



STOCK ASSESSMENT OF NORTHERN QUEBEC (NUNAVIK) BELUGA (*Delphinapterus leucas*)



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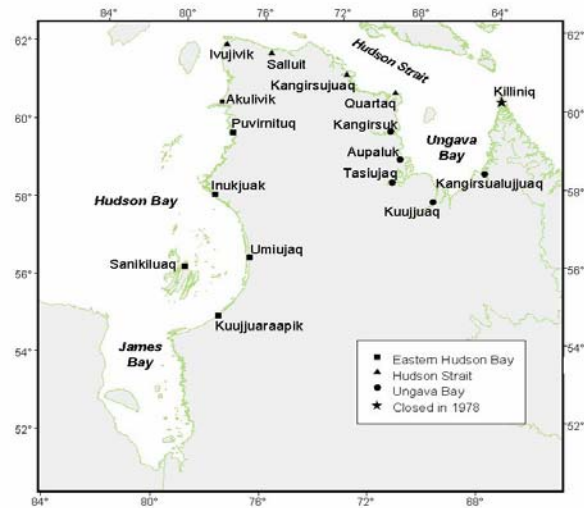


Figure 1. Map of communities in northern Quebec (Nunavik). The community of Killiniq closed in 1978.

Context :

Beluga whales (Delphinapterus leucas) are found in summer along the coasts of Hudson, James and Ungava Bays. The majority of these animals are thought to overwinter in Hudson Strait. At least three separate populations have been identified (Ungava Bay, eastern Hudson Bay and western Hudson Bay). In 2004, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recommended that the Ungava Bay (UB) and eastern Hudson Bay (EHB) population be listed as Endangered.

In addition to the traditional subsistence hunt, commercial hunts in Ungava Bay removed at least 1,340 animals between the 1860's until the early 1900's. The numbers of beluga killed appear to have declined owing to depletion of the population. Commercial hunting at the Little Whale and Great Whale rivers, in eastern Hudson Bay, removed an estimated 7,875 animals between 1854 and 1863. Commercial hunting continued at Great Whale River until at least 1877, but apparently ended owing to depletion of the population. Current subsistence hunting is directed towards both summering concentrations and also migrating whales from a mixture of populations during spring and fall. High subsistence harvests have limited recovery of the eastern Hudson Bay and Ungava Bay beluga populations.

The beluga hunt in northern Quebec is regulated by the Department of Fisheries and Oceans via a three-year management plan, which allows for annual adjustment of quotas upon availability of new scientific information. Harvesting is regulated through a combination of area closures, controlled season and regional quotas. In 2006, the Nunavik Inuit Land Claims Agreement (NILCA) was signed. This agreement calls for the establishment of a wildlife management board that will assume responsibility for the co-management of beluga in northern Quebec.

The three year management plan that regulates harvesting of beluga in this area expires prior to the

2009 hunting season. The last assessment of this stock was completed in 2005. In 2008, new aerial surveys were conducted and new information was obtained on the numbers of animal harvested and the stock composition of the harvest. This information was incorporated into a population model and resulted in an update on the current status of the population to be used in the development of a new management plan. This advisory report summarizes the new information and addresses a request from DFO Quebec Region Fisheries Management for peer-reviewed scientific of the health of the Nunavik beluga population in order to determine an acceptable harvest level for 2009 and future years.

SUMMARY

- Beluga that summer in Ungava Bay, in eastern Hudson Bay and western Hudson Bay are recognized as separate stocks. Genetic analyses support the principle of an eastern and one or more western Hudson Bay and possibly James Bay beluga stocks, but more information is needed. There is insufficient genetic information to confirm the stock identity of whales summering in Ungava Bay. In previous assessments, it was estimated that 21% of the Hudson Strait villages harvest and 13% of the Ungava Bay harvest comprise EHB animals. The spring harvest comprises a lower proportion of EHB animals than the fall harvest. However, there is considerable uncertainty associated with the proportion of animals harvested in the spring versus the fall.
- Aerial surveys flown in 2008 provided an abundance estimate (uncorrected for diving animals and including whales counted in the estuaries) of 9292 in James Bay, 1265 in eastern Hudson Bay (EHB). No beluga whales were seen in Ungava Bay.
- Population modeling, using abundance estimates corrected for diving by multiplying by 2.09, indicates that the eastern Hudson Bay population has likely declined from 4,300 whales in 1985 to 3,000 in 2008.
- Modeling suggests that struck and loss and under-reporting levels may be between 40-80%. This high figure represents a combination of factors including non-reporting, uncertainty in the proportion of EHB animals taken in the harvest as well as high struck and non-recovery of animals.
- A harvest of 50 reported EHB animals would likely not lead to any change in the population, while lower harvests than this would allow some recovery. It is recommended that no harvesting of beluga occur in Ungava Bay. The eastern Hudson Bay arc should also remain closed to hunting.

BACKGROUND

Species Biology

Beluga whales have a circumpolar distribution. They are a medium-sized toothed whale with an adult length of 350 cm and weigh up to 500–600 kg. Mating is thought to occur in March–April in loose ice areas, with calving occurring in mid-summer. The calves are born after a 14 month gestation and lactation lasts for roughly 18 months. The calving interval is estimated at about one calf every 3 years. At birth, the calves are brown or dark bluish in colour. As they mature,

the skin becomes lighter in colour gradually turning to grey and then to white. Female belugas are sexually mature between 8 and 14 years of age. Males are sexually mature at 12-14 years. Beluga have a lifespan of about 80 years, but maximum lifespan is difficult to determine owing to wearing of the teeth.

Beluga lack a dorsal fin, which is believed to be an adaptation to inhabiting ice covered waters. They are often associated with estuaries, which has led to the view that they are a shallow water species. However, aerial surveys and satellite telemetry indicate substantial movements offshore and diving to depths of over 600 m.

The Hunt

Harvest statistics are available since 1974. These statistics represent minimum estimates of the numbers of animals landed only, since not all villages provided catch data in all years, and information on the number of animals killed, but not recovered (struck and lost) and animals killed but not reported is limited or not available. Current reports indicate that a small fraction of animals that are killed, but not recovered, are recorded, but this information is incomplete. During the 12 year period 1974–1985, a total of 5,402 whales (average=450 whales/yr) was reported to have been taken by all Nunavik communities combined. The introduction of quotas in 1986 reduced reported annual landings to an average 258 belugas/yr during 1986–2001 (range: 162–385 belugas/yr), and to an average 175 belugas/yr after 2001 (range: 125–216 belugas/yr).

Historically the highest harvests were from Hudson Strait and this has continued with 69–92% of the total annual landings in this area since 2005 (Table 1). Since 2001 more communities, particularly those from Ungava Bay have been harvesting in Hudson Strait. Another change during this period was a harvest in James Bay/Long Island area (4–13 belugas/yr), which was conducted mainly by communities from the Hudson Bay arc. These changes in hunting patterns are in response to management measures to protect UB and EHB beluga, and an attempt to ensure access to animals for hunters.

Hunting of beluga whales was prohibited in Ungava Bay, and eastern Hudson Bay during 2005 and 2006, but hunters were awarded small allocations in these areas in 2007 and 2008. In 2007, the harvests of some communities exceeded their allocations, which resulted in a reduction of their allocations for 2008.

Age and sex composition of harvests

Of the 1021 beluga sampled in Nunavik waters between 1993 and 2008, 955 individuals, including 286 during the period 2005–2008 were classified by colour. White beluga (older adults) dominated in the harvest during the three periods and accounted for 52–59% of the beluga reported killed. Dark grey animals (juveniles) represented 8%, 10% and 5% of total landings during 1993–2000, 2001–2004, and 2005–2008, respectively. The percentage of grey or light grey beluga landed remained stable over the three periods at 34–40%. Only 24 belugas were sampled in eastern Hudson Bay during 2005–2008. The representation of dark grey (8%), grey (33%) and white (58%) beluga was similar to that estimated for all regions combined.

Median age of harvested beluga varied among regions and was the lowest in EHB, at 16 and 17 yr during 1993–2000 and 2001–2008, and 14.0 yr during the most recent period (2005–2008), compared to 19–20 yr and 18–22 yr in Hudson Strait and Ungava Bay, respectively.

Sex was known for 932 beluga sampled during 1993–2008, including 286 individuals for the period 2005–2008. Equal numbers of males and females were landed, but this changed during the 2005–2008 period, when females represented 58.4% of landings. The over-representation of females reflected an increase in the proportion of dark grey and grey juvenile females, such that they were taken more than twice as often as juvenile males. This tendency to harvest young females was observed in eastern Hudson Bay and Hudson Strait, but not in Ungava Bay. White adult females were also taken twice as often as males in eastern Hudson Bay during the same period.

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Table 1. Beluga whale harvests, including animals struck and lost reported by the different communities of the Nunavik during 2005–2008.

Region	Harvest	Community	2005	2006	2007	2008
James Bay/Long Island		Umiujaq	2	8		
		Kuujuaraapik	11	2	8	9
	N harvested		13**	10	8	9
	Quota		10	30	22	22
Eastern Hudson Bay		Kuujuaraapik				2
		Umiujaq			7	12**
		Inujjuaq			7	7
		Puvirnitug	1		2	2
		Akulivik			5**	5**
	N harvested		1**		21	28**
	Quota		0	0	23	23
Hudson Strait		Ivujvik	37	19	17**	12
		Salluit	23	19	33**	8
		Kangirsujuaq	14	16	16**	13
		Quartaq	15	20	13	17**
		Kangirsuk	8	17	14**	6
		Aupaluk	7	10	9**	4**
		Tasiujaq	9	16	7	5
		Kuujuuaq	15	16	19**	9
		Kangirsualujjuaq		8	2	10**
		Inujjuaq	1			
		Puvirnitug	15		23**	3
		Akulivik	28	6	12**	5
	N harvested		172**	147**	165**	92
	Quota		135	135	120	94
Ungava Bay		Kangirsuk	2		2**	1
		Aupaluk	1		1	
		Tasiujaq	1	1		1
		Kuujuuaq		1	2**	1
		Kangirsualujjuaq	1		1	2
	N harvested		5**	2**	6	5

	Quota		0	0	9	9
King George Islands		Inujjuaq	12			
	N harvested		12	0		
	Quota		25	25		
Belcher Islands		Sanikiluaq	49	22	-	33
		Quota	(NA) ¹	(NA) ¹	(NA) ¹	(NA) ¹

** Indicates harvest exceeds allocation

¹ Not Applicable. The harvesting of beluga whales in Nunavut is not covered by this management plan

ASSESSMENT

Stock structure

Beluga that summer in Ungava Bay, along the eastern Hudson Bay coast, and the western Hudson Bay coast have been recognized as separate stocks. Genetic analyses support the principle of an eastern and one or more western Hudson Bay and possibly James Bay beluga stocks. Genetic information from beluga whales summering in the southern Ungava Bay area is insufficient to confirm their stock identity. A genetic mixture analysis performed with 37 maternally inherited mitochondrial haplotypes distributed among 1432 belugas caught in the Hudson Bay - Hudson Strait - Baffin Island geographical complex between 1984 and 2004 validated the traditional definition of beluga stocks in this area. The array of haplotypes is unusual and very variable at Sanikiluaq, with the spring composition suggesting, as per other studies, a distinct, fluid population in the vicinity.

The genetic mixing analysis indicated that approximately 12% of beluga hunted from Sanikiluaq have EHB haplotypes. Beluga hunted in Hudson Strait villages have a high genetic diversity, confirming that several populations are hunted there. In previous assessments, it was estimated that 21% of the Hudson Strait villages harvest and 13% of the Ungava Bay harvest comprise EHB animals. When examined seasonally, the EHB contribution to the Hudson Strait hunt during the spring is lower (12%) than is the contribution of EHB animals to the hunt in fall (22%). Samples collected since 2004 showed a lower proportion of EHB animals harvested during spring and summer (6% and 9%, respectively), while fall samples comprised 17% EHB animals. DNA analyses of tissues collected during the 2004-2008 period suggest that the overall proportion of EHB animals in the harvest has declined to 9%. However, the tissue sampling program does not necessarily reflect the composition of the harvest, with some years having more tissue collections from the spring, but with a higher proportion of harvests occurring in the fall.

Abundance

Visual systematic transect aerial surveys to evaluate beluga abundance were flown in 1985, 1993, 2001, 2004 and 2008 in James Bay, EHB and Ungava Bay. Ungava Bay was not surveyed in 2004 (Table 2). The survey estimates in both James Bay and EHB have varied widely, with no discernible trend and are characterized by wide confidence intervals.

At low population numbers, detection or failure to detect groups of whales has a significant impact on the final abundance estimates. Survey conditions in 2004 also differed from the 2001 and 2008 surveys. In 2004, persistent ice may have altered the distribution of whales in the

James Bay and southern Hudson Bay area. Extensive fog resulted in the survey taking about one week longer to complete than normal, which could have resulted in the movement of significant numbers of animals between areas. Other differences include observer changes during the survey, and a lower survey altitude which may have affected whale detection. However, similar altitude comparisons in other areas, have shown that this factor does not have an important impact on the estimates. In 2008, the same observer crew was used throughout the survey and the high density stratum was surveyed twice. Even under these conditions significant differences were observed between the first (surface estimate=1,797) and second (surface estimate=657) surveys. These two surveys were averaged to produce a combined estimate of 1,265 animals. In Ungava Bay, the 2008 survey sighted other cetaceans, but did not detect any beluga whales along the transect lines. There have been 5 transect surveys in Ungava Bay since the early 1980s. No beluga whales have been detected during those surveys, which implies that there are very few beluga whales present in this area.

In James Bay, the surveys indicate that large inter-annual changes in the distribution of animals may occur. Some of these changes may be related to the challenges in completing surveys of beluga whales. Some of the changes may also be due to movement of whales between James Bay and the Ontario coast of Hudson Bay, in part due to heavy ice conditions in some years (e.g., 2004).

Table 2. Estimates of beluga abundance (N), standard error (SE), and 95% confidence intervals ([]) from aerial surveys flown in James Bay, Eastern Hudson Bay and Ungava Bay. Estimates have not been corrected for animals that are below the surface when the aircraft has passed over.

Year	James Bay	Eastern Hudson Bay	Ungava Bay
	N (SE)	N (SE)	N (SE)
1985	2,256	2,294	0
1993	3922 (781) [2645–5816]	1,314 (489) [631–2761]	0
2001	8262 (1687) [5463–12,495]	1,418 (635) [615–3339]	0
2004	3998 (1078) [2379–6721]	2045 (698) [1052–3982]	No survey
2008	9292 (5985) [2828 – 30,530]	1265 (570) [545 - 2939]	0

The number of beluga counted from the air must be adjusted to account for animals that were diving. This is done by multiplying the actual counts by a correction factor to determine the true population size. An estimate of 48% was calculated from a study using a helicopter hovering over diving animals in the St Lawrence Estuary. This resulted in multiplying the aerial survey estimates by 2.09.

Previous assessments used a density-dependent model to fit changes in population size to the corrected aerial survey estimates for eastern Hudson Bay, by adjusting initial population size and estimates of struck and loss rates. In this assessment, an exponential model, incorporating information on catches was also fitted to aerial survey estimates of abundance using Bayesian

methods. Comparison runs resulted in an estimated 1985 population of 3,900 using the old model, compared to an estimated 4,100 obtained using the new Bayesian model. In 2008, the estimated population has declined to 3,200 and 3,000 using the old and new models respectively. The Bayesian approach was chosen as a more appropriate model to provide advice. The final run produced an estimate of 4,100 animals in 1985 declining to 3,000 animals in 2008 (Fig. 2).

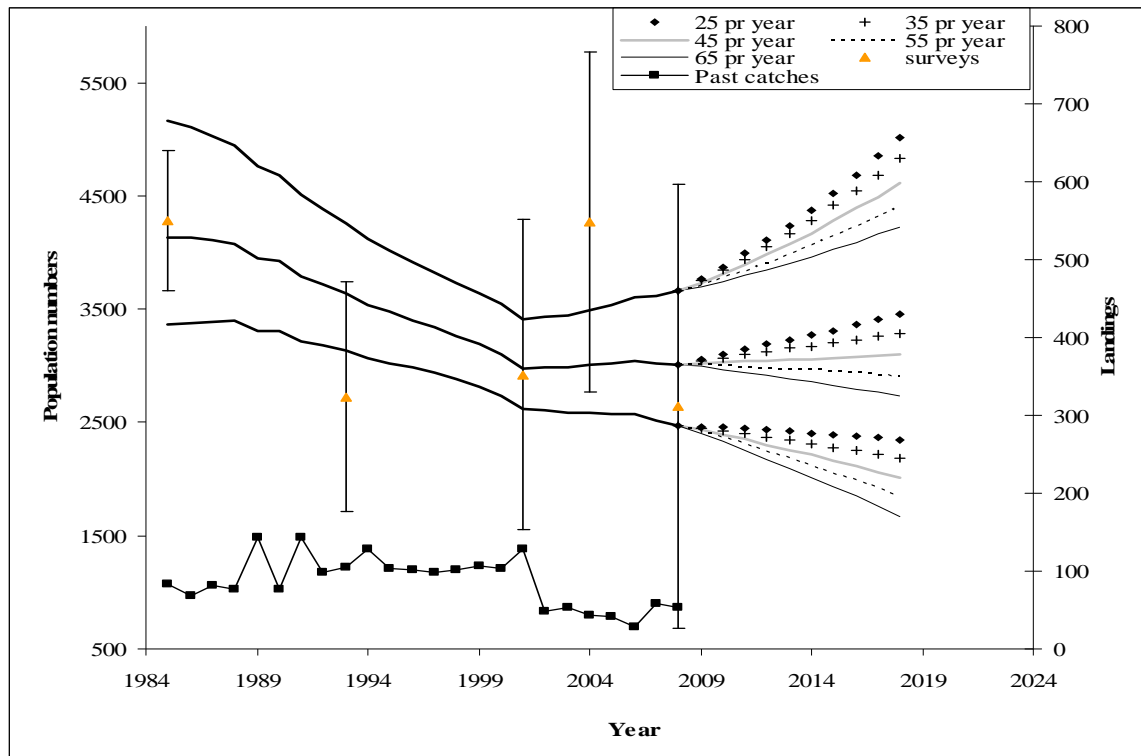


Figure 2: Eastern Hudson Bay belugas: 25%, 50% and 75% quartiles of fitted past and predicted future stock trajectories under different levels of harvest. For example at the 50% quartile, there is a 50% probability that the population is smaller than 3,100 with a harvest of 45 animals per year. The bottom line represents harvests of EHB animals (y-axis on right side). The different points represent expected trajectories under different harvest levels of EHB animals only. The points with bars represent aerial survey estimates (\pm SE).

Under the current management plan overall harvest rates have declined and the model suggests that the rate of decline in the Nunavik beluga population has also slowed or stopped. Both models indicate a maximum harvest of around 50 EHB animals per year if no decline in the population is to occur, provided that all assumptions associated with the model are correct. If the population is to increase, then harvests must be further reduced. A harvest of 50 EHB animals per year has a 50% probability that the population will decrease. A harvest of 40 animals has a 40% probability that the population will decline (Fig. 3).

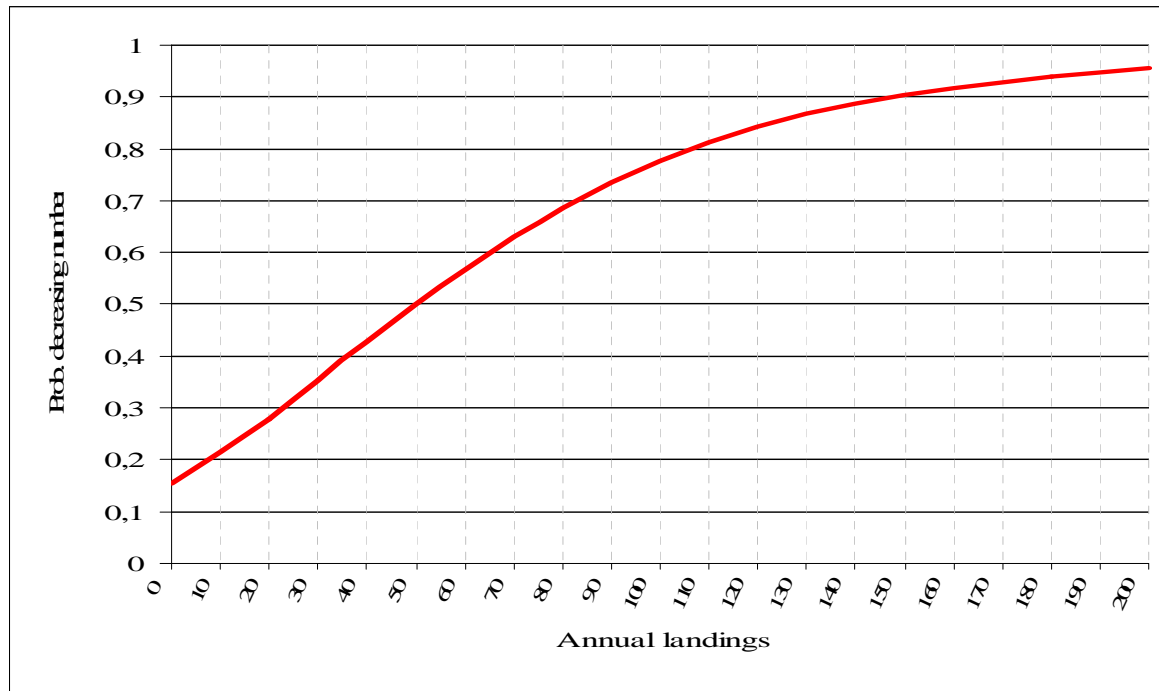


Figure 3: Eastern Hudson Bay belugas. Probability of stock decrease at different catch levels estimated by a Bayesian stock-production model assuming deterministic stock dynamics.

Sources of uncertainty

Aerial survey estimates show very high coefficients of variation (CV=35-74%), which for the most part is due to the highly clumped distribution of beluga whales. This combined with the mobility of these animals and the large area that must be surveyed, it is very difficult to repeat surveys and to obtain similar results. Thus available data on exploitation and abundance of this stock is neither unbiased nor sufficiently comprehensive to yield precise estimates.

There is a lack of data on vital rates, which limits opportunities to model the dynamics of this population. Abundance estimates for this population are limited to five aerial surveys, flown in 1985, 1993, 2001, 2004 and 2008. The 1985 strip-transect survey has been adjusted to allow for comparison with the 1993, 2001, 2004 and 2008 line-transect survey data. A correction factor, derived from research in the St. Lawrence River was applied to the aerial survey estimates to correct for animals that were diving when the survey plane passed overhead. It would be useful to conduct similar research in the Hudson and James Bay study area to establish a correction factor for this area.

Beluga harvested in the community of Sanikiluaq are of mixed origin. However, it is not possible using aerial survey techniques to determine the proportion of animals in the offshore regions that belong to the EHB population or other Hudson Bay population(s). Haplotype composition of samples from animals harvested during spring/early summer indicates that EHB animals represent about 12% of the Sanikiluaq harvest. At current harvest levels, Sanikiluaq probably removes 3–4 EHB beluga from the population annually. Satellite telemetry indicates that from mid-July to late September, a large proportion of the EHB population moves offshore near Sanikiluaq. Although current harvesting is limited to the spring or fall, and the genetic data support that few EHB animals are taken at those times, seasonal changes in harvesting practices by Sanikiluaq hunters could have an important impact on the EHB beluga population.

Communities north of the eastern Hudson Bay arc and in Hudson Strait are hunting beluga from both the small EHB population and the large western Hudson Bay population. Estimates from genetic analyses indicate that a proportion of the beluga harvested by northeastern Hudson Bay (21%) and Hudson Strait (15%) communities may be from the EHB population, but samples collected since the last assessment indicate that the proportion of EHB animals may have declined to as low as 9%. However, sampling in recent years has been dominated by samples from hunting during the spring, whereas overall harvesting occurs during both spring and fall.

Harvest statistics have been gathered since the 1970's. These statistics include a column for animals struck but not recovered. Typically this column has a value in the weekly statistic reports of 0 or 1. Modeling suggests that the struck and loss rate and under-reporting rate is probably between 40 to 80% of the reported landings. This value represents animals killed but not landed, and those landed, but not reported and errors in the classification of animals to the EHB stock.

The maximum rate of increase is not known for northern Quebec beluga. The model fitted to the survey and catch data estimated a rate of increase of 2.9% which is within the range of values accepted for beluga. However, for such a small population relative to estimated pristine levels, a rate approaching the maximum would be expected. The continued high harvests on females with calves may be having some impact on recovery, but this is highly uncertain.

ADDITIONAL STAKEHOLDER PERSPECTIVES

The Inuit in northern Quebec consider beluga whales as an important food resource. There is community concern regarding contaminants and disease agents that could affect the health of beluga or their human consumers. Other global issues of concerns include climate change and the resultant changes in sea ice, which might affect whale movements, their foods and hunter access to whales. Community consultations raised concerns about the increase in numbers of both small boats and large ships, and how increasing noise might disturb beluga, particularly in nearshore areas.

A wide range of concerns have been expressed about beluga whale abundance. Some people have difficulty understanding and accepting survey estimates, since they have seen large numbers of whales in areas where only small numbers of whales have been seen during the survey period. Several people expressed concern that they were seeing fewer animals than in the past. However, it is not clear whether changes in sightings are a result of a reduction in beluga abundance, or animals having moved elsewhere. Some communities in EHB have also expressed that there are fewer whales today than during previous years due to high harvest levels. However, other communities particularly in Hudson Strait feel very strongly that beluga are abundant.

There are differences between western science and traditional knowledge from the hunters on the calving interval for beluga whales. The hunters believe that beluga females have a calf every year, while western science suggests that female beluga whales have on average a calf every three years.

Sanikiluaq hunters have passed a bylaw stating that they will not harvest beluga whales during the summer months.

CONCLUSIONS AND ADVICE

The aerial survey estimates are relatively imprecise, but indicate a low population size. There are still a large numbers of females with calves taken in the hunt, which may further reduce the rate of growth in this population.

Increased participation in the sampling program and improvements in estimates of struck and loss are needed. The efforts put in place over the last decade have succeeded in reducing overall harvest levels and at current reported harvest levels, the population may have stabilized under the current management plan.

The advice provided is based on few surveys. A three year survey interval is recommended, but further analyses are needed to optimize this interval.

Current information indicates that a harvest of 50 EHB animals would likely allow the population to remain stable. However, harvest levels should be reduced further if the population is to be allowed to increase. Continued closure of hunting in the eastern Hudson Bay arc, and particularly at the Little Whale and Nastapoka River estuaries, is recommended.

A management strategy to encourage spring harvesting in Hudson Strait or near the Belcher Islands may reduce harvesting pressure on the EHB stock, but monitoring the harvest during both seasons is necessary, because seasonality effects will assume a greater impact on the population.

Currently the harvest in the Belcher Islands is not part of the Nunavik management plan. However, they have passed a bylaw to limit hunting to not in the summer.

The Ungava Bay summering stock is extremely small. Using the current survey design we are unable to estimate the current population size in Ungava Bay. It is recommended that no harvesting of beluga occur in Ungava Bay.

There is a need for additional information on the abundance and population structure of beluga in Ungava Bay, along the Hudson Bay coast and in James Bay. The biological sampling program aimed at understanding the population composition of the Nunavik harvest should be maintained. Sampling in James Bay is needed to better understand the stock relationships of animals in this area to beluga whale stocks elsewhere in the Hudson Bay-James Bay complex. A skin biopsy sampling program may be valuable. Efforts should be expanded to improve the documentation of harvesting and struck and loss estimates.

OTHER CONSIDERATIONS

Beluga in northern Quebec have been managed by the Department of Fisheries and Oceans under a multi-year management plan. However, with the recent signing of the Nunavik Inuit Land Claims Agreement (NILCA), management of this stock will eventually pass to the new management board to be created under the agreement.

COSEWIC has identified this population as endangered, but no decision has been made by the government of Canada pending the establishment of a consultation framework with the Nunavik management board for SARA issues.

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