numbers and trends in GBIF data as a whole, and for non participatory data alone. Looking at Figure 1a, if error is included it is not clear that there is a strong trend in nonparticipatory data over time.

REVIEWER COMMENTS:

Reviewer #1 (Remarks to the Author):

The manuscript titled "Participatory monitoring drives biodiversity knowledge in global protected areas" describes an interesting, original and timely analysis of the role of citizen science and other participatory monitoring approaches in the accumulation of knowledge about biodiversity in protected areas. This work is particularly timely in the context of the recently agreed 2030 Global Biodiversity Framework as adequate knowledge will be essential to ensure global biodiversity targets are met, as the authors correctly point out.

I find the manuscript generally well framed and well written. The introduction clearly contextualizes the problem and provides a good overview of the potential benefits and challenges associated with participatory monitoring of biodiversity. The study objectives are clearly defined and addressed thoroughly in the results section. The methods used in the analysis are solid and the results section provides a detailed account of the analysis. The discussion is detailed, nuanced and thoughtful, contextualizing the results and highlighting options for further strengthening the contribution of participatory monitoring to biodiversity conservation and management of protected areas.

We appreciate these thoughtful and positive comments! We agree that the two suggested additions below add value to the manuscript; please see below for descriptions of specific revisions in response to each suggestion.

(Note that all line numbers refer to the tracked-changes version of the revised manuscript.)

Overall, I think this is a great manuscript with solid analyses and clearly written and I would like to commend the authors on their great work. There are only two minor aspects that I would like to put forth to the authors consideration for discussion. One is the increasing availability of biodiversity data in other digital platforms (such as social media) that can be seen as a form of participatory monitoring. The contribution of such data has been highlighted before (e.g. see Jaric et al. 2020) and I believe this adds strength to the argument that the author's analysis is a conservative estimate of the contribution of such data to biodiversity knowledge.

This is a great point. We have added a reference to other sources of digital data, including the citation suggested by Reviewer 1, to the manuscript in lines 256 – 258: "Other emerging forms of participatory biodiversity data, including data gathered from social media, online forums, and search engine usage, are also likely underestimated in our dataset due to limited integration with GBIF[88]."

The second aspect is the known socio-cultural drivers of biases in samples derived from participatory monitoring (and indeed non-participatory as well), including for example the cottage effect (e.g. see Millar et al. 2019). The authors refer to the need for national-level policies to create an enabling environment for participatory monitoring, but I wonder if there

is also a role for tailored community-level actions, which could perhaps be more effective at shaping recorder behavior for those already participating in monitoring efforts.

We appreciate this point, and we fully agree that there is a large role for tailored community-level actions to shape recorder behavior. We added this point to the discussion in two places, along with some new references (including the Millar reference suggested by Reviewer 1):

- Lines 236 – 239: "Locally-led monitoring programs often have greater capacity to implement tailored study designs, sampling protocols, and quality control, all of which can mitigate some of the spatial biases that are typical of unstructured biodiversity data collected with digital monitoring platforms[50,51,77,78]."
- Lines 280 – 282: "National support can both facilitate local engagement and also allow for national-level coordination, which can increase the structure and fitness-for-purpose of participatory monitoring data[31]."

We also added slightly to lines 275 – 277 to better allude to the possibility of sharing best practices for tailored actions at the level of individual protected areas: "… protected areas with active monitoring might be used as models to extend participatory monitoring into similar areas **in a way that is tailored to the areas' specific conservation needs**."

References

Jarić, I., Correia, R.A., Brook, B.W., Buettel, J.C., Courchamp, F., Di Minin, E., Firth, J.A., Gaston, K.J., Jepson, P., Kalinkat, G., Ladle, R., Soriano-Redondo, A., Souza, A.T., Roll, U., 2020. iEcology: Harnessing Large Online Resources to Generate Ecological Insights. Trends in Ecology & Evolution. https://doi.org/10.1016/j.tree.2020.03.003

Millar, E.E., Hazell, E.C., Melles, S.J., 2019. The 'cottage effect' in citizen science? Spatial bias in aquatic monitoring programs. International Journal of Geographical Information Science 33, 1612–1632. https://doi.org/10.1080/13658816.2018.1423686

Reviewer #3 (Remarks to the Author):

Participatory monitoring drives biodiversity knowledge in global protected areas

Summary

The authors present a novel summary of how participatory monitoring has contributed to biodiversity data in protected areas, based on of the number and proportion of entries in GBIF. Their analyses reveal "a growing dominance of participatory monitoring data within protected areas" in GBIF.

General Comments

The paper presents interesting trends that are important to consider, for researchers who use GBIF as the basis for their studies or understanding of biodiversity patterns on the landscape, as well as for broader understanding of how biodiversity research is resourced and assessed.

Major Concerns:

I do have some concerns with the paper. First, I think the authors claim a bit too much power for what GBIF represents. For example, they state that present "a global overview of how participatory monitoring has changed the landscape of biodiversity knowledge in protected areas." However, it is not clear to me that GBIF represents a good measure of "biodiversity knowledge in protected areas" as these areas, at least in the Global North, frequently have their own databases of biodiversity and employ biologists and facilitate partnerships with academic and other researchers who also collect biodiversity data on their lands. I believe that much of these data are not contributed to GBIF. In addition, some of the comparisons and statements made by the authors are unclear or not fully supported by the data. See below for additional below.

We agree with this overall point that the GBIF dataset is not fully representative of the totality of biodiversity data collected within protected areas, and we've made some revisions to more clearly express and justify the scope of the manuscript:

First, we revised the sentence quoted here (from line 22 in the abstract; bold text is new) to now say: "… has changed the landscape of **open** biodiversity knowledge …"

Second, we added some sentences, along with four new references, to the discussion (lines 190 – 202) to further discuss sources of biodiversity that may not be included in GBIF, including those mentioned here by Reviewer 3. Key additions include:

> "Indeed, biodiversity monitoring is regularly conducted in protected areas to directly support area management[55] as well as by academic researchers[56], and much of the resulting data are not published on GBIF[57]." (lines 194 – 196)
>
> "Furthermore, participatory monitoring offers potential to fill gaps in data collection in the many protected areas that have limited resources to support professional monitoring[59]." (lines 200 – 202)

Finally, we slightly revised lines 196 – 198, which describe why the identification of patterns and trends in GBIF data is specifically of research and conservation interest in spite of not fully representing trends in biodiversity data as a whole: "Nevertheless, because GBIF data are increasingly relied upon in global syntheses and assessments[49], the decline in ~~sharing~~ **publication** of data from other monitoring approaches **to GBIF** is noteworthy."

Specific responses to Reviewer 3's line-by-line comments are found below.

Minor Editorial suggestions

Line 24: Not critical but the authors consider listing "the world's largest biodiversity data repository" by name in the abstract (Global Biodiversity Information Facility (https://www.gbif.org/)

We've made this change (line 23).

Lines 177-179: The following sentence is a bit unclear in its current phrasing- "Though our results generally support the expectation that an emphasis on charismatic and easily identified species will drive a skewed distribution of data between species, they reveal that participatory monitoring achieves a similar or less skewed distribution compared to non-participatory monitoring for birds, reptiles, and amphibians." I suggest rephrasing in the following way "Though our results generally support the expectation that participatory monitoring emphasizes charismatic and easily identified species and thus results in a skewed distribution of data across species, we also find that participatory monitoring achieves a similar distribution compared to non-participatory monitoring for birds, reptiles, and amphibians."

Following this suggestion, this sentence has been changed to: "Though our results generally support the expectation that participatory monitoring emphasizes charismatic and easily identified species and thus results in a skewed distribution of data across species[46,47], we find that participatory monitoring achieves a similar distribution compared to non-participatory monitoring for reptiles and amphibians, and a less skewed distribution for birds" (lines 177 – 182).

Lines 186-187: The authors write "Impacts of a growing reliance on participatory monitoring will be exacerbated by the parallel decline in sharing of biodiversity data from other sources." This statement is confusing because, until this point in the manuscript, I was not aware until this point that the authors quantified/evaluated data sharing nor that they found a decline in it. I suggest mentioning something about this in the results and/or research questions earlier in the manuscript as this seems to be a central point of interest for the authors.

We rephrased this sentence so that it more clearly references the relevant portion of the results section (lines 190 – 194; new text is bold): "Impacts of a growing reliance on participatory monitoring will be exacerbated by the parallel decline in ~~sharing~~ **publication** of biodiversity data from other sources **on GBIF (Figure 1) that was revealed by our results** …". We further merged this with the following sentence to make it clearer that we have not

evaluated the mechanism for this result: "… which could be driven by either a true decline in data collection or a decline or time lag in the publication of data to GBIF."

Line 223: The authors write "This may be due to limited capacity to support locally-managed participatory monitoring programs." It is unclear whom the authors expect to have limited capacity- the smaller protected areas or the smaller/more focused monitoring programs? I suggest rephrasing to clarify this.

We've rephrased to clarify this (lines 234 – 235; new text is bold): "This may be due to limited capacity **of smaller protected areas** to support locally-managed participatory monitoring programs[70,75,76]."

Line 229: I suggest removing "However" at the start of the paragraph.

Change made (now line 244).

Line 236: I suggest adding "may" so that the phrase says: "These programs may have significant…" since we don't really know the impact of "these programs."

We changed this line (now line 251) to read "These programs **often** have significant…" We prefer "often" instead of the suggested "may" because the references cited in this line (Johnson et al. 2021, Kühl et al. 2020, Newman et al. 2017) provide evidence that the programs referred to in this sentence (i.e., small monitoring programs that do not publish data externally) frequently have significant local impact.

Lines 263-264: When the authors write "Further, nations can enact policies supporting open data infrastructure and incentivization…" I think it would be helpful if they could list 1-2 examples of the kind of policies that can be enacted in support of this.

Great idea. We added a sentence going into more detail here (lines 285 – 287): "Such policies can, for example, open new funding mechanisms, build incentivization into existing funding schemes, address legal and structural barriers to data sharing, and establish new capacity building opportunities[92]."

We also added a new citation, UNESCO 2022, which is a UNESCO guidance document on developing national-level policies to support open science that provides a lot more detail on policies that can support data sharing.

Lines 268-269: The authors write "We show that the sharing of non-participatory data from protected areas has declined, pointing to a need for continued support for both biodiversity monitoring and open data sharing." This statement is a bit misleading and vague. The authors do not appear to quantify trends in sharing of non-participatory data broadly, not to GBIF specifically. They quantify the proportion of participatory research out of all, and this appears to be increasing, but trends in numbers of non participatory data do not appear to be reported. If the authors wish to discuss these trends, then I suggest they add some explicit quantification of numbers and trends in GBIF data as a whole, and for non participatory data

alone. Looking at Figure 1a, if error is included it is not clear that there is a strong trend in nonparticipatory data over time.

We agree that it would be interesting to compare the annual publication rate of data within protected areas on GBIF with the annual publication rate of data on GBIF as a whole, but unfortunately that is outside the scope of this study because we do not have information on the participatory or non-participatory origin of GBIF data outside of protected areas.

To better express the specific scope of this statement, we have revised the sentence to be more specific (now lines 289 – 291, new text in bold): "We show that the ~~sharing~~ **amount** of non-participatory data from protected areas **published annually on GBIF** has declined, pointing to a need for continued support for both biodiversity monitoring and open data sharing."

This revision also brings this statement more into alignment with the revision we made in response to Reviewer 3's above comment on lines 186-7.

24th May 23

Dear Dr Mandeville,

Your manuscript titled "Participatory monitoring drives biodiversity knowledge in global protected areas" has now been seen by our reviewers, whose comments appear below. In light of their advice I am delighted to say that we are happy, in principle, to publish a suitably revised version in Communications Earth & Environment under the open access CC BY license (Creative Commons Attribution v4.0 International License).

We therefore invite you to revise your paper one last time to address the remaining concerns of our reviewers. At the same time we ask that you edit your manuscript to comply with our format requirements and to maximise the accessibility and therefore the impact of your work.

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Please review our specific editorial comments and requests regarding your manuscript in the attached "Editorial Requests Table".

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We hope to hear from you within two weeks; please let us know if you need more time.

Best regards,

Jinfeng Chang, PhD
Editorial Board Member
Communications Earth & Environment
orcid.org/0000-0003-4463-7778

Alienor Lavergne, PhD
Associate Editor
Communications Earth & Environment

REVIEWERS' COMMENTS:

Reviewer #1 (Remarks to the Author):

I have carefully read the revised version of the manuscript titled "Participatory monitoring drives biodiversity knowledge in global protected areas" and find it has greatly improved following the changes implemented by the authors. It is clear that the authors carefully considered the comments and suggestions made in the first round of revisions and have addressed them where possible and relevant. I have no further suggestions on the manuscript and believe it will represent an important contribution to the literature on the topic.

Reviewer #3 (Remarks to the Author):

The authors have addressed all of my previous concerns with this manuscript.

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I have carefully read the revised version of the manuscript titled "Participatory monitoring drives biodiversity knowledge in global protected areas" and find it has greatly improved following the changes implemented by the authors. It is clear that the authors carefully considered the comments and suggestions made in the first round of revisions and have addressed them where possible and relevant. I have no further suggestions on the manuscript and believe it will represent an important contribution to the literature on the topic.

Thank you. We appreciated your thoughtful comments and are glad to hear that you agree they have improved the manuscript.

Reviewer #3 (Remarks to the Author):

The authors have addressed all of my previous concerns with this manuscript.

Thank you for your thoughtful review.