Dear Prof. Anna Kuparinen,

We are writing to submit a revised version of our paper “*Trait-based analyses reveal global patterns in diverse albacore tuna diets”* for consideration by Fish and Fisheries.

We are grateful to all three reviewers for critical feedback and identifying additional edits required. We are again excited to see the reviewers support, as well as keen eyes for improvement. We have addressed their suggestions through revisions to the manuscript text, several figures (including one removed from Supplementary Information), additional discussion content and citations requested. Our key changes include:

* Highlighting in the abstract that taxonomic-based diet analyses remain important, and improving our explanation of how this trait-based analysis adds value to prior research.
* Thorough editing of the entire document to ensure consistent language, and removal of typographic and grammatical errors.
* We emphasize in the discussion and the conclusions that a key benefit of this work is to condense complex taxonomic data and provide a synthesis of historical prey resource use by albacore, as well as reusable data to build on these analyses.
* Additional discussion text to outline next steps for building on this work.

As highlighted in our previous letter and in our responses, we are pleased to bring you a quality body of work thanks to this revision process. We first show taxonomic diversity of albacore diets across the globe can be reduced to a small number of guilds based on habitat use traits. Identifying past trait-based trends in prey resource use alongside taxonomic data provides a linkage between past and future work, validating past research and trends identified in tuna diets. Further, the functional trait groups that result from our analyses could be used to compare to future changes in resource use by albacore and determine which kinds of prey such predators will target in changing oceans, given that the same trait guilds will be present even when taxonomic composition shifts.

We hope that it is now suitable for publication in Fish and Fisheries. Thank you for your consideration. We look forward to hearing from you.

Sincerely,

Dr. Natasha Hardy (on behalf of the author team)

# Response to reviews of “Trait-based analyses reveal global patterns in diverse albacore tuna diets” for Fish and Fisheries

**Please find the reviewer’s comments (*in italics*) and our responses below. Lines numbers in this document refer to the location of changes in the manuscript when viewed with tracked changes.**

## Reviewer: 1

*Most of the comments made on the first version of the manuscript have been taken into consideration. I think the manuscript is worthwhile publishing with very minor edits (see comments in the annotated pdf version of the manuscript). I still have some reservation on the interest of the analysis shown in FigS5, and its interest compared to analysis shown in Fig3b should be explained better. A few sentences in abstract and section 2.4.3 are incomplete.*

We thank this reviewer for helpful and constructive feedback that has significantly improved this body of work.

* *L24 sentence is incomplete 'functional responses of the ecosystem / communities / populations / species? to ecological stessors'?*

L24: Amended to “responses to ecological stressors”

* *L121 Other broad references are: Olson et al 2016:* [*http://www.sciencedirect.com/science/article/pii/S0065288116300049*](http://www.sciencedirect.com/science/article/pii/S0065288116300049)

L117: This seminal paper was cited in the Discussion, and we have added it as suggested.

* *L304 sentence is incomplete. What happens to those rare species, you remove them from the dataset?*

L302: Edited to “these species were removed”.

* *L306 'and in meeting model assumptions' this part of the sentence does not make sense, is there a verb missing? is it 'and in order to meet model assumptions of normality..' or 'and because model assumptions of normality was not met'?*

L304: Amended to “in order to meeting model assumptions of normality”

* *L310 sentence is incomplete. As well as what?*

L308: This was just left behind when we moved the description of removal of rare species to the front of this paragraph. Therefore “, as well as” has been deleted.

* *L354 remove “in” from “and in the Mediterranean”*.

L352: Amended to “and the Mediterranean”

* *L356 “change ; for ,”*

L354: Agreed, we simply split in two sentences.

* *L358 as demonstrated by the cumulative curves*

L356: Edited to include this suggested description “as demonstrated by cumulative species richness curves”.

* *L359 what are the implications of this information?*

Move to Supplementary Information: Agreed, this sentence is not referred to again in the manuscript, we added it to the supplementary information under the caption for Figure S3.

* *L361 change “the most” to “those”*

L358: Changed to “those”.

* *L468 could be worth discussing on how to identify potential shifts in diet in time series*

L473–484: Addressed. Discussion added to provide additional ideas for identifying multivariate trait-based trends in diet data for albacore and other pelagic predators.

* *Figure 4 I recommend adding for each bar plot the number of guilds detected*

We appreciate this suggestion, we have chosen not to add further information to an already busy graph. We have tested the figure for all forms of colour blindness to ensure that it is interpretable widely, and guilds can be interpreted for each time period and region of interest to the reader.

* *Supplementary Information Figure S5, What does this analysis bring compared to fig 3?Would be good to add circles around cluster to have a better idea overlap and/or extent of each cluster*

Correct, this figure did not bring any further information than what has already been introduced in the main text and supplementary information, and has been deleted. It was also only previously referred to twice, alongside another supporting Figure (S4) which remains relevant and in Supplementary Information.

* *Figure S6 It should be Prey taxonomy or Prey order instead of trait guilds?*

Correct, this refers to Prey Order. Because this is described in the figure caption we have simply removed the extraneous label on the x-axis.

## Reviewer: 2

*Well done revising this manuscript and improving the figures. Please find attached my general and specific comments regarding this revision.*

*General comments: The manuscript entitled “Trait-based analyses reveal global patterns in diverse albacore tuna diets” is a well written manuscript that will facilitate interpretation of diverse diets, not only in albacore, as stated by the authors, but also for other tunas and pelagic species that consume similar prey types. The authors conducted a meta-analysis by using data on prey taxa from available diet studies on albacore tuna and used a ‘traits’ database to assist with assigning habitat-based traits to the taxonomic prey composition data provided in the albacore diet studies. This process simplifies the extensive taxonomic diversity observed in albacore diets to functional groups, which are more easily interpretable. These functional groups or ‘traits’ can serve as a basis for exploring hypotheses of potential climate change impacts on prey distributions and availability in future studies, an emerging concern among scientists and fisheries managers. Such a linkage between traditional, taxonomically based stomach contents data and a simplified habitat trait-based approach can be useful for informing ecosystem, mass-balance models for which diet matrices, that form the foundation of these models, include species-specific diet data that have been assigned to functional groups, based on habitat and/or*

*foraging preferences. Therefore, this trait-based approach can be considered a complementary tool to traditional stomach contents, which will facilitate improved interpretation of changes in diet over space and time and under varying oceanographic conditions. Trophic ecologists are often challenged by interpreting long lists of diverse prey taxa from stomach contents analysis of opportunistic pelagic predators. I think the author’s trait database will be useful for other tunas and pelagic species that consume the same prey types as albacore, since traits have already been assigned to an extensive list of prey in the database the authors cite. Additionally, and importantly, I think this manuscript serves as another example for the need to implement ecosystem monitoring programs to reduce data gaps in time series data, which will allow scientists to better address scenarios under a changing climate. I appreciate the improvements the author’s made to this revised manuscript, including improvements to the figures, which nicely summarize the method’s process and results, as well as the table captions.*

Thank you, twice now, for your helpful and constructive feedback which have significantly improved this prospective paper to date. Thank you for recognising its broader value to fisheries science. Initially, this paper was born out of a need to answer a series of devilishly simple questions within and across research groups on the California Current Large Marine Ecosystem and elsewhere about tuna diet composition – and that in the answering of these questions (such as how many prey species do albacore tuna consume?), we needed to produce a series of interesting historical analyses and produce the body of work now contained in this paper, which we also believe is of broad interest.

*I include some minor comments below, which should be addressed prior to publication.*

*Specific comments:*

* *Line 24: This sentence is incomplete. …to ecological what?*

L24: Amended to “responses to ecological stressors”.

* *Line 27: “coarser” may be a better descriptive term than “lower”, especially since in line 352 you refer to the opposite and mention “higher” taxonomic resolution, but I don’t think you’re referring to species here. Same with line 419.*

L27 and 345: Amended to “coarser”. L350: changed “higher” to “finer”.

* *Lines 34-38: I think an idea is missing in these 2 sentences. It is expected that diets may change over space and time due to many reasons. Stomach contents data provides only a snapshot in time and space and many oceanographic factors can influence predator-prey dynamics. Additionally, it’s not surprising that diet composition was variable and diverse. I think what may be missing from this sentence is that it is challenging to interpret a diverse, taxonomically-based diet composition and this is where the trait based approach is beneficial. If I’m understanding your points correctly, a suggested revision might be something like, “Taxonomic information remains important for trophic ecology, for defining biomass flows [and whatever other reasons you want to include]. Not surprisingly, species-based diet composition in albacore tuna was highly variable across geographies and years sampled, making interpretation of these differences in prey across space and time difficult. By simplifying taxonomic-based diets into habitat trait-based diets, we were able to highlight changes in prey resources. For example, trait-based models of albacore diets highlight…”*

L34–36. Thank you for identifying this issue and the solution. We have added the following “making interpretation of these differences in prey across space and time difficult. By simplifying taxonomic-based diets into habitat-based diet traits, we were able to highlight changes in prey resources consumed”

* *What’s important in my opinion is that the trait-based analysis allows for prey categorization (i.e., the taxonomic prey composition is used to categorize or condense a long, diverse list of prey into simpler, groups, therefore the complexity of diverse diet compositions is easily interpretable compared to a long list of prey with no indication of prey functionality). This is nicely explained in the beginning of the abstract. You have already assigned traits to several prey taxa and these taxa are likely eaten by other pelagic predators. Therefore, these prey taxa may be assigned to functional groups for other predators for defining biomass flow. By already having these categories assigned, you greatly decrease the workload of other ecologists working on ecosystem models where researchers have to define functional groups as a basis for the diet matrices in these models.*

Thank you for this helpful and constructive feedback, we have endeavoured to highlight this key observation of the impact of our study, such as adding an edited version of your note on L426–429 “Importantly, trait-based frameworks categorise or condense long lists of diverse prey and functionally redundant food web linkages (Link, 2007), into simpler and tractable groups based on ecological function, and rendering that diversity more interpretable…”. We also provide further discussion text on building on this trait information framework in paragraph L473–484.

* *Lines 173 and 175: Change ‘used’ to ‘was created by using’ and change ‘searched’ to ‘by searching’. The database did not ‘use’ or ‘search’ but a person created the database by using these tools.*

L173: Amended to “was created by using”, and on L176 to “by searching”.

* *Line 180: Add a reference for albacore vertical distribution (i.e., not occurring beyond mesopelagic depths).*

L178–179: Citations added “Goñi et al., 2011; Williams et al., 2015; Nikolic et al., 2017”

* *Line 257: This sentence is confusing because it sounds like the n=69 represents the “cumulative total number of species identified.” Lines 150-151 and the Figure 1a caption provide clearer text on what “observations” represent. I suggest revising this sentence for clarification or maybe changing observations to locations.*

L256: Indeed, because the earlier definition is clear and sufficient, it wasn’t necessary to repeat the “n=69 observations” and “n=26 studies”, this information is also given in the figure caption at the point where it is needed. Therefore, we removed the confusing citation of numbers in the sentence at line 260.

* *Line 276: remove the “and” between “using” and “dendextend”*

L274: Removed.

* *Lines 303-304: This is an incomplete sentence. What happened to these ‘rare species’? Please revise.*

L302: Amended, they “were removed”.

* *Lines 308-310: This is also an incomplete sentence (i.e., as well as what). Please revise accordingly.*

L308: This is an error, it was just left behind when we moved the description of removal of rare species to the front of this paragraph. Therefore “, as well as” has been deleted.

* *Line 351: add “and” before “one hydrozoan”*

L349: Added!

* *Lines 376-377: the rarest prey guild is the non-diel migrating mesopelagics (n=12), correct? The coast & shelf demersals (n=14). Figure 3 is a great figure. I like the combination of the phylogeny and the cluster diagram.*

L373: Correct, thank you for spotting this error. We have amended this and cite that the coast and shelf demersals are the ‘second-rarest’, for want of better words. Thank you again, this figure has taken a lot of work and we appreciate that you share our excitement in displaying this much data in one figure.

* *Line 383: Figure 4 is a nice summary figure.*

Thank you!

* *Line 389: Change “earlier” to “the”*

L386: Amended.

* *Lines 437-440: Can you provide an example and reference for “…projects that have needed to simplify diversity in diet analyses through quantitatively or qualitatively clustering prey species into guilds.”*

L439: core citations added “Pomerleau et al., 2015; Parravicini et al., 2020”.

* *Line 542: “temporally variability” sounds awkward, please rephrase.*

L552: Agreed, amended to “temporally variable”.

* *Table 2: Since the manuscript uses “geographic” instead of “environmental”, please change the (R) column heading. Also please define SPP.*

Table 2: Addressed and accepted.

## Reviewer: 3

*From the original version, I understood that this type of work is required for progress in studies on biology of pelagic predators at a global scale. As well, I totally admitted the importance of providing the framework of trait-based analyses, which can be applied to other pelagic predators. Nonetheless, I voted to a negative recommendation, simply because I considered that the results and conclusions lacked novelty. Obviously, the authors were frustrated with my comments and asked the reasons for such negative comments. My explanations might not have been concrete enough. Simply, however, I did not consider that showing diversity as a global pattern is novel as a main finding, for example. (A finding that taxonomic diversity of the diets across the globe can be reduced to a small number of guilds is a nice achievement of the work, by the way.) Furthermore, diversity and differences in trait-based diet composition across years and locations are quite expected from the diversity and differences in space and time of the respective studies, even though it had not been shown until the meta-analysis was conducted. In short, what has been done by the authors is really novel and important, but what has been drawn from the results did not convince me of significant impacts of the paper. I did not recommend major or minor revisions because I considered that this nature of the paper would not be changed by modifying sentences.*

*To be frank, I stand by my original comments, even after reading through the authors’ responses along with the revised version of manuscript. For example, the Abstract and Conclusions are essentially the same between the original and revised versions. Unfortunately, I found a discrepancy in the points between my original comments and the authors’ responses: we did not talk about the same thing. After repeatedly reading the authors’ responses, however, I came to consider that this discrepancy is due to the differences in the concept of values in novelty of the work.*

*From a fair viewpoint, I would like to emphasize the fact that I totally agree that proposing the framework of trait-based analyses is important and that this type of meta-analysis is truly a required one for progress in studies on top predators at a global scale. The publication merit of these aspects is well justified in the authors’ responses.*

*If the publication merit is approved under the criteria of Fish and Fisheries, I would not claim against the direction of publication. I have confirmed that the methodological descriptions have been much improved to be comprehensive. The revisions based on the comments of the other reviewers are quite reasonable and the authors have clarified many detailed points of concerns. I think the revised version has reached to the optimal point within the range of possible improvement and that it is publishable.*

We sincerely thank this reviewer for sharing your perspective on this paper, both in initial review, and now. Ultimately, while our views on novelty do likely differ, it does seem that we agree that this paper merits peer-reviewed publication to advance our knowledge of albacore tuna and other pelagic predators’ diet variability using functionally informative prey trait information.

While our response to previous feedback did highlight some confusion, we stress this was not frustration. In general our response to feedback is to work hard to make any and all possible changes to improve the work, and if any reviewer is confused, identifies issues or does not see merit in part of the work, then likely others will not either, and so we gratefully accept that feedback and endeavour again to improve anything in our power to do so, including re-evaluating if the work merits submission for publication.

We understand this reviewer’s points, most of the questions we researched appear devilishly simple, and yet answering them has been far from simple. Through the process of answering these questions we devised novel methods of analyses and arrived at some novel and indeed some expected results, we view reproducibility as a good thing. Further, we feel that to push for novelty alone does a disservice to building a body of knowledge, which we feel is also an important goal of science and one that requires re-analysis of data, and condensing a series of previously novel work into knowledge – that is the strength of this paper and why we deemed this piece worthy of submission to and of the readership of Fish and Fisheries.

The main reason we seek publication with Fish and Fisheries is that the information we sought in our research group working on albacore and other tunas, was not available, despite decades of research on these species, and we had to produce it ourselves through this manuscript. Now that we have done so, we sincerely wish that others can build on this work and access the data which we aggregate, rather than photocopying old data again. The authors of this manuscript and this reviewer ultimately agree, we’d all love to see this work go much further. We therefore outline many ways that other research can build on this work.

We hope this response provides some understanding of our process and any potential differences in our views to the reviewer. We sincerely thank this reviewer for their observant and critical eye. This has pushed us in this revision to further edit and ensure the work is presented honestly with respect to novel versus expected results, and in highlighting ways that the work can be built on and improved (further discussion added in section 4.1, also requested by other reviewers).