Center for Independent Experts (CIE)

Desk Review of the Draft Environmental Impact Statement for Research and Data Collection in Closed and Gear Restricted Areas in Support of Spatial Fisheries Management for Atlantic Highly Migratory Species

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Executive summary

The Draft amendment 15 to the 2006 consolidated Atlantic Highly Migratory Species (HMS) Fishery Management Plan provides the basis for scientific advice on the evaluation and modification of several HMS spatial management areas implemented in the early 2000s in the Northwest Atlantic Ocean under U.S. Jurisdiction. In the lack on dependent-fishery data in the current closed area, a species distribution model (SDM), called PRiSM, was used to predict presence/absence of several bycatch species of the pelagic and bottom longline fisheries. PRiSM used environmental factors and observer data collected onboard longline vessels outside the closed areas to evaluate the habitat of the bycatch species. Using score metrics, different time-area management alternatives are compared to the current closed areas. The NOAA Fisheries Report was well-written and easy to evaluate. The trade-off between socio-economics and conservation objectives are clearly presented.

Keeping in mind the limits due to the gap in fishery-dependent data and given the current state of knowledge for the different bycatch species, the report represents the best available science. The application of PRiSM and related analyses is sound, reasonable, and logical, based on the data presented and relevant scientific information. In the light of the metric scores resulting from the comparison of the predicted occurrence rate from PRiSM inside the closed area to the occurrence rate from the fishery outside the closed area, we deduce that the current time-area strata are largely improvable. Notwithstanding the generally very positive review of the DEIS, there are some potential areas for improvement in future use of the PRiSM model as well as research recommendations on the usefulness of integrating tagging data information and on the integration of non-economic social data into decision making leading into spatial management processes.

Background

The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance with the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee.

In the context of the highly dynamic nature of HMS fisheries, the current review objective of the Draft Environmental Impact Statement (DEIS) for Research and Data Collection in Closed and Gear Restricted Areas in Support of Spatial Fisheries Management for Atlantic Highly Migratory Species is to evaluate whether the existing closed areas remain appropriately placed to achieve ongoing conservation and management objectives, and conversely, that they do not unnecessarily prevent fisheries from attaining optimum yield from healthy fish stocks. The assessment of alternative closed areas is also considered in the review. The independent peer-reviews are expected to provide valuable feedback to the NMFS in conducting HMS spatial management plans.

Description of the Reviewer's Role

The Center for Independent Experts (CIE) reviewers will conduct a peer review of the application of HMS PRedictive Spatial Modeling (PRiSM), a species distribution and habitat modeling framework developed by Crear et al. (2021), and related analyses based on the Terms of Reference (ToRs). While the PRiSM methods themselves are not subject to this review, their application for meeting the purpose and need of the action are. The bibliography of materials provided for review and any other

materials relied on during the review are found in Appendix 1. The CIE Statement of Work is found in Appendix 2.

As author of this Desk Review, I was not involved previously with HMS spatial management measures in the USA at any stage. As requested, I have:

1) Conducted the necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact.

2) Conducted an impartial and independent peer review in accordance with the tasks and ToRs specified herein, and each ToRs in Annex 2 of the CIE Work Statement (CIE PWS).

3) Submitted via email to the "CIE" an independent peer review report on August 4, 2022.

Summary of Findings for each ToR

1. Evaluate the *description* of the analytical approach used for each alternative.

a. Are the methods clearly described and understandable in plain language?

The NMFS Atlantic Highly Migratory Species Management Division prepared a report that was carefully constructed and edited, making the job of providing an external review much easier. Specifically, figure and Table captions in chapter 3.1 "A Alternatives: Evaluation and Modification of Spatial Management Areas" and "Appendix 4 – Options, Metrics, and Scoring" are complete, and informative. Congratulations and thanks to the NMFS team for the effort made to facilitate the reading of the report for reviewers and probably for stakeholders' non-specialists of the scientific jargon. The score metrics used to compare the time-area management alternatives with the current closed areas are clearly described. Keeping in mind the limits due the gap in fishery-dependent data, the application of PRiSM and related analyses is sound and reasonable.

In a general way, fishery managers seek a trade-off between socio-economics and conservation objectives. In such context, area-based fisheries management to simultaneously maintain biodiversity and high levels of sustainable food production offer a management tool that has been tested in several oceans (Hilborn et al., 2021). Consequently, the use of spatial management measures such as closed areas and gear restricted areas for the management of Atlantic Highly Migratory Species (HMS) should be further emphasized. This aspect does not only concern the fleets operating in waters under U.S. Jurisdiction (e.g., the Magnuson-Stevens Act, the Endangered Species Act) but also fishing activities beyond the EEZ, managed by Regional fisheries Management Organizations (RFMOs). As an example, the International Commission for the Conservation of Atlantic Tunas (ICCAT) in Rec 21-09, (paragraph 19) « *encourages CPC to prioritize research into identifying mating, pupping and nursery grounds, and other high concentration areas of North Atlantic shortfin Mako; options for spatial temporal measures; mitigation measures (inter alia, gear configuration and modification, deployment options), together for improving stock status* ».This is of course applicable to other migratory species.

Reducing catch of non-target species is also a concern of RFMOs. In this context it must be stressed the progress made by the ICCAT Subgroup on Technical Gear Changes which is exploring the effects of terminal gear modification to address Rec. 19-05 (paragraph 21) not only on billfishes but also on sharks (specifically on shortfin Mako shark). This includes the exploration of potential technical changes to the terminal gear (such as hook shape, hook size, leader type, etc.) and fishing practices (e.g., timing, soaking time, bait, depths, areas) that could reduce bycatch and bycatch mortality (at-vessel and post-release).

The fact that the stock status of several species analyzed in the DEIS has changed since the closed areas have been put in force is an important issue (see Table 1) which justifies evaluating if a closed area's objectives are still being met and/or new time-area alternatives that would be more effective. This is an important point to explain to stakeholders who might be concerned about a modification of the measures in force.

Gear	Since	Species	Status at the starting of the Closed Area	Status at the last Stock Assessment	Source
PLL	2000 2001	Western Bluefin tuna	Overfished Overfishing	2021 S. A. biomass up by 9% from 2017- 2020. No overfishing	2001 SCRS report 2021 SCRS report
		Yellowfin tuna	Around Bmsy and Fmsy	2019 S.A. No overfished, No overfishing.	2001 SCRS report 2019 SCRS report
		Northern Swordfish	2000 S.A. Overfished Overfishing	2017 S.A. No overfished, No overfishing	2001 SCRS report 2017 SCRS report
		Blue Marlin	2000 S.A. Overfished Overfishing	2018 S.A. Overfished Overfishing	2001 SCRS report 2018 SCRS report
		White Marlin	2000 S.A. Overfished Overfishing	2019 S. A. Overfished No overfishing	2001 SCRS report 2019 SCRS report
		Western Sailfish	Unknown	2016 S.A. Not likely overfished Not likely overfishing	2001 SCRS report 2016 SCRS report
		Other billfishes	Unknown	Roundscale spearfish evaluated with white marlin	
		Shortfin Mako	Unknown?	2019 S. A. Overfished Overfishing	2019 SCRS report
		Leatherback sea turtle	?	Endangered 2019 high risk of extinction 2018	IUCN 2019 Red List NMFS-USFWF 2020
BLL	2005	Sandbar shark	2005/2006 S.A. Overfished Overfishing	2017 S.A. Overfished No overfishing	SEDAR 11 S. A. rep. SEDAR 54 S. A. rep.
		Dusky shark	2005/2006 S.A. Overfished Overfishing	2016 updated S.A. Overfished Overfishing	SEDAR 11 S. A. rep. SEDAR 21 S. A. rep.
		Scalloped hammerhead	2005 S.A. Overfished Overfishing		Hayes et al, NAJFM 2009

Table 1. Brief summary of the status of the stocks for the HMS analyzed in the DEIS when setting up the current closed areas and in the most recent years.

b. Is it clear how the underlying science, including PRiSM, was applied?

Due to the lack of fishery-dependent bycatch data within the closed areas during the months of closure, PRiSM uses a habitat suitability modeling framework with the aim to predict the percentage of presence of each bycatch species inside the closed areas. To build habitat suitability model by bycatch species, PRiSM relates species occurrence reported by observers at sea outside the closed areas with environmental data, assuming then that the range of environmental conditions is comparable inside and outside the closed areas, which seems a reasonable assumption. The choice to use presence/absence data rather than catch or catch rate is likely related to heterogeneity in data quality of the different bycatch species collected by observers on board longliners.

The number of candidate options (i.e., sub-alternatives) that are compared with each spatial management measure in force is high (Table 2) and makes the analysis more complicated since

surfaces and months can be different. To partially overcome this aspect the authors propose to use a single standardized value that incorporates both spatial and temporal extents for comparing different spatial management areas. However, it should be kept in mind that summing the surface of a small area throughout a year can produce the same value as a large area closed for only one month, but the global impact in terms of protection of bycatch is probably different.

Gear	Closed area	Months	Since	N. options	Species protected
PLL	Desoto Canyon	Jan-Dec	2000	13	undersized swordfish, billfish, and other overfished and protected species
	Charleston Bump C. A.	Feb-Apr	2001	16	
	East Florida Coast C.A.	Jan-Dec	2001	9	
BLL	Mid-Atlantic Shark C.A.	Jan-Jul	2005	14	juveniles sandbar and dusky sharks

Table 2. Closed areas in force and number of options evaluated (including the current closed areas)

The selection of the different species distribution models (SDM) followed the conventional statistical criterion procedure and particular attention was paid to the cross-validation, to the extent that in addition to the classical 10-fold cross-validation approach, training data sets have also been created with respect to temporal and spatial dimensions. It is unclear, however, how the spatial groups cross-validation procedure account for the offshore-inshore gradient as, except for the DeSoto Canyon closed area, coastal waters are always included in the closed areas of the sub-alternative spatial management (and consequently not sampled, i.e., not included in a training set).

Apart from this question the results of the PRiSM model and the resulting proposal for change represent the best available science, given the current state of knowledge on bycatch for the pelagic and bottom longline fisheries operating in the Northwest Atlantic. Notwithstanding the generally very positive review of the DEIS, there are a few questionable points which will be discussed below.

c. Are any caveats, limitations, and uncertainties in the approach clearly described?

In general, the approach used is well described. I have however some comments on its limitations. First, can the social behaviour of a species (i.e., solitary animals, living in small groups, schooling) bias the interpretation of the score metrics? Is it accounted for in the random cross-validation procedure? (e.g. non-independence of residuals, if the presence of an individual is correlated with the presence of another individual). Concretely, let's assume two scenarios: suppose (1) that the individuals of a low density species are evenly distributed in space and that they occupy the entire area to be closed, and conversely (2) a high abundant species present only in some sites due to its patchy spatial distribution. How will presence/absence data and the score metrics help to identify the potential effectiveness of the closed area? I know that this is an extreme situation but how can one be sure that the results are not group structure dependent?

Second, I understand well that PRiSM combines observer data and environmental data to predict where and when fishery interactions may occur. The proportion of locations within a region where the bycatch species is present was used as a surrogate for species abundance. Nevertheless, the use of presence/absence data in SDM might present the risk of misinterpreting absence (e.g., false negative, Royle and Link, 2006). An observed absence may be due to the fishing gear configuration failing to detect the presence of the species that is actually resident at the fishing location. To correct under-detection (the species is present but not observed) and bias (i.e., when variation in abundance induces

variation in detection probability), maybe repeated measures in the same location could help to estimate the detectability of the bycatch species (Royle and Nichols, 2003; MacKenzie, 2005, among others). If I am not wrong for each bycatch species, the occurrence probability was calculated at the scale of grid cell with sides equal to 1/12°. Is there no way to estimate detectability?

As regards to the bycatch species concerned by the DEIS, several of them have an unbalanced number of absences compared to the number of presences. This was the case for Leatherback sea turtle (only 6% of presence) with the lowest deviance explained (14.1%) among the best PLL models (see table 2 in Crear et al, 2021). It is assumed that the occurrence of the event is better predicted when having larger proportions of ones in the data and on the other hand, non-occurrence of the event is better predicted when having larger proportions of zeros in the data. However, the proportion of presence/absence affects the variance of the estimated parameters of the fitted logistic regression model, ultimately potentially leading to a wrong selection of the significant predictor variables.

As far I understand a balanced subset of data was created for the spatial cross-validation procedure (see Crear et al, 2021, p. 5: "*The size of the spatial blocks and the number of groups (i.e., folds) were selected so that the amount of presences and absences were similar among the groups*."). Has this presence/absence ratio been considered only in the spatial cross-validation? Using a balanced subset of data (i.e., 50% of zeros and ones) will yield smaller variances for the maximum likelihood estimates of parameters, therefore offering less uncertainty in the estimation process, and ultimately in identifying the driver variables for modelling presence/absence response variables (see, Salas-Eljatib et al., 2018). Would there be a possibility of creating a balanced set of data 0/1 to review the selection procedure of GAM models for the Leatherback sea turtle?

Hook type and bait type are important explanatory variables which were included by the PRiSM modelers in the logistic GAM models. Recently several studies have focused on the impact of hook types on at-haulback mortality, post-release mortality, and catch rates of different bycatch species (Reinhardt et al, 2017; Keller et al, 2020; Diaz, 2020; Santos et al, 2020; Ochi et al, 2021). The conclusions do not converge but it is admitted that bait type, gear configuration, targeted species and environmental factors, may interact with hook type. Although the present review does not target the SDM model used in the DEIS, I suggest adding an interaction term between hook type and bait type in future PRiSM analyses.

In the current state of knowledge, it is important to keep in mind the recommendations of *the ICCAT sub-committee of ecosystem: 2022 SC-ECO ENG* with regards to the conservation measures for sea turtles: "*Updated meta-data analyses reviewed by the Subcommittee continue to support that the use of large circle hooks is an effective mitigation measure to reduce sea turtle bycatch. While recognizing that circle hooks have varying effects on other target and bycatch species, the Subcommittee continues to recommend the use of circle hooks for shallow longline sets to increase the effectiveness of conservation measures for sea turtles. The Subcommittee also recommends continued research of the efficacy of terminal gears including circle hooks and the trade-offs across species throughout the ongoing work of the Sub-group on Technical Gear Changes.*". However, and all things considered, it should also be remembered that the Northwest Atlantic Ocean is not the main region in terms of interaction between marine turtles and longline fleets (see Figure 4, Anon., 2021).

2. Evaluate the *application* of the analytical approach.

- **a. Was the PRiSM framework and any other analytical approach applied in a logical, justifiable manner to develop the range of alternatives? Reviewers should refrain from making determinations or demonstrating preferences between or among alternatives in the document.**

The comparison of the different closed area alternatives is based on the calculation of a total metric score which is itself the sum of four metric scores based on the comparison between the occurrence rate from the fishery outside the closed area to the predicted occurrence rate from PRiSM inside the closed area or on the high risk percent overlaps between inside and outside the closed area. The thresholds to define the high-risk areas were based on the Endangered Species Act status and the ICCAT S.A. status of the bycatch species and on the community importance. The metric scores by species are then summed to obtain the total metric score, which is used to rank the different closed area alternatives from the most efficient and effective at conserving the bycatch species to the less effective. The choice to give an equivalent weight to each species or each score metric probably meets the objective of leaving room for maneuver to decision-makers. This option is admissible but (1) some species are in a more undesirable situation (e.g., Mako shark and Large Coastal Sharks (LCS)) than others and (2) some score metrics could be more in relation to the search for effective strata than others (e.g., metric 4 measuring what percentage of the closed area protects high bycatch risk areas). It is just a question I ask, without having a clear solution but mixing different scores metrics may be confusing for little gain, if there is any.

To account for the high migratory nature of the species under study and the variability of the environmental factors, relatively large areas were preferred over small high risk areas. This is justified as bycatch hotspots are less prone to shift from year to year within a large area than within a small one. Basically, the different alternatives consist in modification of either closed surface, or closed months, or both. As requested to the reviewers, I refrain from making any further comment regarding preferences among the different sub-alternatives. I limit my analysis to the factual results of the "Preferred" alternatives presented in chapter 3.1 "A" Alternatives: Evaluation and Modification of Spatial Management Areas.

Mid-Atlantic Shark Spatial Management Area:
A simple temporal shift of two months (November 1 through May 31 instead of January 1 through July 31) would result in higher HMS score metrics.

Sub-Alternative	Months	Surface (nm2)	Scope (nm2) Month*Surface	Metric scores			
				DS	SHH	SB	Sum
A1a (no action)	Jan-Jul	5,407	5,407*7=37,849	19	13	14	46
A1b	Nov-May	5,407	5,407*7=37,849	25	12	16	53
A1c	Nov-May	5,256.1	5,256.1*7=36,793	20	18	15	53
A1d	Nov-May	6,168.4	6,168.4*7=43,179	26	18	18	62

Table 3. Preferred alternatives for Mid-Atlantic Shark Spatial Management Area. DS = Dusky Shark; SHH = Scalloped hammerhead; SB = Sandbar Shark.

Charleston Bump Spatial Management Area:
No effect on Loggerhead Sea Turtle and very weak for the billfish group but significant gains could be obtained for Leatherback sea turtle and Shortfin Mako.

Sub-Alternative	Months	Surface (nm2)	Scope (nm2) Month*Surface	Metric scores				
				TLB	SMA	BIL	TTL	Sum
A2a (no action)	Feb-Apr	36,265.2	36,265.2*3=108,796	9	11	0	1	21
A2b	Dec-Mar	36,265.2	36,265.2*4=145,061	16	14	0	0	30
A2c	Jan-Dec	20,031	20,031*12=240,372	26	20	5	0	51
A2d	Oct-May	10,339	10,339*8=82,712	22	21	1	0	44
A2e	Oct-May	16,591.2	16,591.2*8=132,730	18	18	2	0	38

Table 4. Preferred alternatives for Charleston Bump Spatial Management Area. TLB = Leatherback Sea Turtle; SMA = Shortfin Mako Shark; BIL = Billfish Species Group; TTL = Loggerhead Sea Turtle.

East Florida Coast Spatial Management Area:
The main beneficiary of the modifications of the closed area would be Shortfin Mako Shark. There would be no effect on the two species of turtles and a slow decrease for the billfish group.

Sub-Alternative	Months	Surface (nm2)	Scope (nm2) Month*Surface	Metric scores				
				TLB	SMA	BIL	TTL	Sum
A3a (no action)	Jan-Dec	30,221.1	30,221*12=362,653	21	12	10	0	43
A3b	May-Nov Dec-Apr	30,221.1 15,311.7	(30,221*7) + (15,311*5)=288,106	23	16	10	0	49
A3c	Jan-Dec	15,921.1	15,921*12=191,053	21	17	6	0	44
A3d	Oct-May	22,225	22,225*12=266,700	23	18	8	0	49
A3e	Jun-Sep Oct-May	15,311.7 22,225	(15,311*4) + (22,225*8)=239,047	22	18	7	0	47

Table 5. Preferred alternatives for East Florida Coast Spatial Management Area. TLB=Leatherback Sea Turtle; SMA=Shortfin Mako Shark; BIL= Billfish Species Group; TTL=Loggerhead Sea Turtle

DeSoto Canyon Spatial Management Area:
If we compare it with the option no-action, the best alternative in terms of metric scores suggests that the modification of the closed area would be positive for Leatherback sea turtle and Shortfin Mako, but not for the Billfish species group.

Sub-Alternative	Months	Surface (nm2)	Scope (nm2) Month*Surface	Metric scores			
				TLB	SMA	BIL	Sum
A4a (no action)	Jan-Dec	25,420.2	25,420.2*12=305,042	21	20	24	65
A4b	Apr-Oct Nov-Mar	25,420.2 12,595.5	(25,420.2*7) + (12,595.5*5)=240,914	21	20	21	62
A4c	Jan-Dec	18,979.5	18,979.5*12=227,754	23	21	16	60
A4d	Jan-Dec	26,604.1	26,604.1*12=319,249	26	25	17	68

Table 6. Preferred alternatives for DeSoto Canyon Spatial Management Area. TLB = Leatherback Sea Turtle; SMA = Shortfin Mako Shark; BIL = Billfish Species Group.

The main conclusion that can be drawn is that, with the exception of the DeSoto Canyon closed area, the use of PRiSM indicates that the current time-area strata are largely improvable. From Appendix 4, the current closed areas are ranked 12th out of 14 (Mid-Atlantic Shark closed area), 15th out of 16 (Charleston Bump closed area), and 8th out of 9 (East Florida coast closed area). In contrast the current DeSoto Canyon closed area comes second among the list of 13 proposed spatial management alternatives.

I do not have any specific comment about the data collection alternatives because the scientists involved in these fisheries know this subject better than I do; but please refer to my point on the interest to combine fishery-dependent data collected by fisheries observers and fishery-independent monitoring in the Recommendation section. As regards the C alternatives on the evaluation timing of spatial management areas, alternative C2 (evaluate once three years of catch and effort data are available) makes sense considering the risks of climate change. The feasibility of this short timing should be tested against the workload it represents.

b. To the extent that PRiSM was used to characterize the impacts of each alternative, was the characterization of ecological impacts consistent with the PRiSM results?

First of all, it should be remembered that PRiSM is a tool which makes it possible to compare several spatial management options with each other. All these options use the same knowledge and the same datasets, including within their limits (e.g., no observations in closed areas). That is to say that the ecological impacts are perceived through available data and there is no evidence that these data impact more one spatial management option rather than another. As stated by the authors of the PRiSM model, « *These metrics and their results are not indicative of what fishery managers may or may not do in the future; rather they only present additional information that managers could use* ». I suppose, and I fully agree if this is the case, authors suggest that spatial management measures should be part of a larger package of management measures (e.g., gear restrictions, catch limits, good practices at release, etc.).

There is now a point that could be questioned by external scientists or stakeholders: In which aspects the HMS spatial management plan is specific to high migratory species? i.e., how it would be different from a spatial management plan for less mobile species? The lack of additional work to evaluate the displacement rates and the residence time of each bycatch species inside the different candidate closed areas could stunt the acceptability of the HMS spatial management plan by some stakeholders, more prone to visualize migratory maps than interpreting scores metric tables. There is a lot of information on the movement of the bycatch species of interest (and on target species) from past tagging studies, using conventional tags and electronic tags which could be helpful to assess the effectiveness of the closed areas. As an example, from pop-up archival transmitting satellite tags it was showed that dusky shark horizontal movements overlapped with both the pelagic and bottom longline fisheries in areas off the east coast of the U.S., with some seasons and areas exhibiting higher probability of incidental captures in these fisheries (Kroetz et al., 2021). These observations, if reinforced by other tagging analyses, would militate in favor of a dynamic ocean management approach which can allow the implementation of mobile closures smaller than the existing static closed areas while still providing adequate protection of bycatch (Hazen et al., 2018).

3. Are the ecological and socioeconomic analyses supporting the alternatives logical and documented appropriately?

This is not an easy task to answer whether the socio-economic and the ecological impacts have all been listed in the DEIS, but it is clear that several environmental and socioeconomic costs and benefits associated with closed or restricted areas were mentioned. As far I can tell the pros and cons between, short-term economics interests and long-term sustainability of the fisheries and resource conservation are presented objectively. One of these aspects is the impact which would result from favoring access to the resource to a single fishery while prohibiting access to another fleet. It is clearly identified that changes in access to an area may cause conflicts among different resource users, such as recreational and commercial fishermen, or eco-tourists. However, although the report suggests that several sub-alternatives could reduce interactions between the pelagic longline fishery and the recreational billfish fishery, it is hard to check it. May be, confronting spatial effort distribution maps could make it possible to identify conflict hotspots areas between pelagic longline fishers and other resource users.

The DEIS pays particular attention to the consequences of the changes in management measures for 25 U.S. coastal communities selected for having a greater than average number of Atlantic HMS permits associated with them. A total of 9 social indicators, ranging from fishing engagement and reliance to social vulnerability, could assess a coastal community's vulnerability or resilience to potential economic disruptions such as those resulting from drastic changes in fisheries quotas and seasons. Fishing reliance and engagement index scores provide information on which communities have greater than normal dependence on the recreational and commercial fishing sectors for jobs and economic support, while social vulnerability indices showed which communities would likely experience greater difficulty recovering from economic hardships caused by job losses in the recreational and commercial fishing sectors. The conclusions of the report are that 3 communities have

greater than normal dependence on the recreational and commercial fishing sectors for jobs and economic support and 4 other communities are very dependent on the recreational sector. Compared to vulnerability indicators, 6 communities are classified as communities which would likely experience greater difficulty recovering from economic hardships caused by job losses in the recreational and commercial fishing sectors. This work of identifying communities that could be weakened by a modification of the spatial management areas is necessary but the impact it could have on each socio-economic indicator is not explained. I probably missed this point but how might changes in closed areas affect sport fishing activities, and consequently the communities that depend on it? It is clearly indicated that several sub-alternatives would allow a potential increased access to target species but this seems limited to the longline surface fishery and in the lack of more detailed information this is difficult to evaluate the socio-economic impact of the different alternatives on the communities.

One point that is missing here is how to incorporate different types of stakeholder input, specifically non-economic social data, into decision making leading into spatial management processes. The guideline introduced by Murphy et al. (2022) could provide a framework for the integration of stakeholder perspectives to help inform the trade-offs of alternative regulatory options for the spatial management of the Northwest Atlantic fisheries. Given that the HMS Advisory Panel is composed by members of environmental groups, fishery administration, University, representatives of recreational and commercial fisheries, it could be the ideal place to define which qualitative indicators could be combined to the ecological metrics used by PRiSM.

Recommendations

An interesting point that should be analyzed in the future is an estimate of the decrease in fishing mortality of target species (curiously virtually absent from the DEIS) and bycatch species associated with some candidate closed areas, at least when the new strata configuration is compatible with the closed area in force. This assumes having catch/discard per day and not only presence/absence data. Is there any possibility from catch per day data reported by observer at sea, and with at-haulback and post-release mortality estimates for by-catch, to estimate how many individuals are protected by the portion of the new closed area (or new months) previously fished?

The gap of fishery-dependent data due to the implementation of closed area, clearly mentioned in the DEIS, limits considerably the assessment of the effectiveness of spatial measures (among other things). It should be preferable to maintain a low fishing effort level (beyond a threshold to avoid confidentiality rules) inside the closed area to collect information on the species of interest. This corresponds to option 3 *"Collect data on closed area catch through an observed access program"* of the NMFS report devoted to the data collection in closed areas (NMFS, 2019). Combining fishery-dependent data collected by fisheries observers and fishery-independent monitoring from scientific surveys can help to identify drivers of bycatch. By using both types of data and Delta models, Jannot and Holland (2013) highlighted two important relationships: (1), when the effect of season, time of day, depth, or latitude on bycatch in both the commercial and scientific data is positive, ecological processes are likely strong drivers of bycatch, suggesting technical approaches (e.g., temporal or spatial closures, gear modifications) might effectively control bycatch, (2) alternatively, when the effects of season, time of day, depth, latitude, or target group appear only in the commercial data (but not in survey data), fisher behavior is likely the stronger driver of bycatch, suggesting a need to strengthen incentives for fishers to change behavior to avoid bycatch (e.g., regulatory quotas). This analysis was conducted on the U.S. groundfish fishery, which is very different from the fleets involved in the DEIS, but this could be a line of research in the future.

Appendix 1: Bibliography of materials provided for review and any other materials relied on during the review

Bibliography of materials provided for review

Crear, D.P., Curtis, TH., Durkee, S., and Carlson, J. (2021) Highly migratory species predictive spatial modeling (PRiSM): An analytical framework for assessing the performance of spatial fisheries management. Marine Biology 168:148. doi.org/10.1007/s00227-021-03951-7.

NOAA (2022) Draft Amendment 15 to the 2006 consolidated Atlantic Highly Migratory Species Fishery Management Plan. 150 p., + 3.1 "A" Alternatives: Evaluation and Modification of Spatial Management Areas, 26p., + Appendix 4 – Options, Metrics, and Scoring 61p., NMFS Silver Spring, USA.

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Appendix 2: A copy of the CIE Statement of Work

Performance Work Statement

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Center for Independent Experts Program
External Independent Peer Review

Research and Data Collection in Closed and Gear Restricted Areas in Support of Spatial Fisheries Management for Atlantic Highly Migratory Species

Background

The National Marine Fisheries Service (NMFS) is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards. Further information on the Center for Independent Experts (CIE) program may be obtained from www.ciereviews.org.

Scope

Spatial management measures such as closed areas and gear restricted areas are useful tools for the management of Atlantic Highly Migratory Species (HMS), including tunas, swordfish, billfishes, and sharks. Regulation of fishing behavior in specific geographic areas may affect both fishing effort and catch, and is often done to achieve specific management objectives such as reducing fishing mortality, bycatch, or bycatch mortality. As with any management measure, after implementation there is a need to determine whether the measure is achieving its objective, and whether the balance of associated costs and benefits over time is appropriate. The need to assess the effectiveness of the existing spatial management measures is particularly critical due to the static nature of those spatial management measures and the highly dynamic nature of HMS fisheries. Such reviews should include ensuring that closed areas remain appropriately placed to achieve ongoing conservation and management objectives, and conversely, that they do not unnecessarily prevent fisheries from attaining optimum yield from healthy fish stocks. However, the ability of managers to evaluate the effectiveness of those spatial management measures is

constrained by limited, or non-existent, fishery-dependent data collected from closed or gear restricted areas after implementation.

NMFS is currently developing an action (i.e., a draft environmental impact statement [DEIS] and proposed rule) to evaluate several HMS closed areas, consider modifications to them, and improve the use of spatial management as a tool, including methods to collect data from within closed areas. This current action considers a range of options to collect data in areas currently closed to fishing for HMS and begin to evaluate the effectiveness of the closed areas and determine if the original objectives are still being met. Programs to facilitate data collection could assess the efficacy of closed areas, improve sustainable management of HMS, and optimize benefits to commercial and recreational fishermen.

Some of the alternatives developed under this action are reliant on HMS PRedictive Spatial Modeling (PRiSM), a species distribution and habitat modeling framework developed by Crear et al. (2021). While the PRiSM methods themselves are not subject to this review, their application for meeting the purpose and need of the action are. Given the implications of this new modeling approach, it is important that the methods are clearly conveyed and applied in a logically sound fashion. Therefore, the CIE reviewers will conduct a peer review of the application of PRiSM and related analyses based on the Terms of Reference (ToRs) below. Given the public interest, it will be important for NMFS to have a transparent and independent review process of the model's use in HMS management.

The specified format and contents of the individual peer review reports are found in Annex 1. The ToRs of the peer review are listed in Annex 2.

Requirements

NMFS requires three reviewers to conduct an impartial and independent peer review in accordance with this Performance Work Statement (PWS), OMB Guidelines, and the ToRs below. The reviewers shall have working knowledge and recent experience in spatial modeling, with applications to fisheries management and/or quantitative ecology. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Tasks for Reviewers

Each CIE reviewers shall complete the following tasks in accordance with the PWS and Schedule of Milestones and Deliverables herein.

1. Pre-review Background Documents: Review the following background materials and reports prior to the review:

Crear, DP, TH Curtis, S Durkee, and J Carlson (2021) Highly migratory species predictive spatial modeling (PRiSM): An analytical framework for assessing the performance of spatial fisheries management. *Marine Biology* 168:148. doi.org/10.1007/s00227-021-03951-7.

Approximately, two weeks before the peer review, the NMFS Project Contacts will send by electronic mail or make available at an FTP site to the CIE reviewer all necessary background information and reports for the peer review. If the documents need to be mailed,

the NMFS Project Contacts will consult with the CIE on where to send documents. The CIE reviewer shall read all documents in preparation for the peer review.

2. Webinar: Additionally, approximately two weeks prior to the peer review, the CIE reviewers will participate in a webinar with the NMFS Project Contacts and other staff to address any questions that the reviewers may have regarding the ToRs or the review process. The NMFS Project Contacts will provide the information regarding the arrangements for this webinar.

3. Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the PWS and ToRs, and shall not serve in any other role unless specified herein. Modifications to the PWS and ToRs cannot be made during the peer review, and any PWS or ToRs modifications prior to the peer review shall be approved by the Contracting Officer's Representative (COR) and the CIE contractor.

4. Contract Deliverables: Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the PWS. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Place of Performance

Each CIE reviewer shall conduct an independent peer review as a desk review at their normal place of work as appropriate.

Period of Performance

The period of performance shall be from the time of award through [DATE]. Each reviewer's duties shall not exceed 10 days to complete all required tasks.

Schedule of Milestones and Deliverables

The contractor shall complete the tasks and deliverables in accordance with the following schedule.

Within two weeks of award	Contractor selects and confirms reviewers
Two weeks prior to the review	Contractor provides the pre-review documents to the reviewers. Reviewers participate in webinar.
July 2022	Each reviewer conducts an independent peer review as a desk review
Within two weeks after review	Contractor receives draft reports

Within two weeks of receiving draft reports	Contractor submits final reports to the Government

Applicable Performance Standards

The acceptance of the contract deliverables shall be based on three performance standards: (1) The reports shall be completed in accordance with the required formatting and content; (2) The reports shall address each ToR specified; and (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel

Since this is a desk review, travel is neither required nor authorized for this contract.

Restricted or Limited Use of Data

The contractors may be required to sign and adhere to a non-disclosure agreement.

Project Contacts

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Annex 1: Peer Review Report Requirements

1. The report must be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the application of PRiSM and related analyses is sound, reasonable, and logical, based on the data presented and relevant scientific information.

2. The main body of the reviewer report shall consist of a Background, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

3. The reviewer report shall include the following appendices:
a. Appendix 1: Bibliography of materials provided for review and any other materials relied on during the review
b. Appendix 2: A copy of the CIE PWS

Annex 2: Terms of Reference for the Peer Review

The reviewers will provide a scientific and management peer review of the following document:

Draft Environmental Impact Statement for Research and Data Collection in Closed and Gear Restricted Areas in Support of Spatial Fisheries Management for Atlantic Highly Migratory Species

The reviewers will provide input on the following questions:

1. Evaluate the *description* of the analytical approach used for each alternative.
    d. Are the methods clearly described and understandable in plain language?
    e. Is it clear how the underlying science, including PRiSM, was applied?
    f. Are any caveats, limitations, and uncertainties in the approach clearly described?

2. Evaluate the *application* of the analytical approach.
    a. Was the PRiSM framework and any other analytical approach applied in a logical, justifiable manner to develop the range of alternatives? Reviewers should refrain from making determinations or demonstrating preferences between or among alternatives in the document.
    b. To the extent that PRiSM was used to characterize the impacts of each alternative, was the characterization of ecological impacts consistent with the PRiSM results?

3. Are the ecological and socioeconomic analyses supporting the alternatives logical and documented appropriately?