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Foreword

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

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SUMMARY

The National Marine Mammal Peer Review Committee (NMMPRC) holds at least one annual face-to-face meeting to conduct scientific peer-review and respond to request for scientific advice on marine mammal issues. This approach provides the opportunity to bring together experts on marine mammals from Fisheries and Oceans Canada (DFO) with specific contributions from non-DFO experts to ensure high quality review of the scientific results and to provide sound scientific advice as the basis for the management and conservation of marine mammals in Canada. When time permits, this annual meeting is also an opportunity to review ongoing research projects and provide feedback or guidance to the scientists involved. In addition to these Proceedings, several Research Documents and Science Advisory Reports are published as a result of the meeting.

WORKING PAPER 1: PREDICTING RESPONSES OF ST. LAWRENCE BELUGA TO ENVIRONMENTAL CHANGE AND ANTHROPOGENIC THREATS TO ORIENT EFFECTIVE RECOVERY ACTIONS

(Rob Williams, Robert C. Lacy, Erin Ashe, Ailsa Hall, Caroline Lehoux, Véronique Lesage, Ian McQuinn, Stéphane Plourde)

Rapporteur: Sheena Majewski

Discussion: Preliminary results were presented based on available data with this document being evaluated as an analytical framework/tool for use by DFO.

It was acknowledged that models underestimate the natural variability of the population and that there is uncertainty associated with the necessary reliance on inputs from Bayesian models and best available data. Some suggestions for improvements in the model included: changing the time interval used in the model to better capture timing of calf mortality as it affects breeding rates, and normalizing model inputs and data sources (e.g. linkages between mortality and strandings observations).

The committee agreed that in general, the approach presented in this paper is acceptable for modeling future population trajectories and could be useful in supporting the provision of management advice. While it was concluded that the Vortex model aligns with the overall objectives of the committee by combining various stressors into a cumulative approach, due to limitations with current inputs into the model, caution was recommended in using it to support management decisions. Discussion of current limitations associated with model inputs included concerns over the use of sea surface temperature (SST) as a proxy for environmental conditions and limitations regarding the analysis of impacts of contaminants in the model. It was recommended that additional experimental data on impacts of contaminants and a broader range of contaminants (e.g. hydrocarbons) be considered for integration into the model. It was also recommended that linkages of tissue concentrations to health and demographic effects, remobilization of contaminants such as mercury, and potential impacts of growth dilution be considered. The committee concluded that the contaminants element in the model is considered to be a minimum estimate.

The committee discussed possible ways of exploring other important factors, for which data are limited, in the model including changes in predation, disease, foraging efficiency and competitors. It was agreed that the inputs used for the model were appropriate, but that potential relationships between variables need to be described clearly and the previously reviewed GAM model needs to be referenced more clearly in the document.

The committee agreed that the model seems reasonable, although there was some discussion of concerns regarding demographic parameters, applicability of the model for determining recovery targets, and the need to decide on most relevant time period to project the model forward.

The need to identify key gaps in the data (e.g. mortality rates) to improve this model for St. Lawrence beluga, including relationships and parameters that should be validated in the field (e.g. noise in St. Lawrence, estimates of adult mortality), was discussed.

It was concluded that while limitations of data must be clearly described, the Vortex model is a good starting position using the best available information to determine management actions and priorities. Suggestions of other possible situations where this approach could be used included identification of priority threats, mitigation measures, research needs/priorities/ gaps, population and distribution objectives. While it was acknowledged that uncertainty in the data, including clear discussion of the strengths and weaknesses in the data inputs, needs to be discussed in the paper and additional available data used where feasible, it was agreed that we can go forward with the existing approach using the best available information to inform management actions and priorities.

It was suggested that expert solicitation and structured decision making tools could be used to analyze the approach prior to expanding its use to other regions with significant data gaps, and that it could be applied to a relatively data rich species before trying to apply it to other data poor species.

The committee agreed the document would be finalized as a Research Document, subject to the above mentioned clarifications.

WORKING PAPER 2: EFFECT OF THE 2015 NARWHAL (*MONODON MONOCEROS*) ENTRAPMENT ON THE ECLIPSE SOUND NARWHAL STOCK

(Cortney A. Watt, Marianne Marcoux, J. Blair Dunn, Robert Hodgson, Richard Moore, and Steven H. Ferguson)

Rapporteur: Linda Nichol

Discussion: There was a question about the proportions of whales in the entrapment that belong to different stocks and whether there was any consideration that the event may have included more than just two stocks? The author responded that if the event had included more than two stocks then it is likely the impact to the TALC reduction, in a worst case scenario, would be reduced. Mention of this will be added to the discussion.

There was some discussion as to whether the calculation of Potential Biological Removal (PBR) would already account for an incident that periodically may exceed natural mortality, such as an entrapment event. The author responded that this is a good question and pointed out that this incident would have gone unknown had a hunter not put a hydrophone under the ice. A discussion of the impact of this assumption will be included in the paper.

There was a discussion as to whether entrapment would be part of natural mortality. Information was offered that indicated there was discussion in northern community about the November 2015 entrapment event. People in the village felt strongly that the entrapment had been the result of shipping activity which kept the narwhal from leaving. So if this were the case, the entrapment would need to be considered an anthropogenic source of mortality rather than natural. The author offered to add this anecdotal information to the discussion regarding causes of the event.

It was noted that the authors included a fixed estimate of process error (0.05) and there was a question as to whether this was an appropriate number to use since it was taken from an ungulate analysis. The author was asked if they tried various values. The author indicated that they certainly could try a bunch of different values and they questioned using 0.05 but did so in the end because it seemed reasonable based on reviewing literature. The main point of including it was to add uncertainty to the result. If the assumed process error was smaller it would have less effect and thus the result may be less cautious.

The author was asked if entrapment size vary according to the population size in the model. The author reported that it was random and therefore not dependent on population size. There was then a question of clarification regarding the percent increase in natural mortality. For further analysis at some point, it was suggested that process error could be incorporated using a beta distribution in the model rather than using a separate entrapment model.

A reviewer asked if there was information on the health of the entrapped whales in the 2015 and 2008 events. The author replied that the animals in the 2008 event were thin and appeared to be starving. This was in contrast to the 2015 event, where the animals appear quite healthy.

There was a question about the estimation procedure used to estimate the proportion of stocks in the entrapment using a small sample of satellite tag data. The author explained how 90.5% was arrived at. After more discussion it was concluded that the author should rethink and rewrite the rationale for the stock proportions in the entrapment.

A reviewer asked if the entrapment size was selected randomly in the model iterations. The author confirmed this.

There was a question about the stock proportions in the area. The author explained that they are treated as a summer stock for now until the allocation process finished. The allocation process is the subject of a separate analysis from this paper.

There was a question about the implications of assuming a constant mortality rate versus a mortality rate that varies among years. The author note this is an important point and that they were not able to include age and sex in the model, but that adding age structure would be important. Potential Biological Removal (PBR) assumes that the age structure and sex ratios are proportional to the population and so does not capture these effects. The author noted that we really need to understand entrapment events better.

A reviewer noted that this modelling study has been useful. PBR, as it is set up, does not include process error explicitly and entrapment events are a type of process error that could have an impact. The reviewer suggested removing the estimated number of animals that died from the population estimate if the entrapment mortality is above PBR. There was discussion that if this were done, which number should be used as the number of entrapped whales that died (e.g. 269 animals x 2 considered). The author pointed out that the current total allowable catch would need to be reduced by 8 whales if this were done.

Other reviewers expressed that they were not comfortable reducing the Total Allowable Take, because it is possible that this mortality is captured in PBR. It might be considered if there appears to be a conservation concern, but given the uncertainty, it would be premature to reduce the Total Allowable Landed Catch (TALC). There was some disagreement and it was pointed out that you would, ideally go back and recalculate PBR and develop a Recovery Factor (F_r) that accounts for populations in which entrapments occur. This is a very different mortality than that for which PBR was designed. These are periodic events, and so could have greater impact on the population. So to do this right you should recalculate a new PBR for that. It was further pointed out that in the in US, such an event would be called an Unusual Mortality Event (UME), and it would be subtracted from the population and recalculate. It ensures not exceeding the PBR. PBR was not designed to account for unusual mortality.

The committee agreed that these two options, their consequences, must be explained. One option is to assume entrapment is part of PBR and so there is no need to change the TALC as it is already accounted for. The alternative is to assume the entrapment mortality it is in addition to PBR and therefore, must be taken off the population and TALC recalcuated. This would give managers a range to understand the possible consequences of the entrapment.

WORKING PAPER 3: POPULATION MODELLING FOR NARWHAL (*MONODON MONOCEROS*) STOCKS SHARED BETWEEN EASTERN CANADA AND WEST GREENLAND

(Cortney A. Watt, Lars Witting, Marianne Marcoux, Thomas Doniol-Valcroze, Rikke Guldborg Hansen, Roderick Hobbs Steven H. Ferguson, and Mads Peter Heide-Jørgensen)

Rapporteur: Jack Lawson

Discussion: The Committee asked, when narwhal catches were adjusted in the stock exchange model, was the total catch respected when such corrections were applied? The authors replied that total catches in any one stock are accounted for despite the hunt location being attributed elsewhere; the availability in the matrix is a measure of the availability of each stock in each location, but stocks are different sizes so at each location the size of the sources stock and the availability are combined.

It was clarified further that the likelihood of a narwhal from a stock being taken in a community is estimated by a combination of the relative availability of all stocks (by presence proportions derived from data using satellite tagged narwhal) and the proportional number of each stock likely to move through the area and be available to hunters.

In response to a Committee query, the authors stated that catch statistics are adjusted using struck and loss, and the Canadian and Greenland values are different (but that this factor was the same in all Canadian areas).

The authors were asked if the “Probably Zero” and “Probable Hunt” categories are variations of the same probability; they replied that “Probable Hunt” has a Z correction distributed closer to one, while “Probably Zero” has a Z set to zero. The Z parameter is a way to adjust for the uncertainty.

The Committee asked, given that narwhal move and all assessment surveys did not cover the species’ entire range, how comfortable are the authors with the modelled hunt quota estimates? The authors felt that despite not knowing the stock identity of whales sighted during surveys, they expected that the Coefficient of Variation (CV) in the model estimates would incorporate this distributional variability. The authors also assume that we can separate the narwhals into some distribution of stocks during the summer period.

The authors noted that this approach has now been used with beluga, narwhal, beluga, walrus, and large whales in other areas (e.g., Witting, L. 2013 Selection-delayed population dynamics in baleen whales and beyond. Population Ecology **55**: 377-401). The population model component is the same as used in the Joint Commission on Narwhal and Beluga (JCNB) for years with the addition of an allocation matrix model. This matrix generates a differential catch history to incorporate variation in the catch history into the overall framework; since abundance estimates from the model are fed back to the matrix each year it can be complicated to run. The authors stated that to employ this framework for individual summering aggregations management, users could run the model for all populations, then apply a Potential Biological Removal (PBR) calculations to the model output for any single stock with limited assessment data. With the output take limits for each stock users could return to the allocation matrix to determine how they would be allocated amongst the hunting grounds

The Committee described some of the weaknesses in the Canadian narwhal data; there are no telemetry data for 50% of the stocks, and sex data for landed animals is not available for years previous to the 1970s. Unusual ice entrapment events could be incorporated into the original catch data input to estimate future “acceptable catches”, if desired. If there is limited narwhal stock abundance data, the model can use the K value across years; with a single abundance estimate, it is extrapolated across years in the model. Even if some of the population trajectories are flat, others aren't and since these matrices are all linked there is an opportunity to make the allocation matrix more flexible. Currently there is no age structure in the model and the hunt sex ratio is assumed to be equal.

The Committee asked if the proposed framework allows us to better understand stock dynamics since most model outputs are driven by assumptions (priors). The authors responded that this was not necessarily true, but the framework does (1) help us understand the impacts of different catch magnitudes, and (2) integrates many hunts and stock areas within a probability framework understandable by managers.

The Committee asked the authors if it is possible to couple the availability matrix component to a simpler population model with more input data, rather than the model with 113 parameters as implemented currently (e.g., with many more parameters than data); the more parsimonious approach may be simpler to understand. The authors stated that a simpler population dynamic model would not yield a better tool to inform management actions and would not likely change the analysis output. Also, the authors stated that the model priors used in this framework/approach have been contested at JCNB, and are subject to continued data improvement and analysis.

The Committee agreed that this biological model system is data-poor relative to the other models such as grey and harp seals; we may be giving the impression that we are more precise with our system than is warranted with the available data for narwhal. The Witting (2013) dynamic population model paper should be distributed to the Committee and future users as reference, the model inputs should be better documented, along with statements on our confidence in each of the priors and the outputs. With these additions the population estimates produced by this model could potentially be useful to provide advice to managers

The Committee was told that this dual-model approach was developed more as an advice tool within JCNB, but it could be used in data-poor situations where the PBR is applied within the context of Canada's Precautionary Approach (PA). For example, adjust a stock's allocation probability level when the stock is at a low level.

A member of the Committee felt the model output fit well to data-rich hunting areas such as Somerset Island, but wondered how it would work for data-poor areas like the hunt in Smith Sound? Participants suggested that in data-poor cases perhaps managers might be best served using a PBR approach instead. The authors explained that with more data (e.g., Somerset Is) the model can better characterize the population dynamics, but not so in Jones or Smith Sound with less data. And where the matrix component does not work DFO could instead use a PBR-based estimate.

The Committee requested that the authors provide a simple Excel format file that could be provided to each community so they could each investigate preferences for the magnitude and timing of their hunt.

The Committee asked the authors if the new approach was capable of providing a global estimate of the narwhal allocation, or only stock by stock? The new approach assumes a certain harvest recommendation that the model outputs use to show an increase or decrease at the population level for each summer stock; when you look at particular stock harvests at different times and locations you have to work backwards through the matrix to put quotas on specific hunts; this works for projecting 5 years ahead with fixed harvests. If you want to change these harvests you could do that in the new model (refer to the catch object tradeoff table in the Research Document).

The Committee discussed how to better address sex differences in the narwhal landings since the data show 70% males and 30% females in the take. Only the population model component can incorporate these data, so this new framework is not sex-structured. The authors suggested that the traditional assumption that female mortality is a more important influence on the population trajectory may not be true – males may be more important. The authors felt that sex-structuring could be implemented but that data to support it is poor. If hunts did take more females than males, the currently assumed 50-50 sex ratio would make the model relatively more conservative.

The Committee noted that there is disagreement as to whether Jones and Smith Sound stocks are considered part of Baffin Bay group; this was contentious at JCNB, so there may be interaction with other stocks, and thus these narwhal available in other hunts. Further, during DFO community consultations in Baffin Island in April 2016, hunters in Pond Inlet were concerned that there were morphologically “different” narwhal seen later in the summer that could have been Grise Fiord whales.

While the Committee was impressed by the model, there were questions about how it should be developed further, and the duration of this process. The authors concurred that it is a good framework but that it has not yet been approved by the JCNB. The North Atlantic Marine Mammal Commission (NAMMCO) has approved the approach and awaits further development.

The Committee agreed with replacing Pierre Richard’s previous model with this expert knowledge-based allocation model since the latter accounts for differences in population size (weight the mixing proportion by the number of whales available in each hunt area) and movement (as a measure of mixing in each hunt area), so it should be superior.

The authors discussed the utility of the narwhal tagging percentages for each hunt (the P values in the stock exchange model formula) and multiply by the N of that stock to give number available in the model matrix. The denominator is a sum of all whales available in that summer stock. Where there are no tag data, expert elicitation is more critical and proximity becomes an important consideration. For example, some narwhal might not be available to shore-based hunters if they migrated past further from shore (even if defined as being in that “bay”).

The Committee recommended that more narwhal tagging needs to be done, but concluded that this framework could allow DFO to explicitly assess how additional tagging data makes the model perform better. The allocation model component tries to account for narwhal movements. When there is little tag data users could increase the input uncertainty (larger Z value) to make the model more cautious.

In summary, the Committee liked the allocation model as it accounts for all stocks and allocation. But the model is almost exclusively driven by the assumptions, without a mechanism to update the priors. Where we do have more data the model does seem to perform well. The model collapses down to a simpler model when we have limited data.

The model estimates the probability that quotas will affect summer populations, but it can’t optimize the harvests in all the different hunts using these probabilities since there are many more hunts than summer aggregations. Once you have determined the summer allocations you can work backwards in the matrix to identify areas where the current hunt level would make a difference in meeting the management objectives for narwhal (and there will be multiple objectives [hunt values in each stock] that would work to balance the overall allocation) – managers could weight choices amongst various hunts.

At this stage the Committee concluded that DFO is faced with the choice of (1) accepting what the new model outputs as better reflecting narwhal population dynamics, and let managers chose their population objectives and interpret the output against these, or (2) using the combined model framework and either use the DFO PA criteria or PBR for each modelled stock to create stock-specific hunt quotas. The Committee concluded that the JCNB allocation model is interesting and could be a useful tool as the overall concept is good and the model appears robust; the Committee encourages its further development. The allocation model component represents an improvement over previous approaches as it incorporates narwhal movement and Greenland data (although there remains a lack of some information). The population model component is relatively straightforward, but is limited by what data are available for this species and these populations, and since the model output is driven by these priors it is questionable if the current population model describes the system dynamics well.

The Committee suggested several approaches to advance this allocation model. Since this two-model framework outputs population trajectories for each stock (e.g., independent model runs using the same inputs), if DFO wants to integrate it with the developing DFO precautionary approach, one methodology could be to evaluate outputs for each stock to investigate how well the models describe the dynamics using DFO criteria (PA). To provide catch advice, the models could produce catch numbers that could be input to a risk-based assessment. Alternately, if the population dynamics are not captured well due to the limitations of the input data, then a PBR method could be used instead. Once that decision is made, catch output could be fed back into the model to create an updated catch matrix.

If the model priors are not informative, the Committee recommended sensitivity testing of the two-model framework by adjusting population trajectories etc. to test model robustness against poor data input, and the resultant advice indicated under a PA. This sensitivity analysis could be requested of the JCNB, along with testing of means to update the catch matrices using revised catch allocations (described at the end of previous paragraph).

Overall, the Committee agreed it is a good approach, particularly if it can be integrated within DFO's PA, but a further review/analysis of the framework elements was not requested at this peer review meeting. The Committee concluded by congratulating the JCNB for their efforts on this framework. Further, the Committee recommended that the relevant Working Papers become Research Documents for reference, and that the summary Research Document (WP-3) be updated to more clearly describe the key information from these component sources of information.

WORKING PAPER 4: EVALUATING IMPACTS OF FLEXIBLE QUOTA SYSTEM ON WALRUS HARVESTING

(M.O. Hammill, A. Mosnier, R. Young)

Rapporteur: Linda Nichol

Discussion:

The committee noted that the model results would be affected by the assumed Coefficient of Variation (CV) used in the model. The authors used a CV of 30%. The authors indicate that they did not vary CV in the model, but if your CVs were larger PBR would be recalculated using the larger CV on the abundance estimate which would result in a lower PBR value because the estimated minimum population estimate (N_{min}) would be lower. So PBR will respond the way we expect it to (bigger CV on abundance estimate -> lower N_{min} ->lower PBR).

It was asked if PBR is precautionary enough to account for mortality that is disproportionally directed towards one sex or age class (e.g.a harvest/mortality directed to prime age females)? The authors responded that you would have to reduce PBR if the mortality was known to be prime age females in order to provide the same level of caution. PBR is based on the assumption that removals are directly proportional to the age and sex classes available in the population. Conversely, if harvest were directed to young (harp seals for example), then the PBR would be more risk adverse. If the mortality were disproportionately females then you would expect there to be a population level effect as a result of reproduction which you would then hopefully detect on your next population survey. However, the ability to detect the decline would depend on the precision of the survey design. In reality it might take a few surveys, for example a simulation study of harp seals indicated that if surveys were conducted every 5 years, it would take at least 15 years to detect a change. The authors agreed to make this point in the document.

It was suggested that to be able to detect a population decline the survey frequency should be increased (i.e. conducted more often).

With respect to the advice requested, it was noted that as long as managers respect the total 5-year harvest plan (and update it based on new survey data when available), the population will not decline, regardless of when in the 5 year period of the management plan the harvest was taken.

WORKING PAPER 6A: INDICES OF ABUNDANCE FOR BELUGA (*DELPHINAPTERUS LEUCAS*) IN JAMES AND EASTERN HUDSON BAY IN SUMMER 2015

(Jean-François Gosselin, Mike O. Hammill and Arnaud Mosnier)

Rapporteur: Veronique Lesage

Discussion: There are recurrent concerns over ways to deal with the detection of a few large groups during beluga surveys, as they increase variance around abundance estimates. There was a suggestion to examine the possibility of stratifying the survey by group size, so to build detection curves separately for small vs large group sizes. Another possibility would be to split the large groups into smaller groups with their own perpendicular distances. However, observers are not aggregating whales in one large group because they get overwhelmed with observations. Those big groups do happen, and the authors strongly felt that this variance needs to be expressed in the estimates and not be artificially reduced, projecting a false confidence in the estimates. It was also suggested to apply adaptive sampling when large groups are encountered to better describe them. However, adaptive sampling in the survey setup for eastern Hudson Bay is not viable given the length of survey lines (150 nautical miles); only two lines (offshore and back) can be flown between refueling.

There were discussions about the usefulness of double-platform design. This approach was used in 2013 and worked fine (data are still to be analysed), but was not used in previous years. In order for this approach to be useful, when taking Inuit observers onboard, there is a need for good prior training.

The possibility of adding photographic capacity to the survey was also discussed, but was deemed challenging given the size of the Cessna 337.

There were concerns about the comparability of views for observers occupying the front and rear seats, given that there is an opportunity for the front observer to look ahead of the plane more than when in the rear seat. The authors pointed out that detection functions are developed from the combination of sightings from both observers and thus, that this is accounted for in the detection function developed for the survey.

It was recommended that Table 2 be revised so to clarify how the final estimates were obtained.

There was a recommendation to clarify the reasons for considering the number provided as an index of abundance. The authors explained that the estimates are considered indices as there are factors such as perception biases that are currently not accounted for.

Based on genetics, there is a fraction of the individuals occurring in the survey area during summer that may not be Eastern Hudson Bay (EHB) beluga. There were discussions as to how to account for this, as including non-EHB beluga in the estimate may overestimate the size of the stock. The group conveyed that there was no simple way to account for these non-EHB beluga, and that this should be pointed out both in the research document and the science advisory report as a source of uncertainty.

WORKING PAPER 6B: ESTIMATED ABUNDANCE OF THE WESTERN HUDSON BAY BELUGA STOCK FROM THE 2015 VISUAL AND PHOTOGRAPHIC AERIAL SURVEY

(Cory J.D. Matthews, Cortney A. Watt, Natalie C. Asselin, J. Blair Dunn, Leah M. Montsion, Brent G. Young, Patricia A. Hall, Jack R. Orr, Steven H. Ferguson, Marianne Marcoux)

Rapporteur: Veronique Lesage

Discussion: The abundance estimate presented did not account for perception biases. Given that the data to correct for this bias were acquired during the survey, the authors were encouraged to conduct the analyses as to correct for this bias.

Satellite telemetry was used to determine the proportion of time beluga spent within 0-2 m and 0-5 m from the surface. These two depths were chosen to contrasts conditions for ‘murky’ vs ‘clear’ water. The group questioned the adequacy of these corrections for describing conditions that prevailed in the area where the survey was conducted. Ideally, there would be a need to tag beluga at the same time and in the same area where the survey is conducted.

There were questions about how long the aggregations persist in estuaries. The author pointed out that for the Nelson River, two surveys were conducted at roughly a week interval and the aggregations were present on both surveys.

It was noted that the effective half strip width (EHSW) for this survey was half that estimated for the survey of Eastern Hudson Bay (EHB) beluga. This difference was explained by differences in instructions for observers between the two surveys: those flying the Western Hudson Bay (WHB) survey were instructed to focus their search area closer to the plane.

Given that EHB beluga and WHB beluga abundance estimates are combined in a common model, there were concerns about the fact a different correction for availability bias was applied to the two surveys. However, the authors of the two surveys pointed out that correction factors need to be area-specific as much as possible, and so that there was no reason to reject the availability bias for one or the other region. It was recommended that clarification be included in the documents for both EHB and WHB as to why the value used for availability bias is adequate for the assessed population.

Covariates to account for glare or Beaufort conditions were considered and deemed non-significant, a result that was questioned by the group given that these factors are known to greatly affect detection probability in other surveys. During the WHB beluga survey, these conditions varied little over the survey period, which likely explains their non-significance. There was a suggestion made to add a table providing information on the variability of covariates, and to add text to indicate that the covariates were fitted after selection of the best model.

There were questions related to the consistency among observers or within observers in estimating water murkiness. It was proposed to include a definition of murkiness and glare, so that others can use those criteria in the future (e.g., yellowness, blueness of water). It was also noted that the tag data can only provide a certain amount of precision for beluga location, and so there is a need to decide on the level of precision for 'murkiness' to fit the tag data.

There was a suggestion to add a table where estimates per stratum for the previous surveys be presented concurrently to those of the 2015 survey for the reader to appreciate comparability of counts and efforts, and potential for movements between areas.

It was noted that the coefficient of variation (CV) on the overall estimate was surprisingly low, a result of including the photographic survey which was associated with a zero variance. One way proposed to deal with this bias in variance, would be to combine variance for counts where there is non-zero variances, and then treat the counts with very low or zero variance as a count added on top of the estimate and variance, as we do with counts in estuaries in EHB or the St. Lawrence.

Some estimate of perception bias could be obtained by re-reading photos, but it is expected that the CV obtained from this would still be low.

WORKING PAPER 6C: ABUNDANCE OF BELUGAS IN HUDSON BAY

(M.O. Hammill, A. Mosnier, J-F Gosselin, C.J. Mathews, M. Marcoux and S.H. Ferguson)

Rapporteur: Alejandro Buren

Discussion: There was some discussion regarding maximum growth rate; specifically that the upper limit is not consistent with beluga life history, the lower bound does not allow for zero growth, and Lambda is unrealistically high and extremely uncertain. The authors should provide more explanation, so it does not seem so selective. Alternatively, they could provide a range of different values (i.e. sensitivity analysis)

The process error also did not seem realistic for belugas, and the committee recommended to use a beta distribution instead of a lognormal distribution.

It was recommended to test sensitivity of the model to changes in values of Struck & Lost.

It was recommended to change lower bound of carrying capacity as the assumed prior appears to be limiting the lower estimates.

It was noted that the survey period is long (6 weeks). Therefore, we are not sure what animals are being counted, e.g. surveys in James Bay flip from one year to the next between high and low values, and we are not counting the Little Whale River and Nastapoka stock (severely depleted).

It was noted that Belcher Island winter ice entrapments haplotypes are unique (not found in Hudson Strait hunt), and suggests that there is another non-migratory group around the Belcher Is.

It was asked if joint management for summer groups is possible. The authors replied that there is a lot of uncertainty in stock composition in offshore areas, and this needs to be investigated further. We also need better location data of where animals are hunted. Results suggest that biopsy samples are taken from areas that are not well covered by the harvest.

It was noted that the complexity of the models being fitted does not match the amount of data that is being used to fit them, particularly for Western Hudson Bay stock (WHB stock: 3 surveys, 5 parameters; EHB: 7 surveys, 5 parameters).

WORKING PAPER 6D: UPDATED ANALYSIS OF GENETIC MIXING AMONG BELUGA STOCKS IN THE NUNAVIK MARINE REGION AND BELCHER ISLANDS AREA: INFORMATION FOR POPULATION MODELS AND HARVEST ALLOCATION

(A. Mosnier, M.O. Hammill , S. Turgeon and L. Postma)

Rapporteur: Veronique Lesage

Discussion: Sampling dates were recovered for previous hunts, which allowed augmenting the database. There was curiosity as to how this was possible; a meticulous match among the various databases made this possible.

Clarification was requested as to how it was decided that hunts were part of a same event. Colbeck et al. 2012 indicated that beluga families in EHB travel together during migration. Therefore, it was assumed that animals hunted on the same day in the same location were possibly related, and as a result, only one individual was randomly sampled per event for the mixing analysis.

The issue of some individuals occurring in the survey area during summer not being EHB beluga was raised again. As indicated previously, the group conveyed that there was no simple way to account for these non-EHB beluga, and that this should be pointed out both in the research document and the science advisory report as a source of uncertainty.

WORKING PAPER 6E: A MANAGEMENT FRAMEWORK FOR NUNAVIK BELUGA

(M.O. Hammill, G.B. Stenson and T. Doniol-Valcroze)

Rapporteur: Alejandro Buren

Discussion: The Precautionary Approach (PA) framework should be adopted for all stocks, and beyond stocks that are being harvested because of concerns that the US will not import seafood unless we have stock assessments and removal (e.g. bycatch) estimates for all marine mammals (e.g. northern bottlenose whales, harbour porpoise).

The committee asked the authors to provide some definition of “abundant” and “small”.

It was noted that it is difficult to provide an objective definition in terms of (for example) carrying capacity (K), as we do not know have reliable estimates of K for most populations.

It was noted that non-hunt mortality (e.g. ship strikes, indirect mortality through stress or other compromise) is not mentioned in the approach, and may constitute an additional negative impact.

It was noted that the risk to a population from unexpected events like harmful algal blooms or disease outbreak is greater when a population is at an extremely low level, and also when the population is at a low level for a longer duration. This form of risk is not captured in the Potential Biological Removal (PBR) approach.

It was noted that many Canadian marine mammal populations have no reliable population estimate, so how can we use even a PRB approach? Given our need to operationalize some form of management approach, plus highlight to managers what data limits for any chosen management approach exist for Canadian species, it would be useful to create a national matrix showing existing information and data gaps for all marine mammal species in Canada. This matrix could also designate which species or populations are data rich, data poor, or data nonexistent, and what management approach might be best suited.

There was a proposal to review the criteria used for data rich/data poor, and the table for determining the values of recovery factors to be used from Working Paper 6e. Criteria that might be useful in deciding what management framework could be applied to cetaceans were identified earlier and are presented again here:

1. Certainty in stock composition/identification. Are there data to support stock status, stock composition of the survey/harvest. Is any variability incorporated into the model as a fixed (deterministic) value because there are no data or included as a sampling distribution (probabilistic)?

   Maybe change the wording to reflect the fact that the intent is to capture whether the stock composition is addressed somehow. The spirit is not to say that if we are not absolutely certain, we are in a data poor situation.

2. Is there a time series of three or more abundance estimates available from the last 15 years, with the last estimate ≤5 years old? Are all estimates considered ‘good’ or during peer review were concerns raised? Are the estimates reasonably precise (e.g. CV < 30%)?

   Should generation time be considered in this point? The concept is to have (1) a series of estimates that capture dynamics, (2) with one that is recent and (3) that they are precise. We need an idea of trend, not just abundance (e.g. if we have three surveys in consecutive years, we will have an excellent idea of abundance but not of trend).

   Maybe we should consider the risk of the stock (e.g. EHB beluga); for example, if a stock is more endangered, perhaps we should be more precautionary. There are two separate questions: First, how do we assess the status of the population and what tools do we use to assess it? Second question is what advice do we give? The risk factor comes in when we give advice. The risk the population faces does not affect how we assess the status and our understanding of the population dynamics.

   To acknowledge the use of multiple methods to estimate abundance, the authors should add a line saying: “are a variety of appropriate methods used to estimate abundance”?

3. What type of population model can be fitted to the abundance data? Surplus production? Age-structured?
4. Does the model provide a reasonable fit? Does visual inspection of abundance estimates and model behavior appear reasonable?
5. Is the model robust to the assumptions that have been used?
6. Do model diagnostics suggest internal consistency with the data (e.g. are there signs of autocorrelation, convergence, cross-correlation)?
7. Are there reliable harvest statistics? Are the data obtained from independent observers? Is there verification (Frequency of reporting- Weekly, monthly, end of season? Data missing/ frequently missing? Rarely missing?)

   Expand this point as all reports are self-reporting in the North

8. Are there other data that could provide insights into stock dynamics or trend e.g. levels of mortality, reproduction, trends in mean age/sex composition of the harvest?

   Should knowledge of species life history dynamics be added? Maybe flush out this point further.

Proposed criteria for application of various levels of recovery factors (R_F) for use in Canada.

-	COSEWIC status	Population trend
1	No concern	Abundant, increasing or no signs of decline
0.75	Special concern	Abundant, trend unknown, or survey effort limited
0.5	Threatened	Abundant, declining
0.25	Threatened?	Small, trend unknown
0.1	Endangered	Small and declining

There was a lengthy discussion regarding the use of COSEWIC status, as it is prone to create confusion. COSEWIC status was chosen because all marine mammals in Canada have been assessed by COSEWIC, with the exception of harp seals. It was suggested to integrate the population trend and status into one column.

Under the precautionary approach: if we don't know the trend, it would be appropriate to separate trend unknown and trend declining. Under the precautionary approach the default if trend is unknown should be to be risk adverse (i.e. assume declining).

Proposed new scheme:

Rf	**Population status and trend**
1.0	Abundant, increasing or stable
0.75	Abundant, limited data
0.5	Abundant, declining or unknown
0.25	Small, increasing or stable
0.1	Small, declining or unknown

In case of a discrepancy between criteria (status and population trend), we should adopt the more conservative one.

Issues that have remain unsolved, but will evolve as we start applying these criteria to specific cases: include other criteria such as areas of occupancy; how to deal with stocks where we have no clue what they are doing (e.g. sei whales in the Atlantic); and how to classify abundance as small or abundant (e.g. cod is abundant but is really small in comparison to historical levels. The same situation could apply to small odontocetes).

WORKING PAPER 7A: PUP PRODUCTION AT SCOTIAN SHELF GREY SEAL (*HALICHOERUS GRYPUS*) COLONIES IN 2016

(C.E. den Heyer, S.L.C. Lang, W.D. Bowen, and M.O. Hammill)

Rapporteur: Cortney Watt

Discussion: Overall the paper was well received by the group. There was some discussion about how the model used to determine the timing of pupping was fitted, and the authors referred to a paper by Bowen et al. (2003; Sustained exponential population growth of the grey seal on Sable Island) which provides the details of the model. It was noted that the distribution used by the model was a Weibull distribution which imparts some flexibility, and the authors noted that different islands might have different distributions, but the transect data was not good enough to detect these differences. One reviewer questioned why the Akaike Information Criterion (AIC) values were identical and asked what the AIC values for other distributions would be. It was noted that this was already in the Research Document, and authors stated the AIC values were not actually identical; they just appeared that way was a result of rounding.

The timing of the survey was also discussed, and it was suggested there was some potential for error with the timing of the survey for some islands because the survey was designed to capture Sable Island. As a result of this, the authors felt they may have been a little early at Hay Island. It was asked whether the timing of pupping at Hay Island is later, and the authors noted that they have many years of data that they could look at to determine if it is later or not. The first date of birth on Sable Island is assumed in the paper and the group wondered if changing that date would make a big difference to the conclusions. It would make a difference to the distribution and would move it relative to the survey time which may result in a lower estimate for Hay Island (the proportion of pups present would be lower on the island than suggested by the distribution). However, the authors had three survey estimates for Hay Island and all three were quite close and are presented in the paper, so it was agreed this would not impact the results significantly.

Observer bias on the islands for identifying the pup stages was discussed. Observer bias was seen, and in particular, one observer staged the transition from stage 2 to 3 later than the others, but the three other observers had similar length of stage definitions. The survey team members have been quite consistent over the last few years, but as turnover of participants increases they will need to keep track of any observer biases. The authors noted that having stage data appropriate to the survey year is important.

The authors were asked how confident they were that the sites for staging counts were representative of the timing of distribution for the animals as a whole. The authors said they were confident since the 13 sites they visited covered all areas of the islands, east to west end, and encompassed different types of habitat.

Regarding Figure 8, it was asked what contributes to the variance being so much higher in 2016 compared to 2010, with fluctuations the last few surveys. The authors said this is dependent on the timing of when the estimates were relative to when the pups are born, and when variances were combined, an extra correction was added in the survey data which then adds more variance. The group agreed this should be discussed in the Research Document as it could be confusing.

There was some concern about how some of the results were worded, saying that the rate of increase of pup production has ‘further declined’, but the rate of increase from 1997 through the last set of surveys has gone down to 4-5% per year. Thus, it appears that the rate had declined but has remained relatively constant since 1997. However, it is not clear if the decline has in fact stopped and the authors will look into the wording of this section in the Research Document.

WORKING PAPER 7B: PUP PRODUCTION OF NORTHWEST ATLANTIC GREY SEALS IN THE GULF OF ST. LAWRENCE

(M.O. Hammill, J-F Gosselin and G.B. Stenson)

Rapporteur: Cortney Watt

Discussion: The discussion began with a question about whether the estimates of pupping occurrence were based on dates or dates and locations. The authors explained that they try to visit a colony three times during the pupping season and count the number of pups in different stages and age classes. Based on those proportions they work out when different pups are born. This is site specific so each colony has a different correction factor.

A question was asked as to why the correction for Pictou Island was so large, and noted it was flown early so wondered if there was a correlation between the two. The authors explained the estimate was a little higher than the others (5100 pups), but counting on the island was also a bit more difficult. Regardless, the count conformed to the unmanned aerial vehicle (UAV) results which were flown 11 days later.

It was discussed that one of the issues with the surveys is that some of the pups could have left the island before the counts were conducted. The authors did not model pups leaving, and Sable Island is the only island where there is information on the timing of leaving (it is found to vary). The authors have the impression that pups stay around longer on Sable Island and tend to leave quickly on Pictou Island, and thus, pups leaving the island are a concern for the data collection. It was suggested that surveys could be planned at different times to try to account for this.

There was some discussion on how pup counts are done in Scotland for grey seals, where they experience a huge range of peak pupping dates. In Scotland, they do five surveys and then fit a birth curve, but there are at least two concerns with this. The relationship between peak count and the total pup production is very sensitive to length of stay, and length of stay is itself variable between colonies. Large variation between animals and topographical differences between sites is also an issue. The other concern is the shape of the birth curve. When you fit more age classes the assumed birth curve matters and varies significantly between colonies. Thus, each colony is modelled separately. It was suggested this be done in Canada. The authors said they do the same method and try different distributions (gamma, log-log distribution, Weibull, etc.) and fit to each colony individually. These fits are always sensitive to start date, but since the data is lacking they assume once the pups are there they do not leave. It was asked if it is known what is controlling the length of stay at the Scotland breeding sites, but unfortunately it is unknown. The authors of the Research Document suggested they need to include this possibility in the model; an example was discussed where there is one island (beside Amet Island) where pups stay around longer, whereas on islands with coyotes, the pups tend to leave earlier.

Overall reviewers wondered what the impact of animals leaving early would be on the model and it was confirmed that this would result in an under estimate of the pups since you are saying that any pups born are currently on the island. It was alternatively suggested that this could actually overestimate the pups since the start date would shift earlier and more pupping would be finished by then. The authors stated unfortunately it is not possible to correct for leakage (pups leaving) at this time.

On Sable Island an advance in the birth date of pups by about two weeks occurred between the mid 1990’s and 2000’s. In the Gulf of St. Lawrence it did not appear the birth date has advanced, although it may be a bit earlier on Pictou Island. The authors have not looked at the data to determine that, but their data does go back to 1988 so they agreed they could determine if it has changed. The authors suggested that even on Sable Island it might not be so much that the birth date has shifted but that because of the lack of ice on the Gulf there could be a platform shift.

Regarding Figure 3 it was asked whether the curvilinear relationship with ice is important because it seems to be based on a single data point from 1969. It was suggested the model be run from 1984 forward. The authors stated that the curve is used to correct for the proportion of animals born on land versus ice. However, if 100% of the pups born on ice die, but there are only 10 animals it is not going to make a significant difference. Despite this, it was suggested that the model be changed to exclude the 1969 point.

It was also asked whether the authors think that animals leaving before the survey is occurring more frequently in recent years, and wondered what the impact on the index would be in this case. The authors stated this did not used to be an issue because all the seals in the Gulf of St. Lawrence were ice breeders, but now it may be something they need to consider since seals are in the water, on land, and on ice. The authors were not sure of how this would impact the estimates but it was decided this should be captured in the sources of uncertainty in the Science Advisory Report.

WORKING PAPER 7C: COMPARISON OF METHODS TO ESTIMATE GREY SEAL PUP PRODUCTION AT DIFFERENT COLONIES

(M.O. Hammill, J. Dale, G.B. Stenson, C. den Heyer, J-F Gosselin, P. Leblanc, and D. Johnston)

Rapporteur: Cortney Watt

Discussion: There was some discussion about what the resolution of the camera on the Unmanned Aerial Vehicle (UAV) was and whether the plane could have flown higher to get a better resolution. It was noted that they did not attempt to fly any higher because the seals were already quite small at the distance used. In addition, the flying altitude is also determined by the way the overlap on the imagery is programmed. Seventy percent overlap in both directions restricted the total area they were able to cover. It was noted that the UAV system is good but not as clear as a Nikon. The infrared had even worse resolution, but an automated counting system is being created that could be of use for comparing the visual counts to the infrared. It was noted that you would likely be able to pick up the seals beneath the tree foliage with the infrared. Overall, it was suggested that it would be good to put the resolution, pixel size, lens size, etc. in the Research Document.

WORKING PAPER 7D: ESTIMATING CHANGES IN VITAL RATES OF SABLE ISLAND GREY SEALS USING MARK-RECAPTURE ANALYSIS

(C.E. den Heyer and W. D. Bowen)

Rapporteur: Cory Matthews

Discussion: This paper did not have any outstanding points that need to be addressed.

Clarification was asked on the number of re-sightings an individual was required to have to be entered into the model, and what the impact of excluding an animal that was sighted only once would be on the model. All animals included in the model had to have at least three re-sightings, although all of those could be within the same year.

There was some discussion related to density dependence effects within the population, which could be indicated by an increase in the proportion of females not reproducing (i.e. ‘skipping years’ due to being in poorer condition). There is no evidence to suggest this is the case. There is also no evidence to suggest that these females are pupping elsewhere, since the proportion of females not sighted at Sable Island during a given year is roughly 20%, a number that would not go unnoticed at other sites. There are future efforts to increase data collection and branding at other colonies.

There was also discussion on whether ground fish stock levels influence survivability, and while there is no indication that the collapse of code stocks in early 1990s negatively impacted grey seal population growth, a density dependent effect owing to greater competition for resources as the population increases is suspected.

Discussion about the population model focused on whether emigration occurs, and if so, when. The model is a closed model that treats any emigration as permanent. Emigration occurs prior to recruitment to the breeding colony, as apparent survivability is so high that losses due to emigration once recruitment occurs must be negligible. There have been sightings of animals branded on Sable Island in the Gulf of Maine, where a large photo-database is maintained, and in recent years there are more sightings of branded grey seals off Sable Island as high quality cameras are more common. Juvenile animals branded in the Gulf of St Lawrence and Hay Island have also started showing up on Sable Island during the breeding season. It was asked whether the apparent lower survival of males could reflect emigration to other sites, but fewer sightings of older age males suggest they die at younger ages than females.

There were questions about potential reasons for the decline in pup survival (from 76 to 33%). While some of this could reflect increased emigration prior to recruitment to the breeding colony, the Sable Island colony is sufficiently large that the seals would be noticed elsewhere. Therefore, increased mortality is likely, which could reflect predation by other grey seals or possibly sharks. Again, density dependent effects were brought up, whereby greater numbers of adult seals may force juveniles to forage in less ideal habitat. Tagging results indicate juvenile seals have recently begun foraging more offshore, possibly supporting some density dependent shift in foraging behavior.

In stable grey seal populations in the UK, pup survival is only 10-25%, which is lower than the most recent estimate for Sable Island juvenile (from weaning to recruitment at the breeding colony) survival of 30%. The 76% recruitment previously observed in the Northwest Atlantic population is higher than first year survival in growing populations in the UK (roughly 50-60%). Non-pregnant females are also not observed at the UK breeding colonies, but there is evidence mating occurs offshore. Other estimated parameters for the Northwest Atlantic grey seals are similar to estimates for the UK seals (e.g. sex ratio is 1.67 females to males at UK breeding site). High female survivability is also similar at colonies in both regions.

WORKING PAPER 7E: GREY SEAL POPULATION TRENDS IN CANADIAN WATERS, 1960-2016

(M.O. Hammill, C.E. den Heyer, and W.D. Bowen)

Rapporteur: Cory Matthews

Discussion: Much of the discussion of this paper focused on the change in the assumed relationship between mortality if young of the year and older seals (i.e. gamma value) to 15, the incorporation of a sex ratio that is not 1:1 which differs from previous modelling efforts, and the combination of animals from breeding colonies on Sable Island and coastal Nova Scotia into a single management unit. It was suggested that the paper have clear explanation of each of these changes.

The rationale for changing the gamma to 15 was that new survey results showed adult survival was higher than previously thought. A gamma of 15 was applied to all colonies, with the Sable Island and coastal Nova Scotia sights combined (the Gulf was estimated separately). It was suggested that if independent estimates of gamma were available, they may be used to assess whether the currently applied value is appropriate. Because female survival is greater than that of males, the population sex ratio is skewed toward more females than males. The ratio females and males depends on the age structure of the population, with there being a higher proportion of females in older age classes. It was clarified that the applied sex ratio was calculated assuming constant recruitment and a population consisting of ages 1-25.

These parameters were used in new population models, and in back-calculations of previous model estimates. As a result of these changes, all abundance estimates declined, although the population trajectory is still increasing. It was confirmed that the new abundance estimates indeed reflect a change in methodology and not actual population dynamics. It was asked that this be clarified in the paper.

The degree of exchange among the populations (i.e. recruitment to a different breeding colony than that they were born in) was brought up. This occurs to some degree, as a small amount of Sable Island seals appear to go to coastal Nova Scotia, and seals from Sable Island are likely going to colonies in the northeastern USA. However, there is no quantified estimate of the numbers of animals emigrating from the colony, which would currently factor in juvenile mortality. It was noted that an earlier analysis of the mark-recapture data on Sable Island found that the recruitment age of females has shifted about one year older, and the sampling from the Gulf shows a lower proportion of females pregnant at younger ages. This will also affect recruitment.

WORKING PAPER 7F: HARVEST ADVICE FOR NORTHWEST ATLANTIC GREY SEALS

(M.O. Hammill, C.E. den Heyer, and W.D. Bowen)

Rapporteur: Cory Matthews

Discussion: Suggested changes: 1) on graph showing 95 and 70% young-of-year (YOY) charts draw the line down to indicated where the 80% mark is, and 2) put the numbers for 80% younf of the year scenarios into the table.

It was also suggested for practical management decisions, a table dividing the information presented in Table 3 to present catches in each of the regions that would respect the 80% criterion for each of the herds. It was suggested the first three terms of reference could be addressed using the totals from the figures, and putting them into a table, but the point that any hunt will have proportions of animals from the different herds depending upon the time of the year must be made (i.e. because season and location of hunt unknown, which is relevant to reference terms 1-3 and should be considered caveats).

It was noted that the total number of animals for each region cannot stay the same over all quarters of the year since the pups, which have 60% mortality, are dying over the year.

Telemetry data was used to assign age-structured distributions for adults. It was suggested the lack of same information for juveniles and YOY means the seasonal grey seal abundances should be considered illustrative (along with previous point pups dying throughout the year). This caveat must be included in the table legend.

This working paper will be combined with the previous paper on the population model into a single research document.

APPENDIX 1: TERMS OF REFERENCE

National Marine Mammal Peer Review Committee (NMMPRC) 2016 Annual Meeting

National Peer Review - National Capital Region

October 17-21, 2016
Winnipeg, Manitoba

Chairperson: Garry Stenson

Context

The National Marine Mammal Peer Review Committee (NMMPRC) holds at least one annual meeting to conduct scientific peer-review of marine mammal issues. The meeting(s) provide the opportunity for collaborative review of scientific results by marine mammal experts from Fisheries and Oceans Canada (DFO and from other (non-DFO) organizations. Following NMMPRC peer-review and approval, scientific results are used to provide sound scientific advice for the management and conservation of marine mammals in Canada.

Objective

Specific Terms of Reference for each topic are as follows:

1. Population Viability Analysis of the St. Lawrence Beluga Population

Context:

The St. Lawrence Estuary (SLE) beluga population was listed as Threatened under the *Species at Risk Act* (SARA) in May 2005. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) re-reviewed the status of SLE beluga in November 2014, recommending a status of Endangered.

Under SARA, a Recovery Strategy (RS) was published in the Species at Risk Public Registry for this population (DFO 2012). This strategy identified several threats that limit the recovery of the SLE beluga; these primarily include contaminants, anthropogenic disturbances, and the reduction in quality and quantity of food. The measures proposed in the RS are intended to reduce threats, protect the habitat of SLE beluga, and regularly monitor the population.

Objectives:

The main objective of the project is to conduct an analysis of the viability of the SLE beluga population by quantifying the relative and combined impacts of noise, contaminants, and prey availability on population dynamics. More specifically:

A. Estimate how the primary threats (contamination, noise, prey availability) affect the population and what proportion of the population is affected.

B. Proposed management and mitigation measures for the recovery of the population and estimate the possible impacts of these measures.

C. Use sensitivity analysis and various scenarios to determine the effect of uncertainty and changes in each of these parameters on population response.

D. Propose future research to increase knowledge of these threats and their impacts.

Expected Publication:

- One Research Document

2. Eclipse Sound Narwhal - 2015 ice entrapment Impacts

Context:

In December 2015, an ice entrapment of narwhals was reported in Eclipse Sound, Nunavut. A humane harvest of the entrapped narwhals took place, although the exact number of animals that died is not known.

The impact of natural mortality, including natural entrapment events, is already included in the intrinsic rate of population growth used to determine sustainable harvest levels. Following a large narwhal entrapment event in 2008, DFO Science conducted an analysis to assess the possible impacts of the event on the recommended harvest levels for the Eclipse Sound narwhal stock. Results concluded that if large entrapment events were to become more common, the total allowable landed catch (TALC) may need to be revised to ensure sustainability of the harvest.

Central and Arctic region resource managers have requested science advice on the sustainability of harvest given the latest ice entrapment.

Objectives:

To evaluate the potential impacts of the December 2015 ice entrapment event, and determine if the current total allowable harvest recommendations for narwhal should be revised.

Expected Publications:

- One Research Document
- One Science Advisory Report

3. Baffin Bay Narwhal – Review of a harvest allocation model

Context:

The subsistence harvest of the High Arctic narwhal in Canada is currently managed using Total Allowable Landed Catch (TALC) advice from DFO Science for each of the four summering aggregations of the Baffin Bay populations (Somerset Island, Admiralty Inlet, Eclipse Sound, East Baffin Island) and for summering aggregations of narwhal in Jones Sound and Smith Sound. These summering stocks, as well as the stocks from Greenland, potentially mix together during annual migrations in spring and fall, to and from their overwintering areas, offshore in Baffin Bay and Davis Strait.

Inuit hunt narwhals in their summering aggregations, during the migratory periods as they pass by local communities. Narwhal may also be available to Greenland hunters during winter. The proportion of narwhals belonging to any particular stock in the non-summer harvest period is unknown, but it is assumed to be proportional to the size of each stock relative to the total number of animals in the mixture of stocks.

Recently, the Canada/Greenland Joint Commission on the Management and Conservation of Narwhal and Beluga (JCNB), with the participation of DFO Science, has developed a Narwhal Catch Allocation Model that combines expert opinion, harvest, tracking movement (satellite tagging), and abundance information since 1970 from both Greenland and Canada. This model explicitly incorporates uncertainty in a Bayesian framework and provides a more complete portrait of population dynamics than is currently available in determining TALC advice for internationally shared stocks in the Baffin Bay narwhal population and informing harvest allocation decisions by Nunavut Inuit communities for their summer and migratory narwhal harvest.

Central and Arctic region resource managers have requested Science advice on using the JCNB model to support sustainable harvest recommendation allocations for Baffin Bay narwhal in Nunavut waters.

Objectives:

To evaluate the robustness of this new model and provide recommendations on its use as an allocation tool for the Baffin Bay Narwhal summering aggregations in Canada.

Expected Publications:

- One Research Document
- One Science Advisory Report

4. Atlantic Walrus flexible quota advice

Context:

The Integrated Fisheries Management Plan (IFMP) for walrus in the Nunavut Settlement Area has been presented to the Nunavut Wildlife Management Board (NWMB) for approval. The IFMP includes new harvest levels (Total Allowable Harvests, or TAHs) established in 2016. The NWMB has requested that the Department evaluate options for the carryover of the unused walrus TAH within a Management Unit.

Central and Arctic region resource managers have requested Science advice on the viability of a harvest credit accumulation and/or borrow-back system for unfilled annual Marine Mammal Tags within walrus management units in Nunavut.

Objectives:

The objective of the peer review is to evaluate the following scenarios provided by resource managers with respect to flex quotas:

Once a Total Allowable Harvest (TAH) is established for a walrus stock/Management Unit (MU) in the Nunavut Settlement Area, what form of flex-quota, or carry-over provisions, could be established for use in subsequent harvest seasons? Scenarios should include the following:

- (A1)- 100% CARRY-OVER FOR 1 YEAR ONLY. All unused TAH/quota in a given harvest season within a walrus MU is carried over for use in the next harvest season only. Unused TAH carried-over from the previous year are applied first to walrus harvests in the current year. Carried-over TAHs expire at the end of the harvest year for which they were carried over. No more than 2 times the annual walrus TAH may be landed in the MU over 2 consecutive harvest seasons.
- (B1) If scenario (A1) is unsustainable, is there any proportion of carry-over less than 100% that is sustainable (i.e., [0% to 100%] CARRY-OVER FOR 1 YEAR ONLY)?
- (C1) If scenarios (A1) or (B1) are sustainable, can unused TAH from each harvest season be accumulated for use in subsequent harvest seasons for consecutive years, potentially indefinitely until the existing TAH is modified (i.e., [0% to 100%] CARRY-OVER FOR CONSECUTIVE YEARS)?

Can a form of harvest credit borrowing system be implemented within each of the walrus MU within the Nunavut Settlement Area (NSA) whereby some proportion of the next year's TAH for a given MU is allocated to the current harvest year and the following year's TAH for the MU is discounted by the amount that is borrowed and still be considered sustainable?

- (A2) 100% BORROW-BACK. In any given harvest season, any portion of the next year's TAH for the MU may be used in the current harvest season. However, the MU's

TAH for the subsequent season is discounted by the amount borrowed-back for use in the current harvest season.

- (B2) If 100% borrow-back (A2) is found to be unsustainable, is there any proportion of borrow-back less than 100% that is sustainable (i.e., [0% to 100%] BORROW-BACK)?

Can the 5 year sum of annual TAH for each walrus MU within the NSA be applied as an overall walrus harvest limit that may be prosecuted at any time during this five year consecutive period and still be considered sustainable?

Expected Publications:

- One Research Document
- One Science Advisory Report

5. St. Lawrence Estuary beluga – information relevant to spring, fall, and winter habitat

This topic is postponed to another meeting.

6. Eastern and Western Hudson Bay Beluga - 2015 Aerial Survey Abundance Estimates and Sustainable Harvest Advice

Context:

Belugas are found in summer along the Hudson Bay coast. Western Hudson Bay (WHB) beluga and Eastern Hudson Bay (EHB) beluga are the principle stocks in the mix of beluga harvested by Inuit in Hudson Bay during the summer. In 2004, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated WHB beluga Special Concern and EHB beluga Endangered.

Inuit subsistence harvests of WHB beluga occur in the Kivalliq Region of Nunavut, in the Belcher Islands and in some Hudson Strait communities. There are currently no restrictions on subsistence harvesting of WHB beluga in the Nunavut Settlement Area, however the Nunavut Wildlife Management Board may wish to consider establishment of a Total Allowable Harvest (TAH) in future.

Beluga are also an important food resource for the Inuit in Nunavik, harvesting beluga from the mixture of WHB and EHB beluga as well as other non-identified stocks. Harvesting in Nunavik communities is currently managed under a 3-year management plan developed and implemented by the Nunavik Marine Region Wildlife Board in 2014, which expires in 2016.

Management of beluga relies on the estimation of abundance of summering stocks. In August 2015, DFO conducted aerial surveys of beluga in WHB and EHB. Updated abundance estimates are needed to ensure that harvests of WHB and EHB belugas remain within sustainable limits. As a result, resource managers have requested Science advice on the abundance estimates and sustainable harvest recommendations for WHB and EHB beluga.

Objectives:

1. Review the 2015 aerial survey methods and results for WHB beluga and estimate the stock abundance.
2. Review the 2015 aerial survey methods and results for EHB beluga and estimate the stock abundance.
3. Determine sustainable harvest levels for WHB beluga.
4. Review the population model for EHB beluga and provide advice on sustainable harvest.

a. Determine the maximum number of beluga from the EHB population that can be harvested while maintaining a 25%, 50%, and 75% chance of population increase over the next ten years, taking into account the season and area of the hunt.

b. Develop a precautionary approach (PA) framework that could be used in the management of EHB beluga. Examine the impact of current harvest levels within the framework, recommend a recovery target under the PA, and provide scenarios which include the maximum number of EHB belugas that can be harvested each year and still allow for the population to recover within 25 and 50 years.

5. If appropriate and feasible, review population modelling results incorporating WHB beluga survey data.

Expected Publications:

- Three Research Documents
- One Science Advisory Report

7. Results of 2016 Northwest Atlantic grey seal pup production survey and sustainable harvest advice

Context:

In January 2016, a pup production survey was conducted in the breeding areas of grey seals (Sable Island, Gulf of St. Lawrence, coastal Nova Scotia) in order to provide new estimates of population parameters. Grey seals are managed under the Objective Based Fisheries Management (OBFM) approach for Atlantic seals, which was implemented in 2003. The current management objective is to maintain an 80% probability (L20) that the population will remain above 70% (N70) of the largest population seen.

The assessment will provide managers with the information required to evaluate the proposed harvest levels and ensure their compliance with the principles and objectives of the Integrated Fisheries Management Plan (IFMP) for seals, including compliance with the Precautionary Approach.

Objectives:

Resource Management requests Science to provide an update on the status of this population. Advice should include information on the status of the overall population, as well as changes in the status of the three herds generally known by sub-areas as Sable Island, Eastern Shore and the Gulf of St. Lawrence. The following specific questions will also be evaluated:

1. For the next five years (2017-2021) what would be the maximum sustainable harvest with an 80% confidence of remaining above N70?
2. What is the risk that the grey seal population will drop below 50% and 70% of Nmax at a total allowable catch of 60,000, 70,000 and 90,000, 100,000, 120,000 150,000 and 200,000 animals with a composition of 30% adults / 70% beaters, and 5% adults / 95% beaters?
3. If a target population was set at N70 (e.g. 70% of maximum population observed) what would be the total annual removals required to maintain that target over a range of 5 and 10 years?
4. Estimate the number of grey seals forging in the Southern Gulf of St. Lawrence (4T).

Expected Publications:

- Five Research Documents
- One Science Advisory Report

Additional Expected Publications

In addition to the expected publications listed under each topic, a meeting Proceedings will be produced.

Participation

Participants from the following groups were invited to participate in the meeting:

- Fisheries and Oceans Canada (DFO) (Ecosystems and Oceans Science, Ecosystems and Fisheries Management, Species at Risk)
- Nunavut Wildlife Management Board
- Nunavik Marine Region Wildlife Board
- Makivik Corporation
- Nunavut Tunngavik Inc.
- Greenland Institute of Natural Resources
- National Oceanic and Atmospheric Administration (NOAA)
- Sea Mammal Research Unit – St. Andrews University
- Oceans Initiative
- Academia

APPENDIX 2: PARTICIPANTS

DFO:

Alejandro Buren	Science (NL)
Allison McPhee	Resource Management (C&A)
Ellen Lea	Resource Management (C&A)
Jeff Moyer	Resource Management (C&A)
Anne-Marie Cabana	Resource Management (QC)
Arnaud Mosnier	Science (QC)
Christine Abraham	Science (NCR)
Nicole Bouchard	Resource Management (QC)
Darlene Smith	CSAS (NCR)
Garry Stenson	Science (NL, Chair)
Hilary Moors-Murphy	Science (MAR)
Jack Lawson	Science (NL)
Jean-François Gosselin	Science (QC)
Lianne Postma	Science (C&A)
Linda Nichol	Science (PAC)
Cortney Wheeler	Science (C&A)
Cory Matthews	Science (C&A)
Marianne Marcoux	Science (C&A)
Mike Hammill	Science (QC)
Nell den Heyer	Science (MAR)
Patt Hall	Resource Management (C&A)
Paul Blanchfield	Science (C&A)
Rob Young	Science (C&A)
Sheena Majewski	Science (PAC)
Shelley Lang	Science (MAR)
Steve Ferguson	Science (C&A)
Veronique Lesage	Science (QC)
Jenness Cawthray	Resource Management (NCR)
Joe Crocker	Resource Management (NCR)

Externals and stakeholders:

Dave Thompson	University of St. Andrews
Rod Hobbs	NOAA
Lars Witting	Greenland Institute of Natural Resources
Gary Stern	University of Manitoba
Rob Williams	Oceans Initiative
Bob Lacy	Independent
Danica Crystal	Nunavut Wildlife Management Board
David Lee	Nunavik Tunngavik Inc.
Mark O'connor	Makivik Corp.
Kaitlin Breton-Honeyman	Nunavik Marine Region Wildlife Board
Greg Gilbert	Makivik Corp.
Mark Basterfield	Nunavik Marine Region Wildlife Board