

Rebuttal Letter

Manuscript title:

Beyond 'Trawler' in the Adriatic Sea: Reconstructing Eight Years of Fishing Pressure by Distinct Trawling Strategies

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Dear Editor,

We would like to thank you and the reviewer for the time and effort dedicated to evaluating our manuscript. We are grateful for the constructive feedback, which has been carefully considered and incorporated into the revised version of the paper.

Below, the reviewers' comments are reported in black, followed by our responses, which are presented in **red**. Line numbers referenced in our replies correspond to the downloadable version of the manuscript. The revised text is presented in *cursive*

We believe that these revisions have significantly improved the clarity, completeness, and alignment of the manuscript with the aim of describing our dataset.

Thank you again for your consideration. We remain at your disposal for any additional information or clarification you may require.

Sincerely,

Carmen Ferrà

REVIEWER 1

General comments

This is a useful and timely AIS-derived dataset in the Adriatic Sea which improves upon more general methods used for example by Global Fishing Watch, in particular by providing gear specific information. I recommend it for publication as a data paper but I would suggest to address certain general criticisms of AIS, with a particular inclusion of Hintzen et al., (2025) which brings up concern on how AIS derived data (from GFW in particular) can overestimate the fishing effort by sometimes specifying certain activities, like echosounder use, as fishing activities. I know of Couce et al., (2020) as well which provides similar trawling hours information for the North Sea and it would be nice to see some comparison of methods from that and potentially other similar datasets/methods. I think you can use that information to provide more compelling arguments to how the current methods paper may improve upon other methods while remaining transparent with potential limitations. Overall, I think it's a nice contribution and while the framing could be improved to connect it to other studies, I think it can still be very useful for scientists, managers and policy makers.

We thank the reviewer for the positive assessment of the dataset and for recognising its potential value for scientists, managers and policymakers. We agree that it is important to acknowledge the broader context of AIS-derived fishing effort products, as well as the limitations associated with AIS-based approaches. Following the reviewer's suggestion, we have included references to Hintzen et al. (2025) and Couce et al. (2020) in the Introduction and later in the Discussion to better position the dataset within the broader context of AIS-derived fishing effort products. We also briefly discuss known limitations of AIS-based effort estimation and clarify how the present dataset contributes additional gear-specific information for the Adriatic Sea. Given the nature of this contribution as a data paper, we limited these additions to contextualisation rather than a detailed methodological comparison.

Detailed comments

Abstract

L22 Can you please state explicitly how this supports EBFM? I think you mean because it gives you some good indications/proxies of bottom disturbance (and improvements on other AIS derived information like from GFW) but less informed readers might not pick this up right away. Same for supporting the revision of management plans as it's not so clear (even though it sounds nice).

Introduction

L32 Try and harmonize the use of EBM and EBFM which is in the abstract.

We thank the reviewer for this suggestion. We agree that the link between the dataset and ecosystem-based management could be more clearly stated. We have slightly revised the wording in the Abstract to clarify the potential contribution of the dataset to management applications while keeping the Abstract focused on the dataset itself. Furthermore, following the reviewer's comment below, we replaced EBFM with EBM for manuscript consistency.

L64-67 Here I suggest also including critiques of how GFW uses AIS data. I'm really just thinking about the study from Hintzen et al., (2025) which compared GFW fishing events with independently recorded haul data and found that GFW derived estimates could substantially overestimate the actual trawling being deployed. I would just briefly mention here that study or that critiques exist and go back to this topic in the discussion. Like would your study and improvements on AIS derived fishing effort also be less likely to fall under these criticisms from Hintzen et al., which point out, for instance, that vessels searching for fish using sonar equipment may be mistaken for fishing activities (by GFW derived AIS analysis at least)? Also, if the same critiques are still valid, then this paper should at least mention that as potential limitations. This could potentially strengthen your arguments that this product is a valid improvement compared to prior GFW methods (at least in the Adriatic).

We thank the reviewer for bringing this study to our attention. Following this suggestion, we have included a reference to Hintzen et al. (2025) in the Introduction and added a brief discussion of the limitations associated with AIS-derived fishing effort estimates:

“Nevertheless, trawling strategies remain aggregated under a generic “Trawler” category, limiting the ability to distinguish their specific environmental pressures. In addition, recent studies have shown that AIS-based behavioural classification approaches may overestimate actual fishing activity under certain circumstances, potentially misclassifying non-fishing vessels behaviour as fishing events (Hintzen et al., 2025). These limitations highlight the need for regionally tailored and gear-specific fishing effort products, close collaboration between data providers and fishing industry groups and extensive cross-validation with independently collected information on fishing activity (Hintzen et al., 2025).”

We agree that acknowledging the potential limitations of AIS-derived products improves the transparency and interpretation of the dataset. At the same time, we note that the present regionally tailored dataset differs from GFW products in that it explicitly distinguishes the three main trawling strategies operating in the Adriatic Sea, whereas GFW aggregates trawling activities into a single category. This represents one of the main added values of the dataset that is regionally cross-validated.

However, as this manuscript is intended as a data paper, our objective is to describe the dataset, its construction, and its potential applications rather than to provide a detailed methodological comparison with existing products. For this reason, we limited our revision to a brief contextualisation of recent critiques of AIS-derived fishing effort estimates and their potential implications for the interpretation and use of the dataset.

Methods

L99 Not a huge deal but “together constitute” probably can be phrased simpler (less wordy) with “represent”, “encompass” or something else. I just think it could flow better.

L99-100 It is interesting information to know that these GSA’s are the most highly collaborative fisheries management zone in the Adriatic but it comes out sounding less relevant here compared to the rest of the paper. I would still try to fit it in but suggest breaking up that sentence. Also, isn’t GSA 17 and 18 the total Adriatic? The sentence makes it seem like it is just part of the Adriatic (though I admit I’m less familiar with that sea).

We thank the reviewer for these suggestions. The sentence has been rephrased considering both suggestions as “...FAO-GFCM Geographical Sub-Areas (GSAs) 17 and 18, which encompass the Adriatic Sea. These GSAs represent one of the most intensively exploited fishing grounds in the Mediterranean and constitute a highly collaborative fisheries management area. The dataset spans 8...”

L103-104 again, see if this is enough to evade criticism from Hintzen et al., or like minded scientists (not new text needed here but potentially in the discussion).

We thank the reviewer for this observation. The pre-processing step described here is intended to remove clearly erroneous AIS records, such as duplicated positions, positions located on land, and implausible vessel speeds. We agree that these quality-control procedures address a different source of uncertainty than that discussed by Hintzen et al. (2025), which concerns the potential misclassification of vessel behaviour and the consequent overestimation of fishing activity. For this reason, rather than modifying this section, we have addressed these broader limitations in the Discussion, where we acknowledge the potential uncertainties associated with AIS-derived fishing effort estimates and their interpretation.

“Recent studies have also highlighted broader limitations associated with AIS-derived fishing effort products. For example, Hintzen et al. (2025) showed that behavioural classification approaches may overestimate fishing activity in some circumstances by incorrectly classifying vessel behaviours associated with searching activities as active fishing events. Although the present dataset relies on a different workflow and includes gear-specific classification procedures tailored to Adriatic trawl fisheries, similar sources of uncertainty cannot be entirely excluded. Consequently, the dataset should be interpreted as a reconstruction of fishing effort derived from vessel behaviour rather than as a direct observation of fishing operations.”

L118 so does manually validated mean that local experts took a look and said it was okay? Shouldn’t it then say “visually” validated or something like that. Consider clarifying.

We thank the reviewer for pointing this ambiguity. Local fisheries experts assigned the gear from scratch (rather than visually checking existing assignments based on their knowledge of the fleet and fishing activities. To avoid this ambiguity, we have revised the text and clarified

that the Random Forest classifier was trained on a reference dataset “in which the fishing gear used by each vessel had been independently assigned by local experts.

“A unique gear was then assigned on a monthly basis applying a Random Forest classifier (Liaw & Wiener, 2002) trained on a dataset *in which the fishing gear used by each vessel had been independently assigned by local experts.*”

Results

L175-176 the threshold application for excluding analysis (because they’re probably not trawling below that value), shouldn’t that be introduced in methods not results (I mean I see that it flows kinda nice here but still)? Also for others to reproduce this work, it would be useful in the methods.

We thank the reviewer for this comment. We would like to clarify that the threshold was not applied during dataset generation and therefore does not affect the published dataset, which includes values below 0.33 hours per cell per year. The threshold was introduced solely for the presentation and interpretation of the results, with the aim of excluding grid cells contributing negligibly to the overall fishing activity and improving the readability of the analyses and figures. For this reason, we consider its current placement within the Results section appropriate and have clarified this point in the manuscript.

L179 ok I’ll be the annoying reviewer that suggests more content here. You have some nice qualitative descriptions of the gear specific effort data in figures 1 and 2. Is it possible to also add a small summary table showing more quantitative descriptions like total fishing hours by gear per GSA or other spatial information?

We agree with the reviewer that the inclusion of a quantitative summary would complement the qualitative description of the spatial patterns shown. Following this suggestion, we have added a summary Table 7 reporting the total fishing hours by gear and GSA, providing a more quantitative overview of the relative contribution and distribution of the different trawling strategies across the Adriatic Sea.

L192 I hate to be a stickler but you do use the term significant here in the results to show statistical significance so perhaps just use ‘marked’, or ‘substantial’ instead of significant here.

We agree with the reviewer that the term significant was not appropriate in this context and could be confused with statistical significance. The term has been replaced with substantial, as suggested.

L215-217 the reasons for the Albanian increase may be valid though I wonder if that information belongs in the results and not the discussion (possible improved reporting and fleet expansion).

We thank the reviewer for this suggestion and agree that possible explanations for the observed increase in Albanian fishing effort should be discussed rather than presented as

results. We have therefore moved this interpretation to the Discussion section and revised the text accordingly.

L242 Just to be pragmatic and clear to everyone, can you please specify that these percentages are coming from the full 2 GSA areas (combined) to form the denominator used for the percentages (The Adriatic Sea). I think it can be specified once briefly early in the paragraph (kind of like on line 386 in the discussion).

We thank the reviewer for this suggestion. We have revised the text accordingly and clarified that the reported percentages refer to the entire Adriatic Sea (GSAs 17 and 18).

Discussion

L404 in this paragraph you can add the example of the fleet expansion and better reporting from Albania potentially leading to the results.

We thank the reviewer for this suggestion. We have incorporated this point into the Discussion section by noting that *“The marked increase in reconstructed Albanian fishing effort may partly reflect improved AIS uptake and reporting, as well as a potential expansion of the national fleet, rather than an equivalent increase in actual fishing activity.”*

I don't think you should go overboard on the limitations of the method but a few things come to mind for me. While you might be able to make some assumptions based on gear, I don't see any swept area or swept area ratios for bottom impacting gears. This may be a bit difficult for otter trawling (trawl doors make variable swept areas) but it's relevant because combining gear and gear width information will let you know more about the actual seabed disturbance much more than fishing hours. Also swept area ratio is directly used for analyses like relative benthic status (RBS; Pitcher et al., 2017) and I don't think the study gives indications of gear penetration depth (though they can be inferred/assumed I guess).

Perhaps most important, I think that a discussion integrating the criticisms of GFW methods from Hintzen et al., 2025 is appropriate because they likely also apply in some ways to the current study. I do think this work improves upon the more general GFW methods for that particular area but nonetheless there may be general criticisms which may need to be addressed.

Also the inclusion of Couce et al., 2020 (North Sea) and other similar works are missing from the discussion. Try and add a paragraph which compares and contrasts other work which similarly tries to spatially quantify bottom trawl effort.

Following the reviewer's comments, we expanded the Discussion in three ways. First, we added a comparison with other efforts aimed at reconstructing trawling activity, including Couce et al. (2020), to better position the dataset within the existing literature. Second, we included a discussion of the limitations highlighted by Hintzen et al. (2025), acknowledging that AIS-derived reconstructions may be affected by classification uncertainties and that similar limitations may also apply, to some extent, to the present dataset. Finally, we clarified

that the dataset provides indicators of fishing effort rather than direct measures of seabed disturbance, as information such as gear width, swept area ratio (SAR), and gear penetration depth are not included. We believe these additions improve the transparency of the dataset and provide a more balanced discussion of its strengths and limitations.

“Similar efforts to reconstruct the spatial distribution of trawling activity have been undertaken in other European marine regions. For example (Couce et al., 2020) reconstructed three decades of international trawling effort in the North Sea, providing a valuable long-term perspective on fishing pressure dynamics. In comparison, the present dataset focuses on the Adriatic Sea and provides a higher thematic resolution through the explicit discrimination of the three main trawling strategies operating in the basin (OTB, TBB and PTM). As such, it complements existing fishing effort products by providing a gear-specific representation of trawling activities at high spatial and temporal resolution.”

“Recent studies have also highlighted broader limitations associated with AIS-derived fishing effort products. For example, Hintzen et al. (2025) showed that behavioural classification approaches may overestimate fishing activity in some circumstances by incorrectly classifying vessel behaviours associated with searching activities as active fishing events. Although the present dataset relies on a different workflow and includes gear-specific classification procedures tailored to Adriatic trawl fisheries, similar sources of uncertainty cannot be entirely excluded. Consequently, the dataset should be interpreted as a reconstruction of fishing effort derived from vessel behaviour rather than as a direct observation of fishing operations.”

“. Furthermore, although the dataset can be used to identify areas subject to intensive trawling activity, it does not directly quantify seabed disturbance. Variables such as gear width, swept area, swept-area ratio (SAR), and gear penetration depth are not included and would require additional assumptions and ancillary information. Consequently, applications focused on the ecological effects of bottom-contacting gears should combine these fishing effort indicators with complementary datasets and approaches based on swept area and habitat sensitivity information (e.g. Eigaard et al., 2017; Hiddink et al., 2017; Pitcher et al., 2017).”

The following references were consequently added:

References

- Couce, E., Schratzberger, M., & Engelhard, G. H. (2020). Reconstructing three decades of total international trawling effort in the North Sea. *Earth System Science Data*, 12(1), 373–386.
<https://doi.org/10.5194/essd-12-373-2020>
- Hintzen, N. T., Brigden, K., Kaastra, H.-J., Mackinson, S., Pastoors, M. A., & van de Pol, L. (2025). Bias in Global Fishing Watch AIS data analyses results in overestimate of Northeast Atlantic pelagic fishing impact. *ICES Journal of Marine Science*, 82(3), fsaf033.
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