**Reviewers' comments:**

Reviewer's Responses to Questions

**Comments to the Author**

1. Is the manuscript technically sound, and do the data support the conclusions?

The manuscript must describe a technically sound piece of scientific research with data that supports the conclusions. Experiments must have been conducted rigorously, with appropriate controls, replication, and sample sizes. The conclusions must be drawn appropriately based on the data presented.

Reviewer #1: Partly

2. Has the statistical analysis been performed appropriately and rigorously?

Reviewer #1: Yes

3. Have the authors made all data underlying the findings in their manuscript fully available?

The [PLOS Data policy](http://www.plosone.org/static/policies.action" \l "sharing" \t "_blank) requires authors to make all data underlying the findings described in their manuscript fully available without restriction, with rare exception (please refer to the Data Availability Statement in the manuscript PDF file). The data should be provided as part of the manuscript or its supporting information, or deposited to a public repository. For example, in addition to summary statistics, the data points behind means, medians and variance measures should be available. If there are restrictions on publicly sharing data—e.g. participant privacy or use of data from a third party—those must be specified.

Reviewer #1: Yes

4. Is the manuscript presented in an intelligible fashion and written in standard English?

PLOS ONE does not copyedit accepted manuscripts, so the language in submitted articles must be clear, correct, and unambiguous. Any typographical or grammatical errors should be corrected at revision, so please note any specific errors here.

Reviewer #1: Yes

5. Review Comments to the Author

Please use the space provided to explain your answers to the questions above. You may also include additional comments for the author, including concerns about dual publication, research ethics, or publication ethics. (Please upload your review as an attachment if it exceeds 20,000 characters)

Reviewer #1: This study represents a really interesting and thorough comparison of marine species distributions from two different source, AquaMaps and IUCN range maps and – as part of the AquaMaps team of developers – I consider the developed analytical assessments are very useful for providing diagnostic metrics and indices and the obtained results are very useful from our perspective. However, I have some concerns about the definition or underlying assumptions that the authors have made with respect to AquaMaps predictions, that I think would be important to clarify throughout the paper.

First of all, AquaMaps predictions do not actually necessarily represent the area of occupancy of a given species. Instead, if used in a manner as done in this study (namely simply converting each cell with a predicted probability > 0 into a presence cell) the AquaMaps approach also delineates extent of occurrence from occurrence record with boundaries based environmental borders rather than a polygon drawn by an expert (that may or may not also take environmental factors into account). Based on validation analyses to date (Kaschner et al, 2006, Ready et al, 2010, Kaschner et al, 2011), area of occupancy is probably better represented for most species using a probability threshold >0.6. As a consequence of this, I think, one of the assumptions made by the authors, namely that they would expect Aquamaps ranges to be smaller than IUCN ranges leads to somewhat misleading conclusions to be drawn from the findings of this study.

RESPONSE: Thank you for the clarification. I have adjusted the manuscript to address this concern. My original assumption of AquaMaps as AOO and IUCN data as EOO simply provided a heuristic to help identify potential introductions of omission and/or commission errors; if the map pairs did not meet the original stated expectations, I probed further. However, assuming both datasets actually present alternative approaches to an EOO provides a different, but just as useful, a heuristic to identify possible omission/commission errors.

I have adjusted the manuscript throughout to conform to the assumption of both IUCN and AquaMaps (at max extent) to be extent of occurrence. I believe this reframing improves the accuracy and does not impede the clarity.

For relevant changes, see: Lines 59-71; 124-126; 192-195; 260-261; 267; 271-272; 315-316; 430-431; 435.

Since the manuscript no longer hinges upon an assumption of AquaMaps as an Area of Occupancy, I felt it might be more confusing to describe the 0.6 threshold in the Kaschner et al 2011 validation study, so I elected to not make specific reference to this threshold (or to Area of Occupancy in general) in the paper.

Secondly, I think it would be very important to distinguish between limitation of the AquaMaps approach/methodology itself (of which there are, of course, also plenty) and a limitation of input parameter settings. Like other models, AquaMaps is only as good as its input data – and this is in many cases more than suboptimal. Some general assumptions made for the default maps, like the FAO boundary settings, lead to artefacts as shown in this paper and it’s very useful for this to be highlighted and definitely represents a short-coming of our current data set. However, the analyses conducted in this study do not actually allow an assessment of the overall methodology – which strongly emphasizes the importance of expert-review of input parameter settings to deal with the short-comings of all input data (including the external lists of FAO area occurrences for different species that are used in part to define the so-called bounding boxes for each species). So, to truly assess the match between expert-derived IUCN range maps and AquaMaps, it would have been informative e.g. to also compare the subset of AquaMaps expert-reviewed maps with IUCN ranges.

RESPONSE: Thank you for pointing this out. I have tried to clarify the differences in the manuscript, especially at points you mention in the line-by-line comments below. My original intent was not try to assess the approach/methodology of either AquaMaps or IUCN range maps, but simply to compare the outputs against each other, examining the methodology only when it seemed that errors had been introduced.

In these revisions, based upon your suggestions, I wanted to emphasize the benefits of expert review. To this end, I have added a new plot to the supplemental information that redraws Figure 2 (the quadrant plot and the taxonomic breakdown by quadrant) focusing specifically on expert-reviewed maps, and noted that species with expert-reviewed maps show much better agreement.

In general, however, I want to keep it clear in the manuscript that expert review, though it is the ideal, is not the norm. I want to be careful not to overstate the importance of expert review to the actual dataset, as only 6% of the species maps appear to have been reviewed.

For relevant changes, see: Lines 28; 109; 283-287; 447-455.

The coral example shown in this study is a very good demonstration how the incorporation of known environmental preferences (here with respect to depth) in IUCN range maps actually results in a much closer alignment of both data sets. One of the conclusions drawn from this comparison by the authors is that IUCN range maps could be further improved by incorporating information about temperature and salinity boundaries – which is essentially what AquaMaps already attempts to do.

RESPONSE: As mentioned above, in general I focused more on comparing the outputs of the two datasets, and where systematic misalignments were apparent, then examined how the methods/approaches may lead to such misalignments. In this case, I was focused only on the IUCN maps and suggesting means of addressing the overprediction for species. To address your point, and to help support the idea of improved collaboration, I added specific mention of the approach AquaMaps takes to explicitly include environmental conditions. See line 335.

AquaMaps and IUCN range maps are essentially aiming to achieve the same thing, namely to somehow delineate species ranges (and in the case of AquaMaps - also gradients of relative occurrence) derived from similar sources of information – occurrence records combined with expert knowledge. While the focus of IUCN maps lies on the incorporation of expert knowledge in geographic space (with some – but not clearly defined – consideration of habitat usage), AquaMaps invites the incorporation of expert knowledge in environmental space. Obviously, as stated by the authors, neither approach represents the true distribution of a species, however, I think that this analysis would be a great opportunity to actually encourage closer collaboration between AquaMaps and IUCN species experts to a.) increase the number of expert-reviewed maps and b.) to move towards a more transparent and reproducible approach for describing species maximum ranges based on expert input.

RESPONSE: Based upon this comment, I have included more details to show the benefits of expert review to improve the quality of both datasets. I have also included a note within the conclusion expressly recommending increased collaboration and expert review.

For relevant changes, see: Lines 28; 109; 283-287; 447-455.

While the latter point is not something that the authors necessarily need to address (this would be more a wish list from our perspective), I think the first point about the confusion of Area of Occupancy and Extent of Occurrence may lead to some misleading conclusions to be drawn from this analysis that I think should be addressed before publication.

RESPONSE: I believe my revisions have removed the confusion between AOO and EOO (by reframing as two alternative EOOs) and avoided any misleading conclusions.

More specific comments are included below

28 ‘demonstrate that AquaMaps methodology can produce odd discontinuities at the extremes of a’

Perhaps replace by ‘show’ and ‘default settings’ rather than ‘methodology’

RESPONSE: I clarified, using the term “computer-generated maps” to replace “methodology”; the phrase “default settings” would perhaps be unclear without a deeper explanation of the entire AquaMaps methodology, especially within the abstract. While a few of the expert-reviewed maps also show up in the artificially-bounded map set, they are a small minority (less than 1 percent) and subtle in the clipping. Still at line 28.

53 – add ‘supplemented by expert knowledge’

RESPONSE: Because fewer than 6% of the total maps are expert-reviewed, this seems misleading unless further qualifications are included. Later in the paper, I address the expert review process in more detail. Framing it here as relying “primarily” on model predictions I think hedges the statement adequately, so I don’t believe anyone will be misled into thinking the maps are **only** based on model predictions. I left this line as-is.

67- hundreds of studies might be an exaggeration?

RESPONSE: True. IUCN Red List publications collectively have publications in the thousands, though it is unclear how many of those citations refer directly to the spatial data. I changed “hundreds of” to “many” to avoid hyperbole. See line 72.

114 – as indicated above actually AQ maximum range extent, by definition, would generally correspond to Extent of occurrence. Based on validation analysis, area of occupancy would be better described using a probability threshold of 0.6

RESPONSE: True. I adjusted the assumptions about AquaMaps to reflect this difference and removed references to Area of Occupancy. These changes occur throughout. See lines 124-126 for this particular change.

260 – actually based on my knowledge, IUCN specifically extends species ranges of coastal species outwards (based on a distance to land metric) to allow visual representation of these ranges on global maps. What’s perhaps missing there is a disclaimer to make people using these maps aware of this.

RESPONSE: Thank you for pushing me on this. I had tried to find in the training materials some reason for my observations, but was unable. But based on your comment, I searched further and found that older materials (not those linked from the IUCN page) did make such a reference. The newer materials do not mention this in the main text, though they include a footnote that allows (but doesn’t require) this, stating “a buffer of this size is not essential because the Red List website’s map browser allows users to zoom close into the maps). Unfortunately, older maps, and some newer maps going forward (since it’s optional, many experts will likely continue to add the buffer), will continue to include this buffer.

I have added some of these details to explain the issue and make the reader more aware of the potential problem. See lines 297-300, as well as 319-320 and 325.

285 – this is what AquaMaps already does!!!!

RESPONSE: As mentioned above, my focus in this paragraph was on IUCN data, not AquaMaps; but I have added a mention of AquaMaps here to show that this would be a straightforward improvement to IUCN.

310 – interesting metric, however, extrapolation in environmental space maybe better metric

RESPONSE: I ran the same analysis but measuring the “environmental space” of a cell as product of its geographic area and its suitability (probability of occurrence), and saw largely similar patterns (R^2 = 95%).

Note: If the probability of occurrence included some way to down-weight extrapolation from fewer occurcells (e.g. inverse distance weighting), then we may see a difference between the environmental space and geographic space extrapolation rates for species with fewer occurcells. But this does not seem to be the case, so the environmental space analysis doesn’t seem to provide additional insights.

However, I assume that readers may want to see that both ideas were considered, so I include both here.

Case study MPA gap analysis – this is not really surprising, if you’re looking at the proportion of distribution protectedthe larger the base area (i.e. IUCN range extent or AQ = 0%) the smaller the proportional are protected.

RESPONSE: This would be true when the increased range outside protected areas (due to relaxing the threshold) is proportionally larger than the increased range inside protected areas, which may not always be the case. It appears that only slight differences are evident when adjusting the threshold from 50% to 0% (scenario 2 vs. scenario 3).

But the real comparison to note is the AquaMaps (at 0%) vs IUCN. The comment makes it clear that this point needs to be made more explicitly in the text. I have added an additional explanation about why that comparison is interesting and important. See lines 389-390 and 411-415.

Fig 1 A – am not sure where you would be getting the number of 166 marine mammals. AQ does not yet cover all recognised marine mammals, partially because many of the new species are actually newly split subspecies that were formerly defined as one species (e.g. Sousa chinensis and S. plumbea). However, even the most up-to-date source of marine mammal taxonomy – The Society for Marine Mammalogy’s ad hoc Committee on Taxonomy, only lists 126 marine mammal species and 5 to 6 of those (depending on your definition) are considered to be freshwater only species.

RESPONSE: Thank you for catching this. Upon further review, I found that my matching algorithm (for this plot specifically) was counting multiple synonyms and thus overcounting. Using marine mammals as a check, I identified the problem and fixed it in the code, and then reran the plot. This same issue affected taxa across the whole plot, some more than others. However, the quantitative improvement does not substantially affect the qualitative conclusions…

I checked to make sure the other plots did not suffer the same issue.

Fig 2 B – which terrestrial mammals are you including here – to my knowledge AQ doesn’t include any terrestrial mammals (unless you’re counting the sea otters as terrestrial?)

RESPONSE: These taxonomic groupings were based on the IUCN’s shapefile classifications. Our methodology for identifying marine species involved looking at the “habitat” listings for each species (from their individual species info web pages) and selecting any species with “marine” habitat, so some species (e.g. two species of sea otters) appear in the “terrestrial mammal” shapefile but have both terrestrial and marine in their list of appropriate habitats.

6. If you would like your identity to be revealed to the authors, please include your name here (optional).

Your name and review will not be published with the manuscript.

Reviewer #1: Kristin Kaschner

[NOTE: If reviewer comments were submitted as an attachment file, they will be attached to this email and accessible via the submission site. Please log into your account, locate the manuscript record, and check for the action link "View Attachments". If this link does not appear, there are no attachment files to be viewed.]

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