Peer Community In Ecology

Assessing vulnerability of island biodiversity to global change

Vasilis Dakos *based on peer reviews by* ***T Johnson*** *and 1 anonymous reviewer*

Bellard Céline, Marino Clara, Butt Nathalie, Fernández-Palacios José María, Rigal François, Robuchon Marine, Lenoir Jonathan, Irl Severin, Benítez-López Ana, Capdevila Pol, Zhu G, Caetano Gabriel, Denelle Pierre, Philippe-Lesaffre Martin, Schipper Aafke, M Foden Wendy, Kissling W. Daniel, Leclerc Camille (2025) A framework to quantify the vulnerability of insular biota to global change. HAL, ver. 3, peer-reviewed and recommended by Peer Community in Ecology. https://hal.science/hal-04550966

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Islands may represent just a small fraction (6.67%) of the planet's land but they host a disproportionate 20% of the world's biodiversity. Yet islands are highly vulnerable to human-induced change. Out of all IUCN Red list species, almost half of them are found on islands (Russell and Kueffer, 2019) while from the approximately 800 known extinctions that have occurred since the European expansion around the world, 75% have occurred on islands (IUCN, 2017). Vulnerability is defined as "the degree to which a system is likely to experience harm due to exposure to a hazard" (Fuessel, 2007). It is meaningful to express vulnerability let s say of a population or species to a specific threat, pressure, or stress (like for instance the highly studied species vulnerability to climate change (Pacifici et al., 2015). Vulnerability is typically made up of three components: exposure (the extent of stress or threat that the species encounters and is projected to encounter), sensitivity (the ability of a species to persist under a given stress or threat), adaptation (the ability of the species to adapt to changes in a given stress or threat). When thinking of these three components, it becomes quickly evident that island biodiversity should be "naturally" vulnerable to global change stress (Frankham et al., 2002). First, it is hard to escape for insular species compared to mainland ones meaning that they cannot avoid exposure. Second, insular species are highly sensitive to any stress and stochastic events given their high specialisation due to their endemism. Third, insular species are less likely to adapt to new threats due to their small population sizes and naturally fragmented distribution ranges that both decrease their genetic diversity (aka adaptation potential). Thus, estimating the vulnerability of insular species is an important step towards better management and mitigation of their risk to extinction to ongoing global change. But an assessment framework designed for insular species is currently lacking. Bellard and colleagues (Bellard et al., 2025) contribution is exactly addressing

this objective. The authors present an adapted framework aimed to quantify the vulnerability of terrestrial insular biota by incorporating the idiosyncrasies of island biota: the island syndrome (ie the idiosyncratic evolutionary outcomes that arise in insular environments), the isolated nature of islands, and their high levels of endemism. It is the consequences of these three features that the authors highlight on expanding their insular vulnerability assessment. More in detail, Bellard et al (2025) build on existing vulnerability frameworks that are not specific to island ecosystems by focusing on the inclusion of multiple threats and enlarging the dimensions of diversity (taxonomic, functional and phylogenetic diversity). In that sense, this work stands out as it delivers a missing framework specific for island biodiversity, without minimising its potential as an extension on existing mainland (not island) vulnerability assessments. The framework consists of 5 steps: 1) define the scope of the vulnerability assessment in terms of spatial and temporal extent, relevant threats, and studied biota; 2) determine the markers of exposure, sensitivity, and adaptive capacity; 3) compute measures of vulnerability and its components; and 4) conduct an uncertainty analysis to improve the vulnerability assessment. Step 5 is basically the use of the actual vulnerability assessment for practical conservation action and policy, and the authors are showing (Box 2 in Bellard et al (2025)) how their proposed vulnerability assessment could make the link to what is actually developed for (ie identifying which species are most vulnerable and what drives their vulnerability). No doubt there is a growing number of literature on the design and application of biodiversity vulnerability assessments. Yet, this contribution is making the case for a special treatment of island biodiversity vulnerability assessments, while also providing a rather complete reading to a newcomer into vulnerability assessment frameworks.

References:

Bellard Céline, Marino Clara, Butt Nathalie, Fernández-Palacios José María, Rigal François, Robuchon Marine, Lenoir Jonathan, Irl Severin, Benítez-López Ana, Capdevila Pol, Zhu G, Caetano Gabriel, Denelle Pierre, Philippe-Lesaffre Martin, Schipper Aafke, M Foden Wendy, Kissling W. Daniel, Leclerc Camille (2025) A framework to quantify the vulnerability of insular biota to global change. HAL, ver.3 peer-reviewed and recommended by PCI Ecology https://hal.science/hal-04550966

Frankham, R., Briscoe, D. A., and Ballou, J. D. (2002). Introduction to Conservation Genetics. Cambridge University Press.Fuessel, H.-M. (2007). Vulnerability: A generally applicable conceptual framework for climate change research. Glob. Environ. Change 17, 155–167. doi: 10.1016/j.gloenvcha.2006.05.002

IUCN (2017). IUCN 2017: International Union for Conservation of Nature annual report 2017. Available at: https://iucn.org/resources/annual-reports/iucn-2017-international-union-conservation-nature-annual-report-2017 (Accessed March 10, 2025).

Pacifici, M., Foden, W. B., Visconti, P., Watson, J. E. M., Butchart, S. H. M., Kovacs, K. M., et al. (2015). Assessing species vulnerability to climate change. Nat. Clim. Change 5, 215–224. doi: 10.1038/nclimate2448

Russell, J. C., and Kueffer, C. (2019). Island Biodiversity in the Anthropocene. Annu. Rev. Environ. Resour. 44, 31–60. doi: 10.1146/annurev-environ-101718-033245

Reviews

Evaluation round #2

DOI or URL of the preprint: https://hal.science/hal-04550966
Version of the preprint: 2

Authors' reply, 07 January 2025

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Decision by Vasilis Dakos, posted 26 November 2024, validated 26 November 2024

The authors provide a satisfactory response to reviewers, and the revised version is improved.

Yet the authors themselves express that "We understand that this paper reads like an introduction to a much larger project and the beginning of a long story on island vulnerability, but applying this framework without explaining why it is needed, what are the main questions, limits, implications with policies would be premature. "

Thus I would strongly suggest the authors to attempt a new revision that perhaps will minimise this impression and most importantly will clearly outline what makes this vulnerability assessment so different for insular systems. For instance the authors in the conclusion mention that their detailed framework lays the foundations to understand and predict island biodiversity vulnerability to global change changes, whereas in lines 624 they say: "The vulnerability framework developed here could be used to increase the fundamental knowledge on biodiversity vulnerability (Step 1-3) but has also4) and to guide the potential to help implementing implementation of biodiversity conservation policies (Step 45, Box 2). " In the second statement like in many places in the text one fails to understand what makes this framework distinct for insular vs mainland systems.

I would suggest to remove the word new from the framework as it is not really new.

Instead it is distinct, or specific and this specificity should be clearly explained.

Explained in the terms of scales (what is a scale this framework refers to now and relevant discussion with the reviewers)

Explained in differences between mainland and insular

Explained in differences to the 231 insular studies.

Explained in trait-based vulnerability assessments (functional and phylogenetic) vs species-level markers.

To achieve this I suggest a restructuring:

1. You could start by State of the art of vulnerability assessments on insular biota

so that Vulnerability is clearly defined and the comparison to mainland vulnerability assessment and previous work is more clear.

2. Then you can present the section on uniqueness in relation to the different dimensions of vulnerability.

3. Add a table to highlight the differences/novelties to the mainland framework.

In Figure 2. Markers in bold font represent the markers specifically designed for insular biota. why not just show these ones? Make this scheme specific to the insular case.

4. Perspective title needs to be renamed. An insular-specific trait-based vulnerability assessment?

5. Highlight in each step what is the particularity to islands (cross reference to previous sections)

In Table 2 there are only 4 markers at community level presented. i dont understand community vs species level markers. this should be distinct in the vulnerability analysis. You could be specific what level this framework refers to

Box 1: I dont see its utility- You could remove it.
Box 2 might need renaming : The impact/ use of an insular vulnerability framework for multiple policies?

Evaluation round #1

DOI or URL of the preprint: https://hal.science/hal-04550966
Version of the preprint: 1

Authors' reply, 16 October 2024

See attached the reply
Download author's reply
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Decision by Vasilis Dakos, posted 31 July 2024, validated 03 August 2024

This preprint merits a revision

Dear authors,
I have now received two reviews of your submitted work.
It may have taken some time to secure these reviews but I hope you will find them helpful as I did myself.

I am not an expert on insular biodiversity, but the two reviewers are knowledgeable of biodiversity assessments and insular systems as well.

The fact is that your contribution is of interest and it could have a positive impact in biodiversity assessments in practice.
However, they both raise issues that I agree with upon my own reading and assessment of your work.

In sum, the main concern raised is that the work even if intended to serve as a perspective, it comes a bit thin in making a case for what the authors call a novel framework for insular vulnerability assessments.
What I mean is that it was not very clear to me in what sense this framework differs from other approaches already published by some of the co-authors of this work themselves.
There are some elements that hint to the peculiarities of insular systems that could modify such generic framework but unfortunately they are not really worked out.
In other words, at the moment the piece lacks the rigorousness and novelty to a unique contribution.

I would thus encourage the authors to revise their work based on the comments of the reviewers.

In addition, I would like to add few other points:

1. as also mentioned by reviewer 2, the 1/3 of studies of insular systems does not look low to me. what would be high?

also the geographic, taxonomic, multiple threat biases (or under-representations) are common in biodiversity studies, so I dont see the special case for insular systems.

2. I really struggle of how the metrics chosen in the three parts of vulnerability (or risk, huge confusion as well of names/components of such frameworks but that is another story) are scaled. Are they weighted? how do they become comparable? Just by normalising and ranking?

I know this is an issue treated differently across studies but I find that such clarifications and specifications for insular systems would make your contribution stronger.

3. In the same lines, I would encourage to make the list of properties not non-exhaustive but highlight the most important for insular systems- otherwise Fig 2 looks relevant for any system.
4. Foden ref 2018 and 2019 I think they are the same
5. arrows and numbers in box 2 need to be explained

Reviewed by T Johnson, 19 June 2024

I enjoyed reading 'A framework to quantify the vulnerability of insular biota to global change'. The work is well grounded in the literature and presents a compelling argument for increased effort to protect insular biota. The framework offers a practical, scalable (largely) and evidence-based solution to vulnerabiltiy assessment. Overall, the work is of high quality and should have impact within science and policy. There are only a few small features I believe authors should consider more generally to improve the framework and manuscript:

1) Within the framework, you allow users to essentially define the spatial/taxonomic/temporal extent, and you argue that at broad scales (e.g. Australia?) the framework can help guide policy, whilst at small scales(e.g. St Helena?) it can guide adaptive management. I think it would be good to hear how effective you think the framework will be at these varying scales e.g. at large scales you may have more species at risk of extinction, but the proportion at risk will be lower? That's a terrible example but hopefully you get the point.

2) More generally, can you expand your definition of insular biota. Do you mean islands? Or could the framework also be applied to isolated communities on non-islands

3) When concluding, you point out that the scalability of this framework is conditional on available data? It would be useful here if you could detail what spatial and taxonomic extents you think the framework could be readily applied to e.g. from your expert opinion, where should we be using this?

4) Would you expect the community markers for function and phylgoeny to be correlated between the sensitivity and adaptive capacity groups e.g.is funtional rarity not related to redundancy? Any correlation here could mean you end up locked into a certain part of the vulnerability parameter space, which would be interesting and worth acknowledging as communities with high rarity could be more inclined to have low redundancy and so are just naturally more vulnerable.

5) My main (friendly) critique with the framework would be how to acknowledge and capture uncertainty in these vulnerability estimates. This uncertainty could be in the underlying traits. Or introduced by alternative apporaches to estimate vulnerability. Or just in how well your estimated vulnerability aligns with true vulnerability. It would be nice to hear some dicussion about this.

6) Related to the above, I think you are missing a step 5 in the framework, when you update the vulnaraibility

estimates when confronted with new information e.g. perhaps a island/species you considered highly vulnerable has been very resilient, you are presented with an opportunity to adjust the weightings to acknowledge your imprefect calculations i.e. an itetation and review step

Does the title clearly reflect the content of the article? *Yes*
Does the abstract present the main findings of the study? *Yes*
Does the introduction build on relevant research in the field? *Yes*
Are the methods and analyses sufficiently detailed to allow replication by other researchers? *Yes, but a reproducible code workflow would be a very nice addition so readers could begin applying this framework. However, I apprecaite this is not a small amount of work and will probably be completed as part of another publication*
Are the methods and statistical analyses appropriate and well described? *Yes, but see earlier point about estimating vulnerability*
In the case of negative results, is there a statistical power analysis (or an adequate Bayesian analysis or equivalence testing)? *NA*
Are the results described and interpreted correctly? *NA*
Have the authors appropriately emphasized the strengths and limitations of their study/theory/methods/argument? *Yes*
Are the conclusions adequately supported by the results (without overstating the implications of the findings)? *Yes*

Reviewed by anonymous reviewer 1, 17 July 2024

I must say have mixed feelings about this paper. This could be a much needed perspective, highlighting the need of including islands in vulnerability assessments, and providing ways forward to do it. But as you will see, I find the text too thin for that purpose. What I mean is that in my opinión it lacks the necessary depth so as to make a strong impact in the community; in many senses looks like a first product that precedes something – like an extended grant proposal. Certainly 1) nothing is too novel, as conversations along the theme of adapting large-scale vulnerability assessments have been held for long in the island biology community, and 2) the treatment of most topics is too light. Currently looks a bit like space was at stake, and therefore lacks depth. So after reading the paper I end up with the sensation of "having eaten fast food" after a day of fieldwork… I may need to feed, but I would have certainly enjoyed a more nutritious meal. I'm sorry I can't find a better way of saying it, and perhaps I'm being unfair for a text that is meant to be a perspective… but my feeling is that a clear development of specific ways forward that provide clear guidelines or examples about how to conduct the assessments would have resulted in a much more effective vehicle for the needs highlighted above. Without them, the figures and schematic framework look like excerpts from a general policy assessment manual.

All that said, as I commented I concur it may be unfair given the need of giving more attention to islands in vulnerability assessments. And the truth is that besides such deepening and development of general ideas, I'm only missing two main áreas that require a bit more of attention:

1. I miss an explicit treatment of population genetics and population viability analyses, which are certainly important at the island level. There are many classical Works for that, such as Brook et al J Appl Ecol 1998 or Bakker et al Ecol Mon 2009

2. A deeper treatment of the trait-based and phylogenetic assessments you make. For the traits, I would take a look to two complementary aspects:

2a. for within-species effects you have classical examples in paleontology, such as Jersey red deer or even Homo floresiensis… there is plenty of literature about trait evolution across enviromental and island changes, including some models that account for climate or island size variation… I think this approach could be extrapolable to long-term series for extant fauna and flora

2b. for across-species (community) effects you have the very recent trait-based global assessment of island mammals by Lorente-Culebras et al, which you may have not been aware of while writing the paper. I think it fits perfectly with your Functional Redundancy metrics, and provides a good analytical framework already in place for your suggestion. Check Llorente-Culebras, S., Carmona, C. P., Carvalho, W. D., Menegotto, A., Molina-Venegas, R., Ladle, R. J., & Santos, A. M. C. (2024). Island biodiversity in peril: Anticipating a loss of mammals' functional diversity with future species extinctions. Global Change Biology, 30, e17375. https://doi.org/10.1111/gcb.17375

These are just my "obvious pieces of missing information", but there may be other aspects that could be included and sharpened based on a deeper discussion. Besides them I have a few of relatively minor comments:

The text looks often unpolished, like a rushed submission. I guess part of it (the Split of Box 1 in several 1-line pages) is due to format changes while making the PDF or something like that, but Table 1 looks like a rushed submission, with many typos, open question marks... it would be good to revise it and sharpen the text.

The three reasons in lines 92-100 are not sufficiently developed; reasoning why, say, the body sizes favored by something as inherently diffuse as the island syndrome make species more sensitive needs some deeper explanation, and further support than a handful of papers documenting the syndrome itself. You explain this in more detail below, so I would refer to the text below rather than to these references, which are empty here.

L114-5. Here mention challenges in the sentence (e.g. ¡describe the challenging chatacteristics!, or "which results in challenges that need"), so this summary can be easily linked to the corresponding section

Fig 1A. island biotas, check number concordance

L162. Check gramar and meaning of this sence, currently is a mess

L187-96. 231 our of 741 studies involving islands is not too bad at all given the land Surface that islands occupy, compared to the continents... I may concur that islands deserve special attention, but I would tone down a bit the text here, especially when you say majority (which is true) and ignoring (which is obviously untrue)

L246. Sea-level rise is particularly important for islands, and there is a large-scale assessment that you could cite here to stress that (Weigelt et al Nature 2016)

L343 these papers are about effects of uncertainty, but as far as I know none are about communicating uncertainty... check McInerny et al TREE 2014 for a paper discussing exactly that