Session 15: Arctic Navigation - Practical Application of Sea Ice Information in Current and Future Maritime Operations

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Patterns of historic Arctic shipping risk in sea ice and how they inform future information needs to support Arctic ship operations

H2020 Arctic Passion Pilot Service for POLARIS Risk Management

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ARCTIC PASSION

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Background and context

- Arctic Passion – key motivation is the co-creation and implementation of a coherent, integrated Arctic observing system - tuned to the diverse needs of users, ranging from local inhabitants to academia through to industry and decision-makers.
- Reduce the risk of a shipping incident by improving application of the International Maritime Organization's (IMO) POLARIS risk assessment system

1. Historical analysis of shipping risk in the Arctic.

2. Current risk information to ships at current position.

3. Forecast POLARIS risk assessments based on sea ice forecasts.

4. Onboard delivery, visualisation and evaluation.

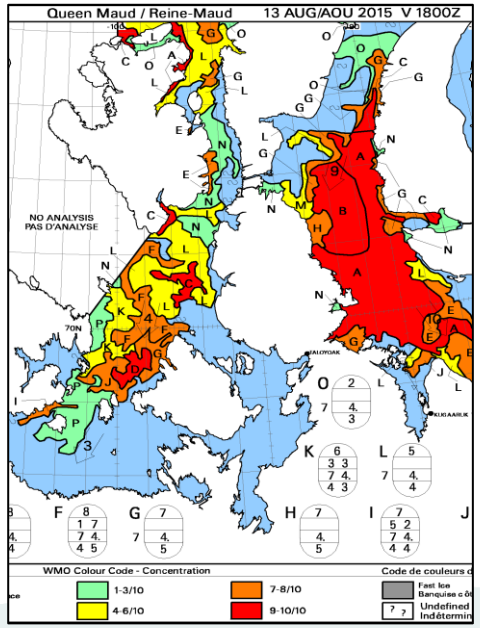
https://arcticpassion.eu

Methods

Operational risk is defined by the IMO Polar Operational Limit Assessment Risk Indexing System (POLARIS), according to:

- Sea ice conditions in the region
- Ice Class of the vessel (i.e. level of hull strengthening)

Ice Concentration



C1… Cn are the concentrations (in tenths) of ice types within a region

x

Risk Index Value (RIV)

Ice Class	Ice-Free	New Ice	Grey Ice	Grey White Ice	Thin First Year ice 1st Stage	Thin First Year Ice 2nd Stage	Medium First Year Ice less than 1 m thick	Medium First Year Ice	Thick First Year Ice	Second Year Ice	Light Multi Year Ice, less than 2.5 m thick	Heavy Multi Year Ice
PC1	3	3	3	3	2	2	2	2	2	2	1	1
PC2	3	3	3	3	2	2	2	2	2	1	1	0
PC3	3	3	3	3	2	2	2	2	2	1	0	-1
PC4	3	3	3	3	2	2	2	2	1	0	-1	-2
PC5	3	3	3	3	2	2	1	1	0	-1	-2	-2
PC6	3	2	2	2	2	1	1	0	-1	-2	-3	-3
PC7	3	2	2	2	1	1	0	-1	-2	-3	-3	-3
IA Super	3	2	2	2	2	1	0	-1	-2	-3	-4	-4
IA	3	2	2	2	1	0	-1	-2	-3	-4	-5	-5
IB	3	2	2	1	0	-1	-2	-3	-4	-5	-6	-6
IC	3	2	1	0	-1	-2	-3	-4	-5	-6	-7	-8
Not Ice Strengthened	3	1	0	-1	-2	-3	-4	-5	-6	-7	-8	-8

Source: IMO, 2016

RIV is based on the Polar Code Ice Class and each sea ice type within the region

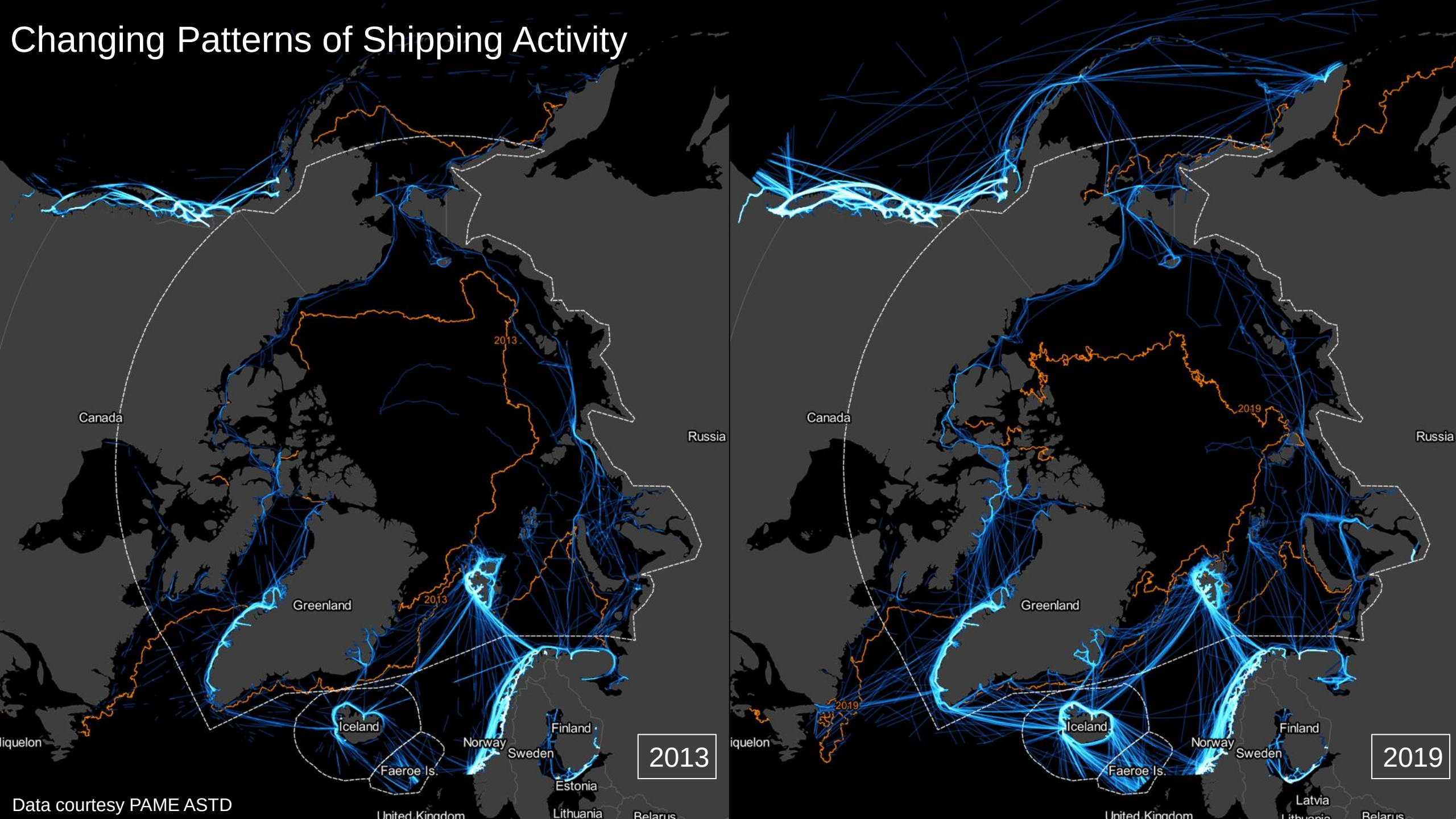
$$RIO = (C_1 \times RIV_1) + (C_2 \times RIV_2) + (C_3 \times RIV_3) + \ldots (C_n \times RIV_n)$$

=

Risk Index Outcome (RIO)

RIO ≥ 0	Normal Operation
RIO <0 to -10	Elevated Risk
RIO < -10	High Risk

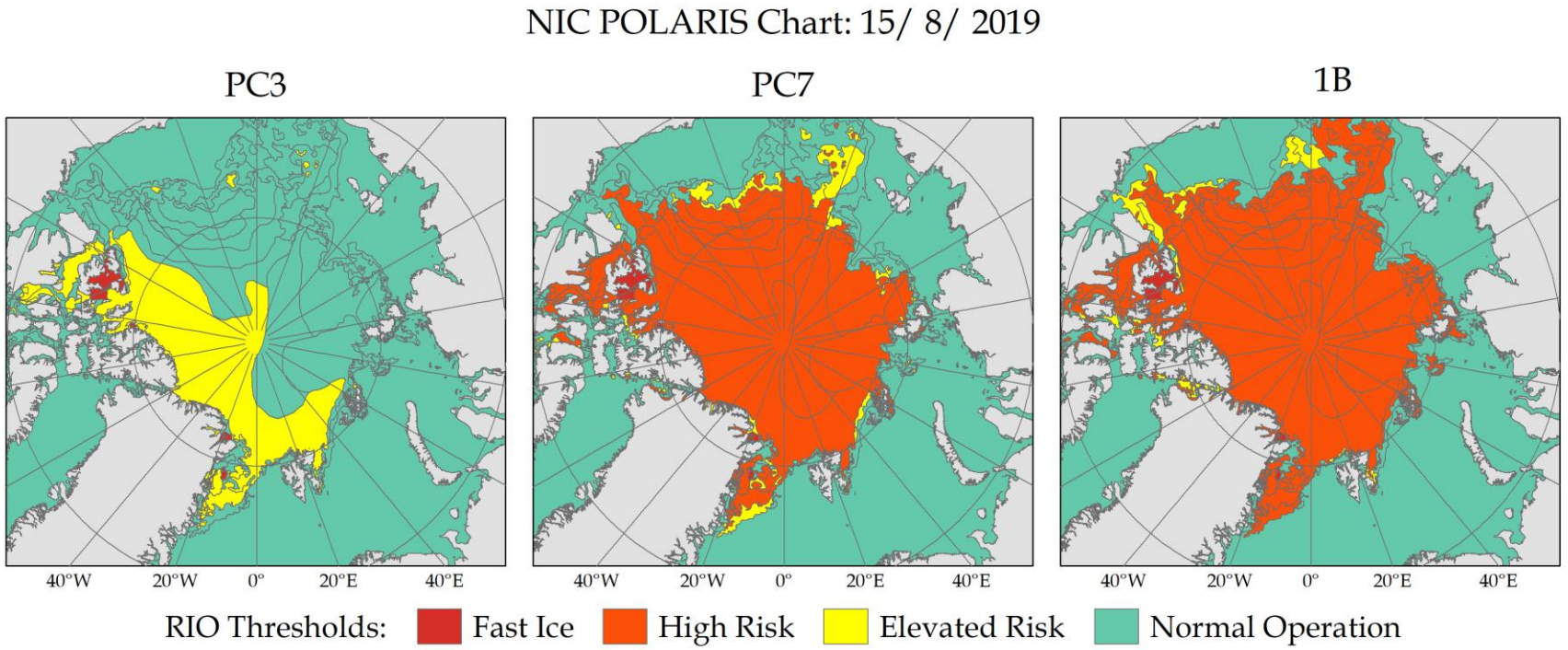
Changing Patterns of Shipping Activity



Data courtesy PAME ASTD

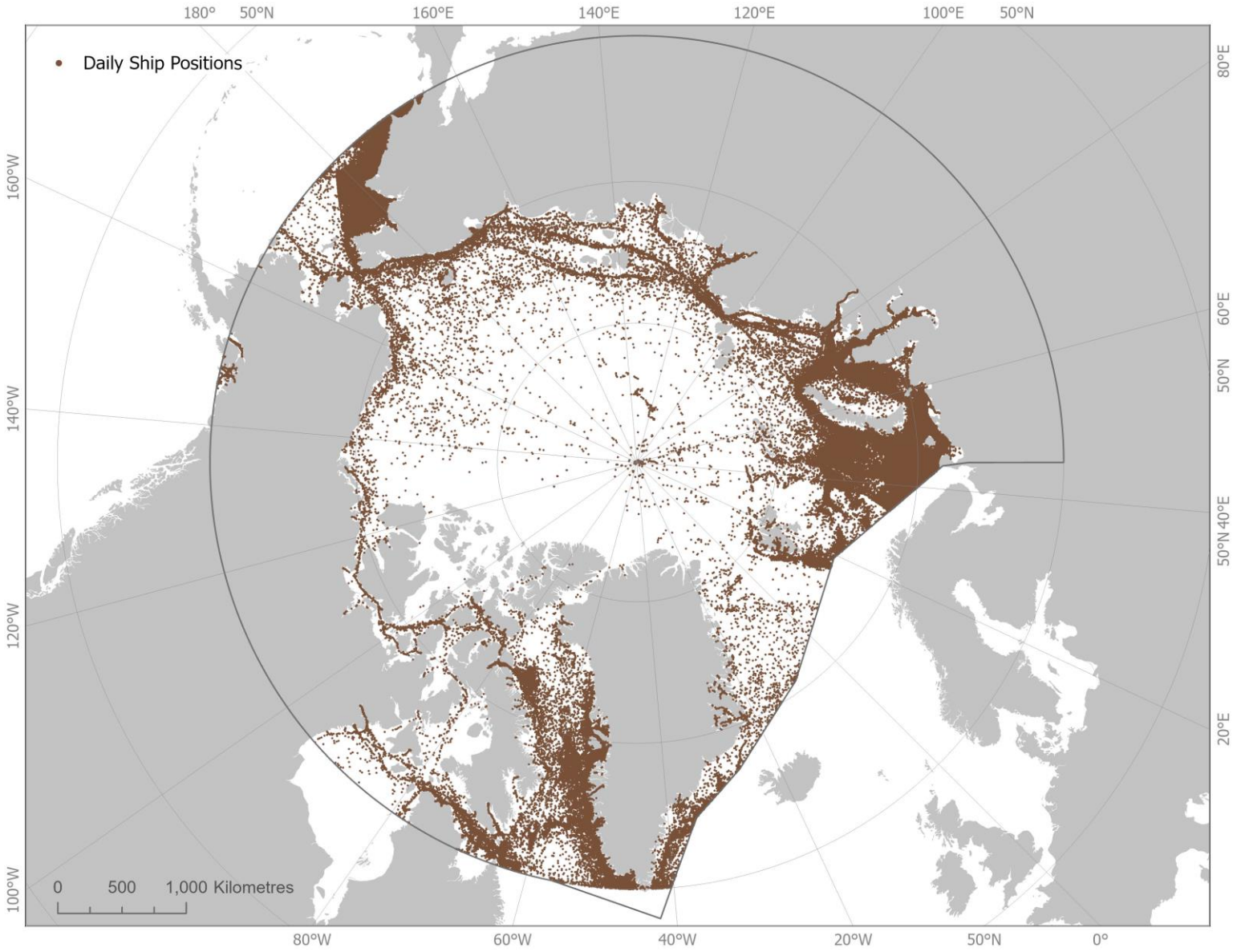
Methods

- Each ship position is assigned a RIO value from a coincident Pan-Arctic weekly National Ice Center (NIC) ice chart.
- Only ship position reports up to 4 days before the chart issue date are included.
- The RIO Threshold that corresponds to the vessel Ice Class is attributed to the ship position report.



Pan-Arctic weekly NIC ice charts, converted to POLARIS, are available between February 2015 and April 2022 (NIC chart dates are on Thursdays, using satellite imagery from Sunday-Wednesday).

Daily Ship Positions Assigned an RIO Value from a POLARIS Chart 2015 – 2022 : All ship positions

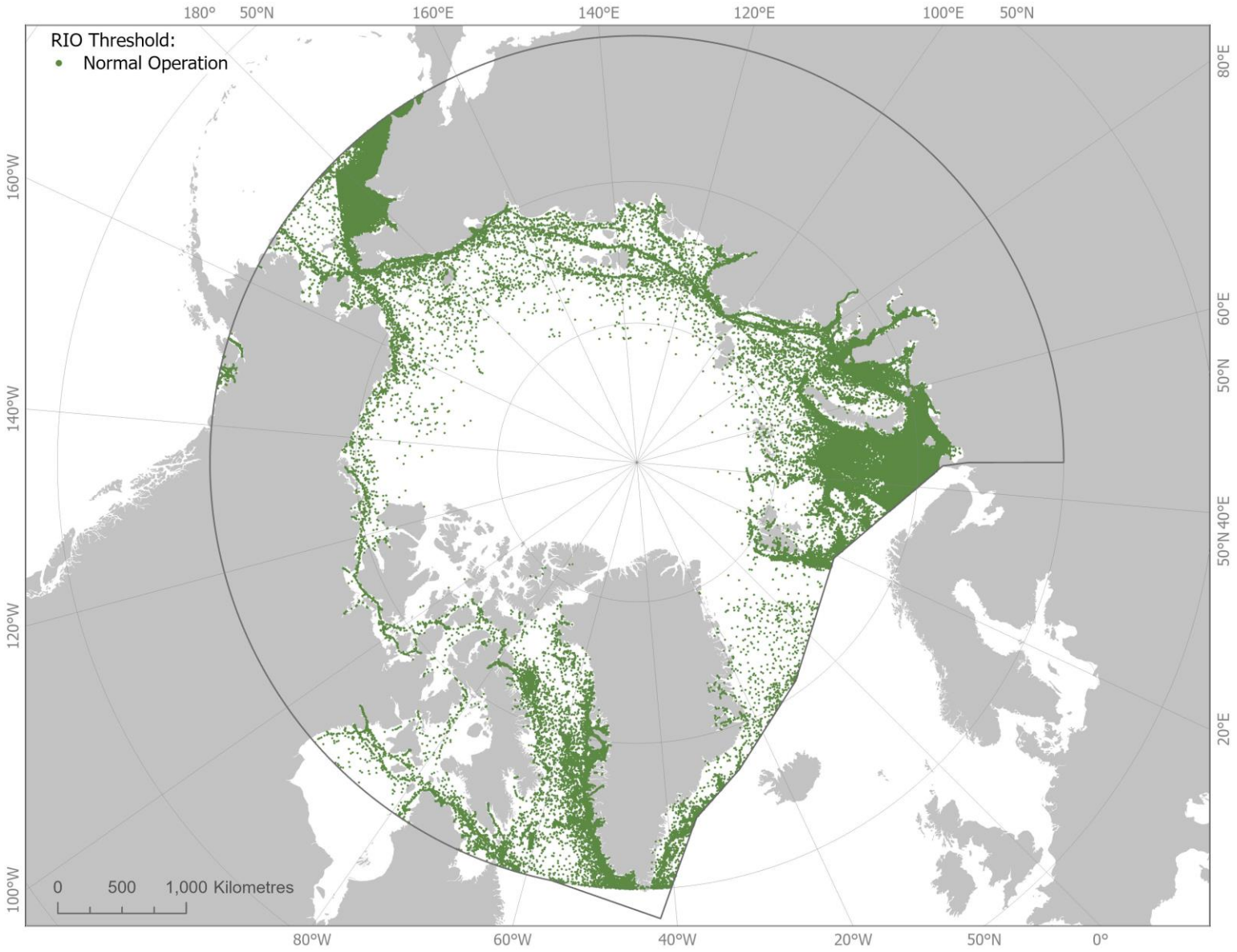


Total Ship Positions: 227,177

Unique Ships: 2,159

- 61% of the 372,465 daily ship positions that were RIO analyzed.

Daily Ship Positions Assigned an RIO Value From a POLARIS Chart Open Water: 2015 – 2022

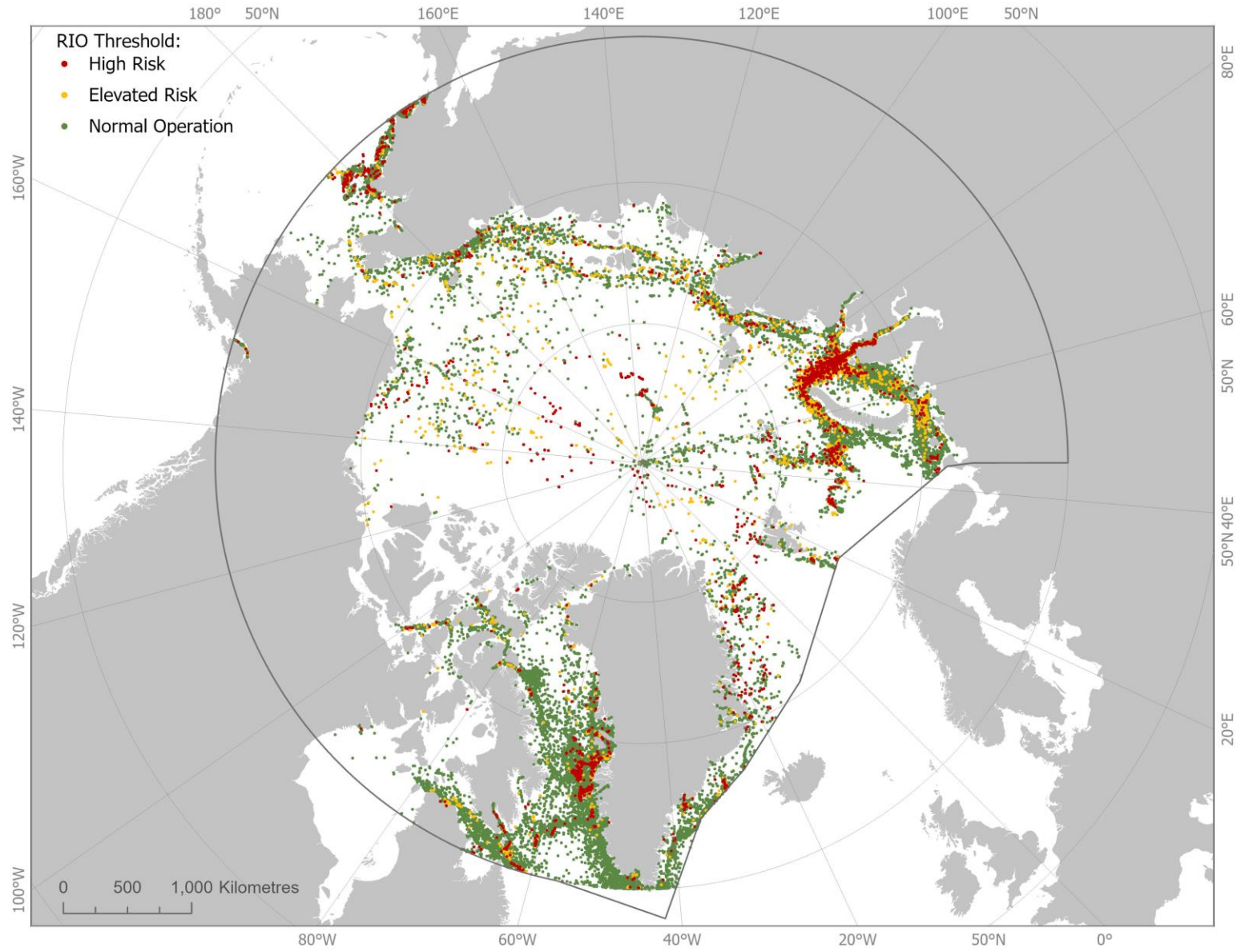


Total Ship Positions: 175,396

Unique Ships: 2,091

- 77% of the daily ship positions with Ice Class data and a coincident Ice Chart.

Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 - 2022

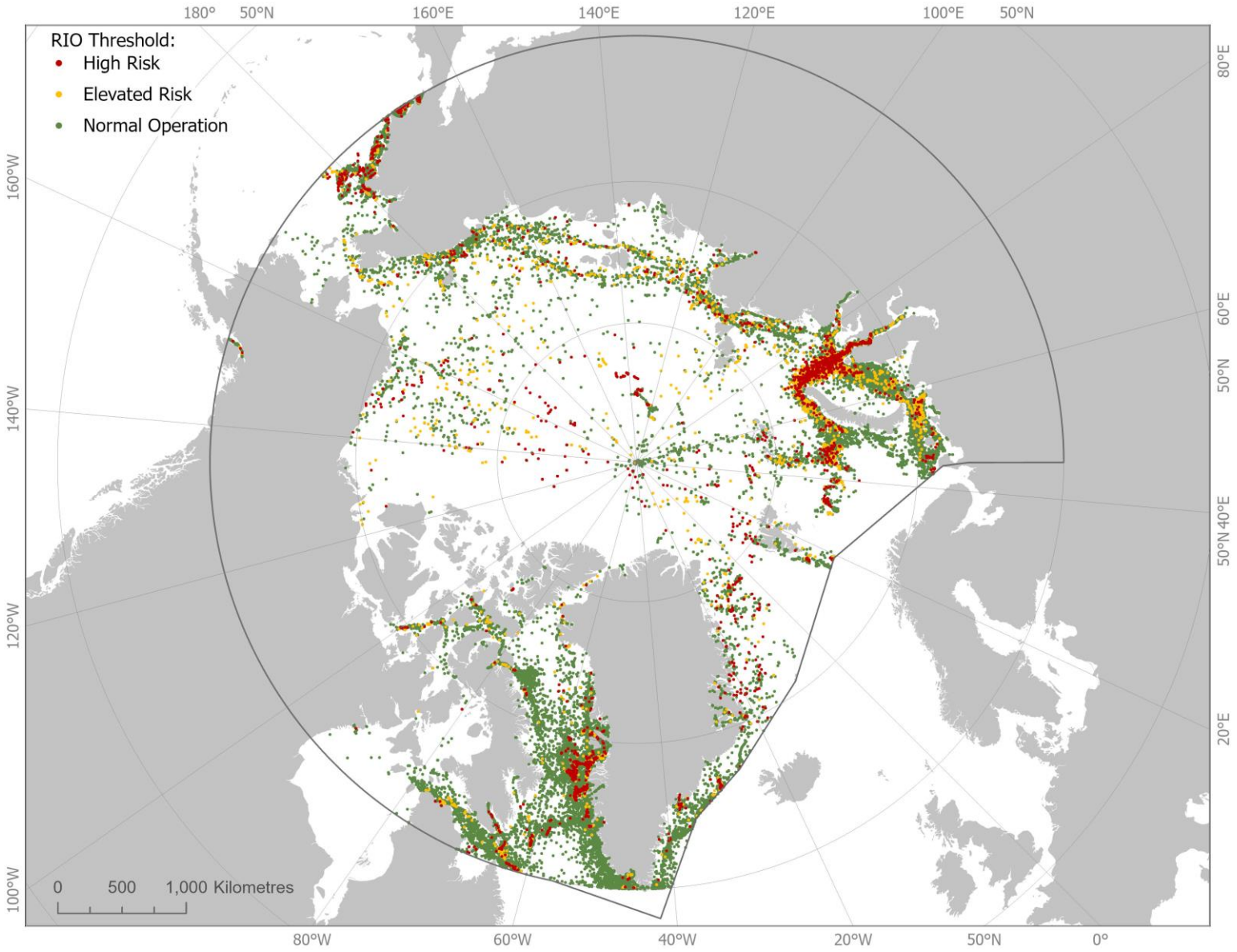


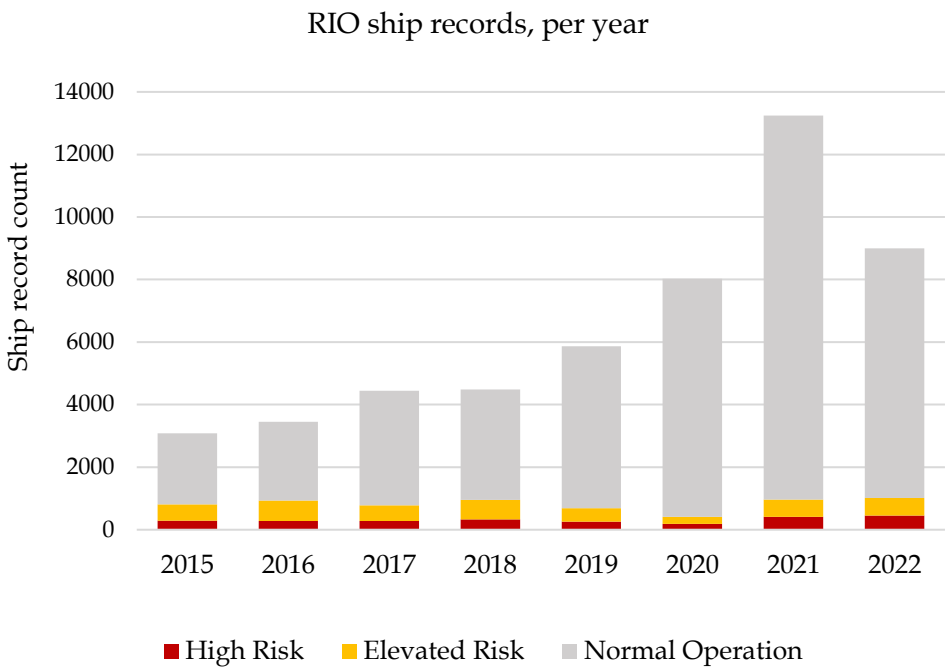
Total Ship Positions: 51,602

Unique Ships: 1,400

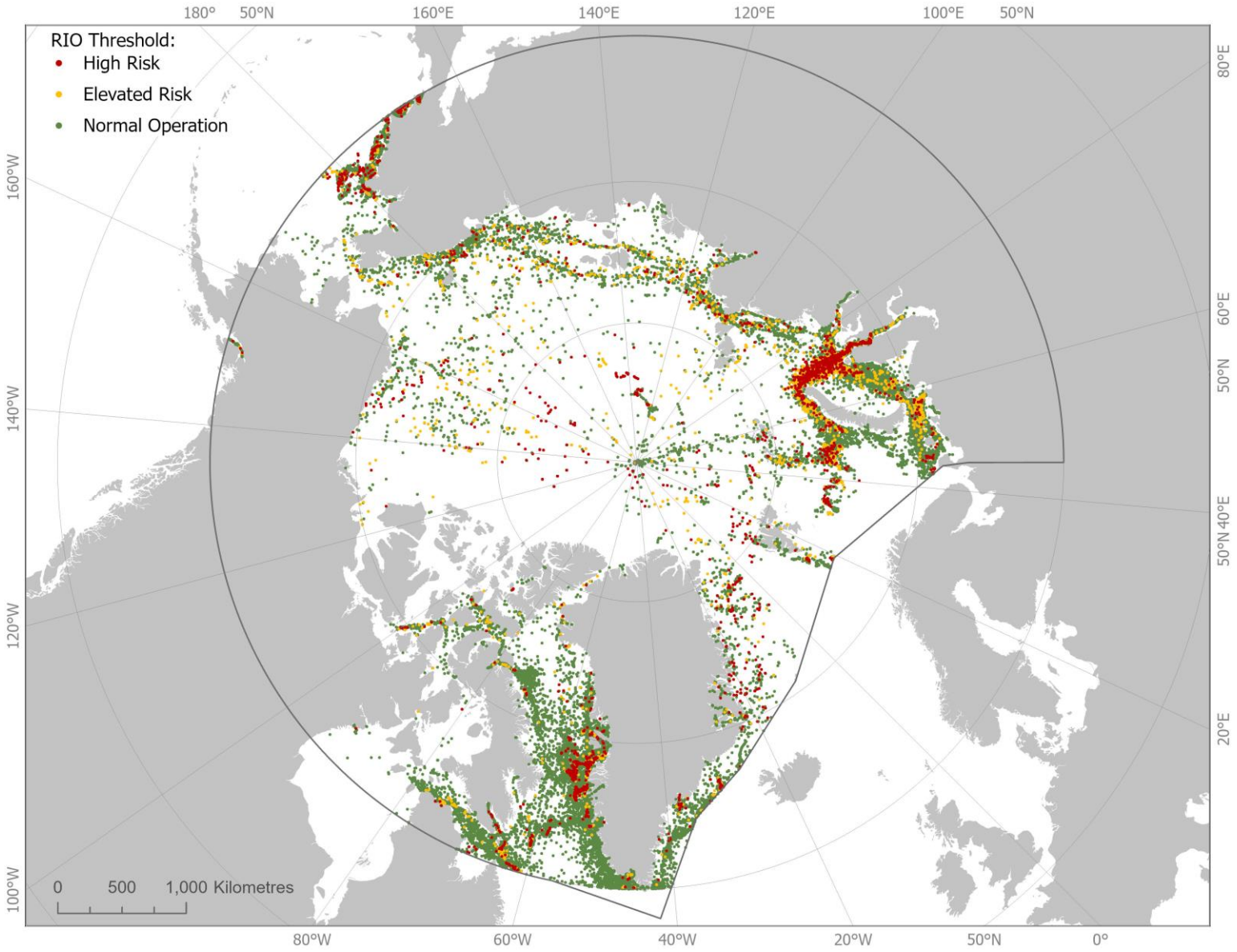
- 23% of the daily ship positions with Ice Class data and a coincident Ice Chart.

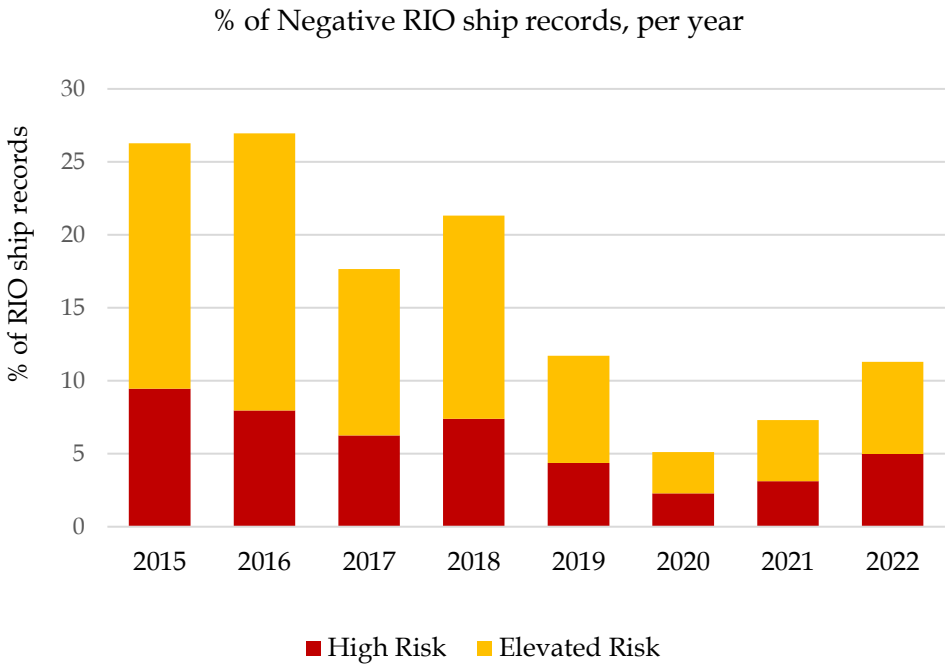
Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 – 2022 : Ship records per year



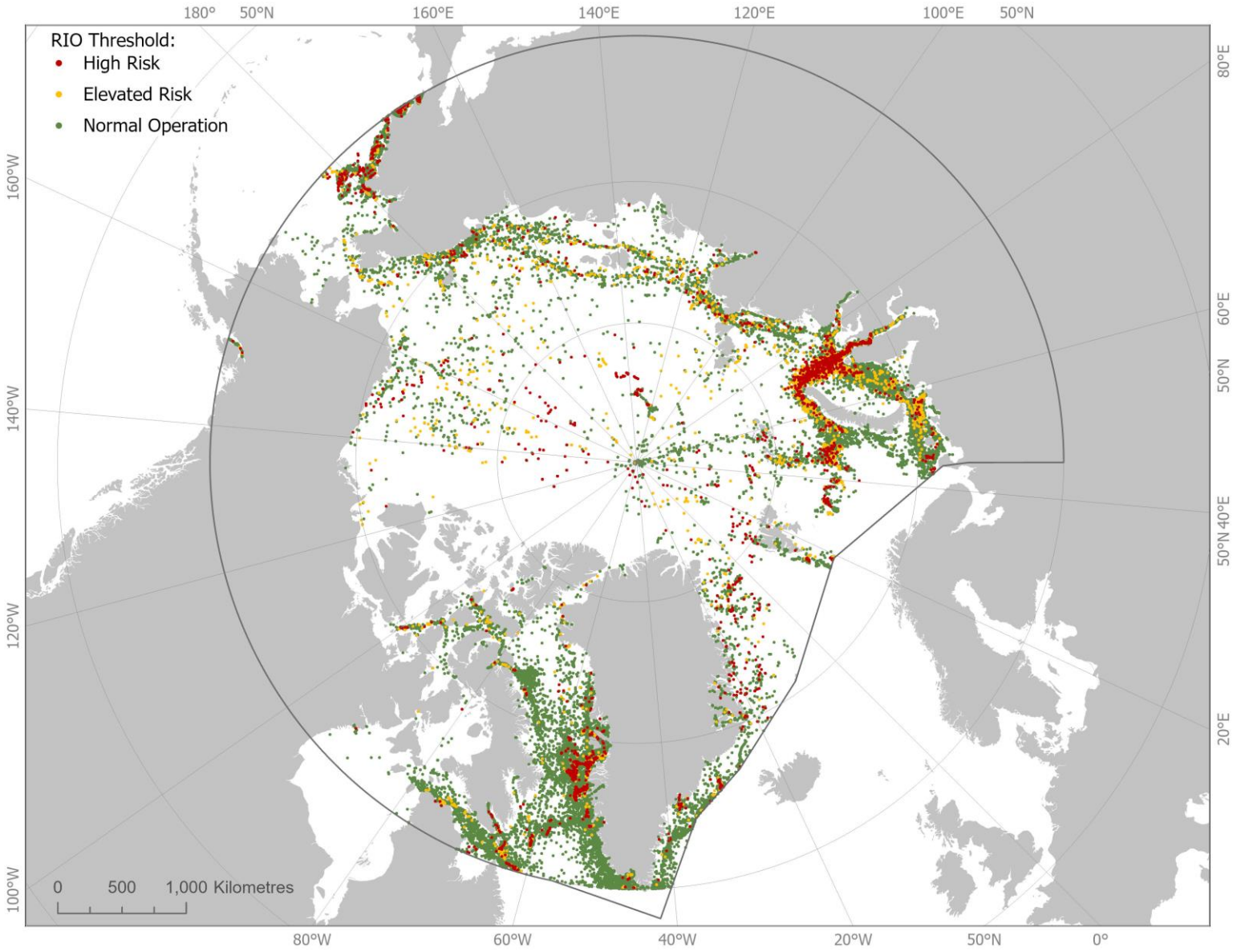


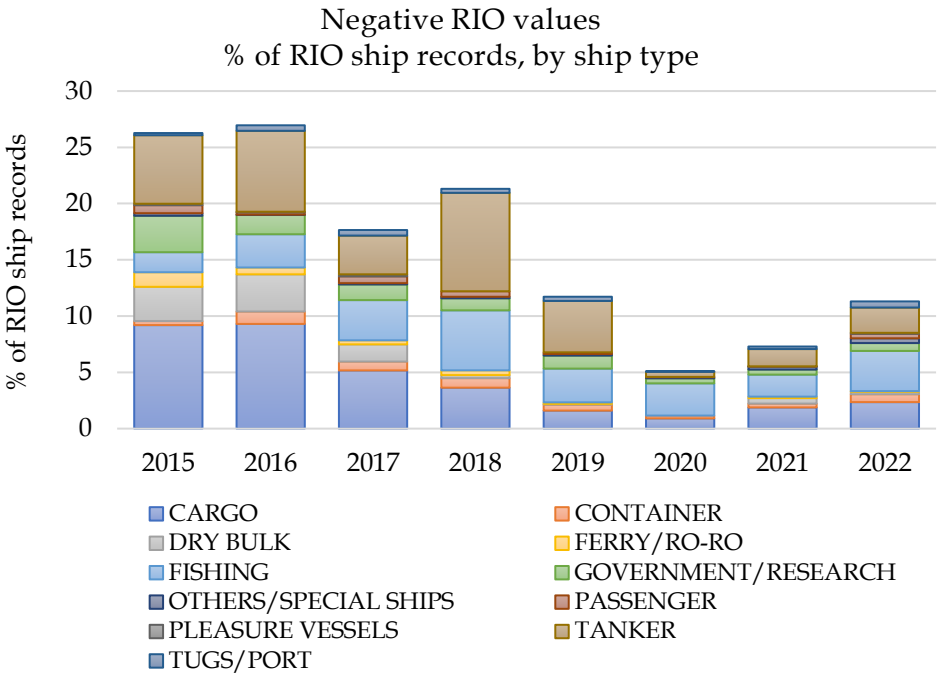
Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 – 2022 : Percentage ship elevated and high risk



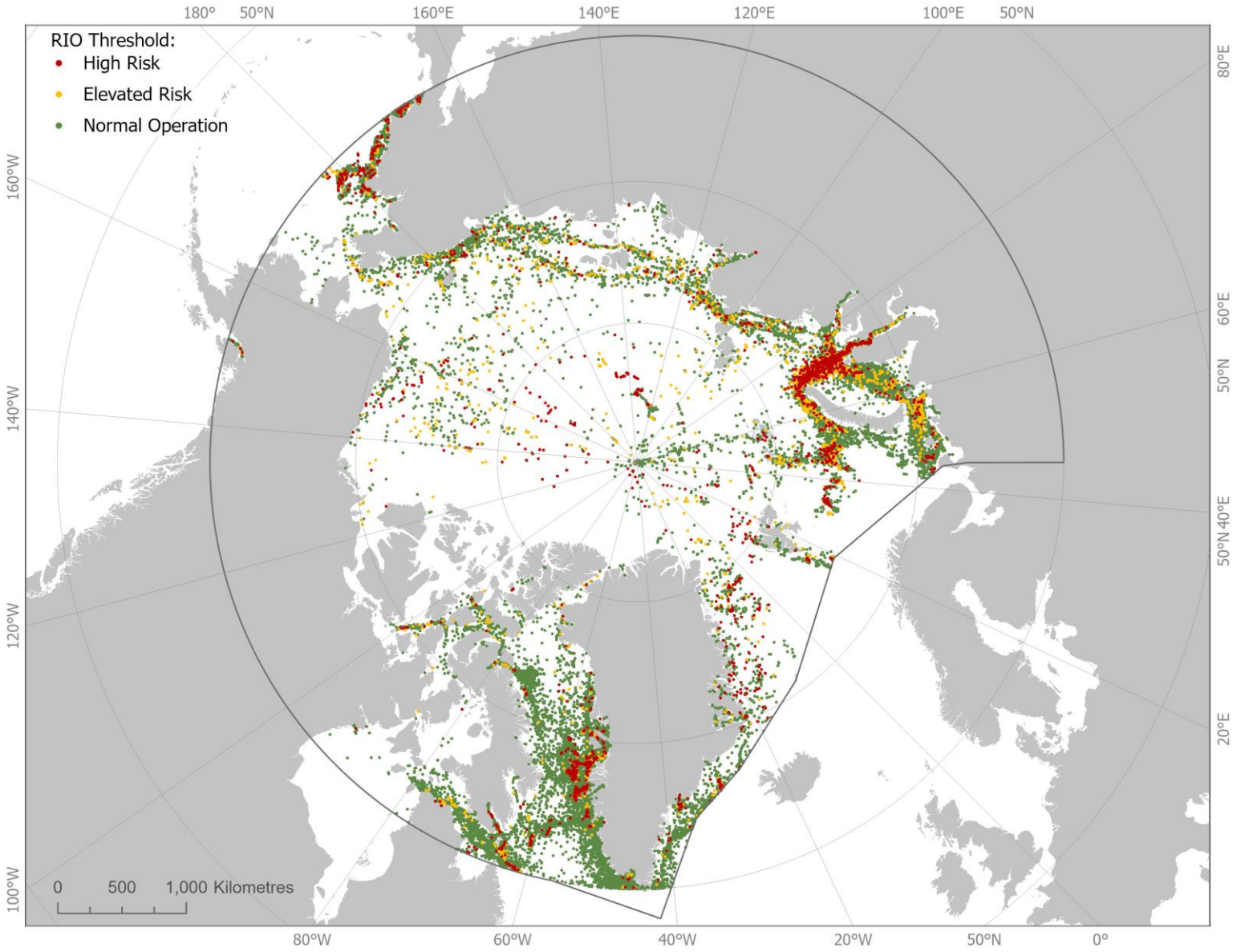


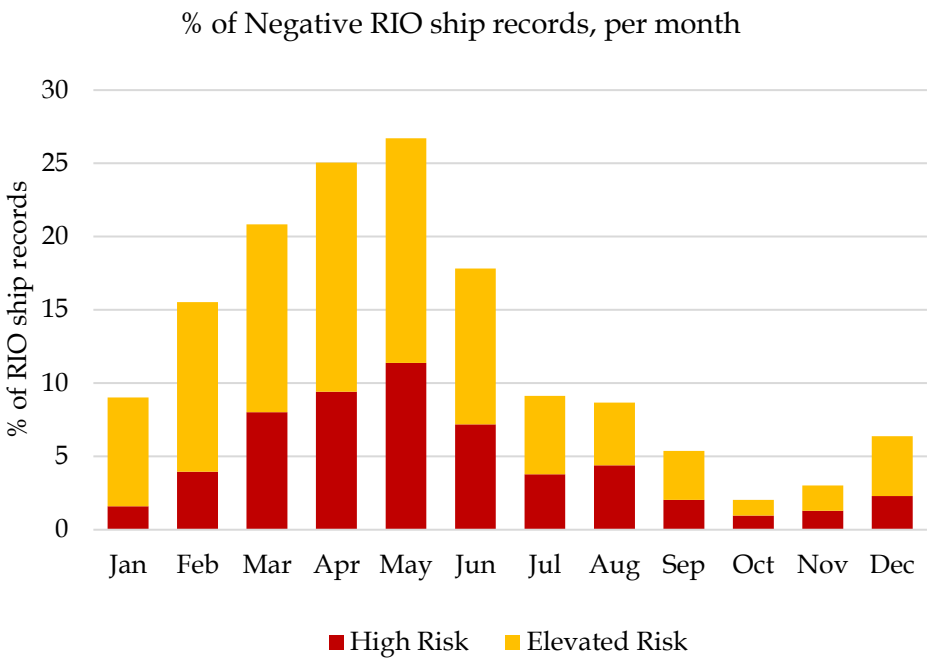
Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 – 2022 : Negative RIO by ship type



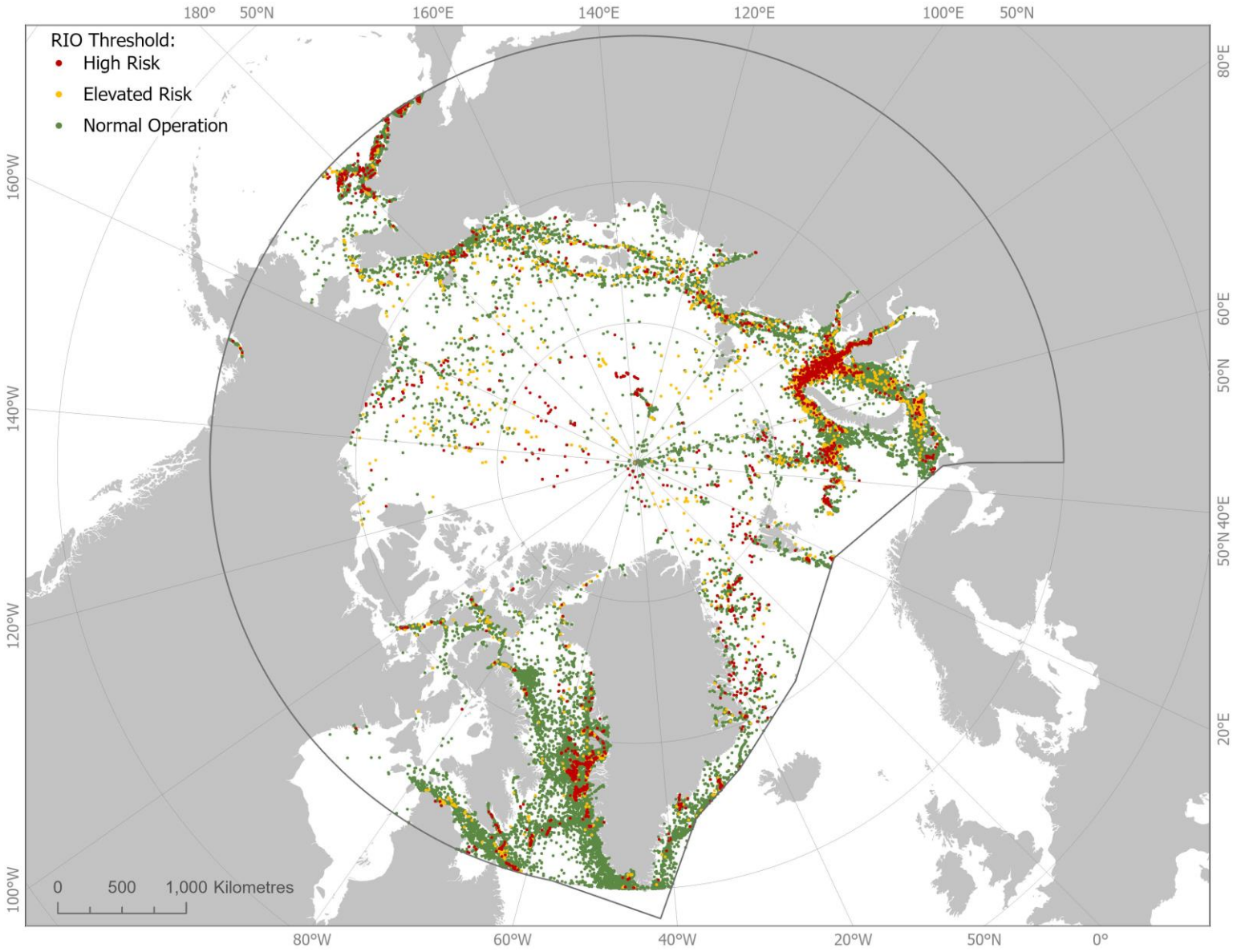


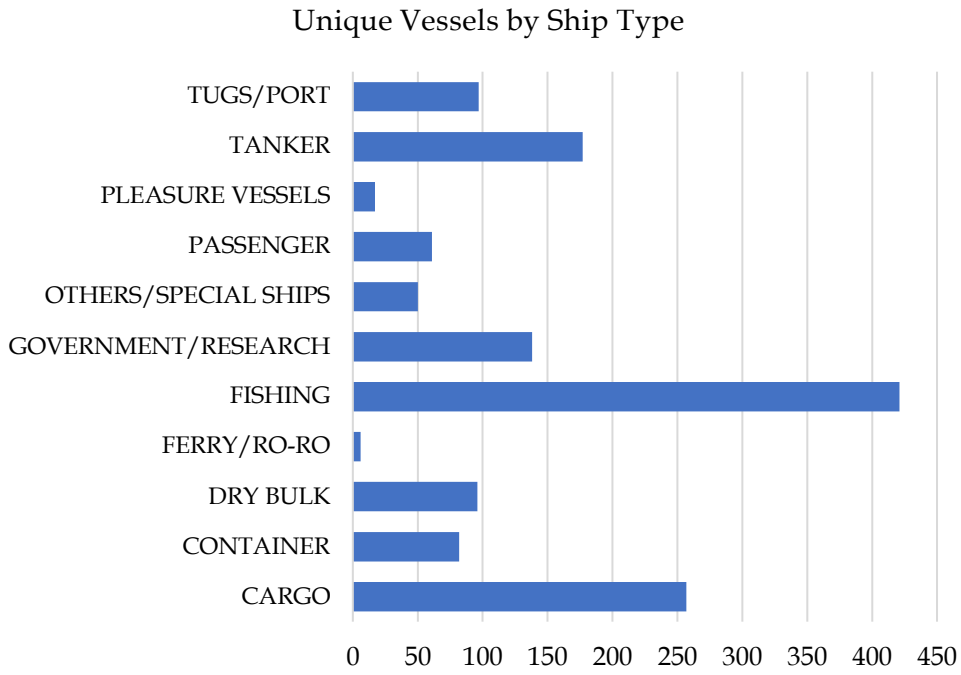
Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 – 2022 : Negative RIO per month



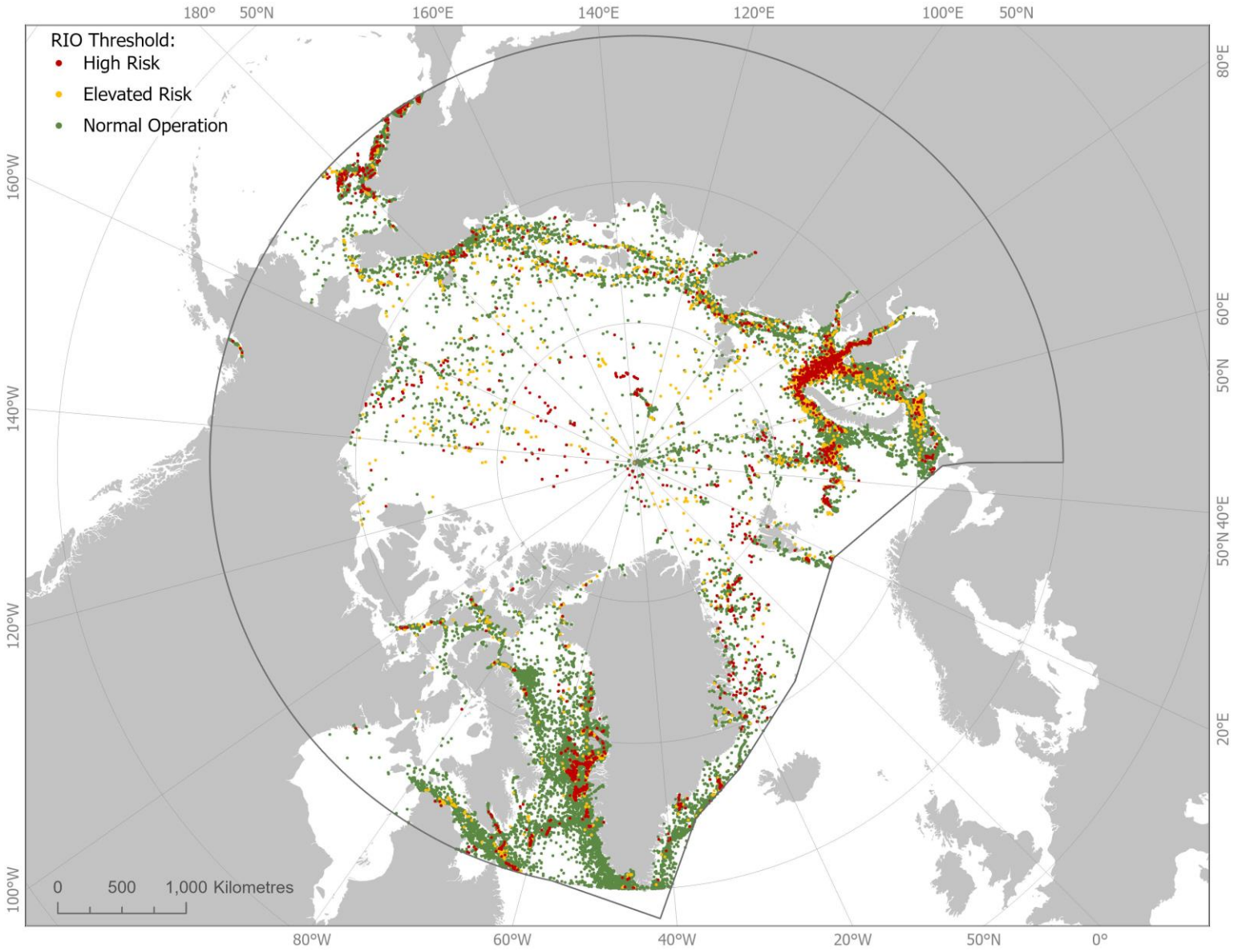


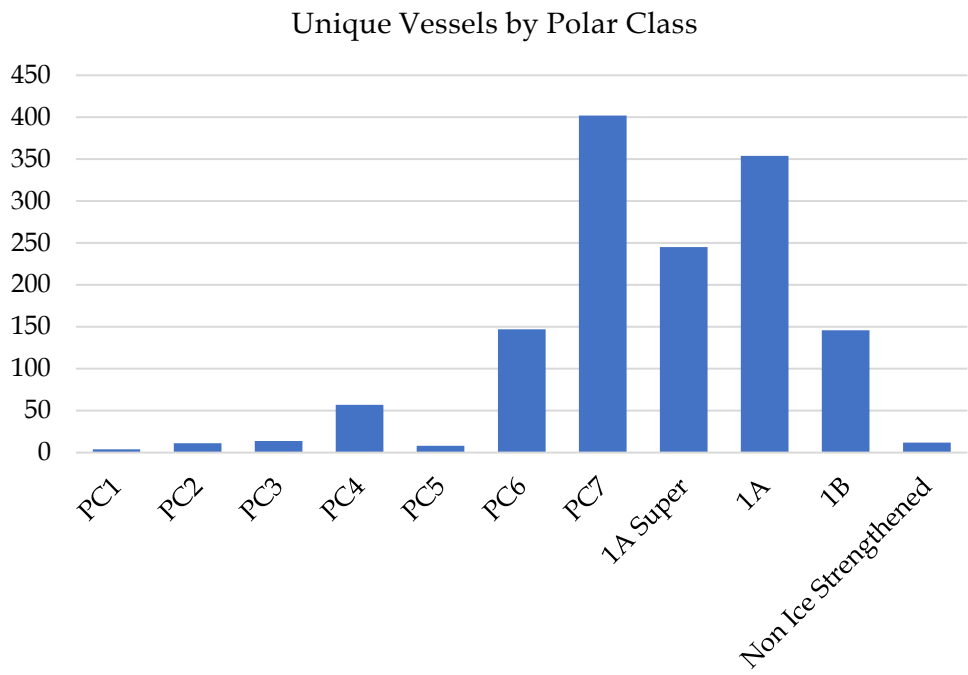
Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 – 2022 : Unique vessels by Ship Type



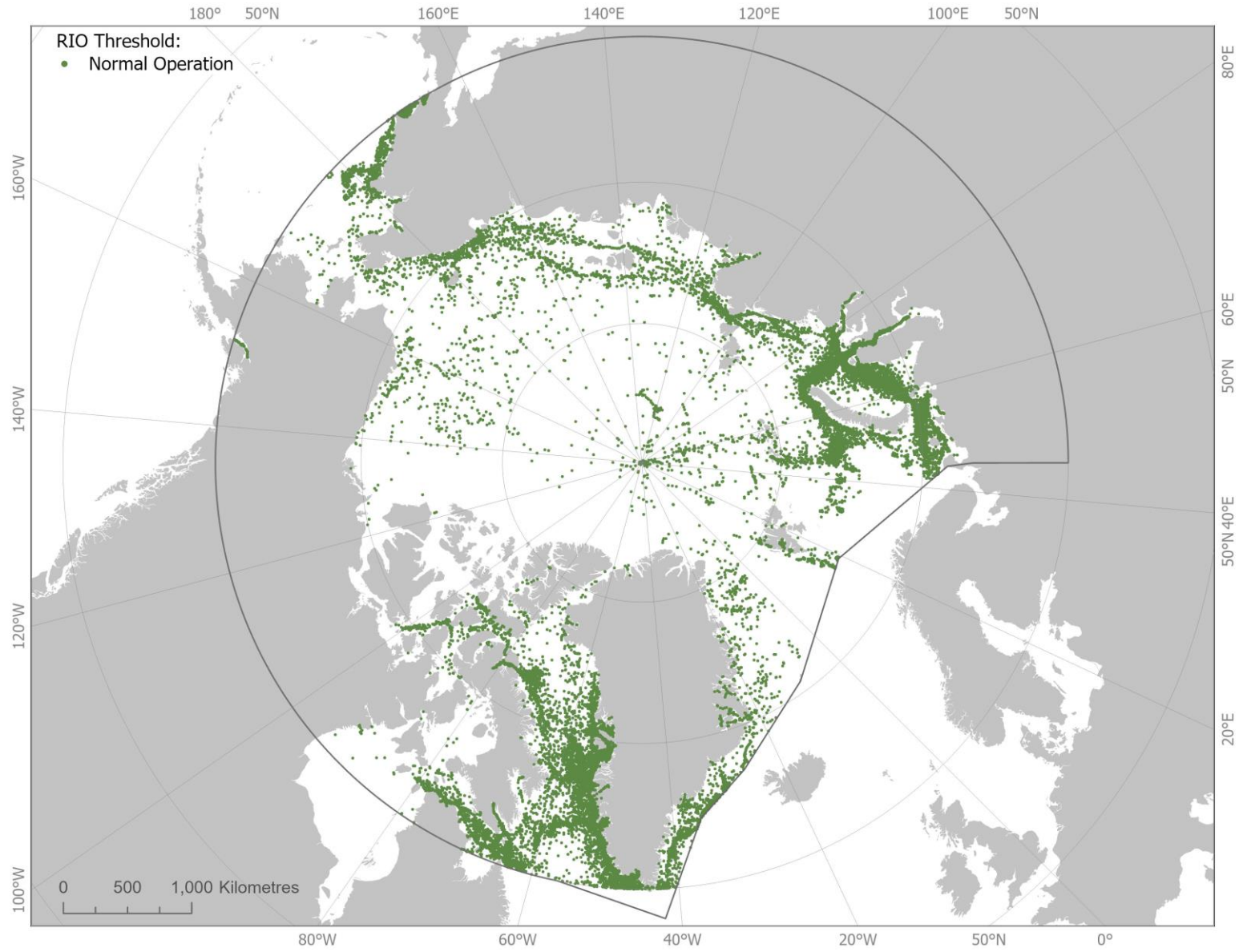


Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 - 2022 : Unique vessels by Polar Class





Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 – 2022 : Normal Operations

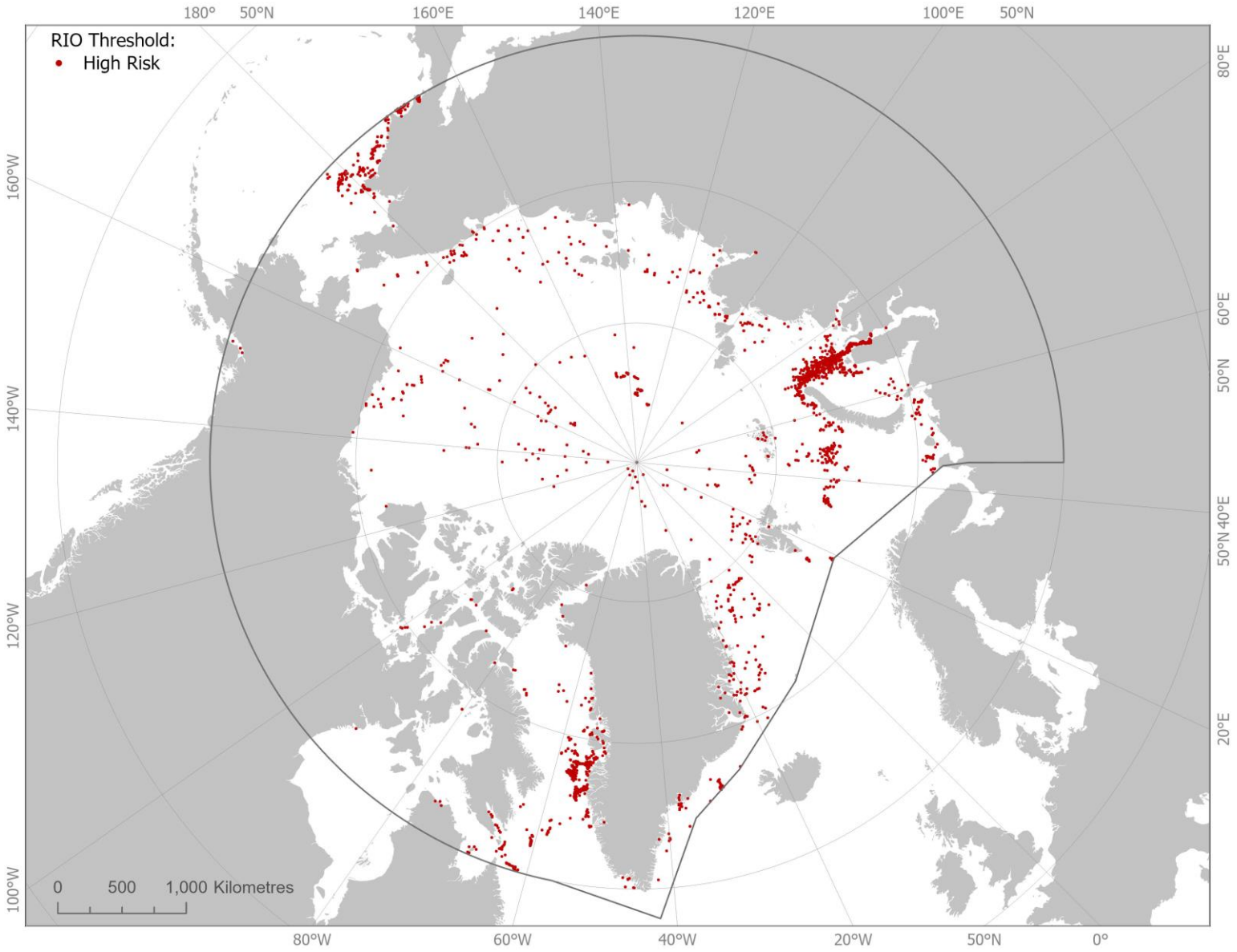


Normal Operation:
45,040 Ship Positions

- 87% of the daily ship positions in water with Ice Present.

- 1,367 Unique Ships

Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 – 2022 : High Risk

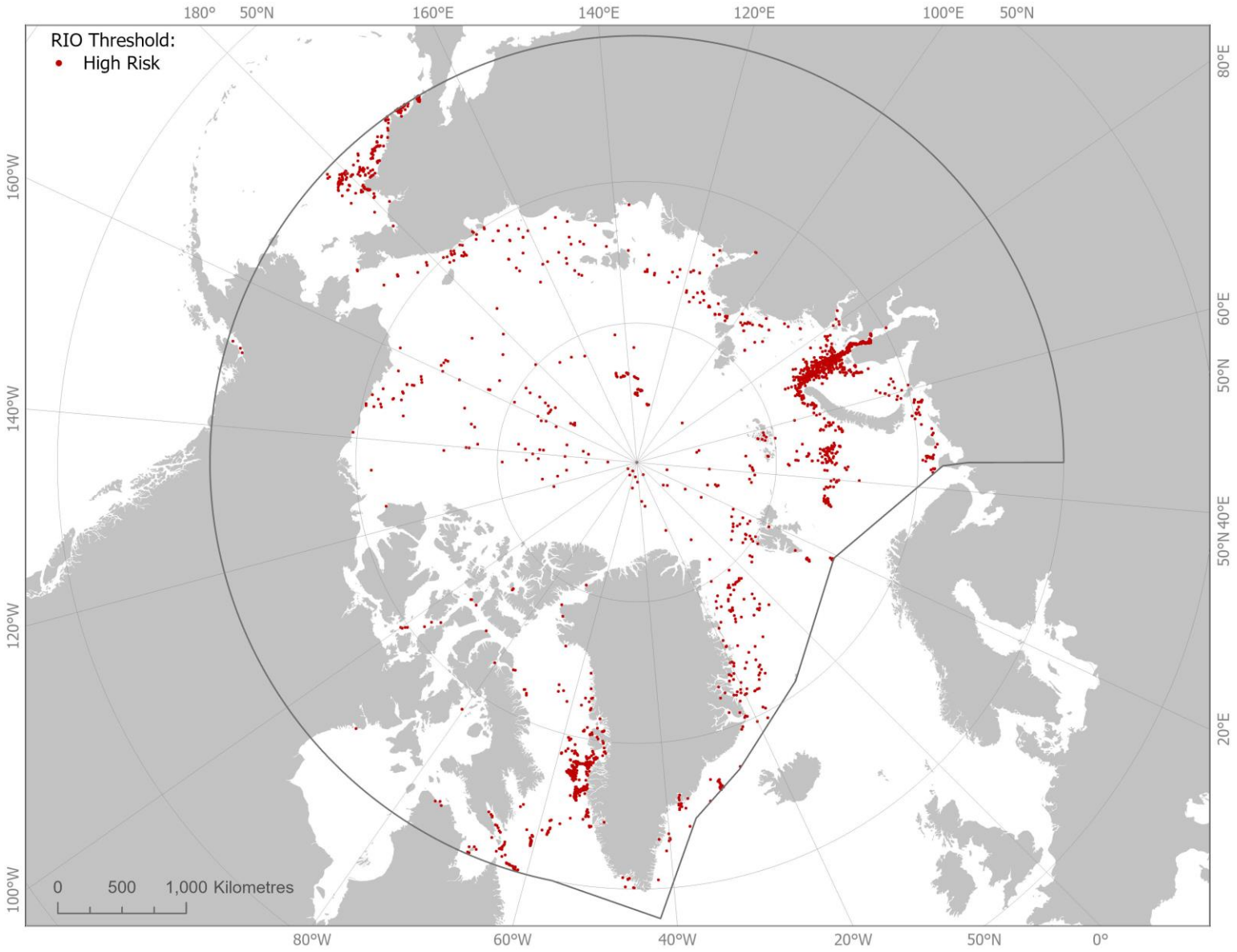


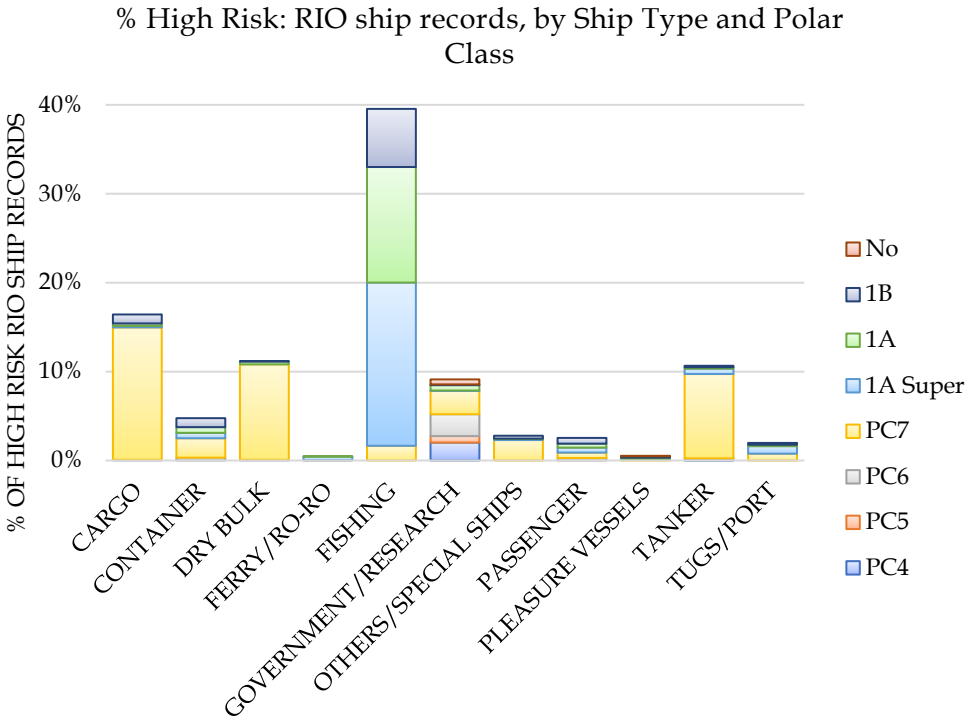
High Risk:
2,478 Ship Positions

- 5% of the daily ship positions in water with Ice Present.

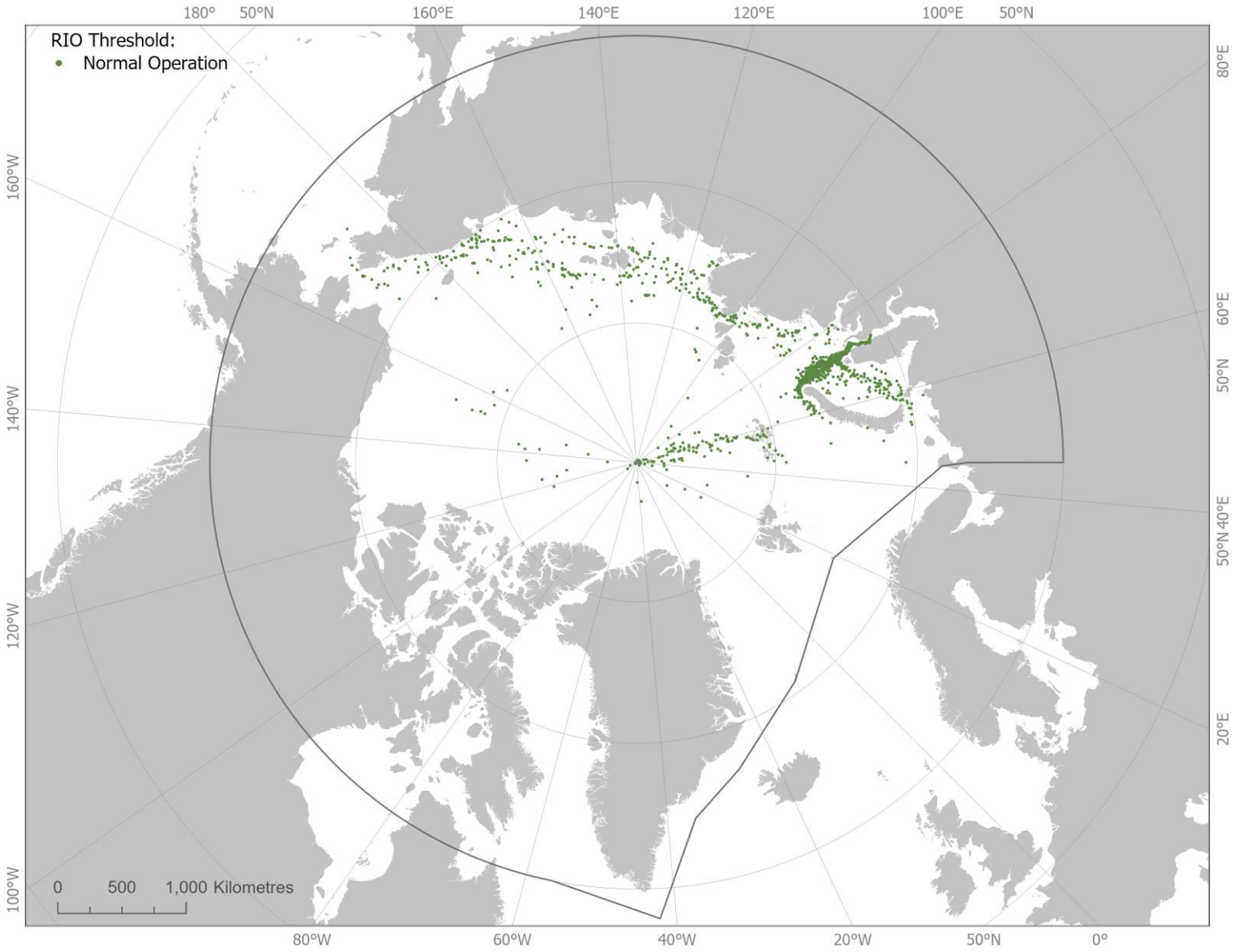
- 424 Unique Ships

Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 – 2022 : High Risk by Ship Type & Ice Class





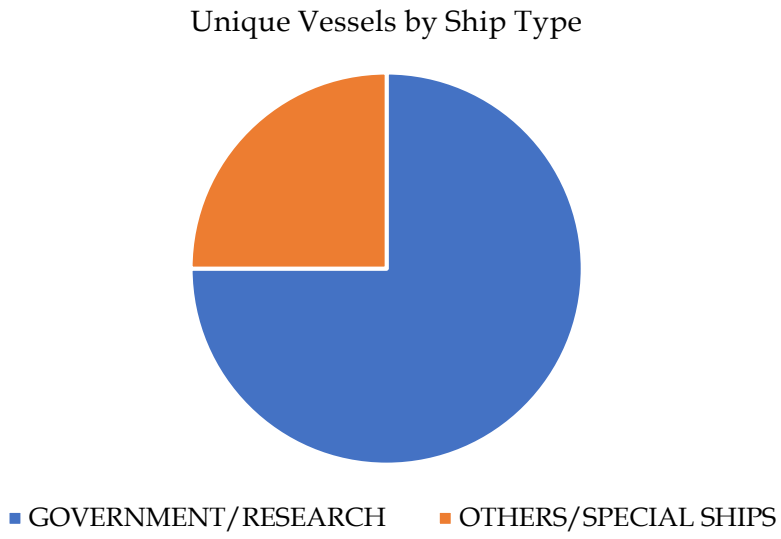
Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 - 2022 : Polar Class 1



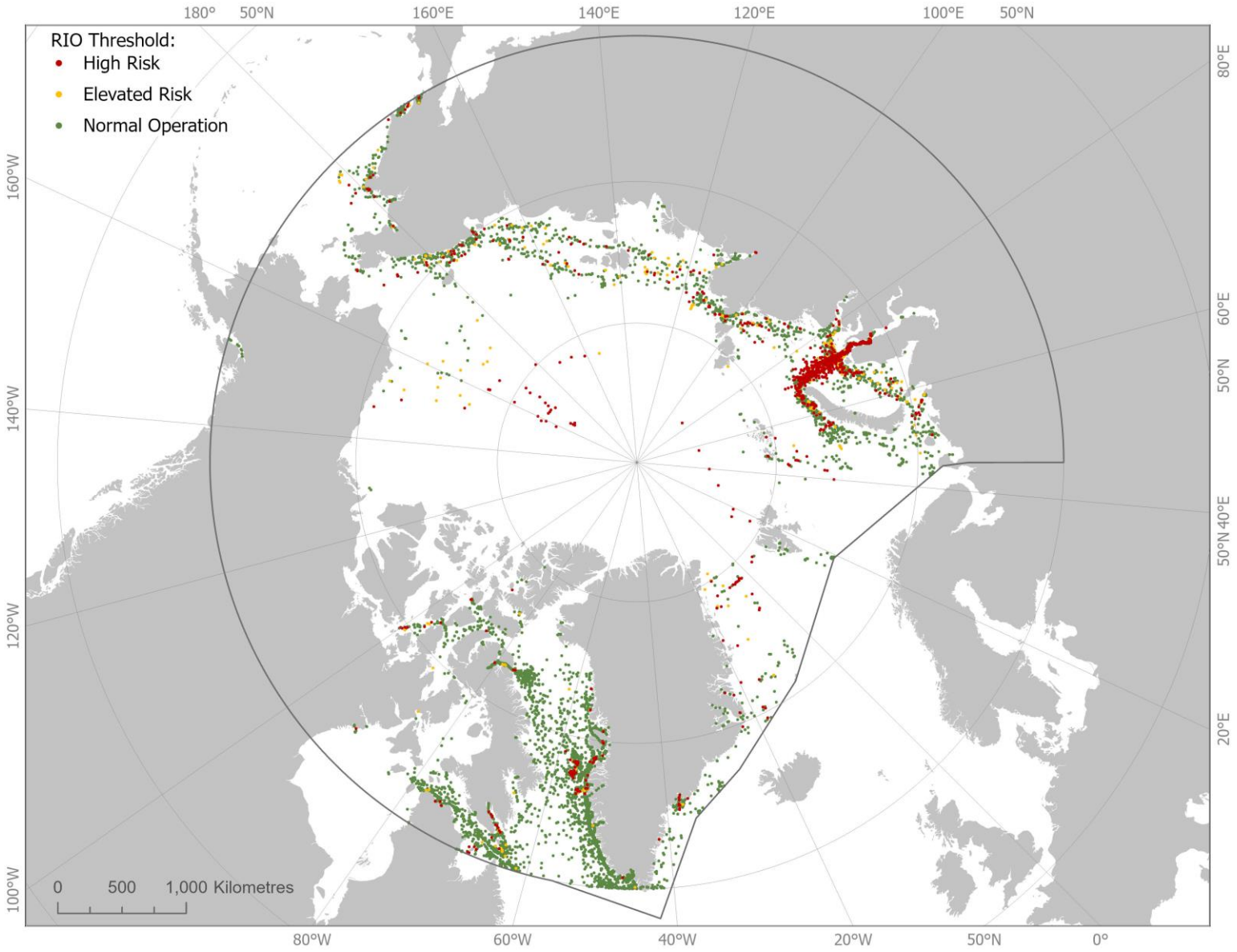
PC1

Normal Operation (100%)

- 4 Unique Ships



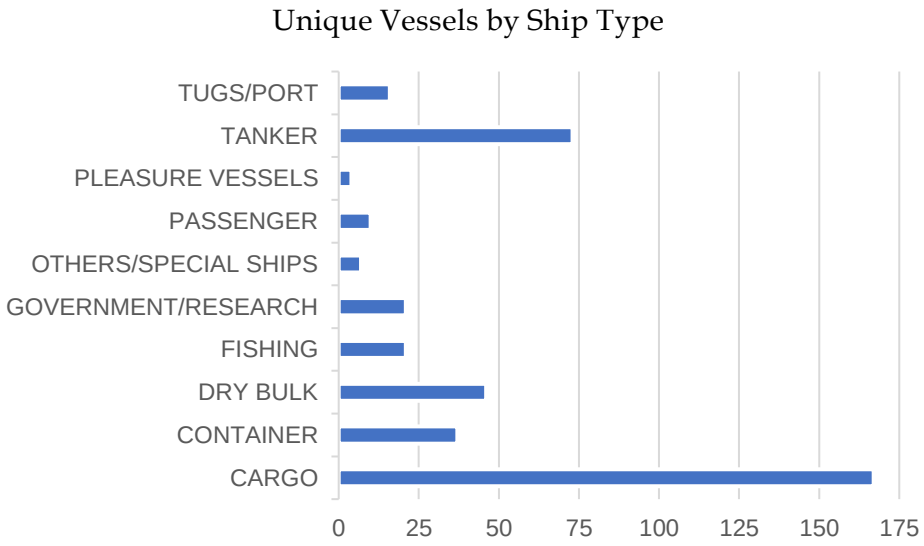
Daily Ship Positions Assigned an RIO Value From a POLARIS Chart
Ice Present: 2015 – 2022 : Polar Class 7



PC7

High Risk (14%)
Elevated Risk (4%)
Normal Operation (82%)

- 402 Unique Ships



Initial findings

- Results should not be viewed as an evaluation of compliance or non-compliance due to the scientific limitations involved in the approach - but the analysis is a good proxy for the relative levels of ‘risk’ emerging among operational vessels in the Arctic over this period.
- Relatively low number of vessels operating in elevated or high-risk ice conditions and the levels have remained relatively constant over time.
- Some indication of increased operation in high-risk ice areas in more recent years.
- Highest risk times of the year seem to be during break-up (April and May), with lower levels of risk in the summer and fall seasons.
- Western Greenland and the Russian Arctic are geographic regions with with most frequent operations in high-risk ice conditions.
- The ship type most often seen to be operating in high-risk ice conditions were non-ice strengthen fishing vessels, followed by medium ice strengthened cargo vessels and then tankers.

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