

## Towards a unified study of multiple stressors: divisions and common goals across research disciplines

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### Article citation details

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### Review timeline

Original submission: 25 February 2020  
1st revised submission: 3 April 2020  
2nd revised submission: 4 April 2020  
Final acceptance: 6 April 2020

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

## Review History

### RSPB-2020-0421.R0 (Original submission)

#### Review form: Reviewer 1

##### Recommendation

Accept with minor revision (please list 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?

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?**

Yes

**Is it clear?**

Yes

**Is it adequate?**

Yes

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

No

### **Comments to the Author**

In the manuscript "Towards a Unified Study of Multiple Stressors: Divisions and Common Goals Across Research Disciplines" the authors have reviewed and examined how multiple-stressor research is currently divided between different disciplines due to e.g. different terminology used in the different disciplines.

The paper was interesting to read and it did get me thinking e.g. how much even my own research is biased just because of the key words that I have used when I have been searching for research articles from my own field. Hence, if publishing this paper, gets other researchers to wonder about this also, the paper is surely worth publishing.

I have only few suggestions or general comments for the paper.

1. The paper could benefit from a short glossary that would shortly explain some of the terms used in the paper (e.g. antagonistic, null model e.g. ).
2. Page 4, lines 91-92. Why do you think the aquatic, terrestrial and ecotoxicological investigations into multiple stressors differ so greatly in their focus?
3. Page 5, lines 106-107. This sentence seems to be contradicting the message said in lines 91-92. How the concepts of multiple stressor research is now similar among the different disciplines when in lines 91-92 you say, the different disciplines differ greatly in their focus. Maybe you could clarify what you mean.
4. Page 6, lines 126. I guess one reason why ecologists tend not to cite work carried out in systems outside of their own, is that if you do that, you easily get negative feedback asking "how can you be sure that things work the same way in the different systems"? If you understand what I mean.
5. Page 12, Table 1. Increased temperature has been listed as a common predictor variable for all the disciplines. I guess in many cases this refers to climate change research..
6. Page 21, lines 428-431. This was a little bit difficult sentence to comprehend. Maybe you could rephrase this.

7. Page 22, Conclusions.

What other reasons than just different terminology has resulted in the separation of the different disciplines? Maybe the different disciplines are just too different, which has resulted in this division?

8. Page 22, lines 467-468. Unfortunately the number of keywords that you can include in the keyword section of research papers is often limited and fixed in journals. And because researchers need their papers to get citations, it is more safe to include familiar keywords related to their own field, as it is more likely to get citations that way. If more than "5" keywords could be added, this could promote the use of keywords from other fields also.

9. Page 22, Conclusions. 470-474) Overall, I think that the idea of this paper (that researchers should expand the "search terms" and keywords they use to include terms that other researchers use in their own different fields) should not be restricted to "multiple-stressor" research only, but to the whole field of ecological research in general. So, maybe you could "generalize" your results in the conclusions.

## Review form: Reviewer 2 (Michael D. Bell)

### Recommendation

Accept with minor revision (please list 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?**

Yes

**Is it clear?**

Yes

**Is it adequate?**

Yes

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

No

**Comments to the Author**

The paper "Towards a Unified Study of Multiple Stressors: Divisions and Common Goals Across Research Disciplines," provides a summary of multiple stressor research in four distinct disciplines and discusses the similarities and differences in approaches. I believe that this paper is of high importance, because it has the potential to bring the attention of the four main disciplines studying multiple stressors together to identify common themes that are currently disparate. The paper is well written and clear in its conclusions.

I appreciated the depth of the discussion around the terminology used across disciplines and the attempt to map the similar words dominant in each discipline. I also think the authors did a good job in the ecological complexity and temporal scale sections.

I see two potential small gaps based on my area of expertise. I am very aware that not every example can be included in the document, so bring these up as options, but no means requirement for inclusion. I think sections 4.1 and 4.2 are a bit limiting in that they seem to mostly focus on insect populations.

One potential addition kind of spans the ecological complexity and temporal scale sections, I think there is room for an extended discussion about multiple stressors and changes in species interactions. Terrestrial forest systems are often under the stress of climate, increased C in atm, multiple types of air pollution (N, S, O<sub>3</sub>), insect infestations/herbivory, and others. Within some of these a pollution/climate stressor allows for increased herbivory/infestation by insects, while others make populations more vulnerable to a stochastic event.

One topic that could be added to the temporal scale section is the cumulative impact of some stressors. A recent study shows that cumulative deposition of N pollution is a stronger driver than yearly change.

Payne, R. J., C. Campbell, A. J. Britton, R. J. Mitchell, R. J. Pakeman, L. Jones, L. C. Ross, C. J. Stevens, C. Field, S. J. M. Caporn, J. Carroll, J. L. Edmondson, E. J. Carnell, S. Tomlinson, A. J. Dore, N. Dise, and U. Dragosits. 2019. What is the most ecologically-meaningful metric of nitrogen deposition? *Environmental Pollution* 247:319-331.

This particular example takes other variables into account, while focusing mostly on the pollution aspect, but I think covers well the long term addition before effects are seen.

One specific comments is on Figure 1. I just want to insure that the image is 508 compliant and that the red and green colors are distinguishable from one another, or else the clustering will not be visible.

**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?**

Excellent

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

Good

**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?**

Yes

**Is it clear?**

Yes

**Is it adequate?**

Yes

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

No

### **Comments to the Author**

The authors present a cross-disciplinary review of literature on multiple stressor research, spanning four branches of the biological/environmental sciences: terrestrial ecology, marine ecology, freshwater ecology and ecotoxicology. In a well-written synthesis, they outline the goals shared between these disciplines and argue the need for common conceptual framework. I find their arguments convincing.

Lack of exchange of ideas between separate fields of research pursuing similar goals impedes scientific progress and leads to parallel development of tools and methods. The authors argue that differences in the concepts and ideas used in different branches of multiple stressor research can be linked to differences in terminology. Their demonstration of the separation between disciplines is supported by a bibliometric analysis.

I found the manuscript to be worthy of publication in RSPB. I have a few minor comments:

L61 "we discuss the shared goals increased realism through both biological and temporal complexity". I don't understand this clause. Did you mean "shared goal \*of\* "?

Along with Table 1, I find the common glossary presented in table SI8 to be a very useful, practical outcome of this study. This is not a demand but I would suggest that this might be worthy of a place in the main body of the article, rather than as supplementary material.

Figure 2 - The results of the citation network analysis (Fig 1) are interesting and described clearly by the authors. However, it took some time for me to understand the "term network". My initial reaction was that it is hardly surprising to discover that "soil" is used exclusively in terrestrial studies, "lake" and "river" in freshwater studies and "oyster" in marine studies. However, if I have

understood correctly, then these terms have been identified as being unique to specific disciplines and are then used as markers for the location of the different disciplines within the network. The network analysis then shows the proximity of many other "general" terms to these discipline-specific terms and thereby allows us to say something about the co-occurrence of terms in each discipline. Have I understood this correctly? In any case, I suggest that the explanation of this analysis could be made clearer.

## Decision letter (RSPB-2020-0421.R0)

23-Mar-2020

Dear Dr Orr:

Your manuscript has now been peer reviewed and the reviews are pretty favourable. I found the manuscript an interesting read too. The reviewers' comments (not including confidential comments to the Editor) are included at the end of this email for your reference. As you will see, the reviewers, while positive, have raised some concerns with your manuscript and we 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, 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.

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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)

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Referee: 2

Comments to the Author(s)

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One specific comments is on Figure 1. I just want to insure that the image is 508 compliant and that the red and green colors are distinguishable from one another, or else the clustering will not be visible.

Referee: 3

Comments to the Author(s)

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## Author's Response to Decision Letter for (RSPB-2020-0421.R0)

See Appendix A.

## Decision letter (RSPB-2020-0421.R1)

03-Apr-2020

Dear Dr Orr

I am pleased to inform you that your manuscript RSPB-2020-0421.R1 entitled "Towards a Unified Study of Multiple Stressors: Divisions and Common Goals Across Research Disciplines" has been accepted for publication in Proceedings B.

You've done a comprehensive job of addressing and incorporating the referees' points, and made it very easy for me to track the revisions. Thankyou! 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 final 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 any changes on the originally submitted version of the manuscript. Instead, if you need to, revise your manuscript and upload a new version through your Author Centre.

Before uploading your 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.

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

Best wishes,  
Innes

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

## Decision letter (RSPB-2020-0421.R2)

06-Apr-2020

Dear Mr Orr

I am pleased to inform you that your manuscript entitled "Towards a Unified Study of Multiple Stressors: Divisions and Common Goals Across Research Disciplines" 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.

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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

Dear Prof. Cuthill,

Thank you for handling our paper “*Towards a Unified Study of Multiple Stressors: Divisions and Common Goals Across Research Disciplines*”. We are grateful for the referees’ positive assessments and their helpful feedback, and we have revised our manuscript accordingly. As requested by Referees 1 and 3, we have moved the common glossary from the ESM into the main text by cutting ~300 words to stay within the journal’s page limit. This was done by making our writing more concise while maintaining the same content. Below are our responses (in blue) to the three referees’ comments.

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## Response to Referee 1:

In the manuscript “*Towards a Unified Study of Multiple Stressors: Divisions and Common Goals Across Research Disciplines*” the authors have reviewed and examined how multiple-stressor research is currently divided between different disciplines due to e.g. different terminology used in the different disciplines. The paper was interesting to read and it did get me thinking e.g. how much even my own research is biased just because of the key words that I have used when I have been searching for research articles from my own field. Hence, if publishing this paper, gets other researchers to wonder about this also, the paper is surely worth publishing. I have only few suggestions or general comments for the paper.

**Response:** Thank you very much for your helpful and constructive comments, which have improved our manuscript. We have responded to each specific comment below. Line numbers refer to the revised manuscript with track changes in this document.

1. The paper could benefit from a short glossary that would shortly explain some of the terms used in the paper (e.g. antagonistic, null model).

**Response:** The common glossary with synonyms grouped that was originally provided in the supplementary material has now been moved to the main text (Table 2 – lines 362-364). To include this common glossary and still remain within our word limit we removed ~300 words. This was done by making our writing more concise while maintaining the same content. This streamlining can be seen in the tracked changes version of the manuscript below.

2. Page 4, lines 91-92. Why do you think the aquatic, terrestrial and ecotoxicological investigations into multiple stressors differ so greatly in their focus?

**Response:** See response to 3. (below).

3. Page 5, lines 106-107. This sentence seems to be contradicting the message said in lines 91-92. How the concepts of multiple stressor research is now similar among the different disciplines when in lines 91-92 you say, the different disciplines differ greatly in their focus. Maybe you could clarify what you mean.

**Response:** In these two paragraphs, we are trying to explain that although the focus or approach of multiple-stressor researchers from the different disciplines is quite dissimilar (lines 95-114 and explored further in SM7: cross-discipline comparison), the underpinning, theoretical concepts are the same. This is why greater cross-discipline exchange would be beneficial. We have revised the text in order to clarify this point by replacing “focus” with “approach” (line 96) and rewording the sentence from lines 116-117.

4. Page 6, lines 126. I guess one reason why ecologists tend not to cite work carried out in systems outside of their own, is that if you do that, you easily get negative feedback asking “how can you be sure that things work the same way in the different systems”? If you understand what I mean.

**Response:** This is definitely a factor that might explain observed citation patterns. One of the papers that we cite, Menge *et al.* (2009), has some interesting insights on the topic (line 135). A division already exists between these research disciplines and is exacerbated in multiple-stressor research by the use of differing terminology. To emphasise this point we have modified the text on line 132 by adding the word “pre-existing” to the notion of separation between disciplines.

5. Page 12, Table 1. Increased temperature has been listed as a common predictor variable for all the disciplines. I guess in many cases this refers to climate change research.

**Response:** Yes, increased temperature as a stressor is primarily linked to climate change – a predictor variable that is of interest to all disciplines. However, in a freshwater context, increased temperature has also been linked to a reduction of (upstream) riparian shading (e.g., Piggott, Lange, Townsend, & Matthaei, 2012) which is cited in SM7: cross-discipline comparison. No change to the manuscript.

6. Page 21, lines 428-431. This was a little bit difficult sentence to comprehend. Maybe you could rephrase this.

**Response:** Thanks, we have rephrased this sentence (now, lines 579-581). It now reads:  
*A shift towards regression-style experimental designs would enhance our understanding of stressor-response relationships, thus increasing our ability to predict threshold responses.*

7. Page 22, Conclusions. What other reasons than just different terminology has resulted in the separation of the different disciplines? Maybe the different disciplines are just too different, which has resulted in this division?

**Response:** It is true that there are meaningful differences between disciplines. For example, the

importance of global change factors (or stressors) is perceived differently by marine and terrestrial ecologists (Knapp et al., 2017) and there are stressors and approaches that are specific to disciplines (Table 1 – lines 304-312). However, these differences do not apply to the more fundamental concepts and questions of multiple-stressor research. The field would certainly benefit from enhanced interdisciplinary collaboration (discussed in the Introduction). One of our key messages is that differing terminology will further exacerbate any pre-existing divisions. This is why we state in the Conclusions that different terminology has “reinforced this separation” (line 668). No change to the manuscript.

8. Page 22, lines 467-468. Unfortunately the number of keywords that you can include in the keyword section of research papers is often limited and fixed in journals. And because researchers need their papers to get citations, it is more safe to include familiar keywords related to their own field, as it is more likely to get citations that way. If more than “5” keywords could be added, this could promote the use of keywords from other fields also.

**Response:** Good point, thanks for bringing that to our attention. Limits to the number of keywords is certainly a potential issue. We have added a sentence about this in the conclusion (lines 676-678).

9. Page 22, Conclusions. 470-474. Overall, I think that the idea of this paper (that researchers should expand the “search terms” and keywords they use to include terms that other researchers use in their own different fields) should not be restricted to “multiple-stressor” research only, but to the whole field of ecological research in general. So, maybe you could “generalize” your results in the conclusions.

**Response:** Yes, this is definitely a fair point. In terms of multiple-stressor research it is very clear that this is an issue, as highlighted in our review. But of course, being aware of terminology and concepts in disciplines other than your own is definitely a good idea for all researchers. We have included a sentence on this topic in the Conclusions (lines 671-672).

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### **Response to Referee 2:**

The paper "Towards a Unified Study of Multiple Stressors: Divisions and Common Goals Across Research Disciplines," provides a summary of multiple stressor research in four distinct disciplines and discusses the similarities and differences in approaches. I believe that this paper is of high importance, because it has the potential to bring the attention of the four main disciplines studying multiple stressors together to identify common themes that are currently disparate. The paper is well written and clear in its conclusions. I appreciated the depth of the discussion around the terminology



used across disciplines and the attempt to map the similar words dominant in each discipline. I also think the authors did a good job in the ecological complexity and temporal scale sections. I see two potential small gaps based on my area of expertise.

**Response:** We are grateful for this positive feedback. Thank you for reviewing our manuscript and for your helpful comments, which we respond to below. Line numbers refer to the revised manuscript with track changes in this document.

I am very aware that not every example can be included in the document, so bring these up as options, but no means requirement for inclusion. I think sections 4.1 and 4.2 are a bit limiting in that they seem to mostly focus on insect populations. One potential addition kind of spans the ecological complexity and temporal scale sections, I think there is room for an extended discussion about multiple stressors and changes in species interactions. Terrestrial forest systems are often under the stress of climate, increased C in atm, multiple types of air pollution (N, S, O<sub>3</sub>), insect infestations/herbivory, and others. Within some of these a pollution/climate stressor allows for increased herbivory/infestation by insects, while others make populations more vulnerable to a stochastic event.

**Response:** It is true that there are many good examples that we have not been able to include due to word limit restrictions. Furthermore, many of our examples have indeed used insects as study organisms. This is partly due to the bias towards insect/other invertebrate model systems in ecotoxicology. In an effort to address this bias and to include a wider range of examples we have added an example about (deer) herbivory and climate change interactions (Didion, Kupferschmid, Wolf, & Bugmann, 2011) in the ecological complexity section to expand our discussion on the importance of species interactions, as you suggested (lines 437-440).

One topic that could be added to the temporal scale section is the cumulative impact of some stressors. A recent study shows that cumulative deposition of N pollution is a stronger driver than yearly change.

Payne, R. J., C. Campbell, A. J. Britton, R. J. Mitchell, R. J. Pakeman, L. Jones, L. C. Ross, C. J. Stevens, C. Field, S. J. M. Caporn, J. Carroll, J. L. Edmondson, E. J. Carnell, S. Tomlinson, A. J. Dore, N. Dise, and U. Dragosits. 2019. What is the most ecologically-meaningful metric of nitrogen deposition? *Environmental Pollution* 247:319-331.

This particular example takes other variables into account, while focusing mostly on the pollution aspect, but I think covers well the long term addition before effects are seen.

**Response:** This is an interesting point that we had not thought about, thank you. We have included this topic (and the reference you have provided) at the end of our discussion of temporal scales (lines 540-541).

One specific comment is on Figure 1. I just want to insure that the image is 508 compliant and that the red and green colors are distinguishable from one another, or else the clustering will not be visible.

**Response:** It is true that the use of colour in our figures is important for their interpretation. In reply to this, we have modified all figures to accommodate those with red-green colour-blindness – we have checked that our images are interpretable for those with red-green colour-blindness using an online tool. Thank you for ensuring the accessibility of our work.

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### **Response to Referee 3:**

The authors present a cross-disciplinary review of literature on multiple stressor research, spanning four branches of the biological/environmental sciences: terrestrial ecology, marine ecology, freshwater ecology and ecotoxicology. In a well-written synthesis, they outline the goals shared between these disciplines and argue the need for common conceptual framework. I find their arguments convincing. Lack of exchange of ideas between separate fields of research pursuing similar goals impedes scientific progress and leads to parallel development of tools and methods. The authors argue that differences in the concepts and ideas used in different branches of multiple stressor research can be linked to differences in terminology. Their demonstration of the separation between disciplines is supported by a bibliometric analysis. I found the manuscript to be worthy of publication in RSPB. I have a few minor comments:

**Response:** Many thanks for reviewing our manuscript and for your positive and constructive feedback. Below are our responses to your comments. Line numbers refer to the revised manuscript with track changes in this document.

L61 "we discuss the shared goals increased realism through both biological and temporal complexity". I don't understand this clause. Did you mean "shared goal \*of\* "?

**Response:** Fixed, thanks (line 62).

Along with Table 1, I find the common glossary presented in table SI8 to be a very useful, practical outcome of this study. This is not a demand but I would suggest that this might be worthy of a place in the main body of the article, rather than as supplementary material.

**Response:** The common glossary has now been moved to the main text (Table 2 – lines 362-364). To include this common glossary and still remain within our word limit we removed ~300 words. This was done by making our writing more concise while maintaining the same content. This streamlining can be seen in the tracked changes version of the manuscript below.

Figure 2 - The results of the citation network analysis (Fig 1) are interesting and described clearly by the authors. However, it took some time for me to understand the "term network". My initial reaction was that it is hardly surprising to discover that "soil" is used exclusively in terrestrial studies, "lake" and "river" in freshwater studies and "oyster" in marine studies. However, if I have understood correctly, then these terms have been identified as being unique to specific disciplines and are then used as markers for the location of the different disciplines within the network. The network analysis then shows the proximity of many other "general" terms to these discipline-specific terms and thereby allows us to say something about the co-occurrence of terms in each discipline. Have I understood this correctly? In any case, I suggest that the explanation of this analysis could be made clearer.

**Response:** That is correct, the coloured terms give us a rough idea of where each discipline is located in the network. Like you said, they act as "markers", against which the more general terms of interest can be compared. We have clarified this point in the text by adding the sentence (lines 246-247): *These coloured terms act as markers against which the location of general terms of interest can be compared.*

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