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National Capital Region

ASSESSMENT OF THE RELATIVE RISK OF LETHAL VESSEL STRIKES TO NORTH ATLANTIC RIGHT WHALES IN THE GULF OF ST. LAWRENCE, CABOT STRAIT AND THE ST. LAWRENCE ESTUARY BETWEEN 2020 AND 2024 - PART 1

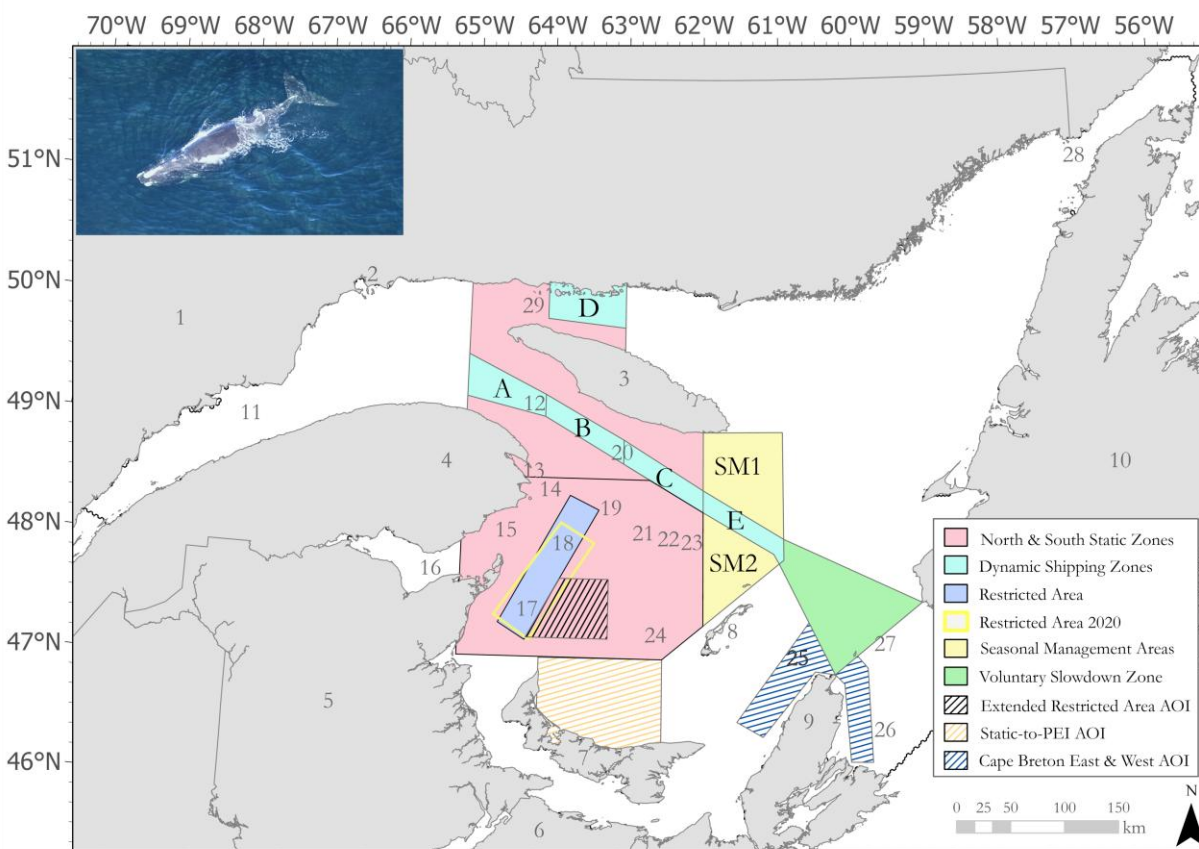


Figure 1. Transport Canada's Management Areas and Zones where speed restrictions are implemented in the Gulf of St. Lawrence, and four areas of interest (AOI). The numbers represent land locations (1-10) and bathymetric features such as banks, troughs, straits, and valleys (11-29): 1 = Quebec, 2 = Sept Îles, 3 = Anticosti Island, 4 = Gaspé Peninsula, 5 = New Brunswick, 6 = Nova Scotia, 7 = Prince Edward Island (PEI), 8 = Magdalen Islands, 9 = northern Cape Breton, 10 = Newfoundland, 11 = St. Lawrence Estuary, 12 = Honguedo Strait, 13 = Gaspé Bay, 14 = American Bank, 15 = Chaleur Trough, 16 = Chaleur Bay, 17 = Shediac Valley, 18 = Orphelin Trough, 19 = Orphelin Bank, 20 = Laurentian Channel, 21 = Western Bradelle Valley, 22 = Northern Bradelle Bank, 23 = Eastern Bradelle Valley, 24 = Southern Bradelle Bank, 25 = Cape Breton Trough, 26 = Sydney Bight, 27 = Cabot Strait, 28 = Strait of Belle Isle, 29 = Jacques Cartier Strait. Top left corner, Photo of North Atlantic right whale: DFO Science aerial survey team (2021).

CONTEXT

A Recovery Potential Assessment for the endangered North Atlantic right whale (NARW) reconfirmed vessel strikes, along with fishing-gear entanglements, as a leading cause of NARW mortality and a major contributor to the species' population decline. Since 2017, Transport Canada (TC) has implemented a suite of vessel traffic management measures in areas of the Gulf of St. Lawrence (GSL) and Cabot Strait aimed at reducing the risk of vessel strikes to NARWs. These measures are revised each year in collaboration with maritime traffic and scientific experts, industry stakeholders, and non-governmental organizations. Currently, TC's vessel management measures include static and dynamic speed restrictions in areas of the GSL and Cabot Strait, as well as a restricted area. To help support the ongoing adaptive management of their vessel traffic management measures, TC has requested scientific advice from DFO Science on the risk of vessel strikes to NARWs in the GSL and Cabot Strait, with particular interest in the Cabot Strait Voluntary Speed Reduction Zone, the area between the Static Zone and Prince Edward Island, and Dynamic Shipping Zones A, B, C, D, and E. To address this request, a national peer-review meeting was held to provide scientific advice on current and estimated changes in vessel strike risk to NARWs in the GSL and the Cabot Strait. Specific objectives included:

1. Reviewing the NARW vessel strike relative risk model developed for this assessment, including its scientific basis, assumptions, data inputs, validation approaches, and uncertainties;
2. Characterizing the changes in the relative risk of lethal vessel strikes to NARWs by vessel size class in the GSL and Cabot Strait under TC's vessel management measures from 2020 to 2024; and,
3. Estimating the changes in relative risk under alternative scenarios, including the absence of TC's 2020-2024 vessel management measures, and with vessel traffic increases of 5% and 10% under TC's 2024 vessel management measures.

This Science Advisory Report encompasses Part 1 of the national peer review held from March 24 - 26, 2026 on the Assessment of the Risks of Vessel Strikes to North Atlantic Right Whales (NARW) in the Gulf of St. Lawrence and Cabot Strait, and includes advice on objectives (1) and (2) described above; additional advice arising from Part 2 and addressing objective (3) will be published separately. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

SUMMARY

- Advice was sought on the relative risk of vessel strikes to the North Atlantic right whale (NARW) by vessel size class in the Gulf of St. Lawrence (GSL) and the Cabot Strait under Transport Canada's (TC) vessel traffic management measures from 2020-2024, as well as under various traffic scenarios. This is part 1 of the advice and evaluates the scientific foundations of the model which estimates the relative risk of lethal vessel strike to NARWs ("the model"). It assesses the relative risk for the requested area and the St. Lawrence Estuary (SLE) by vessel size class under the TC management measures from 2020-2024. Part 2 will explore risk under various traffic scenarios.
- The model components include:
 - the spatial and temporal variation in the relative probability of NARW occurrence;
 - vessel traffic information characterized via Automatic Identification System (AIS) data;
 - estimation of the rate of encounter between NARWs and vessels;

- the dive behavior of whales and overlap with vessel drafts; and,
- the probability that a given vessel strike will be lethal based on vessel size and speed. The model does not account for behaviour by either the whale or the vessel to avoid a potential strike.
- Participants considered the relative risk model to have a sound scientific approach, it is supported by reasonable assumptions, and uses the best available data and models as inputs, while considering important uncertainties.
- The relative probability of NARW occurrence model predicts high occurrence in the Shediac Valley from April to November, with nearby valleys south of the Laurentian Channel peaking later in the season, and areas west of Bradelle Bank becoming suitable from late July. Additional seasonal hotspots include the entrance to Chaleur Bay, the waters east of the Gaspé Peninsula, and around northern Cape Breton (in the western Cabot Strait), though these show high variability. In the northern Gulf, waters west of Anticosti Island show higher use early in the season and again in late August through September, with occasional suitability in the Honguedo Strait and the St. Lawrence Estuary entrance.
- The study includes extra-large (greater than 108 m), large (19.8 – 108 m), medium (12.1 – 19.9 m), and small (less than 12.1 m) vessel size classes. Recognizing the under-representation of small and medium vessels in AIS data, the analyses indicate that extra-large vessels dominate traffic in the study area. As expected, the density of extra-large and large vessels is highest in the shipping lanes, although, all vessel classes transit through the southern GSL.
- The model of relative probability of NARW occurrence is an important driver of the relative risk of lethal vessel strikes. Because of the lower confidence in the predicted NARW occurrence in spring (April/May) and fall (October/November), combined with other sources of uncertainty, the participants are less confident that the areas of highest risk are correctly identified in these months.
- Extra-large vessels were the size class that contributed most to the relative risk of lethal vessel strike to NARWs across most areas examined from 2020-2024, with the exception of the Restricted Area, where they are excluded for a portion of the year, as well as the Extended Restricted Area AOI.
- Considering the TC risk mitigation measures that were in place in various areas of the GSL from 2020-2024, the model predicts recurring areas of elevated relative risk in the entrance to Chaleur Bay, American Bank, northwest of Anticosti Island, waters along the east and west coasts of northern Cape Breton, and throughout the major shipping lanes, both inside and outside TC's vessel traffic management areas.
- Given tagging data mainly reflect summer foraging behaviour, relative risk estimates are most likely underestimated in some cases due to under-sampled near-surface whale activities.
- Small and medium vessels are under-represented in AIS data; therefore, the risk model reflects minimum estimates of relative risk of lethal vessel strike for these vessel size classes.
- By identifying areas of persistent elevated relative risk of lethal vessel strikes to NARWs, this study provides important information to inform adaptive management both inside and outside of TC's vessel management areas.

INTRODUCTION

The North Atlantic right whale (NARW) is considered one of the most endangered large whale species and is designated as Endangered under Canada's *Species at Risk Act*, with an estimated 384 individuals as of 2025. Necropsy findings indicate that most documented deaths are attributable to human activities, particularly fishing-gear entanglements and vessel strikes, which are the primary drivers of population decline. Following a distributional shift into the Gulf of St. Lawrence (GSL), 12 mortalities were recorded in 2017, four of which were attributed to probable or suspected vessel strikes. In 2019, nine additional deaths were documented in Canadian waters, and of the six necropsied, three deaths were considered probable vessel strikes and another as a suspected vessel strike. While there is recent evidence suggesting a slowing of the population decline observed since 2011, overall recovery is not yet assured and depends on sustained population growth and reduced mortalities.

Several conservation initiatives and management measures have been implemented internationally and domestically to reduce vessel strike risk. These measures include mariner awareness and recognition programs, mandatory, recommendatory, or voluntary vessel rerouting using Areas to be Avoided, modifications to traffic separation schemes, or recommended routes, as well as the use of mandatory or voluntary speed restrictions. In response to the increased overlap between NARWs and vessel traffic in the GSL, TC has implemented seasonal and area-based speed restrictions since 2017. Since 2020, these measures have remained relatively consistent and include two large Static Zones, two Seasonal Management Areas, five Dynamic Shipping Zones, a Voluntary Slowdown Zone, and one Restricted Area (Figure 1).

Vessel strike risk analyses can take many forms and include various parameters to account for whale behaviour and differences among vessel sizes and speeds. In this assessment, a spatially explicit model for the GSL, St. Lawrence Estuary (SLE), and Cabot Strait was developed to quantify the spatial, seasonal, and interannual variability in the relative risk of lethal vessel strikes to NARWs from 2020 to 2024. The model integrates the relative probability of NARW occurrence, an encounter rate model, Automatic Identification System (AIS) vessel data, the probability that a whale is within the vessel's draft, and the probability of lethality given a vessel strike. The objective of this assessment is to provide scientific advice on patterns of relative risk of lethal vessel strikes across management zones and areas of interest to support the adaptive management of TC's vessel management measures.

ANALYSIS

Methods

The relative risk of a lethal vessel strike, i.e., relative mortality risk, to a NARW in the SLE, GSL, and Cabot Strait was calculated for each vessel track segment, within each grid cell (10 km²), as a function of:

1. Spatially explicit estimates of the relative probability of NARW occurrence for the study area (Mosnier et al. 2025);
2. The rate at which a transiting vessel encounters NARWs (Martin et al. 2016);
3. The probability of a whale being within the depth of the vessel draft, estimated using dive data from tagged NARWs (Lesage et al. 2026); and,
4. The probability of a lethal injury given a vessel strike has occurred (Garrison et al. 2025).

To account for differences in vessel characteristics that influence vessel strike risk, vessels were classified into size classes based on overall length as small (≤ 12.1 m), medium ($> 12.1 - 19.8$ m), large ($> 19.8 - 108$ m), and extra-large (> 108 m).

This analysis examines the relative distribution of risk of lethal vessel strikes across space and time, rather than absolute risk. As such, results should be interpreted as the proportion of monthly risk in each area, and not the probability of a lethal vessel strike occurring. To facilitate interpretation, model outputs were normalized per month, resulting in values corresponding to the proportion of monthly risk in each area. Comparison of risk among months reflects the shifts in the spatial distribution of risk, rather than changes in overall risk levels. For example, one can say “a higher proportion of the monthly risk is located in area X in month A than in month B” but one cannot say “the risk was higher in month A than in month B”.

Relative risk is presented for the entire study area, with a focus on TC’s management zones: Dynamic Shipping Zones A-E, the Voluntary Slowdown Zone, Seasonal Management Areas 1 & 2, North and South Static Zones, and the Restricted Area. Four additional areas of interest (AOI) were also examined: 1) the Extended Restricted Area AOI, which is east of the Restricted Area and within the Southern Static zone and is an area of high NARW occurrence (Appendix), 2) the region between the Southern Static Zone and Prince Edward Island, 3) & 4) the waters east of Cape Breton and west of Cape Breton, where both the probability of occurrence of NARWs and vessel traffic are relatively high.

Results

The relative risk of lethal vessel strikes to NARWs is strongly driven by the combination of the relative probability of whale occurrence and intensity of extra-large vessel traffic. Areas where the two co-occur are those of highest risk. The lethal vessel strike risk assessment, i.e., the model, identified areas of highest risk within the existing Transport Canada management zones (Figure 2A/B & 3); however, it also demonstrated that a large portion of risk occurred outside these zones (~40%). Shipping lanes (i.e., major shipping routes), particularly in the western GSL, were frequently areas of highest relative risk. Dynamic Shipping Zones A and B were consistently areas of highest risk throughout the year (April to November), along with Dynamic Shipping Zone D from July through November. The Northern Static Zone was also an area of highest relative risk during these months, particularly along the shipping lanes connected to Zone D, northeast of Sept-Îles and northwest of Anticosti Island.

Hotspots of highest risk also included the entrance to Chaleur Bay and the American Bank, which fall within the Southern Static Zone and part of the Northern Static Zone. The Northern and Southern Static Zones are the largest of the management zones and contained the largest proportion of monthly relative risk (monthly average of ~6% and ~7%, respectively), second to Dynamic Shipping Zones A, B, and D in some months. An exception to this pattern is in April and May, when the Northern Static Zone contained a smaller proportion of the monthly relative risk.

Other areas of highest risk were the Cape Breton East and West AOIs, which, despite their small size, had some of the highest proportions of relative risk of the management zones and AOIs. For the Cape Breton East AOI, the relative risk was prominent in April and May, then again in August through November. The Cape Breton West AOI showed peak relative risk in August.

Overall, the Cabot Strait Voluntary Slowdown Zone, as well as Dynamic Shipping Zones C and E had smaller proportions of risk than the Dynamic Shipping Zones A, B and D, and the Cape Breton AOIs. Although the Southern and Northern Static Zones also had a larger proportion of the total risk, the average proportion of risk across grid cells within each zone was higher in

Dynamic Shipping Zones C and E and in the Voluntary Slowdown Zone. In the Cabot Strait Voluntary Slowdown Zone, the majority of the relative risk was concentrated in the outbound shipping lane closest to Cape Breton.

The SLE had areas of highest relative risk in most months but the NARW relative probability of occurrence varied greatly interannually, indicating this is may not be a reliable habitat. While the SLE may not consistently support whale presence, when a NARW is present, the risk of a lethal vessel-strike is very high, particularly in the shipping lanes.

Seasonal Management Areas and the Static-to-PEI AOI had the smallest proportions of monthly relative risk compared to the other zones, although Seasonal Management Area 2 showed slightly higher proportions, largely due to the transit routes linking the Laurentian Channel shipping lanes to the Magdalen Islands.

The relationship between vessel speed and risk differs by vessel size, with risk increasing more rapidly for extra-large vessels as speed increases, compared to other size classes. Small, medium, and large vessels contributed risk primarily in the waters around northern Cape Breton and the southwest GSL at the entrance to Chaleur Bay, the American Bank, and Orphelin Trough. Relative risk from extra-large and large vessels was particularly prominent in the northwest shipping lanes. Notably, the transits between PEI and the Magdalen Islands, where there are no management measures, was also an area of elevated risk from extra-large vessels, particularly in August.

Extra-large vessels contributed the largest proportion of relative risk across all areas examined, except for the Restricted Area and the Extended Restricted Area AOI. The Restricted Area and the Extended Restricted Area AOI were not collision risk hotspots in most months. Many large and extra-large vessels, such as cargo vessels, are not permitted within the Restricted Area when in effect, thereby preventing co-occurrence with NARWs. This restriction may also reduce relative risk in the adjacent Extended Restricted Area AOI, as vessels must modify their traffic patterns to avoid the Restricted Area. In addition, vessels transiting to and from the eastern Gaspé Peninsula are displaced to more northern routes, which may contribute to the frequent high relative risk observed across the American Bank and entrance to Chaleur Bay, as vessels are further concentrated in these areas. Vessels travelling to and from the southern GSL (e.g., New Brunswick and western Prince Edward Island) may also pass closer to the Gaspé Peninsula.

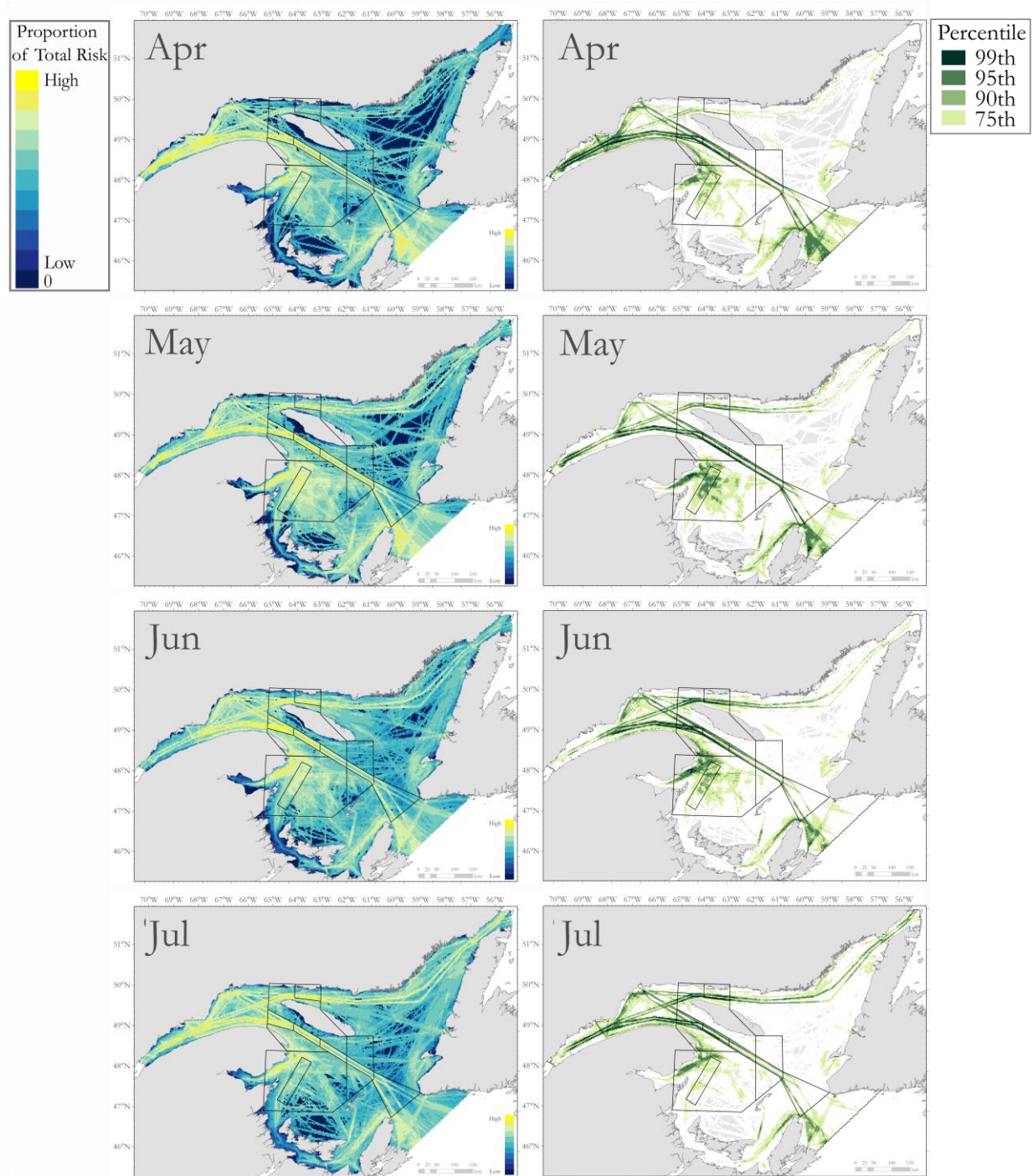


Figure 2A. Each panel represents a monthly average over 2020-2024 of the relative risk of lethal vessel strikes to North Atlantic right whale (NARW) in the St. Lawrence Estuary and Gulf of St. Lawrence. On the left, the value of each grid cell represents the proportion of that month's total risk, where each month sums to one. The colours are displayed on an exponential scale, with an $8.5\times$ increase in value between successive categories. The panels on the right represent the 99th, 95th, 90th, and 75th percentiles of the relative risk. The darkest blue (left) or the light grey (right) represent areas where no vessels carrying AIS were detected, i.e., not carrying or transmitting AIS, or their messages were not received. Data for November 2024 and April 2022 were excluded as vessel data was incomplete.

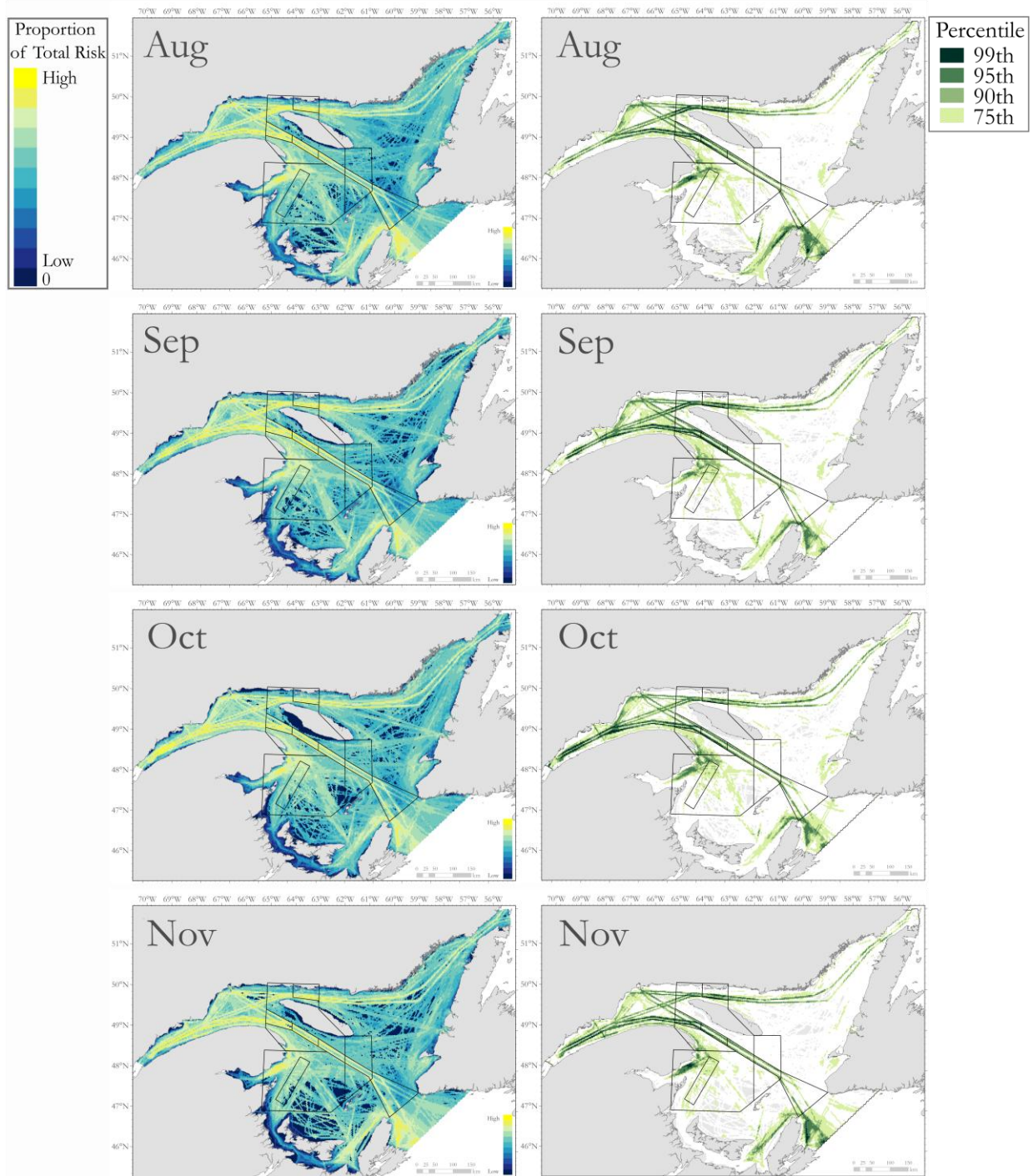


Figure 2B. Each panel represents a monthly average over 2020-2024 of the relative risk of lethal vessel strikes to North Atlantic right whale (NARW) in the St. Lawrence Estuary and Gulf of St. Lawrence. On the left, the value of each grid cell represents the proportion of that month's total risk, where each month sums to one. The colours are displayed on an exponential scale, with an $8.5\times$ increase in value between successive categories. The panels on the right represent the 99th, 95th, 90th, and 75th percentiles of the relative risk. The darkest blue (left) or the light grey (right) represent areas where no vessels carrying AIS were detected, i.e., not carrying or transmitting AIS, or their messages were not received. Data for November 2024 and April 2022 were excluded as vessel data was incomplete.

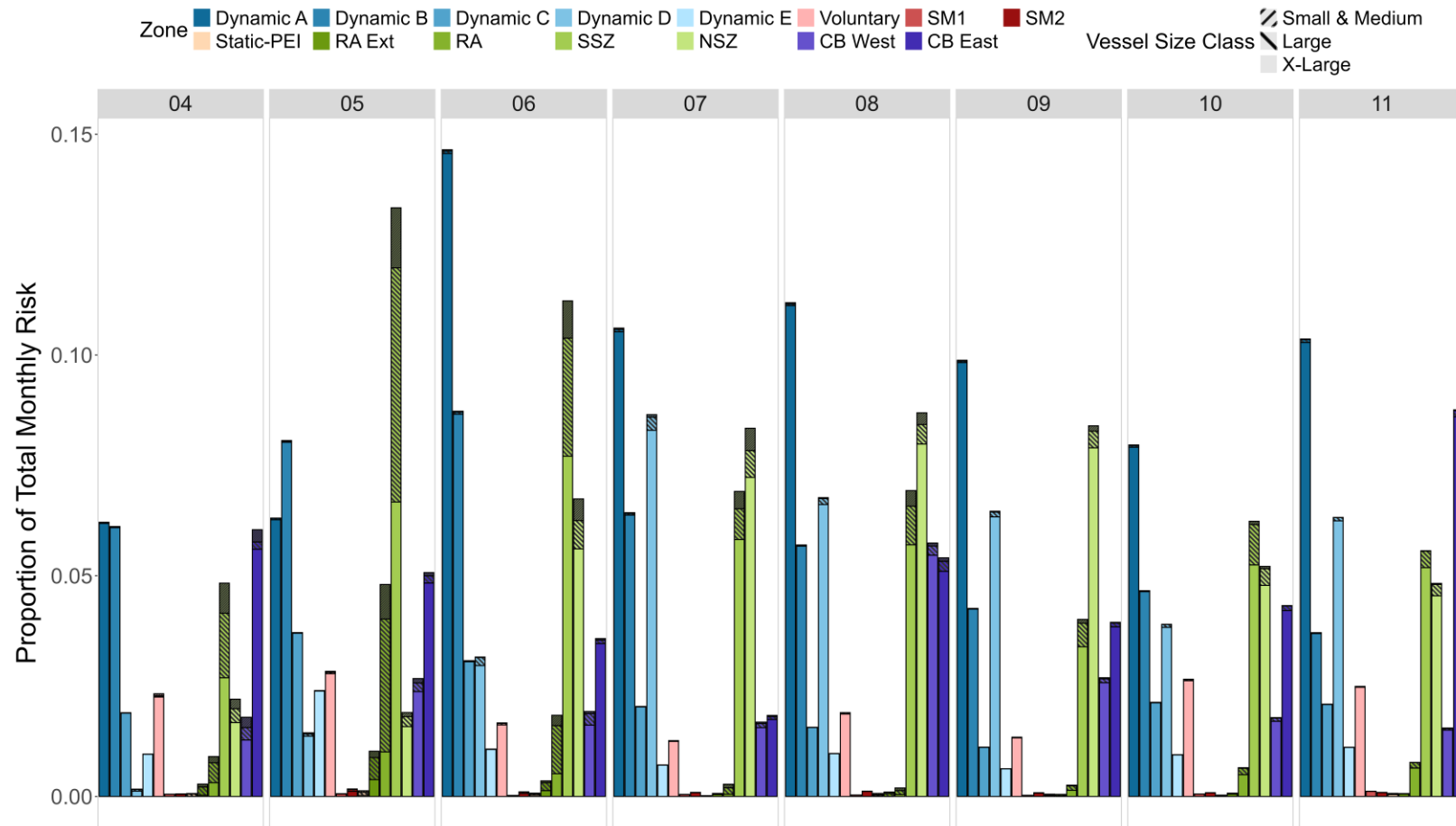


Figure 3. Proportion of total monthly relative risk of a lethal vessel strike to a North Atlantic right whale (NARW) found in each zone, for April through November (04-11), averaged over 2021-2024. Proportions are also separated by vessel size class (small & medium (dense diagonal hatching): ≤ 19.8 m, large (spaced diagonal hatching): $> 19.8 - 108$ m, and extra-large (solid-fill): > 108 m). The entire study area of each month sums to one, and the values represent the proportion of that sum found in each zone. Zones/Areas of Interest: Dynamic Zones A,B,C,D,E, Voluntary Slowdown Zone, Seasonal Management Areas 1 & 2 (SM1/SM2), Static-to-PEI AOI, Extended Restricted Area, Restricted Area, Northern/Southern Static Zones (NSZ/SSZ), Cape Breton East/West AOIs. (April 2022 excluded as vessel data was incomplete; no November 2024 data).

Sources of Uncertainty

The estimated relative risk of lethal vessel strikes to NARWs is exclusive to vessels carrying and transmitting AIS, which are only required for certain vessels, primarily those longer than 20 m, although some smaller vessels do carry and transmit AIS. In addition, not all vessels consistently comply with AIS requirements, and transmissions may be intermittently disabled or turned off. Therefore, small and medium-sized vessels are under-represented, and overall vessel activity may be underestimated due to gaps in AIS use and compliance. In addition, the under-representation is likely not spatially uniform throughout the study area.

Due to the limited number of collisions available to inform the creation of the lethality model by Garrison et al. (2025), only four size classes were used. This restricts the ability to distinguish finer-scale differences in risk among vessel sizes, particularly within the broad 'large vessel' category. However, this approach was considered preferable over assuming uniform probability of lethality across all vessels.

Due to tag limitations, NARW dive data depths shallower than 6 m could not be differentiated; therefore, all whale depths and vessel drafts within the upper 6 m of the water column were treated equivalently. In addition, the dive data were used uniformly throughout the GSL and did not account for spatial variations in behavioural state. The majority of the tagging data are from NARWs that remained in the southern GSL after being tagged and exhibited area-restricted search behaviour associated with feeding. The tagging data primarily reflects summer conditions and does not capture potential seasonal differences in behaviour. Surface-active groups were likely not represented due to the high probability of tag detachment when animals were involved in such activities and therefore estimates of proportion of time spent at the surface represent a minimum.

Avoidance of a collision by either whales or vessels, which may influence vessel strike risk, were not considered, as these processes are not sufficiently characterized to be explicitly represented. Extra-large vessels typically have reduced maneuverability, potentially decreasing the ability to avoid whales who surface near the vessel. In addition, extra-large vessels have deeper drafts, which increases the response time required by the whale to successfully perform a vertical dive that is deep enough.

Uncertainty in the NARW probability of occurrence model and therefore relative risk of lethal vessel strikes is higher during the shoulder seasons (April/May and October/November), driven by reduced detections of NARWs due to their lower presence in the Gulf and limited survey effort during these periods. Spatially, there were limited survey efforts east of Cape Breton and in the SLE, and additional uncertainty in chlorophyll-a estimates within the SLE, which increased uncertainty in predictions in both areas. While NARW occurrence is a key driver of relative risk, other components of the risk model, including vessel traffic intensity, vessel size, and vessel speed, remain important drivers in shaping overall risk patterns.

CONCLUSIONS AND ADVICE

The analysis identifies areas of highest relative risk of lethal vessel strikes to NARWs in the SLE, GSL, and Cabot Strait under TC's vessel management measures from 2020 to 2024. Recurring areas of highest relative risk were in the entrance to Chaleur Bay, the American Bank, waters surrounding northern Cape Breton, and throughout the major shipping lanes, both inside and outside TC's management areas. The consistency in relative risk hotspots highlights areas which can be targeted for conservation efforts. While there are some spatial uncertainties associated with the calculated relative risk and under-representation of some vessel classes, the results indicate that extra-large vessels pose the greatest relative risk to NARWs among

vessel size classes. Overall, the analysis identifies spatial patterns in highest relative risk of lethal vessel strike, driven primarily by the co-occurrence of NARWs and high volume of vessel traffic particularly from extra-large vessels. This information can support the ongoing evaluation and adaptation of management approaches.

These results suggest that additional or expanded measures such as further speed reductions, voluntary routing measures, or mechanisms incentivizing compliance with mandatory management measures and/or participation in voluntary measures in high-risk areas may be beneficial in reducing risk where vessel traffic cannot be eliminated. Other considerations, such as including a NARW distribution or habitat layer to Whale Insight, could further support mariners in identifying areas where they pose the greatest risk to NARW and increase their awareness when transiting through areas identified as NARW important habitat (Ratelle and Vanderlaan et al. 2025). Encouraging mariners to document and report whale sightings would also complement existing monitoring programs.

Relative risk was presented using the best available data and models while accounting for the variation in each component. The modelling framework could be applied to assess risk in subsequent years as NARW distribution and vessel traffic patterns and composition change, provided that the corresponding whale and vessel data are available. The model framework can also be applied to other species with the appropriate data to build risk maps.

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APPENDIX

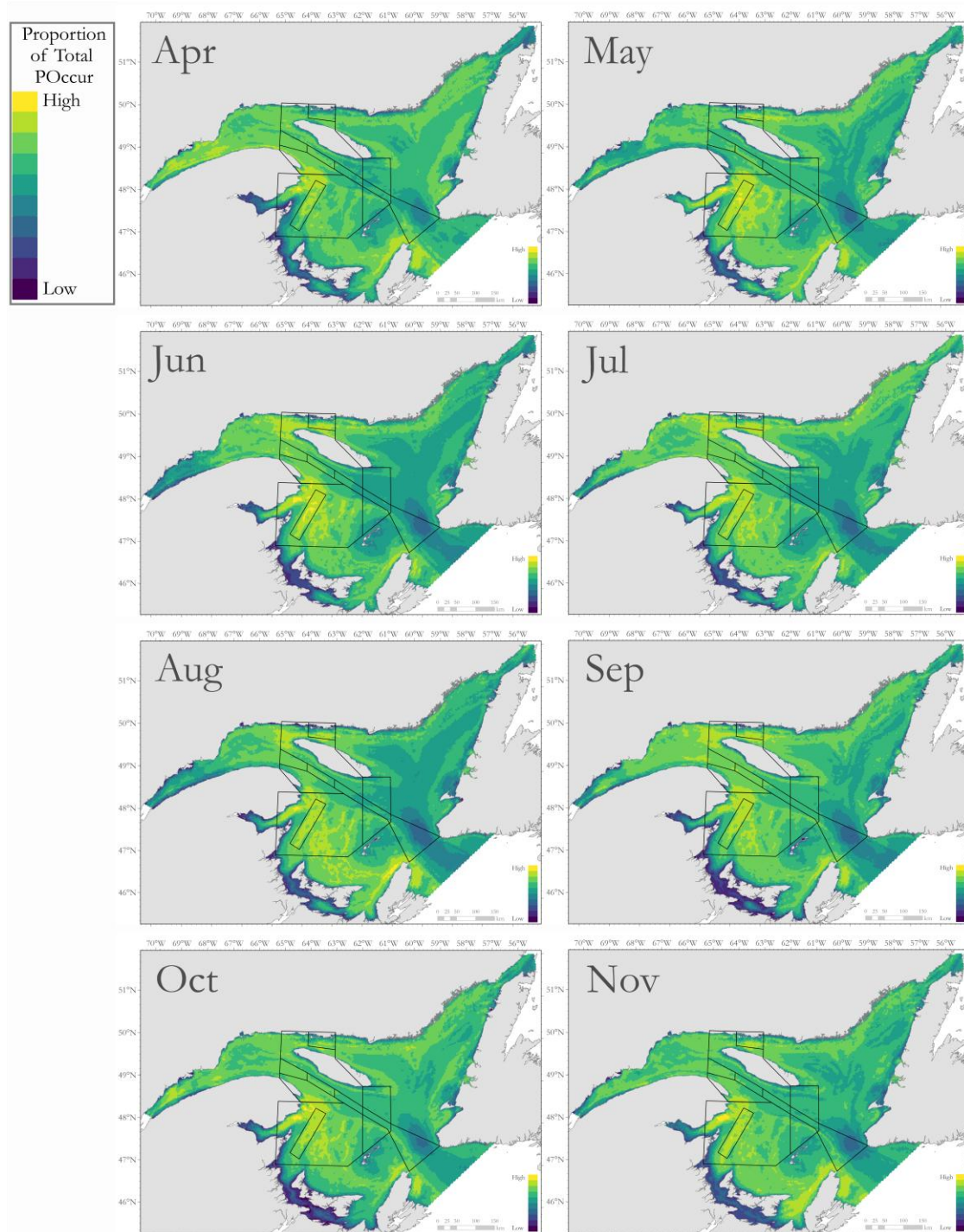


Figure A1. Each panel represents a monthly average over 2020-2024 of the North Atlantic right whale (NARW) relative probability of occurrence (POccur) in the St. Lawrence Estuary and Gulf of St. Lawrence. The value of each grid cell represents the proportion of that month's total probability of occurrence, where each month sums to one. The colours are displayed on an exponential scale, with a $5.2\times$ increase in value between successive categories. Data for April 2022 and November 2024 were excluded to match the risk maps.

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