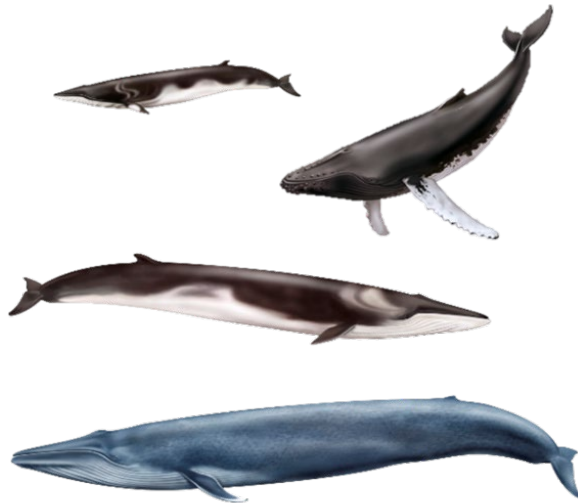




Quebec Region

SPATIAL DISTRIBUTION AND SEASONAL OCCURRENCE OF MINKE, HUMPBACK, FIN AND BLUE WHALES IN THE ST. LAWRENCE ESTUARY



Parks Canada / C. Soucy.

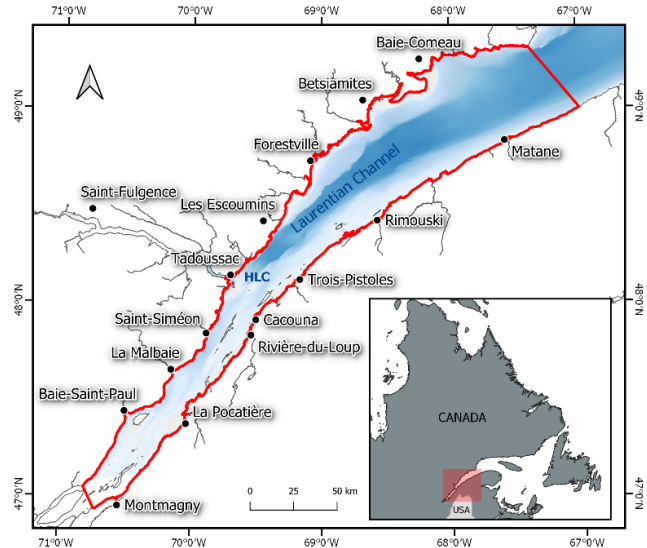


Figure 1. Location of the study area. HLC indicates the head of the Laurentian Channel.

Context:

Multiple baleen whale and other marine mammal species use the St. Lawrence Estuary (SLE) for feeding. Their abundance in this area led to the creation of the Saguenay–St. Lawrence Marine Park (SSLMP), and to a proposed network of marine protected areas (MPA) in the region surrounding the SSLMP. The SLE is also an important shipping route, with nearly five thousand ships transiting to Canada and United States each year. During summer, a fleet of approximately 35 whale-watching vessels offering several departures a day adds to marine traffic by concentrating activities in this area, raising concerns for potential whale/ship interactions and vessel collisions. Motivated by the desire to reduce collision risks, temporary voluntary protection measures, which included slowdown, avoidance and cautious zones, were implemented in 2013. These zones were defined based on opportunistic sightings data of baleen whales collected during whale-watching cruises.

To determine the adequacy of the current protective measures, and to inform any potential adjustments to the current measures or the development of additional measures in the context of the proposed network of MPAs, an integration of the best information currently available on the spatial and temporal distribution of the whales vulnerable to vessel strikes was requested from DFO Science and SSLMP authorities.

This Science Advisory Report is from October 21-26, 2019 National Peer Review on seasonal distribution and concentration of large whales in the St. Lawrence Estuary held as part of the National Marine Mammal Peer Review Committee (NMMPRC): October 2019 Biannual meeting. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

SUMMARY

- The St. Lawrence Estuary (SLE) and the Gulf (GSL) are the feeding ground of several North Atlantic whales, including the endangered blue whale and fin whale (special concern), as well as minke and humpback whales. Vessel strikes are an important source of mortality for these species.
- To determine the spatial and temporal distribution of baleen whales in the SLE, analyses were conducted using four datasets: DFO's aerial and boat surveys (1995-2017), Parks Canada and collaborators data from boat surveys (2006-2011), and observations obtained from whale watching activities monitoring (1994-2018) and a citizen science program (2008-2018).
- Spatial modelling was used to identify important areas for the four species. The head of the Laurentian channel (HLC) appeared as a core area for minke, humpback and fin whales. Fin, humpback and blue whales were predicted to occur and were observed along the steep slopes of the Laurentian Channel (LC) (comprised in between 100-200 m isobaths). Blue whales were also found in waters deeper than 200 meters in the LC. Shallow water slopes (between 20-100 m isobaths) were identified as important habitat for minke whales.
- The data available did not allow for a full analysis of seasonal changes in baleen whale habitat use within the SLE. Maps of modelled habitat are representative of the spatial distribution of baleen whales within the SLE from May to October, the period which includes most sightings.
- Based on the combined datasets, minke whales were observed in the SLE from April to November; humpback and fin whales from May up to October and November, respectively; and blue whales from March to November.
- Spatial and temporal patterns of whale distribution in the SLE represent the integration of systematic surveys and other sources of data collected over the last 25 years; environmental variability may result in changes in whale distribution. Regular monitoring of the distribution of these species will be needed to ensure that management plans are achieving their objectives.

BACKGROUND

Canadian Atlantic waters, and in particular the St. Lawrence Estuary (SLE) and the Gulf (GSL) are a feeding ground for many North Atlantic species of whales, including the endangered blue whale and the fin whale, which is considered of special concern. The St. Lawrence River is also an important shipping route to and from Canada and United States. Ferries, pleasure boats and whale-watching vessels also contribute significantly to the ship traffic in the SLE. Vessel strike is considered to be an important source of mortality and injuries for several species of whales including minke, humpback, fin, and blue whales. Management measures to reduce the risk of vessel strikes were included in the regulations of marine activities in the Saguenay–St. Lawrence Marine Park, specifically by limiting the number of whale watching permits, defining speed limits in observation zones, and minimum distances to keep from whales. The regulations also made it obligatory to report all incidents of vessel strikes to Parks Canada. However, these measures mostly aimed at reducing vessel strikes with beluga and baleen whales involving commercial and recreational whale watching boats and apply only within the Saguenay–St. Lawrence Marine Park limits. To extend protection measures to the shipping industry, a working group was formed in 2011 by bringing together representatives from the maritime industry, the

government, non-governmental organizations and academia. This group defined voluntary protection measures applied in the St. Lawrence Estuary since 2013. These measures, in effect from May to October, consist of an area with speed limitation, avoidance and caution zones in sectors identified as important for whales. These measures were, however, based on a limited dataset of opportunistic observations and publications mostly aimed at blue whales. It was recognized that bringing together the best available science on the spatial and temporal distribution of the four species of baleen whales was needed before undergoing a review of the provisional measures.

ANALYSIS

Spatial distribution

To identify important areas, a species distribution modelling (SDM) approach, using Generalized Additive Models, was used to relate whale occurrence to the environmental characteristics of the habitat. This approach integrated information from three datasets (Martins et al. 2022; Mosnier et al. 2022):

- DFO's aerial and boat surveys (1995-2017), most of which were systematic surveys, covering the SLE (64 aerial surveys and 130 boat surveys), and the GSL (32 aerials surveys and 25 boat surveys).
- Parks Canada and collaborators systematic boat surveys (2006-2011)
- Observations obtained from the whale watching activities monitoring (1994-2018) conducted by Parks Canada and collaborators, which use whale watching boats as platform of opportunity to conduct systematic data collection.

These models included several variables characterising the bottom (e.g. depth, bottom slope) and the water column (e.g. sea surface temperature, thermal fronts). Datasets from Park Canada were constrained within the limits of the Saguenay-St.-Lawrence Marine Park.

Comparable results were obtained with the three models. The head of the Laurentian channel appeared as an important area for minke, humpback and fin whales (Figures 2 to 5). Fin, humpback and blue whales were predicted to occur and were observed along the steep slopes of the LC between 100-200 m isobaths. Blue whales were also found in waters deeper than 200 meters in the LC. Shallow water slopes, between 20-100 m isobaths, were identified as important habitat for minke whales.

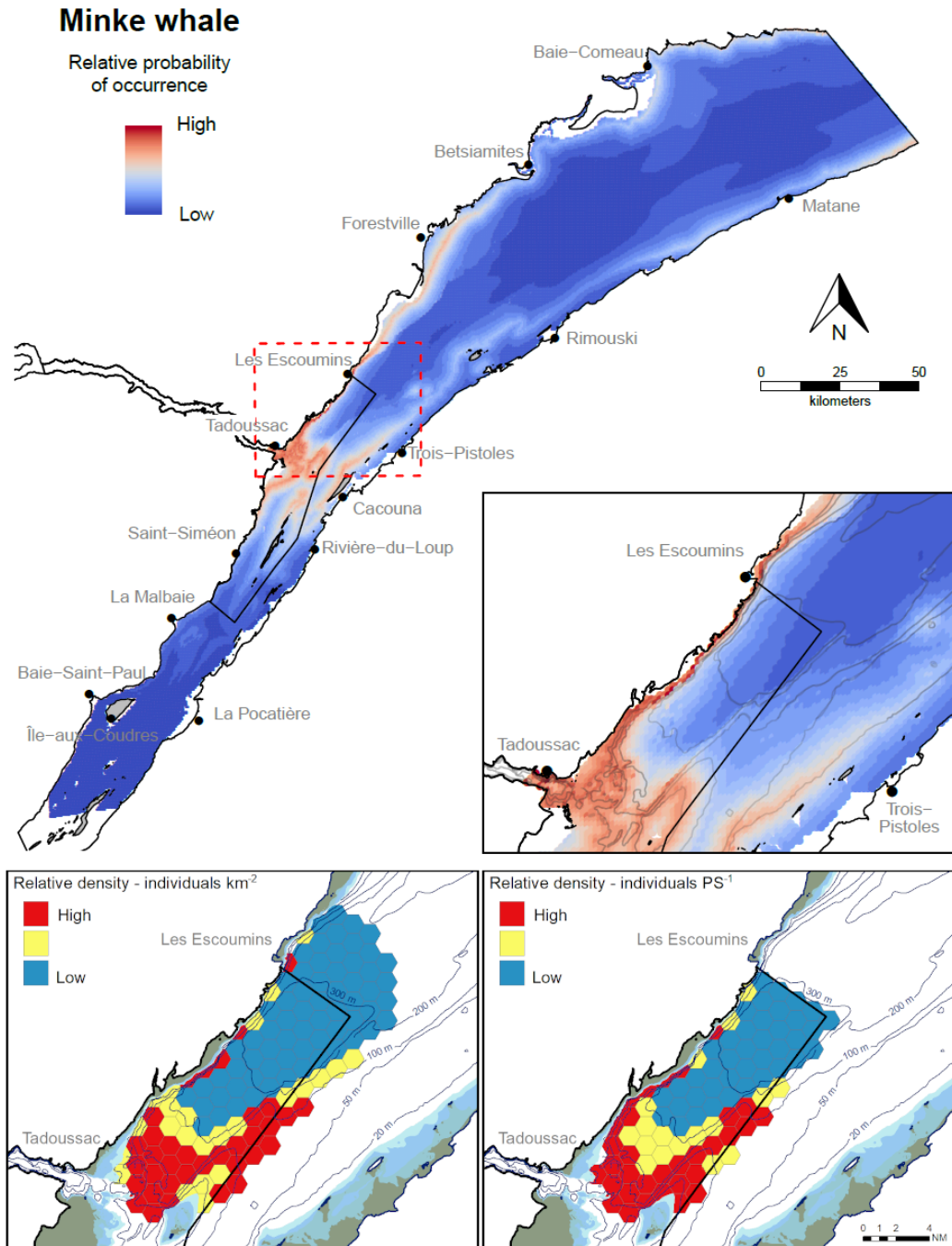


Figure 2. Upper part: Relative probability of Minke whale occurrence in the St. Lawrence Estuary from a spatial model incorporating information from boat and aerial surveys 1995-2017 conducted by DFO. The red dotted line shows the spatial coverage of data presented in the insert. The insert presents the relative density predictions in the area covered by Parks Canada dataset (lower part). Predicted relative density of minke whale from a spatial model incorporating information from: systematic boat surveys 2006-2011 (Lower left); whale watching activities monitoring 1994-2018 (lower right). The Saguenay–St. Lawrence Marine Park limits are indicated by the thick black line.

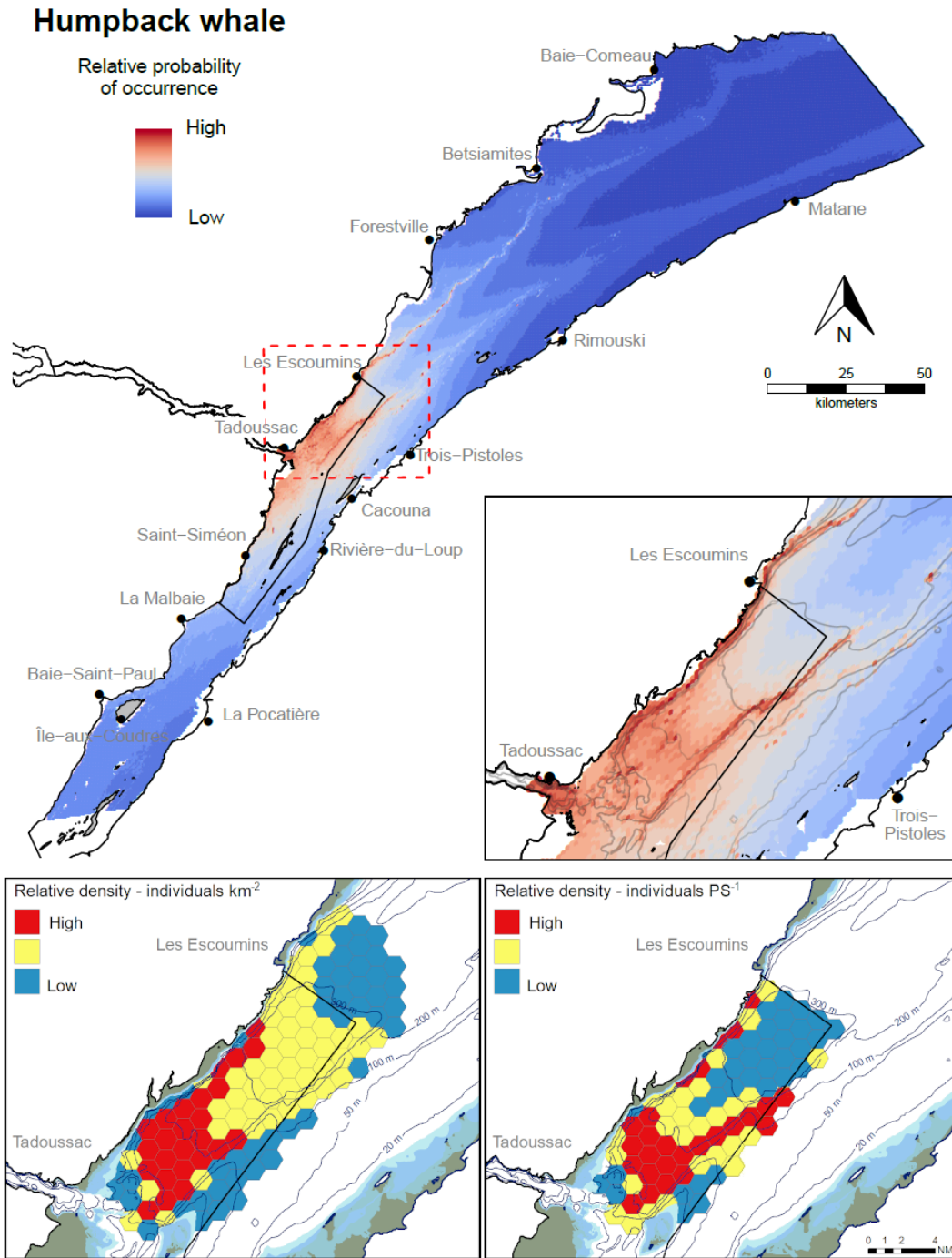


Figure 3. Upper part: Relative probability of Humpback whale occurrence in the St. Lawrence Estuary from a spatial model incorporating information from boat and aerial surveys 1995-2017 conducted by DFO. The red dotted line shows the spatial coverage of data presented in the insert. The insert presents the relative density predictions in the area covered by Parks Canada dataset (lower part). Predicted relative density of humpback whale from a spatial model incorporating information from: systematic boat surveys 2006-2011 (Lower left); whale watching activities monitoring 1994-2018 (lower right). The Saguenay–St. Lawrence Marine Park limits are indicated by the thick black line.

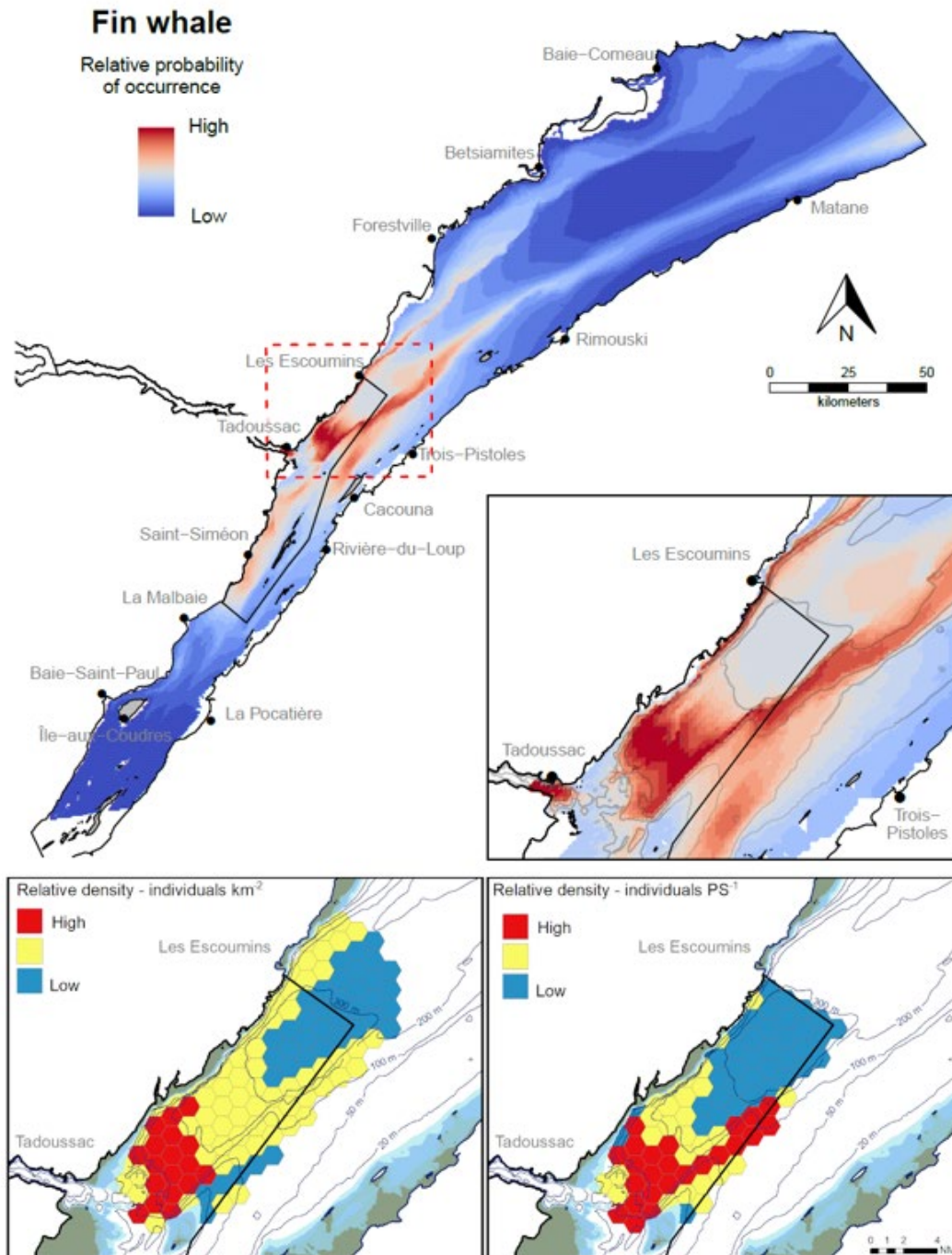


Figure 4. Upper part: Relative probability of Fin whale occurrence in the St. Lawrence Estuary from a spatial model incorporating information from boat and aerial surveys 1995-2017 conducted by DFO. The red dotted line shows the spatial coverage of data presented in the insert. The insert presents the relative density predictions in the area covered by Parks Canada dataset (lower part). Predicted relative density of fin whale from a spatial model incorporating information from: systematic boat surveys 2006-2011 (Lower left); whale watching activities monitoring 1994-2018 (lower right). The Saguenay–St. Lawrence Marine Park limits are indicated by the thick black line.

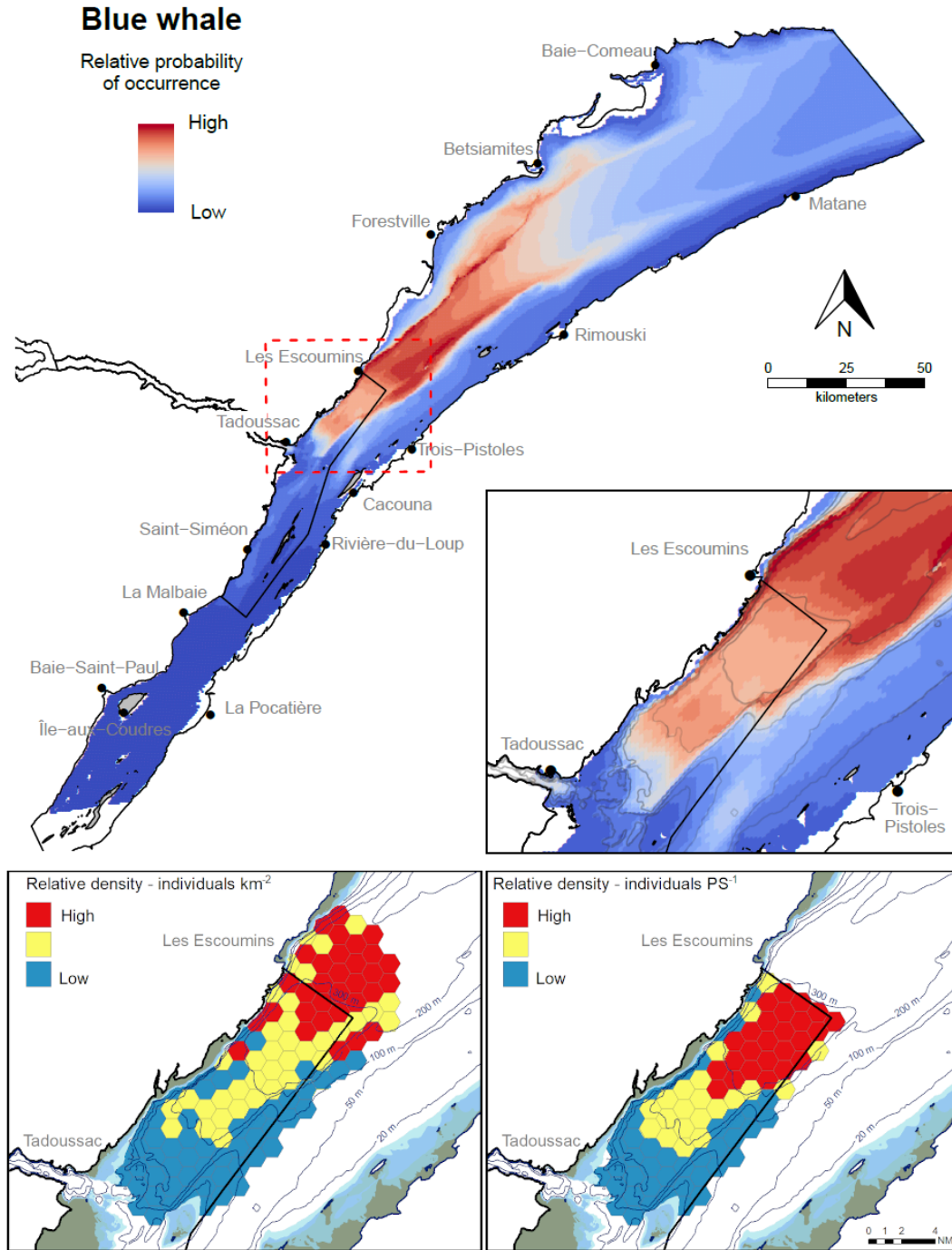


Figure 5. Upper part: Relative probability of Blue whale occurrence in the St. Lawrence Estuary from a spatial model incorporating information from boat and aerial surveys 1995-2017 conducted by DFO. The red dotted line shows the spatial coverage of data presented in the insert. The insert presents the relative density predictions in the area covered by Parks Canada dataset (lower part). Predicted relative density of Blue whale from a spatial model incorporating information from: systematic boat surveys 2006-2011 (Lower left); whale watching activities monitoring 1994-2018 (lower right). The Saguenay–St. Lawrence Marine Park limits are indicated by the thick black line.

Seasonal occurrence

The period of occurrence of each species in the SLE was characterised by combining the three datasets used in the analyses above with the presence/absence data from Parks Canada and collaborators' citizen science program conducted from 2008 to 2018 (Figure 6). This resulted in 25 years of weekly presence/absence data (1994-2018).

Minke whales occurred from April to November, and humpback and fin whales sightings were recorded from May until October and November, respectively (Figure 5). Blue whales occurred in the SLE from March to November.

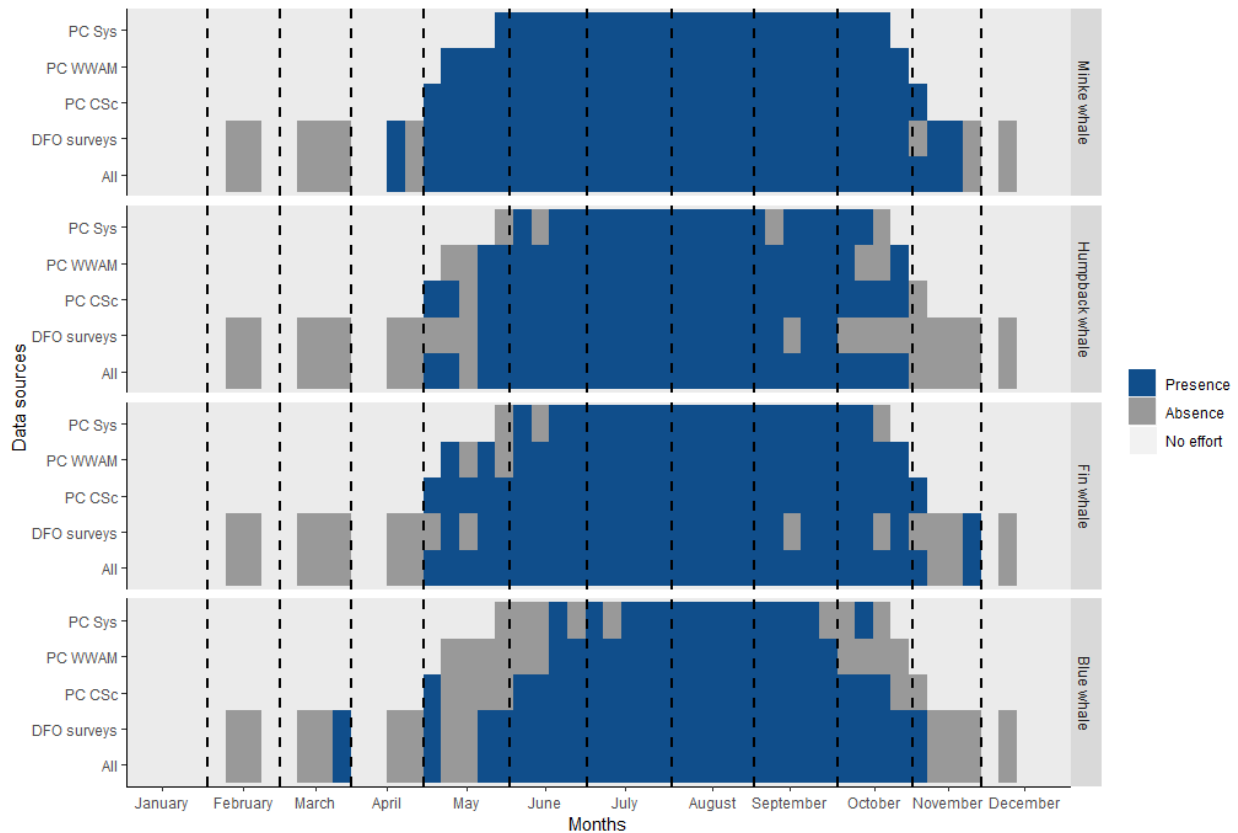


Figure 6. Period of known occurrence of each baleen whale species based on presence/absence data from 1994 to 2018 of each data source. PC: Parks Canada and collaborators data covering the marine portion of the Saguenay–St. Lawrence Marine Park (PC Sys: Systematic surveys; PC WWAM: whale watching activities monitoring; PC CSc: Citizen Science), DFO surveys: Department of Fisheries and Ocean aerial and boat surveys covering the St. Lawrence Estuary.

Sources of Uncertainty

Observation effort is limited outside of the period May to October, which reduces the ability to detect the presence of the species during this time of year (winter, early spring). Also, because there was not enough systematic effort covering the whole SLE in each year, it was not possible to examine the inter-annual variability of habitat use. Continuing the sampling over the SLE would allow for an examination of potential changes in habitat use of baleen whales in this area over the longer term. Several environmental variables (e.g. bathymetry, bottom slope, water temperature) were considered in the models to describe their relationships with baleen whale

occurrence. However, other physical variables such as salinity or biological elements (e.g. prey) may have improved models' predictions but were not available.

CONCLUSIONS AND ADVICE

Modelling approaches (i.e. SDMs) used to represent the relative probability of occurrence (DFO's analysis) or densities (Park Canada analysis) of the four species of whale showed consistent patterns. Our results demonstrate that a simple suite of geophysical parameters allow us to predict the occurrence of several species of baleen whales in the SLE. The HCL appeared as an important area for minke, humpback and fin whales. The steep slopes of the LC comprised in between 100-200 m isobaths were predicted as important for humpback, fin and blue whales. Blue whales were also found in waters deeper than 200 meters in the LC. Finally, shallow water slopes between 20 and 100 m isobaths were identified as important habitat for minke whales.

Minke whales occurred in the SLE from April to November. Humpback whales sightings were recorded between May and October, while fin were observed from May to November. Finally, blue whales were present in the SLE from March to November.

Models provided maps of important areas for the four species of baleen whales in the SLE. These maps are representative of their spatial distribution from May to October, the period which includes most sightings. These models synthesized data collected during a large number of surveys and provided a simple way to present the results, identifying important areas to be considered when defining management plans and regulations aiming to avoid risk and severity of collisions.

OTHER CONSIDERATIONS

Other sources of published information are available on blue whale spatial distribution in the SLE, but none exist for the three other species of baleen whales. Information on temporal occurrence can however be found for minke, fin and blue whales.

Spatial and temporal patterns of whale distribution in the SLE presented in this document represent the integration of systematic surveys and other sources of data collected over the last 25 years. Environmental variability may result in changes in future whale distribution. Regular monitoring of the distribution of these species will be needed to ensure that management plans are achieving their objectives.

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**Spatial distribution and seasonal
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Quebec Region

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SOURCES OF INFORMATION

This Science Advisory Report is from October 21-26, 2019 National Peer Review on seasonal distribution and concentration of large whales in the St. Lawrence Estuary held as part of the National Marine Mammal Peer Review Committee (NMMPRC): October 2019 Biannual meeting. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

Martins, C.C.A., Turgeon, S., Michaud, R., and Ménard, N. Seasonal occurrence and spatial distribution of four species of baleen whales vulnerable to ship strikes in the Saguenay–St. Lawrence Marine Park (Quebec, Canada). DFO Can. Sci. Advis. Sec. Res. Doc. 2022/012. In press.

Mosnier, A., Gosselin, J.-F. and Lesage, V. 2022. [Seasonal distribution and concentration of four large whales species in the St. Lawrence Estuary based on 22 years of DFO observation data](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2020/053. iv + 119 p.

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