Dear Editors,

Please find below point-by-point response to each of the reviewer's comments (in bold).

Reviewer 1 Comments and Responses

Line 25 - 26: I would write the sentence as "the state has the ambitious goal of 2.8 GW of offshore wind energy capacity by the year 2030.

Response: Sentence has been edited as suggested.

Line 39: Electromagnetic fields are already mentioned and abbreviated above in line 36, so here can be "EMF"

Response: Replaced as EMF

Line 40: Also the overview given in Hutchinson et al. 2020 (https://www.jstor.org/stable/26965753)

Response: Citation and reference has been added

Line 44: comma missing in citation

Response: comma added

Line 45: dot missing in citation

Response: dot added

Line 50: dot missing in citation

Response: dot added

Line 52: sediment suspension can also cause organisms burial, which can lead to lethal and sublethal responses.

Response: Sentence has been edited to include lethal organism burial and sublethal responses

Line 56 - 58: I would mention what you mean by positive effects: mainly the artificial reef effect, which attracts sessile and benthic species as well as pelagic species. This creates a better link to the next sentence

Response: Sentence has been edited as suggested to include attraction of organisms via artificial reef effect

Line 58: Social impacts are introduced too briefly and not clearly despite representing an important factor of conflict in cable routing. I would dedicate extra explanations on which social impacts are expected, which are considered positive, and which potentially negative ones could arise as well.

Response: Two additional sentences have been added to provide more detail on positive and negative social impacts.

Line 60: OWF has not been introduced yet, it should be written out in its entirety

Response: Sentence has been edited as suggested

Line 64-66: This last sentence I believe aims at introducing the approach of using geospatial techniques in impact studies (incl. Cumulative impacts), and therefore being of reference for the methods used in this study. Thus, I would expand this sentence into a small paragraph where the use of different geospatial information is introduced more in detail, with possibly referencing other studies that have planned cable routing using this information. This will create a link with the aim of this study.

Response: A new sentence has been added, with reference to marine spatial planning, GIS and other sea and seabed users.

Line 68: “this will be” change to “this is accomplished” to keep in present tense

Response: Edited as suggested

Line 70: Consider adding “....applied to the case study of offshore coast North Carolina”

Response: Edited as suggested

Line 84 -85: Isn’t this a repetition of line 78? The acronym OSW has not been used before, but I would consider using OWF as it is more commonly used

Response: This sentence has been removed. OSW has been replaced with OWF. The acronym was introduced earlier in Line 62.

Line 94: Use of OSW

Response: Changed to OWF

Line 102 -103: Figure 1 - I would consider using in the right panel the shape of the leasing area (ok in white) instead of a square box. In that way it links better to the maps in the results and is more directly understandable. I would also have the study area polygon used in the results instead of the dotted circle.

Response: Figure 1 has been edited as suggested

Line 105: 31.5 km or nm? Above you mention 31.5km (17nm). Add the word “tracks” after hurricane

Response: Caption has been edited as suggested.

Line 118: “this study used” change to “this study uses” to keep in present tense

Response: Edited as suggested

Line 119: no capital ‘a’.

Response: Edited as suggested

Line 119: “For the region” change to “of the region and study area”

Response: Edited as suggested

Line 123: Consider changing the sentence to as follows. No new paragraph, but additional sentences to the first paragraph which gives an overview of the method. After which, the first step (literature review) is described. “The final product is an environmental heat map that combines all identified receptors quantified by their sensitivity, areal extent, or hazard for cable integrity.”

Response: This paragraph has been edited with additional detail.

Line 126 - 127: I would move this sentence from here to when describing the procedure for the heat maps

Response: The sentence has been moved as suggested to Line 151/152

Line 129 130: Consider revising sentence to “This allowed a strategy development from the heat map exercise and the choice of relevant data from all types of data available (Table 1). Is there any extra detail on how this choice was made?

Response: Sentence has edited as suggested and additional detail has been provided on the sensitivity values used in the assessment.

Line 131: Offshore wind farm shortened to OWF

Response: Edited as suggested

Line 138: Consider integrating the sentence removed above from line 123 here: “the spatial analysis to produce heat maps is performed using geospatial technology in ESRI’s ArcMap 10.8.2 and follows a basic…”

Response: Edited as suggested – see previous comment

Line 140 - 141: “as part of the project design” consider removing, redundant

Response: Edited as suggested

Line 141: ‘input’ change to ‘spatial layer’

Response: Edited as suggested

Line 146 - 147: No paragraph spacing

Response: We have decided to keep as is, other wise the preceding paragraph would be too long.

Line 153: “table identifies” change to “tables identify”

Response: Edited as suggested

Line 156: Table 1 - It would be useful to add a column with “description’ where the layers are described with few words (e.g., what the difference between the two bathymetry maps, between the two EFH maps and what are danger zones) and if available provide the spatial resolution.

Response: We have added a two additional columns, including Description and Mitigation Type in Table 1.

Line 157: Table 1 - Commented in H11413 Sidescan Data (NOAA) row - Why are these three layers not shown in the figures?

Response: Not all layers have been added to the figures – often due resolution and/or quality.

Line 158: Which risk value was given to Essential Fish Habitat, and which to Cetacean Biological Important Areas? Is it necessary to see all environmental layers represented in the risks, expecting that seafloor habitats will get higher values than for example cetaceans given expected impacts of cable routing.

Response: Sensitivity values were only given to ‘spatially fixed’ receptors and hazards. Sensitivity values were not assigned to highly mobile species or receptors due to their temporary, spatially undefined, nature. This is explained further in Lines 154/155 and Table 2 caption.

Line 169: “from surrounding hazards…” add “...and sensitive receptors.”

Response: Edited as suggested

Line 169 - 172: The last two sentences are part of the results and should be moved there.

Response: Both sentences have been moved to Results as suggested.

Line 174. Some layers from Table 1 are not listed here, and some layers listed here are not present in Table 1. I understand that e.g. Bathymetry was not classified with risks and Anchorage areas may be available within the shipping/navigation layers, but they should be mentioned in both. Plus in the text I would mention why and which layers were not rasterized with risk values. Please also consider combining Table 1 and 2 with following columns: Data layer, Source, Description, Associated risk value, by merging the two captions and legend.

Response: Please see previous comments, including edits to Table 1 and assignment of risk values to spatially defined and permanent receptors. After careful consideration, we decided to keep the tables separate rather than combining them into one big table.

Line 183: 4.1 Physical Environment - Consider combining some figures together into a/b left/right panels when possible and meaningful

Response: Edited as suggested. We have combined quite a few of the figures.

Line 185: Use acronym WEA in place of Wind Energy Area

Response: Edited as suggested.

Line 191: Figure 2 - Call the lease area a "WEA" in legend

Response: We have decided to keep it as Lease Area, for consistency with all of the other figures.

Line 192: "Note extensive" change to "note the extensive"

Response: Edited as suggested.

Line 195: "displayed in this figure" change to "displayed in Figure 2".

Response: Edited as suggested.

Line 195: Could you over-impose the contours of frying pan shoals if available?

Response: To date, Frying Pan Shoals has not been defined spatially and therefore specific contours are not included in the figure.

Line 198 - 199: I would move this type of consideration to the discussion section

Response: After careful consideration, we have decided to keep it as is. The authors believe it is OK as it stands.

Line 202 - 203: I would move this type of consideration to the discussion section

Response: After careful consideration, we have decided to keep it as is. The authors believe it is OK as it stands.

Line 204: Figure 3 - You need the same legend as above in Figure 2 indicating color codes for sediment types.

Response: Figure has been revised. Legend has been updated and sediment color codes are now clearly displayed.

Line 214: Again, if available, it could be useful to have such 2 locations contoured in the map to indicate where they are. Either in Fig 2 or 3 or both.

Response: Please see previous response – specific contours are not available for either location. We have added the location of Jay Bird Shoals (Cape Fear River Mouth, CFR in Figure 1 and legend) and Line 236 of the text.

Line 221: Use HAPC acronym for Habitat Areas of Particular Concern

Response: Edited as suggested.

Line 223: Figure 4 - add study area legend

Response: Figure 4 has been revised with new legend as suggested.

Line 227: Do Wahoo, Snapper, and Grouper represent a group of species each? If not, provide the species name, if yes, I would say "snapper species" etc.

Response: Dolphin/Wahoo and Snapper/Grouper are grouped together as specific Fisheries under management by the South Atlantic Fisheries Management Group. This is clarified in (revised) Figure 3 and Lines 253-255.

Line 236: Consider "Marine mammal residential, reproduction and migration areas, especially the North Atlantic Right whale and bottlenose dolphins, and designated Audubon important bird species"

Response: Caption has been edited as suggested.

Line 240: Here you can say that it was considered. But the recommendation and considerations made afterward (line 240-242) should be moved to the discussion

Response: We have decided to keep it as is for consistency and clarity.

Line 283: I would use the same bold heading “4.4 Environmental Heat Maps”

Response: Edited as suggested.

Line 283: The following section is a mix of Results and Discussion. I would limit this section to present the two maps and the potential cable routes while moving the implications and considerations to the Discussion.

Response: We have decided to keep it as is. We understand that it has a combination of both but it would be cumbersome to split it as suggested and it does not impact the flow of the manuscript.

Line 285: Consider: “This section provides a summary of the GIS-based heat maps, delineating high-risk versus low-risk areas for cable routing, based on the sum of risk values of each environmental constraint considered.”

Response: Edited as suggested.

Line 291: Given the absence of EFH , HAPC, Cetacean BIA etc. from Table 2, I assume they were assigned risk 0. Although I understand that a cable route has a long-term risk 0 for e.g. cetaceans, this should be clearly explained in the risk assignment and in the results. For the important benthic environments instead, the risk is higher. Hardrock bottoms have been included but for example the shallow shoals representing the essential fish habitat around and including Frying Pan Shoals should have been assigned a risk score >0, I believe. Potentially this can be achieved creating a contour area (shapefile) of the water depths below e.g. 10 meters and contour area of the Frying Pan shoals and assigning risk >0? Something to consider, as the current results of Figure 8 undervalue the importance of impacts on environmental habitats (despite reasonably less risky and impacted than other hazards) by giving risk 0... The overall route planning I believe wont be impacted much as you are already avoiding such areas.

Response: Please see previous comments and edits specifying that Frying Pan Shoals has not been delineated by contours and also that EFH is not fixed, but instead is mostly based on mobile fish species, especially sharks. This is also specified in Lines 340-345 and Caption in Figure 5. If EFH and Frying Pan shoals were ‘delineated spatially’ they would certainly be included in the risk assessment.

Line 302: In Figure 9 I would number the potential cable routes and refer to the number in the text like “(Cable 1, Figure 9)”

Response: Edited as suggested. We have included the specific routes in the revised Figure 6 legend and they have been clarified in the discussion

Line 332: “impacts remain” change to “impacts that remain”

Response: This phrase has been removed.

Line 341: I think marine spatial planning has been used before so an acronym would be appropriate

Response: Edited as suggested.

Line 351: offshore wind farm – acronym

Response: Edited as suggested.

Line 356: What do you mean by ‘exceeds’?

Response: Further clarification has been provided in parentheses.

Line 403: Consider adding a panel to show where in the study area is roughly located

Response: Location included as Reef in Figure 4 (right) and in figure caption.

Line 406: “due rock” change to “due to rock”

Response: Edited as suggested.

Line 447: use of the word ‘avoiding’. I’d say mitigate, not avoid as it is not certain weak EMF are not emitted and reaching above seafloor

Response: Edited as suggested.

Line 449: Offshore wind farm acronym

Response: Edited as suggested.

Line 463: “can” - do you mean cannot?

Response: Edited as suggested.

Line 468: Offshore wind farm acronym

Response: Edited as suggested.

Line 488: References - not fully alphabetized, some references have no DOI

Response: DOI is not always available for all references.

Line 491: hyperlink missing

Response: Edited as suggested.

Reviewer 2 Comments and Responses

Line 150 - 151: Why is the value “3” related to impacts on the cables, rather than on receptors? In this case it would combine a suitability analysis (here the rank “3” is linked to unsuitable areas for cables) with an impact assessment analysis (where the rank “3” would correspond to areas where installing / decommissioning cables would lead to major impacts on the environment.

Response: Multiple receptors were assigned a value of 3, including Reefs, Protected Areas etc. These are shown in Table 2.

Line 175: Table 2 - An improved set of values for the associated risk of input layers could be obtained from questionnaires / interviews with experts (ecologists, marine biologists, etc), complemented by repositories compiled from studies made in other sea basins (eg: North Sea, Mediterranean Sea, Black Sea)

Response: We have referred to some additional German MSP reports regarding export cables and shipping lanes. It is important to note that this is a ‘high level’ GIS based modeling and EIA study, not a detailed and thorough description of each receptor and expert judgment, which is beyond the scope of this study. We do acknowledge the subjective nature of the assigned values, but they are based on local stakeholder issues, local environmental knowledge, basic EIA principles and the authors’ best judgment. This is noted in Lines 137-141

Line 284 - 287: and conflict with other uses?

Response: The sentence has been edited, as suggested by Reviewer 1.

Line 315: Figure 9 - Is the text in the legend for the scale of “Proximity to Hazards” inverted? As red areas would be in the “high” proximity to hazards while the blue areas are in “low” proximity to hazards. Additionally, regarding the proposed route for the cables that pass through the areas designated for shipping: is the diagonal route optimal when considering it crosses the shipping route on a diagonal. Would a route that is perpendicular in direction to the direction of the shipping lanes imply less risk? (the German MSP plan can be a good reference point for the planning of cables that intersect shipping routes.

Response: We have edited the figure legend for clarity, and also added a route that crosses perpendicularly across the shipping lane, as suggested. This additional route is also discussed under Cable Route Options. German MSP studies have also been referenced.

Line 332 - "creating impacts remain primarily human" is quite vague and may be misleading. Maybe an alternative formulation can be "leading to socio-economic impacts such as increased time at sea and costs (eg: fuel) for shipping or fisheries.

Response: This phrase has been removed.

Line 383 - Subsection 5.2 Essential Fish Habitat/Hardbottom - while it provides a value context, the majority of the text in the subsection could be rather integrated in the Introduction of the study area chapters. A more relevant approach in the Discussion section would be to highlight how the proposed method is taking into account the ecological diversity of the area, or, if that is a limitation of the study, indicate how it can be better incorporated in future studies.

Response: We have decided to keep it as is, rather than organizing the content and structure of the paper. We feel it is OK as it stands.

Line 423 - "temporary human impacts" change to "temporary socio-economic impacts"

Response: Edited as suggested.

Line 439 - Conclusion - the conclusion may add a few sentences, very briefly, highlighting the main findings on this particular case study

Response: Two additional sentences have been added in the first paragraph of the Conclusions,

highlighting the main findings of this study

Reviewer 3 Comments and Responses

Line 25 – 27: This sentence is unclear. Recommend separating into two sentences: one focusing on "Off coastal … this study" and the other focusing on "the state has … Executive Order No. 218."

Response: After discussing it with the co-authors, we have decided to keep it as it is. We believe the sentence structure and content is fine.

Line 36 – 38: Unclear if this is claiming that acoustic disturbances are a problem or not. More information on this would be helpful – what type of behavioral impacts? Why is (or isn't) this a problem?

Response: Acoustic disturbances can have potential impacts. As mentioned in the text: 'Acoustic disturbances have the potential to alter the behavior of surrounding organisms, but studies have generally shown a low probability of inflicting bodily harm or mortality on nearly all taxa that have been observed (Nedwell et al., 2012; Mooney et al., 2020). A detailed study of acoustic disturbances is not the purpose of this study – we are only presenting introductory effects of cable installation and transmission.

Line 41 – 43: What are the impacts of EMF? Are the behavioral impacts similar to those from acoustic disturbances? Why are behavioral impacts not considered a concern?

Response: Several EMF cable studies are highlighted and covered from Lines 39-47. As above, we are only introducing the subject, not providing a detailed review of EMFs. As suggested by Reviewer 1, we have added a citation and reference for Hutchinson et al., 2020.

Line 56 – 58: The mention of social impacts seems out of place in this paragraph about seabed and sediments. What are the positive social impacts? Would like to see further discussion of this aspect of offshore wind.

Response: We have expanded this section and added more detail on positive socio-economic aspects. This was also suggested by Reviewer 1. Refer to Lines 57-63. We have also replaced 'social' with 'socio-economic.'

Line 76 – 78: This sentence reads as if the prospective developers, rather than the WEA, are "comprising a 11,000 acre offshore region." Recommend reordering the sentence or separating into two sentences.

Response: Edited as suggested. We have separated it into 2 sentences.

Line 87 – 88: Unclear if authors intend "are located along the coast" as a restrictive or nonrestrictive clause. Is the location meant to be additional information, or is the sentence specifying that tourism is a major source of income only for rapidly growing towns in this specific area?

Response: Sentence has been edited for clarity – 'are located along the coast' has been replaced with coastal towns.'

Line 91 – 93: Unclear why the word "range" is repeated in this sentence. Recommended edit: "… within the study area range between 7.5 m/s at the coast and 9.0 m/s at …"

Response: Edited as suggested. Second 'range' has been removed.

Line 93 – 94: What do the authors mean by "best"? Are the highest wind speeds in the country occurring here? Does this region have the most consistent wind? Does wind in this area always fall within the ideal range for OSW turbines?

Response: The sentence has been modified for clarity. The term 'best' has been removed.

Line 95 – 96: What is the impact of tropical storms on the area's potential for an OSW farm? Unclear if these are mentioned because it is a positive or negative factor.

Response: The sentence has been modified and now includes 'creating a possible hazard for OWF development.'

Line 109: Additional context requested regarding the size of the eligible area. How does 100,000 acres compare to other wind farms? What is the expected energy from an area of this size?
Response: We have added the expected wind energy output (1.3 GW) to place it into context with other wind farms in the USA.

Line 148 – 149: How are "minor" and "major" impacts quantified?
Response: They are based on the nature of impact and examples are described in the same paragraph. E.g. a minor impact may be a temporary closure, whereas major impact may affect the structural integrity of the cable or policies which do not allow such infrastructure within their boundaries.

Line 151: If policies disallow such infrastructure, why were these areas not completely removed from the model?
Response: Co-authors and I feel that it is particularly important to describe and show these locations in the maps and model. Removing them would defeat the purpose of the exercise and make them seem 'unimportant.' It is also important to note that jurisdictions and policies could change in the future, and therefore having them presented is contextually important.

Line 187: "… most prominent feature of …" should be "… most prominent features of …"
Response: Edited as suggested.

Line 197 – 198: What is the significance of this depth? Is this deeper or shallower than usual for placing cable? Does this add any additional challenges?
Response: We have added the following clarification in the sentence: 'which is perfectly manageable by export cable installation companies.'

Line 217 – 234: This section mentions several types of habitats (EFH, HAPC, BIA). What are the restrictions for building in each type of habitat?

Response: The following sentence has been added: Where possible, these areas should be avoided during cable routing and installation plans, or at least discussed carefully with the management and conservation agencies in charge of protecting the habitats.

Line 243 – 245: How is this type of zone quantified in the model?
Response: Temporary and mobile species are not quantified in the model due to the difficulty of doing – this has been addressed in different parts of the study (refer to Reviewer 1 and 2 responses).

Line 260: How are the physical obstructions quantified in the model? If the obstruction makes it impossible to lay cable here, is the location completely removed from consideration?
Response: Edited as suggested. As mentioned before, we feel it is important to map and describe all of the sensitive receptors/obstructions, even if installation activities cannot take place there.

Line 270 – 272: What does "significant concern" mean in this context?
Response: Reason for significant concern is explained in the subsequent sentence. Not sure this needs to be quantified or elaborated on further.

Line 279: "Although avoiding navigation areas are not a requirement…" should be "Although avoiding navigation areas is not a requirement…"
Response: Edited as suggested.

Line 287 – 288: More information about these "scores" would be helpful. Are there any zones with scores 4 or lower that are not actually accessible, due to previously discussed factors?
Response: Specific scores are provided in Table 2. The scoring/ranking limitations (some subjectivity, local environmental knowledge) has been addressed previously – please refer to Reviewer 1 and 2 responses.

Line 297 – 298: Aren't these implications definitive? The protected areas would need to be completely avoided when routing cables.
Response: They have been described as 'no go' areas. Not sure what the reviewer's comment refers to, or what is suggested.

Line 305 – 306: Is there a feasible route that would use a shorter cable? Is this just a comparison to physical distance, or will this be compared with another path that may be more expensive, but shorter?
Response: A new section called Cable Route Options (4.5), describing all route alternatives, including distance, has been added to the current manuscript.

Line 319 – 320: "Each substation … are the closest …" should be "Each substation … is the closest"
Response: Edited as suggested.

Line 328 – 330: This sentence is unclear.
Response: This section has been edited for clarity.

Line 330 – 331: This sentence is unclear.
Response: This section has been edited for clarity.

Line 331 – 332: Unclear what the authors mean by "creating impacts remain primarily human." Recommend rewording.
Response: This section has been edited for clarity.

Line 347: What is "MPA's"? This term has not been used or defined yet.
Response: We have replaced MPAs with Marine Protected Areas

Line 348 – 350: In the list of locations, the word "off" applies to all three items, which does not make sense with the final item ("off" the Baltic Sea). Recommend changing to "… off Taiwan, off Spain, and in the Baltic Sea."
Response: Edited as suggested.

Line 354 – 355: "… environmental consultancy companies which use similar techniques …" should be "… environmental consultancy companies that use similar techniques …" 2023 3
Response: Edited as suggested.

Line 357 – 360: This sentence is unclear. Reads as though "the main wind energy area / production site and the coast" are two parties that have competing interests. Reword to make it clearer that this is a description of the location.
Response: The sentence has been edited for clarity.

Line 362: "… but also similar marine industries …" should be "… but also by similar marine industries …"
Response: Edited as suggested.

Line 363: Why is the word 'receptor' in quotes when its other uses have not been in quotes?
Response: Quotes have been removed.

Line 377 – 380: The second half of this sentence ("… and importantly …") is a key point. Recommend separating into a new sentence so that it does not get lost in the first section.
Response: Edited as suggested i.e. separate sentence.

Line 385: "… Essential Fish Habitat (ESH) …" should be "… Essential Fish Habitat (EFH) …"
Response: Edited as suggested.

Line 385 – 286: What is the significance of including the descriptor "sediment-starved" here?
Response: Replaced with sand limited.

Line 391 – 393: Has the other 90% been mapped in other ways (such as less modern survey methods) or not at all? This sentence conflates "being mapped" and "specifically being mapped with modern survey methods." Are these the same thing in practice? Without the modern methods, would mapping be useless?
Response: Modern has been replaced with 'standard'

Line 423 – 425: How easy is this to minimize? Are there other temporal limitations on construction (i.e. marine migration patterns, weather)? What is the overlap with busy tourist season?
Response: Temporal mitigation techniques have been described. Keeping as is.