THE NORTHWEST PASSAGE
FUTURE HIGHWAY OR HISTORIC BYWAY?

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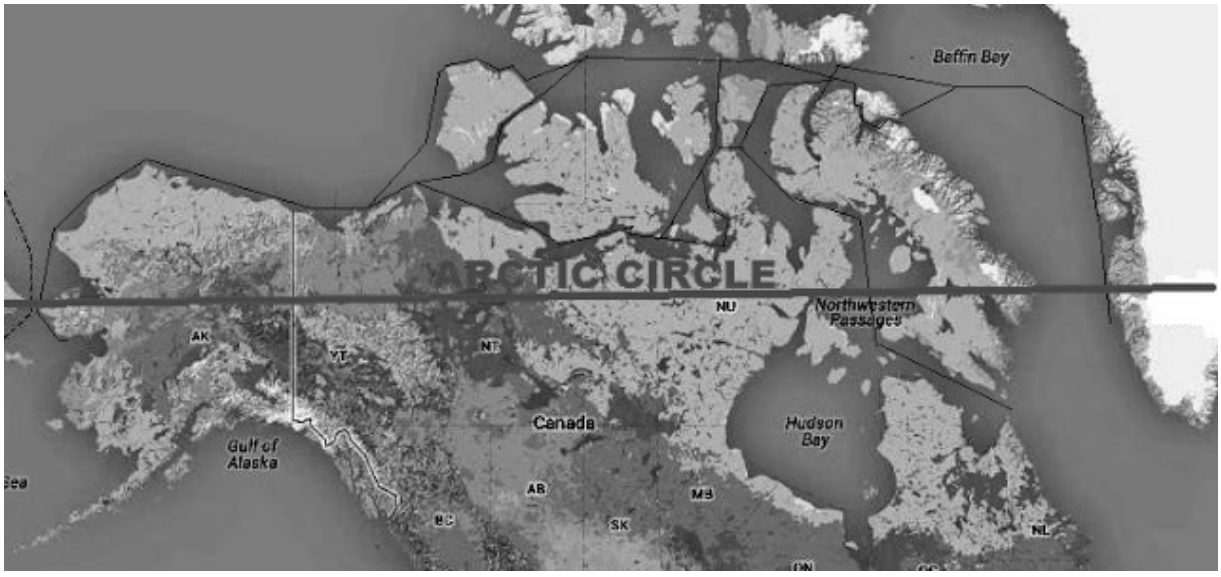
Introduction

After climate change impacts on Arctic sea ice became fodder for the media, the opportunity for shipping through the "fabled Northwest Passage" has been a regular target of Arctic punditry. This paper sets out some of the key issues regarding future transits as well as providing information on past activity. Competitive North American routes are discussed, as well as possible origin/destination cargoes.

Traffic is classified by type, ie Cargo(includes Dry Bulk, Tanker, Heavy Lift etc.), Container, Passenger, Institutional and Research. Some Arctic shipping activity is destinational, ie it starts or finishes in the Arctic, and therefore is not a full transit, which is considered to be a Pacific/Atlantic trip or vice versa.

While the focus is on the Canadian route and modal alternatives, a brief comparison is provided with the Russian Northeast Passage (NEP), or Northern Sea Route.

Figure 1: North West Passage Routes



http://northwestpassage2014.blogspot.ca/2014/04/nw-passage-2014-which-way-are-you-going.html

Northwest Passage Routes

The traditional Southern route, from East to West is Baffin Bay, Lancaster Sound, Peel Sound, Franklin Strait, Victoria Strait, Queen Maud Gulf, Coronation Gulf, Dolphin and Union, Amundsen Gulf, Beaufort Sea. A variation on this route is via M'Clintock Channel. The Northern Route is in deep water. From East to West it is Baffin Bay, Lancaster Sound, Barrow Strait, Viscount Melville Sound, Beaufort Sea. A variation on this route uses Prince of Wales Sound. An alternative route, which has only recently become accessible on a regular basis is from Hudson Strait via Foxe Basin, Fury and Hecla Strait, Gulf of Boothia, Bellot Strait, Franklin Strait then as for the traditional route.

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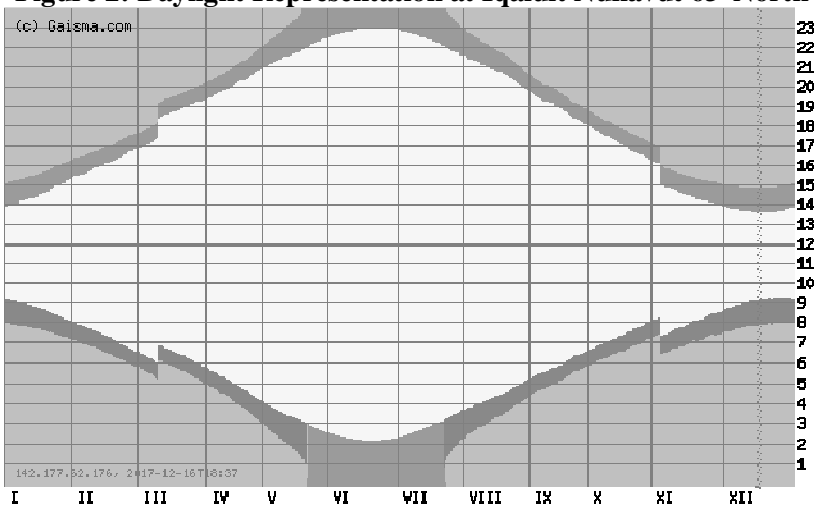
Figure 1 also shows a variant in terms of access from Baffin Bay to Lancaster Sound via Pond Inlet and Eclipse Sound, as well as one between Lancaster Sound and Bellot Strait.

The Northwest Passage

Much has been written about the Northwest Passage (NWP), mainly to do with Franklin's disastrous voyage and the searches, first for him and his crew, later for his two ships. These searches were successfully concluded in 2017 with the discovery of the *Erebus*. The transits of the cruise ship *Crystal Serenity* in 2016 and 2017 have also generated much attention.

This paper is partly about the historic use of the passage and, based on the economics of the route, partly about what the author's expectations are for future traffic. Climate change has been the focus of much media attention in suggesting vast numbers of ships could use the route in the future. However, these prognostications focus on supposed distance savings and ignore the fact that at the latitude of much of the NWP, it is dark for a substantial part of the year. Figure 2 below shows the hours of darkness (shaded) for Iqaluit at 63° North, Lancaster Sound is 11° further north, and hours of darkness are continuous during about 60 winter days. Also there will still be ice, both during the open water period, not just during the winter. Another factor that is overlooked by most commentators is that ships cannot proceed at open water speeds in Arctic channels; the risk of ice requires moderation. Also, there are many other elements, including alternative modal routes, which will affect decisions about use of the passage.

Figure 2: Daylight Representation at Iqaluit Nunavut 63° North



From: https://www.gaisma.com/en/location/iqaluit.html

Transit History

For the purposes of this paper, a transit means that the vessel traveled between Davis Strait and went around Point Barrow, or v.v. Also, transits are counted in the season that they started. Some transits, particularly by small craft, may take two or more seasons to complete. Small craft are considered to be any personal craft under 100feet or 30m in length. From 30m upwards, they are classed as mega yachts. These craft, although many are privately owned, may carry passengers as guests of the owner. Some are actually small cruise ships and available for charter, eg the *Hanse Explorer* 48m. Russian research icebreakers are treated as cruise ships, as the purpose of their trips is passenger carrying.

The first transit, which was East to West, by Roald Amunsen's *Gjoa* between August 1903 and August 1906. There was then no activity until the RCMP *St Roch* undertook a West to East transit that extended over two winters between 1940 and 1942. The boat then did a return trip in a single season in 1944. All was quiet until the Canadian icebreaker *Labrador* undertook an East to West transit in 1954; this was followed by three small USCG icebreakers in 1957, traveling West to East. Transit activity picked up over the

1960's and 70's with a transit by the tanker *Manhattan* in 1969. The ship left Chester (DE) on August 24 and reportedly visited Barrow[1] (AK) on 20 September. She returned to New York (NY) on 12 November carrying a ceremonial barrel of oil loaded at Prudhoe Bay. An interesting event took place in 1977 when the Dutch sailing vessel *Williwaw* undertook a single season transit. The Canadian yacht *JE Bernier* had started a transit in 1976, but didn't complete it until 1979, so the credit for the first small craft transit goes to the *Williwaw*.

Activity during the 1980's and 90's was relatively quiet, although a signature event occurred in 1984 when the expedition cruise ship *Linblad Explorer* undertook an East to West transit. This was the start of numerous cruise ship transits by different operators, although such transits were not annual events until after 1994. Numbers, though, have usually been less than five in a season until 2013 when seven cruise ships and mega yachts undertook transits. Cruise activity was still only three ships, while the mega yachts made up the difference. One of the biggest, and on its third transit in 2012, was Paul Allen's *Octopus*. At 128m it is as big as a small cruise ship, and its itinerary, this time from West to East, suggested that the owner might have been on board.

While tankers regularly visit the Arctic for community and mine re-supply, until 2017 only one tanker has completed a transit. This was the 23,400dwt *Primula*, which carried 18,600tonnes of fuel for the Hope Bay Gold Mine in the Western Arctic, wintered at Robert's Bay, and then completed the transit in 2011 in ballast, traveling eastbound. In 2017, the *Havelstern* undertook an East to West transit in ballast, following cargo delivery.

2013 was the first time a bulk cargo ship went through the NWP. The *Nordic Orion* undertook a transit with a reported cargo of 73,500tonnes of coal from Vancouver (BC) to the Finnish port of Pori. The trip commenced 06 September and was completed on 09 October. Earlier in the year the ship had carried 66,000tonnes of Iron Ore from Murmansk to Lanshan in China via the North East Passage (NEP). Also in 2013, the ship owner sent the sister ship, *Nordic Odyssey* through the NEP, also with 73,500tonnes of coal from Vancouver and also to Pori; this trip started on 04 October.

The NWP transit by the *Nordic Orion* demonstrated that a commercial depth route exists through Dolphin and Union Strait. The ship has a fully loaded draft of over 14m, which would need at least 16m for safe transit. Up until this time available charts only showed that up to 12m could be carried through the Strait.

Although not carrying cargo, an earlier commercial transit of the NWP took place in 1999 when the *Admiral Makarov* a Russian icebreaker and the tug *Irbis* towed two pieces of a dry dock from Korea to the Caribbean. There have been a number of project cargo moves in recent years, with two taking place in 2016 and one in 2017.

As will be seen from the data in Tables 1 through 5, a major change in activity has been the growth in personal craft, everything from rowboats to high-end yachts. As noted many of these, perhaps underestimating the rigors of the passage, take two or more seasons to complete their transit. Of note in 2017, apart from the extraordinary number of small boat transits, the *Polar Prince*, technically a research icebreaker for hire, was used as a small passenger ship on a voyage to celebrate Canada 150. Also, the Chinese research icebreaker *Xue Long* undertook an East to West transit. The first American Government transit in many years took place with the USCG buoy tender *Maple*. No mega yachts made a transit; they all cruised in the Eastern Arctic.

Table 1: Transits during the 1970's

Type of Transit	70	71	72	73	74	75	76	77	78	79
Exploration and Research						3				
RCMP										
Canadian Icebreaker	2						1		1	2
Other Icebreaker										
Small Boat							1	1		1

Cruise and Mega yacht										
Commercial							T			
Total	**2**					**3**	**3**	**1**	**1**	**3**

T=Tug or Anchor Handling Tug, C=Cable Layer

Table 2: Transits during the 1980's

Type of Transit	80	81	82	83	84	85	86	87	88	89
Exploration and Research	1			2						
RCMP										
Canadian Icebreaker	1	1		1					2	
Other Icebreaker						1			1	1
Small Boat						1	1		1	
Cruise and Mega yacht					1	1			1	
Commercial				T						
Total	**2**	**1**		**4**	**1**	**3**	**1**		**5**	**1**

Table 3: Transits during the 1990's

Type of Transit	90	91	92	93	94	95	96	97	98	99
Exploration and Research										
RCMP										
Canadian Icebreaker	1		1			4	1			
Other Icebreaker	1									
Small Boat				1	1	2				1
Cruise and Mega yacht			2	2	3	1	2	2	2	1
Commercial										3
Total	**2**		**3**	**3**	**4**	**7**	**3**	**2**	**2**	**5**

Table 4: Transits during the 2000's

Type of Transit	00	01	02	03	04	05	06	07	08	09
Exploration and Research										
RCMP	1									
Canadian Icebreaker	1									
Other Icebreaker	1			1		1				
Small Boat	1	3	2	3	2	2	2	3	6	11
Cruise and Mega yacht	2	2	2	2	2	2	2	2	1	2
Commercial			T						C	
Total	**6**	**5**	**5**	**6**	**4**	**5**	**4**	**5**	**8**	**13**

Table 5 Transits during the 2010's

Type of Transit	10	11	12	13	14	15	16	17	18	19
Exploration and Research								1		
RCMP										
Canadian Icebreaker				1		2	1			
Other Icebreaker						2		2		
Small Boat	11	15	12	12	7	13	11	23		
Cruise and Mega yacht	2	1	5	7	4	4	5	4		
Commercial	1		1	1	1		2	2+T		
Total	**14**	**16**	**18**	**21**	**12**	**21**	**19**	**33**		

The Future

Looking at the historic transit mix, it is obvious there is an attraction to "adventurers" in small boats who wish to pit their sailing skills against a still unforgiving ocean, perhaps depending on the perception that climate change means an easy ride. In fact some have ended up having to be rescued by the Canadian Coast Guard when the going has become too rough. Wealthy individuals will provide the support for a growing number of expedition vessels that will offer a luxurious trip through the North, and those with even more wealth will take their mega yachts on the same trip. With the number of expedition vessels on order (seventeen for Polar Itineraries), combined with the existing fleet, we can expect these numbers to remain relatively high. Over the past three years, although not every season, fifteen small cruise ships have cruised in the Canadian Arctic. Of these only the three older Russian research icebreakers (*Akademik Ioffe, Akademik Sergey Vavilov, and Kapitan Khlebnikov*) may retire. Of the expedition cruise ships on order, five are for Le Ponant, who have three that cruise regularly in the Arctic, one of which will have enhanced ice capability, and four are for Crystal Cruise Lines. Crystal will replace their *Crystal Serenity* with their smaller expedition vessel *Crystal Endeavour* in 2019. This ship can probably cruise unaccompanied in Arctic waters, and reduce their transit costs by eliminating the need for an escort vessel. Most stay in the Eastern Arctic and do not undertake NWP transits; only two "regulars" have done so in each of the last three years. The *Crystal Serenity* cruises in 2016 and 2017 were unusual, given the size of the ship and the perceived need for an escort. Having set the barrier so high, the probability of a similar size vessel, none of which appear to have any ice classification, undertaking a similar transit is low. A factor which undoubtedly persuaded Crystal to use a smaller and more capable ship in the future is that passenger numbers dropped from about 1,000 on the 2016 trip to about 750 in 2017.

An interesting group of vessels that might undertake transits is cargo carrying commercial vessels. There will certainly be opportunities for project cargo shipments from Far East locations such as South Korea and China to North America. For example, the *Happy Rover*, in 2016, which sailed from Ulsan in South Korea to Burnside on Lake Michigan. The ship had previously transited the Northern Sea Route from Zeebrugge (Belgium). On it's NWP it took the route through Bellot Strait and Fury and Hecla. The *Africaborg* also transited the NWP in 2016 from China to Baie Comeau (QC) with a cargo of carbon anodes for aluminium production. The *Atlanticborg* repeated this trip in 2017. These types of cargo and ships will likely be the primary commercial cargoes through the NWP in the future. Indicative cargo quantities, taken from Panama Canal statistics, is about 4million tonnes of manufactured iron and steel and 400,000tonnes of manufactured goods (other than automotive and trucks). Not all of this originates in China, South Korea or Japan, and not all is heading to the North America eastern seaboard, which are primary transit origin/destination regions, but given the size of ship involved - typically under 20,000dwt, ice strengthened and shallow draft - there is a possibility for a reasonable number of transits each season.

On the other hand the type represented by the *Nordic Orion* will be among the least likely to undertake a transit; neither the economics nor cargo availability work in favour of significant transit numbers. Prior to the completion of the new Panama Canal locks with deeper draft, a case could be made because a Panamax[2] ship (ie one designed to the dimensions of the old Panama Canal) could not carry a full cargo due to draft restrictions in the old locks. For example, the *Nordic Orion* could probably have carried only 58,500tonnes, not the 73,500tonnes it was able to haul through the NWP. With the new locks it could carry a full cargo. Also, the new Panama locks will take Cape Size[3] ships, although at reduced draft. Table 6 provides a comparative estimate of a Panamax load of coal from Vancouver to Pori, and shows how the economics of using the New Panama Canal have materially undercut the potential benefits of both the NWP and the NEP.

Cargo quantities are also relatively small with 2.6million tonnes of coal heading into the Atlantic Basin in 2017, and 1.6million tonnes of lumber. These would be the most likely bulk cargoes as they originate in the Pacific North West, but as shown in Table 6, the margins may not be sufficient to support a decision to use the NWP. Ore from the St Lawrence might present an opportunity, but it generally uses Cape Size and

larger ships. Because of their draft, they would need to use the Northern NWP, which still has ice issues and icebreaker assistance would be essential.

As noted earlier, until this year, there has been only one tanker that has transited the NWP. The primary purpose of the *Primula* was to provide winter fuel for a mine development site, and the ship completed the West to East transit in ballast. Other ships that have come into the Western Arctic from the Pacific with fuel have returned the same way, back around Point Barrow. Community fuel re-supply tankers generally sail from Eastern North American refineries. In 2017 the Canadian Flag *Havelstern* proceeded West in ballast after delivering re-supply fuel to Nunavut Western Arctic communities.

NEP transits include a considerable number of tankers as well as the occasional LNG carrier. From available transit data most of these vessels are Russian owned or operated. While many have been destinational transits, some have been full Pacific to Atlantic voyages or v.v. There are possibilities for increased traffic in this category as neither North America nor Europe is building new refineries, although some US Gulf refineries are expanding. Several US East Coast and European refineries have closed rather than invest the capital needed to upgrade or expand. Most new refinery capacity is in the Far East and a typical trip might be Singapore to the US Eastern seaboard or to Rotterdam. Tanker transits of the NWP are moot at present, given the reduction in domestic demand in the USA and the availability of cheap fracked crude to US refineries. This has encouraged US refined product output for export. For both routes, the Suez Canal has a distance advantage over both the NWP and the NEP, demonstrating that for the northern routes to successfully compete with existing routes, origin and destination must be in reasonable proximity to passage entry and exit points.

It is unlikely that crude oil would be shipped from Valdez to US refineries on the east coast as these are not set up to handle the type of crude from Alaska. While it is feasible that cargoes could be shipped to Irving's Saint John Refinery, which is set up to handle heavier crudes, transportation costs would have to compete with more traditional crude import routes. Given the state of the tanker market at present and for the foreseeable future, achieving a low NWP cost in an Aframax tanker relative to a VLCC on a transatlantic or Middle East voyage is unlikely.

Vessel repositioning is a possible opportunity, and has been used by a number of ship owners with the NEP. The only repositioning trips, so far, with the NWP has been by Mega Yachts shifting between Atlantic and Pacific basins or v.v.

Table 6:Estimated Costs of hauling Coal from Vancouver (BC) to Pori (Finland) in a Panamax vessel
Note that these costs are approximate and include only those elements that are route dependent. i.e. they exclude port dues and charges, which would be common to all options

Activity	Panama Canal old locks	Panama Canal new locks	North West Passage	North East Passage	Cape Horn
Open Water Distance[4]	9,600	9,600	4,500	3,800	15,400
Passage distance	na	na	3,800	2,500	
Total Distance	9,600	9,600	8,300	6,300	15,400
Days transit open water @13.5kts	29.6	29.6	13.8	11.7	47.5
Days transit passage @10.0kts	1.0	1.0	15.8	10.5	na
Total Days	30.6	30.6	29.6	22.2	47.5
Ship Cost[5] @$20,000/day	612,000	612,000	592,000	444,000	950,000
Main Engine Fuel[6], @ $380/tonne	409,306	409,306	395,930	296,947	635,360

Auxiliary Fuel, @ $600/tonne	45,900	45,900	44,400	26,640	71,250
Transit Insurance[7]	na	na	140,000	120,000	na
Transit Fees[8]	226,500	268,500	20,000	300,000	na
Total Cost	1,293,706	1,335,706	1,192,330	1,187587	1,656,610
Cargo Carried[9]	58,000	73,500	73,500	73,500	73,500
Cost per tonne	**$22.31**	**$18.17**	**$16.22**	**$16.16**	**$22.54**

From Table 6 there would seem to be a benefit to using the NWP, but the margin is only $2.00. Also, although the estimated transit time was about 30 days, the *Nordic Orion* actually took 33 days. Those additional days would have increased comparative costs to $17.64 effectively eliminating the benefit if using the new locks at Panama. When the ship undertook the transit in 2013, these locks were not available and the margin would still have been worth considering, mainly because of the extra cargo that could be carried.

Much attention has been given to the possible use of the NWP by container ships hauling goods between China and the US Eastern Seaboard. However, these prognostications ignore the overall logistics chain and total delivery time from factory to US warehouse. See below for distances from Shanghai to key points, together with total modal delivery times to New York[10].

Prince Rupert (BC)	4,568nm direct, then by rail	19days
Los Angeles (CA)	5,659nm direct, then by rail	22days
New York (NY)	10,510nm via Panama Canal	26days
New York (NY)	8,500nm via NWP	27days

The Prince Rupert route is even faster to the key North American distribution centre of Chicago (16 days), which perhaps explains why the port's container activity is rapidly expanding.

The NEP route to Europe is often quoted as the most desirable short cut for shipping between the Far East and Europe, with a 40% distance saving. However, NEP distances vary depending on the route, from about 2,500nm to 3,400nm[11], assuming the least NEP distance and 5,331nm open water, Shanghai to Antwerp (Belgium) via the NEP is 7,831nm vs 10,356nm via the Suez Canal, which is only a 25% saving. The 40% figure appears to be relative to Yokohama (Japan) to Rotterdam (Netherlands) with comparative distances of 6,920nm versus 11,460nm. Yokohama is not, perhaps the best port to choose from a container trade perspective as it only handled 1.4million TEUs in export trade versus 36.5million TEUs from Shanghai[12].In Europe Rotterdam handled 12million TEU versus 10million for Antwerp[13].

Thus a more reasonable assessment in terms of NEP transit time might be 24 days transit versus 26 days via the Suez Canal, if a day is allowed for canal transit. As with the NWP, this kind of saving, given the hazards and extra costs of the NEP might not encourage much use. This is perhaps why, in 2013, Nils Anderson, CEO of AP Moller-Maersk, when asked about the Northeast Passage, stated that he did not believe that Maersk would consider it for 10-20 years.

The NEP does have a number of advantages over the NWP: it is well supplied with icebreakers – their use for most ships is mandatory – and there are several communities on the transit with support facilities. However, drafts are limited to 12m because the usual route is south of the Novosibirsk Archipelago. However, with changing ice conditions deeper draft transits north of the Archipelago are now permissible, although use may vary depending on ice conditions. Technically ships are limited to a beam of 30m, which is the beam of the largest icebreaker. This rule does not appear to be strictly enforced as ships up to 42m beam have transited.

The problem with arctic routes and the container trades is that voyage predictability is key. A cargo ship can generally accept a 1-2 day delay, a containership cannot. The days of "just in case" delivery are long gone, today "just in time" rules.

Conclusions

The NWP is unlikely to be a future highway, because the new Panama Canal has undercut the benefits for most cargo vessels. However, it may present opportunities for specific types of vessels, particularly passenger vessels. Future expectations might be for three to four cruise ships and/or Mega Yachts each season and one to two project cargo vessels. The expected flood of activity will not occur, except perhaps with small craft, and their numbers will be unpredictable.

Resources

Transits of the Northwest Passage to end of the 2017 Navigation Season; RK Headland and Associates; Scott Polar Research Institute, University of Cambridge
NORDREG Ship movements
Panama Canal Authority, Statistics and Models Administration Unit
CHNL Information Office (for NEP Transits)
The Cruise Critic for expedition vessels on order
Author's Files

End Notes

1) Another source states 14 September, but there seems to be confusion between Point Barrow, and the town of Barrow, which is a few miles south west of the point. It is perhaps as well that the voyage was undertaken in 1969, as a return trip in 1970 was stymied by serious ice conditions and only managed to get as far as the entrance to Lancaster Sound, and this with ice breaker assistance.
2) Typical features, 225m length, 32.3m beam, 14.25m draft, 75,000dwt, Main engine consumption 35.2tonnes per day Heavy Fuel Oil, 2.5tonnes per day Marine Diesel Oil for auxiliaries
3) Ships too large for the Panama or Suez Canals, thus needing to travel around the Cape.
4) Distances from VESON distance tables, where available. Some chart estimates for arctic legs.
5) Market Reports November 2017
6) Fuel costs end November 2017 in New York Harbour per Cockett Marine Oil.
7) Transit Insurance; author's estimates based on ship values and GRT. NWP assessed higher percent on value because of lack of support services in the Canadian Arctic.
8) Panama Canal tolls from Wilhelmsen Toll calculator. NEP fees author's guesstimate from official fee schedule and market comments. Transit fees in the NWP are the author's estimate of ice navigator services
9) Cargo quantities in the old locks are draft limited. The old locks have a maximum draft of 12.04m while the new locks can accommodate 15.2m draft. Full cargo elsewhere less 1,500tonnes fuel water and stores deduction.
10) Distances from VESON distance tables where possible. NWP passage distances partially by chart work. Delivery times from https://people.hofstra.edu/geotrans/eng/ch2en/appl2en/NA_east_coast_routing.html
11) Distances are derived from vessel reports for NWP transits. The predominant distance is about 2,500nm
12) Journal of Commerce reports for 2015
13) Port of Antwerp and Journal of Commerce Reports for 2016