Center for Independent Expert Independent Peer Review of the North Atlantic Right Whale Decision Support Tool

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Executive Summary

The Decision Support Tool (DST) was developed to assess different management options, such as trap reductions, fishing closures or ropeless fishing methods, in reducing the risk of serious injury or mortality on the North Atlantic Right Whale (NARW; *Eubalaena glacialis*) population. This can be achieved through the DST determining risk as a product of the number of vertical rope lines (VL), whale abundance and the severity of entanglement based on the fishing gear used. The purpose of this review, that had an onsite component at Marine Biological Laboratory Swope Center, Woods Hole MA on 19-21 November 2019, is to assess the inputs of, and outputs from, the DST and it appropriateness to evaluate relative whale entanglement risk. In addition to providing research recommendations to improve the DST this review also provides comment on the methods to apportioning anthropogenic mortality by country.

There is considerable input data, which has been collated, and in most cases these data represent all available data. However, there are some data pertaining to NARW relative abundance that should be included. The omission of these data leads to regions having an underestimated NARW abundance. While all available fishery data has been accessed, these data are dated and relatively course, with a uniform distribution across a statistical fishing area which does not take into account variation in lobster habitat within that area (with the notable exception of the new work undertaken in LMA 3). The gear threat model is a novel addition to the existing co-occurrence model and will be a valuable tool once it is appropriately formulated and refined. Currently there is too much uncertainty regarding the mechanisms surrounding an entanglement and how these are likely to be impacted by changes to gear configuration and whale size etc. Finally, variation is not incorporated into the model for any of the input data sources. The whale habitat model did generate variance estimates, though these were not carried into the DST; rather mean values of whale abundances, averaged over several years, were combined with a mean vertical line density, from a single year, to generate the likelihood component of the risk score. The variation in the gear threat model was also not included in the model. This would have a considerable impact on the estimates of risk reduction achieved by any management strategy.

The model outputs are generally well considered and useful. The incorporating of model run parameters in the output allows future runs of the model with the exact same parameterization. Some suggestions on model output were provided but the main input for future outputs should be

derived from the end-users of the DST. Should the model incorporate variation into its assessment, these should also be provided in outputs.

The DST is an appropriate, well designed tool which takes advantage of disparate data, combined in such a way that it provides end-users with a mechanism by which to assess various management options aimed at reducing the risk of serious injury and mortality (SI-M) to NARW. Once the DST has been stabilized in its development, work should be undertaken to decrease run time and increase usability for interested parties, particularly those which may not be have the necessary programming / computing skills.

Finally, the apportionment of SI-M for NARW between Canada and the US is extremely difficult. Given the low numbers of SI-M which can be attributed to a particular country, it is possible to justify the split 50:50 of unknown SI-M between the two countries. However, given the recent distributional shift of the NARW, highlighted by recent Canadian SI-M, alternate methods of apportioning SI-M between the two countries should be explored.

The development of the DST has clearly been a considerable undertaking over a relatively short period of time. NMFS, and particularly Burton Shank, should be commended for work on this product, and the continued development of this DST. Numerous positive comments from industry and state officials, expressed during the meeting, reflected the importance of this tool in the development of implementation of management outcomes to mitigate SI-M on NARW. Its application at the recent Atlantic Large Whale Take Reduction Team (TRT) meeting to generate potential gear modifications, which achieved a similar level of risk reduction across a range of fisheries, highlights the tool's effectiveness. However, there exists a significant amount of work required to improve this tool. Nevertheless, it is my opinion that rule changes that were identified at the recent TRT meeting represent progress; noting that if a more robust version of the DST in the future contra-indicates current management measures effectiveness then they can be replaced by more suitable measures. A list of recommendations (not in priority order) from the report is as follows.

1. Recommendation: Undertake sensitivity analysis or incorporate variation around VL densities obtained from the various fishery input data sources
2. Recommendation: Expansion of the method for effort distribution in LMA 3 to other regions in the DST
3. Recommendation: Improved catch and effort reporting at a spatial scale sufficient to ensure meaningful overlap with the whale habitat model

4. Recommendation: Standardization of data reporting such that times series of effort distribution can be generated and seamlessly integrated into future model runs permitting time series of effort and effort stability to be appropriately assessed.
5. Recommendation: Future model developments with the planned split in NARW distributions should be run in tandem to ensure management measures are robust to the changing NARW spatial distribution
6. Recommendation: Uncertainty from the NARW density surface models needs to be incorporated into the DST
7. Recommendation: Increase survey effort in regions of high vertical line density and high uncertainty in the density surface model for NARW
8. Recommendation: Incorporate all available spatial data and include telemetry and acoustic detection data where possible
9. Recommendation: Incorporate variation in rope breaking strength into DST estimates of reduced risk
10. Recommendation: Include variation about the observed data on rope strengths in assignment of relative risk posed by ropes of different strengths
11. Recommendation: Examine possible methods to determine the functional form of risk provided by different configurations of gear
12. Recommendation: Once incorporated into the DST, include estimates of variation in model outputs
13. Recommendation: Once model development has plateaued, methods to decrease run time should be explored
14. Recommendation: Reinstitute a user friendly interface to enable greater accessibility to the DST and a lesser requirement for modeler input in scenario testing
15. Recommendation: Examine the use of the entanglement simulator model to better understand the method of entanglement and the threat posed by different gear configurations
16. Recommendation: Expand the spatial extent of the DST to encompass the entire NARW distribution in North America
17. Recommendation: Improve gear marking techniques to enable "remote" identification of gear at a finer spatial scale (state as a minimum)
18. Recommendation: Enable dynamic, end-user generated rules to redistribute traps moved in the DST
19. Recommendation: Reassess the current apportionment of anthropogenic mortalities of unknown origin to reflect the recent change in population distribution

Background

The Decision Support Tool (DST) was developed by the National Marine Fisheries Service (NMFS) and used at the recent Atlantic Large Whale Take Reduction Team (TRT) meeting in April 2019. The DST was designed to assist TRT members in the development of management measures which would reduce the risk of serious injury or mortality (SI-M) to North Atlantic Right Whales (NARW; *Eubalaena glacialis*) to a level below Potential Biological Removal

(PBR). Through a range of management options (e.g., including trap reductions, trap caps, closures, trawl lengths and ropeless fishing, etc.), the reduction in risk can be assessed against the base (*status quo*) case.

There has been a significant change in the distribution of NARW in recent years (Record et al. 2019) and similarly a decline in population size (Pettis et al. 2019). In addition, the SI-M for this population has been above the PBR and, consequently, requires management measures to reduce the incidence of SI-M for NARW.

This document is a review primarily of the DST with terms of reference (TOR; detailed below) addressing the DST's input data (TOR 1), outputs (TOR 2), its appropriateness (TOR 3) and potential research recommendations for the DST improvement (TOR 4). A fifth TOR is included examining the apportionment of mortalities by country (TOR 5).

Terms of Reference

1. Evaluate the data inputs (e.g., spatial and seasonal gear configuration, spatial and seasonal right whale distribution, etc.) used in the Decision Support Tool.
2. Evaluate the data outputs (e.g., vertical line estimates, relative risk to right whales, etc.) produced by the Decision Support Tool.
3. Comment on the appropriateness of using the Decision Support Tool as an approach to evaluate relative entanglement risk to right whales and advise on the strengths and weaknesses of using the DST to compare management measures. The goal is to understand the relative risk of entanglement in different geographic locations and the reduction in relative risk based on different proposed mitigation scenarios.
4. Provide research recommendations for further improvement of the Decision Support Tool.
5. Evaluate whether the methods represent the best available scientific approach for apportioning anthropogenic mortality by country.

Review

The review was conducted at the Marine Biological Laboratory Swope Center, Woods Hole MA on 19-21 November 2019. The agenda of the meeting is provided in Appendix 2 (Annex 3) and this was followed, with some minor changes to the timing and order of presentations. The review panel consisted of Dr. Julie van der Hoop (Independent), Dr. Jason How (Dept. Primary Industries and Regional Development Western Australia) and Dr. Don Bowen (Dalhousie University). Dr. van der Hoop volunteered to facilitate the meeting, for which no chair had been pre-arranged. Reviewers were presented with written information prior to and during the review (Appendix 1) as well as with a copy of all of the presentations given during the review (see Agenda for details). In addition, a PowerPoint presentation was provided by Patrice McCarron of the Maine Lobstermens' Association to reviewers before the discussion regarding apportionment of NARW mortalities (Appendix 2; Annex 3).

On site there were the listed presenters (Appendix 2; Annex 3) as well as other members of the public (

Appendix 3). As the review was webcast, with phone in options, additional parties were presented and offered the option to comment during the presentation. These persons are identified where possible in

Appendix 3.

TOR 1: Evaluate the data inputs (e.g., spatial and seasonal gear configuration, spatial and seasonal right whale distribution, etc.) used in the Decision Support Tool.

There are three main data inputs into the decision support tool (DST). The initial trap density which, through a range of sub-models, translates available fishery data into a vertical line (VL) density. This, when combined with a whale habitat model based on sightings surveys, provides a co-occurrence model. The co-occurrence model forms the likelihood component of a risk matrix, with the consequence component provided through the gear threat model. The combination of these three main data set models forms the basis of the DST.

Initial Trap Densities

The estimates of VL density throughout the northeast US waters was generated through the Industrial Economics Incorporated (IEc) VL model, producing monthly VL density estimates at a 1 nautical mile resolution. The strengths of this technique come through collaboration between State and Federal regulatory authorities in the provision and incorporation of all available data. The collation of a range of disparate data sources into a single model is challenging and the developers should be commended in this difficult undertaking. The DST has augmented the IEc model through a separate analysis of offshore lobster fishing (LMA 3) data which was identified as having little/no effort in areas of known lobster habitat in the original IEc model.

There are concerns over the process by which the VL densities were generated and their spatial representation. VL densities were achieved through moving available data through a range of sub models. While these particular sub-models (2.7 # Trap / Trawl and 2.11 # Endlines / Trawl; Shank 2019) seem reasonable in their formulation, the underlying data which is utilized is currently not adequate for a determination in risk reduction.

Fishery Data

There was minimal description in the documentation of the DST (Shank 2019) as to how the data from each State was generated. For example (4.1.1.1; Shank 2019) stated that "active vessels were determined from permitting and landings data. Unique vessel classes and number of traps fished and traps per trawl were based on an annual mail-based survey of lobstermen". There was no indication as to the participation rate and spatial distribution of responses across statistical areas from the mail survey, nor, how landings data was apportioned to vessels / vessel classes and hence fishing effort. There were comments from fishing industry representatives that there has been an increase in lobster catch rates which were not incorporated into the assessment. Therefore, there may be a significant over estimation of some VL densities depending on the method of calculation.

The subset of data which is reported, e.g. “Maine’s harvester reporting, which includes a 10% subset of lobster license holders in any given year” (4.3.2 Shank 2019) does not include any estimate of the variance within these data. Data is presumably presented as a mean value, though this not explicitly stated. While it was acknowledged that incorporating variance throughout the modeling process would be problematic with the diversity of data inputs, sensitivity analysis should be undertaken to establish how robust these data are to variation about these mean values.

1. Recommendation: Undertake sensitivity analysis or incorporate variation around VL densities obtained from the various fishery input data sources

Spatial Distribution

The DST employed an alternate method to the IEc model for the apportionment of VL in LMA 3 to address an apparent spatial misrepresentation of effort. This was a significant improvement from the methods employed in other management areas as it attempted to apportion VL to areas associated with lobster habitat based on environmental covariates. By contrast, VL densities in other statistical fishing areas were uniform assigned throughout the statistical area regardless of habitat changes. This, by default, assumes that lobsters are homogenously distributed across the zone leading to equal fishing effort throughout. This is unlikely to be the case and is an unfortunate limitation of the data sources which are being used to generate the VL densities. In the absence of improved data sources, attempts should be made to adjust fishing effort within a statistical area such that it is more aligned with likely lobster habitat.

2. Recommendation: Expansion of the method for effort distribution in LMA 3 to other regions in the DST

There was discussion throughout the meeting of improved reporting of fisher catch and effort information which is due to be implemented in coming seasons. This would be a significant improvement to the model if these data were collected with sufficient rigor and spatial extent such that it will be possible to differentiate important fishing areas within a statistical area. For example, there is a potential shift in lobster abundances (Zheng 2017) as well as NARW distribution (Record et al. 2019) due to changing environmental conditions. Depending on environmental drivers causing shifts in distributions of lobsters and NARW, this may serve to increase or decrease the spatial conflict between the fishing effort and whales. However, without improved spatial effort data, this cannot be adequately assessed and may lead to erroneous management outcomes as the two datasets are not sufficiently spatially aligned in terms of resolution.

3. Recommendation: Improved catch and effort reporting at a spatial scale sufficient to ensure meaningful overlap with the whale habitat model

Temporal Distribution

It was not clear in the documentation provided as to the temporal extent of data. Through the review process it was evident that only certain years were analyzed and incorporated into the model. Clearly fishing is dynamic and including monthly variation is important to the model structure, but equally, or more importantly, is the inter-annual variation in fishing effort distribution. Assessment of risk based on a fixed year or years' fishing effort with multi-year averaged whale abundance implies that the particular year, or years', pattern of fishing effort is representative. It is critical to understand the variation in fishing effort inter-annually, as this variation must be taken into account when assessing the effectiveness of possible management measures. Due to the time frames to institute new legislation, any management measures must be robust to inter-annual variation in fishing effort to ensure their overall effectiveness. Therefore a time series of effort data is required such that it can assess the changes in fishing effort and provide mean values, as well as variance estimates, for the effectiveness of any proposed management measure.

4. Recommendation: Standardization of data reporting such that times series of effort distribution can be generated and seamlessly integrated into future model runs permitting time series of effort and effort stability to be appropriately assessed.

Whale Habitat Model

The whale habitat models for NARW were developed by Duke University utilizing a range of survey data across a number of years to produce a series of average monthly density surface models at a 10km pixel resolution from 1998-2017. The models take advantage of ship-based and aerial transect surveys with appropriate detection profiles and a series of environmental covariates to establish the density surfaces. The review of the DST was based on the version (v7) of the model which was run at the TRT meeting in April 2019. As with other aspects of the DST there has been considerable development subsequent to the meeting and more future work planned. Where appropriate this review also addresses some of these developments in the modeling.

Temporal Distribution

The model in its current form (v7/8) provides monthly average densities utilizing data from 1998-2017. The averaging over such an extended period clearly doesn't reflect any inter-annual changes in abundance. This has been recognized by the developers (Roberts PPT; slide 20) with a planned component of the next model to incorporate a comparison of older (1998-2010) to more recent (2010-2018) NARW survey data due to the shift in distribution in recent years (Record et al. 2019). This will result in a significant advancement in the DST as it will better represent the recent change in the NARW distribution. Any scenario run of the DST, once v9 has been incorporated, should be run in tandem to compare management action effectiveness against both the recent and historic NARW distribution (Record et al. 2019). Due to time needed to develop and implement management measures, they should be robust to be effective under both the current NARW distribution, but also its historic distribution.

5. Recommendation: Future model developments with the planned split in NARW distributions should be run in tandem to ensure management measures are robust to the changing NARW spatial distribution

Spatial Distribution

The incorporation and presentation of uncertainty in the density surface models is valuable, however, it is not transitioned into the DST. Uncertainty could be examined by running the two time periods in tandem (see above). There exists considerable uncertainty, particularly in low abundance areas. Some of these low abundance areas correspond to regions with high estimates of VL densities. Presentation of recent NARW survey effort (Roberts PPT; slide 138) highlights the lack of spatial coverage in these areas and increased survey data may serve to increase precision in these regions and hence assessment of management effectiveness.

6. Recommendation: Uncertainty from the NARW density surface models needs to be incorporated into the DST
7. Increased survey effort in regions of high vertical line density and high uncertainty in the density surface model for NARW

Additional Data Sources

Information was presented on the percentage of days where NARW were detected on passive acoustic receivers located throughout the species range (Roberts PPT; slide 114). These data are currently not incorporated into the density surface models. Of concern is some areas of low predicted NARW density from the model that showed a high percentage of NARW acoustic detections. Therefore, the presence of NARW in these areas is being under-represented, which can have implications for the potential effectiveness of management responses assessed by the DST. Incorporation of all available data sources, including any telemetry data or acoustic detections should be integrated into the model.

8. Recommendation: Incorporate all available spatial data and include telemetry and acoustic detection data where possible

Similarly, efforts should be undertaken to better understand the drivers or environmental factors which correlate with *Calanus* distribution. As the majority of SI-M stems from the foraging grounds of NARW, with *Calanus* their dominant food source, understanding the mechanisms which drive their distribution and abundance should greatly improve the predictive power of the model as NARW seek out these areas to feed.

Gear Threat Model

The addition of a gear threat model permitted the consequence component of the risk assessment to be incorporated into the DST. This was based primarily around the concept that thinner ropes (lower breaking strain), generally associated with shorter trawls, provide a lesser consequence from entanglement than thicker rope with generally higher breaking stains (Knowlton et al 2015). This is an extremely valuable component of the model, however, in its current form I believe that it is not fit for purpose.

The version of the DST used at the April TRT meeting utilized a survey based assessment of risk (Figure 4.7.1a; Shank 2019). A Bayesian approach was used to analyze these results and provide a mean score for different gear configurations. I have several issues with this approach and clearly some of them were echoed by the DST development team because since the TRT meeting they updated this component of the model to a more quantitative assessment. As a result there is little point providing feedback on this technique as I believe the more quantitative approach is a step in the right direction.

The version of the DST which was presented for the CIE review involved a quantitative assessment of rope strength which was derived through a series of sub-models from rope diameter. I commend the DST on moving to a rope strength metric to assess severity of entanglement injury and or subsequent mortality. While rope diameter may have a minor impact on the ability of a rope to be detected visually by a NARW, rope strength ultimately determines the force needed to break the entanglement. Considerable work, within a short period of time, has clearly gone into assessing rope strength compared to rope diameter, and assessing the relative risk of varying rope strengths. However, I believe that additional work is required before this can be formally incorporated into the DST.

Model Variation

Through running the DST, the rope diameters potentially encounter by NARW were converted to rope strength through the Rope Diameter Line Strength Model (2.14 Shank 2019). There was considerable variation in rope strength which a whale may encounter even for a particular gear configuration (e.g. single pot trawls; Figure 4.6.3.a Shank 2019) which wasn't included in the modeling. Coupled with variation about the number and types of vertical lines which may be encountered (see TOR 1; Fishery Data), there exists considerable unaccounted for variation in the rope strength which a whale may encounter.

9. Recommendation: Incorporate variation in rope breaking strength into DST estimates of reduced risk

Note: A document has been provided to the review panel regarding incorporation of variation in the gear threat model but was unable to be reviewed in time for this report. Feedback will be provided to the developer independent of this report.

The assignment of risk from ropes of various strengths was determined through comparison of rope strengths obtained from entangled whales (Figure 4.7.2.1.b Shank 2019). The ratio of rope strength encountered compared to that observed from entangled whales was used as a proxy for risk. As with the ropes encountered, there was no assignment of variation about the observed ropes from entangled whales. This could be achieved through the use of Clopper-Pearson confidence intervals. Incorporation of both of these sources of variation would produce a more robust assessment of the relative risks associated with ropes of different breaking strengths.

10. Recommendation: Include variation about the observed data on rope strengths in assignment of relative risk posed by ropes of different strengths

Functional Form of Gear Threat

The gear threat model attempts to determine a relative risk from what could be two extreme management outcomes; 1) where all traps are fished as singles with light ropes but have an extremely high VL density or 2) where traps are fished on extremely long trawls with very heavy ropes but a considerably lower VL density. The current assessment of gear threat uses a single metric, namely rope strength with a progressive relationship of increasing rope strength leading to an increased risk of SI-M.

Clearly there are multiple factors which impact on an entanglement and its ultimate severity (e.g., animal size and condition, behavior, surrounding gear densities and number of traps per trawl). However, moving to a lighter rope may indeed enable the whale to break free of the traps, but the remaining entanglement may serve to increase the chances of picking up additional surrounding gear. This may have a compounding effect. With such a multitude of factors and scenarios available and the lack of empirical evidence (e.g., witnessing an entanglement) it is difficult to determine the true functional form of entanglements as they relate to gear configurations and rope strength. One possible avenue of exploration could be through agent based modeling. Moving an agent through a field of randomly located gear with various densities and varying likelihoods of entanglements on adjacent gear may be one method to examine this. This would require some expert elicitation to inform the priors, but it may provide some insight into these rare yet often fatal encounters.

11. Recommendation: Examine possible methods to determine the functional form of risk provided by different configurations of gear

TOR 2: Evaluate the data outputs (e.g., vertical line estimates, relative risk to right whales, etc.) produced by the Decision Support Tool.

The outputs from the model run produced multiple files across three different file formats (.pdf, .csv and .xlsx). There appears to be considerable overlap in the data which is presented, i.e. the same data is presented in multiple formats. The .pdf files produce a series of figures under the default and scenario run, while the final .pdf provides a series of tables. The spreadsheets provide a readable version of the tables in the .pdf format in two formats.

I think there is merit in the continued export of data in multiple formats (.pdf and spreadsheets) as spreadsheet formats (.csv and .xlsx) provides the opportunity for end-users to explore model outputs in a versatile, simple and widely available software package. The .pdf format provides a document from the model run which records the model inputs and associated outputs which is important when looking to replicate the model run as future developments occur.

There is the opportunity to improve the presentation of the data from model outputs, but I believe that these should be secondary to improvements to the model inputs (see above) as, without these, improved model outputs simply produce a nicer demonstration of imperfect data. However, some suggested improvements to model outputs are provided below.

Single pdf Document

There would be benefit in a single pdf document which

- Details the base data used in the model run and the scenario parameters tested (as presented in the Tables.pdf)
- Presents maps where there is a change in risk. The current provision of data has separate files for default and scenario runs. It would benefit end users to see where there have been changes in risk and how much is achieved in each area.

End User Consultation

Again, upon completion of the model, it would be beneficial to consult with end users to determine the types of figures / outputs they would like to see. While, as reviewers we can provide comments on some components of the outputs, as a DST, it is there to support end users. As such, their requirements to make an informed decision is ultimately the major requirement of any outputs generated.

Variation

As mentioned throughout the review of TOR1, variation for all of the input components of the DST are not incorporated into the model. With their incorporation into the modeling, associated variation in the outputs should also be displayed to enable end-users. This will allow determination of how robust the management measures are likely to be to changes in the input data.

12. Recommendation: Once incorporated into the DST, include estimates of variation in model outputs

TOR 3: Comment on the appropriateness of using the Decision Support Tool as an approach to evaluate relative entanglement risk to right whales and advise on the **strengths and weaknesses** of using the DST to compare management measures. The goal is to understand the relative risk of entanglement in different geographic locations and the reduction in relative risk based on different proposed mitigation scenarios.

The DST is a significant step forward in the comparison of management measures to reduce the risk of entanglements in US fisheries. This sentiment was clearly echoed by industry members and managers who found the DST to be a useful tool in assessing a myriad of potential management measures at the recent TRT meeting. The developers should be commended on its initial, and continued, development which has been reactive to comments from stakeholders. It is an appropriate vehicle by which to evaluate relative risk of entanglement.

The strengths of the DST lie in its ability to assess a relative change in risk from a management measure, permitting these to be compared against different management measures in other areas. This enabled "buy-in" from stakeholders that all fishers were undertaking management measures which would result in a similar level risk reduction.

As with all models, as the complexity of this model evolved so did run time and the ability to address a number of management measures in a timely manner. A strength built into this model is the ability to run the analysis at a low-resolution which significantly decrease run time. Once stability is achieved in the model design, effort should be made to streamline the code such that run time is decreased. This will significantly increase its usability by enabling a number of scenarios to be run in a shorter period of time for comparison.

13. Recommendation: Once model development has plateaued, methods to decrease run time should be explored

Initially the DST had an interactive "shiny-app" interface which interacted with the code. This was understandably not supported as the model went through a series of development changes. Again, once stabilized the DST would benefit greatly from a "shiny-app" interface such that it can be used by industry members without the requirement for modeler input.

14. Recommendation: Reinstitute a user friendly interface to enable greater accessibility to the DST and a lesser requirement for modeler input in scenario testing

TOR 4: Provide research recommendations for further improvement of the Decision Support Tool.

Below are a series of recommendations which coupled with those listed previously would improve the confidence, usability and ultimately robustness of the DST.

Entanglement Dynamics

There is some concern over the Gear Threat Model as it is currently implemented in the DST (TOR 1; Gear Threat Model) and is an area which could benefit from significant additional research. As stated previously, it is unclear the form of the relationship between gear configuration and risk of SI-M takes during an entanglement. The model simulation developed by Howle et al. (2019) may provide a means by which this relationship could be addressed. While this only examined two case studies of entanglements, further use of the simulator for other documented entanglements may assist in determining the method of entanglement, but also the threat posed by gears of different configurations.

15. Recommendation: Examine the use of the entanglement simulator model to better understand the method of entanglement and the threat posed by different gear configurations

Spatial Expansion of the DST

Clearly the issue of SI-M to the NARW is at the population level and isn't restricted to just those fisheries in the US. This is evident by the need to apportion anthropogenic mortalities between the US and Canada (TOR 5). The clear shift in the distribution of the species in recent years (Record et al. 2019), coupled with the increase in known Canadian entanglements highlights the need for a collaborative approach. Currently the DST is restricted, understandably, to US waters, but the structure of the DST could readily be adapted to include Canadian effort data.

It was not possible to determine the extent of knowledge on the configuration of Canadian fishing gear. Therefore, to fully implement the DST, this information may be needed to implement the gear threat component of the DST. Expansion of the DST to include Canadian waters would ensure all stakeholders from both countries were invested in reducing SI-M of NARW, knowing all parties were undertaking similar levels of effort reduction.

16. Recommendation: Expand the spatial extent of the DST to encompass the entire NARW distribution in North America

Gear Marking

There is currently considerable debate as to which fisheries, states or even countries are involved in an entanglement. This is often due to the inability to identify the gear which may be sighted or even retrieved from an entanglement. Therefore, efforts should be made to move gear marking towards identification at finer spatial scales (e.g. by State and or management area). These markings should be sufficient such that gear can be identified without having to recover it from an entanglement (e.g., unique rope colors identified from a photograph) as opposed to 12 inch colored sections which are currently required (NOAA Fisheries 2014). This may be impractical in the short-term, but may be viable in the longer-term. As ropes are replaced by fishers (3-6 years; Shank 2019) a move to a set of unique single colors for the buoy line may make this a viable option. For example, those fishers in Maine may only fish with a red buoy line. This could be implemented as a compulsory measure in 2025, for example, when Maine fishers change their ropes they should replace them with red buoy lines. This would enable identification of management areas associated with entanglements and provide direct evidence of where future management measures may need to be focused.

17. Recommendation: Improve gear marking techniques to enable "remote" identification of gear at a finer spatial scale (State as a minimum)

Trap Redistribution Rules:

Currently the trap redistribution rules move effort from a soon-to-be closed area to an adjacent area based on the distance to that area and the relative abundance of VL in that area. This was acknowledged as a simple model and not likely to reflect what would be a "difficult to predict and idiosyncratic" (Burton PPT; slide 47) response from industry. There was concern from industry members over some of the assumptions in the trap redistribution methods.

Given the complex, and often varied response from fishers in response to a closure, consultation should occur such that appropriate rules can be inputted into the model. This could take a number of forms, but a separate spreadsheet input which details the likely response from industry is one possible mechanism. If end users had the capacity to vary the responses from fishers within the model then they could test the robustness of a closure to a range of potential pot redistribution scenarios.

18. Recommendation: Enable dynamic, end-user generated rules to redistribute traps moved in the DST

TOR 5: Evaluate whether the methods represent the best available scientific approach for apportioning anthropogenic mortality by **country**.

The reports of serious injuries or mortalities (SI-M) since 2009 have been few, averaging less than five per annum, however these are significant in a whale population of this limited size. Even fewer of these reported SI-M were attributable to fisheries of a particular country (<1 p.a.). This has resulted in a large number of SI-M which were of an "unknown" source. For the assessment of US fisheries against PBR limits, "unknown" SI-M were assigned based on the location that they were first sighted. However, as entangled whales are known to move considerable distances from the site of entanglement to where they are reported, the location of where whales are first sighted is not an appropriate measure by which to assign SI-M of an individual to a particular country. Recently, there has been a shift in the assignment of SI-M reports of an "unknown origin" to evenly apportion them between the US and Canada (50% unknowns are US). This has resulted in the proposed risk reduction in the US of 60%, with an upper limit of 80% to account for cryptic mortalities.

There does appear to be a widely accepted distributional shift in NARW abundances (Record et al. 2019) with more whales reported in Canadian waters. This is further illustrated with an increase in known SI-M which have been attributed to Canadian fisheries with all known Canadian entanglements (n=7) occurring in the last three seasons (2016-2018) compared to no known SI-M from US fisheries during this time. It was noted by presenters at the review that this may be a result of increased sighting effort in Canadian waters in recent seasons, which may also account for the similarity of total mortalities estimated from modeling being similar to the observed mortalities in 2017 (Coogan PPT 2 Slide 4).

The current 50% apportionment of unknowns to US fisheries does not reflect the current shift in NARW distribution and the recent increase in Canadian fisheries involvement in SI-M. Discussions between industry and government should therefore be entered into to find a compromise solution, whereby the recent shift in NARW abundance is accounted for, but fishers are still required to address the SI-M issues which likely arise from their fisheries noting the large number of unknown SI-M which can't be attributed to a particular country. A suggested starting point is postulated below, noting that significant negotiation should occur to ensure an appropriate outcome.

1. Unknowns for a given year are apportioned based on the proportion of known SI-M for that year: i.e. if all knowns are US then 100% Unknowns are US, but if there were 2 US and 1 CN known then 67% Unknowns are US.
2. If there are no known reports from either US or CN then unknowns are equally apportioned (50% Unknowns are US).
3. If there are no US knowns and all knowns come from CN, then US would have 25% of Unknowns attributed. This is to avoid situations such as 2018 where only a single SI-M came from CN, none from the US but there were 4.75 unknowns. Given the low numbers of knowns, it would be unlikely that none of these unknowns would be from the US hence the attribution of 25% to the US for the purpose of assessment against PBR. This would also account for some of the "non-detected mortalities" which may also be US and hence assists in possible management to address these.

Alternatively the apportionment of unknown SI-M could be based on the relative proportions of the NARW population which occurs in either the US or Canadian waters. This inherently assumes an equal risk of entanglement within each country's waters. This is unlikely to be the case, but until the DST or some similar mechanism is available to assess the relative risk between each jurisdiction, it may be a simple method which accounts for the recent shift in NARW abundances in recent years.

19. Recommendation: Reassess the current apportionment of anthropogenic mortalities of unknown origin to reflect the recent change in population distribution

Conclusions

The development of the DST has clearly been a significant undertaking over what appears to be a relatively short period of time. NMFS and, particularly, Burton Shank should be commended for their work on this product, and the continued development of this DST. Numerous positive comments from industry and state officials expressed during the meeting reflected the importance of this tool in the development of implementation of management outcomes to mitigate SI-M on NARW. Its application at the recent TRT meeting to generate potential gear modifications to achieve a similar level of risk reduction across a range of fisheries highlights the tool's effectiveness. Given this significant step forward, I am reluctant to restrict the gear management discussion until a fully developed and stable model is developed due to the immediacy of the problem of NARW entanglement leading to SI-M; however, there are several significant concerns in the DST which limit its overall effectiveness.

These limitations lie predominantly in the input data (TOR 1; Initial Trap Densities and Whale Habitat Model) but, particularly, the application of the gear threat model (TOR 1; Gear Threat Model) which I believe requires significant additional work before it will be ready to be incorporated into the DST. Much of the data presented are "average" values from a number of years (whale habitat model) or from set years (fishery data) without regard for the inherent year-to-year variation. While some of this is an unfortunate by-product of the availability of data, additional data is available in some cases, and proposed model development aims to incorporate this and better capture variation.

While it is necessary to construct the DST with a fine spatial scale (1nm) in order to incorporate all the potential management areas, this does lead to the impression that the data are available at this resolution which is not the case. Therefore care should be taken by end users such that they are not undertaking "surgical" changes in management. Broad stroke management options are better placed to take advantage of the DST as they better reflect the nature of the data upon which the DST is based.

The review was generally well presented. The NMFS staff and other presenters provided very valuable presentations and were generous in their time explaining various components of their work. As indicated above, there is more work that is required on the DST, including some of the documentation. While the present DST documentation (Shank 2019) covered most of the pertinent information, more attention to report layout would have enabled a more efficient review of the DST. Additionally, some documentation was not available for the review, such as the EIc documentation for the recent version of the model. Finally, any future reviews of the DST should be on a stable model version which is not currently under development.

Appendix 1

Documentation Provided for the Review and Cited References

Documents

Andersen, M. S. *et al.* 2007. Differentiating Serious and Non-Serious Injury of Marine Mammals: Report of the Serious Injury Technical Workshop, 10-13 September 2007, Seattle, Washington. US Department of Commerce., NOAA Tech. Memo. NMFS-OPR-39. 94 p.

Borggaard. D. L., *et al.* 2017. Managing U.S. Atlantic large whale entanglements: Four guiding principles. Marine Policy. 84 : 202–212 pp.

Farmer. N. A. *et al.* 2016. Evaluation of Alternatives to Winter Closure of Black Sea Bass Pot Gear: Projected Impacts on Catch and Risk of Entanglement with North Atlantic Right Whales *Eubalaena glacialis.* Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 8: 202–221 pp.

Hayes. S. A., *et al.* 2018. North Atlantic Right Whales- Evaluating Their Recovery Challenges in 2018, US Department of Commerce, Woods Hole, Massachusetts.

Hayes. S. A., *et al.* 2019. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2018. US Department of Commerce, Woods Hole, Massachusetts.

Henry. A., *et al.* 2016. Serious injury and mortality determinations for baleen whale stocks along the Gulf of Mexico, United States East Coast, and Atlantic Canadian Provinces, 2012-2016. US Dept Commerce, Northeast Fish Sci Cent Ref Doc. 19-13; 54 p.

Henry. A., *et al.* 2019. Serious injury and mortality determinations for baleen whale stocks along the Gulf of Mexico, United States East Coast, and Atlantic Canadian Provinces, 2012-2016. US Department of Commerce, Northeast Fish Sci Cent Ref Doc. 19-13; 54 p.

Howle LE, Kraus SD, Werner TB and Nowacek DP (2019) Simulation of the entanglement of a North Atlantic right whale (*Eubalaena glacialis*) with fixed fishing gear. Marine Mammal Science. 35(3):760-778

Industrial Economics Incorporated. 2014. Draft Technical Document for the vertical line model. *(Draft – Do not cite or quote)*

Knowlton et al. (2015) Effects of fishing rope strength on the severity of large whale entanglements. Conservation Biology 30(2): 318-328

McDonald S. L., and Rigling-Gallagher. D. 2015. Participant perceptions of consensus-based, marine mammal take reduction planning. Marine Policy. 61 : 216–226 pp.

NOAA Fisheries (2014) Atlantic Large Whale Take Reduction Plan: Northeast Trap/Pot Fisheries Requirements and Management Areas. https://www.maine.gov/dmr/science-research/species/lobster/documents/netrappot07-14.pdf [accessed 1 Dec 2019]

North Atlantic Right Whale Consortium. 2019. Right Whale Consortium Final Agenda 2019.

Pettis, H.M. *et al.* 2018. North Atlantic Right Whale Consortium 2018 Annual Report Card. Report to the North Atlantic Right Whale Consortium.

Pettis, H.M. *et al.* 2019. North Atlantic Right Whale Consortium 2019 Annual Report Card. Report to the North Atlantic Right Whale Consortium. *(Incomplete Draft – Do not cite or quote)*

Shank, B (2019) Decision Support Tool Model Documentation

Zheng, X (2017) "Shifts in Thermal Habitats in the Gulf of Maine under Climate Change: A Case Study on American Lobster". Honors Theses. Paper 866. https://digitalcommons.colby.edu/honorstheses/866

2019 North Atlantic Right Whale Consortium Annual Meeting University of Southern Maine, Portland, ME, USA 14-15 November 2019 *(Information contained within this booklet is intended for use at the 2019 North Atlantic Right Whale Consortium Annual Meeting. Data and analyses presented in these abstracts are not peer reviewed and are not to be cited.)*

Forms/Maps

Commonwealth of Massachusetts. 2018. Fixed Gear Supplemental Report

Lobster Management Stock Area Map Nov 2016

Commonwealth of Massachusetts. MA Division of Marine Fisheries - Monthly Trip-Level Commercial Report.

National Oceanic and Atmospheric Administration. 2018. Greater Atlantic Region Fishing Vessel Trip Report Reporting Instructions.

Spreadsheets / Programs / Data

DecisionSupportTool_2.0.2

Details on Serious Injuries and Mortalities [SI_M 2009-2018.xlsx]

PowerPoint Presentations (provided but not presented)

Pace. R. M., and Kraus. S. D. (2019). Estimating Latent Mortality of North Atlantic Right Whales.

McCarron (2019) Information for Decision Support Tool Peer Review

Appendix 2

Performance Work Statement (PWS)

National Oceanic and Atmospheric Administration (NOAA)

National Marine Fisheries Service (NMFS)

Center for Independent Experts (CIE) Program

External Independent Peer Review

North Atlantic Right Whale Decision Support Tool

Background

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

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards. (http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf).

Further information on the CIE program may be obtained from www.ciereviews.org.

Scope

NMFS is required to use the best available scientific and commercial data in making determinations and decisions under the Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA). Right whales, humpback whales, and fin whales are listed as endangered species under the ESA. Pursuant to the ESA and the MMPA, the National Marine Fisheries Service (NMFS) – with guidance from the Atlantic Large Whale Take Reduction Team (ALWTRT) – is responsible for the development and implementation of measures to reduce the risks of entanglement. These measures are embodied in the Atlantic Large Whale Take Reduction Plan (ALWTRP). The plan seeks to reduce the risks of entanglement through a set of gear modifications and other requirements that affect commercial fishing operations in Atlantic waters.

A continuing concern in the evolution of the ALWTRP is the risk of entanglement in vertical line; i.e., buoy lines associated with lobster trap/pot gear, or other fixed gear. To better understand this risk and, particularly, the potential impact of management measures designed to address it, NMFS requires information on the risks of entanglement and injury associated with vertical line used by various fisheries amount of vertical line used by various fisheries, especially the extent to which that line is fished in areas and during seasons in which whales are likely to be present. An absolute measure of entanglement risk is not feasible, but measures of relative risk are possible. At the most recent ALWTRT meeting in April 2019, NMFS introduced a North Atlantic Right Whale Decision Support Tool (DST) to help understand relative risk of entanglement in different geographic locations, and, most importantly, the reduction in relative risk based on different proposed mitigation scenarios.

The information and analysis contained in the report to be presented will include essential factual elements upon which the agency may base its rule-making determination. Accordingly, it is critical that the reports contain the best available information on the relative risk and reduction in relative risk based on mitigation scenarios, and that all scientific findings be both reasonable and supported by valid information contained in the documents. Therefore, the CIE reviewers will conduct a peer review of the scientific information and mathematical approach in the DST based on the Terms of Reference (ToRs). The CIE reviewers will ensure an independent, scientific review of information for a management process that is likely to be controversial.

The specified format and contents of the individual peer review reports are found in **Annex 1**. The specified format and contents of the summary report are found in **Annex 2**. The Terms of Reference (ToRs) for the review of the North Atlantic Right Whale DST are listed in **Annex 3**. Lastly, the tentative agenda of the panel review meeting is attached in **Annex 4**.

Requirements

NMFS requires three reviewers to conduct an impartial and independent peer review in accordance with the PWS, OMB guidelines, and the TORs below. The reviewers shall have a working knowledge and recent experience in the application of one or more of the following: 1) Atlantic large whales and entanglement; 2) Co-occurrence risk modeling; 3) Fixed gear/fishing rope strength and the severity of whale entanglements; 4) Lethal and sublethal impacts of interactions with fishing gear on protected species.

Tasks for Panel Reviewers

1) <u>Pre-review Background Documents</u>: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewer the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE on where to send documents. CIE reviewers are responsible only for the

pre-review documents that are delivered to the reviewer in accordance to the PWS scheduled deadlines specified herein. Each CIE reviewer shall read all documents in preparation for the peer review.

Background documents will be provided by NMFS prior to the CIE review.

2) Panel Review Meeting: The CIE reviewers shall conduct the independent peer review in accordance with the PWS and ToRs, and shall not serve in any other role unless specified herein. Modifications to the PWS and ToRs cannot be made during the peer review. The CIE reviewers shall actively participate in a professional and respectful manner as members of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.
3) Contract Deliverables - Independent CIE Peer Review Report: The CIE reviewers shall complete an independent peer review report in accordance with the PWS. The CIE reviewer shall complete the independent peer review according to required format and content as described in **Annex 1**. The CIE reviewer shall complete the independent peer review addressing each ToR as described in **Annex 2**.
4) Other Tasks – Contribution to Summary Report: The CIE reviewers will assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. The CIE reviewers are not required to reach a consensus, and should provide a brief summary of their views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.
5) Deliver their reports to the Government according to the specified milestones dates.

Foreign National Security Clearance

When reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for reviewers who are non-US citizens. For this reason, the reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/ and http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration- system.html. The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance

The place of performance shall be at the contractor's facilities, and at the Northeast Fisheries Science Center in Woods Hole, MA.

Period of Performance

The period of performance shall be from the time of award through January 2020. The CIE reviewer's duties shall not exceed 14 days to complete all required tasks.

Schedule of Milestones and Deliverables: The contractor shall complete the tasks and deliverables in accordance with the following schedule.

Within two weeks of award	Contractor selects and confirms reviewers' participation
At least two weeks prior to the panel review meeting	Contractor provides the pre-review documents to the reviewers
November 19-21, 2019	Each reviewer participates and conducts an independent peer review during the panel review meeting
Within two weeks after review	Contractor receives draft reports and summary report
Within two weeks of receiving draft reports	Contractor submits final reports to the Government

Applicable Performance Standards

The acceptance of the contract deliverables shall be based on three performance standards:

(1) The reports shall be completed in accordance with the required formatting and content; (2) The reports shall address each ToR as specified; and (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel

All travel expenses shall be reimbursable in accordance with Federal Travel Regulations (http://www.gsa.gov/portal/content/104790). International travel is authorized for this contract. Travel is not to exceed $10,000.

Restricted or Limited Use of Data

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

NMFS Project Contact:

Tara Trinko Lake

NMFS/Northeast Fisheries Science Center

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The report must be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The report must contain a background section, description of the individual reviewers' roles in the review activities, summary of findings for each TOR in which the weaknesses and strengths are described, and conclusions and recommendations in accordance with the ToRs.

   a. Reviewers must describe in their own words the review activities completed during the panel review meeting, including a brief summary of findings, of the science, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, but especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the summary report that they believe might require further clarification.

   d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The report shall represent the peer review of each ToR, and shall not simply repeat the contents of the summary report.

3. The report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review

   Appendix 2: A copy of this Performance Work Statement

   Appendix 3: Panel membership or other pertinent information from the panel review meeting.

Annex 2: Summary Report Requirements

1. The main body of the report shall consist of an introduction prepared by the chair that will include the background and a review of activities and comments on the appropriateness of the process in reaching the goals of the review. Following the introduction, the report should address whether or not each Term of Reference of the Right Whale Decision Support Tool review was completed successfully. For each Term of Reference, the Summary Report should state why that Term of Reference was or was not completed successfully.

   To make this determination, the chair and reviewers should consider whether or not the work provides a scientifically credible basis for developing management advice. If the reviewers and chair do not reach an agreement on a Term of Reference, the report should explain why. It is permissible to express majority as well as minority opinions.

   The report may include recommendations on how to improve future use of the Right Whale Decision Support Tool.

2. The report shall also include the bibliography of all materials provided during the review, and relevant papers cited in the Summary Report, along with a copy of the CIE Statement of Work.

Annex 3: Terms of Reference

For the North Atlantic Right Whale Decision Support Tool

1. Evaluate the data inputs (e.g., spatial and seasonal gear configuration, spatial and seasonal right whale distribution, etc.) used in the Decision Support Tool.
2. Evaluate the data outputs (e.g., vertical line estimates, relative risk to right whales, etc.) produced by the Decision Support Tool.
3. Comment on the appropriateness of using the Decision Support Tool as an approach to evaluate relative entanglement risk to right whales and advise on the strengths and weaknesses of using the DST to compare management measures. The goal is to understand the relative risk of entanglement in different geographic locations and the reduction in relative risk based on different proposed mitigation scenarios.
4. Provide research recommendations for further improvement of the Decision Support Tool.
5. Evaluate whether the methods represent the best available scientific approach for apportioning anthropogenic mortality by country.

Annex 4: Tentative Agenda – Panel Review

North Atlantic Right Whale Decision Support Tool

Woods Hole, MA

November 19-21, 2019

Tuesday, November 19, 2019

Time	**Activity**	**Lead**
10:00 am	Welcome and Introductions	Sean Hayes/Tara Trinko Lake
10:10 am	Overview and Process	Sean Hayes/Tara Trinko Lake
10:30 am	TRT Background **[Coogan PPT 1]**	Mike Asaro/Colleen Coogan
11:00 am	Co-Occurrence Model- **[Etre PPT 1]**	IEC Neil Etre
11:30 am	Decision Support Tool Purpose and Scope **[Hayes PPT 1]**	Sean Hayes
11:45 am	Model Overview and Fishery Inputs **[Shank PPT 1]**	Burton Shank / IEC
12:15 pm	**Lunch**	
1:15 pm	Fishery Inputs Continued	Burton Shank
2:00 pm	Discussion/ Review of Fishery Inputs	Review Panel
2:30 pm	Model Inputs: Gear Threat **[Shank PPT 2]**	Burton Shank / PSB Staff
3:15 pm	**Break**	
3:30 pm	Model Inputs: Gear Threat Continued	Burton Shank / PSB Staff
4:15 pm	Discussion / Review of Gear Threat Model	Review Panel
4:45 pm	Public Comment	Public
5:00 pm	General Discussion / Day1 Wrap-up	Review Panel / Presenters
5:30 pm	Adjourn	

Wednesday, November 20, 2019

Time	**Activity**	**Lead**
9:00 am	Brief Overview and Logistics	Sean Hayes/ Tara Trinko Lake
9:10 am	Model Inputs - Whale Habitat Modeling **[Roberts PPT 1]**	Jason Roberts
10:30am	Discussion / Review of Whale Habitat Modeling	Review Panel
11:00pm	Public Comment	Public
11:15 am	**Break**	
11:30am	Model Inputs- User Configurations	Burton Shank
12:30 pm	**Lunch**	
1:30 pm	Discussion / Review of User Inputs	Review Panel
1:45 pm	Model outputs- Risk to Right Whales	Burton Shank
2:45 pm	**Break**	
3:00 pm	Model Outputs- Risk to Right Whales Discussion/Review/Summary	Review Panel
4:15 pm	Public Comment Public	
4:30 pm	General Discussion/Day 2 Wrap-Up Key Topics	Review Panel/ Presenters
5:00 pm	Adjourn	

Thursday, November 20, 2019

9:00 am	Brief Overview and Logistics	Sean Hayes/Tara Trinko Lake

9:10 am	Right Whale Mortality Apportionment **[Coogan PPT 2]**	Colleen Coogan
10:10 am	Discussion/Review of Mortality Apportionment	Review Panel
10:40 am	Public Comment	Public
10:55 am	Break	
11:10 am	Meeting Wrap-Up and Discussion of Key Topics	Review Panel
12:00 pm	Lunch	
1:00 pm	Report Writing	Review Panel
5:00 pm	Adjourn	

*All times are approximate, and may be changed at the discretion of the chair. The meeting is open to the public; however, during the Report Writing sessions we ask that the public refrain from engaging in discussion with the reviewers.

Appendix 3

The review panel consisted of Dr. Julie van der Hoop (Independent), Dr. Jason How (Dept. Primary Industries and Regional Development Western Australia) and Dr. Don Bowen (Dalhousie University).