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

Center for Independent Experts (CIE) Program
External Independent Peer Review Report

by

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Executive Summary

The Atlantic Large Whale Take Reduction Team (ALWTRT) is responsible for the development and implementation of measures to reduce the risks of entanglement of North Atlantic Right Whales (NARW) in vertical lines associated with lobster trap/pot gear, or other fixed gear in Atlantic USA waters. 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 fishing operations. In April 2019, the National Marine Fisheries Service (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.

This report represents my independent review of the scientific information and mathematical approach used in the DST based on the following 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.

In my view, the best available scientific data have been used as inputs to the DST. This also applies to the Industrial Economics, Incorporated (IEc) model which forms the basis for much of the data and approach used in the DST. The DST model incorporates relevant new information as it becomes available and can be regarded as an evolving simulation environment with which to explore the consequences of different management scenarios.

The DST model is modular in structure, allowing new features to be added as needed. It also provides ample opportunity for the user to input conditions (e.g., fleet closures or caps, gear configurations) that together would represent different management scenarios. Thus, the DST is fit for the purpose of exploring a wide range of management actions that could reduce the risk of NARW entanglement.

Nevertheless, available data on the location of the fishery and on the configuration of gear used in the lobster fishery is of poor quality. There are few quantitative sources with associated measures of uncertainty. Much of the current information comes from expert opinion collected at the scale of statistical reporting zones.

By contrast, there are good quantitative data on the density distribution of NARW as result of comprehensive surface density modelling of many systematic surveys conducted over a period of years. Nevertheless, the resulting model estimates of distribution are climatological in nature as they represent long-term averages and may not reflect the distribution of whales in a given year.

Other sources of right whale distributional information - acoustic detection data, opportunistic sighting and movements of individuals fitted with satellite-linked tags - have not been incorporated into the model of right whale habitat use. It is not clear how or if these sources of information could be used in the surface density model, as they differ fundamentally from the systemic surveys, but they do provide insight into gaps in our understanding of right whale movements and point to biases resulting from the use of systematic survey data alone. Therefore, they should be considered.

The DST model attempts to assess the gear threat of entanglement by including an estimate of severity based on the breaking strength of the entangling rope. Three approaches have been attempted for use in the DST, but none are well supported by the limited data. Although rope breaking strength is no doubt an important contributor to the severity of an entanglement, other factors may often override breaking strength resulting in no clear relationship between rope breaking strength and severity. Gear configuration, density of gear, and characteristics of NARW presumably interact in complex ways in any given entanglement. Therefore, the search for a single factor, although attractive, may not be productive and a multi-factor approach may ultimately provide a more useful measure of severity.

The appropriateness of using the DST to explore management options depends on the scale of actions contemplated. Given the poor quality of the input data, the DST is not suitable as a platform for exploring the consequences of small-scale management actions. In its current state of development, the DST will be most useful in exploring management scenarios that do not depend on accurately predicting the density of vertical lines that NARW are likely to encounter in any month or subarea.

The NARW is a transboundary species and transboundary species guidelines already exist indicating that the PBR for US fisheries should be apportioned from the total PBR based on the fraction of time that the population resides in US waters (Barlow et al. 1995). Based on available data, conducting such an analysis to estimate this fraction would appear to be problematic. Therefore, the 50/50 split would seem a reasonable assumption until such time as there is evidence to indicate otherwise.

Recommendations

Until the location of lobster gear is known with considerably greater precision and accuracy, estimates of risk to NARW will necessarily be imprecise, likely biased, and may lead to incorrect conclusions about risk reduction associated with simulated management scenarios. It is **recommended** that reporting requirements be improved so that location of fishing gear is reported on a scale commensurate with the spatial grid used in the DST. It is also **recommended** that consideration be given to standardizing the information collected among state and Federal jurisdictions.

Given the critical importance of information about the characteristics of gear to assessments of entanglement risk, it is **recommended** that quantitative information on the configuration of gear fished be collected from state and Federal waters based on statistical sampling designs. These data should be collected sufficiently often as to estimate spatial and temporal trends in the fishery. The ability to capture trends will be needed, particularly in the face of a changing climate, to effectively update estimates of relative entanglement risk. It is also **recommended** that consideration be given to standardizing the information collected among state and Federal jurisdictions.

NARW range over large areas of coastal and offshore US waters during migration and when foraging. They travel singly and in groups and, at any one time, the locations of a significant fraction of individuals in the population are unknown. These features of their biology make it challenging to estimate or predict the distribution of individuals and hence their risk of entanglement in fishing gear. Although systematic surveys are still the best overall source of information on right whale distribution, it is **recommended** that other sources of information be incorporated in models of right whale distribution. These sources include satellite-linked tracked whales, acoustic recordings, and opportunistic sightings. For example, there would seem to be reasonable promise that passive acoustic surveys could be incorporated to inform the distribution of NARW. It is also **recommended** that more effort be directed to near real time estimates of NARW densities to better represent the entanglement risk in areas of high vertical line densities.

The DST currently suffers from a lack of high-resolution location and gear configuration data from the fishery. Better predictions of entanglement risk must await better input data. In the interim, it is **recommended** that more explicit goals be set out with respect to the scale of interventions contemplated to reduce the relative risk of entanglement to right whales. Those goals should recognize the spatial limitations of the current model. It is also **recommended** that measure of uncertainty in the input data be included in the model and where this is not possible, that sensitivity of outputs to assumptions and point estimates be explored to provide a better basis for drawing conclusions about the merits of different management scenarios.

Background

Commercial whaling brought the North Atlantic right whale (*Eubalaena glacialis*) to the brink of extinction by the late 1800s. Since 1970, this species has been listed as endangered under the USA Endangered Species Act. Right whales undergo a seasonal migration of more than 1600 km from northeastern Florida along eastern coastal waters of South Carolina, Georgia, New England and Canada. Although commercial harvesting is no longer a threat, this annual migration exposes right whales to entanglement in fishing gear and vessel strikes which are thought to be leading causes of right whale mortality.

North Atlantic right whales increased at approximately 2.8% per year from 270 in 1990 to 482 in 2010. Numbers then levelled off and have subsequently declined through 2018 to about 412 (Pace et al. 2017, ALWRT backgrounder NMFS presentation). Low birth rate and some 30 mortalities since 2017 have accelerated the rate of population decline.

The Atlantic Large Whale Take Reduction Team (ALWTRT) is responsible for the development and implementation of measures to reduce the risks of entanglement of NARW in vertical lines associated with lobster trap/pot gear, or other fixed gear in Atlantic USA waters. To better understand this risk and, particularly, the potential impact of management measures designed to address it, National Marine Fisheries Service (NMFS) requires information on the risks of entanglement and injury associated with vertical lines used by fishing operations. In April 2019, the 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 expected reduction in relative risk associated with proposed management scenarios that can be simulated with the DST.

This report represents my independent review of the scientific information and mathematical approach used in the DST based on the following 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.

I reviewed background documents provided by NMFS (listed below) and attended a 3-

day meeting in Woods Hole, MA. in November 2019 with two other CIE review panelists, Dr. J. van der Hoop, and Dr. J. How. Dr. J. van der Hoop volunteered to facilitate the meeting, for which no chair had been pre-arranged. During the meeting, the other members of the CIE review team and I heard presentations by Industrial Economics, Incorporated on vertical line estimation (the IEc model), by NMFS on the ALWRT, the DST, the estimation of entanglement severity, and the apportionment of mortalities between Canadian and US waters, and by Duke University on the estimation of the spatial and temporal distribution of right whales.

Addressing the Terms of Reference

1. Evaluate data inputs to the DST

The DST uses three sources of data inputs: those derived from the fishery, those derived from the distribution of right whales, and gear threat data and assumptions derived from entangled NARW. These data are combined in the DST at a resolution of 10 km to estimate the spatial and temporal overlap of right whales and vertical lines associated with lobster trap fisheries in state and federal waters off eastern USA. The DST allows users to evaluate a wide range of management scenarios to reduce the relative risk of entanglement given the distributions of lobster gear and NARW. The DST model incorporates relevant new information as it becomes available and can be regarded as an evolving simulation environment.

On the fisheries side, the approach in the Industrial Economic (IEc) model (used as input to the DST) is to estimate the number of vessels fishing by statistical area and month using a spatial resolution of 1 min grid cells to distribute fishing effort. Subsequently, what are termed "model vessels" are used to estimate the configuration of gear (i.e., the number of vertical lines and number of pots per trawl) used by state and federal fisheries. The monthly distribution of vertical lines in the water is then the product of number of vessels times the average gear configuration of those vessels.

Number and Location of Lobster Vessels

The number of vessels fishing in the IEc model is estimated from several sources. In the Northeast, vessel trip reports (VTR) are used to indicate fishing location to nearest minute of longitude/latitude. Vessels with multiple trips in a month are assigned locations proportionally by the number of trips. VTR are not used in waters off the coast of Maine. State Fisheries Data for nearshore waters (i.e., LMAs 1, 2, 4, OC) are used to estimate the number and distribution of fishing vessels in Maine, Massachusetts, and Rhode Island. The estimated number of vessels fishing each month is distributed evenly throughout the reporting Zones/Statistical Areas. In offshore federal waters (LMA 3) NMFS permitted vessels are assigned to NMFS Statistical Areas based on proportion of available VTR point locations. Although vessels fishing only lobster are not required to make VTRs, most lobster vessels are licensed for other species that do require VTRs. However, lobster vessels often reuse the same location in VTRs despite fishing elsewhere. Finally, the Southeast region the number and location of vessels to reported from logbooks to the nearest degree of

longitude and latitude.

The DST uses a different approach than the IEc model to estimate the number and location of lobster fishing in LMA 3. Here, the DST uses limited observer data (primarily from 2014-2015), landings, federal VTRs, and bathymetry to estimate of the spatial distribution of gear density.

Concerns - Although using the best available data is clearly a strength of the DST (and IEc as input to the DST), available data sources fall short in several important respects. There is no single, uniform source of data on commercial fishing activity in waters used by right whales. Permitting and reporting requirements vary by political jurisdiction (among states and Federal waters). As a result, the quality of data on commercial fishing activity varies considerably across jurisdictions. VTRs are not required from the lobster vessels that exclusively fish lobsters in Federal waters and therefore the only location data come from vessels that also fish other species that have reporting requirements. It is not clear what fraction of the lobster fleet is represented by such VTRs, how this fraction may vary over the course of the year, or over longer periods of time. Although the best available data are being used, the extent to which these data are representative of the number and location of lobster vessels cannot be determined. Location of fishing as determined from state fisheries data for LMA 1, 2, 4, and OC and from logbooks in the Southeast is distributed evenly over large reporting zones or to the nearest degree, respectively, with the result the actual distribution of gear in the water is poorly known. In LMA 3, bathymetry is used to spread fishing location more broadly than would be indicated from repeatedly used VTR locations.

Gear configuration

Quantitative information on the configuration of gear used by vessels operating in state and federal lobster fisheries is generally not available. Therefore, the gear configuration of model lobster vessels was estimated through consultation with NMFS gear specialists and outreach to state sources. For some states, gear configuration was estimated from logbooks reported by fishermen. For other states, surveys or best professional judgment were the primary source of gear configuration information. Based on these consultations, point estimates by month by area were made of the total number traps fished, the number of traps per trawl, the number of vertical lines per trawl, and the number of anchor lines per trawl. In the absence of sampled information from fisheries, the model attempts to capture variability by specifying multiple model vessels to represent the wide range of gear configurations currently in use and specifies the percentage of active lobster vessels to which each configuration applies.

Concerns - As above, although this represents the use of the best available information, it falls short of providing the information needed to properly estimate the spatial and temporal distribution of vertical lines associated with lobster fishing activity in the waters seasonally inhabited by right whales. Assumptions about typical gear configurations are often available for a single year only and are applied over large statistical areas. The best data appear to come from a Maine mail-based survey in which about 50% of fishers responded to questions about the configuration of gear used. Thus, there appear to be few

quantitative sources of information on the configuration of gear used in the lobster fishery and little information on interannual or long-term trends in configuration that would impact assessment of risk to right whales. As a result, uncertainly associated with point estimates currently used in the IEc and DST models cannot be assessed or accounted for in model outputs.

NARW density distribution

There are multiple sources of information on the movements and seasonal distribution of NARW, including designed surveys, acoustic detections, opportunistic sightings, and tracks of whales fitted with satellite-linked tags. However, only systematic aerial and ship-board surveys provide effort-based information that has been used to estimate the distribution and density of NARW. The time-series of surveys from 1998 to 2016 were used to create a surface density model, and associated uncertainty, to predict seasonal and monthly NARW density distributions (Miller et al. 2016). Different models were fit by season and subregion to reflect differences in species-environment relationships based on NARW biology. In V8 of the model, surveys of Cape Cod Bay conducted by the Center for Coastal Studies and additional surveys by the New England Aquarium, NLPSC surveys of the Massachusetts and Rhode Island wind energy areas were added. V9 of the model will add the most recent surveys through 2018 and split the time series at 2010 to reflect the large change in the distribution of NARW. This state-of-the-art analysis represents the best available information on density and distribution of NARW for use in the DST.

Concerns – Although models are fit by season and subregion, predictions from these models are based on long-term average distributions, and therefore may not accurately reflect interannual, seasonal variation or trends in the density distribution of right whales. Acoustic detection data, opportunistic sighting and movements of individuals fitted with satellite-linked tags have not been incorporated into the model of right whale habitat use. It is not clear how or if these sources of information could be used in the surface density model, as they differ fundamentally from the systemic surveys, but they do provide insight into gaps in our understanding of right whale movements and point to biases resulting from the use of systematic survey data alone. Nevertheless, there would seem to be reasonable promise that passive acoustic surveys could be incorporated to inform the distribution of NARW. Users of DST output also need to be aware that at any given time of the year, the whereabouts of a large proportion of the population is unknown and the distributions of missing individuals may not be well represented by the fraction that have been observed. Finally, uncertainly associated with the surface density estimates is generated by the model and should be incorporated into the DST.

Gear threat model

The DST model attempts to assess the gear threat of entanglement by including an estimate of severity based on the breaking strength of the entangling rope. Breaking strength of rope is considered an important contributor to entanglements that result in severe injury or death (Knowlton et al. 2016). Three approaches have been attempted for use in the DST, but none are well supported by the limited data. The first involves the opinion of seven expert groups on the relationship between severity of entanglement on 10-point ordinal scale and rope diameter. Although groups generally agreed that larger rope would result in more severe outcome, the nature of the relationships among groups differed dramatically

(i.e., scores ranged from 0 to 9 among groups over most diameters) providing little support for this approach. The relationship between rope strength and serious outcome also proved unsatisfactory, probably because the outcome of an entanglement depends on multiple factors. Attempts to include whale size, as presumably one of those factors, failed to improve model predictions. The third approach attempted to calculate the ratio of rope strengths encountered by right wales compared to those recovered from seriously entangled whales as a measure of rope selectivity. Although perhaps the most promising, there was still a clear lack to fit to the data suggesting model misspecification.

Concerns - Little is known about the circumstances that lead right whales to become entangled or those that result in the whale becoming disentangled. As a result, ropes removed from whales are very likely a biased sample of those entangling whales. Although rope breaking strength is no doubt an important contributor to the severity of an entanglement, other factors may often override breaking strength, resulting in no clear relationship between rope breaking strength and severity. Gear configuration (trawl size, rope diameter, age and strength), density of gear, and characteristics of the whale (size, condition, reproductive status) presumably interact in complex ways in any given entanglement. Therefore, the search for a single factor, although attractive, may not be productive and a multi-factor approach may ultimately provide a more useful measure of severity.

2. Model outputs from the DST

The stated objectives of the DST are first to provide a means estimating the spatiotemporal overlap between lobster fishing gear and NARW distributions in state and Federal waters of the USA; secondly, to provide a way to explore management options designed to reduce the risk of right whale entanglement in lobster gear, in other words, to ask how the risk of entanglement might change as a result of changes to the spatial distribution and configuration of lobster gear. To do this the DST attempts to estimate the monthly overlap (co-occurrence) of the fishery and right whales using the best available information and to assess risk to whales by also inferring severity from the breaking strength of the entangling ropes.

The DST model is modular in structure, allowing new features to be added as needed. It also provides ample opportunity for the user to input conditions (e.g., fleet closures or caps, gear configurations) that together would represent different management scenarios. Thus, the DST is fit for the purpose of exploring a wide range of management actions that could reduce the risk of NARW entanglement. Estimates of vertical line density from the model follow from the assumptions and quality of the input data (see above).

Concern – All data inputs to the IEc and DST models are point estimates. Thus, outputs are presented without a measure of their uncertainty. Many of the inputs are based on assumptions and others are poorly sampled and therefore formal estimates of uncertainty (i.e., measure error) are not available. Given the generally poor quality of the input data, it will be important to explore the sensitivity of outputs to uncertainty in the data inputs. Where possible, uncertainty in the input data, for

example that associated with the surface density model of NARW distribution, should be reflected in model outputs.

3. Relative entanglement risks from the DST

The appropriateness of using the DST to explore management options depends on the scale of actions contemplated. As noted above, data on the lobster fleet are currently collected at the scale of statistical reporting areas but are subsequently gridded at a resolution of 1 NM or 10 km. Although necessary to reflect the geography of the inshore, this level of spatial detail is not supported by the data. With respect to the density distribution of NARW, estimates are at a climatology scale in so far as they represent a long-term average condition. Neither of these features are conducive to exploring the consequences of small-scale management actions. As Jason Roberts noted in his presentation of the surface density model, "Decision-makers should favor solutions that do not depend on accurately predicting distribution changes, such as fishery-wide gear mitigations. Time-area mitigations, if used, should be broad rather than surgical."

I expect NOAA is contemplating actions that are broad in scale. Nevertheless, this is not explicit in the documentation reviewed. Although the distribution of vertical lines from lobster gear may be somewhat more stable in space and time than that of the right whales, right whales migrate over a large range and their movements during much of the year are strongly influenced by the somewhat unpredictable distribution of their main prey. In its current state of development, the DST will be most useful in exploring management scenarios that do not depend on accurately predicting the density of the vertical lines that NARW are likely to encounter in any month or subarea.

4. Recommendations to improve the DST

Right whales are entangled in the vertical lines from bottom set lobster traps. A primary objective of the DST is to estimate the relative risk of NARW entanglement in lobster gear in state and Federal US waters. To do this the DST attempts to simultaneously estimate the spatial and temporal density of vertical lines associated with the lobster fishery and co-occurrence of NARW with lobster gear.

Although the best information has been used in the development of the model, information on the quantity, configuration, and location of lobster gear is inadequate. The spatial resolution used in the model is not supported by the fishing location data which are collected at the scale of large statistical reporting areas. Thus, relatively low confidence can be placed on model outputs of the actual spatial distribution and density of lobster gear. Until the location of lobster gear is known with considerably greater precision and accuracy, estimates of risk to NARW will necessarily be imprecise, likely biased, and may lead to incorrect conclusions about risk reduction associated with simulated management scenarios. It is **recommended** that reporting

requirements be improved so that the locations of fishing gear are reported on a scale commensurate with the spatial grid used in the DST. It is also **recommended** that consideration be given to standardizing the information collected among state and Federal jurisdictions.

Both the risk and severity of entanglement depend to some considerable extent on the quantity and configuration of the gear being fished. At present there is little quantitative information on the number of traps per trawl and the characteristics of the rope used to deploy trawls. Although mail-based surveys have been conducted in some areas to collect this kind of information, in many jurisdictions, professional expert opinion appears to be the primary information source. While expert opinion can play an important role, particularly in designing data collection protocols, it falls short in several respects. One-off surveys provide no measure of interannual or longer-term trends that may affect estimates of risk to whales. It is difficult to judge how well professional opinion may represent variation in the entire fishery at state and Federal levels. It is also difficult to formally estimate the uncertainty associated with information collected in this way.

Given the critical importance of information about the characteristics of gear to assessments of entanglement risk, it is **recommended** that quantitative information on the configuration of gear fished be collected from state and Federal waters based on statistical sampling designs. Information should include – the number of traps per trawl, rope configuration and characteristics (e.g., thickness) per trawl, number of trawls, soak time, and other variables that could influence the risk of entanglement. These data should be collected sufficiently often as to estimate spatial and temporal trends in the fishery. The ability to capture trends will be needed, particularly in the face of a changing climate, to effectively update estimates of relative entanglement risk. It is also **recommended** that consideration be given to standardizing the information collected among state and Federal jurisdictions.

NARW range over large areas of coastal and offshore waters during migration and when foraging. They travel singly and in groups and, at any one time, the locations of a significant fraction of individuals in the population are unknown. These features of their biology make it challenging to estimate or predict the distribution of individuals and hence their risk of entanglement in fishing gear. Nevertheless, there is evidence to indicate that a significant fraction of the population is entangled each year. To date, our best understanding of the monthly distribution of NARW comes from a state-of-the-art analysis of many systemic aerial surveys. The resulting surface density model of NARW distribution is the best available. Nevertheless, it falls short of providing information on the scale needed to estimate the risk of entanglement of NARW as the resulting maps are long-term averages of whale density constructed from years of surveys. Given the variability in the movements of individual whales tracked using satellite-linked tags and interannual changes in the distributions of groups of whales, and the unknown whereabouts of a significant fraction of the population, these longer-term average densities are unlikely to accurately inform risk reduction scenarios using the current DST.

Although systematic surveys are still the best overall source of information on right whale distribution, it is **recommended** that other sources of information be incorporated in models of right whale distribution. These sources include satellite-linked tracked whales, acoustic recordings, and incidental sightings. For example, there would seem to be reasonable promise that passive acoustic surveys could be incorporated to inform the distribution of NARW. Because the other sources differ fundamentally in how the data are collected, it is not clear how or if they could be used, but these other sources may serve to highlight gaps in coverage and possible bias in density maps based only on systematic surveys. It is also **recommended** that more effort be directed to near real time estimates of NARW densities to better represent the entanglement risk in areas of high vertical line densities.

The DST currently suffers from a lack of high-resolution location and gear configuration data from the fishery. Better predictions of entanglement risk must wait better input data. In the interim, it is **recommended** that more explicit goals be set out with respect to the scale of interventions contemplated to reduce the relative risk of entanglement to right whales. Those goals should recognize the spatial limitations of the current model. It is also **recommended** that measures of uncertainty in the input data be included in the model and where this is not possible, that sensitivity of outputs to assumptions and point estimates be explored to provide a better basis for drawing conclusions about the merits of different management scenarios (van der Bles et al. 2019). It is understandable that the sensitivity analyses have yet to be undertaken, given that the model is new, complex and evolving, but they should be a priority and accompany any discussion of management scenario evaluation.

5. Apportioning anthropogenic mortality by country

Between 2009 and 2018, only 18% of serious injury or mortalities from entanglement were identified by country of origin. The remainder are unassigned. Of those unassigned, 60.8% were first seen in US waters. A reduction of 66% in serious injuries or mortalities would be needed to achieve PBR based on entangled whales first seen in US waters. Assuming a 50/50 split of the unassigned entanglements provides a similar reduction of 60%.

Nevertheless, there has been a shift in the distribution of NARW further north into Canadian waters and an increase on mortalities recorded there. If this redistribution continues, then a larger faction of the population may inhabit Canadian waters for a longer period than in the past. If so, the current approach for apportioning unassigned human-caused mortality by country may not be the most appropriate approach. A third of the population are now resident in Canada during the summer, fall and early winter (Crowe et al. 2019). Nevertheless, the location of the remaining population during this period is unknown. Ganley et al. (2019) report that most of the population is sighted in US waters in spring, and recent surveys have found right whales persisting in US waters through the summer and fall. Much of the population resides in US waters during the winter as well. Given this evidence of continuing changes in the distribution of the population in Canadian

and US waters and uncertainty about the whereabouts of a significant fraction of the population, a 50/50 split may be under-represent the time spent in US waters.

The NARW is a transboundary species and transboundary species guidelines already exist indicating that the PBR for US fisheries should be apportioned from the total PBR based on the fraction of time that the population resides in US waters (Barlow et al. 1995). Based on available data, conducting an analysis to estimate this fraction would appear to be problematic. The 50/50 split would seem a reasonable assumption until such time as there is evidence to indicate otherwise.

References

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Pace, R. M., P. J. Corkeron, and S. D. Kraus. 2017. State-space mark-recapture estimates reveal a recent decline in abundance of North Atlantic right whales. Ecology and Evolution **7**:8730-8741.

van der Bles, A. M., van der Linden, S., Freeman, A. L. J., Mitchell, J., Galvao, A. B., Zaval, L. and Spiegelhalter, D. J. 2019. Communicating uncertainty about facts, numbers and science. *Royal Society Open Science* 6, 181870.

Appendix 1: Bibliography of materials provided for review

In addition to the citations below, other documents not to be cited, seven PowerPoint presentations, and a copy of the input data and DST model code where made available for the review.

Henry A, Garron M, Reid A, Morin D, Ledwell W, Cole TVN. 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 Dept Commer, Northeast Fish Sci Cent Ref Doc. 19-13; 54 p. Available from: http://www.nefsc.noaa. gov/publications/

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NMFS, 2019. *CIE Review Background: Decision Support Tool Model Documentation.* NOAA Fisheries Northeast Fisheries Science Center, Protected Resources Division briefing document.

Pace, R. M. III and Kraus, S. 2019 Estimating Latent Mortality of North Atlantic Right Whales. 2019-11-14-PACE.ppt

Pettis, H. M., Pace, R. M. III, Hamilton, P. K. 2018. North Atlantic Right Whale Consortium 2018 Annual Report Card

Appendix 2: A copy of this Performance Work Statement

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) Pre-review Background Documents: 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

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At least two weeks prior to the panel review meeting	Contractor provides the pre-review documents to the reviewers
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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 166 Water St.
Woods Hole,
MA 02540 508-
495-2395
tara.trinko@noaa.gov

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

Time	Activity	Lead
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	Review Panel
Discussion/Review/Summary		
4:15 PM	Public Comment Public	
4:30 PM	General Discussion/Day 2 Wrap-Up	Review Panel/ Presenters
Key Topics		
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: Panel membership or other pertinent information from the panel review meeting.

William Don Bowen, Dalhousie University, Halifax, Nova Scotia, Canada
Julie van der Hoop, Independent, Halifax, Nova Scotia, Canada
Jason How, Department of Primary Industries and Regional Development, Western Australia