We would like to take the opportunity to thank you and the reviewers for the review of our work. The suggestions have been extremely helpful in revising the manuscript.

In general we have followed the suggestions to widen the focus to evidence synthesis and to frame the cumulative meta-analysis as one tool in a wider toolbox that could be used for detecting and reducing research waste.

**Point-by-point response**

*Editorial comments*

*1. Title.*

*Although the choice of title is largely yours, I would recommend something shorter and more declarative. For example: “Evidence accumulation for tackling research waste”*

We have changed shoterned the title to read: “Evidence synthesis for tackling research waste”.

*2. Headings.*

*I would also recommend adding a couple of brief subheadings to create structure in the text.*

We have added six sub-headings to create more structure as suggested.

*3. Standfirst.*

*I recommend editing the standfirst down to two sentences. For example:*

*"There is an urgent need for a change in research workflows so that pre-existing knowledge is better utilised in designing new research. A formal assessment of the accumulated knowledge prior to research approval would reduce the waste of already limited resources caused by asking low priority questions."*

We have amended the standfirst to read: *“There is an urgent need for a change in research workflows so that pre-existing knowledge is better utilised in designing new research. A formal assessment of the accumulated knowledge prior to research approval would reduce the waste of already limited resources caused by asking low priority questions.”*

*Reviewer #1 (Remarks to the Author):*

*In a climate where research funding for ecology and conservation is limited and the problems are really pressing it’s vitally important that we consider how to minimise research waste. This piece is urgent, necessary and will be of broad interest in ecology and conservation. However, I think it requires some minor adjustments:*

*1. The authors should add a discussion of how publication bias would influence the utility of using cumulative meta-analysis to evaluate research waste. If publication bias is too severe the approach might not be appropriate.*

Publication bias is an issue for most, if not all, evidence synthesis methods. We have added an acknowledgement of this and highlighted that cumulative meta-anaylsis can (by ordering the effects by the impact factor of journals for example) be used to identify publication bias and that the only potential solution to publication bias is to follow open science practices.

“In addition, publication bias, where the direction of statistical significance of the outcome influences the decision to publish the result, might bias the evidence base available. This is a major caveat for all evidence synthesis approaches, but one which can be identified. With cumulative meta-analysis one can explore publication bias13 by accumulating the effect sizes in order of journal impact factor for example. Although this method makes it possible to detect publication bias it will not not solve the underlying problem, and researchers should endeavour to reduce publication bias by following open science (Table 1).”

*2. The initial section defining ‘research waste’ (lines 19-30) should be altered to accommodate the section from 106-109.*

This section from the original manuscript has been removed, however we have amended the definition of research waste to include this concept.

““Research waste” is a well-established concept in medical research1. Research is wasted when its outcomes cannot be used for the benefit of society2, for the benefit of training students or the benefit of engaging stakeholders, for example because no new knowledge is gained or the knowledge gained cannot be applied.”

*3. I’d like to see the authors address the trade-off between spending time conducting meta-analyses to determine whether a research idea is worthwhile and conducting new research. I recommend the authors suggest that people start by looking for existing meta analyses – a good resource for this is Conservation Evidence (*[*https://www.conservationevidence.com/*](https://www.conservationevidence.com/)*)*

We have added a line in the “Outlook” section to direct the reader to published syntheses.

“A good starting point for researchers and funders is to search for existing research syntheses (e.g. <https://www.conservationevidence.com/>).”

*4. In lines 103-105 it’s not clear exactly what a ‘systems modelling approach’ would be in this context. It would be great if the authors could clarify this.*

We have expanded this concept (within the confines of the word limit) and added a reference to published work.

“To address this and the problem of synthesising diverse information sources in non-linear systems with multiple complexities, methodologists propose use of systems models to combine empirical evidence from systematic reviews and meta-analysis with expert opinion which allows key areas of uncertainty in a topic to be identified and prioritised for research focus (e.g. 14). Formal value of information analysis can then be undertaken if a decision-theoretic framework exists.”

*5. Figure 1: This figure is a bit confusing. It’s unclear what the dotted vs solid arrows mean. Also, research waste seems like a weird end point- it sort of looks like all roads lead to research waste. Perhaps it could be reframed so that the pathway leads to useful/utilised research but that it can sometimes branch into research waste instead. It would also be neat to depict things that take things off the desired path to being useful and into research waste. Alternatively, perhaps Figure 1 could be switched out for supplementary table 1 (which is excellent)*

Figure 1 has now been moved to the Supplementary material and there has been more description added to the figure legend.

*6. Figure 2: figure needs a legend explaining what the different colours mean. Are these different years?*

Figure 2 has been removed entirely to help reduce the focus on cumulative meta-analysis.

*Reviewer 2*

*• Key results:*

*This MS highlights the importance of using previously published work to inform when there has been sufficient evidence published to indicate where research effort should not be directed. The authors focus the MS on cumulative meta-analysis (C M-A)*

*• Validity:*

*The MS suggests/implies that C M-A can reduce research waste. Rather, C M-A is an additional statistical procedure within a M-A that can demonstrate when and where research waste has occurred (i.e. identify and quantify past research waste), rather than assisting authors in avoiding research waste. The latter can be achieved by utilising or undertaking systematic reviews and/or maps*

*• Originality and significance:*

*The use of C M-A is not novel (as the authors acknowledge), though the application to the data (M-A) within this paper is. I agree that the awareness of the use of C M-A should be raised in the discipline, yet I do not agree with the way that it is presented here, as a formal assessment of prior published research that can aid the minimisation of research waste (see comments under “validity”.*

We have made substantial changes to the manuscript to broaden the scope to evidence synthesis and show the cumulative meta-analysis of one tool that could be used to identify research waste and hence limit future studies which would be wasteful of resources.

*• Data & methodology:*

*The authors extracted the code from R, and presumably used the csv file in the Supplementary information of the original analysis (though they did not say this, so I cannot say for certain). This would mean that they are dependant on the accurate extraction of data from the primary studies by the original authors. This limitation, and other limitations of this MS and analysis are not presented by the authors anywere.*

We have added acknowledgement of the potential bias in the original research in the methods.We intended the use of the original analysis as an example of the approach rather than explicitly making recommendations to acoustic surveying researchers. We provide the RCode and data set (from the original paper) at <https://github.com/DrMattG/Research_waste>. The Markdown file will recreate the analysis, manuscript and figures. The Table is also available.

*Points about Figure 1 are detailed in the direct comments on the MS- in summary, the figure does not provide a very helpful demonstration of the flows, and the legend does not expand on those equally or well. As such, it does not really provide additional information to S1.*

We have changed Figure 1 and moved it to the supplementary materials. We intend it as a schematic representation of the information in Table 1. Table 1 has been moved in to the main manuscript.

*Presentation of Figure 2- it is difficult to determine to which points the years (2000, 2025, 2018) relate. As mentioned in my direct comments on the MS, I do not see the value of focusing on the year, and not on the publication and year. Figure S1 legend does not sufficiently describe the Forest plot therein e.g. the names of studies are listed on the left, and the legend does not clearly state that this indicates which study was added. Table S1 is based on (admittedly heavily modified from) a table from another publication (Chalmers and Glasziou), but without citation of that publication within the legend. Table S1 also makes a number of points that are not covered within the MS text, e.g. “Better training*

*of early-career researchers in methods.” “Research gluts should be synthesised providing evidence to relevant stakeholders.”. It doesn’t seem appropriate to state such points in a table in the Supplementary information without reference in the main text.*

Table 1 has been moved in to the main manuscript. We have expanded the figure legend and methods to include information about study inclusion.

*• Appropriate use of statistics and treatment of uncertainties:*

*Authors do not compare the z score method with the method of determining when the confidence interval of the cumulative effect size crosses the line of no effect. As a non-expert in this, I cannot fully comment on the appropriateness, but the Authors have not provided a justification for using the z score method. Authors do not mention whether studies originating from the same authors are grouped (there is a group of studies from the same author that are on the opposite side of the line of no effect- Hobson).*

We have removed this part of the analysis to ensure that 1) we have enough space to incorporate evidence synthesis as a main focus and 2) because the Z-score method is (in this case at least) a slight “overkill”. The accumulation of evidence in sequence (by year in this case) effectively runs a “new” meta-analysis as each effect is added in sequence and from the forest plot we can see that there has been no major shift in the effect size from close to 0.07 and therefore there is little benefit (we argue) to do another study that addresses the same question. This outcome would not be so clear in a meta-analysis not ordered by year.

*• Conclusions: Do you find that the conclusions and data interpretation are robust, valid and reliable?*

*No, given the above, key point about C M-A not reducing research waste, but identifying and quantifying it.*

We have substantially changed the manuscript to broaden the focus to evidence synthesis and provide CMA as an example of one approach to identify research waste has occurred (and hence can be addressed by stopping research that asks already answered questions)

*• Suggested improvements:*

*Given directly in the MS. Reduce the focus on C M-A, instead focus on evidence syntheses. Or re-frame the C M-A as a tool to identify and quantify, rather than to minimise research waste (unless the purpose of C M-A is to demonstrate and raise awareness of research waste, in which case, it would act, indirectly, to minimise it).*

*• Clarity and context:*

*The abstract is clear and accessible, but doesn’t describe the focus on C M-A. Abstract and introduction is appropriate and relevant, but the later focus on C M-A is inappropriate (I feel the focus should be on systematic reviews and maps). The conclusions are appropriate apart from stating that “cumulative meta-analysis in particular, would be one important remedy to reduce research waste in ecology and conservation”*

*• Please indicate any particular part of the manuscript, data, or analyses that you feel is outside the scope of your expertise, or that you were unable to assess fully.*

*As abovementioned, the appropriateness of the Z score rather than simply sequentially adding studies to a meta-analysis in chronological order until the point at which significance of the effect size is reached.*

As stated above we have removed this part of the analysis.