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# *Risk Assessment in Ice*

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*Arctic Shipping Forum*
*Montreal 29-31 October 2019*

# Fundamental Considerations

- Area
- Date
- Ice-Class
- Identification of ice
- Speed/Power
- Manoeuverability
- Redundancy
- Sustainability
- Survivability
- Experience

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# Outline

- Ice Class
- Access to the Cdn Arctic
- Tactical Risk Assessment
- Strategic Risk Assessment
- “Safe” Speed?
- Experience
- Ice Navigators

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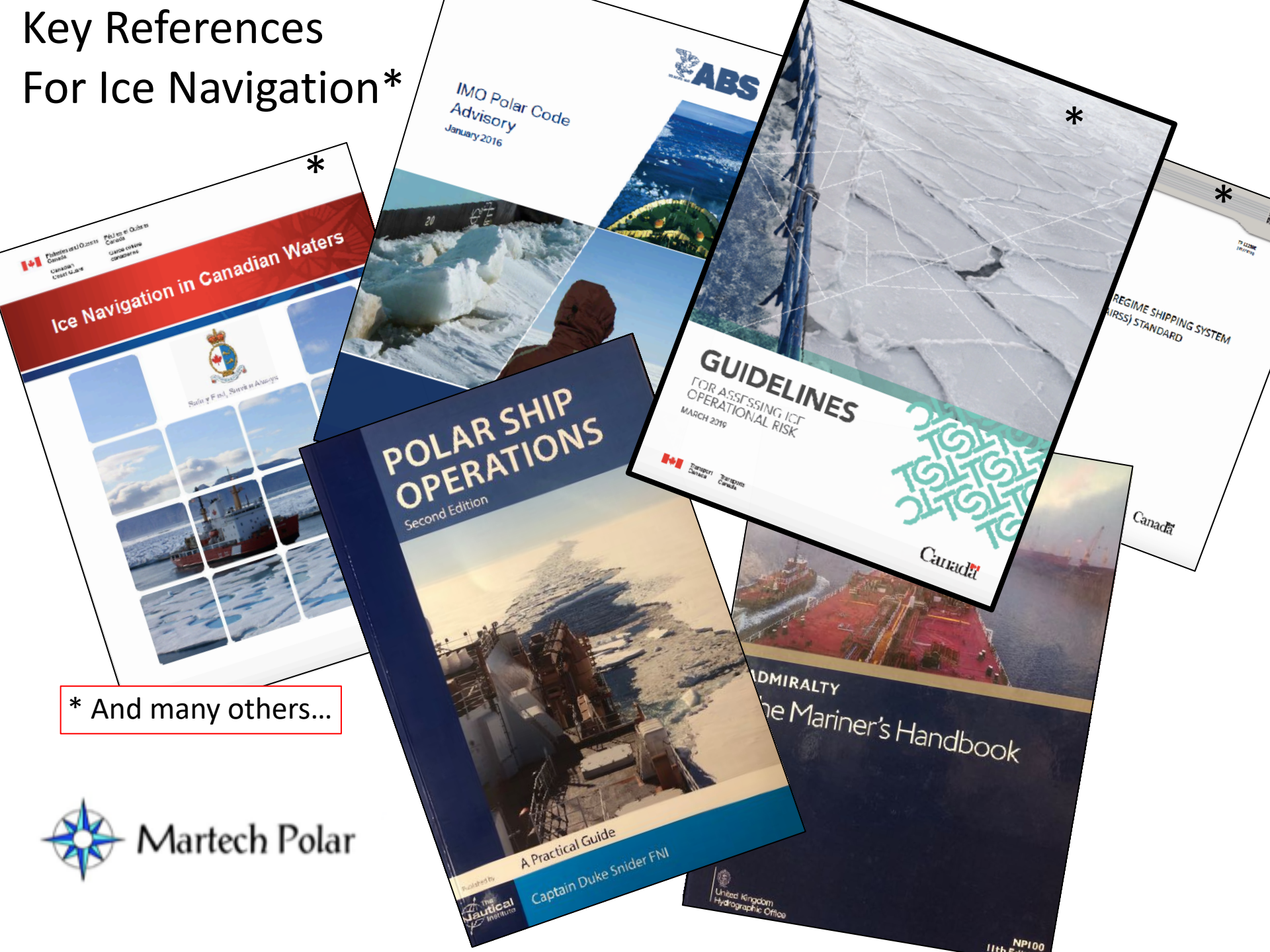
# Key References For Ice Navigation*




* And many others…

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# ZDS – Zone/Date System

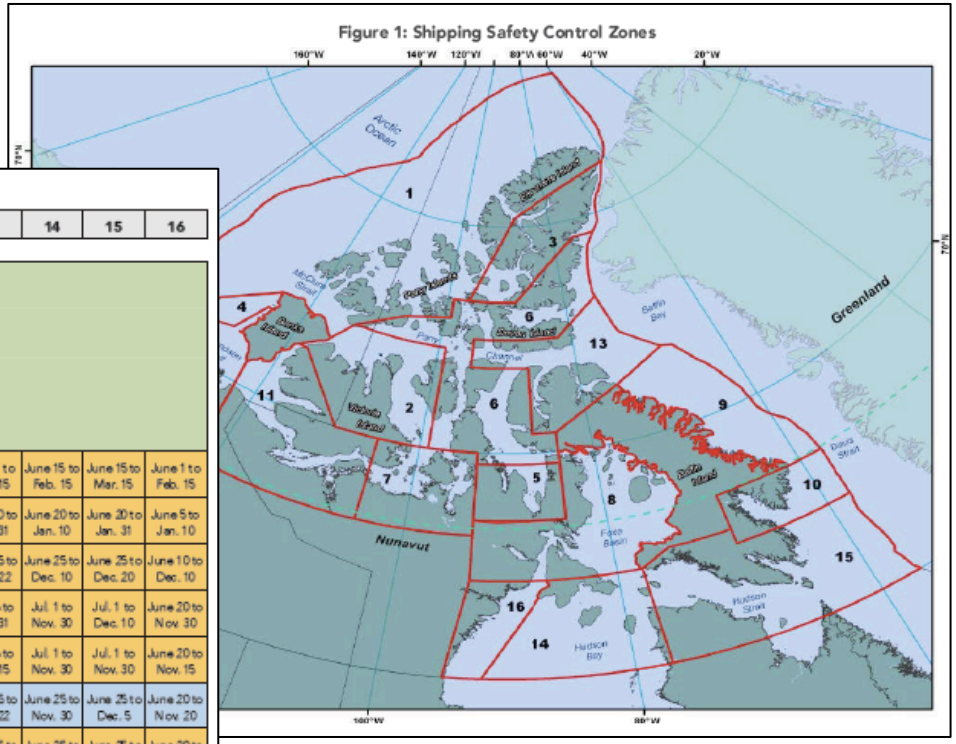


**Table 2: Dates of Entry**

| Zones | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Categories | | | | | | | | | | | | | | | | |
| AC 10, CAC 1 | ALL YEAR | | | | | | | | | | | | | | | |
| AC 8, CAC 2 | Jul. 1 to Oct. 15 | ALL YEAR | | | | | | | | | | | | | | |
| AC 7 | Aug. 1 to Sept. 30 | Aug. 1 to Nov. 30 | Jul. 1 to Dec. 31 | Jul. 1 to Dec. 15 | Jul. 1 to Dec. 15 | ALL YEAR | | | | | | | | | | |
| AC 6, CAC 3 | Aug. 15 to Sept. 15 | Aug. 1 to Oct. 31 | Jul. 15 to Nov. 30 | Jul. 15 to Nov. 30 | Aug. 1 to Oct. 15 | Jul. 15 to Feb. 28 | Jul. 1 to Mar. 31 | Jul. 1 to Mar. 31 | | | Jul. 1 to Mar. 31. | | | | | |
| AC 4 | Aug. 15 to Sept. 15 | Aug. 15 to Oct. 15 | Jul. 15 to Oct. 31 | Jul. 15 to Nov. 15 | Aug. 15 to Sept. 30 | Jul. 20 to Dec. 31 | Jul. 15 to Jan. 15 | Jul. 15 to Jan. 15 | Jul. 10 to Mar. 31 | Jul. 10 to Feb. 28 | Jul. 5 to Jan. 15 | June 1 to Jan. 31 | June 1 to Feb. 15 | June 15 to Feb. 15 | June 15 to Mar. 15 | June 1 to Feb. 15 |
| AC 3, CAC 4 | Aug. 20 to Sept. 15 | Aug. 20 to Sept. 30 | Jul. 25 to Oct. 15 | Jul. 20 to Nov. 5 | Aug. 20 to Sept. 25 | Aug. 1 to Nov. 30 | Jul. 20 to Dec. 15 | Jul. 20 to Dec. 31 | Jul. 20 to Jan. 20 | Jul. 15 to Jan. 25 | Jul. 5 to Dec. 15 | June 10 to Dec. 31 | June 10 to Dec. 31 | June 20 to Jan. 10 | June 20 to Jan. 31 | June 5 to Jan. 10 |
| AC 2 | | | Aug. 15 to Sept. 30 | Aug. 1 to Oct. 31 | | Aug. 15 to Nov. 20 | Aug. 1 to Nov. 20 | Aug. 1 to Nov. 30 | Aug. 1 to Dec. 20 | Jul. 25 to Dec. 20 | Jul. 10 to Nov. 20 | June 15 to Dec. 5 | June 25 to Nov. 22 | June 25 to Dec. 10 | June 25 to Dec. 20 | June 10 to Dec. 10 |
| AC 1A | | | Aug. 20 to Sept. 15 | Aug. 20 to Sept. 30 | | Aug. 25 to Oct. 31 | Aug. 10 to Nov. 5 | Aug. 10 to Nov. 20 | Aug. 10 to Dec. 10 | Aug. 1 to Dec. 10 | Jul. 15 to Nov. 10 | Jul. 1 to Nov. 10 | Jul. 15 to Oct. 31 | Jul. 1 to Nov. 30 | Jul. 1 to Dec. 10 | June 20 to Nov. 30 |
| AC 1 | | | | | | Aug. 25 to Sept. 30 | Aug. 10 to Oct. 15 | Aug. 10 to Oct. 31 | Aug. 10 to Oct. 31 | Aug. 1 to Oct. 31 | Jul. 15 to Oct. 20 | Jul. 1 to Oct. 31 | Jul. 15 to Oct. 15 | Jul. 1 to Nov. 30 | Jul. 1 to Nov. 30 | June 20 to Nov. 15 |
| PC 1-7 | | | Aug. 20 to Sept. 10 | Aug. 20 to Sept. 20 | | Aug. 15 to Oct. 15 | Aug. 1 to Oct. 25 | Aug. 1 to Nov. 10 | Aug. 1 to Nov. 20 | Jul. 25 to Nov. 20 | Jul. 10 to Oct. 31 | June 15 to Nov. 10 | June 25 to Oct. 22 | June 25 to Nov. 30 | June 25 to Dec. 5 | June 20 to Nov. 20 |
| Type A (IA super) | | | Aug. 20 to Sept. 10 | Aug. 20 to Sept. 20 | | Aug. 15 to Oct. 15 | Aug. 1 to Oct. 25 | Aug. 1 to Nov. 10 | Aug. 1 to Nov. 20 | Jul. 25 to Nov. 20 | Jul. 10 to Oct. 31 | June 15 to Nov. 10 | June 25 to Oct. 22 | June 25 to Nov. 30 | June 25 to Dec. 5 | June 20 to Nov. 20 |
| Type B (IA) | | | Aug. 20 to Sept. 5 | Aug. 20 to Sept. 15 | | Aug. 25 to Sept. 30 | Aug. 10 to Oct. 15 | Aug. 10 to Oct. 31 | Aug. 10 to Oct. 31 | Aug. 1 to Oct. 31 | Jul. 15 to Oct. 20 | Jul. 1 to Oct. 25 | Jul. 15 to Oct. 15 | Jul. 1 to Nov. 30. | Jul. 1 to Nov. 30 | June 20 to Nov. 10 |
| Type C (IB) | | | | | | Aug. 25 to Sept. 25 | Aug. 10 to Oct. 10 | Aug. 10 to Oct. 25 | Aug. 10 to Oct. 25 | Aug. 1 to Oct. 25 | Jul. 15 to Oct. 15 | Jul. 1 to Oct. 25 | Jul. 15 to Oct. 10 | Jul. 1 to Nov. 25 | Jul. 1 to Nov. 25 | June 25 to Nov. 10 |
| Type D (IC) | NO ENTRY | | | | | | Aug. 10 to Oct. 5 | Aug. 15 to Oct. 20 | Aug. 15 to Oct. 20 | Aug. 5 to Oct. 20 | Jul. 15 to Oct. 10 | Jul. 1 to Oct. 20 | Jul. 30 to Sept. 30 | Jul. 10 to Nov. 10 | Jul. 5 to Nov. 10 | Jul. 1 to Oct. 31 |
| Type E (Non Ice-Strengthened) | | | | | | | Aug. 10 to Sept. 30 | Aug. 20 to Oct. 20 | Aug. 20 to Oct. 15 | Aug. 10 to Oct. 20 | Jul. 15 to Sept. 30 | Jul. 1 to Oct. 20 | Aug. 15 to Sept. 20 | Jul. 20 to Oct. 31 | Jul. 20 to Nov. 5 | Jul. 1 to Oct. 31 |

Based on Schedule 1 of the *Arctic Shipping Safety and Pollution Prevention Regulations* with added row PC 1-7

- Historical/empirical approach
- Zones in descending order of difficulty
- Allowed access dates by CASPPR Ice Class
- PC1-7 equate to Type A (?)
- System rigid, inflexible … not compatible with climate change
- Depends on established equivalence with Cdn ice classes

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# Ice Class - Equivalents

| Column 1 | Column 2 |
|---|---|
| Category | Zone 1 |
| Arctic Class 10, CAC 1 | All year |
| Arctic Class 8, CAC 2 | Jul. 1 to Oct. 15. |
| Arctic Class 7 | Aug. 1 to Sept. 30 |
| Arctic Class 6, CAC 3 | Aug. 15 to Sept. 15 |
| Arctic Class 4 | Aug. 15 to Sept. 15 |
| Arctic Class 3, CAC 4 | Aug. 20 to Sept. 15 |
| Arctic Class 2 | No Entry |
| Arctic Class 1A | No Entry |
| Arctic Class 1 | No Entry |
| Type A | No Entry |
| Type B | No Entry |
| Type C | No Entry |
| Type D | No Entry |
| Type E | No Entry |

Ref: ASSPPR, Schedules 1 & 2

Current to June 5, 2019

## Construction Standards for Types A, B, C, D and E Vessels

| Item | Column 1<br>Type of Vessel | Column 2<br>American Bureau of Shipping (ABS) | Column 3<br>Bureau Veritas (BV) | Column 4<br>China Classification Society (CCS) | Column 5<br>Nippon Kaiji Kyokai (ClassNK) | Column 6<br>DNV-GL | Column 7<br>Finnish-Swedish Ice Class Rules (FS/CR) | Column 8<br>International Association of Classification on Societies (IACS) | Column 9<br>Korean Register of Shipping (KR) | Column 10<br>Lloyd's Register of Shipping (LR) | Column 11<br>Polski Rejestr Statkow (PRS) | Column 12<br>Rina Services (RINA) | Column 13<br>Russian Maritime Register of Shipping |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Type A | Ice Class A0 | ICE CLASS IA SUPER | Ice Class B1* | NS (Class 1A Super Ice Strengthening) | Ice (1A*) or ICE-1A or E4 | 1A Super | PC1 to PC7 | 1A Super | Ice Class 1AS FS (+) or Ice Class 1AS FS (+) | L1A | ICE CLASS 1A SUPER | UL or LU6 or Arc5 |
| 2 | Type B | Ice Class B0 | ICE CLASS IA | Ice Class B1 | NS (Class 1A Ice Strengthening) | Ice (1A) or ICE-1A or E3 | 1A | | 1A | Ice Class 1A FS (+) or Ice Class 1A FS | L1 | ICE CLASS 1A | L1 or LU4 or Arc4 |
| 3 | Type C | Ice Class C0 | ICE CLASS IB | Ice Class B2 | NS (Class 1B Ice Strengthening) | Ice (1B) or ICE 1B or E2 | 1B | – | 1B | Ice Class 1B FS (+) or Ice Class 1B FS | L2 | ICE CLASS 1B | L2 or LU3 or Ice 3 |
| 4 | Type D | Ice Class D0 | ICE CLASS IC | Ice Class B3 | NS (Class 1C Ice Strengthening) | Ice (1C) or ICE-1C or E1 | 1C | – | 1C | Ice Class 1C FS (+) or Ice Class 1C FS | L3 | ICE CLASS 1C | L3 or LU2 or Ice 2 |
| 5 | Type E | Ice Class E0 | 1D | Ice Class B | NS (Class 1D Ice Strengthening) | ICE C or E | Category II | | 1D | Ice Class 1D or Ice Class 1E | L4 | 1D | L1 or LU1 or Ice 1 |

Arctic Shipping Safety and Pollution Prevention Regulations
Schedule 2
Règlement sur la ...
Figure
ANNEXE 2

22

*Canadian ASPPR classes from ZDS table (Sched 1, left)*
*Equivalents to foreign ice classes (Sched 2, above)*

- Difficulty of establishing ice-class equivalents
- Applicable for ZDS/AIRSS
- Also “Categories”: A (PC1-5), B (PC6-7), C (others)

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# AIRSS - Arctic Ice Regime Shipping System

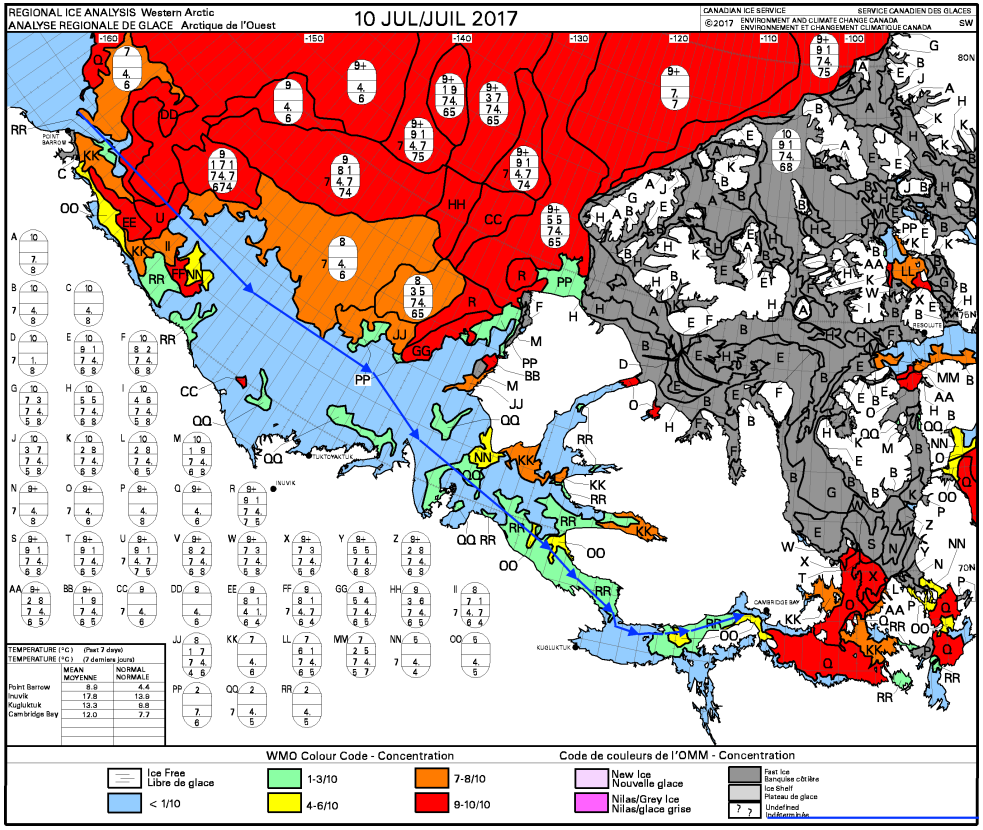


Table 8. AIRSS Ice Multipliers

| | | OPEN WATER | GREY ICE | GREY WHITE ICE | THIN FIRST YEAR 1ST STAGE | THIN FIRST YEAR 2ND STAGE | MEDIUM FIRST YEAR | THICK FIRST YEAR | SECOND YEAR | MULTI YEAR |
|---|---|---|---|---|---|---|---|---|---|---|
| VESSEL CATEGORY | Ice Type Symbol | OW | G | GW | TnFY1 | TnFY2 | MFY | ThFY | SY | MY |
| | Egg Code | (1 or 2) | (4) | (5 or 6) | (8) | (7 or 9) | (1.) | (6 or 4.) | (8.) | (7. or 9.) |
| CAC 3 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | -1 |
| CAC 4 | | 2 | 2 | 2 | 2 | 2 | 2 | 1 | -2 | -3 |
| Type A (A Super) | | 2 | 2 | 2 | 2 | 2 | 1 | -1 | -3 | -4 |
| Type B (A) | | 2 | 2 | 1 | 1 | 1 | -1 | -2 | -4 | -4 |
| Type C (B) | | 2 | 2 | 1 | 1 | -1 | -2 | -3 | -4 | -4 |
| Type D (C) | | 2 | 2 | 1 | -1 | -1 | -2 | -3 | -4 | -4 |
| Type E (Not ice strengthened) | | 2 | 1 | -1 | -1 | -1 | 2 | 2 | -4 | -4 |

*The IM can be adjusted for ice decay by a value of +1 for MFY and thicker.

Ice Numeral (IN) = cumulative addition of partial concentrations if ice types weighted by multipliers for ice type and ice class

Eg: $(C_1xM_1)+(C_2xM_2)+\ldots+(C_xxM_x) = IN$

- If IN=>0, "**GO**"; if IN<0, "**NO GO**"

- Flexible to changing ice conditions in Zones
- Allows access outside of ZDS limits
- Allows access on basis of reported or observed conditions
- Adjustments of IM for rough or decayed ice
- Must be observed/calculated by an Ice Navigator
- CAC1/2 effectively unrestricted (outside system)

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# POLARIS – Polar Operational Limits and Risk Assessment System

*Implemented icw the Polar Code*
*Oriented to PC/Type-class vessels,*
*vessels built after 1 Jan 17*

- Fundamentally similar methodology to AIRSS
- Allows more flexibility (dependent on Ice Class) to proceed with operational precautions (speed reduction) iaw PWOM
- Some differences in definition of ice types
- Allows considerably more flexibility for PC vessels which are significantly undervalued in ZDS
- No continuous hierarchy of PC/Type except in POLARIS

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Table 5: POLARIS Risk Index Values

| | | ICE FREE / OPEN WATER | NEW | GREY | GREY WHITE | THIN FY, 1ST STAGE | THIN FY, 2ND STAGE | MEDIUM FY (< 1 M) | MEDIUM FY | THICK FY ICE | SECOND YEAR ICE | LIGHT MULTI YEAR (< 2.5 M) | HEAVY MULTI YEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VESSEL CATEGORY | ICE TYPE SYMBOL | IF/OW | N | G | GW | TNFY1 | TNFY2 | MFY-1 | MFY | TKFY | SY | LMY-2.5 | HMY |
| | EGG CODE | 1 OR 2 | | 4 | 3 OR 5 | 8 | 7 OR 9 | | 1• | 6 OR 4• | 8• | | |
| 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 (Type A) | | 3 | 2 | 2 | 2 | 2 | 1 | 0 | -1 | -2 | -3 | -4 | -4 |
| IA (Type B) | | 3 | 2 | 2 | 2 | 1 | 0 | -1 | -2 | -3 | -4 | -5 | -5 |
| IB (Type C) | | 3 | 2 | 2 | 1 | 0 | -1 | -2 | -3 | -4 | -5 | -6 | -6 |
| IC (Type D) | | 3 | 2 | 1 | 0 | -1 | -2 | -3 | -4 | -5 | -6 | -7 | -8 |
| Not Ice Strengthened (Type E) | | 3 | 1 | 0 | -1 | -2 | -3 | -4 | -5 | -6 | -7 | -8 | -8 |

The Risk Value Index can be adjusted for ice decay (yellow highlight) by +1

Risk Index Outcome (RIO) = cumulative addition of partial concentrations if ice types weighted by Risk Index Values (RIV) for ice type and ice class
Eg: $(C_1 x RIV_1)+(C_2 x RIV_2)+\ldots+(C_x x RIV_x)$ = RIO

- If RIO=>0, "**GO**";
- if -10<RIO<0, "**NO GO,**" (Type ships) or "**GO with operational precautions iaw PWOM**" (PC3-7);
- if RIO <-10, "**NO GO**" (except PC1-2)

# Ice Class Tables from TC "Guidelines for Assessing Ice Operational Risk"

**Table 4 : Polar Class Descriptions**

| POLAR CLASS | GENERAL DESCRIPTION |
|---|---|
| PC 1 | Year-round operation in all Polar Waters |
| PC 2 | Year-round operation in moderate multi year ice conditions |
| PC 3 | Year-round operation in second-year ice which may include multi year inclusions |
| PC 4 | Year-round operation in thick first-year ice which may include old ice inclusions |
| PC 5 | Year-round operation in medium first-year ice which may include old ice inclusions |
| PC 6 | Summer/autumn operation in medium first-year ice which may include old ice inclusions |
| PC 7 | Summer/autumn operation in thin first-year ice which may include old ice inclusions |

PC descriptions suit a variety of scenarios and their relationships are set to provide a smooth gradation of capability. PC vessels may operate inside the ZDS on the same dates allowed for Type A (IA Super) vessels and make use of POLARIS when outside those access dates.

**Table 3: Construction Standards for Type Vessels**

| TYPE OF VESSEL | ABS | BV | CCS | CLASSNK | DNV-GL | FSICR | KR | LR | PRS | RINA | RMRS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Type A | Ice Class IAA | ICE CLASS IA SUPER | Ice Class B1* | NS (Class 1A Super Ice Strengthening) | Ice (1A*) or ICE-1A or E4 | IA Super | IA Super | Ice Class 1AS FS or Ice Class 1AS FS (+) | L1A | ICE CLASS 1A SUPER | UL or LU5 or Arc5 |
| Type B | Ice Class IB | ICE CLASS IA | Ice Class B1 | NS (Class 1A Ice Strengthening) | Ice (1A) or ICE-1A or E3 | IA | IA | Ice Class 1A FS (+) or Ice Class 1A FS | L1 | ICE CLASS 1A | L1 or LU4 or Arc4 |
| Type C | Ice Class IC | ICE CLASS IB | Ice Class B2 | NS (Class 1B Ice Strengthening) | Ice (1B) or ICE-1B or E2 | IB | IB | Ice Class 1B FS (+) or Ice Class 1B FS | L2 | ICE CLASS 1B | L2 or LU3 or Ice 3 |
| Type D | Ice Class D0 | ICE CLASS IC | Ice Class B3 | NS (Class 1C Ice Strengthening) | Ice (1C) or ICE-1C or E1 | IC | IC | Ice Class 1C FS (+) or Ice Class 1C FS | L3 | ICE CLASS 1C | L3 or LU2 or Ice 2 |
| Type E | Ice Class E0 | ID | Ice Class B | NS (Class 1D Ice Strengthening) | ICE-C or E | Category II | ID | Ice Class 1D or Ice Class 1E | L4 | 1D | L4 or LU1 or Ice 1 |

Based on Schedule 2 of the *Arctic Shipping Safety and Pollution Prevention Regulations* minus the column for the PC categories, which are set out in the IACS Unified Requirements for Polar Ships.

FSICR categories are based on HELCOM Rec 25/7.

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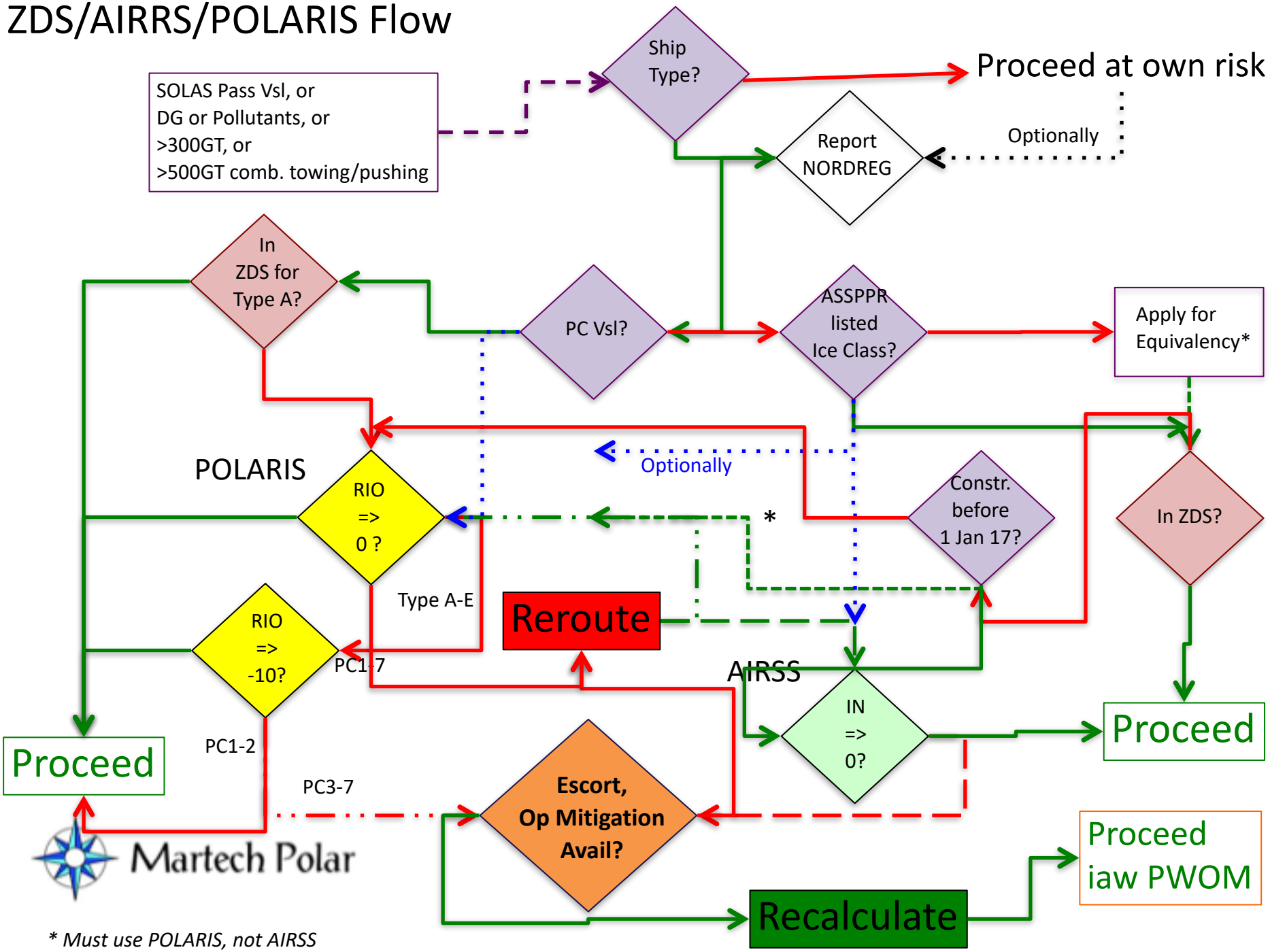
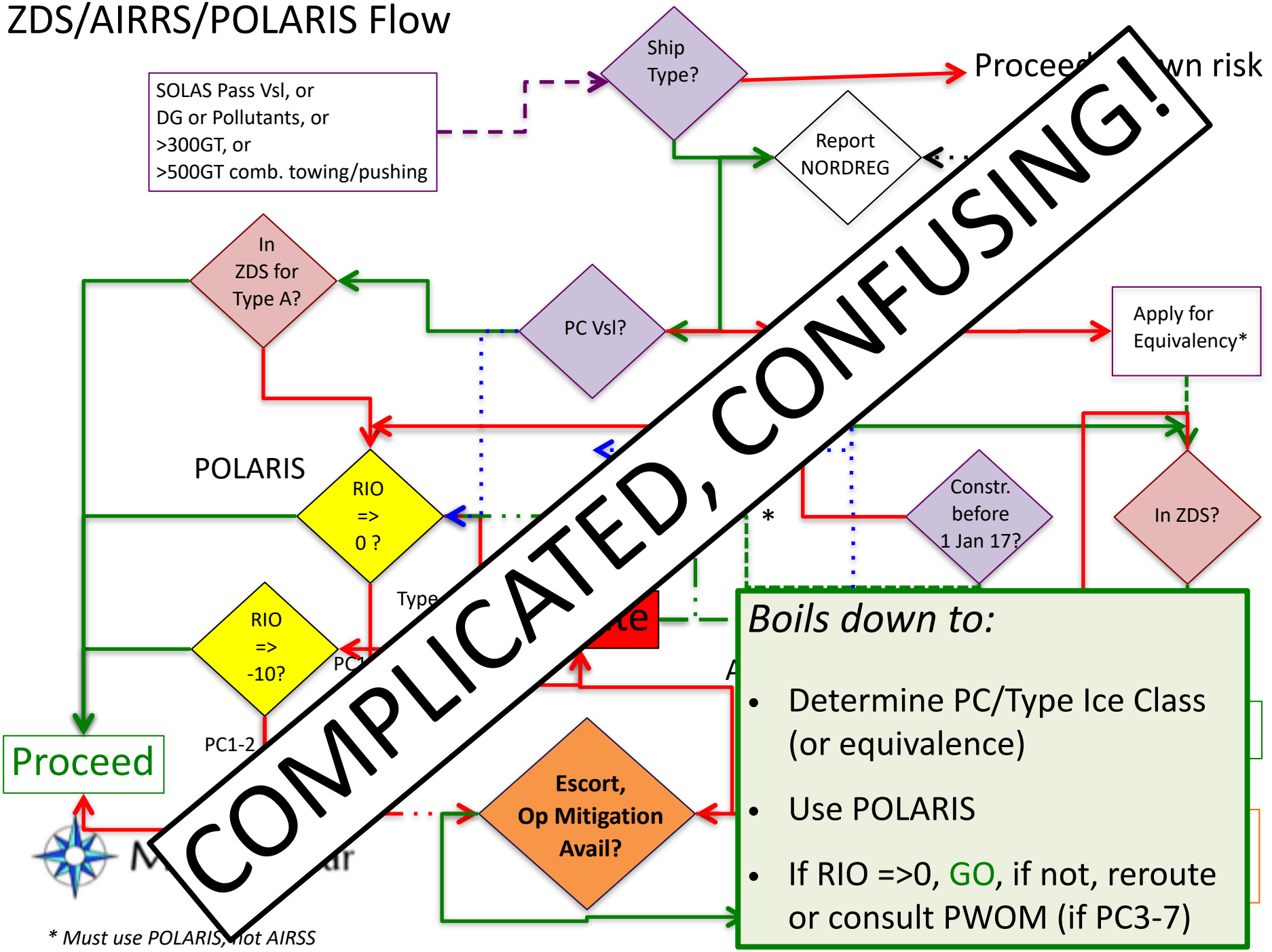
- Applicable for POLARIS (PC/Type) or AIRSS (Type)

# ZDS/AIRRS/POLARIS Flow

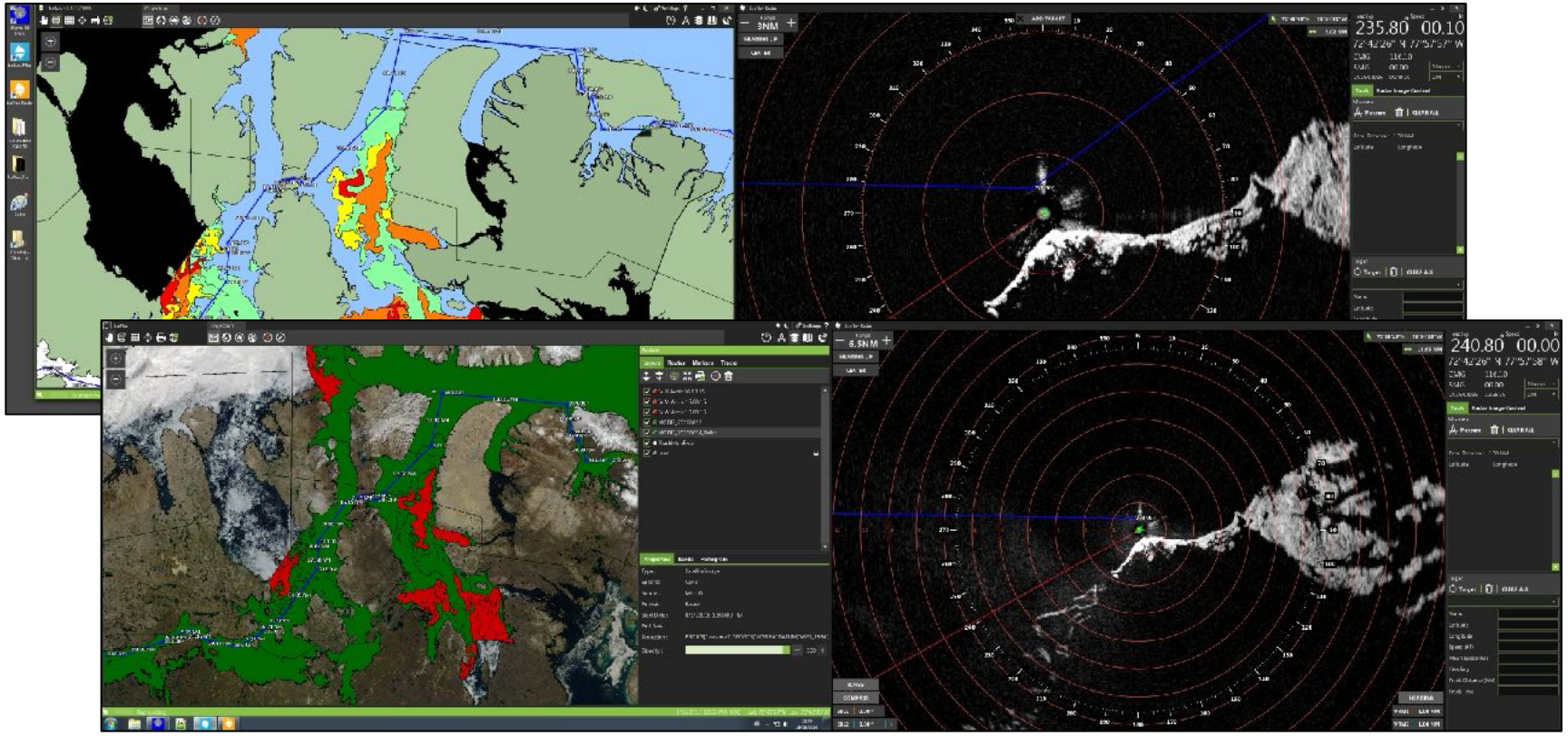


# ZDS/AIRRS/POLARIS Flow



# IceNav™

*(Proprietary system of Enfotec)*



- Presentation of CIS shapefiles in GIS application
- Superimposed ship position, route, radar input
- Ability to display geo-ref'd photos and satellite radar files
- Calculation of AIRSS and POLARIS IN/RIO from shapefiles
- Generation of Ice Regime Routing Msg as req'd by TC

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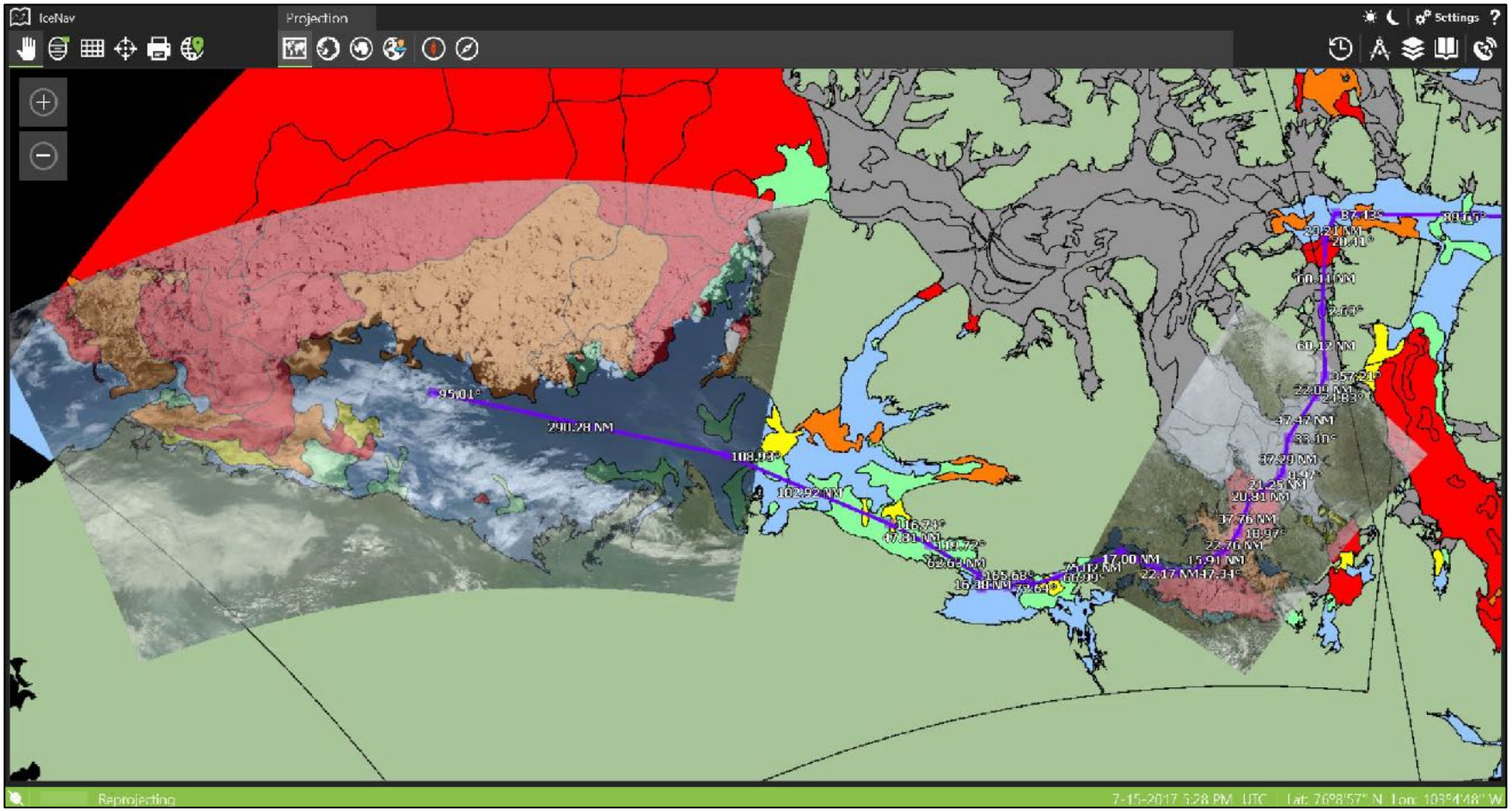
# IceNav

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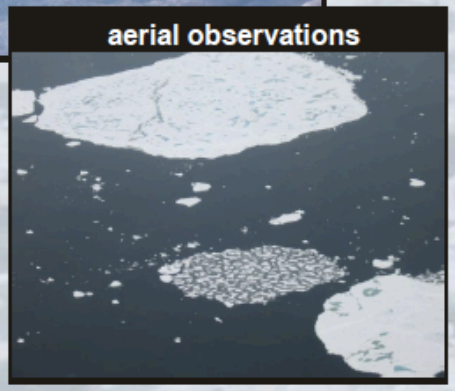
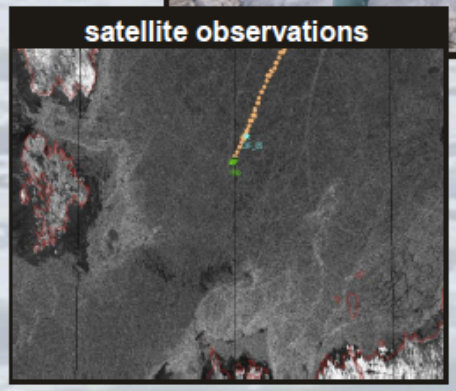
Superimposition of CIS ice charts, satellite observations and ship route from MSV Nordica 2017 NWP transit

# Understanding and Identifying Old Ice in Summer






M.E. Johnston and G.W. Timco

December 2008

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Understanding and Identifying Old Ice in Summer,
National Research Council of Canada
http://globalcryospherewatch.org/cryonet/methods_docs/ICETECH_08_Old_Ice_Guide.pdf

# Strategic Assessment (feasibility)

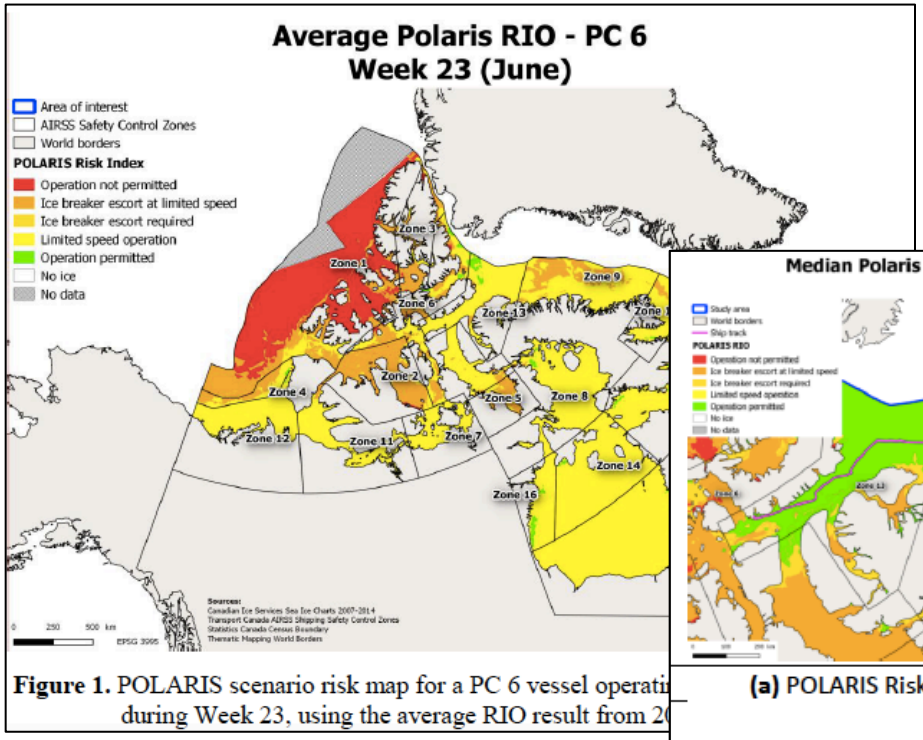
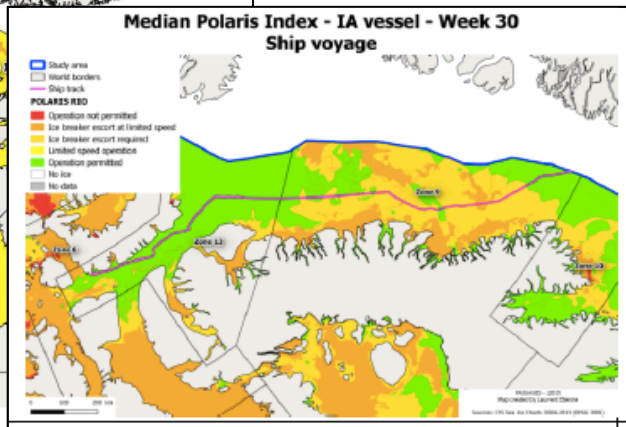


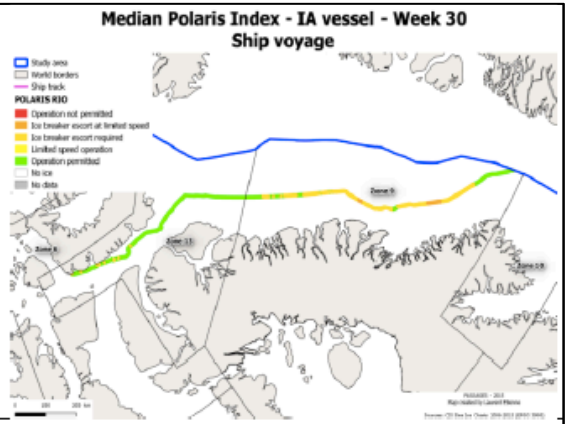

**Figure 1.** POLARIS scenario risk map for a PC 6 vessel operati
during Week 23, using the average RIO result from 2

Ref: Stoddard et al, Making Sense Out of Arctic Marine Traffic Using POLARIS, 2016

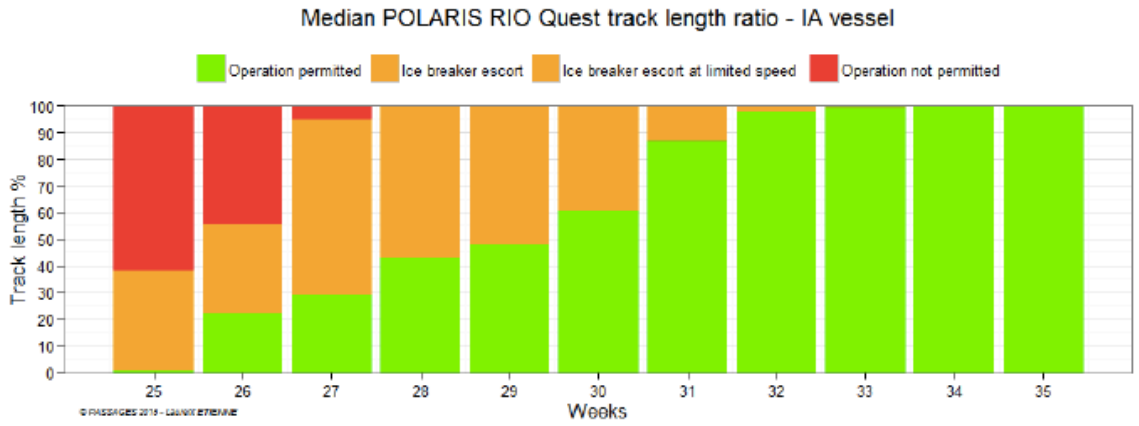
- POLARIS enables computer-based feasibility of specific tracks, dates, based on long-term averages of ice conditions




**(a)** POLARIS Risk Map and Planned Route




**(b)** Intersection of RISK Map and Route




**(c)** Percentage of total track length corresponding to each POLARIS ship limitation for a number of potential execution weeks.

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# CASRAS – Canadian Arctic Shipping Risk Assessment System

*(developed by National Research Council Canada)*

CASRAS is an integrated risk assessment system for marine transportation in the Canadian North that enables sound decision-making leading to safer, more efficient shipping in this harsh environment while ensuring the minimal negative impact on the life of Northerners, and decreasing the risk of polluting the environment.

- *CASRAS provides a picture of risk assessment factors, either actual or statistical, based on multiple geographic-historical data sets (bathymetry, ice, metocean, wildlife, conservation areas, community services/infrastructure, places of refuge, nautical knowledge, chart coverage, etc…)*
- *Parameters or filters (time, area, route, conditions, etc) are determined by the user*
- *CASRAS then uses cumulative ice data since 1980 to calculate AIRSS IN for projected routes and determine % frequency of passable conditions in specified timeframes (eg: month by month)*

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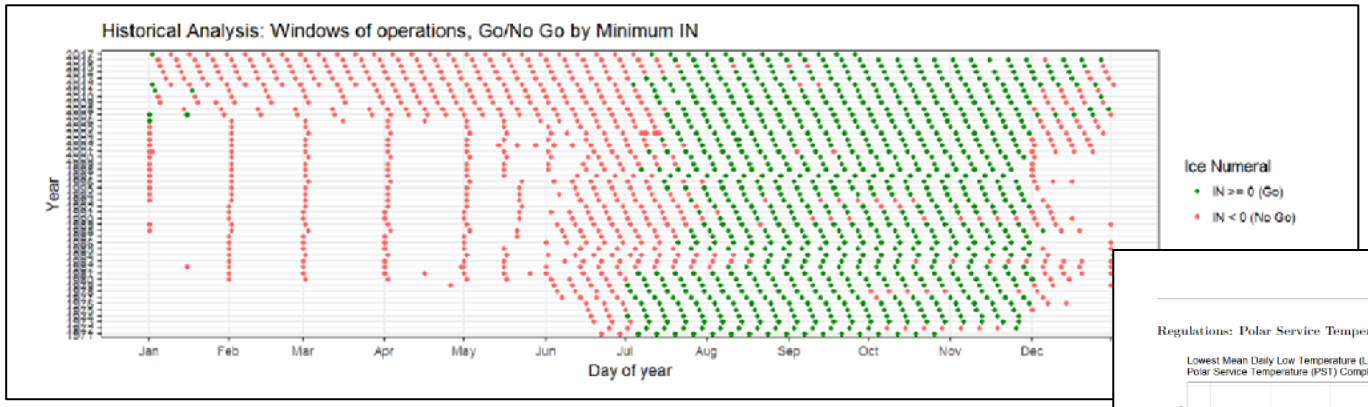
**Current content: 76 datasets; 230 GB; over 200,000 files**

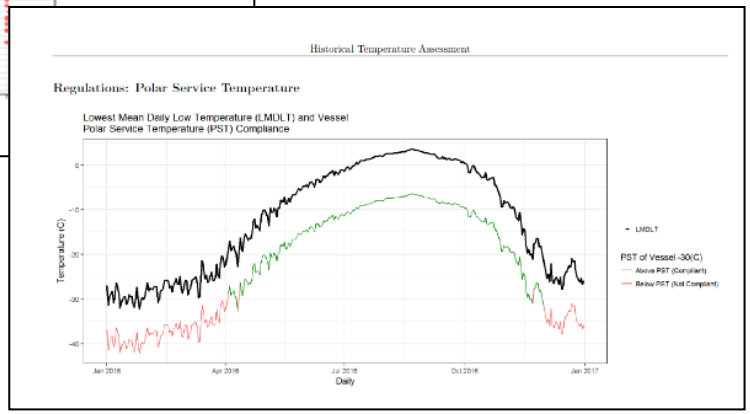
# Examples extracted from CASRAS

AIRSS Ice Numeral evaluation

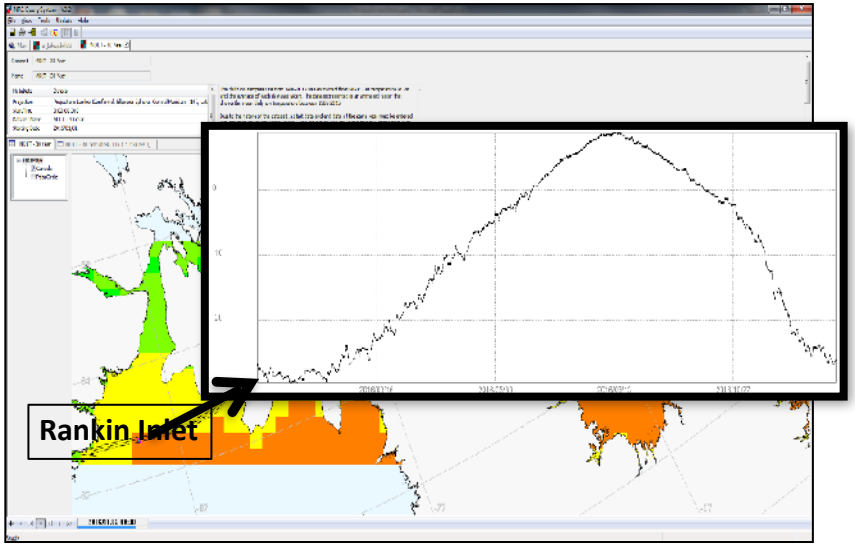



CASRAS Interface

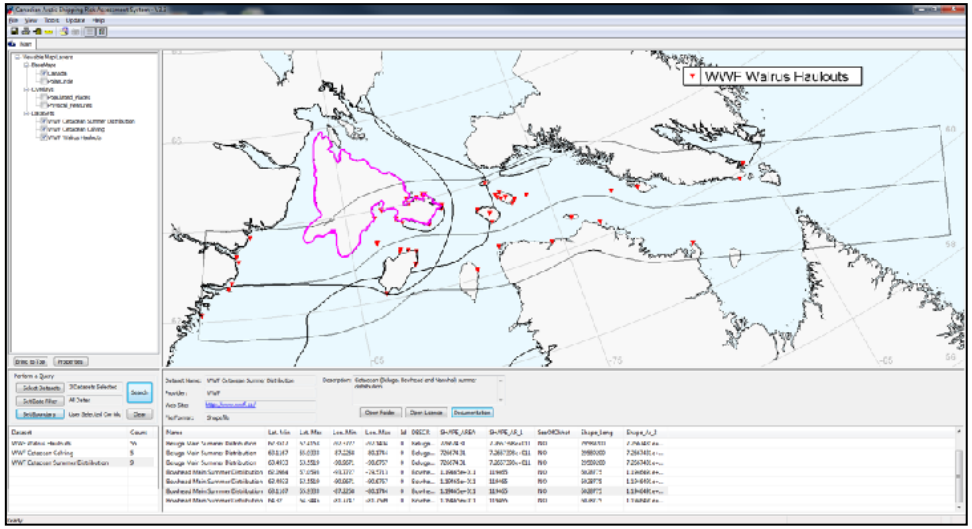

Polar Service Temperature Assessment




Mean Daily Low Temperature - 30 Year Average, November 2nd




Location of mammal sensitive sites within 150NM:




*Slide courtesy of Ivana Kubat, NRC*

# CASRAS – Canadian Arctic Shipping Risk Assessment System

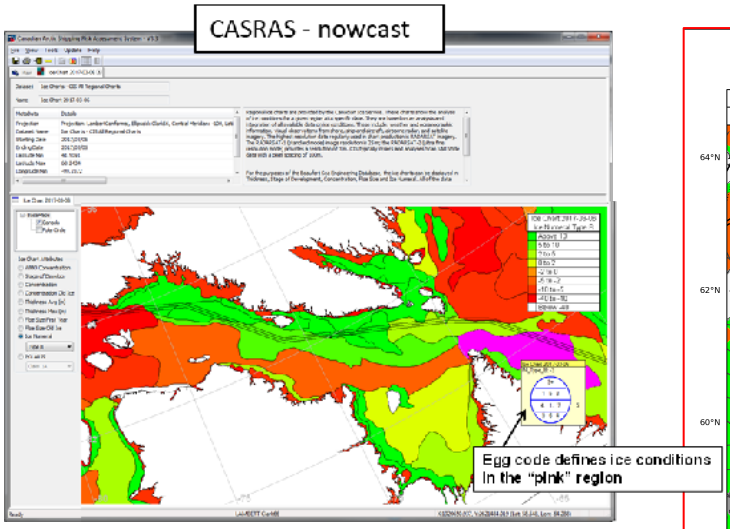
## (developed by National Research Council Canada)

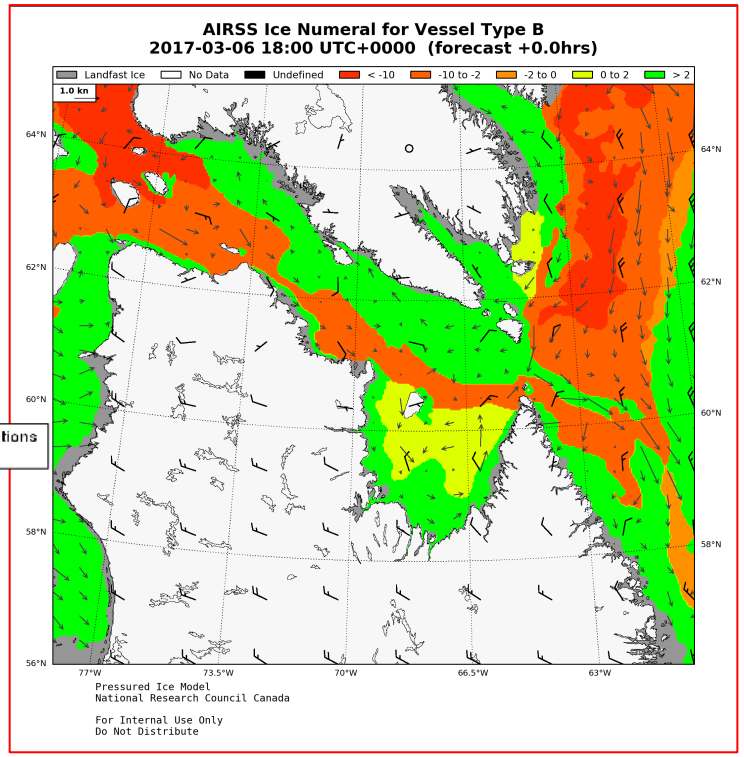
Pressured Ice Model - forecast

<u>Current work:</u>

Two main objectives are:

1. Develop mariner knowledge specific to the Wester Arctic trade corridors, with a focus on community resupply and commercial activities in the Northwest Territories
2. Integrate advanced sea-ice forecasting models into the CASRAS platform




<u>CASRAS use:</u>

- CASRAS has been used and tested onboard CCG icebreakers
- Onboard several commercial vessels (by Captains who have provided feedback on CASRAS development)
- CASRAS has been licensed to the Marine Institute as a training tool - Polar Code and Ice Navigation training program at the Centre for Marine Simulations

CASRAS can run on a stand-alone PC laptop

Cost: TBC … $$$

*Slide courtesy of Ivana Kubat, NRC*

# Safe Speed?

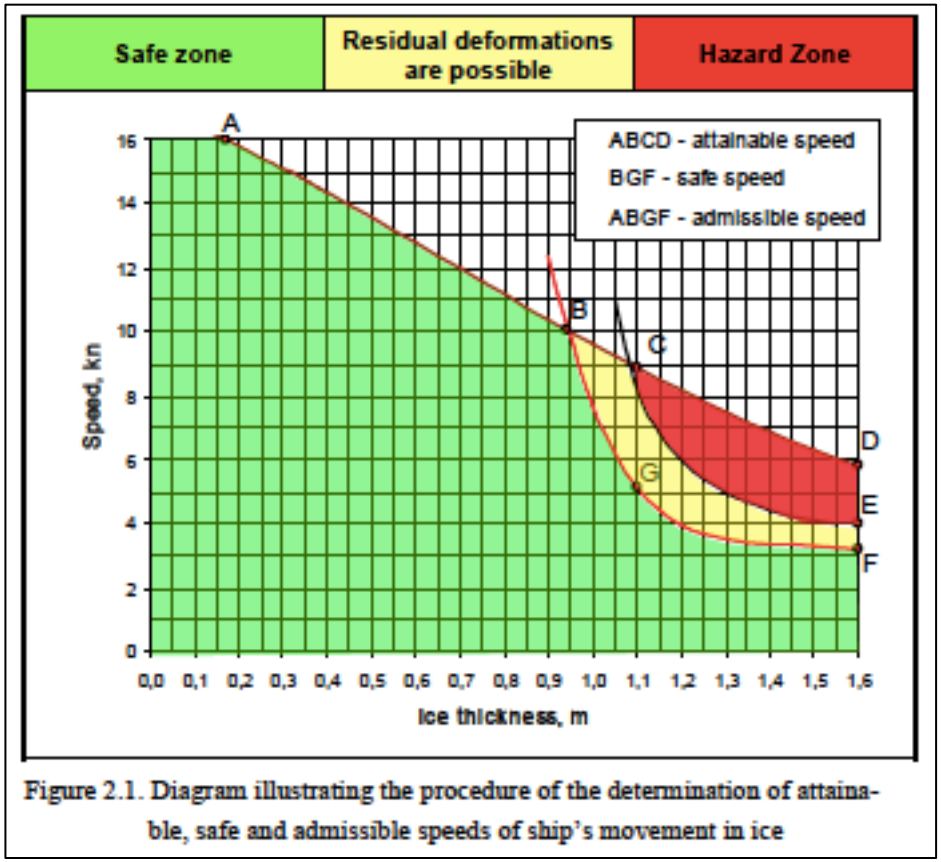



Figure 2.1. Diagram illustrating the procedure of the determination of attainable, safe and admissible speeds of ship's movement in ice

Ref: CMIINF, Ice Certificate for 70,000DWT Arctic Shuttle Tankers, 2007

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## Russian Ice Certificate/Passport

- Tailored examination of performance for each ship (class)
- Examines attainable speeds in different ice regimes and resulting effects, to draw limits of prudent operation
- Recognizes that ships may be powered to exceed safe speed in some ice conditions
- Examines pressure/no-pressure scenarios, different load conditions
- Proposes safe speeds, safe following distance for escort

◆ "Passport" issued for specific ship/ dates, assigning equiv. Russian ice class and approving independent/escorted operations in varied ice conditions (pre-PC)

# Empirical Approach to Safe Speed

- Enfotech study done in 1996 to help validate early AIRSS work in determining how safe IR were
- Safe Speed in range 2-6kts as Ice Numeral approaches **(+) 0-10**

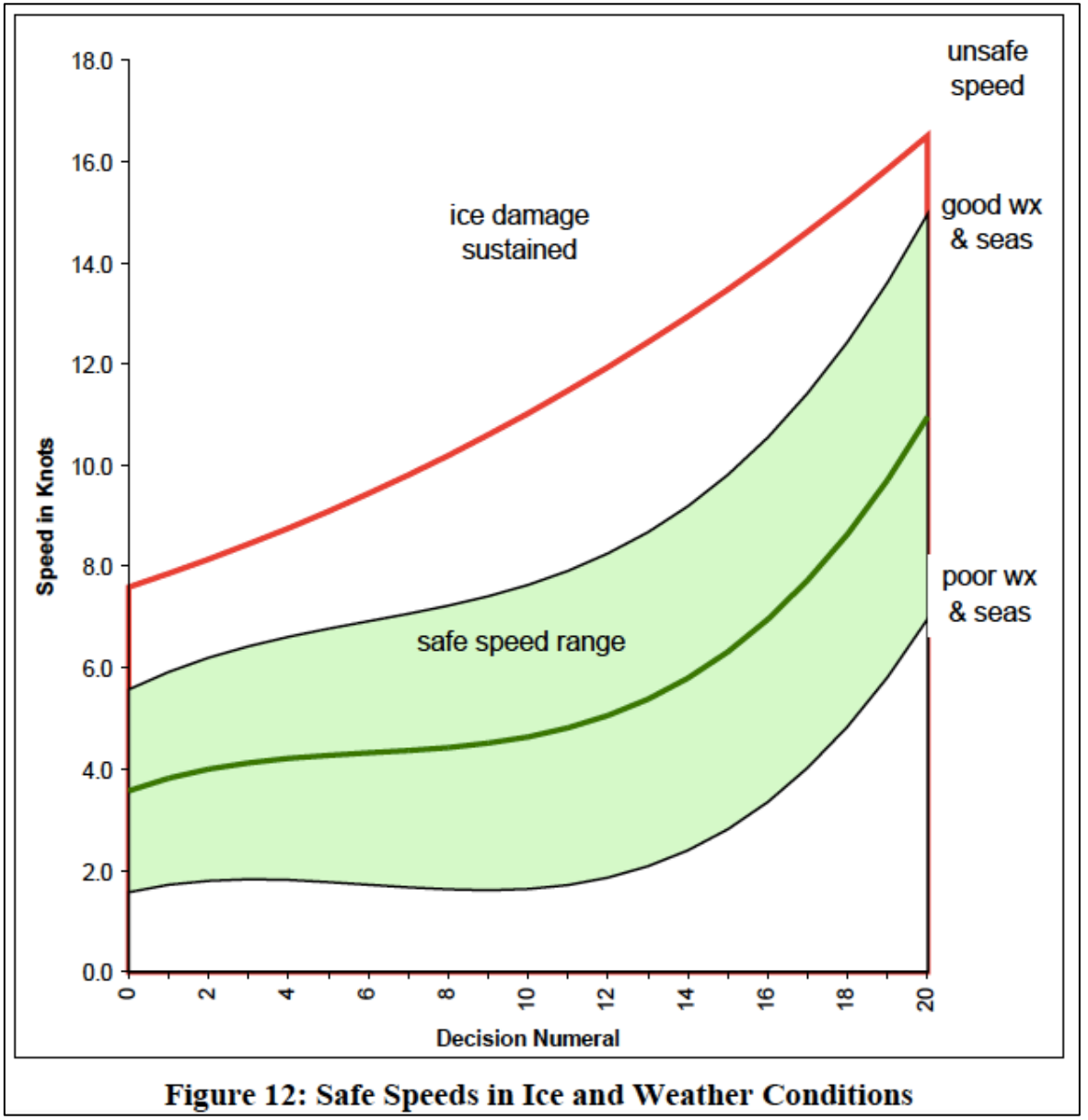


**Figure 12: Safe Speeds in Ice and Weather Conditions**

Ref: Enfotec, Safe Speed in Ice, Dec 1996

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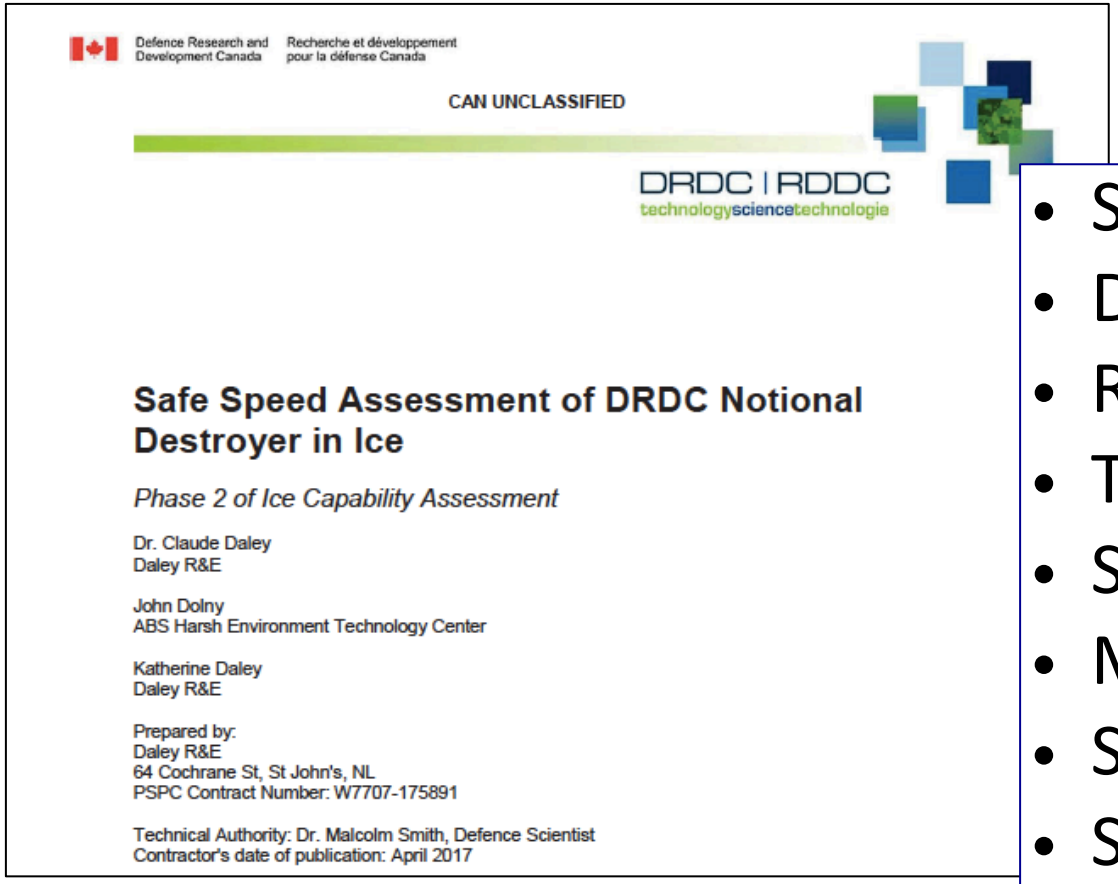
# Analytical Approach to Safe Speed:



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**Safe Speed Assessment of DRDC Notional Destroyer in Ice**

*Phase 2 of Ice Capability Assessment*

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PSPC Contract Number: W7707-175891

Technical Authority: Dr. Malcolm Smith, Defence Scientist
Contractor's date of publication: April 2017

Computer based simulation of hull form/ structure response to ice interactions

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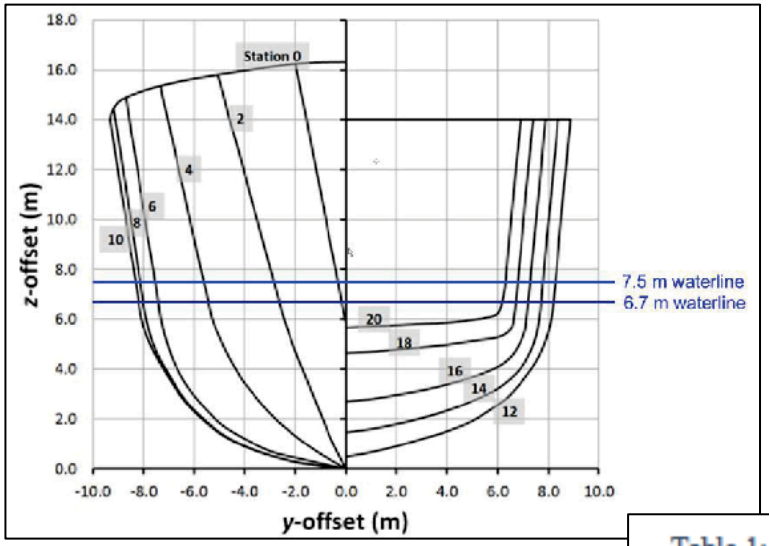
Considerations of Naval Ops in Polar Waters

- Sustainability
- Damage control
- Redundancy
- Top-side icing
- Sea Intakes
- Metallurgy
- Structural strength
- Shell plating strength
- Power
- Hull form
- **Speed**

*Used with permission of Dr C. Daley*




# Modeling of ice impacts:

- "Notional Destroyer" of ~7700t
- Hard ice, TFY or MY (6MPa)
- Glancing blows on the bow (~fr14)
- Direct Load Limit and Large Deflection cases
- Modeled isolated floes and pack ice
- Ice thickness variable 0.2-1.0m
- **Result indicates "Technical Safe Speeds"**

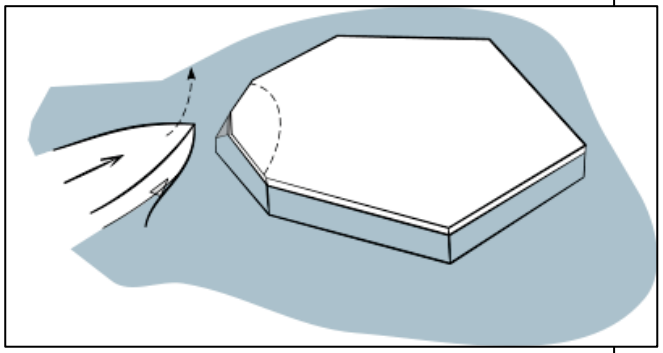
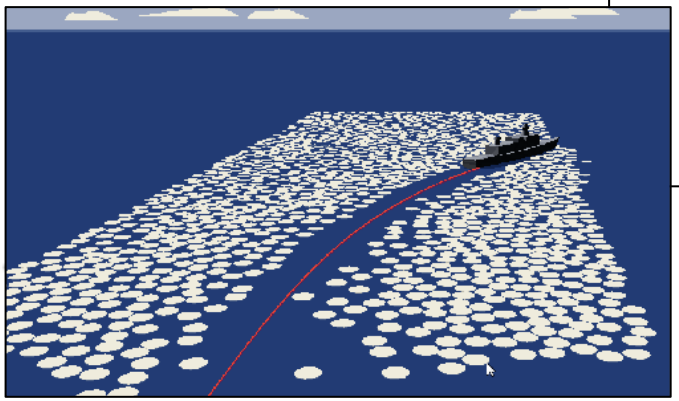


Table 1: Notional Destroyer – Main Particulars

| *Particular* | *Beginning of Life (no ice accretion)* | *End of Life (with max ice accretion)* |
|---|---|---|
| *Length overall* | 151.4 m | |
| *Overall depth* | 16.5 m | |
| *Amidships depth* | 14.0 m | |
| *Maximum breadth* | 18.7 m | |
| *Displacement* | 7673 t | 9095 t |
| *Length along waterline* | 142.8 m | 143.5 m |
| *Length between perpendiculars* | 137.8 m | 138.5 m |
| *Amidships location*[a] | 68.9 m | 69.2 m |
| *Longitudinal center of gravity*[a] | 72.0 m | 73.8 m |
| *Waterline breadth* | 16.8 m | 17.0 m |
| *Draft* | 6.7 m | 7.5 m |
| *Block Coefficient* | 0.48 | 0.51 |

[a] *Distance aft from forward perpendicular (FP). The FP is 0.80 m and 1.48 m forward of frame 0 (F0 at x=0) for the beginning and end of life, respectively.*



**Note: no modeling of bow sonar dome!!**

*Used with permission of Dr C. Daley*

# * Assumes shell-plating deformation acceptable…

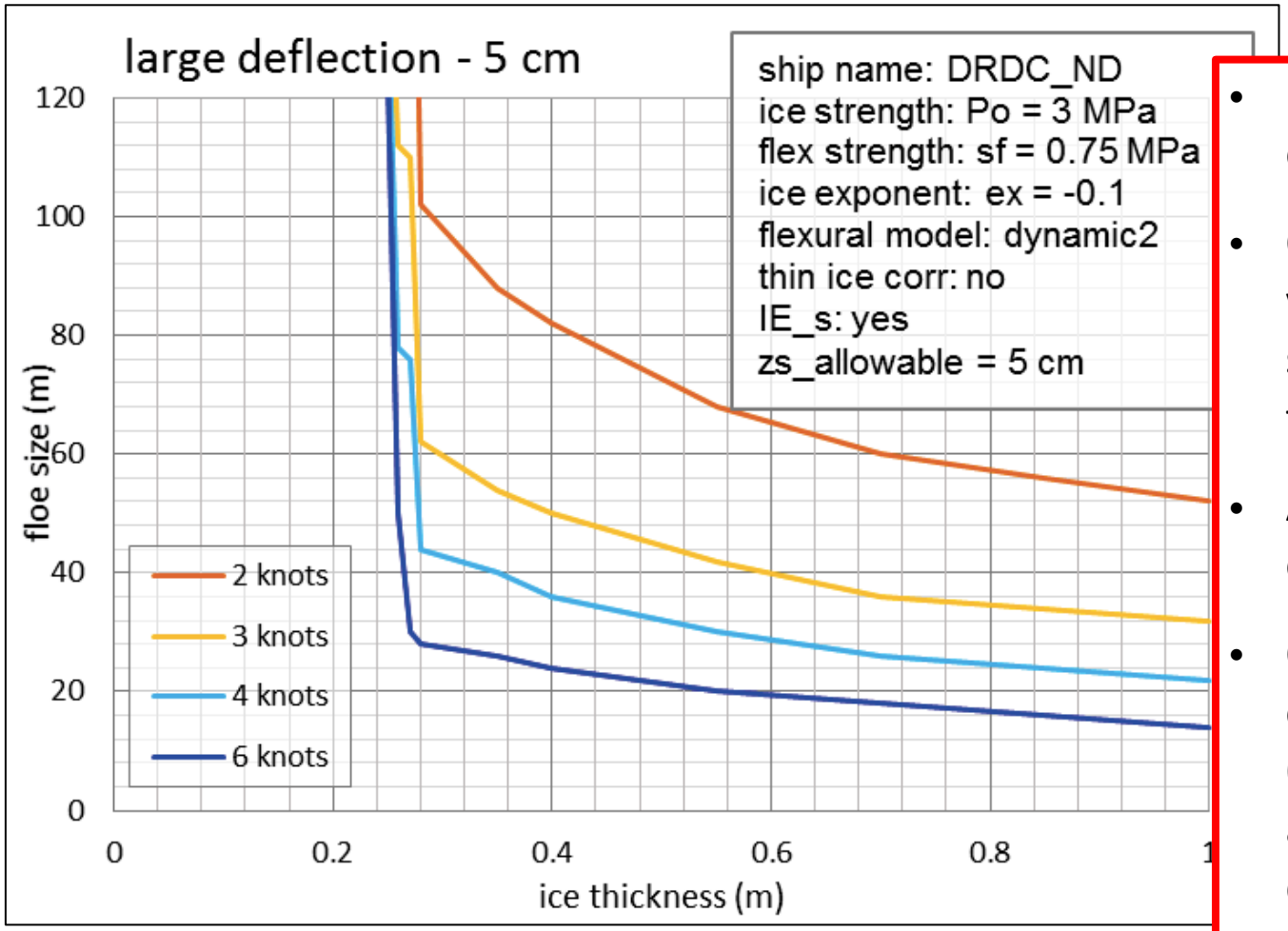



Figure 52: Summary plot of 5 cm deflection limit speed curves versus ice thickness and floe size

- Marginal capability to operate in pack ice
- Cautious operation in very light pack ice of small floes, limited thickness
- At 6kts, limited to operations in brash ice
- Contact at 6kt with floes of 20m diameter and 60cm thickness acceptable (with deformation)
- Increasing probability of deformation with increasing concentration

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*Used with permission of Dr C. Daley*

# For 5000t, PC5, Patrol Vessel *(RCN AOPS ~ 6600t)*

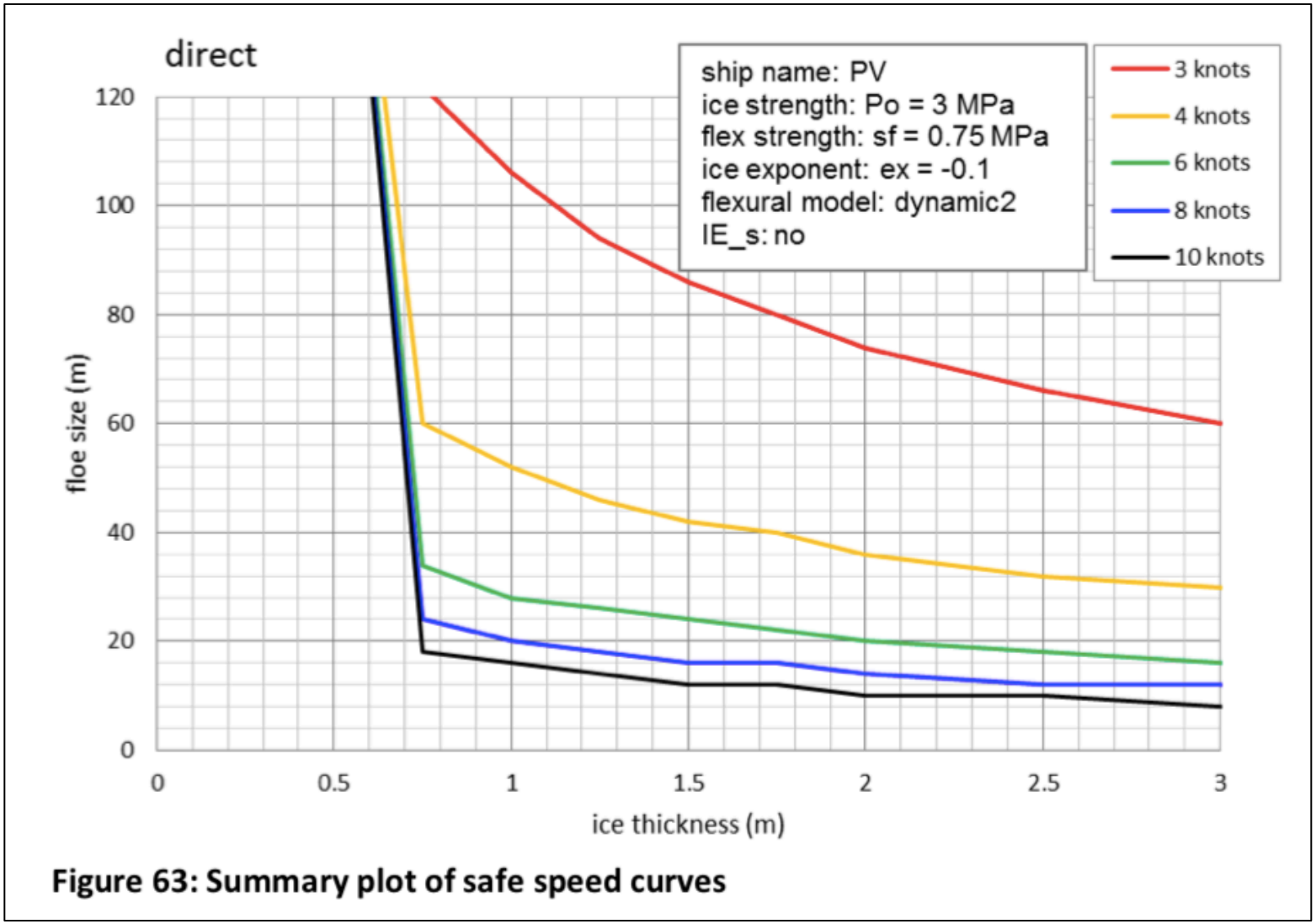


**Figure 63: Summary plot of safe speed curves**

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Ref: Dolny, SSC-473, Methodology For Defining Technical Safe Speeds For Light Ice-strengthened Government Vessels Operating In Ice, 2018

# POLARIS and Speed

Ref: IMO MSC Circ-1 1519

*Table 1.1: Risk Index Outcome criteria*

| $RIO_{SHIP}$ | *Ice classes PC1-PC7* | *Ice classes below PC 7 and ships not assigned an ice class* |
|---|---|---|
| RIO ≥ 0 | Normal operation | Normal operation |
| -10 ≤ RIO < 0 | Elevated operational risk* | Operation subject to special consideration** |
| RIO < -10 | Operation subject to special consideration** | Operation subject to special consideration** |

*1.4 Elevated Operational Risk*

1.4.1 Ships operating in an elevated risk ice regime, l
limit the speed to the values indicated in table 1.2. Oper
provision of additional watch keeping or use of icebreaker
may impair the ship manoeuvrability, the operation should

**Table 1.2 Recommended speed limits for el**

| Ice Class | Recomm Speed Li |
|---|---|
| PC1 | 11 knots |
| PC2 | 8 knots |
| PC3-PC5 | 5 knots |
| Below PC5 | 3 knots |

IACS **POLARIS: Speed reduction in Negative RIOs**

Table 1.3 Marginal capability speed limitations

| Ship Category (ice class) | Independent Operation Speed (knots) | Escorted Operation Speed (knots) |
|---|---|---|
| A (PC1 – PC2) | NA | NA |
| A (PC3 – PC5) | 5 knots | 5 knots |
| B (PC6 – PC7) | 3 knots | 3 knots |
| C (IA Super - IA) | NA | 3 knots |
| C (below IA) | NA | NA |

- Acknowledges that there is not a finite point when the ship cannot operate
- Based on IACS ice class rule formulations

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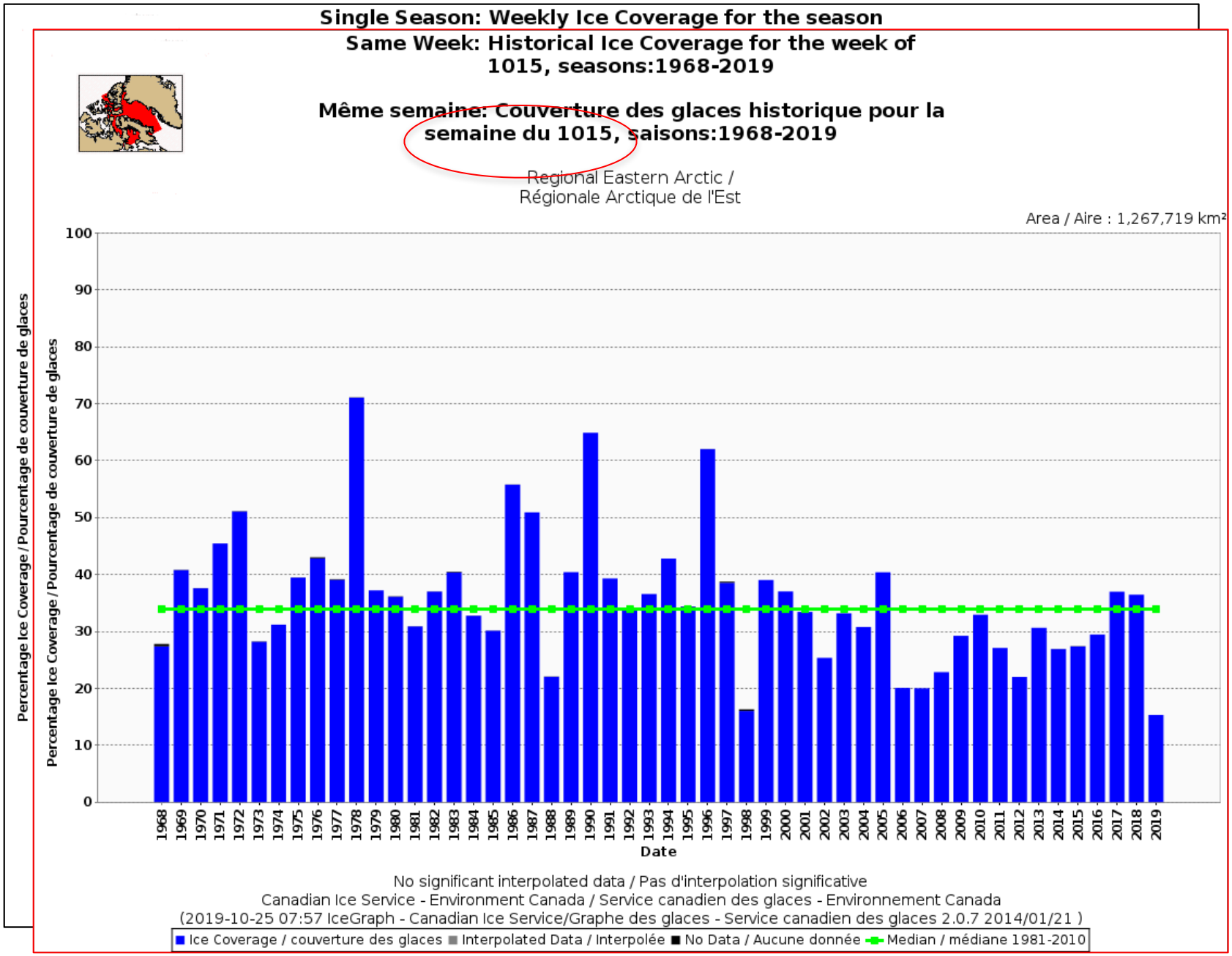
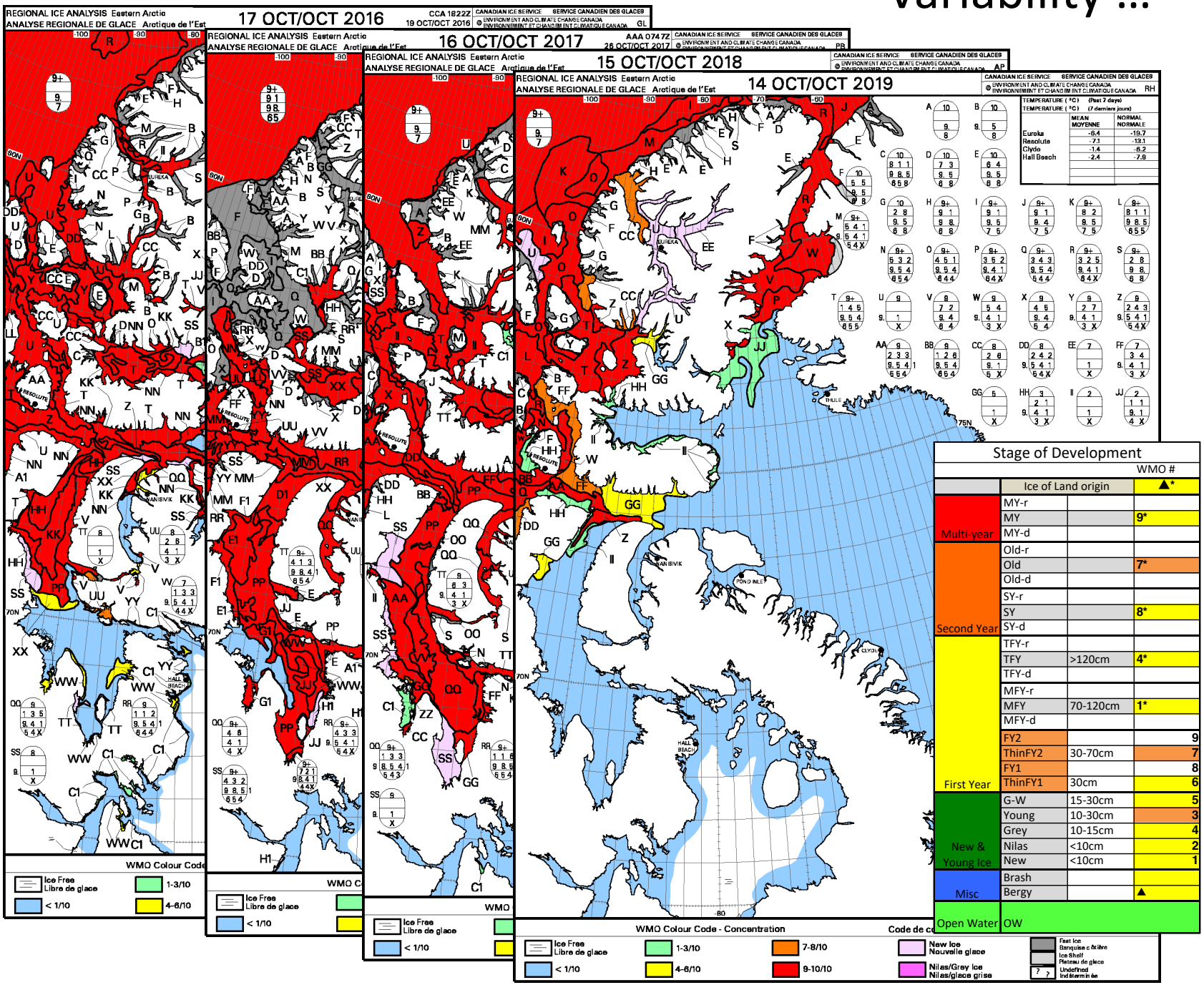
# Variability of Ice Coverage from Year to Year



# Variability …



# Experience

**CASPPR "Ice Navigator"**

- Canadian requirement under ASSPPR for operation under AIRSS
- 30 days "in ice"

**Canadian Polar Waters Advanced Trng Certificate**

- Adv Trng + 2mo sea service in PW or in waters with acceptable ice conditions
- *(til 2020) 3mo of sea service in last 5yr, of which 1mo in PW and 2mo in ice**

**Nautical Institute "Ice Navigator Certification"**

- Professional certification scheme introduced by the NI in 2017
- Level II = Adv Trng + 50d at sea as Master/OOW, of which 30d "in ice"
- *Grandfathering: Level II = 90d "in ice"* ***or*** *Trng + 50d "in ice"*
- 5 yr renewal = 30d in ice

- Canadian recognized Ice Navigators provide more than Ice Advice;
  - they provide local knowledge, experienced interface with local authorities and
  - a network of info exchange, interpretation and understanding of Cdn Regulations

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* *IMO does not require the time in ice*

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RV Xue Long, NWP 2017

# Conclusions:

- P5 (*"P***-Poor Planning Predicts Performance"*)
- More info is better (*limited internet is false economy!*)
- Distinguish between Old and FY ice
- Avoidance is key
- Know your capabilities & limitations
- Practice patience
- Engage experience

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# Questions?


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