Peer Community In Ecology

Don’t jump to conclusions on arthropod abundance dynamics without appropriate data

Tim Coulson *based on peer reviews by* ***Gabor L Lovei*** *and 1 anonymous reviewer*

François Duchenne, Emmanuelle Porcher, Jean-Baptiste Mihoub, Grégoire Loïs, Colin Fontaine (2022) Controversy over the decline of arthropods: a matter of temporal baseline? Missing preprint_server, ver. 3, peer-reviewed and recommended by Peer Community in Ecology. https://www.biorxiv.org/content/10.1101/2022.02.09.479422v2

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Humans are dramatically modifying many aspects of our planet via increasing concentrations of carbon dioxide in the atmosphere, patterns of land-use change, and unsustainable exploitation of the planet’s resources. These changes impact the abundance of species of wild organisms, with winners and losers. Identifying how different species and groups of species are influenced by anthropogenic activity in different biomes, continents, and habitats, has become a pressing scientific question with many publications reporting analyses of disparate data on species population sizes. Many conclusions are based on the linear analysis of rather short time series of organismal abundances. There has been particular interest in how arthropods are impacted by environmental change, with several recent papers reporting contradictory results. To investigate why these contradictions might arise, Duchenne et al. (2022) conducted an analysis of four published data sets along with a series of experimental analyses of simulated time series to examine the power of widely used statistical analyses to gain inference on temporal trends. Their important paper reveals that accurate inference on dynamics, particularly of species that exhibit large temporal fluctuations in abundance, requires time series that are substantially longer than are typically collected, as well as careful thought as to whether linear models are appropriate. Linear analyses of short time series are susceptible to providing unreliable inference as trends can be strongly influenced by points at either end of the time series. Duchenne et al.’s paper provides important insight on the conditions when strong inference on temporal trends of arthropod (and other species) abundances can be made, and when they should be treated with caution. They do not doubt that many insect and arachnid species are changing their abundances, and that patterns in these changes may vary

spatially. What their results do say is that we should treat grand claims of population recovery or rapid declines apparently to extinction with caution when they are based on short time series, particularly of species that show significant boom and bust dynamics. In many ways, these results are not unexpected, but it is nice to see such careful and thoughtful analyses and interpretation. More data are required for most arthropod species before clear assessments of abundance trends can be made. Given our reliance on many arthropods for food, pollination, and numerous ecosystem services, and the ability of other species to spread devastating human diseases such as dengue and malaria, it is advisable that we slow our modification of their habitats while additional data are collected to allow us to better characterise the trajectory of arthropod populations to understand what the consequences of our actions on the natural world are likely to be. **References**

Duchenne F, Porcher E, Mihoub J-B, Loïs G, Fontaine C (2022) Controversy over the decline of arthropods: a matter of temporal baseline? bioRxiv, 2022.02.09.479422, ver. 3 peer-reviewed and recommended by Peer Community in Ecology. https://doi.org/10.1101/2022.02.09.479422

Reviews

Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.1101/2022.02.09.479422
Version of the preprint: 1

Authors' reply, 18 May 2022

cf. response to review
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Decision by Tim Coulson, posted 23 March 2022

The challenge of assessing long-term biodiversity trends with an elegant analysis of arthropods abundances

Both reviewers, and I, consider this to be an excellent preprint. The analyses that are conducted across four impressive datasets reveals several important results. In particular, the analyses reveal that a lack of good baseline data make it close to impossible to assess long-term abundance trends, and this is particularly the case with short-time series exhibiting non-monotonous dynamics.

One reviewer has very few comments, stating that, for them, this was a rare occassion to read such a well-produced, and important paper that requires little modification. The suggested changes are minor. The second reviewer has a number of suggested edits, all that seem sensible, and none that will impact the results or conclusions. Given this, I am asking the authors to revise their manuscript to address these minor issues. Once that is done, I do not consider it necessary to seek re-review. Instead I will read the revised manuscript, and will recommend.

I would like to finish by congratulating the authors on a very impressive, and important, piece of work.

Reviewed by anonymous reviewer 1, 22 March 2022

The authors use a series of simulations, some using independent large, published datasets to thoroughly address the issue of how artifacts of methodology can generate different conclusions about long-term arthropod

population trends. Surveys taken over too short a period can be especially prone to give results reflecting only a portion of a taxon's nonlinear or non-monotonic population dynamics, predicting an abundance trend that differs from the true long-term trend. The results make intuitive sense, but the simulations bring rigor and statistical demonstration of how this happens. The analyses are particularly relevant given the conflicting conclusions being reported in the literature about long-term arthropod abundance trends: some showing widespread arthropod decline, others that arthropods are increasing, and others that no substantive change is detected. This paper clarifies how and why that can happen. There are no easy fixes, because there is no control over monitoring in the past. But it seems clear that predicting long-term trends from short-term datasets is particularly hazardous. My comments are mostly related to presentation and the need for some better explanation in spots.

L28-29: Change "abundance variations" to "variation in abundance"

L52: Change "but" to "and"

L78-83: The phrase "temporal coverage" is used 4 times in these lines, but it is not obvious what it means. Does it mean the particular span of years (e.g., 1970-1995) over which a taxon or community is sampled? the number of years for which data are available regardless of which particular years those are? the length of time series? The authors should define it so the reader is not in doubt.

Fig. 1: Excellent figure for getting the point across. Would it be possible to provide more separation between the red, green, and yellow lines in panels a-d? As it is, there is so much overlap it is hard to distinguish the three lines.

Also, for all figures relying on color, it is best practice to avoid red and green in the same figure because they cannot be easily distinguished by those with red-green color blindness (~8% of males and 0.4% females).

L106: Please explain what is meant by "annual occupancy estimate". Is this presence/absence per geographic unit? What is being occupied?

L108: change "form" to "from"

L109: "aggregated" is used twice, once for taxonomic resolution, which is clear. But the first use: "annual estimates of arthropod abundances aggregated by van Klink..." is unclear. What particular estimates did van Klink aggregate, and from where? Who generated the estimates? I could go to the original paper and find out, but this should not be necessary for the reader to have to do to understand the study.

For the four data sets in general: please give some basic background on the nature of each dataset. Who and how were the data collected, what was the geographic extent of each dataset. It does not have to be super detailed, but give the reader some idea of what the data analyzed in these different studies were and how they were gathered.

Fig. 2 caption: Instead of relying only on a narrative of "First we did this, then we did that...", please reference the various Steps and Goals to help the reader know exactly what part of the figure is being described.

L118-119: change "but also" to "as well as"

L121: "keeping"? Do the authors mean "using only"?

L122: spell out what GBIF stands for.

L132: what is meant by "time period gathering most of the data"? Do the authors mean the time period when most of the data were gathered?

L136: delete "First of all, since" and begin sentence with "Because"

L175: This should be a separate sentence: "Classic standardization..." Something is missing and I suddenly got lost; are you saying classic standardization is what you did? Or is classic standardization something you did NOT do (in contrast to the log/logit transformations) because it gives inappropriate weighting to species with lower variability in abundance? I assume that classic standardization is a good thing based on the corresponding lines in Fig. S4b, but please state explicitly to ensure the reader stays with you.

L186-189: "We removed abundance trends..." This sentence is a bit hard to follow because of its length; please consider breaking into two sentences.

L195: change ”three-ways” to ”three-way”

L206: change ”calculated” to ”calculate”

L213: change ”depend” to ”depends”

Fig. 3 caption: For box plots, please describe the parts of the plots; e.g., what does each box encompass (67% of observations? 95% of observations? upper and lower CI?), what is the thick black horizontal line (mean? median?), what are the thin vertical lines (range? SE? SD?), what is the dot above the box at turning points = 9?

Also, ”Proportion” is misspelled on the y-axis.

Fig. 4 caption: Describe symbols comprising box plots as described above for Fig. 3.

Fig. 4d: It might be more helpful for the reader to shrink the scale on the y-axis so that details of variation around the true growth rate are visible, and find a different way to indicate the outlier values that cannot be shown (e.g., break y-axis // to show extreme values).

L271-273: This is an important conclusion and a main take-home message of the study. It seems misplaced in the Results, and should be in the Discussion instead.

Same is true for L300-302.

Fig. 6c caption (L333), (and 6c x-axis title): change ”relatively” to ”relative”

L323: Collembola is misspelled (only one l in ”-bola”)

L325: Coleoptera is misspelled

L361-363: I’m not understanding this sentence. I wonder if the problem is the phrase ”posterior to 1990”. Does this mean before or after 1990?

L381: ”anterior to the rise” – here and elsewhere, instead of ”anterior” and ”posterior”, please use ”before” and ”after” when talking about time. Their meanings are immediately and unambiguously understood in this context. Anterior and posterior are spatial descriptors for ”in front of” and ”behind”, and their use in a time context is disorienting and ambiguous.

L383: change ”would” to ”will”

L385-387: change to ”Whether or not scientists can manage to obtain…” ”…to effectively turn back the clock, our…”

L389: change ”such that our” to ”so our” ; change ”

L139-140: change to ”does not introduce new elements that may affect the reliability…”

L393-394: not clear what is meant by ”joining criticisms”. Do the authors mean ”inviting” or ”provoking” criticism? or something else?

L403: change ”diffuse over” to ”apply widely over”

L415: Change ”Consistently” to ”Consistent”.

L415, change to …”we show that transforming data with (log(x+1)) before statistical modeling, as done by Crossley…” I am not sure my suggested change reflects the authors’ intended meaning.

L416: unclear what is meant by ”instead of adapting model structure”: The log transformation does not adapt model structure as intended? or the authors should have tried adapting model structure instead of a log transformation? or something else? What does ”adapting model structure” mean?

L414-417: This whole sentence is hard to follow and should be restructured, perhaps as two sentences.

L422: change ”questions” to ”brings into question”

L423-426: Hard to follow sentence because of length and too many thoughts at once. Break into two sentences: ”…taxonomic group. Losses and gains…”

L427: change ”are” to ”is” ; change ”sometime” to ”sometimes”

L426-429: another sentence that is hard to follow because it is trying to accomplish too much at once. Break into two sentences: ”…sometimes non-monotonous. This suggests that…”

L428: change ”although” to ”despite”

L429: not sure what the authors are trying to say with ”should at least always be associated to temporal coverage” ; associated in what way? associated how?

L437: change ”from a non-successful submission” to ”of a previous version”

Supplementary: The needed material is all in this pdf. However, the Supplemental material will need to be better organized. It should start with a title page with authors followed by a coherent table of contents that includes everything in the document. As presented, the sub-section for Code is something of a document-within-a-document. This includes its own Table of Contents referencing page numbers (even though the pages of the Code sub-section are not numbered); also the supplementary figures and table are indicated to be at the end of the Code section, but actually come before the Code section in pages that are numbered differently. Providing a holistic Table of Contents at the beginning of everything will also help the reader find the relevant materials referenced in the main paper's text.

Reviewed by Gabor L Lovei, 22 March 2022

This is one of those extremely rare manuscripts where I do not suggest substanial changes - and in fact, very few changes. One is almost ridiculous - I do not think that you should capitalize the word 'arthropods'.

The text is well written, clear and understandable, and even the English is very good. Even if I were to write a little differently, it'd be nit-picking to suggest linguistic changes.

The only suggestion I can think of is about defining baselines. One possibility is to establish a mean abundance over a period of X years, and consider that as a baseline. As I understand it, the MS considers single years as baselines - and then the choice of years will very clearly influence the trend/slope. Another possibility is not to force to find linear trends but to employ loess regression.

Other than these minor comments, I was glad to reada a clearly argued, well written MS.