Trends in Arctic and Antarctic Vessel Activity

Dr. Jackie Dawson, Scientific Director & Canada Research Chair

ArcticNet & Department of Geography, Environment and Geomatics, University of Ottawa

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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
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

Sea-ice extent
- Minimum in 2019
- Minimum in 1990

Average ship traffic density
- Relatively low
- Relatively high

1,000 km
Yearly average traffic density by vessel types (2012-2019)

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
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

Pan Arctic Vessel Patterns by vessel type (2012-2019)

- Cargo (13.2%)
- Container (4.6%)
- Dry Bulk (4.8%)
- Ferry/Ro-Ro/Passenger (9.9%)
- Fishing (40.0%)
- Others/Special Ships (8.5%)
- Government/Research (5.7%)
- Tugs/Port (3.9%)
- Tanker (8.7%)
- Pleasure Vessels (0.7%)

Pan Arctic Vessel Patterns by Country (EEZ) (2012-2019)

- Norway (45.8%)
- Iceland (12.9%)
- United States (20.8%)
- Russia (20.8%)
- Sweden (1.4%)
- Finland (2.1%)
- Greenland (4.3%)
- Faroe Islands (3.9%)
- Canada (1.4%)
- United Kingdom (3.2%)
- None (2.3%)

Proportions of the yearly average nm sailed by vessel type (left) and by country EEZ (right) North of 60° 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

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).
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.
Operational risk depends on (Polar Code):

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

Source: IMO, 2016

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

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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
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).

**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 | -
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

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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)

Canadian Arctic Shipping Patterns - Risk

https://arcticpassion.eu/
Indigenous Knowledge – safe navigation
- **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

Dr. Jackie Dawson Canada Research Chair and Professor

Department of Geography, Environment and Geomatics, University of Ottawa

jackie.dawson@uottawa.ca
www.espg.ca
www.arcticcorridors.ca