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ABUNDANCE AND TOTAL ALLOWABLE LANDED CATCH FOR THE NORTHERN HUDSON BAY NARWHAL POPULATION

Narwhal Monodon monoceros
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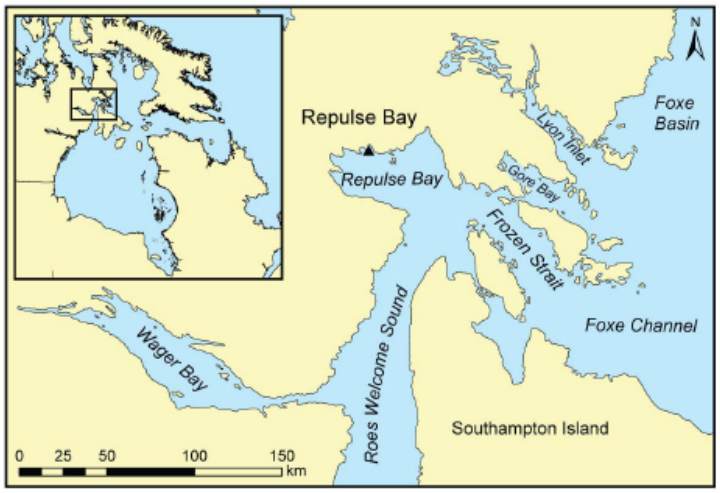

Figure 1. Areas where the Northern Hudson Bay narwhal population aggregates in summer in waters near the community of Repulse Bay, Nunavut (from Asselin et al. 2012).

Context

In August 2008, Fisheries and Oceans Canada (DFO) conducted a survey of the summer aggregation area for the Northern Hudson Bay narwhal population. There were apparent defects in the 2008 survey. Given uncertainty in the survey results and, therefore, estimation of sustainable catches, a new survey was recommended. DFO conducted additional aerial surveys of the Northern Hudson Bay summer aggregation area in August 2011. This science advisory report presents a new population abundance estimate, recommended Total Allowable Landed Catch and hunt sustainability for the purpose of informing management of this population.

SUMMARY

- Visual aerial surveys were conducted in August 2011 to estimate abundance of the Northern Hudson Bay narwhal population.
- Based on traditional ecological knowledge and the advice of local people, the 2011 surveys were expanded to include areas not previously surveyed.
- Adjusting the surface-visible estimate for submerged whales and whales missed by observers produced a population estimate of 12,485 narwhals (95% confidence interval 7,515 – 20,743).

- Based on the 2011 Northern Hudson Bay narwhal survey results, the estimated Potential Biological Removal for this population is 201 narwhals. The Potential Biological Removal was adjusted for hunting losses resulting in a Total Allowable Landed Catch for this population of 157 narwhals.
- Harvests at the levels of 2010 and 2011 are below the updated Total Allowable Landed Catch for this population and therefore can be considered sustainable.

BACKGROUND

The Northern Hudson Bay narwhal population is a geographically distinct population of narwhals that resides in the Canadian Arctic. In summer, most of the population aggregates in waters near the community of Repulse Bay (Nunavut) (Figure 1). The population is hunted by subsistence hunters from Repulse Bay and other communities in the Kivalliq and Qikiqtaaluk regions. Indices of abundance have been obtained for Northern Hudson Bay narwhals from aerial photographic surveys and visual surveys conducted in and around Repulse Bay in 1982-1984 (Richard 1991), 2000 (Bourassa 2003) and 2008 (Richard 2010). The 2008 survey experienced equipment problems and poor weather; a low population estimate was obtained. Population-dynamic models using Bayesian and deterministic methods were developed and run for the purpose of determining whether the low estimate from the 2008 survey could be explained by a serious decrease in stock size due either to recent increases in reported takes or by increased predation (Kingsley et al. 2012). The modelling exercise was also undertaken to review the sustainability of hunting at the levels of recent years. The modelling results indicated the recent 2008 survey appeared incompatible with earlier survey estimates and reported catches. Introducing predation since the survey in 2000 did not appear to provide a good explanation for the low 2008 survey result. It was concluded that the 2008 survey results were unreliable thus making it difficult to estimate sustainable catch levels (Kingsley et al. 2012). A new survey was recommended. In August 2011, aerial surveys were conducted in the waters near Repulse Bay to provide a new estimate of abundance.

ANALYSIS

Abundance of Northern Hudson Bay Narwhals

Stratified, systematic, visual line-transect aerial surveys were flown in a DeHavilland Twin Otter (DH-6) equipped with bubble windows and an optical-glass-covered camera hatch at the rear (survey details are described in Asselin et al. 2012). The visual survey had two observers on each side of the plane. Two digital cameras were operated in the rear camera hatch to photograph the area directly below the aircraft that could not be seen by the observers. A continuous stream of photographs was taken throughout the surveys. Aerial photos were used to confirm species identification and to measure or confirm perpendicular distances for some sightings.

Surveys were flown between 4 and 17, August, 2011. The best survey conditions were encountered during the final survey conducted on 14-17, August, when transects were flown in Repulse Bay, Frozen Strait, Wager Bay, northern Roes Welcome Sound, Lyon Inlet, Gore Bay and parts of Foxe Channel.

Distance 6.0, a Windows-based computer package for designing and analyzing distance sampling surveys of wildlife populations, was used to analyze the sighting data. Numbers of narwhals

reported by the survey observers were corrected for perception and detection biases using Mark-Recapture Distance Sampling (survey analysis described in Asselin et al. 2012). The Repulse Bay stratum was surveyed twice, on 14-15 August and on 17 August; the weighted average surface estimate from these two surveys was 1,429 (Table 1). This value was summed with the surface estimates for each of the other water bodies to produce a total surface estimate of 4,452 (95% confidence interval (CI): 2,707 – 7,322). To account for animals submerged when the survey plane flew over, numbers of narwhals from the visual surveys were also corrected for availability bias using a weighted availability bias correction factor of 2.80. This final adjustment produced a total population estimate of 12,485 narwhals (95% CI: 7,515 – 20,743).

Table 1. Narwhal surface estimates by stratum and the final abundance estimate corrected for availability bias. (CI = confidence interval; CV = coefficient of variation)

	Lower Limit of 95% CI	**Mean**	**Upper Limit of 95% CI**	**CV**
Repulse Bay 1	852	1,692	3,361	0.34
Repulse Bay 2	307	1,160	4,381	0.69
Average Repulse Bay	740	1,429	2,758	0.35
Foxe Channel	29	76	199	0.52
Wager Bay	354	1,095	3,386	0.63
Roes Welcome Sound	28	107	406	0.77
Northern Bays	763	1,746	3,998	0.44
Total Surface Estimate	**2,707**	**4,452**	**7,322**	**0.26**
Availability Correction		2.80		0.05
Abundance Estimate	**7,515**	**12,485**	**20,743**	**0.26**

The 2011 survey used methods that were different from those used by its predecessors flown in 2000 and the early 1980s. These differences are great enough to prevent us from using the survey series as a basis for calculating a population growth rate or for modelling the population dynamics of Northern Hudson Bay narwhals until the older survey estimates have been adjusted.

Total Allowable Landed Catch

Potential Biological Removal (PBR) is an accepted method of making a conservative estimate of sustainable human-induced mortality (DFO 2008). Based on the 2011 Northern Hudson Bay survey results, the estimated PBR for this population is 201 narwhals (Asselin et al. 2012). Total Allowable Landed Catch (TALC) is PBR divided by a Loss Rate Correction. Using a Loss Rate Correction of 1.28 (Richard 2008) yielded a Northern Hudson Bay narwhal TALC of 157.

$$TALC = \frac{PBR}{LRC}$$

Where:

$PBR = 0.5 \times R_{Max} \times \hat{N}_{Min} \times F_r$

$LRC =$ Loss Rate Correction

$R_{Max} =$ Maximum rate of increase for the stock

$\hat{N}_{Min} =$ 20th percentile of the log-normal distribution of the total (corrected) population estimate

$F_r =$ Recovery factor

As the maximum rate of increase for the stock (R_{Max}) is unknown, the default of 0.04 for cetaceans was used. The recovery factor (F_r) was set at 1.0, a value considered appropriate for a population that shows no sign of depletion.

Sustainability of Narwhal Harvests

In 2010 and 2011, a total of 108 and 92 narwhals, respectively, were landed from the Northern Hudson Bay population. These numbers are less than the TALC. Harvests at these levels are considered sustainable.

Sources of Uncertainty

The 2011 surveys covered a larger study area than previous Northern Hudson Bay narwhal surveys. Expanding the study area beyond what had been previously sampled increased the chances of capturing a larger portion of the population to produce a more accurate estimate of abundance. However, narwhals were sighted outside the survey region around the same time as the surveys. There were also a number of sources of uncertainty associated with the estimation of population size. The correction factor for availability bias has a large effect on the estimated size of the population but it is currently based on records of the diving behaviour of a small number of animals and there is uncertainty as to the effect of ice cover on dive behaviour and surface visibility. There is, therefore, concern that the calculated value for the uncertainty of this correction is too small. Killer whales were reported in the area shortly before the surveys but none were sighted by the survey observers. Narwhal behaviour changes in the presence of killer whales. Whether their presence affected the distribution or behaviour of narwhals during the surveys is unknown.

Uncertainty in the calculation of TALC comes from using a fixed Loss Rate Correction (1.28) derived from hunts throughout Nunavut. This was the same Loss Rate Correction used for provision of the original TALC advice in 2008.

CONCLUSIONS AND ADVICE

The 2011 surveys of the summering aggregations of Northern Hudson Bay narwhals produced a population estimate of 12,485 (95% CI: 7,515 – 20,743). On the basis of this survey result, and a fixed Loss Rate Correction of 1.28, the PBR calculation (201 narwhals) was converted to a TALC of 157. Harvests at the levels of 2010 and 2011 are below this updated TALC for the Northern Hudson Bay population and therefore can be considered sustainable. The fixed Loss Rate Correction used to calculate TALC for the Northern Hudson Bay population could be improved by more current information from the communities that harvest from this population, especially Repulse Bay.

SOURCES OF INFORMATION

This Science Advisory Report is from the May 10-11, 2012 zonal peer review of the Stock Identification, Abundance, Hunt Sustainability, and Tracking and Movements of Canadian Narwhal. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule at www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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