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Marcus Matthias Keupp *Editor*

The Northern Sea Route

A Comprehensive Analysis

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Contents

The Northern Sea Route: Introduction and Overview

Marcus Matthias Keupp

> *The* Vega *steamed into the harbour of Stockholm on April 24, 1880. The entire city was illuminated. Buildings near the water-front were lit up by countless lamps and torches. On the Royal Palace, a star, Vega, shone forth in bright gas-flames; and amid this sea of lights, the famous ship came gliding into the harbour. (…) From the quays, streets, windows, and roofs, enthusiastic cheers roared like thunder. And I thought, 'I, too, would like to return home that way.'*
> (Hedin, 1926: 16).

Not too long ago, Sven Hedin's euphoria about the return of the *Vega*, Adolf Erik Nordenskiöld's vessel by which this seafarer had just completed the first motorized passage[1] through the Northern Sea Route (NSR), was replicated in our time. Since the beginning of the 20th century, principal commercial maritime routes had changed very little (Verny and Grigentin, 2009). This status quo was challenged when, in 2007, the M/V *Beluga Transit* and the M/V *Beluga Fraternity* each completed the first modern passage of a container ship through the NSR. Following the passage of these two vessels, many scholars and practitioners predicted that the NSR was soon to become a viable alternative to the conventional route via the Suez Canal, not the least because it significantly reduced the sea distance between these two regions. Simultaneously, reports about an accelerating ice melt in the Arctic, Russia significantly increasing her military expenditure, and research predicting significant untapped hydrocarbon resources in the Arctic led many commentators to believe that armed conflict and 'resource wars' in the Arctic would be imminent. Highly emotional scholarly discussions ensued, which focused on the Arctic in general, particularly its political framework, its economic potential, and the purported likelihood of armed conflict. Exhibit 1 provides the reader with a topographic and bathymetric overview of the Arctic region, with its ecological boundary in red as defined by the Conservation of Arctic Flora and Fauna (CAFF) working group of the Arctic Council.[2]

By the beginning of 2015, the tone of the discussions about the Arctic and its future development had become much more sober, since neither the euphoric predictions about the development of the extractive industry nor the dire predictions about the development of the Arctic in general have materialized, and the latest publications now have a much more sober and pragmatic tone (e.g., Buixadé Farré et al., 2014).

1 However, Vitus Bering and Russian seafarers had explored many of the sectors and associated coastlines of the NSR, most notably in east Siberia.

2 While other generally accepted measures to delimit the Arctic region exist (e.g., the 10° Celsius isothermal line, or any areas to the north of the 66°33´ parallel), this definition goes beyond mere political or geographical references and also considers the environment and the indigenous population; further, it is multilaterally accepted by the members of the Arctic Council.

M. M. Keupp (ed.), *The Northern Sea Route,*
DOI 10.1007/978-3-658-04081-9_1,

Exhibit 1: Arctic topography and bathymetry (Ahlenius, 2012)

At the same time, the specific analysis of the NSR has been relatively neglected vis-à-vis discussions about the Arctic in general and the political relations of the five Arctic littoral states as a whole. Moreover, although many important regulatory changes regarding shipping in the NSR have taken effect recently, and although climate change in the Arctic is accelerating and transit bulk and container traffic has grown, the NSR has received little scholarly attention over the last ten years. To date, specific research about the NSR, as opposed to publications on the Arctic environment in general, has been sparse ever since Armstrong (1952) delivered the first detailed account of both the early history of the NSR and its navigational challenges, infrastructure, and traffic statistics. Since at least 1964, Armstrong has published a series of short annual reports on the NSR in the journal *Polar Record*, all termed 'The Northern Sea Route,' and labeled with the respective year. This series of reports was continued by Brigham in the 1990s; however, the tradition of these annual updates ceased in 2001. Since 2012, the *Arctic Yearbook*[3] provides the public annually with both scholarly thought and comments about the development of the Arctic in general. However, with the exception of Humpert's brief research note in its 2013 issue, no dedicated analyses about the NSR have been published in its issues up to 2014. From 1993 to 1999, specific research on the NSR was conducted by the International Northern Sea Route Programme (INSROP) (see Brubaker and Ragner, 2010 and Østreng, 2006, for a discussion of the results). In 2000, a collection of conference papers presenting scholarly and management thought on the NSR was presented by Ragner (2000). Since then, few contributions have provided contemporary analysis, although the NSR situation has developed significantly ever since, with the exception of Østreng et al. (2013) whose comprehensive work on Arctic shipping explains the key facts about the NSR and integrates findings from earlier research. Still, few analyses of the general framework of the NSR (as opposed to that of the Arctic) are available, covering either domestic and international law and regulations (Bunik and Mikhaylichenko, 2013; Solski, 2014; Stepanov et al., 2003; Timchenko, 2001) or specific geostrategic analysis (Blunden, 2012; Luzin, 2007).

Renewed scholarly interest in the NSR starting in approximately 2005, probably as a result of the continued warming of the Arctic, peaked in the years from 2008 to 2011, mirroring the period of both euphoria and fear discussed at the beginning of this chapter. While interest in the NSR has declined since, three major lines of NSR research have emerged. The first of these is primarily interested in climatological change with respect to the NSR including ensuing environmental and social consequences (Khon et al., 2010; Meschtyb et al., 2005; Matishov, 2007). The second line focuses on estimating the commercial potential of the NSR for container, bulk, and liquid cargo (Buixadé Farré et al., 2014; Furuichi and Otsuka, 2014; Ho, 2011; Lasserre and Pelletier, 2011; Liu and Kronbak, 2010; Schøyen and Bråthen, 2011; Verny and Grigentin, 2009; Xu et al., 2011). Finally, the third line is interested in sea ice prediction, satellite coverage, and navigation in the NSR, all with a firm goal of developing implications for ship construction, ice classification, and navigational aids (Erikstad and Ehlers, 2012; Johannessen et al., 2007; Stephenson et al., 2014).

3 See http://www.arcticyearbook.com

The purpose of this book is to connect these research streams from an interdisciplinary and multilevel perspective, with the aim of reviving scholarly analysis of the NSR. Given relatively little guidance from prior literature, the book has a firmly pioneering, exploratory and contemporary character. Integrating thought from politics, economics, international law, maritime logistics, and navigation, the book combines scholarly analysis and business practice to not only contribute to academic discussion but also to provide empirical, real-world evidence about the potentials, challenges, and opportunities the NSR encompasses. Finally, the book aims to place the NSR in its Arctic context by analyzing how and why political and economic issues in the political agendas of the Arctic littoral states, as well as the developments of the shipping and extractive industries are likely to influence the future development of the NSR.

As a result of this approach, this book addresses multiple audiences. Staff officers and military analysts may benefit from the geostrategic analysis of the general framework of the NSR and of the security implications of disputed sovereignty and rights of economic utilization in the Arctic. Legal experts and diplomats at international institutions are likely to be interested both in the discussions of international maritime law featured in this book as well as in the many analyses that highlight discrepancies between the *de jure* and *de facto* situation as far as the NSR is concerned. Navigators, line operators, and shipowners will obtain insights into many areas relevant for shipping in the NSR, particularly the navigational challenges and regulatory issues, and they will see differentiated perspectives on the 'business case NSR'. Finally, scientific and academic discourse will hopefully find fruitful ground for debate as a result of the—sometimes provocative and counterintuitive—analyses and conclusions in this book and will be able to produce further research that extends and deepens the findings featured in this book.

Lamentably, academic books tend to be rather verbose and voluminous. By contrast, this book is an attempt to provide both a comprehensive *and* a concise analysis by focusing on the NSR alone. The Arctic as such is discussed only insofar as implications for the likely future development of the NSR are to be elaborated, or if such discussions are indispensable for the understanding of the NSR. As a result, the book is meant to constitute a highly specialized, lean, yet meaty piece of work, and the reader is invited to judge the extent to which it lives up to this promise. Further, given the past emotional discussions about the Arctic, in all of the chapters this book subscribes to the motto *sine ira et studio* and thus strives to maintain a firmly neutral and balanced perspective at all times, particularly because it is published at a time of renewed East-West tensions.

Any discussion of the NSR must necessarily begin with the definition of what the term 'Northern Sea Route' is supposed to mean, or more precisely, how the area it encompasses should be delimited, both conceptually and geographically. This task is anything but trivial since the term is fuzzy, no generally accepted delimitation exists, and there is in fact more than one sea route that can be navigated (cf. Exhibit 2). This point is very important, since most maps show the NSR as passing through the Kara gate in the Pechora Sea. However, due to the extremely shallow waters in this area most vessels have to take the more northerly route around Cape Zhelaniya.

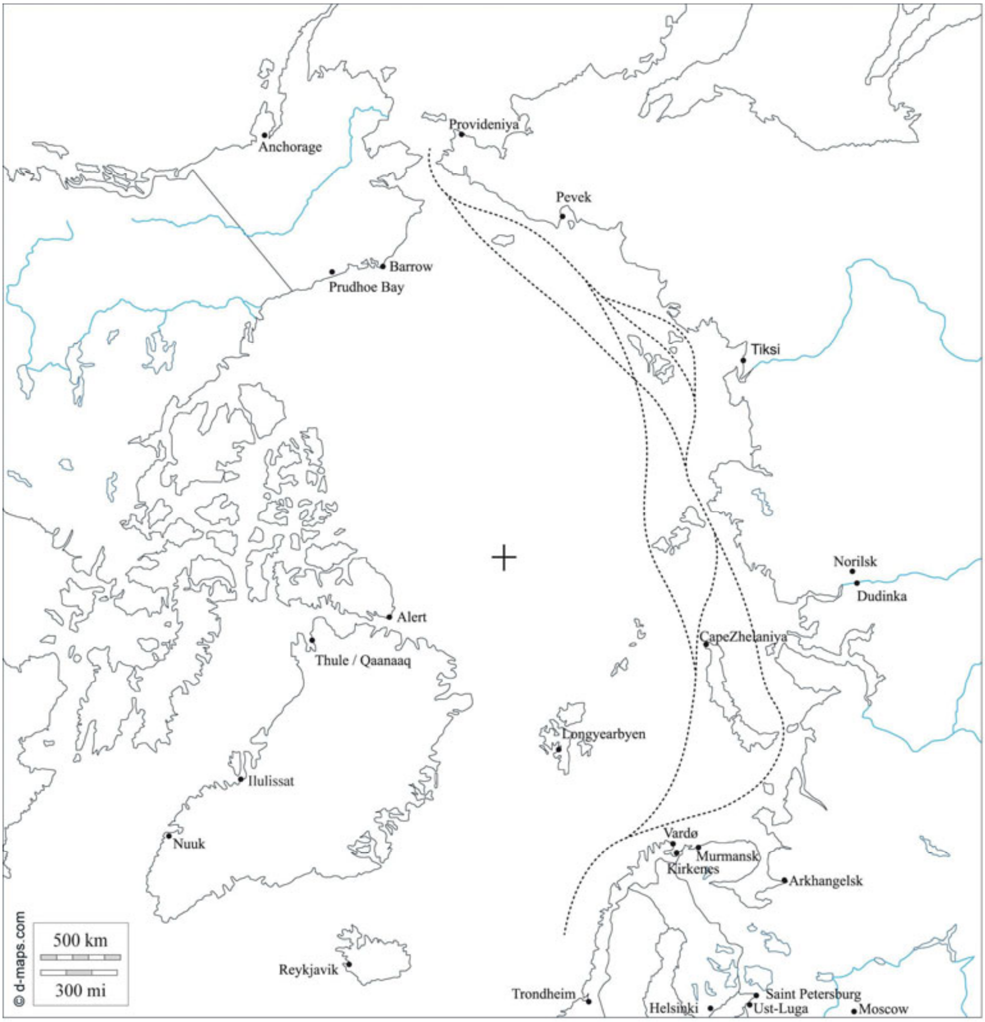

Exhibit 2: Alternative navigable routes (author's creation, *d-maps.com (2015)*)

The same situation applies to the different options of navigating through the New Siberian Islands—shallow waters may force the navigator to use alternative routes. Thus, the navigational situation corresponds more to a set of route options than a single route. In general, the term *Northern Sea Route* refers to a specific subsection of the even fuzzier term *North-East Passage*. Timchenko (2001) defines the NSR as the area from Northwestern Russia to the Bering Strait; however, to date no universally accepted entry and exit points for the term *Northern Sea* have been agreed on in scholarly discussion.

While the Northern Sea Route Administration does provide specific entry (Kara gate / Cape Zhelaniya) and exit points (Cape Dezhnev), this definition is problematic for two reasons. Vessels appearing at any of the two entry points have a history; with the exception of intra-Russian supply traffic their voyage originates either from any of the ports of Northern Europe or from those of Northern Asia. A conceptual definition of the NSR should therefore consider that traffic passing the NSR originates elsewhere. Second, at least as far as container shipping and international bulk transport is concerned, and again with the exception of intra-Russian supply traffic, passage through the NSR constitutes *transit* traffic that must pass the Bering Strait to deliver its cargo. For the purpose of this book, we therefore employ a pragmatic definition: *'Northern Sea Route' is an umbrella term that encompasses a variety of bidirectional navigable routes in the Arctic Ocean that connect the Russian-Norwegian sea border in the Barents Sea to the Bering Strait.*

Overview

The first part of the book starts out with the analysis of the general framework of the NSR, both regarding geostrategic issues as well as international maritime law.

Keupp presents an analysis of how the security, economic, and political interests of the Arctic littoral states are likely to shape the future of the NSR. Highlighting the discrepancies between past alarmist media coverage and the actual tranquility of the region, he comments on each state's military capabilities and the security developments of the last years, emphasizing the *de facto* power of Russia's Northern Fleet and the pragmatic regionalist governance based on bilateral accords between the states. His analysis of disputes about sovereignty and rights of economic utilization in the Arctic suggests that both present and purported future conflicts have been much overstated, and that, notwithstanding the many military installations in the High North and the naval capability of Russia's Northern Fleet, the Arctic to date can be considered a role model for a multilateral interest in peace and stability. He then continues to interpret the implications of these findings for the current and likely future general framework of the NSR.

Kastner provides a detailed yet comprehensive analysis of the international legal situation the NSR is embedded in, commenting on both Soviet and Russian practice, international maritime law, and contemporary jurisdiction. He provides the reader with an in-depth introduction to the United Nations Convention on the Law of the Seas (UNCLOS), considered by all Arctic littoral states to be the central legal basis for bilateral and multilateral relations in the Arctic, and highlights the role of the 'Canadian Clause' (Art. 234 UNCLOS) as the cornerstone of Russia's *Regulations* for shipping in the NSR. He also provides an in-depth legal analysis of the disputed status of some of the key straits of the NSR, emphasizing the difference between the right of innocent passage and the right of transit passage. He concludes that, while UNCLOS is a reliable yet very basic framework, in the future a truly multilateral approach to strengthen the international legal framework of the NSR might be required, particularly if shipping via the NSR should continue to grow.

When read together, the analyses by *Keupp* and *Kastner* pinpoint an important gap in international law. Whereas the Arctic is an ocean surrounded by continents and governed by bilateral and multilateral accords between powerful states, the Antarctic is a continent surrounded by oceans and governed by the 1959 Antarctic Treaty. Although from an international governance or environmental perspective, an Arctic equivalent to this treaty would be desirable, in the short term it seems unlikely due to the strong security and economic interests of the Arctic littoral states in the region. In stark contrast to the Antarctic, the Arctic is an area of significant economic importance; it has over four million inhabitants and an annual economy of roughly US$ 230 billion (World Economic Forum Global Agenda Council on the Arctic, 2014). Both Russia and Canada have defined the Arctic as a significant part of their national identities, and the tone of the 2008 Ilulissat declaration can be interpreted as a preference for regionalist policy. The upcoming negotiations for the delimitation of exclusive economic zones in the polar region that *Keupp* explains will likely become an important stress test for the reliability of international relations in the Arctic. Unless an international legal accord for the NSR can be produced, its *de facto* regulation will be dominated by Russian policy.

On the basis of these discussions and explanations, the second part of the book is thoroughly concerned with the regulatory, operative and navigational challenges of shipping in the NSR that charterers, shipowners, navigators, and line operators are likely to experience. *Keupp and Schöb* send off the M/V *Mærsk Mc-Kinney Møller*, one of the world's largest container vessels, on a hypothetical voyage through the NSR, tracking her passage and analyzing the challenges she would face during her voyage, comparing and contrasting her voyage with the standard trip through the Suez Canal. Further, they provide a detailed commentary about Russia's icebreaker capability, pointing out Russia's *de facto* power over the NSR, both navigationally and regarding domestic regulation, drawing on direct conversations with *Rosatomflot* managers. They conclude that for shipowners, the NSR constitutes a complex trade-off decision with many decision variables involved. They argue that the advantage of a shorter distance between Europe and Asia can easily be offset by operative, insurance, and regulatory costs. However, they also point to unconventional opportunities when they discuss the potential of the NSR for slow steaming or as a 'speedy return route' for empty containers. Finally, their analysis of 18 loops between East Asia and Northern Europe operated by Maersk Line, CMA-CGM, and MSC suggests that the role of intermediary ports along the route from Europe to Asia might have been overstated in past discussions.

Few scholars who write about the NSR have actually taken the trip themselves. The reader should therefore benefit from *Svahn's* intriguing and lively report of a voyage through the NSR onboard the ice-classed tanker *Stena Polaris*. He documents in detail, navigational challenges, regulatory procedures, and icebreaker support. Although his report certainly captures the special light and the ruggedly picturesque beauty of the High North, it encompasses far more than a modern adventure tale. The mishaps the crew experience during their voyage, right from the first day of boarding the ship in northern Norway, point to the many contingencies and operational obstacles that have fraught the NSR business case with considerable uncertainty. The schedule is delayed when the vessel has to throw

anchor in the Laptev Sea and wait for two days for icebreaker assistance. Further, the loneliness and isolation the crew experiences the further the voyage goes, coupled with the breakdown of internet communication, all point poignantly to the lack of infrastructure, maritime support, and satellite coverage in the eastern sectors of the NSR.
Given that modern liner operations rely on tightly planned schedules, real-time surveillance, navigational aids, and support infrastructure, these shortcomings present significant insurance and operative risks.

These two chapters are presented at a time when the International Maritime Organization has almost completed the development of its novel *Polar Code*, a comprehensive regulatory framework for navigation both in Arctic and Antarctic waters. It regulates both ship construction, particularly ice classification, search and rescue measures, and environmental protection. It is expected to come into force by 2017. The code significantly strengthens environmental protection, banning garbage dumping and oily discharge in polar waters. The latter points were strongly opposed by Russia (Thomson, 2014), and to date it is unclear how, or if at all, Russia will attempt to reconcile regulatory differences between (domestic) regulation set forth by the Northern Sea Route Administration and (international) regulation as defined by the Polar Code. Since today the *de facto* regulatory power of the NSR is in Russian hands alone, future regulatory conflict might be on the horizon.

Finally, the third part of the book is concerned with the analysis of the commercial potential of the NSR, both regarding liner operations (i.e., container cargo), bulk and liquid cargo, and shipping triggered by the extractive industry in the Russian Arctic.

Based on original estimates calculated in his dissertation, *Leypoldt* presents the results of a complex prognosis model by which he estimates the ‘capacity potential’ of the NSR by the year 2050, i.e., the extent to which the predicted transport volume between Europe and Asia is eligible for shipping via the NSR. Stratifying his analysis by trade partners and cargo types, he finds that while current operative issues limit the attractiveness of the NSR as an alternative route compared to existing trade lanes, the situation is likely to change from 2030 onward. Finally, he provides the reader with an updated assessment, from a 2015 viewpoint, in which he confirms the general direction of his original estimates. Further, he also highlights the development of the general framework as one of the central variables that will influence the extent to which the predicted capacity potential is likely to materialize. All in all, *Leypoldt* shows that the theoretical shipping potential of the NSR is enormous, but he also points to the many contingencies that will influence the extent to which this potential will really be shipped via the NSR, and highlights that climate change alone does not yet make a profitable business case.

Mietzner, by contrast, focuses exclusively on estimating the extent to which liner operations (i.e., the shipping of containerized cargo) through the NSR could be profitable. First, he provides the reader with a comprehensive introduction into the financing, construction, and chartering of container vessels, highlighting the central aspect of economies of scale in contemporary container vessel construction. Then, proposing a self-developed computational model, he estimates slot cost (i.e., costs per homogenous TEU capacity) as a joint function of travel speed and charter rates for a range of relations between the ports of Northern Europe and those of Northeast Asia. His model highlights the ambiguous role of travel speed, since a curvilinear relationship between charter rates and speed is obtained. The most intriguing part of *Mietzner's* contribution, however, is the connection he makes between profitability and ship design. Comparing extant specifications of a 14,000 TEU container vessel with several smaller, but less fuel-intensive hypothetical vessel types, he finds that a particular container vessel construction may operate profitably on the NSR as long as Asian ports to the north of Shanghai are considered. While he concludes that any ice-classed vessel with conventional engines would have to have a capacity of at least 8,800 TEU to compete with ships traveling via the Suez Canal, he points to opportunities to lower slot costs further by considering novel propulsion technologies such as liquid natural gas (LNG). However, he also points to important contingencies that may neutralize this potential, such as fees for icebreaker support, and the limited potential for capitalizing on economies of scale.

When the analyses of *Keupp and Schöb* and *Mietzner* are compared and contrasted, a joint conclusion is revealed. All the analyses suggest that the manifold navigational, regulatory, and operative peculiarities of the NSR make it highly unlikely that the business model of sending containerized cargo quickly south through the Suez Canal by very large container ships can be seamlessly copied and applied in Arctic waters. Unconventional thinking about business opportunities, novel ship and propulsion designs, and robust scheduling to manage delays would all be required to make container shipping via the NSR a commercial success. *Mietzner* highlights that, as the opportunities in the shipbuilding industry to capitalize further on economies of scale are approaching its physical boundaries, shipowners have begun to look for new business models. The time, therefore, may be right to begin to think unconventionally about the NSR, and such thinking should be thoroughly anchored in the argument that shorter distance is a necessary, but not a sufficient condition for profitable operations.

Given the significant mining and drilling activities in the Russian Arctic, an analysis of the commercial potential of the NSR should not only include containerized cargo, but also bulk and liquid cargo (most notably, oil, gas, and mineral ores). One might argue that demand for these commodities by the industrially strong, yet resource-depleted, states of northeast Asia, particularly China, Japan, and South Korea, may generate significant bulk and liquid cargo traffic by which these resources are directly shipped from the Russian Arctic to northeast Asia via the NSR. In the final chapter, *Keupp and Schöb* examine this argument by reviewing the current and likely future state of the extractive industry in the Russian Arctic, particularly its industrial and logistics infrastructure, and by differentiating liquid and bulk commodity traffic into an eastbound and a westbound component. Their surprising results suggest that eastbound exports of oil, gas, and minerals from the Russian Arctic to northeast Asia are almost non-extant and still very much the exception compared to westbound traffic heading for Murmansk, irrespective of oil price movements. Richly illustrating their results with maps, they trace this effect to the importance of the Murmansk area terminals for oil and gas exports, a firmly western orientation of the maritime logistics infrastructure, and the lack of investment required to develop oil and gas fields and transport infrastructure in eastern Siberia. Thus, their work confirms the skeptical assessment that the Arctic 'is not homogenous with regard to development potential; strong distinctions exist between onshore and offshore environments, and between different regions and countries with regard to existing levels of infrastructure, population, environmental sensitivity and accessibility' (World Economic Forum Global Agenda Council on the Arctic, 2014).

Conclusion: The threat of substitutability

This book concludes that the NSR is still a highly uncertain case fraught with many operative obstacles, some of which might be resolved by 2050 if the general framework is strengthened, but some of which remain. Numerous plans and projects for the intended development of the NSR and its maritime and supply infrastructure have been announced in the past, yet few of these have materialized until today. All in all, this book confirms the sober and skeptical tone of Buixadé Farré et al. (2014) concerning the future potential of the NSR, and that of the authors of the World Economic Forum Global Agenda Council on the Arctic (2014), who put the minuscule number of NSR transits (46 in 2012 and 71 in 2013) in perspective vis-à-vis the 17,749 and 17,225 vessel transits through the Suez Canal in 2012 and 2013, respectively.

In contrast, while global shipping might indeed not be revolutionized in the short to medium term, too much skepticism may blur the reader's view of the unconventional opportunities proposed throughout this book. Certainly, novel and innovative business models are required for shipping in the NSR. 'Combined shipping' loops that integrate NSR transits during the summer months with Suez Canal transits in winter have already been proposed (Furuichi and Otsuka, 2014). Shipowners are watching the development of the NSR closely but still hesitate to invest in the construction of novel vessel types. A report by the Intergovernmental Panel on Climate Change (2014) predicts 125 days of open water conditions per year by 2050. Should this prediction become reality, the NSR might see increased investment and traffic frequency. However, the feasibility of novel business models will be strongly influenced by questions pursuant to insurance law. To date, no universally accepted model exists by which the *Arctic premium*, i.e., excess insurance cost due to increased risks and associated expenses for hull damage, environmental pollution, and lack of search and rescue infrastructure, can be calculated in a relatively straightforward way. Further, the question of the extent to which (if any) war risk insurance, required for traveling in certain international waters around the Horn of Africa, and the Arctic premium will cancel each other out is highly uncertain and speculative. Today, there is only limited knowledge about the marine insurance aspects of Arctic shipping. As a result, the provision of insurance for Arctic shipping tends to be idiosyncratic, expensive, and frequently requiring self-insurance (Østreng et al., 2013).

While climate change in the Arctic is certainly dramatic by historical standards, one should not overestimate its impact on shipping and open water conditions. The Arctic is still an icy cold, dark, and inhospitable place. Even if the North Pole should be ice-free in the summer months of 2050, ice will always re-form in winter; further, climate change also implies thawing permafrost ground and thus, the destabilization of infrastructures and roads on land (World Economic Forum Global Agenda Council on the Arctic, 2014). Year-to-year ice coverage is highly erratic, and one can only truly speak of an 'ice melt' when the unit of analysis is in decades. For the decades to come, of all major international sea routes, the NSR will probably remain the hardest to navigate. Unless significant investments in transport and supply infrastructure in its eastern sectors are made to turn the NSR into a high-volume transit corridor, it will remain a primarily western-oriented local supply route for hydrocarbon resources mined in the Russian Arctic, stretching from Murmansk to Dudinka. Failing such investments, Russia's development goals for the NSR until 2020, particularly Sovcomflot's vision of a 'floating sea bridge' linking the high-potential off-shore fields of Russia to major international energy markets (Blunden, 2012), are unlikely to materialize.

The world, particularly efficient and fast-growing East Asia, is not waiting patiently until these investments are made. As of 2015, the NSR is facing a significant threat of substitution, logistically and technologically, such that further investment delays may quickly produce facts that make the NSR a relatively unfavorable option. Such substitutability is not limited to the direct pipeline transports from eastern Siberia to China that *Keupp and Schöb* briefly mention in their second chapter.

First, Verny and Grigentin (2009) highlighted that NSR and the Transsiberian Railway appear to be roughly equivalent second-tier alternatives to the Suez Canal route. Since December 9, 2014, a new intercontinental railway cargo line (the 'new silk road', as it was baptized by Chinese officials) exists. It directly links Yiwu (China) to Madrid (Spain) via Kazakhstan, Russia, Belarus, Poland, Germany and France. While it is roughly 4,000 km *longer* than the Transsiberian, it makes the journey in 21 days, i.e., faster than the average port-to-port transit via the NSR. Notwithstanding technological and bureaucratic costs of different railway systems along the route, this railway is operative on a year-round basis and passes moderate climate zones during the greatest part of the voyage. As interface problems between railway systems are resolved, travel time may decrease even further. A single train has capacity for about 100 TEU. Thus, while such railway lines are certainly no substitute for the large volumes (and low slot costs) of sea cargo sent via the Suez Canal, they might become a substitute for NSR traffic as long as the number of NSR transits stays low and the Arctic premium high, the shipping of containerized cargo is rather the exception than the norm, and significant investments are deferred as a result of political concerns.

Second, the LNG technology and logistics landscape is changing radically at the time this book is written. BP's *Global Energy Outlook 2035* predicts that by 2035, the majority of global LNG deliveries will no longer be done by pipelines, but rather by LNG tanker vessels, implying a total, and seaborne, globalization of the partially still regional and land-based LNG markets (BP, 2015). While these predicted developments seem advantageous for the NSR at first glance, in their second chapter *Keupp and Schöb* highlight that as of 2015, despite plans and announcements for the construction of a large facility (*Yamal LNG*), no LNG terminals exist in the Russian Arctic, and given Russia's momentary inability to access international financial markets, it is unclear when (or if at all) the *Yamal LNG* project will be completed. Further, LNG tankers delivering from this facility likely require ice-classification, which should, *ceteris paribus*, increase the price of Russian LNG vis-à-vis the world market price. This seems disadvantageous at a time when terminals in Australia, Qatar, the west coast of the USA and (in the near future) East Africa all offer cheaper alternatives available on a year-round basis. As a result, the more these global changes take effect, the more they are likely to draw growth potential for shipping away from the NSR and toward other regions of the world, such that the number of LNG shipments via the NSR will likely remain limited. Accordingly, the *Outlook* expects LNG exports from Russia to be significantly inferior to those of other nations (BP, 2015).

Finally, political concerns as a result of East-West tensions could attain a level where security concerns override breakeven calculations. To date, the NSR's general framework is still far from being complete or perfectly congruent with international law, and shipping seems to be highly sensitive to East-West tensions, although Russian officials are quick to deny any impact of the Ukraine crisis on NSR shipping statistics. It is a fact, however, that cargo transported via the NSR transit dropped 77% in 2014 on a year-over-year basis (Pettersen, 2014). The number of NSR transits decreased by over 25% in 2014 compared to the previous year. When transit statistics for the 2015 shipping season are published in early 2016, the reader will be able to assess whether this decrease was merely an outlier or the beginning of a downtrend. Russia's future policy may turn the tide in either direction.

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Arctic security, sovereignty, and rights of utilization: Implications for the Northern Sea Route

Marcus Matthias Keupp

Both Russia's *Arktika* submarine expedition of 2007, which planted a titanium Russian national flag on the seabed below the North Pole, as well as the prediction of significant hydrocarbon and mineral resources in the Arctic waters and continental shelves (United States Geological Survey, 2008) sparked a flood of alarmist analyses and sensationalist media coverage.[1] Brosnan et al. (2011) provide a detailed frequency analysis of this inundation. These perspectives predicted tension and armed conflict in the Arctic in the wake of significant regional rearmament, as well as a 'scramble' or 'gold rush' for resources based on the speculation that the United Nations Convention on the Law of the Sea (UNCLOS) could not be 'seamlessly applied.' Further, they predicted that mutual remilitarization measures could provoke misunderstandings and escalation, that a lack of international governance in the Arctic may prove problematic, and that both sovereignty conflicts concerning land and sea territories as well as disputes concerning rights of economic exploitation of particular maritime areas may violently escalate (Borgerson, 2008; Emmerson, 2010; Howard, 2009; Lee, 2009; Sale and Potapov, 2010; Zellen, 2009). For some time, these authors succeeded at marketing a purported causality between climate change and armed conflict, overshouting moderate voices such as Young (2009), Trenin and Baev (2010), or Strandsbjerg (2012), who pointed out that such fears were often overstated and Arctic governance was actually peaceful and constantly strengthening.

Surprisingly, for many, by 2015, none of these dire predictions had materialized. Instead, quite the contrary had happened: the Arctic Five[2] confirmed their will to peacefully settle disputes by scientific research, the application of international maritime law, and bilateral negotiation in the 2008 Illulissat Declaration. In the 2009 Tromsø Declaration, all signatories agreed that the rule of law should be the basis of regional development and international relations. The 2010 Russian–Norwegian accord that defined a maritime border in the Barents Sea proved that these declarations were in fact workable.[3] Search and rescue areas in the Arctic Ocean were defined and delimited in the 2011 Nuuk Declaration, which also emphasized the will to maintain peace, stability, and constructive cooperation. In the

1 The continental shelf is defined as the seabed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 nm from the baselines from which the breadth of the territorial sea is measured where the outer edge of the continental margin does not extend up to that distance (UNCLOS, Article 76).

2 For the sake of brevity, in the following, the five Arctic littoral states—the USA, Canada, Denmark (by her sovereignty over Greenland), Norway, and Russia—are combined under this umbrella term.

3 The Gray Zone agreement of 1978 had distributed fishing rights in the Barents Sea, but failed to define a maritime border.

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wake of these developments, very few pessimists had the humility to admit their predictions were wrong—Borgerson (2013) is a noteworthy exception. Against this backdrop, this chapter reviews the contemporary state of military capabilities, disputed sovereignty, and rights of economic utilization in the Arctic and applies this review to the case of the Northern Sea Route (NSR), with the goal of predicting the likely future development of its general security and policy framework.

Military capabilities and conflict potential in the Arctic

Few would doubt that Russia—with her Northern Fleet and the naval infantry, air force, coast guard, and patrol vessels that support it—is by far the most forceful naval power in the Arctic (The Military Balance, 2014; Wezeman, 2012; Brosnan et al., 2011, Hilde, 2014; Conley et al., 2012). Besides the headquarters at Severomorsk, the Northern Fleet has four other large naval bases in the High North, each of which consists of multiple bays, facilities, ports, and installations (Gadzhievo, Zapadnaya Litsa, Vidyayevo, and Gremikha). Current media coverage suggests that a much smaller naval base may be under construction on Wrangel Island (Nilsen, 2014b). Norway also has a number of larger naval bases in its northern regions (at Haakonsvern, Ramsund, and Sortland). By comparison, Canada, the USA, and Denmark, combined have few naval bases in the Arctic. Further, among the Arctic Five, Russia has by far the strongest icebreaking capability, both by the number and the power of her icebreakers (Glukhareva, 2011; Keupp and Schöb, 2015—this book), allowing her combat vessels to operate in ice-infested waters with an ice thickness of up to two meters if they travel in an icebreaker canal. Given that even military vessels can suffer ice-related damage if they have thin hulls (Åtland, 2011), this effect is not to be underestimated. Further, Russia's nuclear icebreakers have to be refueled only once in four years; thus, their radius of operation is almost unlimited.[4] While the U.S. military today has few surface vessels capable of operating in the Arctic, it has significant Arctic undersea capabilities and is able to operate nuclear submarines in the Arctic Ocean and in near-Arctic seas, in open water as well as under the Arctic ice cover (Åtland, 2014). As of 2014, the USA is the only nation able to match the Russian submarine fleet (The Military Balance, 2014). Both nations operate nuclear and conventional submarines in polar waters today and have done so throughout the Cold War.

The case is more nuanced when air and surveillance capabilities are considered. The USA has a significant number of well-equipped air force bases in the High North (Eielson, Fort Clear, Fort Greely, Fort Wainwright, joint base Elmendorf-Richardson, Qaanaaq (Thule) in Greenland). While Canada's combat aircraft are stationed in south-east and central Canada, they are regularly deployed in the Arctic region and can operate from four secondary air bases in northern Canada (Wezeman, 2012). Further, Canada and the USA have

4 All nuclear and some of the conventional icebreakers were part of the Northern Fleet during the Soviet era, but are now civilian vessels held by state-controlled firms. See Keupp and Schöb (2015—this book) for technical and operative details of the nuclear icebreakers; today, these are in charge of accompanying vessels transits through the NSR.

installed sophisticated satellite surveillance and early warning systems in the High North (Polar Epsilon, Ballistic Missile Early Warning System). Russia has many airfields and airbases north of the 60th parallel, some of which have reopened in the past five years (Alykel, Besovets, Khatanga, Kogalym, Kotelny Island, Mirny, Severomorsk (Murmansk), Olenya (Olenegorsk), Raduzhny, Salekhard, Surgut, Syktyvkar, Tiksi, Dresba airbase at Pevek, Petrozavodsk, Ugolny, Yakutsk). However, it is questionable how many of these are fully operational from a military point of view. Russia resumed long-range bomber and patrol flights only from 2007 onward, after many airfields and bases had been dormant for over a decade or even closed due to a lack of funding in the post-Soviet era. *If* all of these bases were fully operational for military purposes, Russia would probably match the air capabilities of its Arctic neighbors. It is important to note that the extreme climate in the Arctic may restrict the use of aircraft, submarines, and vessels not configured for such an environment. For example, the Canadian Forces' diesel submarines cannot function in Arctic waters, and the range of F-16 and F-35 fighter aircraft (Norway and Canada are planning to purchase the latter) may be limited by a lack of tanker aircraft support in the Arctic regions (Wezeman, 2012). Thus, long-range aircraft will probably be at the core of any air capability in the Arctic.

Both from a strategic and a logistics perspective, the hostile environment of the Arctic discourages far-reaching infantry and mechanized operations. Therefore, compared to air and sea capabilities, land capabilities have only limited significance. While Canada maintains a troop of 5,000 rangers in its Arctic territories—dubbed 'invasion force' in 2009 by some colorful Russian rhetoric—these cannot be considered regular military personnel. General Walter Natynczyk's statement, 'If someone were to invade the Canadian Arctic, my first task would be to rescue them' still seems to be valid six years later (Åtland, 2014).

Relying on reports in the public press about planned military expenditures, some authors (e.g., Huebert et al., 2012) have suggested a correlation between the resumption of Russian long-range bomber and patrol flights from 2007 onward and military maneuvers in the Arctic[5] in the following years, concluding that a remilitarization of the Arctic was underway, particularly because some of these flights allegedly[6] violated the airspace of other nations. Consequently, such perspectives predicted 'a resumption of the 'old' Cold War hostilities' (Huebert, 2013). While it is certainly not impossible that Russia aimed to test the air defense readiness condition of her Arctic neighbors, this conclusion ignores two important aspects.

First, *each* of the Arctic Five has a long history of military operations and exercises in the Arctic. As Dittman (2008) points out, Russian and U.S.-American submarines operated in Arctic waters and below the North Pole as early as 1960, and the Canadian Force spent thousands of flying hours in the Arctic archipelago in the 1970s and held frequent exercises

5 Most notably, Canada's *Operation Nanook* in 2009, the U.S. military exercise *Northern Edge* in 2008, and the U.S. polar submarine ice expedition of 2009, the Norwegian exercise *Cold Response* (with other NATO members) in March 2009, and Russian naval exercises involving submarines and military vessels in autumn 2009.

6 It is difficult to ascertain whether 'airspace violations' reported in the public press actually qualify as such since flight movements are politically exploited by all sides. Evidence presented in Åtland (2014a: 155, endnote 67) suggests that particular Russian flights conducted in February 2009 had not violated Canadian airspace though Canadian politicians claimed that they had.

between 1950 and 1970, which trained those forces in winter warfare. The NATO exercise *Cold Response* was first conducted in 2006 (i.e., before the resumption of Russian long-range bomber and patrol flights). The exercise has been repeated in 2010 and 2012. Canada's *Operation Nanook* has been conducted every year since 2007. U.S. submarine deployments to Arctic waters did not cease after the collapse of the Soviet Union (Huebert et al., 2012), while the Russian military activity significantly decreased due to a lack of funding for operations and maintenance. In other words, the Arctic is not *re*militarized now because it was never *de*militarized. What the world has witnessed since 2007 is the *re-activation* of hitherto dormant or decommissioned Russian military bases and materiel, financed by revenues from increased global sales of hydrocarbon resources. Thus, these developments constitute rather a return to the status quo ante than a new round of militarization.

Second, the extent to which announced investments in military capabilities are realized (if at all) is doubtful due to budget constraints and changing political agendas, irrespective of the announcing nation. Further, many of these announcements—particularly those originating from Russia and Canada—exhibit assertive rhetorics intended for a domestic audience and are often more related to prestige policy than *realpolitik*. Thus, they should not be taken at face value, particularly so when they are reproduced by mass media and the public press in other countries (Baev, 2010; Trenin and Baev, 2010; Konyshev and Sergonin 2012; Strandsbjerg, 2012; Wang, 2013; Zysk, 2009; Åtland, 2014). As Wezeman (2012) aptly puts it,

> 'While some media, politicians and researchers have portrayed the changes in the capabilities of the Arctic littoral states as significant military build- ups and potential threats to security, the overall picture is one of limited modernization and increases or changes in equipment, force levels, and force structure. Some of these changes—for example, the strengthening of the Canadian Rangers, the move of the main Norwegian land units to the north of Norway or the new Russian Arctic units—have little or nothing to do with power projection into the areas of the Arctic with unclear ownership; rather they are for the patrolling and protecting of recognized national territories.'

Each of the Arctic Five has produced a foreign policy strategy or statement by now that documents their respective security and economic interests in the Arctic as well as their policy for the foreseeable future.[7] While those of Russia, the USA, and Canada have a more assertive and security-oriented tone compared to those of Denmark and Norway, all five highlight the importance of protecting their sovereignty, their economic interests, and the Arctic environment. Political differences notwithstanding, military installations and materiel are described as *defensive* and primarily serve to dissuade others from challenging economic interests. For Russia, this strategy represents a significant change, since her Northern Fleet was defined as an ocean-going force during Soviet times, but now is commissioned to protect Russia's borders. All five strategies highlight their preference for regional cooperation and normal diplomatic and economic relations. If one is to believe what Russia's Secu-

7 Canada: *Statement on Canada's Arctic Foreign Policy* (2010), Denmark: *Kingdom of Denmark Strategy for the Arctic 2011-2020* (2011), Norway: *High North Strategy* (2006), Russia: *Basics of state policy of the Russian Federation in the Arctic for the time up to 2020 and beyond* (2008), USA: *National Strategy for the Arctic Region* (2013). For detailed comparisons of these strategy documents, see Wang (2013) and Åtland (2014a).

rity Council defines for its strategy in the Arctic up to 2020 and beyond, the strategic goal is not military confrontation, but the transformation of Russia's share of the Arctic into a strategic resource base, based on scientific research and compliance with international law. The document expressly states that such long-term economic development goals are not only impossible to achieve with military means, but on the contrary, they require peace, stability, and international cooperation (Security Council of the Russian Federation, 2008).

Finally, the installation of military and intelligence infrastructure is not necessarily equal to an act of aggression or a signal of increased tension in international relations, but may simply constitute an act of delimiting spheres of sovereignty and protecting economic interests (Trenin and Baev, 2010; Wang, 2013). As U.S. Admiral James Stavridis put it, 'not all military capabilities are designed for force' (Stavridis, 2010). Nevertheless, the development of military capabilities in the Arctic from 2008 onward may also be interpreted in a wider context of increased East–West tensions since the 2008 Georgian War, and given the Ukraine crisis from 2014 on, it is likely that these tensions will continue for the foreseeable future. However, even under the tensions of the Cold War, the Arctic remained a remarkably peaceful region, despite or because of the manifold military operations that took place there. To date, there has never been any armed conflict between any of the Arctic Five in the Arctic region. International initiatives such as the Arctic Military Environmental Cooperation Program (AMEC), its successor, the Nunn-Lugar Cooperative Threat Reduction Program, or the 2011 Nuuk declaration demonstrate that cooperation in security-related areas among the Arctic Five is basically possible and workable.

Arctic governance, sovereignty, and rights of economic utilization

While academic discussion about hypothetical international governance structures in the Arctic continues, it is highly unlikely that such structures will ever emerge in practice. None of the Arctic Five envisages a comprehensive, region-specific legal regime similar to that of Antarctica under the 1959 Antarctic Treaty (Åtland, 2013). Further, under the 1996 Ottawa Declaration, the Arctic Council is not allowed to discuss military and security issues. The tone of the 2008 Ilulissat Declaration illustrates the unanimous view of the Arctic Five that there is nothing special about the Arctic, that it is a place like any other in the world governed by established international law, and in particular, that there is no pressing need to involve outsiders in Arctic governance (Strandsbjerg, 2012). Hence, the Arctic Five are likely to oppose the establishment of any international regime or institution apart from the Arctic Council, and they are likely to take measures to secure their regional economic interests as well as to safeguard their territorial and maritime sovereignty. Several initiatives by the European Parliament, the European Union, and the European Council (see Cavalieri and Kraemer, 2013, for an overview) and by China's Rear Admiral Yin Zhuo (Blunden, 2012), all directed at establishing international governance in the Arctic have been firmly rejected by the Arctic Five. As a result, the role any non-Arctic state can play in Arctic governance will probably be restricted to an observer status in the Arctic Council. Thus, it seems safe to say that the regional interests of the Arctic Five will shape the general security and policy framework of the Arctic for the foreseeable future. For the same reason, any role that NATO can play in the Arctic will be limited since Russia is highly unlikely to tolerate any NATO presence in what she conceives of as her economic sphere of interest (Nilsen, 2014a).

At the same time, this status quo need not necessarily develop into an arena of increased tension, as some writers have projected. The 2010 Russian–Norwegian bilateral accord demonstrates that even longstanding border disputes can be resolved and stable states achieved by peaceful negotiation. Further, in the 2008 Ilulissat Declaration, the Arctic Five universally accept the UNCLOS as a basis for international dispute settlement.[8] As a result, recent efforts to address matters involving sovereignty in the Arctic are marked by a spirit of rule-based problem-solving, rather than an escalating spiral of politically charged claims and counterclaims (Young, 2011).

There has been much confusion in the debate about Arctic conflicts due to a lack of understanding of what distinguishes contested sovereignty from disputed rights of economic utilization. *Sovereignty* refers to a nation's right to exclusively govern a particular area without any outside interference. Under UNCLOS, sovereignty is restricted to a state's territorial waters (12 nautical miles from the coastal baseline), while limited sovereign action may be performed in the contiguous zone (24 nautical miles from the coastal baseline). By contrast, the right of utilization under UNCLOS is established by defining an exclusive economic zone (200 nautical miles from the coastal baseline) that the coastal state may exploit, both regarding resources in these waters and in the continental shelf below them.[9] However, this right of *economic* exploitation of the 200-mile zone does not make the coastal state *sovereign* over the waters or the continental shelf beyond the 12-mile zone.[10] Instead, these are governed by international maritime law and its institutions (not by the state's national legislation).[11] So are the high seas—the international waters beyond any exclusive economic zone are not the maritime equivalent to *terra nullius*. Neither is the seabed below the high seas (and any resources it might hold) a free-for-all cornucopia; instead, any prospecting involving the seabed below the high seas is subject to the issuance of a research license by the International Seabed Authority, and subsequent economic exploitation requires an additional license.

8 While, as of 2015, the USA has neither signed nor ratified UNCLOS, its maritime policy in the Arctic *de facto* abides by it. Until it ratifies UNCLOS, the USA is bound by the 1958 Convention on the High Seas, which it has signed and ratified.

9 Under UNCLOS (Art. 76), coastal states may extend their claim to the continental shelf (and hence, their right of utilization) to up to 350 miles from the coastal baseline. However, this is not a unilateral act; instead, the claim must be reviewed and approved by the United Nations Commission on the Limits of the Continental Shelf (UNCLCS).

10 With the exception of limited constabulatory rights in the contiguous zone, such as customs and coast guard operations.

11 Binding judgments can be pronounced by the International Tribunal for the Law of the Sea (created by UNCLOS), the International Court of Justice, or by arbitration once all states involved in the conflict accept to be bound by the decision (UNCLOS, Art. 279; Annexes V through VIII). In the contiguous zone, the state has limited sovereign-like rights, e.g., regarding police and customs operations and environmental protection, but it is not sovereign over these waters in a strict sense.

Some analysts cite examples from contemporary history, such as the British–Norwegian–Icelandic disputes over fishing zones in the North Sea in the 1970s and 1980s, or recent conflicts in the East and South China Sea, to argue that force-on-force encounters of constabulary forces and conflict escalation may also occur in the Arctic as a result of disputes over territorial sovereignty or rights of utilizing maritime resources (e.g., Borgerson, 2008; Åtland, 2013; Huebert, 2013). However, such analogies seem somewhat far-fetched. First, international maritime law in the 1970s and 1980s was governed by the 1958 Convention on the High Seas, which did not provide signatories with an exclusive economic zone, implying the ‘cod wars’ were a product of their time.[12] Second, conflicts in the East and South China Sea around the Kurile, Spratly, Paracel, and Senkaku (Diaoyu) Islands emerged precisely because the parties involved in these conflicts lacked a common understanding to accept the provisions of international maritime law to settle their disputes and failed to conclude international accords to resolve territorial disputes before they escalate. More specifically, an equivalent to the 2008 Ilulissat Declaration does not exist among the neighboring countries of the East and South China Sea; thus, the Arctic should rather be seen as a role model for these regions than vice versa. Third, the conflicts in the South China Sea are fueled by overlapping exclusive economic zones, which the parties involved in these conflicts dispute and fail to delimit peacefully, although it would be their obligation to do so (UNCLOS, Art. 279 and 280). By contrast, exclusive economic zones established in the Arctic Ocean are neither overlapping nor disputed, and almost all existing and purported resources in the Arctic are located firmly within a single exclusive economic zone.

Alarmist projections about ‘armed brinkmanship’ in the Arctic as a result of climate change (e.g., Borgerson, 2008) tend to overlook that sovereignty claims in the Arctic are not a consequence of climate change, but originate from state policy. As early as 1909 and 1925—i.e., at a time when the Arctic ice was anything but melting—Canada passed laws fixing the borders and status of her polar territories, claiming they stretch from her Arctic coastlines to the North Pole, and the Soviet Union did the same in 1926 (Trenin and Baev, 2010). The USA claimed Wrangel Island from the end of the 19th century to 1924, when a colonization party was ousted by Soviet forces. However, despite even such extreme claims, the Arctic has remained remarkably peaceful, and with the following exceptions, unaffected by disputes over contested sovereignty. This fact compares very favorably to other resource-rich regions in the world.

Canada and Denmark have unresolved disputes over the delineation of their joint maritime border in the Lincoln Sea and regarding who is sovereign over tiny Hans Island. But for symbolic incidents—such as placing liquor bottles and erecting flag poles—these conflicts have never escalated, and as of 2015, they are subject to bilateral talks (Krogh Søndergaard, 2014). From a global perspective, such often-cited conflicts seem relatively insignificant. The maritime border between the USA and Russia in the Bering Sea is *de jure*

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12 The reader should note that the wide exclusive economic zones known today only entered into effect after UNCLOS had been finally ratified by a sufficient number of signatories, i.e., in 1994 (!). In comparison with the 1958 Convention on the High Seas, UNCLOS significantly reduced the freedom of the high seas in favor of the economic interests of the coastal states.

undefined, since the Soviet Union collapsed before it could ratify an international accord defining the borderline. However, both nations *de facto* abide by the accord and act accordingly (Brosnan et al., 2011). The USA and Canada disagree about how to draw their joint maritime border in the Beaufort Sea, but are currently discussing the issue peacefully through diplomatic channels, despite the probable existence of significant shale oil and gas resources in the continental shelf below the waters. Finally, while Canada claims that the Canadian Arctic is an archipelago of islands less than 100 nautical miles apart, and therefore, the waters between the islands are territorial—implying the Northwest Passage is an internal waterway under Canadian sovereignty—a conflicting view prominently supported by the USA argues the Northwest Passage is an international strait.[13] As of 2015, the dispute is unresolved. Still, it has never escalated to a point where force-on-force confrontation was reported, although Canada has increased its coastguard presence in the region. All in all, it seems that these conflicts have been much overstated and overinterpreted.

The stability these examples portray is not necessarily specific to the Arctic region. In fact, conflicts over contested sovereignty can remain *unresolved yet peaceful* anywhere in the world, even for a very long time. For example, in central Europe, no international boundary has *ever* been agreed between Germany, Austria, and Switzerland concerning the Obersee, which forms the greatest part of Lake Constance. Whereas Austria argues that this area is a condominium, implying that sovereignty over the area be jointly administered by all three nations, Switzerland insists the area is physically separated between the littoral states (implying about 32% of the waters are under Swiss and merely 10% under Austrian sovereignty). Germany does not support any position (Khan, 2004). As a result, Swiss maps show state borders partitioning the lake whereas German and Austrian maps do not. By contrast, fishing rights were distributed as early as 1893 by the Bregenz Accord, and they have not been disputed since. To date, while all three nations patrol the lake with regional flotillas, no naval war between them has broken out. In other words, at the heart of the issue is not contested sovereignty as such, but the will of all involved actors to either tolerate an unresolved status quo or to negotiate solutions by international dialogue. It needs to be noted though that this view was challenged by a more aggressive Canadian view from the 1990s onward, which purported that sovereignty can be abandoned by de facto dereliction, and therefore, continuous military presence would be required to prevent a loss of sovereignty (e.g., McRae, 1994). Such perspectives may increase rather than decrease the likelihood of escalation.

Conflicts in the Arctic region do not only emerge from disputed sovereignty, but also from disputed rights of economic utilization. Norwegian sovereignty over the Svalbard Islands is not disputed, but since UNCLOS did not come into effect before 1994, the 1920 Svalbard Treaty does not discuss the extent to which its signatories may exploit the waters of the Svalbard archipelago beyond the territorial waters. Russia argues that under the Svalbard Treaty, all signatories have this right, whereas Norway claims that under UNCLOS, all maritime areas beyond Svalbard's territorial waters are part of Norway's exclusive economic zone. As of 2015, the dispute is unresolved. Occasionally, clashing

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13 See Rothwell (1993) for an excellent legal analysis of this dispute.

fishing vessels provoke coast guard and patrol operations from both sides, but apart from these incidents, Svalbard's demilitarized status has remained remarkably stable to date, particularly during the Cold War. All in all, the conflict has been much overstated (Ebinger and Zambetakis, 2009).

Further, Canada, Denmark, and Russia have all been doing geological research with the goal of proving that the Lomonossov and Mendeleev ridges—underwater continental crusts below the North Pole—are actually an extension of their respective continental shelves, implying that the state's exclusive economic zone could be extended to 350 nautical miles from the coastline up to the North Pole (cf. exhibit 1). This dispute has received much media attention, not the least because, in 2007, the Russian submarine expedition *Arktika* planted a titanium national flag on the seabed below the North Pole in order to substantiate Russia's geological claims. This move has been misinterpreted much. Russia does not seek to extend its sovereignty to the North Pole, but wants to secure the right of utilization of purported hydrocarbon resources below the seabed (as do Canada and Denmark). The conflict is still fought out by scientists before the United Nations Commission on the Limits of the Continental Shelf (UNCLCS), and all three states have agreed to abide by its rules and regulations. As of 2015, all nations have submitted updated claims and geological research; a decision is expected by summer 2015. When a ruling is made, the UNCLCS issues a final and binding recommendation. However, the delimitation of the *actual* boundaries of exclusive economic zones is subject to negotiation between the affected states.[14] The extent to which such trilateral negotiation can produce an equivalent to the 2010 Russian–Norwegian accord is likely to mirror the contemporary willingness to peacefully resolve conflicts in the Arctic region.

What is more remarkable, however, is that none of the three states has ever considered the deployment of military force to the North Pole as a viable means to substantiate their claims. Despite assertive rhetorics from both sides, with the 2010 Canadian–Russian accord, both nations agreed to settle their disputes peacefully before the UNCLCS. The Russian government has issued a similar stance regarding upcoming negotiations with Denmark (Pettersen, 2014). Thus, the suggestion that 'interstate resource wars' are looming on the horizon seems somewhat far-fetched (Åtland, 2013; Young, 2013). Further, any claims for (purported) polar hydrocarbon resources are probably motivated more by political than economic issues, given that current estimates have predicted relatively limited potentials or not assessed the polar region at all (United States Geological Survey, 2008; Gautier, 2009). Further, given the technological challenges of deep-water drilling in the polar region (Trenin and Baev, 2010), the profitable exploitation of any potential will likely remain unfeasible until the North Pole becomes ice-free during the summer months—an event that is expected for the years from about 2050 onward (National Snow & Ice Data Center, 2015).

14 UNCLOS, Article 76(8), Article 83, Article 9 of Annex II

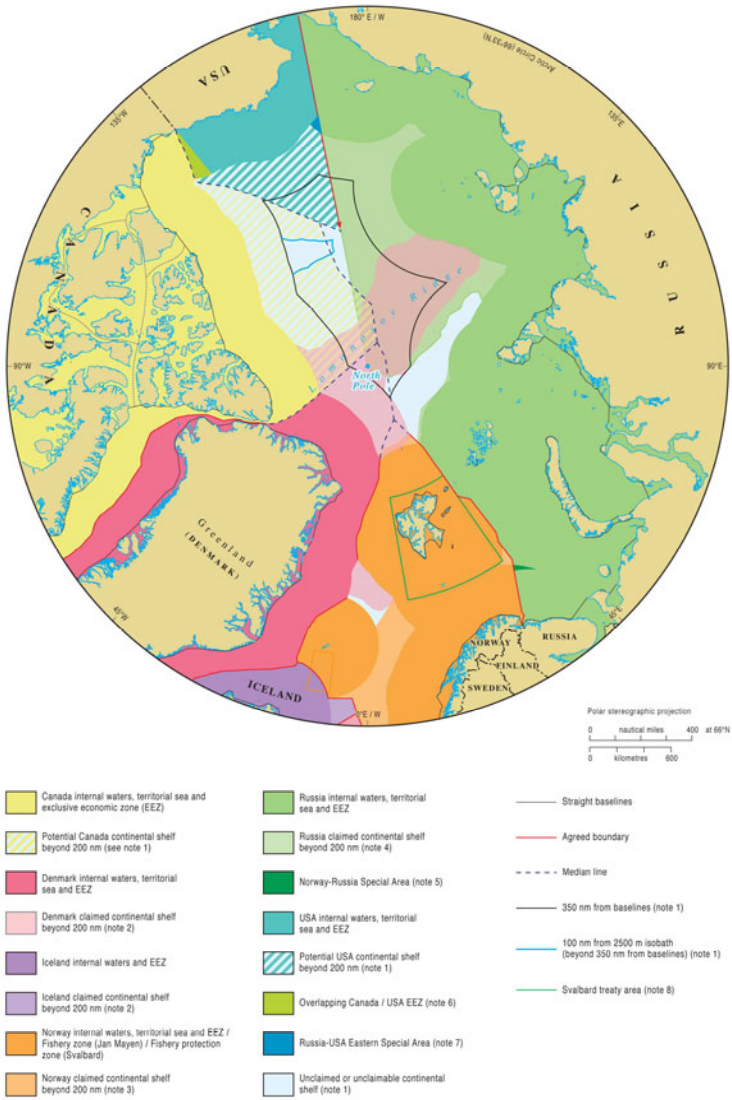

Exhibit 1: Maritime jurisdiction and boundaries in the Arctic region (IBRU, Durham University, 2014)

Implications for the general framework of the Northern Sea Route

In the *Basics of state policy of the Russian Federation in the Arctic* (Security Council of the Russian Federation. 2008), Russia defines the following development goals for the Northern Sea Route (NSR):

- organization of technical control over the strait zones, rivers estuaries, firths on the itinerary of the Northern Sea Route;
- creation and development of the infrastructure and control system of communications of the Northern Sea Route for solving problems of maintenance of the Eurasian transit;
- use of the Northern Sea Route as a national single transport communication of the Russian Federation in the Arctic;
- use of the Northern Sea Route for international navigation under the jurisdiction of the Russian Federation and according to international treaties of the Russian Federation;
- to provide re-structuring of volumes of cargo transportation through the Northern Sea Route, including through the state support of construction of vessels of ice-breaking, rescue and auxiliary fleets, and also the coastal infrastructure.

All in all, these points demonstrate that Russia's strategic goal is the *economic* development of the NSR; and this point has to be seen in the larger context of the ultimate goal to develop 'the Arctic zone of the Russian Federation into a leading strategic resource base of the Russian Federation' by 2020 (Security Council of the Russian Federation, 2008). This economic motivation constitutes a significant departure from prior Soviet policy, under which the NSR was neglected once its function as a discrete channel for troop movements between oceans had lost its military relevance (Armstrong, 1992).

At the same time, the formulation of the above goals leaves little doubt that Russia considers the NSR to be a primarily national affair, implying that the presence of any other state or international organization, particularly NATO, will not be tolerated (Staalesen, 2010a; Wang, 2013). By her Northern Fleet and icebreaker capability, Russia has the necessary means and power to enforce this policy. Russia's recent investments in military infrastructure in the Arctic should be seen in this light—quite an obvious hint that no other nation is to interfere in what she perceives as internal Russian affairs. It needs to be noted, though, that the maritime doctrine of the Russian Federation (2001) highlights the priority of political and diplomatic, economic, and other non-military means in resolving conflicts. The nontolerance of political or military interference does not necessarily equal a blockade of the NSR. While Russia has strongly rebuked Chinese initiatives for involvement in Arctic policy, it has granted China's icebreaker *Xue Long* (*Snow Dragon*) passage through the NSR, and collaboration with Chinese researchers as well as Arctic training of Chinese mariners is underway (Pettersen, 2013).

This *de facto* exclusive power over the NSR is not uncontested in the scholarly discussion of international law. While Russia's above-cited maritime doctrine explains that 'compliance with generally accepted principles and rules of international law and international treaties of the Russian Federation in the course of maritime activities' is sought, some commentators are questioning the extent to which this compliance actually exists. A view prominently supported by the USA holds that the key straits of the NSR are international straits (Blunden, 2012), whereas in the Russian perspective, these straits are internal waterways (Kolodkin and Volosov, 1990). As a result, the Russian perspective gives Russia sovereign rights over the complete passage, whereas under the U.S. perspective, it would be illegal to block the passage of any vessel as long as it travels under the right of innocent passage. Kastner (2015—this book) provides an excellent discussion of this matter of dispute.

Shipowners, therefore, face significant political risks since the regionalist power structure in the Arctic discussed in this chapter implicates the fate of the NSR will *de facto* be determined by Russian policy alone. There is little doubt that Russia possesses the necessary power to completely control any shipping on the NSR. It holds both the Western and the Eastern sea entrance to the NSR; further, with strong icebreaker support available, irrespective of the time of year and weather conditions, her Northern Fleet can be deployed to any point of the route at any time to enforce any policy. Theoretically, Russia could block the NSR at any time by intercepting traffic at strategic choke points, such as the De Long, Laptev, Sannikov, and Vilkitsky straits, at Wrangel Island, and at the Kara gate (see Keupp and Schöb, 2015—this book and Svahn, 2015—this book, for a detailed discussion of the key straits and navigational challenges of the NSR). Further, in a climate of international tension, national environmental legislation, or even the provisions of international law, such as the Canadian clause, may be used under false pretenses to deny passage for non-Russian ships or to impound vessels traveling on the route.[15] Shipowners should take note that many national marine parks and environmentally protected zones are passed while traveling along the NSR (cf. exhibit 2).[16] The Russian President Putin has repeatedly set himself in scene as the prime protector of the polar bear (Nilsen, 2014b). Finally, although the mandatory inspection of vessels upon entry into the NSR has been abandoned as of January 17, 2013 (see Keupp and Schöb, 2015—this book, for a detailed discussion), 'inspections', i.e., harassment, may be re-introduced if international relations should deteriorate.

15 Under Article 234 UNCLOS (the 'Canadian clause'), coastal states have 'the right to adopt and enforce non-discriminatory laws and regulations for the preservation, 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.'

16 Most notably, Wrangel Island, the *Kandalaksha Nature Reserve,* the *Taimyrsky State Nature Biosphere Reserve*, and the *Russian Arctic National Park.*

Exhibit 2: Protected areas along the NSR (Ahlenius, 2012)

However, these risks are somewhat mitigated once the practical aspects of economic development are taken into account. It seems quite illogical that Russia should authorize a policy hostile to international trade and transit traffic since such a policy would sabotage the very development goals it has defined for the Arctic in general and the NSR in particular. Russia primarily needs the Arctic to remain a stable region that will be able to attract the long-term investment necessary to capitalize on Russia's natural resources (Wang, 2013).

The sanctions imposed against Russia in the wake of the Ukraine crisis from 2014 on demonstrate that any noncooperative policy is likely to cause significant reduction of international trade, currency depreciation, and outright recession in Russia. Historical analysis shows that in the mid-1990s, when federal financing for the development of the Russian Arctic was effectively terminated following the collapse of the Soviet Union, the flow of cargo through the NSR declined sharply, many polar towns and polar stations were evacuated, and the North radio relay line ceased to operate (Kovalev and Gainutdinova, 2012). Likewise, effects are to be expected when Russia fails to attract foreign capital to finance the future development of the NSR, particularly the construction of maritime infrastructure along the sectors east of Dudinka.

Compared to the previous years, the 2014 transit statistics for the NSR already exhibit a significant decline in non-Russian shipping, assuming that Russian ships only operate under the Russian flag (cf. Table 1). This decline might be related to increased international tensions following the Ukraine crisis of 2014. To date, Russia has failed to develop the NSR as an East–West transit corridor; extant commodity and oil transports are almost completely westbound and container transit to and from Asia is still the exception (Keupp and Schöb, 2015—this book).

	Number of transits under Russian flag	Number of transits under non-Russian flag	Transits under non-Russian flag as a percentage of all transits
2011	26	15	36.6%
2012	18	28	60.9%
2013	46	25	35.2%
2014	47	6	11.3%

Table 1: NSR transits between 2011 and 2014 by flag (author's calculation using data from Northern Sea Route Information Office, 2014).

Of course, the passage might be restricted to Russian transit only, but with the Suez Canal route as a powerful competitor and Singapore anxiously striving to maintain its significance as the central transit hub for East–West shipping, shipowners and line operators will likely ignore the NSR, should Russia close it for international traffic. Its role would then be restricted to a regional commodity supply channel, with little, if any, growth potential. Thus, Russia should have a great self-interest in keeping the passage open for international business, not the least because many other nations are interested in the development of the NSR.

Norway as the closest neighbor is likely to benefit from increased trade and transit traffic, and since the focus of Norwegian oil production will shift to the Barents Sea region as the North Sea fields become depleted, regional interests will likely mitigate global tensions. Finland has a long history of tanker, cargo vessel, and icebreaker construction for the Soviet Union and Russia, and it has suggested intensifying bilateral cooperation to market the NSR (Nilsen, 2011). South Korea's shipbuilder Samsung Heavy Industries has already constructed and delivered ice-classed and icebreaking tankers, and in 2014 Daewoo Shipbuilding & Marine Engineering won a tender to construct icebreaking liquid natural gas tankers for deployment in the Yamal region. Naturally, both nations would benefit from increased shipping volumes on the NSR. Germany, being a nation dependent on its exports for economic growth, is interested in developing the NSR since it provides the shortest route to Japan. Iceland and Greenland (once it becomes independent from Denmark) may position themselves as local shipping hubs or relays for Arctic East–West traffic and may further extend their strategic importance once transpolar shipping becomes possible. China National Petroleum Corporation has signed an agreement with Sovcomflot about shipping along the NSR (Staalesen, 2010c), and effective commercial shipping seems to have begun in 2013 (Pettersen, 2013). All in all, the long-term economic disadvantage from a confrontational policy (and hence, the collapse of non-Russian traffic through the NSR) is likely much greater than any short-term tactical benefits. In 2010, then Russian Prime Minister Putin firmly advocated a picture of the Arctic as a zone of peaceful cooperation, where disputes are solved on the basis of international law and bilateral negotiation and where both sovereignty and economic ownership are mutually respected (Staalesen, 2010b). If this promise holds, the economic development of the NSR will likely continue.

However, Russian politics are not always governed by rational and logical conclusions about trade and commercial interests since significant hardliner factions both in politics and the military continue to exert influence. Assertive rhetorics, nationalism, Soviet romanticism, prestige policy, and anti-Western propaganda directed at an internal audience are salient features of Russian political life, and sometimes, these features are misinterpreted by Western commentators as acts of warmongering. Further, laws and regulations in Russia may be subject to post-hoc interpretation and negotiation, and the spirit of the effective administration of rules and regulations may significantly depart from their letter (see Keupp and Schöb, 2015—this book, for an application of this problem to the renegotiation of 'official' NSR fees). However, statements justifying military presence and citing the need for defending national interests likely undermine the credibility of the many diplomatic declarations concerning peaceful development through dialogue and cooperation, particularly so when they are reproduced by mass media. However, once this distorting influence is filtered out, most Russian diplomatic actions can be seen to undergird the desire for peaceful development through cooperation (Wang, 2013).

Shipowners, commentators, and scholars alike should, therefore, be interested in observing the development of the following three issues; these may serve as early warning systems for the development of East–West relations in general and of the general framework of the NSR in particular.

First, being a direct neighbor with longstanding and pragmatic diplomatic relations with Russia, Norway has played a central role in many political or economic initiatives to develop this relationship. The future development of Russian–Norwegian relations is seen as a key tenet of Norway's High North strategy, and the development of a sustainable petroleum industry has prompted unprecedented levels of cooperation with Russia (Sharp, 2011). To date, the Ukraine crisis since 2014 has not had a significantly negative impact on these relations. While Norway has suspended all bilateral military activities until the end of 2015; both nations continue to invest in joint cross-border infrastructure projects (Nilsen, 2015). Thus, repercussions from the Ukraine conflict are probably unlikely to spread to the NSR in the immediate future.

Second, once a ruling from UNCLCS regarding the Lomonossov and Mendeleev ridges dispute is issued, the following trilateral negotiations between Russia, Canada, and Denmark about how to delimit their respective exclusive economic zones might be interpreted as a proxy for how reliable East–West relations are as of 2015. More specifically, the tone with which Russia negotiates may be interpreted as a proxy for how serious it is about anchoring its Arctic policy in international law, and what subsequent enforcement or patrol operations (if any) ensue in polar waters, should conflicts of interest persist. During the demarcation process, vociferous political rhetoric from all sides is to be expected (Wang, 2013).

Third, the contemporary development of actual Russian jurisdiction, i.e., the de facto application of laws and regulation, may serve as a relatively reliable gauge for how enforceable foreign claims are before Russian courts. For shipping in the NSR, the central legal document from a Russian point of view is the 1998 federal act, *On the inland waters, territorial sea and contiguous zone of the Russian Federation.* To date, jurisdiction by the Supreme Court of the Russian Federation has been largely business-friendly. Case law evidence suggests that shipowners and operators do not owe any fees for transiting the NSR as such; fees are only owed for actual icebreaker service, if purchased (*no services rendered–no fees owed*). See Bunik and Mikhaylichenko (2013) for a detailed commentary of these cases. However, these cases only involved Russian companies and state-controlled firms; the extent to which Russian jurisdiction may favor foreign business interests is debatable. The history of past East–Western joint ventures in the oil and gas business between 2007 and 2010 suggests that foreign direct investment is not safe in Russia if politically motivated state interests prevail over business interests. Shipowners should therefore carefully track the developments in case law of the highest Russian courts and assess the extent to which this developing jurisdiction may be politically influenced.

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International Legal Dimensions of the Northern Sea Route

Philipp Kastner

The Northern Sea Route (NSR) is the most important route of navigation in the Russian Arctic.[1] While the NSR is navigable without icebreakers only for some months during Arctic summer, it is expected that due to climate change and the increasingly rapid melting of the ice in the Arctic, the NSR will become increasingly important for international shipping. Moreover, if global warming continues, the direct transpolar passage could be navigable by 2040.

Due to this enormous economic potential, the numerous unresolved legal issues surrounding the NSR, notably with respect to the right of passage of foreign vessels, are of particular relevance. Among other issues, it is disputed to what extent Russia, as the coastal state, can rely on specific provisions in international law pertaining to ice-covered areas to regulate maritime traffic in the NSR and whether the NSR is or could develop into an 'international strait.' The legal questions are also related to the fact that the Arctic environment is particularly sensitive to anthropogenic influences.

As will be discussed, international law allows the coastal state to enact special measures to protect these particularly vulnerable ice-covered areas. It should also be borne in mind that the Arctic region is inhabited by indigenous people whose lifestyle may be affected drastically by increased navigation along the NSR and whose rights, notably the right to self-determination under international law, must be taken into consideration, both by states and the industry.

Since the past use of the NSR may be relevant for the assessment of current legal claims, it is worth noting at the outset that the NSR, or at least parts of it, were used for navigation throughout the 20th century. As a matter of fact, up to the 1980s, the Soviet Union invested heavily in the development of an Arctic icebreaker fleet. This enabled partial use of the NSR throughout the year, with hundreds of vessels transporting several million tons of cargo along the NSR each year in the late 1980s (Brigham, 1988: 132). After the breakup of the Soviet Union, however, these numbers decreased rapidly, and only a few vessels sailed through the entire NSR each year during the 1990s.

1 Although the terms 'NSR' and 'Northeast Passage' are sometimes used interchangeably in the literature, NSR refers only to one section of the Northeast Passage, namely from the Northwestern part of Russia to the Bering Strait. For this definition, see Tymchenko (2001: 270f).

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The applicable international legal regime

Contrary to the Antarctic, no particular legal regime has been developed for the Arctic region. General public international law concerning the law of the sea, with the 1982 United Nations Conventions on the Law of the Sea (UNCLOS)[2]—entered into force in 1994 and ratified by the Russian Federation in 1997—and customary international law being the most important sources, therefore applies to Arctic waters. With respect to the NSR, the following provisions are especially relevant:

- internal waters, such as bays, over which the coastal state may exercise its sovereignty in the same way as over its land territory
- the territorial sea, extending up to 12 nautical miles measured from the low water line along the coast
- the exclusive economic zone, which may extend up to 200 nautical miles
- the high seas as well as
- two different rights of passage, namely, the right of innocent passage through the territorial sea and the right of transit passage through an international strait. These rights are obviously of particular interest to foreign states and vessels sailing under their flag. While both forms bestow, in principle, a right of passage, we will see below that the right of transit passage is more extensive than the right of innocent passage.[3]

It should be noted that states have also relied on other approaches to claim ownership or certain rights over Arctic waters. For instance, the 'sector theory' was sustained by Canada and the Soviet Union, albeit to varying degrees, from the beginning of the 20th century with respect to the whole of the Arctic. A 1926 Decree of the Presidium of the USSR Central Executive Committee pertaining to lands and islands in the Arctic Ocean was notably interpreted by a number of Soviet scholars as including all ice-covered areas, but this approach has been largely abandoned.[4] A similar development can be discerned with respect to the rather unconvincing claim that certain coastal areas are 'historic bays' or 'historic straits,' and therefore, internal waters of the USSR or Russia (Tymchenko, 2001: 277f). Although a statute adopted in 1960 did provide that 'internal sea waters of the U.S.S.R. shall include … waters of bays, inlets, coves, and estuaries, seas and straits, historically

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2 *United Nations Convention on the Law of the Sea* (adopted December 10, 1982, entered into force November 16, 1994) 1833 UNTS 396. The Convention was adopted after a decade of negotiations at the Third United Nations Conference on the Law of the Sea (also called UNCLOS III). The Convention also established the International Tribunal for the Law of the Sea, which has its seat in Hamburg and has jurisdiction over disputes relating to the interpretation and application of the Convention. So far, most cases have concerned disputes between states parties, but the Tribunal has also issued several advisory opinions. Private companies and individuals could only bring cases in connection with activities in the seabed. Moreover, states parties to the Convention coordinate their activities relating to the seabed and the continental shelf through specialized organizations that were also established pursuant to the Convention, namely, the International Seabed Authority and the Commission on the Limits of the Continental Shelf.

3 The *marge de manoeuvre* of the coastal state to adopt regulations is larger in the case of innocent passage (article 21 UNCLOS) than in the case of transit passage (article 42 UNCLOS).

4 For this discussion, see Tymchenko (2001: 276f).

belonging to the U.S.S.R.,'[5] no Arctic waters were specifically named. In short, the claim to historic waters, explicitly disputed by the United States in the 1960s, now only plays a marginal role, and it can be concluded that the fact that the Soviet Union did not allow any foreign vessels to navigate on the NSR is insufficient to sustain Russia's claims for historic title and to consider the NSR as a national waterway.[6]

Straight baselines and new internal waters

The possibility under international law of drawing so-called straight baselines, and the resulting creation of internal waters, has affected the legal status of several straits along the NSR.[7] The baseline usually corresponds to the low-water line along the coast and is used to measure the breadth of the territorial sea (see article 5 UNCLOS). In particular geographical situations, the baselines may, however, be drawn more generously, which was first accepted by the International Court of Justice in the *Anglo-Norwegian Fisheries Case* in 1951. Article 7(1) UNCLOS provides that '[i]n localities where the coastline is deeply indented and cut into, or if there is a fringe of islands along the coast in its immediate vicinity, the method of straight baselines joining appropriate points may be employed in drawing the baseline from which the breadth of the territorial sea is measured.' Article 7(3) further specifies that the drawing of these baselines 'must not depart to any appreciable extent from the general direction of the coast, and the sea areas lying within the lines must be sufficiently closely linked to the land domain to be subject to the regime of internal waters.'

The drawing of straight baselines changes the legal status of such newly enclosed internal waters since the coastal state has full sovereignty over its internal waters. Similar to many other states, the Soviet Union made use of the possibility of drawing straight baselines along its Northern coast. In 1985, straight baselines were drawn in the Arctic, which turned several straits separating islands or groups of islands from the coast, such as the *Vil'kitskii*, *Dmitrii Laptev,* and *Sannikov Straits*, into internal waters. A few states protested against the Soviet Union's application of the provision on straight baselines, but today, Russia's straight baselines in the Arctic are hardly disputed any more. As a matter of fact, with the ratio of land-to-enclosed water largely corresponding to the situation in the *Anglo-Norwegian Fisheries Case*, the establishment of straight baselines in the Arctic by the Soviet Union appears to have been consistent with international law.[8]

5 As cited in Brubaker (2005: 34).
6 As Brubaker has pointed out, Russia could, however, 'provide more extensive historical material substantiating its claims.' (Brubaker, 2005: 35)
7 Detailed maps to illustrate these discussions are imprinted in Franckx (1993: 149, 151) and Brubaker (2005: 7).
8 For this view, see also Rothwell (1996: 186) and Brubaker (2005: 39).

Rights of passage of foreign ships along the NSR

One of the most salient legal questions concerns the freedom of navigation along the NSR and the extent to which Russia, as the coastal state, can regulate the passage of foreign vessels. Under international law, two different rights of passage of foreign vessels are conceivable in the context of the NSR. First, a right of *innocent* passage through the territorial sea, and also in certain internal waters, must be granted by the coastal state. Second, Russia may also have to grant a more extensive right of *transit* passage if the straits in question are deemed to be used for international navigation.

Right of innocent passage

While the coastal state may extend its territorial sea to up to 12 nautical miles, as measured from its baselines (article 3 UNCLOS), the sovereignty of the coastal state is limited by the right of innocent passage through the territorial sea that is enjoyed by ships of all states (articles 17–26 UNCLOS). Generally speaking, any passage is innocent, according to article 19 UNCLOS, 'so long as it is not prejudicial to the peace, good order or security of the coastal State.' While a number of activities are listed in the same article that render such passage non-innocent, including the launching of military devices and fishing activities, even warships are usually considered as being able to enjoy the right of innocent passage. However, article 21 UNCLOS provides that the coastal state may regulate the passage of ships through its territorial sea, among other things, to ensure safety of navigation, preserve the environment, and prevent pollution. Such regulatory measures are not unrestrained, but must be made 'in conformity with the provisions of this Convention and other rules of international law' (article 21(1) UNCLOS). Moreover, these measures can usually not lay down the design, construction, or equipment of foreign ships (article 21(2) UNCLOS).

Generally speaking, foreign ships enjoy the right of innocent passage through the territorial sea along the NSR, including in those straits that are narrower than 24 nautical miles and are, therefore, part of Russia's territorial sea. With respect to internal waters, the situation is slightly more complicated. Based on the argument that internal waters are linked more closely to the land than the territorial sea, there is generally no right of innocent passage through internal waters. As noted above, several straits along the NSR were turned into internal waters by Russia's drawing of straight baselines in 1985, which would imply that no right of innocent passage exists in the case of these straits. Yet, there is an important exception to this rule. According to article 8(2) UNCLOS, the right of innocent passage through internal waters that were newly enclosed by the drawing of straight baselines must still be granted: '[w]here the establishment of a straight baseline in accordance with the method set forth in article 7 has the effect of enclosing as internal waters areas which had not previously been considered as such, a right of innocent passage as provided in this Convention shall exist in those waters.' A similar provision also appears in article 5(2) of the Convention on the Territorial Sea and the Contiguous Zone that was adopted in 1958, and to which Russia is also a state party.[9] In sum, although the legal status of several straits along the NSR changed with the drawing of straight baselines, the right of innocent passage of foreign ships was not affected and must still be granted by Russia.

Right of transit passage

In addition to the right of innocent passage, foreign ships may also enjoy the right of transit passage through the straits along the NSR. As a precondition for the existence of this right, the straits in question must be international straits in the sense of part III of UNCLOS. Article 37 UNCLOS refers to such straits as those 'which are used for international navigation between one part of the high seas or an exclusive economic zone and another part of the high seas or an exclusive economic zone.' The International Court of Justice had already recognized the principle of a right of passage through an international strait, without previous authorization of the coastal state, in the *Corfu Channel Case* in 1949. This right was codified and further specified in UNCLOS to maintain some equilibrium between the possible extension of the territorial sea to 12 nautical miles by the coastal state and the interests of international navigation. Otherwise, as it was feared, straits narrower than 24 nautical miles could become impracticable for international navigation due to the potentially far-reaching regulatory measures adopted by the respective coastal state.

Two criteria must be fulfilled so that a strait can be considered an international strait in the sense of UNCLOS: a geographic and a functional criterion. Regarding the geographic criterion, the strait must lie between one part of the high seas or an exclusive economic zone and another part of the high seas or an exclusive economic zone. As already mentioned, the NSR is not one strait in the sense of international law since large portions of the NSR—for instance, in the Barents and Laptev Seas—are part of the high seas. It is therefore, strictly speaking, imprecise to speak of a possible right of transit passage through the NSR itself.[10] Several straits along the NSR, however, fulfill the geographic criterion for an international strait, which allows us, based on similar situations and legal implications, to speak of a possible right of transit passage through several Russian Arctic straits.

The functional criterion is a more complex and also contested point. A careful interpretation of the rather vague provision 'used for international navigation' and its application to the straits along the NSR is hence required. Clearly, only relatively few foreign ships have used the straits in question in the past. When compared to other straits that are used more regularly and frequently—and throughout the year—for international navigation, the straits along the NSR fulfilling the geographic criterion may only appear to be candidates for international straits. Moreover, while the NSR has been used for navigation throughout the 20th century, and certainly more extensively than its Canadian counterpart, the Northwest Passage, the use of the straits along the NSR has been largely limited to Soviet, and subsequently, Russian, ships. As a result, it is unconvincing to conclude that the past use by for-

9 The Soviet Union signed this convention in 1958 and ratified it in 1960.
10 Some authors have, therefore, conducted separate analyses to assess the legal status of the dozens of straits in the Russian Arctic (e.g., Brubaker, 2005).

eign ships could establish the Russian Arctic straits as international straits in the sense of UNCLOS.

At the same time, there is no precise threshold that could be read into the provision, which means that no specific number of ships can be identified as having to sail through a strait to make it 'used for international navigation' in the sense of article 34 UNCLOS. It is, moreover, highly doubtful that the same criteria should apply in the case of easily navigable waters, such as in the Mediterranean Sea, and in the polar regions.[11] In other words, the use of the NSR would not necessarily have to reach the level of straits already recognized as international straits, such as the straits of Gibraltar, Hormuz, and Malacca. Furthermore, it has been argued that the clause 'used for international navigation' does not only include past and present use, but also future use. This position has been adopted by the United States with respect to the NSR, but virtually all other states have followed the Russian position that insists on actual use (Brubaker, 2005: 120; Pharand, 1984: 102). The latter view is certainly more consistent with the ordinary meaning attached to the phrase 'used for international navigation' that appears in the title of part III of UNCLOS. Furthermore, article 37 UNCLOS defines the scope of this section and refers specifically to 'straits which *are* used,'[12] a wording that plainly excludes straits which *will* or *may be* used for international navigation in the future.

In sum, it is safe to conclude that, at this point, the straits along the NSR are not international straits in the sense of UNCLOS, which precludes any claims to a right of transit passage. This situation might, of course, be subject to change. Even though navigation through the NSR has not yet increased significantly—among other things, because of the high costs associated with the support of icebreakers—more and more foreign ships will use the NSR. It is, therefore, conceivable that with the intensification of international shipping through the NSR, Russia will be under an international legal obligation to grant the right of transit passage to foreign ships through the straits along the NSR. As mentioned above, a precise threshold cannot be established. However, due to the radically different climate conditions, a much smaller number of ships than in the case of easily navigable waters could be sufficient to fulfill the functional criterion for an international strait.

Special protective measures for ice-covered areas–article 234 UNCLOS

UNCLOS allows coastal states to adopt specific regulations governing navigation in ice-covered areas. As several marine accidents, such as the one of the *Exxon Valdez* in 1989, have illustrated, the Arctic environment is particularly vulnerable, and hence, in need of special protective measures to prevent its pollution. By way of example, low temperatures and the presence of ice slow down the dissipation of oil, and even relatively minor oil spills

11 For this discussion, see also Rothwell (1996: 199).
12 Emphasis added.

may affect the simple—and therefore, delicate—food chains in the Arctic significantly.[13] Moreover, the harsh conditions in the Arctic entail an increased risk of damaged vessels, which, in turn, increases the danger of maritime pollution. A single incident may have serious consequences, which means that the coastal state—in this case, Russia—and the international community as a whole may have a particular interest in protecting this fragile environment.

Article 234 UNCLOS, also called the 'Canadian clause' since it was Canada that pushed for the inclusion of such a provision into the Convention (Huebert, 2001: 249), attempts to address this need by allowing states to protect their waters, up to the limits of the exclusive economic zone, in ice-covered areas. According to this provision,

> 'Coastal States have the right to adopt 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. Such laws and regulations shall have due regard to navigation and the protection and preservation of the marine environment based on the best available scientific evidence.'

Article 234 states expressly that it applies to areas that are covered by ice 'for most of the year.' The fact that the NSR is largely—and increasingly—free of ice for several weeks, or even months, during the summer, does not, therefore, preclude Russia from adopting and enforcing measures to prevent, reduce, and control marine pollution within its exclusive economic zone in the Arctic. With the rapidly changing climate in the Arctic, it is, however, conceivable that article 234 might become inapplicable in the foreseeable future. The wording 'most of the year' implies that an area must be covered with ice during significantly more than half of the year; the mere presence of a few icebergs in usually ice-free waters, for instance, although being a considerable danger for ships, could hardly justify applying article 234. Due to the increasingly rapid melting of the ice in the Arctic, with a transpolar route possibly being navigable by 2040, national regulations based on article 234 do not stand on very solid ground. Moreover, article 234 does not mention a single example of the kind of possible measures that a coastal state may adopt. It is, in other words, unclear to which extent national regulations based on this provision may impinge on naval traffic.

Before entry into force of UNCLOS in 1994, both Canada in 1970, with its *Arctic Waters Pollution Prevention Act*, and Russia in 1990, with the *Regulations for Navigation on the Seaways of the Northern Sea Route*,[14] adopted measures that largely followed the logic that the coastal state ought to be allowed to ensure the protection of ice-covered areas. The final text of article 234 and the entry into force of UNCLOS in 1994 can be seen as bestowing, at least in part, a belated international legal legitimacy to these measures. Indeed, a closer scrutiny of the 1990 *Regulations* reveals that they appear to correspond, in principle,

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13 For a succinct overview of some of the characteristics of the Arctic environment relevant to oil and gas activities and for the behavior of oil in ice-covered waters, see Arctic Monitoring and Assessment Programme (2007: ix, 25). See also Østreng et al. (2013: 160–162).

14 The Soviet Union had already enacted special requirements, which were explicitly based on article 234 UNCLOS, regarding the navigation of ships in its exclusive economic zone. (Franckx, 1993: 180)

to the objectives of article 234 and can, therefore, be considered consistent with UNCLOS in this respect. Among other things, the *Regulations* require that ships follow a certain route and be supported by icebreakers when navigating through some of the straits along the NSR; they also specify requirements regarding the design and equipment of these vessels.[15]

Finally, it has been suggested that the provision relating to ice-covered areas does not apply to straits used for international navigation.[16] If the straits along the NSR were to develop into international straits, but were, at the same time, still covered with ice for most of the year, Russia as the coastal state would then be denied another legal basis to regulate shipping along the NSR. However, UNCLOS provides explicitly that only sections 5, 6, and 7 do not apply to international straits (article 233 UNCLOS); section 8, with its sole article 234, is not mentioned. Consequently, it is safer to conclude that the 'Canadian clause' also applies to international straits.

Soviet/Russian practice - confrontation and regulation

In practice, questions of sovereignty and rights of passage were of little interest to the international community for a long time. Although the Soviet Union began developing the NSR as a means of transportation as early as in the 1930s—among other things, by constructing harbors along the route—the NSR remained of exclusive national interest, leading one commentator to conclude that the NSR constituted an 'internal sea route' (Rothwell, 1996: 201).

The right of passage of foreign vessels became an issue in the context of the 1958 Territorial Sea Convention, with the sensitive right of passage of warships being particularly controversial. The Soviet Union had added a reservation to article 23 of this convention, in which it expressed its opinion that the coastal state 'has the right to establish procedures for the authorization of the passage of foreign warships through its territorial waters.'[17] In line with this policy, the Soviet Union adopted a law in 1960 that granted foreign ships the right of innocent passage through the territorial sea, in accordance with section III of the Territorial Sea Convention, but required that the passage of foreign warships through its territorial sea be authorized (Rothwell, 1996: 204). However, the subsequent, more cooperative Soviet practice of the 1980s largely eliminated the problem and allowed for a consistent application of the right of innocent passage (Butler, 1991: 220; Franckx, 1993: 158).

In the early 1960s, the United States began challenging more actively both the Soviet and Canadian positions with respect to the legal status of waters in the Arctic, notably by sending the icebreakers *Northwind* and *Burton Island* to the Chukchi See, the Eastern Siberian Sea, and the Laptev Sea. These passages were meant to underscore that large portions of the NSR were, in fact, part of the high seas. Interestingly, the Soviet Union did not formally protest against these passages, which implied the definitive abandonment of the occasionally articulated claim that, among others, the Kara, Laptev, and Chukchi Seas were

15 For more information, see e.g., Østreng et al. (2013: 252f) and Franckx (1993: 189).
16 For this discussion, see Brubaker (2001: 269) and Brubaker (2005: 135).
17 1964 UNTS 273.

internal waters (Rothwell, 1996: 204f). In other words, the high seas status of these waters was implicitly recognized by the Soviet Union. Only in 1964 did the Soviet Union protest against the possible passage of the *Burton Island* through the Dmitrii Laptev and Sannikov Straits, claiming that these straits were historic waters. Both straits are approximately 30 nautical miles wide, which means that, when measuring 12 miles of territorial sea from each side, a high seas corridor of several nautical miles remains. The United States argued, moreover, that the straits were international straits—an equally shaky argument as the Soviet Union's claim to historic title. It can be said that although the status of the straits remained somewhat uncertain for another 20 years, the Soviet Union's drawing of straight baselines in 1985 provided some clarity.

Another incident that occurred in 1967 merits to be mentioned. When the United States planned to send two icebreakers through the whole NSR, it only notified the Soviet authorities of this plan. Since the Soviet Union did not receive a formal request to authorize the passage, it denied the passage by arguing that '[f]or passing the strait... military ships must obtain preliminary permission of U.S.S.R. government through diplomatic channels one month before expected date of passing' (as cited in Franckx, 1993: 158). The icebreakers did not proceed, but the United States protested against the apparent violation of the right of innocent passage through the territorial sea (Franckx, 1993: 150). It is interesting to note that, subsequently, and contrary to the situation regarding the Northwest Passage,[18] neither the United States nor other states challenged the Soviet position overtly. The altogether few passages—or attempted passages—of foreign ships through the NSR did, therefore, not have a major impact, although they forced the Soviet Union to clarify its position vis-à-vis the legal status of the NSR.

In 1987, the Soviet policy with respect to its Arctic waters shifted quite radically with Mikhail Gorbachev's announcement that the NSR would be opened for international navigation. The subsequent adoption, in 1990, of the *Regulations for Navigation on Seaways of the Northern Sea Route*, sought to both enable the navigation of all ships along the NSR and protect the sensitive Arctic environment. As noted above, the *Regulations* require, among other things, icebreaker support, and ships may be inspected under certain conditions and denied passage. Moreover, a newly created *NSR Administration* was to be informed of all operations in the NSR. It is worth noting that the *Regulations* also apply to foreign warships, which are, hence, not subject to any distinct legislation any more. The *Regulations* are still in force; subsequently adopted legislation, while complementing the *Regulations*, did not change the situation significantly. While Russia signaled greater commitment to opening the NSR and established a new Northern Sea Route Administration in 2013, among other things, to ease the application process and issue permissions more swiftly—[19]salient facets of the regulatory regime remain largely unchanged, including with respect to mandatory icebreaker assistance.

18 See Rothwell (1996: 205).

19 For more information about the new office, see http://www.arctic-lio.com/nsr_nsra and http://www.nsra.ru/en/celi_funktsii/

When assessed under international law, the question is whether the *Regulations* respect the applicable rights of passage.[20] It is quite obvious that the *Regulations* are incompatible with a right of transit passage. As argued above, the straits in question cannot be considered to be used for international navigation at the moment, which means that the *Regulations* are not contrary to international law in this regard. However, the right of innocent passage through the territorial sea and internal waters that were created by the drawing of straight baselines must be granted. While Russia recognizes this right in principle, it appears that some of the provisions of the *Regulations*, such as those pertaining to the design of ships as well as to their possible inspection by Russia, can hardly be justified. By way of example, article 21(2) UNCLOS requires that the laws and regulations relating to innocent passage that the coastal state may adopt 'shall not apply to the design, construction, manning or equipment of foreign ships unless they are giving effect to generally accepted international rules or standards.' As will be discussed below in the context of guidelines adopted within the framework of the International Maritime Organization[21] (IMO), a specialized agency of the United Nations dealing with various aspects of shipping, such rules or standards have only emerged very recently or are in the process of development. This leads to the conclusion that at least some provisions of the *Regulations* unduly limit the right of innocent passage. In the end, they can only be defended, from an international legal perspective, by reference to article 234 UNCLOS, and only if this specific clause is not interpreted too narrowly. Interestingly, Russia can find some support in the practice of two other important actors in the Arctic, namely of Canada and its 1970 *Arctic Waters Pollution Prevention Act* and of the United States and its 1990 *Oil Pollution Prevention Act*, which has led to the conclusion that regional customary international law may be emerging with respect to the regulation of passage of ships in the Arctic (Stepanov, Ørebech & Brubaker, 2005: 7). It must be said, however, that since the *Regulations* do not seem to be applied to Russian and foreign ships in the same way, especially with respect to fees that are charged for services (Stepanov, Ørebech & Brubaker, 2005: 10), the implementation of the *Regulations* is discriminatory, which means that the Russian practice does not comply with article 234 in this regard.

The relevance of legally nonbinding rules

In addition to the general rules on the protection and preservation of the marine environment, notably those under section XII of UNCLOS, various rules and standards for ship construction, equipment, operations, and crewing have been developed under the aegis of the IMO. Several conventions that were adopted within the framework of the IMO, including the 1973 *International Convention for the Prevention of Pollution from Ships*

20 The validity of the requirement of icebreaker support for foreign state vessels has also been questioned. (Franckx, 1993: 192).

21 *Convention on the International Maritime Organization* (adopted 6 March 1948, entered into force March 17, 1958) 289 UNTS 48.

(MARPOL) that seeks to prevent both accidental pollution and that from routine operations, have been ratified by all Arctic states, and therefore, also apply to the Arctic region.

Moreover, while no specific binding rules for the Arctic have been developed, several nonbinding instruments that seek to strengthen the regulatory framework governing shipping in the Arctic have been adopted. Several sets of IMO guidelines merit particular attention. The *Guidelines for Ships Operating in Arctic Ice-covered Waters* (*Arctic Guidelines*), adopted by the IMO Assembly in 2002, recognize that existing instruments do not address safety concerns in the Arctic to a sufficient degree and seek to 'meet appropriate standards of maritime safety and pollution prevention' (Preamble, P-1.2). By way of example, these guidelines recommend that all ships operating in Arctic ice-covered waters carry at least one ice navigator (Chapter 1, 1.2.) and refer to specific anchoring and towing arrangements (Chapter 6) and life-saving equipment (Chapter 11). As their name indicates, these guidelines are not mandatory, but rather recommendatory in nature, which may be seen as an important weakness.[22] However, they already shape state practice and are being used by the shipping industry (Østreng et al., 2013: 245, 177-239). Among other reasons, it is compliance with such—albeit nonbinding—guidelines that will carry much weight when a ship owner or operator is accused of negligence (Østreng et al., 2013: 245). In other words, the form of a certain rule may not be decisive for its effect in practice,[23] and formally nonbinding instruments, such as the *Arctic Guidelines*, may also inform the interpretation of treaty provisions, such as article 234 UNCLOS.

Building on these guidelines, the *Guidelines for Ships Operating in Polar Waters*, adopted in 2009 by the IMO Assembly and published in 2010, address the fact that the polar environment imposes additional demands on ship systems, 'including navigation, communications, life-saving appliances, main and auxiliary machinery, environmental protection and damage control' (Preamble, P-2.4). Among other things, these guidelines establish a system of polar classes to designate different levels of capability of ships to navigate safely in the Arctic and Antarctic waters, from year-round operation in all ice-covered waters to summer/autumn operation on thin ice (Table 1.1). Furthermore, it is clearly expressed that pollution from routine operations 'should be minimized by equipment selection and operational practice' (Guide, G-2.3).[24]

With purely national approaches being both impracticable and having little foundation in international law, it is important to recall that cooperation between states is fundamental. A direct reference to this need can even be found in UNCLOS. Article 197 provides that

> 'States shall cooperate on a global basis and, as appropriate, on a regional basis, directly or through competent international organizations, in formulating and elaborating international rules, standards and recommended

22 For this and other points of criticism of the *Arctic Guidelines*, see Chircop (2009: 373f).

23 It should be noted that IMO has also been working on the development of a mandatory code of safety for ships operating in polar waters. See http://www.imo.org/MediaCentre/HotTopics/polar/Pages/default.aspx

24 A number of additional proposals have been made to ensure greater protection of the Arctic waters. For instance, portions of the Arctic Ocean, provided they are within the exclusive economic zone of a state, could be designated as Particularly Sensitive Sea Areas (PSSA) by the IMO. This would allow the coastal states, in accordance with article 211(6)(a) UNCLOS, to adopt additional laws and regulations to prevent, reduce, and control pollution from vessels. For these proposals, see Chircop (2009).

> practices and procedures consistent with this Convention, for the protection and preservation of the marine environment, taking into account characteristic regional features.'

The most relevant initiative with respect to the NSR is certainly the Arctic Council, an intergovernmental forum that was established in 1996 by the eight Arctic states, namely, Canada, Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden, and the United States.[25] The Arctic Council's main objective is to enhance cooperation among these states in the field of sustainable development and environmental protection. In addition to specific programs that are dedicated to climate change in the Arctic and the conservation of the Arctic flora and fauna, the working group *Protection of the Arctic Marine Environment* (PAME) is of particular relevance here.[26] In its *Arctic Marine Shipping Assessment 2009 Report*,[27] for instance, PAME has worked on and issued recommendations with respect to marine safety and marine environmental protection. This report also addresses the fact that Arctic communities are affected by marine shipping, with oil spills being one of the most immediate concerns.[28] The report recommends, among other things, that

> 'the Arctic states decide to determine if effective communication mechanisms exist to ensure engagement of their Arctic coastal communities and, where there are none, to develop their own mechanisms to engage and coordinate with the shipping industry, relevant economic activities and Arctic communities (in particular during the planning phase of a new marine activity) to increase benefits and help reduce the impacts from shipping.[29]'

This approach can be seen as being part of the Arctic Council's promise to take into account the rights and needs of indigenous peoples in the region. Regarding the institution itself, several indigenous peoples' organizations also have the status of Permanent Participants,[30] which guarantees them 'active participation and full consultation.'[31] These organizations include the Russian Association of Indigenous Peoples of the North, which itself represents over 40 groups living in the territory of the Russian Federation.[32] It is useful to recall that numerous rights of indigenous peoples were recognized in 2007 at the global level in the *United Nations Declaration on the Rights of Indigenous Peoples*,[33] including the right to self-determination (article 3), the right not to be subjected to the destruction of their culture (article 8(1)), and the right to the conservation and protection of the environment of their lands and resources (article 29(1)). Regarding the development and use of indigenous peoples' lands and resources, states are also under an obligation to mitigate adverse environmental impact (article 32(3)).

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25 See http://www.arctic-council.org
26 See http://www.pame.is
27 Arctic Council (2009)
28 Arctic Council (2009: 133)
29 Arctic Council (2009: 6)
30 See http://www.arctic-council.org/index.php/en/about-us/permanent-participants
31 Declaration on the Establishment of the Arctic Council (Ottawa Declaration), 19 September 1996, article 2.
32 See http://www.arctic-council.org/index.php/en/about-us/permanent-participants/russian-association-of-indigenous-peoples-of-the-north-raipon
33 *United Nations Declaration on the Rights of Indigenous Peoples* (13 September 2007), UN Doc A/RES/61/295.

These rights and obligations are relevant in the context of the increasing use of the NSR and of projects pertaining to the exploitation of natural resources in this area. Due regard must be given to the possible impact on the life of indigenous peoples.

Conclusion

From an international legal perspective, the law of the sea, in particular, via UNCLOS, provides a decent yet only basic framework to regulate navigation along the NSR, and in the Arctic more generally. In other words, even if differing opinions exist, legal uncertainty *per se* is, at least at the moment, not a major problem. If applied coherently by the states concerned, the current regime should be able to provide sufficient and adequate responses with respect to the legal status of the NSR and rights of passage of foreign ships. There are several mechanisms, such as the International Tribunal for the Law of the Sea or an arbitral tribunal constituted in accordance with UNCLOS, through which possible disputes between Russia and other states, including flag states representing the interests of the shipping industry, can be resolved. The adoption of an international convention to clarify the legal status of the NSR, as it has sometimes been called for (e.g., Tymchenko, 2001: 289), is not essential.

However, while such a concerted and somewhat onerous effort might not be necessary to balance the interests of international navigation and those of the coastal state, a determinedly multilateral approach would certainly be valuable. Indeed, with the increasing importance of the NSR for international shipping and, as a result, also increasing threats for the vulnerable Arctic maritime environment, the current framework will not be able to respond adequately to these imminent challenges. Article 234 UNCLOS, for instance, which is the cornerstone of the Russian *Regulations*, is too specific and does not embrace cooperative approaches. In the long run, it can, hence, not be considered a viable normative solution on its own.

It is therefore desirable to harmonize and further develop the regulatory framework governing navigation along the NSR, and in the Arctic more generally. Exclusively state-centered approaches focused on binding international law cannot live up to this challenge, which is why the initiatives made within multilateral frameworks, such as IMO, are particularly valuable. Moreover, the Arctic Council is a promising example of an institution that reflects an increasingly stronger commitment to go beyond the state paradigm. While important progress has been made in recent years,[34] further and truly multilateral cooperation, both between states as well as with nongovernmental organizations, indigenous peoples, and the shipping industry, is required to protect the environment and the rights and interests of all actors involved.

34 Arctic Council (2009: 67).

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United Nations Declaration on the Rights of Indigenous Peoples (13 September 2007), UN Doc A/RES/61/295

The potential of container vessel operation on the Northern Sea Route: Nautical, regulatory, and operative issues[1]

Marcus Matthias Keupp; Ramon Schöb

Extant literature dealing with operative and economic aspects of container shipping in the Northern Sea Route (NSR) has concentrated on the analysis of a particular vessel *type*. Table 1 demonstrates that this type corresponds to a small, ice-classed container ship such as the *COSCO Yong Sheng*, whose voyage from Dalian to Rotterdam in August, 2013, constituted one of the first known container shipping operations by way of the NSR.

Unfortunately, this type of vessel is rather the exception in global container shipping, especially when it concerns routes between Northern Europe and Asia. Almost none of the container vessels operating on the high seas today, including any of those 90 vessels worldwide whose completion is expected by 2017, is ice-classed. Further, the average capacity of vessels on routes between Europe and Asia has exponentially grown, from 4,500 TEU in 1998 to 8,000 TEU in 2011 and 11,000 TEU in 2014 (Ferrari et al., 2012; Mietzner, 2015–this book). The largest container cargo vessels existing today have a capacity of over 19,000 TEU. As a result of this development, the draft and beam of such ships have greatly increased. Critical authors believe that these effects likely relativize the potential of the NSR as an alternative route for global container shipping (Ho, 2011).

In an attempt to contribute to this debate, we use one of the largest existing container vessels, the M/V *Mærsk Mc-Kinney Møller*, as our unit of analysis, letting her complete a hypothetical voyage through the NSR and elaborating in detail both the nautical, operative, and regulatory issues she would face during her journey. Her technical specifications are presented in Table 2. Thus, we attempt to discuss not only the contemporary but also the future situation of container shipping by considering the current size developments in container shipping.

Nautical issues

The waters of the NSR are part of a large and shallow shelf sea that stretches far to the north from the coast of the Russian mainland (cf. exhibit 1). As a result, many key passages and straits, both within the NSR and in the adjacent seas, are characterized by waters less than 30 meters deep, and some of these are exceptionally shallow (cf. Table 3 and Exhibit 2 in this chapter). Vessels as large as the *Mærsk Mc-Kinney Møller* with a draft of 14.5 me-

1 This chapter partially draws on material and texts first published in the second author's Master's thesis at the University of St. Gallen (Switzerland).

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ters are not able to pass these bottlenecks without causing major damage to the hull or even running aground. The only option that remains is to sail around, rather than through these problematic waters. The reader should note that the problem of shallow waters exists irrespective of the extent to which they are ice-covered.

Authors	Vessel capacity (TEU)	Ice-classed?	Window of operation	Trip
Niini, Arpiainen, and Killi (2006)	750 / 5,000	Yes	Year round	Europe–Aleutian Islands
Verny and Grigentin (2009)	4,000	Yes	Year round	Shanghai–Hamburg
Liu and Kronbak (2010)	4,300	Yes	Seasonal (90–270 days)	Yokohama–Rotterdam
Furuichi and Otsuka (2014)	4,000	Yes	Seasonal (105–225 days)	Yokohama–Hamburg
Xu et al. (2011)	10,000	No	Seasonal (30 days)	Various

Table 1: Literature analyzing container vessel operation on the NSR

Attribute	Specification
Manufacturer	Daewoo Shipbuilding & Marine Engineering Co., Ltd
Ship owner	A. P. Møller-Mærsk A/S (Mærsk Line)
Cost to build	Approx. US$ 190 million (estimate)
Nominal capacity	18,270 TEU
Homogenous capacity[2]	13,500 TEU
LOA	399 meters
Beam	59 meters
Draft	14.5 meters
GT	194,849 tons
NT	79,120 tons
Propulsion	Two MAN B&W S80ME-C9-TII engines
Design speed	23 knots
Energy efficiency	168 grams of fuel oil per kWh

Table 2: Technical specification of the Mærsk Mc-Kinney Møller (American Bureau of Shipping, 2013; Maersk, 2013a, 2013b; MAN Diesel & Turbo, 2010; World News, 2011)

2 Defined as the maximum load-bearing capacity given an average weight of 14 tons for a twenty-foot container.

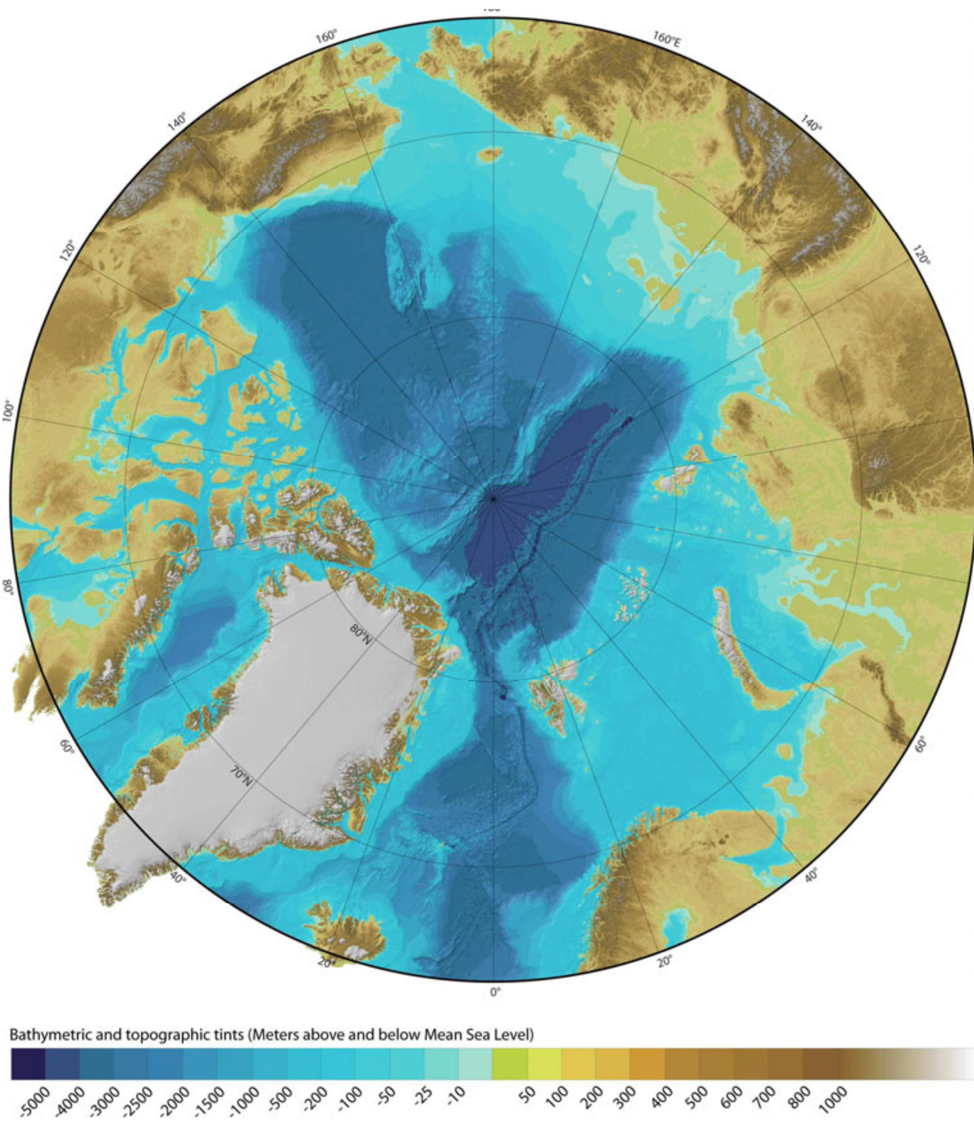

Exhibit 1: Bathymetric map of the Arctic Ocean (Jakobsson et al., 2012)

The extreme shallowness of the Pechora Sea implies that large container vessels will have to take the more northerly route along the coast of Novaya Zemlya and around Cape Zhelaniya, which Svahn (2015, this book) describes. Navigation in the De Long and La Pérouse straits may prove difficult in adverse weather since no more than five meters of the water head remain to cushion the ship from hitting the seabed when it rides high waves. The most critical points, the Sannikov and Laptev Straits share the same longitude and present alternatives to navigate through the New Siberian Islands (viz. Exhibit 2).

Site	Approximate position	Minimum depth (meters)
Pechora Sea	69° N, 54° E	6
Sannikov Strait	74.5 N, 140° E	12.6
Laptev Strait	73 N, 142° E	12 to 15

Table 3: Exceptionally shallow waters in the NSR (Arctic Council, 2009; Eger, 2010; Rottem and Moe, 2007; Belkin, 2015)

The Laptev Strait in the south will most probably be too shallow to traverse for the *Mærsk Mc-Kinney Møller*. The same can be said for the Strait of Sannikov, situated farther to the north, except that two bypasses to the extreme North, with a respective minimum depth of at least 25 meters, exist by which the Strait of Sannikov can be circumnavigated. The feasibility of this option, however, depends on whether or not the local ice conditions make those northern routes accessible (Belkin, 2015). To guarantee safe operations, the *Mærsk Mc-Kinney Møller* would probably have no choice but to rely on one of these bypasses. In a worst-case scenario, this implies she would have to wait until local ice conditions or icebreaker support would allow her to pass. The greatest part of the NSR waters lies to the north of the 70th parallel. Beyond this boundary, radio and GPS communications are significantly restricted due to magnetic and solar phenomena, interference, and geostationary satellite geometry (Emmerson and Lahn, 2012); however, this problem is expected to be largely mitigated with the update of the Iridium satellite network and the novel installation of the mobile user objective system (MUOS) network (Magnuson, 2014). Still, as of 2014, marine communication and navigation are difficult, and internet access is often impossible. There is dense fog along the route in June and July. Weather conditions can change abruptly, there are hardly any meteorological offices along the route, with satellite-based weather prediction often inaccurate; in addition, vessels may collide with drifting sea ice. Further, when the large surface area of a container ship freezes and subsequently becomes covered with ice (*icing*), the vessel's center of gravity can shift, implying increasing roll and a lack of stability (Emmerson and Lahn, 2012; Pollock, 2009; Roberts, 2012; Svahn, 2015 - this book). For a large and heavy ship, such as the *Mærsk Mc-Kinney Møller*, these navigational risks are a serious concern.

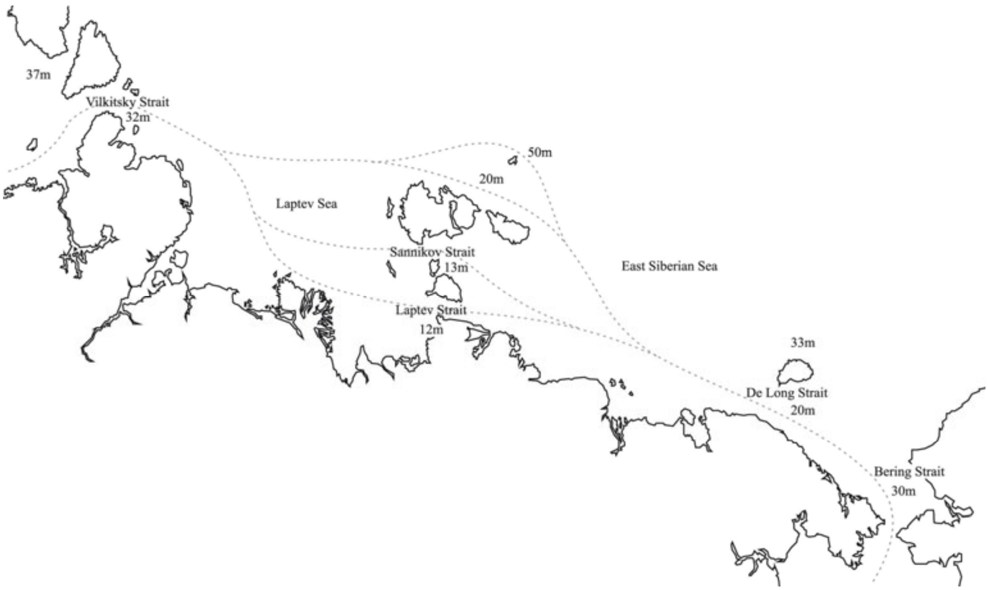

Exhibit 2: Key bottlenecks of the NSR (authors' creation)

As of 2014, marine support and rescue infrastructure is rudimentary. For the whole NSR, there are only three established marine rescue coordination centers: Dikson, Tiksi, and Pevek[3]. Each center is staffed with a lifeboat, rescue ship, and long-range aircraft; additionally, the station at Tiksi has one medium-range helicopter and that Pevek one light helicopter. These two centers are manned from July through September only. Icebreakers operating along the NSR can be mobilized for rescue operations (Northern Sea Route Administration, 2013). At the end of 2014, Russia opened a third search and rescue center in Arkhangelsk. The German shipbuilder *Nordic Yards* completed the construction of two new search and rescue vessels, the *Beringov Proliv* (based in the Sakhalin region) and the *Murman* (based in the Murmansk region), in February 2015. Case study reports of known incidents suggest that search and rescue operations may take considerable time (Emmerson and Lahn, 2012; Pettersen, 2013); further, to the best of our knowledge, no search and rescue exercises simulating a large cargo ship in need of support have been performed yet. In case of an emergency, the *Mærsk Mc-Kinney Møller* would probably be on her own for several days until local rescue operations could be organized.

3 Maps of their locations, areas of operation, and radio frequencies are available from *http://nsra.ru/en/pso/*

Regulatory issues

Irrespective of the juridical discussions about the NSR's legal status as a whole and that of particular straits (see Kastner, 2015–this book), navigation in the NSR is *de facto* regulated by the Northern Sea Route Administration (Northern Sea Route Administration), an agency of the Russian state, and permission must be obtained for every passage[4]. The requirement for permission is independent of the ship's build, technical configuration, route, or ice class. Since January 17, 2013, the regulatory framework has been considerably liberalized. As a result, in theory, *any* vessel may now pass the NSR (cf. Table 4) even without ice-breaker support (ice class, sea ice, and open water conditions permitting)[5]. The reader should note that, in stark contrast to the passage of the Suez Canal, no transit fees are incurred for navigating the NSR (Ministry of Transport of Russia, 2013). However, the *mode by which* a particular vessel may *navigate* the NSR will be determined by the Northern Sea Route Administration. Its decision depends on both the local ice conditions in the sea area(s) the vessel intends to pass and on the ice classification of the vessel. The latter is assessed according to the Russian ice classification as defined by the Russian Maritime Register of Shipping, of which Wallin and Åkerström (2012) provide detailed documentation as well as a comparison with other classificatory schemes. The decision is not arbitrary; on the contrary, it is made according to highly formalized and objective checklists that are publicly available from the Northern Sea Route Information Office[6]. In all cases, an ice pilot[7] and additional insurance to cover the risks of environmental pollution are mandatory.

A closer analysis of these tables reveals two important facts. First, vessels with any of the ice classes Ice 1, Ice 2, or Ice 3 *(non-Arctic ships*) as well as those without any ice class may only pass between the beginning of July and November 15. Second, the extent to which icebreaker support is mandatory is primarily a function of sea ice conditions. Applying these criteria to the *Mærsk Mc-Kinney Møller*, we find that she could only operate in the NSR during the above timespan since, as of her current build, she has no reinforced hull and, thus, no ice classification. Additionally, even during that short time window, the Northern Sea Route Administration will grant her the right of independent navigation only under *open water* conditions; otherwise, icebreaker support is mandatory, implying navigation is not free but guided (see Svahn, 2015–this book, for a documentation of traveling in such a convoy)[8].

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4 Non-compliant vessels are publicly denounced at *http://nsra.ru/en/non_compliant_vessels/*

5 However, in contrast to the written regulations, Rosatomflot insists that independent navigation for non-ice-classed vessels is prohibited. Further, Rosatomflot does not recommend that non-ice-classed vessels enter the NSR on their own due to past incidents (hull damage, environmental concerns) and suggests that underwriters are reluctant to provide coverage for vessels with an ice class below 1A (Belkin, 2015; Sekretev, 2013). This would imply that vessels without any ice class would likely encounter *de facto* regulatory and insurance problems once they attempt to pass the NSR even if they may be eligible to pass on a *de jure* basis.

6 See *http://www.arctic-lio.com/nsr_iceclasscriteria*

7 At a rate of US$ 673 per pilot and day (Furuichi and Otsuka, 2014). Note that larger ships often require two pilots (Roberts, 2012). Still, compared with the cost of operations and transit fees, this cost seems negligible.

8 *Open water* conditions correspond to a large area of freely navigable water in which sea ice is present in concentrations of less than 1/10th and ice of land origin is absent (World Meteorological Organization, 2012).

Aspect	Before	After
Registration	Ship must be pre-registered at least four months before passage and it will be inspected at the owner's cost before entry.	Ship must be pre-registered at least 15 days before passage. No inspection.
Administrative authority	Shared between two marine operation headquarters.	Northern Sea Route Administration handles all administrative issues.
Technical requirements	Vessel must have at least Arc 4 ice class. Other vessels may only pass by way of exception. Double bottom floor and propeller with at least four blades required. Switching from *full ahead* to *crash back* must not take more than 45 seconds.	All vessels may enter and pass the NSR irrespective of their ice class, including those that have no ice class at all. The extent of mandatory icebreaker support is determined by the vessel's ice class (if any) and local sea ice conditions.
Staff requirements	Vessel must have enough crew members to organize continuous watch in three shifts. Captain must have at least 15 days of NSR navigation experience; else, an ice pilot is mandatory.	No particular staff requirements. An ice pilot is always mandatory.
Mandatory Insurance[9]	n/a	Vessel must have liability insurance covering environmental pollution.

Table 4: Liberalization of NSR regulatory framework since January 17, 2013 (Belkin, 2015; Ministry of Transport of Russia, 2013; Northern Sea Route Administration, 2013; Østreng et al., 2013; Russian Federation, 1996)

This will probably restrict her effective period of operation to between the end of August and beginning of October, when ice conditions in the NSR are easiest (Belkin, 2015). If icebreaker support in the NSR is required, then the *Mærsk Mc-Kinney Møller* would likely obtain it from the *Federal State Unitary Enterprise Atomflot*, or *Rosatomflot* for short, a state-controlled company that currently operates four nuclear-powered icebreakers in the

9 However, these regulatory requirements may strongly differ from the requirements that private underwriters put forward. Industry practice suggests that underwriters are quite reluctant to provide coverage unless the vessel has at least ice class 1A (Belkin, 2015).

NSR area[10]. Their technical specifications are presented in Table 5. Only icebreakers under Russian flag may escort vessels through the NSR (Ministry of Transport of Russia, 2013). Thus, we believe it is highly unlikely that Russia would ever allow other nations' icebreakers, such as China's *Snow Dragon*, to operate in the waters of the NSR.

It goes without saying that icebreaker support does not come for free. Escort fees depend on the ship's gross tonnage, its ice class (if any), and the time of year[11]. According to the official list of fees, the *Mærsk Mc-Kinney Møller*, having no ice class and a gross tonnage that exceeds 100,000 tons, would have to pay between 268 and 536 rubles (between US$4.32 and US$8.64 at the time of writing) per ton of gross tonnage, depending on the number of sectors along the NSR for which she requires support (Federal Tariff Service of Russia, 2014)[12]. Given her gross tonnage of 194,849 tons, the shipowner can expect an *official* fee in the range of US$1–2 million for a single icebreaker[13].

	50 Let Pobedy	*Yamal*	*Vaygach*	*Taymyr*
In service since	2007	1992	1990	1989
Gross tonnage	23,439	20,646	20,791	20,791
Propulsion power (MW)	55.2	55.2	36.8	36.8
LOA (meters)	159.6	150.0	149.7	149.7
Beam (meters)	30.0	30.0	28.9	28.9
Draft (meters)	11.0	11.0	9.0	9.0
Speed (knots)	21.0	21.0	20.0	20.0
Icebreaking capacity (thickness in meters)	2.8	2.0	1.77	1.77

Table 5: Rosatomflot's nuclear icebreakers operating in the NSR[14] *(Russian Maritime Register of Shipping, 2015; Rosatomflot, 2015b; Northern Sea Route Administration, 2015)*

This fee seems prohibitively high, particularly so in comparison with the US$230,000 the shipowner pays when a fully laden and northbound *Mærsk Mc-Kinney Møller* passes the

10 Since 2008, Atomflot is a subsidiary of the state nuclear corporation *Rosatom* (Rosatomflot, 2015a). Two other state-controlled companies also offer icebreaker assistance in the waters of the NSR (*Rosmoport* with the vessel *Kapitan Drantisyn* and *Fesco* with the vessels *Krasin* and *Admiral Makarov*). However, these vessels are restricted to offshore support operations with close bunker fuel proximity. To date, all international transits through the NSR have been accompanied by Rosatomflot's nuclear icebreakers (Belkin, 2015).

11 Detailed lists of fees (termed 'tariffs') are publicly available from http://www.arctic-lio.com/nsr_tariffsystem

12 Given the development of the dollar–ruble exchange rate in the wake of the sanctions imposed against Russia during the Crimea and Ukraine crises of 2014, these fees have, *de facto*, been cut in half. In November, 2013, one US dollar was worth 33 rubles; by January, 2015, it was worth 67 rubles.

13 These fees decrease significantly once the vessel is ice-classed. For example, a ship of the same size and GT as the *Mærsk Mc-Kinney Møller*, with an Arctic 4 ice class, would pay about 50% less.

14 The vessel *50 Let Pobedy* is also known under its translated name: *50 Years of Victory*. As of 2015, it is the largest and most powerful icebreaker in the world. A fifth nuclear icebreaker operated by Rosatomflot, the *Sovetskiy Soyuz*, has been out of service since 2007 and is scheduled for break up; however, in 2014 it was reported she will be recommissioned. A new generation of icebreakers is currently under construction, with completion planned for 2017 (Staalesen, 2014).

Suez Canal[15]. However, in practice, these official fees are not final but, rather, subject to negotiation. Real rates paid by the German firm *Beluga Shipping* while it was shipping in the NSR suggest a realistic dimension of about US$2.25 per dwt for the complete passage (Østreng et al., 2013), implying that the shipowner of the *Mærsk Mc-Kinney Møller* should negotiate for a rate of about US$437,000 for icebreaker support along the complete route. It needs to be noted, however, that the *Mærsk Mc-Kinney Møller* may require the assistance of two icebreakers since her wide beam of 59 meters surpasses the maximum canal width of about 40 to 42 meters that any single icebreaker operating in the NSR area can create; however, this problem may be mitigated by the arrival of a new class of icebreakers expected to become operative from 2017 (Belkin, 2015).

Finally, calculating and negotiating the premium for the mandatory insurance to cover the special risks of traveling in the NSR, such as pollution of the sensitive Arctic ecosystem, injury to persons, and costs of potential salvage operations *(Arctic premium)* are highly complex tasks. These potential liabilities are likely to increase the premium for the vessel's protection and indemnity (P&I) insurance. Further, statistics analyzing 40 years of vessel movements in Arctic waters suggest that navigation in shallow and ice-infested waters, as well as movements behind icebreakers, significantly increase the risk of hull damage. Given that ordinary hull and machinery (H&M) insurance does not cover operation in ice-infested waters, underwriters will likely charge a supplement to cover these risks (Chernova and Volkov, 2010; Emmerson and Lahn, 2012; Østreng et al., 2013). The operationalization of the Arctic premium as a multiple of the Suez Canal excess insurance cost, as proposed by Østreng et al. (2013), is not really helpful since underwriters do not publish the war risk insurance rates they charge[16]. Even if these rates were known, they are still subject to contemporary geopolitical events and are, therefore, extremely volatile. Hence, attempts to directly compare the insurance cost for the Suez Canal route against that for the NSR remain extremely speculative. Suffice it to say that, geopolitically speaking, the NSR has been unaffected by either war or piracy to date, implying a certain rate trade-off calculation between the routes should be possible.

Considerations for the NSR's future container shipping potential

For large container vessels, the cost for icebreaker support is likely to exceed any Suez Canal transit fees, particularly when vessels with a wide beam, such as the *Mærsk Mc-Kinney Møller*, may require the assistance of two icebreakers along more than one or two sectors of the NSR. However, this situation is likely to change in favor of the NSR as unrelenting climate change increases the number of days with open water conditions. During

15 To calculate this fee, we used the online toll calculator provided by the Suez Canal Authority (http://www.suezcanal.gov.eg/calc.aspx) with the following specifications: Container ship, northbound, 8 tiers on deck, laden, NT = 79,120, GT = 194,849, draft = 48 feet, beam = 194 feet, SDR = 0.683269 per USD.

16 The excess insurance cost for the Suez Canal route is primarily determined by the requirement to buy *war risk insurance* to cover the risks of piracy, terrorism, and war-related damage when passing 'listed areas', such as the Horn of Africa (Skuld, 2009, 2013). The reader should note that this insurance only covers the vessel (but not the loss or damage of any cargo it carries).

such days, in theory any vessel can operate independently on the NSR, which saves the cost of retrofitting to comply with ice classification[17] as well as any Suez Canal transit fees. Against the backdrop of these savings, the cost for a mandatory ice pilot seems negligible and the cost of additional liability insurance to cover the risk of environmental pollution may be more than offset by saving expenses for war risk insurance. Additionally, open water conditions allow the shipowner to better plan and predict itinerary times and, thus, reduce the often-quoted imponderabilities of Arctic shipping due to unpredictable weather and ice conditions. At the same time, these benefits can only be fully reaped when the *complete* NSR has open water conditions; otherwise, the benefits diminish when only some sectors of the NSR can be navigated independently while others require icebreaker support. Finally, the effective administration of NSR regulations may enforce the use of icebreaker support for vessels without ice classification even under open water conditions. Technically speaking, this *de facto* policy is contradictory to the letter of these regulations (cf. footnotes 5 and 6).

Further, climate change is only unrelenting when *long-term averages* are considered. When the sea ice extension in the Arctic Ocean between 1979 and 2013 is regressed to the mean, *average* ice coverage is clearly shrinking; however, the standard deviation suggests that *year-to-year* coverage is erratic and volatile (National Snow & Ice Data Center, 2015). Particularly, a reduction of the overall ice coverage in the Arctic Ocean need not imply the NSR will be ice-free. Indeed, the NSR can be partially or completely ice-infested while other areas of the Arctic Sea have open water conditions (National Snow & Ice Data Center, 2013a, 2013b). Personal communication with Belkin (2013) suggests that today the NSR has about 30 days with open water and 30 days with easy ice conditions per year. Since the latter condition requires mandatory icebreaker support for vessels that are not ice-classed, shipowners should closely monitor the number of days with open water conditions over the coming years. Once a critical number of open water days has been reached, and once these days are not isolated events but occur in coherent time segments, the business case for shipping in the NSR is likely to become very attractive.

Additional potential for cost savings can result from deliberate slow-steaming when shipping in the NSR. For example, the Rotterdam–Shanghai route via the NSR (approx. 8,200 nautical miles) is about 2,300 nautical miles shorter than the Suez Canal route (approx. 10,500 nautical miles)[18]. Assuming constant travel at her design speed of 23 knots, the *Mærsk Mc-Kinney Møller* reaches either destination about 100 hours earlier if she travels via the NSR.

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17 Retrofitting the *Mærsk Mc-Kinney Møller* would require costly adaptions, such as installing protection for the rudders and propellers, hull enforcements, and ice-proof sealing of cooling water openings in the hull (MAN Diesel and Turbo, 2012). Since such retrofitting for largo cargo ships has not yet been done, the extent to which the associated investments would amortize is unknown. However, the existence of newly built ice-classed bulk vessels and tankers operating in the NSR suggests that profitable operation of ice-classed ships is essentially possible (cf. Mietzner, 2015 – this book, and Keupp and Schöb, 2015 – this book).

18 Distance for the Suez Canal route was calculated with data from *http://www.sea-distances.org* and rounded; distance for the NSR was calculated by adding the distance between Rotterdam and Hamburg (305 nautical miles as calculated by this website) to the distance between Hamburg and Shanghai given by Mietzner (2015, this book) and rounding the technical result of 8,130 nautical miles to 8,200.

Alternatively, if time is not of the essence, her owner might deploy a slow-steaming strategy, implying she reaches her destination at the same time as a vessel traveling through the Suez Canal route, but with less fuel consumption and, hence, lower bunker cost. The advantage of 100 hours is equivalent to a minimum slow-steaming speed of 18 knots[19].

The main cost driver of container shipping is bunker cost, incurred as a result of fuel oil consumption. At her design speed of 23 knots, the *Mærsk Mc-Kinney Møller* can expect to burn almost 240 tons of fuel oil during a 24-hour period of operation, or approximately 10,000 liters per hour[20]. Since her capacity exceeds 10,000 TEU, according to Notteboom and Cariou (2009), this consumption is reduced by approximately 38% at 20 knots and by 46% at 18 knots. Her engines can burn most commercially available heavy fuel oils as long as their viscosity is below 700 centistokes at 50° Celsius (MAN Diesel & Turbo, 2010), implying prices of the most common type of bunker fuel, IFO 380, can be used for calculation. The price of IFO 380 is highly volatile and depends, *inter alia*, on the port where it is bunkered and the situation of the global oil-producing industry[21]. Assuming an average price of US$420 per metric ton, slow-steaming in the NSR corresponds to significant bunker cost reductions of 29% and 31%, respectively (cf. Table 6). These savings would either increase her owner's profit (assuming constant charter rates) or allow the owner to outcompete others in contested markets by offering lower charter rates.

Speed (knots)	Hours to either destination	Fuel consumption (tons/24 h)	Total fuel consumption (tons)	Associated bunker cost (US$)
23	357	240.00	3,570.00	1,499,400
20	410	148.80	2,542.00	1,067,640
18	456	129.60	2,462.40	1,034,208

Table 6: Bunker cost reduction potential of the Mærsk Mc-Kinney Møller by slow-steaming on the relation Rotterdam–Shanghai via the NSR (own calculation)

The potential savings from slow-steaming should be considered when future business cases concerning the NSR are calculated. Ship owners might consider offering 'fast track' services that capitalize on the shorter travel time, or 'economy' shipping at slow-steaming rates.

Finally, the logistics and scheduling aspects of global container shipping operations are likely to influence the extent to which the NSR will be perceived as a viable alternative to the Suez Canal route. Container ships do not tramp but operate as liner services, i.e., they

19 At this speed, travel time in hours is equivalent, assuming the given distances and constant 24-hour operation at identical speed without any calls at intermediary ports.

20 Her engines require 168 grams of fuel oil to produce 1 kWh (Maersk, 2013c) and one hour of operation at her design speed of 23 knots requires 59,360 kW of energy (Maersk, 2013a, 2013b; MAN Diesel & Turbo, 2010).

21 Prices for the average 380 centistoke fuel oil per metric ton bunkered at the largest European ports bottomed at US$192 in December, 2008 and topped at US$707 in March, 2012. In November, 2014, the price had declined to US$420 (Bunker Index, 2014).

travel bidirectional itineraries, with fixed start and end points and pre-defined intermediate ports along the route (*loops*). A loop defines fixed travel times between any two ports. As a result, customers are being given a reliable structure by which they can synchronize their production to maritime logistics (Stopford, 2009; Verny and Grigentin, 2009). The *Mærsk Mc-Kinney Møller* sails the loop AE 10 between Northern Europe and Asia (Maersk, 2013d).

Due to this tight scheduling and synchronization, ships must travel pre-defined routes at pre-defined times. Reliability and predictability are key for the profitability of such container operations, such that any given vessel cannot be spontaneously redirected to travel the NSR instead of the Suez Canal route, not even when weather conditions should be highly favorable. For the same reason, a vessel will stop at all intermediate ports that its loop defines, irrespective of whether or not it can load additional cargo. A more intensive utilization of the NSR would require the planning of (if seasonal) loops. Given the nautical and weather difficulties described further above in this chapter, predictability will probably be hard to attain for such loops.

To assess the shipping potential of the NSR under these circumstances, we analyzed data on 18 loops between East Asia and Northern Europe operated by Maersk Line, CMA-CGM, and MSC (Maersk Line, 2015; MSC, 2014; CMA-CGM, 2015). Structurally, these 18 loops are very similar. Eastbound, they connect the ports of Northern Europe, i.e., those located northeast of Brest, to those of East Asia[22]. All loops pass through the Suez Canal and the regional hubs Singapore–Tanjung Pelepas[23] and Kelang. Westbound, the same ports are called on the return journey. However, the loops differ regarding the intermediate ports they call at during either eastbound or westbound journeys. The 18 loops we examined call at between nine to 23 ports during their itinerary. All loops call at least at two intermediate ports, or at least at the Hong Kong region or Southeast Asian ports. There is no loop that only calls at ports in Northeast Asia and in Northern Europe; further, there is no direct eastbound or westbound connection between these two regions. Thus, the NSR cannot serve as a direct substitute for any loop; instead, independent planning with the establishment of new loops specifically designed for northern travel would have to be established.

Further, we transformed the published structural information about the 18 loops into a binary matrix that assigns a value of 1 whenever a port is called at during any eastbound or westbound journey (including the start and end of that voyage), and a value of 0 otherwise. While this procedure may inflate the number of calls at the start or end point if the vessel is turned around immediately, it removes potential bias from arbitrary removal of double counting since the start and end points of the loops differ across the shipping companies, and since no information is given about handling times. For the sake of clear presentation, we aggregated the data by port into three geographical regions. The region *Northern Europe* includes all ports located in Europe but northeast of Brest. The *Intermediate Region* includes all ports that are located between Brest and Port Kelang along the Suez Route. The

22 Within East Asia, calls concentrate on the Hong Kong region (ports of Hong Kong, Chiwan, Yantian, Shekou, Xiamen, Nansha, and Taipeh) and the Northeast (ports of Ningbo, Shanghai, Tianjin, Xingang, Qingdao, Dalian, Busan, Kwangyang, Kobe, Nagoya, and Yokohama).
23 Due to the immediate vicinity of these ports, our analysis combines them into one port area.

region *East Asia* summarizes Port Kelang and all ports to the east. It is further differentiated into the three sub regions: *Southeast Asia*, *Hong Kong Region*, and *Northeast Asia*[24].

The numerical results of our analysis are presented in Table 7 and suggest that, in total, the importance of calls at regional ports is somewhat mitigated, since the 41 calls at intermediate ports only account for 10.2% of all port calls. Tanger and Colombo are most frequently called at, with six calls each. These results suggest that, except for the opportunity to load or unload additional cargo at an intermediate port, trade via the Suez Canal route is, by and large, direct traffic between East Asia and Northern Europe. However, a large part of this direct traffic is routed via the hubs of Singapore–Tanjung Pelepas and Kelang, both in eastbound and in westbound directions.

Region	Sub region	Number of calls at ports (region)	Number of calls at ports (sub region)	% share of total calls per region
East Asia	-	207	-	51.5% *(of which)*
-	Northeast Asia	-	109	*(27.1%)*
-	Hong Kong Region	-	64	*(15.9%)*
-	Southeast Asia	-	34	*(8.5%)*
Northern Europe	-	154	-	38.3%
Intermedi-ate	-	41	-	10.2%
Total		402	207	100%

Table 7: Port calls across all examined loops between Northern Europe and Asia. Own calculation using data from Maersk Line (2015), MSC (2014), and CMA CGM (2015)

These results confirm the analysis of Ho (2011) who suggested that more than 50 per cent of the total Far East–Europe trade has to pass through Singapore. To not call at these ports may, therefore, imply high opportunity costs, and these would have to be factored in when the cost of traveling the NSR is calculated. The lack of any intermediate ports or hubs along the NSR effectively reduces the competitive advantage of the NSR to shortening the geographical *distance* (and, hence, reducing fuel cost) for itineraries between Northern Europe and East Asia, since travel *speed* may be subject to weather conditions.

Thus, opportunity costs of not calling at the hubs of Singapore–Tanjung Pelepas and Kelung have to be offset against bunker cost (and possibly travel time) savings.

Finally, the NSR may be thought of as a *fast return route for underutilized vessels*, whereby ships that have unloaded their cargo in Northern Europe would return to Asia via the NSR. Thus, a ship could call at any intermediate port during its westbound journey and capitalize on either shorter travel time (weather permitting) or bunker cost savings on its

24 Due to limitations of space, the data matrix is not presented here. It is available on request from the first author.

return journey. Such a novel north–south loop may mitigate known load factor problems in the container shipping industry, since westbound transport volume from Asia to Europe by far exceeds the corresponding eastbound transport volume. As a result, eastbound load factors are only between 30% and 55% of the westbound ones, and many vessels return laden with empty containers, implying that eastbound charter rates are about 60% lower than westbound rates (Schönknecht, 2009; Verny and Grigentin, 2009). Shipping via the NSR may provide an opportunity to neutralize this disadvantage. Further, since reduced cargo tonnage would also result in shallower draft, some of the navigational challenges of the NSR might be mitigated for eastbound voyages.

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Through the Northern Sea Route by *Stena Polaris*: A logbook[1]

Patrik Svahn

Day 1
Date: September 25, 2013
Position: Vardø, Norway, 70°37' N, 31°10' E
Weather: Rough sea, strong winds, blistering cold

When the Russian ice advisor Sergey and I arrived in Vardø, high up in north-eastern Norway, we were looking forward to finally embark on the *Stena Polaris*—a 65,000 dwt ice-classed tanker. With great excitement, we boarded the small boat that was to take us to the tanker that drifted some nautical miles from shore. We had been warned the previous evening that the weather forecast was quite bad, and we were unsure if we could embark. As we passed the breakwaters, we realized that the small boat could not handle the big waves well. When we saw the *Stena Polaris* vaguely in the horizon, we could already find that she was rolling quite heavily. After approximately 30 minutes of cutting through waves three to four meters high, we finally made it to the *Stena Polaris*, or so I believed, because the saltwater spray all over the boat's windows barely enabled us to glimpse outside. The boat drivers were trying to carefully approach the ship's side where the crew had rigged the pilot ladder as agreed—one meter above the water line. However, in the rough sea, the heavy tanker now rolled from four meters above to four meters below the waterline. As none of us wanted to risk our lives, we canceled our attempts to embark and headed back to the shore.

I asked the two Norwegian boat drivers for their suggestion. They replied in chorus: 'Kirkenes!' (the next port 50 miles to the southwest). I immediately called our agent there to discuss the matter, and he promised to arrange for a launch boat. Thereafter, I called up the master of the *Stena Polaris* on the very high frequency (VHF) radio and instructed him to immediately sail to Kirkenes, a trip that would take the vessel approximately two and a half hours. Unless one wants to enjoy a scenic drive along the coastal road all afternoon, the only way to go from Vardø to Kirkenes is by airplane. Thereafter, we stood in the blistering cold and strong winds, waiting for a taxi to take us to the airport where we managed to mount a DHC-8 aircraft just before it was scheduled to depart.

We arrived in Kirkenes after a 20-minute flight, while the *Stena Polaris* was still at sea and expected to arrive within an hour. However, our agent informed us on the phone that

1 This chapter is based on original material the author first published online in a series of personal blog entries (*http://www.stenanorthernsearoute.com*). The author and the editor of this volume worked together to revise these texts, forming a comprehensive narrative and including additional information and illustrations. All photographs published in this chapter were taken by Patrik Svahn.

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the weather had worsened and the launch had been cancelled. We were disappointed after this news. The agent then suggested taking the vessel into the fjord as the waters there would be calmer, but this implied embarking a pilot. Meanwhile, the captain of the *Stena Polaris* explained that he did not have any charts for this area; hence, he had to navigate far away from the shore. This meant the pilot could not embark. While we waited in a restaurant for hours, the captain ordered electronic charts and calculated a route into the fjord. Now the question was whether there were any pilots available. We waited for another three hours at the restaurant before the agent finally called with the best news we had received all day: the pilot was confirmed. He would pick us up in 45 minutes and take us to the pilot boat by which we would embark the *Stena Polaris*. The waves were calmer here than in Vardø, although still two meters high. However, the vessel lay steadily in the water this time, so we finally managed to climb up the ladder. While the crew hoisted our luggage on board, we walked to the bridge wherein we received a warm welcome onboard the ship from Captain Sasa Stipanovic.

Day 2

Date: September 26, 2013
Position: Southwestern Barents Sea, 72°55' N, 41°58' E
Weather: Rough sea, strong winds

The weather gods were not with us tonight. The wind that was forecast for the night rapidly increased in strength, making the ship roll and pitch madly. Our good night's sleep thus was transformed into a struggle to not fall out of bed and onto the floor. The crew got less than two hours of sleep, and the ship continued to roll through breakfast such that coffee and orange juice almost escaped our cups.

In the morning, I talked to the master, inquiring about the preparation of the voyage. He explained the company's procedures for sailing Arctic waters and the Russian ice advisor's role in helping us navigate the safest possible route through these special waters. I finally made my way to the bridge where the advisor was already busy planning the route with the navigational officer. I looked over their shoulders and observed that the two men conversed in Russian, which was their native language.

Day 3

Date: September 27, 2013
Position: Southeastern Barents Sea, 74°53' N, 49°57' E
Weather: Rough sea at night, then a calm day, sunshine

I woke up at about two o'clock in the morning when the rolling ship threw me out of bed and against the starboard wall of my cabin. This merry game continued all night, but when I looked outside my cabin window in the morning with sleepy eyes, the sea was quiet and the sun had just risen. After breakfast, I had a meeting with the South Korean passengers onboard: four journalists, one professor, and one representative from the charterers. The charterers' representative expressed his gratitude for the opportunity to ship the first South Korean cargo ever through the Northern Sea Route (NSR). All of them are hoping that the NSR will help South Korea's trade, industry, and ports to grow further in future.

After lunch, I wanted to enjoy the weather, so I took a walk on the deck. It was just 3° C outside, so I had to put on my winter jacket and a hat. I started walking along the starboard side, enjoying the view, then made my way to the forecastle. There, I did what I always do when I am on a ship: I looked down the forward fairlead to see the bulb and the Stena shield, which significantly fronts all Stena ships and, in a way, represents a modern figure-head. I have always been fascinated by the figureheads on old sailers; to see the shield above the bulb breaking the water while hearing nothing, but the waves crashing against this most forward part of the ship is the perfect stress release. When I returned to the bridge, I met the ice advisor who told me that tomorrow we would pass the official border to the NSR.

Day 4

Date: September 28, 2013
Position: Cape Zhelaniya, 76°57′ N, 68°34′ E
Weather: Calm sea, heavy snowfall

Today, we passed Cape Zhelaniya, a desolate place on the northernmost point of the island of Novaya Zemlya. Its snow-covered hills separate the Barents Sea from the Kara Sea. Thus, the cape marks the western entrance to the NSR. The sea is calm this morning, but very dark clouds hang in the sky. The officer on watch tells me that the snow is coming.

On the bridge, I asked the mate if he had seen any other vessels in the area. He informed me that we were alone except for a few fishing vessels and the icebreaker *Yamal,* which we would shortly meet. *Yamal* is one of the nuclear icebreakers that operate along the NSR. Sergey, our Russian ice advisor, had spoken to the crew of the icebreaker earlier this morning as he usually works as its master when he is not working as an ice advisor. He had learned that the *Yamal* was heading west to Murmansk for repairs. On the radar, I could see both the *Yamal* and dark clouds approaching our position. I went down to my cabin to fetch my camera because I wanted to take some pictures of the icebreaker; when I reached the bridge, so had the snow. We now could not see any further than a ship's length, so the only idea we got of the nuclear icebreaker was a blimp on the radar screen. In his broken English, the ice advisor assured us we would meet another icebreaker as soon as we reached Matisen Strait. Ironically, just about an hour after we had passed the *Yamal*, the snow clouds disappeared and the sun appeared again, giving us some of the best weather we have seen so far.

Day 5
Date: September 29, 2013
Position: Southwestern Kara Sea, 76°54' N, 84°57' E
Weather: Calm sea, grey skies

Today is a grey day, and we are heading on a southwest course across the Kara Sea. The sea is calm, and we are all alone on the waters except for a big whale that passed us this afternoon on our starboard side. We are approaching the rendezvous point with the icebreaker at Matisen Strait.

Last night, we learned that our voyage will be delayed. The convoy we were bound to follow had passed Matisen Strait already, so we will have to drop anchor on arrival and wait for the icebreaker to return. Even though the first section of Matisen Strait has open water and only drifting ice, the NSR administration is very strict regarding safety and thus they will not allow us to pass without icebreaker assistance. Thus, when we arrive tomorrow morning, we will have to wait for approximately two days for the icebreaker to take its convoy to the New Siberian Islands and then return to meet up with us. What should we do to pass the time while at anchorage? First, I thought of fishing, but I do not know what fish one could catch here in these icy cold arctic waters.

Day 6
Date: September 30, 2013
Position: Matisen Strait, 76°20' N, 96°00' E
Weather: Icy cold, drifting ice at sea

Early this morning, the *Stena Polaris* struck ice for the first time on her voyage. The temperature is now below 0° C. For now, we see little more than drifting ice patches on the sea, but in the distance the ice is firming up. We dropped anchor this morning in Matisen Strait, and now we are awaiting the icebreaker.

Unexpected good news reached us: the icebreaker is ready to meet up earlier, so our waiting time is reduced from two days to 14 hours. Our convoy will be composed of the *Stena Polaris* and the M/V *Boris Vilkitsky*, scheduled to arrive at our position at the same time as the icebreaker. Together, we will sail through the first icebreaker assisted part of the route until we reach the New Siberian Islands. Thereafter, we will meet the second icebreaker for the last assisted part of the route.

We expect the ice to become increasingly solid as we sail deeper into the Arctic waters and further from civilization. One feels isolated out here in the middle of nowhere, far from family and everyday life. Our only companions now are the seals that are passing the ship every now and then. All seamen onboard have crossed the Atlantic, the Pacific and the Indian Oceans, sailed through the Panama and Suez Canals, and passed both the Cape of Good Hope and Cape Hoorn, but none of them has ever sailed the NSR. We are on a journey into the unknown with only each other to cling to.

Day 7
Date: October 1, 2013
Position: Vilkitsky Strait, 77°57' N, 103°35' E
Weather: Ice covered yet calm sea despite very strong winds

Ice as far as the eye can see is what we all woke up to this morning. We are close to the North Pole now and follow the icebreaker *Taymyr* (see photo 1), which is taking us through these waters. It arrived late last night and so did the second vessel in the convoy, the M/V *Boris Vilkitsky*. The three of us began the journey through the ice in the pitch dark night.

Photo 1: Icebreaker *Taymyr* leading the way

Our ice advisor commands us over the radio, instructing us how to navigate and to watch out for icebergs. The *Taymyr* is a so-called river-class icebreaker, a shallow drafted vessel that can go up small rivers to break ice. With her nuclear powered engine she has a total power of 36.8 MW, so the term *beast* may best describe her nature. She was built in 1989 and has a length overall (LOA) of 152 m and a beam of 29.2 m. The vessel is operated by a crew of 110, including one agent who is instructed to destroy navigational documents and current tables in case of an emergency so no one else might use the information. She needs to refuel her nuclear energy every four years at a price of one billion rubles.

Skipping icebergs and cruising between snow-covered islands, we wonder how anything could survive in this part of the world. The water is freezing cold even though we are traveling in the so-called summertime, and the islands—the only land in our sight—are flat and do not provide any shelter from the strong winds. So far, the only wildlife we have seen has been some seals, a few seagulls, and a whale. However, that was before we entered the particularly harsh part of our journey.

This year, winter is coming earlier than expected, so the ice advisor is surprised to see the amount of ice that has already built up. We learn that there are two types of ice: old and new. We are now cutting through mostly new ice, that is, ice less than one year old and 10 to 50 cm thick. In contrast, old ice has existed for several decades and is very thick, heavy, and strong. Icebergs are made of this material, and thus they are quick to cut a ship's hull (see photo 2). Not that the icebreaker would care. She dances right between the icebergs, and when they are too big to go around, she merely goes straight through them and crushes them, relentlessly propelled by her nuclear engine. This sight makes us feel safe.

Photo 2: Tip of an iceberg composed of old ice

In the afternoon, the weather conditions worsened. The wind picked up even more and finally blew at a steady 20–22 knots, making it unbearable to be outside. Nevertheless, thanks to the ice at sea, the strong winds have little effect on us; our vessel is proceeding through the icy water like a barge. 'If this were the North Atlantic, the ship would be rolling like hell,' Captain Stipanovic laughs.

Day 8
Date: October 2, 2013
Position: Western Laptev Sea, 77°51' N, 108°38' E
Weather: Snowstorm, strong winds, icy cold

After she had guided us through the ice, the *Taymyr* made a swift U-turn and, shortly after, disappeared in the dark night like a ghost ship. We had expected her to escort us until this morning, but the ice conditions lightened and the sea opened up. She is now going back to Matisen Strait to lead the next convoy through the ice, while we are heading toward the New Siberian Islands. There, we will meet her sister ship, the *Vaygach*, for our next transit through the ice. For now, we are all alone, sailing the open waters of the Laptev Sea.

The *Vaygach* is busy with another convoy, so we will drop our anchor for at least two days here in the Laptev Sea and wait for her to guide us through heavy, solid, old ice all along the East Siberian Sea and through Long Strait— considered to be the most dangerous part of the NSR. But we are not worried, only excited.

The temperature today is always below 0° C. The deck of our vessel, usually an intense red color, is slowly turning white (see photo 3). We are in the middle of a snow storm and the winds are still between 20 and 22 knots, just like yesterday. The *Stena Polaris* is slowly rolling from side to side, and in a way, we rather appreciate the calming slow rocking of the ship. There have been long watches with sharp lookouts on the bridge during the passage through the ice, and there will be even more during the next ice passage. The calm rest is welcomed by the crew. During the last passage, there were always two officers and one crew member on watch on the bridge. At least one of the officers must speak Russian to facilitate communication with the icebreakers because they hardly speak English onboard there.

Before the voyage commenced, our vessel's technical managers, Northern Marine Management, had to make sure that everybody onboard had the proper equipment to transit the NSR. This meant winter clothes, such as warm jackets and pants, and also winter boots, gloves, and hats. In Arctic conditions, a lack of appropriate clothing can cause significant freezing injuries. As the vessel is transiting remote waters, medical assistance is far away.

Photo 3: Stena Polaris' red deck turns white

Day 9
Date: October 3, 2013
Position: Southwestern Laptev Sea, 74°59' N, 122°50' E
Weather: Grey skies, snowstorm, strong winds

The third mate hastily called me to the bridge last night just before midnight. Standing in the blistering cold, the third mate, the captain, and I witnessed the glow of the northern lights—the aurora borealis—their intense green color lighting up the pitch black sky right above our heads. The light was moving and changing shape constantly, like a green fairy dancing slowly across the sky. We, being all alone on the Laptev Sea, felt like she was dancing for us.

When I woke up in the morning, the skies were grey. The dark clouds and the wind that bring the snow are here again. The ship is rolling and pitching slightly in the strong winds; the snow falls for approximately 30 minutes, then stops for 30 minutes, then falls again, and so the game continues. The weather forecast for the Bering Sea does not look good. We expect to meet really heavy storms along our way southward to Korea.

Today, we have passed the mid-point of our voyage. This means that we have covered half of the total distance between Ust Luga and Yeosu. It is yet another quiet day onboard as we are still all alone on the Laptev Sea; everybody onboard has something to do or to work with. The second officer is preparing the charts for the latter part of our voyage on the bridge; the chief officer is doing research about cargo pumps in the cargo control room; and the third officer is sitting next to him, updating the list for onboard safety equipment. In the crew day room, the two mess men are taking a well-deserved and relaxing break after having served lunch to everyone onboard, while the engineers are conversing in the engine control room. The Korean journalists are busy in the ship's office, writing articles about the NSR and the natural resources that it sustains.

Day 10

Date: October 4, 2013
Position: Anchored in the eastern Laptev Sea, 74°53′ N, 135°58′ E
Weather: Pancake ice on the sea, sunshine first, then a sudden snowstorm

Pancakes as far as the eye can see! Not for breakfast, though. Pancake ice is what greeted us this morning as we approached the point for our rendezvous with the icebreaker *Vaygach*. This ice structure resembles pancakes floating on the sea, and the sun paints a golden shine across the water between them. I learn that pancake ice is formed when slush ice begins to float together and finally arranges itself in a round shape. The long waves make the pancakes move in a slow rhythm, creating an extraordinary scenery around our vessel (see photo 4).

Photo 4: Pancake ice

Later in the morning, we arrived at our anchoring position where we are to await the *Vaygach*. All ice advisors are calling the icebreakers twice every day, at 09:00 and 21:00 Moscow time. It goes without saying that they communicate only in Russian. The icebreakers then provide all vessels that are to team up in a convoy with news about their status and position. Our ice advisor received bad news on the medium frequency (MF) radio: the *Vaygach* would not reach our position before October 7 at noon Moscow time—in other words, in three days—and there is nothing we can do but wait for her. There are only two icebreakers assisting in these waters, the *Taymyr* and the *Vaygach*. They are taking convoys from west to east and vice versa, implying that when an icebreaker has not yet reached the far eastern end of the passage with a convoy, any vessel will have to wait until the icebreaker has escorted the first convoy and taken the next one back through to the west side of the ice-covered area where we are waiting.

At the same moment that we received this news, a big dark cloud appeared on the horizon. We watched how quickly the snowstorm made its way over the water and the pancake ice toward us with great fascination. After less than three minutes, it was just off our port side, and one minute later, our vessel was completely inside the storm. Thereafter, it disappeared as quickly as it had engulfed us.

Day 11
Date: October 5, 2013
Position: Anchored in the eastern Laptev Sea, 74°53′ N, 135°58′ E
Weather: Cloudy

Today, we saw three walruses playing just off our starboard side. They enjoyed the few rays of sunshine coming through the thick clouds. Thereafter, they disappeared into the water again. We could see them pop up through the surface farther and farther away from us until they finally disappeared. After witnessing the crew performing drill exercises scheduled for today, I went up to the bridge where I saw the sunset over the Laptev Sea. We heard from the ice advisor today that there is a small chance that *Vaygach* will come in as early as tomorrow evening. We will see tomorrow.

Day 12
Date: October 6, 2013
Position: Anchored in the eastern Laptev Sea, 74°53′ N, 135°58′ E
Weather: Icy cold

The water is definitely getting colder now, as is the outside temperature. The pancakes are starting to stick together and form one big pancake. Winter is coming … or was it ever summer? I do not know. All I know is that it is cold and it is getting colder by the day.

At three o'clock in the afternoon, we finally heaved up anchor. The ice advisor had spoken to the crew of the icebreaker *Vaygach,* who advised us to heave and to slowly proceed eastward to meet them later tonight. Things change quickly in shipping. We were not supposed to meet them, but they wanted to save some time for the convoy to pass through one of the toughest parts of the transit during daylight. As the *Stena Polaris* is a 1A ice-classed tanker, they made an exception and let Captain Stipanovic navigate slowly through the thin ice.

Day 13
Date: October 7, 2013
Position: East Siberian Sea, 72°53′ N, 151°44′ E
Weather: Snowfall, strong winds, blistering cold, thick old ice at sea

Late last night, we could finally see the *Vaygach* in the dark distant night. She was escorting another vessel, an Aframax tanker, on a westbound course. As soon as she had passed us on our port side, she called up the other vessel and instructed it to proceed on its own. Thereafter, she made a U-turn and headed toward us. She snuck up on our starboard side and proceeded ahead of us. The snow was raging outside, and we could almost not see her when she passed fairly close (see photo 5). We started to follow her as she steamed through the same broken ice trail where she had just escorted the Aframax. We all agreed that it felt good to be moving again, as staying at anchor could become quite dull in the long run. We are now in a convoy with the M/V *Mari Ugland*, a Panamax vessel, and the *Vaygach* leading the way. Today, we also saw our first polar bear. We were all mesmerized by the big creature making its way over the frozen Arctic waters. As they normally live farther up north and not in the waters through which we are steaming, we were extremely lucky to be given the opportunity to see one.

In the morning, we easily steamed through new ice, but in the toughest part of the NSR, which we are approaching now, the ice is much thicker. Behind us, the M/V *Mari Ugland* is constantly lagging. The *Vaygach* constantly calls her on the VHF, instructing her to keep her speed and to not lag more than six cables behind us. The icebreakers are very strict and insist that that you follow their orders as the ice can be tricky and the visibility is poor. Currently, there are icebergs all around us, and even if a vessel is built in conformance with the highest ice class, an iceberg could cause significant damage to the hull. Last year, the *Vaygach* escorted two Finnish icebreakers through the NSR twice.

In the late afternoon, the ice became even thicker. We could see more and more of the grey-colored old ice. At some places, it was up to three meters thick. Old ice closes the channel created by the icebreaker much faster than new ice. Even though we were following the icebreaker just six cables aft, the channel had almost closed again, although it had been created just minutes ago by the *Vaygach.* Our ship jumped a little every time the heavy slabs of old ice smashed against our hull. The ice advisor informs us that this area is known for challenging ice navigation; it is quite difficult to see the difference between old and new ice when everything is covered in snow. The fact that it is dark outside is not helping (see photos 6 and 7).

Photo 5: Following the *Vaygach* through adverse weather

Photo 6: The *Vaygach* crushing thick ice

Photo 7: Bulb of the *Stena Polaris* crushing the ice

Day 14
Date: October 8, 2013
Position: East Siberian Sea, 71°55′ N, 161°59′ E
Weather: Heavy winds, rough sea

Today is a rather quiet day on board. We are still following the *Vaygach*, which leads us through the waters of the East Siberian Sea. This morning when I came to the bridge, I could see pancake ice around the ship. The spots with old hard ice are still there, but the ice is definitely lighter compared to yesterday. However, we have passed through some tough ice during the night. On many occasions, I felt that our vessel had struck the ice hard; one could feel the whole ship shaking as it hit one of the massive slabs. However, we are confident because the hardest and most dangerous part of the NSR now lies behind us.

Our challenge now is to disembark the ice advisor. In general, the icebreaker would launch a small speed boat that would come alongside our vessel. The ice advisor would then disembark using the pilot ladder, the same way he and I came onboard in Kirkenes. But the weather forecast shows heavy winds, meaning big waves and a heavy swell, so with the failed attempt to embark at Vardø fresh in his memory, the ice advisor is concerned about getting off the *Stena Polaris*. While joking with him that he is certainly welcome to accompany us to South Korea, we can do nothing but hope the weather will improve.

Day 15
Date: October 9, 2013
Position: East Siberian Sea, 70°59′ N, 173°45′ E
Weather: Calm sea, partly cloudy, sunshine

When I came to the bridge early this morning, the sun had been up for an hour or so, and between the clouds one could see the sunshine. We had become used to the greyish color of the sea and sky, and they often even seemed to melt together. But this morning was different. With this fine weather and the calming wind, there was hardly any swell on the water, so the ice advisor could finally disembark. As the launch boat with him on board left our side, it headed swiftly towards the westbound bulk carrier *Nordic Bothnia,* which was slowly steaming toward our position. The ice advisor would directly transfer onto that vessel to take her through the NSR along the route we had just traveled.

By the afternoon, we were steaming by ourselves through the East Siberian Sea, with no icebreaker to lead the way and no ice advisor to assist. The density of the ice had increased slightly compared to this morning, and now we were surrounded by pancakes again. Before departing, the *Vaygach* had provided us with a heading and instructed us to not steam faster than nine knots while making our way through the final part of the ice belt. Although we have now almost completed the ice-covered part of our trip, we are far from concluding it. The next challenge is to reach the Bering Strait and then cross the rough Bering Sea. We expect hard weather conditions and are doing anything but sitting back and relaxing. It is time for rock ‘n’ roll, as Captain Stipanovic likes to put it.

Day 16
Date: October 10, 2013
Position: Chukchi Sea, 69°50′ N, 176°56′ W
Weather: Fine weather, calm sea

I went to the bridge around three o’clock in the afternoon and realized it was already dark outside. But the icy part of our voyage has concluded. We are now completely out of the ice-covered area, and the East Siberian Sea lies open and calm ahead of us. It is a nice day today with little wind as we and the M/V *Mari Ugland* on our starboard side pass the Russian mainland and the Chukotka region. Today, we steer into the Chukchi Sea, the last part of the NSR before we expect to arrive at the Bering Strait tomorrow afternoon. Increasing number of villages are coming up on the charts, and our southwestern heading is leading back to civilization. While I rather enjoyed being in a remote part of the world for two weeks without any access to the Internet, TV, or any of the other media that one takes for granted in everyday life, two weeks of this experience are enough for me. Everyone on board is looking forward to having Internet access again to contact their families and read a newspaper.

Day 17
Date: October 11, 2013
Position: Bering Strait, 66°00' N, 169°00' W
Weather: A warm zero degrees, but strong winds, later some heavy rain

Summer is here! For the first time since we left Vardø two and a half weeks ago, the temperature is above 0° C. In the afternoon, the wind picked up to approximately 30 knots, and we began to feel the rock 'n' roll of the Bering Strait coming closer. We were still a few hours away, and the ship was already rolling. Heavy rain began to pour down on us, and it was raining sideways due to the wind. Nevertheless, the deck of the *Stena Polaris* was regaining its red color as the snow slowly melted away. At about four o'clock in the afternoon, we passed Cape Dezhnyov and entered the Bering Strait. The weather was now slightly worse as the winds had picked up further and it was also completely dark outside.

Day 18
Date: October 12, 2013
Position: Bering Sea, 63°12' N, 175°02' W
Weather: Rough sea

The Bering Sea has asked us for a dance and we delightedly accepted. The swell is coming both from the starboard side and from the aft, thus making the ship slowly roll from side to side (see photo 8). As we expect a storm to hit us the day after tomorrow, we expect the rolling to become worse. We are now proceeding on a southwesterly course across the Bering Sea. This morning the sun rose at half past three in the morning, and it will go down at half past one in the afternoon, so we slightly feel out of sync onboard. It is quite strange to experience these shifting daylight times. One knows that two o'clock in the afternoon is no time to go to bed; still, one starts yawning and feels sleepy. Certainly, our northerly latitude also affects the daylight times. We had the option to change the ship's time further, but made the decision to stop when we were on South Korean time. In my opinion, this was the correct decision as otherwise we would just keep changing the time forward and then back again, leading to even greater confusion.

Photo 8: Stena Polaris rolling in the Bering Sea

Day 19
Date: October 13, 2013
Position: Bering Sea, 61°40' N, 179°55' W
Weather: Fine weather, calm sea, sunshine

Unexpectedly, we are experiencing a beautiful day and fine weather while cruising the Bering Sea. The sun makes the calm sea glow as we steam on a southwesterly course toward South Korea. We are enjoying this fine weather as long as it lasts, but we still expect the storm to hit us tomorrow: the forecast predicts winds of 45 knots. The crew is completely busy, ensuring that all loose items are safely lashed before the storm hits us. Heavy equipment and many items onboard could get loose in heavy weather, with terrible consequences if they do.

Day 20
Date: October 14, 2013
Position: Bering Sea, 59°09' N, 172°49' E
Weather: Stormy, very rough sea

The storm has now hit us. The night was rather quiet, but when I woke up this morning, I could feel the ship moving from side to side. On the stairs that lead to the bridge, I was swung from port to starboard side. I had to hold firmly on to the railing so I would not fall over or down the stairs. When I finally made it up to the bridge, I saw nothing but the angry Bering Sea through all windows, throwing the bow of the *Stena Polaris* ten meters from side to side. The waves smashed against the ship's hull, making her roll from starboard to port and back again. I could see white foam forming on top of the waves, which were up to eight meters high. I was told the wind speed was approximately 50 knots, a clean 10 on the Beaufort scale.

As the swell built up even further in the afternoon, the captain issued a restriction for the deck and ordered all crew members to remain inside. While we expect the storm to be over by tomorrow, the forecast gives us merely one day of fine weather before we expect another storm to hit us.

Day 21
Date: October 15, 2013
Position: Kamchatka Peninsula, 58°18' N, 167°21' E
Weather: Fine weather, sunshine

Photo 9: The snow-covered volcanoes of Kamchatka

The weather is nice and the sea is quiet again. We have now left the Bering Sea. The storm is behind us, and we traverse the North Pacific Ocean, heading south for the Sea of Japan. There is still some swell on the sea after yesterday's storm, but it does not affect our vessel much. The skies are clear and blue, and the sun is shining bright. It also seems that the next storm will not hit us until the day after tomorrow, so we can enjoy two days of fine weather. Moreover, we are not alone anymore. We now sail along the snow-covered volcanoes of the Kamchatka Peninsula (see photo 9). A few vessels passed us on our starboard side today, and a family of whales quickly surfaced to breathe some air before swiftly disappearing into the ocean again.

Day 22
Date: October 16, 2013
Position: The North Pacific Ocean, 50°07' N, 157°20' E
Weather: Stormy, rough sea

I woke up really early this morning, feeling that I was almost falling out of bed. The bad weather was not supposed to come so soon, but the ship was rolling and one had to hold on to things to not fall over. On the Beaufort scale, the storm was a nine, and the wind and the waves were coming on our port bow, so the ship was jumping in a way that it was not two days ago.

The captain informs me that tomorrow will be even worse. Rough weather is nice every now and then as it makes one feel alive, but it becomes tiresome as it disturbs your sleep to the point that one cannot rest properly any more. In two days, we expect to pass La Pérouse Strait. We cross our fingers and hope that the more protected waters of the Sea of Japan will grant us some good weather.

Day 23
Date: October 17, 2013
Position: The North Pacific Ocean, 45°10' N, 152°51' E
Weather: Stormy, rough sea, sunshine, rain later

The weather today is the same as yesterday with strong winds and a big swell, yet the sun is shining. But for the wind, this could have been a really nice morning. We are forced to adjust our course just to keep the ship from rolling too much. A cyclone passed us during the night. Fortunately it did not hit us, but it caused the wind and the waves we are experiencing now. Not too far off our route, two vessels were caught in the cyclone and ran aground. We are making good speed, and the wind is expected to slow down later tonight. Everyone is quite tired and struggles just to stay in bed as the ship rolls. We hope we can all have a good night's sleep after two consecutive days of stormy weather.

In the afternoon, it has begun to rain. Through the rainy windows on the bridge, we can see the waves smash up against the ship's hull as the wind blows them in on our starboard side. The whole ship is shaking as the great impact of the sea strikes us. Nevertheless, everyone on board is in a good mood, expecting to arrive in South Korea soon.

Day 24
Date: October 18, 2013
Position: La Pérouse Strait, 45°43' N, 142°01' E
Weather: Calm sea

Calm sea at last! This morning when I woke up, I could feel the ship moving smoothly through the water. It was not until early morning that the winds and the sea calmed. But we are grateful that they did so we can catch up on some sleep and perform our duties in a normal way without things flying around us. When I came to the bridge this morning, we were just passing Cape Aniva on our starboard side. This is the first cape one passes on a westbound course through the strait.

Day 25
Date: October 19, 2013
Position: Sea of Japan, 42°14' N, 136°46' E
Weather: Fine weather, blue skies, sunshine

It is another beautiful day as we steam on a southwesterly course across the Sea of Japan. The sun is shining, and the skies are blue. We are all enjoying these last few days of our voyage as we will soon reach our final destination in South Korea. The temperature outside continues to increase. Today, it reached 17° C, so it took us just a week to go from Arctic conditions to spring time. For the first time, I enjoyed my afternoon coffee outside on the bridge. What a feeling to sit outside for a while without fearing frostbite or pneumonia.

Day 26
Date: October 20, 2013
Position: Sea of Japan, 37°57' N, 132°53' E
Weather: Fine weather, quiet sea

Another nice and quiet day as we steam on a southwesterly course. We expect to arrive at Yeosu in South Korea, the final destination of our voyage, tomorrow afternoon. The crew has begun to clean all accommodation and deck areas to make the ship look presentable as it enters the harbor. We expect some rather prominent people to be standing on the jetty and greeting us at a welcome ceremony that is being planned for the ship.

Day 27
Date: October 21, 2013
Position: Coastal waters off Pusan, South Korea, 34°54′ N, 129°13′ E
Weather: Fine weather, quiet sea

We have sailed for almost 30 days, seeing little, if any, civilization and few other vessels in our vicinity. Suddenly, when I arrived on the bridge this morning, we were passing the city of Pusan, the biggest port and second largest city in South Korea with 3.6 million inhabitants. Pusan is the fifth largest port in the world, so we had to carefully navigate in these busy waters as everything from large container vessels to small fishing boats surrounded the ship. In the afternoon, we slowly approached the anchorage at Yeosu. The Korean passengers prepared to disembark. 'Five shackles on the port anchor,' Captain Stipanovic commanded. The anchor slowly submerged in the water, and at half past three local time it was down.

Day 28
Date: October 22, 2013
Position: Port of Yeosu, South Korea, 34°55′ N, 127°55′ E
Weather: Fine weather, quiet sea

Today is the final day of our voyage, the day we arrive at the berth at Yeosu, discharging the cargo that we have carried from Ust Luga to South Korea via the NSR. We woke up to a beautiful morning at the anchorage today. At ten o'clock, two pilots climbed up the ladder on the starboard side, and assisted by two tug boats we slowly made our way through the port area to the berth. We continued to enjoy the beautiful scenery that was surrounding us on this final day.

The welcome ceremony was scheduled for three o'clock in the afternoon. The Stena Glovis banners were hung on the side of the ship, and all naval officers changed into their uniforms. Everywhere, people were following Captain Stipanovic like he was a rock star, wanting to talk to him and interview him. The captain and the chief engineer were admired like heroes. They were presented with a floral garland hung around their neck and many gifts while photo shoots went on relentlessly. Twenty reporters crowded around the heroes who had taken the first Korean cargo through the NSR. In the evening, a dinner was held in the grand ballroom of the World Expo Center where numerous round tables had been set and decorated with Stena Glovis flags. Many speeches and toasts were made, and a slideshow of the pictures I created during the voyage was presented. But all great things must come to an end. As I was not heading back to the ship, I said my goodbyes to all the companions with whom I had been on this adventure and I shook their hands with some sadness.

The capacity potential of the Northern Sea Route by 2050

Patrick Leypoldt

Despite a great number of past contributions, research concerning the future utilization of the Northern Sea Route (NSR) as a result of the long-term growth of global transport volume is missing. This chapter, based on the author's dissertation originally published in 2009 in German, which at the time of writing constituted one of the first attempts to respond to this research gap (Leypoldt, 2009).

This chapter predicts ocean freight transport volume between Europe and the Australasian region by 2050.[1] Then, it assesses determinants of sea route choice, competing sea routes, and the current and likely future state of the NSR, with the goal of determining the extent to which the predicted transport volume is eligible for shipping via the NSR at different points in time. This eligible transport volume is termed the *capacity potential* of the NSR. While current operative issues existing today limit the attractiveness of the NSR as an alternative route vis-à-vis existing trade lanes, this situation will likely change from 2030 onwards. Finally, these considerations and predictions made in 2009 are revisited from a 2015 viewpoint. Results are presented stratified by trade partners and transport segments (liquid, bulk, and container cargo).

It goes without saying that any long-term prognosis over a time span of 30 years and more is highly speculative and should be interpreted as a systematic projection of assumptions made on the basis of data available at the time of writing. Therefore, this chapter intends to elaborate plausible tendencies for the near and distant future rather than to predict precise numbers. The model is based on a fundamental stability scenario that carefully extrapolates trends from the past into the future. Its trend forecasts account for past cyclical variability; thus, the ups and downs of the global economy only have a minor influence on the results.

However, these considerations do not mean the model is not strict and rigorous in a quantitative sense. In fact, its many technicalities, detailed assumptions, and econometric methods cannot be presented comprehensively in the narrow confines of a book chapter. Instead, the reader is offered a stylized description of the analytical procedures used and is invited to consult the original dissertation or to contact the author for further technical information.

1 Due to limitations of space, in this contribution, only results concerning relations between Northern Europe and Asia are presented.

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Methods

Table 1 summarizes the countries whose imports and exports the model predicts. Predictions are made up to the year 2050 because of data availability issues and because UN population forecasts do not extend beyond 2050. The choice of the countries included in the analysis was made based on trade statistics ranging from 1999 to 2007, the extent to which the countries had significant trade with each other on ocean routes, and the extent to which the NSR might offer them a favorable alternative to existing routes by shortening the geographic distance of their trade routes.[2] Note that summary reports for the European Union (EU) area are entered into the model as a separate factor.

Europe				
Eastern Europe	*Northern Europe*	*Southern Europe*	*Western Europe*	
BG Bulgaria	DK Denmark	GR Greece	AT Austria	European Union
CZ Czech Republic	EE Estonia	IT Italy	BE Belgium	
HU Hungary	FI Finland	MT Malta	FR France	
PL Poland	IE Ireland	PT Portugal	DE Germany	
RO Romania	LV Latvia	SI Slovenia	LU Luxemburg	
SK Slovakia	LT Lithuania	ES Spain	NL Netherlands	
	NO Norway		CH Switzerland	
	SE Sweden			
	GB United Kingdom			

Asia			Oceania / Australia
Eastern Asia	*South-East Asia*	*South-Central Asia*	
CN China	ID Indonesia	IN India	AU Australia
HK Hong Kong	MY Malaysia		NZ New Zealand
KR South Korea	SG Singapore		
JP Japan	TH Thailand		
TW Taiwan	VN Vietnam		

Table 1: Countries chosen for the analysis

For each country, time series data on population growth, labor supply, gross domestic product (GDP), and foreign trade recorded between 1995 and 2006 are used to predict imports and exports by the year 2050, such that any trends observed in the recorded data are

2 For reasons of scope, Russia, Ukraine, and Belarus were not included in the analysis; neither was North America.

conservatively extrapolated into the future.[3] These predictions are stratified by trade partners and the type of goods traded. Finally, the extent to which these imports and exports are traded by ocean freight is isolated and differentiated by transport segment (container, bulk, or liquid cargo).[4] Prediction follows a mixed-methods approach: the plausibility of quantitative regression results throughout all analytical steps is assessed in workshops with industry experts and, if necessary, ensured by manual adjustments.

Transport volume vs. capacity potential: Factors of ocean route choice

The predicted transport volume is not yet equal to the capacity potential of the NSR. Before this potential can be quantified, an assessment must be made regarding what fraction of this transport volume is (theoretically) eligible for shipping via the NSR. Determinants of ocean route choice must be considered first. The most important of these determinants is distance. Tables 2, 3 and 4 show three groups of trade relations whose distance in nautical miles is most reduced when shipping via the NSR compared to the Suez Canal route.[5] European trade with Japan, Northern China, and South Korea is likely to benefit most from the NSR. By contrast, locations to the south and west of a crest line that runs approximately from Hong Kong to Sydney will have little to no advantage from sailing the NSR in terms of reduced distance; this argument particularly applies to all ports of Oceania, Australia, Singapore, Malaysia, Thailand, and India.[6]

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3 These data were obtained from the United Nations and from many other sources; the complete list of references is given in Leypoldt (2009). Technically speaking, for the labor supply data, forecasts up to the year 2010 are used.

4 The complete list of additional data sources used in step 3 is given in Leypoldt (2009). Differentiation of goods by type was made according to the Standard Goods for Transport Statistics/revised (NST/R) nomenclature.

5 Almost all of these relations concern trade between Northern Europe and Asia. For southern Europe, only the port of Algeciras can be expected to realize a minor distance advantage of about 10% on average for relations with Japan, whereas for other ports in the Mediterranean Sea (Barcelona, Marseille, Genoa, and Gioia Tauro), the NSR offers no distance advantage.

6 Further details and tables for all trade relations considered are presented in Leypoldt (2009). For reasons of scope and limitations of space, only a subset of the relations is presented here. Nations located to the southeast of this crest line are likely to consider the NSR as an alternative route only under exceptional circumstances (e.g., when passage through the Suez Canal is impossible or no longer economically viable).

		DE HAMBURG	DE BREMEN / B'HAVEN	DE WILHELMSHAVEN	NL AMSTERDAM	NL ROTTERDAM	BE ANTWERP	UK FELIXSTOWE	FR LE HAVRE	
JP	YOKOHAMA	7'267 -36%	7'234 -36%	7'238 -36%	7'294 -35%	7'322 -35%	7'391 -34%	7'326 -34%	7'484 -32%	nm %
JP	TOKIO	7'281 -36%	7'248 -36%	7'252 -36%	7'308 -35%	7'336 -35%	7'405 -34%	7'340 -34%	7'498 -32%	nm %
JP	NAGOYA	7'404 -35%	7'371 -35%	7'375 -35%	7'432 -33%	7'460 -33%	7'529 -32%	7'464 -32%	7'621 -30%	nm %
JP	KOBE	7'544 -33%	7'511 -33%	7'515 -33%	7'571 -31%	7'599 -31%	7'688 -30%	7'603 -30%	7'760 -28%	nm %
JP	OSAKA	7'552 -33%	7'519 -33%	7'523 -33%	7'579 -31%	7'607 -31%	7'676 -30%	7'611 -30%	7'769 -28%	nm %
JP	MOJI / KITAK-YUSHU	7'585 -31%	7'552 -31%	7'556 -31%	7'613 -30%	7'641 -29%	7'710 -29%	7'645 -29%	7'802 -27%	nm %
KR	PUSAN	7'596 -31%	7'562 -31%	7'566 -31%	7'623 -30%	7'651 -29%	7'720 -28%	7'655 -29%	7'812 -26%	nm %
KR	KWANGYANG	7'696 -30%	7'633 -30%	7'667 -30%	7'724 -28%	7'752 -28%	7'821 -27%	7'756 -27%	7'913 -25%	nm %
KR	INCHEON	8'004 -28%	7'971 -28%	7'975 -28%	8'031 -26%	8'059 -26%	8'128 -25%	8'063 -25%	8'221 -23%	nm %

Table 2: Distances via NSR for relations between ports in Japan, South Korea, and Europe. Percentages show the distance reduction (in nautical miles) vis-à-vis the Suez Canal route.

Besides distance, other factors of route choice have to be considered. There are other ocean routes besides the Suez Canal route that may constitute viable alternatives to the NSR. However, it is assumed that such competition will only play a minor role. The Northwest Passage will be ice-infested for a considerably longer time than the NSR. The Strait of Magellan and the Cape of Good Hope are not feasible since shortcuts are available as substitutes for these routes (the Panama and Suez Canal routes).

Only about 7% of the transport volume originating from relations relevant for the NSR is shipped via the Panama Canal; moreover, the costly enlargement of the Panama Canal, which was financed by transit fees, gives the Suez Canal route a competitive edge as far as such fees are concerned.[7]

		DE	DE	DE	NL	NL	BE	UK	FR	
		HAMBURG	BREMEN / B'HAVEN	WILHELMSHAVEN	AMSTERDAM	ROTTERDAM	ANTWERP	FELIXSTOWE	LE HAVRE	
CN	QINGDAO	8'082 -27%	8'049 -27%	8'053 -27%	8'109 -25%	8'137 -24%	8'206 -24%	8'141 -24%	8'299 -22%	nm %
CN	DALIAN	8'140 -27%	8'107 -27%	8'111 -27%	8'167 -25%	8'195 -25%	8'265 -24%	8'199 -24%	8'357 -22%	nm %
CN	TIENTJIN	8'317 -27%	8'284 -27%	8'288 -27%	8'344 -25%	8'372 -24%	8'441 -24%	8'376 -24%	8'534 -22%	nm %
CN	SHANGHAI	8'057 -25%	8'023 -25%	8'027 -25%	8'084 -23%	8'112 -23%	8'181 -22%	8'116 -22%	8'273 -20%	nm %
CN	NINGBO	8'098 -25%	8'065 -25%	8'069 -25%	8'125 -23%	8'153 -22%	8'222 -22%	8'157 -22%	8'315 -20%	nm %

Table 3: Distances via NSR for relations between ports in Northern China and Europe. Percentages show the distance reduction (in nautical miles) vis-à-vis the Suez Canal route.

Land-based transport via the Trans-Siberian railway will remain a niche product, since even a double-track railway could not transport more than 50 to 100 million tons of cargo per year; to date, this corresponds to roughly 12% of the volume shipped via the Suez Canal. All in all, one can expect that, normally, the predicted transport volume would likely be shipped via the Suez Canal route.

7 However, should the NSR become a serious competitor, one might expect that both the Suez Canal Authority and the Autoridad del Canal de Panama will grant discounts for vessels that may alternatively sail the NSR, e.g., for bulk carriers.

		DE HAMBURG	DE BREMEN / B'HAVEN	DE WILHELMSHAVEN	NL AMSTERDAM	NL ROTTERDAM	BE ANTWERP	UK FELIXSTOWE	FR LE HAVRE	
TW	KEELUNG	8'289 -20%	8'256 -20%	8'260 -20%	8'316 -18%	8'344 -17%	8'413 -17%	8'348 -17%	8'506 -14%	nm %
CN	XIAMEN	8'464 -17%	8'431 -17%	8'435 -17%	8'492 -15%	8'520 -14%	8'589 -14%	8'524 -14%	8'681 -11%	nm %
TW	KAOHSIUNG	8'497 -16%	8'464 -16%	8'468 -16%	8'524 -14%	8'553 -14%	8'622 -13%	8'557 -13%	8'714 -10%	nm %
HK	HONGKONG	8'739 -12%	8'705 -12%	8'706 -12%	8'766 -10%	8'794 -10%	8'863 -9%	8'798 -9%	8'955 -6%	nm %
CN	GUANGZHOU	8'812 -12%	8'779 -12%	8'783 -12%	8'839 -10%	8'867 -9%	8'936 -8%	8'871 -8%	9'029 -6%	nm %
CN	SHENZHEN	8'855 -12%	8'822 -12%	8'826 -12%	8'883 -10%	8'911 -9%	8'980 -8%	8'915 -8%	9'072 -6%	nm %

Table 4: Distances via NSR for relations between ports in Southern China, Taiwan, and Europe. Percentages show the distance reduction (in nautical miles) vis-à-vis the Suez Canal route.

Finally, the current and future state of the NSR must be considered. While many operative problems impede an intense utilization of the NSR today, this situation is likely to change from about 2030 onwards. Thus, while the NSR is not a fully fledged alternative to the Suez Canal route *today*, the capacity potential *in the future* will be influenced by the extent to which these problems are solved over time. This chapter discusses the current state of the NSR regarding these problems and subsequently describes expectations for the future.

Today, container cargo traffic is organized by scheduled services that must be precisely planned. Delays cannot be tolerated since many firms today have synchronized their production and logistics processes. Therefore, container cargo vessels travel fixed loops, calling at predetermined ports on particular days according to their travel schedule. A container loop from Europe to Asia involves six to eight vessels, which should all be of equal size in order to take empty containers on board during each transport. A typical loop from Europa to Asia will call at ports in the Mediterranean, North Africa, the Arabian Gulf, India, and Southeast Asia. Tramping still plays a role in bulk cargo transport; however, scheduled service is becoming more and more important even in this transport segment. In contrast to container cargo traffic, bulk traffic mostly moves point-to-point, such that the vessel is loaded at the port of origin and then travels directly to the port of destination, where it is unloaded. Tanker vessels operate between these two extremes.

Continuous supply is organized by scheduled service, whereas additional transports triggered by increased demand are organized by tramping. Schedules can be changed quickly in container cargo operations as long as alternative routes are very well known. To date, this does not yet apply to the NSR. Larger container vessels may utilize the NSR as a rapid point-to-point loop; however, for the foreseeable future, this rapid route would be infeasible to operate in winter. Further, even during the summer months, schedules would have to be strictly adhered to when traveling the NSR. The situation is less problematic as far as the type of goods is concerned. Theoretically, there are no goods that would *not* be eligible for shipping via the NSR. Arrangements can be made to maintain the temperature of sensitive cargo by using specially equipped containers. Even today, heat-sensitive products are transported right through deserts. The feasibility of this option is primarily a matter of price. It goes without saying that bulk items such as coal and iron ore are unresponsive to extreme temperatures, such that the NSR is likely a more attractive route for these goods vis-à-vis container cargo. Further, given the current vessel sizes in container shipping, might there be a future vessel that is simply too large to fit the locks of either the Panama or the Suez Canal? According to expert assessments, vessel size growth in container shipping is ongoing, yet it is unlikely to reach a point where a vessel's construction will preclude its operation on a particular route. However, one cannot expect that the attractiveness of the NSR will increase given the current sizing trends. From a logistics point of view, the NSR is likely relevant for bulk and liquid cargo, since such traffic does not require local markets along the route; moreover, these goods are relatively insensitive to delays and temperature. With respect to container cargo, the NSR will only become attractive once the route is well known, the vessel can be loaded completely with point-to-point cargo, and fixed schedules can be adhered to.

Taking infrastructure into account exposes more serious problems of the NSR. A modern and competitive ocean route necessarily requires an infrastructure that can provide for repairs; ports of distress; maintenance facilities to stock up on bunker fuel, fresh water, and food; technical maintenance of the vessel; search and rescue facilities; satellite-based navigational aid; radar surveillance; and equipment for cargo handling.

Further, for the particular case of the NSR, icebreaker support and real-time weather forecasting and sea ice surveillance would be required. To date, the extent to which the NSR lives up to these infrastructure expectations is insufficient. With the exception of Murmansk, situated in the extreme western sector of the passage, there are basically no ports of distress at all along the route. While there are some ports in the eastern sectors, these would have to be equipped with additional landing stages. Moreover, these ports are not eligible for large vessels in distress since their waters are too shallow for the exceptional drafts of large vessels. While the Northern Sea Route Administration does offer search and rescue service, the length of the route, the few available means, and insufficient satellite navigation are all problematic in case of emergency. Airplanes and helicopters are available for crew rescue operations, but maintenance facilities that may provide bunker fuel, fresh water, and food are completely absent. Radar surveillance is fragmentary, satellite coverage can only be rendered with delays, and a system to measure ice thickness is not available. As a result, significant investments in infrastructure would have to be made before the NSR becomes a safe and attractive route. This implies that, in the immediate future, the NSR will only be used to a very limited extent as an ocean transport route. Particularly, ship owners of container vessels and oil tankers will make passage subject to the availability of an infrastructure than can provide security.

Vessels encounter some very shallow waters, some with a draft of not more than 10 meters, while traveling the NSR. Further, they must traverse several narrow and ice-infested isthmuses. Thus, only smaller vessels with a maximum draft of 12 meters will be able to pass those sectors of the route that will first exhibit open water conditions. Larger ships will likely not be deployed until route variations further to the north exhibit such conditions. Most probably, separate summer and winter schedules will need to be designed. During the summer season, even under open water conditions, the appearance of icebergs will have to be taken into account, and the winter schedule must be planned to accommodate seasonal variance, e.g., an early onset of winter. To guarantee year-round operations, the Northern Sea Route Administration would have to keep the NSR ice-free at all times. However, past experience shows that it is often impossible to choose the shortest route among all NSR options without icebreaker support due to ice-infested waters. All in all, restrictions regarding draft along the NSR will determine maximum vessel size for NSR operations. The main route can only accommodate smaller vessels, but bypasses further to the north can accommodate larger vessels. The extent to which the NSR can be utilized as a transit route will depend on the effective period of navigability. The longer this period, the more the NSR will be feasible for transport. As of today, the NSR is attractive only for tramping bulk and liquid cargo during the summer season.

Operating in ice-infested waters requires elaborate technological upgrades, such as a reinforced hull, stronger engines, or a different propulsion technology altogether. To date, only a few ice-classed bulk cargo vessels exist. Specialized ice-classed container vessels operate in Canada, in the Baltic Sea, and in Norway. Independent navigation without icebreaker support requires ice classification. Larger ships may independently break sea ice as long as it is between 30 and 50 centimeters thick; however, passage in winter is impossible except with icebreaker support. The breadth of the canal an ice breaker can create (30 meters) limits the range of eligible ships that can operate on the NSR. Today, two icebreakers operating side by side may create larger channels; however, new ice-breaking technologies have also been developed, such as the oblique technique for icebreakers, or the double-acting technology for cargo vessels. The latter is being successfully deployed as of today.

These technological issues will have great influence on the future utilization of the NSR. Today, for most of the year, a vessel must either be ice-classed or rely on icebreaker support in order to navigate the NSR. While Arctic ice coverage is decreasing, vessels operating on the NSR will require larger investments for a long time to come. This raises the question of whether (if at all) ship owners will want to finance such special and costly vessels. Both cost to build and insurance premiums will be higher, and vessels will be specific to the route.

Further, decisions regarding route choice should take into account safety issues related to safe operation and travel as well as security concerns (e.g., threats, terrorist attacks, or acts of war). International sea routes such as the Panama or Suez Canal are vulnerable. These risks will impact traffic on the NSR even if the risk of immediate threats there is likely lower. Terrorist attacks and piracy in the Arctic Ocean seem relatively improbable for the foreseeable future. All in all, the risk of terrorist attacks and acts of war in the area surrounding the Suez Canal region will make the NSR more attractive in the long term.

Underwriters lack experience with Arctic shipping. To date, such shipping was highly specialized, financed mostly by states, and done on a low-volume level. To date, underwriters are unprepared for a mass transit of vessels on the NSR. While Russia does have extensive experience with Arctic shipping, this information is not shared with global insurance companies. Thus, they are stripped of the very information they would require to assess the risk. As a result, the majority of ship owners bear all or the greatest part of these risks themselves. This fact seems to constitute one of the greatest obstacles to a more intense utilization of the NSR. Ship owners not only have to pay for icebreaker support or retrofitting of their vessels according to ice classifications, but they must also allow for excessive insurance premiums. On the other hand, these higher premiums are codetermined by the lack of infrastructure along the NSR. If this infrastructure was reconditioned and developed according to the requirements, the risk of passage and thus the premiums paid may be reduced.

Finally, the utilization of the NSR will depend on the trade-off between cost savings due to distance reductions on the one hand and higher capital expenditure for retrofitting or novel construction, higher insurance premiums, and icebreaker support on the other hand. In principle, as the example of Norilsk Nickel's double-acting vessels operating between the Kara Sea and Murmansk shows, profitable shipping on the NSR is possible. However, such transports are not readily comparable to transits along the complete NSR, since such transits will have to compete with the 'race course' of the Suez Canal.

When all of these considerations are taken into account in calculating the capacity potential, *today* the NSR is not a viable alternative transit route between Europe and the Australasian region. Some tramping bulk vessels may potentially use the route. However, *from 2030 onwards*, the route will probably become more attractive for shipping since changes in the general framework are highly likely to take place. As commodity sites in the regions east of Murmansk are developed, infrastructure is likely to be built. This infrastructure, in turn, will increase the safety of operations and thus reduce insurance premiums. Continuous climate change will increase the time during which navigation is possible in the Arctic summer. It is therefore assumed that the NSR will constitute an alternative for bulk and liquid cargo transport by 2030. Moreover, a certain share of container shipping may be routed via the NSR by then, if by tramping only.

Up until the year 2050, further improvements can be expected. For these reasons, both container and bulk cargo transport volumes in 2030 and 2050 are considered for relevant relations. However, only a fraction of all container cargo is likely eligible for shipping via the NSR since the opportunity of taking on extra load from ports along the Suez Canal route will likely always route some container shipping exclusively via the Suez Canal.

The capacity potential of the NSR by 2050

Taking all of these factors and considerations into account, the capacity potential of the NSR can now be isolated from the predicted transport volume. In an east-west direction, i.e., concerning European imports from East Asia (Japan, South Korea, mainland China, Hong Kong, and Taiwan), the model predicts a total capacity potential of 201 million tons in 2030 and 307 million tons in 2050. In 2030, Japan and South Korea together will export 23.5 million tons of goods to Europe; by 2050, this combined volume will grow to over 28 million tons. Figure 1 below differentiates this combined volume by transport segment. Japan's share will decrease from 49% in 2007 to 38% in 2050. The share of bulk and liquid goods as a percentage of all European imports from these two countries will fall from 29% in 2007 to 25% by 2050; particularly, liquid bulk goods will play a lesser role. However, even in 2050, Japan and South Korea combined will ship almost 7 million tons of bulk and liquid goods to Europe. Containerization will increase: by 2050, Europe will receive 76% of all imported goods from Japan and South Korea, or about 21 million tons of goods, by way of container cargo. (In 2007, container cargo imports amounted to a mere 8 million tons.)

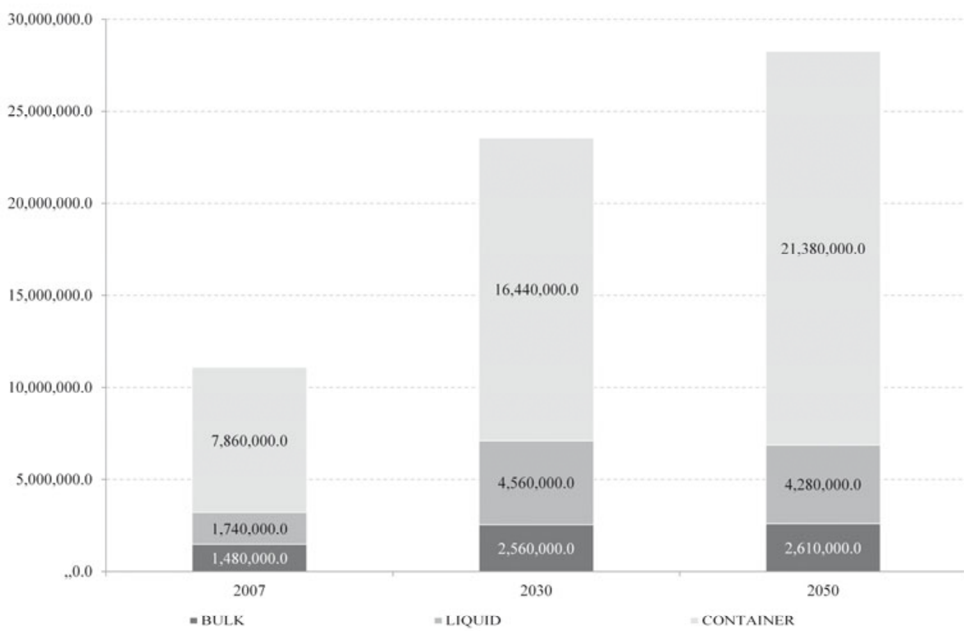

Figure 1: Ocean freight import volume to Europe from Japan and South Korea eligible for shipping via the NSR by 2050. All figures are given in tons.

Together, Europe will import over 177 million tons of goods from mainland China, Hong Kong, and Taiwan by 2030, and almost 279 million tons by 2050. Mainland China will account for 97% of these imports (compared to 94% in 2007). The share of bulk and liquid goods as a percentage of all imports from these countries will decrease to 25%, or roughly 69.5 million tons, by 2050 (compared to 34% in 2007). Liquid goods will account for less than 1% of total import volume, or about 2.2 million tons. As in the case of imports from Japan and South Korea, containerization will increase from 66% in 2007 to 75%, or over 209 million tons of container cargo, by 2050.

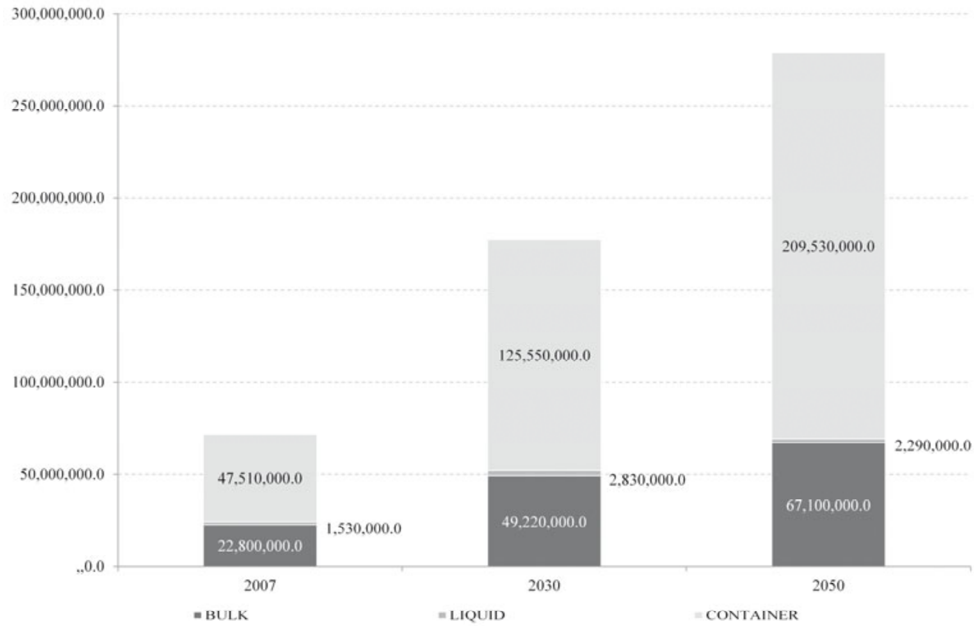

Figure 2: Ocean freight import volume to Europe from mainland China, Hong Kong, and Taiwan eligible for shipping via the NSR. All figures are given in tons.

Figure 3 stratifies combined imports from Japan, South Korea, mainland China, Hong Kong, and Taiwan by European importers such that the main importers are shown explicitly. By 2030, the five largest importers combined will import 58% of the total import volume (compared to 54% in 2007), but this share is forecast to decline to 51% by 2050. By 2050, Italy will import 13% of the total volume (Germany: 12%; UK: 9%; Netherlands: 9%; France: 6%). In comparison with 2007, French imports will remain stable at 6%, Dutch imports will increase by 2%, and the Swiss and Norwegian shares will decline from 1% to 0.6%, respectively).

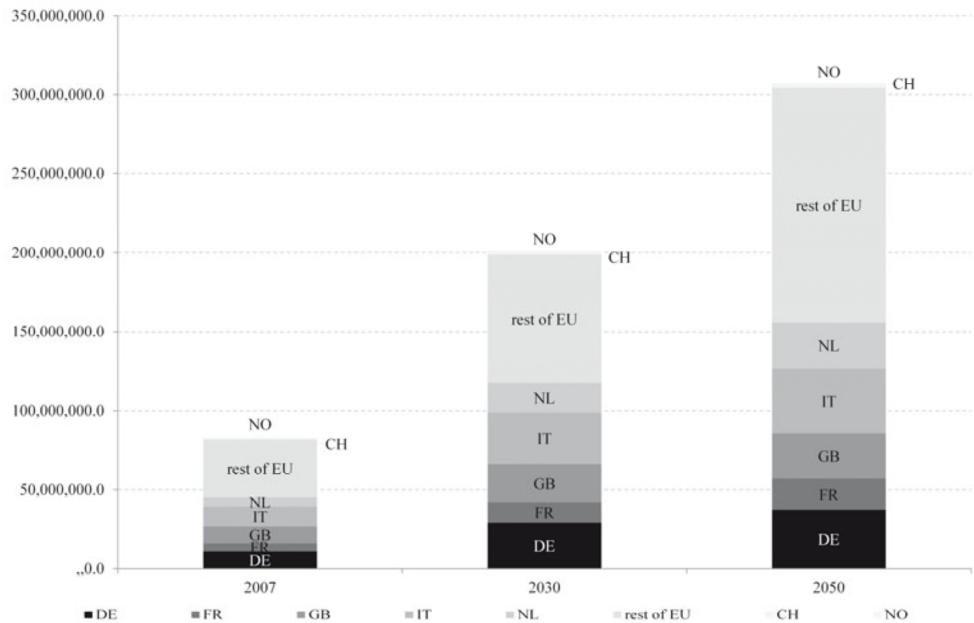

Figure 3: Ocean freight import volume from Eastern Asia[8] to Europe eligible for shipping via the NSR, stratified by importer. All figures are given in tons. Identifiers refer to Germany (DE), France (FR), the United Kingdom (GB), Italy (IT), the Netherlands (NL), the European Union (EU), Switzerland (CH), and Norway (NO).

In a west-east direction, i.e., concerning European exports to East Asia (Japan, South Korea, mainland China, Hong Kong, and Taiwan), the model predicts a total capacity potential of 101 million tons in 2030 and 134 million tons in 2050. In 2050, Europe will export 13 million tons of goods to Japan (compared to 7 million tons in 2007) and 12 million tons to South Korea (compared to 4 million tons in 2007). Figure 4 differentiates this combined volume by transport segment. While the overall transport volume to these two nations and the transport volume from Europe to Japan will double, transport volume to South Korea will treble. The share of bulk and liquid goods exported from Europe to Japan and South Korea as a percentage of total transport volume will decrease to about one-third. In 2050, this share will correspond to more than 7 million tons. In 2007, dry bulk cargo accounted for 63% of the total transport volume; by 2050, this share will decrease to 53%. The share of container cargo as a percentage of total transport volume to Japan and South Korea will increase from 62% in 2007 (7 million tons) to 72% in 2050 (18 million tons).

8 For the sake of brevity, the umbrella term *Eastern Asia* is used here and in Figure 6 for the combined import volume originating from Japan, South Korea, mainland China, Hong Kong, and Taiwan.

European exports to mainland China, Hong Kong, and Taiwan are clearly dominated by the importance of mainland China as an export market for Europe. In 2050, about 90% of the total transport volume of European exports shipped to this region will be bound for mainland China, compared to 75% in 2007. By 2050, total transport volume to this region will quadruple from 27 million tons to roughly 109 million tons, and transport volume directed for mainland China only will quintuple from 20 million tons in 2007 to 97 million tons.

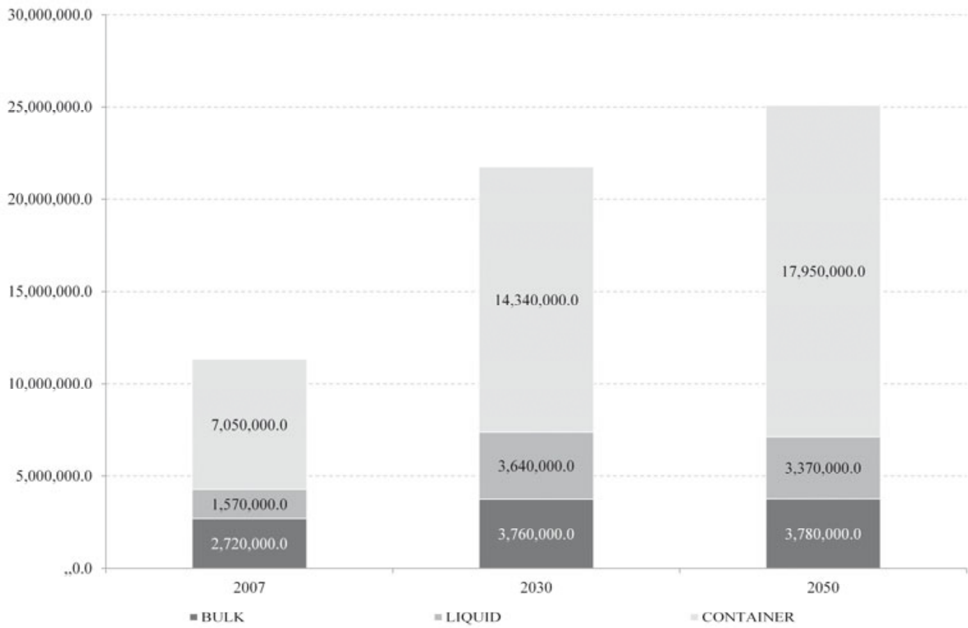

Figure 4: Ocean freight export volume from Europe to Japan and South Korea eligible for shipping via the NSR by 2050. All figures are given in tons.

The combined share of bulk and liquid cargo as a percentage of total transport volume will decrease from 32% (9 million tons) in 2007 to 22% (24 million tons) by 2050. Containerization will continue. The share of container cargo as a percentage of total transport volume to the region will increase from 67% in 2007 (18 million tons) to 78% in 2050 (85 million tons).

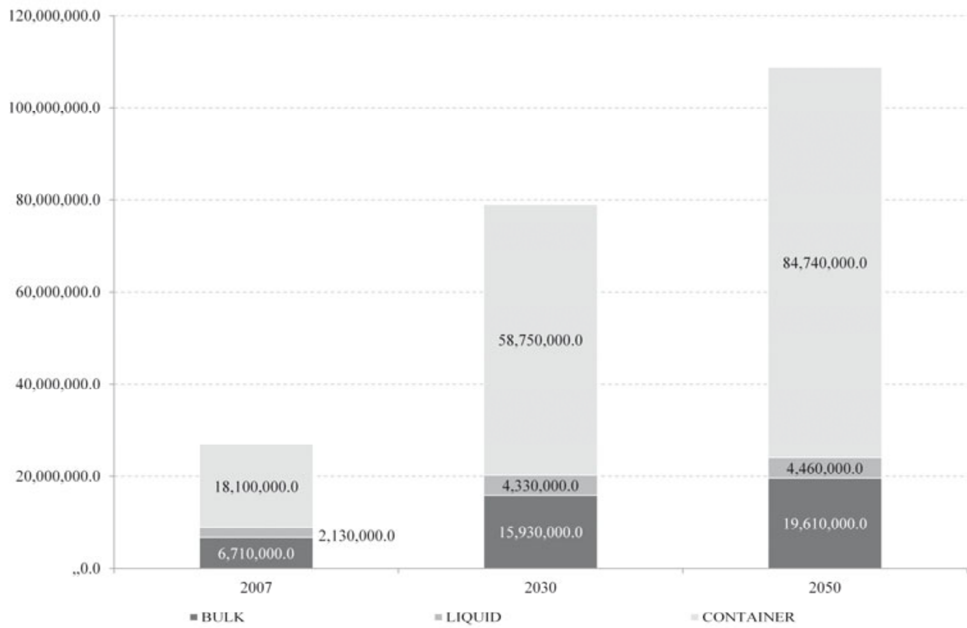

Figure 5: Ocean freight export volume from Europe to mainland China, Hong Kong, and Taiwan eligible for shipping via the NSR by 2050. All figures are given in tons.

Figure 6 stratifies combined European exports to Japan, South Korea, mainland China, Hong Kong, and Taiwan by the exporting nation, such that the exporter is shown explicitly. Exports to East Asia are clearly dominated by five countries: in 2007, 20% of the total transport volume was shipped from Germany, 15% from the UK, 13% from the Netherlands, 9% from Italy, and 8% from France. The remainder was exported by other EU states (32%); Switzerland and Norway exported a combined 3%. By 2050, these shares will change significantly. With the exception of Germany, which will continue to be the largest exporter to East Asia, the other four states will lose exports to other EU states (UK: −6%; Italy: −4%; Netherlands: −3%; France: −3%). Switzerland and Norway will be able to uphold their combined share at a little less than 3%.

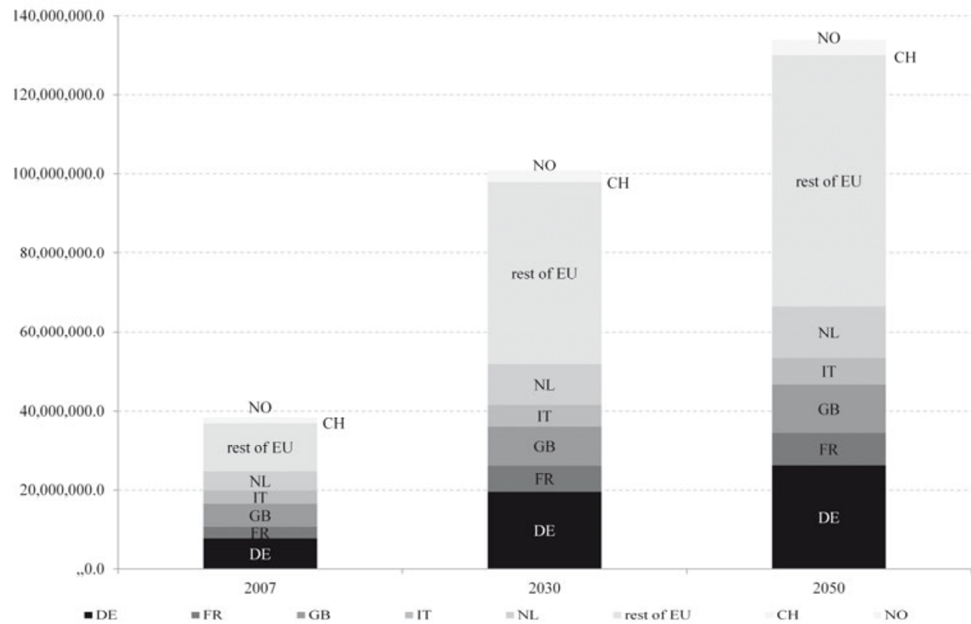

Figure 6: Ocean freight export volume to Eastern Asia from Europe eligible for shipping via the NSR, stratified by exporter. All figures are given in tons. Identifiers refer to Germany (DE), France (FR), the United Kingdom (GB), Italy (IT), the Netherlands (NL), the European Union (EU), Switzerland (CH), and Norway (NO).

Reassessment from a 2015 viewpoint

It is beyond question that the NSR has great potential. However, the general framework must be attractive if this potential is to be utilized. Today, the conditions of navigating the NSR do not yet live up to the requirements of potential customers (ship owners). These projections of capacity potential show that relevant transport volume on the NSR will materialize by 2030. In theory, by 2050, 307 million tons of cargo eligible for transport via the NSR will be shipped in an east-west direction, and 134 million eligible tons will be shipped in the opposite direction. However, in fact, only a portion of this volume will be shipped via the NSR, such that these figures should be interpreted as upper boundaries.

In the medium to long term, an increased utilization of the NSR for transit between Europe and Asia seems more probable as the NSR becomes more attractive in terms of the determinants of ocean route choice. Against this backdrop, future utilization will be primarily influenced by the policy of the Russian government, since Russia is the only actor with great freedom of action regarding the determinants of route choice. It will be Russia's task to invest in the development of the NSR in order to minimize the risks of shipping there. If support infrastructure can be developed to the level that ship owners desire, and if icebreaker support fees are competitive and administration workable, this ocean route may indeed gather momentum to a point where transport volume between Asia and Europe will be displaced north. Still, even though Arctic ice coverage may shrink even faster than predicted in the years to come, the NSR will remain the hardest of all ocean routes to navigate by far during the model's prediction timespan.

The results presented here were elaborated in 2009; thus, the available data sets used for prediction are no longer completely up-to-date. The following quick look at contemporary data is taken in order to assess the extent to which the model's predictions can still be called meaningful as of 2015.

The predicted dynamics of foreign trade relationships are generated both by socioeconomic and foreign trade data input. The most salient antecedent of these dynamics is demographic development. When the model is inspected using the United Nations' latest population development figures up to the year 2050 (United Nations, 2012), the 2012 revision is unlikely to induce any major changes to the forecast. For example, predictions for Germany or China up to the year 2030 are basically identical to data the model uses, whereas Japan's population will likely shrink at a slower rate (now at −16%, compared to −20% in the model). By the year 2050, the new data now project that Germany's population will shrink faster, at a rate of −12.2% (compared to −10.4% in the model), while China's population will grow at a reduced rate of 5% (compared to 7% in the model).

For any given country, the model predicts future GDP as a function of per-capita productivity. To date, comparable long-term prognosis regarding both figures is not available. The model's forecasts up to the year 2050 are based on an analysis of time series data recorded between 1995 and 2006. It is assumed that adding another five years of recorded data to this set would not substantially alter the forecasts, since the timespan is too short. The same argument applies to the foreign trade data the model uses. Since the calculations were made in 2009, electronically available data sets and databases have been advanced strongly. It seems advisable to rebuild the model's complete data input in five to ten years using more detailed statistics.

A quick look at contemporary foreign trade statistics for the year 2013 (European Union, 2014) yields further interesting insights. Regarding Sino-German trade, predicted German exports to China (7.5 million tons) almost exactly correspond to current figures (7.9 million tons), while current German imports from China in 2013 (8.5 million tons) stayed behind the predicted 14.5 million tons. A similar picture is revealed for German-Japanese trade. Forecasted exports from Germany to Japan (1.31 million tons) correspond neatly to current figures (1.37 million tons). German imports from Japan were predicted to decline by about 9% to 0.97 million tons, yet the actual reduction was much larger (−18% between 2000 and 2013). This seems to be due to extraordinary events such as the onset of the global financial crisis in 2007 and the Fukushima nuclear reactor catastrophe in 2011.

Given that the model delivers a highly speculative, long-term forecast, it seems safe to say that the data are still timely. If the question is to determine whether or not the NSR has significant capacity potential in terms of eligible transport volume (and if so, when it will materialize), the general tendencies the model extrapolates are still up-to-date.

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The Northern Sea Route as an alternative container shipping route: A hypothetical question or a future growth path?

Andreas Mietzner

Commercial ship financing is a century old, yet a risky business. It typically involves high leverage, with up to 80% of the vessel's building cost financed by loans (Stopford, 2009; Verny and Grigentin, 2009), and is mostly organized by establishing a *one-ship company* that only holds one large asset (the ship itself) in its books. To securitize his loans, the financer will typically encumber this ship with a mortgage. Many one-ship companies (including their ship managers) do not have access to the vessel's cargo. Their revenue is generated only by the operation and chartering of the vessel they own. Therefore, often not only does the ship itself but also the charter party contract serve as collateral for the loan. Unless a vessel can be assigned to a shipping company with access to the vessel's cargo a financer will usually not authorize shipbuilding until a long-term charter party contract can be signed. Moreover, since the global financial crisis, the traditional banks specializing in ship financing have become more conservative; they now demand larger equity buffers, reduced credit portfolios, or even exit the market (Mietzner, 2013), implying that providers of alternative finance in the business, such as private wealth funds or investment banks, are likely to demand superior risk-return ratios.

Indeed, the operative risks that can reduce charter revenue are manifold; they encompass both technical aspects (e.g., nautical risks, collision, corrosion, mechanical or engine failure) and commercial hazards (e.g., construction delays, changes in national regulatory and tax regimes, piracy). In particular, the risk of being unable to arrange for alternative charter party contracts once a particular contract has expired can be significant (Kummerow, 2005).

As a result, the profitability of a particular vessel will decisively depend on the extent to which it can be chartered over its lifespan. Therefore, *charter risk control* is at the center of any profitability calculations in ship finance. A charterer will not conclude a long-term charter party contract with any ship owner unless the ship can be operated more efficiently than others on a given route or profitably on new route. For the case of the Northern Sea Route (NSR), this implies that a shipping company will have to demonstrate that container shipping in the NSR is profitable, even if compared to the Suez Canal route. The remainder of this chapter attempts to assess the extent to which this can be demonstrated.

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Traffic volume and operative aspects

In 2009, the first commercial transit of non-Russian ships[1] through the NSR took place. Commercial traffic volume in the NSR steadily increased between 2007 and 2013, but decreased in 2014 (cf. Table 1).

Year	Number of vessels transiting the NSR
2007	2
2008	3
2009	5
2010	10
2011	41
2012	46
2013	71
2014	53

Table 1: Traffic volume in the NSR (Northern Sea Route Information Office, 2014)

A detailed analysis of all transits completed in 2013 revealed that the majority of vessels transiting were dry and liquid bulk carriers. Generally, these do not operate according to scheduled services, but engage in tramping on the basis of voyage charter party contracts. This is not surprising, given that the relative geographic proximity between resource-abundant Scandinavia and commodity-hungry Japan and South Korea predestines the NSR to be a bulk cargo route that connects commodity suppliers and consumers. Still, the structure of completed transits (cf. Table 2) suggests that the NSR is still a long way from what might be considered a regular shipping route.

Type of vessel or voyage	Number of transits in 2013
Liquid bulk carrier (tanker)	31
Dry bulk carrier	4
Liquefied natural gas (LNG) carrier	1
General cargo vessel	13
Empty trip	15
Positioning trip	7

Table 2: NSR transits in 2013 by voyage and vessel (Own calculation using data from Northern Sea Route Information Office, 2014)

1 This was by M/V *Beluga Transit* and M/V *Beluga Fraternity*, operated at the time by the now bankrupt German heavy-lift shipping company Beluga Shipping.

Given these transit data, how (if at all) could a scheduled liner service by container operators be commercially viable? The answer to this question is possibly a function of economies of scale and slot costs (i.e., costs per homogenous TEU capacity[2]). Today, the shipping industry is characterized by tough cost competition and continuously decreasing bunker fuel consumption.[3] At the same time, low freight rates and continuously increasing bunker costs lead to increasing cost pressures for ship owners and operators.

Over the last years, historically low new building prices, the Panama Canal extension, increasing bunker costs,[4] and global excess liquidity have triggered a wave of new building orders. For shipping companies offering scheduled liner services, these orders are meant to realize economies of scale. While size growth in container shipping has not yet reached its peak rate, particularly if compared to that of other vessel types such as tankers, alternative measures by which slot costs can be reduced are becoming increasingly attractive. Shipping in the NSR might provide such an alternative means of reducing slot costs.

A model for estimating the slot cost of an NSR transit

The commercial viability of container shipping in the NSR is influenced by many factors, including the route, fuel consumption curves, travel speed, charter rates, bunker costs, insurance rates, transit fees, etc. To deliver a clear yet significant analysis, the following discussion assumes that additional insurance premiums, port dues, and auxiliary motor fuel consumption are equal for both routes and all vessel types; thus, they will not influence the results.[5] In reality, these costs will, inter alia, depend on the vessel type, age, and shipping route. However, the share of these factors as a fraction of slot cost is relatively insignificant, such that they only have a minor effect on the results.

This section proposes a self-developed model to estimate slot cost as a joint function of speed and charter rates. The model merely considers the essential determinants of slot cost: bunker costs, transit fees, asset costs, and operation expenses. The best indicator to estimate the latter two is the charter rate for the respective ship category.[6] Bunker cost (i.e., bunker fuel consumption) depends on speed and ship-specific consumption profiles, yet it accounts for between 30 and 80% of the total voyage cost. Due to expected future supply shortages, bunker costs are likely to gain relevance. The results presented here are based on an assumed bunker cost of US$650 per metric ton. Slot cost is calculated as follows (B: bunker

2 This is defined as a vessel's twenty-foot equivalent unit (TEU) carrying capacity at a weight of 14 tons per container.

3 Hence the technical term 'bunker cost' refers to the volume of bunker fuel (consumption in metric tons times price per metric ton) a vessel consumes during its voyage.

4 Even though oil and hence bunker prices significantly decreased since the second half of 2014, it is possible that prices of fossil fuels will rise again in the medium term.

5 Insurance costs for protection and indemnity (P&I) and ship damages are covered by the charter rate. Additional insurance for NSR transit likely has only a marginal influence on slot cost.

6 Charter contracts for any given timeframe are negotiated in the time charter market. Normally, the resulting charter rates will cover both the ship's operating expenses (staff, lubricants, insurance, maintenance, miscellaneous costs of operation) and capital expenditure.

cost; *C*: charter cost; *T*: transit cost; *TEUh*: homogenous TEU capacity; *kn*: speed in knots; *d*: distance; *mt*: consumption in metric tons per day; *bp*: bunker fuel price; *c*: charter rate):

$$Slot\ cost_i(kn) = \frac{B + C + T}{TEUh} = \frac{\left(\left(\frac{d}{kn \cdot 24}\right) \cdot mt(kn)\right) \cdot bp + \left(\frac{d}{kn \cdot 24}\right) \cdot c + T}{TEUh} \tag{1}$$

with

$$mt(kn) = \alpha \cdot kn^x \tag{2}$$

where α and x are auxiliary parameters determined by the ship's engine configuration. While formula (2) shows that bunker fuel consumption exponentially grows with speed, *increasing* slot cost, formula (1) shows that speed also *reduces* slot costs by diminishing the cost-driving influence of the charter rate. Thus, for any given set of parameters an optimal travel speed that minimizes slot cost can be calculated.[7]

It goes without saying that compared to the Suez Canal route, shipping in the NSR establishes a relative geographic proximity between Northern Europe and Northeast Asia; thus, slot cost reductions can be expected due to smaller voyage distances. However, this comparison is incomplete since the contemporary construction of ultra large container ships (ULCS)[8] does not permit them to transit the NSR. Therefore, to generate a realistic slot cost comparison the largest ice-classed vessel existing today with its capacity of 2,800 TEU must be compared to a standard 14,000 TEU container vessel. Implementing formulae (1) and (2), Table 3 below shows the results of this comparison for a voyage from Hamburg to Tokyo, both inclusive and exclusive of transit fees.

7 For the sake of clarity, the operationalization of some factors is omitted. Further information is available from the author of this chapter.
8 This class designates vessels with a nominal volumetric capacity of 10,000 TEU and above.

Speed (knots)	Slot cost inclusive of transit fees		Slot cost exclusive of transit fees	
	NSR	Suez Canal	NSR	Suez Canal
20	768.34	394.17	476.43	366.70
19	748.09	379.76	456.18	352.30
18	730.90	367.94	438.99	340.47
17	717.32	358.79	425.41	331.32
16	706.23	352.25	414.32	324.78
15	698.77	348.25	406.86	320.78
14	694.34	346.89	402.43	319.43
13	693.64	348.57	401.73	321.11
12	695.22	353.54	403.31	326.07
11	703.18	362.13	411.27	334.67
10	716.56	375.16	424.64	347.69

Table 3: Slot costs (in US$) for the route Hamburg–Tokyo

The direct comparison of slot costs inclusive of transit fees shows that fees for icebreaker support and the transit permit are significantly higher than the fees incurred for a Suez Canal transit. The 2,800 TEU vessel has an optimal travel speed of about 13 knots compared to an optimal 14 knots for the 14,000 TEU container vessel. Both inclusive and exclusive of transit fees, the Suez Canal route is significantly cheaper than the NSR. The disadvantage of the NSR with respect to profitability is due to the limited economies of scale that a 2,800 TEU vessel can realize, implying the business case is even worse for any port south of Tokyo.

However, this raises the question, for which vessel size would the NSR constitute a profitable alternative route? If larger ice-classed vessels were constructed, the results would likely change. Therefore, the model is now extended to consider four hypothetical ice-classed vessels. Table 4 details their possible building parameters. For the sake of comparability, these hypothetical types are contrasted with an existing container vessel type (CV14,000) that corresponds to a standard 14,000 TEU ship traveling from Asia to Europe through the Suez Canal.

Attribute	Vessel HT3,600	HT5,000	HT6,600	HT8,800	CV14,000
Draft (meters)	11.70	13.60	14.00	14.50	16.00
Capacity (TEU)	3,538	5,000	6,612	8,800	14,000
Homogenous capacity (TEU)	2,950	3,600	4,975	7,100	10,640
LOA (meters)	240.39	294.10	305.60	299.95	365.80
Beam (meters)	32.20	32.20	40.00	48.20	51.20
DWT (tons)	42,686	66,700	81,000	110,300	166,000
GT (tons)	40,827	48,400	69,809	95,390	151,963
NT(tons)	24,146	29,000	39,534	56,260	90,033

Table 4: Hypothetical technical parameters of larger ice-classed container vessels. LOA: length overall; DWT: deadweight tonnage; GT: gross tonnage; NT: net tonnage.

The parameters of these hypothetical vessels were chosen such that they correspond to the existing ship designs in the industry. For example, type HT3,600 corresponds to an older generation of Panamax vessels. Type HT5,000 corresponds to a Panamax-Max vessel. This design is one of the largest vessels that can still pass the old locks of the Panama Canal. Type HT6,600 mirrors a second-generation Post-Panamax vessel which due to its beam of 40 meters can no longer pass these locks; yet its homogenous capacity of roughly 5,000 TEU significantly surpasses the capacity of smaller Panamax vessels. Type HT8,800 represents a latest-generation Post-Panamax vessel, which can be deployed since its length is relatively short compared to larger Neo-Panamax vessels. This vessel type is also known as Handy-Neo-Panamax, since its beam just allows it to pass the new Panama Canal locks, which are due to be completed in 2016. Further, the model is extended to consider additional destinations south of Tokyo. Their nautical distances from Hamburg are detailed in Table 5.

Distance to Hamburg	via Suez Canal route	via NSR
Tokyo	11,811	7,102
Busan	11,401	7,380
Shanghai	11,041	7,825
Ningbo	10,969	7,875
Keelung	10,712	8,089
Hong Kong	10,330	8,505

Table 5: Nautical distances from Hamburg to selected East Asian ports. All distances are given in nautical miles (Port World, 2014)

The model now compares the slot costs of the 14,000 TEU container vessel CV14,000 traveling the Suez Canal route with those of the four hypothetical ice-classed vessels, HT3,600, HT5,000, HT6,600, and HT8,800, each of which is traveling the NSR. Travel speed varies between 10 and 20 knots, the port of destination varies, and the port of call in Europe is Hamburg. Results of these calculations per port of destination are presented in Tables 6 through 8.

For the routes Hamburg–Tokyo and Hamburg–Busan, the slot costs of vessel HT8,800 are significantly lower than those of vessel CV14,000, implying that profitable container shipping via the NSR would be possible. Further, the model suggests that any hypothetical ice-classed vessel with a lower capacity than HT8,800 would not operate profitably due to a lack of economies of scale (viz. Exhibits 1 and 2). Thus, any ice-classed vessel with conventional engines would have to have a capacity of at least 8,800 TEU to compete with ships traveling via the Suez Canal.

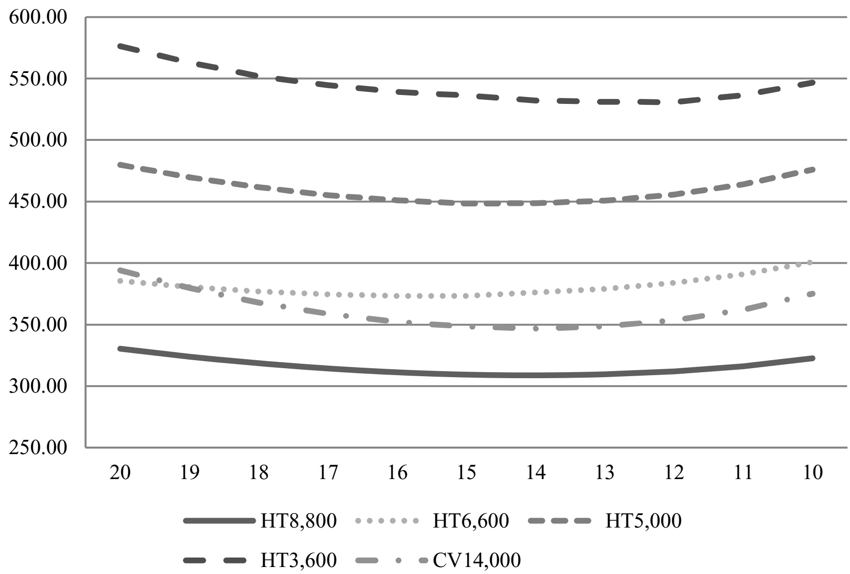

Exhibit 1: Slot costs for the route Hamburg–Tokyo as a function of vessel type and speed

Finally, the break-even point where the slot costs of HT8,800 and CV14,000 are approximately equal is located some nautical miles north of Shanghai implying that given the underlying assumptions of the model, the NSR is only an attractive container shipping route as long as the port of destination is north of Shanghai (viz. Exhibit 3).

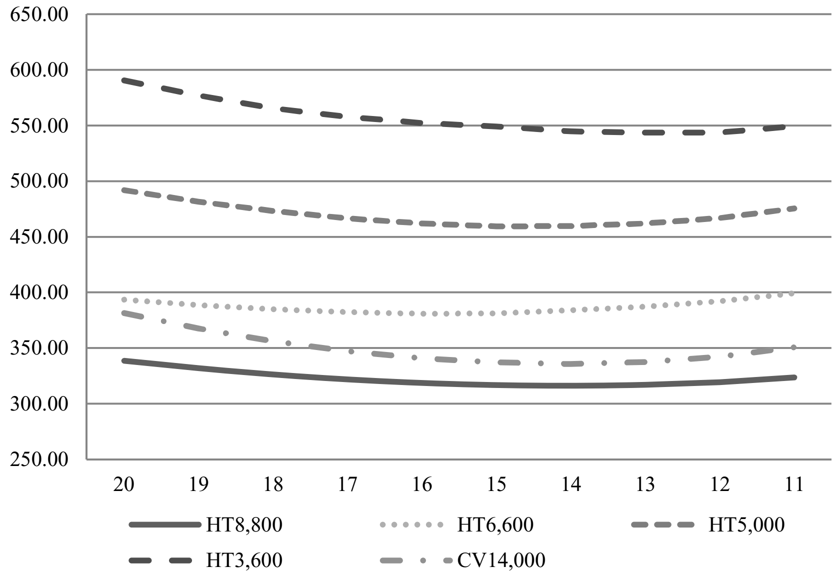

Exhibit 2: Slot costs for the route Hamburg–Busan as function of vessel type and speed

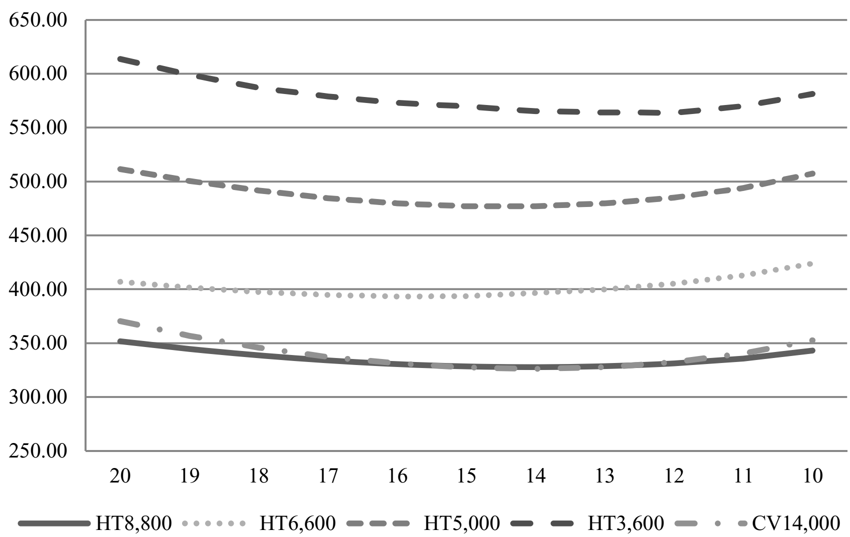

Exhibit 3: Slot costs for the route Hamburg–Shanghai as a function of vessel type and speed

While naval architects should be able to realize a vessel such as HT8,800, the more pressing question is the extent to which it could freely operate in Arctic waters. Presently, ice conditions in the Sannikov Strait limit the maximum draft to between 11 and 14 meters. Thus, they impede the passage of a Post-Panamax vessel such as HT8,800. In theory, two solutions are available by which this bottleneck could be overcome.

First, the deployment of alternative engine configurations or propulsion technology (e.g., burning LNG instead of bunker fuel) might allow shipowners to profitably construct and operate smaller vessels with less draft. This alternative propulsion could cause less pollution to the sensitive Arctic ecosystem; further, the cost efficiency of LNG is significantly greater than that of the conventional heavy fuel oil, intermediate fuel oil, or marine gas oil.

Second, two alternative routes with respective drafts of 20 and 50 meters exist by which ships can bypass the New Siberian Islands on a northerly course (rather than going straight through them by sailing the Sannikov Strait). Yet, the navigability of these alternative routes depends on ice conditions. Since the draft of a ship increases with its size, the more economies of scale a ship owner desires, the more these northerly bypasses of the Sannikov Strait will become attractive.

	Hamburg–Tokyo				
Speed (kn)	HT8,800	HT6,600	HT5,000	HT3,600	CV14,000
20	330.46	385.40	479.74	576.17	394.17
19	324.00	380.59	469.73	562.98	379.76
18	318.63	376.97	461.57	551.95	367.94
17	314.37	374.52	455.27	544.61	358.79
16	311.28	373.20	450.87	539.21	352.25
15	309.41	373.26	448.37	536.13	348.25
14	308.81	376.09	448.56	532.14	346.89
13	309.58	379.06	450.85	531.05	348.57
12	311.83	383.81	455.73	530.86	353.54
11	315.97	390.83	463.94	536.57	362.13
10	322.56	400.80	475.92	546.68	375.16
	Hamburg–Busan				
Speed (kn)	HT8,800	HT6,600	HT5,000	HT3,600	CV14,000
20	338.59	393.63	491.95	590.61	381.44
19	331.88	388.63	481.54	576.91	367.53
18	326.29	384.87	473.06	565.45	356.12
17	321.88	382.32	466.53	557.82	347.28
16	318.66	380.96	461.95	552.20	340.97
15	316.71	381.02	459.35	549.00	337.11
14	316.09	383.96	459.55	544.86	335.81
13	316.89	387.04	461.92	543.72	337.43
12	319.23	391.98	467.00	543.53	342.22
11	323.53	399.27	475.53	549.46	350.52
10	330.38	409.63	487.98	559.96	363.09

Table 6: Slot costs (in US$) for hypothetical ice-classed vessels vis-à-vis a standard 14,000 TEU container vessel (Hamburg–Tokyo and Hamburg–Busan)

	Hamburg–Shanghai				
Speed (kn)	HT8,800	HT6,600	HT5,000	HT3,600	CV14,000
20	351.61	406.80	511.50	613.72	370.26
19	344.49	401.51	500.46	599.19	356.80
18	338.57	397.52	491.47	587.04	345.74
17	333.88	394.81	484.54	578.96	337.19
16	330.48	393.37	479.69	573.00	331.07
15	328.41	393.43	476.93	569.61	327.33
14	327.75	396.55	477.15	565.21	326.07
13	328.60	399.82	479.66	564.01	327.64
12	331.08	405.05	485.04	563.80	332.28
11	335.64	412.79	494.08	570.09	340.31
10	342.91	423.77	507.29	581.23	352.49
	Hamburg–Ningbo				
Speed (kn)	HT8,800	HT6,600	HT5,000	HT3,600	CV14,000
20	353.07	408.28	513.69	616.32	368.02
19	345.91	402.95	502.59	601.70	354.65
18	339.95	398.94	493.54	589.47	343.66
17	335.23	396.22	486.56	581.33	335.17
16	331.81	394.76	481.68	575.34	329.09
15	329.73	394.83	478.91	571.92	325.38
14	329.06	397.97	479.12	567.50	324.12
13	329.92	401.26	481.65	566.29	325.68
12	332.41	406.52	487.07	566.08	330.29
11	337.00	414.31	496.17	572.41	338.27
10	344.31	425.36	509.45	583.62	350.37

Table 7: Slot costs (in US$) for hypothetical ice-classed vessels vis-à-vis a standard 14,000 TEU container vessel (Hamburg–Shanghai and Hamburg–Ningbo)

	Hamburg–Keelung				
Speed (kn)	HT8,800	HT6,600	HT5,000	HT3,600	CV14,000
20	359.33	414.62	523.09	627.43	360.04
19	351.97	409.14	511.69	612.42	346.98
18	345.85	405.02	502.39	599.86	336.26
17	341.01	402.22	495.23	591.50	327.96
16	337.49	400.73	490.21	585.34	322.03
15	335.35	400.80	487.36	581.83	318.40
14	334.67	404.02	487.58	577.29	317.17
13	335.55	407.40	490.18	576.04	318.69
12	338.11	412.81	495.75	575.83	323.19
11	342.83	420.81	505.09	582.33	330.99
10	350.34	432.16	518.74	593.84	342.80
	Hamburg–Hong Kong				
Speed (kn)	HT8,800	HT6,600	HT5,000	HT3,600	CV14,000
20	371.50	426.93	541.36	649.04	348.18
19	363.76	421.18	529.37	633.25	335.59
18	357.33	416.84	519.60	620.05	325.24
17	352.24	413.90	512.07	611.26	317.24
16	348.53	412.33	506.79	604.78	311.52
15	346.29	412.40	503.80	601.09	308.02
14	345.57	415.79	504.03	596.32	306.84
13	346.49	419.35	506.76	595.01	308.31
12	349.19	425.03	512.61	594.79	312.65
11	354.15	433.44	522.44	601.62	320.17
10	362.04	445.38	536.79	613.73	331.56

Table 8: Slot costs (in US$) for hypothetical ice-classed vessels vis-à-vis a standard 14,000 TEU container vessel (Hamburg–Keelung and Hamburg–Hong Kong)

Conclusion

Given the analyses presented here, how likely is it that ship finance and charterers can be found who would be willing to finance new building orders for vessels that can operate in the NSR, such as the HT8,800 type? Till date, with very few exceptions, container shipping on the NSR barely exists.[9]
However, liner operators are closely watching the development of the NSR, seeking out new ways of reducing cost since the potential to further realize economies of scale by up-sizing container vessels is about to approach its physical boundaries.[10]

Economies of scale are still the main factor for the decision of whether or not to finance and build a ship. In summer 2014, the average nominal capacity of all container vessels traveling between Asia and Northern Europe was about 11,300 TEU. Since the completion of about 90 container vessels with a nominal capacity of between 13,000 and 19,000 TEU each is expected by the end of 2017 (Alphaliner, 2014), this average capacity will increase to about 14,000 TEU. Moreover, the Suez Canal route allows liner operators to call at ports in the Mediterranean Sea and the Indian Ocean, thus increasing capacity utilization vis-à-vis the NSR. Overcoming such economies of scale by shipping on the NSR, given the current inventory of ice-classed container vessels will be a virtually impossible challenge. Nevertheless, the shortening of the Hamburg–Tokyo sea route by 4,700 nautical miles holds a potential for cost reduction that should be considered not only from an entrepreneurial perspective but also with regard to its significance for the economy of Northern European and Northern Asian states as a whole.

Till date, the general framework of the NSR is still too unstable to establish a regular scheduled liner service. These instabilities regard both the timing and prediction of the Arctic summer in general and the minimum extension of sea ice in particular, the shortness of the window during which the NSR is free of ice, ecological and safety aspects, and the nautical difficulties of operating in ice-infested waters. The prospect of regular scheduled services between Northern Europe and Asian ports north of Shanghai will only be feasible if the NSR will be free of ice for longer periods of time. Rising temperatures could allow larger vessels to seek more northerly routes to circumvent shallow waters such as the Sannikov Strait, thus neutralizing their restrictions regarding maximum draft. On the other hand, such northerly headings exacerbate the known navigational challenges.

9 In August 2013, the MV *COSCO Yong Sheng* traveled from Dalian to Rotterdam, completing one of the first ever known transits through the NSR by a container vessel. Since the vessel is a non-cellular (multipurpose) box ship, it is accounted for as a general cargo vessel in Table 2.
10 At the end of 2014, the two biggest container vessels in the world had a capacity of 18,980 TEU. By 2016, the biggest vessels will have a nominal capacity of over 19,000 TEU. While demand for vessels with a capacity exceeding 20,000 TEU exists, technological challenges and significant limitations regarding port infrastructures and canal sizes remain (Probst and Bergmann, 2014).

Presently, despite the temporary melting of drifting ice during the Arctic summer, ships traveling in the NSR should be built at least according to ice-classed standard C1 and ideally to standard A1 to guarantee safe operations.[11]

Finally, ship financers will want to assess the extent to which a vessel specifically designed for the NSR will be able to operate elsewhere. The commercial viability of a particular ship is not only assessed with respect to its current charter party contract but also regarding the risk of not finding a replacement charter once the original contract expires. If vessels are built according to the requirements of a niche route, it may be difficult to identify alternative charter options for routes elsewhere in the world. As a result, the asset specificity of ice-classed vessels built for operation in the NSR can be expected to be relatively high.

This consideration highlights the importance of expectations about both the stability of the NSR's political and general economic framework and the nautical implications of climate change for profitability calculations in ship finance.

11 A1 denominates the Swedish ice class for ice thickness up to 0.8 meters. This class approximately corresponds to the Russian Arc 4 and the German E3 ice classes. C1 is the Swedish ice class for ice thickness up to a maximum of 0.4 meters and corresponds to the Russian Ice 1 and the German E1 ice classes.

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Go west: The insignificance of eastbound shipping for Russia's extractive industry

Marcus Matthias Keupp, Ramon Schöb

To date, most maritime traffic on the Northern Sea Route (NSR) carried bulk goods and commodities (Mietzner, 2015 – this book), and the Russian extractive industry is a major producer of bulk traffic. Hence, future commodity exports (mineral ores, oil, and gas) from the Russian Arctic may increase traffic and transport volume on the NSR. In this chapter, we analyze the extent to which (if any) this may be the case, stratifying documented traffic by route and destination. Finally, we assess probable future developments.

We define the Russian Arctic as those landmasses north of the Arctic Circle between the Russian-Norwegian land border and Cape Dezhnev that are under undisputed Russian sovereignty, inclusive of that share of the Arctic Ocean, which is firmly located within Russia's exclusive economic zone as it was internationally acknowledged at the end of 2014.[1] Our analysis restricts to traffic generated by the extractive industry in the Russian Arctic, whereas the analysis of other sources of traffic on the NSR, such as the Norwegian extractive industry or transit traffic from central Europe to Far East and vice versa, is beyond the scope of this chapter. Second, we focus on mineral ore, oil, and gas operations, since their impact on NSR traffic by far exceeds that of the timber, fishing, and agriculture industries in the Russian Arctic.

Commodities in the Russian Arctic

The economic performance of the Russian Arctic is inextricably linked to the extracting and shipping of mineral ores, oil, and gas.[2] According to the plans for the development of Russia's northern territories, by 2016 to 2020, the Russian Arctic is to become Russia's 'leading strategic resource base' (Konyshev and Sergonin, 2012). Compared to the other countries bordering the Arctic Ocean, Russia has undoubtedly the biggest and the most developed mining industry north of the Arctic Circle. The Russian Arctic is the world's primary producer of palladium, platinum, apatite, cobalt, and nickel (Konyshev and Sergonin 2012; Le Mière and Mazo, 2013). The Khibiny complex in the middle of the Kola Peninsula con-

1 Throughout this book, the term *Russian Arctic* is used with a strictly geographical understanding, and no political connotations or territorial claims whatsoever should be inferred from our use of this term.
2 Sale of oil and gas resources contribute approx. 52% to the gross regional product of the Russian Arctic, whereas mining (7.7%), mineral extraction (4%), and combined timber, fishing, and agriculture (3.3%) are of lesser importance. The residue to 100% is contributed by education, administration, water supply, and other services (Glomsrød et al., 2009). As a whole, the Russian Arctic currently provides about 11% of Russia's national income (Konyshev and Sergonin, 2012).

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tains the world's biggest magmatic phosphate reserve (Elsner et al., 2014). Detailed information on all metals and mining operations in the Russian Arctic is available in Urazova and Buchholz (2012). The Kola Peninsula is the most important mining region in the Russian Arctic. Over 700 different minerals have been found there (Østreng et al., 2013); gold, titanium, copper, and iron are mined. The second most important mining site is the Norilsk region where nickel, palladium, platinum, gold, silver, and copper are mined. The Norilsk region alone accounts for 90% of Russia's platinum supply. The firm Norilsk Nickel, by its mining facility Polar Division, covers 40% of global platinum production and is a significant contributor to the global copper and nickel supply. While East Siberia is relatively underdeveloped and underexplored compared to these two regions, gemstones, gold, and coal are all mined; in 2012, nearly 14% of the total Russian coal production came from East Siberia (EIA, 2013; Elsner et al., 2014; Seidler, 2009; Urazova and Buchholz, 2012).

While estimates concerning oil and gas reserves in the Russian Arctic vary among authors and government agencies, it seems safe to say that they constitute the world's largest energy reserve outside the OPEC countries (Blunden, 2012). Exhibit 1 compares the size and location of the known basins in the Russian Arctic with those of Russia's Arctic neighbors. Compared to other Arctic regions, oil and gas production in the Russian Arctic is highly developed. When measured by the total number of large fields, the Russian Arctic is undoubtedly the top oil and gas producing region north of the Arctic Circle (Bambulyak and Frantzen, 2011; Harsem et al., 2011). About 80% of all oil and 99% of all gas produced north of the Arctic Circle originates from the Russian Arctic (Le Mière and Mazo, 2013). East Siberia has become the center of production growth for Rosneft. The start-up of the Vankorskoye (Vankor) oil and gas field in August 2009 has dramatically increased production in the region and has been a significant contributor to Russia's increase in oil production since 2010. Vankor, located north of the Arctic Circle, was the largest oil discovery in Russia in nearly three decades. The gas industry in the Russian Arctic is dominated by the fields of the Yamalo-Nenets Region; this region alone accounted for 83% of all gas produced in 2012. Further, drilling and shipping infrastructure for oil production exists along the Timan-Pechoran oil and gas basin. Its fields are relatively small in comparison, but the region exports oil via Arctic ports such as the Varandey terminal (EIA, 2013).

Overall, the highly developed sites of the excavating industry in the Russian Arctic are firmly located along the western sectors of the NSR; they encompass regions that stretch approximately from Murmansk to Dudinka. By comparison, few developed sites operate east of Dudinka, despite the significant potential that the East Siberian regions may hold. Exhibits 2 and 3 illustrate these imbalances between the eastern and the western hemisphere of the Russian Arctic with respect to population density, economic activity, transportation routes, and pipeline infrastructure.

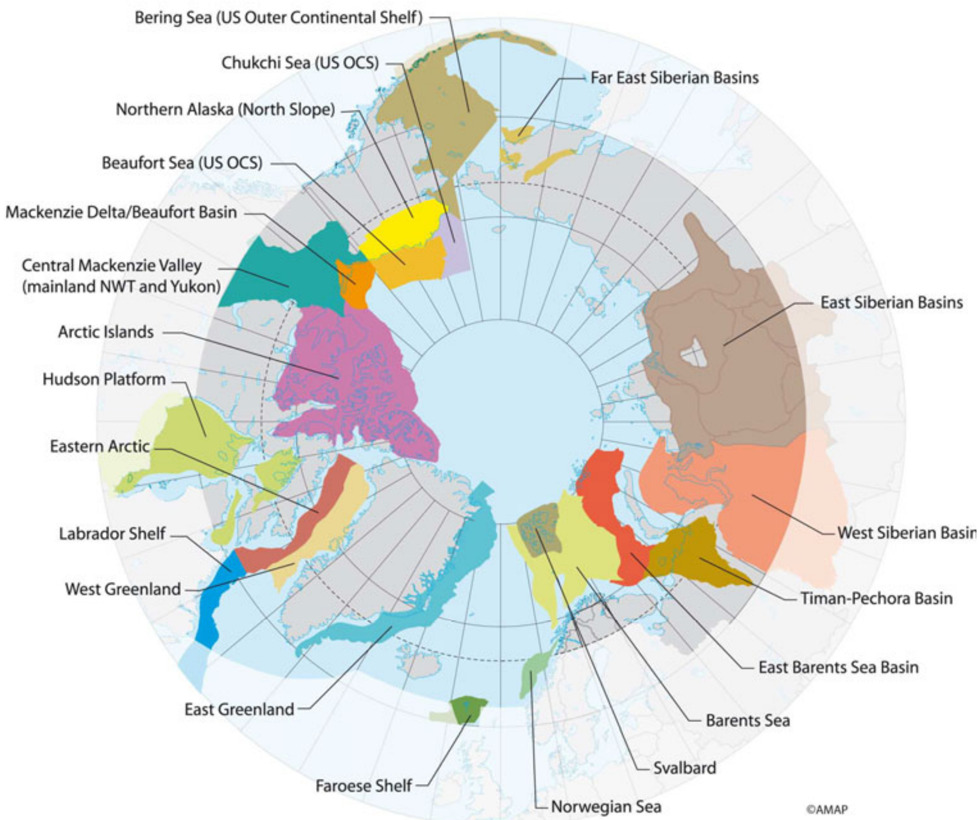

Exhibit 1: Major oil and gas provinces and basins around the Arctic (Bellamy, 2010)

Exhibit 2: Towns and industrial activities in the Arctic (Pravettoni, 2012)

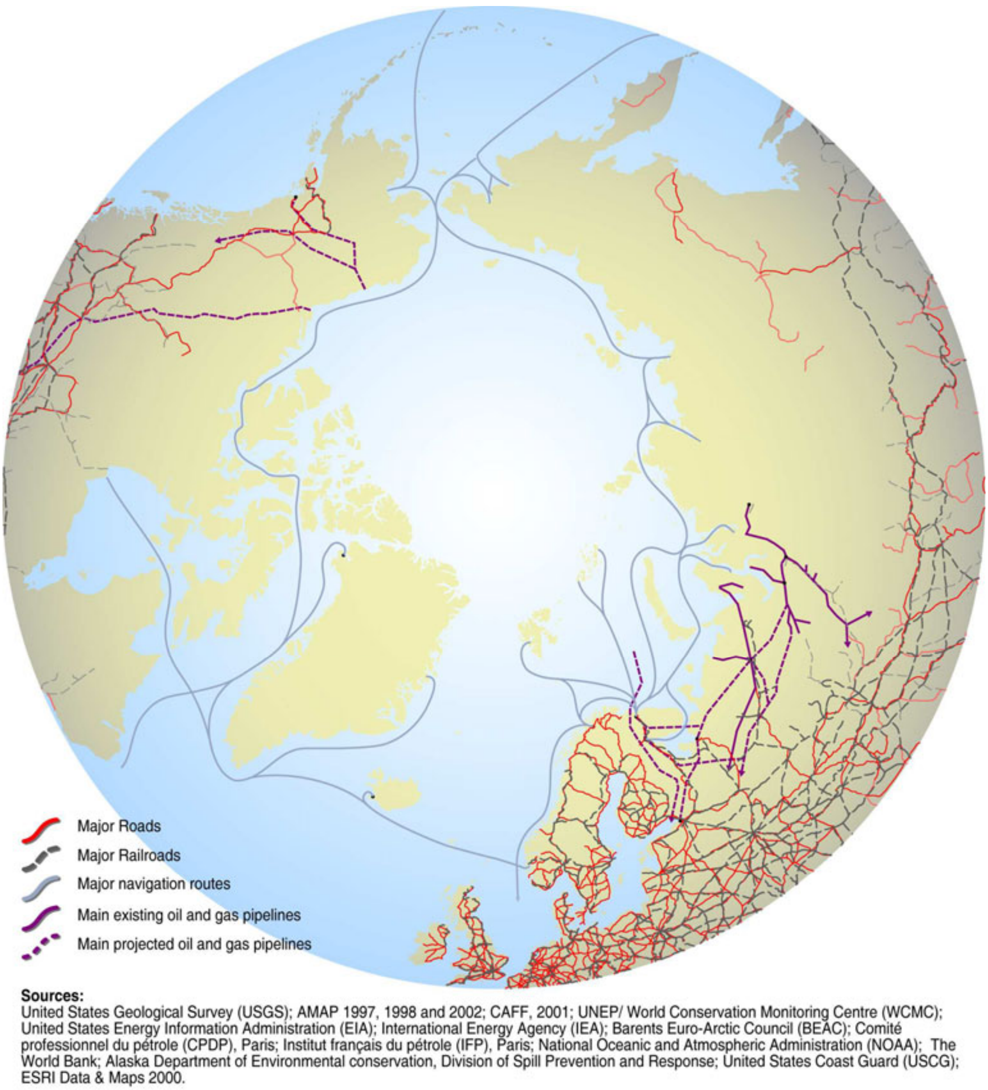

Exhibit 3: Transportation routes and pipeline infrastructure in the Russian Arctic (Ahlenius, 2012)

Logistics and shipping infrastructure for seaborne commodity export

There are 17 ports in the Russian Arctic, of which eight are located in the Pechora, White, and Barents Sea; five in the Kara Sea and the Ob Bay; and only three between the Laptev Sea and the Bering Strait. Those ports with the highest cargo turnover and year-round ice-free conditions are located in the Barents and White Sea (Northern Sea Route Information Office, 2014a). See Exhibit 4 below for a detailed map of these regions.

Minerals and ores mined in the Kola Peninsula are shipped by the port of Murmansk, which is not only the largest port in the region but also the transport hub for all shipping on the Russian Arctic. Estimates for coal exports by the port of Murmansk range between 11 and 27 million tons (Østreng et al., 2013; Staalesen, 2013a). Mineral exports from the Norilsk region concentrate on the port of Dudinka; this port is also Norilsk Nickel's main hub for both west- and eastbound shipping. In comparison, the ports of Igarka and Dikson are small and merely used for supplying the local population (Northern Sea Route Information Office, 2014a). The ports of the East Siberian region (Tiksi, Pevek, and Provideniya) handle supplies for the local population but lack any developed infrastructure for large-scale commodity shipping. While the Yamalo-Nenets region borders the Kara Sea, there is no infrastructure that would allow ships to load and transport any significant volume of oil or gas products. Plans to build an oil export terminal in Dikson were shredded in 2006; instead, an onshore pipeline was built (EIA, 2013; Østreng et al., 2013; AMAP, 2010). By today, with the exception of a single oil delivery from the Novy Port field in February 2015, no remarkable export of oil or gas from the West Siberian basin by the Kara Sea has been recorded. Further, it is interesting to note that as of 2014, there is no liquefied natural gas (LNG) platform in the Russian Arctic. The only existing Russian LNG platform is Sakhalin Energy's LNG plant in Far East Russia; however, it is located firmly south of the Arctic Circle and concentrates on direct regional trade with nations in northeast Asia.

Today, only three noteworthy facilities for seaborne commodity export exist in the Russian Arctic: Norilsk Nickel's *Polar Division* operation, the *Varandey oil terminal*, and the *Prirazlomnaya oil platform*.[3] These are located close to or inside the maritime sectors of the NSR and generate year-round maritime traffic in the Arctic Ocean.

First, Polar Division uses the port of Dudinka for year-round seaborne export of mineral ores and oil by five ice-classed vessels and one ice-breaking tanker, all commissioned in 2006. These vessels only require icebreaker assistance when any sea ice is thicker than 1.5 meters. According to company estimates, their vessels reduce transportation costs per ton of cargo by 60%. Theoretically, these vessels could ship mineral ores directly to any European or Asian customer.

3 A project that announced the opening of an export terminal in Indiga (AMAP, 2010) has not been realized to date; as of 2014, it seems unlikely that this project will be realized in the foreseeable future.

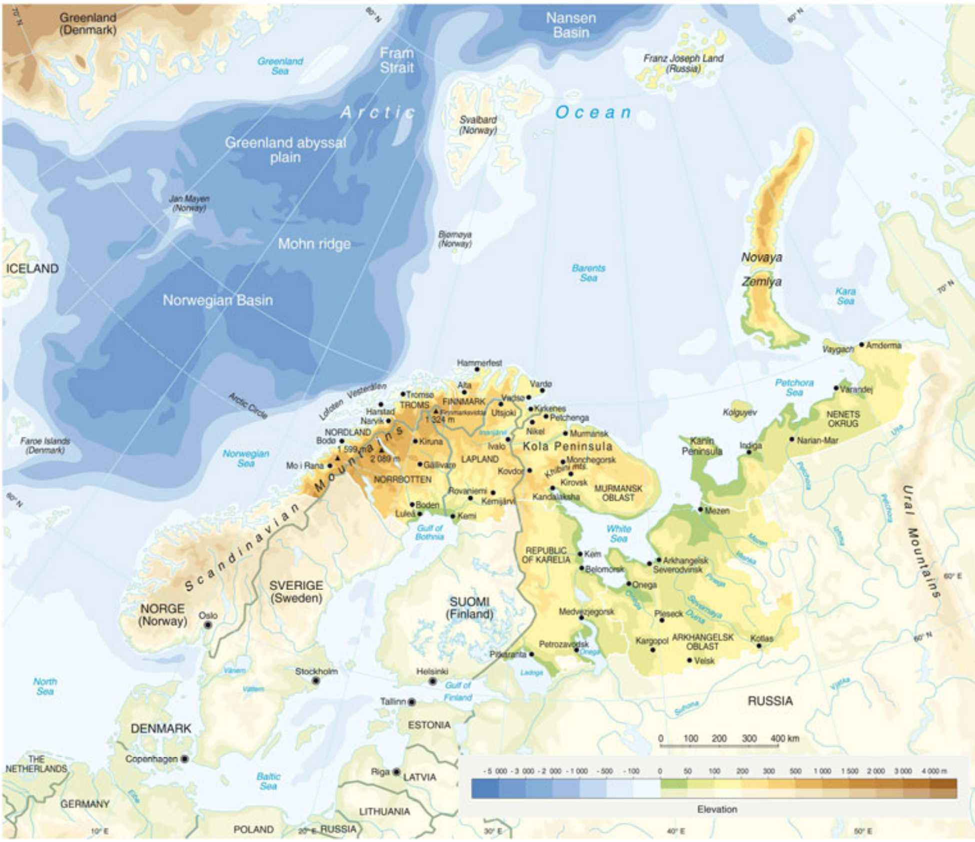

Exhibit 4: The Barents, Pechora, and Kara seas (Rekacewicz, 2012)

Second, the Varandey oil terminal is located 22 kilometers offshore in the southern Pechora Sea. Operated by Lukoil, it opened in 2008 with a capacity of 12 million tons of oil per year (Staalesen, 2013b). However, the actual export volumes are much lower—latest data recorded 5.4 million tons shipped in 2013. The terminal receives oil from the Yuzhno-Khilchuyu oil field. The drilled oil is transported via a pipeline into a costal crude storage; from there it is transported by a 22.6 km long underwater pipeline to the terminal which has a height of 64 meters and a sea depth of 17.3 meters. Three ice-classed shuttle tankers with a capacity of 70,000 DWT then transport the oil to a floating reservoir near Murmansk where it is reloaded into long distance tankers and delivered westward to international markets (Lukoil, 2013, 2014a, 2014b; Sovcomflot, 2014).

Third, the Prirazlomnaya oil platform, owned and operated by Gazprom Neft, a subsidiary of Gazprom, is located 60 km offshore in the Pechora Sea and started production in December 2013. Being the first operative offshore installation in the Russian Arctic, it directly drills oil from the Prirazlomnoye field in the continental shelf. Estimates project that this field holds 72 million tons of oil reserves. An annual production of 6.6 million tons is planned, and the platform is intended to tap several other fields in the region (Gazprom, 2014; Sovcomflot, 2014). The logistics concept is similar to that of the Varandey terminal. Two 70,000 DWT ice-classed shuttle tankers load the oil and transport it to for further transshipment into the Barents Sea. There, the oil is reloaded onto line tankers exported to the international markets. In theory, it would be possible to export oil eastwards over the NSR from this terminal (Bambulyak and Frantzen, 2011).

Implications for eastbound traffic and transport volume on the NSR

As a result, the logistics concept of existing infrastructures in the Russian Arctic for seaborne export of oil, gas, and mineral ores emphasizes *westbound* transport towards Murmansk for further processing and handling. In comparison, eastbound transport towards North East Asian destinations is negligible to date. To assess the extent to which this effect influences traffic frequencies and transport volume on the NSR, we analyzed the data collected by the Northern Sea Route Administration (Northern Sea Route Information Office, 2014b) and the shipping operations of Norilsk Nickel's *Polar Division*. The latter data show that their mineral exports from the Russian Arctic, with very few exemptions, go westbound (see Table 1).

In this table, *intra-Russian shipments* designate trilateral voyages between the ports of Dudinka, Murmansk, and Arkhangelsk (MMC Norilsk Nickel, 2012). In every year shown in the table, combined transport volume to Europe and Asia totaled roughly 1.1 million tons per year.

Year	Intra-Russian shipments	Directly to Europe[b]	Directly to Asia[b]	Total
2013	47	11	0	58
2012	56	4	0	60
2011	48	5	1	54
2010	41	12	1	54

Table 1: Shipping statistics of Norilsk Nickel's Polar Division (authors' calculation based on data from MMC Norilsk Nickel 2010, 2011, 2012a, 2013)

These data correspond to the transit statistics of voyages through the NSR collected by the Northern Sea Route Administration. No eastbound export of minerals was recorded from the port of Dudinka in 2012 and 2013, and in 2011, a single ship delivered copper and nickel from that harbor eastbound to China. To date, Murmansk is the only Russian Arctic port that regularly exports mineral products over the NSR, however, the volume is minuscule in comparison with westbound exports. In each year from 2011 to 2013, only three ships departed Murmansk eastbound to deliver mineral ores to Asia via the NSR (Northern Sea Route Information Office, 2014b). No international export of minerals from any East Siberian port has been recorded to date; traffic on these sectors of the NSR is regional only. While ships from Murmansk and Arkhangelsk bound towards these ports deliver general cargo and diesel fuel supply, ships coming from these ports are mostly laden with ballast or on a positioning voyage. In 2014, local oil exports from Pevek seemed to pick up, with six crude oil and oil products tankers leaving the port of Pevek westbound with a heading to Cape Zhelaniya. Further, the 2014 transit statistics show a total of seven voyages that crossed the NSR with an eastbound heading, all exiting the NSR at Cape Dezhnev, suggesting that eastbound export is at low levels.[4]

The situation is similar with respect to the export of oil and gas products (i.e., naphtha, heavy oil, and gas condensate). According to the official transit statistics of the NSR, no eastbound maritime export of oil or gas products has *ever* taken place from either the Varandey terminal or the Prirazlomnaya platform to date. Given the strong similarities between the logistical concepts of the Varandey and the Prirazlomnaya installations, it is very likely that their future exports will travel westbound.

4 The comparability of the 2014 transit statistics to earlier editions is somewhat limited since harbors of origin and destination are no longer given in the 2014 statistics; neither is the transport volume per voyage.

Between 2011 and 2013, only the ports of Murmansk, Vitino, and Ust Luga exported oil and gas products eastbound over the NSR between 2011 and 2013. Table 2 further details these voyages. Finally, probably due to its remote location in the Sea of Okhotsk, Sakhalin Energy's LNG platform has not influenced NSR traffic to date.

Departure port	2011	2012	2013
Murmansk	0	9	3
Vitino	8	0	0
Ust Luga	0	0	2

Table 2: Origin and number of eastbound exports of oil and gas products via the NSR (Authors' calculation using data from Northern Sea Route Information Office, 2014b).

Overall, direct eastbound exports of mineral ores as well as oil and gas products via the NSR to destinations in Asia are minuscule in comparison with westbound exports. Although 2012 was the year with the highest eastbound commodity export volume so far on the NSR—a total of twelve voyages carrying a total transport volume of roughly 0.726 million tons of oil and gas products and mineral ores combined—this volume has to be seen from the fact that between 15 and 30 tankers are leaving the Russian Arctic every *month* on a westbound journey. In 2011 alone, this volume corresponded to a total of 274 ships carrying 11 million tons of oil (Nilsen, 2012).

New traffic induced by current oil and gas drilling projects in the Russian Arctic

Future traffic on the NSR might increase with more intensive exploitation of known mineral deposits. Norilsk Nickel estimates the respective proved and probable resources at 157 million tons (Kola MMC operation) and 715 million tons (Polar Division). Transports would likely increase in number and volume as this potential is commercialized; however, the majority of this future traffic will likely be westbound. Future traffic may also increase with the development of discovered (but not yet mined) mineral deposits. Particularly, a novel site with a high concentration of rare earth metals has been discovered in the Tomtor region in East Siberia, above the Arctic Circle and close to the waters of the NSR (Kryukov, 2014). The reserves of these deposits are estimated to amount to 154 million tons. This makes Tomtor the world's largest rare earth metals deposit (Elsner et al., 2014). Rostec plans to develop a complete production cycle to exploit this potential; an estimated 145 billion roubles will be required to finance the project (Rostec, 2014). As of 2014, little detailed information was available about the intended project. Yet, given the closeness of the Tomtor region to the waters of the NSR, and given that many Asian nations—particularly Japan—desire to reduce their unilateral dependency from rare earth metals imports from China, a direct eastbound delivery from Eastern Siberia to North East Asia seems attractive (Kryukov, 2014). In comparison, the potential for future traffic on the NSR induced by (yet highly speculative) technology such as ocean floor mining in Arctic waters, or the serendipitous discovery of new sites, seems relatively limited.

Future traffic on the NSR may also be generated from the substitution of pipeline by seaborne transports of oil and gas drilled in the Russian Arctic, and from the development of known onshore and offshore fields close to the waters of the NSR. Seaborne export of oil and gas from the Russian Arctic is advantageous compared to pipeline transports because commodities can be sold globally, increasing profit margins vis-à-vis regional sales; further, the quality of pipelines in Russia is questionable, and new infrastructure is likely to be costly since melting permafrost soils make the ground unstable. Two pipeline projects that intended to transport oil from the West Siberian and the Timan-Pechora basin towards the ports of Murmansk and Indiga have not been realized so far; on the other hand, the Russian railway system today is in a much better position to transport oil products to the ports of the Barents and the White Seas. Finally, according to the Federal Agency of Sea and River Transports of Russia, the capacity of Russian seaports should nearly double between 2010 and 2030 (Bambulyak and Frantzen, 2011; AMAP, 2010). As a result, the realization of these projects would increase the number of land-based transports to the ports in the White and Barents Seas. Given the logistics and port infrastructures we discussed above, the majority of this additional traffic will likely go westbound.

The development of known oil and gas fields in the Russian Arctic has made progress. Particularly, two large projects may increase future traffic on the NSR. First, the south Tambeyskoye field was discovered in 1974 and contains 492 billion cubic meters of proved natural gas and 14 million metric tons of proved liquid hydrocarbon reserves. The production potential of the field exceeds 27 billion cubic meters of natural gas per annum and it is planned to ship the gas towards international markets using LNG tankers. The shipment will take place from the seaport of Sabetta, where 16 LNG tankers with ice class Arc-7 should enable year-round LNG transports. The first of these tankers was ordered from Daewoo Shipbuilding & Marine Engineering in 2013. China National Petroleum Corporation (CNPC) has a 20% stake in the project; the commercial launch is planned for 2017 (Novatek, 2014a). Exports from this field will be westbound since long-term delivery contracts have been concluded with Gas Natural Fenosa, Spain's largest provider of gas and electricity. However, eastbound export may also be expected in the future since a contract concluded with CNPC on May 20, 2014, provides CNPC with an annual delivery of three million tons of LNG. Technically speaking, LNG shipments could head either eastbound or westbound; however, the current logistics concept plans to direct these to the Fluxys LNG terminal in Zeebrugge (Belgium), which will be used as a transshipment port to reach any Asian-Pacific buyers (Novatek, 2014b). It is planned that every 38 hours a tanker will load LNG at the Yamal LNG terminal. This project will make the port of Sabetta one of the busiest in the Far North (Total, 2014), and to date, the Russian government has invested over 1.3 billion Euro to construct the port of Sabetta (Pettersen, 2014). While traffic from this port will primarily be westbound in the near future, the ice class of the newly constructed LNG tankers would allow them to deliver their LNG eastbound at any time of the year.

Second, the Novy Port oil and gas condensate field located in the southeast of the Yamal Peninsula is currently developed by Gazprom's subsidiary *Gazprom Neft*. From the onshore field, the crude oil is being transported via a 103-kilometer pipeline (annual capacity of 600,000 tons of oil) to a terminal near Cape Kameny where the oil is loaded on ships. This terminal is located 400 kilometers to the south of Sabetta; to date it is still under construction, and completion is expected in 2015. Exports from the terminal will probably also be dominated by westbound transport since the first three shipments made in 2014 went directly to Europe (Gazprom Neft, 2013, 2014).

Finally, maritime traffic in the waters of the NSR may increase as the development of offshore reserves located in and below the continental shelf intensifies. However, despite the discovery of the enormous Shtokman oil and gas field in the Barents Sea[5] and the equally large Rusanovskaya and Leningradskaya fields in the Kara Sea, the degree of development of the Russian Continental Shelf is very low, and drilling in its eastern part is almost absent (AMAP, 2010). Further, the majority of all known sites with large oil and gas reserves as detailed in the US Geological Servey (USGS, 2008) are located in the western regions of the Russian Arctic. Thus, traffic emerging as a result of the exploration of these sites will likely be westbound.

Conclusion

Our analysis shows that both existing production as well as the intended development of mineral sites, oil fields, and gas deposits in the Russian Arctic will primarily induce westbound traffic, while direct delivery of any commodities from these sites to northeast Asia is relatively unlikely due to the lack of infrastructure and logistics support for basically the complete region east of Dudinka. Further, ice conditions are much harsher in these sectors, compared to the Barents and Pechora seas. As a result, westbound passages through these seas are possible even in winter, whereas eastbound voyages are not yet economically viable except for the short timespan between July and September (though this imbalance may be reduced as climate change continues).

Unless such infrastructure will be developed, the NSR, at least as far as commodity exports from the Russian Arctic are concerned, will not constitute a commodity highway to northeast Asia, but a regional sea route through the Barents and Kara Sea whose traffic is almost exclusively westbound. In fact, it is quite ironic that although Russia possesses the required icebreaker technologies and ice-classed bulk, oil and LNG carriers that would enable eastbound shipping, and despite significant demand for oil, gas, and minerals exists in northeast Asia, almost all traffic from existing and developing sites is westbound, heading for the terminals of Murmansk and thence to those of northern Europe. It is important to note that this structural effect is independent of oil price movements. The massive fluctuations in the prices for Brent and WTI crude oil that began in 2008 and continue throughout today did not significantly influence eastbound shipping; on the contrary, both the transport

5 The development of which, as of 2013, had still not begun (EIA, 2013).

volume and the number of voyages remained constant at very low levels. Thus, the lack of eastbound shipping seems primarily a structural problem rather than one that could be mitigated by higher oil prices or lower production cost.

Any realistic option to deliver minerals, oil, and gas directly to northeast Asia would require intensive development of shipping and port infrastructure in the regions east of Dudinka, and particularly so in east Siberia. Given Russia's inability to access international financial markets in the wake of the sanctions imposed during the Ukraine crisis of 2014, funds for investment would have to be provided from either Russian state-controlled energy companies, the Russian state itself, or foreign direct investment. All three options seem relatively unlikely at the moment given the high investment risk, Russia's inability to access international financial markets for refunding debt, and a history of foreign equity holders being squeezed out of Western-Russian joint ventures by state-controlled companies.

Once the economic sanctions are lifted, Russia may reconsider such investments as a long-term project for the future. Such investments will probably imply high opportunity costs since land-based transport of oil and gas by pipelines to China may be a viable alternative to eastbound shipping via the NSR. In May 2014, Russia and China signed a US$400 billion deal for a delivery of 38 billion cubic meters of natural gas over the next 30 years; transport is to be done by a (yet to be constructed) 2,000 kilometer pipeline from east Siberia to the Chinese border. Given its current economic situation, Russia will probably not be able to raise enough capital to finance both the maintenance and extension of its pipeline network *and* the development of port and logistics infrastructure in east Siberia. This implies that for the time to come, eastbound transport of minerals, oil, and gas from the Russian Arctic via the NSR will remain a rather exotic exemption compared to westbound transport.

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