HÁSKÓLINN Á BIFRÖST
BIFRÖST UNIVERSITY

An Arctic Dream-The Opening of the Northern Sea Route: impact and possibilities for Iceland

Author: Sigurður Almar Ómarsson

Advisor: Guðmundur Ólafsson, assistant professor

May 2010

Final confirmation to B.S. degree in Business Administration

Thesis: An Arctic Dream - The Opening of the Northern Sea Route: impact and possibilities for Iceland

Author: Sigurður Almar Ómarsson

The final project has been evaluated according to the rules and requirements of the University of Bifröst and has received a grade of _____

Bifröst _____

_____

Dean

HÁSKÓLINN Á BIFRÖST
BIFRÖST UNIVERSITY

An Arctic Dream-The Opening of the Northern Sea Route: impact and possibilities for Iceland

Thesis submitted in partial fulfillment of the requirements towards a Bachelor of Science in Business Administration degree at Bifröst University

Author: Sigurður Almar Ómarsson

Advisor: Guðmundur Ólafsson, assistant professor

May 2010

Abstract

The Arctic is melting at an unprecedented rate which might, in the not so distance future, open up the Northern Sea Route, shortening the distance between East Asia and Europe a great deal (approximately 40%) and making the exploration of natural minerals in the Arctic feasible. This thesis takes a look at what might happen if Iceland can take advantage of its strategic location in the North-Atlantic, at the end of the NSR, to become a transshipment port for ongoing cargo destined for North-America and Europe, or even yet a base for Arctic exploration and processing of natural minerals like oil and gas.

By examining the technological aspects of NSR navigation, present state of sea-transportations, and how the development of transshipment ports and vessel sizes has changed the landscape of international logistics. With this information, I will try to evaluate if it is economically feasible to use the NSR as an international cargo gateway, and if Iceland has what it takes to become a hub for cargo transshipments.

Although shipping through the Suez Canal is still by far the least expensive option, the NSR offers a great potential to become a realistic alternative; however, the potentials for Iceland are less than desirable at the moment in regards to a transshipment port, but are more realistic in the field of processing natural resources.

Key Words: Arctic, Northern Sea Route, Natural Conditions, International Transit Route, Container shipping, Transshipment ports, Iceland, Port Locations, Oil refinery, Environmental Issues

Acknowledgements

I wish to express my gratitude to my advisor, Guðmundur Ólafsson, for accepting to supervise me on this thesis. I want to thank my father for making valuable suggestions for improvements.

I also wish to thank Shawn M. Clankie, author and linguistic for helping me with questions, that arose during the writing of this thesis and Alan Talbott for proofreading and correcting my English.

My deepest appreciation goes to my wife Erla who stood by me throughout this challenging ordeal. Her support in running the house made it possible for me to be away from my family during the long hours of writing this and she always ensured that I stayed on track and did not lose sight of the goal.

Table of Contents

List of Figures and Tables

1. Introduction

Due to changes in the weather, mainly contributed to global warming, the Arctic Cap has started to melt faster than previously estimated. This has triggered hopes that in the not so distant future a possible shipping route might open up between Europe and Asia (the Northern Sea Route), cutting the present sailing route nearly in half.

This could present itself as an opportunity for Iceland to become a transshipment port because of its location in the North-Atlantic where the Northern Sea Route ends on the European side. In this paper I will take a look to see if that is a realistic option by examining the route's economic potential and importance as an international transit route along with the obstacles that are associated with the route, matters like extreme natural conditions, complicated legal issues and the technological aspects required for navigation on this harsh but promising route.

Secondly I will examine how conditions are in Iceland both economically and geographically, when referring to geographically that means taking a closer look into possible locations within Iceland and the countries strategic location in regards to the Northern Sea Route in general.

In 1993, three institutes formed an international joint project called the International Northern Sea Route Program (INSROP) with the purpose of shattering the myths about the NSR and replace them with scientific knowledge. Over a six-year period, some 390 front-line researchers from 14 different countries took part, created 167 reports on everything concerning the NSR. These results have been the sources of many papers, books, and articles written about the subject of the NSR as a potential shipping route. Most of the material I found on this subject was somehow based on these findings, and although the author did not have direct access to the original data due to cost factors, he found three extensive reports (on the subject) that were a great source of secondary data otherwise unavailable, and are therefore quoted regularly in this thesis.

1.1. The Proposed Idea

After having read a few short articles about the possibility that the Northern Sea Route might open up due to climate changes and that Iceland might benefit from the situation, the course was taken to research this matter further and find out if it is a realistic notion. Efforts will be made to answer the research question:

"An Arctic Dream – The Opening of the Northern Sea Route: impact and possibilities for Iceland"

1.2. Scope and Limitations of the Project

The main limitation of this paper is the fact that the author is studying and located in Japan. Access to English books is very limited in the school library and material about Icelandic circumstances is nonexistent. This restricts the material available only to what can be found on the internet and online databases. Interviews with people related to the subject, such as the Icelandic shipping companies, the Department of Foreign Affairs etc. would have been nice but due to time difference between Iceland and Japan it would have been very troublesome. The above factors limited numerous angles that could have been explored.

1.3. Outline of Chapters to Follow

The thesis is divided into seven chapters, with the introduction. In chapter two a brief introduction of the Arctic and the Northern Sea Route is presented along with how the jurisdiction is in the region. Chapter three discusses the natural conditions of the Arctic, mainly the climate and the sea ice. Chapter four is about the present state of shipping between Europe and Asia, with emphasis on the Panama and Suez Canals, in addition the evolutions of transportation ships and transshipments ports are examined further. Chapter five is about the Northern Sea Route, its historical use and what potentials it has to become an international transit route along with the requirement needed to navigate the NSR. Chapter six is about what role Iceland can play in becoming a major transshipment port and what locations in Iceland are best suited for that. And finally in chapter seven the environmental impact of such a transshipment port is discussed in regards to pollution and possible oil spills. This is followed by conclusions about the topic and points of further research.

1.4. Terminology

Twenty-foot equivalent unit: (abbreviated to **TEU**) is an inexact unit of cargo capacity often used to describe the capacity of container ships and container terminals. It is based on the volume of a 20-foot long intermodal container, a standard-sized metal box which can be easily transferred between different modes of transportation, such as ships, trains and trucks. One TEU represents the cargo capacity of a standard intermodal container, 20 feet (6.1 m) long and 8 feet (2.4 m) wide. There is a lack of standardization in regards to height, ranging between 4.25 and 9.5 feet (1.30 and 2.9 m), with the most common height being 8.5 feet (2.6 m).

Nautical mile: (abbreviated to **nm**) is a unit of length corresponding approximately to one minute of arc of latitude along any meridian. By international agreement it is exactly 1852 meters (approximately 6076 feet). It is a non-SI (International System of Units) unit used especially by navigators in the shipping and aviation industries, and also in polar exploration. It is commonly used in international law and treaties, especially regarding the limits of territorial waters. It developed from the sea mile and the related geographical mile.

Knot: is a unit of speed equal to one nautical mile per hour, which is equal to exactly 1.852 km/h and approximately 1.151 mph.

Deadweight tonnage: (abbreviated to **DWT**) is a measure of how much weight a ship is carrying or can safely carry. It is the sum of the weights of cargo, fuel, fresh water, ballast water, provisions, passengers, and crew.

Draft: The draft (or draught) of a ship's hull is the vertical distance between the waterline and the bottom of the hull (keel). Draft determines the minimum depth of water a ship or boat can safely navigate

Transshipment: is the shipment of goods or container to an intermediate destination, and then from there to yet another destination. One possible reason is to combine small shipments into a large shipment, dividing the large shipment at the other end. Transshipment usually takes place in transportation hubs.

Suezmax: is a naval architecture term for the largest ships capable of transiting the Suez Canal fully loaded, and is almost exclusively used in reference to tankers. Since the canal has no locks,

the only serious limiting factors are draft, and height due to the Suez Canal Bridge. The current channel depth of the canal allows for a maximum of 20 m (66.0 ft) of draft.

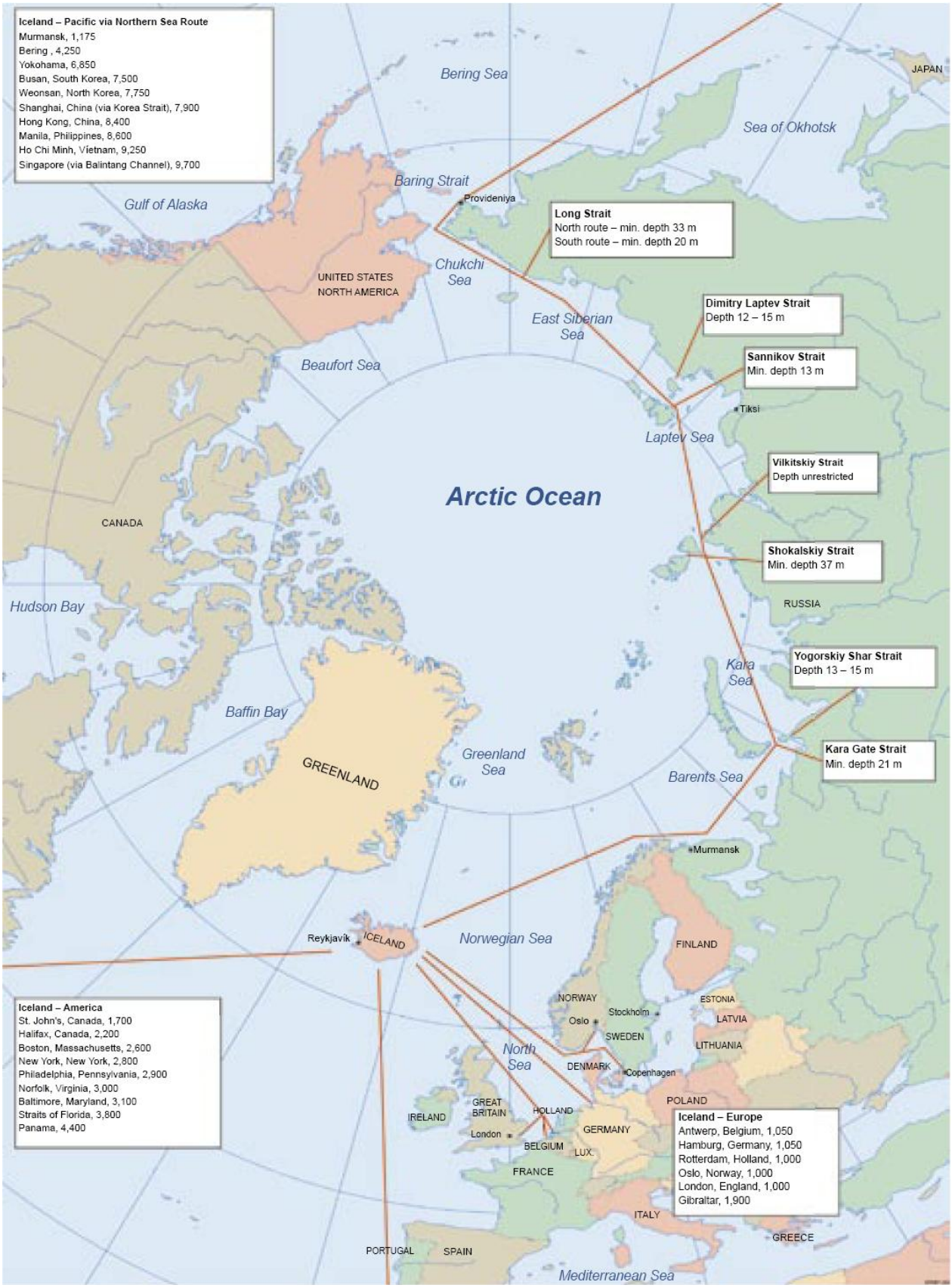
Panamax: are the largest ships that can pass through Panama Canal. The size is limited by the dimensions of the lock chambers and the depth of the water in the canal.

- Length: 294.13 m (965 ft)
- Beam (width): 32.31 m (106ft)
- Draft: 12.04 m (39.5ft)
- Air draft: 57.91 m (190ft) measured from the waterline to the vessel's highest point

A Panamax cargo ship will typically have a DWT of 65,000-80,000 tons and in terms of TEU it can handle vessels up to about 4,500 -5,000 TEU.

Exclusive economic zone: (abbreviated to **EEZ**) under the law of the sea, an Exclusive economic zone is a sea-zone over which a state has special rights over the exploration and use of marine resources. It stretches from the seaward edge of the state's territorial sea out to 200 nautical miles from its coast. In casual use, the term may include the territorial sea and even the continental shelf beyond the 200 mile limit.

N.B. These explanations are taken word-for-word from the online encyclopedia Wikipedia although sometimes altered to make them more precise.


Iceland – Pacific via Northern Sea Route
Murmansk, 1,175
Bering , 4,250
Yokohama, 6,850
Busan, South Korea, 7,500
Weonsan, North Korea, 7,750
Shanghai, China (via Korea Strait), 7,900
Hong Kong, China, 8,400
Manila, Philippines, 8,600
Ho Chi Minh, Vietnam, 9,250
Singapore (via Balintang Channel), 9,700
Bering Sea
JAPAN
Sea of Okhotsk
Baring Strait
Gulf of Alaska
Provideniya
Long Strait
North route – min. depth 33 m
South route – min. depth 20 m
Chukchi Sea
UNITED STATES
NORTH AMERICA
East Siberian Sea
Dimitry Laptev Strait
Depth 12 – 15 m
Sannikov Strait
Min. depth 13 m
Beaufort Sea
Tiksi
Laptev Sea
Vilkitskiy Strait
Depth unrestricted
Arctic Ocean
CANADA
Shokalskiy Strait
Min. depth 37 m
RUSSIA
Hudson Bay
Yogorskiy Shar Strait
Depth 13 – 15 m
Kara Sea
Baffin Bay
GREENLAND
Greenland Sea
Kara Gate Strait
Min. depth 21 m
Barents Sea
Murmansk
Reykjavik
ICELAND
Norwegian Sea
FINLAND
Iceland – America
St. John's, Canada, 1,700
Halifax, Canada, 2,200
Boston, Massachusetts, 2,600
New York, New York, 2,800
Philadelphia, Pennsylvania, 2,900
Norfolk, Virginia, 3,000
Baltimore, Maryland, 3,100
Straits of Florida, 3,800
Panama, 4,400
NORWAY
ESTONIA
Stockholm
Oslo
LATVIA
SWEDEN
LITHUANIA
North Sea
DENMARK
Copenhagen
POLAND
GREAT BRITAIN
HOLLAND
IRELAND
London
GERMANY
BELGIUM
LUX.
FRANCE
Iceland – Europe
Antwerp, Belgium, 1,050
Hamburg, Germany, 1,050
Rotterdam, Holland, 1,000
Oslo, Norway, 1,000
London, England, 1,000
Gibraltar, 1,900
ITALY
GREECE
PORTUGAL
SPAIN
Mediterranean Sea

2. The Arctic - Introduction and Basic Features

For a long time the Arctic was nothing more than a frozen wasteland to most nations, and the interest in the region was minimal. In the last few decades, the Arctic has emerged quietly and almost unbeknownst to the general public as a strategic arena of vital significance to the countries surrounding the Arctic. The Arctic region includes the Arctic Ocean along with parts of Finland, Sweden, Iceland, Russia, Norway, Greenland, Canada and the United States. The last five share the Arctic Oceans 45.000 km coastline. The Arctic Ocean has a surface area of 14,000 $km^{2,}$ which is 1 ½ times the area of the United States.

Figure 1 Map of the Arctic region

Source: United Nations Environment Programme (n.d.). *Global Outlook for Ice and Snow*

In the 1980s, The Arctic became one of the world's most active and important areas for military operations.[1] This was when the US and the Soviet Union were the superpowers of the world and the cold war was at its height. Since then, the military significance of the region has decreased but the economic aspect has been rising. This is due to the fact there are believed to be large reserves of oil, gas and other minerals in the region, and also that it might open up a new maritime highway between Asia and Europe/America. There are two routes mainly mentioned in that context, and those are the Northwest Passage and the Northern Sea Route. I will mainly focus on the Northern Sea Route, since it is more relative to the context of this paper, as Iceland lies closer to that route than the Northwest Passage, and is thought to become usable sooner.

[1] Young (1986)

2.1. Arctic Explorations through History

In the past, no one saw many reasons to venture north to the Arctic. There are some records of Norwegian/Icelandic Vikings sailing to Skraeling Island and Ruin Island outside of Canada for hunting expeditions and to trade with the Inuit groups who already inhabited the region. On the other side of the Arctic cap, the shores of the Eurasian continent had been mapped by Russian expeditions, entering the Arctic Sea from the Siberian Rivers, trying to expand their profitable fur trade with local indigenous people and to extend their sovereignty. It was not until the European colonial powers saw the benefits of possibly finding an alternative seaway to China and India, that these explorations began in earnest. Countries such as England and the Netherlands went on countless expeditions to find such a seaway, and although they failed, new coasts and islands were discovered. Between the 17th and 18th century, the Russians were almost alone in the exploration of the NSR, and the Russian-funded explorations led by Danish born Vitus Bering made many new findings in the region, and several locations are named after him, i.e. the Bering Sea, Bering Strait and Bering Island where he fell ill and died after an expedition turned sour.

However, it was in 1878 that the NSR was first "conquered" when Finnish-Swedish explorer Adolf Erik Nordenskjöld reached the Bering Strait after having carried out a full passage from Europe during the Vega expedition. Although a great historic achievement, it did not have any major impact on world trade patterns. The route was simply too rough, and the icy conditions posed a major hindrance.

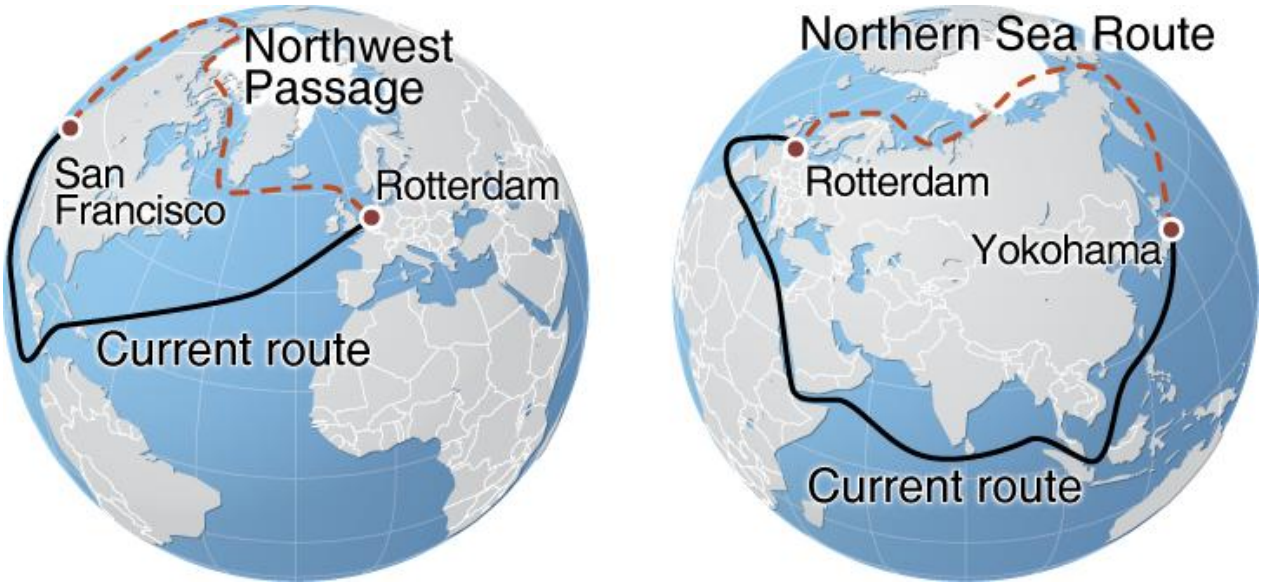
After the Russian Revolution in 1917 the NSR became inaccessible to non-Soviet vessels and remained closed until 1991 when then Soviet President Gorbachev opened the route again as part of his Perestroika policy. During that time the NSR was used as an internal Russian waterway and was an important, integrated part of the Russian Arctic infrastructure, serving industrial, military and scientific purposes. It reached its peak 1987 when 6.6 million tons of cargo was transported on the route. The same year NSR was opened to foreigners, the Soviet Union was dissolved, and as a consequence, commercial navigation of the NSR went into decline, and completely ceased on some internal routes.[2345]

[2] Ragner (2000:2)
[3] Utanríkisráðuneytið (2005)
[4] Wikipedia (n.d.). *Northern Sea Route*
[5] Biographybase (n.d.). *Vitus Bering Biography*

2.2. Northwest Passage

The Northwest Passage runs between Greenland and Newfoundland in the Atlantic Ocean, and along the northern coast of Canada and Alaska, ending in the Bering Strait. The Bering Strait is an 85 km wide strait separating Russia and Alaska between the Arctic Ocean and the Bering Sea (part of the Pacific Ocean).[6] It is believed that this route will open later than the Northern Sea Route for general traffic, although this route has been penetrated with the help of icebreakers.

Figure 2 Northern Sea Route and the Northwest Passage compared with currently used shipping routes



Source: United Nations Environment Programme (n.d.). *Global Outlook for Ice and Snow*

[6] Worldatlas (n.d.). *Bering Strait*

2.3. Northern Sea Route

The Northern Sea Route (NSR) lies along Russian coast also connecting the North-Atlantic with the Pacific Ocean. Before the beginning of the 20th century it was known as the Northeast Passage, and is still sometimes referred to by that name. The NSR, however, should not be thought of as one clearly defined linear *route*, but should instead be thought of as the entire *sea area* north of Russia. Due to the highly variable and difficult ice conditions present along most of the NSR, the optimal route choice for vessels navigating it will vary.[7] To define closer it is sometimes divided into two routes: the Inner and Outer Northeast Routes. The Inner route is a coastal one, today used for regional transportation and exports from Northwest-Russia while the Outer one lies outside the islands Severnaya Zemlya and New-Siberia and is much deeper than the Inner one.[8]

The Russians have a clear definition of the NSR found in the "Regulations for Navigation on the Seaways of the Northern Sea Route." According to this definition, the NSR is a passage linking Novaya Zemlya with the Bering Strait, which includes, from west to east, the Kara Sea, Laptev Sea, East Siberian Sea and Chukchi Sea. Depending on the context, it may also be taken to include the Barents Sea, which links these seas with the North-Atlantic Ocean.[9]

In this thesis, the author will focus primarily on the NSR's potential as an intercontinental transit route, while briefly also touching upon its other functions. As an intercontinental transit route, this will refer to the path between East-Asia to the Northern part of Europe and not only to the Russian definition inside its borders.

In order to be competitive as a transit route, economics of scale require that larger vessels be used. A vessel capable of carrying approximately 15,000 TEU should be adequate and therefore eliminate the possibility of using the Inner route around the area of the Laptev Sea since the draft of these ships would be around 20 meters (the Laptev Sea has two straits that limit the draft of vessels to 12-15meters). Therefore, when referring to the future use of the NSR as a potential transshipment route, this could occur only when passage north of New Siberian Island would be possible.

[7] Ragner (2008:1)
[8] Utanríkisráðuneytið (2005:13)
[9] Ship & Ocean Foundation (2001:64)

2.4. Jurisdiction and Regulations

Under international law, no country currently owns the North Pole or the region of the Arctic Ocean surrounding it. The eight nations that border the Arctic Region are limited to an exclusive economic zone (EEZ) of 200 nautical miles (370 km) adjacent to their coasts. Each one of these states has additional claims regarding territorial and maritime affairs, and while there is widespread agreement among the Arctic States on many of these claims, particularly the territorial claims, there remains staunch disagreement with respect to numerous maritime claims.

Both Canada and the Russians claim formal jurisdiction over their part of the Arctic. The Canadian government, in accordance with the provisions of UNCLOS (United Nations Convention on the Law of the Sea), claims that part of the Northwest Passage, especially the part that lies in the Canadian Arctic Archipelago, is to be considered territorial waters or "internal waters" and that they have sovereignty and jurisdiction over that area by drawing straight baselines around the outer edges of the archipelago. This gives them full control over what is called "transit passage" and "innocent passage" and requires that all vessels, aircraft and persons comply with Canadian domestic law. The U.S., along with other countries, disputes this claim, and argues that the Northwest Passage is an international strait and "transit passage" is permitted. This means that Canada would still have certain jurisdiction over the waters in matters such as fishing and environmental regulations as well as laws intended for the safety of shipping, but would not be able to hinder ships or to close the passage.[10] The Canadians have strong feelings about this, and their Prime Minister Harper made Arctic Sovereignty an election priority and said on one occasion, *"Canada has a choice when it comes to defending our sovereignty over the Arctic. We either use it or lose it. And make no mistake; this Government intends to use it"*.[11] To prove their point, they have established a deep-water port in the far North and increased the presence of national guards in the region. Canadian Joint Task Force North, in their effort to maximize the claim, no longer refers to it as there Northwest Passage, but as Canadian Internal Waters[12].

The Russians, on the other hand, use another approach, and claim formal jurisdiction over the NSR based on Article 234 of the UNCLOS, that states: *Coastal States have the right to adopt*

[10] Office of Naval Research et al, (2001:35). Naval Operations in an Ice-free Arctic (2001:35)
[11] Reuters (2007, June 9). *Canada plans ships to assert Arctic sovereignty*
[12] Canada.com (2006, September 4). *Northwest Passage gets political name change*

and enforce non-discriminatory laws and regulations for the prevention, reduction and control of marine pollution from vessels in ice-covered areas within the limits of the exclusive economic zone, where particularly severe climatic conditions and the presence of ice covering such areas for most of the year create obstructions or exceptional hazards to navigation, and pollution of the marine environment could cause major harm to or irreversible disturbance of the ecological balance.[13]

Under this article, the Russian Northern Sea Route Administration composed a directive in the year 1991 stating that all vessels wishing to enter the NSR and the Russian 200 nautical mile EEZ should give notifications to the Russian authorities beforehand. They also implemented requirements that vessels have Russian navigation guides abroad, pay a set fee to use the route, and are obligated to buy the service of Russian icebreakers. This obligation is sometimes referred to as the "icebreaker fee". They also reserve the right to close the area, revoke permissions, arrest lawbreakers and even stipulate that all vessels are under the jurisdiction of Russian law, including foreign research ships and military ships.[14] Other countries have more or less accepted Russia's de facto control of these waters, and have not challenged the regime Russia has put in place. This does not include the U.S., which maintains the same argument here as in the Northwest Passage outside Canada: that it should be considered international straits and therefore open to transit passage.[15] Some counties have some doubts about certain aspects of the directive that stipulate that the guides and the icebreakers must be Russians.[16]

Future precedents on how vessels will challenge Russia's dominance over the region could be crucial to the future of the NSR as an international transit route. Russia's claim of control is based on Article 234 which concerns "ice-covered areas," but what happens when the ice starts to decline or even disappears? If vessels continued to accept Russia's control over these circumstances, then Russia might make a claim on the basis of historical grounds. In its campaign to claim rights over a large part of the Arctic, the Russians in 2009 sent a nuclear-powered icebreaker and two submarines to plant a Russian flag, housed in a titanium tube, on the

[13] United Nations Convention on the Law of the Sea (1982:115)
[14] Utanríkisráðuneytið (2005:15)
[15] Ragner (2008:6)
[16] Utanríkisráðuneytið (2005:15)

seabed underneath the North Pole, much to the frustration of their rival Arctic neighbors who also claims the rights to the Arctic.

Why all this fuss about jurisdiction? Well jurisdiction grants control of natural resources and also the right to collect tariffs. The Panama Canal has annual revenues of around $1.4 billion USD and the Egyptian government raised more than $5 USD billion dollars from ships passing through the Suez Canal and it is Egypt's third-largest source of revenue after tourism and remittances from expatriate workers.[17][18]

The topic of jurisdiction and international water disputes concerning the Arctic are quite interesting and could be researched in greater detail and might be a nice topic for a separate thesis. But for now, it is beyond the scope of this paper and the author merely wanted to give an insight to this vast and complex matter.

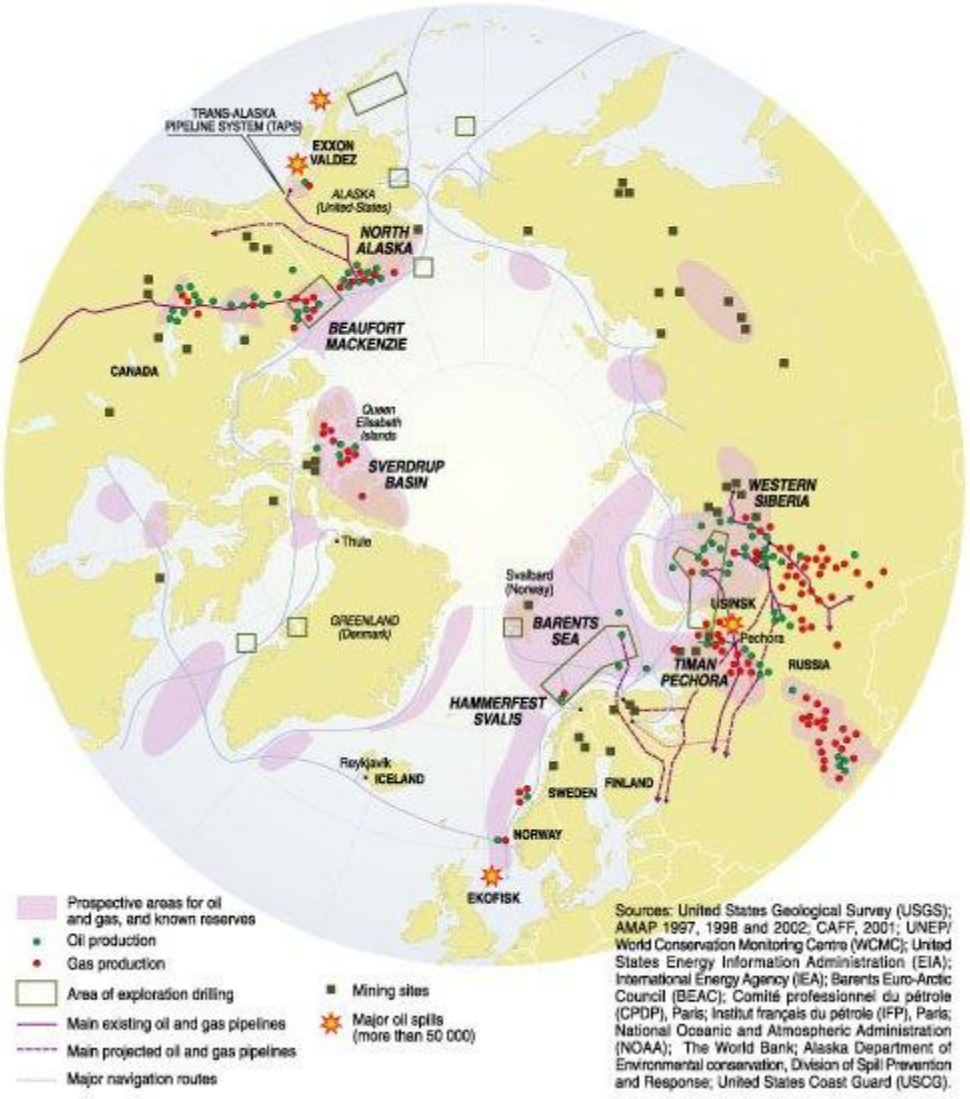
2.5. A Well of Natural Resources

Under the pristine ice of the Arctic, a wide range of natural resources are to be found, but many known reserves are not exploited due to their inaccessibility. But with the thawing of the Arctic ice, a new interest has awoken, and some think a new "gold rush" might be in the pipelines. The region is believed to contain about 20 per cent of the world's untapped resources, mainly nickel, copper, coal, gold, uranium, tungsten, diamonds, and iron, along with natural gas and oil. This has kindled old disputes about jurisdiction in this area, since everyone wants to claim its vast natural resources.

Although it is not believed that any of the natural resources are to be found within the 200 nm exclusive economic zone of Iceland except the possibility of some minor oil reserves, there is still a chance for Iceland to tap into the activity surrounding the exploration and processing of those natural resources. As figure 6 shows there is a great deal of natural resources to be found around Greenland, and above all, in the Sverdrup Basin and the Barents Sea. These areas are within a reasonable distance from Iceland and if the purpose it to export it to Europe or America, then Iceland is in the direct path.

[17] Reuters (2008, February 19). *Panama Canal Authority sees revenue growth in 2008*
[18] The Straits Times (2009, March 23). *Suez Canal revenue drops*

Figure 3 Map showing the Arctic's oil, gas, and mineral development



Source: Arctic Economics (n.d.). ***The Arctic's Economic Center of Gravity....***

One of the characteristics of the Arctic region is that it has relatively few inhabitants and the weather, as mentioned earlier can be quite cold, therefore not many locations in the region are suitable for industrial plants. In addition, basic infrastructure, needed to support an industry is scarce.

Greenland for example has very few inhabitants—the capital Nuuk has a population of 15,000 people, making it one of the smallest capitals in the world by population.[19] The same is to be said about the northern part of Canada where almost no inhabitants are to be found, and severe cold makes it an impractical place for processing. As can been seen on figure 7, there are no large coastal communities to be found in this part of the Arctic region except for in Iceland, possibly the area around Tromsö in Norway, and of course the area around Murmansk in Russia, which is densely populated.

Figure 4 Population density in the Arctic

Source: Arctic Economics (n.d.). *The Arctic's Economic Center of Gravity....*

When the feasibility of these three locations is compared, then Iceland is better located with regards to Greenland and its surroundings. When it comes to the Barents Sea, the location of Iceland is not the nearest one; both Tromsö and Murmansk are closer. With that said, there might be many reasons why companies would not like to use Murmansk as a destination for their resources. Russia is a very unstable country both politically and economically, and with a heavy mafia presence, that makes operations in the country much harder than in most other western countries. For that reason, companies might take the extra detour to Iceland, where the infrastructure is strong and the risk of losing a plant due to nationalization or the Mafia is minimal.

[19] Citypopulation (n.d.). *Greenland*

3. Natural Conditions of the Arctic

The natural conditions and the forces of nature are vastly different in the Arctic compared to elsewhere in the world where commercial shipping is conducted. When sailing through the Arctic there are many threats prevailing: extreme cold, magnetic storms, arctic nights which are pitch black, shallow seas, Arctic haze and of course, the sea ice—the major obstacle when traveling through the Arctic. For this reason, extra precautions should be taken into consideration when navigating through this region and should also reflect on how ships are designed and equipped.

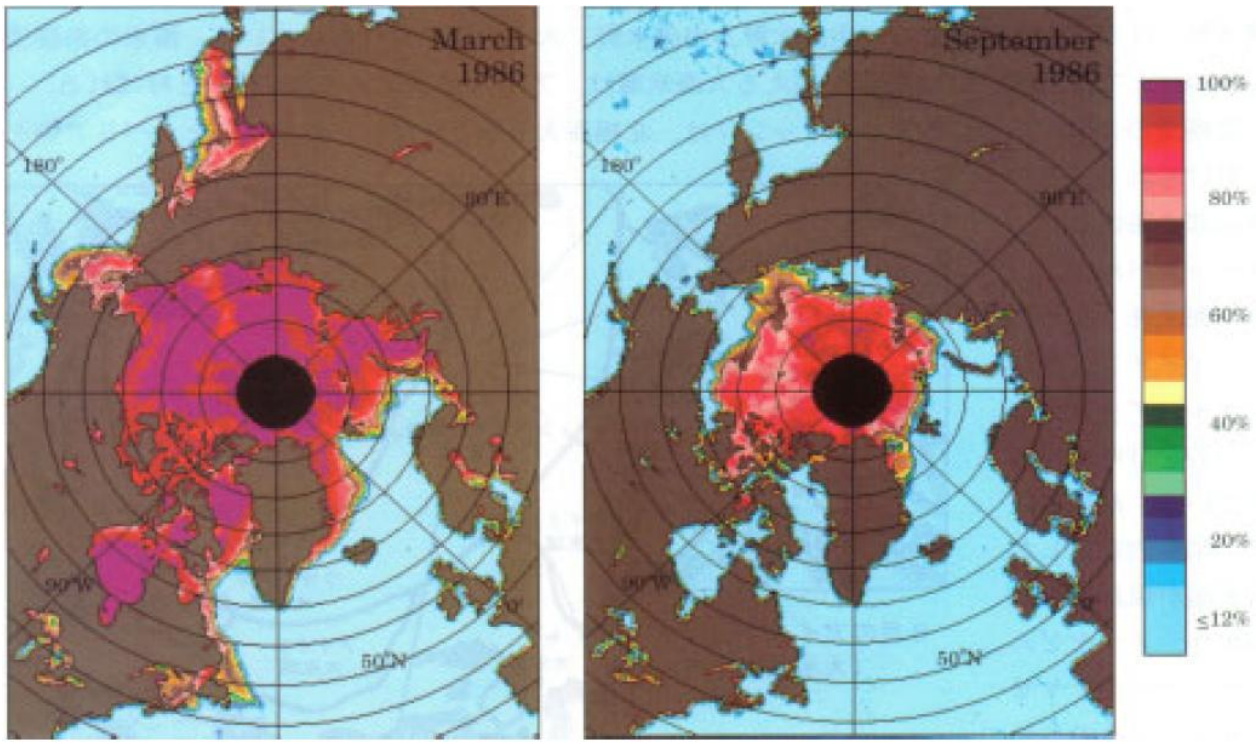
3.1. Climate

The climate in the Arctic is characterized by freeze and a rather small fluctuation in seasonal temperatures compared with other regions of the world. The main change is in the hours of sunlight, provided there *is* sunlight (the winter has long periods of night, while the summer sometimes sees 24 hours of daylight). These phenomena are called "arctic days" and "arctic nights," and sometimes the arctic days are referred to as the "Midnight Sun." The Laptev Sea (72.5°N), for example, is witness to 88 arctic days and 76 arctic nights. Further north, around Svalbard, there are 138 arctic days and 126 arctic nights.[20] These arctic days makes navigation much easier in the summer time when the majority of transportation takes place on the NSR.

The hottest and coldest months are July and January, respectively. Average air temperatures in July lie around 0 degrees Celsius. In January, on the other hand, the coldest regions (such as Siberia) receive temperatures near of -44°C while the average elsewhere lies around -20— -30° degrees Celsius. The oceans from the Sea of Norway to Barents Sea are warmed by the Gulf Stream, preventing the surface from freezing even during the arctic nights.[21]

[20] Ship & Ocean Foundation (2001:20)
[21] Ship & Ocean Foundation (2001:21)

Figure 5 Monthly average distributions of areas of sea ice, March and September 1986



Source: Ship & Ocean Foundation (2001:34)

3.2. Sea Ice

Most of the Arctic is covered in ice, although the ice conditions vary between regions, seasons and even years. Tough ice conditions cause increased fuel consumption, damage to vessels, detours and reduced speed as well as the need of expensive icebreakers. Table 1 shows average percentage of ice-free regions during the summer months:

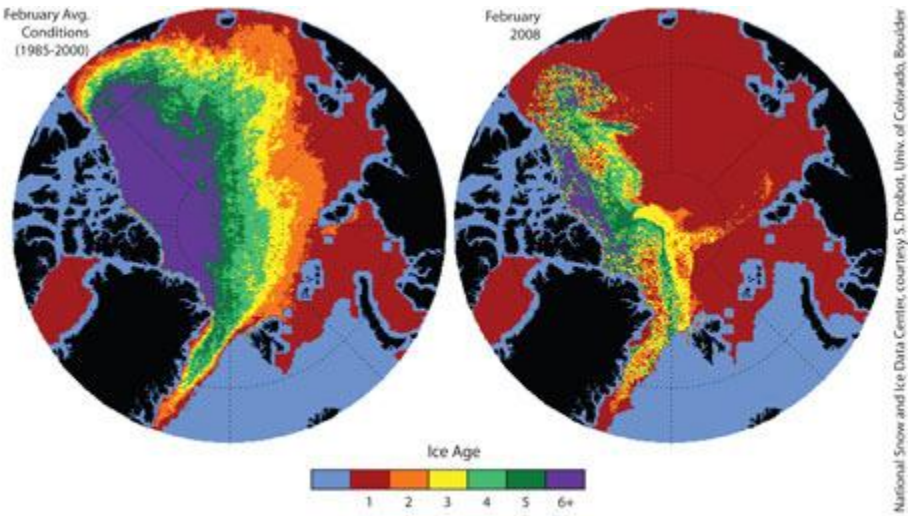
Table 1 Summer ice-free regions of the Russian Arctic seas (average percentage of region's total area that is ice free)

	Region						
End of month	South-western Kara Sea	North-eastern Kara Sea	Western Laptev Sea	Eastern Laptev Sea	Western East Siberian Sea	Eastern East Siberian Sea	South-western Chukchi Sea
June	17	0	10	10	0	0	27
July	40	18	24	33	10	6	57
August	85	41	45	69	31	17	75
September	95	53	51	80	49	27	85

Source: Ragner (2000:8)

As the table clearly shows no parts of the NSR are completely ice-free, not even during September which is the most favorable summer month. It also shows that both ends of the NSR have the lightest ice-conditions, and that the main bottleneck for transit navigation lies in the East Siberian Sea, the most difficult sea to navigate because of the mighty Ayonskiy Ice Massif, consisting of thick and hardened multi-year ice.[22]

Figure 6 The different age of the ice, where red indicates one-year old seasonal ice

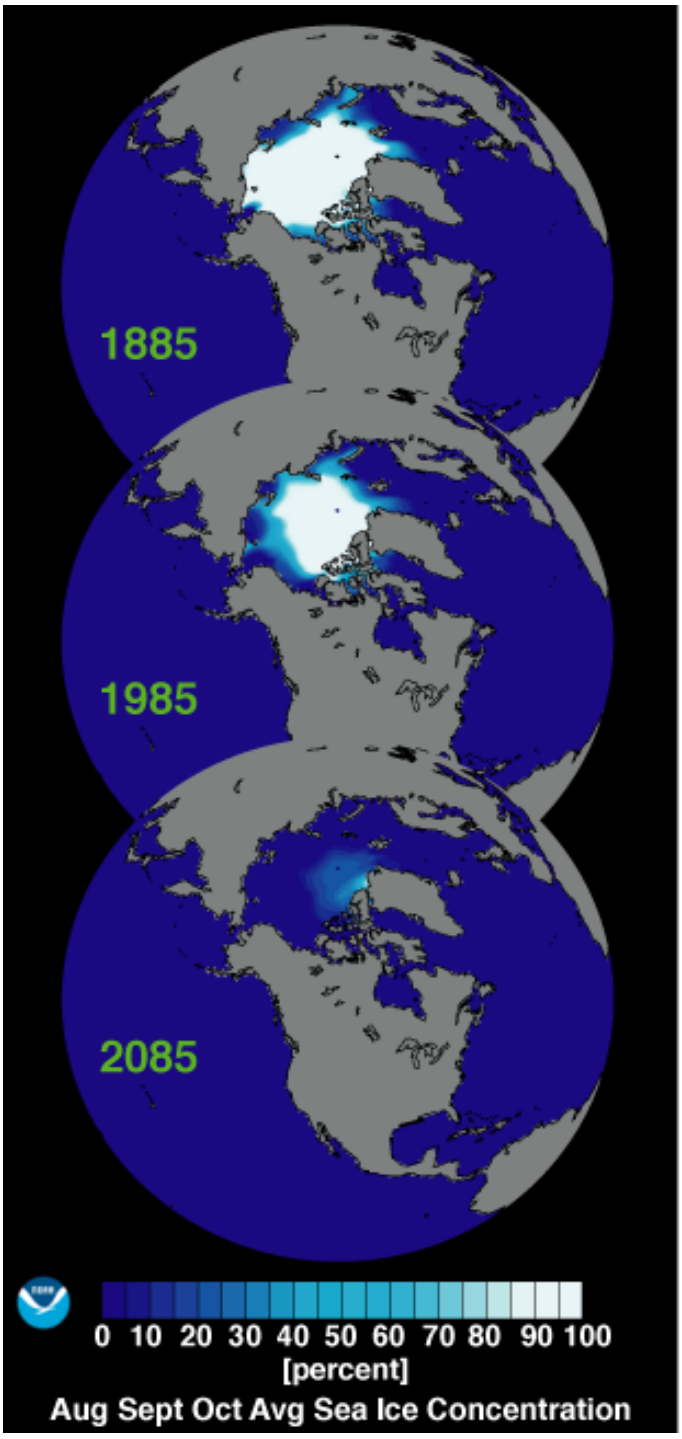


Source: Arctic Economics (n.d.). *The Arctic's Economic Center of Gravity....*

Ice is mainly divided into three categories, depending on age. Initial ice formation occurs in the form of small platelets and needles called frazil. Continued freezing results in the production of grease ice, which then forms a solid, continuous ice cover with thickness between 1 and 10 cm (under quiescent conditions.) Then, what is called first-year ice, with thickness ranging from 30 cm up to 2 m. If the ice survives two summers or more, it is called multi-year ice or perennial ice. Multi-year ice varies greatly in thickness, but is usually 3-6 m thick.[23] The older the ice is, the more solid and thicker it becomes, making it harder to sail through, and as one person said: *"Hitting multi-year ice is like hitting granite."*[24] The ice is at its greatest mass per year in the end of the winter, and around May-June the formation of new ice halts and starts to melt and in the beginning of October, the ice starts to rebuild mass again. The ice in the Arctic is not a continuum, but rather a mass of Ice floes. Ice floes are floating chunks of ice. If the chunk is less

[22] Ragnber (2000:8)
[23] Ship & Ocean Foundation (2001:33)
[24] Leung (2006, February 27)

Figure 7 Simulation showing the melting of the Arctic ice cap



Source: National Oceanic and Atmospheric Administration

than 10 km in diameter, it is called an ice patch. If it is larger than that, it is an ice field. Very large, dense ice fields having an area of 1,000 km^2 or more, and ice concentrations of 70% or more are referred to as ice massifs.[25] They are the main barrier when navigating through the Arctic.

3.3. Climate Changes and the Thawing of Sea Ice

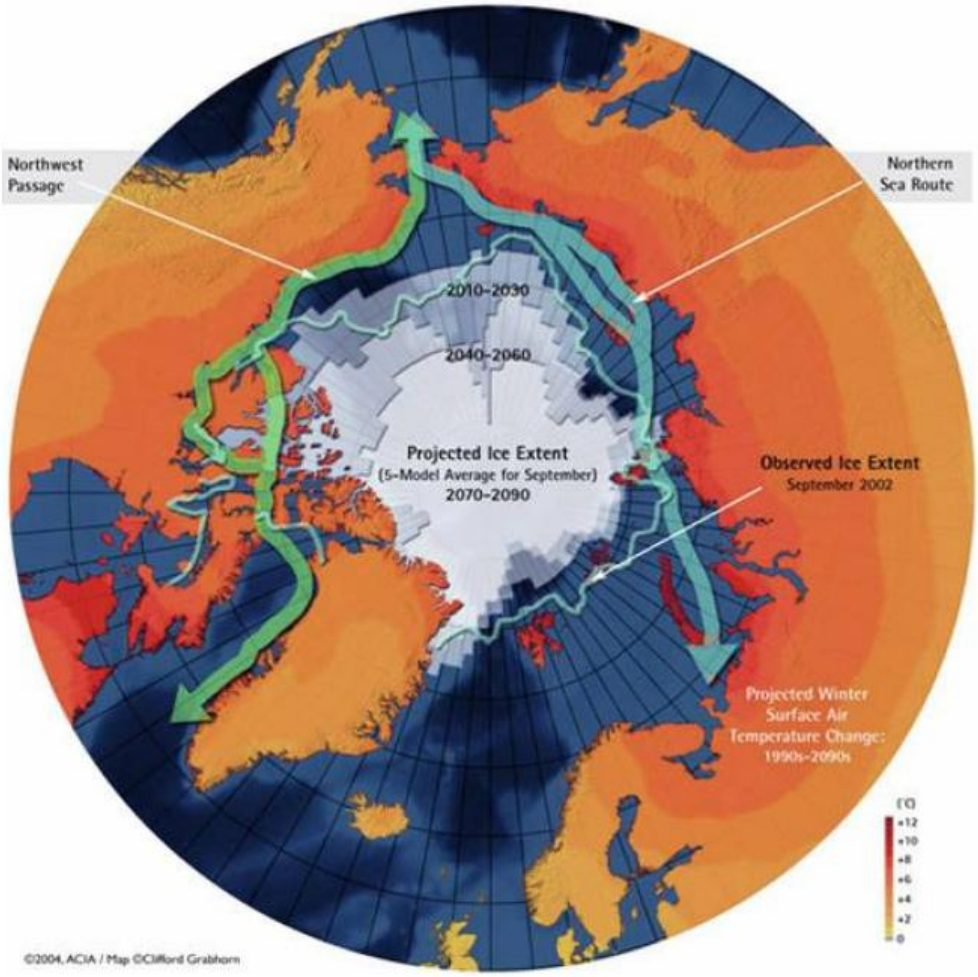
Countless reliable researchers of the last few decades have come to the conclusion that global temperatures are rising and the sea ice is gradually shrinking and thinning in the Arctic. This is a fact; what is still uncertain is the pace of the process. Predictions about the pace and future ice cover differ greatly. This is mainly because the polar ice caps are shrinking at an unprecedented rate, and some research reports indicate that the pace is dramatic. Some scenarios like the Arctic Climate Impact Assessment in 2004 predicted an ice-free Arctic Ocean during the late summer in 100 years, while others, more recent, see the same occurring after only 30-50 years, yet other predict an even longer process than

[25] Ship & Ocean Foundation (2001:34)

100 years.[26] It is thought that the average temperature might rise about 3-9°C over next hundred years in the Arctic, double the average for the rest of the world.[27]

According to satellite data since 1978, the extent of sea ice in the Arctic Ocean has been decreasing by an average of 3% per decade. In addition, a 7% per decade decrease in thicker, multi-year ice pack has been revealed, accompanied by substantial decreases of 42% in the average ice thickness from 3.1 to 1.8 m, averaging about 4 cm per year. In other words, the amount of multi-year ice is shrinking and the ice is rapidly getting thinner. This rapid deterioration of the ice has sparked beliefs that the Arctic ice might disappear in this century.

Figure 8 Simulation showing a different scenario of the melting Arctic ice cap



Source: Arctic Climate Impact assessment (n.d.). Impacts of a Warming Arctic

[26] Ragner (2000:
[27] Johnston (2002:150)

3.4. Shallow Seas

A distinct feature of the Russian Arctic and a major hindrance to NSR shipping are the shallow seas and straits along the way. Deep-draft ships are forced to choose a route far from the coast, making them more vulnerable to extreme ice conditions. This is especially true around the New Siberian Islands where draft restrictions are 12.5 m in the Sannikov Strait and only 6.7 m in the Dmitry Laptev Strait. In addition to shallow seas many of the NSR ports are also too shallow to accommodate ships with drafts greater than 9.0 m, making it almost impossible for big ships to load/unload without the help of smaller vessels, and can also pose a threat to larger ships in need of shelter or repair in emergency situations.[28]

3.5. Other Forces of Nature

Along with the shallow seas, the extreme cold, and the sea ice there are other threats that lurke in the Arctic region. The presence of the Aurora Borealis (Northern lights) is relatively common in the Arctic region and can be quite spectacular to observe but in the event of a solar flare, the aura becomes highly excited and the magnetosphere is deformed, creating what is called a magnetic storm. Magnetic storms have been known to overheat transformers in Canada, causing massive power failures, and to corrode oil pipelines in Alaska and Siberia. Because the NSR is directly within the aurora zone, a strong magnetic storm could render satellite positioning and satellite broadcast of ice-flow data inoperative, and even damage electronic equipment aboard vessels.[29] Another risk for navigation is the fact that the Arctic Ocean is often covered in low-lying clouds called arctic strati, which sometimes descends to surface level to become fog. This fog, referred to as Arctic haze, has great affect on visibility. Whereas, on a clear day the horizon is visible at a distance of 200 km, when the Arctic haze on the other hand settles in the visibility is cut to 3-8 km.[30]

This shows that the environmental factors, especially the sea ice, play a big role in the future of the NSR. Scientists generally agree that the sea ice will continue to melt, even though the rate is a matter of dispute. The sea along the Inner NRS has been, for the past years, mostly ice-free, and will be even more so in the close future during the summer months and well into the autumn when it begins to freeze again. This will most likely result in increased marine traffic, which in

[28] Ragner (2000:8)
[29] Ship & Ocean Foundation (2001:21)
[30] Ship & Ocean Foundation (2001:25)

turn will accelerate the development and research of technologies necessary for Arctic sailing, such as reinforced vessels and navigation equipment used for surveying and monitoring movements and channels in the ice. This will in turn be very useful when the perennial ice might disappear from the Outer NSR and be replaced by thinner one year ice, making it possible for reinforced cargo vessels to penetrate the ice. At present time there are vessels capable of penetrating through ice up to one meter thick. It is very difficult to predict when the route will open for general shipping, but in light of the rapid changes in the Arctic climate, along with the rapid shrinking of the Arctic ice cap, the possibility of a new intercontinental transit route might appear much sooner than expected, and therefore constant monitoring of the evolution is crucial.

4. International Shipping Routes of Today and Future Development

Sailing has been vital to the evolution of mankind, both economically and culturally. Explorers like Magellan, Vasco da Gama, Marco Polo, and Christopher Columbus altered the course of history when they found new sailing routes, resulting in new economic centers and huge expansion in world trade.

The importance of sailings and sea transports did not diminish even though new means of transportation came along, including trains, cars and airplanes. After World War II, the use of shipping containers took off and the movement of packaged goods (which is rapid, smooth and secure rather compared to the transport of bulk goods), is, according to some, the primary force behind trade internationalization.[31]

4.1. Current State of Cargo Shipping

The increase of international trade in the world since 1950 has been 6% annually, compared to only 4% economic growth in the world. International trade has therefore developed quicker than economic growth in the world. This suggests that the trend will continue and even increase. At the same time, the cost of shipping on long routes has decreased, due to larger volume, port efficiency and bigger vessels. Actually, distances, volume and vessel sizes are of a completely different magnitude than before, resulting in the fact that the shipping cost has decreased enough

[31] Verny (2009:3)

to make it profitable to transport frozen fish from North-Europe to China, where it is fully processed, and then back again.[32]

In 2007, more than 7 billion tons of merchandise was transported worldwide. About 80% of this, or 5.6 billion tons, was carried on commercial shipping lines.[33] Industrialization in East and Southeast Asia are the main forces behind this development. The growth in world trade is due to intra-trade between the countries of East-Asia, or between East-Asia and other countries, China being the biggest party.[34]

The growth in world trade has a direct impact on the growth of container shipping, since most of today's merchandise is transported in containers, excluding heavy machinery, liquids, wheat, coal etc. For that reason, container shipping has risen in the same pace as world trade, or 5-7% for the last years. Continuing on this pace means that it will double itself in 10 to 15 years, which means that by the year 2020 the transportation between East-Asia and North-Atlantic could be around 12 million TEU, and 30-40 million TEU by the middle of the century, and around that same time, the NSR would become feasible for transportation.[35] Today, much of the cargo transported from Asia to Europe and America goes through two canals: the Panama and the Suez Canal. Transportation limits experienced by both canals in the present day could either be a hindrance for the North-Atlantic region, shifting the importance of the region somewhere else, or it could be a blessing, making the NSR more economically appealing.

4.2. The Panama Canal

The Panama Canal opened in 1914 and instantly became a vital route between the West coast of America and Europe; a great deal of cargo originating in East-Asia also passes through the canal. Originally, the U.S. owned and built the canal, but handed it over to the Panamanian government in the year 2000. The canal is approximately 80 km long and runs from the Pacific to the Atlantic, making the route between NY and San Francisco 9,500 km long, instead of the long and dangerous route via Cape Horn that is 22,500 km. A substantial portion of the Canal lies above sea level, making the use of locks essential to carry through ships; this restricts the size of

[32] Utanríkisráðuneytið (2005:29)
[33] Verny (2009:3)
[34] Utanríkisráðuneytið (2005:29)
[35] Utanríkisráðuneytið (2005:29)

possible vessels.[36] The maximum size of a vessel that can use the canal is known as *Panamax*. The size limits for Panamax are 274.3 meters long, 32 meters wide with a draft of 11.3 meters, making them able to carry approximately 4,500 TEU. An increasing number of modern ships meet this requirement. Some even exceed this limit and are known as *post-Panamax* or *super-Panamax* vessels.[37]

As the Panama Canal began losing its competitiveness due to the size restrictions, a huge step was taken when the expanding of the canal was announced. Construction, with an estimated cost of $5.25 USD billion, is scheduled to start in the beginning of 2010, and the canal is expected to open for traffic in 2015. This will allow for the transit of vessels with a beam of up to 49 meters, an overall length of up to 366 meters and a draft of up to 15 meters, equivalent to a container ship carrying around 12,000 TEU.[38] This will allow for the Panama Canal to gain back much of the cargo flow it lost to the Suez Canal because of its size limitations.

4.3. The Suez Canal

The Suez Canal, on the other hand, has no locks; seawater flows freely through the canal, which is at sea-level. It is man-made and was opened 1869, running from the Red Sea port town Suez, which its name is taken from, to the Mediterranean Sea town of Port Said, allowing ship transportation between Europe and Asia without navigating around Africa, and has been the most important sailing route between Asia and the North-Atlantic ever since it was opened. This route is either referred to as the Southern Sea Route or the Royal Route, and threads through the Straits of Malacca and across the Indian Ocean to pass through the Suez Canal. The Canal has undergone numerous repairs, and today it is 193 km long, where 68 km have two separate lanes, allowing ships to meet. The width spans 60 m (where most narrow) to 365 meters, and since the canal has no locks, the only serious limiting factors are the draft, which has a restriction of 20 meters, and height restrictions of 68 meters, due to the Suez Canal Bridge.[39] Draft maximums of 20 meters are still good enough for the largest container-cargo vessels, but are not enough for the next generation of cargo ships, and only 70% of the world's tankers are within these limitations.[40] These limits define the maximum size of vessels capable of transiting the Suez Canal fully loaded,

[36] Panama Canal Authority (n.d.). *This is the Canal*
[37] Wikipedia (n.d.). *Panamax*
[38] Panama Canal Authority (2006, April 24). Proposal for the Expansion of the Panama Canal - Third Set of Locks Project.
[39] Suez Canal Authority (n.d.). *About Suez Canal*
[40] Suez Canal Authority (n.d.). *Suez Canal Future Plans*

and are referred to with the term *Suezmax*. The canal accommodates most of the containerized traffic between Asia and Europe—more than 20,200 ships and 745 million tons of freight in 2007, making container ships 46% of the vessels transiting, oil tankers taking up the larger part of the remainder.[41]

A few concerns regarding the Suez Canal are worth mentioning. Firstly, the canal runs on maximum capacity, and due to much traffic, long waiting lines occur during rush hours, expanding the normal transit time from 4-5 hours to around 30 hours. Secondly, the war between the Israelis and the Egypt's demonstrated how vulnerable the canal is to wars and social conflicts in the region. During the war, the canal was closed for transit for two years, resulting in an enormous increase in freight and oil prices. The recent terrorist activity has sparked new concerns about the security of the canal, which could easily be closed if a terrorist attack were to occur upon a ship. And lastly, there is the threat of sea-piracy around the Strait of Malacca, part of the Royal route, where pirates sometimes board cargo vessels, and many containers have vanished in that area.[42]

4.4. The Recent Evolution of Transportation Ships

The size restrictions placed on the two canals have somewhat hampered the evolution of ships becoming bigger. This would not be a problem on the Outer NSR, as there are no size restrictions, and possible port locations in Iceland would be capable of handling larger-draft ships. Economics of scale is indisputable: increasing the size of container vessels is favored by shipping lines in order to reduce both the transportation cost per TEU and the shipbuilding cost per TEU. According to Samsung Heavy Industries, the reduction in costs by building one 12,000 TEU vessel rather than two 6,200 TEU vessels was approximately 16% along with a reduction of 17% in fuel costs per TEU.[43] The growth in ship sizes has been quite dramatic in the past few years. Around 1980, the world's largest vessel was 3,000 TEU. 1990, the size was 4,000 TEU, and in the year 2000 it was 7,000 TEU. By 2006, the world's biggest vessel, the Emma Mærsk, could handle 15,200 TEU. To give a brief idea how big that is, a ship the size of 9,600 TEU would be able to transport cargo equivalent to 1.3 million 29 inch color TVs, or 50 million mobile

[41] Verny (2009:4)
[42] Utanríkisráðuneytið (2005:22)
[43] Chang, Ho Yang (n.d). *The impact of bigger vessels on shipping & ports*

phones.[44] In 2008, South Korean shipbuilder STX announced it had completed the design of a 22,000 TEU containership with a proposed length of 450 meters, making it the longest ship to ply the oceans. Two alternate versions were designed, one with a single propeller, and the other with twin propellers. Compared to Emma Mærsk, this new ship would increase the capacity by 50% and add 50 meters in extra length. According to STX, the price of fuel is a major driver for bigger ships and these new vessels could cut the shipping price per container by 40%.[45] Large vessels consume a lot of fuel, and the Emma Mærsk (with its mammoth engine, five storeys tall and weighing 2,300 tons) consumes approx 16 tons of fuel per hour or 380 tons per day while at sea.[46]

Figure 9 Emma Mærsk

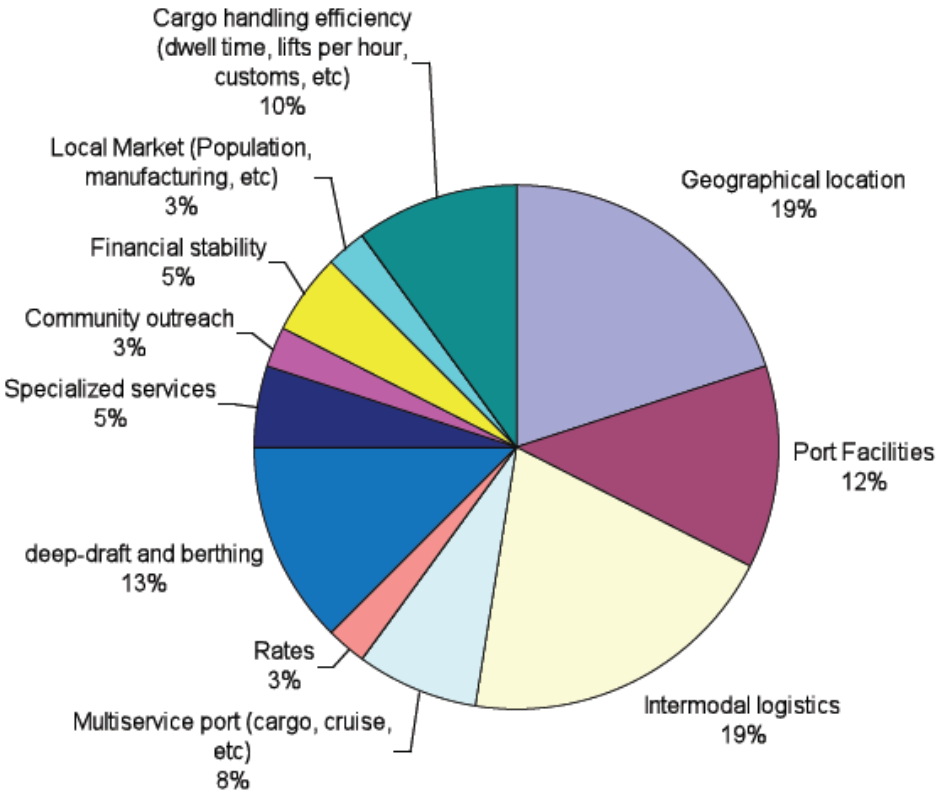
Source: gCaptain (n.d.). *Emma Maersk – The Secret Story of Building the World's Largest Container Ship » The Emma Maersk*

[44] Gizmag (2006, June 10). *The World's largest Container Ship launched*
[45] SeatradeAsiaOnline (2008, May 29). *STX reveals design for world's largest containership*
[46] Gizmag (2009, April 23). *Big polluters: one massive container ship equals 50 million cars*

4.5. Transshipment Ports

In order to cope with the increasing cargo traffic in the world there has been an increase in large transshipment ports, especially along the Royal Route. Big ships, usually around 10,000 to 14,000 TEU, transport cargo between these ports where the cargo is sorted depending on final destinations, and smaller vessels then service the route between the transshipment port and other nearby ports. It is estimated that 25-30% of all containers used in international sea trafficking were transshipped in 1999-2000 and that number is rising sharply.

Figure 10 Factors that count when ships call upon ports



Source: Environmental Issues in Port Competitiveness (2010:14)

The above table shows factors that ports have listed as the main reasons why ships call upon their port when future competitive advantage is discussed. Due to low response rates, the figure is not statistically valid but does give a loose idea of what port authorities think is important to the

competitiveness of ports. *Intermodal logistics* is not important in a transshipment port: all the cargo leaves the port again and therefore a network of further logistics such as trains, trucks etc. in not necessary. Other factors like *Cargo handling efficiency, deep-draft and berthing* and *Geographical location* would probably carry more weight in such a survey.

4.5.1. Locations

In order to succeed, a transshipment port needs to be well-located, preferably on a busy international marine route or on either end of it. Table 5 shows this clearly. All of these major transshipment ports lie along the Royal Route, one of the busiest routes in the world. Other factors such as the depth of the port, sufficient turning space, and adequate space for container storage and related services are also important, and will be discussed further when taking a closer look at possible port locations in Iceland. Furthermore, the port must be able to load and unload the cargo in the shortest possible time.

Table 2 Transshipment ratio and annual increase in various ports

Port	Country	2003 ,000 TEU	2002 ,000 TEU	Transshipment ratio (%)	Annual increase (%)	Depth (m)
Singapore	Singapore	18,300	16,940	85	8	14.8
Kaoshiung	Taiwan	8,843	8,490	55	4	14.0
Kelang	Malasia	4,840	4,533	54	7	16.5
PT Pelepas	Malasia	3,450	2,660	95	30	14.0
Gioia Tauro	Italy	3,081	2,955	95	4	15.0
Algeceiras	Spain	2,520	2,229	85	13	16.0
Salalah	Oman	2,001	1,260	98	59	15.0
Colombo	Sri Lanka	1,925	1,765	70	9	14.0
Pireus	Greece	1,595	1,398	62	14	14.0
Malta Freeport	Malta	1,305	1,244	93	5	15.5

Source: Umskipunarhöfn á Íslandi fyrir Íshafssiglingar (2007:33)

This table shows how transshipment is becoming a bigger part of the international logistic networks and is increasing over the years. This same trend is also occurring in older ports where the proportion of transshipment is between 25-50% even though they were not originally built

with transshipment in mind.[47] Notice that the depths in these ports are not sufficient for the next generation of ships, and it would be necessary to deepen them further in order to facilitate these ships.

When it comes to possible locations in the North-Atlantic for transshipment ports serving the NSR there are a few other good locations in addition to Iceland. The Northern coast of Norway and the Northern part of the United Kingdom are as geographically well-suited as any location in Iceland, and even more so depending on the flow of the potential cargo.

Scapa Flow in the Orkneys is worth mentioning as an alternative location, as it has been an important harbor since the settlement of Vikings a thousand years ago, and was U.K's chief naval port in both World Wars. Natural port conditions are suitable, and the harbor could easily handle potential super-sized vessels in the future, and it is already used as an oil terminal for large oil tankers that cannot call on other ports. The port authorities of the Orkney Islands have expressed their wish to become a large transit port for cargo between North-America and Europe, and have already taken steps in that direction. According to a cost analysis made by them, it would cost $196 million USD to develop a port capable of handling 1.12 million TEU a year by building on existing ports. The quay would be 850 m with eight container cranes capable of servicing two 4,000 TEU ships per week. If enlarged to handle 3.91 million units, extensive changes on current facilities would need to be made, running the cost up to $686 million USD. The quayside would then stretch almost 3,000 m with 28 cranes that could load and unload four 4,000 unit ships and two 6,000 unit ships each week.[48]

This plan by the Orkney Islands is not related to the possibility of the opening of the NSR but instead based on current shipping between North-America and Europe, and the fact that most major harbors on continental Europe are running on full capacity and the possibilities of expansion are limited due to vicinity to urban areas and high cost of land. Well-established transshipment ports in the North-Atlantic would probably be favored when the NSR opens up and would therefore procure potential cargo.

It is therefore essential that Iceland make its interest known, should that be its intention, by promoting itself as a future option, and make all the necessary preparations so that the country be

[47] Utanríkisráðuneytið (2005:33)
[48] Utanríkisráðuneytið (2005:39)

ready should one of the big container shipping companies show interest in Iceland as a location for a transshipment port. There is actually a lot at stake, since most likely there will only be "operational capacity" for one transshipment port in the North-Atlantic, at least to begin with.

Some even think that in the future, the shipping trade will consist of a few mega-hub ports where ships larger than 15,000 TEU would service the East and West trade, and rather smaller sized vessels (250-6,000 TEU) would then transport the transshipment cargo North and South from these mega ports. If and when the NSR becomes a reality, the location of Iceland in the middle of the North-Atlantic between North-Europe and the east coast of North-America would be an ideal location for such a mega port. The fact that it would be able to serve both sides of the Atlantic is a great advantage, since the same cannot be said about ports on Continental Europe, as it would be too much of a detour for cargo destined for North-America.

5. Technological Aspects of NSR Navigation

The main characteristic of the NSR is the presence of sea ice, which has many complications for ships traveling along the NSR. They are forced to reduce speed and the ice can at times cause damage to the ship's hull and propulsion systems. Therefore navigation on these unique waters requires the design and construction of special vessels.

5.1. Historic and Present NSR Freight Traffic

The annual volumes of cargo transported along the NSR have varied widely. From modest volumes under the 1930s to ever increasing volumes after World War II which led to a peak in 1997 when almost 7 million tons were moved along the NSR. Most of the goods transported to or from Russian Arctic ports fell to a low but stabilized flow of around 1.4 to 2 million tons annually since 1996.[49] Since 1997, there have been no cargo vessel transits, except one isolated occurrence in 2001 and from 1991 when the route was opened to foreigners there has not been one single "ordinary", commercial transit by a non-Russian vessel.[50] In late 2009, however, due to near-record low sea ice conditions in the Arctic, two German heavy-lift vessels, the 12,744 DWT twins Beluga Fraternity and Beluga Foresight from the shipping company Beluga, made

[49] Ragner (2000:11)
[50] Ragner (2008:4)

the transit between Ulsan, South Korea to Europe with commercial cargo, making them the first western merchant vessels to do so.[51] These two ships spent nearly a month at the Russian port of Vladivostok awaiting various clearances, which shows the urge for reforms on behalf of the Russian authorities, since time is money and this kind of spectacle is not something anyone wants when trying to promote NSR as an optional route in the international marine traffic.

Table 3 Total cargo volumes transported along the NSR, 1933-2003, thousands of tons

1933	1943	1953	1963	1973	1983	1987	1993	1998	2003
130	289	506	1,264	3,599	5,445	6,579	3,016	1,458	1,700

Source: Umskipunarhöfn á Íslandi fyrir Íshafssiglingar (2007:11)

Table 4 Cargo transit between Europe and Asia on the Northern Sea Route 1991-1997

	1991	1992	1993	1994	1995	1996	1997
Number of vessels	15	12	22	7	8	3	2
Volume (tons)	210,000	186,000	226,000	10,000	120,000	38,000	30,000

Source: Umskipunarhöfn á Íslandi fyrir Íshafssiglingar (2007:11)

The figures in Table 3 refer to the formal definition of the NSR, confined by Novaya Zemlya in the west and the Bering Strait in the east, (therefore excluding the Barents Sea where some shipping occurs.) One drawback with these numbers is that they do not take into consideration *how far* the cargo is transported.

Today, the cargo transportation on the NSR route mainly consists of three distinct trade routes. The biggest, being non-ferrous metals and ores from the Norilsk industrial complex in Dudinka to Murmansk and Western Europe, next, the import of supplies to the Arctic settlements, and finally oil and gas exports. The latter are rapidly increasing, and volumes are expected to continue rising

[51] Beluga Group (2009, December 1). *Successful transit of Northeast Passage*

as new Arctic oil-fields and terminals are developed.[52] Other traditional cargo flows, such as timber and coal exports from Siberia, are today mostly handled by the Trans-Siberian Railway.[53]

5.2. The Cargo Fleet and the Development of Icebreakers

The standard NSR cargo vessels of today are the Russian SA-15 ships, which make up the core of the Soviet fleet and are the most commonly used icebreaking cargo ships—not just in Russia but around the world. SA-15 is a project name denoting a SubArctic 15,000 DWT multipurpose ship. The vessels are specially constructed with the Arctic in mind and are therefore capable of continuous icebreaking of ice up to 1m thick. They are 174 m long and 24 m wide, with a limited draft of 9.0 meters, designed with the shallow waters of the NSR in mind. They were built for the Soviet Union in Finland during the period of 1982-87.[54]

INSROP research revealed that under present NSR conditions, and with the present technology, the maximum size of an NSR transit vessel is approximately 50,000 DWT (approximately 4,250 TEU). The main limitations in size are due to the 13 m depth of the Sannikov Strait, which only allows for a draft of 12.5 m and a breadth of 30 m—2 m wider than the largest Russian icebreaker.[55] As mentioned earlier, this might not be sufficient enough to establish the NSR as a transit route, at least not for containerized cargo.

Russia has the world's largest fleet of icebreakers and ice-transiting ships, including the world's only seven active nuclear icebreakers (the most powerful in the world), along with several strong diesel-electric vessels.[56] This large fleet of fortified vessels along with their NSR shipping activities gives Russia more experience in this field of navigation than any other country.[57] Sadly, Russia has not built any new icebreakers since the construction of the *Yamal* in 1993 and the new *50 Let Pobedy*, which was launched in 2007, more than 20 years after its construction began. The rest of the icebreaker fleet dates back to the 1970s and 1980s which means that some of the vessels are reaching the end of their service lives, making maintenance and replacement increasingly difficult.[58]

[52] Ragner (2008:4)
[53] Ragner (2000:17)
[54] Ship & Ocean Foundation (2001:50-53)
[55] Ragner (2000:29)
[56] Ragner (2000:5)
[57] Ship & Ocean Foundation (2001:45)
[58] Ship & Ocean Foundation (2001:55)

In more recent years, a program to re-equip the existing nuclear icebreakers with the purpose of prolonging their lifetime up to 30, and possibly even 35, years has been embarked upon.[59] While this does not solve the problem, it is a temporary solution, and another problem is that it takes around ten years to build a new boat after its initial conception.

For the moment, the icebreaker fleet is capable of fulfilling the demand for cargo shipment, but while capacity is bound to diminish, the need will surely increase in the coming future, as petroleum activities and transport increases in the Barents and Kara Seas, making demand surpass supply.[60]

Figure 11 Icebreaker sailing through ice

Source: Esquire (2009, February 16). *Sixteen Things Canada Is Good At*

[59] Ship & Ocean Foundation (2001:73)
[60] Ragner (2008:5)

5.3. Forecasting Future Potential NSR Cargo Flow

The geographical fact that the NSR is a shorter route between Western Europe/Northeast America and Northeast Asia has given rise to much attention to the NSR as a potential transit route for cargo, as it would be much shorter, and for much of the year, faster. The big question is, however: Will it also be more profitable than moving cargo via traditional and well-established routes? Before taking a look into that matter, let's see what kind of cargo is more suitable than others, and what is currently being shipped between these regions. Although cost is a big factor in the shipping industry, reliability and punctuality is even more important, which is not easy to ensure in unpredictable ice conditions, where delays are unavoidable even with icebreaker escort.

Also essential is the ability to achieve economy-of-scale, which is difficult unless stable, preferably year-round operations can be assured on sufficiently large vessels. Therefore, most studies come to the conclusion that low-value bulk cargoes are the most feasible for this route. Containerized cargo is the least suitable one, given that it operates on very strict time schedules, and is more likely to contain merchandise that is sensitive to extreme thermal conditions, running the risk of freeze damage to the cargo. Counter-measures can be taken to prevent this, but that would only raise the freight rate, making it uneconomical.

As mentioned earlier, the size limits for vessels on the Inner NSR is approximately 50,000 DWT, far less than the current vessels operating on the existing, traditional routes. In practice, this rules out profitable transit transport of several bulk cargoes, most notably oil.[61] Here, we are talking about transit, not oil originated in the Russian Arctic. Based on the present cargo traffic through the Suez Canal, potential transit cargo that might move along the Inner NSR can be estimated by analyzing statistics on country of origin and country of destination for the different cargo segments. Ramsland, during the INSROP project, identified fabricated metals and mineral fertilizers as the two dominating NSR-relevant *eastbound* bulk cargoes along with the possibility of some cereals and ores, but in rather small volumes. Also, fish from Norway and other countries in NW Europe is a possibility, but also in trivial volumes. When it comes to *westbound* cargo, there is no obvious large candidate, which is a problem since imbalance in directions will affect the profitability of operations. In effect, the price of sending something to Europe includes the cost of returning it empty back to Asia if no westbound cargo can be found. The same study

[61] Ragner (2000:25)

did however find two possible candidates for westbound cargo: one being Chinese coal, (4.03 million tons of it passed thru the Suez in 1997) and the other being car imports—especially from Japan and Korea.[62]

5.4. Sailing Distances in a Perspective

The importance of the NSR as an international sailing route arrives from the fact that it is shorter than the current Royal Route between Europe and East-Asia, along with the fact that no size restrictions would be placed on future ships if the Outer NSR became ice-free. A shorter sailing route has many benefits for the shipping companies, including savings in fuel, wages, time and the number of ships needed for maintaining a regular schedule.

Hong Kong marks the spot where the equal distance point lies between the port of Rotterdam and East-Asia. All ports northeast of Hong Kong have shorter distances via the NSR than going on the traditional Royal Route, and thus all ports southwest of Hong Kong would choose the Royal Route.

The equal distance point for shipments bound for New York and the east coast of North-America, lies a little more south in the area of Manila in the Philippines, thus making it shorter via the Suez Canal for countries like Vietnam, Thailand and Singapore.[63]

Based on the above information, the whole of East-Asia lies within the zone where sailing is shorter via the NSR, both for destinations in the north of Europe and the east coast of North-America. This means that 7 out of the 10 world's busiest container seaports lay within the zone affected, and should benefit the NSR in becoming an international shipping route.[64]

The first table shows the distance in nautical miles and the number of sailing days between the port of Rotterdam and four ports in East-Asia. The calculations are based on a traveling speed of 21 knots and the same conditions for ships on all routes. The second table shows the distance from Halifax, Canada with the same assumptions and ports. The NRS calculations are based on the Inner route alongside the coast, whereas the Outer route would be much shorter.

[62] Ragner (2000:23)
[63] Utanríkisráðuneytið (2005:24)
[64] Port of Hamburg (n.d.). *Container port throughput in a global comparison*

Table 5 Distance in nautical miles and the sailing time in days from Rotterdam to four ports in Asia via three shipping routes

	Shanghai		Busan		Hong Kong		Yokohama	
	Distance	Time	Distance	Time	Distance	Time	Distance	Time
	Nautical miles	Days	Nautical miles	Days	Nautical miles	Days	Nautical miles	Days
Rotterdam - Cape of Good Hope	13,889	27.6	14,209	28.2	13,161	26.1	14,506	28.8
Rotterdam - Suez Canal	9,612	19.1	9,907	19.7	8,859	17.6	11,212	22.2
Rotterdam - Northern Sea Route	8,865	17.6	8,490	16.8	9,410	18.7	7,825	15.5

Source: Utanríkisráðuneytið (2005:25)

Ships within the size limits of the Suez Canal would not gain so much by taking the NSR, if departing from ports close to the equal distance point, e.g. Hong Kong and Shanghai while ports further north have more to gain. For ships larger than Suezmax, the advantage of the NSR is enormous, e.g. cutting the distance between Rotterdam and Yokohama by half. Such a difference may well open up the possibility that the NSR might be feasible for regular navigation, even though partial sea ice would be on part of the way.

Table 6 Distance in nautical miles and the sailing time in days from Halifax to four ports in Asia via four shipping routes

	Shanghai		Busan		Hong Kong		Yokohama	
	Distance	Time	Distance	Time	Distance	Time	Distance	Time
	Nautical miles	Days	Nautical miles	Days	Nautical miles	Days	Nautical miles	Days
Halifax - Panama Canal	10,904	21.6	10,441	20.7	11,533	22.9	10,020	19.9
Halifax - Suez Canal	11,818	23.4	12,239	24.3	11,191	22.2	12,517	24.8
Halifax - Cape of Good Hope	15,998	31.7	16,318	32.4	15,270	30.3	16,028	31.8
Halifax - Northern Sea Route	10,091	20.0	9,716	19.3	10,636	21.1	9,051	18.0

Source: Utanríkisráðuneytið (2005:25)

To the east coast of North-America, the difference is negligible in using the NSR when compared to the other two routes via the Panama or Suez Canal. Here, the strength of the NSR lies in the limitations of two canals, both running on maximum capacity and the trend of ships becoming bigger and bigger. In 1995, 12% of cargo shipments were carried out on ships bigger than Panamax and by 2011 the number will be approximately 37%[65].

When the expansion of the Panama Canal is expected to finish in 2015, it will be able to handle ships up to 12,000 TEU along with Capemax dry-bulk vessels and Suezmax, taking away the advantage for shipments going to North-America, unless the trend continues and future ships become larger than this, which some experts actually think will happen. Already, Mærsk is operating 8 vessels that are 15,200 TEU and no further back than the beginning of the millennium, experts were raising the possibility of ships being around 15,000 TEU before 2020.[66] Since the NSR will not be fully operational until 2050 or even later, this advantage might re-appear by then, being that further expansion of the Panama Canal is highly unlikely, and the majority of the ships will probably be bigger than 12,000 TEU.

5.5. Evaluation of Economic Feasibility

Even though the NSR route is much shorter and even faster sometimes, there are other factors that have to be considered when evaluating the viability of the NSR when compared to other routes like the Royal Route, which passes through the Suez Canal. Vessel speed, modifications of the ships, insurance premiums and icebreaker fees are but a few things that have to be taken into consideration.

The author did not make his own cost simulation as it would be beyond the scope of this paper. During my research, I came across several reports that included cost simulations on the NSR, some of them were very comprehensive, consisting of complex mathematical regression analysis, down to more simple ones. The most comprehensive one was carried out under the INSROP project and I will briefly recite that study here as it is presented in the report from the Ship and Ocean Foundation (2001:93-111). In the *INSROP Simulation study* an operation simulation was conducted to calculate shipping costs through four representative NSR routes, using three hypothetical NSR ships, a 25,000 DWT bulk/container vessel with "high" ice-class, a 40,000

[65] Panama Canal Authority (2006, April 24). Proposal for the Expansion of the Panama Canal - Third Set of Locks Project.
[66] Chang, Ho Yang (n.d). *The impact of bigger vessels on shipping & ports*

DWT bulk/container vessel built on similar principles, and a 50,000 DWT bulk vessel with "medium" ice-class. The hypothetical *conventional* vessel used for simulation of ongoing Suez route operations was a 50,900 DWT Handymax vessel. The study was conducted using the following cost parameters: building costs, capital cost, crew, maintenance, insurance, fuel and port costs along with the transit fees of the NSR and Suez Canal.

The most important aspect of the cost simulation was the determination of the ship speed under various types of ice conditions. Knowing the ship's speed makes it possible to determine how many days the vessel will be at sea from port to port, so that most of the shipping expenses could be calculated. This was done by using detailed, historical data of weather and ice conditions from1957-1990 and applying that to the hypothetically route between Yokohama and Hamburg. From this the total cost for the various ships, routes and seasons were calculated and compared with the standard Suez route. Costs were calculated on both a monthly basis and on an annual basis.

The study found that NSR transit fees are a major component of total operational cost and when applied, the NSR cannot compete successfully with the route via the Suez Canal and a tariff reduction of 26% (down to $5 USD/gross tone) was found to satisfy this requirement. The NSR transit fee includes what is known as the "icebreaker fee" (which is by far the largest component of the NSR fee) and is not directly linked to actual services rendered but functions as a flat-rate fee, charged per voyage, regardless of the frequency of icebreaker escort. In fact, the transit dues must be paid even if no ice is encountered and icebreaker service is required.

Capital costs have the most significant impact on the NSR operational cost. Improvement in icebreaking capability resulted in much higher building costs and as mentioned earlier, economics of scale favors larger ships, (reducing both the transportation cost per TEU and the shipbuilding cost per TEU). Therefore, of the three vessels investigated, the larger and faster 50,000 DWT cargo ship with less ice-class was clearly the most commercially rational vessel to use. The lower ice-class would mean more days of icebreaker escort and higher icebreaker fees, but as long as the present system of *flat* icebreaking fees is in effect, the extra icebreaker fees are more than outweighed by smaller capital costs and other, favorable factors.

The study came to the conclusion that a NSR transit operation with the 50,000 DWT vessels could be sufficiently competitive with the operation of conventional handy-size bulk carriers through the Suez Canal route during the *summer* months. On a year-round operation the NSR was not competitive with the Royal Route. The maximum yield would be reached by switching between the NSR and the Suez route according to prevailing ice conditions, by using satellite data to obtain accurate information on ice conditions before entering the NSR. The simulation further revealed that in some instances the NSR would still be chosen over the Suez route, even if ice conditions would make the NSR a few days longer. This was caused by the considerably lower fuel expenses for the much shorter NSR route, and since the study was conducted in the 90's the price of oil has increased a great deal, making it even more feasible. The overall results of the INSROP Simulation Study concluded that the increase in operational income would not produce an acceptable return on the increased capital costs necessary to finance the building of a suitable ice-class cargo vessel.[67]

Even though the study is good and valid the author would have liked to see the use of larger vessels in the simulation than the 50,000 DWT (approximately 4,250 TEU) ship. The reason for not using larger vessels are as mentioned earlier in chapter 5.3 the depth limitations of the Sannikov Strait (13 m) and a breadth of 30 m—2 m wider than the largest Russian icebreaker. These limitations can be bypassed by simply building a larger icebreaker and by going around the Anzhu Islands, which will be doable in the near future if the ice cap continues to melt at present rate.

Concrete evidence is always better than theoretical analysis, and the fact that the German shipping company Beluga made a transit between South Korea to Europe with commercial cargo in 2009 and managed to do so in a lucrative way shows that it can be done. According to Niels Stolberg, president and CEO of Beluga Shipping, the company reduced the bunker consumption of oil by roughly 200 tones in total per vessel, resulting in financial savings of about $100,000 USD plus $20,000 for each day that the travelling on the NSR shortened the usual voyage time. All in all, about $300,000 per vessel was saved by transiting the formerly ice packed Northern Sea Route. Mr. Stolberg further stated that the 2009 pioneer voyages where only the beginning for further innovative projects and in the next trip scheduled for 2010 the use of 20,000 DWT

[67] Ship & Ocean Foundation (2001:93-111)

vessels would be used, which might result in financial savings of about $600,000 per vessel and transit.[68] Maybe the route is becoming economically feasible earlier then thought before.

6. The Role of Iceland

Iceland has always considered itself well-positioned in the North-Atlantic, right between America and Europe, and has tried to take advantage of this position for a long time without truly succeeding. Talk of becoming a financial hub, and also the possibility of establishing a free zone, have been around for a long time, but without any true measures being taken to achieve these goals. The workforce of Iceland is quite educated, and many scholars seek their education overseas, resulting in the fact that English and Scandinavian languages are widely spoken. Rules regarding employment protection are not as strict as in many other European countries. The country is a democracy and the political landscape has been rather stable in the country. These factors should make the country quite feasible for foreign investments.

6.1 The Currency

With that said, there have always been the two obstacles that discourage foreign investment: the fact that inflation has always been a constant reality and that the currency of Iceland, the Krona, is one of the smallest free standing currencies in the world. The volatility of the Krona has been quite high since it began to float in the year 2001 and before that the government periodically devaluated it to make exports more competitive. This kind of uncertainty does not go well with international companies searching for potential locations for their investments; they want stability in order to make accurate long term plans. Singapore is a good example where the Government has decided that a stable currency is the key ingredient to economic growth. Adoption of the Euro in Iceland would probably help a lot in those matters, and it could be interesting to research further what affect stable currencies have on the economic growth. The adoption of the Euro has been a hot topic in Iceland for a few years now and has sparked quite a debate. Particularly after the financial crisis, many wanted to adopt the Euro unilaterally without the consent of the EU. How long until the adoption of the Euro or an alternative major currency will become a reality in Iceland is hard to say, but one thing is for sure: if Iceland wants to become an attractive choice

[68] LogisticsManager.com (2009, October 2). *Beluga Shipping completes first Northeast-Passage commercial transit.*

for foreign investments, they need to do something about their currency, particularly regarding the current currency restrictions, which are hostile towards new FDI.

Even though the economic scene has seen better days in Iceland, all the natural conditions and infrastructure to build a large transshipment port in Iceland are quite desirable.

6.2. Port Conditions in Iceland and Possible Locations

When choosing a site for a big transshipment port, or for that matter an oil refinery, there are a few factors that have to be taken into consideration, not only if it is geographically a good location with concerns to the actual shipping route, but also if the necessary infrastructure is in place. Natural conditions have to be favorable as well. Strong wind and tides are not desirable, and it would be a good advantage if the natural depth were enough for large draft vessels, therefore eliminating the extra cost of deepening the harbor.

In Iceland, there are a few places that fulfill these requirements, and I have chosen four possible locations that will be explained further, one of them also being a possible location for an oil refinery. The locations are Hvalfjörður, close to the capital Reykjavik; Eyjafjörður in the north of Iceland where Akureyri lies; Reyðarfjörður, where the new aluminum smelter is located on the East side; and finally, Dýrafjörður in the Westfjords, where the possibility of an oil refinery has already been discussed and some primary preparations had begun before the financial crash, but have probably been put on hold since then.

Figure 12 The Outer Northern Sea Route and how it divides into the North- Atlantic

Source: Heiðarsson (2007:15)

Cargo shipments through the Arctic have three different routes to choose from after passing the point between Novaya Zemlya and Franz Josef Land. After this point, the distance differs depending on the final destination. If heading for North or Central Europe, the course would be taken alongside Norway towards the North Sea. West of Scotland and Ireland, for destinations like Ireland, South of France, South- Europe and even the West coast of Africa. And if heading west to Canada or the US east coast a route alongside Iceland would be selected.

One of the main advantages to a shipping route through the Arctic is the reduction of distance traveled, and therefore a transshipment port along this route should not lengthen the overall traveling distance too much, thereby reducing the original benefits. For that reason, let's take a better look at the deviation from the optimal route, should a port call in Iceland be included.

Table 7 Prolonging of the route due to a stop in an Icelandic port

Detour of the route due to a stop in the following ports (km):	To Rotterdam	To N-America	Past West coast of Ireland
Eyjafjörður	1,264	294	764
Reyðarfjörður	826	344	248
Hvalfjörður	1,849	386	929
Dýrafjörður	1,703	107	810

Source: Umskipunarhöfn á Íslandi fyrir Íshafssiglingar (2007:18)

As table 7 shows, a port call in Iceland would only slightly prolong the distance for a ship going west towards America, but in the case of the other two routes, there is a significant increase in the distance, especially if the destination is Rotterdam. From a distance point of view, Reyðarfjörður is the best alternative, although not the optimal location for traffic going west. The difference is minimal in the context of the total journey. The ports of Singapore, and Salalah in Oman, to mention some, prove the significance of a strategic geographical location, both being en-route to the Royal Route and at a point where the routes divide and ships then head for a number of destinations. The port of Singapore is the busiest in the world, and Salalah has the highest percentage of transshipment, or 99.5%[69] probably due to the fact that it is located just before the "entry" to the Red Sea where the Suez Canal begins.

6.2.1. Natural conditions

As mentioned earlier, aside from the geographical factor, there is also the natural and "social/service/ infrastructure" factor to consider when evaluating possible locations for a transshipment port. According to Heiðarson (2007), there has to be sufficient space to rotate the huge ships intended for Arctic sailing. In order to not limit the future function of the port, should ships continue to grow as until now, a rotation zone of 1 km minimum would be advisable, allowing for a ship length of approximately 614 m.

Port activity requires a great deal of space and for a 2 million TEU transshipment port, a land area of one hundred hectares is needed (100 hectares = 1 km^2). To handle the enormous traffic expected in the future there should be the possibility to extend the port up to 200 hectares and

[69] Bahru (2007, June 12)

preferably more. To put this into perspective, Salalah is handling 3.1 million TEU, and the port of Singapore 29.9 million TEU as of 2008.

The reason for why only fjords were selected as possible locations in Iceland is because they provide natural shelter from ocean, waves, and currents, and the wind is more likely to be head-on with the ship, which rocks it far less than a side wind.

All of the four possible locations meet the conditions regarding depth, land space, sufficient turning space and good weather conditions. Worth mentioning is that available land in Reyðarfjörður is limited, and the aluminum smelter Fjarðarál is probably situated on the best available spot in the fjord, two other areas in Reyðarfjörður have the necessary land area needed, one of them being quite close to the town, therefore excluding itself since it would hardly be acceptable having a huge transshipment port next to the town.

6.2.2. Infrastructure

The final aspect for consideration when possible locations are evaluated is the infrastructure of the surrounding area. Here Heiðarson (2007) points out that, first and foremost, a source of labor is needed to operate a transshipment port. A few dozen to a couple of hundred employees are needed for such a port, while during the actual construction, the number would probably rise to a few thousands.

A big port with substantial operations is also in need of related services. This can range from supplying spare parts for lifting cranes to repairs on the ships. It also includes social services like the need for hospitals, law enforcement and access to a fire department.

Transportations are vital to and from the port. When referring to transportations they may be divided into three groups. This includes local, national and international transportations.

Local: Labor and service needed to facilitate the harbor has to be able to move around freely.

National: From a transshipment port point of view, access to other parts of Iceland is not that important since all the cargo would come and leave by ships. For the Icelanders it would matter since that port would probably represent the point where the lowest cost would be and would most likely become the main harbor for export and import. Also in the need of specialized service, not available locally, good connections to the capital would be helpful.

International: Good connections to the rest of the world are also essential. The possibility of flying to and from the port to other countries has to be relatively simple and not too expensive. The presence of an international airport would be best, but a local one with good linkage to an international airport would also suffice.

In order for a transshipment port to operate, it would have to be a Free Zone or Free Port. This means that only cargo leaving the area is processed by the customs authorities. This in turn means that the whole area needs to be highly secured with a fence, and nothing leaves the area except through special gates where customs would perform security checks. Therefore a location that is fairly easy to fence off, secure and monitor the premises would have to be chosen.

Here, the differences between the four locations are more than in previous comparison of natural conditions. Access to labor and thus also service is minimal if only the closest vicinity from the harbor is selected (15 km). If the distance is raised to 15-55 km then Eyjafjörður has by far the greatest access to labor and service, being that Akureyri, sometimes referred to as the capital of the north, has a population of around 17,000 people and is well within this distance. Akureyri has a good infrastructure, including Iceland's second largest hospital, an international airport, a lot of related services such as a shipyard, and the two biggest fisheries in Iceland are located there. In the vicinity of 60 km, Hvlalfjörður has access to the metropolitan area of the capital city Reykjavík where the majority of the Icelandic population lives. This has both pros and cons; the con being that it takes around 1-2 hours to drive that distance and probably only few employees would endure such a long drive back and forth to work. The pro is that it's fairly close to the capital, with all it has to offer. Both Reyðarfjörður and Dýrafjörður are similar when it comes to labor access. Within 50 km there is a population of around 5,000 and with regards to regional transportations, the conditions are worst in Dýrafjörður.

Figure 13 Grundartangi in Iceland

Source: Utanríkisráðuneytið (2005:40)

Which of these four locations suits the best for a transshipment port will not be answered here, since it depends on the final destination of the cargo, if it is going mainly to Europe, a destination like Eyjafjörður or preferably Reyðarfjörður would best suit, distance-wise. For westbound cargo, Dýrafjörður has the clear advantage while the others are quite similar. And if choosing a port that would serve both; the same ports that's suits Europe would be chosen, given that proportionally it would not differ so much for the total distance from East-Asia to North-America. The author cannot see how Hvalfjörður would be chosen from a distance point of view, but if other factors were to outweigh the importance of distance then Hvalfjörður has the clear advantage of the other three locations. For a possible location for an oil refinery the location of Dýrafjörður is clearly the best, distance-wise, since the majority of the oil would go the United States and would not be as visible to the public as oil refineries are usually an eyesore.

The tendency in Iceland on the political scene has been to allocate new job opportunities in regards to the influence on regional development and to preserve the population in a certain

region. This was clearly the case when the location was chosen for the new aluminum smelter, which was later built in Reyðarfjörður.

The author does not think this would be the case here since ultimately it would be the decision of the shipping companies, and they assess a port's location and facilities based on its overall profitability and how it fits into the international transport network. Today big companies like the APM Terminal, a subsidiary of the Danish shipping giant Mærsk Sealand, with its own transshipment area in over 30 ports and the world's third largest port operating company, more or less decide by themselves where they want to be located and are always receptive to new proposals that can be shown to be potentially economical.

This was demonstrated in August 2000, when Mærsk Sealand decided to shift its transshipment/hub operations from Singapore to Malaysia's brand new port, Tanjung Pelepas (PTP) in Johor, after they purchased a 30 percent stake in the PTP. The shift was believed to be the biggest single move in the port industry in Southeast Asia, and it guaranteed PTP an annual volume of two million TEU and making PTP one of the largest ports on Mæarsk Sealand's global network. PTP's "early bird" tariffs which where 30 percent lower than Singapore's probably has something to do with the move, since ship carriers are under a lot of pressure to lower their costs from global customers, and therefore forced to seek out the lowest cost options for themselves. But according to Flemming Ipsen, chief executive officer in Asia the move was also an opportunity to start fresh with a completely new Greenfield port which they own a stake in and therefore have more to say about the progress of their operations or as he said it: *"The move to PTP represents a quantum leap for Mærsk Sealand to master its own destiny and yet another step to remain in the forefront in the industry,"*[70]

This shows the effect a big company like Mærsk Sealand can have would they choose to start up a new port away from more established ones. The PTP only began operations in late 1999 and was handling 20,696 TEU and with the arrival of Mærsk Sealand the number jumped to 2 million TEU in 2001. The arrival of Mærsk Sealand probably served as a catalyst to attract other major carriers because in 2005 they where handling over 4 million TEU and today they are in 18th place over the largest container ports with a turnover of 6 million TEU.[71][72] Therefore it is never too

[70] Asia Times (2000, September 2). *Southeast Asia - A new era in Asian shipping*
[71] Port of Tanjung Pelepas (n.d.). *Historical Journey*

late for a country to establish itself as an attractive location for a transshipment port if they are reasonably close to a shipping lane and have something extra to offer e.g. lower tariffs or tax reductions that make them more competitive then the already established one.

6.3. Oil Refinery/Terminal

Another thing that is possible is to establish an oil terminal and later on when the NSR opens up it would be possible to build upon that port. The presence of an oil refinery or an oil terminal is an advantage, almost essential, when it comes to transshipment ports because large vessels use thousands of tons of fuel for each voyage and there would have to be large enough oil depot to service a fleet of merchant ships. The total fuel requirements of a relatively small international transshipment port would be similar to the current volume of oil and fuel used in Iceland.[73]

The possibility of an oil refinery has actually been discussed in Iceland, and Dýrafjörður was the prime location for the site. It was a Russian oil company that wanted to build the plant and the final market for the oil was the United States. Russia is thought to possess greater reserves of oil than any other country outside the OPEC group of nations, and its reserves of natural gas are the most extensive in the world. Russia's mainland and territorial waters are expected to yield as many as 500 exploitable oil-fields although production has yet to begin.[74]

It is stated in the prospectuses from the company presenting the idea that if built it would be the largest investment in the history of Iceland and during the construction around 4,000 people would be employed yielding 12 million working hours. The actual operation would employ up to 500 people and 2,000 more in ancillary industries and services connected in one way or another with the oil refinery.[75]

Even though the author is not personally fond of big industrial units like aluminum smelters and oil refiners, the fact cannot be ignored that the country of Iceland is in need of diversifying its job market and income sources. Depending on only fishing, tourism and aluminum is not healthy because fluctuations in price of these commodities can directly affect the Icelandic economy. Being too dependent on one sector can have catastrophic consequences as the failure of the banking system showed, when a lot of people lost their jobs and the state lost a big portion of

[72] Port of Hamburg (n.d.). *Container port throughput in a global comparison*
[73] Utanríkisráðuneytið (2005:36)
[74] Utanríkisráðuneytið (2005:13)
[75] Ólafur Egilsson (n.d.). *Olíuhreinsunarstöð á Vestfjörðum*

their tax income. The development of data plants for storage of digital information is on its way to becoming a reality in Iceland and would be a good newcomer to the Icelandic job market. These kinds of high-tech industries along with sectors like software development are what the author would like to see as a future add-on to the otherwise homogeneous "job market" rather than heavy industry, but if that is the only choice to get the economy going and to diversify the "job market" then so be it.

6.4. Post-financial Crisis

In the aftermath of the financial crisis the new Icelandic government which is a left-socialist one has raised taxes on both individuals, companies along with raising the capital tax and re-introducing the wealth tax. For the sake of future prosperity the author hopes that this is only a short-lived action and will be abolished as soon as possible as this clearly affects the country's competitiveness and takes away the few things the country was actually doing well before.

Before the financial crisis hit the country in 2008 the government and many municipalities were financially in good health and well capable of undertaking big projects like construction of a transshipment port. Today the same cannot be said as the country is virtually bankrupt and the same goes for the municipalities and most of the companies in the country. The two largest shipping companies Eimskip and Samkip are in no financial health to join this project and are only operating on the goodwill of their creditors. It is safe to say that the establishment of a transshipment port will not be undertaken by only local parties in the near future.

Therefore the involvement of international shipping companies is essential for the development of a transshipment port in Iceland and after the financial crisis the Icelandic currency is currently at a level that makes investments and cost of goods very compatible compared to other monetary zones. From being one of the most expensive countries in the world, Iceland became quite comparable and even cheap after the crash of the Icelandic Krona in 2009.

A weak currency along with other factors such as a competent workforce, a politically stable landscape, good infrastructure and excellent natural port conditions are all compelling points when the competitiveness of Iceland is assessed combined with the geographical location of the country. If it is enough to establish Iceland as a future location for transshipment port only time can tell.

7. Environmental Impact

Environmental issues and protection of nature has been a big issue for the past decades, especially in the western world, and economic progress has to go alongside the protection of the environment these days. Establishing a big transshipment port, or for that matter oil refineries, in Iceland along with the sea traffic that would accompany that kind of operation would most likely only have some minor environmental impact on the country, with the exception of a possible oil spill.

7.1. Pollution

The air pollution that comes from regular shipping is far less then what is released into the air in cities and other industrialized areas. Even for the most travelled route in the world, the Malacca Strait, air and sea pollution is not a serious hazard, although one quarter of the world's commerce and half of the world's oil passes through it. In number form, that makes more than 60,000 thousand ships a year, or around 170 per day, the majority of them being big tankers and container vessels. If all ships are included, meaning an addition of pleasure crafts and small boats, then the number goes up to around 600 daily.[76] This amount of traffic of course produces some pollution like oily bilge, water sludge, and sewage going into the water but the traffic around the shores of Iceland would never be anywhere close to the enormous traffic of the Malacca Strait, so therefore the pollution due to regular traffic would be negligible. Even with this immense sea traffic around the world and countless oil rigs it is believed that only 20% of sea pollution comes from ships, rigs and other objects on the sea and 80% is from the "land".[77]

With that said the largest ships like Emma Mærsk with its consumption of approximately 16 tons of fuel per hour or 380 tons per day while at sea, certainly pollute. According to a new research, in one year, a single large container ship can emit cancer and asthma-causing pollutants equivalent to that of 50 million cars. This is because the low grade bunker fuel used by cargo ships contains up to 2,000 times the amount of sulfur compared to diesel fuel used in automobiles, making shipping by far the biggest *transport* polluter in the world.[78] On the other hand, a passage through the NSR would shorten the distance between Europe and Asia and as a result the amount of sulfur and greenhouse gas emissions admitted into the air would be greatly reduced.

[76] GISdevelopment.net (n.d.). *Potential future transportation infrastructure in South East Asia*
[77] Umhverfisstofnun (n.d.). *Varnir gegn mengun sjávar*
[78] Gizmag (2009, April 23). *Big polluters: one massive container ship equals 50 million cars*

Bear in mind that it is not *where* the pollution is admitted but their combined effect in the atmosphere that is important.

The same can be said about oil refineries. Today plants, with their state-of-the-art equipment, are not the same menace to the environment as before, and the biggest oil refinery company in the US, Valero, has frequently been awarded for their environmental protection and improvements on current plants.[79] The new aluminum smelter Fjarðarál is an example of this. When constructed it was the first new greenfield aluminum smelter built in over 20 years and by using advanced scrubbing technology, emissions are reduced and process material is managed so as to minimize impact on the ecosystem.[80] The fact that plants pollute less today then before can been read from the fact that Alcoa, a leader in the production of aluminum has reduced greenhouse gas emission from aluminum production by over 30% since 1990, although production has increased substantially over the same period.[81]

Other environmental impacts are possible to minimize, such as excavating land or dredging during the actual construction of the transshipment port. When Bechtel was building the aluminum smelter Fjarðarál, they received the Conch Award, given annually by Iceland's Ministry of Environment, honoring companies that contribute to environmental protection. During the construction no unclean water was discharged into the nearby fjord and paper, glass, metals, timber, plastic, and other by-products where recycled or reused, and biodegradable waste was safely disposed of.[82]

7.2. Oil Shipments and Possible Hazards

The main threat, on the other hand, and the most serious one, is the possibility of a ship accident, and in particular accidents involving large oil tankers. Even though they don't occur often, the fact of the matter is that when they do occur, they can pose a real threat to the environment, as the Exxon Valdez incident outside the cost of Alaska in 1989 clearly demonstrated. That incident received a lot of media attention and raised public awareness about the threat that big oil tankers pose to the environment. Since then, the media has been keen on covering news about oil spills

[79] Valero (n.d.) *Awards & Honors*
[80] Alcoa (n.d.). *Smelter Information*
[81] Alcoa (n.d.). *Besta fáanlega tækni*
[82] Bechtel (2007, April 27). *Iceland Honors Bechtel for Environmental Excellence*

and possible new "Valdez" incidents each time an oil tanker becomes stranded or runs into some trouble.

Today, around 600,000 tons of oil and oil products are imported to Iceland, the majority on ships carrying 20,000 -30,000 ton each, totaling about 25 ships per year.[83] So far, thankfully, no big oil spill accident has happened on or around Iceland. The equipment needed to handle oil catastrophes at present are simple "kits" that include the basic things needed for oil retrieval, and are dispersed among the island in most major harbors. Although probably sufficient for today's status, this would be inadequate if an oil refinery or a transshipment port were to materialize in the country. A point worth mentioning is that according to the *Copenhagen Amendment*, a country can call upon the help of others, should it not be adequate to handle the situation themselves, and in addition the Nordic countries have made a similar pact.[84]

7.3. Environmental Regulations

In Iceland, the law 33/2004 *Lög um varnir gegn mengun sjávar og stranda*, roughly translated as *Law for the Prevention of Marine Pollution* states that the administration authority in Iceland, in the case of an environmental disaster on the sea, is divided between two parties. In the case of an accident inside the harbor, the municipality would be in charge, and outside the harbor on the open sea the state would have jurisdiction. This law was a renewal of an older one dating back to 1986 which was faulty in many ways and was an obstacle for successful operations by the Icelandic government to tackle possible marine pollution when it occurred. This was demonstrated when the ship Erik Boye run aground in *Breiðdalsvík* outside the shores of Iceland in 1992, but nothing was done to change the law then. It was not until *Víkartindur* stranded in 1997 where the flaws of the law truly revealed themselves and change was made; first, with a temporary directive, and later the new law from 2004. Before the change, it was not clear who had the final authority at the location of the incident, and depending on the pollution, which law covered that particular substance. In other words, the oil onboard the ship was the concern of one institution while the cargo pertained to another institution and the ship itself to yet another one.[85] This demonstrates the necessity for clear laws and guidelines stipulating what should be done and

[83] Ráðstefna um aðkomu að bráðamengun (n.d). *Viðbrögð við bráðum mengunaróhöppum. Löggjöf og skipulag*
[84] Utanríkisráðuneytið (2005:47)
[85] Ráðstefna um aðkomu að bráðamengun (n.d). *Viðbrögð við bráðum mengunaróhöppum. Löggjöf og skipulag*

in what order when oil leaks occur, as every second counts when thousands of tons of oil are pouring into the sea, and every mishap could have devastating effects on the environment.

8. Conclusion

The diminishing Arctic sea ice cover is a fact, while the pace of the process is still uncertain. The recent commercial transit from Asia to Europe, made by the Beluga shipping company shows that the possibility of using the Northern Sea Route as a viable alternative to the more conventional Royal Route is becoming a reality, ahead of previous estimations. The NSR is already faced with many obstacles, both natural and technological and therefore the present compulsory flat-rate escort tariff system has to be abolished and a new shipping support system, more closely attuned to market principles, has to be implemented in order for a more beneficial use of the Northern Sea Route. Although it will for a long time to come only be a seasonal route, the window of opportunity is opening up and the NSR might become an important waterway with large-scale, year-round transit operations before the end of the century, perhaps even sooner.

As a result, it is still too early to start making concrete plans for shifting all the cargo transit from Asia to Europe through the NSR, but it is not too early to start planning for the reality ahead by taking necessary steps in preparations for the future. The NSR has all the potentials to become a realistic alternative to the Suez Canal, even though shipping through the Canal is still by far the least expensive option.

As for the potentials of Iceland to establish a transshipment port that would serve the European end of the NSR is not something the author sees as a promising outcome in the future. Even though the country has good natural conditions and infrastructure, the detour from the optimal route is too great for cargo destined for mainland Europe, although within reasonable range if the destination is North-America or Southern Europe given that the location of Reyðarfjörður would be chosen. The deviation there is similar to the one of Salalah in Oman. Other potential port locations like Scapa Flow in the Orkneys and Hunterston, Scotland are situated better, in relevance to Europe and are equivalent when it comes to other bearing factors.

It is not to say that Iceland does not have a possibility, the final word lies with the international shipping companies and they are always receptive to new proposals that can be shown to be

potentially economical. The fact that a transshipment port located in Iceland would be able to serve both sides of the Atlantic is to a great advantage. Iceland's advantages are, however, worth little unless a concerted effort is made to awaken the interest of international shipping companies. Iceland seems to require nearly all the stars to be aligned for it to become a realistic opportunity.

8.1. Final Thoughts

Another thing that has to be considered is the image of Iceland. Today the country of Iceland promotes itself as a clean, pure and un-spoiled country, and that is the image that most people actually have of the country. This image is crucial to maintain especially for the tourism industry and for the export of fish. These two industries are the pillars of the Icelandic economy and it is vital for them that the image of Iceland stays intact. Therefore it is important that industries that do not have a "clean" image like aluminum smelters, oil refineries and even large ports are located where they are not in eye-sight or try to locate them where traffic is minimal and off the beaten track. Unlike the aluminum smelter in Hafnarfjörður which is located by the road to Reykjavík, coming from the main international airport, every single person visiting Iceland drives past it. The funny thing about image is that it is more what you promote rather than the actual truth, as they say: *"When it comes to image, perception is everything"*

8.2. Further Research

Unfortunately the *INSROP Study* did not provide a definite answer to the question of the feasibility of opening the NSR to international shipping with large vessels and therefore an economic-and-feasibility study on this subject is needed.

It would also be interesting to study further what impact higher oil prices have on the economical feasibility of the NSR given that consumption of oil is enormous on large vessels and a big part of the total expenditure of a voyage. In connection with that, a further look into the use of alternative fuels would be interesting, and especially the use of hydrogen since Iceland would be in a unique position to supply hydrogen from renewable energy resources to the cargo fleet, something other countries would not be able to do.

9. Bibliography

About Suez Canal. (n.d.). Suez Canal Authority. Retrieved April 3, 2010 from: http://www.suezcanal.gov.eg/sc.aspx?show=17

Arctic's Economic Center of Gravity.... (2010, August 4). Arctic Economics. Retrieved April 4, 2010 from: http://benmuse.typepad.com/arctic_economics/2008/08/at-arctics-economic-center-of-gravity.html

Awards & Honors. (n.d.). Valero. Retrieved April 25, 2010 from: http://www.valero.com/OurBusiness/Pages/AwardsHonors.aspx

Bahru, Johor. (2007, June 12). *Transhipment and Global Container Traffic Growth*. [Powerpoint slides]. Retrieved from: http://www.docstoc.com/docs/19596137/Transhipment-and-global-container-traffic-growth/

Beluga Shipping completes first Northeast-Passage commercial transit. (2009, October 2) LogisticsManager.com. Retrieved April 1, 2010 from: http://www.logisticsmanager.com/Articles/12410/Beluga+Shipping+completes+first+Northeast-Passage+commercial.html

Bering Strait. (n.d.). World Atlas.com. Retrieved March 29, 2010 from: http://www.worldatlas.com/aatlas/infopage/bering.htm

Besta fáanlega tækni. (n.d.). Alcoa. Retrieved April 26, 2010 from: http://www.alcoa.com/iceland/ic/info_page/environment_greenhouse.asp

Big polluters: one massive container ship equals 50 million cars. (2009, April 23). gizmag. Retrieved April 17, 2010 from: http://www.gizmag.com/shipping-pollution/11526/

Cambridge University Press. (n.d.). *Impacts of a Warming Arctic*. Cambridge: Author.

Canada plans ships to assert Arctic sovereignty. (2007, June 9). Vancouver, British Columbia: Reuters. Retrieved April 2, 2010 from: http://www.reuters.com/article/idUSN0929956620070709

Chang, Ho Yang (n.d). *The impact of bigger vessels on shipping & ports*. Shipping, Logistics and Port Research Center, Korea Maritime Institute. Retrieved from: http://www.kmi.re.kr/english/data/publication/k2004_02.pdf

Container port throughput in a global comparison. (n.d.). Port of Hamburg. Retrieved April 15, 2010 from: http://www.hafen-hamburg.de/en/content/container-port-throughput-global-comparison

Emma Maersk – The Secret Story of Building the World's Largest Container Ship » The Emma Maersk. (n.d.). gCaptain. Retrieved 2010, April 18 from: http://gcaptain.com/maritime/blog/emma-maersk-from-shipyard-fire-to-world-records/the-emma-maersk-6/

Global Outlook for Ice and Snow. (n.d.). United Nations Environment Programme. Retrieved 2010, April 5 from: http://www.unep.org/geo/geo_ice/graphics.asp

Greenland. (n.d.). citypopulation. Retrieved April 6, 2010 from: http://www.citypopulation.de/Greenland.html

Historical Journey. (n.d.). Port of Tanjung Pelepas. Retrieved April 26, 2010 from: http://www.ptp.com.my/history-2006.html

Iceland Honors Bechtel for Environmental Excellence. (2007, April 27). Bechtel. Retrieved April 5, 2010 from: http://www.bechtel.com/2007-04-27.html

Johnston, Douglas. M. (2002). The Northwest Passage Revisited. *Ocean Development & International Law* (33), 145-164.

Leung, Calvin (2006, February 27). Arctic Dream. *Canadian Business*, 79 (5). Retrieved December 12, 2009 from Business Source Premier Database: http://www.ebscohost.com

Northern Sea Route. (n.d.) Wikipedia. Retrieved 29.3.2010 from: http://en.wikipedia.org/wiki/Northern_Sea_Route

Northwest Passage gets political name change. (2006, September 4). Canada.com. Retrieved April 2, 2010 from: http://www.canada.com/edmontonjournal/news/story.html?id=6d4815ac-4fdb-4cf3-a8a6-4225a8bd08df

Office of Naval Research, Naval Ice Center, Oceanographer of the Navy, and the Arctic Research Commission (2001, April 17-18). Naval Operations in an Ice-free Arctic. Author.

Ostreng, Willy (2002). Looking ahead to the northern sea route. *Scandinavian Review*, Retrieved April 2, 2010 from: http://findarticles.com/p/articles/mi_qa3760/is_200210/ai_n9130313/

Ólafur Egilsson (n.d.). *Olíuhreinsunarstöð á Vestfjörðum*. Reykjavík: Íslenskur hátækniiðnaður ehf. Retrieved from Fjórðungssamband Vestfirðinga: http://www.fjordungssamband.is/fv/upload/files/malthing_um_storidnad/hafsteinnhelgason.pdf

Panama Canal Authority sees revenue growth in 2008. (2008, February 19). Reuters. Retrieved April 27, 2010 from: http://www.reuters.com/article/idUSN1929376720080220

Panamax (n.d.) Wikipedia. Retrieved March 29, 2010 from: http://en.wikipedia.org/wiki/Panamax

Potential future transportation infrastructure in South East Asia. (n.d.). GISdevelopment.net . Retrieved March 29, 2010 from: http://www.gisdevelopment.net/application/utility/transport/ma05150pf.htm

Proposal for the Expansion of the Panama Canal - Third Set of Locks Project. (2006, April 24). Panama Canal Authority. Retrieved April 3, 2010 from: http://www.pancanal.com/eng/plan/documentos/propuesta/acp-expansion-proposal.pdf

Ragner, Claes Lykke (2008). Den norra sjövägen. *Föreningen Nordens Årbok 2008*, 114-127.

Ragner, Claes Lykke (2000). *Northern Sea Route Cargo Flows and Infrastructure - Present State and Future Potential*. Lysaker, Norway: The Fridtjof Nansen Institute.

Ráðstefna um aðkomu að bráðamengun (n.d). *Viðbrögð við bráðum mengunaróhöppum. Löggjöf og skipulag*. Retrieved from: http://www.ust.is/media/fraedsluefni/bradamengunarvidbunadur_grein.pdf

Ship and Ocean Foundation (2001). *The Northern Sea Route: The shortest sea route linking East Asia and Europe* (ISBN 4-88404-027-9). Tokyo: Author

Smelter Information. (n.d.). Alcoa. Retrieved April 26, 2010 from: http://www.alcoa.com/locations/iceland_reydarfjordur/en/home.asp

Sixteen Things Canada Is Good At. (2009, February 16). Esquire. Retrieved 2010, April 10 from: http://www.esquire.com/features/facts-about-canada-0309

Southeast Asia - A new era in Asian shipping. (2000, September 2). Asia Times. Retrieved April 25, 2010 from: http://www.atimes.com/se-asia/BI02Ae02.html

STX reveals design for world's largest containership. (2008, May 29). SeatradeAsiaOnline. Retrieved April 15, 2010 from: http://www.seatradeasia-online.com/News/2668.html

Suez Canal Future Plans. (n.d.). Suez Canal Authority. Retrieved April 3, 2010 from: http://www.suezcanal.gov.eg/sc.aspx?show=6

Suez Canal revenue drops. (2009, March 23). The Straits Times. Retrieved April 27, 2010 from: http://www.straitstimes.com/Breaking%2BNews/World/Story/STIStory_353615.html

Successful transit of Northeast Passage. (2009 December 1). Beluga Group. Retrieved April 9, 2010 from: http://www.beluga-group.com/en/press/press-review/browse/1/?cHash=18d725bb722fbcd3988ab9f43ba6ffb1#Press-Pressreview-Pressreview

This is the Canal. (n.d.). Panama Canal Authority. Retrieved April 4, 2010 from: http://www.acp.gob.pa/eng/general/asi-es-el-canal.html

United Nations Convention on the Law of the Sea (1982, December 10). Retrieved March 30, 2010 from: http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm

Utanríkisráðuneytið (2005). Fyrir Stafni Haf - Tækifæri Tengd Siglingum á Norðurslóðum. Reykjavík: Author.

Varnir gegn mengun sjávar. (2004, September 28). Umhverifsstofnun. Retrieved April 1, 2010 from: http://www.ust.is/Mengunarvarnir/Mengunhafsogstranda/varnirgegnmengunsjavar/

Verny, Jérome. (2009). Container Shipping on the Northern Sea Route. *Transport for a Global Economy.* Leipzig: International Transport Forum.

Vitus Bering Biography. (n.d.). biographybase. Retrieved March 29, 2010 from: http://www.biographybase.com/biography/Bering_Vitus.html

World's largest Container Ship launched. (2006, June 10). gizmag. Retrieved April 4, 2010 from: http://www.gizmag.com/go/5853/

Young, Oran R (1986). The Age of the Arctic. Foreign Policy (61), pp. 160-179 Published by: Washingtonpost.Newsweek Interactive, LLC Retrieved December 29, 2009 from Jstor Database: http://www.jstor.org/stable/1148707