Trends in Arctic and Antarctic Vessel Activity

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Polar Maritime Seminar
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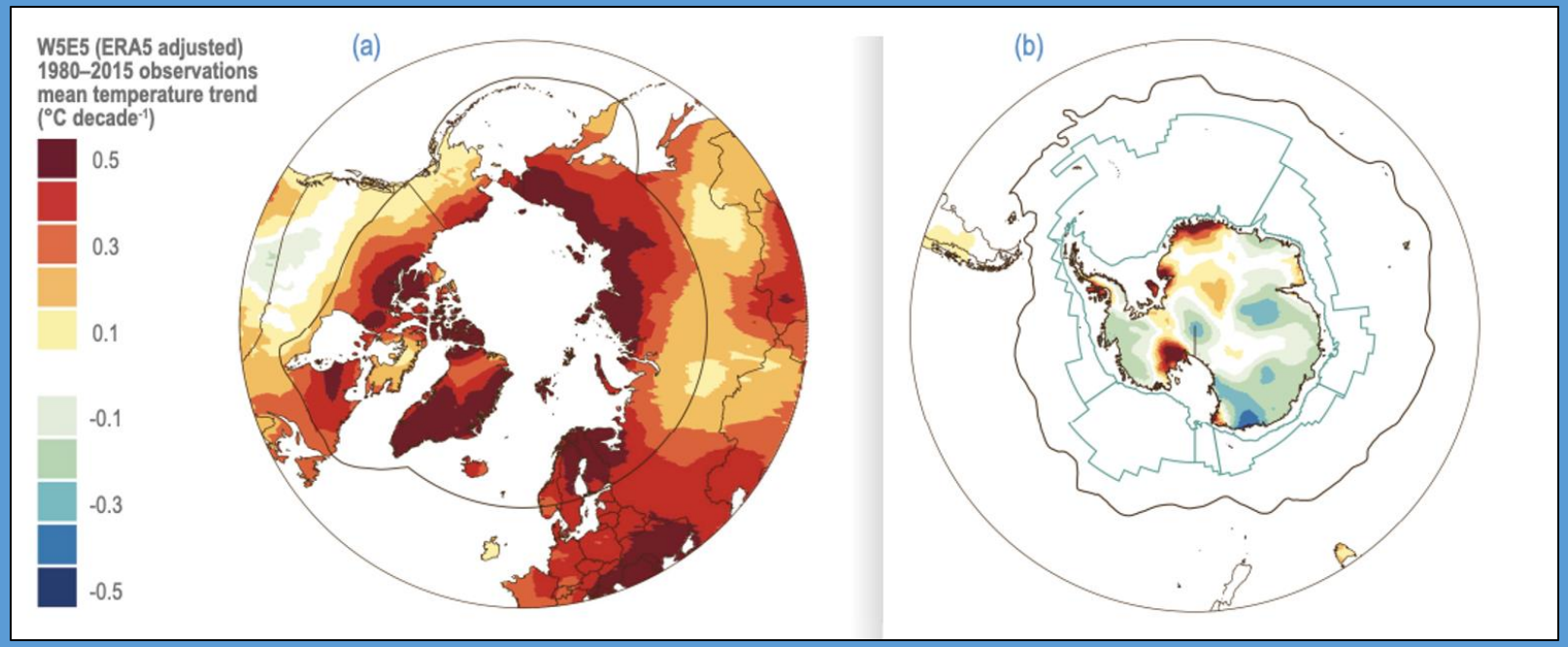
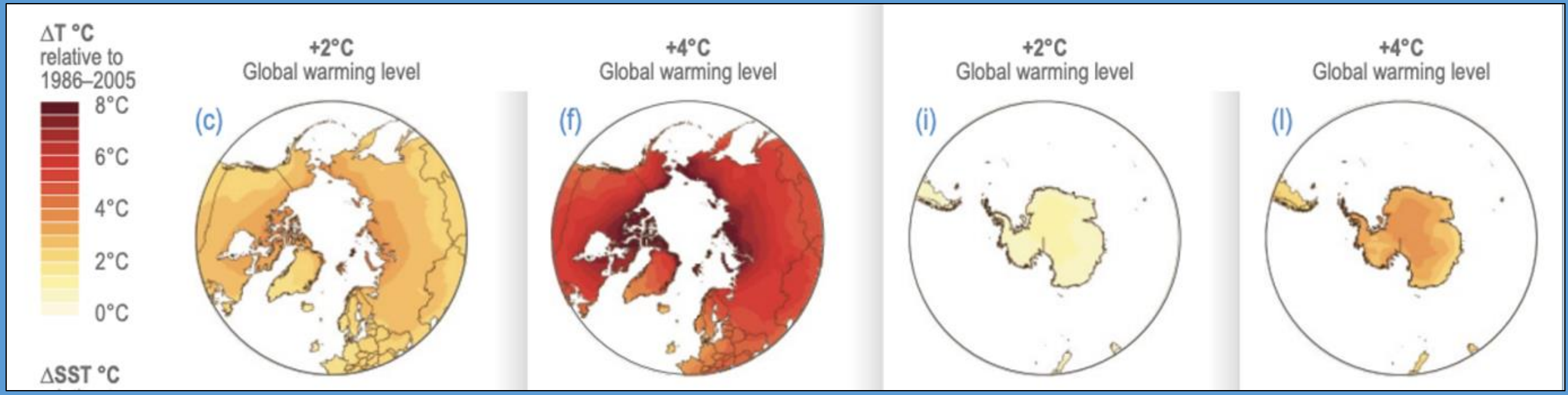
Outline

- Observed and Projected Warming in the Polar Regions
- Historic Shipping Patterns
- Arctic Accident Patterns
- POLARIS (RIO) as a Tool for Understanding Risk
- Indigenous Knowledge for Navigation

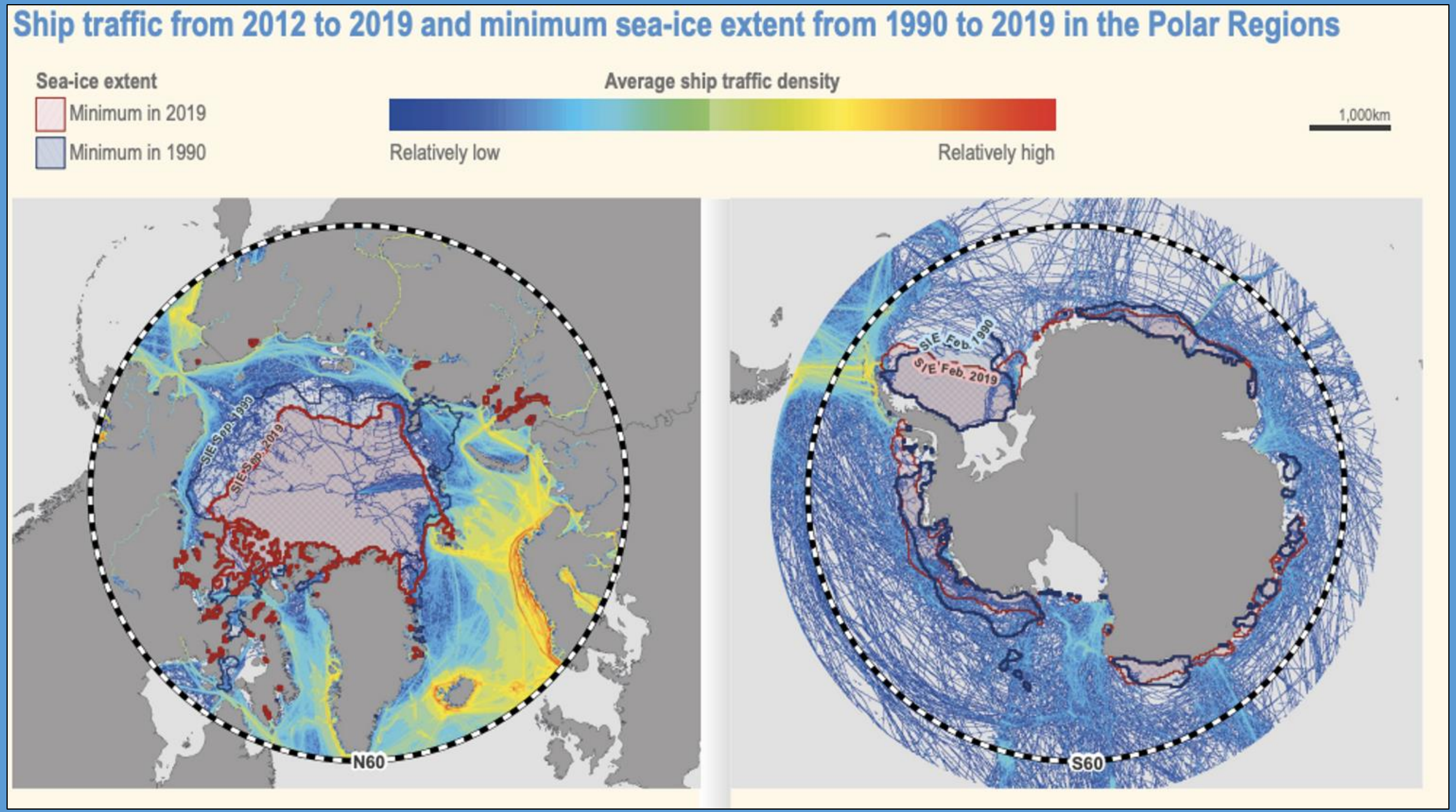
ESPG Environment, Society and Policy Group

Observed and Projected Warming in the Polar Regions





Ship traffic from 2012 to 2019 and minimum sea-ice extent from 1990 to 2019 in the Polar Regions



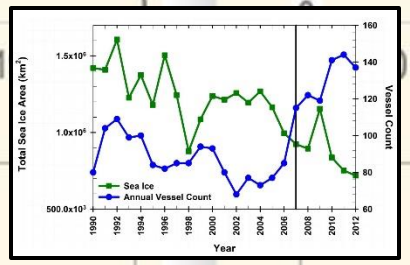
Minimum sea-ice extent (North of the 60th parallel)

Sea-ice extent millions of km²

Min. sea-ice extent 1990 vs 2019: **-29.9%**

Minimum sea-ice extent (South of the 60th parallel)

Min. sea-ice extent 1990 vs 2019: **-10.5%**



Sea-ice extent millions of km²

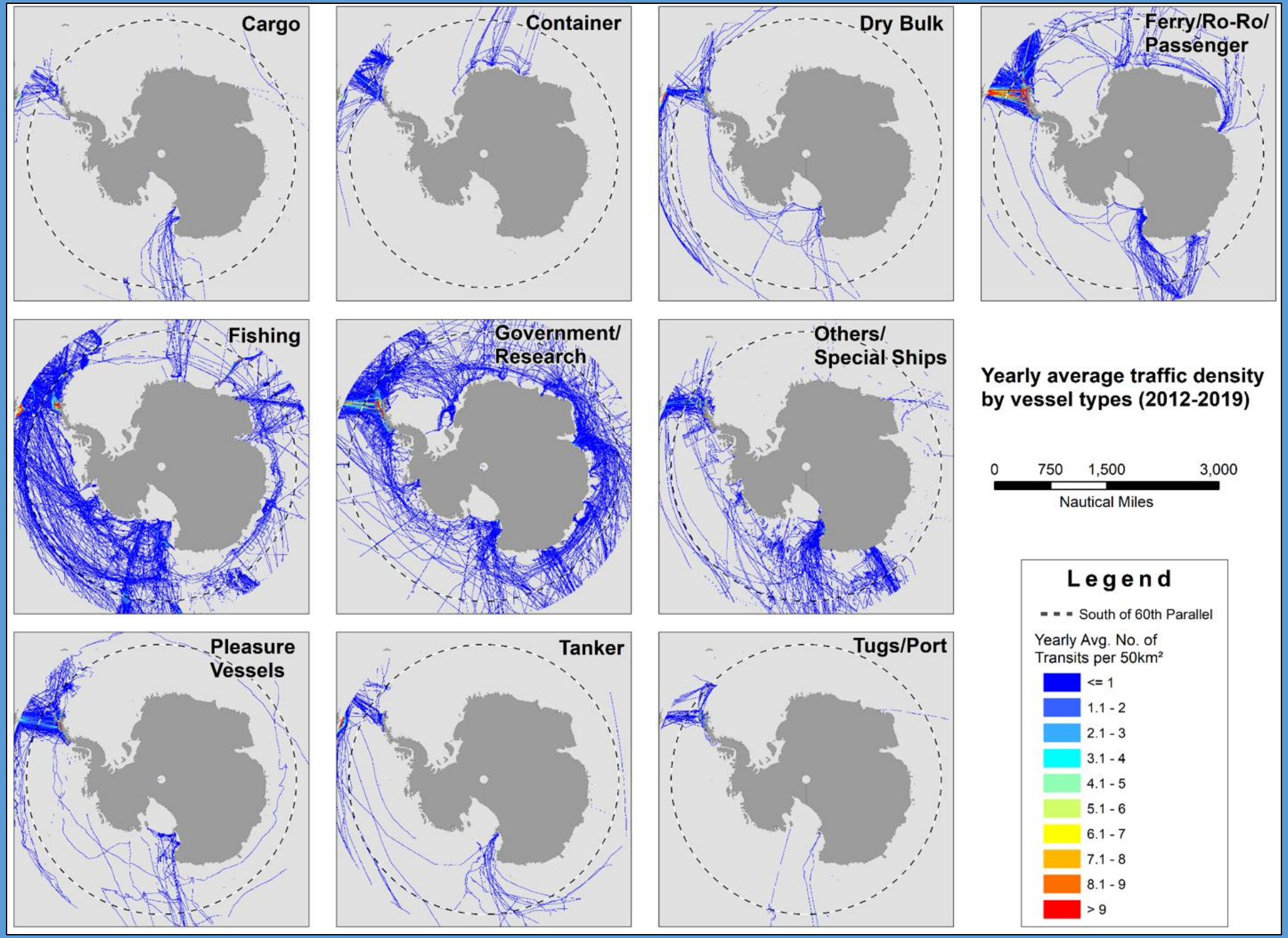
Ship traffic nm sailed

Min. sea-ice extent 2013 vs 2019: **-17.8%** All ship traffic 2013 vs 2019: **+70%**

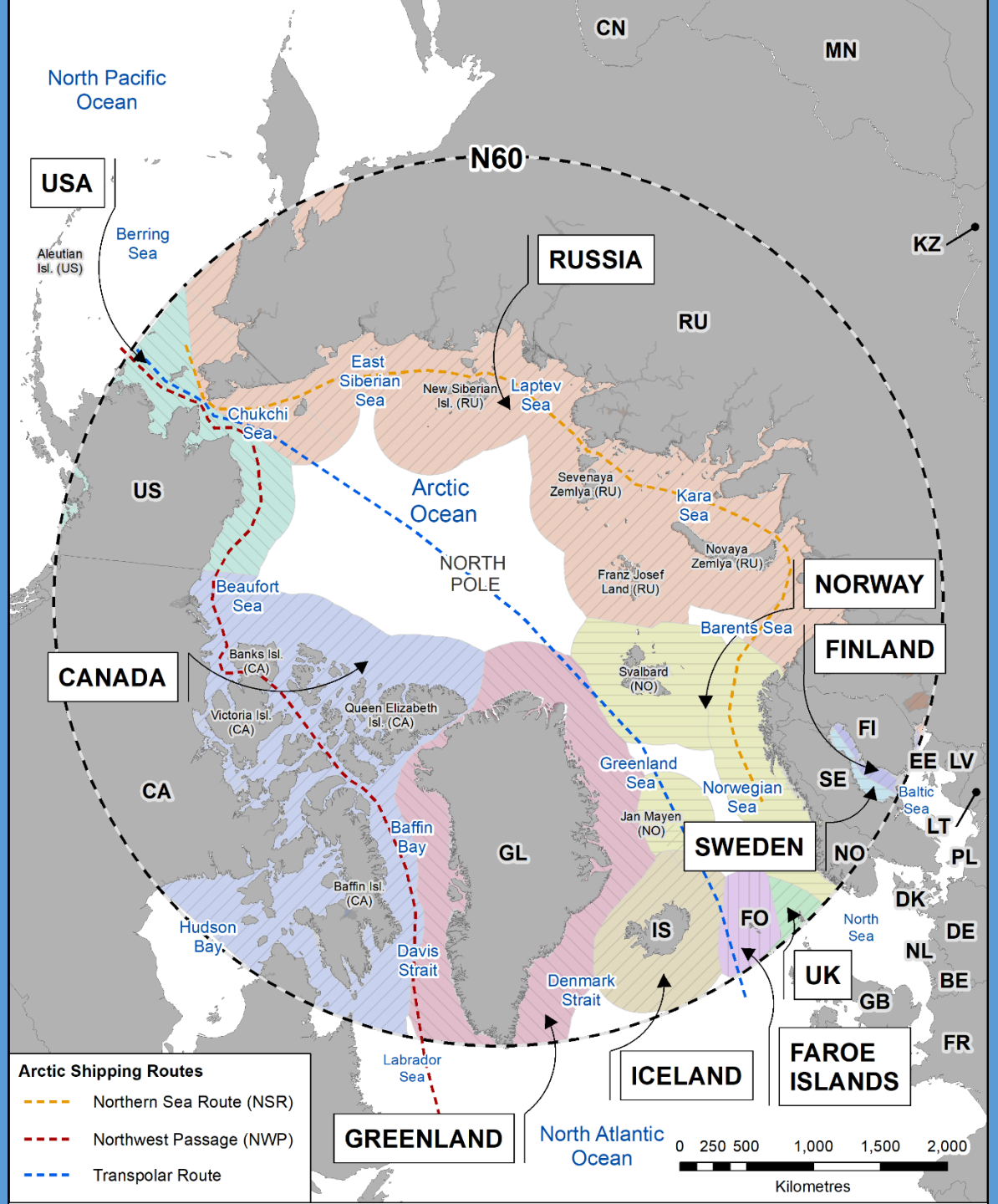
Sea-ice extent millions of km²

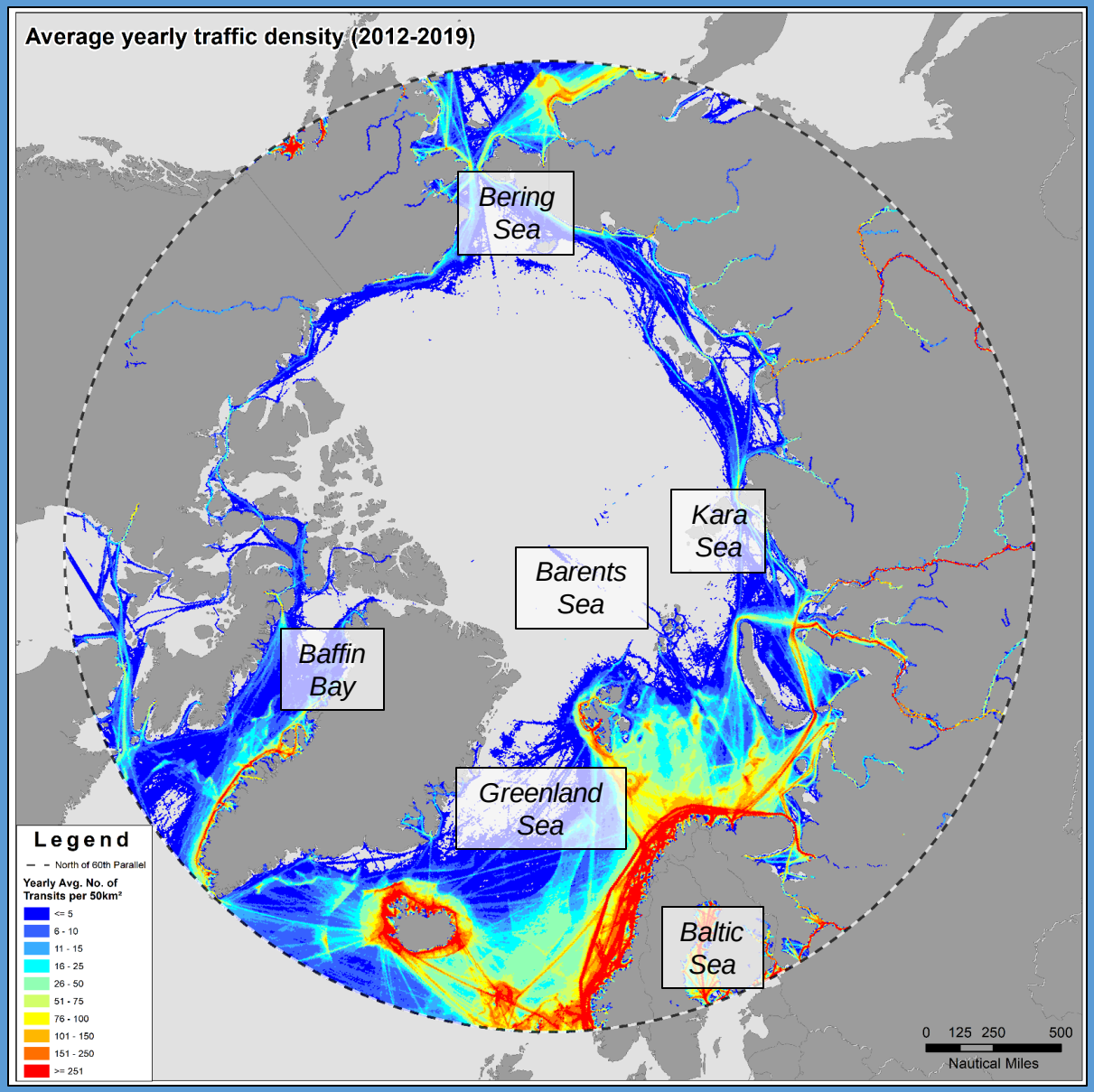
Ship traffic nm sailed

Min. sea-ice extent 2013 vs 2019: **-29.6%** All ship traffic 2013 vs 2019: **+62.6%**


Cargo
Container
Dry Bulk
Ferry/Ro-Ro/
Passenger
Fishing
Government/
Research
Others/
Special Ships
Pleasure
Vessels
Tanker
Tugs/Port
Yearly average traffic density
by vessel types (2012-2019)
0
750
1,500
3,000
Nautical Miles
Legend
South of 60th Parallel
Yearly Avg. No. of
Transits per 50km²
<= 1
1.1 - 2
2.1 - 3
3.1 - 4
4.1 - 5
5.1 - 6
6.1 - 7
7.1 - 8
8.1 - 9
> 9

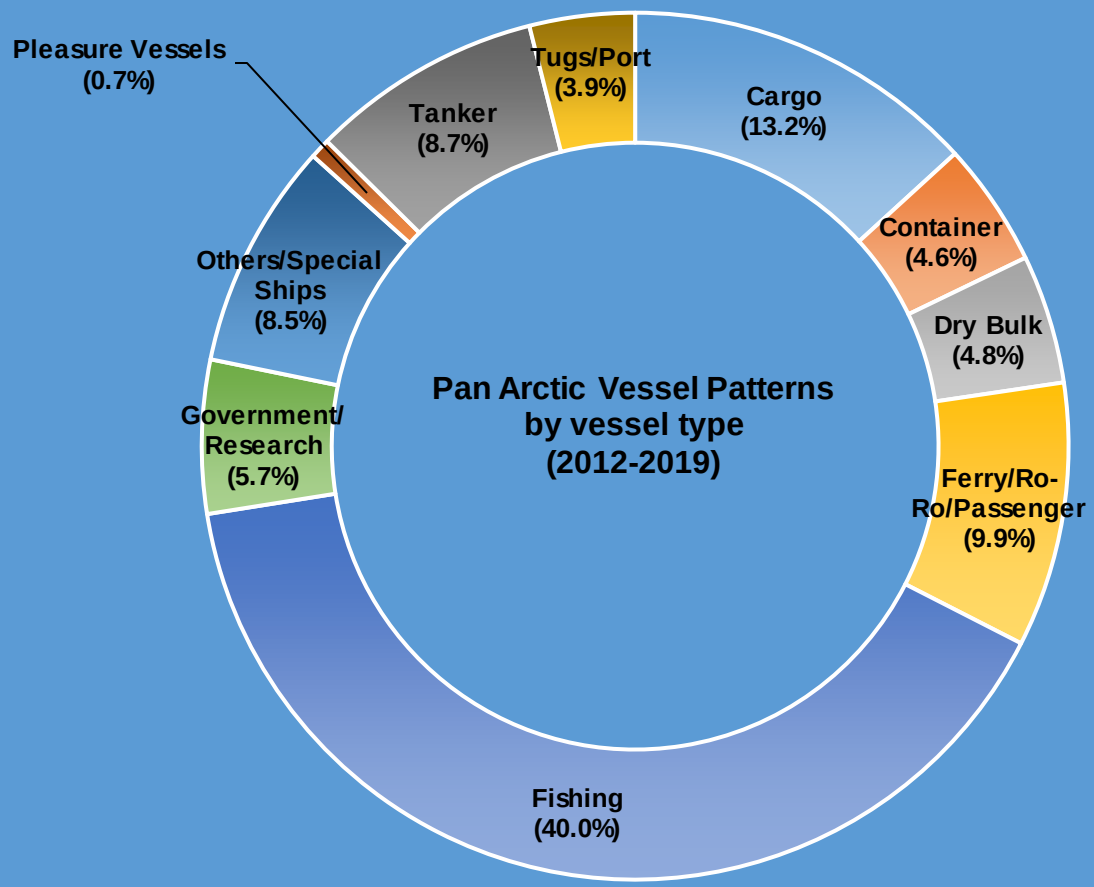
Adrian Nicol – thesis research

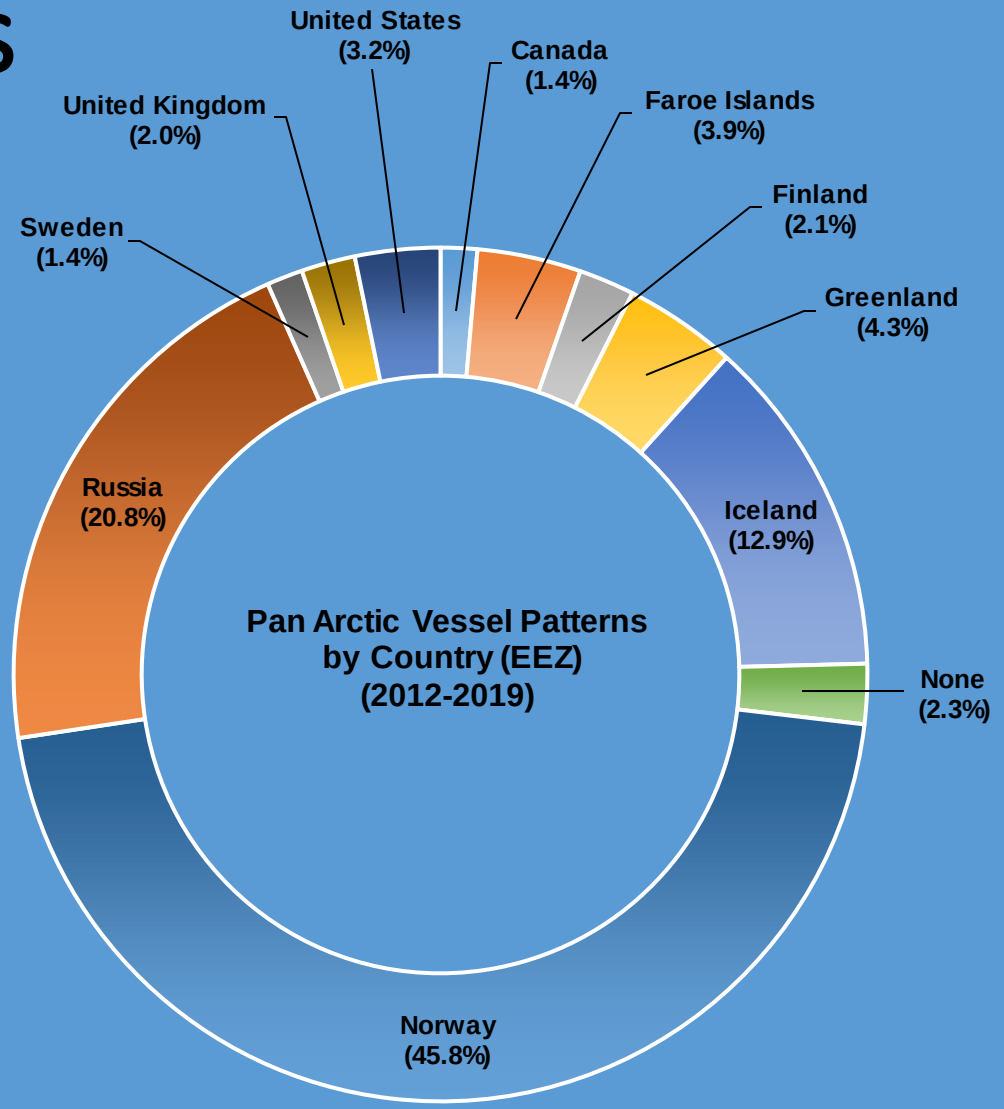




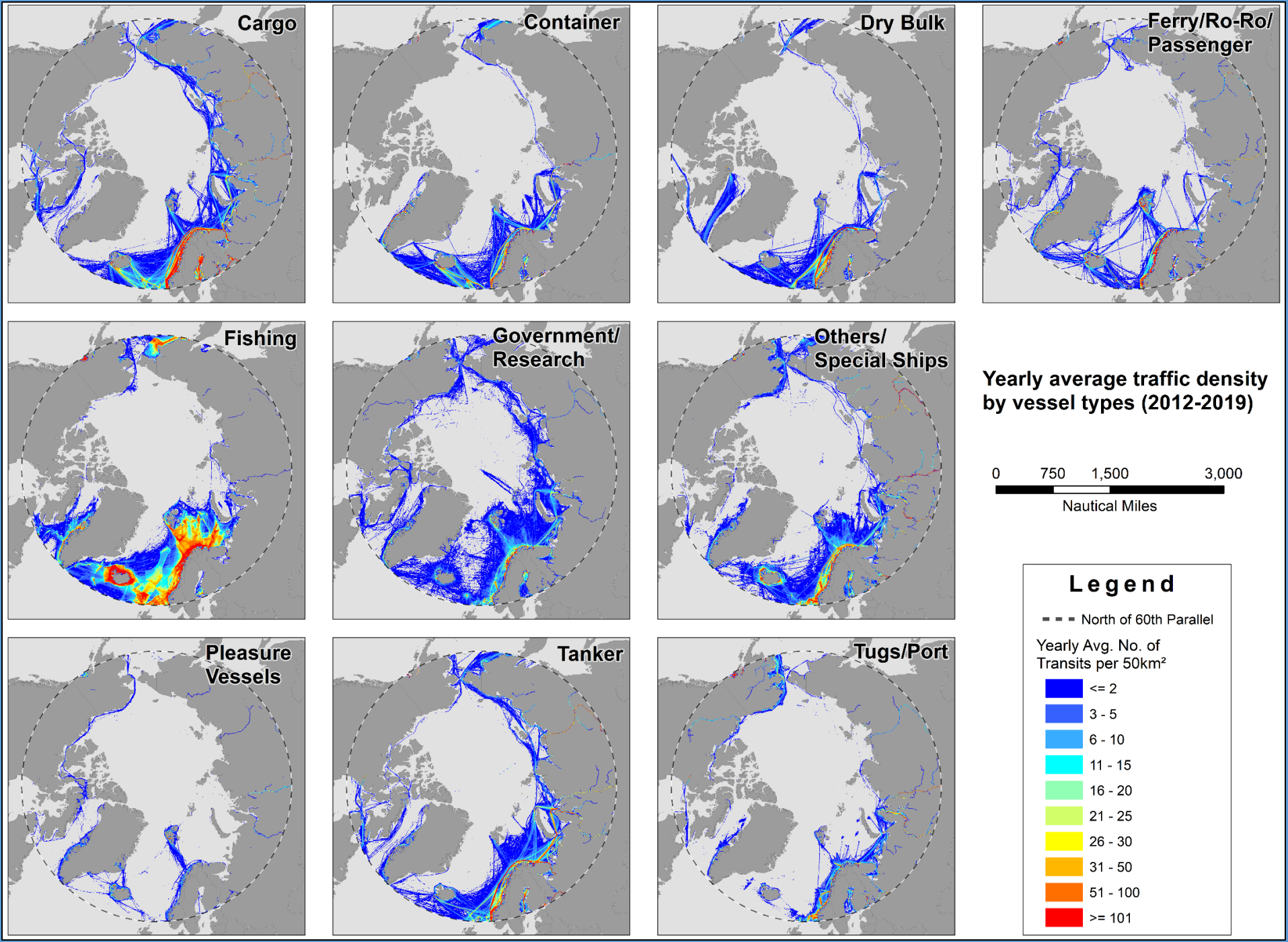
Map of the Pan Arctic (left); Map of the average yearly (2012-2019) traffic density at a resolution of 50 km² for all vessels (AIS) (right).

Pan Arctic Shipping Patterns





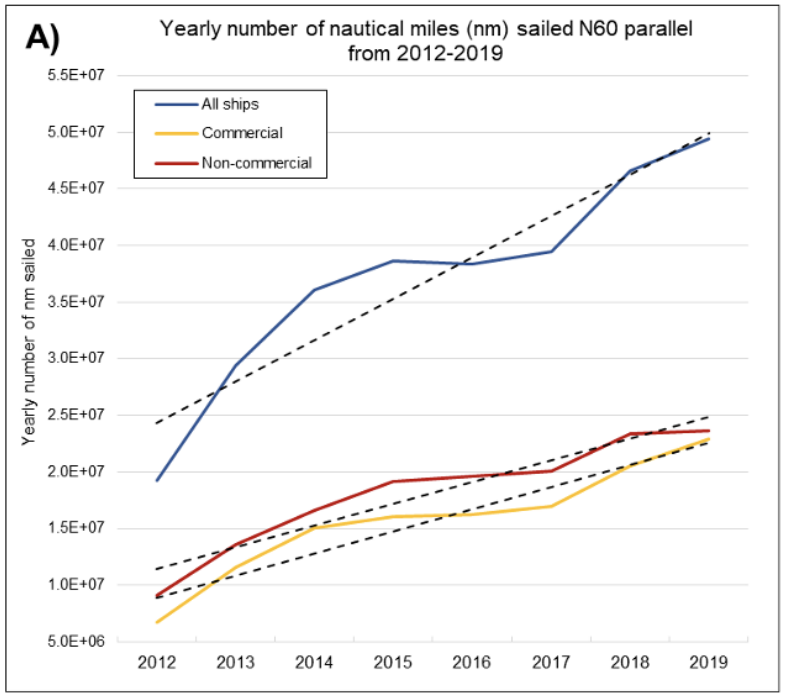
Proportions of the yearly average nm sailed by vessel type (left) and by country EEZ (right) North of 60th parallel (2012-19)



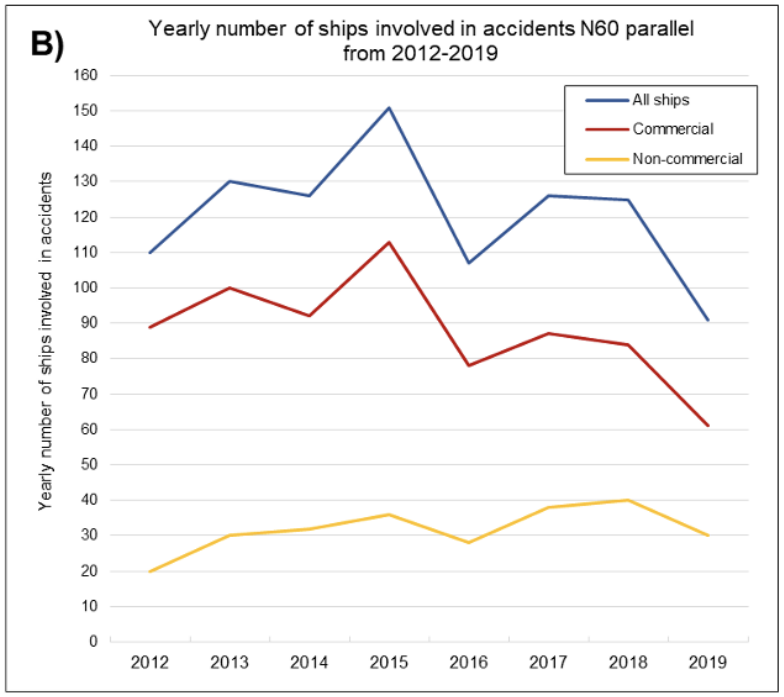
Maps of the average yearly (2012-2019) traffic density by vessel types at a resolution of 50 km² for all vessels captured by Satellite-AIS.

Pan Arctic Shipping Patterns - Accidents

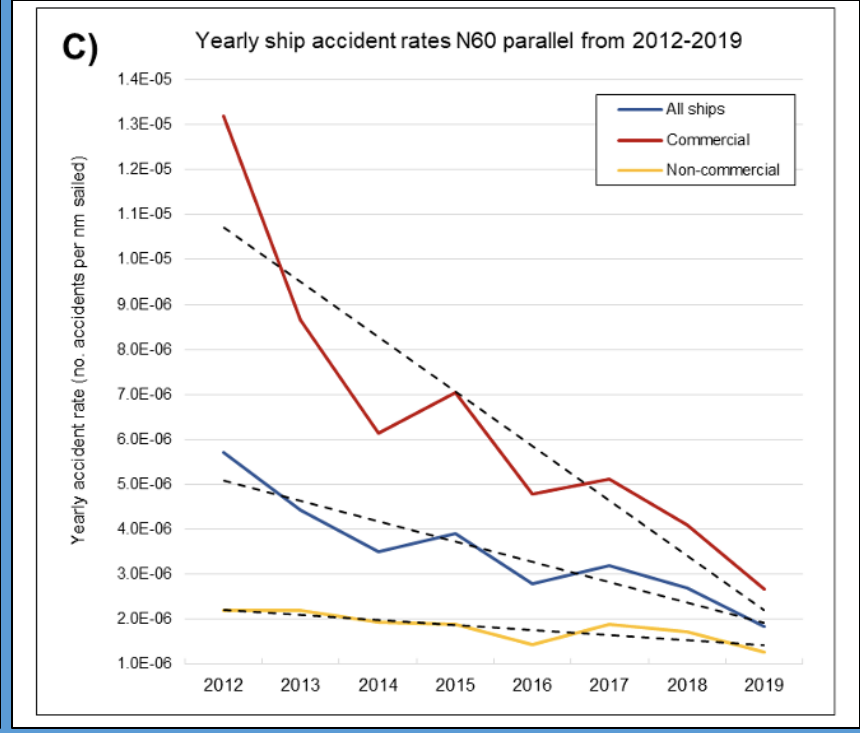
Total nm sailed



Number of accidents

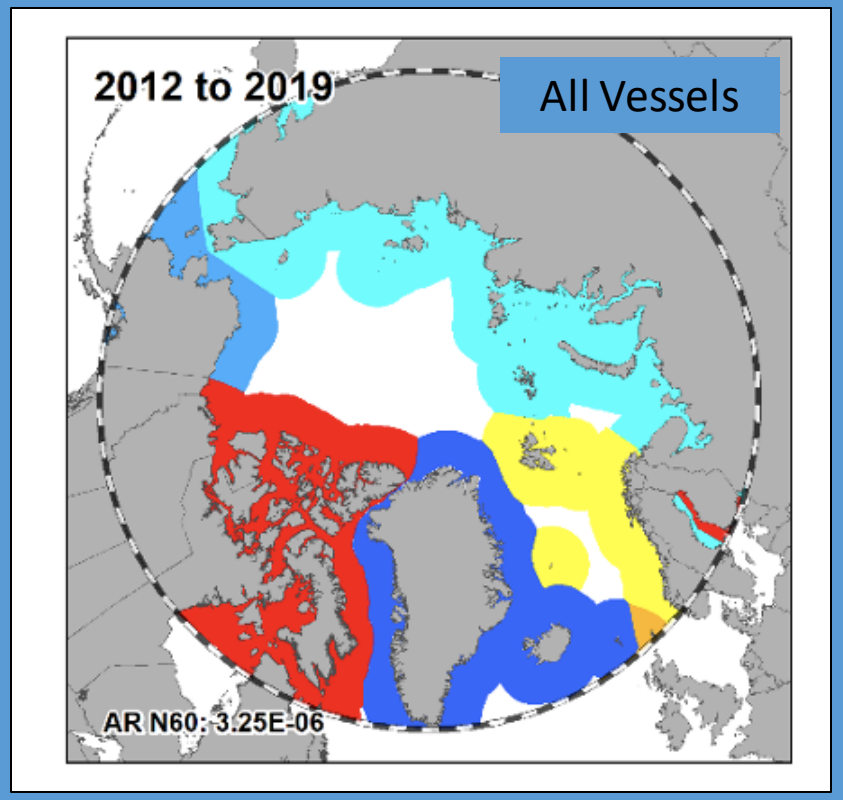


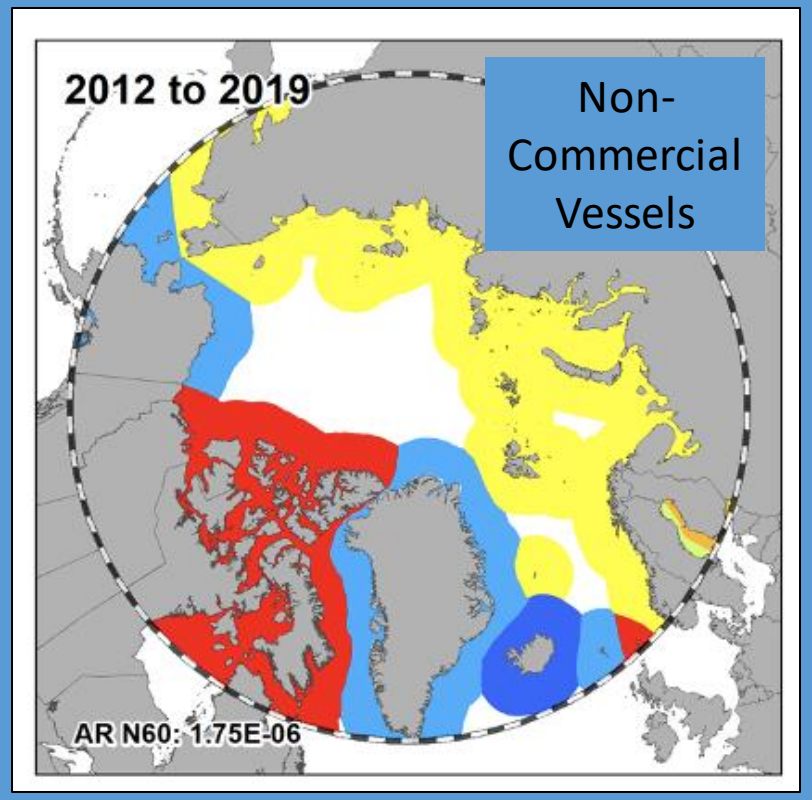
Accident rate

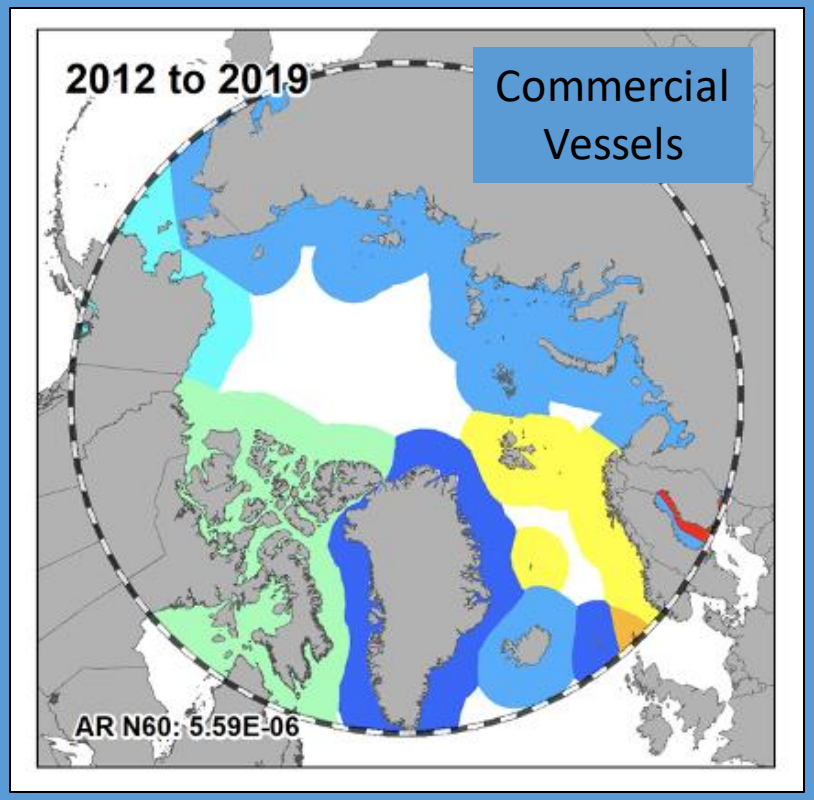


A) Yearly number of nautical miles (nm) sailed by all, commercial, and non-commercial ships (>300 GT) from 2012 to 2019 N60 parallel as recorded by S-AIS; dotted lines indicate trend(s). B) Yearly number of vessels involved in accidents by all, commercial, and non-commercial ships (>300 GT) from 2012 to 2019 N60 parallel as recorded by Lloyd's. C) Yearly accident rate (number of vessels involved in accidents per nm sailed) by all, commercial, and non-commercial ships (>300 GT) from 2012 to 2019 N60 parallel; dotted lines indicate trend(s).

Pan Arctic Shipping Patterns - Accidents







Maps of the relative difference (%) per EEZ from the N60 2012 to 2019 accident rate for all non-commercial ships >300 GT, for 2012 to 2019 and for each year from 2012 to 2019. Locations in blue indicate a negative difference (i.e., lower accident rate), whereas locations in red indicate a positive difference (i.e., higher accident rate) from the N60 2012 to 2019 accident rate for all non-commercial ships >300 GT. Text on bottom left of each sub-map indicate the accident rate for all non-commercial ships >300 GT for the time-period, where the percentage represents the relative difference of the year compared to N60 2012 to 2019 accident rate.

POLARIS – Changing Levels of Navigational Risk

Operational risk depends on (Polar Code):

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

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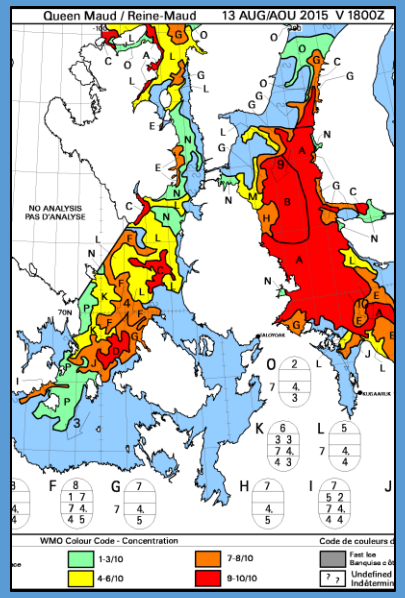
Ice Concentration



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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	Thin First Year Ice less than 1 m thick	Medium First Year Ice	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

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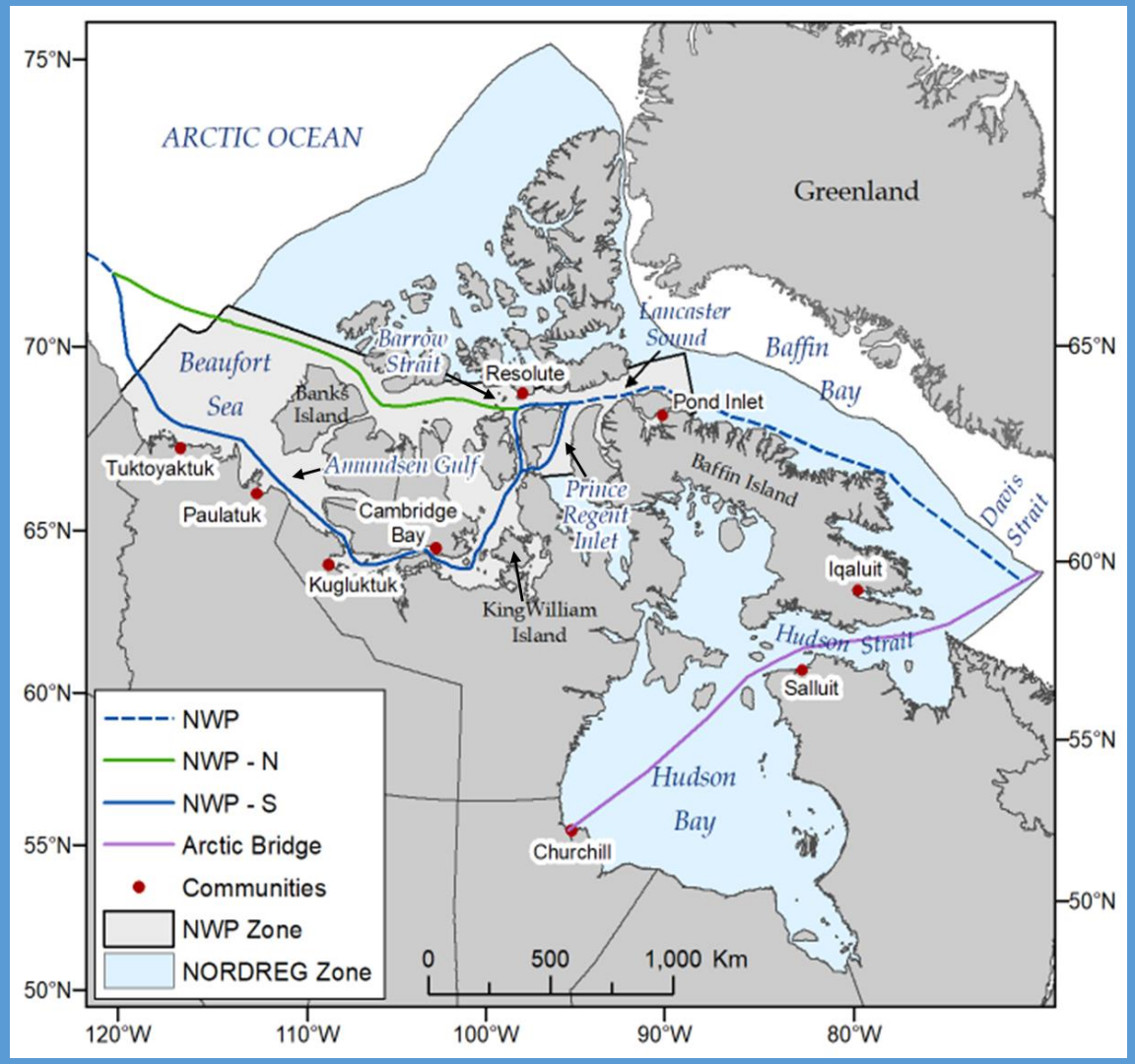
Risk Index Outcome (RIO)

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

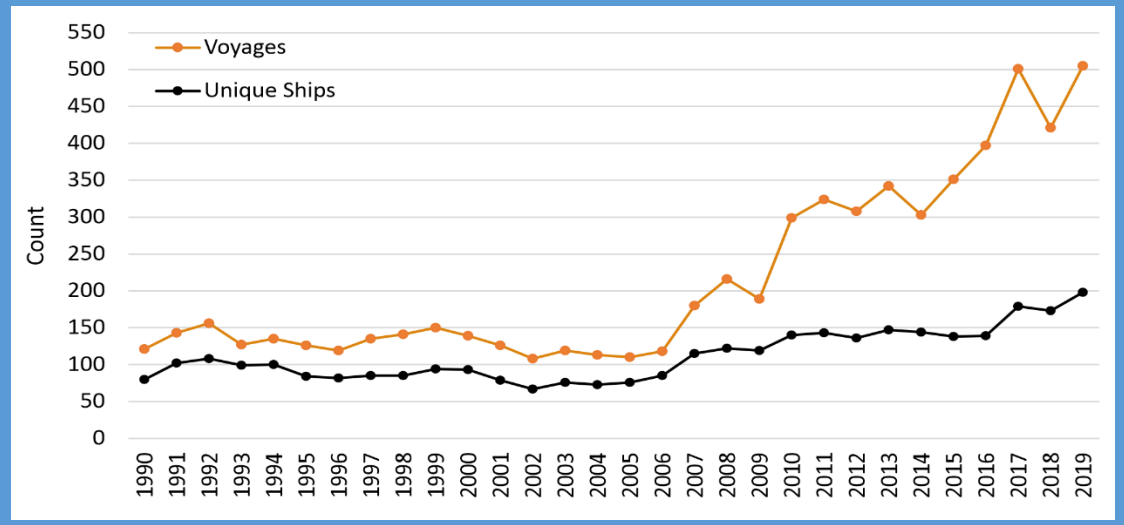
Methods for calculating RIO values that were compared against ship position reports

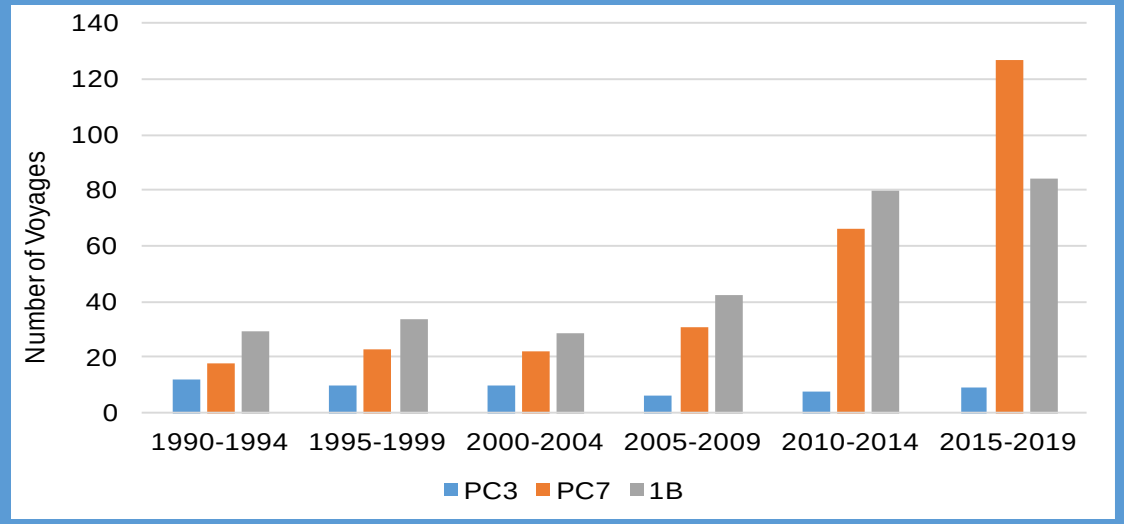
$$RIO = (C_1 \times RIV_1) + (C_2 \times RIV_2) + (C_3 \times RIV_3) + \ldots (C_n \times RIV_n)$$

Canadian Arctic Shipping Patterns



Map of NORDREG Zone

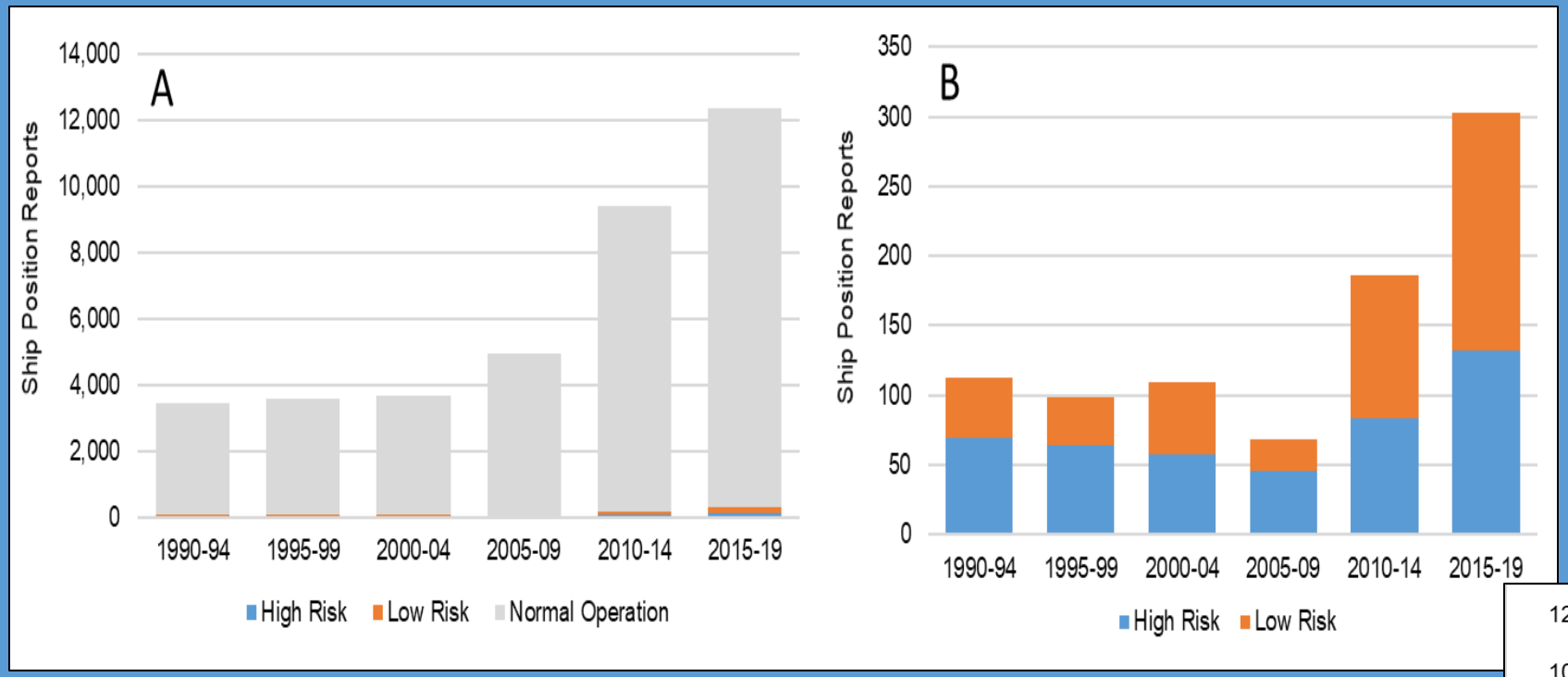




Mean annual unique ship counts in the NORDREG zone- all ships (top) and by ice-class (bottom)

Dawson et al. 2022

Canadian Arctic Shipping Patterns - Risk

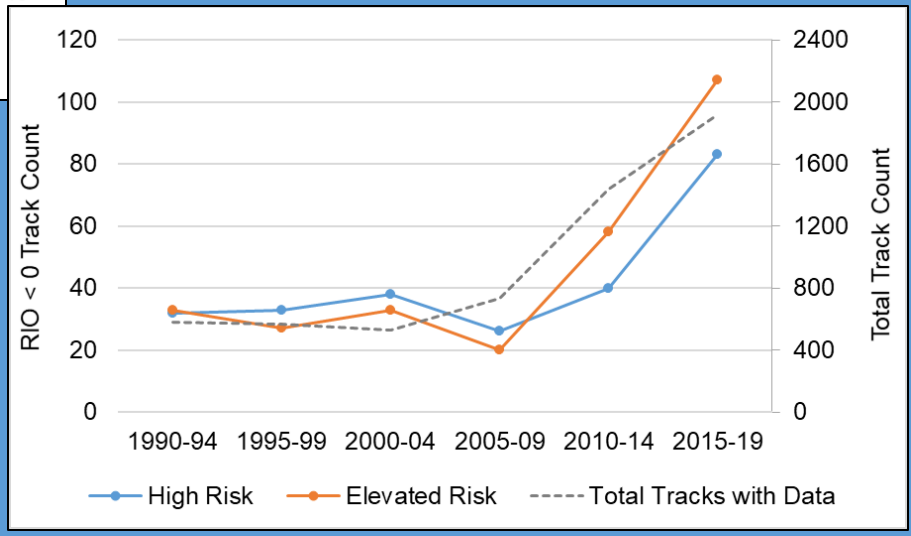


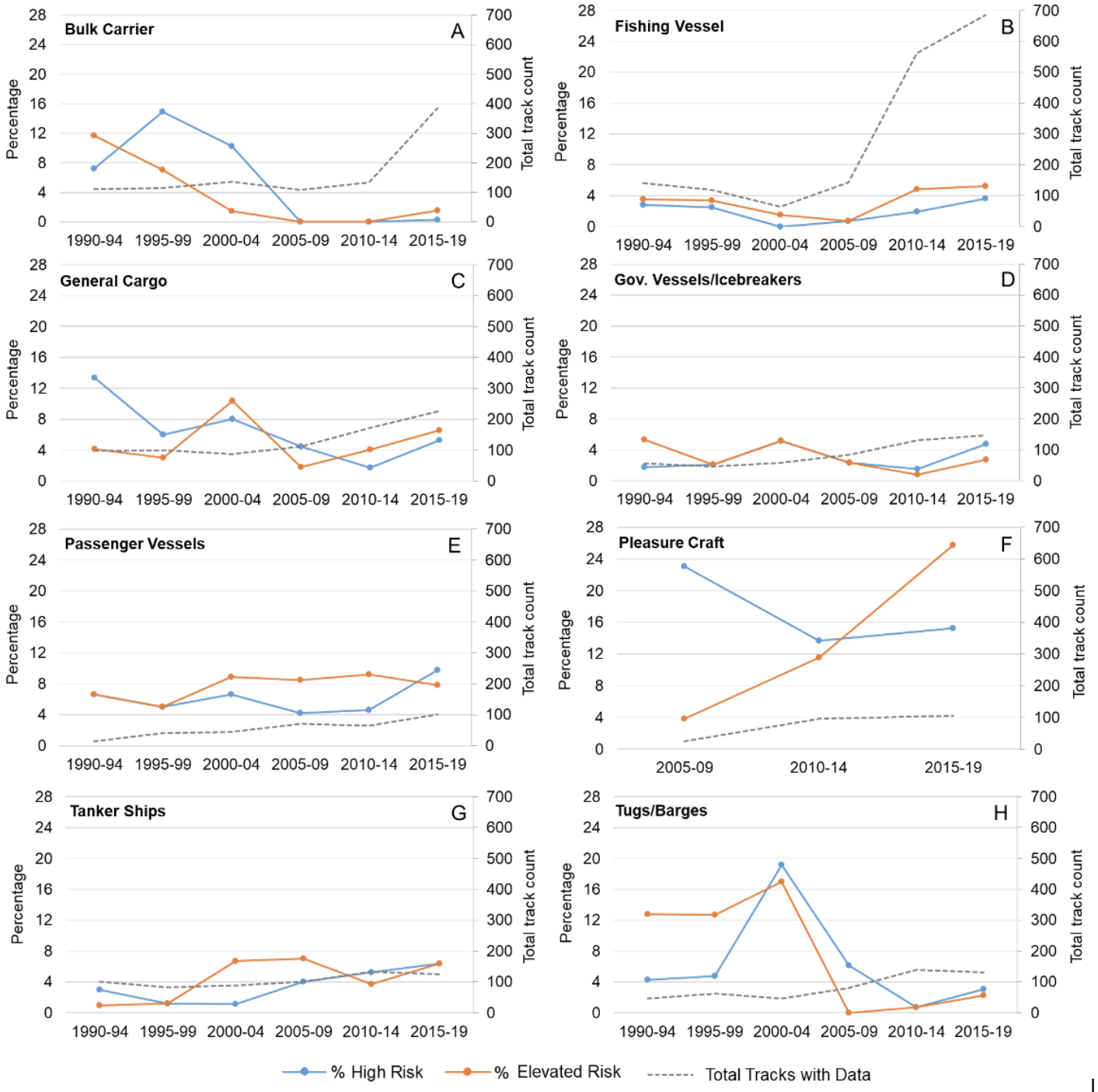
(A) Total count of ship tracks with RIO values for 5-year time intervals between 1990 and 2019, categorized by risk thresholds; (B) highlighting only high and elevated risk categories (left); over time (right)

RIO values assigned to **37,520 ship position reports** for 1990-2019

Majority of ship position reports (>~96%) in normal category

1-2% in low and high risk categories, but total number increasing over time



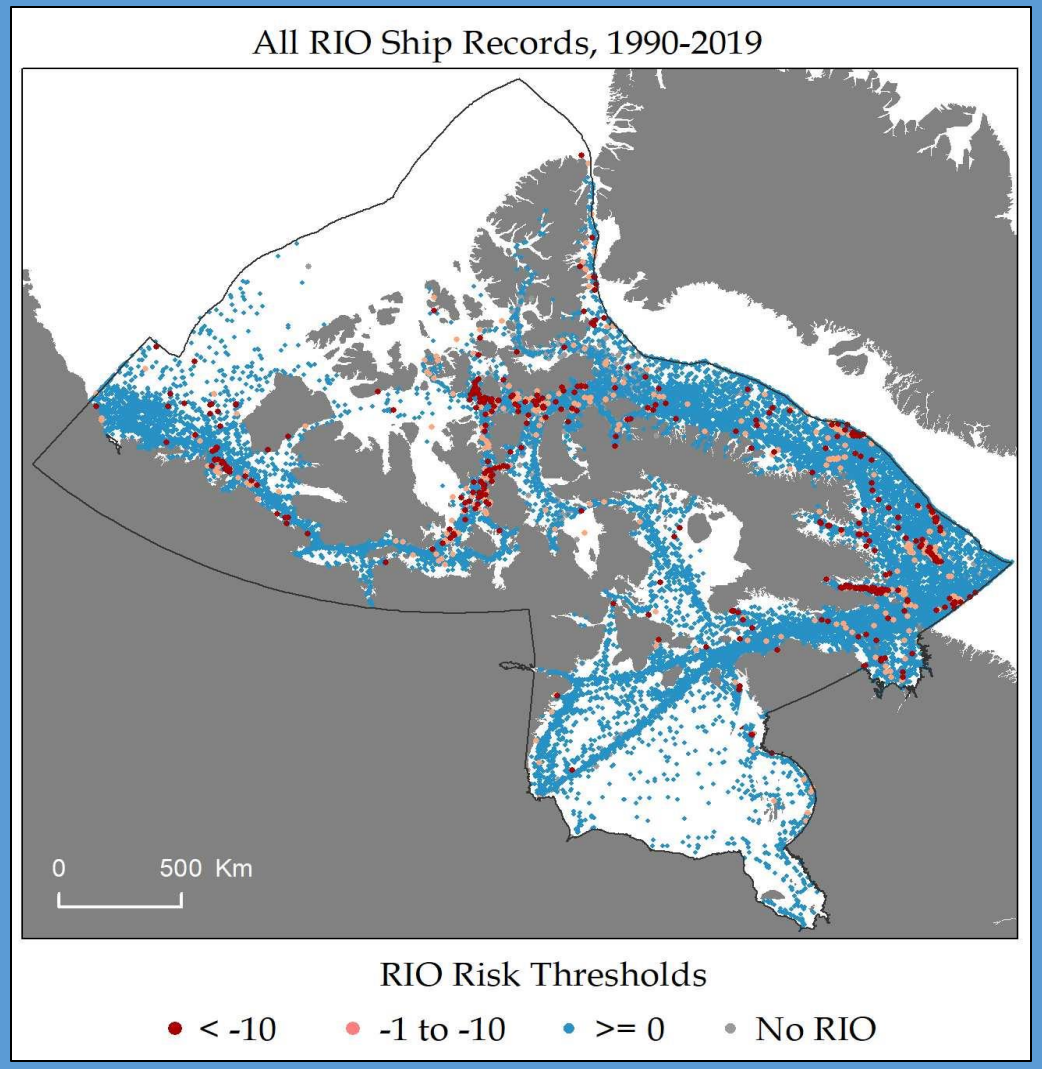


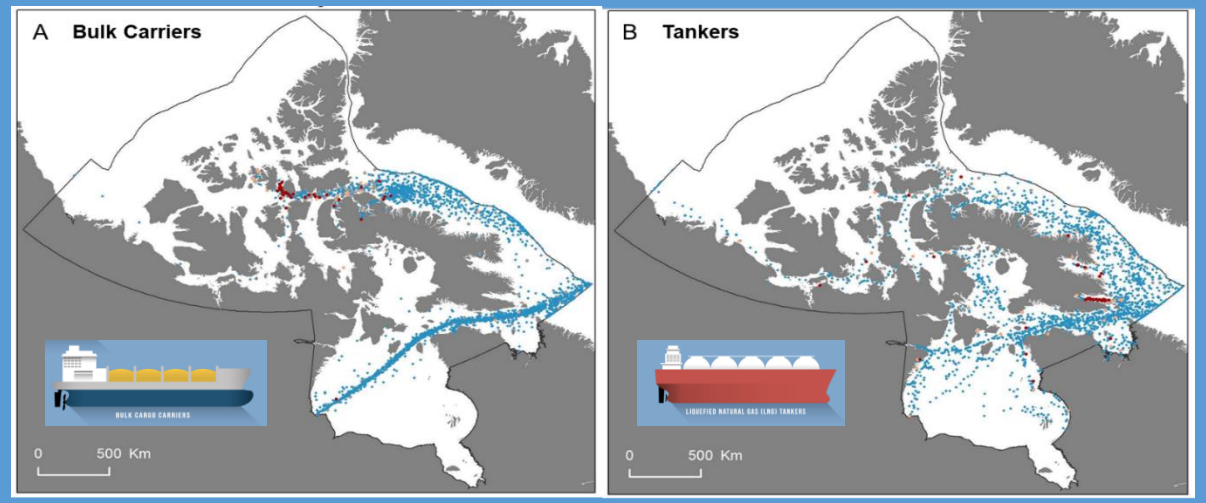
Classification	Description	Examples
Government Vessels and Icebreakers	- Designed to move and navigate in ice-covered waters - Must have a strengthened hull, an ice-clearing shape, and the power to push through ice	- Icebreakers (private, research, government) - Research vessels
Container Ships	- Cargo ships that carry their load in truck-size containers	- Cargo transport
General Cargo	- Carries various types and forms of cargo	- Community resupply - Roll on/roll off cargo
Bulk Carriers	- Bulk carriage of materials	- Timber, oil, ore - Automobile carriers
Tanker Ships	- Bulk carriage of liquids or compressed gas	- Oil, natural gas, chemical tankers
Passenger Ships	- Ships that carry paying passengers	- Cruise ships - Ferries
Pleasure Craft	- Recreational vessels that do not carry passengers for remuneration	- Motor yachts - Sail boats - Row boats
Tug / Barge	- Tug: designed for towing or pushing - Barge: non-propelled vessel for carriage of bulk or mixed cargo	- Used for resupply - Bulk cargo transport
Fishing Vessels	- Used in commercial fishing activity	- Small fishing boats - Trawlers - Fish processing boats
Oil and Gas Exploration Vessels	- Designed for the exploration and extraction of natural gas and oil	- Seismic, hydrographic, oceanic survey vessels - Offshore resupply - Portable oil platform

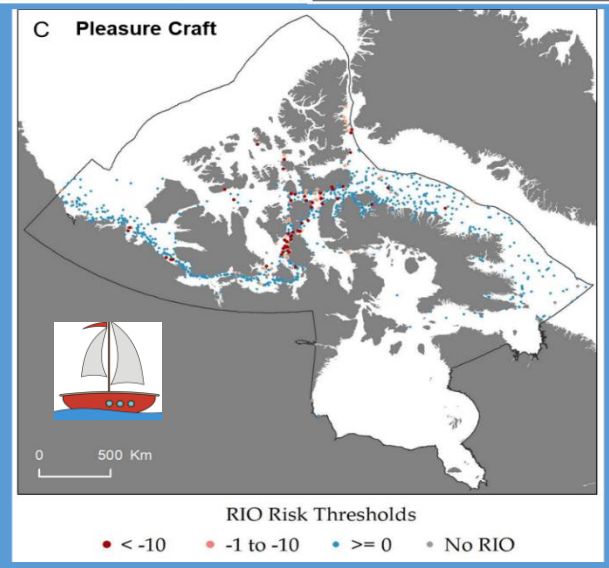
Percentage of tracks in each risk threshold for each ship type: (A) bulk carriers, (B) fishing vessels, (C) general cargo, (D) government vessels/icebreakers, (E) passenger vessels, (F) pleasure craft, (G) tankers, and (H) tugs/barges (left); ship type reference table (right).

Dawson et al. 2022

Canadian Arctic Shipping Patterns - Risk



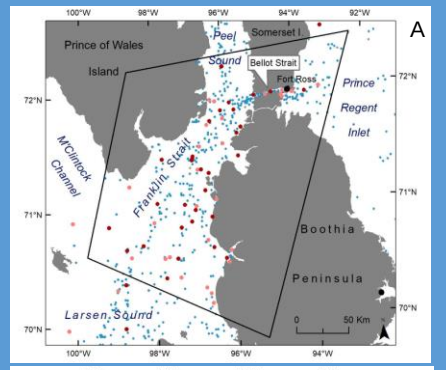


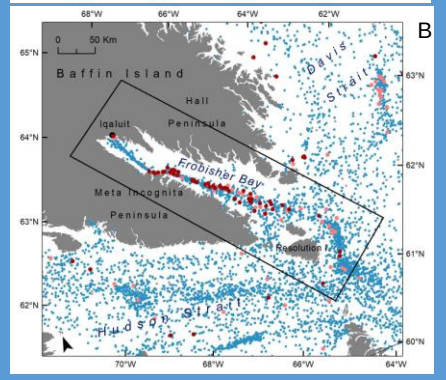


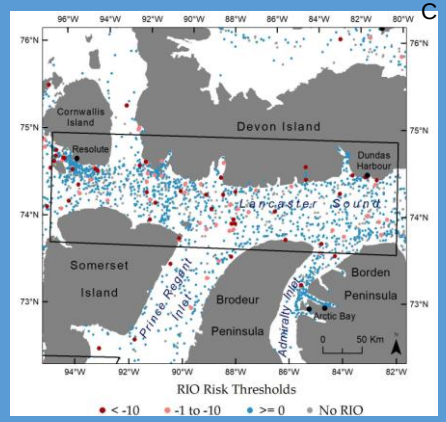
Spatial distribution of all ship position reports with RIO values from 1990-2019 (left) and by vessel type (right) A. bulk carriers, B. tankers, C. pleasure craft

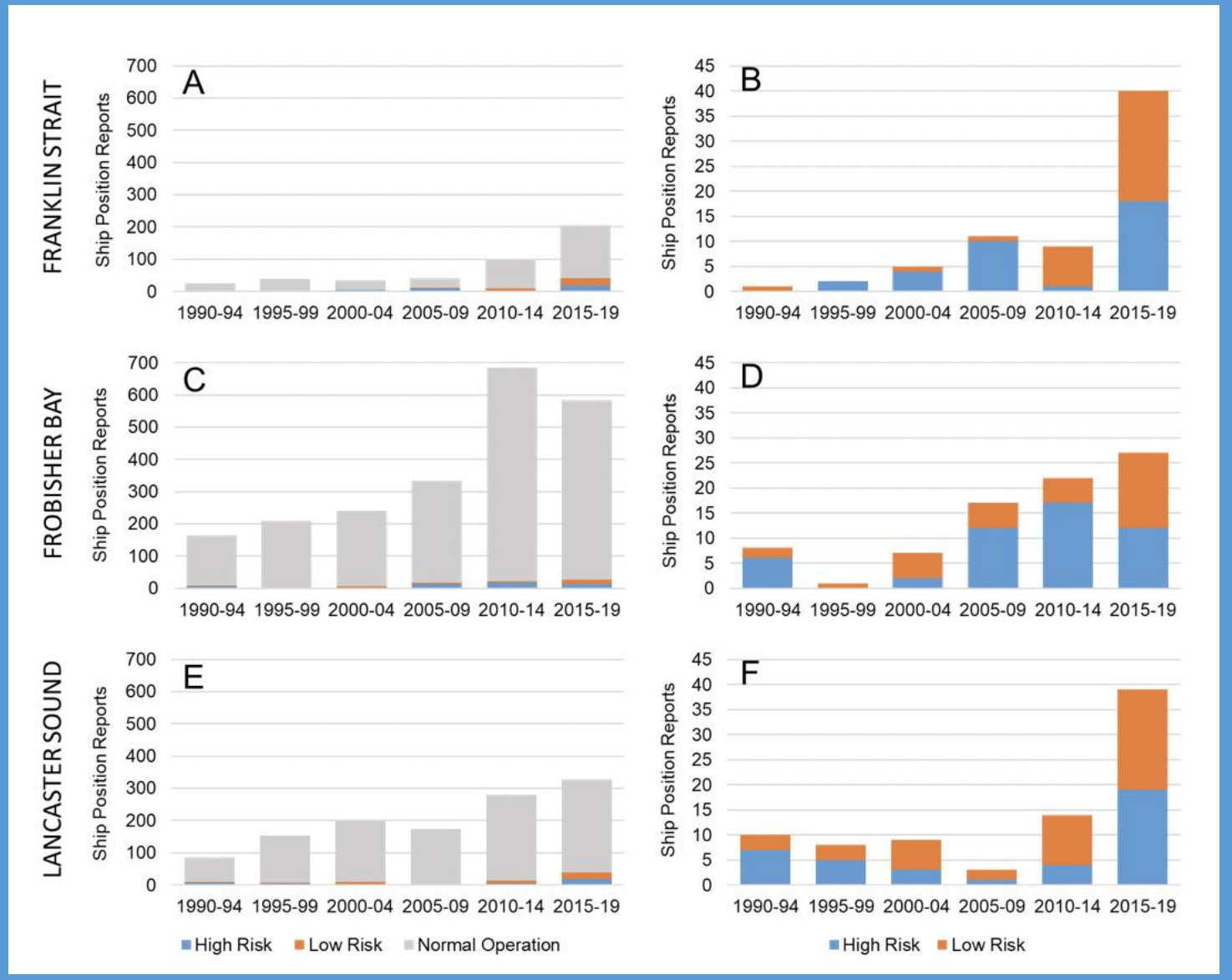
Canadian Arctic Shipping Patterns - Risk

Spatial distribution of all ship position reports in 3 hot spot areas with RIO values from 1990-2019 (left); Total number of ship position reports with RIO values categorized by: (A, C, E) all risk thresholds, and (B, D, F) just high and low risk categories over 5-year periods between 1990 – 2019 for all ship types, for: (A and B) Franklin Strait, (C and D) Frobisher Bay, (E and F) Lancaster Sound (right)









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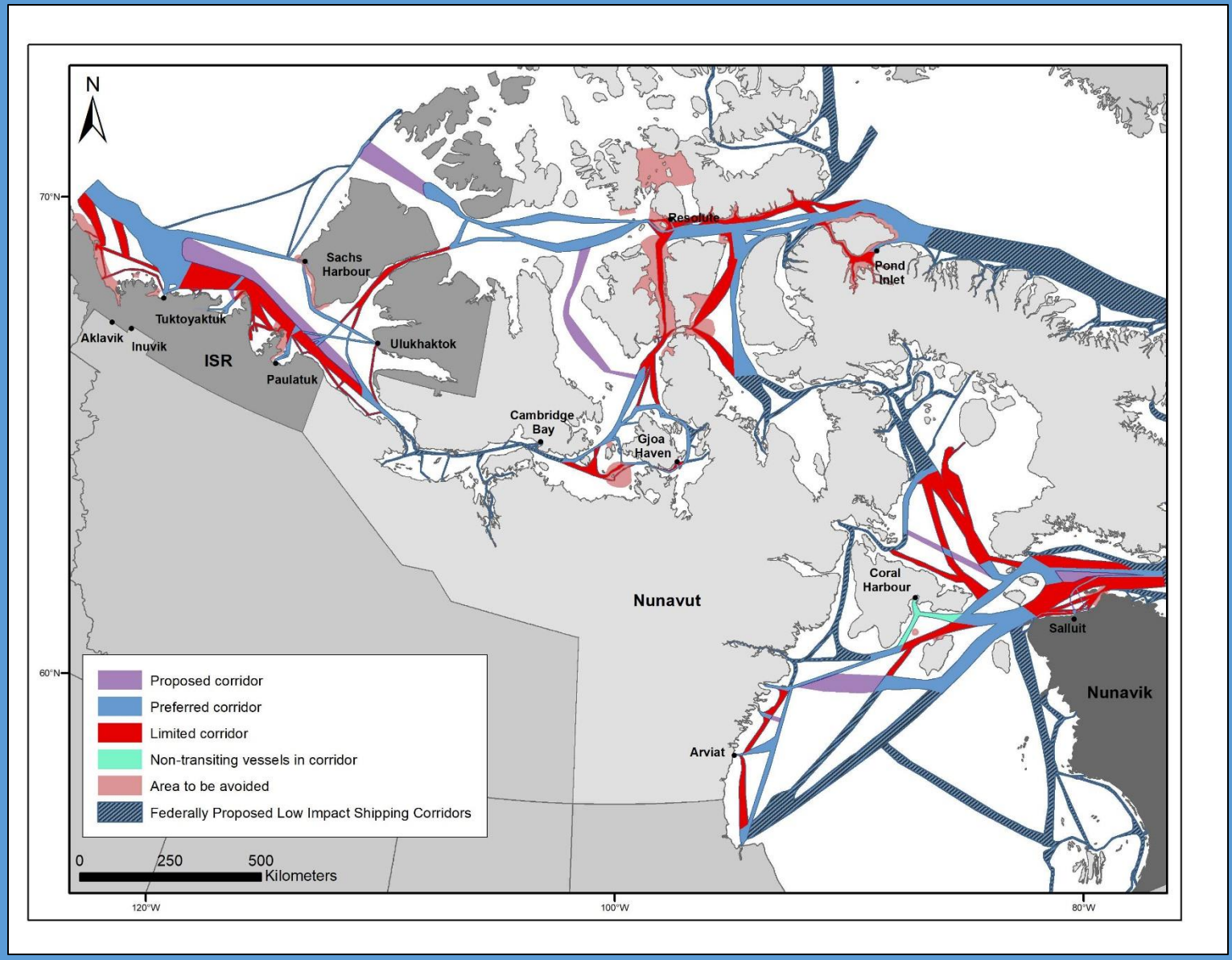
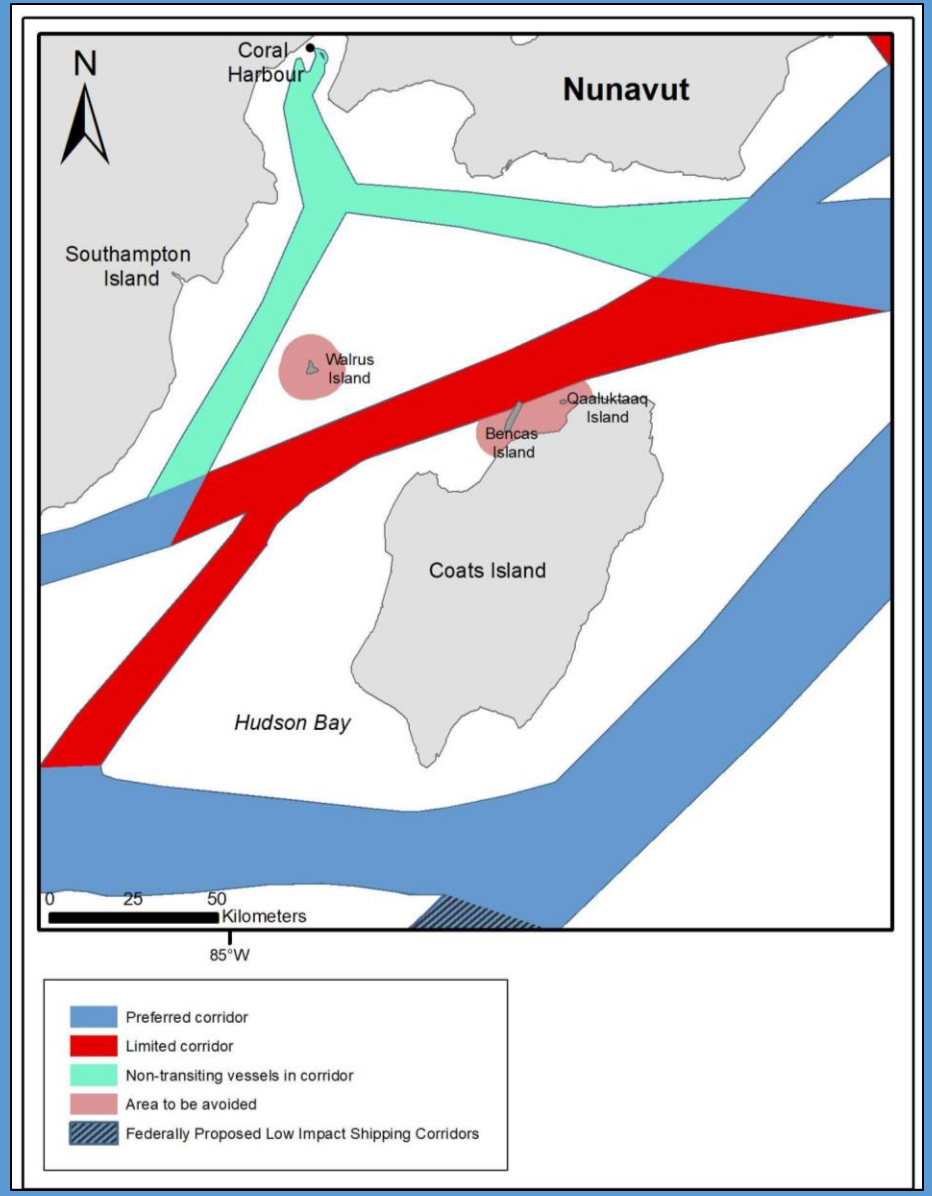
Indigenous Knowledge – safe navigation

ARCTIC CORRIDORS RESEARCH

www.arcticcorridors.ca



- **Preferred corridors**
  - Revise corridors near protected areas
  - Locate corridors further offshore to limit impact on wildlife and communities
- **Area to avoid**
  - Avoid protected areas such as MPAs and Migratory Bird Sanctuaries
  - Avoid sensitive areas important to communities and marine wildlife
- **Restricted shipping seasonally**
  - No icebreaking year round
  - No icebreaking during forming and break up phases
  - Scares away animals and dangerous for hunters
- **Modification of vessel operation**
  - Reduce noise and speed to limit impact on wildlife
- **Charting needed**
  - Proposed areas where charting is needed



Questions

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