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Proceedings Series 2011/045 | **Compte rendu 2011/045**

Maritimes Region | **Région des Maritimes**

Considerations for the Estimation of Incidental Catch in the Eastern Canadian Swordfish/Other Tunas Longline Fishery Science Peer Review

July 11 - 12, 2011
St. Andrews Biological Station,
St. Andrews, New Brunswick

Kirsten Clark
Meeting Chair

Facteurs à considérer dans l'examen scientifique par les pairs de l'estimation des captures accessoires dans la pêche de l'espadon et des autres thonidés à la palangre dans l'est du Canada

Les 11 et 12 juillet 2011
Station biologique de St. Andrews
St. Andrews (Nouveau-Brunswick)

Kirsten Clark
Présidente de séance

Fisheries and Oceans Canada / Pêches et Océans Canada
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November 2011 | **Novembre 2011**

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings 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.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d’analyses ou d’interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenues dans le présent rapport puissent être inexactes ou propres à induire en erreur, elles sont quand même reproduites aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considérée en tant que reflet des conclusions de la réunion, à moins d’indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l’information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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Novembre 2011

ISSN 1701-1272 (Printed / Imprimé)
ISSN 1701-1280 (Online / En ligne)

Published and available free from:
Une publication gratuite de :

Fisheries and Oceans Canada / Pêches et Océans Canada
Canadian Science Advisory Secretariat / Secrétariat canadien de consultation scientifique
200, rue Kent Street
Ottawa, Ontario
K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/

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Correct citation for this publication:
On doit citer cette publication comme suit :

DFO. 2011. Considerations for the Estimation of Incidental Catch in the Eastern Canadian Swordfish/Other Tunas Longline Fishery Science Peer Review; 11-12 July 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/045.

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SUMMARY

The Incidental Catch in the Eastern Canadian Swordfish and Other Tuna Longline Fishery Regional Advisory Process (RAP) was held July 11-12, 2011, at the St. Andrews Biological Station, St. Andrews, New Brunswick. Participants included DFO staff (Science, Fisheries Management, Species at Risk, and Policy and Economics), stakeholders and external experts. The objectives of this RAP meeting were taken from the Work Plan to Address Incidental Catch in Canadian Large Pelagic Fisheries*,* a living document created by Fisheries Management and Science to address issues of incidental catch in large pelagic fisheries. These objectives addressed the Work Plan themes of 1) level of Observer coverage and 2) managing discards for all target species. The focus of the Work Plan is directed toward six key species: bluefin tuna, porbeagle, shortfin mako, blue shark, leatherback sea turtle and loggerhead sea turtle as well as discarding of swordfish. Specifically this meeting was to address the level of Observer coverage and estimates of precision; discard estimation; and survival of released bycatch.

In addition to the Proceedings, there will be a Science Advisory Report and three Research Documents resulting from this meeting.

SOMMAIRE

La réunion du Processus consultatif régional (PCR) portant sur les captures accessoires dans la pêche de l'espadon et des autres thonidés à la palangre dans l'est du Canada a eu lieu les 11 et 12 juillet 2011 à la Station biologique de St. Andrews, à St. Andrews (Nouveau-Brunswick). Y participaient des membres du personnel du MPO (Sciences, Gestion des pêches, Espèces en péril et Politiques et Économique), les acteurs concernés et des experts externes. Les objectifs de cette réunion du PCR étaient tirés du plan de travail visant à apporter des solutions au problème des captures accessoires dans les pêches canadiennes des grands poissons pélagiques, un document évolutif produit par la Gestion des pêches et les Sciences. Ils étaient axés sur les thèmes de ce plan de travail, à savoir 1) le degré de présence d'observateurs et 2) la gestion des rejets de toutes les espèces ciblées. Le plan de travail s'intéresse à six grandes espèces : le thon rouge, le requin-taupe commun, le requin-taupe bleu, le requin bleu, la tortue luth et la caouanne, ainsi qu'aux rejets d'espadon. La réunion avait pour but spécifique de traiter du degré de présence d'observateurs et des estimations de la précision, ainsi que des estimations des rejets et de la survie des captures accessoires remises à l'eau.

Outre le compte rendu découlant de la réunion, celle-ci débouchera aussi sur la publication d'un avis scientifique et de trois documents de recherche.

DAY ONE: JULY 11, 2011

INTRODUCTION

The meeting was convened on July 11th, at 8:30 a.m. The Chair, Kirsten Clark, welcomed the 35 participants and introduced the two external reviewers, Hugues Benoît from the Gulf Fisheries Centre and Christie Whelan from Fish Population Science Branch in Ottawa. The meeting Agenda, Terms of Reference and List of Participants can be found in Appendices 1-3, respectively.

These Proceedings are meant to serve as a consensus summary of the meeting's principle discussions and conclusions and are not intended to be a chronological transcript. The Proceedings document complements the Science Advisory Report (SAR) and the supporting Research Documents and is not intended to be used in isolation. The SAR captures the discussion and conclusions of the meeting; the Proceedings document expands on how the conclusions were reached and the major discussion points; the Research Documents provide sufficient detail so analyses can be repeated.

Following the introductions, the context for the meeting Terms of Reference was explained. The Terms of Reference were based on the Work Plan to Address Incidental Catch in Canadian Large Pelagic Fisheries*,* a living document created by Fisheries Management and Science to address issues of incidental catch in large pelagic fisheries. The focus of this plan is directed toward six key species: bluefin tuna, porbeagle, shortfin mako, blue shark, leatherback sea turtle and loggerhead sea turtle as well as discarding of swordfish. The Work Plan is organized into projects under three main themes: 1) level of Observer coverage, 2) manage discards for all targeted species and 3) control incidental mortality for non-targeted species. At this meeting projects which fell under the first and second theme were reviewed. These projects were to address:

Level of Observer Coverage: Estimates of Precision (Theme 1)

- Describe the evolving fishery patterns of the swordfish/other tunas longline fishery, summarize their Observer coverage and determine the nominal estimates of precision for the discard:effort and discard:landed ratios of each of the seven study species (bluefin tuna, porbeagle, shortfin mako, blue shark, leatherback sea turtle, loggerhead sea turtle and swordfish).
- Investigate sampling implications of practical alternative stratification schemes.
- Evaluate the utility of the higher Observer coverage conducted in 2001-2002 with respect to quantifying the improvement in precision.
- Review the applicability and results of various bycatch reporting methodologies for achieving desired precision of estimated discards.

Discard Estimation (Theme 2)

- Conduct a comparative evaluation of the data, methods and results for estimation of total (live+dead) discard of bluefin tuna, swordfish, porbeagle, mako and blue shark.
- Recommend best practice.

Survival of Released Bycatch (Theme 2)

- Review methods for determining post-release mortality.
- Develop guidelines for best practice when determining total dead discards from fisheries, but in particular from swordfish/other tunas longline fisheries.

To address these objectives, four working papers were prepared and presented:

- Hanke, A.R., Andrushchenko, I. and Croft, G. 2011. Observer coverage of the Atlantic Canadian swordfish and other tuna longline fisheries: an assessment of current practices and alternative methods. CSA Working Paper 2011/28.
- Neilson, J.D., Busawon, D.S., Andrushchenko, I., Campana, S.E., Carruthers, E.H., Harris, L.E. and Stokesbury, M. 2011. A review of approaches to assess survival of released catch from Canadian large pelagic longline fisheries. CSA Working Paper 2011/26.
- Andrews, D.W. and Harris, L.E. 2011. Sea turtle bycatch and condition in Atlantic Canada's pelagic longline fishery: a delta-model using Observer data from 2001-2009. CSA Working Paper 2011/27.
- Campana, S.E., Brading, J. and Joyce, W. 2011. Shark bycatch and associated mortality in Canadian Atlantic fisheries.

Research Documents will be prepared for three of the four working papers. By consensus of the group, no Research Document will be prepared for CSA Working Paper 2011/27 (Sea turtle bycatch and condition in Atlantic Canada's pelagic longline fishery: a delta-model using Observer data from 2001-2009). Authors were reminded of the four month time frame to complete CSAS Research Documents.

When the Agenda and Terms of Reference (Appendices 1 and 2) were reviewed it was identified that the original title of the meeting, Incidental Catch in Canadian Large Pelagics Fisheries, was misleading since only the swordfish and other tuna longline fisheries were being considered. The point was noted and the title of the SAR was changed to Considerations for the Estimation of Incidental Catch in the Eastern Canadian Swordfish/Other Tunas Longline Fishery. Concern was expressed that the Terms of Reference did not address the incidental catch issue for all large pelagic fisheries. This issue was outside the scope of the meeting.

LEVEL OF OBSERVER COVERAGE: ESTIMATES OF PRECISION

- **Describe the evolving fishery patterns of the swordfish/other tunas longline fishery, summarize their Observer coverage and determine the nominal estimates of precision for the discard:effort and discard:landed ratios of each of the seven study species (bluefin tuna, porbeagle, shortfin mako, blue shark, leatherback sea turtle, loggerhead sea turtle and swordfish).**
- **Investigate sampling implications of practical alternative stratification schemes.**
- **Evaluate the utility of the higher Observer coverage conducted in 2001-2002 with respect to quantifying the improvement in precision.**
- **Review the applicability and results of various bycatch reporting methodologies for achieving desired precision of estimated discards.**

Working Paper: Observer coverage of the Atlantic Canadian swordfish and other tunas longline fisheries: an assessment of current practices and alternative methods. CSA Working Paper 2011/28.
Presenter: A. Hanke
Rapporteur: I. Andruschenko

Presentation Abstract

The sampling of the Atlantic Canadian longline fishery by the Canadian Fisheries Observer Program (CFOP) is reviewed to determine if the sampling is representative of the spatial and temporal extent of the fleet's fishing, the range in fishing capacity or power of its vessels and the intensity of fishing with respect to time, area and vessel characteristics. The precision of ratios used to scale bycatch to the whole fleet is evaluated for the existing sampling design with a view to recommending practical alternative sampling and stratification schemes and optimal levels of

Observer coverage for seven study species (swordfish, bluefin tuna, porbeagle, shortfin mako, blue shark, leatherback sea turtle and loggerhead sea turtle). Alternative ways of scaling the observed bycatch to the entire fishery were compared.

Reviewers' Comments

The reviewer's report is in Appendix 4.

Comments and Discussion

It was reinforced that the at-sea Observer coverage requirement for the fishery was 5%, not 10% as was shown as a reference in some of the figures. The Observer coverage has only increased recently with additional funding by Fisheries and Oceans, Canada (DFO). It was agreed that this point would be clarified in both the SAR and Research Document.

Patterns of the Fishery

When the fishery data were broken down by area there was an area called ATLIC. The definition of this coding was unknown so it needs to be investigated and the area identified.

There was discussion around the division of the fleet into length categories. The working paper stated that most of the vessels were about 30 feet to 40 feet long with some over 100 feet in length and this was shown in Figure 3. However, the fishing industry indicated that the numbers of vessels in the smallest and largest categories were incorrect. It was concluded that if vessel lengths are to be used to classify the fleet, the data source should be checked to ensure that the vessels are assigned correctly to length categories.

There was considerable discussion about the comparison between optimal and actual Observer coverage (Historical Coverage section in the working paper). It was suggested that these comparisons should have been tested statistically, as the differences seen graphically (*e.g.,* Figures 15 and 16 in the working paper) may not have been significant due to small sample sizes. It is a concern that some fishing vessels or licenses may be getting a disproportionate amount of Observer coverage whilst others receive little or no coverage. The working paper examined Observer coverage by vessel length but fishing industry representatives recommended that Observer coverage should be examined in terms of license rather than vessel length or tonnage class. It was also noted that the higher coverage of the offshore license and large boats reflected license requirements or additional Observer coverage that was paid for by the industry not a concentration of regular Observer coverage on the offshore.

If Observer data is to be used to calculate incidental catch, it is important that the Observer coverage is randomly applied to the fleet. The experimental design could be examined by calculating the annual probability of a vessel or vessel license holder being observed over time.

It was noted that, since Observer deployment occurs at the trip level, trends in coverage at the level of sea day or set may be secondary. It is more appropriate to examine sampling trends at the level at which the sampling was done (trip).

The Observer deployment scheme recommended in Stephenson (2000) was based on 20% Observer coverage and needs to be revisited to account for current lower levels of coverage and changes in the fishery. The sampling schedule could be monitored in real time through better communication between Science, Fisheries Management and the at-sea Observer company and through monitoring of the Vessel Monitoring System (VMS). It was asked who

would be conducting the in-season monitoring of VMS. An alternative is to use the previous year's data to get a better indication of appropriate Observer deployments in the current year.

Summary of Observer Coverage

It was once again suggested that since larger vessels sometimes pay for their own Observers, this fact should be identified to explain the skewed representation of Observers on these vessels. An additional suggestion to minimize the small vessel bias was to use an automated deployment system similar to the one recently piloted with the groundfish fleet in NAFO Div. 4X, where the boat chosen for an Observer trip is not permitted to leave port until they accommodate an Observer.

The issue of lower Observer coverage of the smaller vessels and shorter trips in 4X4W was discussed. It was noted that when a vessel hails out, the captain indicates the area that the vessel will be going to, but does not indicate the length of the trip since this will vary depending on the availability of the target species. As a result, it is hard to specifically target short trips.

Fishing industry representatives indicated that the activity of the offshore fishing license differs from the rest of the fleet in terms of fishing pattern (time, area and target species) and license requirements and should therefore be excluded from the analyses of the activity of the rest of the longline fleet. This was agreed to by the group.

It was suggested that a stratification of the data by time (month, quarter or season) and area may be beneficial and might impact the analyses. As a result, it remained unclear whether higher Observer coverage in 2002 affected precision estimates. It was noted that for the International Commission for the Conservation of Atlantic Tunas (ICCAT) purposes the data are stratified into two areas: east and west of 60°W. This division is based on growth rates.

It was noted that since swordfish and other tuna licence holders are able to catch swordfish with either longline or harpoon gear, harpoon data are often included with the longline information. It was concluded that it was appropriate to remove the harpoon component from the discard calculations for the longline fishery by selecting for the correct licence types and gear and excluding records whose effort amount in hooks was less than 10. It was also suggested that when bluefin tuna dead discards are calculated, trips with unused bluefin tags available need to be discounted from the calculation.

Precision of Ratios

Graph titles and axes labels were requested for figures in the SAR and Research Document. Currently many of the figures in the working paper lack titles and labels.

The fishing industry suggested that a revision of the methodology for calculating bluefin tuna discards is required because the fishery has changed since the current method was developed. There were also concerns that the data used in the simulation do not accurately represent what is going on in the fishery. It was recommended that trips and sets be differentiated based on species sought (in addition to the area and season stratifications suggested earlier), though this may not be possible due to the way the database is set up. It was also suggested that differences between auxiliary variables can be better quantified, so that the best ones can be chosen.

The need for stratification of the data by time and area was raised again and there was considerable discussion about the desirability of accurate versus precise estimates of incidental

catch. It was recommended that the accuracy and bias of the estimates be looked at in the future, although this was not a requirement of the current Terms of Reference.

Effects of Higher Coverage

There was more discussion around the issue of the simulation data not being representative of the fishery. It was suggested that the data should be simulated in a similar manner to the way in which they were collected (*i.e.,* imposing the non-random type of sampling seen in the fishery). This would better capture the actual uncertainty seen in the fishery. A log-normal distribution was assumed in the simulation but it was suggested that a discrete distribution would be more appropriate.

There is a need to include a discussion of Observer effects in the SAR. Observer effects have been demonstrated in other fisheries (Benoît and Allard, 2008) and if they exist, they will impact on the estimates of discards for the entire fleet. It was noted that Observer effects are likely not as big an issue in the large swordfish/other tunas fleet because the value of the catch and cost of the trips mean that captains will not change their fishing plans just because of the presence of an Observer.

It was suggested that the recommendations and suggestions made during this meeting should go into the final Research Document, to indicate where there are gaps in the knowledge and the sampling scheme.

DISCARD ESTIMATION: BLUEFIN TUNA AND SWORDFISH

- **conduct a comparative evaluation of the data, methods and results for estimation of total (live+dead) discard of bluefin tuna and swordfish**
- **recommend best practice**

Although a brief mention of methods used to estimate discards of bluefin tuna and swordfish was made in the presentation, a comparative evaluation was not done for bluefin tuna and swordfish. It was recommended that there be a separate process to evaluate dead discard estimation methods for these species.

Best practices related to the estimation of bycatch were not reviewed in this meeting, but have been reviewed in other fora (Cotter and Pilling 2007, ICES 2000 and Rochet and Trenkel 2005). No conclusions were reached on best practices related to ratio estimators and the current meeting did not evaluate the relative merits of design based versus model-based estimation.

SURVIVAL OF RELEASED BYCATCH

- **Review methods for determining post-release mortality**
- **Develop guidelines for best practice when determining total dead discards from fisheries, but in particular from swordfish/other tunas longline fisheries**

Working Paper: A review of approaches to assess survival of released catch from Canadian large pelagic longline fisheries. CSA Working Paper 2011/26.
Presenter: J. Neilson
Rapporteur: K. Smedbol

Presentation Abstract

To address part of the Terms of Reference for this RAP, methods for assessing post-release mortality in marine fisheries were reviewed. The methods can be grouped into five classes of

methods, including confinement, field observations, conventional tagging, telemetry, and physiological correlates of mortality. Based on the review, best practices were recommended for determining post-release survival in the Canadian pelagic longline fishery, focusing on the seven species of particular interest to the RAP (bluefin tuna, porbeagle, shortfin mako, blue shark, leatherback sea turtle, loggerhead sea turtle, and swordfish). Of the currently available methods, it was concluded that a combination of field observations using standardized release codes validated with telemetry offers the most informative results.

Reviewers' Comments

The reviewers' report is in Appendix 4 but additional comments are recorded below.

The reviewers asked that the presenters provide a short summary of the type of data provided by the techniques, and the potential usefulness of these data.

There was discussion about the level of certainty in the allocation of bycatch to the "dead" category (*i.e.,* were individual animals actually dead, or just moribund). The authors acknowledged that in general "dead" can be difficult to assess with certainty, and the accuracy of this category may be fishery- and species-dependent. For instance, blue sharks are not brought aboard and are assessed while still in the water, making it more difficult to make an accurate assessment. It is therefore likely that error exists in these estimates. In contrast, during a research study, sharks were brought onboard the boats and their condition assessed directly, rather than "over the side". This research study reported a slightly higher bycatch mortality rate.

The ease and quality of satellite tag deployment was questioned. There was concern that the usual approach to deployment may result in a clustering of effects (*e.g.,* all tags might be deployed from one vessel during one trip, or in a single area). The authors replied that thus far, most of satellite tags have been applied by science staff. However, some sharks have been tagged by at-sea Observers and fishers, and a new project to tag loggerhead sea turtles will use at-sea Observers to apply tags. The handling of individual fish for tagging is an issue, and the potential effects are not equal across taxa (*e.g.,* sea turtles versus sharks). However, it was noted that Observer (individual Observer staff) can be included as a random effect when the data are modeled.

Comments and Discussion

In many of the studies completed to date, healthy animals are often tagged preferentially because the tagging studies from which the data are derived had objectives other than assessing post-release mortality, such as habitat use or migration. This preferential tagging may bias the results concerning bycatch mortality, as individuals in poor condition were excluded from tagging.

Although to date most satellite tags have been applied by science staff, industry representatives noted that the pelagic longline fleet has fishers who have been trained to apply satellite tags.

A table was presented which prioritized the need for studies of post-release mortality of swordfish, bluefin tuna, shortfin mako, blue shark, porbeagle, loggerhead and leatherback sea turtles. The assignment of priority was subjective but considered the availability of information from completed studies, stock status, and the scale of the discards in relation to the catch. The presenters were asked if they took into account the population status and trends of the bycatch species in the determination of their priority rankings. In response, the authors indicated that

bycatch status had been reviewed for some species. Bycatch mortality for porbeagle was high enough relative to total mortality that its estimation was informative in setting priorities.

The authors were asked why they discounted biochemical methods. It was noted that studying various stressors would be time consuming, and the derivation of non-stressed, baseline condition would be very difficult to obtain (captured/fished animals would be stressed by captured, and thus would not be suitable as controls).

Working Paper: Sea Turtle bycatch and condition in Atlantic Canada's longline fishery: a delta-model using Observer data from 2001-2009. CSA Working Paper 2011/27.
Presenter: D. Andrews
Rapporteur: K. Smedbol

Presentation Abstract

Sea turtles are of conservation concern in Atlantic Canada. Two species, the loggerhead sea turtle and the leatherback sea turtle, make up the vast majority of sea turtles caught as bycatch in Atlantic Canadian fisheries. Many of these turtles are encountered by the swordfish/other tunas longline fleet targeting tunas and swordfish throughout the fishing season. The sea turtles either get hooked on longlines or become entangled in the gear. Since 2001, when sea turtles are caught or entangled, fisheries Observers have been collecting sea turtle interaction data. These data include species, how the sea turtle was hooked or entangled, release condition, and various environmental and fishery related variables that may influence the bycatch of sea turtles. An exploratory analysis was conducted in order to identify factors which may reduce the severity of sea turtle injuries. Due to the low number of leatherback sea turtle captures, the analysis could only be done for loggerhead sea turtles.

In addition to the sea turtle condition analysis, bycatch was modeled using a delta-general linear model approach for standard fisheries Observer data collected from 2001-2009. A stepwise algorithm was used to select the final models based on the reduction in Akaike Information Criteria (AIC) values. Loggerhead sea turtle catch per unit effort was significantly affected by location, fishing depth, gangion length, target fishery, and sea surface temperature. Leatherback sea turtle catch per unit effort was significantly related to location, season, hook type, bait type, soak time, and target fishery. These analyses were exploratory in nature and continued research is required before recommendations for mitigation measures can be developed.

Discussion

There were two sections to this paper: one which focused on a generalized linear model of sea turtle bycatch and a second which focused on an analysis of the relationship between the variable measuring sea turtle disposition and other variables.

General Linear Model of Sea Turtle Bycatch

Reviewers' Comments

In addition to their report (Appendix 4), the reviewers made some further comments. The reviewers requested that exploratory plots of the data be provided, allowing for preliminary visual inspection of potential patterns in the data. The presenters were advised to investigate the possibility of multi-collinearity among explanatory variables, and to determine if influential

points exist. Estimates of the model fit should be provided in addition to AIC values, and there is a need to test model assumptions. One suggestion was to use catch as the response variable instead of catch rate, because the formulation of the capture model presented (second part of the delta model) included effort measures on both sides of the glm equation.

The investigation of the effect of individual variables from the model shows some single-variable effects that were unexpected given knowledge of sea turtle biology and the fishery. The interpretation of these results might be improved through comparison to tagging analyses undertaken by the US National Marine Fisheries Service.

Other Comments and Discussion

The authors were advised to investigate the use of 3-day averages for sea surface temperature (SST) rather than monthly means. Three-day averages may provide a better balance of data availability and spatial-temporal accuracy. There may also be value in reducing model terms and lowering the resolution of independent variables (*e.g.,* dividing the data into three spatial areas instead of point coordinates for each data point). Another option may be to investigate the use of multivariate techniques to address potential collinearity among independent variables (*e.g.*, the use of Principle Components Analysis to collapse collinear variables into a single axis).

During analyses and during presentation of recommendations, there is value in considering the potential effect on the target species (and fishery). It was noted by fishing industry representatives that the influence of luminous gear on bycatch rate may actually be a vessel effect rather than a gear effect, as the few fishers who used luminous gear attachments were also known to spend considerable effort in the handling and dehooking of bycaught sea turtles. J-hooks will not be used by the fleet next year, so it was suggested that perhaps there is not much value in including them in the analysis. However, others felt that there may be value in including J-hooks in order to determine if the change to circle hooks has resulted in a reduction in bycatch rate. The result indicating that bait-type effected catch rate for leatherback sea turtle catch rate is likely due to bait-type covarying with another variable (*e.g.,* mackerel bait used for swordfish, squid for tunas, and these species prefer slightly different temperature regimes).

Conclusion

The model was rejected, and it was agreed that no firm conclusions could be drawn from this analysis.

Sea Turtle Disposition

Reviewers' Comments

The reviewers suggested using an approach that tests all possible comparisons simultaneously (*e.g.,* a generalized linear model with a multinomial model structure). The reviewers questioned why the amount of gear removed and how the sea turtle was hooked were considered dependent variables, rather than being defined as independent variables? It is possible that these variables would have an effect on disposition of bycaught sea turtles. Also, having disposition as the only response variable would simplify the analyses.

Other Comments

It was suggested that the use of assessed condition be removed from the analysis since only two years of data are available and at-sea Observers are not experts on sea turtle condition. One of the pitfalls of multiple simultaneous tests is the likelihood of obtaining a significant result by chance alone.

Conclusion

The analysis was rejected, and it was agreed that no firm conclusions could be drawn. It was recommended that the data be analyzed using glm methods.

A small group was tasked to prepare a draft Science Advisory Report to review on Day Two. The Chair adjourned the meeting at 4:15 p.m.

DAY TWO: JULY 12, 2011

INTRODUCTION

The meeting reconvened on July 12th, at 8:30 a.m. The Chair welcomed participants back and indicated that there were hard copies of three new papers at the back of the room: the draft SAR, a summary of recommendations, and a new working paper by Steve Campana. This new working paper was not available to be posted ahead of time, but since it was directly relevant to the second term of reference to evaluate data, methods and results for estimation of total discards for porbeagle, mako and blue shark, it was considered appropriate that it be presented at this meeting.

The Chair indicated that the agenda for the second day of the meeting would be adjusted so that after her summary of the proceedings of the previous day Dr. Campana would present his paper, followed by a discussion of the Research. The focus of the group would then shift to the preparation of the SAR.

DISCARD ESTIMATION: PORBEAGLE, SHORTFIN MAKO AND BLUE SHARK

- **Conduct a comparative evaluation of the data, methods and results for estimation of total (live+dead) discard of porbeagle, mako and blue sharks**
- **Recommend best practice**

Working Paper: Shark bycatch and associated mortality in Canadian Atlantic fisheries.
Presenter: S. Campana
Rapporteur: K. Smedbol

Presentation Abstract

The estimation of pelagic shark bycatch, discards and discard mortality was an objective of both the Work Plan *to Address Incidental Catch in Canadian Large Pelagic Fisheries* and the associated Regional Advisory Process meeting (held 11-12 July 2011). In addition to quantifying all sources of bycatch for porbeagle, shortfin mako, and blue shark, documented or inferred capture and post-release mortality rates were used to estimate total discard mortality, and the key assumptions underlying the use of Observer data to estimate fishery-scale discards were tested. Annual estimates of shark discards by fishery indicated that the swordfish/tuna fishery accounted for 58% of 57 mt of porbeagle discards, 70% of 23 mt of mako discards, and 99% of

1,414 mt of blue shark discards in 2010. Aggregated across all fisheries, an estimated 29 mt of non-retained porbeagle died from fishing-related causes in 2010, which is equivalent to 35% of reported landings. A total of 11 mt of non-retained mako did not survive fishing in 2010, which is equivalent to 29% of the reported landings. Discarded blue sharks which did not survive fishing totaled 495 mt in 2010. Based on tests of accuracy of the bycatch estimation method, the bycatch and discard amounts for these shark species are expected to be reasonably close to reality. Porbeagle bycatch is largely limited to Emerald Basin and the edge of the Scotian Shelf, but bycatches of mako and blue shark are more broadly representative of the distribution of the swordfish/other tunas longline fishery in the northwest Atlantic.

Reviewers' Comments

It was noted that independent surveys would be useful in determining species range, and might indicate if the potential exists that areas of bycatch are being missed. The author noted that two fishery independent porbeagle surveys have been undertaken in recent years, and if there was poor correspondence between the fishery coverage of the population range and the true range, then one would expect to see a poor correlation in the bycatch weight ratio estimators relative to aggregated target fisheries. This is not the case, and the correlation is relatively high.

Other Comments and Discussion

The question was asked as to why the inter-annual mean of the ratio estimator was used to calculate discards rather than annual estimate. It was explained that the use of annual ratio estimators introduces much more variability into the discard estimates. The use of the mean value assumes that there are no true inter-annual differences in the annual ratios. Visual inspection of the data indicates that this assumption is supported. Industry representatives noted that year effects may have been introduced into the ratio estimates through changes in the management of the fishery. In past years the fishery used to land shortfin mako and porbeagle bycatch. In more recent years the fishery has been asked not to retain live mako and porbeagle. This change means that there may have been years when the true discard rate was zero (all bycatch was landed) and other years when the rate was non-zero (live bycatch was discarded due to management requests).

It was asked if it was necessary to disaggregate the ratio estimators by quarter and species sought. Disaggregation results in a lower sample size and higher variance for each subgroup (quarter/species). However since, for example, some quarters have higher average catches than others, the author wanted to capture these higher resolution patterns. The ratio estimators for each quarter are then averaged across years, which increases the total sample size and smooths the variance. It was noted that it would be possible to estimate the ratios in a generalized linear model framework, with species and quarter as explanatory variables and this approach would allow the variance to be calculated and carried forward in the estimation procedure. The author agreed, but indicated that to his knowledge, this approach is not used by any group to determine ratio estimators.

Conclusion

The group was asked if it was appropriate to include information from this paper in the SAR.
It was concluded that the information presented was relevant to the Terms of Reference and that thus some text concerning this working paper would be included in the SAR. A Research Document would also be prepared.

RESEARCH RECOMMENDATIONS

Draft Research Recommendations were presented and discussed and the approved list of recommendations follows:

Level of Observer Coverage

The Observer sampling scheme requires a clear set of objectives from both Fisheries Management and Science to focus the planning and the sampling. Included in these objectives should be attainable and acceptable species-specific levels for the precision of the estimates.

Stratification should not be based on a rigid decade-old method, but where possible, a real time or near real time evaluation (*i.e.,* use of VMS data) of the progress of the sampling should be conducted so that in season adjustments can be made to the allocation of Observer time based on the fishery. An evaluation of the coverage should be conducted to ensure the sampling reflects the changing nature of the fishery and is optimal for species that are important.

Better communication between DFO Science and the Observer contracting company is required so that guidance can be provided when changes to the sampling strategy are required.

To improve the quality of field observations on condition of released incidental catch, it is recommended that the DFO Science work with the Observer contracting company to develop standards that will help Observers more consistently categorize release condition. This initiative could include photographs as part of a revised field manual.

It was recommended that DFO continue to explore alternative methods of measurement including video-based monitoring, Fishers Self-Sampling Programmes and the use of VMS data for estimating fishing effort.

Though the Terms of Reference specified an analysis of precision, it was noted that bias and accuracy are as important as precision (*e.g.,* an estimate could be very precise, but biased). It was recommended that analyses of the accuracy of the sampling and estimates be conducted.

It is clear that catches of sea turtles are highly clustered by time and space, thus creating difficulties for modelling the effects of factors that influence the catch of sea turtles. This work should be pursued further.

Dead Discard Estimation

It was recommended that a separate process is needed to address dead discard estimation methods for swordfish and bluefin tuna. It was noted that there is a related National Advisory Process scheduled for 2011; Maritimes Region could provide input for review at this NAP.

Survival of Released Bycatch

It was recommended that a combination of field observations using standardized release codes validated with pop-up satellite telemetry would provide the most informative results concerning survival of released incidental catch. Among the species considered at this meeting, the highest priorities for studies of post-release mortality were thought to include porbeagle and loggerhead sea turtle.

Adjustments to the Work Plan to address Incidental Catch in the Canadian Large Pelagics Fisheries

It was noted that the Work Plan to Address Incidental Catch in the Canadian Large Pelagics Fisheries is a "living" document. It is recommended that it should be adjusted to focus on gaps. The RAP recommended an examination of other Canadian Atlantic fisheries both targeting large pelagic species (*i.e.,* bluefin tuna and shark) and taking large pelagic species as bycatch (*i.e.,* herring purse seine, mackerel trapnet, herring gillnet and groundfish fixed gear). This examination should review available data for the various fisheries, outline where no data are available and make recommendations to fill these gaps. Recommendations should include appropriate Observer coverage levels on a fishery-by-fishery basis.

DISCUSSION OF THE SCIENCE ADVISORY REPORT

Rapporteur: D. Busawan

The draft SAR was presented to the group. The agreement was to go through the SAR section-by-section to ensure that the text accurately reflected the information presented and the decisions and conclusions of the meeting. Additions and changes to the document were made in real-time as the group directed.

General Comments

It was suggested that it should be specified in the introduction that a considerable amount of work is currently ongoing. It was also felt that it was important to note why there is a focus on the seven species mentioned in the SAR.

The title was discussed in relation to comments raised by Industry representatives on the first day. It was considered important to clearly define which fishery the meeting addressed. The title was reworded as "Consideration for the estimation of incidental catch in the eastern Canadian swordfish/other tunas longline fishery".

It was noted that figures and tables should be appropriately titled and labelled.

Context

Analysis in CSA Working Paper 2011/28 excluded harpoon vessels by removing vessels that fished with less than ten hooks from the analysis. It was proposed that this methodology should be recorded in the section on recommended practices since it is important that this practice continue in the future.

Introduction

It was recognized that it is important to mention in this section that the fishing industry is actively participating in the effort to improve discard estimates.

Analysis

Level of Observer Coverage: Estimates of Precision

It was noted by industry representatives that, in general, there was a good fit between Observer coverage and fishery activity but concern was expressed that the comments on Observer deployments did not capture this point. The wording was modified. Additional figures were requested comparing the optimal and actual Observer coverage. If the figures are taken from the Working Paper 2011/28, then axis labels are required.

Fishing industry representatives commented that Working Paper 2011/28 showed that the same level of precision was achieved for 5% and 20% Observer coverage. Reviewers commented that according to statistical theory, precision will increase with increased sampling/coverage. The simulation results were reviewed and it was demonstrated that precision continuously increased with increasing Observer coverage.

Discard Estimation

Once again, it was brought to the attention of the group that the harpoon component was removed from the analysis for Working Paper 2011/28 and that this should be recommended for other analyses that are done in the future. Furthermore, the fishing industry suggested that trips on vessels with unused bluefin tags should also be removed from analyses. It was commented that the latter may not be possible as information concerning unused tags is not readily available in the databases used by Science.

Survival of Released Bycatch

There was discussion regarding the criteria used for assigning priority to studies of post-release mortality (Table 1 in the SAR). Priorities were assigned based on information in the literature, information on stock status, and the scale of the discards in relation to the catch. It was suggested that it might be helpful to add two columns to the table: levels of discards and catch. This suggestion was not adopted for the table in the SAR.

Conclusions and Advice

There was discussion of how the discard estimates and estimates of post-release mortality will be used once they are calculated. The aim is to incorporate post-release mortality into assessments.

It was noted that additional work will be required to deal with issues in the Terms of Reference that this meeting was not able to complete. It was recommended that there be a separate process to evaluate dead discard estimation methods for bluefin tuna, swordfish, shortfin mako, porbeagle and blue shark. Key additional issues include development of best practices for dead discard estimation, and appropriate Observer coverage levels taking into account requirements for each bycatch species.

It was also noted that bias and accuracy are as important as precision (*e.g.*, an estimate could be very precise, but biased). It was recommended that analyses of the accuracy of the estimates be conducted.

SUMMARY AND CLOSING

The four working papers presented at this meeting addressed two of the main themes from the Work Plan to Address Incidental Catch in Canadian Large Pelagic Fisheries*:* 1) level of Observer coverage and 2) manage discards for all targeted species. The projects explored the distribution of Observer coverage and using a simulation explored levels of coverage and their impact on precision; the evaluation of data, methods and results for estimating porbeagle, shortfin mako and blue shark discards and post-release mortality; and methods for determining post-release mortality of bluefin tuna, swordfish and sharks. The group recommended further work in a number of areas (see Research Recommendations section) and another CSAS Science Peer Review meeting to review this work, particularly in relation to the comparative evaluation of data, methods and results for estimating total discards of bluefin tuna and swordfish.

At the conclusion of the meeting there was consensus on the draft Science Advisory Report including the Summary Bullets. The Chair indicated that once the modified figures (provided by the Large Pelagics Science team) and the text (provided by Hugues Benoît and agreed to by the group) were added to the SAR, it would be circulated to all participants for information.

The Chair thanked all the participants for a productive meeting and for their helpful comments and suggestions throughout. She specifically thanked the reviewers for their useful and insightful contributions to the process. She noted that the papers presented at the meeting represented a large amount of work and that the Large Pelagics Science team should be commended for their efforts. Although there is more work to be done to fully address all the Terms of Reference, this meeting represented a step forward in the process.

The meeting was adjourned at 4:30 p.m. 12 July 2011.

SOURCES OF INFORMATION

Benoît, H.P., and J. Allard. 2009. Can the data from at-sea observer surveys be used to make general inferences about catch composition and discards? Can. J. Fish. Aquat. Sci. 66: 2025-2039.

Campana, S.E., W. Joyce, and M.J. Manning. 2009. Bycatch and discard mortality in commercially caught blue sharks *Prionace glauca* assessed using archival satellite pop-up tags. Mar. Ecol. Prog. Ser. 387: 241-253.

Cotter A.J.R., and G.M. Pilling. 2007. Landings, logbooks and observer surveys: improving the protocols for sampling commercial fisheries. Fish Fish. 8:123-152.

ICES. 2000. Report of the Study Group on Discards and Bycatch Information. Advisory Committee on Fishery Management. ICES CM 2000/ACFM: 11.

Rochet, M.-J., and V.M. Trenkel 2005. Factors for the variability of discards: assumptions and field evidence. Can. J. Fish. Aquat. Sci 62: 224-235.

Stephenson, R.L. 2000. Meeting of the RAP ICCAT Working Group. DFO Can. Stock Asses. Sec. Proc. Ser. 2000/20.

APPENDIX 1: Meeting Agenda

Incidental Catch in Canadian Large Pelagics Fisheries
11-12 July 2011
Hachey Conference Centre
St. Andrews Biological Station
531 Brandy Cove Road, St. Andrews NB

AGENDA

Monday, 11 July 2011

0830-0845	Welcome and Introductions (Chair: Kirsten Clark)
0845-1000	Observer Coverage of the Atlantic Canadian Swordfish and Other Tuna Longline Fishery: An Assessment of Current Practices and Alternative Methods - Project 1A and 2.1A. (A.R. Hanke, G. Croft and I. Andrushchenko)
1000-1015	Break
1015-1200	*Continued:* Observer Coverage of the Atlantic Canadian Swordfish and Other Tuna Longline Fishery
1200-1300	Lunch (provided)
1300-1500	A Review of Approaches to Assess Survival of Released Catch from Canadian Large Pelagic Longline Fisheries - Project 2.2A. (J. Neilson, D. Busawon, E. Carruthers, S. Campana, L. Harris and D. Andrews)
1500-1515	Break
1515-1700	Factors Affecting Sea Turtle Bycatch in the Large Pelagic Fishery – Project 2.2A (D. Andrews and L. Harris)

Tuesday, 12 July 2011

0830-1000	Summary of Day 1 and Discussion
1000-1015	Coffee Break
1015-1200	Science Advisory Report
1200-1300	Lunch (provided)
1300-1500	Science Advisory Report
1500-1515	Break
1515-1700	Science Advisory Report

APPENDIX 2: Terms of Reference

Maritimes Regional Science Advisory Process

Incidental Catch in Canadian Large Pelagic Fisheries

11-12 July 2011
St. Andrews, NB

Chairperson: Kirsten J. Clark

TERMS OF REFERENCE

Context

Incidental bycatch and discarding of non-targeted species occur in many fisheries. Discarding of targeted species also occurs for a variety of regulatory reasons, *e.g.,* undersized fish, licence restrictions, *etc*. An objective of an Ecosystem Approach to Fisheries Management is to control incidental mortality for non-targeted species and to manage discard mortality for targeted species. This requires a comprehensive plan for monitoring fishing activity, measuring the discard mortality and establishing suitable references to indicate when that mortality is unacceptable.

The Work Plan to Address Incidental Catch in Canadian Large Pelagic *Fisheries* addresses concerns about bycatch and discard issues in Canadian large pelagic fisheries focusing on the swordfish/other tunas longline fishery at this time. The focus of this plan is directed toward six key species: bluefin tuna, porbeagle, shortfin mako, blue shark, leatherback sea turtle and loggerhead sea turtle as well as discarding of swordfish. The Work Plan is organized into projects under three main themes: 1) Level of Observer coverage, 2) Manage discards for all targeted species and 3) Control incidental mortality for non-targeted species.

The Fisheries and Oceans Maritimes Region has moved forward with projects considered highest priority with respect to available resources. Three projects are to be reviewed in this RAP meeting:

- Level of Observer coverage: Estimates of Precision (1A).
- Discard Estimation: Evaluation of data, methods & results for estimating discards (2.1A).
- Survival of Released Bycatch: review methods for determining post-release mortality of bluefin tuna and swordfish (2.2A).

Objectives

Level of Observer Coverage: Estimates of Precision (Project 1A) [Hanke]

- Describe the evolving fishery patterns of the swordfish/other tunas longline fishery, summarize their Observer coverage and determine the nominal estimates of precision for the discard:effort and discard:landed ratios of each of the seven study species (bluefin tuna, porbeagle, shortfin mako, blue shark, leatherback sea turtle, loggerhead sea turtle and swordfish).
- Investigate sampling implications of practical alternative stratification schemes.
- Evaluate the utility of the higher Observer coverage conducted in 2001-2002 with respect to quantifying the improvement in precision.

- Review the applicability and results of various bycatch reporting methodologies for achieving desired precision of estimated discards.

Discard Estimation (Project 2.1A) [Hanke, Neilson, Campana]
- conduct a comparative evaluation of the data, methods and results for estimation of total (live+dead) discard of bluefin tuna, swordfish, porbeagle, mako and blue shark
- recommend best practice

Survival of Released Bycatch (Project 2.2A) [Neilson, Campana]
- Review methods for determining post-release mortality
- Develop guidelines for best practice when determining total dead discards from fisheries, but in particular from pelagic longline fisheries

Expected Publications

CSAS Science Advisory Report
CSAS Proceedings
CSAS Research Document(s)

Participation

DFO Science
DFO Resource Management
Provincial government (NB and NS)
Large pelagic longline fishing industry
Aboriginal communities/organizations
Other stakeholders

APPENDIX 3: List of Participants

Name	Affiliation
Andrushchenko, Irene	DFO Maritimes, Science, St. Andrews Biological Station
Andrews, David	DFO Maritimes, Science, St. Andrews Biological Station
Annand, Chris	DFO Maritimes, Fisheries Management
Arnold, Shannon	Ecology Action Centre
Atkinson, Troy	ICCAT Commissioner and Nova Scotia Swordfishermen's Association
Bennett, Lottie	DFO Maritimes, Science, Centre for Science Advice
Brilliant, Sean	Canadian Wildlife Federation
Buchanan, Dylan	Javitech Ltd. (Observer Company)
Busawon, Dheeraj	DFO Maritimes, Science, St. Andrews Biological Station
Campana, Steven	DFO Maritimes, Science, Population Ecology Division
Clark, Kirsten	Chair, DFO Maritimes, Science, St. Andrews Biological Station
Eagles, Mike	DFO Maritimes, Fisheries Management
Elsworth, Sam	Southwest Nova Tuna Association
Emery, Pamela	DFO Maritimes, Science, St. Andrews Biological Station
Fraser, Doug	ICCAT Commissioner
Gross, Eric	DFO Maritimes, Science, St. Andrews Biological Station
Hanke, Alex	DFO Maritimes, Science, St. Andrews Biological Station
Harris, Lei	DFO Maritimes, Science, St. Andrews Biological Station
James, Michael	DFO Maritimes, Science, St. Andrews Biological Station
Jacquard, Eric	Southwest Nova Tuna Association
LaBillois, Barry	Maritime Aboriginal Aquatic Resources Secretariate
Lester, Brian	DFO Ottawa, Fisheries Management
Malone, Chris	Southwest Nova Tuna Association
Mood, Corey	Nova Scotia Swordfishermen’s Association
Neilson, John	DFO Maritimes, Science, St. Andrews Biological Station
Paul, Stacey	DFO Maritimes, Science, St. Andrews Biological Station
Porter, Julie	DFO Maritimes, Science, St. Andrews Biological Station
Quigley, Sara	DFO Maritimes, Fisheries Management
Showell, Mark	DFO Maritimes, Science, Population Ecology Division
Smedbol, Kent	DFO Maritimes, Science, St. Andrews Biological Station
Stone, Heath	DFO Maritimes, Science, St. Andrews Biological Station
Vanderlaan, Angelia	DFO Maritimes, Science, St. Andrews Biological Station
Whelan, Christie	DFO National Capital Region, Science
Williams, Wendy	DFO Maritimes, Policy and Economics
Wimmer, Tonya	World Wildlife Fund Canada, Atlantic Region

APPENDIX 4: Reviewers' Comments

Reviewer: H. Benoît

1. Working Paper 2011/26. Neilson *et al*. A review of approaches to assess survival of released catch from Canadian large pelagic longline fisheries

The document is very well written and does an excellent job of summarizing the literature and weighing the relative merits of different approaches to estimating mortality. I have no substantive comments.

Minor comments:

i) Concerning subjectivity in Observer scoring of condition/vitality, the authors could consider the use of random effects (RE) in the analysis of those data (*e.g.,* Benoît *et al*. 2010). However, while RE can account for some of the variability in condition scoring, they cannot account for systematic biases in the application of scoring criteria as described in the working paper.

ii) A note on the discussion concerning using pop-up satellite tag (PAT) technology for mortality estimation. In addition to the points raised in the document (*e.g.,* tagging bias towards healthier animals, small sample size, *etc*.), there is also a strong potential for a cluster effect in the estimated mortality. If fish are tagged from a small number of fishing sets (perhaps even during a single trip), estimated mortality may not be representative of discards in the broader fishery.

2. Working Paper 2011/27. Andrews and Harris. Sea turtle bycatch and condition in Atlantic Canada's pelagic longline fishery: a delta-model using Observer data from 2001-2009

This is a reasonably well written document and there is generally a good rationale underlying the analyses. However, I have a number of concerns about the analyses that should be addressed before the results could be used as part of Science advice.

i) I would have liked to see plots of the data so that I could judge the appropriateness of the models, rather than seeing only plots of model predictions (which themselves may not be reliable, see iii below). Maps such as Fig 1 should be produced for each sea turtle species using expanding circles to indicate the size of the catch. The frequency distribution of sea turtle catches (numbers, not CPUE) should be plotted so that the reader can assess whether the distributional assumptions made by the authors are supported. Bivariate and trivariate plots of catch vs. covariate(s) would help determine whether there are indications of leverage for particular variables and determine whether the assumption of a linear relationship with CPUE is justified. I doubt it is justified for variables such as latitude, longitude and temperature, and the interactions that involve them.

ii) Concerning the point above, how was model fit assessed? AIC provides an indication of changes in model fit with additional variables but doesn't say anything about whether the model is appropriate.

iii) I suggest that positive catches be modelled directly, with effort as a covariate, rather than modelling CPUE. First, this keeps the relationship closer to the original data. Second, it does not impose a strict zero-intercept linear relationship between catch and effort, which may not exist. For example if sea turtles occur in rare clusters of socially interacting individuals, conditional on having captured a sea turtle, the number caught may be weakly related to fishing effort. Third, it reduces some confusion as to why one effort variable (hooks) was used to calculate CPUE, while another (soak time) are used as a predictor. Fourth, the data

might more naturally be modelled using an overdispersed-Poisson or negative-binomial model, rather than resorting to a delta model with positive catches modelled differently for the two sea turtle species. Delta models are somewhat *ad hoc*, implying that different processes affect the probability of a capture and the size of catch conditional on capture.

iv) Greater attention needs to be placed on the choice of covariates for analysis. First, the authors should justify the inclusion of candidate covariates and for interactions – *i.e.,* why might you expect an effect of inter-hook distance on sea turtle catch. Second, the authors should examine the covariates and the interaction terms for multicollinearity before beginning the analysis. Multicollinearity will affect the inferences made on the role of individual predictors. In the presence of collinearity, predictions for individual covariates can be incorrect.

v) The variable selection procedure is a little unclear and based on my interpretation may not be ideal. The authors appear to have used AIC minimum to select their model, however models within 2 AIC units (some would say within 4) from one another should be considered as equally likely. I would therefore have expected to see more than one "selected" model for each species. Adding variables in multiple regression often reduces AIC, so basing decisions on absolute AIC is likely to result in an overparameterized model.

Other Comments:

i) It would be useful to the reader to show the equation for obtaining means and variances from the delta model rather than simply referring to Stefannsson.

ii) Show the correlation between observed and predicted temperatures (p 7)

iii) what is 'Program R' mentioned in the text. Do you mean in the XXX routine of the R statistical programming environment?

3. Working Paper 2011/28. Hanke *et al.* Observer coverage of the Atlantic Canadian swordfish and other tuna longline fisheries: an assessment of current practices and alternative methods.

This paper takes a very detailed look at spatial and temporal patterns in the distribution of Observers, which is very useful for understanding the existing data and planning Observer surveys for the future. There are a few issues that I believe could be addressed to improve the document.

i) There is no mention of Observer effects (*i.e.,* a change in fishing behaviour when Observers are present). These effects can greatly affect the reliability of bycatch estimates using Observer surveys. The data are available to test for the presence of Observer effects (*e.g*., see Benoît and Allard 2009), though at a minimum they should at least be discussed.

ii) Because Observers are deployed to trips, these are the sampling units (*i.e.,* the level at which sampling decisions are made). Differences in coverage for the number of sets or sea days is a consequence of the sampling decision, either due to non-random selection of trips with respect to their intended fishing effort or due to an Observer effect. This should perhaps be made clearer in the text.

iii) Though the numerous graphs show that distribution of Observers to trips has been non-random, it would have been nice if this had been tested statistically. In some cases where sampling intensity is low, apparent deviations from 'ideal' sampling may not be different from random.

iv) The Monte Carlo simulation is for an ideal situation (simple random sampling - SRS), whereas the authors have shown that the distribution of Observers to fishing trips is non-random. To be useful in decision-making, the simulation should ideally try to mimic how sampling is actually done. Currently the assumption of SRS leads to an unbiased estimator (as a result there was no need to calculate relative bias to show this).The reality would be

different. Again see Benoît and Allard 2009 for ideas about how to simulate the sampling. There are also two other issues concerning the simulation as implemented. First, the authors should use a discrete probability distribution to generate catches, rather than a continuous probability distribution (the lognormal). Second, as indicated at the meeting, the CV should tend to zero as coverage tends to 100%. The reason it does not in the simulation is because the authors draw their catch rates for observed sets from a continuous probability distribution with infinite support and therefore an infinite number of different possible catch rates drawn. In a fishery, the number of individual catches is finite and is equal to the number of fishing sets. Observed sets are some subset of this finite ensemble. To properly simulate the effect of percent coverage on precision, the authors need to modify their reference population in their simulation (*i.e.,* the finite ensemble of fished sets, not the population of catch rates that are possible for the fish population).

v) Given the non-random sampling, the authors should strongly consider applying some form of post stratification when estimating bycatch and associated variability. This would help control some important sources of bias
vi) The confidence intervals for estimated bycatch occasionally overlap with zero suggesting that the distributional assumptions for the estimated error are not met. The authors may want to consider non-parametric estimation (bootstrapping) or finding a more appropriate error structure. At a minimum this should be addressed in the discussion.
vii) Figures 21-22. I do not understand why actual coverage is predicted from the model? Actual coverage is known without error, *i.e.*, it is not a stochastic variable. The expected (target) number of covered trips, given a target level of coverage, is a random variable. The logistic regression used to generate the intervals is however useful in testing and calculating effects sizes for year and area differences in realized coverage.

Other Comments:

i) p. 4, Define *pi* as the actual or realized coverage rate.
ii) p. 5, logistic regression. Why not include vessel size?
iii) Monte Carlo simulation. Why was a parametric bootstrap used rather than non-parametric (*i.e.,* resampling from the observations)? The authors should show plots to support the choice of parametric distribution. In particular, a discrete pdf (negative binomial, Poisson, *etc*.) should be used.
iv) I would avoid using the term ‘optimal coverage’, which implies that a choice was made with respect to certain constraints. Rather I would say ‘target coverage’
v) P. 11. “If the composition of the longline catch is affected by vessel size, then the sampling must be structured to include all vessel size classes”. No, sampling must be structured to be actually or conditionally (*e.g.,* using stratification) representative of fishing effort by different sizes.
vi) Fig 1+. Suggest using colour to distinguish the years.
vii) Fig 9. I am not certain I understand this plot. The box above seems to indicate which panel is which, though this is somewhat confusing. Perhaps each panel could be labelled directly.
viii) Fig 18. This caption is not very clear. I had to re-read it a couple of times and refer to the text to understand what it is meant to show.
ix) Fig 23 doesn’t appear to be cited in the text
x) Fig 26 is largely redundant with Fig 24 and provides less info
xi) Figures 30+ (plots of point estimates with error). Why are the various points not plotted in some consistent order (*e.g.,* red, green, blue… for each year)? This would enhance clarity. Also, in these plots and elsewhere in the text, please refer to species names rather than codes.

References:

Benoît, H.P., and J. Allard. 2009. Can the data from at-sea observer surveys be used to make general inferences about catch composition and discards? Can. J. Fish. Aquat. Sci. 66:2025-2039.

Benoît, H.P., T. Hurlbut, and J. Chassé. 2010. Assessing the factors influencing discard mortality of demersal fishes in four fisheries using a semi-quantitative indicator of survival potential. Fish. Res. 106: 436-447.

Reviewer: C. Whelan

1. Working Paper 2011/26. Neilson *et al*. A review of approaches to assess survival of released catch from Canadian large pelagic longline fisheries

This paper is well written and concise. It provides a good review of the available approaches for estimating post-hooking mortality. I only have a few minor comments or requests for clarification/more detail.

i. Page 5, paragraph 1. More detail here on the condition of the fish when released would be helpful for context. How were they released? Were the lines cut? Hooks removed? Even if the animals are only alongside the boat and therefore some measurements cannot be taken, the condition of the animal can be greatly informed by what gear is removed or left attached.
ii. Page 6, paragraph 2. Carapace length for sea turtles was not measured correctly by Canadian Observers for a long time, leading to very skewed data indicating we had larger animals in our waters. Has this been properly corrected? Is there a correction factor available for the older data?
iii. Page 8, end of paragraph 1. Reference needed.
iv. Page 14. For the Sasso and Epperly paper, it is important to note if any of the longline caught sea turtles were deeply hooked (hook swallowed or in the throat) or not.
v. Page 15, end of paragraph 1. It would be helpful to add a sentence here for clarification on how the biochemical methods would be applied/used. Would the mortality estimates/predictors be used to adjust TAC or management decisions?
vi. Figure 3. What is the x-axis for this figure? Days? Hours?

2. Working Paper 2011/27. Andrews and Harris. Sea turtle bycatch and condition in Atlantic Canada's pelagic longline fishery: a delta-model using Observer data from 2001-2009

While this is an interesting exercise and is starting to tease apart the factors contributing to increased bycatch, the analysis is lacking the incorporation of the biology and the behaviour of the animals and the knowledge of the fishing industry practices. As a result, some of the results provided in the paper do not make sense when considering the biology or behaviour of the species. In particular, the analysis would be greatly improved with some input from industry on how the fishing sets are set up and why. For example:

- What conditions lead to the hooks being set wider apart or closer together? Is this to target a specific species? In that case, would the water temperature play a large factor? Without the knowledge of why the fishing industry is setting gear in a particular way, using the gear formation to predict bycatch might not be addressing the real reason that the chance of bycatch is higher or lower. Furthermore, the feeding biology of loggerheads would likely

lead to higher bycatch of the species if the hooks are closer together than if they are further apart as they would be looking for aggregations of food.

- Similarly, is swordfish targeted more than tuna under certain conditions? Again, the reason the fishing industry is doing something is important to know when considering this analysis. My understanding is that tunas are targeted in warmer water, so it makes sense that more loggerheads would be caught. Not because the boat is targeting tuna, but because the water is warmer.

Better understanding of the fishing practices around the use of floats, light sticks, gangion length, distance between hooks, soak time, *etc*. is needed to better inform this discussion. The reasons for specific gear settings may be completely controlled by other variables (*e.g.,* sea surface temperature, target species, *etc*.) and therefore are not good predictors of bycatch by themselves.

Given loggerhead sea turtles' inability to regulate temperature, the temperature of the water is a critical factor in conducting this analysis. Monthly averages are likely not sufficient from completing this task. Temperature can change quickly along a front and therefore skew the data analysis significantly.

Discussion around a biological explanation for these results is needed to verify their validity. The higher bycatch of loggerheads in warmer water and the higher bycatch of leatherbacks in colder water are easily explained by their physiology. However, what explanations can be given for the results of higher loggerhead bycatch with less distance between hooks or shorter gangion lengths? Luminous gangions are more likely to attract loggerheads that to keep them away. Leatherbacks are extremely unlikely to untangle themselves from gear. Given their swimming behaviour they would be more likely to get more tangled the longer the gear is in the water. Therefore more discussion and investigation is also required on the results that a longer soak time leads to higher bycatch of leatherbacks.

This analysis would be great improved by adding a multi-variate analysis.

Table four and the map in Figure 1 seem to contradict each other. Table 4 indicates that there is an increase in interactions with loggerheads moving from -65º W to -50º W; however, the map indicates that there are much more interactions with loggerheads in the western area. This needs to be clarified.

For non-statisticians, it is hard to determine what the tests used are and what they are indicating. Better description of the methodology and statistical tests used is needed. Also, more description is needed on why some things were lumped together and others weren't (*e.g.,* the bait combinations). The paper notes that it was to avoid overparameterization, but how were the lumping decisions made. Were they verified against the biology of the bycatch species or against the fishing practices of the industry?

Minor Editorial Comments:

i. Need to be consistent with the capitalization of the common names of species.
ii. Correct the COSEWIC citations in the document to 2010, not 2011.

3. Working Paper 2011/28. Hanke *et al.* Observer coverage of the Atlantic Canadian swordfish and other tuna longline fisheries: an assessment of current practices and alternative methods.

I am not a statistician, so aspects of this paper are difficult to comment on. My comments are broader as a result.

There is no analysis or discussion of Observer effects. This should have been included and discussed.

It is clear from the analysis that the Observer coverage is higher in the lower fishing times and not reaching the 5% coverage level in the months with the highest fishing intensity. Some areas are also not being observed at the appropriate level (*i.e.,* undersampling in 4X). I think that the paper would have been greatly improved if it also included some stronger and more specific recommendations with the analysis on how to correct these issues with the Observer coverage.

Specific Comments:

i. Pg 2 – paragraph 4. Clarify that there are no other allocated tuna quotas in EASTERN Canada. We catch Tuna in the Pacific as well.
ii. Figure 9. It is unclear which panel refers to which vessel length. One panel with four coloured lines would be easier to understand.
iii. Figure 10 is difficult to read, particularly the year box on the right hand side and the LOA box at the top
iv. Figure 14 would be greatly improved if the 5% coverage line was also included as that was the target coverage level for a large portion of this time period.
v. Figure 15, 16 and 17 are very difficult to absorb. There is a lot of information included there. It might be more effective to break it out into 5 series so that the information comes across more clearly. More description in the text and better labelling of the axes would help with the interpretation of the graphs.
    - The scaling factors should be included for (a). However, the description in the text for these plots is clear and easy to interpret.
    - The (c) (d) and (e) plots are difficult to interpret and better explanation of what the lines mean would be helpful.
vi. Figure 19. Similar comments to figures 15-17. It is difficult to interpret some of these plots. It would have been more effective to break it out into 4 series so that the information comes across more clearly. It would be much easier to interpret if text had been included similar to what was written for figures 15-17 (on page 8-9) describing what each series meant and how they are interpreted.
vii. Figure 21. These plots are difficult to read and distinguish the lines. It is also unclear why the Observer coverage estimates are being predicted by a model when we have to data to know exactly what the coverage was.
viii. Figure 23 is not mentioned in the text.
ix. Figure 30 and 31. Same comments as for other figures. Might be more clear if broken out into more series. The headers with the number IDs for the species should also included the species name to clarify the plots. More description in the text (similar to what was done for figures 15-17) would be very helpful as some of these plots are very difficult to interpret.
x. Figure 32. The species number codes need to be written out to indicate which species it is referring to.