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Canadian Science Advisory Secretariat
Quebec Region **Science Advisory Report 2017/015**

AN UPDATE OF BELUGA (*DELPHINATERUS LEUCAS*) ABUNDANCE AND REPORTED DEATHS IN THE ST. LAWRENCE RIVER ESTUARY

Photo: Véronique Lesage.

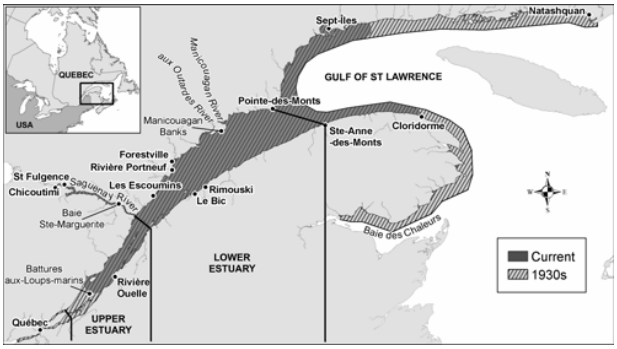

Figure 1. Current and historical (1930s) distribution of St Lawrence River Estuary beluga whale.

Context:

The St. Lawrence Estuary (SLE) beluga population is located at the southernmost limit of the species range. It occurs primarily in the SLE and seasonally in the Gulf of St. Lawrence. Local interest to protect the beluga and its habitat was a determining factor in the creation of the Saguenay-St. Lawrence Marine Park, a jointly managed provincial/national park established in 1998. SLE beluga are protected under the Species at Risk Act and a recovery plan is in place. A review of the population status (2007) concluded that the population over the period 1988-2007 was stable. However, in recent years there has been an increase in reported deaths of young-of-the-year and an apparent increase in perinatal mortalities. This increase as well as change in the age/sex structure of the deaths suggests that its status may have changed. A review in 2013 incorporated carcass monitoring and aerial survey data into a population model. The model results indicate that the population was slightly increasing from the 1960s to the early 2000s and has probably declined, to under 1000 animals during the last decade. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the population as 'endangered' in 2014, and its status is "threatened" according to the Species at Risk Act.

In 2014, new aerial surveys were flown. The Species at Risk directorate requested that these surveys be reviewed and that the number of reported deaths be updated.

SUMMARY

- The beluga is an Arctic species, and the St. Lawrence Estuary (SLE) population is at the southernmost limit of the species distribution. It occurs primarily in the SLE and seasonally in the Gulf of St. Lawrence. Its current range is about 65% of the extent used historically, whereas the size of its annual core distribution is at the lower limit of areas of occupancy described for any population of this species.
- The SLE population of beluga is listed as Threatened under the Canadian Species at Risk Act (SARA) since 2005, and was designated Endangered by the Committee on the Status of

Endangered Wildlife in Canada (COSEWIC) in 2014. Their Critical Habitat has been identified, and corresponds to the summer area occupied by females accompanied by calves and juveniles.

- Eight visual line-transect surveys were flown during August and September 2014 to estimate beluga abundance in the SLE. Surface abundance indices varied from 400 to 1,169 between surveys, with a mean estimate of 738 animals.
- Adjusting the surface abundance indices for animals below the surface while the plane passed overhead (re. availability bias) and adding counts in the Saguenay River resulted in population abundance index estimates of 885 to 2,463, with a mean estimate of 1,574 (95% CI: 1,189 – 2,021) beluga in 2014.
- The 2014 abundance index is the second highest in the time series of visual surveys flown since 2001, but a regression analysis using 36 visual estimates from 2001 to 2014 did not show a significant trend.
- Data from a carcass monitoring program indicate year-to-year variation, but no trend in the number of adult beluga carcasses (male and female) reported over the period 1983 to 2014 with a median of 15 whales annually. Since the last population review, the total number of carcasses reported was near this median in 2013 and 2014 with 17 and 11, respectively. The number of reported newborn calves deaths have increased since 2008, and continues to be higher than the 0 to 3 carcasses per year (median = 1) reported between 1983 and 2007. In 2013 and 2014, a total of 5 and 6 newborn calf carcasses, respectively, were found in the SLE.
- The population model represents the most reliable tool for evaluating the trend of the SLE beluga population. The model requires comparable survey estimates of abundance, information on the number, sex and age composition of beluga carcasses recovered, and data on the proportion of calves in the population obtained from photographic surveys. Different correction factors for perception and availability bias have to be applied to photographic and visual survey abundance indices to make them comparable. Until these are developed, it is not possible to use these as comparable indices in the population model. Therefore, the review completed in 2013, which used the photographic survey time series, remains the most recent and complete status evaluation for this population.

INTRODUCTION

The St. Lawrence Estuary (SLE) beluga, *Delphinapterus leucas*, is a relict Arctic population genetically distinct from all other Canadian beluga populations. Along with the Eastern Hudson Bay beluga, the SLE beluga have the lowest genetic diversity of mtDNA and microsatellite alleles within Canadian beluga populations. SLE beluga is the most southerly of the beluga populations. Their current range is about 65% of that used in the 1930's (Figure 1), whereas their annual core distribution is at the lower limit of areas of occupancy described for any population of this species. Severely depleted by intensive hunting, this beluga population was protected from hunting in 1979. At that time, the population was estimated to number in the low hundreds. An apparent failure of the population to recover after hunting was prohibited was ascribed to the presence of high levels of various persistent contaminants in beluga and their environment. A carcass monitoring program investigating causes of mortality initiated in the 1980s, highlighted the plight of the SLE beluga. Concern over its future was a determining factor leading to various research efforts, contaminant reduction measures through the St. Lawrence

Action Plan, and the establishment, in 1998, of the Saguenay-St. Lawrence Marine Park, jointly managed by the federal and provincial governments.

The status of this population was last examined in 2013 (DFO 2014). The assessment indicated that the population had increased slightly from a low of around 900 in the 1960s to around 1000 in the early 2000s, then declined to around 900 animals in 2012.

The SLE population of beluga was amended as threatened under the Canadian Species at Risk Act (SARA) in 2005. It was re-assessed by COSEWIC as 'Endangered' in 2014. Critical Habitat has been identified, and corresponds to the summer area occupied by females accompanied by calves and juveniles.

Species Biology

Belugas have a circumpolar distribution. They are medium-sized toothed whales with an adult length of 350 cm and can weigh up to 1900 kg. Beluga lack a dorsal fin, which is believed to be an adaptation to inhabiting ice covered waters. Mating is thought to occur during winter or early spring. Calves are born after a 14 month gestation, and are weaned after roughly 18 months. Beluga calves spend 2-3 years with their mother, during which time, they perform several seasonal migrations. It has been suggested that this extended parent-offspring association could provide the opportunity for learning migration routes. The calving interval is generally 3 years. At birth, the calves are brown in colour. The skin becomes lighter in colour as they mature, gradually turning to grey and then to white. Sexual maturity might fall between 8 and 14 years of age, and longevity may be 60 years and more.

Across their entire range, belugas are known to visit estuaries and river mouths during summer, which has led to the view that they are a shallow water species. However, satellite telemetry and aerial survey data have shown that beluga can undertake regular trips to and from estuaries, sometimes hundreds of kilometres away, over the course of the summer.

The core distribution of the SLE beluga population is centered on the confluence with the Saguenay River, and currently extends from the Battures-aux-Loups-Marins to Rivière-Portneuf / Rimouski in the Estuary, to Baie-Ste-Marguerite in the Saguenay River (Figure 1). The SLE is thought to be favorable to the beluga's continued presence as a result of an upwelling of cold, mineral-rich waters, high productivity and sea ice coverage. The oceanographic processes responsible for these conditions are deemed crucial to the survival and recovery of this population.

ASSESSMENT

Systematic line-transect surveys covered two strata in the SLE with a spacing of 7.4 km (4 NM). The upstream stratum in the SLE covered the recognised summering range of belugas, centered at the confluence and included the Saguenay River (Figure 2). In addition, beluga in the Saguenay fjord were counted using two passes from Tadoussac to Saint-Fulgence. The downstream stratum covered the area from Rimouski to Pointe-des-Monts.

There were ten surveys, each lasting one day. Eight days were used to survey the upstream stratum and two days were used to cover the downstream stratum. Surveys completed on different days were considered as replicate indices to estimate density and abundance in each stratum. The number and size of beluga groups were recorded and the data were analysed using line-transect methods.

An average of 105 groups (255 individuals) was detected during the eight visual surveys of the upstream stratum with counts ranging from 53 to 153 groups (145 to 389 individuals). No beluga were detected during the two surveys covering the downstream stratum.

For line-transect analyses, the distribution of the sightings distance relative to the plane track line is used to estimate the reduction in probability of detection with increasing perpendicular distance from the aircraft trajectory. This information is used to estimate the density. This detection function can include covariates that affect sightability (observers, Beaufort sea state, sun glare intensity, percentage of cloud cover, water color and subjective visibility). It allows the detection model to include the sighting conditions in the estimation of density and abundance. The abundance estimates were variable from day to day mainly because belugas tend to be clumped together. The number of groups detected per line (encounter rate) was the main contributor to the variance in density and abundance, contributing on average 72.1% (CV = 0.15) to the daily variance (Table 1).

The Saguenay was surveyed on the same day as the upstream stratum with the same plane and the same set of observers after or before the systematic survey of the SLE was completed. The total number of beluga counted ranged from 0 to 49 (Table 1), which represented up to 5% of the estimated abundance index corrected for availability (i.e. animals underwater while the plane passed overhead).

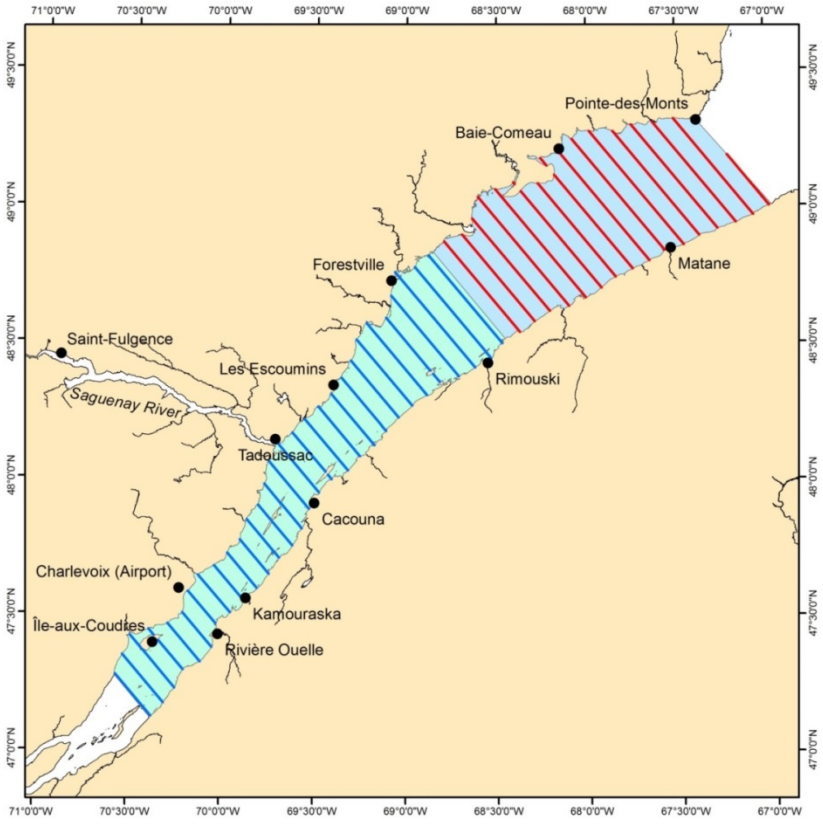

Figure 2. An example of the systematic survey design with random placement. Eight line-transect surveys were flown in the upstream stratum (blue lines) and two line-transect surveys were conducted in the downstream stratum (red lines). The figure only shows one set of lines for each stratum, but the number of lines varied from 28 to 29 in the upstream stratum. There were 16 lines in both downstream surveys.

Table 1. Density and abundance indices of St Lawrence belugas for eight line-transect surveys of the main summering areas in 2014. Coefficient of variation is shown in parenthesis.

Date	Effective strip width (m)	Estimated group size	Encounter rate (groups/km)	Density index in the Estuary (Ind./km^2)	Surface abundance index in Estuary	Saguenay count	Abundance index	95% CI
19 Aug	1,077 (0.08)	2.27 (0.09)	0.1247 (0.25)	0.1314 (0.28)	758	n/a	1,586 (0.31)	869-2,895
20 Aug	1,219 (0.06)	2.55 (0.07)	0.1937 (0.18)	0.2027 (0.20)	1,169	17	2,463 (0.24)	1,539-3,943
21 Aug	1,163 (0.11)	2.78 (0.18)	0.0581 (0.36)	0.0694 (0.41)	400	48	885 (0.41)	398-1,966
24 Aug	1,023 (0.10)	2.26 (0.09)	0.0874 (0.39)	0.0964 (0.41)	556	38	1,202 (0.42)	527-2,744
29 Aug	1,183 (0.08)	2.22 (0.07)	0.1860 (0.38)	0.1748 (0.40)	1,009	26	2,136 (0.41)	948-4,810
3 Sep	1,377 (0.09)	2.44 (0.16)	0.0800 (0.34)	0.0785 (0.39)	409	49	904 (0.39)	423-1,932
8 Sep	1,343 (0.07)	2.41 (0.08)	0.1574 (0.24)	0.1410 (0.26)	813	22	1,724 (0.29)	974-3,052
10 Sep	1,301 (0.08)	2.51 (0.10)	0.1448 (0.46)	0.1396 (0.48)	805	0	1,685 (0.50)	651-4,360
2014					738	29	1,574 (0.13)	1,189-2,021

Population indices

Although the 2014 abundance index is the second highest in the time series of surveys flown since 2001, a regression analysis using 36 visual estimates from 2001 to 2014 did not show a significant trend (adjusted $R^2 = 0.06$; the slope was not significantly different from zero, $p = 0.08$, df = 34; Table 2; Figure 3).

Table 2. Aerial survey abundance indices of SLE beluga including both photographic strip-transect and visual line-transect surveys. The corrected abundance indices account for animals not at the surface when the plane flew over.

Year	Method	Number of surveys	Surface abundance index in Estuary	Saguenay count	Corrected abundance index (cv)	95% CI
1988	Photo	1	417	22	893 (0.20)	751-1,062
1990	Photo	1	527	28	1,129 (0.50)	446-2,860
1992	Photo	1	454	3	952 (0.16)	702-1,291
1995	Photo	1	568	52	1,239 (0.18)	881-1,742
1997	Photo	1	575	20	1,222 (0.16)	903-1,654
2000	Photo	1	453	6	953 (0.14)	724-1,254
2001	Visual	1	529	15	1,122 (0.28)	555-1,675
2003	Photo	1	630	2	1,319 (0.20)	896-1,942
2003	Visual	5	658	7	1,378 (0.14)	1,039-1,828
2005	Visual	14	492	39	1,068 (0.09)	891-1280
2007	Visual	1	822	29	1,746 (0.23)	1,047-2,583
2008	Visual	1	502	11	1,053 (0.26)	636-1,744
2009	Photo	1	319	10	676 (0.16)	499-915
2009	Visual	6	460	17	979 (0.14)	750-1,277
2014	Visual	8	738	29	1,574 (0.13)	1,189-2,021

There are two time series of SLE beluga abundance. One index is based on photographic surveys, and the second is based on visual surveys. Photographic surveys use a different methodology than visual surveys and should have different correction factors for animals that are missed. Therefore, they cannot be pooled together to estimate trends in abundance over time until these correction factors are known. Six of the seven surveys flown between 1988 and

2001 were flown following the photographic survey method (Table 2). Photographic surveys provide information on the proportion of young of 0 to 1 year old in the population, as well as a permanent snapshot of animals at the surface when the survey aircraft flies overhead. Over the period 2001-2014, six of the eight surveys were visual surveys. Visual surveys are less expensive to complete, and can be repeated several times to obtain multiple estimates of abundance within a single year, but do not provide information on population age- or size-structure. Currently, the comparability between the two different time series is not known.

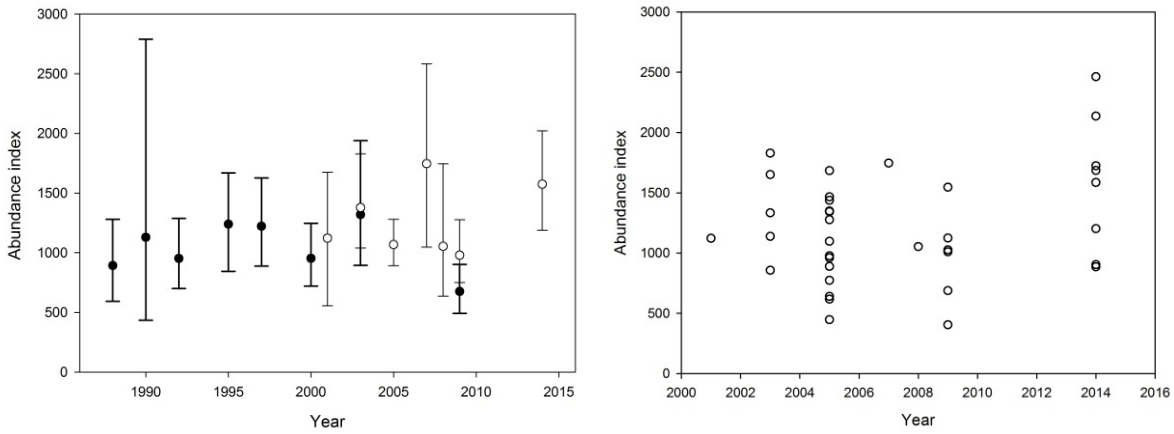

Figure 3. Abundance indices of St Lawrence Estuary beluga from eight photographic surveys (close circles) and from the yearly average of 36 visual line-transect surveys (open circles) from 1988 to 2014 (left panel). The visual line-transect survey abundance indices were averaged from several surveys in some years (n = 5 in 2003, n = 14 in 2005, n = 6 in 2009 and n = 8 in 2014). Right panel: Abundance indices of the 36 visual line-transect surveys corrected for availability in the Estuary (factor 2.09) and adding the Saguenay count from 2001 to 2014. A linear regression showed a poor fit (adjusted R^2 = 0.06) and the slope was not significantly different from zero (p = 0.08, df = 34).

Reported mortalities

The number of beluga reported dead is another source of information that is integrated into the population model. Data from a carcass monitoring program indicate year-to-year variation, but no trend in the number of adult beluga carcasses (male and female) reported over the period 1983 - 2014 with a median of 15 whales annually (Figure 4). Since the last status review, the total number of adult carcasses reported in 2013 and 2014 were near this median with 17 and 11, respectively. Higher numbers of new born calves have been reported dead since 2008. The number of new born death reports varied annually from 0 to 3 until 2007 with a median of 1, but much higher numbers were recorded in 2008, 2010, and 2012 with 8, 8 and 16 carcasses respectively. The number of newborn carcasses reported were lower in 2011 (n=4), 2013 (n=5) and 2014 (n=6), although these numbers remain above the long-term median.

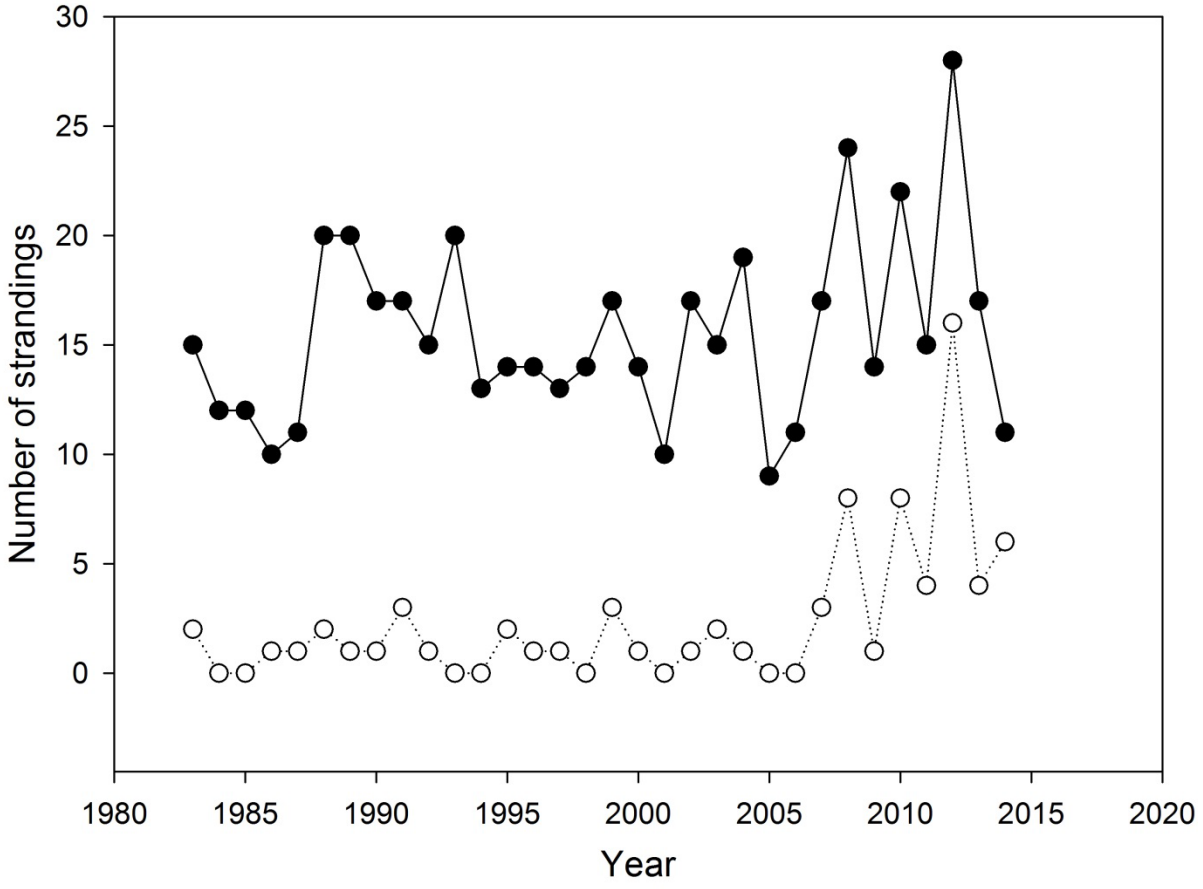

Figure 4. Total number of reported dead beluga (solid dots) and the number of reported dead newborn calves (open dots) in the Estuary and Gulf of St. Lawrence from 1983 to 2014. The overall average is 15.5 for total number, and 2.3 for new born calves.

Sources of Uncertainty

Bias during surveys arises from two main sources: not all animals are detected by observers or on photographs (perception bias) and some animals are submerged and not available (availability bias). Our visual estimates were not corrected for perception bias and consequently our final estimates will underestimate abundance by 2% to 8% compared to previous photographic surveys if only this bias is considered. The availability bias is also a large source of uncertainty for the visual survey estimates. The availability correction factor applied was developed for photographic surveys. A proper availability correction for visual survey considering that any point at the surface of the water is observed for a certain amount of time will likely not increase the surface abundance indices as much as the photographic correction that assumes instantaneous observation. But availability bias can change with the behaviour and distribution of the animals within the SLE and more analyses of movements and diving behaviour will be required.

Visual and photographic aerial surveys are exposed to different levels of perception and availability bias. Improvements in our understanding of these two sources of bias associated with each technique are needed before estimates from the photographic and visual survey time series can be combined.

Another source of uncertainty associated with the estimation of abundance of SLE beluga, is uncertainty about the distribution of belugas outside of their summer range and potential for not counting a portion of the population. Information on seasonal distribution and migration and concurrent surveys outside of the recognised summer range when abundance surveys are conducted are required to estimate this potential bias.

CONCLUSIONS AND ADVICE

The 2014 abundance index is the second highest in the time series of surveys flown using the same methodology since 2001, but a regression analysis using 36 visual estimates from 2001 to 2014 did not show a significant trend.

Our ability to detect a trend in the SLE beluga population would be improved with increased precision of the abundance estimates. The variance observed for each survey and between surveys is believed to be associated with changes in distribution of beluga within or outside of their summer range and surveyed area. Therefore, a better understanding of animal movements is needed to improve the precision of the abundance estimates.

The population model represents the most reliable tool to estimate the trend of SLE beluga. The population model integrates abundance indices, data on the proportion calves in the population obtained from photographic surveys, and mortality data from a carcass recovery program. The 2014 surveys only used visual methods, which provide information on abundance, but do not provide a reliable index for the proportion of calves in the population. The 2014 visual surveys do not provide abundance indices that are comparable to the photographic abundance indices due to different correction factors required for both methods for perception and availability biases. The visual surveys do not provide an update of the proportion of 0 and 1 year old in the population like the photographic surveys. A photographic survey or specific correction factors for visual abundance estimates and a new estimate of proportion of calves are required to update the model and the status of the population.

SOURCES OF INFORMATION

This Science Advisory Report is from the October 20-23, 2015 Annual Meeting of the National Marine Mammal Peer Review Committee (NMMPRC). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

DFO. 2014. Status of beluga (*Delphinapterus leucas*) in the St. Lawrence River estuary. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/076.

Gosselin, J.-F., Hammill, M.O., Mosnier, A. and Lesage, V. 2017. Abundance index of St. Lawrence Estuary beluga, *Delphinapterus leucas*, from aerial visual surveys flown in August 2014 and an update on reported deaths. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/019. v + 29 p.

Mosnier, A, T. Doniol-Valcroze, J.-F. Gosselin, V. Lesage, L.N. Measures and M.O. Hammill. 2015. Insights into processes of population decline using an integrated population model: the case of the St. Lawrence Estuary beluga (*Delphinapterus leucas*). Ecol. Model. 314:15-31.

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