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| **Technical comments** | |
| This is a really well done analysis and it well written though copy editing is needed as there are several typographic errors. | We have gone through the manuscript, identified and corrected the typographic errors mentioned, in particular consistent use of spatiotemporal (replacing any use of “spatio-temporal”). |
| The results can be a bit hard to follow because of the various species grouping and terminology. | We have gone through the text of the results extensively to ensure consistency and simplicity. While there remains some specific terminology, where possible we’ve tried to ensure the reader is introduced to the different terms before reading the results and to ensure that consistent terminology is used throughout the entire manuscript. |
| I might suggest a summary of main points in bullet form would simplify understanding of the results. | We now include a leading paragraph to the results summarising for the reader what to expect at a high level before delving into the details [Lines XX-XX]. Rather than bullet form, we have included as an opening paragraph to maintain the flow of the text and maintain consistency with Scientific Reports manuscripts. |
| In addition, some attention should be paid to the use of the terms for the factors. The text says they are referred to as average spatial variation, encounter probability and positive density. But this isn't entirely consistent in the results. I can't find a reference to average spatial variation. Encounter probability is sometimes average encounter probability and positive density is sometimes average positive density. That makes things a bit more confusing. | We now ensure that there is clear distinction in the text between “average encounter probability” and “spatiotemporal encounter probability” and introduced a description of the term before its first used [Line XX]. This should ensure a clear link between the terms usage in the methods, results and discussion sections.  [n.b. Coilin/Jim: We could switch out the term “average encounter probability” etc… for “spatial encounter probability”, but I think keeping the distinction of persistent effects vs temporal ones is quite useful]  Agreed. |
| **Remarks to author** | |
| Very nice analysis of an important problem. I had some minor technical comments on terminology. I also note that the results section is rather dense to read and a summary would be useful that gives the primary relationships that emerge from the analysis both in terms of species associations and drivers (depth and substrate). Perhaps a table or a flowchart? | We have revised the results section to make both the terminology and the key points clearer to the reader. |
| More substantively, I would suggest you give some more thought to the applicability of this type of analysis. As you note at line 236 "A role that science can play in supporting effectiveness of spatiotemporal avoidance could be to provide probabilistic advice on hotspots for species occurrence and high species density which can inform fishing decisions."  Yes that is possible but I suspect fishermen know most of the patterns you identify. That doesn't mean that forecasting is not useful, but it is unlikely to be the basis for regulation. That is particularly so since it would make it impossible to hold fishermen accountable for bycatch if you "forecast" that the bycatch would be low ("the government made me do it"). Rather, I think the applicability is to perhaps model the efficacy of any regulatory approach with technical measures for addressing the mixed catch problem and then designing additional measures to incentivize reductions in unwanted catch. | Yes we agree that regulating to change spatial fishing patterns is challenging in bringing out the intended effect, not least as there is an incentive to get around such measures. Where we think the strength lies is using the forecasting approach as a way of integrating information from several sources: for example, while fishers may possess good knowledge of expected catch at their regular fishing grounds, there will be places they have little of no experience. Our framework provides a method of integrating collective knowledge as a tool for fishers, rather than for regulation per se.  We agree that this is a method that could be best employed to assess how effective such changes in spatial fishing patterns could be / how far they could go to addressing the mixed fishery problem and we have clarified this in the discussion [Lines XX-XX]. Ultimately, it will be up to fishers to match their catch to available quota limits, but the science can support fishers in achieving this goal by highlighting the trade off and consequences of particular choices. We hope that this is now clearer.  [n.b. Coilin/Jim: I’m not sure how strong a response this is but I thought we couched it in terms of advice not regulation...so not sure what else we can say?]  [JT: I tend to think that this method could provide a plausible “lower bound” on how much fishers could affect their catch ratios (a.k.a. bycatch rates) by modifying gear or locational decisions. So I think that something could be said about using the tool to identify the range of catch ratios that are achievable in these ways, and using them to guide strategic decisions (i.e., an upper bound on lost economic profit from some change in quota for a choke species) that would then subsequently be tested by some incentivized management system]  Also relevant for science-fishery partnerships where strategies can be discussed without a regulation but in collaboration. Quotas are presented to industry who will ask how it is possible to realise them while adhering to the LO? Potential of spatial mitigation will be a key topic at these discussions. Paul you can use your management background and currentground to good effect here. |
| Another, more interesting application is to look at, in a sense, the reverse problem. That is, given that fishermen under the new EU regs will have a disincentive to encounter unwanted catch, is it possible to predict when things go wrong. So for example, if you look at the tow by tow catch data, when there is a large bycatch, how is that deviating from the model results you present here? And are their some common factors (fishing to top up a trip, fishing in the wrong place, weather, or other conflicts) that result in big deviations from expected catches given the factors you have identified. That might provide an interesting avenue for advice on reducing unwanted catches. | A potential application for the model could be used to predict risk of overshooting quota for particular locations given the observed distribution of catches and simulating several fishing events for that location. We would anticipate the distributions to be spatially varying (i.e. some areas providing more consistently low catches, some more irregularly high catches), though care would need to be taken to ensure the distribution chosen allows for such extreme events.  We would envisage in a future study the model parameter estimates could be used to simulate potential outcomes given the distributions of catches observed in the fishery. While we don’t have information on all the covariates such as quota uptake, weather etc. It would be interesting to compare such a study, but it is outside of the scope of our work here.  We have included a paragraph discussing this point[Lines XX-XX], in order to identify and draw attention to the need to consider these extreme events in future work.  [JT: Another potential response to the reviewer is that covariates (like weather or previous catches within a trip) could be inputted as “catchability covariates” to screen for covariates that predict higher or lower CPUE than expected given location and gear]  This links to into incorporating catch data into the models. Link to this in the Discussion (Line 277 currently). |
| **Editorial board comments** | |
| In your revision please fully address the comments/suggestions made by reviewer #1.  In particular it would be great if you could address this particular point made by reviewer #1: "More substantively, I would suggest you give some more thought to the applicability of this type of analysis. As you note at line 236 "A role that science can play in supporting effectiveness of spatiotemporal avoidance could be to provide probabilistic advice on hotspots for species occurrence and high species density which can inform fishing decisions." | We have significantly modified the text to incorporate the comments of this reveiwer. In particular, addressing a simplification of the presentation of the results and the incorporation of additional text in the discussion to address applicability of the results, as detailed in the point by point responses above. |