Examining vessel traffic patterns and conformance to voluntary guidelines in the western Canadian Arctic Notice to Mariners

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The Notice to Mariners (NOTMAR) in the Inuvialuit Settlement Region (ISR) was created in 2019 to reduce risk from vessel traffic to beluga and bowhead whales and reduce the environmental impacts of vessel traffic in marine protected areas (MPAs). The specific guidelines are to avoid the MPAs if possible, and if not possible, to travel at speeds less than 10 knots. Beyond the MPAs, vessels in areas important for whales are also asked to travel at speeds less than 10 knots. In this report, we assess the conformance of vessel traffic to the voluntary guidelines in the NOTMAR to provide a benchmark of vessel activity in the ISR under the current management system. Conformance to the NOTMAR was strong in the Tarium Niryutait MPA (TNMPA), with only essential vessels travelling through the area and most vessels travelling at speeds less than 10 knots (74% ± 33% of distance travelled per year at speeds less than 10 knots). Two classes of vessels in the Anguniaqvia Niqiqyuam MPA (ANMPA) conformed with the NOTMAR guidelines (cruise ships and coast guard/research vessels), by avoiding the MPA entirely or travelling at slow speeds when carrying out objectives within the ANMPA. However, tugboats, cargo ships, tankers, and pleasure craft all continued travelling through the ANMPA, and all tankers and cargo ships travelled at speeds greater than 10 knots. No vessel classes seemed to alter routes or rate of travel in the areas important for whales, and vessels that travelled at speeds greater than 10 knots before the NOTMAR continued to do so after it was instated.

Résumé

Halliday, W.D., Scharffenberg, K.C., Kortsalo, P., Dawson, J., and Insley, S.J. 2025. Examining vessel traffic patterns and conformance to voluntary guidelines in the western Canadian Arctic Notice to Mariners. Can. Tech. Rep. Fish. Aquat. Sci. 3707: vi + 18 p.
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L’Avis aux navigateurs (NOTMAR) dans la Région désignée des Inuvialuit (RDI) a été créé en 2019 pour réduire les risques que pose le trafic maritime aux bélugas et aux baleines boréales, ainsi que pour atténuer les impacts environnementaux du trafic maritime dans les zones de protection marine (ZPM). Les lignes directrices spécifiques recommandent d’éviter les ZPM si possible, ou, si cela est inévitable, de naviguer à une vitesse inférieure à 10 nœuds. En dehors des ZPM, il est également demandé aux navires circulant dans les zones importantes pour les baleines de respecter une vitesse inférieure à 10 nœuds. Dans ce rapport, nous évaluons la conformité du trafic maritime aux lignes directrices volontaires du NOTMAR afin d'établir un point de référence de l’activité navale dans la RDI sous le régime de gestion actuel. La conformité au NOTMAR était forte dans la ZPM de Tarium Niryutait (ZPMTN), seuls les navires essentiels traversant la zone et la majorité naviguant à des vitesses inférieures à 10 nœuds (74 % ± 33 % de la distance parcourue annuellement à moins de 10 nœuds). Deux catégories de navires dans la ZPM de Anguniaqvia Niqiqyuam (ZPMAN) ont respecté les lignes directrices du

NOTMAR (navires de croisière et navires de la Garde côtière ou de recherche), en évitant complètement la ZPM ou en naviguant à faible vitesse lors de leurs activités dans la ZPMAN. Cependant, les remorqueurs, cargos, pétroliers et embarcations de plaisance ont continué à traverser la ZPMAN, et tous les pétroliers et cargos ont circulé à des vitesses supérieures à 10 nœuds. Aucune catégorie de navires ne semble avoir modifié son itinéraire ou sa vitesse dans les zones désignées comme importantes pour les baleines à l'extérieur des ZPMs, et ceux qui naviguaient à plus de 10 nœuds avant l'instauration du NOTMAR ont continué à le faire par la suite.

1. Introduction

The Arctic is seeing an unprecedented increase in vessel traffic due to reductions in the extent of summer sea ice and associated increased accessibility and industrial interest in the Arctic for a variety of activities (Liu et al. 2024, PAME 2024). Due to increases in mining, resource exploration, and tourism, as well as the opening of newly navigable global shipping routes, the Canadian Arctic experienced a tripling of vessel traffic in some areas between 1990 and 2015 (Dawson et al. 2018). Vessel traffic has multiple negative effects on marine life, including pollution (air pollution from exhaust, microplastics, greywater discharge, and possible oil spills; Su et al. 2019), introduction of invasive species (Hewitt et al. 2009), underwater noise (Merchant et al. 2014, McWhinnie et al. 2017), and vessel strikes (Schoeman et al. 2020). Vessel traffic can also disrupt traditional subsistence activities by displacing target species (e.g., marine mammals and fish) (Raymond-Yakoubian 2018, Halliday et al. 2019, Dawson et al. 2021). Inuvialuit communities have raised concern over increased vessel traffic in the Inuvialuit Settlement Region (ISR), specifically over impacts of vessel traffic on marine species and subsistence and cultural activities (FJMC 2024).

The Notice to Mariners (NOTMAR) publication is a national navigational service that informs mariners of navigational safety matters and the enactment of regulations and procedures affecting Canadian Waters. The Western Arctic NOTMAR was created in partnership between Fisheries and Oceans Canada, Transport Canada, Canadian Coast Guard (CCG), the Fisheries Joint Management Committee, the Inuvialuit Game Council, the Inuvialuit Regional Corporation, the Environmental Impact Screening Committee, Northwest Territories Department of Industry, Tourism, and Investment, Parks Canada, Crown-Indigenous Relations and Northern Affairs Canada and Wildlife Conservation Society Canada (WCSC) (CCG 2019, DFO 2024). The Western Arctic NOTMAR lists two sets of voluntary measures for the ISR which are published in the annual edition of the national Notice to Mariners, as well as monthly during the Arctic shipping season, June through to November. The first measure is related to the two marine protected areas (MPAs) in the ISR, the Tarium Niryutait MPA (TNMPA) near Tuktoyaktuk and the Anguniaqvia Niqiqyuam MPA (ANMPA) near Paulatuk (Figure 1.). The TNMPA is located in the Mackenzie River Delta and estuary and consists of three sub-regions—Niaqunnaq, Okeevik, and Kittigaryuit covering approximately 1,750 km². Much of the TNMPA is shallow (< 5 m) aside from a few deeper channels which are used for navigation (Whalen et al. 2020). The ANMPA is located in Darnley Bay and borders the east coast of the Parry Peninsula, near the community of Paulatuk covering an area of 2,361 km^2. Vessels are asked to avoid both MPAs if possible, and if that is not possible, to travel at speeds less than 10 knots (18.5 km/h). Vessels conducting community resupply (in the case of the TNMPA), safety operations, approved research, and visiting sites within the MPAs would be considered essential vessels that cannot avoid the MPAs. All other vessels can presumably avoid the MPAs, unless they are forced into these areas due to poor weather or other safety considerations.

The second voluntary measure is related to areas identified as core habitat for beluga whales (*Delphinapterus leucas*) and bowhead whales (*Balaena mysticetus*) in the ISR. These were designed to include areas identified as Zone 1 within the Beaufort Sea Beluga Management Plan (FJMC 2024) for beluga whales, whereas for bowhead whales, the areas are an amalgamation of

areas identified using satellite telemetry as core seasonal habitat used by bowhead whales (e.g., Halliday et al. 2021, Harwood et al. 2017) and areas identified by Inuvialuit traditional knowledge as important for bowhead whales (Figure *1*.). Within these whale habitats, vessels are asked to travel at speeds less than 10 knots. The NOTMAR first came into effect on 30 August 2019, and has been in place seasonally and annually since then. The delineation of important Whale Areas was updated in 2021 and again in 2023 to incorporate updated information about the distribution of belugas and bowheads (Figure 1.) (CCG 2021, 2023).

The 10 knot speed restriction used for both MPAs and whale areas is a measure aimed specifically at reducing the risk from vessels due to ship strikes and underwater noise. Generally, vessels travelling at speeds < 10 knots are less likely to strike a baleen whale (e.g., Halliday et al., 2022). Vessels travelling more slowly also typically create less underwater noise, which reduces disturbance to marine mammals (e.g., MacGillivray et al., 2019).

The purpose of this report is to assess the conformance of vessel traffic to the voluntary guidelines in the NOTMAR and to provide a benchmark of vessel activity in the ISR under the current management system. It is hoped this will allow us to track vessel activity over time and inform recommendations for the future of the NOTMAR and vessel management in the ISR.

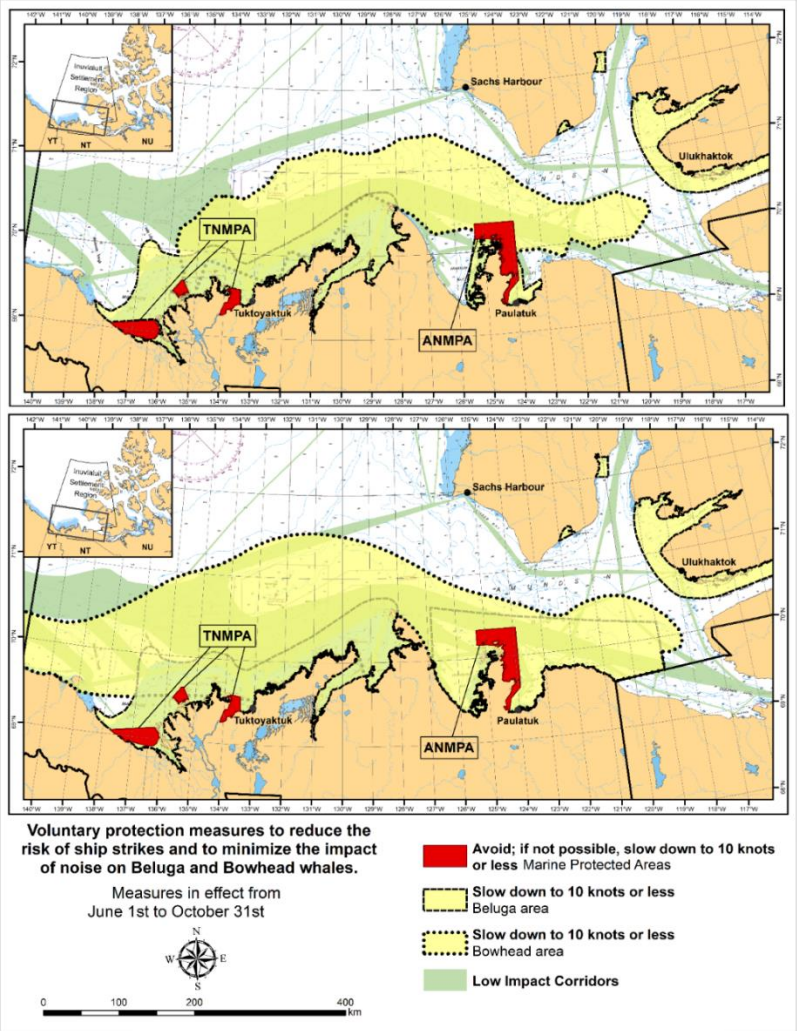

Figure 1. The Inuvialuit Settlement Region (ISR) and Notice to Mariners management zones, including marine protected areas (MPAs; red) and slow down areas for beluga whales and bowhead whales (referred to in this report as 'Whale Areas')(yellow). The Whale Areas were different for 2019-2020 (top) and 2021-2022 (bottom). This figure was adapted from the 2019 and 2021 NOTMARs (CCG 2019 and CCG 2021).

2. Methods

We used satellite Automatic Identification System (AIS; Spire Global Inc, Cambridge, ON) vessel tracking data to examine vessel movements through the ISR between 2015 and 2022. This timeframe included four years before the NOTMAR came into effect (2015-2018) to provide baseline information on vessel movements prior to management measures. When interpreting results of the vessel traffic analysis, it is important to highlight the timing of key events and vessel management decisions which affect the results:

1. The NOTMAR was instated on 30 August 2019. 2015-2018 therefore represents the pre-NOTMAR, and 2020-2022 is the NOTMAR period. Because the NOTMAR was instated partway through the shipping season in 2019, this year represents both periods. However, because the guidelines were so recent, vessel traffic operating in September and October 2019 may not have been responding to the NOTMAR.
2. 2018 was a heavy ice year, with multi-year sea ice from the Beaufort Sea effectively blocking the Amundsen Gulf for much of the shipping season. All passenger vessels scheduled to come to the ISR cancelled their trips, along with any pleasure craft that were not already in the region. Other vessels traveling through the ISR in that year had to adjust their course or itinerary in response to the ice.
3. Travel restrictions were in place in 2020 and 2021 due to the COVID-19 pandemic; these forbade passenger ships or pleasure crafts from travelling in the Canadian Arctic.

2022 therefore represents the best year to assess how all vessels in the region were conforming to the guidelines.

The AIS data consists of tracking points recorded via satellite with date, time, position, speed over ground, and unique vessel identification information. Based on the date and time data we first converted all the points into track segments for individual vessels, which was a least cost path accounting for land. This was done to fill large gaps in vessel position point data, especially in earlier datasets when satellite coverage was sparse (e.g., > 30 minutes between points). Satellite coverage has improved in recent years, resulting in fewer gaps between consecutive AIS positions, with the exception of small vessels in the pleasure craft category which use AIS transponders with weaker signals (class B AIS). We then measured the distance and the average speed over ground of each track segment for each vessel within each management area (MPAs and whale areas) and outside of these management areas. Note that the speed restrictions in the NOTMAR (as of 2022) stated that the 10-knot limit is measured as speed through water, which effectively accounts for the effect of current on the boat (CCG 2022). However, speed over ground is the more commonly used metric, is more straightforward to measure, requiring no information on local conditions, and is what is reported by AIS data. Speed over ground and speed through water are the same in scenarios with low current and low wind.

We looked up the vessel name and class in online databases (e.g., marinetraffic.com, vesselfinder.com), and assigned each vessel to one of eight classes that were present in the region (Table 1). One class, community vessels, which are small community boats equipped with AIS transponders through the Enhanced Maritime Situational Awareness (EMSA) project in Tuktoyaktuk, were present from 2019-2022 (Transport Canada 2022). However, these vessels are typically engaged in subsistence activities, and have been active in the region much longer than the EMSA project so we assume any change in this type of vessel activity would be due to recent uptake of AIS transponders, rather than actual changes in vessel activity. As such we identified these vessels in the dataset and removed them from further analyses, and focused on the remaining seven vessel classes.

We extracted track segment data from the entire ISR and classified segments into four areas: the ANMPA, the TNMPA, the Whale Areas identified in the NOTMAR (which include both bowhead and beluga areas), and the remaining ISR (Figure 1.). Note that the Whale Areas were refined in 2021 (CCG 2021) to include updated information on the distribution of beluga and bowhead whales, so the Whale Areas defined in 2019 were used for 2019 and 2020, and the areas defined in 2021 were used for 2021 and 2022. We then calculated the total distance travelled and average and maximum speed over ground for each vessel in each of the four areas in each year. We also calculated the distance travelled by each vessel at speeds greater than 10 knots in each of the areas. We then summarized the values across vessels within the same categories and across all categories, and counted the number of unique vessels within each area in each year.

Table 1. Vessel classes used in this analysis.

Vessel Class	Descriptions
Cargo	Large vessel (typically > 100 m long) carrying various cargo. Includes container ships, bulk carriers, big lifts, etc.
Coast Guard/Research	Government coast guard vessels, icebreakers, and research vessels. F/V Frosti, a fisheries research vessel, is included in this class.
Community Vessel*	Small boats equipped with AIS transponders as part of the Enhanced Maritime Situational Awareness project from Tuktoyaktuk. These boats are differentiated from Pleasure Craft since they all start and stop at communities, mostly Tuktoyaktuk.
Navy	Military vessels from the Canadian Navy.
Passenger Vessel	Cruise ships.
Pleasure Craft	Sailboats and private yachts.
Tanker	Large vessel (typically > 100 m long) carrying fuel.
Tug	Tugs and barges, typically involved in community resupply, but also involved in supplying and working at industrial sites.

*Community vessels were identified in the data, but not included in the analysis of vessel conformance.

3. Results

3.1 Number of Vessels

Between 2015 and 2022, the ISR saw 11 to 46 unique vessels annually, with the majority making transits across the region. The highest number of vessels transited in 2022 (46 vessels) and the fewest transited in 2016 (11 vessels).

Between 5 and 24 unique vessels transited through the ANMPA annually during 2015-2022, with the fewest number of vessels in 2016 and the highest number in 2019 (Figure 2, Figure *3*). The ANMPA saw an increase in the number of unique vessels entering the area since the NOTMAR was instated; 5 to 9 vessels per year were present before the NOTMAR (2015-2018), and 8 to 14 vessels were present after (2020-2022). Each of seven vessel classes (Table *1*; excluding

Community Vessels) entered the ANMPA in at least three of the eight years of the study and all vessel classes except passenger ships continued travelling through the ANMPA after the NOTMAR was instated. Coast guard/research vessels were present in every year of the study, but showed a decline in the number of unique vessels entering after the NOTMAR was instated (max 4 vessels pre-NOTMAR to max 2 vessels post-NOTMAR). The remaining classes showed no change or an increased presence in the ANMPA after the NOTMAR was announced.

Between 3 and 9 unique vessels transited through in the TNMPA annually during 2015-2022 (Figure 2, Figure 4). Only five vessel classes were present during this time: coast guard vessels and tugboats were present in every year, passenger vessels and pleasure craft were present in two years, and one navy vessel was present in one year. There was a slight increase in the annual total number of vessels moving through the TNMPA since the NOTMAR was instated (3-9 vessels during 2015-2018 compared with 7-9 vessels during 2020-2022), primarily due to an increase in the number of tugboats. Since the NOTMAR was instated, only tugboats and coast guard vessels were present in TNMPA, both of which are considered essential traffic for community resupply and safety.

Between 2015 and 2022, 10 to 43 vessels travelled through the Whale Areas annually, with all seven classes present at some point during the study period (Figure 2, Figure *5*). The highest number of unique vessels occurred in 2022, with 43 vessels, followed by 2019 with 36. The fewest vessels transited in 2016 with 10 vessels. Pleasure craft had the most unique vessels, with 11 in 2019 and 10 in 2022. Cargo ships, coast guard ships, and tugboats all had a maximum of 8 unique vessels in a year. Similarly, between 11 and 40 vessels travelled annually in ISR areas that are not included in the NOTMAR, with almost identical patterns to the Whale Areas, demonstrating that most of the ship traffic transiting the ISR travelled through Whale Areas at some point on their voyage (Figure *5*).

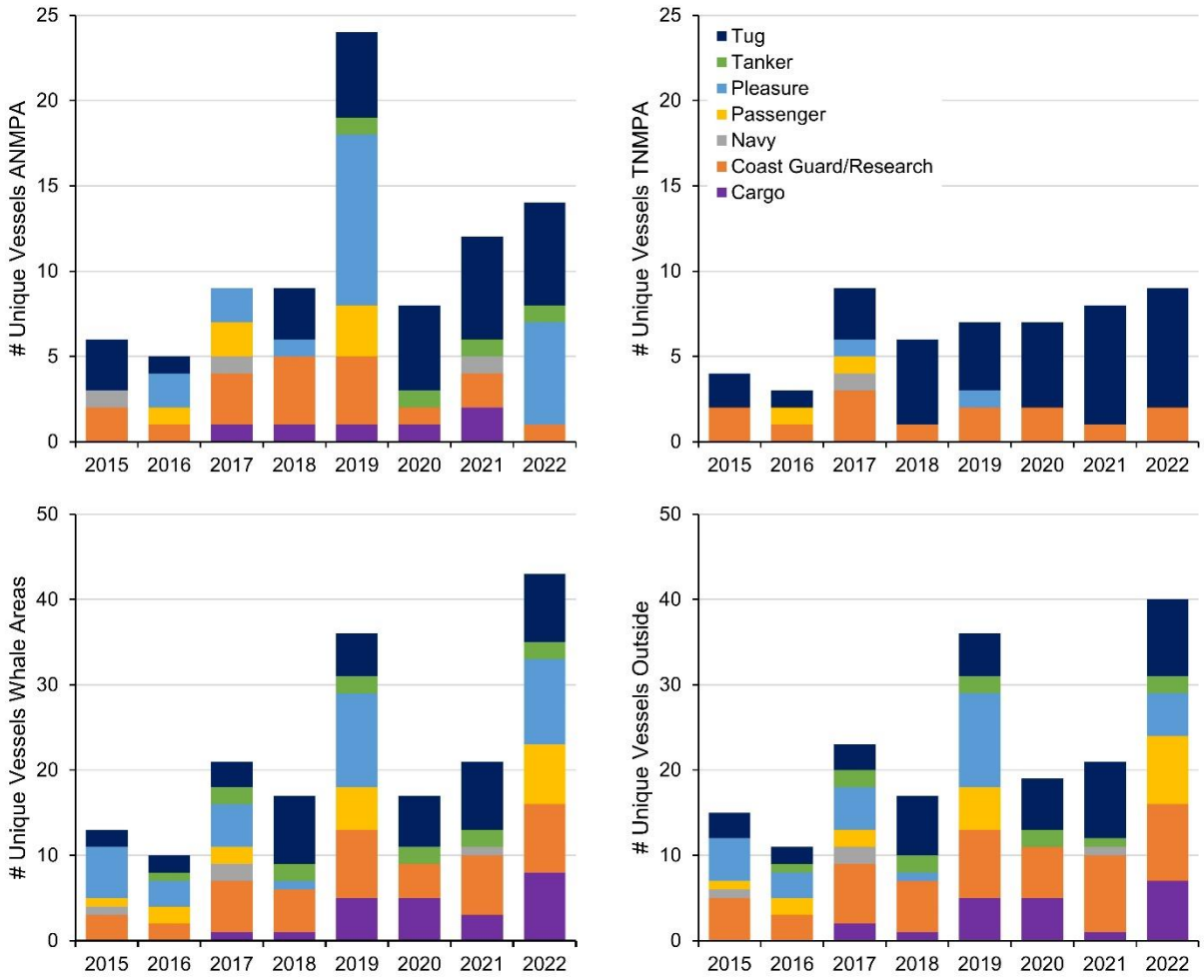

Figure 2. Number of unique vessels in different vessel classes travelling per year in the Anguniaqvia Niqiqyuam Marine Protected Area (ANMPA), Tarium Niryutait Marine Protected Area (TNMPA), beluga and bowhead whale areas (Whale Areas), and the remainder of the ISR outside all of these aforementioned management areas (Outside).

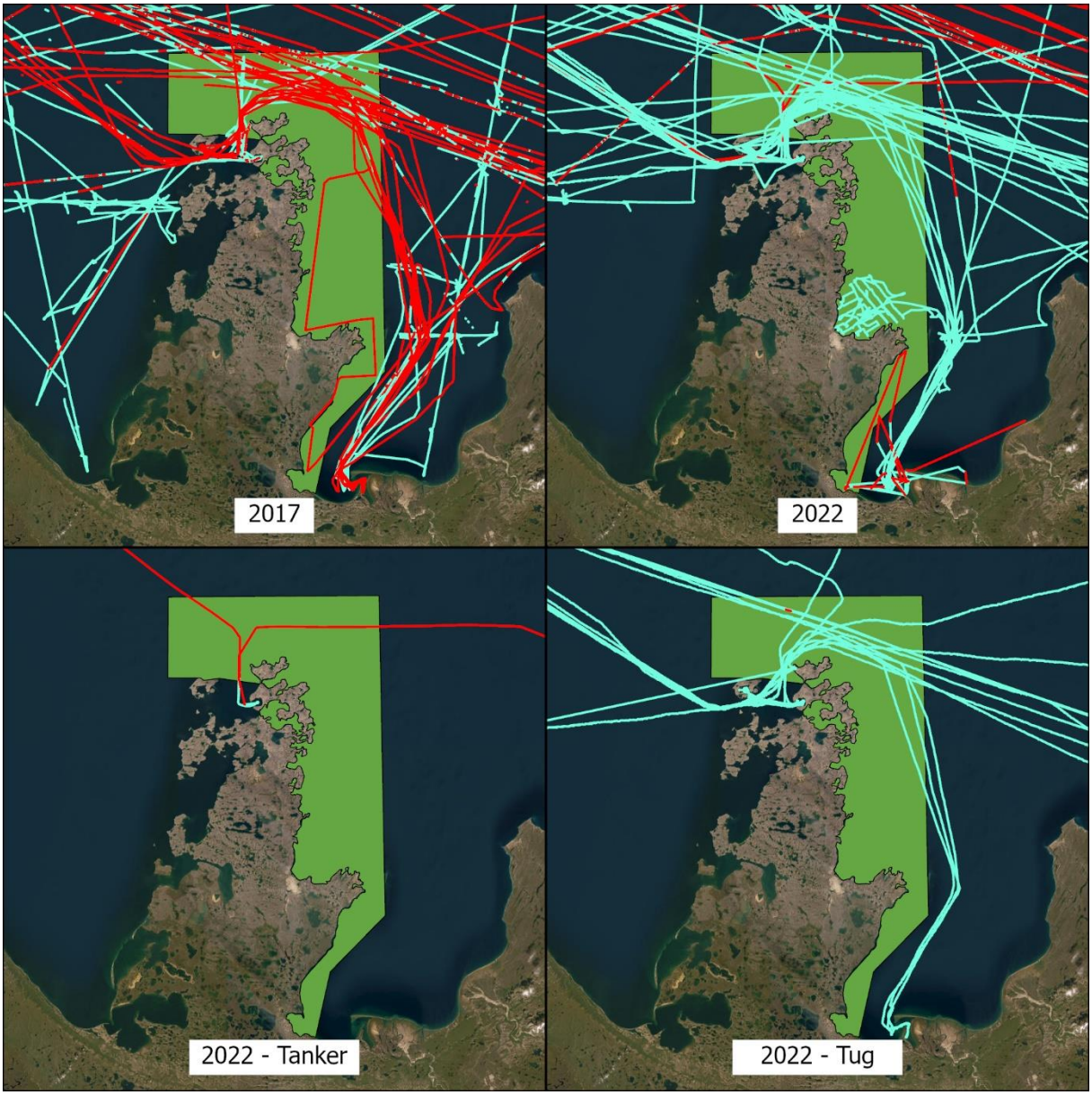

Figure 3. Vessel traffic in the Anguniaqvia Niqiqyuam Marine Protected Area, showing all tracks in 2017 (before the NOTMAR; top left) and 2022 (after NOTMAR; top right), as well as just the tracks for tankers in 2022 (bottom left) and for tugs in 2022 (bottom right). Track lines are colour-coded by vessel speed, with speeds < 10 knots as blue and speeds ≥ 10 knots as red.

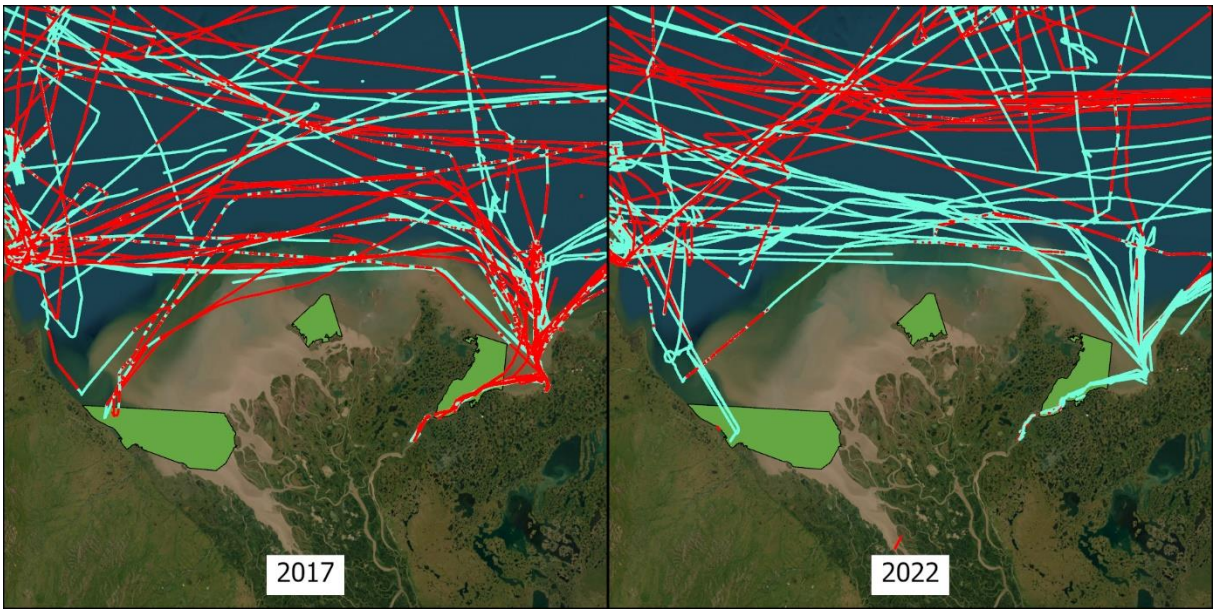

Figure 4. Vessel traffic in the Tarium Niryutait Marine Protected Area, showing all tracks in 2017 (before the NOTMAR; left) and 2022 (after NOTMAR; right). Track lines are colour-coded by vessel speed, with speeds < 10 knots as blue and speeds ≥ 10 knots as red.

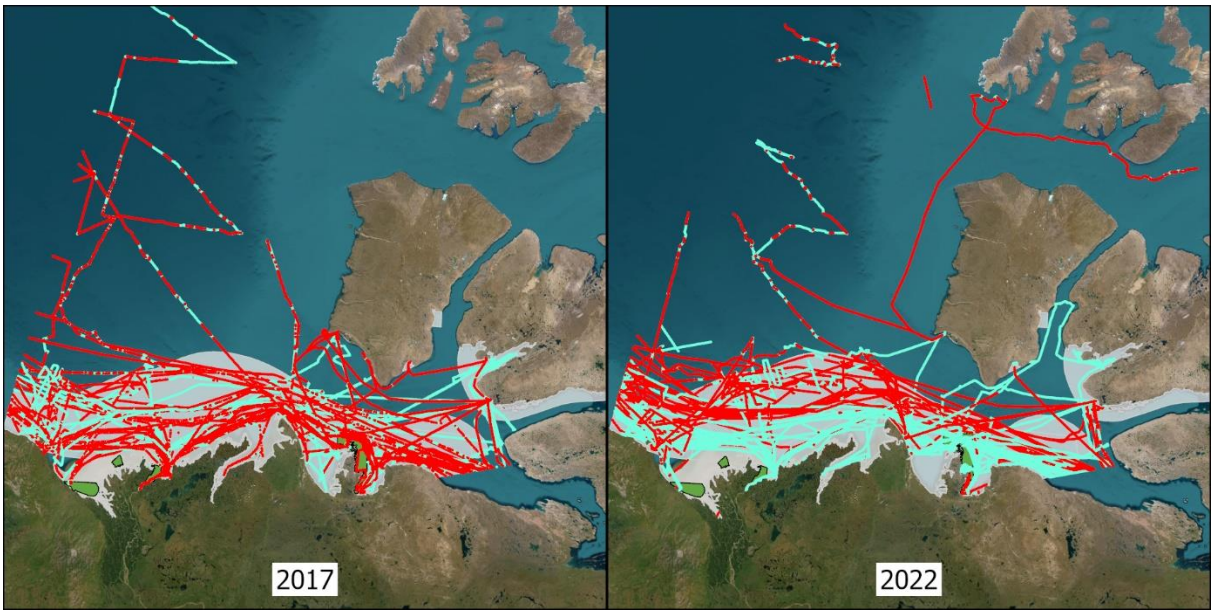

Figure 5. Vessel traffic in the Whale Areas (gray), showing all tracks in 2017 (before the NOTMAR; left) and 2022 (after NOTMAR; right). Track lines are colour-coded by vessel speed, with speeds < 10 knots as blue and speeds ≥ 10 knots as red.

3.2 Vessel Speed

Ship class was the primary determinant of speed rather than the area of travel across the ISR (Figure 6) with similar trends for the ANMPA, TNMPA and Whale Areas. We considered 10 knots a threshold for comparing speeds based on the speed recommendations in the NOTMAR (CCG 2019). Cargo ships and tankers had mean travel speeds above 10 knots in all areas, and did not significantly decrease their speed after the NOTMAR was instated. For example, one tanker was in the ANMPA each year from 2019 to 2022, and it maintained a mean speed of > 11 knots, with the highest yearly mean being 14 knots in 2022. Similarly, two tankers were present in the Whale Areas each year between 2017 and 2022 and maintained a mean speed of > 10 knots in all years except 2018 (where mean speed decreased to 9.7 knots). Although only one cargo ship was present per year in the ANMPA from 2017-2021, it travelled at mean speeds ≥ 12 knots. Between one and eight cargo ships were present in the Whale Areas per year between 2017 and 2022, and these vessels travelled fast (> 14 knots) on average. Coast guard/research vessels, pleasure craft, and tugboats had median speeds < 10 knots and travelled at slower speeds in all areas, suggesting vessel capability and trip purpose were the primary determinant of speed, rather than voluntary adherence to the NOTMAR. Passenger ships and navy vessels had median speeds around 10 knots with transponders reporting speeds below and above 10 knots equally.

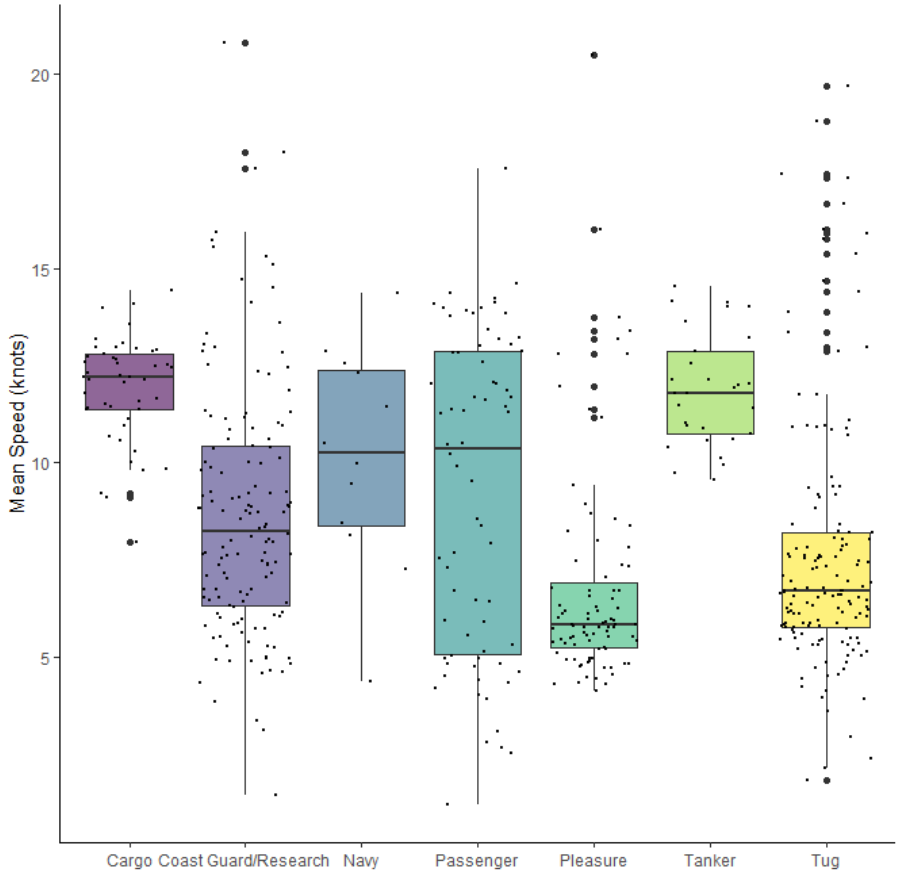

Figure 6. Mean vessel speed (knots) for different vessel classes travelling in all areas of the Inuvialuit Settlement Region, 2015-2022. The box represents the interquartile range, the line

within the box is the median, the whiskers outside the box are the 95% confidence interval, and large black points outside the whiskers are outside the confidence interval. All small dots represent the raw data points.

3.3 Distance Travelled

The distance travelled within an area may be a more useful metric of vessel activity than the number of unique vessels in an area, especially in the case of coast guard/research vessels and tugboats in the ISR where the same vessel was active multiple times or for prolonged periods. In our dataset there was only a weak correlation between the number of unique vessels and the distance travelled (Pearson's correlation coefficient of 0.62 when examining one value per vessel class per area per year, n=142), suggesting distance travelled more accurately reflects the amount of potential disturbance to marine mammals. Still, annual patterns in distance travelled per year per vessel class (Figure 7) roughly reflected annual patterns in the number of unique vessels (Figure 2), with some key differences. For example, 2019 had large spike in unique vessels transiting the ANMPA due to a group of sailboats making single transits, but the increase in total distance traveled was not as substantial.

Between 2015 and 2022 vessels travelled 429 to 1600 km annually in the ANMPA, with the lowest distance occurring 2016 and the largest in 2022 (Figure 7). The total distance travelled did not decrease in the ANMPA after the NOTMAR was instated, but passenger ships (no longer present) and coast guard/research vessels traveled less, while tugboats traveled more.

Between 2015 and 2022, vessels travelled 261 to 1203 km annually in the TNMPA, with the lowest distance occurring 2015 and the largest in 2020 (Figure 7). There was an overall increase in distance travelled in the TNMPA since the NOTMAR was instated, due to increases in distance traveled by coast guard/research vessels and tugboats (the two main classes present in the TNMPA). Other vessel classes which were less common before were not present at all after the NOTMAR was instated.

Between 2015 and 2022 vessels travelled 11,579 to 57,114 km annually in the Whale Areas, with the lowest distance in 2016 and the farthest in 2022 (Figure 7). There was an overall increase in distance travelled in the Whale Areas between 2015 and 2022, with cargo ships, passenger ships, and tugboats showing continued increases in distance travelled after the NOTMAR was instated Total distance travelled per year by all vessels outside the management areas was variable between 2015 and 2022, ranging from 13,491 km to 31,295 km (in 2016 and 2017 respectively), with no obvious temporal trends. Coast guard/research vessels remained the class with the greatest distance travelled every year outside the management areas.

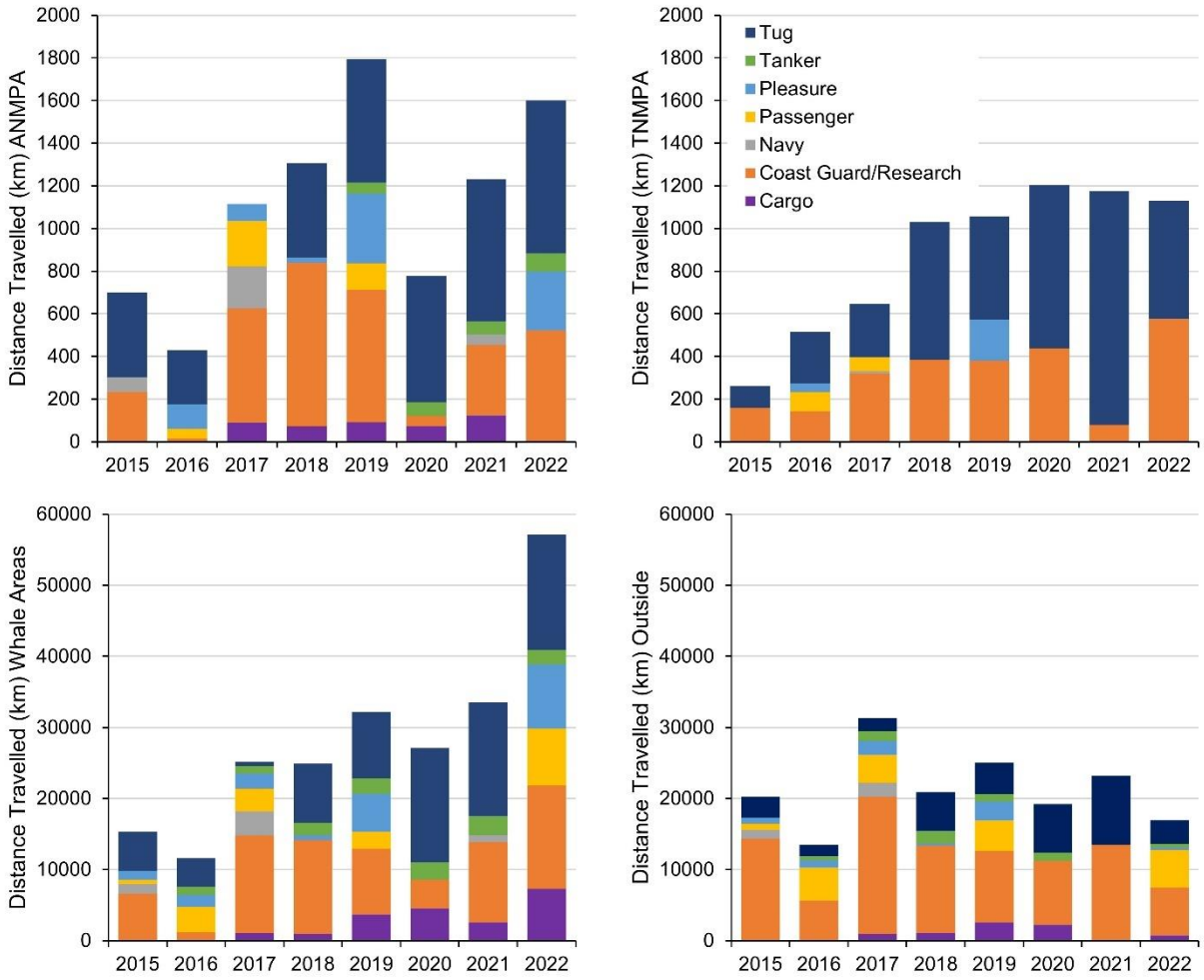

Figure 7. Distance travelled (km) by different vessel classes per year in the Anguniaqvia niqiqyuam Marine Protected Area (ANMPA), Tarium Niryutait Marine Protected Area (TNMPA), beluga and bowhead whale areas (Whale Areas), and the remainder of the ISR outside all of these aforementioned management areas (Outside).

3.4 Distance Travelled at Fast Speeds

The total distance travelled by vessel class at speeds > 10 knots (Figure 8) differed from the main trends in total distance travelled (Figure 7), further demonstrating the importance of vessel class in predicting speed of travel (i.e., some classes spent higher proportion of their time travelling fast than others). Between 2015 and 2022 vessels travelled at speeds > 10 knots for 60-662 km annually in the ANMPA, 75-751 km annually in the TNMPA, 5,914-18,180 km annually in the Whale Areas, and 5,873-15,912 km annually outside the management areas.

Within the ANMPA, all vessel classes periodically exceeded 10 knots prior to 2022, with cargo ships, coast guard/research vessels, passenger ships, and tanker ships travelling the furthest distance at speeds > 10 knots(Figure *8*). In 2022 tanker vessels were the only class to consistently exceed > 10 knots (accounting for 98.8% or 83 km of their total distance) in the

ANMPA; tugboats also exceeded > 10 knots in 2022, but only for 1.6 km (Figure 3, Figure 8). Notably, the one research vessel present in 2022 travelled 100% of its 522 km voyage in the ANMPA at speeds under 10 knots.

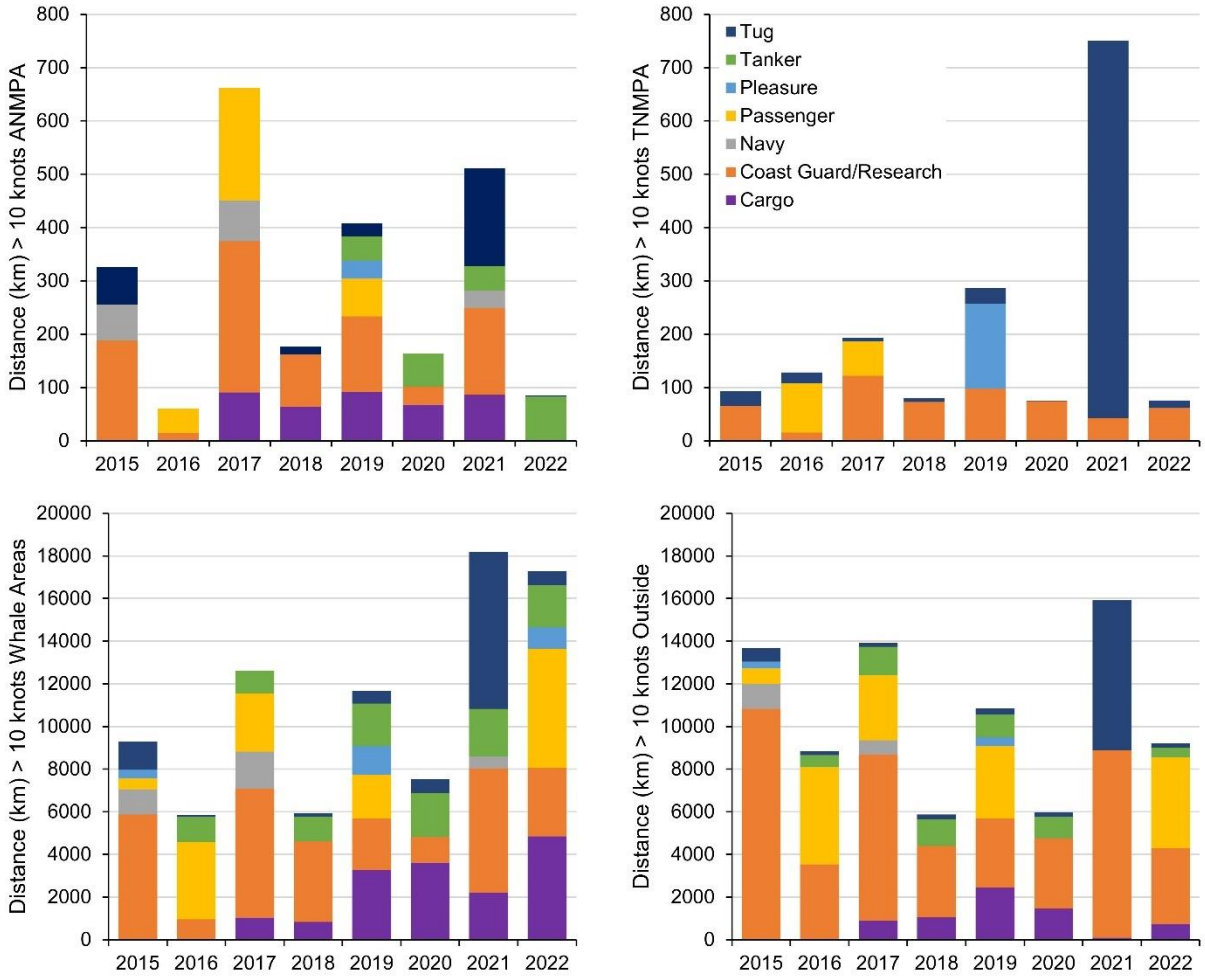

Figure 8. Distance travelled (km) at speeds > 10 knots by different vessel classes per year in the Anguniaqvia niqiqyuam Marine Protected Area (ANMPA, Tarium Niryutait Marine Protected Area (TNMPA), beluga and bowhead whale areas (Whale Areas), and the remainder of the ISR outside all of these aforementioned management areas (Outside).

The two most common vessels in the TNMPA, coast guard vessels and tugs, typically travelled at speeds < 10 knots (Figure 4, Figure 8), with the exception of tugs in 2021 which travelled 65% (or 709 km) of their total distance at speeds > 10 knots (a drastic difference from other years in the study period), and coast guard vessels which travelled between 11 and 53% (or 15 to 98 km) of their total distance at speeds > 10 knots annually. No other vessel classes were present in the TNMPA after the NOTMAR was instated, so we did not examine their speeds further.

There was no apparent reduction in total distance travelled at speeds > 10 knots for any vessel class in the Whale Areas after the NOTMAR was established (Figure 5, Figure 8). All vessel classes exceeded 10 knots in the Whale Areas at least some of the time, with cargo ships (67 to 100% of total distance travelled), coast guard/research vessels (22 to 89% of total distance travelled), passenger ships (70 to 100% of total distance travelled), and tanker ships (66 to 100% of total distance travelled) regularly exceeding the threshold. Tugboats in 2021 also travelled relatively long distances (7,352 km, 46% of total distance travelled) at speeds > 10 knots. Outside of the management areas, coast guard/research vessels most consistently travelled far distances (3,236 to 10,818 km) at speeds > 10 knots, making up between 27 and 76% of their total distance.

4. Discussion

Vessel traffic in the Canadian Arctic has tripled in some areas between 1990 and 2015 (Dawson et al. 2018) and AIS tracking data indicates this trend has persisted in the ISR since 2015. A portion of this increase in traffic may be due to the growing use of AIS trackers as not all vessels carried AIS, especially particularly in early years of this study (Halliday et al. 2018). All large commercial and passenger vessels are required to carry AIS while small vessels (some tugboats and pleasure craft) are not, although their use has increased in recent years (Halliday, unpublished data). Despite removing community vessels – which constitute the majority of new vessels carrying AIS – from our study, some of the increase in activity could be attributed to new uptake, though the major trends in increased activity are likely accurate. As traffic continues to rise, implementing vessel management strategies like NOTMARs (either voluntary or mandatory) will be critical to mitigate impacts on the Arctic ecosystem.

While it is beyond the scope of this report to determine if the NOTMAR was the reason for conformance, conformance can still be measured (i.e., how many vessels stayed within the recommended speed limits regardless of their reasoning). Conformance of vessels to the NOTMAR was highest in the TNMPA, where only essential vessels were present after the NOTMAR was established and they were travelling at speeds mostly < 10 knots along the community supply route. However, navigation of the shallow depths in the TNMPA (the majority of the MPA is < 5 m deep) likely require slower speeds and thus may not represent intentional adherence to the NOTMAR. In the ANMPA, coast guard/research vessels and cruise ships conformed with the NOTMAR – cruise ships did not enter the ANMPA at all after the NOTMAR was instated, and the two coast guard/research vessels active in the area were conducting approved research activities and travelled under 10 knots. Cargo ships, tankers, tugboats, and pleasure craft continued travelling through the ANMPA despite having no specific objective in the area. Tanker ships, which need to stop at Cape Parry, could use an alternate route to west of the ANMPA, though this would add distance and travel time in the Whale Areas. Cargo ships and tankers also continued travelling at speeds > 10 knots through the ANMPA. There was no evidence of vessels travelling slower in the Whale Areas; vessels that travelled at speeds > 10 knots before the NOTMAR continued to do so after the NOTMAR was announced.

Enhanced communication would be a key strategy to improve conformance. Most importantly, communication with companies and captains of tugs, tankers, and cargo ships about NOTMAR

guidelines is crucial. Communication should occur before the shipping season and in real-time if needed; the EMSA program may be well placed to assist with real-time communication. Most vessels can avoid the ANMPA, and tankers heading to Cape Parry through the MPA should be reminded to travel at speeds less than 10 knots. If vessels ignore guidelines, understanding their reasons (e.g., safety, supply deadlines, lack of awareness) can help find solutions. Communication with pleasure craft operators requires a broader strategy to inform them before they travel to the ISR likely involving a variety of organizations locally, nationally, and internationally.

Clarifying whether NOTMAR speed recommendations refer to speed through water or speed over ground is also essential for clear communication and assessment of conformance. This study measured speed over ground, which can differ from speed through water due to currents and wind effects, though the difference is often minor. The NOTMAR text as of 2022 specified speed through water, but the map (which is likely the most commonly used resource) did not provide this information (CCG 2022). Using speed over ground is easier to monitor and standard for other speed restrictions, such as in the Gulf of St. Lawrence for North Atlantic right whales (Transport Canada 2023). Speed through water can be unreliable due to inaccuracies in onboard measuring devices, while speed over ground is easily measured using GPS and is reported by AIS and thus easier to assess for conformance. As of 2023, the NOTMAR map was amended to specify speed over ground (CCG 2023).

5. Conclusions

The NOTMAR has seen partial conformance since it was implemented in 2019. Conformance was higher within the TNMPA, partial in the ANMPA, and lower for the Whale Areas. Improved engagement and communication with companies, captains, and private vessel owners would be an important first step for increasing uptake of the NOTMAR, particularly in the ANMPA. The lack of uptake in the Whale Areas may be because these areas are large and offshore, and speed reduction over such an area could be costly for vessels, though further work needs to be done to understand the reasons for non-conformance. Future work into the importance of reducing vessel noise and strike risk in Whale Areas will help to determine whether alternative management measures should be undertaken to increase conformance.

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