Ship Traffic in Milne Inlet, Nunavut, 2022-2024

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By

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Abstract

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Milne Inlet is in the southernmost reaches of the Tallurutiup Imanga National Marine Conservation Area in Canada's eastern Arctic. Ship traffic in Milne lnlet is both substantial and temporally compressed into a relatively short (approximately three-month) annual shipping window. The Integrated Marine Response Planning (IMRP) program within the Science Sector of the Department of Fisheries and Oceans seeks to improve understanding of shipping in Milne Inlet as an example of an Arctic port with substantial ship traffic for the purpose of preparedness and response to marine spills. The assessment presented may be employed to improve understanding of other Arctic deepwater port locations. Automatic Identification System (AIS) data were obtained from the Protection of the Arctic Marine Environment (PAME) Arctic Ship Traffic Database (ASTD) for the years 2022, 2023, and 2024. Here, ship traffic is described geographically and broken down by ship types along with hours and kilometers spent sailing in Milne Inlet. Most of the ship traffic in Milne Inlet is composed of bulk carriers, tugs, icebreakers, chemical tankers, and general cargo ships. Canadian Anchorage Areas, as defined by the Canadian Hydrographic Service, exist within Milne Inlet. Ship traffic in Milne Inlet in 2022-2024, principally bulk carriers, visit the Canadian Anchorage Area south of Imiliit in the north end of Milne Inlet, and the Canadian Anchorage Area at the very south end of Milne Inlet at the Milne Inlet Port. Visitation timing and duration for bulk carriers as well as bathymetric statistics for three ship-selected areas at each of the Imiliit and Milne Inlet Port anchorage areas are presented.

Résumé

Galley, R., Friesen, M., Coombs, D. 2025. Ship traffic in Milne Inlet, Nunavut, 2022-2024. Can. Tech. Rep. Hydrogr. Ocean Sci. 230: viii + 56 p.

Milne Inlet se trouve à l'extrémité sud de la zone de conservation marine nationale Tallurutiup Imanga, dans l'est de l'Arctique canadien. Le trafic maritime à Milne Inlet est important et concentré sur une période relativement courte (environ trois mois) de l'année. Le programme de planification intégrée des interventions maritimes (PIIM) du secteur des sciences du ministère des Pêches et des Océans vise à améliorer la compréhension du trafic maritime à Milne Inlet, exemple de port arctique à fort trafic, afin de se préparer et d'intervenir en cas de déversements en mer. L'évaluation présentée peut être utilisée pour améliorer la compréhension d'autres ports en eaux profondes de l'Arctique. Les données du système d'identification automatique (AIS) ont été obtenues à partir de la base de données sur le trafic maritime dans l'Arctique (ASTD) du Programme de protection du milieu marin arctique (PAME) pour les années 2022, 2023 et 2024. Ici, le trafic maritime est décrit géographiquement et ventilé par type de navire, avec le nombre d'heures et de kilomètres parcourus à Milne Inlet. La plupart du trafic maritime à Milne Inlet est composé de vraquiers, de remorqueurs, de brise-glaces, de chimiquiers et de navires de marchandises diverses. Les zones d'ancrage canadiennes, telles que définies par le Service hydrographique du Canada, existent dans le Milne Inlet. Le trafic maritime dans l'inlet Milne entre 2022 et 2024, principalement composé de vraquiers, dessert la zone d'ancrage canadienne au sud d'Imiliit, à l'extrémité nord de l'inlet Milne, et la zone d'ancrage canadienne à l'extrémité sud de l'inlet Milne, au port de Milne Inlet. Le calendrier et la durée des visites des vraquiers ainsi que les statistiques bathymétriques pour trois zones sélectionnées pour les navires dans chacune des zones d'ancrage d'Imiliit et du port de Milne Inlet sont présentés.

1. Introduction

Milne Inlet is located at the northeast corner of Baffin Island, branching south-southwest from the southwest corner of Bylot Island (Figure 1) where Navy Board Inlet and Tasiujaq (Eclipse Sound) meet. Milne Inlet is approximately 87 km in length and nearly 20 km in width, with variable bathymetry throughout (Figure 2). Milne Inlet is within the Eastern Arctic marine bioregion (DFO, 2009) and more specifically within Tallurutiup Imanga, a National Marine Conservation Area (NMCA) established through the signing of an Inuit Impact and Benefit Agreement between the Government of Canada and the Qikiqtani Inuit Association (QIA). With this NMCA, Parks Canada contributes to international efforts for the establishment of a worldwide framework of representative marine protected areas, and more specifically to the Government of Canada's marine conservation targets. Parks Canada endeavors to manage these areas in a sustainable manner without compromising the structure and function of their ecosystems (Parks Canada, 2022).

The Mary River Iron Mine on northern Baffin Island (71.31°N, -79.28°E) is operated by the Baffinland Iron Mines Corporation and consists of at least nine high-grade iron ore deposits that are mined, crushed, and screened on-site. Iron ore is transported by truck from the mine site via the project's tote road (approximately 100 km) north to Milne Inlet Port (71.89°N, -80.90°E) at the southern end of Milne Inlet. Milne Inlet Port consists of an ore dock, maintenance facility, a freight dock, a 3-6 million-tonne (Mt) ore stockpile, 65000 m^3 of fuel storage capacity, and associated operational infrastructure. Iron ore is stockpiled at the port year-round, and loaded onto bulk carriers for transport to mostly European markets during the summer shipping season through Milne Inlet and Tasiujaq into Baffin Bay.

In 2022, Baffinland reported that 62 vessel voyages shipped 4.7 Mt of iron ore from Milne Inlet Port using both individual voyages and planned ship convoys that were incorporated for the first time to reduce regional underwater noise as part of a Narwhal Adaptive Management Response Plan (Baffinland, 2022). Multiyear ice drift into the shipping route stranded 0.9 Mt of iron ore at Milne Inlet Port when it ended the 2022 shipping season prematurely (Baffinland, 2022). In their reporting to the Nunavut Impact Review Board (NIRB), Baffinland indicated that 74 bulk carrier voyages were employed to ship 6.1 Mt of iron ore from Milne Inlet Port between 9 August 2023 and 31 October 2023 (Baffinland, 2023). This was the most ore shipped in a single summer since shipping began in 2013, enabled in part by the use of Capesize bulk carriers which also served to reduce the total number of required voyages. In 2024, Baffinland reported that 39 individual ore carriers, many of them Capesize vessels, made 70 voyages to Milne Inlet Port, shipping 6.06 Mt of iron ore between 27 July and 26 October 2024 (Baffinland, 2025). Baffinland (2025)

also indicated a planned reduction to the approved 4.2 Mt shipping amount in 2025 (which returns the project to the previous "Early Revenue Phase" transportation limits).

Shipping from Milne Inlet Port has raised concerns, including the potential for ship interference with local hunting, the potential for dust to impact the marine environment, the potential for vessels to affect marine mammals, and the potential for shipping activity to harm the health of the marine ecosystem (Baffinland, 2023b). Baffinland committed to addressing these concerns as negotiated in the project licensing (Baffinland, 2023b), including using convoys and larger vessels (e.g. Capesize) to reduce the total number of transits and total underwater sound exposure, following the approved shipping route, and travelling at a maximum speed of nine knots in Tasiujaq and Milne Inlet.

Anchorage areas play a role in the shipping of iron ore from Milne Inlet Port. Canadian Anchorages and Anchorage Areas exist in Milne Inlet northwest and west of Pisiktarfik Island, south of Imiliit (Ragged Island), in Koluktoo Bay, and at the south end of Milne Inlet next to Milne Inlet Port (Figure 1, 2, Table 1). As part of the project license, up to three ships can be anchored or drifting simultaneously at Imiliit. Vessels turn off their main engine at anchorage, using only auxiliary power to reduce sound (however the Master has wide ranging authority to maintain the safety of the ship). There are also negotiated commitments regarding no-go zones in Koluktoo Bay and along the shoreline of Bruce Head, maximum sea ice concentration and type for ship passage, ballast water exchange, marine mammal surveys and monitoring, and notifications of deviations from some of these commitments (Baffinland, 2023b).

The objectives of the work presented here are to (i) elucidate the ship traffic by type in the region to improve capacity for preparedness and response, (ii) characterize ship visitation and bathymetry in the Canadian Anchorage Areas. We accomplish these objectives using the Arctic Ship Traffic Database (ASTD) developed by the Protection of the Arctic Marine Environment (PAME) working group of the Arctic Council for 2022, 2023, and 2024.

2. Data and Methods

2.1 Ship Traffic

Automatic Identification System (AIS) data, principally geographic position, identity, course, and speed, are transmitted by ships to shore-based receiving stations and/or 19 satellite receiving stations as required by the International Marine Organization (IMO) for collision avoidance. These data are collated, managed, and undergo quality assurance, control, and distribution by the ASTD project (https://pame.is/index.php/projects/arctic-marine-shipping/astd) developed by the PAME working group

of the Arctic Council, who saw a need for reliable, near-real time shipping information in the Arctic. AIS data recorded every six minutes in the ASTD (PAME, 2021) are augmented with ship information in the IHS Lloyd's Register database using IMO (International Maritime Organization) ship identification numbers (seven digits that stay with the ship permanently through its lifetime). Fuel information for each ship is also imported to the PAME-ASTD from Det Norske Veritas-Germanischer Lloyd (DNV-GL), whose certification ensures ships (and/or their components) comply with class rules for safety, reliability, and environmental impact.

Monthly PAME ASTD level 1 data (please see https://pame.is/images/03_Projects/ASTD/Documents/ASTD_data/ASTD_Data_v3.pdf for level 1 data properties) for 2022, 2023, and 2024 were obtained from the PAME ASTD File Transfer Protocol server for the whole of the ASTD geographic region (map available at https://map.astd.is). R version 4.3.1 (R Core Team, 2023) was used to geographically filter the data to include only those ASTD positions within Canada's exclusive economic zone. Next, ships with less than ten reported positions per month were excluded from further analysis (after PAME, 2021). In order to characterize shipping activity by ship type, the ASTD ship types (n = 15) were employed. One of the ASTD ship types is o*ther activities*, which is more accurately described here using the IHS Fairplay/Lloyd's – Level 5 ship type (n = 228) for each of those vessels (https://www.pame.is/images/03_Projects/ASTD/Ship_type/ASTD_Ship_types.xlsx).

2.2 Bathymetry

Bathymetric data (depth in meters) in the Milne Inlet study area were gleaned from the Canadian Hydrographic Service (CHS) NON-NAvigational-10 (NONNA-10, where "10" represents the approximate grid resolution in meters) bathymetry dataset (https://open.canada.ca/data/en/dataset/d3881c4c-650d-4070-bf9b-1e00aabf0a1d). Between 68°N and 80°N the NONNA-10 product resolution is 0.1° latitude x 0.2° longitude. These data represent a consolidation of digital bathymetry data sources in Canada managed by the CHS. Forty-two NONNA-10 data tiles covering the study area were downloaded (in .tiff format) using the CHS online data portal at https://data.chs-shc.ca/dashboard/map. These tiles were used to assemble a composite bathymetric map of the region using R version 4.3.1 (R Core Team, 2023) and the *terra* package (Hijmans, 2024). These data, and all other geographic data in this report were projected using the Lambert Conformal Conic (LCC) projection used by the Canadian Ice Service (projection string = "+proj=lcc +lat_0=40 +lon_0=-100 +lat_1=49 +lat_2=77 +x_0=0 +y_0=0 +datum=NAD27 +units=m +no_defs"). Example bathymetric maps using the NONNA-10 data are presented for the Milne Inlet study area, and for two subregions in Figure 2.

2.3 Anchorage Areas

The CHS Canadian Anchorages and Anchorage Areas dataset (https://open.canada.ca/data/en/dataset/622a7f72-4a00-4f9e-b04f-af6551c77db3) is used to indicate the location of anchorage areas in Milne Inlet (Figure 1, Table 1).

In order to accurately describe usage of the ship-selected Imiliit Anchorage Area and the Milne Inlet Port Anchorage Area, all the ASTD positions for *bulk carriers* only were first selected from the three years (2022-2024) of AIS data. Second, from those *bulk carrier* positions, only those whose distance-to-next-point was less than 100 m were selected. Distance-to-next-point is a variable within the ASTD that shows how far a ship has moved since its last AIS transmission. Using the standard 6-minute transmission interval the maximum velocity of those points selected is 1 knot. This filtering refined delineation of areas used by relatively motionless bulk carriers outside of the approved Northern Shipping Route (NSR) where the Imiliit and Milne Inlet Port Canadian Anchorage Areas exist.

The *bulk carrier* ship traffic points in each of the ship-selected Imiliit and Milne Inlet Port areas whose distance-to-next-point was less than 100 m were then geo-processed using ArcGIS Pro (version 3.3.2) to aggregate those points (aggregation distance = 3000 m) to create polygons which encapsulate the individual AIS locations at those ship-selected anchorage areas as tightly as possible.

Polygons created by point aggregation in ArcGIS Pro for each of the ship-selected anchorage areas were then used to select all geographically co-located NONNA-10 bathymetric grid cells under each of the ship-selected anchorage areas on the Lambert Conformal Conic (LCC) projection. The NONNA-10 bathymetry in each of the polygons were used to create bathymetric frequency distributions, and to produce summary statistics for the bathymetry in each area.

3. Results

3.1 Ship Traffic in 2022

In 2022, the Milne Inlet study area (extent indicated in Figure 3) saw the navigation of 53 unique ships who sailed 12932 hours, covering 16251 km (Table 2). The shipping season began on 31 July 2022 when the bulk carrier *Nordic Odin* entered Milne Inlet. Almost all ship positions in the region in 2022 followed the approved NSR closely, and ship positions were also aggregated around the Canadian Anchorage Area south of Imiliit, and at the Canadian Anchorage Area close to the Milne Port (Figure 3).

The 53 unique ships were broken down by ASTD ship type. There were 35 unique *bulk carriers*, four unique *general cargo ships*, two unique *chemical tankers*, seven unique ships classified by ASTD as *other activities*, and five unique ships of *unknown* ASTD ship type (Table 2). Figure 4 subdivides the ship position data in 2022 in the Milne Inlet region by ASTD ship type. It is clear that only ASTD *bulk carriers* departed the NSR for the anchorages south of Imiliit in 2022 (Figure 4) and that *bulk carriers*, *general cargo ships* and *chemical tankers* all navigated carefully using the approved NSR. Some *other activities* ship traffic strayed from the approved NSR in the north end of Milne Inlet, but followed the NSR closely south of Imiliit (Figure 4). *Bulk carriers* were responsible for more than 50% of the total hours and more than 70% of the total kilometers sailed in the region (Figure 5), while the second most hours and kilometers were sailed by the ASTD *other activities* ship type.

When ASTD *other activities* ship type traffic is more finely characterized using the IHS Fairplay/Lloyd's Level-5 ship types, five different Level-5 ship types emerge: *tugs*, *research survey vessels*, *yachts*, *icebreakers*, and *patrol vessels* (Figure 6, Table 3). *Tug* traffic is concentrated in the vicinity of the Milne Inlet Port (Figure 6) and, as a result, *tugs* accounted for more than 80% of the *other activities* hours and more than 25% of the total ship-hours in Milne Inlet (Figure 7). *Icebreaker* traffic accounted for nearly the rest of the *other activities* ship traffic in 2022, and about 5% of the ship-hours in the region (Figure 7). Two *yachts* were present in the region in from 1-3 August 2022 (Figure 6), the *Pursuit*, a 51-m, 493 GT luxury vessel, and the 50-m *Legacy* (< 1000 GT). A *Research Survey Vessel* (the *Nansen Explorer* (71-m, 1859 GT) sailing under the Norwegian flag was also present in the region in 2022 (Figure 6, Table 3). Upon investigation of the use of that vessel, *Nansen Explorer* appears to have been converted to a luxury cruise vessel, highlighting the importance of the ancillary data (in this case the Maritime Mobile Service Identity (MMSI)) in the PAME ASTD level 1 files which allows for accurate portrayal of ship traffic. One icebreaker, *Botnica*, (97-m, 6370 GT) was present in the study region in 2022 (Figure 6, Table 3) from 13 August to 13 October. *Botnica* is owned by the Port of Tallinn and flagged in Estonia, and operated under a charter agreement with Baffinland Iron Mines Corporation to escort other vessels from Milne Inlet Port to the open sea. Finally, one *patrol vessel*, Canadian warship *HMCS Margaret Brooke*, a Harry DeWolf-class Arctic offshore patrol vessel, was present in the north end of Milne Inlet in 2022 (Figure 6, Table 3) on 19 and 22 August.

Although there were five vessels of *unknown* ASTD ship type in the region in 2022, the PAME ASTD level-1 data contains detail like MMSI numbers which are useful in determining the ships that made up this particular type of traffic. For example, using the MMSI numbers provided in the ASTD, we can reliably

indicate that several small *tugs*, namely *Arctique Polaire, Eclipse Polaire,* and *Magie Polaire* transmitted AIS data upon deployment in close proximity to the freight dock by Desgagnés Transarctik *general cargo* ships. These *tugs* are approximately 11 m in length and are off-loaded by their *general cargo* motherships along with barges and even front-end loaders to transfer freight to shore ramps during northern sealift operations. The *unknown* ship type also included another Canadian warship, the Kingston-class coastal defense vessel *HMCS Goose Bay* in Milne Inlet on 22-23 Aug 2022, identified using ancillary information in the PAME ASTD. *Tugs Ocean Tundra* and *Ocean Taiga* were among the last vessels to leave Milne Inlet, with the *icebreaker Botnica* and the *bulk carrier Flag Mette* sailing out of the study region on 13 October 2022 to end the 2022 shipping season.

3.2 Ship Traffic in 2023

In 2023, 52 unique ships sailed within the bounds of the Milne Inlet study region over 13887 hours, covering a total of 21922 km (Figure 8, Table 4), an increase of 955 hours and 5673 km compared to 2022 using one less unique ship. The shipping season began on 10 August 2023 when *tugs Ocean Tundra*, *Ocean Taiga* and the *Claude A. Desgagnes* (the only *general cargo* ship to visit the region in 2023) navigated into Milne Inlet. Almost all ship positions in the region in 2023 followed the approved NSR closely, with the exception of a small number of positions in Tremblay Sound west of Milne Inlet, and in Milne Inlet west of the NSR (Figure 8). Again, there were significant aggregations of ship positions around Canadian Anchorage Areas at Imiliit and Milne Inlet Port in 2023.

The 52 unique ships were broken down by ASTD ship type. There were 39 unique *bulk carriers*, one *general cargo ship*, three unique *chemical tankers*, seven unique ships classified by ASTD as *other activities*, and two ships of *unknown* type (Table 4). The positions of these ships by ASTD type in the Milne Inlet region in 2023 are shown in Figure 9. It is clear from these maps that only the ASTD *other activities* ship type strayed from the approved NSR in 2023, whereas *bulk carriers*, *chemical tankers*, and the *general cargo ship* navigated carefully along the NSR (Figure 9). Note the ASTD *unknown* ship type positions at the Milne Inlet Port (Figure 9). Using the MMSI numbers and other data contained within the ASTD, these two *unknown* ships were both identified as small (<11 m *tugs*) named *Nuit Polaire* and *Siku*. These lighters were associated in time and space with Desgagnés Transarctik *general cargo* and *chemical tanker* ships in close proximity to the Milne freight dock in mid-August 2023. *Bulk carriers* were responsible for about 50% of the total hours and almost 70% of the total kilometers sailed in the region, while nearly all the remaining hours (approximately 40%) and kilometers (more than 20%) were sailed by the ASTD *other activities* ship type in 2023 (Figure 10).

When the 2023 ASTD *other activities* ship type traffic was more finely characterized using the IHS Fairplay/Lloyd's Level-5 ship types, three different Level-5 ship types emerge: *tugs*, *icebreakers*, and *patrol vessels* (Figure 11, Table 5). The *patrol vessel* traffic (*HMCS Harry DeWolf*) sailed briefly into Tremblay Sound west of Milne Inlet, and in Milne Inlet west of the NSR while navigating Milne Inlet (Figure 11, Table 5) on 12-13 September 2023. As was the case in 2022, the *tugs* sailed the bulk of the *other activities* hours covering relatively few kilometers, while the *icebreakers* covered the most *other activities* kilometers in relatively few hours (Table 5). The *tug* traffic used the NSR, and so did the *icebreaker* traffic with the exception of some deviations at the mouth of Milne Inlet and in the area of the Imiliit anchorages (Figure 11). *Icebreakers CCGS Pierre Radisson* visited the north end of Milne Inlet and the northern Imiliit anchorage area from 11-13 August 2023, and *CCGS Des Groseilliers* sailed in the same area between 18-20 August 2023. *Botnica* and *Fennica,* a Finnish-flagged icebreaker (116-m, 9392 GT) operated by Artia Offshore Limited, were responsible for the remaining *icebreaker* ship traffic in Milne Inlet at the Milne Inlet Port and within the NSR in 2023. *Botnica* entered Milne Inlet on 26 September 2023, exiting on 31 October 2023 at the end of the shipping season. *Fennica* was also under contract with Baffinland Iron Mines Corporation in 2023 to assist safe navigation to and from the Milne Port. *Fennica* first entered Milne Inlet on 1 October 2023, and left at the end of the 2023 shipping season on 31 October. As in 2022, and owing to their differing responsibilities, *tug* traffic was responsible for most of the *other activities* hours and nearly 30% of the total all ship-hours in Milne Inlet in 2023. Conversely, *icebreaker* traffic was responsible for most of the *other activities* kilometers and 15% of the total all ship-kilometers in Milne Inlet in 2023 (Figure 12).

3.3 Ship Traffic in 2024

In 2024, 52 unique ships sailed the Milne Inlet study region covering 22594 kilometers over 15289 hours (Figure 13, Table 6), representing increases of 1402 hours and 672 kilometers compared to 2023, and year-over-year increases since 2022. The shipping season began on 27 July 2024 when *Ocean Tundra* and *Ocean Taiga* entered Milne Inlet, followed on 28 July by *bulk carriers Nordic Sannguuq*, *Nordic Oasis*, and *Nordic Olympic* (possibly in convoy) which proceeded directly to Milne Inlet Port using the NSR. Ship traffic in 2024 followed the NSR with the exception of those ships sailing in and out of the anchorages south of Imiliit and at Milne Port (Figure 13). There were 39 unique *bulk carriers*, two unique *general cargo ships*, two unique *chemical tankers*, one *offshore supply ship*, five unique ships classified by ASTD as *other activities*, and three unique ships of *unknown* type (Table 6). The positions of these ASTD ship types are shown in Figure 14, indicating that the *bulk carriers* were the only ASTD ship type to visit the Imiliit

anchorages, while the *general cargo ships*, *offshore supply ship*, and *chemical tankers* sailed directly south to the Milne Inlet Port area. The *offshore supply ship*, *CCGS Jean Goodwill*, is an icebreaking anchor handling tug supply vessel (AHTS) (83-m, 6872 GT) which sailed in Milne Inlet on 13-14 August 2024 without closely following the NSR (Figure 14). As in 2022 and 2023, the *unknown* ASTD type vessel positions were in the area of the Milne Inlet Port (Figure 14), specifically near the freight dock. The ASTD indicates that the *unknown* ship type was composed of the *Beluga Polaire*, *Siku*, and *Glacier Polaire*, all <11 m tugs associated in time and space with Desgagnés Transarctik *chemical tankers* and *general cargo ships* offloading in August and October 2024. It is likely these *tugs* were deployed by motherships to aid in the offload of cargo to the Milne freight dock. ASTD *Bulk carriers* were responsible for nearly 50% of all ship-hours, and nearly 70% of all ship-kilometers in 2024. ASTD *other activities* accounted for nearly all the remaining ship-hours, while ASTD *unknown* and other activities ship types accounted for nearly all the remaining ship-kilometers in the Milne Inlet study area (Figure 15).

When the 2024 ASTD *other activities* ship type traffic was more finely characterized using the IHS Fairplay/Lloyd's Level-5 ship types, three different Level-5 ship types emerge in the 2024 data: *tug*, *icebreaker*, and *research icebreaker* (Figure 16, Table 7). The *icebreakers* were *Botnica* (1-26 October 2024) and *Fennica* (1-26 October 2024), while *research icebreaker CCGS Amundsen* sailed briefly into Milne Inlet (Figure 16, Table 7) on 28-29 September 2024. The three *icebreakers* were responsible for 60% of the *other activities* ship-hours, with the remaining other activities ship-hours sailed by *tugs* (Figure 17). *Tugs* were responsible for 80% of the *other activities* ship-kilometers in the region in 2024, with the three *icebreakers* responsible for the rest (Figure 17). *Tug* traffic composed nearly 30% of all ship-hours in the region in 2024 while the three *icebreakers* made up about 10% of all ship-hours and all ship-kilometers (Figure 17).

3.4 Imiliit Anchorage Areas

Close inspection of the PAME ASTD Level-1 AIS data in 2022-2024 indicates that ships in Milne Inlet may deviate from the approved NSR to visit the CHS Anchorage Area south of Imiliit. This is also illustrated specifically by the spatial traffic data for *bulk carriers* (Figures 4, 9, 14), and to a lesser extent *icebreakers* (Figures 6, 11). The ASTD data indicate that *bulk carriers* visit the Imiliit Anchorage Area prior to navigating south to the Milne Port, and not when they are sailing out of Milne Inlet bound for Baffin Bay. Visual inspection of the AIS locations in the north end of Milne Inlet show three groups of points south of Imiliit, in the immediate vicinity of the CHS Canadian Anchorage Area there (Figure 1, Table 1). The ASTD Level-1 data from 2022-2024 indicate that *bulk carrier* ship traffic in the area of the Imiliit anchorage may select

one of three distinct areas (Figure 18) to wait before sailing south to the Milne inlet Port. This is congruent with the project license that indicates a maximum of three ships can be moored south of Imiliit at any one time.

3.4.1 Imiliit Anchorage Area Bulk Carrier Visitation

Using only the relatively motionless (distance-to-next-point < 100 m) *bulk carrier* positions in 2022, 2023, and 2024, the ASTD Level-1 AIS data were used to determine visit duration statistics at each of the three ship-selected areas south of Imiliit (Table 8). The *bulk carrier* visit timing for each of the three Imiliit areas in each year (Figure 19) generally elucidate the area usage, visit length, and visit overlaps in these three ship-selected areas at any given day during each of the three shipping seasons.

In the 2022-2024 aggregate ASTD data, Imiliit-1 saw total visitation of almost 74 bulk carrier-days over 46 visits (mean visit = 38.5 hours), accounting for 45% of the total bulk carrier-time in the three ship-selected Imiliit anchorage areas in the three years (Table 8). Imiliit-2 saw total visitation of more than 37 bulk carrier-days over 28 visits (mean visit = 32 hours), accounting for 23% of the total bulk carrier-time in one of the three ship-selected areas. Between 2022-2024, Imiliit-3 saw total visitation of more than 51 bulk carrier-days over 53 visits (mean visit = 23 hours), accounting for 32% of the total bulk carrier-time in one of the three ship-selected areas (Table 8). Imiliit-1 saw the most bulk carrier ship traffic, while Imiliit-2 saw the least (Table 8, Figure 19) between 2022-2024.

3.4.2 Imiliit Anchorage Area Bathymetry

The polygon encompassing Imiliit-1 is 143 ha and covers 10700 NONNA-10 bathymetric grid cells on the LCC grid which range in depth from -139 m to -35 m (mean = -78 m) (Table 9, Figure 20). Seventy five percent of the grids cells at Imiliit-1 are deeper than 57 m. The distribution of bathymetric depths at Imiliit-1 is roughly bimodal (shown by 5-m depth bins in Figure 20a), with one mode centered at -47.5 m, and a second mode centered at -82.5 m.

Imiliit-2 was the least occupied (Figure 19). Imiliit-2 is 121 ha covering 9036 NONNA-10 bathymetric grid cells on the LCC projection grid which range from -156 m to -37 m around a mean of -91 m (Table 9). 75% of the grid cells at Imiliit-2 are deeper than 68 m (Table 9). The bathymetric frequency distribution at Imiliit-2 (Figure 20b) indicates a mode around a 5-m bin centered on -82.5 m and the distribution is negatively skewed with a thick left tail (Figure 20b).

The polygon generated by point aggregation to encompass Imiliit-3 is 173 ha covering 12822 NONNA-10 grid cells on the LCC projection ranging from -205 m to -16 m (mean = -99 m) (Table 9, Figure 20c). 75% of the bathymetric grid cells at Imiliit-3 are deeper than 73 m (Table 9). The bathymetric frequency distribution at Imiliit-3 shows three modes centered on 5-m bins at -67.5 m, -92.5 m, -122.5 m (Figure 20c).

3.5 Milne Inlet Port

The Milne Inlet Port area is defined here as the area south of the southernmost waypoint (roughly located at 71.92°N, -80.82°E) in the approved NSR where vessels diverge in course southward to their respective target operation. The PAME ASTD ship traffic data for 2022, 2023, and 2024 indicate three main operations at the Milne Inlet Port (Figure 21): (i) *bulk carrier* anchorage visitation (see Table 1 for CHS Canadian Anchorage Area location) and ore dock operation, (ii) *chemical tanker* operations nearest the fuel farm east of the ore dock, and (iii) *general cargo ship* operations at the freight dock. Each of these operations are variably supported by *tugs*, *barges*, and *icebreakers*. Using all the ASTD AIS information for each ship position in the Milne Inlet Port area (extent shown in Figure 22) in 2022, 2023, and 2024, the percent of the total ship time in the area was calculated for each of five ship types (shown in Figure 22).

Bulk carriers made up almost half of the total ship time (44.5%) in the Milne Inlet Port area in 2022-2024, while *general cargo* ships made up 4.2% and *chemical tankers* made up 4.1% (Figure 22). *Tugs* and *icebreakers* supporting the *bulk carrier*, *chemical tanker* and *general cargo* operations made up 39% and 8.2% of the total ship time in the Milne Inlet Port in 2022-2024 respectively. Together, *bulk carriers* and *tugs* accounted for 83.5% of the ship time in the Milne Inlet Port area between 2022 and 2024 (Figure 22).

The Milne Inlet Port has received relatively few unique *chemical tankers*: two in 2022 (Table 2), three in 2023 (Table 4), and two in 2024 (Table 6). In all three years, the percent of the total hours and kilometers sailed by *chemical tankers* was very low (Figures 5, 10, 15). The ASTD ship positions indicate that *chemical tankers* navigating into the Milne Inlet Port area are either (i) sailing directly to positions nearshore (within approximately 600 m) the Milne Inlet Port tank farm for fuel offload by floating hose, or (ii) sailing to the southeast corner of the Milne Inlet Port area before sailing to positions nearshore the tank farm to offload fuel (Figure 22). Guidelines for the transfer of oil in Arctic waters are set out by Transport Canada (1997).

Milne Inlet Port received four unique *general cargo ships* in 2022 (Table 2), one unique *general cargo ship* in 2023 (Table 4), and two unique *general cargo* ships in 2024 (Table 6). In all three years, the percent of

the total hours and kilometers sailed by *general cargo* ships was very low (Figures 5, 10, 15). In the three years analyzed here, *general cargo ships* sailed into the Milne Inlet Port area directly to the southeastern corner nearest the freight ramp (Figures 21, 22). From there, cargo is offloaded at the freight ramp using lighters and *tugs* carried by the *general cargo* ship. Ship position data reveal that *icebreakers* often use the most southwestern corner of Milne Inlet Port area should they wish to remain relatively motionless (Figure 22), while *tugs* are largely spatially coincident with *bulk carrier*s (Figure 22).

3.5.1 Milne Inlet Port Anchorage Area Bulk Carrier Visitation

Using only the relatively motionless (distance-to-next-point < 100 m) *bulk carrier* positions in 2022, 2023, and 2024, the ASTD Level-1 AIS data were used to determine visit duration statistics (Table 10) for each of the three ship-selected areas at the Milne Inlet Port (Figure 23). Visit timing by relatively motionless *bulk carriers* for each of the three Milne Inlet Port areas in each year (Figure 24) generally elucidate the area usage, visit length, and visit overlaps in these three ship-selected areas at any given day during each of the three shipping seasons are presented here.

In the 2022-2024 aggregate ASTD data, Milne Inlet Port-1 saw total visitation of almost 139 bulk carrier-days over 93 visits (mean visit = 35.8 hours), accounting for 40% of the total bulk carrier-time in the three ship-selected Milne Inlet Port anchorages (Table 10). Milne Inlet Port-2 saw total visitation of more than 28 bulk carrier-days over 27 visits (mean visit = 25.5 hours), accounting for only 8% of the total bulk carrier-time in one of the three ship-selected areas at the Milne Inlet Port. Milne Inlet Port-3 saw total visitation of more than 178 bulk carrier-days over 132 visits (mean visit = 32 hours), accounting for 52% of the total bulk carrier-time across the three locations (Table 10). Milne Inlet Port-3 saw the most *bulk carrier* ship traffic, while Milne Inlet Port-2 saw the least (Table 10, Figure 24).

3.5.2 Milne Inlet Port Anchorage Area Bathymetry

The NONNA-10 bathymetry in each of the three polygons (Figure 23) were used to create bathymetric frequency distributions (Figure 25), and to produce summary statistics for the bathymetry in each area (Table 11).

The polygon encompassing Milne Inlet Port-1 is 93 ha on the sea surface and covers 7015 NONNA-10 bathymetric grid cells on the LCC grid, ranging from -109 m to -77 m (mean = -94.56 m) (Table 11, Figure 25). 75% of the bathymetric grids cells at Milne Inlet Port-1 are deeper than 89 m. The distribution of bathymetric depths at Milne Inlet Port-1 contains one mode centered on a 5-m bin at -92.5 m (Figure 25a).

Milne Inlet Port-2 is by far the least occupied in the three years studied (Table 10, Figure 24). Milne Inlet Port-2 is 97.7 ha covering 7307 NONNA-10 bathymetric grid cells on the LCC projection ranging from -111 m to -63 m around a mean of -91 m (Table 11). 75% of the grid cells at Milne Inlet Port-2 are deeper than 84 m (Table 11). The bathymetric frequency distribution at Milne Inlet Port-2 (Figure 25b) indicates a mode around a 5-m bin centered on -97.5 m and the distribution is positively skewed with a thick right tail, representative of shallower areas (Figure 25b).

The polygon encompassing Milne Inlet Port-3 is 97 ha, covering 7251 NONNA-10 grid cells on the LCC projection ranging from -90 m to -58 m (mean = -73.5 m) (Table 11, Figure 25c), making it the shallowest of the three ship-selected areas in Milne Inlet. 75% of the bathymetric grid cells at Milne Inlet Port-3 are deeper than 66 m (Table 11). The bathymetric frequency distribution at Milne Inlet Port-3 is centered on 5-m bin at -67.5 m and the distribution is negatively skewed (Figure 25c).

3.6 Anchorage Visit Case Studies

Arcs and circular features (e.g., Davis et al., 2016) in the PAME ASTD Level-1 AIS data are visible in the ship-selected areas in the vicinity of both the Imiliit and Milne Inlet Port Anchorage Areas (Figure 26). Example circles at both the Imiliit and Milne Inlet Port Anchorage Areas made by unique ships in one visit (highlighted in red, Figure 26) are further analyzed below.

Polygons created by point aggregation in ArcGIS Pro for two circular features in the ASTD Level-1 AIS data in Imiliit-2 and Milne Inlet Port-3 anchorage areas (Figure 26, in red) were then used to select all the underlying geographically co-located NONNA-10 bathymetric grid cells. The NONNA-10 bathymetry in each circular feature made by one ship in one visit were used to create bathymetric frequency distributions (Figures 27, 28), and to produce summary statistics for the bathymetry in each area (Table 12).

3.6.1 Circular Feature Example 1 - Imiliit

An example circular feature in the ship traffic database created by a single relatively motionless (distance-to-next-point < 100 m) bulk carrier (227 m, 36 m beam) spending four days (2024-09-22 to 2024-09-26) within the Imiliit-2 ship-selected anchorage area (Figure 26 (left)) was selected from 2024. A polygon was created from the individual ship positions in the example circular feature using the point aggregation method using the ArcPro GIS point aggregation method (Figure 27). This polygonal area at Imiliit-2 was 13.8 ha covering 1084 NONNA-10 grid cells on the LCC projection (Figure 27a). The depth at its centroid was 81.85 m. The underlying NONNA-10 bathymetric grid cells range from -99 m to -61 m (mean = -80.85

m) (Table 12, Figure 27b). 75% of these NONNA-10 grids cells selected by this example circular feature in the AIS data are deeper than 75 m. The distribution of bathymetric depths (bin size = 0.5m) reflects the trimodal nature of the bathymetry (Figure 27a), with modes at -98.25m, -78.75m, and -64.25m (Figure 27b).

3.6.2 Circular Feature Example 2 – Milne Inlet Port

An example circular feature in the ship traffic database created by a single relatively motionless (distance-to-next-point < 100 m) bulk carrier (225 m, 32.3 m beam) spending one and a half days (2024-09-14 to 2024-09-15) within the Milne Inlet Port-3 ship-selected anchorage area (Figure 26 (right)) was selected from 2024. The polygonal area covered by this example circle of ship positions at Milne Inlet Port-3 was 11 ha covering 875 NONNA-10 grid cells on the LCC projection (Figure 28a). The depth at its centroid was 73.87 m. The underlying NONNA-10 bathymetric grid cells range from -79 m to -68 m (mean = -73.89 m) (Table 12, Figure 28b). 75% of the grids cells under this example circular feature in the AIS data created by a single ship over a single visit are deeper than 71.7 m. The distribution of bathymetric depths (bin size = 0.5 m) reflects the lower range of values contained within the polygon (Figure 28b). The most common bathymetric depth in this circular feature is -76.75 m (Figure 28b).

4. Conclusions

An analysis of ship traffic in Milne Inlet in Canada's eastern Arctic in 2022, 2023, and 2024 has been undertaken to improve knowledge and understanding of shipping in the region for the purposes of preparedness and response by the Integrated Marine Response Plan (IMRP) program at DFO-Science, Arctic Region. The Milne Inlet study region saw an increase in the number of kilometers and hours sailed in each year from 2022-2024.

Ship traffic in Milne Inlet was mostly composed of *bulk carriers*. *Tug* and *icebreaker* traffic made up the majority of the rest of the traffic, interspersed with *general cargo* ships and *chemical tankers*. The ship traffic in Milne Inlet was almost completely restricted to the approved NSR with few exceptions. B*ulk carrier* traffic deviated to the CHS anchorage area south of Imiliit on the way to the Milne Inlet Port.

Ships, principally *bulk carriers*, may choose to sail to one of three ship-selected anchorage areas south of Imiliit where they may remain relatively motionless before proceeding south to the Milne Inlet Port. The amount of time spent at one of these three ship-selected Imiliit areas is variable and up to three ships may be present at any given time (one in each of the ship-selected areas). The individual visitation duration range was 0.9 to 180 hours, and the Imiliit areas saw visitation of more than 162 bulk carrier-days in 2022,

2023, and 2024 combined. Imiliit-1 saw the most bulk carrier visitation. The ship-selected anchorage areas south of Imiliit ranged from 126 to 180 hectares on the ocean surface, and had mean depths of 78 m, 91 m, and 95 m within a total bathymetric range of -205 m to -16 m. Circular features (arcs, circles) are visible within the AIS ship locations in the Imiliit ship-selected anchorage areas. Areal and bathymetric statistics for one complete circular polygon made by a *bulk carrier* at Imiliit-2 are presented.

In the Milne Inlet Port area, the AIS data indicate three main operations: (i) *bulk carriers* visiting the ore dock, (ii) *chemical tankers* visiting the tank farm, and (iii) *general cargo* ships visiting the freight ramp, all variably supported by *tugs* and *icebreakers*. More than 85% of the total time spent by ships in the Milne Inlet Port area was composed of *bulk carrier* and *tug* traffic. *General cargo* ships and *chemical tankers* each accounted for about 4% of the total ship time in the area, and *icebreakers* accounted for 8% of the total ship time in the area.

Individual visitation durations at the Milne Inlet Port ship-selected anchorage area ranged from 0.4 to 206 hours. The Milne Inlet Port areas saw visitation of more than 345 bulk carrier-days in 2022, 2023, and 2024 combined, with Milne Inlet Port-3 seeing 52% of that *bulk carrier* visitation. The ship-selected anchorage areas at Milne Inlet Port were 93 or 97 ha on the ocean surface, and had mean depths of 95.5 m, 91.29 m, and 73.5 m within a total bathymetric range of -110 m to -57.8 m. Circular features (arcs, circles) are visible within the AIS ship locations in the Milne Inlet Port ship-selected anchorage areas. Areal and bathymetric statistics for one complete circular polygon made by a *bulk carrier* at Milne Inlet Port-3 are presented.

The exercise of creating this report has improved our basic understanding of shipping in the Milne Inlet area for the purpose of Integrated Marine Response Planning under the Oceans Protection Plan (2.0). We also suggest that this methodological framework be applied to assess ship traffic and anchorage use at other Arctic port facilities.

5. Acknowledgements

We acknowledge Hjalti Hreinsson at the PAME Secretariat for providing access to their high quality AIS dataset for the Arctic region. We acknowledge Reddit user Viscount1881 for providing the photo of the Milne Inlet port in Figure 21 (top panel). We are grateful to Andy Majewski and Tonya Burgers for their comprehensive, constructive, and thoughtful reviews of this work. This work Is a contribution of the Integrated Marine Response Planning Program, Department of Fisheries and Oceans, Science sector.

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7. Figures

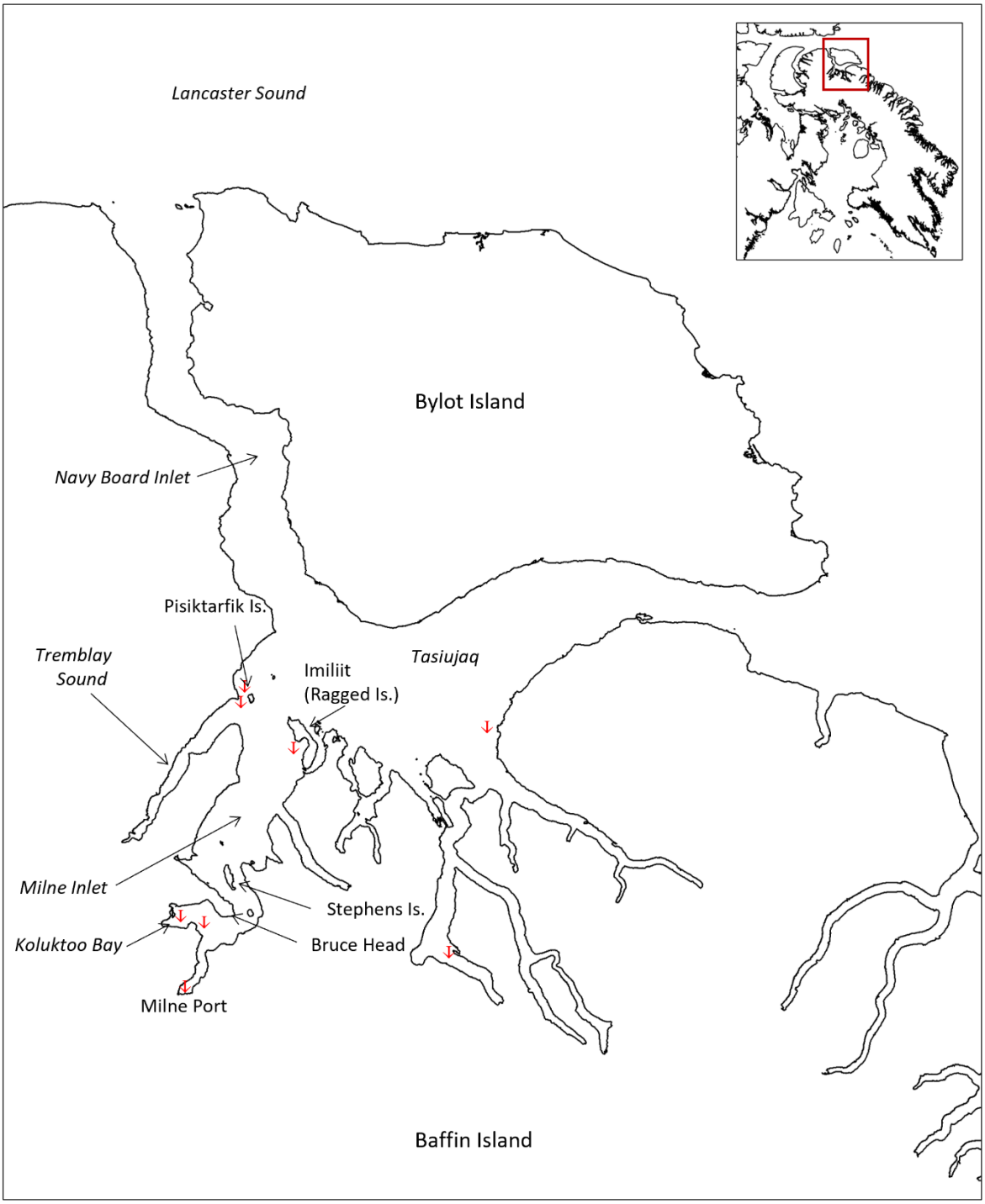


Figure 1: Milne Inlet in northeastern Baffin Island geographically situated at the south end of Navy Board Inlet and the west end of Tasiujaq (Eclipse Sound). Canadian Anchorage Area locations denoted by ↓. (Inset) Canadian eastern Arctic coastline map including Baffin Island and Milne Inlet (red square).

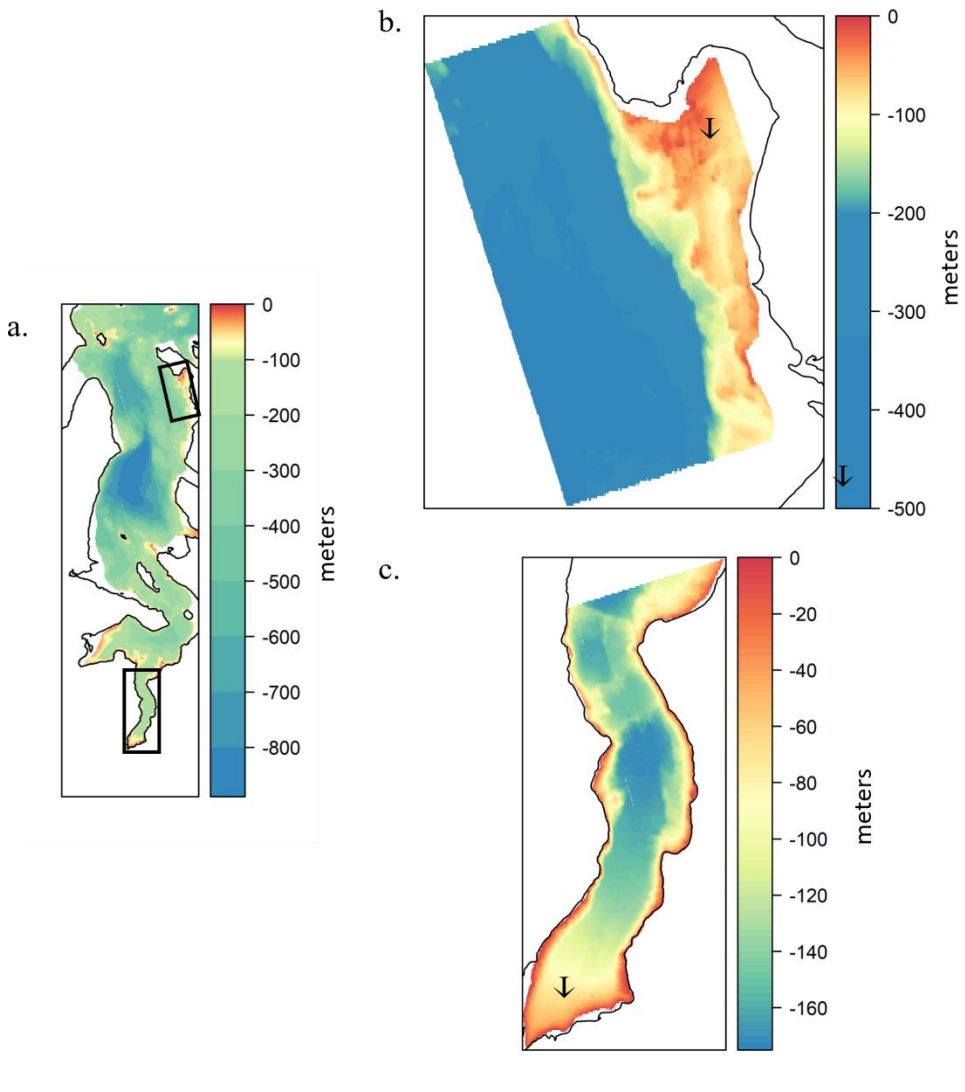


Figure 2: Canadian Hydrographic Service NON-NAvigational (NONNA) bathymetry data (10-m resolution) in meters in (a) Milne Inlet, (b) at the Canadian Anchorage Area (↓) south of Imiliit, and (c) in the far south reaches of the inlet and the Milne Inlet Port. Note variation in the bathymetric range (in meters) for each panel.

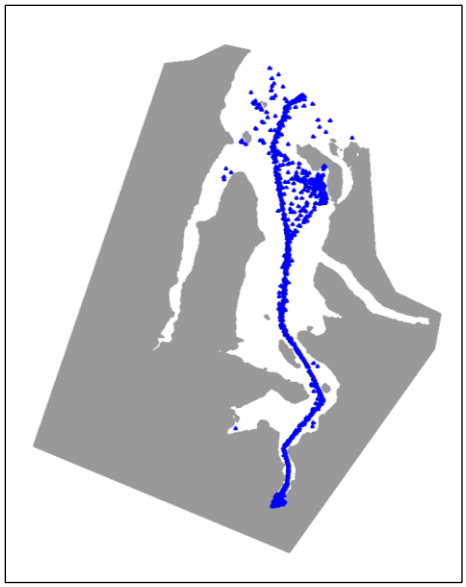


Figure 3: Ship positions from the ASTD level-1 data in the Milne Inlet study area in 2022.

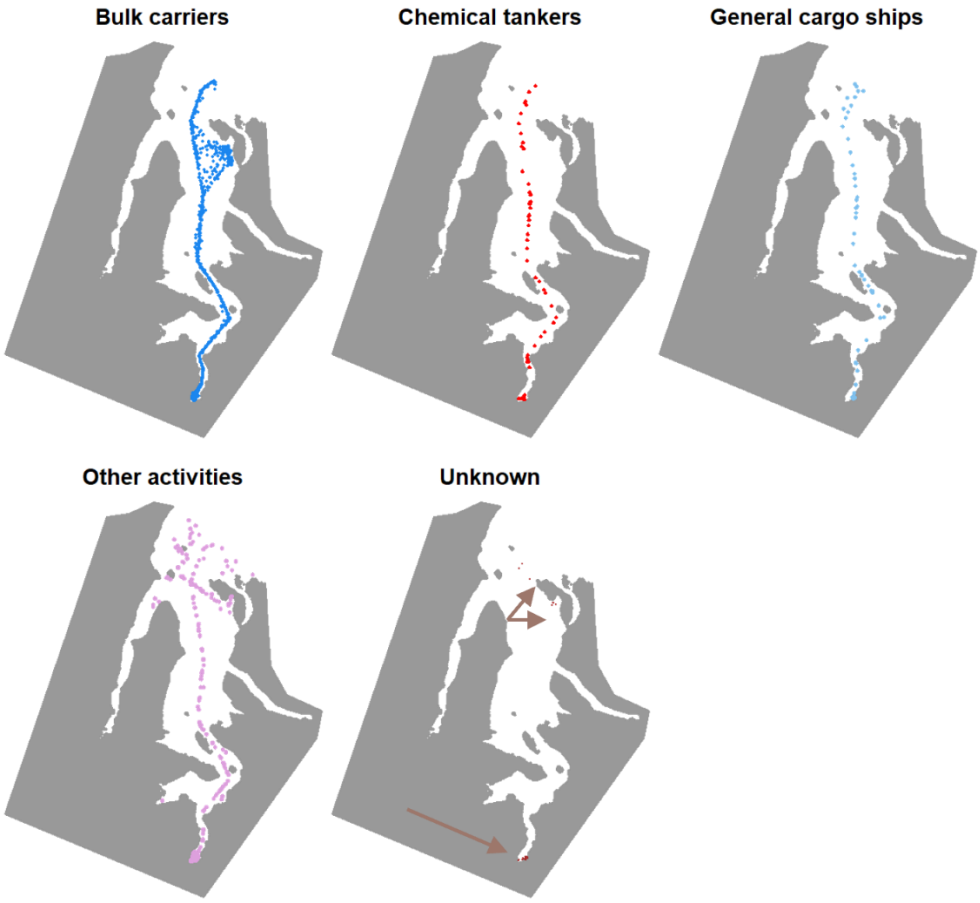


Figure 4: Ship positions from the ASTD Level-1 data in the Milne Inlet study area in 2022 subdivided by individual ASTD ship types.

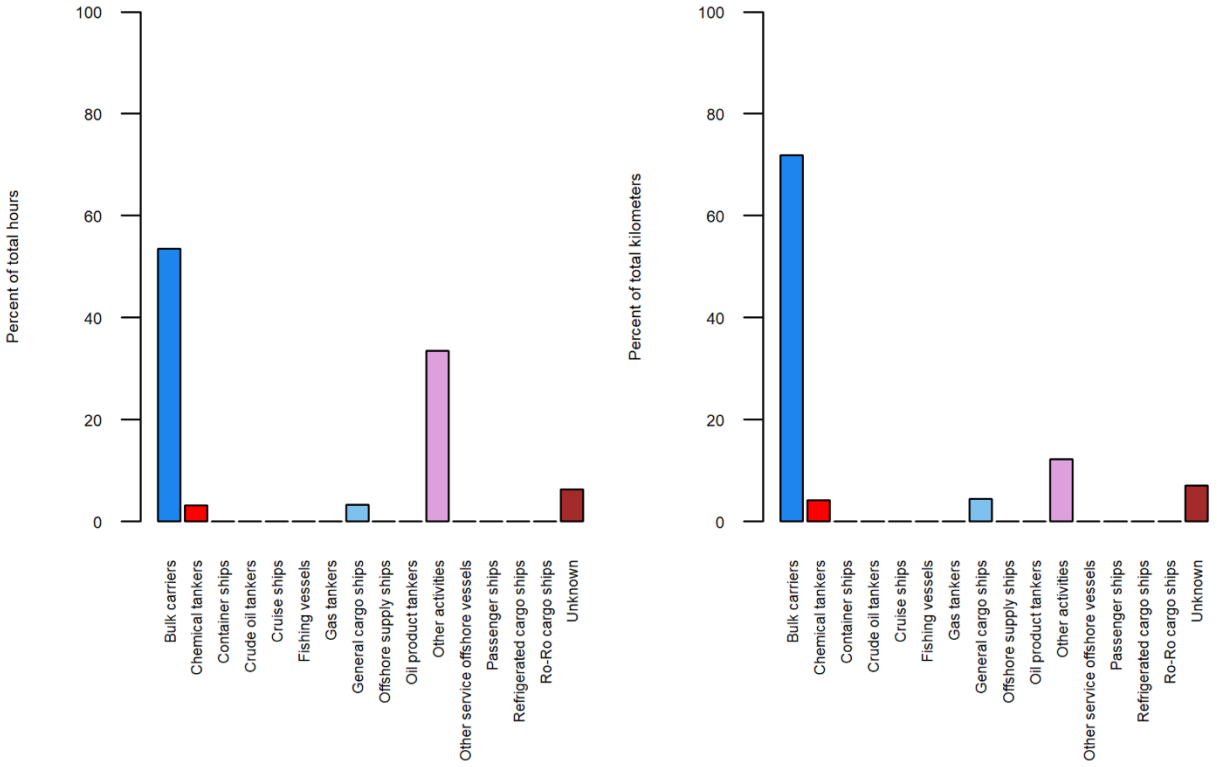


Figure 5: Percent of the total hours (left panel) and total kilometers (right panel) sailed by each ASTD ship type in the Milne Inlet study area in 2022.

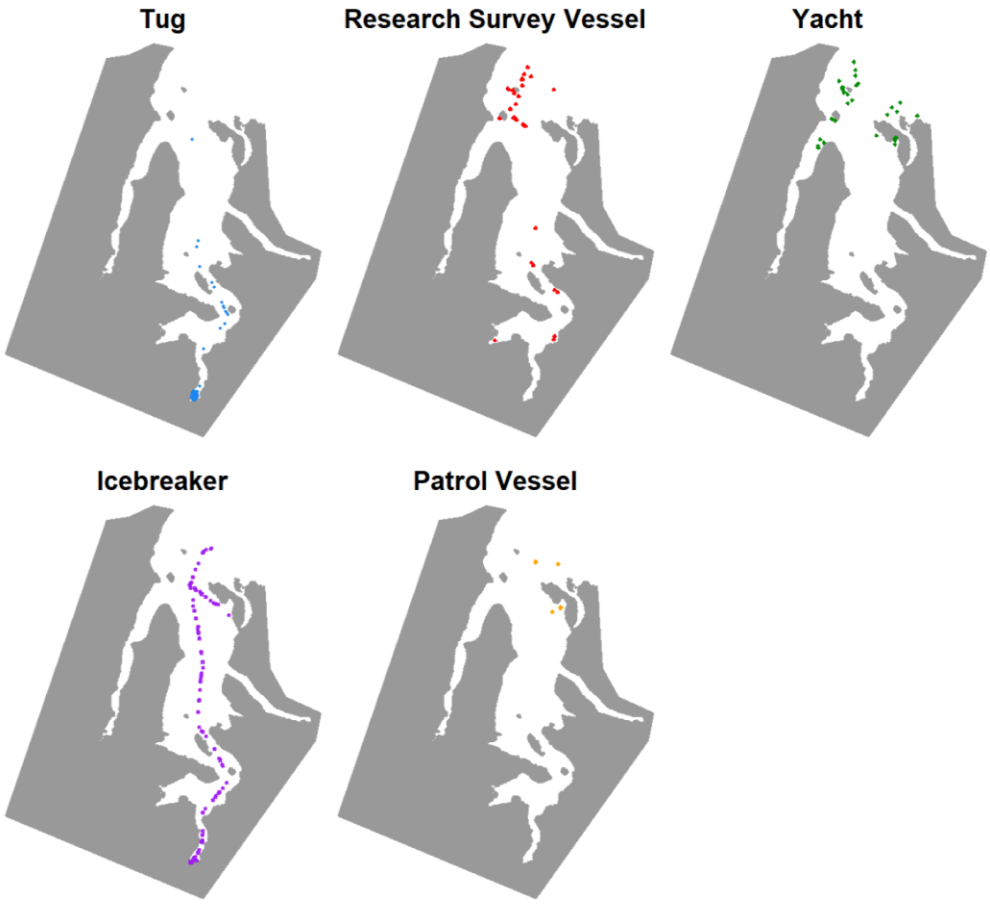


Figure 6: ASTD “Other Activities” ship positions from the ASTD Level-1 data in the Milne Inlet study area in 2022 subdivided by individual Lloyd’s category 5 ship types.

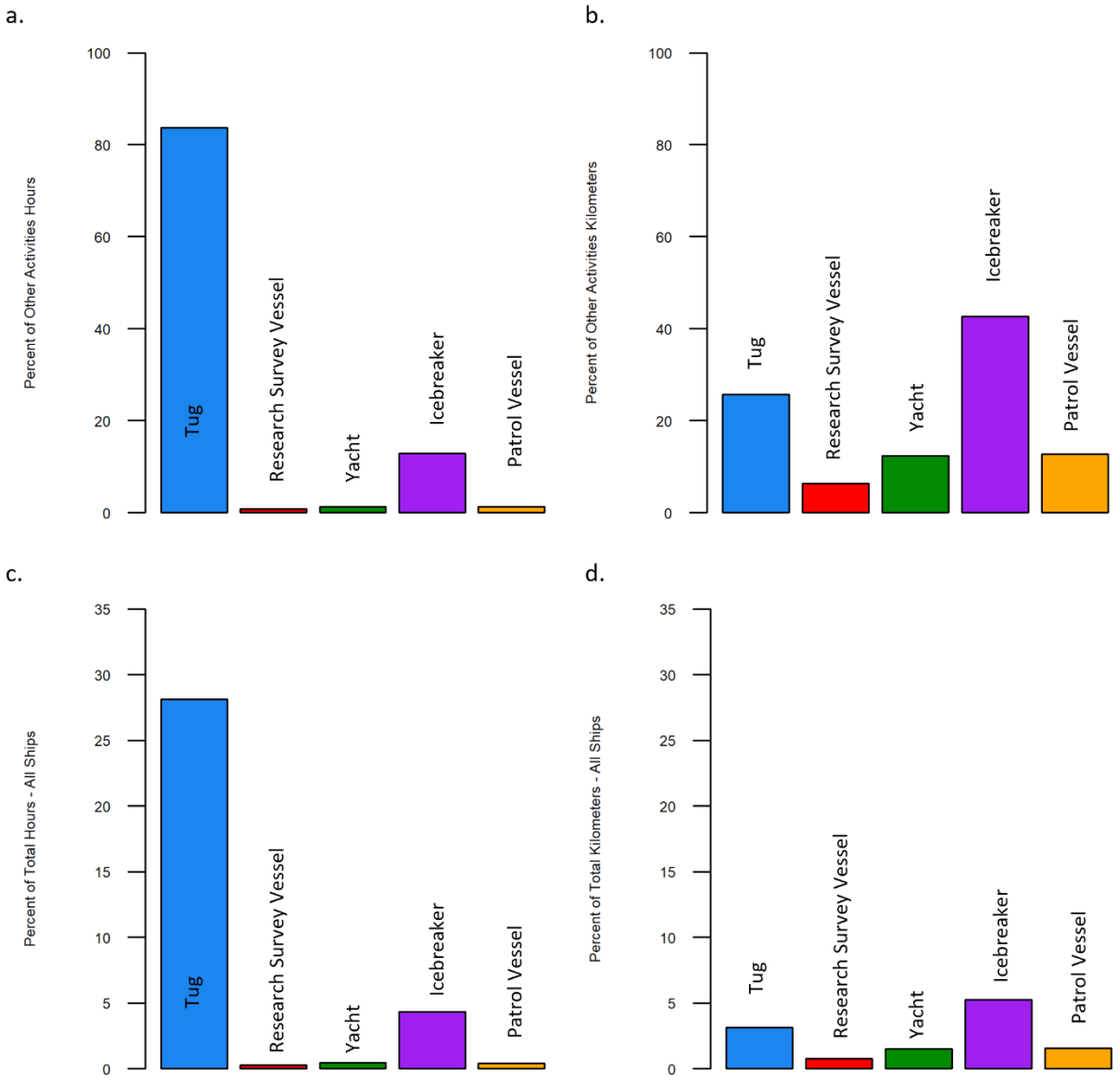


Figure 7: Percent of the ASTD "Other Activities" ship type (a) hours, (b) kilometers sailed by each Lloyd's category 5 ship type in the study area in 2022; Percent of the total ship (c) hours, (d) kilometers sailed by each Lloyd's category 5 ship type in the study area in 2022.

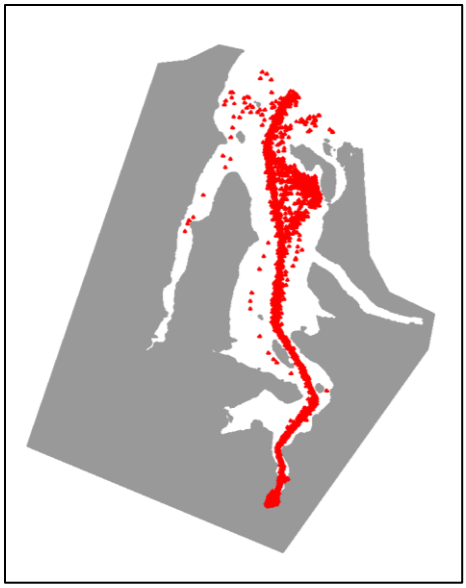


Figure 8: Ship positions from the ASTD level-1 data in the Milne Inlet study area in 2023.

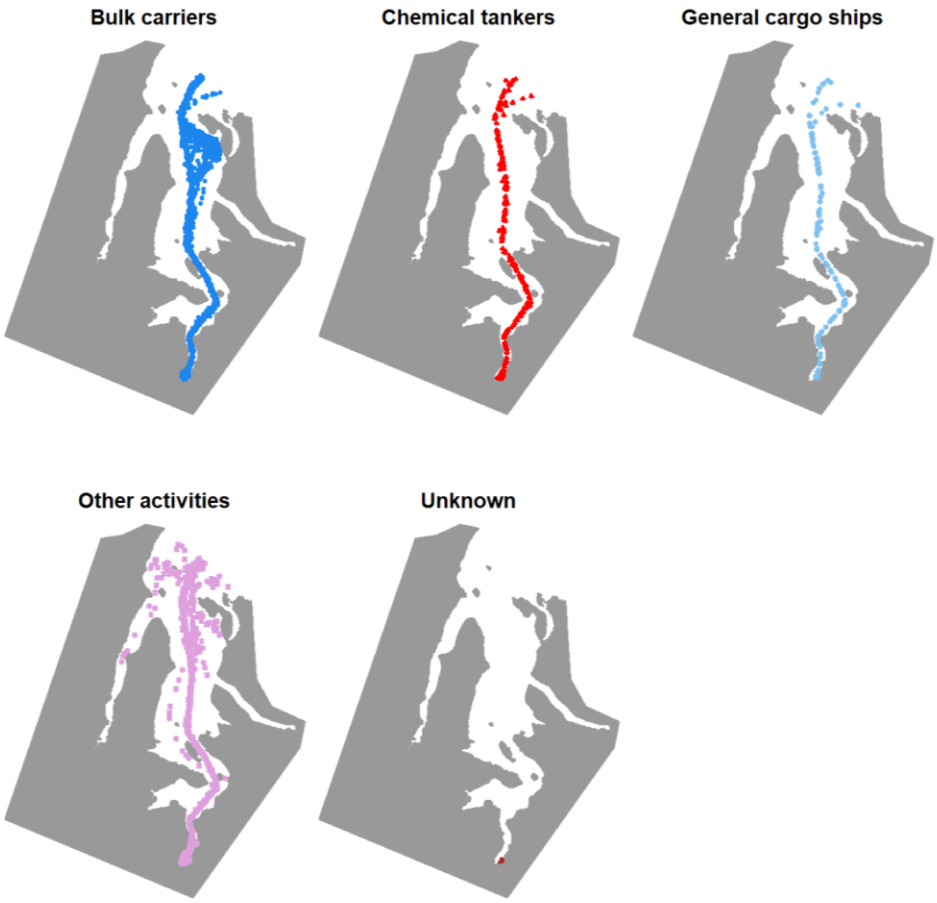


Figure 9: Ship positions from the ASTD Level-1 data in the Milne Inlet study area in 2023 subdivided by individual ASTD ship types.

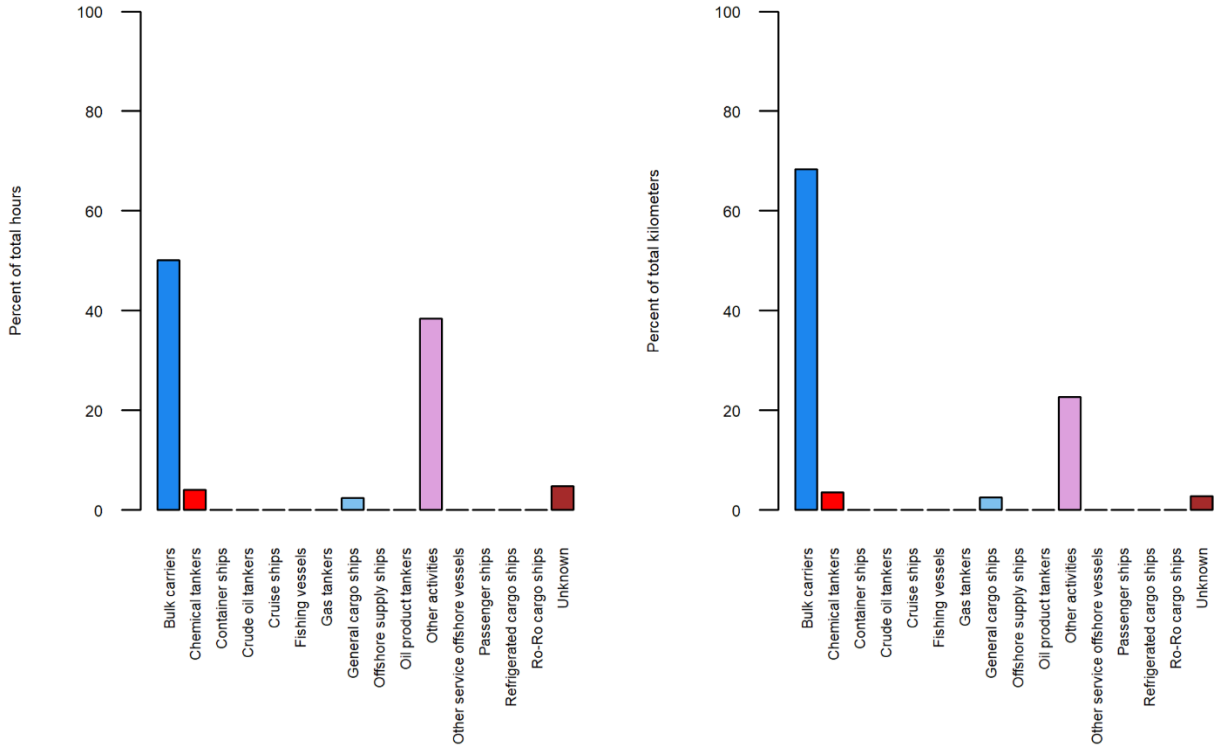


Figure 10: Percent of the total hours (left panel) and total kilometers (right panel) sailed by each ASTD ship type in the Milne Inlet study area in 2023.

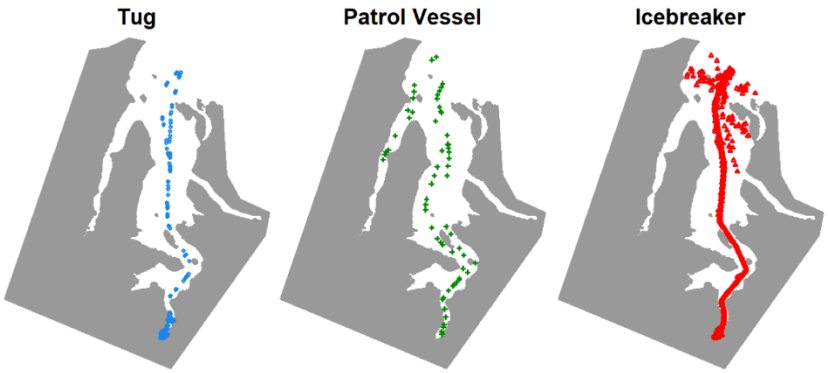


Figure 11: ASTD “Other Activities” ship positions from the ASTD Level-1 data in the Milne Inlet study area in 2023 subdivided by individual Lloyd’s category 5 ship types.

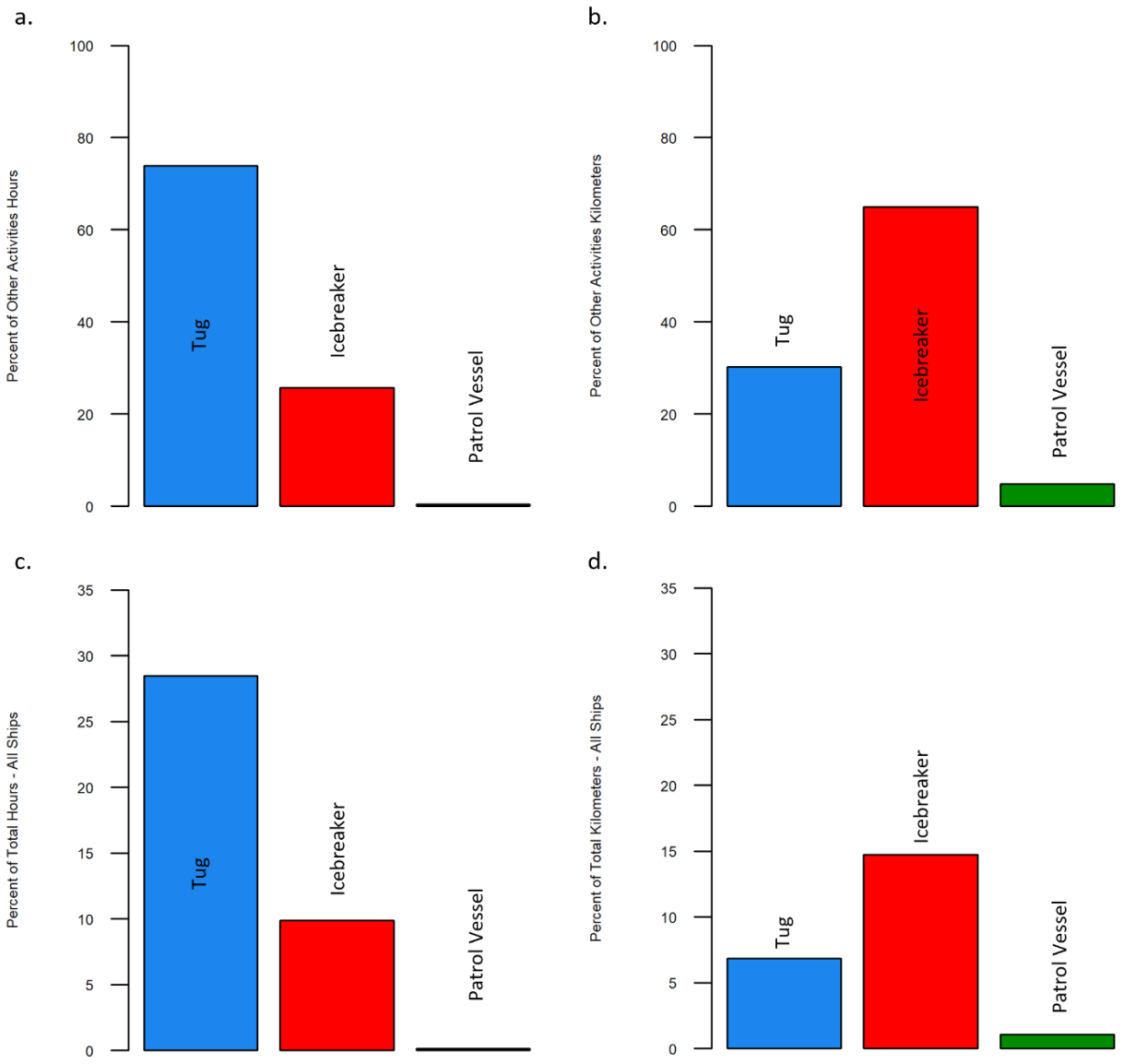


Figure 12: Percent of the ASTD “Other Activities” ship type (a) hours, (b) kilometers sailed by each Lloyd’s category 5 ship type in the study area in 2023; Percent of the total ship (c) hours, (d) kilometers sailed by each Lloyd’s category 5 ship type in the study area in 2023.

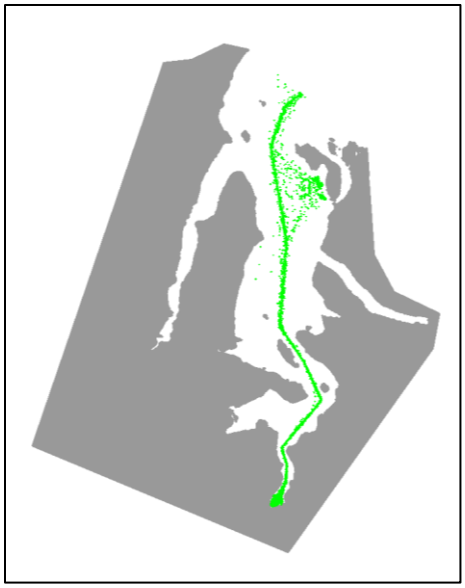


Figure 13: Ship positions from the ASTD level-1 data in the Milne Inlet study area in 2024.

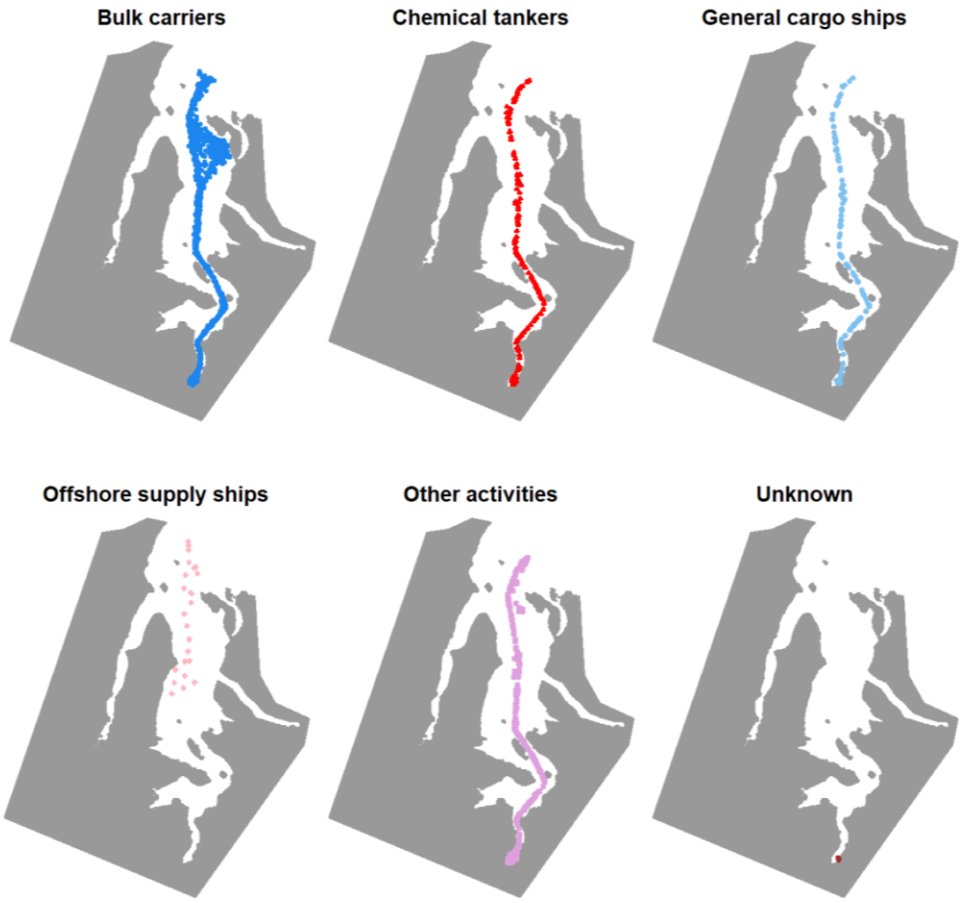


Figure 14: Ship positions from the ASTD Level-1 data in the Milne Inlet study area in 2024 subdivided by individual ASTD ship types.

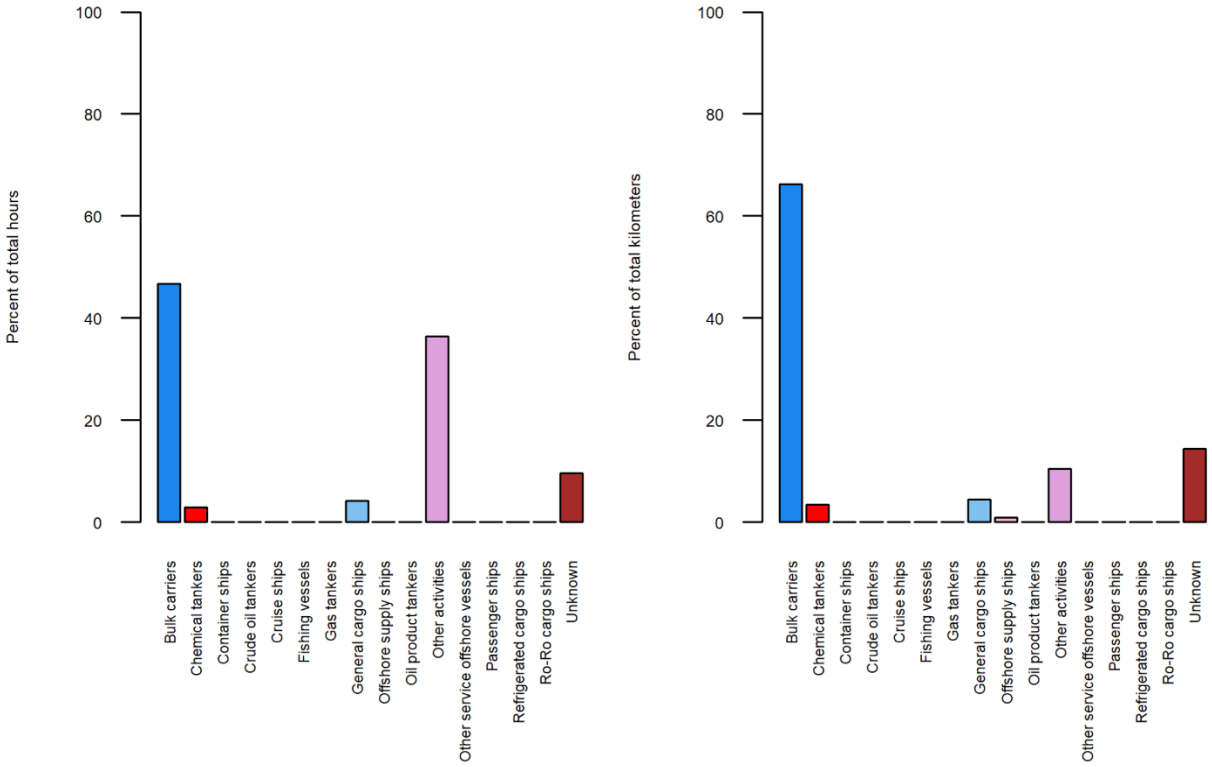


Figure 15: Percent of the total hours (left panel) and total kilometers (right panel) sailed by each ASTD ship type in the Milne Inlet study area in 2024.

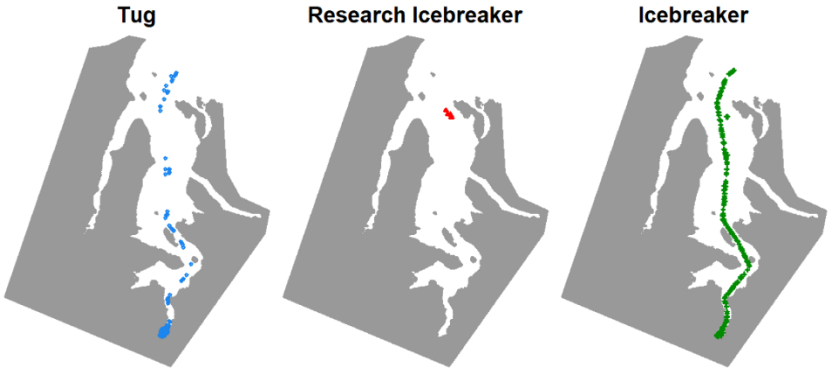


Figure 16: ASTD “Other Activities” ship positions from the ASTD Level-1 data in the Milne Inlet study area in 2024 subdivided by individual Lloyd’s category 5 ship types.

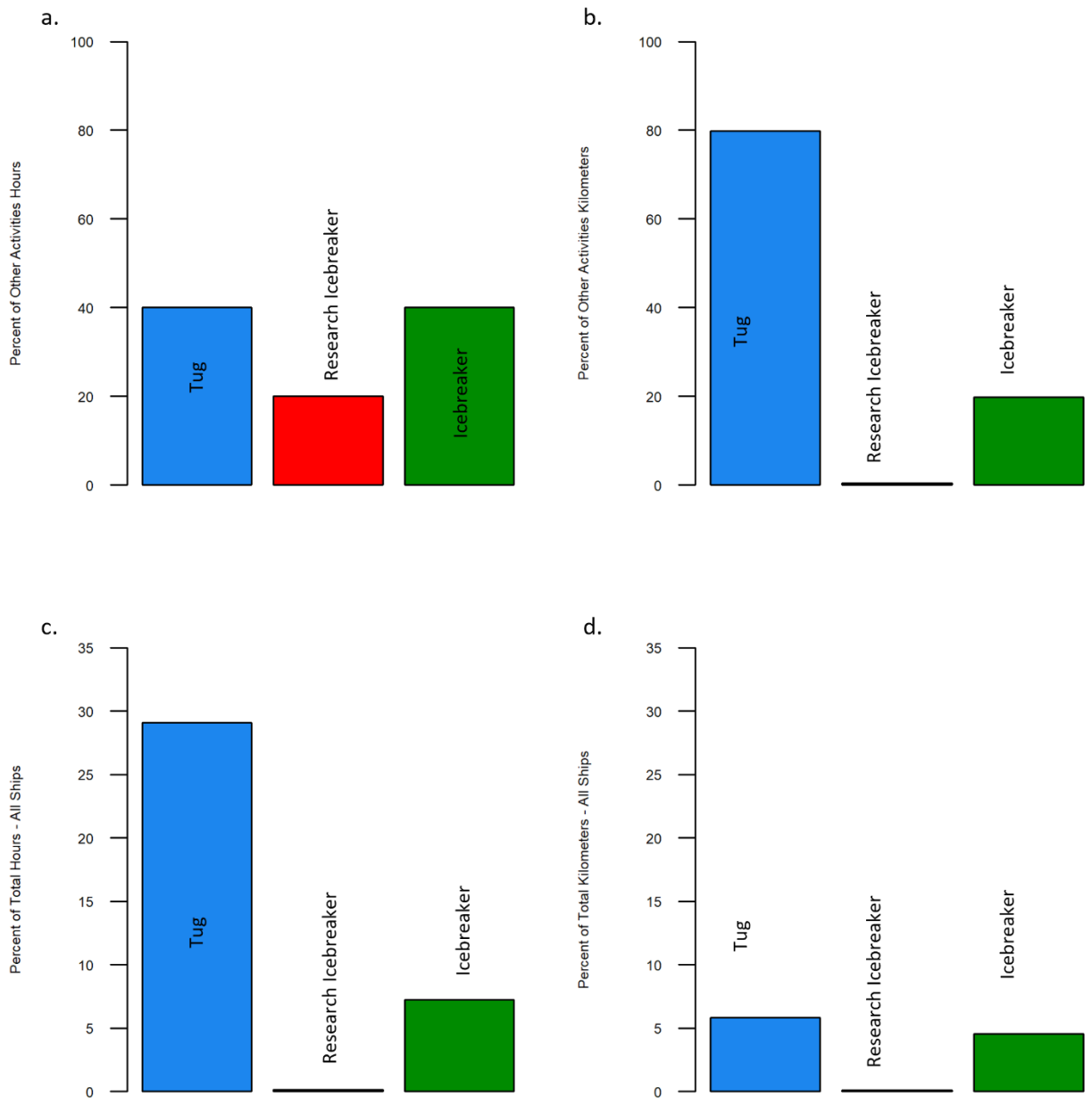


Figure 17: Percent of the ASTD “Other Activities” ship type (a) hours, (b) kilometers sailed by each Lloyd’s category 5 ship type in the study area in 2024; Percent of the total ship (c) hours, (d) kilometers sailed by each Lloyd’s category 5 ship type in the study area in 2024.

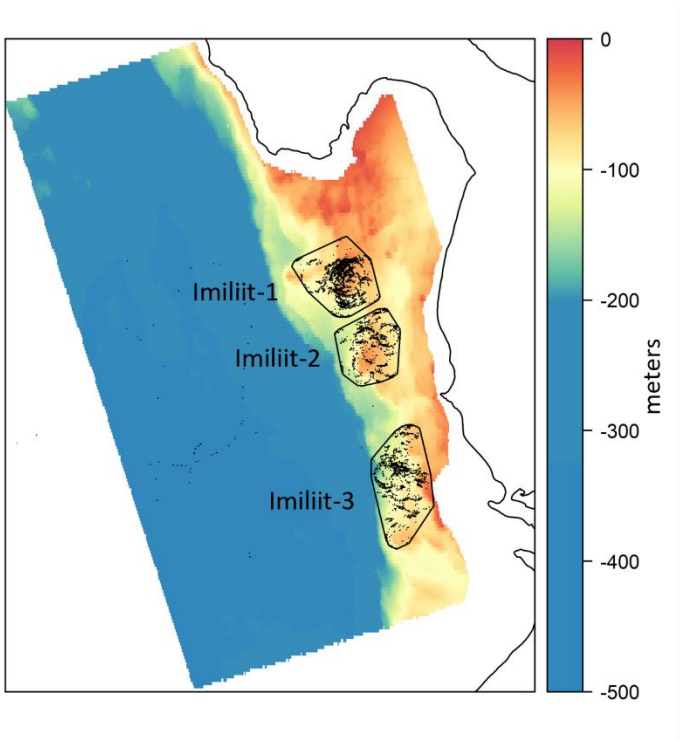


Figure 18: Ship-selected areas where relatively motionless bulk carrier AIS locations (black points) occur south of Imiliit near the Imiliit Canadian Anchorage Area. Polygons (black lines) generated by point aggregation in ArcGIS Pro around each of the three ship-selected areas, both overlaid on NONNA-10 bathymetric data (in meters).

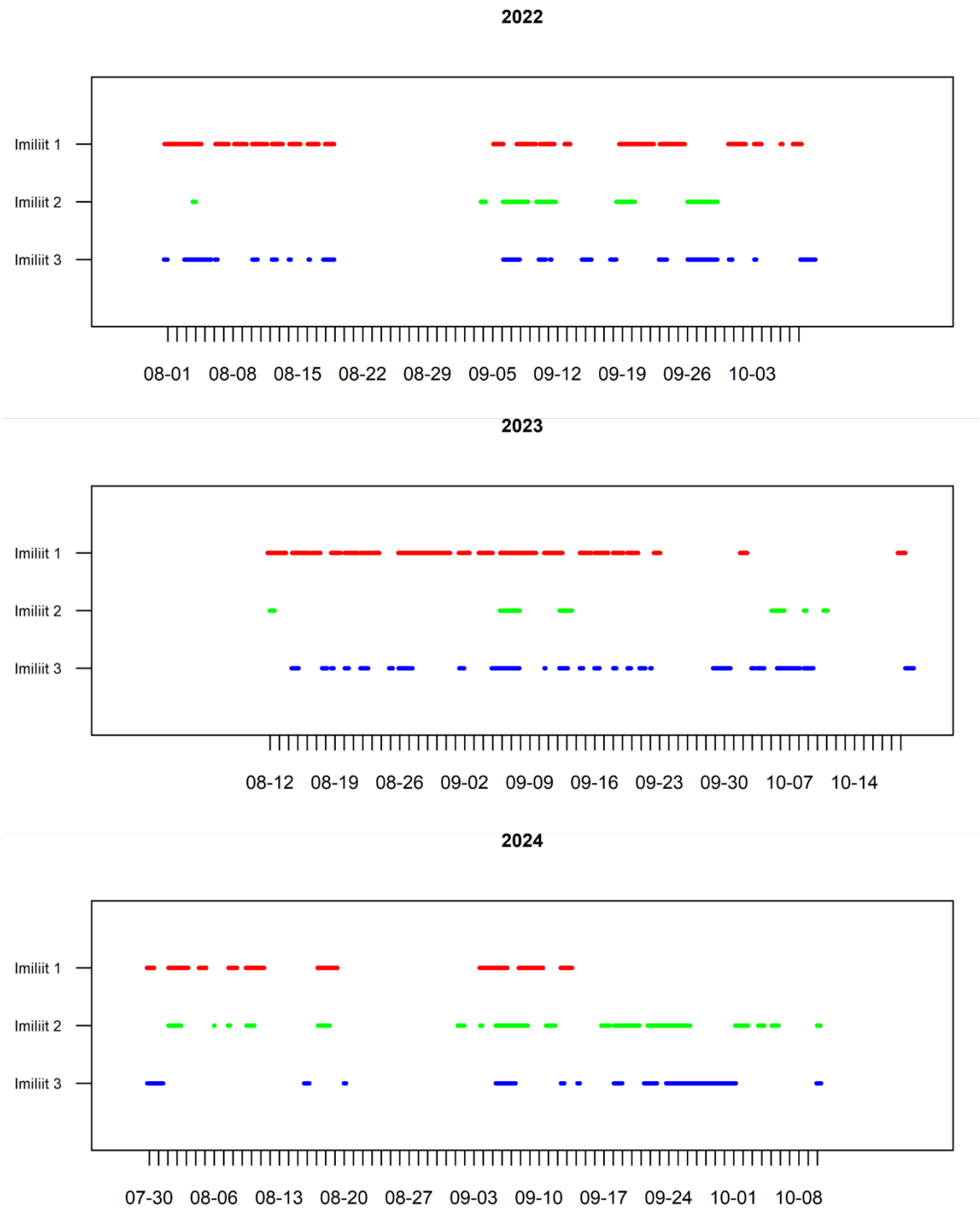
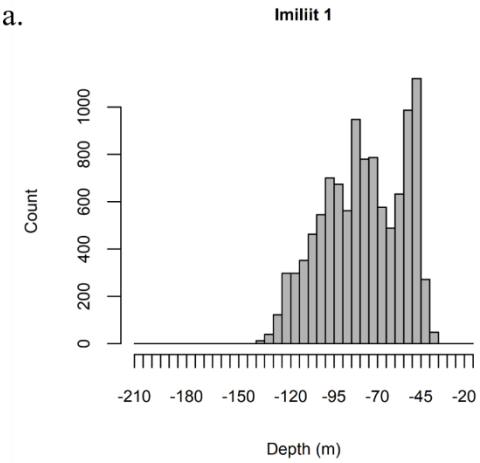
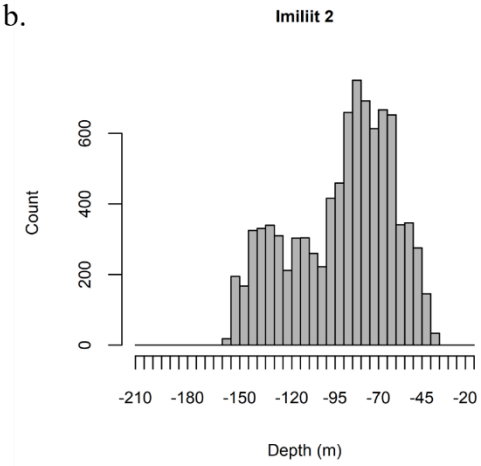


Figure 19: Relatively motionless bulk carrier visits in each of the three ship-selected Imiliit anchorage areas in each year analyzed in this work (2022, 2023, and 2024).

a.



b.



c.

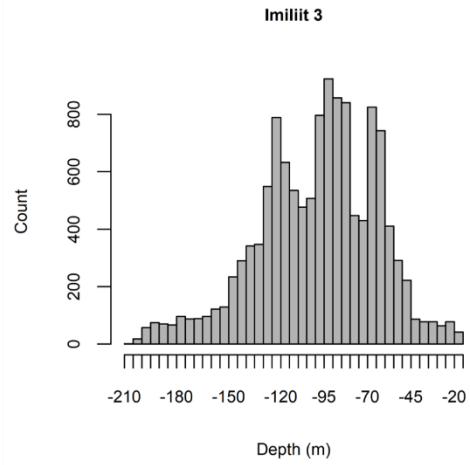


Figure 20: Bathymetric frequency distributions (5-m bins) of the bathymetric data in each of the three ship-selected Imiliit anchorage area polygons from the CHS NONNA-10 dataset.

Figure 21: (top) Milne Inlet Port as viewed from the south, (bottom) Milne Inlet Port as viewed from above, showing the ore dock, the tank farm location, and the freight ramp (left to right).

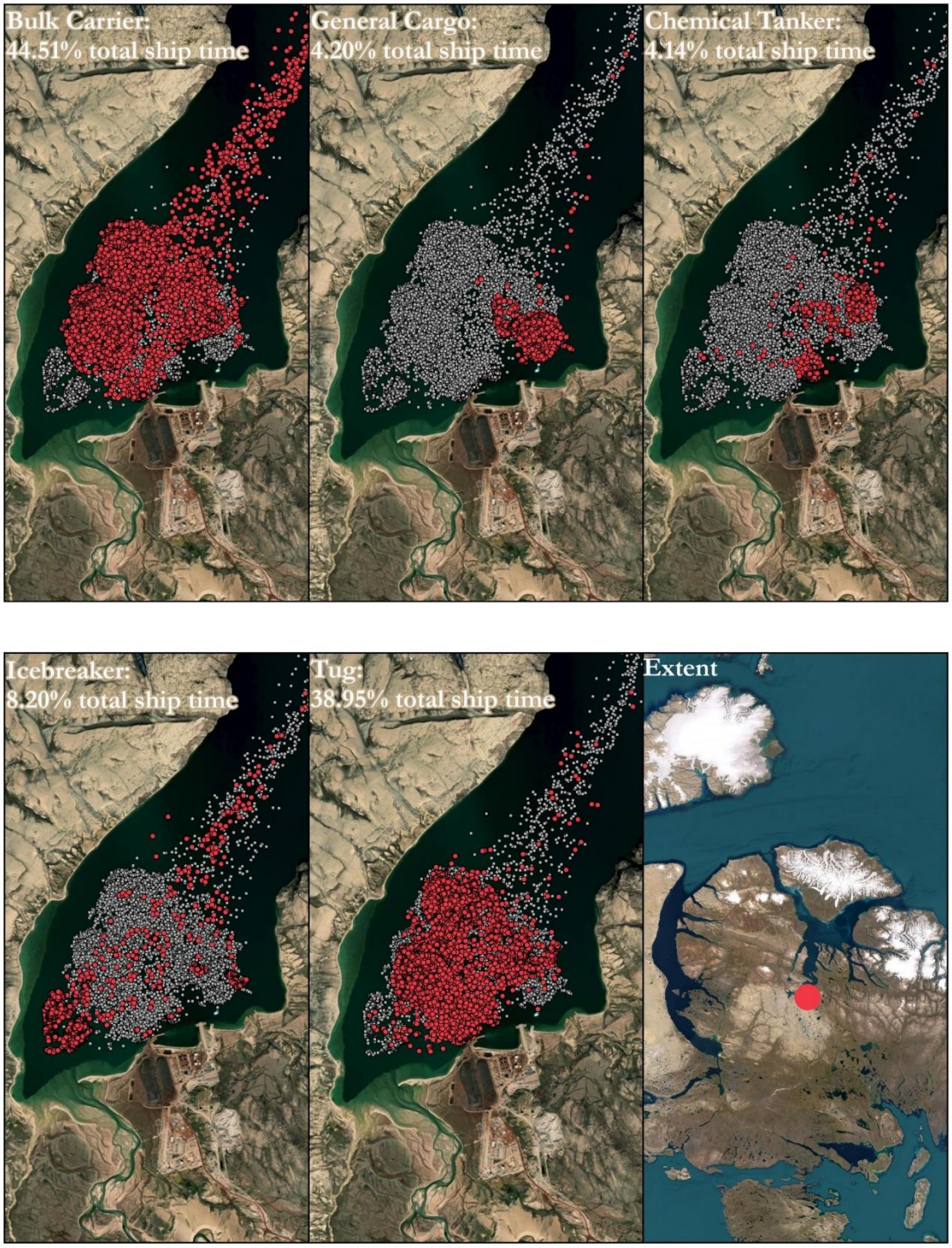


Figure 22: Ship AIS positions for each of Lloyd's 5 categories in red (bulk carriers, general cargo ships, chemical tankers, icebreakers, and tugs) underlain by all other ship type positions in grey. Using the sum of the total time spent in the map extent shown, the percent of that time for each ship type is noted on each panel.

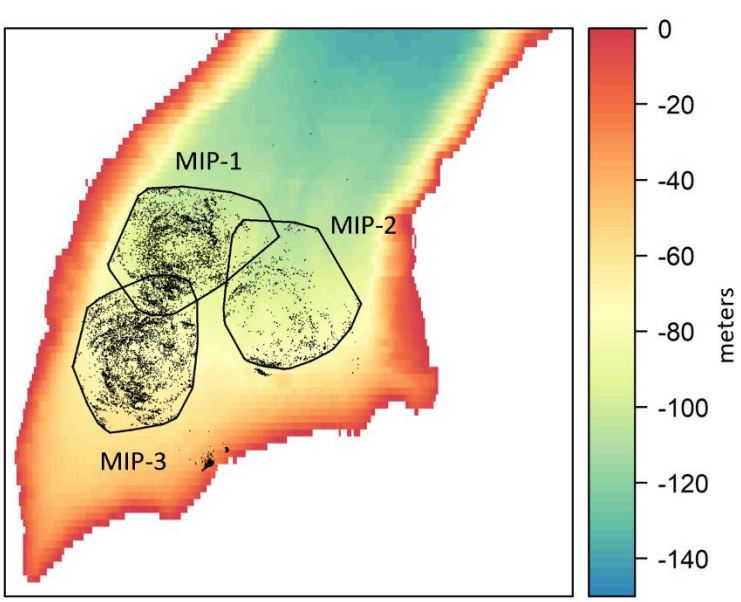


Figure 23: Ship-selected areas where relatively motionless bulk carrier AIS locations (black points) occur south at the Milne Inlet Port Canadian Anchorage Area. Polygons (black lines) generated by point aggregation in ArcGIS Pro around each of the three ship-selected areas, both overlaid on NONNA-10 bathymetric data (in meters).

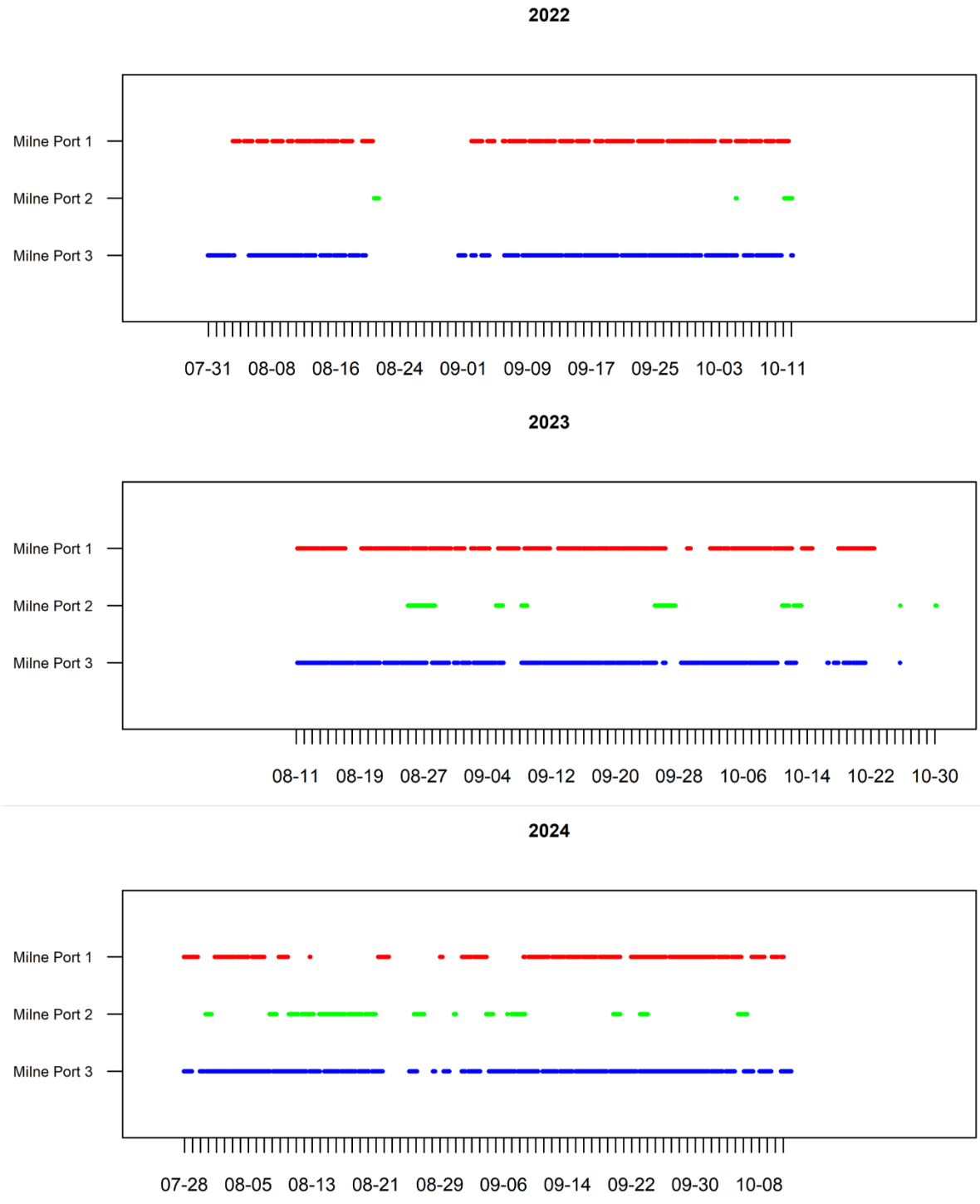
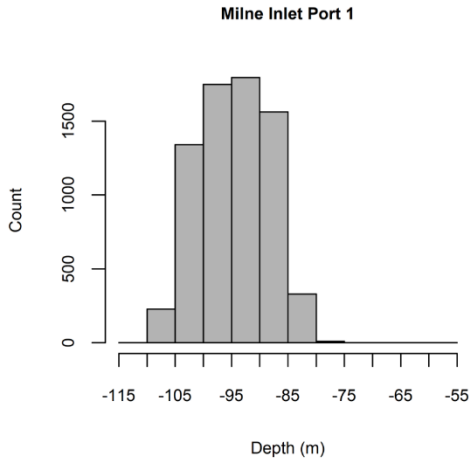
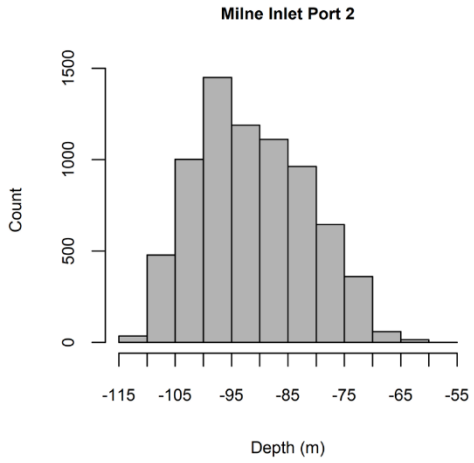


Figure 24: Relatively motionless bulk carrier visits (dates and duration) in each of the three ship-selected Milne Inlet Port anchorage areas in each year analyzed in this work (2022, 2023, and 2024).

a.



b.



c.

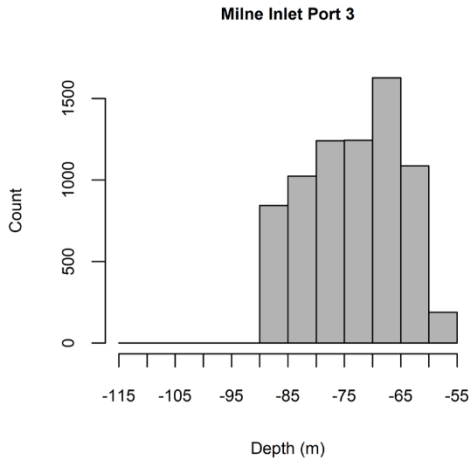


Figure 25: Bathymetric frequency distributions (5-m bins) of the bathymetric data in each of the three ship-selected Milne Inlet Port anchorage area polygons from the CHS NONNA-10 dataset.

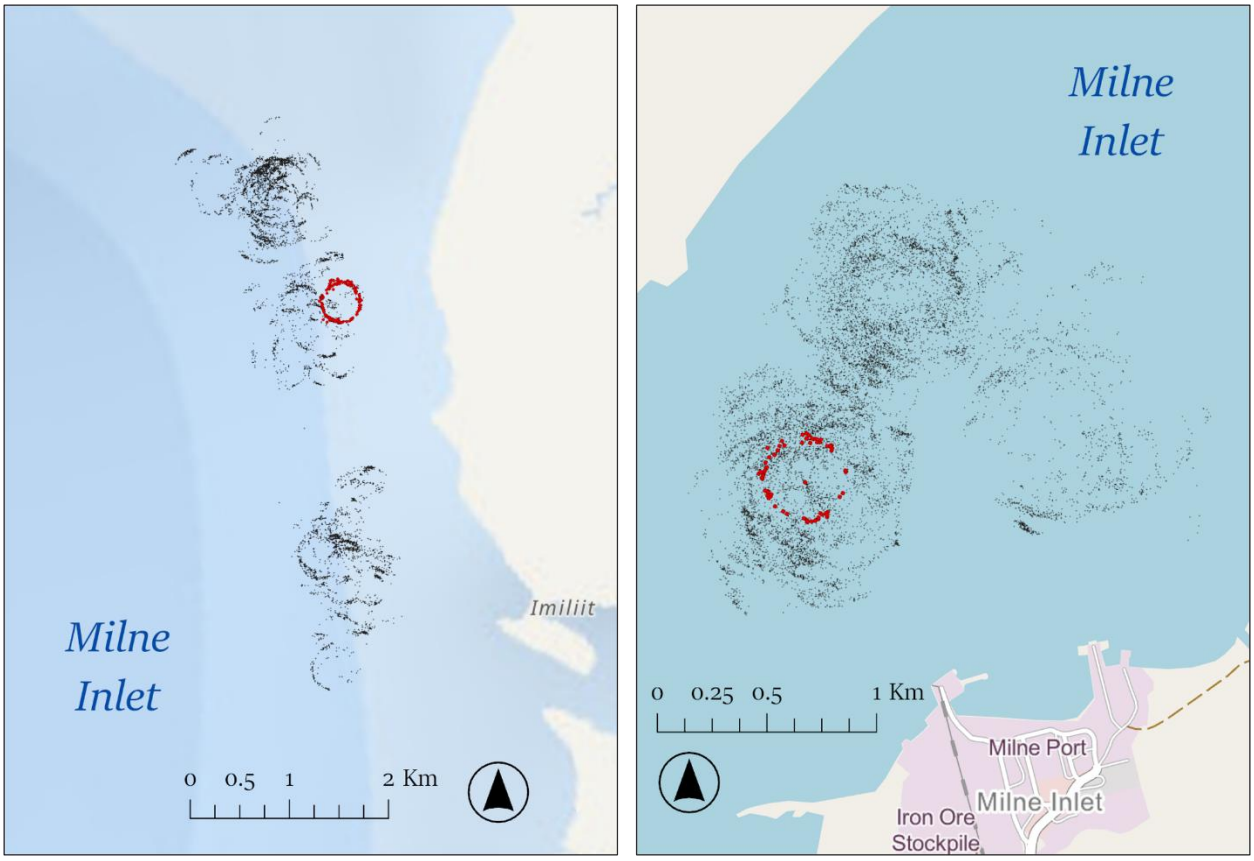


Figure 26: Relatively motionless bulk carrier AIS locations west of Imiliit (left) and at the Milne Inlet Port (right) showing circles and arcs. Individual ship visit examples of full circles at two of the ship-selected anchorage areas (Imiliit-2 and Milne Inlet Port-3) highlighted in red.

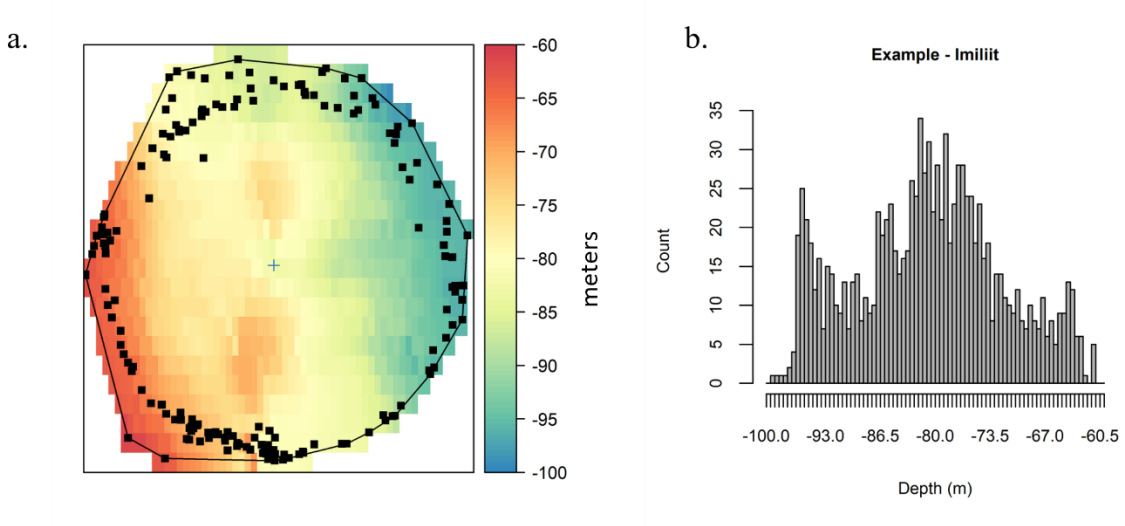


Figure 27: (a) Circular AIS ship positions for one bulk carrier at Imiliit-2 over four days (centroid denoted by +) with polygon (black line) calculated by point aggregation in ArcGIS Pro overlaid on NONNA-10 bathymetry data in meters; (b) bathymetric frequency distribution of the depths at the NONNA-10 cells selected by the point aggregation polygon (all those cells shown in (a)).

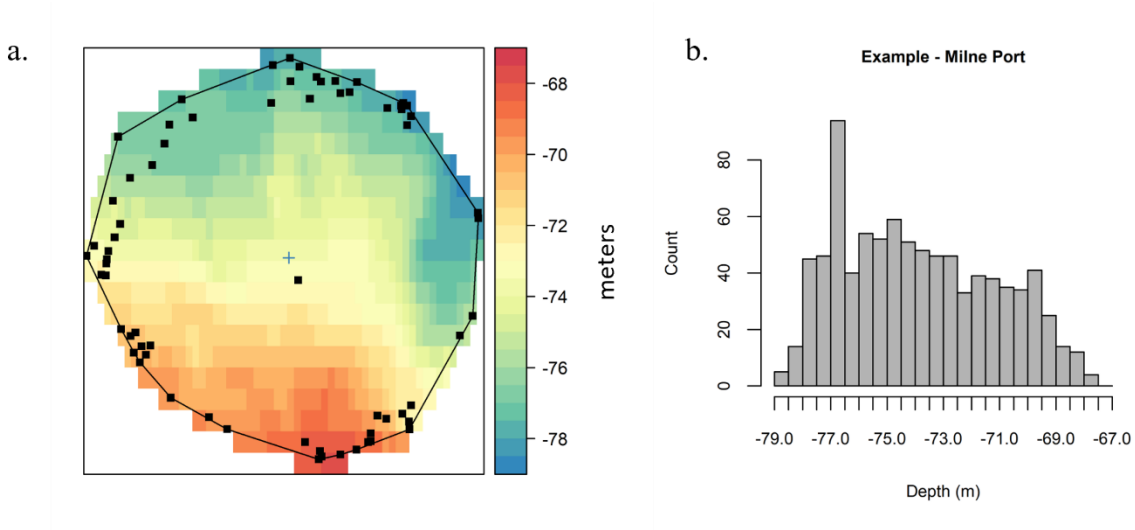


Figure 28: (a) Circular AIS ship positions for one bulk carrier at Milne Inlet Port-3 over one and a half days (centroid denoted by +) with polygon (black line) calculated by point aggregation in ArcGIS Pro overlaid on NONNA-10 bathymetry data in meters; (b) bathymetric frequency distribution of the depths at the NONNA-10 cells selected by the point aggregation polygon (all those cells shown in (a)).

8. Tables

Table 1: Geographic coordinates for the Canadian Hydrographic Service Canadian Anchorage Areas in the Milne Inlet study area.

Anchorage Area	Latitude (°N)	Longitude (°E)
Pisiktarfik Island - N	72.605	-80.435
Pisiktarfik Island - S	72.5763	-80.4488
Imiliit (Ragged Island)	72.4658	-80.001
Koluktoo Bay - W	72.0633	-80.9413
Koluktoo Bay - E	72.0339	-80.7401
Milne Port	71.8967	-80.9143

Table 2: Number of unique ships, hours, and kilometers sailed in the Milne Inlet study region in 2022 categorized by ASTD ship type.

ASTD Ship Type	Unique Ships	Hours	Kilometers
Bulk carriers	35	6924.59	11691.81
Chemical tankers	2	418.90	694.56
Container ships	0	0	0
Crude oil tankers	0	0	0
Cruise ships	0	0	0
Fishing vessels	0	0	0
Gas tankers	0	0	0
General cargo ships	4	431.81	720.28
Offshore supply ships	0	0	0
Oil product tankers	0	0	0
Other activities	7	4341.30	1998.83
Other service offshore vessels	0	0	0
Passenger ships	0	0	0
Refrigerated cargo ships	0	0	0
Ro-Ro cargo ships	0	0	0
Unknown	5	815.11	1145.28
Sum	53	12931.71	16250.75

Table 3: Number of unique ships, hours, and kilometers sailed in the Milne Inlet study region in 2022 for the ASTD “Other Activities” ship type categorized by Lloyd’s category 5 ship types.

Lloyd's Category 5 Ship Type	Unique Ships	Hours	Kilometers
Tug	2	3634.85	515.09
Research Survey Vessel	1	34.75	126.06
Yacht	2	57.14	248.71
Icebreaker	1	558.67	854.29
Patrol Vessel	1	55.90	254.68
Sum	7	4341.30	1998.83

Table 4: Number of unique ships, hours, and kilometers sailed in the Milne Inlet study region in 2023 categorized by ASTD ship type.

ASTD Ship Type	Unique Ships	Hours	Kilometers
Bulk carriers	39	6964.84	14993.80
Chemical tankers	3	561.03	778.10
Container ships	0	0	0
Crude oil tankers	0	0	0
Cruise ships	0	0	0
Fishing vessels	0	0	0
Gas tankers	0	0	0
General cargo ships	1	337.32	573.76
Offshore supply ships	0	0	0
Oil product tankers	0	0	0
Other activities	7	5344.91	4963.55
Other service offshore vessels	0	0	0
Passenger ships	0	0	0
Refrigerated cargo ships	0	0	0
Ro-Ro cargo ships	0	0	0
Unknown	2	678.67	613.10
Sum	52	13886.77	21922.32

Table 5: Number of unique ships, hours, and kilometers sailed in the Milne Inlet study region in 2023 for the ASTD “Other Activities” ship type categorized by Lloyd’s category 5 ship types.

Lloyd's Category 5 Ship Type	Unique Ships	Hours	Kilometers
Tug	2	3950.32	1500.09
Icebreaker	4	1372.34	3224.89
Patrol Vessel	1	22.26	238.57
Sum	7	5344.91	4963.55

Table 6: Number of unique ships, hours, and kilometers sailed in the Milne Inlet study region in 2024 categorized by ASTD ship type.

ASTD Ship Type	Unique Ships	Hours	Kilometers
Bulk carriers	39	7137.47	14975.35
Chemical tankers	2	446.34	782.48
Container ships	0	0	0
Crude oil tankers	0	0	0
Cruise ships	0	0	0
Fishing vessels	0	0	0
Gas tankers	0	0	0
General cargo ships	2	648.54	1011.73
Offshore supply ships	1	9.60	208.89
Oil product tankers	0	0	0
Other activities	5	5575.81	2373.97
Other service offshore vessels	0	0	0
Passenger ships	0	0	0
Refrigerated cargo ships	0	0	0
Ro-Ro cargo ships	0	0	0
Unknown	3	1471.32	3241.80
Sum	52	15289.07	22594.22

Table 7: Number of unique ships, hours, and kilometers sailed in the Milne Inlet study region in 2024 for the ASTD “Other Activities” ship type categorized by Lloyd’s category 5 ship types.

Lloyd's Category 5 Ship Type	Unique Ships	Hours	Kilometers
Tug	2	4447.73	1321.60
Research Icebreaker	1	23.02	25.83
Icebreaker	2	1105.05	1026.53
Sum	5	5575.81	2373.97

Table 8: Visitation duration statistics (in hours unless otherwise indicated) for the ship-selected anchorage areas south of Imiliit for all ship traffic in all three shipping seasons interrogated (2022, 2023, and 2024).

	Minimum	Mean	Maximum	Total Visits	Total bulk carrier-hours	Total bulk carrier-days	% Total
Imiliit 1	4.75	38.49	110.90	46	1770.73	73.78	45
Imiliit 2	0.9	32.01	109.98	28	896.33	37.35	23
Imiliit 3	2.14	23.15	180.75	53	1226.69	51.11	32
						Sum = 162.24	

Table 9: Bathymetry statistics (in meters unless otherwise noted) for the three ship-selected anchorage areas south of Imiliit.

	Area (ha)	NONNA10 cells	Maximum	3rd Quartile	Median	Mean	1st Quartile	Minimum
Imiliit 1	143	10700	-139.58	-95.78	-78.06	-78.34	-57.24	-35.1
Imiliit 2	121	9036	-156.77	-113.62	-85.02	-91.25	-68.67	-37.59
Imiliit 3	173	12822	-205.47	-121.40	-94.96	-98.88	-73.44	-16.58

Table 10: Visitation duration statistics (in hours unless otherwise indicated) for the ship-selected anchorage areas at the Milne Inlet Port for all ship traffic in all three shipping seasons interrogated (2022, 2023, and 2024).

	Minimum	Mean	Maximum	Total Visits	Total bulk carrier-hours	Total bulk carrier-days	% Total
Milne Port 1	0.40	35.8	138.5	93	3332.9	138.9	40
Milne Port 2	0.61	25.5	81.9	27	689	28.7	8
Milne Port 3	0.16	32.4	205.9	132	4275	178.1	52
						Sum = 345.7	

Table 11: Bathymetry statistics (in meters unless otherwise noted) for the three ship-selected anchorage areas at the Milne Inlet Port.

	Area (ha)	NONNA10 cells	Maximum	3rd Quartile	Median	Mean	1st Quartile	Minimum
Milne Port 1	93.1	7015	-109.59	-99.31	-94.48	-94.56	-89.52	-77.73
Milne Port 2	97.7	7307	-110.99	-98.77	-92.33	-91.29	-84.06	-63.37
Milne Port 3	97.2	7251	-89.67	-80.22	-72.83	-73.54	-66.66	-57.78

Table 12: Area (ha), number of NONNA-10 cells, and bathymetry statistics (in meters unless otherwise noted) for circular features in the ASTD Level-1 AIS data at the Imiliit-2 and Milne Inlet Port-3 ship-selected anchorage areas.

	Area (ha)	NONNA-10 cells	Max	3rd Quart	Median	Mean	1st Quart.	Min	Centroid depth
Imiliit-2	13.8	1084	-99.05	-86.8	-80.73	-80.85	-75.13	-61.06	-81.85
Milne Port-3	11	875	-78.96	76.33	-74.25	-73.89	-71.7	-67.9	-73.87