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Canadian Science Advisory Secretariat
Central and Arctic Region **Science Advisory Report 2018/012**

IMPACT OF THE 2015 NARWHAL (*MONODON MONOCEROS*) ENTRAPMENT ON THE ECLIPSE SOUND STOCK

*Narwhal (*Monodon monoceros*) by R. Phillips.*

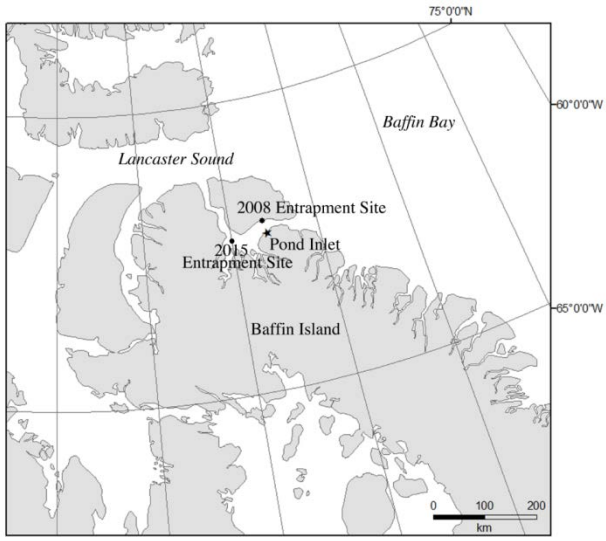

Figure 1. Map of Pond Inlet entrapment sites.

Context:

*A narwhal (*Monodon monoceros*) entrapment event occurred near the community of Pond Inlet, Nunavut in November 2015 (Figure 1). Harvesting of narwhals in Nunavut is regulated through the establishment of Total Allowable Harvest (TAH) levels as outlined in the Nunavut Land Claims Agreement. Fisheries and Oceans Canada (DFO) Science advice to establish the TAH is provided by calculating Potential Biological Removals (PBR) and subsequent Total Allowable Landed Catches (TALC). Resource managers have requested science advice on the sustainability of the current harvest if PBR does not fully account for narwhal mortality from the 2015 entrapment. Of 249 whales known to have died, 229 narwhals were harvested in December at the entrapment event. Whales from this entrapment are thought to be from the Eclipse Sound stock. The present analysis was undertaken with two scenarios; one assumed all of the whales come from Eclipse Sound while the other assumed a portion of the whales come from Admiralty Inlet. These scenarios were used to assess how the Eclipse Sound TALC may need to be adjusted to account for mortality from the entrapment event.*

SUMMARY

- An ice entrapment event, where at least 249 narwhals died, occurred in Eclipse Sound in November 2015.
- This study assessed the impact of this entrapment on the current TALC, and the abundance trajectory for the Eclipse Sound narwhal stock.
- It is uncertain if the PBR approach accounts for the mortality caused by a single entrapment event of this size. In the past, it has been assumed these events are encompassed by the natural mortality component of PBR.
- We assessed how entrapments that resulted in the death of 249, or an assumed level of 1,000 whales, would impact the PBR and resulting TALC, if entrapment mortality is considered in addition to natural mortality included in PBR.
- These scenarios were repeated to determine the impacts if the entrapment included individuals from both Eclipse Sound and Admiralty Inlet.
- If PBR fully accounts for the mortality from this entrapment event, the TALC would not need to be adjusted. If mortality from the entrapment event is in addition to natural mortality included in PBR, the TALC would need to be reduced by 3 whales for an entrapment that resulted in the death of 249 whales and 13 whales for an entrapment resulting in the death of 1,000 whales (an estimated upper limit). If some of the whales were assumed to come from Admiralty Inlet, these numbers would be lower.
- Results of several model simulations indicated entrapments occurring every 3, 5 or 10 years may result in a decline in the stock abundance.

INTRODUCTION

An entrapment occurred near Pond Inlet in 2015, where at least 249 narwhals died. This was seven years after the previous large entrapment of 2008 near Pond Inlet where 629 narwhal were harvested (DFO 2012). The present analysis is in response to a request for DFO Science to determine how this entrapment event impacts the Eclipse Sound stock. Specific questions include:

1) should the TALC be changed to account for mortality from this event, and
2) how will the abundance of the Eclipse Sound stock change if entrapments of this magnitude become more frequent?

There are satellite telemetry data that indicate that some narwhal from Admiralty Inlet move to Eclipse Sound in the fall and may have been present during an entrapment event. Therefore, two scenarios were examined, one where all of the whales in the entrapment come from the Eclipse Sound stock, and another where a portion of the whales come from the Admiralty Inlet stock.

ANALYSIS

The portion of whales that may have originated from the Admiralty Inlet narwhal stock was estimated based upon the satellite telemetry data. Of 42 whales tagged in Admiralty Inlet, 4 travelled into Eclipse Sound. Adjusting for the relative sizes of the two populations resulted in an estimated proportion of Admiralty Inlet whales that could have been in the entrapment event of 0.24. Thus, in the second scenario it was assumed that 24% of the individuals in the entrapment event come from Admiralty Inlet, while 76% come from the Eclipse Sound narwhal stock.

Potential Biological Removal (PBR) was calculated following Wade (1998; $PBR_t = N_{min,t} * 0.5 * R_{max} * F_r$) and then divided by a struck and loss (S&L) rate of 1.28 (Richard 2008) to calculate a revised TALC. The confirmed number of whales that died (249) was considered to be a minimum while the maximum number of potential deaths was set at 1,000 whales. To some extent, natural mortality is already included in PBR calculations, but it is unknown if it captures events of this magnitude. As a result, we calculated scenarios where entrapment mortality is considered to be in addition to natural mortality. Recalculations of PBR for the Eclipse Sound narwhal stock indicated that when all the whales in the entrapment came from Eclipse Sound, the TALC would need to be reduced by 3 or 13 whales for mortality levels of 249 and 1,000 whales, respectively (Table 1). If only 76% of the whales in the entrapment came from Eclipse Sound, the TALC would need to be reduced by 2 or 9 whales for mortality levels of 189 and 759 Eclipse Sound narwhals, respectively (Table 1).

Table 1. Revised PBR and TALC resulting from different entrapment mortality estimates assuming all whales involved in the entrapment came from the Eclipse Sound stock, and assuming some of the whales came from Admiralty Inlet. PBR was calculated after the entrapment event. The final column indicates the difference between the current proposed TALC of 134 pre-entrapment and re-calculated TALCS that consider the 2015 entrapment mortality to be above natural mortality.

Proportion of Eclipse Sound Narwhals	Number of narwhal killed	N_{Min}	PBR	TALC (after S&L)	Difference from proposed TALC
100%	249	8,390	168	131	-3
	1000	7,775	155	121	-13
76%	189	8,439	169	132	-2
	759	7,972	159	125	-9

Model Simulations

The model used in this analysis was based upon a model presented by Richard and Young (2015). It included an error term to account for natural variability in birth and death rates. Entrapment event mortality was then subtracted to estimate the impacts of entrapments on the Eclipse Sound narwhal stock:

$$\mathrm{Nt}+1 \;=\; \mathrm{Wt} * (\mathrm{Nt} + \mathrm{Nt} * \mathrm{Rmax}\,[1 - (\mathrm{Nt}/\mathrm{K})\theta] - \mathrm{PBR} - \mathrm{E})$$

The model was run with three entrapment frequencies, assuming an entrapment event every 3, 5, and 10 years. The model assumes that entrapment mortality is in addition to natural mortality included in PBR. The magnitude of entrapments varied randomly between 200–1000 narwhals. The model assumes all whales (from 200–1000) come from the Eclipse Sound narwhal stock and all died.

Model simulations indicated that the median Eclipse Sound stock size would decline over 100 years at all frequencies of entrapment examined (Figure 2).

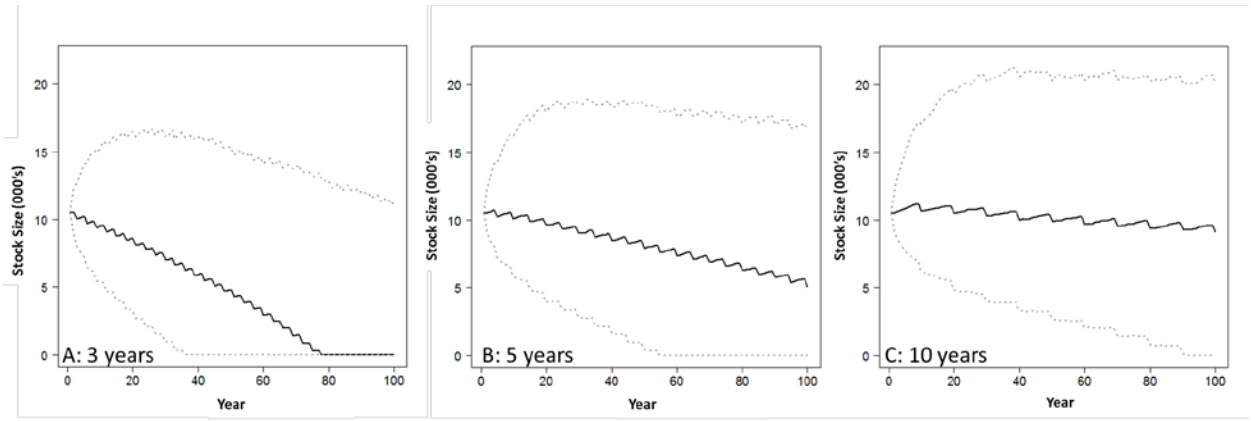

Figure 2. Abundance trajectories for the Eclipse Sound narwhal stock assuming entrapment events varying from 200-1000 narwhals occur every 3 (A), 5 (B), or 10 (C) years. Black solid lines indicate median stock abundance over 10,000 iterations, while grey dashed lines indicate the 90% confidence intervals around the median.

Sources of Uncertainty

PBR already includes a natural mortality component; whether or not this base level of mortality accounts fully for entrapments of this magnitude is unknown.

We have no idea of the frequency or magnitude of entrapment events, or if they are increasing in frequency.

The number of narwhals that died in this entrapment is unknown. We examined the implications of mortality up to an assumed maximum of 1,000 whales, but it is unknown if the actual number falls within this range.

There were more females (than males) harvested at the entrapment event; however, the model considered a 1:1 sex ratio of narwhal mortality. The implication of removing a greater proportion of females was not examined.

It is unknown how much exchange exists between the Eclipse Sound and Admiralty Inlet narwhal stocks. As a result, the actual proportion of whales in the entrapment from the two stocks is unknown.

The model simulations have a number of assumptions that have not been tested, and the results may be sensitive to these assumptions.

CONCLUSIONS

If PBR fully accounts for the mortality from this entrapment event, the TALC would not need to be adjusted. If the entrapment mortality is assumed to be in addition to the level of natural mortality included in PBR, and if all the 249 whales that died in the entrapment come from the Eclipse Sound narwhal stock, the TALC would need to be reduced by 3 animals. The TALC would need to be reduced by 13 animals for an entrapment of 1,000 Eclipse Sound whales. If some of the whales were assumed to come from Admiralty Inlet, these numbers would be less.

The model simulations showed the Eclipse Sound narwhal stock declines at all entrapment frequencies (every 3, 5 and 10 years) investigated.

OTHER CONSIDERATIONS

There is no information about the sex ratio of narwhals entrapped included in the model. If females are entrapped more frequently than males (as is seen in the harvest proportions for both the 2008 and 2015 entrapments), this may have a greater impact on the stock and therefore should be considered in the future.

SOURCES OF INFORMATION

This Science Advisory Report is from the October 17-21, 2016 National peer review of the Eclipse Sound narwhal – 2015 ice entrapment impacts. Additional publications from this meeting will be posted on the DFO Science Advisory Schedule as they become available.

DFO. 2012. Effect of 2008 ice entrapment on the Eclipse Sound narwhal total allowable landed catch. DFO Can. Sci. Advis. Sec. Sci. Resp. 2012/020.

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Wade, P.R. 1998. Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. Mar. Mammal Sci. 14: 1–37.

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MPO. 2018. Incidence de l'emprisonnment de narvals (Monodon monoceros) dans les glaces en 2015 sur le stock du détroit D'Eclipse. Secr. can. de consult. sci. du MPO, Avis sci. 2018/012.