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**Documentation of Maritime Traffic and Navigational Interactions with
St. Lawrence Estuary Beluga (*Delphinaterus leucas*) in Calving Areas Between
2003 and 2012**

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

Anthropogenic disturbance resulting from navigation is considered a current threat to the recovery of the St. Lawrence Estuary (SLE) beluga population, in addition to contaminants, changes in abundance and type of prey as well as habitat degradation (DFO 2012). Many hypotheses, including anthropogenic disturbance, were proposed in attempts to explain the increase in number of calf carcasses found in 2010 and 2012, as well as in female mortalities due to dystocia (Lair et al. 2014). The principal concern regarding maritime activities for the beluga population stems from the fact that these activities peak in July and August during the period of beluga calving and caring for newborns. Furthermore, areas of high residency of belugas are easily accessible by boats of all types in this coastal region. Various data bases and information were brought together to document maritime traffic and navigational interactions with beluga from 2003 to 2012. Although the information collected was not specifically designed to address whether anthropogenic disturbance from navigation could be a risk factor for calving females and newborn calves, we documented an increase in some types of navigational activities in specific portions of the critical habitat of the population over the past decade. The high number of calf mortalities reported in 2010 and 2012 coincide with peaks in recreational boating activity in Tadoussac marina, higher co-occurrences between belugas and boats in the Saguenay Fjord, and good weather conditions in the critical habitat during July and August. These results suggest that anthropogenic disturbance may have played a role in the increase in mortalities reported for those years. These results indicate a need to address anthropogenic disturbance in a strategic manner by focusing on specific areas at critical times for calving females and newborn.

Documentation du trafic maritime et des interactions entre la navigation et le béluga de l'estuaire du Saint-Laurent (*Delphinaterus leucas*) dans les aires de mise bas entre 2003 et 2012

RÉSUMÉ

Le dérangement anthropique résultant de la navigation est considéré comme étant une menace courante au rétablissement de la population de béluga de l'estuaire du Saint-Laurent (ESL), en plus des contaminants, de changement dans l'abondance et du type de proies, ainsi que d'autres dégradations de son habitat (DFO 2012). Plusieurs hypothèses, incluant le dérangement anthropique, furent proposées pour tenter d'expliquer la hausse du nombre de carcasses de veaux retrouvées en 2010 et 2012, de même que l'accroissement récent de mortalité de femelles à la suite d'une dystocie (Lair et al. 2014). La principale préoccupation pour la population de béluga à l'égard des activités maritimes vient du fait que ces activités se pratiquent principalement en juillet et août, durant la période de mise bas et de soin des nouveau-nés. De plus, dans cette région côtière les aires de haute résidence du béluga sont faciles d'accès par divers types d'embarcations. Afin de documenter le trafic maritime et les interactions entre les activités de navigation et les bélugas, diverses bases de données et sources d'informations furent rassemblées pour la période de 2003 à 2012. Malgré que ces données et informations n'étaient pas spécifiquement destinées à évaluer si le dérangement anthropique pouvait comporter un facteur de risque pour les femelles lors de la mise bas et du soin des nouveau-nés, il a été possible de documenter une hausse de certains types d'activités de navigation dans des lieux précis de l'habitat essentiel du béluga au cours de la dernière décennie. En 2010 et 2012, alors que des mortalités élevées de veaux ont été rapportés, ces deux années coïncident avec des pics de fréquentation de plaisanciers à la marina de Tadoussac, une hausse des cooccurrences entre les bateaux et les bélugas dans le Fjord du Saguenay ainsi que de bonnes conditions météorologiques en juillet et août. Ces résultats suggérant que le dérangement anthropique pourrait avoir joué un rôle dans la hausse des mortalités rapportées pour ces années. Les résultats de cette étude démontrent le besoin d'agir de manière stratégique pour réduire le dérangement anthropique en ciblant des endroits précis à des moments critiques pour la mise bas et le soin des nouveau-nés.

1. INTRODUCTION

The plight of the St. Lawrence Estuary (SLE) beluga population has been an important conservation issue in Quebec for the past decades. Protected from hunting in 1979, willingness to recover the population was an impetus to conservation and protection actions, namely the reduction in contaminant emissions in the St. Lawrence and the Saguenay Fjord ecosystems and the establishment of the Saguenay-St. Lawrence Marine Park in 1998 (Ménard et al. 2007). The SLE beluga population has failed to show signs of recovery (Gosselin et al. 2007a; Hammill et al. 2007; Mosnier et al. 2014) and is listed as *Threatened* under the *Canadian Species at Risk Act* (SARA). The critical habitat has been defined in the recovery strategy of the population as the area occupied by females accompanied by calves and juveniles in summer (DFO 2012).

Hammill et al. (2007) hypothesized that the lack of recovery of the population could be due to problems in recruitment, possibly stemming from high rates of juvenile mortality. In recent years, the increase in calf mortality and in female mortality during the birth process (Lesage et al. 2014a; Lair et al. 2014) has highlighted a problem for the SLE beluga related to calving and survival of newborns. The number of beluga calf carcasses found between July and October 2012 attained an unprecedented level of 16 since the onset of the carcass collection program in 1982. The number of calf carcasses found in 2012 was double that in the preceding peak years of 2008 and 2010 when 8 carcasses had been found each year. In August 2012, during the presumed peak calving period for SLE beluga, when numbers of calf carcasses found were increasing and a few females were reported carrying dead calves, the Quebec Marine Mammal Emergency Response Network (RQUMM) convened a group of specialists to discuss possible causes and potential action plans. The group raised the question as to whether the mortalities observed in 2012 were an unusual mortality event, as occurred in August 2008 due to a toxic algal bloom of *Alexandrium tamarense*, or if the mortalities were due to changes occurring in the ecosystem for which effects were just beginning to be observed. Among the many hypotheses for the observed mortalities put forward by the specialist group, the effects of anthropogenic disturbance on females during calving and on females caring for newborns were investigated.

Anthropogenic disturbance resulting from navigation is considered a current threat to the SLE beluga population, along with contaminants, reduced availability and quality of prey as well as habitat degradation (DFO 2012). Anthropogenic disturbances are, however, localized and seasonal. Navigation in the SLE is more intensive between May and October, with 52,000 boat trips of all types estimated in 2007 for the Marine Park alone (Chion et al. 2009). The effects of anthropogenic disturbance discussed in the SLE beluga recovery strategy involve disruption of vital activities (e.g., hunting, feeding, communication and socializing, mating and rearing calves), collisions with boats, and excessive noise affecting the quality of the critical habitat. Although any form of boat or ship traffic can affect belugas in various ways (DFO 2012), the greater maneuverability and speed of smaller craft can potentially create additional problems (Lesage et al. 1999).

Navigational activities related to tourism in the beluga summer habitat have increased since the mid-1980's, as a result of marina development and a rapidly growing whale-watching industry. Areas of high residency of belugas are easily accessible by motorized and non-motorized boats in this coastal region well serviced by maritime infrastructures (ports, marinas and boating ramps). In the 1990's, new activities appeared such as use of personal watercraft, kayaks and speedboats. Today, the various forms of navigational activities have become an important economic motor and leisure for coastal communities along the SLE and the Saguenay Fjord.

Studies examining the potential effects of disturbance resulting from navigational activities on the SLE beluga have investigated short-term behavioral response (Blane and Jackson 1994),

habitat use in high-traffic areas (Pippard 1985; Caron and Sergeant 1988; Chadenet 1997; Busque 2006; Conversano 2013) and the effects of navigation-generated noise (Lesage 1993; Lesage et al. 1999; McQuinn et al. 2011; Gervaise et al. 2012). The development of the marina in the bay of Tadoussac is suspected to have contributed to the abandonment of this site by the beluga (Pippard, 1985). Contrary to Caron and Sergeant (1988), Conversano (2013) showed that the occurrence and total numbers of beluga at the mouth of the Saguenay River, which is considered to be the area with the most intensive maritime traffic in the Saguenay-St. Lawrence Marine Park, did not vary with the number of boats and ships (Chion et al. 2009). However, a significant negative correlation between the number of boats (all types) present and the percentage of young of the year observed in beluga groups was found (Conversano 2013). Possible explanations for this result is that females with calves may extend their diving duration in the presence of a high number of boats and ships, resulting in a decreased observation rate, or that females avoid the area during high traffic periods (Conversano 2013). Also, Martin (2012) reported a significant decrease since 2008 in the presence of calves in Baie Saint-Marguerite, an area of high residency used by females and calves located in the Saguenay Fjord.

These studies, however, did not determine the biological cost of anthropogenic disturbance resulting from navigation on reproduction or survival of beluga. Of SLE beluga carcasses examined, 4% died of ship/boat collisions (Lair et al. 2014). No data are available to evaluate the possible effects of disturbance from maritime traffic or interactions between animals and vessels on calving and calf care in this population. The principal concern regarding calving and care of newborn beluga is due to the fact that navigational activity in the SLE, especially related to tourism (ex: whale watching, sea kayaking, recreational boating) peaks in July and August, which corresponds to the peak calving period of SLE beluga (Michaud 1993; Lemieux-Lefebvre et al. 2012). For example, between May and October 2006, the number of recreational boating trips was estimated to 9277, 77% of which were undertaken in July and August (Gosselin et al. 2007b; SOM 2007; Chion et al. 2009).

In domestic mammals, the effects of disturbance during parturition are widely documented (Lair et al. 2014). For example, disturbance of dairy cows while giving birth increases risks of prolonged calving, dystocia and stillbirth (Mee 2008 and references therein.). Prolonged calving may also weaken females and calves (Stéphane Lair, Université de Montréal, pers. comm.). In addition to an increase in beluga calf carcasses found in recent years, increases in females dying of dystocia (during the birth process) and post-partum complications are reported since 2010 (Lair et al. 2014). The risk of separating calf-female pairs could also be increased by disturbance, especially if the calf and or female are weak or ill (Stéphane Lair, pers. comm.; Robert Patenaude, former veterinary at the Jardin Zoologique de Québec, pers. comm.).

The present study explores the potential significance of anthropogenic disturbance caused by maritime traffic in the critical habitat of the SLE beluga, corresponding to the summer distribution of groups of adults with newborn calves and juveniles (DFO 2012) (Figure 1). Available data is fragmentary yet permits documenting maritime traffic and navigational interactions in the area used by groups of adults and new-born calves and juveniles between 2003 and 2012. An increase in maritime traffic is considered to increase the probability of interactions with belugas. Reported interactions between boats/ships and beluga in specific areas used by groups of adults and young during the summers of 2010 and 2012, when high calf mortalities are unexplained, are also presented. Particular attention is brought to areas of high residency where newborn calves have been observed in groups of belugas and navigational activities are known to occur frequently in July and August, since repetitive and prolonged events of close-up observation and harassment could potentially harm females attempting to give birth or care for less mobile newborn calves.

2. METHODS

2.1 STUDY AREA

The study area (Figure 1) covers a portion of the critical habitat of the SLE beluga defined in the recovery strategy (DFO 2012). Most of the information available on maritime traffic covers the upper SLE downstream of Cap-à-l'Aigle and Kamouraska, the north shore of the lower SLE, the mouth of the Saguenay River and the Saguenay Fjord. This area is largely comprised within the Saguenay-St. Lawrence Marine Park, which covers 37% of the critical habitat. This region is used by various boats and ships, especially between May and October (Chion et al. 2009).

The locations of carcasses found during the 2012 season between May and October were mapped to visualize whether there was a specific spatial pattern in their distribution (Figure 1). As is usually the case, most carcasses were found on the south shore of the SLE because of prevailing currents.

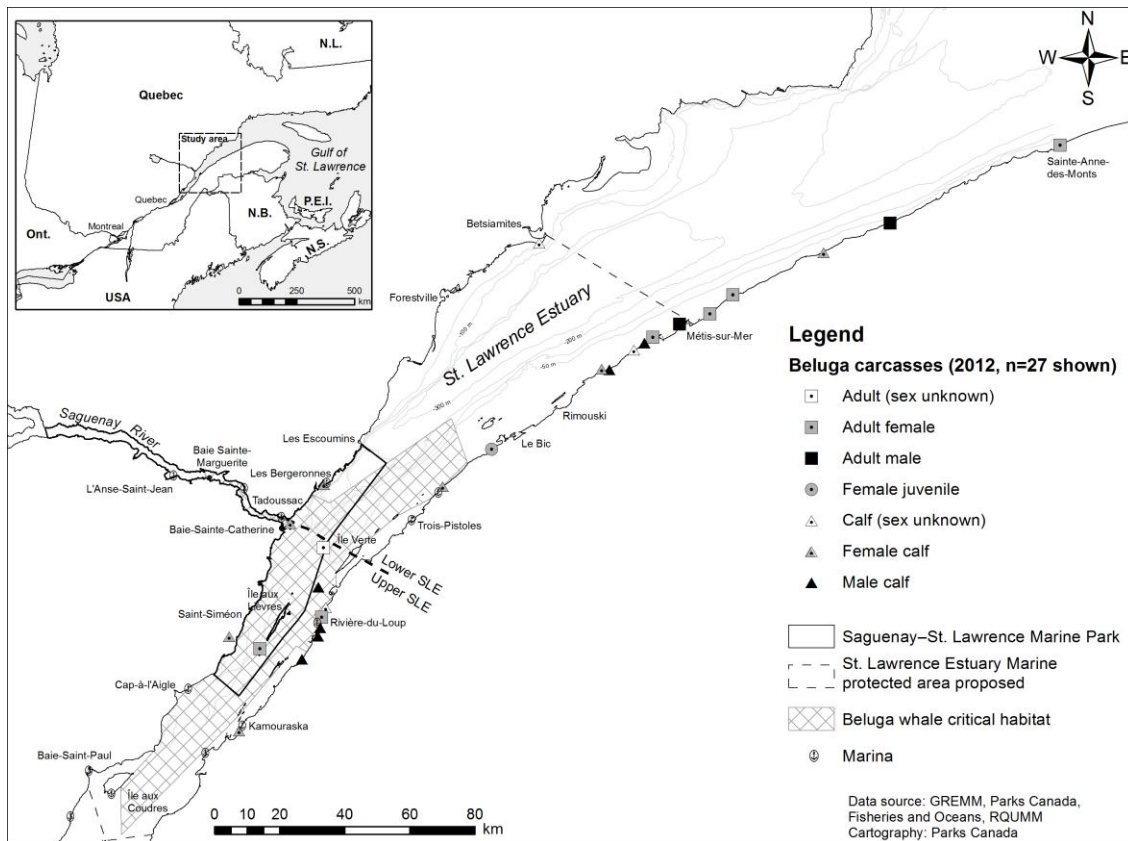


Figure 1. Study area in the St. Lawrence Estuary, covered by a portion of the critical habitat of SLE beluga (DFO 2012). Beluga carcasses found in 2012 (27 of 28 carcasses found) are shown by age and sex group.

2.2 DATA MINING

Documentation of both maritime traffic in the SLE and of navigational activities with beluga was initiated through an inventory of potential data bases and other sources conducted in winter 2013. The objectives were to document navigational activities, co-occurrences and interactions of beluga with boats and ships and to compile reported incidents or regulatory infractions pertaining to boaters with regards to beluga protection measures. Some data were readily available in Parks Canada's database for studies undertaken in the Marine Park. For other data,

individuals or groups with potentially useful data were contacted personally and were informed of project objectives as well as provided a short project summary. Contacted stakeholders were generally interested in beluga and were willing to collaborate. Only data available in an electronic format and collected in a systematic manner between 2003 and 2012 were retained in the present study (Table 1). The number of excursions per year is the only data type retained that is estimated periodically (1993, 1999 and 2007). Data description and sources are listed in Table 1.

Data were compiled and analyzed using simple statistics, mapping and descriptive methods. Analysis was restricted to a 10-year period because we were interested in documenting recent changes in potential sources of anthropogenic disturbances caused by navigation in the beluga critical habitat, especially with regards to the change in numbers of beluga calf carcasses found since 2008. Some data sets were pooled in two time periods (2003-2007 and 2008-2012) to compare the situation before and after 2008. Given the small sample size of some types of data, these had to be pooled in 5-year periods to increase sample size.

The documentation of maritime traffic took into account the three following variables: i) yearly commercial shipping traffic estimated through the number of assignments of pilots; ii) the estimated number of whale-watching excursions available for certain years and iii) yearly recreational boating activity as indicated by available marina statistics. Marina managers were contacted personally by phone but were generally not available in the winter. Many marinas did not have a systematic method of compiling data on visits (number of boat-nights per season) over the period of interest. Tadoussac, Rivière-du-Loup and Cap-à l'Aigle marinas had the most complete data series for 2003 to 2012. For Tadoussac, marina management changed in 2009, resulting in possible changes in the method of compilation. For this marina, data is presented for the periods 2003-2008 and 2009-2012. As for the ferry services operating in the study area, ferry data were not included to document maritime traffic since ferry services are relatively constant and have not changed significantly between 2003 and 2012. The only notable changes for the last few years are that three boats have been operating instead of two in Tadoussac during peak tourist period (June to September) and the Trois-Pistoles–Les Escoumins ferry service was interrupted between 2005 and 2008 for dock repairs.

The documentation of navigational interactions with belugas took into account the three following variables: i) the percentage of whale-watching activities targeting beluga obtained through the monitoring of observation activities at sea; ii) the number of boats around visually tracked beluga herds, and iii) reported infractions towards beluga regarding boats, at Baie Sainte-Marguerite in the Saguenay Fjord. The methods used to collect and analyze each of these data types are presented in the following sections.

Table 1. Data bases and sources related to maritime traffic and navigational interactions with beluga in the St-Lawrence Estuary used in the present study.

Data types	Description	Source	Availability
Data on maritime traffic			
Commercial shipping activity estimated by the number of trips assigned to pilots	Number of yearly assignments between Les Escoumins and Quebec used as an indicator of commercial shipping traffic	Laurentian Piloting Authority	2003-2012
Commercial whale-watching excursions undertaken in the Saguenay-St. Lawrence Marine Park	Estimates of the total number of excursions per year aboard small and large boats	GREMM 1993; Canadians Coast Guard Marine communications and Traffic Services in Les Escoumins, 1999 ; Chion et al. 2009	1993, 1999, 2007
Recreational-boating activity	Number of annual members and number of visitors per year at various marinas	Marina docking statistics obtained through marina managers of Tadoussac, Rivière-du-Loup and Cap-à-l'Aigle	2003-2012; unavailable for 2005 and 2007 at Tadoussac and 2003 at Rivière-du-Loup
Data on navigational interactions with beluga			
Percentage of whale-watching excursions targeting beluga obtained through monitoring of activities at sea in the Saguenay- St. Lawrence Marine Park and surrounding waters	Position, time and activities of whale-watching boats, % of excursions targeting various species of whales, and number of boats in a radius of 400 m and 2000 m of beluga	GREMM, Parks Canada and DFO	2003-2012
Number of boats in the vicinity of beluga obtained through visual tracking of herds (social organization study)	Number of boats within a radius of 2000 m of beluga	GREMM	2003-2012
Infractions towards beluga regarding boats at Baie Sainte-Marguerite	Number of infractions (boats within 400 m of belugas), interactions or harassment events observed by park naturalists	Parcs Québec	2003-2012

2.3 MONITORING OF OBSERVATION ACTIVITIES AT SEA

In 1985, the Group for Research and Education on Marine Mammals (GREMM, Tadoussac, Quebec) initiated sampling of observation activities at sea onboard whale-watching boats in the area that became the Saguenay-St. Lawrence Marine Park. As of 1994, a more systematic and detailed method was implemented in collaboration with Parks Canada. Data were collected by trained observers aboard commercial whale-watching boats operating out of 6 ports giving access to in the Saguenay-St. Lawrence Marine Park and surrounding waters. Boats departing from Tadoussac, Bergeronnes and Les Escoumins operate mainly in the lower SLE whereas boats departing from Kamouraska operate solely in the upper SLE. Boats departing from Rivière-du-Loup and St-Siméon use both portions of the estuary.

Instantaneous observations were done at 10-minute intervals throughout the monitored excursion. The number of boats per type as well as the number and species of marine mammals present within a 2000 m radius were noted. Time, position, and speed of the monitored boat were recorded every minute by GPS. If the monitored boat was engaged in whale-watching, the target species was noted (Michaud et al. 2010).

From 2005 to 2010, the Department of Fisheries and Oceans (DFO) joined the project to include monitoring of observation activities at sea within the proposed St. Lawrence Estuary Marine Protected Area. Extensive monitoring was conducted in 2005-2007 and 2010, covering not only the Marine Park but also portions of the upper SLE and the south shore (GREMM, Parks Canada and DFO). These years of extensive spatial monitoring are the only ones used in the present study to map co-occurrences of beluga and commercial excursion boats in various areas of the SLE.

2.4 BOATS AROUND VISUALLY TRACKED BELUGA HERDS

In the context of a long-term study initiated in 1989 on the social organization of the SLE beluga population, over 752 visual tracks of beluga herds were undertaken during the summer or early fall from 2003 to 2012. The number of boats and ships present within a 2000 m radius of tracked beluga herds was systematically documented.

One research team (GREMM, Tadoussac, Canada) acquired most of the data, but a second team (DFO, Mont-Joli, Canada) contributed to sampling in 2003 to 2005. Surveys were neither random nor systematic but opportunistic and covered the various sectors of the summer distribution of the SLE beluga population and a broad range of habitats (for detailed description of the methods, see Lemieux-Lefebvre et al. 2012). However, spatial sampling effort between 2003 and 2012 was concentrated in the lower Saguenay Fjord and the northern portion of the SLE, with an under-representation of the portion of the upper SLE upstream of Ile-aux-Lièvres and on the south shore (Figure 2).

During the first 15 min of observation, the research team collected preliminary information on herd composition and size while maintaining a distance of 300 to 500 m from the herd. Herd characteristics such as the position, composition, movement, and behavior of the herd were noted in a consistent way every 30 min. These surveys also included the position of the research vessel, the number of boats and ships within a 2000 m radius of herds being tracked and prevailing weather conditions. Herd tracks lasted generally 3 h at most, but their duration varied depending on sampling protocols and prevailing field conditions.

The maximum number of boats and ships observed within a 2000 m radius around herds and herds with calves was used as indicator of the exposure of belugas to boats between 2003 and 2012 in various areas sampled.

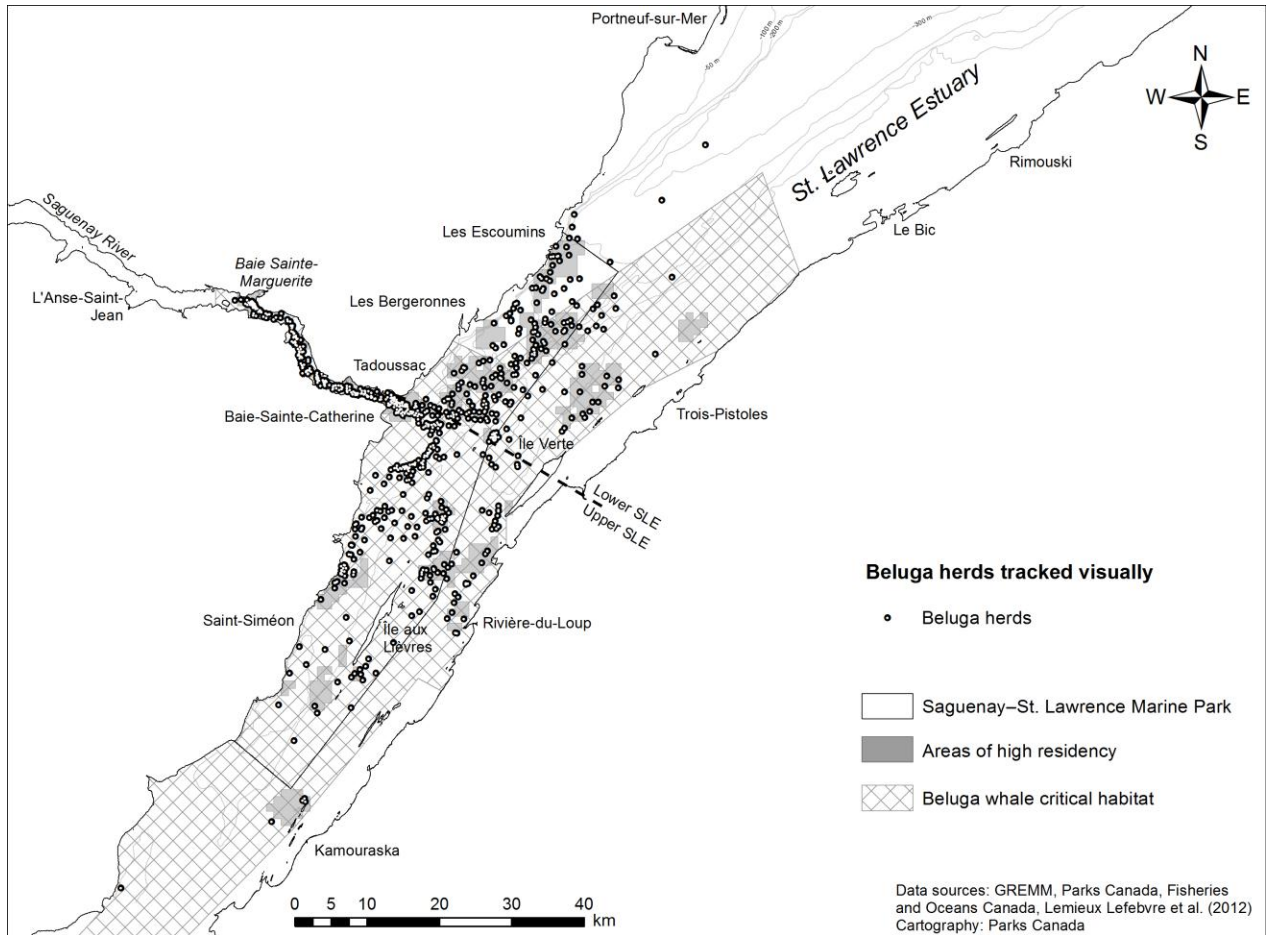


Figure 2. Spatial distribution of beluga herd tracks in August from 2003 to 2012.

2.5 REPORTED INFRACTIONS REGARDING BOATS

Park naturalists from Parcs Québec (Parc national du Fjord-du-Saguenay) were posted at a lookout on the shore of Baie Saint-Marguerite every afternoon of the week from the end of June to the beginning of September to systematically complete an incident report when an infraction to the 400 m rule or any type of harassment event towards beluga was observed. The number of infractions documented at Baie Sainte-Marguerite allow for comparisons over the years. The number of days monitored per year varied because of operational reasons or incidents to infrastructures that occurred certain years. These reports were retained as an indicator of infractions for an area of high residency (AHR) used by herds of adults with calves and juveniles.

For 2012 in particular, specific reports of beluga harassment events in other areas are also presented in this paper.

3. RESULTS

3.1 COMMERCIAL SHIPPING

In the SLE, maritime shipping routes are of the corridor-type and overlap with the critical habitat over a distance of approximately 150 km (Figure 3). The number of assignments of pilots operating between Les Escoumins and Québec City obtained from the Laurentian Piloting

Authority is a good indicator of commercial shipping traffic in the SLE (Figure 4). Shipping activity was variable among years, peaking in 2007 and declining rapidly in 2009. However, by comparing the means of the number of assignments between 2003-2007 and 2008-2012 (7399 and 7492 assignments, respectively), shipping activity remained essentially the same during the 2 periods with an increase of about 100 assignments during the latter period.

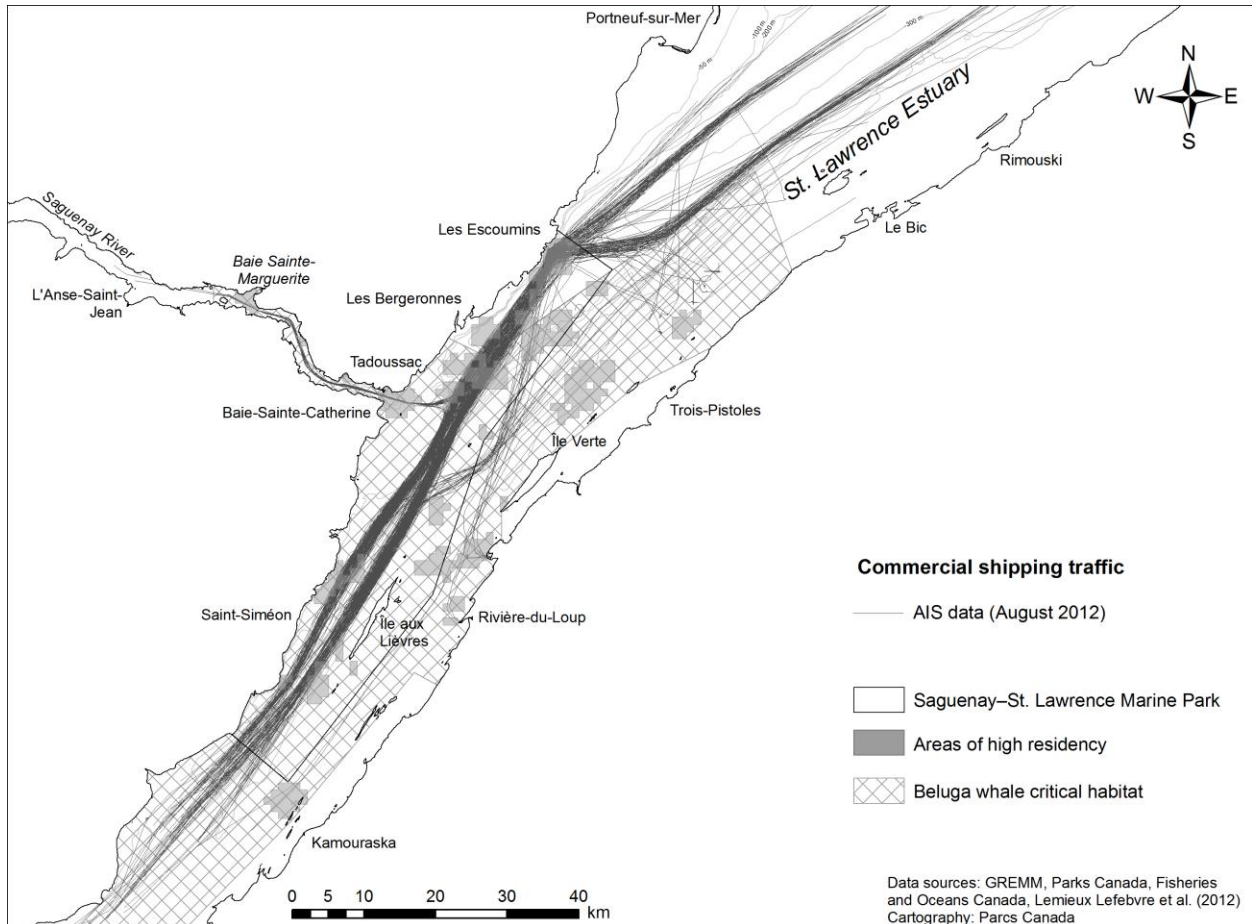


Figure 3. Commercial shipping routes obtained through automatic information system (AIS) data for 2012 in the SLE overlain on the SLE beluga critical habitat (DFO 2012) and areas of high residency (Lemieux Lefebvre et al. 2012).

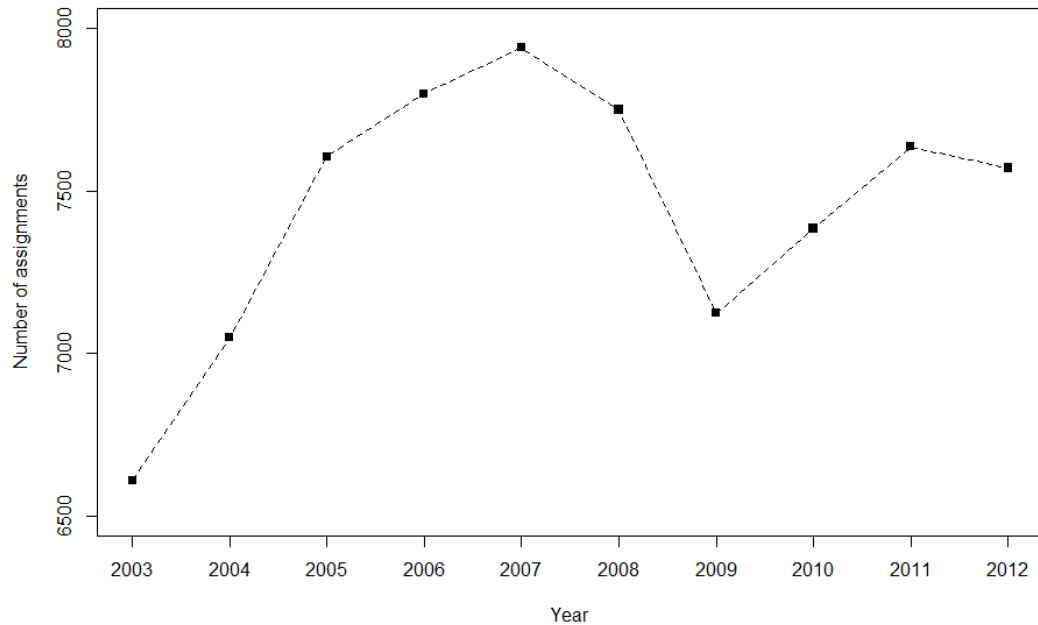


Figure 4. Number of assignments of pilots for commercial shipping vessels between Les Escoumins and Quebec City between 2003 and 2012 (Source: Laurentian Piloting Authority).

3.2 COMMERCIAL WHALE-WATCHING EXCURSIONS (MOTORIZED)

The commercial whale-watching industry has experienced tremendous growth the past 20 years. In the Saguenay-St. Lawrence Marine Park area alone, whale-watching excursions increased from an estimated 5,000 in 1993 (GREMM 1993) to 9,000 in 1999 (Claude Paquette, Canadian Coast Guard Marine Communications and Traffic Services, Les Escoumins, reported in Dionne 2001) to 13,073 in 2007 (Chion et al. 2009). Within the limits of the Saguenay-St. Lawrence Marine Park, the number of boats operating commercial whale-watching excursions has been limited since 2002 through a permitting system (*Marine Activities in the Saguenay–St. Lawrence Marine Park Regulations* SOR/2002-76). The regulations limit the number of boats operating in the Marine Park but not the number of excursions. However, the estimate of 13,073 excursions for 2007 can be considered representative of the order of magnitude of the number of excursions per year from 2003 to 2012 since no major changes occurred with regards to management or development of these activities in the area during this period.

Monitoring of observation activities at sea from 2003 to 2012 indicates that the number of whale-watching excursions that targeted beluga in the SLE varied within years and areas (Table 2). Large boats departing from Tadoussac are the only ones that have been consistently monitored over the years. Boats from Tadoussac seek mostly observation of rorquals (humpback, fin, minke and blue whales) which migrate to the lower SLE to feed. The percentage of ships/boats from Tadoussac targeting beluga varied from a maximum of 11% (in 2005) to a minimum of 1.3% (in 2004). The port in Tadoussac is located at the mouth of the Saguenay River, and encounters with beluga while heading out and back to port occur very regularly. By regulation, all boats and ships must respect a 400 m distance from beluga within the Marine Park, but compliance is more challenging in a narrow passage like the Saguenay Fjord. Between 2003-2007 and 2008-2012, there was a slight increase the 5-year average of observations targeting beluga (4.4% to 6.1% respectively) by large ships from Tadoussac, though 2012 was one of the lowest years with 2.6% of all whale-watching activities targeting beluga by large boats departing from this port. For the other boats operating in the lower SLE (Bergeronnes and Les Escoumins), beluga were targeted in a maximum of 4.4% of whale

watching activities (2003), and there has been a decline in observations targeting belugas by these boats for subsequent years. Like in Tadoussac, boats departing from these ports giving direct access to the lower SLE primarily target rorquals.

Within the Saguenay-St. Lawrence Marine Park the number of permits issued for the practice of commercial excursions at sea has been limited since 2002. In 2004, 5 permits for boats which operated in the lower SLE, where rorquals are the main staple of the whale-watching industry, were shifted to St-Siméon in the upper SLE, an area mostly used by herds of adult beluga accompanied by calves and juveniles. Furthermore, in 2005, a new company began to operate out of Kamouraska, outside the limits of the Marine Park, close to an area of high residency of herds of adults with young (Lemieux Lefebvre et al. 2012). Only 3 boats were operating out of St-Siméon in 2012, one having its permit shifted to the Saguenay Fjord and the other shifted to Les Escoumins. Other than these changes, the situation has remained relatively constant over the years because of the limitation on the number of boats in the Marine Park.

For small boats operating in the upper SLE (Kamouraska, Rivière-du-Loup, St-Siméon), monitored in 2005, 2006, 2007 and 2010 (not St-Siméon for the latter year), beluga were a significantly more important target than for small boats operating from other ports of departure (Table 6). Beluga are essentially the only targeted species of whales for boats operating out of Kamouraska (mean= 99.5% of whale watching activities target belugas, 4 years sampled), whale watching being about 30% of the activity practiced during an excursion departing from this port, scenic viewing and bird watching also being part of excursions (Michaud et al. 2010). Small boats operating out of Rivière-du-Loup (mean=60% of whale watching activities targeting belugas, 4 years sampled) and, to a lesser extent, from St-Siméon (mean=25% of whale watching activities targeting belugas, 3 years sampled), also target beluga significantly for whale-watching.

The spatial distribution of whale-watching ships/boats targeting beluga overlaps with areas of high residency (AHR) identified by Lemieux Lefebvre et al. (2012) at the mouth of the Saguenay River as well as the north (St-Siméon) and south shores (Kamouraska and Rivière-du-Loup) of the upper SLE (Figure 5) (Michaud et al. 2010). Data for kayak guided tours are not presented here because the sampling effort is uneven in the study area. There is however a documented overlap between the areas visited by kayakers and beluga AHR at Kamouraska (Michaud et al. 2010), the mouth of the Saguenay River (Turgeon et al. 2008; Conversano 2013) and Baie Sainte-Marguerite (Busque 2006; Turgeon 2008).

Table 2. Percentage of whale watching activities targeting SLE belugas by port of departure (data source: GREMM, Parks Canada and DFO). Percentages above 25% are highlighted in bold.

Port (type of boat)	Year									
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Kamouraska (small)	-	-	100	100	98	nd	nd	100	nd	nd
Rivière-du-Loup (large)	nd	nd	13.3	nd	nd	nd	nd	13.9	nd	nd
Rivière-du-Loup (small)	nd	nd	36.4	44.4	60	nd	nd	100	nd	nd
Saint-Siméon (large)	-	nd	28.4	29.1	18.3	nd	nd	nd	nd	nd
Tadoussac (large)	2.7	1.3	11	3.4	3.8	6.8	9.8	4.1	7.1	2.6
Les Escoumins (small)	4.4	nd	1.1	1.7	2.3	3.3	1.8	0.8	0	nd
Bergeronnes (small)	nd	nd	2.2	2.8	3.7	nd	nd	nd	3.6	nd

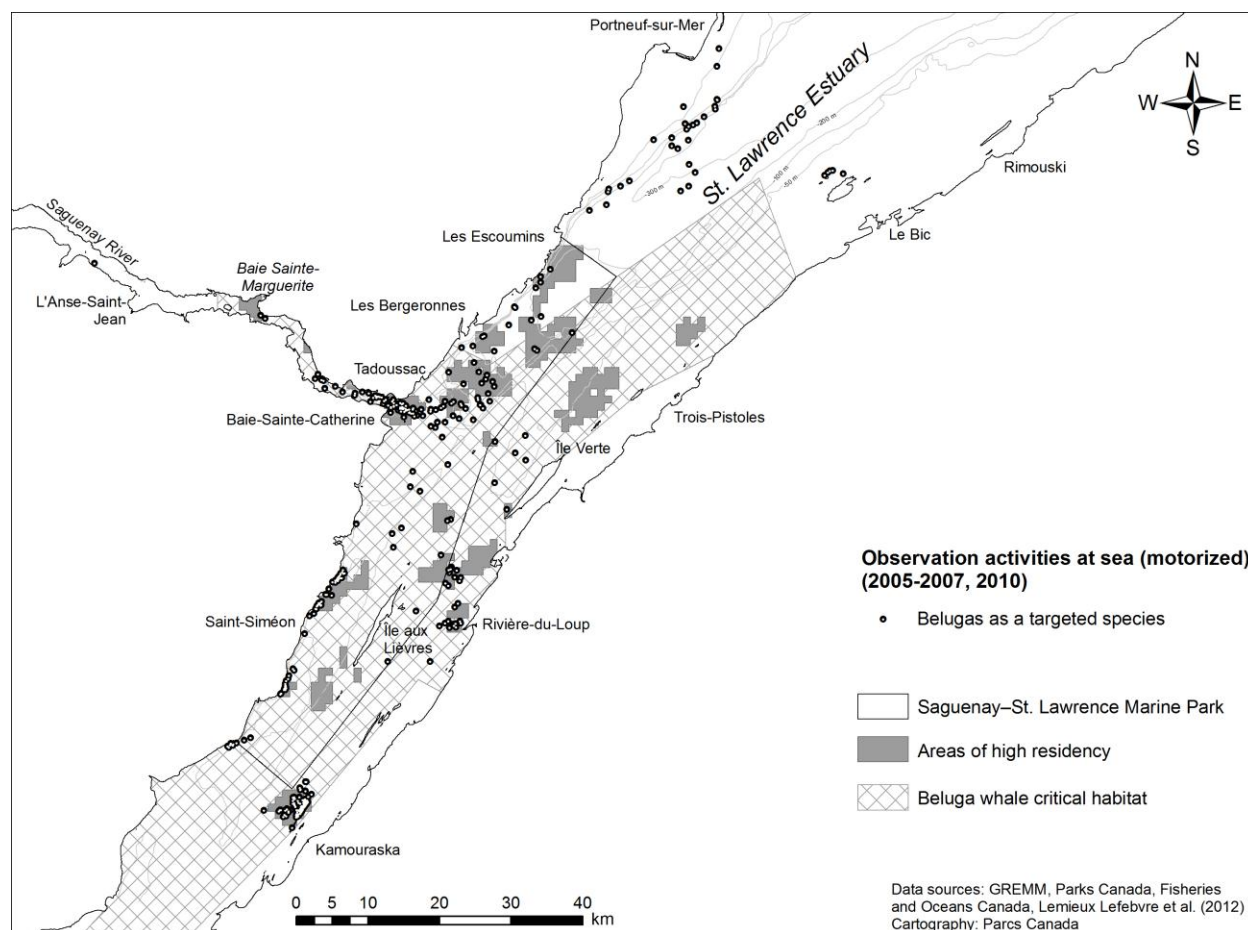


Figure 5. Commercial observation activities at sea (motorized boats) targeting belugas for whale-watching. Boats were sampled in 2005, 2006, 2007 and 2010 (not St-Simeon for the latter year).

3.3 RECREATIONAL BOATING STATISTICS AT MARINAS

Eleven marinas are located in the immediate vicinity of the beluga’s critical habitat: 5 on the north shore of the SLE, 4 on the south shore of the SLE and 2 in the Saguenay Fjord. Marina

statistics were available only for Tadoussac, Rivière-du-Loup, and Cap-à-l'Aigle (Figure 6). It should be noted that the method of compiling data is specific to each marina. Furthermore, the method of compiling data was changed slightly in Tadoussac in 2009 with a change in management, thus trends for this marina are examined separately for the periods 2003-2008 and 2009-2012.

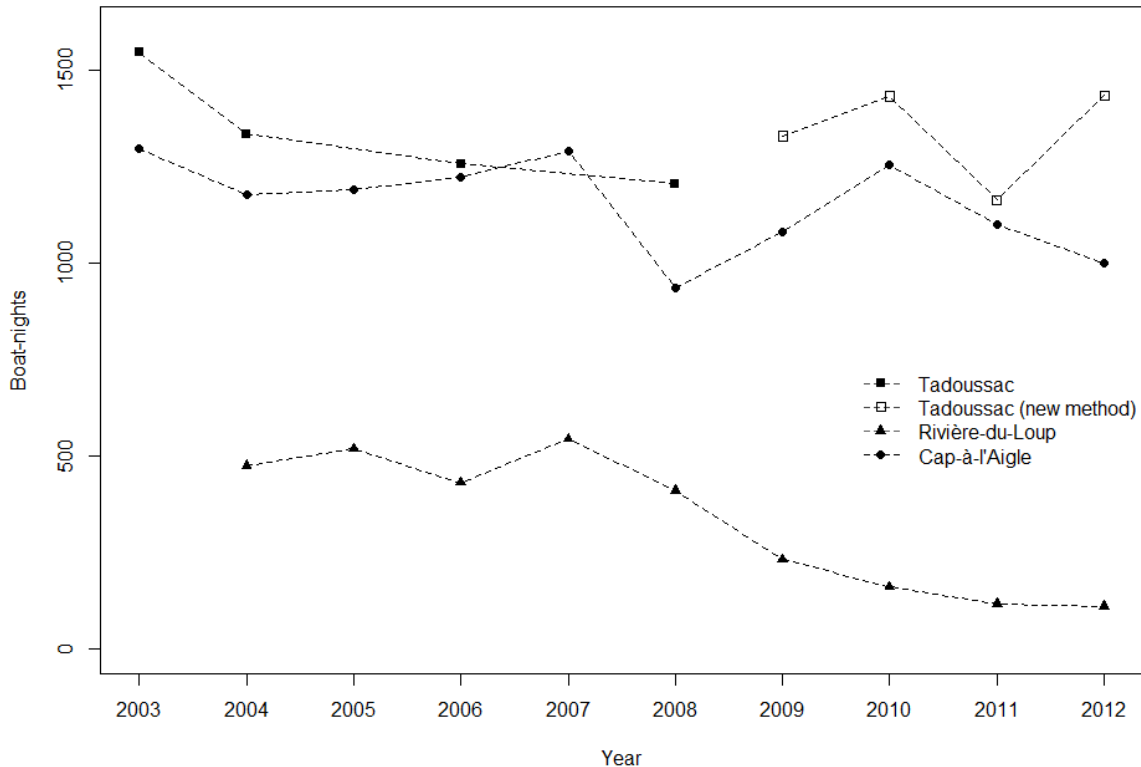


Figure 6. Marina statistics at Tadoussac, Rivière-du-Loup and Cap-à l'Aigle between 2003 and 2012 (source: marina managers at Tadoussac, Cap-à-l'aigle and Rivière-du-Loup).

For Tadoussac, there was a slight decrease in the number of boat-nights from 2003 to 2008, with occupancy in 2008 being the lowest recorded for the years data was available. In 2009, 2010 and 2012, the latter two years being identical in terms of occupancy, there was a slight increase in boat-nights, only 2011 showing a drop. Only Tadoussac shows an increase in occupancy by recreational boaters from 2003 to 2012. For this particular site, it should be noted that between mid-July and the end of August, the marina is regularly full and boaters must anchor in the bay. The statistics for this marina thus do not fully account for the use of the area by recreational boaters during the peak period.

For Cap-à-l'Aigle, occupancy is generally constant within the 2003-2007 period. Like in Tadoussac, a significant drop is observed in 2008, resulting in a decrease in mean occupancy for 2008-2012 as compared to the former period (average occupancy at 1235 boat-nights for 2003-2007 versus 1074 for 2008-2012). For Rivière-du-Loup, there was a constant decrease in occupancy due to an accumulation of silt limiting access for many boats. No statistics were available for the marinas located in the Saguenay Fjord, namely L'Anse-de-Roche and L'Anse-Saint-Jean, nor for the use of boating ramps in Kamouraska. Regular users report an increase in recreational boating in the Saguenay Fjord (Sylvain Desbiens, Croisières Personnalisées du Saguenay, L'Anse-Saint-Jean, pers. comm.).

3.4 BELUGA-BOAT CO-OCCURRENCES BETWEEN 2003 AND 2012 AND IN DIFFERENT AREAS

The number of boats within a distance of 2000 m of beluga observed during the visual tracking of herds showed a very high variability amongst years, probably due to variations in spatio-temporal sampling effort. Table 3 presents the data of the mean maximum number of boats counted around visually tracked herds by herd type per year. The median hour of sampling was 10:00 a.m. and the median month of sampling was August for data presented in Table 3. A comparison of the maximum number of boats within a 2000 m radius of herds for the periods 2003-2007 and 2008-2012 revealed that the maximum number of boats and ships within a 2000 m radius of herds had increased significantly over time. For the period 2003-2007 (n=445), the maximum number of boats within 2000 m of herds per track was on average 0.33 ± 1.18 SD, while it was 0.62 ± 1.50 SD for 2008-2012 (n=342). The two means are significantly different ($p < 0.05$, *Wilcoxon one-tailed test*). For herds with calves, the maximum number of boats within 2000 m was on average 0.26 ± 0.70 SD for the 2003-2007 period (n=127) and 0.59 ± 1.35 SD for the 2008-2012 period (n=103). The two means are significantly different ($p < 0.05$, *Wilcoxon one-tailed test*). Although 2012 shows an apparent increase in the maximum number with on average 0.97 boats within 2000 m of herds with calves during visual tracks, it is not significantly different from that in years 2003-2011 ($p > 0.05$, *Wilcoxon one-tailed test*).

Table 3. Mean and standard deviation of maximum number of boats within 2000 m observed per year during visual track of beluga herds of (a) all types per year and (b) with calves per year as well as means for periods 2003-2007 and 2008-2012 for herds of (c) all types and (d) with calves (n=number of visual tracks). (Data: GREMM).

	Year									
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
a) Mean maximum number of boats within 2000 m of herds (all types) per year	0.35 ±0.61 n=71	0.11±0.54 n=103	0.20±0.66 n=90	1.00±2.58 n=61	0.25±0.78 n=103	0.51±1.08 n=74	0.87±1.82 n=61	0.69±1.74 n=64	0.43±1.13 n=82	0.74±1.84 n=43
b) Mean maximum number of boats within 2000 m of herds with calves per year	0.69±0.84 n=13	0.16±0.72 n=38	0.11±0.52 n=36	0.38±0.65 n=13	0.36±0.79 n=22	0.57±1.00 n=28	0.38±0.65 n=13	0.44±0.92 n=25	0.54±1.13 n=13	0.97±2.30 n=22
c) Mean maximum number of boats within 2000 m of herds (all types) between 2003-2007 and 2008-2012	0.33 ± 1.18 n=428					0.62 ± 1.50 n=324				
	<i>p</i> = 0.0004, Wilcoxon one-tailed test									
d) Mean maximum number of boats within 2000 m of herds with calves between 2003-2007 and 2008-2012	0.26 ± 0.70 n=122					0.59 ± 1.35 n=101				
	<i>p</i> = 0.0129, Wilcoxon one-tailed test									

Table 4 presents the maximum mean number of boats within 2000 m of beluga by area sampled. The increase of the number of boats around herds between the two periods is significant at the mouth of the Saguenay River, whereas it is not significant for the upper SLE, and has remained constant in the lower SLE. These results must be interpreted by considering the effect of sampling hour, since the number of boats at sea is strongly related to time of the day. At the mouth of the Saguenay River, from 2003 to 2007, median sampling time was 8:00 a.m., capturing fewer boaters than in the period of 2008-2012 for which the median sampling hour was 10:00 a.m. For other areas, median sampling hour between the two periods are comparable. Furthermore, sampling is deficient in the upper SLE upstream of Ile-aux-Lièvres and Kamouraska. This latter area, which has undergone important developments of nautical tourism over the past decade, is essentially not represented in this data set (Figure 2).

Table 4. Mean and standard deviation of number of boats within a 2000 m radius of visually tracked beluga herds in different areas for the two time periods (2003-2007 and 2008-2012). Median sampling month is August (data: GREMM).

Area	Year	
	2003-2007	2008-2012
Mouth of the Saguenay River	0.294 ± 0.729 (n=51) (median sampling hour =8:00)	1.742 ± 2.265 (n=31) (median sampling hour =10:00)
	$\rho = 0.00006$, Wilcoxon one-tailed test	
Saguenay Fjord	0.347 ± 1.019 (n=95) (median sampling hour =11:00)	0.876 ± 1.671 (n=89) (median sampling hour =12:00)
	$\rho = 0.00272$, Wilcoxon one-tailed test	
Lower SLE	0.492 ± 1.797 (n=128) (median sampling hour =10:00)	0.489 ± 1.430 (n=88) (median sampling hour =10:00)
	$\rho = 0.5992$, Wilcoxon two-tailed test	
Upper SLE	0.195 ± 0.584 (n=154) (median sampling hour =9:00)	0.241 ± 0.881 (n=116) (median sampling hour =10:00)
	$\rho = 0.4244$, Wilcoxon one-tailed test	

3.5 INFRACTIONS REPORTED CONCERNING BELUGA PROTECTIONS MEASURES

Within the Marine Park, a 400 m distance from beluga must be respected, and if a boat is approaching closer it is considered an infraction. Although the number of days monitored per season (mid-June to beginning of September) for infractions at Baie Sainte-Marguerite has been decreased since 2010, the percentage of days with reported infractions reached 55% (n=64 days) in 2010 and 64% (n=51 days) in 2012 (Table 5). The mean percentage of days with infractions also increased between the periods, being 26.2% of days (n=377 days) for 2003-2007 and 38.4% of days (n=316 days) for 2008-2012.

These results are corroborated by experienced observers working in the Saguenay Fjord, especially during 2012. A commercial excursion operator based in L'Anse-Saint-Jean who has been in operation for 22 years reported many cases of infractions to Parks Canada law enforcement officers in 2012 (Sylvain Desbiens, pers. comm.). He reported cases of harassment with personal watercraft in Baie Saint-Marguerite and reported videos of recreational boaters among herds of beluga. According to this experienced observer, cases of severe harassment of beluga by recreational boaters were higher in 2012 than in any other year.

In Kamouraska, an area outside the Marine Park, systematic data on infractions are not available. A resident of the area reported a severe case of harassment which occurred at the end of July or beginning of August 2012 (Jérémie Caron, biologist, Saint-Germain de Kamouraska, pers. comm.). The event implicated a personal watercraft which circulated among

beluga at high speed for over an hour and a half. According to this observer, many recreational boaters use the boating ramp in Kamouraska and he has heard of boaters attempting to feed beluga with canned fish.

Table 5. Infractions with regards to beluga protection measures reported by naturalists per year at Baie Sainte-Marguerite (n= number of days sampled per year) (source: Parcs Québec, Parc national du Fjord-du-Saguenay).

	Year									
	2003 n=81	2004 n=78	2005 n=76	2006 n=74	2007 n=68	2008 n=74	2009 n=80	2010 n=64	2011 n=47	2012 n=51
Number of days sampled with belugas present	53	45	57	41	52	45	44	53	47	39
Number of days with infractions reported	10	7	21	14	13	9	10	29	14	25
% of days with infractions reported	19	16	37	34	25	20	23	55	30	64
Mean % of days with infractions reported for 2003-2007 and 2008-2012	26.2					38.4				

3.6 RELATIONSHIP BETWEEN UNEXPLAINED HIGH CALF MORTALITIES, MARITIME TRAFFIC AND WEATHER CONDITIONS DURING THE CALVING PERIOD

Figure 7 (a) presents the number of calf carcasses found and the number of female carcasses found for which mortalities were associated to dystocia between 2003 and 2012 (Lesage et al. 2014a; Lair et al. 2014). The massive *Alexandrium tamarens* bloom of August 2008 (Scarratt et al. 2014) is suspected to have caused the observed increase in beluga mortalities for that year (Lair et al. 2014), including the high number of calf carcasses (DFO 2014). The peaks in calf carcasses found in 2010 and 2012 (Lesage et al. 2014a) and the peaks in females for which the cause of death was associated to dystocia reported in 2010 and 2011 (Lair et al. 2014) remain unexplained. It should be noted that in 2011, the four calf carcasses found were above the maxima observed from 1983 to 2008 whereas females found dead from perinatal complications peaked that year at 3 cases.

The other graphs in Figure 7 bring together information related to belugas and boats in the Saguenay Fjord, the portion of the critical habitat where data are the most complete, and weather conditions in July and August at Les Bergeronnes (the closest meteorological station which records temperature and precipitation in the area). Marina recreational boating statistics for Tadoussac, beluga-boat co-occurrences within 2000 m in the Saguenay Fjord, and the percentage of days with infractions reported in Baie Saint-Marguerite, consistently showed peaks in 2010 and 2012. All these variables, at higher values, increase the probability of anthropogenic disturbance of beluga. During these two years, weather conditions were also favorable to nautical recreational activities, with mean temperatures at a high and precipitation at a low in July and August.

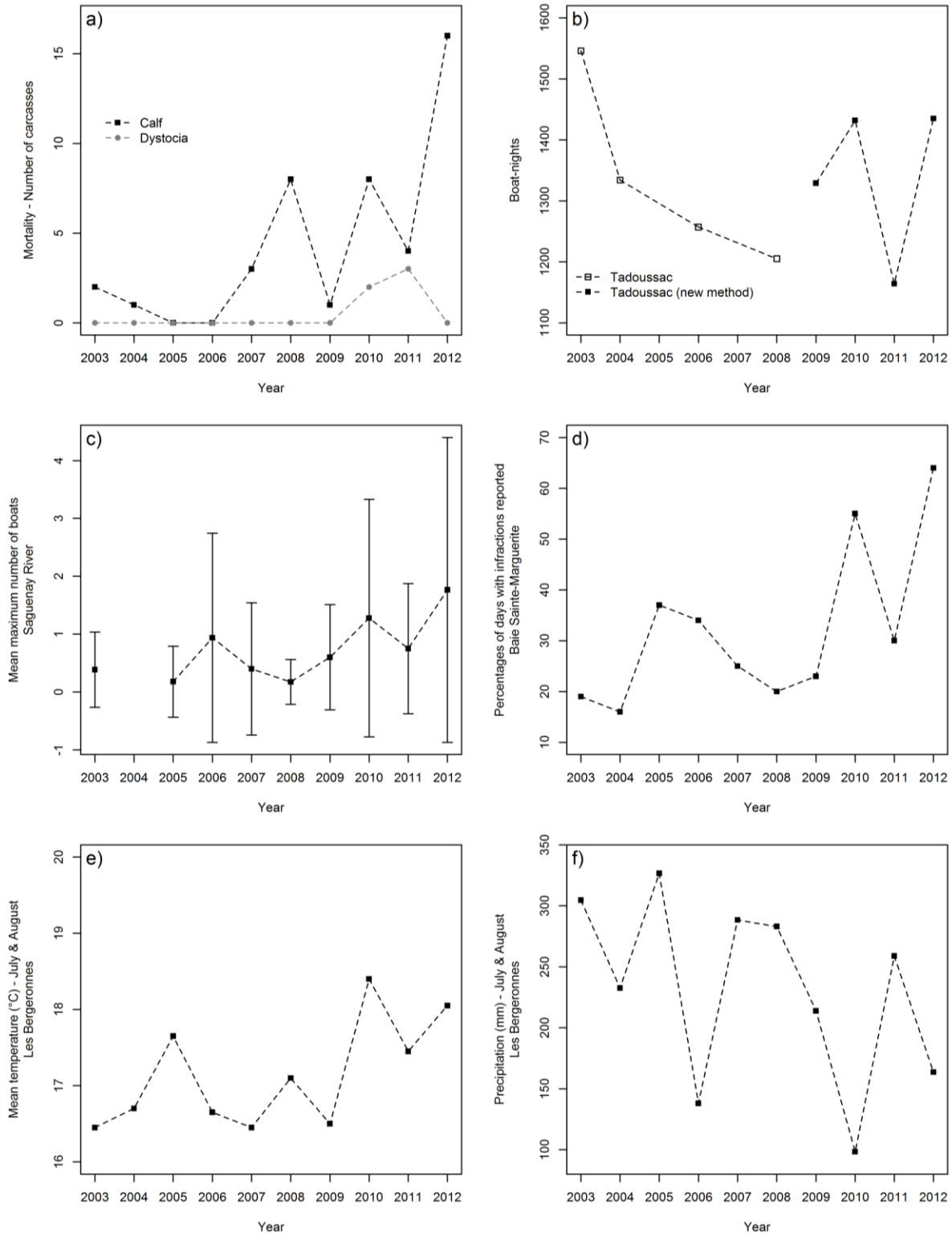


Figure 7. Time series of a) the number of calf carcasses and females found dead from dystocia; b) Tadoussac marina statistics; c) maximum mean number of boats within 2000 m of belugas in the Saguenay, the bars representing the standard deviation; d) infractions reported at Baie Saint-Marguerite; e) mean temperature in July and August for Bergeronnes; f) total precipitation in July and August for Bergeronnes.

4. DISCUSSION

There is not one single source of information specifically designed to evaluate the potential effects of maritime traffic and boat and ship interactions with the SLE beluga population. Gathering data of various sources, collected for other purposes, nonetheless permits documentation of changes in maritime traffic and interactions with beluga over the last decade. It also allows examining maritime traffic and beluga-boat interactions regarding specific events that occurred in 2010 and 2012, two years when calf mortalities were high but when no apparent cause was found like in 2008, when calf mortalities were attributed to a toxic algal bloom.

4.1 MARITIME TRAFFIC

Economic activity appears to be the main driver of maritime shipping activity in the SLE, as illustrated by the 2009 drop due to the economic crisis. Other than slight variations, commercial shipping and ferry activities have been relatively constant over the past decade, as much in numbers as in routes taken. Ships and ferries have a constant trajectory and do not seek interactions with belugas, although the effects of shipping and ferry services on the beluga habitat can have an effect on ambient noise (Lesage et al. 1999; McQuinn et al. 2011, Gervaise et al. 2012, Lesage et al. 2014b).

Recreational boating statistics vary among marinas, with an apparent increase at Tadoussac, but occupancy at marinas does not necessarily represent boating activity. The information is presented per boating season (May to October), yet it should be kept in mind that peak presence of boaters occurs in July and August.

One important factor influencing boating activity and the number of recreational boaters using marinas is the weather. Poor weather is probably responsible for the drop in boaters using the Tadoussac and Cap-A-l'Aigle marinas in 2008 and 2011, as compared to highs observed for 2010 for both marinas and 2012 for Tadoussac. July and August of 2008 and 2011 were very rainy (Figure 7) and August was exceptionally stormy in 2011, whereas July and August of 2010 and 2012 were warmer than average and precipitation was low (data from climate.weather.gc.ca and climat-quebec sites). These conditions are favorable for nautical activities in the SLE and the Saguenay Fjord. The exceptional weather conditions for 2012 may explain the higher increase in Tadoussac compared to Cap-à-l'Aigle because excellent conditions would be favorable for boaters coming from upstream regions all the way to Tadoussac (Maryline Gagné, Marina de Tadoussac, pers. comm.). These good weather conditions could also explain the peaks in infractions reported for Baie Sainte-Marguerite in 2010 and 2012 but not as severe in 2011. A similar pattern to 2011 is observed in 2008, when weather conditions were unfavorable for navigation, as indicated by low marina occupancy, lower number of boats within 2000 m of beluga in the Saguenay and low reported infractions. The coincidence of unexplained high calf mortalities for 2010 and 2012 with high recreational boating activity in Tadoussac marina, higher co-occurrences between belugas and boats for those years in the Saguenay and good weather conditions in the critical habitat in July and August of those years suggest that anthropogenic disturbance may have played a role in some of the reported mortalities.

In 2010 and 2012, marinas upstream in the fluvial portion of the St Lawrence experienced problems due to lack of water because of drought and navigation in some portions of the St. Lawrence were more hazardous, which may have encouraged boaters to use the SLE where water levels were adequate. The warm and dry season observed in 2012 also favored small boats, such as personal watercraft and kayaks, which are easily launched from shore or small boating ramps, are highly maneuverable and have access to shallower areas.

Unfortunately, a lack of marina statistics at l'Anse-Saint-Jean and Kamouraska preclude knowledge of exposure of beluga in AHR where recreational boating appears to be problematic for herds of adults and calves. Given that the Tadoussac marina is centrally located in the critical habitat and that the majority of visitors in July and August at this marina come primarily from upstream areas of Québec and, to a lesser extent, from the upstream region of the Saguenay and from the south shore of the SLE (Maryline Gagné, pers. comm.), statistics at this marina may be considered as a general indicator of recreational boating activity in the critical habitat.

It cannot be excluded that good weather conditions in 2010 and 2012 may have favored a better detection of beluga carcasses found on the water and on shore. However, it is highly unlikely that this effect would account for the much higher number in carcasses found in 2010 and 2012 compared to previous years. In August 2012, when numbers of calf carcasses found were increasing, a decision was made by the members of the Quebec Marine Mammal Emergency Response Network (RQUMM) not to publicize the mortality events specifically to maintain the probability of reporting by the public comparable to previous years.

4.2 BELUGA AS A TARGETED SPECIES FOR WHALE WATCHING

As for whale-watching, the main change over the last decade is the appearance of new companies operating in the upper SLE out of St-Siméon (2004) and Kamouraska (2005). Areas of high residency close to these ports are strongly used by these whale-watching boats. No commercial excursions operated prior to 2004 (St-Siméon) and 2005 (Kamouraska) in these areas which are used by beluga herds with young.

Belugas are the target of small boats operating out of Kamouraska and Rivière-du-Loup. In the Marine Park, regulations require that a 400 m distance from beluga be maintained. They are nonetheless occasionally targeted from boats operating out of St-Siméon and at the mouth of the Saguenay River, although proportionally less than boats with homeports on the south shore of the SLE operating outside the Marine Park. It should be noted that maritime traffic is most intensive at the mouth of the Saguenay River, where commercial excursions account for 51% of the traffic (Chion et al. 2009). These conditions as well as the narrowness of the Saguenay Fjord increase the probability of navigational interactions with belugas in this specific area.

Kayakers target beluga in easily accessible areas close to shore at Kamouraska, the mouth of the Saguenay River and Baie Saint-Marguerite, all areas used by herds of adults with young. There is a general belief that non-motorized boats such as kayaks have less potential to disturb wildlife, but this is not necessarily the case (Henry and Hammill 2001). Kayakers are regularly seen remaining for long periods among herds of beluga, especially in Baie Saint-Marguerite (Busque 2006; Turgeon 2008) and Kamouraska (Michaud et al. 2010). In Baie St. Marguerite, Turgeon (2008) noted that the spatial distribution of kayaks was significantly different based on the presence or absence of belugas.

Kayaking has grown in the past few years and social media networks are being used to inform kayakers of the presence of beluga in the Saguenay Fjord (Chloé Bonnette, Parcs Québec, Saguenay-St. Lawrence Marine Park, pers. comm.). Furthermore, a video of kayakers among herds of belugas posted on Youtube in August 2010 has had a viral effect (17 000 viewings as of October 2013). Experienced kayakers in the Fjord suggest that this video may have increased interactions between beluga and kayakers in 2012 (Nathaël Bergeron, Parcs Québec, Saguenay-St. Lawrence Marine Park, pers. comm.). Many videos posted on YouTube in recent years also involve interactions between recreational boaters and beluga, which may have an effect of promoting these encounters.

4.3 BELUGA-BOAT CO-OCCURRENCES

Beluga visual tracking conducted by the GREMM indicates that beluga-boat co-occurrences have increased between the periods 2003-2007 and 2008-2012 in the Saguenay Fjord. The apparent increase at the mouth of the Saguenay River is probably not as important as suggested by beluga visual tracks because of differences in the median sampling hours in the day. At the mouth of the Saguenay River, the number of boats at this location is relatively constant over the past decade (Conversano 2013). For 2012, this is the year with the smallest number of visual tracks (43 versus an average of 80 per year for the 10 year series); with only 22 tracks of herds with calves (only 5 with boats). The lower effort in visual tracks in 2012 limits interpretation for that year using that data base.

The 2000 m radius in which boat numbers are counted during visual tracks corresponds approximately to the average width of the Fjord (2 km). Because of the narrowness of this waterway, boaters and beluga more easily co-occur here than in the SLE, which is roughly 20 km wide in the upper SLE and 25 km wide in the lower SLE. The Saguenay Fjord is mostly used by recreational boaters circulating between Tadoussac and L'Anse-St-Jean (Chion et al. 2009), which covers a portion of the critical habitat of the SLE beluga.

In the upper SLE, the beluga herd visual tracking does not cover areas of Kamouraska during the years analyzed. This area is highly used by recreational boaters, kayakers and a commercial whale-watching operator. The density of recreational boaters is however lower in the upper SLE as compared to the Saguenay Fjord based on information from 2006 (Chion et al. 2009 and references therein) and as indicated by marina statistics available for this region.

4.4 INFRACTIONS

The 400 m distance requirement from belugas appears to be generally respected by commercial whale-watch operators in the Marine Park. In the Saguenay Fjord however, regular users and observers have noted problems with recreational boaters, personal watercraft and kayakers, especially in 2012. For Kamouraska, which is outside the Marine Park and not patrolled, the one reported case by a resident may suggest issues in this area, which has undergone significant development in terms of tourism in recent years (Louise Séguin, Tourisme Québec, pers. comm.). The *Fisheries Act* and the *Species at Risk Act* applies to all areas within and outside the Marine Park, but enforcement resources are considered insufficient and data to adequately evaluate infractions with regards to beluga protection throughout their critical habitat are practically inexistent.

5. CONCLUSION

Data gathered in this study indicate that maritime traffic and interactions between boats and beluga in calving areas have increased over the last decade. Anthropogenic disturbance could be an aggravating factor in calving situations or for females and new-born calves, especially if their health is compromised (i.e. dystocia, contaminants, biotoxins or other unfavorable environmental conditions). Given the fact that belugas calf and nurse in water, the mechanism by which anthropogenic disturbance could interfere with calving and nursing is practically impossible to observe. It could involve physical avoidance of boats by beluga (e.g., collision avoidance, repetitive diving), physiological effects such as stress for calving females in a vulnerable state or increased noise masking essential communication between individuals.

Although newborn calves are appearing every year as of July in the critical habitat, belugas giving birth have rarely been observed in the SLE or Saguenay because parturition occurs under water. Only experienced researchers have reported calving events. Based on the one

published event (Béland et al. 1990) and two reported calving events at Baie Sainte-Marguerite in 1984 (Ned Lynas in Michaud 1992) and in 2004 (Busque 2006), as well as one observed in captivity (Robert Michaud, pers. observation), calving individuals spend considerable time at the surface and calving may take many hours (Stéphane Lair, pers. comm.). Thus calving females, or females caring for newborns with limited swimming ability, could be more visible at the surface and easier targets for boaters seeking them for whale-watching.

The SLE beluga is a relatively small, threatened population. Repetitive and prolonged anthropogenic disturbance, especially in calving areas when females and new born calves are more vulnerable, likely affects the population. In dolphins, Bejder et al. (2006) found a substantial effect of tour vessels on dolphin abundance in a region of low-level tourism (Shark Bay, Australia). Some specific portions of the calving area in the SLE are subject to medium to high level tourism activities, namely the lower Saguenay Fjord, the north shore of the upper and lower SLE, Kamouraska and Rivière-du-Loup. The portion of the critical habitat downstream of Ile Verte appears to be relatively less used by recreational and whale-watching boats.

Beluga whales are an iconic species in the St. Lawrence and some individuals have been shown to interact with boats, especially sailboats running on outboard motors. These interactions incite boaters to actually seek beluga with the belief that beluga are attracted to boats for play. Boaters seeking to watch beluga cannot discriminate which groups are more sensitive to disturbance, such as calving females and newborn.

Sources of anthropogenic disturbance in the SLE are localized and seasonal, occurring mostly in July and August. The most problematic areas are documented herein. Although beluga are constantly exposed to the effects of maritime traffic in their habitat (e.g., noise), severe cases of disturbance are probably punctual. However, it should be kept in mind that punctual, severe incidents of harassment occurring at a critical time such as when a female is attempting to give birth or care for a newborn calf could have severe consequences for individuals. The degree of severity of such punctual and localized incidents is unknown, yet it is reasonable to consider such incidents as risk factors for the most vulnerable members of a population that is not showing signs of recovery.

Even with the most sophisticated methods to evaluate the effects of anthropogenic disturbance on the SLE beluga population, it is difficult to measure the impact of punctual events on calving and care of newborns, and even more difficult to evaluate the long-term consequences on the population. However, successful calving and care of young of the year is critical in the recovery of this population, and the potential impact of anthropogenic disturbance could be addressed strategically through management actions at specific locations in critical habitat during the peak calving period.

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LITERATURE CITED

- Bejder, L., A. Samuels, H. Whitehead, N. Gales, J. Mann, R. Connor, M. Heithaus, J. Watson-Capps, C. Flaherty and M. Krützen. 2006. Decline in relative abundance of bottlenose dolphins exposed to long-term disturbance. *Conserv. Biol.* 20: 1791-1798.
- Béland, P., A. Faucher and P. Corbeil. 1990. Observations on the birth of a beluga whale (*Delphinapterus leucas*) in the St. Lawrence Estuary, Quebec, Canada. *Can. J. Zool.* 68: 132-1329.
1994. The impact of ecotourism boats on the St. Lawrence beluga whales. *Environ. Conserv.* 2: 267-269.
- Busque, V. 2006. Utilisation de la baie Sainte-Marguerite par le béluga du Saint-Laurent (*Delphinapterus leucas*) et les embarcations nautiques : rapport des saisons 2003 à 2005. Rapport présenté à Parcs Canada. 50 p. +annexe.
- Caron, L. M. J. et D. E. Sergeant. 1988. Yearly variation in the frequency of passage of beluga whales (*Delphinapterus leucas*) at the mouth of the Saguenay River, Québec, over the past decade. *Can. Field Nat.* 178: 111-116.
- Chadenet, V. 1997. Fréquentation et bilan d'activités du béluga (*Delphinapterus leucas*) du Saint-Laurent dans la baie Sainte-Marguerite. Mémoire de maîtrise, Université Laval. 75 p. +annexes
- Chion, C., S. Turgeon, R. Michaud, J.-A. Landry, et L. Parrott. 2009. Portrait de la navigation dans le parc marin du Saguenay-Saint-Laurent. Caractérisation des activités sans prélèvement de ressources entre le 1er mai et le 31 octobre 2007. Présenté à Parcs Canada. 86 p.
- Conversano, M. 2013. Utilisation d'un habitat particulier par le béluga (*Delphinapterus leucas*) du Saint-Laurent : Fréquentation interannuelle, saisonnière, circadienne et tidale de l'embouchure du Saguenay. Mémoire de M. Sc., Université du Québec à Rimouski, Québec. xxx + 191 p.
- DFO. 2012. Recovery Strategy for the beluga whale (*Delphinapterus leucas*) St. Lawrence Estuary population in Canada. *Species at Risk Act Recovery Strategy Series*. Fisheries and Oceans Canada, Ottawa. 88 +x p.
- DFO. 2014. Status of beluga (*Delphinapterus leucas*) in the St. Lawrence River estuary. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/076. 17 p.
- Dionne, S. 2001. (Sous la direction de). Plan de conservation des écosystèmes du parc marin du Saguenay–Saint-Laurent, Parcs Canada, parc marin du Saguenay-Saint-Laurent. 538 p.
- Gervaise, C, Y. Simard, N. Roy, B. Kinda, and N. Ménard. 2012. Shipping noise in whale habitat: Characteristics, sources, budget, and impact on belugas in Saguenay–St. Lawrence Marine Park hub. *J. Acoust. Soc. Am.* 132: 76-89.
- Gosselin, J-F., Hammill, M.O., and Lesage V. 2007a. Comparison of photographic and visual abundance indices of belugas in the St Lawrence Estuary in 2003 and 2005. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/025. ii + 27p.
- Gosselin, D., M. Pagé, N. Ouellet, J.-M. East and A. Germain. 2007b. Étude auprès des plaisanciers naviguant dans le parc marin du Saguenay–Saint-Laurent. Parcs Canada;
- GREMM. 1993. Les activités d'observation en mer des baleines dans l'estuaire du Saint-Laurent. Situation actuelle et problématique. 31 p.+ annexes.

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- Hammill, M.O., Measures L.N., Gosselin J.-F. and Lesage V. 2007. Lack of recovery in St. Lawrence Estuary beluga. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/026. 23 p.
- Henry, E. and M. Hammill. 2001. Impact of small boats on the haulout activity of harbor seals (*Phoca vitulina*) in Métis Bay, Saint Lawrence Estuary, Québec, Canada. *Aquat. Mamm.*, 27: 140-148.
- Lair, S., Martineau, D., Measures, L.N. 2014. Causes of mortality in St. Lawrence Estuary beluga (*Delphinapterus leuca*) from 1983 to 2012. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/119. iv + 36 p.
- Lemieux Lefebvre, S., R. Michaud, V. Lesage, D. Berteaux. 2012. Identifying high residency areas of the threatened St. Lawrence beluga whale from fine-scale movements of individuals and coarse-scale movements of herds. *Mar. Ecol. Prog. Ser.* 450: 243-257.
- Lesage, V. 1993. The effect of noise from an outboard motor on a ferry on the vocal activity of beluga (*Delphinapterus leucas*) in the St. Lawrence estuary. Mémoire de maîtrise, Université Laval, Québec. 129p.
- Lesage, V., C. Barrette, M.C.S. Kingsley, and B. Sjare. 1999. The effect of vessel noise on the vocal behaviour of belugas in the St. Lawrence River Estuary, Canada. *Mar. Mammal Sci.* 15: 65-84.
- Lesage, V., Measures, L., Mosnier, A., Lair, S., Michaud, R. and Béland, P. 2014a. Mortality patterns in St. Lawrence Estuary beluga (*Delphinapterus leucas*), inferred from the carcass recovery data, 1983-2012. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/118. iv + 23 p.
- Lesage, V., McQuinn, I.H., Carrier, D., Gosselin, J.-F., and Mosnier, A. 2014b. Exposure of the beluga (*Delphinapterus leucas*) to marine traffic under various scenarios of transit route diversion in the St. Lawrence Estuary. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/125. iv + 27 p.
- Martin, A. 2012. Rapport sur l'observation du béluga du Saint-Laurent *Delphinapterus leucas* à partir du belvédère de la baie Sainte-Marguerite-Saison 2012. 39p.
- McQuinn, I.H., V. Lesage, D. Carrier, G. Larrivée, Y. Samson, S. Chartrand, R. Michaud, and J. Theriault. 2011. A threatened beluga (*Delphinapterus leucas*) population in the traffic lane: Vessel-generated noise characteristics of the Saguenay-St. Lawrence Marine Park, Canada. *J. Acoust. Soc. Am.* 130: 3661-3673.
- Mee, J.F. 2008. Prevalence and risks factors for dystocia in dairy cattle: A review. *Vet. J.* 176: 93-101.
- Ménard, N., M. Pagé, V. Busque, I. Croteau, R. Picard, et D. Gobeil. 2007. Rapport sur l'état du parc marin du Saguenay-Saint-Laurent 2007. 65 p. + annexes.
- Michaud, R. 1992. Fréquentation de la baie Sainte-Marguerite par le béluga du Saint-Laurent (*Delphinapterus leucas*) Contrat # FP 707 1 5171, rapport final présenté au Ministère des Pêches et Océans, Institut Maurice-Lamontagne et au Service canadien des parcs. INESL, Tadoussac, Québec. 34 p.
- Michaud, R. 1993. Distribution estivale du béluga du St-Laurent : synthèse 1986-1992. *Rapp. tech. can. sci. halieut. aquat.* 1906: vi + 28p.
- Michaud, R., M. Moisan, V. de la Chenelière, S. Duquette et M.-H. D'Arcy. 2010. Les activités d'observation en mer des mammifères marins (AO3M) dans l'estuaire du Saint-Laurent : zone de protection marine Estuaire du Saint-Laurent et parc marin du Saguenay-Saint-

-
- Laurent : Portrait 2005-2010. Rapport final. GREMM, Tadoussac, Québec, conjointement avec le parc marin du Saguenay–Saint- Laurent, Qc, et le ministère des Pêches et des Océans du Canada, Qc. 33 pp. + annexe.
- Mosnier, A., Doniol-Valcroze, T., Gosselin, J.-F., Lesage, V., Measures, L., and Hammill, M.O. 2014. An age structured Bayesian population model for St. Lawrence Estuary beluga (*Delphinapterus leucas*). DFO Can. Sci. Advis. Sec. Res. Doc. 2013/127. v + 39 p.
- Pippard, L. 1985. Patterns of movement of the St. Lawrence white whales (*Delphinapterus leucas*). Canadian wildlife service et Parcs Canada. Rapport technique. 225p.
- Scarratt, M., Michaud, S., Measures, L., Starr, M. 2014. Phytotoxin analyses in St. Lawrence Estuary beluga. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/124. v + 16 p.
- SOM. 2007. Étude auprès des plaisanciers navigants dans le parc marin Saguenay-Saint-Laurent, Rapport final présenté à Parcs Canada, Service de la recherche en sciences sociales, Centre de services du Québec. 63p.
- Turgeon, S., C.C. de Albuquerque Martins, L. Parrott. 2008. Analyse spatio-temporelle de la cooccurrence entre les bélugas et le trafic maritime à l'embouchure de la rivière Saguenay de 2003 à 2007. Rapport présenté à Parcs Canada. 37 p.
- Turgeon, S. 2008. Analyse spatio-temporelle de la cooccurrence entre les bélugas et le trafic maritime à la Baie-Sainte-Marguerite de 2003 à 2008. Rapport présenté à Parcs Canada. Montréal : Université de Montréal. 40p.