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Ecologically and Biologically Significant Areas (EBSAs) in the Estuary and Gulf of St. Lawrence – A marine mammal perspective

Zones d'importance écologique et biologique (ZIEB) pour l'estuaire et le golfe du Saint-Laurent – une perspective des mammifères marins

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Abstract

The importance of some areas of the Estuary and Gulf of St. Lawrence for the aggregation for marine mammals is a long-recognized phenomenon. In this report, results from three aerial surveys and two satellite-telemetry studies are analysed and combined with results from the existing literature to identify known areas of concentration of marine mammals. The quality of areas of marine mammal concentration and associated functions are assessed against criteria developed to identify Ecologically and Biologically Significant Areas (EBSAs). Based on these criteria, there would be eleven areas of ecological and biological significance for marine mammals: 1) Pointe-des-Monts to Sept-Îles, 2) West of Anticosti, 3) Jacques-Cartier Strait, 4) Strait of Belle-Isle/Mecatina Plateau, 5) Western shelf of Newfoundland, 6) Entrance of St Georges Bay, Newfoundland, 7) Cape Breton Trough, 8) Offshore Gaspé, including the channel of Baie des Chaleurs, 9) North margin of the Laurentian Channel to the south of Anticosti, 10) the St. Lawrence Estuary, and finally, 11) the Shelf of southern Gulf, which would find its importance mainly during the ice-covered period.

Résumé

L'importance de certaines aires de l'estuaire et du golfe du Saint-Laurent pour l'agrégation des mammifères marins et un phénomène reconnu depuis longtemps. Dans ce rapport, les résultats de trois inventaires aériens et de deux études de télémétrie par satellite sont analysés et combinés aux résultats de la littérature existante afin d'identifier les aires connues de concentrations de mammifères marins. La qualité de ces aires de concentration de mammifères marins et leurs fonctions sont déterminées à l'aide de critères développés pour identifier les Zones d'Importance Écologique et Biologique (ZIEBs). Selon ces critères, il existerait onze aires d'importance écologique et biologique pour les mammifères marins: 1) Pointe-des-Monts à Sept-Îles, 2) Ouest d'Anticosti, 3) Détroit de Jacques-Cartier, 4) Détroit de Belle-Isle/Plateau Mecatina, 5) Plateau à l'ouest de Terre-Neuve, 6) Entrée de St Georges Bay, Newfoundland, 7) Tranchée du Cap Breton, 8) Au large de Gaspé, incluant le chenal de la Baie des Chaleurs, 9) Marge nord du chenal Laurentien au sud d'Anticosti, 10) L'estuaire du Saint-Laurent, et finalement, 11) le plateau du sud du golfe, qui trouve son importance principalement lorsque la glace est présente dans cette région.

Introduction

The importance of some areas of the Estuary and Gulf of St. Lawrence for the aggregation for marine mammals is a long-recognized phenomenon. Cartier, from his first voyages to the New World in 1535, noted important densities of marine mammals in the Gulf of St. Lawrence, mentioning having seen more whales near Anticosti than they could remember ever having seen before (Prince 1905). The Basque whalers and others after Cartier also reported an abundance of marine mammals in several areas of the Estuary or Gulf of St. Lawrence (e.g., Charlevoix 1744; Reeks 1871; Saint-Cyr 1886; reviewed in True 1904; Prince 1905). Archaeological searches and national archives have also indicated a long history of marine mammal exploitation within these regions (e.g., see reviews in Anonymous 2003; Barkham 1984; Comeau 1945; Dickinson and Sanger 2005; McDougall 1979; Reeves 1986). Species present in the Estuary and Gulf of St. Lawrence belong to the order Cetacea (dolphins, porpoises and whales) and the order Pinnipedia (seals and walruses). Their abundance in the Gulf and Estuary likely results from the combination of abundant food resources, sheltered haul-out areas and stable ice. In modern times, the relative proximity of these concentrations of marine mammals to human centres has contributed to supporting a seasonal commercial hunt of pinnipeds, and to the development of multimillion dollar seal and whale observation industries centred near Tadoussac in the St. Lawrence Estuary, and near Gaspé, the Mingan Islands, southeast Prince Edward Island, the Îles-de-la-Madeleine, and Cheticamp in the Gulf of St. Lawrence (Hoyt 2001; Figure 1).

In spite of this qualitative traditional information about the importance of the Estuary and Gulf of St. Lawrence for a variety of marine mammal species, quantitative data to describe their seasonal abundance and distribution are generally scarce, particularly for cetaceans. Data concerning the two marine mammal groups also differ markedly in type, details and areas covered. Research on seals has been conducted mainly in the Îles-de-la-Madeleine and in the southeastern Gulf of St. Lawrence near St Georges Bay since the late 1970's and early 1980's, although more recent research efforts have included sites in the Estuary and northern Gulf of St. Lawrence. Studies have been directed primarily towards harvest management, estimating population size, diet composition, and reproductive behaviour (e.g., Asselin et al. 1993; Baker et al. 1995; Boulva and McLaren 1979; Chouinard et al. 2005; Hammill et al. 1997; Hammill et al. 1998; Hammill et al. 2005; Hammill and Stenson 2000; Kovacs et al. 1991; Kovacs and Lavigne 1992; Lesage et al. 2001; Lydersen et al. 1994; Lydersen and Kovacs 1993; Morissette et al. 2006; Robillard et al. 2005; Sergeant 1991; Stenson et al. 1993; Stenson et al. 2002; Stewart and Lavigne 1984; Stewart and Murie 1986; Yunker et al. 2005). Information concerning at-sea movements of pinnipeds is more limited (Goulet et al. 2001; Hammill 1993; Lavigueur et al. 1993; Lavigueur and Hammill 1993; Lesage et al. 2004), although results from recent satellite tracking studies should partially fill knowledge gaps for some of these species (Harvey 2007; C. Bajzak, Laval University, Qc, in prep.). Directed research on cetaceans has been conducted mainly in the Estuary and some areas of the northern Gulf of St. Lawrence and near Cape Breton in the southern Gulf. Quantitative information on seasonal distribution and movements, diet composition, and reproductive biology is particularly weak to non-existent for many species. Some NGOs have deployed considerable efforts collecting data on the distribution and relative abundance of some species, but few results are available in the primary or secondary literature. Directed research efforts by other groups have been sporadic and overall, scarce. Sears and Williamson (1982) and Kingsley and Reeves (1998) represent the main sources of information for the distribution and abundance of cetaceans in the Estuary and Gulf of St. Lawrence. A few other studies provided information for specific species and areas (e.g., beluga: Béland et al. 1985; Gosselin et al. 2001; Gosselin et al. 2007; Kingsley 1998a; Kingsley 1999; Michaud et al. 1990; Michaud 1993; Sergeant et al. 1970; Vladykov 1946; Vladykov 1944; Balaenopteridae in the northwestern Gulf: Doniol-Valcroze 2001; Doniol-Valcroze et al. 2007; Naud et al. 2003; Balenopteridae in the Estuary: Edds and Macfarlane 1987; killer whales: Mitchell and Reeves 1988; Vladykov 1944; Wenzel and Sears 1988; various cetacean in the northern Gulf: Tournois 2003).

Information on seasonal distribution, areas of concentration, and purpose of use of different habitats is central to the understanding of the ecology of species and of ecosystem structure and functioning. Coastal and marine urban, rural, and industrial development impose increasing pressure on the marine environment and habitats. The identification of areas of ecological and biological significance is essential to allow marine development to proceed while protecting ecosystem integrity.

In this report, we first provide a brief outline of marine mammal species that may be encountered in the Estuary or Gulf of St. Lawrence. This report presents the results from a few studies conducted recently by DFO, and examines the distribution of marine mammals in the Estuary and Gulf of St. Lawrence. These results are combined with results from the existing literature to identify known areas of concentration of marine mammals. The quality of areas of marine mammal concentration and associated functions are assessed against criteria developed to identify Ecologically and Biologically Significant Areas (EBSAs) (DFO 2004).

Pinnipeds

Seven species of pinnipeds occur in the Estuary or Gulf of St. Lawrence. The four most common species in the Estuary and Gulf of St. Lawrence are the harp (*Pagophilus groenlandicus*), hooded (*Cystophora cristata*), grey (*Halichoerus grypus*) and harbour (*Phoca vitulina concolor*) seals. Harp and hooded seals are seasonal visitors to the study area, as they move into the Gulf and Estuary in December–January, with most individuals leaving the area in April–May (Hammill 1993; Mansfield 1967b; Sergeant 1976; Sergeant 1982b; Sergeant 1991). Grey seals are primarily summer residents to the area, but some animals occupy the Gulf region year round (Austin et al. 2004; Goulet et al. 2001; Harvey 2007; Lavigueur and Hammill 1993; Mansfield and Beck 1977; Robillard et al. 2005; Stobo et al. 1990). Harbour seal colonies are found in several areas of the Estuary and Gulf of St. Lawrence and reside there throughout the year (Boulva and McLaren 1979; Lesage et al. 2004; Robillard et al. 2005). Ringed seals (*Phoca hispida*) were resident in the Saguenay River and the Estuary until at least the mid-1960s, but appear to have disappeared once ice-breaking began in the Saguenay river (Lavigne 1978b MS[1]). They are now along with bearded seals (*Erignathus barbatus*) only occasional visitors to the northern Gulf, and rare visitors to the southern Gulf of St. Lawrence (Gosselin and Boily 1994; Mansfield 1967b). Occasional sightings of walruses are still reported from the southern Gulf of St. Lawrence, but these are likely vagrant animals, as the last walrus was exterminated from the Îles-de-la-Madeleine in the 1700's (Kingsley 1998b).

Cetaceans

At least twelve species of cetaceans are known to occur with more or less regularity in the Estuary or Gulf of St. Lawrence. These include minke whales (*Balaenoptera acutorostrata*), fin whales (*Balaenoptera physalus*), blue whales (*Balaenoptera musculus*), humpback whales (*Megaptera novaeangliae*), harbour porpoises (*Phocoena phocoena*), Atlantic white-sided dolphins (*Lagenorhynchus acutus*), whitebeaked dolphins (*Lagenorhynchus albirostris*), beluga whales (*Delphinapterus leucas*), sperm whales (*Physeter macrocephalus*), killer whales (*Orcinus orca*), North Atlantic right whales (*Eubalaena glacialis*), and long-finned pilot whales (*Globicephala melas*). Based on their ecology and preferred habitats elsewhere, an additional four species might also enter the study area, although available information precludes any firm conclusion as to their presence or the regularity of their occurrence. These species include northern bottlenose whales (*Hyperdon ampullatus*), striped dolphins (*Stenella coeruleoalba*), shortbeaked common dolphins (*Delphinus delphis*), and sei whales (*Balaenoptera borealis*). Among the cetaceans, the beluga is the unique permanent resident to the Estuary or Gulf of St. Lawrence (Michaud et al. 1990; Vladykov 1944; reviewed in Lesage and Kingsley 1998). Although blue whales and other rorqual whales are known to occur in the waters of the Estuary and Gulf of St. Lawrence throughout the year, these and other cetacean species are considered as seasonal visitors, coming into the St. Lawrence system mainly for feeding purposes (reviewed in Hammill et al. 2001; Kingsley and Reeves 1998; Sears and Calambokidis 2002; see also Sergeant et al. 1970; GREMM unpubl. archived data, available at www.baleinesendirect.net). Historically, bowhead whales were harvested in the northeastern Gulf in the Strait of Belle Isle, but there exists to our knowledge, no contemporary reports of this species in the Gulf of St. Lawrence (Barkham 1984; Rastogi et al. 2004).

[1] Lavigne, J.-P. 1978. La chasse estivale du phoque dans le Saint-Laurent. Unpubl. manuscript prepared for Fisheries and Oceans Canada, Qc. Available at: M.O. Hammill, DFO, 850 Route de la Mer, Mont-Joli, Qc G5H 3Z4.

Methods

The initial objective of the present study was to incorporate all of the survey data obtained from shipboard or aerial surveys conducted by DFO since 1988 into a quantitative analysis to define EBSAs for marine mammals. However, due to time constraints for data analysis, the detailed analyses presented here were restricted to three aerial surveys only. These surveys were chosen because they targeted mainly cetaceans, for which little information currently exists in the literature, they covered a large portion of the Gulf of St. Lawrence, and all followed a similar and systematic design, which allowed for linking observations to effort (see below). In addition to these data, the results from two satellite-telemetry studies presenting home range analyses of grey seal and hooded seal movements were exploited to define areas of concentrations (see below).

Surveys

Field methodology

The surveys that were retained for analyses in the context of this exercise were three aerial surveys conducted following a line-transect design. Surveys were flown from late-July to mid-September along transect lines spaced 15' of longitude or 10' of latitude apart in 1995 and 1996, and 10 miles apart in 2002 (Figures 2–4). Results from the 1995 and 1996 surveys have been published previously, and a detailed description of the methodology can be found in the original publication (Kingsley and Reeves 1998).

Data collection during the three surveys followed the standard methodology for a line-transect design. Observations were recorded by two observers seated in the back of a Cessna-337 (Skymaster) equipped with a GPS and bubble windows, and flying at an altitude of 700 ft in 1995 and 1996, and 500 ft in 2002, and at a speed of 110 kn. For each sighting, the species, number of individuals, time and declination angle were noted. In 1995 and 1996, the time (usually to the nearest minute) was entered manually. In 2002, the sighting data including time, weather conditions and the aircraft position for every 2 s were logged directly onto a computer linked to a GPS by a third observer seated in the co-pilot seat, using custom-designed software (VOR, D. Palka, National Marine Fisheries Service, Woods Hole, MA). In 2002, data entered for each sighting also included cues to sighting, swimming direction of animals, and reaction to the aircraft. Angle from the horizon was measured to the nearest degree using an inclinometer. The angle perpendicular to the trackline was measured using an inclinometer or wing strut markers as a backup (1995 and 1996) or on an anglemeter fixed to the side of the windows (2002). Sea state (Beaufort), reflection intensity, cloud cover, and visibility were recorded at the beginning of each transect or as they changed. In 2002, these information were also noted at the end of each transect and at a 15–30 min interval. Positions for sightings, and changes in conditions were interpolated assuming a constant flying speed. All observers had previous experience with marine mammal surveys.

Sightings were identified to the species when possible. Unidentified individuals were assigned to one of four categories depending on their size, behaviour and blow: *unidentified dolphins* when size and shape was that of a dolphin and no blow was visible, or when animals were porpoising at the surface; *unidentified seal* when a head was observed at the surface and the size and shape was that of a seal; *unidentified small cetacean* when no blow was visible and size was relatively small; or *unidentified large whale* when animals were of a size larger than a minke whale or when only a large back or a distinct blow was observed. The *unidentified small cetaceans* might comprise minke whales, pilot whales, beaked whales, beluga or harbour porpoises, whereas the *unidentified large whales* might comprise the larger Balaenopteridae (fin, humpback, right and blue whales) as well as sperm whales. Only individuals associated with positive identification to species level were used in this study.

Data analysis

Sightings made under acceptable survey conditions, i.e., in Beaufort sea states of < 4, when no fog prevailed within 2 nm from the trackline, and when sun reflection was nil to moderate (see Kingsley

and Reeves 1998 for definition), were analysed in detail. The mid-point of the range was used as the estimate of pod size when counts were imprecise.

A rigorous analysis of line-transect data to obtain the best possible density estimates requires the development of sea state- and species-dependent detection functions. A correction for g(0), i.e., for detectability and availability at the surface, also needs to be applied to crude density estimates to obtain precise density and abundance estimates from the sighting data (Buckland et al. 1993; Buckland et al. 2001). In this study, time constraints prevented such a thorough analysis. Instead, raw sightings were used as indices of density. These figures are considered minimal and have unknown bias because species with different detectability and availability characteristics were lumped together (see below). Detectability at the surface depends on many factors, some of which are highly dependent on species characteristics, such as size, color and behaviour (e.g., CETAP 1982; Kingsley and Gauthier 2002). Availability is related to diving behaviour and surface-breathing frequency, which also varies greatly between species.

The study area was divided into cells of 1/8 degree of longitude by 1/12 degree of latitude (Figure 5). Survey effort was expressed in kilometres of trackline per cell, whereas encounter rates corresponded to biomasses or number of individuals encountered per km of trackline surveyed in each cell. Biomasses of marine mammals were calculated by using the mean mass of adult males and females (Table 1). Biomass indices were expressed for each cell as the percentile of the cell biomass relative to the range and maximum biomasses observed across the study area. Distribution of marine mammals was examined at the species level, but also according to their known or presumed diets, resulting in four categories. The *zooplankton-consumers* were represented by blue whales and right whales (Kenney et al. 1986; Mayo and Marx 1990; Murison and Gaskin 1989; Sergeant 1966). The *fish consumers* consisted of the beluga whale and harbour porpoise, all the pinniped species except the harp seal, and all the dolphins species, desspite that some species of dolphins and the beluga are known to feed to some extent on squids (Bowen and Harrison 1996; Fontaine et al. 1994b; Gaskin 1992b; Gaskin 1992c; Hammill et al. 1997; Hammill and Stenson 2000; Lien et al. 2001; Murie and Lavigne 1992; Palka et al. 1997; Ross 1993; Sergeant et al. 1980; Vladykov 1946). The *opportunistic feeders* designated mainly those Balaenopteridae, whose diets may vary between zooplankton and fish depending on areas or time of the year, i.e., fin, minke, and humpback whales (e.g., Bredin 1985; Brodie 1978; Gambell 1985; Katona and Beard 1991; Kawamura 1980; Mitchell 1973; Mitchell 1974b; Mitchell 1975b; Murison and Gaskin 1989; Piatt et al. 1989; Sergeant 1963; Sergeant 1966; Whitehead and Carscadden 1985; Winn and Reichley 1985). This category included also the harp seal, whose diet is composed of invertebrates and fish (Hammill et al. 2005). Finally, the *squid consumers* comprised deep-diving species such as sperm whales, beaked whales and pilot whales that are known to include squid regularly as prey in their diet (Reeves and Whitehead 1997; Sergeant 1962; Whitehead et al. 2003; Whitehead and Wimmer 2005).

Telemetry studies

Field methodology

Grey seals (N = 59) were captured by deploying a net in the water near their haul-out site in the Estuary at Bic or Metis, and at Anticosti Island, Miramichi, Amet Island in the Northumberland Strait, or on the ice in one of their whelping area in St Georges Bay near Cape Breton in the Gulf of St. Lawrence (Figure 1). Hooded seals (N = 23) were captured on the ice in their whelping area of the southern Gulf of St. Lawrence using a net set between two aluminium poles. Seals were immobilised with an intramuscular injection of Telazol® (Tiletamine and Zolazepam, Fort Dodge® Laboratories, Iowa) at a dose of 0.5 to 1.0 mg kg^{-1} body mass. Animals were equipped with half-watt or one watt satellite-linked time-depth recorders (PTT, Wildlife Computers, Redmond, Washington) or half-watt satellite relays data loggers of the 9000 series (Sea Mammal Research Unit, Scotland). The telemetry device was glued high on the neck on the back of the skull.

Data analysis

A detailed analysis of the movements and diving behaviour of grey seals and hooded seals forms the core of two Master's degree thesis that are currently under review (Harvey 2007). Only a short summary of the data analysis and results from this work are presented in this report. Briefly, a 95% fixed kernel home range (Worton 1989) was calculated from individual locations pooled by sex for hooded seals, and pooled for the species as a whole for grey seals, using the Animal Movement Extension in Arcview 3.2a (Environmental System Research Institute, Inc. 2000). Home ranges for grey seals were calculated by randomly selecting 30 locations per individuals (N = 51). This procedure was repeated several times to insure similarity in location and size of home ranges between trials (Harvey 2007). In the case of hooded seals, home ranges were based on 673 locations from 10 females and 539 locations from 10 males. Autocorrelation between successive locations was reduced by selecting locations separated by at least 12 hours. Least-squares cross-validation were used to select the smoothing parameter providing the least biased area estimates (Seaman and Powell 1996). Home ranges for grey seals were calculated separately for the ice-free (April to December) and ice-covered periods (January to March). In the case of hooded seals, PTTs transmitted data only during the period between the reproduction and the moult, i.e., between approximately mid-March and mid-May, and thus, corresponded grossly to the ice-free period.

Ecologically and Biologically Significant Areas (EBSAs)

The designation of EBSAs was based on the criteria developed in 2004 (DFO 2004), and included species diversity and total biomasses as indices of possible importance. Diversity indices were qualified as the minimum number of species detected in an area. The biomass indices for a candidate EBSA were evaluated by determining the biomass percentile most frequently observed among the cells of this area. The delineation of EBSAs should have been made through spatial analyses. However, areas were delimited subjectively by hand due to time constraints.

Results

Surveys

The effort deployed in good survey conditions was distributed non-uniformly throughout the Estuary and Gulf of St. Lawrence (Figure 6). Indeed, no effort was deployed in the Estuary or in the sectors north of Îles-de-la-Madeleine, east of Miscou, and off Cloridorme along the Gaspé Peninsula. Limited effort was made in St Georges Bay (west of Cape Breton), to the east and northeast of Prince Edward Island and south of the Îles-de-la-Madeleine. Conversely, effort was slightly more intense just east of Pointe-des-Monts, and in the eastern Gulf along the Lower North Shore and western Newfoundland. Given the small number of surveys, few areas were covered more than once.

A total of 519 sightings of 1757 individuals from 11 species were made during the three surveys combined (Table 2). Harbour porpoises were the most frequently observed species, being detected 4.5 times more often than the other most common species, which were, in decreasing order of importance, the minke whales, Atlantic white-sided dolphins, humpback whales, and shortbeaked common dolphins. Group sizes were usually one or a few individuals for most species, except for dolphins and pilot whales for whom groups of a few tens of individuals were sometimes encountered.

The distribution of sightings of the different species was non-uniform within the survey area (Figures 7—17). Blue whales were mainly observed to the northeast of Pointe-des-Monts, with one sighting off the Gaspé Bay (Figure 8). Fin whale sightings were all reported in the portion of the Gulf north of the Îles-de-la-Madeleine, mainly on the shelves or along channel margins (Figure 9). Harp seals, humpback whales, whitebeaked dolphins, and shortbeaked common dolphins were far more abundant in the Belle-Isle/Esquiman Channel/Mecatina Plateau area in the northeastern Gulf (Figures 7, 10, and 16, 17). However, some humpback whales were also observed to the northeast of Pointe-des-Monts and along western Newfoundland, whereas concentrations of shortbeaked common dolphins were also observed in the Laurentian Channel near Cabot Strait (Figure 10). Concentrations of Atlantic white-sided dolphins were generally observed in areas of relatively deep water, such as the Esquiman Channel, the

Laurentian Channel near St Georges Bay in southwestern Newfoundland, the entrance of the Gaspé Bay, the area to the northeast of Pointe-des-Monts, and the deeper waters of the Jacques-Cartier Strait (Figure 15). One exception to this pattern was a concentration of white-sided dolphins, which was observed in the shallower waters of the Strait of Belle-Isle/Mecatina Plateau. Pilot whale sightings were concentrated in deep waters of the southeastern part of the Gulf, and more specifically in the Cape Breton trough, and at the entrance of St Georges Bay in southwestern Newfoundland, with a few sightings at the confluence of the Jacques-Cartier and Esquiman channels (Figure 13). Beluga sightings in the Gulf all occurred in an area off Sept-Îles (Figure 12). Harbour porpoises were ubiquitous in the Gulf of St. Lawrence (Figure 14). However, they were detected in larger numbers in the northern part of the Gulf, with encounter rates being particularly high on the Banc Parent just west of Anticosti Island, at the entrance of the Gaspé Bay, in the Jacques-Cartier Strait and eastward onto the north shore shelf, and along the western shelf of Newfoundland from Bay of Island and northward. Minke whales were also ubiquitous in the Gulf, although they were observed more frequently along the north shore shelf, including the Strait of Belle Isle (Figure 11).

When animals were grouped according to their feeding habits, the *krill consumers* were concentrated to the northeast of Pointe-des-Monts and off the entrance to Baie des Chaleurs (Figure 18). The *fish consumers* were widely distributed in the northern and eastern parts of the Gulf, with notable concentrations in St Georges Bay (Newfoundland), the Mecatina Plateau/Strait of Belle Isle area, the Jacques-Cartier Strait and Cape Breton trough (Figure 19). *Opportunistic feeders* also occurred is several areas of the Gulf, but were associated mainly with the north shore shelf and the margins of the Laurentian, Esquiman and Jacques-Cartier channels, with particularly high concentrations of animals in the Mecatina Plateau/Strait of Belle Isle area (Figure 20). The *squid consumers*, which were represented only by the pilot whales on survey tracklines, were observed mainly in the trough to the west of Cape Breton, and at the entrance to St Georges Bay (Newfoundland), with a few sightings at the confluence of the Jacques-Cartier and Esquiman channels (Figure 21).

Telemetry studies

Home range analyses of telemetry data delineated areas mainly used by grey and hooded seal while in the Estuary or Gulf of St. Lawrence. During the period between mid-March and mid-May, hooded seals confined their movements to the Laurentian Channel, although their range also included sectors to the west of Anticosti and to the northeast of Pointe-des-Monts (Figure 22). The core of their distribution corresponded to sectors of the Laurentian Channel located south and west of Anticosti and included Cabot Strait, as revealed by the 50% kernel home ranges.

During the ice-free period, grey seals mainly used the sector to the west of Anticosti, between the Banc Parent and the north shore, and the shelf of the western Gulf all along the Gaspé peninsula, the coast of New Brunswick, Nova Scotia and Cape Breton (Figure 23). Areas of concentration at this period included the Miramichi area, Northumberland Strait and northwestern sector of Cape Breton, including the trough. During the ice-covered period, the Anticosti area was deserted and the distribution of grey seals shifted south to include other sectors outside of the Gulf on the Scotian Shelf and south of Newfoundland, with a core distribution in the Gulf centered on Miramichi, part of Northumberland Strait and northwest of Cape Breton, including the trough (Figure 23).

Areas supporting high biomasses or biological diversity

Nine areas of aggregation were suggested by the total biomasses of cetaceans (including a few sightings of harp seals) observed on transects during summer aerial surveys. These areas of concentration were the sectors of 1) Pointe-des-Monts east to Sept-Îles, 2) to the west of Anticosti, 3) the Jacques Cartier Strait, 4) the Strait of Belle Isle/Mecatina Plateau area, 5) the western shelf of Newfoundland, 6) the entrance of St Georges Bay in western Newfoundland, 7) the Cape Breton trough, 8) the area offshore Gaspé including the channel of Baie des Chaleurs, and 9) the north (and possibly the south) margin of the Laurentian Channel to the south of Anticosti (Figure 24). These areas were also characterized by generally diverse megafauna and served primarily nutritional functions (Table 3; see also Discussion). The sectors from Pointe-des-Monts to Sept-Îles and to the west of Anticosti were also

identified through the home range analyses of telemetry data as areas of aggregation for grey seals and/or hooded seals during summer (Figures 22 and 23). An additional area of aggregation, whose maximal use occurred during winter, was identified through the telemetry study, and will be referred to as 10) the shelf of the southern Gulf of St. Lawrence (Figure 24; Table 5). The analyses also identified other sectors of aggregation (see previous section), which appeared to be used only by limited biomasses of a small number of species. Consequently, based on the data analysed in this study, only the ten above-mentioned areas were retained as potential candidates for designation as EBSAs.

Ecologically and Biologically Significant Areas

Only a limited amount of the available data was used so far in this study to identify candidate EBSAs. In order to propose a list of EBSAs, which is the most realistic possible, the results from this study need to be complemented with published and unpublished information. Consequently, for clarity purposes, proposed EBSAs and the rational for their spatial and temporal designation will be presented in the Discussion section rather than in the Results section of this report.

Discussion

The results presented here are limited in several ways. None of the datasets covered the entire study area. They differed in the period they covered and were acquired generally over short periods of time. For example, aerial survey results came from three surveys that covered various parts of the study area and were flown during non-overlapping short time windows, but all within a 1.5-month period during summer. Considering that the distribution and abundance of marine mammals in the Estuary and Gulf of St. Lawrence is highly seasonal, variability in distribution and abundance was expected, even during the short period (late July – mid September) over which the three surveys were carried out (e.g., Edds and Macfarlane 1987; Sears and Williamson 1982). The occurrence of relatively abundant species or of those species entering the study area for a relatively long period of time during summer was likely captured during these surveys, as they were conducted relatively late in the summer season. However, the low coverage and short time window likely underestimated the area of occupancy of most species, and probably also limited the detection of the less abundant species, those species with limited distribution, or which were present only sporadically in the study area. These species include blue whales, shortbeaked common dolphins, striped dolphins, bottlenose whales, killer whales, sperm whales, North Atlantic right whales, etc.

Another limitation to this study is the very basic treatment of the data. As indicated previously, encounter rates are minimal as they represent exclusively the animals detected at the surface. Encounter rates are also highly biased towards species that are more detectable either through their size or surface behaviour (e.g., time spent at the surface or behaviour at the surface). It is likely that encounter rates of small and cryptic species such as harbour porpoises, or long- and deep-diving species, such as bottlenose whales and sperm whales, were underestimated in this study (e.g., Okamura et al. 2006; Scott and Gilbert 1982).

The home range analysis of grey seal data covered most of their annual cycle. However, the core (50%) and general distribution (kernel 95%) areas identified through this exercise were highly dependent on tagging sites, which has likely biased the results (see below). The home range analysis of hooded seal data was less likely to be biased spatially, given that all of the individuals were tagged in the only whelping area for the species in the Gulf. However, satellite telemetry data covered only a small portion of the annual cycle of this species and, therefore, did not capture areas that were used between late fall and early winter when hooded seals move into the Gulf and Estuary to eventually reproduce in March.

Considering these important limitations to the results, the list of EBSAs presented below should be used with extreme caution, as this list is likely incomplete and somewhat biased due to limited effort, both spatially and temporally. For example, the relative importance of the St. Lawrence Estuary was not characterized by the analyses due to an absence of effort in this area. Finally, the EBSAs are likely highly

imprecise not only in their spatial and temporal delineation, but also in the biomasses and species they support.

The next two sections validate the results of our analysis against the existing literature and unpublished data for 1) the distribution and areas of aggregation of each species, and 2) the use of areas of aggregation identified as candidate EBSAs based on species diversity and biomass indices. This provides a rationale as to whether areas should or should not be classified as EBSAs, and will allow setting of spatial and temporal boundaries to the retained EBSAs. Other areas of potential importance for marine mammals, not revealed through the current study, will also be discussed to propose a final set of EBSAs (Tables 4 and 5; Figure 24).

Distribution and areas of aggregation of the different species

Grey seals

The grey seal inhabits continental shelf waters throughout the year in the Northwest Atlantic (Bowen et al. 2006; Goulet et al. 2001; Harvey 2007). This species is believed to enter the St. Lawrence Estuary in April-May possibly to moult, then mainly to feed, and to leave the area sometime during the autumn to breed in the southern Gulf of St. Lawrence, on the Scotian Shelf at Sable Island, or in Maine and Massachusetts (Beck et al. 2003; Hammill and Gosselin 2005; Lavigueur et al. 1993; Lavigueur and Hammill 1993; Mansfield and Beck 1977; Stobo et al. 1990; Waring et al. 2007). Grey seals represent the second most abundant pinniped species in the Gulf of St. Lawrence, with an estimated 52,000 individuals entering the Gulf t reproduce in 2004, or approx. 20% of the total population of the Northwest Atlantic, based on pup counts in whelping areas (Bowen et al. 2007; Hammill and Gosselin 2005; Trzcinski et al. 2006). Both Sable Island and southern Gulf of St. Lawrence grey seals occupy the Estuary and Gulf during the ice-free period, but the number of individuals present in the St. Lawrence system during that period, although in the thousands, remains uncertain (Bowen et al. 2007; Robillard et al. 2005).

In the Estuary, the largest aggregations are observed at Île-aux-Fraises and Bic archipelago, and along the north shore of the Lower St. Lawrence Estuary between the Betsiamites River mouth and Baie-Comeau (Lavigueur et al. 1993; Robillard et al. 2005; see the latter report for detailed locations). Aggregations of grey seals also occur in many areas of the Gulf of St. Lawrence during the ice-free period, notably on Anticosti Island, which supports the largest colonies, but also in the Mingan Islands, Miramichi Bay, Prince Edward Island, and on the small islands surrounding the Îles-de-la-Madeleine (Île Brion et Deadman Island) (Clay and Nielsen 1985; Fortin and Hudon 1978; Lavigueur and Hammill 1993; Robillard et al. 2005; Sears et al. 1981; see the latter report for detailed locations). Whelping in the Gulf occurs on small islands off Nova Scotia and Cape Breton Island (e.g., Amet Island and Hay Island) and the Îles-de-la-Madeleine (e.g., Deadman Island), as well as on the pack ice between Prince Edward Island, Nova Scotia and Cape Breton Island (Gosselin et al. 2007; Hammill et al. 1998; Mansfield and Beck 1977).

The home range analysis of grey seal satellite data indicated a core distribution centred on Miramichi Bay during both the ice-free and ice-covered periods, with additional winter core distribution areas in the Northumberland Strait and off Cape Breton (Figure 23). As indicated previously, grey seal distribution and areas of aggregation were biased in this study by the distribution of tagging effort. The large proportion of animals tagged in the Miramichi Bay (N = 37 of 59 ind.) compared to the relative abundance of grey seals in this specific area strongly biased the home range analysis towards this summer aggregation area in the southern Gulf. Similarly, the low tagging effort at Anticosti Island (N = 10 ind.) compared to the size of this colony (i.e., several thousands of individuals) has likely underestimated the importance of this region for grey seal. Although a 95% probability distribution area was identified by the kernel analysis in the Jacques-Cartier Strait near the Mingan Islands during summer, a tagging effort proportional to the relative size of the grey seal colonies in this area would probably have identified it as an important core distribution area (e.g., Goulet et al. 2001). Similarly, the low tagging effort in the St. Lawrence Estuary (N = 3 ind.) where several hundreds of grey seals occur during summer likely resulted in the absence of a core distribution area in this sector as well (Austin et al. 2004; Lavigueur et al. 1993; Robillard et al. 2005). Grey seals appear to have a strong requirement to periodically haul out outside of

the reproductive and moulting season and frequently forage within 50 km of these haul out sites (Sjöberg and Ball 2000; Sparling et al. 2007). Consequently, counts at haul-out sites provide relative indices of concentration in different areas throughout the Gulf and Estuary and thus, can be used to assess potential biases in home range analyses (Clay and Nielsen 1985; Robillard et al. 2005).

The distribution and core distribution areas of grey seals during the ice-covered period were also likely biased to some extent. The disproportionately high tagging effort in Miramichi Bay probably overestimated the importance of this region relative to other wintering areas. During winter months, most of the grey seals still occupying the Gulf are expected to be found in the southern Gulf. Consequently, the overall and core distribution areas identified through the home range analysis correspond well with the general wintering and whelping areas (Hammill et al. 1998; Lavigueur and Hammill 1993; Mansfield and Beck 1977). However, the relative importance and boundaries of the different core distribution areas within the southern Gulf may be expected to change towards a greater importance of the Northumberland Strait and Cape Breton area with a more balanced tagging effort (e.g., Hammill and Gosselin 2005).

Consequently, based on the available information, grey seals are likely abundant in each of the candidate EBSA, except possibly the western shelf of Newfoundland and the north margin of the Laurentian Channel to the south of Anticosti.

Harbour seals

The harbour seal is a coastal phocid that inhabits temperate and Arctic waters of the northern hemisphere (Boulva and McLaren 1979; Mansfield 1967a; Mansfield 1967b). This species is believed to be relatively sedentary throughout the year, although long-distance migrations have been documented among adults of this species (Bjørge et al. 1995; Gjertz et al. 2001; Harvey 1987; Lesage et al. 2004; Lowry et al. 2001; Pitcher and McAllister 1981; Stewart and Yochem 1994; Thompson et al. 1996; Thompson et al. 1998). The species occurs in both the Estuary and Gulf of St. Lawrence throughout the year (Lesage et al. 2004). In Atlantic Canada, trends in harbour seal numbers are largely undocumented, but this species is considered the least abundant of the pinnipeds, with an estimated total population size of approx. 10,000–15,000 individuals (Boulva and McLaren 1979; Bowen et al. 2003; Fowler and Stobo 2005; Gilbert et al. 2005; Hammill and Stenson 2000; Robillard et al. 2005; Sjare et al. 2005; Waring et al. 2007). Although total population size and its relative distribution remain highly uncertain, the St. Lawrence might support approximately 4000–5000 harbour seals or a third of the total population, of which approximately 75–80% would occur in the Gulf of St. Lawrence (Robillard et al. 2005; Smith 2006).

Harbour seal distribution and abundance data in the Estuary and Gulf of St. Lawrence during the ice-free period come from 1) a study where questionnaires were sent to fisheries agents during the 1970's (Boulva and McLaren 1979Lavigne 1978 MS, summarized in Robillard et al. 2005), 2) local studies conducted in the 1970s and 1980s in the Forillon area (Gaspé peninsula) and Mingan Archipelago (Desaulniers 1989; Fortin and Hudon 1978; Sears et al. 1981) and in the late 1990s in Prince Edward Island (Cairns et al. 2000), and more recently, from 3) repeated aerial or shipboard surveys of the Estuary, and 4) one survey of the north and western part of the Gulf of St. Lawrence (Lavigueur et al. 1993; Robillard et al. 2005). Information on the winter distribution is much scarcer, and comes essentially from a satellite telemetry study of a few harbour seals tagged in the Estuary, from a few opportunistic boat surveys and local studies in the Forillon area and Mingan Archipelago (Desaulniers 1989; Fortin and Hudon 1978; Lavigueur et al. 1993; Lesage et al. 2004). During the ice-free period, harbour seal haul-out sites occur throughout the St. Lawrence Estuary (Boulva and McLaren 1979; Desaulniers 1989; Lavigne 1978 MS, summarized in Robillard et al. 2005; Robillard et al. 2005). Similar to grey seals, harbour seals appear to remain in the vicinity of their haul-out sites during the summer (Lesage et al. 2004). Consequently, survey counts at haul out sites were used as an index of relative abundance in different sectors. Recent studies based on aerial surveys of haul out sites indicate that harbour seals are more numerous in the Lower Estuary and along the south shore than in the Upper Estuary or the Saguenay River or along the north shore (Robillard et al. 2005). The zones of highest abundance in the Estuary include, in decreasing order of importance, the Bic archipelago, Batture aux Alouettes and Île Blanche near the Saguenay mouth, Pointe Mitis, Hauts-fonds de Mille-Vaches, Batture de Tobin / Batture de l'Île Ronde, and Batture aux Outardes (Robillard et al. 2005; see report for detailed locations). In the Gulf,

harbour seals are essentially concentrated around Anticosti and Prince Edward Island, and to a lesser extent near Gaspé, in the Mingan Archipelago, and at the Îles-de-la-Madeleine (Boulva and McLaren 1979; Cairns et al. 2000; Desaulniers 1989; Fortin and Hudon 1978; Lavigne 1978 MS, summarized in Robillard et al. 2005; Robillard et al. 2005). Although recent information is lacking for the Lower North shore and western Newfoundland, older data suggest that harbour seals may also use these areas, at least during the ice-free period (Boulva and McLaren 1979; Lavigne 1978 MS, summarized in Robillard et al. 2005). Information on areas of occupancy during winter indicates that harbour seals occupy areas of the Estuary or Gulf of St. Lawrence where ice conditions remain light to intermediate (Lesage et al. 2004). These preferences explain why no harbour seals were seen in the Mingan Archipelago during winter, as this area was totally covered with ice at that time (Desaulniers 1989).

There exists little information on the at-sea distribution of harbour seals in the Estuary or Gulf of St. Lawrence (Lavigueur et al. 1993; Lesage et al. 1995; Lesage 1999; Lesage et al. 2004). Movement and diving patterns documented using satellite telemetry during both the ice-free and ice-covered periods indicate that daily harbour seal movements are generally limited to within a few kilometres from their haul-out sites and that the species is a shallow diver in this area (Lesage et al. 1999; Lesage 1999; Lesage et al. 2004). Consequently, no specific data pertaining to the harbour seal offshore distribution or abundance was incorporated in the current analyses, and the likelihood of their presence in different areas of the Gulf was determined based on the proximity of known haul-out sites. Based on these indirect evidences of habitat use, harbour seals were expected to be present in each of the candidate EBSA zones, with the exception of the north margin of the Laurentian Channel and the western shelf of Newfoundland where the exploitation of areas that far offshore is uncertain.

Harp seals

The harp seal is a highly migratory, pelagic phocid that summers in the High Arctic, and winters off the northern Newfoundland and Labrador coasts as well as in the Estuary and Gulf of St. Lawrence (Hammill and Stenson 2000; Lacoste and Stenson 2000; Lavigueur et al. 1993; Sergeant 1991). Part of the population enters the Gulf in late November or December to feed in the Estuary or the Gulf of St. Lawrence (Beck et al. 1993; Lavigueur et al. 1993; Murie and Lavigne 1986; Ronald and Dougan 1982; Sergeant 1976; Sergeant 1991). Harp seals whelp on the pack ice in the southern Gulf near the Magdalen Islands and Prince Edward Island, in the northeastern Gulf (Mecatina Patch) and off the northeast coast of Newfoundland (The Front), and normally leave the Gulf by the end of May (Mansfield 1967b; Sergeant 1976; Sergeant 1982b; Sergeant 1991). The harp seal is the most abundant pinniped in Atlantic Canada with an estimated population of 5.8 million animals, of which approximately one third are produced in the Gulf (Hammill and Stenson 2005; Stenson et al. 2005).

Large herds of harp seals are seen throughout winter until late-May and some observations continued into the summer since a few years in the St. Lawrence Estuary and northern Gulf (e.g., Lavigueur et al. 1993; Sears and Williamson 1982; Sergeant 1991; Lesage and Hammill, DFO, unpubl. data). In the Gulf, harp seals are seen or hunted all along the north shore east to the Strait of Belle Isle, around the Îles-de-la-Madeleine, on the ice off Cheticamp and south into the eastern Northumberland Strait beginning in January through to April—May (Sears et al. 1981; Sears and Williamson 1982; Sergeant 1991; Stenson et al. 2003b; J.-F. Gosselin, DFO, unpubl. data; M.O. Hammill, DFO, unpubl. data). The pups appear to follow the ice as it leaves the Gulf through Cabot Strait (Sergeant 1967). Once the ice enters Cabot Strait some pups may remain with the ice, while others move north along the west coast of Newfoundland, exiting via the Strait of Belle Isle in June (Sergeant 1965; Sergeant 1991). After the pup is weaned, the females undergo a brief period of intensive feeding in the southern Gulf or in the St. Lawrence Estuary (Beck et al. 1993; Sergeant 1991). Males remain with the whelping patch throughout the whelping and breeding period. Once breeding has ended then animals haul out on the ice to moult (Mansfield 1967b). In normal years, seals moult on ice around the Magdalen Islands or in the northern Gulf of St. Lawrence (Sergeant 1982b; Sergeant 1991).

Only a few individual harp seals were detected during this study, and all were observed in the northwestern Gulf of St. Lawrence (Figure 7). The small number of individuals detected during surveys probably resulted from a combination of the date of the surveys, which were conducted when most harp

seals would have left the study area, and of the low sightability of this species at sea when not aggregated into large herds. Nevertheless, these observations support earlier reports that some harp seals persist in some sectors of the Gulf of St. Lawrence throughout the year (Hammill and Stenson 2000).

Currently, the information available is insufficient to estimate the distribution of harp seals during the period comparable to the other species, i.e., between April and November—December. During December to May, the species is known to occur in most of the candidate EBSAs. However, their presence in St Georges Bay, off Gaspé and along the north margin of the Laurentien Channel to the south of Anticosti has not been specifically documented. Particularly large concentrations have been documented in the Mecatina area and in the southern Gulf of St. Lawrence around the Îles-de-la-Madeleine, in the Northumberland Strait, and along Cape Breton and Prince Edward Island. These sectors have been combined to form a candidate winter EBSA for pinnipeds (see below).

Hooded seals

The hooded seal is a highly migratory pelagic phocid, which summers in the Arctic and migrates to eastern Canada to spend the winter (Lavigne and Kovacs 1988; Reeves and Ling 1981). Hooded seals form a single population (Coltman et al. 2007). In the Northwest Atlantic, hooded seals whelp on the pack ice in three main regions, i.e., Davis Strait, off the northeastern Newfoundland coast and in the Gulf of St. Lawrence (Bowen et al. 1987; Hammill et al. 1992; Sergeant 1974; Stenson et al. 1997). The hooded seal population was estimated at nearly 600, 000 individuals in 2005, of which a variable, but relatively low proportion reproduced in the Gulf (Hammill and Stenson 2006).

Information on hooded seal movements has been gathered from tag resightings, observations and from deployment of satellite transmitters (Hammill 1993; Sergeant 1976; C. Bajzak, in prep.). Hooded seals enter the Gulf of St. Lawrence during the autumn and remain there until early the beginning of May (Hammill 1993; C. Bajzak, unpubl. data). Some individuals likely move into the St. Lawrence Estuary to feed prior to and after reproduction, as suggested by anecdotal sightings (Comeau 1945; Sergeant and Hoek 1983; L. Measures, DFO, Quebec region, Mont-Joli, unpubl. data). However, their solitary nature at sea and pelagic habits make them hard to detect, particularly during winter when ice is present along shores. Hooded seals are seen in the southern Gulf in December. Pupping occurs on the pack ice during mid-March in the sector to the north of Prince Edward Island, although in some years, the patch may be found off Cheticamp, to the west of Cape Breton (Bowen et al. 1987; Hammill et al. 1992). Females leave the whelping patch once the pups are weaned and move to the northern slope of the Laurentian Channel where they remain until the start of May. At that time, a few animals exit the Gulf via the Strait of Belle Isle, but the majority exist via Cabot Strait along the south coast of Newfoundland and migrate to Greenland (C. Bajzak, in prep). Males remain associated with the whelping patch until breeding ceases near the end of March and like females, they move to the north slope of the Laurentian Channel for a period of about four weeks before leaving the Gulf for Greenland (C. Bajzak, in prep). The pups remain with the ice as it drifts north from the Prince Edward Island coast towards Cabot Strait (Hammill 1993). The direction of the drift varies with local wind conditions. However, a proportion of the pups likely remain in the Estuary and Gulf of St. Lawrence during their first year, as indicated by the many reports of hooded seals found live or dead on the shore of the Estuary and Gulf of St. Lawrence, or south of their normal distribution range (Harris et al. 2001; Harris and Gupta 2006; Lucas et al. 2003; Lucas and Daoust 2002; L. Measures, DFO, Quebec region, unpubl. data; Réseau d'urgence Mammifères Marins, Tadoussac, unpubl. data).

No hooded seals were sighted during the aerial surveys. These results were unsurprising as this species is not expected to be found in significant number in the Gulf during late summer. The home range analysis of hooded seal satellite data indicated a spring core distribution centred in the Gulf on the Laurentian Channel, including the Esquiman channel, with concentrations of movements to the west and southwest of Anticosti and in Cabot Strait (Figure 22). Considering that all tagging effort occurred on the whelping grounds, hooded seal distribution and areas of aggregation reflect the distribution of mature animals alone, and only for the post-breeding period.

Based on the current knowledge, five candidate EBSAs are likely to be used by hooded seals, including 1) West of Anticosti, 2) the western shelf of Newfoundland, particularly the Esquiman channel, 4) the winter candidate EBSAs of the shelf of the southern Gulf of St. Lawrence where they reproduce, and 4) the north margin of the Laurentian Channel to the south of Anticosti.

Blue whale (Balaenoptera musculus)

Blue whales in the North Atlantic inhabit coastal and offshore waters from high latitudes during the feeding season (Ingebrigtsen 1929; Jonsgård 1955; Jonsgård 1966). During the ice-free period in the northwest Atlantic, they are reported regularly in the Estuary and Gulf of St. Lawrence, sporadically off Labrador and Newfoundland and on the Scotian Shelf, and occasionally in the Gulf of Maine (Doniol-Valcroze et al. 2007; Edds and Macfarlane 1987; Hooker et al. 1999; Kingsley and Reeves 1998; Lavigueur et al. 1993; Lawson 2003; Pippard and Malcolm 1978; Ramp et al. 2006; Sears et al. 1990; Sears and Williamson 1982; Sergeant 1966; Sutcliffe and Brodie 1977; Wenzel et al. 1988). Little is known about the winter distribution of blue whales in the North Atlantic, but historical as well as recent data suggest that at least some blue whales occur at lower latitudes at that time (reviewed in National Marine Fisheries Service (NMFS) 1998; Sears and Calambokidis 2002; see also Reeves et al. 2004b). Winter reports from different areas of the Estuary and northern Gulf of St. Lawrence, and from southern Newfoundland and St Georges Bay in southwest Newfoundland indicate that a proportion of the population remains at our latitude and in the study area throughout the year (Gosselin and Lawson 2004; Lavigueur et al. 1993; Mitchell 1975b; Sears and Calambokidis 2002; Sears and Williamson 1982; Sergeant 1982b; Stenson et al. 2003b; Stenson et al. 2003a GREMM, unpubl. archived data, available at www.baleinesendirect.net). Blue whales in the Northwest Atlantic appear to form a single population, although the distribution range of this population and existence of others in the North Atlantic are not entirely resolved (Clark 1994; National Marine Fisheries Service (NMFS) 1998; Reeves et al. 2004b; Sears et al. 1990; Sears and Calambokidis 2002; Sears and Larsen 2002; Wenzel et al. 1988). There exists no recent estimates of abundance for blue whales in the northwest Atlantic, but it was felt unlikely by the scientific committee of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) that more than a few hundreds of individuals remained in this population (COSEWIC 2002; Hammond et al. 1990; Mitchell 1974a; Sears and Calambokidis 2002; Sergeant 1982b). The Estuary and northwestern Gulf of St. Lawrence yielded the largest number of recent reports for this species, with 20 to 105 positively identified individuals per year (Sears and Calambokidis 2002). Although the distribution of recent sightings result from the greater effort made in the latter regions (Doniol-Valcroze et al. 2007; Sears et al. 1990), sporadic efforts in other areas of the Northwest Atlantic have failed to detect substantial numbers of blue whales (CETAP 1982; Gosselin and Lawson 2004; Hooker et al. 1999; Larsen et al. 1989; Palka 2006; J. Lawson, DFO, unpubl. data).

Distributional data issued from systematic studies are scarce for blue whales. In the St. Lawrence Estuary, a land-based study conducted in the Les Bergeronnes/Les Escoumins area during the 1970s and early 1980s reported regular sightings of blue whales along the north shore (Edds and Macfarlane 1987; Mitchell 1974b). A long-term study based out of whale-watching vessels confirmed the continued used of this area by blue whales during the 1990s (Michaud et al. 1997). In the Gulf of St. Lawrence, line-transect aerial surveys conducted in 1982 and 1995–1996, and long-term more localized studies using small vessels or aircrafts in the northern Gulf detected blue whales near Pointe-des-Monts, Sept-Îles/west Anticosti, Gaspé, and the Stait of Belle Isle areas (Hammond et al. 1990; Kingsley and Reeves 1998; Sears 1979; Sears et al. 1981; Sears et al. 1990; Sears and Williamson 1982). Reports of ice-entrapment of blue whales in St Georges Bay to the southwest of Newfoundland prior to the 1990s also suggest the presence of blue whale aggregations in this sector during winter (Stenson et al. 2003a). A compilation of anecdotal sightings and small-scale systematic surveys around Newfoundland supports the use of St Georges Bay and the head of the Esquiman Channel by blue whales (Lawson 2003; Lien 1980).

The blue whale distribution data presented in this study, was based partly on the 1995–1996 systematic survey mentioned previously (Kingsley and Reeves 1998), and provided an incomplete and biased image of the probable distribution of blue whales in the Estuary and Gulf of St. Lawrence. Indeed, our results confirmed the use of the sectors located to the northeast of Pointe-des-Monts and off Gaspé near the entrance of Baie des Chaleurs (Figure 8). However, areas known to be used regularly by blue

whales, such as the St. Lawrence Estuary, were not surveyed. Other areas, whose frequentation by this highly mobile species may vary greatly over short periods of time and between years, were surveyed at a low coverage (Hammond et al. 1990).

Based on the available information, blue whales are likely to occur at least seasonally in the following candidate EBSAs: 1) the Strait of Belle-Isle/Mecatina plateau, 2) Pointe-des-Monts to Sept-Îles, 3) west of Anticosti, 4) entrance of St Georges Bay Newfoundland, 5) offshore Gaspé, including channel of Baie des Chaleurs, and the 6) western shelf of Newfoundland including the head of the Esquiman channel (Table 6). In addition, blue whales are known to occur regularly in the St. Lawrence Estuary.

Fin whale (Balaenoptera physalus)

Fin whales occur in most oceans of the world, usually in temperate or polar regions and less commonly, in tropical waters (Aguilar et al. 2002; Jonsgård 1966). In the Northwest Atlantic, the species is distributed from Cape Hatteras in the south to northern Davis Strait in the north, and encompasses in its range the Estuary and Gulf of St. Lawrence (reviewed in Sergeant 1977; see also COSEWIC 2005; Doniol-Valcroze et al. 2007; Edds and Macfarlane 1987; Giard et al. 2001; Hay 1982; Lavigueur et al. 1993; Mitchell 1974b; Sears and Williamson 1982; Sergeant 1966; Tournois 2003; True 1904). Fin whales likely constitute several stocks in the North Atlantic, but their exact number and range remain unresolved (Bérubé et al. 2001; Coakes et al. 2005; Donovan 1991; Mitchell 1974a; Sergeant 1966; Sergeant 1977; Waring et al. 2007). Genetic analyses and photo-identification work suggest that fin whales occurring in the Estuary and Gulf of St. Lawrence, and those found on the Scotian Shelf, in the Bay of Fundy and possibly in the Gulf of Maine, may belong to the same stock (Bérubé et al. 2001; Coakes et al. 2005; R. Sears, unpubl. data, cited in COSEWIC 2005). Fin whales in eastern Newfoundland might be part of a distinct stock (Brodie 1975; Mitchell 1974a; Sergeant 1966; Sergeant 1977). The distribution of fin whales across a wide range of latitudes throughout the year, and the failure to detect calving or breeding wintering grounds, suggest that migration patterns, at least in the North Atlantic, are complex (CETAP 1982; Clark 1995; Jonsgård 1966; Kellogg 1929; Sergeant 1966; Sergeant 1977; reviewed in Aguilar et al. 2002; Waring et al. 2007). One plausible suggestion has been that fin whales perform north-south seasonal migrations, with fin whales of a northern stock occupying summer grounds left empty by the southern migration of a southern stock during winter (CETAP 1982; Kellogg 1929; Mitchell 1974a; Sergeant 1977). An alternative or other component of their seasonal migratory pattern, which is also plausible, is the migration of a number of fin whales to offshore waters during winter (Aguilar et al. 2002; Clark 1995; Sergeant 1977). This suggestion is supported by the observation of a reduced number of fin whales on the continental shelf in November to May compared to more seaward waters in the Northwest Atlantic (Slijper et al. 1964, cited in Sergeant 1977). There exists several abundance estimates for different portions of the range of the species in the Northwest Atlantic (reviewed in COSEWIC 2005; Waring et al. 2007). The species would number in the low thousands in eastern U.S. and Nova Scotia (point estimate of approx. 2,800 ind.; Palka 2006; Waring et al. 2007), between 4000 and 8000 in Newfoundland and Labrador (Mitchell 1974a; but see also Lawson 2006) and in the low hundreds in the Gulf of St. Lawrence (Kingsley and Reeves 1998; Mitchell 1972). The most recent estimate for the Gulf of St. Lawrence (347 ind.) was uncorrected for visibility biases and was qualified as unreliable by the authors due to the small number of sightings.

Fin whales are regular visitors to both the Estuary and Gulf of St. Lawrence. In the Estuary, they can be seen regularly during the ice-free period in waters of the Laurentian Channel up to Tadoussac, and sometimes further west (Edds and Macfarlane 1987; Giard et al. 2001; Lavigueur et al. 1993; Michaud et al. 1997; Mitchell 1975b; Pippard and Malcolm 1978; Sergeant 1977; Tournois 2003). In the Gulf, long-term studies, and whaling records, indicate that fin whales are also regularly present in the sectors between Pointe-des-Monts and Sept-Îles, to the West of Anticosti and in the Jacques-Cartier Strait (Doniol-Valcroze et al. 2007; Mitchell 1974a; Mitchell and Reeves 1983; Sears 1979; Sears et al. 1981; Sears and Williamson 1982). Their distribution there appears to be tightly linked to thermal fronts (Doniol-Valcroze et al. 2007). The historical importance of the Sept-Îles/West Anticosti area for fin whales is evidenced by the establishment of a whaling station in Sept-Îles during the 1905–1915 and the high number of whales (approx. 65), either fin or blue whales, killed at this station (Mitchell and Reeves 1983).

Local studies and whaling records indicate that the species is also abundant in the Gaspé area during the ice-free months (Fortin and Hudon 1978; Reeves 1986; see also Sergeant 1977). Land-based, aerial and shipboard surveys confirmed the presence of fin whales in the Estuary and in each of the areas mentioned above during this period, with additional sightings in the Strait of Belle Isle/Mecatina Plateau area, along the north margin of the Laurentian Channel to the south of Anticosti, and in western Newfoundland including St Georges Bay (Lynch 1987; Perkins and Whitehead 1977; Sears and Williamson 1982; Tournois 2003; J. Lawson, DFO, unpubl. data reported in COSEWIC 2005 as Fig. 4). Anecdotal reports from the late 1970s also support the regular presence of fin whales along the northwestern coast of Newfoundland (Lien 1980). Reports from the southern Gulf appear much scarcer. However, regular fin whale sightings by whale-watching companies based in or near Cheticamp indicate that this species occurs on a regular basis between May and October along the northwestern coast of Cape Breton Island (Hammill et al. 2001). The presence of fin whales in the Strait of Belle Isle/Mecatina Plateau area during the ice-covered period is supported by reports of ice entrapments during the spring (Sergeant et al. 1970). Sighting and ice entrapment reports along the southwestern shore of Newfoundland in March and April suggest that some fin whales either spend the winter or arrive early near or in the sector of St Georges Bay (Sergeant 1966; Sergeant et al. 1970). Anecdotal sightings reported through an observer network also indicates that fin whales are present in different areas of the Estuary and northern Gulf of St. Lawrence, including the Gaspé and Sept-Îles areas until at least the end of January, when the ice forms and observations become more difficult (GREMM, unpubl. archived data, available at www.baleinesendirect.net).

During this study, fin whales were observed exclusively in the northern and northeastern Gulf of St. Lawrence, with a few individuals detected in each of the candidate EBSAs, except the northwestern Cape Breton Trough (Figure 9). The absence of fin whales in the latter sector, and the low densities observed in other sectors might result from the low survey effort, both spatially and temporally. Our results also provide a biased image of the overall abundance and distribution of fin whales due to the lack of coverage of the St. Lawrence Estuary, where they are known to occur regularly during the ice-free period until at least January.

Based on the available information, fin whales are likely to occur regularly in each of the candidate EBSAs, with possibly a more seasonal occurrence in St Georges Bay. The species also occurs regularly in the St. Lawrence Estuary.

Humpback whale (Megaptera novaeangliae)

The humpback whale is a highly migratory species, which is distributed in all oceans of the world (Clapham 2002; see also Reeves et al. 2004b). In the Northwest Atlantic, its range extends from Labrador, Davis Strait and West Greenland south to the West Indies, and includes the Estuary and Gulf of St. Lawrence (Doniol-Valcroze et al. 2007; Edds and Macfarlane 1987; Katona and Beard 1990; Lynch 1987; Sergeant 1966; Smith et al. 1999; Tournois 2003; Whitehead 1987). The species generally migrates between temperate- to high-latitude summer feedings grounds and low latitude winter breeding and calving areas. Nevertheless, some individuals are observed at temperate to high latitudes throughout the year, suggesting either differences in the timing of migrations or individual variability in seasonal migration patterns (Barco et al. 2002; Brown et al. 1995; Clapham et al. 1993; Craig and Herman 1997; Ingebrigtsen 1929; Laerm et al. 1997; Sergeant 1966; Stevick et al. 2003a; Swingle et al. 1993; Whitehead et al. 1982; Wiley et al. 1995). Stock structure has not been completely resolved for humpback whales in the North Atlantic, as there seems to be some sharing of breeding/calving areas among the feeding stocks, and relatively strong fidelity to feeding areas, though some movements among feeding areas have been documented (reviewed in COSEWIC 2003b; see also Stevick et al. 2006). Humpback whales from the Gulf of St. Lawrence would be part of the eastern Canada feeding aggregation (Stevick et al. 2006). There exists a number of estimates of abundance for various areas in the North Atlantic, including an estimate of approx. 11,000 individuals for the entire North Atlantic, and an estimate of approx. 2,500 individuals for the Canadian waters, both of which are suspected to be negatively biased (reviewed in Whitehead 1987; COSEWIC 2003b; see also Anonymous 2001; Smith et

al. 1999; Stevick et al. 2003b). The proportion of animals occurring in the Gulf of St. Lawrence is unknown (Kingsley and Reeves 1998).

Humpback whales are regular visitors to both the Estuary and Gulf of St. Lawrence during the ice-free period. However, only a few individuals are generally present in the Estuary at any one time (Edds and Macfarlane 1987; Pippard and Malcolm 1978; Sergeant 1966; Tournois 2003). In the Gulf, humpback whales appear to concentrate mainly in the northern Gulf in the sectors of Pointe-des-Monts to Sept-Îles, West Anticosti and Strait of Belle Isle/Mecatina Plateau (Doniol-Valcroze et al. 2007; Lien 1980; Lynch 1987; Sears and Williamson 1982; Smith et al. 1999; Stevick et al. 2006; Tournois 2003). According to Sears and Williamson (1982), citing unpublished reports by Lien (1979; 1980; 1982), humpback whales would also be seen regularly, though not commonly, along the west coast of Newfoundland (see also Lynch 1987). Humpback whales would also be present at least occasionally in southwestern Newfoundland (Lynch 1987). The historical presence of humpback whales in the Sept-Îles/ West Anticosti and Belle Isle areas is supported by humpback whale harvest reports from these regions (Mitchell and Reeves 1983; Reeves and Mitchell 1982). Humpback whales were the most common whales encountered by Gaspé whalers during the early 1800s, but because the Sept-Îles to West Anticosti area represented an important whaling ground, it is uncertain whether any humpback whales were actually encountered or hunted off the Gaspé peninsula *per se* (Mitchell and Reeves 1983). However, recent unpublished shipboard survey data and anecdotal sightings, and an older local study in the Forillon National Park area indicate that the species is present in the Gaspé area during the ice-free period (Fortin and Hudon 1978; J.F. Gosselin, DFO, unpubl. data; GREMM, unpubl. archived data available at www.baleinesendirect.net). During a survey conducted in late May 1982, isolated individuals were detected in Cabot Strait, suggesting that humpback whales may occur in small numbers in other areas of the Gulf (Sears and Williamson 1982). The exact location of whale sightings could not be assessed due to the inaccessibility of these unpublished reports. Regular sighting reports by whale-watching companies based out of Cheticamp in western Cape Breton during 2000 indicate that the species may be present in this sector at least on a seasonal basis (Hammill et al. 2001). These observations are supported by earlier reports indicating the presence of the species close to shore in the southern Gulf of St. Lawrence (Sergeant 1966).

The winter occurrence of humpback whales in the Gulf of St. Lawrence remains largely undocumented. The only evidence for their presence in the St. Lawrence during winter comes from regular anecdotal reports made through an observer network. These reports indicate the presence of the species off Gaspé during the ice-free period through to at least mid- to late January, when ice usually forms along the coast and when whale observations become more difficult (GREMM unpubl. archived data, available at www.baleinesendirect.net). Whether the species remains in the Gulf throughout the winter or comes back during the spring remains uncertain.

During this study, aggregations of humpback whales were observed in the Strait of Belle Isle/Mecatina plateau area, at the head of the Esquiman Channel and along the northwestern coast of Newfoundland, with a few sightings to the east of Pointe-des-Monts, to the west of Anticosti, and in St. Georges Bay (Figure 10). Although these results coincide well with previous information on the distribution of humpback whales in the Gulf, the low intensity of effort and short time window to conduct the surveys may have provided a somewhat biased image of the relative abundance of humpback whales in the different sectors of the Gulf. The absence of coverage of the Estuary precluded the assessment of the distribution of the species in this area.

Based on the current knowledge, humpback whales are expected to occur in the following candidate EBSAs: 1) Pointe-de-Monts to Sept-Îles, 2) West Anticosti, 3) Mecatina/Belle Isle, 4) western Newfoundland, 5) St Georges Bay, 6) northwestern Cape Breton, and 7) offshore Gaspé, including the channel of Baie des Chaleurs. Humpback whales are also known to occur regularly but in small numbers in the St. Lawrence Estuary.

Minke whale (Balaenoptera acutorostrata)

The minke whale is found in all oceans of the world from tropical to polar regions (Brownell et al. 2000). In the northern hemisphere, the species is believed to undertake seasonal migrations between northern feeding grounds and southern calving grounds, although the location of the latter is poorly known. In the Northwest Atlantic, minke whales range from Davis Strait and Baffin Bay during summer, south to at least the Carribean during winter (Mitchell 1991; Stewart and Leatherwood 1985). However, winter sightings off the east and south shores of Newfoundland suggest that some individuals might remain at our latitude throughout the year (Lynch 1987; Sergeant 1963). Minke whales are ubiquitous off the east coast of Canada and the eastern U.S., and occur in both the Estuary and Gulf of St. Lawrence usually as singletons (Abraham and Lim 1990; Edds and Macfarlane 1987; Kingsley and Reeves 1998; Lavigueur et al. 1993; Lynch 1987; Mitchell 1975b; Mitchell and Kozicki 1975; Mitchell 1991; Palka 2006; Perkins and Whitehead 1977; Pippard and Malcolm 1978; Sears and Williamson 1982; Sergeant 1963; Tournois 2003). The Canadian east Coast stock of minke whales is estimated at approximately 4,000 individuals (not corrected for detectability and availability biases), a quarter or more of which would occur in the Gulf of St. Lawrence (Kingsley and Reeves 1998; Waring et al. 2007). There exists no reliable estimate for the abundance of minke whales in the St. Lawrence Estuary.

Previous information on the distribution of minke whales in the Estuary and Gulf of St. Lawrence comes mainly from shipboard or aerial surveys conducted in the early 1980s and mid-1990s following a more or less systematic sampling design, and from local studies and anecdotal reports (Doniol-Valcroze et al. 2007; Edds and Macfarlane 1987; Lavigueur et al. 1993; Michaud et al. 1997; Mitchell 1974b; Naud et al. 2003; Perkins and Whitehead 1977; Pippard and Malcolm 1978; Sears 1979; Sears et al. 1981; Sears and Williamson 1982; Sergeant 1963; Tournois 2003). In the St. Lawrence Estuary, minke whales were regularly reported during the ice-free period along the north shore of the St. Lawrence Estuary in the Les Bergeronnes/Les Escoumins area during the 1970s and early 1980s (Edds and Macfarlane 1987; Mitchell 1974b; Pippard and Malcolm 1978; Sears and Williamson 1982). Boat surveys and long-term studies using whale-watching vessels as platforms of observation confirmed the continued used of the area by the species during the 1990s (Lavigueur et al. 1993; Michaud et al. 1997). A local study in the Forillon National Park along the Gaspé Peninsula, line-transect aerial surveys conducted in 1982, and shipboard surveys using platforms of opportunity in 1995–1998 reported minke whale regularly in the sectors of Pointe-des-Monts to Sept-Îles, to the west of Anticosti, and in the Strait of Belle Isle/Mecatina Plateau area, with a few sightings reported in other areas of the Gulf such as Gaspé and St Georges Bay, Newfoundland (Fortin and Hudon 1978; Sears and Williamson 1982; Tournois 2003). The regular occurrence of minke whales in the sector between Pointe-des-Monts and the Mingan Islands during the ice-free months was confirmed from long-term studies conducted in this area since the late 1970s (Doniol-Valcroze et al. 2007; Naud et al. 2003; Sears 1979; Sears et al. 1981). Opportunistic sightings recorded between 1975 and 2004 and shipboard non-systematic surveys confirmed the occurrence of minke whales in other sectors such as the Strait of Belle Isle/Mecatina Plateau, the west coast of Newfoundland, and in St Georges Bay (Lien 1980; J. Lawson, DFO, unpubl. data presented in Dufault 2006). According to two studies conducted in the Mingan Island area, minke whales prefer sectors of sandy bottoms (sand dunes), and are not as tightly associated to thermal fronts as the larger rorquals (Doniol-Valcroze et al. 2007; Naud et al. 2003). Information on the occurrence of minke whales in the southern Gulf of St. Lawrence is much more sparse, but according to the 2000 daily reports from whale-watching companies operating off Cheticamp, Cape Breton, minke whales may be observed on more than 50% of days between May and October, indicating that the area of the to the west of Cape Breton is also used on a regular basis by this species (Hammill et al. 2001). However, information on their distribution or numbers within this area during or outside the summer-early fall seasons is lacking. Similarly, data related to the distribution and occurrence of minke whales during the winter months are also lacking.

The results from this study indicate that minke whales are ubiquitous in the Gulf of St. Lawrence, although they appear more common in the northern Gulf, particularly along the northern shelf (Figure 11). During the flights from 1995 and 1996 alone, approximately 75% of the 1,000 estimated minke whales inhabiting the Gulf at the time of the surveys were seen in the northern Gulf (Kingsley and Reeves 1998).

Repeated sightings were reported in the areas of Pointe-des-Monts to Sept-Îles, Jacques-Cartier Strait, and Strait of Belle Isle/Mecatina Plateau, with a few sightings coming from St Georges Bay, Newfoundland, west of Anticosti, the Gaspé area, and the western shelf of Newfoundland including the Esquiman Channel. The absence of coverage of the Estuary, where the species is expected to be found in significant numbers throughout summer, provided a biased view of the distribution of the species. The absence of minke whales in the candidate EBSA to the west of Cape Breton, and the small number of minke whales detected in the Gaspé area must be interpreted with caution, as these results might be an artifact of the low coverage of the southern Gulf of St. Lawrence and Gaspé area, which were surveyed only once (in 1995). Unpublished data from surveys based on platforms of opportunity and from daily reports by whale-watching companies indicated the presence of the species in both of these areas (Hammill et al. 2001; J.-F. Gosselin, DFO, unpubl. data).

Based on the available information, it is probable that minke whales appear in each of the candidate EBSAs proposed for the ice-free period. Minke whales are also known to occur regularly in the St. Lawrence Estuary.

North Atlantic right whale (Eubalaena glacialis)

The North Atlantic right whale occurs in temperate waters of the eastern and western North Atlantic, although sightings in the former regions are rare (Jacobsen et al. 2004; Kraus and Rolland 2007). In the Northwest Atlantic, the species ranges from Florida to southeast Labrador, including the Gulf, and more rarely the Estuary of the St. Lawrence (Anonymous 2003; Gaskin 1987; Kraus and Rolland 2007; Reeves et al. 1978). North Atlantic right whales exhibit some north-south seasonal movements between high latitude feeding grounds and southern latitude calving and wintering grounds, although the degree of dispersal and extent of distribution during winter are not entirely understood (COSEWIC 2003c; Gaskin 1991; Winn et al. 1986). Documented movements across the Atlantic, and preliminary genetic data suggest that right whales from both sides of the Atlantic might belong to the same population (International Whaling Commission 2001; Jacobsen et al. 2004; Knowlton et al. 1992; Rosenbaum et al. 2000). Approximately 300 individuals remain in this population (COSEWIC 2003c; Kraus et al. 2005)

Historical whaling data indicated that right whales were present in both the Estuary and Gulf of St. Lawrence (McDougall 1979; Mitchell and Reeves 1983). However, by the 1850s, right whales were essential absent from the Gulf, as only a few individuals were killed in the 1850s and only a few were seen in the early 1960s (Mitchell and Reeves 1983). A government report from 1912 mentionned the killing of a right whale upriver from Manicouagan, apparently the first of its kind to have been killed in the Gulf (which, was in fact the Estuary) in 60 years (Wakeham et al. 1913, cited in Mitchell and Reeves 1983). For a long time, there was a belief that right whales were abundant in the Strait of Belle Isle, where they were hunted (Aguilar 1986; Reeves et al. 1999). However, recent genetic analyses using whale bones from archaelogical whaling sites challenged this idea as it indicated that most of the harvest in the Strait of Belle Isle was comprised of bowhead whales, not North Atlantic right whales (Rastogi et al. 2004). In recent years, right whales have been observed in different parts of the Gulf, and only rarely, in the St. Lawrence Estuary (Anonymous 2003; COSEWIC 2003c; Hamilton et al. 2007; Kraus and Rolland 2007). Sectors of observation in the Gulf included Sept-Îles/Mingan Islands, Gaspé, Cabot Strait, and western Newfoundland (Anonymous 2003; Lien et al. 1989; Sears 1979; Sears et al. 1981; N. Cadet, R. Sears and R. Michaud, cited as pers. comm. in COSEWIC 2003; Hamilton et al. 2007; Kraus and Rolland 2007). One stranding in 2001 at the Îles-de-la-Madeleine (L. Measures, DFO Quebec region, unpubl. data) and the incursion into the Gulf of a satellite-tracked entangled individual in the same year (COSEWIC 2003c) suggest that the species may occur on a regular basis in the Gulf, although probably in low numbers. The sector of Gaspé appears to be the most regularly frequented area by the species, although observation effort might be biased toward that particular sector. The Gulf of St. Lawrence would be frequented by mothers that do not take their calves to the main summering area, i.e., the Bay of Fundy, and though, might represent an important summering habitat for a portion of this highly endangered population (Hamilton et al. 2007).

The presence of right whales in the Gulf of St. Lawrence during winter remains largely undocumented. A single anecdotal sighting reported in the Laurentian Channel in the southern Gulf of St. Lawrence during February 2005 is the sole evidence of a possible presence of the species in the Gulf during winter (J. Lawson, DFO, unpubl. data).

Based on the available information, the sole candidate EBSAs where sightings have been reported with some regularity over recent years is 1) offshore Gaspé, including the channel of Baie des Chaleurs. The sector from Sept-Îles to Mingan might also be visited sporadically, but no observations were reported in this sector since 1979.

Beluga whale (Delphinapterus leucas)

The beluga whale is an Arctic species, which is at its southern limit of distribution in the St. Lawrence Estuary (O'Corry-Crowe 2002). The species is migratory, but the extent of its seasonal movements varies greatly among populations (e.g., Kingsley et al. 2001; Lydersen et al. 2001; Richard et al. 2001a; Richard et al. 2001b; Suydam et al. 2001). Beluga whales in the St. Lawrence appear relatively sedentary, with a proportion of the population remaining in the Estuary throughout the year (Pippard and Malcolm 1978; Sears and Williamson 1982). Nevertheless, some seasonal expansion and compression of the population distribution have been documented, including the migration of an unknown proportion of the population into the Gulf of St. Lawrence during winter (Boivin and INESL 1990; Kingsley 1998a; Michaud et al. 1990; Michaud 1993; Michaud and Chadenet 1990; Pippard and Malcolm 1978; Sergeant 1986; Vladykov 1944). According to repeated systematic surveys, the St. Lawrence beluga population has been stable since 1988 at approximately 1000–1200 individuals (Kingsley 1998a; Kingsley 2001; Michaud and Béland 2001; see also Gosselin et al. 2001; Gosselin et al. 2007).

Information on the current seasonal distribution varies greatly in quality depending on season. The summer distribution of beluga, including the identification of areas of intensive use, is relatively well characterized from studies using in many cases, relatively systematic sampling designs (Béland et al. 1985; Gosselin et al. 2001; Gosselin et al. 2007; Kingsley 1998a; Kingsley 1999; Michaud 1993; Pippard and Malcolm 1978; Sergeant and Hoek 1988). The summer distribution is centered near the Saguenay River mouth, and extends west in the Estuary from Batture-aux-Loups-Marins near Île-aux-Coudres to Rimouski in the east, and to Saint-Fulgence in the Saguenay River, with occasional sightings reported outside of these limits (CETAP 1982; Curren and Lien 1998; Gosselin et al. 2007; Kingsley 1998a; Kingsley and Reeves 1998; Lesage and Kingsley 1998; Michaud et al. 1990; Pippard and Malcolm 1978; Reeves and Katona 1980). Beluga distribution during the autumn is similar to that observed during summer, except for a reduction of the distribution in the Saguenay to Baie Sainte-Marguerite, and of what appears to be a progressive displacement of the animals to the east into the Lower Estuary (Boivin and INESL 1990; Pippard and Malcolm 1978, but see Sears and Williamson 1982). In late fall and winter, beluga are mainly found in the Lower Estuary and northern Gulf of St. Lawrence. Reconnaissance surveys along the Gaspé Peninsula and the north shore east to Sept-Îles reported concentrations in the Sept-Îles area and along the Gaspé Peninsula east to Cloridorme (Boivin and INESL 1990). A systematic line transect survey conducted in the Lower Estuary and the northwestern portion of the Gulf in late March 2004 confirmed the extent of the distribution from at least the mouth of the Saguenay (the western limit of the survey design) to the area off Sept-Îles, and reported several beluga sightings just east of Pointe-des-Monts (J.-F. Gosselin, DFO, unpubl. data). The distribution of beluga is likely to be maximal in the spring when beluga are still reported to the east of their summer distribution area into the northwestern Gulf, while they are also reported in the Upper Estuary west to the Battures-aux-Loups-Marins (Michaud and Chadenet 1990; Pippard and Malcolm 1978).

During the late July—early August 1996 survey, three sightings totalling six belugas were reported, all in the area located off Sept-Îles (Figure 12). These sightings were unexpected and considered extralimital to their regular summer distribution, which is believed to be limited to the Estuary at that time of the year (Gosselin et al. 2001; Gosselin et al. 2007; Kingsley 1998a; Lesage and Kingsley 1998; Michaud et al. 1990). Nevertheless, these reports, and the observation of beluga whales on the last transect lines to the east in the St. Lawrence Estuary during the systematic surveys for that population

suggest that a re-evaluation and possibly an extension of the survey area to the east in future surveys might be warranted (Gosselin et al. 2007). Lone juvenile belugas have been reported in a number of harbours on the northwest coast of Newfoundland throughout the summer and fall periods since the early 2000s, but these are considered unusual occurrences (J. Lawson, DFO, unpubl. data).

Based on the available information, we conclude that the entire population of beluga occur in the Estuary during summer, with a large but unknown proportion of the population still occurring there during the spring, autumn and winter. In addition, the candidate EBSAs of Pointe-des-Monts to Sept-Îles is most probably an important wintering area for this population. Although some beluga whales are reported along the Gaspé peninsula outside the summer period, the importance of the candidate EBSA off Gaspé for the beluga remains uncertain.

Killer whale (Orcinus orca)

Killer whales occur in all oceans and most seas of the world, but generally concentrate in coastal, temperate waters of relatively highly productive regions (reviewed in Baird 2001; Ford 2002). The species occurs throughout eastern Canada from Bay of Fundy, Nova Scotia, north to at least Lancaster and Jones Sound in western Arctic, including waters from the Estuary and Gulf of St. Lawrence (Higdon 2007; Katona et al. 1988; Lawson et al. 2007; Lien et al. 1988; Mitchell and Reeves 1988; Pippard and Malcolm 1978; Reeves and Mitchell 1988; Sergeant et al. 1970; Sergeant and Fisher 1957; Vachon et al. 1988; Vachon et al. 1998; Wenzel and Sears 1988; Whitehead and Glass 1985). Although there has been some suggestions that killer whales might migrate seasonally and that their occurrence in polar regions might be limited by the presence of pack ice in winter months (Mitchell and Reeves 1988; Sergeant and Fisher 1957), there has been no reliable north-south movements documented for any of the populations, including killer whales in the northwest Atlantic (Mitchell and Reeves 1988; Reeves and Mitchell 1988; reviewed in Baird 2001). The observation of a killer whale deep into Antarctic sea ice in winter suggests that this species might tolerate heavier ice covers than previously thought (Gill and Thiele 1997). There exists no estimates of killer whale abundance for the northwest Atlantic, but a minimum of 64 individuals have been photo-identified in Newfoundland/Labrador (Lawson et al. 2007). Reports from the early 1900s, from the 1940s and 1970s indicate that killer whales were once abundant in the Estuary and Gulf of St. Lawrence, where they were killed frequently around Prince Edward Island (Prince 1905). Vladykov (1944) described 'infestations' of St. Lawrence waters by this species mainly during the spring and autumn to feed on beluga, and witnessed attacks by groups of up to 40 individuals. Pippard and Malcolm (1978) reported impressions of resident hunters and fishermen, who believed that killer whales were more prominent in the Estuary during the late 1960s - early 1970s then during the late 1970s. Killer whales are still reported occasionally in the Estuary and Gulf of St. Lawrence, but usually as singletons or pods of only a few individuals (Lawson et al. 2007; Lien et al. 1988; Mitchell and Reeves 1988; Vachon et al. 1988; Vachon et al. 1998; Wenzel and Sears 1988; GREMM unpubl. archived data, available at www.baleinesendirect.net). It is unlikely that an entry of any significant number of killer whales into the Estuary would go undetected, considering the high intensity of whale-watching activity and commercial traffic during the ice-free period. However, this might not be the case in the Gulf of St. Lawrence, where sighting effort is concentrated in the northwestern Gulf, with sporadic efforts in the Strait of Belle Isle area (e.g., Wenzel and Sears 1988).

In the Estuary, recent sighting reports mainly came from the north shore of the Estuary and the summer period, where most of the whale-watching and commercial traffic are concentrated (GREMM unpubl. archived data, available at www.baleinesendirect.net). In the Gulf of St. Lawrence, reports since the late 1970s came mostly from the Mingan Island area and the Strait of Belle Isle (Lawson et al. 2007; Mitchell and Reeves 1988; Vachon et al. 1988; Vachon et al. 1998; Wenzel and Sears 1988), although occasional sightings were also reported along the western shelf of Newfoundland and St Georges Bay, Newfoundland (Lawson et al. 2007; Lien et al. 1988). All except two sightings that were reported for other parts of the Gulf are unconfirmed sightings or strandings. Ice-entrapments of killer whales in St Georges Bay, southwest Newfoundland, and one sighting of a killer whale swimming around a fishing vessel off Prince Edward Island in 1979, indicate that this species may still occur at least occasionally in those areas (Mitchell and Reeves 1988; Sergeant 1982a).

No killer whale sightings were reported during the summer surveys presented in this study, even though areas of expected distribution in the Gulf were covered during these surveys. Whether the absence of killer whales on the track lines reflected the absence of the species in the Gulf at that time of the year, and/or the reduced detection probability of the species under the current survey design and effort cannot be resolved. Data quality was obviously insufficient, both in terms of spatial and temporal coverage to describe adequately the seasonal distribution and aggregation patterns, if any, of killer whales in the Estuary and Gulf of St. Lawrence.

Based on the available information, it is likely that killer whales occur in the candidate EBSAs of 1) Strait of Belle Isle/Mecatina Plateau, 2) West Anticosti, 3) Jacques Cartier Strait, with more sporadic or occasional occurrences and 4) in St Georges Bay, Newfoundland. Although killer whales were regularly reported previously in the St. Lawrence Estuary, intrusions in this area are now only occasional.

Long-finned pilot whale (Globicephala melas)

Long-finned pilot whales are widely distributed in cold and temperate waters of the North Atlantic and southern hemisphere. In the Northwest Atlantic, their distribution extends from Cape Hatteras north to Greenland, and includes the Gulf of St. Lawrence and to a much lesser extent, the Estuary (reviewed in Abend and Smith 1999; Nelson and Lien 1996; see also Fortin and Hudon 1978; Palka 2006; Payne and Heinemann 1993; Pippard and Malcolm 1978; Sears et al. 1981; Sears and Williamson 1982; Sergeant et al. 1970; Sergeant and Fisher 1957; Tournois 2003). There is no evidence for a marked north-south seasonal migration of long-finned pilot whales in the North Atlantic, but some seasonal inshore-offshore migrations are suspected in eastern Canadian waters, possibly in response to inshore movements of a preferred prey, the shortfin squid (Mercer 1973; Mercer 1975; Payne and Heinemann 1993; Sergeant 1962; Sergeant and Fisher 1957; reviewed in detail in Abend and Smith 1999). The species has been heavily hunted in the North Atlantic, including Newfoundland (Mercer 1973; Mitchell 1975a). There exists no reliable estimate for the post-whaling abundance of pilot whales, nor is there a clear understanding of the stock structure in the North Atlantic (Abend and Smith 1999; Hay 1982; IWC 1990; Nelson and Lien 1996). In the western Atlantic, pilot whales might number several tens of thousands of individuals, a few thousand of which could occur in the Gulf of St. Lawrence (Abend and Smith 1999; Kingsley and Reeves 1998; Waring et al. 2007).

Long-finned pilot whales have been reported in both the Estuary and Gulf of St. Lawrence. Occasional sightings have been made in the Estuary, but there exists no recent published record of anecdotal sightings for that area (Mathewson 1935; Pippard and Malcolm 1978; Préfontaine 1930). Pilot whales have also been observed occasionally in the northern Gulf of St. Lawrence, in the sectors off Gaspé and to the west of Anticosti Island during the ice-free period (Fortin and Hudon 1978; Sears et al. 1981; Sergeant and Fisher 1957). The largest number of pre- and post-whaling sightings came from the southern Gulf of St. Lawrence, particularly from the sectors off northwestern Cape Breton and western Newfoundland, including St Georges Bay, where individual or mass strandings have occasionally been reported (DFO unpubl. journals, cited in Kingsley and Reeves 1998; Lien 1980; Lynch 1987; Sears and Williamson 1982; Sergeant et al. 1970; Sergeant 1982a; Sergeant and Fisher 1957; Tournois 2003). Long-finned pilot whales represent nearly 20% of the reported strandings at Prince Edward Island since 1988, supporting their current presence in the southern Gulf of St. Lawrence (P.-Y. Daoust, cited as unpubl. data in Hammill et al. 2001). According to daily records from whale-watching companies based in or near Cheticamp, pilot whales were observed on 71–99% of days between June and October 2000, including regular sightings of over 100 individuals (and at least one observation of 200+ whales) (Hammill et al. 2001). There is no data on the distribution or occurrence of this species in the Estuary or Gulf of St. Lawrence during winter.

This study confirmed the importance of northwestern Cape Breton and St Georges Bay for pilot whales, as 166 individuals were observed in these two sectors during the single survey covering this part of the Gulf (Figure 13). One sighting was also made in the Laurentian Channel to the east of Anticosti. Whether the absence of sightings elsewhere in the Gulf, e.g., along the western shelf of Newfoundland,

resulted from the low spatial and temporal coverage or from the more occasional use of these areas by pilot whales cannot be determined at this time.

Based on the available information, pilot whales would be present in the following candidate EBSAs: 1) Cape Breton Trough, 2) Entrance of St Georges Bay, Newfoundland, 3) West shelf of Newfoundland, with possible occasional occurrences in 4) the sector to the west of Anticosti Island.

Northern bottlenose whale (Hyperoodon ampullatus)

Northern bottlenose whales are found in cool and subarctic waters of the North Atlantic (Mead 1989). In the western North Atlantic, they are distributed from Nova Scotia to the Davis Strait (Reeves et al. 1993). Bottlenose whales concentrate in the northwest Atlantic off northern Labrador/Davis Strait and on the Scotian Shelf in or near the Gully (Whitehead et al. 1996; Whitehead and Wimmer 2005; Wimmer and Whitehead 2004). Animals in these two areas are suspected to constitute distinct stocks (Dalebout et al. 2001; Dalebout et al. 2006; Whitehead et al. 1996; Whitehead and Wimmer 2005). The absence of documented sightings and the limited number of stranding reports in the Estuary and Gulf of St. Lawrence since 1940 (N = 5) suggest that the species occur only rarely in those regions (Beaugé 1942, cited in Sergeant and Fisher 1957; Fontaine 1995; Mitchell and Chapman 1977; Whitehead and Wimmer 2005; L. Measures, DFO Quebec, unpubl. data). The species is considered relatively sedentary as some animals are observed in the Gully and off Labrador/Davis Strait throughout the year (Reeves et al. 1993; Whitehead et al. 1996), although this may not be the case in all areas. Population size for the Gully bottlenose whales is estimated at approximately 150 individuals (Gowans et al. 2000; Whitehead and Wimmer 2005), whereas there exists no estimate for the northern Labrador/Davis Strait population (Reeves et al. 1993).

No bottlenose whales were observed during this survey. Although it is clear that survey effort was insufficient to detect such scarce and long-diving animals, the available information suggests that this species is probably only a rare visitor to the Estuary and Gulf of St. Lawrence and probably confines itself to the deep waters of the channels.

Sperm whale (Physeter macrocephalus)

The sperm whale is distributed at all latitudes in the northern and southern hemisphere between the north and south polar ice caps (Reeves et al. 2004a; Rice 1989). Sperm whales occur at least during the ice-free period in the Estuary and Gulf of St. Lawrence, and enter these waters most probably to feed (Anonymous 1999b; Reeves and Whitehead 1997). In the North Atlantic, they are thought to constitute a single panmictic population (Anonymous 1999b). Male sperm whales are far more ranging than females and calves, with mature males migrating between northern latitude feeding grounds and tropical and subtropical mating grounds, in addition to performing extensive longitudinal movements (reviewed in Anonymous 1999b; Dufault et al. 1999; Lyrholm et al. 1999; Reeves and Whitehead 1997). There exists no reliable abundance estimate for sperm whales in the North Atlantic, although at least a few thousand likely occur in the western North Atlantic (Anonymous 1999b; Palka 2006; Reeves and Whitehead 1997; Waring et al. 2007; Whitehead 2002).

Sperm whales occur in both the Estuary and Gulf of St. Lawrence, but the rarity of sighting, stranding and harvesting reports suggest that they occur in small numbers in these areas (McAlpine 1985; Reeves and Whitehead 1997; Sears and Williamson 1982; Sergeant et al. 1970; Tournois 2003; Vladykov 1957). Anecdotal reports through an observer network indicate that a few individual sperm whales enter the St. Lawrence Estuary each year (GREMM unpubl. archived data, available at www.baleinesendirect.net). Whaling data in Newfoundland and Labrador and stranding records suggest that animals entering the Estuary and Gulf are mostly, if not exclusively, males (Mitchell 1974a; Reeves and Whitehead 1997; Sergeant 1966; Vladykov 1957). Sperm whales are considered deep-water animals, although males can be seen regularly in shallower waters (Caldwell et al. 1966; Whitehead et al. 1992). Their distribution in the St. Lawrence is unknown, but sighting reports are mainly from the Laurentian Channel or other deep-water areas of the Estuary and Gulf, including the shelf edge to the west of Newfoundland (Sears and Williamson 1982; Tournois 2003).

No sperm whale sightings were reported during this study. The spatial and temporal survey coverage was likely insufficient to allow the detection of this species, which is long-diving, and thus, rarely available to survey platforms. Sperm whales have been observed previously in only one of the candidate EBSA, i.e., the western Newfoundland shelf edge. Unpublished survey data and anecdotal reports support the sporadic occurrence of the species in the St. Lawrence Estuary (GREMM, unpubl. archived data, available at www.baleinesendirect.net) and in the deeper portion of the Cabot Strait (J.-F. Gosselin, unpubl. data). Based on preferences for deep waters, the species might also occur along the north margin of the Laurentian Channel to the south of Anticosti, and to a lesser extent, in the candidate EBSAs of the Cape Breton Trough and St Georges Bay, but their presence there has not been documented.

Harbour porpoise (Phocoena phocoena)

The harbour porpoise is widely distributed in temperate coastal waters of the northern hemisphere (Gaskin 1984; IWC 1996; Mercer 1973; Stenson 2003). In the western North Atlantic, the species occur from Upernavik, Greenland south to Cape Hatteras, North Carolina, and its distribution encompasses the Estuary and Gulf of St. Lawrence (reviewed in Read 1999; see also Béland et al. 1985; Béland et al. 1987; Fontaine et al. 1994a; Gaskin 1984; Gaskin 1992a; Hoek 1992; Larrivée 1996; Laurin 1976; Lavigueur et al. 1993; Lawson et al. 2004; Lesage et al. 2006; Pippard and Malcolm 1978; Tournois 2003). Several sub-populations exist in the western Atlantic, but identity and boundaries remains a matter of debate (reviewed in COSEWIC 2006). Seasonal migrations of harbour porpoises in the Northwest Atlantic are poorly understood, although some north-south migrations have been documented in at least some individuals from the Bay of Fundy/Gulf of Maine (e.g. Rosel et al. 1999; reviewed in COSEWIC 2006). Porpoises in the Estuary and Gulf of St. Lawrence are suspected to leave the area during winter due to ice cover. During the ice-free period, they were qualified as being moderately abundant by Sergeant et al. (1970). Systematic surveys conducted in 1995 and 1996 estimated at 36,000 to 125,000 the number of harbour porpoises summering in the Gulf of St. Lawrence (Kingsley and Reeves 1998). However, the number of porpoises using the Estuary during this period remains uncertain.

The distribution of harbour porpoises in the Estuary and Gulf of St. Lawrence has been characterized using interviews with coastal residents (Laurin 1976), anecdotal and stranding reports (Béland et al. 1987; Gaskin 1984; Gaskin 1992a; Hoek 1992; Sergeant et al. 1970), incidental bycatch rates (Fontaine et al. 1994a; Gosselin and Lawson 2004; Larrivée 1996; Lawson et al. 2004; Lesage et al. 2006), more localised observational studies (Fortin and Hudon 1978; Pippard and Malcolm 1978; Sears 1979; Sears et al. 1981) and a few relatively systematic surveys (Lavigueur et al. 1993; Sears and Williamson 1982; Tournois 2003). This information indicates that harbour porpoises are ubiquitous in the Estuary and Gulf of St. Lawrence during the ice-free period, although seasonal changes in abundance are likely to occur during this period. Anecdotal sightings during the 1950s–1990s and strandings during the 1980s were reported from both shores of the St. Lawrence Estuary and northwestern Gulf, and from the Jacques Cartier Strait, Gaspé Peninsula, Baie des Chaleurs, Prince Edward Island and the Îles-de-la-Madeleine (Béland et al. 1987; Gaskin 1992a; Hoek 1992; Katona et al. 1983; Laurin 1976). More localised studies in the Sept-Îles to Mingan sector and around the Gaspé Peninsula during the same period reported the species regularly (Fortin and Hudon 1978; Hoek 1992; Sears 1979; Sears et al. 1981). A study conducted in the Estuary reported harbour porpoise sightings only occasionally during the 1970s (Pippard and Malcolm 1978). Incidental catches in fishing gear during the 1990s and 2000s, which are indicative of the species occurrence, were particularly high in the sectors of Pointe-des-Monts to Sept-Îles, offshore Gaspé, including the entrance of Baie des Chaleurs, the coast of New Brunswick, Prince Edward Island including western Cape Breton, the northeastern Gulf, including the Strait of Belle Isle/Mecatina Plateau area, and the western shelf of Newfoundland (Fontaine et al. 1994a; Larrivée 1996; Lawson et al. 2004; Lesage et al. 2006). Relatively systematic surveys, covering more intensively the northern Gulf, provided mixed results as no porpoises were seen by Sears and Williamson (1982) during their multiple surveys conducted at different times of the year, whereas sightings were numerous in the study by Tournois (2003). The latter study confirmed the presence of harbour porpoises and their relative abundance in most of the sectors mentioned above. No information exists on the winter occurrence or distribution of harbour porpoises in the Estuary or Gulf of St. Lawrence.

This study supports previous observations of a wide distribution of the species in the Gulf of St. Lawrence (Figure 14). However, harbour porpoises appeared much more abundant in the northern Gulf and along western Newfoundland than in the southern or southwestern Gulf. Whether this trend is maintained at other times of the year cannot be confirmed given the general lack of information for other periods. Concentrations of porpoises were detected in each of the candidate EBSAs, with particularly large biomasses observed in the Jacques Cartier Strait, to the west of Anticosti Island, in the Pointe-des-Monts to Sept-Îles area, and along western Newfoundland. The relative importance of the St. Lawrence Estuary could not be assessed given the lack of coverage of this area, although the species is known to occur summer there.

Atlantic white-sided dolphin (Lagenorhynchus acutus)

White-sided dolphins occur in temperate and sub-arctic waters of the northern hemisphere (Reeves et al. 1998a; Reeves et al. 1999; Sergeant et al. 1980; Sergeant and Fisher 1957). In the Northwest Atlantic, the species occurs in continental shelf waters from Greenland, south to at least North Carolina, including the Estuary and Gulf of St. Lawrence (Gaskin 1992b; Palka et al. 1997; Sergeant et al. 1980). Some seasonal changes in distribution appear to occur, but overall, migration patterns of white-sided dolphins are largely unknown (Gaskin 1992b; Palka et al. 1997; Selzer and Payne 1988; Waring et al. 2007). Skull characters are similar among white-sided dolphins from throughout the North Atlantic, suggesting a panmictic population (Hill Mikkelsen and Lund 1994). On the other hand, a three-stock structure was proposed for white-sided dolphins in the northwest Atlantic on the basis of stranding, sighting, and incidental take distributions, and on a hiatus of reports between the three regions, resulting in the following proposed populations: Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea (Palka et al. 1997). There is currently no reliable abundance estimate for white-sided dolphins in the North Atlantic as a whole, or in the Northwest Atlantic, although surveys suggest that they number in the tens of thousands in the latter region (Reeves et al. 1998a; Waring et al. 2007). A survey conducted in late August 1995 provided an index estimate (not corrected for visibility biases) of 12,000 individuals for the Gulf of St. Lawrence, whereas the next year, only approx. 500 individuals were censused a month earlier, suggesting large variations in abundance between years and seasons (Kingsley and Reeves 1998).

Atlantic white-sided dolphins have been reported sporadically in the Estuary during the ice-free months (Sergeant et al. 1980; M.C.S. Kingsley, cited as unpubl.data in Kingsley and Reeves 1998), but are regular visitors to the Gulf of St. Lawrence (Fortin and Hudon 1978; Sears 1979; Sears et al. 1981; Sears and Williamson 1982; Sergeant et al. 1980; Tournois 2003). Their presence in the area between Gaspé and Anticosti, and specifically in the Mingan Island area, the Moisie Bay and the sector of Pointe-des-Monts has been documented regularly during the late 1970s and early 1980s (Sears 1979; Sears et al. 1981; Sears and Williamson 1982; Sergeant et al. 1980). White-sided dolphins were also reported in large numbers off Gaspé, as well as off the west coast of Newfoundland during the same period (Fortin and Hudon 1978; Lynch 1980, cited in Sears and Williamson 1982). Shipboard surveys conducted in August during the period 1995–1998, and covering mainly the northern and northeastern Gulf, including the Laurentian Channel, detected white-sided dolphins in each of the candidate EBSAs (Tournois 2003). No information exists on the occurrence or distribution of this species during the winter months.

White-sided dolphins were also detected in each of the candidate EBSAs of the Gulf during our study, with the exception of the north margin of the Laurentian Channel to the south of Anticosti Island (Figure 15). These results mainly came from the late August surveys (1995 and 2002), since only a few white-sided dolphins were observed during the late-July survey of 1996 (Kingsley and Reeves 1998, Fig. 11). These large differences in abundance suggest that incursions of white-sided dolphins into the Gulf might vary greatly over short periods of time. Observations from Sergeant et al. (1980) suggest that the abundance and distribution of white-sided dolphins may also vary greatly between years. The presence or frequency of occurrence of white-sided dolphins in the Estuary could not be assessed given the absence of coverage of this area in the sampling design. Considering that white-sided dolphins have been reported previously along the north margin of the Laurentian Channel to the south of Anticosti Island, we can conclude that the species occur at least occasionally in each of the candidate EBSAs. The species is also known to occur sporadically in the St. Lawrence Estuary.

Shortbeaked common dolphin (Delphinus delphis)

Shortbeaked common dolphins are widely distributed in temperate, tropical and subtropical waters of all oceans of the world (Evans 1994; Perrin 2002). In the Northwest Atlantic, the species occurs from Cape Hatteras north to Newfoundland (CETAP 1982; Gaskin 1992c; Mercer 1973; Palka 2006; Selzer and Payne 1988; Sergeant et al. 1970; Sergeant and Fisher 1957). Based on published information, shortbeaked common dolphins occur in Canadian waters mainly during summer and autumn, but are absent from the Estuary and Gulf of St. Lawrence (reviewed in Waring et al. 2007). The total estimated population is over 100,000 shortbeaked common dolphins in the Northwest Atlantic (Palka 2006; Waring et al. 2007).

The general belief that the species is absent from the Estuary and Gulf of St. Lawrence is contradicted by a recent stranding record and by data from our study. Indeed, the stranding of one shortbeaked common dolphin at Pointe-à-la-Garde in the Baie des Chaleurs in early November 2005 indicates that the species may occur at least occasionally in the Gulf of St. Lawrence. The observation of 243 shortbeaked common dolphins in three different regions of the Gulf during the 2002 survey supported the presence of this species in the Gulf of St. Lawrence. Species identification was confirmed through digital photography. Areas where the species was encountered included the Strait of Belle Isle/Mecatina Plateau area, the Esquiman Channel, and the Laurentian Channel off St Georges Bay (Figure 16).

Based on these results, it appears that the species may occur in the following candidate EBSAs: 1) Strait of Belle Isle/Mecatina Plateau, 2) St Georges Bay, and 3) western shelf of Newfoundland.

Striped dolphin (Stenella coeruleoalba)

Striped dolphins are common in warm-temperate to tropical waters throughout the world (Archer II 2002; Baird et al. 1993; Evans 1994). In the Northwest Atlantic, the species has been reported from Greenland south to Florida, the Caribbean and the Gulf of Mexico, with regular records along the eastern coast of South America (Baird et al. 1993; CETAP 1982; Gowans and Whitehead 1995; Mansfield 1967c; Mercer 1973; Odell and Chapman 1976; Perrin et al. 1981; Sergeant et al. 1970). The sole report from the Gulf of St. Lawrence comes from an animal found stranded at the northern tip of Cape Breton Island in 1980 (Mitchell 1981). There is no evidence for a strong seasonal migratory pattern in this species in the Northwest Atlantic (Baird et al. 1993; CETAP 1982). There are an estimated nearly 100,000 striped dolphins in the Northwest Atlantic (Palka 2006; reviewed in Waring et al. 2007).

Although considered to be absen from the Estuary and Gulf of St. Lawrence, over 20 striped dolphins were observed in the trough to the northwest of Cape Breton Island during a shipboard survey conducted in June 2002 (J.-F. Gosselin, DFO, unpubl. data). These observations coincided with the sector where one striped dolphin was reported stranded in 1980 (Mitchell 1981). A recent stranding in the St. Lawrence Estuary (Fontaine 2005) suggests that the species may occasionally enter the Gulf and Estuary. These reports are evidences that the occurrence of this species might be underestimated by the currently available data.

Based on the available information, the only candidate EBSA where striped dolphins might occur with some regularity or in numbers is the area of the Cape Breton Trough.

Whitebeaked dolphin (Lagenorhynchus albirostris)

Whitebeaked dolphins occur in cold temperate and subarctic waters of the North Atlantic (Reeves et al. 1998b). In the Northwest Atlantic, their distribution extends from approximately Cape Cod, Massachusetts in the south to central Davis Strait in the north, and includes the Gulf of St. Lawrence (Lien et al. 2001; Reeves et al. 1998b; Sears et al. 1981; Tournois 2003). Their seasonal movement pattern is not understood (CETAP 1982; Lien et al. 2001; McPherson et al. 2001). However, ice

entrapments and repeated sightings along the Newfoundland east coast indicates that whitebeaked dolphins winter at our latitudes (Hai et al. 1996; J. Lawson, DFO Newfoundland, unpubl. data). The total number of whitebeaked dolphins in the Northwest Atlantic is currently unknown, but surveys covering different parts of their range suggest that a few thousand individuals may occur along eastern Canada and eastern U.S. (Alling and Whitehead 1987; CETAP 1982; Kingsley and Reeves 1998). Their abundance in the Gulf, although imprecise, was estimated at approximately 2,500 individuals in 1995 and 1996 (Kingsley and Reeves 1998).

Reports of the presence of whitebeaked dolphins in the Gulf of St. Lawrence are scarce, and come mostly from the northern Gulf (Sears et al. 1981; Tournois 2003). The species has been reported previously in the sector to the west of Anticosti and in the Jacques Cartier Strait, as well as from the Mecatina plateau area and northern Cape Breton, with a single sighting in the Laurentian Channel to the south of Anticosti. Their presence in the Mingan Island area, the Belle-Isle Strait and along the north shore of Cape Breton would also be supported by observations made during the late 1970s and early 1980s (Lynch 1980, Sears 1980, Sears 1981, and Sears et al. 1982, cited in Sears and Williamson 1982). Based on the previous observations, the species would be absent from the St. Lawrence Estuary.

During this study, whitebeaked dolphins were observed exclusively in the northeastern Gulf of St. Lawrence, specifically in the area of the Strait of Belle Isle/Mecatina Plateau (Figure 17). Combining previous information with that of this study, whitebeaked dolphins occur at least occasionally in the following candidate EBSAs: 1) Strait of Belle Isle/Mecatina Plateau, 2) Jacques Cartier Strait, 3) West of Anticosti, and 4) the Cape Breton Trough.

Other species

Some other species are known to occur along the Newfoundland—Labrador coast or on the Scotian Shelf and could represent rare or sporadic visitors to the Gulf of St. Lawrence, although there is no or nearly no record of their presence in this region, even historically. These species included sei whales (*Balaenoptera borealis*), which might have been seen off Gaspé during the late 1970s and more recently, in southwestern Newfoundland (Fortin and Hudon 1978; see also Anonymous 1999a; COSEWIC 2003a; Mitchell and Chapman 1977; J. Lawson, DFO Newfoundland, unpubl. data); Blanville's beaked whale (*Mesoplodon densirostris*) and True's beaked whales (*Mesoplodon mirus*) which are known from Cape Breton Island (Allen 1939; Sergeant et al. 1970; see also Houston 1990); Sowerby's beaked whales (*Mesoplondon bidens*), which have occasionally been recorded along the eastern coast of Newfoundland and which could be attracted sporadically inshore by concentrations of squid (Gowans and Simard 2004; Sergeant and Fisher 1957); pygmy sperm whales, (*Kogia* breviceps), whose occurrence in the Gulf is substantiated by a single stranding on the north shore (Measures et al. 2004); Atlantic walruses, *Odobenus rosmarus*, which were extirpated by exploitation during the 1800s, but which were occasionally reported from the eastern part of the north shore over the last century, and more recently from the central and southern Gulf (reviewed in Kingsley 1998b); bearded seals, *Erignatus barbatus*, which have been observed very occasionally in the Gulf of St. Lawrence during the 20th century (Comeau 1945; Gosselin and Boily 1994; Lavigne 1978MS[2]); ringed seals, *phoca hispida*, whose distribution extended to the north shore into the Estuary and the Saguenay River until the mid 1960s, and which is now restricted to the northeastern Gulf to the east of Old Fort (Hannah 1998; Lavigne 1978MS[2]; M.O. Hammill, DFO, unpubl. data).

[2] Lavigne, J.-P. 1978. La chasse estivale du phoque dans le Saint-Laurent. Unpubl. manuscript prepared for Fisheries and Oceans Canada. Available at: M.O. Hammill, DFO, 850 Route de la Mer, Mont-Joli, Qc G5H 3Z4.

Areas of aggregation and proposed EBSAs

In this section, the existing information on the distribution and aggregation of marine mammals is summarized by sector to evaluate the relative species diversity and biomasses occurring seasonally in the different areas.

1) Pointe-des-Monts to Sept-Îles

During the two surveys that covered the sector to the northeast of Pointe-des-Monts, seven cetacean species were observed between late July and early September, including krill-consumers (blue whales), fish consumers (white-sided dolphins, harbour porpoises and beluga whales), and opportunistic feeders (minke, fin, and humback whales). The home range analysis of hooded seal movements indicated that hooded seals encompassed this area within their territory between mid-March and mid-May (Figure 22), bringing to eight species the diversity index for this area (Table 3).

Aerial surveys and land-based observations conducted between 1979 and 1982 identified considerable biomass of marine mammals at times during the ice-free period in the northeast sector of Pointe-des-Monts (Sears 1979; Sears et al. 1981; Sears and Williamson 1982). A late May flight in 1982 observed concentrations of tens of blue, fin, and minke whales. Similar concentrations of the same species were observed during an early October flight, including 23 blue whales and nearly 20 fin whales, with additional sightings of 11 unidentified large whales, several minke whales, one humpback whale and approximately 180 Atlantic white-sided dolphins. These concentrations of cetaceans had disappeared by early November 1982, i.e., approximately a month later. Few or no cetaceans were seen in this area during an early July flight in 1982, contrasting with the data from this report, which were acquired slightly later during summer (late July–mid-September). Aerial surveys and coastal observations during August 1979 confirmed the importance of this general sector for cetaceans, and identified the Moisie Bay as an area of aggregation for species such as blue whales (Sears 1979). The historical importance of the area is shown by the establishment of a whaling station out from Sept-Iles, where landings were in the order of 65 fin or blue whales per year between 1905 and 1915 (Mitchell 1974a; Mitchell and Reeves 1983).

The published literature also indicates that the results presented here provided a somewhat biased estimate of the diversity of species using this area. For instance, the occurrence of beluga in this area in late summer is considered unusual, since belugas are believed to restrict their distribution to the St. Lawrence Estuary at that time of the year (Gosselin et al. 2001; Gosselin et al. 2007; Kingsley 1998a; Lesage and Kingsley 1998; Michaud et al. 1990). The absence of seal sightings during the surveys was unsurprising considering the low coverage and the difficulty to detect these species when at sea. Suitable haul-out sites for harbour seals or grey seals are also limited in this area due to steep coastlines and a nearly absence of rocks or reefs (Robillard et al. 2005). Nevertheless, the use of this sector by some grey or harbour seals cannot be discarded considering the proximity of major haulout sites at Anticosti Island and of one haul-out site for harbour seals in the area (Boulva and McLaren 1979; Robillard et al. 2005). Finally, right whales might be sporadically present in this area, as shown by observations in 1976 and 1979, which included a pod of three right whales in the Moisie Bay (Sears 1979; Sears et al. 1981). However, no further sightings of right whales in this sector have been reported since 1979.

Between December and May, abundance and distributional data are very scarce. The 1982 survey data suggested little use of the area by most marine mammals during winter since only one sighting of a blue whale was made in late January and no sightings were reported during the early March flight (Sears and Williamson 1982). Predominant winds and local water masses movements result in this area, particularly the Sept-Îles area, being clear of ice most of the time during winter (Saucier et al. 2003). Regular anecdotal reports of blow or rorqual sightings have been made during recent years until late in January and very early in the spring, indicating that some larger baleen whales might remain in the area during most of the winter (GREMM unpubl. archived data, available at www.baleinesendirect.net). In addition, seven patrols during the winters of 1989 and 1990 detected the presence of beluga whales in this general sector, whereas an aerial survey in mid-April 1981 reported the presence of some harp seals

(Boivin and INESL 1990). Sightings of harp seals and beluga whales during a recent systematic aerial survey conducted in late March 2004 confirmed the continued use of this sector by these two species (J.-F. Gosselin, DFO, unpubl. data).

The available information is sufficient to indicate that the sector of Pointe-des-Monts and east to Sept-Îles, is frequented relatively regularly by a high diversity of species (at least 11 species), and at some times of the year, including winter time, by large biomasses of marine mammals, including some endangered and threatened species (e.g., blue and beluga whales). Specifically, between May and December, at least eight species likely occur with more or less regularity in this area, with another three species occurring probably more sporadically. These species include grey and harbour seals, blue, fin, minke, and humpback whales, harbour porpoises and white-sided dolphins, with a more sporadic presence of beluga and hooded seals, and an occasional presence of right whales (Table 4). Between December and May, harp seals, hooded seals and beluga, as well as some larger rorqual whales, possibly blue and fin whales, occur regularly in this sector. Nevertheless, the data is insufficient to qualify the seasonal and inter-annual changes in use of this area by the different species or to estimate, even grossly, the number of individuals of each species using this area seasonally.

The sector to the east of Pointe-des-Monts is characterised by a large, nearly permanent cyclonic gyre (El-Sabh 1976; Saucier et al. 2003), which is favourable to the persistent aggregation of zooplankton such as krill (Sourisseau et al. 2006). The occurrence of large concentrations of krill-consumers and opportunistic feeders at different times of the year (when considering the 1982, 1995-1996 and 2004 surveys together) supports the hypothesis of relatively persistent krill aggregations. The also regular occurrences of several species of fish consumers suggest that fish aggregations probably also persist in the sector. Consequently, we conclude that the sector to the east of Pointe-des-Monts serves mainly a **feeding function** for all of the species described here. Based on the preceding discussion, we considered this area as **unique** because 1) a gyre system such as the one characterizing this area does not exist elsewhere in the Gulf; 2) large biomasses of krill consumers and marine mammals in general are observed in only a few other areas of the Estuary or Gulf; 3) it is one of the rare areas where the endangered blue whales congregate in large numbers; 4) it represents one of the very few known wintering grounds for the beluga outside of the Estuary (Table 4). This area is also considered particularly important for **aggregation**, considering the diversity and biomasses of species using the area (at least 11 species), and the occurrence at times of large biomasses of the endangered blue whale. **Fitness consequences** of a loss of access to this area would probably be important for the larger species, particularly the blue whales, which appear to have access to few alternate feeding sites in the St. Lawrence system (see below). Major feeding sites for the blue whale population of the Northwest Atlantic outside of the Gulf of St. Lawrence have not yet been determined (Reeves et al. 2004b; Sears and Calambokidis 2002). Fitness consequences might also be moderate to high for St. Lawrence beluga as it represents the sole wintering grounds currently used by this species in the Gulf of St. Lawrence.

2) West of Anticosti Island

Five species of cetaceans were reported during the late-July to mid-September surveys in the sector to the west of Anticosti, which comprised the Parent Bank and the area located between the western tip of Anticosti Island and the north shore (Figure 24). Species included opportunistic feeders (fin, minke, and humpback whales) and fish consumers (harbour porpoises, white-sided dolphins). Home range analyses indicated an intensive use of the area by grey seals throughout the ice-free period, as well as its use by hooded seals during the spring, bringing to seven the diversity index (Figures 22 and 23; Table 3).

The recurrent use of the area by opportunistic feeders such as minke, humpback, and fin whales, is known mainly from whaling records, repeated shipboard surveys and long-term studies of cetaceans (e.g., Doniol-Valcroze 2001; Doniol-Valcroze et al. 2007; Mitchell 1974a; Mitchell and Reeves 1983; Naud et al. 2003; Sears 1979; Sears et al. 1981; Smith et al. 1999; Stevick et al. 2006; Tournois 2003). These studies also documented the regular presence of fish consumers such as harbour porpoises and white-

sided dolphins (Sears 1979; Sears et al. 1981; Tournois 2003). These observations are supported by shorter-term studies, such as a surveys conducted in early July of 1982, which identified a few individuals of opportunistic feeders in this area (Sears and Williamson 1982). The distribution of the larger rorqual species in this area appears to be tightly-linked to the distribution of thermal fronts, although a spatial lag, which was smaller for krill-consumers (blue whales) than for opportunistic feeders (fin and humpback whales), was observed between whale and thermal front locations (Doniol-Valcroze et al. 2007). Systematic surveys confirmed opportunistic sightings and earlier data obtained through interviews with local people of an abundance of harbour seals and grey seals all around Anticosti Island (Boulva and McLaren 1979; Desaulniers 1989; Robillard et al. 2005; Sears et al. 1981). A satellite telemetry study using part of the information presented in this study (Figure 23), underscored the importance of the western sector of Anticosti for grey seals (Goulet et al. 2001).

In addition to these species, which were all detected during our study except for the harbour seals, long-term studies indicated the sporadic presence of whitebeaked dolphins (Sears et al. 1981; Tournois 2003), and killer whales, a marine mammal eater (Mitchell and Reeves 1988; Wenzel and Sears 1988), and the occasional visit of pilot whales (Sears et al. 1981). These studies also documented the regular ocurrence of a krill-eater, the blue whale, which may vary considerably in abundance between years (e.g., Doniol-Valcroze 2001; Doniol-Valcroze et al. 2007; Sears 1979; Sears et al. 1981; Sears and Calambokidis 2002). The systematic surveys in the Mingan Islands also indicated the presence of harp seals from at least March to June, inclusively (Desaulniers 1989; Sears et al. 1981).

The available information is sufficient to highlight the high diversity of species using the area, particularly during the ice-free period. A minimum of eleven species appear to use the sector to the west of Anticosti on a relatively regular basis between May and December, i.e., minke, fin, humpback, and blue whales, harbour porpoises, white-sided and whitebeaked dolphins, grey, harbour and harp seals, killer whales. Pilot whales are also present occasionally in this sector during that period. Between December and May, the data is limited, although it indicates the presence of at least harp and hooded seals. Data from long-term studies clearly shows the recurrent occupancy of this sector by different species, but it does not allow the estimation of densities in its current available form due to the limited information available on relative survey effort (e.g., Doniol-Valcroze et al. 2007; Sears et al. 1981). The data from this study and from the literature are also insufficient to qualify the seasonal and inter-annual changes in use of this area by the different species.

The sector to the west of Anticosti is characterised by the presence of wind-driven upwellings, intense tidal mixing and high biological productivity (Koutitonsky and Bugden 1991). Based on this information and on the seasonal occupancy and identity of species, we conclude that this area serves mainly a **feeding function** for all of the species described here. We considered this area moderately **unique** because 1) the sector is characterised by physical and oceanographic features that favour biological productivity; 2) the sector supports what is suspected to be moderate to large biomasses of marine mammal species, which all have alternate habitats in the Estuary or Gulf; 3) it is one of the rare areas where the endangered blue whales may congregate in large numbers, but the use of the area varies considerably between years. This area was considered highly important for **aggregation**, considering the high diversity of species and the moderate to high biomasses of species using the area, and the occurrence at times of large biomasses of the endangered blue whale. **Fitness consequences** of a loss of access to this area would probably be moderate for most species, but could be higher for some of the larger species if their displacement towards other habitats reduced food availability per capita.

3) Jacques-Cartier Strait

Four species of cetaceans were observed during the late-July to mid-September surveys in the Jacques-Cartier Strait, which comprised the deeper channel of the Strait and the shelf to the north of Anticosti Island (Figure 24). Species included opportunistic feeders (fin and minke whales) and fish

consumers (harbour porpoises and white-sided dolphins). Home range analyses have also identified this area as an important part of the distribution range of grey seals during the ice-free period (Figures 23).

Shipboard surveys and long-term more localised studies in this area confirmed the occurrence of the four cetacean species detected during our study, but also reported the presence of whitebeaked dolphins (Sears et al. 1981; Tournois 2003). The presence of the latter species in the Jacques-Cartier Strait had also been reported previously (see Sears and Williamson 1982). This area is likely exploited by harbour seals in addition to grey seals, as large colonies of both species occur in the Mingan Islands and on the north shore of Anticosti in the Jacques-Cartier Strait area (Boulva and McLaren 1979; Desaulniers 1989; Robillard et al. 2005; Sears and Williamson 1982). Long-term studies and anecdotal sightings have also documented the sporadic presence of killer whales in this area (Mitchell and Reeves 1988; R. Sears, cited as pers. obs. in Sears and Williamson 1982). Consequently, based on the available information, not five, but seven species of marine mammals likely occur in this area with some regularity during the ice-free period. These species include grey and harbour seals, minke and fin whales, white-sided and whitebeaked dolphins, and harbour porpoises, with occasional intrusions by killer whales.

Between December and May, data on marine mammal abundance is nearly nonexistent for that particular area. A recent survey in late March indicated the presence of harp seals, an observation that confirmed earlier reports (Sergeant 1965; Sergeant 1991). The report of one blue whale during a mid-January flight just north of the Strait suggests that this area might also be used by some larger rorquals during winter time (Sears and Williamson 1982).

The ability to define the use of this area by marine mammals is limited because the available information come from only a few surveys, all conducted in August (Tournois 2003; this study). Considering the expected temporal variation in the use of the different habitats by the different species of marine mammals, the results and available information should be viewed as fragmentary. It is currently not possible from the available data to estimate seasonal marine mammal densities for that particular area.

The sector of the Jacques Cartier Strait is characterised by the presence of wind-driven upwellings and probably high biological productivity (Sourisseau et al. 2006). Based on this information and on the seasonal occupancy and identity of species, we conclude that this area serves mainly a **feeding function** for all of the species described here. We considered this area not particularly **unique** because 1) the sector is characterised by physical and oceanographic features that favour biological productivity; 2) the sector supports what is suspected to be low to moderate biomasses of marine mammal species, which all have alternate habitats in the Estuary or Gulf. This area was considered moderately important for **aggregation**, considering the moderate diversity (at least 8 species) and biomasses of marine mammals, but the relatively large number of small cetaceans and pinnipeds. **Fitness consequences** of a loss of access to this area would probably be low to moderate, as alternative habitats exist in the Estuary and Gulf of St. Lawrence.

4) Strait of Belle-Isle / Mecatina Plateau

Eight species were observed in the Strait of Belle-Isle/Mecatina plateau area during the mid-July to mid-September surveys (Figure 24). Species included fish consumers (harp seals, shortbeaked common dolphins, whitebeaked dolphins, Atlantic white-sided dolphins, and harbour porpoises) and opportunistic feeders (minke, humpback and fin whales), with particularly large numbers of humpback whales (Figure 10).

The abundance of marine mammals in the Strait of Belle Isle is a long-recognized phenomenon. Basque and Breton whalers and others after them exploited marine mammals in this sector, which was called the Grand Bay (Barkham 1984; Mitchell and Reeves 1983). Recent information relative to the abundance of marine mammals in the Strait of Belle Isle/Mecatina Plateau area is relatively anecdotal, since little systematic effort has been conducted to survey there. Indeed, data for this particular area

mainly comes from ice entrapment, stranding and anecdotal reports (Lien et al. 1988; Mitchell and Reeves 1988; Sergeant et al. 1970; Sergeant and Fisher 1957; Wenzel and Sears 1988; J. Lawson, DFO Newfoundland, unpubl. data presented in COSEWIC 2005), with a few sightings coming from more systematic or local land-based, aerial or shipboard surveys (Lynch 1987; Perkins and Whitehead 1977; Sears et al. 1981; Sears and Williamson 1982; Stevick et al. 2006; Tournois 2003). Indirect information on the occurrence of particular species was also obtained through bycatch reports in fishing gear (Fontaine et al. 1994a; Lesage et al. 2006).

The presence of all except two of the species observed during our surveys has been documented previously. Blue whales, and possibly fin and humpback whales, were heavily harvested in this particular sector (Sergeant 1966), and their recent presence there, in addition to minke whales, was substantiated by land-based, aerial or shipboard surveys (Lynch 1987; Perkins and Whitehead 1977; Sears and Williamson 1982; Tournois 2003), long-term studies (Stevick et al. 2006), and anecdotal reports (J. Lawson, DFO Newfoundland, cited as unpubl. data in COSEWIC 2005). The occurrence of harbour porpoises was documented through relatively high incidental catches associated with fishing operations in this sector (Fontaine et al. 1994; Lesage et al. 2006), and by observations during aerial or shipboard surveys (Sears et al. 1981; Tournois 2003). The use of this sector by white-sided and whitebeaked dolphins was also previously documented during a shipboard survey (Tournois 2003). However, our reporting of the presence of shortbeaked common dolphins in this area of the Gulf is unprecedented, and was substantiated with photography, thereby eliminating the possibility of misidentification. The observation of harp seals in the Strait of Belle Isle/Mecatina Plateau area during a period when most of the harp seals were suspected to have left the Gulf, indicates that a portion of this population remain in the Estuary and Gulf of St. Lawrence throughout the year (see also Lavigueur et al. 1993). Recent harvest reports from the northeastern Gulf during the spring also support these observations (M.O. Hammill, DFO, pers. comm.).

Published records indicate the likely presence of a few other species in the Strait of Belle Isle/Mecatina Plateau area during the ice-free period. For instance, according to repeated anecdotal reports, killer whales would be regularly present in this area (Lawson et al. 2007; Lien et al. 1988; Mitchell and Reeves 1988; Sergeant et al. 1970; Sergeant and Fisher 1957; Vachon et al. 1988; Vachon et al. 1998; Wenzel and Sears 1988). Land-based and shipboard surveys indicate the presence of pilot whales (Lynch 1987). The occurrence of haul-out sites for harbour seals and grey seals in this sector suggest that both species occur there at least during the ice-free period (Boulva and McLaren 1979; Lavigueur and Hammill 1993; Mansfield and Beck 1977). The area was also historically important for bowhead and possibly right whales, although the importance for the latter species has recently been questioned (Barkham 1984; Rastogi et al. 2004).

Ice entrapments of fin whales in March suggest that some fin whales may persist in that area during at least part of the winter, and during at least some years (Sergeant et al. 1970). This area is also a main migration path for harp and hooded seals, and in some years, also a whelping ground for harp seals (Sergeant 1991). Consequently, both these species are expected to be present between December and May (Hammill 1993; Mansfield 1967b; Sears et al. 1981; Sears and Williamson 1982; Sergeant 1965; Sergeant 1991; Stenson et al. 2003b).

The available information is sufficient to indicate that the sector of the Strait of Belle Isle/Mecatina Plateau supports at times, large biomasses of a diverse megafauna (at least 14 species). Specifically, between May and December, at least 13 species likely occur with more or less regularity in this area. These species include grey, harbour and harp seals, fin, minke, and humpback whales, harbour porpoises, white-sided, whitebeaked and shortbeaked common dolphins, pilot whales, with what appears to be a more sporadic presence of blue whales (Table 4). Between December and May, harp seals, hooded seals and possibly fin whales occur regularly in this sector. Harp seals whelp in the area and it is an important area for mouling for Gulf harp seals during the spring. However, the data remain fragmentary, limiting our ability to qualify the seasonal and inter-annual changes in use of this area by the different species. Unfortunately, it is also not possible to estimate even grossly, the number of individuals of each species using this area seasonally.

The Strait of Belle Isle/Mecatina Plateau area is characterized by persistent aggregations of deep-dwelling zooplankton in the mesoscale basin (Mecatina), from which they cannot escape due to local bathymetry (Sourisseau et al. 2006). The occurrence of large concentrations of opportunistic feeders and fish consumers suggests that the sector serves mainly a **feeding function** throughout the year, a **migration function** and in a **reproduction function** for some pinnipeds during winter time. Based on what precedes, we considered this area as **unique** because 1) the local bathymetry results in the retention of large biomasses of zooplankton, and areas with large and predictable food resources are scarce; 2) large biomasses of opportunistic consumers and marine mammals in general are observed in this area, and only a few others in the Estuary or Gulf; 3) it is one of the rare areas where the endangered blue whale may congregate in large numbers, but the use of the area varies between years; 4 it supports an exceptionally diverse marine megafauna (at least 13 species); 5) it supports the largest known biomasses of humpback whales for the entire Estuary and Gulf of St. Lawrence; 6) it represents the sole area known to still be frequented by killer whales in the Gulf of St. Lawrence. This area is considered particularly important for **aggregation**, considering the very high diversity and large biomasses of species using the area. **Fitness consequences** of a loss of access to this area would probably be important as it would likely result in a dramatic increase in the exploitation pressure on the few alternate feeding sites in the St. Lawrence system or the Northwest Atlantic.

5) Western shelf of Newfoundland

Five species of cetaceans were detected during the late-July to mid-September surveys along the western shelf of Newfoundland or at the head of the Esquiman Channel (Figure 24). These species included some fish consumers (harbour porpoises, white-sided dolphins and harp seals), and some opportunistic feeders (humpback and minke whales).

These five species have previously been reported on the west coast of Newfoundland, either as published (Lynch 1987; Sergeant 1963; Sergeant 1991) or unpublished anecdotal reports (several unpubl. reports by J. Lien, cited in Sears and Williamson 1982), and indirectly through information on incidental catches in fishing gear (Lawson et al. 2004) or directly through more systematic surveys (Lynch 1987; Tournois 2003).

Although the existing literature is quite slim for this area of the Gulf, there are also opportunistic sightings of pilot whale and blue whales in this area (Lawson 2003; Lynch 1987; Sergeant and Fisher 1957), and of fin whale and sperm whale observations made during more systematic surveys (Sears and Williamson 1982; Tournois 2003).

The available information is sufficient to indicate that the area is used by at least nine different species during the ice-free period, but the degree of seasonal use of this area by these species and their relative densities remain largely undocumented. The data is also sufficient to attract our attention on the possible importance of the head and slope of the Esquiman Channel as an area of aggregation for foraging marine mammals, since the characteristics of this area ressembles those of other areas where large aggregations of marine mammals have been detected (e.g., head of the Laurentian Channel in the Estuary, Jacques-Cartier Strait, Cape Breton trough, etc.).

The slope and head of the Esquiman Channel on the west coast of Newfoundland are characterized by aggregations of deep-dwelling zooplankton, which appear particularly persistent at the head of the Esquiman Channel (Sourisseau et al. 2006). Consequently, we conclude that this sector serves primarily a **feeding function**. Based on what precedes, we considered this area as moderately **unique** because 1) it allows the persistent aggregation of zooplankton; 2) other regions of similar or higher value exist in the St. Lawrence system; 3) biomasses of fish and opportunistic consumers appear to be low to moderate and so, sectors attracting higher biomasses of marine mammals exist elsewhere in the St. Lawrence system; 4) it supports a moderately diverse megafauna (at least 9 species). This area is considered moderately important for **aggregation**, considering the moderate diversity and moderate to low biomasses of species using the area. **Fitness consequences** of a loss of access to this area would

probably be of little to moderate importance for these species, since alternate habitats with similar characteristics exist elsewhere in the St. Lawrence system.

6) Entrance to St Georges Bay, western Newfoundland

Seven species were detected in or just off St Georges Bay, southwest Newfoundland during our late-July to mid-September surveys (Figure 24). Species included fish consumers (harbour porpoises, white-sided and common dolphins), opportunistic feeders (fin, minke and humpback whales) and squid consumers (pilot whales).

Little information exists regarding the occurrence of marine mammals in St Georges Bay. However, the species observed in this study, except for shortbeaked common dolphins, have been reported previously in this region, either through land-based, aerial or shipboard surveys (Lynch 1987; Sears and Williamson 1982; Tournois 2003), anecdotal sightings (Sergeant and Fisher 1957), stranding reports (Sergeant et al. 1970), or incidental catch reports (Lawson et al. 2004).

Based on interview and aerial survey results, both harbour seals and grey seals would also be present in St Georges Bay, at least during the ice-free period (Boulva and McLaren 1979; Clay and Nielsen 1985; Lavigne 1978 MS, summarized in Robillard et al. 2005). Repeated documented ice-entrapments of blue whales in late winter suggest that the area is likely used on a regular basis by blue whales during winter, although the quality of the area might vary between years depending on ice conditions (Lawson 2003; Stenson et al. 2003a). A single ice-entrapment report of killer whales in 1975 and a few sighting reports in the vicinity of St Georges Bay in 1977—1986 indicates that the use of this sector by killer whale is plausible, although the data is currently too scarce to qualify their use of the area (Lien et al. 1988; Mitchell and Reeves 1988).

The information available is sufficient to highlight the relatively high diversity of species using the sector of St Georges Bay, but is too scarce to qualify the seasonal densities of each species. During the ice-free period, a minimum of nine species appear to use the sector, but data are is too limited to qualify the regularity of use. These species included minke, fin, and humpback whales, pilot and killer whales, harbour porpoises, white-sided and shortbeaked common dolphins, harbour and grey seals. During winter, ice-entrapments suggest that blue whales and possibly killer whales may be present in the area, at least sporadically.

The sector of St Georges Bay is characterised by the presence of aggregations of zooplankton during at least the winter months (Sourisseau et al. 2006). Based on this information and on the seasonal occupancy and identity of species, we conclude that this area serves mainly a **feeding function** for all of the species described here. We considered this area as moderately **unique** because 1) the sector is characterised by physical and oceanographic features that favour biological productivity; 2) the sector supports what is suspected to be moderate biomasses of marine mammal species, which all have alternate habitats in the Estuary or Gulf; 3) it is one of the rare known areas where the endangered blue whales congregate during winter, although the use of the area may vary between years. This area was considered moderately important for **aggregation**, considering the high diversity of species (at least 11 species), the moderate biomasses of species using the area, and the occurrence at times of moderate to large biomasses of the endangered blue whale. **Fitness consequences** of a loss of access to this area would probably be moderate, particularly for blue whales and the larger species as alternate habitats may be limited, particularly during winter.

7) Cape Breton Trough

Only three species were detected along the western shore of Cape Breton during our late-July to early-September survey. This area is delimited by the margins of a deep trough running along the west coast of Cape Breton (Figure 24). Species detected during the survey included fish consumers (harbour porpoises and white-sided dolphins) and squid consumers (pilot whales). The home range analyses

indicated that this sector also formed an important part of the core area of distribution of grey seals and hooded seals during winter (Figures 22—23).

There exists very little information on the occurrence of marine mammals in this area (reviewed in Hammill et al. 2001). However, the importance of this sector during winter for grey seals and hooded seals, but also for harp seals is well documented (Bowen et al. 1987; Hammill et al. 1992; Hammill et al. 1998; Hammill and Gosselin 2005; Mansfield and Beck 1977; Sergeant 1991; Stenson et al. 2003b; M. Hammill, DFO, unpubl. data). During summer, grey seals and harbour seals also occupy this sector (Boulva and McLaren 1979; Clay and Nielsen 1985). Previous aerial and shipboard surveys and stranding data confirmed the occurrence of pilot whales in the area (Sears and Williamson 1982; Sergeant et al. 1970; Sergeant and Fisher 1957; Tournois 2003). Previous studies also confirmed the presence of other species, including humpback whales (Sears and Williamson 1982; Sergeant 1966; J.-F. Gosselin, DFO, unpubl. data), and harbour porpoises (Lesage et al. 2006; Sergeant et al. 1970). Whitebeaked dolphins have been observed in the Laurentian Channel just off the trough during shipboard surveys (Tournois 2003). Based on daily reports from the whale-watching industry and on recent DFO shipboard surveys, species such as fin whales, minke whales, and striped dolphins would also be present in the area (Hammill et al. 2001; J.-F. Gosselin, DFO, unpubl. data; see also Mitchell 1981).

The available information is sufficient to highlight the importance of this area during both the ice-free and ice-covered period, as three of the four seal species frequents the Cape Breton Trough during winter, and at least ten species of marine mammals occur in this sector during the ice-free period. However, the available information is currently too scarce to qualify the seasonal densities of marine mammals using this sector, particularly during the ice-free period.

The sector of the Cape Breton Trough is characterised by a deep channel where food resources are likely to aggregate. Based on seasonal occupancy and identity of species, we conclude that this area serves mainly a **feeding function** during the ice-free period, whereas it has **reproductive and possibly moulting functions** for pinnipeds during the winter and early spring. We considered this area as **unique** because 1) the sector is characterised by physical and oceanographic features that favour biological productivity; 2) the sector supports what is suspected to be moderate biomasses of marine mammals, some of which have few alternate habitats in the Gulf (e.g., pilot whales); 3) it supports a diverse megafauna (at least 12 species) and newborns from three species of seals following whelping, which have very few alternative habitats in the Gulf or the Northwest Atlantic. This area was considered moderately important for **aggregation**, considering the high diversity of species and the moderate biomasses of species using the area. **Fitness consequences** of a loss of access to this area would probably be moderate to high, particularly for pinnipeds during winter, which rely specifically on this general sector to support the production of the year.

8) Area offshore Gaspé, including the channel of Baie des Chaleurs

A total of five species were observed along the Gaspé Peninsula, including the Channel of the Baie des Chaleurs, during our late-July to early-September survey (Figure 24). Species detected during the survey included fish consumers (harbour porpoises and white-sided dolphins), some opportunistic feeders (minke and fin whales), and a krill eater (blue whales).

The frequentation of this sector by these five species during the ice-free period has been documented previously either through aerial or shipboard surveys, by-catch or whaling records, or via local systematic or anecdotal observations (Fontaine et al. 1994a; Fortin and Hudon 1978; Larrivée 1996; Laurin 1976; Lesage et al. 2006; Reeves 1986; Sears and Williamson 1982; Sergeant 1977; Sergeant et al. 1980; Tournois 2003). In addition to these species, previous studies also demonstrated the regular presence of harbour seals and grey seals (Boulva and McLaren 1979; Clay and Nielsen 1985; Fortin and Hudon 1978; Robillard et al. 2005), with occasional occurrences of pilot whales (Fortin and Hudon 1978). Recent anecdotal sightings indicate that the area is also regularly frequented by a small number of North Atlantic right whales during summer, that do not summer in the Fundy area (COSEWIC 2003c; Hamilton

et al. 2007; Kraus and Rolland 2007). Unpublished shipboard survey data and a local study from the late 1970s indicate that humpback whales are also present in the Gaspé area (Fortin and Hudon 1978; J.F. Gosselin, DFO, unpubl. data). The regular occurrence of rorqual species, including large numbers of blue whales, has also been documented through anecdotal reports by the Mingan Island Cetacean Studies (MICS) group. The distribution of their observations suggests that the sector of importance for marine mammals in the Gaspé area may extend west along the northern Gaspé Peninsula to at least Les Méchins (MICS unpubl. archived data, available at www.rorqual.com) (Figure 24).

Data for the ice-covered period are limited to a study using satellite telemetry on harbour seals (Lesage et al. 2004), to a local study conducted during the late 1970s (Fortin and Hudon 1978) and to anecdotal sightings reported through the Group or Research and Education on Marine Mammals (GREMM) by a network of shore-based observers (GREMM unpubl. archived data, available at www.baleinesendirect.net). These observations indicate that harbour seals occur probably throughout the year in the area, including the sector of the Gaspé Bay and Cloridorme, which is located along the northern part of the Gaspé Peninsula. Some rorqual species such as blue, fin, minke and humpback whales are also regularly reported off the Gaspé Peninsula through at least late January and as early as the first days of March. Limited satellite telemetry information also indicate that the entrance to Gaspé Bay/Shediac Valley area are also important spring (March-April) areas for harp seals (M.O. Hammill, DFO, unpubl. data) These observations indicate that the Gaspé sector remains regularly frequented by marine mammals during at least part of the winter.

The available information is sufficient to highlight the importance of this area during both the ice-free and ice-covered periods. The Gaspé Peninsula is frequented regularly by at least nine species of marine mammals and more occasionally by one other species (pilot whales) during the ice-free period, and is regularly frequented by at least five different species during winter. However, the available information is currently too limited to qualify the seasonal densities for each species. Data is also too limited to qualify the regularity of use of the area by the different species.

The sector of the Gaspé Peninsula, including the channel of the Baie des Chaleurs, likely represents an area of aggregation of food, and remains relatively free of ice during most of the winter (Saucier et al. 2003; Sourisseau et al. 2006). Based on seasonal occupancy and identity of species, and on the physical and biological oceanography of the area, we conclude that this area serves mainly a **feeding function** during both the ice-free and ice-covered periods. We considered this area as **unique** because 1) the sector is characterised by physical and oceanographic features that favour the aggregation of food resources throughout the year; 2) the sector remains relatively ice-free during winter, allowing animals to benefit from the locally abundant food resources throughout the year; 3) it supports what is suspected to be moderate biomasses of marine mammal species, some of which have few alternate habitats in the Gulf or even the northwest Atlantic (e.g., blue whales and North Atlantic right whales); 4) it supports a diverse megafauna throughout the year (at least nine species during the ice-free period and five species during winter). This area was considered moderately important for **aggregation**, considering the high diversity of species and the moderate biomasses of species using the area. **Fitness consequences** of a loss of access to this area would probably be moderate to high, particularly for cetaceans during winter, which have a limited number of alternate feeding habitats, where food abundance is predictable and which remains relatively free of ice throughout winter. Fitness consequences might also be high for the right whales, which use this area but do not use the Bay of Fundy summer feeding grounds.

9) North margin of the Laurentian Channel to the south of Anticosti Island

Three cetacean species were detected along the north margin of the Laurentian Channel to the south of Anticosti, which also comprised the margin of the eastern plateau of Anticosti (Figure 24). Species included two opportunistic feeders (minke and fin whales) and one fish eater (harbour porpoises). The home range analyses of hooded seals encompassed the margins of the Laurentian

Channel as part of the core distribution of this species during the spring, but their use of this specific sector as a feeding ground is uncertain from the present analyses (Figure 23).

The sole source of information regarding the occurrence and distribution of marine mammals for that particular sector is a shipboard survey using a plateform of opportunity, conducted in August during 1995—1998 (Tournois 2003). During these four years of survey, at least four species were observed distributed specifically along the north margin of the Laurentian Channel east to the confluence with the Esquiman Channel, including the three species observed during our surveys. These species included some fish consumers (harbour porpoises and white-sided and unidentified dolphins) and some opportunistic feeders (fin whales, minke whales, unidentified rorquals). Although fin whales was the main rorqual species identified in this sector, an observation of a minke whale and several observations of unidentified rorquals and blows suggest that other types of rorquals (humpback or blue whales) or many more individuals than those detected by counts of fin whales alone, might use this sector for feeding.

The combined information from our survey and those conducted by Tournois (2003) are sufficient to highlight the likely non-random distribution of cetaceans in this sector. However, more survey effort at different periods and over several years would be needed to characterize the seasonal importance of that sector for marine mammals. Nevertheless, this area appears to be used regularly during the ice-free period by at least four species, which include minke and fin whales, and possibly other rorqual species, as well as harbour porpoises, white-sided dolphins, and possibly other dolphin species. There is no information as to the importance of this sector during winter.

The north and south margins of the Laurentian Channel to the south of Anticosti, and particularly the margin of the plateau to the east of Anticosti, are characterized by important accumulations of zooplankton biomasses during most of the year (Sourisseau et al. 2006). The occurrence of fish consumers in this sector suggests a concommittent accumulation of fish prey. Based on this information and on the seasonal occupancy and identity of species, we conclude that this area serves mainly a **feeding function** for all of the species described here. We considered this area as moderately **unique** because 1) the sector is characterised by physical and oceanographic features that favour biological productivity; 2) the sector supports what is suspected to be moderate biomasses of marine mammal species, which all have alternate habitats in the Estuary or Gulf; 4) it supports a megafauna which is not diverse (at least 4 species). This area was considered of little to moderate importance for **aggregation**, considering the low diversity but moderate biomasses of marine mammals. **Fitness consequences** of a loss of access to this area would probably be low to moderate, as alternative habitats exist in the Estuary and Gulf of St. Lawrence.

10) Southern Gulf Shelf (winter EBSA)

The area comprised of the southern Northumberland Strait, St Georges Bay, Cape Breton, western Cape Breton, and the waters surrounding the Îles-de-la-Madeleine represents a whelping and breeding area for three species of pinnipeds (Figure 24). Grey seals reproduce on small islands off Cape Breton and in the Northumberland Strait (e.g., Amet Island and Hay Island) and the Îles-de-la-Madeleine (e.g., Deadman Island), as well as on the pack ice between Prince Edward Island and Cape Breton, including the southern Northumberland Strait (Hammill et al. 1998; Hammill and Gosselin 2005; Mansfield and Beck 1977). Harp seals are seen around the Magdalen islands, on the ice off western Cape Breton and down into the eastern Northumberland Strait beginning in January through to April (Sears and Williamson 1982; Stenson et al. 2003b). Normally, the harp seal whelping patch forms approximately 50 miles northwest of the Magdalen Islands (Mansfield 1967b; Sergeant 1976; Sergeant 1982b; Sergeant 1991). However, ice conditions, wind and currents usually move the patch down the west side of the Magdalen Islands. During years of milder winters and lighter ice conditions, like during recent years (since 1998), the whelping patch might be pushed farther south to lie just to the north of Prince Edward Island (e.g., Stenson et al. 2003b). After weaning, the pups appear to follow the ice as it leaves the Gulf through Cabot Strait (Sergeant 1965). Adult males remain with the whelping patch throughout the whelping and breeding period after which, animals haul out on the ice to moult, normally around the

Magdalen Islands or in the northern Gulf of St. Lawrence (Sergeant 1991). Hooded seals also whelp in the same general area as harp seals, although whelping patches are usually found nearer to the north of Prince Edward Island, and in some years, even off Cheticamp, to the west of Cape Breton (Bowen et al. 1987; Hammill et al. 1992).

The grey seal and hooded seal home range analyses presented in this study located core distributions onto the shelf of the southern Gulf for grey seals, but mainly within the Laurentian Channel for hooded seals (Figures 22 and 23). These results likely underestimated the importance of the area for these species as they reflected mostly their post-breeding behaviour. Indeed, tagging efforts were made mostly toward the end of the whelping season and thus, the acquired data reflected little the whelping period and mostly the breeding and post-breeding periods. The importance of the shelf of the southern Gulf for harp, hooded and grey seals is best described through the high number of individuals or the propotion of the different populations that depend on this area to reproduce each year.

The ecological and biological significance of the shelf of the southern Gulf for the three pinniped species is intimately linked to ice quality. The stability of the ice is important for females to successfully rear their young, since suckling occurs only on the ice, but it is also important for pups, which remain on the ice for a further two to three weeks. Without access to stable ice to rest, the pups quickly tire and often drown or die. We conclude that this area serves mainly a **reproductive function** for the three species described here. We considered this area as **unique** because 1) the sector is characterised by ice conditions and water masses that are favourable to whelping; 2) these environmental conditions are found only there in the Gulf or in only one or two other places in the Northwest Atlantic; 3) in the case of hooded seals and grey seals, a lack of access to this area may not be balanced by a displacement toward other whelping areas (Hammill 1993; Lesage and Hammill 2001; Zwanenburg and Bowen 1990). This area was considered highly important for **aggregation** as it supports for each of the three species, many thousands of individuals, and in some cases (e.g., possibly hooded seal), a totally independent population. **Fitness consequences** of a reduction in ice quality or a complete loss of access to the pack ice would probably be moderate to high depending on species, because whelping on thin ice or on land where humans or other hazards are present may reduce the survival of pups.

St. Lawrence Estuary

During this study, there was no effort conducted to survey the St. Lawrence Estuary. However, the existing literature indicates that the area is frequented by a wide diversity of species, some of them in large biomasses. Therefore, this sector was added to the list of candidate EBSA, and its quality was examined in details using published literature and anecdotal information.

Very few systematic surveys have been conducted in the St. Lawrence Estuary for estimation of the abundance of most cetaceans and pinnipeds. Exceptions are the St. Lawrence beluga and the harbour seal and grey seal, for which abundance estimates exist for the sector (reviewed in Gosselin et al. 2001; Gosselin et al. 2007; Kingsley 1998a; Kingsley 1999; Robillard et al. 2005). Beluga and harbour seals represent the sole true resident to the Estuary, and would each number approximately one thousand individuals. Several hundreds to possibly a few thousand grey seals frequent the Estuary during summer, but their exact number have not been estimated (Robillard et al. 2005). The distribution of these species in the Estuary have also been documented in other studies (e.g., Boulva and McLaren 1979; Lavigueur et al. 1993; Lavigueur and Hammill 1993; Mansfield and Beck 1977; Michaud et al. 1990; Michaud 1993; Michaud and Chadenet 1990; Pippard and Malcolm 1978; Sears and Williamson 1982). The regular presence of minke whales during the ice-free period has been documented in many studies (e.g., Edds and Macfarlane 1987; Michaud et al. 1997; Mitchell 1974b; Sears and Williamson 1982). However, although an index of abundance of minke whales is determine each year by the Ocean Research and Education Society (ORES) group, these data remain unpublished at this time. Similarly, the regular occurrence of fin whales during the ice-free period has been documented in many studies, but there exist no estimate of their abundance in the Estuary (Edds and Macfarlane 1987; Giard et al. 2001; Michaud et al. 1997; Pippard and Malcolm 1978; Sears and Williamson 1982; Sergeant 1977). The same is true for harbour porpoises (Béland et al. 1987; Laurin 1976; Lavigueur et al. 1993) and blue whales

(Edds and Macfarlane 1987; Michaud et al. 1997; Pippard and Malcolm 1978; Sears and Williamson 1982; GREMM, unpubl. archives, available at www.baleinesendirect.net; MICS unpubl. archives, available at www.rorqual.com), which are known to occur regularly in the Estuary at this time of the year. Harp seals also represent another species, which is found in large numbers (several hundreds to a few thousand) in late spring or early summer in the Estuary (Sears and Williamson 1982; GREMM unpubl. archived data, available at www.baleinesendirect.net). Other species such as humpback whales and sperm whales have been reported regularly in the Estuary, but seem to occur only as singletons or in very small number (Edds and Macfarlane 1987; Pippard and Malcolm 1978; Sergeant 1966; Sergeant et al. 1980; Tournois 2003; Vladykov 1957; GREMM unpubl. archived data, available at www.baleinesendirect.net). Other species such as the white-sided dolphin occur only sporadically in the sector, but when they do enter the Estuary, they may occur in groups of several tens or hundreds of individuals (Sergeant et al. 1980; Kingsley, cited as unpubl. data in Kingsley and Reeves 1998; GREMM unpubl. archived data, available at www.baleinesendirect.net). Finally, other species such as killer whales, right whales, or pilot whales, are reported only occasionally in the area, although their presence might have been more regular in the past (Mathewson 1935; Pippard and Malcolm 1978; Préfontaine 1930; Vladykov 1944).

There exists only limited information for the ice-covered period. However, the available information indicates that the area continues to be frequented by harbour seals and beluga whales, and that other species such as hooded seals and several thousand of harp seals enter the area at that time of the year to feed intensively (Lavigueur et al. 1993; Sears and Williamson 1982; Sergeant 1991). In addition, regular reports of blow sightings indicate that a number of large rorquals remain in the area during most of the winter (GREMM unpubl. archived data, available at www.baleinesendirect.net).

The available information is sufficient to highlight the importance of this area during both the ice-free and ice-covered period, as the St. Lawrence Estuary is frequented regularly or sporadically by at least twelve species of marine mammals, with rare sightings of three other species (pilot, killer, and right whales). However, the available information is currently too scarce to qualify the seasonal densities of most of the species. Data is also too scarce to qualify the regularity of use of the area by many of the species.

The sector of the St. Lawrence Estuary is characterized by a bathymetry and physical oceanography that favours biological productivity and retention of food resources (Lavoie et al. 2000; Simard et al. 2002). Based on seasonal occupancy and identity of species, and on the physical and biological oceanography of the area, we conclude that this area serves mainly a **feeding function** during both the ice-free and ice-covered periods for most of the species. However, this sector **also** serves a **breeding function** for the beluga and harbour seals. We considered this area as **unique** because 1) the sector is characterised by physical and oceanographic features that favour the aggregation of food resources throughout the year; 2) part of this sector remains relatively ice-free during winter, allowing animals to benefit from the locally abundant food resources throughout the year; 3) supports what is suspected to be moderate to high biomasses of marine mammals, two of which are resident to the Estuary and might have no or few alternate habitats in the Gulf or even the northwest Atlantic (i.e., beluga and harbour seals); 4) it supports a highly diverse megafauna throughout the year (at least 12 species). This area was considered moderately important for **aggregation**, considering the high diversity of species and the moderate to high biomasses of species using the area. **Fitness consequences** of a loss of access to this area would probably be moderate for most species, except the St. Lawrence beluga, which has no alternate habitats. Fitness consequences for harbour seals are uncertain but could be high given the high site fidelity of this species, and what might be limited habitat available in the Gulf of St. Lawrence. Finally, consequences could be moderate to important for harp seals, which enter the Estuary in large number during the winter to feed intensively, although alternate habitats likely exist for this species.

Conclusions

In this study, we have separated marine mammals into categories according to their feeding preferences and general habits in order to determine the quality of the different areas of aggregation. No clear trends in the distribution of krill vs fish consumers were detected when considering the data analysed in this study and the published literature. Most if not all of the candidate EBSAs appear to attract at least periodically, both krill and fish consumers. The EBSAs including deeper waters, such as the Cape Breton Trough, the Esquiman Channel, and the entrance of St Georges Bay are likely to also support squid consumers and dolphin species, which are known to include to some extent squid as part of their diet.

The areas of aggregation of marine mammals identified in this stuy appear to all be characterized by physical or oceanographic features, which are favourable to the aggregation or retention of food resources. Some sectors such as the north margin of the Laurentian Channel to the south of Anticosti Island appeared to sustain only a small diversity of species. However, we believe that the diversity and biomasses of species presented in this study provided only a minimal view of the importance of each sector. Given that marine mammals are constrained by their large size to feed in sectors of high productivity, we concluded that each area of aggregation retained as a candidate EBSA, probably warrants consideration as ecologically and biologically significant for the St. Lawrence ecosystem.

As indicated previously, this analysis was conducted based on what was generally fragmentary data. There is a clear need to increase survey effort by not only conducting surveys during different periods of the year, but also by repeating surveys over several years. Only then, will we be able to characterize with some degree of certainty the seasonal densities of marine mammals in the different sectors and the true ecological and biological significance of these sectors for marine mammals.

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Table 1. Mean mass of adult males and females of marine mammal species susceptible to be observed in the Estuary and Gulf of St Lawrence. Characters in parentheses refer to abbreviations used in other tables.

Species	Average mass (kg)		
	Male	Female	Taxon
Grey seal (Hg)	300 to 350	150 to 200	250
Harbour seal (Pv)	90	70	80
Harp seal (Pg)	140	130	135
Hooded seal (Cc)	275 to 400	275 to 375	331
Blue whale (Bm)	80,000 to 120,000	80,000 to 120,000	100,000
Fin whale (Bp)	29,000	34,000	31,500
Humpback whale (Mn)	25,000 to 30,000	25,000 to 30,000	27,500
Minke whale (Ba)	5,000	6,000	5,500
North Atlantic right whale (Eg)	55,000	55,000	55,000
Beluga whale (Dl)	450 to 1,000	250 to 700	600
Killer whale (Oo)	5,600	3,800	4,700
Long-finned pilot whale (Gm)	2,300	1,300	1,800
Northern bottlenose whale (Ha)	5,700	3,800	4,750
Sperm whale (Pm)	30,000	15,000	22,500
Harbour porpoise (Pp)	45 to 60	45 to 60	53
Atlantic white-sided dolphin (La)	130 to 230	130 to 230	180
Shortbeaked common dolphin (Dd)	70 to 110	70 to 110	90
Striped dolphin (Sc)	160	150	155
Whitebeaked dolphin (Lalb)	135 to 275	135 to 275	205

Table 2. Number of sightings and average (± SD) and median group sizes for each species observed during the three surveys combined.

Species	Total		Group size		
	Sightings	Individuals	Mean	SD	Median
Harp seal	4	5	1.25	0.50	1
Blue whale	5	5	1	0	1
Fin whale	17	33	1.94	1.68	1
Humpback whale	45	69	1.53	1.08	1
Minke whale	53	56	1.06	0.23	1
Beluga whale	3	6	2	1	2
Long-finned pilot whale	16	113	7.06	7.00	5
Harbour porpoise	209	486	2.33	1.97	2
Atlantic white-sided dolphin	46	292	6.35	7.92	3.5
Common dolphin	43	243	5.65	4.45	5
Whitebeaked dolphin	13	102	7.85	7.31	4
Unidentified large whale	27	33	1.22	0.58	1
Unidentified small cetacean	13	32	2.46	2.03	2
Unidentified dolphin	25	282	11.28	29.55	3

Table 3. Diversity and biomass indices (percentage of the maximum biomass detected in a cell) for candidate areas for EBSA designation derived from the analysis of three systematic summer aerial surveys and of telemetry data from hooded seals and grey seals. Diversity indices were qualified as the minimum number of species detected in an area during these studies. Biomass indices corresponded to the biomass percentile most frequently observed among the cells in the area. The ID number refers to the identification number provided in Table 5.

ID	Candidate areas for EBSA designation	Min N of species	Predominant biomass percentiles
1	Pointe-des-Monts to Sept-Îles	8	> 75
2	West of Anticosti	7	> 75
3	Jacques-Cartier Strait	5	25–50
4	Strait of Belle-Isle/Mecatina Plateau	8	> 75
5	W shelf of Newfoundland	5	25–50
6	Entrance of St Georges Bay, Newfoundland	7	50–75
7	Cape Breton Trough	3	25–50
8	Offshore Gaspé, including channel of Baie des Chaleurs	5	> 75
9	North margin of Laurentian Channel to the south of Anticosti	3	> 75
10	Shelf of southern Gulf of St. Lawrence (additional winter EBSA)	2	> 75[a]

[a] This are constitutes the main whelping concentrations for harp, grey and hooded seals in the Gulf of St. Lawrence (see text for references)

Table 4. Updated diversity indices for areas candidate for EBSA designation, using a combination of the data analysed in this study and published and unpublished literature. The predominant biomass percentiles are based solely on the data acquired during the current study and thus, are not based on the published literature due to the general lack of data on that matter. Species names corresponding to abbreviations in column 'Species present' are indicated in table 1.

ID	Candidate areas for EBSA designation	Min N of species	Best estimate of min N of species	Species present	Predominant biomass percentiles
1	Pointe-des-Monts to Sept-Îles	8	11	Hg, Pv, Cc, Pg, Ba, Bm, Bp, Mn, Dl, Pp, La, (Eg)	> 75
2	West of Anticosti	7	12	Hg, Pv, Cc, Pg, Ba, Bm, Bp, Mn, Pp, La, Lalb, Oo, (Gm)	> 75
3	Jacques-Cartier Strait	5	8	Hg, Pv, Oo, Ba, Pp, La, Lalb, Bp	25–50
4	Strait of Belle-Isle/Mecatina Plateau	8	14	Hg, Pv, Cc, Pg, Ba, Bm, Bp, Mn, Oo, Pp, La, Lalb, Dd, Gm	> 75
5	W shelf of Newfoundland	5	9	Pg, Pm; Mn, Bm, Ba, Gm, Pp, La, Bp	25–50
6	Entrance of St Georges Bay, Newfoundland	7	11	Hg, Pv, Bm, Ba, Gm, Pp, La, Bp, Mn, Dd, Oo	50–75
7	Cape Breton Trough	3	12	Hg, Pv; Mn; Gm, Ba, Pp, La, Lalb, Bp, Sc, Pg, Cc	25–50
8	Offshore Gaspé, including channel of Baie des Chaleurs	5	9	Hg, Pv, Eg, Bp, Bm, Ba, Pp, La, Mn, (Gm)	> 75
9	North margin of Laurentian Channel to the south of Anticosti	3	4	Ba, Pp, La, Bp	> 75
10	Shelf of southern Gulf (winter candidate EBSA)	2	3	Hg, Pg, Cc	> 75
11	St. Lawrence Estuary	-	12	Cc, Hg, Pg, Pv, Dl, Ba, Bm, Bp, Mn, Pp, La, Pm (Gm, Oo, Eg)	-

Table 5. Characteristics of the different areas candidate for EBSA designation in the perspective of marine mammal use of these areas. The higher the importance of the criterion, the higher the weight given.

EBSA	Characteristics	Type of data considered			Uniqueness		Aggregation		Fitness consequences	
		Analysed	Unanalysed	Published literature	Description	Weight	Description	Weight	Description	Weight
1. Pointe-des-Monts to Sept-Îles	Feeding function for large biomasses and wide diversity of marine mammals	x	x	x	Unique gyre system; one of few areas of large aggregations for blue whales; one of few wintering grounds for beluga and rorquals in the Gulf	3	Supports large biomasses and diversity of species throughout the year; large biomasses of blue whales suggestive of large carrying capacity	3	Alternative habitat exist for most species; consequences possibly more important for blue whales and for beluga during winter because few alternative areas exist	3
2. West of Anticosti	Feeding function for large biomasses and wide diversity of marine mammals	x		x	Sector of wind-driven upwellings, intense tidal mixing and high biological productivity; similar habitats exist elsewhere in the St. Lawrence	2	Supports moderate to large biomasses of rorquals and a wide diversity of species; suggestive of relatively large carrying capacity	3	Alternative habitat exist for all species, but if large biomasses are supported as suspected, then might affect negatively alternative habitats with limited carrying capacity	2
Jacques Cartier Strait	Feeding function for moderate biomasses of a moderate diversity of pinnipeds and cetaceans	x		x	Sector of wind-driven upwellings and likely high biological productivity; simlar habitats exist elsewhere in the St. Lawrence	2	High numbers of small fish-eating cetaceans and pinnipeds and moderate biomasses of opportunistic rorquals	2	Likely moderate to low, as alternate habitats of equal or superior quality likely exist elsewhere	2

EBSA	Characteristics	Type of data considered			Uniqueness		Aggregation		Fitness consequences	
		Analysed	Unanalysed	Published literature	Description	Weight	Description	Weight	Description	Weight
Mecatina/Belle Isle	Feeding function for diverse and high biomasses of megafauna; migration function during spring and fall; reproduction function during winter for seals	x		x	Local bathymetry results in persistent zooplankton aggregation	3	Large biomasses of a diverse megafauna, including high numbers of humpback whales at some periods of the year	3	Might result in increase in pressure onto the few alternate feeding sites in the Northwest Atlantic if all this biomass was displaced elsewhere	3
Western shelf of Newfoundland	Feeding function for a moderate diversity of species	x	x	x	Local bathymetry favours persistent zooplankton aggregations	1	Moderate diversity of low to moderate biomasses of marine mammals	2	Alternative habitats exist in St. Lawrence, but are limited, particularly for blue whales during winter	2
Entrance of St Georges Bay	Feeding function for a diverse megafauna	x		x	Site of zooplankton aggregation	2	High diversity of moderate biomasses of marine mammals	2	Probably moderate, except possibly for blue whales and the larger species, as alternate habitats may be limited, particularly during winter	2
Cape Breton Trough	Feeding function for a diverse megafauna; reproduction function and moulting function during winter and early spring for pinnipeds	x	x	x	Site of food aggregation; ice conditions, water masses movements favourable to seal whelping; only a couple of alternative sites in the Northwest Atlantic	3	High diversity of moderate biomasses of marine mammals	2	Probably moderate for most species because alternates exist; except for pinnipeds in winter, which rely specifically on this sector for reproduction	3

EBSA	Characteristics	Type of data considered			Uniqueness		Aggregation		Fitness consequences	
		Analysed	Unanalysed	Published literature	Description	Weight	Description	Weight	Description	Weight
Offshore Gaspé	Feeding function for a diverse megafauna	x	x	x	physical and oceanographic features favour food aggregation throughout the year; remains ice-free during winter, allowing access to food; supports endangered species, with few alternate habitats; one of few areas of large aggregations of blue whales, and the sole habitat known in the Gulf for right whales	3	High diversity of moderate biomasses of marine mammals throughout the year	2	Probably moderate for most species, except blue whales, who congregate in extremely large numbers at certain times of the year; sole known habitat for a part of the right whale population; alternate habitats might also be rare for blue whales; likely important during winter, as alternate habitat remaining ice-free with predictable food sources might be rare	3
North margin of Laurentian Channel	Feeding function for moderate biomasses of a low diversity of cetacean species	x		x	Likely high biological productivity	2	Aggregation of a low diversity of species, particularly rorquals in unknown biomasses	1	Alternative habitats exist elsewhere in the St. Lawrence	2

EBSA	Characteristics	Type of data considered			Uniqueness		Aggregation		Fitness consequences	
		Analysed	Unanalysed	Published literature	Description	Weight	Description	Weight	Description	Weight
Shelf of the southern Gulf	Reproduction function for three pinniped species	x		x	Ice conditions and water masses favourable to whelping found in only a couple of other places in the Northwest Atlantic;	3	Supports large biomasses of three species, and approx. 35% or less of each of the populations	3	Ice of bad quality could affect these populations through a reduction in pups survival; a displacement from this area may not result in a heavier use of alternative whelping areas for two of the three species	3
St. Lawrence Estuary	Feeding function for a diverse megafauna and breeding function for harbour seals and beluga whales	x	x	x	physical and oceanographic features favouring food aggregation throughout the year; remains partly ice-free during winter, allowing access to food; supports species which are endangered and have few or no alternate habitats; one of few areas of large aggregations of blue whales	3	Moderate to high biomasses of a wide diversity of species	2	Might be catastrophic for beluga, whose distribution during the ice-free period is confined to the Estuary; also likely important impacts on harbour seals who show high site fidelity; moderate impact for other species as alternate habitats exist elsewhere in the St. Lawrence system	3

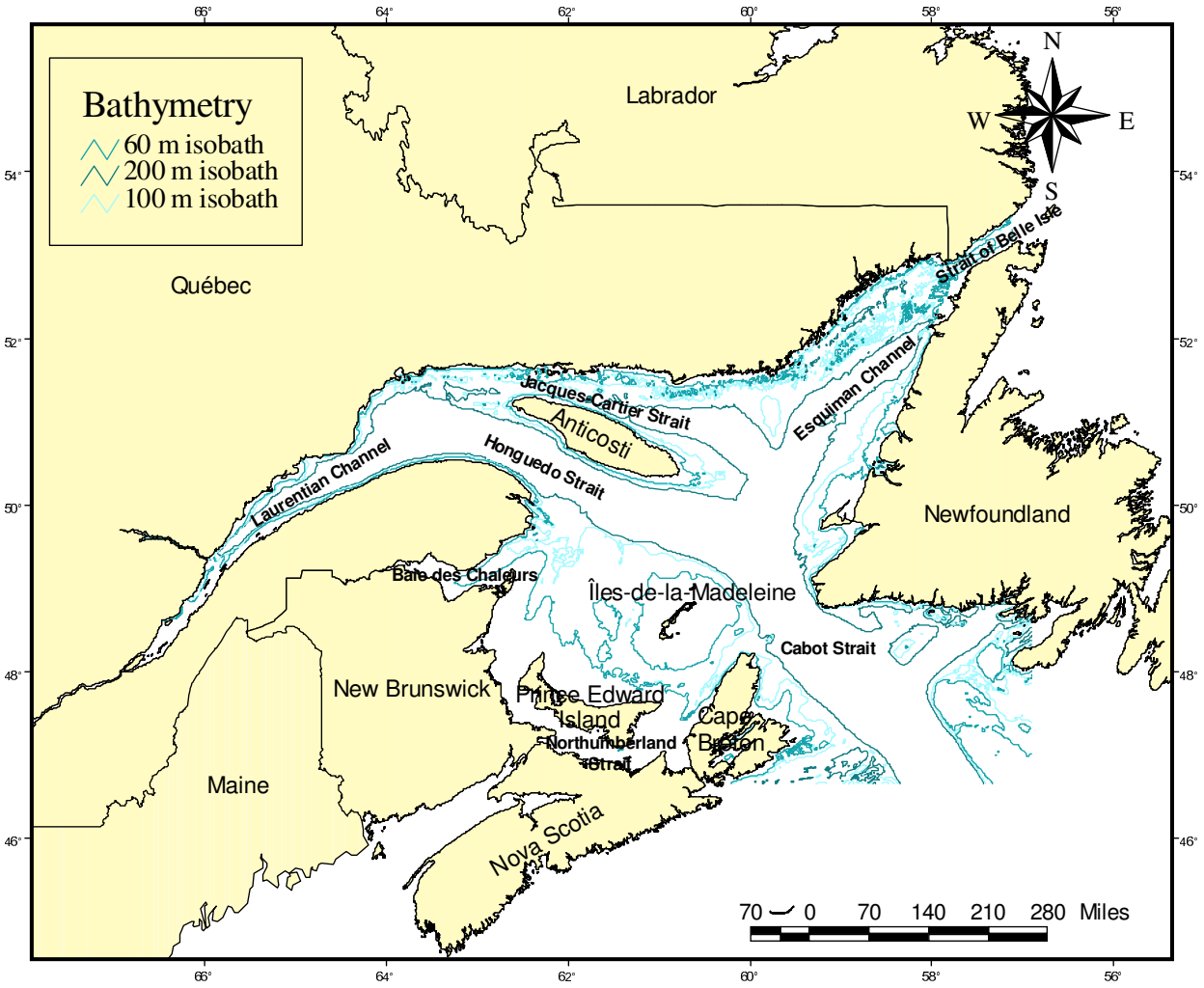

Figure 1. Study area.

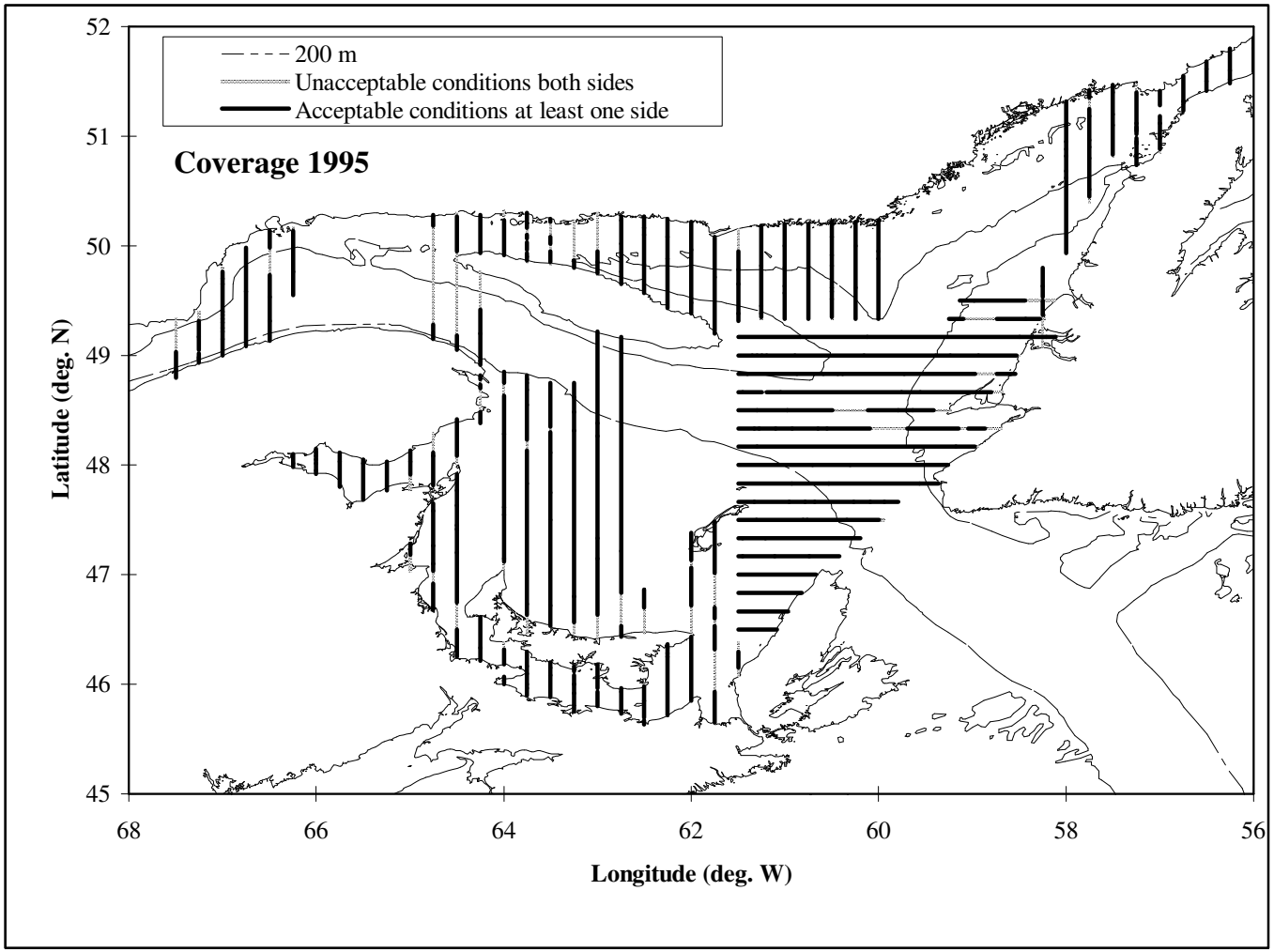

Figure 2. Survey effort in 1995 as per Kingsley and Reeves (1998).

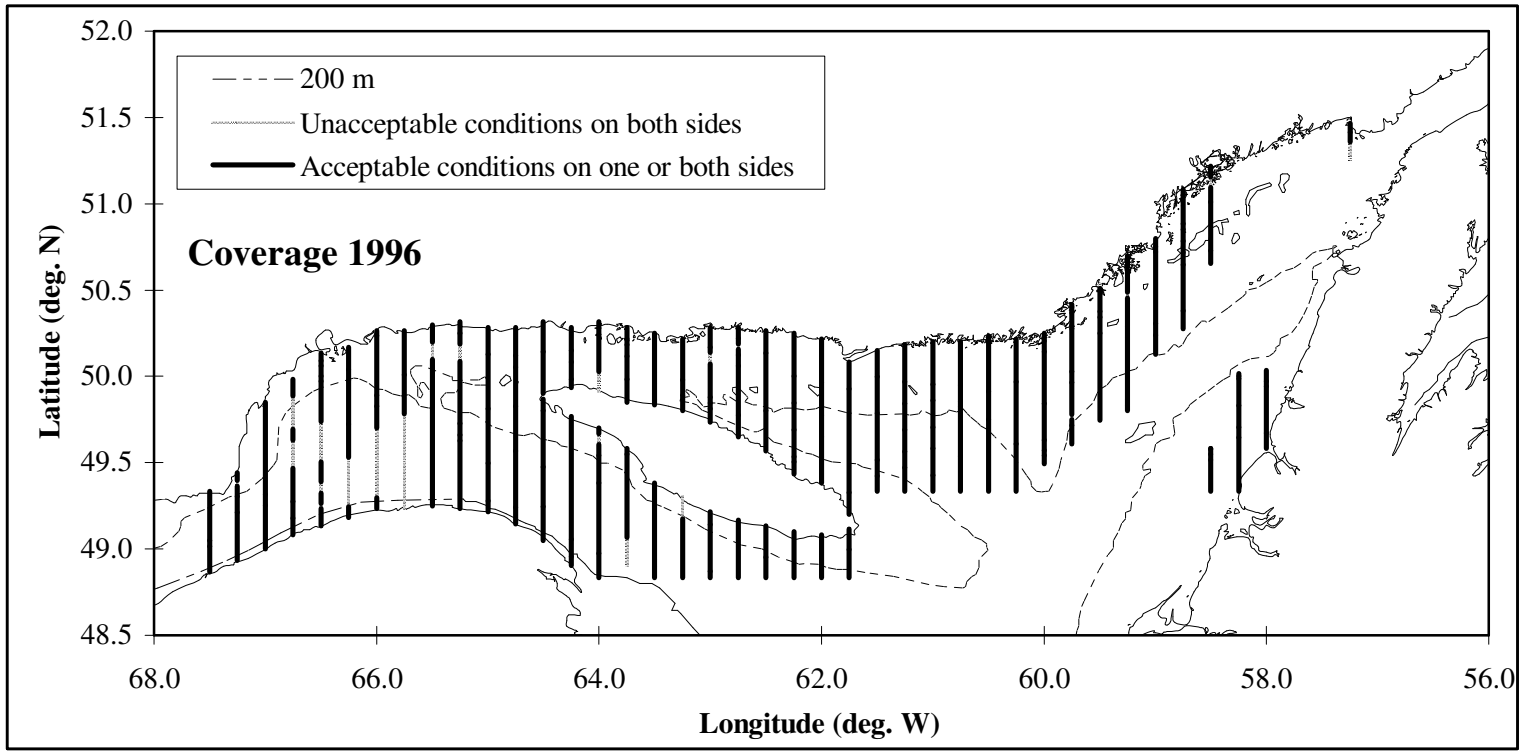

Figure 3. Survey effort in 1996 as per Kingsley and Reeves (1998).

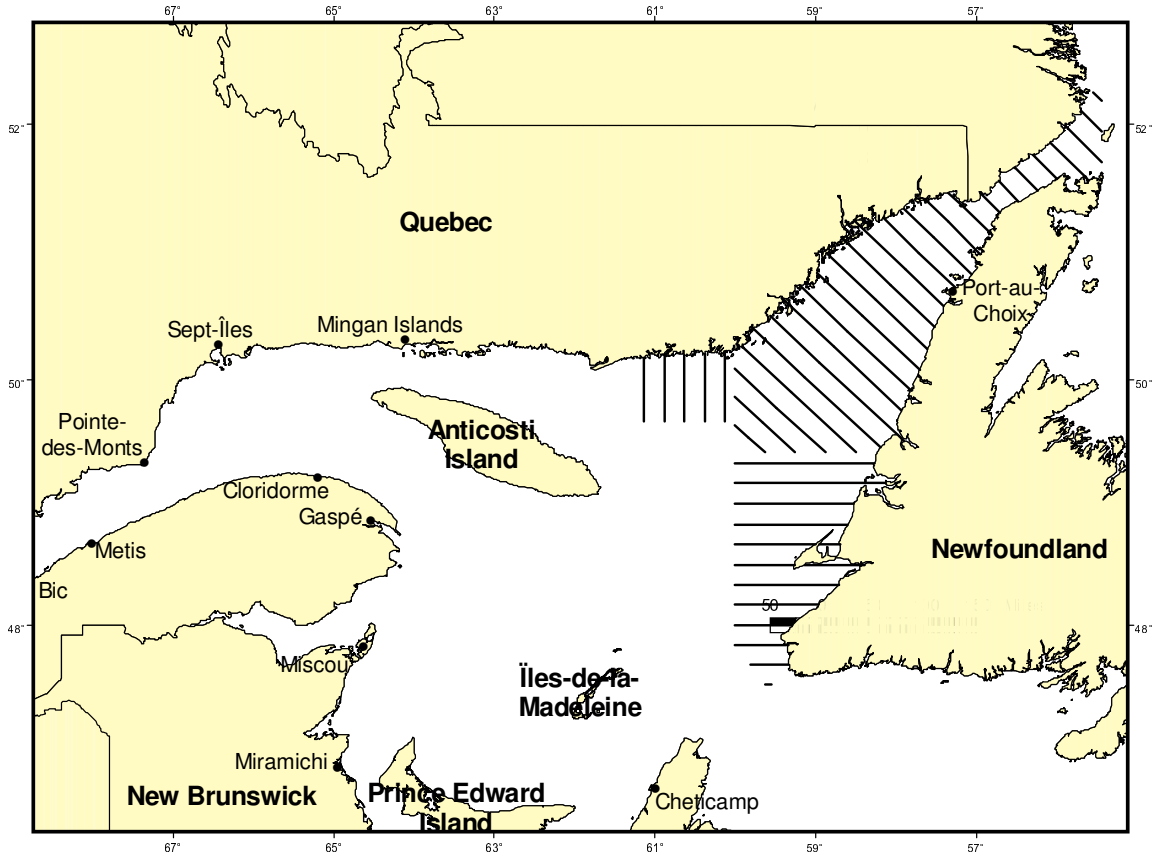

Figure 4. Survey effort in 2002.

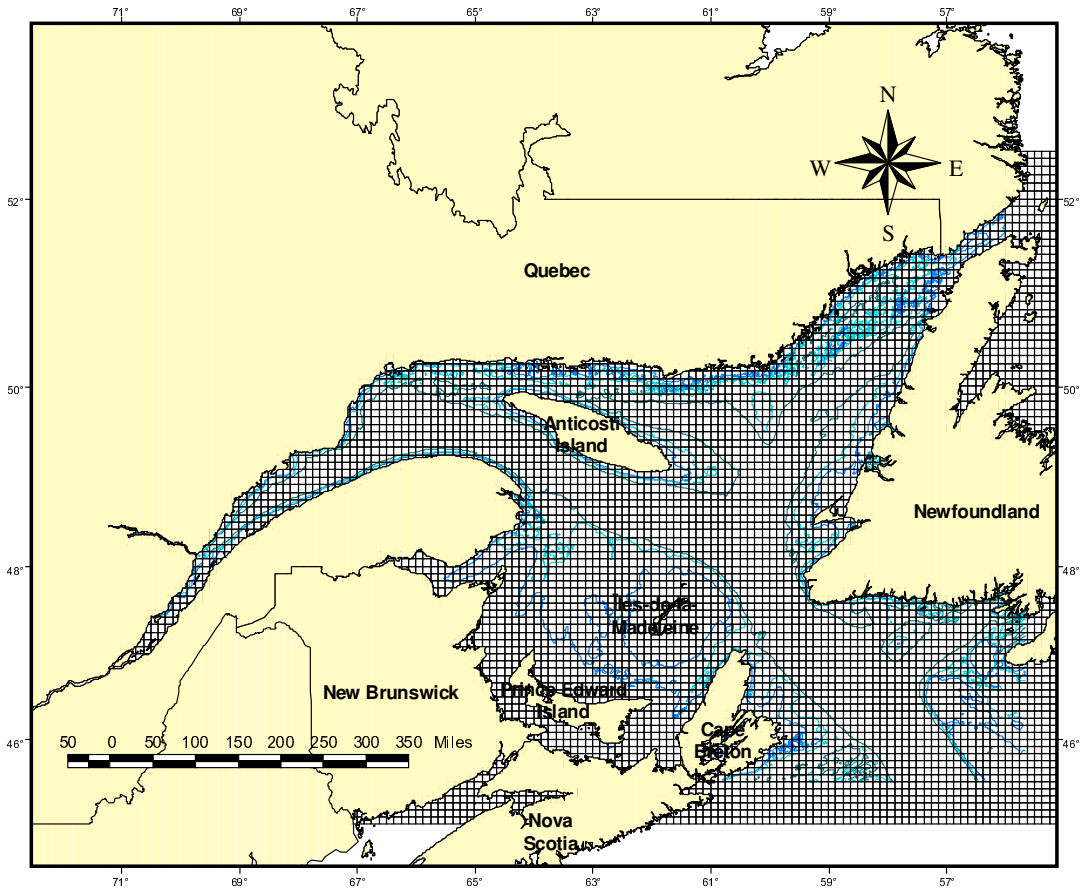

Figure 5. Gridding of the study area at 1/8 longitude by 1/12 latitude.

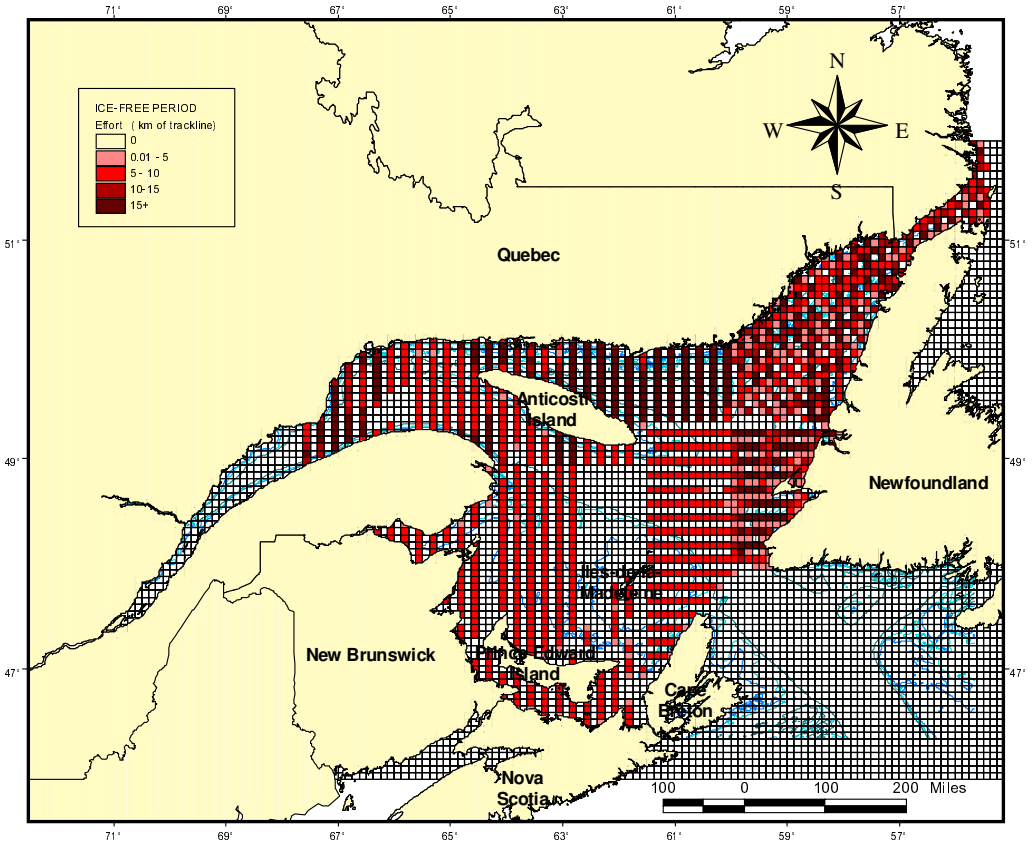

Figure 6. Survey effort in terms of km of trackline per cell for the three aerial surveys combined.

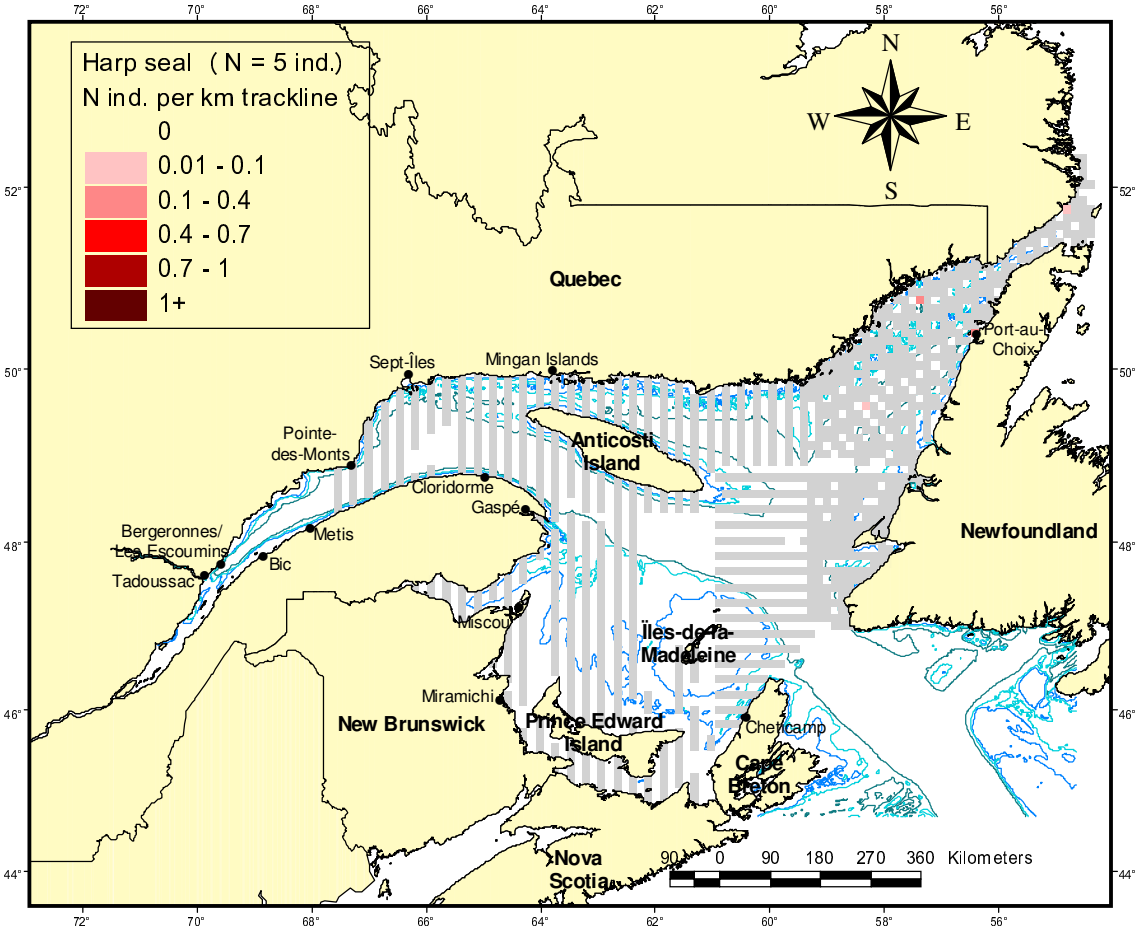

Figure 7. Harp seals encounter rates, expressed in terms of number of individuals per km of trackline, during the three surveys combined. Grey cells represent areas where survey effort was non-zero.

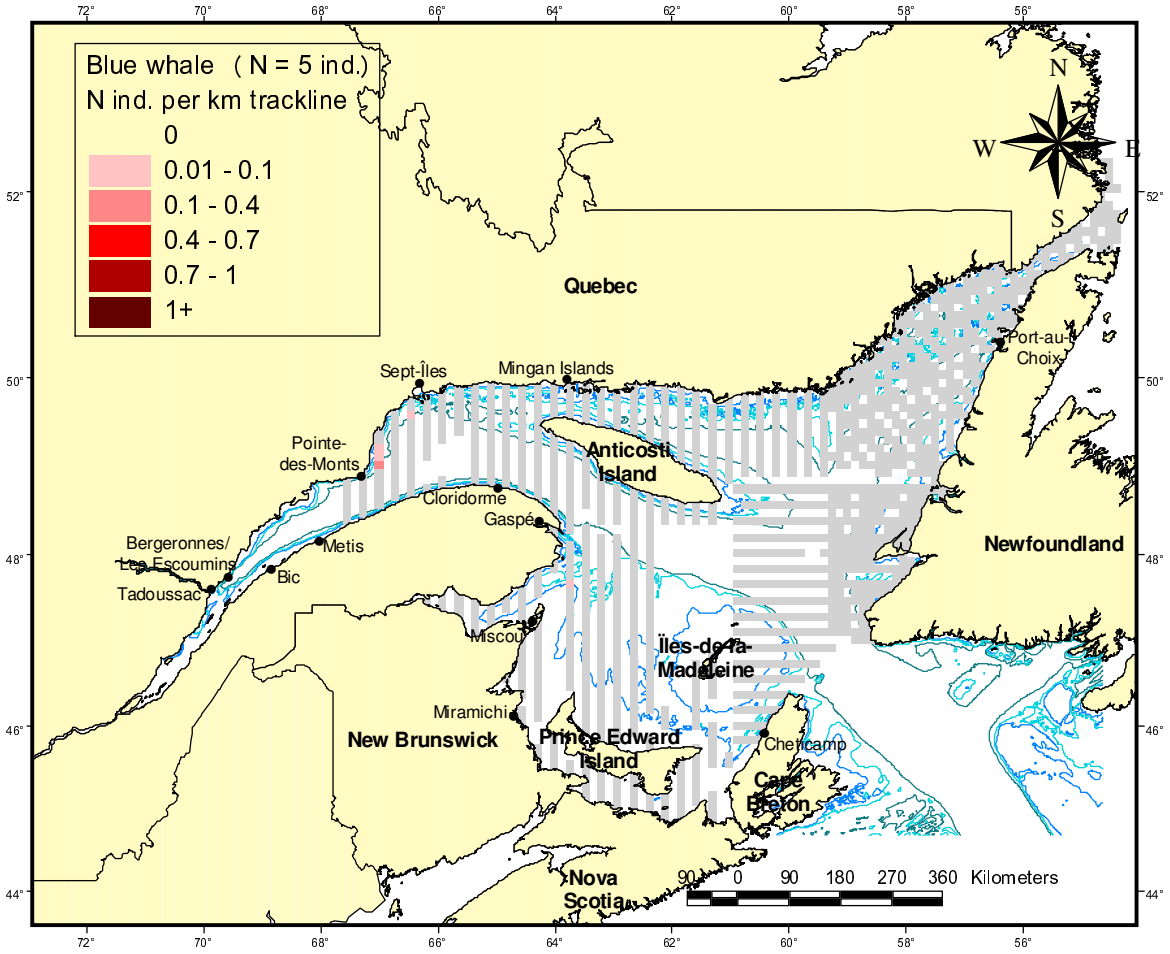

Figure 8. Blue whale encounter rates, expressed in terms of number of individuals per km of trackline, during the three surveys combined. Grey cells represent areas where survey effort was non-zero.

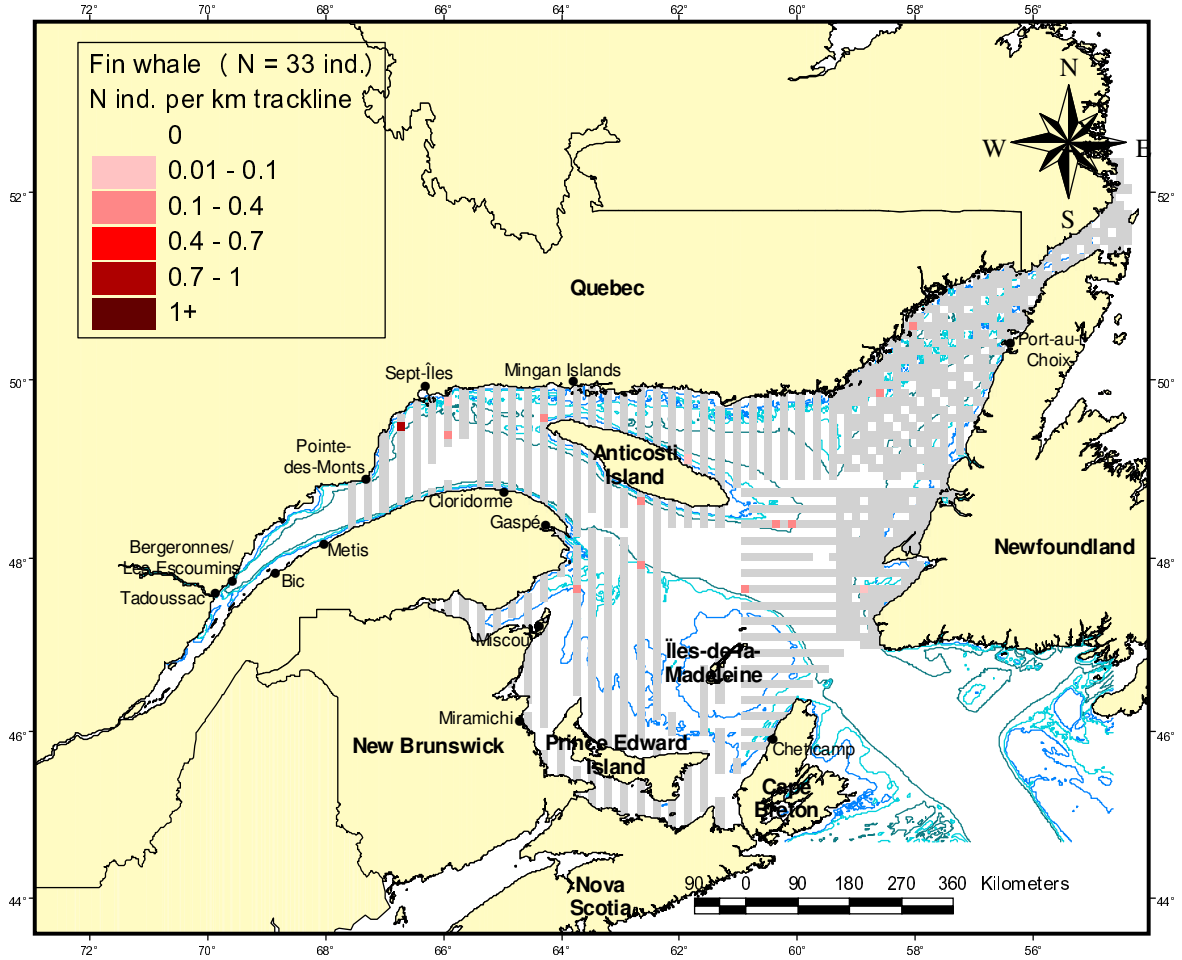

Figure 9. Fin whale encounter rates, expressed in terms of number of individuals per km of trackline, during the three surveys combined. Grey cells represent areas where survey effort was non-zero.

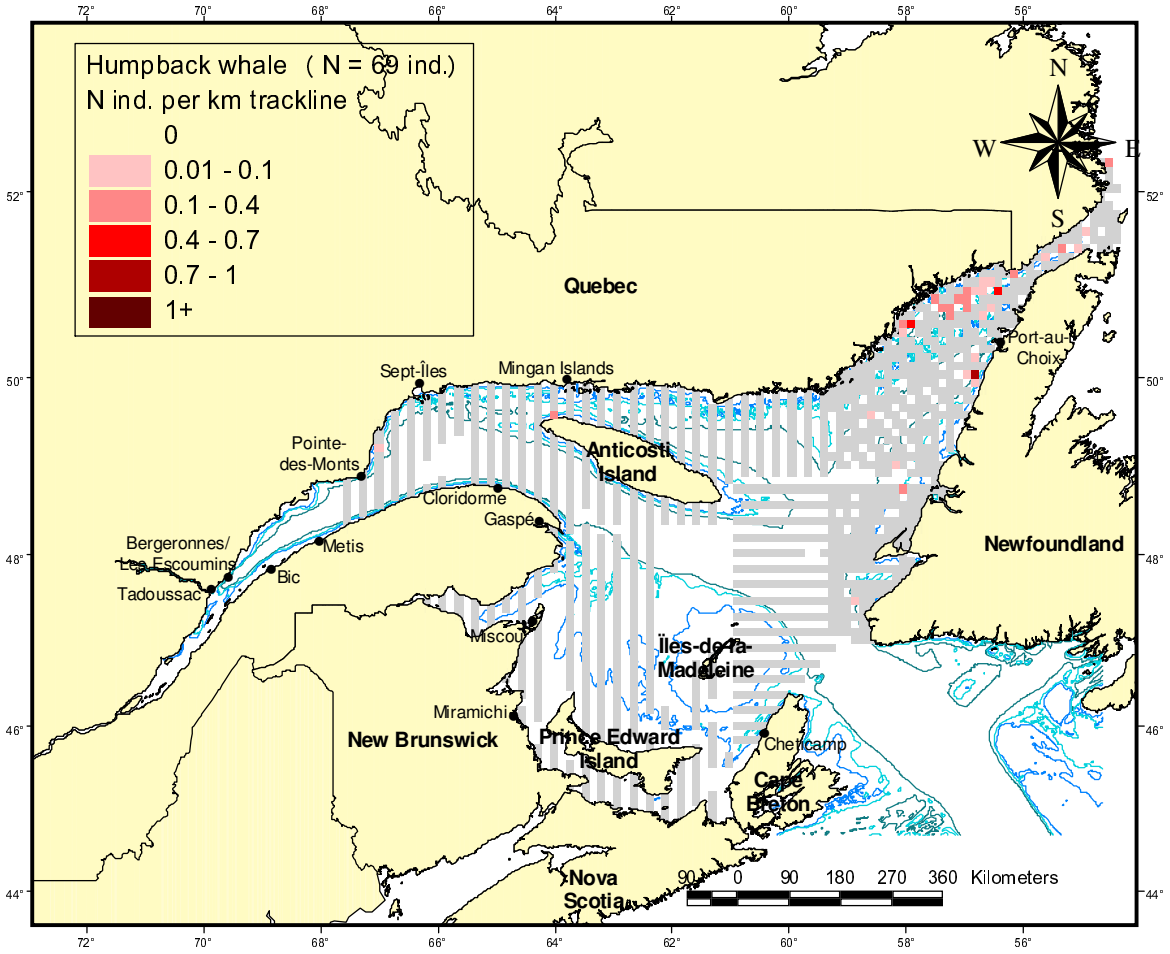

Figure 10. Humpback whale encounter rates, expressed in terms of number of individuals per km of trackline, during the three surveys combined. Grey cells represent areas where survey effort was non-zero.

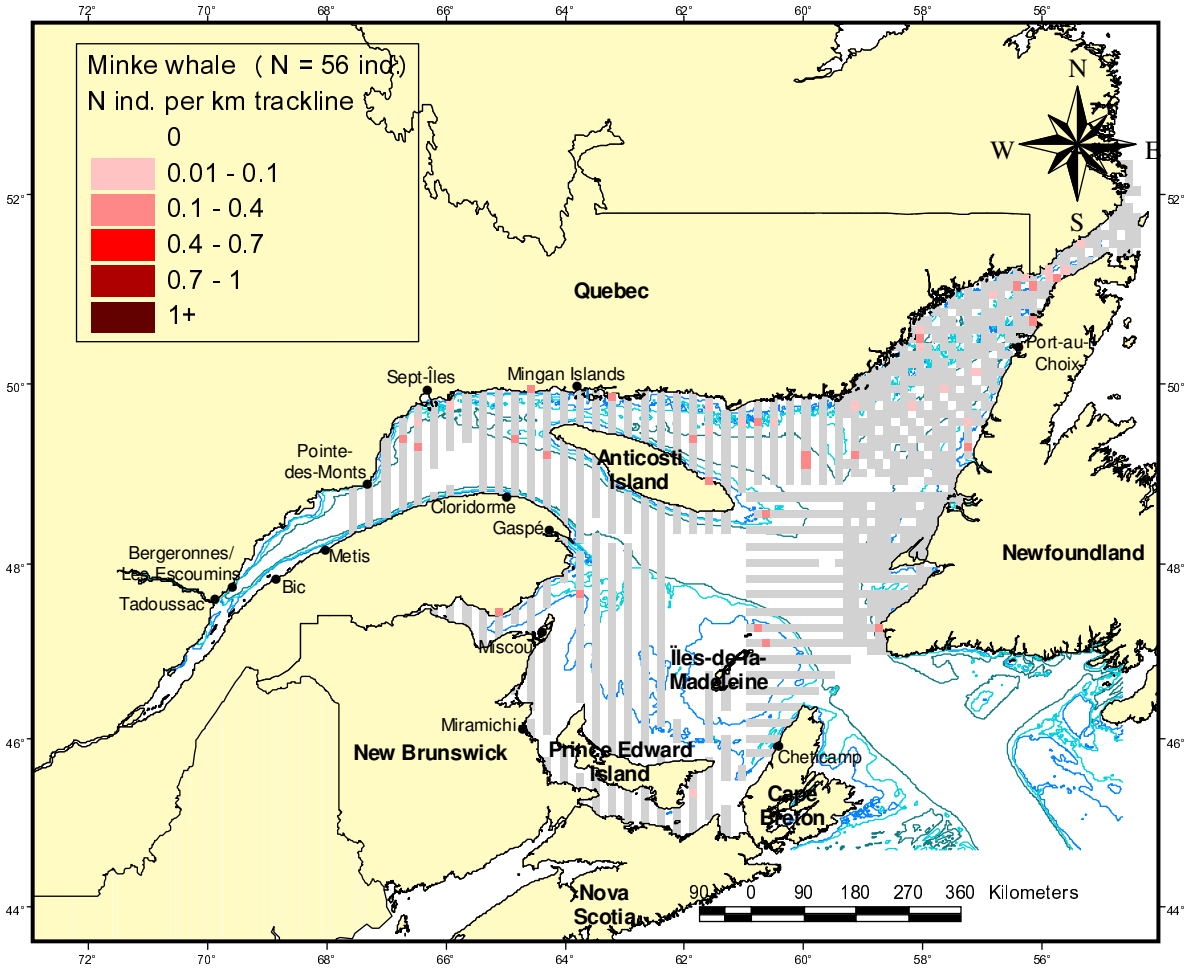

Figure 11. Minke whale encounter rates, expressed in terms of number of individuals per km of trackline, during the three surveys combined. Grey cells represent areas where survey effort was non-zero.

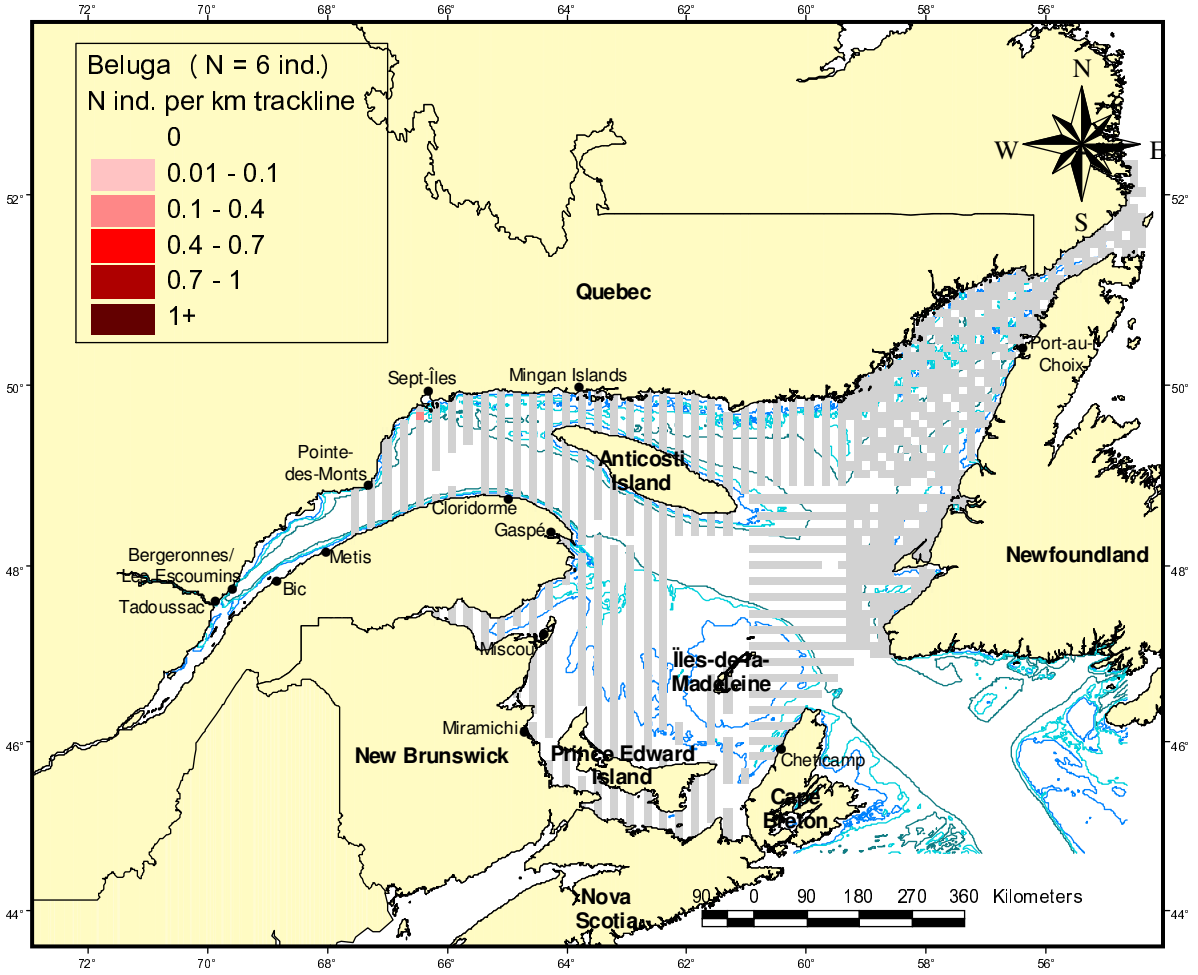

Figure 12. Beluga whale encounter rates, expressed in terms of number of individuals per km of trackline, during the three surveys combined. Grey cells represent areas where survey effort was non-zero.

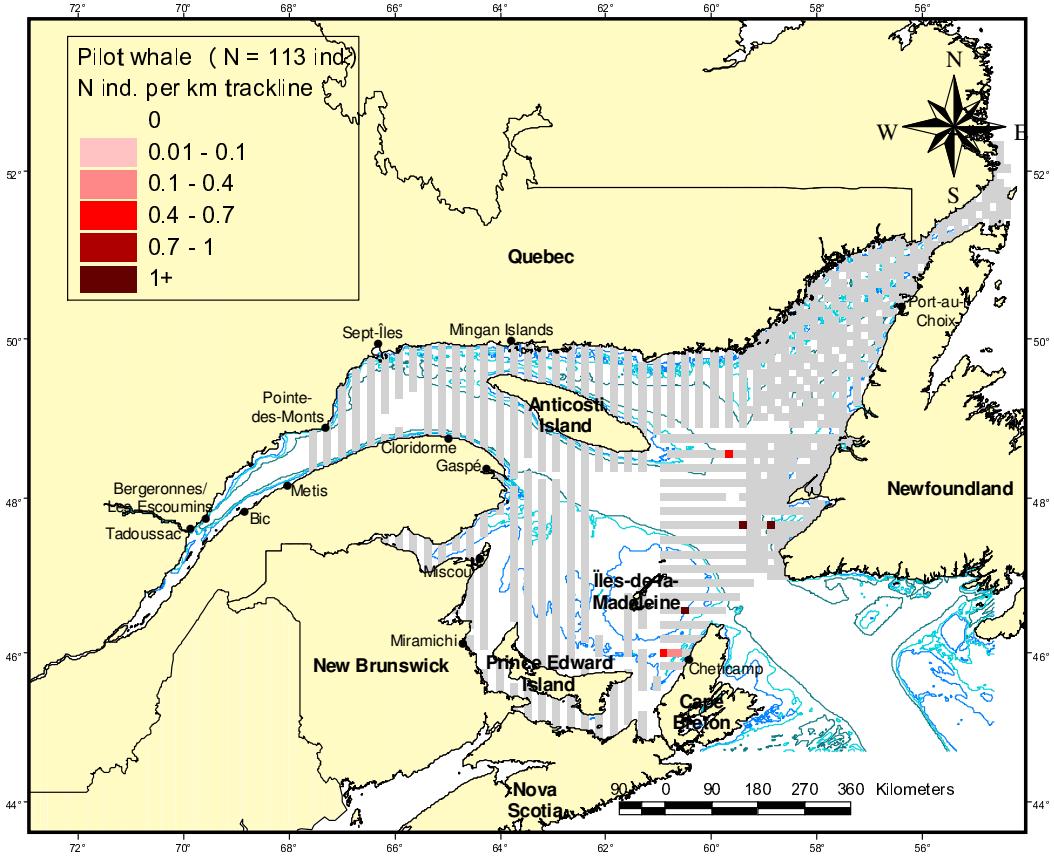

Figure 13. Pilot whale encounter rates, expressed in terms of number of individuals per km of trackline, during the three surveys combined. Grey cells represent areas where survey effort was non-zero.

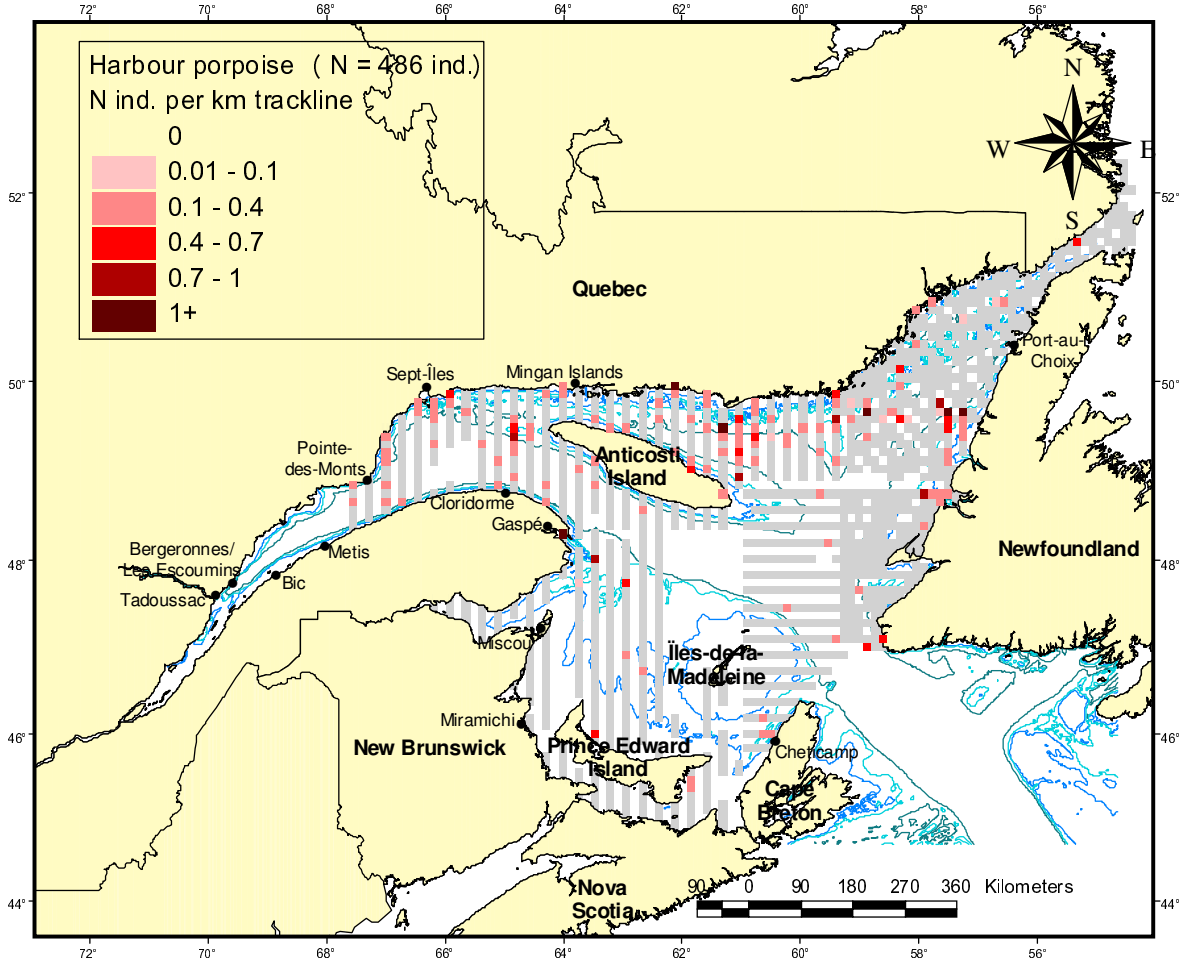

Figure 14. Harbour porpoise encounter rates, expressed in terms of number of individuals per km of trackline, during the three surveys combined. Grey cells represent areas where survey effort was non-zero.

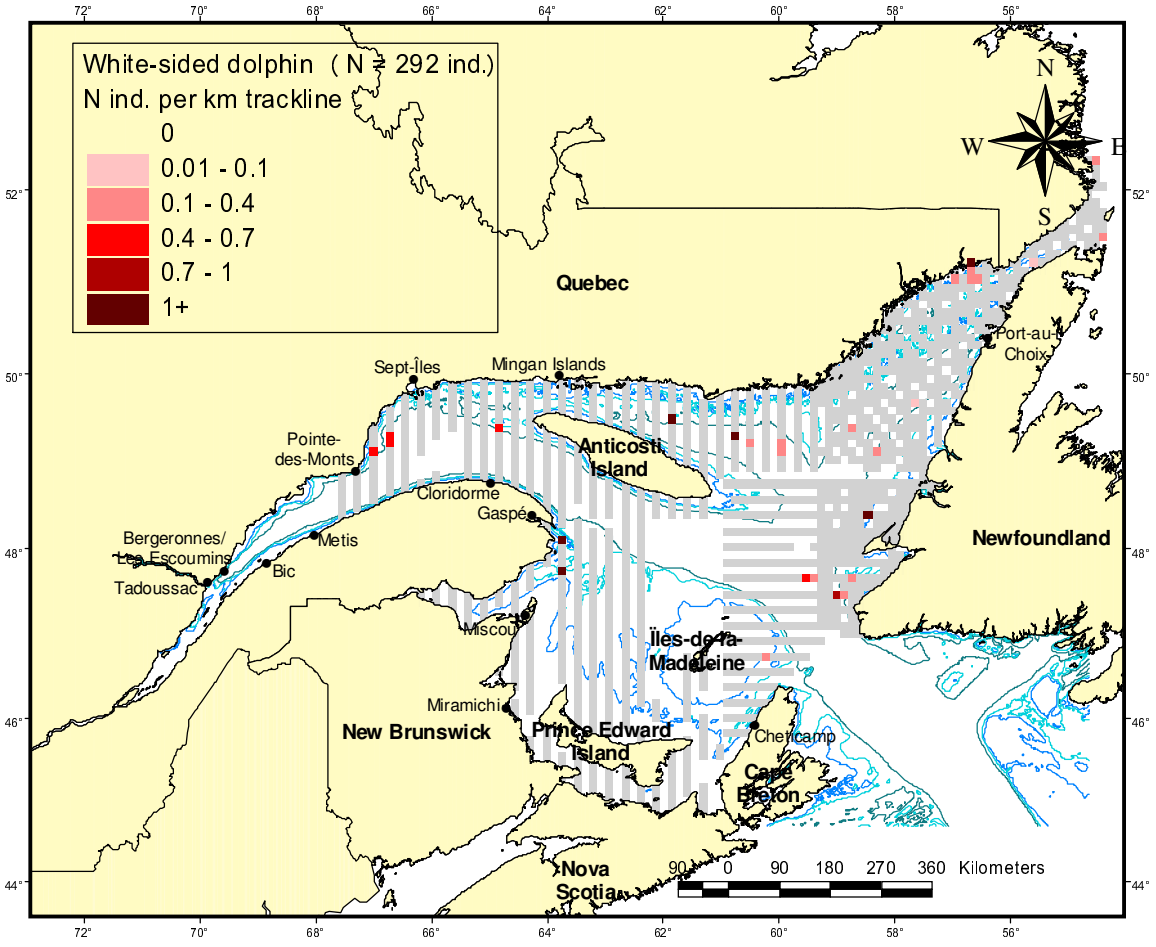

Figure 15. Atlantic white-sided dolphin encounter rates, expressed in terms of number of individuals per km of trackline, during the three surveys combined. Grey cells represent areas where survey effort was non-zero.

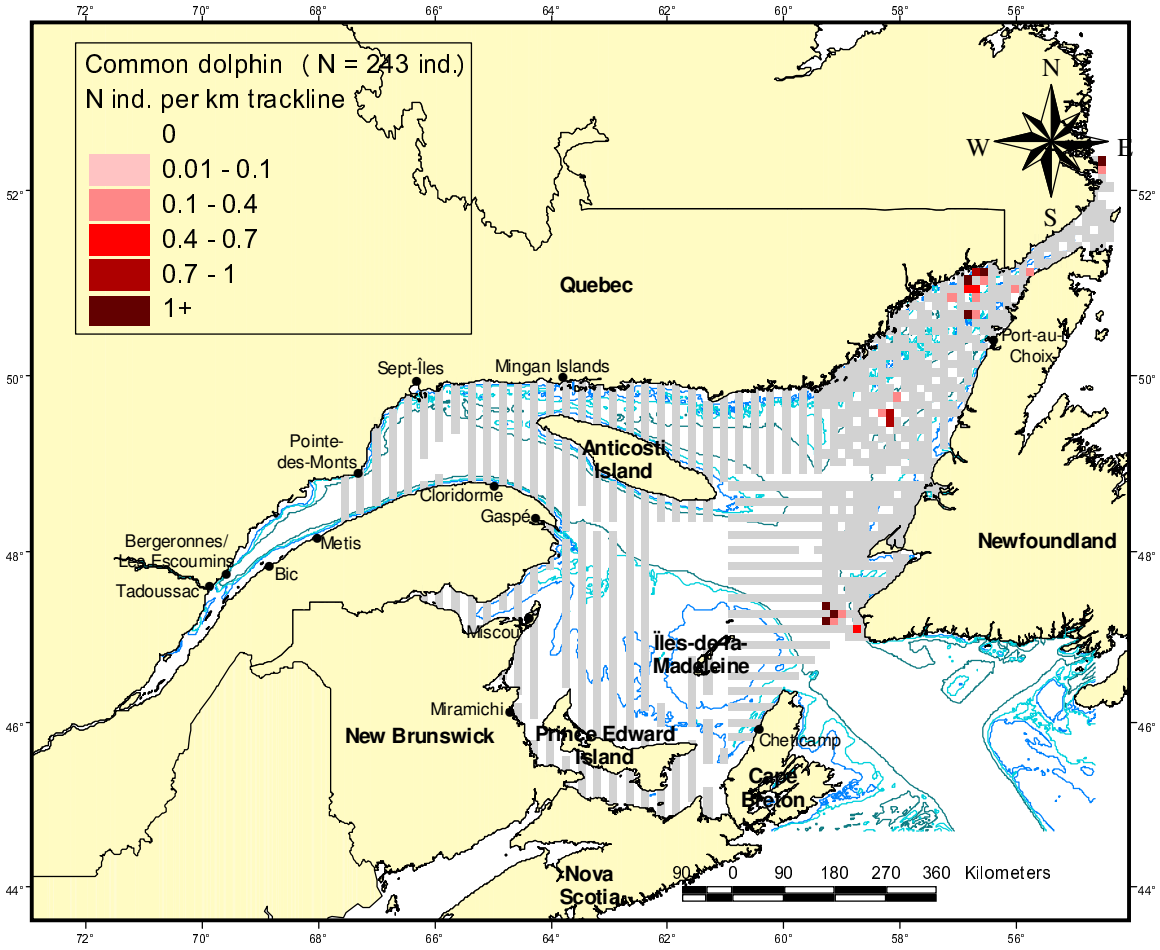

Figure 16. Shortbeaked common dolphin encounter rates, expressed in terms of number of individuals per km of trackline, during the three surveys combined. Grey cells represent areas where survey effort was non-zero.

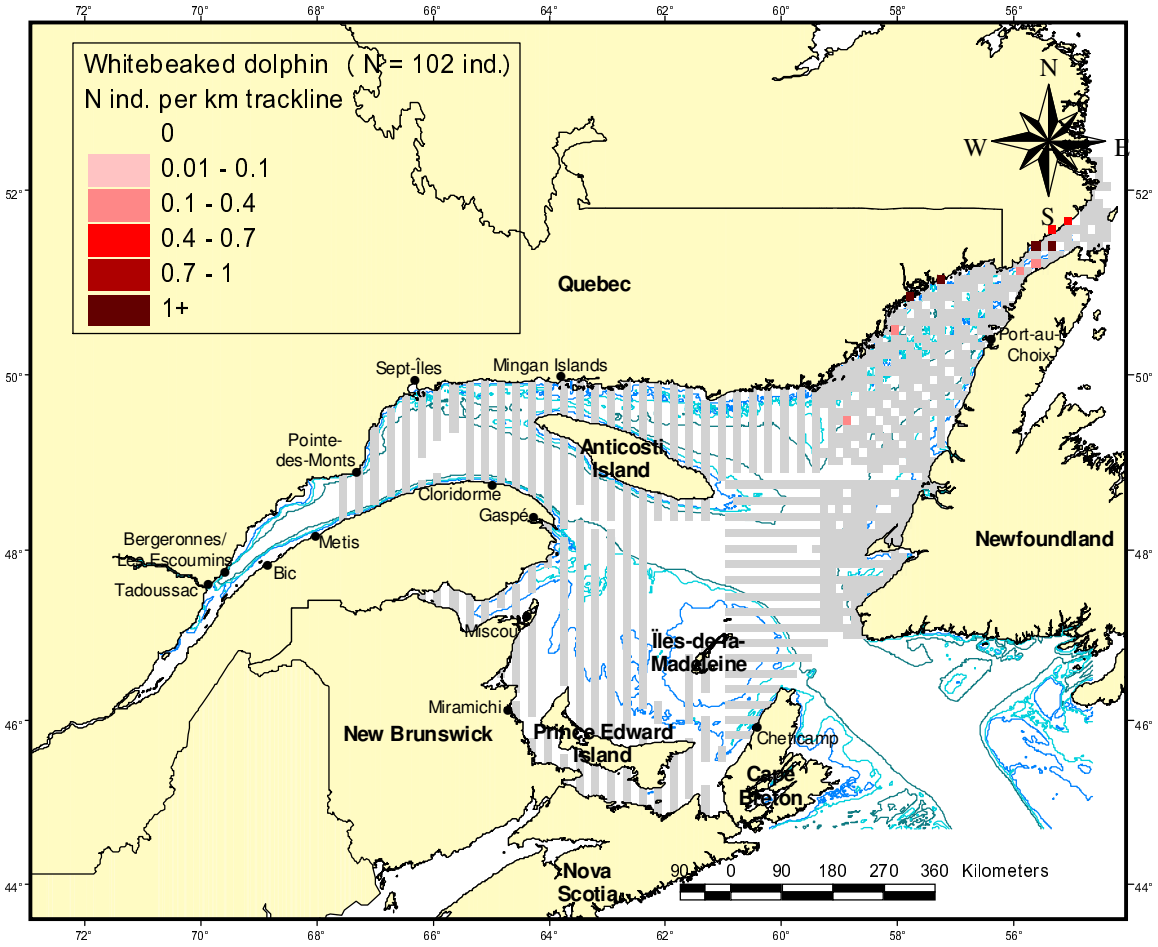

Figure 17. Whitebeaked dolphin encounter rates, expressed in terms of number of individuals per km of trackline, during the three surveys combined. Grey cells represent areas where survey effort was non-zero.

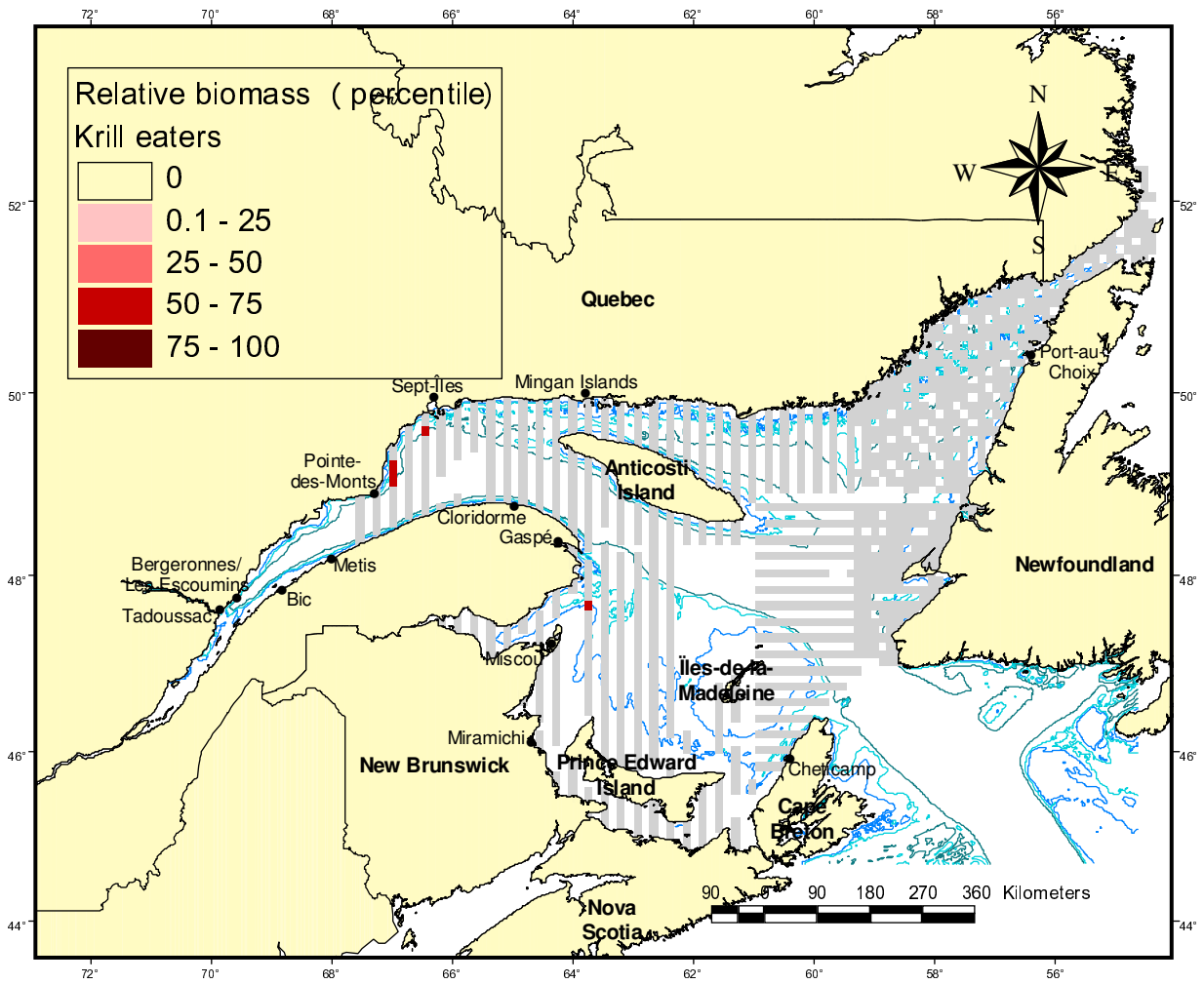

Figure 18. Relative distribution of the biomasses of krill eater.

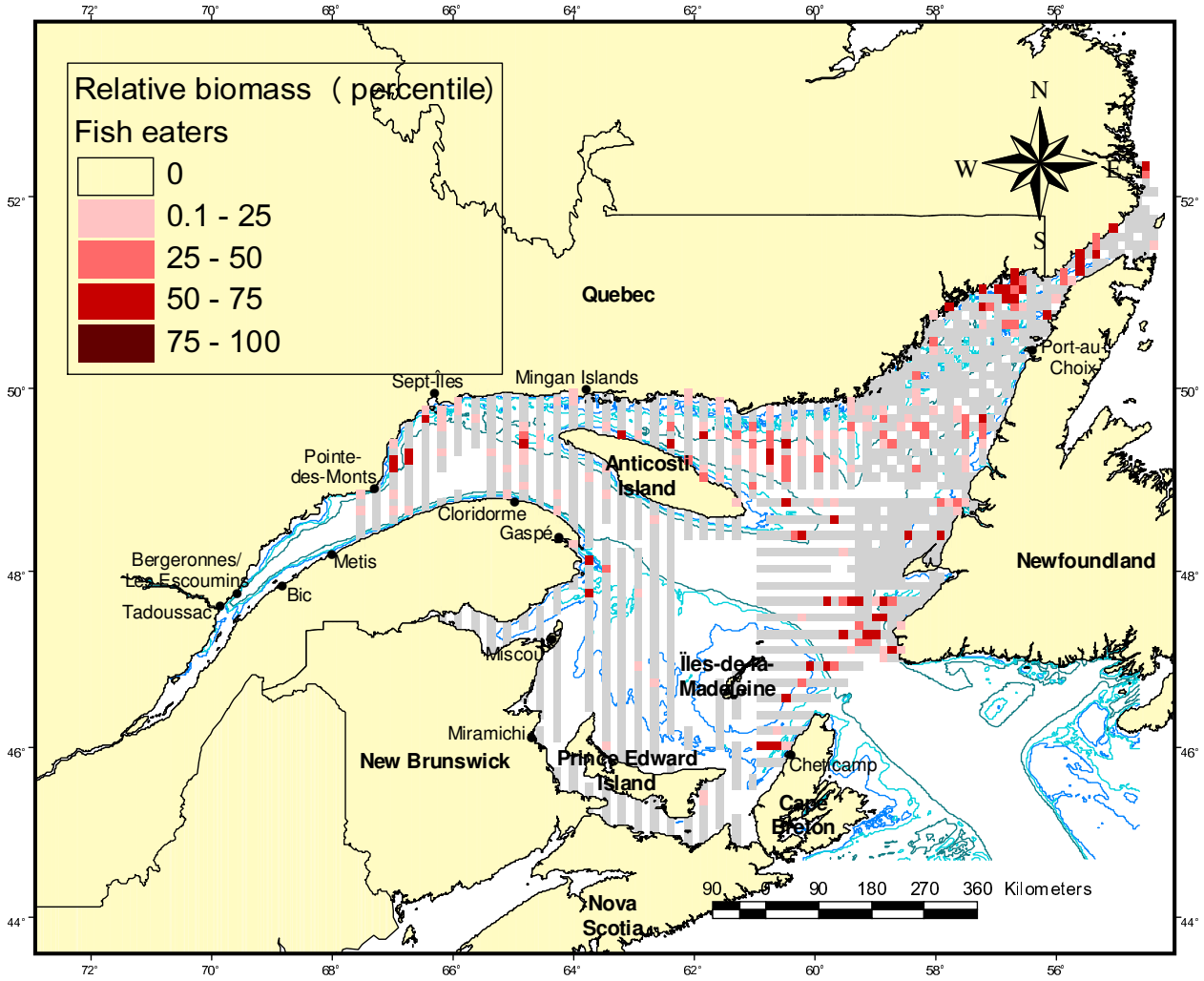

Figure 19. Relative distribution of the biomasses of fish eater.

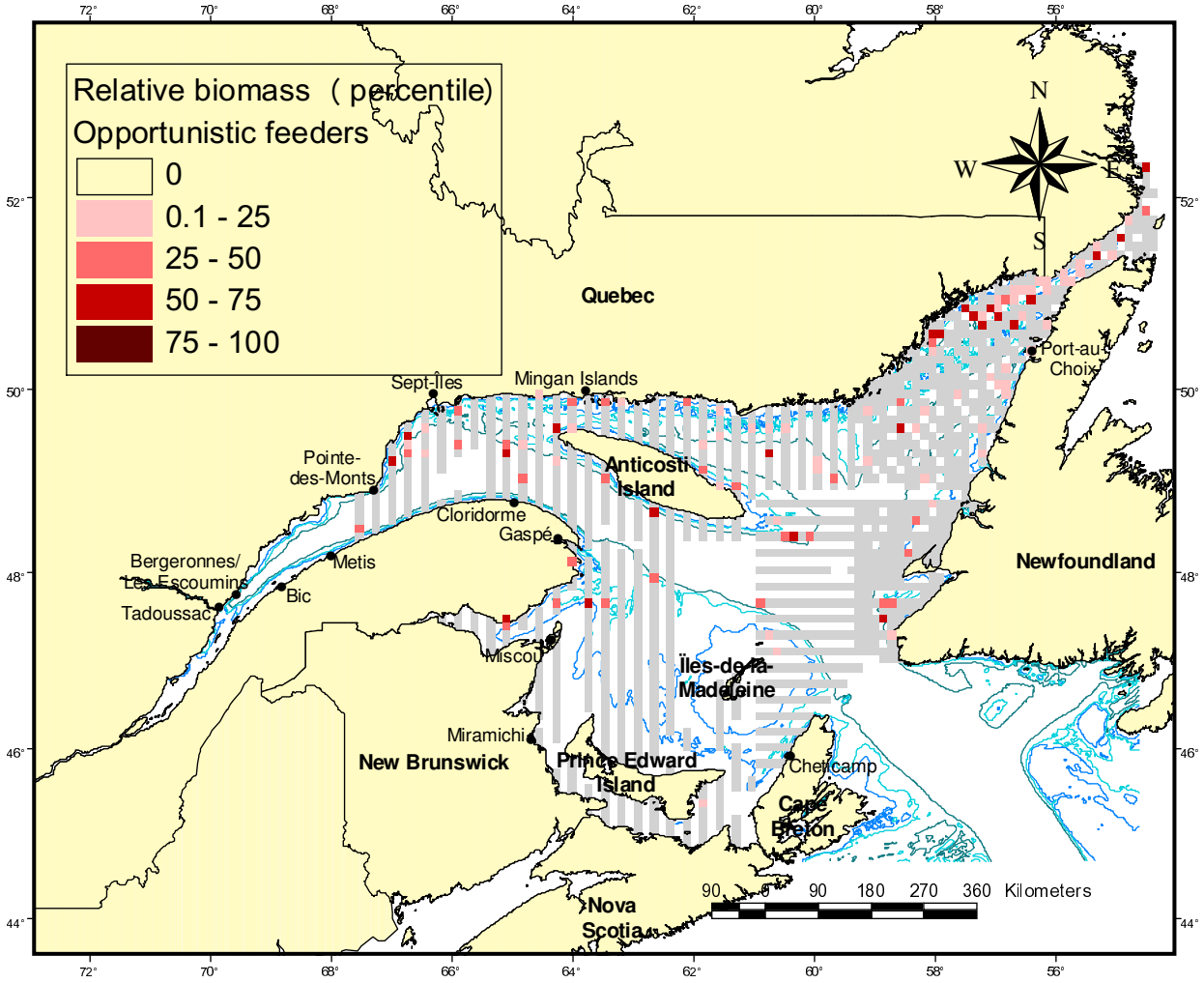

Figure 20. Relative distribution of the biomasses of opportunistic eater.

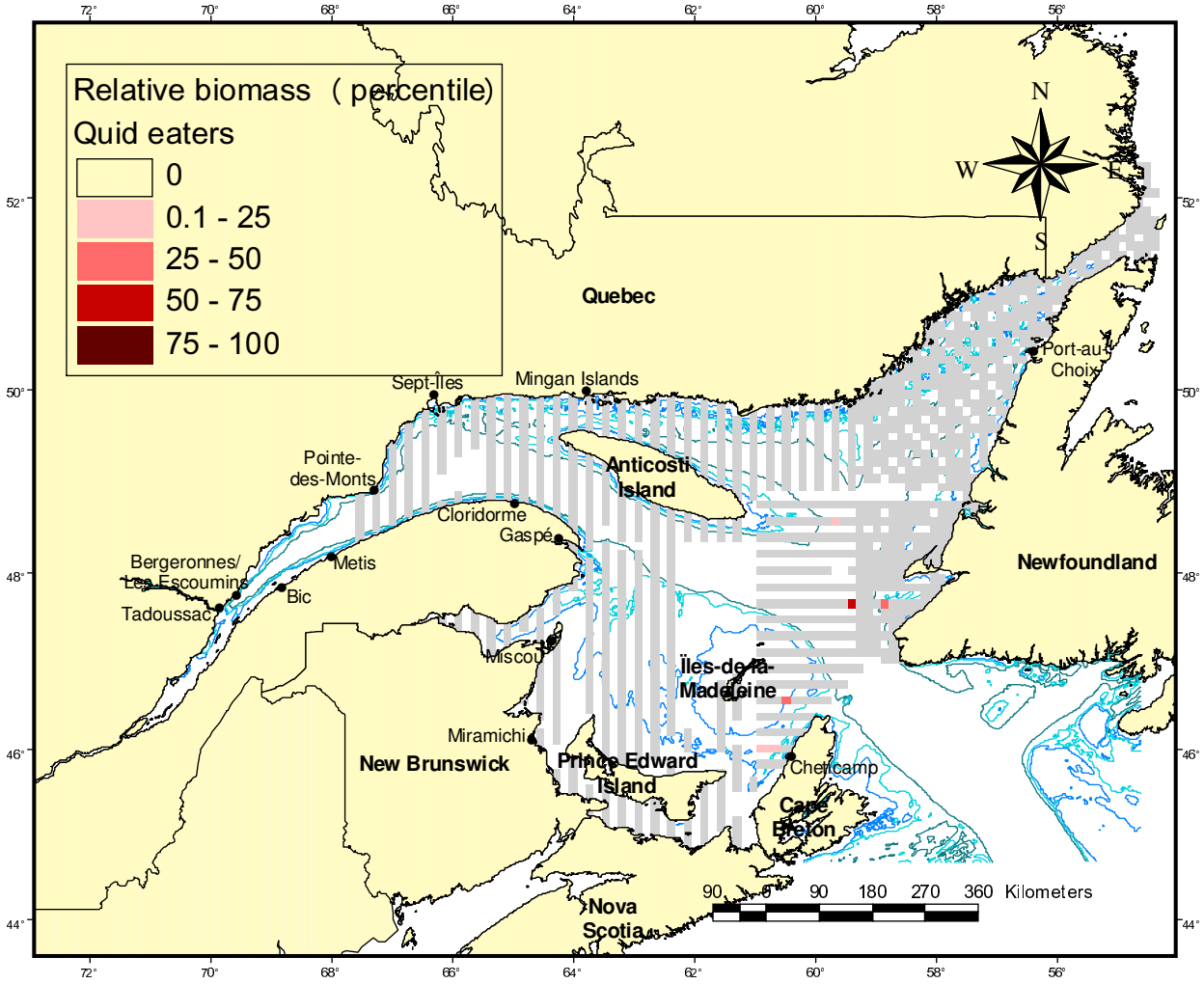

Figure 21. Relative distribution of the biomasses of squid eater.

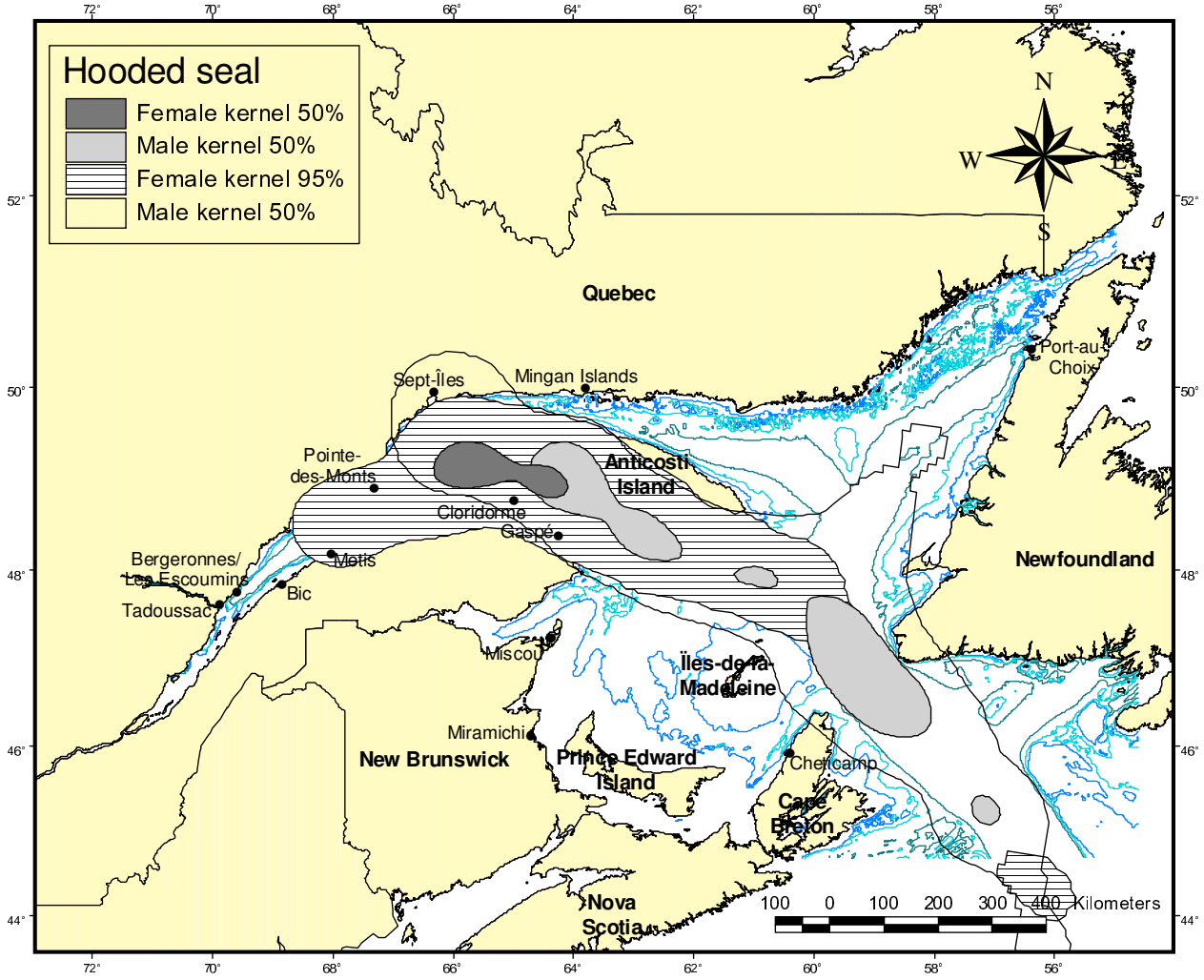

Figure 22. Hooded seal home ranges as determined from satellite telemetry.

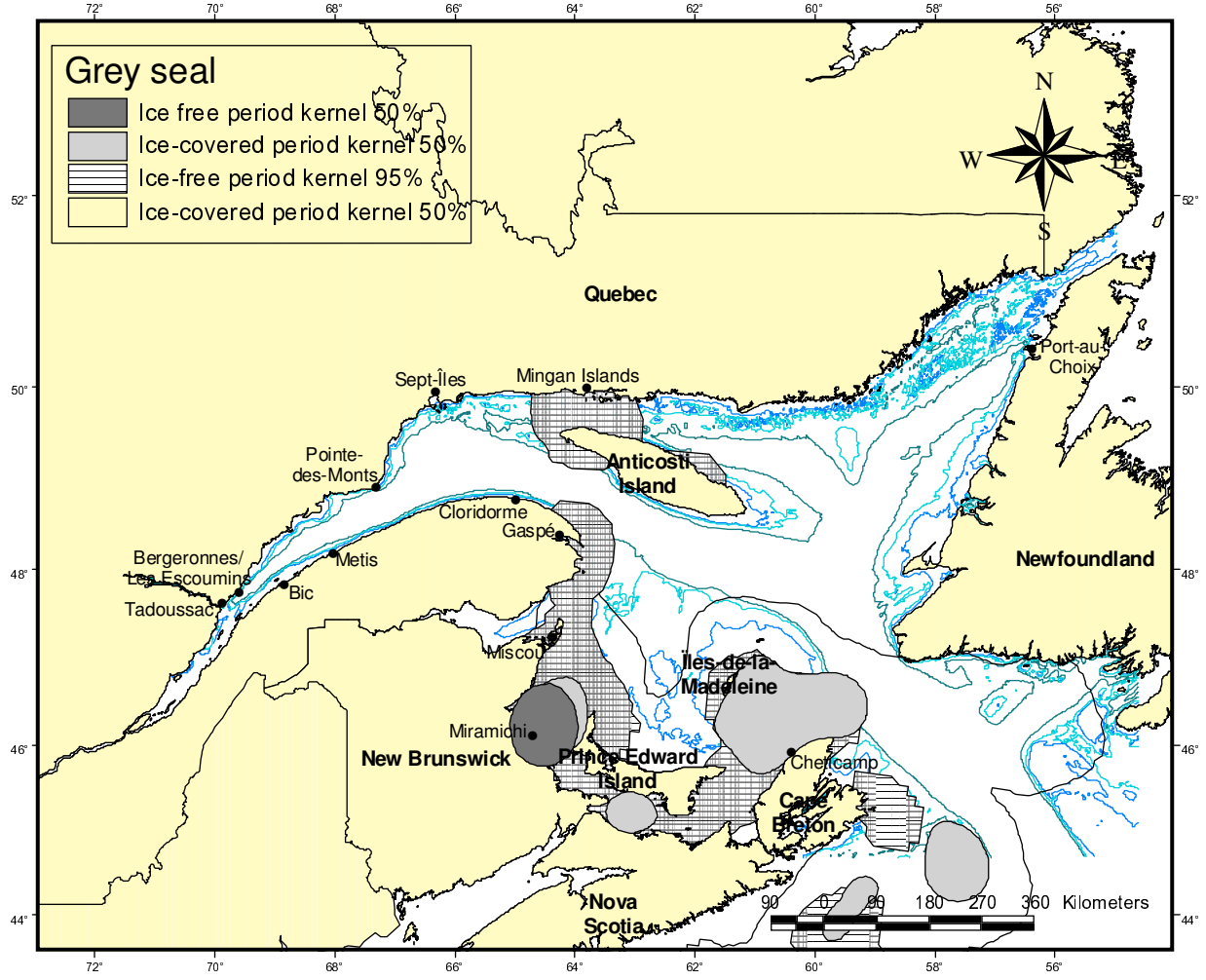

Figure 23. Grey seal home ranges as determined from satellite telemetry.

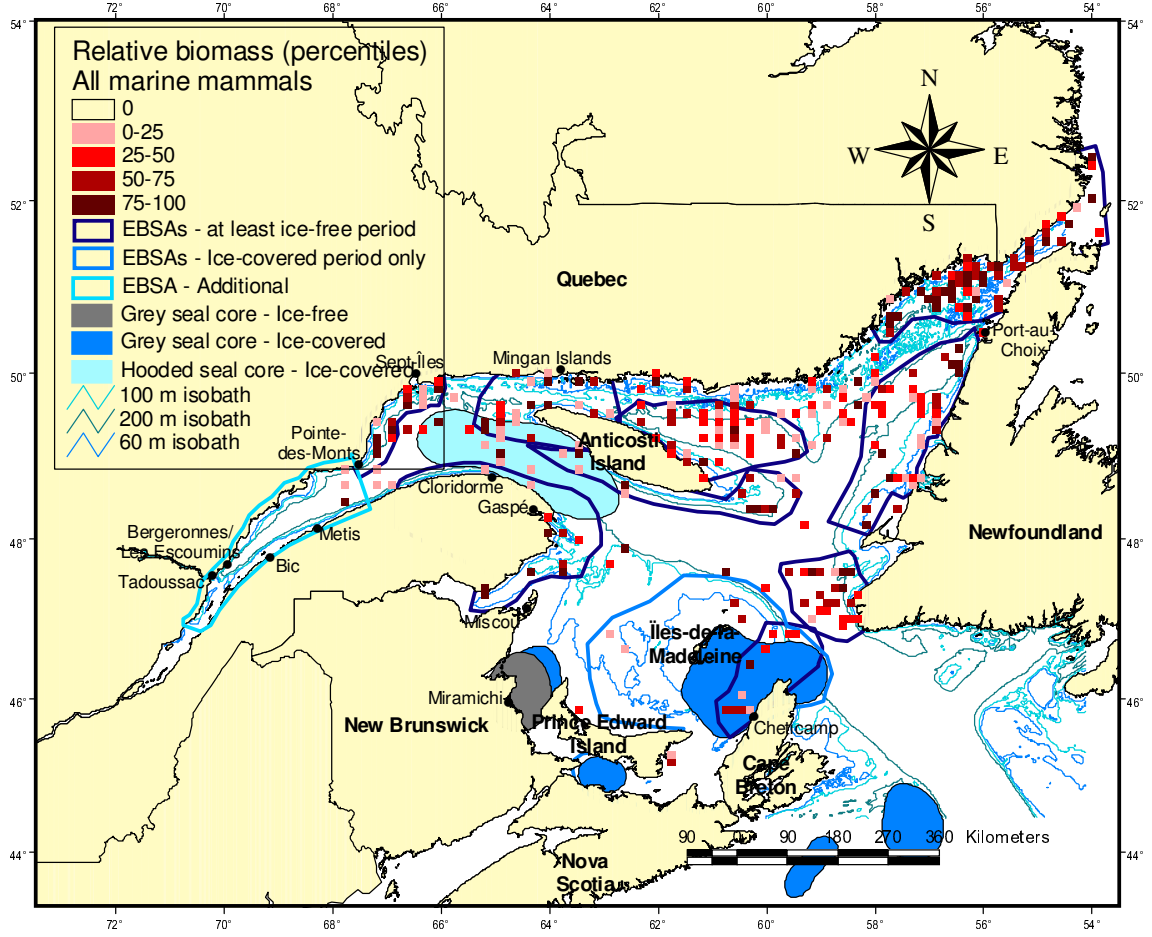

Figure 24. Proposed Ecologically and Biologically Significant Areas (EBSAs) for marine mammals in the Gulf of St. Lawrence, based on data from three systematic line-transect aerial surveys, home range analyses of satellite telemetry data of grey seals and hooded seals, and data from winter aerial surveys for harp seals and grey seals in their whelping areas in the southern Gulf of St. Lawrence. An additional EBSAs is proposed for the St. Lawrence Estuary, based on local knowledge and unpublished data.