Review of Summer Ice Conditions Affecting Vessel Access to the Coronation Gulf Region of Nunavut

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ABSTRACT

This report reviews the range of expected ice conditions and shipping seasons for ice- strengthened cargo vessels serving the Coronation Gulf region of Nunavut. An earlier feasibility study contracted by the Government of the Northwest Territories (GNWT) to look at shipping to Western Artic communities with deep-sea vessels, formed a baseline reference. The original historical ice database was supplemented by adding the results of recent Canadian Ice Service data on ice clearing trends (1998 to 2003), and selected Landsat 7 images available since 1999. In addition, new material was developed to reflect the present status of Arctic shipping regulations and possible long-term trends in ice severity related to climatic change.

KEY WORDS: Arctic; shipping routes; ice conditions.

INTRODUCTION

Ongoing mineral developments in the Coronation Gulf region of Nunavut prompted a study of possible shipping seasons available to different ice class vessels approaching from the North Pacific or North Atlantic.

There is a vast background of experience with ice operations into and through the Coronation Gulf region. Much of the historical activity occurred on the Western route but a number of large drill ships and cargo vessels made summer positioning voyages into the Beaufort from the East. Numerous studies were conducted in the 1970's and 1980's in connection with Beaufort Sea oil development as well as the Arctic Pilot Project. During the period of most intense activity (1976 to 87) companies such as Dome, Gulf and Esso evaluated the reliability of a range of routes for moving drilling structures, drill ships, dredges and supply vessels from both the Pacific and the Atlantic. Over the past fifteen years, the pattern of deep-sea traffic in the Canadian Arctic has reverted to its historical pattern, centred on the Baffin and Eastern Arctic areas. Exceptions are the increasing numbers of specialized cruise vessels and chartered tourist icebreakers, which now complete all or part of the Northwest Passage each year. With the recent closure of both High Arctic mines (Polaris and Nanisivik) regular voyages with large (30 to 40,000 deadweight tonnage (DWT)) ice strengthened bulk carriers have ceased for the present time.

The current high level of interest in mining developments in the Coronation Gulf region and a resurgence of interest in Canadian Beaufort Sea oil and gas reserves could see future growth in Western Arctic shipping patterns once again.

SCOPE OF WORK

Data Sources

This project utilizes the ice database contained in Dickins and Toomey (1998). Commissioned by the Government of the Northwest Territories Department of Transportation, that study examined the feasibility of serving nine Western Arctic communities by deep-sea vessels. The scope of the earlier work covered both eastern and western access into the Coronation Gulf region, and specific communities from Sachs Harbour to Taloyoak. Key differences between the earlier study and the current review completed in 2004 are summarized below:

- The sealift season for GNWT was assumed to end with freeze-up at the communities. In the absence of deep-sea wharfs, offloading cargo by floating fuel hoses and shallow draft lighters to shore could only take place in open water. In this study late season ice information is further evaluated to determine how the application of the Arctic Ice Regime Shipping System (AIRSS) would affect the late-season operations with ice-strengthened vessels.
- The reliability of deep sea access in the GNWT case was predicated on having to use a single large cargo ship or tanker (or at the most a few vessels in tandem) to supply up to nine communities in a single voyage. The inefficiencies of offloading without any port facilities required a minimum-shipping season (with weather contingencies) of 32 to 37 continuous days, which in many years proved difficult if not impossible to achieve with anything other than dedicated icebreaking cargo vessels. In contrast, mineral extraction projects will likely use a number of different ice strengthened vessels throughout a given season. An individual ship would likely make only a single voyage per season and call at only one port.

This preliminary review uses the core dataset created in the GNWT study to address the following main issues:

- Available shipping season and ice conditions (for E & W routes)
- Approximate voyage times to relatively "open" water along both routes
- Review of regulatory issues and the potential for the Arctic Ice Regime Shipping Control System (AIRSS) to permit voyages later than the mandated exit dates.

Additional information sources used to supplement and update the earlier GNWT study include:

- Canadian Ice Service Seasonal Outlooks - 1998 to 2004
- Landsat 7 colour imagery (browse files) available through the United States Geological Survey
- Comments on long term, hypothetical future trends towards decreasing Arctic ice coverage and implications for shipping by the Canadian Ice Service as projected by Falkingham (2000).

Definition of Ship Classes

Different nations (Sweden/Finland, Canada, Russia, Italy, Poland) and ship classification societies (e.g. Lloyds Register, American Bureau of Shipping, Det Norske Veritas, Germanischer Lloyd etc.) have created their own designations and rules for classifying vessels with different levels of ice strengthening.

The Canadian Arctic Shipping Pollution Prevention Regulations (ASPPR) specify a number of vessel ice classes, including typically non-icebreaking or nominally ice-breaking vessels, strengthened to safely encounter different thickness of ice (Table 1 below). Type designations under the Canadian system run from A through E, with Type A being the most capable. Icebreaking vessels with specially designed bow forms and additional power and hull strength are designated under a different classification of Canadian Arctic Class (CAC 1 through 4, with 1 being the most capable). Unlike Type vessels, CAC designated ships are designed to withstand frequent impacts with second or multi-year ice. This study is concerned only with Type class ships designed to operate in predominantly first-year ice. First-year ice thickness limits (related to degrees of ice strengthening) for the different classes are described in Timco and Johnston (2003).

There is an international effort under way to harmonize the complex and varying designations into a unified design code that would apply to new construction. Under the auspices of the International Association of Classification Societies (IACS), a new system of Polar Classes has been developed to designate different levels of ice capability (Ref. IMO 2002). These new requirements are intended to be used in addition to the individual classification society rules to address all aspects of construction for ships of Polar Class. Vessels in the current world fleet can appear with a bewildering array of ice class designations. Annex II of the Canadian Coast Guard Icebreaking Services Fee Schedule (December 21, 1998) contains a detailed table of common equivalencies between the Canadian Type classes and international designations. The table is available at:
http://www.ccg-gcc.gc.ca/msf-dsm/news/ISFDec98FEEschedule_e.htm

Anticipated vessel sizes in this study are in the range of 35,000 to 50,000 deadweight tons (DWT), with a service draft estimated at 13 to 14 m.

Access Routes

Routes considered in this study include:

- The western access route from the Bering Sea out of the North Pacific via the Chukchi Sea, US and Canadian Beaufort Seas, and Amundsen Gulf (Figure 1) and;
- The eastern access route from Davis Strait to Coronation Gulf out of the North Atlantic via Baffin Bay, Lancaster Sound, Peel Sound, Larsen Sound and Victoria Strait (Figure 2).

Fig. 1 The Western Access Route - Bering Sea to Beaufort Sea

Access can be evaluated as function of ice conditions within the so-called "choke" points along each route. These sectors, containing the most persistent, severe ice conditions control the available time window for summer shipping. Over the long term, access dates derived from ice patterns along the choke points provide a reasonable indicator of the historical pattern in shipping windows.

Approaching the Beaufort Sea from the west, the choke point or controlling area usually falls within the stretch from just short of Point Barrow to Barter Island (Figure 1). Additional problems can also be encountered in Amundsen Gulf early in the summer when old ice moves south around the tip of Banks Island and can choke the approaches to Dolphin and Union Strait.

Approaching from the east, the equivalent controlling areas are concentrated in Peel Sound, Larsen Sound, and Victoria Strait where heavy multi-year ice is often slow to break-up (Figure 2).

In theory, there are two choices of deep draft eastern access routes from Parry Channel. Ships can use Prince Regent Inlet, taking Bellot Strait to enter Franklin Strait and eventually Larsen Sound; or they may use Barrow Strait to enter Peel Sound from the north, which also leads to Franklin Strait and Larsen Sound. In terms of ice conditions, the preferred eastern access route will usually be through Peel Sound. From Larsen Sound, the only choice remaining for deep draft vessels is to follow Victoria Strait southward, and to decide whether to pass west of Jenny Lind Island via the Icebreaker Channel to Queen Maud Gulf (the usual route); or to use the channel east of Jenny Lind Island.

Fig. 2. Eastern Route Choke Points - Peel Sound to Victoria Strait

ICE CONDITIONS

Ice Conditions along Western Access Routes

In most years, the timing of a vessel's arrival into the Canadian Beaufort from the west is controlled by the progression of pack ice retreat off the Alaskan north coast sufficient to allow deep draft vessels to round Point Barrow. In an average year, ice concentrations at this Westerly choke point only fall below 7/10 in the last week in July. In extreme years, the pack barely retreats from the coast for most of the summer (e.g. 1988 and 1996), and may leave only a narrow corridor between shore and the ice edge for shallow draft tugs and barges.

By late July, the remaining first-year pack ice off the Alaskan Coast will be mostly well-rotted, discoloured thick first year ice, broken up into brash and mostly small floes, with some pieces of older ice mixed in. There is a good possibility of meeting some large floes of arctic pack (multi-year) in the Point Barrow region, but the chances become less as the ship works eastward. If multi-year ice is encountered, it can often be avoided by working a closer inshore as draft allows (Dickins and Toomey, 2000).

Ice breaking Canadian Arctic Class cargo ships like the M.V. *Arctic* (as opposed to ice strengthened Type vessels) are not as constrained in these severe summers. Such ships can safely enter an area with substantial concentrations of old ice, and force their way back out through difficult freezing conditions in October, or even November in some years.

In terms of the available shipping window (transits possible in either direction through the choke points), the Western route normally maximizes the number of weeks available to ship in or out of the Coronation Gulf region in a "typical" or average year. Sea ice tends to clear from west to east starting with the Beaufort communities of Tuktoyaktuk and Sachs Harbour in mid-July, and progressing as far as Cambridge Bay by the end of July.

Ice Conditions along Eastern Access Routes

The ice conditions in Peel Sound, Franklin Strait and Larsen Sound do not clear sufficiently to allow unescorted commercial shipping until mid-August in most years. In some years, heavy ice blocks this section of the eastern access route for the entire navigation season (August to October). The ice is made up of mostly large, thick first-year floes with a variable proportion of old ice that commonly enters Larsen Sound through M'Clintock Channel. There is often a wide band of old ice at the northern end of Peel Sound as well.

By entering from Bellot Strait a deep draft ship may be able to avoid the old ice which often accumulates in Peel Sound, but Bellot Strait itself can become impassable, especially at the western end, and is not a good place to be trapped with a large vessel due to the difficulty of navigation in the narrow strait with its strong currents. This study focuses on Peel Sound as the primary "choke point" or section containing the most severe ice enroute to the Coronation region from the east.

An ice strengthened vessel arriving from the east will often not be able to penetrate south through Peel Sound area until late August, leaving only a few weeks before freeze-up. A large part of the short summer time window can be wasted waiting for Peel Sound and Larsen Sound to open up. Data compiled from 1962 to 1997 in the GNWT study showed extensive ice clearing (less than 6/10) in these Eastern choke points during only 38% of the years. This finding compared favourably with an estimated 40% quoted in an independent study by Canarctic (1993).

Even in a favourable ice year, Type A vessels can only enter Peel Sound before August 15 if they avoid situations of negative ice numerals under the AIRSS. In practice, ice conditions are usually far too severe in this area to allow early entry to a Type class vessel. Even with the bonus allowed for decayed first-year ice, Type vessels will usually experience negative decision numerals in this area, related to second year or multi-year ice. As a result, early entry from the east (prior to the entry dates called out for Zone 6 under the AWPPR) is not possible for vessels classed below CAC 3.

Route Summary

Ice conditions along the Western route often open up earlier than along the Eastern Route and in most years there is less multi-year ice present off the Alaskan North Slope than in Peel Sound and Larsen Sound. However, either route can be choked with old ice for much of the summer in severe years. It is important to note that the timing of difficult conditions in the West rarely coincides with the same degree of difficulty in the East and vice versa.

During an outbound voyage late in the summer season or during freeze-up, a vessel departing westbound will generally be in a better position. Heading west, the vessel will be moving through a region of similar freezing potential before heading south into the milder, later freezing waters of the Chukchi Sea. Departing Eastbound a vessel will have to sail north through Larsen Sound and Peel Sound into worsening conditions (colder temperatures and more rapidly consolidating ice) before reaching open water in Lancaster Sound or North Baffin Bay.

Each route has a similar distance to run in areas with high summer probabilities of severe ice (300 to 400 n miles). The key difference is that severe ice in the Larsen Sound/Peel Sound sectors often means that no passage is possible all summer, while severe ice off the Alaskan Coast more often translates to delayed or slowed transits. With predominantly open water or light pack ice (<6/10) during the period from mid July to early October, the estimated steaming times from Coronation Gulf to round Point Barrow going west or to depart Lancaster Sound going east are in the order of 100 hours. In heavy ice, the transit times could more than double.

Icebreaker escort may make a difference in marginal years where a Type ship is blocked by high concentrations of mostly first-year ice, but in the most severe cases when passage is prevented by old ice, the presence of an icebreaker will make little difference. This study assumes that government icebreaker support will not be routinely available to assist commercial bulk carriers, based on limited current and projected resources. Vessels will need to be able to navigate independently without assistance.

ANALYSIS

Ice Database

The ice database used in this study consists of a long-term record of weekly ice conditions along the controlling sections of the eastern and western access routes (see previous) compiled from Canadian Ice Service charts. Ice conditions in the database represent the worst weekly ice condition that a vessel would have to overcome in traversing the choke points from east or west going back as far as possible in the available ice charts (complete data was available for the period 1971-97, with some additional information from the 60's). In this study, the most recent ice information in this database from 1988 to 1997 was applied to five possible ice classes (A through E) and used to gauge the likely shipping windows for concentrate vessels traveling to the Coronation Gulf region. The Arctic Ice Regime Shipping System (AIRSS) as a guide to safe operations outside of the season mandated by the Shipping Safety Control Zone Entry and Exit Dates.

Assumptions made at the beginning of the analysis include:

1. The existing situation with regard to the new Arctic Ice Regime Shipping System (AIRSS) is expected to continue for the foreseeable future, namely that the historic Zone Date system for vessel entry and exit into and out of specific control zones will remain in force as a legal entity, and that any application of the AIRSS will only be mandatory for operations outside of those dates. Note: AIRSS only applies to operations in Canadian waters north of 60° Latitude. The most severe portion of the Western access route falls in US Arctic waters. AIRSS is applied to ice conditions along this sector as convenient guide to safety and likely access, recognizing that it has no legal status.
2. Early season voyages (before the July 15 mandated entry date for Zone 11- Coronation Gulf) prior to break-up of the fast ice is neither technically feasible for Type vessels nor acceptable for environmental and social reasons (assuming that the vessel could make progress through the remaining fast ice).

3. Type vessels that normally use an open water bulbous bow, have limited icebreaking capability in continuous level ice. Grey grey-white ice in the 15 to 20 cm range would represent the upper limit for continued progress and then only if there were leads and openings in the vicinity. The exact ice thickness, which can be sustained while still making continuous progress (over 4 knots) will vary somewhat with individual ship characteristics (hull form and power for example). The low icebreaking threshold for most Type class vessels means that they need to depart the region at the onset of freeze-up or soon after. In some years, it may be possible to extend the fall season by a few weeks as long as the ice cover along the deep water route remains mobile and less than 10/10. The actual extension possible in any given year will depend on a wide range of factors including openings in the ice cover, and presence of old ice.
4. The cut-off date for late season voyages (beyond the mandated exit dates) is dictated by the practicalities of trying to navigate with a non-icebreaking vessel in newly forming ice. Under these situations, particularly for vessels with a high level of ice strengthening, AIRSS will often show positive results (allowed to proceed) in ice which is clearly far beyond the capability of the ship to make any progress (e.g. Type A ships only produce negative values under AIRSS when the ice thickness is greater than 120 cm).
5. While Type class vessels may be legally entitled to enter a particular zone (e.g. Beaufort Sea after July 1, Coronation Gulf after July 15), there are many years when ice conditions (high concentrations over 8/10 + multi-year) would not realistically allow any commercial progress.
6. With the long distances involved back to a destination port in Europe or Asia there is a small likelihood of any vessel making more than one voyage in the season.
7. Pre-arranged charter arrangements will probably stipulate that vessels entering from the East leave via the same route and so on. In some years, flexibility in arrival and departure directions could be a distinct advantage. Severe years on the Western route are not correlated with equivalent degrees of severity in the Eastern Arctic and vice versa.
8. The ice database was evaluated in terms of likely shipping windows for Type vessels only. Icebreaking CAC ships were not examined, owing to the very limited availability of such vessels on the world market.

Historic Variability in Shipping Seasons

Spreadsheets were developed to express the results of the ice data analysis in terms of the likely shipping windows that could have been achieved during the period 1988 to 1997 as an example. The ice conditions allowing vessel access through the choke points on each route (green or blue) were shown week by week for each year and vessel class. For comparison each spreadsheet shows the currently regulated shipping season as defined by the allowed entry and exit dates for the relevant zones: Zone 11 covering Coronation Gulf (most stringent for Western access); and Zone 6 covering Larsen Sound and Peel Sound (most stringent for Eastern Access).

The spreadsheets are intended as an initial screening tool to show which class of vessel would be most suitable at different times in the summer. Colour shading relates the ice severity along the most difficult sections of the Western and Eastern routes combining: (1) AIRSS to determine possible safe periods outside the Zone Dates prescribed under the ASPPR, and (2) the likely influence of ice thickness on the progress of non-icebreaking ("Type" class) vessels. It is important to recognize that in practice, the safety and success of any Arctic voyage will depend on the ice conditions at the time, each vessel's individual characteristics and capabilities, and the experience of the crew and Master.

Future Trends in Ice Conditions

A great deal of worldwide attention is being paid to the possible effects of climate change in the Arctic, with a gradual decline in ice cover and thickness often presented as an indicator of dramatic changes to come. The following discussion of this issue is drawn largely from material published by Falkingham (2000).

Observational evidence indicates that the Arctic has been warming and that this warming is unprecedented over the past 400 years. If the recent (past 35 years) rates of ice thinning are sustained, the Arctic Ocean could be essentially ice-free in summer as early as 2050. There is considerable scientific debate about the future state of Arctic sea ice. Natural variability may explain some of the historical trend, and model errors and uncertainties result in a range of projections. That being said, the predominant scientific opinion is that there will be much less ice in the Arctic in future summers than we have seen in the past.

Planning summer shipping seasons based on ice conditions of the past few decades may prove to be conservative within the next twenty years. While there is not enough confidence in the models and forecasts to plan for longer shipping seasons in the development phase of new projects, the long term trend towards diminishing ice cover should lend an added level of confidence to the economics of summer shipping based on data available today.

REGULATORY ISSUES

The Shipping Safety Control Zone/Entry and Exit Date system, legislated under the Arctic Shipping Pollution Prevention Regulations (ASPPR) legally controls vessel access into all Canadian waters north of 60°.

Transport Canada has implemented a supplementary system of controlling vessel entry into different Arctic areas by relating real-time ice conditions to a vessel's degree of ice strengthening. The Arctic Ice Regime Shipping System (AIRSS) can be used by vessels wishing to access a region outside of the dates allowed under the mandated Shipping Safety Control Zone/Entry and Exit Date system (TP 12259E, 1996). The AIRSS system is described and illustrated effectively in Timco and Johnston (2003 - Transport Canada Publication TP14044E). This booklet is highly recommended as it provides a pictorial, easy to understand presentation of ice conditions and the corresponding AIRSS output values for different Classes of vessels.

Although the original long-term intention was to gradually expand the use of AIRSS to cover the whole shipping season, this policy proved to be highly controversial among vessel owners and operators. Eventually, the new system may become the primary means of regulating commercial vessel operations throughout the Arctic. For now, it is likely that the status quo (i.e. dual systems) will persist for the near future.

It must be kept in mind that the new control system was developed strictly to ensure safety (hull integrity) rather than performance. AIRSS does a good job (generally erring on the conservative side) of identifying ice regimes that "could" be dangerous to a particular class of vessel in terms of possible structural damage. That said, the present system has known limitations when applied to practical commercial navigation. It is quite possible (even likely) in many situations that a well-constructed high ice class vessel may be completely beset in ice, while maintaining a positive decision numeral under the AIRSS. The opposite possibility also arises, that a highly capable vessel with an experienced crew can maintain steady progress through ice conditions rated as negative under the AIRSS (entry refused).

Recent revisions developed by the National Research council are aimed at addressing some of these issues but at this stage, the modified AIRSS is only a proposal (Timco et al., 2003). The modified form of AIRSS would provide a bonus in the spring for capable vessels operating in warm (weaker ice) with competent crews and onboard ice navigation systems.

In addition, Transport Canada led an international movement towards the adoption of a universally acceptable Polar Code of Navigation addressing pollution prevention, navigation, communications, survival equipment, crew qualifications and operational measures in polar waters. In its current form, this code exists as a Guideline for Ships Operating in Ice-covered Waters (passed as an IMO MSC draft circular in October 2002). In a parallel effort, the International Association of Classification Societies continues to develop a set of Unified Requirements for polar vessel hull structures and machinery.

SUMMARY AND CONCLUSIONS

Primary conclusions relating to the feasibility of eastern and western access into the Coronation Gulf region are highlighted here based on an examination of expected shipping seasons for different ice class vessels (Types A through E) over a ten year period:

Eastern Route

- Only three years show a likely shipping season more than three weeks long (for Type A vessels only).
- Four years showed a likelihood of no shipping season except for pockets of less than one week scattered through the summer.
- Three years showed a possibility for extended season voyages outside of the regulated dates, and then only for a week at most for Type B or C vessels. Type A vessels would not benefit at all from trying to navigate later than the regulated exit date. Note that entry from the east into Coronation Gulf is not allowed for Type E or D ships, regardless of the ice conditions (mandated under ASPPR)

Western Route

- Type A or B vessels would likely have gained access to Coronation Gulf from the West in every year studied. The average achievable season length is estimated as 10 weeks (shorter than the 15 to 17 weeks currently allowed for entry into Coronation Gulf under the Zone/Date system). The variability in season duration in the analysis ranged from 4 to 14 weeks.
- The legal entry date for Type A classed vessels into Coronation Gulf (Zone 11) is July 10, but in practice, even in a favourable year when transit is possible along the Alaskan coast at that time, vessels could end up waiting for Amundsen Gulf and Dolphin and Union Strait to open up sufficiently to allow access to Coronation Gulf. A more realistic start-of-season date for port sites in the Coronation region would be mid-July in a favourable year, the end of July on average and mid-August in a severe year.
- The analysis indicates that it would have been possible for Type A or B ships to navigate along the Alaskan Coast close up to the end of October in favourable years (3 out of 10). In practice, a stable ice cover will form earlier nearshore in port

than in deeper water along the shipping route. On this basis, the realistic end-of-season date for the last outbound voyage in most years will probably depart in the first half of October. Given the extreme financial liability of being trapped for the winter, most Masters will likely want to depart the area at the first signs of new ice in the vicinity of the docking area.

- Limited extensions to the regulated exit dates may have been possible under AIRSS in four of the years studied. Lower ice class vessels would have benefited the most under this arrangement, gaining as much as three weeks in the most favourable years.
- Lower ice class vessels (C through E) are likely to have achieved at least a one-month shipping window in eight out of the ten years. In some cases, the access is not continuous, with periods of heavy ice off Alaska for weeks at a time in the middle of summer.

The following tables summarize the findings for Type A or B vessel (or international equivalents) in terms of the number of days of berth operation expected in poor, average and good years, taking into account the time needed to transit between Coronation Gulf and Point Barrow (Western Route) and the North end of Peel Sound (Eastern Route).

Table 1. Summary of Expected Shipping Seasons from the West

Ice Conditions	Entry Round Pt. Barrow	Transit to Coronation Gulf	Exit Round Pt. Barrow	Total Berth days (1)
Good	15 July	8 days	24 Oct	90
Average	1 Aug	10 days	5 Oct	70
Poor	15 Aug	12 days	26 Sept	30

Note (1): Early opening dates do not necessarily correspond to late closing dates, and vice versa. For that reason, the berth operating seasons in the table are derived from the actual case studies represented in the spreadsheets (1988-1997), and cannot be computed simply as the duration between start and end dates shown. In some summers, there will be periods where a portion of the route is impassable. These "black out" times are accounted for in the berth season totals shown.

Table 2. Summary of Expected Shipping Seasons from the East

Ice Conditions	First Entry Peel Sound	Transit	Last Departure Peel Sound	Total Berth Season days (1)
Good	20 Aug	5	11 Oct	42
Average	10 Sept	6	13 Oct	17
Poor	Never	N/A	N/A	0

Summary

In summary, the western route offers reliable access for a portion of the summer in almost every year for vessels class B or higher. Lower class vessels can enter in most years, but they cannot be counted on to make a successful voyage every year. The start and end of season dates for lower class vessels are highly variable from year to year. In contrast, ice conditions along the eastern route do not allow reliable access for Type vessels of any class (no better than 40% probability, even with the most capable Type A or B vessels). Icebreaking cargo ships equal or better than the MV *Arctic* in terms of capability would be required to access Coronation Gulf in most years on the eastern route (still no guarantee of success in severe summers).

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