

## The ecology of human–nature interactions

Masashi Soga and Kevin J. Gaston

### Article citation details

*Proc. R. Soc. B* **287**: 20191882.

<http://dx.doi.org/10.1098/rspb.2019.1882>

### Review timeline

Original submission: 12 August 2019  
1st revised submission: 29 October 2019  
2nd revised submission: 3 December 2019  
Final acceptance: 3 December 2019

Note: Reports are unedited and appear as submitted by the referee. The review history appears in chronological order.

## Review History

### RSPB-2019-1882.R0 (Original submission)

#### Review form: Reviewer 1

##### Recommendation

Major revision is needed (please make suggestions in comments)

**Scientific importance: Is the manuscript an original and important contribution to its field?**

Excellent

**General interest: Is the paper of sufficient general interest?**

Excellent

**Quality of the paper: Is the overall quality of the paper suitable?**

Excellent

**Is the length of the paper justified?**

Yes

**Should the paper be seen by a specialist statistical reviewer?**

No

**Do you have any concerns about statistical analyses in this paper? If so, please specify them explicitly in your report.**

No

**It is a condition of publication that authors make their supporting data, code and materials available - either as supplementary material or hosted in an external repository. Please rate, if applicable, the supporting data on the following criteria.**

**Is it accessible?**

N/A

**Is it clear?**

N/A

**Is it adequate?**

N/A

**Do you have any ethical concerns with this paper?**

No

### **Comments to the Author**

Human nature interaction is an important issue which is currently on the rise given its importance for both human and nature conservation. This review manuscript synthesizes and discusses the available knowledge of this important topic and suggest directions for future interdisciplinary research. I find the synthesis interesting and novel I would like to see this manuscript published in the proceeding of the royal Society B. However, I do have few suggestions that I think could help the authors improve their manuscript.

L38: You mentioned that recent technological advances can improve the ability to describe and quantify individual person's interactions with nature. This kind of raised the expectation that you will show how this can be done, but in fact you do not develop this and demonstrate how novel technologies can help in bridging some of the knowledge gaps. In fact, I find the altogether the future directions in this manuscript is relatively poor and it would be great if the authors would elaborate more about what is needed throughout the manuscript. For instance, I find that one of the key knowledge gaps in this field is the lack of experimental approach, as much of the evidence is based on observational studies.

The framework presented in figure 1 is interesting, yet I do not fully agree with the rationale behind its structure or think that further explanation is needed. Since this framework is the key novelty of this manuscript, I think it should be better explained in the text.

First, I wonder what the arrows represent? Do you really think that opportunity can influence orientation and vice versa? Opportunity can influence humans, and this can change orientation, thus humans should be placed in the center.

Second, what is called dynamics here was describe as moderator variables in other publication (even ones of the same authors). If there are differences, they should be developed further and if not maybe integrate the word moderator to keep this framework consistent with previous work.

Third, I do not see understand the arrows within the dynamics section. Of course, as the authors state in the manuscript all this moderator variables interplay to determine human-nature interaction, but the arrows provide a feeling of direction relationships. Also, this section of the

model is not explained at all in the legend.

The definition section is pivotal and important. Yet, these definitions are brought without explain the rational. For instance, why to exclude domesticated animals? I would argue that this should be another dimension in your typology (naturalness). Also, why interaction through media, are excluded, while later you discuss view of roadside trees through window. I would argue again that is just interaction through media is part of your immediateness dimension just less immediate. Generally, I think you need to carefully consider and share the rational beyond your definitions.

L67: The typology you suggest has five key dimensions, but I think we can have more. Above, I have highlighted the naturalness, and I think it is also important to talk about the quality/intensity of nature interaction (see this recent publication: Colleony et al. 2019; <https://doi.org/10.1016/j.landurbplan.2019.03.010> for more discussions). I think this two should be included and perhaps others. Nevertheless, it is important to that this typology is not all inclusive.

L125: reduce risk predation due to human recreational activity can be considered as impact from conservation perspective, so I really wonder if this could be described as positive.

L146: Here I expected some suggestions on how these ideas can be studied and how novel technologies can help here or elsewhere. I think this is important to help advance future research.

L252 the socio-economic section: I find the discussion on the socio-economic rather poor and vey segregated. The first two paragraphs are all about western societies (at least according to the evidence provided) and it turns around inequality. Maybe there is not enough evidence from more developing countries, and in that case, this is a major knowledge gap and future direction. Also, there many of other ways that nature can influence human's economy (e.g. provisioning services) and this apply everywhere. The second section (third paragraph) is more about developing countries and here the discussion goes mostly towards the negative interaction. I suggest trying and provide evidence from different counties, highlight the knowledge gaps, if there are, and keep example of both negative and positive for different regions.

Ref 46 is missing.

Figure 3: I do not see why chart (d) is relevant to the story, please clarify and for chart (e) it is not clear what is the source of data.

## Review form: Reviewer 2

### **Recommendation**

Accept with minor revision (please list in comments)

### **Scientific importance: Is the manuscript an original and important contribution to its field?**

Good

### **General interest: Is the paper of sufficient general interest?**

Excellent

### **Quality of the paper: Is the overall quality of the paper suitable?**

Good

**Is the length of the paper justified?**

Yes

**Should the paper be seen by a specialist statistical reviewer?**

No

**Do you have any concerns about statistical analyses in this paper? If so, please specify them explicitly in your report.**

No

**It is a condition of publication that authors make their supporting data, code and materials available - either as supplementary material or hosted in an external repository. Please rate, if applicable, the supporting data on the following criteria.**

**Is it accessible?**

Yes

**Is it clear?**

Yes

**Is it adequate?**

Yes

**Do you have any ethical concerns with this paper?**

No

### **Comments to the Author**

Dear authors,

I think you made an interesting manuscript highlighting the importance of the need for future research to include numerous (multiple) views of human -nature interactions and not the present way of focusing on one. I think you managed to make a really good overview and provided some interesting insights.

Although I like your title I would like to add multi-into the title since it is really that what you discuss. The ecology of MULTI human-nature interactions. I do not demand this, just suggest something like that.

Concerning "Less conscious (or perhaps subconscious)" you mentioned in a previous paper in TREE about other senses such as sight, sound, smell, taste or touch. Here you mentioned sound but some recent paper also highlighted natural smells as an important stress reducer when experiencing nature which I would recall is rather subconscious (Hedblom et al. 2019. Reduction of physiological stress by urban green space in a multisensory virtual experiment. Scientific Reports) and thus may be one way forward in measuring subconscious?

Degree of human modification, this is the part I have the largest difficulties with. The references makes it clearer to me than the actual reasoning in the text, where the references describe that the more human interventions such as feeding bears creates problems. I guess I have some issues with the remote Island, pristine comparison you used. A remote Island can have crazy loads of tourists such as Galapagos (as far as I heard) and still be pristine but other remote Islands are not having many tourists. So maybe instead of having "human modifications", your thoughts (in my view) are more linked to "human activities" as you write yourselves or maybe "human interventions". I think this part needs some further thoughts to be clearer.

R115. Human benefits from animals is often linked to food, eating the animals. I have no suggestions of to exclude this somehow from human benefits since it is such an important part. Maybe you could state in the beginning somehow that interactions does not include harming the

nature, killing animals. I am not sure here but somehow I just spontaneously felt it difficult to talk about animal benefits without the hunting.

R120-121. You might add the reference: Gunnarsson et al. 2017. Effects of biodiversity and environment-related attitude on perception of urban green space. *Urban Ecosystem*, 20, 37-49. 217 and 219. Spring and autumn or early in the morning has nothing to do with industrialized or not. For me this is about seasons and light in the far Northern hemisphere or in the southern south hemisphere. Today I think it is very confusing using industrialized countries as link. I guess you will find industrialized parts in the tropical china these days just for an example.

240. Developed countries is however perfectly fine here.

254-262 does not explicitly add to the socio-economic part. This I already said in the spatial part? I think you can remove these sentences and stick to the ones starting with socio-economics?

303. "...these outcomes". Along these last sentences it is difficult to follow what you really refer to when you mention "...these outcomes.." please make it more clearer.

Best regards

## Review form: Reviewer 3

### Recommendation

Accept with minor revision (please list in comments)

**Scientific importance: Is the manuscript an original and important contribution to its field?**

Good

**General interest: Is the paper of sufficient general interest?**

Good

**Quality of the paper: Is the overall quality of the paper suitable?**

Good

**Is the length of the paper justified?**

Yes

**Should the paper be seen by a specialist statistical reviewer?**

No

**Do you have any concerns about statistical analyses in this paper? If so, please specify them explicitly in your report.**

No

**It is a condition of publication that authors make their supporting data, code and materials available - either as supplementary material or hosted in an external repository. Please rate, if applicable, the supporting data on the following criteria.**

**Is it accessible?**

N/A

**Is it clear?**

N/A

**Is it adequate?**

N/A

**Do you have any ethical concerns with this paper?**

No

**Comments to the Author**

See attached file. (See Appendix A)

**Decision letter (RSPB-2019-1882.R0)**

09-Oct-2019

Dear Dr Soga:

Your manuscript has now been peer reviewed -- their comments (not including confidential comments to the Editor) and the comments from the Associate Editor are included at the end of this email for your reference. As you will see, the reviewers like the review in general terms, and I myself found it novel and stimulating, but all three reviewers have raised some concerns and so I would like to invite you to revise your manuscript to address them.

We do not allow multiple rounds of revision so we urge you to make every effort to fully address all of the comments at this stage. If deemed necessary by the Associate Editor, your manuscript will be sent back to one or more of the original reviewers for assessment. If the original reviewers are not available we may invite new reviewers. Please note that we cannot guarantee eventual acceptance of your manuscript at this stage.

To submit your revision please log into <http://mc.manuscriptcentral.com/prsb> and enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions", click on "Create a Revision". Your manuscript number has been appended to denote a revision.

When submitting your revision please upload a file under "Response to Referees" in the "File Upload" section. This should document, point by point, how you have responded to the reviewers' and Editors' comments, and the adjustments you have made to the manuscript. We require a copy of the manuscript with revisions made since the previous version marked as 'tracked changes' to be included in the 'response to referees' document.

Your main manuscript should be submitted as a text file (doc, txt, rtf or tex), not a PDF. Your figures should be submitted as separate files and not included within the main manuscript file.

When revising your manuscript you should also ensure that it adheres to our editorial policies (<https://royalsociety.org/journals/ethics-policies/>). You should pay particular attention to the following:

**Research ethics:**

If your study contains research on humans please ensure that you detail in the methods section whether you obtained ethical approval from your local research ethics committee and gained informed consent to participate from each of the participants.

**Use of animals and field studies:**

If your study uses animals please include details in the methods section of any approval and licences given to carry out the study and include full details of how animal welfare standards were ensured. Field studies should be conducted in accordance with local legislation; please include details of the appropriate permission and licences that you obtained to carry out the field work.

Data accessibility and data citation:

It is a condition of publication that you make available the data and research materials supporting the results in the article. Datasets should be deposited in an appropriate publicly available repository and details of the associated accession number, link or DOI to the datasets must be included in the Data Accessibility section of the article (<https://royalsociety.org/journals/ethics-policies/data-sharing-mining/>). Reference(s) to datasets should also be included in the reference list of the article with DOIs (where available).

In order to ensure effective and robust dissemination and appropriate credit to authors the dataset(s) used should also be fully cited and listed in the references.

If you wish to submit your data to Dryad (<http://datadryad.org/>) and have not already done so you can submit your data via this link

[http://datadryad.org/submit?journalID=RSPB&manu=\(Document not available\)](http://datadryad.org/submit?journalID=RSPB&manu=(Document not available)), which will take you to your unique entry in the Dryad repository.

If you have already submitted your data to dryad you can make any necessary revisions to your dataset by following the above link.

For more information please see our open data policy <http://royalsocietypublishing.org/data-sharing>.

Electronic supplementary material:

All supplementary materials accompanying an accepted article will be treated as in their final form. They will be published alongside the paper on the journal website and posted on the online figshare repository. Files on figshare will be made available approximately one week before the accompanying article so that the supplementary material can be attributed a unique DOI. Please try to submit all supplementary material as a single file.

Online supplementary material will also carry the title and description provided during submission, so please ensure these are accurate and informative. Note that the Royal Society will not edit or typeset supplementary material and it will be hosted as provided. Please ensure that the supplementary material includes the paper details (authors, title, journal name, article DOI). Your article DOI will be 10.1098/rspb.[paper ID in form xxxx.xxxx e.g. 10.1098/rspb.2016.0049].

Please submit a copy of your revised paper within three weeks. If we do not hear from you within this time your manuscript will be rejected. If you are unable to meet this deadline please let us know as soon as possible, as we may be able to grant a short extension.

Thank you for submitting your manuscript to Proceedings B; we look forward to receiving your revision. If you have any questions at all, please do not hesitate to get in touch.

Best wishes,  
Innes Cuthill  
Prof. Innes Cuthill  
Reviews Editor, Proceedings B  
<mailto:proceedingsb@royalsociety.org>

Reviewer(s)' Comments to Author:

Referee: 1

Comments to the Author(s)

Human nature interaction is an important issue which is currently on the rise given its importance for both human and nature conservation. This review manuscript synthesizes and discusses the available knowledge of this important topic and suggest directions for future interdisciplinary research. I find the synthesis interesting and novel I would like to see this manuscript published in the proceeding of the royal Society B. However, I do have few suggestions that I think could help the authors improve their manuscript.

L38: You mentioned that recent technological advances can improve the ability to describe and quantify individual person's interactions with nature. This kind of raised the expectation that you will show how this can be done, but in fact you do not develop this and demonstrate how novel technologies can help in bridging some of the knowledge gaps. In fact, I find the altogether the future directions in this manuscript is relatively poor and it would be great if the authors would elaborate more about what is needed throughout the manuscript. For instance, I find that one of the key knowledge gaps in this field is the lack of experimental approach, as much of the evidence is based on observational studies.

The framework presented in figure 1 is interesting, yet I do not fully agree with the rationale behind its structure or think that further explanation is needed. Since this framework is the key novelty of this manuscript, I think it should be better explained in the text.

First, I wonder what the arrows represent? Do you really think that opportunity can influence orientation and vice versa? Opportunity can influence humans, and this can change orientation, thus humans should be placed in the center.

Second, what is called dynamics here was describe as moderator variables in other publication (even ones of the same authors). If there are differences, they should be developed further and if not maybe integrate the word moderator to keep this framework consistent with previous work.

Third, I do not see understand the arrows within the dynamics section. Of course, as the authors state in the manuscript all this moderator variables interplay to determine human-nature interaction, but the arrows provide a feeling of direction relationships. Also, this section of the model is not explained at all in the legend.

The definition section is pivotal and important. Yet, these definitions are brought without explain the rational. For instance, why to exclude domesticated animals? I would argue that this should be another dimension in your typology (naturalness). Also, why interaction through media, are excluded, while later you discuss view of roadside trees through window. I would argue again that is just interaction through media is part of your immediateness dimension just less immediate. Generally, I think you need to carefully consider and share the rational beyond your definitions.

L67: The typology you suggest has five key dimensions, but I think we can have more. Above, I have highlighted the naturalness, and I think it is also important to talk about the quality/intensity of nature interaction (see this recent publication: Colleony et al. 2019; <https://doi.org/10.1016/j.landurbplan.2019.03.010> for more discussions). I think this two should be included and perhaps others. Nevertheless, it is important to that this typology is not all inclusive.



L125: reduce risk predation due to human recreational activity can be considered as impact from conservation perspective, so I really wonder if this could be described as positive.

L146: Here I expected some suggestions on how these ideas can be studied and how novel technologies can help here or elsewhere. I think this is important to help advance future research.

L252 the socio-economic section: I find the discussion on the socio-economic rather poor and very segregated. The first two paragraphs are all about western societies (at least according to the evidence provided) and it turns around inequality. Maybe there is not enough evidence from more developing countries, and in that case, this is a major knowledge gap and future direction. Also, there many of other ways that nature can influence human's economy (e.g. provisioning services) and this apply everywhere. The second section (third paragraph) is more about developing countries and here the discussion goes mostly towards the negative interaction. I suggest trying and provide evidence from different counties, highlight the knowledge gaps, if there are, and keep example of both negative and positive for different regions.

Ref 46 is missing.

Figure 3: I do not see why chart (d) is relevant to the story, please clarify and for chart (e) it is not clear what is the source of data.

Referee: 2

Comments to the Author(s)

Dear authors,

I think you made an interesting manuscript highlighting the importance of the need for future research to include numerous (multiple) views of human -nature interactions and not the present way of focusing on one. I think you managed to make a really good overview and provided some interesting insights.

Although I like your title I would like to add multi-into the title since it is really that what you discuss. The ecology of MULTI human-nature interactions. I do not demand this, just suggest something like that.

Concerning "Less conscious (or perhaps subconscious)" you mentioned in a previous paper in TREE about other senses such as sight, sound, smell, taste or touch. Here you mentioned sound but some recent paper also highlighted natural smells as an important stress reducer when experiencing nature which I would recall is rather subconscious (Hedblom et al. 2019. Reduction of physiological stress by urban green space in a multisensory virtual experiment. Scientific Reports) and thus may be one way forward in measuring subconscious?

Degree of human modification, this is the part I have the largest difficulties with. The references makes it clearer to me than the actual reasoning in the text, where the references describe that the more human interventions such as feeding bears creates problems. I guess I have some issues with the remote Island, pristine comparison you used. A remote Island can have crazy loads of tourists such as Galapagos (as far as I heard) and still be pristine but other remote Islands are not having many tourists. So maybe instead of having "human modifications", your thoughts (in my view) are more linked to "human activities" as you write yourselves or maybe "human interventions". I think this part needs some further thoughts to be clearer.

R115. Human benefits from animals is often linked to food, eating the animals. I have no suggestions of to exclude this somehow from human benefits since it is such an important part. Maybe you could state in the beginning somehow that interactions does not include harming the nature, killing animals. I am not sure here but somehow I just spontaneously felt it difficult to talk about animal benefits without the hunting.

R120-121. You might add the reference: Gunnarsson et al. 2017. Effects of biodiversity and environment-related attitude on perception of urban green space. *Urban Ecosystem*, 20, 37-49. 217 and 219. Spring and autumn or early in the morning has nothing to do with industrialized or not. For me this is about seasons and light in the far Northern hemisphere or in the southern south hemisphere. Today I think it is very confusing using industrialized countries as link. I guess you will find industrialized parts in the tropical china these days just for an example. 240. Developed countries is however perfectly fine here. 254-262 does not explicitly add to the socio-economic part. This I already said in the spatial part? I think you can remove these sentences and stick to the ones starting with socio-economics? 303. “..these outcomes”. Along these last sentences it is difficult to follow what you really refer to when you mention “..these outcomes..” please make it more clearer.  
Best regards

Referee: 3

Comments to the Author(s)  
See attached file

## Author's Response to Decision Letter for (RSPB-2019-1882.R0)

See Appendix B.

## RSPB-2019-1882.R1 (Revision)

### Review form: Reviewer 1

#### **Recommendation**

Accept as is

#### **Scientific importance: Is the manuscript an original and important contribution to its field?**

Excellent

#### **General interest: Is the paper of sufficient general interest?**

Excellent

#### **Quality of the paper: Is the overall quality of the paper suitable?**

Excellent

#### **Is the length of the paper justified?**

Yes

#### **Should the paper be seen by a specialist statistical reviewer?**

No

**Do you have any concerns about statistical analyses in this paper? If so, please specify them explicitly in your report.**

No

**It is a condition of publication that authors make their supporting data, code and materials available - either as supplementary material or hosted in an external repository. Please rate, if applicable, the supporting data on the following criteria.**

**Is it accessible?**

N/A

**Is it clear?**

N/A

**Is it adequate?**

N/A

**Do you have any ethical concerns with this paper?**

No

#### **Comments to the Author**

The authors have addressed comments and suggestion. I feel the manuscript is much improved and I am looking forward to see this published in the Proceedings of the Royal Society B.

Good luck,

## **Decision letter (RSPB-2019-1882.R1)**

19-Nov-2019

Dear Dr Soga

I am pleased to inform you that your manuscript RSPB-2019-1882.R1 entitled "The ecology of human-nature interactions" has been accepted for publication in Proceedings B.

I sent it to just one of the original referees, judging that to be sufficient, and that referee has recommended publication without any further revisions. Therefore, I invite you to upload the final version of your manuscript. Because the schedule for publication is very tight, it is a condition of publication that you submit the revised version of your manuscript within 7 days. If you do not think you will be able to meet this date please let us know.

To upload your manuscript, log into <https://mc.manuscriptcentral.com/prsb> and enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript number has been appended to denote a revision. You will be unable to make your revisions on the originally submitted version of the manuscript. Instead, revise your manuscript and upload a new version through your Author Centre.

Before uploading your revised files please make sure that you have:

- 1) A text file of the manuscript (doc, txt, rtf or tex), including the references, tables (including captions) and figure captions. Please remove any tracked changes from the text before submission. PDF files are not an accepted format for the "Main Document".
- 2) A separate electronic file of each figure (tiff, EPS or print-quality PDF preferred). The format should be produced directly from original creation package, or original software format. PowerPoint files are not accepted.
- 3) Electronic supplementary material: this should be contained in a separate file and where possible, all ESM should be combined into a single file. All supplementary materials accompanying an accepted article will be treated as in their final form. They will be published alongside the paper on the journal website and posted on the online figshare repository. Files on figshare will be made available approximately one week before the accompanying article so that the supplementary material can be attributed a unique DOI.

Online supplementary material will also carry the title and description provided during submission, so please ensure these are accurate and informative. Note that the Royal Society will not edit or typeset supplementary material and it will be hosted as provided. Please ensure that the supplementary material includes the paper details (authors, title, journal name, article DOI). Your article DOI will be 10.1098/rspb.[paper ID in form xxxx.xxxx e.g. 10.1098/rspb.2016.0049].

- 4) A media summary: a short non-technical summary (up to 100 words) of the key findings/importance of your manuscript.

#### 5) Data accessibility section and data citation

It is a condition of publication that data supporting your paper are made available either in the electronic supplementary material or through an appropriate repository.

In order to ensure effective and robust dissemination and appropriate credit to authors the dataset(s) used should be fully cited. To ensure archived data are available to readers, authors should include a 'data accessibility' section immediately after the acknowledgements section. This should list the database and accession number for all data from the article that has been made publicly available, for instance:

- DNA sequences: Genbank accessions F234391-F234402
- Phylogenetic data: TreeBASE accession number S9123
- Final DNA sequence assembly uploaded as online supplemental material
- Climate data and MaxEnt input files: Dryad doi:10.5521/dryad.12311

NB. From April 1 2013, peer reviewed articles based on research funded wholly or partly by RCUK must include, if applicable, a statement on how the underlying research materials – such as data, samples or models – can be accessed. This statement should be included in the data accessibility section.

If you wish to submit your data to Dryad (<http://datadryad.org/>) and have not already done so you can submit your data via this link

[http://datadryad.org/submit?journalID=RSPB&manu=\(Document not available\)](http://datadryad.org/submit?journalID=RSPB&manu=(Document%20not%20available)) which will take you to your unique entry in the Dryad repository. If you have already submitted your data to dryad you can make any necessary revisions to your dataset by following the above link. Please see <https://royalsociety.org/journals/ethics-policies/data-sharing-mining/> for more details.

- 6) For more information on our Licence to Publish, Open Access, Cover images and Media summaries, please visit <https://royalsociety.org/journals/authors/author-guidelines/>.

Once again, thank you for submitting your manuscript to Proceedings B and I look forward to seeing it in print. If you have any questions at all, please do not hesitate to get in touch.

Best wishes and thanks again for a very stimulating review,

Innes

Prof. Innes Cuthill  
Reviews Editor, Proceedings B  
mailto: proceedingsb@royalsociety.org

AReviewer(s)' Comments to Author:

Referee: 1

Comments to the Author(s)

The authors have addressed comments and suggestion. I feel the manuscript is much improved and I am looking forward to see this published in the Proceedings of the Royal Society B.

## Decision letter (RSPB-2019-1882.R2)

03-Dec-2019

Dear Dr Soga

I am pleased to inform you that your manuscript entitled "The ecology of human-nature interactions" has been accepted for publication in Proceedings B.

You can expect to receive a proof of your article from our Production office in due course, please check your spam filter if you do not receive it. PLEASE NOTE: you will be given the exact page length of your paper which may be different from the estimation from Editorial and you may be asked to reduce your paper if it goes over the 10 page limit.

If you are likely to be away from e-mail contact during this period, let us know. Due to rapid publication and an extremely tight schedule, if comments are not received, we may publish the paper as it stands.

If you have any queries regarding the production of your final article or the publication date please contact [procb\\_proofs@royalsociety.org](mailto:procb_proofs@royalsociety.org)

Your article has been estimated as being 10 pages long. Our Production Office will be able to confirm the exact length at proof stage.

Open access

You are invited to opt for open access via our author pays publishing model. Payment of open access fees will enable your article to be made freely available via the Royal Society website as soon as it is ready for publication. For more information about open access publishing please visit our website at [http://royalsocietypublishing.org/site/authors/open\\_access.xhtml](http://royalsocietypublishing.org/site/authors/open_access.xhtml).

The open access fee is £1,700 per article (plus VAT for authors within the EU). If you wish to opt for open access then please let us know as soon as possible.

#### Paper charges

An e-mail request for payment of any related charges will be sent out shortly. The preferred payment method is by credit card; however, other payment options are available.

#### Electronic supplementary material:

All supplementary materials accompanying an accepted article will be treated as in their final form. They will be published alongside the paper on the journal website and posted on the online figshare repository. Files on figshare will be made available approximately one week before the accompanying article so that the supplementary material can be attributed a unique DOI.

You are allowed to post any version of your manuscript on a personal website, repository or preprint server. However, the work remains under media embargo and you should not discuss it with the press until the date of publication. Please visit <https://royalsociety.org/journals/ethics-policies/media-embargo> for more information.

Thank you for your fine contribution. On behalf of the Editors of the Proceedings B, we look forward to your continued contributions to the Journal.

Sincerely,  
Proceedings B  
mailto: [proceedingsb@royalsociety.org](mailto:proceedingsb@royalsociety.org)

## Appendix A

Review of “The ecology of human-nature interactions” by Masashi and Gaston.

The authors provide a coherent overview of the drivers of direct interactions between individual people and nature, attempting to synthesise information from a wide range of research disciplines. Overall, I think this review provides a great introduction to anyone wanting to get up to speed with the current understanding of human-nature interactions and provides recommendations for future research. While I do not agree with how the authors addressed some aspects of human-nature interactions I commend them for making me think! It is a good addition to the growing literature in this area.

The authors state in the caption of figure 1 that the drivers (humans, opportunity and orientation) of human-nature interactions are closely interrelated and largely depend on the dynamics (spatial, temporal and socio-economic). In the main text there is some discussion of this, but it is less clear how the dynamics themselves interact. There is considerable detail on each of the three dynamics, so a subsequent discussion of how they interrelate is required.

There some reference throughout the paper on the challenges and where future research might focus, but these points aren't clear until the end (conclusion). I think a paper like this should make both of those points obvious. This is an excellent overview, but what next? How do we advance this field? I think a specific statement at the end of the abstract giving what the authors recommend is required.

Specific comments:

L62: As a society we are becoming more reliant (and dependent) on technology and in some cases the only way that some people can (and do) interact with nature is through technology. Indeed, technology has been shown to facilitate positive human-nature interactions, and in some cases can be used to encourage people who otherwise wouldn't connect with nature, to do so in a way that suits their preferences. The authors don't need to refine their definition, but rather just discuss this point and provide justification for its exclusion.

Para L150-162: Yes, human-nature interactions, albeit positive or negative have been shown to be strongly correlated with animal abundance – but moving forward, how might these effects be mediated?

L227: There are some specific examples here of human-wildlife conflict, but there are also some good synthesis papers and books that cover this topic that you could direct to your readers. For example: R. Woodroffe, S. Thirgood, A. Rabinowitz (Eds.), *People and Wildlife: Conflict or Coexistence?*, Cambridge University Press, Cambridge (2005).

L235-236: What might some of these environmental and social factors be?

## Appendix B

Below we provide responses to comments from the Associate Editor and Reviewers. Reviewers' comments are in italic font, whilst our responses are in normal font and indented.

### Reviews Editor

*Your manuscript has now been peer reviewed - their comments and the comments from the Associate Editor are included at the end of this email for your reference. As you will see, the reviewers like the review in general terms, and I myself found it novel and stimulating, but all three reviewers have raised some concerns and so I would like to invite you to revise your manuscript to address them.*

REPLY: We are very pleased that both the Reviews Editor and Reviewers consider the manuscript to be timely, novel and worth publishing in *Proceedings B*. We have addressed the amendments suggested. Where we have disagreed with these, we have stated our reasons why. In particular, we have added a much fuller explanation about the definition and conceptual framework for human-nature interactions we propose, as this seems to be at the heart of a number of the issues raised (in particular by Reviewer #1). We have also added a number of future research directions which we believe to be useful in advancing this field.

### Reviewer #1

*Human nature interaction is an important issue which is currently on the rise given its importance for both human and nature conservation. This review synthesizes and discusses the available knowledge of this important topic and suggests directions for future interdisciplinary research. I find the synthesis interesting and novel I would like to see this manuscript published in the proceeding of the royal Society B. However, I do have few suggestions that I think could help the authors improve their manuscript.*

REPLY: We are very pleased that the reviewer considers the manuscript to be interesting, novel, and worth publishing in the journal. We also thank the reviewer for their detailed and very helpful feedback.

*L38: You mentioned that recent technological advances can improve the ability to describe and quantify individual person's interactions with nature. This kind of raised the expectation that you will show how this can be done, but in fact you do not develop this and demonstrate how novel technologies can help in bridging some of the knowledge gaps. In fact, I find the altogether the future directions in this manuscript is relatively poor and it would be great if the authors would elaborate more about what is needed throughout the manuscript. For instance, I*



*find that one of the key knowledge gaps in this field is the lack of experimental approach, as much of the evidence is based on observational studies.*

REPLY: We agree with this point. Following this suggestion, we have now made various recommendations for future research throughout the manuscript (e.g., lines 26–31; 100–102; 108–110; 161–166; 220–221; 256–259; 315–317; 329–333).

*The framework presented in figure 1 is interesting, yet I do not fully agree with the rationale behind its structure or think that further explanation is needed. Since this framework is the key novelty of this manuscript, I think it should be better explained in the text.*

REPLY: We have now added a much fuller explanation about the conceptual framework.

*First, I wonder what the arrows represent? Do you really think that opportunity can influence orientation and vice versa? Opportunity can influence humans, and this can change orientation, thus humans should be placed in the center.*

REPLY: We agree – these arrows might imply that there are bidirectional causal links among the drivers (Fig. 1). As we already discussed in the main text (lines 209–221), in this framework we did not attempt to argue that the three drivers influence each other, but intended just to say that the distributions of humans, opportunity, and orientation are interrelated to each other. Following this comment, we have deleted the arrows (Fig. 1).

*Second, what is called dynamics here was describe as moderator variables in other publication (even ones of the same authors). If there are differences, they should be developed further and if not maybe integrate the word moderator to keep this framework consistent with previous work.*

REPLY: In the present paper, we do not regard the dynamics of human-nature interactions as moderators (and do not intend them to take the place of previous discussions of moderators). We think that this confusion may be due to the lack of an adequate explanation of what we mean by dynamics. In the revised version of the manuscript, we have added a detailed explanation about it at the beginning of the paper (line 57).

*Third, I do not see understand the arrows within the dynamics section. Of course, as the authors state in the manuscript all these moderator variables interplay to determine human-nature interaction, but the arrows provide a feeling of direction relationships. Also, this section of the model is not explained at all in the legend.*

REPLY: In order to avoid confusion, we have now deleted these arrows and just connected the three types of dynamics with lines. We have also added a more detailed explanation

about the links between the three types of dynamics both in the main text (lines 308–317) and figure legend.

*The definition section is pivotal and important. Yet, these definitions are brought without explain the rationale. For instance, why to exclude domesticated animals? I would argue that this should be another dimension in your typology (naturalness). Also, why interaction through media, are excluded, while later you discuss view of roadside trees through window. I would argue again that is just interaction through media is part of your immediateness dimension just less immediate. Generally, I think you need to carefully consider and share the rationale beyond your definitions.*

REPLY: We have now added explanation of the rationale for our definitions (see lines 59–76). What comprises nature has been a topic of discussion for centuries, with no uniformly agreed outcome, and we acknowledge that our definition is one of the many different possibilities. However, we think that in terms of human-nature interactions it is helpful to draw a distinction between those organisms with self-sustained populations and those without, and we focus our paper on the former. If domesticated animals are included, then essentially a nature interaction becomes one with any non-human form of life, as it becomes hard to draw any other line (and so would include e.g. potted houseplants, domestic pets). Of course, there are lots of interesting questions to be asked about the interactions that lie outside our definition.

In a similar vein, our manuscript is focused on direct sensory interactions with nature, and the issues that these raise. We think it is important to distinguish these from watching or hearing nature through images, film, recordings etc, as these do not involve direct interactions. Again, engagement with media and what effects this has on people are perfectly valid questions, but not ones that we want to engage with in this manuscript. Indeed, we have some concerns that the distinction between direct interactions with nature and use of media is getting confused in some of the literature, with for example lots of tests of the effects of direct interactions being conducted using media on the assumption that the two are simply substitutable.

*L67: The typology you suggest has five key dimensions, but I think we can have more. Above, I have highlighted the naturalness, and I think it is also important to talk about the quality/intensity of nature interaction (see this recent publication: Colleony et al. 2019 for more discussions). I think this two should be included and perhaps others. Nevertheless, it is important to that this typology is not all inclusive.*

REPLY: We agree that it would be possible to add further dimensions, and make no claim to those we identify being exhaustive. However, we do stand by these being key ones. As in our response above, we prefer to retain our definition of nature, so a 'naturalness' dimension does not seem appropriate. As to the quality/intensity of nature interactions, to some degree this is already captured in the dimensions that we recognize, as it is likely to be determined in large part by combinations of immediateness, human mediation, consciousness, intentionality and direction of outcomes. The strength of the direction of outcomes itself is likely to be a good measure of the quality of a nature interaction (either for a person or the component of nature). We have now made these links more explicit (lines 161–163).

*L125: reduce risk predation due to human recreational activity can be considered as impact from conservation perspective, so I really wonder if this could be described as positive.*

REPLY: We define a positive interaction as one that has beneficial effects on the survival, growth, and reproduction of organisms (lines 137–139). We agree with the reviewer that from the perspective of conservation such an effect might nonetheless be regarded as a negative one. We have now explicitly highlighted this distinction (lines 138–139).

*L146: Here I expected some suggestions on how these ideas can be studied and how novel technologies can help here or elsewhere. I think this is important to help advance future research.*

REPLY: Following this suggestion, we have added a possible direction for future research (lines 163–166).

*L252 the socio-economic section: I find the discussion on the socio-economic rather poor and very segregated.*

REPLY: The socio-economic section, which we have now edited, consists of three parts. The first paragraph discusses how large-scale socio-economic changes affect the patterns of human-nature interactions (it focuses on relatively large-scale features). Then, we move to a more detailed discussion of the relationship between an individual's socio-economic status and nature interactions (the second and third paragraphs). In the latter two paragraphs we focus on the relationship between wealth and positive interactions and poverty and negative interactions, because these are key research topics in the field of human-nature interactions.

*The first two paragraphs are all about western societies (at least according to the evidence provided) and it turns around inequality. Maybe there is not enough evidence from more*

*developing countries, and in that case, this is a major knowledge gap and future direction.*

REPLY: The first and second paragraphs were not intended to focus on Western societies. We have now cited additional studies conducted in non-Western societies in these paragraphs (e.g., Bigirimana et al. 2012; Zhang et al. 2014; Wang et al. 2015; Muslim et al. 2017; Kumar et al. 2019). In order to make the connection between the second and third paragraphs clear, we have deleted the sentence about the health inequalities.

*Also, there many of other ways that nature can influence human's economy (e.g. provisioning services) and this apply everywhere.*

REPLY: We entirely agree that nature provides lots of benefits to humankind. However, in the main ecosystem services do not for most people concern *direct* personal interactions with nature, and thus lie beyond the scope of this manuscript.

*The second section (third paragraph) is more about developing countries and here the discussion goes mostly towards the negative interaction. I suggest trying and provide evidence from different counties, highlight the knowledge gaps, if there are, and keep example of both negative and positive for different regions.*

REPLY: As we have explained above, the third paragraph aims at discussing the relationship between poverty and negative human-nature interactions. Since this issue is particularly relevant to developing countries where a large number of disadvantaged people die from being attacked by wildlife or poisoned by venomous animals every year, we discuss it mainly in the context of developing countries.

*Ref 46 is missing.*

REPLY: Apologies – we have added this citation accordingly.

*Figure 3: I do not see why chart (d) is relevant to the story, please clarify and for chart (e) it is not clear what is the source of data.*

REPLY: We added panel (d) to show that the distribution of human-nature interactions (number of frog observations) is spatially biased towards areas near major transport routes and urban areas: i.e. the degree of human-nature interactions is mainly determined by the distribution of humans. We have revised the main text to explain this point (lines 187–190). Panel (e) was made based on information from the following paper.

Baverstock, S., Weston, M. A., & Miller, K. K. (2018). A global paucity of wild bird feeding policy. 441 *Science of the Total Environment*, 25, 105-111

## Reviewer #2

*I think you made an interesting manuscript highlighting the importance of the need for future research to include numerous (multiple) views of human –nature interactions and not the present way of focusing on one. I think you managed to make a really good overview and provided some interesting insights.*

REPLY: We are grateful to the reviewer for these encouraging remarks.

*Although I like your title I would like to add multi-into the title since it is really that what you discuss. The ecology of MULTI human-nature interactions. I do not demand this, just suggest something like that.*

REPLY: We thank the reviewer for this suggestion. However, we think that the sense that the manuscript concerns multiple interactions is captured by the current title and would prefer to retain that.

*Concerning “Less conscious (or perhaps subconscious)” you mentioned in a previous paper in TREE about other senses such as sight, sound, smell, taste or touch. Here you mentioned sound but some recent paper also highlighted natural smells as an important stress reducer when experiencing nature which I would recall is rather subconscious (Hedblom et al. 2019. Reduction of physiological stress by urban green space in a multisensory virtual experiment. Scientific Reports) and thus may be one way forward in measuring subconscious?*

REPLY: Following this suggestion, we have added smelling scent of wildflowers as an example of less conscious interactions and have cited the literature (lines 94–95).

*Degree of human modification, this is the part I have the largest difficulties with. The references makes it clearer to me than the actual reasoning in the text, where the references describe that the more human interventions such as feeding bears creates problems. I guess I have some issues with the remote Island, pristine comparison you used. A remote Island can have crazy loads of tourists such as Galapagos (as far as I heard) and still be pristine but other remote Islands are not having many tourists. So maybe instead of having “human modifications”, your thoughts (in my view) are more linked to “human activities” as you write yourselves or maybe “human interventions”. I think this part needs some further thoughts to be clearer.*

REPLY: We agree with this point. We did not intend to define more human-modified interactions as those interactions that occur in human-modified environments. Indeed, some more modified interactions often occur in less modified environments (e.g., being attacked by a bear that is habituated to humans in protected areas). To avoid such confusion, therefore, we have changed the term “human modification” to “human mediation”

throughout the manuscript.

R115. *Human benefits from animals is often linked to food, eating the animals. I have no suggestions of to exclude this somehow from human benefits since it is such an important part. Maybe you could state in the beginning somehow that interactions does not include harming the nature, killing animals. I am not sure here but somehow I just spontaneously felt it difficult to talk about animal benefits without the hunting.*

REPLY: We do not consider consumptive harvesting activities (eating plants and animals) as generally positive human-nature interactions because for most people the associated beneficial outcomes are normally derived from dead organisms which lie beyond our definition of nature – we focus on interactions with living organisms (see the *Definition* section). In this review, we do not exclude activities that harm nature (e.g., insect catching, flower picking), as these could be categorised as negative human-nature interactions (from the nature perspective).

R120-121. *You might add the reference: Gunnarsson et al. 2017. Effects of biodiversity and environment-related attitude on perception of urban green space. Urban Ecosystem. 20, 37-49.*

REPLY: We thank the reviewer for proposing the useful citation. We have cited it.

217 and 219. *Spring and autumn or early in the morning has nothing to do with industrialized or not. For me this is about seasons and light in the far Northern hemisphere or in the southern south hemisphere. Today I think it is very confusing using industrialized countries as link. I guess you will find industrialized parts in the tropical china these days just for an example.*

REPLY: Following this suggestion, we have modified these sentences accordingly (lines 238–243).

254-262 *does not explicitly add to the socio-economic part. This I already said in the spatial part? I think you can remove these sentences and stick to the ones starting with socio-economics?*

REPLY: The first paragraph of the *Socio-economic* section discusses the role of socio-economic development in shaping the patterns of human-nature interactions, which was not discussed in the *Spatial dynamics* section. Of course, the spatial and socio-economic dynamics of human-nature interactions are closely linked to each other, which has now been discussed (lines 308–317).

303. “..these outcomes”. Along these last sentences it is difficult to follow what you really refer to when you mention “..these outcomes..” please make it more clearer.

REPLY: We have revised the sentence accordingly (line 333).

### **Reviewer #3**

*The authors provide a coherent overview of the drivers of direct interactions between individual people and nature, attempting to synthesise information from a wide range of research disciplines. Overall, I think this review provides a great introduction to anyone wanting to get up to speed with the current understanding of human-nature interactions and provides recommendations for future research. While I do not agree with how the authors addressed some aspects of human-nature interactions I commend them for making me think! It is a good addition to the growing literature in this area.*

REPLY: We thank the reviewer for their positive comments.

*The authors state in the caption of figure 1 that the drivers (humans, opportunity and orientation) of human-nature interactions are closely interrelated and largely depend on the dynamics (spatial, temporal and socio-economic). In the main text there is some discussion of this, but it is less clear how the dynamics themselves interact. There is considerable detail on each of the three dynamics, so a subsequent discussion of how they interrelate is required.*

REPLY: We consider that this is a very important point. Following this suggestion, we have now discussed the linkages among the three types of dynamics (lines 308–317). We have also added a fuller explanation in the figure legend.

*There some reference throughout the paper on the challenges and where future research might focus, but these points aren't clear until the end (conclusion). I think a paper like this should make both of those points obvious. This is an excellent overview, but what next? How do we advance this field? I think a specific statement at the end of the abstract giving what the authors recommend is required.*

REPLY: We agree. Following this suggestion, we have added major research challenges we identified in the abstract (lines 26–33).

### *Specific comments:*

*L62: As a society we are becoming more reliant (and dependent) on technology and in some cases the only way that some people can (and do) interact with nature is through technology. Indeed, technology has been shown to facilitate positive human-nature interactions, and in*

*some cases can be used to encourage people who otherwise wouldn't connect with nature, to do so in a way that suits their preferences. The authors don't need to refine their definition, but rather just discuss this point and provide justification for its exclusion.*

REPLY: We have added these points in the *Definition* section (lines 75–76).

Para L150-162: Yes, human-nature interactions, albeit positive or negative have been shown to be strongly correlated with animal abundance – but moving forward, how might these effects be mediated?

REPLY: Of course, there are likely to be a number of variables that mediate the relationship between the abundance of nature and the levels of human-nature interactions (e.g., abiotic conditions, behaviour of animals, nature orientation). We already discussed the role of these variables in shaping human-nature interactions in the first (lines 175–177), second (lines 191–198), and third paragraphs (lines 200–207) in this section.

L227: There are some specific examples here of human-wildlife conflict, but there are also some good synthesis papers and books that cover this topic that you could direct to your readers. For example: R. Woodroffe, S. Thirgood, A. Rabinowitz (Eds.), *People and Wildlife: Conflict or Coexistence?* Cambridge University Press, Cambridge (2005).

REPLY: We have added this citation.

L235-236: What might some of these environmental and social factors be?

REPLY: We have revised this sentence accordingly (lines 258–259).