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Proceedings of the Regional Science Peer Review Assessment of Incidental Catch in the Atlantic Canadian Swordfish/Other Tuna Longline Fishery

February 24-25, 2016
Dartmouth, Nova Scotia

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

Incidental bycatch and discarding of non-targeted species occur in many fisheries. An objective of sustainable fisheries management is to manage discard mortality for targeted species and to control the incidental mortality for non-targeted species. Fisheries and Oceans Canada (DFO), Maritimes Region, has undertaken research to evaluate incidental catch in the Atlantic Canadian Swordfish/Other Tuna longline fishery, with a focus on seven species: Bluefin Tuna, Porbeagle, Shortfin Mako, Blue Shark, Loggerhead Turtle, Leatherback Turtle, and undersized Swordfish. As part of the Regional Science Peer Review process, a meeting was held on February 24-25, 2016, at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia, to review an assessment of incidental catch in the Atlantic Canadian Swordfish/Other Tuna longline fishery. The meeting was follow-up to a meeting previously held on this topic in July 2011 entitled ‘Incidental Catch in Canadian Large Pelagic Fisheries’. To guide discussion, one Working Paper was provided to meeting participants in advance of the meeting date on February 17, 2016.

Peer reviewers felt that the Working Paper was not of sufficient detail to fully understand the methods used in analysis. In addition, the analysis was not as extensive as it could have been, and it was recognized that the Terms of Reference for the meeting were too broad in scope relative to the available resources. As a result, the reviewers did not feel that a Science Advisory Report or Research Document could be completed for publication at this time. The reviewers and meeting participants provided comments on the science findings, and reviewers provided recommendations for additional analysis that could be pursued as next steps to advancing this research. All participants agreed that without sufficient observer coverage levels, both spatially and throughout the fishing season (i.e., high enough to observe/define spatio-temporal components of the fishery), it is difficult to reasonably account for spatial and temporal components/variation in the fishery with respect to incidental catch. Further, it was agreed that continuation of this research in a timely manner was viewed as a priority for the Department to pursue. The meeting Chair noted that this message would be communicated to senior science managers for consideration within the 2016-2017 science work plan (there was no resolution by the end of the meeting about if, how, or when this research may be completed).

Sincere efforts were made in the science peer review process to acknowledge and address all comments and concerns raised by meeting participants provided they were appropriate and within the confines of acceptable peer review practice. This Proceedings document constitutes a record of meeting discussions, recommendations, and conclusions.

Compte rendu de la réunion régionale sur l’évaluation scientifique par les pairs des prises accessoires d’espadon et d’autres thons dans le cadre de la pêche à la palangre dans les eaux canadiennes de l’Atlantique

SOMMAIRE

Des captures accessoires et des rejets d’espèces non ciblées se produisent dans de nombreuses pêches. Un objectif de la gestion durable des pêches consiste à gérer la mortalité due aux rejets des espèces ciblées et à contrôler la mortalité accidentelle des espèces non ciblées. La Région des Maritimes du ministère des Pêches et des Océans (MPO) a entrepris des travaux de recherche pour évaluer les prises accessoires d’espadon et d’autres thons dans le cadre de la pêche à la palangre dans les eaux canadiennes de l’Atlantique. Les travaux portaient principalement sur sept espèces : thon rouge, maraîche, requin-taupe bleu, requin bleu, tortue caouanne, tortue luth et espadon de taille non réglementaire. Dans le cadre du processus d’examen régional par les pairs, une réunion a eu lieu les 24 et 25 février 2016 à l’Institut océanographique de Bedford, à Dartmouth, en Nouvelle-Écosse, afin d’évaluer les prises accessoires d’espadon et d’autres thons dans le cadre de la pêche à la palangre dans les eaux canadiennes de l’Atlantique. Cette réunion donne suite à une réunion tenue précédemment sur ce sujet en juillet 2011 intitulée « Captures accessoires dans les pêches canadiennes de grands poissons pélagiques ». Afin de guider les discussions, un document de travail a été distribué aux participants de la réunion le 17 février 2016, avant la tenue de la réunion.

Les pairs examinateurs sont d’avis que le document de travail n’est pas suffisamment détaillé pour bien comprendre les méthodes utilisées dans l’analyse. De plus, l’analyse n’est pas aussi étendue qu’elle aurait pu l’être, et on reconnaît que la portée du cadre de référence de la réunion est trop vaste par rapport aux ressources disponibles. Par conséquent, les examinateurs n’ont pas l’impression qu’un avis scientifique ou un document de recherche peut être terminé aux fins de publication pour le moment. Les examinateurs et les participants de la réunion fournissent des commentaires sur les résultats scientifiques, et les examinateurs formulent des recommandations aux fins d’analyse approfondie qui pourraient être envisagées comme prochaines étapes pour faire avancer cette recherche. Tous les participants conviennent que sans niveau suffisant de présence d’observateurs en mer, sur le plan spatial et tout au long de la saison de pêche (c.-à-d., suffisamment élevé pour observer ou définir les composantes spatio-temporelles de la pêche), il est difficile d’estimer raisonnablement les composantes et les variations spatiales et temporelles de la pêche en ce qui concerne les prises accidentelles. De plus, on convient que la poursuite de cette recherche en temps opportun est considérée comme une priorité pour le Ministère. Le président de la réunion indique que ce message devrait être communiqué aux cadres supérieurs du Secteur des sciences aux fins de prise en compte dans le plan de travail scientifique 2016-2017 (aucune résolution n’a été obtenue à la fin de la réunion quant à la façon de mener la recherche, le moment où elle sera terminée ou si elle sera même effectuée).

Des efforts sincères ont été déployés dans le cadre du présent processus d’examen scientifique par les pairs pour prendre connaissance de tous les commentaires et préoccupations soulevés par les participants et pour en tenir compte, à la condition qu’ils aient été appropriés et dans les limites d’une pratique d’examen par les pairs acceptable. Le présent document est un compte rendu des discussions, des recommandations et des conclusions de la réunion.

INTRODUCTION

Incidental bycatch and discarding of non-targeted species occurs in many fisheries. An objective of sustainable fisheries management is to manage discard mortality for targeted species and to control the incidental mortality for non-targeted species. In the context of the longline fishery for Swordfish and Other Tunas (Bigeye Tuna, Yellowfin Tuna, and Albacore), this requires a comprehensive plan for monitoring fishing activity, measuring discard mortality, and establishing suitable reference points that indicate when mortality has reached an unacceptable level. Fisheries and Oceans Canada (DFO), Maritimes Region, has undertaken research to evaluate incidental catch in the Atlantic Canadian Swordfish/Other Tuna longline fishery, with a focus on seven species: Bluefin Tuna, Porbeagle, Shortfin Mako, Blue Shark, Loggerhead Turtle, Leatherback Turtle, and undersized Swordfish. As part of the Regional Science Peer Review process, a meeting was held on February 24-25, 2016, at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia, to review an assessment of incidental catch in the Atlantic Canadian Swordfish/Other Tuna longline fishery.

The meeting was a follow-up to a meeting previously held on this topic in July 2011 entitled ‘Incidental Catch in Canadian Large Pelagic Fisheries’ (DFO 2011a). The meeting Chairperson, Mr. Kristian Curran, introduced himself, followed by an introduction of meeting participants (Appendix 1). The Chair thanked meeting participants for attending the DFO Regional Peer Review Process. The Chair provided a brief overview of the Canadian Science Advisory Secretariat (CSAS) peer review process and invited participants to review the meeting Terms of Reference (Appendix 2) and Agenda (Appendix 3). To guide discussion, one Working Paper was provided to meeting participants in advance of the meeting date on February 17, 2016. The meeting Chair noted that the meeting Working Paper and Background Papers were distributed for purposes of meeting discussion, and are not to be used in any other forum, distributed, or cited. This Proceedings document constitutes a record of meeting discussions, recommendations, and conclusions.

RESULTS AND DISCUSSION

ASSESSMENT OF INCIDENTAL CATCH

Title: Assessment of Incidental Catch in the Atlantic Canadian Swordfish/Other Tuna Longline Fishery

Science Lead: A. Hanke
Rapporteur: K. Curran

Presentation: Levels of Observer Coverage Needed to Estimate Discards

For purposes of the science analysis that was presented, the Science Lead noted that Terms of Reference #1 was to be interpreted as “document factors associated with ~~discarding~~ **dead discards** of the target species and provide estimates of juvenile Swordfish discards” (note: there was a discussion on this interpretation, with several meeting participants noting that they felt the Terms of Reference #1 was clear as drafted in it was referring to **all** discards and not just dead discards). The Science Lead indicated that the science questions to be addressed in the presentation included:

1. are changes in dead discard amounts statistically and biologically significant?;
2. what level of biological change do we wish to detect?; and

3. what level of observer coverage is required to detect this change?

The method used to estimate detectable change in dead discards (from 0-200%) versus a range of observer coverage (from 0-100%) was then presented, with individual rating curves per year (from 2002-2010) presented for Bluefin Tuna, Porbeagle, Shortfin Mako, Leatherback Turtle, Loggerhead Turtle, and undersized Swordfish. It was noted that differences in the various rating curves were attributed to species distribution relative to fishing, as well as the amount of observer coverage per year.

The Science Lead reviewed an approach to characterize dead discards in context of the species stock level, in order to identify what level of observer coverage might be considered acceptable. It was noted that stock status is typically assessed by evaluating its relationship to the biomass at Maximum Sustainable Yield (MSY) and Fishing Mortality (F) at MSY. In doing this, one can determine the difference in biomass of a stock at its current level and at a point where the mortality rate is equal to F_{MSY}. This biomass can then be compared to the biomass removed from the stock due to dead discards. Through use of a Kobe matrix, a method to estimate the observer coverage level to detect dead discards was then presented. Criteria that might be considered in deciding upon an appropriate level of coverage were then reviewed (e.g., impact of other fisheries on the species, need for a buffer, status of species, etc.). The Science Lead concluded that it is difficult to establish a level of observer coverage without having a dead discard management objective identified for the stock.

Discussion

A peer reviewer noted that the approach used to characterize the dead discards in the context of the species stock level was not in the Working Paper, which made the presentation difficult to follow. The reviewer noted that the magnitude of bias, if bias exists, declines as coverage increases, particularly for upper levels of coverage, as suggested in the presentation. The reviewer also felt that the power analysis should have been part of the Working Paper and not included as a separate paper because it compromised his ability to critically-review the science results that were presented.

A reviewer expressed concern that the equation presented was typically used for large sample sizes (asymptotic statistics), while the sample sizes presented were perhaps too small for this analysis to be valid. The Science Lead indicated that the analysis presented was viewed as a guide, and that potentially-larger margins of error must be kept in mind. Notwithstanding, the reviewer expressed concern with using the equation, questioning the reliability of the observer coverage rating curves that were presented (particularly at the lower levels of coverage). The Science Lead responded that on a relative basis the analysis was likely accurate, although on an absolute basis the results might be more difficult to interpret due to the small sample sizes being used (i.e., much more stochasticity for certain species). Another reviewer also expressed concern with the proposed rating curves, asking if there was any way to undertake the simulation in a manner that better quantified observer coverage. For instance, it was suggested that an inverse analysis could be pursued, in order to evaluate what levels of observer coverage might be meaningful. This Science Lead noted that this type of analysis could be done, although the results would only be as good as the inputs.

A reviewer asked if the assumption of setting discard mortality at a fixed level was reasonable (i.e., 50%), suggesting that a more realistic discard mortality rate per species could be used. The reviewer recommended that the analysis first quantify the discard level and then apply a mortality rate (as the discards are reasonably well-known quantities, while mortality rate is more uncertain). The reviewer then expressed confusion regarding the proposed levels of coverage between 5-10%, asking what difference could be expected within this range. That is, presenting the results as a range is ambiguous. In contrast, presenting the results as fixed values would be more informative, and management could then determine which values they prefer. The Science Lead noted that the results are even more nuanced, as observer coverage levels by species might be more preferable rather than setting a fixed observer coverage level for all species. The Science Lead indicated that more specific numbers could be presented, but that this would require further analysis.

A meeting participant noted that the data used in the analysis only went back to 2002, asking if more historical data, when higher levels of observer coverage existed, could be used. The Science Lead responded that he was not as familiar with the available data prior to 2002, so did not incorporate this into the analysis. Another meeting participant indicated that no fishery existed in the 1980s or 1990s, and that the highest level of observer coverage for the fishery was in the early-2000s, with some opportunity for test fishery observer coverage being available from the late-1990s for select areas of the Scotian Shelf (a participant familiar with the data indicated that that there was a change in the characteristics of the fishery that occurred in 2002, as the fishery changed from a truly competitive fishery in 1999 to an Individual Transferable Quota fishery in 2002, with a couple of transitionary years in between). It was noted that observer coverage, even in the best years, was not ideal both spatially and temporally throughout the fishing season. It was suggested that looking into observer coverage data from other fisheries, such as the Porbeagle fishery (including non-Canadian fishery), might be informative. A reviewer noted, however, that relatively little observer coverage from the Porbeagle fishery was available, so may not provide any meaningful results. In addition, the Porbeagle fishery is not likely representative, as the fishing practices differ markedly from the swordfish/tunas longline and the level of bycatch were very low. The participant noted that observer coverage was augmented up to 10% coverage over the past 5-6 years, although it was not realized in the end due to the unavailability of observers. Last, a participant asked if video data had been included in the analysis and the Science Lead noted that there was no video data available.

The Science Lead indicated that it is difficult to proceed with the scientific analysis without having a sense of management's observer coverage requirements, although it was agreed that science could provide a range of options (including the advantages and disadvantages of selecting any given option for management purposes). It was suggested that the Terms of Reference should focus more on the observer coverage needed to detect a statistical change in the stock, and not necessarily going as far as having an impact on the stock. A reviewer suggested a range of analytical options that could be pursued to address this Terms of Reference (see summary of reviewer comments below). The Science Lead asked if quantifying discards relative to a stock reference was a good way to proceed with the analysis. This approach was generally supported by meeting participants; particularly given that management objectives for the discard species were not well-defined.

All participants agreed that without sufficient observer coverage levels, both spatially and throughout the fishing season (i.e., high enough to observe/define spatio-temporal components of the fishery), it remains difficult to reasonably account for spatial and temporal components/variation in the fishery with respect to incidental catch.

Presentation: Evaluating the Effects of Small Sample Sizes and Count Distribution

The Science Lead reported on an analysis used to evaluate the potential impact of samples size (i.e., coverage levels) and count distribution on the estimate of total. Poisson and negative binomial distribution fundamentals were briefly reviewed, with the precision and bias results reported. The Science Lead concluded that for a given level of coverage, the precision and bias of the total discard estimates depended on the representativeness of the sample, as well as the mean and dispersion of the true count distribution. It was concluded that any factors affecting the count process and sampling would also impact the estimate of discarding and its precision.

Discussion

A reviewer expressed concern that the distributions assumed do not reflect the count distributions realized by thefishery. As a result, the analysis presented would be too conservative in its representation of the fishery. It was pointed out that the analysis presented would only be true if the fished area represented the mean scenario of fishery, which is not likely the case. In reality the underlying mean density of fish is almost certainly spatially and temporally variable and fishery catches will therefore be much more dispersed than assumed by the fixed mean Poisson and Negative binomial models that were simulated. This is the reason why recent simulations of fishery catch data in the literature from Canada and other areas in the world (e.g., by the U.S. National Marine Fisheries Service and ICES) have not used this simple approach.. Other options should therefore be pursed and validated. The reviewer recommended that a way forward, if a decent model was available to describe fishery counts, would be to simulate the range of observer coverages and deployment schemes, suggesting that the model described in a Background Paper to be discussed later in the meeting offered a promising option that could be explored for such analysis[1]. Last, the reviewer indicated that a conclusion of the presentation spoke to bias, although the Working Paper and presentation did not present any findings on bias and in fact by their nature, the simulations should produce unbiased results. The Science Lead indicated the term bias in this context was used to describe the difference between the true mean and the sample mean when in fact it should be the difference between the true mean and the estimate of the true mean based on the multiple realizations. This value would be zero as the reviewer points out and as the figures indicate. Many of the comments made by the reviewer were supported by other reviewers and meeting participants.

Presentation: Evaluating Stratification of Observer Coverage

The Science Lead noted that a large fraction of the total fishing is unobserved, emphasizing that sampling must be designed to take this into account both spatially and temporally. The Science Lead then reviewed methods to evaluate stratification, in order to improve the survey design. The method looked at functional relationships between the bycatch and features of fishing, used a recursive partitioning algorithm to detect features that can produce homogenous subsets of the bycatch data, and then assessed which features could be used to improve the survey design. Recursive partitioning for Porbeagle was reviewed as a working example (including a map demonstrating linear delineations of encounters with Porbeagle). A participant noted that Emerald Basin would likely drive high levels for Porbeagle. The Science Lead noted there is likely better ways to conduct the analysis that are more sensitive to to habitat variables, and not latitude/longitude, for purposes of stratification. The Science Lead then reviewed a summary of recursive partitioning results, followed by a summary of areas for consideration for stratification identified by members of the fishing industry themselves. For example, the Gulf Stream, Emerald Basin, Shelf Break, and Grand Banks were sub-areas identified by fishing industry members for stratification for Swordfish.

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[1] Dr. Aurelie Consandey-Godin presented a Background on shark bycatch estimation using a geo-spatial modeling approach, although her intent is to present the findings in the primary literature. As such, the Background Paper is not available for distribution outside of the meeting discussion. An overview of her presentation, including an accompanying discussion, is described below in the Proceedings.

The Science Lead reviewed some of the models and predictors used in the analysis (e.g., season, trip length, vessel tonnage, etc.). It was noted that stratifying too much would lead to too few samples to say anything meaningful. Other biases, such as vessel size, must also be considered in any advice put forward. The Science Lead surmised that the optimal strata varied by species, although the target versus actual observer coverage required further consideration.

Discussion

A reviewer noted that multi-species stratification is very difficult to achieve, as some species could be improperly accounted for (e.g., marine turtles). The reviewer felt that random sampling across the whole area might be a better approach, rather than sub-dividing the sampling for individual species (due to the many variables to be accounted for). Another reviewer recommended quantifying the optimal level of coverage and then working with industry to implement it, rather than focusing on actual coverage. The reviewer did like the recursive partitioning approach, but noted upfront that capacity to implement strata must be considered. For example, some variables are unpredictable upfront, so should not be included in any analysis used for purposes of identifying strata (e.g., bathymetry). The reviewer suggested pursuing a multi-species optimization to evaluate observer effort, although the reviewer could not provide any type of analysis as a recommendation for moving forward. There was then a brief discussion on fishery-related strata, such as targeted species and fished area (e.g., Gulf Stream), that in practice is difficult to follow/apply as fishermen may change their fishing plan due unexpected factors such as weather and catch level, to name a few.

The Science Lead clarified that the Terms of Reference was intended to look at a range of stratification scenarios that best optimized observer coverage with all species in mind, rather than evaluating the present case scenario (or levels) of observer coverage. A participant noted that fishing effort, based on retained catch, could be considered, although another participant suggested that such an approach does not work when bycatch species do not have a relationship to the target species (i.e., there is a need to tease out associated species from non-associated species, which links back to differences in effort versus species distribution).

Presentation: Assessing the Spatial Patterns of Species Relative to the Fishery

The Science Lead reviewed the spatial patterns of the fishery, non-target species, and observer coverage. The Science Lead noted that spatial patterns are difficult to discern for species such as marine turtles. It was also noted that the figures presented in the Working Paper applied to all fishery gear types, and not just the pelagic longline fishery. A reviewer asked why other datasets (e.g., tag data) were not used in the analysis (rather than simply using observer and DFO Maritimes Fisheries Information System (MARFIS) data), as other data regarding species distribution could be included (e.g., Committee on the Status of Endangered Wildlife in Canada reports). The Science Lead acknowledged that this was a limitation of the analysis that was undertaken and indicated that sourcing this data could not be accomplished in the time allocated. Tagging data was available for Bluefin tuna but processing was not complete. A meeting participant asked if it was juvenile Swordfish or all Swordfish included in the analysis and it was clarified that all Swordfish was included. The Science Lead then presented results that explored overlap of fishing relative to area where species are believed to be found (he reviewed plots for various species). Plots of seasonality for turtles were also reviewed.

It was noted that *Species at Risk Act* (SARA) logbooks might be a good source of data on Leatherback Sea Turtle, given they are listed pursuant to SARA, although the Science Lead indicated that he was unsure of how to access this type of information. A participant noted that gear types have changed over time, and some no longer exist, and this should be considered in the aggregated data that was presented.

Discussion

A reviewer asked if data pre-2002 could be used in the analysis. The Science Lead responded that the data could go back further, but was not used in this instance. The Science Lead welcomed any guidance the reviewer could provide in terms of acquiring any available pre-2002 data. The reviewer suggested that it may be useful to look at older logbooks to review industry-based estimates of discards reported on older logs versus discards estimated from observer data (for comparability). A participant noted that the fishery moved to an Individual Transferable Quote (ITQ), which needs to be factored into the analysis. Another reviewer indicated that the main point of the analysis is to properly characterize the distribution of the species, and that a model may be required to interpolate and extrapolate between data points. The analysis presented in the Working Paper did not get to this level of detail (which is particularly difficult for marine turtles). The third reviewer further supported the need to model species distribution, rather than relying on the analysis presented in the Working Paper. The Science Lead concluded that much more work is required.

A participant stated that he felt what was presented was more harmful than helpful in terms of species distribution. The data misinformed, as it does not include temporal information and does not differentiate between catch and bycatch for particular fisheries. The Science Lead again acknowledged limitations in the analysis that was presented and noted that this format has been used for decision making in other fora.

A participant sought clarity on what was being presented (i.e., presence of observers or where a species was observed). It was clarified that in the analysis presence of an observer does not necessarily match presence of a species at the same point in time. The Science Lead noted that some reports in the analysis appeared erroneous. A participant asked how erroneous data were factored into the analysis. Another participant noted that erroneous data is likely very small, so unlikely to be of concern. A reviewer noted that less than 1% per year of longline fleet data is erroneous within the commercial database. Other participants noted that they have estimated erroneous data upwards of 5%, in their use of data from the commercial database, with 1-3% being a reasonable assumption.

Presentation - Coverage Then and Now

The Science Lead reviewed analysis regarding observer coverage through time, indicating that after the science advisory process held in 2011 on this topic (DFO 2011a) observers moved from a fixed schedule where a prescribed proportion of seadays was allocated by month and area block to one where the coverage was being assigned according to the effort trends of the evolving fishery. It was noted that neither allocation strategy was effective when coverage was less than 5%. Further, observer coverage is not necessarily proportional to relative fishing effort (e.g., August) and there is a need to include observer coverage on smaller vessels. The Science Lead concluded that the current seasonal observer deployment strategy should be continued, with a focus of increasing presence on smaller vessels as well as meeting the minimum requirement of 5% coverage.

Discussion

A reviewer indicated that what was presented could be quantified (e.g., contingency table or treated as a binomial analysis where trips is trial), in order to determine over-sampling and under-sampling. The Science Lead questioned the value in pursuing such quantification given the low levels of observer coverage. The reviewer responded that it would be worth pursuing for certainty in the analysis, rather than basing conclusions on qualitative observations. Again, a participant expressed concern that the maps presented in the Working Paper may be misleading in terms of species distribution. It was cautioned by the participant that although the maps might serve purposes for the meeting Terms of Reference, they could be misleading if applied elsewhere.

It was agreed that any results regarding observer coverage be presented as a range of scenarios for management's consideration, including opportunities and challenges associated with any one scenario.

Presentation - Alternative Methods (Ratio Estimate)

The Science Lead presented various models used to estimate Swordfish discarding versus the ratio estimate approach (a general linear mixed effects model, MCMCglmm, was the best fit). It was noted that precision in the estimates was variable, likely due to sensitivity in the observer coverage. In terms of general conclusions, the glmm and ratio estimates were similar in scale. All methods that were explored were sensitive to level of observer coverage.

Discussion

A reviewer noted that there is no basis to compare the reliability of the models. In the past, the retained fraction of the observer data could be compared to actual landings to assess both bias and confidence in the estimate (this is a means to validate both the data collection and estimation process). The assumption is that the landings are correct. The reviewers felt the models presented in the Working Paper appeared preliminary, as they did not appear to be well-validated. It was emphasized that the models need to be validated before they can be used to predict with confidence. A reviewer emphasized the importance of understanding the uncertainty associated with all of the inputs, before anything meaningful can be said about the outputs. A meeting participant noted that spatial uncertainty of the fishing, relative to the Gaussian Random Fields approach, can be accommodated by decreasing the modeled resolution (e.g., increase the modeled output polygon size to account for longline drift distance from deployment to recovery). A reviewer suggested that these are really complicated models, including issues with data, so would advise starting simple and building the models up in terms of input criteria. In addition, all covariates used should be justified, to assist the reader. Another reviewer noted that latitude and longitude were being used as linear predictors in the GLMM model, which is a strong assumption (and is likely an exception that needs to be checked. Last, it was noted that the selection of covariates required further thought, testing, and justification (as well as evaluated for any potential for non-linearity in the covariates).

GEO-STATISTICAL MODELS OF SHARK BYCATCH

Title: Investigation Alternative Methods for Bycatch Estimation: Geo-statistical Models of Shark Bycatch

Science Lead: A. Cosandey-Godin
Rapporteur: K. Curran

Presentation

The Science Lead reviewed an alternate method for estimating discards, with the goal of reducing the impact of commercial fisheries on non-target species. The modeling approach dealt with unknown covariates, and could operate in Bayesian or non-Bayesian settings. It was noted that the analytical framework allowed to build simple to complex spatio-temporal models. The Science Lead indicated that observer and commercial landings datasets were used in the analysis, with the datasets being cleaned where possible to remove erroneous data. Covariates in the model were divided into fishery (e.g., Gross Registered Tonnage, Number of Kooks), environmental (e.g., Sea Surface Temperature, Bathymetry), and year/location (included as Gaussian Random Fields) categories. It was clarified that targeted species was not included as a covariate in the model, in order to better account for fishing behaviour according to fishing practices. It was further clarified that seasonality was not included in the model, but was reflected in part in the dynamic environmental variables.

The Science Lead explained which covariates were prioritized in terms of their importance to the predictions. The bathymetry and spatio-temporal (locations/years) covariates were most significant to many of the shark species, in terms of predicting bycatch (total catch). The model was generally good at predicting the observations. It was noted that larger differences were observed between years. The Science Lead noted that the results represented total bycatch (i.e., discards and retained). Porbeagle was typically caught in one region (i.e., Emerald Basin), whereas Shortfin Mako and Blue Shark were captured across the fishing domain. An advantage of the model was that time, space, and density, in areas not sampled, also provided information, with uncertainty also being considered. The models provided information on candidate observer stratifications. A limitation of the model was that it did not resolve well at timescales of less than one year aggregated time (included a spatiotemporal indexed by year), plausibly because of limited observer data. Last, there was a brief presentation of spatial dynamic management i.e., areas to avoid to reduce bycatch rate, and what it might look like spatially and temporally and effects on targeted bycatch catch.

Discussion

A reviewer noted that an underlying assumption of the model is that any change in the distribution of animals is strictly related to a change in environmental variables (i.e., behavior is not incorporated into the model). Inferences made on a time scale that is less than annual are unlikely to be correct if there is any seasonal behavior such as migration and aggregation for spawning. However, if inferences are made on an annual time scale, the consequences of ignoring behavior may well be less severe or perhaps even nil particularly if the input data to the model are seasonally representative. Another reviewer asked what kind of model validation occurred, and the Science Lead responded that the model had been cross-validated. The reviewer noted the results exhibited a lot of extrapolation, and this might require additional validation to ensure confidence in the modeled outputs. A participant responded that a potential posterior predictive test could be to match reported landings of Porbeagle and Shortfin Mako sharks during years when they were commonly landed (which provides another opportunity to cross-validate the model). It was noted that closures might compromise the ability to apply the model if input data from closed areas are not available.

A reviewer further noted that the degree of extrapolation, based on covariates used in the analysis, can affect the ability to predict within a set level of confidence. That is, the modeled covariates (e.g., fishing versus environment) need to be accurate for the predictions to be accurate, which would be difficult to do). Depending on the variables used as predictors, some were inferred themselves (e.g., chlorophyll inferred from satellite imagery) and would have uncertainty associated with them; all of these uncertainties need to be incorporated into the estimate of discards.

INSIGHTS FROM MARINE TURTLE BIOLOGY

Title: Incidental Capture of Loggerhead and Leatherback Turtles: Insights from Sea Turtle Biology

Science Lead: M. James
Rapporteur: K. Curran

Presentation

The Science Lead reviewed the nature and magnitude of marine turtle incidental captures associated with pelagic longline fisheries operating globally and in Atlantic Canada, noting that the aim of his research is to reduce incidental capture and enhance survival after release. The Science Lead noted that marine turtles take 25-30 years to reach maturity, so reducing incidental capture at juvenile life stages is of particular importance. Methods presently-available to mitigate incidental capture were then reviewed (e.g., hook type and size, handling practices, etc.). Many factors affect the likelihood marine turtles are captured in the fishery (e.g., morphology, feeding behavior, etc.). Biotelemetry studies can assist in evaluating the behavior of marine turtles in context of the pelagic longline fishery, as well as demonstrate the effectiveness of mitigation measures. Preliminary results of biotelemetry studies were then reviewed. The Science Lead indicated that platform transmitting terminals (PTT) provide near real-time information regarding marine turtle behavior, and that PTT have been applied to Loggerhead turtles (n=9) and Leatherback turtles (n=110) in Atlantic Canadian waters. The Science Lead further noted that pop-up archival tags (PATs) have also been used to study the behavior of marine turtles in region (only applied to Loggerhead turtles), although use of these tags has not been as successful as PTT.

The Science Lead reviewed characteristics of Loggerhead turtles and Leatherback turtles. Of the hard-shelled marine turtles, Loggerhead turtles are most common in Atlantic Canadian waters. They prefer warmer waters, with water temperature being a principle factor in determining their timing and location in the region. Preliminary results of tagging studies indicate that Loggerheads turtles tend to aggregate within the southwest Scotian Shelf slope waters (in the offshore beyond the shelf break between the North East Channel and south of Sable Island). The Science Lead emphasized that more sampling is required east of the Hague Line and west of the Laurentian Channel/Grand Banks, within the offshore slope waters. It was noted that Loggerhead Turtle presence in Atlantic Canada is highly-influenced by the northern limit of Gulf Stream. The majority of Loggerhead turtles (upwards of 95%) have been observed to reside in the upper 30 m of the water column, which overlaps with the typical set depth of the pelagic longline fishery operating in the region (most incidental capture associated with the fishery is observed where sea surface temperature is greater than 20oC). The Science Lead noted that Loggerhead turtles may prefer certain types of bait (squid versus mackerel) and may interact with baited hooks differently depending on the type of bait used (sucking versus biting). Loggerhead turtles eat a range of food, however, and are known to aggregate behind shrimp fleets to forage on the discards (making them susceptible to incidental catch in this fishery as well). It is estimated that 1200 Loggerhead turtles are incidentally captured annually in Atlantic Canadian waters.

Leatherback turtles are broadly distributed in northern waters. Studies have identified aggregations within the southwest Scotian Shelf slope waters in the offshore beyond the shelf break of the North East Channel, off of Cape Breton Island, in the southern Gulf of St. Lawrence, and in coastal areas of southern Newfoundland. That said, Leatherback turtles can be found throughout the Scotian Shelf, southern Gulf of St. Lawrence, and western Grand Banks regions. Leatherback turtles prefer colder waters in Atlantic Canada, so their spatial and temporal locations differ than those of Loggerhead turtles; the two species are not comparable. Further, the distribution of Leatherback turtles is not as constrained by a lower themal tolerance limit (can exploit waters where sea surface temperature is less than 15oC, and have been observed to dive to depths where water temperature is near 0oC). The species exhibits a specialized diet when at high latitudes (i.e., jellyfish), so are not observed to target baited hooks of the pelagic longline fishery. Instead, they tend to get foul-hooked while swimming through areas occupied by the fishery (unlike Loggerhead turtles, Leatherback turtle incidental hooking is to the body and not by hook ingestion). Peak incidental capture of the turtles occur in waters 18-20 0^{o}C, with the majority of dives being less than 30 m from the surface which, again, is the typical set depth of the pelagic longline fleet operating in the region. Overall, Leatherback turtles are of less abundance than Loggerhead turtles in Atlantic Canadian waters.

In summary, there is spatial-temporal overlap between Loggerhead turtles and Leatherback turtles with the pelagic longline fishery operating in Atlantic Canada. There is a need for detailed coding of hooked turtles with fishery interactions (e.g., hook location, anatomy impacted, type of bait, etc.), as it is difficult to obtain biological samples and have confidence in observer scoring; particularly on larger pelagic longline vessels. For comparative purposes, there is a need for information on incidental catch of marine turtles from both large and small vessels.

Discussion

There was a general discussion regarding next steps for additional marine turtle research and analysis. The Science Lead indicated that Loggerhead turtles are of higher priority for additional research given higher abundance in Atlantic Canada, as well as their greater affinity to interact with the pelagic longline fishery that operates in the region. The Science Lead noted that a priority research area is to better understand Loggerhead Turtle movements in the region at higher resolution, including studies to assess seasonality and gear types that exhibit higher rates of incidental catch (e.g., lobster trap entanglements). The Science Lead noted that due to changes in the pelagic longline fishery over the past two decades, there is a need focus on fishery behavior during recent years rather than looking at historical datasets.

A participant asked if Loggerhead turtles found at depth in Atlantic Canadian waters are driven by the presence of other large pelagic species, and the Science Lead noted that there does not appear to be any relationship. Another participant asked if the Science Lead was aware of efforts to reduce sea turtle interactions in the Hawaii-based longline Swordfish fishery (e.g., Gilman et al. 2007), guided primarily by sea surface temperature, asking if this is something that could be reviewed more closely for application in Atlantic Canada. The Science Lead responded that he was aware of the Hawaii-based program but, given many pelagic species in Atlantic Canada occupy the same thermal niche, the approach used in Hawaii may challenge incidental capture mitigation efforts for marine turtles in this region. A reviewer then asked if any information regarding multi-species clustering was available, and the Science Lead indicated that it was. The reviewer suggested that with such information available, management options similar to those used for deep sea corals in frontier areas could be applied, given they are based on clustering theory. Last, a participant asked if the impact of particular fishing fleets on overall marine turtle populations throughout their range in the North Atlantic could be estimated. The Science Lead replied that this type of analysis has not been pursued, with few meta-analyses being available on Loggerhead turtles and the various threats they encounter throughout their range. Another participant noted that previous studies have tried to evaluate the overall impact of fisheries on the Loggerhead Turtle population in the North Atlantic, with tagging studies now being used to validate these previous studies.

OTHER DISCUSSION TOPICS

LIMITATIONS OF THE AT-SEA OBSERVER PROGRAM

A reviewer asked if there is a penalty for observer companies not meeting their targets. A participant familiar with the industry responded that DFO negotiates the contract with at-sea observer companies and industry pays for the programming. As such, industry is not in control of outcomes of the contract. The reviewer noted that this poses a challenge in the analysis, as there is no sense proposing a stratified sample that observer companies cannot achieve (particularly if penalties are not upheld). The participant replied that there have been previous attempts to undertake random stratification, although it has not worked out that well. The participant then emphasized the need for DFO to work with observer companies to ensure well-represented, in space and time, coverage for every fishery (e.g., obtaining all required coverage over the last month of a fishery still does not yield informed information). It was noted that the observer program currently limits ability to stratify and effectively sample the large pelagic longline fishery for bycatch analysis.

In 2013, DFO ended the At-Sea Observer contracting process and regional exclusivity. The program was restructured based on the Dockside Monitoring Program with company designation requirements laid out in National Policy and Procedures followed up by Regional Annexes each company wishing to provide at-sea observer services to industry had to meet. The Canadian Government Standards Board (CGSB) worked with DFO to develop an At-Sea Observer Corporation Certification Program companies also had to pass. This change produced considerable instability in the program, as companies achieving designation and certification were now able to work competitively in any region in Canada. Companies no longer had an “exclusive contract” to service a DFO region. This meant shortfalls in observer coverage in 2013, improvements in 2014 and acceptable performance in 2015. In this competitive environment, working closely with an At-Sea Observer Service Provider to layout observer requirements in advance of the fishery and provide details of the required spatial and temporal spread is essential. Follow-up through the season is a complementary tool to help track fleet and observer coverage targets and fine tune deployments. Some fisheries will always be a challenge to attain targets due to short notice sailing, weather, remote ports and observer availability.

PRIVACY ACT DATA CONSIDERATIONS (‘RULE OF FIVE’)

Meeting participants inquired about the ‘Rule of Five’. Pursuant to the *Privacy Act*, fishery-related information (e.g., landings) falls under personal or third party information and does not meet the threshold required to invoke the public interest clause for release publicly. Generally, public interest relates to urgent matters of health and safety and the existing jurisprudence supports this point of view. Internal to DFO, however, all fishery-related information is available to scientists for science assessment purposes, although the Department’s standard approach to reporting the information is to apply a variety of aggregation and de-identification techniques to anonymize the data when fishery-related information pertains to **less than** five licence holders (‘Rule of Five’). Alternatively, DFO scientists can seek written permission from individual licence holders to report publicly on personal or third party information that pertains to an area or fishery where less than five licences are held. It remains, however, that DFO should continue to evaluate this rule in context of transparent science assessment versus private interests, as well as strive to achieve inter-regional consistency in its application.

ABORIGINAL FISHERIES LANDINGS DATA

Meeting participants inquired about the availability of Aboriginal Communal commercial landings data. The DFO Maritimes Region Commercial Data Division (CDD) is the holder of the MARFIS data. Aboriginal Communal commercial landings data are submitted to Dockside Monitoring Companies for entry into MARFIS, including Communal commercial pelagic longline landings, and can be separated out by licence type or Fisher Identification Number (FIN) in most instances. Requests for commercial fishery-related data can be submitted to CDD at: CommercialData.XMAR@dfo-mpo.gc.ca. Some Aboriginal Communal Food, Social, and Ceremonial (FSC) data is also recorded in MARFIS. Any request for this information should first be directed to DFO Maritimes Region Aboriginal Affairs to determine availability.

SPECIES AT RISK ACT (SARA) LOGBOOK DATA

Meeting participants inquired about the availability of SARA logbook data. All SARA logbook data is entered into MARFIS. Requests for this data can be submitted to CDD at: CommercialData.XMAR@dfo-mpo.gc.ca. Again, internal to DFO, all SARA logbook data is available to scientists for science assessment purposes, although the Department's standard approach to reporting the information is to apply a variety of aggregation and de-identification techniques to anonymize the data when fishery-related information pertains to less than five licence holders. Again, DFO scientists can seek written permission from individual licence holders to report publicly on personal or third party information that pertains to a fishing licence. It was apparent from the meeting discussion that further awareness and guidance needs to be provided to DFO scientists regarding the existence and availability of SARA logbook data.

RECOMMENDATIONS FOR MOVING FORWARD

REVIEWER: HUGUES BENOÎT

Terms of Reference #1: Document factors associated with discarding of the target species and provide estimates of juvenile Swordfish discards.

The reviewer indicated that the model presented by Cosandey-Godin at the meeting, was likely the most effective and efficient tool for addressing a number of the meeting Terms of Reference. The modelling approach presented is probably one of the most statistically-rigorous and robust approaches that is currently available. At its core, it is a regression model, which is the best approach for identifying factors associated with discarding. The R-INLA approach allows for use of non-parametric smooth functions and, thus, non-linear effects of potential covariates can be accommodated. The reviewer recommended that time be spent building the model using common regression approaches, identifying which variables to include and how (e.g., linear or non-linear effect, interactions). Further, validation of the model, via posterior predictive checks, evaluation of residuals and such, would need to be documented in some form of research publication.

As demonstrated by Cosandey-Godin in her presentation, the model could be used to infer catch and discard amounts for the various species reported in the at-sea observer data. The predictive abilities of the model for both interpolation and extrapolation should be evaluated using cross-validation methodology. Furthermore, the range and co-linearity of the covariates in both the data used to fit the model and the locations for which inference is required should be evaluated to ensure that any model extrapolation is consistent with the model fitting.

Any model-based estimation of discards using covariates assumes that the covariate values are accurate and precise. Drifting of longline gear may affect covariate accuracy, particularly since fishing often takes place in high gradient areas (shelf break, Gulf Stream edge, etc.). Some evaluation of the consequences should be undertaken. Furthermore, because some of the covariates are themselves inferred, in some cases at a coarser temporal scale (e.g., chlorophyll-A), the variance in the covariates should somehow be reflected in the variance of inferred quantities, or at least the sensitivity of the model to this variance should be evaluated. The reliability of the model for inference on discard amount should be validated by predicting annual landings based on observed retained catches and comparing these to actual total landings. In this manner, model accuracy and the coverage of credibility intervals generally can be evaluated. Model predictions should also be compared to available tagging data for the various species, as a gauge of model accuracy.

The reviewer recommended that the ratio estimator approach for estimating discards not be discarded from the analysis. Though this approach makes some strong assumptions, which were documented in the Working Paper, in practice in other applications the estimation appears fairly robust to deviations from these assumptions. It may be that the model-based estimation is not much more robust (note: the robustness of the ratio estimator could be evaluated by simulation). The ratio estimator has the advantage that it is widely used, is easy to understand for all interested parties, and makes predictions that will not change with the addition of new annual data. In contrast, the model-based estimates are generated from a complex model that will not be fully understood by most stakeholders and the predictions for any given time period will change, though perhaps only a little, as new data is added and the value of regression coefficients change.

Terms of Reference #2: Determine if observer sampling is representative of the fleet and appropriate for the seven species identified in the 'Work Plan to Address Incidental Catch in the Atlantic Canadian Swordfish/Other Tuna Longline Fishery' (i.e., undersized Swordfish, Bluefin Tuna, Porbeagle, Shortfin Mako, Blue Shark, Leatherback Turtle, and Loggerhead Turtle).

The reviewer questioned the utility of the Terms of Reference as drafted. The reviewer suggested that a more fundamental question is whether deployment is representative of available fishing trips (for design based estimation of discards) or broadly representative of the relevant conditions associated with fishing events that are used for inference via model-based estimation (e.g., date, sea surface temperature, fishing location, etc.). The reviewer noted that the types of comparisons presented in the Working Paper (i.e., Figures 40-42) were useful for evaluating the extent to which deployment is representative of available fishing trips, as well as whether there was a change as a result of changes in the deployment scheme. The reviewer recommended, however, that these comparisons be quantified statistically. Available approaches that could be used include classical contingency-tables analyses or generalized linear modelling methodology (binomial family; with trips as 'trials' and observed trips as 'successes').

The reviewer strongly recommended that the Science Lead undertake analyses to test whether there is evidence for observer effects in the available data (i.e., changes in fishing behaviour in the presence of an observer), as these can bias inferences on catch and bycatch. Methods to do so are described in Faunce and Barbeaux (2011) and Benoît and Allard (2009).

Terms of Reference #3: Identify potential strata for the purpose of improving precision of discard estimates. In addition, investigate alternative methods for discard estimation.

The Terms of Reference was not initially clear to the reviewer, although it is now understood that this was meant to be design-based stratification for observer deployment rather than post hoc stratification for data analysis. As such, the recommendation is to first identify the suite of potential stratification variables that can be used for program-based deployment. These might include date, fishing zone, and vessel size class, but would presumably exclude variables that cannot be specifically identified prior to a fishing trip. Using either (or both) sampling from the original data or simulations from a model (e.g., Cosandey-Godin-type model presented at the meeting), efficiency of stratification from a variance reduction stand-point can be calculated for different deployment schemes.

Terms of Reference #4: Summarize available information on the habitat use of marine turtles in Canadian waters; areas of potential and/or documented turtle-fishery interaction; how ecophysiology can influence species' distribution and occurrence; and how the distribution of observer coverage can enhance the collection of valuable data pertaining to turtle biology and incidental capture.

Regression-type models, as noted above, are suited for determining the factors that best describe turtle habitat and to best estimate space-use by marine turtles. This can be used, among other things, to identify areas and times that should be avoided by the fishery to avoid marine turtle incidental capture. However, sparseness of the available data may make fitting such models difficult. While it is not specified in the Terms of Reference, if the overall intent is to minimize marine turtle encounters in the fishery then an alternate approach to defining areas would be to adopt encounter protocols for the fishery. Such protocols are presently used to minimize fishery interactions with sensitive benthic features (e.g., corals and sponges) located in frontier areas where the distribution of these features is unknown (e.g., Boutillier et al. 2011; DFO 2011b). Given the apparent aggregated nature of turtles, as confirmed by turtle expert Mike James, encounter protocols could be an effective management tool to explore further here as well.

Terms of Reference #5: Assess the change (+/-) in encounters per species to be detected with 95% certainty and estimate the level of annual observer coverage needed to detect this change.

The reviewer acknowledged that simulating reliable observer data is a difficult task. The data are often zero- inflated and may also contain extreme values. Furthermore, because each fishing set is potentially sampling a different latent density of fish (i.e., density is spatially and temporally variable), the resulting counts by definition are not generated from a homogenous latent mean density, resulting in a complex statistical distribution for the counts. However, the Cosandey-Godin-type model presented at the meeting, or a similar empirical model describing catch/bycatch, can readily be used to simulate fishery catch data and therefore simulate the likely results of an at-sea observer survey. This could be used to simulate different deployment levels and deployment schemes (e.g., stratification).

REVIEWER: DAVID KEITH

Terms of Reference #1: Document factors associated with discarding of the target species and provide estimates of juvenile Swordfish discards.

The reviewer recommended stepping back and rethinking from scratch the analysis used for this Terms of Reference. It was suggested that any analysis focus first on estimating total discards; once a model is in place it can be used to estimate dead discards (cannot easily go from dead discards to discards, but it should be possible to move in the other direction). Try to better understand the fishery and the scale it operates at (i.e., spatial and temporal scales of the fishery and the covariates being contemplated). For example, the pelagic longline fishery in Atlantic Canada sets gear based on very fine temperature differences, fishing in temperature fronts that are of very different scale than the monthly-averaged sea surface temperature data used in the analysis. Need to determine if these are implications of this both biologically and statistically.

Start simple, exploring patterns of discards and covariates that might be worth further investigation. Spatial and temporal patterns at different scales are all worth investigation. It is also worth looking at this both in the sense of binomial (0/1) patterns and in terms of counts. The reviewer indicated he would not be surprised if the data is best described as a ZINB (zero inflated negative binomial) type model. There may be patterns of interest in patterns of the binomial process (discard/none), but the patterns may be different in terms of the numbers of discards found. Given the nature of the data, it may be hard to understand what is occurring without considering such separation.

GMRF-INLA modelling is a gold standard in spatial models presently being used, and there is a growing expertise regarding use of these models within DFO (and certainly in the primary literature). The Cosandey-Godin model that was presented has shown that these types of models offer a potential path forward at this time. The reviewer suggested starting with simple models and understanding what they are demonstrating in terms of residual patterns that can guide the development of more complex models. These complex models then need to be validated; if there are "issues" (and likely there will be), these need to be presented and discussed within a peer-review forum, in order to help guide the resolution of model issues or agreeing to live with the problems, but understanding the impact of the issues on the general results.

Terms of Reference #2: Determine if observer sampling is representative of the fleet and appropriate for the seven species identified in the 'Work Plan to Address Incidental Catch in the Atlantic Canadian Swordfish/Other Tuna Longline Fishery' (i.e., undersized Swordfish, Bluefin Tuna, Porbeagle, Shortfin Mako, Blue Shark, Leatherback Turtle, and Loggerhead Turtle).

The reviewer noted that issues related to meeting observer coverage targets need to be addressed first and foremost (similarly for Terms of Reference #3). A recommended next step is to move towards some modeling work that would be helpful, with the geo-spatial model presented by Aurelie Consandey-Godin offering a good starting point for consideration and exploration.

Terms of Reference #3: Identify potential strata for the purpose of improving precision of discard estimates. In addition, investigate alternative methods for discard estimation.

The reviewer noted that if coverage was sufficient some sort of stratification scheme might be beneficial; however, given challenges regarding availability of at-sea observers, some strata may be missed and generally the objectives of stratification would not be realized. Simulations from models that could be developed under Terms of Reference #1 could be used to help determine optimal stratification schemes.

Terms of Reference #4: Summarize available information on the habitat use of marine turtles in Canadian waters; areas of potential and/or documented turtle-fishery interaction; how ecophysiology can influence species' distribution and occurrence; and how the distribution of observer coverage can enhance the collection of valuable data pertaining to turtle biology and incidental capture.

The marine turtle tracking data presented seems to be a reasonable basis for moving forward with this Terms of Reference. Evaluating information on marine turtle seasonal patterns in distribution and behaviour (temperature, depth, and aggregating tendencies), along with available fishery data, will help develop a better understanding of spatio-temporal patterns of incidental capture risk for both Loggerhead Turtle and Leatherback turtles.

Terms of Reference #5: Assess the change (+/-) in encounters per species to be detected with 95% certainty and estimate the level of annual observer coverage needed to detect this change.

Research into this Terms of Reference should be a natural extension of models developed under Terms of Reference #1. Some simulation studies based on the models could be undertaken to determine the influence of observer coverage.

REVIEWER: MARK FOWLER

Terms of Reference #1: Document factors associated with discarding of the target species and provide estimates of juvenile Swordfish discards.

The reviewer recommended documentation of factors relevant to the discarding of target species, noting that the analysis presented focused solely on dead discards. The ultimate relevance of the discard mortality is obvious, but estimating the magnitudes of the discards should come first. The dead Swordfish discards were assumed to equate to only those fish noted as dead or moribund by an observer. Several studies of large pelagic species indicate that mortality of apparently healthy discards can be very high. The reviewer was not aware of any case where post-release morality rates are of trivial quantity, suggesting that the presented analysis under-estimated discard mortality. Last, the reviewer recommended that shark-bit Swordfish not be removed from the analysis, as they represent a portion of mortality that should be accounted for in some manner.

The utility of historical commercial data increases back through time; there is more data per year and less circumspection regarding bycatch by fishermen in years preceding the Species at Risk Act. The current analysis only uses landing data from the MARFIS database, which only dates back to 2002. In contrast, DFO has logbook data going back to 1986. Processing and protocols of logbook data may be problematic in earlier years, but the data should be of good quality since at least 1995. Earlier years' data are archived, although the reviewer can provide an Oracle table of log-based, catch-effort data for 1995-2002 (which includes some reconciliation with slip data). SQL was used to create this table. The logbook data also includes reporting of discards. It was not clear if this was realized by the Science Lead in this meeting or if it was discounted as unreliable. An aspect of the pre-MARFIS logbook data worth considering is they precede an organized approach by DFO Resource Management and Industry to address bycatch issues, which the reviewer believe began in about 2001. The logbook data might also provide a means of filling in data gaps (e.g., small boats, short trips, etc.) posed by observer data.

The reviewer provided the following technical note: the working paper commented that analysis began in 2002 because MARFIS data in 2001 did not properly identify trip number. The MARFIS database truly only starts in 2002. The year 2002 was the overlap year where both old and new catch statistics systems were used in tandem to truth MARFIS processing (also why 2002 was incorporated into the Oracle log data table mentioned above). When 2002 was resolved, analysts attempted back-processing pre-MARFIS data starting with 2001. The exercise was unsuccessful and the initiative abandoned, although the partial and incorrectly processed 2001 data has remained in the MARFIS database ever since.

The reviewer noted that only dead discards of juvenile Swordfish was addressed, whereas the Terms of Reference referred to estimating the 'discarding of target species', suggesting this Terms of Reference would presumably apply to 'other tuna' species. As such, the Terms of Reference should be reviewed prior to any future peer review meeting.

Terms of Reference #2: Determine if observer sampling is representative of the fleet and appropriate for the seven species identified in the 'Work Plan to Address Incidental Catch in the Atlantic Canadian Swordfish/Other Tuna Longline Fishery' (i.e., undersized Swordfish, Bluefin Tuna, Porbeagle, Shortfin Mako, Blue Shark, Leatherback Turtle, and Loggerhead Turtle).

The reviewer noted that limiting the commercial data used in the analysis from 2002 to present could be confounding. Magnitudes of effort go up back through time, so pre-2002 data might be more informative than recent years for this type of analysis. As well, a comparison of distributions between 2002 to present (MARFIS data) with 1977 to present (observer data) would not be expected to correspond well.

The Working Paper did not provide values to work with. What is required is coverage rates presented in a form that could be used in defining an observer sampling scheme. Other minor inconsistencies in the Working Paper made it difficult to evaluate the methods being used (e.g., start year of analysis of 2002 presented in the first paragraph of the methods section than becoming 2004 in the second paragraph). The reviewer questioned if this inconsistency was real or simply a typographical error; if real, the reviewer recommended explaining it further.

The 'Longline Filter #4 (Number fish per Species > 1)' used in the analysis may be problematic. The reviewer noted that the data is already filtered for single species occurrences, so general paucity is dealt with, while this filter seemed to negate fishing sets with bycatch of uncommon species (particularly with marine turtles in mind). In addition, the basis for the 300-hook filter appeared arbitrary and should be justified (e.g., 250-hook filter, 200-hook filter, etc.). A likely top end for the number of hooks used handlining/trolling, as opposed to a typical longline set, should be specified. Last, ensure that the manner in which the analysis is presented is consistent with the 'Rule of Five' pursuant to Privacy Act considerations.

Variability between observers should be investigated, with a particular emphasis on identifying anomalous reporting (e.g., watch out for observers that occur very briefly) that inflates variance in analyses.

Terms of Reference #3: Identify potential strata for the purpose of improving precision of discard estimates. In addition, investigate alternative methods for discard estimation.

Stratification variables that can be considered in the context of at-sea observer deployment protocols are needed. The latitude-longitude demarcation that was presented cannot be used for this purpose. The reviewer recommended further exploration into available fishery-related stratifications, such as statistical unit areas, that could be used for this purpose.

Terms of Reference #4: Summarize available information on the habitat use of marine turtles in Canadian waters; areas of potential and/or documented turtle-fishery interaction; how ecophysiology can influence species' distribution and occurrence; and how the distribution of observer coverage can enhance the collection of valuable data pertaining to turtle biology and incidental capture.

Ensure all data available within the Species at Risk Act (SARA) logbooks are incorporated into the analysis.

Terms of Reference #5: Assess the change (+/-) in encounters per species to be detected with 95% certainty and estimate the level of annual observer coverage needed to detect this change.

The analyses presented at this meeting provided a foundation for this objective, with the caveat that the analyses should probably be redone using landings time series that extend back as far as practicable. In addition, estimates of the relationship between intended and realized coverage is required; that is, if X% coverage is the desired target, a Y% coverage would have to be assumed in the sampling design, in order to ensure the actual coverage level is achieved (with the known limitations of the existing at-sea observer program to achieve target coverage in mind).

CONCLUSIONS

Peer reviewers felt that the Working Paper was not of sufficient detail to fully understand the methods used in analysis. In addition, the analysis was not as extensive as it could have been, though it was also recognized that the objectives were too broad and therefore a challenge to address given the available resources.. As a result, the reviewers did not feel that a Science Advisory Report or Research Document could be completed for publication at this time. The reviewers and meeting participants provided comments on the science findings, and reviewers provided recommendations for additional analysis that could be pursued as next steps to advancing this research. All participants agreed that without sufficient observer coverage levels, both spatially and throughout the fishing season (i.e., high enough to observe/define spatio-temporal components of the fishery), it is difficult to reasonablly account for spatial and temporal components/variation in the fishery with respect to indcidental catch. Further, it was agreed that continuation of this research in a timely manner was viewed as a priority for the Department to pursue. The meeting Chair noted that this message would be communicated to senior science managers for consideration within the 2016-2017 science work plan (there was no resolution by the end of the meeting about if, how, or when this research may be completed). Sincere efforts were made in the science peer review process to acknowledge and address all comments and concerns raised by meeting participants provided they were appropriate and within the confines of acceptable peer review practice. This Proceedings document constitutes a record of meeting discussions, recommendations, and conclusions.

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APPENDICES

APPENDIX 1: LIST OF MEETING PARTICIPANTS

Name/Nom	Affiliation
Atkinson, Troy	NS Swordfishermen's Association
Bennett, Lottie	DFO Maritimes / Centre for Science Advice
Benoit, Hughes	DFO Gulf / Science
Brilliant, Sean	Canadian Wildlife Federation
Chandler, Alan	NS Dept. Fisheries and Aquaculture / Marine
Clark, Kirsten	DFO Maritimes / Population Ecology Division (SABS)
Coffen-Smout, Scott	DFO Maritimes / Oceans & Coastal Management
Cosandey-Godin, Aurelie	World Wildlife Fund Canada, Atlantic
Curran, Kristian	DFO Maritimes / Centre for Science Advice
Dalton, Alex	DFO Maritimes / Population Ecology Division (SABS)
Duprey, Nicholas	DFO Pactific / Marine Ecosystems and Aquaculture
Dureuil, Manuel	Dalhousie University / Biology
Fowler, Mark	DFO Maritimes / Population Ecology Division (BIO)
Grant, Heather	Ecology Action Centre
Gromack, Aimee	DFO Maritimes / Species at Risk Management Division
Hanke, Alex	DFO Maritimes / Population Ecology Division (SABS)
Hanrahan, Joe	NS Dept. Fisheries and Aquaculture
James, Mike	DFO Maritimes / Population Ecology Division (BIO)
Joyce, Warren	DFO Maritimes / Population Ecology Division (BIO)
Keith, David	DFO Maritimes / Population Ecology Division (BIO)
Kulka, Dave	DFO Science Emeritus
Mallet, Pierre	DFO Gulf / Resource Management
McIntosh, Amanda	Woodstock First Nation
McNeely, Joshua	Maritime Aboriginal Peoples Council - IKANAWTIKET
Melvin, Gary	DFO Maritimes / Population Ecology Division (SABS)
Merriman, Cathy	DFO Maritimes / Species at Risk Management
O'Hara, Claude	Glooscap First Nation
Schleit, Katie	Ecology Action Centre
Smith, Colleen	DFO Maritimes / Policy and Economics
Spence, Koren	DFO Maritimes / Species at Risk Management
Stone, Heath	DFO Maritimes / Population Ecology Division (SABS)
Sweet, Marilyn	DFO Maritimes / Resource Management
Wimmer, Tonya	World Wildlife Fund Canada, Atlantic

APPENDIX 2: MEETING TERMS OF REFERENCE

Assessment of Incidental Catch in the Atlantic Canadian Swordfish/Other Tuna Longline Fishery

Regional Peer Review - Maritimes Region

February 24-25, 2016
Dartmouth, Nova Scotia

Chairperson: Kristian Curran

Context

Incidental bycatch and discarding of non-targeted species occur in many fisheries. Discarding of targeted species also occurs for regulatory reasons or licence restrictions as, for example, undersized fish. An objective of sustainable fisheries management is to manage discard mortality for targeted species and to control the incidental mortality for non-targeted species. In the context of the longline fishery for Swordfish and other tunas (Bigeye Tuna, Yellowfin Tuna and Albacore) this requires a comprehensive plan for monitoring fishing activity, measuring the discard mortality, and establishing suitable references to indicate when that mortality is unacceptable.

Fisheries and Oceans Canada (DFO) Resource Management, Maritimes Region, in conjunction with the DFO Science Branch, Maritimes Region, initiated the 'Work Plan to Address Incidental Catch in the Atlantic Canadian Swordfish/Other Tuna Longline Fishery'. The comprehensive work plan consists of a number of projects with three main objectives: 1) examining appropriate levels of observer coverage; 2) managing discards for all targeted species; and 3) controlling incidental mortality for non-targeted species. This science assessment meeting is a follow-up to a meeting previously held on this topic in July 2011 entitled 'Incidental Catch in Canadian Large Pelagic Fisheries' (DFO 2011).

The Work Plan focuses on seven species that are caught as incidental catches in the Swordfish/other tuna longline fishery: Bluefin Tuna, Porbeagle, Shortfin Mako, Blue Shark, Leatherback and Loggerhead turtles, and undersized Swordfish.

Objectives

- Document factors associated with discarding of the target species and provide estimates of juvenile Swordfish discards.
- Determine if observer sampling is representative of the fleet and appropriate for the seven species identified in the 'Work Plan to Address Incidental Catch in the Atlantic Canadian Swordfish/Other Tuna Longline Fishery' (i.e., undersized Swordfish, Bluefin Tuna, Porbeagle, Shortfin Mako, Blue Shark, Leatherback Turtle, and Loggerhead Turtle).
- Identify potential strata for the purpose of improving precision of discard estimates. In addition, investigate alternative methods for discard estimation.
- Describe preferred habitat of marine turtles, proportion of fishing occurring within and outside such habitat, proportion of Swordfish longline fishing occurring within and outside such habitat, and proportion of observer coverage within and outside such habitat.
- Assess the change (+/-) in encounters per species to be detected with 95% certainty and estimate the level of annual observer coverage needed to detect this change.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document

Participation

- DFO Science
- DFO Fisheries and Aquaculture Management
- DFO Species at Risk Management
- DFO Policy and Economics
- Aboriginal communities / organizations
- Provincial (NS and NB) governments
- Industry / non-government organizations

Reference

DFO. 2011. Considerations for the Estimation of Incidental Catch in the Eastern CanadianSwordfish/Other Tunas Longline Fishery. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/057.

APPENDIX 3: MEETING AGENDA

Assessment of Incidental Catch in the Atlantic Canadian Swordfish/Other Tuna Longline Fishery

Lewis H. King Boardroom
Bedford Institute of Oceanography
Dartmouth, NS

24-25 February 2016

Chairperson: Kristian Curran

DRAFT AGENDA

DAY 1 (Wednesday, February 24, 2016)

Time	Topic	Leads
09:00 – 09:15	Welcome and Introduction	K. Curran
09:15 – 10:30	Assessment of Incidental Catch	A. Hanke/A. Dalton
10:30 – 10:45	***Break*** *(Coffee/tea provided)*	
10:45 – 11:30	Assessment of Incidental Catch Cont'd	A. Hanke/A. Dalton
11:30 – 12:00	Prediction of Blue shark, Shortfin Mako and Porbeagle Bycatch Hotspots Using a Bayesian Spatio-temporal Model	A. Cosandey-Godin
12:00 – 13:00	***Lunch*** *(Hospitality not provided)*	
13:00 – 14:00	Prediction of Blue shark, Shortfin Mako and Porbeagle Bycatch Hotspots Using a Bayesian Spatio-temporal Model Cont'd	A. Cosandey-Godin
14:00 – 15:00	~~Sea Turtle Bycatch Estimation in the Canadian Pelagic Longline Fishery~~ Incidental Capture: Insights from Sea Turtle Biology	M. James
15:00 – 15:15	***Break*** (*Hospitality not provided)*	
15:15 – 17:00	~~Sea Turtle Bycatch Estimation in the Canadian Pelagic Longline Fishery~~ Incidental Capture: Insights from Sea Turtle Biology Cont'd	M. James

DAY 2 (Thursday, February 25, 2016)

Time	Topic	Leads
09:00 – 09:30	Review of Previous Day	K. Curran
09:30 – 10:30	Homework from Previous Day	A. Hanke
10:30 – 10:45	***Break*** *(Coffee/tea provided)*	
10:45 – 12:30	Drafting of Science Advisory Report	A. Hanke
12:30 – 13:30	***Lunch*** *(Hospitality not provided)*	
13:30 – 15:00	Drafting of Science Advisory Report Cont'd	A. Hanke

Time	Topic	Leads
15:00 – 15:15	***Break*** *(Hospitality not provided)*	
15:15 – 17:00	Drafting of Science Advisory Report Cont'd	A. Hanke